Tana Monitoring and Research Group

Status of the Tana/Teno River salmon populations in 2020

Report from the Tana Monitoring and Research Group 1/2020

Status of the Tana/Teno River salmon populations in 2020

Report from the Tana Monitoring and Research Group

THE REPORT CITES AS:
Anon. 2020. Status of the Tana/Teno River salmon populations in 2020.
Report from the Tana Monitoring and Research Group nr 1/2020.

Tromsø/Trondheim/Oulu, December 2020

ISSN: 2535-4701
ISBN: 978-82-93716-06-8

EDIT
1

AVAILABILITY
Open

PUBLICATION TYPE
Digital document (pdf)

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

This report is also published as:
In Norwegian: ISSN 2535-4701, ISBN 978-82-93716-04-4
In Finnish: ISSN 2535-4701, ISBN 978-82-93716-05-1

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

Summary

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

This report is the fourth 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 mixed-stock fisheries monitoring in Tana/Teno is currently undergoing a transition, moving away from microsatellite markers to single-nucleotide polymorphism (SNP) markers. The two methods are giving some diverging results, and as part of the process of increasing our understanding of the mechanisms involved, we have done separate status assessments with both genetic methods in this report.

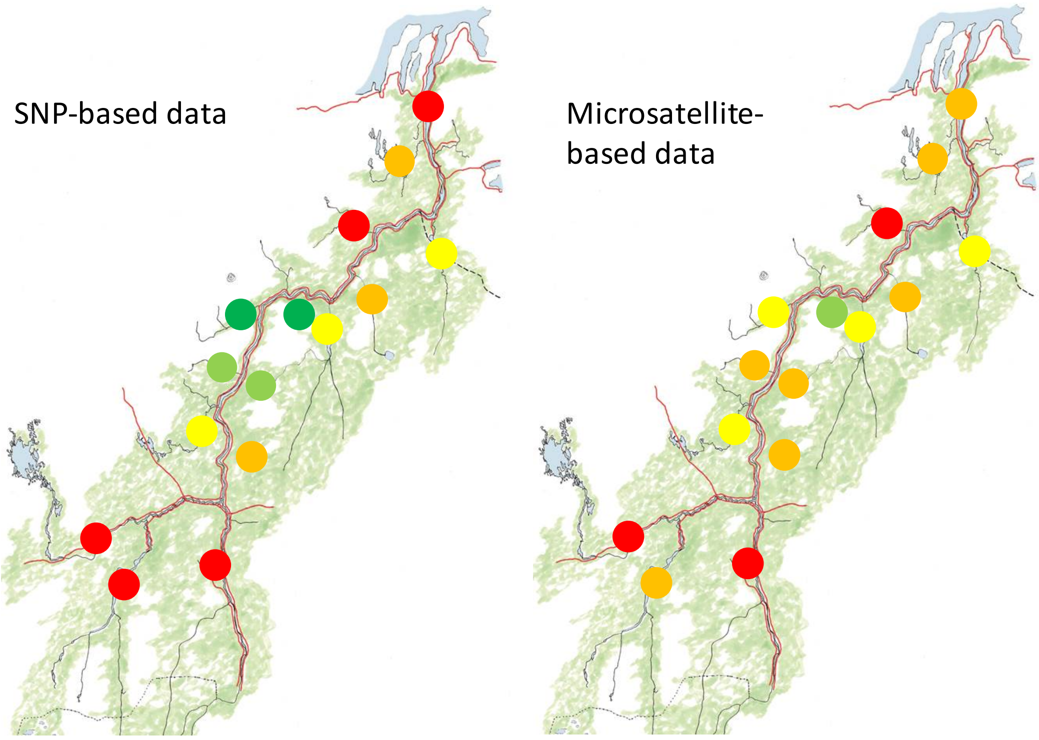
Assessing the stock status is answering the question about how well a salmon stock is doing, how many salmon were left at the spawning grounds and how many should there have been. The question about how many salmon should spawn has been addressed by the defined spawning targets for the different populations (Falkegård et al. 2014). Several alternative ways of estimating the spawning stock are used:

1) **Direct counting of spawners**, In rivers with snorkelling counts during the spawning period.
2) **Combine fish counting and catch statistics**. In rivers with fish counts (e.g. video, sonar) and catch statistics.
3) **Combine estimates of exploitation rate and catch statistics**. In rivers with fishing and catch statistics but no salmon counts.
4) **Combine genetic information from main stem catches, exploitation rates and catch statistics**. In rivers with little/no fishing and catch statistics.

Sonar counts from the Tana/Teno main stem in 2018-2020 give direct estimates of total run size and improve the estimated exploitation rates for both the Tana/Teno mainstem and the tributaries.

The map below summarizes the 2017-2020 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)



Based on SNP data, eight of 15 stocks need a recovery plan with the probability of reaching management target lower than 40 %. Five stocks were placed in the worst status category with very little exploitable surplus over the last four years. The situation evaluated with microsatellites was worse with ten of 15 stocks needing a recovery plan.

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 35 000 kg female spawners annually to reach their combined management targets.

Exploitation estimates show decreasing exploitation for most individual salmon stocks in the mixed-stock fishery in the Tana/Teno mainstem following the 2017 agreement between Norway and Finland. The extents of the reduced exploitation rates are however diverging considerably both between rivers and between assessment methods and we urge precaution in management decision-making in the coming years. We expect most of the diverging results to be resolved in 2021.

To summarize, the overall stock status in most salmon populations of the Tana system in 2020 is poor. Estimated salmon returns and spawning stocks were low and even all-time low for some rivers. The prospects for 2021 salmon run are rather low and therefore the fishing pressure should be kept as low as possible to enable stock recovery.

The table below summarizes the stock-specific management targets and status numbers for 2020 and previous four years, and the probability for reaching the spawning target over the previous 4 years (=the management target).

	2020 target attainment		2020 probability		4-year target attainment		Management target	
	SNP	Msat	SNP	Msat	SNP	Msat	SNP	Msat
Tana/Teno MS	41 %	60 %	0 %	0 %	46 %	67 %	0 %	3 %
Máskejohka	51 %		0 %		91 %		26 %	
Buolbmátjohka/Pulmankijoki	35 %		0 %		98 %		42 %	
Lákšjohka	16 %		0 %		34 %		0 %	
Veahčajohka/Vetsijoki	72 %		5 %		81 %		14 %	
Ohcejohka/Utsjoki (+tributaries)	75 %		4 %		114 %		74 %	
Goahppelašjohka/Kuoppilasjoki	113 %	95 %	68 %	37 %	146 %	125 %	95 %	82 %
Leavvajohka	161 %	85 %	95 %	22 %	210 %	113 %	100 %	61 %
Báišjohka	112 %	61 %	66 %	0 %	139 %	79 %	92 %	12 %
Njiljohka/Nilijoki	29 %		0 %		122 %	85 %	79 %	20 %
Váljohka	66 %	49 %	3 %	0 %	103 %	75 %	50 %	10 %
Áhkojohka/Akujoki	17 %		0 %		32 %		0 %	
Kárášjohka (+tributaries)	29 %		0 %		34 %		0 %	
Iešjohka	9 %		0 %		22 %		0 %	
Anárjohka/Inarijoki (+tributaries)	13 %		0 %		24 %		0 %	

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

Contents

1 Introduction

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

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

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

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

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

1.1 Report premises

1.1.1 The Precautionary Approach

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

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

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

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

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

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

1.1.2 Single- vs. mixed-stock fisheries

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

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

1.1.3 Management and spawning targets

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

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

1.2 Definition and explanation of terms used in the report

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

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

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

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

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

The MRG is tasked with reporting stock status and trends in stock development, and the Precautionary Approach outlines the premises for how a stock status evaluation should be done. In the following we give a brief outline of the procedure we have used in order to produce the stock-specific evaluations in chapter 4. A much more detailed description of the procedure can be found in a previous report of the MRG (Anon. 2016).

1.3.1 Spawning stock assessment

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

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

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

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

https://github.com/mortenfalkegard/Tana_status_assessment

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

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

1.3.2 Pre-fishery abundance and catch allocation

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

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

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

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

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

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

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

2 Salmon stock monitoring

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

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

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

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

- Ascending adult salmon and descending smolts by a video array in Ohcejohka/Utsjoki (since 2002) and Lákšjohka (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, 2017-2020)
- Ascending adult salmon by a sonar in the Tana/Teno main stem (2018-2020)

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), Iešjohka (sonar, 2019-2020) and Máskejohka (sonar, 2020). These pieces of information from individual tributaries are useful as reference levels for estimating their stock status, which in most years make use of catch data only.

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

2.1 Catch 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 2020 resulted in only 916 salmon scale samples, which was 50 % less than in the previous year and the was the lowest since 1985 (Figure 1). The decrease in sample numbers was mostly due to very low abundance of salmon ascending the Tana/Teno system in 2020.

Based on scale reading the proportion of escaped farmed salmon among the samples have varied between 0 and 0.6 %, the long-term average (1985-2020) being 0.19 %. In 2020 no escapees were detected in the scale material.

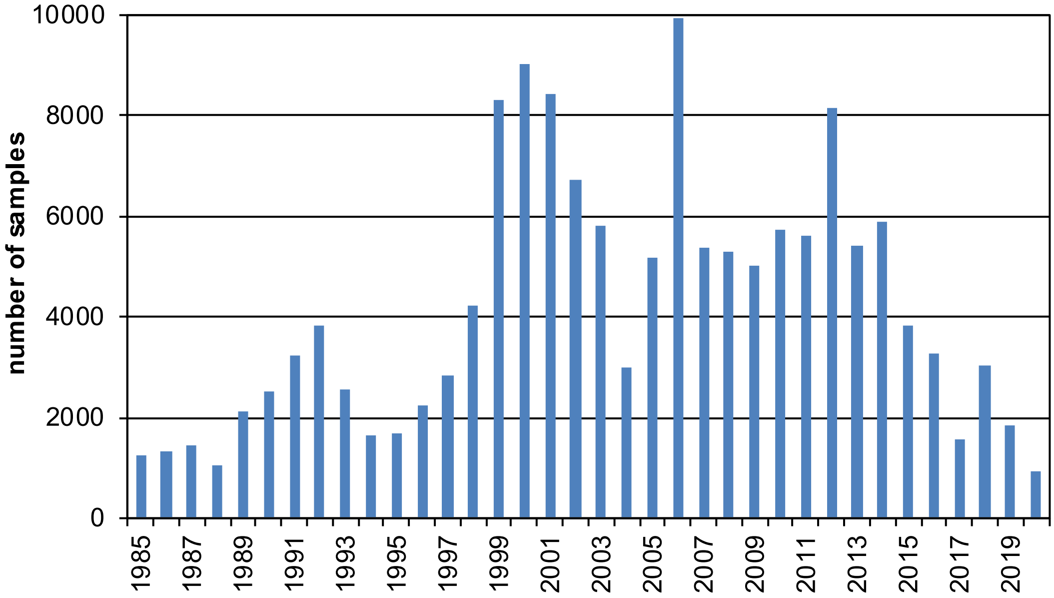


Figure 1. Number of salmon scale samples collected annually from the Tana/Teno system in 1985-2020 including both Finnish and Norwegian samples.

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 2020 was 31,6 tons. The catch decreased 23 % from the previous year and was the lowest in the time series (1972-2020). This total catch equals to c. 6 800 salmon individuals (Figure 2). The Finnish catch was 47 % (14,8 t) and Norwegian catch 53 % (16,8 t) of the total catch. The rather low salmon catches in 2017-2020 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 2019-2020 translating as low catches.

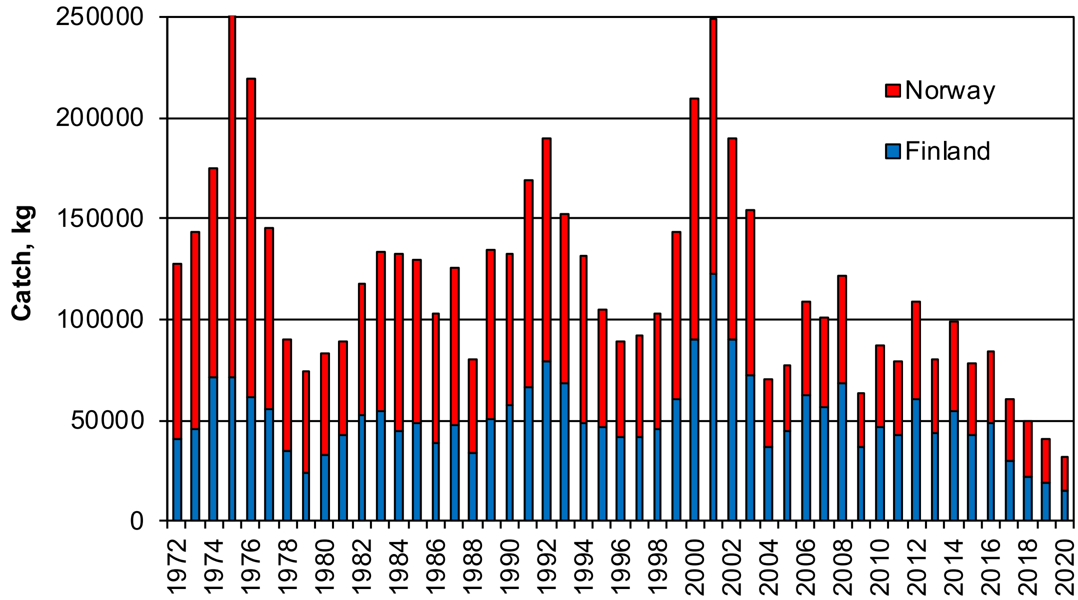


Figure 2. Estimated total salmon catch (kg) in the Tana/Teno river system in Norway and Finland in 1972-2020.

In 2020 catch of small 1SW salmon (=grilse) decreased c. 13 % from the previous year and were the lowest (3550 individuals) recorded within the monitoring period (1975-2020, Figure 3). Grilse constituted only 49 % of the total salmon catch in numbers. Catch of 2SW salmon (<1 000 fish) decreased 75 % from the previous year and they constituted only 14 % of the catch in numbers. The catch of repeat spawners (700 fish) decreased (42 %) also compared to 2019. Catch of large 3SW salmon, however, increased significantly (168 %) from 2019, and they constituted 26 % of the salmon 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.

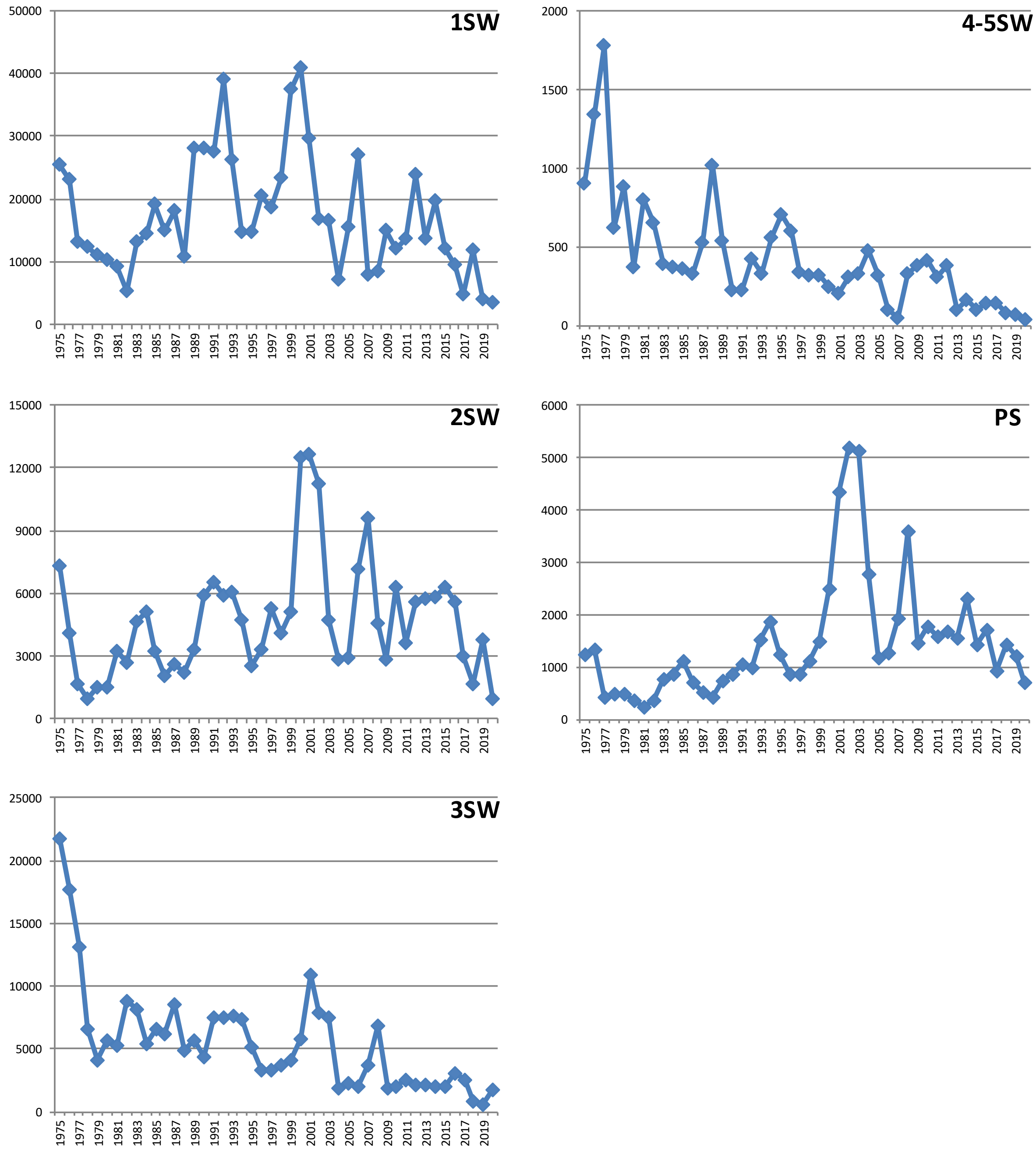


Figure 3. Estimated total salmon catch (number of fish) of different sea-age groups (SW) in the Tana/Teno river system in the years 1975-2020. Note the different scales in vertical axes (PS=previous spawners).

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 2017-2020 have decreased dramatically from the earlier years, being 10 360 day licences and 2 462 fishers in 2020 (Figure 4). In Norway, a total of 5 529 tourist fishing days were sold for the border reach of the Tana/Teno main stem and Anárjohka/Inarijoki in 2020. Additionally, 1060 tourist fishing days were sold for the Norwegian lower Tana area and 712 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 490 in 2020, being somewhat less than the average figure over the previous five years (590). In Norway, a total of 1 310 local fishermen bought licences in 2020 (2019: 1 371).

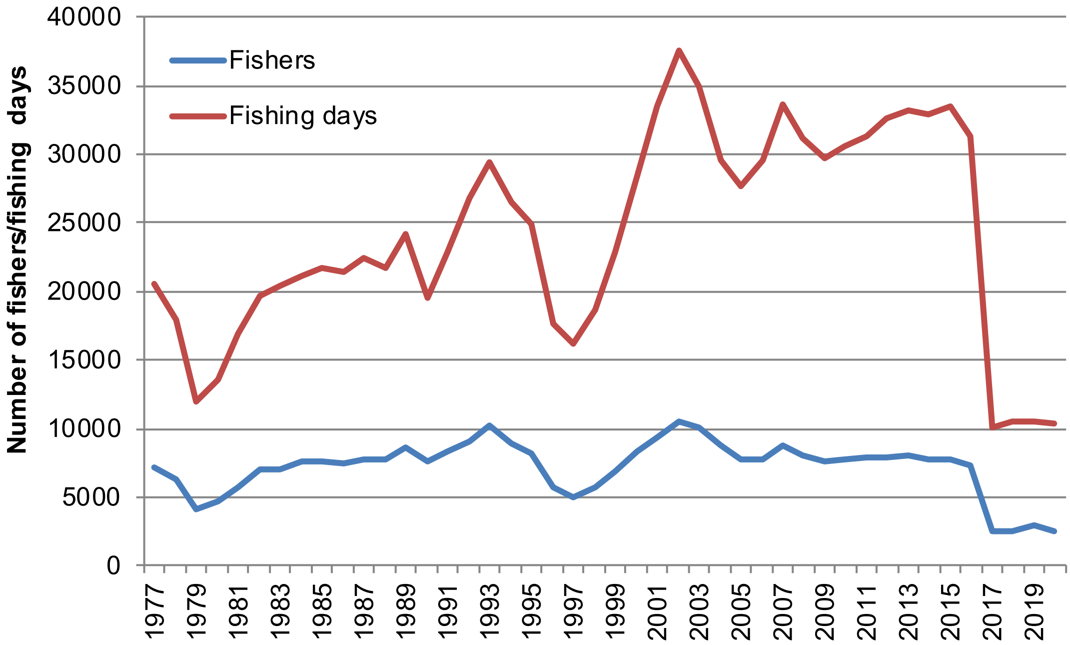


Figure 4. Number of tourist fishers (blue) and daily tourist fishing days (red) in the Tana/Teno river system on the Finnish side in 1977-2020.

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. During the years 2017-2020 part of the Tana/Teno and Anárjohka/Inarijoki sampling sites has not been electrofished because one of the local fishing rights owner's association on the Finnish side has not given permit for it.

Although the juvenile salmon abundance is not used directly in assessing stock status for individual populations (chapter 4), information on juvenile abundance is still an important index of spatial distribution of spawning and juvenile production and their yearly variation.

In 2020 juvenile salmon densities were within the limits of earlier years in Ohcejohka/Utsjoki and in Anárjohka/Inarijoki. In the Tana/Teno main stem the densities of both 0+ and older (≥1+) juveniles, however, were at very low levels matching only densities observed back in 1981 (Figure 5).

In long-term juvenile salmon densities have been fluctuating between years with no apparent clear trends, although 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 must 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.

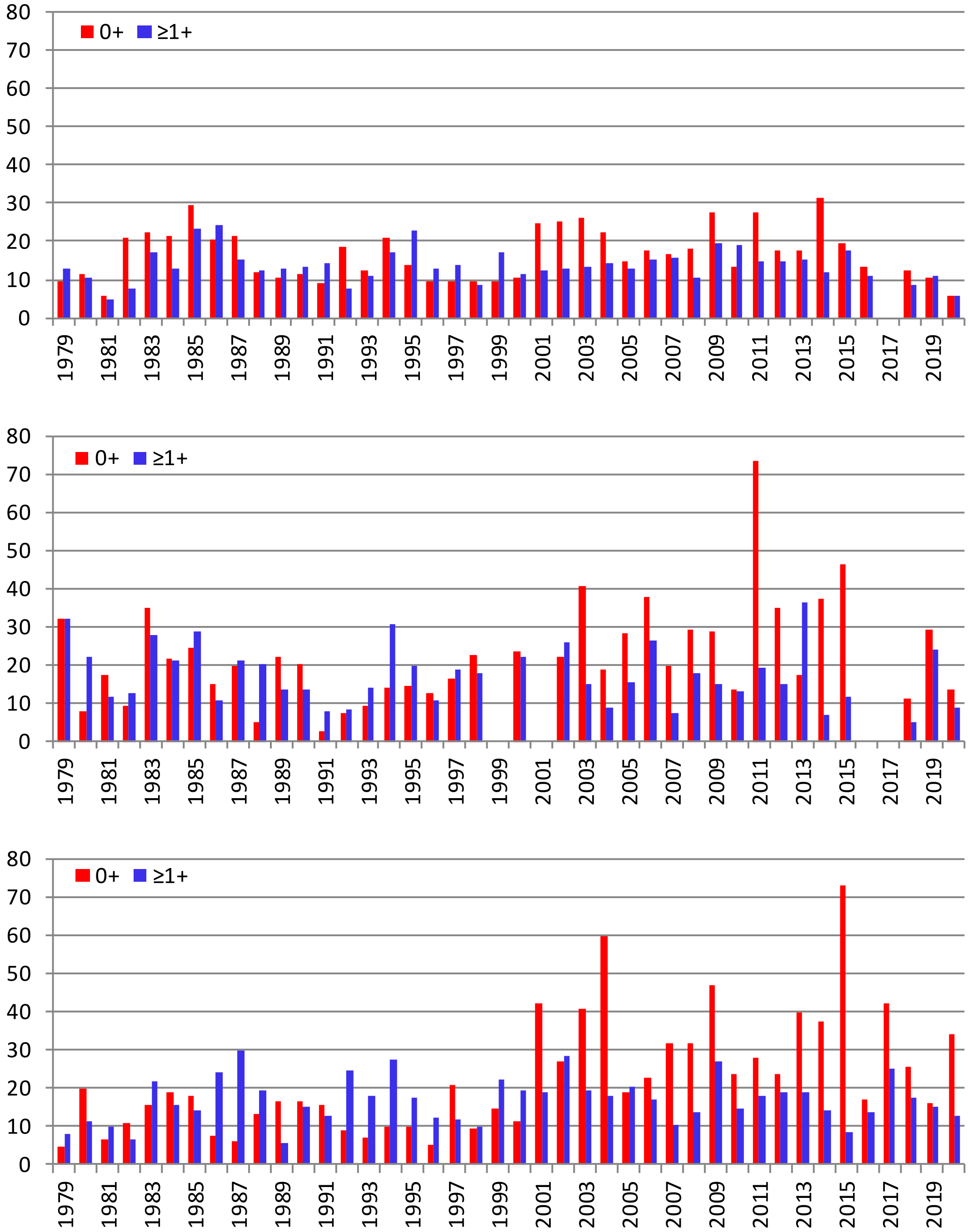


Figure 5. Mean densities (fish/100 m^2; one pass) of salmon fry (0+) and parr (≥1+) at permanent electrofishing sites in the rivers Tana/Teno (uppermost panel), Ohcejohka/Utsjoki (middle panel) and Anárjohka/Inarijoki (lowermost panel) in the years 1979-2020. Note: this data only includes electrofishing sites (Tana/Teno 16-22 sites, Ohcejohka/Utsjoki 11-12 sites and Anárjohka/Inarijoki 5-7 sites) that have been the same throughout the monitoring period.

2.4 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 6).

In 2020 adult salmon counts were performed at the following sites (Figure 6): Tana/Teno main stem (sonar), Máskejohka (sonar), Lákšjohka (video), Ohcejohka/Utsjoki (video), Kárášjohka (sonar), Iešjohka (sonar), Buolbmátjohka/Pulmankijoki (snorkelling), Njiljohka/Nilijoki (snorkelling) and Áhkojohka/Akujoki (snorkelling).

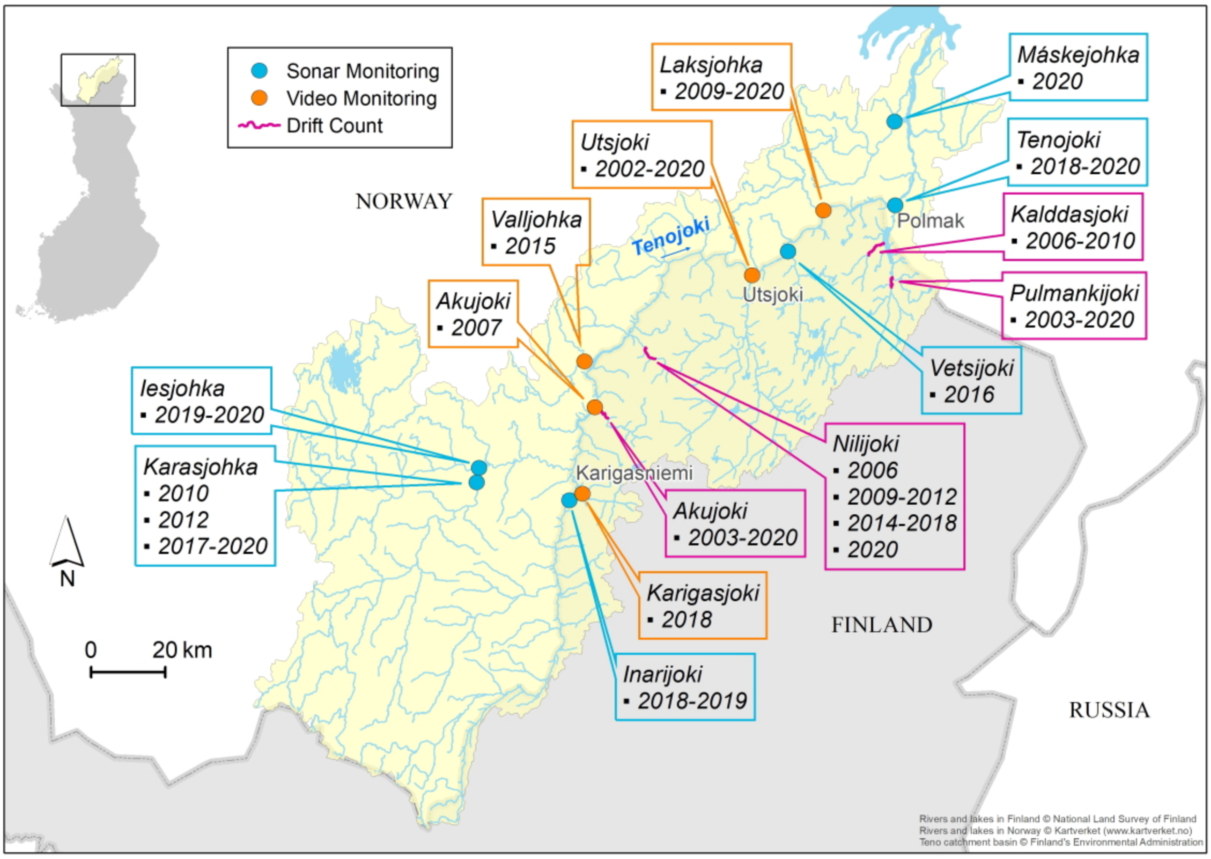


Figure 6. Map of the Tana/Teno river system indicating the most important adult salmon counting sites and counting methods between 2002 and 2020.

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 in 2002-2019 (Figure 7).

In 2020 the counting was performed in very challenging environmental conditions, high discharges prevailing between June and late-July. To estimate salmon ascendance close to the shorelines of Ohcejohka/Utsjoki in these high discharge conditions, four extra cameras were installed between the eastern shore and the eastern bridge pillar. The adult salmon count based on the normal eight cameras between the bridge pillars was only 646 salmon in 2020 (Figure 7). When accounting the results from the four extra cameras the Ohcejohka/Utsjoki the minimum salmon run estimate became 1075 fish (median estimate 1290, maximum estimate 1505). This estimate was still the lowest observed since 2002 (cf. Figure 7).

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 in 2009-2019.

In 2020 the counting was performed in extremely challenging environmental conditions, with flooding or high-water conditions prevailing almost throughout the whole monitoring season. The installed cameras were not able to cover the whole river, very turbid water restricted the visibility of the cameras compared to other years and technical problems (disk malfunction) caused some gaps in the data. Therefore, the Lákšjohka salmon count in 2020 is only a partial count of the true population size. The partial count in Lákšjohka yielded 156 adult salmon (Figure 7).

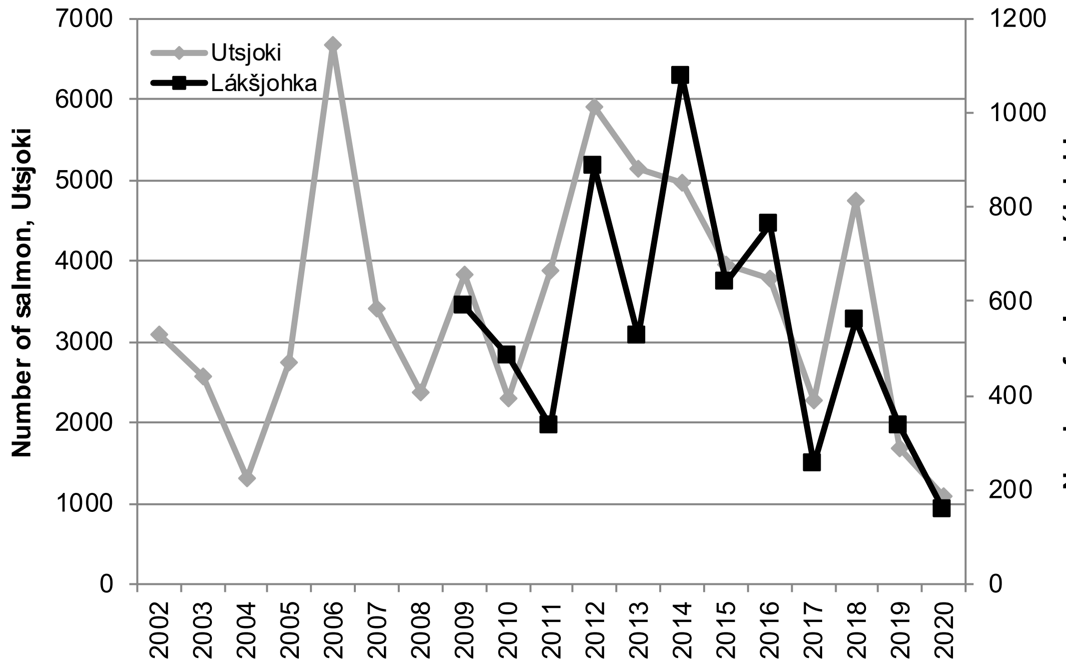


Figure 7. Video counts of ascending adult salmon at the video monitoring sites in the Ohcejohka/Utsjoki and Lákšjohka in 2002-2020. Sea age groups are combined. Note: Utsjoki adult numbers in high-discharge years 2017 and 2020 are corrected upwards based on extra videodata collected in 2020. The Lákšjohka data in 2017 and in 2020 are minimum estimates and are not fully comparable to other years because of challenging environmental conditions affecting the count accuracy.

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 8).

The number of spawning salmon has varied between 31 and 171 in Áhkojohka/Akujoki, between 29 and 215 in Buolbmátjohka/Pulmankijoki and between 49 and 216 in Njiljohka/Nilijoki (Figure 8). In 2020 the snorkelling counts were performed in good environmental conditions and the results are fully comparable to other years. Numbers of spawning salmon were at very low levels in all surveyed tributaries in 2020, reaching all-time low in Buolbmátjohka/Pulmankijoki (29 fish) and in Njiljohka/Nilijoki (49 fish) (Figure 8). Especially the abundance of small one-sea-winter salmon (1SW) were extremely low in all three tributaries.

