Tana Monitoring and Research Group

# Status of the Tana/Teno River salmon populations in 2019

**Report from the Tana Monitoring and Research Group** 1/2019

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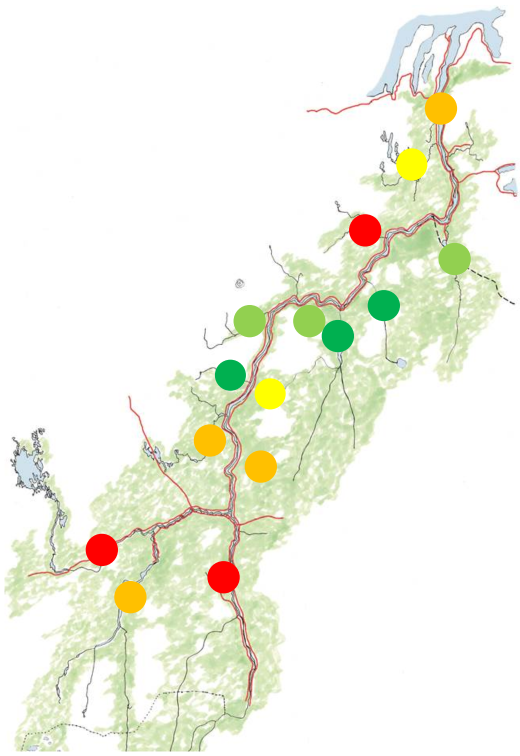
# Summary

Anon. 2019. Status of the Tana/Teno River salmon populations in 2019. Report from the Tana Monitoring and Research Group nr 1/2019.

This report is the third status assessment of the re-established Tana Monitoring and Research Group (MRG) after the new agreement between Norway and Finland. After a summary of salmon monitoring time series in Tana/Teno, we present an updated status assessment of 15 stocks/areas of the Tana/Teno river system. All stocks are evaluated in terms of a management target defined as a 75 % probability that the spawning target has been met over the last four years. A scale of four years has been chosen to dampen the effect of annual variation on the status.

The map below summarizes the 2016-2019 stock status of the evaluated parts of the Tana/Teno river system. Symbol colour designates stock status over the last four years, 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)



Stock status over the last four years (2016-2019) was poor (probability of reaching management target <40 %) in 7 of the 15 stocks that we evaluated. The best status was found in Veahčajohka/Vetsijoki, Ohcejohka/Utsjoki and Báišjohka.

Of the stocks with poor status, the most important thing to note is the status of the upper main headwater areas of Kárášjohka, Iešjohka and Anárjohka/Inarijoki and of the Tana/Teno main stem.

These areas had low target attainment and low exploitable surplus. These four areas constitute 84 % of the total Tana/Teno spawning target and over the last four years, these areas together have lacked an average of 30 000 kg female spawners to reach their combined management targets.

One of the evaluated tributaries, Lákšjohka, was placed in the poorest stock status category due to three years of no exploitable surplus. Over the last four years, there were no exploitable surplus in 2017-2019 and all the coastal, main stem and tributary catch in these three years represent overexploitation of these two stocks. Of the other evaluated stocks, Anárjohka/Inarijoki and Iešjohka had no exploitable surplus in 2018 and 2019, and both were therefore now placed in the red category for the first time. Overexploitation was identified as a significant problem for the Kárášjohka, Iešjohka, Anárjohka/Inarijoki and Tana/Teno main stem areas.

Sonar counts from the Tana/Teno main stem in 2018 and 2019 give direct estimates of total run size and improve the estimated exploitation rates for both the Tana/Teno mainstem and the tributaries. Salmon ascending to the Iešjohka were counted using sonar for the first time in 2018.

Overall, a major result of the present status report is that the exploitation estimates show decreasing exploitation for all individual salmon stocks in the mixed-stock fishery in the Tana/Teno mainstem following the newly implemented agreement between Norway and Finland. The reduced exploitation rates for all stocks in need of recovery are sufficiently high to allow for recovery over two generations.

The table below summarizes the stock-specific management targets and status numbers for 2019 and previous four years, and the probability for reaching the spawning target over the previous 4 years (=the management target).

| | **2019 target attainment** | **2019 probability** | **4-year target attainment** | **Management target** |
|---|---|---|---|---|
| Tana/Teno MS | 61 % | 1 % | 60 % | 1 % |
| Máskejohka | 82 % | 11 % | 112 % | 70 % |
| Buolbmátjohka/Pulmankijoki | 155 % | 98 % | 123 % | 80 % |
| Lákšjohka | 29 % | 0 % | 48 % | 0 % |
| Veahčajohka/Vetsijoki | 155 % | 98 % | 161 % | 99 % |
| Ohcejohka/Utsjoki (+tributaries) | 79 % | 8 % | 170 % | 100 % |
| Goahppelašjohka/Kuoppilasjoki | 92 % | 31 % | 113 % | 66 % |
| Leavvajohka | 116 % | 63 % | 136 % | 83 % |
| Báišjohka | 120 % | 76 % | 140 % | 91 % |
| Njiljohka/Nilijoki | 139 % | 91 % | 108 % | 60 % |
| Váljohka | 80 % | 16 % | 82 % | 19 % |
| Áhkojohka/Akujoki | 37 % | 0 % | 50 % | 0 % |
| Kárášjohka (+tributaries) | 38 % | 0 % | 40 % | 0 % |
| Iešjohka | 24 % | 0 % | 28 % | 0 % |
| Anárjohka/Inarijoki (+tributaries) | 24 % | 0 % | 25 % | 0 % |

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# Contents

# 1 Introduction

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

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

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

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

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

## 1.1 Report premises

### 1.1.1 The Precautionary Approach

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

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

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

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

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

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

### 1.1.2 Single- vs. mixed-stock fisheries

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

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

### 1.1.3 Management and spawning targets

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

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

## 1.2 Definition and explanation of terms used in the report

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

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

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

**Exploitation estimate**. See exploitation rate above. Ideally, we want to have a direct estimate of the exploitation rate using catch statistics and fish counting. Such estimates are available only in rivers with a detailed monitoring. In most cases, indirect estimates of exploitation rates must be used. Such estimates must be based on available data in rivers of comparative size and comparative regulation. A closer discussion on the estimation of exploitation rates in data-poor rivers can be found in Anon. (2011).

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

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

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

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

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

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

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

# 2 Salmon stock monitoring

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

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

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

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

- Ascending adult salmon and descending smolts by a video array in Ohcejohka/Utsjoki (since 2002) and Lákšjohka (since 2009)
- 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, 2017-2019)

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

Recently fish counts have also been carried out at some tributaries, e.g. Váljohka (video, 2015 and some snorkelling counts), Veahčajohka/Vetsijoki (sonar+video, 2016), Anárjohka/Inarijoki (sonar+video, 2018-2019) and Iešjohka (sonar, 2019). These pieces of information from individual tributaries are useful as reference levels for estimating their stock status, which in most years make use of catch data only.

In 2018 sonar counting of ascending salmon was also launched in the Tana/Teno main stem, at Polmak, c. 55 km from the river mouth. This data set has proven valuable, enabling estimation of the total salmon run to the Tana/Teno system. The main stem sonar count was continued in 2019.

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

## 2.1 Catch sampling

Catch samples (i.e. scale samples) have been collected since 1972 with the aim of covering the river system, different fishing gears and user groups, and the fishing season as well as possible. Dozens of local fishermen using traditional netting methods and rods, and many tourist outfitters collecting samples from their clients have participated in sample collection over the years. The samplers have been equipped with standard measuring boards (length) and scales (weight) and carefully instructed to carry out the sampling. Samples reveal the distributions of salmon size, sex and age in catches, and the distinction between wild salmon and escaped farmed fish. The scales are used primarily for age and growth analyses, but recently also for other purposes, such as stock identification by genetic analyses and stable isotope studies.

Scale sampling in 2019 resulted in 1 850 salmon scale samples, which was 39 % less than in the previous year (Figure 1). The decrease in sample numbers was mostly due to very low abundance of 1SW salmon ascending the Tana/Teno system in 2019.

Based on scale reading the proportion of escaped farmed salmon among the samples have varied between 0 and 0.6 %, the long-term average (1985-2019) being 0.20 %. In 2019 the proportion was 0.05 %, meaning only one escapee.

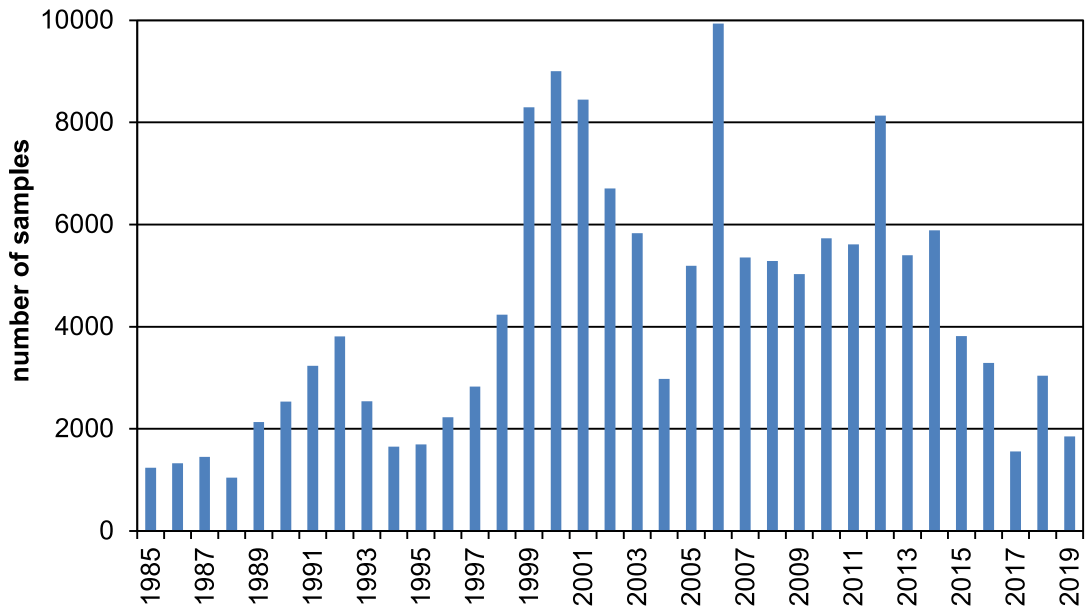


*Figure 1. Number of salmon scale samples collected annually from the Tana/Teno system in 1985-2019 including both Finnish and Norwegian samples.*

## 2.2 Catch and fishery statistics

Catch statistics have been systematically collected since early 1970s with some amendments in methods over the years. Major changes include the introduction of mandatory log books for fishers in Norway in 2004 and mandatory catch reporting in Finland since 2017.

The estimated Tana/Teno total salmon catch in 2019 decreased from the previous year and was the lowest in the time series, c. 40 tons. This equals to c. 10 000 salmon (Figure 2). The Finnish catch was 48 % (19 t) and Norwegian catch 52 % (21 t) of the total catch. The rather low salmon catches in 2017-2019 are partly explained by the new Tana/Teno fishing agreement, which has considerably reduced the fishing effort in both countries. The Tana/Teno salmon run was, however, very small in 2019 translating as low catches.

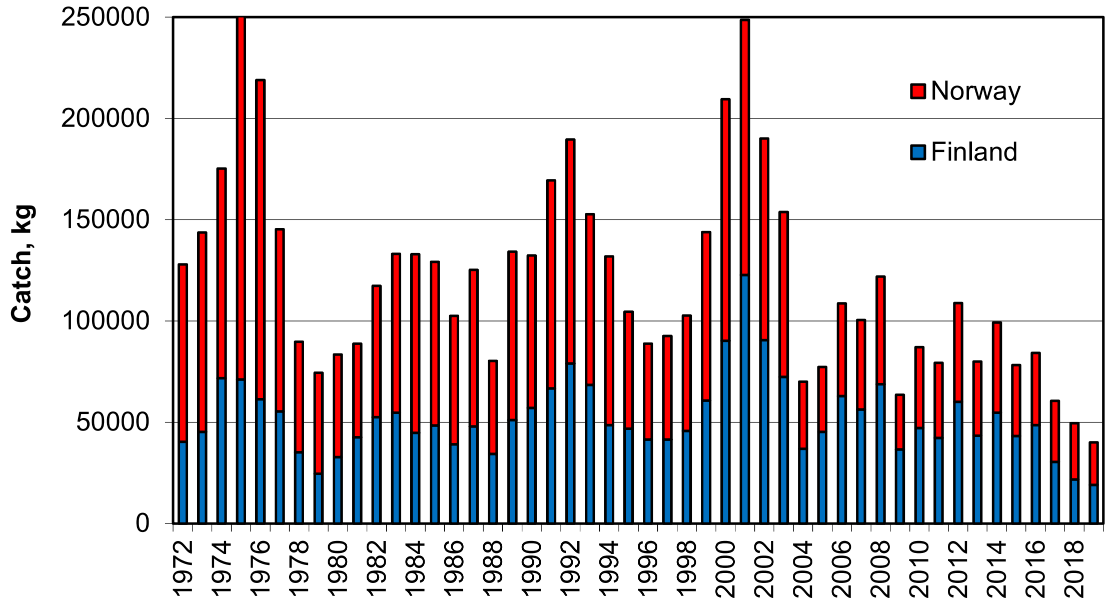


*Figure 2. Estimated total salmon catch (kg) in the Tana/Teno river system in Norway and Finland in 1972-2019.*

In 2019 catches of small 1SW salmon (=grilse) decreased with c. 67 % from the previous year and were the lowest numbers (<4 000 individuals) recorded within the monitoring period (1975-2019, Figure 3). Grilse constituted only 40 % of the total salmon catch in numbers. Catch of 2SW salmon (>4 000 fish) more than doubled from 2018 and constituted 41 % of the catch in numbers. The numbers of repeat spawners were at the same level as 2018. Catches of large 3SW salmon were at all time low, their proportion being only 6 % of the total catch. Overall, there has been a long-term decreasing trend in catches of large 3-5SW salmon (Figure 3).

In addition to catch statistics, yearly information on number of fishers and fishing licences have been collected that provide a good measure of fishing effort especially for the recreational tourist fishing, but to some extent also for local fishing.

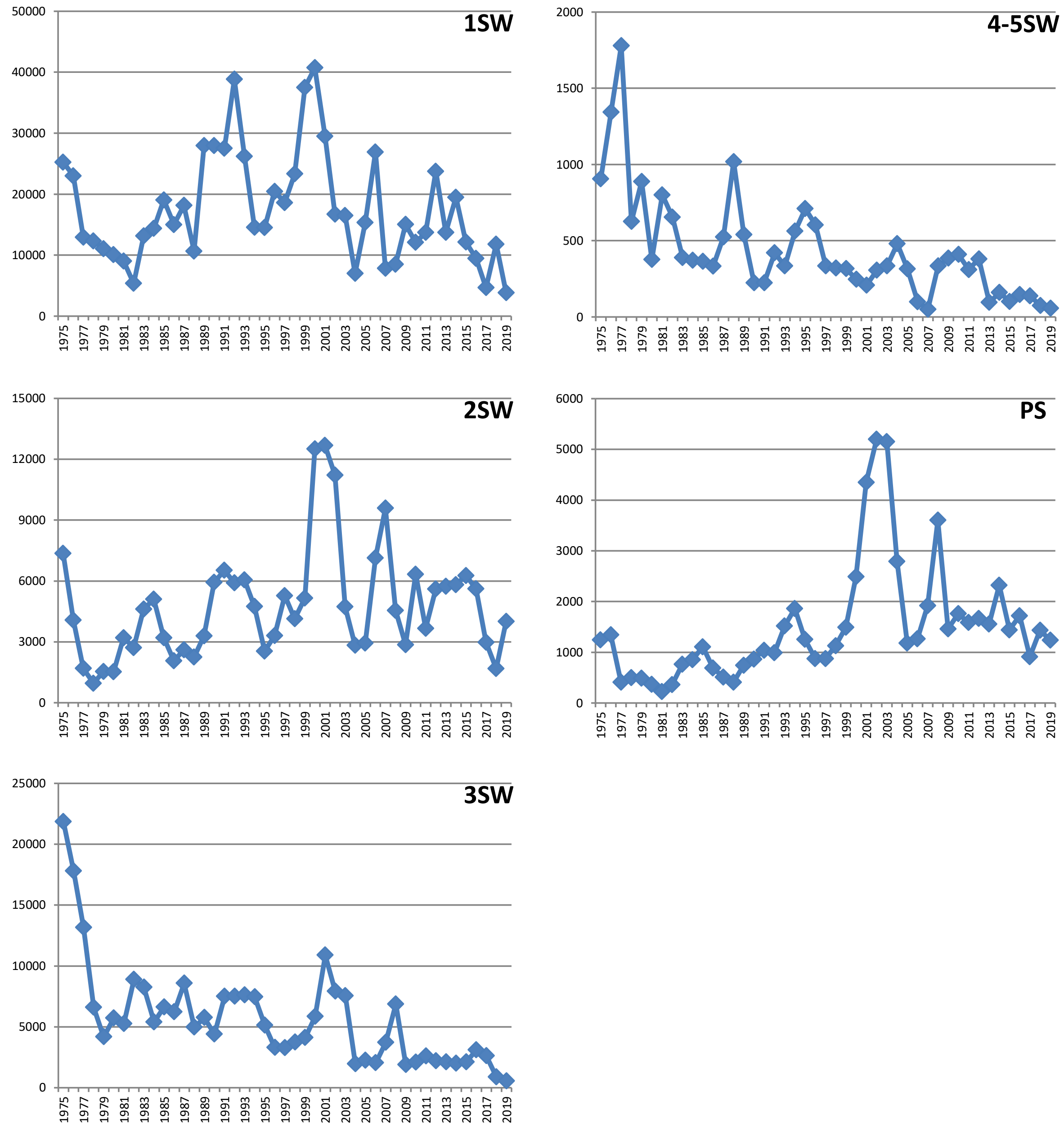


*Figure 3. Estimated total salmon catch (number of fish) of different sea-age groups (SW) in the Tana/Teno river system in the years 1975-2019. Note the different scales in vertical axes (PS=previous spawners).*

Because of the new fishing agreement in 2017, the numbers of tourist licences sold for the Tana/Teno main stem and Anárjohka/Inarijoki in Finland in 2017-2019 have decreased dramatically from the earlier years, being 10 476 day licences and 2 931 fishers in 2019 (Figure 4). In Norway, a total of 5 531 tourist fishing days were sold for the border reach of the Tana/Teno main stem and Anárjohka/Inarijoki in 2019. Additionally, 967 tourist fishing days were sold for the Norwegian lower Tana area and 788 days to Norwegian tributaries. There has been a clear increase in tourist fishing days in Norway since the new Tana/Teno agreement.

The number of local fishermen in Finland was 481 in 2019, being clearly less than the average figure over the previous five years (647). In Norway, a total of 1 371 local fishermen bought licences in 2019 (2018: 1 452).

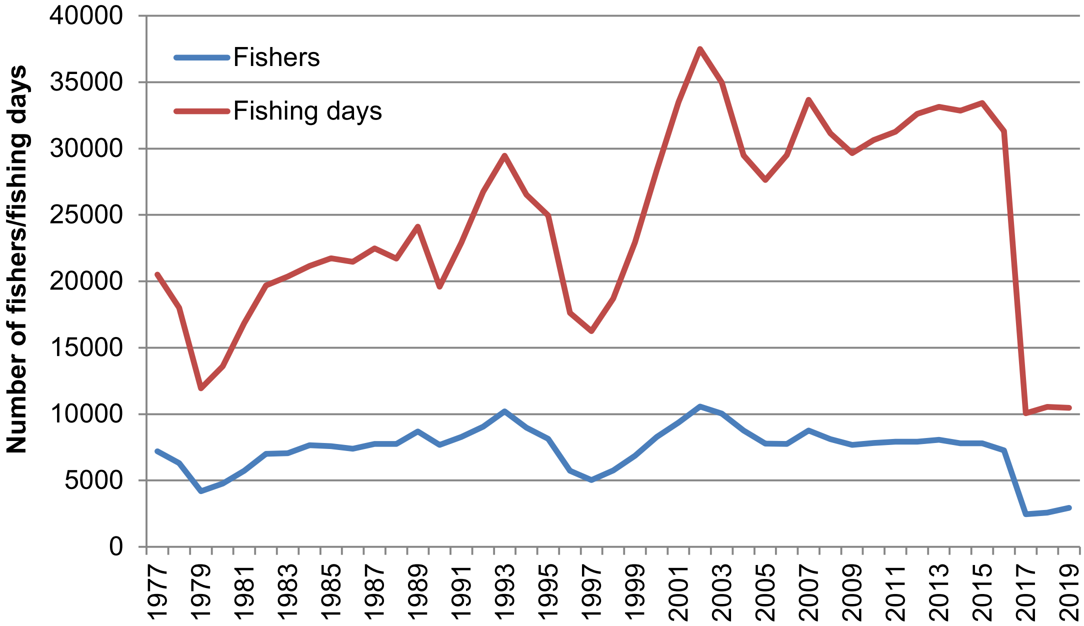


*Figure 4. Number of tourist fishers (blue) and daily fishing licences (red) in the Tana/Teno river system on the Finnish side in 1977-2019.*

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

Overall, the juvenile salmon densities appear to fluctuate between years with no apparent clear trends (Figure 5). In the tributaries and especially in Anárjohka/Inarijoki mean densities of fry (0+) have been at higher levels during 2000s compared to earlier years (Figure 5). It has to be noted, however, that the mean densities of Anárjohka/Inarijoki are based on very limited number of sampling sites, affecting their reliability and generalization of the results.

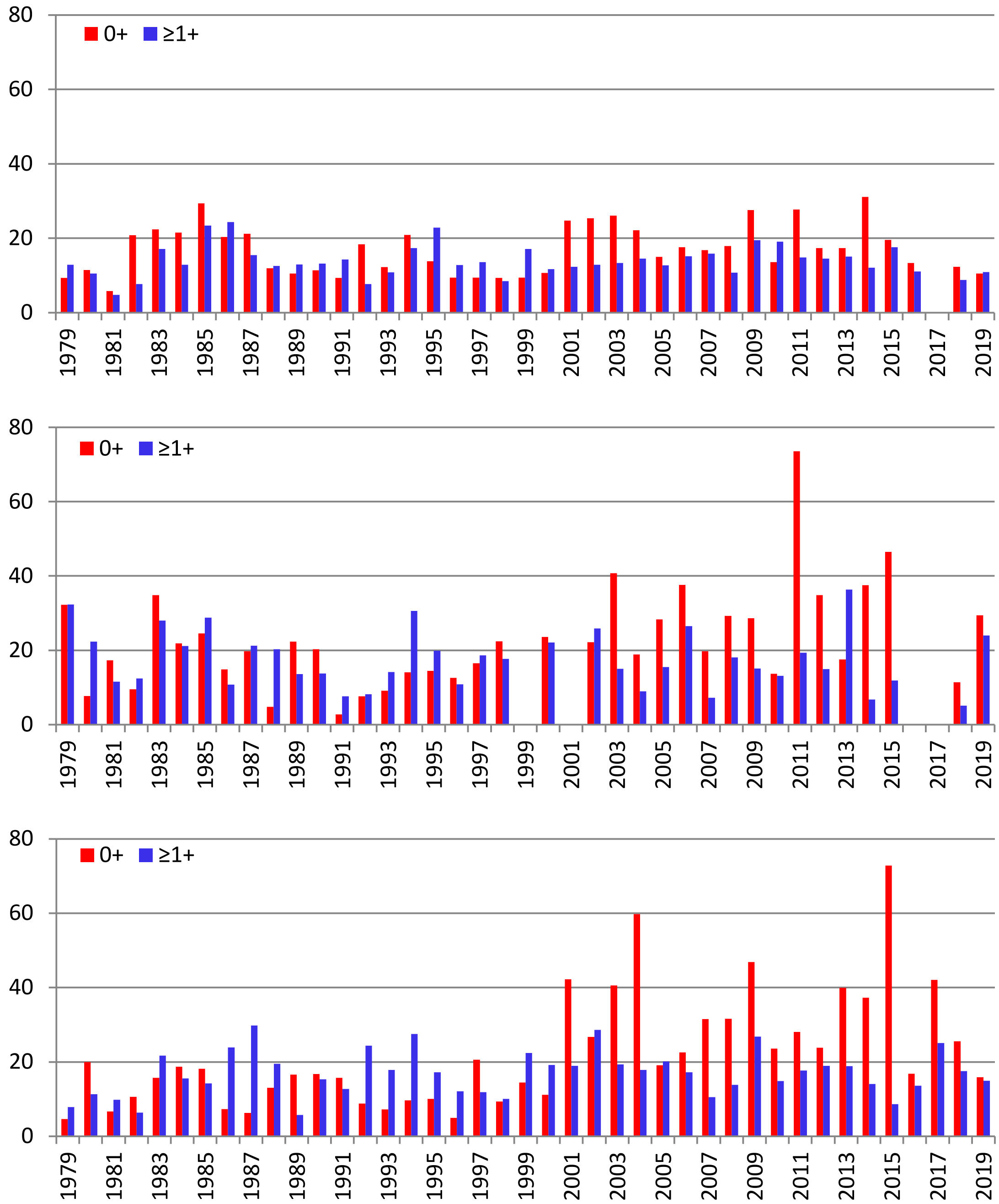


*Figure 5. Mean densities (fish/100m²; one pass) of salmon fry (0+) and parr (≥1+) at permanent electrofishing sites in the rivers Tana/Teno, Ohcejohka/Utsjoki and Anárjohka/Inarijoki in the years 1979-2019. Note: this data only includes electrofishing sites (Tana/Teno 17-22 sites, Ohcejohka/Utsjoki 11-12 sites and Anárjohka/Inarijoki 5-7 sites) that have been the same throughout the monitoring period.*

In addition to the electrofishing of long-term monitoring sites, a survey in the River Tsarsjoki was conducted in 2019, including 26 sampling sites (Figure 6). The aim of this electrofishing was to get an updated overview on the juvenile densities of the river Tsarsjoki and compare these densities to earlier surveys conducted in 2004, 2009 and 2014 (Figure 7). Overall, the juvenile densities in Tsarsjoki have remained in levels observed lately in the long-term monitoring sites (see Figures 5-7). The production of fry (0+) is mostly concentrated to areas above the waterfall (sites 11-26) situated close to the outlet of the Njidgu river. Production areas of parr (≥1+) are more evenly distributed throughout the surveyed sites (Figure 6).

