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Revised first-generation spawning targets for the Tana/Teno river system

Morten Falkegård, Anders Foldvik, Peder Fiske, Jaakko Erkinaro, Panu Orell, Eero Niemelä, Jorma Kuusela, Anders Gravbrøt Finstad, Kjetil Hindar

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Revised first-generation spawning targets for the Tana/Teno river system

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COVER PICTURE
Salmon spawning in Njiljohka/Nilijoki. Photo: Panu Orell, RKTL

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Abstract

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

The use of management targets as a tool to ensure that salmon fisheries are sustainable is a core part of modern salmon fisheries management. A management target provides us with a benchmark telling us how many salmon has to spawn in a particular river so that this river fulfills its production potential in the future. In Norway, first-generation management targets in the form of spawning targets were established in 2007. In this report, we use the experience gathered from using and evaluating these spawning targets in the years since 2007 to revise the Tana/Teno spawning targets. The main goal was to establish revised spawning targets for all tributaries, both Norwegian and Finnish, and make sure that all targets were obtained in a manner consistent with the assumptions of the first-generation spawning target model

The following table provides a summary of the current revised spawning targets in the Tana/Teno river system:

River	Original target (eggs)	Revised target (eggs)	Female biomass (kg) w/fixed fecundity	Female biomass (kg) w/stock-specific fecundity
Tana/Teno main stem	38 120 000	41 049 886	22 805	22 189
Máskejohka	4 276 950	3 155 148	1 753	1 521
Luovtejohka	-	-	-	-
Buolbmátjohka/Pulmankijoki	-	1 329 133	738	511
Lákšjohka	2 981 460	2 969 946	1 650	1 165
Veahčajohka/Vetsijoki	-	2 505 400	1 392	1 101
Ohcejohka/Utsjoki	3 600 000	4 979 107	2 766	2 059
Goahppelašjohka/Kuoppilasjoki	-	695 950	387	273
Borsejohka	-	0	0	0
Leavvajohka	502 680	499 203	277	208
Nuvvosjohka/Nuvvusjoki	-	0	0	0
Báišjohka	-	948 688	527	395
Njiljohka/Nilijoki	-	519 520	289	221
Váljohka	618 090	1 907 595	1 060	779
Áhkojohka/Akujoki	-	282 532	157	126
Lower Kárášjohka	20 702 040	2 013 178	1 118	1 046
Upper Kárášjohka		10 037 498	5 576	5 214
Geaimmejohka		250 824	139	105
Bávttajohka		1 735 823	964	926
Iešjohka	10 351 220	11 536 009	6 408	6 072
Anárjohka/Inarijoki	16 600 000	11 283 952	6 269	5 071
Gáregasjohka/Karigasjoki		598 000	332	239
Iškorasjohka		213 000	118	99
Goššjohka		5 206 840	2 892	2 340
Skiehččanjohka/Kietsimäjoki		398 160	221	187
Tana/Teno (total)	**98 560 570**	**104 274 286**	**57 930**	**51 846**

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Sammendrag

Falkegård, M., Foldvik, A., Fiske, P., Erkinaro, J., Orell, P., Niemelä, E., Kuusela, J., Finstad, A.G. & Hindar, K. 2014. Reviderte førstegenerasjons gytebestandsmål for Tanavassdraget. – NINA Rapport 1087. 68 s.

Forvaltningsmål har blitt et viktig verktøy i lakseforvaltningen for å sikre et bærekraftig fiske etter laks. Forvaltningsmålene gir oss et referansepunkt for hvor mange laks som må gyte i hver elv for å sikre at de ulike elvene oppfyller sine produksjonspotensialer i fremtiden. Et førstegenerasjons forvaltningsmål kalt gytebestandsmål ble etablert i Norge i 2007. I denne rapporten bruker vi erfaringene med å vurdere å evaluere disse gytebestandsmålene i årene siden 2007 til å revidere gytebestandsmålene i Tanavassdraget. Hovedformålet er å etablere reviderte førstegenerasjons gytebestandsmål for alle sideelvene i vassdraget, både norske og finske, og sikre at disse målene beregnes på en konsistent måte i samsvar med antagelsene i modellen for førstegenerasjon gytebestandsmål.

Følgende tabell oppsummerer de reviderte gytebestandsmålene for Tanavassdraget:

Elv	Opprinnelig mål (egg)	Revidert mål (egg)	Vekt hunnlaks (kg) m/fast fekunditet	Vekt hunnlaks (kg) m/bestand-spesifikk fekunditet
Tana (hovedelva)	38 120 000	41 049 886	22 805	22 189
Máskejohka	4 276 950	3 155 148	1 753	1 521
Luovtejohka	-	-	-	-
Buolbmátjohka/Pulmankijoki	-	1 329 133	738	511
Lákšjohka	2 981 460	2 969 946	1 650	1 165
Veahčajohka/Vetsijoki	-	2 505 400	1 392	1 101
Ohcejohka/Utsjoki	3 600 000	4 979 107	2 766	2 059
Goahppelašjohka/Kuoppilasjoki	-	695 950	387	273
Borsejohka	-	0	0	0
Leavvajohka	502 680	499 203	277	208
Nuvvosjohka/Nuvvusjoki	-	0	0	0
Báišjohka	-	948 688	527	395
Njiljohka/Nilijoki	-	519 520	289	221
Váljohka	618 090	1 907 595	1 060	779
Áhkojohka/Akujoki	-	282 532	157	126
Nedre Kárášjohka	20 702 040	2 013 178	1 118	1 046
Øvre Kárášjohka		10 037 498	5 576	5 214
Geaimmejohka		250 824	139	105
Bávttajohka		1 735 823	964	926
Iešjohka	10 351 220	11 536 009	6 408	6 072
Anárjohka/Inarijoki	16 600 000	11 283 952	6 269	5 071
Gáregasjohka/Karigasjoki		598 000	332	239
Iškorasjohka		213 000	118	99
Goššjohka		5 206 840	2 892	2 340
Skiehččanjohka/Kietsimäjoki		398 160	221	187
Tana (totalt)	**98 560 570**	**104 274 286**	**57 930**	**51 846**

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Tiivistelmä

Falkegård, M., Foldvik, A., Fiske, P., Erkinaro, J., Orell, P., Niemelä, E., Kuusela, J., Finstad, A.G. & Hindar, K. 2014. Täydennetyt ensimmäisen vaiheen kutukantatavoitteet lohelle Tenojoen vesistössä. – NINA Report 1087. 68 s.

Nykyaikaisessa lohikantojen hoidossa määritellään kutukantojen tavoitetasot, joiden avulla kalastus mitoitetaan kestävälle tasolle. Tavoitetaso kuvaa jokeen tarvittavaa kutukannan kokoa, joka hyödyntää joen poikastuotantokyvyn täysimääräisesti. Norjassa on kehitetty vuodesta 2007 alkaen lohijoille ensimmäisen vaiheen tavoitetasoja, eli kutukantatavoitteita. Tässä raportissa täydennetään aiempia Tenon vesistölle asetettuja kutukantatavoitteita ja määritellään uusia tavoitteita sivujoille, joilla sellaisia ei aiemmin ole ollut. Raportti esittelee ensimmäisen vaiheen kutukantatavoitteet Tenon pääuomalle ja kaikille tärkeimmille Tenon sivujoille sekä Norjan että Suomen puolella.

Seuraavassa taulukossa esitetäään yhteenveto uudistetuista kutukantatavoitteista Tenojoen vesistössä:

Joki	Alkuperäinen tavoite (mätimunia)	Päivitetty tavoite (mätimunia)	Naaraiden biomassa (kg)/yleis-fekunditeetti	Naaraiden biomassa (kg) /kantakohtainen fekunditeetti
Teno pääuoma	38 120 000	41 049 886	22 805	22 189
Máskejohka	4 276 950	3 155 148	1 753	1 521
Luovtejohka	-	-	-	-
Buolbmátjohka/Pulmankijoki	-	1 329 133	738	511
Lákšjohka	2 981 460	2 969 946	1 650	1 165
Veahčajohka/Vetsijoki	-	2 505 400	1 392	1 101
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Nuvvosjohka/Nuvvusjoki	-	0	0	0
Báišjohka	-	948 688	527	395
Njiljohka/Nilijoki	-	519 520	289	221
Váljohka	618 090	1 907 595	1 060	779
Áhkojohka/Akujoki	-	282 532	157	126
Ala-Kárášjohka	20 702 040 (Ala-Kárášjohka, Ylä-Kárášjohka, Geaimmejohka, Bávttajohka yhteensä)	2 013 178	1 118	1 046
Ylä-Kárášjohka		10 037 498	5 576	5 214
Geaimmejohka		250 824	139	105
Bávttajohka		1 735 823	964	926
Iešjohka	10 351 220	11 536 009	6 408	6 072
Anárjohka/Inarijoki	16 600 000 (Anárjohka/Inarijoki, Gáregasjohka/Karigasjoki, Iškorasjohka, Goššjohka, Skiehččanjohka/Kietsimäjoki yhteensä)	11 283 952	6 269	5 071
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Goššjohka		5 206 840	2 892	2 340
Skiehččanjohka/Kietsimäjoki		398 160	221	187
Tana/Teno (yhteensä)	**98 560 570**	**104 274 286**	**57 930**	**51 846**

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Contents

Foreword

Biological reference points, in the form of conservation limits and management targets have become a fundamental part of modern knowledge-based salmon fisheries management. A first-generation model for estimating conservation limits for Atlantic salmon in Norway was published in 2007. These first-generation targets, called spawning targets, were also estimated for some selected stocks in the Tana/Teno river system.

In the years after 2007, both the Norwegian Scientific Advisory Committee for Atlantic Salmon Management and the Norwegian-Finnish Working Group on Salmon Monitoring and Research in the Tana/Teno River System have used the first-generation targets to assess salmon stock status in the Tana/Teno river system. Based on these experiences it became clear that some additional work was needed. Some stocks were not assigned a spawning target in 2007, while targets for other stocks could benefit from the application of more detailed local knowledge. Because of this, a new project was initiated in late 2012 with the goal of revising the first-generation spawning targets in Tana/Teno.

The project was funded by the Norwegian Environment Agency. The GIS-based work has been done by Anders Finstad, Anders Foldvik, Panu Orell and Jorma Kuusela. Local river habitat quality and potential salmon production assessments have been done within the project group based on extensive local knowledge of the different parts of the Tana/Teno river system.

Tromsø/Trondheim/Oulu, November 2014

Morten Falkegård

1 Introduction

The paramount objective of salmon management in the Tana/Teno river system is to create the foundation for a rich, sustainable fishery after salmon both today and in the future. The fishery is sustainable only when salmon stocks produce an annual surplus, and when the fishery is regulated in a way that ensures that only this surplus is exploited.

How can this be evaluated? How do we know that we are not catching too many salmon, and how do we know that each salmon stock is producing an exploitable surplus? We need a management benchmark that can be used for this purpose. The most natural benchmark is a target telling us how many salmon has to spawn in a particular river so that this river can fulfil its production potential.

Every salmon river has an upper production limit, e.g. expressed as a maximum number of salmon smolt that can be produced every year. This upper limit is caused by a number of factors. The size and length of the river are two important factors. For instance, the production potential will be relatively small in a big river where a waterfall stops the salmon migration after only a few kilometres, compared with a similarly sized river without any waterfalls and tens of kilometres available for salmon migration.

The number of spawning places is also important. The salmon needs a specific habitat type for spawning, and access to such locations can be limited. An example of such a limitation within the Tana/Teno river system can be found in the tributary Lákšjohka in which there are very few possible spawning grounds in the lowermost kilometres (from the river mouth up to a waterfall with a fish ladder). Within this area, the river is dominated by fast-flowing areas and big stones, while the salmon needs more varied and smaller-sized gravel and more slow-flowing water for spawning. In comparison, the tributary Máskejohka has a much richer supply of possible spawning areas in its main stem.

Also of importance is the availability of areas suitable for juvenile salmon. Extensive areas of the Tana/Teno main stem are slow-flowing with sandy bottom. This is low-quality areas for juvenile salmon, which prefer a more varied bottom with an ample supply of interstitial spaces that can be used for hiding. For this reason, most juvenile salmon in the Tana/Teno main stem are found in and around the riffle areas where the water velocity is higher and the substratum is coarser and more varied.

In summary, the river size and length available for salmon migration, number of spawning grounds and availability of suitable juvenile areas are the main factors deciding the production potential of a salmon river. The number of salmon eggs that are spawned each year then determines to what extent this capacity is utilized.

A simplified illustration of this relationship is shown in **Figure 1**. There are too few spawning salmon in the leftmost part of **Figure 1**, resulting in a limited number of eggs and low smolt production. There is an increasing number of spawning salmon as we move towards the right in **Figure 1**, resulting in increasing numbers of eggs, higher densities of juvenile salmon and higher smolt production. As the juvenile density increases, juvenile mortality will also increase due to density dependent competition for food and/or space in the river. This mechanism causes the flattening of the curve towards an upper asymptote. This asymptote represents the smolt production limit of the river, i.e. the maximum number of smolts that a river can produce.

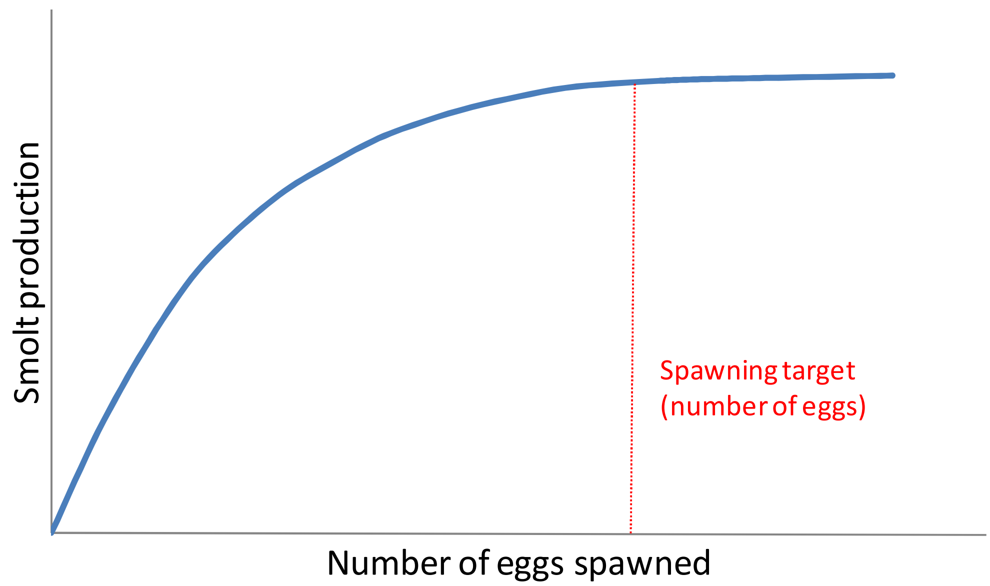

Figure 1. *Simplified relationship between number of eggs spawned and number of smolts produced for a salmon stock.*

The spawning target is the number of eggs at which the smolt production line starts to flatten. In other words, the spawning target is the number of eggs that are needed for the river to produce its maximum number of smolts.

First-generation spawning targets for stocks in the Tana river system were established by Hindar *et al*. (2007). These targets covered only a few major tributaries, most of which were Norwegian, and limited access to Finnish mapping data made it necessary to obtain area estimates from other sources. In this report, we used the experience gathered from actively using and evaluating spawning targets in most Norwegian salmon rivers in the years since 2007 to revise and refine the Tana spawning targets. The main goal was to establish spawning targets for all Tana tributaries, both Norwegian and Finnish, and make sure that all targets are estimated in a consistent manner.

Meanwhile, work on second-generation spawning targets based on objective habitat characteristics for each river is also moving forward. This is, however, a longer process going on into the future and we will still have to wait for some time before this process produces usable second-generation targets.

2 Methods

A thorough discussion of the methods underlying the first-generation spawning targets is given in Hindar *et al*. (2007), and therefore we only provide a brief summary of the methods in this report.

The simplified relationship shown in **Figure 1** is an example of what we call a stock-recruitment relationship, which is the number of recruits (smolts) produced at different stock sizes (number of spawners or eggs). This relationship is unique for each salmon river, and ideally we would want to base our spawning target estimates for different parts of the Tana/Teno river system on stock-recruitment curves obtained specifically for each area. Constructing good stock-recruitment relationships require, however, careful data collection over several years, and this kind of data is therefore available only for a selected few salmon rivers elsewhere in Norway.

One way of circumventing a lack of stock-recruitment data is to establish a method of transferring information from data-rich rivers (i.e. rivers with stock-recruitment data) to data-poor rivers (i.e. rivers lacking stock-recruitment data). A procedure for this was established as part of the first-generation spawning targets. This procedure was based on the establishment of four egg density categories. These categories correspond to the variation observed in data from nine Norwegian salmon rivers with known stock-recruitment relationships.

The four egg density categories were defined as follows:

- **1 egg m^{-2}** (0.5-1.5 eggs m^{-2}). These are unproductive rivers with a low catch of salmon per area unit. A large proportion of the area has a poor habitat quality for juvenile production and/or spawning.
- **2 eggs m^{-2}** (1.5-3 eggs m^{-2}). These are medium productive rivers with a varied habitat quality for juvenile production and spawning.
- **4 eggs m^{-2}** (3-5 eggs m^{-2}). A large proportion of the area in these rivers is good habitat for juvenile production and spawning. The catch per unit river area is relatively high.
- **6 eggs m^{-2}** (>5 eggs m^{-2}). These are highly productive rivers with very good habitat quality.

To be able to use the above four categories, a standardized method of calculating the wetted area of the salmon-producing stretch was also needed. In the first-generation spawning target procedure, it was determined that this area most suitably could be estimated in a GIS-based approach using digital geographic data from the N50 map series (scale 1:50 000). There are lakes present in the salmon-producing parts of many tributaries. When included, the salmon-producing area of these lakes was estimated as either 5-m or 10-m shoreline buffer. The inclusion of lake area in specific areas is noted in the text for different parts of the Tana river system.

Setting a first-generation spawning target for a river thereby involved two steps:

1) Calculate the wetted area using the standardized GIS-approach
2) Assign the river (or parts of the river) to one of the four egg density categories

The assignment of a river to a particular egg density category is a subjective process relying heavily on local knowledge about river characteristics (extent of spawning areas and juvenile production areas) and river history (e.g. catch development).

The spawning target obtained with the above approach is the total number of spawned eggs needed to fulfil the production potential of a river. However, total number of eggs is an awkward target for management purposes and it is far more practical to convert the total number of eggs into the female biomass needed at spawning to produce the target number of eggs. To obtain this female biomass, an estimated number of eggs kg^{-1} female must be employed. In the original work of Hindar *et al*. (2007), a fixed relative fecundity of 1 800 eggs kg^{-1} female was used to convert between total number of eggs and female biomass. This fixed level of 1 800 eggs kg^{-1} corresponds to the fecundity ratio obtained from a regression (forced through the origo) of fecundity and weight from a dataset of salmon caught in the Tana main stem and Utsjoki in the years 1982-1991 (Diserud *et al*. in prep.).

There is a potential problem of using a fixed average number of eggs kg^{-1} for all populations, regardless of size composition. Published salmon fecundity numbers indicate that there is a strong size-component in relative fecundity, with small-sized salmon having a higher number of eggs kg^{-1} than large-sized salmon. This pattern of highest relative fecundity for small females is commonly seen for salmonids (Fleming 1996) and the fecundity values found in Tana correspond well to relative fecundities found in other rivers and areas, e.g. Ims (Jonsson *et al*. 1996), Varzuga in Russia (Lysenko 1997) and Canada (O'Connell *et al*. 2008).

Heinimaa & Heinimaa (2004) and Diserud *et al*. (in prep.) both demonstrate this size-effect, and the consequence is that the different sea-age groups in Tana differ in their relative fecundities. The relationship between size and fecundity in Tana can be described by the following model from Diserud *et al*. (in prep.):

$$\ln Fecundity = 8.05 + 0.737 \times \ln Mass$$

We can then, based on the above model, obtain stock- and sea-age-specific fecundity ratio (eggs kg^{-1}) by using stock-specific sea-age composition data and stock-specific sea-age based average weights.

At first glance, the different fecundities seen for different sea-age groups might be taken as an argument for using stock-specific size compositions when selecting the relative fecundities for each stock. However, there is an important counterpoint to this argument. Employing relative fecundity values based on average size composition numbers effectively removes one important precautionary safety barrier from the spawning target estimate, where the actual egg deposition would depend heavily on annually varying size distributions. In years dominated by large multi-sea-winter salmon, we could end up with too low egg deposits, and vice versa in years dominated by grilse (one-sea-winter salmon).