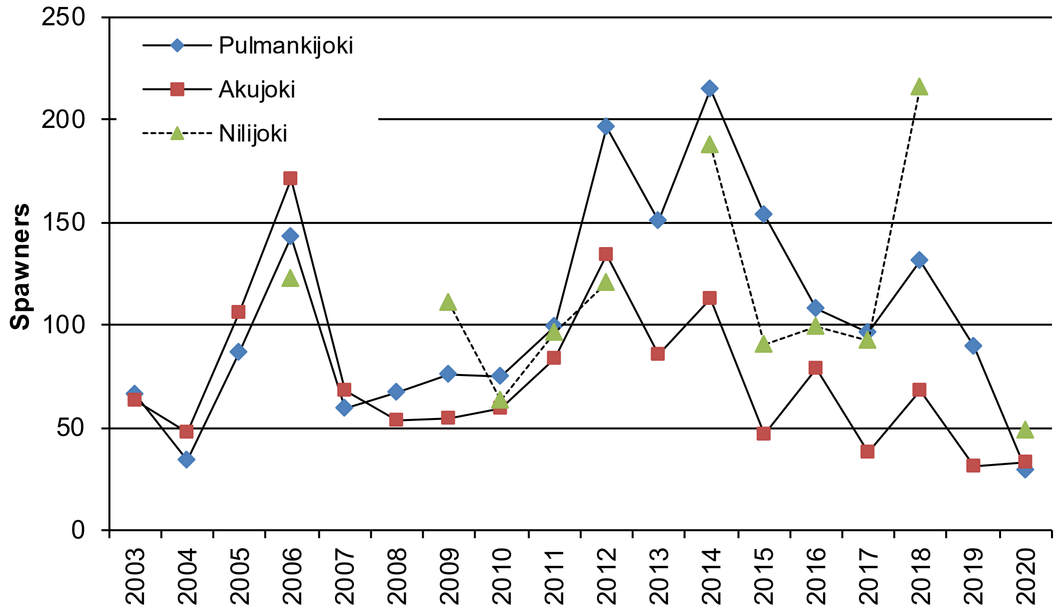


Figure 8. Snorkelling counts of spawning salmon in the rivers Buolbmátjohka/Pulmankijoki, Áhkojohka/Akujoki and Njiljohka/Nilijoki in 2003-2020. Sea-age groups are combined.

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 2020 sonar counts were performed in Kárášjohka, in the Tana/Teno main stem, in Iešjohka and in Máskejohka (Figure 6). 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.

In the River Kárášjohka, sonar technology to count ascending salmon has been used in 2010, 2012 and 2017-2020. 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 three years the monitored river width has been c. 30-35 m.

In total 833 salmon were estimated to pass the sonar counting site in Kárášjohka in 20.6.-15.9.2020 (Figure 9). When accounting the missed time period (29.5.-19.6.) based on earlier years data, the run estimate for 2020 became 1241 salmon. This was slightly lower than in 2019 and almost 60 % less compared to 2018. Salmon migration in 2020 was weak throughout the monitoring period and no clear migration peaks were observed (Figure 9).

The length distribution data of salmon passing the sonar site indicated that 34 % of salmon were <65 cm fish, 36 % were fish between 65 and 90 cm and 30 % were fish ≥90 cm. The length distribution data includes some uncertainty because of a rather long (30-35 m) sonar window used in the survey.

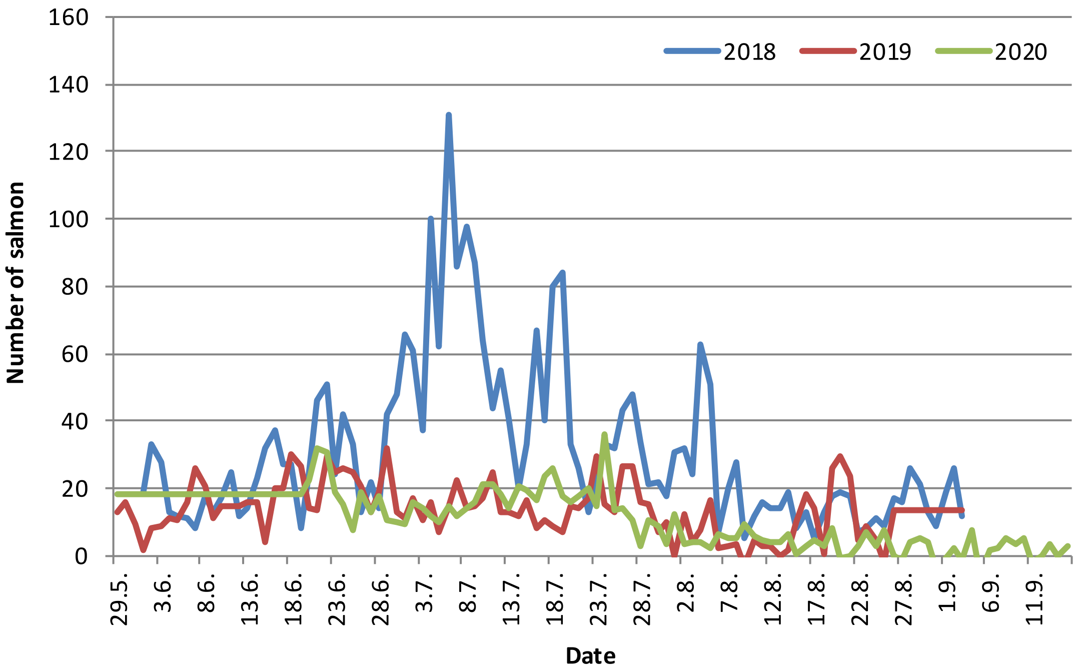


Figure 9. Estimated daily numbers of ascending salmon (≥45 cm) in the Kárášjohka sonar count in 2018 (blue line), 2019 (red line) and 2020 (green line). All size categories are combined. The estimate of the total ascendance through the site in 2018, 2019 and 2020 was 2 962, 1 343 and 1241 salmon, respectively.

The Kárášjohka run size in 2020 was among the lowest observed within the six counting seasons (Table 1). The low numbers are largely explained by poor 1SW salmon run, as observed also elsewhere in the Tana/Teno system in 2020.

Table 1. Sonar count results of ascending salmon numbers in the River Kárášjohka in 2010, 2012, and 2017-2020 divided to 1SW and MSW salmon. Data from 2012 and 2017 are not fully comparable to other years because of differences in used sonar techniques (2012) and unsuitable (high water) counting conditions (2017).

Time period	1SW	MSW	All	Note	Equipment
9.6.-31.8.2010	1016	661	1677	Missing time estimated	Didson
6.6.-27.8.2012	1038	1589	2627	Missing time not estimated	Simsonar
7.6.-31.8.2017	371	492	863	Missing time not estimated	Aris/Simsonar
1.6.-3.9.2018	1786	1176	2962	Missing time not estimated	Aris
29.5.-3.9.2019	569	774	1343	Missing time estimated	Aris
29.5.-15.9.2020	426	815	1241	Missing time estimated	Aris

Sonar counting of ascending salmon numbers was continued in the Tana/Teno main stem in 2020, at Polmak, c. 55 km upstream from the river mouth (Figure 10). 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. Normally the width of the river (c. 130 m) is narrowed to c. 100 with guiding fences to be covered by the two sonars (Figure 10). In 2020 late occurring spring flood and high-water levels during the first weeks of June prevented the use of guiding fences and the two sonars were not fully covering the river until late-June (20.6.). Therefore, the early season salmon run estimate is not as reliable as in 2018-2019.

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.

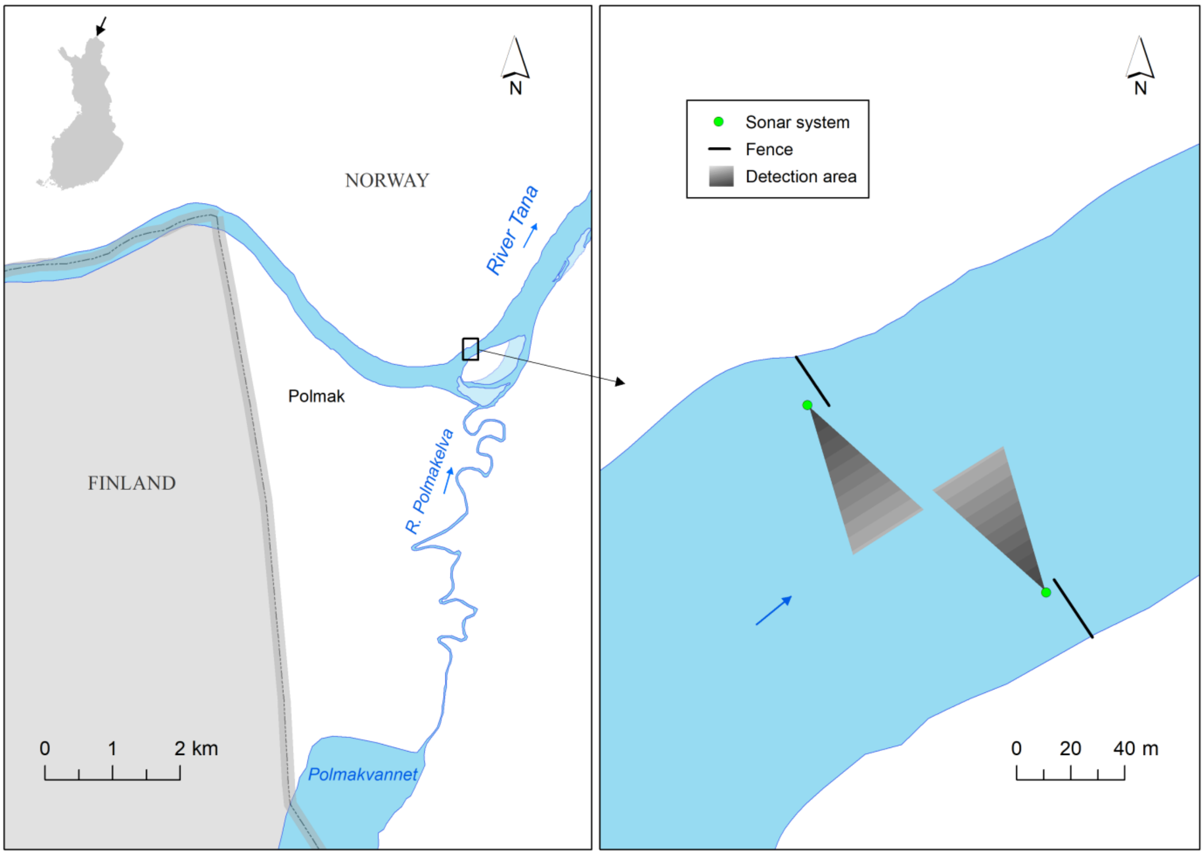


Figure 10. Map of the Tana/Teno main stem sonar counting site including the locations of the two sonar units and guiding fences in 2019-2020.

In total 14 650 salmon were estimated to pass the sonar counting site at Polmak in 5.6.-14.9.2020 (Figure 11). This was clearly the smallest count result during the three years of monitoring in Polmak. Compared to years 2018-2019 the coverage of the sonars in 2020 was not as good during the first three weeks of June. Based on earlier years data from this time period and this year's data after late-June, it can be estimated that between 1000-2000 salmon could have been missed in 2020 during the three first weeks of June. Overall, the count clearly indicated very low salmon ascendance to Tana/Teno, which was also observed in all other surveys throughout the Tana/Teno system.

The length distribution data of salmon passing the sonar site in 2020 indicated that 49 % of salmon were <65 cm fish, 33 % were fish between 65 and 90 cm and 18 % were fish ≥90 cm. The proportion of small salmon (<65 cm) was still very low, although not as low as in 2019 (35%). 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 from Polmak, the total Tana/Teno salmon run size was in minimum c. 19 000 fish in 2020. The total run size estimate for 2018 and 2019 were c. 40 000 and 25 000 salmon, respectively.

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 three first years of sonar monitoring in the Tana/Teno main stem indicates that it provides valuable information for stock status evaluation.

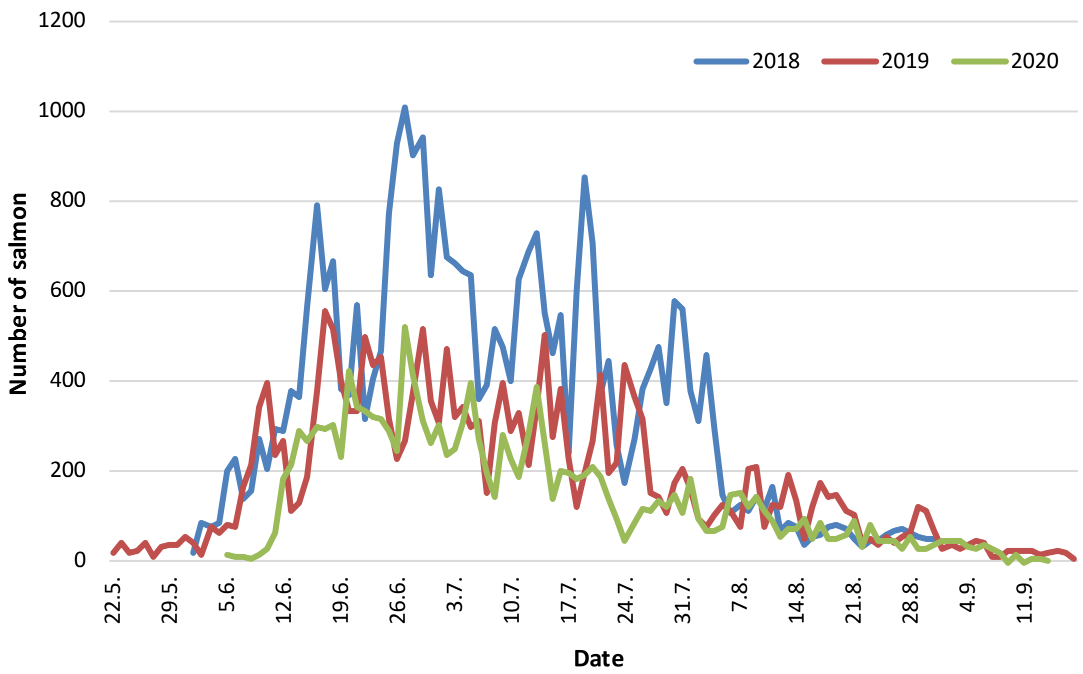


Figure 11. Estimated daily numbers of ascending salmon (≥45 cm) in the Tana/Teno main stem sonar count at Polmak in 2018 (blue line), 2019 (red line) and 2020 (green line). All size categories are combined. The estimate of the total ascendance through the site in 2018, 2019 and 2020 was 32 455, 21 013 and 14656 salmon, respectively.

Sonar counting in River Iešjohka was continued in 2020 close to the confluence of rivers Kárášjohka and Iešjohka, c. 247 km from the Tana/Teno mouth (see Figure 6). 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. 30 m window later in the season. Because of extremely heavy spring flood the sonar counting was started quite late on 18th June (Figure 12). 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 and Tanavassdragets fiskeforvaltning (TF). This estimation included additions of salmon for days with missing sonar data or low channel coverage (=high water period in June) and estimation of proportion of salmon in the size class of 45-65 cm fish. Underwater video material was used as an additional validation data.

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 1.6.-6.9.2020 was only 786 fish (Figure 12). It is obvious that this is a minimum estimate of the Iešjohka salmon run in 2020. The run estimate in 2019 was at the same level, c. 650 fish.

The length distribution data of salmon passing the sonar site indicated that 25 % of salmon were <65 cm fish, 46 % were between 65 and 90 cm and 29 % were fish ≥90 cm. The length distribution data includes considerable uncertainty because of a rather long (from 30 to 50 m) sonar windows 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.

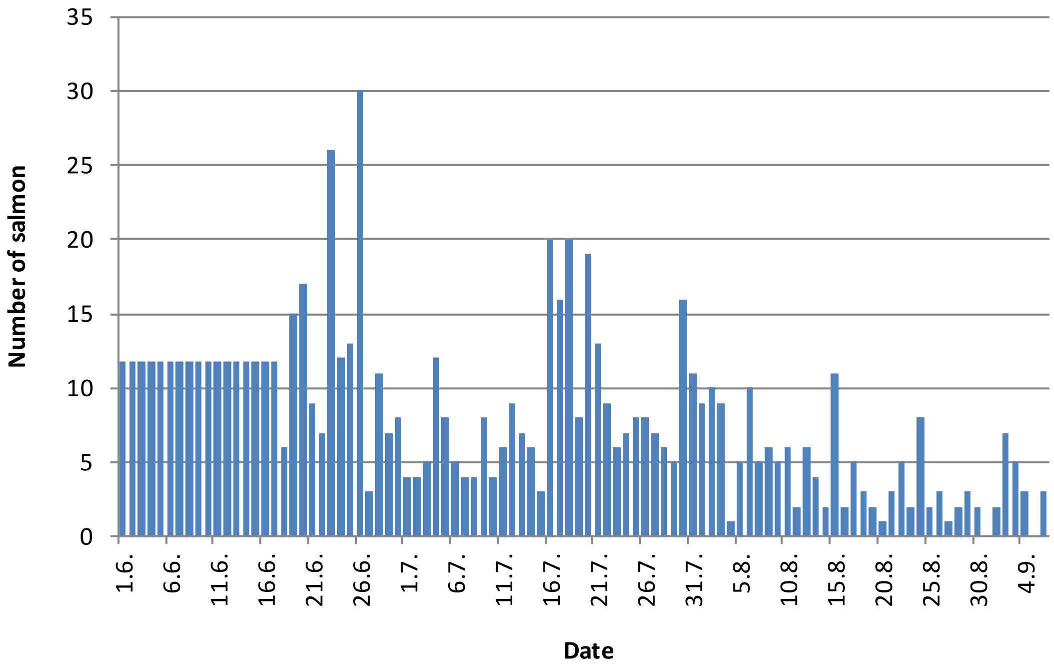


Figure 12. Estimated daily numbers of ascending salmon (≥45 cm) in the River Iešjohka between 1.6. and 6.9.2020. All size categories are combined. The estimate of the total ascendance through the site was 786 salmon.

A pilot sonar counting was conducted in River Máskejohka in the period 1.6 to 15.9 2020. Late and heavy spring flood disrupted the counting in Máskejohka and we have only reliable counts from late 21.6 and onwards. The results of the Máskejohka sonar counting were not fully finished when writing this report and the data is therefore not presented in here. It will be published in a master thesis and added to the 2021 report of the MRG.

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 2006-2020 varied between 54 % (2018 and 2020) and 71 % (2007). On average, the total exploitation was 67 % in 2006-2016 (the old fishing rules) and 58 % in 2017-2020 (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 13). 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 13). 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 38 % (2020) to 74 % (2007) of the Norwegian river catch of Tana/Teno salmon (Figure 14). The proportion caught by other locals varied from 15 % (2018) to 32 % (2020) while tourists accounted for 6 % (2016) to 30 % (2020) of the catch. On average, the proportion caught by locals with gillnet fishing rights changed from 68 % under the old rules to 52 % with the new rules. The proportions caught by other locals was stable at 23 % while for tourists the proportions changed from 9 % to 25 %.

In Finland, the catch of locals with gillnet fishing rights accounted for from 39 % (2009, 2016, 2020) to 55 % (2018) of the Finnish river catch of Tana/Teno salmon (Figure 14). 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 18 % (2020) of the Finnish catch. In 2019-2020, however, part of the cabin owner licenses have been hired to tourist fisherman and cabin owner group therefore include also tourist catch during these two years. On average, the proportion caught by locals with gillnet fishing rights changed from 42 % under the old rules to 44 % with the new rules. The proportions for other locals changed from 10 % to 13 %, for tourists from 47 % to 36 % and cabin owners from 0 to 7 %.

Combined for the two countries, the catch of locals with gillnet fishing rights accounted for 39 % (2020) to 61 % (2018) of the total river catch of Tana/Teno salmon (Figure 14). The proportion caught by other locals varied from 13 % (2007, 2012) to 21 % (2020) while tourists accounted for 23 % (2018) to 35 % (2017). The catch of cabin owners has accounted for 1 % (2018) to 8 % (2020) of the total catch. On average, the proportion caught by locals with gillnet fishing rights changed from 54 % under the old rules to 48 % 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 3 %.

The combined exploitation rate for locals with gillnet fishing rights have changed from 33 % under the old fishing rules to 23 % 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 2 %.

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 four 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.

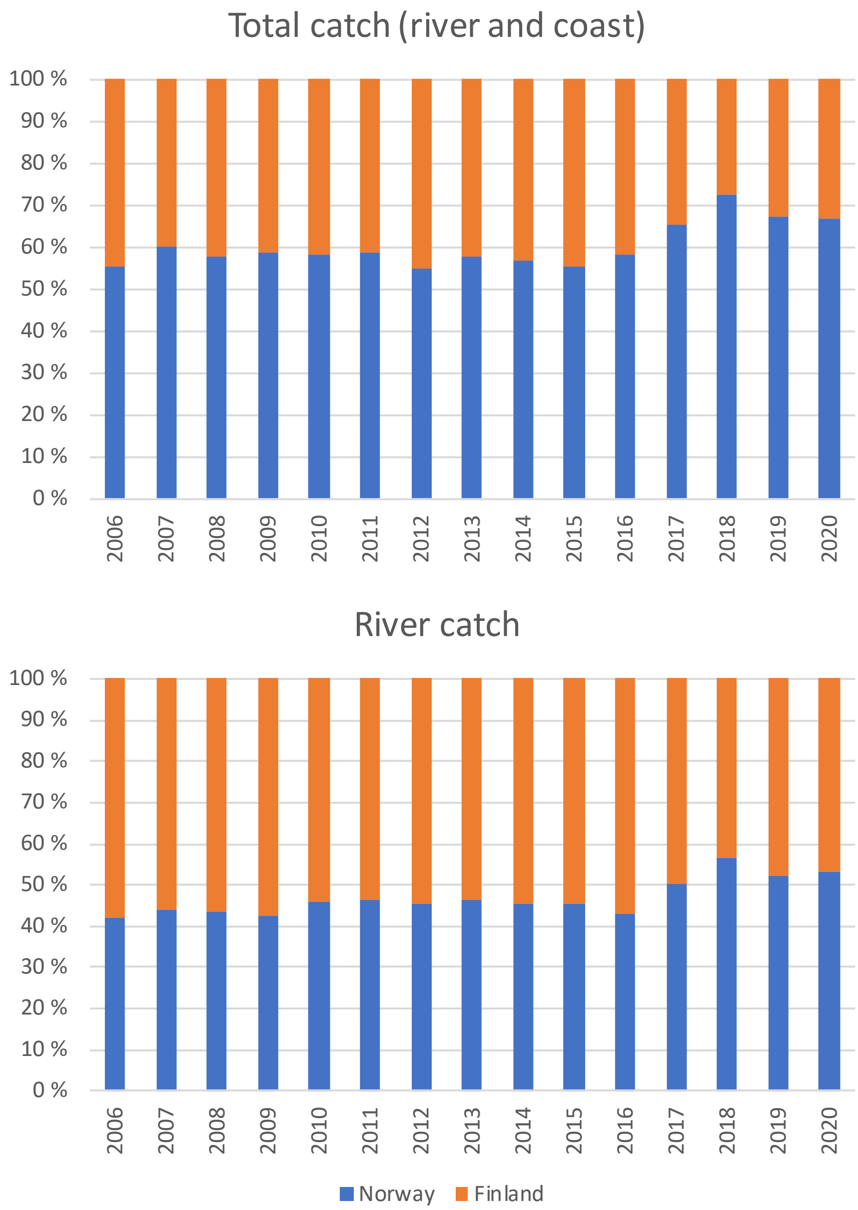


Figure 13. Distribution of catch (%) of Tana/Teno salmon between Norway and Finland for the years 2006-2020. The top graph shows the total catch distribution, with coastal and river catch combined, while the bottom graph shows river catch distribution only.

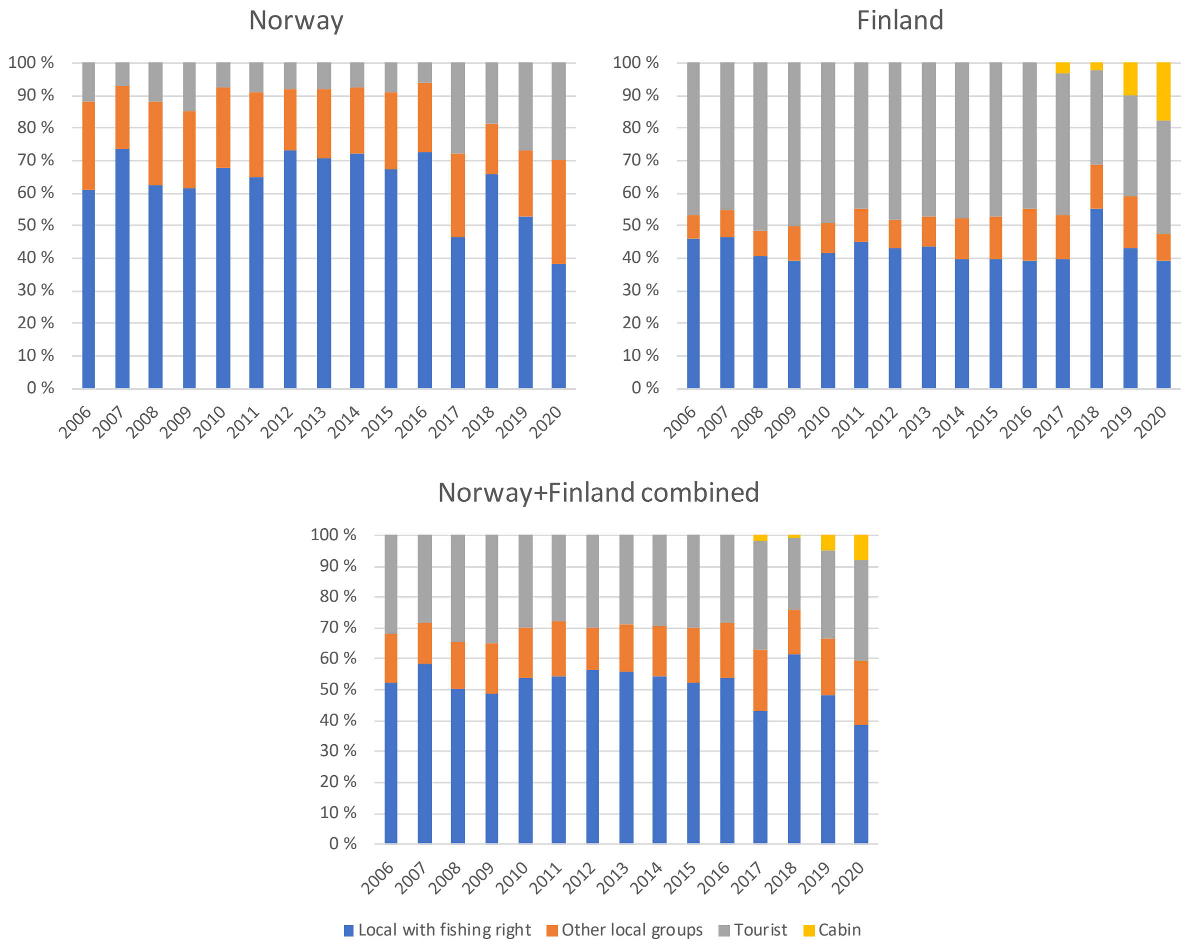


Figure 14. The distribution of catch (%) between groups of fishermen in the two respective countries (top) and Norway and Finland combined (bottom) in the period 2006-2020. Note: the cabin owner group has included also tourist fisherman since 2019 (hired licenses) and therefore the catch proportion of cabin owner group has significantly increased.

Within Norway, driftnet accounted for from 10 % (2006, 2018, 2020) to 28 % (2008) of the Norwegian river catch of Tana/Teno salmon (Figure 15). The proportion caught with weir varied from 10 % (2020) 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 30 % (2020). 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 22 %, for gillnet from 14 % to 14 %, for local rod from 28 % to 27 % and tourists from 9 % to 25 %.

Within Finland, driftnet accounted for from 2 % (2020) to 9 % (2007) of the Finnish river catch of Tana/Teno salmon (Figure 15). The proportion caught with weir varied from 2 % (2017, 2020) 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, 2020). On average, the proportion caught with driftnet changed from 6 % under the old rules to 4 % under the new rules. The proportions for weir changed from 7 % to 5 %, for gillnet from 13 % to 12 %, for local rod from 25 % to 37 % and tourists from 48 % to 42 %.

Combined for the two countries, driftnet accounted for from 6 % (2020) to 16 % (2007, 2016) of the total river catch of Tana/Teno salmon (Figure 15). The proportion caught with weir varied from 6 % (2020) 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 40 % (2020). On average, the proportion caught with driftnet changed from 12 % under the old rules to 8 % under the new rules. The proportions for weir changed from 17 % to 16 %, for gillnet from 13 % to 13 %, for local rod from 26 % to 32 % and tourists from 31 % to 33 %.

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

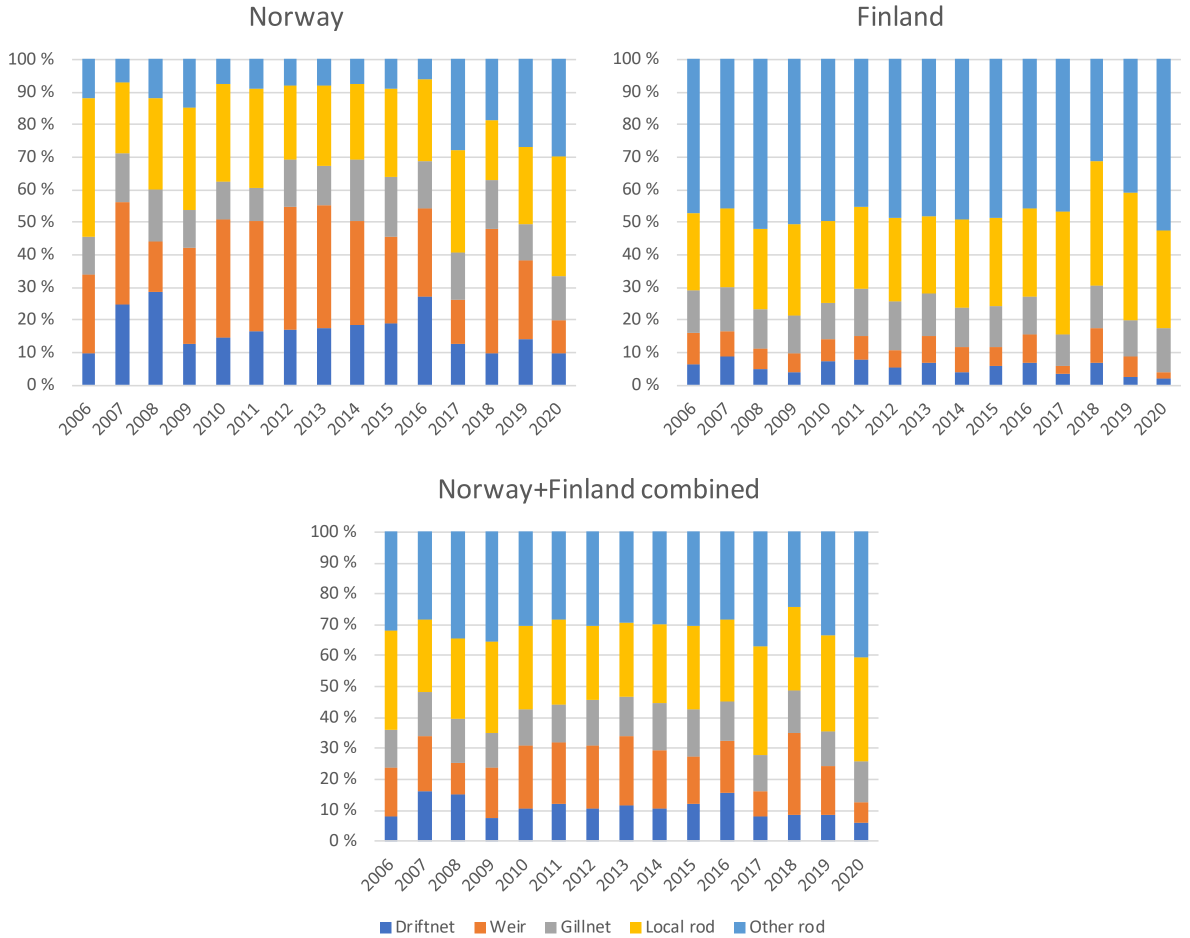


Figure 15. The distribution of catch between fishing gear in the two respective countries (top) and Norway and Finland combined (bottom) in the period 2006-2020.

More data on salmon catches and their distribution between countries and different fishermen groups can be found from the appendixes 1-8 (chapter 7).

4 Stock status assessment

In this chapter we do a status assessment of 15 different areas of the Tana/Teno river system. The assessment contains three main parts: First a spawning stock estimate and evaluation of management targets, secondly an evaluation of how exploitation affects stocks in the different areas, and thirdly the potential for stock recovery.

For each area, we base the assessment on whatever area-specific information is currently available. When fish counting data is available, either in the form of counts of ascending salmon using sonar/video or snorkelling counts of spawning salmon, those numbers are used directly in the assessment. For rivers with catch data and no counting, the catch and an estimate of exploitation rate is used to estimate the spawning stock size. For rivers with no catch data, spawning stock size is estimated from main stem genetic proportions.

The salmon fishery in the Tana/Teno main stem is a mixed-stock fishery in which the catch consists of salmon of largely unknown origin. Genetic stock identification (GSI) of catch samples from the main stem fishery is therefore essential for understanding how the fishery affects different stocks. With the genetic information, it becomes possible to estimate how salmon fisheries by different fisherman groups and on different fishing gears affects different stocks in different areas and different periods of the fishing season.

It is important here to be aware that the genetic work in Tana/Teno currently is in a transition period. Historically, microsatellite markers have been used for the GSI with data available for approximately 20 000 catch samples from the years 2006-2008 and 2011-2012. Starting with 2018, we have been transitioning to a new genetic methodology based on single-nucleotide polymorphism (SNP), which allows for a larger set of markers and a higher degree of confidence in the stock identification compared with the microsatellites. We are, however, currently seeing some discrepancies between the microsatellite data and the SNP data with some stock proportions differing significantly between the old and the new data. At this point, we are too early in the transition to be able to point to the causes of the differences, for instance whether the differences are due to methodological issues or if the differences are a result of actual changes in relative population sizes. For this report, we therefore present the discrepancy as it is, with evaluations based on both microsatellites and SNPs. We should be able to pinpoint more accurately what is and has been going on when the SNP transition has been finalized.

The differences between SNP and microsatellite stock proportions affects both spawning stock assessments and exploitation patterns for the areas that are without catch information and which therefore have evaluations based on main stem catch proportions. In some cases, these areas have results that run counter to expectations. We make cautionary notes in the stock-specific chapters below whenever this occurs.

We present stock-specific figures of estimated pre-fishery abundances for the first time in this report. For the years 2006-2016 the estimates are microsatellite-based while we provide estimates for 2017-2020 with both genetic methods. An estimate of the stock-specific exploitation surplus threshold is also given in each figure. This threshold is calculated by dividing the middle female biomass spawning target with the average female proportion of the stock. The threshold is also used to calculate the maximum sustainable exploitation of each stock. A pre-fishery abundance smaller than the exploitation surplus indicates that there was no exploitable surplus.

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

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

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

The data input for the variables in this formula are summarized in Table 2. Female proportions in Table 2 in the years 2006-2008 and 2011-2012 are based on Tana/Teno main stem stock-identified samples from the Genmix project, while female proportions in other years are based on the size composition of the main stem catch and the 5-year Genmix average female proportion of different size groups weighted with 50 % of the up or down variation of the annual female proportion observed in the scale sampling project.

