STATUS OF THE RIVER TANA SALMON POPULATIONS 2016

Report of the Working Group on Salmon Monitoring and Research in the Tana River System

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CONTENTS

SUMMARY

The Group and its mandate

The Tana monitoring and research group was formally appointed in 2010 by the Ministry of Agriculture and Forestry in Finland and the Ministry of Environment in Norway, based on the Memorandum of Understanding signed in February 2010. Among other points defined in its mandate, the Group should deliver annual reports on the status of the salmon stocks, evaluate the management of stocks, and give advice on relevant monitoring and research. The Group recognizes the potential positive contribution from local/traditional (ecological) knowledge, and currently makes use of relevant knowledge in its work.

Management of the Tana salmon

Both Norway and Finland (through EU) are members of the North Atlantic Salmon Conservation Organization (NASCO), which is an international organization with an objective to conserve, restore, enhance and rationally manage Atlantic salmon. Bilaterally, the Tana fishery agreement has been negotiated between the Ministries of Foreign Affairs, Ministry of Forestry and Agriculture (Finland) and the Norwegian Ministry of the Environment (Norway). The latest general agreement dates back to 1990. Tourist angling has historically been regulated by annual negotiations between regional authorities in both countries (Department of Environmental Affairs, Office of the County Governor of Finnmark, Norway, and the Fishery Unit, Centre for Economic Development, Transport and the Environment in Lapland, Finland). Recently, the newly established River Tana Fisheries Management Board in Norway has taken over the local management on the Norwegian side. Coastal fisheries are regulated nationally in Norway, and in recent years, more restrictive measures have been introduced.

The Tana, its salmon stocks and fisheries

The subarctic River Tana forms the border between northernmost Norway and Finland. The river drains an area of 16 386 km^2 consisting of a multitude of small and large tributaries, most of which (>1 200km) are readily accessible for ascending salmon. The river Tana is also one of the few remaining large river systems that still support abundant Atlantic salmon stocks with little or no human impact to the system, except for fishing.

Tana today supports the largest wild stock of Atlantic salmon in the world, with annual river catches fluctuating between 70 and 250 tonnes, equivalent to an annual average harvest of 30-50 000 salmon. The total salmon stock with a minimum of 30 different populations consists of a wide variety of life histories. The sea-age groups are ranging from one-sea-winter to five-sea-winter salmon, with various types of previously spawned fish. The proportions of escaped farmed salmon in the Tana salmon catches have so far been very low, although the proportions of farmed salmon after the fishing season are unknown (with some few exceptions).

The riverine salmon fisheries in Tana include net fishing methods such as weir, gill net, seine and drift net, in addition to the use of rod and line. In the last five years, the rod catch comprised about 60 % of the total catch of the river system, and the proportions of different fishing methods has remained about the same over the past 30 years. The fishery in all parts of the main stem Tana represents a mixed-stocks fishery. According to the telemetry tagging experiments, harvest rates in the river fisheries could reach the levels of more than 60 %. Together with the sea fishery, the effective exploitation rates for some Tana salmon populations can be significantly high, up to 80 %.

Threat factors

A review of threat factors possibly affecting salmon stocks in Tana show that overexploitation of salmon in the different parts of the salmon migratory system is the major threat factor currently affecting Tana salmon (Figure S1). There are minor or no effects from other human activities like pollution, hydropower development or fish farming. Mining, salmon lice, escaped farmed salmon and *Gyrodactylus salaris* are identified as the main potential future threats of Tana salmon, followed by infections and introduced species.

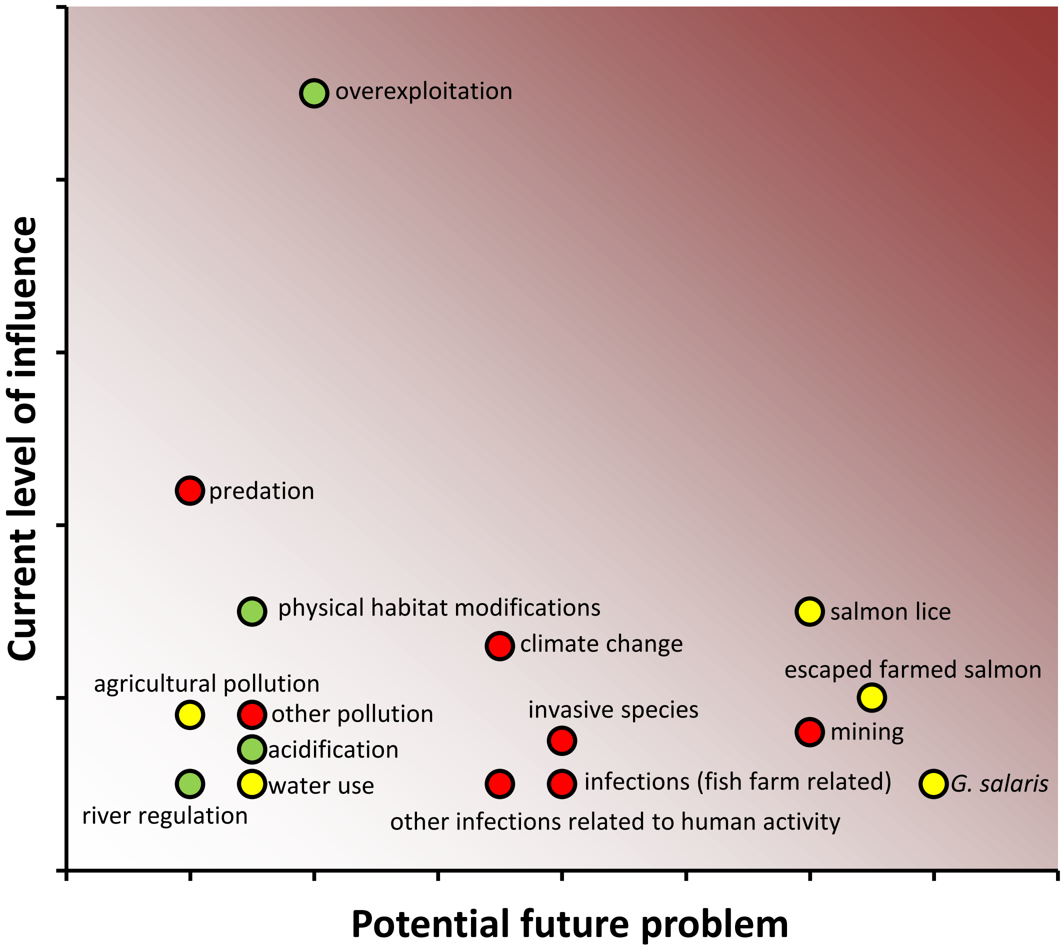


Figure S1. The ranking of different threat factors that affect Tana salmon in an influence-/risk-diagram. Symbol colour designates level of knowledge and uncertainty, with green symbolizing an extensive knowledge level and little uncertainty about the development, yellow symbolizing a moderate level of knowledge and moderate uncertainty, and red symbolizing a low level of knowledge and high level of uncertainty about the development of the factor.

Development in stock size based on pre-fishery abundance

Estimates of the pre-fishery abundance of stocks in northern Norway from 1989 (when the coastal drift net fishery was closed) to 2015 clearly demonstrate the poor development of Tana salmon compared to the rest of the region (Figure S2).

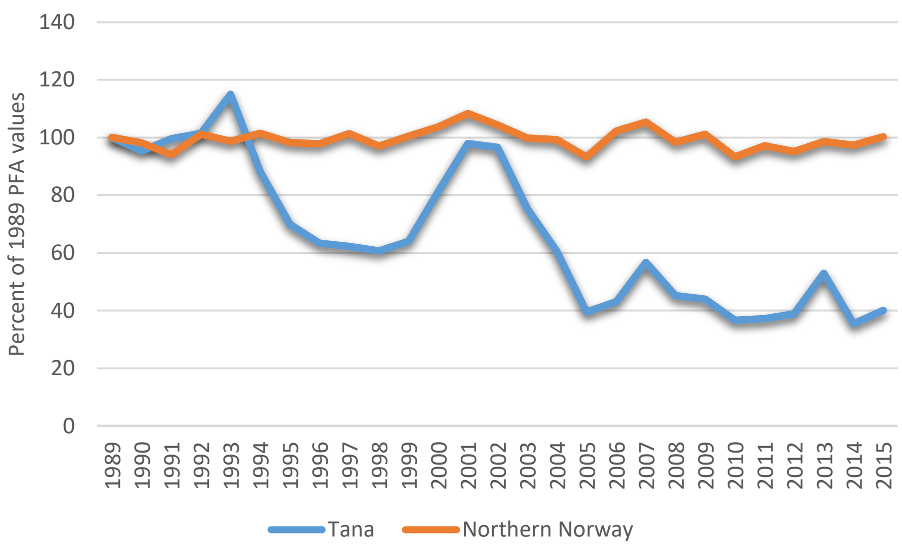


Figure S2. Development of the pre-fishery abundance of northern Norway (orange line, all stocks except Tana) and development of the coastal pre-fishery abundance of Tana salmon (blue line) from 1989 to 2015, presented as percentages of the 1989-value. The data are based on an ARIMA (1, 0, 0) trend analysis. (Analysis from the Norwegian Scientific Advisory Committee for Atlantic Salmon Management.)

Stock status evaluation and management recommendations

In accordance with NASCOs Precautionary Approach, we evaluate stock status based on management targets. The basic procedure of this approach is (1) the definition of stock-specific spawning targets (i.e. the number of eggs needed to fill the production potential of a stock), (2) an estimation of the number of spawning females in a stock after a fishing season, and (3) a probabilistic comparison of the target and the spawning stock estimate. The spawning target, as we use it in the status evaluation, is analogous to NASCOs conservation limit. For management purposes, the management target is the stock level that the fisheries management should aim for in order to ensure that there is a high probability that a stock exceeds its conservation limit. The management target of a stock is reached when the stock has at least a 75 % probability of reaching its spawning target over the last four years.

Spawning targets have recently been established for all parts of the Tana river system, both in Norway and Finland (Falkegård et al. 2014). Based on these spawning targets, we present a stock status evaluation of the following areas: Tana/Teno main stem, Máskejohka, Buolbmátjohka/Pulmankijoki, Lákšjohka, Veahčajohka/Vetsijoki, Ohcejohka/Utsjoki, Váljohka, Áhkojohka/Akujoki, Kárášjohka (+tributaries), Iešjohka, Anárjohka/Inarijoki (+tributaries) and Tana/Teno total.

Two additional terms that are used extensively should also be defined here:

- Maximum sustainable exploitation. Every year a certain number of salmon is available for fishing. The maximum sustainable exploitation is the maximum proportion of the available salmon that can be fished, while still ensuring that enough salmon survive to spawning.
- Overexploitation. The reduction in the spawning stock size that can directly be related to exploitation. Whenever a stock fails to meet its spawning target, all exploitation between the estimated spawning stock size and the spawning target is defined as overexploitation.

The total salmon catch in Tana in the years 1993-2015 varied between 63.5 tonnes in 2009 to 248.5 tonnes in 2001. The total spawning target in Tana is 104 274 286 eggs. The female biomass needed to achieve this egg deposition is 51 846 kg (38 277-77 371 kg). Target attainment varied from 39 % in 2009 to 100 % in 1994 and 2000-2003. The probability of reaching the spawning target varied from 0 % (1996, 1997, 2004, 2005, 2009, 2011 and 2013) to 95 % (2001). Over the last 4 years, overall attainment was 59 %. The management target was not reached, as the last 4 years' average probability of reaching the spawning target was 1 %. The average total exploitation of Tana salmon in 2006-2015 was 67 %. Of an average pre-fishery abundance of 180 307 kg, 15 % was taken in coastal fisheries and 52 % within the Tana river system.

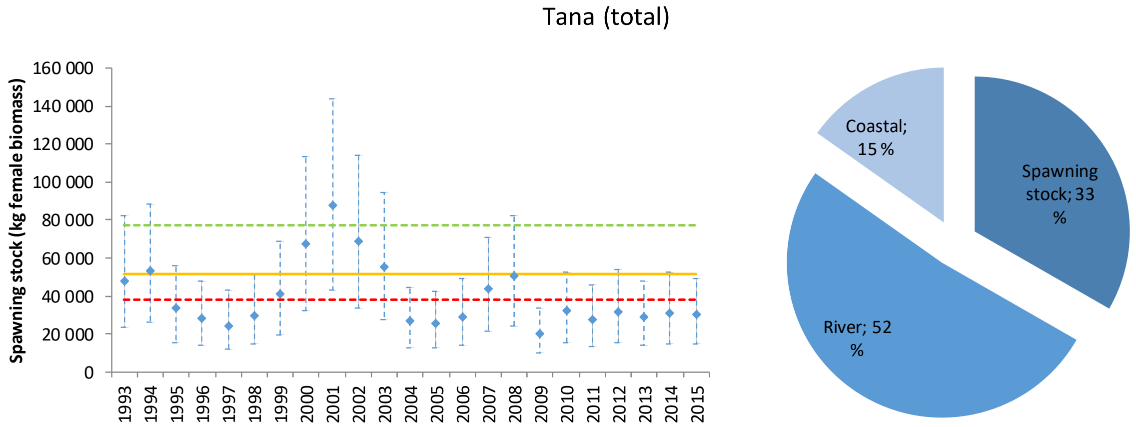


Figure S3. Left: The estimated total spawning stock in the Tana river system in the years 1993-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Tana salmon in the years 2006-2015 separated into coastal catch, river catch and spawning stock.

Almost half (48 %) of the main stem catch of female salmon from the whole Tana river system happens in the border area between Nuorgam to Levajok, followed by the lower Norwegian main stem (34 %) and the upper border area (18 %). Over 80 % of the female salmon were caught in weeks 21-28 (May to mid-July). 34 % of the females were caught by tourists, 22 % with weir, 17 % by local rod fishing, 16 % with driftnet and 11 % with gillnet. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from all stocks by 28 %.

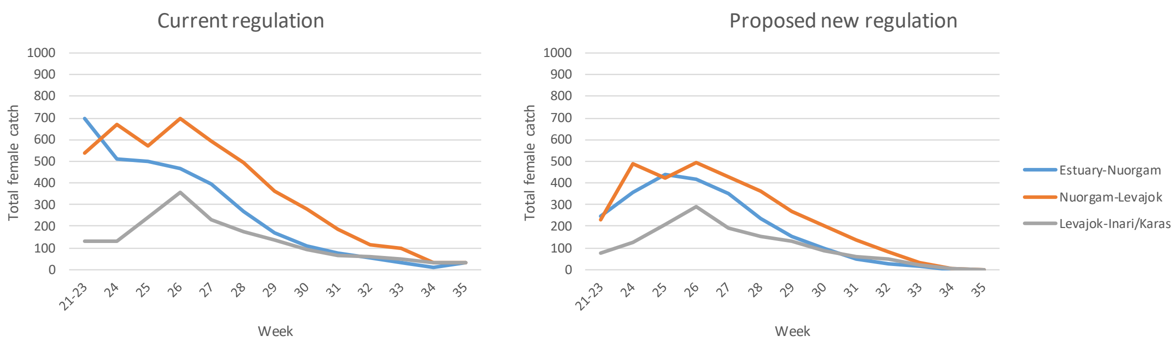


Figure S4. The total annual catch of female salmon from the whole Tana river system caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

The estimated catch of Tana main stem (MS) salmon varied from 28 193 kg in 2009 to 55 203 kg in 2008. The Tana MS spawning target is 22 189 kg (16 642-33 284 kg). Target attainment varied from 49 % in 2009 up to 100 % in 2007 and 2008. The probability of reaching the spawning target varied from 0 % in 2009 to 75 % in 2008. Over the last 4 years, overall attainment was 72 %. The management target was not reached, as the last 4 years' average probability of reaching the spawning target was 8 %. The average total exploitation of Tana MS salmon in 2006-2015 was 63 %, markedly higher than the estimated maximum sustainable exploitation of 50 %. Of an average pre-fishery abundance of 87 456 kg, 16 % was taken in coastal fisheries and 48 % in main stem fisheries. Average overexploitation was 24 %.

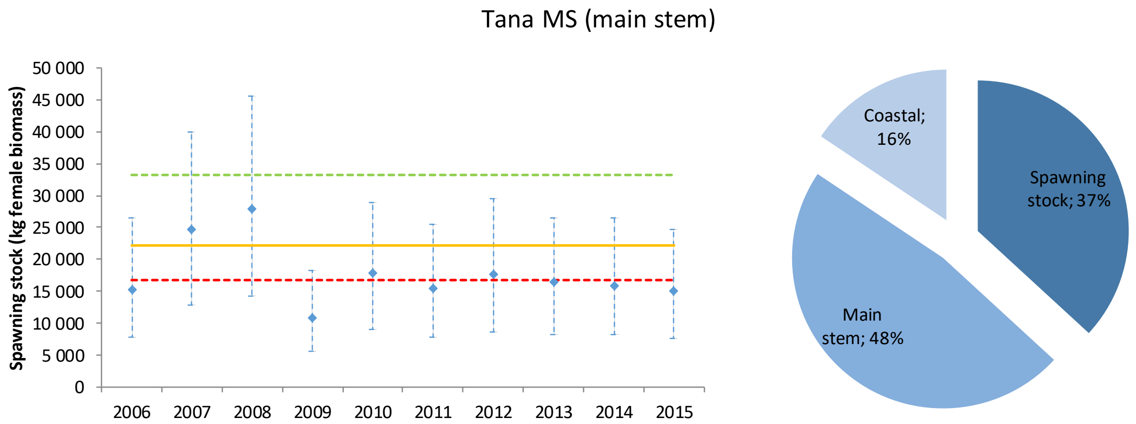


Figure S5. Left: The estimated spawning stock of the Tana MS (main stem) stock in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Tana MS salmon in the years 2006-2015 separated into coastal catch, main stem catch and spawning stock.

Over half (56 %) of the main stem catch of female salmon belonging to the Tana MS stock happens in the border area between Nuorgam to Levajok, followed by the lower Norwegian main stem (36 %) and the upper border area (9 %). Over 80 % of the female salmon were caught in weeks 25-31 (last half of June and July). 37 % of the females were caught by tourists, 25 % with weir, 21 % by local rod fishing, 10 % with gillnet and 7 % with driftnet. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from the Tana MS stock by 27 %.

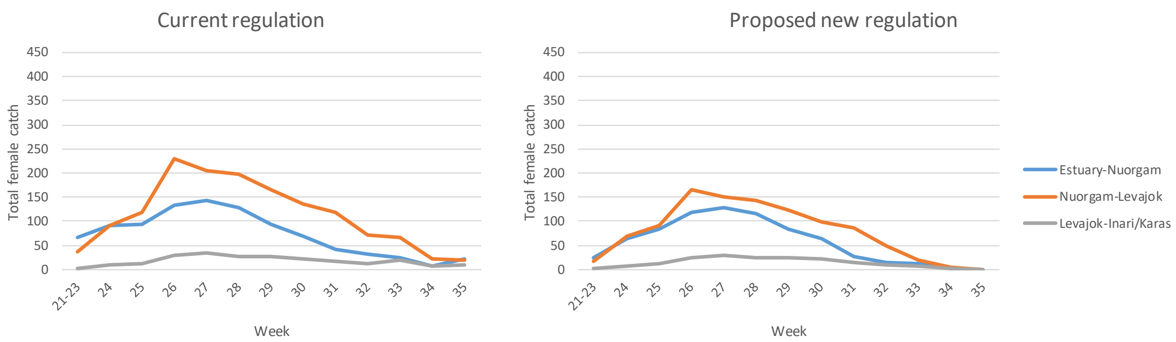


Figure S6. The total annual catch of female salmon from the Tana MS (main stem) stock caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

The catch in Máskejohka in the years 2006-2015 varied from 979 kg (2013) to 2 320 kg (2008). The Máskejohka spawning target is 3 155 148 eggs, and the female biomass needed to obtain this egg deposition is 1 521 kg (1 100-2 000 kg). Target attainment varied from 48 % (2013) to 100 % (2008 and 2010) and the probability of reaching the spawning target varied from 0 % (2013) to 83 % (2008). Over the last 4 years, overall attainment was 67 %. The management target was not reached, as the last 4 years' average probability of reaching the spawning target was 4 %. The average total exploitation of Máskejohka salmon in 2006-2015 was 63 %, markedly higher than the estimated maximum sustainable exploitation of 50 %. Of an average pre-fishery abundance of 6 649 kg, 15 % was taken in coastal fisheries, 23 % in main stem fisheries and 24 % in Máskejohka itself. Average overexploitation was 24 %.

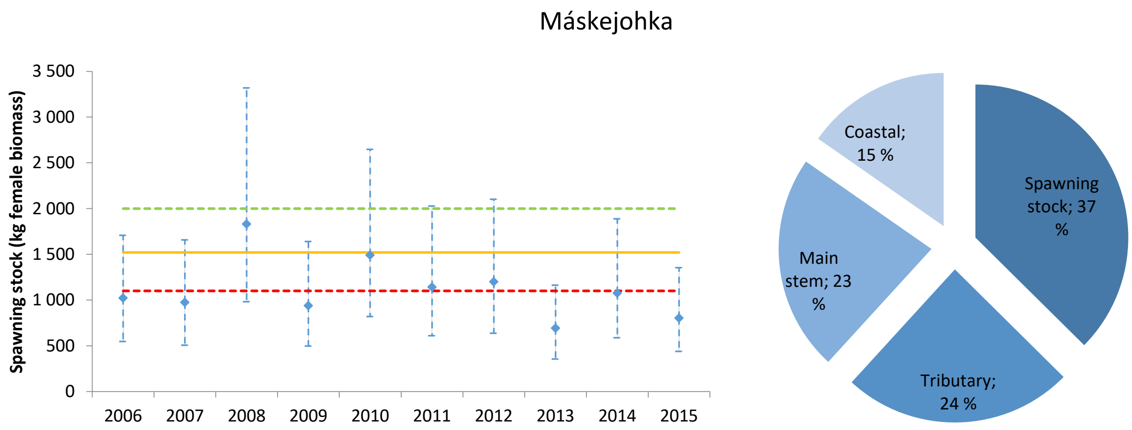


Figure S7. Left: The estimated spawning stock of Máskejohka in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Máskejohka salmon in the years 2006-2015 separated into coastal catch, main stem catch, tributary catch and spawning stock.

About 90 % of the main stem catch of female salmon belonging to the Máskejohka stock happens in the lower Norwegian main stem. Approximately 68 % of the female salmon were caught in weeks 25-28 (late June to mid-July). 52 % of the females were caught with weir, 17 % with gillnet, 12 % by local rod fishing, 11 % with driftnet and 8 % by tourists. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from Máskejohka by 25 %. As a consequence, fishing within Máskejohka must be reduced by approximately 40 % in order to achieve a total exploitation reduction of 30 %.

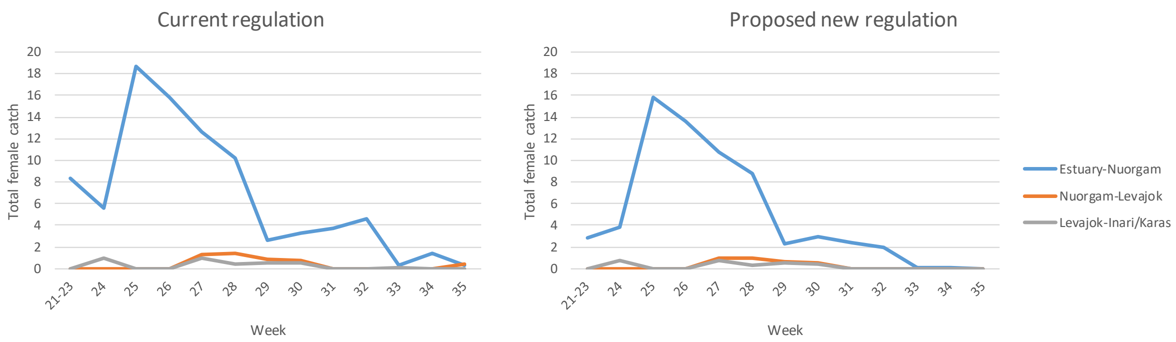


Figure S8. The total annual catch of female salmon from Máskejohka caught from week to week in various parts of the main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

The catch in Buolbmátjohka/Pulmankijoki in the years 2003-2015 varied from 300 kg (2004) to 1 090 kg (2014). Most of this catch was taken in the lake Buolbmátjávri/Pulmankijärvi, very little fishing occurs in the outlet river of the lake and fishing is prohibited in the upper Pulmankijoki. The Pulmankijoki spawning target is 1 329 133 eggs, and the female biomass needed to obtain this egg deposition is 511 kg (383-767 kg). In the years 2003-2015, target attainment varied from 30 % (2004) to 100 % (2006, 2012-2015) and the probability of reaching the spawning target varied from 0 % (2004) to 100 % in 2012 and 2014. Over the last 4 years, overall attainment was 152 %. The management target was reached, as the last 4 years' average probability of reaching the spawning target was 97 %. The average total exploitation of Pulmankijoki salmon in 2006-2015 was 57 %, lower than the estimated maximum sustainable exploitation of 61 %. Of an average pre-fishery abundance of 2 728 kg, 11 % was taken in coastal fisheries, 17 % in main stem fisheries and 29 % in the Pulmanki lake fishery. The average overexploitation in 2006-2015 was 13 %.

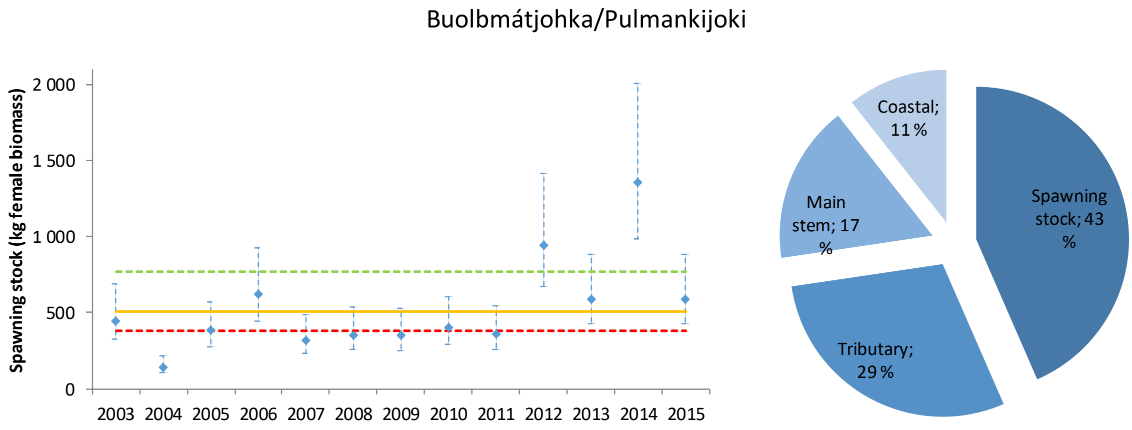


Figure S9. Left: The estimated spawning stock of Buolbmatjohka/Pulmankijoki in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Buolbmátjohka/Pulmankijoki salmon in the years 2006-2015 separated into coastal catch, main stem catch, tributary catch and spawning stock.

About 95 % of the main stem catch of female salmon belonging to the Buolbmátjohka/Pulmankijoki stock happens in the lower Norwegian main stem. Almost 80 % of the female salmon were caught in weeks 21-25 (May to late June). 38 % of the females were caught with weir, 37 % with driftnet, 10 % by local rod fishing, 8 % by tourists and 7 % with gillnet. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from Buolbmátjohka/Pulmankijoki by 36 %.

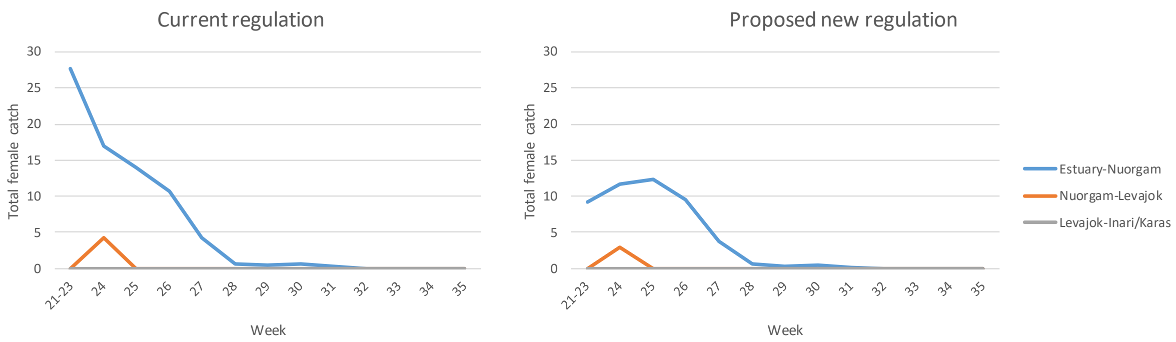


Figure S10. The total annual catch of female salmon from Buolbmátjohka/Pulmankijoki caught from week to week in various parts of the main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

The catch in Lákšjohka in the years 2006-2015 varied from 247 kg (2014) to 700 kg (2006). The Lákšjohka spawning target is 2 969 946 eggs, and the female biomass needed to obtain this egg deposition is 1 165 kg (864-1 747 kg). Target attainment varied from 26 % in 2011 to 89 % in 2006 and 82 % in 2014. The probability of reaching the spawning target was 0 % for most years in the period 2006-2015, with the exceptions of 2006 (29 %) and 2014 (15 %). Over the last 4 years, overall attainment was 46 %. The management target was not reached, as the last 4 years' average probability of reaching the spawning target was 0 %. The average total exploitation of Lákšjohka salmon in 2006-2015 was 60 %, markedly higher than the estimated maximum sustainable exploitation of 17 %. Of an average pre-fishery abundance of 2 459 kg, 11 % was taken in coastal fisheries, 36 % in main stem fisheries and 13 % in Lákšjohka itself. Average overexploitation was 47 %.

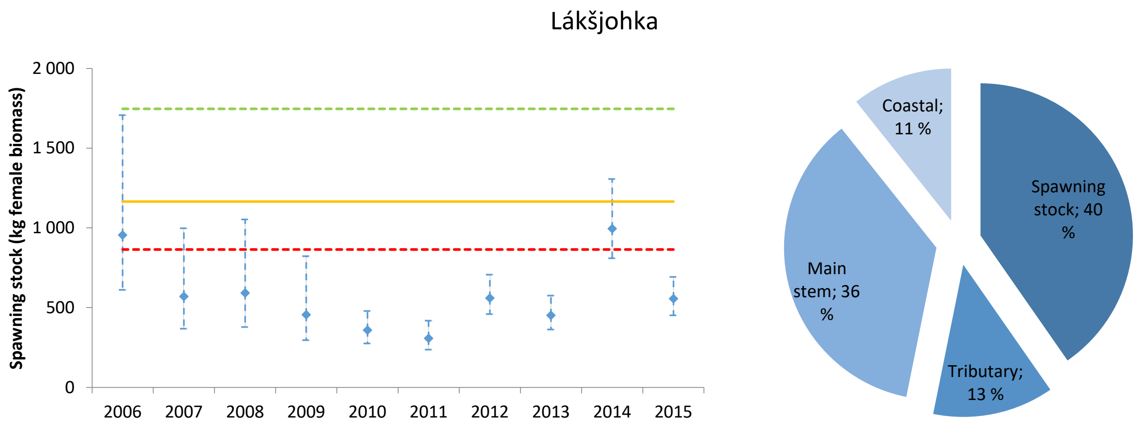


Figure S11. Left: The estimated spawning stock of Lákšjohka in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Lákšjohka salmon in the years 2006-2015 separated into coastal catch, main stem catch, tributary catch and spawning stock.

About 74 % of the main stem catch of female salmon belonging to the Lákšjohka stock happens in the lower Norwegian main stem, followed by 24 % in the lower border area from Nuorgam to Levajok. Approximately 77 % of the female salmon were caught in weeks 21-25 (May to late June). 36 % of the females were caught with driftnet, 25 % with weir, 17 % by tourists, 12 % by local rod fishing and 10 % with gillnet. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from Lákšjohka by 36 %. As a consequence, fishing within Lákšjohka must be reduced by approximately 25 % in order to achieve a total exploitation reduction of 30 %.

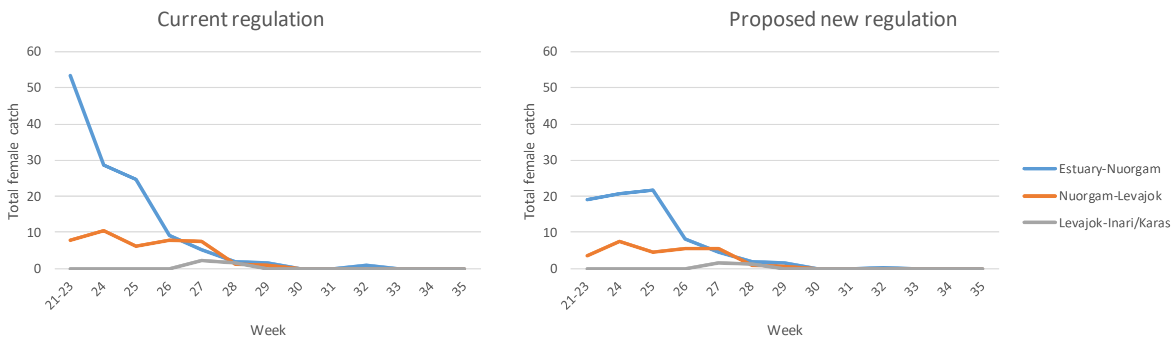


Figure S12. The total annual catch of female salmon from Lákšjohka caught from week to week in various parts of the main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

The catch in Veahčajohka/Vetsijoki in the years 1998-2015 varied from 200 kg (2004) to 1 885 kg (2001). The Vetsijoki spawning target is 2 505 400 eggs, and the female biomass needed to obtain this egg deposition is 1 101 kg (771-1 652 kg). Target attainment varied from 21 % in 2004 to 100 % in 1999-2002 and 2014. The probability of reaching the spawning target varied from 0 % (2003, 2004, 2008, 2013) to 96 % (2001). Over the last 4 years, the overall attainment was 86 %. The management target was not reached, as the last 4 years' average probability of reaching the spawning target was 28 %. The average total exploitation of Vetsijoki-salmon in 2006-2015 was 73 %, higher than the estimated maximum sustainable exploitation of 61 %. Of an average pre-fishery abundance of 5 209 kg, 15 % was taken in coastal fisheries, 45 % in main stem fisheries and 13 % in Vetsijoki itself. Average overexploitation was 28 %.

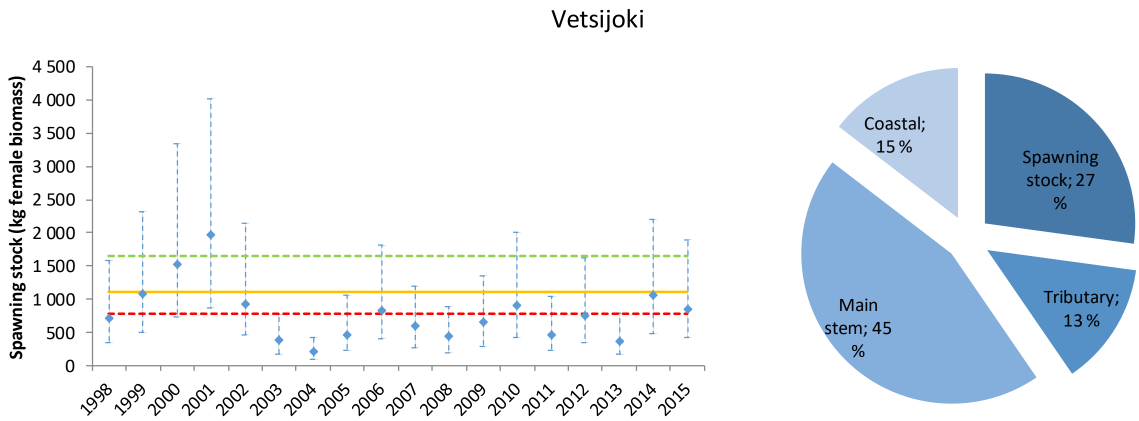


Figure S13. Left: The estimated spawning stock of Veahčajohka/Vetsijoki in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Vetsijoki salmon in the years 2006-2015 separated into coastal catch, main stem catch, tributary catch and spawning stock.

About half (52 %) of the main stem catch of female salmon belonging to the Vetsijoki stock happens in the lower Norwegian main stem, followed by 46 % in the lower border area from Nuorgam to Levajok. Over 90 % of the female salmon were caught in weeks 21-27 (May to early July). 30 % of the females were caught with driftnet, 26 % with weir, 23 % by tourists, 13 % by local rod fishing and 9 % with gillnet. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from Vetsijoki by 33 %. As a consequence, fishing within Vetsijoki must be reduced by approximately 40 % in order to achieve a total exploitation reduction of 30 %.

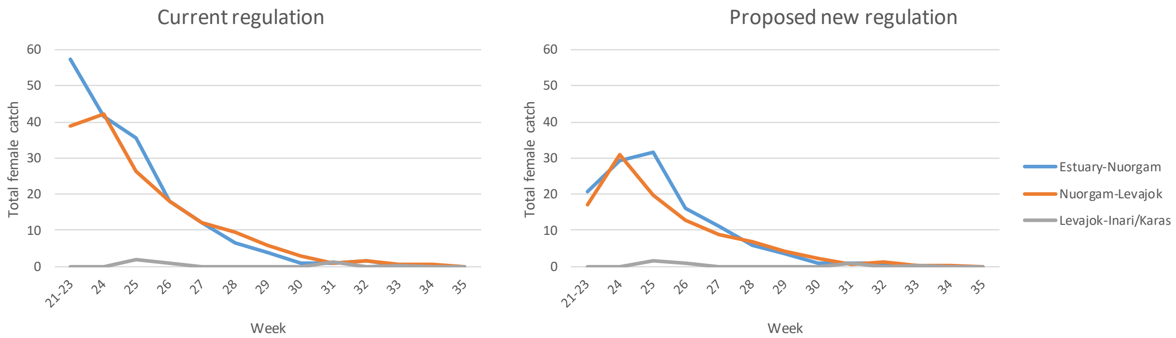


Figure S14. The total annual catch of female salmon from Veahčajohka/Vetsijoki caught from week to week in various parts of the main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

The catch in the Ohcejohka/Utsjoki river system in the years 2002-2015 varied from 800 kg (2004) to 2 955 kg (2014). The Utsjoki (+ tributaries) spawning target is 4 979 107 eggs, and the female biomass needed to obtain this egg deposition is 2 059 kg (1 486-2 972 kg). Target attainment varied from 38 % (2004) to 100 % (2006, 2011-2015). The probability of reaching the spawning target varied from 0 % (2004, 2008) to 100 % (2013, 2014). Over the last 4 years, overall attainment was 164 %. The management target was reached, as the last 4 years' average probability of reaching the spawning target was 99 %. The average total exploitation of Utsjoki-salmon in 2006-2015 was 62 %, slightly lower than the estimated maximum sustainable exploitation rate of 67 %. Of an average pre-fishery abundance of 11 573 kg, 15 % was taken in coastal fisheries, 28 % in main stem fisheries and 18 % in Utsjoki itself. The average overexploitation was 12 %.

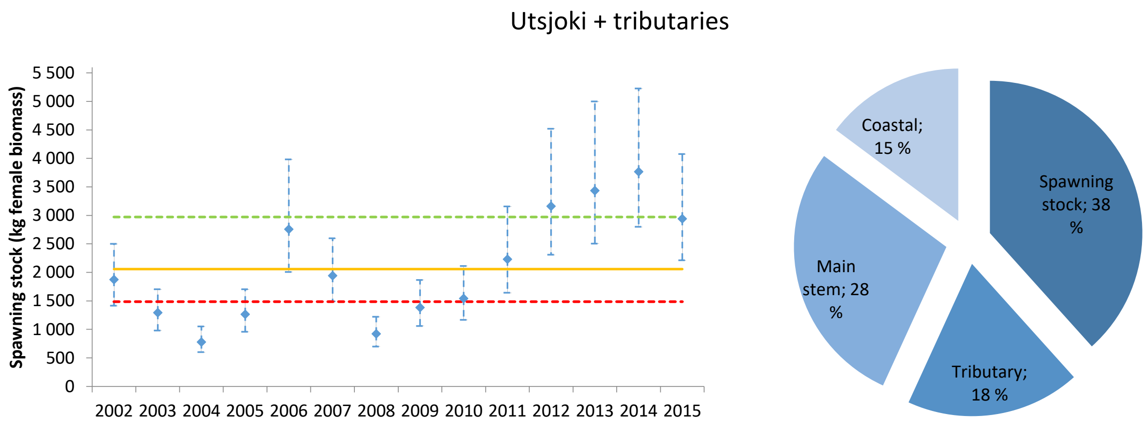


Figure S15. Left: The estimated spawning stock of Ohcejohka/Utsjoki + tributaries in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Utsjoki + tributaries salmon in the years 2006-2015 separated into coastal catch, main stem catch, tributary catch and spawning stock.

About half (49 %) of the main stem catch of female salmon belonging to the Ohcejohka/Utsjoki + tributaries stocks happen in the lower Norwegian main stem, followed by 50 % in the lower border area from Nuorgam to Levajok. Over 87 % of the female salmon were caught in weeks 21-27 (May to early July). 29 % of the females were caught by tourists, 28 % with weir, 22 % with driftnet, 12 % by local rod fishing and 8 % with gillnet. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from Utsjoki by 30 %.

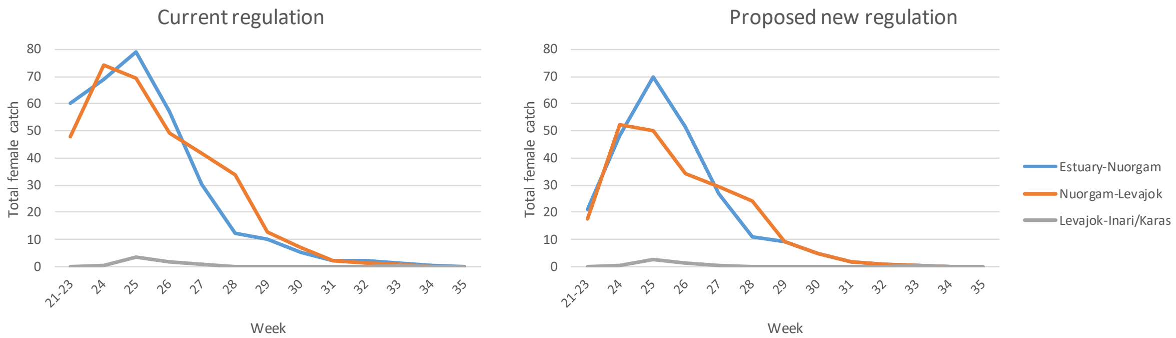


Figure S16. The total annual catch of female salmon from Ohcejohka/Utsjoki + tributaries caught from week to week in various parts of the main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

The catch in Váljohka in the years 2006-2015 varied from 97 kg (2007) to 365 kg (2012). The Váljohka spawning target is 1 907 595 eggs, and the female biomass needed to obtain this egg deposition is 779 kg (508-1 168 kg). Target attainment was 100 % throughout the period 2006-2015 with the exception of 2009 (87 %). The probability of reaching the spawning target varied from 20 % in 2009 to 100 % in 2006, 2011 and 2012. Over the last 4 years, overall attainment was 149 %. The management target was reached, as the last 4 years' average probability of reaching the spawning target was 99 %. The average total exploitation of Váljohka-salmon in 2006-2015 was 46 %, significantly lower than the estimated maximum sustainable exploitation rate of 63 %. Of an average pre-fishery abundance of 4 381 kg, 14 % was taken in coastal fisheries, 28 % in main stem fisheries and 4 % in Váljohka itself. Average overexploitation was 1 %.

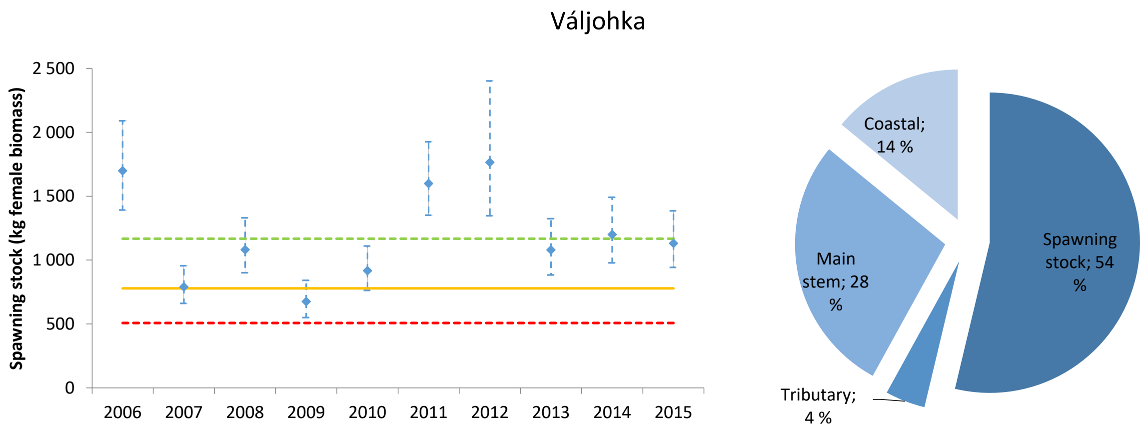


Figure S17. Left: The estimated spawning stock of Váljohka in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Váljohka salmon in the years 2006-2015 separated into coastal catch, main stem catch, tributary catch and spawning stock.

The majority (47 %) of the main stem catch of female salmon belonging to the Váljohka stock happens in the lower border area from Nuorgam to Levajok, followed by the upper border area (28 %) and the lower Norwegian main stem (26 %). Over 85 % of the female salmon were caught in weeks 21-26 (May to end of June). 29 % of the females were caught by tourists, 28 % with driftnet, 17 % by local rod fishing, 14 % with weir and 12 % with gillnet. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from Váljohka by 38 %.

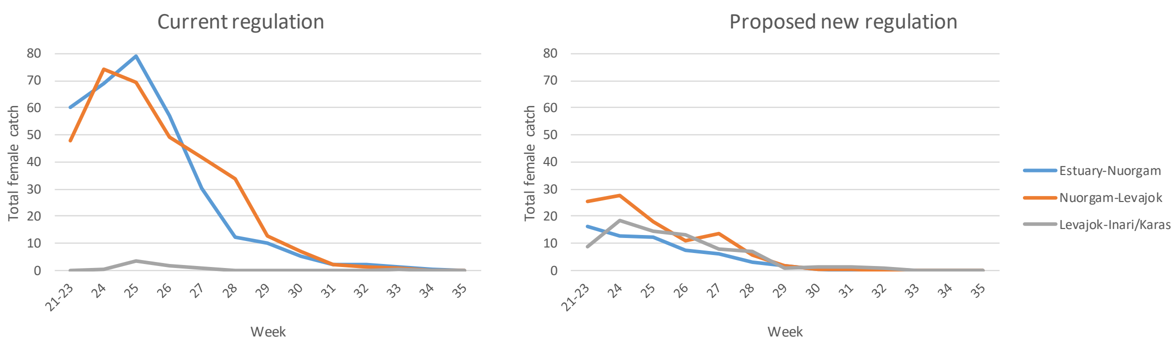


Figure S18. The total annual catch of female salmon from Váljohka caught from week to week in various parts of the main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

The salmon fishery in Áhkojohka/Akujoki is limited so the status assessment of this tributary is based on snorkelling counts from the years 2003-2015. The Akujoki spawning target is 282 532 eggs, and the female biomass needed to obtain this egg deposition is 126 kg (94-188 kg). Target attainment varied from 35 % (2003) to 100 % (2012, 2014). The probability of reaching the spawning target varied from 0 % (2003-2005, 2008-2010, 2015) to 60 % (2014). Over the last 4 years, overall attainment was 100 %. The management target was not reached, as the last 4 years' average probability of reaching the spawning target was 47 %. Due to genetic similarities between salmon sampled in Akujoki and neighbouring areas, it is not possible to make an estimate of the coastal and main stem exploitation specifically for Akujoki.

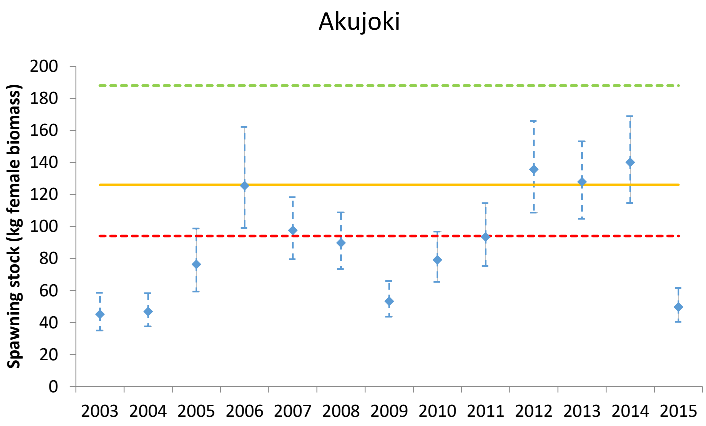


Figure S19. The estimated spawning stock of Akujoki in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits).

The catch in Kárášjohka and its tributaries Bávttajohka and Geaimmejohka in the years 2006-2015 varied from 1 298 kg (2009) to 3 902 kg (2006). The Kárášjohka (+ tributaries) spawning target is 14 037 323 eggs, and the female biomass needed to obtain this egg deposition is 7 290 kg (5 468-10 936 kg). Target attainment varied from 12 % (2009) to45 % (2008). The probability of reaching the spawning target was 0 % in all years. Over the last 4 years, the overall attainment was 35 %. The management target was not reached, as the last 4 years' average probability of reaching the spawning target was 0 %. The average total exploitation of salmon from Kárášjohka (+ tributaries) in 2006-2015 was 78 %, significantly higher than the estimated maximum sustainable exploitation rate of 26 %. Of an average pre-fishery abundance of 17 018 kg, 16 % was taken in coastal fisheries, 45 % in main stem fisheries and 18 % in Kárášjohka (+ tributaries). The average overexploitation was 66 %.

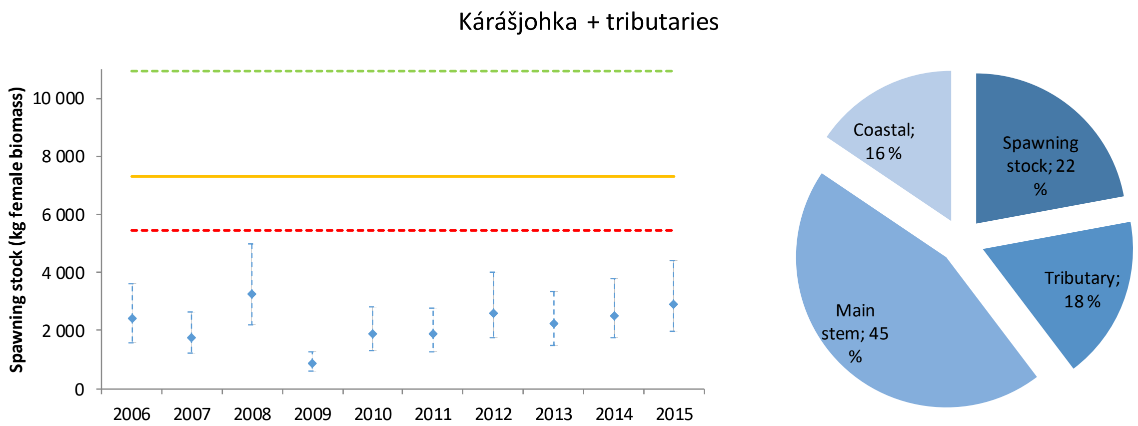


Figure S20. Left: The estimated spawning stock of Kárášjohka + tributaries in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Kárášjohka + tributaries salmon in the years 2006-2015 separated into coastal catch, main stem catch, tributary catch and spawning stock.

The majority (42 %) of the main stem catch of female salmon belonging to the Kárášjohka + tributaries stocks happen in the lower border area from Nuorgam to Levajok, followed by the lower Norwegian main stem (30 %) and the upper border area (28 %). Over 90 % of the female salmon were caught in weeks 21-27 (May to early July). 30 % of the females were caught with driftnet, 25 % by tourists, 16 % with weir, 15 % with gillnet and 14 % by local rod fishing. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from Kárášjohka by 37 %. As a consequence, fishing within Kárášjohka and its tributaries must be reduced by approximately 35 % in order to achieve a total exploitation reduction of 30 %.

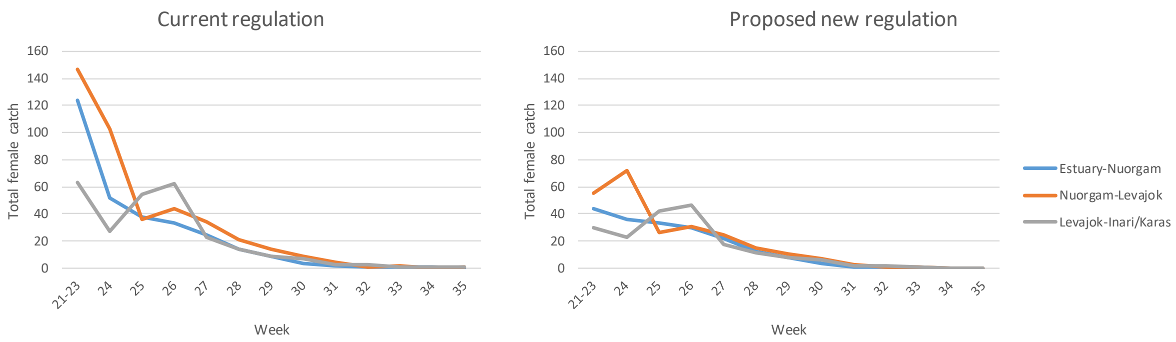


Figure S21. The total annual catch of female salmon from Kárášjohka + tributaries caught from week to week in various parts of the main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

The catch of Iešjohka salmon in Iešjohka and lower Kárášjohka in the years 2006-2015 varied from 1 239 kg (2009) to 4 499 kg (2006). The Iešjohka spawning target is 11 536 009 eggs, and the female biomass needed to obtain this egg deposition is 6 072 kg (4 278-9 107 kg). Target attainment varied from 15 % (2009) to 62 % (2008). The probability of reaching the spawning target was 0 % in all years except 1 % in 2008. Over the last 4 years, overall attainment was 31 %. The management target was not reached, as the last 4 years' average probability of reaching the spawning target was 0 %. The average total exploitation of salmon from Iešjohka in 2006-2015 was 78 %, significantly higher than the estimated maximum sustainable exploitation rate of 31 %. Of an average pre-fishery abundance of 15 463 kg, 16 % was taken in coastal fisheries, 46 % in main stem fisheries and 17 % in Iešjohka. The average overexploitation was 65 %.

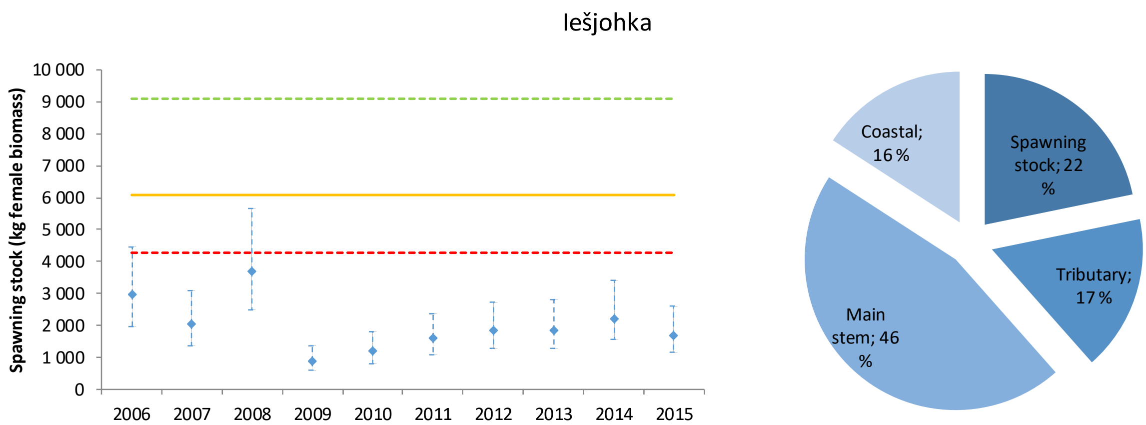


Figure S22. Left: The estimated spawning stock of Iešjohka in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Iešjohka salmon in the years 2006-2015 separated into coastal catch, main stem catch, tributary catch and spawning stock.

The majority (42 %) of the main stem catch of female salmon belonging to the Iešjohka stock happens in the lower border area from Nuorgam to Levajok, followed by the lower Norwegian main stem (34 %) and the upper border area (24 %). Over 86 % of the female salmon were caught in weeks 21-27 (May to early July). 28 % of the females were caught with driftnet, 26 % by tourists, 19 % with weir, 14 % by local rod fishing and 14 % with gillnet. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from Iešjohka by 33 %. As a consequence, fishing within Iešjohka must be reduced by approximately 50 % in order to achieve a total exploitation reduction of 30 %.

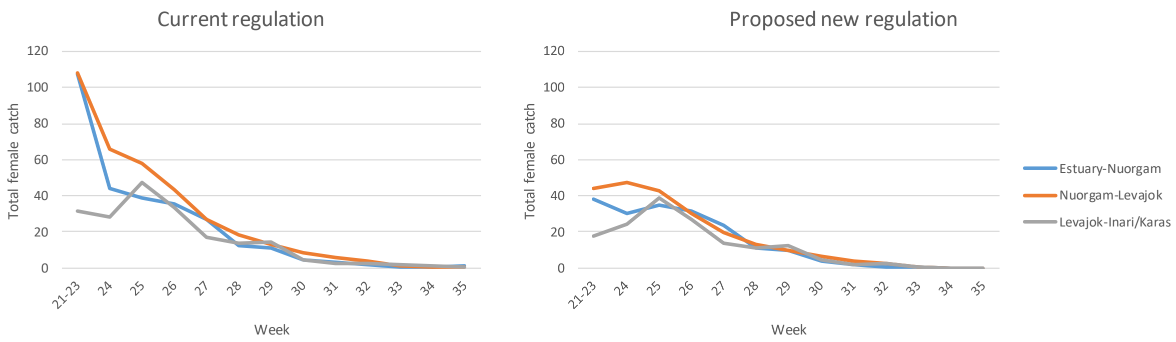


Figure S23. The total annual catch of female salmon from Iešjohka caught from week to week in various parts of the main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

The catch in Anárjohka/Inarijoki (+ tributaries) in the years 2006-2015 varied from 881 kg (2015) to 4 285 kg (2012). The Anárjohka/Inarijoki (+ tributaries) spawning target is 17 669 952 eggs, and the female biomass needed to obtain this egg deposition is 7 937 kg (5 928-11 906 kg). Target attainment varied from 30 % (2011, 2015) to 67 % in 2012 and 65 % in 2006. The probability of reaching the spawning target was 0 % in all years except 8 % in 2012 and 7 % in 2006. Over the last 4 years, overall attainment was 38 %. The management target was not reached, as the last 4 years' average probability of reaching the spawning target was 0 %. The average total exploitation of salmon from Anárjohka/Inarijoki (+ tributaries) in 2006-2015 was 75 %, significantly higher than the estimated maximum sustainable exploitation rate of 35 %. Of an average pre-fishery abundance of 22 855 kg, 15 % was taken in coastal fisheries, 48 % in main stem fisheries and 11 % in Anárjohka/Inarijoki (+ tributaries). The average overexploitation was 59 %.

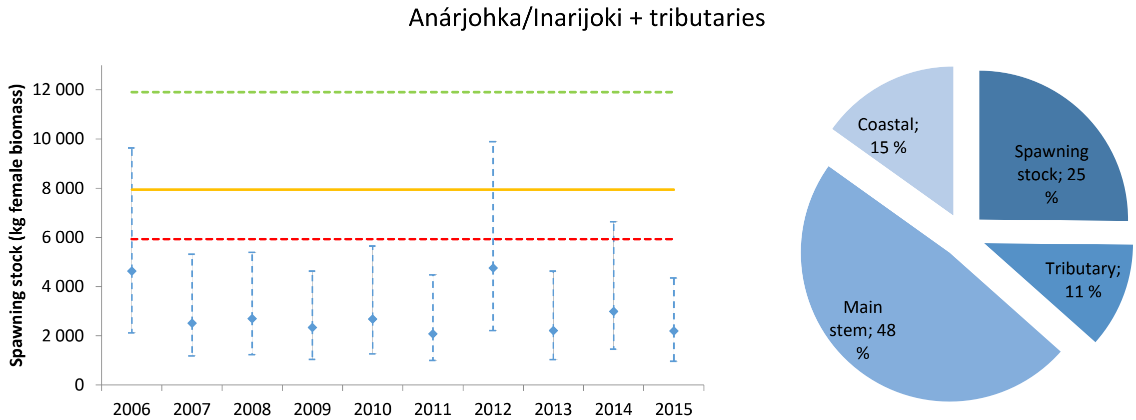


Figure S24. Left: The estimated spawning stock of Anárjohka/Inarijoki + tributaries in the years 2006-2015. Horizontal lines represent spawning target (with upper and lower limits). Right: The proportions of the average pre-fishery abundance of Anárjohka/Inarijoki + tributaries salmon in the years 2006-2015 separated into coastal catch, main stem catch, tributary catch and spawning stock.

Half (50 %) of the main stem catch of female salmon belonging to the Anárjohka/Inarijoki (+ tributaries) stocks happen in the lower border area from Nuorgam to Levajok, followed equally by the lower Norwegian main stem (25 %) and the upper border area (25 %). Approximately 84 % of the female salmon were caught in weeks 24-30 (mid-June to end of July). 41 % of the females were caught by tourists, 22 % with weir, 18 % by local rod fishing, 11 % with gillnet and 9 % with driftnet. The proposed new regulation in Tana will reduce the main stem exploitation of female salmon from Anárjohka/Inarijoki (+ tributaries) by 26 %. As a consequence, the current fishing within Anárjohka/Inarijoki (+ tributaries) must be reduced by approximately 70 % in order to achieve a total exploitation reduction of 30 %.

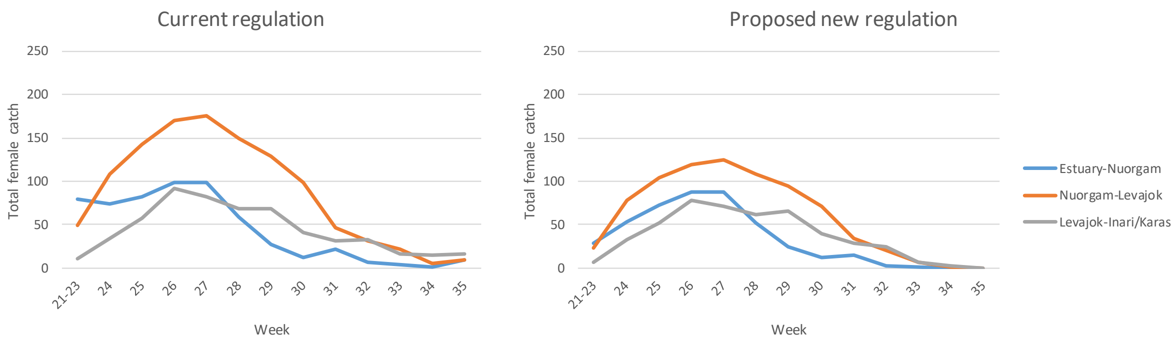


Figure S25. The total annual catch of female salmon from Anárjohka/Inarijoki + tributaries caught from week to week in various parts of the main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland.

In summary, the overall target attainment over the last 4 years (2012-2015) was highest in Ohcejohka/Utsjoki with 164 %, followed by Buolbmátjohka/Pulmankijoki (152 %), Váljohka (149 %), Áhkojohka/Akujoki (100 %), Veahčajohka/Vetsijoki (86 %), Tana/Teno main stem (72 %), Máskejohka (67 %), Lákšjohka (46 %), Anárjohka/Inarijoki + tributaries (38 %), Kárášjohka + tributaries (35 %) and Iešjohka (31 %).

The status assessment demonstrated that the management target (the last 4 years average probability of reaching the spawning target) was below 40 % in all investigated parts of the Tana river system except Buolbmátjohka/Pulmankijoki, Ohcejohka/Utsjoki, Váljohka and Áhkojohka/Akujoki. Worst off were Lákšjohka and the upper headwaters, Kárášjohka (+tributaries), Iešjohka and Anárjohka/Inarijoki (+tributaries), all of which had a management target of 0 %.

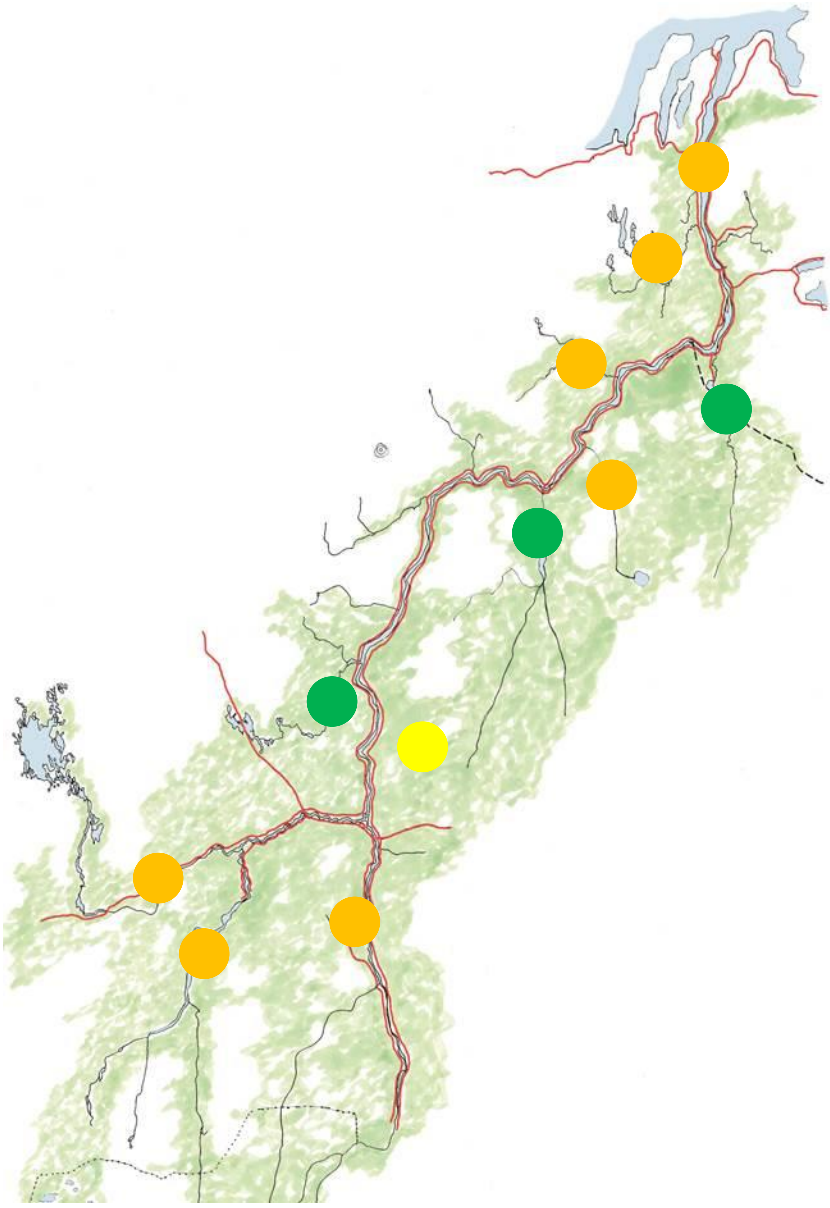


Figure S26. Map summary of the 2012-2015 stock status of the evaluated parts of the Tana river system. Symbol colour designates stock status over the last four years. Possible colours are: Dark green = overall probability of attaining spawning target higher than 75 %, overall target attainment over 140 %. Light green = overall probability of attaining spawning target higher than 75 %. Yellow = overall probability of attaining spawning target between 40 and 74 %, overall target attainment above 75 %. Orange = overall probability of attaining spawning target below 40 %, stock has had an exploitable surplus in at least 3 of the last 4 years. Red = stock had an exploitable surplus in less than 3 of the last 4 years.

The overall exploitation rate in Tana (all stocks) was estimated to 67 % in the period 2006-2015. Of the investigated stocks, the highest estimated accumulated exploitation rates were at over 70 %, with Iešjohka and Kárášjohka (+tributaries) at 78 %, Anárjohka/Inarijoki (+tributaries) at 75 %, and Veahčajohka/Vetsijoki at 73 %. Below 70 % were Ohcejohka/Utsjoki (+ tributaries) at 62 %, Lákšjohka at 60 %, Máskejohka at 63 % and Tana (main stem) at 63 %. The lowest accumulated exploitation rates were estimated for Váljohka at 46 % and Buolbmátjohka/Pulmankijoki at 57 %.

Overexploitation as a threat factor is defined as the extent of a reduction in spawning stock below the spawning target that can be attributed to exploitation. There was extensive overexploitation in all examined parts of the Tana river system in the period 2006-2015, except in Buolbmátjohka/Pulmankijoki, Váljohka and Utsjoki.