In the context of a precautionary approach, this latter perspective is important, and we therefore chose to report both the biomass-based target in terms of a fixed fecundity of 1 800 eggs kg^{-1} and in terms of a stock-specific relative fecundity based on sea-age composition. Stock-specific sea-age compositions (in percentages based on biomass) were estimated from two sources: (1) genetically stock-identified salmon caught in the Tana main stem in 2006-2008, and (2) tributary-specific catch samples pooled from the years 1972-2012.

3 Revised spawning targets

3.1 Tana/Teno main stem

The Tana/Teno main stem starts with the confluence of Kárášjohka and Anárjohka/Inarijoki, from which it flows 211 km in a northern direction towards the Tana fjord. The main stem is mostly slow-flowing with sandy bottom, with an occasional interspersed riffle area with coarser substratum. Approximately 72 % of the total area of the main stem is sandy areas; the remaining 28 % are riffle areas. Most riffle areas are located in the lower middle part of the main stem (between Storfossen/Alaköngäs and Levajok).

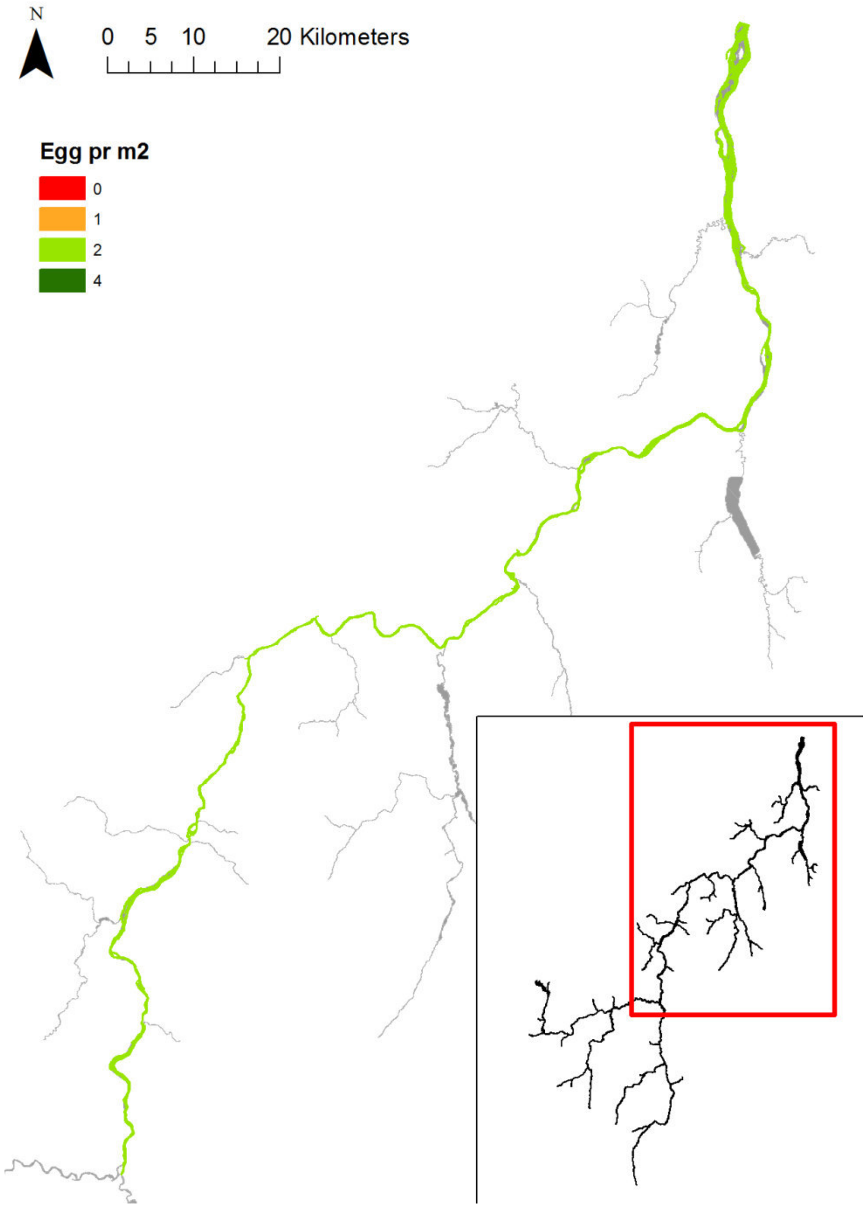

***Figure 2**. Map of the Tana/Teno main stem (marked as green). The green colour merely illustrates the extent of the main stem, and does not signify a specific egg density category as seen in later maps.*

The total area of the main stem is 58 366 688 m^2 (marked as green in **Figure 2**). Of this total area, 16 320 300 m^2 are riffle areas and classified as productive, while the remaining areas are slow-flowing and sandy, unsuitable for spawning and juvenile production and therefore classified as unproductive. However, some fringe parts of these sandy areas are assumed to be used by salmon, so 10 % of the sandy bottom area is added to the productive area. Total productive area then becomes 20 524 943 m^2 (**Table 1**). The productive areas are assigned an egg density of 2 eggs m^{-2}.

The area classification is based upon local knowledge and expert judgment. However, more documentation on what areas are actually suitable as spawning and rearing areas could likely further improve the spawning target assessment. This work is currently in progress.

***Table 1**. Summary table of Tana/Teno main stem area and spawning target calculations.*

Area with 0 eggs m^{-2}	0
Area with 1 egg m^{-2}	0
Area with 2 eggs m^{-2}	20 524 943
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	**41 049 886**
Lower limit (eggs)	30 787 415
Upper limit (eggs)	61 574 829
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**22 805**
Lower limit (kg)	17 104
Upper limit (kg)	34 208
Mean size females (kg)	7
Spawning target (number of females)	**3 258**
Target estimates based on a stock-/sea-age-specific fecundity of 1 850 eggs kg^{-1} (5 % 1SW, 20 % 2SW, 75 % 3SW+):	
Spawning target (female biomass kg)	**22 189**
Lower limit (kg)	16 642
Upper limit (kg)	33 284
Mean size females (kg)	7
Spawning target (number of females)	**3 170**

The revised spawning target for the Tana main stem is 41 049 886 eggs, a significant increase from the original target of 38 120 000 (Hindar *et al*. 2007). This change is caused by a different area estimate. The standardized GIS approach could not be used to estimate the area of the Tana main stem back in 2007 due to a lack of sufficient mapping material for the border area. Instead, the original target in 2007 had to be based on a rough area estimate of 19 060 000 m^2 (after Niemelä *et al*. 1999).

In terms of female biomass, the spawning target became 22 805 kg with a fixed relative fecundity of 1 800 eggs kg^{-1}, up from 21 178 kg in Hindar *et al*. (2007). The sea-age composition of female salmon in the Tana main stem is dominated by large females (74 % of the biomass is 3SW and older), and this corresponds to a stock-/sea-age-specific fecundity of 1 850 eggs kg^{-1} and a female biomass of 22 189 kg.

3.2 Máskejohka

This is the lowermost tributary of the Tana, approximately 26 km upstream of the Tana estuary. The starting point of Máskejohka itself is Máskejávri, and there are two main tributaries: Ciikojohka, which flows into Máskejávri from the south, and Geasis (and its tributary Uvjalátnjá), which enters Máskeluobbal from the west.

Máskejohka itself is 31 km long. The starting point is Máskejávri, further downstream is another lake, Máskeluobbal, and both lakes could be used by juvenile salmon and are therefore included in the production area with a 10 m shoreline buffer. No juvenile salmon were found in a survey in 2013, indicating that the lakes are currently not contributing. The upper part of Máskejohka (dark green area in **Figure 3**) has very good habitat both for spawning and juvenile production while the lower part (red area in **Figure 3**) is a meandering, slow-flowing deep channel with only a few production areas. The area of upper Máskejohka was assigned an egg density category of 4 eggs m^{-2}. 75 % of the area of lower Máskejohka was deemed non-productive and set to 0 eggs m^{-2}, while the remaining 25 % was set to 4 eggs m^{-2} (**Table 2**).

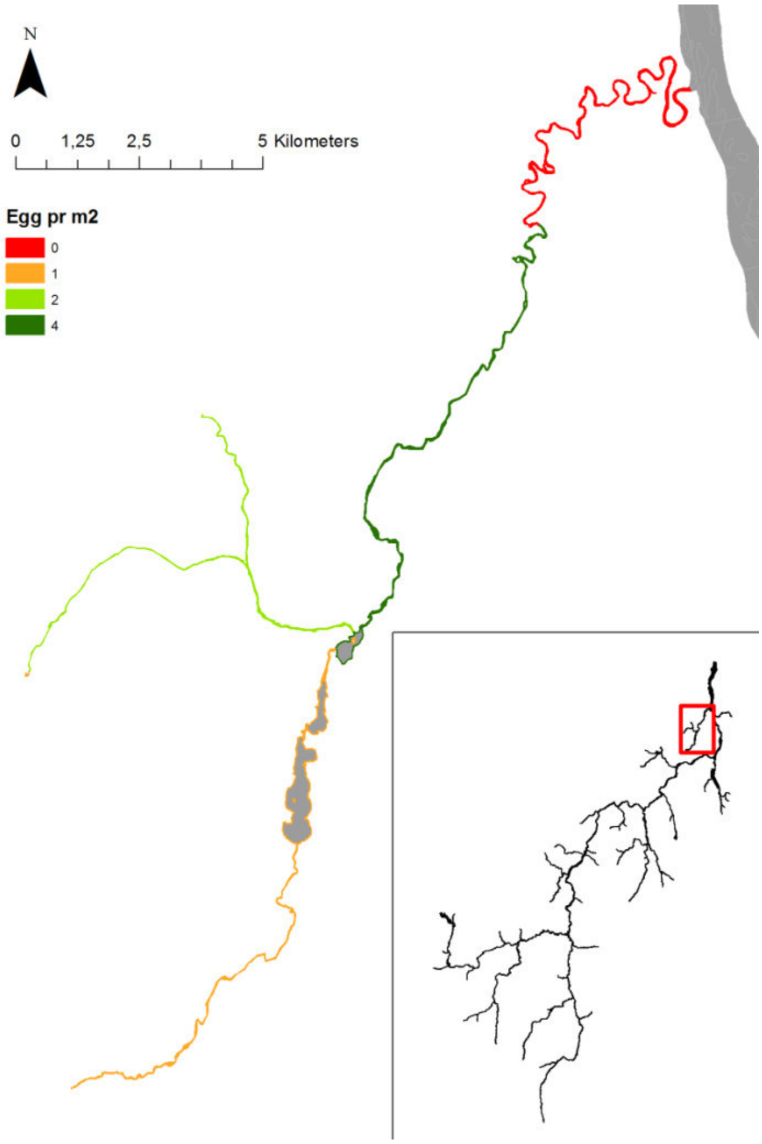

Figure 3. *Map of Máskejohka with different egg category areas marked with colours. Red = 0 eggs m^{-2}, orange = 1 egg m^{-2}, light green = 2 eggs m^{-2} and dark green = 4 eggs m^{-2}.*

Ciikojohka is a small tributary flowing south to north into Máskejávri. There is a waterfall 11 km above Máskejávri that is considered the upper limit of salmon distribution in this river (we have no data indicating whether this waterfall is an absolute migration stop for salmon). The lower part of Ciikojohka is slow-flowing with few production areas, but the habitat improves in the upper part. However, there is a substantial proportion of unfavourable habitat so an egg density of 1 egg m^{-2} was used for this tributary.

Geasis is a middle-sized river entering Máskeluobbal from the west. There are three waterfalls in Geasis. The first is 6.9 km upstream from Máskeluobbal, and is a relatively small and smooth drop that salmon are able to pass. The next, 1.4 km further up, is a more complex waterfall that has been considered an absolute migration stop. However, recent electrofishing data demonstrate juvenile salmon also above this waterfall, indicating that some salmon are able to pass the second waterfall when conditions are favourable. The third waterfall is a narrow canyon located 1 km further up. No juveniles were found above the third waterfall, and this is therefore considered the upper limit of salmon distribution in the area calculation. Geasis is a fast-flowing river with relatively coarse substratum. There is an abundance of good habitat for juvenile production, but likely a scarcity of spawning habitat. For this reason, an egg density of 2 eggs m^{-2} is used for Geasis.

Uvjalátnjá is a small river entering Geasis from the west 3 km upstream of Máskeluobbal. The habitat quality of this tributary is relatively similar to Geasis, and the same egg density of 2 eggs m^{-2} is therefore used. Total length of Uvjalátnjá is 6.7 km, and a marked waterfall forms the upper limit. We have no information about the possibilities for salmon to pass this waterfall.

Table 2. *Summary table of Máskejohka area and spawning target calculations.*

	Máskejohka (total)	Máskejohka (main)	Geasis & Uvjalátnjá	Máskejávri & Ciikojohka
Area with 0 eggs m^{-2}	378 488	378 488	0	0
Area with 1 egg m^{-2}	339 118	0	0	339 118
Area with 2 eggs m^{-2}	241 742	0	241 742	0
Area with 4 eggs m^{-2}	583 137	583 137	0	0
Spawning target (number of eggs)	**3 155 148**	**2 332 548**	**483 484**	**339 118**
Lower limit (eggs)	2 281 583	1 749 411	362 613	169 559
Upper limit (eggs)	4 149 588	2 915 685	725 226	508 677
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:				
Spawning target (female biomass kg)	**1 753**	**1 296**	**269**	**188**
Lower limit (kg)	1 268	972	201	94
Upper limit (kg)	2 305	1 620	403	283
Mean size females (kg)	4	4	4	4
Spawning target (number of females)	**438**	**324**	**67**	**47**
Target estimates based on a stock-/sea-age-specific fecundity of 2 075 eggs kg^{-1} (10 % 1SW, 63 % 2SW, 27 % 3SW+):				
Spawning target (female biomass kg)	**1 521**	**1 124**	**233**	**163**
Lower limit (kg)	1 100	843	175	82
Upper limit (kg)	2 000	1 405	350	245
Mean size females (kg)	4	4	4	4
Spawning target (number of females)	**380**	**281**	**58**	**41**

The revised spawning target for Máskejohka becomes 3 155 148 eggs, which is a substantial decrease from the original estimate of 4 276 950 eggs (Hindar *et al*. 2007). One major attribute of the Máskejohka river system is the differing habitat conditions with contrasting production potentials. In 2007, these differences were tackled by subtracting 25 % from the total area and then using an egg density of 4 eggs m^{-2} for the remaining area. In the current revision, we have strived to treat the differing areas separately. While the Máskejohka main stem has large areas of very good habitat both for spawning and juveniles (except the lowermost slow-flowing area), the salmon face limitations in the upper tributaries. Therefore we divided the system into parts with different egg densities.

When converting eggs to female biomass, the spawning target becomes 1 753 kg when using a fixed fecundity of 1 800 eggs kg^{-1}. The original 2007-target was 2 376 kg. The female sea-age composition of Máskejohka is dominated by 2SW-salmon (75 % of the biomass) with some 3SW+ (19 %) and very few 1SW (6 %). This translates into a stock-specific relative fecundity of 2 100 eggs kg^{-1}. With this average fecundity level, the female biomass needed to produce the necessary number of eggs becomes 1 502 kg.

3.3 Luovtejohka

Luovtejohka is the first tributary on the eastern side of the Tana/Teno, situated approximately 32 km upstream of the Tana/Teno estuary. This is a slow-flowing river with just a few riffle areas suitable for juvenile production and spawning. There is a waterfall approximately 10 km upstream that forms a barrier for salmonid upstream migration. A fish ladder was built in this waterfall in the early 1980s, but due to a complete lack of maintenance the ladder is no longer functioning.

Juvenile salmon were found below the waterfall in electrofishing surveys in 1986, 2000-2002, 2007 and 2013. In the 2000-2002 surveys, juveniles were found both below and above the waterfall, and in these years all age classes, including 0+, were found. No juvenile salmon were observed above the waterfall in 2007 and 2013, indicating that the fish ladder has been completely non-functional for a number of years now.

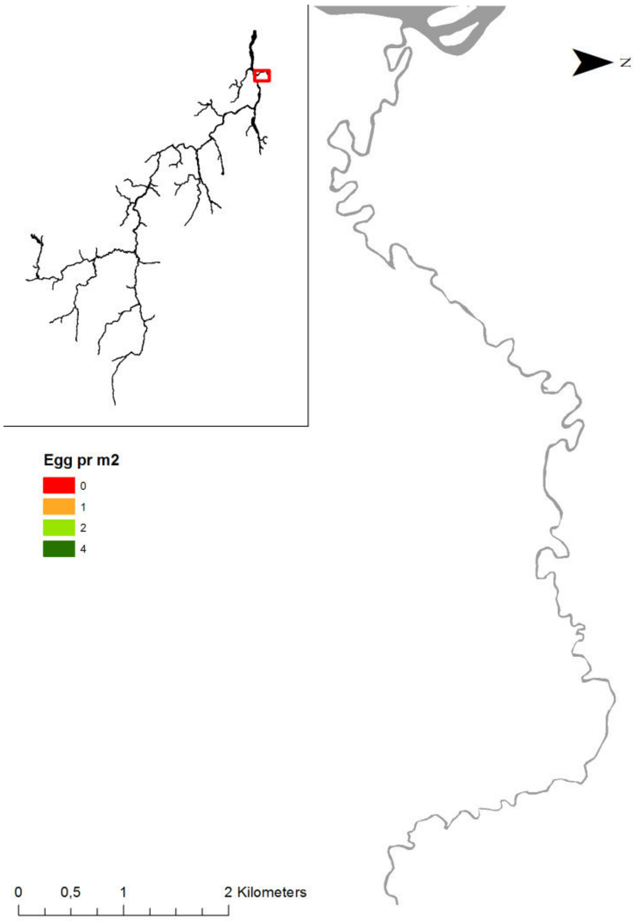

***Figure 4**. Map of the Luovtejohka river.*

Genetic data show that the juveniles found in Luovtejohka are closely related to Tana main stem salmon spawning in the Tana bru area. This indicates that adult salmon spawning in Luovtejohka could be strays from the nearby main stem population.

No spawning target has been set for Luovtejohka in this revision. There is only a small area suitable for juvenile production in the river, and accordingly also a very small production potential. The presence of juveniles and, in some years, also 0+ points towards a potential for contribution that should be quantified as part of the coming second generation spawning targets.

3.4 Buolbmátjohka/Pulmankijoki

Buolbmátjohka/Pulmankijoki is located c. 55 km upstream of the Tana estuary and has a catchment area of 754 km^2. A large lake (Buolbmátjávri/Pulmankijärvi) is situated within the lower middle reaches of the system. The border between Norway and Finland runs through the lake, leaving the northernmost quarter 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 (**Figure 5**).

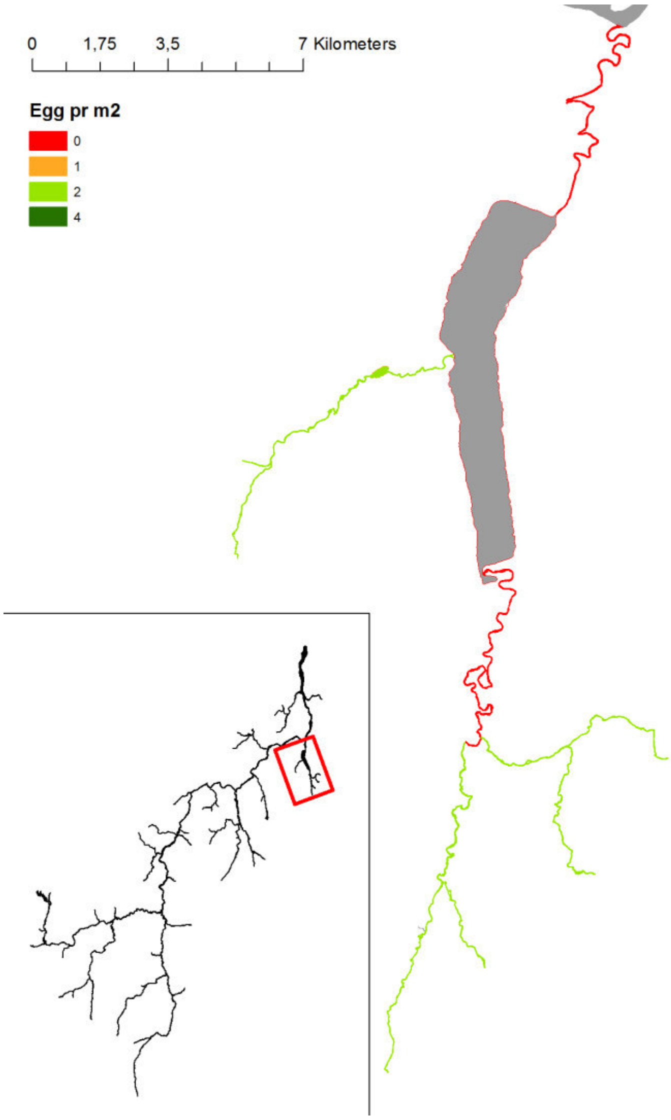

***Figure 5**. Map of the Buolbmátjohka/Pulmankijoki river system. Red = 0 eggs m^{-2}, orange = 1 egg m^{-2}, light green = 2 eggs m^{-2} and green = 4 eggs m^{-2}.*

Buolbmátjohka/Pulmankijoki (outlet, below lake). The outlet river is almost 10 km long and still-flowing, meandering slowly from the lake down to the Tana main stem. The substratum consists mainly of clay and silt, and there are no spawning areas. An egg density of 0 eggs m^{-2} was therefore assigned to the outlet river.