The exploitation of the Tana/Teno MS stock forms part of the main stem mixed-stock fishery and the estimation of spawning stock size therefore requires an estimate of Tana/Teno MS main stem mixed-stock catch proportion. This is obtained through genetic stock identification of main stem catch samples. As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Tana/Teno MS stock proportion differs significantly between the previous microsatellite method (close to 47 %) and the newer SNP method (32 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. Therefore, alternative assessment of the stock is given, based on both SNP- and microsatellite-based data.

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

For 2017, monitoring results indicated that the new fishing rules had reduced exploitation by approximately 10 %, and the main stem exploitation rate estimate was therefore set to 55 %. For 2018, the combined information from the main stem (sonar counting) and tributary counting 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 %. Conditions for monitoring and fishing, especially with gillnet-based gear, were both difficult in 2020 and the exploitation estimate for 2020 was reduced slightly to 35 %.

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/Teno MS stock.

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

When using SNP data, the spawning target attainment was 41 % in 2020 and the probability for meeting the spawning target was 0 %. Based on the old microsatellite average proportions, spawning target attainment becomes 60 % with a probability of meeting the spawning target of 0 %. The management target was not reached with either genetic method, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 0 % with an overall attainment of 46 % when using the SNP data and 3 % with an overall attainment of 67 % with the microsatellite data (Figure 16).

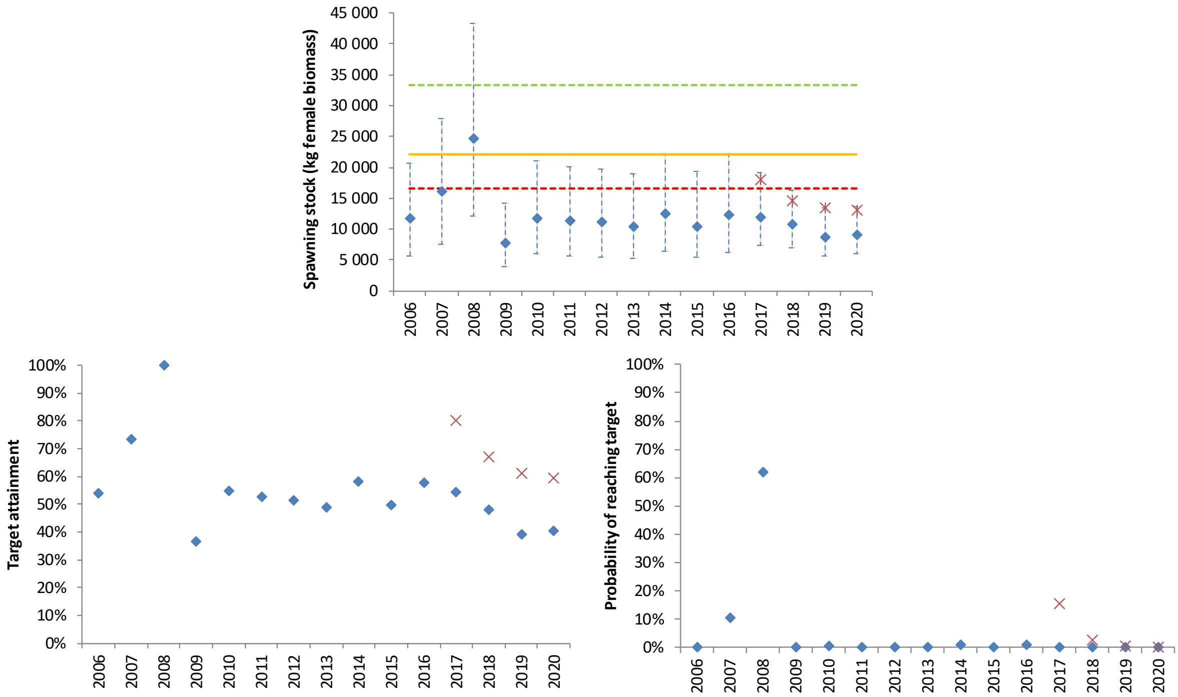


Figure 16. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 for the Tana/Teno MS stock. Red symbols give the result of the status assessment in 2017-2020 when using old microsatellite average stock proportions instead of the more recent SNP proportions.

4.1.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Tana/Teno MS stock has varied from a maximum of 125 786 kg (2008) down to 41 695 kg (2020) with microsatellites or 28 930 kg (2020) with SNPs (Figure 17).

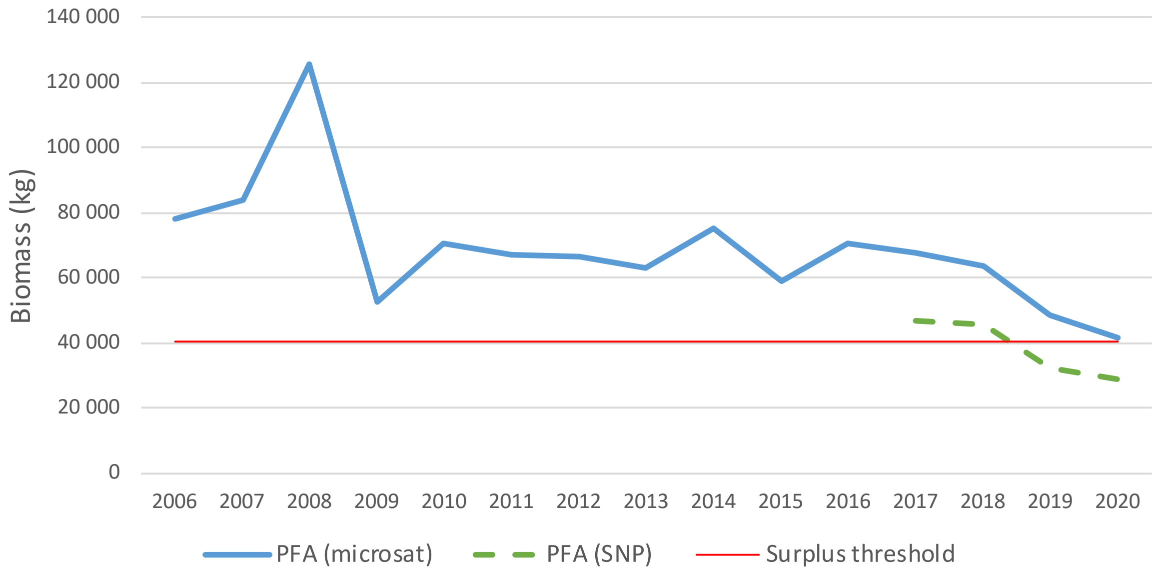


Figure 17. The estimated pre-fishery abundance (PFA) of salmon belonging to the Tana/Teno MS stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Tana/Teno MS salmon was 53 % in the years 2017-2020 when estimating with both genetic methods (Figure 18). With the SNP data, 21 % of the pre-fishery abundance was caught in coastal fisheries, while the microsatellite coastal estimate was 20 %. The main stem fisheries proportion was 32 % with the SNPs and 33 % with the microsatellites.

In the period 2017-2020, the average total pre-fishery abundance for Tana/Teno MS salmon was 38 435 kg and the average total catch was 20 417 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 55 294 kg and 29 045 kg.

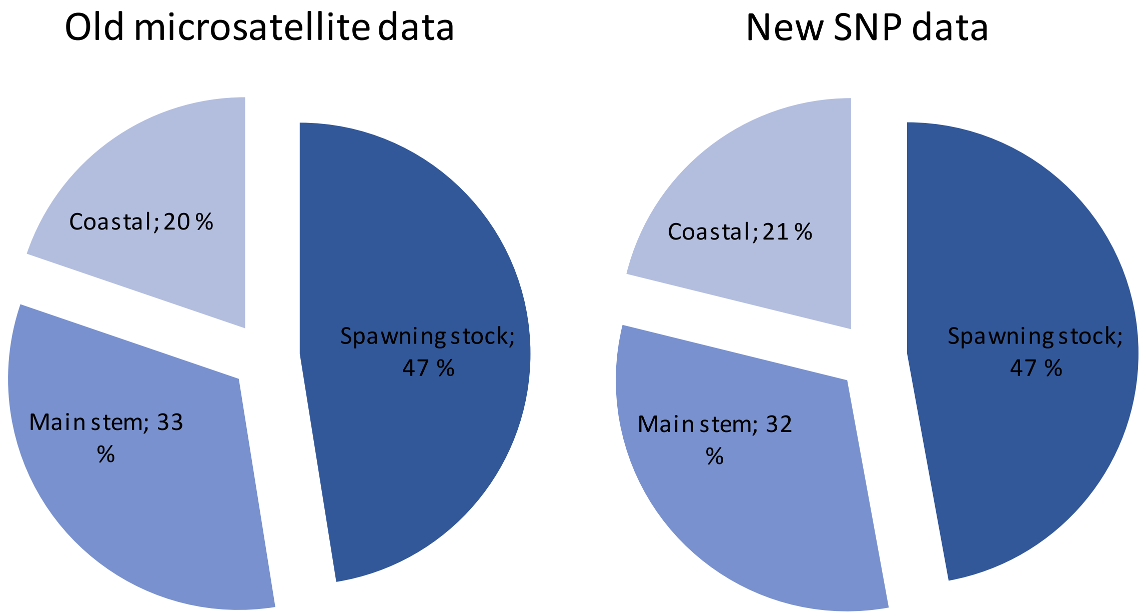


Figure 18. The total amount of salmon belonging to Tana/Teno MS in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal or main stem fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal or main stem fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Even though the estimated proportions of the Tana/Teno MS salmon in the main stem mixed-stock fishery deviates considerably when comparing the SNP and microsatellite data, the estimated relative catch distribution remains relatively equal. The reason for this is that the spawning stock estimates above are both based directly on the respective main stem catch estimates.

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

Table 3. Relative exploitation rates of Tana/Teno MS salmon in different areas (based on weight) in two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	2017-2020 (microsat.)	2006-2016
Coastal	21 %	20 %	18 %
Main stem	40 %	41 %	61 %

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/Teno MS salmon divided by the estimated amount of salmon that have survived the coastal fisheries.

In the years 2017-2020, estimates of overexploitation based on the SNP data varied between 36 % (2020) and 52 % (2018) with an average of 44 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 44 % below the spawning target). With the microsatellite data, overexploitation varied between 19 % (2017) and 41 % (2020) with an average of 33 %.

With the SNP data, maximum sustainable exploitation varied between 0 % (2018-2020) and 22 % (2017). 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 53 %. With the microsatellite data, maximum sustainable exploitation varied between 10 % (2020) and 46 % (2017) with an average of 26 %, significantly lower than the estimated total exploitation of 53 %.

4.1.3 Stock recovery

In a previous report (Anon. 2018), we advised a 19 % reduction in the total river exploitation rate of Tana/Teno MS salmon from the 2006-2016 level in order to achieve stock recovery over two generations. With the SNP data, the estimated river exploitation has been reduced from 61 to 40 %, which corresponds to a 34 % reduction in exploitation. The stock recovery model indicates that this level of reduction is enough to allow for stock recovery after two generations. With the microsatellite data, the river exploitation has been reduced from 61 to 41 %, this is an 33 % reduction.

4.2 Máskejohka

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

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Máskejohka stock proportion differs between the previous microsatellite method (1.7 %) and the newer SNP method (2.5 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. The main stem catch proportion is not used in the spawning stock estimate of Máskejohka, but we present catch distribution and stock recovery results based on both genetic methods.

No fish counting had been done in Máskejohka until 2020, and historical exploitation estimates therefore had to be based on other sources of information. In a comprehensive analysis of 214 historical estimates of exploitation rates from 40 river systems, a pattern was revealed of different exploitation rates among salmon weight classes and among rivers of various size and a table of standardized exploitation estimates were established (Forseth et al. 2013). Máskejohka is a medium-sized river, and historically there have been a relatively high number of fishermen and few restrictions in the river. Based on the exploitation rate table in Forseth et al. (2013) summarizing national Norwegian exploitation rate patterns, we selected 50 %, 40 % and 30 % as exploitation estimates for the three size-groups of salmon in the years 2006-2012 (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 2018-2019 due to the new fishing regulations that were put in place in 2017 and difficult fishing conditions.

In 2020, acoustic fish counting provided the first estimate of run size in Máskejohka. A preliminary interpretation of the acoustic data indicates exploitation rates between 20 and 30 % (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	0.0250
2018	346	371	139	0.33	0.25	0.16	0.15	0.74	0.56	0.0290
2019	201	411	97	0.33	0.25	0.16	0.15	0.74	0.56	0.0210
2020	169	218	141	0.20	0.25	0.30	0.15	0.74	0.56	0.0250

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 51 % in 2020 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 26 % with an overall attainment of 91 % (Figure 19).

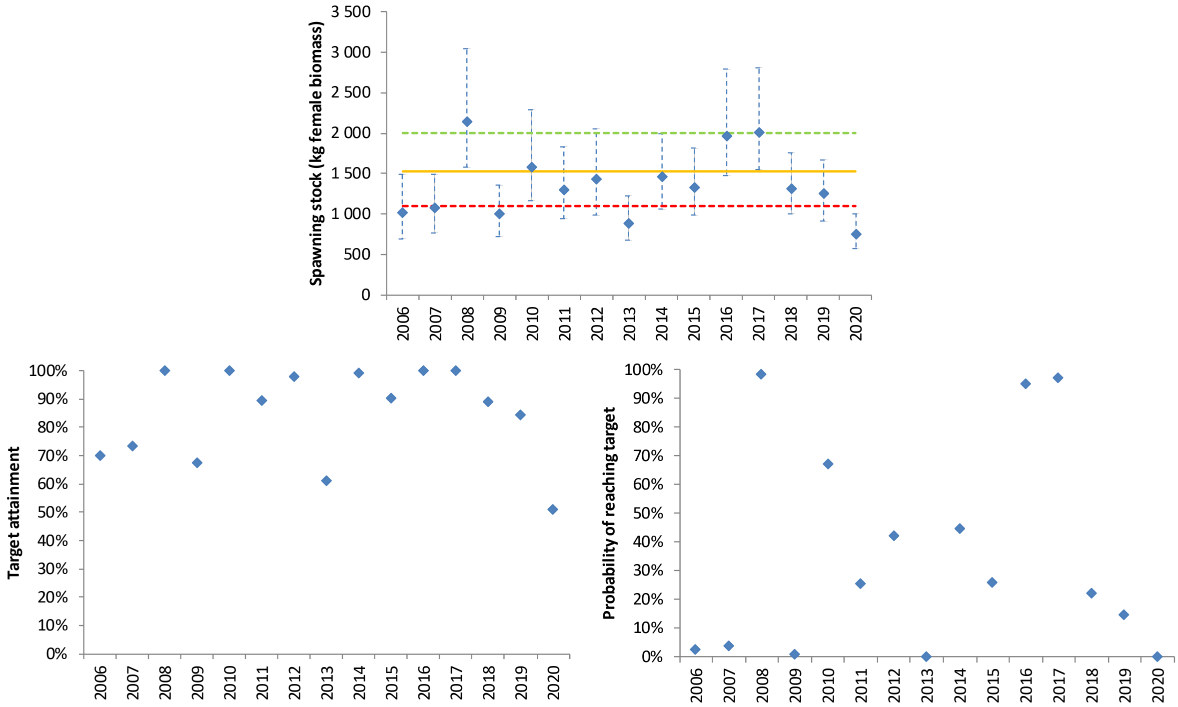


Figure 19. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the Norwegian tributary Máskejohka.

4.2.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Máskejohka stock has varied from a maximum of 8 803 kg (2008) down to 2 847 kg (2020) with microsatellites or 3 129 kg (2020) with SNPs (Figure 20).

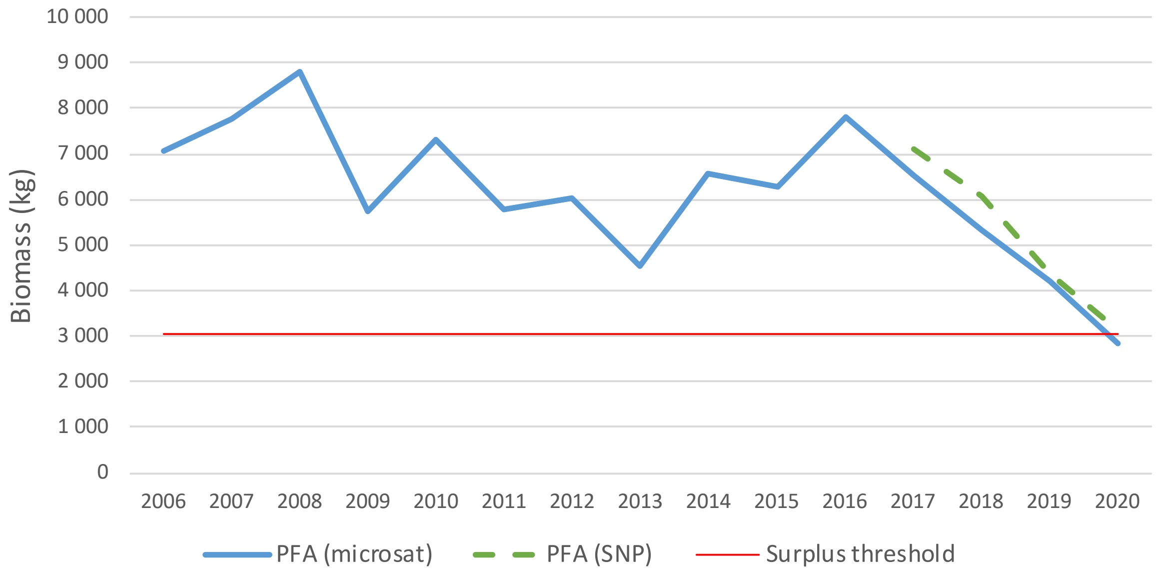


Figure 20. The estimated pre-fishery abundance (PFA) of salmon belonging to the Máskejohka stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Máskejohka salmon was 52 % in the years 2017-2020 when estimating with the SNP-based genetic data and 47 % with the old microsatellite average proportions (Figure 21). With the SNP data, 18 % of the pre-fishery abundance was caught in coastal fisheries, while the microsatellite coastal estimate was 16 %. The main stem fisheries proportion was 19 % with the SNPs and 14 % with the microsatellites. The Máskejohka proportion was 16 % with the SNPs and 17 % with the microsatellites.

In the period 2017-2020, the average total pre-fishery abundance for Máskejohka salmon was 5 174 kg and the average total catch was 2 715 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 4 730 kg and 2 242 kg.

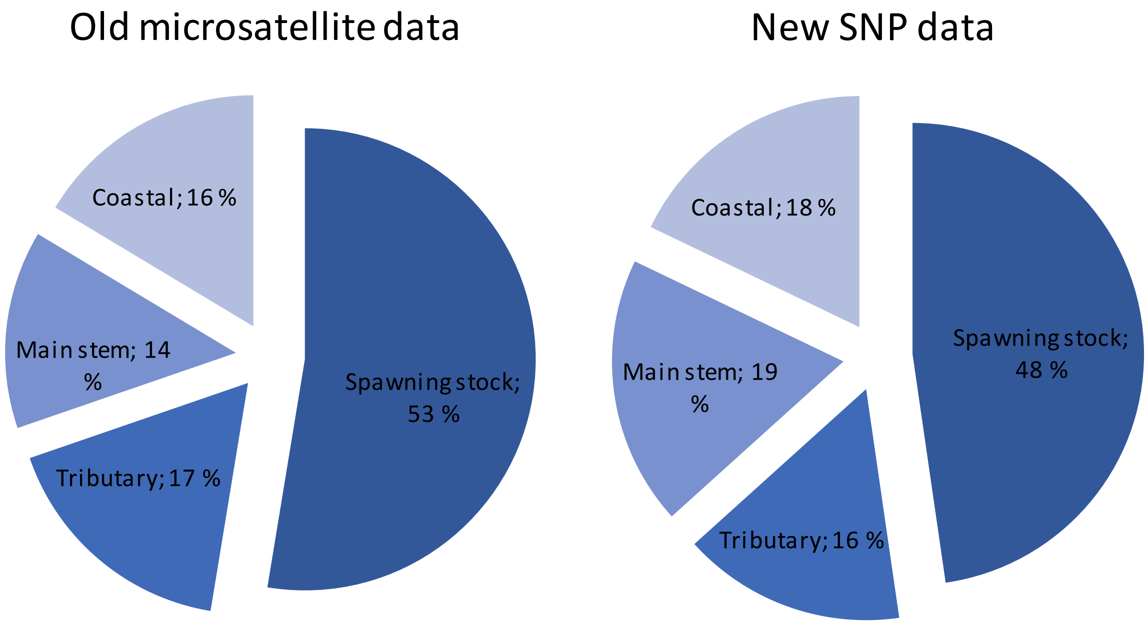


Figure 21. The total amount of salmon belonging to Máskejohka in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Máskejohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Since the estimated proportions of Máskejohka salmon in the main stem mixed stock fishery deviates when comparing the microsatellite and the SNP data while the spawning stock is estimated without using the main stem catch proportion, the estimated catch proportions above differ between genetic methods.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	**2017-2020 (microsat.)**	**2006-2016**
Coastal	18 %	16 %	14 %
Main stem	23 %	17 %	23 %
Tributary	25 %	25 %	36 %
Tributary + main stem	42 %	37 %	50 %

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 2017-2020, estimates of overexploitation based on the SNP data varied between 0 % (2017) and 55 % (2020) with an average of 22 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 22 % below the spawning target). With the microsatellite data, overexploitation varied between 0 % (2017) and 45 % (2020) with an average of 19 %.

With the SNP data, maximum sustainable exploitation varied between 0 % (2020) and 57 % (2017). A maximum exploitation of 0 % indicates no exploitable surplus. The average maximum sustainable total exploitation rate in the period was 30 %, significantly lower than the estimated average total exploitation of 52 %. With the microsatellite data, maximum sustainable exploitation varied between 0 % (2020) and 53 % (2017) with an average of 25 %, significantly lower than the estimated total exploitation of 47 %.

4.2.3 Stock recovery

Management target attainment of the Máskejohka stock is at 26 %, well below the threshold of 40 % that indicates the need for a recovery plan. With the SNP data, the estimated river exploitation of the Máskejohka stock has been reduced from 50 to 42 %, which corresponds to a 17 % reduction in exploitation. Following the stock recovery model from Anon. (2018), this reduction is enough to achieve stock recovery over two generations. With the microsatellite data, the river exploitation has been reduced from 50 to 37 %, a reduction of 26 % that allows for stock recovery over two generations.

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 snorkelling counts.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Buolbmátjohka/Pulmankijoki stock proportion differs between the previous microsatellite method (0.5 %) and the newer SNP method (0.8 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. The main stem catch proportion is not used in the spawning stock estimate of Buolbmátjohka/Pulmankijoki, but we present catch distribution and stock recovery results based on both genetic methods.

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

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

Exploitation rate = Catch / (Spawning count + Catch)

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

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

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 35 % in 2020 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 42 % with an overall attainment of 98 % (Figure 22).

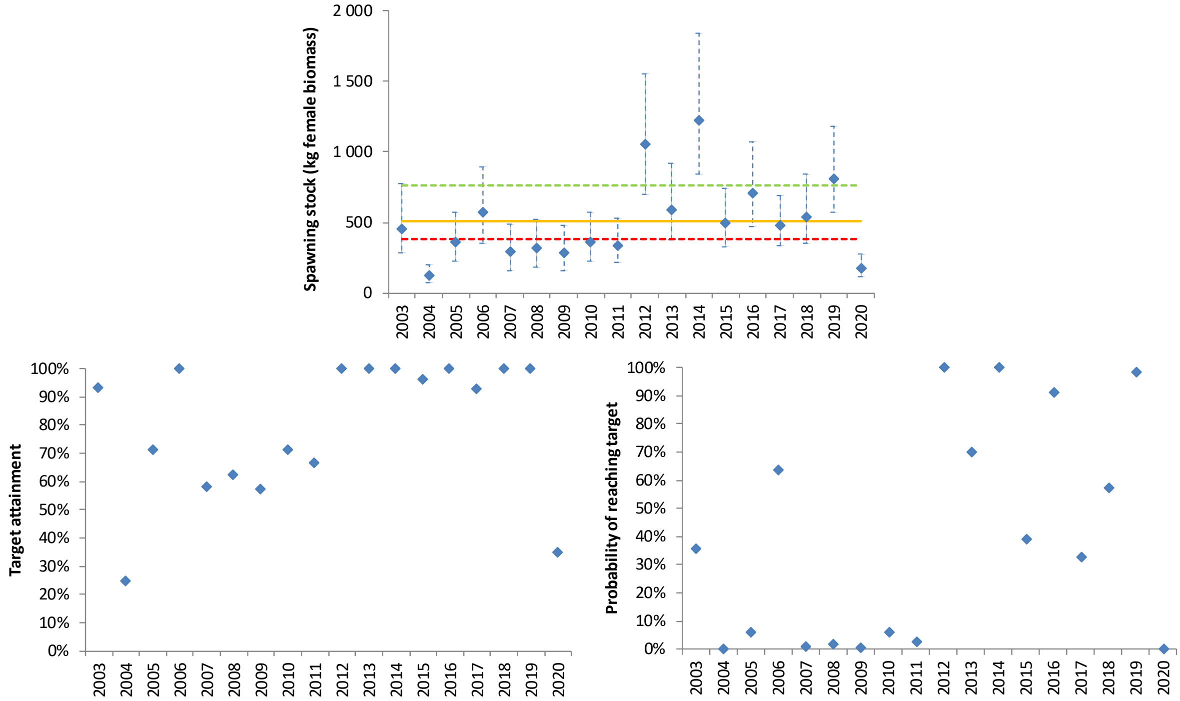


Figure 22. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2020 in the Norwegian/Finnish tributary Buolbmátjohka/Pulmankijoki.

4.3.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Buolbmátjohka/Pulmankijoki stock has varied from a maximum of 4 181 kg (2014) down to 589 kg (2020) with microsatellites or 703 kg (2020) with SNPs (Figure 23)

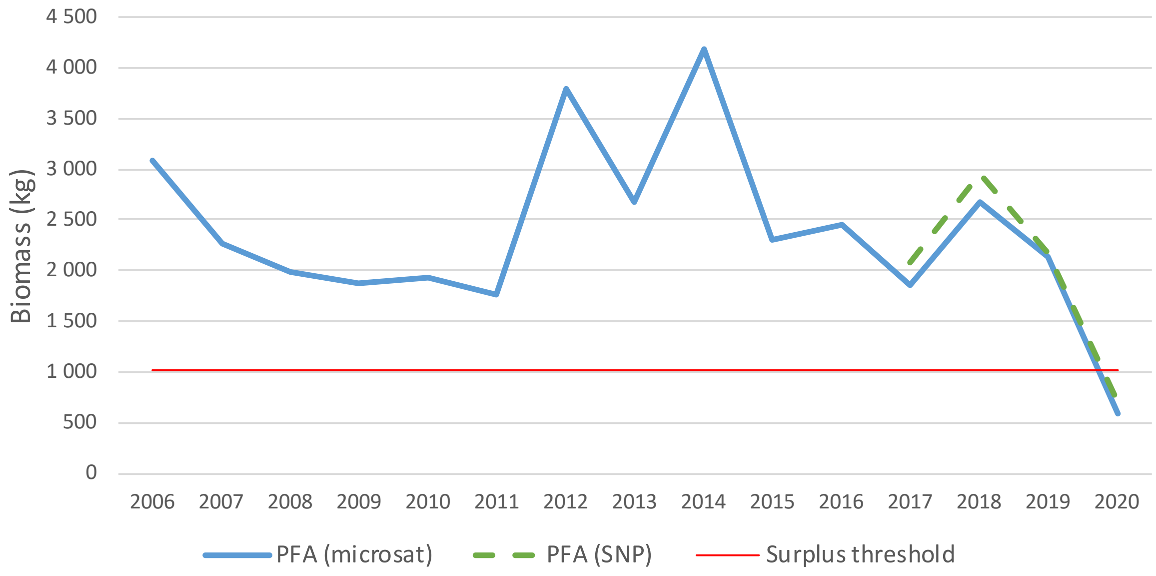


Figure 23. The estimated pre-fishery abundance (PFA) of salmon belonging to the Buolbmátjohka/Pulmankijoki stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Buolbmátjohka/Pulmankijoki salmon was 53 % in the years 2017-2020 when estimating with the SNP-based genetic data and 48 % with the old microsatellite average proportions (Figure 24). With the SNP data, 15 % of the pre-fishery abundance was caught in coastal fisheries, while the microsatellite coastal estimate was 13 %. The main stem fisheries proportion was 16 % with the SNPs and 10 % with the microsatellites. The Buolbmátjohka/Pulmankijoki fisheries proportion was 22 % with the SNPs and 25 % with the microsatellites.

In the period 2017-2020, the average total pre-fishery abundance of Buolbmátjohka/Pulmankijoki salmon was 1 979 kg and the average total catch was 1 050 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 1 811 kg and 875 kg.

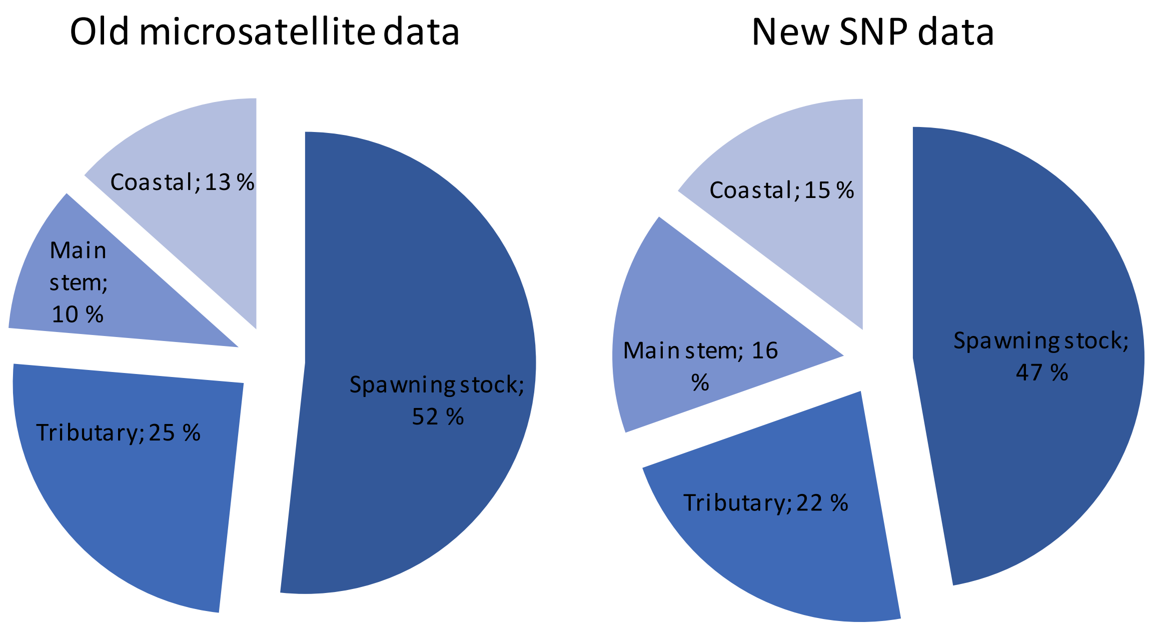


Figure 24. The total amount of salmon belonging to Buolbmátjohka/Pulmankijoki in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Buolbmátjohka/Pulmankijoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Since the estimated proportions of Buolbmátjohka/Pulmankijoki salmon in the main stem mixed stock fishery deviates when comparing the microsatellite and the SNP data while the spawning stock is estimated without using the main stem catch proportion, the estimated catch proportions above differ between genetic methods.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	2017-2020 (microsat.)	2006-2016
Coastal	15 %	13 %	11 %
Main stem	18 %	12 %	16 %
Tributary	32 %	32 %	41 %
Tributary + main stem	45 %	40 %	51 %

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 2017-2020, estimates of overexploitation based on the SNP data varied between 0 % (2018-2019) and 63 % (2020) with an average of 18 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 18 % below the spawning target). With the microsatellite data, overexploitation varied between 0 % (2018-2019) and 48 % (2020) with an average of 14 %.

With the SNP data, maximum sustainable exploitation varied between 0 % (2020) and 57 % (2019). A maximum exploitation of 0 % indicates no exploitable surplus. The average maximum sustainable total exploitation rate in the period was 35 %, significantly lower than the estimated average total exploitation of 53 %. With the microsatellite data, maximum sustainable exploitation varied between 0 % (2020) and 54 % (2019) with an average of 29 %, significantly lower than the estimated average total exploitation of 48 %.

4.3.3 Stock recovery

Management target attainment of the Buolbmátjohka/Pulmankijoki stock is at 42 %, just above the threshold of 40 % that indicates the need for a recovery plan. With the SNP data, the estimated river exploitation of the Buolbmátjohka/Pulmankijoki stock has been reduced from 51 to 45 %, which corresponds to a 12 % reduction in exploitation. With the microsatellite data, the river exploitation has been reduced from 51 to 40 %, a reduction of 20 %.

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. Any functional 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 smaller tributaries, over 17 km in Deavkkehanjohka and 11 km in Gurtejohka.

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

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.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Lákšjohka stock proportion differs between the previous microsatellite method (0.8 %) and the newer SNP method (1.3 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference.

A video camera setup has counted ascending salmon in Lákšjohka since 2009, allowing us to accurately estimate the annual exploitation rate in Lákšjohka. The exploitation rate was around 30 % in 2009-2011 and around 20 % in 2012-2013. We used a total exploitation of around 30 % also for the years preceding 2009. Beginning in 2014, the proportions of released salmon increased significantly in Lákšjohka. This led to decreased exploitation rates, and the combined exploitation rate of all size classes in 2014-2018 have been in the range 6-14 %. There were problems with the video monitoring in 2017, so the video counts were treated as a minimum estimate of the number of ascending salmon, 50 % was added as the most likely estimate of ascending salmon and 100 % as an estimate of the maximum number. In 2018 conditions for video monitoring were good and the counting results indicate an overall exploitation of 6 %. Conditions for video monitoring were again good in 2019, and results indicated that exploitation increased with an overall exploitation of 16 %. Monitoring conditions were challenging in 2020 with suboptimal video coverage and the video counts must therefore be treated as minimum estimates. Both counts and catches were relatively low and an overall exploitation estimate of 11 % (10 % for grilse and 15 % for MSW salmon) was used in the simulation (Table 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	0.0125
2018	39	26	0	0.06	0.06	0.06	0.71	0.61	0.50	0.0070
2019	74	35	0	0.18	0.15	0.15	0.71	0.61	0.50	0.0180
2020	28	7	0	0.10	0.15	0.15	0.71	0.61	0.50	0.0125

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 16 % in 2020 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 0 % with an overall attainment of 34 % (Figure 25).

