Kolarctic CBC – Project KO4178; Conserving our Atlantic salmon as a sustainable resource for people in the North; fisheries and conservation in the context of growing threats and a changing environment.

REPORT XIX. Strong annual variations combined with the long-term declining catches in multi-seawinter salmon in the River Tana (Teno) watershed are indicating weakened stocks; diverse catch distributions in the traditional fisheries and basic ecology of salmon

Niemelä [1,2], E., Hassinen[1,2], E., Länsman[3], M., Kuusela[3], J., Haantie[3], H., Høstmark[4], M.S., Kalske[4], T.H.,

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4) County Governor of Troms and Finnmark; Vadsø, Norway

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Abstract
Official salmon catch statistics have been available since 1972 in Norway and Finland. In the year 1979 the bilateral Tana fishery agreement required both countries to initiate common annual researches, including also the work on salmon catch and fishery statistics. In the River Tana watershed, both in Tana mainstream and in all the tributaries, there has been four net fishing methods allowed to use in salmon fishing since 1873. The methods have been drift net, weir, gillnet and seine fishing. These methods have been allowed until present day, except seine fishing that became prohibited in the year 2017. Rod fishing has been used as long as it has been technically possible. The periods 1974-1976, 1983-1985, 1991-1992, 2000-2001 had peaks in the catch statistics, and they were simultaneous in both countries. After the last peak in the total catches, it was expected to see the next peak in the years 2006-2008 but it did not realize. Instead of the expected increase in catches, there was an all the time decline in both countries.
Combining the catches in Norway and Finland, it looks like the proportions of rod fishery catches have been quite stable during the last almost 50 years. Every year, rod fishery catches have exceeded more than 50% of the total catches in the entire Tana watershed. There are clear differences in the catch distributions between Norway and Finland. In Finland, the proportions of salmon caught with rod has increased and have made in the latest years close to 75 %. In Norway, almost every year rod fishery catches have been much lower than in Finland. In the River Tana watershed, salmon catches have reached 250 tons twice during the 50 years follow-up study. The highest catches took place in the years 1975 and 2001 when catches in Norway and Finland were combined.
Annual variations are notable in the estimated numbers and weights of 1SW, 2SW, 3SW, 4-5SW and previous spawning salmon, which is typical for all wild salmon stocks in all the rivers. In the River Tana watershed, these fluctuations have earlier been regular but after the year 2000, clear annual fluctuations have more or less disappeared. In the period 1974-2020, changes in the numbers between 1SW and 2SW, 2SW and 3SW salmon in the catches have taken place in the successive years. That means: for example good 1SW salmon catches in the year 1990 reflected to good 2SW catches one year later. In the year 1991, good 2SW salmon catches in the year 1991 reflected to good 3SW catches one year later in the year 1992. This kind of relationship has been a general model and it has been working also in those periods when 1SW, 2SW and 3SW salmon have been declining in successive years.
In catch reporting in Norway, fishermen have to inform about their daily catches, devided into three size groups (<3 kg, 3-7 kg, >7 kg). This size classification does not explain the annual changes in the salmon ecology. Each size group is including more than three sea-age groups when various age groups from previous spawners are included. It is noteworthy to observe that for example previous spawners, have made up more than 50% from the weight of 2SW male salmon catches in many years. Previous spawners have also made an important contribution in the catches for salmon larger than 7 kilos.
Previous spawning salmon migrate into the River Tana earliest together with 2SW and 3SW salmon. The smallest salmon (< 3 kg), are mainly belonging to the sea-age group 1SW, and they start to migrate into the River Tana in the second half of June. Depending on the ice-break-up dates and the water temperature in the River Tana, multi-seawinter salmon, 2SW-5SW and previous spawner salmon, can start migrations even early in May. Annual differences in the cumulative catches and in the median dates of capture, show clear variations in the timing of salmon migrations into the River Tana. These annual variations in the migration periods are driven by annual changes in the sea-temperatures, spatial and temporal changes in the efforts of the coastal salmon fishery with bag nets and bend nets (bend nets until the year 2021).