Ylä-Pulmankijoki (inlet). The upper part of Pulmankijoki enters the lake in its southern side. All fishing is prohibited in the river, but effective gillnet fisheries are operated in the Lake Pulmankijärvi. The lowermost part of Ylä-Pulmankijoki shares the characteristics of the outlet river, meandering slowly with no spawning areas available for salmon. The habitat is better in the upper parts, including the small tributaries Luossajohka and Morešveaijohka entering Ylä-Pulmankijoki from the east. Total river length available in these two smaller tributaries is around 15 km, while Ylä-Pulmankijoki is around 29 km long. An egg density of 0 eggs m^{-2} was assigned to the lower slow-flowing part, while 2 eggs m^{-2} was used for the remaining areas.

Gàlddašjohka/Kalddasjoki is a small river (catchment area 120 km^2) entering the Pulmankijärvi on its western side. Fishing is partly prohibited in this river. River length available for salmon is around 13 km, with reasonably good habitat quality for juvenile production and spawning. An egg density of 2 eggs m^{-2} was assigned to the entire area of Kalddasjoki.

The spawning target of Buolbmátjohka/Pulmankijoki was set to 1 329 133 eggs (**Table 3**). No spawning target has been estimated for this tributary earlier.

***Table 3**. Summary table of the Buolbmátjohka/Pulmankijoki river system and spawning target calculations.*

	Buolbmát-johka/ Pulmanki-joki (total)	**Lower part (below lake)**	**Upper part (above lake), incl. lake**	**Kalddas-joki**
Area with 0 eggs m^{-2}	507 747	272 164	235 583	0
Area with 1 egg m^{-2}	0	0	0	0
Area with 2 eggs m^{-2}	664 566	0	521 601	142 965
Area with 4 eggs m^{-2}	0	0	0	0
Spawning target (number of eggs)	**1 329 133**	**0**	**1 043 203**	**285 930**
Lower limit (eggs)	996 849	0	782 402	214 448
Upper limit (eggs)	1 993 698	0	1 564 803	428 895
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:				
Spawning target (female biomass kg)	**738**	**0**	**580**	**159**
Lower limit (kg)	554	0	435	119
Upper limit (kg)	1 108	0	869	238
Mean size females (kg)	2	2	2	2
Spawning target (number of females)	**369**	**0**	**290**	**79**
Target estimates based on a stock-/sea-age-specific fecundity of 2 600 eggs kg^{-1} (36 % 1SW, 54 % 2SW, 10 % 3SW+):				
Spawning target (female biomass kg)	**511**	**0**	**401**	**110**
Lower limit (kg)	383	0	301	82
Upper limit (kg)	767	0	602	165
Mean size females (kg)	2	2	2	2
Spawning target (number of females)	**256**	**0**	**201**	**55**

In terms of female biomass, a fixed fecundity of 1 800 eggs kg^{-1} gave a spawning target of 738 kg. The female sea-age composition of Buolbmátjohka/Pulmankijoki is dominated by small 2SW-salmon (63 % of the biomass) with some 1SW (37 %). The stock-specific relative fecundity then becomes 2 600 eggs kg^{-1}. With this average fecundity level, the female biomass needed to produce the necessary number of eggs becomes 511 kg.

3.5 Lákšjohka

This is a middle-sized river with a catchment area of 359 km^2 and its river mouth is located approximately 75 km from the Tana/Teno estuary. Lákšjohka itself starts with the confluence of two small tributaries, Deavkkehanjohka and Gurtejohka (**Figure 6**). A third very small river, Garpejohka, enters Lákšjohka from the north approximately 400 m downstream of the other two tributaries.

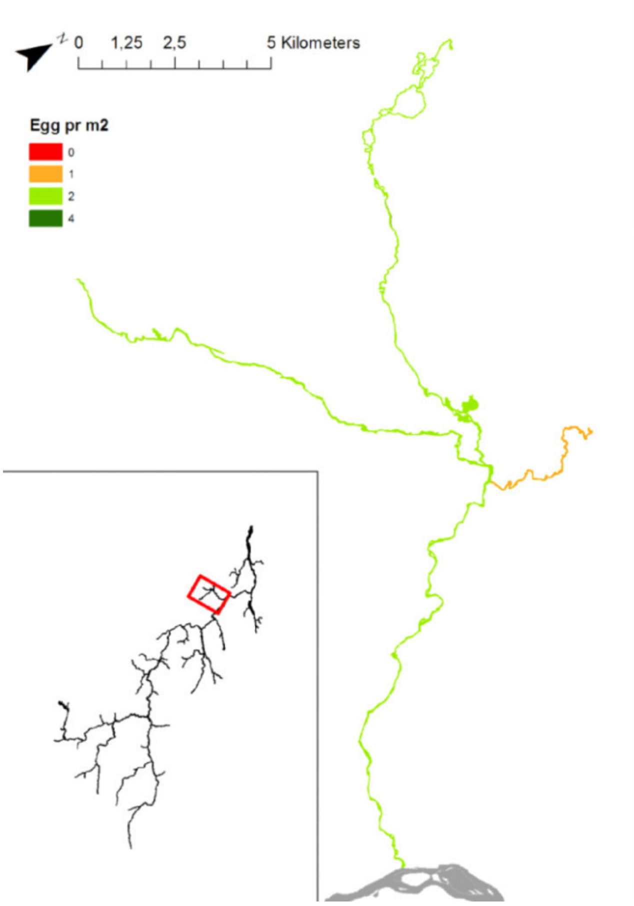

Figure 6*. Map of Lákšjohka showing the river stretches that were included in the area calculation. Orange = 1 egg m^{-2} and light green = 2 eggs m^{-2}.*

Lákšjohka is very fast-flowing in its lowermost 3 km and particularly steep in an area around 0.7-1 km upstream from Tana/Teno where there are several small waterfalls forming a sequence of steps. Above this first fast-flowing area follow extensive slow-flowing areas alternating with shorter fast-flowing stretches. There is a waterfall with a well-functioning fish ladder 7 km upstream the river. The waterfall is a vertical drop of around 3 m, but some salmon are still able to pass without using the ladder when conditions are favourable. There are no further barriers preventing salmon migration above the waterfall. Total length is 13.7 km.

The main limiting factor for salmon production in Lákšjohka is a lack of suitable spawning grounds, which is unfortunate since conditions for juvenile production are generally very favourable. Due to the limited number of available spawning grounds but otherwise good habitat, an egg density of 2 eggs m^{-2} is used in Lákšjohka.

Deavkkehanjohka is a long river flowing in a northeastern direction from Miennajávrrit. There are no obstacles to salmon migration, so there is a challenge finding a limit for salmon distribution in the river. The current limit is set at a point almost 14 km up the river. We do not, as of now, have any data indicating to what extent salmon are present above this point, but there are old records stating that salmon have been caught all the way up to Miennajávrrit, which is 3.5 km further up. In the absence of newer data, we used only the area formed below the current management limit in the area calculation.

For most of its length, Deavkkehanjohka has good habitat for juvenile salmon. However, there are extensive stretches with very coarse substratum, so access to suitable spawning grounds might be a limiting factor. Therefore, an egg density of 2 eggs m^{-2} was chosen for Deavkkehanjohka.

Gurtejohka has a sequence of lakes in its uppermost part, and the distance from the lowermost lake, Gurteluobbal, down to the confluence with Deavkkehanjohka, is 10.4 km. There are no migration barriers in Gurtejohka, so the management limit is somewhat arbitrarily set over 1 km below Gurteluobbal. We have some information about salmon distribution above the management limit, with catch reports from pools around Gurteluobbal and electrofishing data downstream and upstream of Gurtejávri (2000-2002). In the electrofishing, juvenile salmon were found 5.5 km further up than the current management limit, and this point was therefore chosen as the upper limit in the area calculation for Gurtejohka. With this limit, the total length of Gurtejohka becomes 14.4 km. The lakes Gurteluobbal and Gurtejávri are included in the area calculation, both lakes with a 10 m wide shore buffer zone.

Habitat quality in Gurtejohka is generally good, and there are good areas both for spawning and juveniles. An egg density of 2 eggs m^{-2} was therefore chosen for Gurtejohka.

Garpejohka is a very small river that is characterized by extensive slow-flowing areas. Salmon usage of this river is largely unknown today, but there are old records indicating salmon can be found in some of the pools. There are no migration barriers in Garpejohka, and the current management limit is set to a point almost 5 km upstream. In this revision, an egg density of 1 egg m^{-2} has been used due to a predominance of slow-flowing habitat.

***Table 4**. Summary table of Lákšjohka area and spawning target calculations.*

	Lákšjohka (total)	Lákšjohka	Deavkke-hanjohka	Gurte-johka	Garpe-johka
Area with 0 eggs m^{-2}	0	0	0	0	0
Area with 1 egg m^{-2}	95 738	0	0	0	95 738
Area with 2 eggs m^{-2}	1 437 104	546 514	465 765	424 825	0
Area with 4 eggs m^{-2}	0	0	0	0	0
Spawning target (number of eggs)	**2 969 946**	**1 093 028**	**931 530**	**849 650**	**95 738**
Lower limit (eggs)	2 203 525	819 771	698 648	637 238	47 869
Upper limit (eggs)	4 454 919	1 639 542	1 397 295	1 274 475	143 607
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:					
Spawning target (female biomass kg)	**1 650**	**607**	**518**	**472**	**53**
Lower limit (kg)	1 224	455	388	354	27
Upper limit (kg)	2 475	911	776	708	80
Mean size females (kg)	2	2	2	2	2
Spawning target (number of fem.)	**825**	**304**	**259**	**236**	**27**
Target estimates based on a stock-/sea-age-specific fecundity of 2 550 eggs kg^{-1} (23 % 1SW, 70 % 2SW, 7 % 3SW+):					
Spawning target (fem. biomass kg)	**1 165**	**429**	**365**	**333**	**38**
Lower limit (kg)	864	321	274	250	19
Upper limit (kg)	1 747	643	548	500	56
Mean size females (kg)	2	2	2	2	2
Spawning target (number of fem.)	**582**	**214**	**183**	**167**	**19**

The revised spawning target of Lákšjohka was estimated to be 2 969 946 eggs (**Table 4**), a slight decrease from the original target of 2 981 460 eggs (Hindar *et al.* 2007). In the original estimation, 25 % of the total area was subtracted and classified as unsuitable for salmon production. The remaining 75 % were assigned an egg density of 4 eggs m^{-2} as this was expected to be primarily good quality habitat.

Instead of the original 25 % area subtraction, we kept the total area for the revision. This area then has a mixture of good and poor habitat, and therefore egg density were revised downwards from 4 to 2 eggs m^{-2}. For the revision, we extended the distribution limits of salmon in the river system. Most notably, we moved the production limit in Gurtejohka upstream of Gurtejávri, while the limit in the original estimate was below Gurteluobbal. The revised total area was 1 532 842 m^2, while in the original report it was 993 820 m^2.

Converted into female biomass, the biomass needed to produce the number of eggs specified by the target was 1 650 kg when using a fixed fecundity of 1 800 eggs kg^{-1}. This is a slight decrease from the original target of 1 656 kg (Hindar *et al.* 2007).

The female sea age composition of Lákšjohka is dominated by small-sized 2SW (76 % of the biomass) and a few 1SW (24 %). The stock-specific relative fecundity then becomes 2 550 eggs kg^{-1}. With this fecundity ratio, the spawning target as female biomass was 1 165 kg.

There are two remaining issues with the current revision of the Lákšjohka spawning target that merit further study and should be considered when establishing a second-generation target: Firstly, the salmon production in the river is heavily dependent on the fish ladder, as the river area below the waterfall has minimal spawning possibilities. In an electrofishing survey from 2014 (Orell, unpublished data), the main production areas of the river were found above the waterfall, especially in the tributaries Gurtejohka and Deavkehanjohka. The locations of the production areas in relation to the waterfall mean that the stock situation in Lákšjohka will depend heavily on the performance of the fish ladder, which consequently should be kept well maintained.

Secondly, the role of the lakes in the upper part of Gurtejohka might be discussed. Although some juveniles were found in 2002 when electrofishing upstream Gurtejávri (Falkegård, unpublished data), there are very few spawning areas available here and any juveniles using Gurtejávri mostly must colonize from the downstream river areas. In an electrofishing survey from 2014 (Orell, unpublished data), both salmon fry and parr were found in the short river stretch between Gurtejávri and Gurteluobbal.

3.6 Veahčajohka/Vetsijoki

Veahčajohka/Vetsijoki is a middle-sized tributary with a catchment area of 702 km^2 located around 92 km from the Tana estuary. It is one of the most important salmon tributaries flowing to the Tana from the Finnish side, with a significant proportion of MSW salmon. One salmon producing tributary river (Váisjohka/Vaisjoki) flows to the Vetsijoki from the western side (**Figure 7**). A considerable waterfall is situated above the confluence of Vetsijoki and Vaisjoki, but it is not considered as a migration obstacle for salmon.

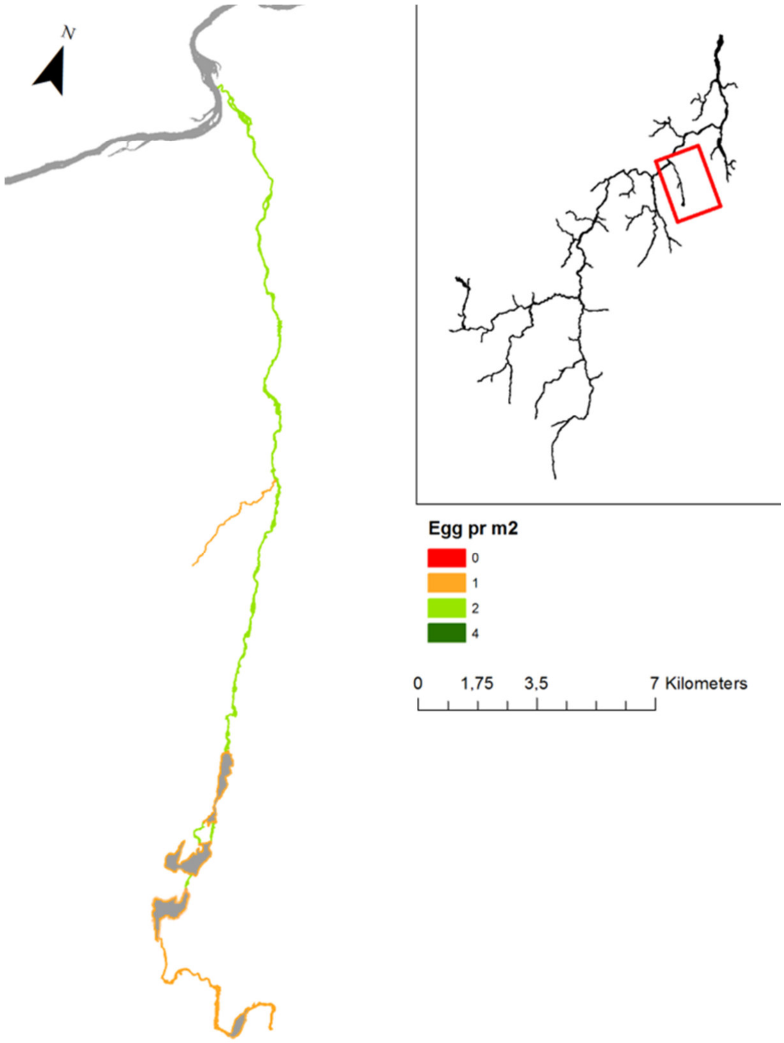

Figure 7. *Map of Veahčakjohka/Vetsijoki. Red = 0 eggs m^{-2}, orange = 1 egg m^{-2}, light green = 2 eggs m^{-2} and green = 4 eggs m^{-2}.*

Veahčajohka/Vetsijoki itself has a salmon-producing river length of around 42 km, going from the Tana main stem all the way up to the Lake Vetsijärvi. Habitat quality within this river length is mostly favourable up to the Lake Ylin Riekkojärvi, further up the quality decreases. For this reason, an egg density of 2 eggs m^{-2} was used for the river stretches below Ylin Riekkojärvi and 1 egg m^{-2} for the river above.

Váisjohka/Vaisjoki. This small river flows from southwest about halfway up Vetsijoki. Total length accessible for salmon is c. 6 km. Due to estimated low habitat quality an egg density of 1 egg m^{-2} was used in Vaisjoki.

The spawning target for Veahčajohka/Vetsijoki was estimated to 2 505 400 eggs (**Table 5**). No target has been estimated earlier for this river.

***Table 5**. Summary table of Veahčakjohka/Vetsijoki area and spawning target calculations.*

	Vetsijoki (total)	Vetsijoki	Vaisjoki
Area with 0 eggs m^{-2}	0	0	0
Area with 1 egg m^{-2}	499 300	437 115	62 185
Area with 2 eggs m^{-2}	1 003 060	1 003 060	0
Area with 4 eggs m^{-2}	0	0	0
Spawning target (number of eggs)	**2 505 400**	**2 443 235**	**62 185**
Lower limit (eggs)	1 754 240	1 723 148	31 093
Upper limit (eggs)	3 758 130	3 664 853	93 278
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:			
Spawning target (female biomass kg)	**1 392**	**1 357**	**35**
Lower limit (kg)	975	957	17
Upper limit (kg)	2 088	2 036	52
Mean size females (kg)	3	3	3
Spawning target (number of females)	**464**	**452**	**12**
Target estimates based on a stock-/sea-age-specific fecundity of 2 275 eggs kg^{-1} (20 % 1SW, 68 % 2SW, 12 % 3SW+):			
Spawning target (female biomass kg)	**1 101**	**1 074**	**27**
Lower limit (kg)	771	757	14
Upper limit (kg)	1 652	1 611	41
Mean size females (kg)	3	3	3
Spawning target (number of females)	**367**	**358**	**9**

The estimated female biomass needed to produce this number of eggs was 1 392 kg when using a fixed fecundity of 1 800 eggs kg^{-1}. The sea age composition among females in Veahčajohka/Vetsijoki is dominated by 2SW (73 % of the biomass) with a small proportion of 1SW (20 %) and 3SW (7 %). The stock-specific relative fecundity becomes 2 275 eggs kg^{-1}. With this fecundity ratio, the female biomass needed to produce the number of eggs defined by the target becomes 1 101 kg.

3.7 Ohcejohka/Utsjoki

The river 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 106 km upstream from the sea. The main stem of Utsjoki comprises large numbers of deep lakes with connecting river stretches (**Figure 8**). Two major tributaries, the rivers Geavvu/Kevojoki and Čársejohka/Tsarsjoki, drain to the middle part of Utsjoki. The Atlantic salmon stock of Utsjoki consist of several distinct sub-stocks with grilse (1SW) populations dominating in the two major tributaries, whereas 2-4 SW spawners form a considerable portion of the spawning stock in the Utsjoki main stem.

