Kolarctic ENPI CBC – Kolarctic salmon project (KO197) - Report VI

Previous spawned salmon having origin from more than 80 stocks improves the catches and widens diversity of the Atlantic salmon life history in Kolarctic salmon project area with reference to the reconditioning of kelts in the River Tana in Norway/Finland

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Photo on the left - The biggest female previous spawned salmon known (photo: Erik Andreassen)
Photo on the right - Previous spawner (photo: Eero Niemelä)

Photo 3. Kelt - Audun Rikardsen
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Contents

Abstract

In the Kolarctic salmon project (KO197) detailed information was collected from the salmon catches including the biology of salmon in the large coastal area in Northern Norway between the counties Nordland and Finnmark in the years 2011 and 2012. In addition there was salmon scale material from the research fishery in Finnmark County in the years 2008 and 2009. Salmon catches included sea-ages of wild 1SW (1SW, one sea-winter), 2SW, 3SW and 4SW and a large variety of sea-age groups of previous spawners and kelts. Salmon can survive the post-spawning period as a post spawner by staying in the river or by migrating straight after the spawning time into the sea. From smaller rivers, without places like deep pools or small lakes, post spawners must migrate to the sea soon after the spawning. This downward migration soon after the spawning usually occurs between October-December. Perhaps in most of the rivers, especially in large rivers with suitable overwintering habitats like in the rivers Neidenelva, Tanaelva, Lakselva (Porsanger), Altaelva and in the Russian large rivers like Kola, Tuloma, Ponoi, Umba, Petchora salmon is migrating as post spawner into the sea after staying 9-12 months in rivers or even two winters like in the river Petchora. These post spawners are called kelts. After kelts have arrived into the sea they start the reconditioning for the next spawning. It has been unknown where kelts are migrating from the rivers in Kolarctic salmon project area after their arrival into the sea but some satellite tagging results indicate that their migration routes goes straight northwards from Finnmark. After surviving the reconditioning period of one, two or even three years they migrate towards their rivers of origin. Some, but very few salmon are reconditioning in a short period during the summer when they left the river as kelt and then ascending into their river of origin. Previous spawning salmon can have two distinct groups; reconditioning takes place in short time like in some months followed the spawning in previous autumn and that group of salmon is called consecutive spawners. Post-spawners that need one or more years to recondition for the following spawning are called alternate spawners.

Main results

Previous spawners occurred in the salmon catches presenting reconditioned fish from all the first time spawners of 1-4SW salmon. In Kolarctic salmon research fishery reconditioned fish of 17 different sea-age groups of salmon were caught.

The most common previous spawner salmon sea-age groups were those fish which are alternate spawners (1S1+, 2S1+, 3S1+). These salmon were on their way to spawn for the second time in their life after one full reconditioning year at sea after they have had their first spawning in the ages of 1SW, 2SW or 3SW. In the salmon material those fish with the ages of 1S+, 2S+ and 3S+ fishes represented kelts out of which some salmon could ascend into the rivers for repeated spawning as consecutive spawners after very short reconditioning period at sea. These kelts were caught all over the fjord and coastal areas.

Material collected only from Finnmark County at sea in 2008, 2009, 2011 and 2012 indicated that the most important sea-age groups within previous spawners and kelts were 1S1+ (47%), 2S1+ (15%), 1S+ (13%), 2S+ (10%), 3S1 (8%), 3S+ (3%) and in addition 4S+ and 4S1+ represented both with less than 1%. Other sea age groups formed 4%.

In the catches of male salmon, previous spawners made high proportion in the length group between 80-95 cm fish. Within the largest male salmon previous spawners made 25-35%. The largest female salmon were all previous spawners. Previous spawners are contributing the largest females into the catches so that more than 75% from fish with the length between 110 and 120 cm were previous spawner.

In Kolarctic salmon project fishermen got the first maiden salmon and previous spawners soon after they started fishing on week 18 (first week of May). The highest previous spawner catches occurred simultaneously, in June, in all the counties and then in July the catches were one third of the catches compared to June. The abundance of previous spawners increases in the early summer on the same way in all the counties and catches peak between the weeks 24 and 26 followed by a clear declining. In eastern Finnmark largest and oldest previous spawners of the age 3S1+ ascend first to the coastal areas followed then by 2S1+ and lastly the youngest 1S1+ previous spawners are target for the coastal fishery. The migration timing of the sea-age groups 1S1+, 2S1+ and 3S1+ takes place in the opposite direction in West Finnmark than in East Finnmark. Females in previous spawners migrated before males into the coastal areas. Of all the female previous spawners caught between the beginning of May and August 4th close to 20% were caught in May. This early ascend into the coastal areas indicates that previous spawners are the first salmon migrating into the rivers.

Salmon in the age groups 1S+, 2S+ and 3S+ are kelts, postspawners, which have been descending from the rives to sea early in summer and some of the kelts are still later in the summer close to the coastal areas or in fjords where they can be exploited. It is probable that most of the kelts leave the coastal areas soon after they migrated out of their rivers of origin and they migrate to ocean feeding grounds. Some of the kelts are starting their reconditioning in the fjords and in outermost coastal areas and they can stay there for longer periods or even the entire reconditioning period until they reach once again the maturity phase.

Previous spawners contributed important numbers and weights into the catches especially in the beginning of the official fishing season in June. Especially in the year 2012 previous spawners made up to 10 % of the catches in terms of mass and a little less in terms of numbers of salmon caught early June. Timing of the migrations of previous spawners in the coastal areas can vary between years. As a group of previous spawners, females and males had the same migratory pattern in both of the years 2011 and 2012. In the entire Kolarctic salmon research area peak migration period takes three to four weeks.

Previous spawners, kelts included, which had originated from seven large Regional Group (RG) areas were caught widely in many municipalities during the official fishing time in Northern Norway. Previous spawners which had Russian origin were caught during the official fishing time in the year 2012 mainly in Sør-Varanger municipality area where their proportion was c. 80% of all Russian origin previous spawners caught in Norway. The rest of Russian origin previous spawning salmon were caught in West Finnmark (Loppa and Hasvik, Porsanger) and also in Vadsø-Nesseby area.

Catches of previous spawners originating from the rivers in East Finnmark distributed between many municipalities but the highest catches and proportions were in the municipalities Vadsø-Nesseby and Sør-Varanger. Previous spawners originating from the River Tana watershed were caught mainly in the inner Tanafjord within Tana municipality but they were exploited also in smaller amounts as well in eastern municipalities (Sør-Varanger) as in western areas (North Troms) and municipalities (Loppa-Hasvik).

Previous spawners originating from the rivers in the large West Finnmark area were exploited during the official fishing time widely within the area from South Troms area to Sør-Varanger. The highest catches were caught in the outermost coastal areas in Loppa-Hasvik and in Hammerfest-Nordkapp-Kvalsund-Måsøy as well as in Alta municipality. Previous spawners originating from the rivers in North Troms area are also exploited within large geographical area covering the entire Kolarctic salmon project area.

Kelts which were caught in Kolarctic salmon project area and which had the sea-age group 1S+ originated mainly from East Finnmark Regional Group area. Russian and Tana origin kelts occurred in the kelt catches in quite small proportions and it is believed that most of kelt originating from Tana like kelts from Russian rivers are migrating straight from rivers or fjord to the high seas. In the age groups 2S+ and 3S+ kelts from West Finnmark Regional Group area formed the highest proportions of the catches.

Previous spawners and kelts together originating from West Finnmark Regional Group area made high proportions within the coastal area of their origin during the entire migration period from May to September. Salmon originating from Tana formed the largest proportion of the catch in Tanafjord in Tana municipality but also formed some proportion in most of the other areas.

The maximum number of stocks of previous spawners in the catches was in Finnmark in the week 24 when the fishery targeted towards to c. 35 stocks. The River Tana stocks made the largest proportion in Finnmark until the week 26 from all stocks of Regional Groups. From the Russian stocks most numerous in the catches were stocks from West Kola area and only a few stocks originating from East Barents and East Kola area were caught. Russian stocks formed a considerable proportion of the stocks caught in Sør-Varanger and Vadsø-Nesseby municipalities. Stocks originating from East Finnmark Regional Group area were caught throughout the summer especially in Sør-Varanger municipality area but they contributed remarkable proportion also into stock components in Vadsø-Nesseby area.

Russian origin previous spawners have passed Finnmark coastal areas by week 27 and from that week onwards previous spawners in the catches originate from Finnmark stocks (West Finnmark, Tana and East Finnmark). In Sør-Varanger municipality c. 60% of previous spawners are in the beginning of June Russian origin but later in the summer their origin is from East Finnmark rivers. Tana origin salmon create an important component in the catches in Vadsø-Nesseby municipalities in May and very early June. Almost all previous spawners caught in Tana municipality in the inner Tanafjord had origin from the River Tana system. In the outermost coastal areas like in Hasvik-Loppa and Nordkapp, Måsøy, Hammerfest, Kvalsund catch consisted of fish originating from eastern and western rivers within Kolarctic salmon project area but majority of the catch originated from West Finnmark.

Kelts after migrating from rivers into the ocean distributed widely along the coastal areas but most of them are believed to swim to ocean feeding grounds straight after descending from their spawning rivers. Those kelts which stayed for longer periods in coastal areas distributed widely to west and east from their spawning rivers. Kelts which were caught in the middle of June in Nordland mainly originated from the rivers in Nordland but some kelts originated from Troms indicating a southward migration direction. Within the large outermost coastal area in West-Finnmark covering; Loppa-Hasvik as well as Nordkapp- Kvalsund-Måsøy-Hammerfest area kelts in the catches originated mainly from rivers north from that area, which confirms the tendency of some kelts to migrate westwards. Kelts caught in Tanafjord and close to that originated from the River Tana system but also from the rivers in Varangerfjord and also some kelts from western stocks. Kelts caught in Varangerfjord area originated from Murmansk rivers, rivers west of Varangerfjord and many rivers situating in Varangerfjord.

After recondition from kelt phase to previous spawner phase salmon are mature and ready for repeat spawning. They are migrating from ocean feeding grounds to coasts and then following the coastal areas heading for their rivers of origin. Some fish are swimming very close to the shore areas and some fish are swimming within longer distance from the shoreline. It is most probable that some amount of salmon is orienting quite directly from ocean feeding grounds to the fjords where their river of origin is located.

Previous spawners which were caught in Nordland County had rivers of origin mainly in Nordland and only few of salmon originated from Troms and West Finnmark rivers. In Troms County main catch component of previous spawners was formed by salmon that originated from rivers in Troms. Some previous spawner salmon stocks originating from Nordland County were also caught in Troms indicating a migration direction from east to west. Many stocks originating from West-Finnmark and Tana river system were caught in Troms County indicating that those stocks came from their ocean feeding grounds to the coastal areas far away from their rivers of origin and migrated towards east. Wide diversity of previous spawning salmon stocks were caught in the large outermost area in Loppa-Hasvik and Nordkapp-Kvalsund-Måsøy-Hammerfest indicating the importance of stocks from Middle and East Finnmark migrate from west to east. Very few previous spawning salmon stocks from Troms area were caught in West Finnmark. Previous spawners caught in Lebesby municipality in the outermost area in Laksefjord represent stocks from large geographical area from Iokanga river in East Kola Peninsula in Russia to Kåfjordelva in Troms County with numerous stocks from the River Tana. In Tanafjord main previous spawner stock components were from the River Tana system. Previous spawner stocks caught in the long and wide Varangerfjord represent salmon stocks from rivers within the huge geographical area stretching from North Troms to East Kola Peninsula. Varangerfjord is a good example from the area where stocks are highly mixed and they are migrating at the same time to east and west and to all the rivers flowing into Varangerfjord.

1. Introduction

Salmon have a complicated life cycle, spending their first years as juveniles in rivers, and then migrating out into the open sea to feed and grow large for one to five years before returning to their home river to spawn. After spawning some salmon succeed to survive and migrate as kelts (post spawners) to the sea for reconditioning and then after one to three years they migrate along the coast back to their river of origin as previous spawners. It has been unknown where kelts are migrating from the rivers in Kolarctic salmon project area after their arrival into the sea but some satellite tagging results indicate that their migration routes goes straight northwards from Finnmark (Svenning and Prusov 2011). Within the huge Kolarctic project area, from Nordland in Norway to Petchora in Russia, there are almost 200 genetically different salmon stocks out of which in the River Tana with its tributaries alone there are 35-40 stocks (Vähä et al. 2007, 2008). During their return migration, salmon are exploited in coastal and river fisheries. These rivers in northernmost Norway, Finland and Russia support the world's largest wild Atlantic salmon stocks and resources.

This Kolarctic salmon research project is contributing to a better understanding of the behavioural processes and stock dynamics that govern the run timing of various life-history stages of Atlantic salmon. This is fundamental to the successful conservation and management of wild Atlantic salmon stocks especially in outermost coastal areas as well as in fjords with high rates of exploitation towards mixed stocks. Atlantic salmon are renowned for their migratory behaviour and for their precise homing as mature fish return to their natal river they left as smolts or as post spawners (kelts). Atlantic salmon are iteroparous; they have the potential to spawn repeatedly.

To describe salmon ecology, to evaluate the reported salmon catch composition in relation to time and location and to describe the stock specific migration patterns in the Kolarctic salmon project it was arranged collection of the basic information on the salmon catches like scales for age determination, lengths and weights, sex and number of salmon lice. The normal SSB (Statistics Norway) salmon catch data where catch is divided into three size groups masks the ecological detailed data (sea-ages, wild or escaped salmon) behind each size groups of salmon. To better understand the diversity of salmon catches and the timing of the migrations of various sea-ages of salmon belonging into different salmon stocks it was necessary to convert the officially collected salmon catch data into the numbers and weights of salmon into 1SW (one sea winter salmon), 2SW, 3SW, 4SW, previous spawners and escaped salmon. These specific numbers of salmon in different sea-ages combined to the genetic information are the tools for the recommendations for new adaptive, knowledgebase management regime to minimize mixed stock fishery where needed to preserve declining and vulnerable stocks. Locally (here in each municipality or combination of municipalities) obtained catch samples were used to convert the official catch data into sea-age groups of wild salmon and escaped salmon. Modern genetic analyses were used to identify the river of origin for each fish with a high accuracy. Finally it was possible to construct migration patterns for each salmon from different rivers and regions which are reported in the official catches.

This report is responding to the specific item mentioned in the Kolarctic salmon project "*Task 3. Combine genetic, biological and environmental information into a salmon migration model that will allow for a more precise and sustainable management.* Moment 3.4. *Describe the salmon catch composition in time and space based on available catch statistics and own data*". Run timing of different sea-age groups of previous spawners and kelts has major management implications if the populations are heavily exploited with numerous fishing methods and gears in different periods and within large coastal areas. Previous spawners are safeguarding against successive years of reproductive failure, as many salmon populations may spawn repeatedly. Many of the largest spawners at least in female salmon are often previous spawners increasing reproductive potential and overall quality of the fishery. To enhance the opportunity for previous spawners to contribute to egg deposition within stock, proper management and knowledge related to the migration timing of this life-history component is needed.

In this Kolarctic salmon project Report VI we are presenting figures from the numbers of previous spawning salmon belonging to numerous stocks caught in research fishery between May and September in counties in Northern Norway as well as in municipalities or groups of municipalities. Ecology and migration patterns of previous spawners are described in details. In addition to present data in figures we have added tables from where persons working in administration, in salmon fishing organizations, in research or private persons can find the detailed basic information for further analysis.

2. Material and methods

Kolarctic salmon project arranged careful sampling from the salmon fishery in Northern Norway in the years 2011 and 2012 (Figure 1). Detailed information on the results covering sea-ages, origin of salmon (wild or escaped salmon) and timing of the catches of various sea-ages etc. are presented in the separate reports ((Kolarctic salmon Report I, data from the sampling in 2011, (Niemelä et al. 2014); Report II, data from the sampling in 2012, (Niemelä et al. 2014); Report III, Summary Report from the samplings in 2011 and 2012, (Niemelä et al 2014)). The genetic origin (geographical area of origin) for official reported salmon catches (SSB data from Norway) in the years 2011 and 2012 is presented in the Kolarctic salmon project Report VII (Niemelä et al. 2014). Here in the Kolarctic salmon project Report V we are presenting the estimated numbers of previous spawners in the officially reported catches for fish which are originating from seven Regional Group areas. Genetic assignment results are included from the adult salmon research in the years 2008 and 2009 into the data from the years 2011 and 2012 to make even better conclusions from the abundance, migration patterns, occurrence of various stocks and spatial and temporal occurrence of previous spawners and kelts in Kolarctic salmon research area.

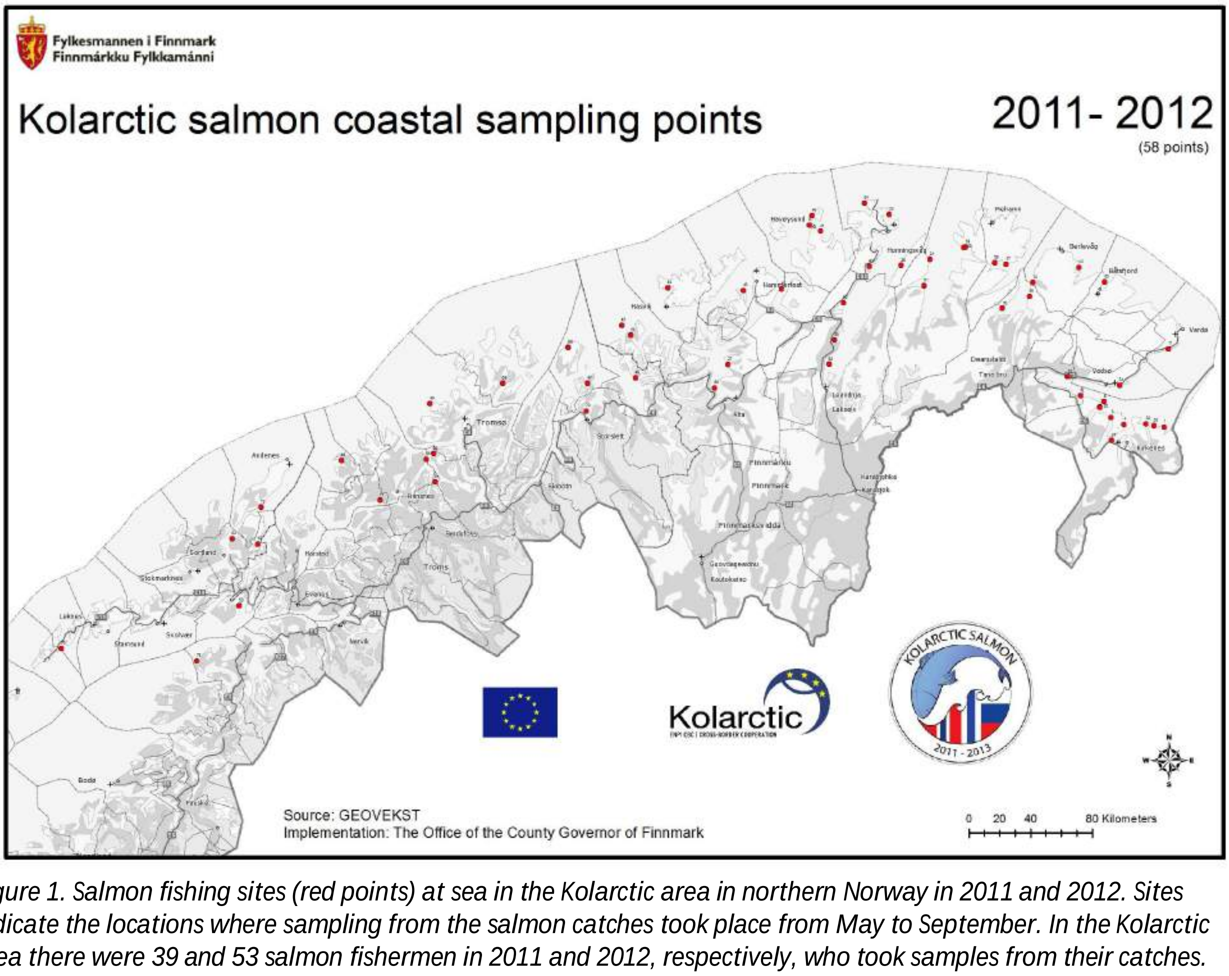


Figure 1. Salmon fishing sites (red points) at sea in the Kolarctic area in northern Norway in 2011 and 2012. Sites indicate the locations where sampling from the salmon catches took place from May to September. In the Kolarctic area there were 39 and 53 salmon fishermen in 2011 and 2012, respectively, who took samples from their catches.

Sampling from salmon fishery in 2011-2012 was taken from 19 524 salmon, with 5%, 29% and 66% coming from Nordland, Troms and Finnmark, respectively. Out of the 39 and 53 fishermen who promised to take samples over the whole season, five and nine ceased the sampling after May or in June in 2011 and 2012, respectively. In 2011, the numbers of salmon caught from May to September were 275, 2411, and 5617 in Nordland, Troms and Finnmark, respectively, and in 2012 were 754, 3183, and 7283. The total mass of salmon caught in the Kolarctic project in 2011 and 2012 was 4, 25 and 54 tons in Nordland, Troms and Finnmark, respectively. In the years 2008 and 2009 it was collected salmon material only from Finnmark.

All the fishermen were advised to take careful measurements from all their salmon catches, such as lengths and weights, and it was especially highlighted that they take the scale samples from the recommended area of the fish. Fishermen had to write information on scale bags. Scales were collected from the advised area of the fish to be certain of getting the correct ageing and growth measurements when the scales were analysed and measured. Fishermen were able to identify the origin (wild/escaped) of the salmon using external and internal features, and a manual with photos of wild and escaped salmon helped in the identification process. The date of the capture, fishing method, sex of the fish and number of salmon lice was also recorded on the scale bag. Fishermen sent the scale bags in envelopes within two weeks of the catch to the County Governor in Finnmark or scales were collected by researcher when frequently visiting the fishermen.

The data written on the scale bags was transferred into data files and the first evaluation of the accuracy of the data took place by correcting false or missing information. All scale bags had a new number which correspond to the number in the data file. In this phase, five scales (from only wild salmon) were put into a new numbered scale bag and were sent for genetic analysis to the University of Turku. Scale impressions for age determination, growth measurements and for analysing the origin of salmon (wild/escaped) were taken from all scales. Impressions on plastic plates were taken from almost all individual salmon. After the scale impressions were available, ageing and discrimination between wild and escaped salmon took place. Work was done following the ICES scale reading working group's (ICES 2011) recommendations. The final task was the internal evaluation and correction of the basic scale data during which we compared the ages of salmon to the recorded lengths and weights.

In the Kolarctic salmon project we study the migratory patterns of salmon in the coast and fjord areas of northern Norway, where the captured salmon originate from some hundreds of rivers. Determining migratory patterns includes clarifying the timing of the wild 1SW (one sea-winter salmon), 2SW, 3SW, 4SW salmon and previously spawned salmon in the catches as well as the timing of the escaped salmon in the catches. The aim was to have continuous sampling covering the entire period during the time when salmon are migrating along the coastal areas from early May to late September. In order to fulfil the goal of the Kolarctic salmon project and to have accurate documentation from the timing of different stocks in different areas and in different fisheries, the fishermen serving this project received special permission to catch salmon outside the official fishing season. Within this project, in Nordland and Troms counties, fishermen were also allowed to use bend nets in addition to or instead of using bag nets, which is the only fishing method allowed there today. In Finnmark fishermen used bend nets and bag nets. Special effort was made to include fishermen from the outermost coastal areas, where the catch reveals more precisely the timing of the migrations in general and the migrations of different stocks specifically, than do the catches in fjords (Figure 1).

River (when applicable) or geographical region of origin i.e. home waters of sampled salmon were estimated using genetic methods. Genetic stock identification takes advantage of the genetic differences among salmon from different rivers and works by estimating the most likely stock of origin of salmon in the mixture. For this, tailored and powerful statistical methods are available. However, the feasibility of applying genetic stock identification depends on the relative genetic distinctiveness of stocks and adequate baseline data capturing the genetic structure and diversity of all the potential stocks in the mixture. In addition, number of markers applied plays a major role in successful stock identification. Details of the genetic structure of the salmon of the Barents region and their stock identification procedure are described in Vähä et al (2014). Below we shortly describe the baseline data and potential for successful stock identification of fishery samples.

For this report, more than 14 000 samples for genetic analysis were collected from 201 sampling locations within 185 rivers along the northern coasts of Norway and Russia. Samples represented 155 river level reporting groups i.e. in some cases tributaries were not treated as separate units.

Both baseline and fishery samples were screened for 31 microsatellite markers displaying from minimum of 6 to maximum of 44 alleles per locus. In total, 660 and 673 alleles were observed in the baseline and coastal samples, respectively.

Baseline samples were tested for family structure as sampling of families rather than populations may bias the relative allele frequency estimates which will have a negative effect on the genetic stock identification. The analyses of kinship in the samples collected demonstrated that full siblings were present in most samples, but also that the proportion varied greatly, with some samples having no full siblings, and other samples containing up to 68% (Storelva Båtsfjord). On average, the baseline samples contained 16% full siblings. Sib-ships were eliminated by exclusion leaving total of 12860 individuals in the baseline data.

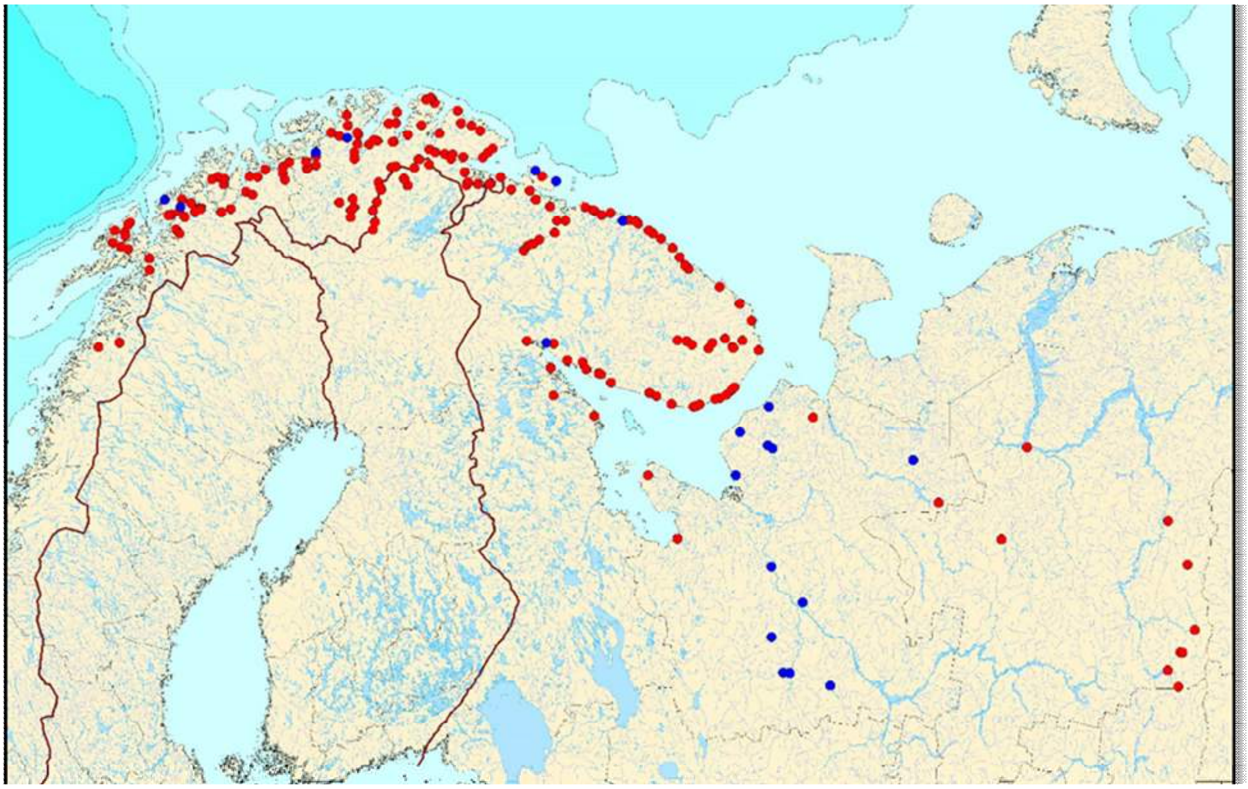


Figure 2. Map showing the baseline river samples. Red dots represent river samples included in the final baseline, blue dots represent samples not included for various reasons (see text).

The various analyses conducted on the baseline data demonstrated large variations in genetic differentiation and diversity among river stocks. On average, the F_{ST} between populations was 0.055. As a whole, this is relatively high compared to studies of Atlantic salmon in other regions, where F_{ST} values in the range 0.01 – 0.04 have often been reported for Atlantic salmon (Griffiths et al. 2010). However, this was partly due to very wide geographical coverage of the samples (Figure 2). Genetic structure analyses and self-assignment tests provided evidence to construct genetically similar groups of salmon rivers i.e. regional reporting groups. Based on results we constructed 9 regional groups (Figure 3). At these smaller regions, average pairwise Fst among salmon rivers within the region was 0.038. Eastern Barents and White Sea rivers and Teno river system displayed high divergence (Fst 0.080 and 0.069, respectively) while genetic divergence of populations within other regions was lower (0.020-0.042).

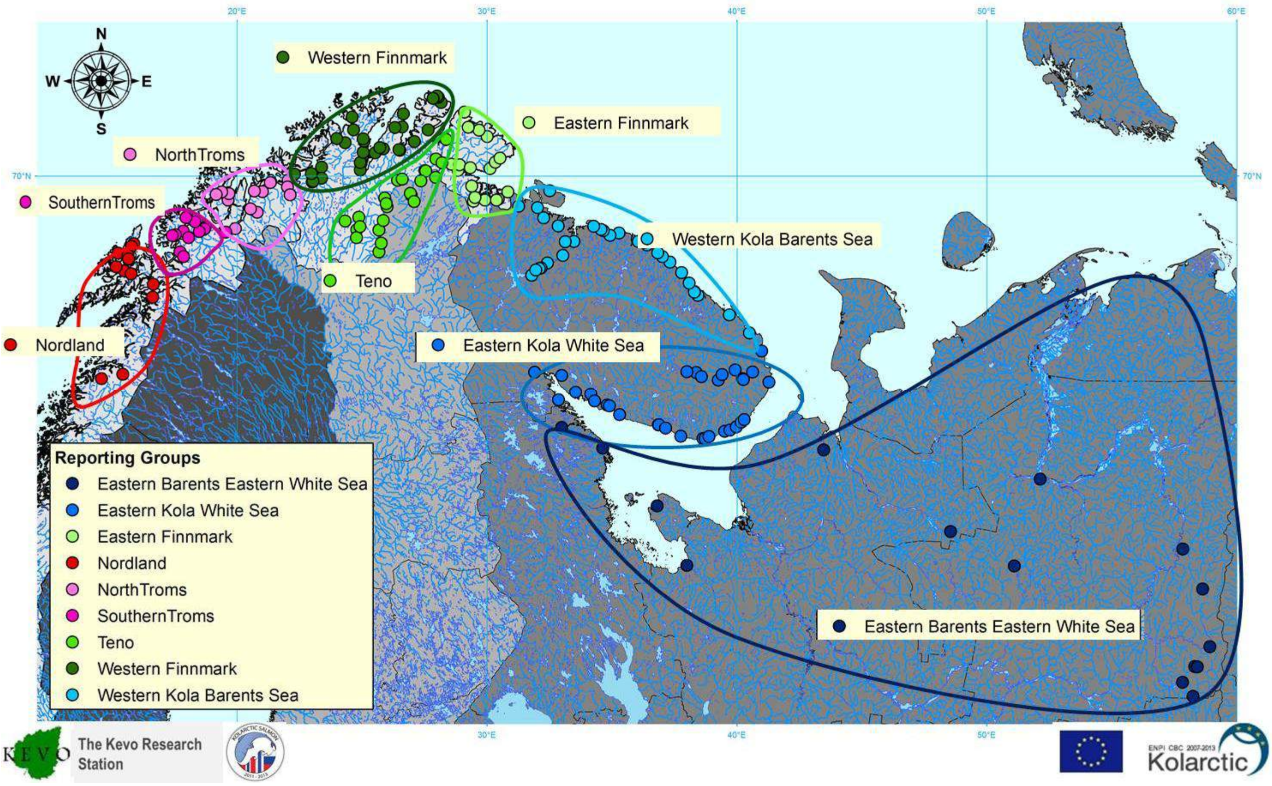


Figure 3. Genetic reporting group areas (later referred into regional groups) for salmon caught in Kolarctic salmon project in Northern Norway (Map – UTU-Kevo)

Similarly to genetic divergence, power tests of genetic stock identification using test samples from the baseline data revealed large differences among rivers and regions. In general, levels of genetic divergence was reflected in the power tests of genetic stock identification – salmon from the highly diverged populations were identified with higher success than those from low divergence populations. Stock assignment accuracy was also affected by the number of samples in the baseline: larger sample sizes provided higher correct assignment rates likely due to better estimates of the relative allele frequency estimates from the baseline population. Nevertheless, genetic stock identification allows the partitioning of samples from the mixed stock fishery catches in to smaller units and if not always representing single rivers, representing regions with genetically similar stocks.

Genetic stock identification to large number of rivers was reliable. On average, 69% of all samples assigned to rivers were correct, but applying river specific cut-off values to filter out false positives overall mean accuracy increased to 75.5%. The highest correct assignments were observed for rivers in the Eastern Barents and White Seas (no cut-off; 95%/ river specific cut-off; 97%) and Teno River system salmon stocks (86%/90%), while the lowest were observed for the Troms (54%/61%) and Nordland stocks (60%/74%). Power tests showed that 90%-98% of samples assigned to Russian, Eastern Finnmark and Teno River system reporting groups were correct. Only slightly lower assignment success was obtained for the samples from rivers in Finnmark County; 87%. Northern and southern Troms reporting groups were most problematic showing 68% and 58% correct assignments, but when combined, 80% of Troms salmon were correct. Nordland had correct assignment rate of 72%.

It should be noted however, that while power tests provide an overview on how reliable an estimate is generally expected, exact proportions of correct as well as miss-assignments will depend on real fishery samples, stock composition and their relative proportions. Furthermore, when conducting power tests the number of samples in the baseline data were reduced (because individuals were removed from the baseline for the test) and this, as shown, has a negative effect on the assignments. Therefore, assignment success rates in the power tests may be underestimates of the true level of accuracy that can be obtained. The method of Pella and Masuda (2001) implemented in the cBAYES used for genetic stock identification also makes use of information from the mixture sample. Allele frequencies of the mixture individuals assigned to baseline populations, at each MCMC step, are used to update the baseline allele frequencies which is thought to improve accuracy.

Scales were analyzed to distinguish maiden 1SW, 2SW, 3SW, 4SW Atlantic salmon (=first time spawner) and previous spawners. The eroded zone in the scale was the criterion to identify samples as a previous spawner. There are two types of previous spawners, alternate and consecutive spawners. Alternate previous spawner of the age groups 1S1, 2S1 and 3S1 or 1S1+, 2S1+ and 3S1+ ((for example, 1S1: 1 year at sea (1) followed by the first spawning (S) and reconditioning period of 1 year (1) at sea and second spawning run)) were the most common previous spawner age groups. If in the scale edges of some alternate and consecutive previous spawners there was any additional growth during that year when they were caught and then the age was like 1S1 or 1S for those fishes. Most of alternate previous spawners had additional growth zone in the scale edges and the age was marked as 1S1+ with + -mark. Also some kelts (salmon which have just left the river as post-spawner after having spawning in previous autumn) were caught and the sea-age was marked as 1S or 1S+. If kelt had in the scale edge some new growth zone after descending into the sea the age was marked with + -mark. Some of the kelts could also be called to consecutive spawners if they would ascend for spawning into the rivers in consecutive year. In the photo 1 there are clear spawning marks for fish that have been spawning for the first time in the age of 1SW and 2SW.