The annual growth of juvenile salmon in the rivers depends especially on the availability of food and water temperatures during their growth season in June, July and August. In each salmon population in the River Tana watershed, juvenile salmon from each spawning year are reaching smolt phase after 3, 4, 5 and 6 years. Mean smolt ages are increasing and decreasing in the same years in all rivers and these simultaneous changes in the mean smolt ages are taking place also between all sea ages and between females and males.
Males have been the major sex in the catches in terms of numbers of fish in the River Tana mainstream. There has been, however, clear annual variations in the proportions of females and males. Especially in those years when the stocks of 1SW salmon are high, the proportions of females in the catches are low. In long-term, the mean proportion of females is 46% in the numbers of salmon but in terms of weight of salmon catch, females are dominating with 59%. The proportions of females have in long-term declined in the catches in the River Tana mainstream in terms of numbers and weights, recognizing also the clear annual variations.
In the River Tana watershed, the mean lengths and weights in 1SW, 2SW, 3SW and 4SW show clear annual fluctuations. These fluctuations are taking place simultaneously in females and males in all sea-age groups. Simultaneous fluctuations can be observed also between sea-age groups and especially between 1SW and 2SW salmon. These simultaneous changes in the mean lengths and weights are due to the ocean temperatures, which are affecting the primary production at sea and finally the nourishment of salmon. In the River Tana watershed, mean lengths and weights of 1SW salmon have increased significantly towards the year 2017 when they were the largest since early 1970's.

Key words:
Multi-seawinter salmon, Atlantic salmon, Salmo salar, bag net, bend net, Tana, Teno, catch distribution, traditional fisheries

Front page photo:
Eero Niemelä

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1. Salmon catches in terms of weights and numbers in traditional fishing methods in the River Tana watershed

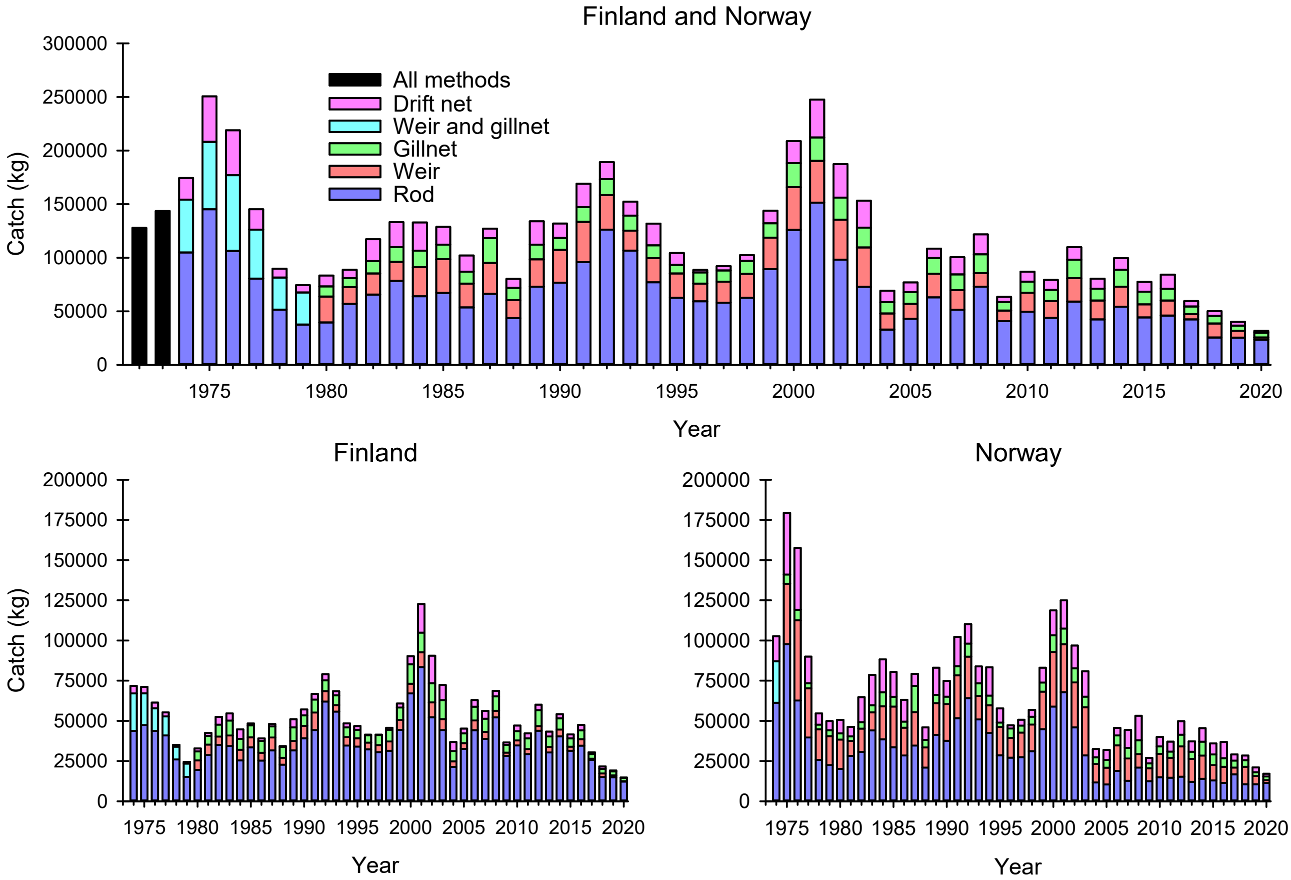

Figure 1. Reported salmon catches in weights for driftnet, gillnet, weir and rod fishery in the River Tana watershed in Norway and in Finland. Source: Luke (Finland),TF organization (Norway).