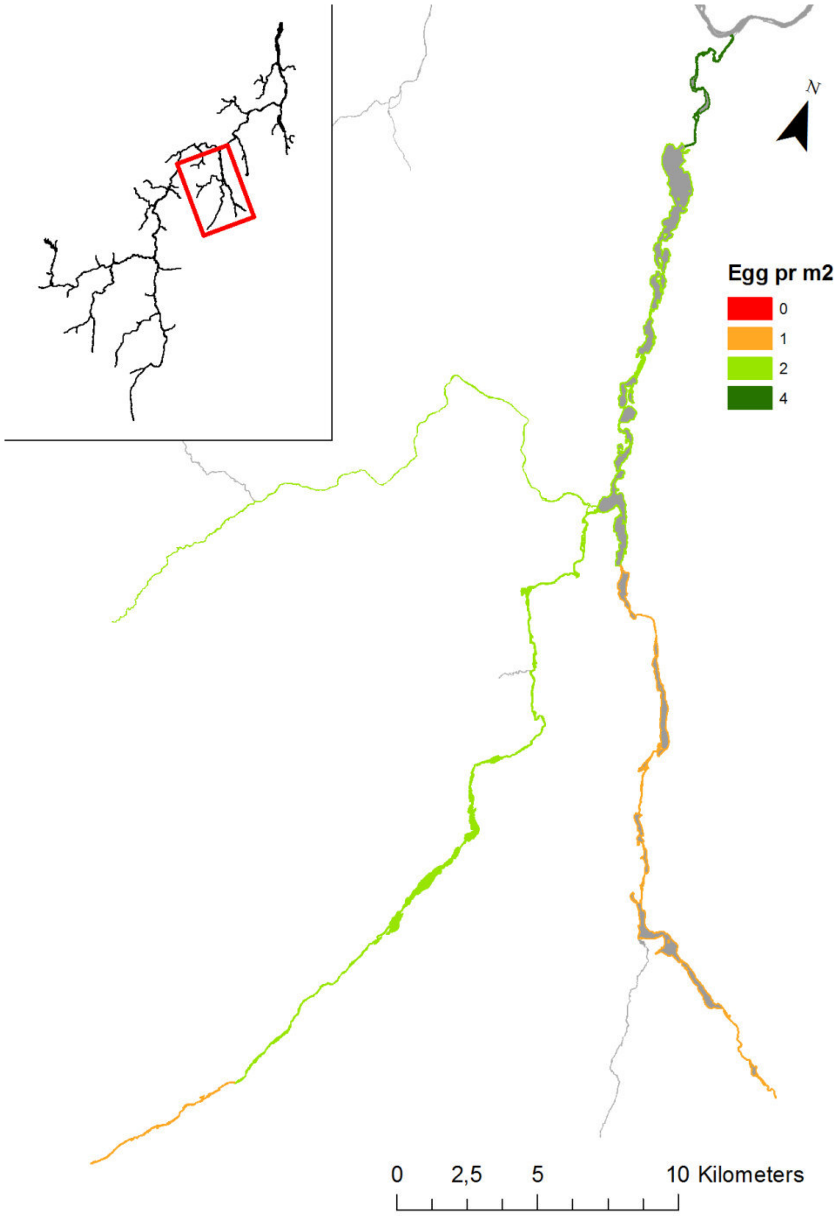

***Figure 8**. Map of the Ohcejohka/Utsjoki river system with the tributaries Geavvu/Kevojoki and Čársejohka/Tsarsjoki. Different egg category areas are marked with colours. Red = 0 eggs m^{-2}, orange = 1 egg m^{-2}, light green = 2 eggs m^{-2} and dark green = 4 eggs m^{-2}.*

The **Ohcejohka/Utsjoki** main stem can be divided to three different habitat quality sections. The lowermost section, situated below the Lake Mantojärvi has excellent habitat quality for salmon production. Thus, an egg density level of 4 eggs m^{-2} was used for this river stretch. The middle reaches of the main stem, between the Lake Mantojärvi and Lake Kevojärvi, is estimated to have reasonably good habitat quality, and an egg density level of 2 eggs m^{-2} were used for this area. Within this section the many lakes were also included to salmon production areas by using a 5 m buffer on shorelines and using the same 2 eggs m^{-2} egg density level within these buffer areas. The uppermost section of the Utsjoki main stem, between the Lake Kevojärvi and Lake Mierasjärvi (= migration limit), has poorer habitat for salmon production. This section is characterized by rather coarse substrate with less spawning areas compared to the two lowermost river sections. Therefore, an egg density level of 1 egg m^{-2} was used for this section.

Čársejohka/Tsarsjoki is a large tributary of the River Utsjoki and has a catchment area of 236 km^2. Tsarsjoki connects to Utsjoki c. 20 km upstream from the Utsjoki mouth. Based on extensive electrofishing and habitat surveys the river is estimated to have reasonably good habitat for salmon production from the river mouth up to the headwaters (32 km). Thus, an egg density level of 2 eggs m^{-2} was used for the whole distribution area.

Geavvu/Kevojoki is another large tributary of the River Utsjoki with a catchment area of 494 km^2. The river connects to the Utsjoki main stem at the same point as the River Tsarsjoki. The River Kevojoki differs from the River Tsarsjoki, as it is characterized by small lakes and large pools, which cannot be found in Tsarsjoki at all. Most of the salmon distribution area in Kevojoki was estimated as reasonably good habitat for salmon production and an egg density level of 2 eggs m^{-2} was used up to the upper part of Bajimuš Roajášjávri (c. 30 km from the river mouth). Egg density level of 1 egg m^{-2} was set for the uppermost river (7 km) section to Fiellugorži, because of lower quality habitat.

Table 6. *Summary table of the Ohcejohka/Utsjoki area and spawning target calculations.*

	Utsjoki (total)	**Kevojoki**	**Tsarsjoki**	**Utsjoki main stem**
Area with 0 eggs m^{-2}	0	0	0	0
Area with 1 egg m^{-2}	540 233	179 422	0	360 811
Area with 2 eggs m^{-2}	1 704 149	646 555	692 235	365 359
Area with 4 eggs m^{-2}	257 644	0	0	257 644
Spawning target (number of eggs)	**4 979 107**	**1 472 532**	**1 384 470**	**2 122 105**
Lower limit (eggs)	3 599 272	1 059 544	1 038 353	1 501 376
Upper limit (eggs)	7 211 017	2 208 798	2 076 705	2 925 514
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:				
Spawning target (female biomass kg)	**2 766**	**818**	**769**	**1 179**
Lower limit (kg)	2 000	589	577	834
Upper limit (kg)	4 006	1 227	1 154	1 625
Mean size females (kg)	2.1	1.7	1.2	6
Spawning target (number of females)	**1 318**	**481**	**641**	**196**
Target estimates based on stock-/sea-age-specific fecundities:		2 550 eggs kg^{-1}	2 625 eggs kg^{-1}	2 225 eggs kg^{-1}
Spawning target (female biomass kg)	**2 059**	**577**	**527**	**954**
Lower limit (kg)	1 486	416	396	675
Upper limit (kg)	2 972	866	791	1 315
Mean size females (kg)	-	1.7	1.2	6
Spawning target (number of females)	**938**	**340**	**440**	**159**

The revised spawning target for the Utsjoki river system becomes 4 979 107 eggs (**Table 6**). This is a significant increase from the original target of 3 600 000 eggs (Hindar *et al.* 2007). The main issue distinguishing the original and the revised target is the area estimation. In the original target, an estimate of only the productive area from the Utsjoki main stem was used as a basis for estimating the spawning target, while in the revised target the standardized GIS-based approach was used for the whole river system. As the original target used an estimate only of productive areas, the egg density used in the original target was 6 eggs m^{-2}. In the revised target, various parts of the river system were assigned different egg densities depending on local habitat quality. These parts were accordingly assigned 1, 2 or 4 eggs m^{-2} as seen in **Figure 8** and **Table 6**.

Based on a fixed fecundity of 1 800 eggs kg^{-1}, the spawning target in terms of female biomass becomes 2 766 kg, significantly higher than the original target of 2 000 kg (Hindar *et al*. 2007). When a stock-/sea-age-specific approach to fecundity is taken, the female biomass needed to produce the target egg deposition becomes 2 059 kg for the whole Utsjoki river system.

3.8 Goahppelašjohka/Kuoppilasjoki

The River 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 as far upstream as allowed for by the river size. A tributary river Birkejohka/Pirkejoki enters Kuoppilasjoki from southwest direction, and this river also has a small tributary (Goaskinjohka) which is likely supporting annual salmon spawning and juvenile production (**Figure 9**).

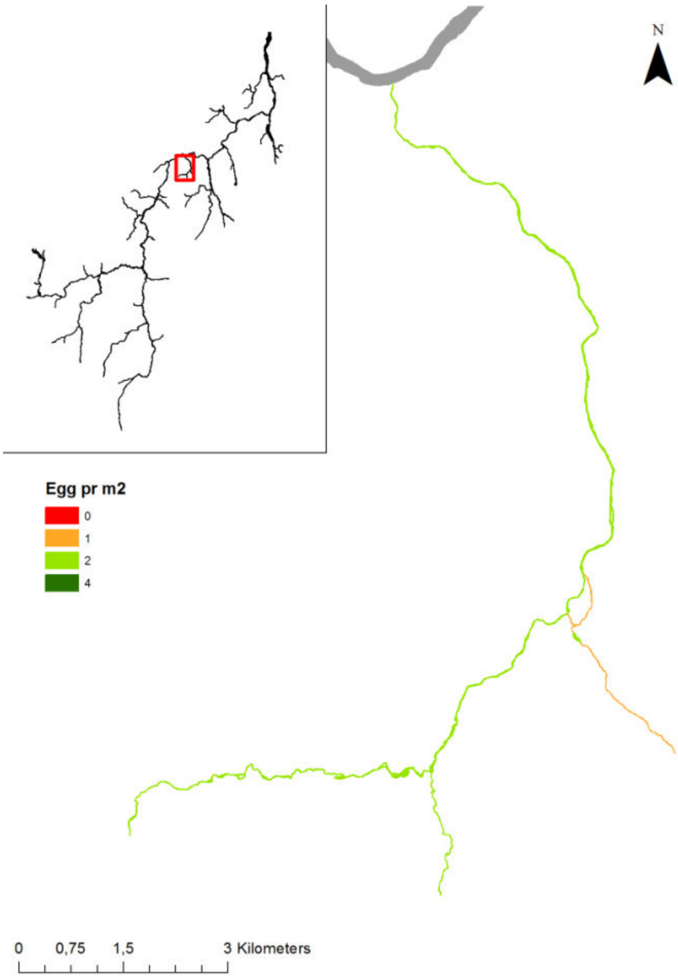

Figure 9*. Map of Goahppelašjohka/Kuoppilasjoki.*

Goahppelašjohka/Kuoppilasjoki. The main channel starts from the Lake Kuoppilasjärvi, with a slightly over 13 km stretch available for salmon production. Habitat quality is estimated to be relatively good for most of the river, up to the confluence with Pirkejoki. The area between the Pirkejoki confluence and Kuoppilasjärvi (c. 4 km) likely contributes little to the salmon production and an egg density of 1 egg m^{-2} was assigned to this area. An egg density of 2 eggs m^{-2} was assigned to the area below the Pirkejoki confluence.

Birkejohka/Pirkejoki. This small river enters the main river Kuoppilasjoki from the southwest approximately 9.5 km upstream from the Tana main stem. The potential salmon-producing river length in Pirkejoki is close to 10 km. An additional 2.5 km is available in the tributary stream Goaskinjoki that flows to middle reaches of Pirkejoki from the south. Habitat quality is estimated as reasonably good, so an egg density level of 2 eggs m^{-2} was assigned to both Pirkejoki and Goaskinjoki.

The estimated spawning target for Goahppelašjohka/Kuoppilasjoki is 695 950 eggs (**Table 7**). No earlier target has been estimated for this river.

Table 7. *Summary table of Goahppelašjohka/Kuoppilasjoki area and spawning target calculations.*

	Kuoppilasjoki (total)	Kuoppilasjoki	Pirkejoki & Goaskinjoki
Area with 0 eggs m^{-2}	0	0	0
Area with 1 egg m^{-2}	14 150	14 150	0
Area with 2 eggs m^{-2}	340 900	183 739	157 161
Area with 4 eggs m^{-2}	0	0	0
Spawning target (number of eggs)	**695 950**	**381 628**	**314 322**
Lower limit (eggs)	518 426	282 684	235 742
Upper limit (eggs)	1 045 925	574 442	471 483
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:			
Spawning target (female biomass kg)	**387**	**212**	**175**
Lower limit (kg)	288	157	131
Upper limit (kg)	580	318	262
Mean size females (kg)	1.7	1.7	1.7
Spawning target (number of females)	**228**	**125**	**103**
Target estimates based on a stock-/sea-age-specific fecundity of 2 550 eggs kg^{-1} (39 % 1SW, 44 % 2SW, 17 % 3SW+):			
Spawning target (female biomass kg)	**273**	**150**	**123**
Lower limit (kg)	203	111	92
Upper limit (kg)	409	225	185
Mean size females (kg)	1.7	1.7	1.7
Spawning target (number of females)	**161**	**88**	**73**

Using a fixed fecundity of 1 800 eggs kg^{-1}, the female biomass needed to produce the target number of eggs is 387 kg. The female spawning stock in Goahppelašjohka/Kuoppilasjoki is dominated by 2SW (50 %) and 1SW (47 %), based on biomass. The stock-/sea-age-specific relative fecundity then becomes 2 550 eggs kg^{-1}, and the spawning target in biomass 273 kg.

3.9 Borsejohka

This tributary enters the Tana main stem on the Norwegian side approximately 130 km from the estuary. It is very steep and fast-flowing in its lowermost part, and several small waterfalls a few hundred meters upstream from the Tana are likely forming a difficult barrier for migrating salmon. There are old sources claiming salmon have been caught further up in Borsejohka, indicating that it might be possible for salmon to pass the waterfalls. However, electrofishing results from 2010 (Orell 2011) and 2013 (Johansen 2013) show only a few older juvenile salmon below the waterfalls and no salmon above.

The substratum is dominated by large boulders below the waterfalls; there are no pools and no spawning opportunities. Above the waterfalls, habitat quality becomes gradually better.

Current available data indicates that Borsejohka likely has no salmon stock. No spawning target is therefore set for this tributary in this revision.

3.10 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 (**Figure 10**). For this reason Leavvajohka is not considered an attractive fishing place for anglers, and there are only a few fishermen visiting each year.

The water temperature of Leavvajohka is low during the summer. Most of the drainage area is high mountains so the river is fed a combination of groundwater and melting snow. The substratum of the river is rather well-suited for juvenile production, but the lack of pools means that the available spawning areas are small and fragmented.

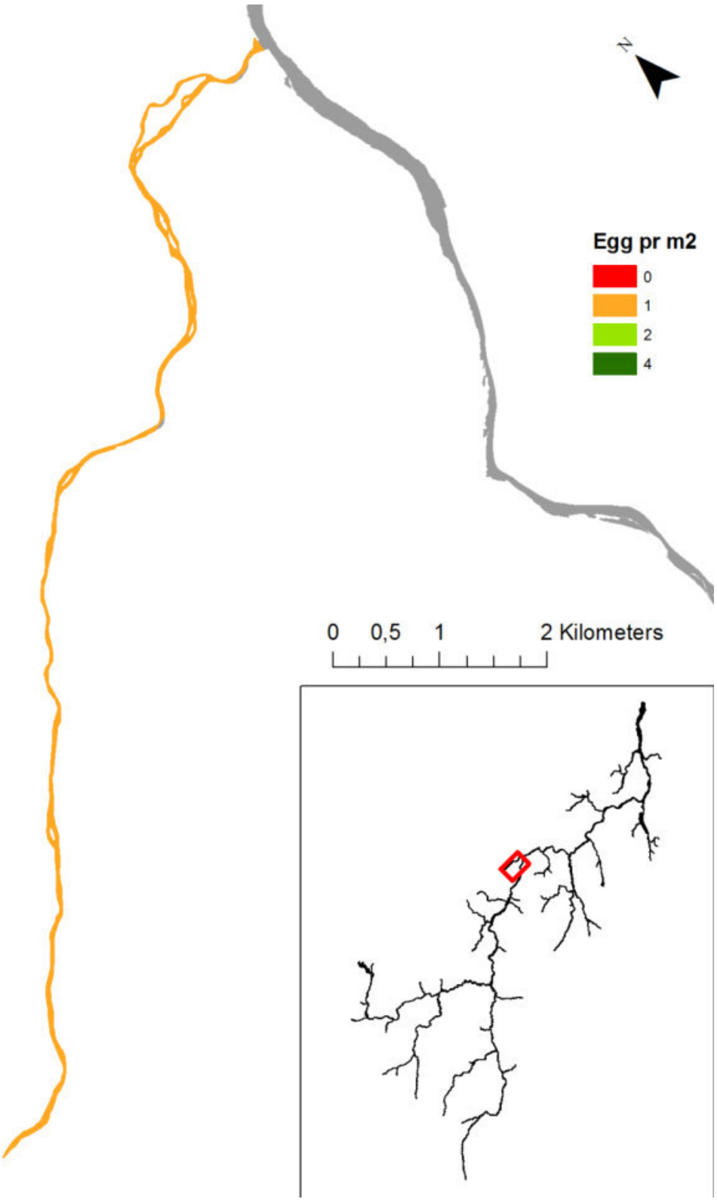

Figure 10. *Map of Leavvajohka.*

Due to low water temperatures and sub-optimal habitat quality, the egg density level in Leavvajohka was set to 1 egg m^{-2}. The revised spawning target of Leavvajohka then becomes 499 203 eggs (**Table 8**).

Table 8*. Summary table of Leavvajohka area and spawning target calculations.*

Area with 0 eggs m^{-2}	0
Area with 1 egg m^{-2}	499 203
Area with 2 eggs m^{-2}	0
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	**499 203**
Lower limit (eggs)	249 602
Upper limit (eggs)	748 805
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**277**
Lower limit (kg)	139
Upper limit (kg)	416
Mean size females (kg)	2.5
Spawning target (number of females)	**111**
Target estimates based on a stock-/sea-age-specific fecundity of 2 400 eggs kg^{-1} (6 % 1SW, 88 % 2SW, 6 % 3SW+):	
Spawning target (female biomass kg)	**208**
Lower limit (kg)	104
Upper limit (kg)	312
Mean size females (kg)	2.7
Spawning target (number of females)	**77**

The revised spawning target of 499 203 eggs is approximately equal to the original target of 502 680 eggs (Hindar *et al*. 2007). The difference is caused by a minor difference in area calculation. In terms of female biomass, the spawning target is 277 kg when using a fixed fecundity of 1 800 eggs kg^{-1} and 208 kg when using a stock-/sea-age-specific relative fecundity of 2 400 eggs kg^{-1}.

The current management limit of Leavvajohka is at a small waterfall at Lávddetgála approximately 13 km upstream. This point has been used as the upper limit of salmon distribution also in this revision of the spawning target. However, there are old reports of salmon caught all the way up to Leavvajávri, and electrofishing data from 2010 (Orell 2011) and 2013 (Johansen 2013) show juvenile salmon also upstream of Lávddetgála. There are, therefore, salmon distributed potentially at least 15 km upstream of Lávddetgála, and this additional river length should be accounted for when a second-generation spawning target is set.

3.11 Nuvvosjohka/Nuvvusjoki

This small tributary (catchment area 62 km^2) enters the Tana main stem from the east c. 160 km from the Tana estuary. Basically, river length available for salmon is >10 km, but based on snorkelling explorations self-sustaining salmon population do not exist in this system (Orell, personal observations) and the juvenile salmon in the river have likely entered from the Tana main stem. Thus egg density level for the whole river is set to 0 eggs m^{-2}. The spawning target for Nuvvusjoki therefore also becomes 0 eggs.

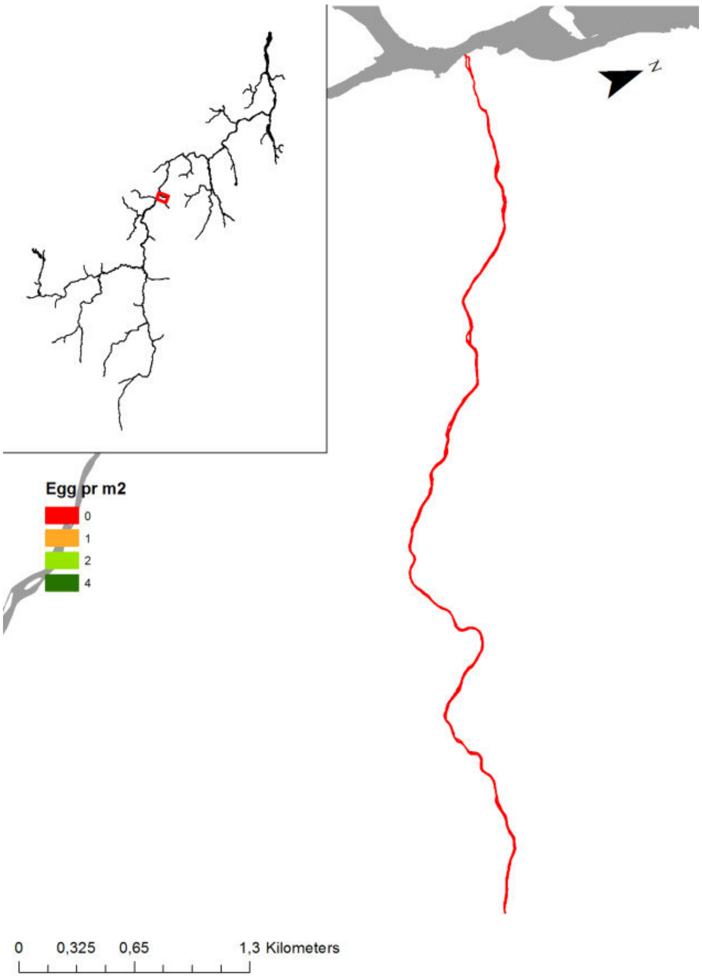

Figure 11. *Map of Nuvvosjohka/Nuvvusjoki.*

Table 9. *Summary table of Nuvvosjohka/Nuvvusjoki area and spawning target calculations.*

Area with 0 eggs m^{-2}	74 180
Area with 1 egg m^{-2}	0
Area with 2 eggs m^{-2}	0
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	0
Spawning target (female biomass kg)	0
Mean size females (kg)	0
Spawning target (number of females)	0

3.12 Báišjohka

Báišjohka is a small-sized tributary entering the Tana main stem from the west approximately 160 km from the estuary. The river has a catchment area of 135 km^2. There are no significant tributaries flowing to Báišjohka (**Figure 12**).