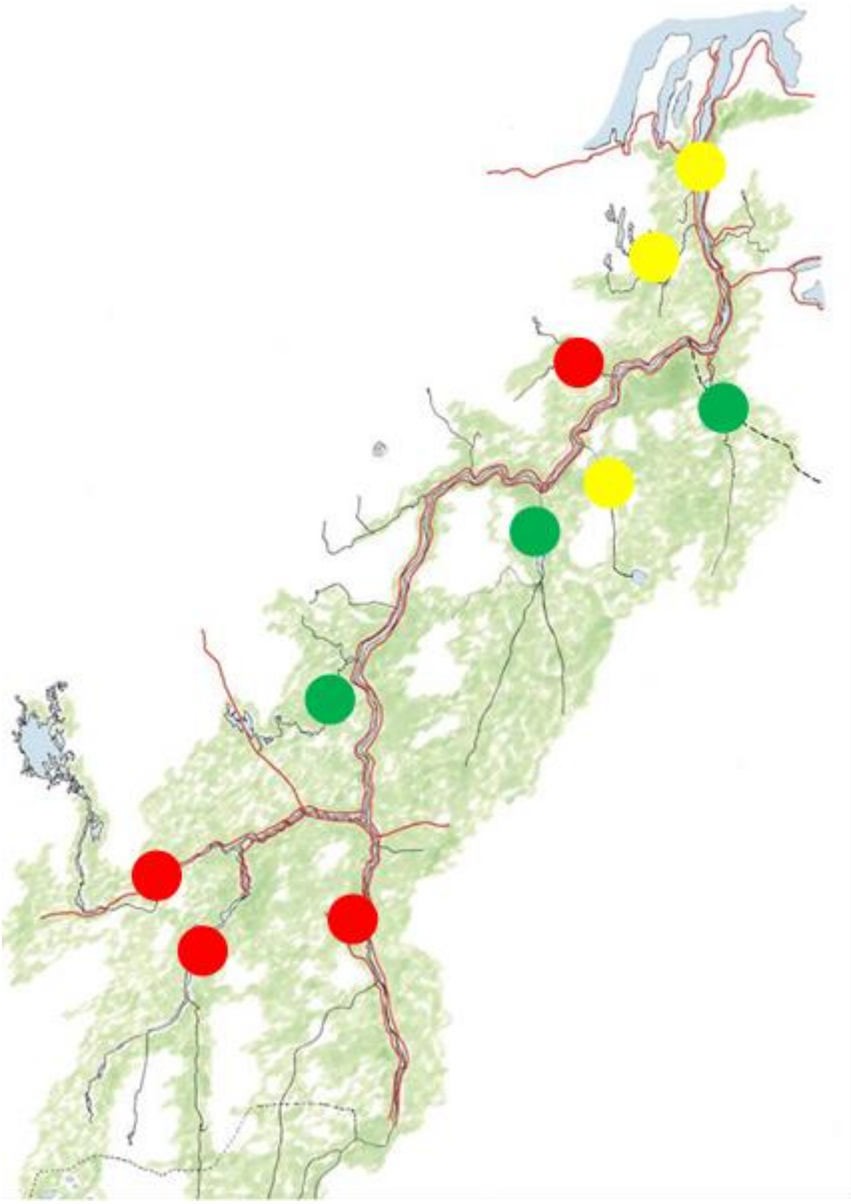


Figure S27. Map summary of the estimated overexploitation experienced in various parts of the Tana river system in the years 2006-2015. Symbol colour represents the extent of the overexploitation (in terms of percentages of the spawning target). Dark green = no effect (0 % of the spawning target), light green = small effect (<10 %), yellow = moderate effect (10-30 %), red = large effect (>30 %).

An estimate of maximum sustainable exploitation (the maximum level of exploitation a stock could sustain while still reaching its spawning target) demonstrates that some of the stocks are depleted to the point of having a very low sustainable surplus. The lowest average maximum sustainable total exploitation rate over the period 2006-2015 was estimated for Lákšjohka at 17 %, followed by Kárášjohka (+tributaries) at 26 %, Iešjohka at 28 %, and Anárjohka/Inarijoki (+ tributaries) at 34 %.

Stock recovery trajectories were constructed for all investigated parts of the Tana river system under three different regulation scenarios. All investigated areas would attain a 75 % probability of reaching their spawning target over a period of three salmon generations if total accumulated exploitation rates were reduced by 30 %.

Long-term monitoring recommendations

Stock status evaluation within an adaptive knowledge-based management regime should be based on the best possible monitoring data, provided through a consistent, long-term monitoring programme. Such a programme should provide (1) a detailed and accurate catch statistics from all different areas and fisheries of the system,

(2) catch samples that provide life history data and enable genetic stock identification of the catch in mixed-stock fisheries, and (3) accurate fish counting, either on fish entering e.g. a tributary or in the main stem (by electronic devices), or in the form of spawner counts after the fishing season (by snorkelling).

There is substantial variation in the exploitation rates experienced by different stocks in different fisheries; the Tana main stem exploitation of salmon being much lower in the lower tributaries compared to that of the tributaries further up in the river system. Therefore, long-term monitoring must be spatially distributed in the lower, middle and upper parts of the Tana system.

The Group strongly endorses finding arenas that allows the communication of local environmental knowledge to the Group and allows dissemination of scientific knowledge to local communities in an accessible manner.

Currently, there is a lack of long-term predictability in most of the research and monitoring activities in the Tana, making it impossible to plan activities for more than 1-2 years ahead. The Group therefore strongly recommends the joint establishment of a permanent Norwegian-Finnish research and monitoring programme for Tana.

SAMMENDRAG

Gruppen og dens mandat

Overvåknings- og forskningsgruppa for Tanavassdraget ble formelt oppnevnt i februar 2010 gjennom en prinsippavtale mellom det finske Jord- og Skogbruksministeriet og det norske Miljøverndepartementet. Gruppas hovedoppgaver er å evaluere laksebestandenes status og forvaltning, samt gi råd om relevant overvåkning og forskning. Gruppa anvender lokal/tradisjonell (økologisk) kunnskap som kan gi positive bidrag i vurderingene og bruker i dag slik kunnskap der det er relevant.

Forvaltningen av laksen i Tana

Både Norge og Finland (gjennom EU) er med i den nordatlantiske organisasjonen for vern av atlantisk laks (NASCO). NASCO har som formål å bevare, gjenoppbygge, fremme og rasjonelt forvalte laksebestander. Fisket i Tana er bilateralt regulert gjennom en avtale mellom Norge og Finland. Nåværende avtale er fra 1990. Turistfisket i Tana har tidligere vært regulert av regionale myndigheter (Miljøvernavdelingen ved Fylkesmannen i Finnmark på norsk side, Fiskerienheten ved senter for økonomisk utvikling i Lappland, Finland). Det regionale ansvaret på norsk side er nå overtatt av et lokalt forvaltningsorgan (Tanavassdragets Fiskeforvaltning). Det norske sjølaksefisket reguleres nasjonalt i Norge, og har i de senere årene blitt mer restriktivt regulert.

Laksebestandene og laksefisket i Tana

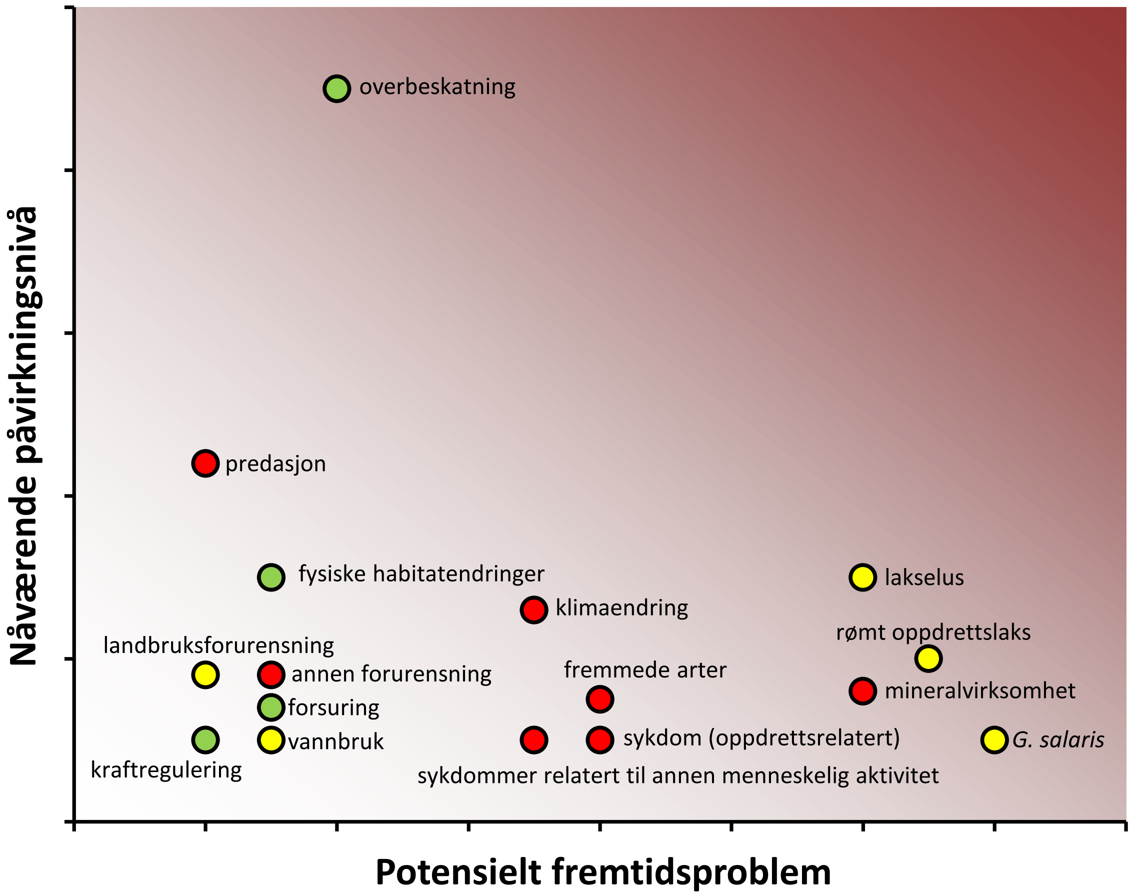
Tanaelva danner grense mellom det nordligste Norge og Finland. Vassdraget har et nedslagsfelt på 16 386 km^2 og består av en mengde små og store sideløp. De fleste av disse, til sammen en elvestrekning på over 1 200 km, er tilgjengelig for laks på gytevandring. Tanavassdraget er et av få store elvesystem som fremdeles har store laksebestander som ikke er påvirket av annen menneskelig aktivitet enn fiske.

Tana har i dag en av verdens største ville laksebestander, med årlige elvefangster som varierer mellom 70 og 250 tonn. Dette tilsvarer en årlig høsting på 30-50 000 laks. Den totale laksebestanden i Tana består av minst 30 ulike populasjoner (laksestammer) med et bredt spekter av livshistorier. Sjøaldersgruppene i elva varierer fra små ensjøvinter til svært store femsjøvinterlaks, og i tillegg finnes en rekke ulike kombinasjoner av flergangsgytere. Andelen av rømt oppdrettslaks i Tana i fangstene sommerstid er svært lav, mens mengden rømt oppdrettslaks senere på høsten i stor grad er ukjent (med noen få unntak).

Elvefisket i Tana inkluderer garnbaserte metoder som stengsel, stågarn, kastenot og drivgarn i tillegg til stangfiske. De siste fem årene har stangfisket stått for omtrent 60 % av den totale laksefangsten i vassdraget, og andelen tatt på de ulike redskapstypene har holdt seg relativt stabilt siste 30 år. Fisket i selve hovedelva er et fiske på blandete bestander. Merkestudier har vist at beskatningsratene i hovedelva kan nå nivå på over 60 %. Samlet kan elv og sjølaksefiske gi akkumulerte beskatningsrater på opptil 80 % for noen av bestandene i vassdraget.

Trusselfaktorer

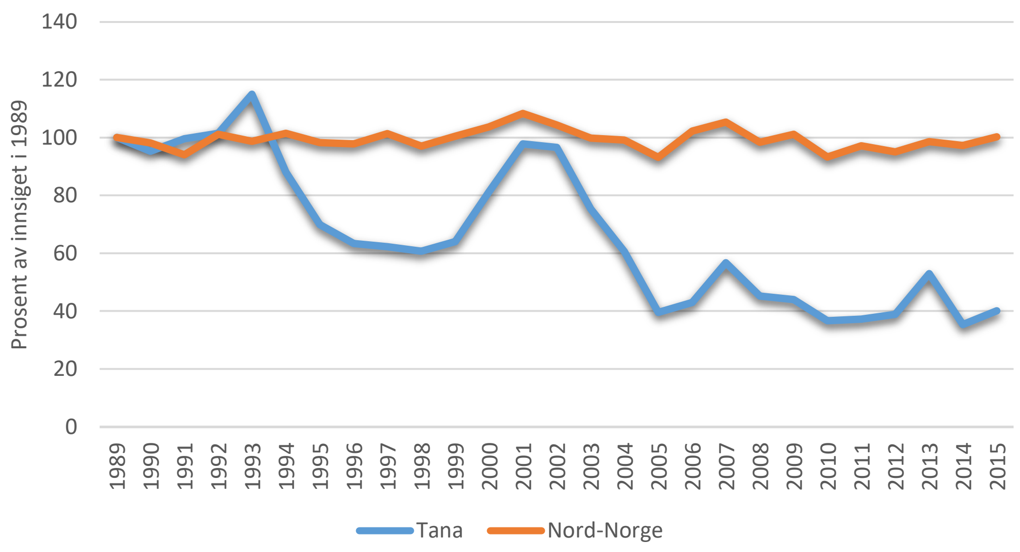
En gjennomgang av trusselfaktorer som potensielt kan påvirke laksen i Tana viser at overbeskatning av laks i ulike deler av laksens vandringsvei er den viktigste trusselfaktoren som påvirker laksen i Tana i dag (Figur S1). Det er få eller ingen effekt av andre menneskelige aktiviteter som forurensning, vassdragsutbygging og lakseoppdrett. Mineralvirksomhet, lakselus, rømt oppdrettslaks og *Gyrodactylus salaris* er identifisert som de viktigste potensielle trusselfaktorene i fremtiden, fulgt av sykdommer og introduserte arter.



Figur S1. Rangering av ulike trusselfaktorer som påvirker Tanalaksen i et påvirknings/risikodiagram. Symbolfargen gir info om kunnskapsnivå og usikkerhet, der grønn farge symboliserer en faktor med omfattende kunnskap og liten usikkerhet rundt utvikling, gul farge symboliserer moderat kunnskap og moderat usikkerhet, mens rød farge symboliserer lavt kunnskapsnivå og høy grad av usikkerhet rundt utviklingen.

Utvikling i bestandsstørrelse basert på innsig av laks

Estimat av størrelsen på lakseinnsiget i Nord-Norge fra 1989 (da drivgarnsfisket i sjøen var blitt stengt) til 2015 viser den svake utviklingen laksen i Tana har hatt sammenlignet med resten av regionen (Figur S2).



Figur S2. Utvikling i innsiget av laks til Nord-Norge (oransje linje, alle bestander bortsett fra Tana) og utvikling av innsig av Tanalaks (blå linje) fra 1989 til 2015. Innsiget er presentert som prosentverdier av innsiget i 1989. Dataene er basert på en ARIMA(1, 0, 0) trendanalyse. (Analyse fra vitenskapsrådet for lakseforvaltning i Norge.)

Statusevaluering av bestandene og forvaltningsråd

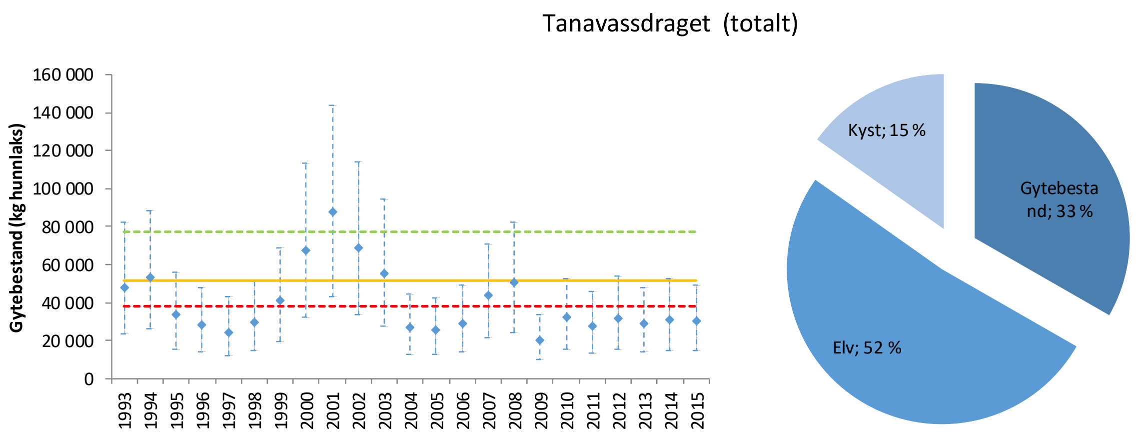
I tråd med NASCO sin føre-var-tilnærming så evaluerer vi bestandsstatus opp mot forvaltningsmål. Evalueringen følger denne prosedyren: (1) etablering av bestandsspesifikke gytebestandsmål (det vil si, antallet egg som trengs for at bestandens produksjonspotensial skal oppfylles), (2) estimering av mengden gytelaks i en bestand etter fiskesesongen, og (3) en sannsynlighetsbasert sammenligning av gytebestandsmål og størrelse på gytebestand. Gytebestandsmålet, slik vi benytter det i statusevalueringen, er analogt med bevaringsgrensen. Forvaltningsmålet er definert av NASCO som det bestandsnivået forvaltningen sikter mot for å være sikker på at bestanden er over bevaringsgrensen sin. Forvaltningsmålet til en bestand er nådd når bestanden har minst 75 % sannsynlighet for å nå gytebestandsmålet sitt siste fire år.

Gytebestandsmål ble nylig etablert for de aller fleste delene av Tanavassdraget, både på norsk og finsk side (Falkegård mfl. 2014). Basert på disse gytebestandsmålene så gjør vi i denne rapporten en statusevaluering av følgende områder: selve Tanaelva, Máskejohka, Buolbmátjohka/Pulmankijoki, Lákšjohka, Veahčajohka/Vetsijoki, Ohcejohka/Utsjoki, Váljohka, Áhkojohka/Akujoki, Kárášjohka (+sideelver), Iešjohka, Anárjohka/Inarijoki (+sideelver) og Tanavassdraget totalt.

To viktige termer som benyttes nedenfor må også defineres her:

- Maksimal bærekraftig beskatning. Hvert år er det et visst antall laks tilgjengelig for de ulike laksefiskeriene. Den maksimale bærekraftige beskatningen er den største andelen av den tilgjengelige laksen som kan fiskes uten at bestandens gytebestand faller under gytebestandsmålet.
- Overbeskatning. Reduksjon i gytebestandsstørrelse som direkte kan tilskrives beskatning. Dersom en bestand ikke når gytebestandsmålet sitt, så vil all fangst som ligger mellom estimert gytebestandsstørrelse og gytebestandsmål være definert som overbeskatning.

Total fangst av laks i Tana i årene 1993-2015 varierer fra 63,5 tonn i 2009 til 248,5 tonn i 2001. Det totale gytebestandsmålet i Tana er 104 274 286 egg. For å nå dette antallet egg må 51 846 kg (38 277-77 371 kg) hunnlaks gyte på høsten. Måloppnåelsen i Tana varierte fra 39 % i 2009 til 100 % i 1994 og 2000-2003. Sannsynligheten for at gytebestandsmålet var nådd varierte fra 0 % (1996, 1997, 2004, 2005, 2009, 2011 og 2013) til 95 % i 2001. Måloppnåelsen siste 4 år var 59 %. Forvaltningsmålet var ikke nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 1 %. Gjennomsnittlig total beskatning av laks i Tana i 2006-2015 var 67 %. Av et gjennomsnittlig innsig på 180 307 kg, ble 15 % tatt i sjølaksefisket og 52 % i elvefisket i Tanavassdraget.



Figur S3. Venstre: Estimert total gytebestand i Tanavassdraget i årene 1993-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av Tanalaks i årene 2006-2015 fordelt på kystfangst, elvefangst og gytebestand.

Nesten halvparten (48 %) av hovedelvfangsten av hunnlaks fra hele Tanavassdraget tas på nedre del av riksgrensen fra Nuorgam til Levajok, fulgt av nedre norsk del (34 %) og øvre del av riksgrensen (18 %). Over 80 % av hunnlaksen tas i uke 21-28 (mai til midten av juli). 34 % av hunnlaksen blir tatt av turister, 22 % med stengsel, 17 % av lokale stangfiskere, 16 % med drivgarn og 11 % med stågarn. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 28 %.

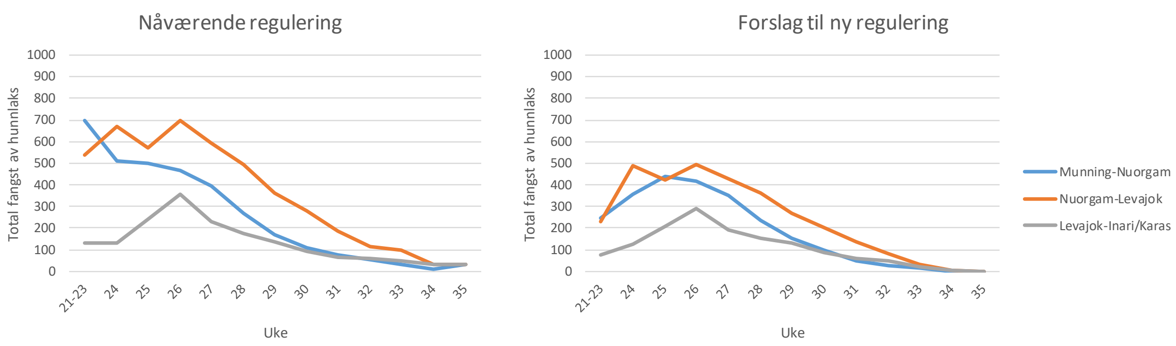
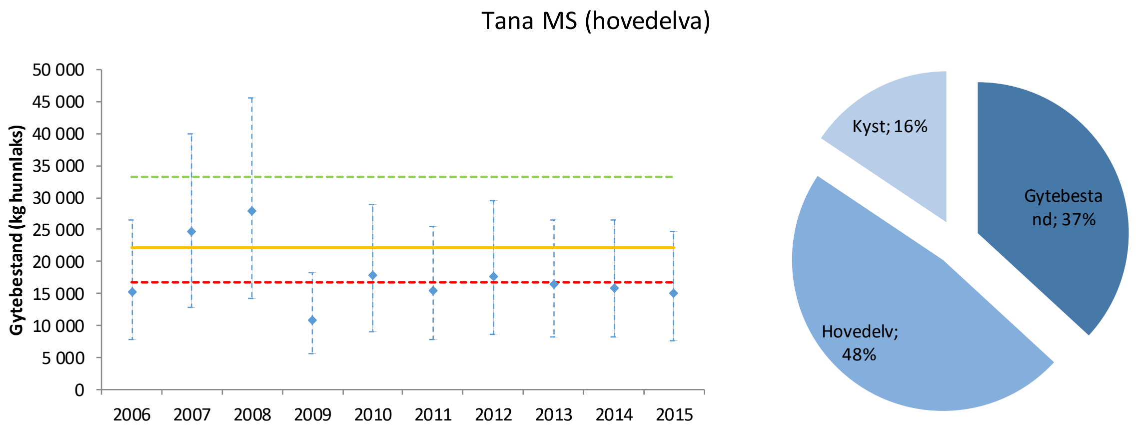


Figure S4. Total årlig fangst av hunnlaks fra hele Tanavassdraget fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Estimert fangst av laks som hører hjemme i selve Tanaelva (Tana MS) varierte fra 28 193 kg i 2009 til 55 203 kg i 2008. Gytebestandsmålet for hovedelva er 41 049 886 egg, for å nå dette antallet egg må 22 189 kg (16 642-33 284 kg) hunnlaks delta i gytingen. Måloppnåelsen varierte fra 49 % i 2009 til 100 % i 2007 og 2008. Sannsynligheten for at gytebestandsmålet var nådd varierte fra 0 % i 2009 til 75 % i 2008. De siste 4 årene har oppnåelsen samlet vært 72 %. Forvaltningsmålet var ikke nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 8 %. Gjennomsnittlig total beskatning av laks fra hovedelva i 2006-2015 var 63 %, godt over den estimerte maksimale bærekraftige beskatningen på 50 %. Av et gjennomsnittlig innsig på 87 456 kg ble 16 % tatt i sjølaksefiske og 48 % i hovedelvfiske. Gjennomsnittlig overbeskatning var 24 %.



Figur S5. Venstre: Estimert gytebestand i selve Tanaelva i årene 2006-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av laks hjemmehørende i selve Tanaelva i årene 2006-2015 fordelt på kystfangst, elvefangst og gytebestand.

Over halvparten (46 %) av hovedelvfangsten av hunnlaks fra selve Tanaelva tas på nedre del av riksgrensen fra Nuorgam til Levajok, fulgt av nedre norsk del (36 %) og øvre del av riksgrensen (9 %). Over 80 % av hunnlaksen tas i uke 25-31 (siste halvdel av juni og juli). 37 % av hunnlaksen ble tatt av turister, 25 % med stengsel, 21 % av lokale stangfiskere, 10 % med stågarn og 7 % med drivgarn. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 27 %.

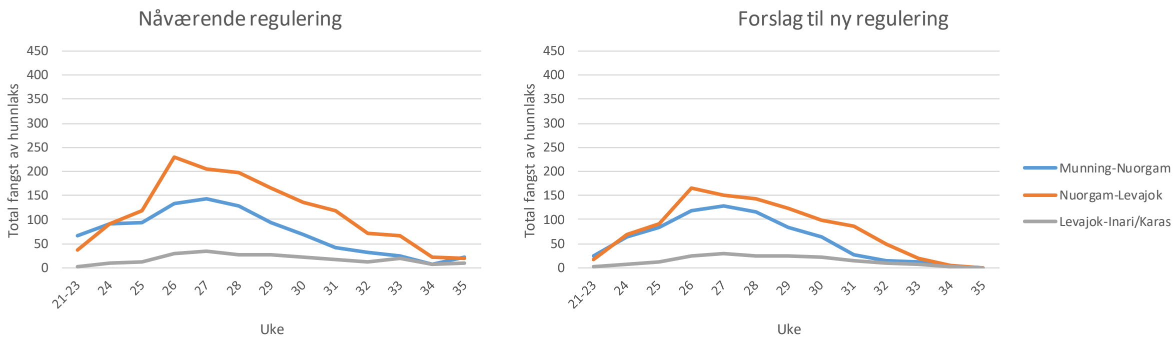
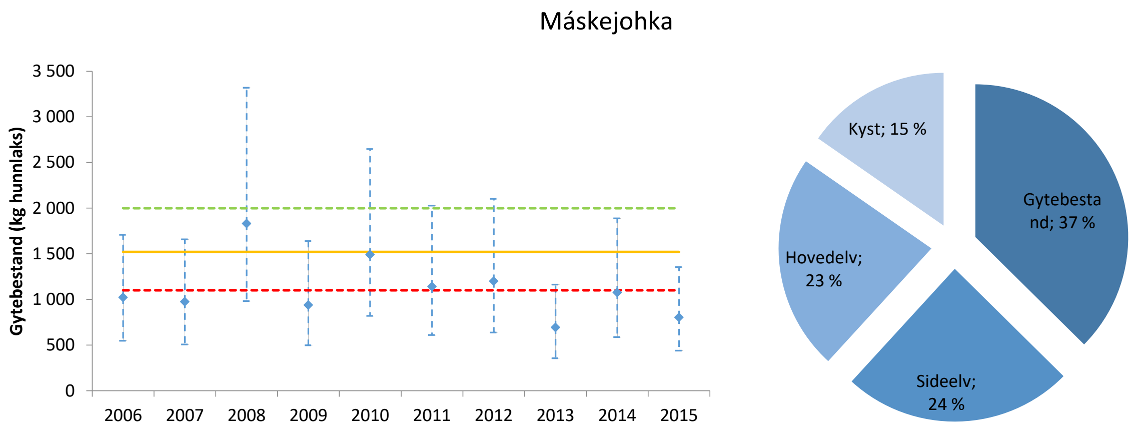


Figure S6. Total årlig fangst av hunnlaks fra bestanden i selve Tanaelva fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Fangst av laks i Máskejohka i årene 2006-2015 varierte fra 979 kg i 2013 til 2 320 kg i 2008. Gytebestandsmålet i Máskejohka er 3 155 148 egg, og for å nå dette eggantallet må 1 521 kg (1 100-2 000 kg) hunnlaks delta i gytingen. Måloppnåelsen varierte fra 48 % i 2013 til 100 % i 2008 og 2010 og sannsynligheten for at gytebestandsmålet var nådd varierte fra 0 % i 2013 til 83 % i 2008. Måloppnåelse over siste 4 år var 67 %. Forvaltningsmål var ikke nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 4 %. Gjennomsnittlig total beskatning av laks fra Máskejohka i 2006-2015 var 63 %, markert høyere enn den estimerte maksimale bærekraftige beskatningen på 50 %. Av et gjennomsnittlig innsig på 6 649 kg ble 15 % tatt i sjølaksefiske, 23 % i hovedelvfiske og 24 % i selve Máskejohka. Gjennomsnittlig overbeskatning var 24 %.



Figur S7. Venstre: Estimert gytebestand i Máskejohka i årene 2006-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av laks hjemmehørende i Máskejohka i årene 2006-2015 fordelt på kystfangst, hovedelvefangst, sideelvfangst og gytebestand.

Rundt 90 % av hovedelvfangsten av hunnlaks fra Máskejohka tas i nedre norsk del. Rundt 68 % av hunnlaksen tas i uke 25-28 (siste halvdel av juni til midt i juli). 52 % av hunnlaksen ble tatt med stengsel, 17 % med stågarn, 12 % av lokale stangfiskere, 11 % med drivgarn og 8 % av turister. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 25 %. Som en konsekvens av det så må fisket i Máskejohka reduseres med rundt 40 % dersom en skal nå en total reduksjon i beskatning på 30 %.

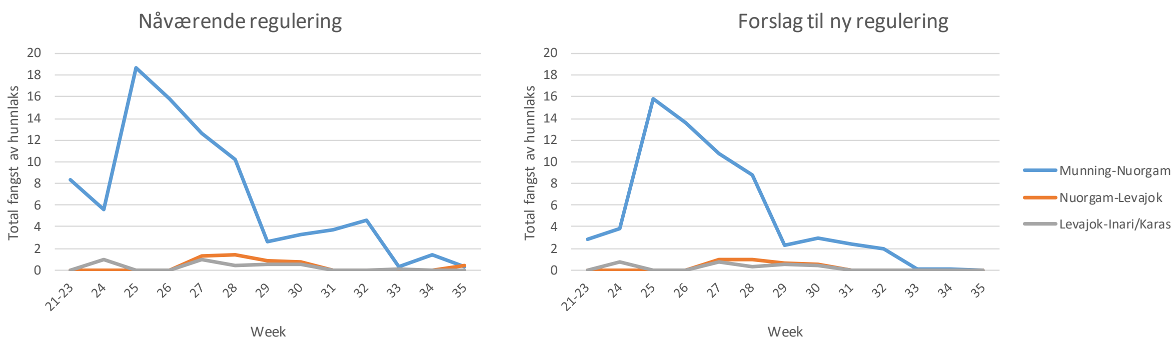
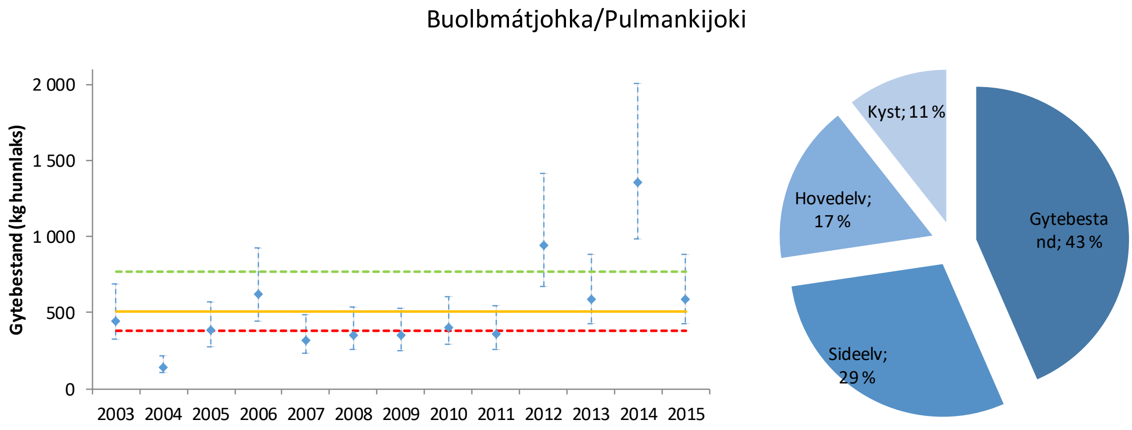


Figure S8. Total årlig fangst av hunnlaks fra Máskejohka fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Fangst av laks i Buolbmátjohka/Pulmankijoki i årene 2003-2015 varierte fra 300 kg i 2004 til 1 090 kg i 2014. Det meste av denne laksen ble fanget i Buolbmátjávri/Pulmankijärvi, det er lite fiske i utløpselva fra innsjøen og fiske er forbudt i øvre Pulmankijoki. Gytebestandsmålet i Buolbmátjohka/Pulmankijoki er 1 329 133 egg, og for å nå dette eggantallet må 511 kg (383-767 kg) hunnlaks delta i gytingen. Måloppnåelsen varierte fra 30 % i 2004 til 100 % i 2006 og 2012-2015. Sannsynligheten for at gytebestandsmålet var nådd varierte fra 0 % i 2004 til 100 % i 2012 og 2014. Måloppnåelse over siste 4 år var 152 %. Forvaltningsmål var nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 97 %. Gjennomsnittlig total beskatning av laks fra Buolbmátjohka/Pulmankijoki i 2006-2015 var 57 %, noe som er lavere enn den estimerte maksimale bærekraftige beskatningen på 61 %. Av et gjennomsnittlig innsig på 2 728 kg ble 11 % tatt i sjølaksefiske, 17 % i hovedelvfiske og 29 % i fisket i innsjøen. Gjennomsnittlig overbeskatning i årene 2006-2015 var 13 %.



Figur S9. Venstre: Estimert gytebestand i Buolbmátjohka/Pulmankijoki i årene 2003-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av laks hjemmehørende i Buolbmátjohka/Pulmankijoki i årene 2006-2015 fordelt på kystfangst, hovedelvefangst, sideelvfangst og gytebestand.

Rundt 95 % av hovedelvfangsten av hunnlaks fra Buolbmátjohka/Pulmankijoki tas i nedre norsk del. Nesten 80 % av hunnlaksen tas i uke 21-25 (mai til slutten av juni). 38 % av hunnlaksen ble tatt med stengsel, 37 % med drivgarn, 10 % av lokale stangfiskere, 8 % av turister og 7 % med stågarn. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 36 %.

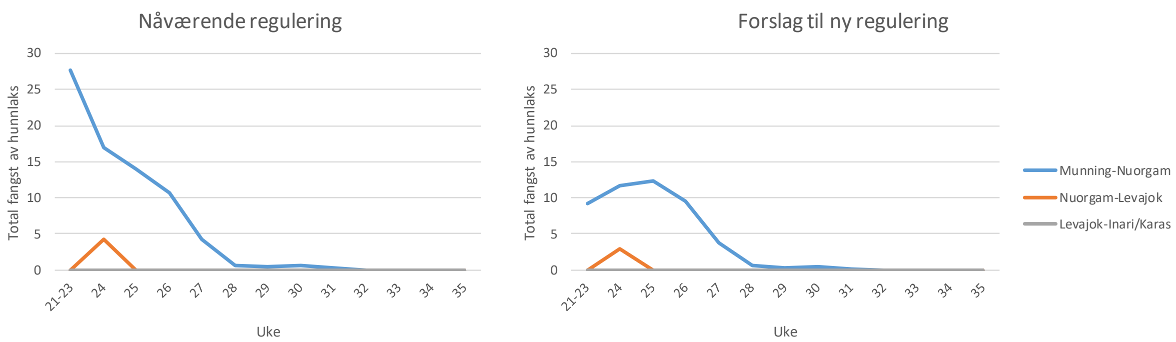
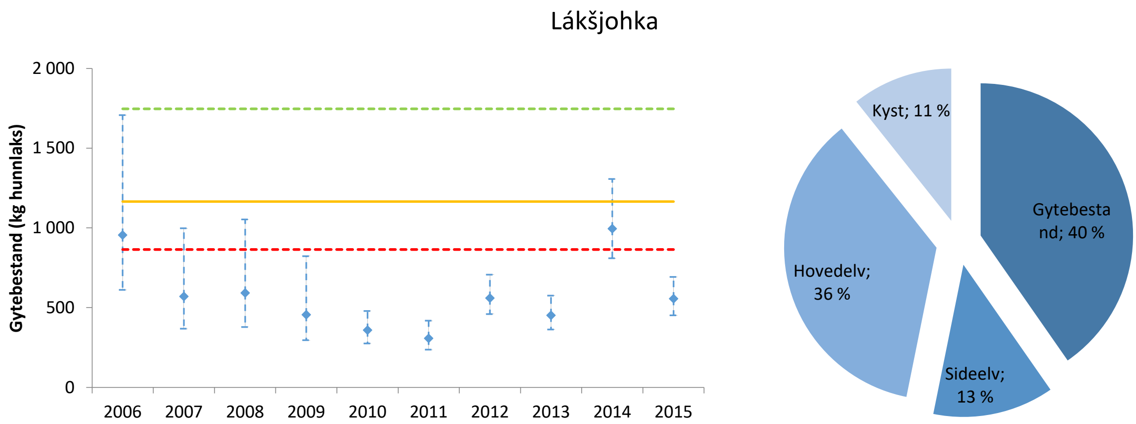


Figure S10. Total årlig fangst av hunnlaks fra Buolbmátjohka/Pulmankijoki fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Fangst av laks i Lákšjohka i årene 2006-2015 varierte fra 247 kg i 2014 til 700 kg i 2006. Gytebestandsmålet i Lákšjohka er 2 969 946 egg, og for å nå dette eggantallet må 1 165 kg (864-1 747 kg) hunnlaks delta i gytingen. Måloppnåelsen varierte fra 26 % i 2011 til 89 % i 2006 og 82 % i 2014. Sannsynligheten for at gytebestandsmålet var nådd var 0 % i de fleste år i perioden 2006-2015 med unntak av 29 % i 2006 og 15 % i 2014. Måloppnåelse over siste 4 år var 46 %. Forvaltningsmål var ikke nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 0 %. Gjennomsnittlig total beskatning av laks fra Lákšjohka i 2006-2015 var 60 %, markert høyere enn den estimerte maksimale bærekraftige beskatningen på 17 %. Av et gjennomsnittlig innsig på 2 459 kg ble 11 % tatt i sjølaksefiske, 36 % i hovedelvfiske og 13 % i selve Lákšjohka. Gjennomsnittlig overbeskatning var 47 %.



Figur S11. Venstre: Estimert gytebestand i Lákšjohka i årene 2006-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av laks hjemmehørende i Lákšjohka i årene 2006-2015 fordelt på kystfangst, hovedelvefangst, sideelvfangst og gytebestand.

Rundt 74 % av hovedelvfangsten av hunnlaks fra Lákšjohka tas i nedre norsk del, fulgt av 24 % i nedre del av riksgrensen. Rundt 77 % av hunnlaksen tas i uke 21-25 (mai til slutten av juni). 36 % av hunnlaksen ble tatt med drivgarn, 25 % med stengsel, 17 % av turister, 12 % av lokale stangfiskere og 10 % med stågarn. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 36 %. Som en konsekvens av det så må fisket i Lákšjohka reduseres med rundt 25 % dersom en skal nå en total reduksjon i beskatning på 30 %.

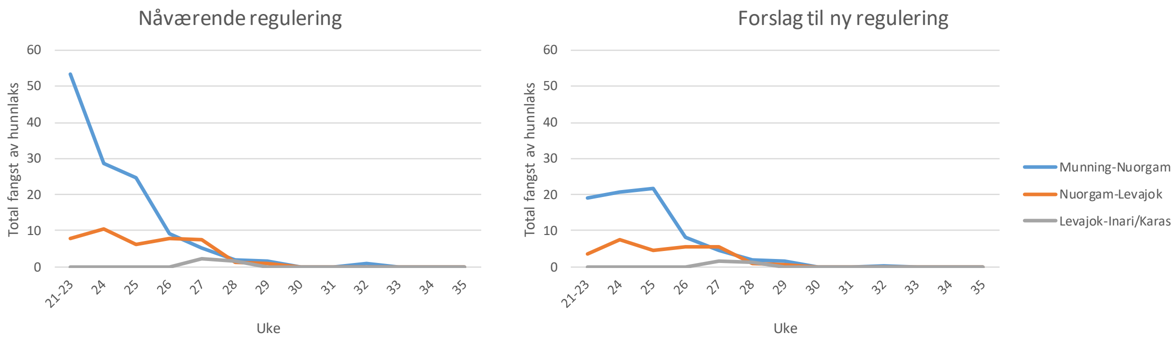
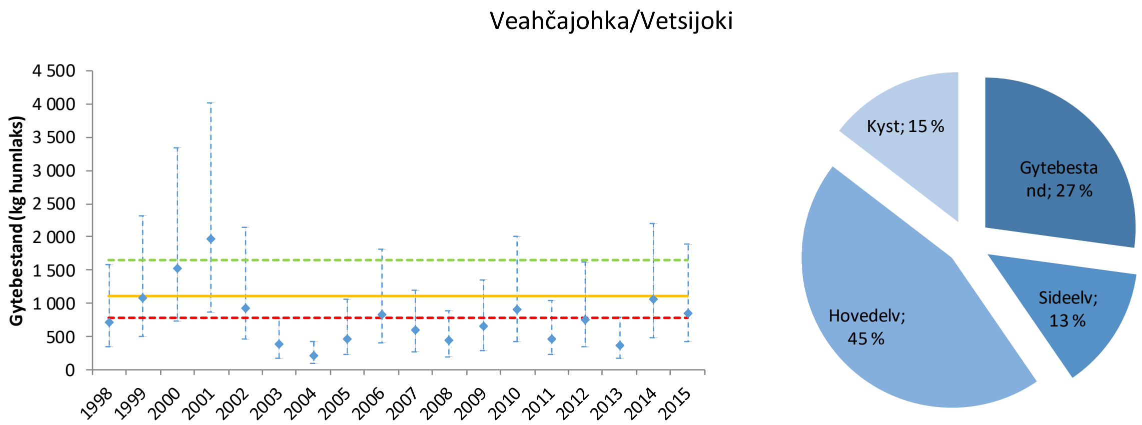


Figure S12. Total årlig fangst av hunnlaks fra Lákšjohka fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Fangst av laks i Veahčajohka/Vetsijoki i årene 1998-2015 varierte fra 200 kg i 2004 til 1 885 kg i 2011. Gytebestandsmålet i Veahčajohka/Vetsijoki er 2 505 400 egg, og for å nå dette eggantallet må 1 101 kg (771-1 652 kg) hunnlaks delta i gytingen. Måloppnåelsen varierte fra 21 % i 2004 til 100 % i 1999-2002 og 2014. Sannsynligheten for at gytebestandsmålet var nådd varierte fra 0 % (2003, 2004, 2008, 2013) til 96 % i 2001. Måloppnåelse over siste 4 år var 86 %. Forvaltningsmål var ikke nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 28 %. Gjennomsnittlig total beskatning av laks fra Veahčajohka/Vetsijoki i 2006-2015 var 73 %, høyere enn den estimerte maksimale bærekraftige beskatningen på 61 %. Av et gjennomsnittlig innsig på 5 209 kg ble 15 % tatt i sjølaksefiske, 45 % i hovedelvfiske og 13 % i selve Veahčajohka/Vetsijoki. Gjennomsnittlig overbeskatning var 28 %.



Figur S13. Venstre: Estimert gytebestand i Veahčajohka/Vetsijoki i årene 1998-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av laks hjemmehørende i Veahčajohka/Vetsijoki i årene 2006-2015 fordelt på kystfangst, hovedelvefangst, sideelvfangst og gytebestand.

Rundt 52 % av hovedelvfangsten av hunnlaks fra Veahčajohka/Vetsijoki tas i nedre norsk del, fulgt av 46 % i nedre del av riksgrensen. Over 90 % av hunnlaksen tas i uke 21-27 (mai til tidlig juli). 30 % av hunnlaksen ble tatt med drivgarn, 26 % med stengsel, 23 % av turister, 13 % av lokale stangfiskere og 9 % med stågarn. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 33 %. Som en konsekvens av det så må fisket i Veahčajohka/Vetsijoki reduseres med rundt 40 % dersom en skal nå en total reduksjon i beskatning på 30 %.

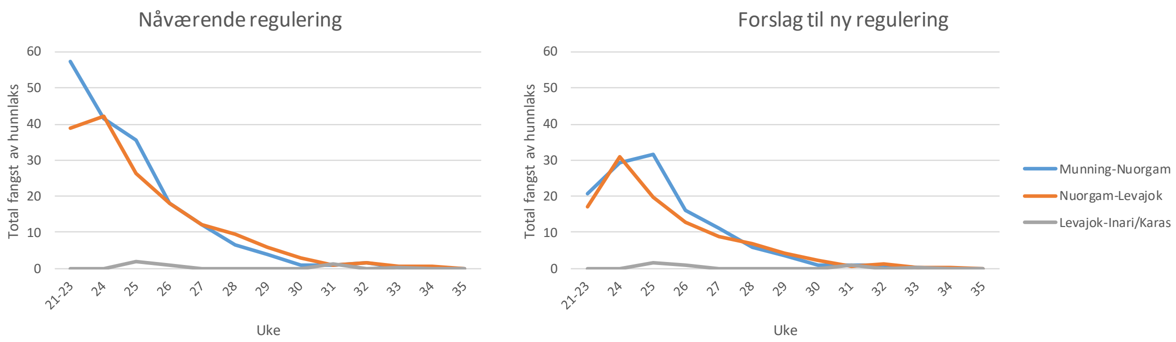
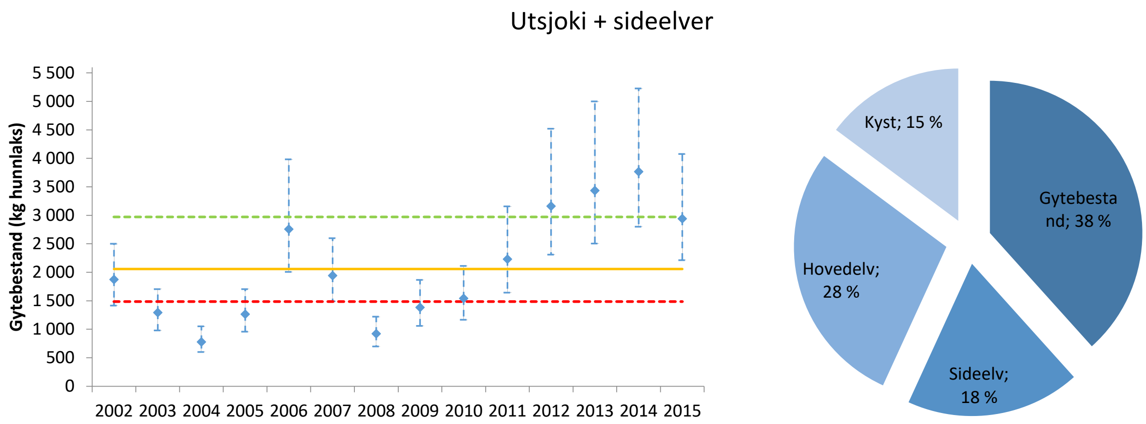


Figure S14. Total årlig fangst av hunnlaks fra Veahčajohka/Vetsijoki fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Fangst av laks i Ohcejohka/Utsjoki (+sideelver) i årene 2002-2015 varierte fra 800 kg i 2004 til 2 955 kg i 2014. Gytebestandsmålet i Ohcejohka/Utsjoki (+sideelver) er 4 979 107 egg, og for å nå dette eggantallet må 2 059 kg (1 468-2 972 kg) hunnlaks delta i gytingen. Måloppnåelsen varierte fra 38 % i 2004 til 100 % i 2006 og 2011-2015. Sannsynligheten for at gytebestandsmålet var nådd varierte fra 0 % i 2004 og 2008 til 100 % i 2013 og 2014. Måloppnåelse over siste 4 år var 164 %. Forvaltningsmål var nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 99 %. Gjennomsnittlig total beskatning av laks fra Ohcejohka/Utsjoki i 2006-2015 var 62 %, noe lavere enn den estimerte maksimale bærekraftige beskatningen på 67 %. Av et gjennomsnittlig innsig på 11 573 kg ble 15 % tatt i sjølaksefiske, 28 % i hovedelvfiske og 18 % i selve Ohcejohka/Utsjoki. Gjennomsnittlig overbeskatning var 12 %.



Figur S15. Venstre: Estimert gytebestand i Ohcejohka/Utsjoki (+sideelver) i årene 2002-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av laks hjemmehørende i Ohcejohka/Utsjoki (+sideelver) i årene 2006-2015 fordelt på kystfangst, hovedelvefangst, sideelvfangst og gytebestand.

Rett under halvparten (49 %) av hovedelvfangsten av hunnlaks fra Ohcejohka/Utsjoki (+sideelver) tas i nedre norsk del, fulgt av 50 % i nedre del av riksgrensen. Over 87 % av hunnlaksen tas i uke 21-27 (mai til tidlig juli). 29 % av hunnlaksen ble tatt av turister, 28 % med stengsel, 22 % med drivgarn, 12 % av lokale stangfiskere og 8 % med stågarn. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 30 %.

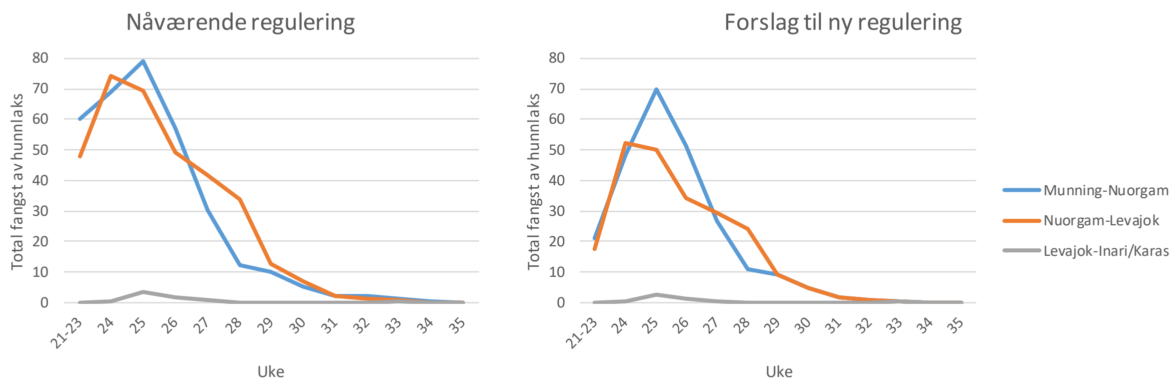
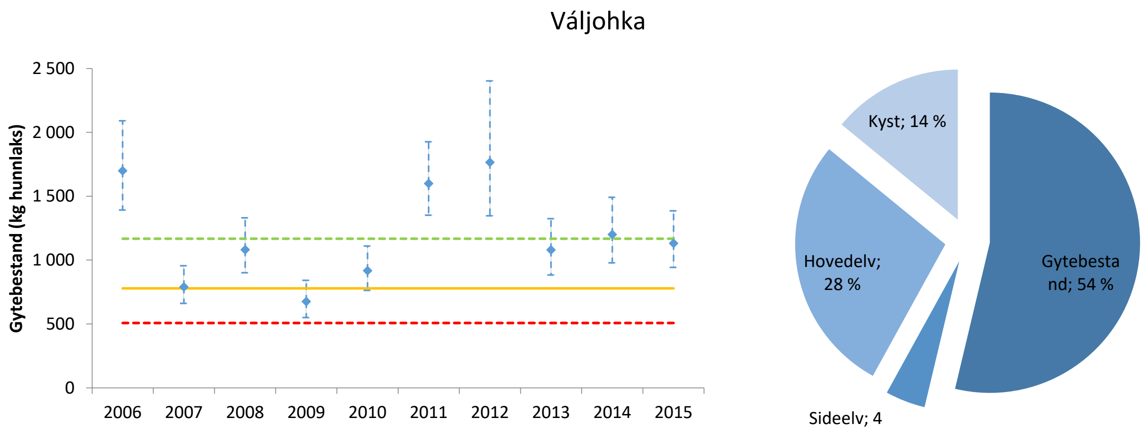


Figure S16. Total årlig fangst av hunnlaks fra Ohcejohka/Utsjoki (+sideelver) fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Fangst av laks i Váljohka i årene 2006-2015 varierte fra 97 kg i 2007 til 365 kg i 2012. Gytebestandsmålet i Váljohka er 1 907 595 egg, og for å nå dette eggantallet må 779 kg (508-1 168 kg) hunnlaks delta i gytingen. Måloppnåelsen var 100 % i de fleste år av perioden 2006-2015 med unntak av 2009 (87 %). Sannsynligheten for at gytebestandsmålet var nådd varierte fra 20 % i 2009 til 100 % i 2006, 2011 og 2012. Måloppnåelse over siste 4 år var 149 %. Forvaltningsmål var nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 99 %. Gjennomsnittlig total beskatning av laks fra Váljohka i 2006-2015 var 46 %, markert lavere enn den estimerte maksimale bærekraftige beskatningen på 63 %. Av et gjennomsnittlig innsig på 4 381 kg ble 14 % tatt i sjølaksefiske, 28 % i hovedelvfiske og 4 % i selve Váljohka. Gjennomsnittlig overbeskatning var 1 %.



Figur S17. Venstre: Estimert gytebestand i Váljohka i årene 2006-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av laks hjemmehørende i Váljohka i årene 2006-2015 fordelt på kystfangst, hovedelvefangst, sideelvfangst og gytebestand.

Noe under halvparten (47 %) av hovedelvfangsten av hunnlaks fra Váljohka tas i nedre del av riksgrensen, fulgt av 28 % i øvre del av riksgrensen og 26 % i nedre norsk del. Over 85 % av hunnlaksen tas i uke 21-26 (mai til slutten av juni). 29 % av hunnlaksen ble tatt av turister, 28 % med drivgarn, 17 % av lokale stangfiskere, 14 % med stengsel og 12 % med stågarn. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 38 %.

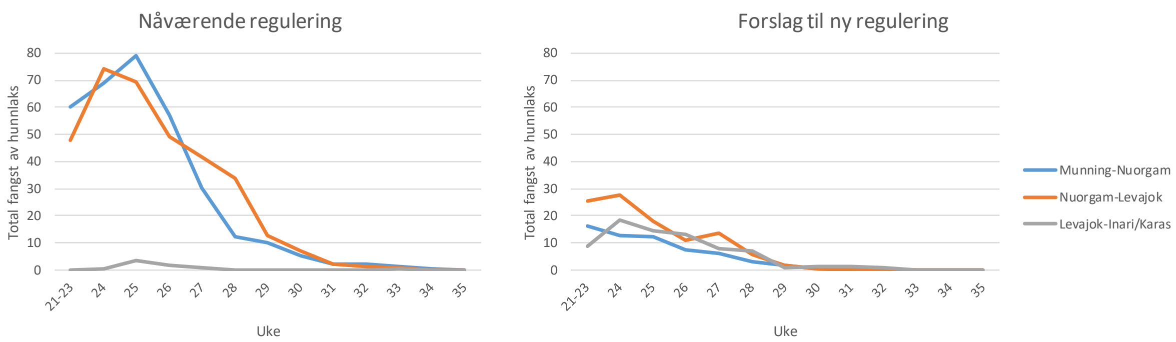
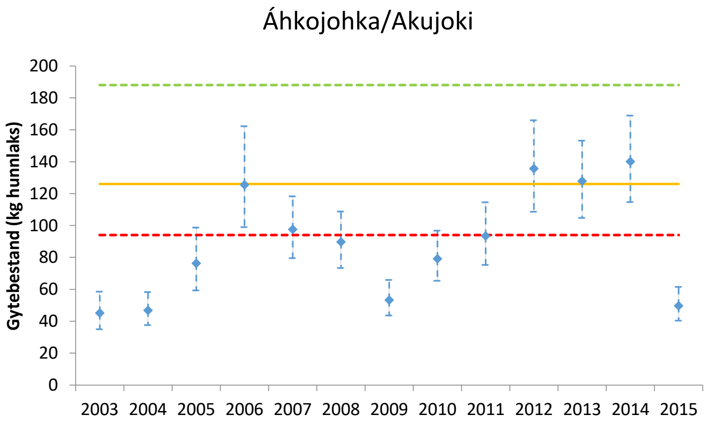


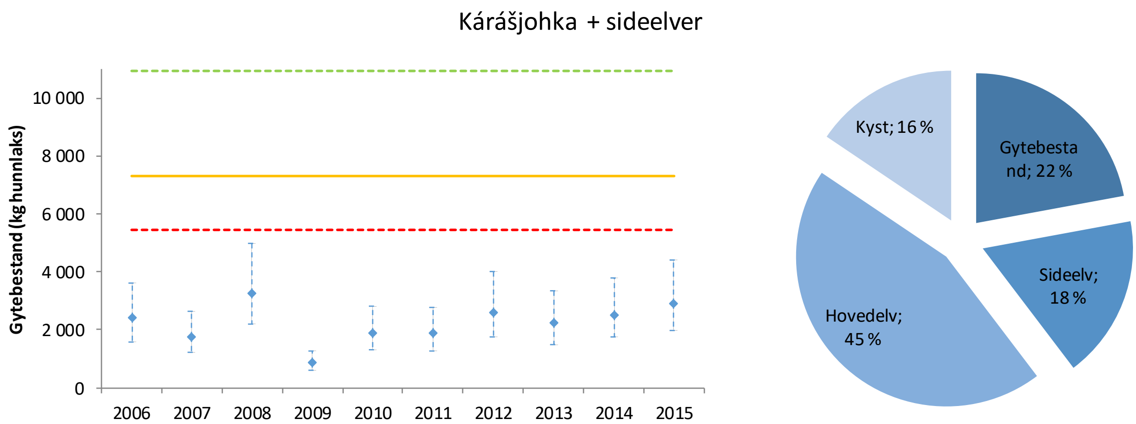
Figure S18. Total årlig fangst av hunnlaks fra Váljohka fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Det er begrenset fiske etter laks i Áhkojohka/Akujoki så statusevalueringen i denne sideelven er basert på de årlige dykketellingene i perioden 2003-2015. Gytebestandsmålet i Áhkojohka/Akujoki er 282 532 egg, og for å nå dette eggantallet må 126 kg (94-188 kg) hunnlaks delta i gytingen. Måloppnåelsen varierte fra 35 % i 2003 til 100 % i 2012 og 2014. Sannsynligheten for at gytebestandsmålet var nådd varierte fra 0 % i 2003-2005, 2008-2010 og 2015 til 60 % i 2014. Måloppnåelse over siste 4 år var 100 %. Forvaltningsmål var ikke nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 47 %. På grunn av genetisk likhet mellom laks fra Akujoki og små naboelver er det ikke mulig å estimere beskatning av laks fra Akujoki i hovedelva og i sjølaksefisket.



Figur S19. Estimert gytebestand i Áhkojohka/Akujoki i årene 2003-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser).

Fangst av laks i Kárášjohka og sideelvene Bávttajohka og Geaimmejohka i årene 2006-2015 varierte fra 1 298 kg i 2009 til 3 902 kg i 2008. Gytebestandsmålet i Kárášjohka (+sideelver) er 14 034 595 egg, og for å nå dette eggantallet må 7 290 kg (5 468-10 936 kg) hunnlaks delta i gytingen. Måloppnåelsen varierte fra 12 % i 2009 til 45 % i 2008. Sannsynligheten for at gytebestandsmålet var nådd var 0 % i alle år i perioden 2006-2015. Måloppnåelse over siste 4 år var 35 %. Forvaltningsmål var ikke nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 0 %. Gjennomsnittlig total beskatning av laks fra Kárášjohka (+sideelver) i 2006-2015 var 78 %, markert høyere enn den estimerte maksimale bærekraftige beskatningen på 26 %. Av et gjennomsnittlig innsig på 17 018 kg ble 16 % tatt i sjølaksefiske, 45 % i hovedelvfiske og 18 % i selve Kárášjohka (+sideelver). Gjennomsnittlig overbeskatning var 66 %.



Figur S20. Venstre: Estimert gytebestand i Kárášjohka og sideelvene Bávttajohka og Geaimmejohka i årene 2006-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av laks hjemmehørende i Kárášjohka og sideelvene Bávttajohka og Geaimmejohka i årene 2006-2015 fordelt på kystfangst, hovedelvefangst, sideelvfangst og gytebestand.

Rundt 42 % av hovedelvfangsten av hunnlaks fra Kárášjohka og sideelvene Bávttajohka og Geaimmejohka tas i nedre del av riksgrensen, fulgt av 30 % i nedre norsk del og 28 % i øvre del av riksgrensen. Over 90 % av hunnlaksen tas i uke 21-27 (mai til starten av juli). 30 % av hunnlaksen ble tatt med drivgarn, 25 % av turister, 16 % med stengsel, 15 % med stågarn og 14 % av lokale stangfiskere. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 37 %. Som en konsekvens av det så må fisket i Kárášjohka reduseres med rundt 35 % dersom en skal nå en total reduksjon i beskatning på 30 %.

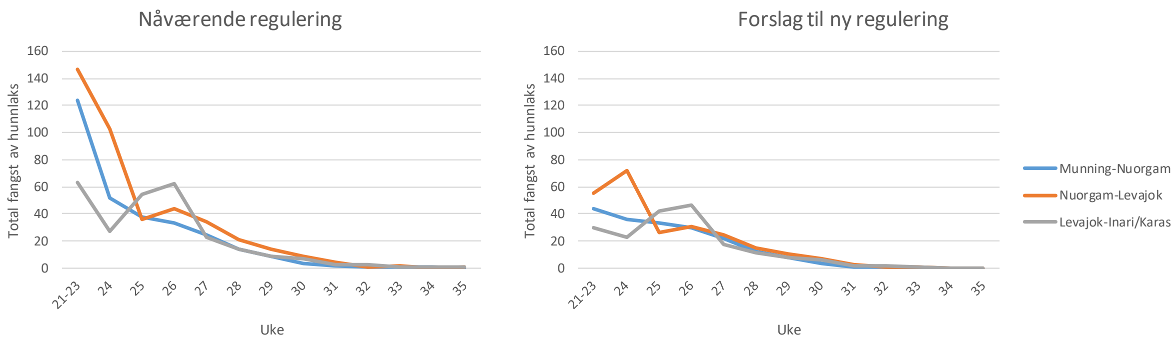
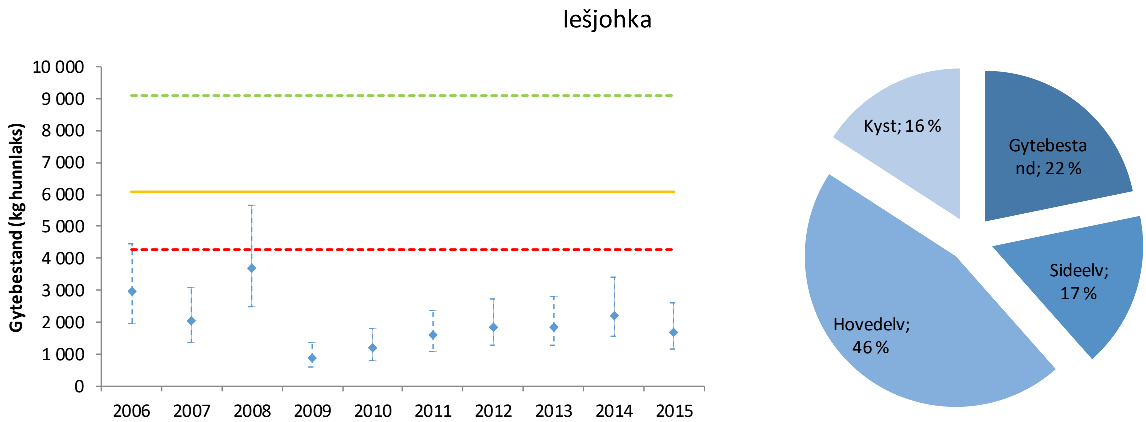


Figure S21. Total årlig fangst av hunnlaks fra Kárášjohka og sideelvene Bávttajohka og Geaimmejohka fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Fangst av laks i Iešjohka i årene 2006-2015 varierte fra 1 239 kg i 2009 til 4 499 kg i 2006. Gytebestandsmålet i Iešjohka er 11 536 009 egg, og for å nå dette eggantallet må 6 072 kg (4 278-9 107 kg) hunnlaks delta i gytingen. Måloppnåelsen varierte fra 15 % i 2009 til 62 % i 2008. Sannsynligheten for at gytebestandsmålet var nådd var 0 % i de fleste år i perioden 2006-2015 med unntak av 1 % i 2008. Måloppnåelse over siste 4 år var 31 %. Forvaltningsmål var ikke nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 0 %. Gjennomsnittlig total beskatning av laks fra Iešjohka i 2006-2015 var 78 %, markert høyere enn den estimerte maksimale bærekraftige beskatningen på 31 %. Av et gjennomsnittlig innsig på 15 463 kg ble 16 % tatt i sjølaksefiske, 46 % i hovedelvfiske og 17 % i Iešjohka. Gjennomsnittlig overbeskatning var 65 %.



Figur S22. Venstre: Estimert gytebestand i Iešjohka i årene 2006-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av laks hjemmehørende i Iešjohka i årene 2006-2015 fordelt på kystfangst, hovedelvefangst, sideelvfangst og gytebestand.

Rundt 42 % av hovedelvfangsten av hunnlaks fra Iešjohka tas i nedre del av riksgrensen, fulgt av 34 % i nedre norsk del og 24 % i øvre del av riksgrensen. Over 86 % av hunnlaksen tas i uke 21-27 (mai til starten av juli). 28 % av hunnlaksen ble tatt med drivgarn, 26 % av turister, 19 % med stengsel, 14 % av lokale stangfiskere og 14 % med stågarn. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 33 %. Som en konsekvens av det så må fisket i Iešjohka reduseres med rundt 50 % dersom en skal nå en total reduksjon i beskatning på 30 %.

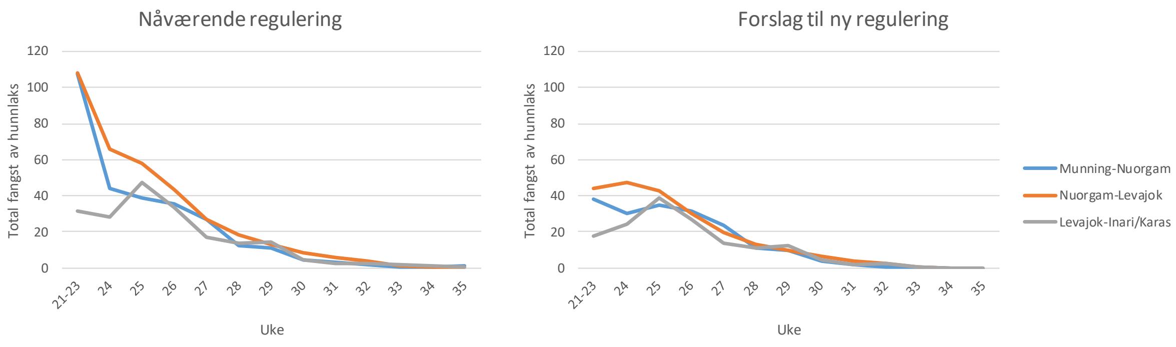
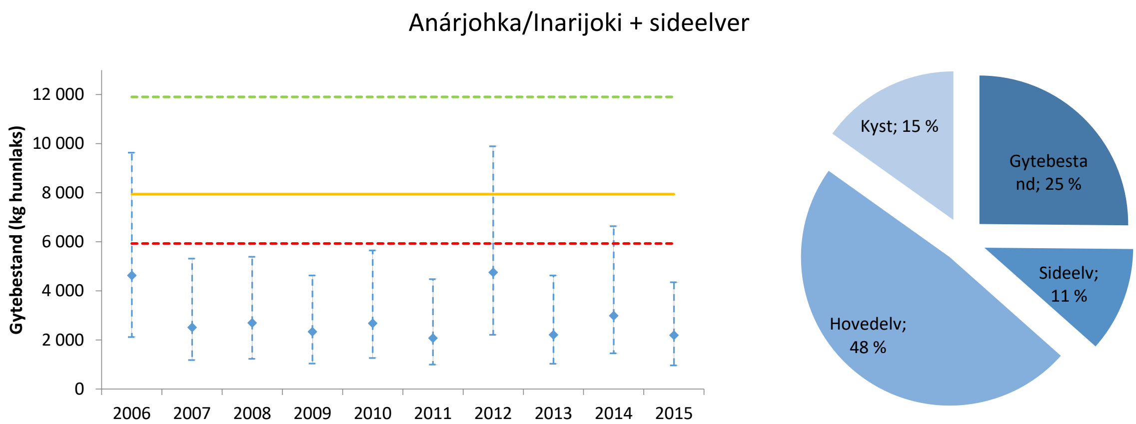


Figure S23. Total årlig fangst av hunnlaks fra Iešjohka fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Fangst av laks i Anárjohka/Inarijoki (+sideelver) i årene 2006-2015 varierte fra 881 kg i 2015 til 4 285 kg i 2012. Gytebestandsmålet i Anárjohka/Inarijoki (+sideelver) er 17 669 952 egg, og for å nå dette eggantallet må 7 937 kg (5 928-11 906 kg) hunnlaks delta i gytingen. Måloppnåelsen varierte fra 30 % i 2011 og 2015 til 67 % i 2012 og 65 % i 2006. Sannsynligheten for at gytebestandsmålet var nådd var 0 % i de fleste år i perioden 2006-2015 med unntak av 8 % i 2012 og 7 % i 2006. Måloppnåelse over siste 4 år var 38 %. Forvaltningsmål var ikke nådd, ettersom gjennomsnittlig sannsynlighet for at gytebestandsmålet var nådd siste 4 år var 0 %. Gjennomsnittlig total beskatning av laks fra Anárjohka/Inarijoki (+sideelver) i 2006-2015 var 75 %, markert høyere enn den estimerte maksimale bærekraftige beskatningen på 34 %. Av et gjennomsnittlig innsig på 22 855 kg ble 15 % tatt i sjølaksefiske, 48 % i hovedelvfiske og 11 % i selve Anárjohka/Inarijoki (+sideelver). Gjennomsnittlig overbeskatning var 59 %.



Figur S24. Venstre: Estimert gytebestand i Anárjohka/Inarijoki (+sideelver) i årene 2006-2015. De horisontale linjene representerer gytebestandsmålet (med øvre og nedre grenser). Høyre: Andel av innsiget av laks hjemmehørende i Anárjohka/Inarijoki (+sideelver) i årene 2006-2015 fordelt på kystfangst, hovedelvefangst, sideelvfangst og gytebestand.