Official salmon catch statistics have been available since 1972 in Norway and Finland (Fig. 1). There are, however, estimates of the annual salmon catches from the 1960's in Finland and from the end of 1800's in Norway. The old Norwegian catches in the River Tana mainstream only cover yearly catches in the lower Norwegian area. Norway and Finland started to collect detailed salmon catches and fishery statistics early in 1970's simultaneously with the start of common salmon stock monitoring. Finally, in the year 1979, the bilateral Tana fishery agreement required both countries to initiate common annual research including the work on salmon catch and fishery statistics.

In the River Tana watershed, both in Tana mainstream and in all the tributaries, there has been four net fishing methods allowed to use in salmon fishing, since 1873. Methods have been driftnet, weir, gillnet and seine fishing. These methods have been allowed until nowadays except for seine fishing that was prohibited in the year 2017. Rod fishing has been used as long as it has been technically possible.

In the time period 1972-2020 there has been four clear peaks in the reported catches; in the periods 1974-1976, 1983-1985, 1991-1992, 2000-2001. These peaks have been simultaneous in both countries. After the last peak in the total catches, it was expected to see the next peak in the years 2006-2008 but it did not realize. Instead of the increase of the catches they have all the time declined in both countries.

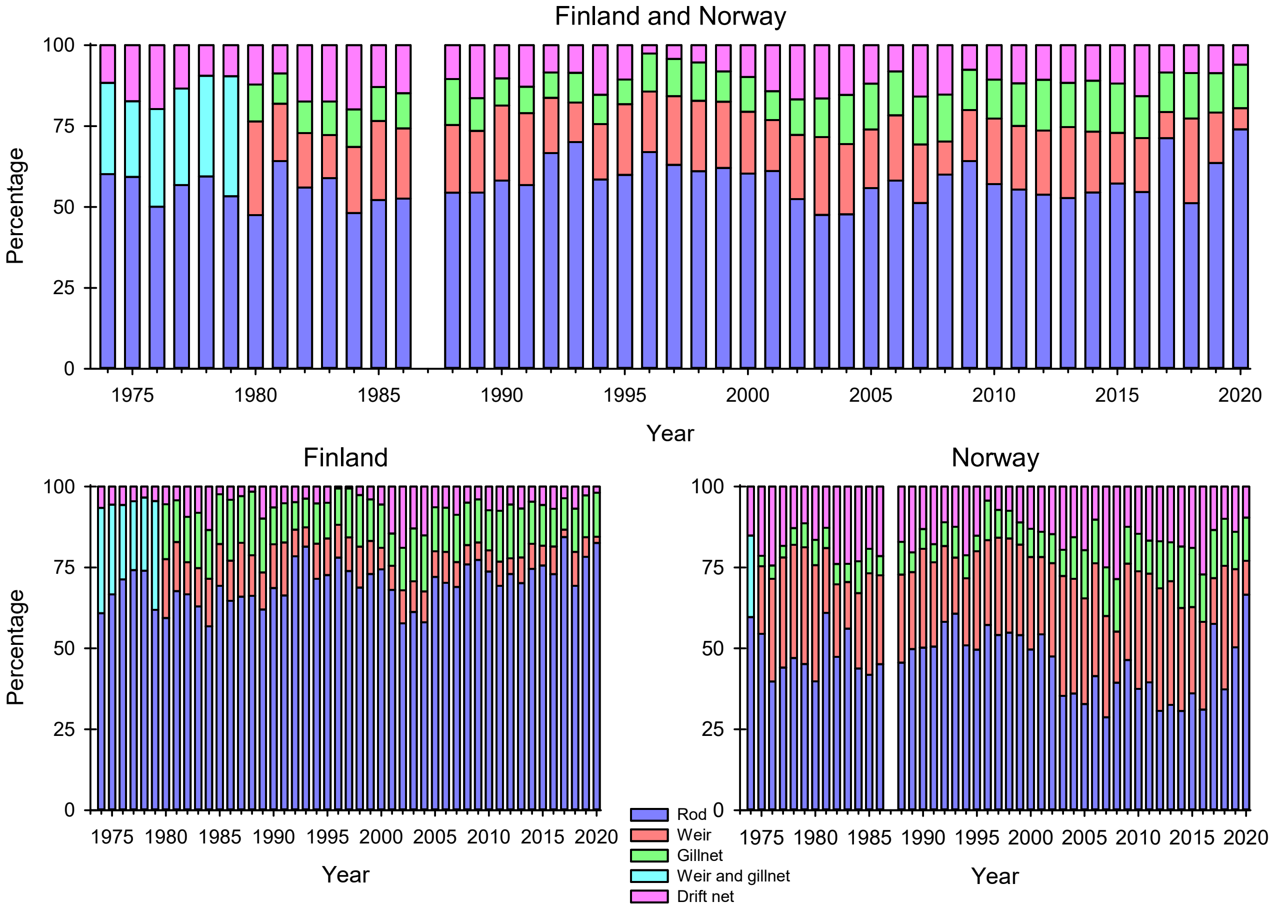

Figure 2. Annual distributions of salmon catches between fishing methods in Norway and in Finland in the River Tana watershed. Distributions are based on the data presented in the figure 1. Source: Luke (Finland),TF organization (Norway).

When combining the catches in Norway and Finland, it looks like the proportions of rod fishery catches have been quite stable for almost 50 years (Fig. 2). Every year, rod fishery catches have exceeded more than 50% from the total catches in the entire Tana watershed. There are clear differences in the catch distributions between Norway and Finland. In Finland, the proportions of salmon caught with rods has increased and have made in the latest years close to 75 %. In Norway, almost every year rod fishery catches have been much lower than in Finland. Since 2003 until 2018, rod fishery catches made in Norway 30%-40%. New salmon fishing restrictions in the River Tana watershed introduced in the year 2017 may have affected some changes in the catch distributions between fishing methods compared to earlier years.

Salmon caught with drift nets has always had larger catch proportions in Norway than in Finland. Proportions of salmon caught with gillnets have increased in Norway and have been quite stable in Finland. In Finland, the proportions of weir caught salmon have in the long-term declined, especially after the new fishing restriction from 2017. In Norway, also the proportions of weir caught salmon have declined since the year 2017 compared to the previous years in 1976-2016.