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. Autumn snorkeling counts have demonstrated a significant number of spawners present in the river (Orell 2009, Johansen 2014a).

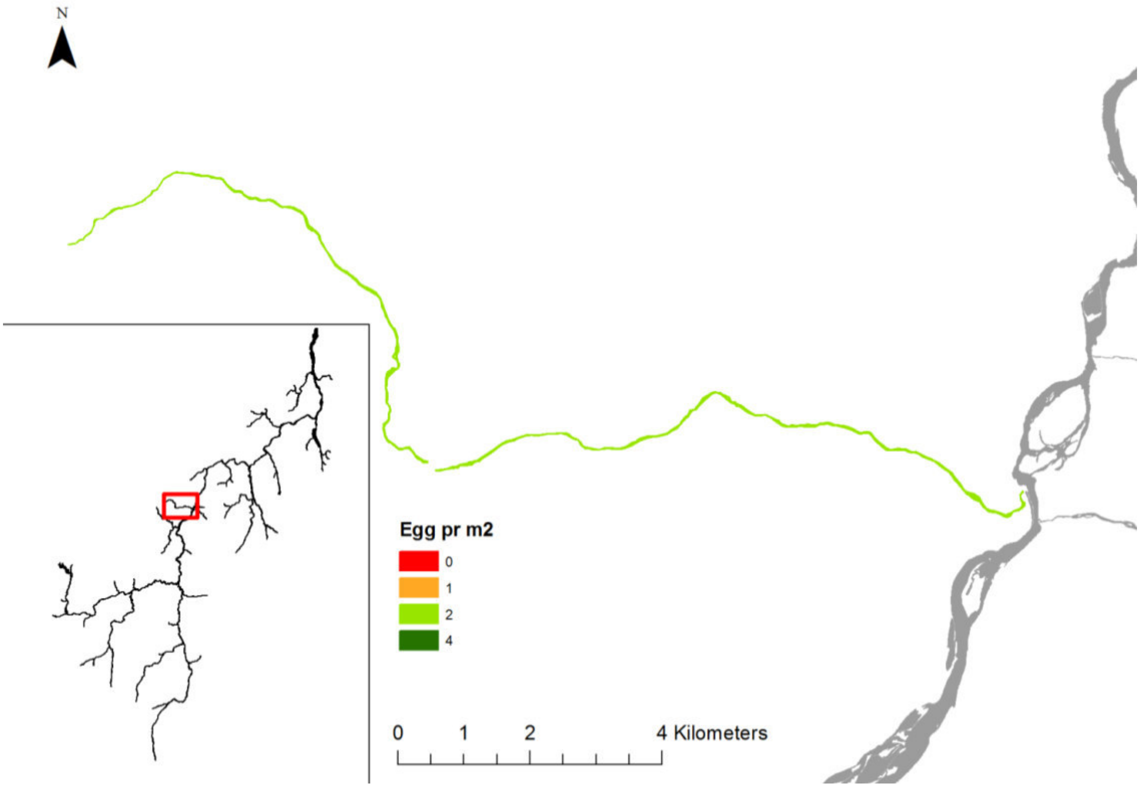

Figure 12. *Map of Báišjohka.*

There are no migration barriers in Báišjohka, so the salmon is free to migrate upstream towards the river sources. The river starts at a series of lakes and the current management limit has been set slightly over 1 km below the lowermost lake (Njárbesjávri), giving a total salmon producing river length of around 20 km.

There are old sources claiming salmon has been caught in Njárbesjávri, but the river is very small in the first km below Njárbesjávri and this uppermost part is therefore likely of little importance. Electrofishing data from 2010 (Orell 2011) show salmon fry and parr all the way up to the current management limit, indicating that the whole river length is currently used for salmon reproduction.

The habitat quality in Báišjohka is mostly favourable both for juveniles and spawning, although there are some steeper areas dominated by boulders that has little to no spawning opportunities. We therefore set the egg density to 2 eggs m^{-2} for the whole river area.

The spawning target for Báišjohka becomes 948 688 eggs (**Table 10**). No target has been set for this tributary earlier.

***Table 10**. Summary table of Báišjohka area and spawning target calculations.*

Area with 0 eggs m^{-2}	0
Area with 1 egg m^{-2}	0
Area with 2 eggs m^{-2}	474 344
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	**948 688**
Lower limit (eggs)	711 516
Upper limit (eggs)	1 423 032
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**527**
Lower limit (kg)	395
Upper limit (kg)	791
Mean size females (kg)	2.5
Spawning target (number of females)	**211**
Target estimates based on a stock-/sea-age-specific fecundity of 2 400 eggs kg^{-1} (10 % 1SW, 73 % 2SW, 16 % 3SW+):	
Spawning target (female biomass kg)	**395**
Lower limit (kg)	296
Upper limit (kg)	593
Mean size females (kg)	2.5
Spawning target (number of females)	**158**

The female biomass needed to meet this spawning target is 527 kg when using a fixed fecundity of 1 800 eggs kg^{-1}. The female sea-age composition in Báišjohka, based on biomass, is dominated by small 2SW salmon (73 %), some 3SW+ salmon (16 %) and a few 1SW salmon (10 %). The stock-/sea-age-specific relative fecundity then becomes 2 400 eggs kg^{-1}, which means that 395 kg females is needed to meet the egg deposition of the spawning target.

3.13 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 (**Figure 13**).

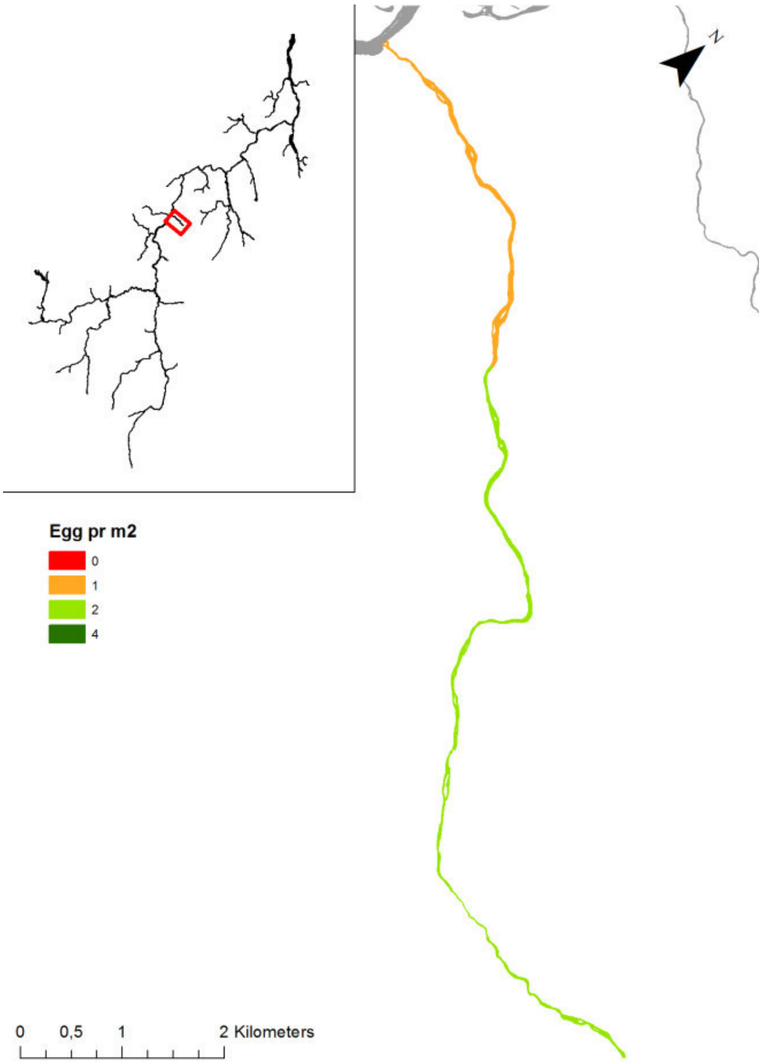

***Figure 13**. Map of Njiljohka/Nilijoki.*

The river channel is broad and steep in the lowermost 3.5 km with very limited spawning possibilities. Therefore, an egg density level of 1 egg m^{-2} was chosen for this lowermost part. The habitats were estimated to be better in the remaining 9 km of the river and an egg density level of 2 eggs m^{-2} was used for this section.

The estimated spawning target for Njiljohka/Nilijoki becomes 519 520 eggs (**Table 11**). No earlier target has been estimated for this river.

***Table 11**. Summary table of Njiljohka/Nilijoki area and spawning target calculations.*

Area with 0 eggs m^{-2}	0
Area with 1 egg m^{-2}	132 040
Area with 2 eggs m^{-2}	192 740
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	**519 520**
Lower limit (eggs)	355 130
Upper limit (eggs)	776 280
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**289**
Lower limit (kg)	197
Upper limit (kg)	431
Mean size females (kg)	2.5
Spawning target (number of females)	**116**
Target estimates based on a stock-/sea-age-specific fecundity of 2 350 eggs kg^{-1} (12 % 1SW, 72 % 2SW, 16 % 3SW+):	
Spawning target (female biomass kg)	**221**
Lower limit (kg)	151
Upper limit (kg)	330
Mean size females (kg)	2.5
Spawning target (number of females)	**88**

The female biomass needed to meet the spawning target is 289 kg when using a fixed fecundity of 1 800 eggs kg^{-1}. The female sea age composition of Njiljohka/Nilijoki is dominated by 2SW (81 % of the biomass), and the stock-/sea-age-specific relative fecundity becomes 2 350 eggs kg^{-1}. With this fecundity, 221 kg females are needed to meet the spawning target.

3.14 Váljohka

Váljohka is a middle-sized river entering the Tana main stem from southwest close to 175 km from the Tana estuary. There is one tributary, Ástejohka, that might contribute to the salmon-producing area. There are no migration barriers in either of these, so salmon are free to migrate upstream as far as allowed for by the river size (**Figure 14**).

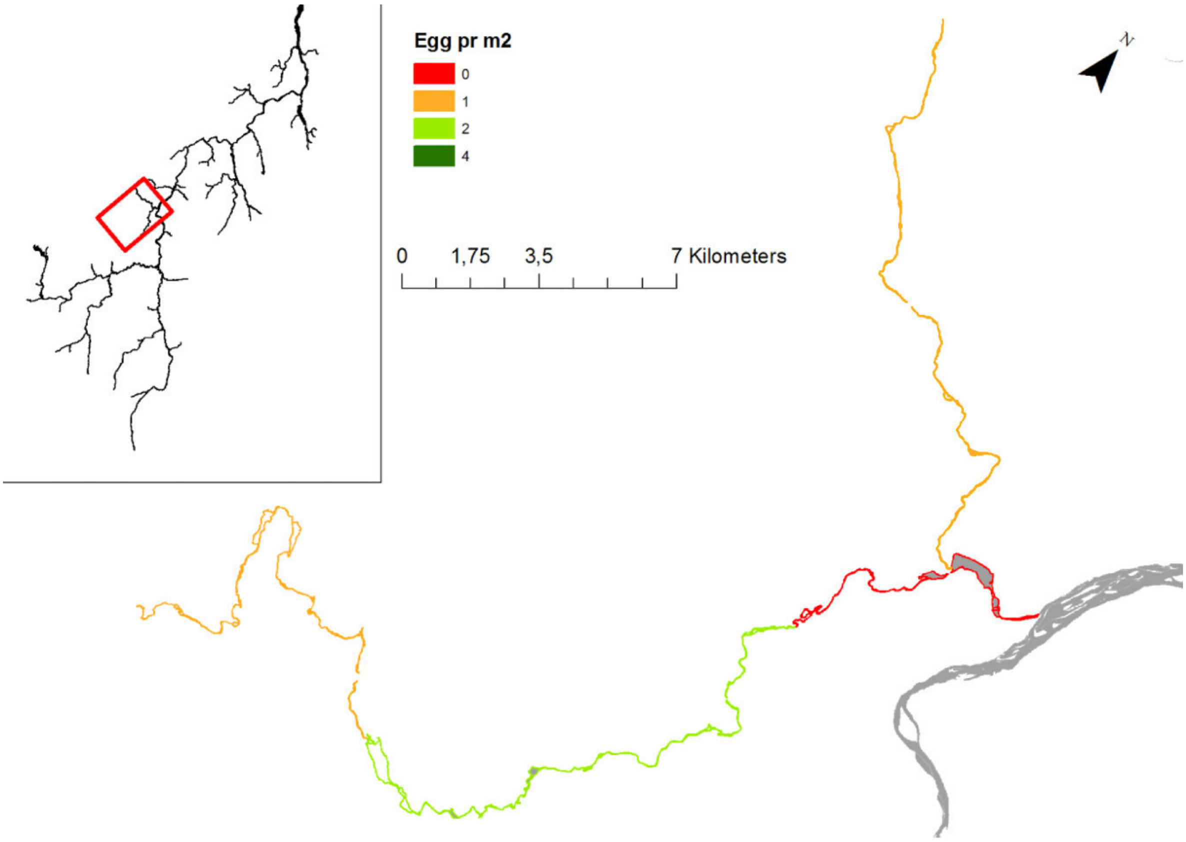

Figure 14*. Map of Váljohka with the different egg category areas marked with colours. Red = 0 egg m^2, orange = 1 egg m^2, light green = 2 eggs m^2.*

Váljohka itself is very slow-flowing in the lowermost part. The lowermost kilometer is a slow-flowing channel, the next 2 km are a lake, Stuorrajávri, and Váljohka continues to run in mostly slow channels for the next 6 km. Further upstream, for the next 15 km, the river becomes more fast-running with riffles and pools. There are some good habitats for spawning and juvenile rearing in this part. Then, in the area from Gimešjávri up to Idjajávri, the river becomes gradually more and more slow-flowing with several lakes. In this revision of the Váljohka spawning target, we use the outlet of Vuolitluoppal as the upper limit of salmon distribution. Total river length in Váljohka with this limit becomes 42 km. This area is separated into the following egg densities:

- Lower slow-flowing part (9 km, marked as red in **Figure 14**): 75 % of the area set to 0 eggs m^{-2}, 25 % set to 2 eggs m^{-2}
- Middle riffle area (17 km, including Gimešjávri, marked as green in **Figure 14**): 2 eggs m^{-2}
- Upper part (16 km, marked as orange in **Figure 14**): 1 egg m^{-2}

All lakes/luobbals within the middle riffle area and the upper part of Váljohka were included in the area calculation with 10 m shoreline buffer areas.

Ástejohka enters Stuorrajávri, the lowermost lake in Váljohka, just 50 m west of Váljohka. Whereas Váljohka has extensive slow-flowing areas in its lower part, Ástejohka is more fast-running. There are no migration barriers and old sources report salmon all the way up to Ástejávrrit. The current management limit has been set just below Ásteluoppal. This gives a total migration length of approximately 18 km. Habitat quality in Ástejohka is favourable for juvenile production, but there is a limited number of pools and spawning opportunities so egg density in Ástejohka is set to 1 egg m^{-2}.

***Table 12**. Summary table of Váljohka area and spawning target calculations.*

	Váljohka (total)	**Váljohka**	**Ástejohka**
Area with 0 eggs m^{-2}	207 314	207 314	0
Area with 1 egg m^{-2}	740 779	352 217	388 562
Area with 2 eggs m^{-2}	583 408	583 408	0
Area with 4 eggs m^{-2}	0	0	0
Spawning target (number of eggs)	**1 907 595**	**1 519 033**	**388 562**
Lower limit (eggs)	1 245 502	1 051 221	194 281
Upper limit (eggs)	2 861 393	2 278 550	582 843
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:			
Spawning target (female biomass kg)	**1 060**	**844**	**216**
Lower limit (kg)	692	584	108
Upper limit (kg)	1 590	1 266	324
Mean size females (kg)	3	3	3
Spawning target (number of females)	**353**	**281**	**72**
Target estimates based on a stock-/sea-age-specific fecundity of 2 450 eggs kg^{-1} (33 % 1SW, 48 % 2SW, 19 % 3SW+):			
Spawning target (female biomass kg)	**779**	**620**	**159**
Lower limit (kg)	508	429	79
Upper limit (kg)	1 168	930	238
Mean size females (kg)	3	3	3
Spawning target (number of females)	**259**	**207**	**53**

The revised spawning target of 1 907 595 eggs (**Table 12**) is a substantial increase from the original target of 618 090 (Hindar *et al*. 2007). There are two main reasons for this. Firstly, the egg density in the original target was 1 egg m^{-2} for the entire area, while in the revised target we use 2 eggs m^{-2} for parts of the area. Secondly, a larger part of Váljohka is included in the area estimate now as we have moved the upper migration limit 18 km upstream, from the outlet of Gimešjávri to the outlet of Vuolitluoppal. In a relatively recent electrofishing investigation (1998), no juvenile salmon were found upstream of Gimešjávri and these data were then used to establish the current management limit below Gimešjávri. This limit was used in the original spawning target estimate. There are, however, no barriers stopping the salmon from migrating past Gimešjávri, and there are substantial areas further up that should contribute to the salmon production in Váljohka. With old records stating that salmon historically have been distributed all the way up to Idjajávri, we therefore set a new production limit at the outlet of Vuolitluoppal. Upstream of this point, the river becomes almost exclusively slow-flowing.

Female biomass needed to produce the egg deposit specified in the spawning target is 1 060 kg when using a fixed fecundity of 1 800 eggs kg^{-1}, a significant increase from the original biomass of 343 kg (Hindar *et al*. 2007). The female sea-age composition in Váljohka is dominated by 2SW (48 % of the biomass), followed by 1SW (33 %) and 3SW+ (19 %), giving a stock-specific relative fecundity of 2 450 eggs kg^{-1}. This means that a female biomass of 779 kg is needed to meet the spawning target.

There are two main issues with the current revision that should be followed up in the coming years: Firstly, the importance of Ástejohka. The current data indicate no salmon production in this tributary. On the other hand, local knowledge sources claim that salmon have been commonly found throughout Ástejohka. We are currently following the local knowledge and include Ástejohka in the area calculation. Secondly, there are questions about the potential salmon production of Váljohka above Gimešjávri. As with Ástejohka, this is an area where current monitoring data indicate no salmon while local knowledge sources claim that salmon were commonly found historically.

3.15 Áhkojohka/Akujoki

The river Akujoki is a small Finnish tributary (catchment area 193 km^2) flowing into the Tana main stem 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, thereafter an impassable waterfall prevents further upstream migration (**Figure 15**).