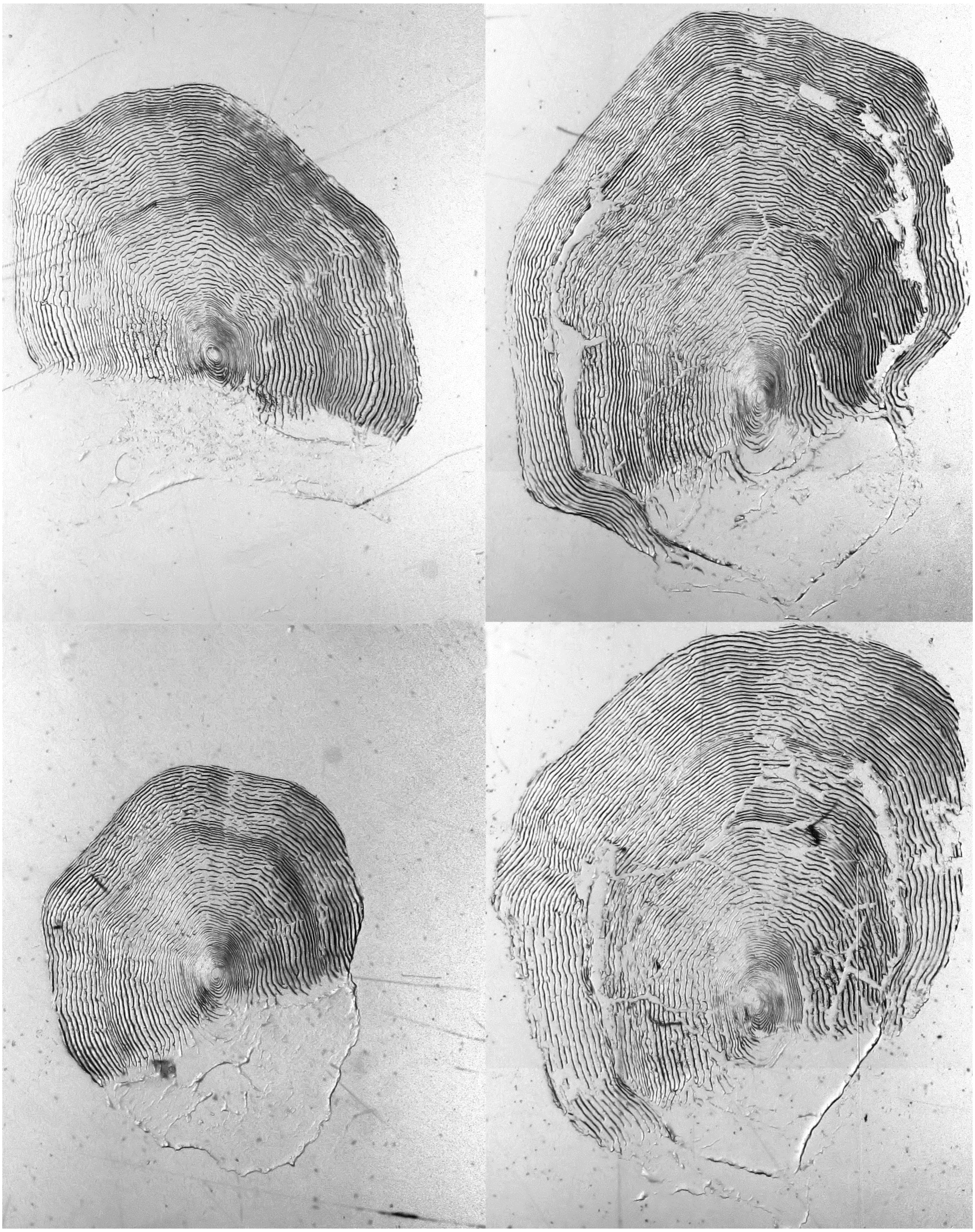


Photo 1. Scales on the left (below first time spawner of the sea-age 1SW salmon, above first time spawner of the sea-age 2SW salmon) and on the right (below previous spawner of the sea-age 1S1 SW salmon, above previous spawner of the sea-age 2S1 salmon) are indicating differences in scale structure. Photo FGFRI /Jorma Kuusela.

3. Results

3.1 Wide life history of previous spawners in the salmon catches at sea

In the coastal salmon fishery in the years 2011 and 2012 there were altogether 17 different sea-age groups of previous spawners in Nordland, Troms and Finnmark. In addition to the previous spawner sea-age groups there were four age groups of first time spawner (maiden salmon 1SW, 2SW, 3SW, 4SW) as a target for exploitation. The most common previous spawner salmon sea-age groups were those fish which are alternate spawners (1S1+, 2S1+, 3S1+) (Table I). These salmon were on their way to spawn for the second time in their life after one full reconditioning year at sea after they have had their first spawning in the ages of 1SW, 2SW or 3SW. In the salmon material those fish with the ages of 1S+, 2S+ and 3S+ fishes represented kelts out of which some salmon could ascend into the rivers for repeated spawning as consecutive spawners after very short reconditioning period at sea. These kelts were caught all over the fjord and coastal areas. Some but very few salmon succeeded to recondition after their second or even third spawning like fish of the sea-ages 2S1S1S1+ and 3S1S1S1+ and they were most probably on their way to their own river to fourth repeat spawning.

Material collected only from Finnmark county at sea in 2008, 2009, 2011 and 2012 indicated that the most important sea-age groups within previous spawners and kelts were 1S1+ (47%), 2S1+ (15%), 1S+ (13%), 2S+ (10%), 3S1 (8%), 3S+ (3%) and in addition 4S+ and 4S1+ represented both with smaller than 1%. Other sea age groups made 4%.

Table I. Numbers of previous spawners for different sea-age groups in 2011 and 2012 in Kolarctic salmon project area in Norway.

	Sea- age groups																
	1S+	1S1+	1S1S+	1S1S1S+	1S2+	2S+	2S1+	2S1S+	2S1S1+	2S1S1S1+	2S2+	3S+	3S1+	3S1S+	3S1S1+	4S+	4S1+	All
Nord-land	8	14				7	10		1			2	2					45
Troms	24	42	3		3	20	41		1			8	36	3	5	1	1	191
Finn-mark	81	145	1	1	3	59	52	2	5	2	1	16	48	3	10	1	1	429
Total	113	201	4	1	6	86	103	2	7	2	1	26	86	6	16	2	2	664

Figure 4 indicates in which length groups previous spawners occurred and their proportions in those length groups. In the catches of male salmon, previous spawners made high proportion in the length group between 80-95 cm fish. In the largest male salmon previous spawners made 25-35%. All the largest female salmon caught were previous spawners. Figure clearly indicates that previous spawners are contributing the largest females into the catches so that more than 75% from fish with the length between 110 and 120 cm were previous spawner. In the total salmon catches in Kolarctic salmon project area previous spawners made 35% -40% in fishes larger than 110 cm.

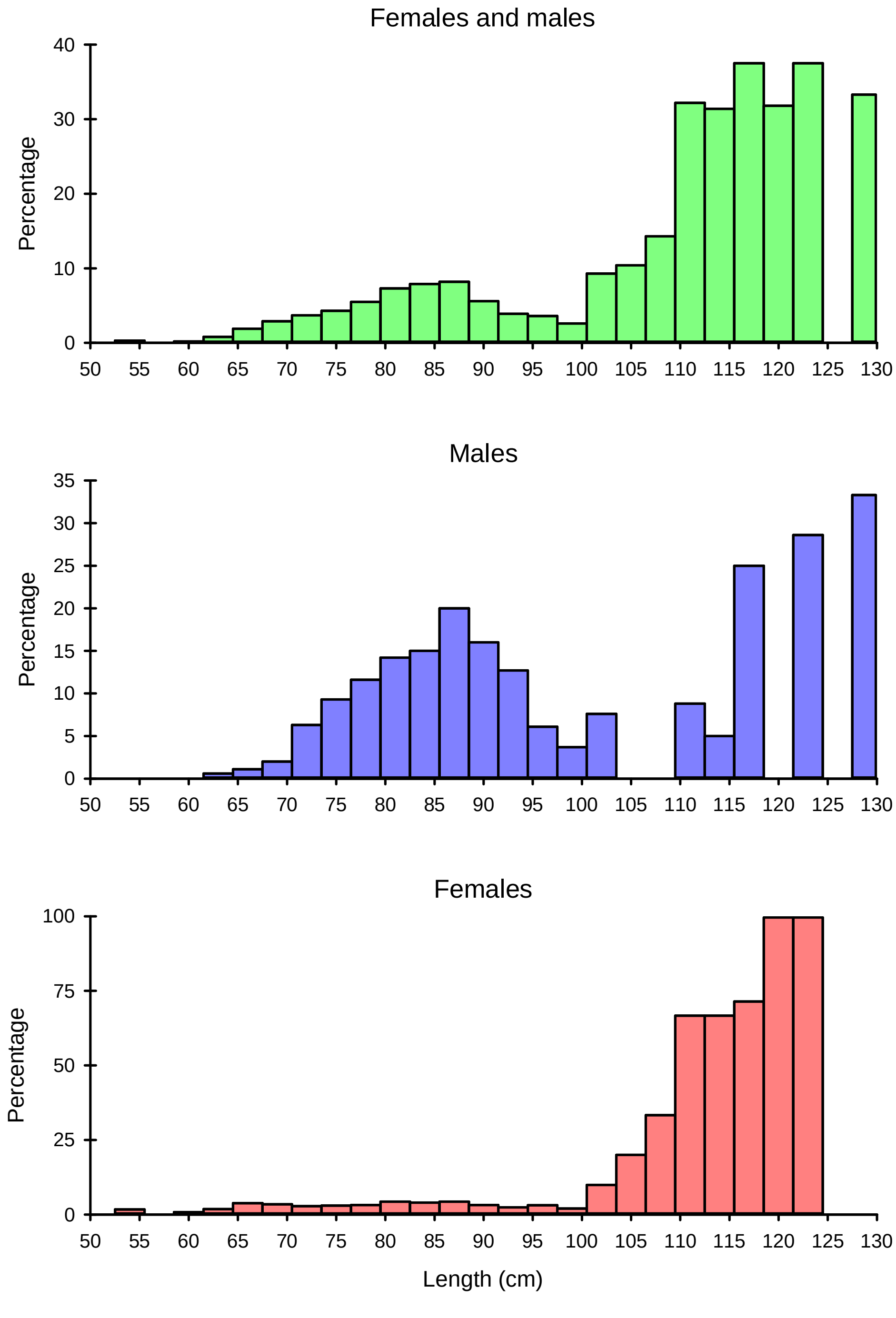


Figure 4. Percentages of previous spawners in female and male salmon catches and in the catches sexes combined in length groups (3 cm interval) in Finnmark.

3.2 Migratory period of previous spawners in the whole Kolarctic salmon project area

Salmon fishing in the outermost coastal areas and in the fjords initiated early May depending on the weather conditions. According to the local fishermen's traditional knowledge there are salmon migrations very early in the spring time in coastal areas. Some information tells that in April large salmon occurred in some specific areas at least in Finnmark coast. But the numbers of those salmon have been quite low in general. In Kolarctic salmon project fishermen got the first maiden salmon and previous spawners soon after they started the fishing in the week 18 (first week of May) (Figures 5, 6). The highest previous spawner catches occurred simultaneously, in June, in all the counties and then in July the catches were one third of the catches compared to June (Figure 5). The catches developed the same way in all the counties through the summer and in September fishermen didn't get any previous spawner. In August and September the fishing activity was very low compared to the activity in midsummer and that is one reason to the low numbers of salmon caught in autumn.

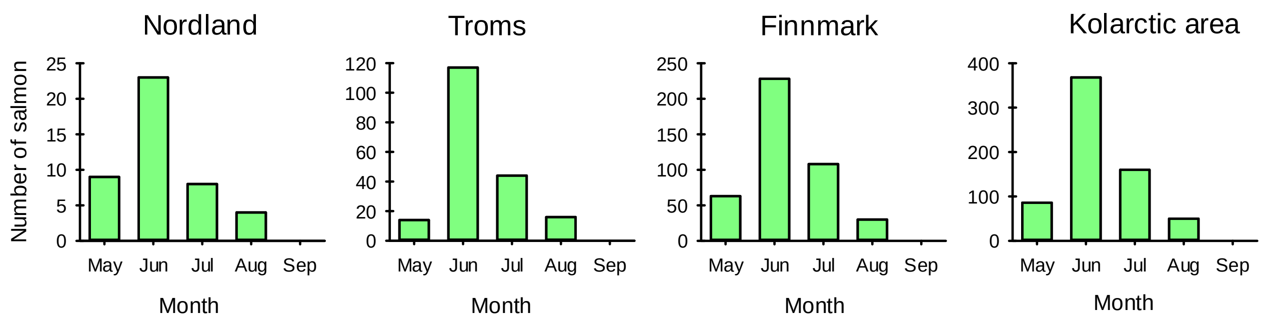


Figure 5. Monthly distribution of previous spawners in the salmon catches in Kolarctic salmon project in three counties in Northern Norway in the years 2011 and 2012

Previous spawners contributed important numbers and weights into the catches especially in the beginning of the official fishing season in June. Especially in the year 2012 previous spawners formed up to 10% of the catches in terms of mass and a little less in terms of number of salmon caught early June (Figure 6). The importance of previous spawners in the declared catches will be highlighted in those years when the stock abundance of especially multi-sea-winter maiden salmon is low due to natural fluctuations.

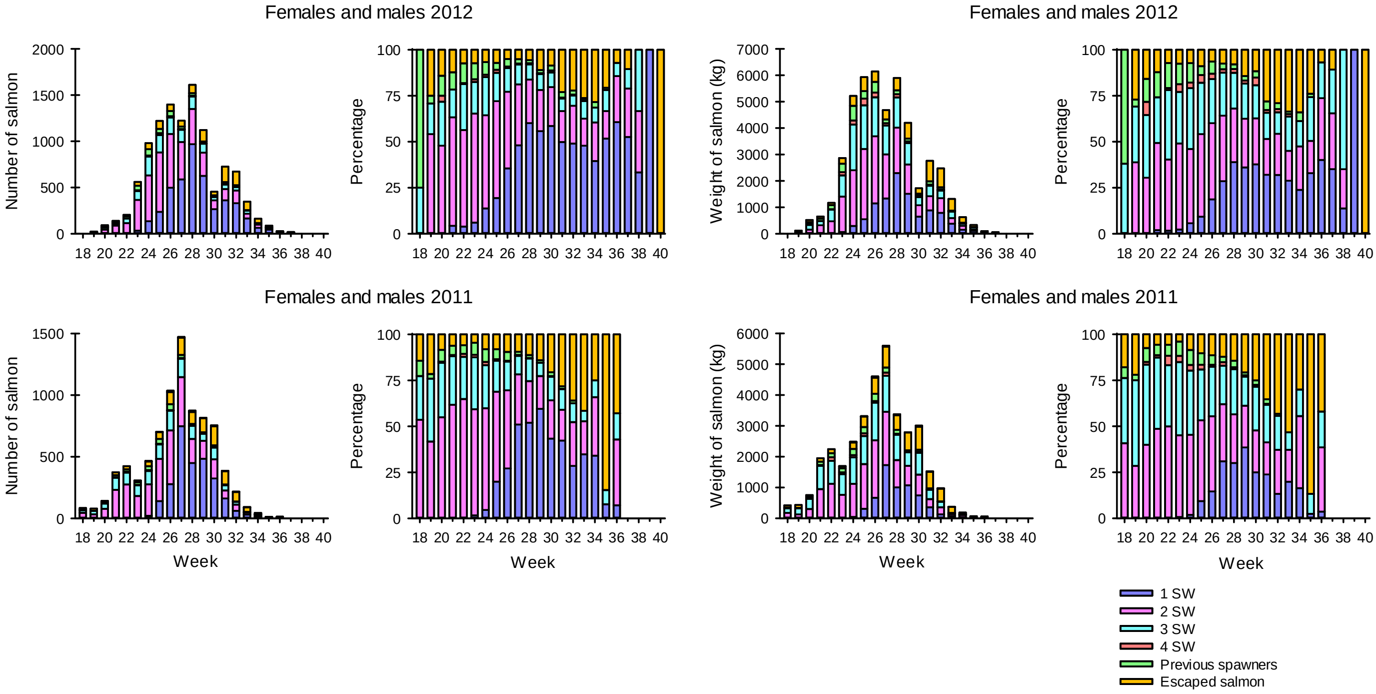


Figure 6. Weekly catches of previous spawners (green bar in the figures), 1-4SW maiden Atlantic salmon and escaped salmon in Kolarctic salmon project area in the years 2011 and 2012.

Photo 2. This female salmon spawned in the age of 1SW and then recondiotened one year at sea and caught as a previous spawner in the age of 1S1.

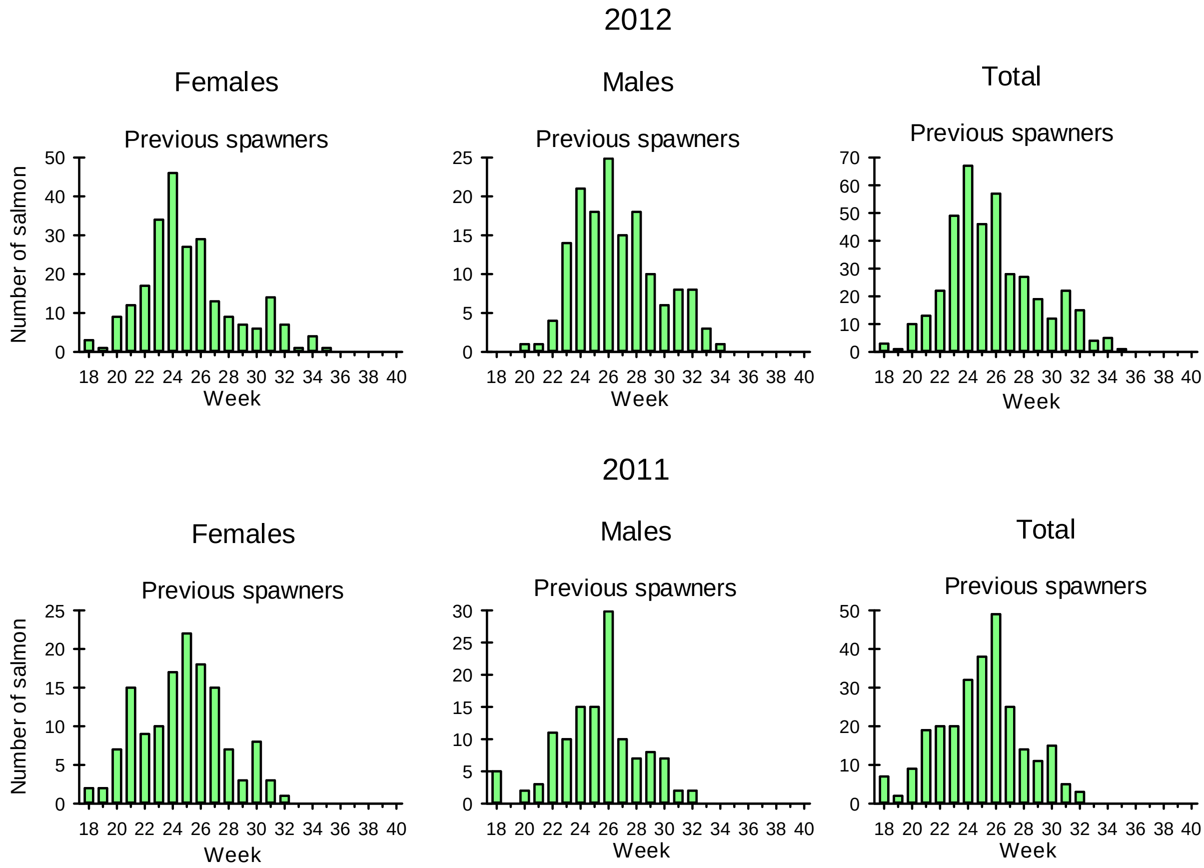
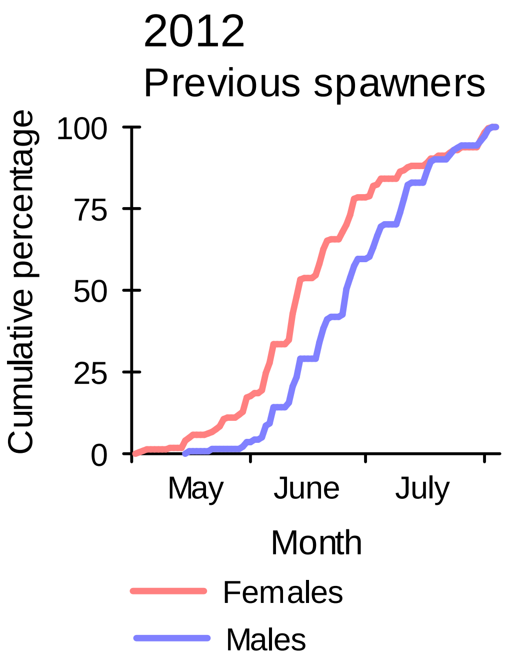


Figure 7. Weekly numbers of previous spawners in the catches in the Kolarctic salmon project area (Nordland, Troms, Finnmark) in the years 2011 and 2012

Timing of the migrations of previous spawners in the coastal areas varies between years. As a group of previous spawners, females and males had the same migratory pattern in both of the years 2011 and 2012. In the entire Kolarctic salmon research area peak migration period takes three to four weeks (Figure 7). Annual variations in the timing of the migrations can be caused by changes in the sea temperatures. Research fishery in the years 2011 and 2012 succeeded to cover almost the entire period of salmon migrations and only April month was uncovered.



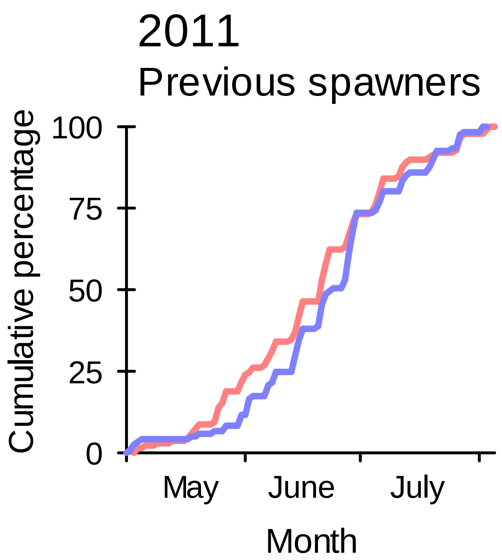


Figure 8. Cumulative percentages of the previous spawner catch for females and males in the Kolarctic salmon project area from May to August 4.

Female previous spawners migrated before males into the coastal areas and that difference was obvious especially in the year 2012 in the entire Kolarctic salmon project area (Figure 8). The same behavior where females are ascending before males to the coastal areas can be found also in maiden salmon. Of all the female previous spawners caught between the beginning of May and August 4th close to 20% were caught in May. This early ascend into the coastal areas indicates that previous spawners are the first salmon migrating into the rivers.

3.3 Differences in the timing of migrations between the counties and between three areas in Finnmark

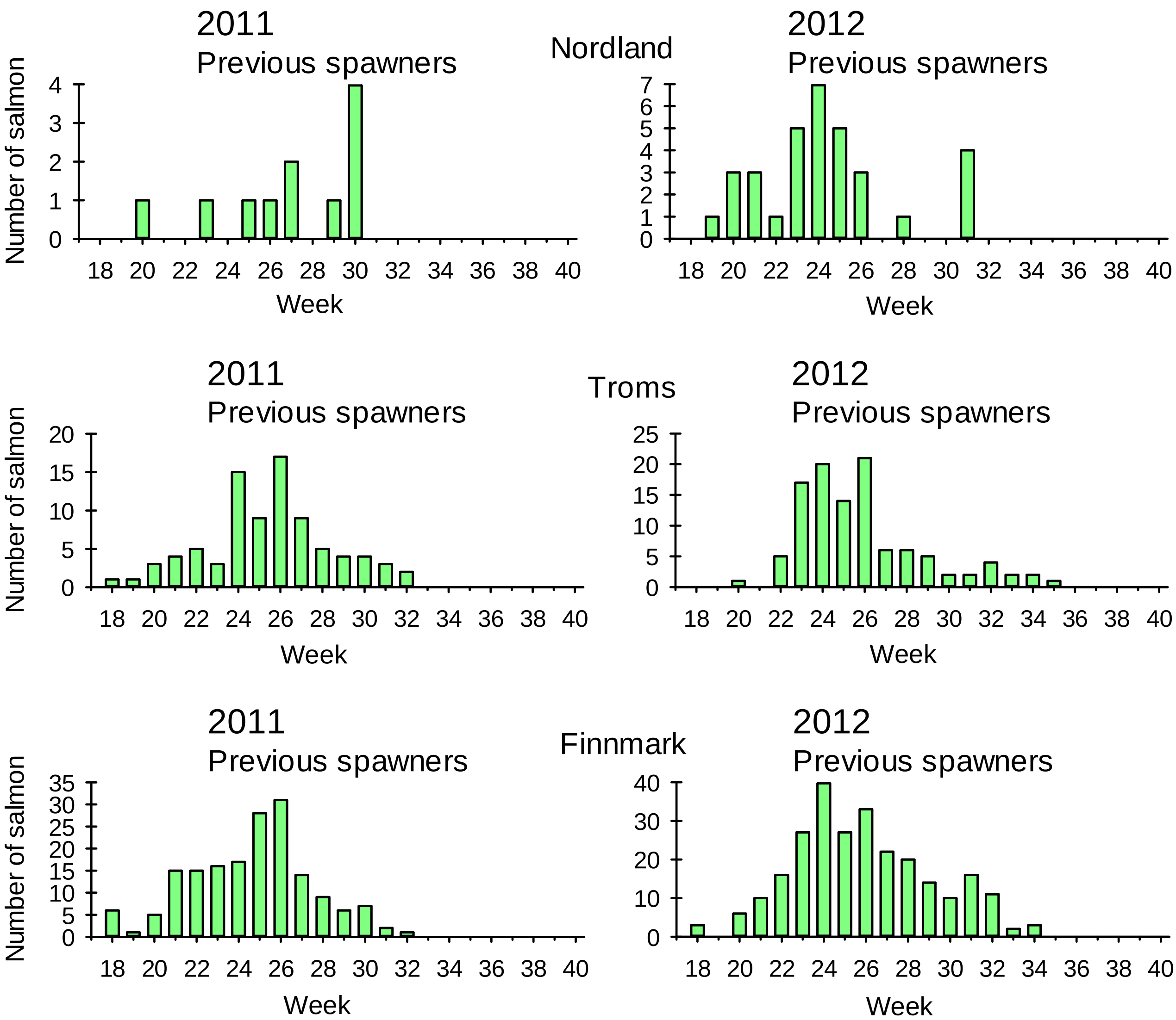


Figure 9. Weekly numbers of previous spawners in the catches in three northern counties in Northern Norway in the years 2011 and 2012.

Figure 9 illustrates the general migratory patterns of previous spawners in three northernmost counties in Northern Norway. This group of salmon most probably has been contributing remarkable proportion to the catches in those historical years when the fishery was allowed early in the spring. The abundance of previous spawners increases in the early summer on the same way in all the counties and catches peak between the weeks 24 and 26 followed by clear declining.

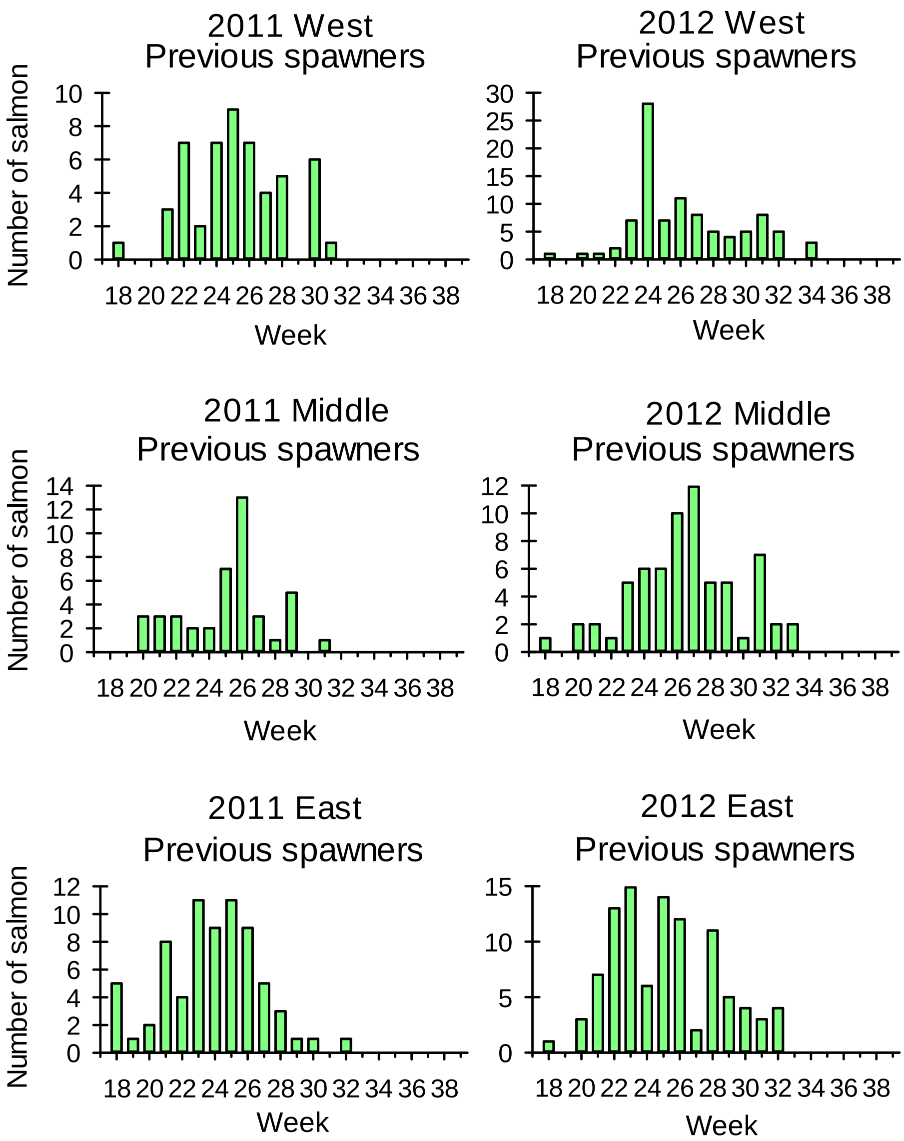


Figure 10. Weekly numbers of previous spawners in West, Middle and East Finnmark in the years 2011 and 2012 in the coastal fishery.

It is unknown from which direction previous spawners are migrating into their rivers of origin. Are they migrating with maiden salmon belonging to the same river or are they migrating with other previous spawners from other rivers? Figure 10 illustrates that there are differences in the migration periods within Finnmark. Interestingly figure 11 shows that in eastern Finnmark largest and oldest previous spawners of the age 3S1+ are ascending first to the coastal areas followed then by 2S1+ and lastly the youngest 1S1+ previous spawners are target for the coastal fishery. These kinds of differences are not obvious in the median dates of catches between 1S1+, 2S1+ or 3S1+ salmon in the Middle Finnmark but then in West Finnmark the youngest 1S1+ previous spawners are ascending first followed by 2S1+ and last there are the oldest 3S1+ salmon in the catches. The migration timing of the sea-age groups 1S1+, 2S1+ and 3S1+ takes place on opposite direction in East and West Finnmark.

Median dates of catches for 1S+, 2S+ and 3S+ salmon are later compared to those of the real previous spawners (1S1+, 2S1+, 3S1+) in East and West Finnmark but they are caught in the same sea- age order like real previous spawners (Figure 11). Salmon in the age groups 1S+, 2S+ and 3S+ are kelts, post spawners, which have been descending from the rives early in summer and some of the kelts stay close to the coastal areas or in fjords where they are exploited. It is highly probable that most of the kelts have left the coastal areas soon after they migrated out from their rivers of origin and they have been migrating to ocean feeding grounds. Some of the kelts start their reconditioning in the fjords and in outermost coastal areas and they can stay there for longer periods or even the entire reconditioning period until they reach once again the maturity phase.

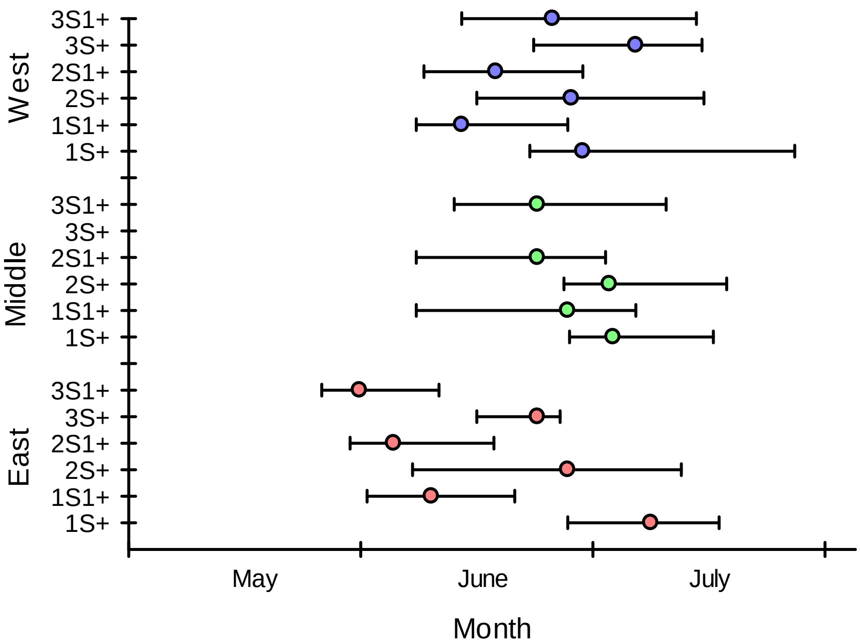


Figure 11. Median dates of the catches with upper and lower quartiles for the most common previous spawner salmon groups in West, Middle and East Finnmark in the years 2011 and 2012.

Photo 3. A kelt from the Alta river (Photo: Audun Rikardsen).