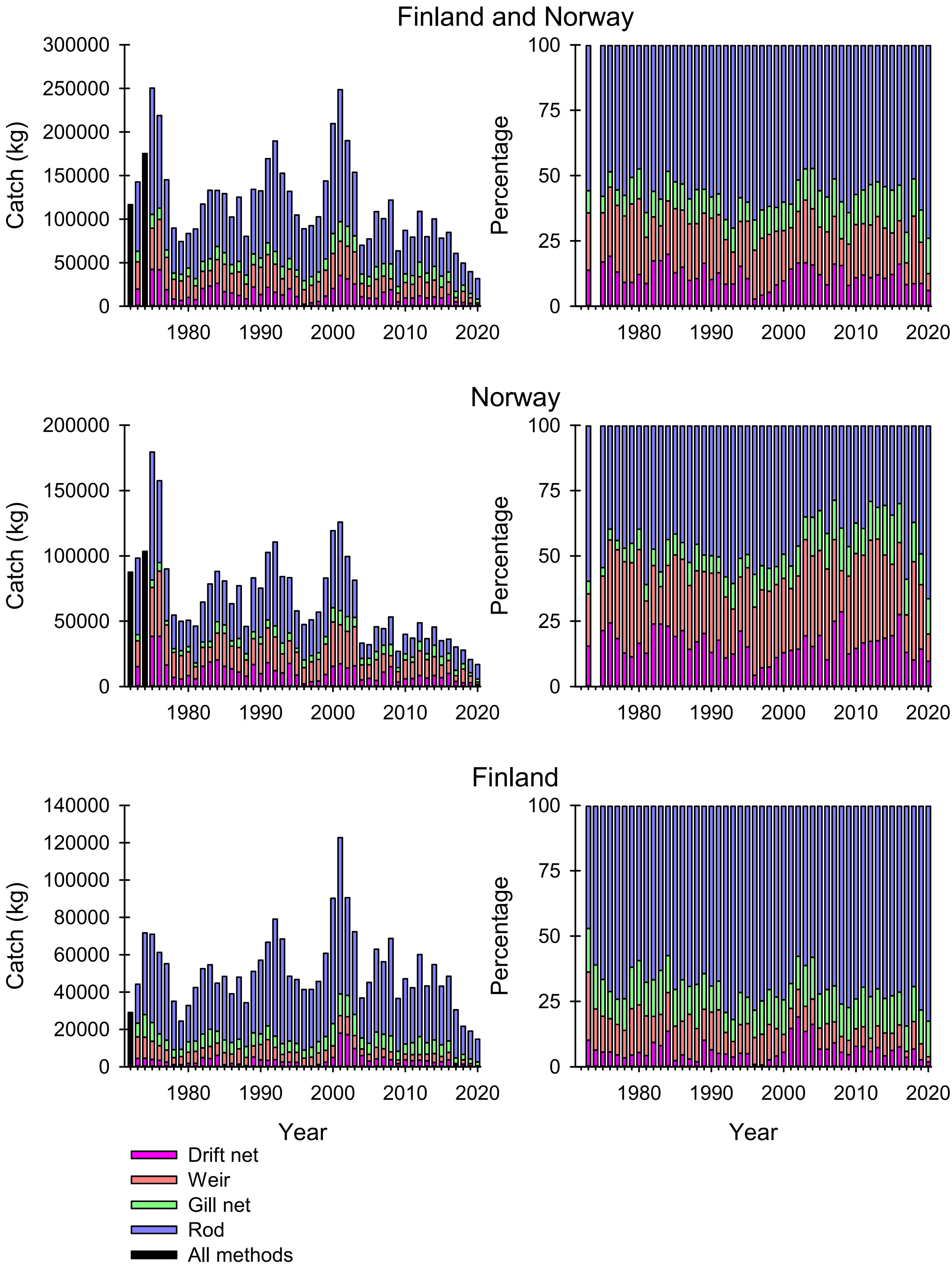

Figure 3. Total reported salmon catches in weights and distributions between fishing methods in the River Tana watershed in Norway and Finland. Source: Luke (Finland),TF organization (Norway).

In the River Tana watershed, salmon catches have reached 250 tons twice during the 50 years follow-up study. Highest catches took place in the years 1975 and 2001 when catches in Norway and Finland were combined. In Norway, the highest catch was recorded in the year 1975 with 175 tons and in Finland, in the year 2001 with 125 tons (Fig. 3). Annual catch fluctuations are similar and simultaneously in Norway and in Finland, indicating that fishermen in the entire watershed are making their fishery more effective during those years when salmon stocks are good. Salmon fishing in the River Tana watershed has changed especially during the last 15 years when the numbers of those old fishermen who used to fish with weirs have declined.