Halvparten (50 %) av hovedelvfangsten av hunnlaks fra Anárjohka/Inarijoki (+sideelver) tas i nedre del av riksgrensen, fulgt av 25 % i nedre norsk del og 25 % i øvre del av riksgrensen. Rundt 84 % av hunnlaksen tas i uke 24-30 (midten av juni til slutten av juli). 41 % av hunnlaksen ble tatt av turister, 22 % med stengsel, 18 % av lokale stangfiskere, 11 % med stågarn og 9 % med drivgarn. Forslaget til ny regulering i Tana vil redusere hovedelvbeskatningen av hunnlaks med 26 %. Som en konsekvens av det så må fisket i Anárjohka/Inarijoki (+sideelver) reduseres med rundt 70 % dersom en skal nå en total reduksjon i beskatning på 30 %.

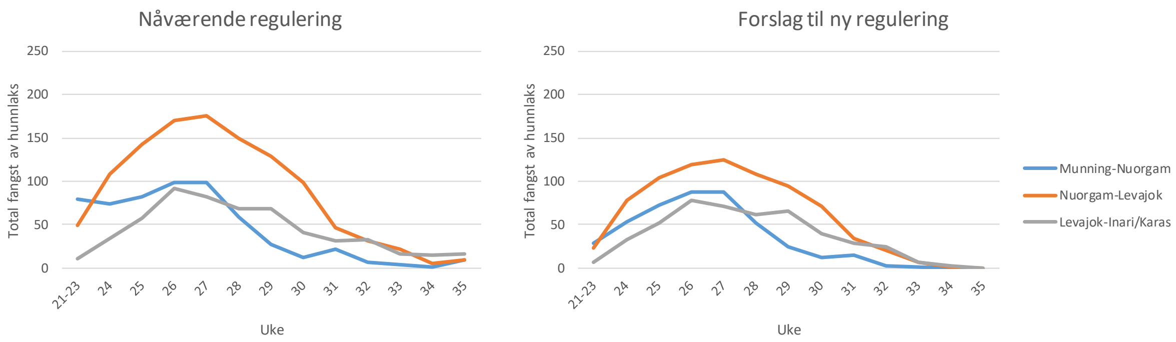
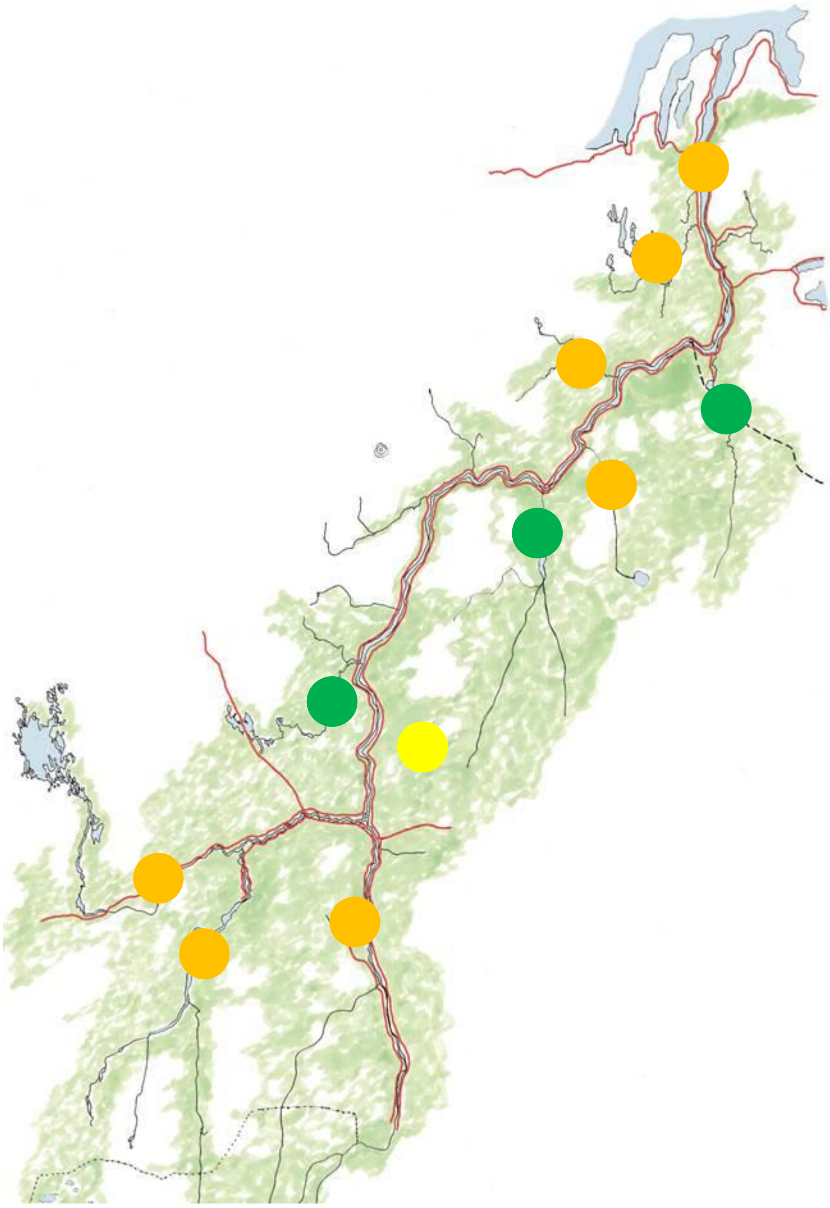


Figure S25. Total årlig fangst av hunnlaks fra Anárjohka/Inarijoki (+sideelver) fordelt på uke og område i hovedelva. Panelet til venstre viser gjennomsnittlig årlig fangst under nåværende regulering, mens panelet til høyre viser estimert årlig fangst med forslaget til ny regulering som kommer fra forhandlingene mellom Norge og Finland.

Oppsummert var måloppnåelsen siste 4 år (2012-2015) høyest i Ohcejohka/Utsjoki med sideelver (164 %), fulgt av Buolbmátjohka/Pulmankijoki (152 %), Váljohka (149 %), Áhkojohka/Akujoki (100 %), Veahčajohka/Vetsijoki (86 %), Tanaelva (72 %), Máskejohka (67 %), Lákšjohka (46 %), Anárjohka/Inarijoki med sideelver (38 %), Kárášjohka med sideelver (35 %) og Iešjohka (31 %).

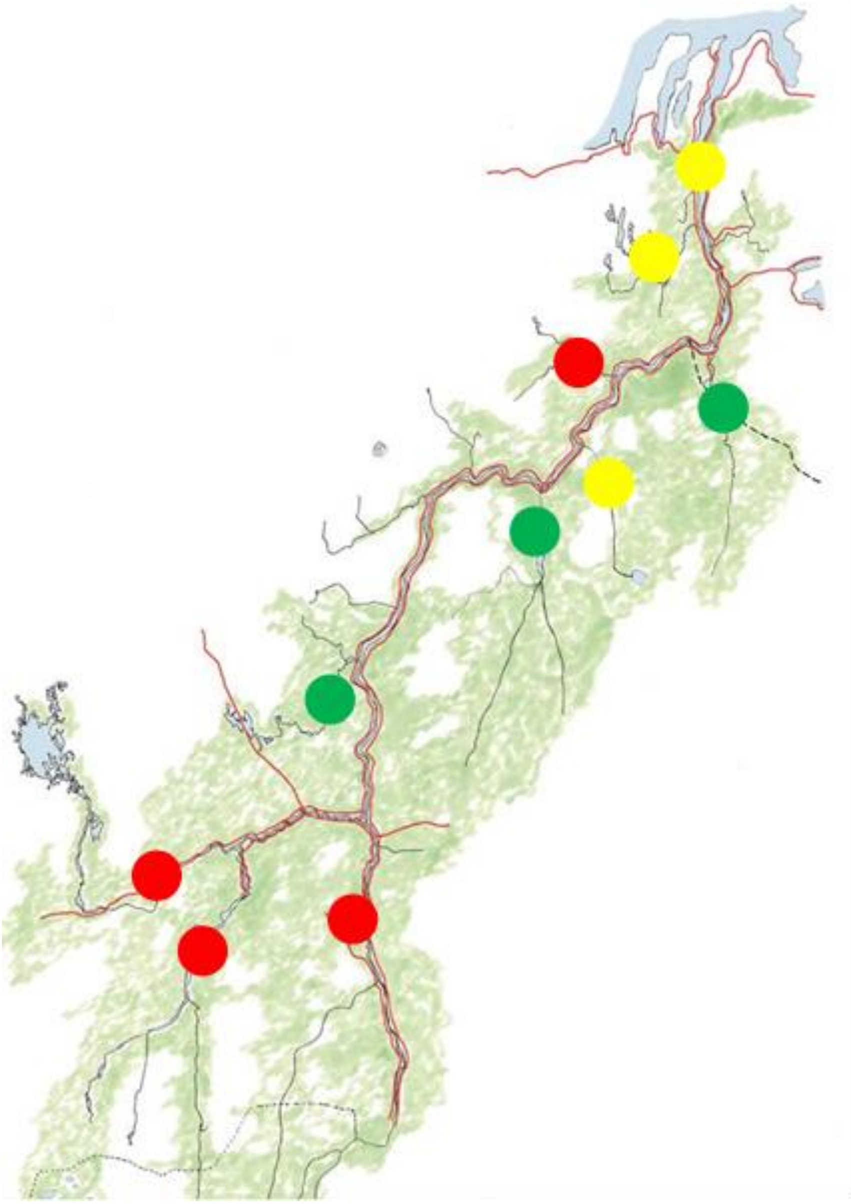
Statusevalueringen demonstrerer at forvaltningsmålet (siste 4 års sannsynlighet for at gytebestandsmålet er nådd) var under 40 % i alle undersøkte deler av Tanavassdraget unntatt Buolbmátjohka/Pulmankijoki, Ohcejohka/Utsjoki, Váljohka og Áhkojohka/Akujoki. Verst er situasjonen i Lákšjohka og de store sideelvene øverst i vassdraget, Kárášjohka (+sideelver), Iešjohka and Anárjohka/Inarijoki (+sideelver) som alle har forvaltningsmål 0 %.



Figur S26. Kart som oppsummerer bestandsstatus for de evaluerte delene av Tanavassdraget i perioden 2012-2015. Symbolfarge viser bestandsstatus siste fire år. Mulige statuskategorier er: Mørk grønn = sannsynlighet for at gytebestandsmål er nådd er høyere enn 75 % og måloppnåelse over 140 %. Lys grønn = sannsynlighet for at gytebestandsål er nådd er høyere enn 75 %. Gyl = sannsynlighet for at gytebestandsmål er nådd er mellom 40 og 74 %, måloppnåelse over 75 %. Oransje = sannsynlighet for at gytebestandsmål er nådd er under 40 %, bestanden har beskattbart overskudd i minst 3 av 4 siste år. Rød = bestanden hadde beskattbart overskudd i mindre enn 3 av 4 siste år.

Total beskatningsrate i Tana (alle bestander) ble estimert til 66 % i perioden 2006-2015. Av de undersøkte bestandene, så var de høyeste estimerte akkumulerte beskatningsratene på over 70 %, med Iešjohka og Kárášjohka (+sideelver) på 78 %, Anárjohka/Inarijoki (+sidelever) på 75 % og Veahčajohka/Vetsijoki på 73 %. På undersiden av 70 % finner vi Ohcejohka/Utsjoki (+sideelver) på 62 %, Lákšjohka på 60 %, Máskejohka på 63 % og selve Tanaelva på 63 %. Lavest akkumulert beskatning ble estimert for Váljohka (46 %) og Buolbmátjohka/Pulmankijoki (57 %).

Overbeskatning som trusselfaktor er definert som i hvilken grad gytebestand blir redusert under gytebestandsmål som et resultat av beskatning. Det var betydelig overbeskatning i alle undersøkte deler av Tanavassdraget i perioden 2006-2015, med unntak av Buolbmátjohka/Pulmankijoki, Váljohka og Utsjoki.



Figur S27. Kart som oppsummerer estimert overbeskatning i ulike deler av Tanavassdraget i 2006-2015. Symbolfarge representerer grad av overbeskatning gitt som prosent av gytebestandsmål. Mørk grønn = ingen effekt (0 % av gytebestandsmål), lys grønn = liten effekt (<10 %), gul = moderat effekt (10-30 %), rød = stor effekt (>30 %).

Estimat av maksimal bærekraftig beskatning (det høyeste beskatningsnivået en bestand kan utsettes for i et gitt år og fremdeles nå gytebestandsmålet) demonstrerer at enkelte bestander er nedfisket til det punktet hvor de i dag har svært lavt bærekraftig overskudd. De laveste estimatene på maksimalt bærekraftig bekatningstrykk i perioden 2006-2015 ble funnet i Lákšjohka med 17 %, fulgt av Kárášjohka (+sideelver) med 26 %, Iešjohka med 28 % og Anárjohka/Inarijoki (+sideelver) med 34 %.

Vi konstruerte gjenoppbyggingsbaner for alle de undersøkte delene av Tanavassdraget for tre ulike reguleringsscenarier. Alle undersøkte områder vil nå 75 % sannsynlighet for at gytebestandsmålet er nådd over en periode på tre laksegenerasjoner dersom total akkumulert beskatningsrate blir redusert med 30 %.

Anbefalinger for et langsiktig overvåkningsprogram av Tanavassdraget

Statusevalueringen innenfor et fleksibelt og kunnskapsbasert forvaltningsregime bør basere seg på gode overvåkningsdata som samles inn gjennom et konsistent, langsiktig overvåkningsprogram. Et slik program bør bestå av (1) en detaljert og nøyaktig fangststatistikk fra de ulike områdene og fiskeriene i vassdraget, (2) skjellprøver som kan gi livshistoriedata og kan benyttes til genetisk bestandsidentifisering av laks i fiske på blandete bestander, og (3) nøyaktig fisketelling, enten i form av video/akustisk telling av fisk som vandrer inn i en elv om sommeren (enten en sideelv eller nederst i hovedelva) eller med gytefisktelling på høsten (snorkling).

De ulike bestandene i Tana blir beskattet forskjellig i de ulike fiskeriene, blant annet ved at hovedelvbeskatningen er lavere for sideelvbestandene nede i vassdraget enn for bestandene lenger opp i vassdraget. Et langtids overvåkningsprogram må derfor være romlig fordelt slik at det fanger opp mønstre i nedre, midtre og øvre del av Tanavassdraget.

Tanagruppa støtter behovet for å finne egnede arenaer for kommunisering av lokal kunnskap til gruppen og formidling av forskningskunnskap til lokale samfunn på en tilgjengelig måte.

Det er i dag en manglende langtids forutsigbarhet i forskning og overvåkning i Tana, noe som gjør det umulig å planlegge aktiviteter mer enn 1-2 år fram i tid. Tanagruppa anbefaler derfor sterkt at det kan etableres et felles permanent norsk-finsk overvåkningsprogram for Tana.

YHTEENVETO

Työryhmä ja sen tehtävä

Suomen maa- ja metsätalousministeriö ja Norjan ympäristöministeriö perustivat Tenojoen seuranta- ja tutkimustyöryhmän vuonna 2010 saman vuoden helmikuussa allekirjoitetun yhteisymmärryspöytäkirjan pohjalta. Työryhmän toimeksiannossa määriteltyjen tehtävien mukaan työryhmän on muun muassa toimitettava vuosiraportteja lohikantojen tilasta, arvioitava kantojen hoitoa sekä annettava seurantaa ja tutkimusta koskevaa neuvontaa. Työryhmä näkee paikallisen ja perinteisen tietämyksen potentiaalisen merkityksen ja myös hyödyntää jo keskeisiä osia siitä työssään.

Tenojoen lohikantojen hoito

Norja ja Suomi (EU:n kautta) ovat molemmat Pohjois-Atlantin lohensuojelujärjestön (NASCO) jäseniä. NASCO on kansainvälinen järjestö, jonka tavoitteena on suojella, elvyttää, parantaa ja hoitaa järkiperäisesti Atlantin lohikantoja. Suomen ja Norjan ulkoasiainministeriöt, Suomen maa- ja metsätalousministeriö ja Norjan ympäristöministeriö ovat myös neuvotelleet kahdenvälisen Tenojoen kalastussopimuksen. Viimeisin kalastussopimus on vuodelta 1990. Matkailijoiden vapakalastusta on perinteisesti säädelty molempien maiden alueviranomaisten vuotuisissa neuvotteluissa sovituilla toimilla (Norjaa on edustanut Finnmarkin lääninhallituksen ympäristöosasto ja Suomea Lapin elinkeino-, liikenne ja ympäristökeskuksen kalatalousyksikkö). Norjassa vastuu paikallistason kalastuksenhoidosta on hiljattain siirtynyt uudelle Tenojoen vesistön kalastusyhdistykselle (Tanavassdragets Fiskeforvaltning). Norja säätelee rannikkokalastusta valtakunnallisesti, ja sitä on viime vuosina rajoitettu aiempaa enemmän.

Tenojoki, sen lohikannat ja kalastus

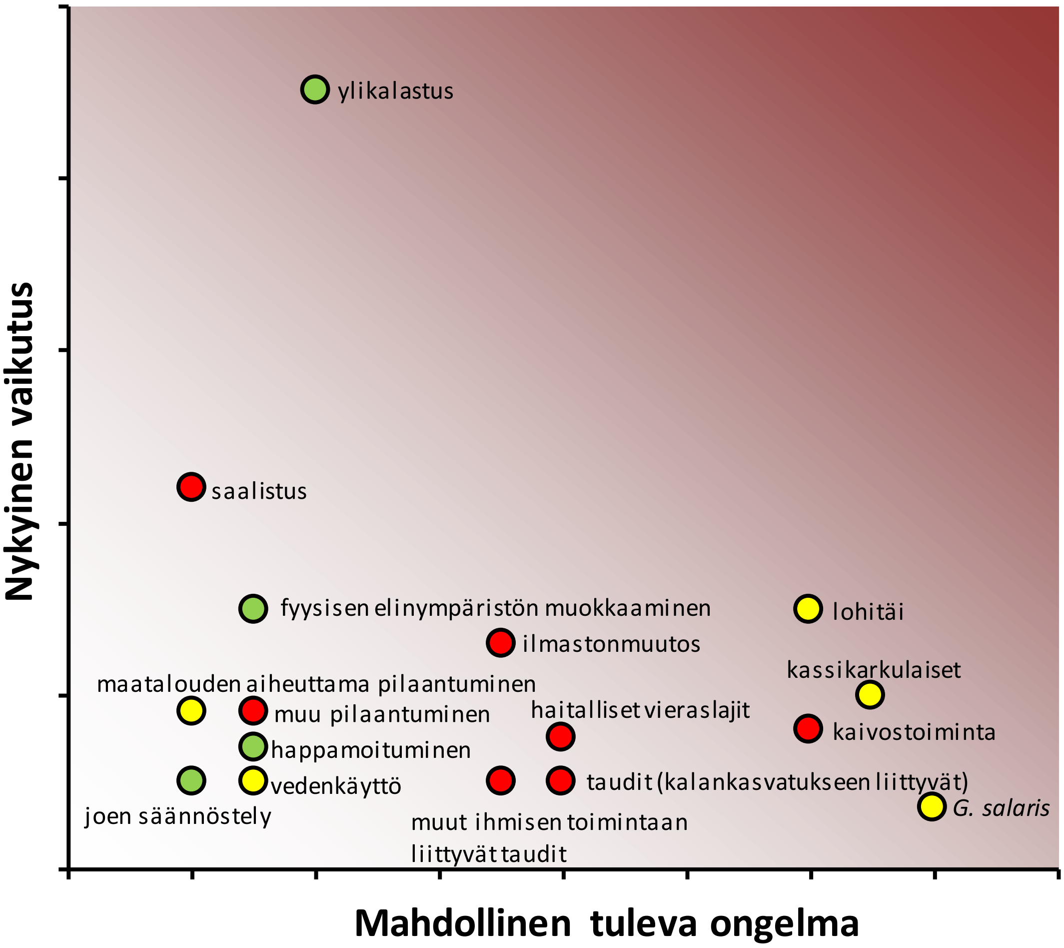
Subarktisella vyöhykkeellä sijaitseva Tenojoki muodostaa pohjoisimman Norjan ja Suomen välisen rajan. Joen valuma-alue on 16 386 km^2, ja se koostuu useista pienistä ja suurista sivujoista, joista useimpiin (yhteensä > 1 200 km) lohet pääsevät nousemaan. Tenojoki on myös yksi harvoja runsaita luonnonvaraisia Atlantin lohikantoja tukevia jokivesistöjä, joihin ihmisen toiminta kalastusta lukuun ottamatta vaikuttaa hyvin vähän tai ei lainkaan.

Tenojoessa on tällä hetkellä Atlantin alueen suurin villilohikanta. Vuotuiset jokisaaliit vaihtelevat 70 ja 250 tonnin välillä, mikä vastaa keskimäärin 30 000–50 000:ta pyydettyä kalaa vuodessa. Koko lohikanta koostuu ainakin 30 erillisestä lohipopulaatiosta, joilla on hyvin moninaisia elinkiertopiirteitä. Meri-ikäryhmät vaihtelevat yhden merivuoden ikäisistä lohista viiden merivuoden lohiin, ja lisäksi tavataan useita erityyppisiä aiemmin kuteneita kaloja. Tenojoen lohisaaliissa on toistaiseksi ollut hyvin vähän kassikasvatuksesta karanneita viljeltyjä lohia, mutta viljeltyjen lohien osuuksia kalastuskauden jälkeen ei tiedetä (joitakin harvoja poikkeuksia lukuun ottamatta).

Lohen jokikalastukseen Tenojoessa kuuluvia menetelmiä ovat vapakalastuksen lisäksi verkkokalastuspyydykset, kuten pato, verkko, nuotta ja ajoverkko. Viitenä viime vuotena vapakalastuksen saaliin osuus on ollut noin 60 % jokivesistön kokonaissaaliista, ja viimeksi kuluneiden 30 vuoden aikana eri kalastusmenetelmien osuudet ovat pysyneet lähes samoina. Lohenpyynti on Tenojoen pääuoman kaikissa osissa sekakantakalastusta. Telemetrisiä merkintämenetelmiä hyödyntävien tutkimusten perusteella jokikalastuksen pyyntiaste voi olla yli 60 %. Kun huomioidaan myös merikalastus, joidenkin Tenojoen lohikantojen todellinen kalastuskuolevuus voi olla hyvin korkea, jopa 80 %.

Uhkatekijät

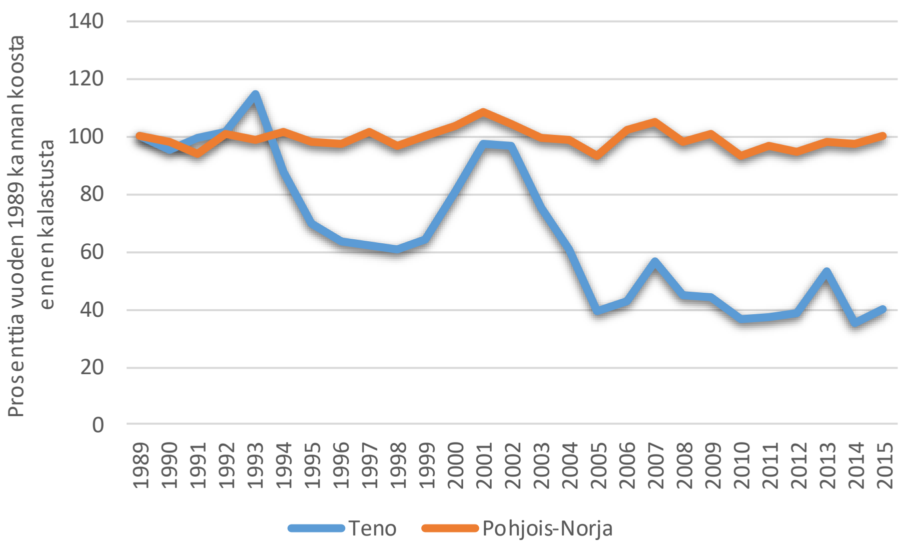
Tenojoen lohikantoihin vaikuttavia uhkatekijöitä koskeva yleiskatsaus osoittaa, että ylikalastus lohen vaellusreitin eri osissa on tällä hetkellä vakavin Tenojoen lohikantoja uhkaava tekijä (kuva S1). Muun ihmisen toiminnan, kuten ympäristön pilaamisen, vesivoiman rakentamisen tai kalanviljelyn, vaikutukset ovat vähäisiä tai olemattomia. Mahdollisista tulevista uhkatekijöistä merkittävimpinä pidetään kaivostoimintaa, lohitäitä, kassikarkulaisia ja *Gyrodactylus salaris* -lohiloista sekä tartuntatauteja ja vieraslajeja.



Kuva S1. Tenojoen lohikantoihin vaikuttavien uhkatekijöiden luokittelu vaikutusta ja riskiä kuvaavassa kaaviossa. Merkkien värit ilmaisevat tiedon ja epävarmuuden määrää: vihreä väri tarkoittaa, että tekijästä on paljon tietoa ja että sen kehityksestä ei juuri ole epävarmuutta, keltainen väri tarkoittaa kohtalaista tiedon ja epävarmuuden määrää ja punainen vähäistä tiedon määrää ja suurta epävarmuutta tekijän kehittymisestä.

Lohikantojen koon kehitys kalastusta edeltävän kantojen koon arvion perusteella

Alla olevassa kuvassa (kuva S2) esitetään arviot Pohjois-Norjan lohikantojen koosta merellä ennen kalastusta vuosina 1989–2015 (ajoverkkokalastus kiellettiin Norjan rannikolla vuonna 1989). Kuvasta käy selvästi ilmi, että Tenojoen lohikantojen kehitys on ollut heikompaa kuin alueen muiden lohikantojen.



Kuva S2. Pohjois-Norjan lohikantojen kalastusta edeltävien koon kehitys (oranssi viiva: kaikki muut kuin Tenojoen kannat) ja Tenojoen lohikantojen koon kehitys rannikolla ennen kalastusta (sininen viiva) vuodesta 1989 vuoteen 2015. Kantojen koot on ilmaistu prosenttiosuutena vuoden 1989 kantojen koosta. Tiedot perustuvat ARIMA (1, 0, 0) -trendianalyysiin. (Analyysin tehnyt Norjan lohikantojen hoidon neuvoa-antava tieteellinen komitea.)

Kantojen tilan arviointi ja hoitosuositukset

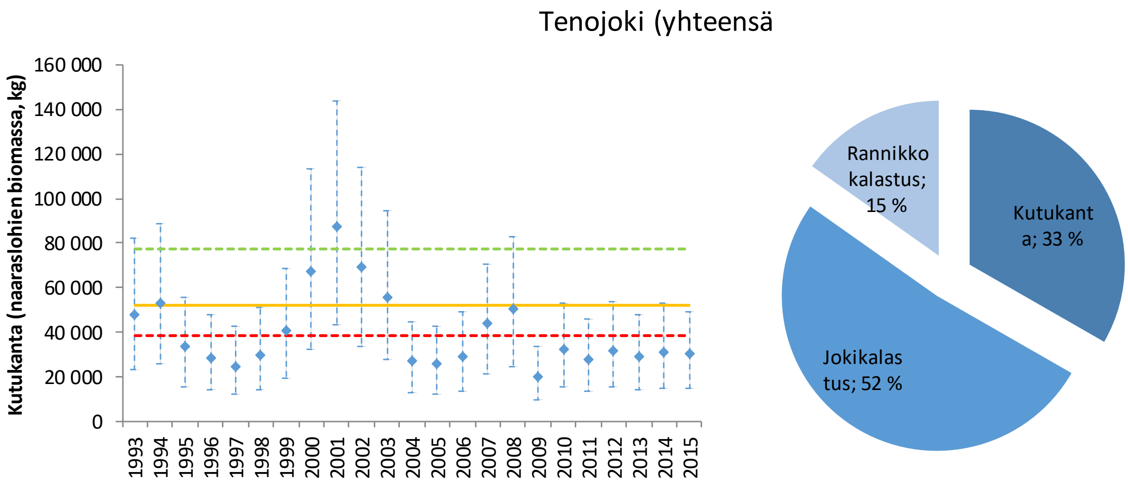
Lohikantojen tilan arviointi perustuu NASCOn varovaisuusperiaatteen mukaisesti hoitotavoitteisiin. Arvioinnin vaiheet ovat 1) kantakohtaisten kutukantatavoitteiden määrittely (ts. kannan tuotantopotentiaalin täyttymiseksi tarvittavan mätimunien lukumäärän arviointi), 2) arvio kutukypsien naaraiden lukumäärästä kalastuskauden jälkeisessä kannassa ja 3) todennäköisyyslaskentaan perustuva kutukantatavoitteen ja kutukanta-arvion välinen vertailu. Tenojoella määritellyt kutukantatavoitteet ovat suoraan verrattavissa NASCO:n käyttämään suojelurajaan (Conservation limit). Kalakantojen hoitotavoite on se kannan koko, johon kalastuksen säätelyn ja muilla keinoin pyritään, jotta todennäköisyys kutukantatavoitteen saavuttamiseksi olisi mahdollisimman suuri. Hoitotavoite määritellään tasoksi, jossa lohikannalla on 75% todennäköisyys saavuttaa kutukantatavoite neljän edellisen vuoden aikana.

Kutukantatavoitteita on määritelty kaikille Tenojoen vesistön osille sekä Norjassa että Suomessa (Falkegård ym. 2014). Näiden kutukantatavoitteiden perusteella kantojen tilaa arvioidaan tässä seuraavien alueiden osalta: Tenojoen pääuoma, Máskejohka, Buolbmátjohka/Pulmankijoki, Lákšjohka, Veahčajohka/Vetsijoki, Ohcejohka/Utsjoki, Váljohka, Áhkojohka/Akujoki, Kárášjohka (+ sivujoet), Iešjohka, Anárjohka/Inarijoki (+ sivujoet) ja koko Tenojoen vesistö.

Määritelmät kahdelle tässä raportissa käytetylle termille:

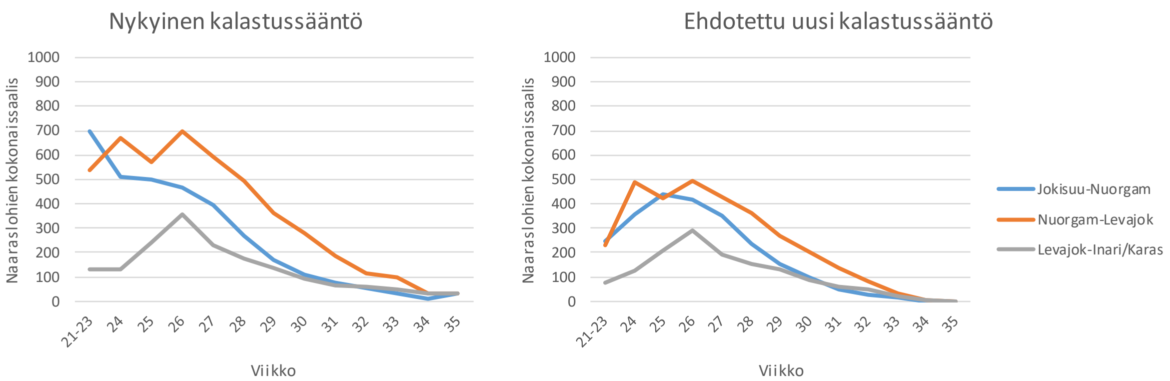
- Korkein kestävä kalastuskuolevuus: Suurin mahdollinen osuus lohista, joka lohikannasta voidaan kalastaa niin että kutukantaan jää riittävä määrä lohia.
- Ylikalastus: Kalastuksen aiheuttama kutukannan pieneneminen alle kutukantatavoitteen. Kun lohikanta ei saavuta kutukantatavoitettaan, kutukantatavoitteen ja arvioidun kutukannan erotus on ylikalastuksen määrä.

Tenojoen kokonaislohisaalis on ollut vuosina 1993–2015 pienimmillään 63,5 tonnia vuonna 2009 ja suurimmillaan 248,5 tonnia vuonna 2001. Tenojoen yhteenlaskettu kutukantatavoite on 104 274 286 mätimunaa. Tämän mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 51 846 kg (38 277–77 371 kg). Kutukantatavoitteen saavuttamisaste on ollut alhaisimmillaan 39 % vuonna 2009 ja korkeimmillaan 100 % vuosina 1994 ja 2000–2003. Kutukantatavoitteen saavuttamisen todennäköisyys on vaihdellut 0 %:sta (1996, 1997, 2004, 2005, 2009, 2011 ja 2013) 95 %:iin (2001). Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 59 %. Hoitotavoitetta ei ole saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 1 %. Tenojoen lohikantojen yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 67 %. Lohikantojen koko ennen kalastusta on ollut keskimäärin 180 307 kg. Kannasta on pyydetty rannikolla 15 % ja Tenojoen vesistössä 52 %.



Kuva S3. Vasemmanpuoleinen kuva: Tenojoen vesistön arvioitu yhteenlaskettu kutukanta vuosina 1993–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla ja jokikalastuksessa pyydettyjen sekä kudulle selviävien lohien osuudet Tenojoen lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

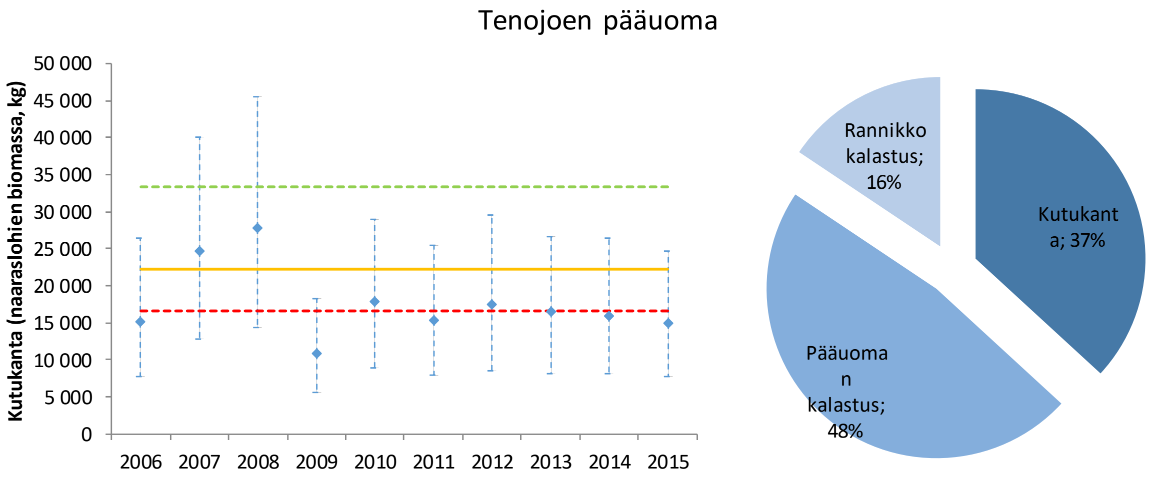
Tenojoen pääuomassa pyydettävistä koko Tenojoen vesistön naaraslohista lähes puolet (48 %) pyydetään Nuorgamista Levajoelle ulottuvalla rajajokiosuudella. Seuraavaksi suurimmat osuudet pyydetään pääuoman alajuoksulla Norjan puolella (34 %) ja rajajokiosuuden yläosassa (18 %). Yli 80 % naaraslohista on pyydetty viikoilla 21–28 (toukokuusta heinäkuun puoliväliin). Kalastusmatkailijoiden osuus naaraslohisaaliista on ollut 34 %, patopyynnin osuus 22 %, paikallisten vapapyytäjien osuus 17 %, ajoverkkopyynnin eli kulkutuksen osuus 16 % ja verkkokalastuksen osuus 11 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi kaikkien lohikantojen naaraslohien kalastuskuolevuutta pääuomassa 28 %.



Kuva S4. Koko Tenojoen vesistöstä pyydettyjen naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

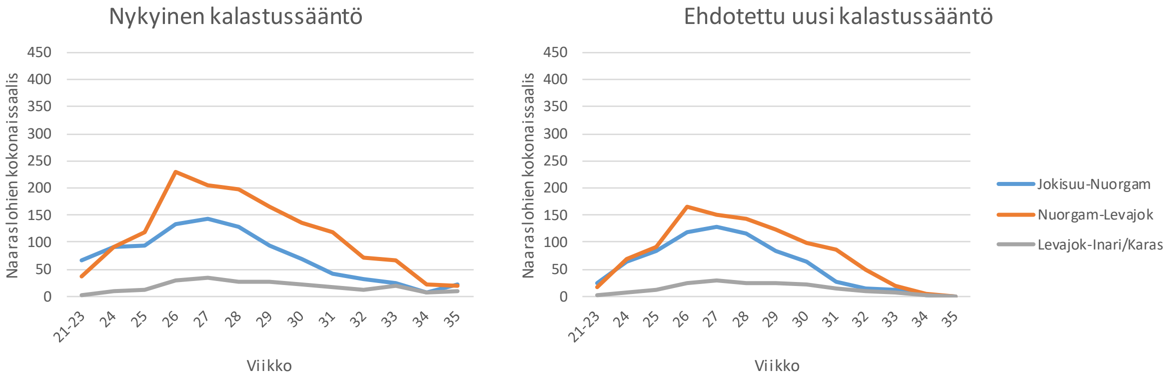
Tenojoen pääuoman lohikannan arvioitu saalis on ollut pienimmillään 28 193 kg vuonna 2009 ja suurimmillaan 55 203 kg vuonna 2008. Tenojoen pääuoman kutukantatavoite on 22 189 kg (16 642–33 284 kg). Kutukantatavoitteen saavuttamisaste on ollut alhaisimmillaan 49 % vuonna 2009 ja korkeimmillaan 100 %

vuosina 2007 ja 2008. Kutukantatavoitteen saavuttamisen todennäköisyys on vaihdellut 0 %:sta (2009) 75 %:iin (2008). Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 72 %. Hoitotavoitetta (viimeisen neljän vuoden keskimääräinen todennäköisyys kutukantatavoitteen saavuttamiseksi = 75%) ei ole saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 8 %. Tenojoen pääuoman lohikannan yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 63 % eli merkittävästi korkeampi kuin arvioitu korkein kestävä kalastuskuolevuus, joka on 50 %. Lohikannan koko ennen kalastusta on ollut keskimäärin 87 456 kg. Kannasta on pyydetty rannikolla 16 % ja pääuomassa 48 %. Keskimääräinen ylikalastus (kutukantatavoitteen alle jäävä kannan koko prosentteina tavoitteesta) on ollut 24 %.



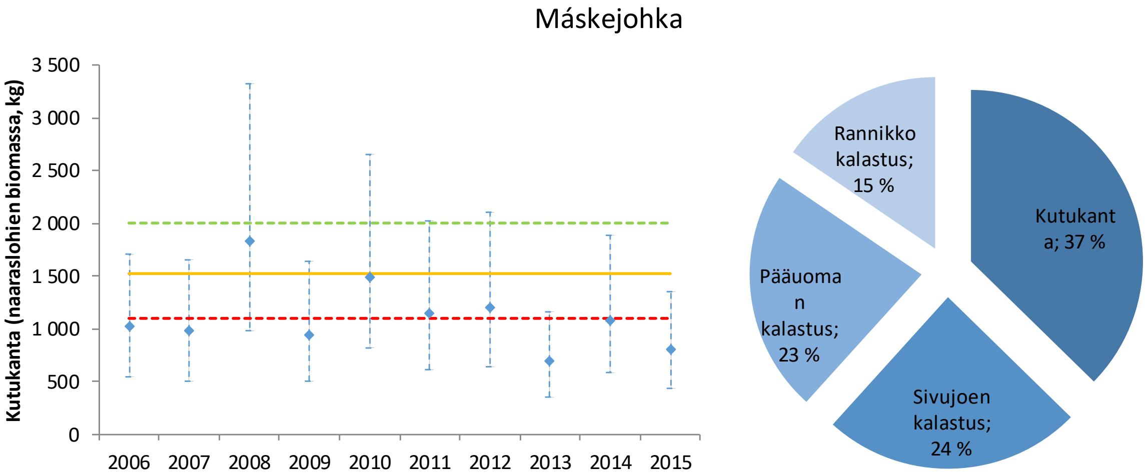
Kuva S5. Vasemmanpuoleinen kuva: Tenojoen pääuoman lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla ja pääuomassa pyydettyjen sekä kudulle selviävien lohien osuudet Tenojoen pääuoman lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

Tenojoen pääuomassa pyydettävistä pääuoman lohikannan naaraslohista yli puolet (56 %) pyydetään Nuorgamista Levajoelle ulottuvalla rajajokiosuudella. Seuraavaksi suurimmat osuudet pyydetään pääuoman alajuoksulla Norjan puolella (36 %) ja rajajokiosuuden yläosassa (9 %). Yli 80 % naaraslohista on pyydetty viikoilla 25–31 (kesäkuun jälkipuoliskolla ja heinäkuussa). Kalastusmatkailijoiden osuus naaraslohisaaliista on ollut 37 %, patopyynnin osuus 25 %, paikallisten vapapyytäjien osuus 21 %, verkkokalastuksen osuus 10 % ja kulkutuksen osuus 7 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi pääuoman lohikannan naaraslohien kalastuskuolevuutta pääuomassa 27 %.



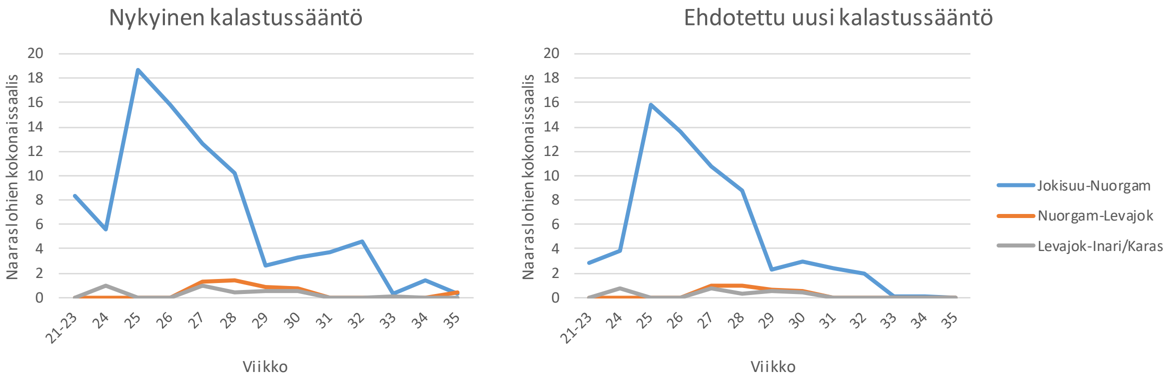
Kuva S6. Tenojoen pääuoman lohikannan naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

Máskejohkan lohisaalis on ollut vuosina 2006–2015 pienimmillään 979 kg vuonna 2013 ja suurimmillaan 2 320 kg vuonna 2008. Máskejohkan kutukantatavoite on 3 155 148 mätimunaa. Mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 1 521 kg (1 100–2 000 kg). Kutukantatavoitteen saavuttamisaste on ollut alhaisimmillaan 48 % vuonna 2013 ja korkeimmillaan 100 % vuosina 2008 ja 2010. Kutukantatavoitteen saavuttamisen todennäköisyys on vaihdellut 0 %:sta (2013) 83 %:iin (2008). Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 67 %. Hoitotavoitetta ei ole saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 4 %. Máskejohkan lohikannan yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 63 % eli merkittävästi korkeampi kuin arvioitu korkein kestävä kalastuskuolevuus, joka on 50 %. Lohikannan koko ennen kalastusta on ollut keskimäärin 6 649 kg. Kannasta on pyydetty rannikolla 15 %, pääuomassa 23 % ja Máskejohkassa 24 %. Keskimääräinen ylikalastus on ollut 24 %.



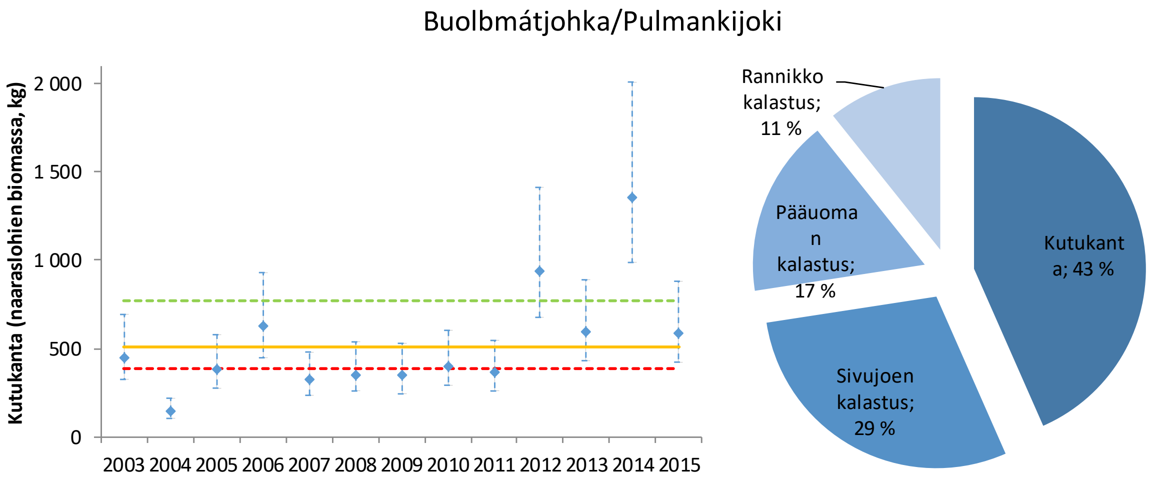
Kuva S7. Vasemmanpuoleinen kuva: Máskejohkan lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla, pääuomassa ja sivujoessa pyydettyjen sekä kudulle selviävien lohien osuudet Máskejohkan lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

Tenojoen pääuomassa pyydettävistä Máskejohkan lohikannan naaraslohista noin 90 % pyydetään pääuoman alajuoksulla Norjan puolella. Noin 68 % naaraslohista on pyydetty viikoilla 25–28 (kesäkuun loppupuolelta heinäkuun puoliväliin). Patopyynnin osuus naaraslohisaaliista on ollut 52 %, verkkokalastuksen osuus 17 %, paikallisten vapapyytäjien osuus 12 %, kulkutuksen osuus 11 % ja kalastusmatkailijoiden osuus 8 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi Máskejohkan lohikannan naaraslohien kalastuskuolevuutta pääuomassa 25 %. Jotta yhteenlaskettua kalastuskuolevuutta saataisiin vähennettyä 30 %, kalastusta on näin ollen vähennettävä Máskejohkassa noin 40 %.



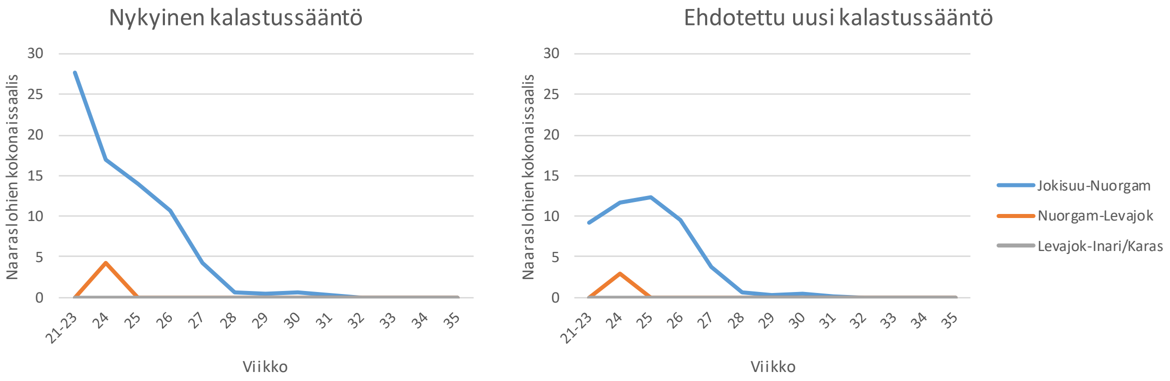
Kuva S8. Máskejohkan lohikannan naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

Pulmankijoen lohisaalis on ollut vuosina 2003–2015 pienimmillään 300 kg vuonna 2004 ja suurimmillaan 1 090 kg vuonna 2014. Suurin osa saaliista on pyydetty Pulmankijärvessä. Kalastus on vähäistä järven laskujoessa ja kiellettyä Pulmankijoen yläjuoksulla. Pulmankijoen kutukantatavoite on 1 329 133 mätimunaa. Mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 511 kg (383–767 kg). Kutukantatavoitteen saavuttamisaste on ollut vuosina 2003–2015 alhaisimmillaan 30 % vuonna 2004 ja korkeimmillaan 100 % vuosina 2006 ja 2012–2015. Kutukantatavoitteen saavuttamisen todennäköisyys on vaihdellut 0 %:sta (2004) 100 %:iin (2012 ja 2014). Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 152 %. Hoitotavoite on saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 97 %. Pulmankijoen lohikannan yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 57 % eli alhaisempi kuin arvioitu korkein kestävä kalastuskuolevuus, joka on 61 %. Lohikannan koko ennen kalastusta on ollut keskimäärin 2 728 kg. Kannasta on pyydetty rannikolla 11 %, pääuomassa 17 % ja Pulmankijärvessä 29 %. Vuosina 2006–2015 keskimääräinen ylikalastus on ollut 13 %.



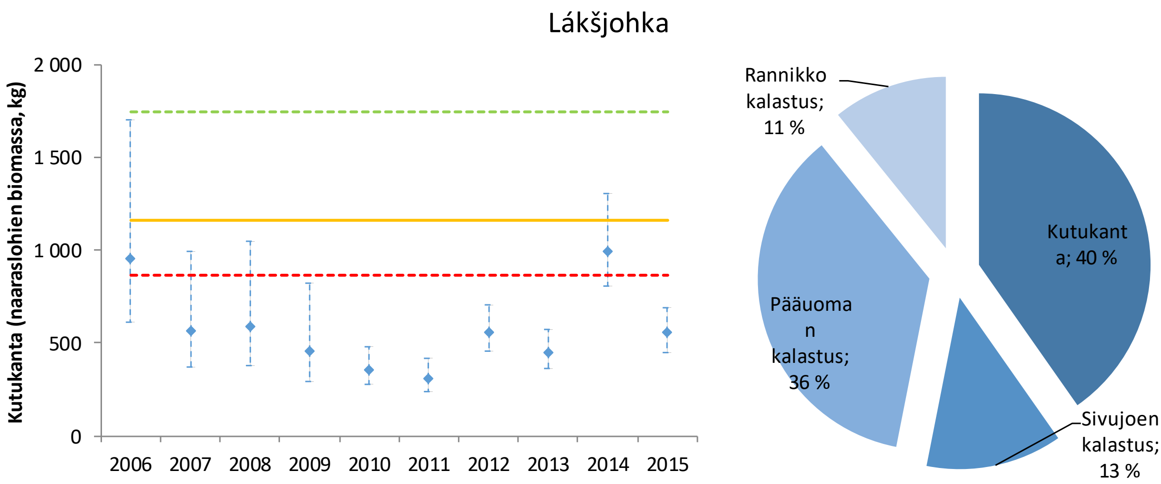
Kuva S9. Vasemmanpuoleinen kuva: Pulmankijoen lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla, pääuomassa ja sivujoessa pyydettyjen sekä kudulle selviävien lohien osuudet Pulmankijoen lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

Tenojoen pääuomassa pyydettävistä Pulmankijoen lohikannan naaraslohista noin 95 % pyydetään pääuoman alajuoksulla Norjan puolella. Lähes 80 % naaraslohista on pyydetty viikoilla 21–25 (toukokuusta kesäkuun lopulle). Patopyynnin osuus naaraslohisaaliista on ollut 38 %, kulkutuksen osuus 37 %, paikallisten vapapyytäjien osuus 10 %, kalastusmatkailijoiden osuus 8 % ja verkkokalastuksen osuus 7 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi Pulmankijoen lohikannan naaraslohien kalastuskuolevuutta pääuomassa 36 %.



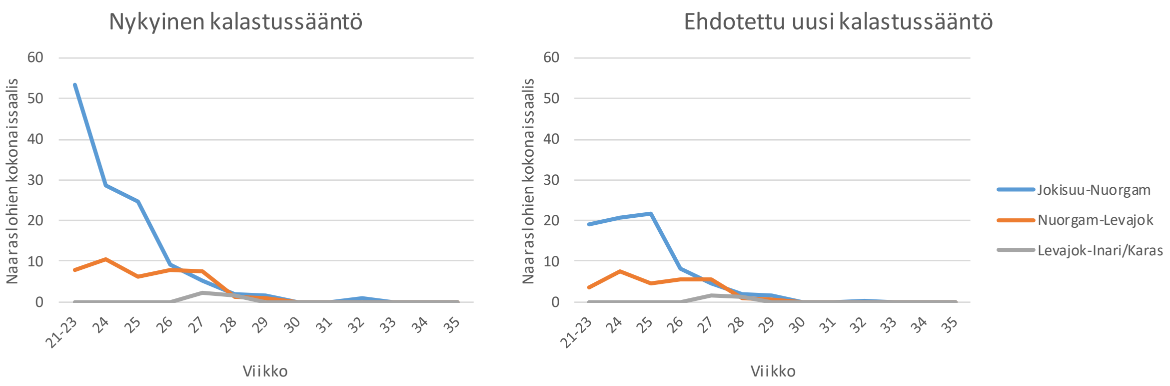
Kuva S10. Pulmankijoen lohikannan naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

Lákšjohkan lohisaalis on ollut vuosina 2006–2015 pienimmillään 247 kg vuonna 2014 ja suurimmillaan 700 kg vuonna 2006. Lákšjohkan kutukantatavoite on 2 969 946 mätimunaa. Mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 1 165 kg (864–1 747 kg). Kutukantatavoitteen saavuttamisaste on ollut alhaisimmillaan 26 % vuonna 2011 ja korkeimmillaan 89 % vuonna 2006 ja 82 % vuonna 2014. Vuosina 2006–2015 kutukantatavoitteen saavuttamisen todennäköisyys oli useimpina vuosina 0 % paitsi vuonna 2006, jolloin se oli 29 %, ja vuonna 2014, jolloin se oli 15 %. Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 46 %. Hoitotavoitetta ei ole saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 0 %. Lákšjohkan lohikannan yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 60 % eli merkittävästi korkeampi kuin arvioitu korkein kestävä kalastuskuolevuus, joka on 17 %. Lohikannan koko ennen kalastusta on ollut keskimäärin 2 459 kg. Kannasta on pyydetty rannikolla 11 %, pääuomassa 36 % ja Lákšjohkassa 13 %. Keskimääräinen ylikalastus on ollut 47 %.



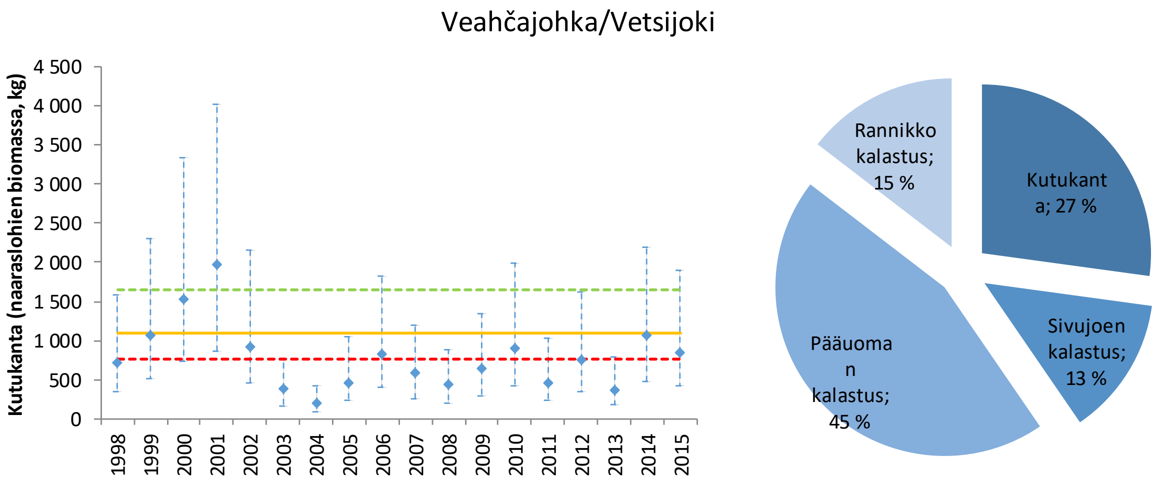
Kuva S11. Vasemmanpuoleinen kuva: Lákšjohkan lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla, pääuomassa ja sivujoessa pyydettyjen sekä kudulle selviävien lohien osuudet Lákšjohkan lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

Tenojoen pääuomassa pyydettävistä Lákšjohkan lohikannan naaraslohista noin 74 % pyydetään pääuoman alajuoksulla Norjan puolella ja 24 % rajajokiosuuden Nuorgamista Levajoelle ulottuvassa alaosassa. Noin 77 % naaraslohista on pyydetty viikoilla 21–25 (toukokuusta kesäkuun lopulle). Kulkutuksen osuus naaraslohisaaliista on ollut 36 %, patopyynnin osuus 25 %, kalastusmatkailijoiden osuus 17 %, paikallisten vapapyytäjien osuus 12 % ja verkkokalastuksen osuus 10 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi Lákšjohkan lohikannan naaraslohien kalastuskuolevuutta pääuomassa 36 %. Jotta yhteenlaskettua kalastuskuolevuutta saataisiin vähennettyä 30 %, kalastusta on näin ollen vähennettävä Lákšjohkassa noin 25 %.



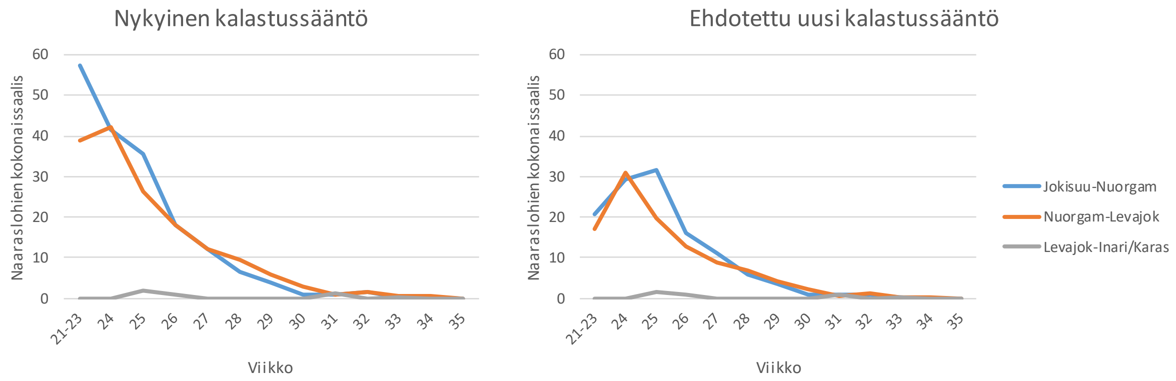
Kuva S12. Lákšjohkan lohikannan naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

Vetsijoen lohisaalis on ollut vuosina 1998–2015 pienimmillään 200 kg vuonna 2004 ja suurimmillaan 1 885 kg vuonna 2001. Vetsijoen kutukantatavoite on 2 505 400 mätimunaa. Mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 1 101 kg (771–1 652 kg). Kutukantatavoitteen saavuttamisaste on ollut alhaisimmillaan 21 % vuonna 2004 ja korkeimmillaan 100 % vuosina 1999–2002 ja 2014. Kutukantatavoitteen saavuttamisen todennäköisyys on vaihdellut 0 %:sta (2003, 2004, 2008 ja 2013) 96 %:iin (2001). Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 86 %. Hoitotavoitetta ei ole saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 28 %. Vetsijoen lohikannan yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 73 % eli korkeampi kuin arvioitu korkein kestävä kalastuskuolevuus, joka on 61 %. Lohikannan koko ennen kalastusta on ollut keskimäärin 5 209 kg. Kannasta on pyydetty rannikolla 15 %, pääuomassa 45 % ja Vetsijoessa 13 %. Keskimääräinen ylikalastus on ollut 28 %.



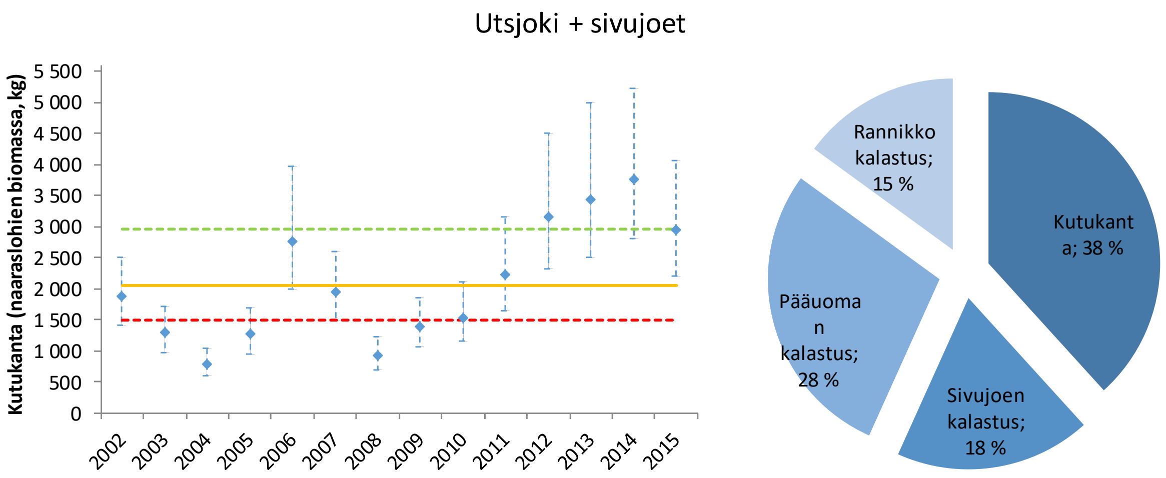
Kuva S13. Vasemmanpuoleinen kuva: Vetsijoen lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla, pääuomassa ja sivujoessa pyydettyjen sekä kudulle selviävien lohien osuudet Vetsijoen lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

Tenojoen pääuomassa pyydettävistä Vetsijoen lohikannan naaraslohista noin puolet (52 %) pyydetään pääuoman alajuoksulla Norjan puolella ja 46 % rajajokiosuuden Nuorgamista Levajoelle ulottuvassa alaosassa. Yli 90 % naaraslohista on pyydetty viikoilla 21–27 (toukokuusta heinäkuun alkuun). Kulkutuksen osuus naaraslohisaaliista on ollut 30 %, patopyynnin osuus 26 %, kalastusmatkailijoiden osuus 23 %, paikallisten vapapyytäjien osuus 13 % ja verkkokalastuksen osuus 9 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi Vetsijoen lohikannan naaraslohien kalastuskuolevuutta pääuomassa 33 %. Jotta yhteenlaskettua kalastuskuolevuutta saataisiin vähennettyä 30 %, kalastusta on näin ollen vähennettävä Vetsijoessa noin 40 %.



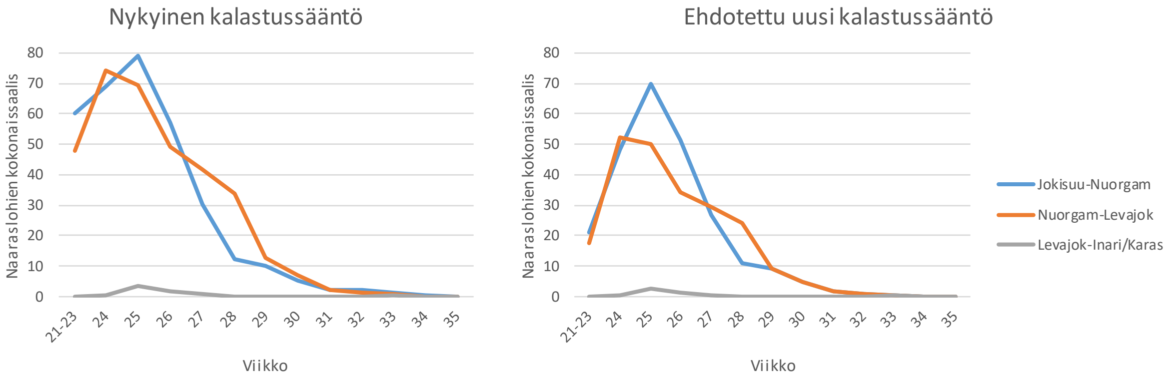
Kuva S14. Vetsijoen lohikannan naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

Utsjoen lohisaalis on ollut vuosina 2002–2015 pienimmillään 800 kg vuonna 2004 ja suurimmillaan 2 955 kg vuonna 2014. Utsjoen (ja sen sivujokien) kutukantatavoite on 4 979 107 mätimunaa. Mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 2 059 kg (1 486–2 972 kg). Kutukantatavoitteen saavuttamisaste on ollut alhaisimmillaan 38 % vuonna 2004 ja korkeimmillaan 100 % vuosina 2006 ja 2011–2015. Kutukantatavoitteen saavuttamisen todennäköisyys on vaihdellut 0 %:sta (2004 ja 2008) 100 %:iin (2013 ja 2014). Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 164 %. Hoitotavoite on saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 99 %. Utsjoen lohikannan yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 62 % eli hieman alhaisempi kuin arvioitu korkein kestävä kalastuskuolevuus, joka on 67 %. Lohikannan koko ennen kalastusta on ollut keskimäärin 11 573 kg. Kannasta on pyydetty rannikolla 15 %, pääuomassa 28 % ja Utsjoessa 18 %. Keskimääräinen ylikalastus on ollut 12 %.



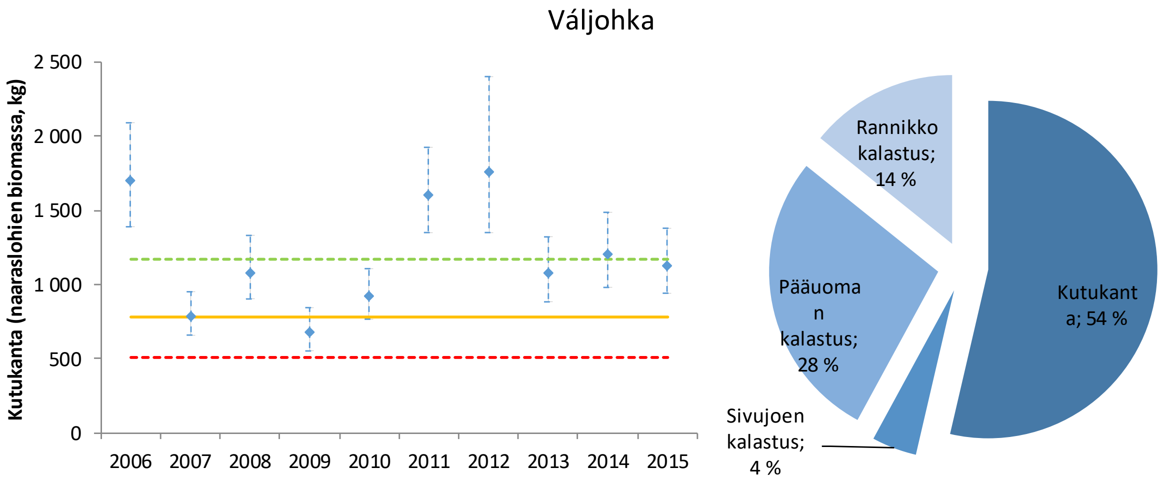
Kuva S15. Vasemmanpuoleinen kuva: Utsjoen ja sen sivujokien lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla, pääuomassa ja sivujoessa pyydettyjen sekä kudulle selviävien lohien osuudet Utsjoen ja sen sivujokien lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

Tenojoen pääuomassa pyydettävistä Utsjoen ja sen sivujokien lohikannan naaraslohista noin puolet (49 %) pyydetään pääuoman alajuoksulla Norjan puolella ja 50 % rajajokiosuuden Nuorgamista ja Levajokeen ulottuvassa alaosassa. Yli 87 % naaraslohista on pyydetty viikoilla 21–27 (toukokuusta heinäkuun alkuun). Kalastusmatkailijoiden osuus naaraslohisaaliista on ollut 29 %, patopyynnin osuus 28 %, kulkutuksen osuus 22 %, paikallisten vapapyytäjien osuus 12 % ja verkkokalastuksen osuus 8 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi Utsjoen lohikannan naaraslohien kalastuskuolevuutta pääuomassa 30 %.



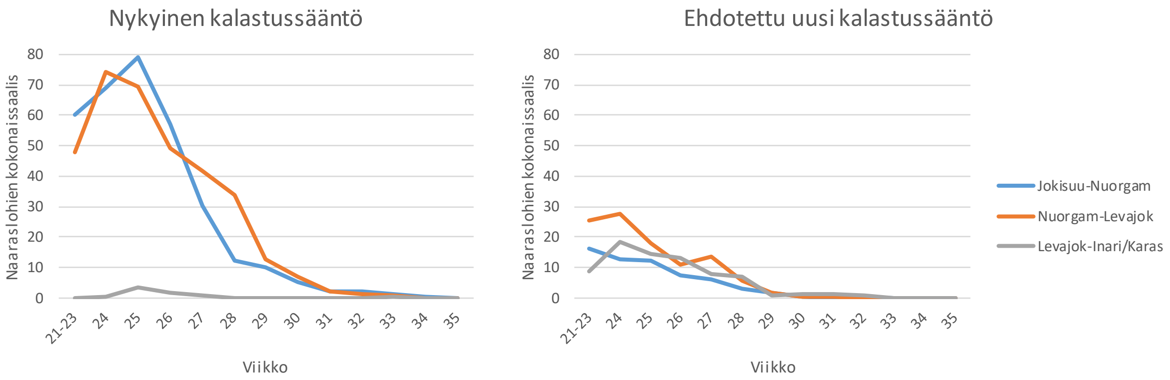
Kuva S16. Utsjoen ja sen sivujokien lohikannan naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

Váljohkan lohisaalis on ollut vuosina 2006–2015 pienimillään 97 kg vuonna 2007 ja suurimmillaan 365 kg vuonna 2012. Váljohkan kutukantatavoite on 1 907 595 mätimunaa. Mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 779 kg (508–1 168 kg). Kutukantatavoitteen saavuttamisen todennäköisyys oli 100 % koko ajanjakson 2006–2015 lukuun ottamatta vuotta 2009, jolloin se oli 87 %. Kutukantatavoitteen saavuttamisen todennäköisyys on vaihdellut 20 %:sta (2009) 100 %:iin (2006, 2011 ja 2012). Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 149 %. Hoitotavoite on saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 99 %. Váljohkan lohikannan yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 46 % eli merkittävästi alhaisempi kuin arvioitu korkein kestävä kalastuskuolevuus, joka on 63 %. Lohikannan koko ennen kalastusta on ollut keskimäärin 4 381 kg. Kannasta on pyydetty rannikolla 14 %, pääuomassa 28 % ja Váljohkassa 4 %. Keskimääräinen ylikalastus on ollut 1 %.