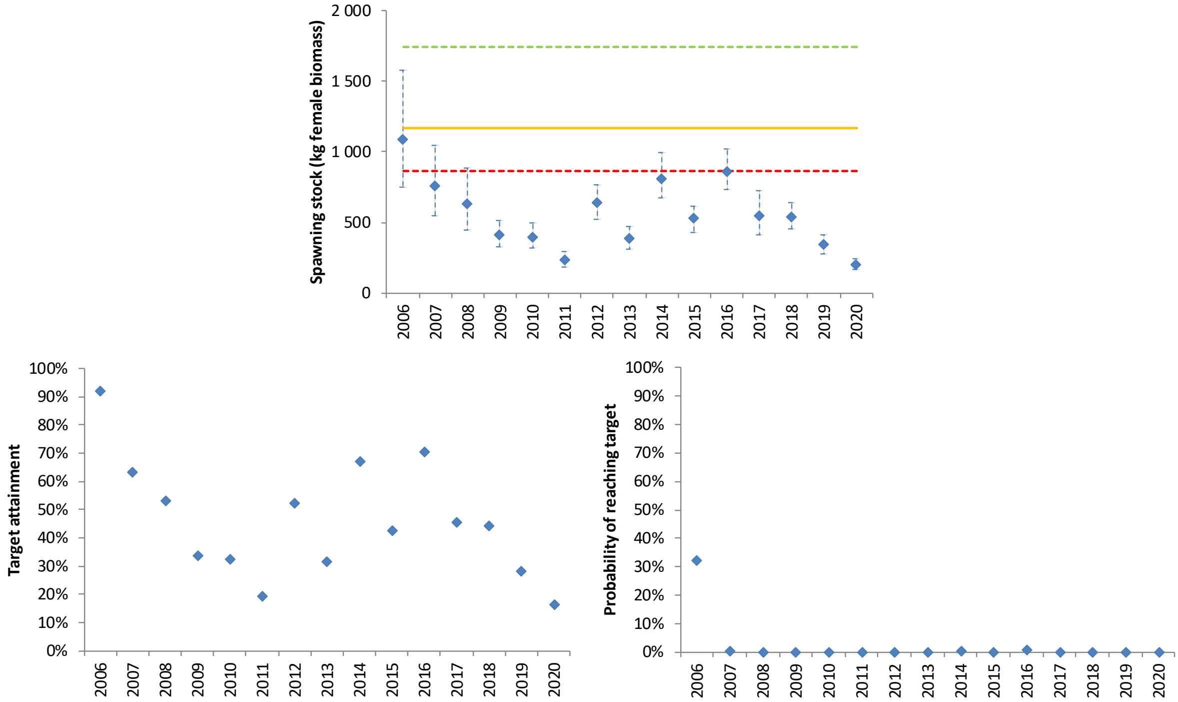


Figure 25. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the Norwegian tributary Lákšjohka.

4.4.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Lákšjohka stock has varied from a maximum of 3 976 kg (2007) down to 621 kg (2020) with microsatellites or 784 kg with SNPs (Figure 26).

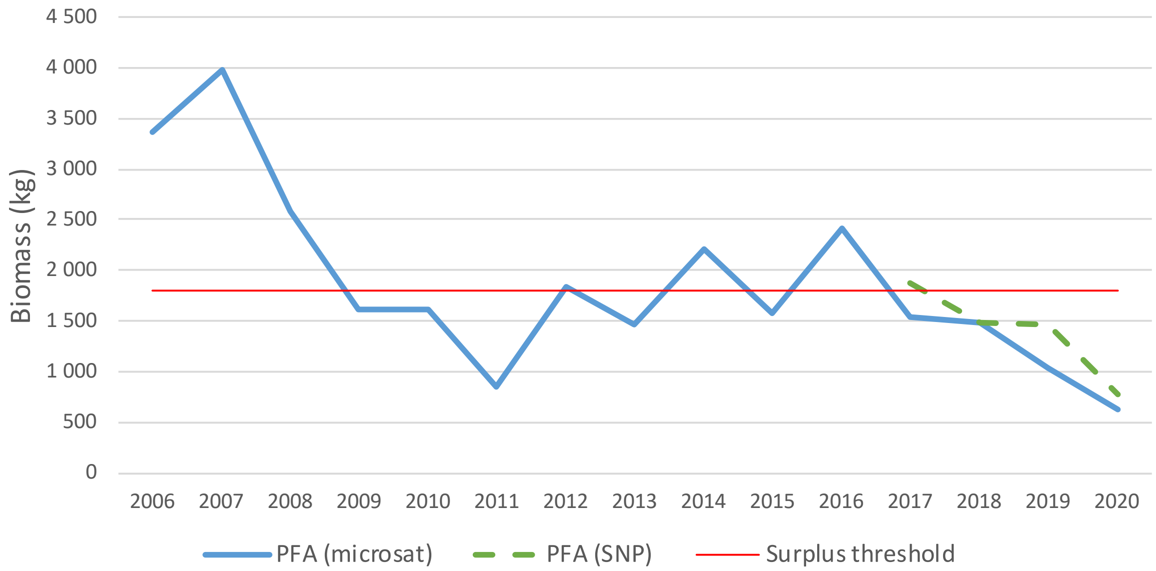


Figure 26. The estimated pre-fishery abundance (PFA) of salmon belonging to the Lákšjohka stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Lákšjohka salmon was 57 % in the years 2017-2020 when estimating with the SNP-based genetic data and 49 % with the old microsatellite average proportions (Figure 27). With the SNP data, 19 % of the pre-fishery abundance was caught in coastal fisheries, while the microsatellite coastal estimate was 18 %. The main stem fisheries proportion was 34 % with the SNPs and 26 % with the microsatellites. The Lákšjohka fisheries proportion was 5 % with the SNPs and 6 % with the microsatellites.

In the period 2017-2020, the average total pre-fishery abundance of Lákšjohka salmon was 1 404 kg and the average total catch 806 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 1 171 kg and 572 kg.

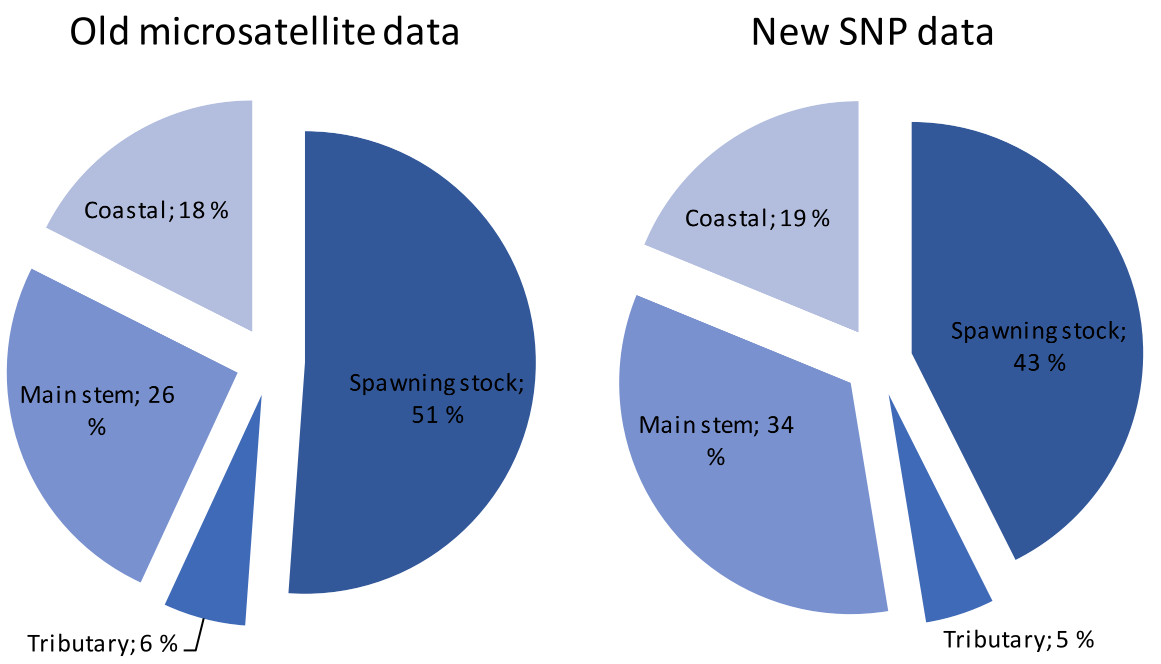


Figure 27. The total amount of salmon belonging to Lákšjohka in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Lákšjohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Since the estimated proportions of Lákšjohka salmon in the main stem mixed stock fishery deviates when comparing the microsatellite and the SNP data while the spawning stock is estimated without using the main stem catch proportion, the estimated catch proportions above differ between genetic methods.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	**2017-2020 (microsat.)**	**2006-2016**
Coastal	19 %	18 %	15 %
Main stem	42 %	31 %	34 %
Tributary	10 %	10 %	24 %
Tributary + main stem	48 %	38 %	49 %

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 2017-2020, estimates of overexploitation based on the SNP data varied between 29 % (2020) and 57 % (2019) with an average of 44 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 44 % below the spawning target). With the microsatellite data, overexploitation varied between 20 % (2020) and 43 % (2017) with an average of 33 %.

With the SNP data, maximum sustainable exploitation varied between 0 % (2018-2020) and 6 % (2017). A maximum exploitation of 0 % indicates no exploitable surplus. The average maximum sustainable total exploitation rate in the period was 1 %, significantly lower than the estimated average total exploitation of 57 %. With the microsatellite data, maximum sustainable exploitation was 0 % for all four years.

4.4.3 Stock recovery

Management target attainment of the Lákšjohka stock is at 0 %, well below the threshold of 40 % that indicates the need for a recovery plan. In a previous report (Anon. 2018), we advised a 23 % reduction of the total river exploitation rate of Lákšjohka salmon from the 2006-2016 level in order to achieve stock recovery over two generations. With the SNP data, the estimated river exploitation of the Lákšjohka stock has been reduced from 49 to 48 %, which corresponds to a 4 % reduction in exploitation. This reduction is not enough to allow for stock recovery. With the microsatellite data, the river exploitation has been reduced from 49 to 38 %, a reduction of 23 % which just meets the recommended reduction needed for stock recovery over two generations.

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.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Veahčajohka/Vetsijoki stock proportion differs largely between the previous microsatellite method (2.9 %) and the newer SNP method (7.5 %). There are several possible reasons that might cause this significant difference, and closer work is needed to further understand the difference. The main stem catch proportion is not used in the spawning stock estimate of Veahčajohka/Vetsijoki, but we present catch distribution and stock recovery results based on both genetic methods.

Ascending salmon was counted in Vetsijoki with an acoustic counting system (ARIS) in 2016. The results indicate an exploitation of under 15 % in Vetsijoki. However, catch estimates from Vetsijoki are among the most uncertain on the Finnish side of Tana/Teno. It is known that Vetsijoki is a popular fishing site, but accurate fisherman information is partly missing and, consequently, catch estimation is very challenging and it is likely that there is significant unreported catch. We therefore selected 20 % as the median exploitation estimate in 2016. The same median exploitation was used also in 2017 and 2020 because of relatively low in-river catch estimates in those years compared with the overall Tana/Teno catch, while a median exploitation of 25 % was used in all other years (Table 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	0.25	0.63	0.0390
2007	560	0.25	0.71	0.0256
2008	415	0.25	0.56	0.0192
2009	630	0.25	0.52	0.0290
2010	930	0.25	0.56	0.0290
2011	485	0.25	0.57	0.0311
2012	755	0.25	0.51	0.0305
2013	375	0.25	0.56	0.0290
2014	1 020	0.25	0.52	0.0290
2015	885	0.25	0.57	0.0290
2016	755	0.20	0.56	0.0290
2017	406	0.20	0.58	0.0745
2018	603	0.25	0.52	0.0720
2019	545	0.25	0.56	0.0770
2020	358	0.20	0.57	0.0745

The spawning target attainment was 72 % in 2020 and the probability of meeting the spawning target was 5 %. The management target was not reached, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 14 % with an overall attainment of 81 % (Figure 28).

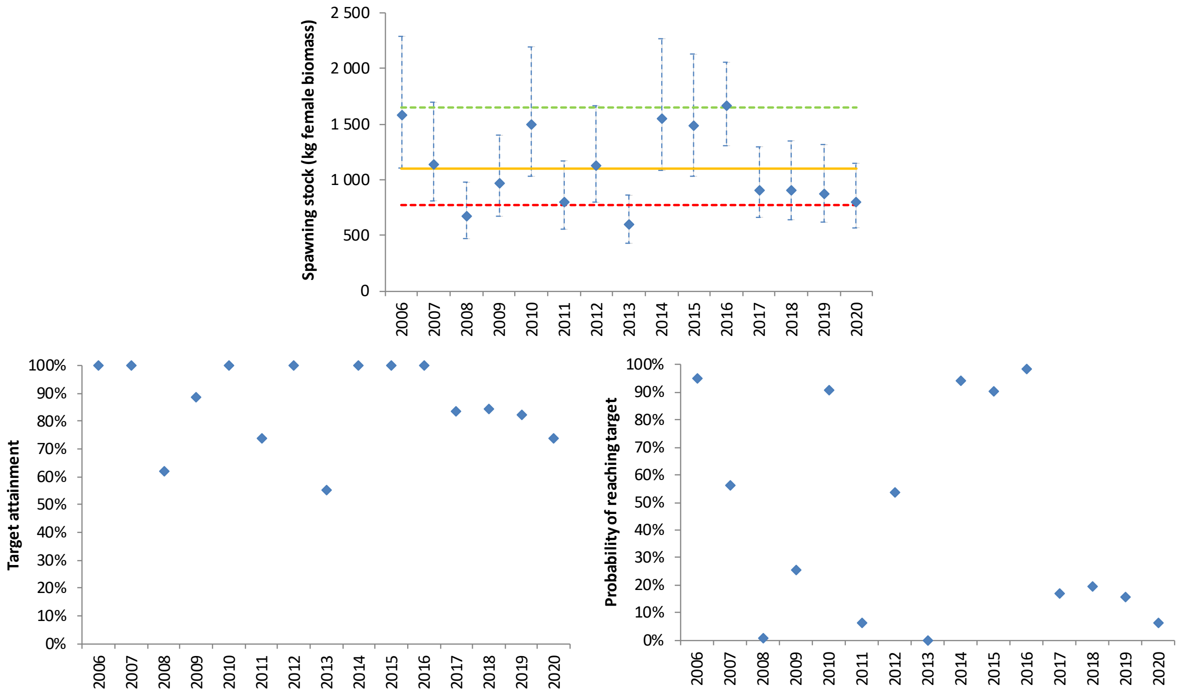


Figure 28. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the Finnish tributary Veahčajohka/Vetsijoki.

4.5.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Veahčajohka/Vetsijoki stock has varied from a maximum of 8 112 kg (2006) down to 2 942 kg (2020) with microsatellites or 4 507 kg (2020) with SNPs (Figure 29).

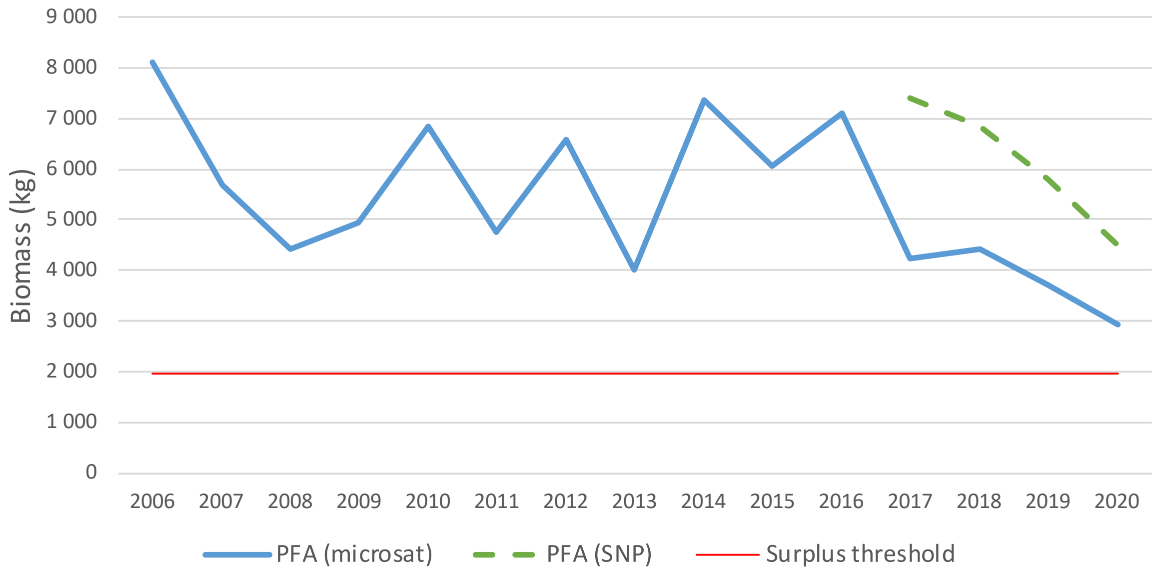


Figure 29. The estimated pre-fishery abundance (PFA) of salmon belonging to the Veahčajohka/Vetsijoki stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Veahčajohka/Vetsijoki salmon was 74 % in the years 2017-2020 when estimating with the SNP-based genetic data and 59 % with the old microsatellite average proportions (Figure 30). The coastal proportion was estimated to 19 % of the pre-fishery abundance with the SNPs and 17 % with the microsatellites. The main stem fisheries proportion was 47 % with the SNPs and 29 % with the microsatellites. The Veahčajohka/Vetsijoki fisheries proportion was 8 % with the SNPs and 12 % with the microsatellites.

In the period 2017-2020, the average total pre-fishery abundance of Veahčajohka/Vetsijoki salmon was 6 145 kg and the average total catch 4 546 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 3 830 kg and 2 256 kg.

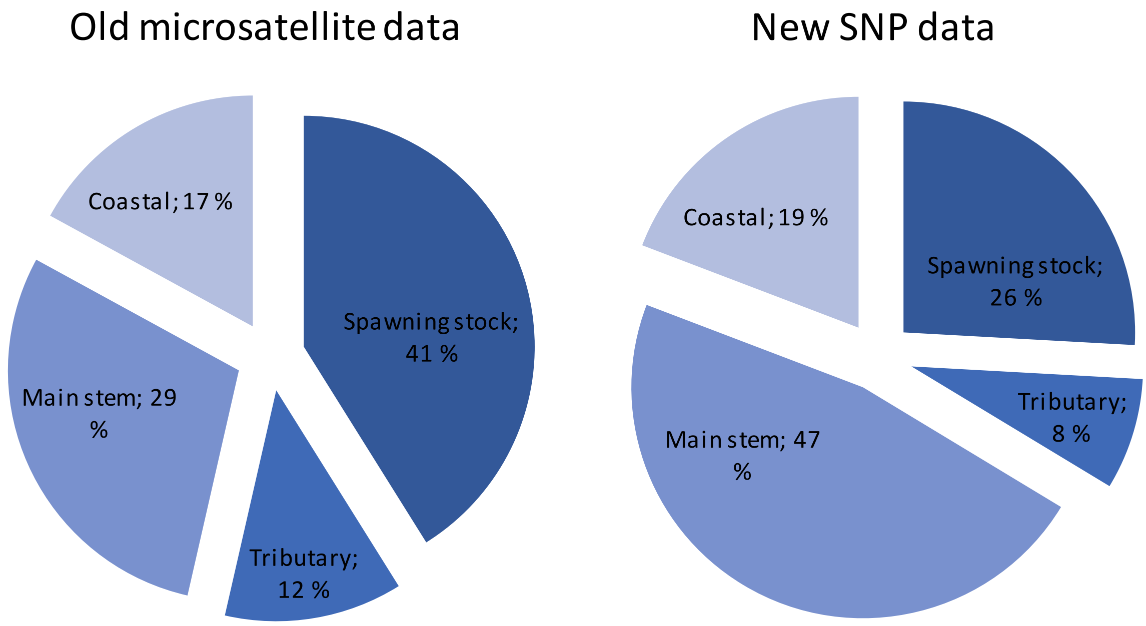


Figure 30. The total amount of salmon belonging to Veahčajohka/Vetsijoki in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Veahčajohka/Vetsijoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Since the estimated proportions of Veahčajohka/Vetsijoki salmon in the main stem mixed stock fishery deviates when comparing the microsatellite and the SNP data while the spawning stock is estimated without using the main stem catch proportion, the estimated catch proportions above differ between genetic methods.

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 two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	2017-2020 (microsat.)	2006-2016
Coastal	19 %	17 %	16 %
Main stem	58 %	35 %	45 %
Tributary	23 %	23 %	25 %
Tributary + main stem	68 %	50 %	58 %

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 2017-2020, estimates of overexploitation based on the SNP data varied between 14 % (2017) and 29 % (2020) with an average of 20 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 20 % below the spawning target). With the microsatellite data, overexploitation varied between 16 % (2018) and 28 % (2020) with an average of 21 %.

With the SNP data, maximum sustainable exploitation varied between 53 % (2020) and 73 % (2017). The average maximum sustainable total exploitation rate in the period was 64 %, lower than the estimated average total exploitation of 74 %. With the microsatellite data, maximum sustainable exploitation varied between 25 % (2020) and 51 % (2017) with an average of 40 %, well below the estimated average total exploitation of 59 %.

4.5.3 Stock recovery

Management target attainment of the Veahčajohka/Vetsijoki stock was at 14 %, well below the threshold of 40 % that indicates the need for a recovery plan. With the SNP data, the estimated river exploitation of Veahčajohka/Vetsijoki stock has increased from 58 % to 68 %, which corresponds to a 17 % increase in exploitation. This is a counterintuitive result that is mainly caused by the significant increase in main stem catch proportion of the Veahčajohka/Vetsijoki salmon with SNPs versus microsatellites. With the microsatellite data, the river exploitation has been reduced from 58 % to 50 %, a reduction of 13 % which, following the exploitation model of Anon. (2018), is not enough to allow for stock recovery over two generations.

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.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Ohcejohka/Utsjoki stock proportion differs largely between the previous microsatellite method (4.3 %) and the newer SNP method (8.2 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. The main stem catch proportion is not used in the spawning stock estimate of Ohcejohka/Utsjoki, but we present catch distribution and stock recovery results based on both genetic methods.

A video camera setup has counted the number of ascending salmon in Utsjoki since 2002. Annual exploitation rates can therefore be estimated from the video counts and used in the status evaluation. Conditions in most years were good with major exceptions in 2017 and 2020, which both had prolonged periods of difficult water level conditions. As described in chapter 2.4.1, extra cameras were used in 2020 to estimate salmon migration close to the shore in Utsjoki during periods with high water levels. We have now used this information to make a new estimate of the Utsjoki run size for 2017 also (Table 12).

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. Sea-age groups are combined in the years 2017-2020.

Year	Catch (kg)	Video count (1SW)	Video count (MSW)	Avg. size (1SW)	Avg. size (MSW)	Expl. rate	Female proportion	Main stem proportion
2002	1 965	2 744	345	1.59	3.59	0.35	0.61	
2003	1 305	2 308	274	1.59	3.59	0.28	0.61	
2004	800	1 202	95	1.59	3.59	0.36	0.62	
2005	1 400	2 699	47	1.59	3.59	0.31	0.58	
2006	2 375	6 555	109	1.61	3.61	0.22	0.61	0.0451
2007	1 945	3 251	167	1.39	3.29	0.38	0.66	0.0506
2008	2 605	2 061	307	1.32	3.58	0.68	0.69	0.0403
2009	2 095	3 712	124	1.59	3.59	0.33	0.57	0.0432
2010	1 305	1 932	377	1.59	3.59	0.30	0.61	0.0432
2011	1 625	3 349	534	1.59	3.86	0.22	0.58	0.0305
2012	2 605	5 029	868	1.75	4.16	0.21	0.61	0.0454
2013	1 695	4 765	367	1.59	3.59	0.19	0.61	0.0432
2014	2 955	3 659	1 319	1.59	3.59	0.28	0.57	0.0432
2015	2 149	3 346	602	1.59	3.59	0.29	0.62	0.0432
2016	2 090	2 934	836	1.59	3.59	0.27	0.62	0.0432
2017	1 853	2 734		2.67		0.25	0.64	0.0820
2018	1 926	4 743		1.72		0.15	0.57	0.0710

2019	1 557	1 650	2.13	0.36	0.62	0.0930
2020	885	1 290	2.71	0.26	0.62	0.0820

The spawning target attainment was 75 % in 2020 and the probability of meeting the spawning target was 4 %. The management target was almost reached, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 74 % with an overall attainment of 114 % (Figure 31).

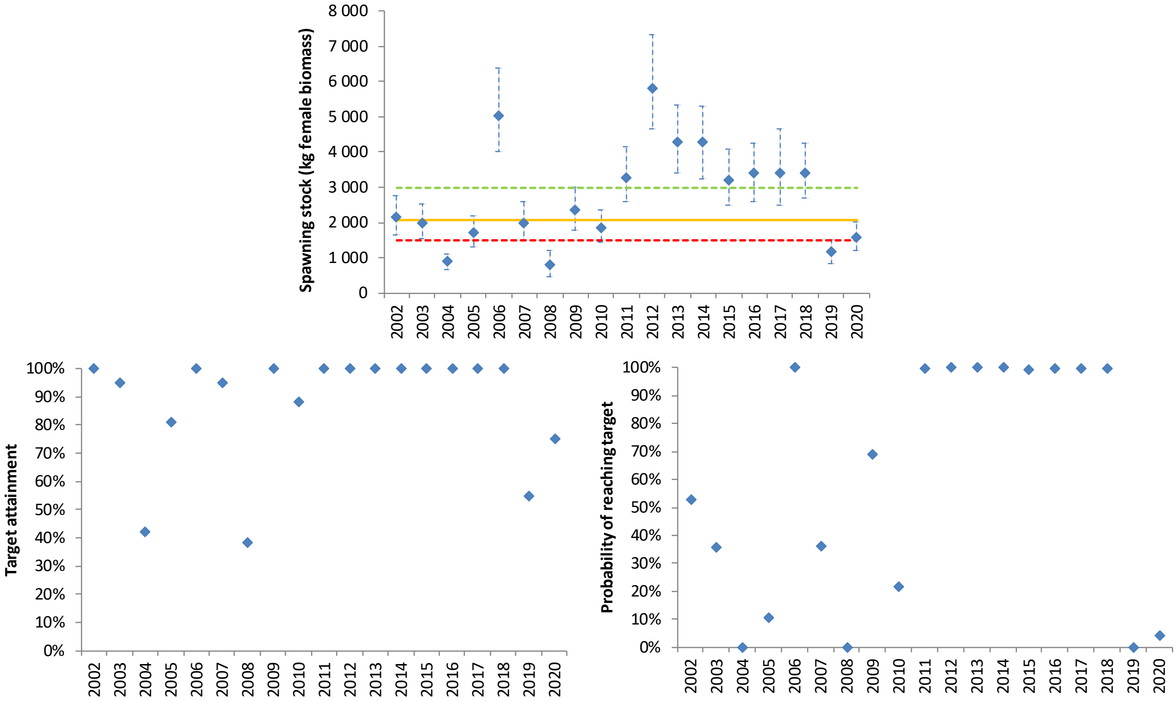


Figure 31. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2002-2020 in the Finnish tributary Ohcejohka/Utsjoki.

4.6.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock has varied from a maximum of 18 493 kg (2012) down to 5 326 kg (2020) with microsatellites or 6 643 kg (2020) with SNPs (Figure 32).

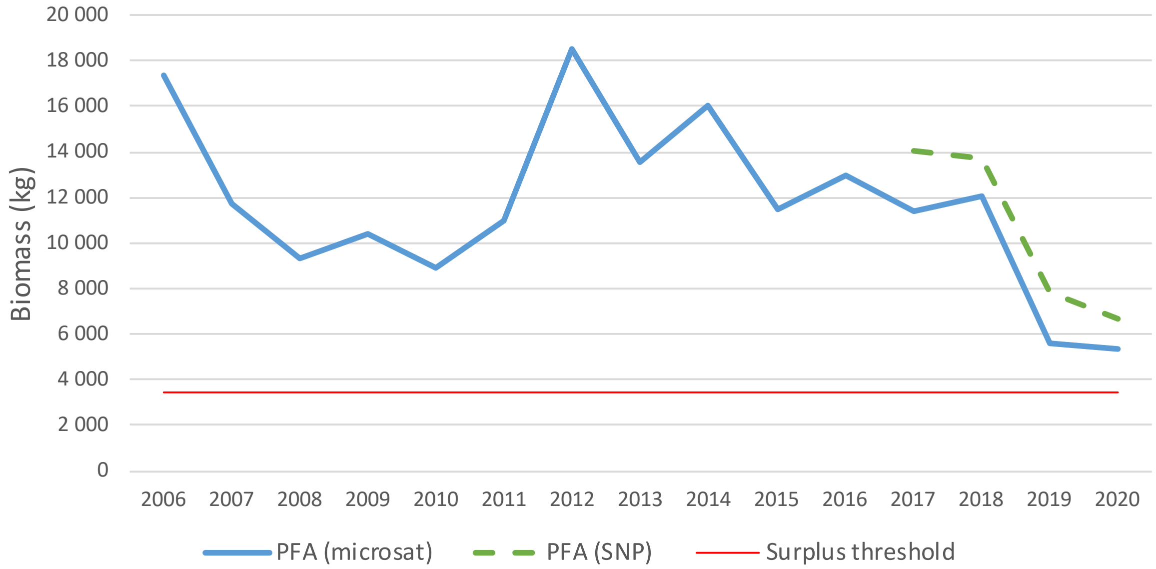


Figure 32. The estimated pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Ohcejohka/Utsjoki salmon was 62 % in the years 2017-2020 when estimating with the SNP-based genetic data and 54 % with the old microsatellite average proportions (Figure 33). The coastal proportion was estimated to 18 % of the pre-fishery abundance with the SNPs and 16 % with the microsatellites. The main stem fisheries proportion was 30 % with the SNPs and 19 % with the microsatellites. The Ohcejohka/Utsjoki fisheries proportion was 15 % with the SNPs and 18 % with the microsatellites.

In the period 2017-2020, the average total pre-fishery abundance of Ohcejohka/Utsjoki salmon was 10 579 kg and the average total catch was 6 616 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 8 605 kg and 4 627 kg.

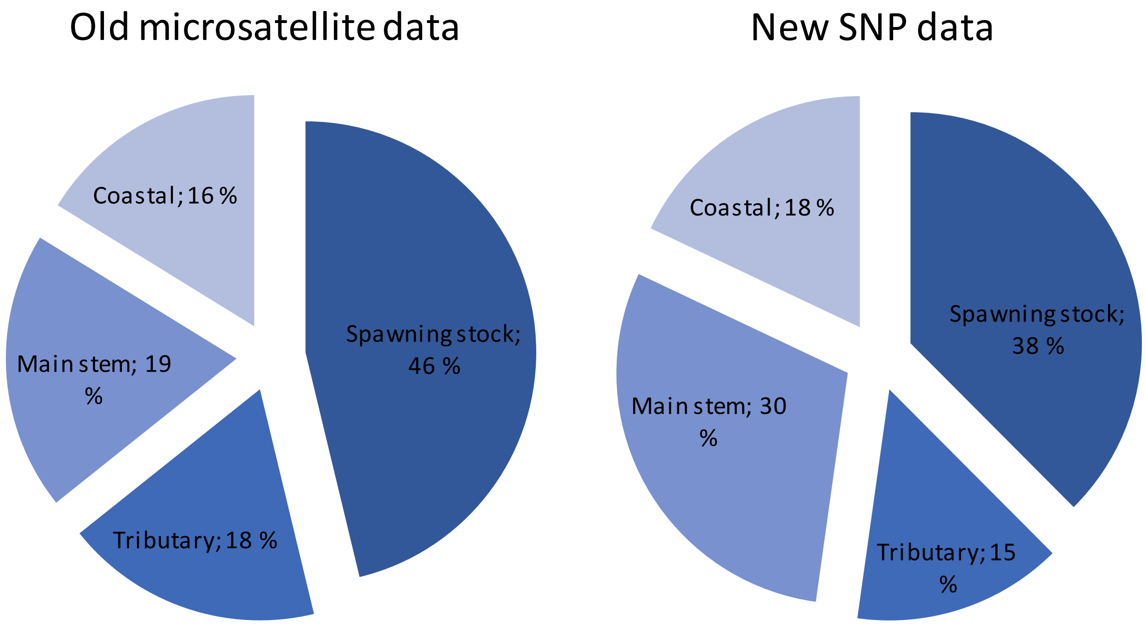


Figure 33. The total amount of salmon belonging to Ohcejohka/Utsjoki in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Ohcejohka/Utsjoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Since the estimated proportions of Ohcejohka/Utsjoki salmon in the main stem mixed stock fishery deviates when comparing the microsatellite and the SNP data while the spawning stock is estimated without using the main stem catch proportion, the estimated catch proportions above differ between genetic methods.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	2017-2020 (microsat.)	2006-2016
Coastal	18 %	16 %	15 %
Main stem	36 %	23 %	31 %
Tributary	28 %	28 %	28 %
Tributary + main stem	54 %	45 %	50 %

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 2017-2020, estimates of overexploitation based on the SNP data varied between 0 % (2017, 2018) and 43 % (2019) with an average of 17 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 17 % below the spawning target). With the microsatellite data, overexploitation varied between 0 % (2017, 2018) and 44 % (2019) with an average of 17 %.

With the SNP data, maximum sustainable exploitation varied between 42 % (2020) and 74 % (2017). The average maximum sustainable total exploitation rate in the period was 58 %, lower than the estimated average total exploitation of 62 %. With the microsatellite data, maximum sustainable exploitation varied between 18 % (2019) and 66 % (2017) with an average of 43 %, well below the estimated average total exploitation of 54 %.

4.6.3 Stock recovery

Management target attainment of the Ohcejohka/Utsjoki stock was at 74 %, well above the threshold of 40 % that indicates the need for a recovery plan. With the SNP data, the estimated river exploitation of Ohcejohka/Utsjoki salmon has increased from 50 to 54 %, which corresponds to an 8 % increase in exploitation. This is a counterintuitive result that is mainly caused by the significant increase in main stem catch proportion of the Ohcejohka/Utsjoki salmon with SNPs versus microsatellites. With the microsatellite data, the river exploitation has been reduced from 50 % to 45 %, a reduction of 11 %.

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 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 and 2 kg in 2020. 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 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 2006-2016.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Goahppelašjohka/Kuoppilasjoki stock proportion differs however relatively little between the previous microsatellite method (0.8 %) and the newer SNP method (1 %). A new SNP-based estimate was used for 2018 and 2019, and an average SNP proportion was used in 2017 and 2020. We give alternative assessments for the period 2017-2020 based on both SNP- and microsatellite-based data.

The main stem exploitation is estimated at 40 % prior to 2017 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	549	0.0100	0.36	0.48
2018	271	0.0060	0.28	0.43
2019	497	0.0140	0.29	0.46
2020	270	0.0100	0.28	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.

When using SNP data, the spawning target attainment was 113 % in 2020 and the probability of meeting the spawning target was 68 %. Based on the old microsatellite average proportions, spawning target attainment becomes 95 % with a probability of meeting the spawning target of 37 %. The management target was reached with both genetic methods, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 95 % with an overall attainment of 146 % based on the SNP data and 82 % with an attainment of 125 % with the old microsatellite average proportions (Figure 34).