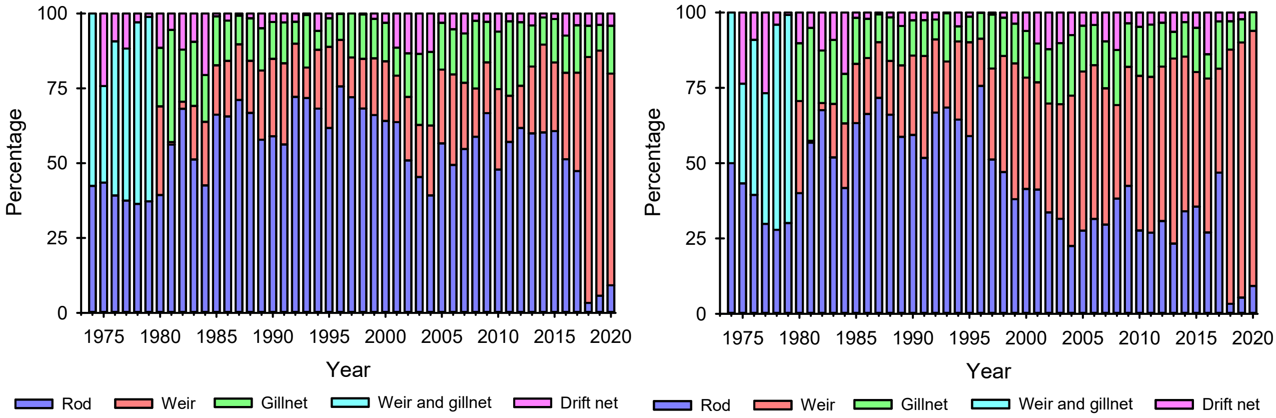

Figure 4. Proportions of salmon (all sea-age groups; 1SW-5SW and previous spawners) catches from the numbers of fish caught with traditional fishing methods in the River Tana watershed (figure on the left) and proportions of salmon which are the first time spawners (1SW-5SW). Source: Luke (Finland),TF organization (Norway).

Figure 4 indicates that when previous spawners are included in terms of numbers into the catches, then the proportions of rod catches is much larger than if previous spawners are not included. In that case, the proportions of weir caught salmon has larger proportions from the end of 1990's onwards. That difference can be explained by rod fishing targetting more towards previous spawners than what weir fishing does.