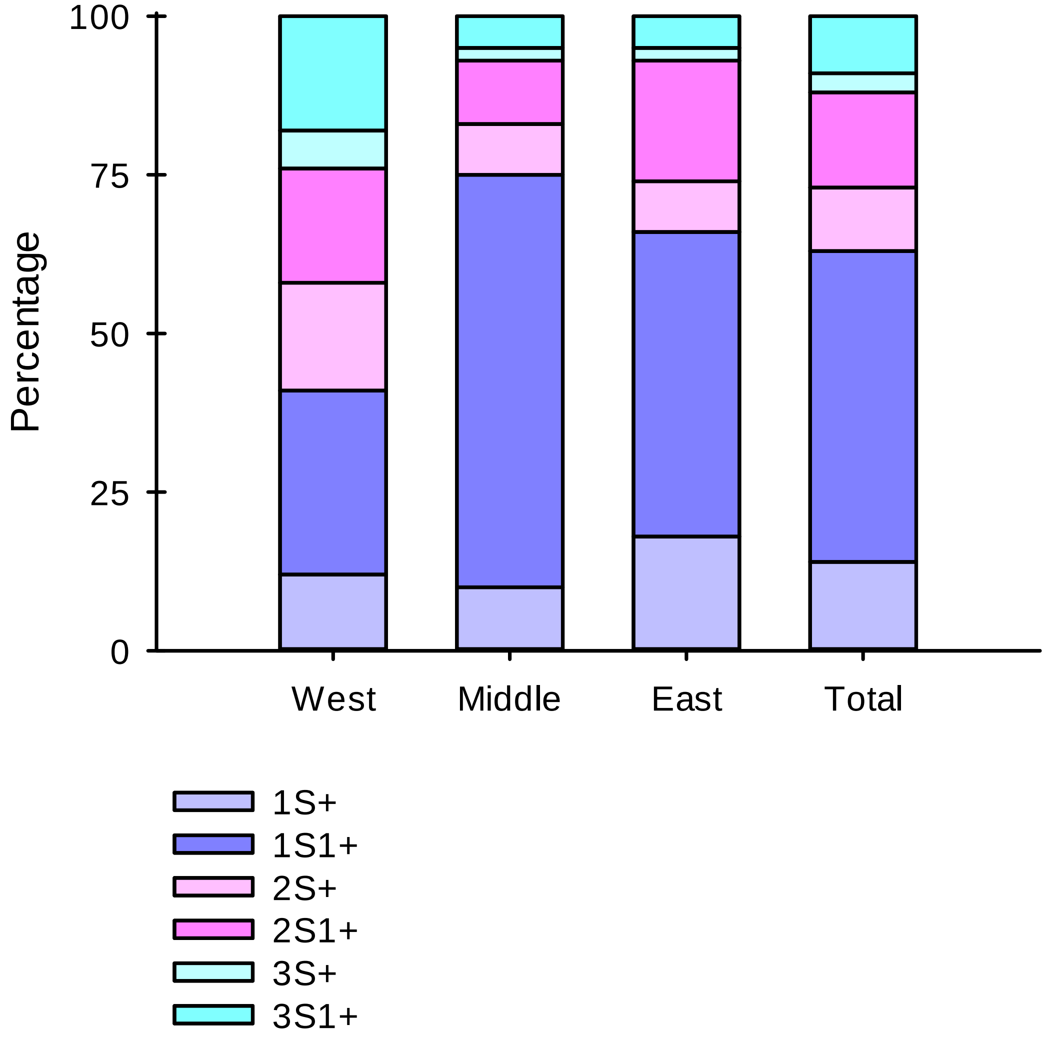


Figure 12. Sea-age distributions of the most common previous spawner age groups in Finnmark in the years 2008- 2009 and 2011-2012 in the data collected in May to August 4.

There were some differences in the distributions of the major sea-age groups of previous spawners in the summer between three geographical areas in Finnmark (Figure 12). In West Finnmark the proportion of 1S1+ sea-age group was much lower than in the Middle and East Finnmark but the proportion of 3S1+ is high compared to other areas. High proportion of 3S1+ in West Finnmark might reflect that those salmon possibly originated from the large rivers Altaelva and Lakselva (Porsanger) where in females maiden 3SW fish is numerous. High proportion of 1S1+ salmon caught in the Middle Finnmark can reflect that they maybe have origin from the tributaries of the River Tana. In East Finnmark the proportion of kelts, 1S+, is high compared to other areas indicating that Varangerfjord area might be important for them as a reconditioning area before most of kelts are moving to ocean feeding grounds.

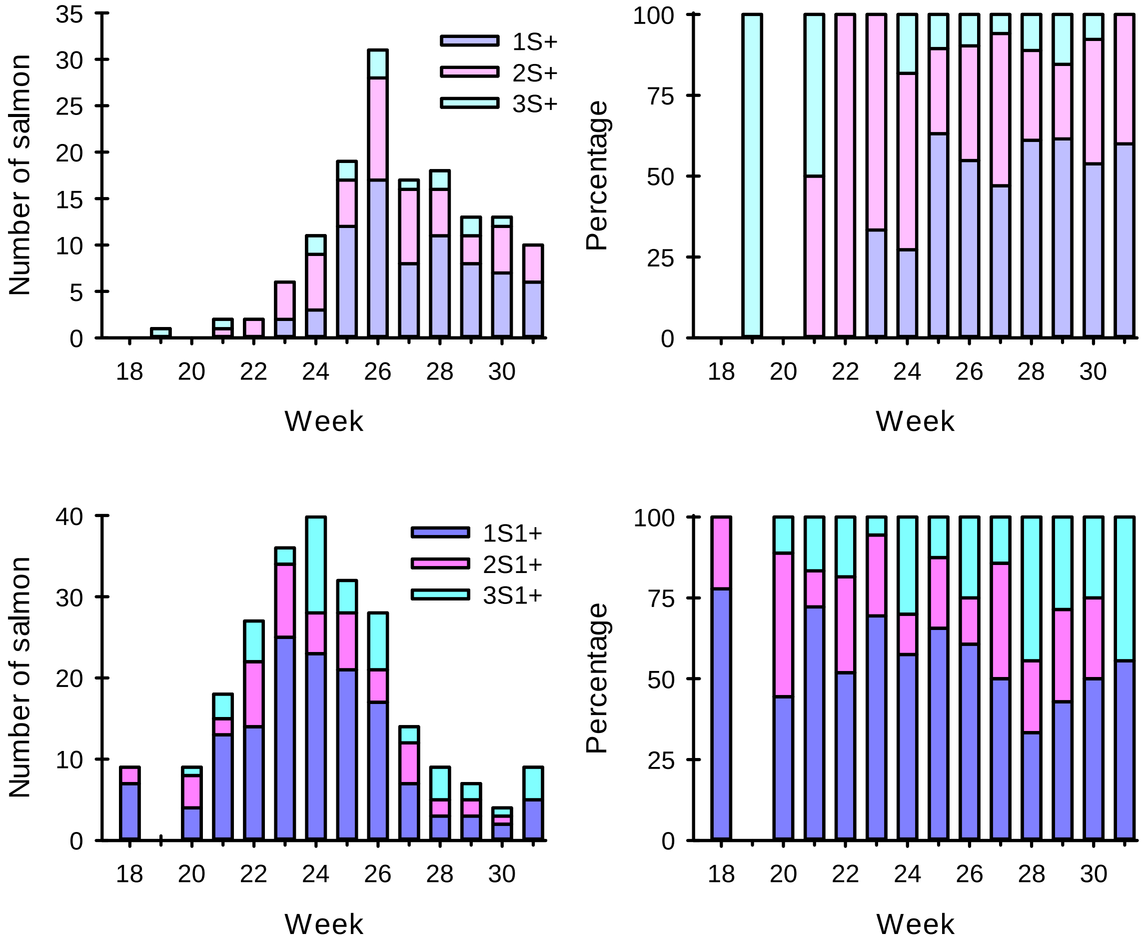


Figure 13. Weekly numbers and sea-age distributions of previous spawners (1S1+, 2S1+, 3S1+) and post spawners (kelts, 1S+, 2S+, 3S+) in the coastal areas of Finnmark in the years 2011 and 2012.

Previous spawners (=alternate spawners,1S1+, 2S1+, 3S1+) peaked in the catches clearly during three weeks time in the middle of June in Finnmark followed by the peak in the catches of normal post spawners (kelts) and / or consecutive spawners (Figure 13). It is interesting to note that the abundance of alternate spawners declined clearly towards the week 30 but the abundance of the sea-age group of 1S+, 2S+ and 3S+ stayed quite stable in July and early August. This confirms that the groups of 1S1+, 2S1+ and 3S1+ really migrated into their rivers of origin but the groups of 1S+, 2S+ and 3S+ reconditioned in coastal areas and some of them migrated later to high seas for reconditioning and maybe some continued to stay and recondition close to shorelines.

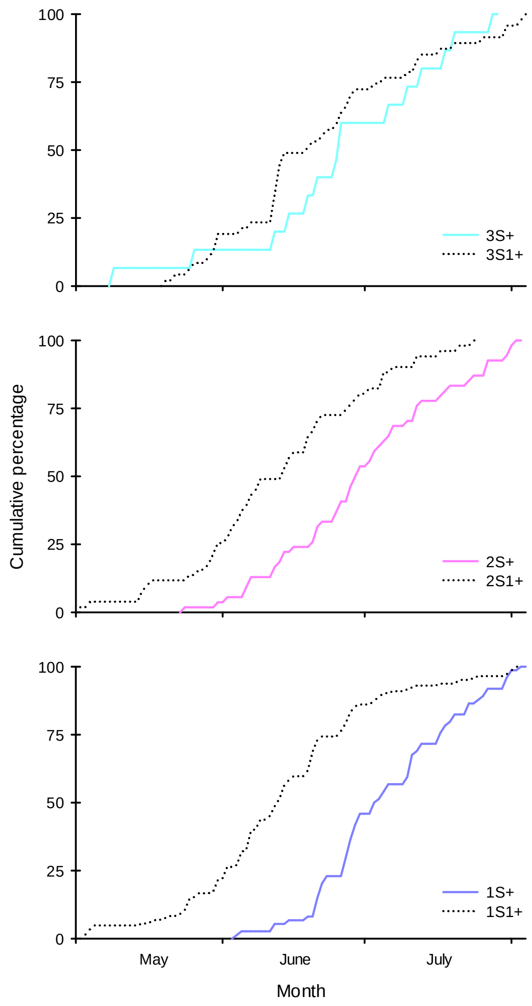


Figure 14 . Cumulative percentages of the most common previous spawner salmon groups (1S1+, 2S1+, 3S1+) and kelts (1S+, 2S+, 3S+) in the catches in Finnmark in the years 2011 and 2012 from May to August 4.

Previous spawners of the sea-ages 1S1+, 2S1+ and 3S1+ were caught approximately the same time in the coastal areas of Finnmark when all the material is combined (Figure 14 and 15). Cumulative percentages of their catches developed also parallel throughout the summer. The youngest female previous spawners, 1S1+ and 2S1+ salmon, however, occurred in the catches earlier in the summer than the oldest female previous spawners (3S1+) which can be observed also from the differences in the median dates of capture (Figure 15). Median dates of catches indicated also that females migrated earlier to the coastal areas than males.

Consecutive spawners or reconditioning kelts were caught later than their alternate spawner counterparts (Figure 15) indicating that they had descended from rivers late in June and initiated feeding and reconditioning. These kelts were caught also after the official fishing season August 4th which indicated that they had not migrated out from the coastal lines to high seas. From the scales of kelts it was possible to find that fish caught late in the summer had additional growth in the edges of scales and they have been weeks at sea reconditioning for the next maturity phase.

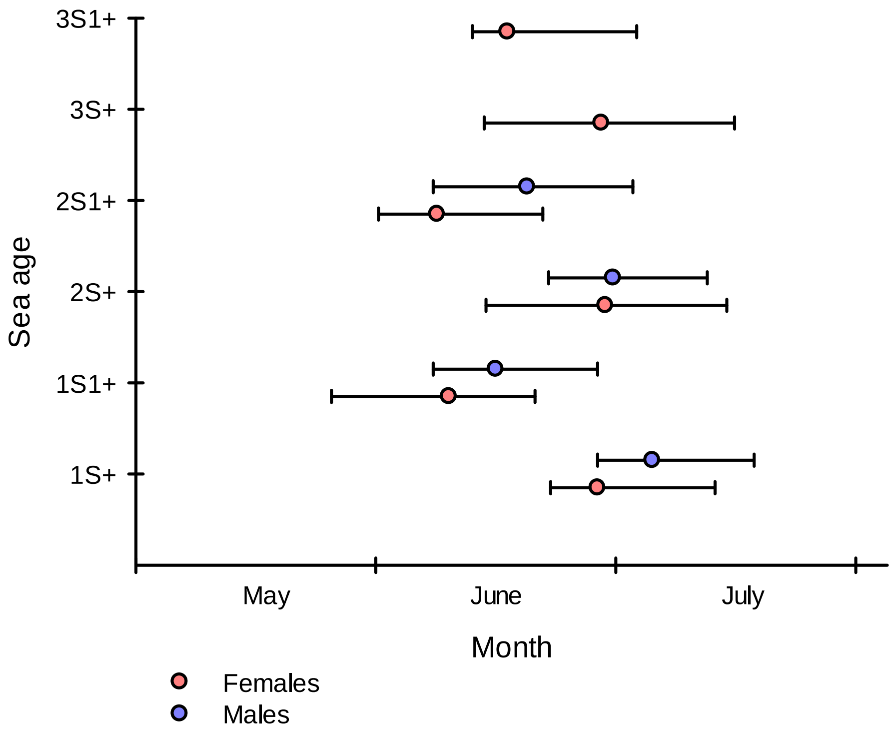


Figure 15. Median dates of catches with upper and lower quartiles for the most common previous spawner salmon groups (1S1+, 2S1+, 3S1+) and kelts (1S+, 2S+, 3S+) in Finnmark in the years 2011 and 2012.

Photo 4. Fisherman Arnt Ivar Ring checking his bag net in Alta fjord

3.4 Sex distribution and development in maturity along the fishing season

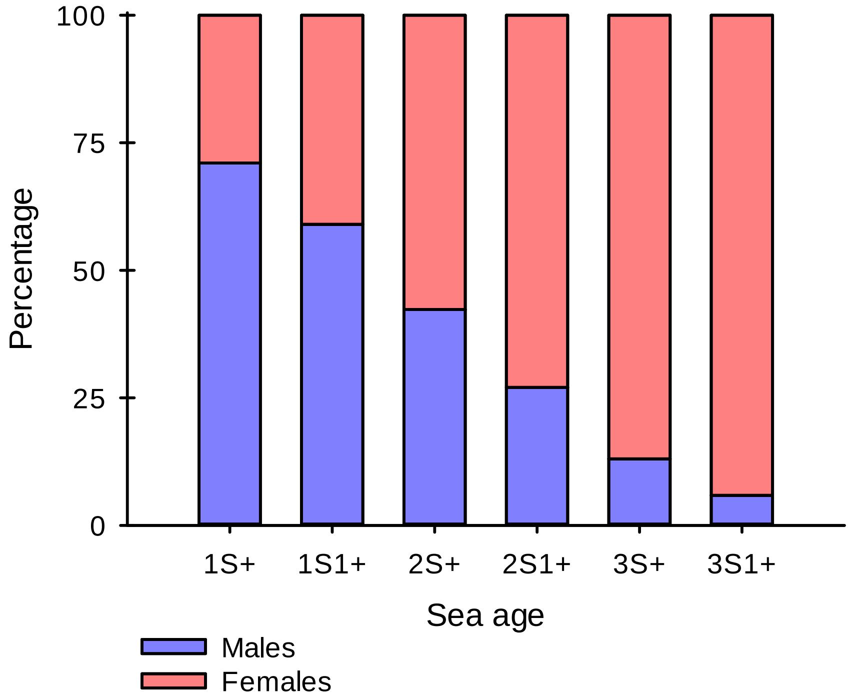


Figure 16. *Sex distributions in the most important previous spawner age groups in Finnmark in the years 2008-2009 and 2011-2012 in Kolarctic salmon project.*

The higher proportions of males in each of the age groups (kelts) of 1S+, 2S+ and 3S+ compared to their counterparts of 1S1+, 2S1+ and 3S1+ one year later might indicate that higher proportion of kelt females tended to migrate out from the coastal areas to high seas soon after they have descended as kelts to sea (Figure 16). Males that have descended to sea as post spawners (kelts) might also have higher natural and fishing mortality if they stay close to shore areas longer than females and maybe therefore the proportions of males were smaller in the sea-age groups 1S1+, 2S1+ and 3S1+ than in 1S+, 2S+ and 3S+.

Fishermen recorded information from the maturity of their salmon into the scale envelopes. Gonads in mature fish, especially in female salmon, filled half or more of the body cavity and then fishermen recorded fish to be mature. The identification was based on the fishermen's local knowledge although they were advised to make correct observation and distinction between mature and immature fish. In males there were some difficulties early in the summer to estimate the stage of maturity because gonads in males are not developing as clearly as in females. In maiden female salmon catches early in May every fourth salmon was immature but already in early June most female salmon were recorded to be mature (Figure 17). Towards autumn the proportion of immature salmon slightly increased and that proportion was smaller than 10% from all females in the weekly catches. In males the proportion of immature fish was high early in May and still in the end of May the proportion of immature fish was close to 50%. Main reason to this observation must be that early in the season it is difficult of determine the developmental stage of gonads in males although those fishes are going to spawn during the ongoing season. In males, however, the proportion of immature fish increased late in the season in the weeks 32-35.

Kelts which left their river of origin soon after spawning in preceding autumn or in that spring or early summer were reported to be already mature. It is well known that gonads start to develop soon after spawning especially in females. Kelts had body cavity half full of eggs already in May and those fishes must have been at sea already for a long period and develop gonads or they have not succeeded to spawn and release eggs in previous autumn. In previous spawners, especially in females, gonads were well developed already early in the season but in males their development happened slowly like in maiden salmon.

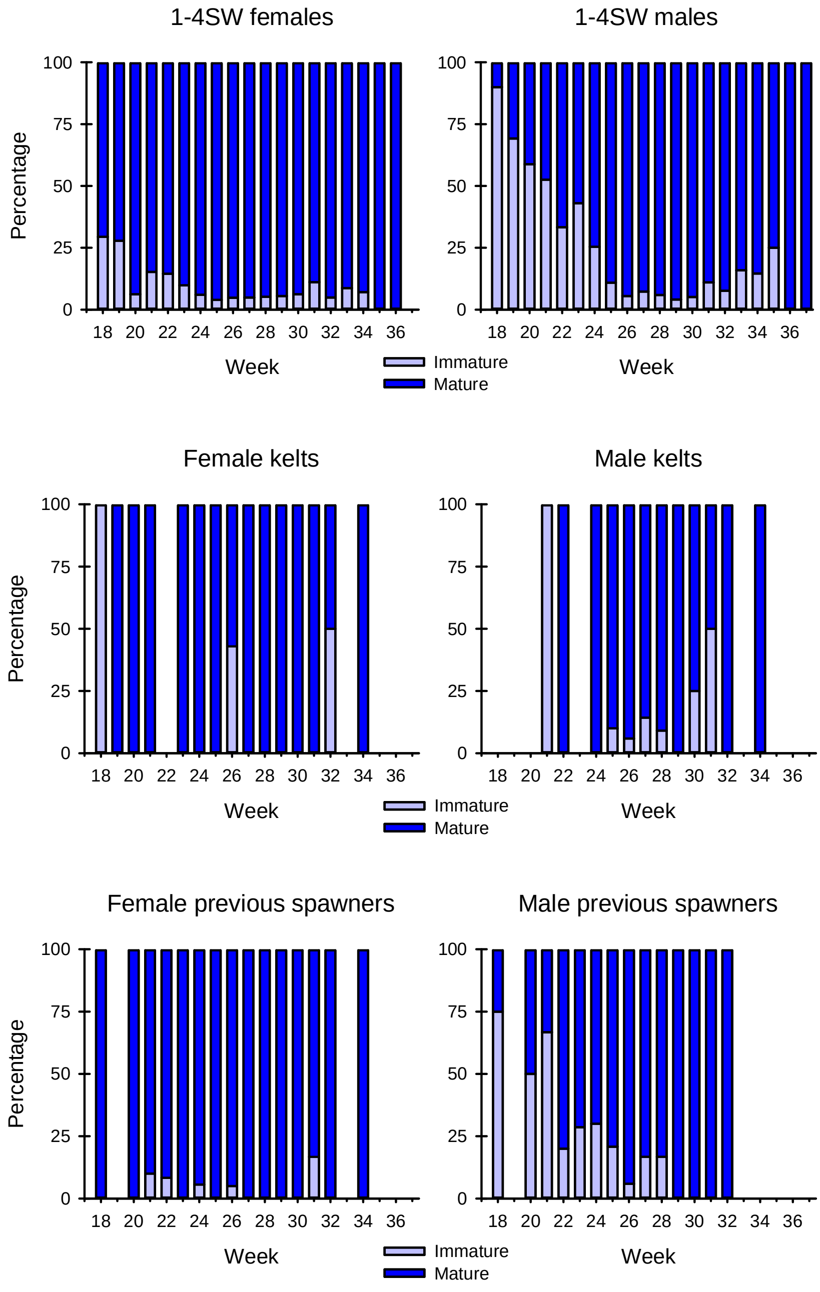


Figure 17. Weekly percentages of mature female and male maiden salmon (figure in the top), kelts (figure in the middle) and previous spawning salmon in Finnmark in Kolarctic salmon research fishery in the years 2008, 2009, 2011 and 2012.

Most of female and male kelts in the age groups of 1S+ and 2S+ were mature during their reconditioning summer (Figure 18). Fishermen recorded the development of gonads and it could have been possible that some of those salmon which were reported to be mature have not succeeded to spawn and release eggs and sperm and therefore they were reported to be mature already early in the summer.

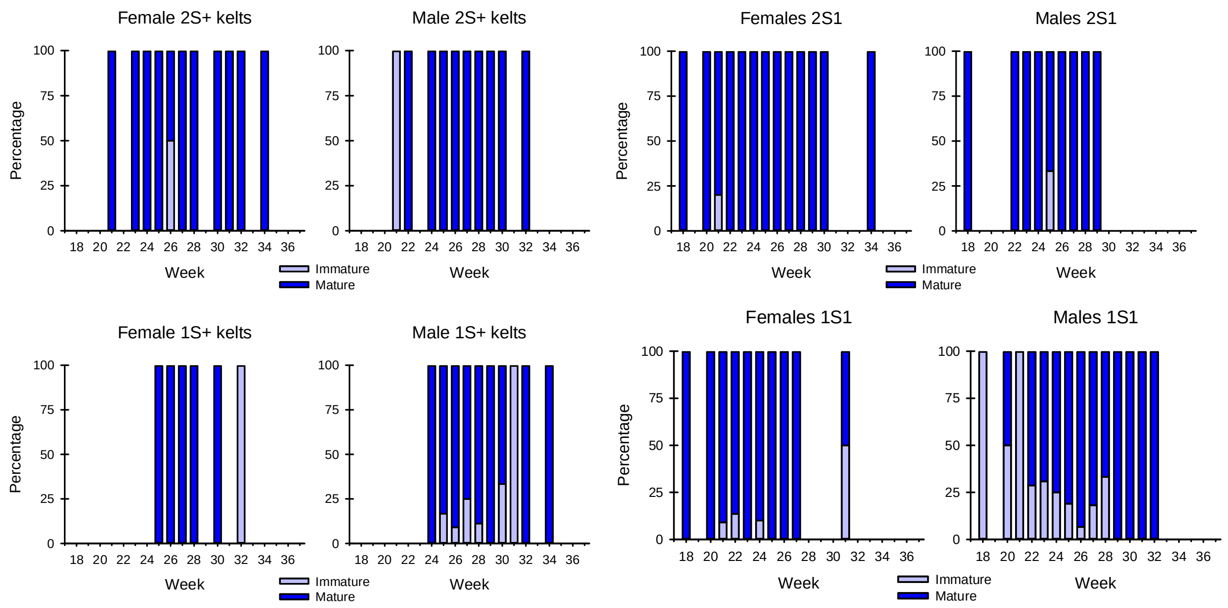


Figure 18. Weekly percentages of mature female and male fish in 1S+ kelts and the corresponding sea-ages one year later for 1S1 previous spawners (figures bottom on the left) and percentages for 2S+ and 2S1 on the top from the material collected in Finnmark in Kolarctic salmon research fishery in the years 2008, 2009, 2011 and 2012.

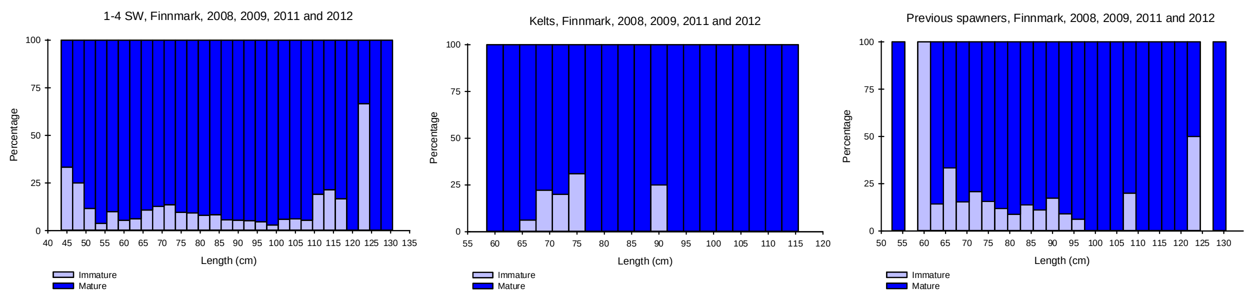


Figure 19. Weekly percentages of mature fish along the length of fish for maiden 1-4SW salmon (figure on the left), for kelts (figure in the middle) and for previous spawning salmon (figure on the right) in Finnmark in Kolarctic salmon research fishery in the years 2008, 2009, 2011 and 2012.

When analyzing the percentages of mature fish by the length of salmon it appears that most of salmon in selected length groups were mature. Only the smallest salmon and fish with the length of 110-120 cm included immature fishes in higher percentages (Figure 19). Some of salmon which are immature especially later in the summer might not ascend into the rivers during the year when they were migrating along the coast and some amount of immature fish were so called late running salmon. Late running salmon ascend into the rivers a year before they reach spawning condition and spawn in the rivers.

Male previous spawners that needed two years for reconditioning in the age group 1S2 originated from the rivers Neiden, Iesjohka, Valjohka, Alta and Målselva and some females in that age group of salmon originated from the rivers Maskejohka and Storelva (Laksefjord). There were previous spawners of the group 4S1 only in the rivers Karasjohka, Alta and Reisa; previous spawners were females in the rivers Karasjohka and Alta and male in the river Reisa.

Sex ratios of previous spawners all sea-age combinations included indicated that in general the majority of fish were females. In many stocks the numbers of samples was very low and therefore any clear conclusion cannot be done (Figure 20). Figures 21, 22 and 23 indicating that females are occurring in higher proportions in the older previous spawner sea-age groups following their majority in maiden 2SW and 3SW salmon. The low proportion or even lack of males in previous spawning age group 3S1 indicates that kelts and post spawners of 3SW salmon have a high mortality after the spawning which can also be observed in the low proportions of 2S1 males in many stocks.

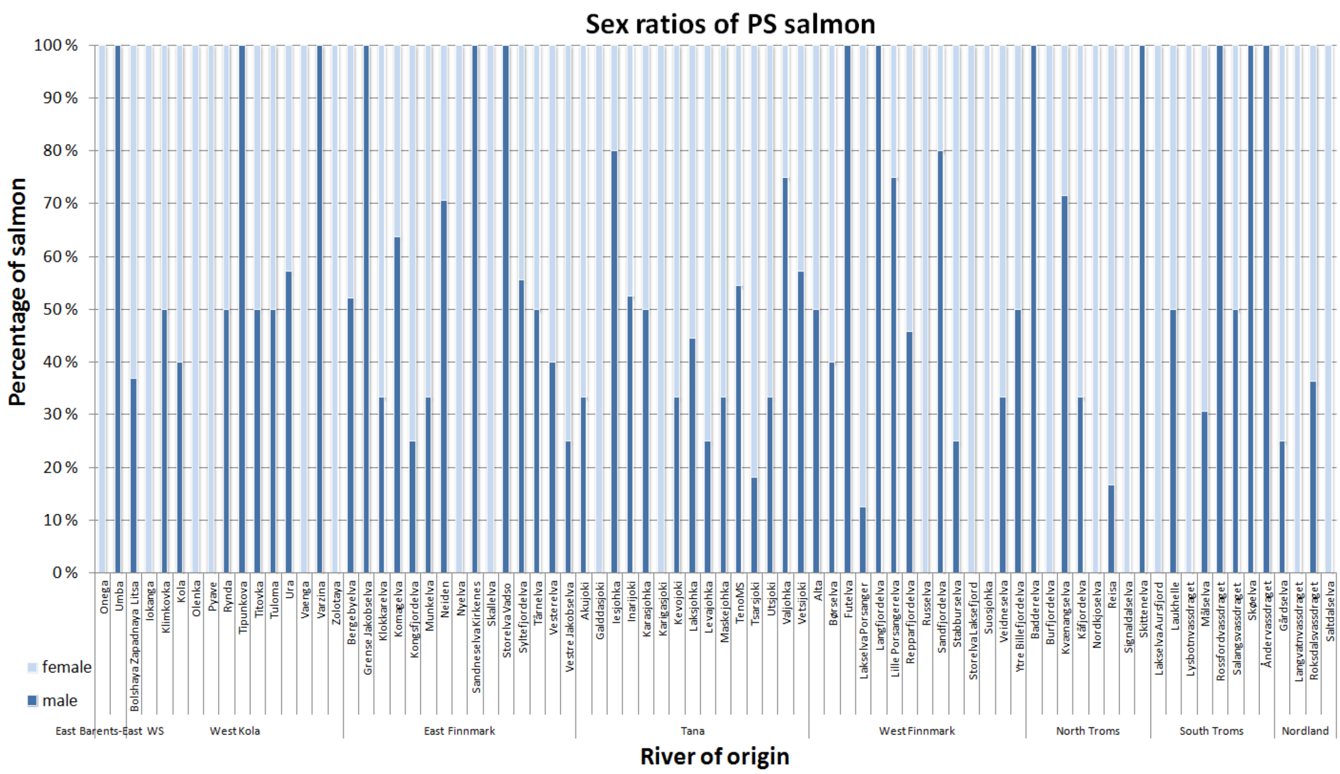


Figure 20: Sex ratios of previous spawners all sea-ages (1S1, 1S2, 2S1, 2S2, 2S1S1, 2S1S1S1, 3S1, 3S1S1, 3S1S1S1, 4S1)included (kelts excluded) of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery.

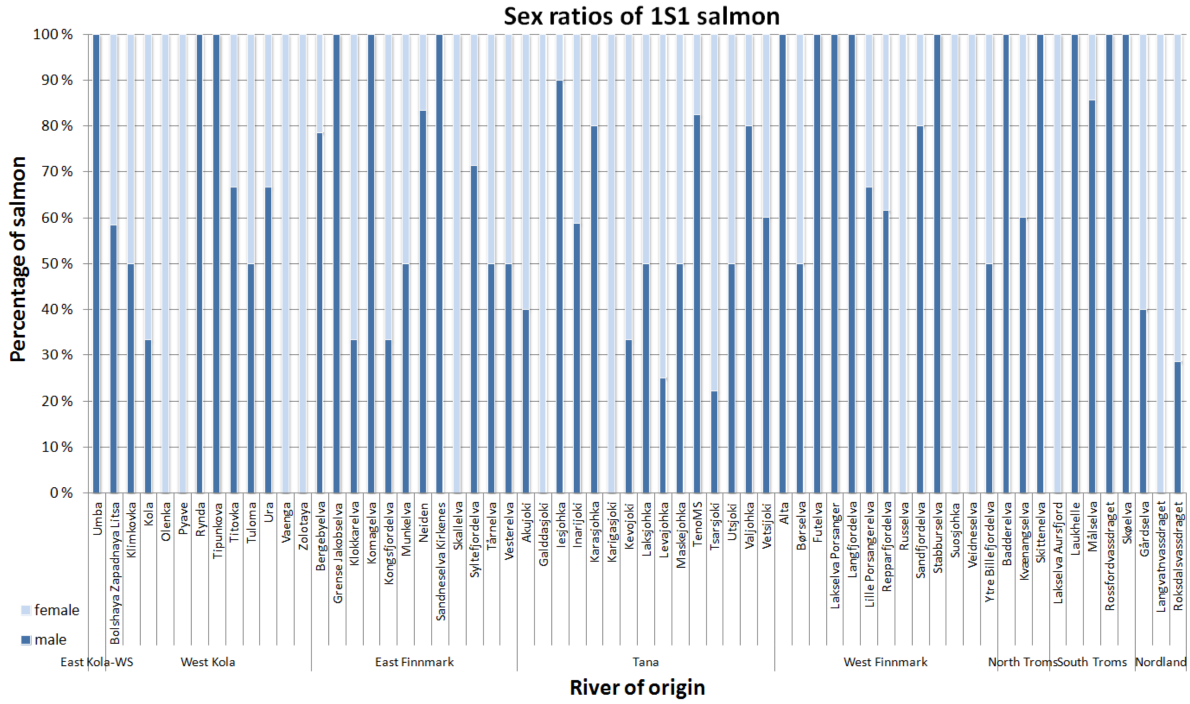


Figure 21. Sex ratios of 1S1 salmon of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery.

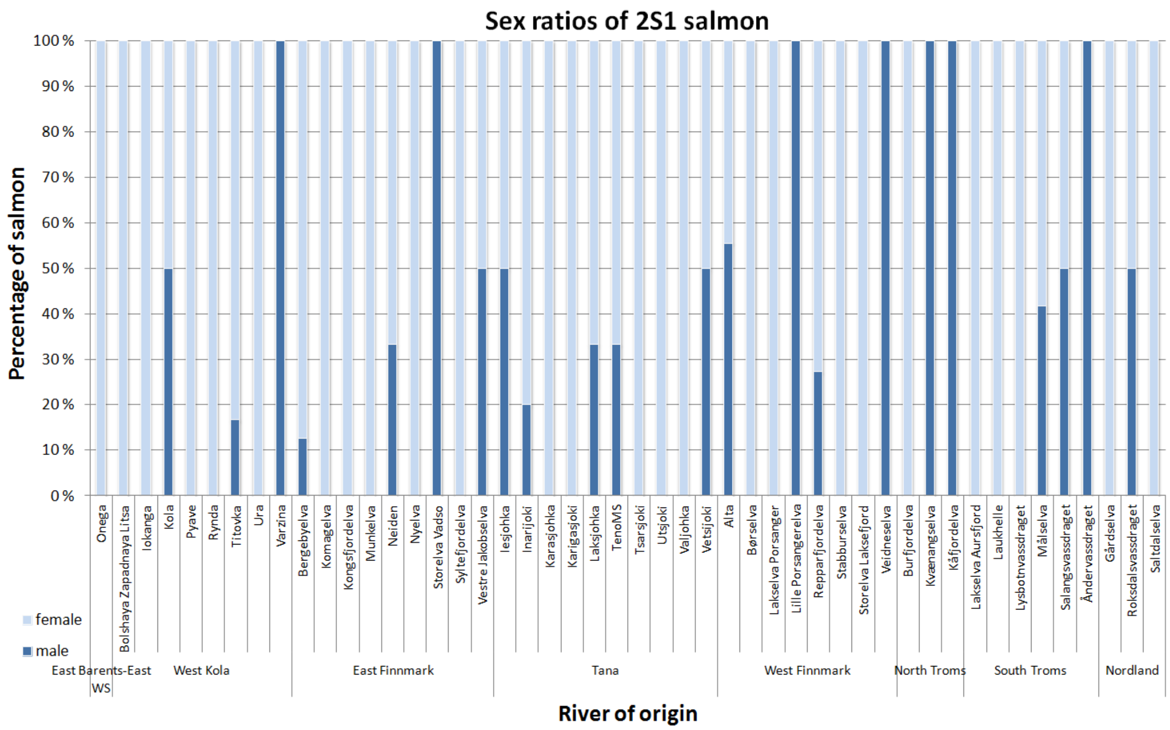


Figure 22. Sex ratios of 2S1 salmon of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery.