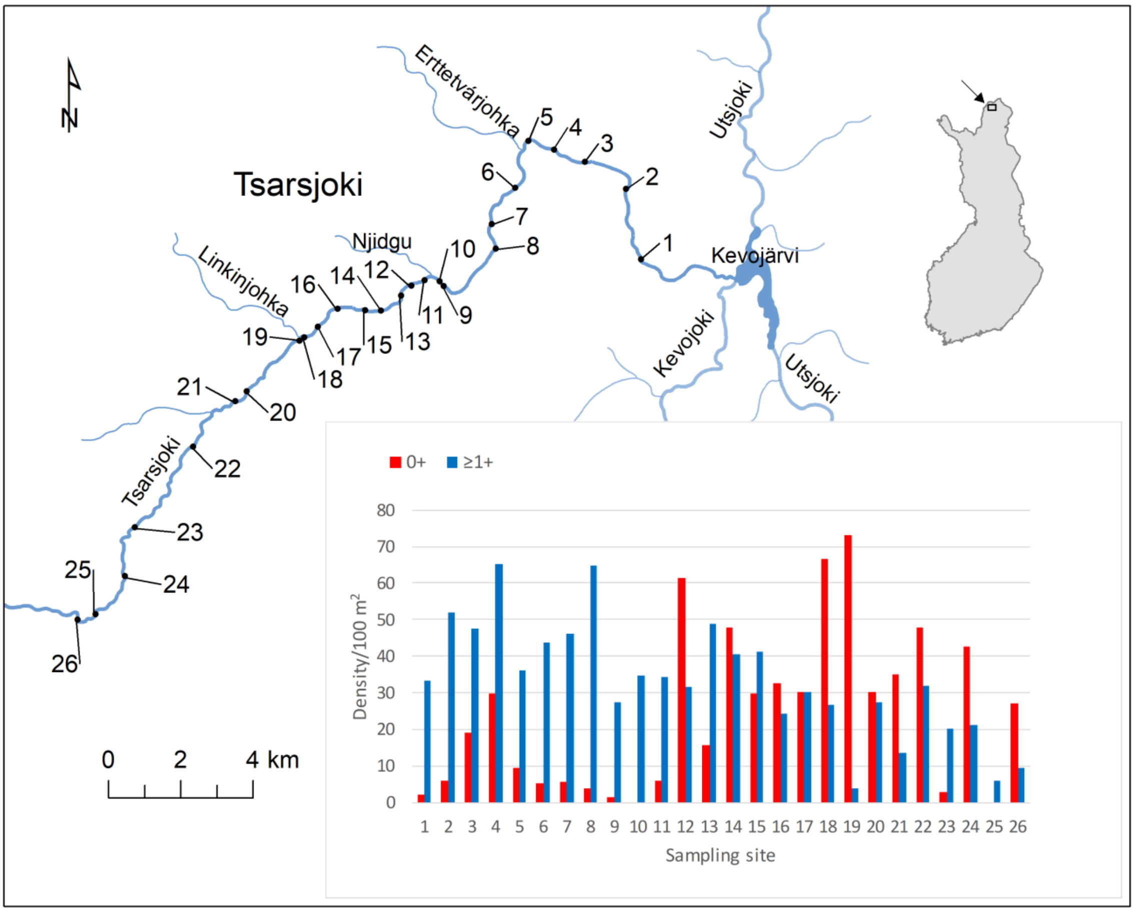


*Figure 6. Densities (fish/100m²; one pass) of salmon fry (0+) and parr (≥1+) in the sampling sites (n=26) of the River Tsarsjoki in 2019.*

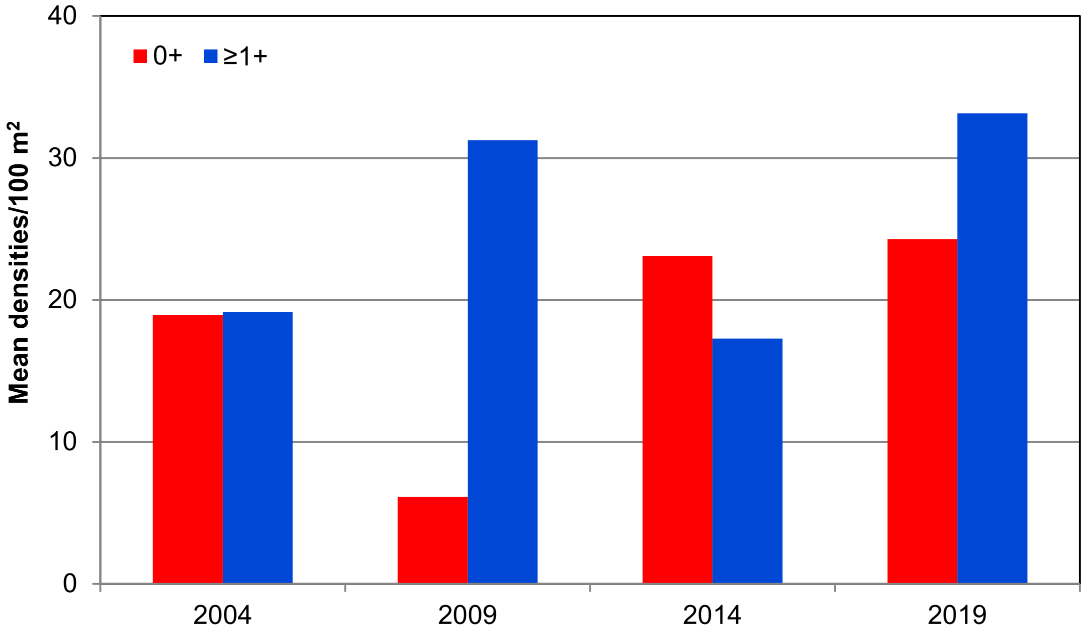


*Figure 7. Mean densities (fish/100m$^2$; one pass) of salmon fry (0+) and parr (≥1+) in the River Tsarsjoki in 2004, 2009, 2014 and 2019. The mean densities are based on data from 26 sampling sites (see Figure 6).*

## 2.4 Adult salmon counting

Counting of adult salmon ascending the Tana/Teno main stem and its tributaries or being present at spawning areas has been carried out in several sites using multiple methods, including video monitoring, sonar counts and snorkelling counts (Figure 8).

In 2019 adult salmon counts were performed at the following sites (Figure 8): Tana/Teno main stem (sonar), Lákšjohka (video), Ohcejohka/Utsjoki (video), Anárjohka/Inarijoki (sonar), Kárášjohka (sonar), Iešjohka (sonar), Buolbmátjohka/Pulmankijoki (snorkelling) and Áhkojohka/Akujoki (snorkelling).

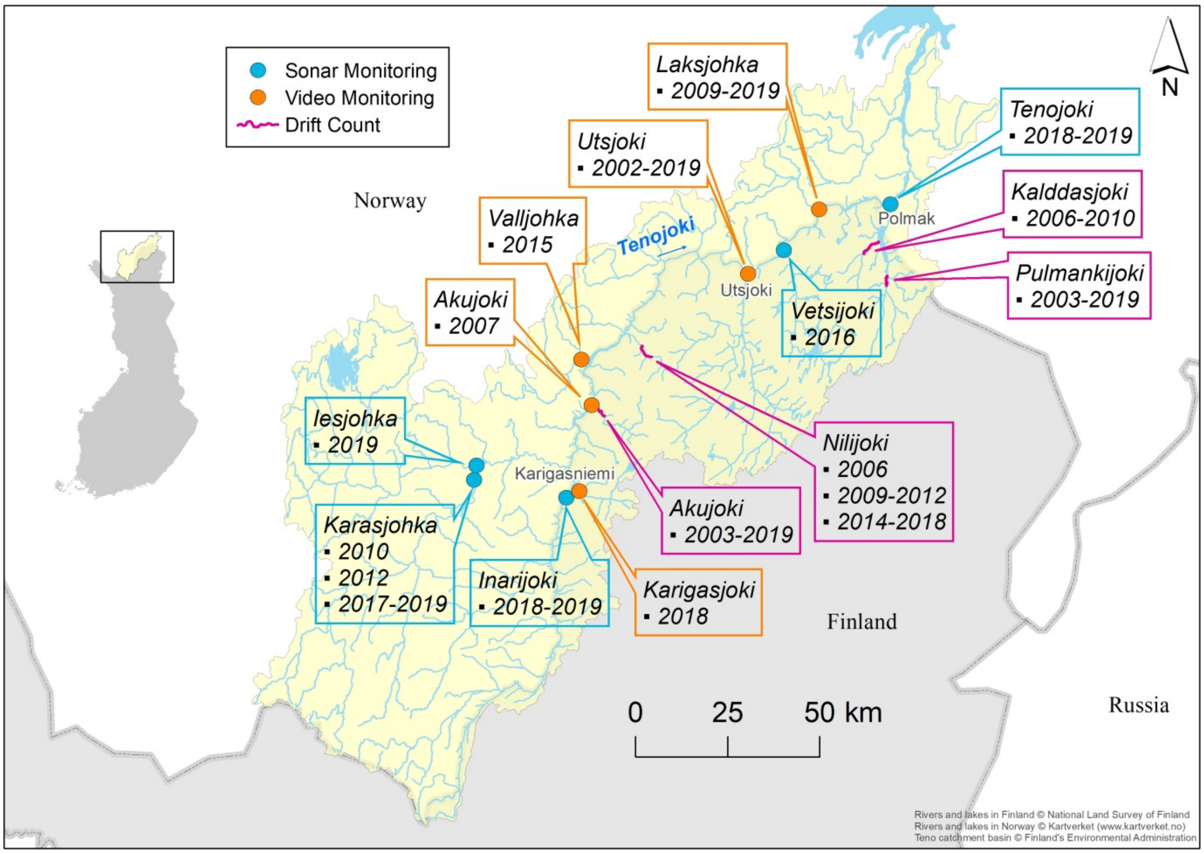


*Figure 8. Map of the Tana/Teno river system indicating the most important adult salmon counting sites and counting methods between 2002 and 2019.*

### 2.4.1 Long-term video monitoring

Monitoring of ascending adult salmon and descending smolts has been conducted in Ohcejohka/Utsjoki since 2002 by an array of eight video cameras below the bridge close to the river mouth (Orell et al. 2007). Numbers of ascending salmon have varied between 1 300 and 6 700 over the years (Figure 9). In 2019 the counting was performed successfully in good environmental conditions. The adult salmon run estimate in 2019 is c. 1 650 individuals (Figure 9), which is 65 % less than in 2018 and significantly below the long-term average of 3 650 individuals.

Monitoring of ascending adult salmon and descending smolts has been conducted in Lákšjohka since 2009 by an array of four video cameras close to the river mouth. Numbers of ascending salmon have varied between 255 and 1 086 over the years. In 2019 the counting was performed successfully in good environmental conditions. The adult salmon run was only 335 individuals in 2019 (Figure 9), decreasing 40 % from the previous year and being clearly below the long-term average of 611 salmon.

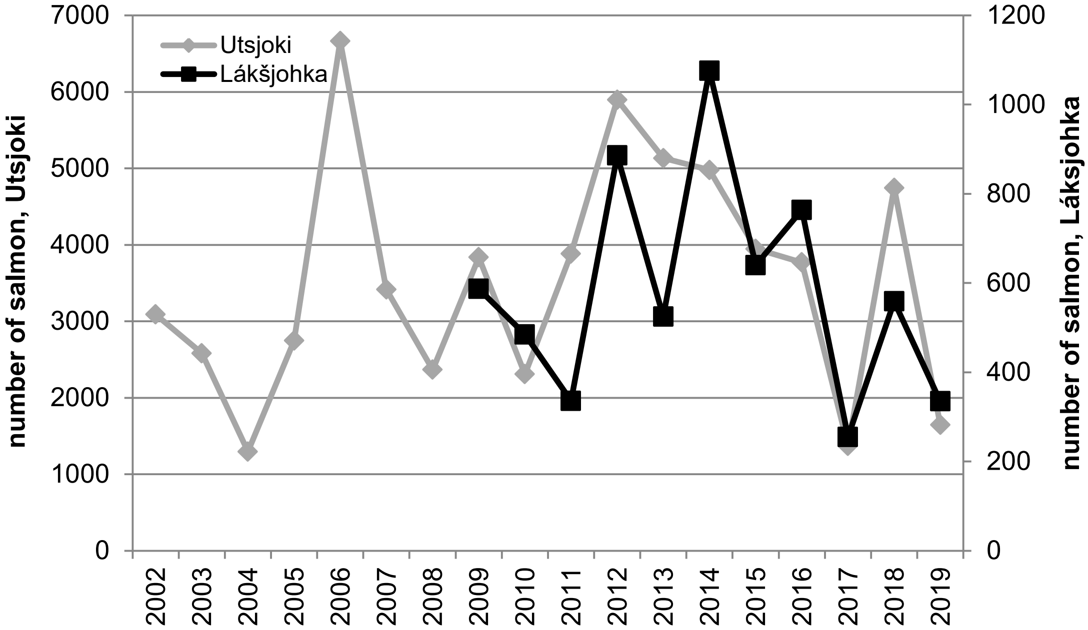


*Figure 9. Video counts of ascending adult salmon at the video monitoring sites in the Ohcejohka/Utsjoki and Lákšjohka in 2002-2019. Sea age groups are combined. Note: the data in 2017 is not fully comparable to other years because of challenging environmental conditions affecting the count accuracy in both locations. The Ohcejohka/Utsjoki 2019 adult count is an estimate, as a small fraction of the data is still being analysed when writing this report.*

### 2.4.2 Snorkelling counts

Salmon spawners have been counted by snorkelling on annual basis in rivers Áhkojohka/Akujoki and Buolbmátjohka/Pulmankijoki since 2003. In Áhkojohka/Akujoki, the counting area covers the entire salmon production area (6 km) below an impassable waterfall, whereas a stretch of 4 km in the central spawning areas of the Buolbmátjohka/Pulmankijoki has been snorkelled every year. In addition, counts have been conducted in shorter time spans or individual years in some other small tributaries as well; the best data is available from the river Njiljohka/Nilijoki, where a 5 km stretch on the upper reaches has been counted almost annually since 2009 (Figure 10).

The number of spawning salmon has varied between 31 and 171 in Áhkojohka/Akujoki, between 34 and 215 in Buolbmátjohka/Pulmankijoki and between 63 and 216 in Njiljohka/Nilijoki (Figure 10). In 2019 the numbers of spawning salmon decreased substantially compared to the previous year, reaching all-time low (31 fish) in Áhkojohka/Akujoki (Figure 10). The decrease in spawner numbers was due to very low abundance of 1SW salmon. Instead numbers of 2SW salmon increased in both rivers compared to 2018. Counting in Njiljohka/Nilijoki was not conducted in 2019 because of very low water levels during the monitoring period.

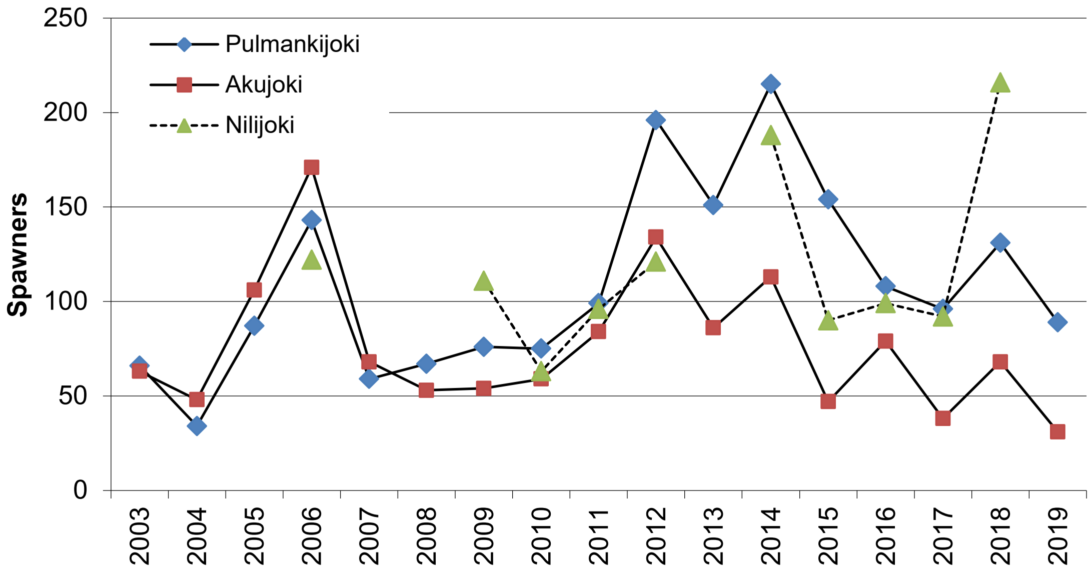


*Figure 10. Snorkelling counts of spawning salmon in the rivers Buolbmátjohka/Pulmankijoki, Áhkojohka/Akujoki and Njiljohka/Nilijoki in 2003-2019. Sea-age groups are combined. Njiljohka/Nilijoki was not counted in 2019 because of extremely low water levels during the monitoring period.*

### 2.4.3 Sonar and video counts

Recently echosounders or sonars have been used in counting the numbers ascending salmon at the Tana/Teno main stem and at some tributaries. In 2019 sonar counts were performed in Kárášjohka, in the Tana/Teno main stem, in Anárjohka/Inarijoki and in Iešjohka. ARIS-sonars were used elsewhere except in Iešjohka, where a Simsonar echosounder was used.

In the sonar data, a minimum size for fish considered as a salmon has been set to 45 cm. This cutting point was chosen to account for other fish species like grayling and sea trout, which are mostly smaller than these lengths. In addition, species distribution and proportion of salmon have been estimated based on nearby catch information (e.g. Tana/Teno main stem) or by video monitoring within the sonar window (e.g. Anárjohka/Inarijoki).

In the River Kárášjohka, sonar technology to count ascending salmon has been used in 2010, 2012 and 2017-2019. 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 two years the monitored river width has been c. 30-35 m.

In total 1 343 salmon were estimated to pass the sonar counting site in Kárášjohka in 29.5.-3.9.2019 (Figure 11). The count was 55 % lower than in 2018. It is obvious that some salmon migrated past the counting site also before and after the survey period, but their proportion is estimated to be rather small. Salmon migration in 2019 was very low throughout the monitoring period and no clear migration peaks were observed, opposite to 2018 (Figure 11).

The length distribution data of salmon passing the sonar site indicated that 42 % of salmon were <65 cm fish, 33 % were fish between 65 and 90 cm and 24 % were fish ≥90 cm. The length distribution data includes some uncertainty because of a rather long (30-35 m) sonar window used in the survey.

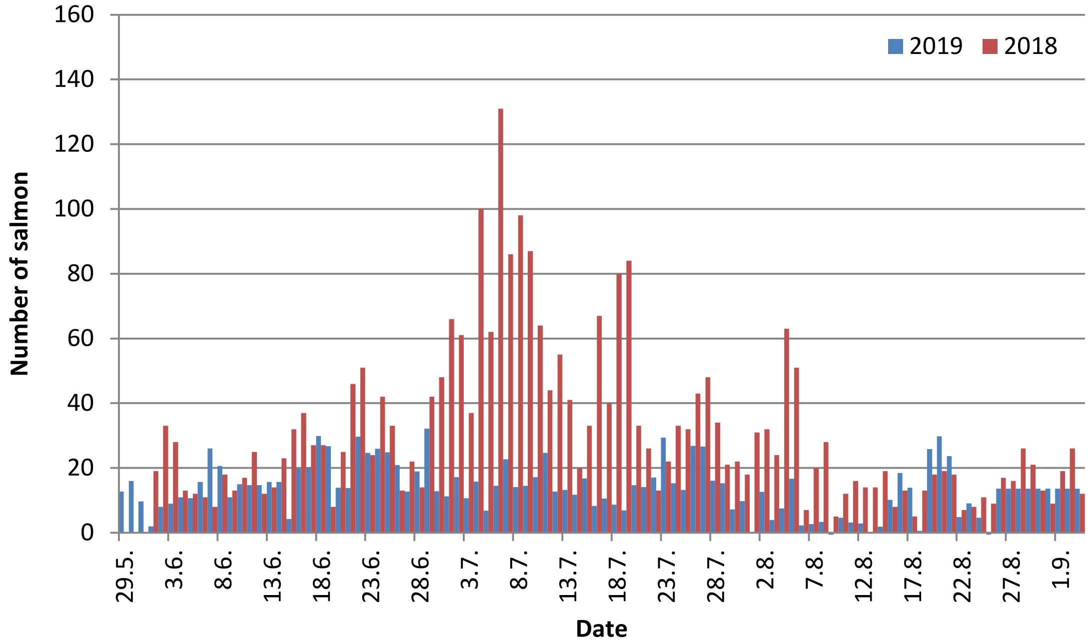


*Figure 11. Estimated daily numbers of ascending salmon (≥45 cm) in the Kárášjohka sonar count in 2018 (red bars) and 2019 (blue bars). All size categories are combined. The estimate of the total ascendance through the site in 2018 and 2019 was 2 962 and 1 343 salmon, respectively. Note: the 2018 numbers have been changed downwards compared to the earlier report because a mistake in datasheet was found.*

The Kárášjohka run size in 2019 was among the lowest observed within the five counting seasons (Table 1). The low numbers are largely explained by poor 1SW salmon run, although the numbers of larger MSW salmon were also rather low.

*Table 1. Sonar count results of ascending salmon numbers in the River Kárášjohka in 2010, 2012, and 2017-2019. Data from 2012 and 2017 are not fully comparable to other years because of differences in used sonar techniques (2012) and unsuitable (high water) counting conditions (2017). Note: the 2018 numbers have been changed downwards compared to the earlier report because a mistake in datasheet was found.*

| Time period | 1SW | MSW | All | Note | Equipment |
|---|---|---|---|---|---|
| 9.6.-31.8.2010 | 1 016 | 661 | 1 677 | Missing time estimated | Didson |
| 6.6.-27.8.2012 | 1 038 | 1 589 | 2 627 | Missing time not estimated | Simsonar |
| 7.6.-31.8.2017 | 371 | 492 | 863 | Missing time not estimated | ARIS/Simsonar |
| 1.6.-3.9.2018 | 1 786 | 1 176 | 2 962 | Missing time not estimated | ARIS |
| 29.5-3.9.2019 | 569 | 774 | 1 343 | Missing time estimated | ARIS |

Sonar counting of ascending salmon numbers was continued in the Tana/Teno main stem in 2019, at Polmak, c. 55 km upstream from the river mouth (Figure 12). The aim of this survey is to estimate the total salmon run of the Tana/Teno system. Two sonars units were used, one on each shore. By using guiding fences on both shores the width of the river (130 m) was narrowed to c. 100 m which was covered by the two sonars (Figure 12). Species distribution and proportion of salmon of the sonar count was estimated based on sonar length frequency data and species distribution in catch of the Norwegian Tana Bru-national border area.

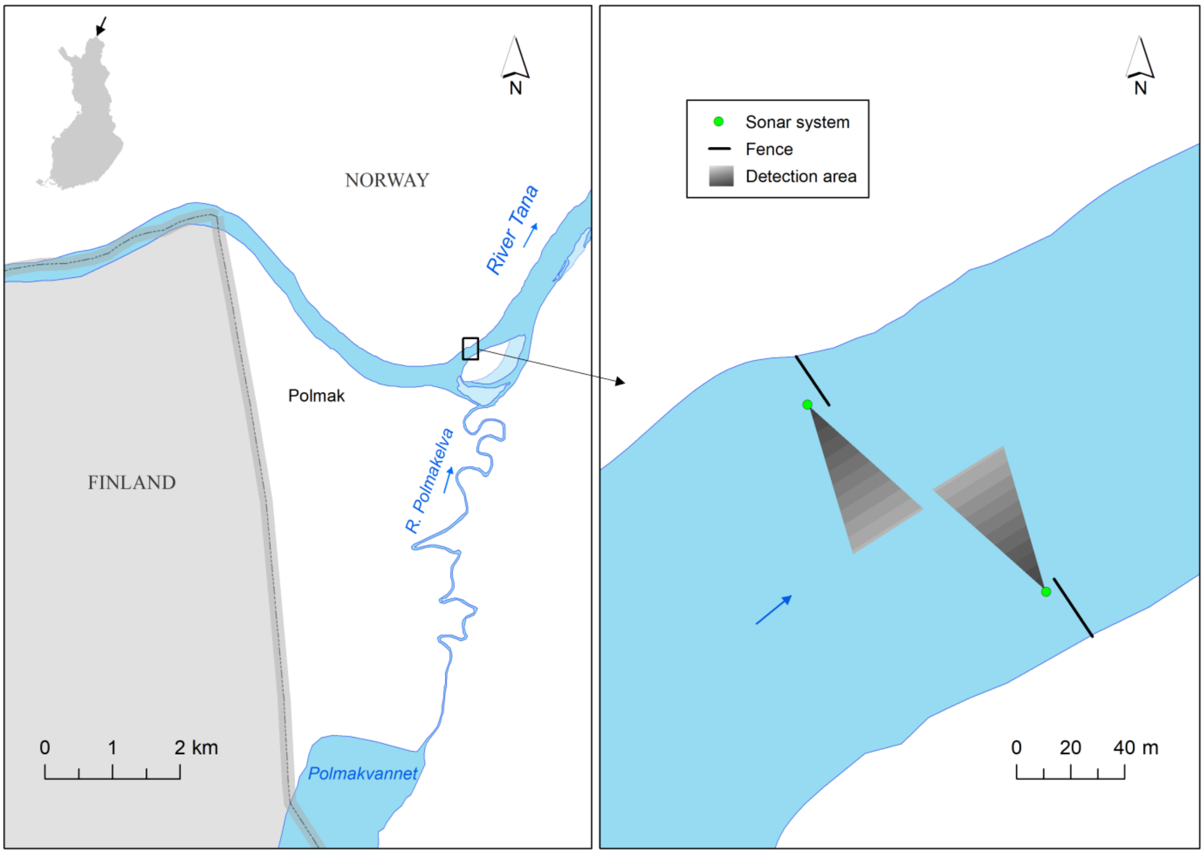


*Figure 12. Map of the Tana/Teno main stem sonar counting site including the locations of the two sonar units and guiding fences in 2019.*

In total 21 000 salmon were estimated to pass the sonar counting site at Polmak in 22.5.-17.9.2019 (Figure 13). Salmon numbers decreased c. 35% from the previous year. It is obvious that some salmon migrated also before and after the counting period, but their proportion is estimated to be negligible. The most intensive salmon migration occurred at the same time as in 2018 (Figure 13).

The length distribution data of salmon passing the sonar site indicated that only 35 % of salmon were <65 cm fish, 47 % were fish between 65 and 90 cm and 17 % were fish ≥90 cm. Compared to 2018 count results (62 %) the proportion of <65 cm salmon was very low in 2019. The length distribution data, however, includes considerable uncertainty because of long sonar windows (c. 50 m) used in the counting.

When accounting the lower Tana/Teno salmon catches (including Tana/Teno main stem, Maskejohka and Pulmankijoki) below the sonar counting site, estimated spawning stocks in Maskejohka and Pulmankijoki and the sonar count numbers, the total Tana/Teno salmon run size was in minimum c. 25 000 fish in 2019. The total run size estimate for 2018 was c. 40 000 salmon.

The Tana/Teno main stem sonar count, in addition to giving the total salmon run size, allows estimating exploitation rates for the main stem. These numbers also improve total exploitation estimates for the tributary populations. These two first years of sonar monitoring in the Tana/Teno main stem indicates that it provides valuable information for stock status evaluation.

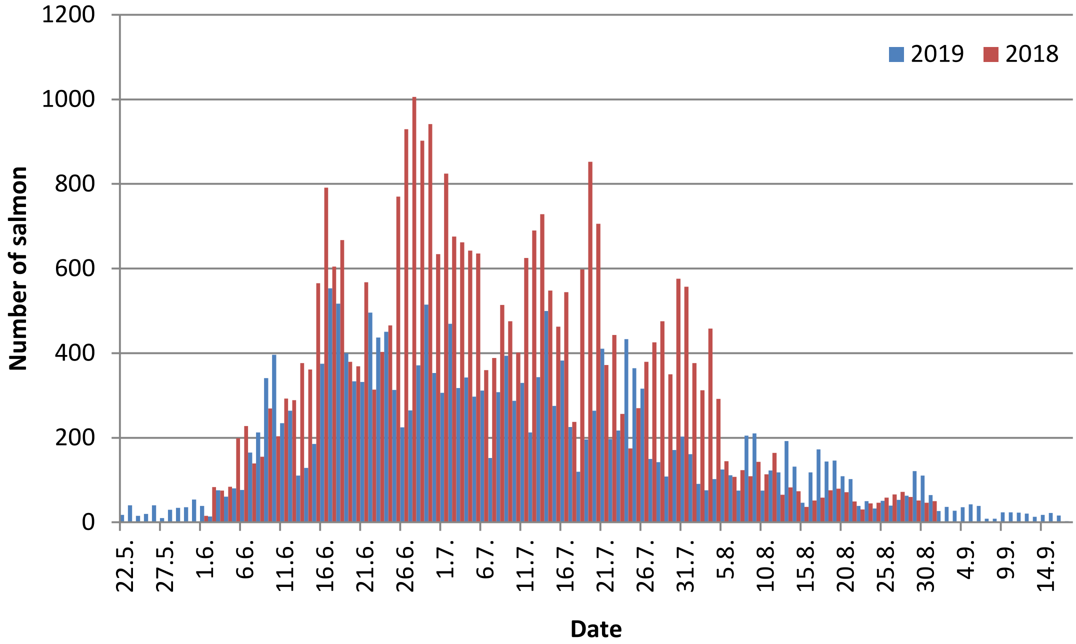


*Figure 13. Estimated daily numbers of ascending salmon (≥45 cm) in the Tana/Teno main stem sonar count at Polmak in 2018 (red bars) and 2019 (blue bars). All size categories are combined. The estimate of the total ascendance through the site in 2018 and 2019 was 32 455 and 21 013 salmon, respectively.*

The Anárjohka/Inarijoki sonar survey launched in 2018 was continued in 2019, just above the Gáregasjohka/Karigasjoki confluence, c. 220 km upstream from the Tana/Teno river mouth (Figure 14). One sonar unit was placed to the river, pointing from the Norwegian side to the Finnish side. Guiding fences were installed on both shores to narrow the river for accurate sonar monitoring (Figure 14). The sonar window fully covered the narrowed river (c. 30 m). Species distribution and proportion of salmon of the sonar count was estimated based on data from four underwater cameras installed at the sonar counting line.

In total 1 593 salmon were estimated to pass the sonar counting site in Anárjohka/Inarijoki in 4.6.-18.9.2019 (Figure 15). Observed salmon numbers decreased by 44 % from previous year. Salmon migration was rather low throughout the monitoring period and no clear migration peaks were observed, opposite to that in 2018 (Figure 15). The migration continued clearly to September and probably also slightly continued after the counting period (Figure 15).

The length distribution data of salmon passing the sonar site indicated that 58 % of salmon were <65 cm fish, 34 % were between 65 and 90 cm and 8 % were fish ≥90 cm. The length distribution data includes some uncertainty because of a rather long (30 m) sonar window used in the survey.