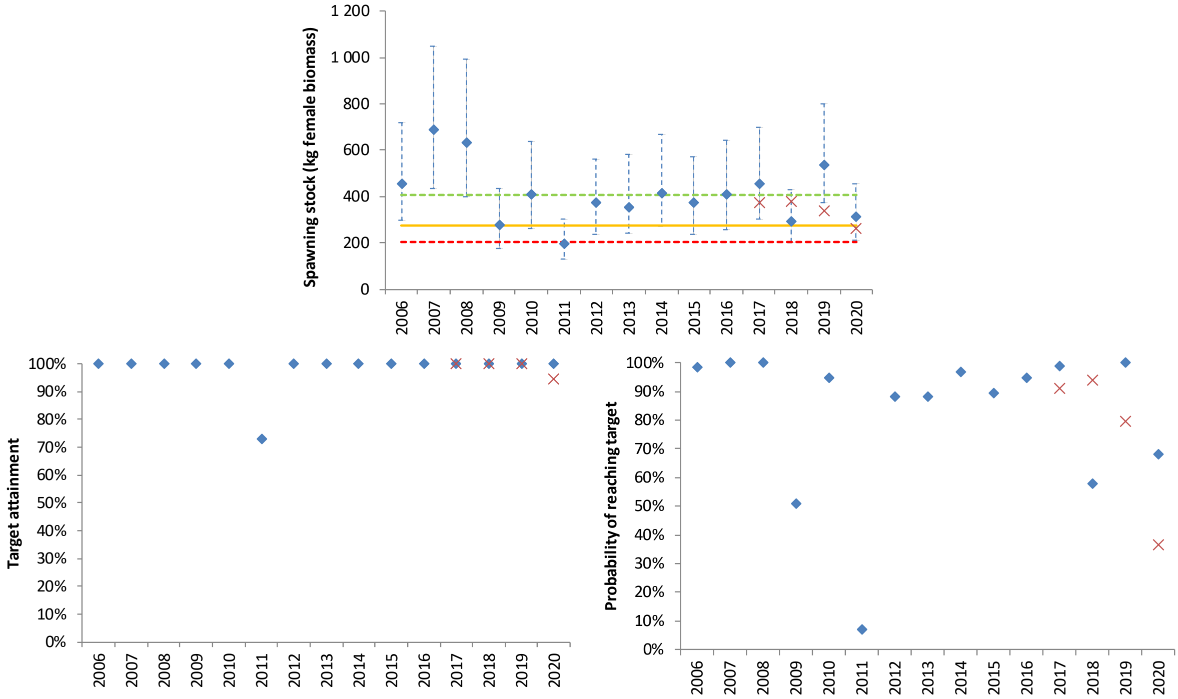


Figure 34. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the Finnish tributary Goahppelašjohka/Kuoppilasjoki. Red symbols give the result of the status assessment in 2017-2020 when using old microsatellite average proportions instead of the more recent SNP proportions.

4.7.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Goahppelašjohka/Kuoppilasjoki stock has varied from a maximum of 2 673 kg (2007) down to 923 kg (2020) with microsatellites or 1 124 kg (2020) with SNPs (Figure 35).

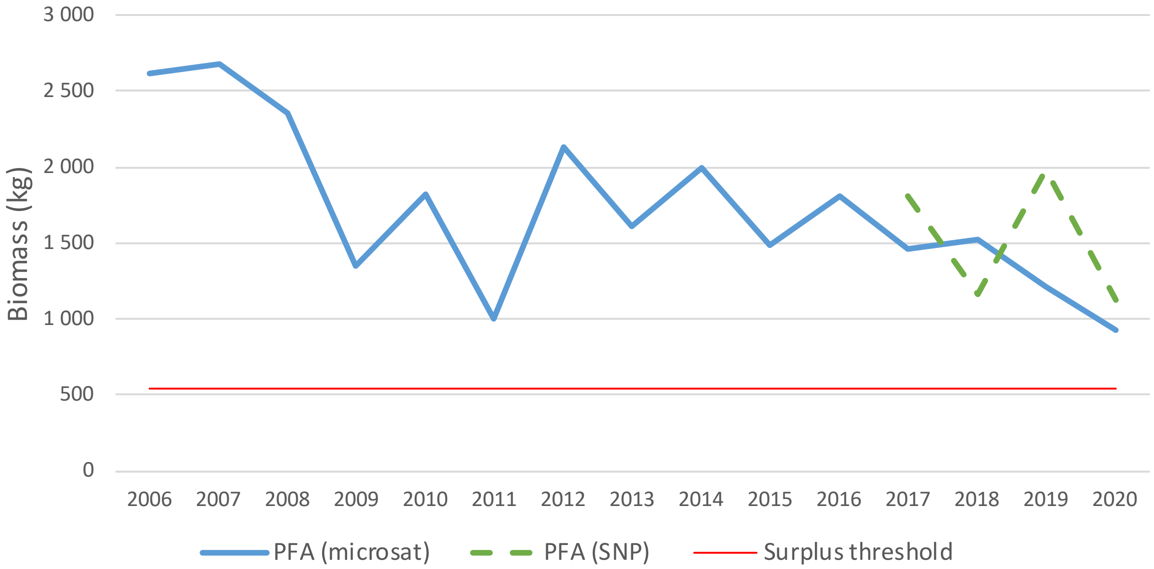


Figure 35. The estimated pre-fishery abundance (PFA) of salmon belonging to the Goahppelašjohka/Kuoppilasjoki stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Goahppelašjohka/Kuoppilasjoki salmon was 43 % in the years 2017-2020 when estimating with the SNP-based genetic data and 42 % with the old microsatellite average proportions (Figure 36). With the SNP data, 18 % of the pre-fishery abundance was caught in coastal fisheries, while the microsatellite coastal estimate was 17 %. The main stem fisheries proportion was 24 % with both genetic methods. The Goahppelašjohka/Kuoppilasjoki fisheries proportion was 1 % with both methods.

In the period 2017-2020, the average total pre-fishery abundance for Goahppelašjohka/Kuoppilasjoki salmon was 1 520 kg and the average total catch was 651 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 1 278 kg and 538 kg.

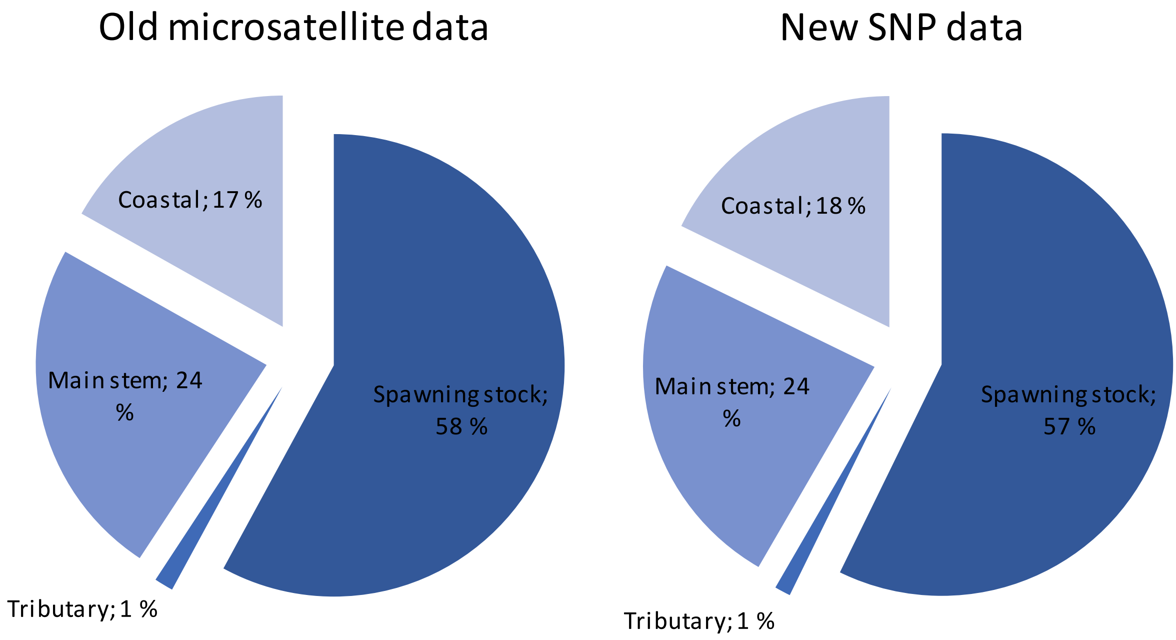


Figure 36. The total amount of salmon belonging to Goahppelašjohka/Kuoppilasjoki in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Goahppelašjohka/Kuoppilasjoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	**2017-2020 (microsat.)**	**2006-2016**
Coastal	18 %	17 %	16 %
Main stem	29 %	29 %	41 %
Tributary	2 %	2 %	0 %
Tributary + main stem	30 %	30 %	41 %

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 2017-2020, estimates of overexploitation based on the SNP data were 0 % for all four years. With the microsatellite data, overexploitation varied between 0 % (2017-2019) to 4 % (2020) with an average of 1 %.

With the SNP data, maximum sustainable exploitation varied between 45 % (2018) and 70 % (2019). The average maximum sustainable total exploitation rate in the period was 58 %, higher than the estimated average total exploitation of 43 %. With the microsatellite data, maximum sustainable exploitation varied between 36 % (2020) and 61 % (2017) with an average of 51 %, well above the estimated average total exploitation of 42 %.

4.7.3 Stock recovery

Management target attainment of the Goahppelašjohka/Kuoppilasjoki stock was 95 % based on the SNPs and 82 % with microsatellites, both estimates well above the threshold of 40 % that indicates the need for a recovery plan. With the SNP data, the estimated river exploitation of Goahppelašjohka/Kuoppilasjoki salmon has been reduced from 41 to 30 %, which corresponds to a 26 % reduction in exploitation. With the microsatellite data, the river exploitation has been reduced from 41 to 30 %, a reduction of 26 %.

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 older reports (2017-2018), Leavvajohka has been evaluated using a spawning target based on an underestimated salmon distribution area. Based on recent monitoring data, a new distribution area has been established since 2019, 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 2006-2016.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Leavvajohka stock proportion differs considerably between the previous microsatellite method (1.3 %) and the newer SNP method (2.5 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. The new SNP-based estimate was used for 2018 and 2019, and an average SNP proportion was used in 2017 and 2020. We give alternative assessments for the period 2017-2020 based on both SNP- and microsatellite-based data.

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	1 167	0.0131	0.45	0.50
2007	1 863	0.0211	0.45	0.80
2008	1 364	0.0130	0.45	0.62
2009	696	0.0130	0.45	0.52
2010	981	0.0130	0.45	0.56
2011	415	0.0061	0.45	0.59
2012	1 037	0.0113	0.45	0.48
2013	890	0.0130	0.45	0.56
2014	1 085	0.0130	0.45	0.52
2015	850	0.0130	0.45	0.57
2016	948	0.0130	0.45	0.56
2017	1 296	0.0245	0.40	0.58
2018	756	0.0180	0.35	0.52
2019	1 040	0.0310	0.35	0.56
2020	657	0.0245	0.35	0.57

When using SNP data, the spawning target attainment was 161 % in 2020 and the probability of meeting the spawning target was 95 %. Based on old microsatellite average proportions, spawning target attainment becomes 85 % with a probability of meeting the spawning target of 22 %. The management target was reached with the SNP data, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 100 % with an overall attainment of 210 %. The management target was not reached with the microsatellite data, as the probability was 61 % with an overall attainment of 113 % (Figure 37).

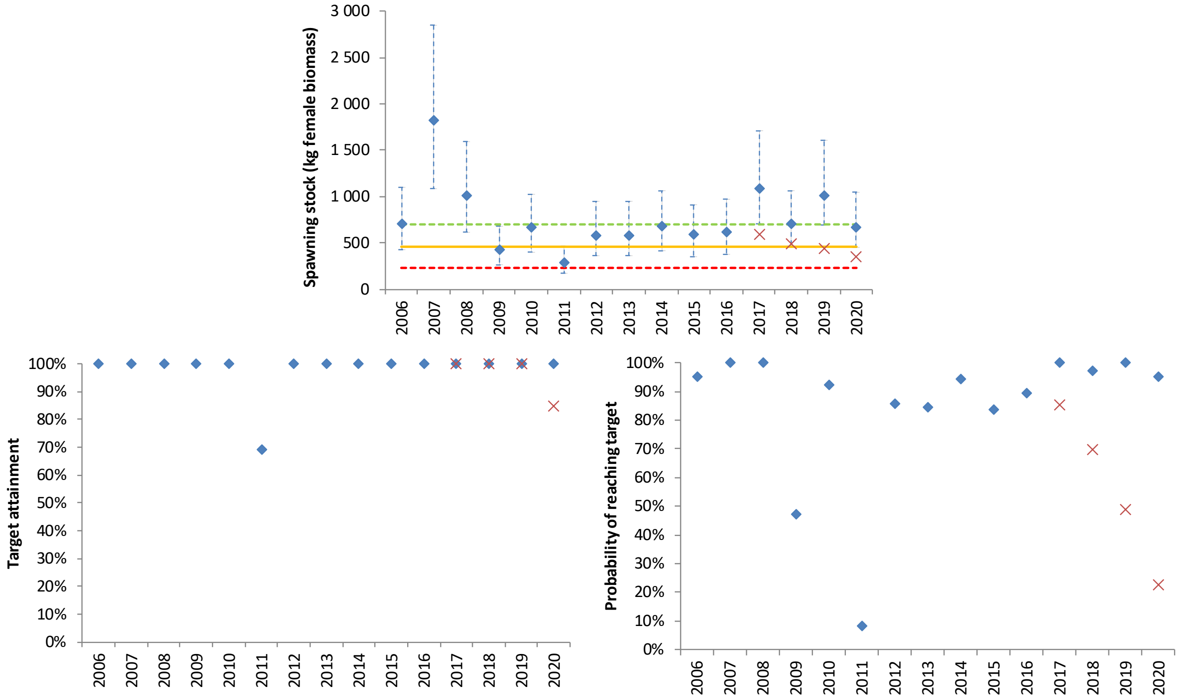


Figure 37. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the Norwegian tributary Leavvajohka. Red symbols give the result of the status assessment in 2017-2020 when using old microsatellite average proportions instead of the more recent SNP proportions.

4.8.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Leavvajohka stock has varied from a maximum of 5 227 kg (2007) down to 498 kg (2011) (Figure 38).

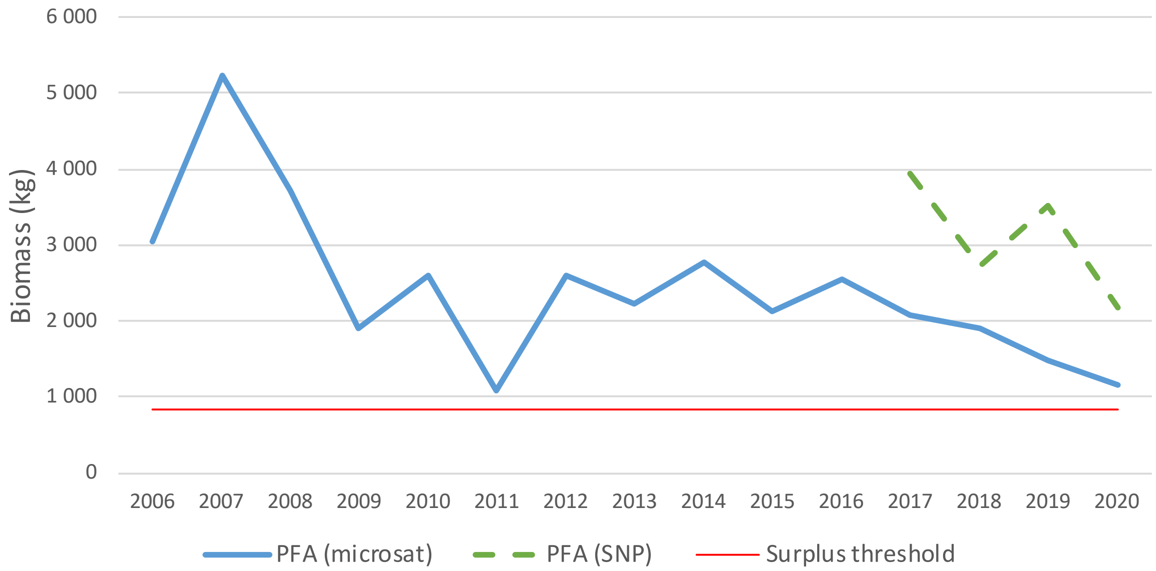


Figure 38. The estimated pre-fishery abundance (PFA) of salmon belonging to the Leavvajohka stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Leavvajohka salmon was 50 % in the years 2017-2020 when estimating with the SNP-based genetic data and 49 % with the old microsatellite average proportions (Figure 39). With the SNP data, 19 % of the pre-fishery abundance was caught in coastal fisheries, while the microsatellite coastal estimate was 18 %. The main stem fisheries proportion was 30 % with the SNPs and 31 % with the microsatellites. The Leavvajohka fisheries proportion was 0 %.

In the period 2017-2020, the average total pre-fishery abundance of Leavvajohka salmon was 3 093 kg and the average total catch was 1 541 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 1 652 kg and 808 kg.

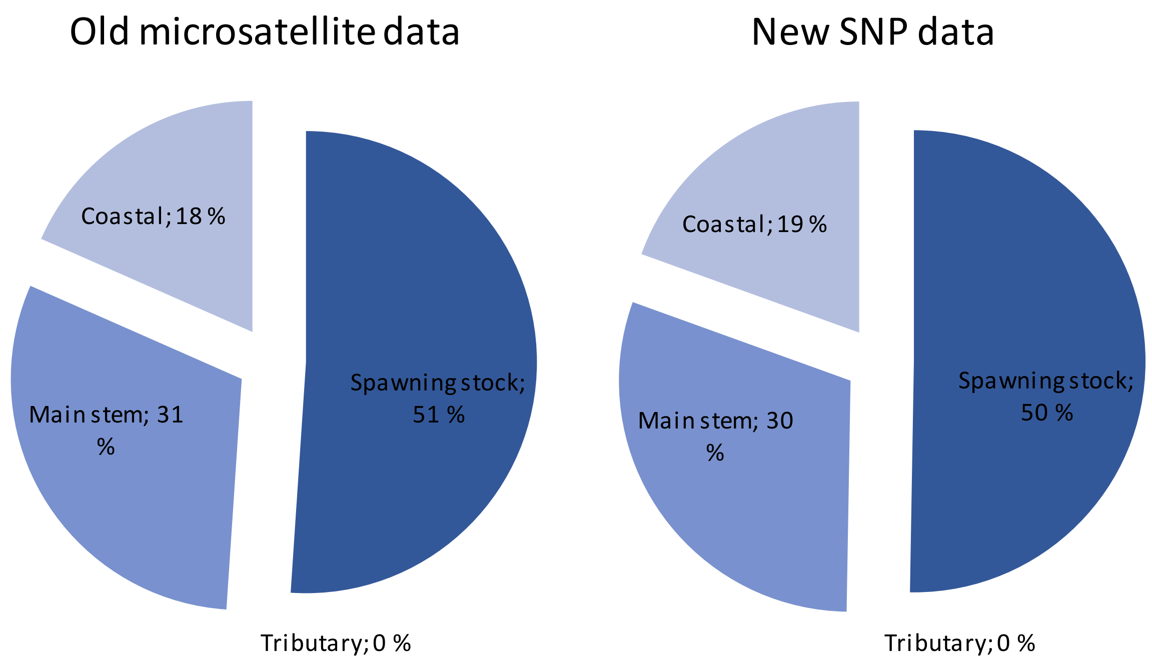


Figure 39. The total amount of salmon belonging to Leavvajohka in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Leavvajohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Even though the estimated proportions of the Leavvajohka salmon in the main stem mixed-stock fishery deviates considerably when comparing the SNP and microsatellite data, the estimated relative catch distribution remains relatively equal. The reason for this is that the spawning stock estimates above are both based directly on the respective main stem catch estimates.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020	**2017-2020 (microsat.)**	**2006-2016**
Coastal	19 %	18 %	17 %
Main stem	38 %	37 %	45 %
Tributary	0 %	0 %	0 %
Tributary + main stem	38 %	37 %	45 %

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 2017-2020, estimates of overexploitation based on the SNP data were 0 % for all four years. With the microsatellite data, overexploitation varied between 0 % (2017, 2018) and 23 % (2020) with an average of 7 %.

With the SNP data, maximum sustainable exploitation varied between 63 % (2020) and 79 % (2017). The average maximum sustainable total exploitation rate in the period was 72 %, higher than the estimated average total exploitation of 50 %. With the microsatellite data, maximum sustainable exploitation varied between 29 % (2020) and 61 % (2017) with an average of 47 %, just below the estimated average total exploitation of 49 %.

4.8.3 Stock recovery

Management target of the Leavvajohka stock is at 100 % with the SNP data and 61 % with the microsatellites, both estimates well above the threshold of 40 % that indicates the need for a recovery plan. With the SNP data, the estimated river exploitation of the Leavvajohka stock has been reduced from 45 to 38 %, which corresponds to a 17 % reduction in exploitation. With the microsatellite data, the river exploitation has been reduced from 45 to 37 %, a reduction of 18 %.

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 2006-2016.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Báišjohka stock proportion differs between the previous microsatellite method (0.7 %) and the newer SNP method (1.3 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. The new SNP-based estimate was used for 2018 and 2019, and an average

SNP proportion was used in 2017 and 2020. We give alternative assessments for the period 2017-2020 based on both SNP- and microsatellite-based data.

The main stem exploitation is estimated at 45 % based on the location along the Tana main stem and the main stem exploitation of other stocks. The main stem exploitation rate estimate in 2017 was reduced by 10 % from previous years in 2017 due to the implementation of new fishing rules in Tana. The exploitation estimate was reduced to 0.35 % in 2018-2020 as indicated by the combined main stem and tributary fish counting (Table 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	473	0.0053	0.45	0.49
2007	1 026	0.0116	0.45	0.77
2008	813	0.0078	0.45	0.75
2009	381	0.0071	0.45	0.57
2010	536	0.0071	0.45	0.61
2011	207	0.0030	0.45	0.44
2012	701	0.0077	0.45	0.57
2013	487	0.0071	0.45	0.61
2014	593	0.0071	0.45	0.57
2015	465	0.0071	0.45	0.62
2016	518	0.0071	0.45	0.62
2017	529	0.0130	0.40	0.64
2018	546	0.0130	0.35	0.57
2019	507	0.0160	0.35	0.62
2020	348	0.0130	0.35	0.62

When using SNP data, the spawning target attainment was 112 % in 2020 and the probability of meeting the spawning target was 66 %. Based on the old microsatellite average proportions, spawning target attainment becomes 61 % with a probability of meeting the spawning target of 0 %. The management target was reached with the SNP data, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 92 % with an overall attainment of 139 %. The management target was not reached with the microsatellite data, as the probability was 12 % with an overall attainment of 79 % (Figure 40).

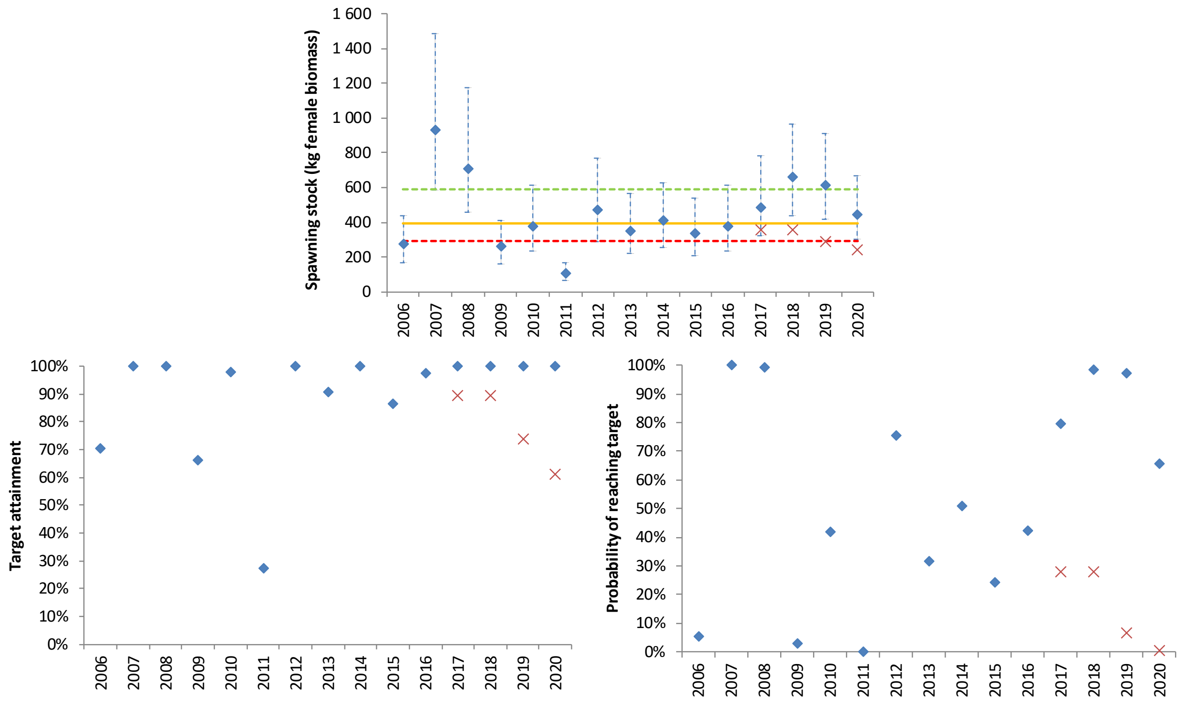


Figure 40. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the Norwegian tributary Báišjohka. Red symbols give the result of the status assessment in 2017-2020 when using old microsatellite average proportions instead of the more recent SNP proportions.

4.9.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Báišjohka stock has varied from a maximum of 2 840 kg (2007) down to 525 kg (2011) with microsatellites (Figure 41).

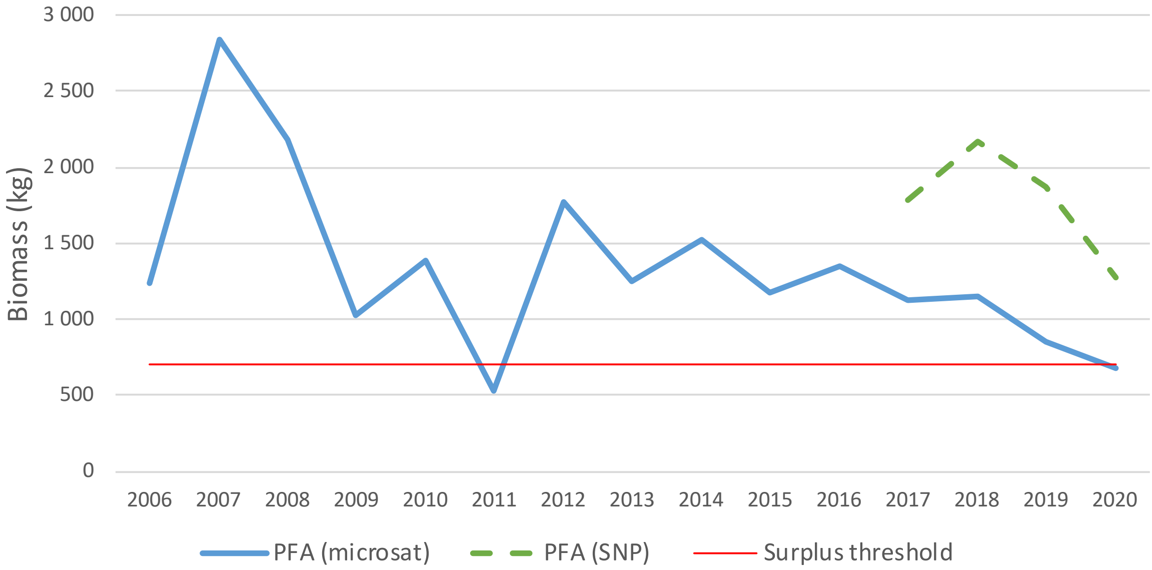


Figure 41. The estimated pre-fishery abundance (PFA) of salmon belonging to the Báišjohka stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Báišjohka salmon was 49 % in the years 2017-2020 when estimating with the SNP-based genetic data and 47 % with the old microsatellite average proportions (Figure 42). With the SNP data, 19 % of the pre-fishery abundance was caught in coastal fisheries, while the microsatellite coastal estimate was 18 %. The main stem fisheries proportion was 30 % with the SNPs and 29 % with the microsatellites. The Báišjohka fisheries proportion was 0 %.

In the period 2017-2020, the average total pre-fishery abundance of Báišjohka salmon was 1 771 kg and the average total catch was 866 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 952 kg and 444 kg.

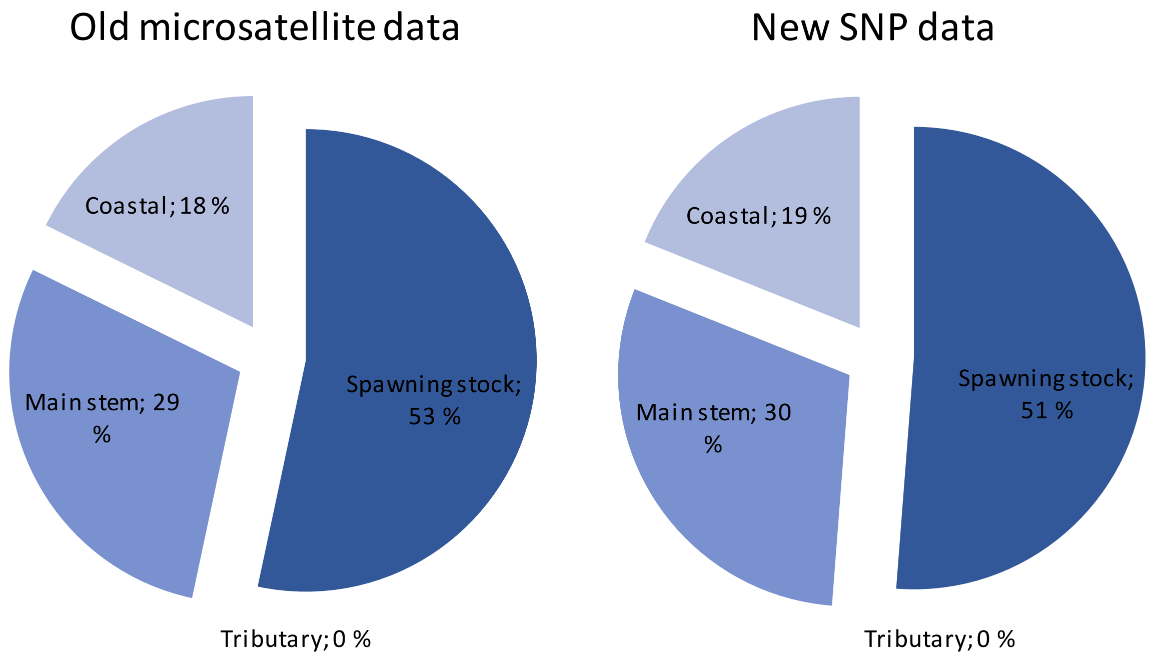


Figure 42. The total amount of salmon belonging to Báišjohka in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Báišjohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Even though the estimated proportions of the Báišjohka salmon in the main stem mixed-stock fishery deviates considerably when comparing the SNP and microsatellite data, the estimated relative catch distribution remains relatively equal. The reason for this is that the spawning stock estimates above are both based directly on the respective main stem catch estimates.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	**2017-2020 (microsat.)**	**2006-2016**
Coastal	19 %	18 %	17 %
Main stem	37 %	35 %	46 %
Tributary	0 %	0 %	0 %
Tributary + main stem	37 %	35 %	46 %

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 2017-2020, estimates of overexploitation based on the SNP data was 0 % for all four years. With the microsatellite data, overexploitation varied between 10 % (2017, 2018) and 39 % (2020) with an average of 22 %.

With the SNP data, maximum sustainable exploitation varied between 49 % (2020) and 68 % (2018). The average maximum sustainable total exploitation rate in the period was 62 %, higher than the estimated average total exploitation of 49 %. With the microsatellite data, maximum sustainable exploitation varied between 6 % (2020) and 45 % (2017) with an average of 29 %, well below the estimated average total exploitation of 47 %.

4.9.3 Stock recovery

Management target of the Báišjohka stock is at 92 % with the SNP data, well above the threshold of 40 % that indicates the need for a recovery plan. The estimated river exploitation of the Báišjohka stock has been reduced from 46 to 37 %, which corresponds to a 20 % reduction in exploitation.

With the microsatellite data, management target of the Báišjohka stock was only 12 %, well below the threshold of 40 % that indicates the need for a recovery plan. The estimated river exploitation has been reduced from 46 to 35 %, a reduction of 23 %.

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 snorkelling in the years 2006-2020, with the exceptions of 2007, 2008, 2013 and 2019. The snorkelling counts can be used directly as a basis for the target assessment of Njiljohka/Nilijoki and the following basic formula estimates the annual spawning stock size in the snorkelling years:

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

The data input for the variables in this formula are summarized in Table 20. Female proportions in Table 20 are based on snorkelling detections of males and females each year. Fishing pressure in Njiljohka/Nilijoki is low and no catch statistics is available. Average sizes in Table 20 are based on a combination of main stem Genmix samples from 2006-2008 and 2011-2012.

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

Year	Snorkelling count (1SW)	Snorkelling count (MSW)	Average size (1SW)	Average size (MSW)	Detection rate	Area covered	Female prop. (1SW)	Female prop. (MSW)
2006	210	6	1.3	3.6	0.80	1	0.41	0.83
2007								
2008								

2009	127	14	1.3	3.6	0.75	1	0.37	0.64
2010	65	24	1.3	3.6	0.80	1	0.42	0.70
2011	131	16	1.3	3.6	0.80	1	0.40	0.75
2012	151	14	1.3	3.6	0.75	1	0.51	0.43
2013								
2014	154	34	1.3	3.6	0.80	0.7	0.52	0.65
2015	75	15	1.3	3.6	0.80	0.7	0.36	0.80
2016	70	29	1.3	3.6	0.75	0.7	0.40	0.93
2017	65	27	1.3	3.6	0.75	0.7	0.36	0.63
2018	205	11	1.3	3.6	0.75	0.7	0.43	0.50
2019								
2020	42	7	1.3	3.6	0.8	0.7	0.29	0.86

In the years without snorkelling (2007, 2008, 2013, 2019), an alternative approach can be taken based on the proportion of Njiljohka/Nilijoki salmon found in the main stem fisheries and an estimate of the main stem exploitation rate (Table 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 35 % was used in 2019.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Njiljohka/Nilijoki stock proportion differs considerably between the previous microsatellite method (0.8 %) and the newer SNP method (1.5 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. For this reason, we give alternative assessments for 2017-2020 based on both SNP- and microsatellite proportions.

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	751	0.0085	0.45	0.78
2008	500	0.0048	0.45	0.63
2009				
2010				
2011				
2012				
2013	538	0.0079	0.45	0.58
2014				
2015				
2016				
2017				
2018				
2019	567	0.0160	0.35	0.58
2020				

To account for uncertainty, the exploitation rate and female proportion estimates in Table 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 29 % in 2020 and the probability of meeting the spawning target was 0 %. The management target was reached with the SNP data, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 79 % with an overall attainment of 122 %. The management target was not reached with the microsatellite data, as the probability was 56 % with an overall attainment of 105 % (Figure 43).