2. Annual salmon catches in terms of weights and numbers and proportions for all sea-age salmon in traditional fishing methods in the River Tana watershed

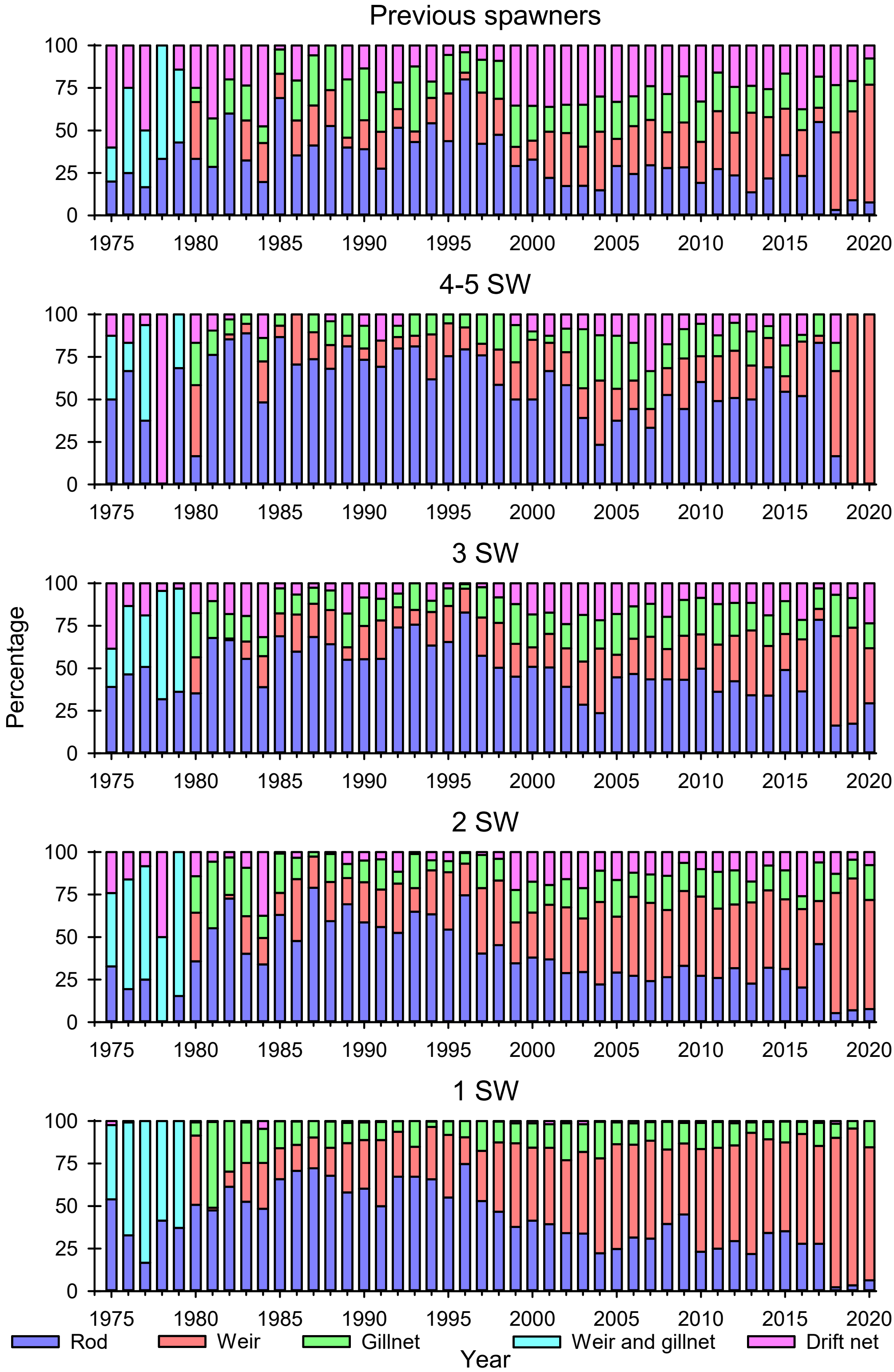

Figure 5. Proportions of salmon caught with traditional fishing methods in terms of estimated numbers in 1SW, 2SW, 3SW, 4-5 SW and previous spawners fish in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

Figure 5 indicates that the proportions of salmon caught with the traditional fishing method, weir, is increasing along the years and that is true for all sea-ages of salmon. Since the new fishing agreement introduced in 2017, there has been remarkable declining in the proportions of salmon caught with rod fishing and that is true for all sea-age groups of salmon. Previous spawning salmon is entering into the River Tana early in the summer and therefore, their proportions have been high in the annual driftnet catches. Driftnet fishery is allowed only early in June and therefore the proportions of late run 1SW salmon is minimal in driftnet fishery.