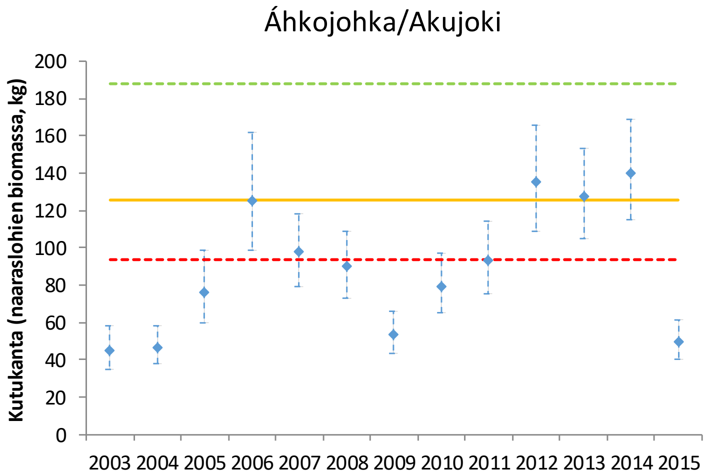
Kuva S17. Vasemmanpuoleinen kuva: Váljohkan lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla, pääuomassa ja sivujoessa pyydettyjen sekä kudulle selviävien lohien osuudet Váljohkan lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

Tenojoen pääuomassa pyydettävistä Váljohkan lohikannan naaraslohista yli puolet (47 %) pyydetään rajajokiosuuden Nuorgamista Levajoelle ulottuvassa alaosassa. Seuraavaksi suurimmat osuudet pyydetään rajajokiosuuden yläosassa (28 %) ja pääuoman alajuoksulla Norjan puolella (26 %). Yli 85 % naaraslohista on pyydetty viikoilla 21–26 (toukokuusta kesäkuun loppuun). Kalastusmatkailijoiden osuus naaraslohisaaliista on ollut 29 %, kulkutuksen osuus 28 %, paikallisten vapapyytäjien osuus 17 %, patopyynnin osuus 14 % ja verkkokalastuksen osuus 12 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi Váljohkan lohikannan naaraslohien kalastuskuolevuutta pääuomassa 38 %.



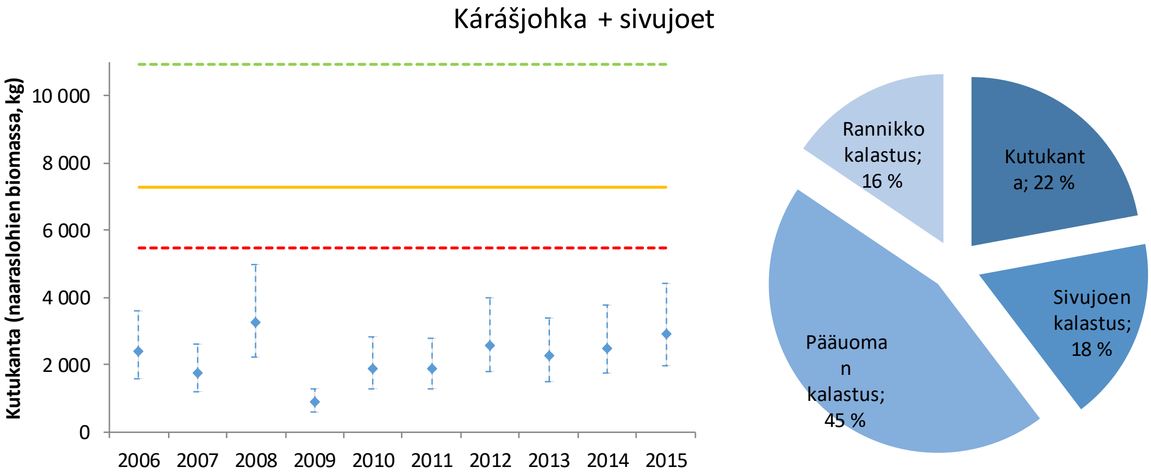
Kuva S18. Váljohkan lohikannan naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

Akujoessa kalastetaan lohta vain vähän, joten sivujoen lohikannan tilan arviointi perustuu pintasukeltamalla vuosina 2003–2015 tehtyihin lohilaskentoihin. Akujoen kutukantatavoite on 282 532 mätimunaa. Mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 126 kg (94–188 kg). Kutukantatavoitteen saavuttamisaste on ollut alhaisimmillaan 35 % vuonna 2003 ja korkeimmillaan 100 % vuosina 2012 ja 2014. Kutukantatavoitteen saavuttamisen todennäköisyys on vaihdellut 0 %:sta (2003–2005, 2008–2010 ja 2015) 60 %:iin (2014). Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 100 %. Hoitotavoitetta ei ole saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 47 %. Koska Akujoesta ja sen lähialueilta otetut lohinäytteet ovat geneettisesti samankaltaisia, on mahdotonta arvioida Akujoen lohikannan kalastusta rannikolla ja Tenojoen pääuomassa.



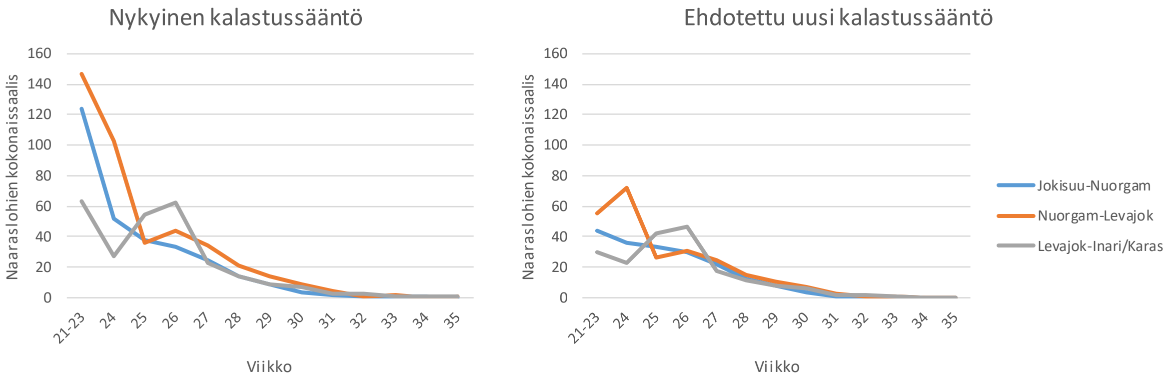
Kuva S19. Akujoen lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja).

Kárášjohkan ja sen sivujokien Bávttajohkan ja Geaimmejohkan lohisaalis on ollut vuosina 2006–2015 pienimmillään 1 298 kg vuonna 2009 ja suurimmillaan 3 902 kg vuonna 2006. Kárášjohkan (ja sen sivujokien) kutukantatavoite on 14 037 323 mätimunaa. Mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 7 290 kg (5 468–10 936 kg). Kutukantatavoitteen saavuttamisaste on ollut alhaisimmillaan 12 % vuonna 2009 ja korkeimmillaan 45 % vuonna 2008. Kutukantatavoitteen saavuttamisen todennäköisyys oli joka vuosi 0 %. Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 35 %. Hoitotavoitetta ei ole saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 0 %. Kárášjohkan ja sen sivujokien lohikannan yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 78 % eli merkittävästi korkeampi kuin arvioitu korkein kestävä kalastuskuolevuus, joka on 26 %. Lohikannan koko ennen kalastusta on ollut keskimäärin 17 018 kg. Kannasta on pyydetty rannikolla 16 %, pääuomassa 45 % ja Kárášjohkassa ja sen sivujoissa 18 %. Keskimääräinen ylikalastus on ollut 66 %.



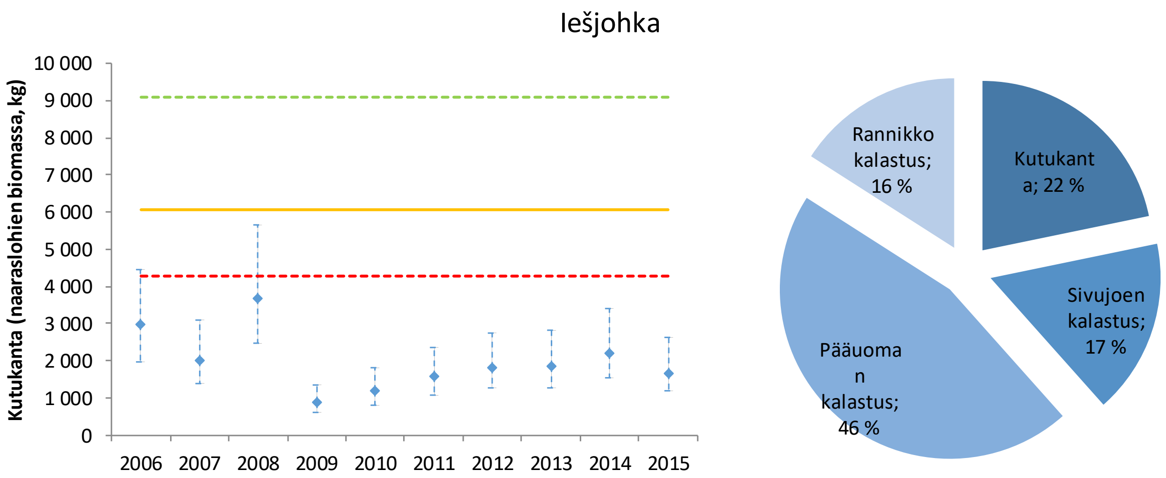
Kuva S20. Vasemmanpuoleinen kuva: Kárášjohkan ja sen sivujokien lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla, pääuomassa ja sivujoessa pyydettyjen sekä kudulle selviävien lohien osuudet Kárášjohkan ja sen sivujokien lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

Tenojoen pääuomassa pyydettävistä Kárášjohkan ja sen sivujokien lohikannan naaraslohista suurin osa (42 %) pyydetään rajajokiosuuden Nuorgamista Levajoelle ulottuvassa alaosassa. Seuraavaksi suurimmat osuudet pyydetään pääuoman alajuoksulla Norjan puolella (30 %) ja rajajokiosuuden yläosassa (28 %). Yli 90 % naaraslohista on pyydetty viikoilla 21–27 (toukokuusta heinäkuun alkuun). Kulkutuksen osuus naaraslohisaaliista on ollut 30 %, kalastusmatkailijoiden osuus 25 %, patopyynnin osuus 16 %, verkkokalastuksen osuus 15 % ja paikallisten vapapyytäjien osuus 14 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi Kárášjohkan lohikannan naaraslohien kalastuskuolevuutta pääuomassa 37 %. Jotta yhteenlaskettua kalastuskuolevuutta saataisiin vähennettyä 30 %, kalastusta on näin ollen vähennettävä Kárášjohkassa ja sen sivujoissa noin 35 %.



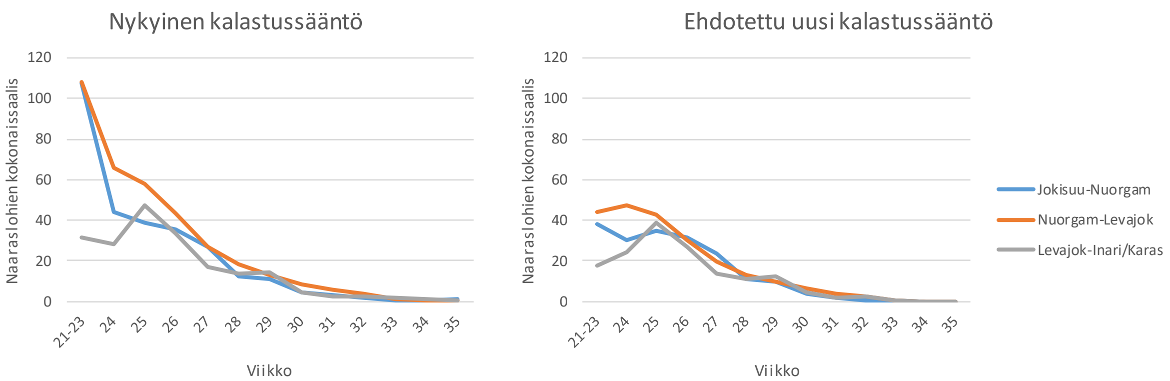
Kuva S21. Kárášjohkan ja sen sivujokien lohikannan naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

Iešjohkan lohikannan lohisaalis Iešjohkassa ja Kárášjohkan alajuoksulla on ollut vuosina 2006–2015 pienimmillään 1 239 kg vuonna 2009 ja suurimmillaan 4 499 kg vuonna 2006. Iešjohkan kutukantatavoite on 11 536 009 mätimunaa. Mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 6 072 kg (4 278–9 107 kg). Kutukantatavoitteen saavuttamisaste on ollut alhaisimmillaan 15 % vuonna 2009 ja korkeimmillaan 62 % vuonna 2008. Kutukantatavoitteen saavuttamisen todennäköisyys oli joka vuosi 0 % lukuun ottamatta vuotta 2008, jolloin se oli 1 %. Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 31 %. Hoitotavoitetta ei ole saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 0 %. Iešjohkan lohikannan yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 78 % eli merkittävästi korkeampi kuin arvioitu korkein kestävä kalastuskuolevuus, joka on 31 %. Lohikannan koko ennen kalastusta on ollut keskimäärin 15 463 kg. Kannasta on pyydetty rannikolla 16 %, pääuomassa 46 % ja Iešjohkassa 17 %. Keskimääräinen ylikalastus on ollut 65 %.



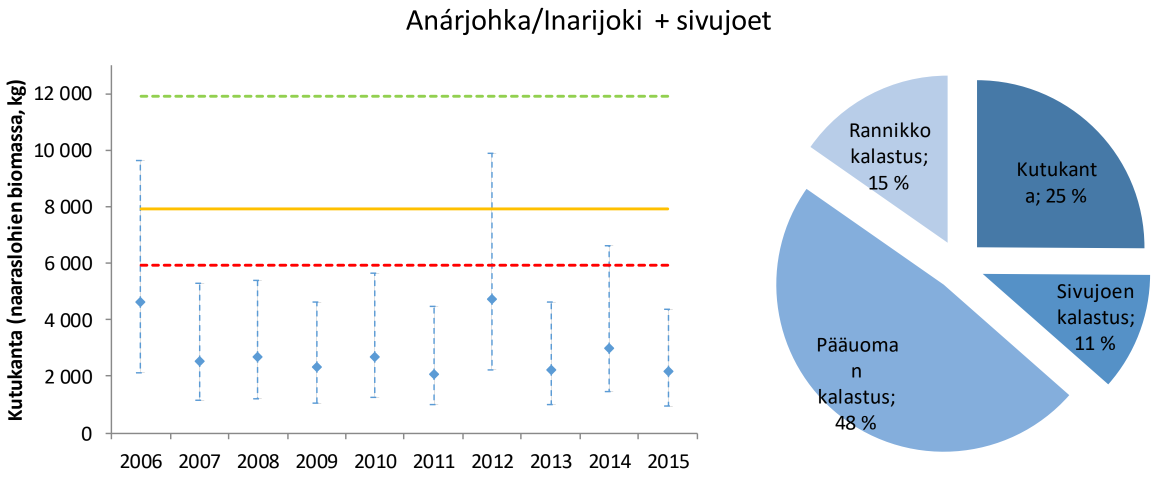
Kuva S22. Vasemmanpuoleinen kuva: Iešjohkan lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla, pääuomassa ja sivujoessa pyydettyjen sekä kudulle selviävien lohien osuudet Iešjohkan lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

Tenojoen pääuomassa pyydettävistä Iešjohkan lohikannan naaraslohista suurin osa (42 %) pyydetään rajajokiosuuden Nuorgamista Levajoelle ulottuvassa alaosassa. Seuraavaksi suurimmat osuudet pyydetään pääuoman alajuoksulla Norjan puolella (34 %) ja rajajokiosuuden yläosassa (24 %). Yli 86 % naaraslohista on pyydetty viikoilla 21–27 (toukokuusta heinäkuun alkuun). Kulkutuksen osuus naaraslohisaaliista on ollut 28 %, kalastusmatkailijoiden osuus 26 %, patopyynnin osuus 19 %, paikallisten vapapyytäjien osuus 14 % ja verkkokalastuksen osuus 14 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi Iešjohkan lohikannan naaraslohien kalastuskuolevuutta pääuomassa 33 %. Jotta yhteenlaskettua kalastuskuolevuutta saataisiin vähennettyä 30 %, kalastusta on näin ollen vähennettävä Iešjohkassa noin 50 %.



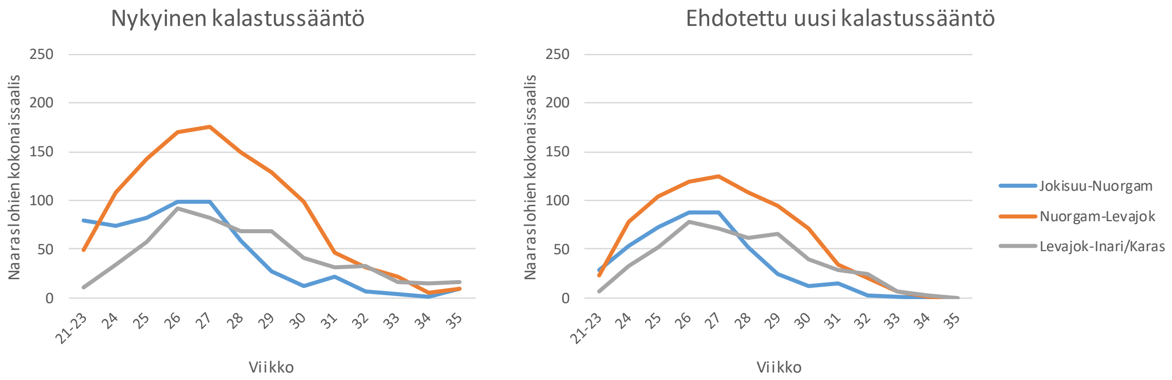
Kuva S23. Iešjohkan lohikannan naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

Inarijoen ja sen sivujokien lohisaalis on ollut vuosina 2006–2015 pienimmillään 881 kg vuonna 2015 ja suurimmillaan 4 285 kg vuonna 2012. Inarijoen ja sen sivujokien kutukantatavoite on 17 669 952 mätimunaa. Mätimäärän tuottamiseen tarvittava naaraslohien biomassa on 7 937 kg (5 928–11 906 kg). Kutukantatavoitteen saavuttamisaste on ollut alhaisimmillaan 30 % vuosina 2011 ja 2015 ja korkeimmillaan 67 % vuonna 2012 ja 65 % vuonna 2006. Kutukantatavoitteen saavuttamisen todennäköisyys oli joka vuosi 0 % lukuun ottamatta vuotta 2012, jolloin se oli 8 %, ja vuotta 2006, jolloin se oli 7 %. Tavoitteen saavuttamisaste on neljän viime vuoden aikana ollut 38 %. Hoitotavoitetta ei ole saavutettu, sillä kutukantatavoitteen saavuttamisen todennäköisyys on ollut neljän viime vuoden aikana keskimäärin 0 %. Inarijoen ja sen sivujokien lohikannan yhteenlaskettu kalastuskuolevuus oli vuosina 2006–2015 keskimäärin 75 % eli merkittävästi korkeampi kuin arvioitu korkein kestävä kalastuskuolevuus, joka on 35 %. Lohikannan koko ennen kalastusta on ollut keskimäärin 22 855 kg. Kannasta on pyydetty rannikolla 15 %, pääuomassa 48 % ja Inarijoessa ja sen sivujoissa 11 %. Keskimääräinen ylikalastus on ollut 59 %.



Kuva S24. Vasemmanpuoleinen kuva: Inarijoen ja sen sivujokien lohikannan arvioitu kutukanta vuosina 2006–2015. Vaakasuorat viivat kuvastavat kutukantatavoitetta (ja sen ylä- ja alarajoja). Oikeanpuoleinen kuva: rannikolla, pääuomassa ja sivujoessa pyydettyjen sekä kudulle selviävien lohien osuudet Inarijoen ja sen sivujokien lohikannan keskimääräisestä koosta ennen kalastusta vuosina 2006–2015.

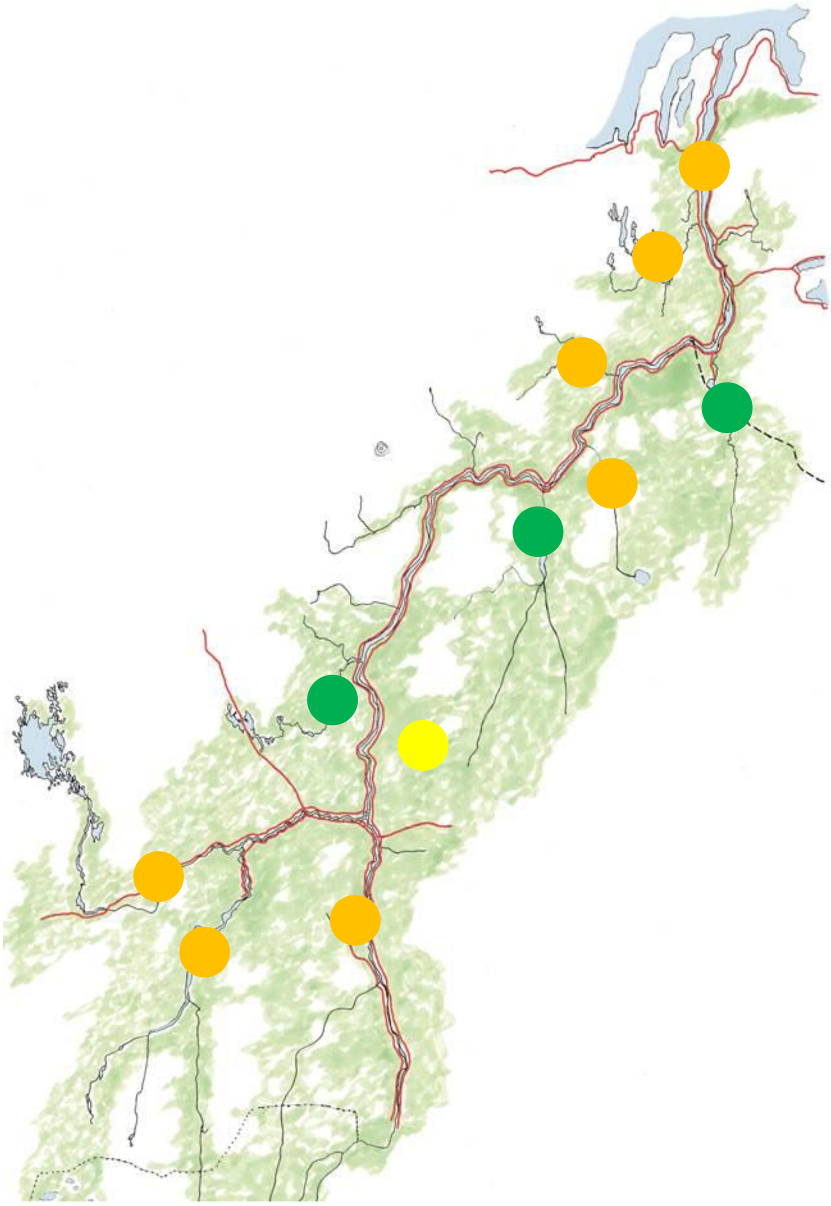
Tenojoen pääuomassa pyydettävistä Inarijoen ja sen sivujokien lohikannan naaraslohista puolet (50 %) pyydetään rajajokiosuuden Nuorgamista Levajoelle ulottuvassa alaosassa. Seuraavaksi suurimmat osuudet pyydetään pääuoman alajuoksulla Norjan puolella (25 %) ja rajajokiosuuden yläosassa (25 %). Noin 84 % naaraslohista on pyydetty viikoilla 24–30 (kesäkuu puolivälistä heinäkuun loppuun). Kalastusmatkailijoiden osuus naaraslohisaaliista on ollut 41 %, patopyynnin osuus 22 %, paikallisten vapapyytäjien osuus 18 %, verkkokalastuksen osuus 11 % ja kulkutuksen osuus 9 %. Ehdotettu Tenojoen uusi kalastussääntö vähentäisi Inarijoen ja sen sivujokien lohikannan naaraslohien kalastuskuolevuutta pääuomassa 26 %. Jotta yhteenlaskettua kalastuskuolevuutta saataisiin vähennettyä 30 %, kalastusta on näin ollen vähennettävä Inarijoessa ja sen sivujoissa noin 70 %.



Kuva S25. Inarijoen ja sen sivujokien lohikannan naaraslohien vuotuinen kokonaissaalis jaoteltuna Tenojoen pääuoman eri osista pyydettyihin viikkosaaliisiin. Vasemmanpuoleisessa kuvassa on esitetty nykyisen kalastussäännön mukainen keskimääräinen vuosisaalis ja oikeanpuoleisessa kuvassa Norjan ja Suomen välisissä neuvotteluissa esitetyn uuden kalastussäännön mukainen arvioitu vuosisaalis.

Yhteenvetona voidaan todeta, että neljän viime vuoden aikana (2012–2015) kutukantatavoitteen saavuttamisaste on ollut paras Utsjoessa (164 %) ja sen jälkeen Pulmankijoessa (152 %), Váljohkassa (149 %), Akujoessa (100 %), Vetsijoessa (86 %), Tenojoen pääuomassa (72 %), Máskejohkassa (67 %), Lákšjohkassa (46 %), Inarijoessa ja sen sivujoissa (38 %), Kárášjohkassa ja sen sivujoissa (35 %) ja Iešjohkassa (31 %).

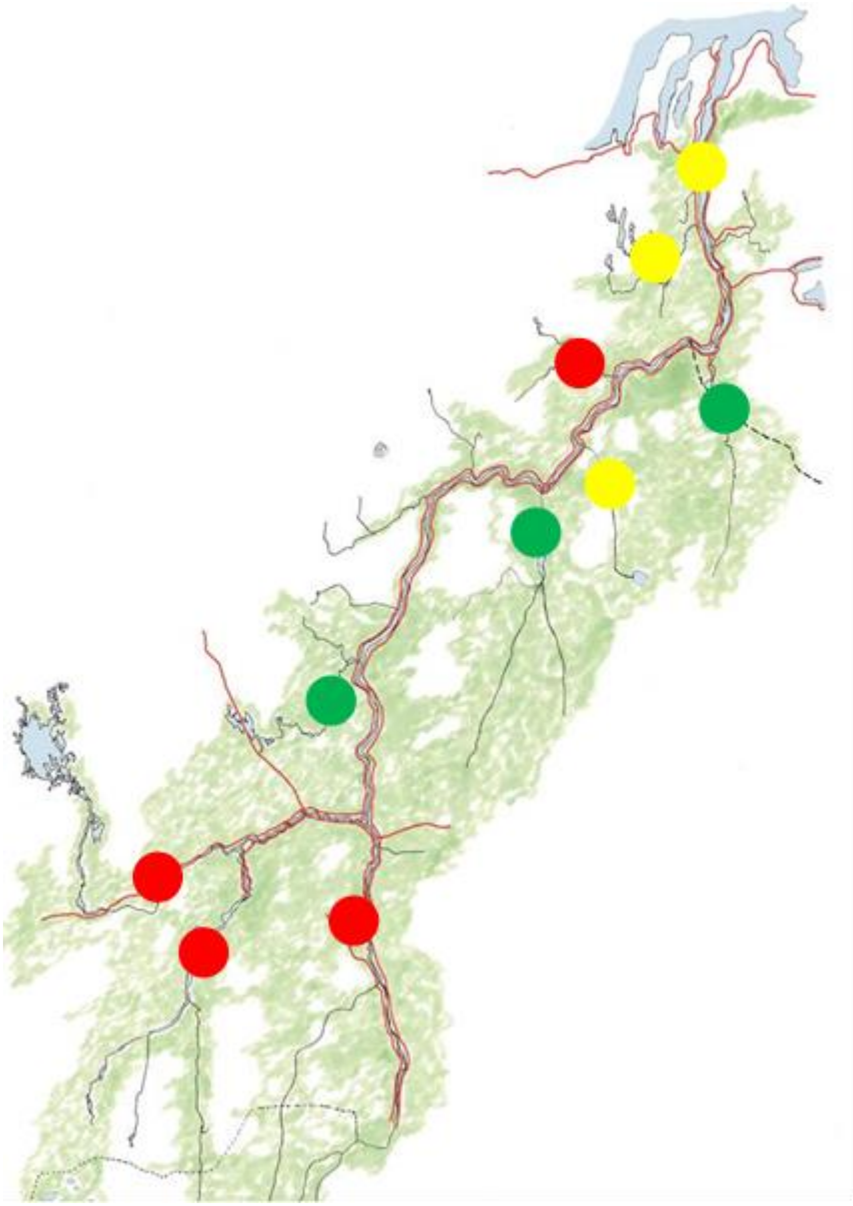
Lohikantojen tilan arviointi osoitti, että hoitotavoitteen toteutuma (kutukantatavoitteen saavuttamisen keskimääräinen todennäköisyys neljän viime vuoden aikana) oli alle 40 % kaikissa Tenojoen vesistön tutkituissa osissa paitsi Pulmankijoessa, Utsjoessa, Váljohkassa ja Akujoessa. Tilanne oli huonoin Lákšjohkassa ja yläjuoksun latvajoissa, Kárášjohkassa ja sen sivujoissa, Iešjohkassa sekä Inarijoessa ja sen sivujoissa. Niissä kaikissa hoitotavoitteen toteutuma oli 0 %.



Kuva S26. Yhteenvetokartta lohikantojen tilasta Tenojoen vesistön tutkituissa osissa vuosina 2012–2015. Symbolien värit kuvaavat lohikannan tilaa neljän viime vuoden aikana. Kartassa käytetyt värit ja niiden selitykset: Tummanvihreä = kutukantatavoitteen saavuttamisen todennäköisyys yli 75 %, tavoitteen saavuttamisaste yli 140 %. Vaaleanvihreä = kutukantatavoitteen saavuttamisen todennäköisyys yli 75 %. Keltainen = kutukantatavoitteen saavuttamisen todennäköisyys 40–74 %, tavoitteen saavuttamisaste yli 75 %. Oranssi = kutukantatavoitteen saavuttamisen todennäköisyys alle 40 %, kannassa on ollut hyödynnettävää ylijäämää vähintään kolmena neljästä viime vuodesta. Punainen = hyödynnettävää ylijäämää ollut alle kolmena neljästä viime vuodesta.

Tenojoen lohen kalastuskuolevuus (kaikki kannat) oli vuosina 2006–2015 arviolta 67 %. Tutkittujen lohikantojen kumuloitunut kalastuskuolevuus oli korkeimmillaan arviolta yli 70 %: Iešjohkassa sekä Kárášjohkassa ja sen sivujoissa 78 %, Inarijoessa ja sen sivujoissa 75 % ja Vetsijoessa 73 %. Alle 70 %:n jäivät Utsjoki ja sen sivujoet (62 %), Lákšjohka (60 %), Máskejohka (63 %) ja Tenojoen pääuoma (63 %). Kumuloituneen kalastuskuolevuuden arvioitiin olevan alhaisin Váljohkassa (46 %) ja Pulmankijoessa (57 %).

Ylikalastuksen määrittely uhkatekijänä perustuu siihen, missä määrin kutukannan pienenemisen kutukantatavoitteen alapuolelle voidaan katsoa johtuvan kalastuksesta. Ylikalastus oli vuosina 2006–2015 laajamittaista kaikissa Tenojoen vesistön tutkituissa osissa Pulmankijokea, Váljohkaa ja Utsjokea lukuun ottamatta.



Kuva S27. Yhteenvetokartta arvioidusta ylikalastuksesta Tenojoen vesistön eri osissa vuosina 2006–2015. Symbolien värit kuvaavat ylikalastuksen tasoa (prosentteina kutukantatavoitteesta): Tummanvihreä = ei vaikutusta (0 % kutukantatavoitteesta), vaaleanvihreä = lievä vaikutus (< 10 %), keltainen = kohtalainen vaikutus (10–30 %), punainen = suuri vaikutus (> 30 %).

Arvioitu korkein kestävä kalastuskuolevuus (korkein kalastuksen taso, jonka kanta kestää siten, että kutukantatavoite saavutetaan) osoittaa, että osaa kannoista verotetaan niin paljon, että kestävää ylijäämää syntyy hyvin vähän. Vuosina 2006–2015 korkein kestävä kalastuskuolevuus oli arvioiden mukaan alhaisin Lákšjohkassa (keskimäärin 17 %) ja sen jälkeen Kárášjohkassa ja sen sivujoissa (26 %), Iešjohkassa (28 %) sekä Inarijoessa ja sen sivujoissa (34 %).

Kaikille Tenojoen vesistön tutkituille alueille laskettiin kannan elpymisen kehityspolut kolmen eri säätelyskenaarion mukaan. Jos kumuloitunut kalastuskuolevuus pienenisi 30 %:lla, kutukantatavoite saavutettaisiin 75 %:n todennäköisyydellä kaikilla alueilla kolmen lohisukupolven aikana.

Pitkän aikavälin seurantasuositukset

Tietoon perustuvaan, sopeutuvaan hoitojärjestelmään kuuluvan kannanarvioinnin tulee pohjautua parhaisiin mahdollisiin, jatkuvasta pitkän aikavälin seurantaohjelmasta saatuihin seurantatietoihin. Tällaisen ohjelman tulee tuottaa 1) yksityiskohtaiset ja täsmälliset saalistilastot kaikilta eri alueilta ja kaikesta vesistössä tapahtuvasta kalastuksesta, 2) saalisnäytteitä, joista selvitetään lohen elinkiertopiirteet ja jotka mahdollistavat geneettisen kantaosuusanalyysin sekakantakalastuksen saaliista ja 3) tarkat ja täsmälliset laskennat esimerkiksi tiettyyn sivujokeen tai pääuomaan nousevista kaloista (elektronisten laitteiden avulla) tai kalastuskauden jälkeisten kutukalojen laskentojen muodossa (pintasukeltamalla).

Kalastuskuolevuudessa on huomattavia eroja eri lohikantojen ja alueiden välillä: Tenojoen pääuoman kalastuksessa alajuoksun sivujokien kantojen kalastuskuolevuus on paljon alhaisempi kuin ylempänä jokivesistössä sijaitsevien sivujokien. Siksi pitkäaikainen seuranta tulee jakaa maantieteellisesti Tenojoen vesistön ala-, keski- ja yläosien seurantaan.

Työryhmä suosittaa voimakkaasti sellaisten työtapojen etsimistä, jotka mahdollistavat paikallisen ympäristötiedon viestittämisen työryhmälle ja tieteellisen tiedon levittämisen paikallisyhteisöihin helposti ymmärrettävällä tavalla.

Tällä hetkellä useimmista Tenojokea koskevista tutkimus- ja seurantatoimista puuttuu pitkän aikavälin ennustettavuus, minkä vuoksi toimintoja voidaan suunnitella vain 1–2 vuodeksi eteenpäin. Siksi työryhmä suosittaa voimakkaasti pysyvän norjalais-suomalaisen Tenojoen tutkimus- ja seurantaohjelman käynnistämist.

THE GROUP MANDATE AND PRESENTATION OF MEMBERS

The Working Group on Salmon Monitoring and Research in the Tana River System (referred hereafter as the Group or the Tana Group) was formally appointed in 2010 by the Ministry of Agriculture and Forestry in Finland and the Ministry of Environment in Norway, based on the Memorandum of Understanding signed in February 2010. Among other points defined in its mandate, the Group should deliver annual reports on the status of the salmon stocks, evaluate their management, and give advice on relevant monitoring and research.

The following mandate was given for the Group:

1. *To deliver annual reports on the status of the salmon stocks, including trends in stock development.*
2. *To evaluate the management of stocks in light of relevant NASCO guidelines.*
3. *To integrate local and traditional knowledge of the stocks in their evaluations.*
4. *To identify gaps in knowledge and give advice on relevant monitoring and research.*
5. *To give scientific advice on specific questions from management authorities.*
6. *To collect information from local communities and organizations and cooperate with such bodies in the dissemination of scientific results to the public.*

It was further detailed that the group shall consist of four scientists, two appointed from Norway and two appointed from Finland. The following group members have been appointed:

- Morten Falkegård (Norwegian Institute for Nature Research, NINA), leader
- Jaakko Erkinaro (Natural Resources Institute Finland, LUKE)
- Panu Orell (LUKE)
- Tor G. Heggberget (NINA)

1 INTRODUCTION

1.1 PURPOSE OF THE REPORT

The Tana Group is tasked with providing annual status evaluations of Tana salmon stocks, and otherwise answer questions asked by the management authorities. Currently, the main management process concerning the Tana is the ongoing negotiations between the two countries, aiming to agree on a new target-based, adaptive knowledge-based management regime for salmon fisheries in the Tana. The contents of the present Group report reflect the information needs of the negotiation process.

In summary, the present report covers the following topics:

1) Give an updated account of the developments of the Tana salmon fisheries (chapter 2).
2) Evaluate the threat factors possibly affecting Tana salmon (chapter 3).
3) Give an updated evaluation of the status of Tana stocks based on spawning and management targets, exploitation patterns and stock rebuilding (chapter 4).
4) Outline a Tana monitoring programme designed to meet the knowledge demanded by a target-based adaptive management regime (chapter 5).

1.2 PREMISES OF THE REPORT

1.2.1 THE PRECAUTIONARY APPROACH

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

1) Stocks should be maintained above a conservation limit by the use of management targets.
2) Conservation limits and management targets should be stock-specific.
3) Possible undesirable outcomes, e.g. stocks depleted below conservation limits, should be identified in advance.
4) A risk assessment should be incorporated at all levels, allowing for variation and uncertainty in stock status, biological reference points and exploitation.
5) Pre-agreed management actions should be formulated in the form of procedures to be applied over a range of stock conditions.
6) The effectiveness of management actions in all salmon fisheries should be assessed.
7) Stock rebuilding programmes should be developed for stocks that are below their conservation limits.

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

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

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

1.2.2 SINGLE- VS. MIXED-STOCK FISHERIES

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

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

1.2.3 MANAGEMENT AND SPAWNING TARGETS

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

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

1.2.4 DATA BASIS

The Tana Group has based its assessments on all information and data sets currently available to the Group. This includes vocal sources that the Group have been presented with.

1.3 EXPLANATION OF TERMS USED IN THE REPORT

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

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

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

Exploitation efficiency. See exploitation rate above.

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

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

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

Overexploitation. This refers to the extent of a reduction in spawning stock below the target that can be attributed to exploitation. See chapter 4.4 for a detailed definition.

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

Production potential. Every river with salmon has a limited capacity for salmon production. The level of this capacity is decided by environmental characteristics and river size. See Chapter 4.2.

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

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

Total exploitation. See accumulated exploitation above.

2 THE RIVER TANA, THE TANA SALMON AND SALMON FISHERIES

2.1 THE TANA AND ITS SALMON

The subarctic River Tana (Teno in Finnish, Deatnu in Sami) forms the border between northernmost Norway and Finland (70 ° N, 28 ° E). The river drains an area of 16 386 km^2 (of which almost 70 % is in Norway) and the river system consists of a multitude of small and large tributaries (Figure 1), most of which are readily accessible for ascending salmon. Historically, salmon have been found distributed over a total of over 1 200 km.

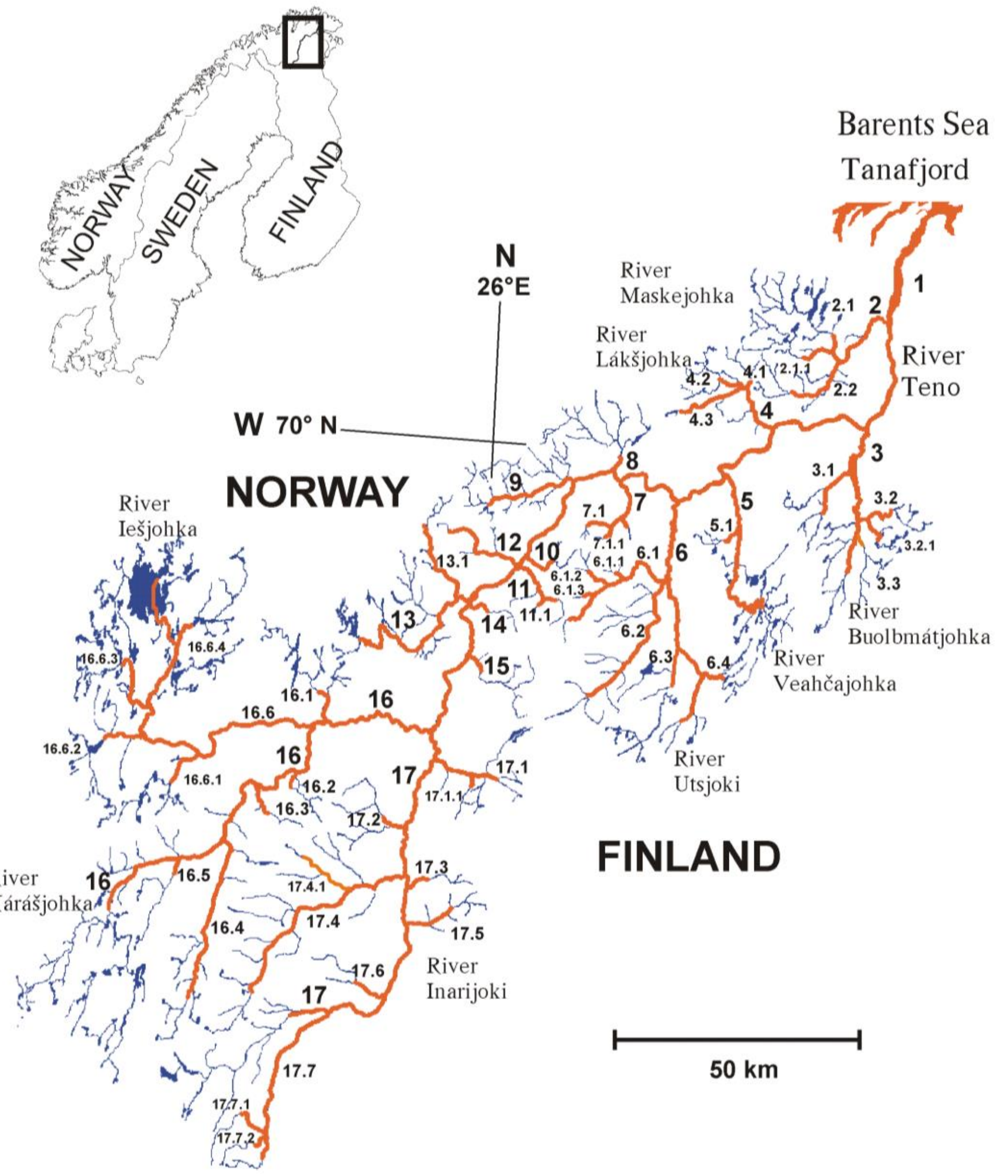


Figure 1. Map of the Tana river system. The orange line indicates the historical distribution of salmon based on historical sources and interviews. Map from Eero Niemelä, LUKE.

The Tana salmon shows an extremely large variation in life histories, with smolt ages ranging from two to eight years (mostly 3-6 years), and adult sea-ages ranging from one (one-sea-winter-salmon, 1SW) to five sea-winters. In addition, there are different types of previously spawned salmon. The smallest tributaries are dominated by 1SW fish (both males and females) with a small to medium percentage 2SW females (Figure 2). Multi-sea-winter (MSW) salmon are mainly found in the Tana main stem, the Norwegian tributary Máskejohka, Finnish tributary

Utsjoki, and the uppermost large tributaries Anárjohka, Kárášjohka and Iešjohka. In these tributaries, the female spawning stocks are almost exclusively 2- and 3SW fish and previous spawners.

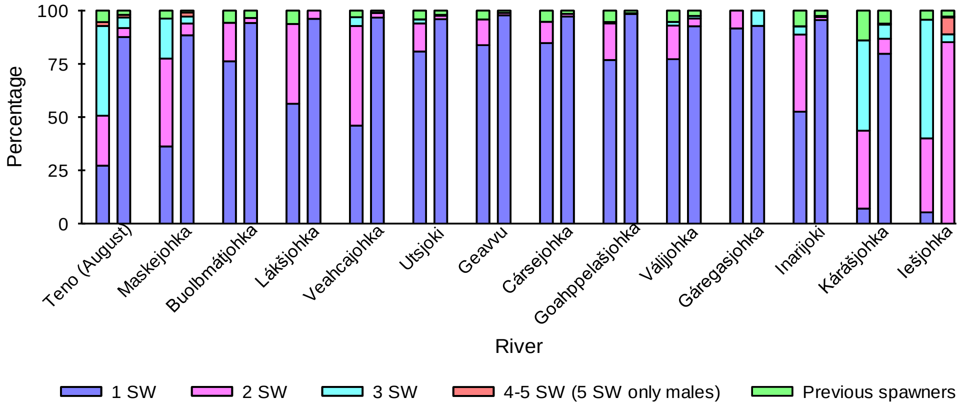


Figure 2. Sea-age distribution of salmon catch in different parts of the Tana river system. Left-hand bars: female salmon; right-hand bars: males. Figure from Niemelä (2004).

In addition to the productive main stem, there are more than 30 tributaries supporting distinct spawning stocks (Berg 1964; Moen 1991; Elo *et al.* 1994; Figure 1), and a high genetic differentiation among stocks from the different tributaries has been revealed through the use of polymorphic microsatellite markers (Vähä *et al.* 2007) (Figure 3). DNA microsatellite analyses have indicated pairwise F_{ST}[1] values between inferred populations ranging from 1 % to 19 % with an average of 6.5 %.

[1] F_{ST} refers to the proportion of the total genetic variance contained in a subpopulation relative to the total genetic variance. Values can range from 0 to 100% (or from 0 to 1). High F_{ST} implies a considerable degree of differentiation among populations.

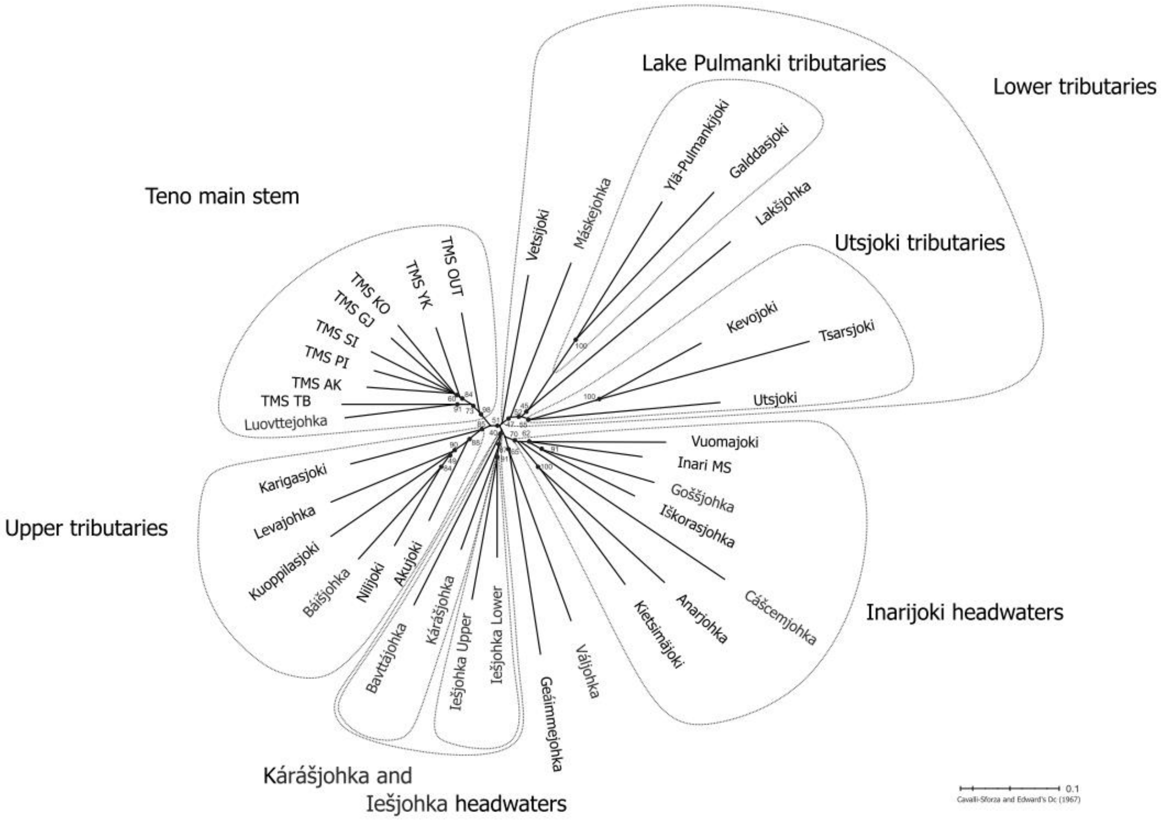


Figure 3. Stock complex of the Tana river system, based on genetic baseline samples from various tributaries and areas (figure from J.-P. Vähä, University of Turku).

Salmon migrating to the upper parts of the river system must cover long distances. From this it could be expected that salmon belonging to upper tributaries such as Anárjohka/Inarijoki, Kárášjohka and Iešjohka, are harvested relatively late in the season. Data from catch records and scale samples, however, show that most of the MSW salmon in Kárášjohka and Iešjohka are caught by the end of June (Figure 4). Median dates of capture in these uppermost areas are comparable to median dates for the lower part of Tana main stem (and slightly earlier than median dates for the middle part of Tana main stem), indicating that the salmon ascending to Kárášjohka and Iešjohka enter the River Tana very early in the season. This early run timing also indicates that these stocks are exposed early in the summer in the coastal fisheries and river fisheries in the main stem Tana.

While return rates of adult salmon has decreased significantly during the last half of the 1900s in most salmon rivers on both sides of the Atlantic, the northernmost salmon stocks in Finnmark (including the river Tana) and the Kola Peninsula have fluctuated in a cyclic manner with no clear declining trend. Since early 2000s, however, some negative developments have been observed in the Tana river system. A negative trend for large MSW (3- and 4SW) salmon (Figure 5), especially the females, is particularly worrying. Even though the numbers vary from year to year, there is a negative trend indicating that the return of large fish has been decreasing during the two last decades. During the same period, the trend for 2SW fish is positive while the abundance of 1SW salmon in the river system has been below the long-term average during most of the last ten-year period (Figure 5). Earlier observations of positive correlations among Tana and some other western Finnmark rivers seem to have changed during the last 10 years, i.e. supporting these negative trends. This could be due to factors connected with heavy exploitation (sea and/or river fishery), changes in prey availability in the Barents Sea, climate change and so on. However, Tana still today likely supports the largest wild stock complex of Atlantic salmon in the world.

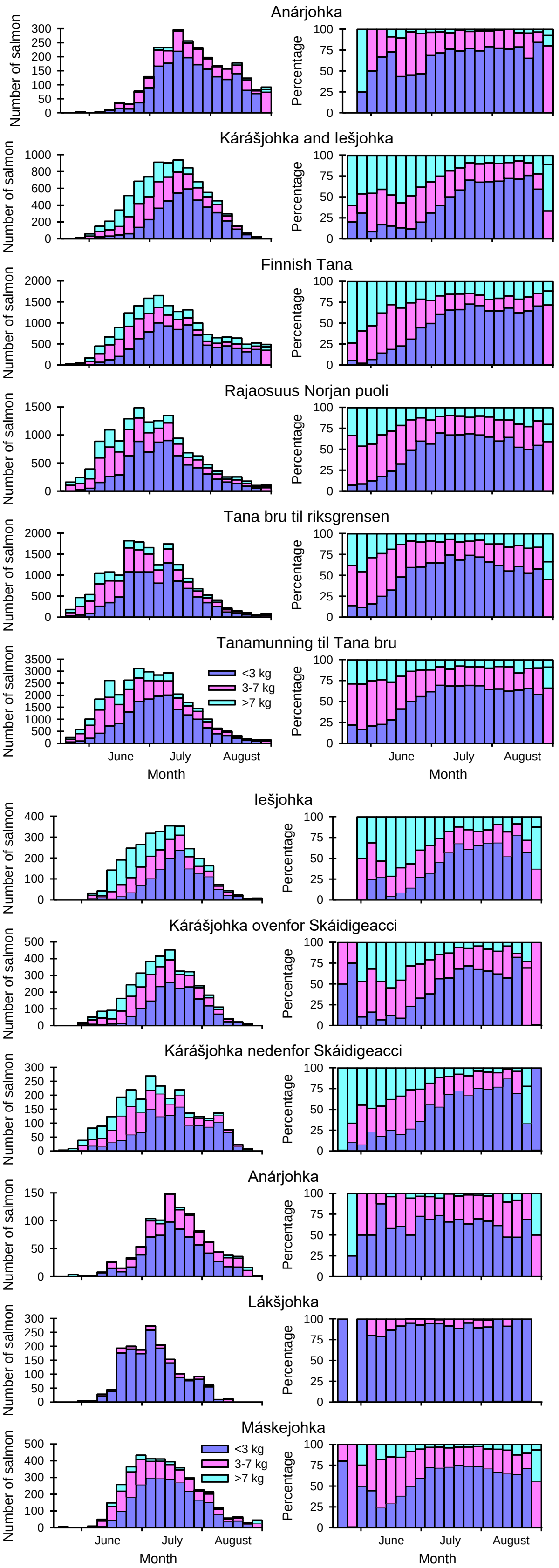


Figure 4. Catch distribution throughout the summer in the different parts of the Tana main stem and some tributaries. Data from the years 2004-2013 are combined.

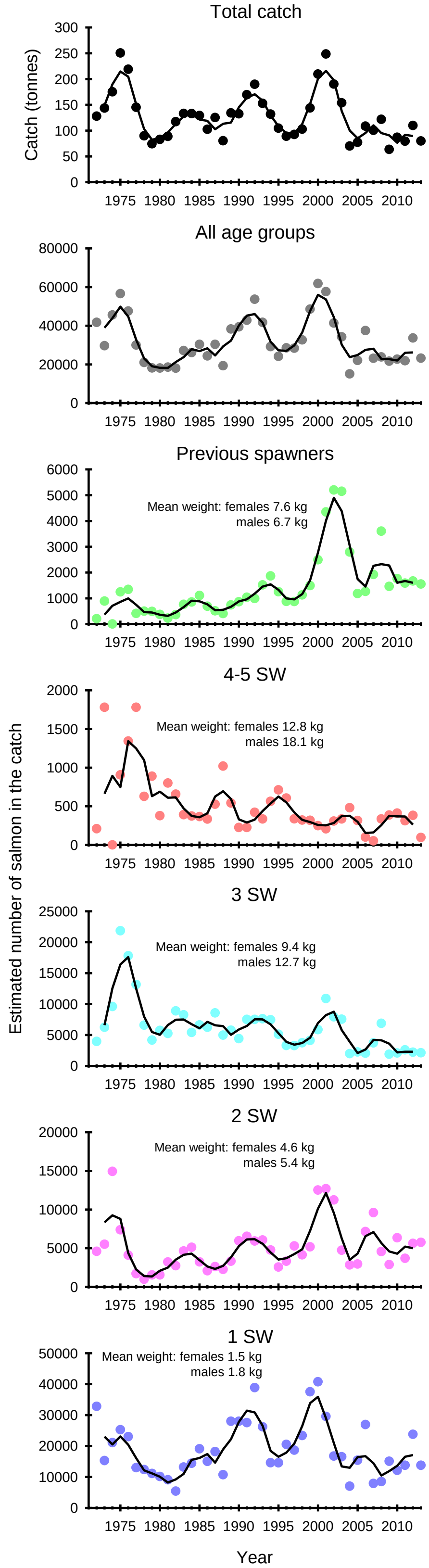


Figure 5. Estimated numbers of captured salmon in different age groups, and the total catch in tonnes.

2.2 TANA SALMON FISHERIES

The riverine salmon fisheries in Tana include a variety of fishing methods such as weir, gill net, seine and drift net, in addition to rod and line. The net fisheries are practiced by local people and it is permitted by fishing rights based on land owning, agriculture production or inherited rights. Fishing in the lower section is mixed-stock fishery throughout the season, whereas this is true for the upper section until the second half of July, when stocks from the tributaries have mostly ascended into their spawning rivers. In the upper section, fishing in August is directed to sub-stocks reproducing mainly in the main stem. According to the telemetry tagging experiments in the early 1990s, harvest rates in the river fisheries could reach the levels of more than 60 % (Erkinaro *et al.* 1999; Karppinen *et al.* 2004). A recent study in the large tributary, Utsjoki, even suggested exploitation rates of more than 80 % on MSW salmon. It should be emphasised, that by including the sea fishery, the effective exploitation rates for Tana salmon is even higher.

Tana salmon is further exploited in the sea fisheries along the coast of northern Norway. This coastal fishery has historically had yearly catches up to 700 tonnes, but regulations in the later years have brought the catch down to well under 200 tonnes. Earlier tagging experiments have indicated that around a third of this coastal catch might be Tana salmon and the total salmon production of the River Tana system has then been estimated to be up to 600 tonnes. Tagging of smolts from the River Tana in the 1970s indicated a fifty-fifty distribution of the catch between the coastal fisheries and the River Tana in terms of number of salmon. A recent genetic study assigning the coastal salmon catches to their population of origin has indicated that *c*. 15-17 % of the total salmon catch originating from the Tana river is caught in coastal fisheries (Svenning *et al*. 2014).

The catch statistics for the Tana River system have historically been divided into two separate parts, the Norwegian catch and the Finnish catch. The Norwegian catch statistics were calculated by the County Governor of Finnmark up until and including 2010. In 2011 the responsibility was transferred to the new local River Tana Fisheries Management Board. The Natural Resources Institute Finland (LUKE; formerly the Finnish Game and Fisheries Research Institute FGFRI) compile the catch on the Finnish side.

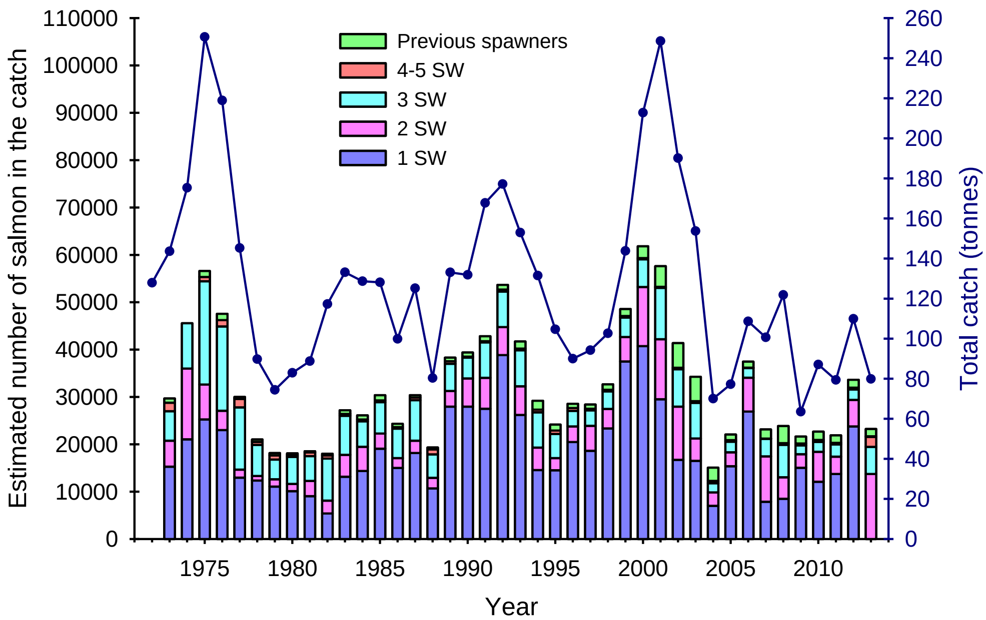


Figure 6. Total salmon catch in the River Tana system (both Norway and Finland) in 1972-2013 in terms of mass (line) and number of fish (bars). Bars are separated into different sea age groups.

Between 1972 and 2013, the annual salmon catch in the river have fluctuated between 63 and 250 t with an average of 130 t (Figure 6). Total number of salmon caught in the entire Tana system typically vary between 30 000 and 50 000, exceeding 60 000 fish in the best years and sinking to around 15 000 fish in the worst years.

The total salmon catch in the River Tana system has historically fluctuated in a seemingly periodic manner, with peaks every 8-9 years (Figure 6). This period length corresponds roughly with the average generation time of female spawners in the system. For example, good catches in the early 1990s resulted in good catches in the early 2000s. Worryingly, these periodic cycles seem to have broken down in the last years. The good catches in early 2000s did not result in high catches in 2006-2008, even though the catches of 1SW salmon in 2006, 2SW in 2007 and 3SW in 2008 were higher than the long-term averages. Effective salmon fishery of Tana River stocks in coastal areas and within the entire Tana River system in the early 2000s might therefore have resulted in too low spawning stocks. The average salmon catch in Tana over the last decade has been below the long-term average both in terms of salmon numbers and mass. Following the long-term fluctuations in the total catch, much higher catches were expected in 2009, 2010 and 2011 than what was observed.

Salmon catches have fluctuated in the same manner in Norway and in Finland (Figure 7). However, the relative development in catch level is very different between the two countries. Since 2004, the Norwegian catches have been much lower relative to the long-term average than the catches in Finland. This reflects a general trend of lower fishing intensity in Norway, especially in the lower Norwegian part of the Tana main stem. The extent of the Norwegian fishery is, thus, declining while the Finnish catches make up a larger proportion. During the 1970s and 1980s, the Norwegian catch was responsible for 60-70 % of the total catch. During the 1990s, this proportion gradually declined towards 50 %, and in the 2000s, the Finnish catch has made up over 50 % of the total (Figure 7).

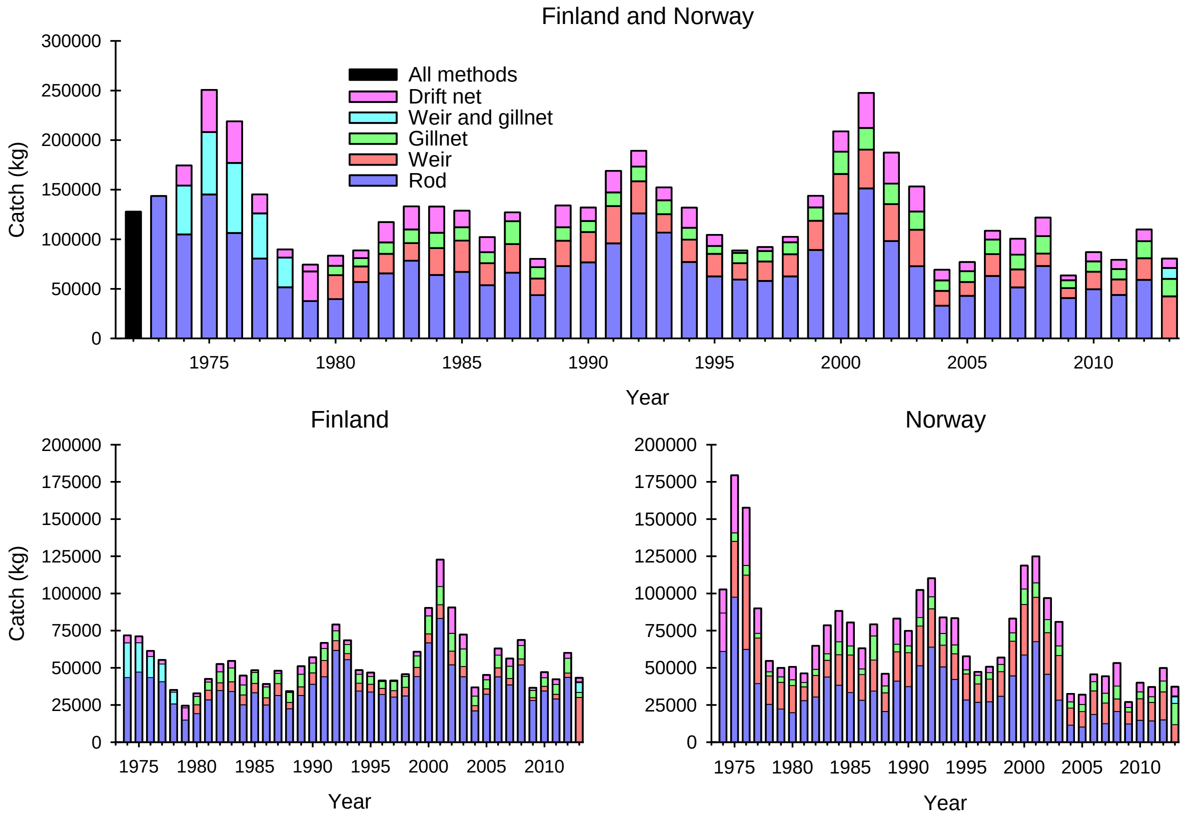


Figure 7. Total salmon catches in the Tana river system by countries and fishing methods.

Despite a large annual variation in the salmon catch estimates, the proportion of salmon caught with different fishing methods have remained relatively stable (Figure 8). The proportion of salmon caught with rod increased slightly from the 1970s until the early 2000s. There are, however, clear differences between the two countries. Around 75 % of the salmon caught in Finland have been taken with rod, while more than half (60-70 %) of the Norwegian catch is caught by nets. In Norway the proportion of rod catch has declined since the early 1990s, while in Finland it has increased since the early 2000s. In Norway the proportion of salmon caught with driftnets has increased since the mid-1990s.

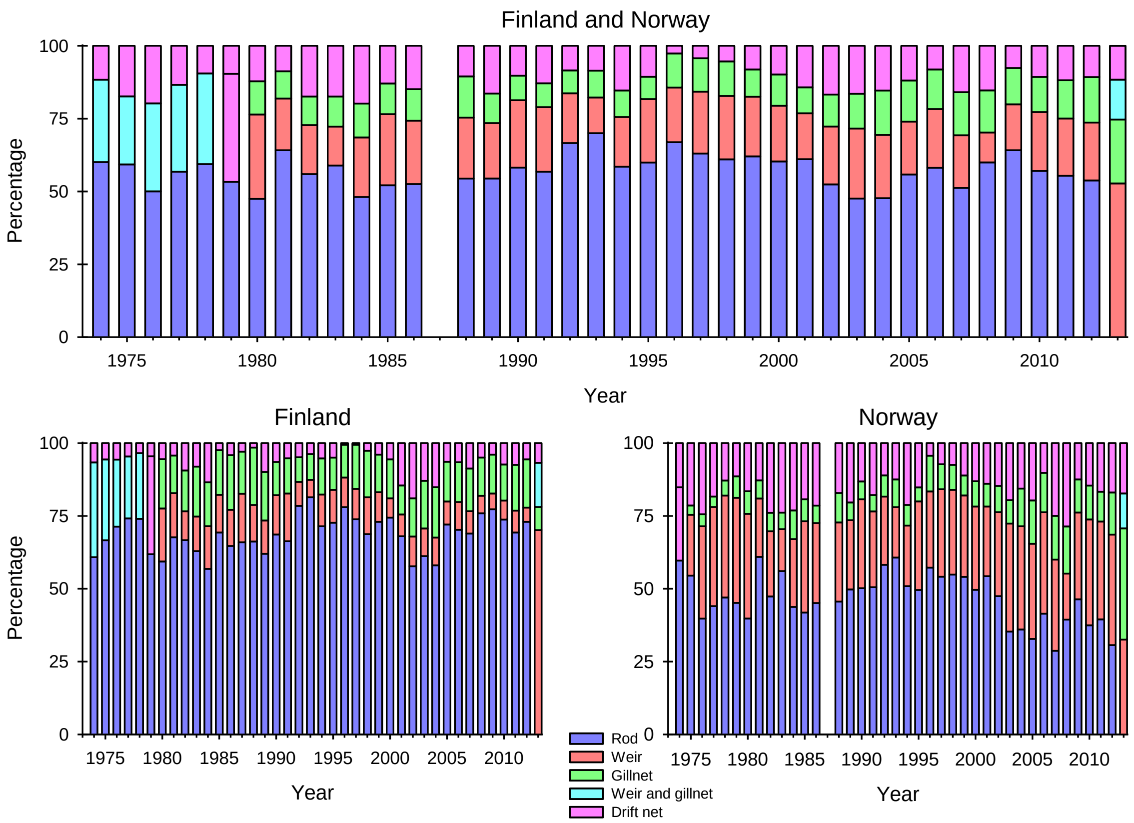


Figure 8. Percentage distribution of salmon catches in terms of mass for fishing gears in Norway and Finland.

In general, the proportion of rod-caught salmon in terms of numbers increased from the 1970s until the mid-1990s (Figure 9). After 1996, the proportion decreased steadily until 2004 followed by an increase until 2009. The proportion of salmon caught on gillnets has shown an increasing trend since mid-1980s. Large annual variations in the proportion of salmon caught on driftnet largely reflects annual variations in environmental conditions, especially the ice-break-up, following discharge and water level, which are determining the practical length of the drift net fishing season.

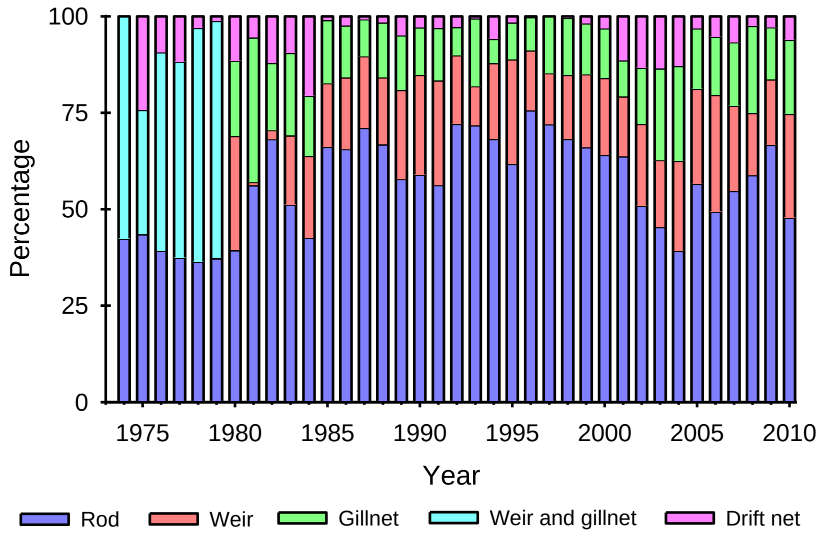


Figure 9. Percentage distribution of salmon catch (based on number of fish) between fishing methods in the River Tana system.