Overall, the Anárjohka/Inarijoki sonar count is a minimum estimate of the total run size, as the sonar site is situated 9 km upstream from the river mouth and as the River Gáregasjohka/Karigasjoki is running to Anárjohka/Inarijoki below the counting site. The total salmon run of Anárjohka/Inarijoki was most probably c. 1 900-2 000 fish in 2019. The estimate for 2018 was 3 500-3 600 salmon.

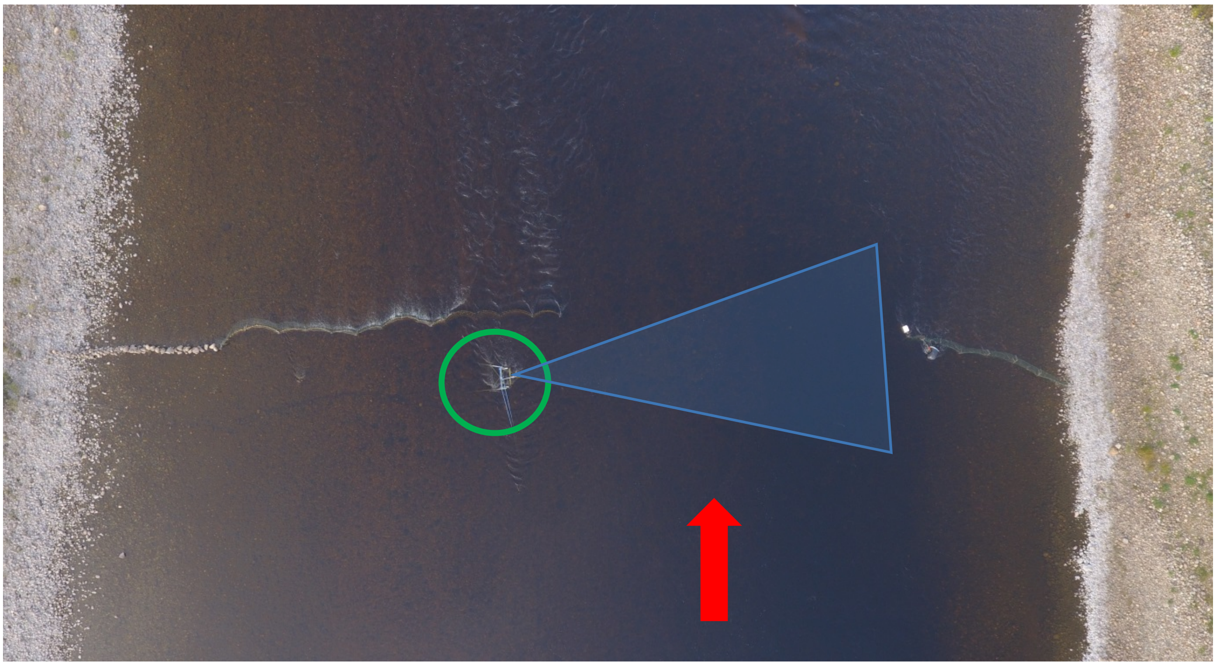

*Figure 14. An aerial photo from the Anárjohka/Inarijoki sonar counting site, just above the confluence of the Gáregasjohka/Karigasjoki. The sonar unit is located inside the green oval and the blue triangle indicates the sonar window. Flow direction is indicated by the red arrow. Photo: Jari Lindeman (Luke).*

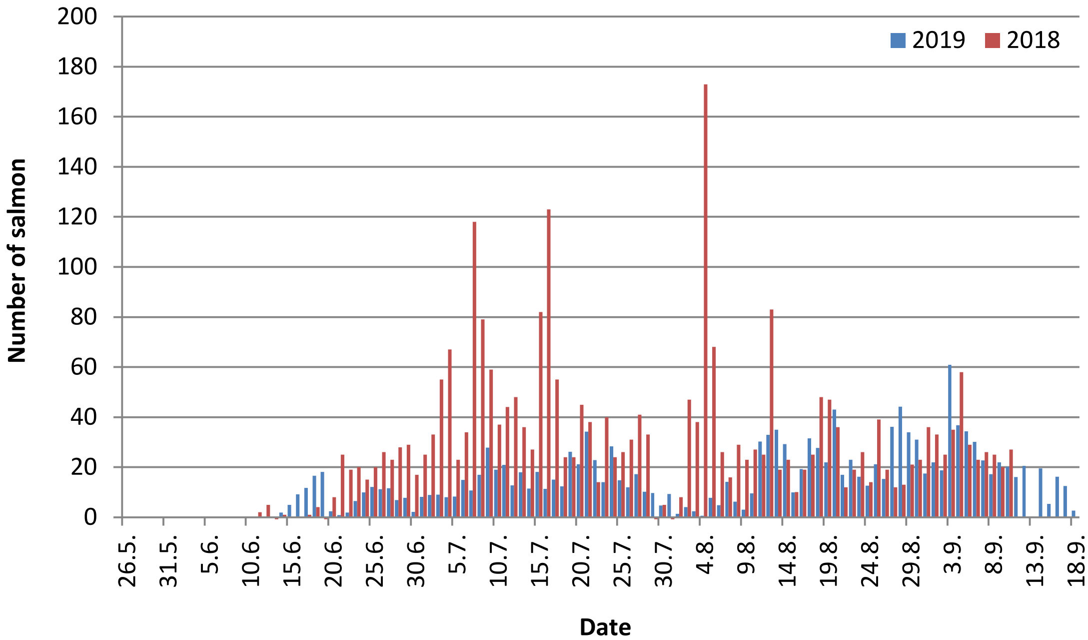


*Figure 15. Estimated daily numbers of ascending salmon (≥45 cm) in the Anárjohka/Inarijoki sonar count in 2018 (red bars) and 2019 (blue bars). All size categories are combined. The estimate of the total ascendance through the site in 2018 and 2019 was 2 848 and 1 593 salmon, respectively.*

A pilot sonar count in the River Iešjohka was conducted in 4.6.-2.9.2019 close to the confluence of rivers Kárášjohka and Iešjohka, c. 247 km from the Tana/Teno mouth (see Figure 8). Guiding fences were used on both shores to narrow the counting area. The count was performed by a Simsonar echosounder with c. 50 m long sonar window at the beginning and c. 20 m window later in the season. Because of problems in electricity supply the actual counting was started on 8th June (Figure 16). Data-analysis of the Iešjohka sonar material was conducted by the Simsonar Company and the results were not checked by the Tana/Teno monitoring and research group (MRG). MRG, however, made the final estimation of daily salmon numbers based on the data provided by Simsonar. This estimation included additions of salmon for days with missing sonar data and estimation of proportion of salmon in the size class of 45-65 cm fish.

In general the numbers of salmon ascending to Iešjohka were very low, as was the case in other monitored tributaries also. The total salmon estimate within 8.6.-2.9.2019 was only 656 fish (Figure 16). It is obvious that some salmon have migrated upstream before the sonar count was started.

The length distribution data of salmon passing the sonar site indicated that 66 % of salmon were <65 cm fish, 23 % were between 65 and 90 cm and 10 % were fish ≥90 cm. The length distribution data includes considerable uncertainty because of a rather long (from 20 to 50 m) sonar window used in the survey. Secondly, the length frequency results obtained with Simsonar echosounder are not fully comparable to other sonar counts in Tana/Teno area conducted with ARIS sonars.

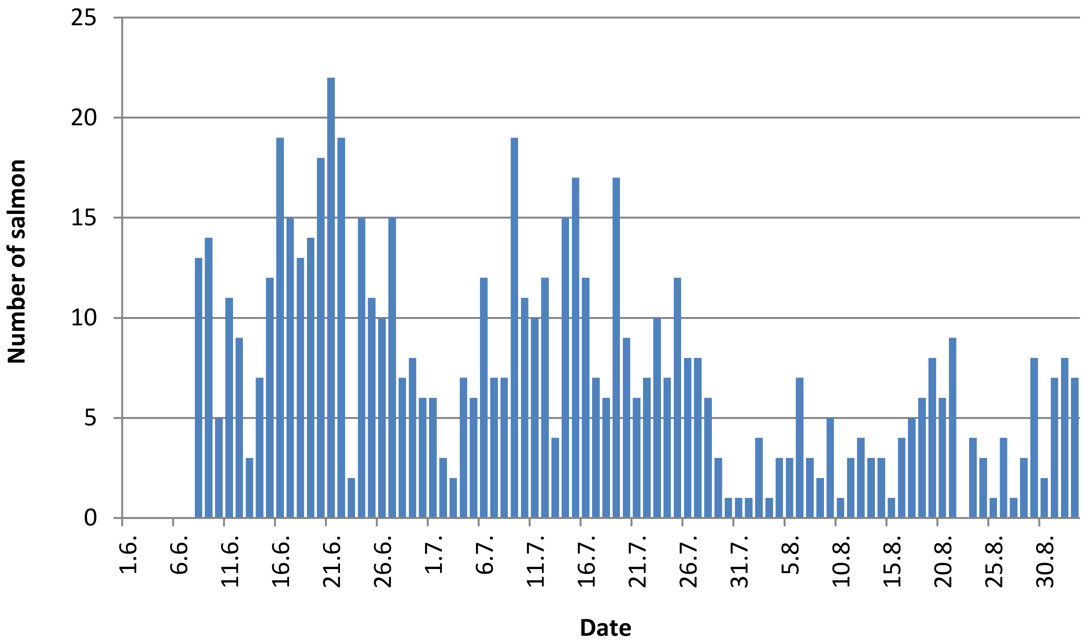


*Figure 16. Estimated daily numbers of ascending salmon (≥45 cm) in the River Iešjohka between 4.6. and 2.9.2019. All size categories are combined. The estimate of the total ascendance through the site was 656 salmon.*

## 2.5 Pink salmon occurrence

Pink salmon, an invasive species originating from the Pacific area, occurred in the Tana/Teno system in rather high numbers in 2019, as was the case also two years earlier, during the 2017 season. Overall, abundance of this odd-year pink salmon stock has recently increased substantially within large areas of the North Atlantic including the Tana/Teno.

The catch estimate (=reported catch and estimated unreported catch) of pink salmon from the Finnish side of the Tana/Teno system was 640 individuals and 835 kilos. Reported pink salmon catch of the

Norwegian side was 1 400 individuals and 2 000 kilos. As the Norwegian numbers are reported catches only, the total catch may have been somewhat higher.

The numbers of pink salmon in the Tana/Teno main stem sonar count was also roughly estimated based on length frequency data of sonar count and catch data from the Norwegian river stretch between the Tana Bru and the national border. These data sources indicated a pink salmon run of c. 4 600 individuals, migration starting at late June and continuing actively to late-July (Figure 17). This estimate is most probably an underestimate of the true run size, as the sonar count only included fish detections >45 cm in length. Therefore a considerable portion of the pink salmon may have been uncounted.

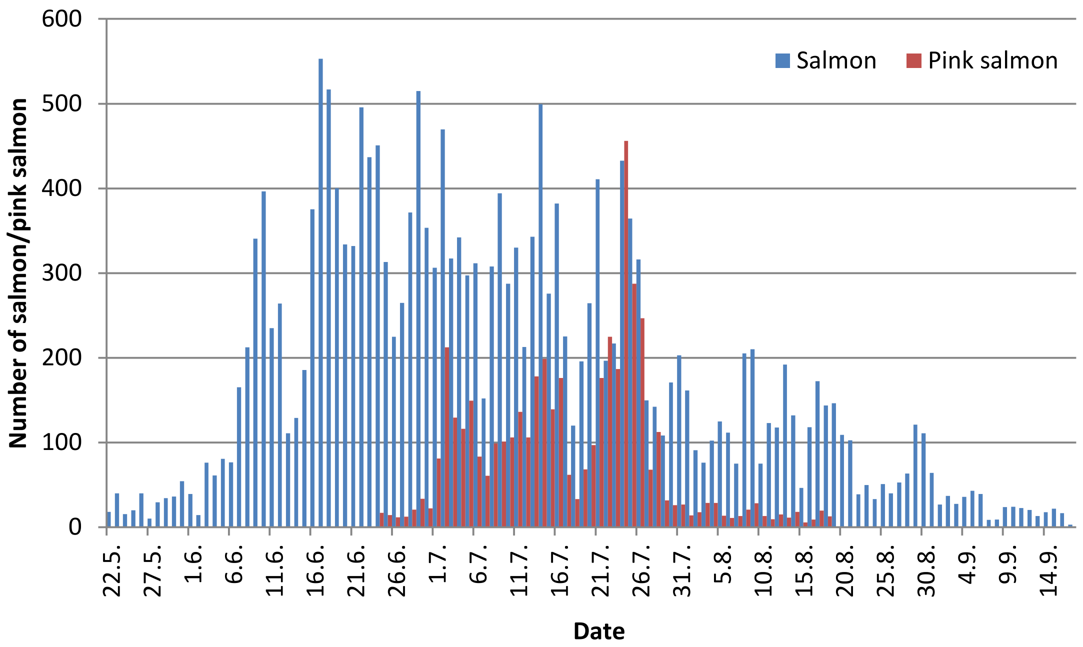


*Figure 17. Estimated numbers of salmon (21 013) and pink salmon (4 593) in the Tana/Teno main stem sonar count in 2019. Separation of salmon and pink salmon is based on length frequency data of sonar count and catch data from the nearby river area. Note: the pink salmon numbers are most probably minimum estimates, as only fish larger than 45 cm were measured from the sonar data.*

A better estimate on pink salmon numbers was available from the Anárjohka/Inarijoki sonar count, as species identification there was based on underwater video data. During the monitoring period c. 350 pink salmon migrated past the counting site (Figure 18). Pink salmon migration at the Anárjohka/Inarijoki site started one to two weeks later compared to the Tana/Teno main stem sonar count and continued actively to late-July (Figure 18).

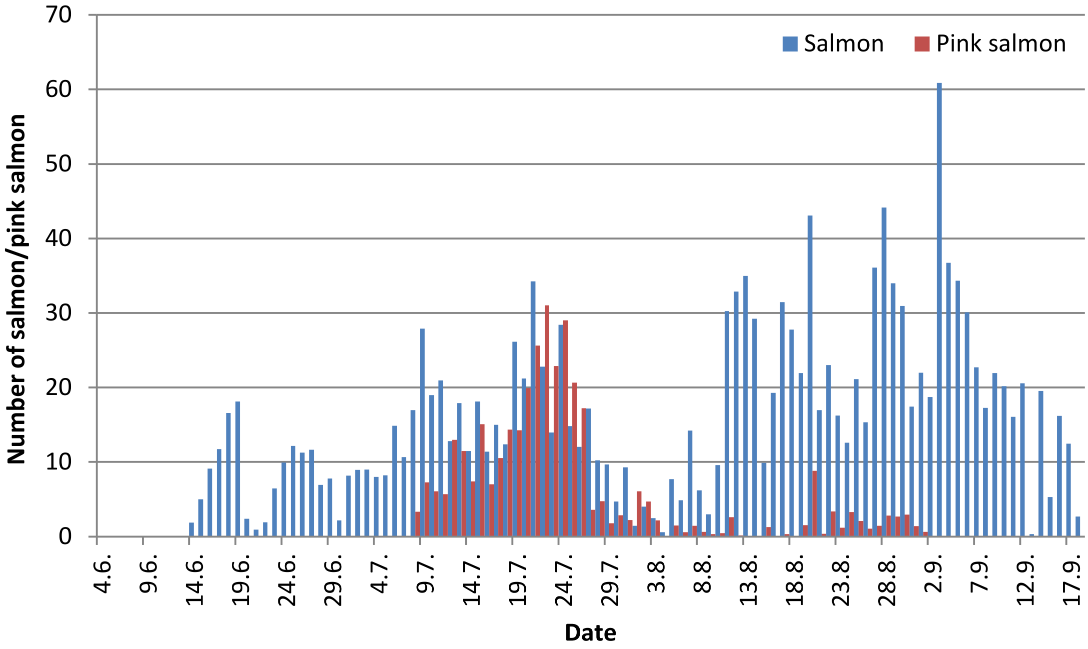


*Figure 18. Estimated numbers of salmon (1 593) and pink salmon (353) in the Anárjohka/Inarijoki sonar count in 2019. Separation of salmon and pink salmon is based on length distribution data of sonar count and video monitoring data from the sonar counting line.*

Sonar data and other sources of information, e.g. eDna sampling, snorkelling counts and video counts, indicated that pink salmon migration is somewhat clustered to certain areas and tributaries but rather low or no occurrence in some other areas or tributaries. In 2019 pink salmon clearly migrated to Anárjohka/Inarijoki, Kárášjohka, Leavvajohka and Maskejohka, whereas no observations were recorded from many of the smaller Tana/Teno tributaries and only very limited numbers were observed e.g. in the River Ohcejohka/Utsjoki. A more thorough study on pink salmon occurrence and distribution within the Tana/Teno system is being planned for coming years.

# 3 Assessment of fisheries changes with new fishing rules

Salmon belonging to the Tana/Teno watershed are exploited extensively during their spawning migration when they migrate along the coast of northern Norway, in the Tana/Teno main stem and in their respective home tributaries. The total exploitation in the period 2006-2019 varied between 54 % (2018) and 71 % (2007). On average, the total exploitation was 67 % in 2006-2016 (the old fishing rules) and 58 % in 2017-2019 (the new fishing rules).

Distributed between countries, the total catch (river and coast) proportion of Norway varied from 55 % (2006, 2012) to 73 % (2018) (Figure 19). On average, the total catch proportion were 58 % Norway and 42 % Finland under the old fishing rules and 68 % Norway and 32 % Finland under the new fishing rules. Looking at river catch only, the catch proportion of Norway varied from 42 % (2006, 2009) to 57 % (2018) (Figure 19). On average, the river catch proportions were 45 % Norway and 55 % Finland under the old fishing rules and 53 % Norway and 47 % Finland under the new fishing rules.

Within Norway, the catch of locals with gillnet fishing rights accounted for from 46 % (2017) to 74 % (2007) of the Norwegian river catch of Tana/Teno salmon (Figure 20). The proportion caught by other locals varied from 15 % (2018) to 27 % (2006) while tourists accounted for 6 % (2016) to 28 % (2017) of the catch. On average, the proportion caught by locals with gillnet fishing rights changed from 68 % under the old rules to 55 % with the new rules. The proportions caught by other locals changed from 23 % to 21 % and for tourists from 9 % to 24 %.

In Finland, the catch of locals with gillnet fishing rights accounted for from 39 % (2009, 2016) to 55 % (2018) of the Finnish river catch of Tana/Teno salmon (Figure 20). The proportion caught by other locals varied from 7 % (2008) to 16 % (2016, 2019) while tourists accounted for 29 % (2018) to 52 % (2008). The catch of cabin owners was part of the tourist catch in the years 2006-2016, after 2017 the cabin owners have accounted for 2 % (2018) to 10 % (2019) of the Finnish catch. On average, the proportion caught by locals with gillnet fishing rights changed from 42 % under the old rules to 45 % with the new rules. The proportions for other locals changed from 10 % to 14 %, for tourists from 47 % to 36 % and cabin owners from 0 to 5 %.

Combined for the two countries, the catch of locals with gillnet fishing rights accounted for 43 % (2017) to 61 % (2018) of the total river catch of Tana/Teno salmon (Figure 20). The proportion caught by other locals varied from 13 % (2007, 2012) to 20 % (2017) while tourists accounted for 23 % (2018) to 35 % (2017). The catch of cabin owners was part of the tourist catch in the years 2006-2016, after 2017 the cabin owners have accounted for 1 % (2018) to 5 % (2019) of the total catch. On average, the proportion caught by locals with gillnet fishing rights changed from 54 % under the old rules to 50 % with the new rules. The proportion caught by other locals changed from 16 % to 18 %. The catch proportion of tourists was 30 % both under the old and new fishing rules while the catch proportion of cabin owners went from 0 to 2 %.

The combined exploitation rate for locals with gillnet fishing rights have changed from 33 % under the old fishing rules to 25 % under the new rules. The exploitation rates of other locals have changed from 10 % to 9 %, of tourists from 18 % to 14 %, and for cabin owners from 0 % to 1 %.

One cautious note: When interpreting the national changes in proportions between fisherman groups, it is important to be aware that the new fishing rules intentionally changed the distribution between countries for tourists. This will in itself affect the observed proportions. This analysis is not sufficient if the objective is to estimate the relative burden that the new fishing rules have imposed on the different groups. To answer that, it is necessary to look specifically at the three years with new fishing rules and compare the observed catch levels with the catch that would have been expected in these three years with the old fishing rules.

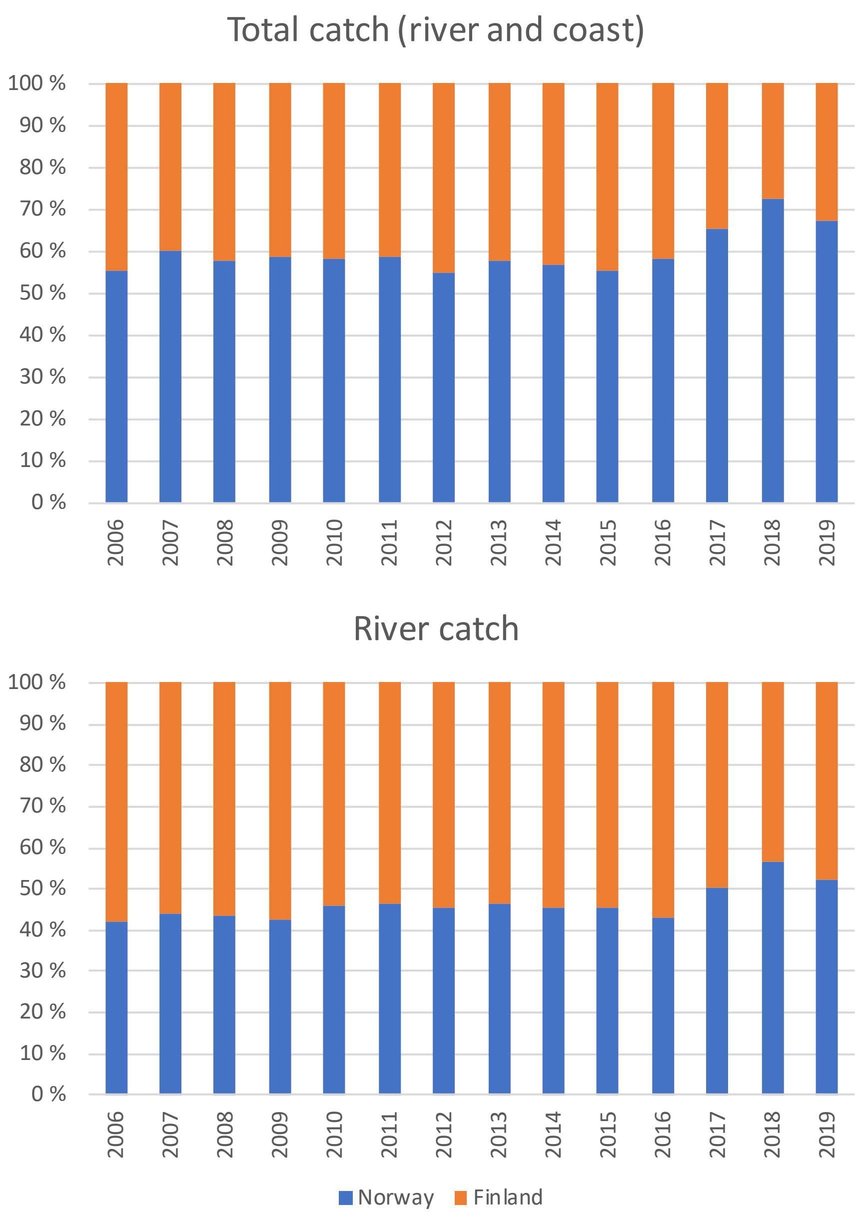


*Figure 19. Distribution of catch of Tana/Teno salmon between Norway and Finland for the years 2006-2019. The top graph shows the total catch distribution, with coastal and river catch combined, while the bottom graph shows river catch distribution only.*

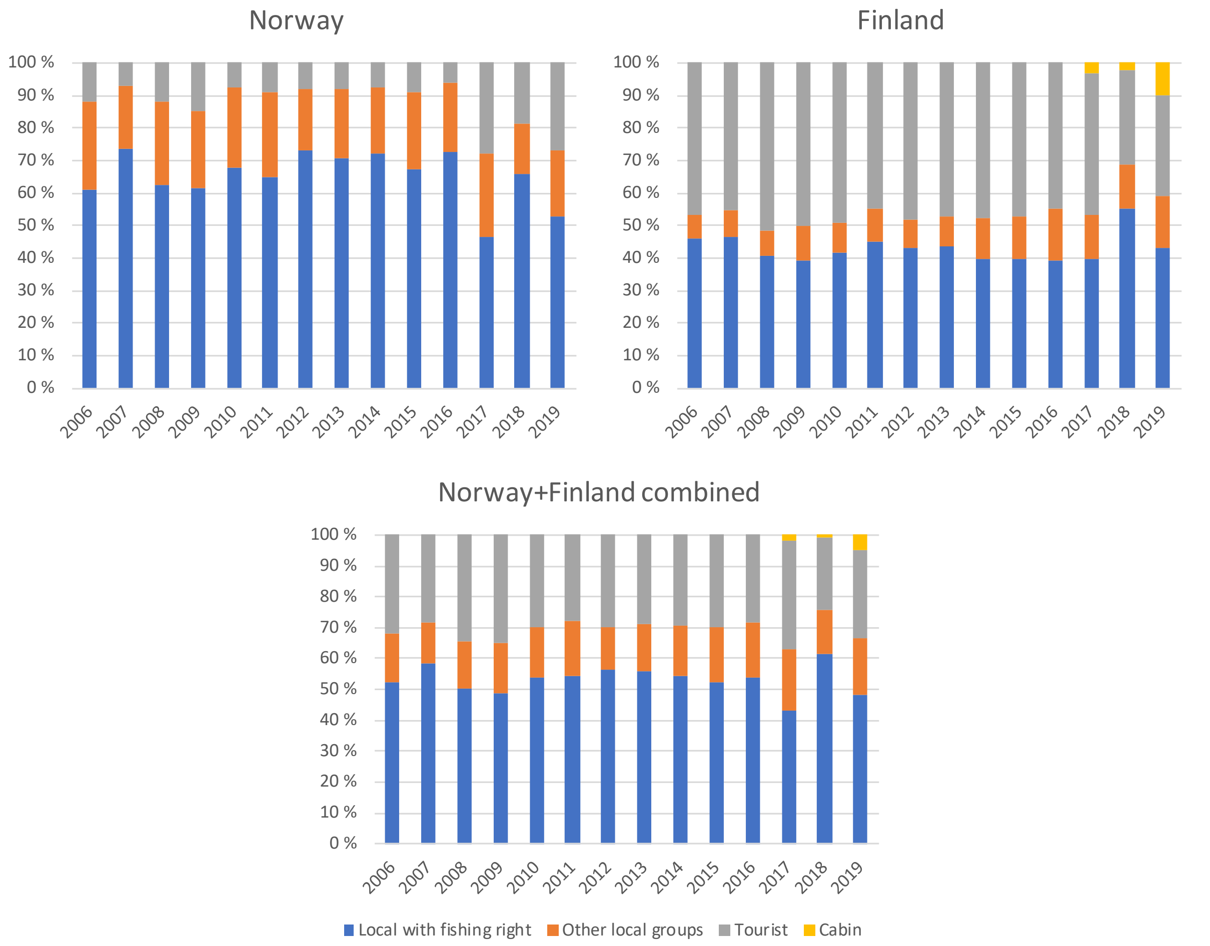


*Figure 20. The distribution of catch between groups of fishermen in the two respective countries (top) and Norway and Finland combined (bottom) in the period 2006-2019.*

Within Norway, driftnet accounted for from 10 % (2006, 2018) to 28 % (2008) of the Norwegian river catch of Tana/Teno salmon (Figure 21). The proportion caught with weir varied from 14 % (2017) to 38 % (2012, 2013. 2018), gillnet varied from 10 % (2011) to 19 % (2014), local rod from 18 % (2018) to 42 % (2006) and tourists (other rod) from 6 % (2016) to 28 % (2017). On average, the proportion caught with driftnet changed from 19 % under the old rules to 12 % under the new rules. The proportions for weir went from 30 % to 25 %, for gillnet from 14 % to 14 %, for local rod from 28 % to 25 % and tourists from 9 % to 24 %.

Within Finland, driftnet accounted for from 3 % (2019) to 9 % (2007) of the Finnish river catch of Tana/Teno salmon (Figure 21). The proportion caught with weir varied from 2 % (2017) to 10 % (2006, 2018), gillnet varied from 10 % (2017) to 15 % (2012), local rod from 24 % (2006-2008, 2013) to 39 % (2019) and other rod (tourists, cabin owners) from 31 % (2018) to 52 % (2007). On average, the proportion caught with driftnet changed from 6 % under the old rules to 4 % under the new rules. The proportions for weir went from 7 % to 6 %, for gillnet from 13 % to 11 %, for local rod from 25 % to 38 % and tourists from 48 % to 40 %.