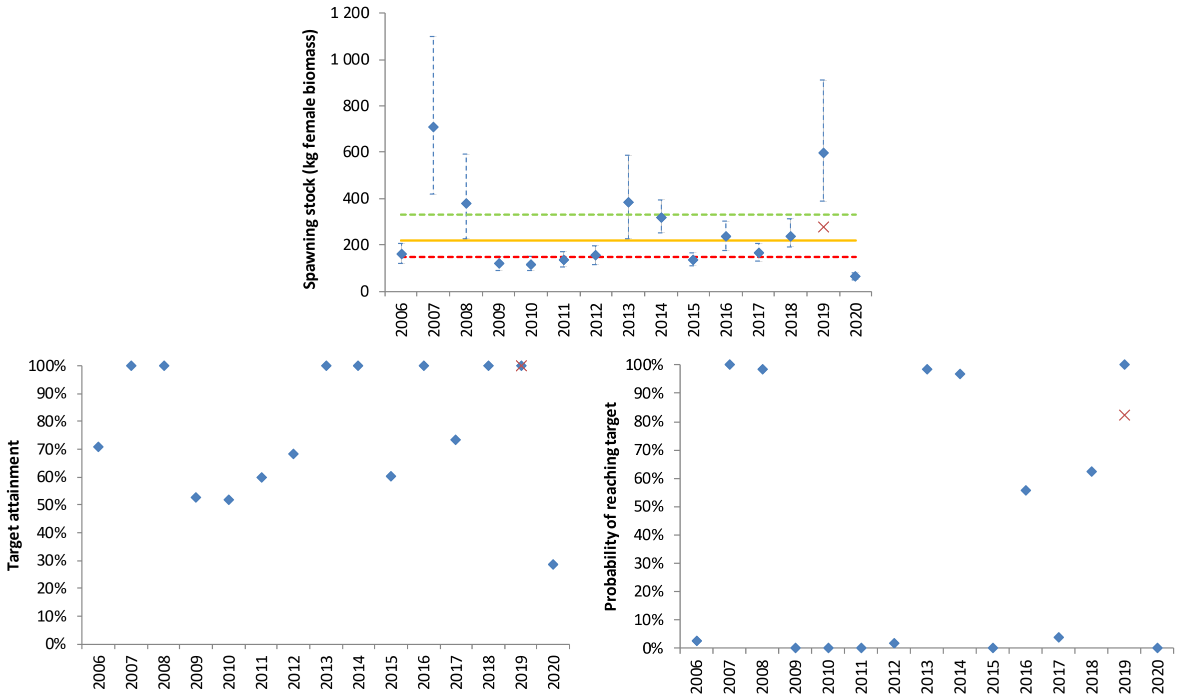


Figure 43. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the Finnish tributary Njiljohka/Nilijoki. Red symbols give the result of the status assessment in 2017-2020 when using old microsatellite average proportions instead of the more recent SNP proportions.

4.10.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Njiljohka/Nilijoki stock has varied from a maximum of 2 100 kg (2007) down to 459 kg (2020) with microsatellites or 676 kg (2020) with SNPs (Figure 44).

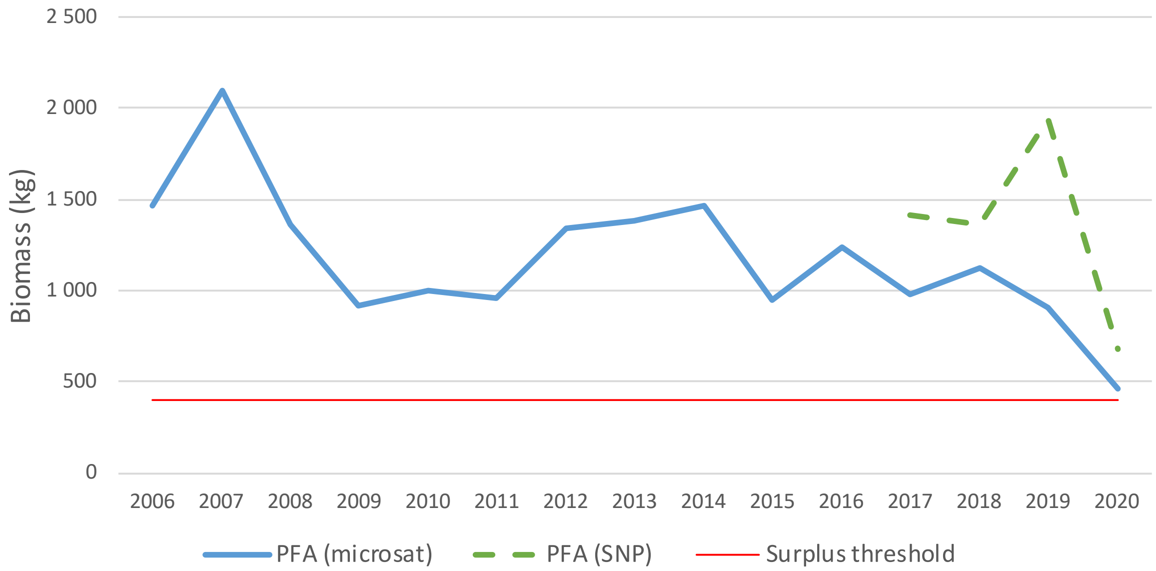


Figure 44. The estimated pre-fishery abundance (PFA) of salmon belonging to the Njiljohka/Nilijoki stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Njiljohka/Nilijoki salmon was 60 % in the years 2017-2020 when estimated with the SNP-based genetic data and 54 % with the old microsatellite average proportions (Figure 45). The coastal proportion was estimated to 20 % of the pre-fishery abundance with the SNPs and 19 % with the microsatellites. The main stem fisheries proportion was 41 % with the SNPs and 35 % with the microsatellites. The Njiljohka/Nilijoki fisheries proportion was 0 %.

In the period 2017-2020, the average total pre-fishery abundance of Njiljohka/Nilijoki salmon was 1 348 kg and the average total catch was 816 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 865 kg and 468 kg.

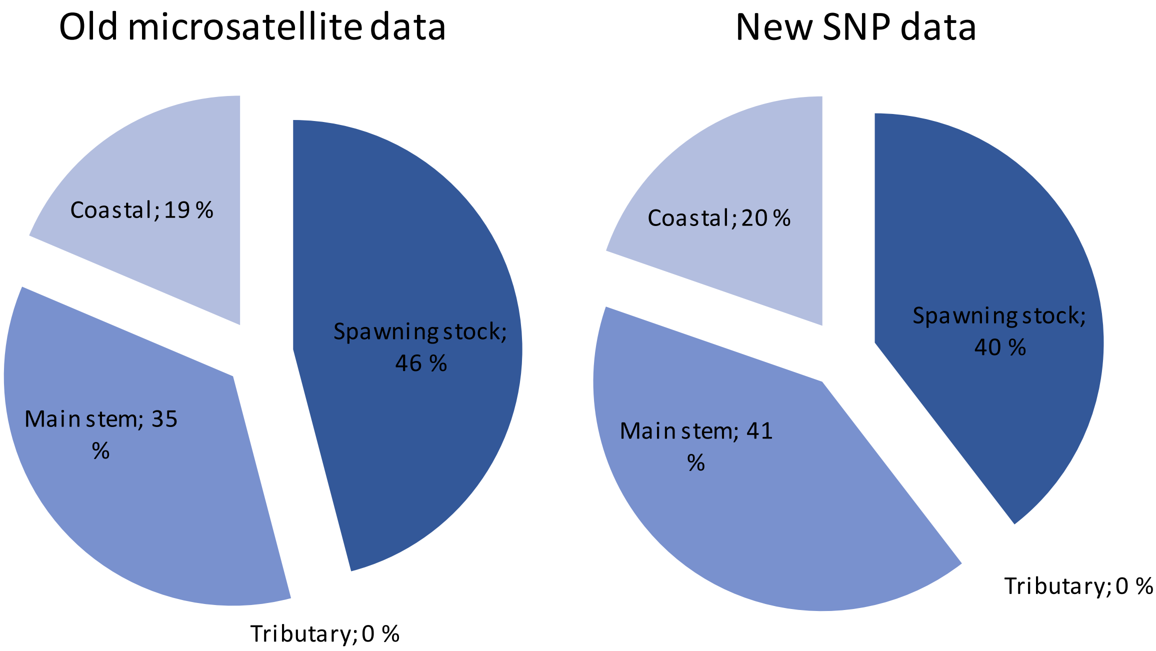


Figure 45. The total amount of salmon belonging to Njiljohka/Nilijoki in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Njiljohka/Nilijoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Since the estimated proportions of Njiljohka/Nilijoki salmon in the main stem mixed stock fishery deviates when comparing the microsatellite and the SNP data while the spawning stock is estimated without using the main stem catch proportion, the estimated catch proportions above differ between genetic methods.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	**2017-2020 (microsat.)**	**2006-2016**
Coastal	20 %	19 %	17 %
Main stem	51 %	44 %	57 %
Tributary	0 %	0 %	0 %
Tributary + main stem	51 %	44 %	57 %

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 2017-2020, estimates of overexploitation based on the SNP data varied between 0 % (2018, 2019) and 71 % (2020) with an average of 24 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 24 % below the spawning target). With the microsatellite data, overexploitation varied between 0 % (2018, 2019) and 48 % (2020) with an average of 18 %.

With the SNP data, maximum sustainable exploitation varied between 11 % (2020) and 80 % (2019). The average maximum sustainable total exploitation rate in the period was 55 %, slightly lower than the estimated average total exploitation of 60 %. With the microsatellite data, maximum sustainable exploitation varied between 0 % (2020) and 58 % (2019) with an average of 40 %, well below the estimated average total exploitation of 54 %. A maximum exploitation of 0 % indicates no exploitable surplus.

4.10.3 Stock recovery

Management target of the Njiljohka/Nilijoki stock is at 79 % based on the SNPs and 56 % with microsatellites, both above the threshold of 40 % that indicates the need for a recovery plan. With the SNP data, the estimated river exploitation of Njiljohka/Nilijoki salmon has been reduced from 57 to 51 %, which corresponds to a 12 % reduction in exploitation. With the microsatellite data, the river exploitation has been reduced from 57 to 44 %, a reduction of 24 %.

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 (2006-2020). 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 proportions from these five years to cover the remaining years in the period 2006-2016.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Váljohka stock proportion differs between the previous microsatellite method (1.7 %) and the newer SNP method (2.6 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. The new SNP-based estimate was used for 2018 and 2019, and an average SNP proportion was used in 2017 and 2020. We give alternative assessments for the period 2017-2020 based on both SNP- and microsatellite-based data.

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 2018-2020 as indicated elsewhere in Tana through the combined results of the main stem and tributary fish countings (Table 23).

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	1 348	0.0255	0.45	0.57
2018	1 261	0.0300	0.37	0.45
2019	705	0.0210	0.37	0.63

2020	683	0.0255	0.37	0.44

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.

When using SNP data, the spawning target attainment was 66 % in 2020 and the probability of meeting the spawning target was 3 %. Based on old microsatellite average proportions, spawning target attainment becomes 49 % with a probability of meeting the spawning target of 0 %. The management target was not reached with either genetic method, as the last 4 years' (2017-2020) overall probability of reaching the spawning target based on SNPs was 50 % with an overall attainment of 103 % while the probability based on microsatellites was 10 % with an overall attainment of 75 % (Figure 46).

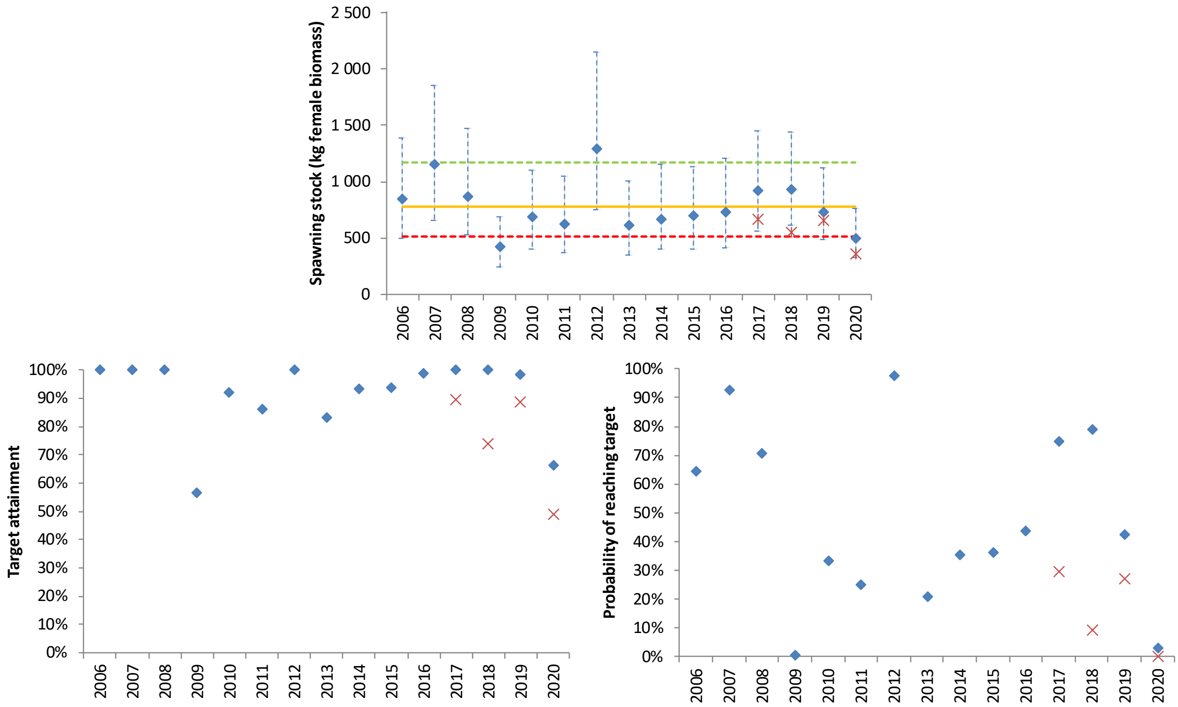


Figure 46. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the Norwegian tributary Váljohka. Red symbols give the result of the status assessment in 2017-2020 when using old microsatellite average proportions instead of the more recent SNP proportions.

4.11.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Váljohka stock has varied from a maximum of 6 815 kg (2012) down to 1 526 kg (2020) with microsatellites or 2 192 kg (2020) with SNPs (Figure 47).

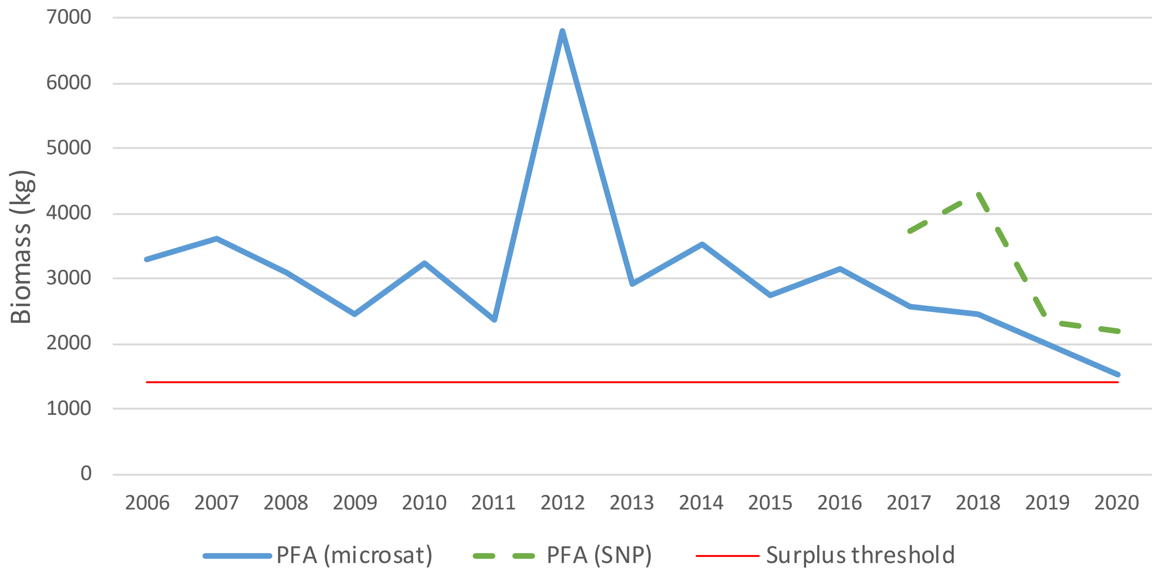


Figure 47. The estimated pre-fishery abundance (PFA) of salmon belonging to the Váljohka stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Váljohka salmon was 53 % in the years 2017-2020 when estimating with the SNP-based genetic data and 50 % with the old microsatellite average proportions (Figure 48). With the SNP data, 20 % of the pre-fishery abundance was caught in coastal fisheries, while the microsatellite coastal estimate was 19 %. The main stem fisheries proportion was 30 % with the SNPs and 29 % with the microsatellites. The Váljohka fisheries proportion was 2 % with the SNPs and 3 % with the microsatellites.

In the period 2017-2020, the average total pre-fishery abundance of Váljohka salmon was 3 136 kg and the average total catch 1 641 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 2 133 kg and 1 072 kg.

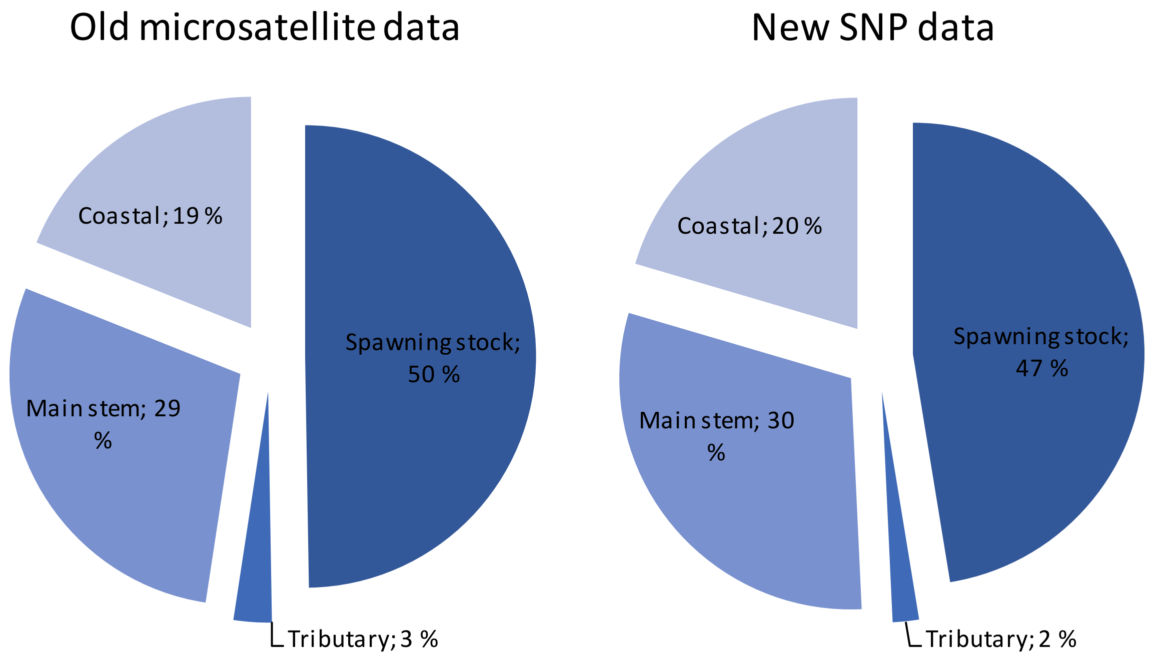


Figure 48. The total amount of salmon belonging to Váljohka in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Váljohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Even though the estimated proportions of the Váljohka salmon in the main stem mixed-stock fishery deviates considerably when comparing the SNP and microsatellite data, the estimated relative catch distribution remains relatively equal. The reason for this is that the spawning stock estimates above are both based directly on the respective main stem catch estimates.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	2017-2020 (microsat.)	2006-2016
Coastal	20 %	19 %	17 %
Main stem	38 %	35 %	42 %
Tributary	4 %	5 %	11 %
Tributary + main stem	40 %	39 %	48 %

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 2017-2020, estimates of overexploitation based on the SNP data varied between 0 % (2017, 2018) and 37 % (2020) with an average of 11 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 11 % below the spawning target). With the microsatellite data, overexploitation varied between 15 % (2017, 2019) and 40 % (2020) with an average of 25 %.

With the SNP data, maximum sustainable exploitation varied between 18 % (2020) and 62 % (2017). The average maximum sustainable total exploitation rate in the period was 47 %, lower than the estimated average total exploitation of 53 %. With the microsatellite data, maximum sustainable exploitation varied between 0 % (2020) and 47 % (2017) with an average of 29 %, lower than the estimated average total exploitation of 50 %.

4.11.3 Stock recovery

Management target attainment of the Váljohka stock is at 50 % with the SNP data, above the 40 % threshold that indicates the need for a recovery plan. With the SNP data, the estimated river exploitation of the Váljohka stock has been reduced from 48 to 40 %, which corresponds to a 16 % reduction in exploitation.

Management target attainment was only 10 % with the microsatellite data, below the 40 % threshold that indicates the need for a recovery plan. The estimated river exploitation has been reduced from 48 to 39 %, a reduction of 19 %.

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

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

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

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Áhkojohka/Akujoki stock proportion differs largely between the previous microsatellite method (0.3 %) and the newer SNP method (1.4 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. The main stem catch proportion is not used in the spawning stock estimate of Áhkojohka/Akujoki, but we present catch distribution and stock recovery results based on both genetic methods.

Fishing pressure in Áhkojohka/Akujoki is low and there is no catch statistic. 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 under snorkelling 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	0.0140
2018	65	3	1.3	3.6	0.80	1	0.51	0.33	0.0060
2019	24	7	1.3	3.6	0.85	1	0.54	1	0.0220
2020	23	10	1.3	3.6	0.85	1	0.17	0.40	0.0140

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 17 % in 2020 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 0 % with an overall attainment of 32 % (Figure 49).

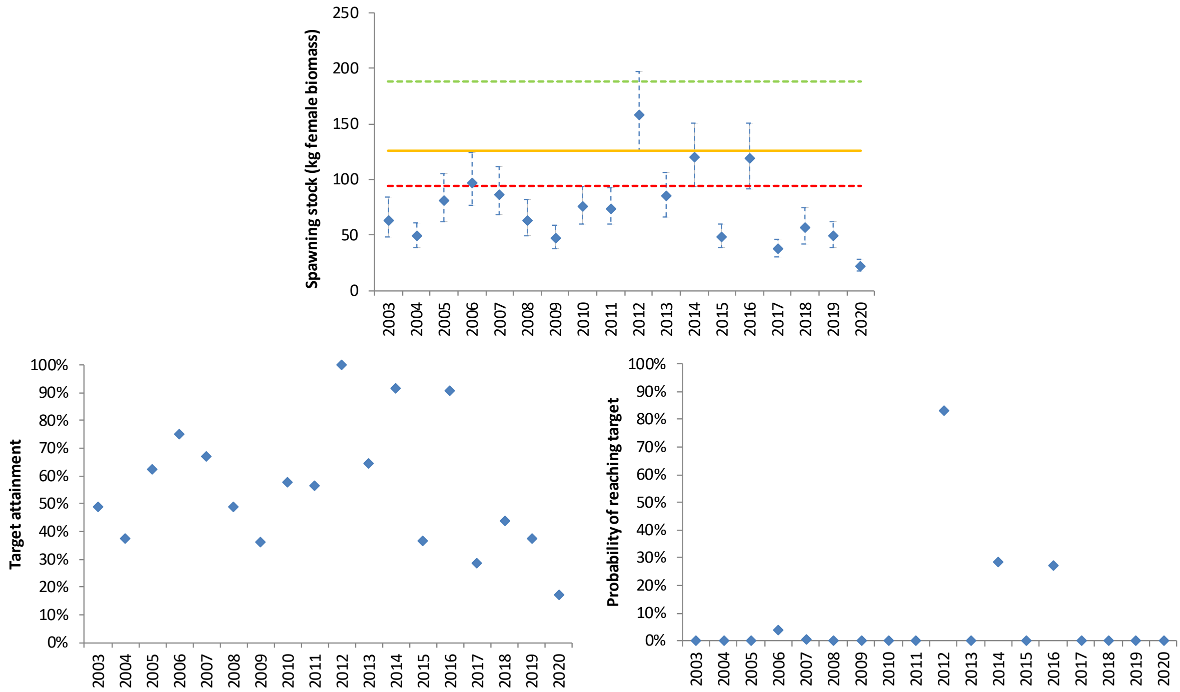


Figure 49. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2020 in the Finnish tributary Áhkojohka/Akujoki.

4.12.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock has varied from a maximum of 734 kg (2006) down to 208 kg (2020) with microsatellites or from 1 042 kg (2017) down to 466 kg (2018) with the SNPs (Figure 50).

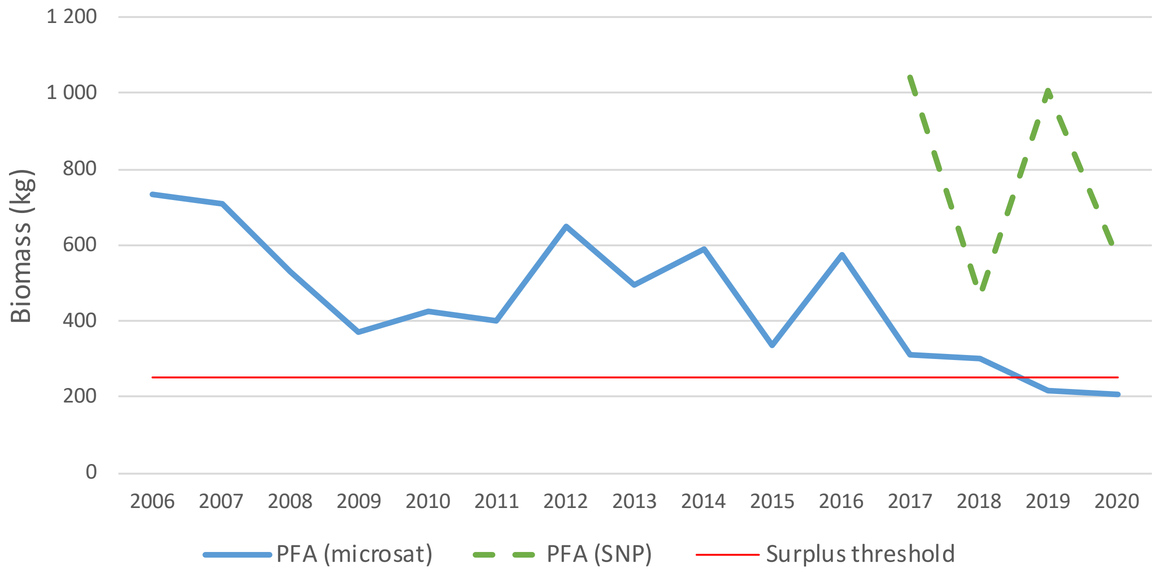


Figure 50. The estimated pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Áhkojohka/Akujoki salmon was 88 % in the years 2017-2020 when estimating with the SNP-based genetic data and 63 % with the old microsatellite average proportions (Figure 51). The coastal proportion was estimated to 19 % of the pre-fishery abundance with SNPs and 18 % with microsatellites. The main stem fisheries proportion was 68 % with the SNPs and 45% with the microsatellites. The Áhkojohka/Akujoki fisheries proportion was 0 %.

In the period 2017-2020, the average total pre-fishery abundance for Áhkojohka/Akujoki salmon was 770 kg and the average total catch was 675 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 258 kg and 164 kg.

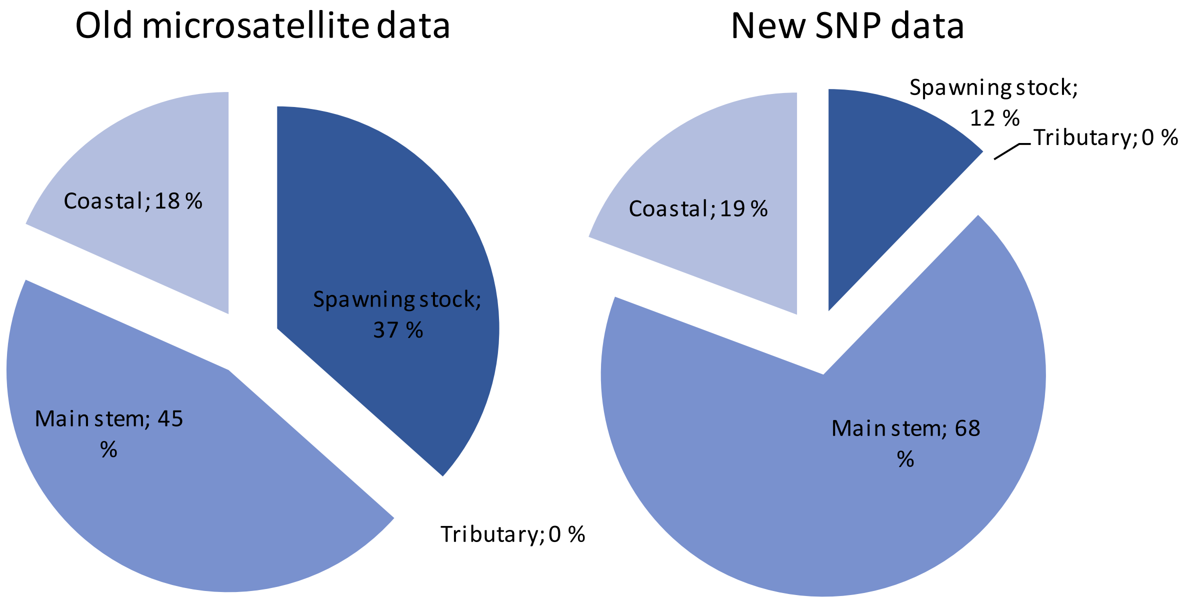


Figure 51. The total amount of salmon belonging to Áhkojohka/Akujoki in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Áhkojohka/Akujoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Since the estimated proportions of Áhkojohka/Akujoki salmon in the main stem mixed stock fishery deviates when comparing the microsatellite and the SNP data while the spawning stock is estimated without using the main stem catch proportion, the estimated catch proportions above differ between genetic methods.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	**2017-2020 (microsat.)**	**2006-2016**
Coastal	19 %	18 %	17 %
Main stem	85 %	55 %	54 %
Tributary	0 %	0 %	0 %
Tributary + main stem	85 %	55 %	54 %

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 2017-2020, estimates of overexploitation based on the SNP data varied between 56 % (2018) and 82 % (2020) with an average of 67 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 67 % below the spawning target). With the microsatellite data, overexploitation varied between 21 % (2020) and 68 % (2017) with an average of 51 %.

With the SNP data, maximum sustainable exploitation varied between 7 % (2020) and 81 % (2019). The average maximum sustainable total exploitation rate in the period was 51 %, significantly lower than the estimated average total exploitation of 88 %. With the microsatellite data, maximum sustainable exploitation varied between 0 % (2017, 2020) and 16 % (2018) with an average of 6 %, well below the estimated average total exploitation of 63 %. A maximum exploitation of 0 % indicates no exploitable surplus.

4.12.3 Stock recovery

Management target attainment of the Áhkojohka/Akujoki stock is at 0 %, well below the threshold of 40 % that indicates the need for a recovery plan. In a previous report (Anon. 2018), we advised an 8 % reduction of the total river exploitation rate of Áhkojohka/Akujoki salmon from the 2006-2016 level in order to achieve stock recovery over two generations. With the SNP data, the estimated river exploitation of the Áhkojohka/Akujoki stock has increased from 54 to 85 %, which corresponds to a 58 % increase in exploitation. This is a counterintuitive result that is caused by the significant increase in main stem catch proportion of the Áhkojohka/Akujoki salmon with SNPs versus microsatellites.

With microsatellite data, the river exploitation increased from 54 to 55 %, which corresponds to a 3 % increase in exploitation.

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 can pass and spawn above this waterfall. There is one major tributary, Bávttajohka, approximately 98 km upstream from Skáidegeahči. In this tributary, close to 40 km is available for salmon. Just downstream of the confluence between Kárášjohka and Iešjohka, there is another smaller tributary, Geaimmejohka, with 10 km available for salmon. The status assessment in this chapter is a combined evaluation of Kárášjohka and the tributaries Bávttajohka and Geaimmejohka.

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.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Kárášjohka stock proportion differs between the previous microsatellite method (12.2 %) and the newer SNP method (10 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. The main stem catch proportion is not used in the spawning stock estimate of Kárášjohka, but we present catch distribution and stock recovery results based on both genetic methods.

There were acoustic fish counting in 2010, 2012 and 2017-2020 at Heastanjárga, close to the upper bridge over Kárášjohka, approximately 5 km upstream from Skáidegeahči. These counts provide an estimate of the number of salmon of different size groups that migrated up into the upper part of Kárášjohka. The estimated exploitation rates in 2010 and 2012, in combination with the estimated catch of Kárášjohka-salmon downstream of the counting site, gave an estimated exploitation rate of 25 % for salmon <3 kg and 45 % for salmon >3 kg in the period 2006-2016. The estimate for 2017 was lower and 15 % was used for salmon <3 kg and 33 % for salmon >3 kg. Fish counting in 2018 indicated a further reduced exploitation, down to 15 % for salmon <3 kg and 25 % for salmon >3 kg. The 2019 and 2020 monitoring indicated continued low exploitation (Table 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	1 774	1 277	1 110	0.25	0.45	0.45	0.09	0.79	0.73	0.1100
2007	272	1 281	761	0.25	0.45	0.45	0.23	0.70	0.82	0.0989
2008	245	1 160	2 716	0.25	0.45	0.45	0.25	0.69	0.72	0.1181
2009	456	291	619	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2010	506	894	1 210	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2011	500	908	1 163	0.25	0.45	0.45	0.06	0.73	0.73	0.1405
2012	1 259	1 525	1 129	0.25	0.45	0.45	0.06	0.63	0.67	0.1476
2013	565	1 325	1 145	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2014	772	1 229	1 571	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2015	435	1 691	1 661	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2016	246	743	2 158	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2017	121	523	1 473	0.15	0.33	0.33	0.09	0.71	0.73	0.1001
2018	352	403	638	0.15	0.25	0.25	0.09	0.71	0.73	0.1200
2019	80	507	814	0.15	0.25	0.25	0.09	0.71	0.73	0.0802
2020	124	225	755	0.15	0.25	0.25	0.09	0.71	0.73	0.1001

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 29 % in 2020 and the probability for meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 0 % with an overall attainment of 34 % (Figure 52).