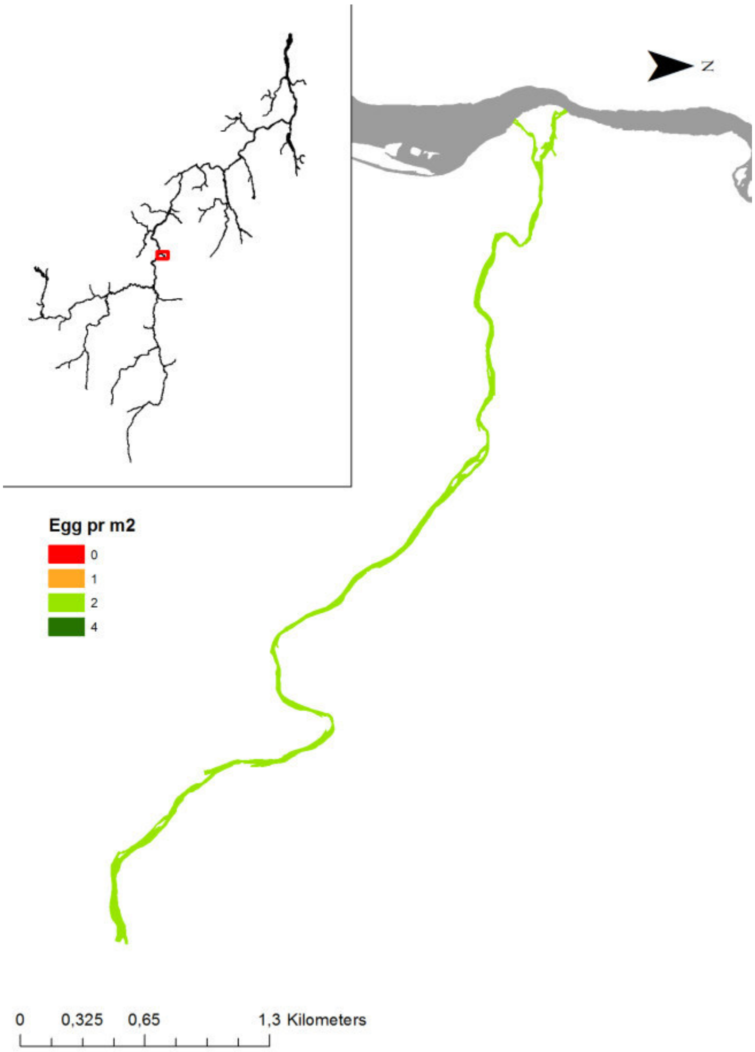

Figure 15. *Map of Áhkojohka/Akujoki.*

Based on both habitat and extensive electrofishing surveys, the river habitat below the waterfall is considered to be relatively good for salmon production. Thus, an egg density level of 2 eggs m^{-2} was set for the whole salmon distribution area.

The estimated spawning target for Áhkojohka/Akujoki then becomes 282 532 eggs (**Table 13**). No earlier target has been set for this river.

***Table 13**. Summary table of Áhkojohka/Akujoki area and spawning target calculations.*

Area with 0 eggs m^{-2}	0
Area with 1 egg m^{-2}	0
Area with 2 eggs m^{-2}	141 266
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	**282 532**
Lower limit (eggs)	211 899
Upper limit (eggs)	423 798
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**157**
Lower limit (kg)	118
Upper limit (kg)	235
Mean size females (kg)	2
Spawning target (number of females)	**79**
Target estimates based on a stock-/sea-age-specific fecundity of 2 250 eggs kg^{-1} (7 % 1SW, 73 % 2SW, 20 % 3SW+):	
Spawning target (female biomass kg)	**126**
Lower limit (kg)	94
Upper limit (kg)	188
Mean size females (kg)	2
Spawning target (number of females)	**63**

In terms of female biomass, a total of 157 kg is needed to meet the spawning target when using a fixed fecundity of 1 800 eggs kg^{-1}. The female sea-age composition of Áhkojohka/Akujoki is dominated by 2SW (73 % of the biomass) and the stock-/sea-age-specific relative fecundity becomes 2 250 eggs kg^{-1}. With this fecundity, a female biomass of 126 kg is needed to meet the egg deposition of the spawning target.

3.16 Lower Kárášjohka

The River Kárášjohka is one of the three headwater rivers that together form the Tana main stem. The total catchment area of Kárášjohka and Iešjohka is approximately 5 255 km^2.

The lowermost part of Kárášjohka, below the confluence with Iešjohka, is treated separately from the rest of Kárášjohka in this revision of the Tana spawning targets. This is in contrast to the original Kárášjohka-target (Hindar *et al*. 2007), which treated lower and upper Kárášjohka together.

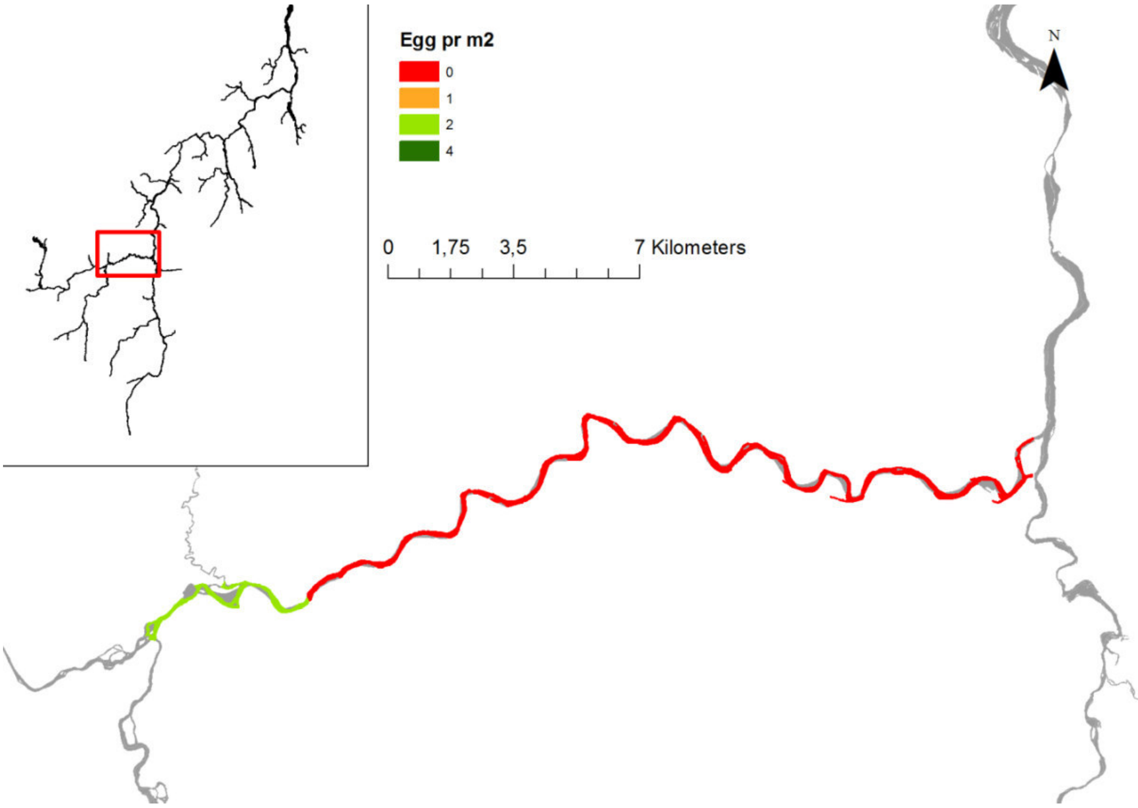

Figure 16. *Map of lower part of Kárášjohka with different egg category areas marked with colours. Red = 0 eggs m^{-2}, light green = 2 eggs m^{-2}.*

Most of lower Kárášjohka is a slow-flowing channel with sandy bottom (**Figure 16**). Only the uppermost part has better salmon habitat with gravel bottom and some spawning pools (marked light green in **Figure 16**). This upper area is assigned an egg density of 2 eggs m^{-2}. Egg density in 90 % of the lower slow-flowing area is set to 0 eggs m^{-2} (marked as red in **Figure 16**), while the remaining 10 % of the lower part is considered fringe areas used by salmon and set to 2 eggs m^{-2}.

The spawning target for the lower part of Kárášjohka then becomes 2 013 178 eggs (**Table 14**). No earlier target has been set specifically for this area.

***Table 14**. Summary table of lower Kárášjohka area and spawning target calculations.*

Area with 0 eggs m^{-2}	3 098 034
Area with 1 egg m^{-2}	0
Area with 2 eggs m^{-2}	1 006 589
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	**2 013 178**
Lower limit (eggs)	1 509 884
Upper limit (eggs)	3 019 767
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**1 118**
Lower limit (kg)	839
Upper limit (kg)	1 678
Mean size females (kg)	6
Spawning target (number of females)	**186**
Target estimates based on a stock-/sea-age-specific fecundity of 1 925 eggs kg^{-1} (3 % 1SW, 39 % 2SW, 58 % 3SW+):	
Spawning target (female biomass kg)	**1 046**
Lower limit (kg)	784
Upper limit (kg)	1 569
Mean size females (kg)	6
Spawning target (number of females)	**174**

When converting into female biomass using a fixed fecundity of 1 800 eggs kg^{-1}, a female biomass of 1 118 kg is needed to meet the egg deposit of the spawning target. The female sea age composition of Kárášjohka is dominated by large females, most notably 3SW (57 % of the biomass) and 2SW (40 %). The stock-/sea-age-specific relative fecundity then becomes 1 925 eggs kg^{-1}. With this relative fecundity, a total female biomass of 1 046 kg is needed to meet egg deposition of the spawning target.

3.17 Upper Kárášjohka

The habitat and river characteristics of Kárášjohka become more varied above the confluence with Iešjohka. There is one potential migration barrier, Šuorpmogorži, almost 55 km upstream from the confluence with Iešjohka. At this point, the river is divided into two channels, one with a vertical fall of 6-7 m; the other has a more gradual fall. Salmon can pass Šuorpmogorži, but we have no data to indicate how frequent this is, e.g. if it is possible only at certain favourable water levels.

There are no further migration barriers upstream, so salmon can migrate as far as river size allows above Šuorpmogorži. Electrofishing data from 2007 found juvenile salmon up to the outlet of Vuottašluoppal, 13.5 km above Šuorpmogorži. At this stage we need further mapping of the uppermost parts of Kárášjohka to establish a more accurate distribution limit, and for this revision of the spawning target we conservatively set the migration limit to the outlet of Vuottašjávri, 6 km above Vuottašluoppal (**Figure 17**).

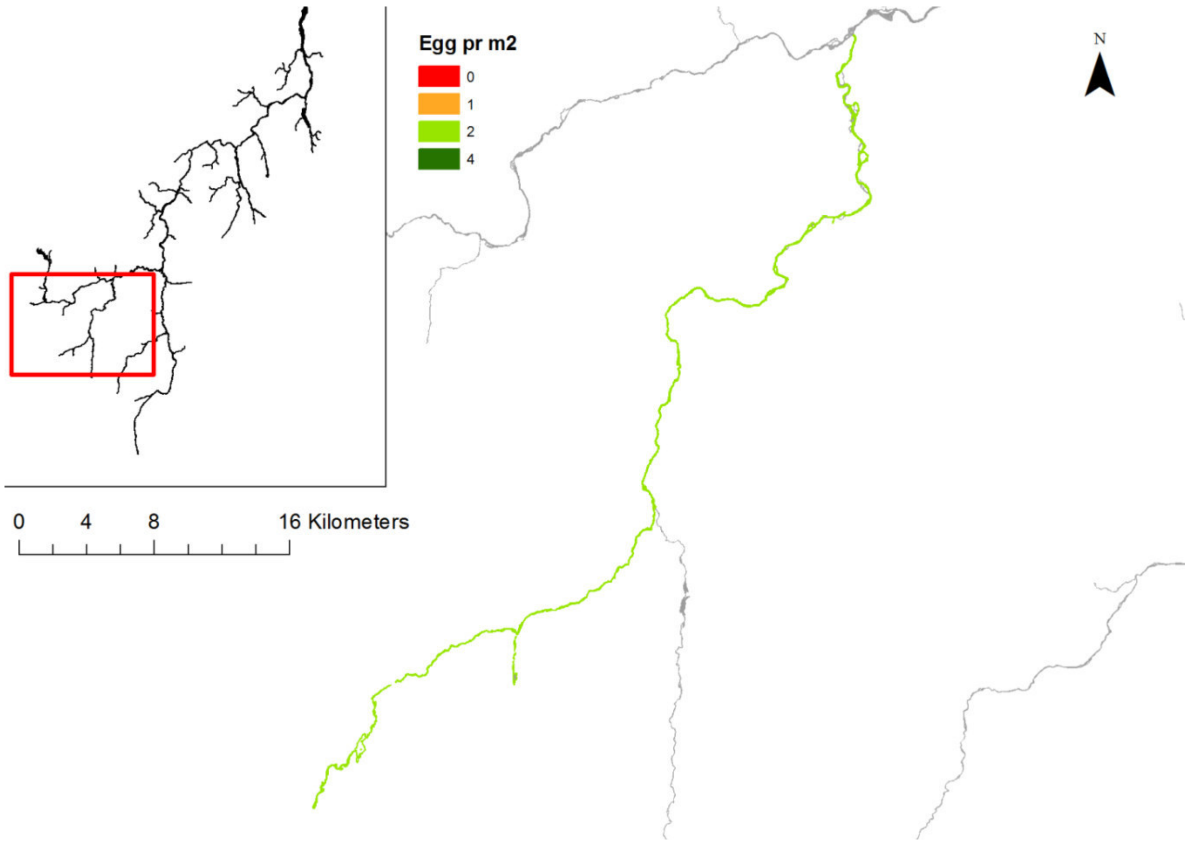

***Figure 17**. Map of upper part of Kárášjohka.*

The habitat of upper Kárášjohka is varied. Close to 40 % of the area are riffles and glides, a bit over 40 % are pools and the rest is slow-flowing areas. There are extensive areas well-suited for both spawning and juvenile production. We therefore set the egg density to 2 eggs m^{-2} for the entire area.

The estimated spawning target for upper Kárášjohka becomes 10 037 498 eggs (**Table 15**). No spawning target has been set specifically for this area earlier.

***Table 15**. Summary table of upper Kárášjohka area and spawning target calculations.*

Area with 0 eggs m^{-2}	0
Area with 1 egg m^{-2}	0
Area with 2 eggs m^{-2}	5 018 749
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	**10 037 498**
Lower limit (eggs)	7 528 124
Upper limit (eggs)	15 056 247
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**5 576**
Lower limit (kg)	4 182
Upper limit (kg)	8 365
Mean size females (kg)	6
Spawning target (number of females)	**929**
Target estimates based on a stock-/sea-age-specific fecundity of 1 925 eggs kg^{-1} (3 % 1SW, 39 % 2SW, 58 % 3SW+):	
Spawning target (female biomass kg)	**5 214**
Lower limit (kg)	3 911
Upper limit (kg)	7 821
Mean size females (kg)	6
Spawning target (number of females)	**869**

When using a fixed fecundity of 1 800 eggs kg^{-1}, a female biomass of 5 576 kg is needed to meet the spawning target. The female sea-age composition of Kárášjohka is dominated by large females, most notably 3SW+ (57 % of the biomass) and 2SW (40 %). The stock-/sea-age-specific relative fecundity then becomes 1 925 eggs kg^{-1}. With this relative fecundity, a total female biomass of 5 214 kg is needed to meet egg deposition of the spawning target.

It is difficult to compare the revised spawning targets with the original target set by Hindar *et al.* (2007). In this revision, we establish separate targets for lower and upper Kárášjohka and also separate targets for Bávttajohka and Geaimmejohka. The original target of 20 702 040 eggs was estimated by pooling all these areas together and using a constant egg density of 2 eggs m^{-2} for the entire area.

3.18 Geaimmejohka

This is a small tributary entering the lower Kárášjohka at Ássebákti, just 3.5 km downstream of the confluence between Kárášjohka and Iešjohka. Almost 10 km are available for salmon migration in Geaimmejohka, and the upper limit is formed by a waterfall (**Figure 18**).

There are some catch records from Geaimmejohka, indicating a grilse-based stock distributed all the way up to the waterfall. Snorkeling counts indicate a substantial spawning population (Johansen

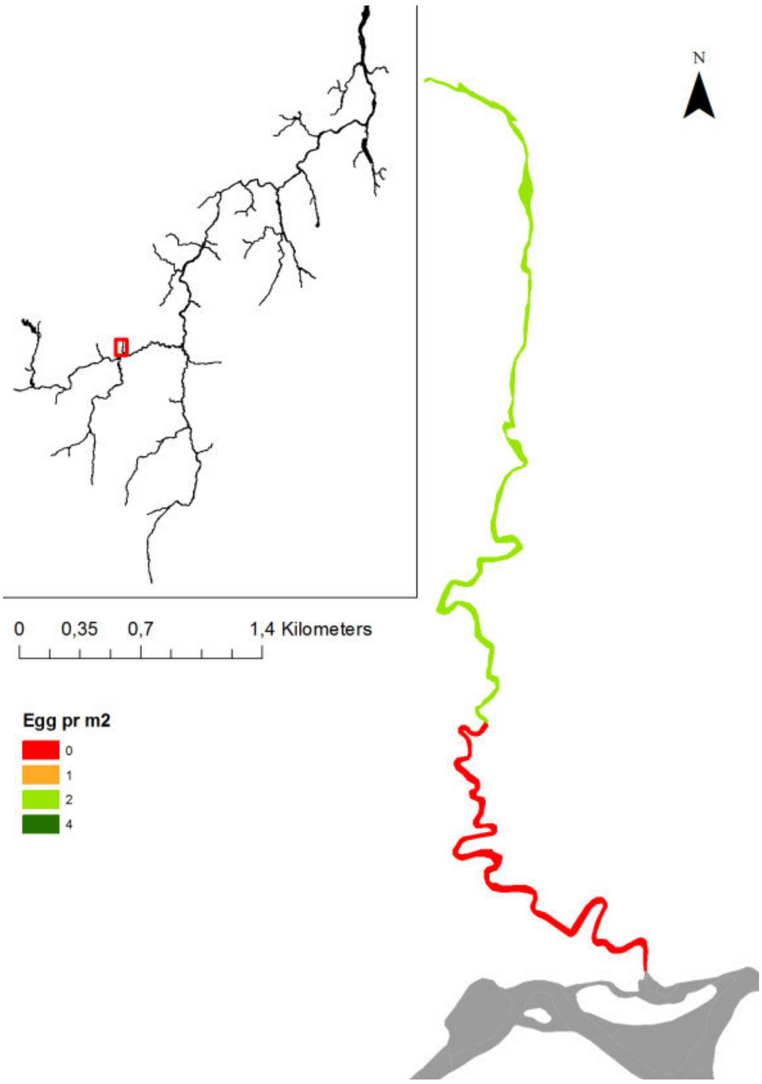

Figure 18. *Map of Geaimmejohka with different egg category areas marked with colours. Red = 0 eggs m*$^{-2}$*, light green = 2 eggs m*$^{-2}$*.*

The upper two-thirds of Geaimmejohka are relatively fast-flowing with considerably good salmon habitat (marked light green in **Figure 18**). An egg density level of 2 eggs m^{-2} was chosen for this area. The lower third is mostly slow-flowing channels (marked red in **Figure 18**), and 90 % of this area was set to 0 eggs m^{-2} while the remaining 10 % was set to 2 eggs m^{-2} to account for some fringe areas with better salmon habitat.

The spawning target for Geaimmejohka is 250 824 eggs (**Table 16**). No earlier target has been estimated specifically for this tributary.

Table 16. *Summary table of lower Geaimmejohka area and spawning target calculations.*

Area with 0 eggs m^{-2}	85 282
Area with 1 egg m^{-2}	0
Area with 2 eggs m^{-2}	125 412
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	**250 824**
Lower limit (eggs)	188 118
Upper limit (eggs)	376 236
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**139**
Lower limit (kg)	105
Upper limit (kg)	209
Mean size females (kg)	2.5
Spawning target (number of females)	**56**
Target estimates based on a stock-specific fecundity of 2 400 eggs kg^{-1} (20 % 1SW, 49 % 2SW, 31 % 3SW+):	
Spawning target (female biomass kg)	**105**
Lower limit (kg)	78
Upper limit (kg)	157
Mean size females (kg)	2.5
Spawning target (number of females)	**42**

In terms of female biomass, a total spawning stock of 139 kg females is needed to meet the spawning target when using a fixed fecundity of 1 800 eggs kg^{-1}. The female sea-age composition of Geaimmejohka is dominated by small 2SW salmon (49 % of the biomass) with a significant proportion 3SW+ salmon (31 %, mainly previous spawners) and 1SW salmon (20 %). The stock-/sea-age-specific relative fecundity then becomes 2 400 eggs kg^{-1}. With this fecundity, a spawning stock of 105 kg females is needed to meet the spawning target.

3.19 Bávttajohka

This is a medium-sized tributary entering the upper Kárášjohka at Beaivvašgieddi. Bávttajohka is a long tributary without any migration barriers, so the salmon can migrate upstream as long as there is sufficient water available (**Figure 19**).

Bávttajohka is a remote and inaccessible river with few visiting fishermen and scant catch reports. A 2007-electrofishing trip demonstrated that fry and juvenile salmon were found at least 20 km upstream in Bávttajohka, with good densities in some locations (Orell *et al*. 2008). There are local reports claiming that a significant proportion of the salmon migration past Beaivvašgieddi enters Bávttajohka instead of moving further up Kárášjohka, which might indicate the existence of a significant salmon population in the river.