Based on scale reading, it is possible to estimate the relative abundance of different sea age-classes captured throughout the season. The time series dating back to 1973 demonstrates how the fishing exploits salmon of different sea age-classes (Figure 10 and Figure 11). Most virgin female spawners have been two (2SW) or three years (3SW) at sea, while most virgin males have spent only one year (1SW) at sea. There are also quite a few 1SW females, many of which belong to smaller tributaries, and also some large 4SW females. The largest males are 4SW and 5SW fish.

Both the number and mass of female and male salmon have fluctuated simultaneously (Figure 10 and Figure 11). The expected increase in salmon abundance in 2006-2009 did not occur, and in particular, the catches of females have been low in the later years. The catches of 1SW salmon in 2010 and 2011 were recruited mainly from the spawning stocks of 2004 and 2005, which were the lowest in the Tana salmon catch records since 1973, whereas the increase in 1SW catch in 2012 reflected the relatively good run of grilse in 2006 (Figure 10).

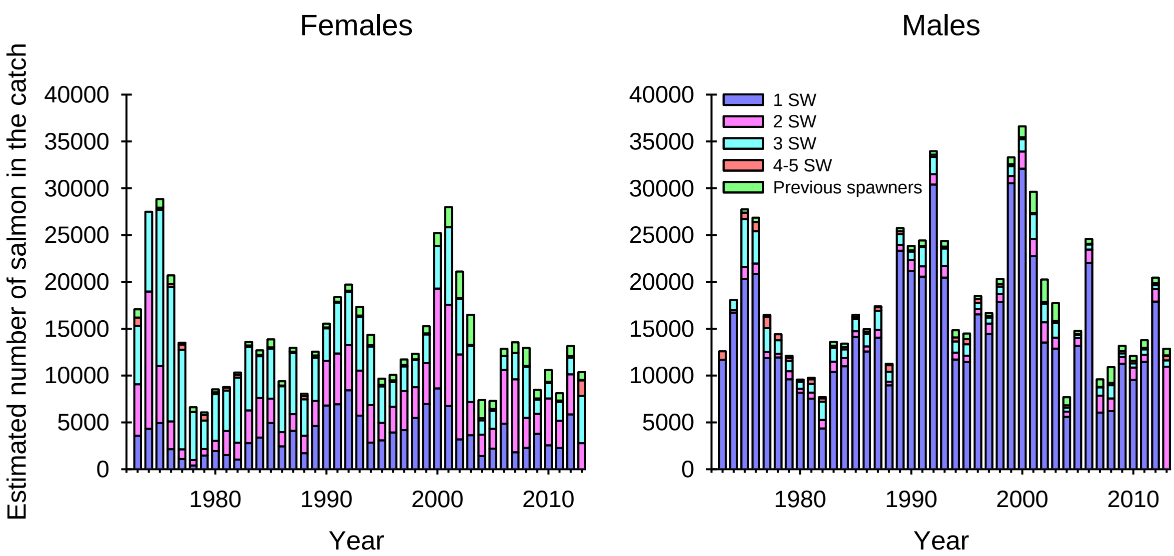


Figure 10. Estimated numbers of salmon in the River Tana catches for 1SW–4-5SW salmon and previous spawners.

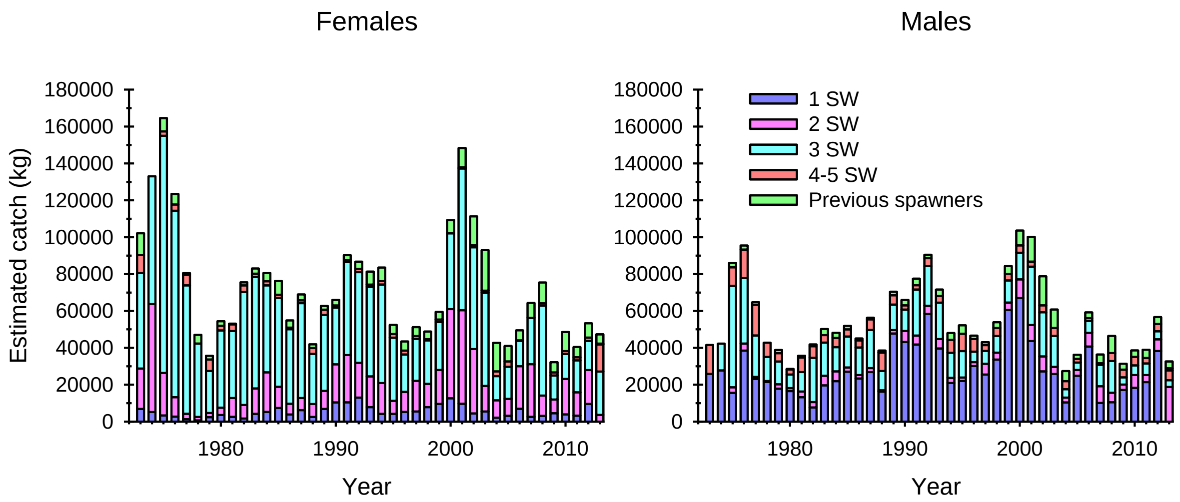


Figure 11. Estimated mass of salmon in the River Tana catches for 1SW–4-5SW salmon and previous spawners.

Female 2- and 3SW fish make an important contribution in the catches by mass because of their larger size compared to male-dominated 1SW fish. The estimated catches of large salmon have been low over the last 10 years except for the year 2008 (Figure 12).

The estimated number of salmon of different sea- age classes show a decreasing trend for especially large fish (3SW-4SW salmon, Figure 12), while the patterns for smaller salmon (1-2 SW) are less clear. There is a significant increasing trend for previous spawners. The long-term data show large annual variations, e.g. the numbers of 1SW salmon can vary 4-5 folds between the years of highest and lowest abundance.

The decreasing trend for larger salmon is evident both for females and males (Figure 12), but mostly for females. The numbers of female salmon in the catches all sea-ages combined has been below the long-term average during the last 10 years. During the last years the numbers of previous spawners have also declined from the record high figures to the level of long-term average. Between the years with high catches, there have always been periods of low catches. The duration of low catches has typically been 5-7 years.

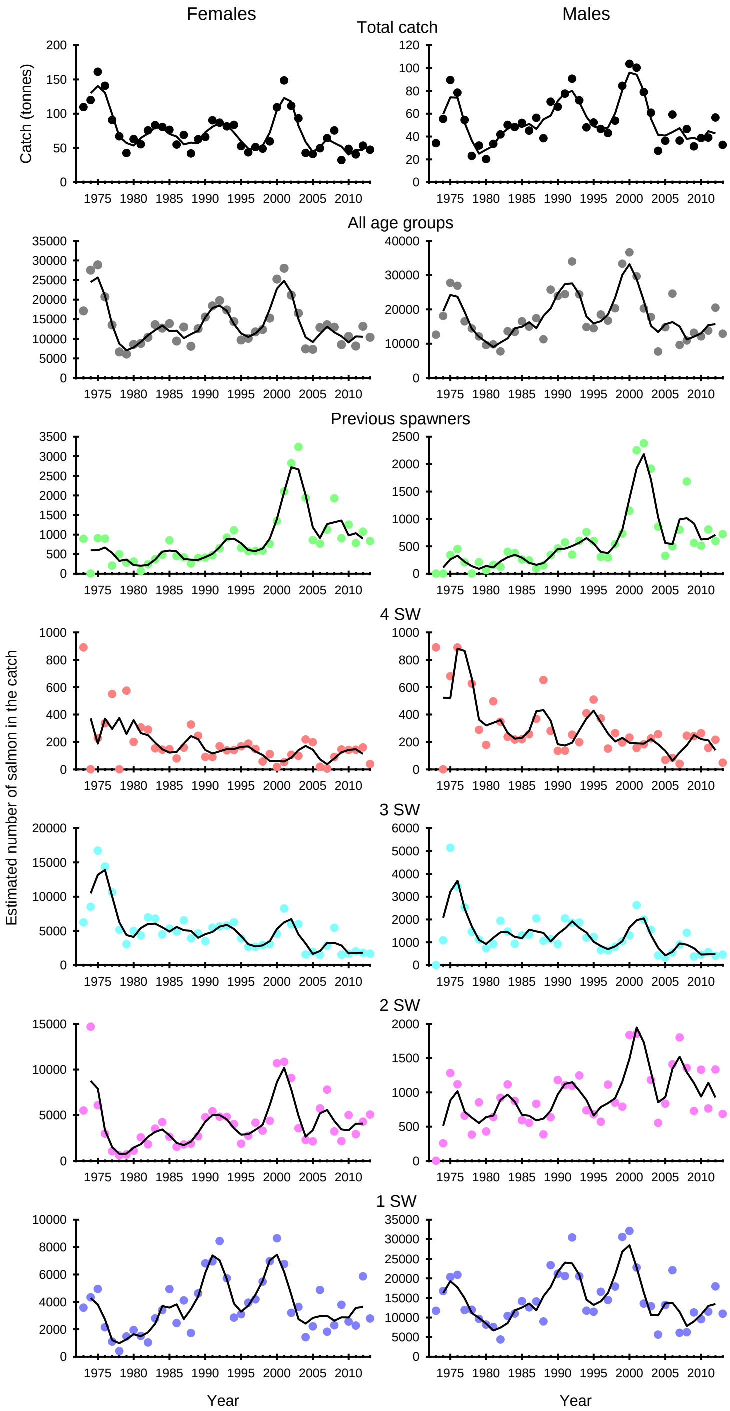


Figure 12. Estimated numbers of salmon of different sea-age-groups in catches of the River Tana system in 1973-2013.

3 THREAT FACTORS

There are a multitude of human-derived factors that have the potential to affect salmon stocks in a negative way. The Scientific Advisory Committee for Atlantic Salmon Management in Norway has devised a system for evaluating and ranking such factors in terms of their influence and threat levels (Anon. 2014).

In this system, threat factors are ranked through a combination of the possible *influence* the threat factors can have on stocks in terms of reduced production and potential loss of stocks, and the *risk* that the factors might lead to additional and increasing losses in production and stocks. This leads to a two-dimensional system with an influence axis and a risk axis (Figure 13).

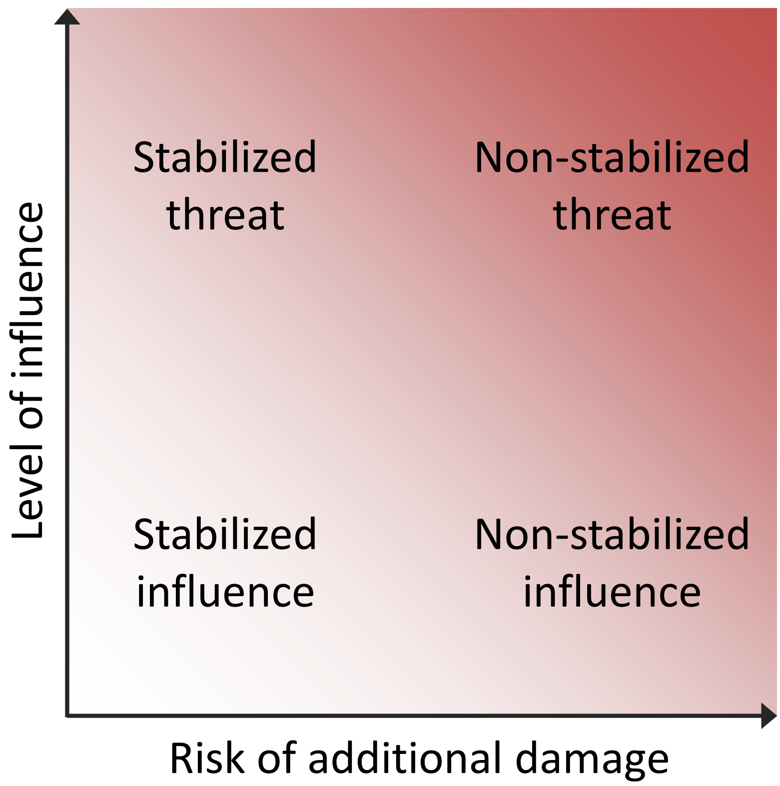


Figure 13. The two-dimensional system that was developed by the Scientific Advisory Committee for Atlantic Salmon Management in Norway to evaluate factors influencing and threatening Norwegian salmon stocks (figure from Anon. 2014).

Four different regions can be identified within the combination of the two axes (Figure 13):

1) **Non-stabilized threat**. A factor that affects stocks to the extent that they become critically threatened and even extinct. Mitigating measures are either lacking or not able to control or reduce the influence and extent of the threat factor.
2) **Stabilized threat**. A factor that can affect stocks to the extent that they become critically threatened and even extinct. Effective mitigating measures are available.
3) **Non-stabilized influence**. A factor that causes reductions in stock production (but not to the extent that stocks are threatened). Mitigating measures are either lacking or not able to control or significantly reduce the influence of the factor.
4) **Stabilized influence**. A factor that causes reductions in stock production (but not to the extent that stocks are threatened). Effective mitigating measures are available.

A total of 16 threat factors were identified and evaluated on a national level in Norway in terms of knowledge level, threat potential (for affecting stock size, production, stock structure and genetic integrity), extent of geographic distribution and the availability of mitigating measures (Anon. 2014). The national ranking of the factors is shown in Figure 14.

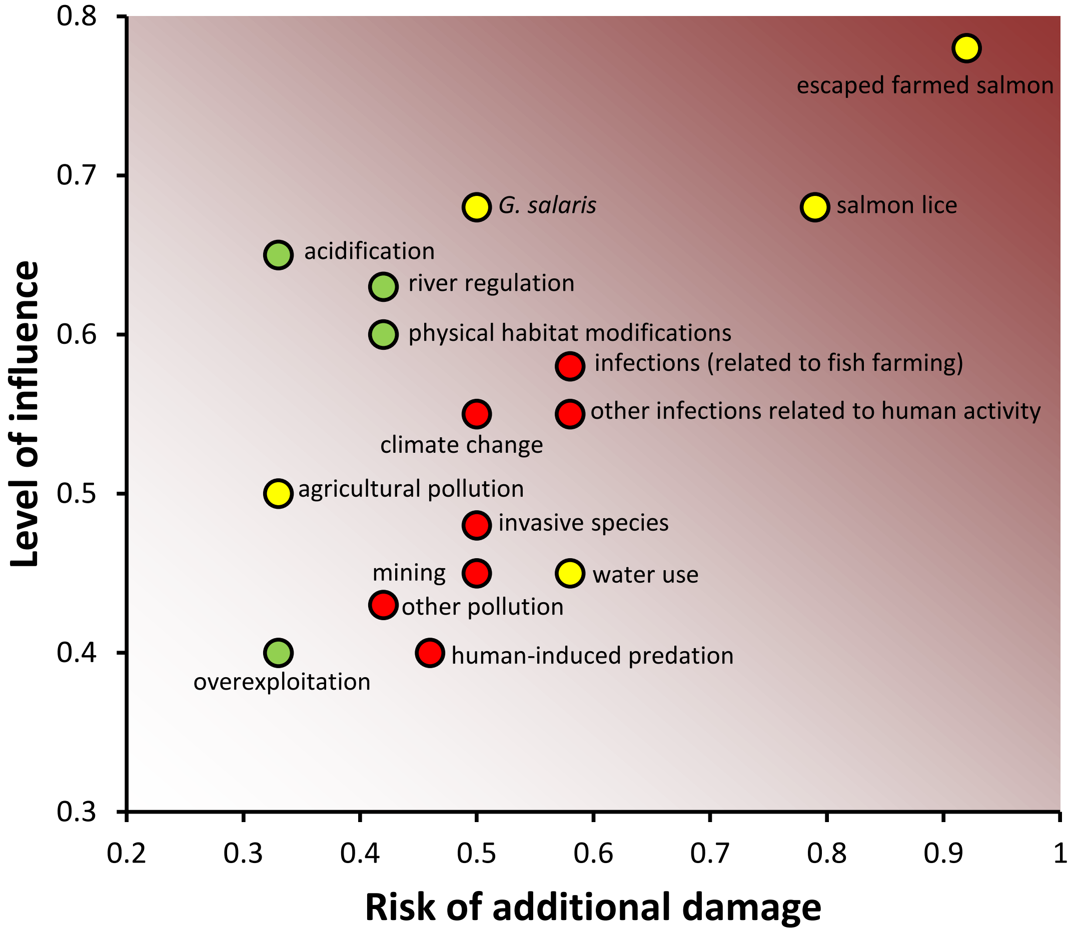


Figure 14. The **national** (Norwegian) ranking of different threat factors affecting salmon in an influence-/risk-diagram. The background colour illustrates level of severity (dark colour is most severe). Symbol colour designates level of knowledge and uncertainty, with green symbolizing an extensive knowledge level and little uncertainty about the development, yellow symbolizing a moderate level of knowledge and moderate uncertainty, and red symbolizing a low level of knowledge and high level of uncertainty about the development of the factor (figure from Anon. 2014).

3.1 Review of individual human-caused threat factors

Please note that the national ranking shown in Figure 14 reflects the overall influence and risk of the factors in Norway. However, the influence/risk of individual factors differs locally among river systems, and in the following text we therefore evaluate the risk and pertinence of the individual threat factors from Figure 14 within the Tana river system. We make the evaluation over two different axes: (1) the current level of influence in Tana, and (2) the risk of (additional) damage in the future.

3.1.1 River regulation (hydropower)

Currently, no parts of the Tana river system have been regulated for hydropower purposes, and no plans exist for such developments in the future. We have therefore placed this factor low both on the current influence axis and the risk of future damage axis.

3.1.2 Water use

Water from the river system can potentially be used for a variety of purposes, e.g. hatcheries, freshwater fish farming, industry and agriculture (irrigation). The extent of such water use in Tana is insignificant today, and the risk of future development is currently viewed as small.

3.1.3 Acidification

Acidification is a threat factor that historically has eradicated several salmon stocks in areas exposed to acid rain. It is also a factor that can be countered effectively with liming, and several eradicated Norwegian salmon stocks have been reestablished through the national liming program. Water chemistry within the Tana river system indicate that acidification currently is not influencing Tana salmon stocks negatively. Therefore, we place this factor low on the current influence axis and with a low risk of increased future damage.

3.1.4 Physical habitat modifications

Physical habitat modifications include habitat changes such as channelization, embankments and river sills. Embankments can potentially have both negative and positive effects, while channelization and sills usually have negative effects. We have numerous embankments within the Tana river system, while channelization primarily is a habitat modification that might affect smaller streams within the system. The current level of influence from physical habitat modifications is likely small to moderate. Due to the strong restrictions on implementing habitat modifications, we assign a small risk of additional future damage from habitat modifications.

3.1.5 Agricultural pollution

Agricultural activity can increase the nutrient salt load of the river system and contribute to erosion. The former can influence salmon production both positively and negatively, depending on river productivity and hydrology. The latter effect is negative as it can cause an increased input of fine-particulate matter into rivers, and this fine-particulate matter might reduce habitat quality and have clogging effects in spawning redds. There is widespread agricultural activity in the Tana river system, but the effect of this activity is likely small. We therefore place this factor low on both the influence and the risk axis.

3.1.6 Mining activity

Mining activity commonly causes increased metal concentration, increased particle input and spill of production chemicals. All of these will have negative effects. In particular, an increased metal load will reduce the smolts ability to adapt to saltwater and thereby cause significantly decreased smolt survival. Increased particle load and spill of production chemicals will reduce egg and juvenile survival. We are severely missing knowledge about critical levels of different metals and chemicals, but experience from other river systems indicate that mining can severely decrease salmon production. Currently, mining activity is at a very low level within the Tana river system, but this activity is expected to increase in the future. We therefore place this factor low on the current influence level, but high on the risk of future damage axis.

3.1.7 Other causes of pollution

River systems receive contaminants in the form of metals, PCB and various pesticides both through local and long-range sources. The effects of these contaminants can vary from weak reductions in reproduction, by way of chronically increased mortality, to episodes of extensive mortality of adults and/or juveniles. The knowledge-level about contaminant effects in general is poor, and we have virtually no knowledge about this factor in Tana. The remoteness of large parts of the Tana river system and the low level of human activity in the area is an indication that this factor likely currently has a low influence and a low risk of future damage.

3.1.8 Gyrodactylus salaris

The parasite *G. salaris* has caused several Norwegian salmon stocks to be critically endangered (or even extinct) and for this reason it is critically important to avoid transmission of the parasite into the Tana river system. The parasite has not yet been found in Finnmark. The nearest Norwegian localities with *G. salaris* are the rivers

Skibotnelva and Signaldalselva in Troms, both of which have been treated now with rotenone. The parasite is found in Finland and Sweden in several rivers flowing into the Baltic Sea. A nearby example is the large River Tornionjoki/Torneälv. The parasite has been introduced with fish farming into the Inari/Enare lake which forms the source of the River Paatsjoki/Pasvik. Some of the headwaters of both these systems are situated very close to the source areas of the Tana river.

The parasite causes very high juvenile mortality, to the extent that salmon stocks become critically endangered and even extinct. Rotenone treatment is the current main approach to eradicating the parasite, but this treatment is, in practice, untenable in the Tana river system. This makes preventative measures highly important.

The parasite is currently not found in Tana, so this threat factor is placed low on the current influence axis. It is, however, set very high on the risk of future damage axis, due both to the profound negative effects and the extreme difficulties involved in eradicating the parasite from Tana if it ever is transmitted.

3.1.9 Salmon lice

It is likely, given the current level of knowledge about the possible effects of salmon lice on anadromous salmonids, that increased levels of salmon lice caused by aquaculture have caused increased sea mortality and, thereby, decreased the number of salmon returning to rivers from the sea. On a national level in Norway, salmon lice is currently ranked as the second-most important threat factor for salmon (Figure 14). With the currently observed salmon lice levels in Finnmark (Taranger *et al*. 2014) we are likely approaching a moderate effect level of salmon lice in the area. The risk of future damage is high, as there will be a continuous pressure to increase the aquaculture production biomass in Finnmark in the coming years. Effects from climate change might further increase negative salmon lice effects on salmon.

3.1.10 Infections related to fish farming

The immense scale and volume of fish in aquaculture comes with a proliferation of infectious agents, and the potential influences of these agents on wild salmon are largely unknown. The impact of this threat factor is likely small in Finnmark with the current level of aquaculture, but the risk of future damage is deemed moderately high due to planned increases of the aquaculture production biomass along the coast of Finnmark.

3.1.11 Other infections (not related to fish farming)

There are other infective agents (virus, bacteria, fungi and parasites) that are not related to aquaculture but still can be related to human activity. For instance, there are fish diseases that occur under very particular environmental conditions such as high summer water temperatures and low water levels (both of which can be related to climate change or river regulation). Proliferative kidney disease (PKD) is an example of such a disease, and PKD has been associated with significant juvenile mortality (Forseth *et al*. 2007). It is unlikely that this threat factor is affecting Tana salmon negatively today, but increasing summer water temperatures in Tana in the future means that the risk of future damage is set at a moderate level.

3.1.12 Climate change

Climate change potentially affects salmon stocks on a multitude of levels, from changes in discharge, water temperature and water chemistry within rivers to large-scale changes in oceanic ecosystems (Anon. 2011a). With the current level of knowledge, climate change as a threat factor is placed low on the influence axis for Tana and moderate on the risk of future damage axis. However, the risk of future damage might be moved upwards on the risk axis as correlations between climate and salmon growth and survival become better understood.

3.1.13 Escaped farmed salmon

Escaped farmed salmon can influence wild salmon populations on a number of levels, e.g. being vectors of infections, causing ecological effects such as competition and creating a chronic genetic pressure on stocks. The production levels of the aquaculture industry have increased tremendously since its infancy in the early 1970s, and today the natural production of wild salmon is vanishingly small compared to the production of farmed salmon. In 2010, 1 000 000 tonnes farmed salmon were produced in Norway, while the river catch of wild salmon in comparison were only around 430 tonnes, of which approximately 20 % were taken in the River Tana.

In Tana, registrations of farmed salmon have come from two sources: 1) the regular scale samples taken from fishermen during the summer, and 2) monitoring fishing close to the river mouth during the autumn (1990/91, 1996/97 and 2003/04). The proportion of farmed salmon in the catches during the summer has been very low, well below 1 %. In the autumns of 1990 and 1991, the proportions were at their highest with 43-47 % (Erkinaro *et al.* 2010). However, the numbers of fish caught in the samples were only 19 and 7, respectively. The proportions of farmed salmon in the other autumn investigations was 0-13 %, but still with low total numbers of fish (8-21).

After the formal ratification of the Tana fjord as a national salmon fjord in Norway in 2003, all aquaculture in the fjord has been closed.

With the current low levels of escaped salmon in Tana, we currently score escaped farmed salmon low on the influence axis. However, there is a significant and ongoing pressure to increase the production biomass of farmed salmon in Finnmark, and for this reason there is a high risk of future damage from this threat factor.

3.1.14 Invasive (or introduced) species

An invasive (introduced) species is an animal (or plant) that is not native to a location. These species might have been introduced to a location either directly by humans (a primary introduction) or they might have moved to the location from another primary introduction by their own means (a secondary introduction). There are some invasive species in Tana: bullhead (*Cottus gobio*), pink salmon (*Oncorhynchus gorbuscha*) and rainbow trout (*Oncorhyunchus mykiss*). The rainbow trout are farmed escapees and we have, until now, no record of any natural reproduction of rainbow trout in the area. The probability of this happening will increase with the increasing biomass of rainbow trout along the Finnmark coast. The pink salmon originate from a massive introduction programme in Russia in the period 1956-1998. There are self-reproducing stocks of pink salmon now in Russian rivers (Zubchenko *et al*. 2005) and we have indications of pink salmon reproduction in Norwegian rivers in the Varanger area (R. Muladal, pers. comm.).

The bullhead (*Cottus gobio*) is a newly introduced fish species in the Tana river system. It was first observed in Utsjoki in 1979, and has increased its distribution in that tributary since. Ten years ago, the bullhead was first observed in the Tana main river at quite many places between the river mouth of Utsjoki and downstream to the Storfossen/Alaköngäs area. This new fish species has also been found already approximately 5-10 km upstream from the river Utsjoki in the River Tana in the Kordsam-Kaava area. The bullhead that have been detected during the annual juvenile salmon survey have been larger than 4 cm, indicating that they most probably have been migrating from the River Utsjoki and they might therefore not be from bullhead that have spawned in the River Tana.

There have been some studies of the potential interactions between bullheads and juvenile salmonids. Bullhead is found to be frequent in areas with low salmon density but not found in high abundance in areas with a high salmon density, but decisive answers about its impact on salmon are still lacking. Focus should be kept on the bullhead in the annual juvenile monitoring, especially to see if the observations from Storfossen/Alaköngäs and upstream of the River Utsjoki river mouth represent a new establishment. Most probably there will occur some competition between juvenile salmon and bullhead in the River Tana because there are not such kind of habitat segregation like lakes and pools which can be found in the River Utsjoki, where salmon and bullhead currently can live separately.

In the current evaluation, we place invasive species low on the current influence axis and at a moderate level on the risk of future damage axis.

3.1.15 Overexploitation

A detailed definition of overexploitation is provided in chapter 4.4. In summary, overexploitation is defined as any part of a fisheries that cause the spawning stock to be below the spawning target. Salmon exploitation should be based on a sustainable surplus. The current Tana stock status evaluation clearly demonstrates that the exploitation of most stocks in Tana far exceeds their sustainable surplus. In the period 2006-2015, Tana salmon have been overexploited with an average of 35 %, with some stocks as high as approximately 60 % (Iešjohka and Anárjohka/Inarijoki). In other words, a significant proportion of the pre-fishery abundance of most Tana stocks is caught in fisheries and only a small proportion survives to spawning. This makes exploitation a major factor affecting the development of Tana salmon stocks and, accordingly, overexploitation is placed high on the current influence axis.

However, the current negotiation process between Norway and Finland has a strong focus on establishing an adaptive target-based management regime in Tana that should bring exploitation down to a sustainable level. Due to this expectation, we place overexploitation low on the risk of additional damage axis. Overexploitation might be moved upwards on the risk axis if the negotiation process fails.

3.1.16 Predation

Predation on salmon by birds, mammals and other fish are natural mortality factors that always have affected salmon populations and are factors that salmon are adapted to handle. In this sense, it might seem counterintuitive to include predation as part of an evaluation of *human-caused* threat factors.

However, the occurrence of predators might be influenced by human activity, either directly by hunting/fishing the predator species or indirectly by hunting/fishing the alternative prey species of the predators. For instance, heavy exploitation of other fish species in the Tana river system might deplete alternative prey for fish predators such as pike, which could cause predation to become more focused on salmon. Depleting the number of sandeel in the Tana estuary might increase seal and goosanders predation on salmon and trout. Attempts to reduce pike predation by removing pike might result in reduced numbers of large pike. However, large pike are a major predator on small pike, while small pike can be a major predator on salmon juveniles and smolts. Reducing the number of pike might therefore, in the end, increase salmon predation. All these are examples of human activity causing potential changes in predation levels.

The proportion of the salmon populations that are removed by predators is highly affected by salmon stock status. The highest proportions removed by predators will be observed when salmon stocks are depleted, while only low proportions will be removed when salmon stocks are healthy. When salmon stocks are highly depleted, natural levels of predation might even turn negatively density dependent. With heavily depleted stocks, salmon reproduction levels become so small that the natural density dependent compensatory mechanisms of salmon populations stop working. This is a dangerous situation for a population as stock recovery would be very challenging.

As salmon stocks in Tana currently are depleted due to human exploitation and are expected to recover through the implementation of stock recovery plans, we set predation at a moderate to low level on the current influence axis and at a low level on the risk of future damage axis.

3.2 Ocean conditions

There is little doubt that environmental conditions in the ocean have contributed to reduced survival and decreased number of grilse in Norway in the last decades. However, it is difficult to evaluate this factor as a *human-caused* threat factor.

3.3 Overall view of Tana salmon threat factors

The ranking of individual threat factors made specifically for Tana above can be visualized in an influence/risk-diagram (Figure 15).

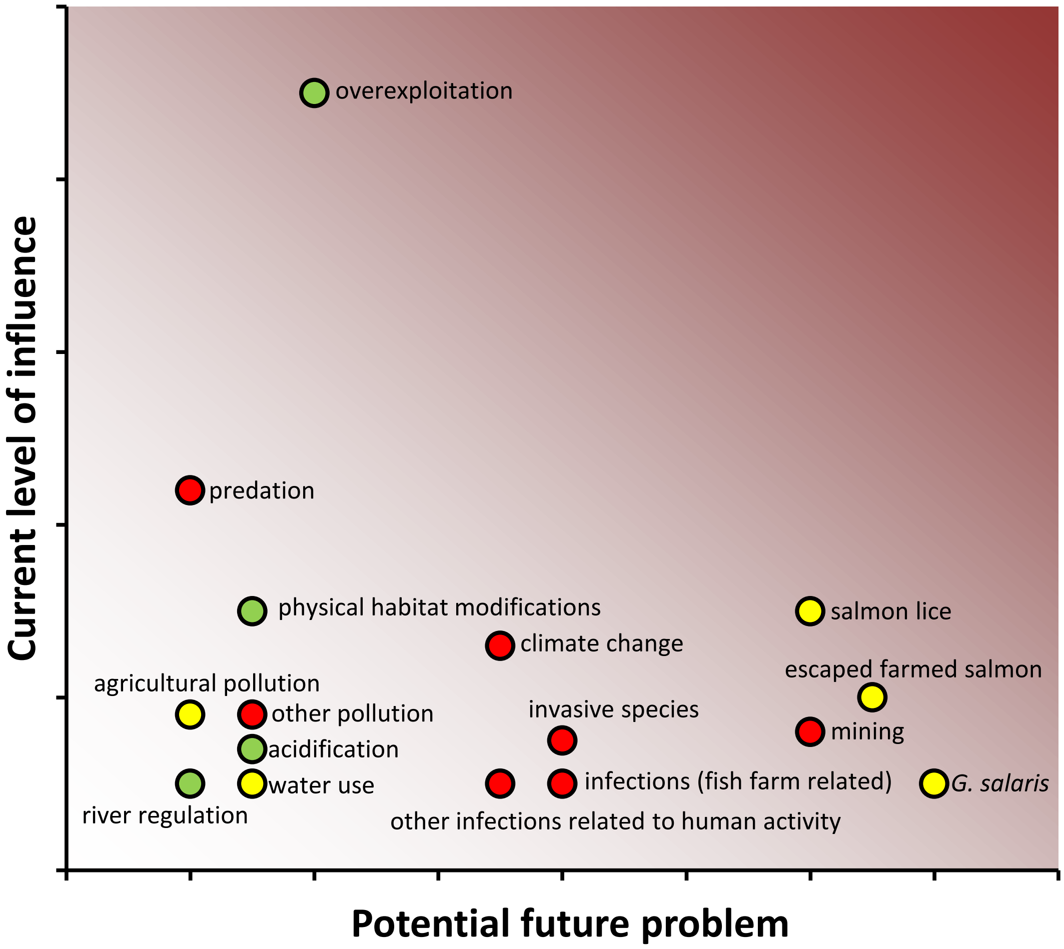


Figure 15. The ranking of different threat factors that affect Tana salmon in an influence-/risk-diagram. Symbol colour designates level of knowledge and uncertainty, with green symbolizing an extensive knowledge level and little uncertainty about the development, yellow symbolizing a moderate level of knowledge and moderate uncertainty, and red symbolizing a low level of knowledge and high level of uncertainty about the development of the factor.

4 STOCK STATUS EVALUATION

This chapter provide a comprehensive status update on salmon from 10 different parts of the Tana river system, in addition to a total status estimate for the whole river system. The status evaluation is based on (and extended from) the status evaluations in Anon. (2012a; 2015) and work done by the Scientific Advisory Committee for Atlantic Salmon Management in Norway.

4.1 HOW TO EVALUATE STOCK STATUS?

Traditionally, stocks have been evaluated based on their historical catch statistics. Long time-series of catch data are illustrations that initially look easily interpretable. However, upon closer scrutiny, a number of problems arise with this approach.

Primarily, it is very difficult to pinpoint the exact reason for fluctuations in catch statistics. Differences between years can arise from several factors. Such factors include e.g. variations in salmon abundance, differences in number of fishermen, fishing conditions and/or fisheries regulations. Together, the largely unknown contribution of each factor will confound the catch statistics interpretation.

Secondly, it is problematic to relate the catch to any meaningful benchmark of how the stock is doing. The catch statistic provides an estimate of the number of killed fish, and thus is a useful way of describing how well the fishermen have been doing. It tells us very little, however, about how the salmon stock is doing. How many salmon were left at the spawning grounds and how many should there have been? What was the exploitable surplus and how was that surplus reflected in the catch? These are examples of questions that point to the need for a different approach.

The lack of a meaningful benchmark when using catch statistics (and other related and derived descriptive statistics) becomes an obvious problem in processes related to changing fisheries regulations. It is not immediately apparent how to justify the regulatory needs and the selection and evaluation of which regulations to implement. The management regime itself commonly formulates only qualitative goals, and proposed regulations under this regime rarely have specific goals and lack a clear information basis that managers can use for evaluation.

Salmon as a species pose some explicit management challenges with its spatially and temporally complex life cycles, spanning vast areas and several years. This is especially true in the Tana River system, in which there are close to 30 genetically distinct stocks and a large variety of possible life history combinations. The management is further complicated by the presence of extensive mixed-stock fisheries both along the coast of northern Norway and in the Tana main stem.

The implementation of a target-based management regime has largely solved the historical problems described above. We are now able to compare individual stocks against performance-related benchmarks, thus eliminating the interpretational problems of the catch statistics. The focus has turned from how well the fishermen were doing (which is the story of the catch) to how well we are able to care about the individual stocks for the future by ensuring a sufficient number of salmon survive to spawn.

4.2 SALMON PRODUCTION AND SPAWNING TARGETS

A major objective for salmon conservation and fisheries management is to develop a practical basis for managing individual salmon stocks and the environment in which they live in order to optimize sustainable yield. One way of achieving this, is to specify stock-specific targets for reproduction (e.g. egg deposition). For a salmon stock, the number of adults estimated to be lost through exploitation and natural mortality subtracted from the total run size, is called the spawning escapement. This escapement can be converted to a total egg production for the stock and then compared to a stock-specific threshold value for egg production. This threshold is the conservation limit (CL) (or Minimum Biologically Acceptable Limit) recommended by NASCO, and is the stock level that supports maximum yield and thus maximizes potential yield under the life-cycle characteristics applying to the stock. The CL is the threshold level below which stocks should not fall, and it is recommended that managers should aim to hold escapement at a higher (unspecified) level termed the management target.

The salmon production capacity in different parts of the Tana River system is limited, meaning that there exist a maximum number of salmon smolts that can be produced. This is usually referred to as the production potential. The factors that limit production are of two types, either (1) density-dependent or (2) density-independent.

Density-dependent factors vary in strength depending on the fish density. With increasing fish density, density-dependent factors such as competition become increasingly intensive. Density-dependence is most easily observed for juvenile salmon. As fish density increases, less food and space become available for each individual fish. This inevitably leads to some fish dying, with mortality increasing with the fish density. A river, accordingly, contains room for only a certain number of juveniles, and this number depends on the river area, abiotic factors such as habitat quality (e.g. the number of available hiding places) and biotic factors such as food availability.

When the spawning stock size is small, relatively few eggs are spawned and the density-dependent competition plays a relatively small role. With low stock levels, the number of smolts produced are proportionally dependent on the number of eggs that are spawned (left part of Figure 16). With increasing spawning stock size, the competition effect will gradually become more important. Thus, with increasing egg density, the increase in smolt production slows towards an asymptote (middle part of Figure 16). At high egg density levels, the river reaches its smolt production potential (right part of Figure 16).

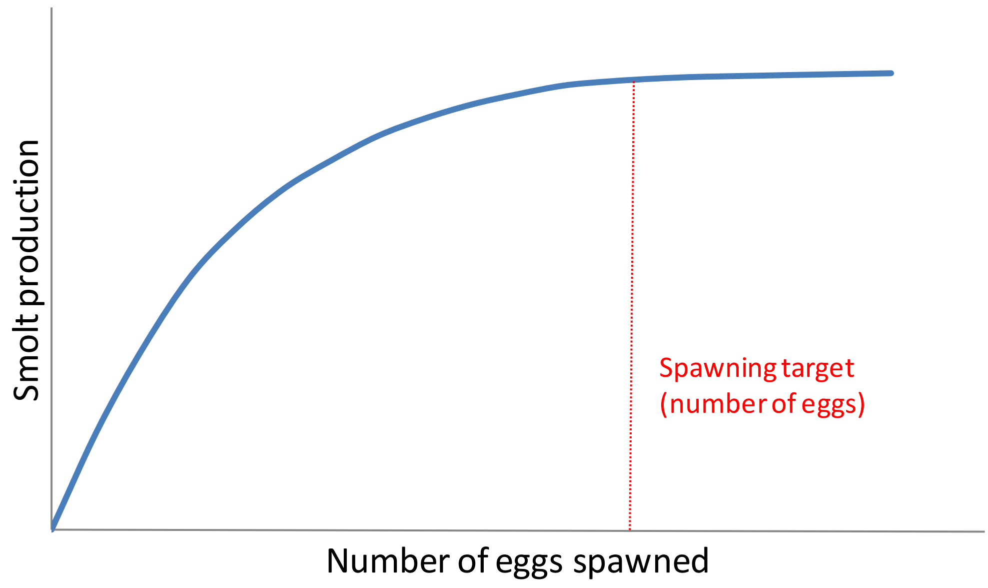


Figure 16. Simplified theoretical relationship between number of eggs spawned and number of smolts produced for a salmon stock.

The production potential varies greatly within different parts of the Tana River system. In some areas of the system, the habitat is predominantly of a good quality with lots of hiding places and rich food availability, and consequently the fish production potential is high. Other areas have predominantly poor habitat quality, with few hiding places available for juveniles and lower food availability, and consequently the fish production potential is low. Habitat factors such as water velocity, substratum composition and presence of other competitors (such as trout) are also affecting the production capacity.

Density-independent factors are not depending on fish density and occur more randomly. The occurrence of factors such as floods, drought, temperature and predation will result in fish dying. But the occurrence and intensity of these factors can vary greatly from year to year. In some years, the water level and temperature are favourable, resulting in high growth rates and low mortality. Under such conditions, juveniles might even smoltify and migrate to sea a year earlier than average. This will give a boost to the river smolt production, both because the river mortality is reduced by one year and because the remaining juveniles get better conditions because fish density is reduced. Other years can have extreme environmental conditions, e.g. severe droughts or rough spring floods with difficult ice conditions, which will be associated with a high mortality level for juvenile salmon and, accordingly, lowered smolt production.

Random spatial and temporal variation in environmental factors will lead to considerable fluctuations in production and observations both within and between areas of the river system. However, based on long time-series of stock-recruitment data between recruitment (number of eggs or number of spawning females) and production (number of smolts produced), it is possible to estimate the minimum number of spawning females that is needed to ensure that the resulting smolt production is at or near the production capacity of the river. In practice, a small buffer should be added to this minimum number, as a compensating insurance for random events that might cause increased mortality.

First-generation spawning targets have recently been established for the Tana river system (Table 2; Falkegård *et al*., 2014), based on the general methodology used in Norway (Hindar *et al*. 2007).

Table 1. Spawning targets for the Tana river system (from Falkegård *et al*., 2014).

River	*Spawning target (eggs)*	*Female biomass*	*Number of females*
Tana/Teno main stem	41 049 886	22 189	3 170
Máskejohka	3 155 148	1 521	380
Luovtejohka	-	-	-
Buolbmátjohka/Pulmankijoki	1 329 133	511	256
Lákšjohka	2 969 946	1 165	582
Veahčajohka/Vetsijoki	2 505 400	1 101	367
Ohcejohka/Utsjoki	4 979 107	2 059	938
Goahppelašjohka/Kuoppilasjoki	695 950	273	161
Borsejohka	0	0	0
Leavvajohka	499 203	208	77
Nuvvosjohka/Nuvvusjoki	0	0	0
Báišjohka	948 688	395	158
Njiljohka/Nilijoki	519 520	221	88
Váljohka	1 907 595	779	259
Áhkojohka/Akujoki	282 532	126	63
Lower Kárášjohka	2 013 178	1 046	174
Upper Kárášjohka	10 037 498	5 214	869
Geaimmejohka	250 824	105	42
Bávttajohka	1 735 823	926	154
Iešjohka	11 536 009	6 072	1 012
Anárjohka/Inarijoki	11 283 952	5 071	1 268
Garegasjohka/Karigasjoki	598 000	239	120
Iškorasjohka	213 000	99	33
Goššjohka	5 206 840	2 340	780
Skiehččanjohka/Kietsimäjoki	398 160	187	47

Tana/Teno (total)	104 274 286	51 846	10 998

Following the NASCO Precautionary Approach, the management of the Tana river system should, as far as possible, be stock-specific. This is a major challenge in the Tana River system. Genetic analyses have demonstrated with its high number of different stocks, for example due to the lack of data on the spatial boundaries of different stocks. Most of the spawning targets in Table 1 are tributary-specific and represent the closest approximation we currently have to a stock-specific evaluation. There is a need to focus on conservation of each discrete stock, as exchange of individuals among populations appears to be low, at least in the short term, so neighbouring populations do not easily compensate for local shortfalls in production elsewhere (Youngson *et al*. 2003). The main problem here is, of course, that current resource limitations make it impossible to obtain total coverage for assessments of any refinement on any geographical scale within the system, and in practice, compromise approaches have to be taken. Such compromises will however involve using inter-population numbers, and will probably not be able to catch population specific factors.

4.3 A PROCEDURE FOR TARGET-BASED STOCK EVALUATION

4.3.1 ESTIMATING TARGET ATTAINMENT

The introduction of spawning targets completely changes the management focus, turning it away from a question about how many fish are caught into a question about having a sufficient number of salmon survive to spawn. Obtaining an estimate of the spawning stock size (in terms of number of spawning females) and compare this to the spawning target accordingly becomes the main priority.

There are three alternative ways of estimating the target attainment of a stock:

1) **Direct counting of spawners**, e.g. through snorkelling. This approach is most useful in small tributaries of the Tana River system (Orell & Erkinaro 2007) where it has been shown to be fairly accurate, especially under good conditions with an experienced diving crew (Orell *et al.* 2011).
2) **Combine fish counting and catch statistics**. A count of ascending salmon, either through video (Orell *et al.* 2007) or acoustics (DIDSON/ARIS/Simsonar), will, when combined with catch statistics, provide an estimate of spawning stock size.
3) **Combine estimates of exploitation rate and catch statistics**. For most stocks we lack both spawner counts and fish counts. In these cases, it is necessary to rely directly on the catch statistic and use an estimate of the exploitation rate to calculate the spawning stock size. Because the exploitation rate has to be estimated, it is necessary to have access to monitoring data from comparable rivers in the area where the exploitation rate have been calculated (either through counting of spawners or through counting of ascending salmon).

Common for all three approaches is the use of simulation and probability distributions in all calculations. This includes both the spawning targets themselves and the exploitation rate estimates.

The spawning targets are listed as single numbers in Table 1, reflecting the points at which we believe each target most likely is. However, we do not know where the targets *actually* are, and to reflect this we need a measure of uncertainty. We use triangular probability distributions to quantify the target uncertainty. A triangular probability distribution is a useful tool whenever we lack precise knowledge about a factor, but we still have sufficient knowledge to state what the most likely level of a factor might be and also what the upper and lower bounds of the factor might be. So, for instance for a spawning target of 2 eggs m^{-2}, the triangular probability distribution is defined with a modal value of 2 eggs m^{-2}, a minimum egg density of 1.5 eggs m^{-2} and a maximum egg density of 3 eggs m^{-2} (Figure 17).

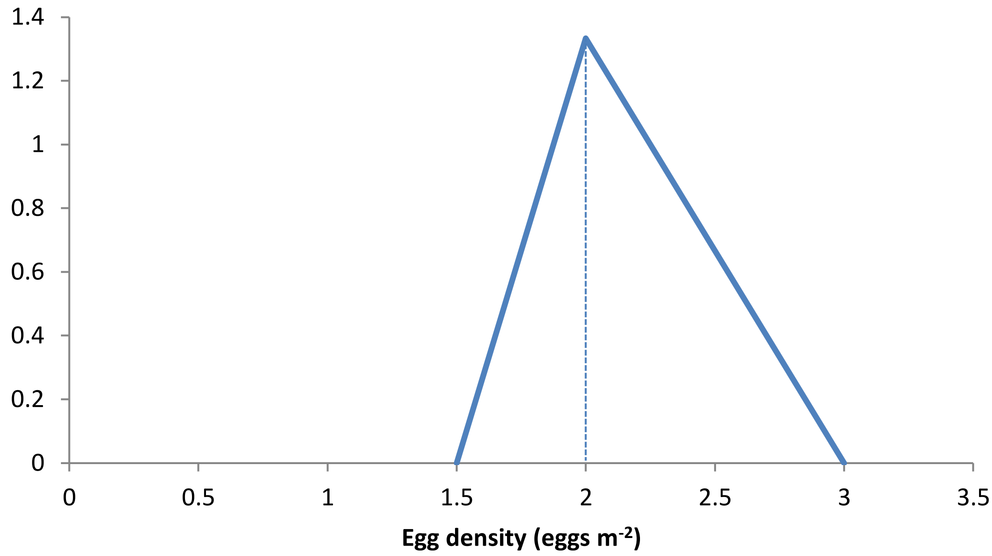


Figure 17. Triangular probability distribution for a spawning target based on the 2 eggs m^{-2} category.

The probability-based approach taken for spawning targets is also used for the exploitation rate estimates. We lack annual monitoring information for most of the evaluated stocks in Tana (with six notable exceptions described below), which means that we have to employ conservative exploitation estimates with a broad level of uncertainty in order to minimize the risk of overestimating the spawning stock size.

Two stocks, Ohcejohka/Utsjoki and Lákšjohka, have long-term time series of video counting. Based on these, relatively narrow exploitation estimates can be calculated on an annual basis. There are annual snorkelling counts in Buolbmátjohka/Pulmankijoki and Áhkojohka/Akujoki. In the case of the former, the snorkelling counts cover only parts of the tributary, increasing the level of uncertainty. In the case of the latter, the snorkelling counts cover the whole tributary, allowing for relatively precise estimates of spawning stock size.

We have isolated fish counting data points from two years in two tributaries, Váljohka and Kárášjohka. We are using the data from these particular counts for the whole assessment period of both these tributaries, and it allows for less conservative exploitation estimates than the ones used for the stocks that lack monitoring data.

The final estimation of target attainment involves putting together the different factors described above in a Monte Carlo simulation with 100 000 iterations. The result is a probability distribution for the egg numbers in each year for each stock. These egg numbers are then translated to female biomass through stock-specific fecundity estimates (average number of eggs per kg female for each stock).

4.3.2 Management target definition

According to NASCOs Precautionary Approach, managers should define two stock-specific reference points that can be used to benchmark stock status in different river systems. The first of these points is the conservation limit, i.e. the minimum number of spawners required to maintain maximum sustainable yield. In Tana, we have defined these as the spawning targets.

The second reference point that must be defined is the management target. The management target represents the stock level that fisheries managers should aim for to ensure that stocks are kept above their conservation limits.

It follows from these two reference points that stocks can be in one of two states: the stock is either (1) above or (2) below its conservation limit. The first situation implies that regulations for this particular stock should be selected to ensure that the stock-specific total exploitation rate is lower than the estimated maximum sustainable exploitation rate. The second situation should automatically trigger the implementation of a recovery plan designed to increase the spawning stock size above the conservation limit again. These two situations require different management target definitions.

4.3.2.1 Management target definition for the stock-rebuilding period

An important part of the stock rebuilding period is to define a recovery trajectory. The shape of this trajectory depends on the change in exploitation rate experienced by a stock, and it is this stock recovery exploitation rate that effectively becomes the target during the stock recovery period. Accordingly, we define the stock recovery management target as:

The estimated stock-specific total exploitation rate derived from the stock recovery trajectory.

The stock recovery trajectories are constructed based on certain levels of reduction in the exploitation rate experienced by the different stocks. These new exploitation rates then become the management targets that are used during the stock recoveries. Exploitation advice for stocks currently under recovery should then be based on a comparison of experienced exploitation rate and the exploitation rate defined by the recovery plan.

Please note, however, that no recovery plans have been implemented in Tana yet and we therefore base status evaluations in this report on the management target definition given below.

4.3.2.2 Management target definition for long-term sustainability

The role of the management target in the long-term sustainable period following the stock-rebuilding period will be to ensure that stocks are kept above the conservation limit. This management target thus should represent the stock level that ensures long-term viability of the stock, and can be defined as follows:

The average probability that a stock has reached its spawning target must exceed 75 % over the last 4 years.

This definition is essentially saying that we need to be at least 75 % certain that the spawning target actually is exceeded by the actual spawning stock size. The same definition is used by the Scientific Advisory Committee for Atlantic Salmon Management in Norway in its evaluation of all Norwegian salmon stocks. Extended failure to meet the management target should directly lead to the implementation of a stock recovery plan.

As exemplified in Figure 17, the spawning target is based on a probability distribution that is defined by what we think is the most likely value for the target, and what we believe are the minimum and maximum level that a target in a particular river can be. Figure 18 provides an example of this, using numbers from the total Tana evaluation, with the target converted from egg density into female biomass. For Tana in total, we believe it is most likely that the total spawning target is 52 491 kg, with a lower limit of 38 766 kg and an upper limit of 78 343 kg (blue-coloured triangle).

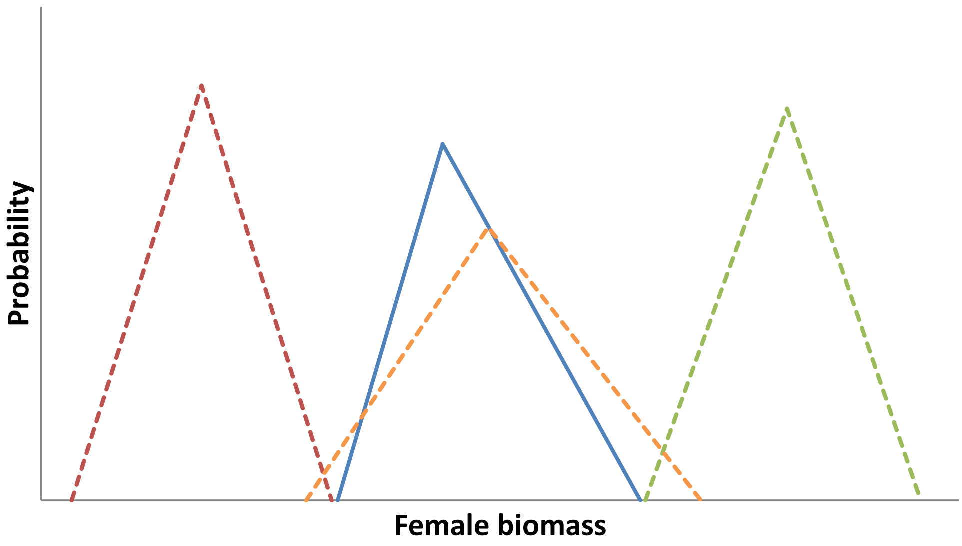


Figure 18. The triangular probability distribution describing the Tana (total) spawning target (blue line) and the triangular probability distributions of three exemplified spawning stock sizes: (1) an estimate completely below the target, representing a 0 % probability that the target was reached (red dotted line), (2) an estimate completely above the target, representing a 100 % probability that the target was reached (green dotted line), and (3) an estimate located within the target distribution (orange dotted line), representing in this example a 57 % chance that the target was reached.

We also rely on probability distributions when estimating the spawning stock size, e.g. by estimating the exploitation rate with a central, most likely value together with lower and upper limits. Some possible spawning stock estimates are shown, together with the spawning target, in Figure 18. So, given these estimates for the target and the spawning stock, how certain can we be that the target actually was reached in this particular example? It is obvious from Figure 18 that there are some spawning stock distributions where we can be 100 % sure, either that the spawning stock was below all possible values of the spawning target (0 % probability, dotted red line in Figure 18) or that the spawning stock was above all possible values of the spawning target (100 % probability, dotted green line in Figure 18).

The most complex situation happens when we have overlap between the spawning stock estimate and the spawning target, as exemplified in Figure 18 with the orange line. There are some parts of the orange line that is completely below the spawning target distribution. If these spawning stock sizes were true, then the target was definitely not reached. Likewise, there are spawning stock values above the upper limit of the target. If these were true, then the spawning target was definitely reached.

For all spawning stock values located within the range of the spawning target, there is a possibility that the target exceeds the spawning stock. For instance, a spawning stock of 60 000 kg in Figure 18 would have over 20 000 kg of spawning target on the downside, and close to 20 000 kg of spawning target on the upside. The entire range of potential spawning targets on the upside in this case represents a possibility that the target was not reached. This is the reason we cannot simply look at the target attainment values. We need a measure of how likely it is that the target actually was reached, given the uncertainty we have about estimating the spawning target and the spawning stock.

In the particular example with the orange line in Figure 18, the probability that the target was reached was 57 %. This particular value is below the average value specified in the management target, signifying that the spawning stock in this particular year was not big enough for us to have enough confidence that the spawning target actually was reached.

There are ways of increasing the probability that the spawning target was reached. The most obvious way, of course, is to decrease the exploitation and thereby increase the spawning stock size.

Another possibility is to decrease the uncertainty of spawning stock and target estimates through monitoring and research. An example of the effect of a lack of knowledge is the wide uncertainty ranges used for the exploitation rate estimates in areas without fish counting. This uncertainty becomes much smaller with the implementation of fish counting, e.g. illustrated by comparing the stipled green line with the dotted red line in Figure 19. The dotted line is the spawning stock estimate from Figure 18, while the stipled green line shows the resulting spawning stock distribution when better monitoring data are available. In addition, lack of monitoring data means that we have to be cautious and use relatively high exploitation estimates. A consequence of this is that the estimated spawning stock size becomes smaller. In this example, the result of better monitoring data, increases the spawning target attainment from 57 to 77 %.

This example provides an illustration of the importance of strong monitoring. Stock assessments can be done with less uncertainty, which lessens the regulatory consequences for the fishermen.

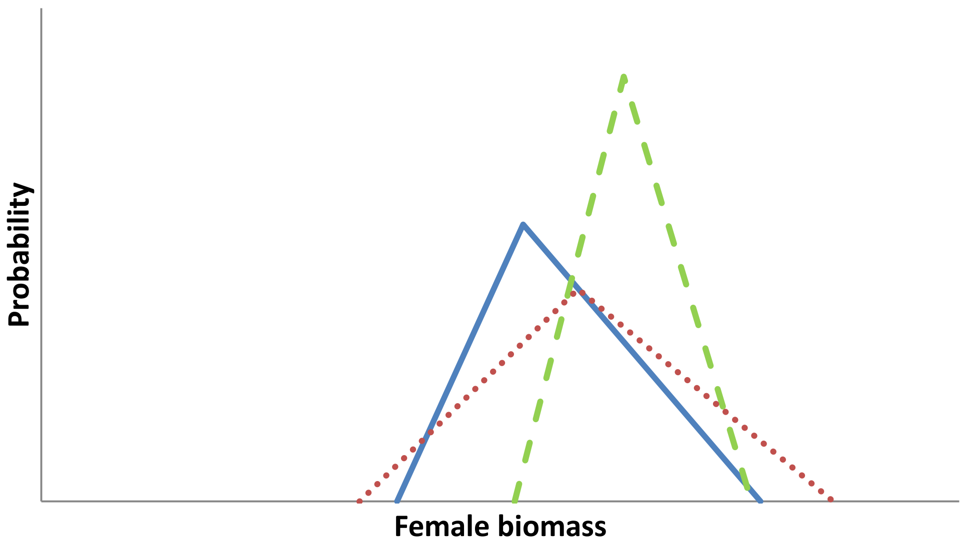


Figure 19. The triangular probability distribution describing an example spawning target (solid blue line) and the triangular probability distribution describing the exemplified spawning stock from Figure 18 (dotted red line). The stipled green line indicates the possible shape of the estimated spawning stock distribution if better monitoring data had been available.

4.3.3 Pre-fishery abundance and catch allocation

The estimation of spawning stock size and exploitation rates can further be used to evaluate the relative efficiency of different fisheries exploiting a salmon stock and estimate pre-fishery abundance.

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

The fishery in each area is defined by its own set of regulations, and accordingly the fishery in each area is characterized by its own exploitation rate. Due to stock differences in run timing and size composition, the vulnerability of each stock to exploitation in an area will differ, and this is one important factor to keep in mind when designing research and monitoring studies.

Most of the exploitation on different stocks in Tana takes place in areas with mixed-stock fisheries. This is the case along the coast, in the Tana fjord and the Tana main stem, leaving only the tributaries themselves as areas of single-stock fisheries. A mixed-stock fishery represents a major impediment when the exploitation rate on different stocks is to be evaluated, as the level of exploitation on each stock participating in a mixed-stock fishery is not apparent without specific knowledge gained e.g. through genetic stock identification of catch samples or some large-scale tagging program.

Tagging studies (a total of 29 000 salmon tagged on 23 tagging stations distributed north to south on the coast of Norway in the period 1935-1982) have shown that the salmon caught in the coastal fisheries belong to a large number of stocks covering a substantial area. Based on the tagging recaptures, a distribution key for the coastal catch statistics can be constructed (see Anon. 2011b for details). We have been able to further refine this distribution key using large-scale data from a recent project (EU Kolarctic ENPI CBC KO197) that used genetic stock identification to identify stock of origin for a large number of salmon caught along the coast of northern Norway in 2011 and 2012. We have used the resulting distribution key to estimate the exploitation of Tana salmon in different coastal regions.

Steps for estimating the Tana catch from the coastal catch statistics:

1) Using the distribution key, 10 % of the catch from the outer coastal area of Troms and 33 % of the outer coastal catch of Finnmark is estimated to belong to the Tana fjord region. The redistributed catch from the outer coastal regions are then added to the reported catch in the Tana fjord.
2) There are two salmon rivers in the Tana fjord: Tana and Laggo. The estimated total catch from the Tana fjord is separated into either Tana or Laggo based on the relative abundance of salmon in the two rivers (estimated from the river catch) and each rivers size composition (fish larger than 1.5 kg are positively selected in the coastal fisheries). The resulting number represents the total fishing mortality of Tana salmon in the coastal fisheries.
3) The estimated total coastal catch of Tana salmon is further separated into different Tana stocks (Figure 3) based on the relative abundance and size composition of each stock (inferred from the main stem catch, see below).

In an ambitious project (GenMix, funded by the Norwegian Environment Agency), the stock of origin of a large number of salmon caught in the Tana main stem in the years 2006-2008 and 2011-2012 were identified based on a comprehensive genetic baseline. Using the stock-identified data, we made an estimate of the percentage contribution of each Tana stock in the total main stem catch. These percentages were then used to estimate the total main stem catch of each stock from year to year.

After the catch in the coastal and main stem mixed-stock fisheries have been distributed into different Tana stocks, we can estimate the total exploitation, overexploitation, and maximum sustainable exploitation for each stock.

4.4 OVEREXPLOITATION

Historically, we have several examples demonstrating that it is possible to draw too heavily on salmon stocks through exploitation. However, history also teaches us that it is possible to have a sustainable and at the same time extensive fishery for salmon. The only caution in this comes from the problems that potentially can arise from fisheries induced evolution, a topic that so far have received scant attention in Tana.

Exploitation is, simultaneously, both a management goal and a potential threat factor for salmon stocks. A basic tenet of an adaptive knowledge- and target-based management regime is that stocks should be managed in a way that enables them to fulfil their production potential. That level of production ensures a rich fishery that would favour local communities, rights holders and visiting anglers. However, the salmon fishery remove salmon that would otherwise be a part of the spawning stock. It is therefore inherently assumed that this removal should be sustainable, i.e. that the fishing takes place only on a stock surplus. The management targets define lower acceptable limits for stocks, and it follows that a full-recruited stock is *overexploited* when fishing reduces the spawning stock below the spawning target (Figure 20).

Overexploitation can be defined as **the extent of a reduction in spawning stock below the target that can be attributed to exploitation**. In a situation when the pre-fishery abundance of a stock is smaller than the spawning target (i.e. no exploitable surplus exists), the percentage overexploitation is calculated as:

$$\frac{catch}{spawning\ target} \times 100$$

When the pre-fishery abundance is higher than the spawning target, the overexploitation is calculated as:

$$\frac{spawning\ target - spawning\ stock}{spawning\ target} \times 100$$

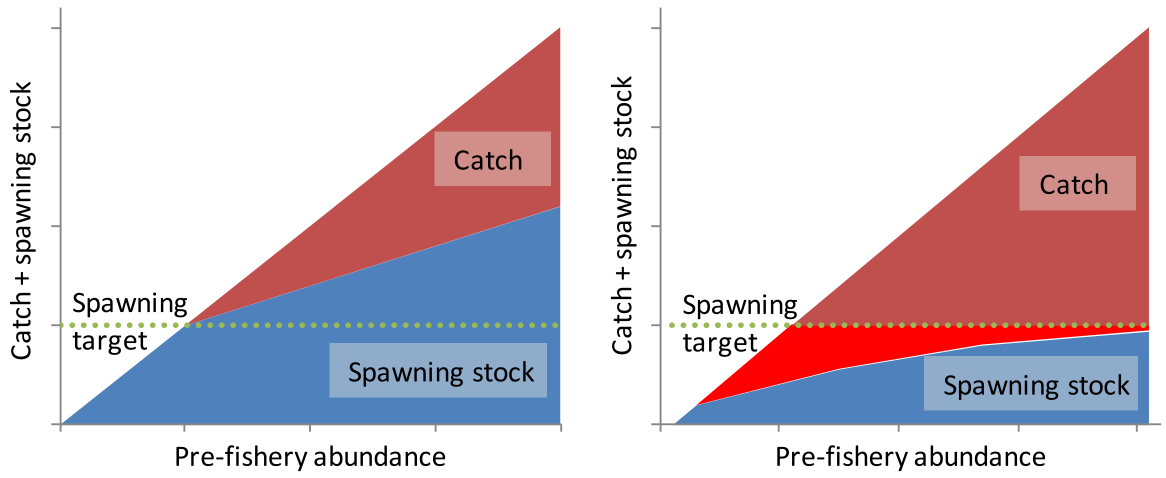


Figure 20. The left figure shows a situation *without* overexploitation, as the spawning stock is not reduced below the spawning target because of exploitation. The right figure shows a situation *with* overexploitation, as the spawning stock is reduced by exploitation below the spawning target. The stipled green line represents the spawning target. The bright red part of the right figure (between the blue spawning stock and the dark red catch) depicts the part of the catch that represents overexploitation. Please observe that it is only the part of the catch that is between the spawning target and spawning stock that is characterized as overexploitation, the catch above the spawning target is not included. Figure from Anon. (2010).

A direct consequence of a reduction in spawning stock through overexploitation is reduced smolt production and, consequently, fewer returning adult salmon. There are, however, also other possible negative effects of overexploitation. Exploitation, by its nature, inevitably causes a significant proportion of the adult salmon to die before spawning, and this mortality leads to a high selection pressure that can cause genetic changes in the population (Hard *et al.* 2008). Changes can be seen in the salmon life history, for example reducing the proportion of large salmon, shifting the run timing towards later river entry, or change survival, growth and habitat use so that the production potential of the stock becomes reduced. These are examples of unwanted changes that can be difficult to reverse. We have very little knowledge about what level of exploitation can cause such evolutionary changes in salmon stocks, but simulations indicate that exploitation at the level of maximum sustainable yield (F_{msy}) has a low probability of causing evolutionary changes (Hutchings 2009).

In practical terms, sustainable yield is not a fixed quantity. This is a major challenge for salmon management, as stocks must be kept at some sustainable level despite uncertainties in how environmental factors affect salmon stocks at any given time. First of all, salmon survival, both freshwater and oceanic, is very variable both in space and time, making it inherently difficult to estimate run size before the fishing season. Making management decisions therefore becomes difficult. Secondly, there is uncertainty in how different environmental conditions affect salmon survival, and this uncertainty becomes increasingly difficult to cope with as the climate itself appears to be changing. Thirdly, there is substantial uncertainty about the relationships between management actions, exploitation efficiencies and the resulting spawning stock sizes.

The exploitable surplus will, therefore, vary both with the size of previous spawning stocks (relative to the spawning target) and within the limits set by other influencing factors both in the river and at sea. Environmental factors in the river and size of the spawning stock ultimately decide the smolt production, which, together with sea survival, determines the pre-fishery abundance of adult salmon. The extent to which different stocks can be exploited will therefore have to be calculated individually from stock to stock and year to year, depending on the characteristics of each stock and the available knowledge of environmental factors in river and at sea.

A very simplified model can give a hint about which exploitation levels, given different levels of sea survival and smolt production, a salmon stock can sustain before it falls below its spawning target (Figure 21). A basic premise of the model is the relationship between smolt production and spawning stock from the spawning target model of Hindar *et al.* (2007). With sea survival at a medium level (5 %), a total exploitation of over 50 % can be sustained even if smolt production is somewhat reduced (>75 %). At higher sea survival (>10 %), a total exploitation of up to 80-90 % can be sustained. The maximum sustainable exploitation rapidly declines with both low sea survival and low smolt production (a situation that equals poor target attainment).

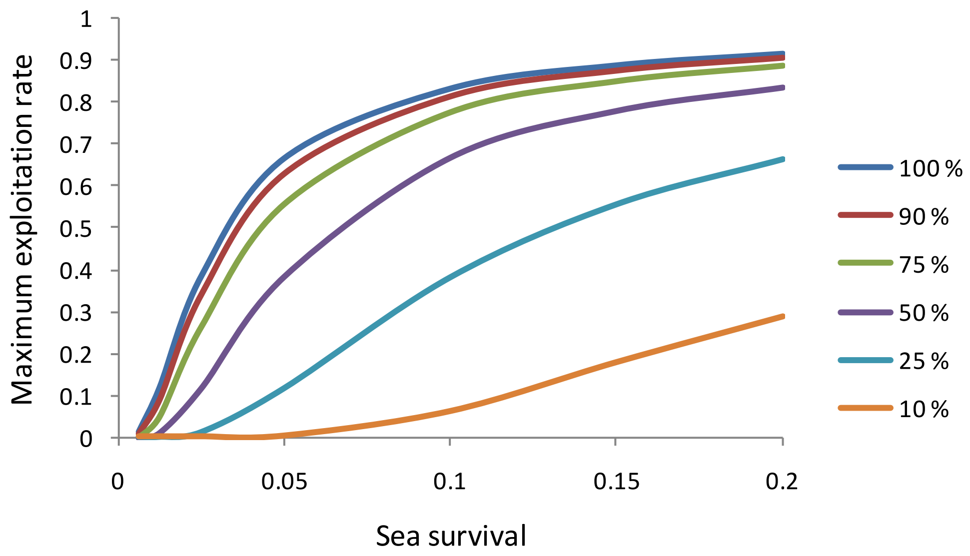


Figure 21. Maximum sustainable exploitation rate in a river under different levels of sea survival and six different smolt production scenarios (from 10 to 100 % of the river capacity). Maximum exploitation is the rate at which the resulting spawning stock falls below the spawning target. The different lines (10-100 % smolt production) corresponds to reduced smolt production that can be caused by earlier spawning below the spawning target and/or impact factors that reduce juvenile/smolt survival. The model is based on the relationship between smolt production and spawning stock from Hindar *et al.* (2007). Figure from Anon. (2010).

The estimated maximum exploitation in Figure 21 is based on the stock recruitment (hockey stick model) and smolt production from the spawning target models of Hindar *et al.* (2007). The reproductive rate of a stock is at its maximum when the spawning stock gets close to zero, and this maximum rate can be described by the slope of a stock recruitment curve close to the starting point of the curve. A review of different stock recruitment curves indicate that this slope is relatively consistent among different fish species, with a slope of 3-5 commonly observed for salmon (Myers *et al.* 1999). In the absence of other affecting factors, a maximum reproductive rate of 3-5 translates to a maximum sustainable exploitation rate of 65-80 %, slightly lower than the estimates from Figure 21.