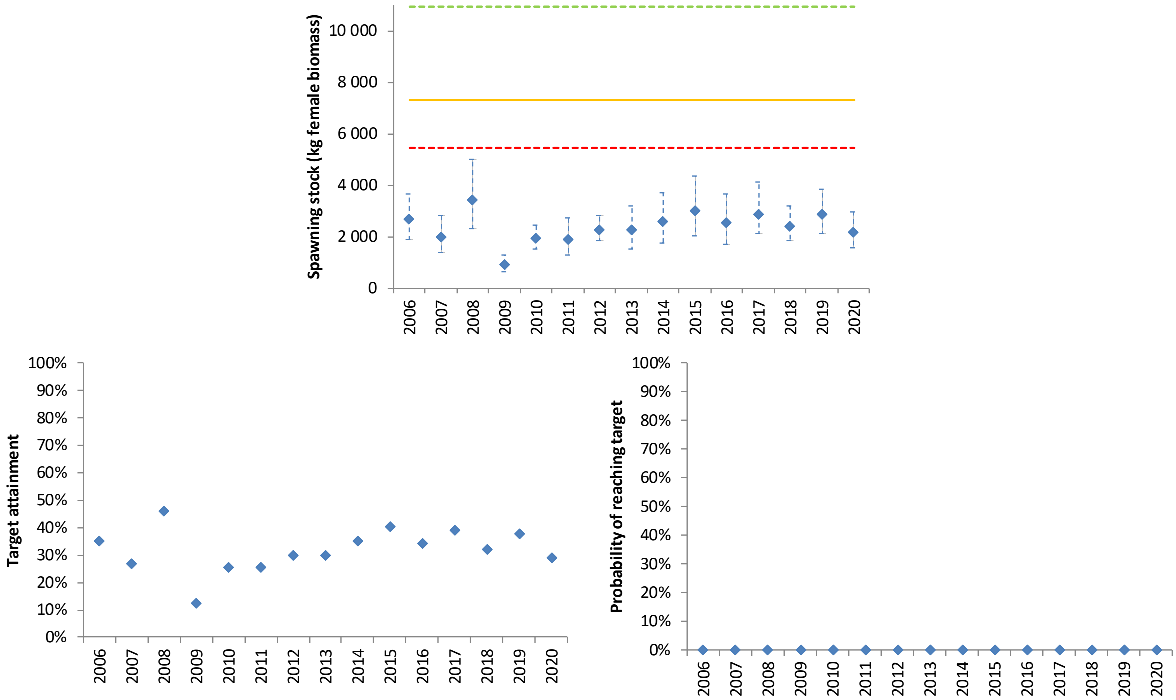


Figure 52. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the Norwegian tributary Kárášjohka.

4.13.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Kárášjohka stock has varied from a maximum of 25 852 kg (2008) down to 9 789 kg (2020) with microsatellites or 8 471 kg with SNPs (2020; Figure 53).

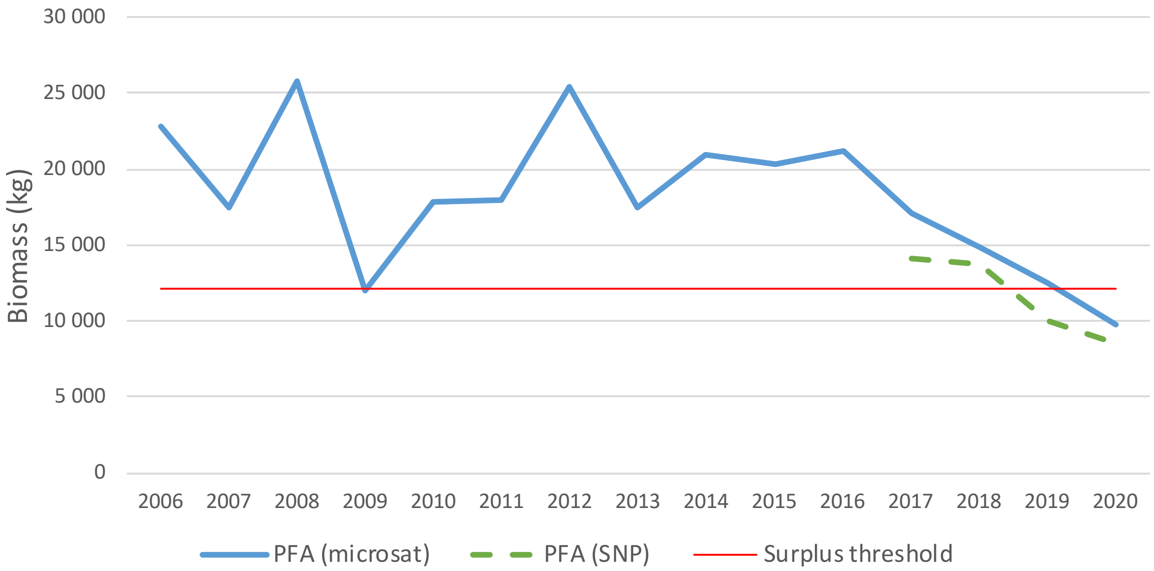


Figure 53. The estimated pre-fishery abundance (PFA) of salmon belonging to the Kárášjohka stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Kárášjohka salmon was 66 % in the years 2017-2020 when estimating with the SNP-based genetic data and 71 % with the old microsatellite average proportions (Figure 54). With the SNP data, 19 % of the pre-fishery abundance was caught in coastal fisheries, while the microsatellite coastal estimate was 18 %. The main stem fisheries proportion was 34 % with the SNPs and 42 % with the microsatellites. The Kárášjohka fisheries proportion was 13 % with the SNPs and 11 % with the microsatellites.

In the period 2017-2020, the average total pre-fishery abundance of Kárášjohka salmon was 11 588 kg and the average total catch was 7 602 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 13 597 kg and 9 621 kg.

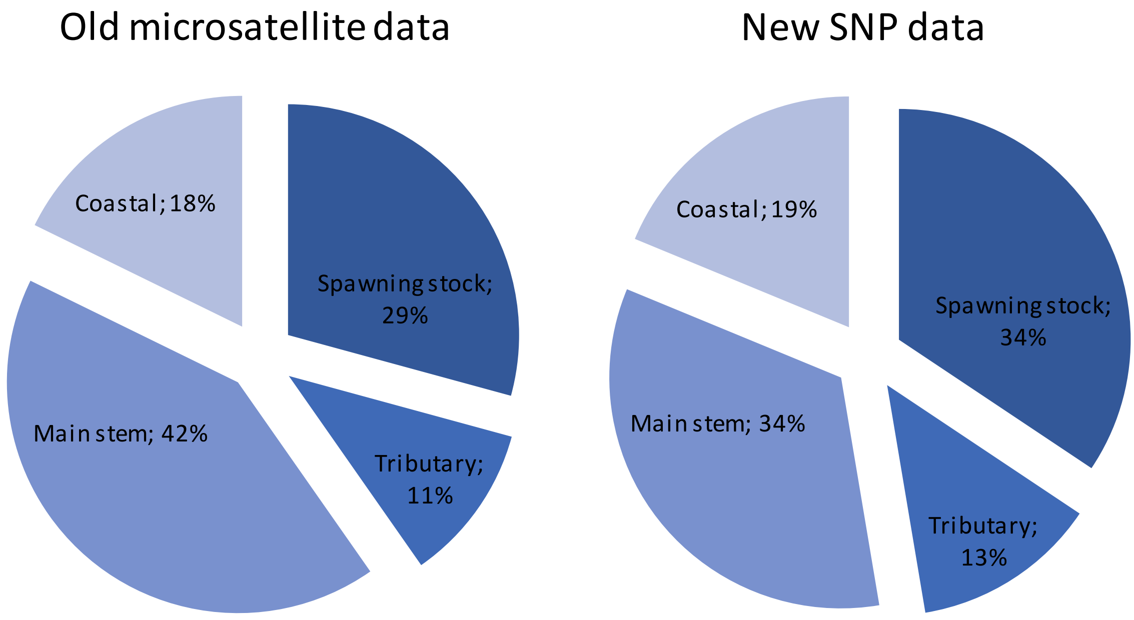


Figure 54. The total amount of salmon belonging to Kárášjohka in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Kárášjohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Since the estimated proportions of Kárášjohka salmon in the main stem mixed stock fishery deviates when comparing the microsatellite and the SNP data while the spawning stock is estimated without using the main stem catch proportion, the estimated catch proportions above differ between genetic methods.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	**2017-2020 (microsat.)**	**2006-2016**
Coastal	19 %	18 %	15 %
Main stem	42 %	51 %	57 %
Tributary	27 %	27 %	44 %
Tributary + main stem	58 %	64 %	76 %

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 2017-2020, estimates of overexploitation based on the SNP data varied between 46 % (2020) and 72 % (2018) with an average of 59 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 59 % below the spawning target). With the microsatellite data, overexploitation varied between 41 % (2020) and 67 % (2018) with an average of 62 %.

With the SNP data, maximum sustainable exploitation varied between 0 % (2018-2020) and 12 % (2018). A maximum exploitation of 0 % indicates no exploitable surplus. The average maximum sustainable total exploitation rate in the period was 3 %, significantly lower than the estimated average total exploitation of 66 %. With the microsatellite data, maximum sustainable exploitation varied between 0 % (2020) and 30 % (2017) with an average of 10 %, significantly lower than the estimated average total exploitation of 71 %.

4.13.3 Stock recovery

Management target attainment of the Kárášjohka stock is at 0 %, well below the 40 % threshold that indicates the need for a recovery plan. In a 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. With the SNP data, the estimated river exploitation of the Kárášjohka stock has been reduced from 76 to 58 %, which corresponds to a 24 % reduction in exploitation. This level of reduction is just enough to allow for stock recovery after two generations. With the microsatellite data, the river exploitation has been reduced from 76 to 64 %, a reduction of 16 %.

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.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Iešjohka stock proportion differs between the previous microsatellite method (9.6 %) and the newer SNP method (8.3 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. The main stem catch proportion is not used in the spawning stock estimate of Iešjohka, but we present catch distribution and stock recovery results based on both genetic methods.

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

In the years 2006-2008, the relative catch in Iešjohka was significantly higher than the catch in upper Kárášjohka, given the indication from their relative proportions in the Tana main stem fisheries remain. This indicates a higher exploitation rate in Iešjohka than Kárášjohka during these three years (Table 29 vs. Table 27). The estimated main stem proportions and the proportional catch in Iešjohka and Kárášjohka were relatively equal in the years 2009-2016. Exploitation rates in Iešjohka were therefore set equal to the Kárášjohka rates in this period.

In 2017, very few fishermen were active in Iešjohka and fishing conditions were severe in the first half of the fishing season. A comparison of the catches in Iešjohka and Kárášjohka indicated a significantly lowered exploitation in Iešjohka in 2017 and the exploitation rates for Iešjohka were set 25 % lower than the Kárášjohka estimates. In 2018, acoustic counting from the neighbouring Kárášjohka indicate continued low exploitation and the exploitation estimate in Iešjohka was set equal to the Kárášjohka rates (Table 29).

The first attempt at counting ascending salmon in Iešjohka were done in 2019. The count of salmon <3 kg in Iešjohka was not sufficiently reliable to estimate an exploitation rate for grilse. The catch indicates a higher exploitation of grilse than the 2017 estimate, and a level of 15 % was chosen (equal to Kárášjohka). The 2019 monitoring indicates an exploitation of 25 % for larger salmon (Table 29).

The Iešjohka run size was estimated with acoustics also in 2020. The catch statistics indicated that large MSW salmon were heavily exploited in 2020 and this was corroborated by the acoustic counts. A direct comparison between the count and catch of salmon >7 kg and treating the count as a minimum number of ascending salmon yields an exploitation estimate of around 85%. We used this as a maximum rate, with 75 % as the modal value and 65 % as the lower limit. The catches of smaller salmon were relatively low, and the exploitation rates for salmon smaller than 7 kg were kept at levels from preceding years (Table 29). A word of caution on the high exploitation estimate for salmon >7 kg in 2020: The estimate is contingent upon several assumptions. The fish counting started late, so the important early run of large salmon had to be estimated. We have based that estimate on data from earlier years (Iešjohka 2019 and Kárášjohka 2018 and 2019) but we might still have underestimated the actual numbers. There are also assumptions made to try to correct for methodological issues with the sonar (issues pertaining to river width coverage and fish size estimation).

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	1 531	1 110	1 573	0.30	0.50	0.50	0.09	0.69	0.64	0.0864
2007	184	749	1 389	0.30	0.50	0.50	0.17	0.77	0.76	0.0777
2008	227	933	2 943	0.30	0.50	0.50	0.18	0.50	0.73	0.0928
2009	329	205	636	0.25	0.45	0.45	0.10	0.66	0.69	0.0963
2010	227	404	782	0.25	0.45	0.45	0.10	0.66	0.69	0.0963
2011	365	456	1 149	0.25	0.45	0.45	0.02	0.61	0.66	0.1104
2012	505	694	1 169	0.25	0.45	0.45	0.12	0.65	0.64	0.1159
2013	240	632	1 330	0.25	0.45	0.45	0.10	0.66	0.69	0.0963
2014	363	700	1 580	0.25	0.45	0.45	0.10	0.66	0.69	0.0963
2015	138	566	1 183	0.25	0.45	0.45	0.10	0.66	0.69	0.0963
2016	112	280	1 423	0.25	0.45	0.45	0.10	0.66	0.69	0.0963
2017	62	204	794	0.11	0.25	0.25	0.10	0.66	0.69	0.0834
2018	287	221	394	0.15	0.25	0.25	0.10	0.66	0.69	0.1000
2019	33	214	435	0.15	0.25	0.25	0.10	0.66	0.69	0.0668
2020	49	112	1 323	0.15	0.25	0.75	0.10	0.66	0.69	0.0834

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 9 % in 2020 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 0 % with an overall attainment of 22 % (Figure 55).

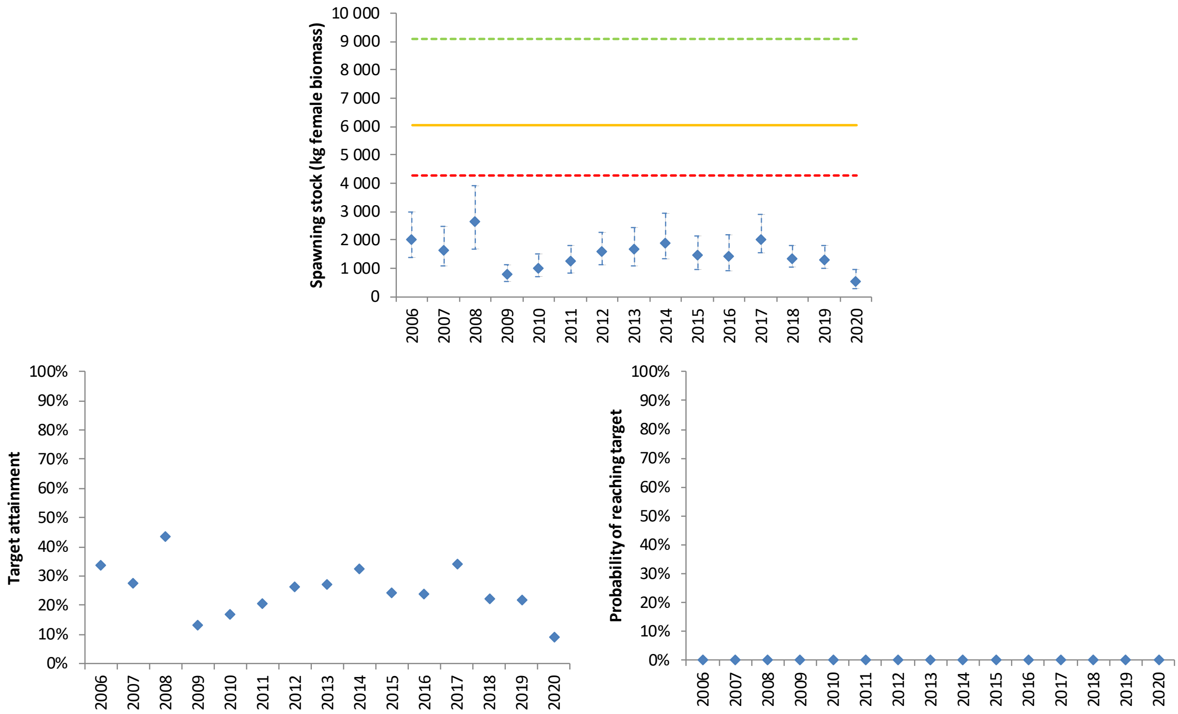


Figure 55. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the Norwegian tributary Iešjohka.

4.14.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Iešjohka stock has varied from a maximum of 21 120 kg (2008) down to 4 754 kg (2020) with microsatellites or 5 215 kg (2020) with SNPs (Figure 56).

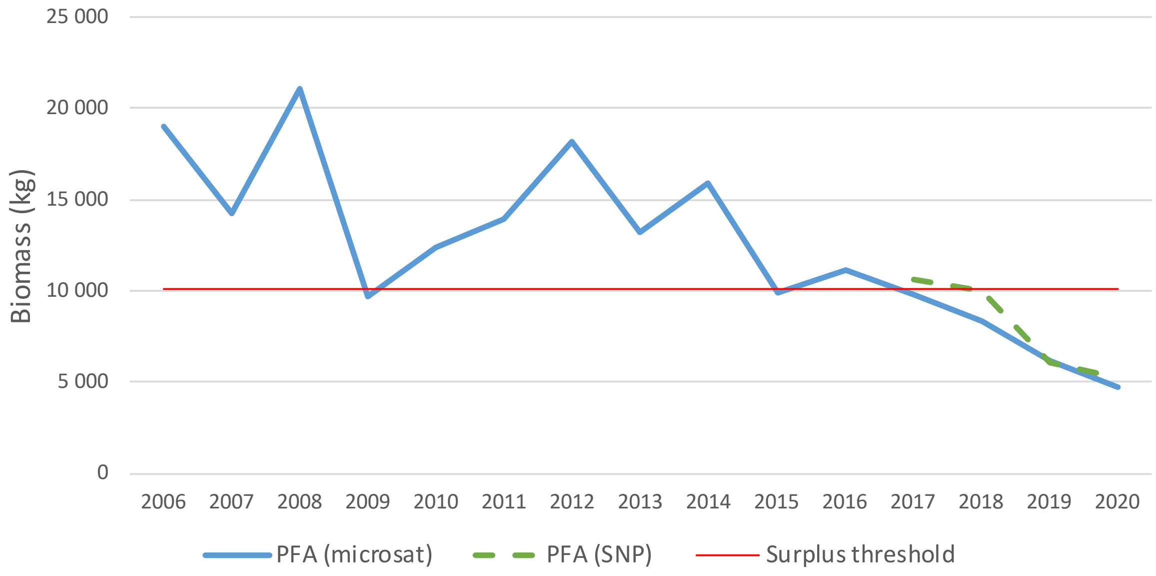


Figure 56. The estimated pre-fishery abundance (PFA) of salmon belonging to the Iešjohka stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Iešjohka salmon was 73 % in the years 2017-2020 when estimating with the SNP-based genetic data and 70 % with the old microsatellite average proportions (Figure 57). The coastal proportion was estimates to 19 % of the pre-fishery abundance with the SNP data and 17 % with the microsatellite data. The main stem fisheries proportion was 41 % with the SNPs and 38 % with the microsatellites. The Iešjohka fisheries proportion was 13 % with SNPs and 14 % with microsatellites.

In the period 2017-2020, the average total pre-fishery abundance of Iešjohka salmon was 7 974 kg and the average total catch was 5 809 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 7 269 kg and 5 071 kg.

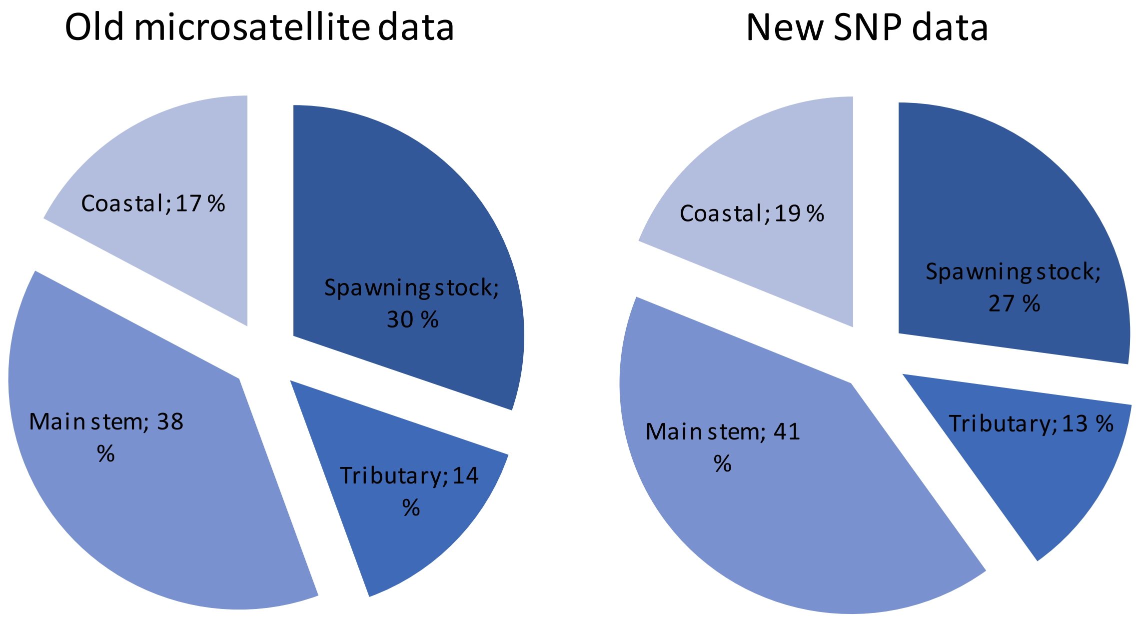


Figure 57. The total amount of salmon belonging to Iešjohka in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Iešjohka fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Since the estimated proportions of Iešjohka salmon in the main stem mixed stock fishery deviates when comparing the microsatellite and the SNP data while the spawning stock is estimated without using the main stem catch proportion, the estimated catch proportions above differ between genetic methods.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	**2017-2020 (microsat.)**	**2006-2016**
Coastal	19 %	17 %	15 %
Main stem	51 %	46 %	60 %
Tributary	32 %	32 %	47 %
Tributary + main stem	67 %	63 %	79 %

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 2017-2020, estimates of overexploitation varied between 43 % (2019) and 67 % (2017) with an average of 55 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 55 % below the spawning target). With the microsatellite data, overexploitation varied between 44 % (2019, 2020) and 71 % (2017) with an average of 51 %.

With the SNP data, maximum sustainable exploitation varied between 0 % (2018-2020) and 2 % (2017). A maximum exploitation of 0 % indicates no exploitable surplus. The average maximum sustainable total exploitation rate in the period was 1 %, significantly lower than the estimated average total exploitation of 73 %. With the microsatellite data, maximum sustainable exploitation was 0 % for all years.

4.14.3 Stock recovery

Management target attainment of the Iešjohka stock is at 0 %, well below the 40 % threshold that indicates the need for a recovery plan. 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. With the SNP data, the estimated river exploitation of the Iešjohka stock has been reduced from 79 to 67 %, which corresponds to a 15 % reduction in exploitation. This level of reduction is not enough to allow for stock recovery after two generations. With the microsatellite data, the river exploitation has been reduced from 76 to 63 %, a reduction of 17 %.

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.

As noted in the introduction to the stock status assessment chapter, we are currently changing the genetic method used in the stock identification. The average Anárjohka/Inarijoki stock proportion differs between the previous microsatellite method (15 %) and the newer SNP method (18 %). There are several possible reasons that might cause this difference, and closer work is needed to further understand the difference. The main stem catch proportion is not used in the spawning stock estimate of Anárjohka/Inarijoki, but we present catch distribution and stock recovery results based on both genetic methods.

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 and 2020, as a combination of difficult fishing conditions, few active fishermen and new regulatory measures aimed at decreasing exploitation likely led to significantly lower exploitation than previous years.

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

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	0.1845
2018	788	0.14	0.51	0.1650
2019	564	0.15	0.62	0.2040
2020	326	0.15	0.58	0.1845

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 13 % in 2020 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2017-2020) overall probability of reaching the spawning target was 0 % with an overall attainment of 24 % (Figure 58).

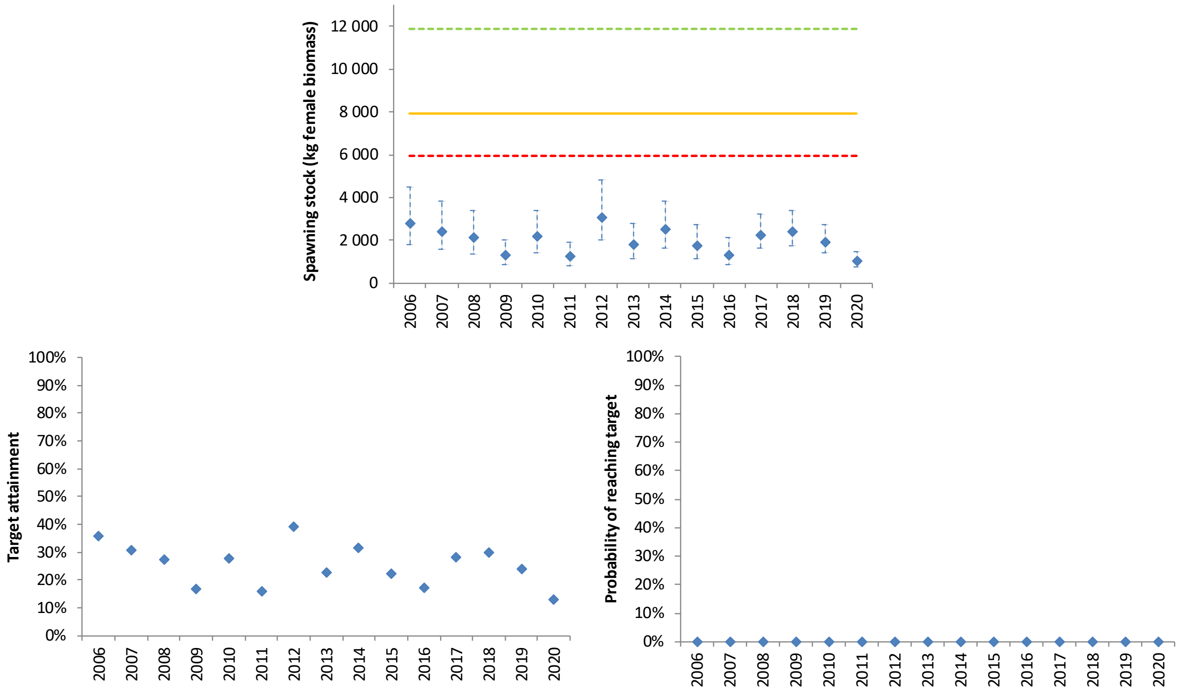


Figure 58. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2020 in the tributary Anárjohka/Inarijoki.

4.15.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the Anárjohka/Inarijoki stock has varied from a maximum of 31 779 kg (2006) down to 7 324 kg (2020) with microsatellites or 8 505 kg (2020) with SNPs (Figure 59).

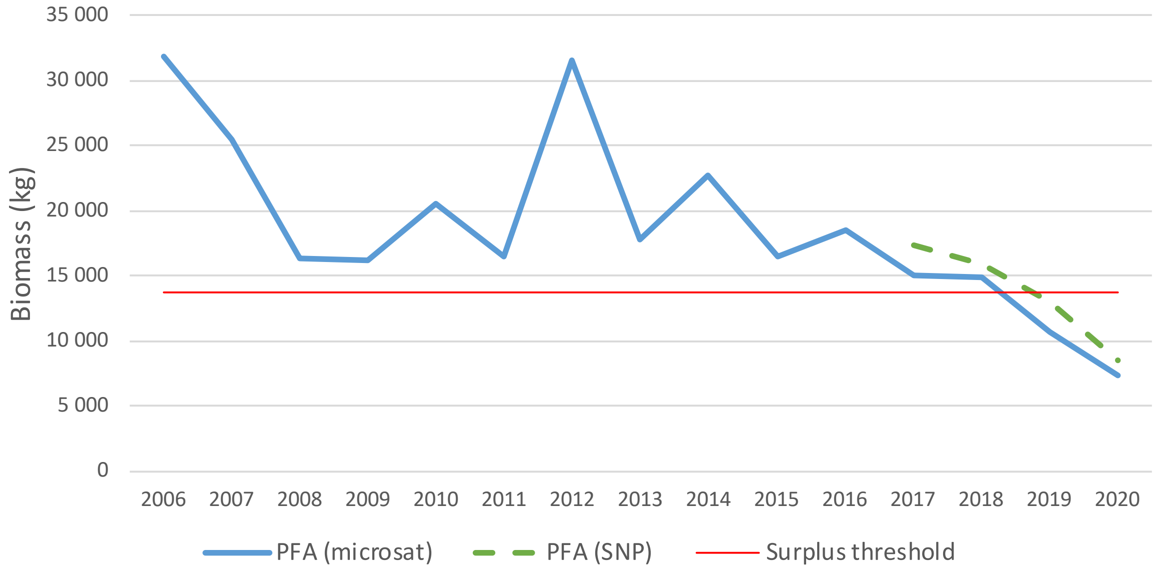


Figure 59. The estimated pre-fishery abundance (PFA) of salmon belonging to the Anárjohka/Inarijoki stock in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Anárjohka/Inarijoki salmon was 76 % in the years 2017-2020 when estimating with the SNP-based genetic data and 72 % with the old microsatellite average proportions (Figure 60). The coastal proportion was estimated to 20 % of the pre-fishery abundance with the SNPs and 19 % with the microsatellites. The Tana/Teno main stem fisheries proportion was 52 % with the SNPs and 49 % with the microsatellites. The Anárjohka/Inarijoki fisheries proportion was 4 % with the SNPs and 5 % with the microsatellites.

In the period 2017-2020, the average total pre-fishery abundance for Anárjohka/Inarijoki salmon was 13 708 kg and the average total catch was 10 425 kg when estimated with the SNP data. Corresponding numbers with microsatellite data were 11 990 kg and 8 683 kg.

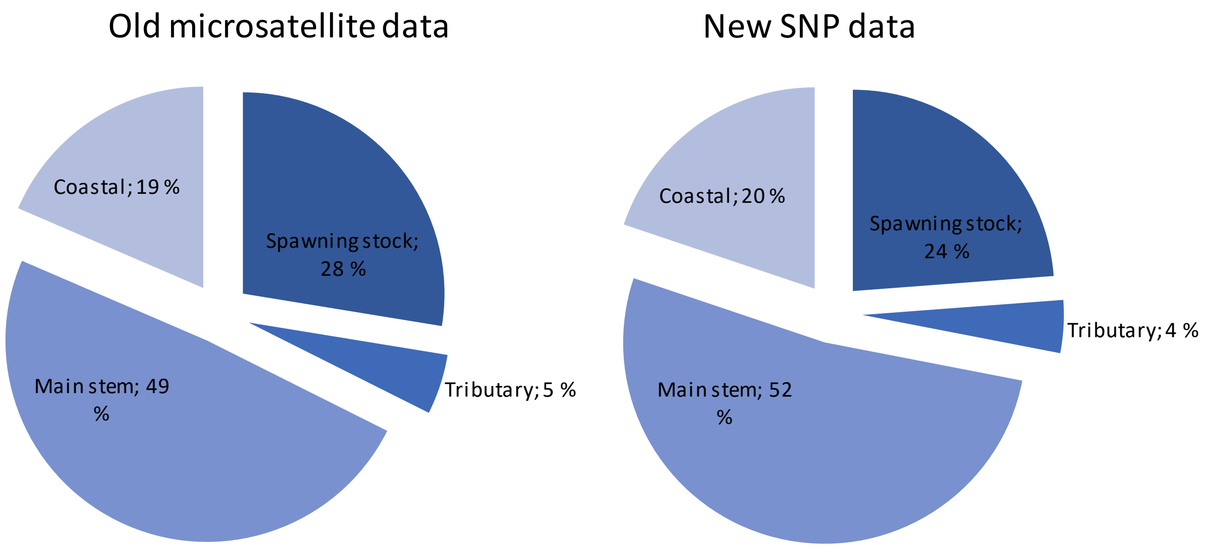


Figure 60. The total amount of salmon belonging to Anárjohka/Inarijoki in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or Anárjohka/Inarijoki fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries. Left: Estimates based on old microsatellite proportions (average of data from 2006-2008 and 2011-2012). Right: Estimates based on new SNP proportions (data from 2018-2019).

Since the estimated proportions of Anárjohka/Inarijoki salmon in the main stem mixed stock fishery deviates when comparing the microsatellite and the SNP data while the spawning stock is estimated without using the main stem catch proportion, the estimated catch proportions above differ between genetic methods.

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 two periods. First two columns are the years 2017-2020, corresponding to the management target-period, estimated with SNP or microsatellite data. Third column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020 (SNP)	2017-2020 (microsat.)	2006-2016
Coastal	20 %	19 %	15 %
Main stem	65 %	60 %	66 %
Tributary	15 %	15 %	41 %
Tributary + main stem	70 %	66 %	80 %

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 2017-2020, estimates of overexploitation based on the SNP data varied between 49 % (2020) and 77 % (2019) with an average of 67 % (meaning that exploitation on average was responsible for reducing the spawning stock size by an amount of 67 % below the spawning target). With the microsatellite data, overexploitation varied between 40 % (2020) and 72 % (2017) with an average of 59 %.

With the SNP data, maximum sustainable exploitation varied between 0 % (2018-2020) and 26 % (2017). 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 76 %. With the microsatellite data, maximum sustainable exploitation varied between 0 % (2018-2020) and 13 % (2017) with an average of 3 %, significantly lower than the estimated average total exploitation of 72 %.

4.15.3 Stock recovery

Management target attainment of the Anárjohka/Inarijoki stock is at 0 %, well below the 40 % threshold that indicates the need for a recovery plan. In an older 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. With the SNP data, the estimated river exploitation of the Anárjohka/Inarijoki stock has been reduced from 80 to 70 %, which corresponds to a 12 % reduction in exploitation. This level of reduction is not sufficiently high to allow for stock recovery after two generations. With the microsatellite data, the river exploitation has been reduced from 80 to 66 %, a reduction of 17 %.

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	0.60	0.49
1994	131 878	0.60	0.63
1995	104 631	0.60	0.49
1996	88 832	0.60	0.51
1997	92 506	0.60	0.43
1998	102 627	0.60	0.46
1999	143 821	0.60	0.44
2000	209 532	0.60	0.50
2001	248 585	0.60	0.55
2002	190 107	0.60	0.56
2003	153 738	0.60	0.58
2004	69 994	0.60	0.59
2005	77 190	0.60	0.52
2006	108 596	0.60	0.42
2007	100 542	0.60	0.67
2008	121 860	0.60	0.64
2009	63 499	0.60	0.50
2010	87 058	0.60	0.56
2011	79 342	0.60	0.54
2012	108 794	0.60	0.46
2013	79 883	0.60	0.56
2014	99 236	0.60	0.49
2015	78 124	0.60	0.60
2016	84 744	0.60	0.58
2017	60 608	0.50	0.62
2018	49 530	0.45	0.50
2019	40 006	0.50	0.58
2020	31 591	0.50	0.59

The spawning target attainment was 36 % in 2020 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years’ (2017-2020) overall probability of reaching the spawning target was 0 % with an overall attainment of 49 % (Figure 61).