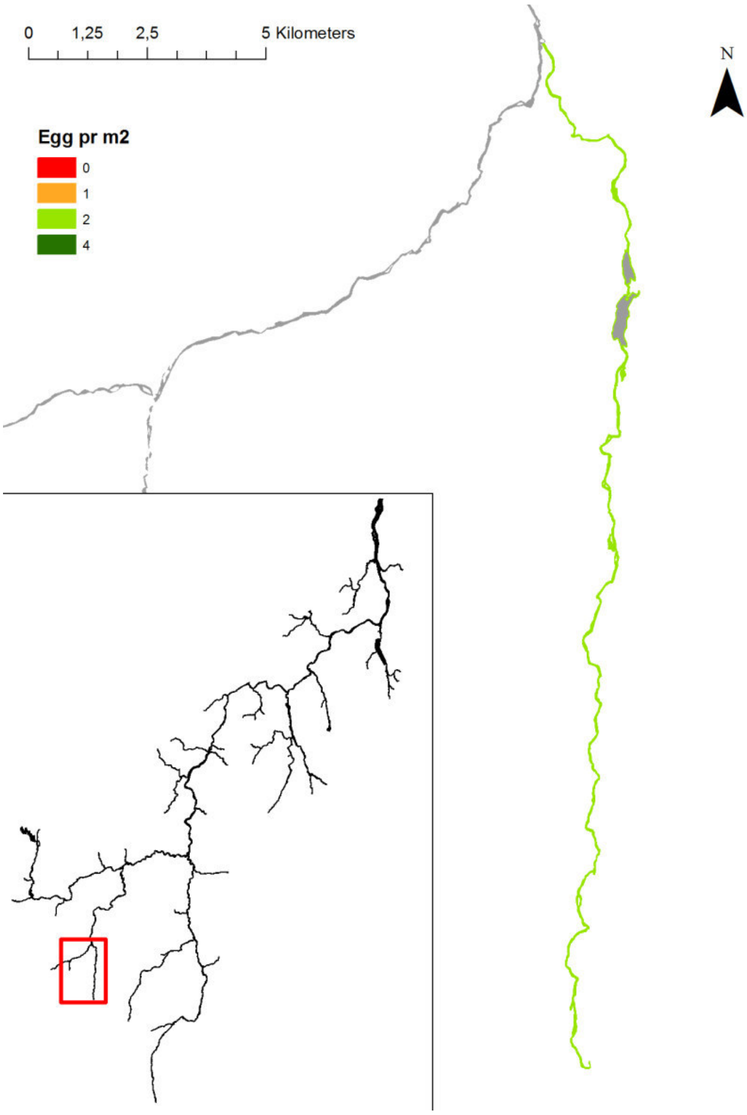

Figure 19. *Map of Bávttajohka.*

There is a lot of habitat variation along the Bávttajohka, with both extended areas with riffle-pool habitats and several lakes. A 10 m shoreline buffer was used to calculate area contribution from lakes. The overall habitat quality is good, but there are likely some areas with limited spawning opportunities. Egg density for the entire river area was set to 2 eggs m^{-2}.

The spawning target for Bávttajohka is estimated to 1 735 823 eggs (**Table 17**). No spawning target has been set specifically for this tributary earlier.

***Table 17**. Summary table of Bávttajohka area and spawning target calculations.*

Area with 0 eggs m^{-2}	0
Area with 1 egg m^{-2}	0
Area with 2 eggs m^{-2}	867 911
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	**1 735 823**
Lower limit (eggs)	1 301 867
Upper limit (eggs)	2 603 733
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**964**
Lower limit (kg)	723
Upper limit (kg)	1 447
Mean size females (kg)	6
Spawning target (number of females)	**161**
Target estimates based on a stock-/sea-age-specific fecundity of 1 875 eggs kg^{-1} (3 % 1SW, 22 % 2SW, 75 % 3SW+):	
Spawning target (female biomass kg)	**926**
Lower limit (kg)	694
Upper limit (kg)	1 389
Mean size females (kg)	6
Spawning target (number of females)	**154**

When converted to female biomass using a fixed fecundity of 1 800 eggs kg^{-1}, a total biomass of 964 kg is needed for the egg deposition to reach the spawning target. The female sea-age composition in Bávttajohka is dominated by large salmon, with 75 % of the female biomass being 3SW+ salmon and previous spawners. The resulting stock-/sea-age-specific relative fecundity becomes 1 875 eggs kg^{-1}, and the female biomass needed to meet the spawning target becomes 926 kg.

The current management limit in Bávttajohka is set to just above Gaibafielbmá, approximately 25 km upstream from Beaivvašgieddi. This is the point used to define the salmon producing area for the spawning target in this revision. There are, however, old local knowledge sources citing catch reports over 20 km further upstream. A new management limit has therefore been suggested set at Njuvdindievvá, close to 50 km upstream of Beaivvašgieddi. There is a paucity of data available about the current and potential salmon distribution in Bávttajohka, and this lack of data should be remedied before setting a second-generation spawning target for the river.

3.20 Iešjohka

This large headwater river joins the Kárášjohka from the west at Ássebákti. Iešjohka comes from the large Lake Iešjávri, giving a total river length of approximately 87 km. In addition there are five tributaries – Sádejohka, Ástejohka, Vuottašjohka, Rágesjohka and Mollešjohka – that potentially contribute to salmon production in Iešjohka (**Figure 20**).

There is one major migration barrier, Iešjohkgorži, around 65 km from the confluence with Kárášjohka. This waterfall is approximately 5 m high; vertical on the eastern side but more gradually sloped in a channel on the western side. Salmon can pass in this western channel at low water levels. There are no migration barriers further up, so salmon that pass the waterfall are free to swim all the way up to Iešjávri. There are rivers entering Iešjávri that could potentially contribute to salmon production, but this is largely unknown. Iešjávri is used as the upper limit of salmon distribution in this revision of the Iešjohka spawning target.

The inclusion of the area above Iešjohkgorži (Iešjohka up to Iešjávri and Mollešjohka) is problematic as we have no information about to what extent and under which conditions the waterfall functions as a barrier. There are, however, several reliable local knowledge accounts of salmon being caught throughout the uppermost areas of Iešjohka. Juvenile salmon were found above the waterfall in 1986 (Moen, unpublished data), while no juveniles were found in an extensive survey in 2007 (Orell *et al.* 2010). This indicates that the area above Iešjohkgorži potentially can contribute to salmon production in Iešjohka, but that this contribution has been low with the poor stock situation in the last couple of decades. This notion is corroborated by recent local knowledge reports from the area.

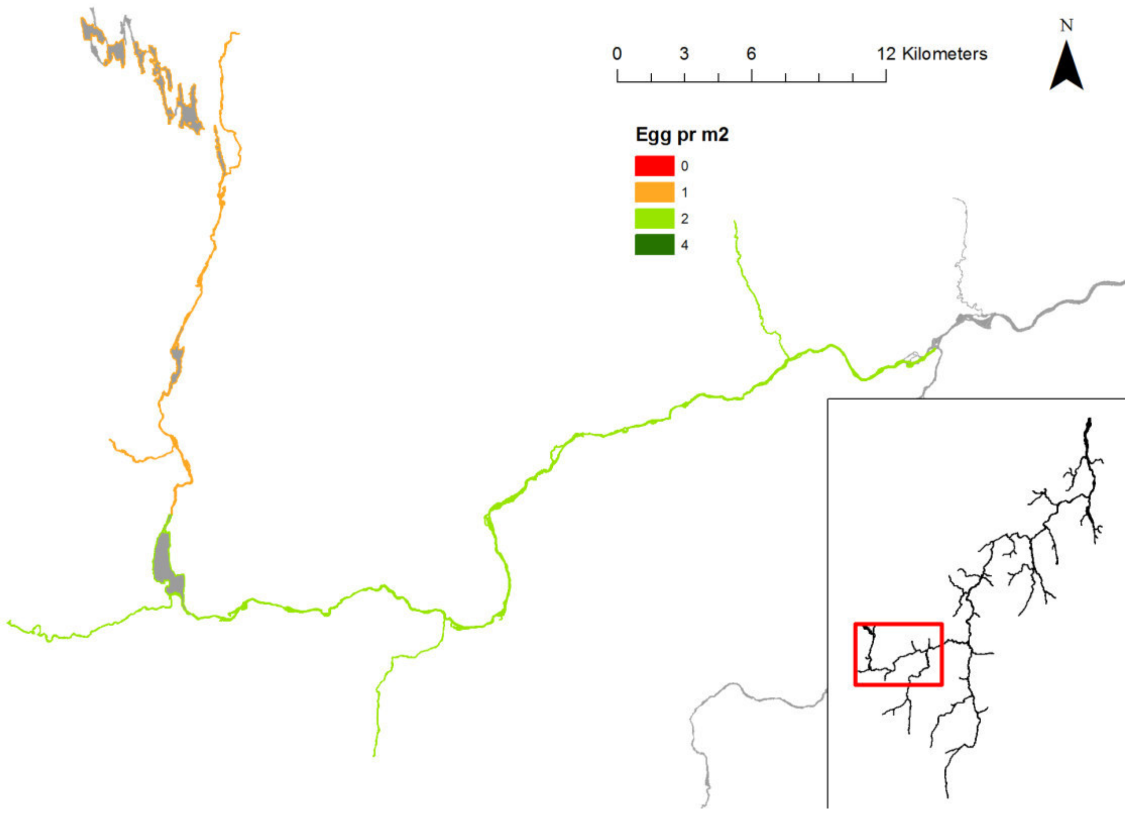

Figure 20*. Map of Iešjohka with different egg category areas marked with colours. Orange = 1 egg m^{-2}, light green = 2 eggs m^{-2}.*

The habitat of **Iešjohka** is a combination of fast-flowing riffles, pools and lakes. There is a major contrast between the river above and below the lake Šuoššjávri. Around 41 % of the area from Kárášjohka to Šuoššjávri is riffles and glides, 32 % are pools and 27 % lakes. There is a lot of good habitat for spawning and juveniles in this part. Above Šuoššjávri, 83 % of the river area is lake sections, while fast-flowing riffles and glides form 7 % and pools form 10 % of the area. The substratum throughout this area is coarse. This combination of predominantly rocky substratum and lakes indicates that spawning grounds are in short supply, probably constraining salmon production above Šuoššjávri.

Due to the clear separation in habitat above and below Šuoššjávri, we separated the Iešjohka into two parts with differing egg densities:

1) Below Šuoššjávri, an egg density of 2 eggs m^{-2} was used (marked light green in **Figure 20**).

2) Upstream Šuoššjávri an egg density of 1 egg m^{-2} was used (marked orange in **Figure 20**).

For all lakes, a 10 m shoreline buffer was used for area calculations. No juvenile salmon were found in lake Šuoššjávri in a test sampling in 2013 (Johansen 2014), indicating that this lake currently is not contributing to salmon production in the river. However, the low densities of juvenile salmon found in the lake inlet and outlet areas is a clear indication that salmon spawning in the area has been at very low levels in recent years. The lack of juveniles in the lake is therefore not surprising.

Sádejohka is a small river that enters Iešjohka from the north c. 8 km above the confluence with Kárášjohka. There are no migration barriers apart from a steep area c. 2 km upstream from the river mouth. In an anonymous electrofishing survey from 1979 (County Governor of Finnmark, unpublished data), juvenile salmon, including some fry, were found from the river mouth and close to 5 km upstream in Sádejohka. There are several areas that are favourable for salmon production, and Sádejohka is likely an important rearing habitat for Iešjohka-salmon.

Ástejohka is a river entering Iešjohka from the south close to 25 km upstream from the confluence between Iešjohka and Kárášjohka. There are no migration barriers in the form of waterfalls, but the river channel is very wide and shallow in several areas. This is especially the case for the river outlet, which is broken into several discrete channels, each of which are wide and shallow, effectively flowing only in between rocks at lower water levels. Salmon migration into Ástejohka is therefore likely limited to high-flow periods. There are local knowledge reports that adult salmon occasionally have been caught in Ástejohka. The habitat quality of Ástejohka is favourable for salmon production, particularly juvenile, and the river is likely an important rearing habitat for salmon. Juvenile salmon was found to be widespread in Ástejohka in an electrofishing survey from 1985 (Moen, unpublished), with the highest densities in the upper part of the river (towards Ástejávri). The catch was mostly parr that might have migrated into Ástejohka from Iešjohka, but the presence of some fry indicates that at least some spawning had taken place also in Ástejohka.

Vuottašjohka enters the lake Šuoššjávri from the west. It forms a deep and slow-flowing channel in its lowermost part, including the river mouth, but further up the habitat becomes favourable for salmon. No juvenile salmon has been found in Vuottašjohka in recent years, but some salmon parr were found throughout the river in an electrofishing survey in 1985 (Moen, unpublished).

Rágesjohka enters Iešjohka from the west c. 4 km upstream of Šuoššjávri. Old local knowledge sources state that salmon have been caught in Rágesjohka all the way up to Rágesjávri, c. 15 km from the river mouth. The present management limit is however set to a point in the lowermost part c. 3.5 km from the river mouth and 2 km below Rágesluobbalat, and this point was used for area calculations in this report. The overall habitat quality in Rágesjohka is favourable for salmon production. The river mouth, however, likely poses a challenge for ascending adult salmon. The river becomes divided into several wide and shallow channels and upstream migration of adult salmon will be a problem at low water levels. A few juvenile salmon (parr only) were found in the lower part of Rágesjohka in an electrofishing survey in 1985 (Moen, unpublished).

***Table 18**. Summary table of Iešjohka area and spawning target calculations.*

Area with 0 eggs m^{-2}	0
Area with 1 egg m^{-2}	2 096 991
Area with 2 eggs m^{-2}	4 719 509
Area with 4 eggs m^{-2}	0
Spawning target (number of eggs)	**11 536 009**
Lower limit (eggs)	8 127 759
Upper limit (eggs)	17 304 014
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**6 408**
Lower limit (kg)	4 515
Upper limit (kg)	9 613
Mean size females (kg)	6
Spawning target (number of females)	**1 068**
Target estimates based on a stock-/sea-age-specific fecundity of 1 900 eggs kg^{-1} (3 % 1SW, 28 % 2SW, 69 % 3SW+):	
Spawning target (female biomass kg)	**6 072**
Lower limit (kg)	4 278
Upper limit (kg)	9 107
Mean size females (kg)	6
Spawning target (number of females)	**1 012**

The revised target of 11 536 009 eggs (**Table 18**) is markedly higher than the original target of 10 351 220 eggs (Hindar *et al*. 2007). This difference is mainly caused by a higher area estimate in the revision (revised area 6 816 500 m^2, original area 5 175 610 m^2) that can be traced to moving the upper limit of salmon production from Iešjohkgorži to Iešjávri.

When we use a fixed fecundity of 1 800 eggs kg^{-1}, the revised female biomass needed to meet the egg deposition of the spawning target becomes 6 408 kg. This is a significant increase from the original target of 5 751 kg (Hindar *et al.* 2007). The female sea-age composition in Iešjohka is dominated by 3SW+ salmon and previous spawners (69 % of the biomass) with a significant fraction of 2SW salmon (28 %). The stock-/sea-age-specific relative fecundity then becomes 1 900 eggs kg^{-1}. When using this fecundity ratio, a total biomass of 6 072 kg is needed to produce the number of eggs specified by the spawning target.

3.21 Anárjohka/Inarijoki

The large headwater river Anárjohka/Inarijoki flows northwards and eventually forms the Tana main stem together with Kárášjohka. The total river length available for salmon migration in Anárjohka/Inarijoki is 93 km, with the 12-15 m high Gumpegorži forming an efficient upper barrier for salmon migration (**Figure 21**). The lower 83 km are border areas between Norway and Finland, while the remaining uppermost 10 km are Norwegian only. There are several tributaries with salmon stocks on both sides of Anárjohka/Inarijoki.

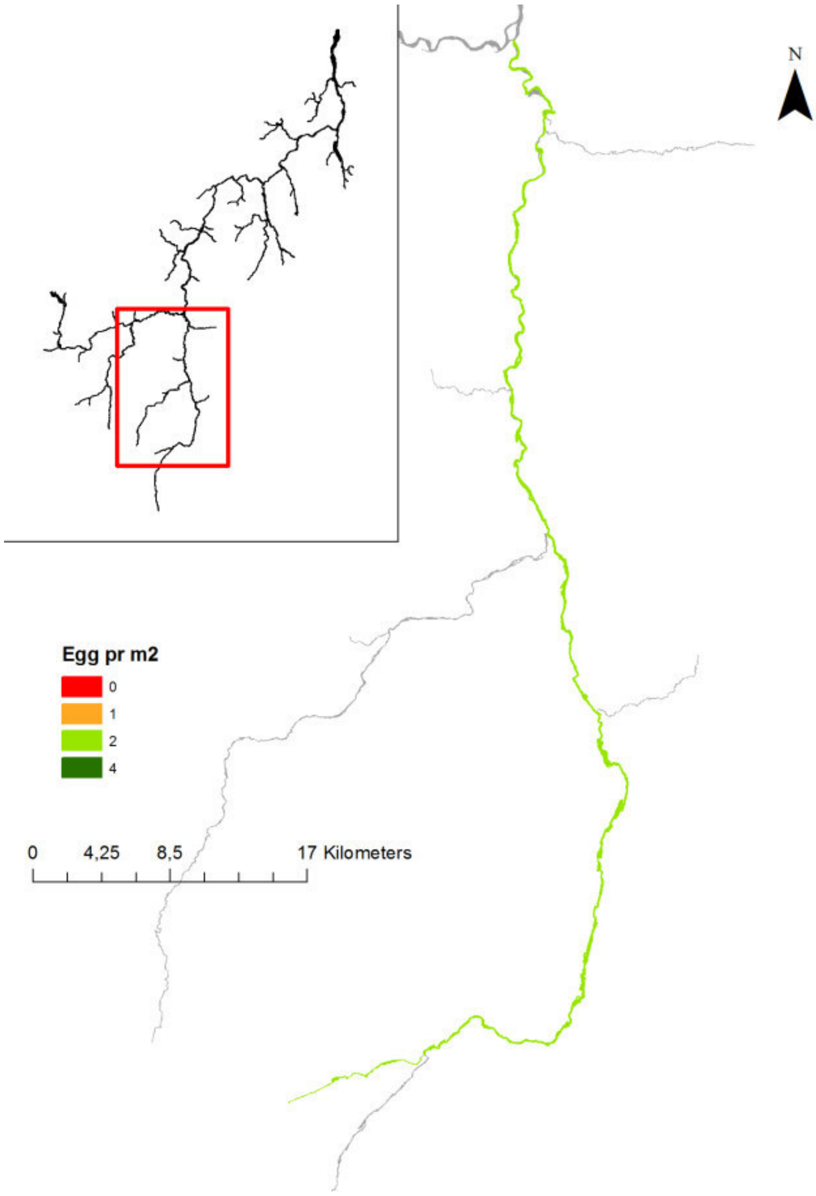

Figure 21*. Map of Anárjohka/Inarijoki.*

There are several slow-flowing areas/lakes in the lowermost 10 km (up to Bahásguoika). For the next 40-45 km (up to Ártnetjávri), Anárjohka/Inarijoki has better habitat with lots of pools and several good spawning grounds. Above Ártnetjávri, all the way up to Gumpegorži, the slow flowing areas/lakes occur more frequently again, but with quite a few riffle sections in between. An egg density of 2 eggs m^{-2} was assigned to the production areas in Anárjohka/Inarijoki. Lake area was included as 5-m shoreline buffers.

***Table 19**. Summary table of Anárjohka/Inarijoki area and spawning target calculations.*

	Anárjohka/ Inarijoki (total)	**Anárjohka/ Inarijoki (border)**	**Anárjohka (upper Norwegian)**
Area with 0 eggs m^{-2}	2 600 000	2 600 000	0
Area with 1 egg m^{-2}	0	0	0
Area with 2 eggs m^{-2}	5 641 976	4 861 376	780 600
Area with 4 eggs m^{-2}	0	0	0
Spawning target (number of eggs)	**11 283 952**	**9 722 751**	**1 561 200**
Lower limit (eggs)	8 462 964	7 292 064	1 170 900
Upper limit (eggs)	16 925 928	14 584 128	2 341 800
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:			
Spawning target (female biomass kg)	**6 269**	**5 402**	**867**
Lower limit (kg)	4 702	4 051	651
Upper limit (kg)	9 403	8 102	1 301
Mean size females (kg)	4	4	4
Spawning target (number of females)	**1 567**	**1 351**	**217**
Target estimates based on a stock-/sea-age-specific fecundity of 2 225 eggs kg^{-1} (19 % 1SW, 63 % 2SW, 17 % 3SW+):			
Spawning target (female biomass kg)	**5 071**	**4 370**	**702**
Lower limit (kg)	3 804	3 277	526
Upper limit (kg)	7 607	6 555	1 052
Mean size females (kg)	4	4	4
Spawning target (number of females)	**1 268**	**1 092**	**175**

The revised spawning target for Anárjohka/Inarijoki was estimated to 11 283 951 eggs (**Table 19**). This revised target cannot be directly compared with the original spawning target of 16 600 000 eggs (Hindar *et al.* 2007). Firstly, the original target includes both the Anárjohka/Inarijoki and connected tributaries, while in this revision all tributaries to Anárjohka/Inarijoki are treated separately. Secondly, the original target was estimated using a rough estimate of productive area from Niemelä *et al.* (1999). The revised target of Anárjohka/Inarijoki plus tributaries is 17 910 000 eggs, which is a significant increase from the original target.