The estimated maximum exploitation rates are total exploitation of female salmon, accumulated for both coastal and river fisheries. Within Norway, estimates of total exploitation vary substantially from region to region. In southern Norway, the estimated total exploitation is around 50 %, in middle Norway around 40 % and in northern Norway 70-80 %. The observed level of exploitation in northern Norway is very close to the modelled maximum in a situation with good sea survival and little to no reduction in smolt production (Figure 21). The current management regime therefore has very little buffer against changes in environmental conditions in northern areas (including Tana).

The model of maximum sustainable exploitation can be used to simulate the level of negative effects that exploitation can have on spawning target attainment (Figure 22). The maximum sustainable exploitation rate sinks rapidly both with low sea survival and reduced smolt production, illustrating the potential importance of other impact factors for fisheries interests. Noteworthy also in Figure 22 is that there is a very small difference between an exploitation rate that produces a large negative effect and exploitation with no effect, even in a situation with relatively high sea survival and good smolt production. This greatly underlines the importance of managing with a safety margin.

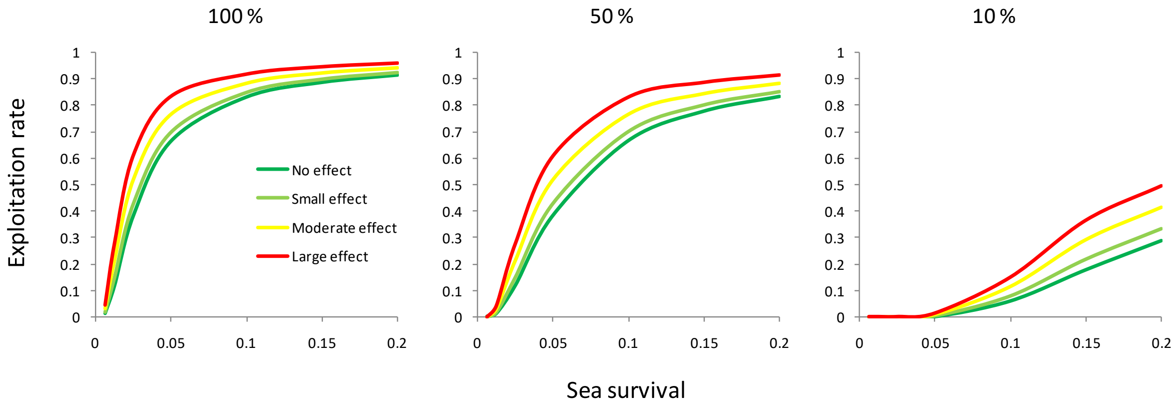


Figure 22. The exploitation rates that leads to no (spawning stock at or above spawning target), small (spawning stock >90 % of target), moderate (70-90 %) or large (<70 %) negative effects on spawning target attainment at different levels of sea survival and smolt production. Three different scenarios for smolt production: 100 % (left), 50 % (middle) and 10 % (right). Reduced smolt production can be caused by spawning stock below spawning target and/or impact factors that reduce juvenile/smolt survival. Figure from Anon. (2010).

Both Figure 21 and Figure 22 demonstrate how the maximum sustainable exploitation rate sinks rapidly with lowered sea survival. This is a vulnerable and difficult situation for the fisheries management, and points to the need for establishing accurate monitoring indicators that can provide early estimates of annual sea survival and can be used to trigger season-specific fisheries regulations in situations with a low pre-fishery abundance. Stocks inevitably become more vulnerable towards fisheries selection when impact factors create lowered survival (both in river and sea). The monitoring must, accordingly, be designed so that it intercepts important demographic factors and life history traits. Examples of important factors are fish size, migration timing, stock-specific exploitation rates, growth (size at age) and ability to reproduce (Kuparinen & Merilä 2007).

4.5 Development in stock size

The pre-fishery abundance (PFA) or run size of a stock is the parameter that tells us the total amount of salmon available for exploitation. The spawning target tells us how many salmon must survive, and the difference between the PFA and the spawning target tells us how many salmon actually can be exploited sustainably.

It is possible to estimate the size of the PFA, and these estimates can be used as an approximation of stock size development. The method of estimating PFA is largely similar to the "run reconstruction" method used to estimate the size of the North Atlantic salmon stock (Potter et al. 2004), with the exception that the current analysis is back-calculated based on river catches, while the "run reconstruction" method was based on total catches. A detailed description of the current PFA simulation method can be found in Anon. (2012b).

The PFA simulation start year was 1989, which is the year coastal drift-net fisheries were closed. The PFA simulations show that the run size of salmon to the Tana fjord has been reduced from over 190 000 salmon in the early 1990s down to approximately 49 000 in 2015. No similar decline has been seen for other North Norwegian stocks (Figure 23).

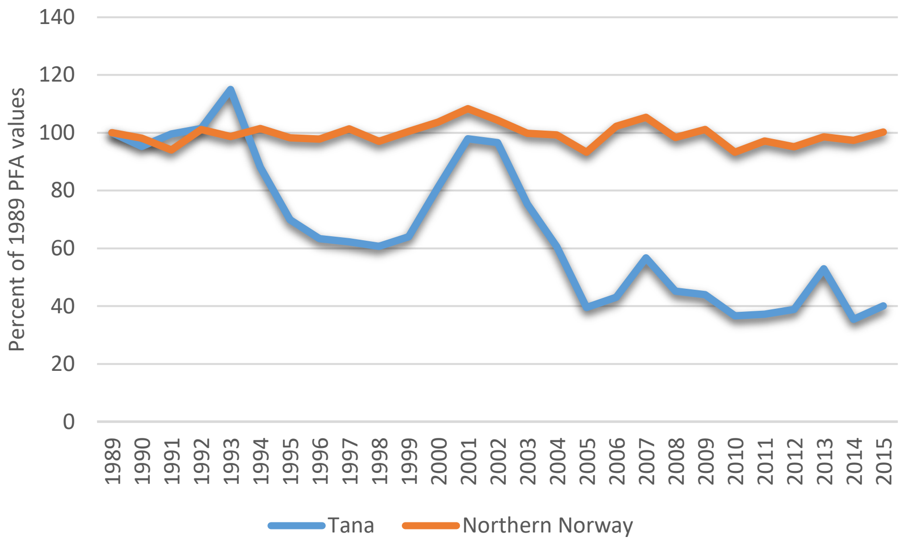


Figure 23. Development of the coastal pre-fishery abundance of northern Norway (orange line, all stocks except Tana) and development of the coastal pre-fishery abundance of Tana salmon (blue line) from 1989 to 2015, presented as percentages of the 1989-value. The data are based on an ARIMA (1, 0, 0) trend analysis. (Analysis from the Norwegian Scientific Advisory Committee for Atlantic Salmon Management.)

4.6 Stock-specific status evaluation

The first-generation targets in Tana were recently revised (Falkegård *et al*. 2014) to cover most salmon-producing areas of the Tana river system. However, as a consequence of knowledge-limitations, we are unable to provide a status evaluation of all parts of the Tana with the same resolution as the targets in Falkegård *et al*. (2014). The stock status in the present report is therefore evaluated for 12 areas:

- Tana main stem
- Máskejohka (in the lower part of the Tana main stem)
- Buolbmátjohka/Pulmankijoki (in the lower part of the Tana main stem)
- Lákšjohka (middle part)
- Veahčajohka/Vetsijoki (middle part)
- Ohcejohka/Utsjoki (middle part)
- Válljohka (upper part)
- Áhkojohka/Akujoki (upper part)
- Iešjohka (headwater)
- Kárášjohka (headwater)
- Anárjohka/Inarijoki (headwater)
- Tana total (an evaluation covering all Tana stocks)

All evaluations are based on the standardized probabilistic approach described in chapter 4.3. The main strength of this approach is that it provides us with a measure of how **likely** it is that spawning targets have been reached for the various areas.

Please observe that there are different exploitation estimates in the following text. The exploitation rate estimates used to simulate spawning target attainment are based on number of salmon in three different size groups (<3 kg, 3-7 kg and >7 kg), while the exploitation estimates used in the stock allocation of salmon from the coastal and Tana main stem mixed-stock fisheries are based on total weight. Exploitation estimates for Utsjoki are based on video counts of ascending adult salmon and the estimated catch. There is no fishing in Akujoki, and the spawning target attainment there is evaluated by direct spawner counts by snorkelling.

4.6.1 TANA/TENO (TOTAL)

4.6.1.1 STATUS ASSESSMENT

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

The total salmon catch in Tana varied from 63.5 tonnes (2009) to 248.5 tonnes (2001) within the period 1993-2015.

The following exploitation rate was used to estimate the total spawning stock size in Tana throughout the period 1993-2014: **60 % (50 %-75 %)**. This exploitation estimate is equivalent to the average total river exploitation rate estimated for the individually evaluated stocks in the period 2006-2015.

The revised Tana total spawning target is 104 487 286 eggs (77 005 421-155 648 837 eggs). The female biomass needed to obtain this egg deposition is 51 846 kg (38 277-77 371 kg) when using stock-specific fecundities.

Target attainment varied from 39 % in 2009 to 100 % in 1994 and 2000-2003. Overall attainment over the last four years was 59 %. The probability of reaching the spawning target varied between 0 % (1996-1997, 2004, 2005, 2009, 2011, 2013) to 95 % (2001) throughout the period 1993-2015. The management target was not reached, as the last 4 years' (2012-2015) average probability of reaching the spawning target was 1 %.

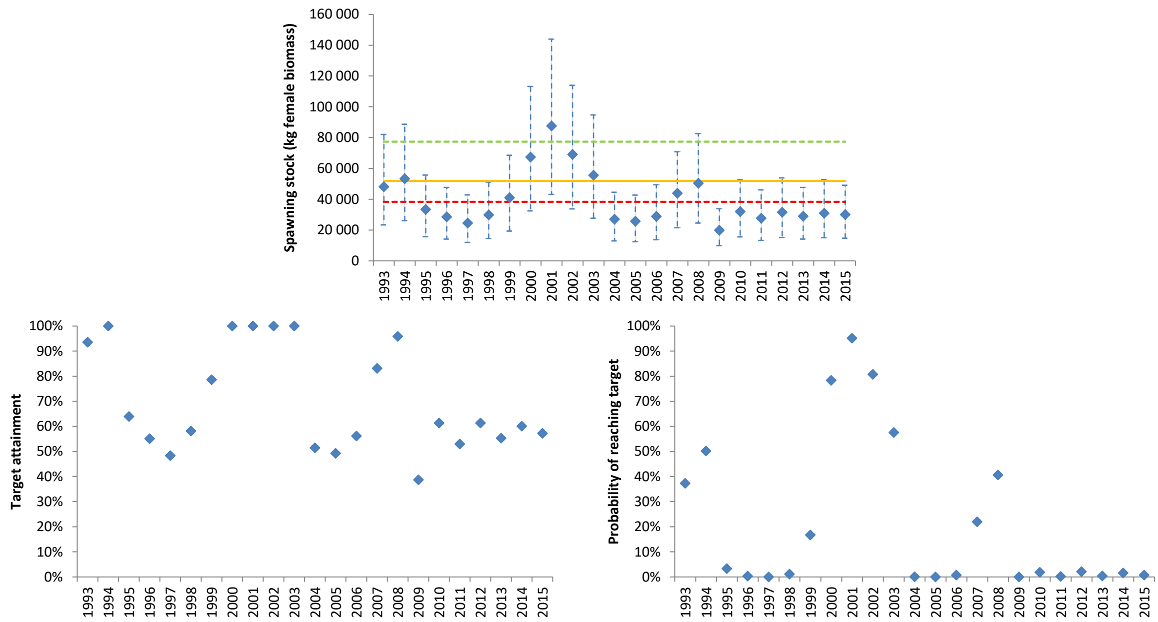


Figure 24. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 1993-2015 in total in Tana/Teno.

4.6.1.2 EXPLOITATION

The estimated total exploitation rate (based on weight) of Tana salmon was 67 % in the years 2006-2015 (Figure 25) with 15 % of the pre-fishery abundance caught in coastal fisheries and 52 % in river fisheries. The average estimated total pre-fishery abundance was 180 307 kg and the average total catch was 120 272 kg in the period 2006-2015.

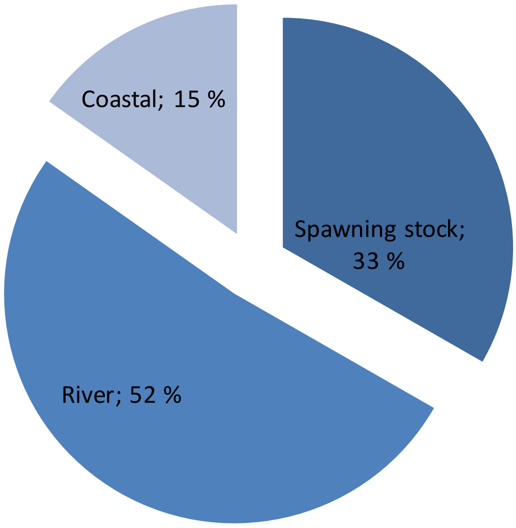


Figure 25. The total amount of salmon belonging to the Tana river system in 2006-2015, distributed into surviving spawning stock and salmon caught in fisheries in either coastal or river fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal or Tana river system fisheries.

Estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 15 %
- Tana river system: 61 %

The average overexploitation was estimated at 45 %, meaning that exploitation was responsible for reducing the total spawning stock size in Tana by an amount of 45 % below the total spawning target. The average maximum sustainable total exploitation rate for the whole Tana river system in the period 2006-2015 was 42 %.

The majority of the main stem catch of both female and male salmon from the whole Tana river system happens in the border area from Nuorgam to Levajok (48 % for females, 51 % for males, Figure 26), followed by the lower Norwegian main stem (34 % and 29 %) and the upper border area (18 % and 20 %). Temporally, over 80 % of the female salmon were caught in weeks 21-28 (May to mid-July), while 85 % of the males were caught in weeks 25-32 (late June to early August). 34 % of all females were caught by tourists, 22 % with weir, 17 % by local rod fishing, 16 % with driftnet and 11 % with gillnet. In comparison, 41 % of the males were caught by tourists, 24 % with weir, 20 % by local rod fishing, 11 % with gillnet and 4 % with driftnet.

It is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the main stem exploitation of female salmon from all stocks by 28 % and male salmon by 26 %. The estimated main stem catch distribution of female salmon from all stocks will change to 30 % caught by tourists, 26 % with weir, 23 % by local rod fishing, 12 % with driftnet and 9 % with gillnet. For male salmon, the estimates are 35 % caught by tourists, 27 % by local rod fishing, 27 % with weir, 8 % with gillnet and 3 % with driftnet.

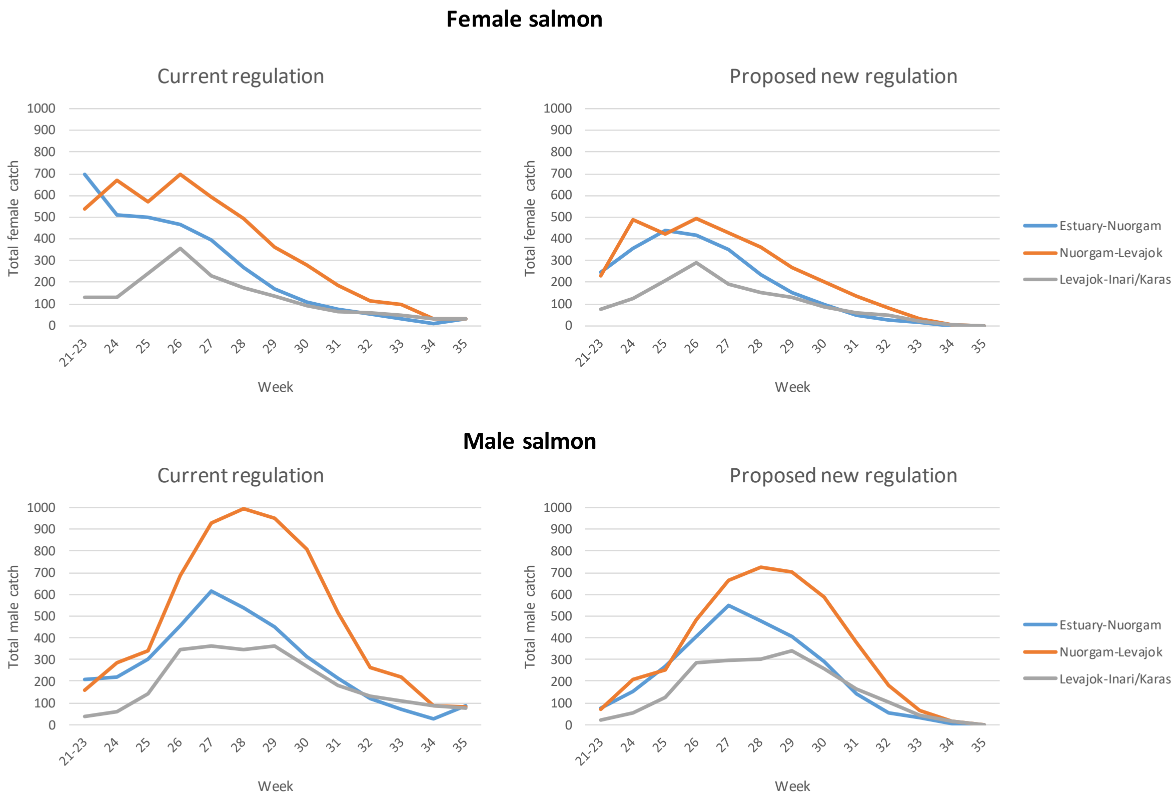


Figure 26. The total annual catch in number of female salmon (upper panel) and male salmon (lower panel) from the whole Tana river system caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.1.3 STOCK RECOVERY

In the years 2006-2015, the overall probability that the spawning target for the entire Tana/Teno river system was reached was 3 %. This means that the entire river system needs a significant reduction in exploitation to improve overall status.

The average spawning stock size in the period 2006-2015 was 31 820 kg (15 740-53 898 kg). With the current exploitation estimates, we would need a spawning stock of close to 66 000 kg in order to reach a 75 % probability of meeting the spawning target and over 108 000 kg to reach 100 % probability. In the years 2006-2015, we have, therefore, on average lacked a female biomass of over 34 000 kg in order to reach the 75 % probability level specified by the management target.

With a 20 % reduction in river exploitation, we would exceed a 75 % probability of reaching the spawning target after 3 generations (21 years, Figure 27). With a 30 % reduction, the stock recovery period would last 1 generation (7 years), and with a 50 % reduction, we would exceed a 75 % probability immediately.

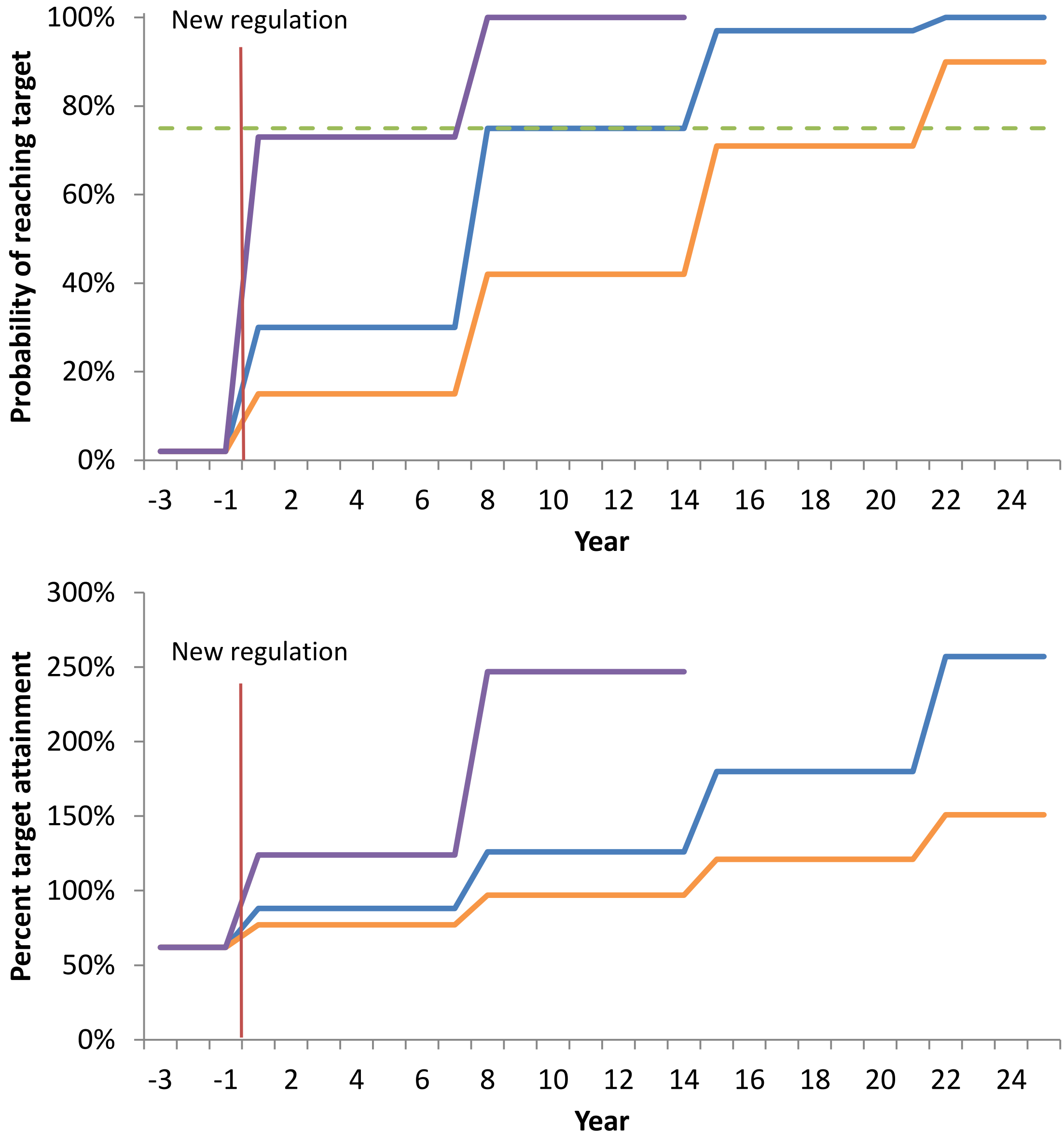


Figure 27. Stock recovery trajectories for Tana/Teno (total), corresponding to three scenarios of reduced river exploitation. (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.2 Tana/Teno main stem

The Tana/Teno main stem starts with the confluence of Kárášjohka and Anárjohka/Inarijoki, from which the main stem flows 211 km in a northern direction towards the Tana fjord.

4.6.2.1 Status assessment

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

There is no fish counting of salmon in the Tana main stem so we must base the target evaluation on a combination of an estimated exploitation rate and catch statistics (see chapter 4.3.1). The following exploitation estimate was used throughout the period 2006-2015: **55 % (45 %-75 %)**.

The estimated catch of Tana MS salmon within the main stem varied from 28 193 kg in 2009 to 55 203 kg in 2008. These estimates are based on a combination of main stem catch statistics and the proportion of Tana MS salmon in the main stem fisheries observed in the 2006-2008 and 2011-2012 Genmix material. The estimated proportion of Tana MS salmon in the main stem catch varied from 23 to 40 % in the Genmix study years, with an average proportion over the five study years of 30 %. The individually observed proportions were used in 2006-2008 and 2011-2012, while the average proportion was used in 2009 and 2013-onwards.

Target attainment reached 100 % in 2007 and 2008, followed by 79 % in 2010 and 2012. The lowest target attainment was 49 % in 2009. Overall attainment over the last four years was 72 %. The highest probability of reaching the spawning target was 75 % in 2008. The management target was not reached, as the last 4 years' (2012-2015) average probability of reaching the spawning target was 8 %.

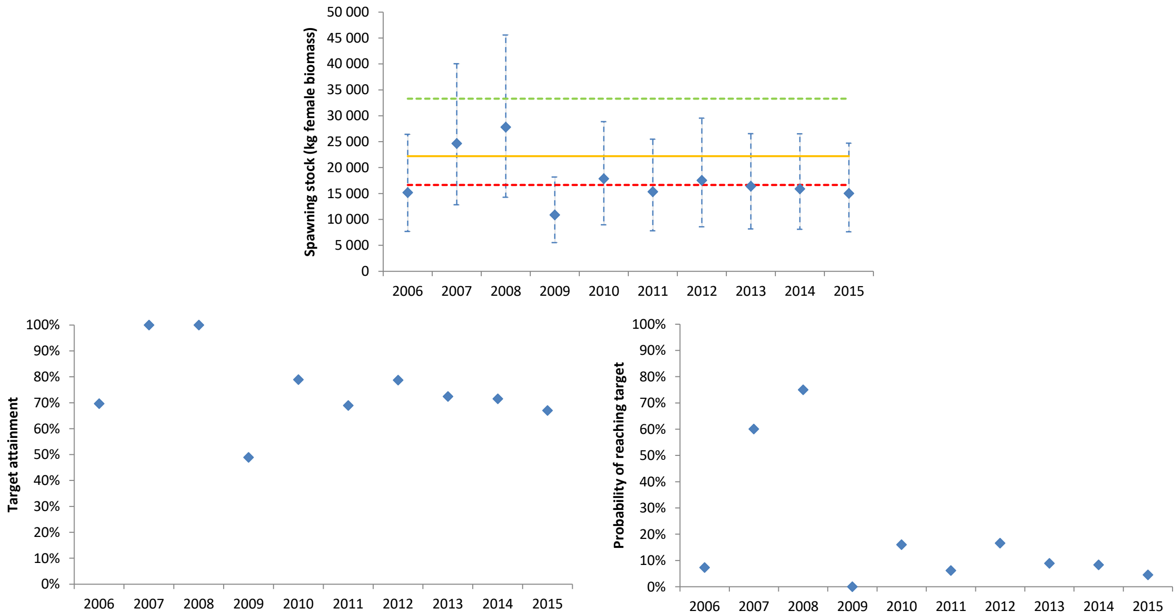


Figure 28. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 2006-2015 of the Tana main stem (MS) stock.

4.6.2.2 Exploitation

The estimated total exploitation rate (based on weight) of Tana MS salmon was 63 % in the years 2006-2015 (Figure 29), with 16 % of the pre-fishery abundance caught in coastal fisheries and 48 % in main stem fisheries. The average estimated total pre-fishery abundance was 87 456 kg and the average total catch was 55 229 kg in the period 2006-2015.

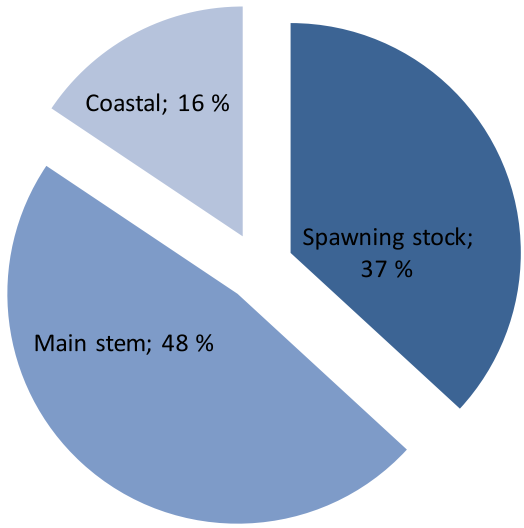


Figure 29. The total amount of salmon belonging to the Tana main stem (MS) stock in the years 2006-2015, distributed into surviving spawning stock and salmon caught in fisheries in either coastal or main stem fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal or main stem fisheries.

The estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 16 %
- Tana main stem: 56 %

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

The average overexploitation was estimated at 24 %. This means that exploitation was responsible for reducing the spawning stock size by an amount of 24 % below the spawning target. The average maximum sustainable total exploitation rate in the period was 50 %, markedly lower than the estimated total exploitation rate of 63 %.

The majority of the main stem catch of both female and male salmon belonging to the Tana MS stock happens in the border area between Nuorgam and Levajok (56 % and 58 % of the total catch of females and males, respectively), followed by the lower Norwegian main stem (36 and 32 %) and the upper border area (9 and 10 %, Figure 30). Temporally, 80 % of the female Tana MS salmon were caught in weeks 25-31 (last half of June and July), while 84 % of the males were caught in weeks 27-33 (July to mid-August). 37 % of the Tana MS females were caught by tourists, 25 % with weir, 21 % by local rod fishing, 10 % with gillnet and 7 % with driftnet. In comparison, 40 % of the males were caught by tourists, 25 % with weir, 24 % by local rod fishing, 10 % with gillnet and 2 % with driftnet.

For stock recovery purposes, it is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the main stem exploitation of Tana MS female salmon by 27 % and male salmon by 29 %. The estimated main stem catch distribution of Tana MS female salmon will change to 31 % caught by tourists, 28 % by local rod fishing, 28 % with weir, 7 % with gillnet and 6 % with driftnet. For male salmon, the estimates are 34 % caught by tourists, 32 % by local rod fishing, 26 % with weir, 6 % with gillnet and 2 % with driftnet.

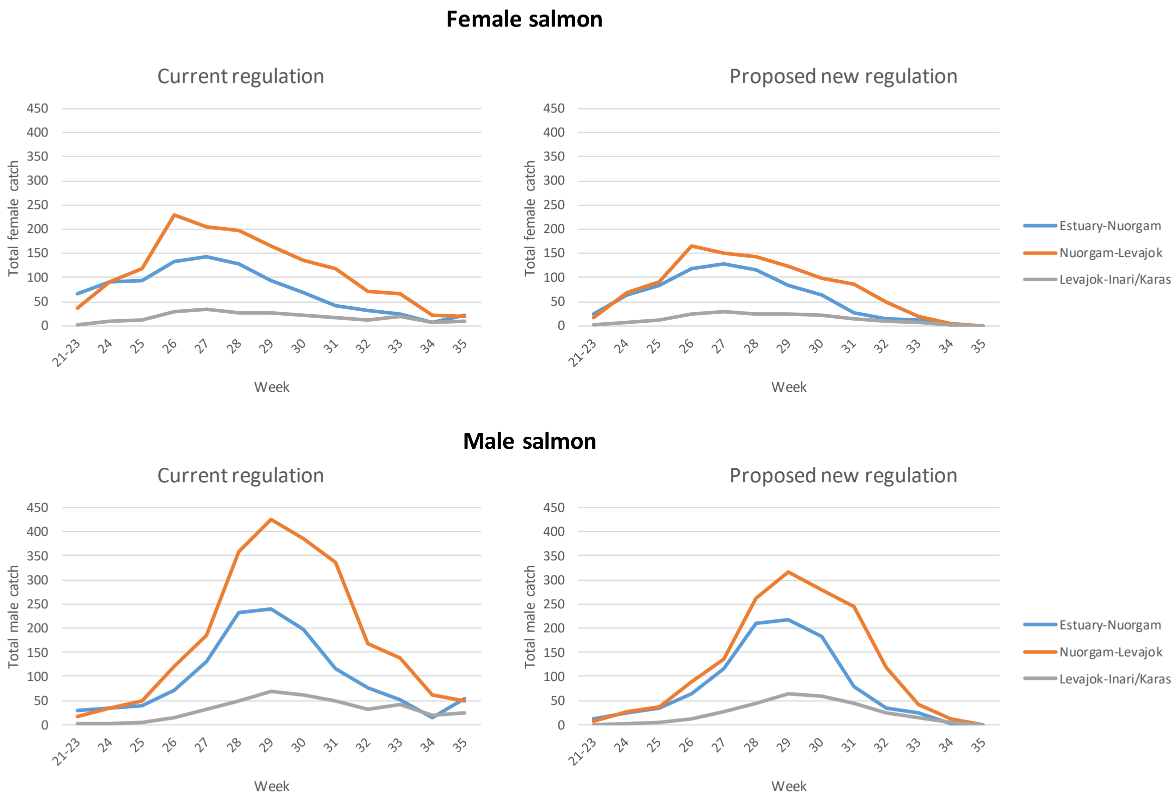


Figure 30. The total annual catch in number of Tana MS female salmon (upper panel) and male salmon (lower panel) caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.2.3 Stock recovery

Over the years 2006-2015, the overall probability that the spawning target was reached in the Tana main stem was 16 %. A significant reduction in the total exploitation rate is therefore needed to improve status and rebuild the stock.

The average spawning stock size in the period 2006-2015 was 17 378 kg (8 958-29 265 kg). A spawning stock of approximately 26 500 kg is needed to reach a 75 % probability of meeting the spawning target and over 45 000 kg to reach 100 % probability. In the years 2006-2015, we have on average lacked a female biomass of approximately 9 000 kg in order to reach the 75 % probability level specified by the management target.

With a 20 % or a 30 % reduction in river exploitation, we would achieve 75 % probability of reaching the spawning target after 1 generation (7 years, Figure 31). With a 50 % reduction, we would achieve 75 % probability immediately.

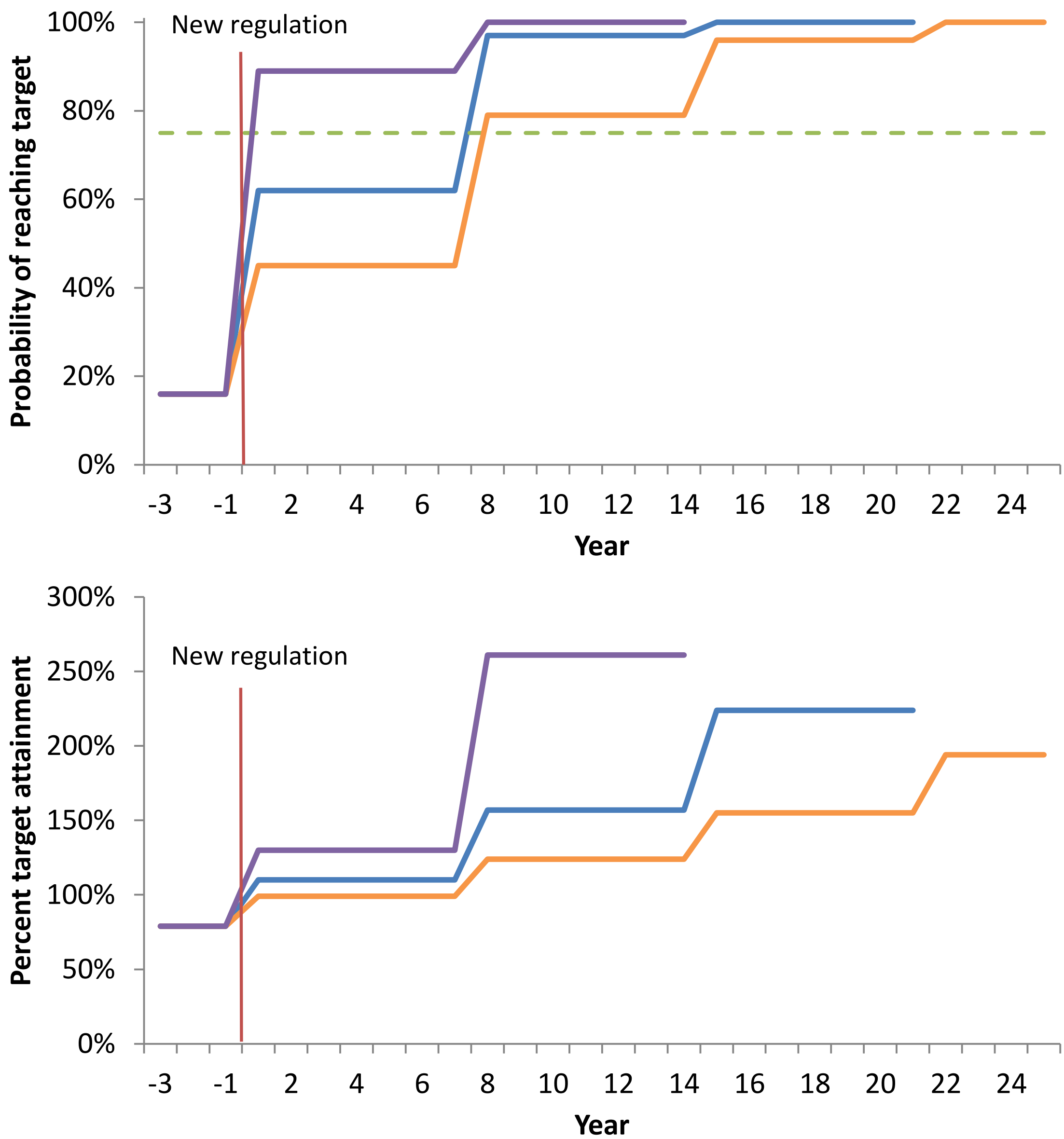


Figure 31. Stock recovery trajectories for Tana MS salmon, corresponding to three scenarios of reduced exploitation in the Tana main stem. (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.3 Máskejohka

Máskejohka is the lowermost major tributary in the Tana River system, entering the Tana approximately 28 km upstream from the Tana estuary. It is a middle-sized river with a total of 55 km available for salmon of which 30 km constitutes the main Máskejohka. The lowermost 10 km of the main river is slow-flowing and meandering with very little production area available for salmon, but there are extensive areas available both for spawning and juvenile production further upstream. The rest of the Máskejohka-system consists of the tributaries Geasis (7 km), Uvjalátnjá (7 km) and Ciikojohka (11 km). In all of these smaller tributaries, salmon distribution is upwards limited by waterfalls. The Máskejohka salmon stock has a good mixture of sea-age groups, mostly 1-3SW and a few 4SW.

4.6.3.1 Status assessment

The revised spawning target for Máskejohka is 3 155 148 eggs (2 281 583-4 149 588 eggs). The female biomass needed to obtain this egg deposition is 1 521 kg (1 100-2 000 kg) when using a stock-specific fecundity of 2 075 eggs kg^{-1}.

There is no fish counting in Máskejohka so target evaluation must be based on a combination of an estimated exploitation rate and catch statistics (see chapter 4.3.1). The following exploitation estimates were used throughout the period 2006-2015:

- Salmon <3 kg: 50 % (40-60 %)
- Salmon 3-7 kg: 40 % (30-60 %)
- Salmon >7 kg: 30 % (20-50 %)

These are fairly high exploitation estimates, reflecting a relatively high number of visiting fishermen during the fishing season.

The catch in Máskejohka varied between 979 kg (2013) and 2 320 kg (2008) in the period 2006-2015.

Target attainment reached 100 % in 2008 and 2010. Lowest attainment was 48 % in 2013. Overall attainment over the last four years was 67 %. The highest probability of reaching the spawning target was 83 % in 2008. The management target was not reached, as the last 4 years' (2012-2015) average probability of reaching the spawning target was 4 %.

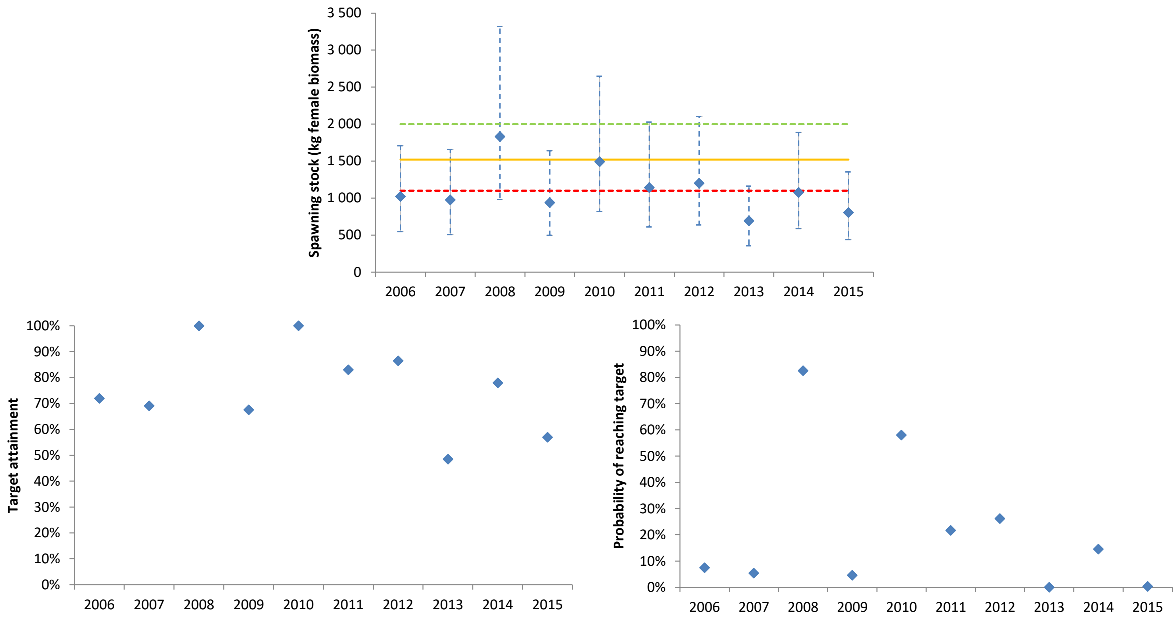


Figure 32. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 2006-2015 in the Norwegian tributary Máskejohka.

4.6.3.2 Exploitation

The estimated total exploitation rate (based on weight) of Máskejohka salmon was 63 % in the years 2006-2015 (Figure 33), with 15 % of the pre-fishery abundance caught in coastal fisheries, 23 % in main stem fisheries and 24 % in Máskejohka itself . The average estimated total pre-fishery abundance was 6 649 kg and the average total catch was 4 166 kg in the period 2006-2015.

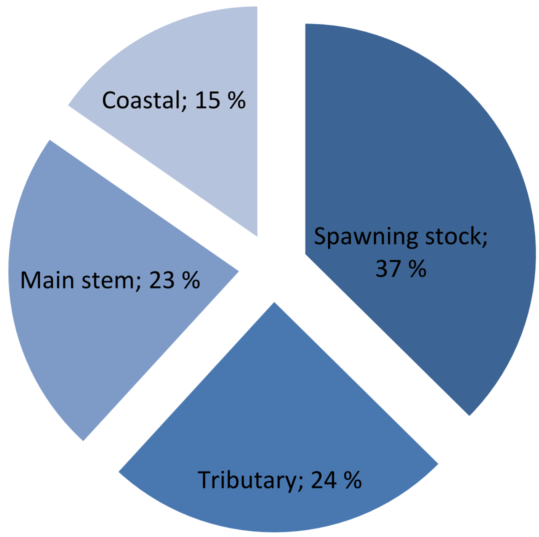


Figure 33. The total amount of salmon belonging to Máskejohka in 2006-2015, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or within-tributary fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.

Estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 15 %
- Tana main stem: 27 %
- Within Máskejohka: 39 %

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

The average overexploitation was estimated at 24 %. This means that exploitation was responsible for reducing the spawning stock size by an amount of 24 % below the spawning target. The average maximum sustainable total exploitation rate in the period was 50 %, markedly lower than the estimated total exploitation of 63 %.

The majority of the main stem catch of both female and male salmon belonging to the Máskejohka stock happens in the lower Norwegian part (90 % and 86 % of the total catch of females and males, respectively; Figure 34). Temporally, approximately two-thirds (68 %) of the Máskejohka female salmon were caught in weeks 25-28 (late June to mid-July), while 84 % of the males were caught in weeks 26-32 (end of June to early August). 52 % of the Máskejohka females were caught with weir, 17 % with gillnet, 12 % by local rod fishing, 11 % with driftnet and 8 % by tourists. In comparison, 54 % of the Máskejohka males were caught with weir, 16 % with gillnet, 15 % by local rod fishing, 13 % by tourists and 2 % with driftnet.

For stock recovery purposes, it is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the main stem exploitation of Máskejohka female salmon by 25 % and male salmon by 25 %. As a consequence, if a stock recovery plan requiring 30 % reduction in fishing pressure were to be implemented for Máskejohka, fishing within Máskejohka would have to be reduced by approximately 40 % in order to achieve a total exploitation reduction of 30 % for Máskejohka female salmon. Stock recovery advice for Máskejohka is found below.

With the suggested new regulation, the estimated main stem catch distribution of Máskejohka female salmon will change to 57 % caught with weir, 15 % by local rod fishing, 13 % with gillnet, 8 % by tourists and 7 % with driftnet. For male salmon, the corresponding estimates are 56 % with weir, 18 % by local rod fishing, 13 % by tourists, 12 % with gillnet and 1 % with driftnet.

Figure 34. The total annual catch in number of Máskejohka female salmon (upper panel) and male salmon (lower panel) caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.3.3 Stock recovery

In the years 2006-2015, the overall probability that the spawning target was reached in Máskejohka was 18 %. A significant reduction in the total exploitation rate is therefore needed to improve status in Máskejohka.

The average spawning stock size in the period 2006-2015 was 1 129 kg (593-1 945 kg). With the current exploitation estimates, we would need a spawning stock of approximately 1 800 kg to reach a 75 % probability of meeting the spawning target and approximately 2 400 kg to reach 100 % probability. In the years 2006-2015, we have, therefore, on average lacked a female biomass of approximately 700 kg in order to reach the 75 % probability level specified by the management target.

With a 20 or 30 % reduction in river exploitation, we would achieve 75 % probability of reaching the spawning target after 1 generation (7 years, Figure 35). With a 50 % reduction, we would achieve 75 % probability immediately.

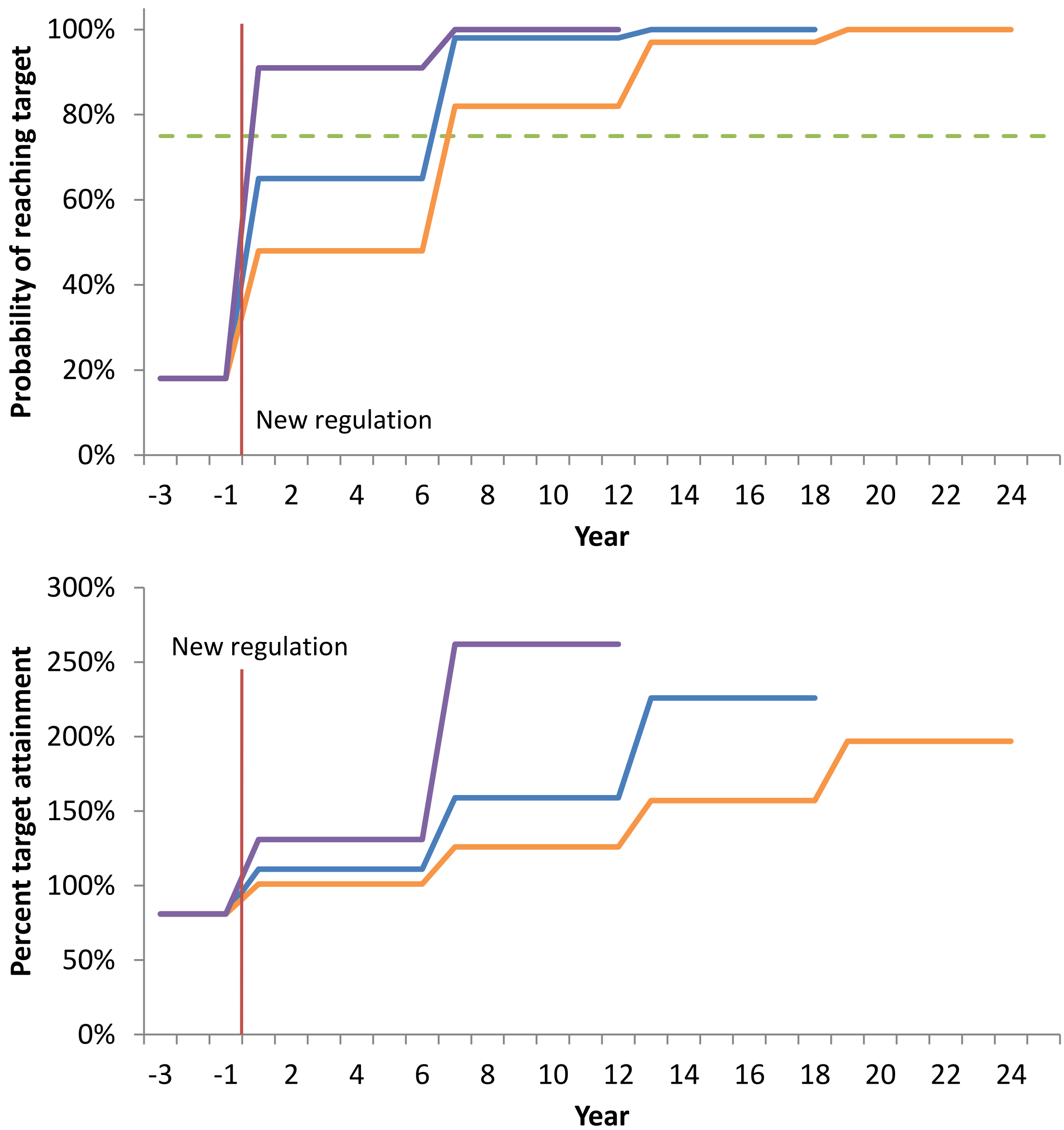


Figure 35. Stock recovery trajectories for Máskejohka, corresponding to three scenarios of reduced river exploitation (Tana main stem + Máskejohka). (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.4 Buolbmátjohka/Pulmankijoki

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

The lowermost 10 km (below the lake) are still-flowing and meandering with substratum consisting mainly of clay and silt. No spawning areas are present in this part. The main spawning areas are found in Kalddasjoki and the upper Pulmankijoki.

The salmon stock is dominated by 1SW males and 2SW females.

4.6.4.1 STATUS ASSESSMENT

Very little fishing occurs in the outlet river of Pulmankijärvi. There is a gillnet salmon fishery operating in the lake, while fishing is prohibited in the upper Pulmankijoki and partly in Kalddasjoki. The reported catch in Buolbmátjohka/Pulmankijoki in the years 2000-2015 vary from 300 kg in 2004 to 1090 kg in 2014.

The spawning stock of a 4 km stretch of upper Pulmankijoki has been monitored with snorkelling in the years 2003-2015. The monitored area covers approximately 15-20 % of the salmon producing area of Pulmankijoki. Based on the snorkelling counts, the exploitation rate of the lake fishery in the years 2003-2015 becomes 42 % (32-50 %).

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

The percentage target attainment varied from 28 % in 2004 to 100 % in 2006 and 2012-2015. The overall attainment over the last four years was 152 %. The probability of reaching the spawning target varied from 0 % in 2004 to 100 % in 2012 and 2014. The management target was reached, as the last 4 years' (2012-2015) probability of reaching the spawning target was 97 %.

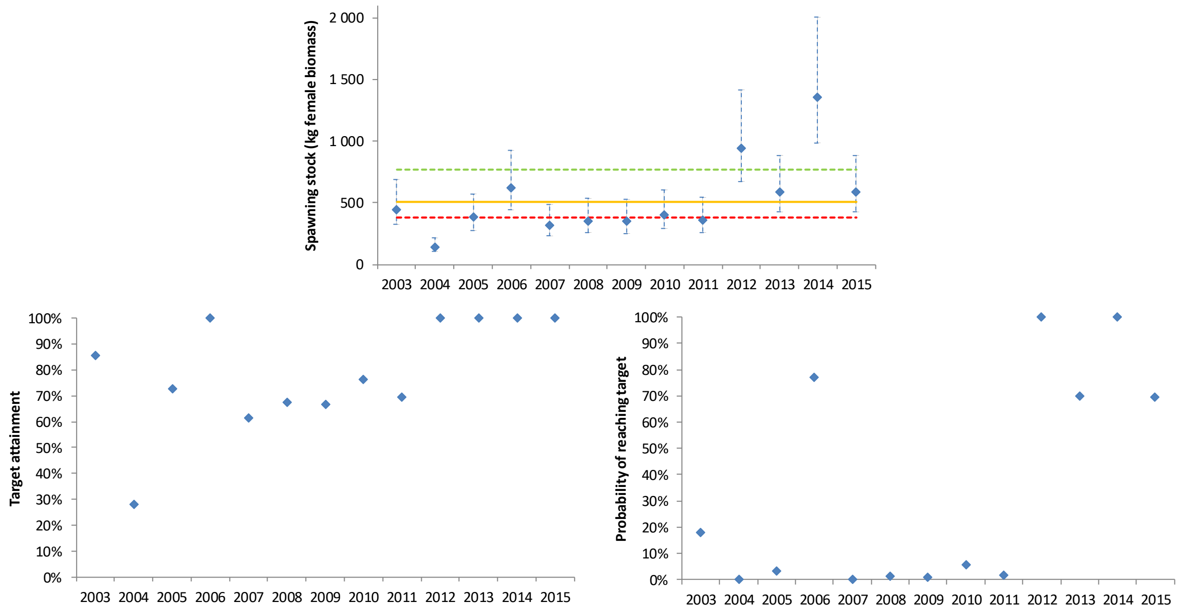


Figure 36. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 2003-2015 in the tributary Buolbmátjohka/Pulmankijoki.

4.6.4.2 EXPLOITATION

The estimated total exploitation rate (based on weight) of Buolbmátjohka/Pulmankijoki salmon was 57 % in the years 2006-2015 (Figure 37), with 11 % of the pre-fishery abundance caught in coastal fisheries, 17 % in main stem fisheries and 29 % in Buolbmátjohka/Pulmankijoki itself. The average estimated total pre-fishery abundance was 2 728 kg and the average total catch was 1 544 kg in the period 2006-2015.

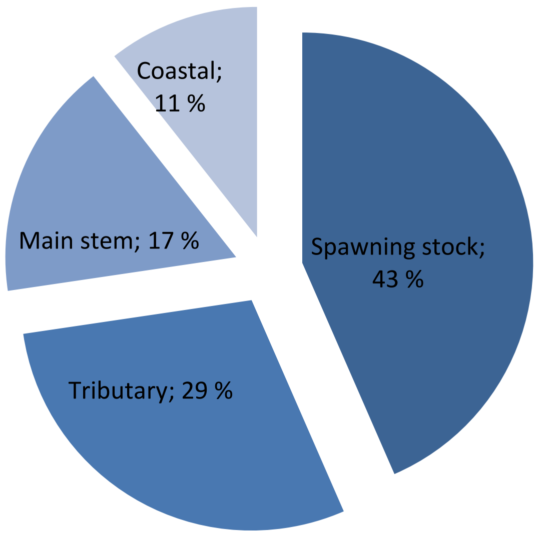


Figure 37. The total amount of salmon belonging to Buolbmátjohka/Pulmankijoki in 2006-2015, distributed into surviving spawning stock and salmon caught in either coastal, main stem or within-tributary fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.

The estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 11 %
- Tana main stem: 19 %
- Within Buolbmátjohka/Pulmankijoki: 40 %

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

The average overexploitation was estimated at 13 %. This means that exploitation was responsible for reducing the spawning stock size by an amount of 13 % below the spawning target. The average maximum sustainable total exploitation rate in the period was 61 %.

The majority of the main stem catch of both female and male salmon belonging to the Buolbmátjohka/Pulmankijoki stock happens in the lower Norwegian part (95 % and 94 % of the total catch of females and males, respectively; Figure 38). Temporally, almost 80 % of the Buolbmátjohka/Pulmankijoki females were caught in weeks 21-25 (May to late June), while 82 % of the males were caught in weeks 21-26 (May to early July). 38 % of the Buolbmátjohka/Pulmankijoki females were caught with weir, 37 % with driftnet, 10 % by local rod fishing, 8 % by tourists and 7 % with gillnet. In comparison, 50 % of the Buolbmátjohka/Pulmankijoki males were caught with weir, 25 % with driftnet, 10 % by local rod fishing, 8 % with gillnet and 7 % by tourists.

For stock recovery purposes, it is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the main stem exploitation of Buolbmátjohka/Pulmankijoki female salmon by 36 % and male salmon by 30 %.

With the suggested new regulation, the estimated main stem catch distribution of Buolbmátjohka/Pulmankijoki female salmon will change to 48 % caught with weir, 27 % with driftnet, 12 % by local rod fishing, 7 % by tourists and 6 % with gillnet. For male salmon, the corresponding estimates are 58 % with weir, 18 % with driftnet, 11 % by local rod fishing, 8 % by tourists and 7 % with gillnet.

Figure 38. The total annual catch in number of Buolbmátjohka/Pulmankijoki female salmon (upper panel) and male salmon (lower panel) caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.4.3 Stock recovery

In the years 2006-2015, the overall probability that the spawning target was reached in Buolbmátjohka/Pulmankijoki was 84 %.

The average spawning stock size in the period 2006-2015 was 651 kg (425-1 057 kg). With the current exploitation estimates, we would need a spawning stock of approximately 600 kg to reach a 75 % probability of meeting the spawning target and approximately 850 kg to reach 100 % probability. The total spawning stock in the Pulmanki river system has therefore been approximately 50 kg above the level needed to meet the management target.

As the management target is already met, a recovery plan is not needed for the Pulmanki river system (Figure 39).

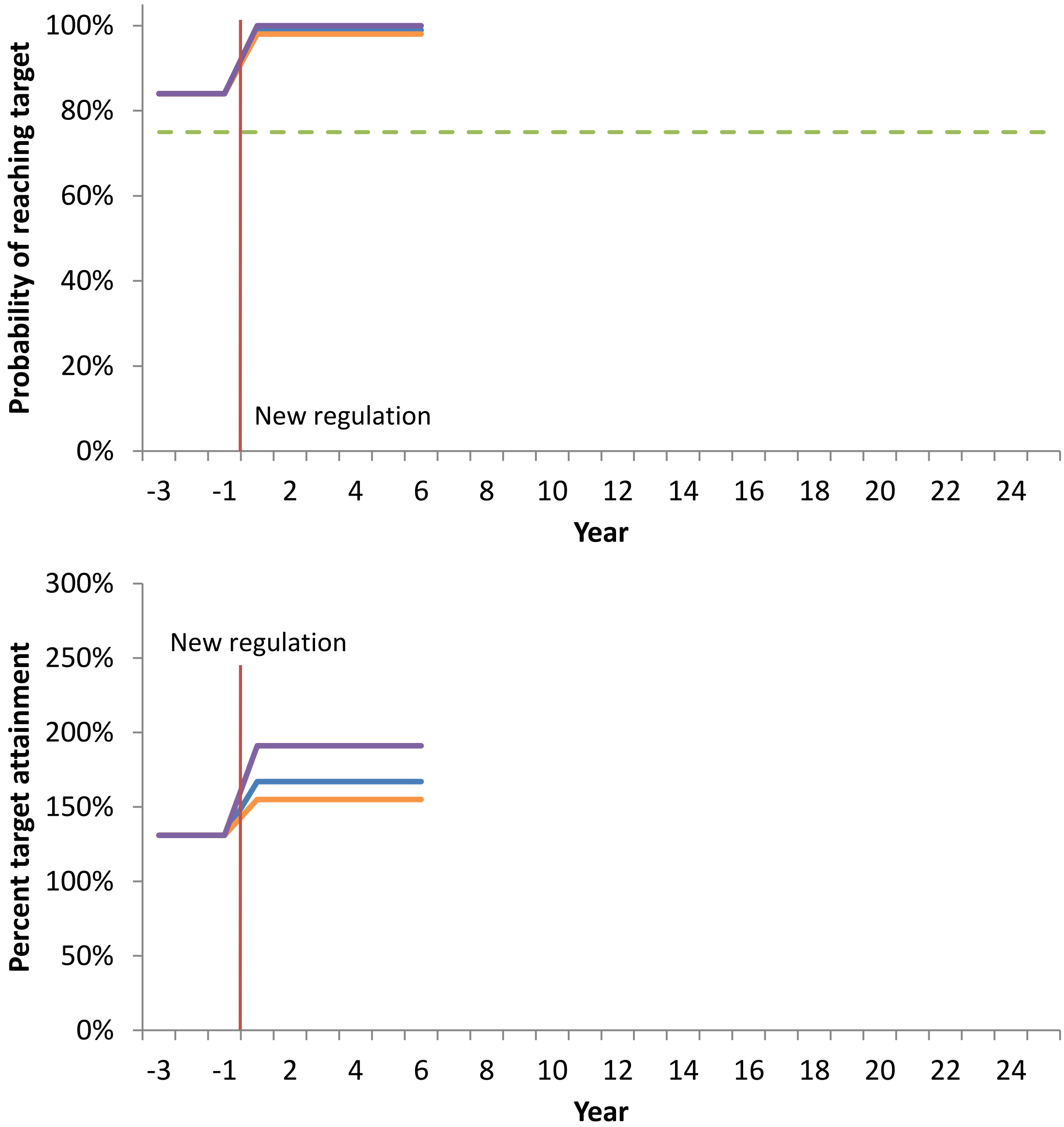


Figure 39. Stock recovery trajectories for Buolbmátjohka/Pulmankijoki, corresponding to three scenarios of reduced river exploitation (Tana main stem + Pulmanki). (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.5 LÁKŠJOHKA

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

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

The salmon in Lákšjohka are relatively small-sized, with 1SW fish weighing around 1 kg and 2SW fish 2-3 kg. Fish larger than 7 kg are rarely caught.

4.6.5.1 Status assessment

The catch in Lákšjohka varied from 247 kg (2014) to 700 kg (2006) in the period 2006-2015. A significant proportion of the total catch has been released in 2014 and 2015. In 2014, a total catch of 247 kg was reported, of which 148 kg was released and 99 kg kept. In 2015, a total of 275 kg was reported, of which 141 kg was released and 133 kg kept.

A video camera setup has counted ascending salmon in Lákšjohka since 2009. These counts have provided good estimates of the annual exploitation rate in the river. The exploitation rate was around 30 % in 2009-2011 and around 20 % in 2012-2013. We used a total exploitation of around 30 % also for the years preceding 2009. The high proportions of released salmon in 2014 and 2015 translate to exploitation rates of 6 % and 13 %, respectively. The exploitation reductions observed in the years 2012-2015 in Lákšjohka are a result of two factors, firstly, that the number of visiting fishermen has decreased substantially, and secondly, that the proportions of released salmon have increased, especially in 2014 and 2015.

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

The percentage target attainment varied from 26 % in 2011 to 89 % in 2006 and 84 % in 2014. Overall attainment over the last four years was 46 %. The probability of reaching the spawning target was 0 % for most years of the period 2006-2015. The exceptions were 2006 (29 %) and 2014 (15 %). The management target was not reached, as the last 4 years' (2012-2015) average probability of reaching the spawning target was 0 %.

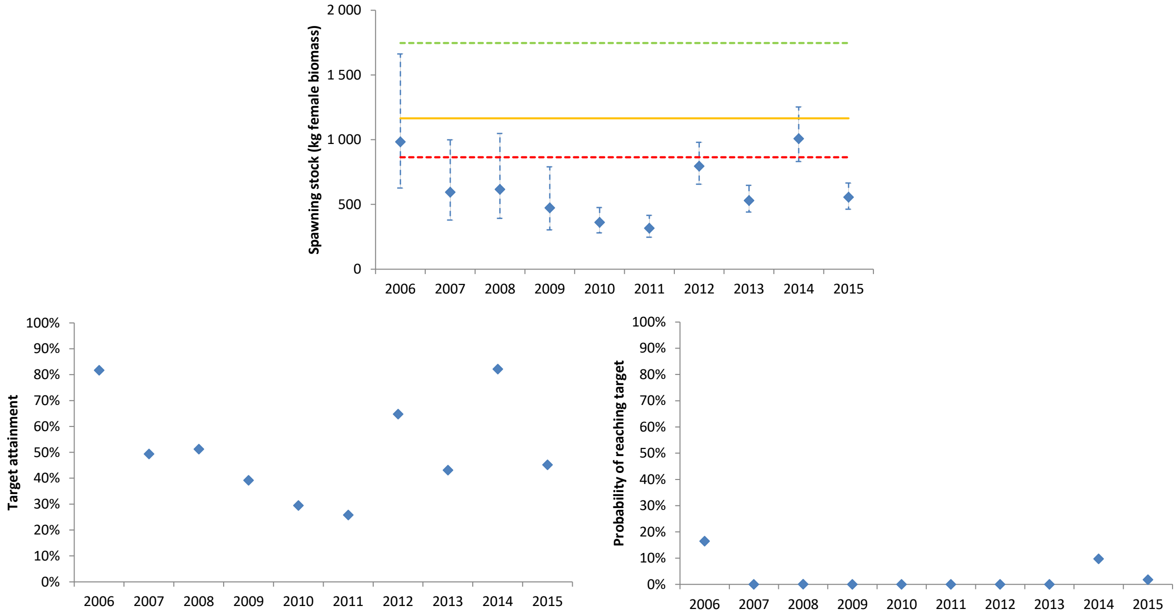


Figure 40. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 2006-2015 in the Norwegian tributary Lákšjohka.

4.6.5.2 Exploitation

The estimated total exploitation rate (based on weight) of Lákšjohka salmon was 60 % in the years 2006-2015 (Figure 41), with 11 % of the pre-fishery abundance caught in coastal fisheries, 36 % in main stem fisheries and 13 % in Lákšjohka itself. The average estimated total pre-fishery abundance was 2 459 kg and the average total catch was 1 469 kg in the period 2006-2015.

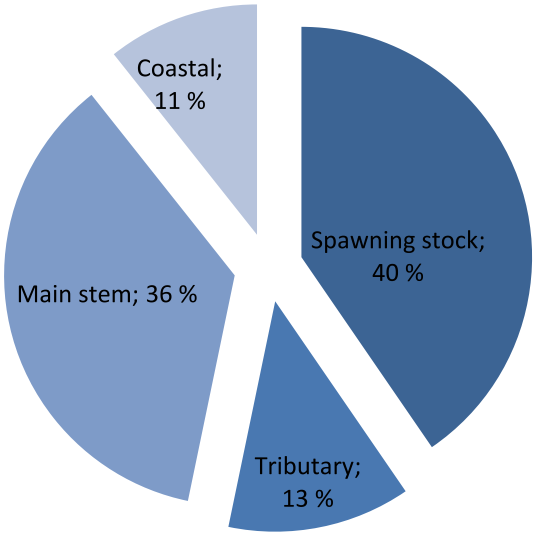


Figure 41. The total amount of salmon belonging to Lákšjohka in 2006-2015, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or within-tributary fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.

The estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 11 %
- Tana main stem: 40 %
- Within Lákšjohka: 24 %

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

The average overexploitation was estimated at 47 %. This means that exploitation was responsible for reducing the spawning stock size by an amount of 47 % below the spawning target. The average maximum sustainable total exploitation rate in the period was 17 %.

The majority of the main stem catch of both female and male salmon belonging to the Lákšjohka stock happens in the lower Norwegian part (74 % and 70 % of the total catch of females and males, respectively), followed by the lower border area from Nuorgam to Levajok (24 % and 27 %, respectively; Figure 42). Temporally, 77 % of the Lákšjohka females were caught in weeks 21-25 (May to late June), while 80 % of the males were caught in weeks 21-26 (May to early July). 36 % of the Lákšjohka females were caught with driftnet, 25 % with weir, 17 % by tourists, 12 % by local rod fishing and 10 % with gillnet. In comparison, 31 % of the Lákšjohka males were caught with driftnet, 27 % with weir, 20 % by tourists, 12 % by local rod fishing and 10 % with gillnet.

For stock recovery purposes, it is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the main stem exploitation of Lákšjohka female salmon by 36 % and male salmon by 34 %. As a consequence, if a stock recovery plan requiring 30 % reduction in fishing pressure were to be implemented for Lákšjohka, fishing within Lákšjohka would have to be reduced by approximately 25 % in order to achieve a total exploitation reduction of 30 % for Lákšjohka female salmon. Stock recovery advice for Lákšjohka is found below.

With the suggested new regulation, the estimated main stem catch distribution of Lákšjohka female salmon will change to 32 % caught with weir, 26 % with driftnet, 18 % by tourists, 17 % by local rod fishing and 8 % with gillnet. For male salmon, the corresponding estimates are 33 % caught with weir, 23 % with driftnet, 20 % by tourists, 17 % by local rod fishing and 8 % with gillnet.

Figure 42. The total annual catch in number of Lákšjohka female salmon (upper panel) and male salmon (lower panel) caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.5.3 Stock recovery

In the years 2006-2015, the overall probability that the spawning target was reached in Lákšjohka was 3 %. A significant reduction in the total exploitation rate is therefore needed to improve status in Lákšjohka.

The average spawning stock size in the period 2006-2015 was 623 kg (463-894 kg). With the current exploitation estimates, we would need a spawning stock of approximately 1 350 kg to reach a 75 % probability of meeting the spawning target and approximately 1 750 kg to reach 100 % probability. In the years 2006-2015, we have, therefore, on average lacked a female biomass of approximately 700 kg in order to reach the 75 % probability level specified by the management target.

With a 50 % reduction in river exploitation, we would achieve 75 % probability of reaching the spawning target after 1 generation (6 years, Figure 43). With a 30 % reduction, we would achieve 75 % probability after 2 generations (12 years). With a 20 % reduction, we would meet the management target by the end of the third generation (18 years).