Combined for the two countries, driftnet accounted for from 8 % (2006, 2009, 2017) to 16 % (2007, 2016) of the total river catch of Tana/Teno salmon (Figure 21). The proportion caught with weir varied from 8 % (2017) to 26 % (2018), gillnet varied from 11 % (2010, 2019) to 15 % (2012, 2014, 2015), local rod from 23 % (2007) to 35 % (2017) and other rod (tourists, cabin owners) from 24 % (2018) to 37 % (2017). On average, the proportion caught with driftnet changed from 12 % under the old rules to 8 % under the new rules. The proportions for weir went from 17 % to 16 %, for gillnet from 13 % to 13 %, for local rod from 26 % to 31 % and tourists from 31 % to 32 %.

The combined exploitation rate of driftnet have changed from 7 % under the old fishing rules to 4 % under the new rules. The exploitation rates of weir have changed from 10 % to 8 %, of gillnet from 8 % to 6 %, for local rod from 16 % to 15 % and other rod (tourists, cabin owners) from 18 % to 15 %.

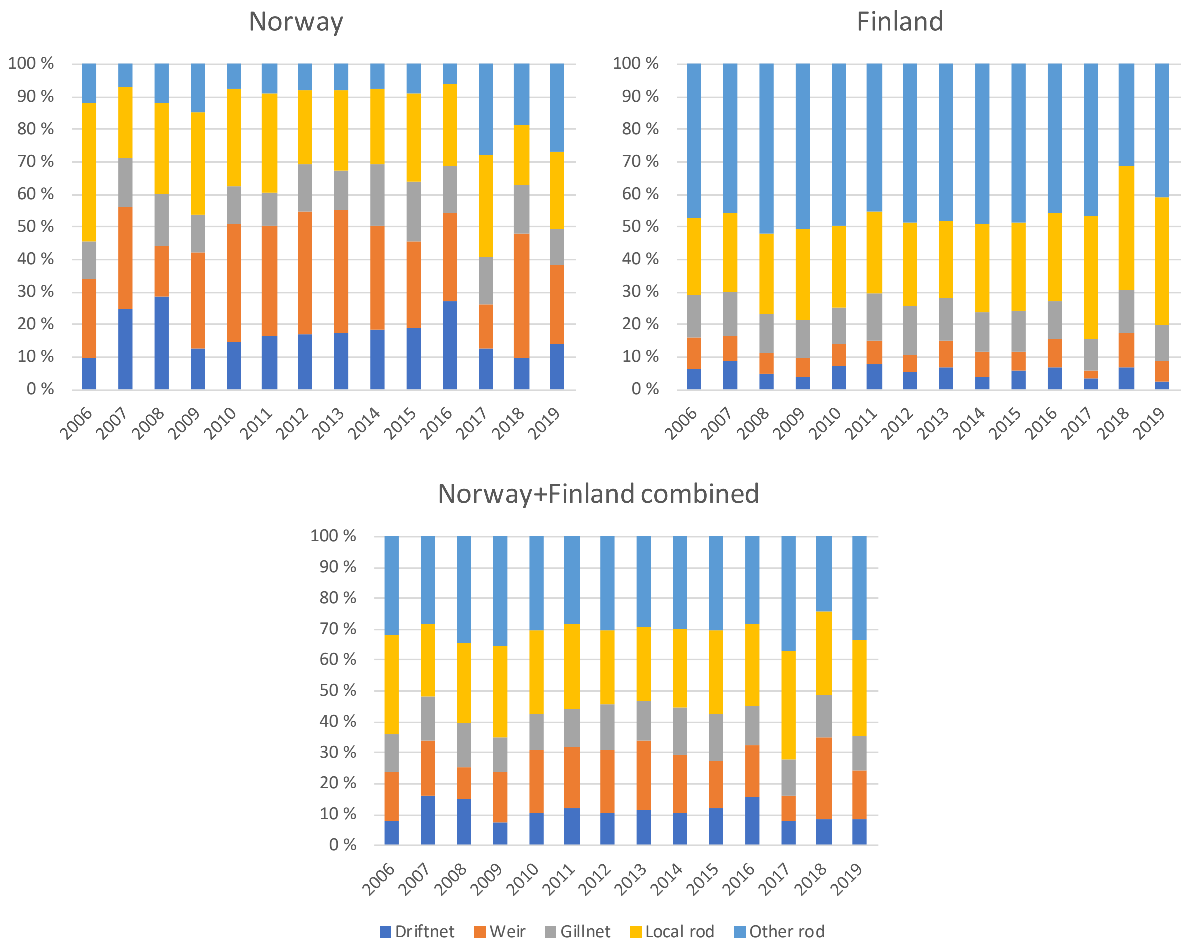


*Figure 21. The distribution of catch between fishing gear in the two respective countries (top) and Norway and Finland combined (bottom) in the period 2006-2019.*

# 4 Stock status assessment

## 4.1 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.

### 4.1.1 Status assessment

The spawning target for the Tana 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 MS stock:

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

The data input for the variables in this formula are summarized in Table 2. Female proportions in Table 2 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 other years before 2018 are based on the size composition of the main stem catch and the 5-year Genmix average female proportion of different size groups weighted with 50 % of the up or down variation of the annual female proportion observed in the Tana scale sampling project.

There are 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. 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 main stem before reaching their respective home rivers and therefore likely provide an accurate estimate of the main stem exploitation experienced by the Tana MS stock. An exploitation rate of 60 % was therefore selected for the Tana 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 and tributary counting indicate a further reduced exploitation rate, and the exploitation estimate for 2018 was therefore set to 38 %, representing a 33 % reduction in exploitation with the implementation of a new agreement (Table 2). Monitoring information from 2019 indicated an exploitation rate of 39 %.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 2 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 22 189 kg as the mode, 16 642 kg as the minimum and 33 284 kg as the maximum value.

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

*Table 2. Summary of stock data used to estimate annual spawning stock sizes of the Tana MS stock.*

| Year | Total main stem catch (kg) | Tana MS proportion | Tana MS catch (kg) | Exploitation rate | Female proportion |
|---|---|---|---|---|---|
| 2006 | 88 873 | 0.4358 | 38 731 | 0.60 | 0.47 |
| 2007 | 88 443 | 0.4443 | 39 298 | 0.60 | 0.62 |
| 2008 | 104 659 | 0.5820 | 60 907 | 0.60 | 0.63 |
| 2009 | 53 450 | 0.4667 | 24 945 | 0.60 | 0.50 |
| 2010 | 75 340 | 0.4667 | 35 161 | 0.60 | 0.53 |
| 2011 | 68 256 | 0.4902 | 33 457 | 0.60 | 0.52 |
| 2012 | 91 636 | 0.3771 | 34 550 | 0.60 | 0.51 |
| 2013 | 68 344 | 0.4667 | 31 896 | 0.60 | 0.53 |
| 2014 | 83 312 | 0.4667 | 38 881 | 0.60 | 0.51 |
| 2015 | 65 287 | 0.4667 | 30 469 | 0.60 | 0.55 |
| 2016 | 72 814 | 0.4667 | 33 982 | 0.60 | 0.57 |
| 2017 | 52 880 | 0.4679 | 24 679 | 0.55 | 0.61 |
| 2018 | 41 673 | 0.4679 | 14 294 | 0.38 | 0.49 |
| 2019 | 33 556 | 0.4679 | 11 510 | 0.39 | 0.57 |

The spawning target attainment was 61 % in 2019 and the probability for meeting the spawning target was 1 %. The management target was not reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 1 % with an overall attainment of 60 % (Figure 22).

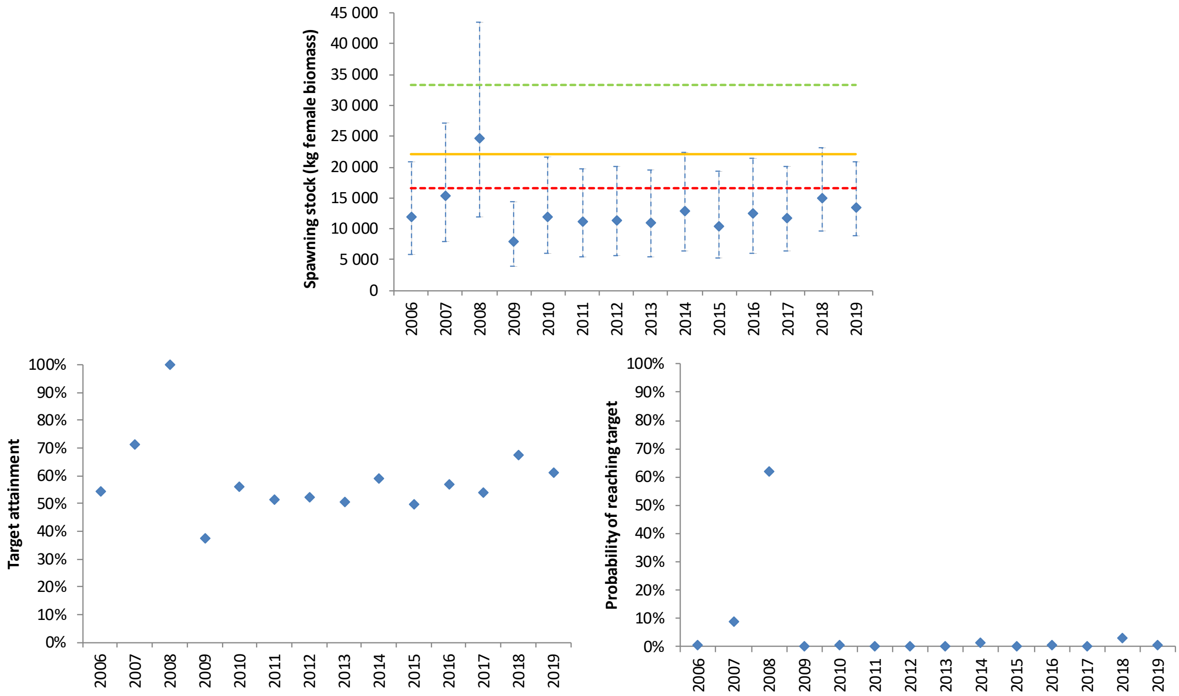


*Figure 22. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 for the Tana MS stock.*

### 4.1.2 Exploitation

The estimated total exploitation rate (based on weight) of Tana MS salmon was 60 % in the years 2016-2019 (Figure 23), with 20 % of the pre-fishery abundance caught in coastal fisheries and 39 % in main stem fisheries. The average estimated total pre-fishery abundance for Tana MS salmon was 59 356 kg and the average total catch was 35 518 kg in the period 2016-2019.

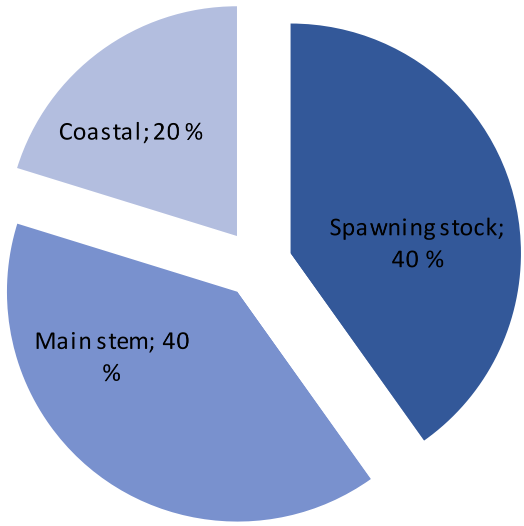


*Figure 23. The total amount of salmon belonging to Tana MS in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal or main stem fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal or main stem fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 3.

*Table 3. Relative exploitation rates of Tana MS salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | 2016-2019 | 2006-2016 | 2018-2019 |
|---|---|---|---|
| Coastal | 20 % | 17 % | 20 % |
| Main stem | 50 % | 61 % | 39 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Tana MS salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation varied between 32 % (2018) and 47 % (2017). The average overexploitation was estimated at 41 %. This means that exploitation on average was responsible for reducing the spawning stock size by an amount of 41 % below the spawning target. Maximum sustainable exploitation varied between 19 % (2019) and 44 % (2016). The average maximum sustainable total exploitation rate in the period was 32 %, significantly lower than the estimated average total exploitation of 60 %.

### 4.1.3 Stock recovery

In a previous report (Anon. 2018), we advised a 19 % reduction in the total river exploitation rate of Tana MS salmon from the 2006-2016 level in order to achieve stock recovery over two generations. The current evaluation indicates that river exploitation has been reduced from 61 to 39 %, which corresponds to a 35 % reduction in exploitation. The stock recovery model indicates that this level of reduction is sufficiently high to allow for stock recovery after one generation.

## 4.2 Máskejohka

Máskejohka is the lowermost major tributary in the Tana River system, entering the Tana approximately 28 km upstream from the Tana estuary. It is a middle-sized river with a total of 55 km available for salmon of which 30 km constitutes the main Máskejohka. The lowermost 10 km of the main river is slow-flowing and meandering with very little production area 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.

### 4.2.1 Status assessment

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 4. Female proportions in Table 4 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.

Ascending salmon have not been counted so far in Máskejohka, so the exploitation estimates must 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 first years of the assessment (Table 4). 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 due to the new fishing regulations that were put in place in 2017 and difficult fishing conditions (Table 4).

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

*Table 4. Summary of stock data used to estimate annual spawning stock sizes in Máskejohka.*

| Year | Catch kg(<3 kg) | Catch kg (3-7 kg) | Catch kg (>7 kg) | Expl. rate (<3 kg) | Expl. rate (3-7 kg) | Expl. rate (>7 kg) | Female prop. (<3 kg) | Female prop. (3-7 kg) | Female prop. (>7 kg) | Main stem prop. |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 1 097 | 714 | 102 | 0.50 | 0.40 | 0.30 | 0.14 | 0.73 | 0.39 | 0.0175 |
| 2007 | 427 | 672 | 192 | 0.50 | 0.40 | 0.30 | 0.34 | 0.74 | 0.46 | 0.0346 |
| 2008 | 740 | 889 | 691 | 0.50 | 0.40 | 0.30 | 0.06 | 0.59 | 0.87 | 0.0086 |
| 2009 | 731 | 449 | 307 | 0.50 | 0.40 | 0.30 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2010 | 620 | 1 020 | 330 | 0.50 | 0.40 | 0.30 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2011 | 429 | 608 | 405 | 0.50 | 0.40 | 0.30 | 0.04 | 0.77 | 0.66 | 0.0155 |
| 2012 | 726 | 783 | 260 | 0.50 | 0.40 | 0.30 | 0.11 | 0.86 | 0.60 | 0.0095 |
| 2013 | 388 | 478 | 113 | 0.45 | 0.35 | 0.25 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2014 | 534 | 754 | 208 | 0.45 | 0.35 | 0.25 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2015 | 663 | 488 | 167 | 0.40 | 0.30 | 0.20 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2016 | 485 | 801 | 252 | 0.40 | 0.30 | 0.20 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2017 | 202 | 705 | 244 | 0.36 | 0.27 | 0.18 | 0.15 | 0.74 | 0.56 | 0.0183 |
| 2018 | 346 | 371 | 139 | 0.33 | 0.25 | 0.16 | 0.15 | 0.74 | 0.56 | 0.0183 |
| 2019 | 197 | 407 | 94 | 0.33 | 0.25 | 0.16 | 0.15 | 0.74 | 0.56 | 0.0183 |

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 82 % in 2019 and the probability of meeting the spawning target was 11 %. The management target was not reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 70 % with an overall attainment of 112 % (Figure 24).

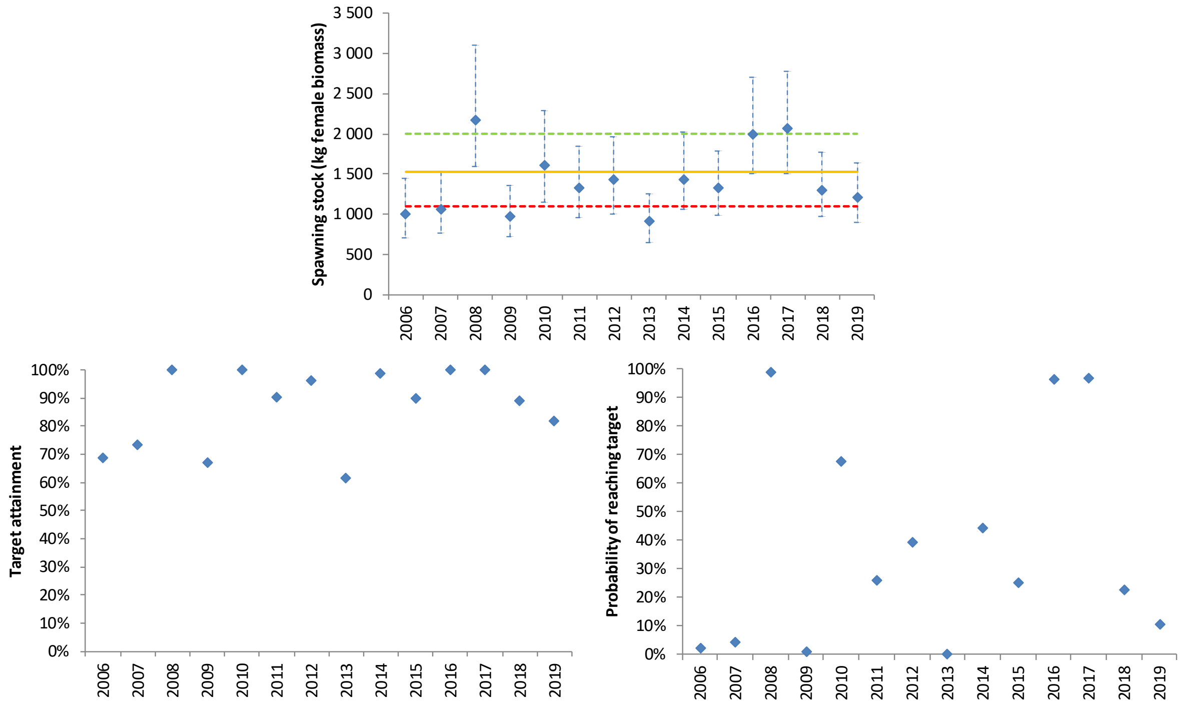


*Figure 24. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 in the Norwegian tributary Máskejohka.*

### 4.2.2 Exploitation

The estimated total exploitation rate (based on weight) of Máskejohka salmon was 49 % in the years 2016-2019 (Figure 25), with 17 % of the pre-fishery abundance caught in coastal fisheries, 15 % in main stem fisheries and 18 % in Máskejohka. The average estimated total pre-fishery abundance for Máskejohka salmon was 6 004 kg and the average total catch was 2 952 kg in the period 2016-2019.

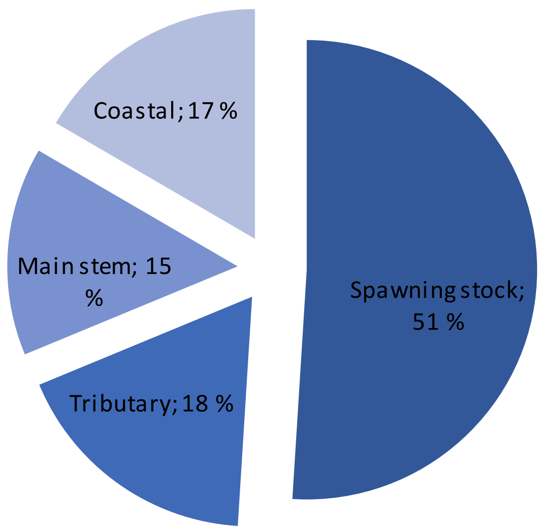


*Figure 25. The total amount of salmon belonging to Máskejohka in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Máskejohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 5.

*Table 5. Relative exploitation rates of Máskejohka salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | 2016-2019 | 2006-2016 | 2018-2019 |
|---|---|---|---|
| Coastal | 17 % | 13 % | 17 % |
| Main stem | 18 % | 23 % | 17 % |
| Tributary | 26 % | 36 % | 24 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Máskejohka salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation varied between 0 % (2016, 2017) and 20 % (2019). The average overexploitation was estimated at 9 %. This means that exploitation on average was responsible for reducing the spawning stock size by an amount of 9 % below the spawning target. Maximum sustainable exploitation varied between 20 % (2019) and 55 % (2017). The average maximum sustainable total exploitation rate in the period was 39 %, lower than the estimated average total exploitation of 49 %.

### 4.2.3 Stock recovery

Management target attainment of the Máskejohka stock is at 71 %, well above the threshold of 40 % that indicates the need for a recovery plan. The current evaluation indicates that the main stem plus tributary exploitation of the Máskejohka stock has been reduced from 51 to 37 %, which corresponds to a 27 % reduction in exploitation.

The estimates of maximum sustainable exploitation and the total exploitation of Máskejohka-salmon indicate that over the last four years, the total exploitation has been slightly higher than the estimated maximum sustainable exploitation. The exploitation of Máskejohka-salmon must therefore be monitored closely to ensure that exploitation rates are kept at a reasonable level compared to the maximum sustainable exploitation rate.

## 4.3 Buolbmátjohka/Pulmankijoki

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

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

### 4.3.1 Status assessment

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

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

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

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

The data input for the variables in this formula are summarized in Table 6. Female proportions in Table 6 are based on the sex distribution observed in the autumn snorkeling counts.

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

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

*Exploitation rate = Catch / (Spawning count + Catch)*

*Table 6. Summary of stock data used to estimate annual spawning stock sizes in Buolbmátjohka/Pulmankijoki.*

| Year | Catch (kg) | Snorkeling count | Snorkeling 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 | 0.0046 |
| 2018 | 856 | 131 | 0.70 | 0.2 | 0.39 | 0.42 | 0.0046 |
| 2019 | 435 | 89 | 0.80 | 0.2 | 0.26 | 0.66 | 0.0046 |

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 511 kg as the mode, 383 kg as the minimum and 767 kg as the maximum value.

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

The spawning target attainment was 155 % in 2019 and the probability of meeting the spawning target was 98 %. The management target was reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 80 % with an overall attainment of 123 % (Figure 26).

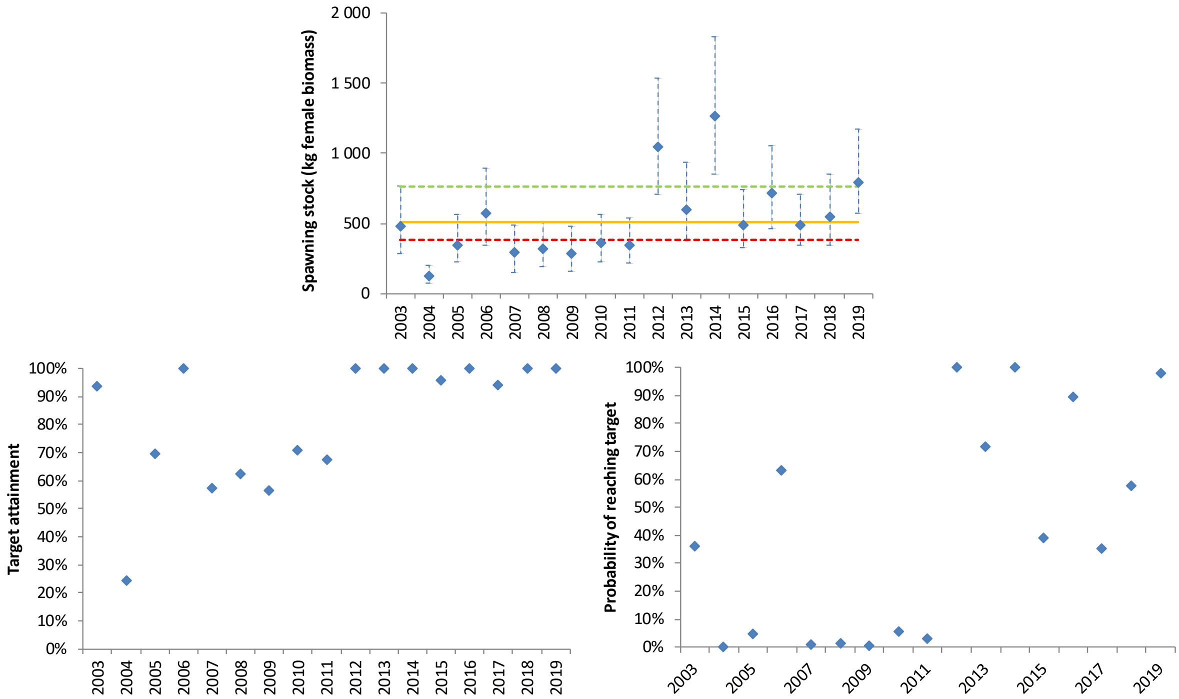


*Figure 26. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2019 in the Norwegian/Finnish tributary Buolbmátjohka/Pulmankijoki.*

### 4.3.2 Exploitation

The estimated total exploitation rate (based on weight) of Buolbmátjohka/Pulmankijoki salmon was 49 % in the years 2016-2019 (Figure 27), with 13 % of the pre-fishery abundance caught in coastal fisheries, 10 % in main stem fisheries and 25 % in Buolbmátjohka/Pulmankijoki (=Lake Pulmankijärvi). The average estimated total pre-fishery abundance for Buolbmátjohka/Pulmankijoki salmon was 2 262 kg and the average total catch was 1 109 kg in the period 2016-2019.

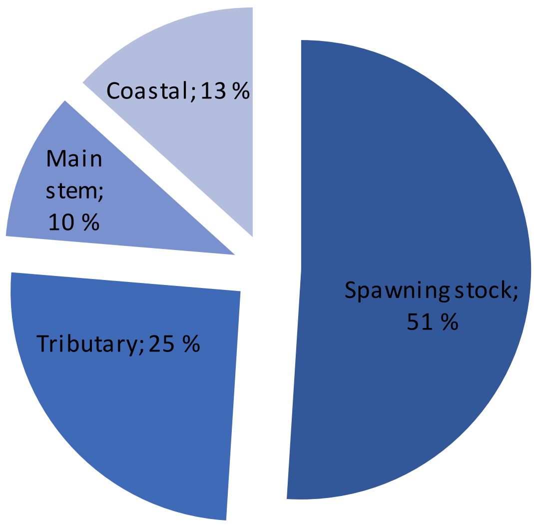


*Figure 27. The total amount of salmon belonging to Buolbmátjohka/Pulmankijoki in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Buolbmátjohka/Pulmankijoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 7.

*Table 7. Relative exploitation rates of Buolbmátjohka/Pulmankijoki salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | **2016-2019** | **2006-2016** | **2018-2019** |
|---|---|---|---|
| Coastal | 13 % | 10 % | 13 % |
| Main stem | 12 % | 16 % | 8 % |
| Tributary | 33 % | 41 % | 34 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Buolbmátjohka/Pulmankijoki salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation varied between 0 % (2016, 2018-2019) and 5 % (2017). The average overexploitation was estimated at 1 %. This means that exploitation on average was responsible for reducing the spawning stock size by an amount of 1 % below the spawning target. Maximum sustainable exploitation varied between 32 % (2017) and 55 % (2016). The average maximum sustainable total exploitation rate in the period was 43 %, lower than the estimated average total exploitation of 49 %.

### 4.3.3 Stock recovery

Management target attainment of the Buolbmátjohka/Pulmankijoki stock is at 80 %, well above the threshold of 40 % that indicates the need for a recovery plan. The current evaluation indicates that the main stem plus tributary exploitation of the Buolbmátjohka/Pulmankijoki stock has been reduced from 51 to 39 %, which corresponds to a 23 % reduction in exploitation.

## 4.4 Lákšjohka

Lákšjohka is a small- to medium-sized tributary that enters the Tana 77 km upstream from the Tana 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. Problems with the ladder will therefore directly limit salmon production in Lákšjohka.

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 small 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 kg and 2SW fish 2-3 kg. Fish larger than 7 kg are rarely caught.

### 4.4.1 Status assessment

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 8. Female proportions in Table 8 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 % (Table 8).

To account for uncertainty, the exploitation rate and female proportion estimates in Table 8 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.

*Table 8. 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 | 0.0065 |
| 2018 | 39 | 26 | 0 | 0.06 | 0.06 | 0.06 | 0.71 | 0.61 | 0.50 | 0.0065 |
| 2019 | 74 | 35 | 0 | 0.18 | 0.15 | 0.15 | 0.71 | 0.61 | 0.50 | 0.0065 |

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 29 % in 2019 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 0 % with an overall attainment of 48 % (Figure 28).