With a fixed fecundity of 1 800 eggs kg^{-1}, a total of 6 269 kg females are needed for the stock to attain its spawning target. The female sea age composition of Anárjohka/Inarijoki is dominated by 2SW salmon (68 %) with only a small proportion of 3SW+ salmon (13 %) and 1SW salmon (19 %). This results in a stock-/sea-age-specific relative fecundity of 2 225 eggs kg^{-1}. With this fecundity, the female biomass needed to reach the spawning target becomes 5 071 kg.

3.22 Gáregasjohka/Karigasjoki

Gáregasjohka/Karigasjoki is a small tributary entering the River Inarijoki from the Finnish side approximately 9 km upstream from the confluence with Kárášjohka. Karigasjoki has a catchment area of 200 km^2, and c. 18 km of the river is available for salmon production (**Figure 22**).

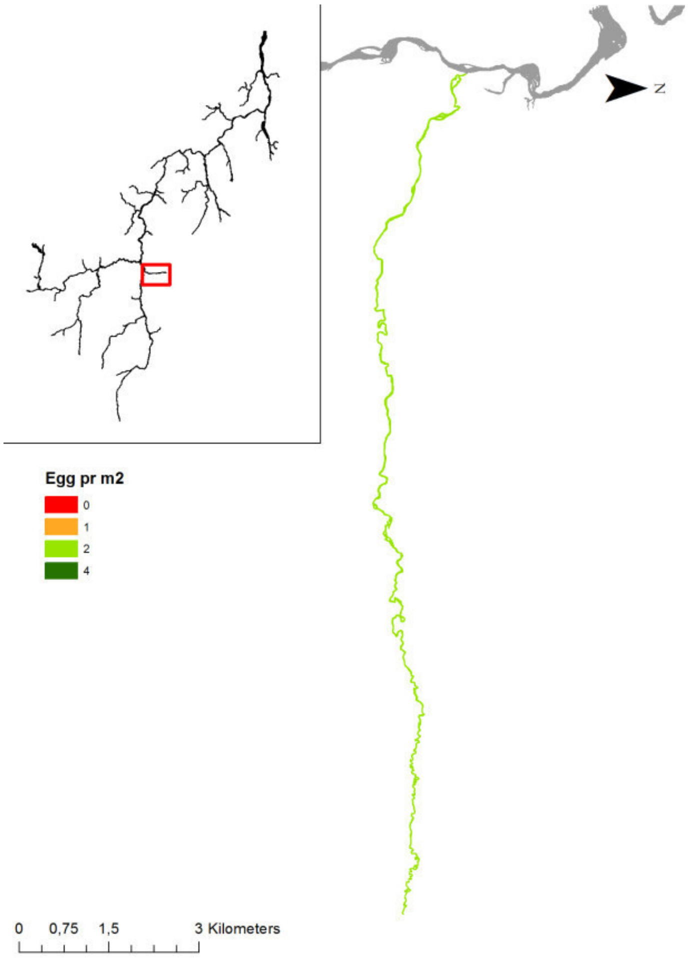

***Figure 22**. Map of Gáregasjohka/Karigasjoki.*

Based on habitat and electrofishing surveys, the habitat quality of Karigasjoki is estimated as reasonably good and an egg density level of 2 eggs m^{-2} was therefore set to the whole salmon distribution area.

The spawning target was estimated to 598 000 eggs (**Table 20**). No earlier spawning target has been estimated for this tributary.

Table 20. *Summary table of Gáregasjohka/Karigasjoki area and spawning target calculations.*

Area with 0 eggs m^2	0
Area with 1 egg m^2	0
Area with 2 eggs m^2	299 000
Area with 4 eggs m^2	0
Spawning target (number of eggs)	**598 000**
Lower limit (eggs)	448 500
Upper limit (eggs)	897 000
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**332**
Lower limit (kg)	249
Upper limit (kg)	498
Mean size females (kg)	2
Spawning target (number of females)	**166**
Target estimates based on a stock-/sea-age-specific fecundity of 2 500 eggs kg^{-1} (49 % 1SW, 38 % 2SW, 13 % 3SW+):	
Spawning target (female biomass kg)	**239**
Lower limit (kg)	179
Upper limit (kg)	359
Mean size females (kg)	2
Spawning target (number of females)	**120**

Using a fixed fecundity of 1 800 eggs kg^{-1}, the female biomass needed to produce the egg number specified by the spawning target becomes 332 kg. The sea-age composition of Karigasjoki is dominated by 1SW (49 % of the biomass) and 2SW (38 %) and the stock-/sea-age-specific relative fecundity becomes 2 500 eggs kg^{-1}. With this fecundity, 239 kg females are needed for the egg deposition to reach the spawning target.

3.23 Iškorasjohka

This small-sized Norwegian tributary enters Anárjohka/Inarijoki almost 30 km upstream from the Kárášjohka confluence. There are no migration barriers so salmon are free to migrate as far upstream as allowed for by river size. The current management limit is set 7 km upstream in Iškorasjohka (**Figure 23**). Electrofishing data from 2010 (Orell 2011) found, however, juvenile salmon fry and parr over 1 km upstream of the Heargejohka-outlet, indicating that salmon are present over a river length of 11 km in Iškorasjohka and we used this river length in the spawning target estimation here.

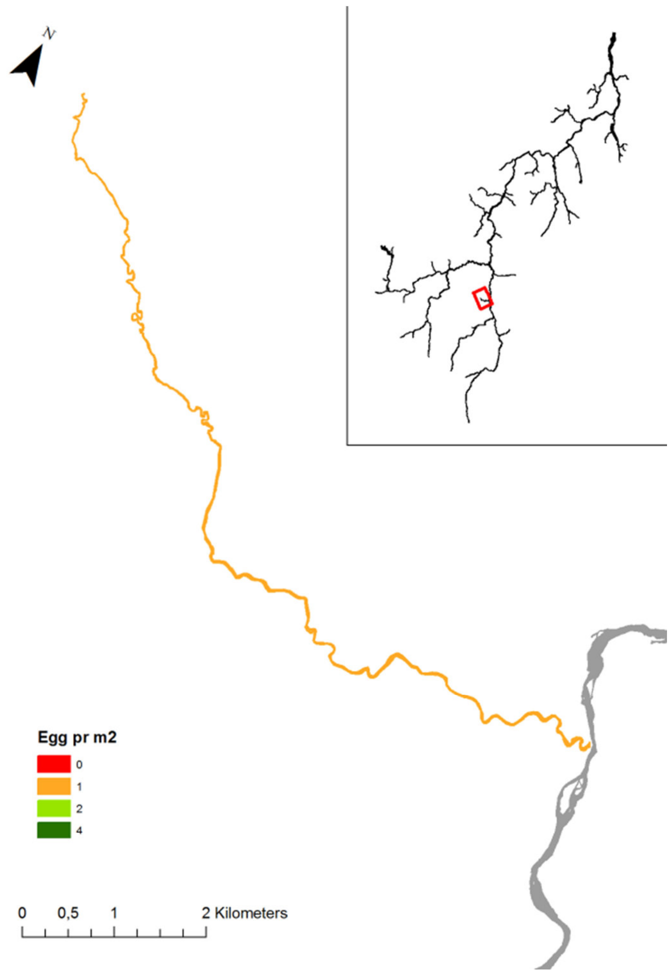

***Figure 23**. Map of Iškorasjohka.*

The overall habitat quality of Iškorasjohka is not favourable either for spawning or juvenile production, so an egg density of 1 egg m^{-2} was used for the entire river area.

The spawning target for Iškorasjohka was estimated to 213 000 eggs (**Table 21**). No earlier target has been set for this river.

***Table 21**. Summary table of Iškorasjohka area and spawning target calculations.*

Area with 0 eggs m^2	0
Area with 1 egg m^2	213 000
Area with 2 eggs m^2	0
Area with 4 eggs m^2	0
Spawning target (number of eggs)	**213 000**
Lower limit (eggs)	106 500
Upper limit (eggs)	319 500
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**118**
Lower limit (kg)	59
Upper limit (kg)	178
Mean size females (kg)	3
Spawning target (number of females)	**39**
Target estimates based on a stock-/sea-age-specific fecundity of 2 150 eggs kg^{-1} (8 % 1SW, 56 % 2SW, 36 % 3SW+):	
Spawning target (female biomass kg)	**99**
Lower limit (kg)	50
Upper limit (kg)	149
Mean size females (kg)	3
Spawning target (number of females)	**33**

Using a fixed fecundity of 1 800 eggs kg^{-1}, the female biomass needed to produce the egg number specified by the spawning target becomes 118 kg. The sea age composition of Iškorasjohka is dominated by 2SW (56 % of the biomass) and the stock-/sea-age-specific relative fecundity becomes 2 150 eggs kg^{-1}. With this fecundity, 99 kg females are needed for the egg deposition to reach the spawning target.

The status of Iškorasjohka as a salmon river is contentious. On one hand, electrofishing surveys have found salmon fry, albeit in limited numbers, indicating that salmon spawning have occurred. We also have historic reports of salmon catches. On the other hand, there are indications that the river primarily is used by trout, e.g. as demonstrated in a snorkeling survey in 2014 which found several large-sized trout and no salmon (Orell, unpublished data). The genetic profile of juveniles from Iškorasjohka also has clear similarities to the genetic profile of salmon from the neighbouring river Goššjohka. Taken together, this is an indication that the occasional catches and spawning of salmon in Iškorasjohka might be strays from neighbouring rivers and not salmon from an actual Iškorasjohka-population.

3.24 Goššjohka

This is a medium-sized tributary with a catchment area of 786 km^2 localized close to 40 km up in Anárjohka/Inarijoki. There are no migration barriers in Goššjohka, so salmon are free to migrate upstream as far as the river size allows. The current management limit is set almost 50 km up the river, at a point close to Geatkevárri. There is one tributary, Vuččoljohka, that also contributes a few km to the salmon production area.

The entire river length shown in **Figure 24** was mapped with electrofishing in 2013. Juvenile salmon, both fry and parr, were found at all investigated sites, indicating that the whole accessible river length is currently being used for salmon production.

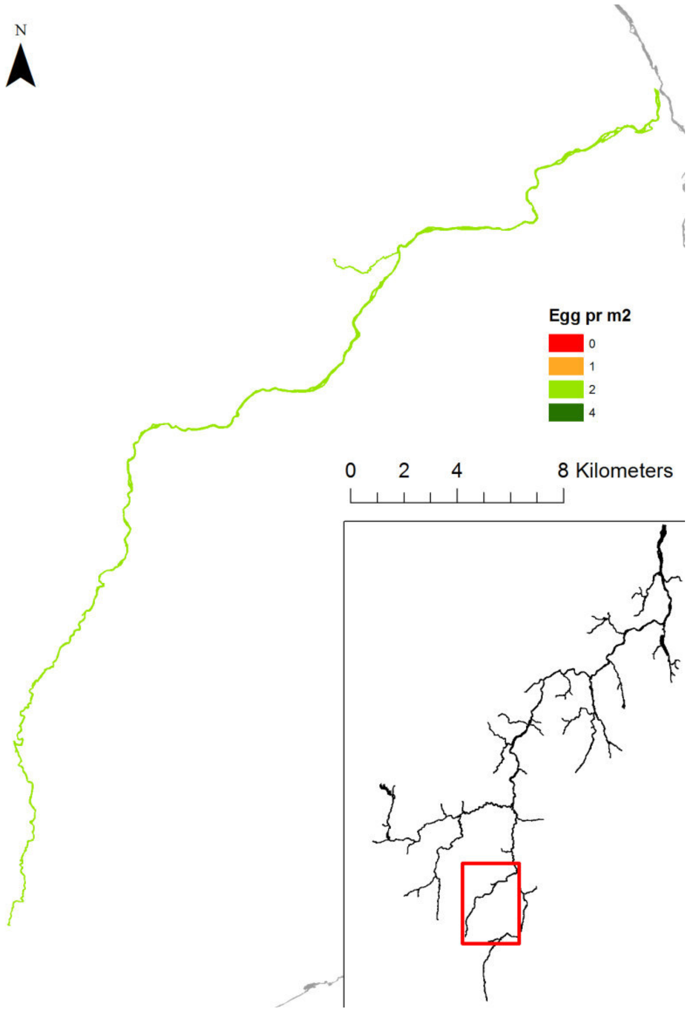

Figure 24*. Map of Goššjohka.*

The overall habitat quality in Goššjohka is good for salmon production, both spawning and juveniles. An egg density of 2 eggs m^{-2} was therefore used for the entire area.

The spawning target was set to 5 206 840 eggs (**Table 22**). No earlier target has been set for this river.

***Table 22**. Summary table of Goššjohka area and spawning target calculations.*

Area with 0 eggs m^2	0
Area with 1 egg m^2	0
Area with 2 eggs m^2	2 603 420
Area with 4 eggs m^2	0
Spawning target (number of eggs)	**5 206 840**
Lower limit (eggs)	3 905 130
Upper limit (eggs)	7 810 260
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**2 892**
Lower limit (kg)	2 170
Upper limit (kg)	4 339
Mean size females (kg)	3
Spawning target (number of females)	**964**
Target estimates based on a stock-/sea-age-specific fecundity of 2 225 eggs kg^{-1} (9 % 1SW, 67 % 2SW, 24 % 3SW+):	
Spawning target (female biomass kg)	**2 340**
Lower limit (kg)	1 755
Upper limit (kg)	3 510
Mean size females (kg)	3
Spawning target (number of females)	**780**

The estimated female biomass needed to produce the above number of eggs was 2 892 kg when using a fixed fecundity of 1 800 eggs kg^{-1}. The sea-age composition among females in Goššjohka is dominated by 2SW (67 % of the biomass) with a small proportion of 3SW and previous spawners (24 %) and 1SW (9 %). The stock-/sea-age-specific relative fecundity then becomes 2 225 eggs kg^{-1}. With this fecundity, the female biomass needed to produce a sufficient number of eggs becomes 2 340 kg.

3.25 Skiehččanjohka/Kietsimäjoki

Skiehččanjohka/Kietsimäjoki is the uppermost tributary of Anárjohka/Inarijoki, entering from the south approximately 83 km upstream from the Inarijoki mouth. At this point, Inarijoki turns west into Norway, and the border between Norway and Finland continues as River Kietsimäjoki. The river has a catchment area of 276 km^2. Most of the Kietsimäjoki is a succession of lakes, separated by riffle stretches of varying lengths (**Figure 25**).

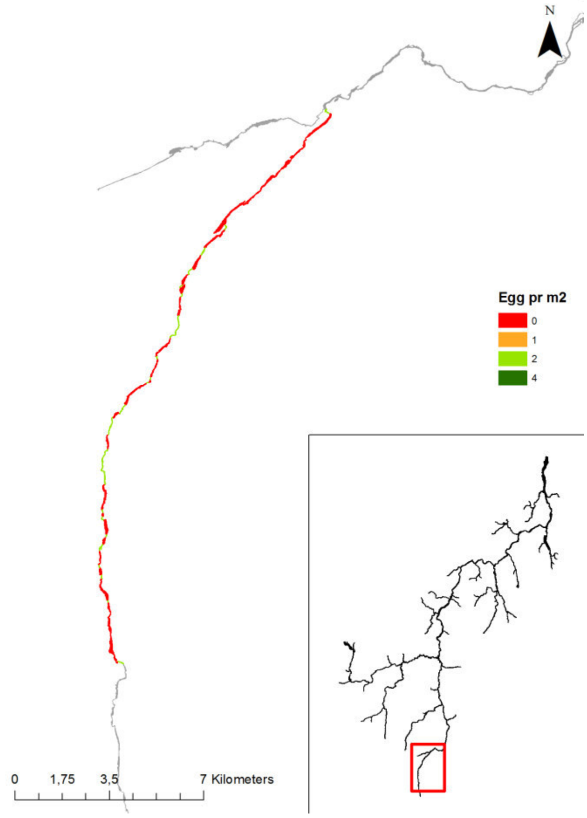

Figure 25. *Map of Skiehččanjohka/Kietsimäjoki.*

There are no migration barriers, so salmon is capable of migrating as far up as the river size allows. The only reasonable production areas in Kietsimäjoki are the short riffle stretches between the lakes. Overall, based on habitat and electrofishing surveys in 2011, the habitat quality of Kietsimäjoki is estimated as moderate or poor. Thus, egg density level for the riffle areas was set to 2 eggs m^{-2} and the remaining lake areas were set to 0 eggs m^{-2}.

The spawning target of Skiehččanjohka/Kietsimäjoki was estimated to 398 160 eggs (**Table 23**). No earlier target has been set for this river.

***Table 23**. Summary table of Skiehččanjohka/Kietsimäjoki area and spawning target calculations.*

Area with 0 eggs m^2	898 820
Area with 1 egg m^2	0
Area with 2 eggs m^2	199 080
Area with 4 eggs m^2	0
Spawning target (number of eggs)	**398 160**
Lower limit (eggs)	298 620
Upper limit (eggs)	597 240
Target estimates based on a fixed fecundity of 1 800 eggs kg^{-1}:	
Spawning target (female biomass kg)	**221**
Lower limit (kg)	166
Upper limit (kg)	332
Mean size females (kg)	4
Spawning target (number of females)	**55**
Target estimates based on a stock-/sea-age-specific fecundity of 2 125 eggs kg^{-1} (6 % 1SW, 58 % 2SW, 36 % 3SW+):	
Spawning target (female biomass kg)	**187**
Lower limit (kg)	141
Upper limit (kg)	281
Mean size females (kg)	4
Spawning target (number of females)	**47**

In terms of female biomass, a total of 221 kg is needed to meet the spawning target when using a fixed fecundity of 1 800 eggs kg^{-1}. The female sea-age composition of Skiehččanjohka/Kietsimäjoki is dominated by 2SW (63 % of the biomass) and 3SW (31 %), and the stock-/sea-age-specific relative fecundity becomes 2 125 eggs kg^{-1}. With this fecundity, a female biomass of 187 kg is needed to meet the egg deposition of the spawning target.

4 Concluding discussion and future recommendations

Spawning targets are the main basis for a knowledge-based management of salmon in Tana. The targets represent a benchmark for evaluating the stock status throughout the river system, and this report forms the first comprehensive study of spawning targets in all parts of the Tana river system. We employed the first-generation spawning target model established by Hindar *et al*. (2007), and have revised the original targets with new local expert knowledge and established new targets for the areas that were missing in the original report.

Throughout the text, we have tried to identify knowledge gaps that affect the present spawning target estimation. Most of these questions are related to habitat and salmon distribution. The habitat related questions are directly relevant and probably best dealt with within the context of establishing second-generation targets in Tana (see below).

The distribution-related questions are more problematic. For instance, there are tributaries in which the present distribution (even a lack of salmon in some cases) is smaller than the distribution shown (or suggested in some cases) by historic data. One large-scale example of this is the upper part of Iešjohka, where recent surveys show little evidence of any salmon reproduction. This is in strong contrast to historic data (e.g. electrofishing survey in Bjerknes 1978) and local knowledge in the area.

So, when establishing new targets, subjective decisions needed to be made about the total salmon production area. Historic local knowledge and habitat suitability evaluations were used to infer the likely maximum salmon distribution in a tributary. This distribution is thought to reflect a good stock situation, as opposed to a limited distribution caused by the depleted stock situation some of these stocks are struggling with today.

Work has started on establishing second-generation spawning targets. The second-generation model has three main goals: (1) improve spawning target precision, (2) increase transparency and decrease the reliance on local expert opinion by developing more objective evaluation criteria for habitat classification, and (3) improve public endorsement by actively employing local stakeholder groups in the data collection necessary for establishing improved spawning targets.

The present revision now enables a comprehensive stock status evaluation covering the entire Tana river system. The estimated targets represent the best knowledge we currently have, and should therefore immediately, in accordance with the precautionary approach, form a decisive basis for current status evaluations and management decisions.

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