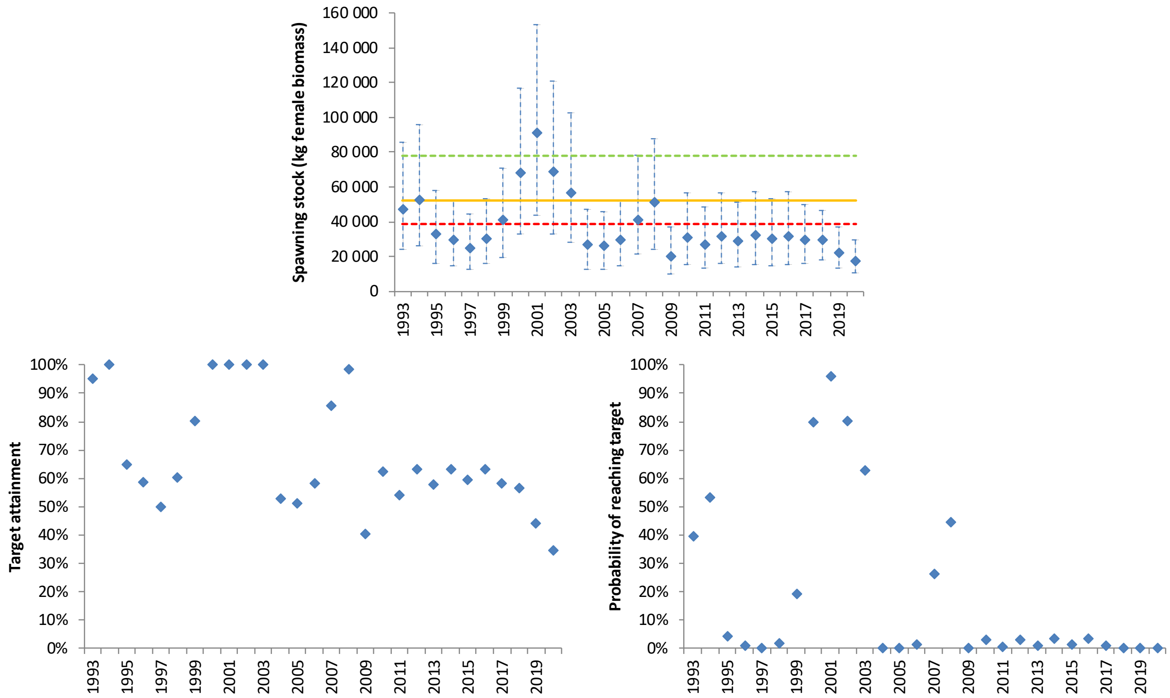


Figure 61. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 1993-2020 for Tana/Teno (total).

4.16.2 Exploitation

The estimated pre-fishery abundance (PFA) of salmon belonging to the entire Tana/Teno river system has varied from a maximum of 230 028 kg (2008) down to 78 178 kg (2020) with microsatellites or 84 279 kg (2020) with SNPs (Figure 62).

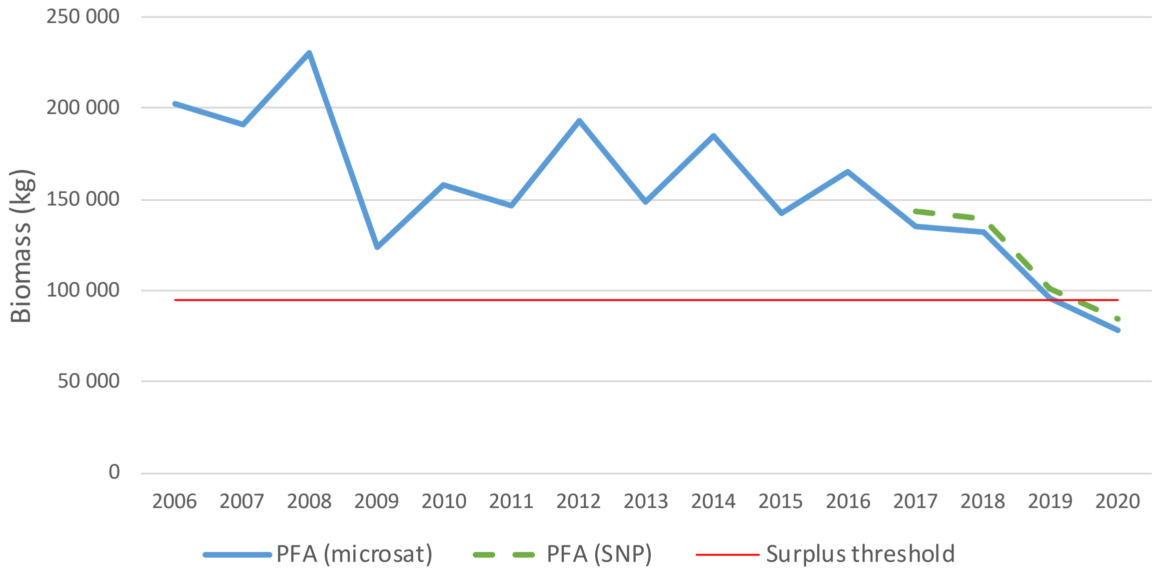


Figure 62. The estimated pre-fishery abundance (PFA) of salmon returning to the entire Tana/Teno river system in the period 2006-2020. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation. Due to the differences between SNPs and microsatellites, PFA has been estimated with both methods in 2017-2020.

The estimated total exploitation rate (based on weight) of Tana/Teno (total) salmon was 60 % in the years 2017-2020 (Figure 63), with 19 % of the pre-fishery abundance caught in coastal fisheries and 40 % in river fisheries. The average estimated total pre-fishery abundance for Tana/Teno salmon was 110 569 kg and the average total catch was 66 478 kg in the period 2017-2020.

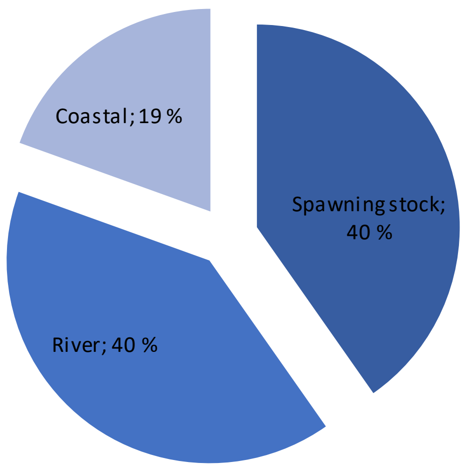


Figure 63. The total amount of salmon belonging to all Tana/Teno stocks in 2017-2020, distributed into surviving spawning stock and salmon caught in fisheries in either coastal or main stem fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to 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 two periods. First column is the years 2017-2020, corresponding to the management target-period. Second column is the years 2006-2016, corresponding to the years with available data before the new agreement.

	2017-2020	2006-2016
Coastal	19 %	16 %
Tana/Teno	50 %	62 %

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 (2017-2020) was poor in 8 of the 15 areas that we evaluated with the SNP-based genetic data (Figure 64). The evaluation based on old microsatellite average proportions was even worse with 10 of 15 areas below the 40 % management target threshold that indicates a need for stock recovery.

Of the stocks with poor status, the most important thing to note is the status of the upper main headwater areas of Kárášjohka, Iešjohka and Anárjohka/Inarijoki and of the Tana/Teno main stem. These areas had low target attainment and low exploitable surplus. These four areas constitute 84 % of the total Tana/Teno spawning target and over the last four years, these areas on average have lacked an annual total of approximately 35 000 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 64) should, following NASCO guidelines, automatically trigger the formulation of a recovery plan for the affected stock. Eight of the 15 evaluated stocks are currently in this situation when estimated with SNPs, while ten of 15 stocks are in the same situation with the old microsatellites. Each recovery plan should contain an analysis of factors negatively affecting a stock and how to lessen the impact of factors identified as negative. We have identified overexploitation as a major factor affecting all stocks needing recovery in Tana (Figure 65) and the exploitation analyses of this report demonstrate a mixed situation with some stocks experiencing sufficient reduction in exploitation following the 2017 agreement to allow for stock recovery within two generations (*c*. 15 years), while the reduction for other stocks unfortunately seems to be insufficient. Examples of the latter are Lákšjohka, Veahčajohka/Vetsijoki, Iešjohka and Anárjohka/Inarijoki.

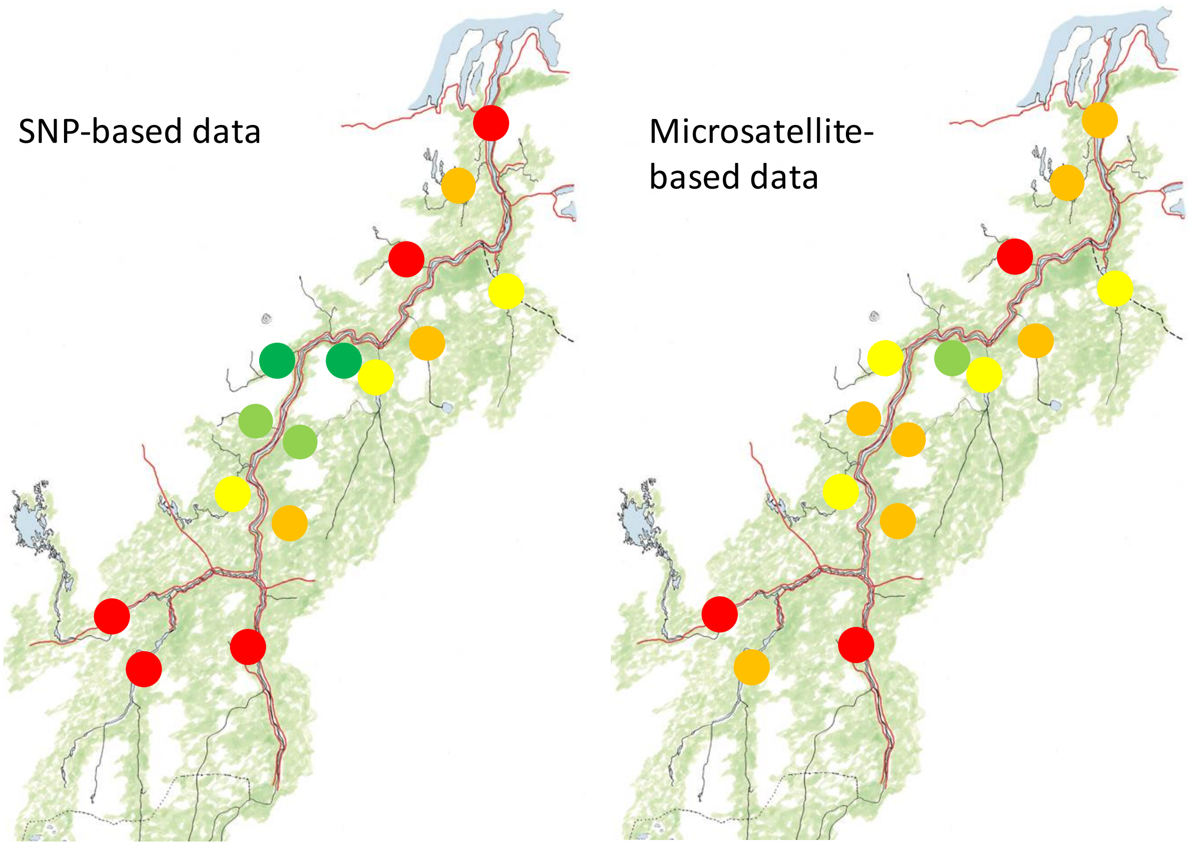


Figure 64. Map summary of the 2017-2020 stock status of the evaluated parts of the Tana/Teno river system. Left: Management target based on new SNP data. Right: Management target based on old microsatellite average proportions. Symbol colour designates stock status over the last four years. Possible 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.

Genetic stock identification is a hugely important part of the Tana/Teno monitoring as it, combined with detailed catch statistics, is our only way of keeping track of the extensive mixed-stock fishery in the main stem. We are currently in a transitional state where a new SNP-based genetic baseline is under construction. This new baseline is expected to be completed in 2021. The old microsatellite-based baseline was used to identify home rivers of mixed-stock samples from 2006-2008 and 2011-2012, and these data are central for our interpretation of the situation in the years before the new agreement (2006-2016). Mixed-stock catch samples from 2018 and 2019 have been analysed with the partly completed SNP baseline, and these results form the main basis for our interpretation of the last four years (2017-2020). However, there are some discrepancies between the SNP-based stock identification and the microsatellite-based, so we have included the assessment for 2017-2020 based on the old microsatellite proportions for comparison.

Currently, there are counter-intuitive results with both genetic methods. For instance, the microsatellite proportion of Ohcejohka/Utsjoki salmon in the main stem catches is disproportionately low considering the run size estimates from the video counts. The pattern for Veahčajohka/Vetsijoki is opposite, showing a disproportionately high SNP proportion compared to other tributaries. And the small Áhkojohka/Akujoki which shows an extremely high proportion with the SNPs and merely a high proportion with the microsatellites. Clearly, there are questions here that needs an answer, and as soon as the new SNP baseline is completed, we will have to invest significant work looking into how and why the two genetic approaches differ.

Estimates of overexploitation in the years 2017-2020 showed a significant effect on the salmon stocks in the upper headwater rivers and the main stem (Figure 65). 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.

To conclude, the situation in different salmon populations of the Tana system in 2020 show an overall negative status with low numbers (in some cases all-time low) of estimated salmon returns and spawning stocks. Based on this, and the overall low returns of 1SW salmon in recent years, the prospects for 2021 salmon run are rather low and therefore the fishing pressure should be kept as low as possible to enable stock recovery.

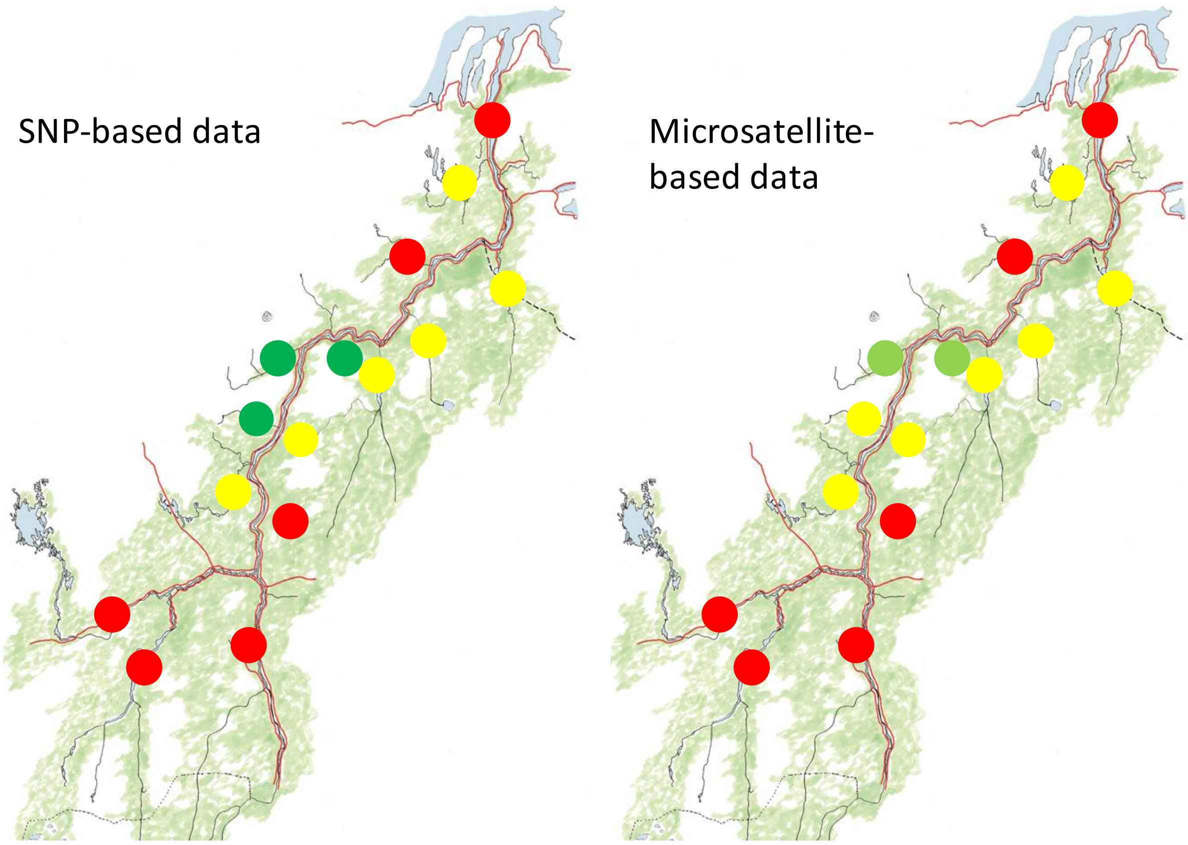


Figure 65. Map summary of the estimated overexploitation experienced in various parts of the Tana/Teno river system in the years 2017-2020. Left: Estimates of overexploitation based on new SNP data. Right: Overexploitation based on old microsatellite average proportions. Symbol colour represents the 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 %).

6 References

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

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

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

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

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

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

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

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

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

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

7 Appendix tables

Appendix 1. Catches (kg) and distribution of catches (%) of Tana/Teno salmon between Norway and Finland for the years 2006-2020. Total catch includes the coastal and river catch of the Tana/Teno salmon.

	Total catch (coast+river), kg		Total catch (coast+river), %		River catch, kg		River catch, %	
Year	Norway	Finland	Norway	Finland	Norway	Finland	Norway	Finland
2006	78361	62930	55 %	45 %	46039	62930	42 %	58 %
2007	85511	56230	60 %	40 %	44312	56230	44 %	56 %
2008	94959	68720	58 %	42 %	52638	68720	43 %	57 %
2009	52033	36540	59 %	41 %	26959	36540	42 %	58 %
2010	65938	47095	58 %	42 %	39963	47095	46 %	54 %
2011	60878	42305	59 %	41 %	37037	42305	47 %	53 %
2012	74019	60075	55 %	45 %	49789	60075	45 %	55 %
2013	59008	43275	58 %	42 %	37228	43275	46 %	54 %
2014	71825	54640	57 %	43 %	45468	54640	45 %	55 %
2015	54042	43135	56 %	44 %	35956	43135	45 %	55 %
2016	67470	48470	58 %	42 %	36841	48470	43 %	57 %
2017	57237	30391	65 %	35 %	30566	30391	50 %	50 %
2018	57240	21663	73 %	27 %	28467	21663	57 %	43 %
2019	39204	19096	67 %	33 %	21018	19096	52 %	48 %
2020	30087	14801	67 %	33 %	16965	14801	53 %	47 %

Apppendix 2. The distribution of catch (kg) between groups of fishermen in Norway and Finland and countries combined in the period 2006-2020.

	Norway			Finland				Norway and Finland combined			
Year	Local with fishing right	Other locals	Tourist	Local with fishing right	Other locals	Tourist	Cabin owners	Local with fishing right	Other locals	Tourist	Cabin owners
2006	28018	12573	5448	28845	4755	29330	0	56863	17328	34778	0
2007	32593	8685	3034	26250	4665	25315	0	58843	13350	28349	0
2008	32982	13430	6226	28065	5125	35530	0	61047	18555	41756	0
2009	16535	6426	3997	14355	3965	18220	0	30890	10391	22217	0
2010	27076	9905	2981	19665	4370	23060	0	46741	14275	26041	0
2011	24011	9763	3264	19080	4350	18875	0	43091	14113	22139	0
2012	36293	9405	4091	25785	5420	28870	0	62078	14825	32961	0
2013	26383	7828	3017	18785	4125	20365	0	45168	11953	23382	0
2014	32825	9254	3389	21700	6875	26065	0	54525	16129	29454	0
2015	24146	8633	3177	17120	5750	20265	0	41266	14383	23442	0
2016	26817	7784	2240	19135	7635	21700	0	45952	15419	23940	0
2017	14153	7973	8440	12016	4202	13188	985	26169	12175	21628	985
2018	18728	4397	5342	11979	2918	6274	492	30707	7315	11616	492
2019	11107	4305	5607	8276	3016	5945	1859	19383	7321	11552	1859
2020	6456	5450	5059	5832	1225	5150	2594	12288	6675	10209	2594

Appendix 3. The distribution of salmon catch (%) between groups of fishermen in Norway and Finland and countries combined in the period 2006-2020.

	Norway			Finland				Norway and Finland combined			
Year	Local with fishing right	Other locals	Tourist	Local with fishing right	Other locals	Tourist	Cabin owners	Local with fishing right	Other locals	Tourist	Cabin owners
2006	61 %	27 %	12 %	46 %	8 %	47 %	0 %	52 %	16 %	32 %	0 %
2007	74 %	20 %	7 %	47 %	8 %	45 %	0 %	59 %	13 %	28 %	0 %
2008	63 %	26 %	12 %	41 %	7 %	52 %	0 %	50 %	15 %	34 %	0 %
2009	61 %	24 %	15 %	39 %	11 %	50 %	0 %	49 %	16 %	35 %	0 %
2010	68 %	25 %	7 %	42 %	9 %	49 %	0 %	54 %	16 %	30 %	0 %
2011	65 %	26 %	9 %	45 %	10 %	45 %	0 %	54 %	18 %	28 %	0 %
2012	73 %	19 %	8 %	43 %	9 %	48 %	0 %	57 %	13 %	30 %	0 %
2013	71 %	21 %	8 %	43 %	10 %	47 %	0 %	56 %	15 %	29 %	0 %
2014	72 %	20 %	7 %	40 %	13 %	48 %	0 %	54 %	16 %	29 %	0 %
2015	67 %	24 %	9 %	40 %	13 %	47 %	0 %	52 %	18 %	30 %	0 %
2016	73 %	21 %	6 %	39 %	16 %	45 %	0 %	54 %	18 %	28 %	0 %
2017	46 %	26 %	28 %	40 %	14 %	43 %	3 %	43 %	20 %	35 %	2 %
2018	66 %	15 %	19 %	55 %	13 %	29 %	2 %	61 %	15 %	23 %	1 %
2019	53 %	20 %	27 %	43 %	16 %	31 %	10 %	48 %	18 %	29 %	5 %
2020	38 %	32 %	30 %	39 %	8 %	35 %	18 %	39 %	21 %	32 %	8 %

Appendix 4. The distribution of salmon catch (kg) between fishing gear in Norway and Finland and countries combined in the period 2006-2020.

	Norway					Finland					Norway and Finland combined				
Year	Driftnet	Weir	Gillnet	Local rod	Other rod	Driftnet	Weir	Gillnet	Local rod	Other rod	Driftnet	Weir	Gillnet	Local rod	Other rod
2006	4494	11116	5430	19522	5448	4110	6030	7940	14870	29330	8604	17146	13370	34392	34778
2007	11061	13863	6651	9685	3034	4895	4320	7445	13475	25315	15956	18183	14096	23160	28349
2008	14990	8265	8444	14713	6226	3415	4110	8325	16650	35530	18405	12375	16769	31363	41756
2009	3354	8039	3059	8510	3997	1455	1975	4250	10030	18220	4809	10014	7309	18540	22217
2010	5821	14529	4638	11986	2981	3445	3085	5045	11670	23060	9266	17614	9683	23656	26041
2011	6186	12429	3783	11374	3264	3160	3155	5965	10460	18875	9346	15584	9748	21834	22139
2012	8418	18861	7231	11188	4091	3330	2925	9110	14970	28870	11748	21786	16341	26158	32961
2013	6424	14226	4461	9099	3017	2930	3415	5625	10010	20365	9354	17641	10086	19109	23382
2014	8415	14481	8638	10545	3389	2000	4215	6445	14330	26065	10415	18696	15083	24875	29454
2015	6811	9584	6579	9805	3177	2360	2540	5230	11150	20265	9171	12124	11809	20955	23442
2016	9999	9997	5391	9214	2240	3265	4045	5530	12915	21700	13264	14042	10921	22129	23940
2017	3910	4128	4340	9748	8440	1101	704	2949	11464	14173	5011	4832	7289	21212	22613
2018	2825	10848	4191	5261	5342	1475	2273	2897	8252	6766	4300	13121	7088	13513	12108
2019	2928	5095	2385	5004	5607	520	1164	2160	7448	7804	3448	6259	4545	12452	13411
2020	1632	1751	2279	6244	5059	281	287	2010	4479	7744	1913	2038	4289	10723	12803

Appendix 5. The distribution of salmon catch (%) between fishing gear in Norway and Finland and countries combined in the period 2006-2020.

	Norway					Finland					Norway and Finland combined				
Year	Driftnet	Weir	Gillnet	Local rod	Other rod	Driftnet	Weir	Gillnet	Local rod	Other rod	Driftnet	Weir	Gillnet	Local rod	Other rod
2006	10 %	24 %	12 %	42 %	12 %	7 %	10 %	13 %	24 %	47 %	8 %	16 %	12 %	32 %	32 %
2007	25 %	31 %	15 %	22 %	7 %	9 %	8 %	13 %	24 %	46 %	16 %	18 %	14 %	23 %	28 %
2008	28 %	16 %	16 %	28 %	12 %	5 %	6 %	12 %	24 %	52 %	15 %	10 %	14 %	26 %	35 %
2009	12 %	30 %	11 %	32 %	15 %	4 %	5 %	12 %	28 %	51 %	8 %	16 %	12 %	29 %	35 %
2010	15 %	36 %	12 %	30 %	7 %	7 %	7 %	11 %	25 %	50 %	11 %	20 %	11 %	27 %	30 %
2011	17 %	34 %	10 %	31 %	9 %	8 %	8 %	14 %	25 %	45 %	12 %	20 %	12 %	28 %	28 %
2012	17 %	38 %	15 %	22 %	8 %	6 %	5 %	15 %	25 %	49 %	11 %	20 %	15 %	24 %	30 %
2013	17 %	38 %	12 %	24 %	8 %	7 %	8 %	13 %	24 %	48 %	12 %	22 %	13 %	24 %	29 %
2014	19 %	32 %	19 %	23 %	7 %	4 %	8 %	12 %	27 %	49 %	11 %	19 %	15 %	25 %	30 %
2015	19 %	27 %	18 %	27 %	9 %	6 %	6 %	13 %	27 %	49 %	12 %	16 %	15 %	27 %	30 %
2016	27 %	27 %	15 %	25 %	6 %	7 %	9 %	12 %	27 %	46 %	16 %	17 %	13 %	26 %	28 %
2017	13 %	14 %	14 %	32 %	28 %	4 %	2 %	10 %	38 %	47 %	8 %	8 %	12 %	35 %	37 %
2018	10 %	38 %	15 %	18 %	19 %	7 %	10 %	13 %	38 %	31 %	9 %	26 %	14 %	27 %	24 %
2019	14 %	24 %	11 %	24 %	27 %	3 %	6 %	11 %	39 %	41 %	9 %	16 %	11 %	31 %	33 %
2020	10 %	10 %	13 %	37 %	30 %	2 %	2 %	14 %	30 %	52 %	6 %	6 %	14 %	34 %	40 %

Appendix 6. Salmon catch (kg) of different fishermen groups in different fishing zones in the Tana/Teno-Anarjohka/Inarijoki main stem on the Finnish side in 2017-2020.

Fisherman group	**Fishing zone**	**2017**	**2018**	**2019**	**2020**
Tourist fisherman (rod)	Inarijoki	74	83	66	42
Tourist fisherman (rod)	Outakoski area	2409	1305	1341	772
Tourist fisherman (rod)	Utsjoki area	3047	1460	1217	1102
Tourist fisherman (rod)	Vetsikko area	4835	1850	1750	1983
Tourist fisherman (rod)	Nuorgam area	2824	1576	1571	1253
Tourist fisherman TOTAL		13189	6274	5945	5151
Cabin owner (rod)	Inarijoki	5	2	6	0
Cabin owner (rod)	Outakoski area	262	103	249	303
Cabin owner (rod)	Utsjoki area	251	143	603	995
Cabin owner (rod)	Vetsikko area	369	168	743	722
Cabin owner (rod)	Nuorgam area	97	68	258	574
Cabin owner (rod) TOTAL		985	485	1859	2593
Local fisherman (net and rod)	Inarijoki	442	523	333	195
Local fisherman (net and rod)	Outakoski area	2829	3406	2244	2230
Local fisherman (net and rod)	Utsjoki area	3244	2435	1800	940
Local fisherman (net and rod)	Vetsikko area	3112	2137	1547	814
Local fisherman (net and rod)	Nuorgam area	3990	2996	2804	1473
Local fisherman TOTAL		13616	11496	8728	5653
In total		**27790**	**18255**	**16532**	**13397**

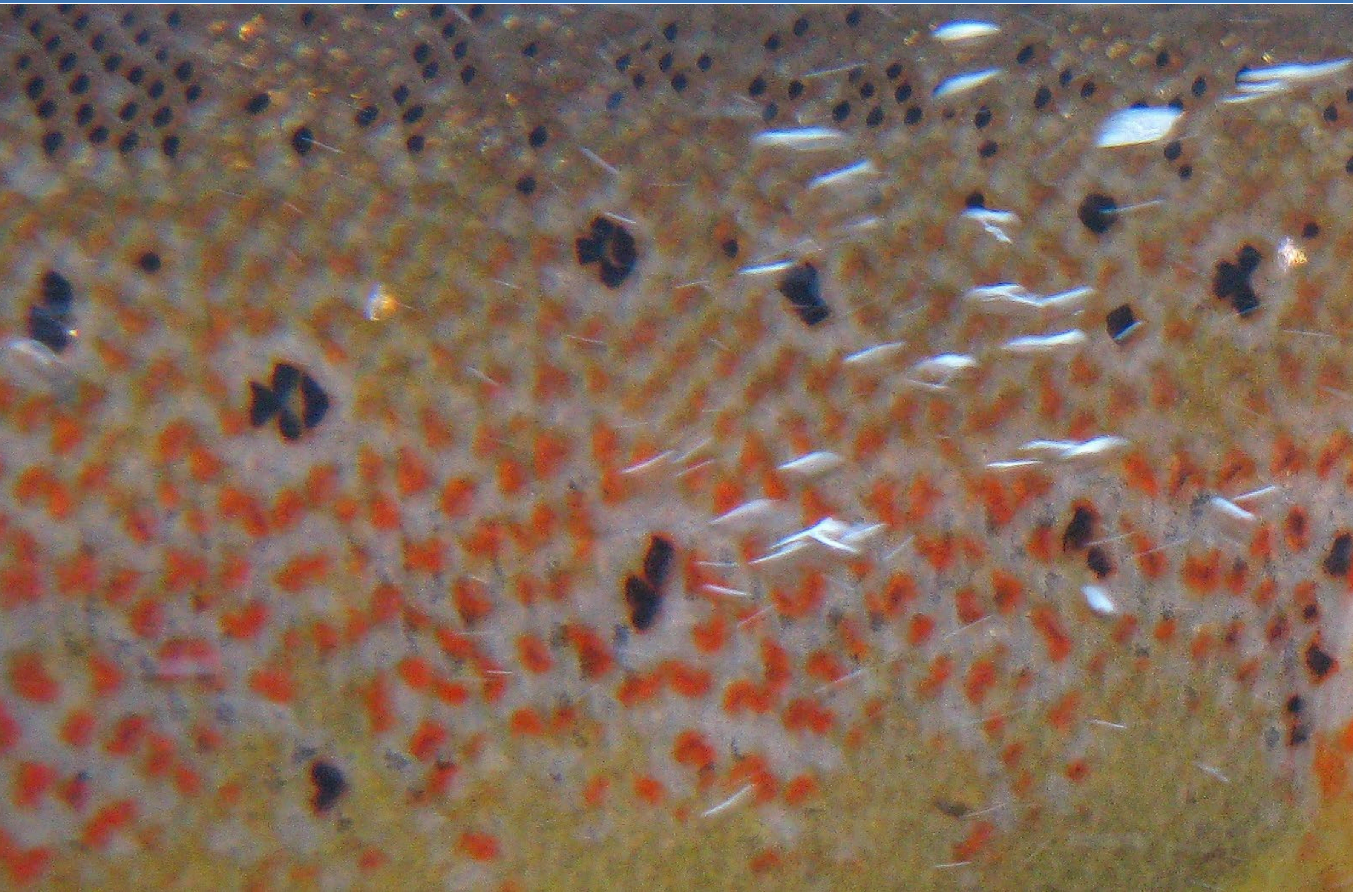
Appendix 7. Salmon catch (kg) of different fishermen groups in different fishing zones in the Tana/Teno-Anarjohka/Inarijoki main stem on the Norwegian side in 2017-2020.

Fisherman group	**Fishing zone**	**2017**	**2018**	**2019**	**2020**
Tourist fisherman (rod)	Tana estuary - Tana bru	0	172	74	99
Tourist fisherman (rod)	Tana bru - Nuorgam	647	375	257	149
Tourist fisherman (rod)	Nuorgam - Borsejohka	580	3651	3847	3762
Tourist fisherman (rod)	Tana above Borsejohka	37	417	570	560
Tourist fisherman TOTAL		1264	4614	4748	4570
Local fisherman (rod)	Tana estuary - Tana bru	1389	940	726	379
Local fisherman (rod)	Tana bru - Nuorgam	3727	1782	1659	2092
Local fisherman (rod)	Nuorgam - Borsejohka	1338	277	563	924
Local fisherman (rod)	Tana above Borsejohka	88	23	36	271
Local fisherman (rod) TOTAL		6543	3022	2984	3666
Local fisherman (net)	Tana estuary - Tana bru	5163	7497	4509	2260
Local fisherman (net)	Tana bru - Nuorgam	3636	5084	2914	1264
Local fisherman (net)	Nuorgam - Borsejohka	2496	3636	2345	1542
Local fisherman (net)	Tana above Borsejohka	604	618	260	280
Local fisherman (net) TOTAL		11899	16836	10028	5347
In total		**19706**	**24472**	**17759**	**13583**

Appendix 8. Salmon catch (kg) in 15 tributaries of Tana/Teno in 2013-2020. Line indicates missing data.

Tributary	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Mean**
Máskejohka	979	1496	1318	1538	1151	856	709	529	1072
Buolbmátjohka/Pulmankijoki	890	1090	630	665	348	854	435	148	633
Lákšjohka	184	99	133	154	61	64	113	35	105
Veahčajohka/Vetsijoki	375	1020	885	755	406	603	545	368	620
Ohcejohka/Utsjoki	1695	2955	2150	2085	1904	1924	1558	885	1895
Goahppelašjohka/Kuoppilasjoki	-	-	-	-	-	19	27	2	16
Leavvajohka	5	8	8	0	0	0	0	0	3
Báišjohka	-	-	-	-	0	5	0	0	1
Njiljohka/Nilijoki	0	0	0	0	0	0	0	0	0
Váljohka	171	200	155	89	89	37	67	38	106
Áhkojohka/Akujoki	0	0	0	0	0	0	0	0	0
Kárášjohka	3321	4123	4342	3545	2354	1615	1634	1337	2784
Iešjohka	1915	2092	1333	1417	823	680	487	1250	1250
Anárjohka/Inarijoki (FIN+NOR)	1930	2776	1829	1615	626	789	520	289	1297
Goššjohka	48	56	53	39	17	19	45	36	39
In total	**11513**	**15915**	**12836**	**11902**	**7779**	**7465**	**6140**	**4917**	**9819**

Tana Monitoring and Research Group



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

ISSN: 2535-4701
ISBN: 978-82-93716-06-8