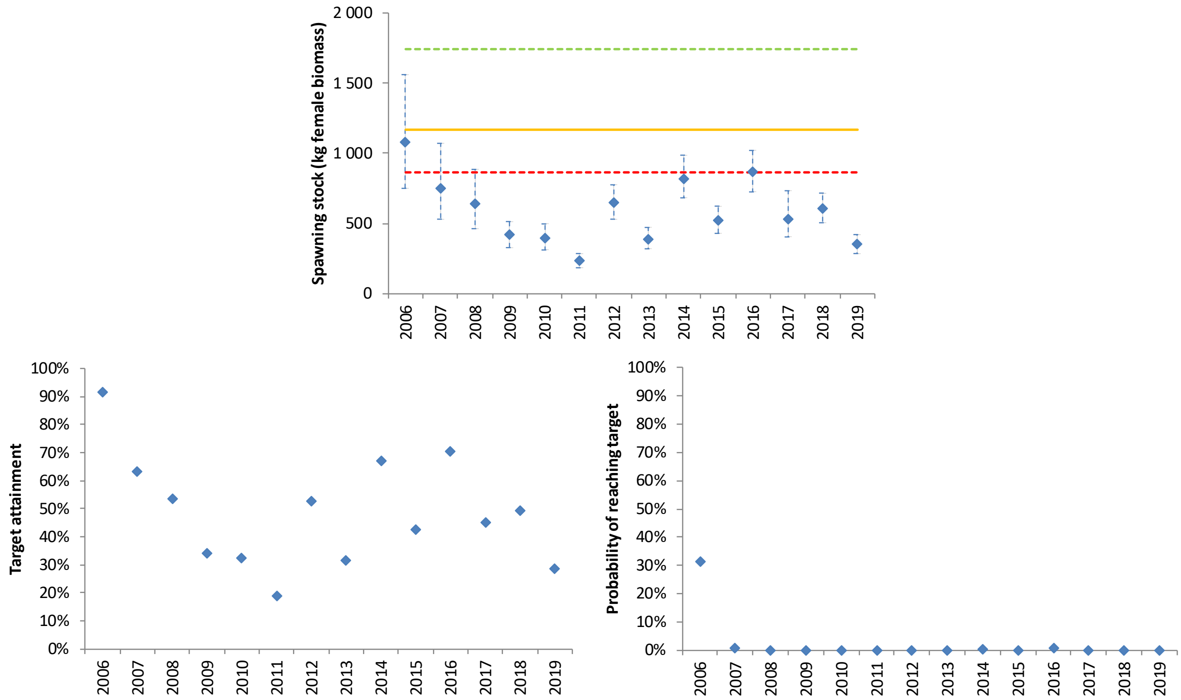


*Figure 28. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 in the Norwegian tributary Lákšjohka.*

### 4.4.2 Exploitation

The estimated total exploitation rate (based on weight) of Lákšjohka salmon was 46 % in the years 2016-2019 (Figure 29), with 18 % of the pre-fishery abundance caught in coastal fisheries, 22 % in main stem fisheries and 6 % in Lákšjohka. The average estimated total pre-fishery abundance for Lákšjohka salmon was 1 605 kg and the average total catch was 730 kg in the period 2016-2019.

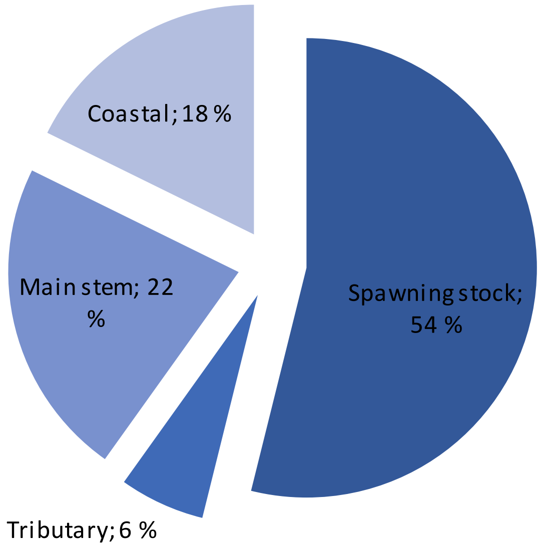


*Figure 29. The total amount of salmon belonging to Lákšjohka in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Lákšjohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 9.

*Table 9. Relative exploitation rates of Lákšjohka salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | **2016-2019** | **2006-2016** | **2018-2019** |
|---|---|---|---|
| Coastal | 18 % | 14 % | 17 % |
| Main stem | 26 % | 34 % | 24 % |
| Tributary | 10 % | 24 % | 11 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Lákšjohka salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation varied between 26 % (2016) and 40 % (2017). The average overexploitation was estimated at 33 %. This means that exploitation on average was responsible for reducing the spawning stock size by an amount of 33 % below the spawning target. Maximum sustainable exploitation varied between 0 % (2017-2019) and 23 % (2016). A maximum exploitation of 0 % indicates no exploitable surplus. The average maximum sustainable total exploitation rate in the period was 6 %, significantly lower than the estimated average total exploitation of 46 %.

### 4.4.3 Stock recovery

In a previous report (Anon. 2018), we advised a 23 % reduction in the total river exploitation rate of Lákšjohka salmon from the 2006-2016 level in order to achieve stock recovery over two generations.

The current evaluation indicates that the main stem plus tributary exploitation of the Lákšjohka stock has been reduced from 50 to 32 %, which corresponds to a 36 % reduction in exploitation. The stock recovery model indicate that this level of reduction is sufficiently high to allow for stock recovery after one generation.

## 4.5 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.

### 4.5.1 Status assessment

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

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

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

The data input for the variables in this formula are summarized in Table 10. Female proportions in Table 10 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are the 5-year average from Genmix weighted with 50 % of the up or down variation of the annual female proportion observed in the Tana scale sampling project.

Ascending salmon was counted in Vetsijoki with an acoustic counting system (ARIS) in 2016. The results indicate an exploitation of under 15 % in Vetsijoki and 15 % was selected as the exploitation rate in 2016. The level of catch within Vetsijoki compared to the estimated proportion in the Tana MS indicates a 15 % exploitation also in the following years (Table 10).

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

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

*Table 10. Summary of stock data used to estimate annual spawning stock sizes in Veahčajohka/Vetsijoki.*

| Year | Catch (kg) | Exploitation rate | Female proportion | Main stem proportion |
|---|---|---|---|---|
| 2006 | 860 | 0.20 | 0.63 | 0.0390 |
| 2007 | 560 | 0.20 | 0.71 | 0.0256 |
| 2008 | 415 | 0.20 | 0.56 | 0.0192 |
| 2009 | 630 | 0.20 | 0.52 | 0.0290 |
| 2010 | 930 | 0.20 | 0.56 | 0.0290 |
| 2011 | 485 | 0.20 | 0.57 | 0.0311 |
| 2012 | 755 | 0.20 | 0.51 | 0.0305 |
| 2013 | 375 | 0.20 | 0.56 | 0.0290 |
| 2014 | 1 020 | 0.20 | 0.52 | 0.0290 |
| 2015 | 885 | 0.20 | 0.57 | 0.0290 |
| 2016 | 755 | 0.15 | 0.56 | 0.0290 |
| 2017 | 406 | 0.15 | 0.58 | 0.0604 |
| 2018 | 603 | 0.15 | 0.52 | 0.0604 |
| 2019 | 545 | 0.15 | 0.56 | 0.0604 |

The spawning target attainment was 155 % in 2019 and the probability of meeting the spawning target was 100 %. The management target was reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 99 % with an overall attainment of 161 % (Figure 30).

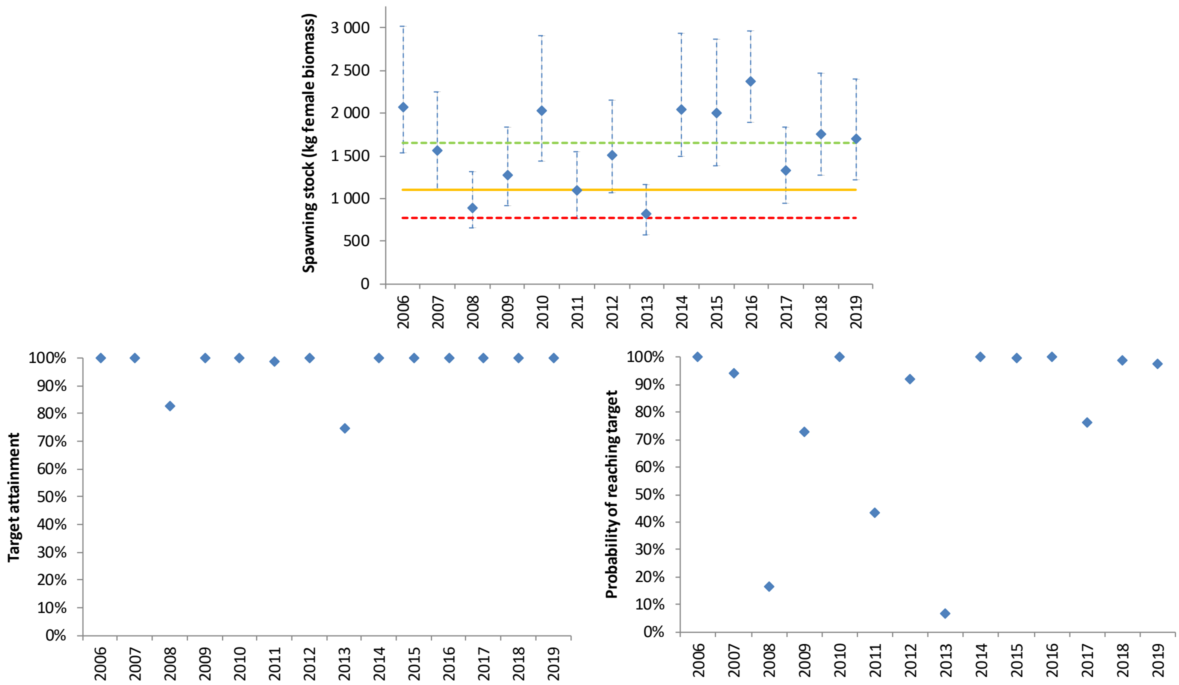


*Figure 30. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 in the Finnish tributary Veahčajohka/Vetsijoki.*

## 4.5.2 Exploitation

The estimated total exploitation rate (based on weight) of Veahčajohka/Vetsijoki salmon was 58 % in the years 2016-2019 (Figure 31), with 18 % of the pre-fishery abundance caught in coastal fisheries, 32 % in main stem fisheries and 8 % in Veahčajohka/Vetsijoki. The average estimated total pre-fishery abundance for Veahčajohka/Vetsijoki salmon was 7 672 kg and the average total catch was 4 460kg in the period 2016-2019.

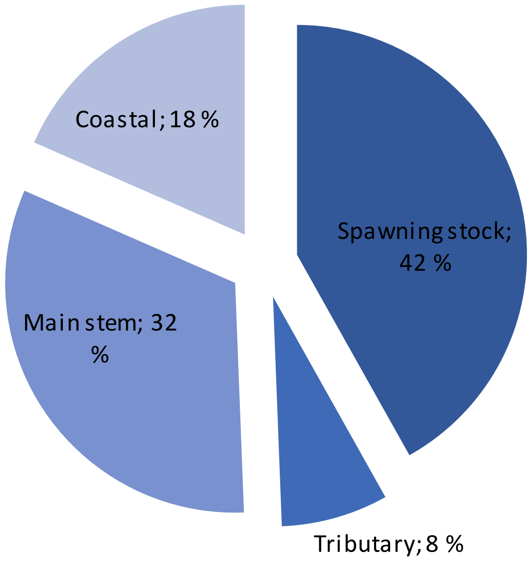


*Figure 31. The total amount of salmon belonging to Veahčajohka/Vetsijoki in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Veahčajohka/Vetsijoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 11.

*Table 11. Relative exploitation rates of Veahčajohka/Vetsijoki salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | **2016-2019** | **2006-2016** | **2018-2019** |
|---|---|---|---|
| Coastal | 18 % | 15 % | 18 % |
| Main stem | 39 % | 39 % | 38 % |
| Tributary | 15 % | 20 % | 15 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Veahčajohka/Vetsijoki salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation was 0 % for all years and the average overexploitation was therefore also estimated at 0 %. Maximum sustainable exploitation varied between 68 % (2017) and 75 % (2016). The average maximum sustainable total exploitation rate in the period was 72 %, higher than the estimated average total exploitation of 55 %.

### 4.5.3 Stock recovery

Management target attainment of the Veahčajohka/Vetsijoki stock is at 99 %, well above the threshold of 40 % that indicates the need for a recovery plan. The current evaluation indicates that the main stem plus tributary exploitation of the Veahčajohka/Vetsijoki stock has been reduced from 51 to 47 %, which corresponds to a 7 % reduction in exploitation.

## 4.6 Ohcejohka/Utsjoki + tributaries

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

### 4.6.1 Status assessment

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

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

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

The data input for the variables in this formula are summarized in Table 12. Female proportions in Table 12 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are the 5-year average from Genmix weighted with 50 % of the up or down variation of the annual female proportion observed in the Tana scale sampling project.

A video camera setup has counted the number of ascending salmon in Utsjoki since 2002. Annual exploitation rates can therefore be estimated from the video counts and used in the status evaluation. There were problems with water level during 2017 which might have caused many salmon to pass without being counted. The video counts in 2017 were therefore treated as a minimum estimate and we added 30 % as an estimate of the most likely number of ascending salmon and 60 % as an estimate of the maximum number. Conditions for monitoring in 2018 and 2019 were very good.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 12 were treated as modal values, with a 10 % uncertainty used to estimate minimum and maximum values of exploitation for all years. In all years, 10 % uncertainty was used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 2 059 kg as the mode, 1 486 kg as the minimum and 2 972 kg as the maximum value.

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

*Table 12. Summary of stock data used to estimate annual spawning stock sizes in Ohcejohka/Utsjoki. In 2018 and 2019 data the sea-age groups are combined.*

| Year | Catch (kg) | Video count (1SW) | Video count (MSW) | Avg. size (1SW) | Avg. size (MSW) | Expl. rate | Female proportion | Main stem proportion |
|---|---|---|---|---|---|---|---|---|
| 2002 | 1 965 | 2 744 | 345 | 1.59 | 3.59 | 0.35 | 0.61 | |
| 2003 | 1 305 | 2 308 | 274 | 1.59 | 3.59 | 0.28 | 0.61 | |
| 2004 | 800 | 1 202 | 95 | 1.59 | 3.59 | 0.36 | 0.62 | |
| 2005 | 1 400 | 2 699 | 47 | 1.59 | 3.59 | 0.31 | 0.58 | |
| 2006 | 2 375 | 6 555 | 109 | 1.61 | 3.61 | 0.22 | 0.61 | 0.0451 |
| 2007 | 1 945 | 3 251 | 167 | 1.39 | 3.29 | 0.38 | 0.66 | 0.0506 |
| 2008 | 2 605 | 2 061 | 307 | 1.32 | 3.58 | 0.68 | 0.69 | 0.0403 |
| 2009 | 2 095 | 3 712 | 124 | 1.59 | 3.59 | 0.33 | 0.57 | 0.0432 |
| 2010 | 1 305 | 1 932 | 377 | 1.59 | 3.59 | 0.30 | 0.61 | 0.0432 |
| 2011 | 1 625 | 3 349 | 534 | 1.59 | 3.86 | 0.22 | 0.58 | 0.0305 |
| 2012 | 2 605 | 5 029 | 868 | 1.75 | 4.16 | 0.21 | 0.61 | 0.0454 |
| 2013 | 1 695 | 4 765 | 367 | 1.59 | 3.59 | 0.19 | 0.61 | 0.0432 |
| 2014 | 2 955 | 3 659 | 1 319 | 1.59 | 3.59 | 0.28 | 0.57 | 0.0432 |
| 2015 | 2 149 | 3 346 | 602 | 1.59 | 3.59 | 0.29 | 0.62 | 0.0432 |
| 2016 | 2 090 | 2 934 | 836 | 1.59 | 3.59 | 0.27 | 0.62 | 0.0432 |
| 2017 | 1 853 | 856 | 509 | 1.59 | 3.59 | 0.45 | 0.64 | 0.0508 |
| 2018 | 1 926 | 4 743 | | 2.67 | | 0.15 | 0.57 | 0.0508 |
| 2019 | 1 557 | 1 650 | | 2.67 | | 0.36 | 0.62 | 0.0508 |

The spawning target attainment was 79 % in 2019 and the probability of meeting the spawning target was 8 %. The management target was reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 100 % with an overall attainment of 170 % (Figure 32).

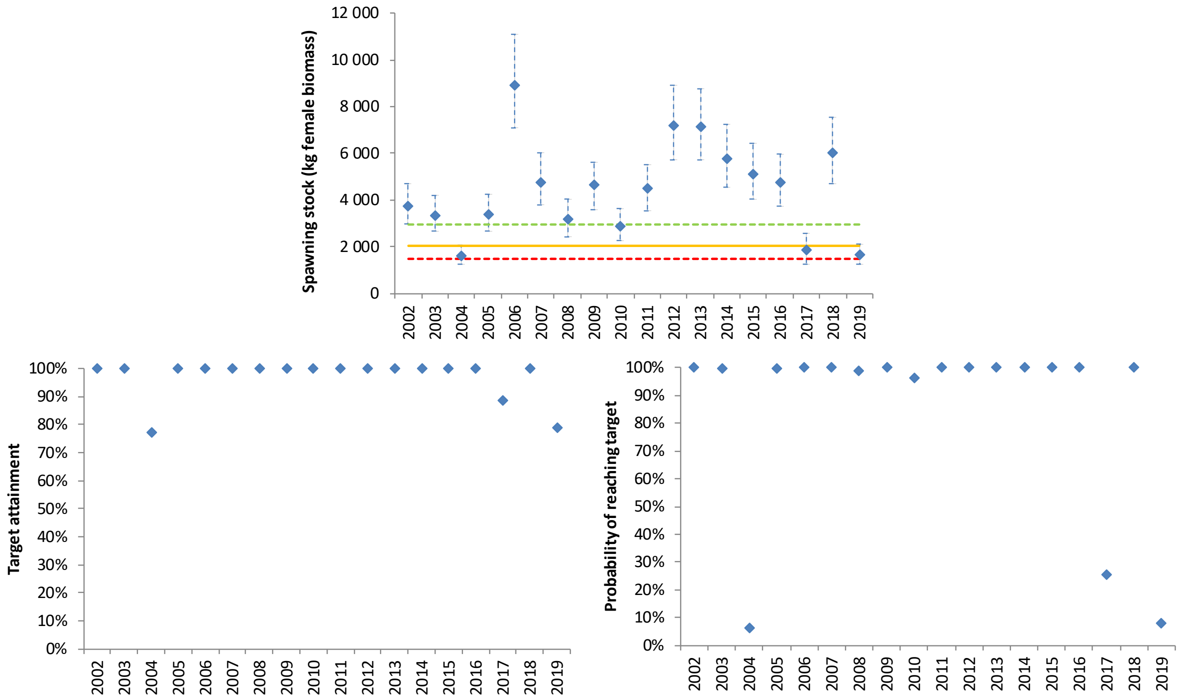


*Figure 32. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2002-2019 in the Finnish tributary Ohcejohka/Utsjoki.*

### 4.6.2 Exploitation

The estimated total exploitation rate (based on weight) of Ohcejohka/Utsjoki salmon was 52 % in the years 2016-2019 (Figure 33), with 17 % of the pre-fishery abundance caught in coastal fisheries, 20 % in main stem fisheries and 15 % in Ohcejohka/Utsjoki. The average estimated total pre-fishery abundance for Ohcejohka/Utsjoki salmon was 12 324 kg and the average total catch was 6 366 kg in the period 2016-2019.

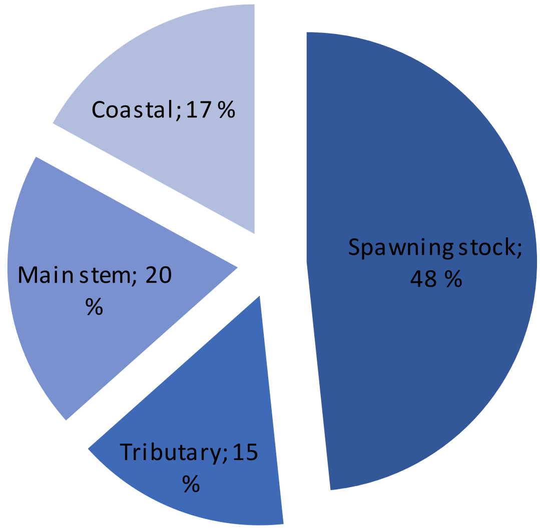


*Figure 33. The total amount of salmon belonging to Ohcejohka/Utsjoki in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Ohcejohka/Utsjoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 13.

*Table 13. Relative exploitation rates of Ohcejohka/Utsjoki salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | **2016-2019** | **2006-2016** | **2018-2019** |
|---|---|---|---|
| Coastal | 17 % | 15 % | 17 % |
| Main stem | 24 % | 24 % | 19 % |
| Tributary | 24 % | 20 % | 21 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Ohcejohka/Utsjoki salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation was 0 % for 2016 and 2018, 10 % in 2017 and 20 % in 2019. The average overexploitation was estimated at 8 %. This means that exploitation on average was responsible for reducing the spawning stock size by an amount of 8 % below the spawning target. Maximum sustainable exploitation varied between 38 % (2019) and 77 % (2018). The average maximum sustainable total exploitation rate in the period was 61 %, higher than the estimated average total exploitation of 52 %.

### 4.6.3 Stock recovery

Management target attainment of the Ohcejohka/Utsjoki stock is at 100 %, well above the threshold of 40 % that indicates the need for a recovery plan. The current evaluation indicates that the main stem plus tributary exploitation of the Ohcejohka/Utsjoki stock has been reduced from 39 to 36 %, which corresponds to a 8 % reduction in exploitation.

## 4.7 Goahppelašjohka/Kuoppilasjoki

Goahppelašjohka/Kuoppilasjoki is a small river entering the Tana main stem from the south c. 125 km upstream from the Tana estuary. The river has a catchment area of 102 $km^2$. There are no evident migration barriers in this river system, so salmon can migrate relatively far upstream. Starting from the lake Kuoppilasjärvi, a 13-km river stretch is available for salmon. A tributary river Birkejohka/Pirkejoki enters Kuoppilasjoki from the southwest direction, and this river also has a small tributary (Goaskinjohka) which is likely supporting annual salmon spawning and juvenile production. An additional 12 km is available in Pirkejoki and Goaskinjohka.

The salmon stock is small-sized, dominated by 1SW and some small 2SW salmon.

### 4.7.1 Status assessment

The Goahppelašjohka/Kuoppilasjoki spawning target is 695 950 eggs (518 426-1 045 925 eggs). The female biomass needed to obtain this egg deposition is 273 kg (203-409 kg) when using a stock-specific fecundity of 2 550 eggs $kg^{-1}$.

The following basic formula estimates the annual spawning stock size for Goahppelašjohka/Kuoppilasjoki:

*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 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.

Historically, there has been no catch statistics from Goahppelašjohka/Kuoppilasjoki and no monitoring or fish counting either. The license selling was changed in 2017 and an estimated catch of 20 kg were caught both in 2017 and 2018. The catch estimate in 2019 was 27 kg. There has been fishing and catches in Goahppelašjohka/Kuoppilasjoki also earlier, but the extent of this is largely unknown. The tributary stock status must therefore be evaluated by alternative means. One feasible approach is to use the proportion of salmon belonging to Goahppelašjohka/Kuoppilasjoki 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 Goahppelašjohka/Kuoppilasjoki salmon in 2006-2008 and 2011-2012 and can use the average from these five years to cover the remaining years in the period 2006-2017. A new SNP-based estimate was used for 2018 and 2019. The main stem exploitation is estimated at 40 % 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 due to the implementation of new fishing rules in Tana. The exploitation estimate was further reduced by 20 % in 2018 as indicated by the combined main stem and tributary fish counting (Table 14).

To account for uncertainty, the exploitation rate and female proportion estimates in Table 14 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation for all years. In all years, 10 % uncertainty was used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 273 kg as the mode, 203 kg as the minimum and 409 kg as the maximum value.

*Table 14. Summary of stock data used to estimate annual spawning stock sizes in Goahppelašjohka/Kuoppilasjoki.*

| Year | Estimated main stem catch (kg) | Main stem proportion | Main stem exploitation rate | Female proportion |
|---|---|---|---|---|
| 2006 | 901 | 0.0101 | 0.40 | 0.35 |
| 2007 | 877 | 0.0099 | 0.40 | 0.54 |
| 2008 | 792 | 0.0076 | 0.40 | 0.55 |
| 2009 | 443 | 0.0083 | 0.40 | 0.43 |
| 2010 | 624 | 0.0083 | 0.40 | 0.46 |
| 2011 | 343 | 0.0050 | 0.40 | 0.40 |
| 2012 | 764 | 0.0083 | 0.40 | 0.33 |
| 2013 | 566 | 0.0083 | 0.40 | 0.45 |
| 2014 | 690 | 0.0083 | 0.40 | 0.43 |
| 2015 | 541 | 0.0083 | 0.40 | 0.47 |
| 2016 | 603 | 0.0083 | 0.40 | 0.46 |
| 2017 | 337 | 0.0043 | 0.36 | 0.48 |
| 2018 | 272 | 0.0043 | 0.28 | 0.43 |
| 2019 | 228 | 0.0043 | 0.29 | 0.46 |

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

The spawning target attainment was 92 % in 2019 and the probability of meeting the spawning target was 31 %. The management target was reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 66 % with an overall attainment of 113 % (Figure 34).

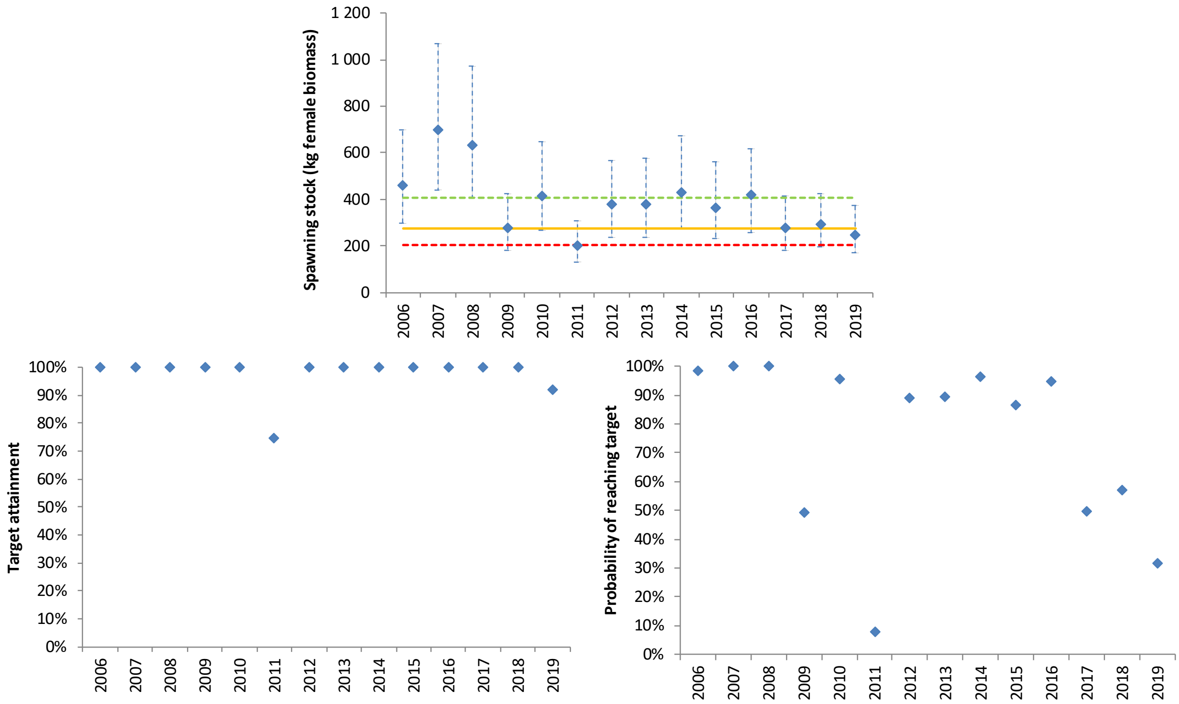


*Figure 34. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 in the Finnish tributary Goahppelašjohka/Kuoppilasjoki.*

### 4.7.2 Exploitation

The estimated total exploitation rate (based on weight) of Goahppelašjohka/Kuoppilasjoki salmon was 42 % in the years 2016-2019 (Figure 35), with 17 % of the pre-fishery abundance caught in coastal fisheries, 24 % in main stem fisheries and 1 % in Goahppelašjohka/Kuoppilasjoki. The average estimated total pre-fishery abundance for Goahppelašjohka/Kuoppilasjoki salmon was 1 170 kg and the average total catch was 491 kg in the period 2016-2019.