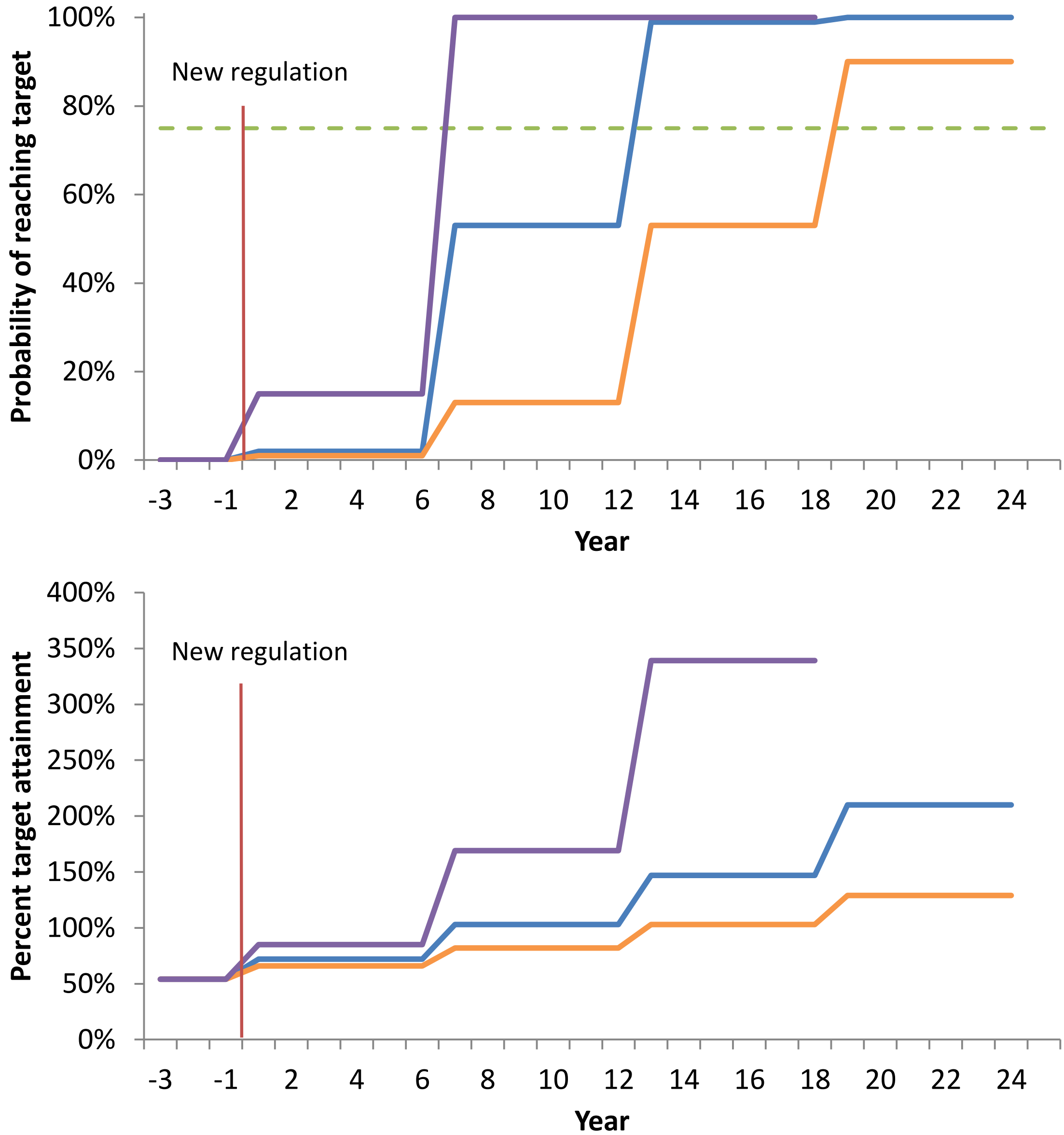


Figure 43. Stock recovery trajectories for Lákšjohka, corresponding to three scenarios of reduced river exploitation (Tana main stem + Lákšjohka). (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.6 Veahčajohka/Vetsijoki

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

4.6.6.1 Status assessment

The catch in Vetsijoki varied from 200 kg (2004) to 1 885 kg (2001) in the period 1998-2015.

There has been no fish monitoring in Vetsijoki in the years 1998-2015, so the target evaluation must be based on an estimated exploitation rate in combination with catch statistics. The following exploitation estimate (based on number of fish) was used for the period 1998-2015: **30 % (20-50 %)**. Monitoring data will be available for the season 2016 and this will provide a much improved exploitation estimate for the assessment in Vetsijoki.

This exploitation estimate corresponds to a level defined as low exploitation for small Norwegian rivers (Anon. 2011b). This exploitation estimate also corresponds to the exploitation rate most commonly observed in the neighbouring Utsjoki river.

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

Target attainment varied from 21 % in 2004 to 100 % in 1999-2002 and 2014. Overall attainment over the last four years was 86 %. The highest probability of reaching the spawning target was 96 % in 2001, while in the last four years the probability varied from 0 to 55 %. The management target was not reached, as the last 4 years' (2012-2015) average probability of reaching the spawning target was 28 %.

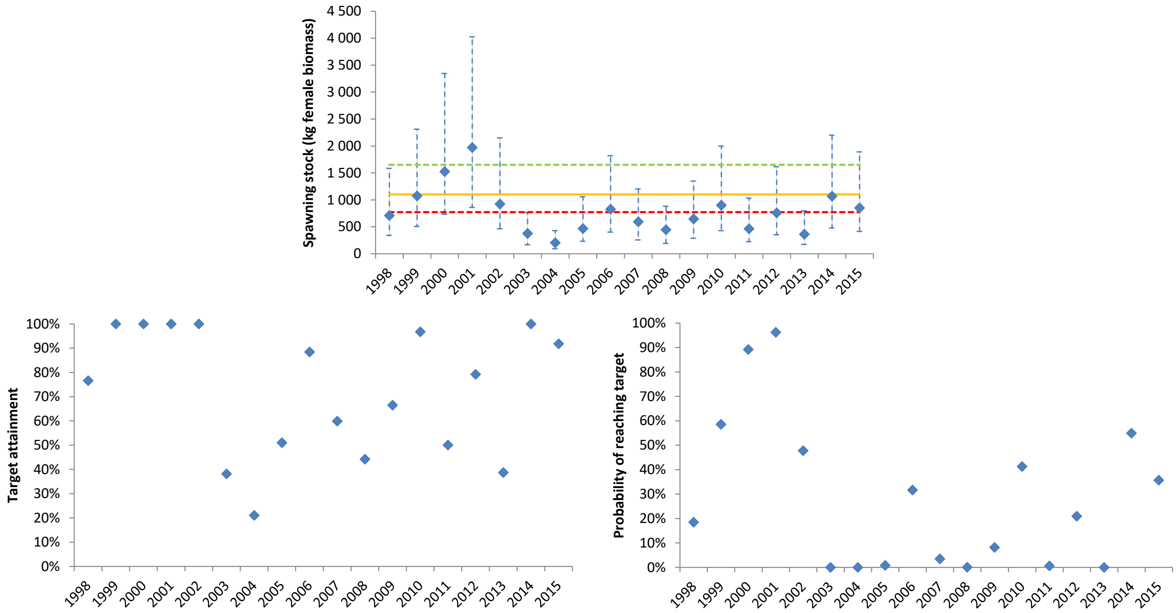


Figure 44. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 1998-2015 in the Finnish tributary Veahčajohka/Vetsijoki.

4.6.6.2 Exploitation

The estimated total exploitation rate (based on weight) of Vetsijoki salmon was 73 % in the years 2006-2015 (Figure 45), with 15 % of the pre-fishery abundance caught in coastal fisheries, 45 % in main stem fisheries and 13 % in Vetsijoki itself. The average estimated total pre-fishery abundance was 5 209 kg and the average total catch was 3 794 kg in the period 2006-2015.

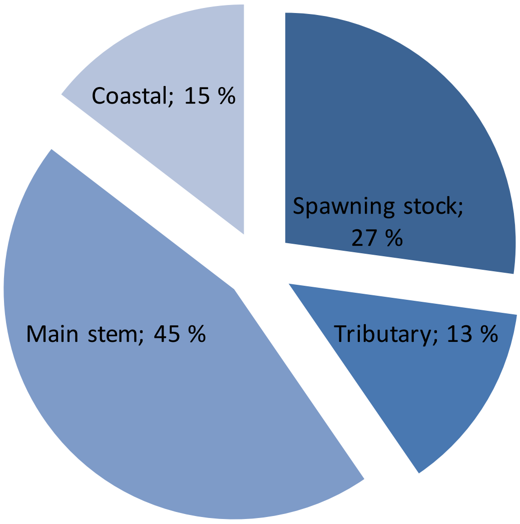


Figure 45. The total amount of salmon belonging to Veahčajohka/Vetsijoki in 2006-2015, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or within-tributary fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.

Estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 15 %
- Tana main stem: 53 %
- Within Vetsijoki: 33 %

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

The average overexploitation was estimated at 28 %. This means that exploitation was responsible for reducing the spawning stock size by an amount of 28 % below the spawning target. The average maximum sustainable total exploitation rate in the period was 61 %.

Both female and male salmon belonging to the Vetsijoki stock were caught to an equal extent in the lower Norwegian part of the main stem (52 % and 47 % of the total catch of females and males, respectively) and the border area from Nuorgam to Levajok (46 % and 50 %, respectively; Figure 46). Temporally, over 90 % of the Vetsijoki females were caught in weeks 21-27 (May to early July), while 84 % of the males were caught in weeks 24-29 (mid-June to late July). 30 % of the Vetsijoki females were caught with driftnet, 26 % with weir, 23 % by tourists, 13 % by local rod fishing and 9 % with gillnet. In comparison, 36 % of the Vetsijoki males were caught with weir, 35 % by tourists, 13 % by local rod fishing, 8 % with driftnet and 8 % with gillnet.

For stock recovery purposes, it is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the main stem exploitation of Vetsijoki female salmon by 33 % and male salmon by 24 %. As a consequence, if a stock recovery plan requiring 30 % reduction in fishing pressure were to be implemented in Vetsijoki, fishing within Vetsijoki would have to be reduced by approximately 40 % in order to achieve a 30 % reduction in total exploitation of Vetsijoki female salmon. Stock recovery advice for Vetsijoki can be found below.

With the suggested new regulation, the estimated main stem catch distribution of Vetsijoki female salmon will change to 31 % caught with weir, 23 % with driftnet, 21 % by tourists, 17 % by local rod fishing and 7 % with gillnet. For male salmon, the corresponding estimates are 41 % caught with weir, 29 % by tourists, 17 % by local rod fishing, 6 % with driftnet and 6 % with gillnet.

Figure 46. The total annual catch in number of Veahčajohka/Vetsijoki female salmon (upper panel) and male salmon (lower panel) caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.6.3 Stock recovery

In the years 2006-2015, the overall probability that the spawning target was reached in Vetsijoki was 22 %. A significant reduction in the total exploitation rate is therefore needed to improve status towards the 75 % probability specified by the management target.

The average spawning stock size in the period 2006-2015 was 800 kg (357-1 610 kg). With the current exploitation estimates, we would need a spawning stock of close to 1 300 kg to reach a 75 % probability of meeting the spawning target and approximately 2 050 kg to reach 100 % probability. In the years 2006-2015, we have, therefore, on average lacked a female biomass of approximately 500 kg in order to reach the 75 % probability level specified by the management target.

With a 50 % reduction in river exploitation, we would achieve 75 % probability of reaching the spawning target immediately (Figure 47). With a 20 or 30 % reduction, we would achieve 75 % probability after 1 generation (6 years).

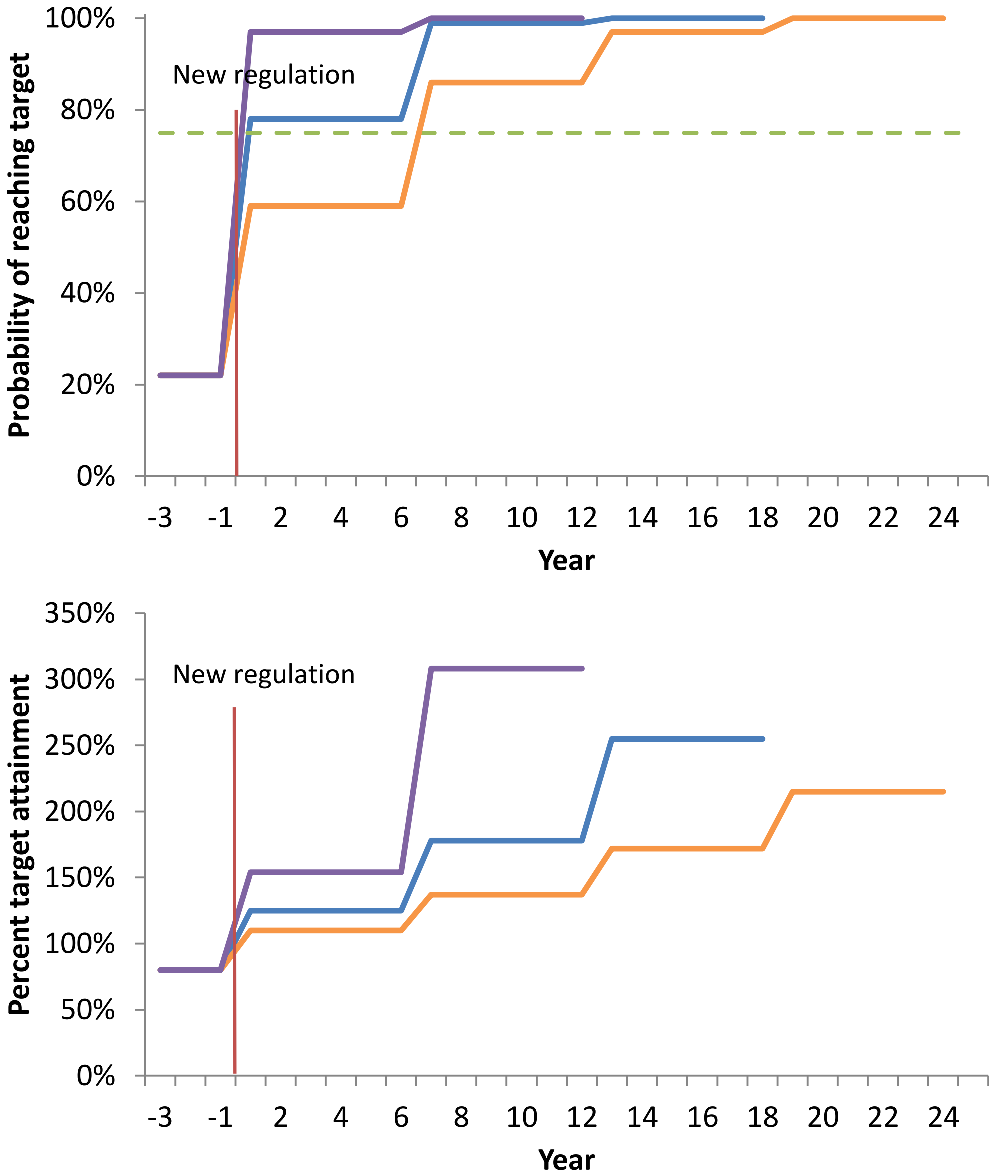


Figure 47. Stock recovery trajectories for Vetsijoki, corresponding to three scenarios of reduced river exploitation (Tana main stem + Vetsijoki). (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.7 Ohcejohka/Utsjoki + tributaries

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

4.6.7.1 Status assessment

The estimated catch in the Utsjoki river system varied from 800 kg (2004) to 2 955 kg (2014) in the period 2002-2015.

A video camera setup has counted the number of ascending salmon in Utsjoki since 2002. Annual exploitation rates can therefore be estimated and used in the status evaluation. Combining video counts and catch statistics directly give estimated exploitation rates varying from 20 % (2013) up to 60 % (2008).

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

Target attainment varied from 38 % in 2004 to 100 % in 2006 and 2011-2015. Overall attainment over the last four years was 164 %. The highest probability of reaching the spawning target was 100 % in 2013 and 2014. In the last four years the probability of reaching the target varied from 97 to 100 %. The management target was reached, as the last 4 years' (2012-2015) average probability of reaching the spawning target was 99 %.

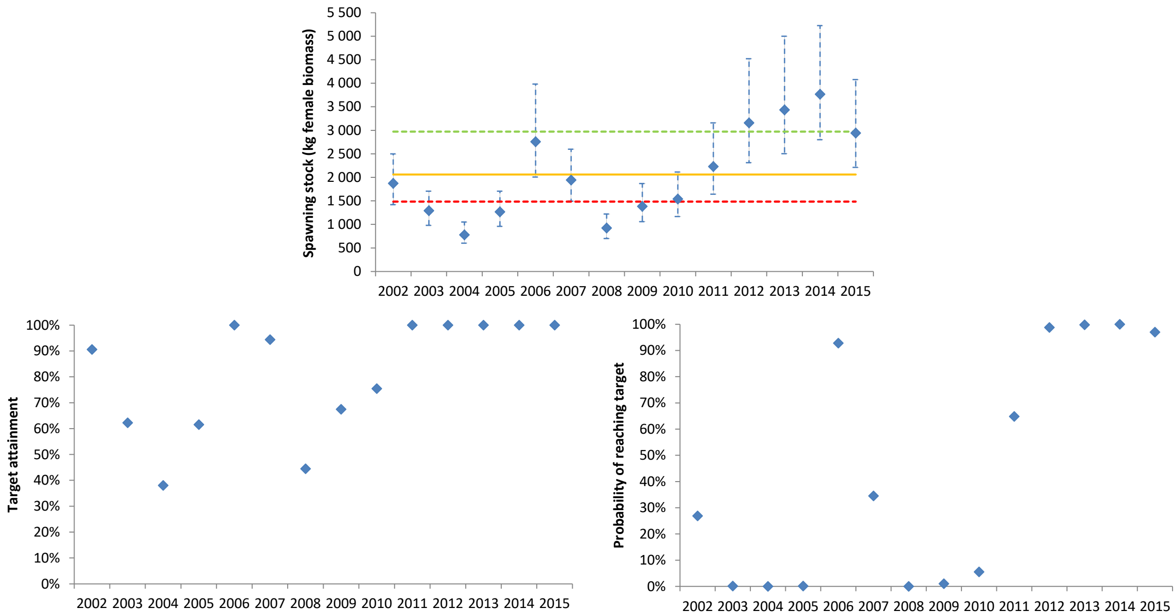


Figure 48. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 2002-2015 in the Finnish tributary Ohcejohka/Utsjoki (including tributaries).

4.6.7.2 Exploitation

The estimated total exploitation rate (based on weight) of Utsjoki salmon was 62 % in the years 2006-2015 (Figure 49), with 15 % of the pre-fishery abundance caught in coastal fisheries, 28 % in main stem fisheries and 18 % in Utsjoki itself. The average estimated total pre-fishery abundance was 11 573 kg and the average total catch was 7 143 kg in the period 2006-2015.

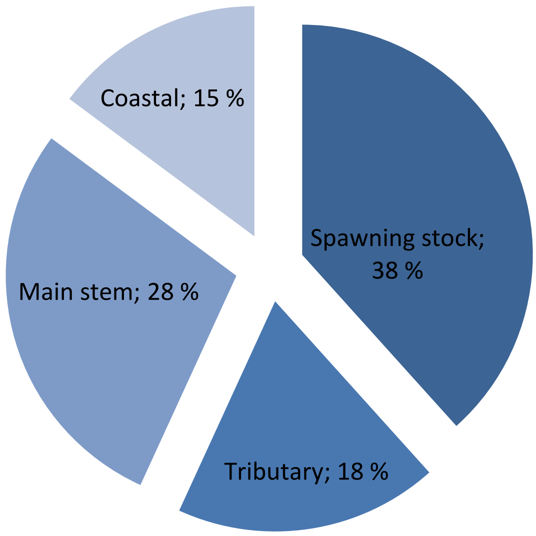


Figure 49. The total amount of salmon belonging to Ohcejohka/Utsjoki (including tributaries) in 2006-2015, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or within-tributary fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.

Estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 15 %
- Tana main stem: 33 %
- Within Utsjoki: 33 %

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

The average overexploitation in the period 2006-2015 was estimated at 12 %. This means that exploitation was responsible for reducing the spawning stock size by an amount of 12 % below the spawning target. The average maximum sustainable total exploitation rate in the period was 67 %.

The majority of the main stem catch of both female and male salmon belonging to the Utsjoki + tributary stocks happen to an equal extent in the lower Norwegian part of the main stem (49 % and 45 % of the total catch of females and males, respectively) and the border area from Nuorgam to Levajok (50 % and 54 %, respectively; Figure 50). Temporally, over 87 % of the Utsjoki females were caught in weeks 21-27 (May to early July), while 91 % of the males were caught in weeks 24-30 (last half of June to end of July). 29 % of the Utsjoki females were caught by tourists, 28 % with weir, 22 % with driftnet, 12 % by local rod fishing and 8 % with gillnet. In comparison, 37 % of the Utsjoki males were caught by tourists, 32 % with weir, 14 % by local rod fishing, 10 % with driftnet and 7 % with gillnet.

For stock recovery purposes, it is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the main stem exploitation of Utsjoki female salmon by 30 % and male salmon by 25 %.

With the suggested new regulation, the estimated main stem catch distribution of Utsjoki female salmon will change to 34 % caught with weir, 27 % by tourists, 17 % with driftnet, 16 % by local rod fishing and 6 % with gillnet. For male salmon, the corresponding estimates are 37 % caught with weir, 31 % by tourists, 18 % by local rod fishing, 8 % with driftnet and 6 % with gillnet.

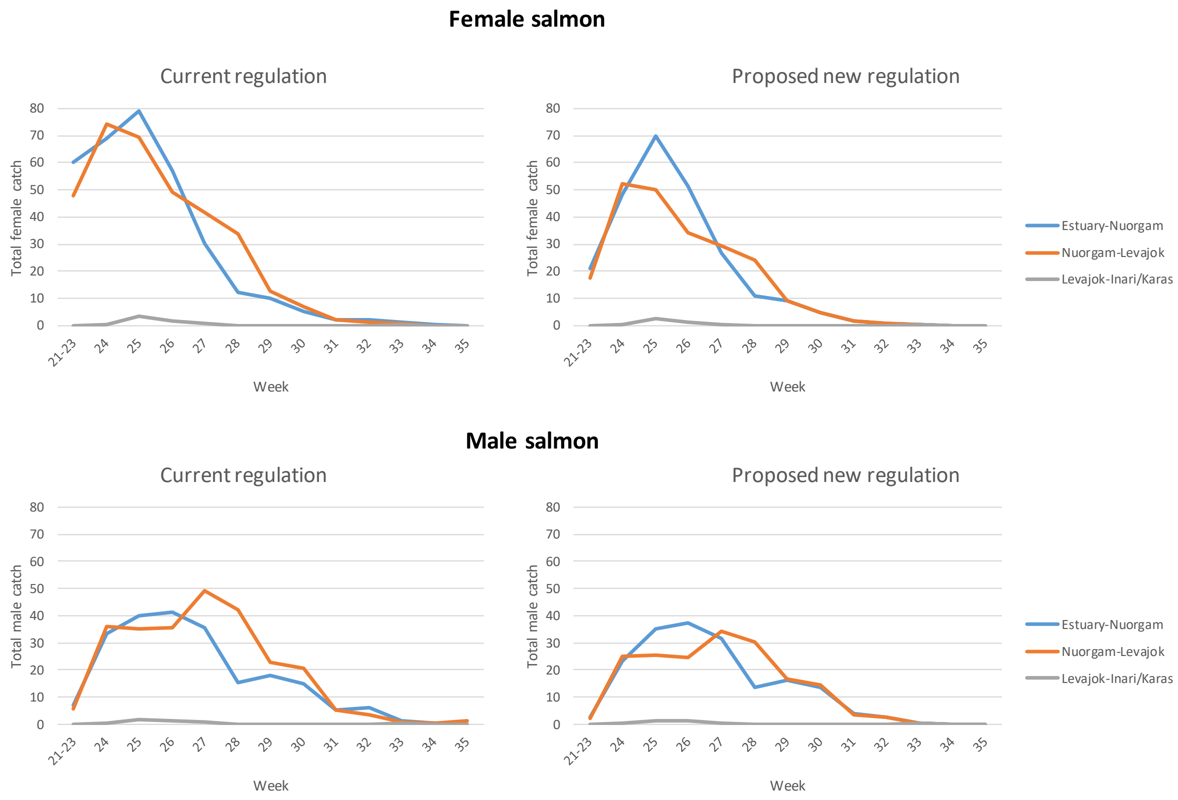


Figure 50. The total annual catch in number of Ohcejohka/Utsjoki (+tributaries) female salmon (upper panel) and male salmon (lower panel) caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.7.3 Stock recovery

In the years 2006-2015, the overall probability that the spawning target was reached in Utsjoki was 90 %, exceeding the management target level of 75 %.

The average spawning stock size in the period 2006-2015 was 2 689 kg (1 948-3 798 kg). With the current exploitation estimates, we would need a spawning stock of over 2 350 kg in order to reach a 75 % probability of meeting the spawning target and over 3 100 kg in order to reach 100 % probability. The total spawning stock in the Utsjoki river system has therefore been approximately 300 kg above the level needed to meet the management target.

As the management target is already met, a recovery plan is not needed for the Utsjoki river system (Figure 51).

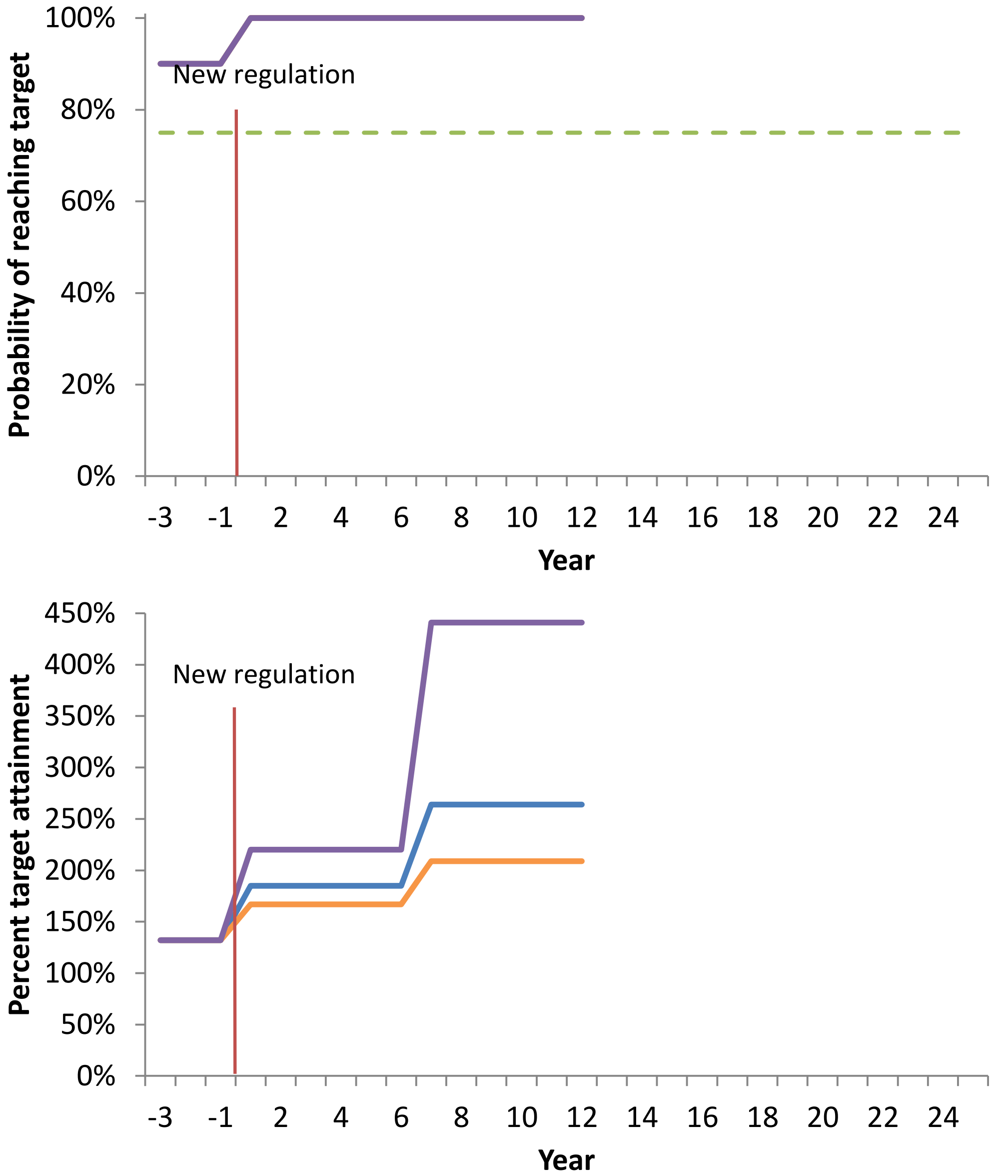


Figure 51. Stock recovery trajectories for Ohcejohka/Utsjoki, corresponding to three scenarios of reduced river exploitation (Tana main stem + Utsjoki). (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.8 Váljohka

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

4.6.8.1 Status assessment

The catch in Váljohka varied from 97 kg (2007) to 365 kg (2012) in the period 2006-2015.

In previous status reports, we have had to base the evaluation of Váljohka on a subjective assessment of the local fishery due to a lack of objective fish counting data. In 2015, however, ascending salmon were counted with a video camera setup, and with the addition of snorkelling counts in 2014 and 2015 we now have a rather good basis for assessing the stock status of Váljohka. In 2015, a minimum number of 741 salmon (629 1SW, 112 MSW) were counted in Váljohka. An additional 100 salmon were counted in the tributary Ástejohka (not covered by the video cameras). In combination with the catch statistics, the estimated exploitation rate in 2015 becomes 7 % (6-8 %).

In the previous status report (Anon. 2015), we made an estimate of the Váljohka exploitation rate based on the 2014 snorkeling counts with the assumption that the snorkelling observed at least 50 % of the spawning stock. A comparison between the snorkelling and video counts in 2015 show that the snorkelling observed only approximately 25 % of the salmon. A 25 % observation rate in 2014 translates to an exploitation of only 4 %. The fishing activity in Váljohka is low with only a few licenses sold each year. The low number of licenses combined with low accessibility for fishermen in combination with the recent monitoring results indicates a low exploitation level throughout the status assessment period (2006-2015). We therefore use the same exploitation estimate throughout the period 2006-2015 (7 %), with the exception of 2012 where we adjust the exploitation slightly upwards to 8 % (6-10 %) due to a higher number of fishermen in this particular year compared to preceding and subsequent years.

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

Target attainment was 100 % throughout the period 2006-2015 with the exception of 2009 (87 %). Overall attainment over the last four years was 149 %. The probability of reaching the spawning target varied between 20 % in 2009 and 100 % in 2006, 2011 and 2012. The management target was reached, as the last 4 years' (2012-2015) average probability of reaching the spawning target was 99 %.

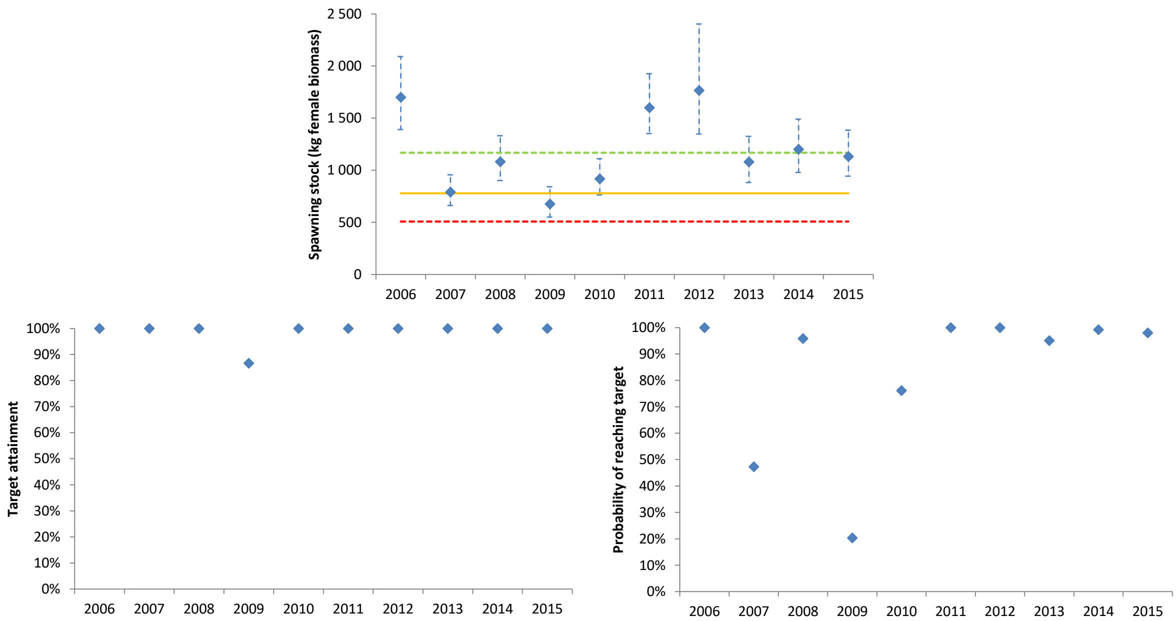


Figure 52. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 2006-2015 in the Norwegian tributary Váljohka.

4.6.8.2 Exploitation

The estimated total exploitation rate (based on weight) of Váljohka salmon was 46 % in the years 2006-2015 (Figure 53), with 14 % of the pre-fishery abundance caught in coastal fisheries, 28 % in main stem fisheries and 4 % in Váljohka itself. The average estimated total pre-fishery abundance was 4 381 kg and the average total catch was 2 032 kg in the period 2006-2015.

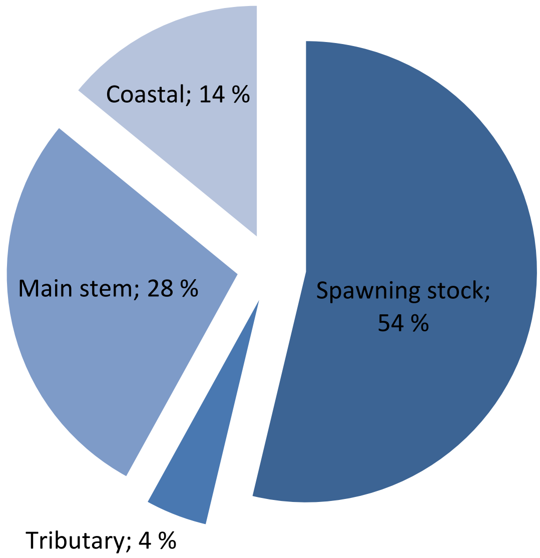


Figure 53. The total amount of salmon belonging to Váljohka in 2006-2015, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or within-tributary fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.

Estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 14 %
- Tana main stem: 32 %
- Within Váljohka: 7 %

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

The average overexploitation in the years 2006-2015 was estimated at 1 %. This means that exploitation was responsible for reducing the spawning stock size by an amount of 1 % below the spawning target. The average maximum sustainable total exploitation rate in the period was 63 %, significantly higher than the estimated total exploitation rate of 46 %.

The majority of the main stem catch of both female and male salmon belonging to the Váljohka stock happens in the border area from Nuorgam to Levajok (47 % and 43 % of the total catch of females and males, respectively), followed by the upper border area (28 % and 35 %, respectively) and the lower Norwegian main stem (26 % and 22 %, respectively; Figure 54). Temporally, over 85 % of the Váljohka females were caught in weeks 21-26 (May to end of June) while 88 % of the males were caught in weeks 21-28 (May to early July). 29 % of the Váljohka females were caught by tourists, 28 % with driftnet, 17 % by local rod fishing, 14 % with weir and 12 % with gillnet. In comparison, 40 % of the Váljohka males were caught by tourists, 17 % with weir, 17 % by local rod fishing, 14 % with driftnet and 12 % with gillnet.

For stock recovery purposes, it is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the main stem exploitation of Váljohka female salmon by 38 % and male salmon by 31 %.

With the suggested new regulation, the estimated main stem catch distribution of Váljohka female salmon will change to 28 % caught by tourists, 23 % by local rod fishing, 21 % with driftnet, 18 % with weir and 10 % with gillnet. For male salmon, the corresponding estimates are 35 % caught by tourists, 24 % by local rod fishing, 21 % with weir, 11 % with driftnet and 10 % with gillnet.

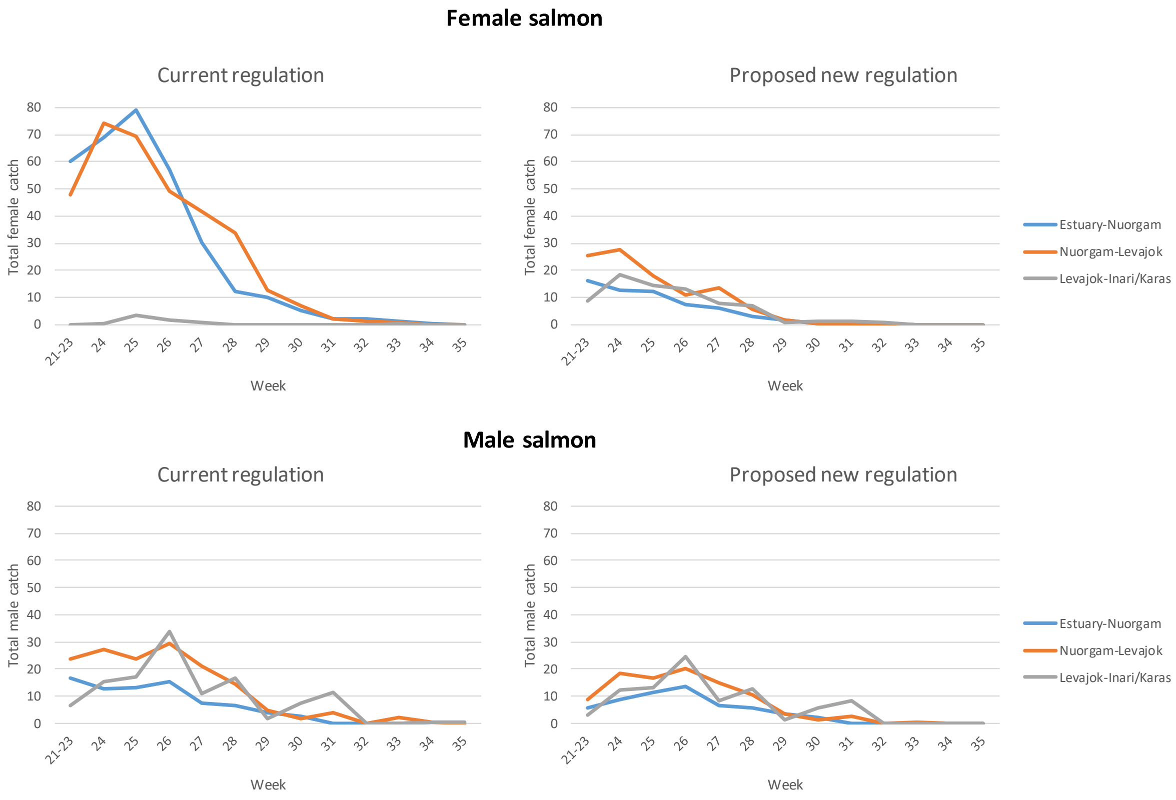


Figure 54. The total annual catch in number of Váljohka female salmon (upper panel) and male salmon (lower panel) caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.8.3 STOCK RECOVERY

In the years 2006-2015, the overall probability that the spawning target was reached in Váljohka was 100 %.

The average spawning stock size in the period 2006-2015 was 1 201 kg (980-1 495 kg). With the current exploitation estimates, we would need a spawning stock of slightly above 900 kg in order to reach a 75 % probability of meeting the spawning target and over 1 250 kg in order to reach 100 % probability. The spawning stock in Váljohka has therefore been close to 300 kg above the level needed to meet the management target in the period 2006-2015.

No stock recovery plan is currently needed for Váljohka (Figure 55).

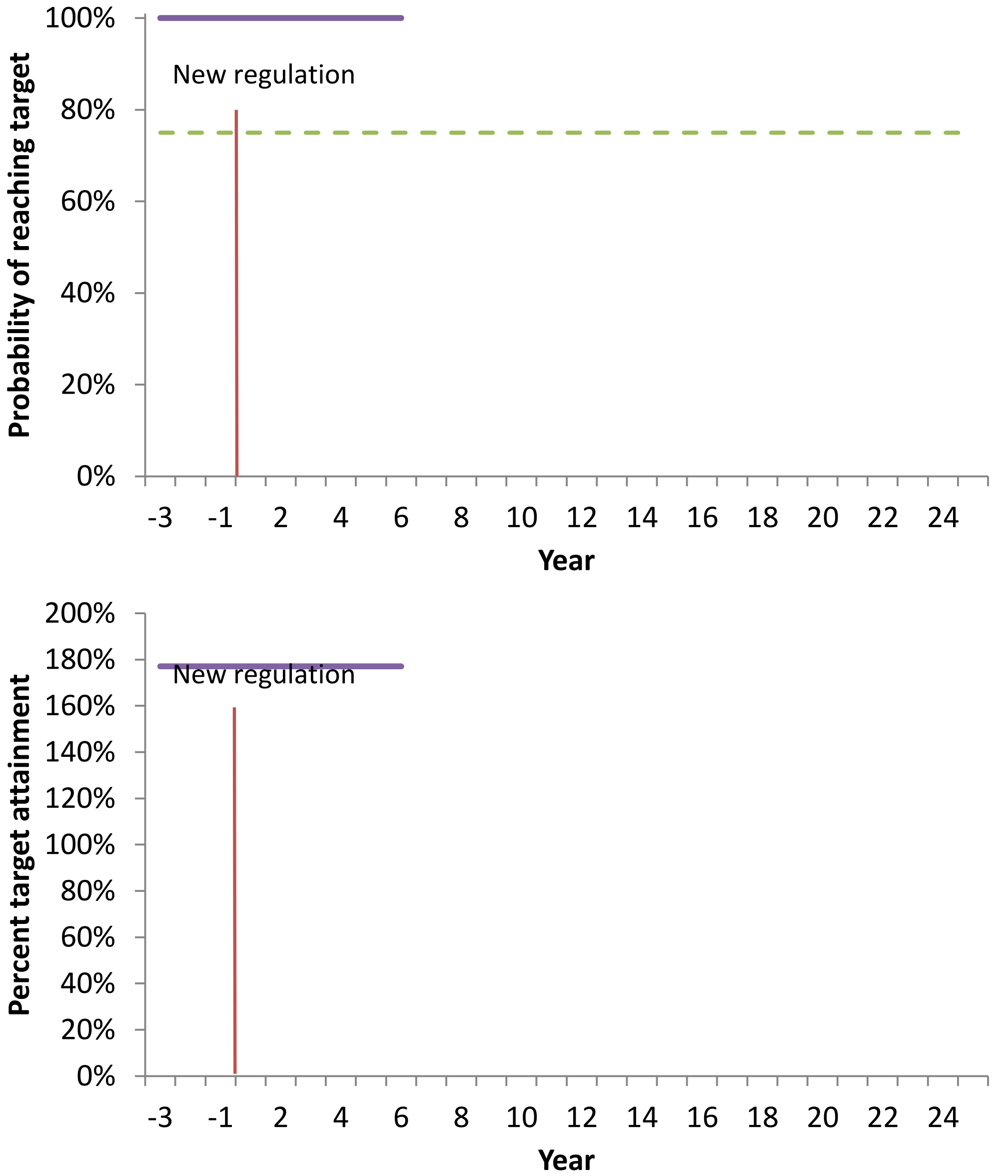


Figure 55. Stock recovery trajectories for Váljohka, corresponding to three scenarios of reduced river exploitation (Tana main stem + Váljohka). (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.9 Áhkojohka/Akujoki

The river Akujoki is a small Finnish tributary (catchment area 193 km^2) flowing into the Tana mainstem from the east approximately 190 km upstream of the Tana estuary. Only the lower 6.2 km of the river is available for salmon production as an impassable waterfall prevents further upstream migration.

4.6.9.1 Status assessment

The salmon fishery in Akujoki is very limited and we cannot base the status assessment on catch information. However, spawning salmon in Akujoki have been counted annually in the autumn with snorkelling in the years 2003-2015. Field tests of these snorkelling counts have demonstrated that it is a reasonably accurate method, and we have used these counts directly as a basis for the target assessment of Akujoki.

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

Target attainment varied from 35 % in 2003 to 100 % in 2012 and 2014. Overall attainment over the last four years was 100 %. The probability of reaching the spawning target varied from 0 % (2003-2005, 2008-2010, 2015) to 60 % (2014). The management target was not reached as the last 4 years' (2012-2015) average probability of reaching the spawning target was 47 %.

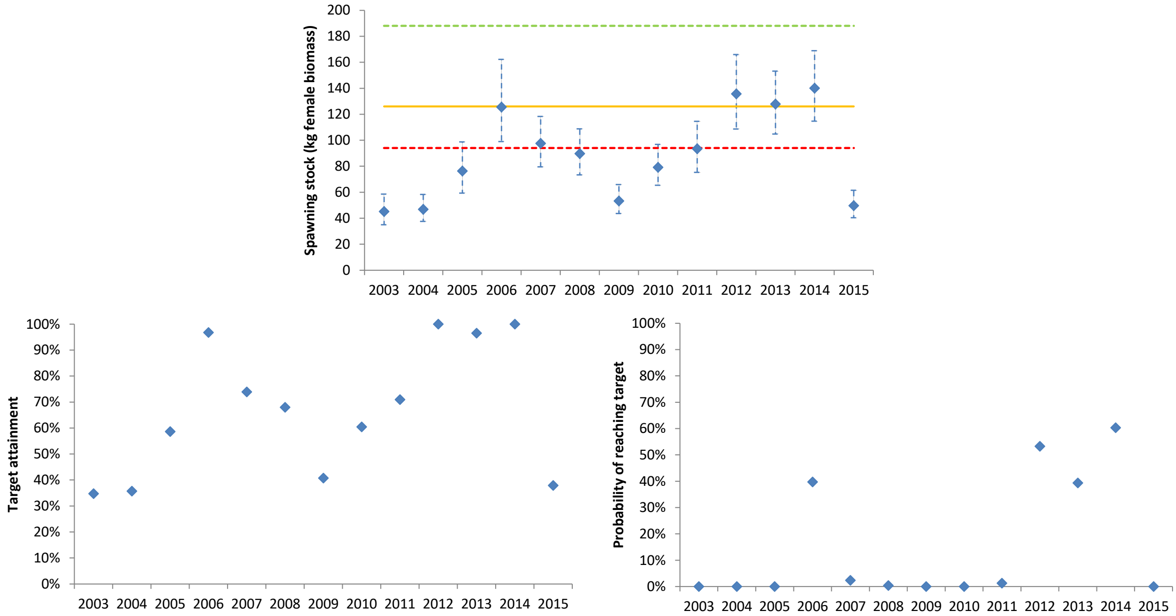


Figure 56. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 2003-2015 in the Finnish tributary Akujoki.

4.6.9.2 Exploitation

Due to genetic similarities between salmon sampled in Akujoki and neighbouring areas, it is not possible to make an estimate of the coastal and main stem exploitation specifically for Akujoki.

4.6.9.3 Stock recovery

In the years 2006-2015, the average probability that the spawning target was reached in Akujoki was 3 %. A reduction in the total exploitation rate experienced by Akujoki-salmon is therefore needed to improve the stock status.

The average spawning stock size in the period 2006-2014 was 99 kg (80-120 kg). With the current uncertainty level in the spawning stock estimates, we would need a spawning stock of over 150 kg in order to reach a 75 % probability of meeting the spawning target and over 200 kg in order to reach 100 % probability. In the years 2006-2013, we have, therefore, on average lacked a female biomass of approximately 50 kg in order to reach the 75 % probability level specified by the management target.

With all simulated reductions in river exploitation (20, 30 and 50 % reductions), we would achieve 75 % probability of reaching the spawning target immediately following a new regulation (Figure 57).

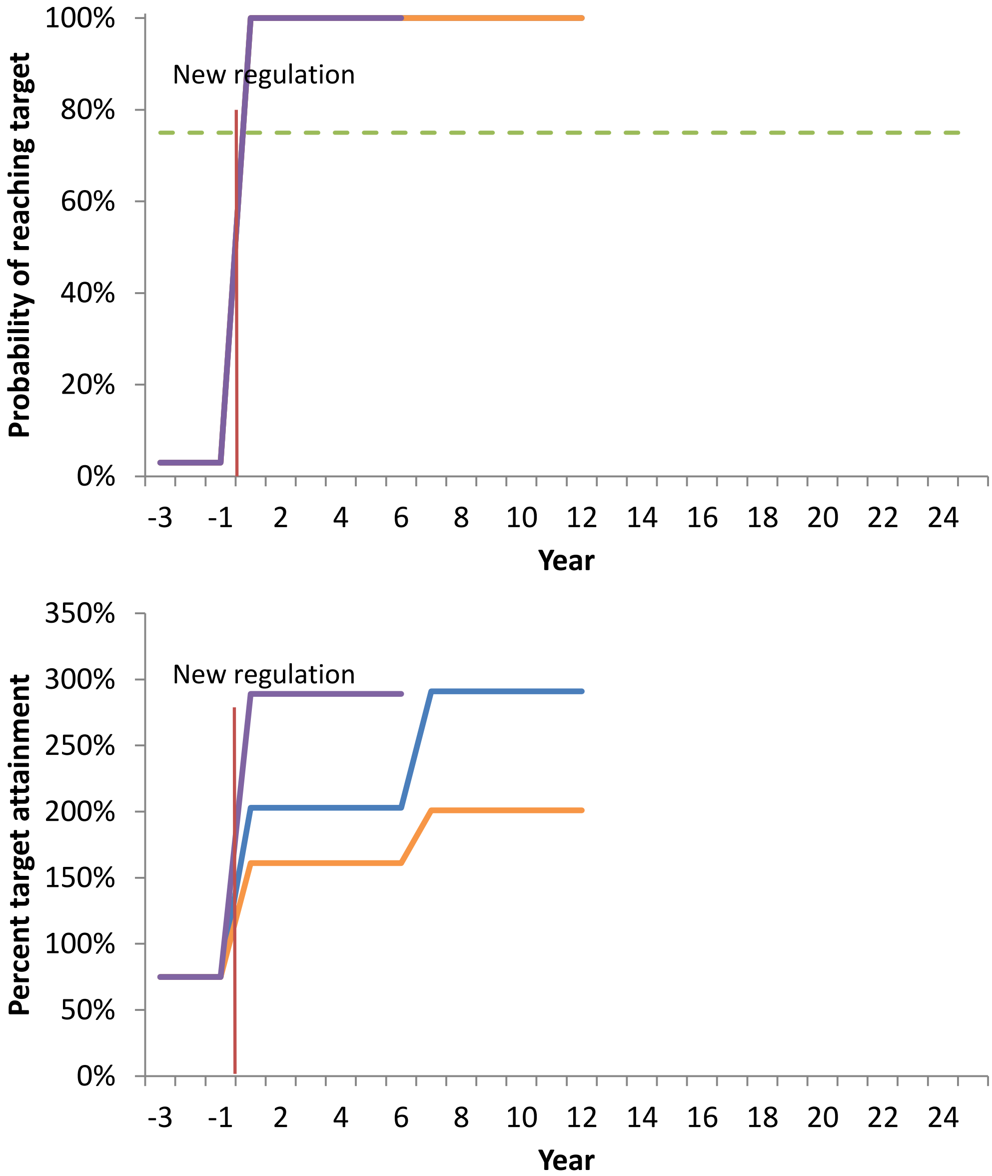


Figure 57. Stock recovery trajectories for Akujoki, corresponding to three scenarios of reduced river exploitation (Tana main stem + Akujoki). (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.10 Kárášjohka + tributaries

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

4.6.10.1 Status assessment

The status assessment in this chapter is a combined evaluation of Kárášjohka and its tributaries Bávttajohka and Geaimmejohka. The total catch reported in Kárášjohka and its tributaries Bávttajohka and Geaimmejohka in the years 2006-2015 varied from 1 543 kg (2009) to 4 977 kg (2006). However, a significant part of the catch reported below Skáidegeahči is salmon belonging to Iešjohka. Genetic stock identification of salmon belonging to either Kárášjohka or Iešjohka from the uppermost part of the Tana main stem show that approximately 46 % of the salmon belong to Iešjohka. We have subtracted this part from the reported catch below Skáidegeahči, and the resulting catch for Kárášjohka (+tributaries) varies from 1 298 kg (2009) to 3 902 kg (2008).

There was acoustic fish counting in 2010 and 2012 at Heastanjárga (the upper bridge over Kárášjohka), approximately 5 km upstream from Skáidegeahči. These counts provided an estimate of the number of salmon of different size groups that migrated up into the upper part, which then could be used to estimate the 2010 and 2012 exploitation rate in the upper part of Kárášjohka. In addition, there is some exploitation in the lower part. In combination, the following exploitation estimates (based on number of fish) were used to estimate spawning stock size in Kárášjohka in the years 2006-2015:

- Salmon <3 kg: 25 % (20-30 %)
- Salmon 3-7 kg: 45 % (35-55 %)
- Salmon >7 kg: 45 % (35-55 %)

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

Target attainment varied from 12 % in 2009 to 45 % in 2008. The overall attainment over the last four years was 35 %. The probability of reaching the spawning target was 0 % for all years in the period 2006-2015. The management target was not reached, as the last 4 years' (2012-2015) average probability of reaching the spawning target was 0 %.

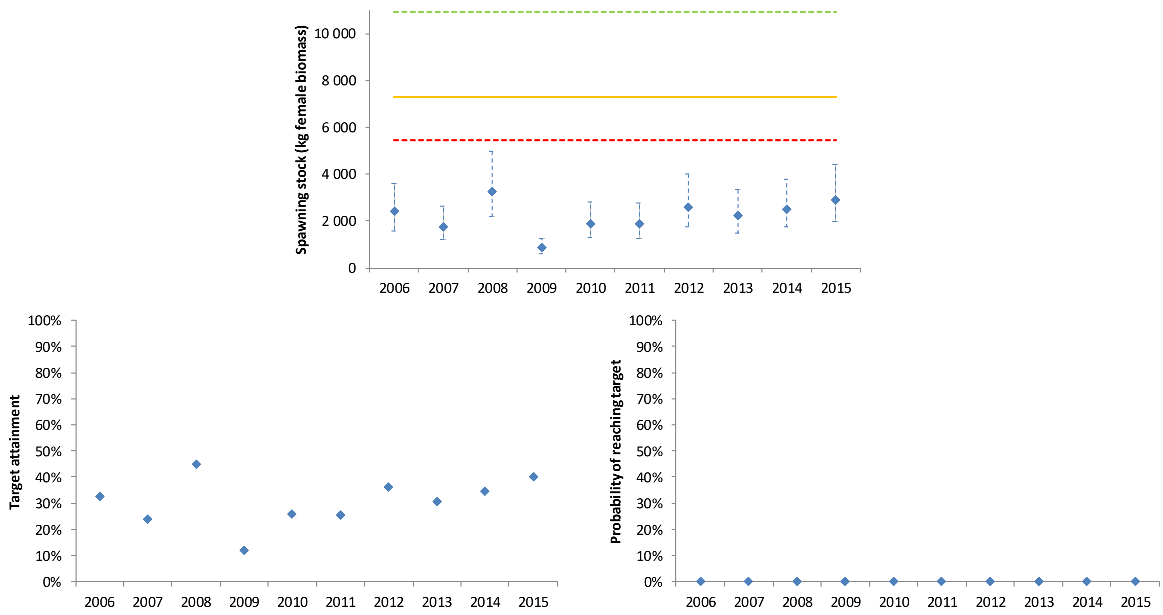


Figure 58. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 2006-2015 in the Norwegian tributary Kárášjohka (including the tributaries Bávttajohka and Geaimmejohka).

4.6.10.2 Exploitation

The estimated total exploitation rate (based on weight) of Kárášjohka salmon was 78 % in the years 2006-2015 (Figure 59), with 16 % of the pre-fishery abundance caught in coastal fisheries, 45 % in main stem fisheries and

18 % in Kárášjohka itself. The average estimated total pre-fishery abundance was 17 018 kg and the average total catch was 13 258 kg in the period 2006-2015.

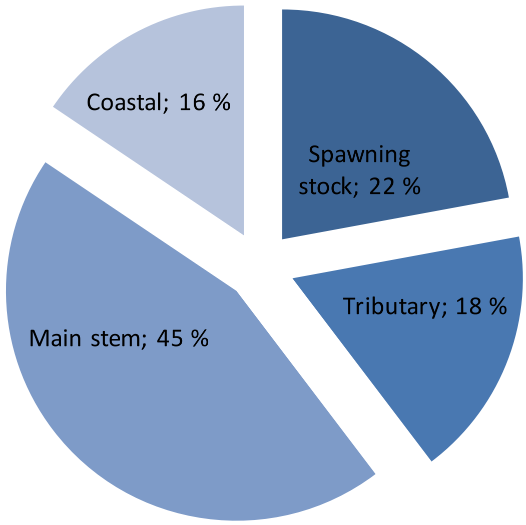


Figure 59. The total amount of salmon belonging to Kárášjohka (including Bávttajohka and Geaimmejohka) in 2006-2014, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or within-tributary fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.

Estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 16 %
- Tana main stem: 53 %
- Within Kárášjohka: 44 %

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

The average overexploitation was estimated at 66 %. This means that exploitation was responsible for reducing the spawning stock size by an amount of 66 % below the spawning target. The average maximum sustainable total exploitation rate in the period was 26 %, significantly lower than the estimated total exploitation of 78 %.

The majority of the main stem catch of both female and male salmon belonging to the Kárášjohka + tributaries stock complex happens in the border area from Nuorgam to Levajok (42 % and 41 % of the total catch of females and males, respectively; Figure 60Figure 54). The rest is equally divided between the upper border area (28 % and 32 % for females and males, respectively) and the lower Norwegian main stem (30 % and 27 %). Temporally, over 90 % of the Kárášjohka females were caught in weeks 21-27 (May to early July), while 84 % of the males were caught in weeks 25-31 (late June to early August). 30 % of the Kárášjohka females were caught with driftnet, 25 % by tourists, 16 % with weir, 15 % with gillnet and 14 % by local rod fishing. In comparison, 40 % of the Kárášjohka males were caught by tourists, 25 % with weir, 16 % by local rod fishing, 12 % with gillnet and 6 % with driftnet.

For stock recovery purposes, it is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the main stem exploitation of Kárášjohka female salmon by 37 % and male salmon by 25 %. As a consequence, if a stock recovery plan requiring 30 % reduction in fishing pressure were to be implemented for Kárášjohka, fishing within Kárášjohka and tributaries would have to be reduced by approximately 35 % in order to achieve a total exploitation reduction of 30 % for Kárášjohka female salmon. Stock recovery advice for Kárášjohka is found below.

With the suggested new regulation, the estimated main stem catch distribution of Kárášjohka female salmon will change to 24 % caught by tourists, 22 % with driftnet, 21 % with weir, 20 % by local rod fishing and 13 % with gillnet. For male salmon, the corresponding estimates are 34 % caught by tourists, 29 % with weir, 22 % by local rod fishing, 10 % with gillnet and 4 % with driftnet.

Figure 60. The total annual catch in number of Kárášjohka (+tributaries) female salmon (upper panel) and male salmon (lower panel) caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.10.3 Stock recovery

In the years 2006-2015, the overall probability that the spawning target was reached in Kárášjohka (including the tributaries Bávttajohka and Geaimmejohka) was 0 %. A significant reduction in the total exploitation rate is therefore needed to improve status in the Kárášjohka river system.

The average spawning stock size in the period 2006-2015 was 3 407 kg (2 309-5 031 kg). With the current exploitation estimates, we would need a spawning stock of over 8 500 kg in order to attain a 75 % probability of reaching the spawning target and over 11 500 kg in order to attain 100 % probability. In the years 2006-2015, we have, therefore, on average lacked a female biomass of approximately 5 100 kg in order to reach the 75 % probability level specified by the management target.

With a 50 % reduction in river exploitation, we would achieve 75 % probability of reaching the spawning target after 1 generation (7 years, Figure 61). With a 30 % reduction, we would achieve 75 % probability after 2 generations (14 years). With a 20 % reduction, we would need 3 generations (21 years).

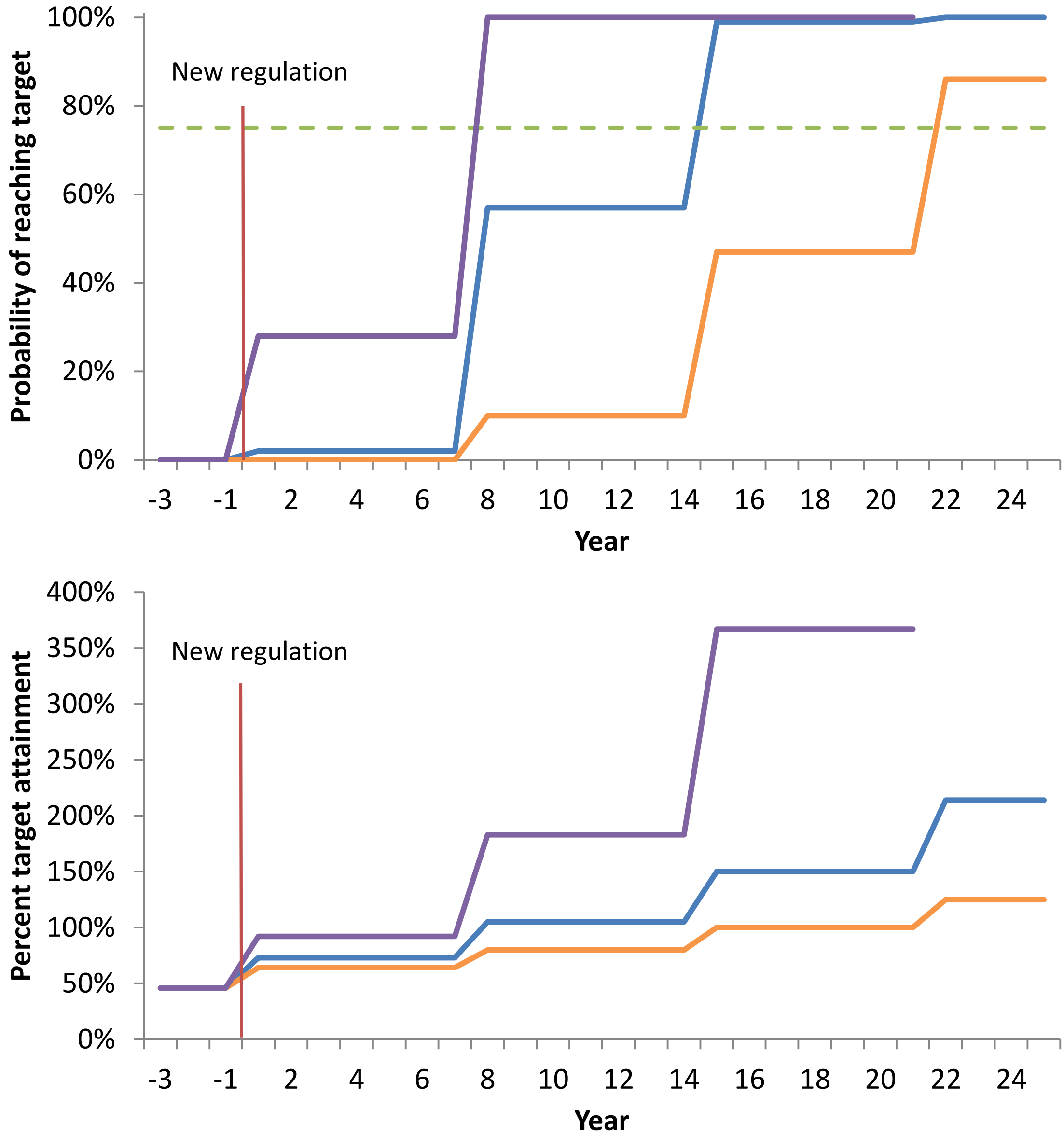


Figure 61. Stock recovery trajectories for Kárášjohka, corresponding to three scenarios of reduced river exploitation (Tana main stem + Kárášjohka). (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.11 Iešjohka

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

4.6.11.1 Status assessment

The catch in Iešjohka itself varied from 995 kg (2009) to 3 498 kg (2008) in the period 2006-2015. In addition, approximately 46 % of the salmon caught in Kárášjohka below Skáidegeahči belongs to Iešjohka. We include this proportion in the status assessment, and the resulting catch used in the status assessment varied from 1 239 kg (2009) to 4 499 kg (2006).

There is no fish monitoring in Iešjohka, so the target evaluation must be based on an estimated exploitation rate in combination with catch statistics. The following exploitation estimates (based on number of fish) were used in the period 2006-2015:

- Salmon <3 kg: 25 % (20-30 %)
- Salmon 3-7 kg: 45 % (35-55 %)
- Salmon >7 kg: 45 % (35-55 %)

These estimates are partly based on the results from the acoustic fish countings in the neighbouring Kárášjohka in 2010 and 2012, with an added level of exploitation from Kárášjohka below Skáidegeahči.

The revised Iešjohka spawning target is 11 536 009 eggs (8 127 759-17 304 014 eggs). The female biomass needed to obtain this egg deposition is 6 072 kg (4 278-9 107 kg) when using a stock-specific fecundity of 1 900 eggs kg^{-1}.

Target attainment varied from 15 % in 2009 to 62 % in 2008. The overall attainment over the last four years was 31 %. The probability of reaching the spawning target was 0 % throughout the period 2006-2015 with the exception of 1 % in 2008. The management target was not reached, as the last 4 years' (2012-2015) average probability of reaching the spawning target was 0 %.

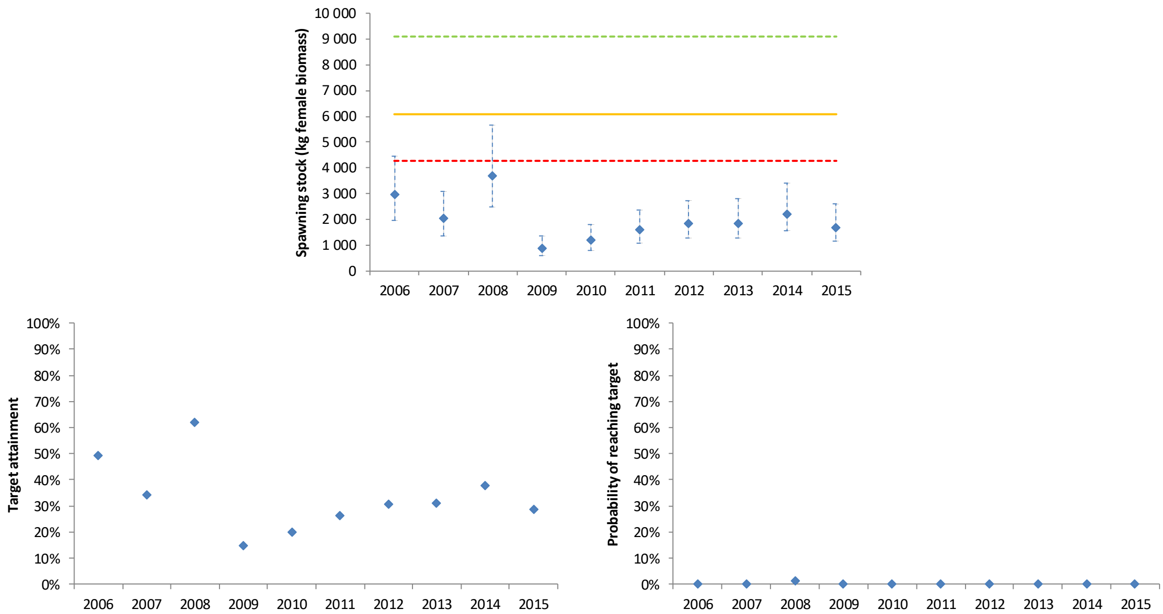


Figure 62. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 2006-2015 in the Norwegian tributary Iešjohka.

4.6.11.2 Exploitation

The estimated total exploitation rate (based on weight) of Iešjohka salmon was 78 % in the years 2006-2015 (Figure 59), with 16 % of the pre-fishery abundance caught in coastal fisheries, 46 % in main stem fisheries and 17 % in Iešjohka. The average estimated total pre-fishery abundance was 15 463 kg and the average total catch was 12 100 kg in the period 2006-2015.

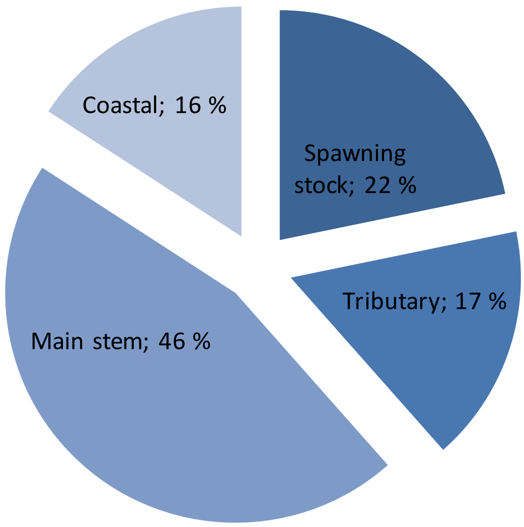


Figure 63. The total amount of salmon belonging to Iešjohka in 2006-2015, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or within-tributary fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.

Estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 16 %
- Tana main stem: 54 %
- Within Iešjohka: 43 %

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

The average overexploitation was estimated at 65 %. This means that exploitation was responsible for reducing the spawning stock size by an amount of 65 % below the spawning target. The average maximum sustainable total exploitation rate in the period was 31 %.

The majority of the main stem catch of both female and male salmon belonging to the Iešjohka stock happens in the border area from Nuorgam to Levajok (42 % and 40 % of the total catch of females and males, respectively; Figure 64), followed by the lower Norwegian main stem (34 % and 31 %) and the upper border area (24 % and 29 %). Temporally, over 86 % of the Iešjohka females were caught in weeks 21-27 (May to early July), while 84 % of the males were caught in weeks 25-31 (late June to early August). 28 % of the Iešjohka females were caught with driftnet, 26 % by tourists, 19 % with weir, 14 % by local rod fishing and 14 % with gillnet. In comparison, 39 % of the males were caught by tourists, 27 % with weir, 17 % by local rod fishing, 11 % with gillnet and 6 % with driftnet.

For stock recovery purposes, it is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the exploitation of Iešjohka female salmon within the Tana main stem by 33 % and male salmon by 22 %. As a consequence, if a stock recovery plan requiring 30 % reduction in fishing pressure were to be implemented for Iešjohka, fishing within Iešjohka would have to be reduced by approximately 50 % in order to achieve a total exploitation reduction of 30 % for Iešjohka female salmon. Stock recovery advice for Iešjohka is found below.

With the suggested new regulation, the estimated main stem catch distribution of Iešjohka female salmon will change to 24 % caught by tourists, 24 % with weir, 20 % with driftnet, 20 % by local rod fishing and 12 % with gillnet. For male salmon, the corresponding estimates are 33 % by tourists, 30 % with weir, 23 % by local rod fishing, 9 % with gillnet and 4 % with driftnet.

Figure 64. The total annual catch in number of Iešjohka female salmon (upper panel) and male salmon (lower panel) caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.11.3 Stock recovery

In the years 2006-2015, the overall probability that the spawning target was reached in Iešjohka was 0 %. A significant reduction in the total exploitation rate is therefore needed to improve status in this river.