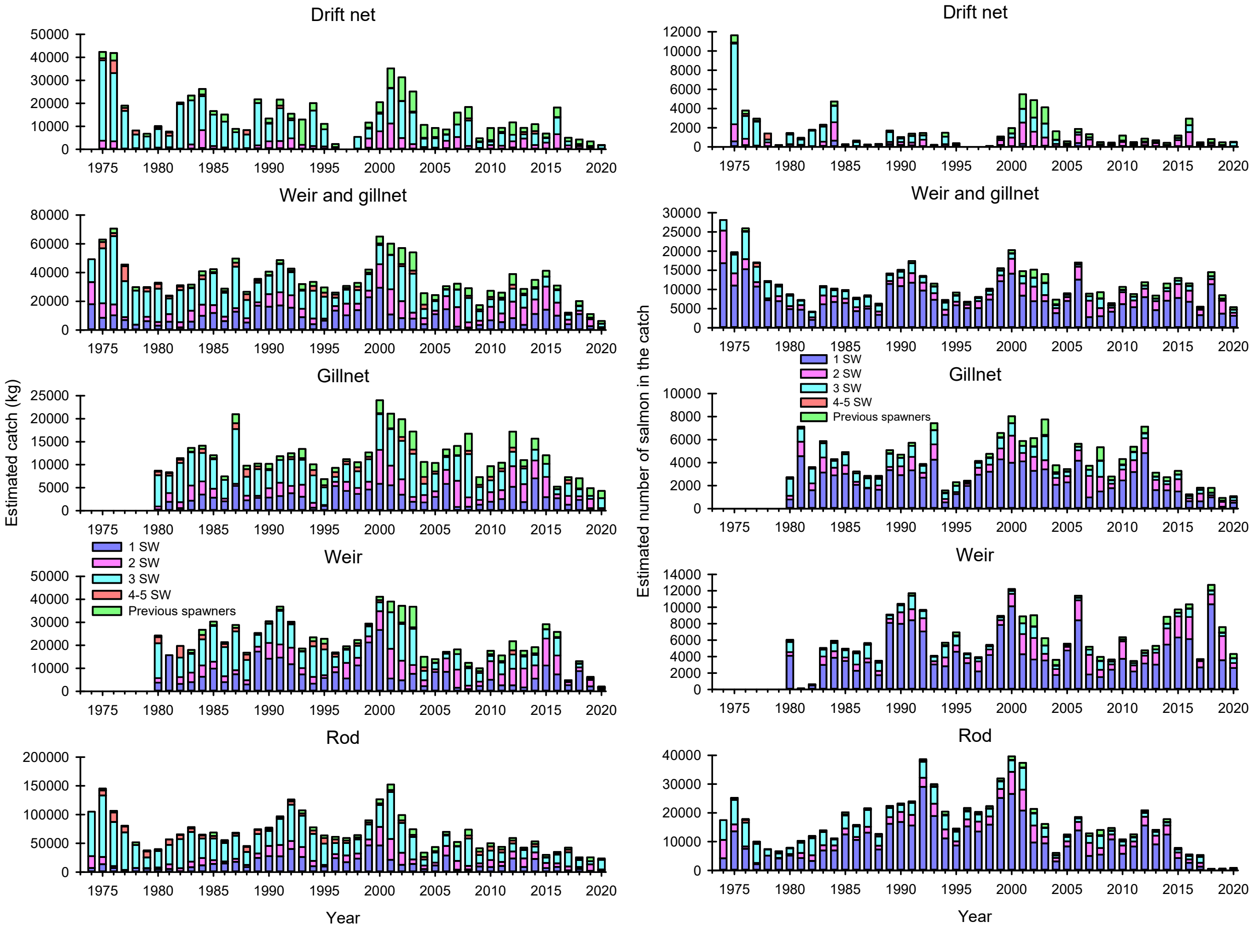

Figure 6. Estimated weights (figure on the left) and numbers (figure on the right) of 1SW, 2SW, 3SW, 4-5SW and previous spawning salmon in the annual rod, weir, gillnet, weir/gillnet and driftnet catches in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

Catches and proportions of three sea winter old salmon have declined in term of weight and numbers during the last approx. 50 years. This is true for all the fishing methods (Figs. 6, 7, 8, 9). Catches have fluctuated and peaks and low stock sizes have been simultanously between all the fishing methods. The proportions of previous spawners started to increase early 1990’s especially in the catches of driftnet fishery. In some years, previous spawners have made up to 50% in the driftnet catches.