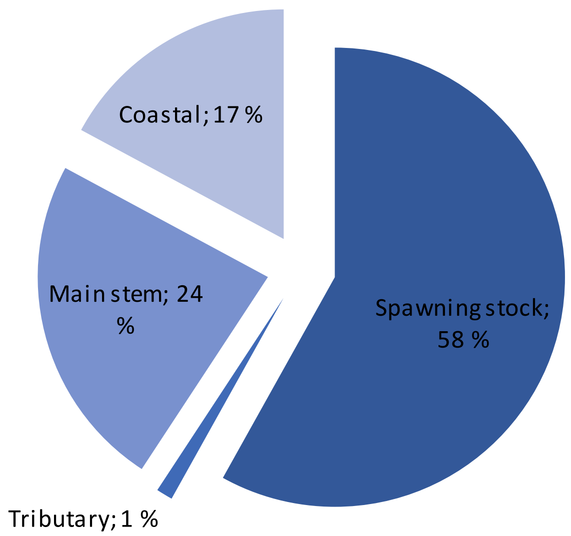


*Figure 35. The total amount of salmon belonging to Goahppelašjohka/Kuoppilasjoki in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Goahppelašjohka/Kuoppilasjoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 15.

*Table 15. Relative exploitation rates of Goahppelašjohka/Kuoppilasjoki salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | **2016-2019** | **2006-2016** | **2018-2019** |
|---|---|---|---|
| Coastal | 17 % | 15 % | 17 % |
| Main stem | 29 % | 41 % | 19 % |
| Tributary | 2 % | 0 % | 2 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Goahppelašjohka/Kuoppilasjoki salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation was 0 % for three years (2016-2018) and 9 % in 2019. The average overexploitation was estimated at 2 %. Maximum sustainable exploitation varied between 27 % (2019) and 67 % (2016). The average maximum sustainable total exploitation rate in the period was 49 %, higher than the estimated average total exploitation of 44 %.

### 4.7.3 Stock recovery

Management target attainment of the Goahppelašjohka/Kuoppilasjoki stock was 66 %, well above the threshold of 40 % that indicates the need for a recovery plan. The current evaluation indicates that the main stem plus tributary exploitation of the Goahppelašjohka/Kuoppilasjoki stock has been reduced from 41 to 21 %, which corresponds to a 48 % reduction in exploitation.

## 4.8 Leavvajohka

Leavvajohka is a middle-sized tributary (catchment area 313 $km^2$) running into the Tana main stem almost 140 km from the Tana 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 some small 2SW salmon.

### 4.8.1 Status assessment

In previous reports, Leavvajohka has been evaluated using a spawning target based on an underestimated salmon distribution area. Based on recent monitoring data, a new distribution area have been established, covering Leavvajohka all the way up to a point between Suonjirgáisá and Uhcagáisá. The 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 16. Female proportions in Table 16 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are the 5-year average from Genmix weighted with 50 % of the up or down variation of the annual female proportion observed in the Tana scale sampling project.

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 2006-2017. A new SNP-based estimate was used for 2018 and 2019. 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 by 20 % in 2018 as indicated by the combined main stem and tributary fish counting (Table 16).

To account for uncertainty, the exploitation rate and female proportion estimates in Table 16 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 466 kg as the mode, 233 kg as the minimum and 699 kg as the maximum value.

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

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

| Year | Estimated main stem catch (kg) | Main stem proportion | Main stem exploitation rate | Female proportion |
|---|---|---|---|---|
| 2006 | 1167 | 0.0131 | 0.45 | 0.50 |
| 2007 | 1863 | 0.0211 | 0.45 | 0.80 |
| 2008 | 1364 | 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 | 1037 | 0.0113 | 0.45 | 0.48 |
| 2013 | 890 | 0.0130 | 0.45 | 0.56 |
| 2014 | 1085 | 0.0130 | 0.45 | 0.52 |
| 2015 | 850 | 0.0130 | 0.45 | 0.57 |
| 2016 | 948 | 0.0130 | 0.45 | 0.56 |
| 2017 | 681 | 0.0129 | 0.40 | 0.58 |
| 2018 | 541 | 0.0129 | 0.32 | 0.52 |
| 2019 | 432 | 0.0129 | 0.33 | 0.56 |

The spawning target attainment was 116 % in 2019 and the probability of meeting the spawning target was 63 %. The management target was reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 83 % with an overall attainment of 136 % (Figure 36).

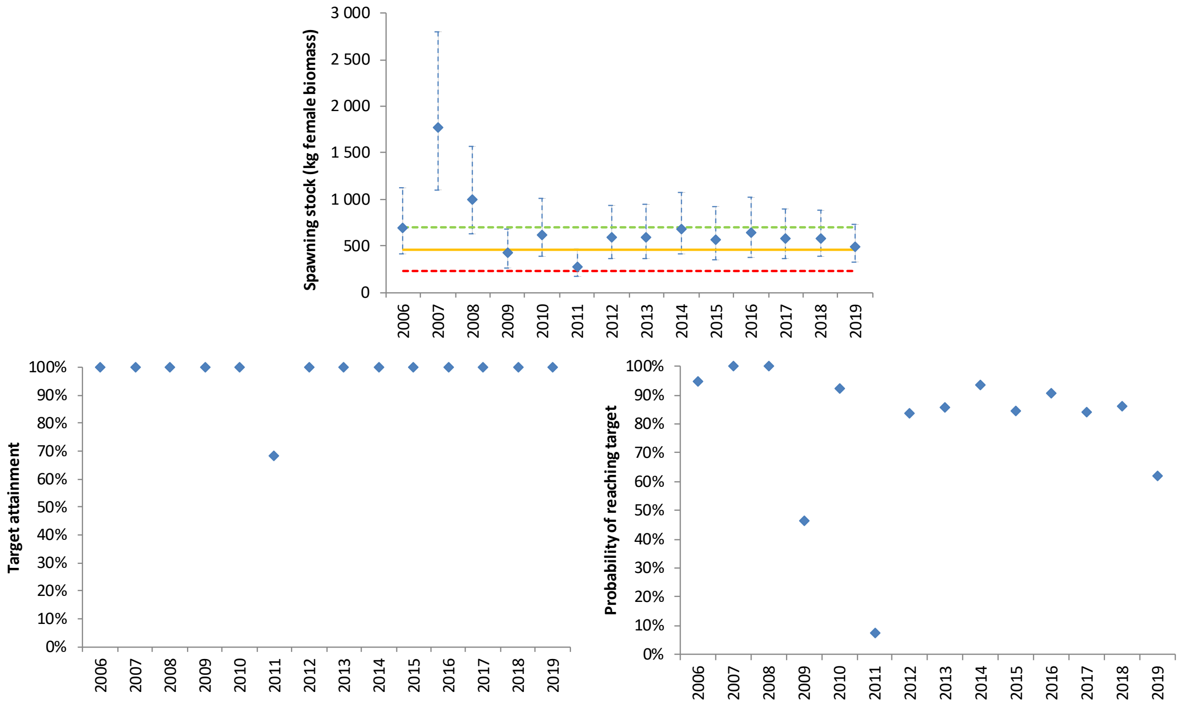


*Figure 36. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 in the Norwegian tributary Leavvajohka.*

### 4.8.2 Exploitation

The estimated total exploitation rate (based on weight) of Leavvajohka salmon was 51 % in the years 2016-2019 (Figure 37), with 19 % of the pre-fishery abundance caught in coastal fisheries, 32 % in main stem fisheries and 0 % in Leavvajohka. The average estimated total pre-fishery abundance for Leavvajohka salmon was 2 058 kg and the average total catch was 1 037 kg in the period 2016-2019.

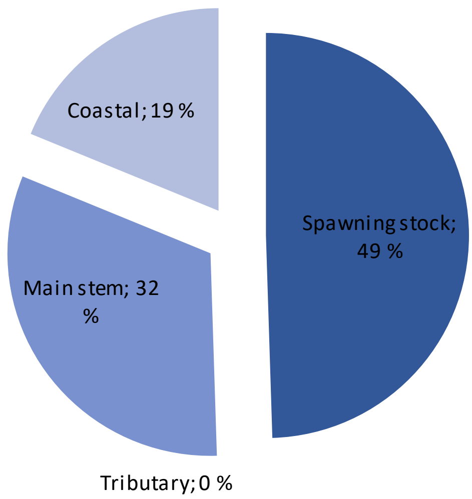


*Figure 37. The total amount of salmon belonging to Leavvajohka in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Leavvajohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 17.

*Table 17. Relative exploitation rates of Leavvajohka salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | 2016-2019 | 2006-2016 | 2018-2019 |
|---|---|---|---|
| Coastal | 19 % | 16 % | 18 % |
| Main stem | 39 % | 46 % | 33 % |
| Tributary | 0 % | 0 % | 0 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Leavvajohka salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation was 0 % for all years and the average overexploitation was therefore also estimated at 0 %. Maximum sustainable exploitation varied between 47 % (2019) and 67 % (2016). The average maximum sustainable total exploitation rate in the period was 58 %, higher than the estimated average total exploitation of 51 %.

### 4.8.3 Stock recovery

Management target of the Leavvajohka stock is at 83 %, well above the threshold of 40 % that indicates the need for a recovery plan. The current evaluation indicates that the main stem plus tributary exploitation of the Leavvajohka stock has been reduced from 46 to 33 %, which corresponds to a 28 % reduction in exploitation.

## 4.9 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.

### 4.9.1 Status assessment

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 18. Female proportions in Table 18 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are the 5-year average from Genmix 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 direct 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 2006-2017. A new SNP-based estimate was used for 2018 and 2019. 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 by 20 % in 2018 as indicated by the combined main stem and tributary fish counting (Table 18).

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 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 779 kg as the mode, 508 kg as the minimum and 1 168 kg as the maximum value.

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

*Table 18. 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 | 1 107 | 0.0125 | 0.45 | 0.49 |
| 2007 | 1 372 | 0.0155 | 0.45 | 0.77 |
| 2008 | 1 090 | 0.0104 | 0.45 | 0.75 |
| 2009 | 608 | 0.0114 | 0.45 | 0.57 |
| 2010 | 856 | 0.0114 | 0.45 | 0.61 |
| 2011 | 533 | 0.0078 | 0.45 | 0.44 |
| 2012 | 1 096 | 0.0120 | 0.45 | 0.57 |
| 2013 | 777 | 0.0114 | 0.45 | 0.61 |
| 2014 | 947 | 0.0114 | 0.45 | 0.57 |
| 2015 | 742 | 0.0114 | 0.45 | 0.62 |
| 2016 | 828 | 0.0114 | 0.45 | 0.62 |
| 2017 | 621 | 0.0117 | 0.40 | 0.64 |
| 2018 | 493 | 0.0117 | 0.32 | 0.57 |
| 2019 | 394 | 0.0117 | 0.33 | 0.62 |

The spawning target attainment was 120 % in 2019 and the probability for meeting the spawning target was 76 %. The management target was reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 91 % with an overall attainment of 140 % (Figure 38).

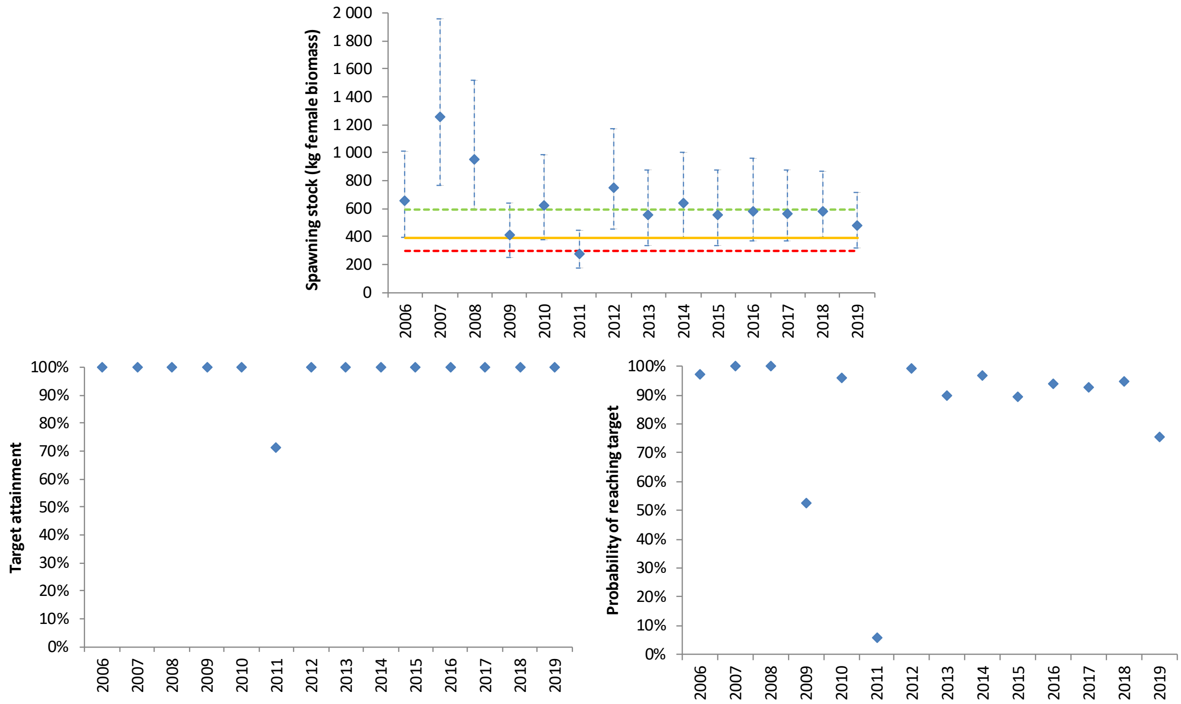


*Figure 38. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 in the Norwegian tributary Báišjohka.*

### 4.9.2 Exploitation

The estimated total exploitation rate (based on weight) of Báišjohka salmon was 50 % in the years 2016-2019 (Figure 39), with 18 % of the pre-fishery abundance caught in coastal fisheries, 32 % in main stem fisheries and 0 % in Báišjohka. The average estimated total pre-fishery abundance for Báišjohka salmon was 1 819 kg and the average total catch was 913 kg in the period 2016-2019.

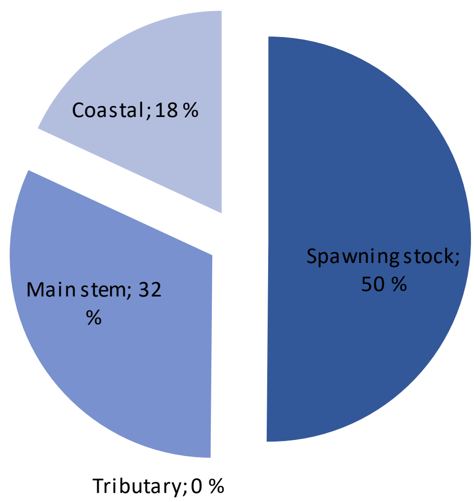


*Figure 39. The total amount of salmon belonging to Báišjohka in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Báišjohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 19.

*Table 19. Relative exploitation rates of Báišjohka salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | 2016-2019 | 2006-2016 | 2018-2019 |
|---|---|---|---|
| Coastal | 18 % | 16 % | 18 % |
| Main stem | 39 % | 46 % | 33 % |
| Tributary | 0 % | 0 % | 0 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Báišjohka salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation was 0 % for all years and the average overexploitation was therefore also estimated at 0 %. Maximum sustainable exploitation varied between 55 % (2019) and 70 % (2016). The average maximum sustainable total exploitation rate in the period was 64 %, higher than the estimated average total exploitation of 50 %.

### 4.9.3 Stock recovery

Management target of the Báišjohka stock is at 91 %, well above the threshold of 40 % that indicates the need for a recovery plan. The current evaluation indicates that the main stem plus tributary exploitation of the Báišjohka stock has been reduced from 46 to 33 %, which corresponds to a 28 % reduction in exploitation.

## 4.10 Njiljohka/Nilijoki

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

### 4.10.1 Status assessment

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

Spawning salmon have been counted almost annually in Njiljohka/Nilijoki in the autumn with snorkeling in the years 2006-2018, with the exceptions of 2007, 2008, 2013 and 2019. The snorkeling 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 snorkeling years:

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

The data input for the variables in this formula are summarized in Table 20. Female proportions in Table 20 are based on snorkeling detections of males and females each year. Fishing pressure in

Njiljohka/Nilijoki is low and no catch statistics is available. Average sizes in Table 20 are based on a combination of main stem Genmix samples from 2006-2008 and 2011-2012.

*Table 20. Summary of snorkeling data used to estimate annual spawning stock sizes in Njiljohka/Nilijoki.*

| Year | Snorkeling count (1SW) | Snorkeling 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 | | | | | | | | |

In the years without snorkeling (2007, 2008, 2013, 2019), an alternative approach can be taken based on the proportion of Njiljohka/Nilijoki salmon found in the main stem fisheries and an estimate of the main stem exploitation rate (Table 21). 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 32 % was used in 2019.

*Table 21. Summary of stock data used to estimate annual spawning stock sizes in Njiljohka/Nilijoki in the years without snorkelling data.*

| Year | Estimated main stem catch (kg) | Main stem proportion | Main stem exploitation rate | Female proportion |
|---|---|---|---|---|
| 2006 | | | | |
| 2007 | 1 016 | 0.0115 | 0.45 | 0.78 |
| 2008 | 807 | 0.0077 | 0.45 | 0.63 |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | 575 | 0.0084 | 0.45 | 0.58 |
| 2014 | | | | |
| 2015 | | | | |
| 2016 | | | | |
| 2017 | | | | |
| 2018 | | | | |
| 2019 | 250 | 0.0075 | 0.32 | 0.58 |

To account for uncertainty, the exploitation rate and female proportion estimates in Table 20 and 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 221 kg as the mode, 151 kg as the minimum and 330 kg as the maximum value.

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

The spawning target attainment was 139 % in 2019 and the probability of meeting the spawning target was 100 %. The management target was reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 60 % with an overall attainment of 108 % (Figure 40).

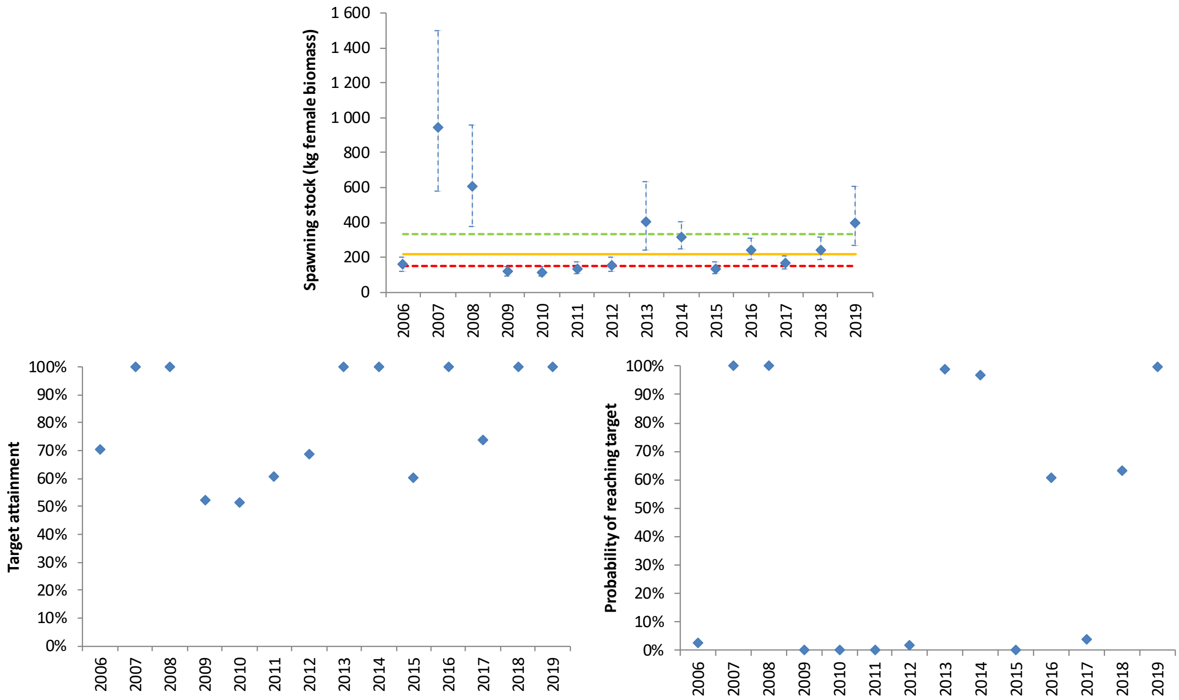


*Figure 40. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2018 in the Finnish tributary Njiljohka/Nilijoki.*

### 4.10.2 Exploitation

The estimated total exploitation rate (based on weight) of Njiljohka/Nilijoki salmon was 56 % in the years 2016-2019 (Figure 41), with 19 % of the pre-fishery abundance caught in coastal fisheries, 37 % in main stem fisheries and 0 % in Njiljohka/Nilijoki. The average estimated total pre-fishery abundance for Njiljohka/Nilijoki salmon was 1 065 kg and the average total catch was 592 kg in the period 2016-2019.

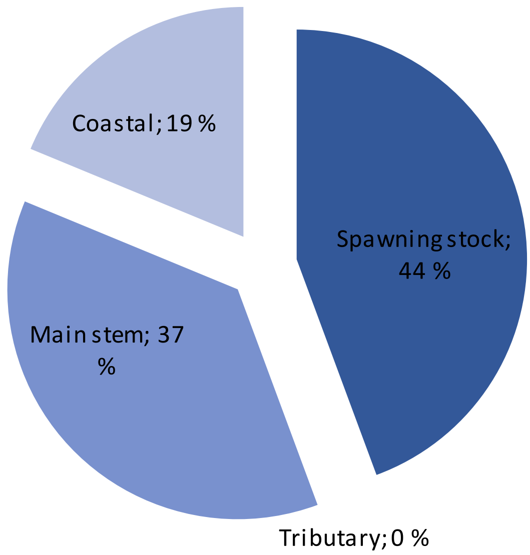


*Figure 41. The total amount of salmon belonging to Njiljohka/Nilijoki in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Njiljohka/Nilijoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 22.

*Table 22. Relative exploitation rates of Njiljohka/Nilijoki salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | **2016-2019** | **2006-2016** | **2018-2019** |
|---|---|---|---|
| Coastal | 19 % | 16 % | 18 % |
| Main stem | 45 % | 56 % | 34 % |
| Tributary | 0 % | 0 % | 0 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Njiljohka/Nilijoki salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation varied between 0 % (2016, 2018, 2019) and 26 % (2017). The average overexploitation was estimated at 6 %. Maximum sustainable exploitation varied between 48 % (2017) and 69 % (2016). The average maximum sustainable total exploitation rate in the period was 57 %, slightly higher than the estimated average total exploitation of 56 %.

### 4.10.3 Stock recovery

Management target of the Njiljohka/Nilijoki stock is at 60 %, well above the threshold of 40 % that indicates the need for a recovery plan. The current evaluation indicates that the main stem plus tributary exploitation of the Njiljohka/Nilijoki stock has been reduced from 56 to 34 %, which corresponds to a 39 % reduction in exploitation.

## 4.11 Váljohka

Váljohka is a small-sized river flowing into the Tana main stem 175 km from the Tana river estuary. The lowermost part of Váljohka is relatively slow-flowing, but further upstream the water velocity picks up and more spawning and production areas become available. A total of 45 km is available for salmon in Váljohka itself. In addition, approximately 18 km is available in the small tributary Ástejohka.

### 4.11.1 Status assessment

The Váljohka spawning target is 1 907 595 eggs (1 245 502-2 861 393 eggs). The female biomass needed to obtain this egg deposition is 779 kg (508-1 168 kg) when using a stock-specific fecundity of 2 450 eggs $kg^{-1}$.

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

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

The data input for the variables in this formula are summarized in Table 23. Female proportions in Table 23 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 Váljohka catch and the 5-year Genmix average female proportion of different size groups.

Fishing pressure in Váljohka is low with only a few fishermen every year and a limited reported catch ranging from 37 kg (2018) to 321 kg (2012). We have one year of fish counting with a video camera setup in 2015 that have provided an exploitation estimate. In addition, there have been snorkeling counts of the lower part of Váljohka in 2014-2015 and in Ástejohka in 2015. The video counting found that a minimum number of 741 salmon (629 1SW, 112 MSW) ascended Váljohka in 2015. An additional 100 salmon were counted in the tributary Ástejohka (which were not covered by the video counting). In combination with the catch statistics in 2015, the estimated exploitation rate in 2015 becomes 7 %. A comparison between the snorkeling and video counts in 2015 show that due to the limited area covered by snorkeling, only 25 % of the salmon were accounted for during the snorkeling. A 25 % observation rate in the 2014 snorkeling points to an exploitation of only 4 % in this year.

The small number of licenses combined with low accessibility for fishermen in combination with the recent monitoring results indicates a low exploitation level throughout the status assessment period (2006-2018). This is a problem for the status assessment. The size of the spawning stock estimate is highly vulnerable to even minor changes in the exploitation estimate when we operate at exploitation estimates below 10-15 %. Consequently, the status assessment becomes highly sensitive when using only tributary-based numbers. We will therefore use a combined approach to assess status in Váljohka.

In addition to tributary catch statistics, we include main stem fisheries and the main stem genetic stock identification results so that we have two sources of information for the assessment: 1) estimated main stem catch, and 2) the Váljohka catch statistics. We have direct estimates of the main stem proportion of Váljohka salmon in 2006-2008 and 2011-2012 and can use the average size group female proportions from these five years to cover the remaining years in the period 2006-2017. A new SNP-based estimate was used for 2018 and 2019. The reported Váljohka catch is added to the estimated main stem catch every year. The main stem exploitation is estimated at 45 % in 2006-2016 based on the location along the Tana main stem, the Váljohka salmon size composition and the estimated main stem exploitation of other stocks. If we then set the fisheries exploitation within Váljohka to 8 %, the combined exploitation rate estimate used for the status assessment in 2006-2016 becomes 50 %. The 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 by a further 20 % in 2018 as indicated elsewhere in Tana through the combined results of the main stem and tributary fish countings (Table 23). This exploitation level was slightly adjusted in 2019.

*Table 23. Summary of stock data used to estimate annual spawning stock sizes in Váljohka.*

| Year | Estimated main stem and tributary catch (kg) | Main stem proportion | Combined exploitation rate | Female proportion |
|---|---|---|---|---|
| 2006 | 1 517 | 0.0143 | 0.50 | 0.58 |
| 2007 | 1 466 | 0.0155 | 0.50 | 0.80 |
| 2008 | 1 354 | 0.0115 | 0.50 | 0.68 |
| 2009 | 1 037 | 0.0172 | 0.50 | 0.42 |
| 2010 | 1 429 | 0.0172 | 0.50 | 0.50 |
| 2011 | 1 113 | 0.0130 | 0.50 | 0.59 |
| 2012 | 3 212 | 0.0315 | 0.50 | 0.42 |
| 2013 | 1 344 | 0.0172 | 0.50 | 0.47 |
| 2014 | 1 630 | 0.0172 | 0.50 | 0.44 |
| 2015 | 1 276 | 0.0172 | 0.50 | 0.55 |
| 2016 | 1 339 | 0.0172 | 0.50 | 0.56 |
| 2017 | 893 | 0.0152 | 0.45 | 0.57 |
| 2018 | 677 | 0.0152 | 0.36 | 0.45 |
| 2019 | 576 | 0.0152 | 0.37 | 0.63 |

To account for uncertainty, the exploitation rate and female proportion estimates in Table 23 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 779 kg as the mode, 508 kg as the minimum and 1 168 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 80 % in 2019 and the probability of meeting the spawning target was 16 %. The management target was not reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 19 % with an overall attainment of 82 % (Figure 42).