The average spawning stock size in the period 2006-2015 was 1 938 kg (1 284-2 968 kg). With the current exploitation estimates, we would need a spawning stock of over 7 050 kg in order to reach a 75 % probability of meeting the spawning target and over 9 000 kg to reach 100 % probability. In the years 2006-2015, we have therefore, on average, lacked a female biomass of over 5 100 kg in order to reach the 75 % probability level specified by the management target.

With a 20 % reduction in river exploitation, we would not achieve a 75 % probability of reaching the spawning target by the end of the recovery period simulated in Figure 65 (25 years). With a 30 % reduction, the stock recovery period would last 3 generations (21 years), and with a 50 % reduction 1 generation (7 years).

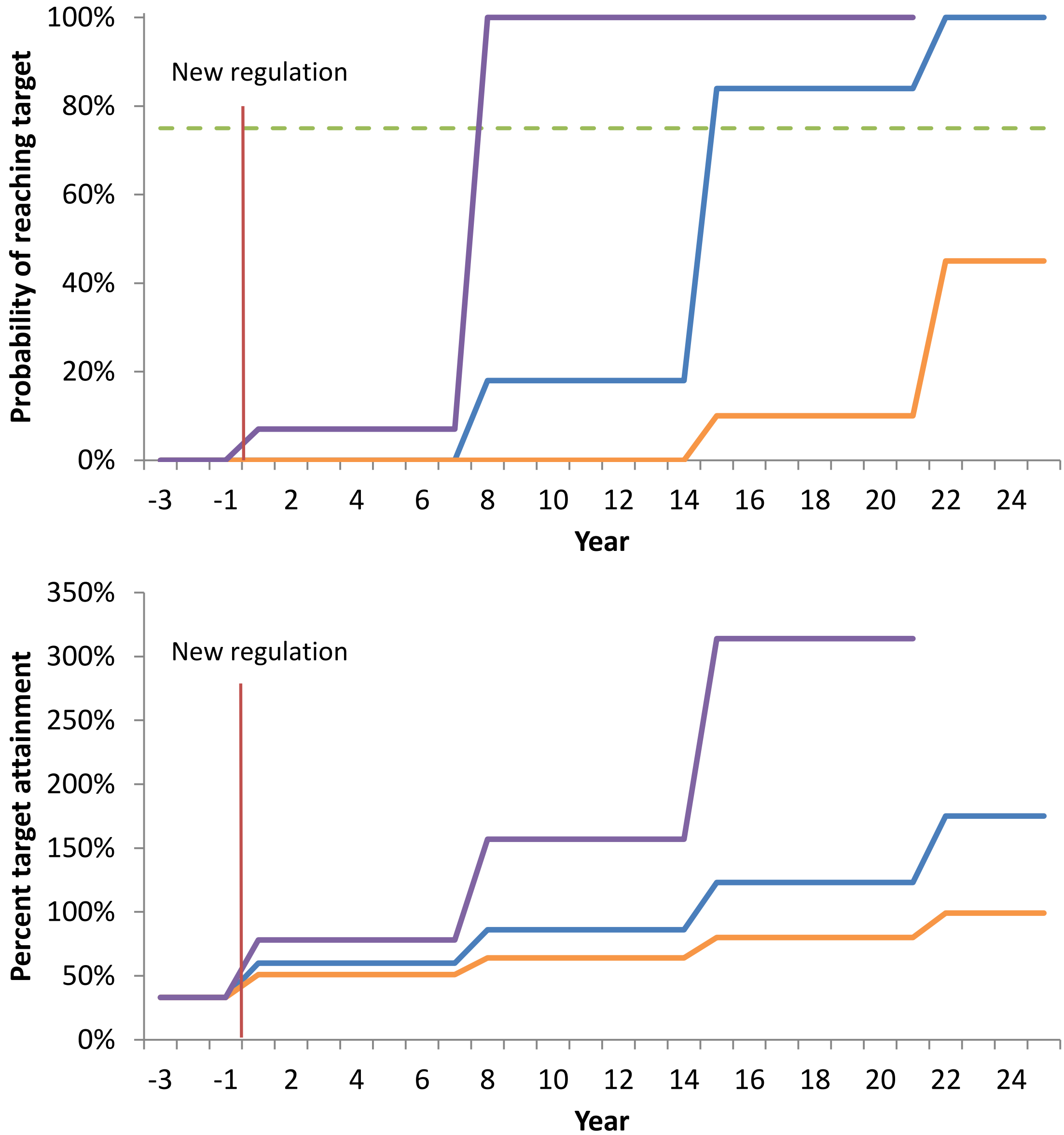


Figure 65. Stock recovery trajectories for Iešjohka, corresponding to three scenarios of reduced river exploitation (Tana main stem + Iešjohka). (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.12 Anárjohka/Inarijoki + tributaries

Anárjohka/Inarijoki is one of the three large headwater rivers that together form the Tana main stem. The lower 83 km of Anárjohka/Inarijoki are border areas between Norway and Finland, while the remaining uppermost 10 km are Norwegian only. The salmon are efficiently stopped at the 12-15 m high Gumpegorži. There are several tributaries with salmon stocks on both sides of the river.

4.6.12.1 Status assessment

The catch in Anárjohka/Inarijoki (including tributaries) varied from 1 881 kg (2015) to 4 285 kg (2012) in the period 2006-2015.

There is no fish monitoring in Anárjohka/Inarijoki, so the target evaluation must be based on an estimated exploitation rate in combination with catch statistics. The following exploitation estimate (based on number of fish) was used in the period 2006-2015: **30 % (20 %-50 %)**.

This exploitation estimate is somewhat lower than the estimates used in Kárášjohka and Iešjohka.

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

Target attainment varied from 30 % in 2011 and 2015 to 67 % in 2012 and 65 % in 2006. The overall attainment over the last four years was 38 %. The probability of reaching the spawning target was 0 % in all years except 8 % in 2012 and 7 % in 2006. The management target was not reached, as the last 4 years' (2012-2015) average probability of reaching the spawning target was 0 %.

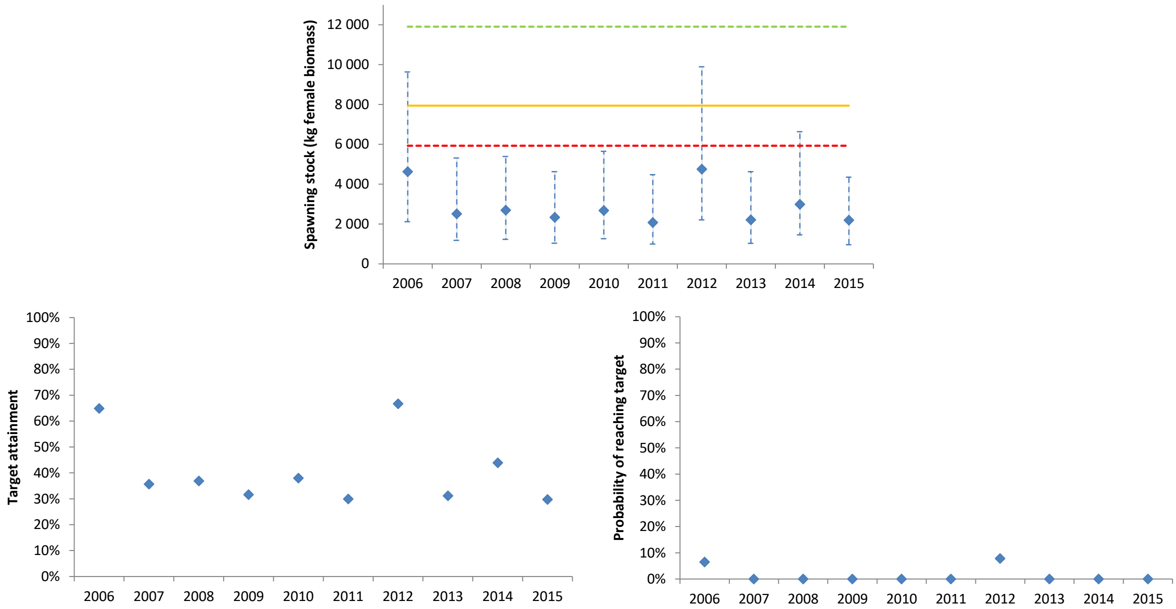


Figure 66. The estimated spawning stock (top row), percent target attainment (bottom row, left) and probability of reaching the target (bottom row, right) in the period 2006-2015 in the common headwater river Anárjohka/Inarijoki (including Norwegian and Finnish tributaries).

4.6.12.2 Exploitation

The estimated total exploitation rate (based on weight) of Anárjohka/Inarijoki salmon was 75 % in the years 2006-2015 (Figure 59), with 15 % of the pre-fishery abundance caught in coastal fisheries, 48 % in main stem fisheries and 11 % in Anárjohka/Inarijoki itself. The average estimated total pre-fishery abundance was 22 855 kg and the average total catch was 17 119 kg in the period 2006-2015.

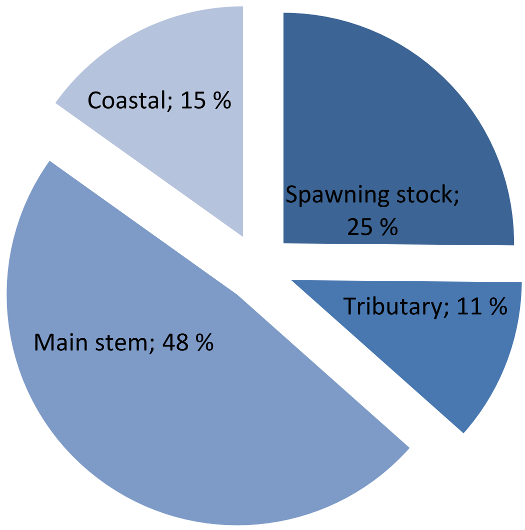


Figure 67. The total amount of salmon belonging to Anárjohka/Inarijoki (+tributaries) in 2006-2015, distributed into surviving spawning stock and salmon caught in fisheries in either coastal, main stem or within-tributary fisheries. The percentages in the figure represent the proportion of the pre-fishery abundance that survives to spawning or are caught in coastal, main stem or tributary fisheries.

Estimated relative exploitation efficiencies (based on weight) in areas in the period 2006-2015 were:

- Coastal: 15 %
- Tana main stem: 57 %
- Within Anárjohka/Inarijoki: 31 %

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

The average overexploitation was estimated at 59 %. This means that exploitation was responsible for reducing the spawning stock size by an amount of 59 % below the spawning target. The average maximum sustainable total exploitation rate in the period was 35 %.

The majority of the main stem catch of both female and male salmon belonging to the Anárjohka/Inarijoki (+tributaries) stock complex happens in the border area from Nuorgam to Levajok (50 % and 51 % of the total catch of females and males, respectively; Figure 64), followed equally by the lower Norwegian main stem (25 % and 20 %) and the upper border area (25 % and 29 %). Temporally, 84 % of the Anárjohka/Inarijoki females were caught in weeks 24-30 (mid-June to end of July), while 82 % of the males were caught in weeks 26-32 (end of June to early August). 41 % of the Anárjohka/Inarijoki females were caught by tourists, 22 % with weir, 18 % by local rod fishing, 11 % with gillnet and 9 % with driftnet. In comparison, 40 % of the males were caught by tourists, 20 % with weir, 19 % with gillnet, 18 % by local rod fishing and 2 % with driftnet.

For stock recovery purposes, it is estimated that the new regulation proposal coming from the recent negotiations between Norway and Finland will reduce the exploitation of Anárjohka/Inarijoki female salmon within the Tana main stem by 26 % and male salmon by 22 %. As a consequence, if a stock recovery plan requiring 30 % reduction in fishing pressure were to be implemented for Anárjohka/Inarijoki, fishing within Anárjohka/Inarijoki would have to be reduced by approximately 70 % in order to achieve a total exploitation reduction of 30 % for Anárjohka/Inarijoki female salmon. Stock recovery advice for Anárjohka/Inarijoki is found below.

With the suggested new regulation, the estimated main stem catch distribution of Anárjohka/Inarijoki female salmon will change to 36 % caught by tourists, 25 % with weir, 24 % by local rod fishing, 9 % with gillnet and 7 % with driftnet. For male salmon, the corresponding estimates are 36 % by tourists, 25 % by local rod fishing, 22 % with weir, 14 % with gillnet and 2 % with driftnet.

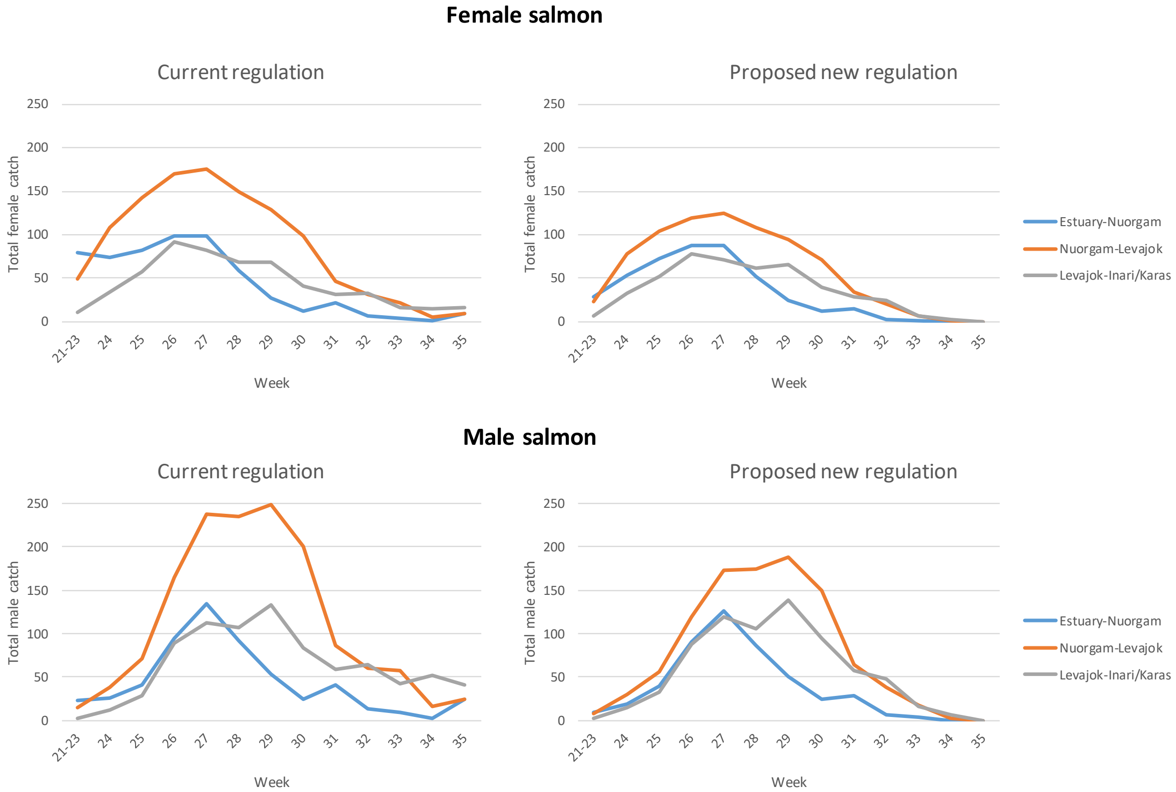


Figure 68. The total annual catch in number of Anárjohka/Inarijoki (+tributaries) female salmon (upper panel) and male salmon (lower panel) caught from week to week in various parts of the Tana main stem. Left panel is the average annual catch under the current regulation, right panel is the estimated annual catch under the new regulation proposed from the negotiations between Norway and Finland. Average estimates are based on genetic stock identified samples from the years 2006-2008 and 2011-2012.

4.6.12.3 Stock recovery

In the years 2006-2015, the overall probability that the spawning target was reached in Anárjohka/Inarijoki was 0 %. A significant reduction in the total exploitation rate is therefore needed to improve status.

The average spawning stock size in the period 2006-2015 was 3 076 kg (1 342-6 113 kg). With the current exploitation estimates, we would need a spawning stock size of almost 9 400 kg to reach a 75 % probability of meeting the spawning target and approximately 13 000 kg to reach 100 % probability. In the years 2006-2015, we have, therefore, on average lacked a female biomass of approximately 6 300 kg in order to reach the 75 % probability level specified by the management target.

With a 20 % reduction in river exploitation, we would not achieve a 75 % probability of reaching the spawning target by the end of the recovery period simulated in Figure 69 (25 years). With a 30 % reduction, the stock recovery period would last 2 generations (14 years), and with a 50 % reduction 1 generation (7 years).

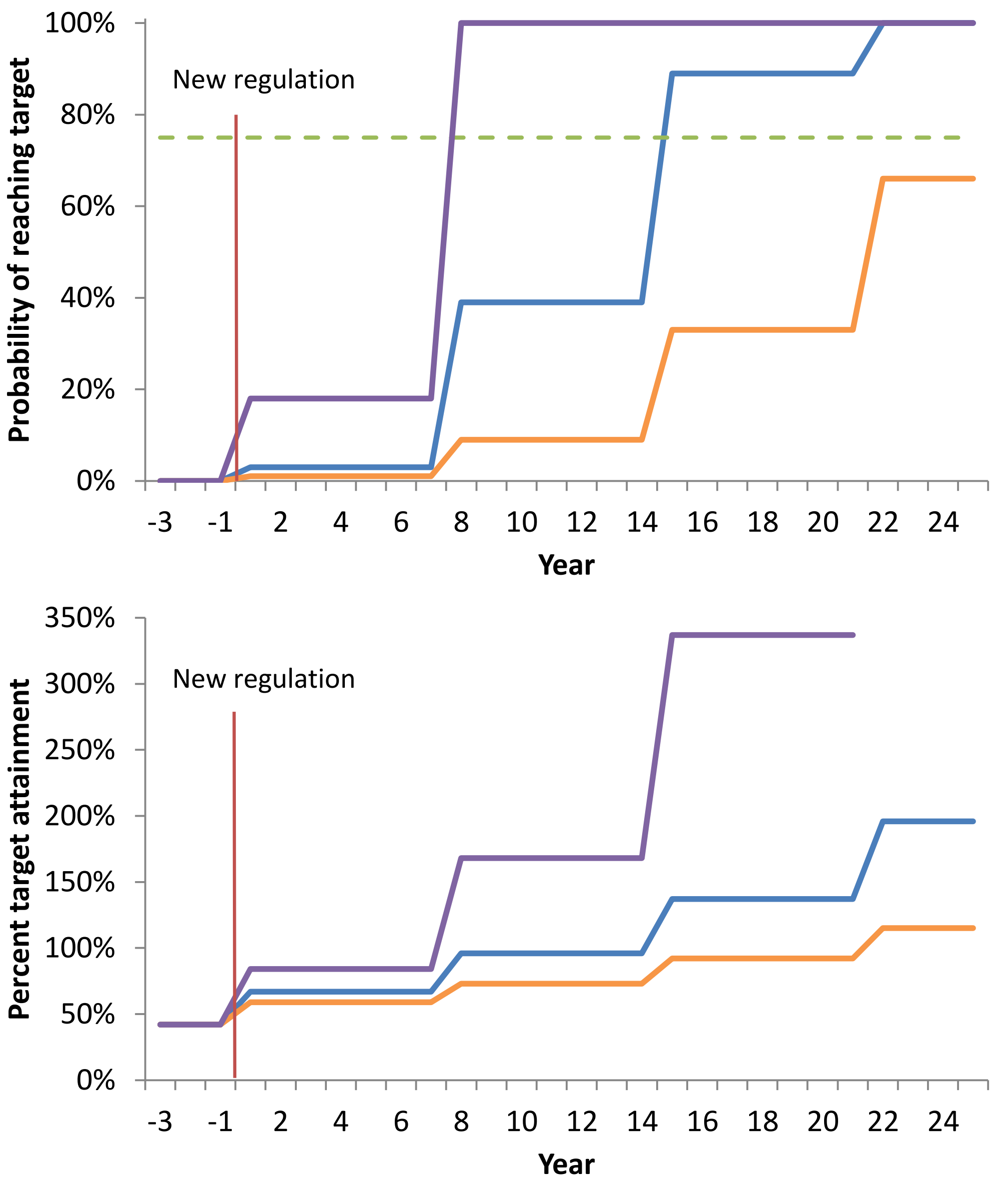


Figure 69. Stock recovery trajectories for Anárjohka/Inarijoki, corresponding to three scenarios of reduced river exploitation (Tana main stem + Anárjohka/Inarijoki). (Orange) A 20 % reduction, (Blue) a 30 % reduction, and (Purple) a 50 % reduction. Upper panel depicts the development in probability of reaching the spawning target, bottom panel the development in percentage target attainment. The green dotted line represents the 75 % probability line.

4.6.13 Summary and discussion of stock status and exploitation patterns

When interpreting the stock status estimates and the resulting exploitation advice, it is important to realize the direction of the burden of proof in target-based salmon fisheries regulations. The overall goal is to keep a stock at or above a designated threshold (the management target). The extent to which a fishery can be opened thus depends on 1) the knowledge level and 2) the target attainment. Throughout the regulation process, the best available knowledge should be put to use. As a consequence, the goal of monitoring is not gathering information to find the evidence needed to restrict the fisheries. The situation is vice versa: Evidence is needed to argue more open regulations. A lack of evidence leads to cautious assessments and restrictive fisheries.

Stock status over the last 4 years (2012-2015) was poor in 7 of the 11 stocks that we evaluated (Figure 70). The best status was found in Buolbmátjohka/Pulmankijoki, Ohcejohka/Utsjoki and Váljohka. All of these are low-exploitation tributaries, either partly (Utsjoki and Pulmanki) or as a whole (Váljohka). The poorest stock status was found in the upper main headwater areas of Kárášjohka, Iešjohka and Anárjohka/Inarijoki, all of which had low target attainment and low exploitable surplus.

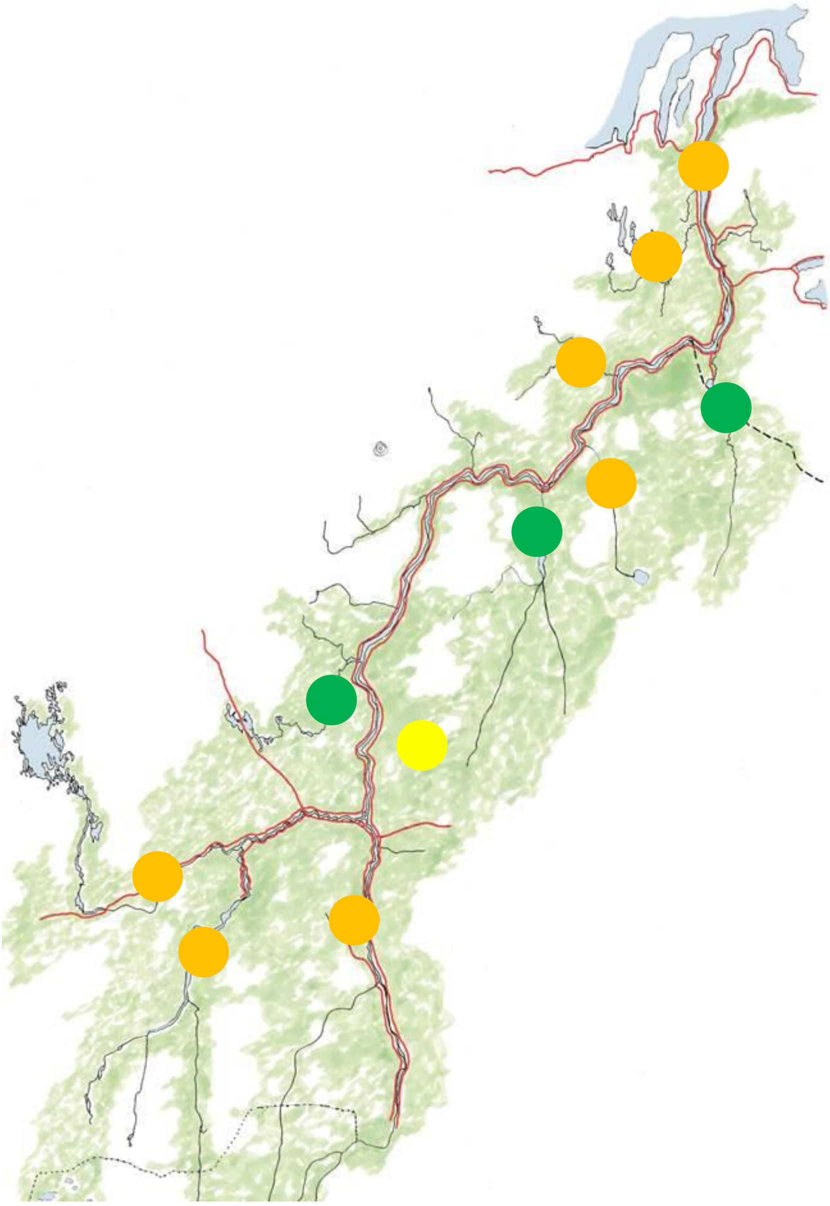


Figure 70. Map summary of the 2012-2015 stock status of the evaluated parts of the Tana/Teno river system. Symbol colour designates stock status over the last four years. Possible colours are: Dark green = overall probability of attaining spawning target higher than 75 %, overall target attainment over 140 %. Light green = overall probability of attaining spawning target higher than 75 %. Yellow = overall probability of attaining spawning target between 40 and 74 %, overall target attainment above 75 %. Orange = overall probability of attaining spawning target below 40 %, stock has had an exploitable surplus in at least 3 of the last 4 years. Red = stock had an exploitable surplus in less than 3 of the last 4 years.

A lower than 40 % overall probability of reaching the spawning target over the last 4 years (corresponding to the orange colour in Figure 70) should, following NASCO guidelines, automatically trigger the formulation of a recovery plan for the affected stock. Seven of the 11 evaluated stocks are currently in this situation. It is important to note here that the worst status was found for stocks that have little or no monitoring (with the exception of Lákšjohka). In order to minimize the risk of overestimating the spawning stock size, exploitation estimates for the non-monitored areas must be selected cautiously with broad uncertainty ranges. An implementation of a broad well-designed monitoring program, as suggested in chapter 5, would enable us to evaluate all areas with narrower and more precise knowledge-based estimates.

It is, however, important to realize that the spawning stock estimates of the three main headwater rivers deviate so significantly from the respective spawning targets that it is extremely unlikely, regardless of the use of wide and conservative exploitation estimates, that these stocks might be anywhere close to a healthy status.

The main pattern summarized in Figure 70 is that the salmon stocks found in the three main headwater river systems, in addition to the Tana main stem (MS) stock, are doing worst in terms of stock status. This is an expected pattern, given that exploitation is the main impact factor affecting salmon stocks in Tana. The headwater stocks have the longest migration route and are affected by fisheries over the longest distances, and these stocks therefore experience the highest total exploitation rates in Tana. The Tana MS salmon is affected by the intensive main stem fisheries throughout the fishing season, while in comparison, tributary stocks escape the main stem fisheries as soon as they are able to enter their respective home tributaries.

The evaluation of Tana MS salmon is the most difficult to achieve. With the current lack of any main stem fish counts, we have to combine a set of information from different sources and different tributaries in order to estimate the status of the Tana MS stock complex. We use genetic stock identification from five years (2006-2008 and 2011-2012) in order to be able to estimate how many Tana MS salmon were caught in the mixed stock main stem fisheries. In addition, we need an exploitation estimate. We currently use the average estimated main stem exploitation rate of the other evaluated stocks as an estimate of the Tana MS exploitation rate. There is, however, one major problem with this approach. Whereas the different tributary stocks can escape the main stem fisheries by entering their respective tributaries, the Tana MS stock is exposed to main stem fisheries throughout the fishing season. Using the average main stem exploitation rate of the tributary stocks therefore likely underestimates the actual exploitation rate of Tana MS salmon, which leads to an overestimation of the Tana MS target attainment.

The lowermost tributaries in the Tana river system experience the lowest main stem exploitation rates. Despite this, stock status in Máskejohka remains poor. Due to a lack of fish counting data from Máskejohka, we have had to resort to a cautious exploitation rate estimate based on other rivers with a comparable number of active fishermen. The lack of knowledge, e.g. fish counts, means that Máskejohka definitely is a weak point in the current status assessment. However, this is the best available knowledge we have about the river and as such the current evaluation is what decisions should be based on until better knowledge becomes available.

The very poor stock situation in Lákšjohka is somewhat surprising. This stock is dominated by small-sized 1- and 2SW-females which are expected to be less exposed to net-based exploitation in coastal and main stem fisheries than many other stocks in Tana. Despite this, catches in Lákšjohka have been relatively low since 2004. The number of ascending salmon in Lákšjohka have been counted since 2009 so the poor stock situation is well-documented. Fishing activity in Lákšjohka has been significantly lowered in the last decade as the number of fishermen has decreased, but despite this, the estimated exploitation rate was still around 30 % when video monitoring began in 2009. This might indicate that the fishing pressure historically, when the number of fishermen was higher, have been too high within Lákšjohka. In the last couple of years, exploitation has decreased even further due to fishermen releasing a high proportion of the salmon. In addition to the possible high historical exploitation, the annual production levels in Lákšjohka are vulnerable. Most of the spawning areas are situated upstream of a fish ladder, and the salmon production is therefore highly dependent on how well the ladder functions.

The current status assessment of Veahčajohka/Vetsijoki was done with the same methodology as the assessment in Máskejohka, and the points made for Máskejohka above therefore are valid also for Vetsijoki. Preliminary fish counts from 2016 indicates that the estimated exploitation range used in Vetsijoki might be too high. Accordingly, the stock situation in Vetsijoki might be better than shown in the current evaluation. The status assessment of Vetsijoki will be revised in 2017 with the results of the 2016 echo sounder counts.

Ohcejohka/Utsjoki is doing particularly well in the current assessment. There is a long-term video counting time series from Utsjoki, which can be used, together with catch statistics, to estimate exploitation rates and spawning stock sizes of the Utsjoki stock complex. However, there are anecdotal, but also fairly systematic, annual observations on salmon abundance in some parts of the system, e.g. stretches of Kevojoki, indicating less than favourable status. Snorkelling counts in upper Utsjoki in 2003 found very small numbers of spawners and a genetic bottleneck situation has been observed for this area. The status assessment in this report is a pooled assessment for the whole Utsjoki river system, and a contrasting status situation might hide behind the seemingly healthy stock level reported in our assessment.

A particular problem in Utsjoki is that the presence of monitoring actually gives fishermen an incentive for not reporting their catch. An underestimated catch will in this case lead to an overestimated spawning stock size. The situation is vice versa for rivers without video counting, the incentive here would be to increase the reporting as that would increase the estimated spawning stock size. This is clearly an area we need to solve in future reports.

The presence of a very small population such as Áhkojohka/Akujoki in the status assessment is valuable. Small salmon populations are vulnerable, with high annual fluctuations caused by chance alone. This is in itself important information and something managers need to keep in mind. The inclusion of Akujoki has been critized on this basis, and this criticism raises an important question: Are the big stocks more valuable than the small ones? At which point is the cost of accommodating small stocks in a mixed-stock fisheries regulation too high? Small stocks are inherently more vulnerable, and in that sense needs more protection. But is it worthwhile? However, at this point, the stock situation in Akujoki has not been used to argue changes to the main stem fisheries. And for the purposes of the status report, Akujoki represents a valuable indicator river with a long time-series of snorkeling data that accurately reflects the actual number of spawners present.

The evaluation of Kárášjohka and Iešjohka both depend on the exploitation estimates from two years of acoustic counting in upper Kárášjohka (2010 and 2012). The results of both countings yielded roughly comparable exploitation estimates, and these estimates have therefore been used throughout the assessment of both Kárášjohka and Iešjohka. There is, however, one currently unsolved methodological problem with the assessment. The salmon catch in lower Kárášjohka is a mixture of salmon belonging to Kárášjohka, Iešjohka and their respective tributaries. We have not tried to separate Iešjohka-salmon from the lower Kárášjohka catch, and the status assessment of Kárášjohka (+tributaries) therefore somewhat overestimates the target attainment of Kárášjohka. This problem does not affect the status assessment of Iešjohka.

The assessment of Anárjohka/Inarijoki (+tributaries) is based on the same approach as Máskejohka and Veahčajohka/Vetsijoki and therefore vulnerable to the same problems. The estimated stock status of Anárjohka/Inarijoki is very poor. At the same time, the long-term juvenile monitoring of Anárjohka/Inarijoki indicates that average juvenile densities might have increased. On the other hand, estimates of the number of Anárjohka/Inarijoki salmon in the mixed stock main stem fisheries in comparison to other stocks indicate that the status of the salmon stock within Anárjohka/Inarijoki itself is poor, on a comparative level to Kárášjohka and Iešjohka, while the status of the Norwegian tributary Goššjohka likely is much better. There are a lot of sources of variation when it comes to numbers from juvenile surveys that make it very difficult to see how the results of the juvenile monitoring can be used in practice in the status evaluation. For this reason, an actual count of ascending salmon in Anárjohka/Inarijoki is the only option for changing the current evaluation.

Overexploitation had either a moderate or a large effect in all evaluated parts of the Tana, except Pulmankijoki, Utsjoki and Váljohka (Figure 71). When interpreting this result, it is highly important to remember the definition of overexploitation. It is defined as the reduction in spawning stock size below the spawning target that is caused by exploitation. Figure 71 therefore illustrates, in particular, how the current fisheries regulation is negatively favouring the headwater stocks. The estimated pre-fishery abundance of different stocks tells us the amount of fish doing their spawning migration each year. Some of these fish are taken in coastal fisheries, some in main stem fisheries and some in their respective tributaries. For the overexploited stocks, the total catch exceeds the sustainable surplus.

A common criticism of the status assessments in Tana is that we overlook the importance of other factors, such as natural variation and predation. This criticism is partly based on a misunderstanding of the above point. Regardless of natural variation and regardless of the presence or absence of predation, a basic tenet of fisheries management is that a fishery should be regulated so that it only exploits the surplus production. This is not at all the case with the current regulation in Tana, and this discrepancy must be solved before any discussions about other possible impact factors can be taken seriously.

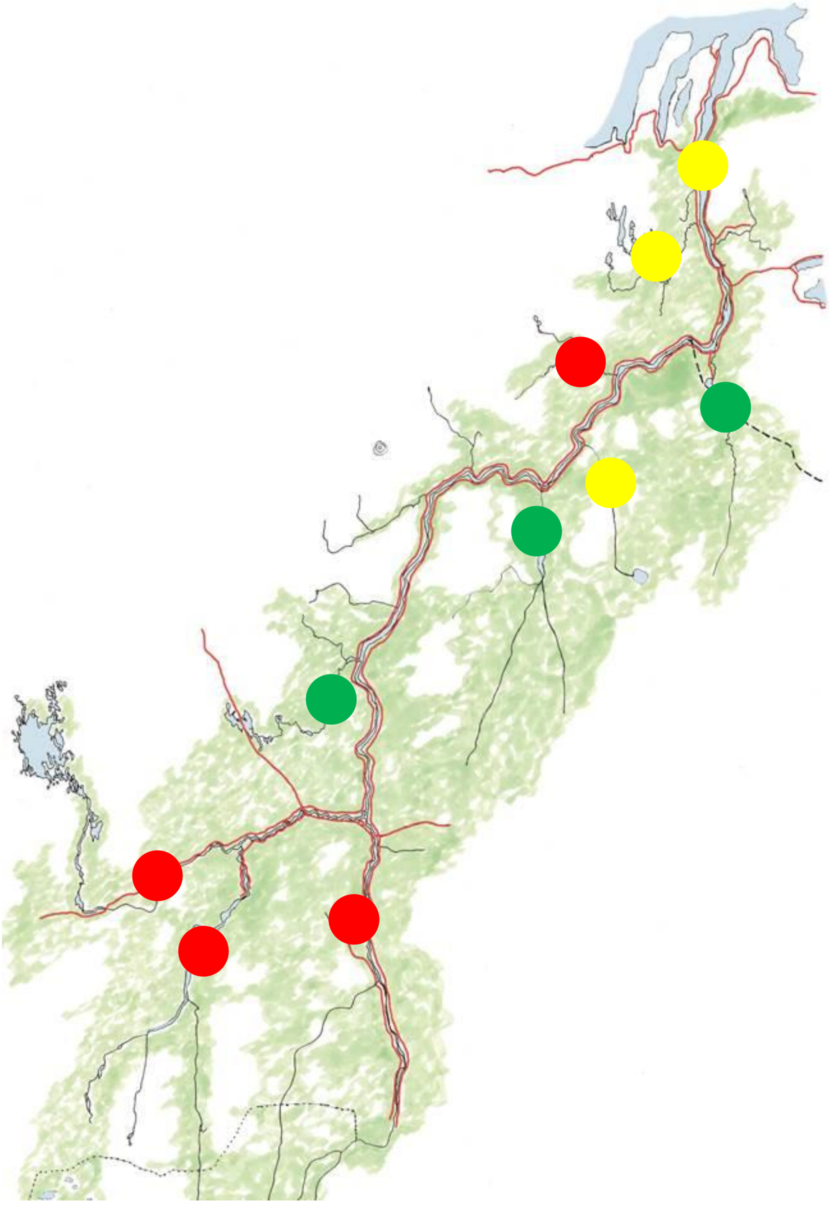


Figure 71. Map summary of the estimated overexploitation experienced in various parts of the Tana/Teno river system in the years 2012-2015. Symbol colour represents the extent of the overexploitation (in terms of percentages of the spawning target). Dark green = no effect (0 % of the spawning target), light green = small effect (<10 %), yellow = moderate effect (10-30 %), red = large effect (>30 %).

4.7 The role of local/traditional knowledge in the current status evaluation

4.7.1 The role of local/traditional knowledge within the scientific status assessment

Over the years, a recurring criticism of the scientifically based status evaluations of salmon stocks in Tana/Teno has been that local/traditional knowledge has not been sufficiently acknowledged (see Joks & Law 2016 and Solbakk 2016 for some recent examples). From our point of view, this criticism is fundamentally wrong.

The evaluation presented in this report is a scientific probability-based assessment of stock status. A major strength of this approach is that it allows us to incorporate information from a number of different sources into a coherent framework that is both open and flexible. Lack of information or diverging information is directly reflected in the presented probabilities. New information can dynamically change the conclusions (e.g. see the current evaluation of Váljohka and how it has changed compared to earlier evaluations) and improve the precision of the assessment (again, reflected in the probability values we present).

Within this framework, relevant local/traditional knowledge can easily be accommodated. However, it is crucial to realize exactly what we are saying here. We have taken a scientific procedure and identified the levels at which we have possible sources of supplemental information in addition to the scientifically gathered information. In this procedure, we need information that is as unprocessed and unbiased as possible. This is basically what would be the raw data material for a LEK/TEK researcher. Examples of local knowledge that has been used in this process are information from different tributaries about habitat quality, historical and present salmon distribution, information about the extent and distribution of adult salmon spawning activity (crucial for estimating production potentials) and information about the fishing experiences in different areas (which is crucial for estimating exploitation levels from year to year).

We find that there is a significant amount of confusion surrounding the research knowledge in Tana, especially when it comes to its data basis and what kinds of information is relevant and not relevant for the conclusions that are provided. The work of the monitoring group, as presented in this report, is a comprehensive and thorough attempt at synthesizing all available data sources into a coherent status evaluation that provides the best possible summary of the current stock status in Tana. This is an open process that is constantly improved with established scientific methods and the gathering of new data, including local and traditional knowledge.

Arguments about researchers not using local/traditional knowledge is also fundamentally flawed. A core issue in this argument stem from a misunderstanding about the possible relationship between natural science and local/traditional knowledge research. Natural sciences are concerned with finding objective truths, while the research of local/traditional knowledge is relativistic and descriptive about people and their knowledge-belief system. Parts of this belief system pertain to the fishermen and how they exercise their fishery, other parts pertain to the salmon. It is the latter that is relevant for the science-based status evaluation. The use of the latter pose a challenge that cannot be solved by segregating the domain of natural science and the domain of local/traditional knowledge. Rather, the only possible solution is that we as biologists need to find proper input levels for alternative sources of data, of which local/traditional knowledge is one. The Tana working group on salmon monitoring and research remains strongly committed to improve its evaluations with new knowledge from different sources.

4.7.2 Relative roles of the status assessment and the LEK/TEK in management decision-making

The perspective changes when moving from the requirements and needs of a science-based status evaluation towards the data-basis needed for management decision-making. Management decisions must balance two (often conflicting) aspects: 1) the needs of the salmon stocks, and 2) the needs of the fishermen. As such, a successful fisheries management needs to manage both salmon and people, and in this context both natural sciences and social sciences provide valid input that should affect management decision-making.

It is in the management of people and their fishery that LEK/TEK has its real strength. This part of LEK/TEK stands on its own feet. This is not at all the case for aspects of LEK/TEK that pertains to the salmon. These parts need to be evaluated through the science-based framework described above. But a successful future management regime needs alternative sources of input. It needs LEK/TEK to manage people and their fishery, and it needs the natural sciences to assess the fisheries effects on the salmon. Researchers from both fields need to acknowledge each other's strengths and make active contact with locals in order to disseminate and provide an arena where concerns, meanings and knowledge can be exchanged and discussed.

4.7.3 Brief discussion of alternative explanatory factors

What then about other issues and factors raised by locals? Locals commonly raise a number of alternative explanatory factors such as natural variation, predation and a discrepancy between number of salmon seen/caught and number of salmon counted by monitoring methods. All of these have been heard and evaluated, and for various reasons deemed irrelevant for the conclusions presented in this report.

Predation is the factor that most people raise. The point that is made is that while the locals historically were able to control the number of predators, this control has disappeared in recent years and as a result, the number of predators have proliferated. This has been repeatedly discussed in previous status reports, here we will briefly reiterate some points.

Predators in Tana are part of a complex ecosystem with multiple predator and prey species. Within this complexity, it is simply impossible for predation to singularly affect salmon in the negative way that some people claim. The reason for this lies within the very nature of predation, which can be very simplified as follows: A predator selects its prey based on availability and ease of capture. If predation starts affecting the number of salmon, the number of prey individuals for the predator decreases and it becomes more difficult to catch salmon. The predator will, accordingly, focus more on other prey species, of which there is an abundance in Tana. Also, as the number of prey individuals decrease, less food is available for the predators and the number of predators will decline. This again causes the predation rate to decrease, allowing for more prey individuals to survive. This leads to a cyclic balance, not a strong negative decline.

The number of salmon are declining on both sides of the Atlantic and despite decades of research, not one single example has been able to identify predation as a major cause of decline. We are not saying here that predation is not important, on the contrary, predation is highly important for ecosystem structure and function. Predation occurs all the time, predators eat other organisms and are even eaten themselves. As such, predation is a constant factor in the life cycle of salmon, and it is a factor that is highly important when it comes to structuring the ecosystem. Predation affects the relative numbers of different species and thereby also affects the relative levels of competition and relative levels of predation. However, all of these interactions make it really hard to predict what effects would arise from efforts to control the number of different predators.Changing the numbers of one predator might increase the level of competition or the number of other predators, which would negate any potential positive effects.

What about the stock status pattern seen in Tana? It is highly unlikely that the observed pattern can be explained by predation. E.g., pike is a major predator of salmon juveniles and smolt in Tana. This is predominantly a predator found in slow-flowing areas of the river system. There are three tributaries in Tana with a healthy stock situation in the current assessment (Figure 70), and a tributary such as Váljohka has extensive slow-flowing areas with potentially heavy pike predation. Yet, the salmon seem to be doing well.

On a more general level, trout and salmon share many characteristics when it comes to spawning and early within-river life history stages and should both be exposed to the same within-river predation threats. Yet, local knowledge states that the trout seem to be doing very well whilst salmon is struggling. This should not be the case if predation was at such levels that it could cause big declines in salmon numbers.

An additional example comes from the Tana estuary which harbours a colony of common seal. The local claim has been that the number of seal has increased and become a major threat for the salmon, predating both migrating smolt and returning adults. However, salmon is only temporarily exposed to the seal, whilst trout are exposed to seal predation throughout the summer. If seal predation (or estuary bird predation) was a significant problem, this should affect the trout to a much larger negative extent than the salmon. Yet this is not the case, further undermining the hypothesis about predation as an important threat factor.

A further point should be made here. Regardless of any negative impact of predation, we should not dismiss the singular fact that this report documents a mismatch between the number of salmon caught and the number of salmon spawning for most salmon stocks in Tana. The total accumulated exploitation of all fisheries affecting Tana salmon takes a too high proportion of the available salmon, leaving too few fish for spawning. This needs to be addressed before any other potential impact factors are examined. Regulating the exploitation rates are a factor that helps immediately. Controlling predator numbers is a significantly slower and more uncertain process. Within this context, predation is a needless distraction. The current singular focus on the role of fishery should not be regarded as a dismissal of local knowledge. Rather, it is the result of a conscious evaluation of the observed patterns and all sources of information. The significant discrepancy between estimated exploitation rates and the maximum sustainable exploitation rates point to a management situation that is not sustainable regardless of the situation with predators.

What then about natural variation? The core of this argument is that the abundance of salmon in Tana is cyclical. Bad years come and go and have always been followed by good years, which is an observation that can easily be observed in the historical catch records. By itself, the argument is deeply troubling in the sense that it absolves everyone of any responsibility when it comes to stock development. But the argument can be outright dismissed when it is viewed in context of the stock development elsewhere in Finnmark (and northern Norway, Figure 23). Natural variation is caused by environmental factors affecting the salmon over large scales, both within-river and marine. Historically, Tana has closely followed the fluctuations of other Finnmark rivers. This correlation has broken down and Tana is cyclical in a downward manner while neighbouring rivers are seeing record numbers of salmon.

The local argument that has the most merit is the one that says that there are more salmon in the river system than the scientists are able to observe. The status evaluation can never be better than the data that are put into the evaluation, and we lack physical fish counting for most areas in Tana. In the absence of such data, we have to make a conservative evaluation and this might easily be unrealistically negative.

However, the argument that there is “enough” salmon in Tana is based on two sources of observation that both are problematic. The first observation is that the fishermen have caught high numbers of kelts during drift net fishing in recent years, and the argument is that this is an indication of a healthy stock status. This argument has several problems. First of all, the number of kelts caught in the driftnets are highly correlated with the spring climate. Increasing water temperature lead to increasing kelt movement, which increases their susceptibility for being caught. Incidentally, we have frequently seen early snow melting and relatively high water temperatures during the driftnet season during the last couple of decades. Also, there are around 30 distinct salmon stocks with contrasting stock status within the Tana river system. A general number of kelts found in the drift net fishery does not provide any information about the specific status of the weaker stocks within the river.

The second observation comes directly from the catch records of the active fishermen. Most active fishermen in the lower part of Tana can point to really good catches in recent years. It is of prime importance to remember that fishermen in this area exploit salmon from all populations in Tana. The lower part of the Tana main stem is therefore the area where we are least likely to observe the effects of any population declines. Another point is that the number of active fishermen has dropped significantly in the lower main stem from the 1980s to today (documented e.g. in Solbakk 2016). There are fewer fishermen sharing the amount of salmon available, which inevitably leads to what initially looks like a paradox: Researchers are stating that stock status decline, while fishermen can demonstrate that their personal catches are increasing. The reason for the increased catches are not an increasing stock status, rather it is the result of lower competition among the fishermen.

A further problem in this is that the sequential nature of the Tana main stem fisheries, decreasing numbers of active fishermen will not automatically lead to decreasing exploitation rate. The most important effect of decreasing the number of active fishermen has been moving the exploitation further upstream in the main stem, making a larger proportion of the salmon available for rod fishing in the border areas. This negates the argument from right holders in Tana, as it can be found in Solbakk (2016), that a lower number of stationary nets in Tana has decreased the fishing pressure.

5 Design and implementation of a stock-specific monitoring programme in Tana

5.1 Background

Riverine and coastal areas of the Tana River represent one of the world's most important systems for Atlantic salmon, and are by far the most important for Atlantic salmon in Norway and Finland. As indicated in the chapter on threat factors (chapter 3), fisheries in and outside the river represent the main factor affecting the salmon. Hydropower development, pollution or fish farming do not exist in or near the Tana River. There are strong indications that several salmon stocks in the Tana system are significantly overharvested, and mixed stock fisheries, both in coastal areas of Finnmark, and in different parts of the Tana River represent major challenges for future management of the Tana salmon.

The NASCO Precautionary Approach emphasises the use of management targets as a primary tool when evaluating stock status, and the establishment of management actions that are triggered when stock status fails to meet the designated target. This procedure turns the management into an adaptive knowledge-based regime which is transparent and predictable in its decision-making, away from the much more abstract, obscure and rigid traditional regime that current regime that has proven to be insufficient in stopping the negative development in many stocks in the river system.

The present report points towards a target-driven knowledge-based adaptive management which should be fully adopted in the Tana system in the future. Such a management regime puts great demands on the level of monitoring and research that is needed, especially since most of the fisheries in Tana are mixed-stock fisheries. A mixed-stock fishery greatly complicates the management of each stock. Stocks differ in their status, with some stocks doing significantly worse than others. Without detailed exploitation knowledge, the only way to counteract this would be to carefully control the overall exploitation rate in the mixed-stock fishery to ensure the conservation of less-productive stocks within an area of mixed-stock fishery. Overexploitation will, eventually, push the numbers of returning salmon stocks below sustainable levels, and as salmon abundance declines, diversity and resilience are reduced and risk of extinction is increased.

Fish management basically consists of the following four questions:

1) For each stock present in the Tana river system, how many fish should survive to spawn each year?
2) What is the pre-fishery abundance of each stock?
3) Given points 1 and 2, how many fish can then be caught from each stock?
4) And following point 3, where should these fish be caught?

These questions and their implications are summarized in Figure 72. The main challenge for a monitoring programme is to be able to provide accurate information on stock-specific pre-fishery abundance, exploitation and spawning stock size. A detailed discussion on how to achieve some of this is provided in the report from the Norwegian-Finnish temporary working group on monitoring and research in Tana (Johansen *et al*. 2008), and most of this discussion still applies today. A further summary of this discussion is provided in the rest of this chapter.

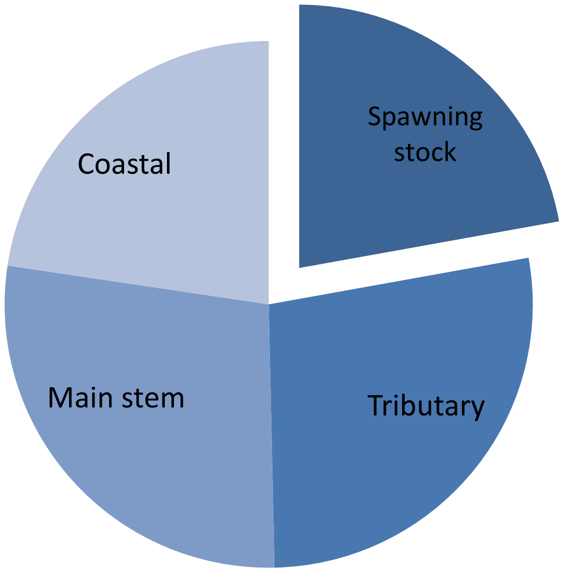


Figure 72. The figure shows how management of a stock really is about allocation. The whole pie chart represents the pre-fishery abundance of a stock, with a proportion caught in different fisheries (coastal, main stem and tributary in this case). The surviving remainder represents the spawning stock size, which should be compared with the stock management target. Ideally, the allocation of catch in different fisheries should be controlled so that the surviving spawning stock remains larger than the target. The pre-fishery abundance will fluctuate from year to year, meaning that the surplus available for exploitation also will vary.

5.2 Catch statistics

Accurate catch and fisheries statistics form a fundamental part of the stock monitoring, and both countries should establish routines that ensure a comprehensive and detailed statistic is available relatively quickly after each fishing season. This is such a fundamentally important issue that we therefore are not including it as part of an actual monitoring programme.

5.3 Implementation plan for a Tana stock monitoring programme

We have designed the monitoring programme in order to cover the following three core areas of information that are all necessary to follow the Tana salmon recovery on a stock-specific basis, while still allowing for a fairly large-scale salmon fishery:

1) **Stock-specific status assessment** (spawning escapement compared to target)
2) **Stock-specific exploitation patterns** (especially in areas of mixed-stock fisheries)
3) **Juvenile production** (i.e. the resulting production of the spawning escapement)

This will be achieved with three main monitoring methods:

1) **Fish counting**, either ascending number of adult salmon or spawner counts.
2) **Main stem catch samples**, in the form of scale samples that provide life history data and genetic stock identification.
3) **Electrofishing**

The monitoring programme design is based on a system of index rivers that have been selected to reflect the status and exploitation seen in different parts of the river system, from the lowermost part of Tana to the uppermost headwater areas. The monitoring will provide data on exploitation effects starting with the Tana river mouth. All stocks in Tana are also affected by mixed-stock coastal fisheries along the coast of Nordland, Troms and Finnmark, but these fisheries are outside the scope of the programme defined in this report.

5.4 Stock-specific status assessment using a system of index rivers

The basis of the status assessment is a stock-specific comparison between number of spawners after the fishing season and the stock spawning target. To achieve this, fish counting must be performed at some point. There are several possibilities here:

1) Counting spawners after the fishing season. This provides a direct estimate of target attainment.
2) Counting the fish entering a tributary and then use the tributary catch statistic to estimate the number of spawners.
3) Counting the number of fish in the Tana main stem and use a combination of catch statistics and genetic stock identification of mixed-stock fishery catch samples to estimate exploitation rates and, subsequently, spawning stock size.

Logistically and technically, fish counting in the Tana main stem remains a daunting task, and it is therefore our current recommendation to focus the counting on tributaries and then use genetic stock identification of main stem catch samples to estimate stock-specific Tana main stem exploitation effects. It is, however, possible to do main stem counting in the Tana, and the methods and resources involved in this should be examined more closely. A positive effect of a total fish count from the main stem is that it would simplify the estimation of exploitation rates and pre-fishery abundances. There is, however, one important caveat in this: A total fish count of migrating salmon in the main stem is not really useful unless it is supplemented with genetick stock identification of main stem catch samples (necessary to ensure that we have stock-specific resolution of the fish counts) and fish counting in some selected tributaries. A total fish count in the main stem by itself would not fulfil the needs of a target-based stock-specific management regime.

Actual spawner counts can be obtained in smaller tributaries, but this is logistically difficult in larger tributaries.

There is substantial variation in the exploitation rates experienced by different stocks in different fisheries within the Tana river system. For instance, the Tana main stem exploitation of salmon from Máskejohka is much lower than the Tana main stem exploitation of salmon from Iešjohka. The main reason for this is different migration distances in the Tana main stem. A short migration distance (tributaries in the lower part of Tana) leads to a low main stem exploitation rate, while a longer migration distance (tributaries in the middle and, especially, upper parts of Tana) leads to a higher main stem exploitation rate. Because of this, we need a spatial distribution of the fish counting.

We therefore propose dividing the Tana into three different monitoring areas:

1) The lower Norwegian part of the Tana main stem
2) The common border area of the Tana main stem
3) Upper Tana (the three main headwater rivers Anárjohka, Kárášjohka and Iešjohka)

This geographical distribution will also be of invaluable help in the evaluation of the exploitation in various parts of the main stem mixed-stock fishery, as the localization of fish counting in tributaries in each of the three monitoring areas allows us to more finely calibrate exploitation rate estimates of different parts of the Tana main stem.

5.4.1 Large index rivers

We propose five large index rivers with continuous fish counting in Tana:

1) Lower part:
    a. **Máskejohka** (N). This is a medium sized river that could potentially be counted with video, but as the river flows through areas with lots of clay there are long periods of low water

visibility that excludes video as an effective solution. Ascending salmon must therefore be counted acoustically with an echo-sounder.

2) Middle part:
    a. **Lákšjohka** (N). Video cameras have been operated in this tributary since 2009.
    b. **Utsjoki** (F). Video cameras have been operated in this tributary since 2002.
3) Upper part:
    a. **Kárášjohka** (N). This is a large-sized tributary in the upper part, and forms the Tana main stem at its confluence with Anárjohka. The size of this river precludes the use of video, and the ascending salmon must therefore be counted acoustically with an echo-sounder.
    b. **Anárjohka/Inarijoki** (N/F). The size of this river precludes the use of video, and the ascending salmon must therefore be counted acoustically with an echo-sounder. The run timing of Anárjohka/Inarijoki differs from the neighbouring Kárášjohka and Iešjohka. The latter two tributaries have early-migrating salmon, whereas the run-timing of Anárjohka/Inarijoki-salmon is later, comparable to the run-timing of Tana main stem salmon.

In addition, we propose video counting in three additional tributaries: Vetsijoki, Váljohka and Goššjohka. These could be covered in a rolling plan in which each river was counted every third year.

5.4.2 Small index rivers

As a supplement to the large index rivers, we recommend having annual spawner counts in a two small tributaries. These smaller rivers can be covered very cost-efficiently with snorkelling and are, accordingly, much easier to monitor than the larger rivers.

The following tributaries are suggested:

1. Upper parts of the **Pulmanki**-system (F)
2. **Akujoki** (F)

5.5 Controlling the Tana main stem mixed-stock fishery

The complex stock situation in Tana, with 20-30 uniquely different stocks, means that large parts of the Tana fisheries are mixed-stock fisheries. This is especially the case for the Tana main stem fisheries, which affects all stocks within the Tana river system. However, due to differences in stock life history compositions and run timings, various stocks within the river system will be affected differently by the main stem fisheries, and these differences will have both a spatial and a temporal variation to them.

Within the context of a future adaptive management regime in Tana, the target attainment of each stock is evaluated individually, resulting in stock-specific recommendations about exploitation pressure with poor target attainment resulting in a recommendation of lowered overall exploitation rates. In this system, it is imperative that we are able to separate how each stock is exploited within the main stem mixed-stock fishery. And this knowledge must be stock-specific for different areas of the main stem, different fishing gears, different times of the season and different life history classes.

Taken together, the following annual monitoring activities will provide the necessary knowledge to control the mixed-stock fishery:

1) Collection of **catch samples** (fish scales) from all main stem fisheries (all fishing gears, all areas, all weeks of the season)
2) **Scale reading**. This part of the monitoring provides essential information about the life history composition of the catch.
3) **Genetic stock identification**. With this tool, it becomes possible to assign a stock of origin for every catch sample. This is necessary to identify the extent of exploitation of the different stocks.

5.6 JUVENILE PRODUCTION

Juvenile assessments using electrofishing is a cost-effective monitoring method that has been used in the Tana river system since 1979 with a total of 57 sites being annually monitored. These sites are spaced out in the Tana main stem, the river Inarijoki/Anárjohka and the river Utsjoki/Ohcejohka. This program has provided data on changes in juvenile salmon production (densities), occurrence and densities of other fish species, and long-term growth variations of juveniles.

In addition, frequent electrofishing mapping surveys have been undertaken in most Tana tributaries. Surveys like this are potentially highly informative for assessments of spawning and territory saturation, which is an important part of the evaluation of target attainment in various parts of the Tana river system.

5.7 OVERALL MONITORING OUTPUT

The monitoring outlined here is designed to be complementary, and taken together, the three approaches (fish counting in tributaries, main stem catch sampling, juvenile production) provide a complete basis for:

1) Stock-specific evaluations of spawning target attainment
2) Stock-specific evaluations of exploitation rates in the main stem mixed-stock fishery
3) Stock-specific evaluations of the effects of different regulations as they are implemented

The approaches are mutually beneficent but also mutually dependent, e.g. the evaluation of the main stem mixed-stock fishery depends highly on the existence of fish counting in tributaries as those counts serve as a calibration for the relative exploitation rates seen in the main stem catch samples.

5.8 DATA INFRASTRUCTURE, SHARING AND DATABASES

The monitoring programme outlined above will generate large amount of data on a variety issues important for sustainable management of the Tana stocks. The collected information will doubtless continue to be important, and it is of great importance that these data are available for future management and research. We strongly recommend that infrastructure and routines for data sharing and storage are established to ensure that these important data are not corrupted or lost. Such measures will ensure transparency regarding the scientific basis of the bilateral management, and shared access to data will further prevent the possibility of misgiving between the two countries in regard to data interpretation.

5.9 MONITORING AND MID-SEASON VS. END-OF-SEASON EVALUATIONS

The suggested monitoring programme is mainly tailored towards fulfilling the needs of a comprehensive annual assessment where stock status is evaluated in the winter between fishing seasons. There are additional challenges involved in designing a monitoring programme that also can provide faster information during the fishing season, and the framework and logistics of this need further consideration.

5.10 MONITORING ACTIVITIES AND COST ESTIMATES

In the following tables, monitoring activities are summarized with current cost estimates. The cost estimates are based on joint Norwegian-Finnish participation in the monitoring, with an estimated cost of joint proposals (Norwegian and Finnish institutes together) within a competitive bidding framework with open calls for the different monitoring tasks.

In summary, the annual cost estimates in the tables below are € 310 000 for fish counting, € 200 000 for monitoring the main stem mixed stock fishery and € 85 000 for monitoring of juvenile production. Total annual running cost then becomes € 595 000.

There are some additional annual costs not directly related to the monitoring tasks below. Foremost are the costs associated with running the Norwegian-Finnish working group on salmon monitoring and research in the

Tana river system. Current annual running costs to meet the working group mandate on the Norwegian side are € 50 000. The second additional cost estimate below concerns specific research needs that might arise from year to year.

5.10.1 Fish counting

	Method	Investment costs	Annual costs	Country
Large index rivers				
Lower part:				
Máskejohka	Acoustic	€ 80 000*	€ 65 000	N
Middle part:				
Lákšjohka	Video	€ 10 000**	€ 45 000	N
Ohcejohka/Utsjoki	Video	€ 20 000**	€ 45 000	F
Upper part:				
Anárjohka/Inarijoki	Acoustic	€ 80 000*	€ 65 000	N/F
Kárášjohka	Acoustic	€ 80 000*	€ 65 000	N
Rolling plan:				
Vetsijoki, Váljohka, Goššjohka	Video	€ 10 000**	€ 45 000	N/F
Small index rivers				
Upper Pulmanki	Snorkelling	€ 1 500***	€ 5 000	F
Áhkojohka/Akujoki	Snorkelling		€ 5 000	F
		€ 281 500	**€ 340 000**	

* Investment costs, acoustic: These are costs that will have to be realized at the start of the monitoring programme. Subsequently, acoustic equipment will have to be replaced at a c. 10-year interval.

** Investment costs, video: These costs will be realized when old equipment needs replacing, at a c. 10-year interval.

*** Investment costs, snorkelling: These are dry suit equipment that must be replaced every second/third year.

5.10.2 Main stem fisheries monitoring

	Collection costs	Analysis costs	Country
Scale sampling programme	€ 50 000	€ 50 000	N/F
Genetic stock identification		€ 100 000	N/F
	€ 50 000	**€ 150 000**	

5.10.3 Juvenile production

	Investment costs	Annual costs	Country
Electrofishing (long-term sites)	€ 5 000*	€ 35 000	F
Tributary mapping		€ 50 000**	N/F
	€ 5 000	**€ 85 000**	

* Investment costs, electrofishing: These costs will be realized when old equipment needs replacing, at a c. 10-year interval.

** Annual costs, tributary mapping: Most parts of the Tana river system are not covered by the permanent sites. A useful tool for monitoring the stock situation in other tributaries is electrofishing trips. It is therefore proposed to do mapping trips in 2-3 tributaries per year to look at juvenile densities and juvenile distribution. Annual costs here will strongly depend on which tributaries are chosen, the given figure is a rough average of three tributaries covered with a combination of Finnish and Norwegian personnel.

6 REFERENCES

Anon. (2010) Kvalitetsnormer for laks – anbefalinger til system for klassifisering av villaksbestander. Topic report from the Scientific Advisory Committee for Atlantic Salmon Management in Norway, 1, 110 pp.

Anon. (2011a) Prognoser for lakseinnsig, regnbueørret og klimaendringer: utfordringer for forvaltningen. Topical report from the Scientific Advisory Committee for Atlantic Salmon Management in Norway, 2, 48 pp.

Anon. (2011b) Status for norske laksebestander i 2011. Report from the Scientific Advisory Committee for Atlantic Salmon Management in Norway, 3, 285 pp.

Anon. (2012a) Status of the River Tana salmon populations. Report from the Working Group on Salmon Monitoring and Research in the Tana River System, 1-2012, 99 pp.

Anon. (2012b) Status for norske laksebestander i 2012. Report from the Scientific Advisory Committee for Atlantic Salmon Management in Norway, 4, 103 pp.

Anon. (2014) Status for norske laksebestander i 2014. Report from the Scientific Advisory Committee for Atlantic Salmon Management in Norway, 6, 225 pp.

Anon. (2015) Status of the River Tana salmon populations. Report of the Working Group on Salmon Monitoring and Research in the Tana River System, 105 pp.

Berg, M. (1964) Nord-Norske Lakseelver. Tanum, Oslo.

Elo, K., Vuorinen, J.A. & Niemelä, E. (1994) Genetic resources of Atlantic salmon (Salmo salar L.) in Teno and Näätämö rivers, northernmost Europe. Heredity, 120, 19-28.

Erkinaro, J., Økland, F., Moen, K. & Niemelä, E. (1999) Return migration of the Atlantic salmon in the Tana River: distribution and exploitation of radiotagged multi-sea-winter salmon. Boreal Environment Research, 4, 115-124.

Erkinaro, J., Niemelä, E., Vähä, J.-P., Primmer, C.R., Brørs, S. & Hassinen, E. (2010) Distribution and biological characteristics of escaped farmed salmon in a major subarctic salmon river. Implication for monitoring. Canadian Journal of Fisheries and Aquatic Sciences, 67, 130-142.

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.

Forseth, T., Fjeldstad, H.-P., Ugedal, O. & Sundt, H. (2007) Effekter av vassdragsregulering på smoltproduksjonen i Åbjøravassdraget. NINA Rapport, 233, 87 pp.

Gjøen, H.M. & Bentsen, H.B. (1997) Past, present, and future of genetic improvement in salmon aquaculture. ICES Journal of Marine Science, 54, 1009-1014.

Hard, J.J., Gross, M.R., Heino, M., Hilborn, R., Kope, R.G., Law, R. & Reynolds, J.D. (2008) Evolutionary consequences of fishing and their implications for salmon. Evolutionary Applications, 1, 388-408.

Hindar, K., Diserud, O., Fiske, P., Forseth, T., Jensen, A.J., Ugedal, O., Jonsson, N., Sloreid, S.-E., Arnekleiv, J.V., Saltveit, S.J., Sægrov, H. & Sættem, L.M. (2007) Gytebestandsmål for laksebestander i Norge. NINA Rapport, 226, 78 pp.

Hutchings, J.A. (2009) Avoidance of fisheries-induced evolution: management implications for catch selectivity and limit reference points. Evolutionary Applications, 2, 324-334.

Johansen, M., Erkinaro, J., Niemelä, E., Heggberget, T.G., Svenning, M.A. & Brørs, S. (2008) Atlantic salmon monitoring and research in the Tana river system. Outlining a monitoring and research program for the River

Tana within the framework of the precautionary approach. Report from the Norwegian-Finnish working group on monitoring and research in Tana, 64 pp.

Johansen, N.S. 2015. Drivtelling i Tanavassdragets sideelver 2014. Tanavassdragets fiskeforvaltning, report 2015-02, 18 pp.

Joks, S. & Law, J. (2016) Sámi salmon, state salmon: LEK, technoscience and care. Heterogeneities.net (http://www.heterogeneities.net/publications/JoksLaw2016SamiSalmonScienceSalmon.pdf)

Karppinen, P., Erkinaro, J., Niemelä, E., Moen, K. & Økland, F. (2004) Return migration of one-sea-winter Atlantic salmon in the River Tana. Journal of Fish Biology, 64, 1179-1192.

Kuparinen, A. & Merilä, J. (2007) Detecting and managing fisheries-induced evolution. Trends in Ecology & Evolution, 22, 652-659.

Lura, H. & Sægrov, H. (1991) Documentation of successful spawning of escaped farmed female Atlantic salmon, Salmo salar, in Norwegian rivers. Aquaculture, 98, 151-159.

Moen, K. (1991) Tana - vårt beste laksevassdrag. Ottar, 185, 63-67.

Myers, R.A., Bowen, K.G. & Barrowman, N.J. (1999) Maximum reproductive rate of fish at low population sizes. Canadian Journal of Fisheries and Aquatic Sciences, 56, 2404-2419.

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

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

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

Niemelä, E. (2004) Variation in the yearly and seasonal abundance of juvenile Atlantic salmon in a long-term monitoring programme. Methodology, status of stocks and reference points. Acta Universitatis Ouluensis, A415, 54 pp.

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

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

Potter, E.C.E., Crozier, W.W., Schön, P.-J., Nicholson, M.D., Maxwell, D.L., Prévost, E., Erkinaro, J., Gudbergsson, G., Karlsson, L., Hansen, L.P., MacLean, J.C., Maoiléidigh, N.Ó. & Prusov, S. (2004) Estimating and forecasting pre-fishery abundance of Atlantic salmon (*Salmo salar* L.) in the Northeast Atlantic for the management of mixed-stock fisheries. ICES Journal of Marine Science, 61, 1359-1369.

Solbakk, Aa. (2016) Buođđu – utviklingen av garnfisket i Tanavassdraget. Med vekt på perioden 1984-2015. Fanasgieddi, 08.08.2016.

Svenning, M.-A., Falkegård, M., Fauchald, P., Yoccoz, N., Niemelä, E., Vähä, J.-P., Ozerov, M., Wennevik, V. & Prusov, S. (2014) Region- and stock-specific catch and migration models of Barents Sea salmon. Report from the Kolarctic ENPI CBC – Kolarctic salmon project (KO197), 95 pp.

Taranger, G.L., Svåsand, T., Kvamme, B.O., Kristiansen, T. & Boxaspen, K.K. (eds.) (2014) Risikovurdering norsk fiskeoppdrett 2013. Fisken og havet, 2-2014, 158 pp.

Vähä, J.-P., Erkinaro, J., Niemelä, E. & Primmer, C.R. (2007) Life-history and habitat features influence the within-river genetic structure of Atlantic salmon. Molecular Ecology, 16, 2638-2654.

Youngson, A.F., Jordan, W.C., Verspoor, E., McGinnity, P., Cross, T. & Ferguson, A. (2003) Management of salmonid fisheries in the British Isles: towards a practical approach based on population genetics. Fisheries Research, 62, 193-209.

Zubchenko, A.V., Veselov, A.E. & Kalyuzhin, S.M. (2005) Pink salmon (*Oncorhynchus gorbuscha*): problem of acclimatization in the north of European part of Russia. Report, 77 pp. (in Russian)