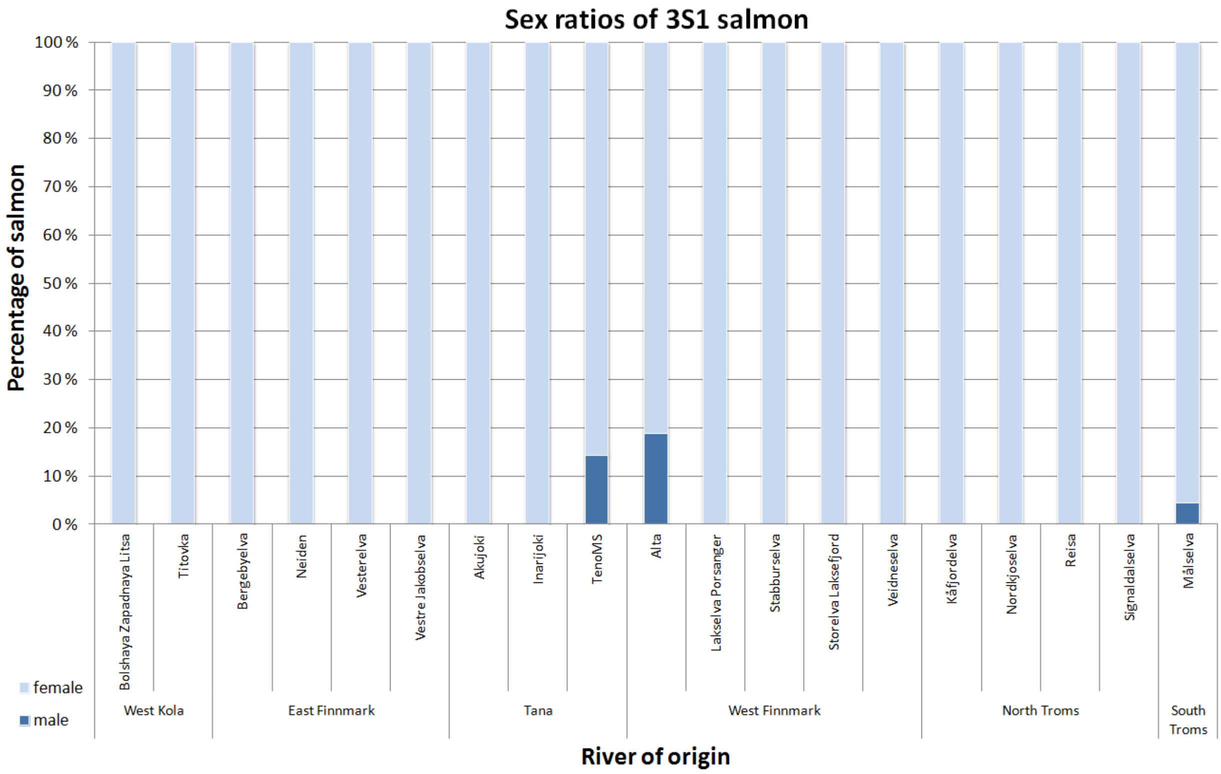


Figure 23. Sex ratios of 3S1 salmon of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery

Photo 5. Kelt. Photo: PINRO

3.5 Large variation in length and weight distributions in previous spawning salmon

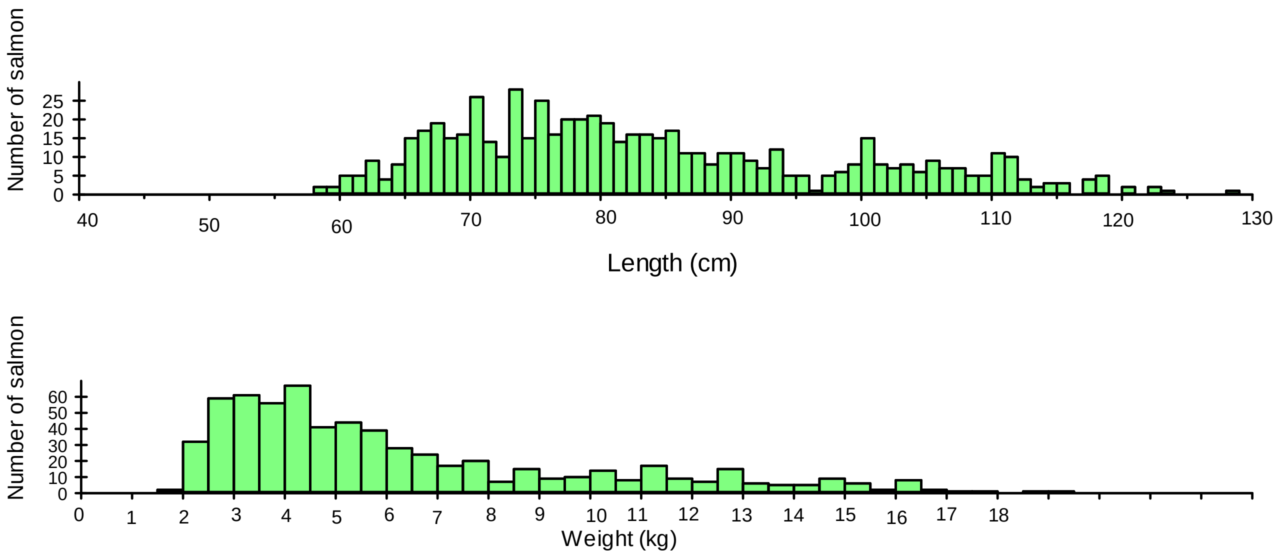
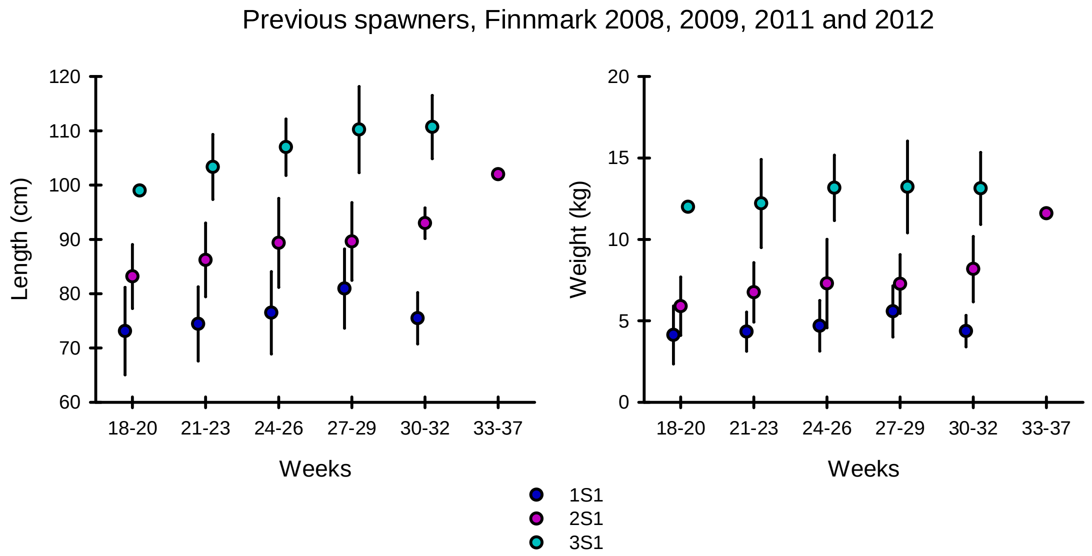


Figure 24. Length and weight distributions of previous spawners in research fishery in Kolarctic salmon project in the years 2011 and 2012.

Previous spawners and kelts represented a group of salmon belonging into many sea-age groups and therefore it is impossible to identify any of those age groups from the length or weight distributions. Lengths and weights are overlapping between age groups. Majority of previous spawners were in the weight groups between 2.5 kg to 4.5 kg. The largest previous spawner was close to 130 cm in length (Figure 24).

Photo 6. Tommy Dikkanen sampling for the Kolarctic salmon project



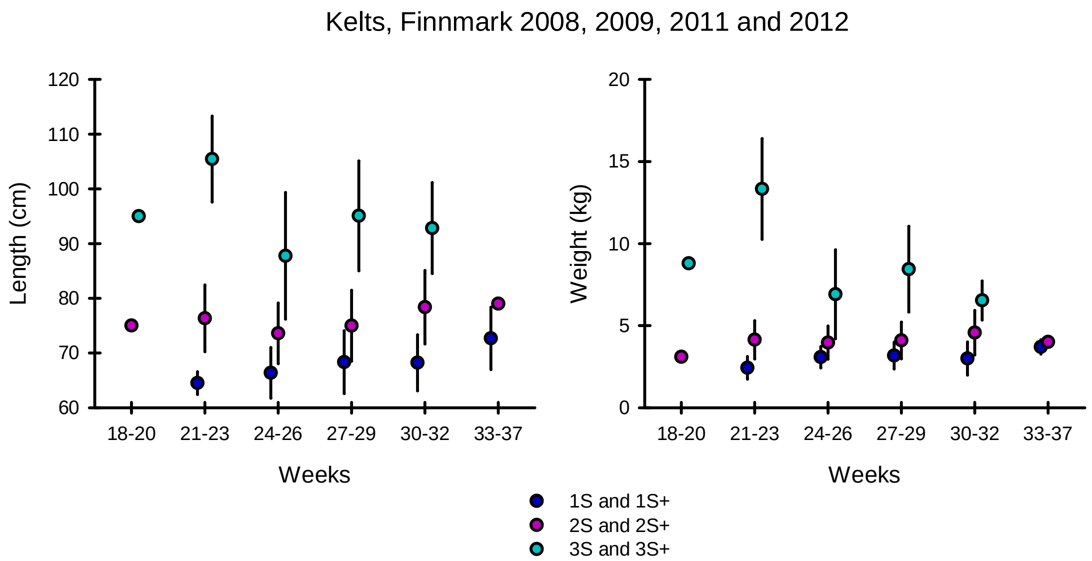


Figure 25. Mean lengths and weights of kelts and previous spawners caught in Kolarctic salmon project research fishery in Finnmark.

The mean weekly sizes of kelts (1S+, 2S+, 3S+) give a general picture of the reconditioning of post spawners. These post-spawners represent salmon stocks originating mainly from rivers in Northern Norway. Post-spawners in the age group of 2S+ are mainly females which have lost a lot from their weight during spawning and therefore their mean weights are only a little larger than the mean weight for 1S+ fish which are mainly males (Figure 25). Mean weights and lengths of previous spawners in each age group of 1S1, 2S1 and 3S1 are also increasing along the summer weeks. Differences in the mean sizes in the summer are also affected by the different origin and therefore different growth patterns of the stocks. Some previous spawner stocks are migrating later than others and also thus their sizes are different.

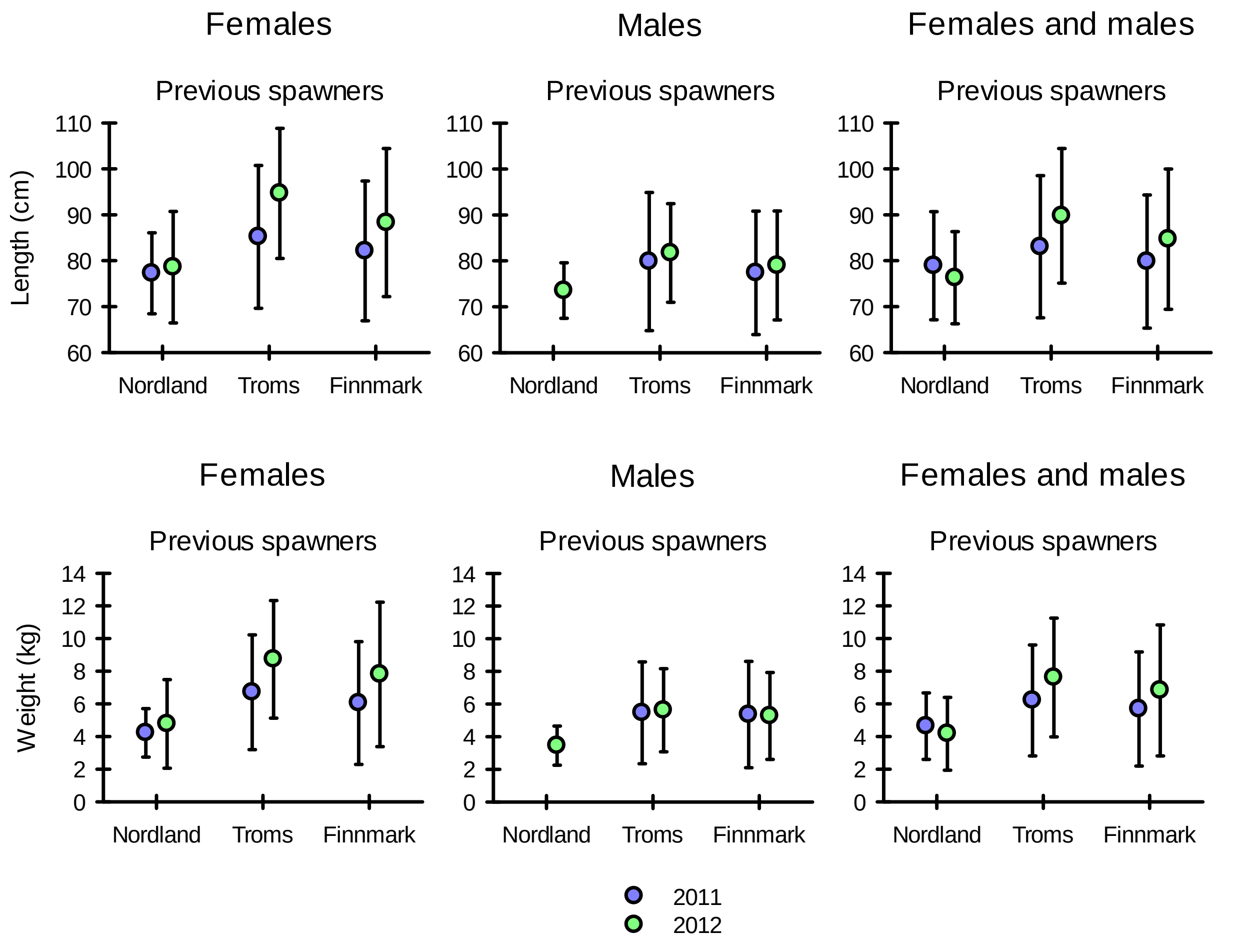


Figure 26. Mean lengths and weights of female and male previous spawners in three counties in the years 2011 and 2012.

Mean sizes of female previous spawners were larger in Troms and Finnmark counties in 2012 than in 2011 (Figure 26). That might reflect better feeding areas for females than for males in the reconditioning year and also differences in the sea-ages between the years 2011 and 2012. The mean sizes were close to the same for both sexes in Troms and Finnmark but clearly smaller in Nordland. In Nordland the mean sizes were smaller due to the absence of older previous spawners in the catches but those old previous spawners especially sea-age groups of 2S1+ and 3S1+ occurred in high numbers in Troms and Finnmark. Previous spawners occurred numerously in that size group of salmon which is the most numerous in the sea catches.

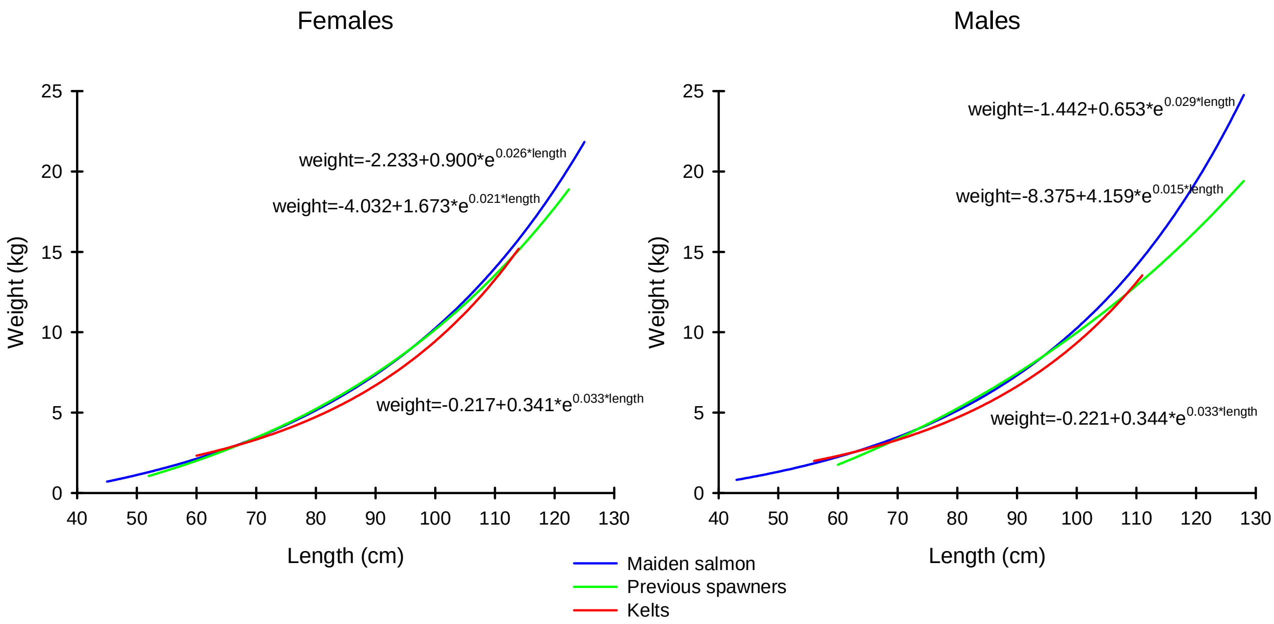


Figure 27. Curves from the length-weight relations for kelts, previous spawners and first time spawners in Kolarctic salmon project area. This material covers the years 2008, 2009, 2011 and 2012.

Length-weight curves indicate the condition of salmon between three life history phases (Figure 27). First time spawners and previous spawners have about the same model in the curves. Curve for kelts is different indicating that those fishes have lost weight during their spawning in rivers and in the reconditioning phase at sea they have not reached the weight which corresponds to the normal length-weight relationships found in first time spawner.

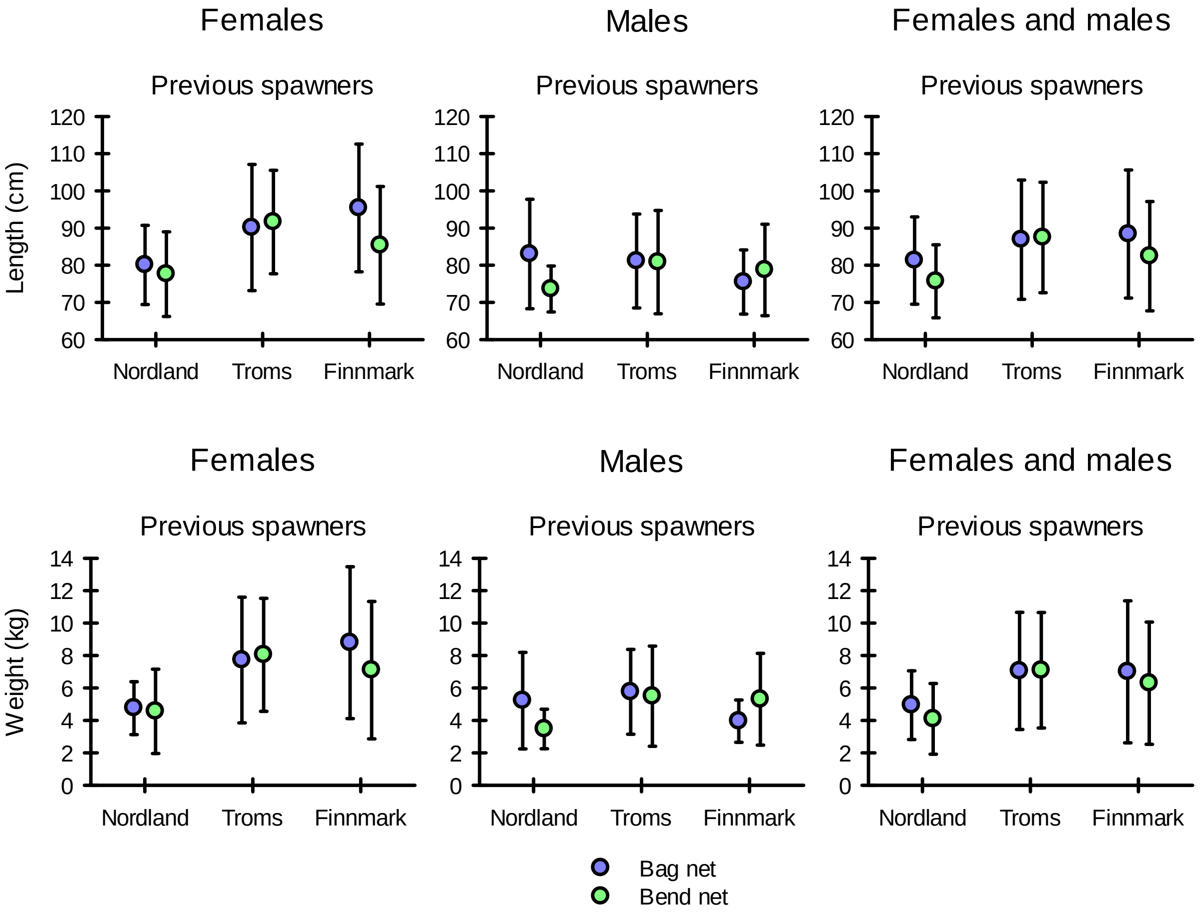


Figure 28. Mean sizes of previous spawners caught with bag net and bend net in Kolarctic salmon project areas in the years 2011 and 2012.

The mean sizes of previous spawners did not show clear differences between bag net and bend net when material from both sexes was combined. The mean sizes of previous spawners are already so big that it is believed that there is not any size selectivity between the fishing methods (Figure 28). The mean size of female previous spawners is larger than that of males and reason for that is the difference in sea-age distributions. Most from male previous spawners were the sea-age 1S1 but most of female previous spawners were the sea-ages of 2S1 and 3S1 (See Table II).

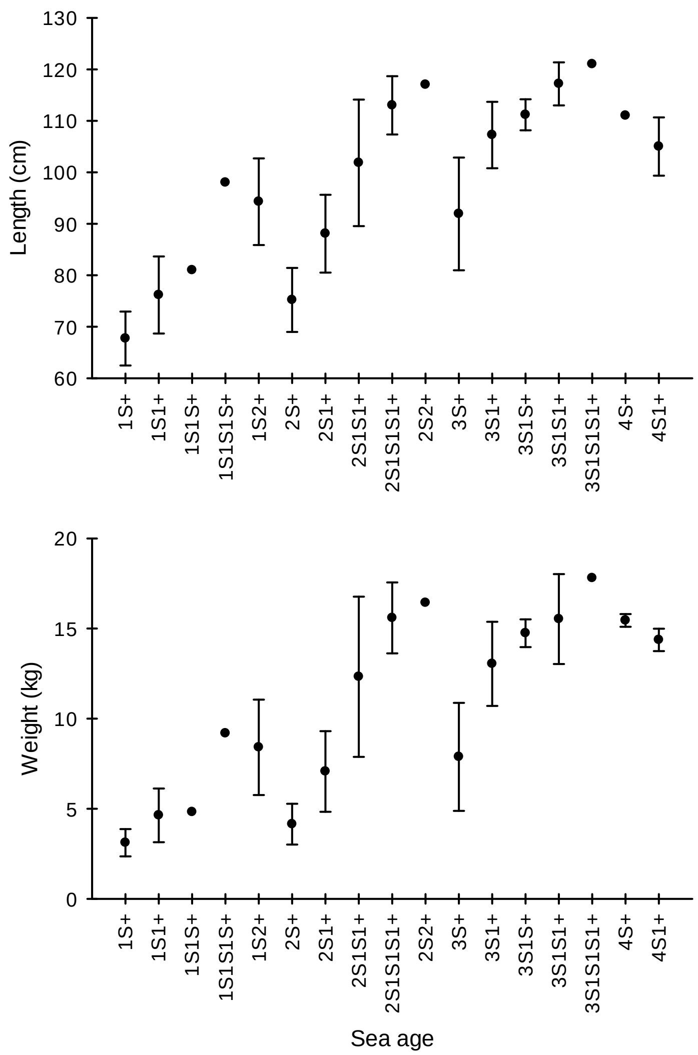


Figure 29. Mean weights and lengths of previous spawners and kelts in Finnmark in the material from the years 2008, 2009, 2011 and 2012. Figures are illustrating mean values sexes combined.

Mean weights and lengths of previous spawners and kelts are increase with age like in maiden salmon (Figure 29, Table II). Salmon, which had spawned for the first time in the age of 1SW fish and then two more spawning times (age 1S1S1S1+) had weight of c. 9 kg owing the total sea-age of 7 year. Salmon with the sea-age of 2S1S1S1+ had total sea-age of 8 year and the mean weight of 16 kg and salmon with the sea-age of 3S1S1S1+ had total sea age of 9 years and weight of 18 kg. Each spawning consumes a lot of energy reserves from the salmon body which must be first rebuild into the body during the reconditioning period and thereafter salmon can continue the growth in length and weight.

Table II. Mean lengths and weights of previous spawners for various sea-age groups in Kolarctic salmon project area in 2008, 2009, 2011 and 2012 years combined.

	1S	1S1	1S1S	1S1S1S	1S2	2S	2S1	2S1S1	2S1S1S1	2S2	3S	3S1	3S1S	3S1S1	3S1S1S1	4S	4S1
Males (n)	73	225			7	32	33	1	1	1	3	4		2		1	
Length (cm)	67.8	78.3			95.3	73.1	88.4	117.0	109.0	117.0	91.7	117.4		122.5		111.0	
Weight (kg)	3.1	5.0			8.7	3.9	7.2	16.4	14.2	16.4	7.6	16.4		15.7		15.2	
Females (n)	31	158	1	1	2	44	88	5	1		20	61	3	8	1	1	2
Length (cm)	67.5	73.3	81.0	98.0	90.9	76.4	87.6	98.8	117.0		92.4	106.6	111.2	116.0	121.0	111.0	105.0
Weight (kg)	3.2	4.1	4.8	9.2	7.4	4.2	6.9	11.5	17.0		7.8	12.8	14.7	15.5	17.8	15.7	14.4

3.5 Stock specific mean lengths and weights of previous spawning salmon

Mean lengths and weights of previous spawners as a group of salmon had large differences between stocks. Differences reflect the different sea-age structures in those stocks. Stocks with high mean weights are large rivers where 2SW and 3SW first time spawners occur and survive into previous spawners, the age of 2S1 and 3S1 (Figure 30 and 33). In many smaller rivers previous spawners are originating from first time spawners of 1SW and having repeat spawning in the age of 1S1 and therefore their mean weights are smaller. Mean lengths and weights of male previous spawners do not differ as much as in females indicating that many male previous spawners are 1S1. In the figures 28-33 all previous spawner sea-age groups are combined which makes large size differences between areas and stocks.

The mean sizes of 1S1, 2S1 and 3S1 previous spawners have large differences between stocks for females and males or sexes combined (Figures 36-49). Differences in the sizes are stock specific and also the time when they have been caught reflects to the sizes. Some previous spawner stocks are migrating later in the summer to the coastal areas and therefore they have had longer period to recondition and reach larger size.

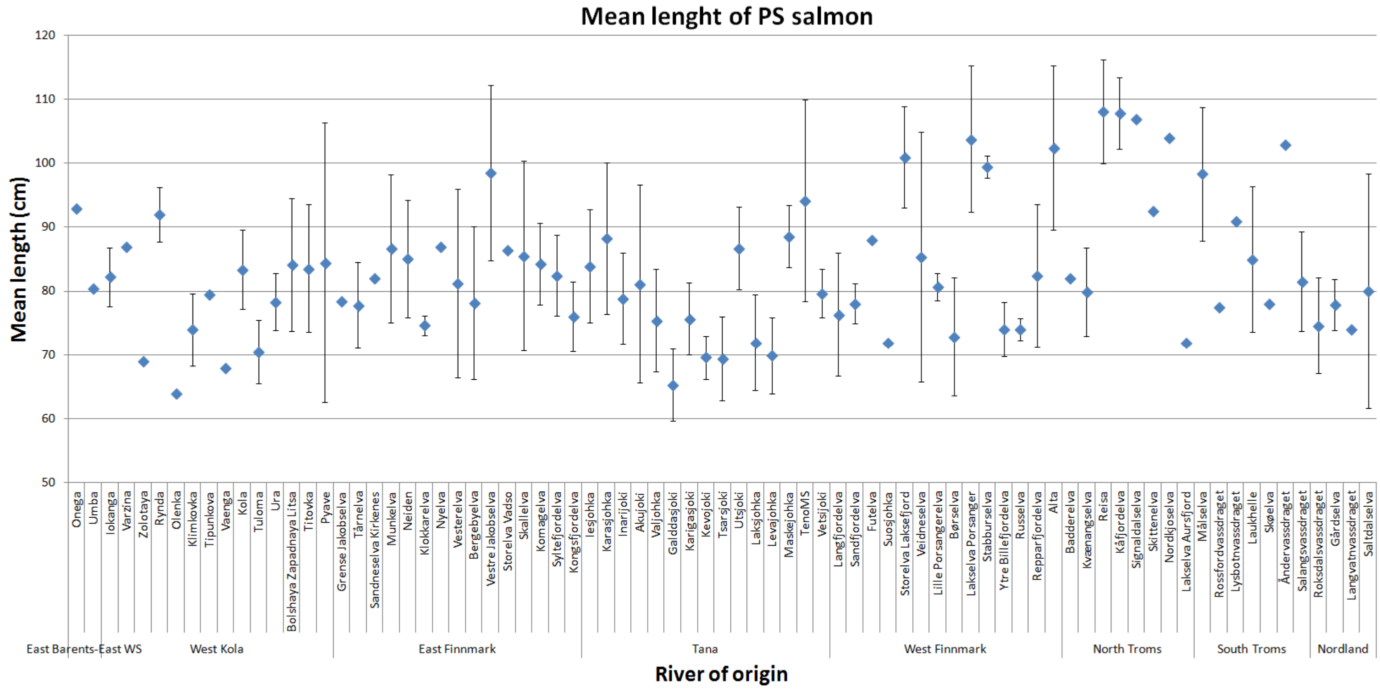


Figure 30. Mean lengths of previous spawners all sea-ages (1S1, 1S2, 2S1, 2S2, 2S1S1, 2S1S1S1, 3S1, 3S1S1, 3S1S1S1, 4S1) included (kelts excluded) of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

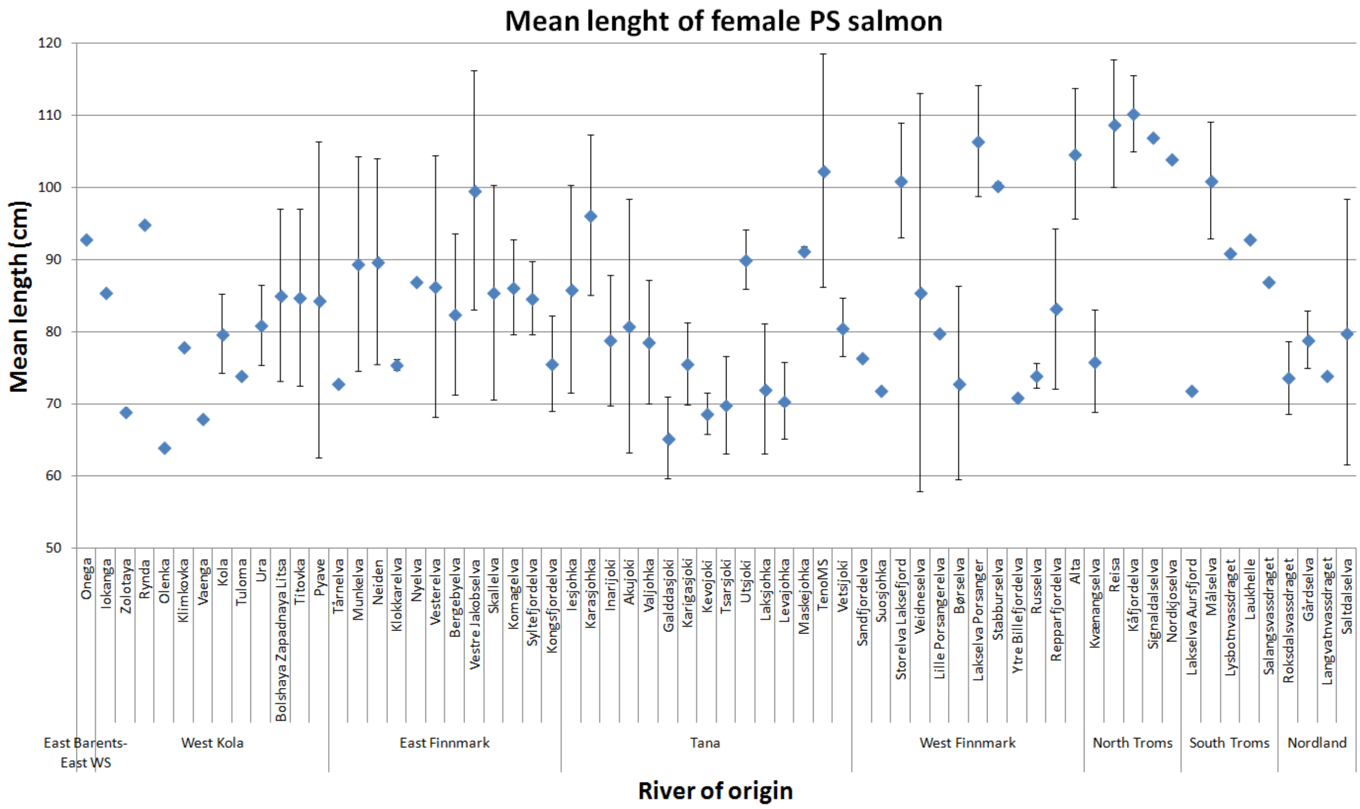


Figure 31. Mean lengths of female previous spawners all sea-ages included (kelts excluded) of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

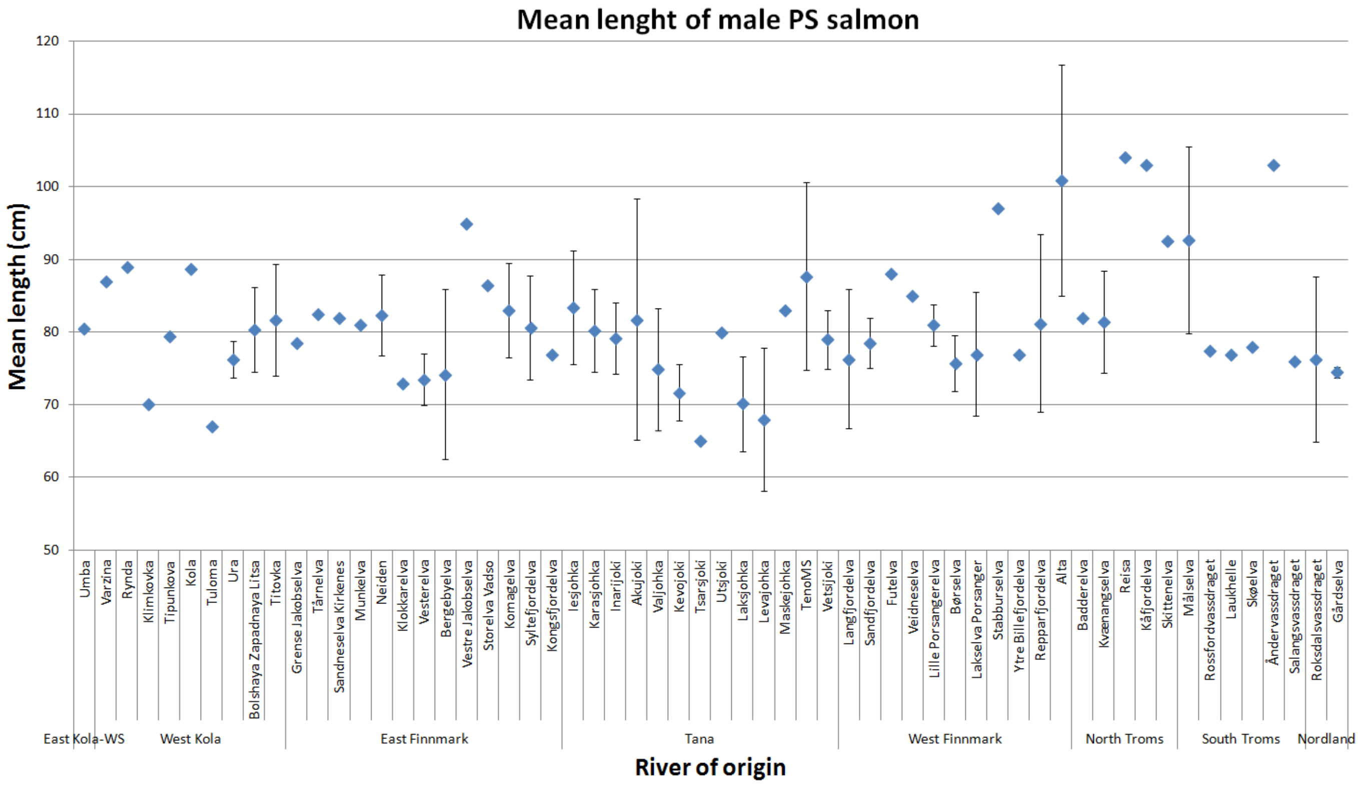


Figure 32. Mean lengths of male previous spawners all sea-ages included (kelts excluded) of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