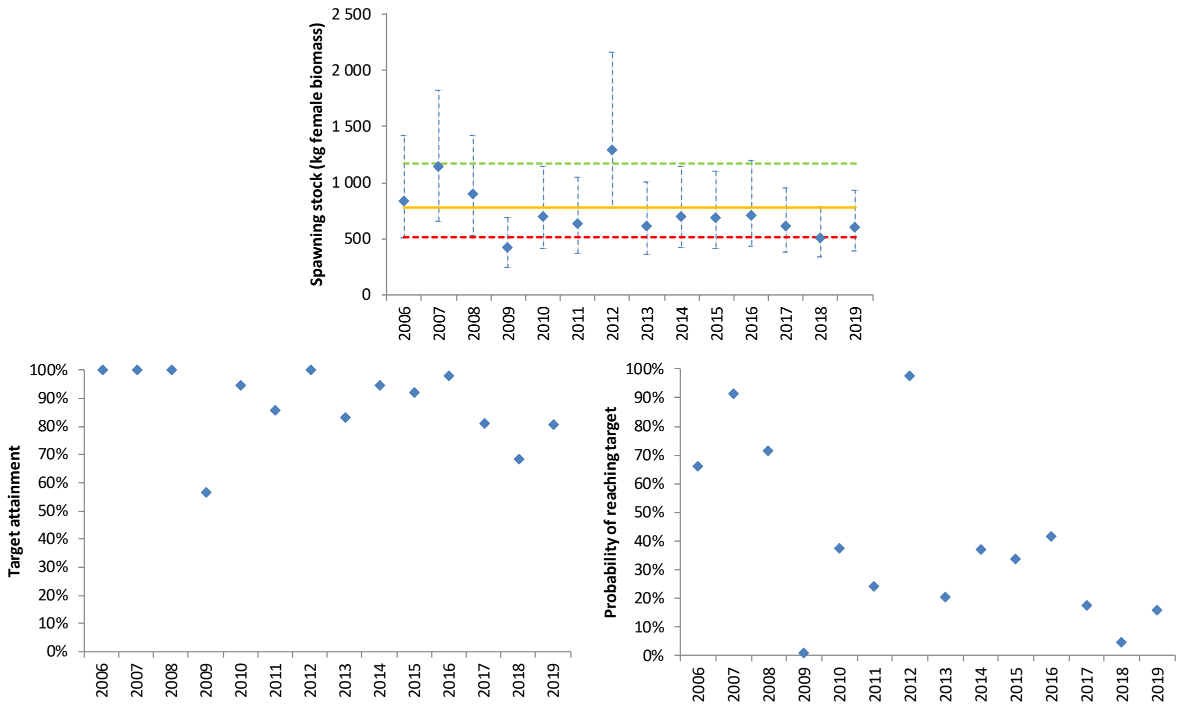


*Figure 42. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 in the Norwegian tributary Váljohka.*

### 4.11.2 Exploitation

The estimated total exploitation rate (based on weight) of Váljohka salmon was 53 % in the years 2016-2019 (Figure 43), with 19 % of the pre-fishery abundance caught in coastal fisheries, 31 % in main stem fisheries and 3 % in Váljohka. The average estimated total pre-fishery abundance for Váljohka salmon was 2 367 kg and the average total catch was 1 261 kg in the period 2016-2019.

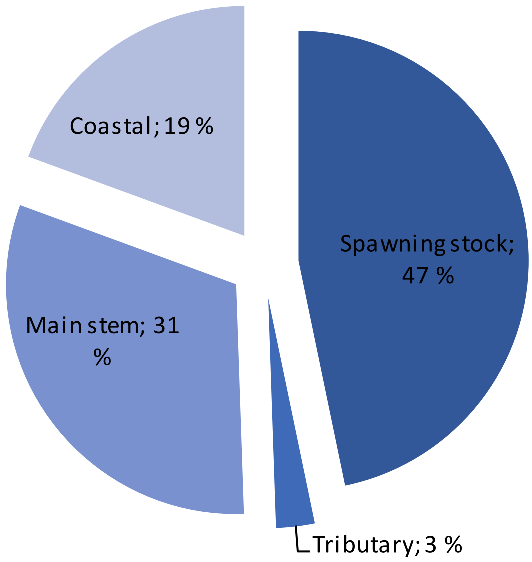


*Figure 43. The total amount of salmon belonging to Váljohka in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Váljohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 24.

*Table 24. Relative exploitation rates of Váljohka salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | 2016-2019 | 2006-2016 | 2018-2019 |
|---|---|---|---|
| Coastal | 19 % | 16 % | 19 % |
| Main stem | 39 % | 42 % | 33 % |
| Tributary | 5 % | 9 % | 4 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Váljohka salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation varied between 8 % (2016) and 35 % (2018) and the average overexploitation was estimated at 22 %. Maximum sustainable exploitation varied between 21 % (2018) and 55 % (2016). The average maximum sustainable total exploitation rate in the period was 37 %, lower than the estimated average total exploitation of 53 %.

### 4.11.3 Stock recovery

In the present evaluation of Váljohka, management target is at 19 %, below the 40 % threshold that should trigger a recovery plan. The current evaluation indicates that the main stem plus tributary exploitation of the Váljohka stock has been reduced from 48 to 36 %, which corresponds to a 25 %

reduction in exploitation. This level of reduction is sufficiently high to allow for stock recovery after one generation.

## 4.12 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.

### 4.12.1 Status assessment

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

Spawning salmon have been counted annually in Áhkojohka/Akujoki in the autumn with snorkeling in the years 2003-2019. 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 = (Snorkeling count * Average size * Female proportion) / (Detection rate * Area covered)*

The data input for the variables in this formula are summarized in Table 25. Female proportions in Table 25 are based on snorkeling detections of males and females each year.

Fishing pressure in Áhkojohka/Akujoki is low and there are no catch statistics. Average sizes in Table 25 are based on a combination of main stem Genmix samples from 2006-2008 and 2011-2012 and salmon samples from within Áhkojohka/Akujoki in 2007 and 2011. Area covered is 100 % of the salmon distribution area in Áhkojohka/Akujoki each year.

*Table 25. 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 | 0.0030 |
| 2018 | 65 | 3 | 1.3 | 3.6 | 0.80 | 1 | 0.51 | 0.33 | 0.0029 |
| 2019 | 24 | 7 | 1.3 | 3.6 | 0.85 | 1 | 0.54 | 1 | 0.0029 |

To account for uncertainty, the exploitation rate and female proportion estimates in 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 126 kg as the mode, 94 kg as the minimum and 188 kg as the maximum value.

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

The spawning target attainment was 37 % in 2019 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 0 % with an overall attainment of 50 % (Figure 44).

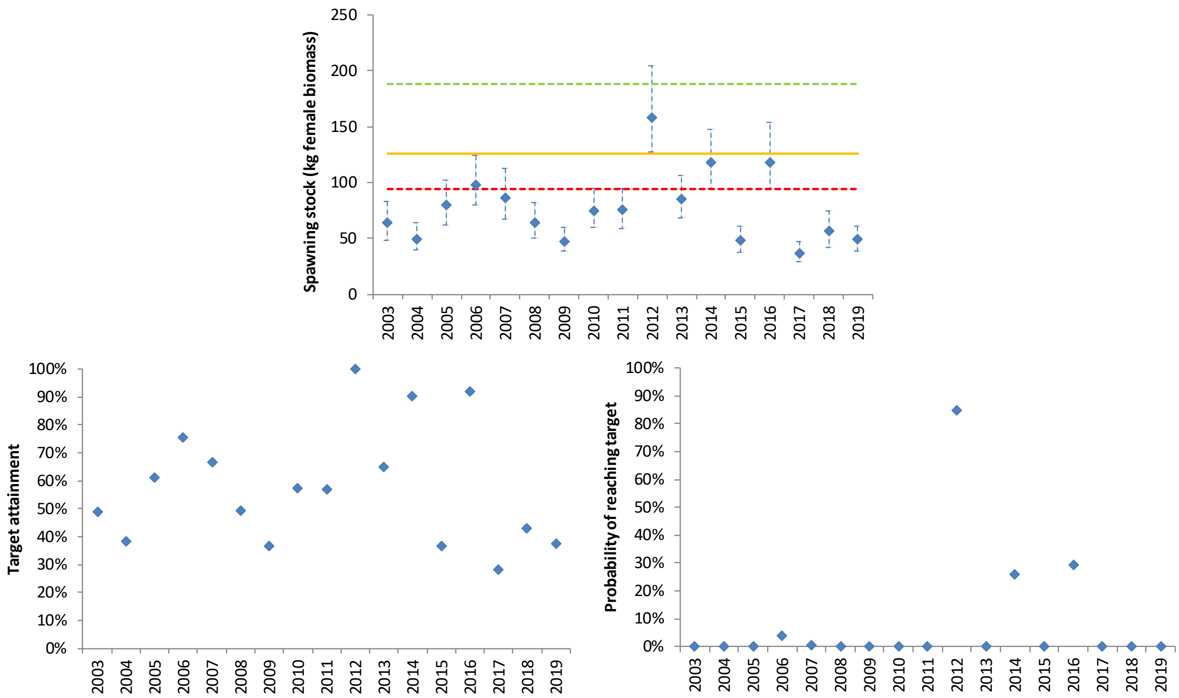


*Figure 44. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2019 in the Finnish tributary Áhkojohka/Akujoki.*

### 4.12.2 Exploitation

The estimated total exploitation rate (based on weight) of Áhkojohka/Akujoki salmon was 62 % in the years 2016-2019 (Figure 45), with 19 % of the pre-fishery abundance caught in coastal fisheries, 43 %

in main stem fisheries and 0 % in Áhkojohka/Akujoki. The average estimated total pre-fishery abundance for Áhkojohka/Akujoki salmon was 342 kg and the average total catch was 209 kg in the period 2016-2019.

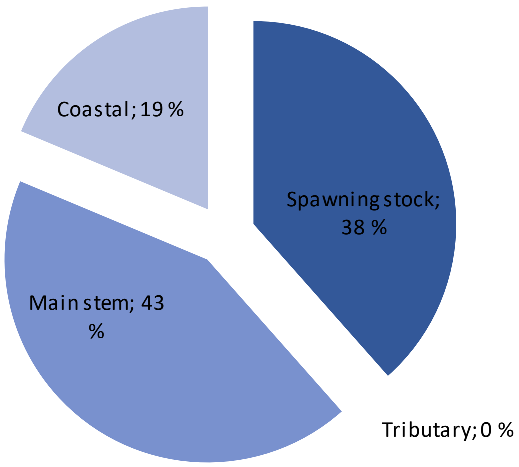


*Figure 45. The total amount of salmon belonging to Áhkojohka/Akujoki in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Áhkojohka/Akujoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 26.

*Table 26. Relative exploitation rates of Áhkojohka/Akujoki salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | **2016-2019** | **2006-2016** | **2018-2019** |
|---|---|---|---|
| Coastal | 19 % | 16 % | 19 % |
| Main stem | 52 % | 54 % | 53 % |
| Tributary | 0 % | 0 % | 0 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Áhkojohka/Akujoki salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation varied between 6 % (2016) and 69 % (2017). The average overexploitation was estimated at 48 %. Maximum sustainable exploitation varied between 0 % (2017) and 53 % (2016). The average maximum sustainable total exploitation rate in the period was 18 %, significantly lower than the estimated average total exploitation of 62 %.

### 4.12.3 Stock recovery

In the previous report (Anon. 2018), we advised an 8 % reduction in the total river exploitation rate of Áhkojohka/Akujoki salmon from the 2006-2016 level in order to achieve stock recovery over two generations. The current evaluation indicates that the main stem plus tributary exploitation of the Áhkojohka/Akujoki stock has been reduced from 54 to 53 %, which corresponds to a 1 % reduction in exploitation. One note of caution here, however, the main stem exploitation estimate is based on genetic data that likely overestimates the exploitation rate of salmon from Áhkojohka/Akujoki. This will be addressed with more accurate genetic methods in the coming years.

## 4.13 Kárášjohka + tributaries

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

### 4.13.1 Status assessment

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

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

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

The data input for the variables in this formula are summarized in Table 27. Female proportions in Table 27 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are the 5-year average from Genmix.

There was acoustic fish counting in 2010, 2012 and 2017-2018 at Heastanjárga, below the upper bridge over Kárášjohka, approximately 5 km upstream from Skáidegeahči. These counts provided an estimate of the number of salmon of different size groups that migrated up into the upper part of Kárášjohka. The estimated exploitation rates in 2010 and 2012, in combination with the estimated catch of Kárášjohka-salmon downstream of the counting site, gave an estimated exploitation rate of 25 % for salmon <3 kg and 45 % for salmon >3 kg in the period 2006-2016. The estimate for 2017 was lower and 13 % was used for salmon <3 kg and 33 % for salmon >3 kg. Fish counting in 2018 indicated a further reduced exploitation, down to 10 % for salmon <7 kg and 20 % for salmon >7 kg. The 2019 monitoring indicate lower exploitation for grilse and higher for salmon >3 kg (Table 27).

*Table 27. Summary of stock data used to estimate annual spawning stock sizes in Kárášjohka.*

| Year | Catch kg (<3 kg) | Catch kg (3-7 kg) | Catch kg (>7 kg) | Expl. rate (<3 kg) | Expl. rate (3-7 kg) | Expl. rate (>7 kg) | Female prop. (<3 kg) | Female prop. (3-7 kg) | Female prop. (>7 kg) | Main stem prop. |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 1774 | 1277 | 1110 | 0.25 | 0.45 | 0.45 | 0.09 | 0.79 | 0.73 | 0.1100 |
| 2007 | 272 | 1281 | 761 | 0.25 | 0.45 | 0.45 | 0.23 | 0.70 | 0.82 | 0.0989 |
| 2008 | 245 | 1160 | 2716 | 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 | 1210 | 0.25 | 0.45 | 0.45 | 0.09 | 0.71 | 0.73 | 0.1225 |
| 2011 | 500 | 908 | 1163 | 0.25 | 0.45 | 0.45 | 0.06 | 0.73 | 0.73 | 0.1405 |
| 2012 | 1259 | 1525 | 1129 | 0.25 | 0.45 | 0.45 | 0.06 | 0.63 | 0.67 | 0.1476 |
| 2013 | 565 | 1325 | 1145 | 0.25 | 0.45 | 0.45 | 0.09 | 0.71 | 0.73 | 0.1225 |
| 2014 | 772 | 1229 | 1571 | 0.25 | 0.45 | 0.45 | 0.09 | 0.71 | 0.73 | 0.1225 |
| 2015 | 435 | 1691 | 1661 | 0.25 | 0.45 | 0.45 | 0.09 | 0.71 | 0.73 | 0.1470 |
| 2016 | 246 | 743 | 2158 | 0.25 | 0.45 | 0.45 | 0.09 | 0.71 | 0.73 | 0.1470 |
| 2017 | 121 | 523 | 1473 | 0.15 | 0.33 | 0.33 | 0.09 | 0.71 | 0.73 | 0.1416 |
| 2018 | 352 | 403 | 638 | 0.12 | 0.15 | 0.20 | 0.09 | 0.71 | 0.73 | 0.1416 |
| 2019 | 80 | 507 | 814 | 0.10 | 0.25 | 0.25 | 0.09 | 0.71 | 0.73 | 0.1416 |

To account for uncertainty, the exploitation rate and female proportion estimates in Table 27 were treated as modal values, with a 10 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 7 290 kg as the mode, 5 468 kg as the minimum and 10 936 kg as the maximum value.

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

The spawning target attainment was 38 % in 2019 and the probability for meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 0 % with an overall attainment of 40 % (Figure 46).

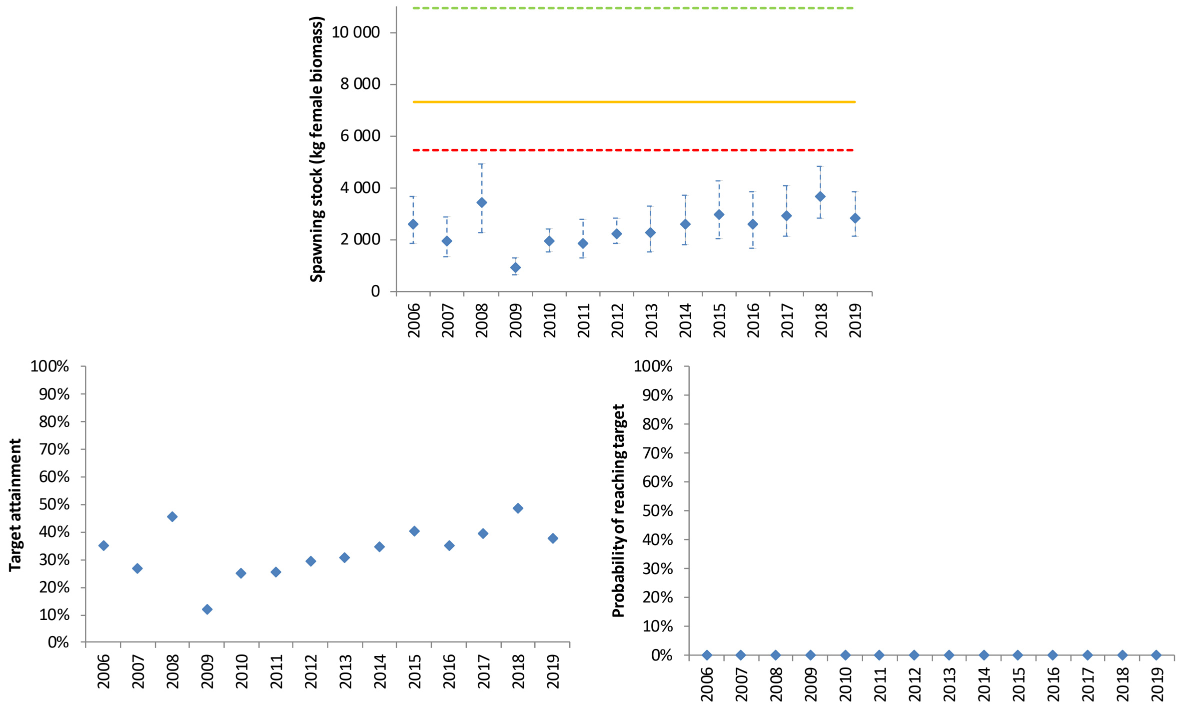


*Figure 46. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 in the Norwegian tributary Kárášjohka.*

### 4.13.2 Exploitation

The estimated total exploitation rate (based on weight) of Kárášjohka salmon was 73 % in the years 2016-2019 (Figure 47), with 18 % of the pre-fishery abundance caught in coastal fisheries, 43 % in main stem fisheries and 12 % in Kárášjohka. The average estimated total pre-fishery abundance for Kárášjohka salmon was 16 910 kg and the average total catch was 12 252 kg in the period 2016-2019.

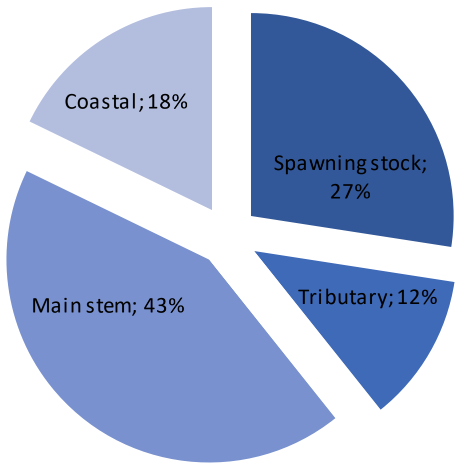


*Figure 47. The total amount of salmon belonging to Kárášjohka in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Kárášjohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 28.

*Table 28. Relative exploitation rates of Kárášjohka salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | 2016-2019 | 2006-2016 | 2018-2019 |
|---|---|---|---|
| Coastal | 18 % | 14 % | 18 % |
| Main stem | 52 % | 58 % | 45 % |
| Tributary | 30 % | 44 % | 21 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Kárášjohka salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation varied between 50 % (2018) and 64 % (2016). The average overexploitation was estimated at 59 %. This means that exploitation on average was responsible for reducing the spawning stock size by an amount of 59 % below the spawning target. Maximum sustainable exploitation varied between 2 % (2019) and 40 % (2016). The average maximum sustainable total exploitation rate in the period was 22 %, significantly lower than the estimated average total exploitation of 73 %.

### 4.13.3 Stock recovery

In the previous report (Anon. 2018), we advised a 23 % reduction in the total river exploitation rate of Kárášjohka salmon from the 2006-2016 level in order to achieve stock recovery over two generations. The current evaluation indicates that the main stem plus tributary exploitation of the Kárášjohka stock has been reduced from 77 to 56 %, which corresponds to a 27 % reduction in exploitation. This level of reduction is sufficiently high to allow for stock recovery after two generations.

## 4.14 Iešjohka

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

### 4.14.1 Status assessment

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 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.

The run timing and size composition of salmon belonging to Kárášjohka and Iešjohka is very similar, and it is therefore reasonable to expect that salmon from both stocks are subject to the same exploitation in the Tana main stem. Given this assumption, the ratio of salmon entering Iešjohka and salmon entering upper Kárášjohka should equal the ratio of Iešjohka and Kárášjohka salmon in the main stem indicated by the respective main stem genetic proportions. The resulting exploitation rate of the Iešjohka fishery becomes 25 % for salmon <3 kg and 40 % for salmon >3 kg for the years 2009-2016. Some salmon from Iešjohka is also exploited in the lower Kárášjohka, this catch increase the Iešjohka exploitation estimate with 5 % for all size groups, and we used 20 % for salmon <3 kg and 40 % for salmon >3 kg in this period.

In the years 2006-2008, the relative catch of salmon in Iešjohka is significantly higher than the catch in upper Kárášjohka, even though their relative proportion in the Tana main stem fisheries remain relatively equal. This indicates a higher exploitation rate in Iešjohka these years (Table 29).

In 2017, very few fishermen were active in Iešjohka and fishing conditions were severe in the first half of the fishing season. Comparing Iešjohka with the neighbouring Kárášjohka indicate a highly significantly lowered exploitation in Iešjohka in 2017. We reduced the exploitation estimate by 50 % in 2017. In 2018 results from the neighbouring Kárášjohka indicate continued low exploitation and the exploitation estimate in Iešjohka was reduced accordingly (Table 29).

The first attempt at counting ascending salmon in Iešjohka were done in 2019. This count indicates that approximately one third of the salmon entering lower Kárášjohka belong to Iešjohka. This ratio was used to estimate the catch of Iešjohka salmon in the lower Kárášjohka area. The 2019 count indicate an exploitation rate of 15 % for salmon 3-7 kg and 20 % for salmon >7 kg. The 2019 count of salmon <3 kg in Iešjohka was not sufficiently reliable to estimate an exploitation rate for grilse. The low catch of salmon <3 kg indicate a low exploitation rate and we used 5 %, equivalent to the estimate from the neighbouring upper Kárášjohka. With the added exploitation from lower Kárášjohka, the resulting exploitation rates become 10, 20 and 25 % for the three size groups in 2019 (Table 29).

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 6 072 kg as the mode, 4 278 kg as the minimum and 9 107 kg as the maximum value.

*Table 29. Summary of stock data used to estimate annual spawning stock sizes in Iešjohka.*

| Year | Catch kg (<3 kg) | Catch kg (3-7 kg) | Catch kg (>7 kg) | Expl. rate (<3 kg) | Expl. rate (3-7 kg) | Expl. rate (>7 kg) | Female prop. (<3 kg) | Female prop. (3-7 kg) | Female prop. (>7 kg) | Main stem prop. |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 1531 | 1110 | 1573 | 0.30 | 0.50 | 0.50 | 0.09 | 0.69 | 0.64 | 0.0864 |
| 2007 | 184 | 749 | 1389 | 0.30 | 0.50 | 0.50 | 0.17 | 0.77 | 0.76 | 0.0777 |
| 2008 | 227 | 933 | 2943 | 0.30 | 0.50 | 0.50 | 0.18 | 0.50 | 0.73 | 0.0928 |
| 2009 | 329 | 205 | 636 | 0.20 | 0.40 | 0.40 | 0.10 | 0.66 | 0.69 | 0.0963 |
| 2010 | 227 | 404 | 782 | 0.20 | 0.40 | 0.40 | 0.10 | 0.66 | 0.69 | 0.0963 |
| 2011 | 365 | 456 | 1149 | 0.20 | 0.40 | 0.40 | 0.02 | 0.61 | 0.66 | 0.1104 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 505 | 694 | 1169 | 0.20 | 0.40 | 0.40 | 0.12 | 0.65 | 0.64 | 0.1159 |
| 2013 | 240 | 632 | 1330 | 0.20 | 0.40 | 0.40 | 0.10 | 0.66 | 0.69 | 0.0963 |
| 2014 | 363 | 700 | 1580 | 0.20 | 0.40 | 0.40 | 0.10 | 0.66 | 0.69 | 0.0963 |
| 2015 | 138 | 566 | 1183 | 0.20 | 0.40 | 0.40 | 0.10 | 0.66 | 0.69 | 0.0718 |
| 2016 | 112 | 280 | 1423 | 0.20 | 0.40 | 0.40 | 0.10 | 0.66 | 0.69 | 0.0718 |
| 2017 | 62 | 204 | 794 | 0.10 | 0.25 | 0.25 | 0.10 | 0.66 | 0.69 | 0.0692 |
| 2018 | 287 | 221 | 394 | 0.15 | 0.20 | 0.25 | 0.10 | 0.66 | 0.69 | 0.0692 |
| 2019 | 33 | 214 | 435 | 0.10 | 0.20 | 0.25 | 0.10 | 0.66 | 0.69 | 0.0692 |

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 24 % in 2019 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 0 % with an overall attainment of 28 % (Figure 48).

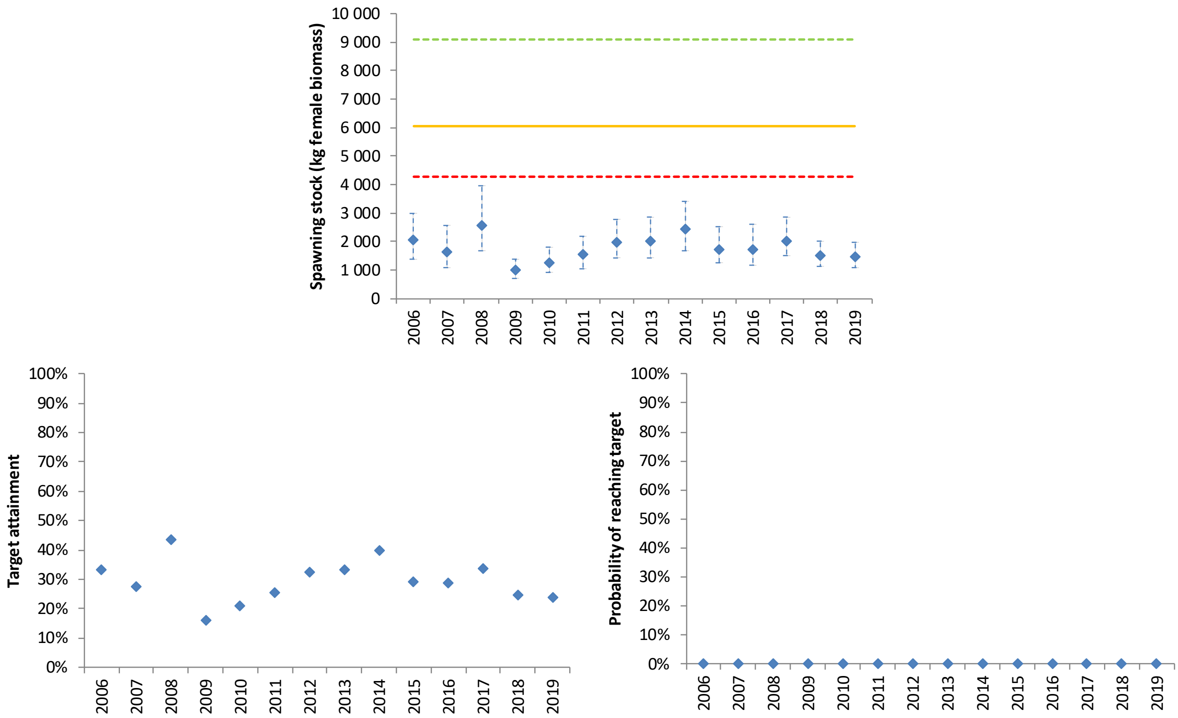


*Figure 48. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 in the Norwegian tributary Iešjohka.*

### 4.14.2 Exploitation

The estimated total exploitation rate (based on weight) of Iešjohka salmon was 69 % in the years 2016-2019 (Figure 49), with 18 % of the pre-fishery abundance caught in coastal fisheries, 39 % in main stem fisheries and 12 % in Iešjohka. The average estimated total pre-fishery abundance for Iešjohka salmon was 9 019 kg and the average total catch was 6 240 kg in the period 2016-2019.

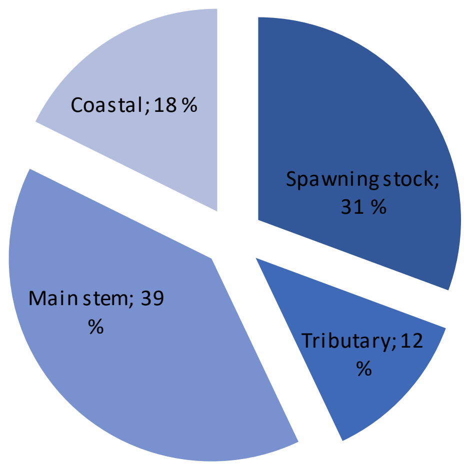


*Figure 49. The total amount of salmon belonging to Iešjohka in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Iešjohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 30.