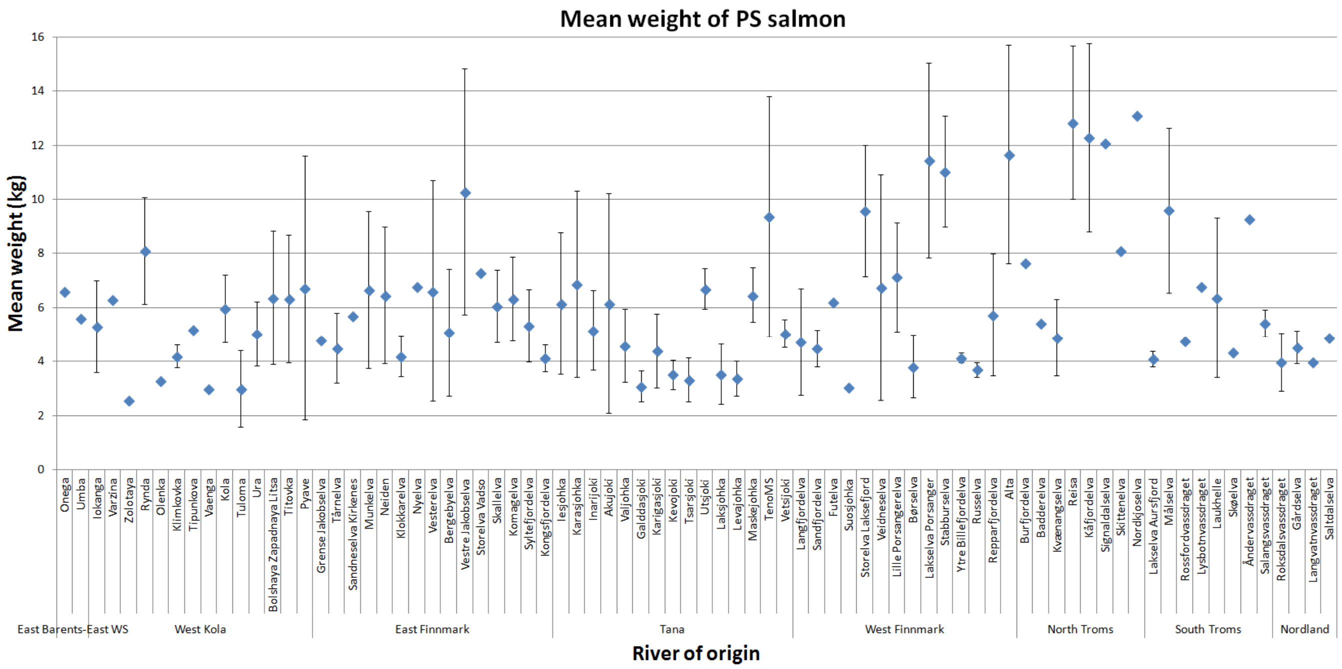


Figure 33. Mean weights of previous spawners all sea-ages (1S1, 1S2, 2S1, 2S2, 2S1S1, 2S1S1S1, 3S1, 3S1S1, 3S1S1S1, 4S1) included (kelts excluded) of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

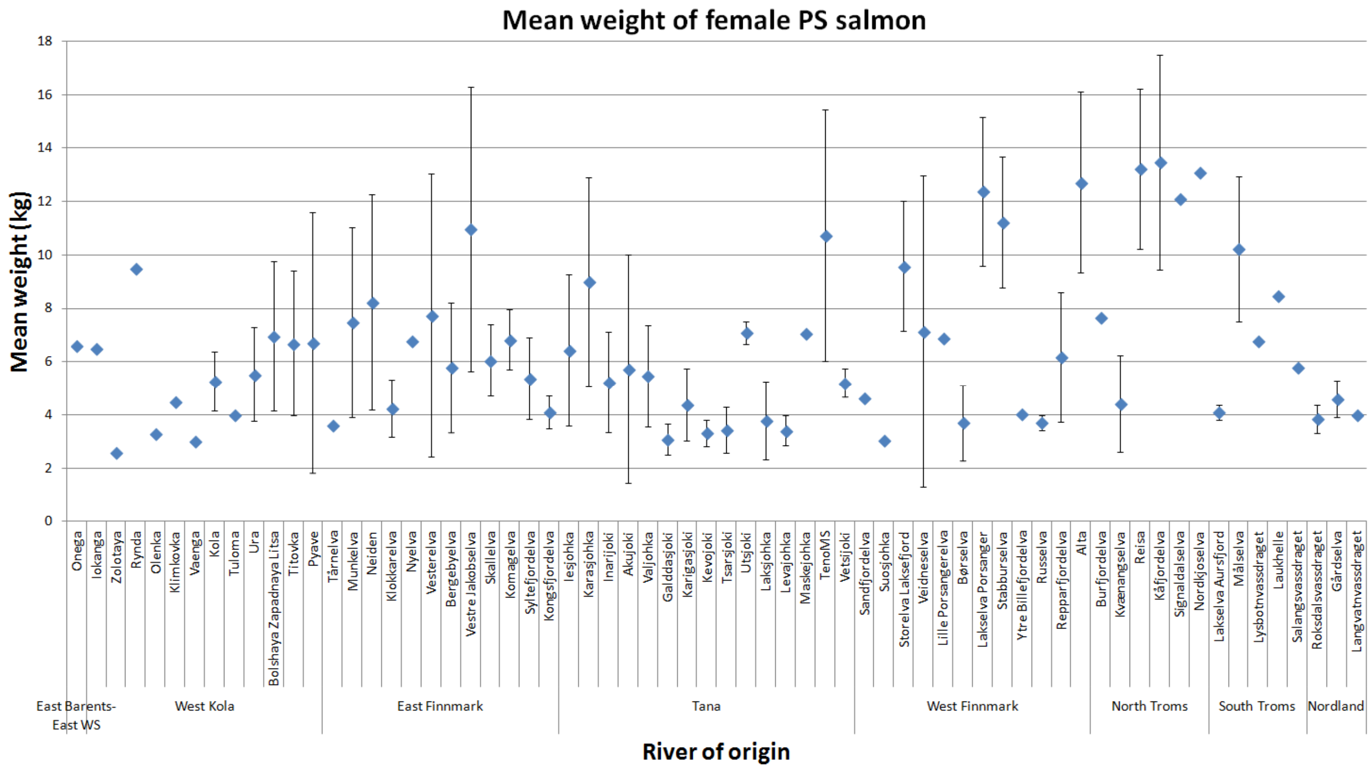


Figure 34. Mean weights of female previous spawners all sea-ages included (kelts excluded) of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

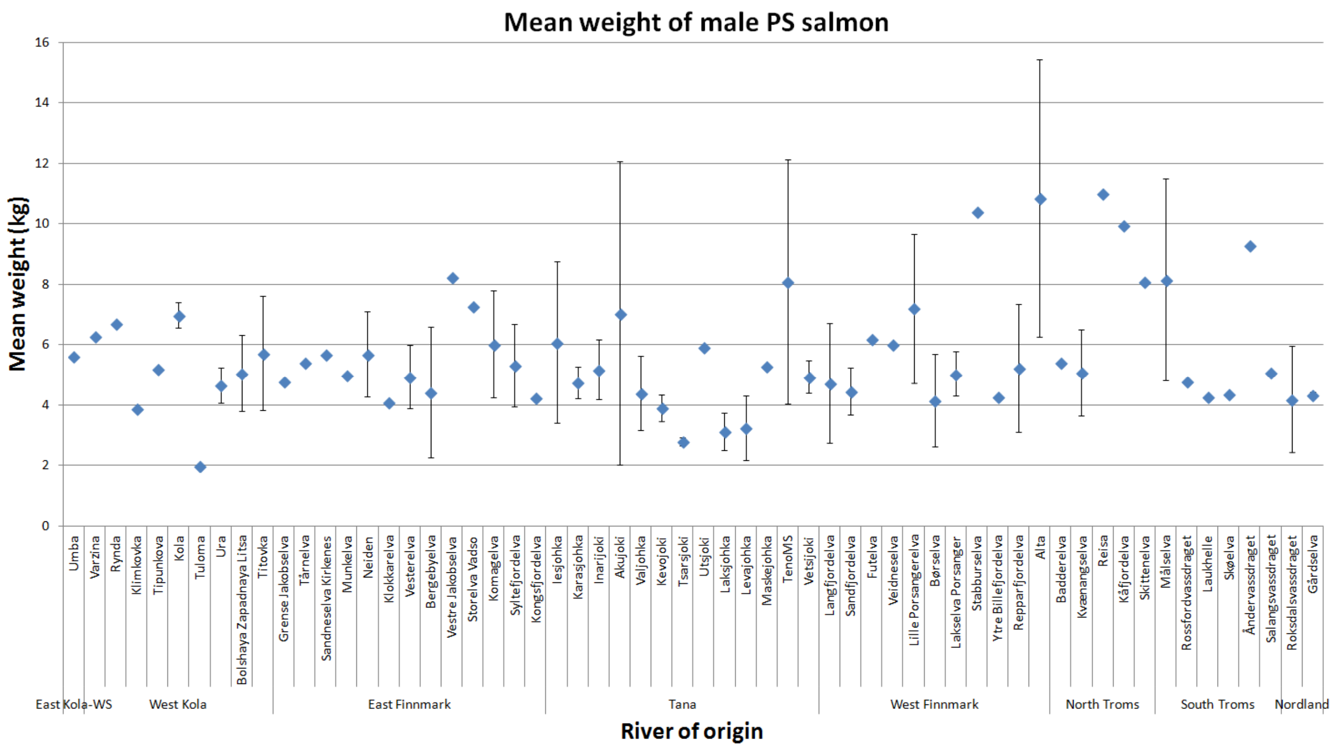


Figure 35. Mean weights of male previous spawners all sea-ages included (kelts excluded) of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

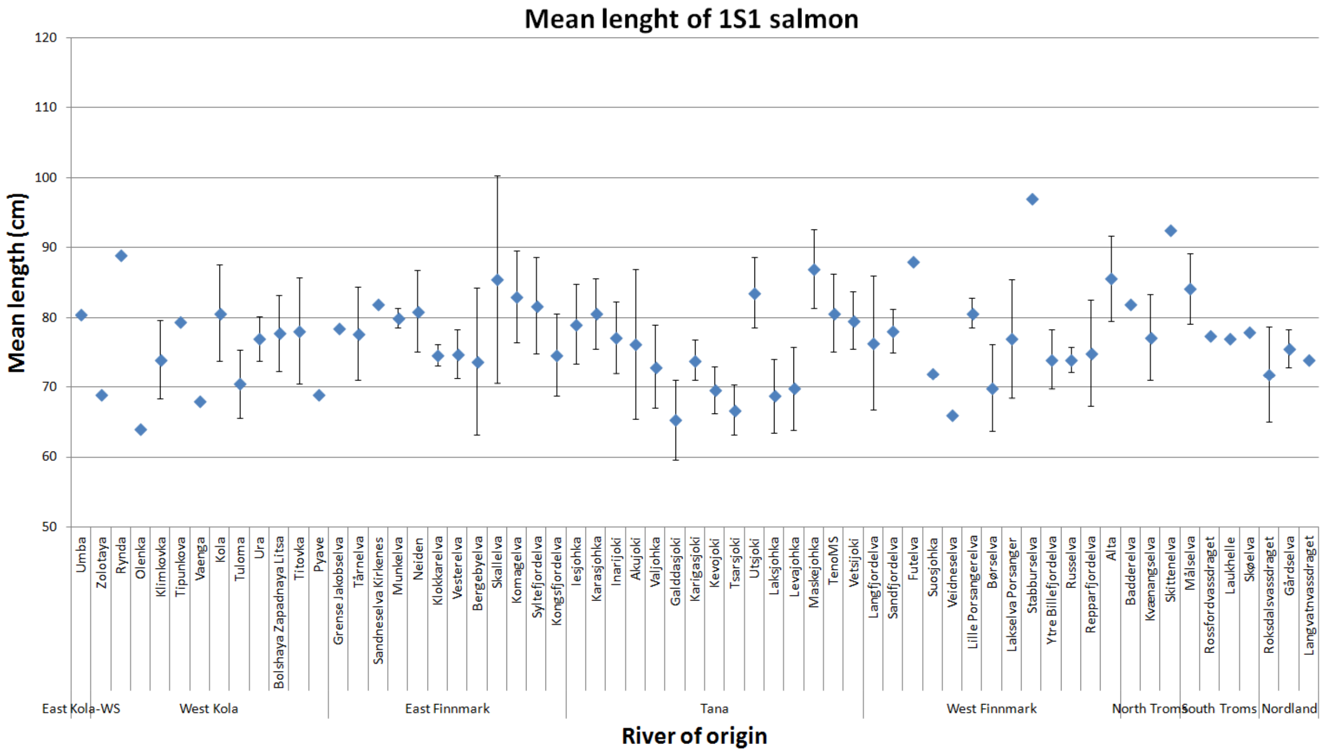


Figure 36. Mean lengths of previous spawners in the sea-age group 1S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

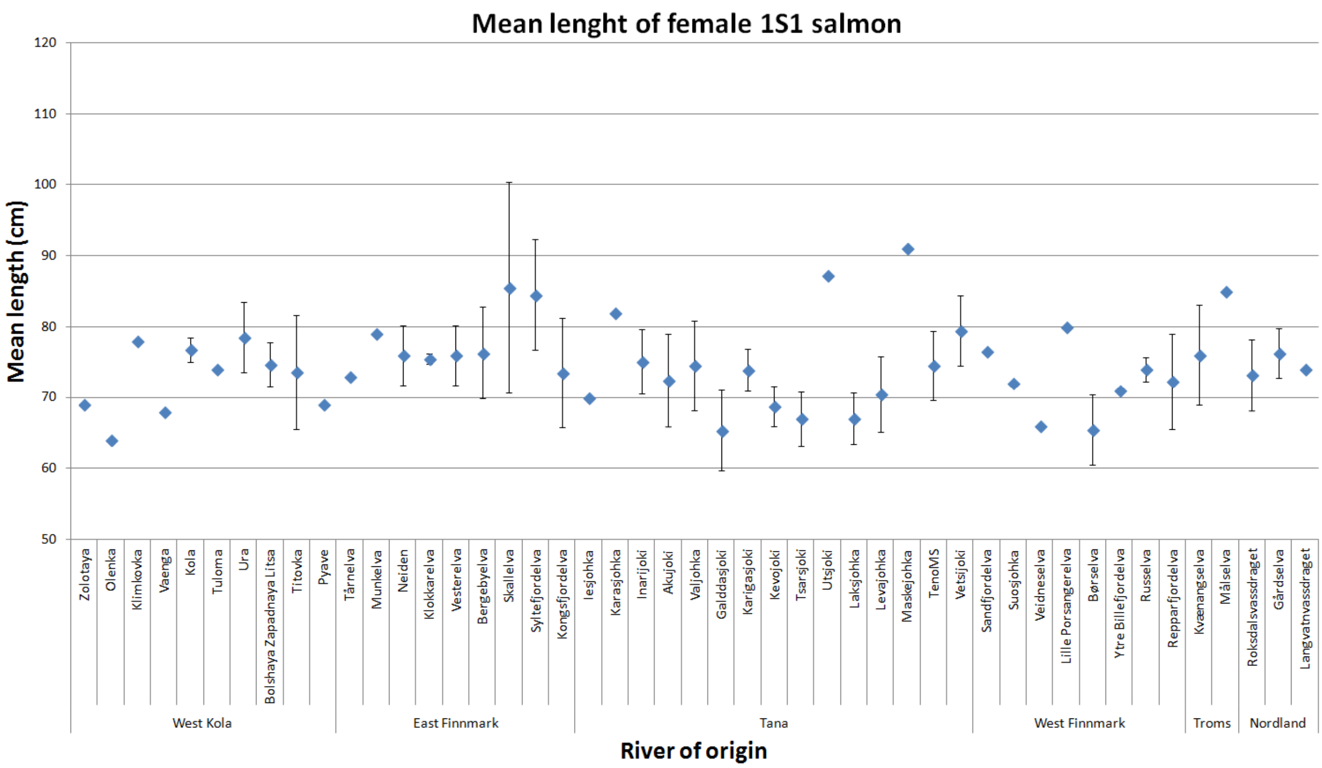


Figure 37. Mean lengths of female previous spawners in the sea-age group 1S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

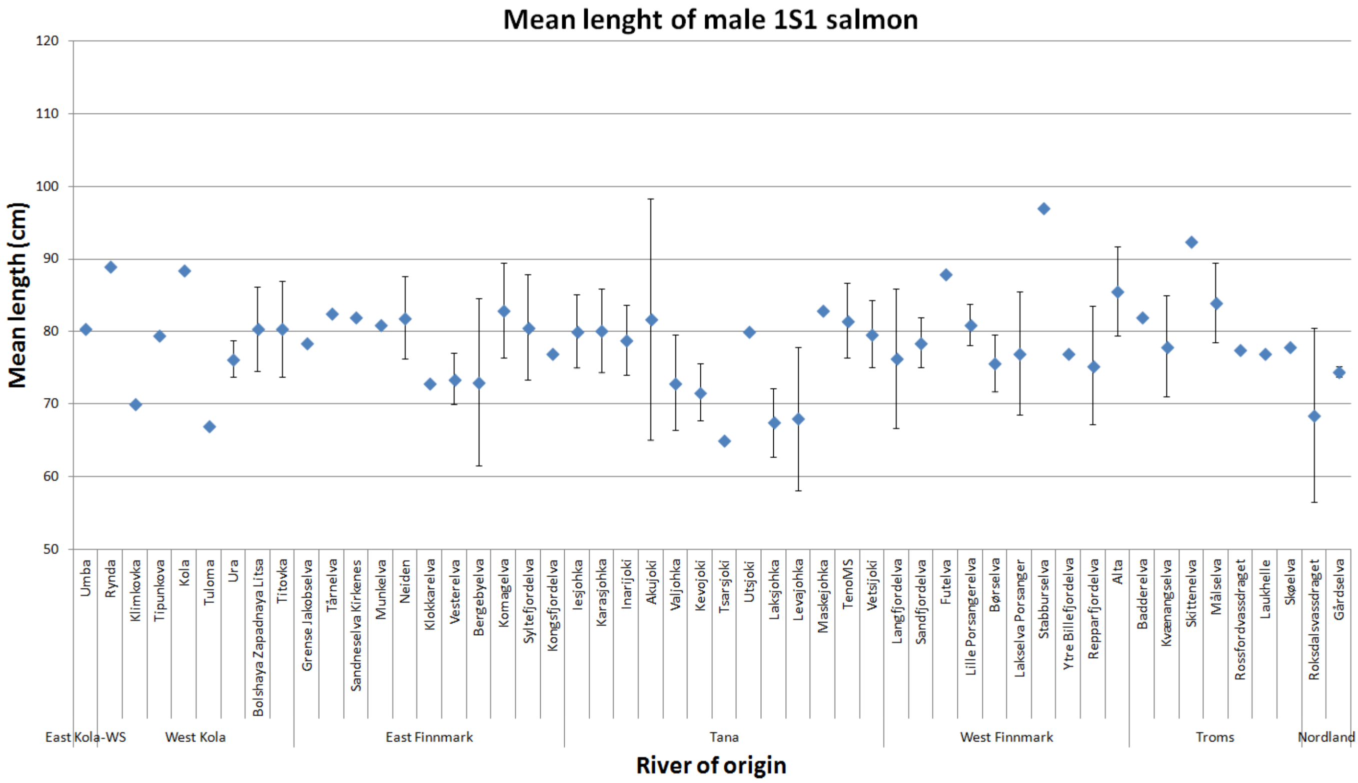


Figure 38. Mean lengths of male previous spawners in the sea-age group 1S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

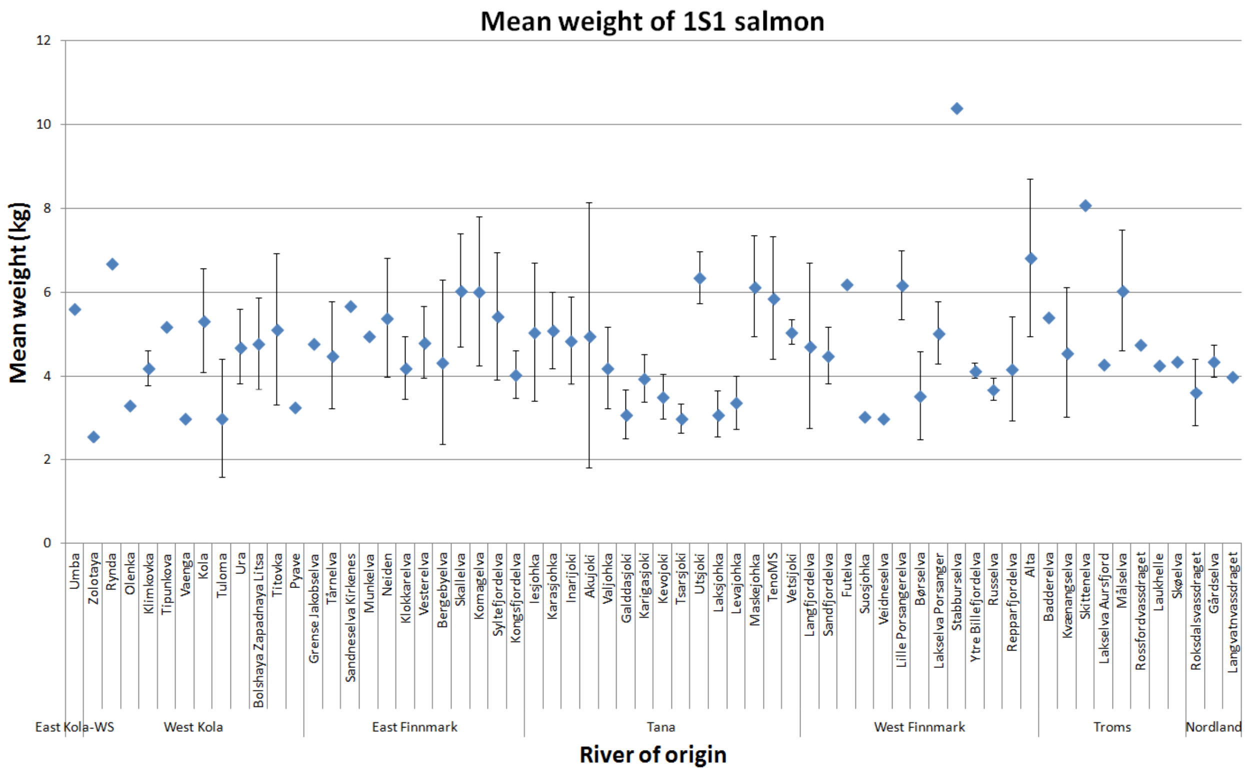


Figure 39. Mean weights of previous spawners in the sea-age group 1S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

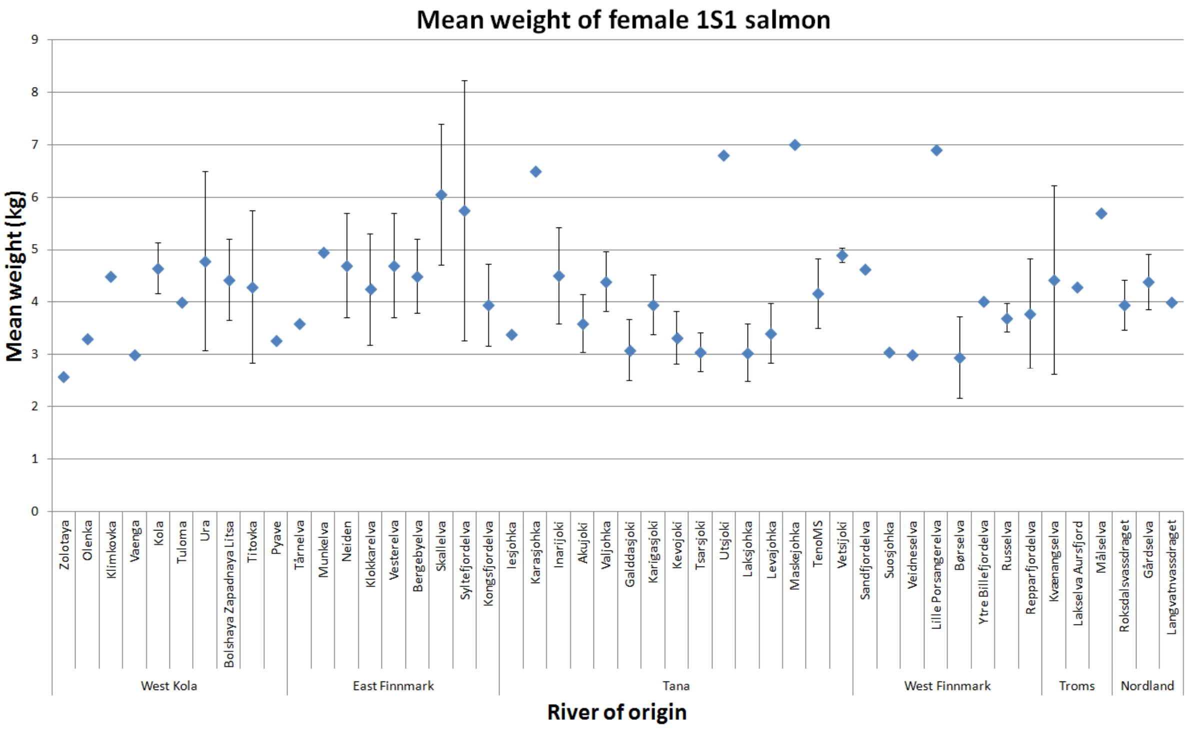


Figure 40. Mean weights of female previous spawners in the sea-age group 1S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

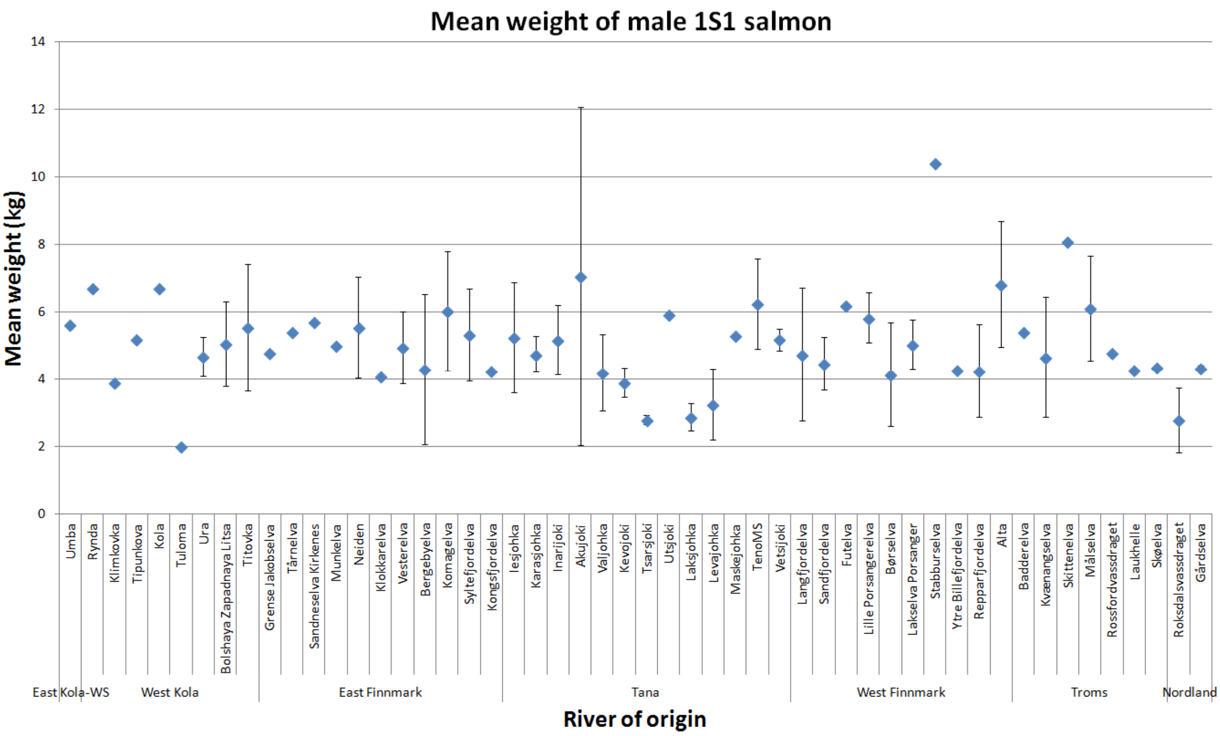


Figure 41. Mean weights of male previous spawners in the sea-age group 1S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

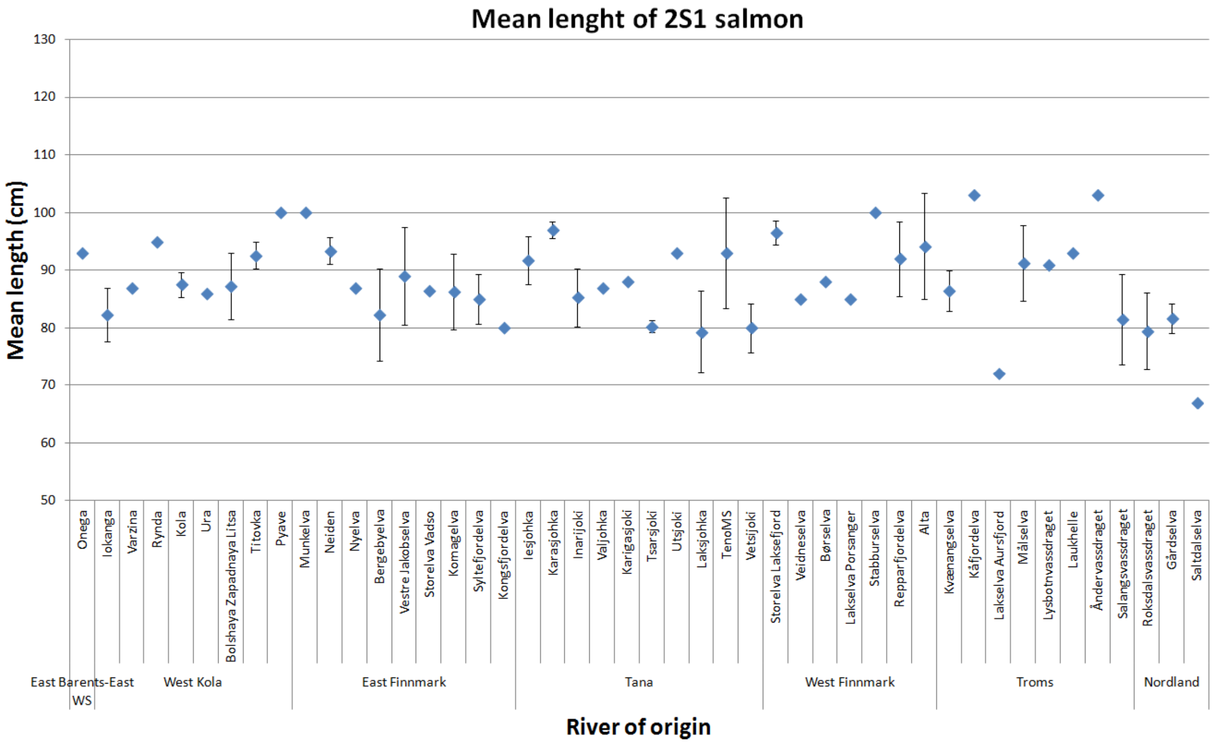


Figure 42. Mean lengths of previous spawners in the sea-age group 2S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

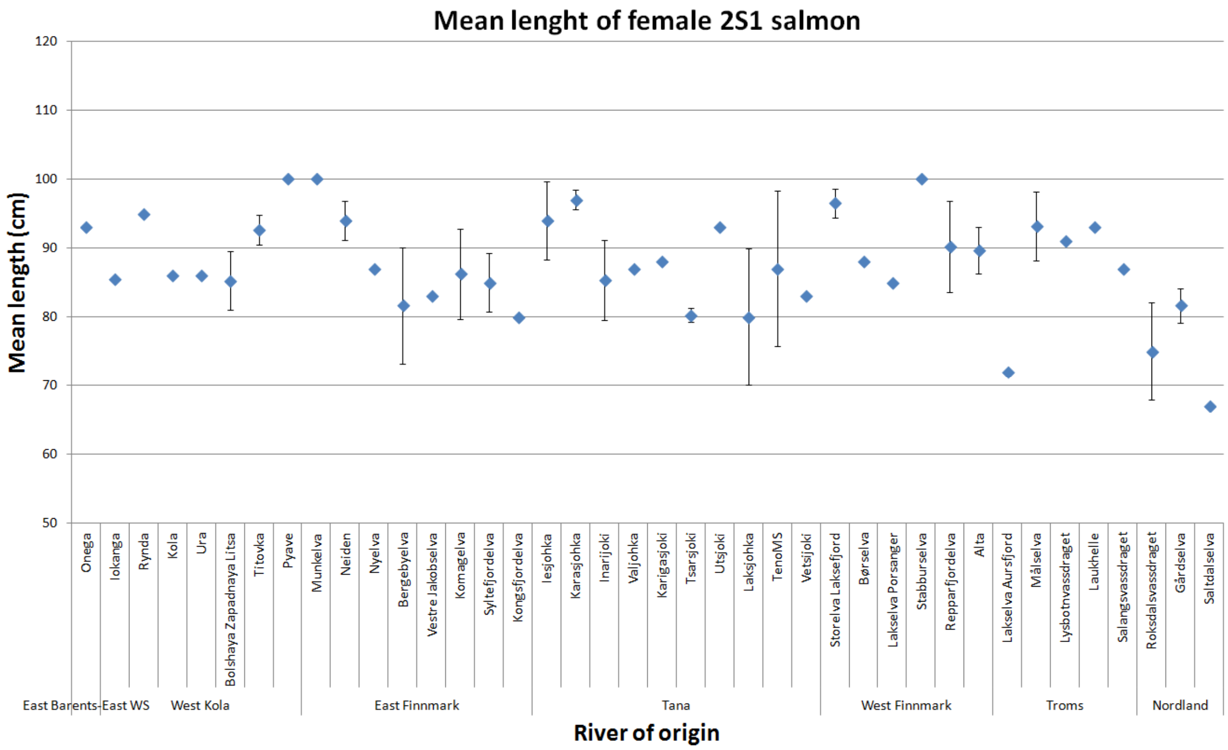


Figure 43. Mean lengths of female previous spawners in the sea-age group 2S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