*Table 30. Relative exploitation rates of Iešjohka salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | **2016-2019** | **2006-2016** | **2018-2019** |
|---|---|---|---|
| Coastal | 18 % | 14 % | 18 % |
| Main stem | 48 % | 57 % | 43 % |
| Tributary | 29 % | 43 % | 23 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Iešjohka salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation varied between 43 % (2019) and 71 % (2016). The average overexploitation was estimated at 57 %. This means that exploitation on average was responsible for reducing the spawning stock size by an amount of 57 % below the spawning target. Maximum sustainable exploitation varied between 0 % (2017, 2018, 2019) and 5 % (2016). The average maximum sustainable total exploitation rate in the period was 1 %, significantly lower than the estimated average total exploitation of 69 %.

### 4.14.3 Stock recovery

In a previous report (Anon. 2018), we advised a 22 % reduction in the total river exploitation rate of Iešjohka salmon from the 2006-2016 level in order to achieve stock recovery over two generations. The current evaluation indicates that the main stem plus tributary exploitation of the Iešjohka stock has been reduced from 76 to 56 %, which corresponds to a 26 % reduction in exploitation. This level of reduction is sufficiently high to allow for stock recovery after two generations.

## 4.15 Anárjohka/Inarijoki + tributaries

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

### 4.15.1 Status assessment

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

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

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

The data input for the variables in this formula are summarized in Table 31. Female proportions in Table 31 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are based on the size composition of the catch and the 5-year Genmix average female proportion of different size groups.

There have been no attempts at counting salmon in Anárjohka/Inarijoki before 2018. Sonar counting in Anárjohka/Inarijoki in 2018 indicate an exploitation rate of 0.14 and this estimate was used for 2018 (Table 31). A similar level of exploitation (0.15) was estimated from the counting in 2019. We used the same level of exploitation in 2017, as a combination of difficult fishing conditions, few active fishermen and new regulatory measures aimed at decreasing exploitation likely led to significantly lower exploitation than previous years.

In the previous report, we used 0.25 as an exploitation rate estimate throughout the period 2006-2016. Based on the level of information that now have accumulated about Anárjohka/Inarijoki and the catch distribution procedure over the period 2006-2019, a tributary exploitation of 0.25 clearly was an underestimation. When comparing the catch levels in Tana/Teno main stem, in the neighbouring Kárášjohka and in Anárjohka/Inarijoki, together with fish counting and genetic proportions, it is clear that the historic exploitation levels in Anárjohka/Inarijoki were significantly higher than 0.25 and the indications are that exploitation was in the region of 0.40. This is a level comparable to the historic exploitation in the neighbouring headwaters Kárášjohka and Iešjohka.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 31 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 6 072 kg as the mode, 4 278 kg as the minimum and 9 107 kg as the maximum value.

*Table 31. Summary of stock data used to estimate annual spawning stock sizes in Anárjohka/Inarijoki.*

| Year | Catch (kg) | Exploitation rate | Female proportion | Main stem proportion |
|---|---|---|---|---|
| 2006 | 4 137 | 0.40 | 0.47 | 0.1903 |
| 2007 | 2 266 | 0.40 | 0.74 | 0.1648 |
| 2008 | 2 323 | 0.40 | 0.64 | 0.0755 |
| 2009 | 2 005 | 0.40 | 0.45 | 0.1516 |
| 2010 | 2 442 | 0.40 | 0.62 | 0.1516 |
| 2011 | 1 908 | 0.40 | 0.45 | 0.1370 |
| 2012 | 4 285 | 0.40 | 0.50 | 0.1920 |
| 2013 | 1 986 | 0.40 | 0.62 | 0.1516 |
| 2014 | 2 832 | 0.40 | 0.60 | 0.1516 |
| 2015 | 1 881 | 0.40 | 0.65 | 0.1516 |
| 2016 | 1 654 | 0.40 | 0.57 | 0.1516 |
| 2017 | 639 | 0.15 | 0.64 | 0.1264 |
| 2018 | 788 | 0.14 | 0.51 | 0.1264 |
| 2019 | 564 | 0.15 | 0.62 | 0.1264 |

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 24 % in 2019 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 0 % with an overall attainment of 25 % (Figure 50).

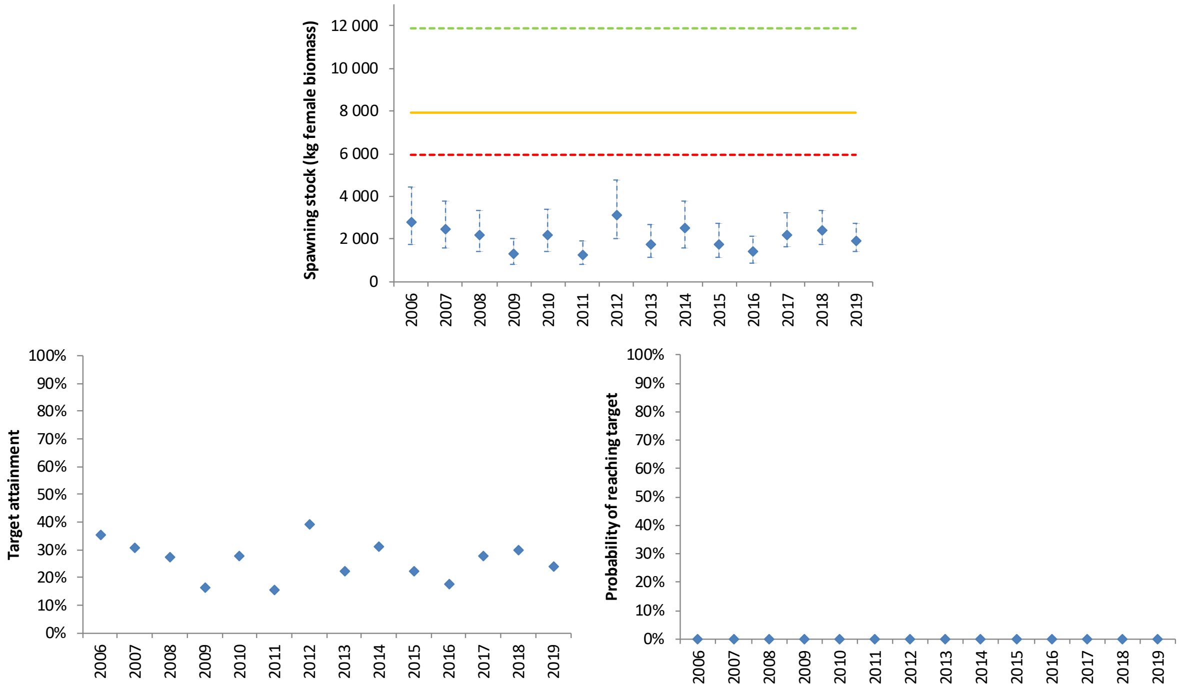


*Figure 50. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2019 in the tributary Anárjohka/Inarijoki.*

### 4.15.2 Exploitation

The estimated total exploitation rate (based on weight) of Anárjohka/Inarijoki salmon was 75 % in the years 2016-2019 (Figure 51), with 19 % of the pre-fishery abundance caught in coastal fisheries, 50 % in main stem fisheries and 7 % in Anárjohka/Inarijoki. The average estimated total pre-fishery abundance for Anárjohka/Inarijoki salmon was 13 690 kg and the average total catch was 10 273 kg in the period 2016-2019.

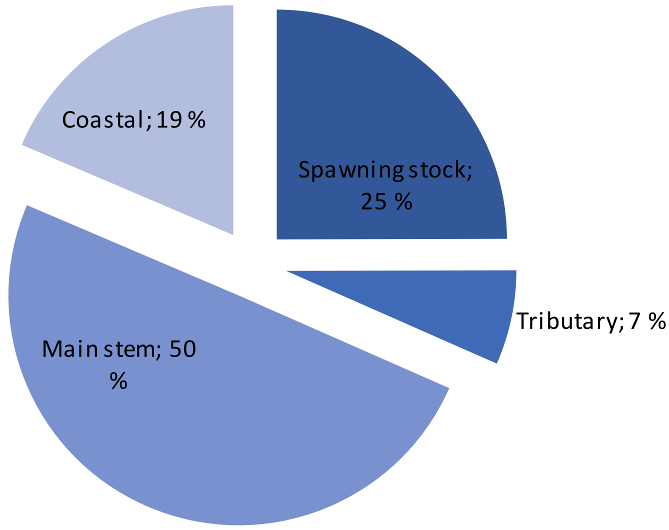


*Figure 51. The total amount of salmon belonging to Anárjohka/Inarijoki in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Anárjohka/Inarijoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 32.

*Table 32. Relative exploitation rates of Anárjohka/Inarijoki salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | 2016-2019 | 2006-2016 | 2018-2019 |
|---|---|---|---|
| Coastal | 19 % | 15 % | 18 % |
| Main stem | 61 % | 66 % | 51 % |
| Tributary | 19 % | 41 % | 15 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Anárjohka/Inarijoki salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2016-2019, overexploitation varied between 50 % (2019) and 82 % (2016). The average overexploitation was estimated at 65 %. This means that exploitation on average was responsible for reducing the spawning stock size by an amount of 65 % below the spawning target. Maximum sustainable exploitation varied between 0 % (2018, 2019) and 16 % (2016). A maximum exploitation of 0 % indicates no exploitable surplus. The average maximum sustainable total exploitation rate in the period was 5 %, significantly lower than the estimated average total exploitation of 75 %.

### 4.15.3 Stock recovery

In the previous report (Anon. 2018), we advised a 22 % reduction in the total river exploitation rate of Anárjohka/Inarijoki salmon from the 2006-2016 level in order to achieve stock recovery over two generations. The current evaluation indicates that the main stem plus tributary exploitation of the Anárjohka/Inarijoki stock has been reduced from 80 to 58 %, which corresponds to a 27 % reduction in exploitation. This level of reduction is sufficiently high to allow for stock recovery after two generations.

## 4.16 Tana/Teno (total)

### 4.16.1 Status assessment

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

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

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

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

The data input for the variables in this formula are summarized in Table 33. Female proportions in Table 33 are based on long-term scale data. The exploitation rates are based on the combined catch distribution estimates of the stock-specific evaluations above.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 33 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 52 312 kg as the mode, 38 510 kg as the minimum and 78 070 kg as the maximum value.

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

*Table 33. 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 | 0.6 | 0.49 |
| 1994 | 131 878 | 0.6 | 0.63 |
| 1995 | 104 631 | 0.6 | 0.49 |

| | | | |
|---|---|---|---|
| 1996 | 88 832 | 0.6 | 0.51 |
| 1997 | 92 506 | 0.6 | 0.43 |
| 1998 | 102 627 | 0.6 | 0.46 |
| 1999 | 143 821 | 0.6 | 0.44 |
| 2000 | 209 532 | 0.6 | 0.50 |
| 2001 | 248 585 | 0.6 | 0.55 |
| 2002 | 190 107 | 0.6 | 0.56 |
| 2003 | 153 738 | 0.6 | 0.58 |
| 2004 | 69 994 | 0.6 | 0.59 |
| 2005 | 77 190 | 0.6 | 0.52 |
| 2006 | 108 596 | 0.6 | 0.42 |
| 2007 | 100 542 | 0.6 | 0.67 |
| 2008 | 121 860 | 0.6 | 0.64 |
| 2009 | 63 499 | 0.6 | 0.50 |
| 2010 | 87 058 | 0.6 | 0.56 |
| 2011 | 79 342 | 0.6 | 0.54 |
| 2012 | 108 794 | 0.6 | 0.46 |
| 2013 | 79 883 | 0.6 | 0.56 |
| 2014 | 99 236 | 0.6 | 0.49 |
| 2015 | 78 124 | 0.6 | 0.60 |
| 2016 | 84 744 | 0.6 | 0.58 |
| 2017 | 60 608 | 0.55 | 0.62 |
| 2018 | 49 530 | 0.45 | 0.50 |
| 2019 | 40 006 | 0.5 | 0.58 |

The spawning target attainment was 43 % in 2019 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2016-2019) overall probability of reaching the spawning target was 0 % with an overall attainment of 55 % (Figure 52).

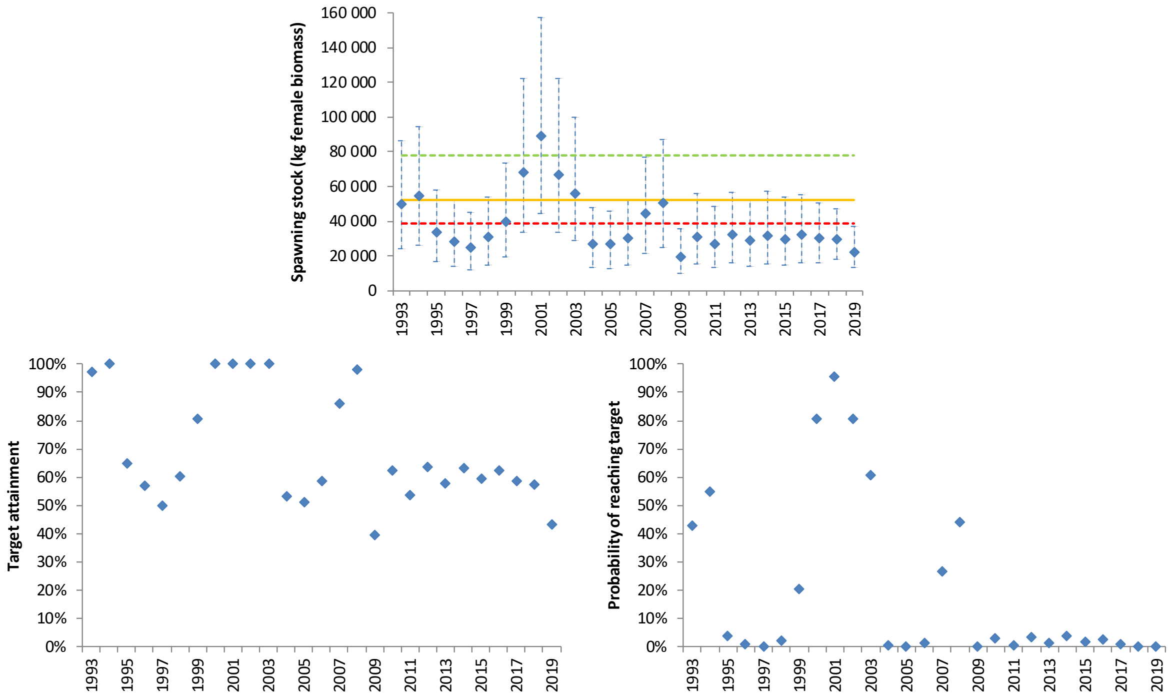


*Figure 52. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 1993-2019 for Tana/Teno (total).*

### 4.16.2 Exploitation

The estimated total exploitation rate (based on weight) of Tana/Teno (total) salmon was 61 % in the years 2016-2019 (Figure 53), with 19 % of the pre-fishery abundance caught in coastal fisheries and 42 % in river fisheries. The average estimated total pre-fishery abundance for Tana/Teno salmon was 137 810 kg and the average total catch was 84 584 kg in the period 2016-2019.

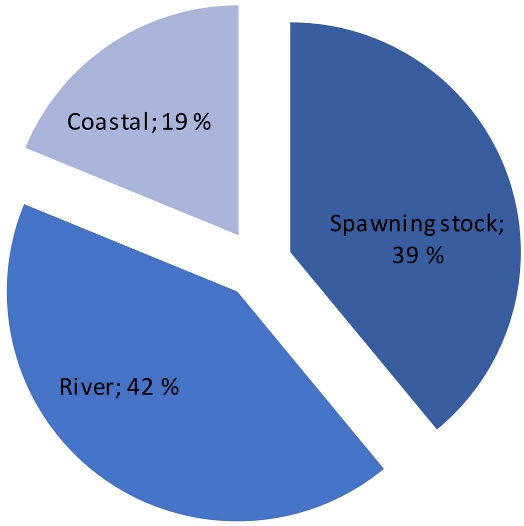


*Figure 53. The total amount of salmon belonging to all Tana/Teno stocks in 2016-2019, distributed into surviving spawning stock and salmon caught in fisheries in either coastal or main stem fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal or main stem fisheries.*

Estimated relative exploitation efficiencies (based on weight) in areas in various periods are given in Table 34.

*Table 34. Relative exploitation rates of Tana/Teno salmon in different areas (based on weight) in three periods. First column is the years 2016-2019, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement. The third column is the two most recent years, 2018-2019 (2017 was omitted due to significant problems with monitoring results caused by persistent challenging environmental conditions).*

| | **2016-2019** | **2006-2016** | **2018-2019** |
|---|---|---|---|
| Coastal | 19 % | 16 % | 19 % |
| Tana/Teno | 52 % | 60 % | 43 % |

The relative exploitation efficiencies represent the proportion of surviving salmon that are caught in an area. So, for instance, the main stem efficiency estimate is the estimated main stem catch of Tana MS salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

# 5 Conclusions and further insights into the status assessment

Stock status over the last four years (2016-2019) was poor in 7 of the 15 stocks that we evaluated (Figure 54). The best status was found in Veahčajohka/Vetsijoki, Ohcejohka/Utsjoki and Báišjohka.

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

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 54) should, following NASCO guidelines, automatically trigger the formulation of a recovery plan for the affected stock. Seven of the 15 evaluated stocks are currently in this situation. Each recovery plan should contain an analysis of factors negatively affecting a stock and how to lessen the impact of factors identified as negative. This has largely been taken care of for the recovering stocks in Tana. We have identified overexploitation as a major factor affecting all stocks needing recovery in Tana (Figure 55) and the exploitation analyses of this report demonstrate that the reduction in exploitation with the fishing rules from 2017 are sufficiently high to allow for stock recovery for all affected stocks within two generations (*c*. 15 years).

The current stock status assessment makes no attempt to estimate any proportion of unreported catches in the different areas and the catch statistics of both countries are treated as an accurate representation of the actual catch in various parts of Tana. The MRG are looking at options of implementing such procedures as part of the assessment. The main consequence of including unreported catch in the assessment is that the target attainment will decrease.

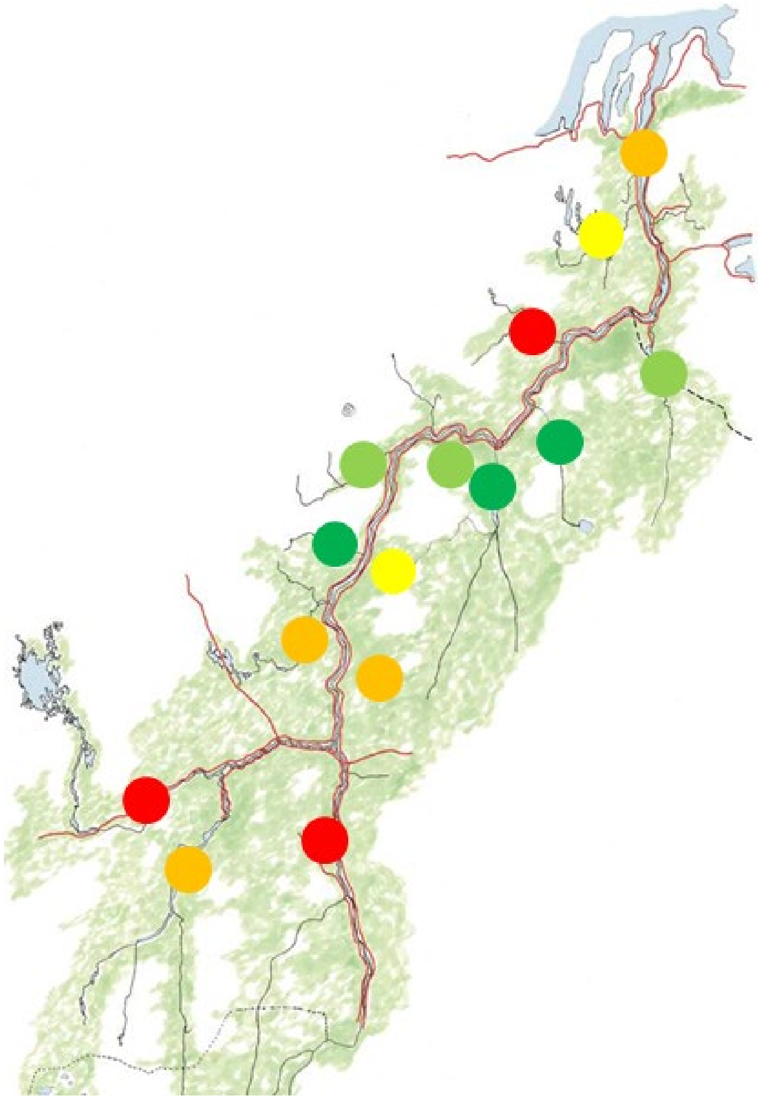

*Figure 54. Map summary of the 2016-2019 stock status of the evaluated parts of the Tana/Teno river system. Symbol colour designates stock status over the last four years. Possible colours are: Dark green = overall probability of attaining spawning target higher than 75 %, overall target attainment over 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.*

Genetics were used to identify the home stock of main stem scale samples from the years 2006-2008 and 2011-2012. Genetic stock identification of the scale samples from the lower Norwegian main stem can be used as an indication of how well the different stocks are doing in comparison to each other and their spawning target. Such an analysis is a useful alternative approach to assessing stock status. If the catch proportion of a stock is higher than the spawning target proportion, that is an indication that the pre-fishery abundance of that stock is relatively high compared to other stocks. And a relatively high pre-fishery abundance would be the first indication that a stock is in relatively decent shape compared to the stocks that have a lower catch proportion. Such an analysis were performed with the old genetic data from the years 2006-2008 and 2011-2012 (Anon. 2018). This analysis was relevant for the fisheries situation under the old fishing rules, but with limited transferability to the situation with new fishing rules (2017-2019). We are currently in a transitional state where a new SNP-based genetic baseline is under construction, and we will redo the analysis when the new baseline have been completed.

Estimates of overexploitation in the years 2016-2019 showed a significant effect on the salmon stocks in the upper headwater rivers and the main stem (Figure 55). When interpreting this result, it is highly important to remember the definition of overexploitation. It is defined as the reduction in spawning stock size below the spawning target that is caused by exploitation. The estimated pre-fishery abundance of different stocks tells us the amount of fish doing their spawning migration each year. Some of these fish are taken in coastal fisheries, some in main stem fisheries and some in their respective tributaries. For the overexploited stocks, the total catch exceeds the sustainable surplus.

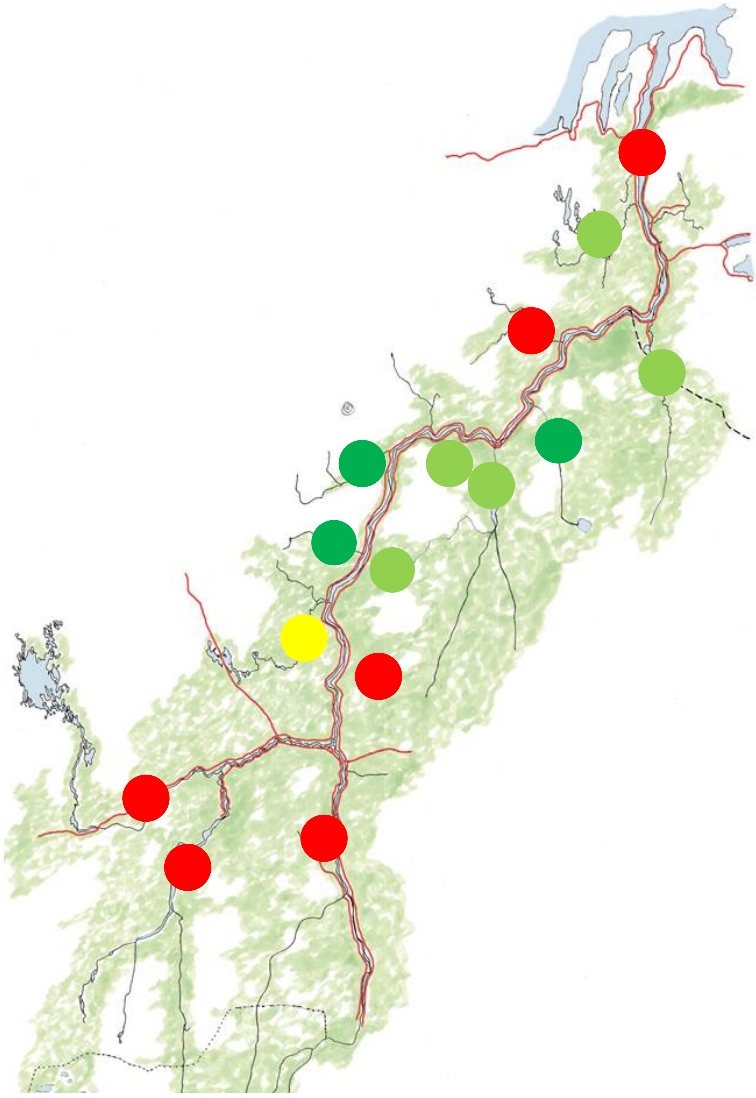

*Figure 55. Map summary of the estimated overexploitation experienced in various parts of the Tana/Teno river system in the years 2016-2019. Symbol colour represents the extent of the overexploitation (in terms of percentages of the spawning target). Dark green = no effect (0 % of the spawning target), light green = small effect (<10 %), yellow = moderate effect (10-30 %), red = large effect (>30 %).*

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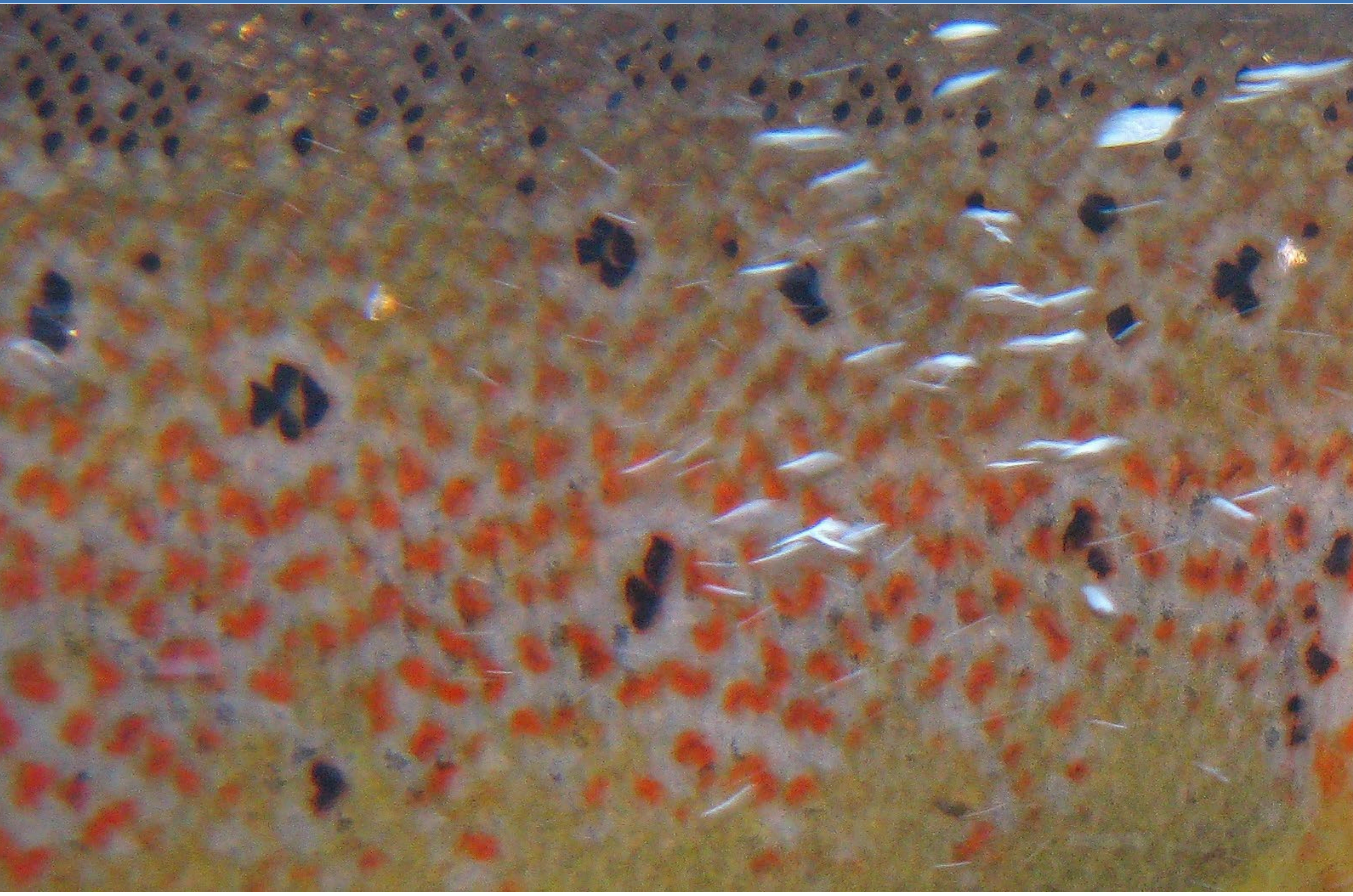

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