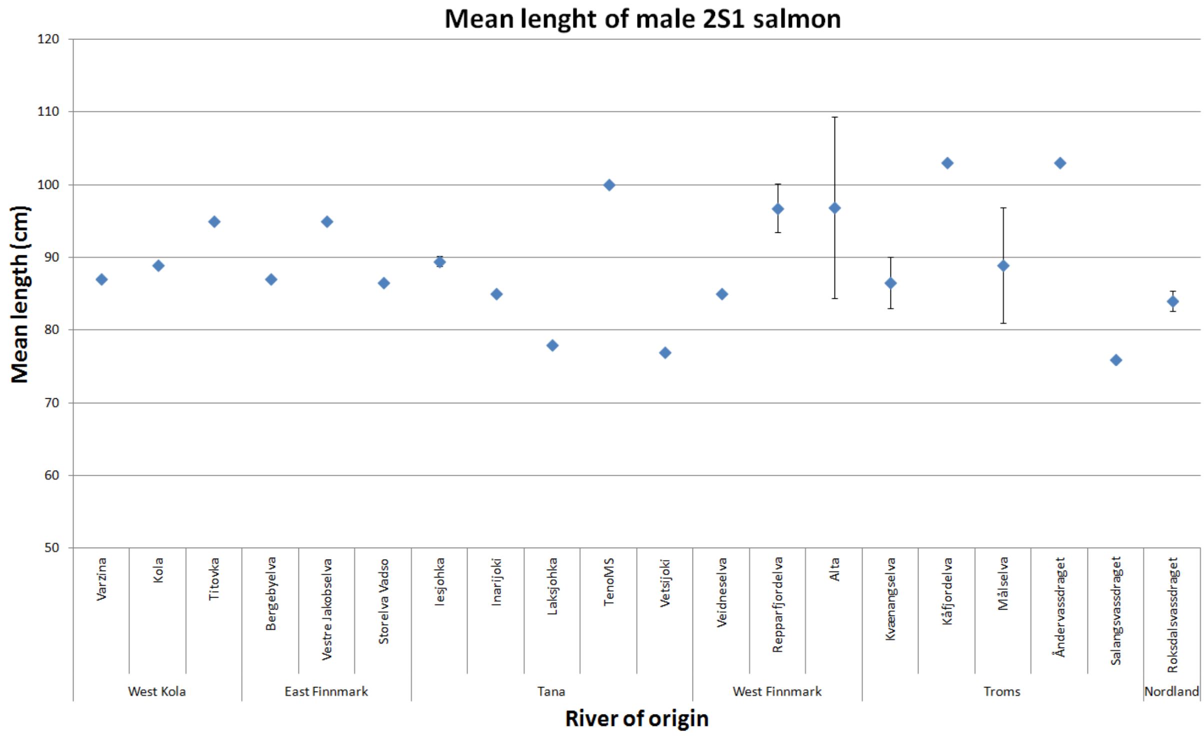


Figure 44. Mean lengths of male previous spawners in the sea-age group 2S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

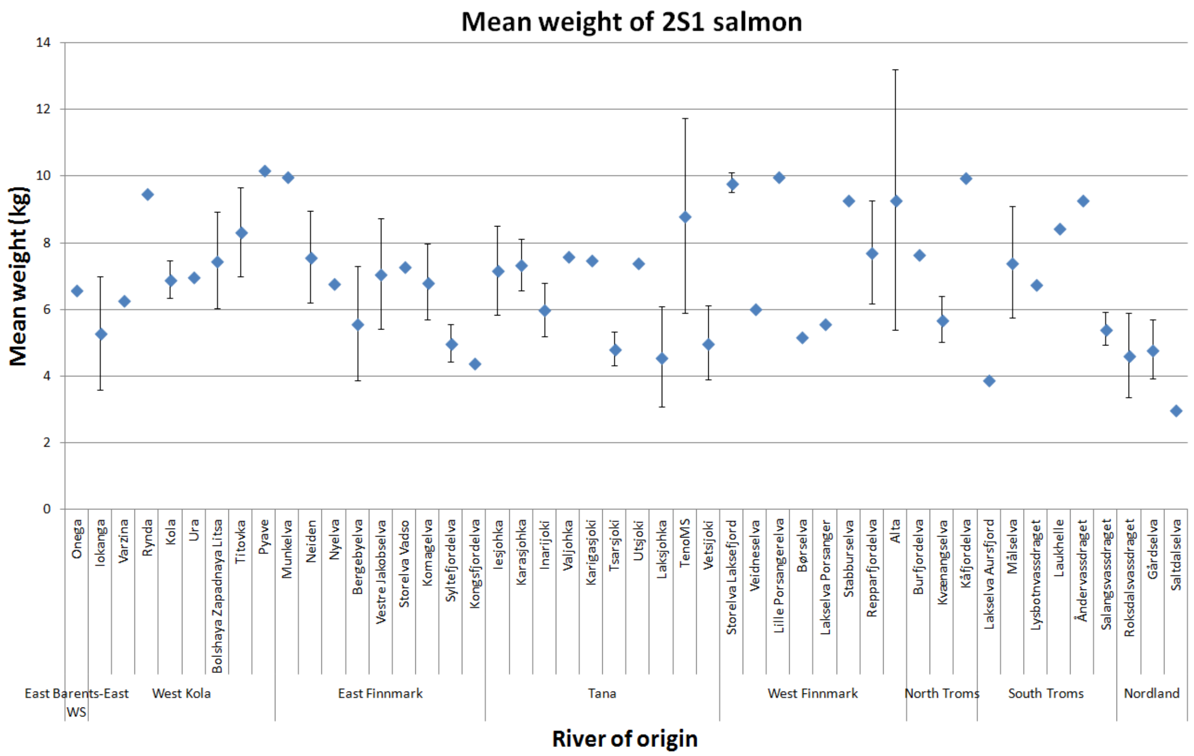


Figure 45: Mean weights of previous spawners in the sea-age group 2S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

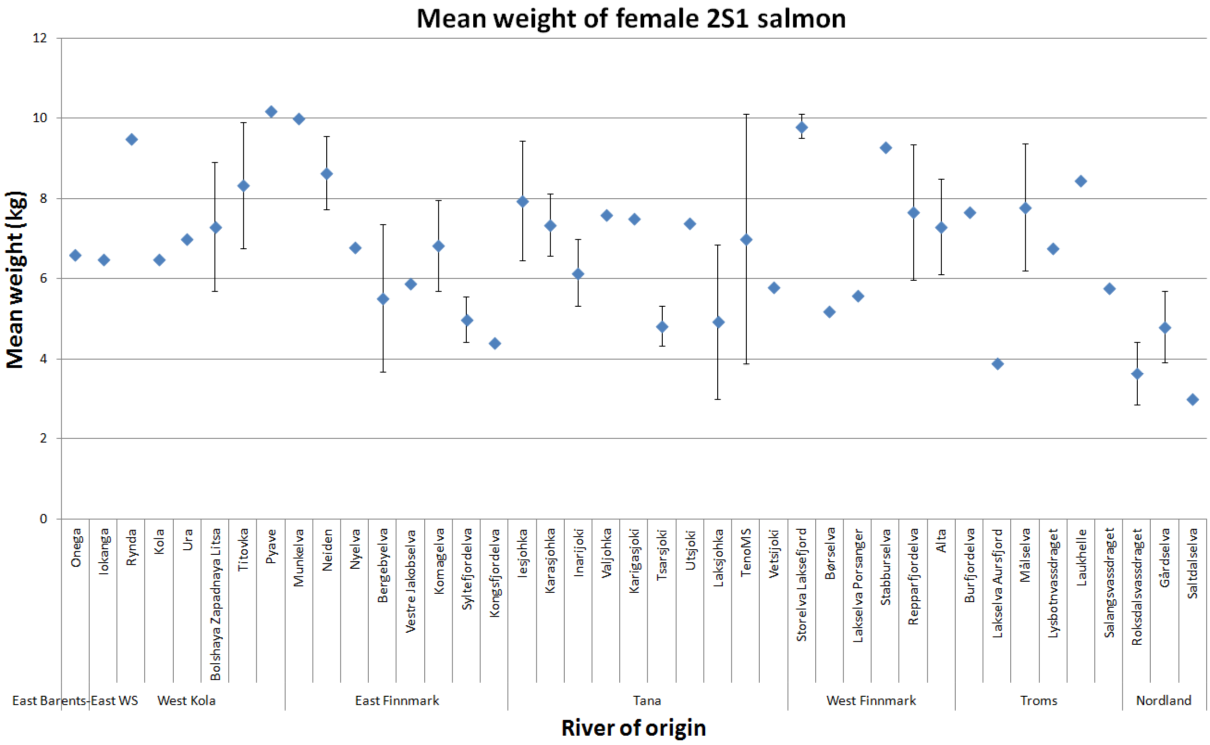


Figure 46: Mean weights of female previous spawners in the sea-age group 2S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

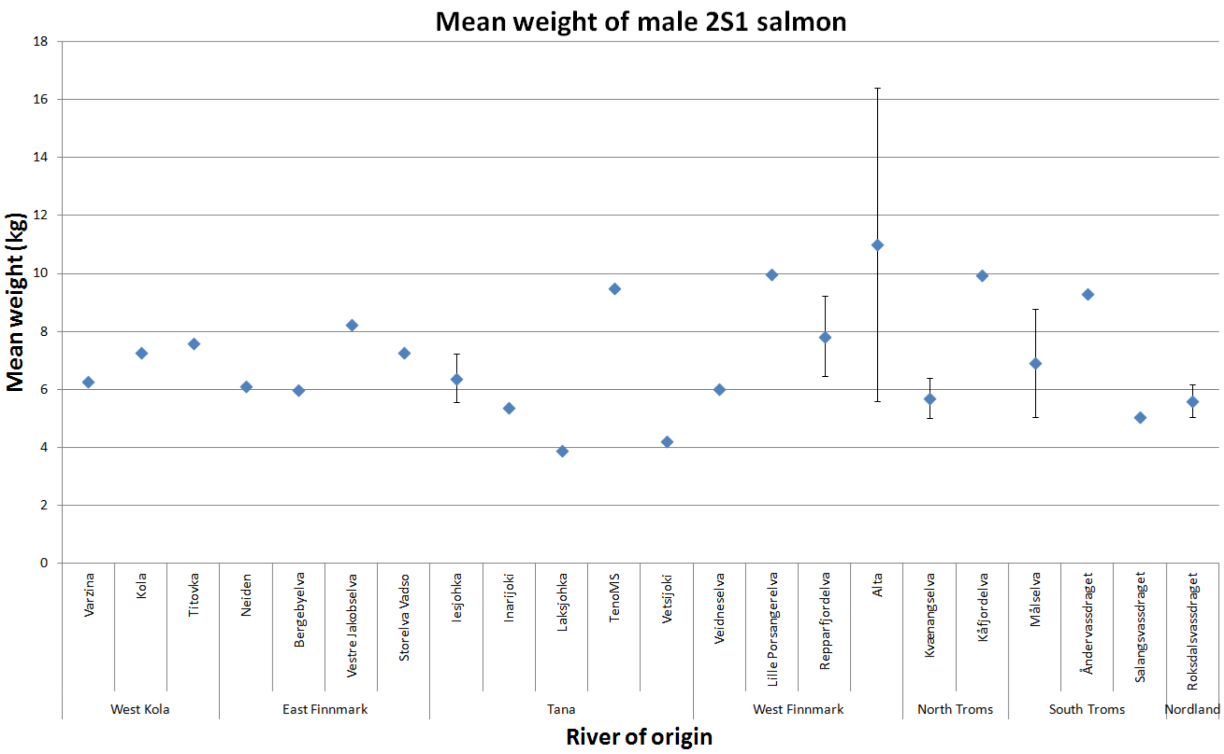


Figure 47: Mean weights of male previous spawners in the sea-age group 2S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

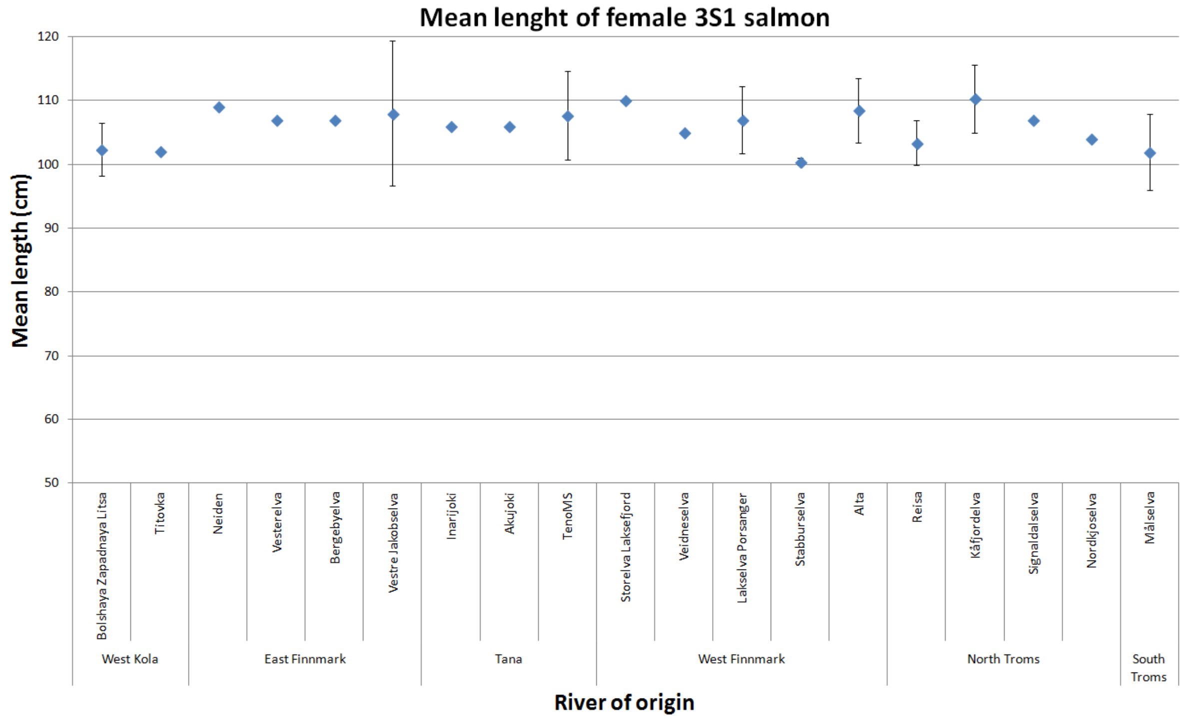


Figure 48: Mean lengths of female previous spawners in the sea-age group 3S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

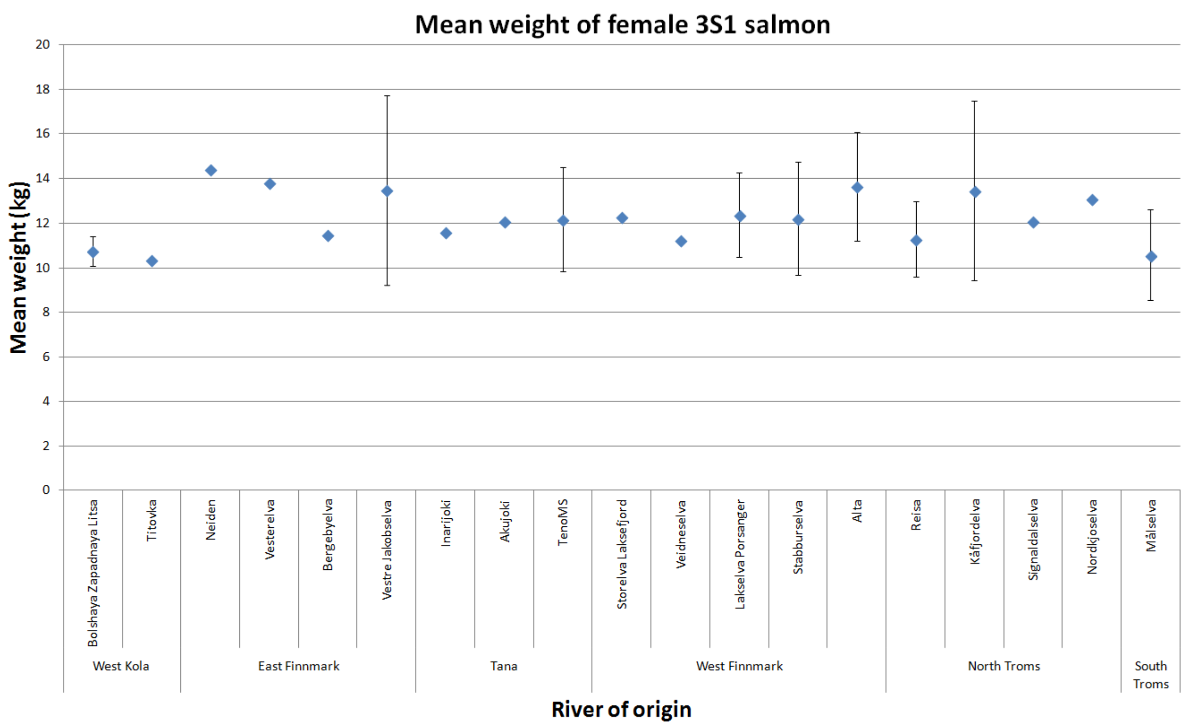


Figure 49: Mean weights of female previous spawners in the sea-age group 3S1 of rivers in the years 2008, 2009, 2011 and 2012 in Kolarctic salmon project research fishery in Northern Norway.

3.6 Abundance of previous spawners in the official salmon catches in Kolarctic salmon project area

Table III. Percentages of previous spawners (from the numbers and from the weight of salmon) in the reported official salmon catches during the official fishing season in each county. Reported salmon catch is from SSB (Statistics Norway) and it has been converted into the abundance of previous spawners using the data from salmon scale samples for each municipalities.

	2011		2012	
	From numbers	From weight	From numbers	From weight
Nordland	11	9	<1	1
Troms	2	4	2	2
Finnmark	5	8	4	7

Previous spawners and kelts are included as salmon in the official catch report because fishermen cannot recognize them. In this report we separated previous spawners, kelts included, as an own life history phase from the official reported salmon catches. Although previous spawners did not represent a high proportion in numbers in the catches their importance is more significant in weight, especially early in the season. In Finnmark previous spawners made 7-8% in the catches in the years 2011 and 2012 (Table III). In the year 2012 proportion of previous spawners was smaller in Nordland, Troms and Finnmark counties than in the previous year because there was lower occurrence of previous spawners in that year in northern salmon stocks. Figure 50 illustrates the sea-age distributions in the official reported salmon catches in municipalities or group of municipalities in Finnmark and in Troms and Nordland counties. Catches of previous spawners vary between areas (Table IV). Previous spawners contribute a remarkable amount into the catches in the municipalities Alta, Porsanger, Lebesby and especially Tana. The catch of previous spawners in Porsanger in the year 2011 is not correct due to too few scale samples from the fishery which contributed to the erroneous estimation.

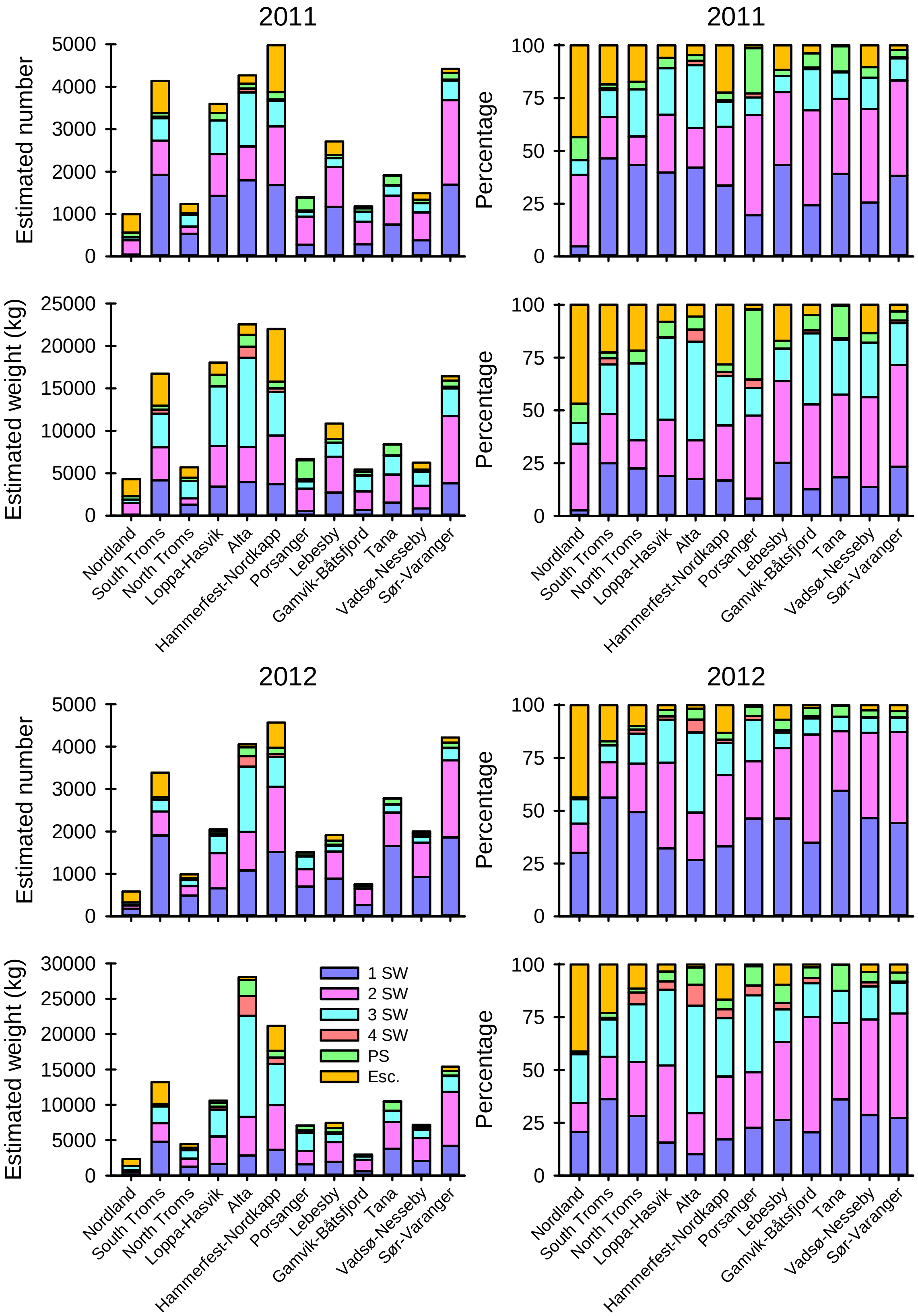


Figure 50. Numbers and kilos of salmon within sea-age groups of 1SW, 2SW, 3SW, 4SW salmon, previous spawners (PS) and escaped salmon (Esc.) in the reported official SSB catches (Statistics Norway) in Kolarctic salmon project area in the years 2011 and 2012 caught in the official fishing time.

Table IV. Percentages of previous spawners from the numbers and from the weight of salmon in the reported official salmon catches during the ordinary fishing season in each municipality or in the groups of municipalities. Reported salmon catch is from SSB (Statistics Norway) and it has been converted into sea-age groups. Hammerfest area includes Kvalsund, Måsøy and Nordkapp. Gamvik and Båtsfjord areas include Berlevåg and Vardø.* Numbers and weights in Porsanger in the year 2011 are incorrect due to inadequate amount of scale samples for fish larger than 7 kilos.

	Year 2011		Year 2012	
	From numbers	From weight	From numbers	From weight
Nordland	11	9	1	1
South Troms	1	3	1	2
North Troms	3	6	1	2
Loppa/Hasvik	4	7	3	5
Alta	2	6	5	8
Hammerfest et al.	3	4	3	5
Porsanger	21*	33*	4	9
Lebesby	2	4	4	9
Gamvik/Båtsfjord et al.	6	7	3	6
Tana	11	15	5	12
Vadsø/Nesseby	5	5	3	5
Sør-Varanger	3	4	2	4

3.7 Estimated numbers of previous spawners originating from seven Regional Group (RG) areas and places where they have been caught in northern Norway during the official fishing season

Previous spawners, kelts included, which had origin from seven large Regional Group (RG) areas (Russian salmon stocks from rivers in Russia, salmon stocks from Eastern Finnmark, stocks from the River Tana watershed, stocks from Western Finnmark, stocks from North Troms, stocks from South Troms, stocks from Nordland) were caught widely in many municipalities during the official fishing time in Northern Norway (Figure 51). Previous spawners which had Russian origin (in the figure 51 “Russian salmon in catches”) were caught in the year 2012 mainly in Sør-Varanger municipality area where their proportion was c. 80% of all Russian origin previous spawners caught in Norway. The rest of Russian origin previous spawning salmon were caught in West Finnmark (Loppa and Hasvik, Porsanger) and also in Vadsø-Nesseby area. Material from previous spawners of Russian origin in the year 2011 is not good to make conclusions from the catch distribution between municipalities due to the lack of proper fish scale information.

Catches of previous spawners originating from the rivers in East Finnmark distributed between many municipalities but the highest catches and proportions were in the municipalities Vadsø-Nesseby and Sør-Varanger. Previous spawners originating from the River Tana watershed were caught mainly in the inner Tanafjord within Tana municipality but they were exploited also in smaller amounts as well in eastern municipalities (Sør-Varanger) as in western areas (Nord Troms) and municipalities (Loppa-Hasvik).

Previous spawners originating from the rivers in the large West Finnmark area were exploited during the official fishing time widely within the area from South Troms area to Sør-Varanger. The highest catches were caught in the outermost coastal areas in Loppa-Hasvik and in Hammerfest-Nordkapp-Kvalsund-Måsøy as well as in Alta municipality. In West Finnmark Regional Group area there are large rivers like Altaelva, Repparfjorelva, Stabburselva, Lakselva and Børselva which are situating within large geographical area in many municipalities and therefore also catches of previous spawners are distributing over many municipalities.

Previous spawners originating from the rivers in North Troms area are also exploited within large geographical area covering the entire Kolarctic salmon project area. However the abundance of previous spawners originating from North Troms is small everywhere.

Previous spawning salmon originating from Nordland and South Troms areas were caught mainly close to their “home rivers” but there are indications that those stocks are caught also in northern areas. Very probably these stocks are caught also in the areas south from the Kolarctic salmon research area.

Figure 51 indicates the abundance and spatial distribution of previous spawners in the official reported catches originating from rivers in seven RG areas. The limited official fishing time with some 2-4 weeks in July in Nordland and Troms counties affects to the low abundance of previous spawning salmon in the reported salmon catches. Although previous spawners don’t appear in high proportions and numbers in the total reported salmon catches at sea, their abundance especially in the areas close to the rivers of origin might be high like their catches in Tanafjord are. Previous spawners have also important economical impact to the total catches especially in the beginning of the season.

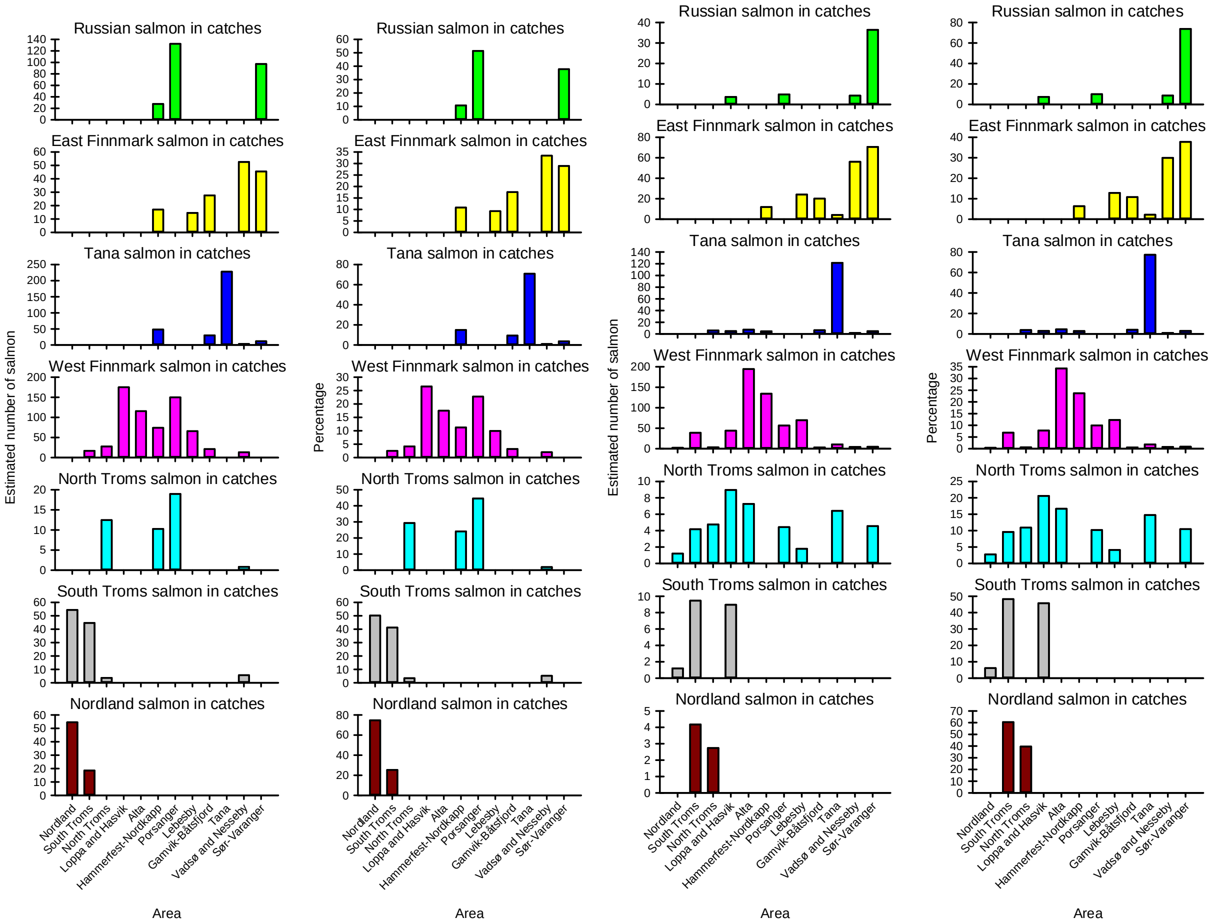


Figure 51. Exploitation during the official fishing time in terms of numbers of previous spawners originating from seven different RG-areas in 12 fishing areas in the year 2011 (on the left) and in the year 2012 (on the right). The estimated numbers of Russian origin previous spawners in the Porsanger catch in the year 2011 is incorrect due to the insufficient numbers of salmon larger than 7 kilos in the research fishing.

3.8 Life history of previous spawners (alternate and consecutive spawners), their origin from Regional Group areas and distribution in the catches in Northern Norway between May and September in Kolarctic salmon research fishery

Salmon scale material collected from the research fisheries in the years 2008, 2009, 2011 and 2012 indicates that there are two life history types (alternate and consecutive spawners) of previous spawners available to be caught at sea in Kolarctic salmon project area. Alternate and consecutive spawners are divided into these groups according to their ecological features and migration patterns. Alternate spawner is the most common previous spawning salmon group in Kolarctic salmon project area and it is believed that almost all salmon in this group ascend into their rivers of origin during that year when they are migrating in late spring or in early summer along the coastal areas. Alternate spawners need at least one full year between successive spawning for reconditioning from kelt phase to matured fish.

Consecutive spawners are found seldom in the northern salmon populations at least in the rivers in Kolarctic salmon research area. Here consecutive spawners are called kelts which have left their rivers of origin soon after the spawning in previous year or early in the summer in the year when they were caught between May and September. Kelts leave the rivers and then they start reconditioning at sea to reach the next maturity phase. It is known that many of kelts are migrating directly to high seas for feeding. It is also known that some kelts staying and feed close to outermost coastal areas and also in fjords where they are exploited during the official salmon fishing time. Sea temperature in coast in late autumn, winter and early spring in addition to the favorable feeding opportunities might be the main factors forcing some kelts to stay longer periods close to the coastal areas. Few earlier studies have indicated that some kelts and even salmon which have not yet spawned, immature fish (gjellfisk in Norwegian), are feeding in coastal areas late autumn and in winter in East Finnmark.

Genetic assignment analysis was utilized for identification of the river of origin of 582 previous spawning salmon altogether from 80 rivers in Kolarctic salmon research area. The 282 kelts originated from 56 rivers (Table V). This large number of rivers from where previous spawners originate indicates high rate of biodiversity from the genetic point of view and also from the ecological perspective with high number of river and sea-age compositions in previous spawning salmon and in kelts.

Previous spawners, here alternate spawners, have three main sea-ages (1S1, 2S1, 3S1) and the other sea-age groups are making 2% from all previous spawners. From all the collected scale material in the years 2008, 2009, 2011 and 2012 salmon with the sea-ages 2S1S1S1 and 3S1S1S1 had origin from the River Tana mainstream. These groups of salmon were on the way to spawn fourth time in the River Tana mainstream. Salmon with the sea-age 2S1S1 had origin in the rivers Tana mainstream, Altaelva, Målselva and Saltdalselva and with the sea-age 3S1S1 had origin in the rivers Tana mainstream, Lakselva (Porsanger), Altaelva, Reisaelva and Målselva.

From six main sea-age groups of previous spawners (1S1, 2S1, 3S1) and kelts (1S+, 2S+, 3S+) caught between May and September in Kolarctic salmon project area the origin of fishes belonging into six Regional Groups are presented in the figure 52. In the sea-age group 1S1+ in previous spawners the largest proportion of salmon had origin in Tana watershed and 1S1+ previous spawners which originated from East and West Finnmark and Russian origin salmon had equal and smaller proportions. 2S1+ previous spawning salmon originated with the similar proportions from all Regional Group areas except the proportion from Nordland was small. Previous spawners with the age of 3S1+ had home rivers mainly in West Finnmark and Troms Regional Group areas and c. 20% from these fishes had rivers of origin in Russia, East Finnmark and Tana Regional Group areas. Surprisingly, 3S1+ salmon from Tana Regional group area represented a low proportion reflecting low abundance of first time spawner 3SW salmon population found in Tana watershed recently.

Kelts which were caught in Kolarctic salmon project area and which had the sea-age group 1S+ originated mainly from East Finnmark Regional Group area (Figure 52). Russian and Tana origin kelts occurred in the kelt catches with quite small proportions and it is believed that most of Tana origin kelts like kelts from Russian rivers are migrating straight from rivers or fjord to high seas. In the age groups 2S+ and 3S+ kelts from West Finnmark Regional Group area made the highest proportions in the catches.

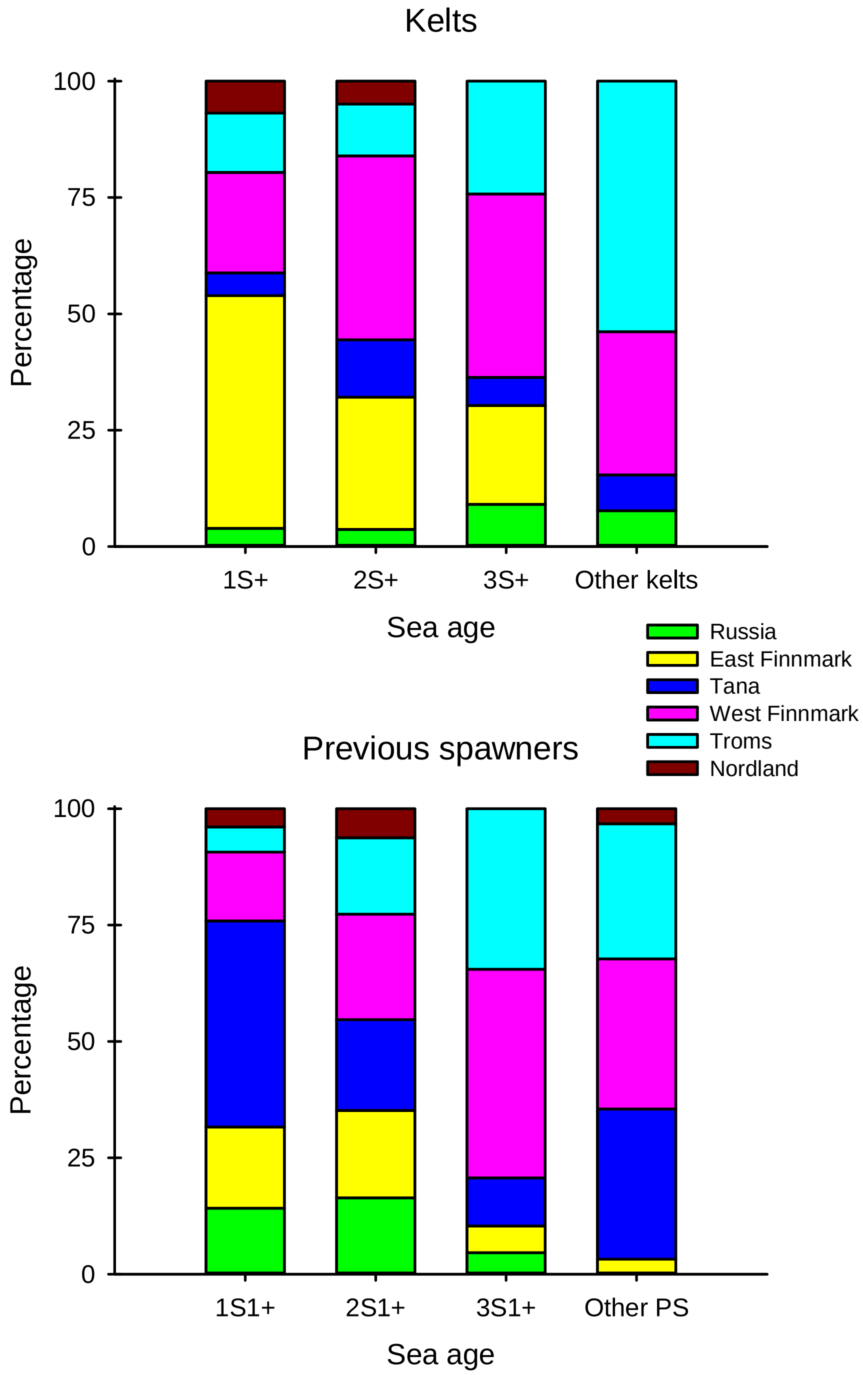


Figure 52. Proportions of fish originating from six Regional Group areas within sea- age groups in previous spawners and kelts. Data is collected in Kolarctic salmon project area in the years 2008, 2009, 2011 and 2012 between May and September.

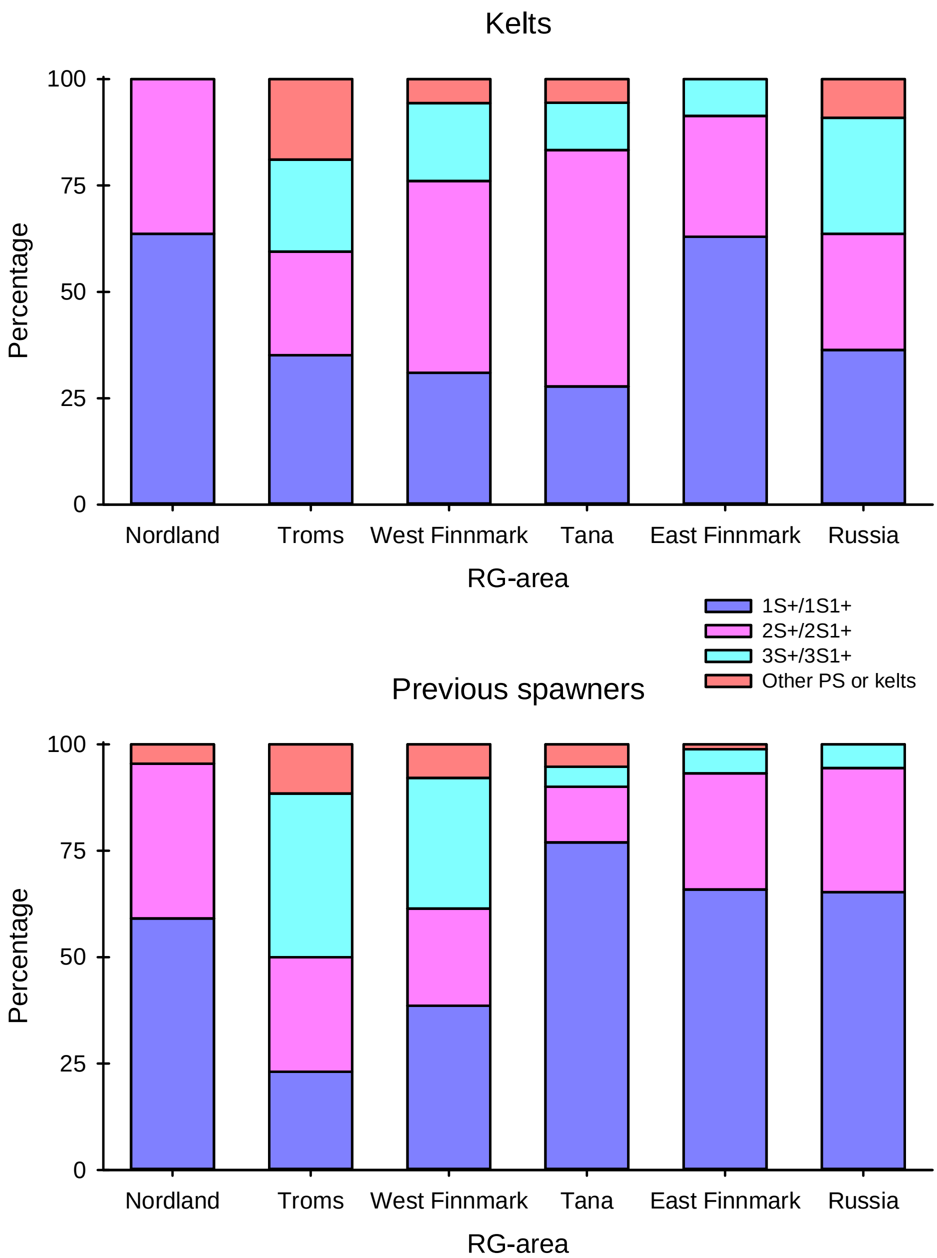


Figure 53. Sea-age distributions of previous spawners (1S1+, 2S1+, 3S1+) and kelts (1S+, 2S+, 3S+) originating from rivers in sex Regional Group areas. Data is collected in Kolarctic salmon project area in the years 2008, 2009, 2011 and 2012 between May and September.

In Nordland and East Finnmark Regional Group areas the sea-age distributions were close the same between previous spawning salmon and kelts (Figure 53). In West Finnmark, Tana and Russia Regional Group areas sea-age proportions differed clearly between previous spawners and kelts. Reasons for these differences are most probably linked to the fishery practices and that kelts and previous spawners are not behaving similarly in coastal and fjord areas, migration times are differing and therefore exploitation is not the same towards these two life history types.

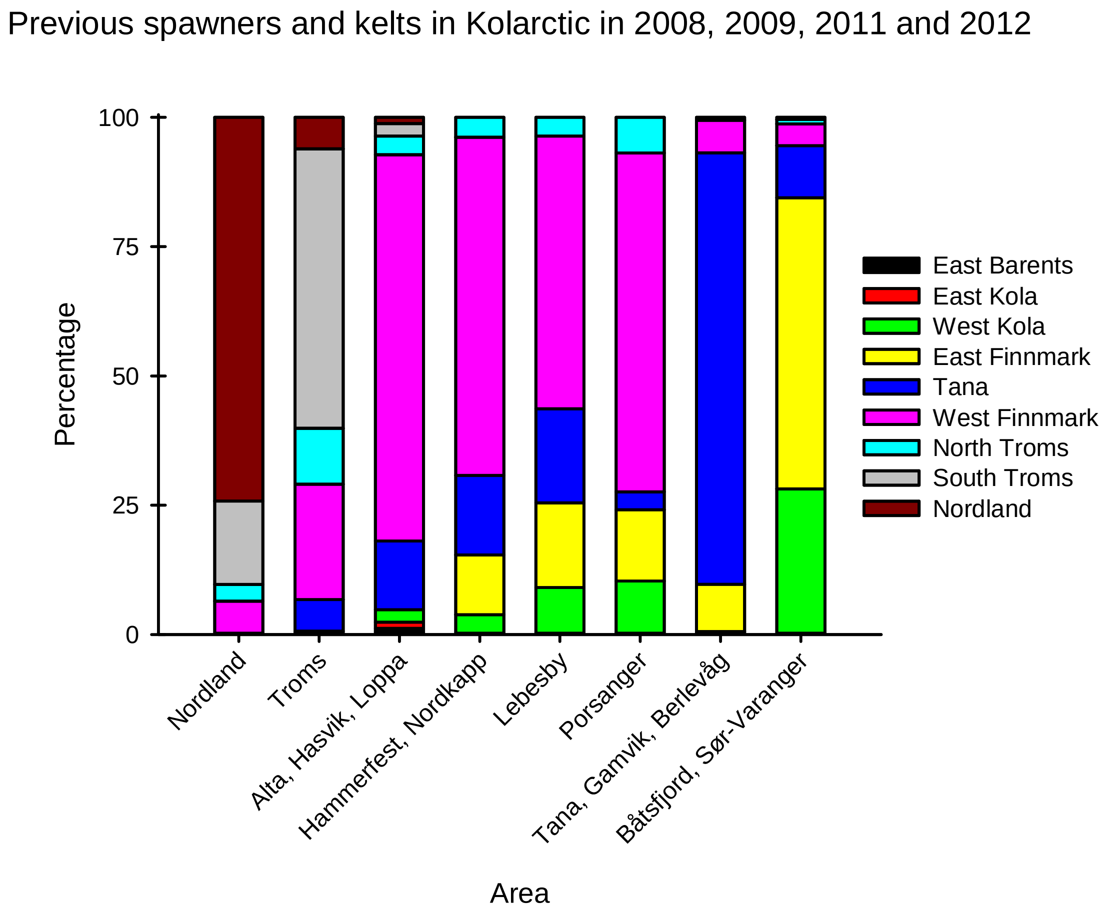


Figure 54. Origin of previous spawners and kelts belonging into nine Regional Group areas and caught in eight geographical areas in Kolarctic project area in Northern Norway in the years 2008, 2009, 2011 and 2012 between May and September. Hammerfest area includes Nordkapp, Måsøy and Kvalsund; Båtsfjord area includes Vardø, Vadsø, Nesseby and Sør-Varanger.

Previous spawners and kelts together originating from West Finnmark Regional Group area made high proportions within the coastal area of their origin during the entire migration period from May to September (Figure 54). Tana origin salmon made the largest proportion in Tanafjord in Tana municipality but Tana origin salmon made also some catch proportions in most of the other areas. These percentages and distributions of the origin of previous spawning salmon are giving slight information where different Regional Group stocks are exploited if the fishery could be possible within the period from May to September. Figure 55 indicates the percentage distribution of previous spawning salmon catches between eight geographical areas in Northern Norway for salmon originating from seven Regional Group areas. There are not so large differences between the information found in the figure 51, which is based only on the data from official fishing time, and in the figure 55, which is based on the period from May to September representing the total migration period of previous spawners and kelts.

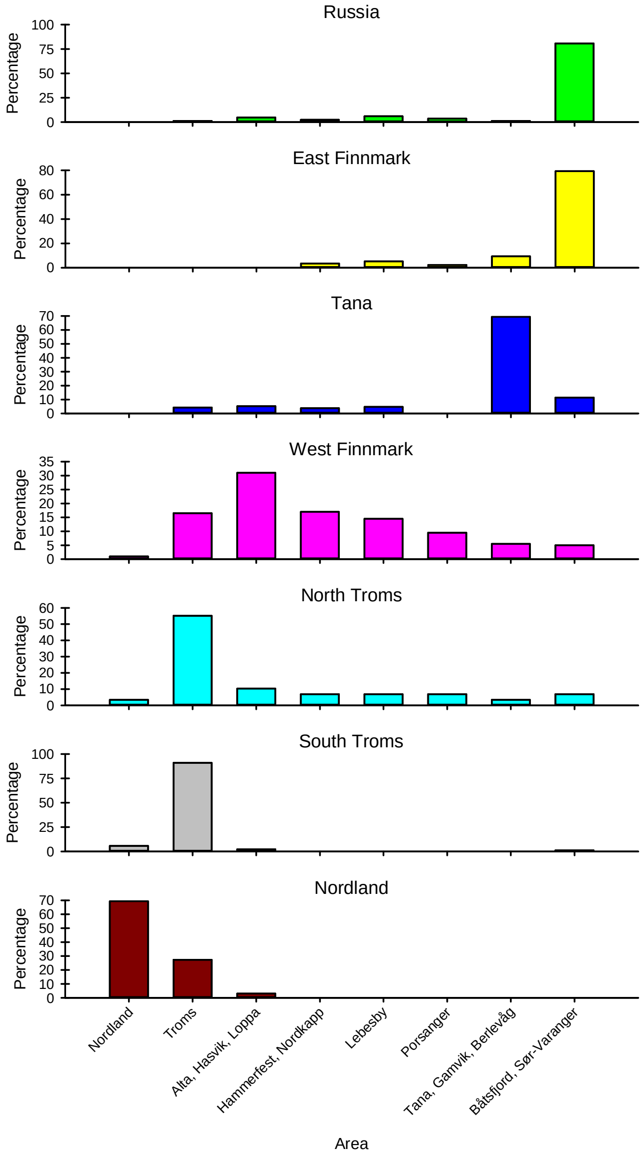


Figure 55. Catch distributions (%) between municipalities and areas for previous spawners and kelts having origin in seven Regional Group areas. Data is collected in Kolarctic salmon project area in the years 2008, 2009, 2011 and 2012 between May and September. Hammerfest municipality includes also Nordkapp, Måsøy and Kvalsund; Båtsfjord municipality includes also Vardø, Vadsø, Nesseby and Sør-Varanger.

3.9 Numbers of stocks in previous spawner and kelt salmon catches along the summer from May to September in Kolarctic salmon research fishery

It's known that there is close to 200 hundred salmon rivers with their own salmon stocks withing the Kolarctic salmon project area from Lofooten area in Norway to the River Petchora close to Ural Mountains in Russia. All of these rivers have stocks which are genetically different from the stocks in neighboring rivers. In many rivers there are also separate stocks within the same river like in the rivers Tana, Tuloma, Ponoi and Petchora. Stocks are consisting in maximum of five sea-age groups (1SW-5SW) in first time spawning salmon. In all rivers the stocks include sea-ages of 1SW in females and males and in most of the rivers females of 2SW also occur. In the largest rivers life history of salmon stocks includes also the oldest first time spawners.

After spawning, which takes place from the middle of September to the end of October, post-spawners, kelts, are searching places in their rivers for wintering or they are descending into sea. During the post spawning period in the rivers there is natural mortality which varies from year to year depending firstly from the physiological conditions of post-spawner and then from many physical conditions in the rivers like from the ice formation, ice thickness and ice smelting process. At sea kelts meet predators like seals which try to catch fishes in weak condition. Coastal and fjord fishery is also targeting on kelts. All these above mentioned factors are affecting into the numbers and sea-ages of salmon ascending towards their rivers of origin after one to three years later their descend from home rivers. The wide variety in rivers of origin in previous spawners indicates that reconditioning from one spawning to the next maturity is a common phenomenon (Table V). In some stocks survival from spawning to the next maturity can be high and in some stocks very low. Changes or annual variations in the life history (sea-age compositions) of salmon is affected by selective fishery combined to especially severe changes in the conditions at sea.

Figures 56, 57 and 58 indicate the weekly numbers of genetically different salmon stocks of previous spawners (kelts excluded) in the research fishery catches in the years 2008, 2009, 2011 and 2012 in Finnmark and in the municipalities or group of municipalities. The maximum number of stocks in the catches was in Finnmark in the week 24 when the fishery targeted towards to c. 35 previous spawner salmon stocks. Figure 56 indicates also that the River Tana stocks made the largest proportion in Finnmark until the week 26 from all stocks of Regional Groups. The proportions and numbers of stocks belonging into nine Regional Groups of salmon increased and decreased quite smoothly between May and September. This indicates clearly that those regionally grouped salmon stocks had their own migratory pattern which overlapped more or less with other regionally grouped salmon stocks. From the Russian stocks most numerous in the catches were stocks from West Kola area and only a few stocks originating from East Barents and East Kola area were caught. Russian stocks formed a remarkable proportion of the stocks caught in Sør-Varanger and Vadsø-Nesseby municipalities. Stocks originating from East Finnmark Regional Group area were caught throughout the summer especially in Sør-Varanger municipality area but they contributed remarkable proportion also into stock components in Vadsø-Nesseby area.

Previous spawner stocks from West Finnmark Regional Group area occurred with high proportions in the weekly catches in West Finnmark in the outermost coastal areas and in fjords. Figures 56, 57 and 58 are indicating wide weekly distribution of all the stocks from Regional Group areas over many areas. Stocks from West Finnmark Regional Group area are meeting exploitation all over the Kolarctic salmon research area in Norway, in east as well as in west. This indicates that there is not only one migration direction for the stocks of previous spawners from west or from east to their Regional Group areas but some can migrate straight from the high seas and not to follow along the coastal areas.

Table V. Numbers of previous spawners (Ps) and kelts of genetically known origin caught in Kolarctic salmon research fishery in 2008, 2009, 2011 and 2012 in Northern Norway between the weeks 18 and 37.

River of origin	Number Ps	Number kelts	River of origin	Number Ps	Number kelts	River of origin	Number Ps	Number kelts
Onega	1		Kongsfjordelva	4	13	Russelva	3	1
Umba	1		Storelva/Berlevåg		1	Repparfjordelva	25	17
Iokanga	2		Iesjohka	15	1	Alta	42	12
Varzina	1		Karasjohka	8		Burfjordelva	1	1
Zolotaya	1		Inarijoki	41	4	Badderelva	1	
Rynda	2		Akujoki	6		Kvænangselva	7	
Olenka	1		Valjohka	13		Oksfjordvassdraget		1
Klimkovka	2		Galddasjoki	3		Reisa	6	5
Tipunkova	1		Karigasjoki	8		Kåfjordelva	3	
Vaenga	1		Kevojoki	21	2	Signaldalselva	1	
Kola	5	2	Tsarsjoki	11	1	Breivikelva		1
Tuloma	2		Utsjoki	3	1	Skittenelva	1	
Ura	7	2	Laksjohka	10		Nordkjoselva	1	
Zapadnaya Litsa	20	3	Levajohka	8	3	Lakselva Aursfjord	2	7
Titovka	23	2	Maskejohka	3		Målselva	48	12
Pyave	2	2	TenoMS	34	2	Rossfordvassdraget	1	
Grense Jakobselva	1	2	Vetsijoki	7	4	Lysbotnvassdraget	1	3
Tårnelva	2		Langfjordelva	3	6	Laukhelle	2	1
Sandneselva Kirkenes	1	1	Risfjordelv		1	Skøelva	1	1
Munkelva	3		Sandfjordelva	5	10	Åndervassdraget	1	
Neiden	18	1	Futelva	1	2	Løksebotnvassdraget		1
Klokkarelva	3	1	Mehamnelva		1	Salangsvassdraget	2	1
Nyelva	1	1	Suosjohka	1		Roksdalsvassdraget	11	3
Vesterelva	5	2	Storelva Laksefjord	4	1	Alsvågvassdraget		1
Bergebyelva	23	27	Veidneselva	3	2	Gårdselva	8	5
Vestre Jakobselva	4	9	Lille Porsangerelva	4	3	Kjerringnesvassdraget		1
Storelva Vadso	1		Børselva	6	7	Langvatnvassdraget	1	
Skallelva	2	6	Lakselva Porsanger	24	6	Tårstadvassdraget		1
Komagelva	11	7	Stabburselva	4		Saltdalselva	2	
Syltefjordelva	9	10	Ytre Billefjordelva	2	2			

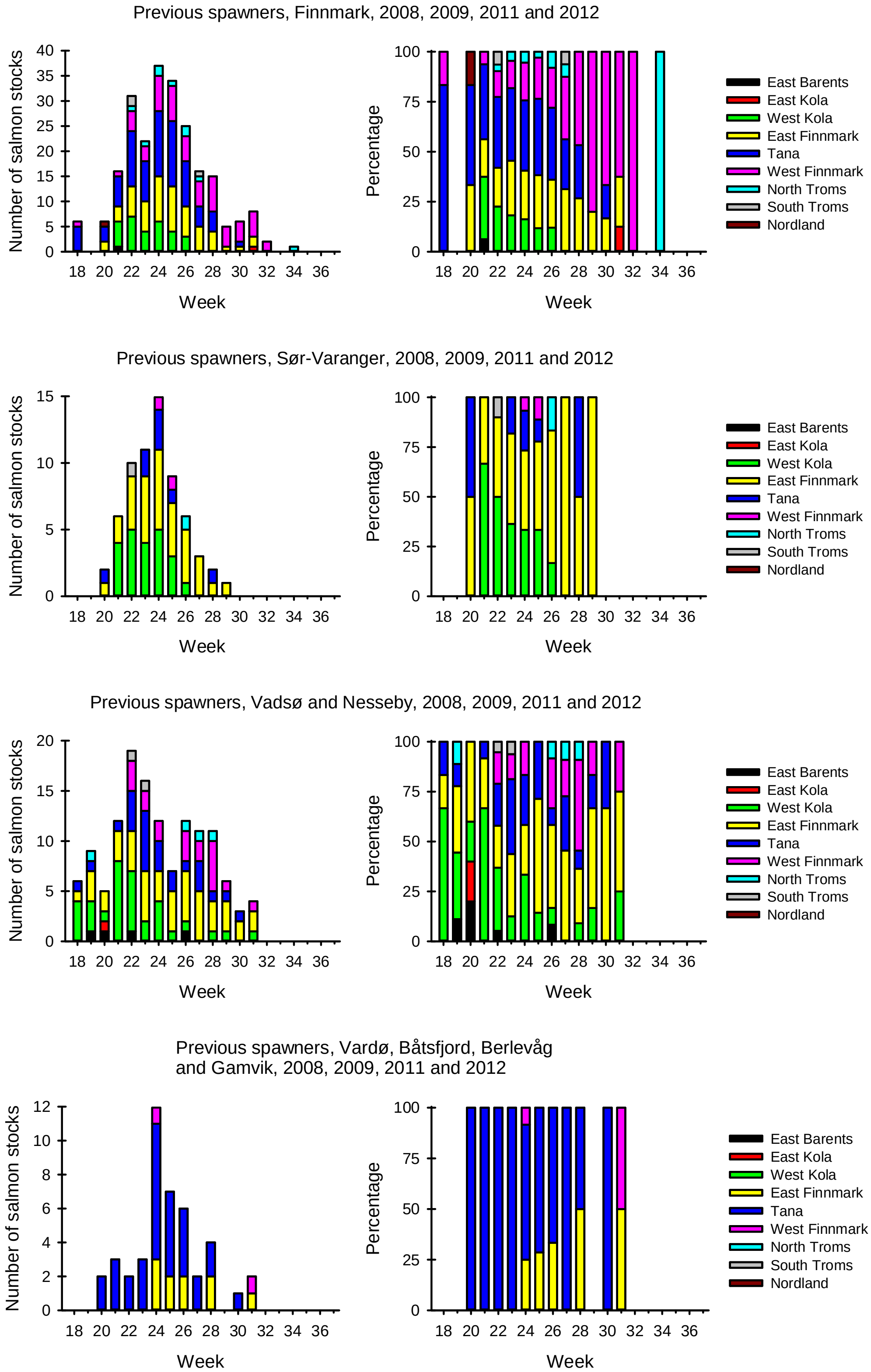


Figure 56. Weekly numbers and percentages of salmon stocks in the catches of previous spawners (kelts excluded) which originate from nine Regional Group areas. Material is the Kolarctic salmon research fishery from May to September.

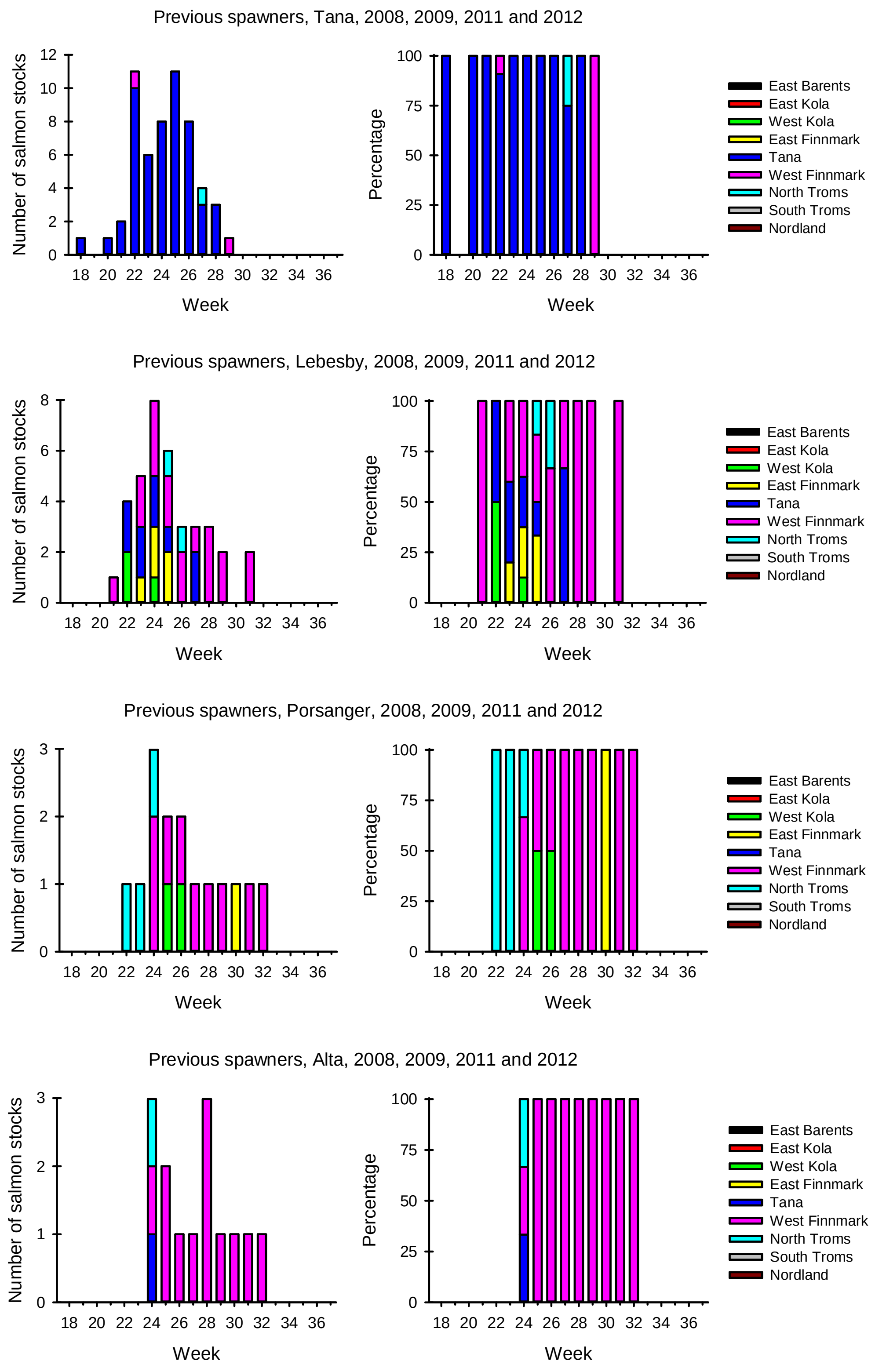


Figure 57. Weekly numbers and percentages of salmon stocks in the catches of previous spawners (kelts excluded) which originate from nine Regional Group areas. Material is the Kolarctic salmon research fishery from May to September.

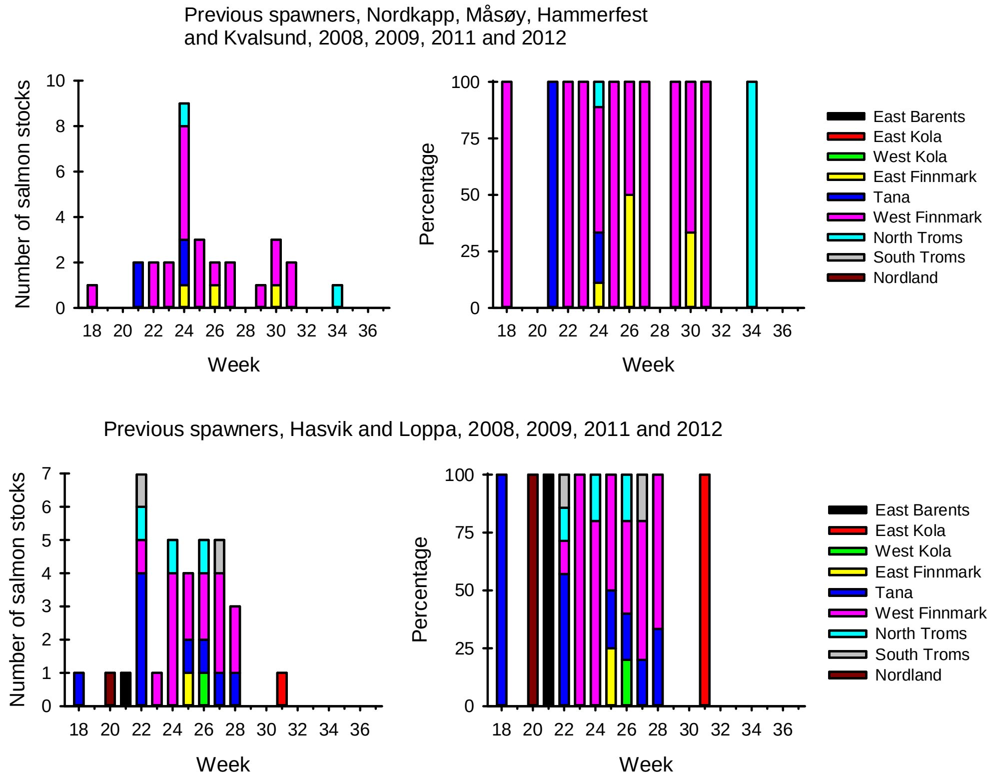


Figure 58. Weekly numbers and percentages of salmon stocks in the catches of previous spawners (kelts excluded) which originate from nine Regional Group areas. Material is the Kolarctic salmon research fishery from May to September.

3.10 Weekly numbers and proportions of known origin previous spawners (kelts excluded) in Kolarctic project area in research fishery

Coastal and fjord salmon fishery targets on numerous stocks of previous spawning salmon (Figure 59, 60). Russian origin previous spawners have passed Finnmark coastal areas in the week 27 and from that week onwards previous spawners in the catches originate from West Finnmark, Tana and East Finnmark. Most of previous spawners can be caught between the weeks 22 and 26 in Finnmark and in most areas in Finnmark catches peak between the weeks 24 and 26. In Sør-Varanger municipality c. 60% from previous spawners are in the beginning of June Russian origin but later in the summer their origin is from East Finnmark rivers. Tana origin salmon are making important component in the catches in Vadsø-Nesseby municipalities in May and very early June. The occurrence of Tana origin salmon east from Tana river confirms that some previous spawning salmon are migrating from east to west. Almost all previous spawners caught in Tana municipality in the inner Tanafjord had origin from the River Tana system. In the outermost coastal areas like in Hasvik-Loppa and Nordkapp, Måsøy, Hammerfest, Kvalsund catch consisted of salmon originating from eastern and western rivers within Kolarctic salmon project area but majority of the catch originated from West Finnmark. Those few previous spawners that were caught in Nordland originated from Nordland rivers.

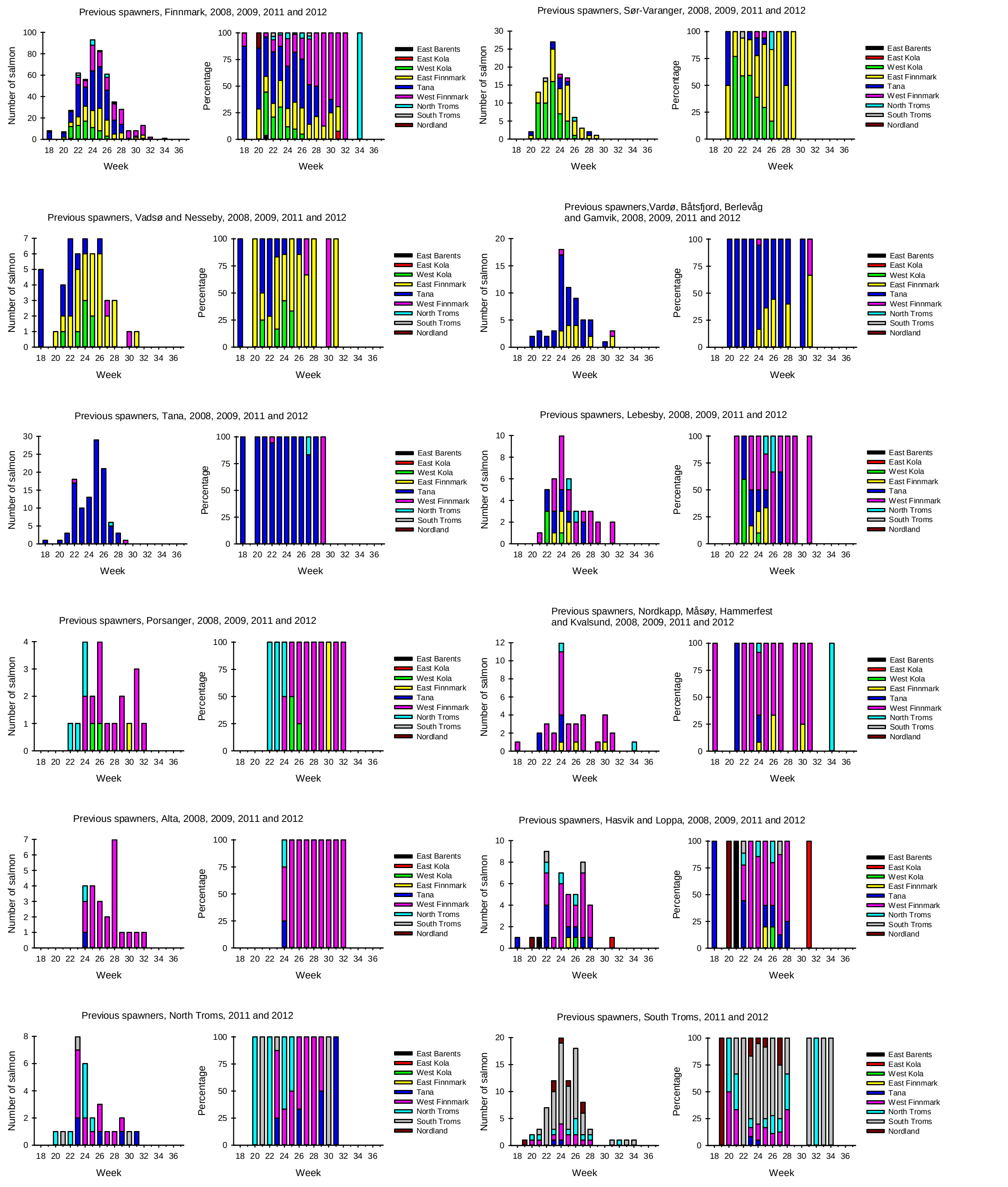


Figure 59. Weekly numbers and percentages of previous spawners (kelts excluded) originating from nine Regional Group areas and caught in Finnmark County and in separate or combined municipalities. Material is the Kolarctic salmon research fishery from May to September.

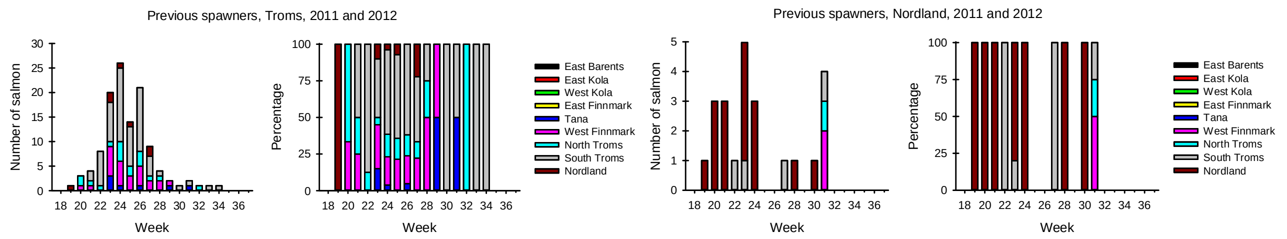


Figure 60. Weekly numbers and percentages of previous spawners (kelts excluded) originating from nine Regional Group areas and caught in the counties Troms and Nordland. Material is the Kolarctic salmon research fishery from May to September.

3.11 Catches of previous spawners are overlapping with catches of kelts in the Kolarctic salmon research fishery

The difference in the life history phase between previous spawners and kelts is based on the recognition of the difference in the scale structure. Kelts have descended from their rivers of origin to sea in the year when they were caught and in their scale edges large eroded areas indicated that they had visited river in the previous year. Usually in the scale edges of kelts there was only a small additional growth. In the scales of previous spawners 1-3 clear spawning marks were found and all previous spawning salmon had stayed at least one full year at sea before migrating back to coastal areas. It was a common phenomenon that kelts were found in coastal areas in the entire Kolarctic salmon project area also late in the season although most of kelts is supposed to migrate to high seas for recondition (Figure 61). Kelts occurred in increasing numbers towards autumn especially in East Finnmark, Varangerfjord area, where their proportions were also high from all previous spawners. Previous spawners have ascended into their rivers of origin in the summer and therefore proportions of kelts are increasing. Phenomenon that kelts are occurring all over in the coastal areas, in sheltered fjords as well as in the outermost coastal areas, was a general observation. The low numbers of kelts late in July and August in the coastal catches indicates, however, that the phenomenon at moment might not have so important effect to the wild salmon stocks. Phenomenon might be more important for salmon stocks if environmental conditions will be changed by the increase in sea temperatures when kelts could recondition close their rivers of origin. In the figure 62 previous spawners and kelts are combined within each Regional Group areas.

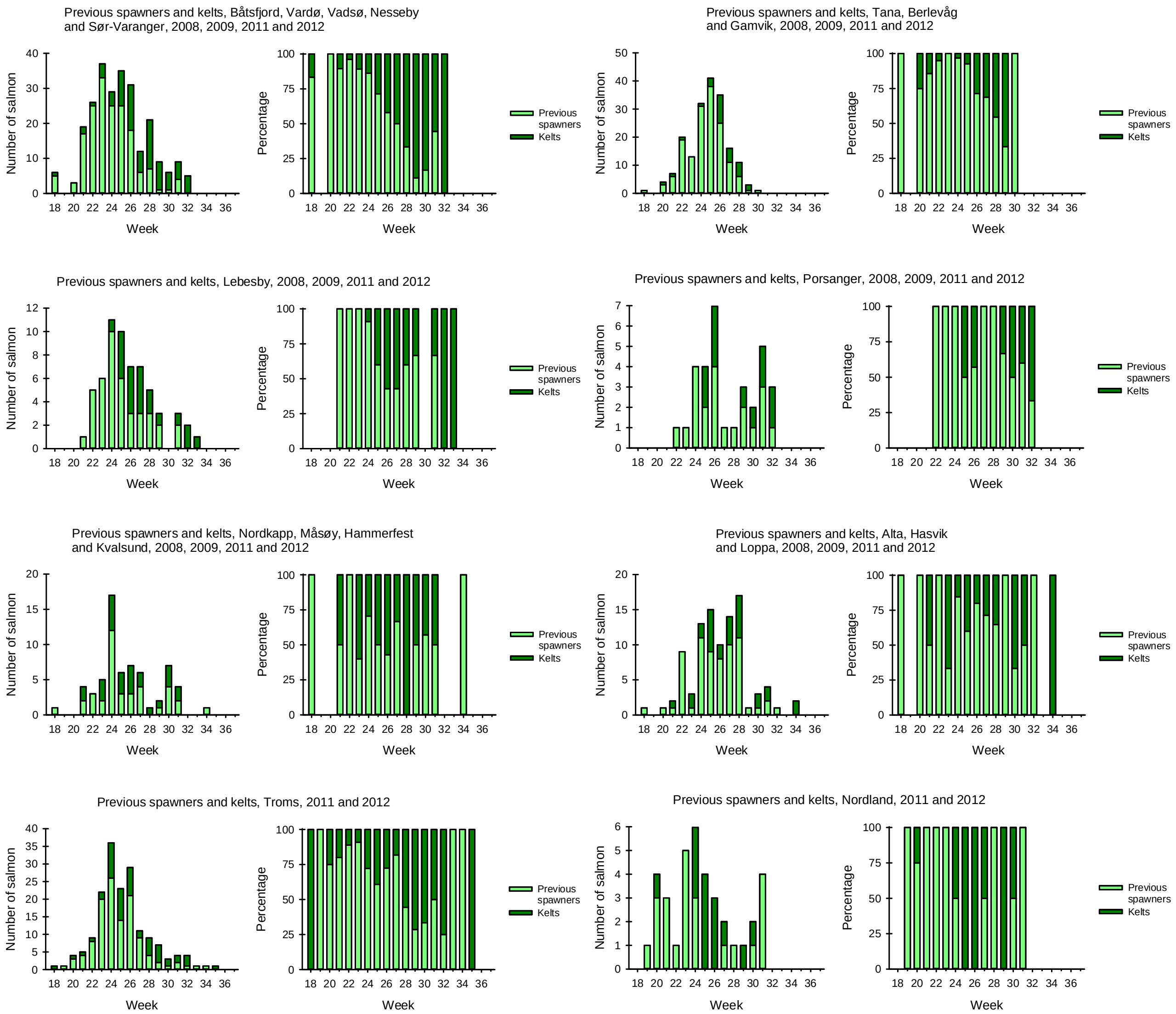


Figure 61. Weekly numbers and proportions of previous spawners and kelts in municipalities and areas in Kolarctic salmon research fishery from May to September.

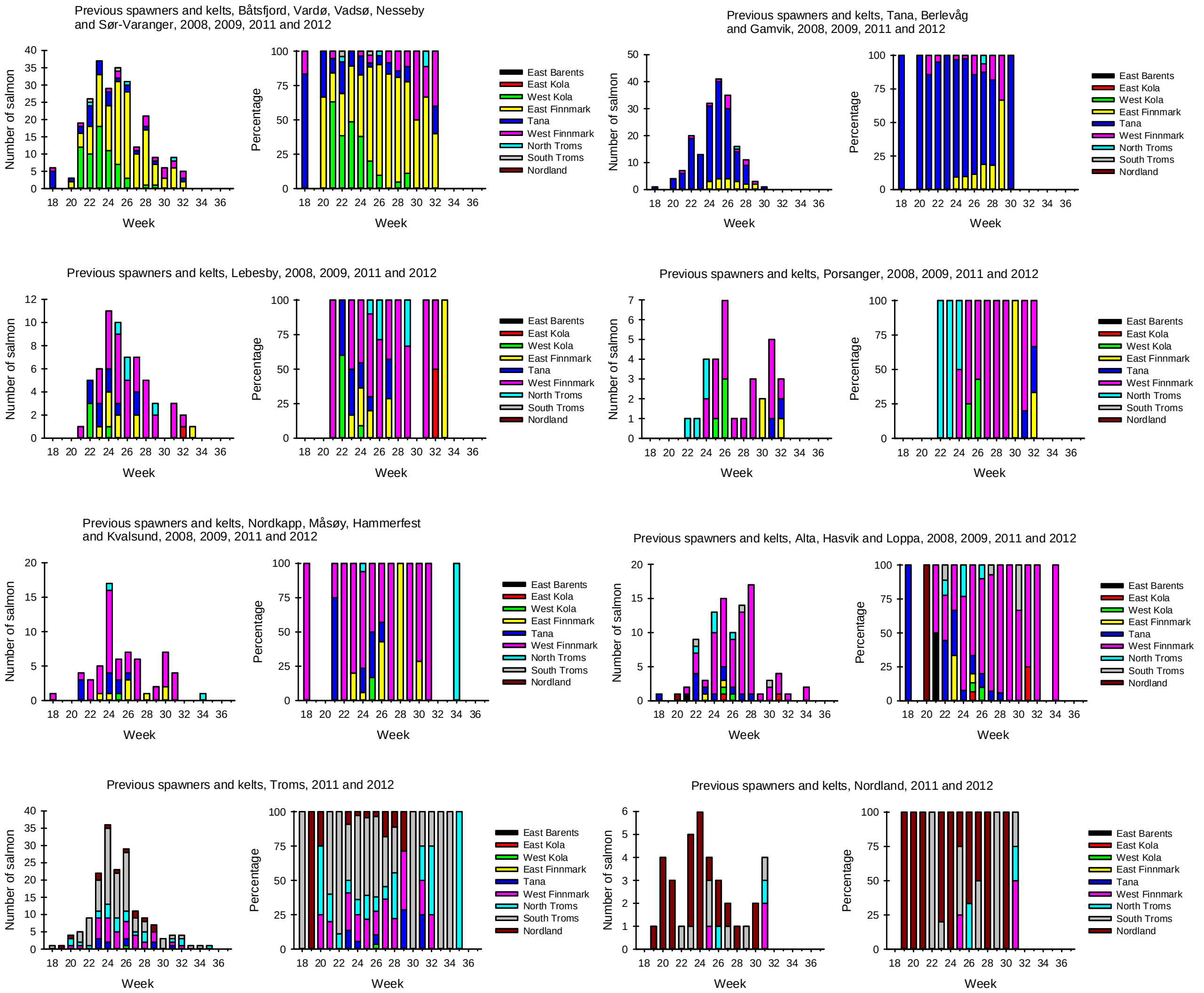


Figure 62. Weekly numbers and percentages of previous spawners and kelts combined originating from nine Regional Group areas and caught in municipalities or combined groups of municipalities in Finnmark County and in Troms and Nordland counties. Material is the Kolarctic salmon research fishery from May to September.

3.12 Spatial and temporal distribution of known origin kelts and previous spawners in Kolarctic salmon project area in research fishery

Kelts after migrating from rivers into the sea distributed widely along the coastal areas but most of them are believed to swim to ocean feeding grounds straight after descending from their spawning rivers. Those kelts which stayed for longer periods in coastal areas distributed widely to west and east from their spawning rivers. Kelts which were caught in the middle of June in Nordland mainly originated from the rivers in Nordland but some kelts originated from Troms indicating the southern migration direction (Table VI). Kelt salmon caught in Troms county area had river of origin in wide area from the tributary stocks of Tana to stocks in Nordland including stocks from the rivers Altaelva, Repparfjordelva, Lakselva (Porsanger), Börselva and Storelva (Laksefjord) like stocks from Troms rivers (Table VII). Within the large outermost coastal area in West-Finnmark covering Loppa-Hasvik as well as Nordkapp-Kvalsund-Måsøy-Hammerfest area kelts in the catches originated mainly from rivers north from that area (Table VIII, IX) which confirms the tendency of some kelts to migrate westwards. Kelts caught in Porsanger and Lebesby municipality areas originated mainly from eastern populations rather than western populations (Table X, XI). Kelts caught in Tanafjord and close to that originated from the River Tana system but also from the rivers in Varangerfjord eastwards from Tanafjord and also some kelts from western stocks (Sandfjordelva, Börselva, Repparfjordelva) were caught in the outermost coastal area (Table XII). Table XIII indicates that kelts caught in Varangerfjord area originate from Murmansk rivers, rivers west from Varangerfjord and many rivers situated in Varangerfjord itself. Especially interesting information is the late occurrence of those kelts in the catches like fishes caught in the week 26, last week in June, to the early September. Varangerfjord might be important area for reconditioning for kelts and also for their overwintering.

Table VI. Numbers of fish and rivers of origin for **kelts** caught in **Nordland County** in the years 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (consecutive spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week												
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Burfjordelva									1				
Skøelva								1					
Salangsvassdraget												1	
Roksdalsvassdraget			1				2						
Alsvågvassdraget								1					
Gårdselva							1			1			1
Kjerringnesvassdraget								1					

Table VII. Numbers of fish and rivers of origin for **kelts** caught in **Troms County** in the years 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (consecutive spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week																	
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**
Inarijoki												1						
Utsjoki									1									
Vetsijoki							1											
Sandfjordelva								1										
Storelva Laksefjord									1									
Lille Porsangerelva							1											
Børselva														1				
Lakselva Porsanger												1						
Russelva										1								
Repparfjordelva							1			1		1						
Altaelva								1							1			
Oksfjordvassdraget														1				
Reisaelva						1					1							1
Breivikelva															1			
Lakselva Aursfjord					1		3	2	1									
Målselva	1			1		1	4	2	3		1		1					
Lysbotnvassdraget										1		1						
Laukhelle											1							
Løksebotnvassdraget													1					
Gårdselva									1			1						
Tårstadvassdraget												1						

Table VIII. Numbers of fish and rivers of origin for **kelts** caught in municipalities **Alta, Hasvik and Loppa** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (consecutive spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week																
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
Bolshaya Zapadnaya Litsa								1									
Inarijoki								1									
Vetsijoki						1											
Sandfjordelva								1					1				
Veidneselva										1							
Børselva										1							
Lakselva Porsanger											1						
Ytre Billefjordelva								1									
Repparfjordelva										2	2						1
Altaelva							1		1	1	3			2			1
Reisaelva							1										
Målselva													1				

Table IX. Numbers of fish and rivers of origin for **kelts** caught in the municipalities **Nordkapp, Kvalsund, Måsøy and Hammerfest** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (consecutive spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week													
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Titovka								1						
Bergebyelva						1			1					
Komagelva											1			
Kongsfjordelva									1				1	
Kevojoki								1						
Levajohka									1					
TenoMS				1										
Risfjordelva							1							
Sandfjordelva									1				1	1
Mehamnelva												1		
Repparfjordelva						1	2			1			1	1
Altaelva				1										

Table X. Numbers of fish and rivers of origin for **kelts** caught in the municipality **Porsanger** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (consecutive spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week														
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Pyave									2						
Nyelva									1						
Skallelva															1
Syltefjordelva													1		
Tsarsjoki															1
Lakselva Porsanger												1			
Ytre Billefjordelva								1							
Repparfjordelva														1	

Table XI. Numbers of fish and rivers of origin for **kelts** caught in the municipality **Lebesby** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (consecutive spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week															
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Grense Jakobselva															1	
Skallelva										1						
Syltefjordelva							1			1						
Kongsfjordelva										1						1
Langfjordelva										1						
Sandfjordelva								1	1							
Futelva								2								
Veidneselva																1
Lille Porsangerelva								1	1							
Børselva											2				1	
Reisaelva												1				

Table XII. Numbers of fish and rivers of origin for **kelts** caught mainly in Tanafjord **in** the municipalities **Tana, Gamvik and Berlevåg** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (consecutive spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week													
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Bergebyelva									1		1			
Syltefjordelva								1		1		2		
Kongsfjordelva									2	3	1			
Iesjohka									1					
Inarijoki										1	1			
Kevojoki					1									
Levajohka			1				1							
TenoMS									1					
Langfjordelva									2		1			
Sandfjordelva											1			
Børselva								1	1					
Repparfjordelva										1				

Table XIII. Numbers of fish and rivers of origin for **kelts** caught in the municipalities **Båtsfjord, Vardø, Vadsø, Nesseby and Sør-Varanger** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (consecutive spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week														
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Kola							1				1				
Ura						1				1					
Zapadnaya Litsa		1			1										
Titovka				1											
Grense Jakobselva									1						
Sandneselva Kirkenes												1			
Neidenelva							1								
Klokkarelva								1							
Vesterelva										1	1				
Bergebyelva						1	1	5	8	2	5	1			
Vestre Jakobselva	1						1			2		1	1	1	2
Skallelva											2	1	1		
Komagelva									1		3		1	1	
Syltefjordelva						1			1					1	
Kongsfjordelva								1				1	1		
Storelva/Berlevåg								1							
Vetsijoki						1									1
Langfjordelva				1							1				
Sandfjordelva								1							
Lakselva Porsanger											1				2
Repparfjordelva												1			
Lysbotnvassdraget								1							

After reconditioning from kelt phase to previous spawner phase salmon are mature and ready for repeat spawning. They are migrating to coasts from ocean feeding grounds and then following the coastal areas orienting to their rivers of origin. Some fish swim very close to the shore areas and some fish swim within a longer distance from the shoreline. It is most probable that some amount of salmon head quite directly from ocean feeding grounds to the fjords where their river of origin is located. Those stocks which are swimming long stretches following nearby coastal areas and visiting frequently on their way in fjords on their way to home rivers will meet higher exploitation compared to the stocks which are coming more directly into the fjords where their home river is locating.

Previous spawners which were caught in Nordland County mainly originated from Nordland rivers and only few of salmon originated from Troms (Målselva) and West-Finnmark rivers (Altaelva, Lakselva-Porsanger) (Table XIV). Previous spawners caught in Troms County mainly originated from rivers in Troms. Some previous spawner salmon stocks originating from Nordland County were also caught in Troms indicating their migration direction from east to west. Many stocks originating from West-Finnmark and Tana river system were caught in Troms County indicating that those stocks came from their ocean feeding grounds to the coastal areas far away from their rivers of origin and migrated towards east. It is noteworthy to observe that previous spawner stocks from Varangerfjord rivers were not present in the catches in Troms coastal areas (Table XV). Wide diversity of previous spawning salmon stocks were caught in the large outermost area in Loppa-Hasvik and Nordkapp-Kvalsund-Måsøy-Hammerfest indicating the importance of stocks from Middle and East Finnmark migrating from west to east. Alta stocks were caught mainly in Altafjord and Loppa-Hasvik areas (Table XVI, XVII). Very few previous spawning salmon stocks from Troms area were caught in West Finnmark indicating low migration rate within that geographical area from east to west. Previous spawners caught in Porsangerfjord had main origin from the River Lakselva (Porsanger) but also some fish originating from eastern rivers as well as from Troms County rivers indicates that salmon also follow coastal areas in fjords on their way to home rivers (Table XVIII). Previous spawners caught in Lebesby municipality indicates fish caught mainly in the outermost area in Laksefjord where the origin of fish represents stocks from large geographical area from Iokanga river in East Kola Peninsula in Russia to Kåfjordelva in Troms County with numerous stocks from the River Tana (Table IXX). Tanafjord is a rather narrow and reasonably short fjord compared to other fjords in Finnmark and therefore there the occurrence of other stocks in the catches is low. In Tanafjord main previous spawner stock components were from the River Tana system (Table XX). Previous spawner stocks caught in the long and wide Varangerfjord are representing salmon stocks from rivers within the huge geographical area stretching from North Troms to East Kola Peninsula. Varangerfjord is a good example from the area where stocks are highly mixed and they are migrating at the same time to east and west and to all the rivers running into Varangerfjord. (Table XXI).

Table XIV. Numbers of fish and rivers of origin for **previous spawning salmon** caught in the **Nordland County** area in the years 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (alternate spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week													
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Lakselva Porsanger														1
Altaelva														1
Målselva														1
Skøelva					1									
Åndervassdraget										1				
Roksdalsvassdraget		1	2	2		1	1				1			
Gårdselva						2	2						1	
Langvatnvassdraget				1										
Saltdalselva			1											

Table XV. Numbers of fish and rivers of origin for **previous spawning salmon** caught in the **Troms County** area in the years 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (alternate spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week															
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Zolotaya									1							
Iesjohka									1							
Karasjohka												1				
Inarijoki						1										
Tsarsjoki						1										
Laksjohka						1										
TenoMS														1		
Langfjordelva								1								
Sandfjordelva						1										
Storelva Laksefjord						3										
Børselva							1			1						
Stabburselva									1							
Russelva				1				1								
Repparfjordelva			1			1	2		1	1						
Altaelva								1	2		2	1				
Burfjordelva											1					
Badderelva							1									
Kvænangselva						1										
Reisaelva					1		4	1								
Kåfjordelva									1		1					
Lakselva Aursfjord						1	1									
Målselva				2	3	6	14	7	10	4	1					1
Rossfordvassdraget									1							
Lysbotnvassdraget					1											
Laukhelle					2											
Salangsvassdraget									1							
Roksdalsvassdraget		1				1		1								
Gårdselva						1	1									
Saltdalselva										1						

Table XVI. Numbers of fish and rivers of origin for **previous spawning salmon** caught in the municipalities **Alta, Hasvik and Loppa** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (alternate spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week														
River	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Onega				1											
Umba														1	
Rynda									1						
Iesjohka								1			1				
Inarijoki					1					1					
Galddasjoki	1				1										
Kevojoki					1										
Utsjoki					1										
Maskejohka					1										
Veidneselva											1				
Børselva									1	1					
Stabburselva							1								
Ytre Billefjordelva							1								
Repparfjordelva					3	1	1	1	1						
Altaelva							5	4	3	6	8	1	1	1	1
Kvænangselva							1		1						
Salangsvassdraget										1					
Gårdselva			1												

Table XVII. Numbers of fish and rivers of origin for **previous spawning salmon** caught in the **municipalities Nordkapp, Kvalsund, Måsøy and Hammerfest** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (alternate spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week													
River	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Titovka												1		
Syltefjordelva									1					
Iesjohka							1							
Inarijoki				1										
Laksjohka				1										
Vetsijoki							2							
Sandfjordelva							2							
Børselva						1								
Lakselva Porsanger					2		2						2	1
Stabburselva							1							
Ytre Billefjordelva								1						
Repparfjordelva						1		1		1			1	1
Altaelva								1	2	2				
Kvænangselva					1									
Skittenelva							1							

Table XVIII. Numbers of fish and rivers of origin for **previous spawning salmon** caught in the municipality **Porsanger** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (alternate spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week														
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Pyave								1							
Kongsfjordelva													1		
Futelva							1								
Suosjohka									1						
Veidneselva											1				
Lille Porsangerelva											1				
Lakselva Porsanger							1	1	3			2		3	1
Repparfjordelva										1					
Kvænangselva					1	1									

Table IXX. Numbers of fish and rivers of origin for **previous spawning salmon** caught in the municipality **Lebesby** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (alternate spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII).

	Week													
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Iokanga					2									
Varzina					1									
Tipunkova							1							
Titovka					1									
Munkelva								1						
Komagelva							1							
Syltefjordelva								1						
Karasjohka								1		1				
Inarijoki					1									
Akujoki							3							
Kevojoki					1		1							
Tsarsjoki						1								
TenoMS						1								
Langfjordelva														1
Sandfjordelva				1										
Lille Porsangerelva								1			1	1		
Børselva									1					
Lakselva Porsanger							1		1		1			1
Stabburselva										1				
Repparfjordelva						2	3							
Altaelva						1						1		
Kåfjordelva									1					

Table XX. Weekly numbers of fish and rivers of origin for **previous spawning salmon** caught mainly in Tanafjord in the municipalities **Tana, Gamvik and Berlevåg** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are differences in the fishing time between municipalities (See Kolarctic salmon project Report VII).

	Week													
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Ura							1							
Syltefjordelva							1	2						
Kongsfjordelva							1							
Iesjohka				1			2	4	2	1	1			
Karasjohka			1				2		1		1			
Inarijoki					1	2	6	9	6	5				
Akujoki					1			2						
Valjohka			1		4	3	1	1	1					
Galddasjoki					1									
Karigasjoki					1	1	1	1	4					
Kevojoki					3	3	4	5	1					
Tsarsjoki	1			2		1	2	1						
Utsjoki									1		1			
Laksjohka				1	2	1		1						
Levajohka			1		1	1	2	1						
Maskejohka							1	1						
TenoMS						1	3	10	6	4	3		1	
Vetsijoki				1	2		1	1						
Langfjordelva														1
Veidneselva							1							
Russelva					1									
Repparfjordelva							1							
Signaldalselva										1				

Table XXI. Weekly numbers of fish and rivers of origin for **previous spawning salmon** caught in the municipalities **Båtsfjord, Vardø, Vadsø, Nesseby and Sør-Varanger** in the years 2008, 2009, 2011 and 2012 during the entire research period from the begin of May to the middle of September. All previous spawning sea-ages (alternate spawners) are included. Official fishing time in Norway is covering the weeks from 23 to 31 but there are some differences between municipalities (See Kolarctic salmon project Report VII). Table is continuing to the next page.

	Week													
River of origin	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Rynda						1								
Olenka					1									
Klimkovka							1	1						
Vaenga								1						
Kola				1	1	3								
Tuloma					1		1							
Ura				2	1	1	2							
Zapad. Litsa				1	5	8	4	1	1					
Titovka				4	4	6	2	4	1					
Pyave				1										
Gr Jakobselva					1									
Tårnelva					1	1								
Sandneselva K							1							
Munkelva					2									
Neidenelva			1	2	1	7	4		2	1				
Klokkarelva				1			2							
Nyelva						1								
Vesterelva						1	1	3						
Bergebyelva					1	5	1	7	6	1	2			
V. Jakobselva								1	1		1			1
Storelva Vad					1									
Skallelva										1				1
Komagelva						1	1	2	3	1	2			
Syltefjordelva								1	1		1	1		
Kongsfjordelva							1							1
Inarijoki	1			2	2			1	1					
Valjohka						1	1							
Kevojoki	1				1									
Tsarsjoki	2													
Laksjohka	1				1		1							
Levajohka					1	1								
TenoMS					1	1	1				1			
Sandfjordelva														1
Storelva, Laksf													1	
Lakselva, Pors.										1				
Kvænangselva									1					
Nordkjoselva					1									

3.13 Reconditioning from kelt to mature repeat spawner; example from the river Tana.

Salmon which has descended from the spawning from fresh water to sea to recondition have lost a lot of their weight from the time when it ascended into the home river to reproduce. At sea salmon are gathering energy reserves (lipids, protein) into its body and during the freshwater phase it is using these for developing gonads, migrating into spawning grounds, making nests for egg deposition, and surviving the winter following the spawning. In some cases salmon can lose almost 50% from their weight before ascending into the river during the spawning period. When reconditioning at sea kelts are first reaching the weight corresponding the length and thereafter they can start to invest to the growth in length and weight.

One sea-winter old female salmon will increase its weight 6.3-fold, male will increase 6.7-fold before it reaches the sea-age of three years. Correspondingly two sea-winter old female salmon increases its weight 2.8-fold, male increases weight 2.4-fold before it reaches the sea-age of four years. These calculations are based on the assumptions that 1SW and 2SW old salmon are continuing their growth at sea without any break like spawning migrations between 1SW and 3SW or 2SW and 4SW years.

If salmon of one sea-winter (1SW), however, ceases feeding and growing at sea while it is making spawning migration for the first time in its life and after the spawning it is reconditioning one full year from kelt phase to mature previous spawner of the sea-age of three sea-winters (1S1) then it has increased its weight only 3.8-fold for females and 4.1-fold for males (Figure 63 and 64).

If two-sea-winter (2SW) salmon ceases its feeding and growing at sea while it is making spawning migration for the first time in its life and after the spawning it is reconditioning one full year from kelt phase to mature previous spawner of the sea-age of four sea-winters (2S1) then it has increased its weight 2.3-fold for females and 2.6-fold for males (Figure 63 and 64). This 2.3-fold increase in females is almost the same as is the weight increase between maiden 2SW female salmon and maiden 4SW female salmon which is 2.8-fold. The increase in the weight between 2SW male kelts and reconditioned 2S1 male previous spawners was larger than the increase between maiden 2SW and maiden 4SW fish.

The increase in the weights between male kelt of the age 3SW and the corresponding reconditioned weight in the age of 3S1 was 1.8-fold which was the same increase in weight than between maiden 3SW and maiden 5SW fish.

When salmon have spawned in the age of 1SW and thereafter have been reconditioning to the age 1S1 its weight is only 47% in females and 45% in males compared to the weight of same chronological sea-age of immature 3SW salmon. Correspondingly salmon which have spawned in the age of 2SW and thereafter reconditioned to 2S1 fish its weight is 64% in females and 53% in males from the weight of chronological sea-age immature 4SW salmon which has been feeding at sea consecutively four years. Also the weight of male salmon which has been spawning in the age of 3SW and then its weight after reconditioning at sea in the age of 3S1 is 59% from the weight of maiden male 5SW salmon.

After the spawning kelts are reconditioning well but in any (1S1, 2S1, 3S1) previous spawning salmon age group weights don't correspond weights of maiden fish in the same chronological sea-ages. Reason to the difference is that those salmon which migrated into rivers for spawning have lost additional growth from that year they ascended into river at least in 2SW and 3SW salmon which are migrating early in the season into the rivers. Especially these 2SW and 3SW salmon have lost also a lot of their weight during their stay in rivers.

If we analyze reconditioning of female kelts from the viewpoint that they have lost one full ocean growth year when staying in the river without feeding, then we find that weights are about the same for fish which have been the same number of years at sea. Females previous spawner with the age 1S1 has been actually two years at sea and their mean weight is 4.37 kilos corresponding mean weigh of 4.53 for maiden 2SW. Females previous spawner with the age 2S1 has been actually three years at sea and their mean weight is 8.06 kilos corresponding mean weigh of 9.39 for maiden 3SW and mean weight for 3S1 is 12.92 and for the corresponding maiden fish of 4SW weight is 12.68.

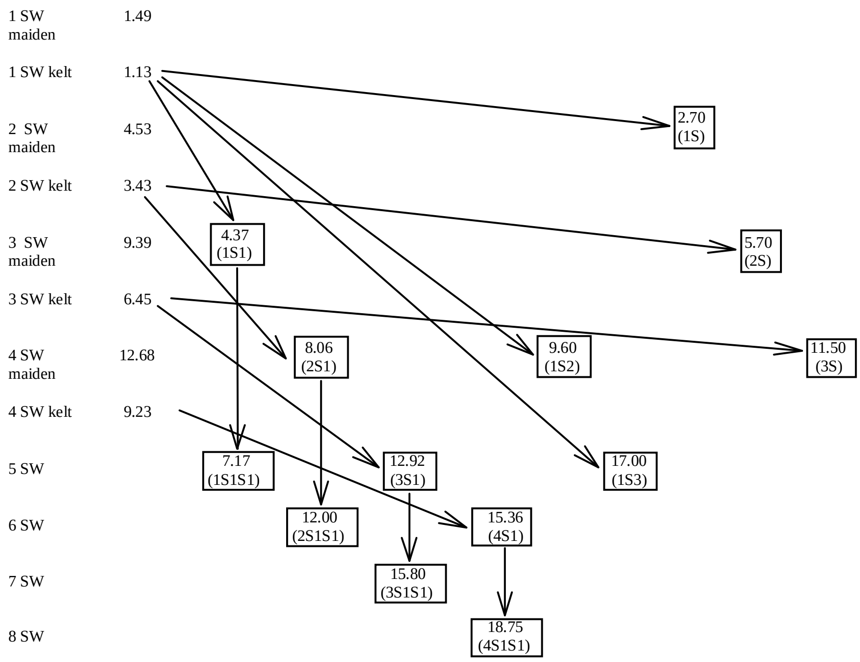


Figure 63. Thematic graph from the reconditioning of female salmon from kelt (=post spawner) to reconditioned repeat spawner indicated by the changes in the weights in the River Tana. Numbers in the boxes are indicating the sea-ages or previous spawners with mean weights. (Niemelä et al. 2011)

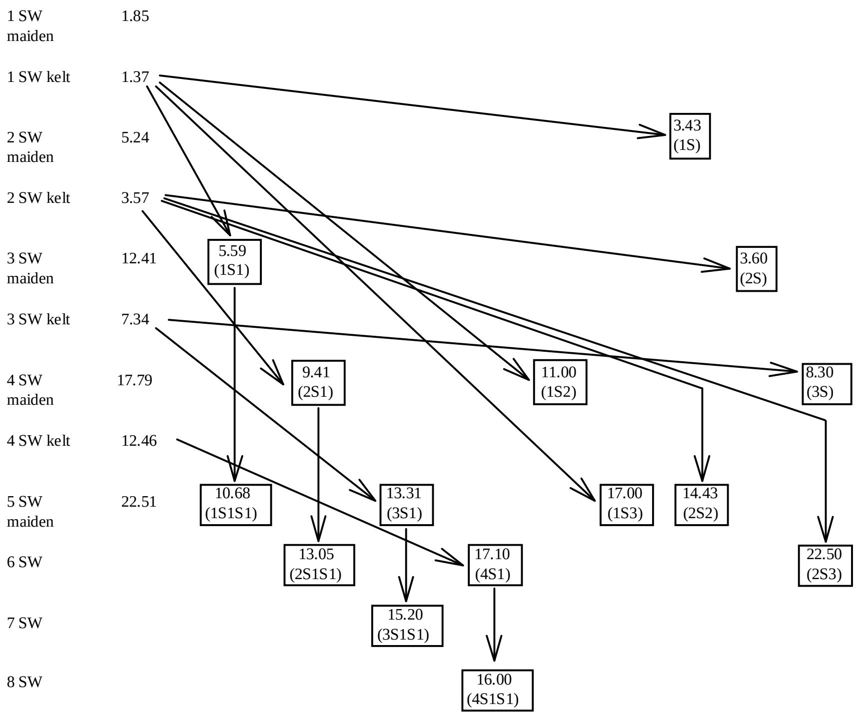


Figure 64. Thematic graph from the reconditioning of male salmon from kelt (=post spawner) to reconditioned repeat spawner indicated by the changes in the weights in the River Tana. Numbers in the boxes are indicating the sea-ages or previous spawners with mean weights. (Niemelä et al. 2011)

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Responsibilities in this report: FGFRI conducted the work concerning the salmon scales collected in Nordland, Troms and Finnmark: establishing the basic scale information file, making impressions from the scales, ageing salmon, designing and producing the graphs and writing the text. UTU and IMR made the genetical analysis from all maiden salmon, previous spawners and kelts and UTU made the text for methods chapter. FMFI organised together with FGFRI the scale collection and sampling arrangements including: information to fishermen, scale sampling manual drafting, design and purchase of scale bags, handling incoming samples and payments to fishermen.

NINA applied for the special research permission from the Norwegian Directorate of Nature Management for fishing outside the ordinary fishing season and had contact with fishermen in Nordland and Troms.

The Sea salmon fishers associations in Finnmark and Troms gave valuable input and contacted potential fishermen, who collected the research material.

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