If previous spawners are not included in the catches in driftnet fishery, we can clearly notice the long-term dramatic declining for 3SW salmon in weights, numbers and in proportions. Two sea-winter salmon started to be more common in the catches for driftnet, weir, gillnet and rod fishing and that started soon after the prohibition of driftnet fishery at sea in Norway in the year 1988.

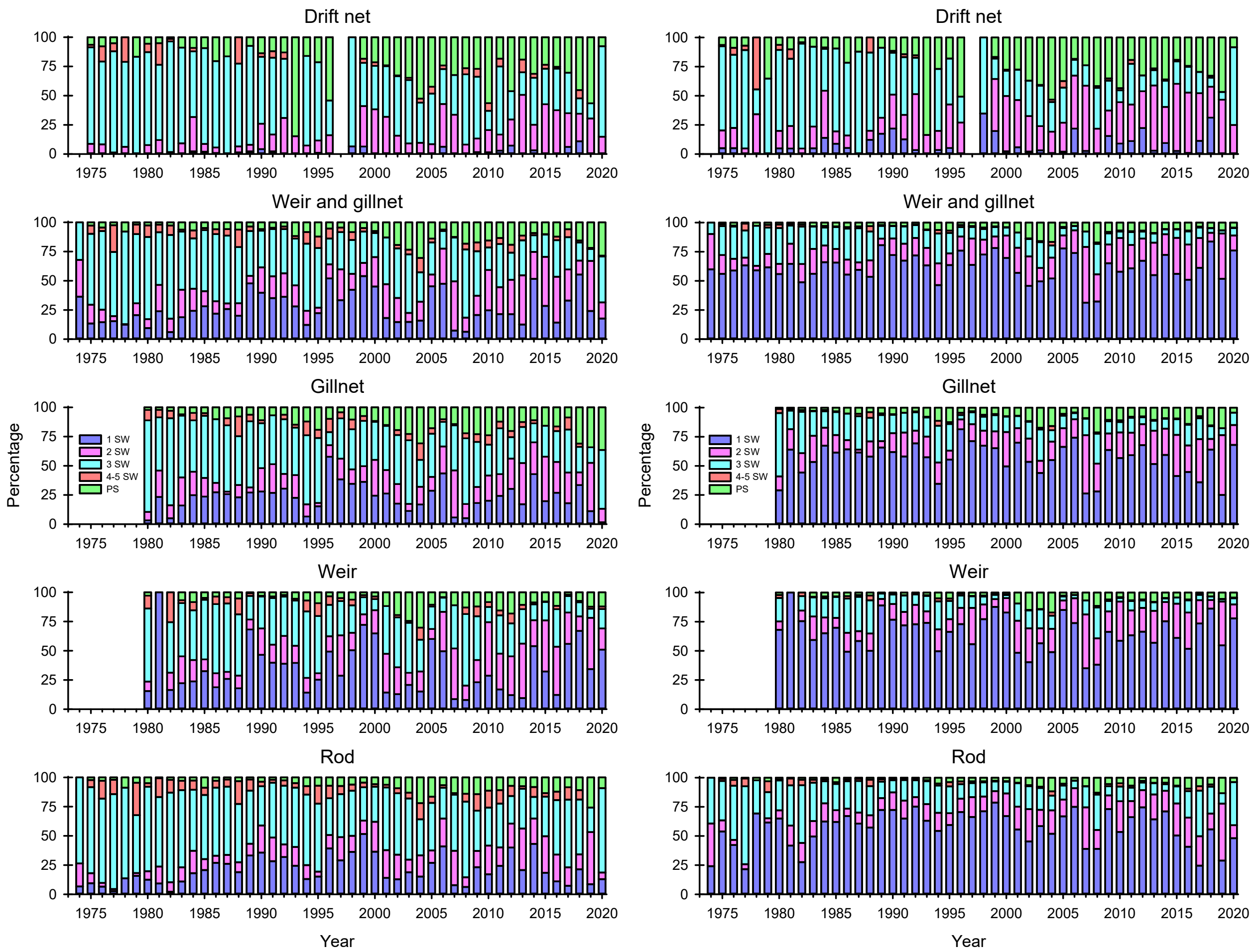

Figure 7. Annual proportions of 1SW, 2SW, 3SW, 4-5SW and previous spawning salmon (PS) from the estimated weights (figure on the left) and numbers (figure on the right) in the rod, weir, gillnet, weir/gillnet and driftnet catches in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

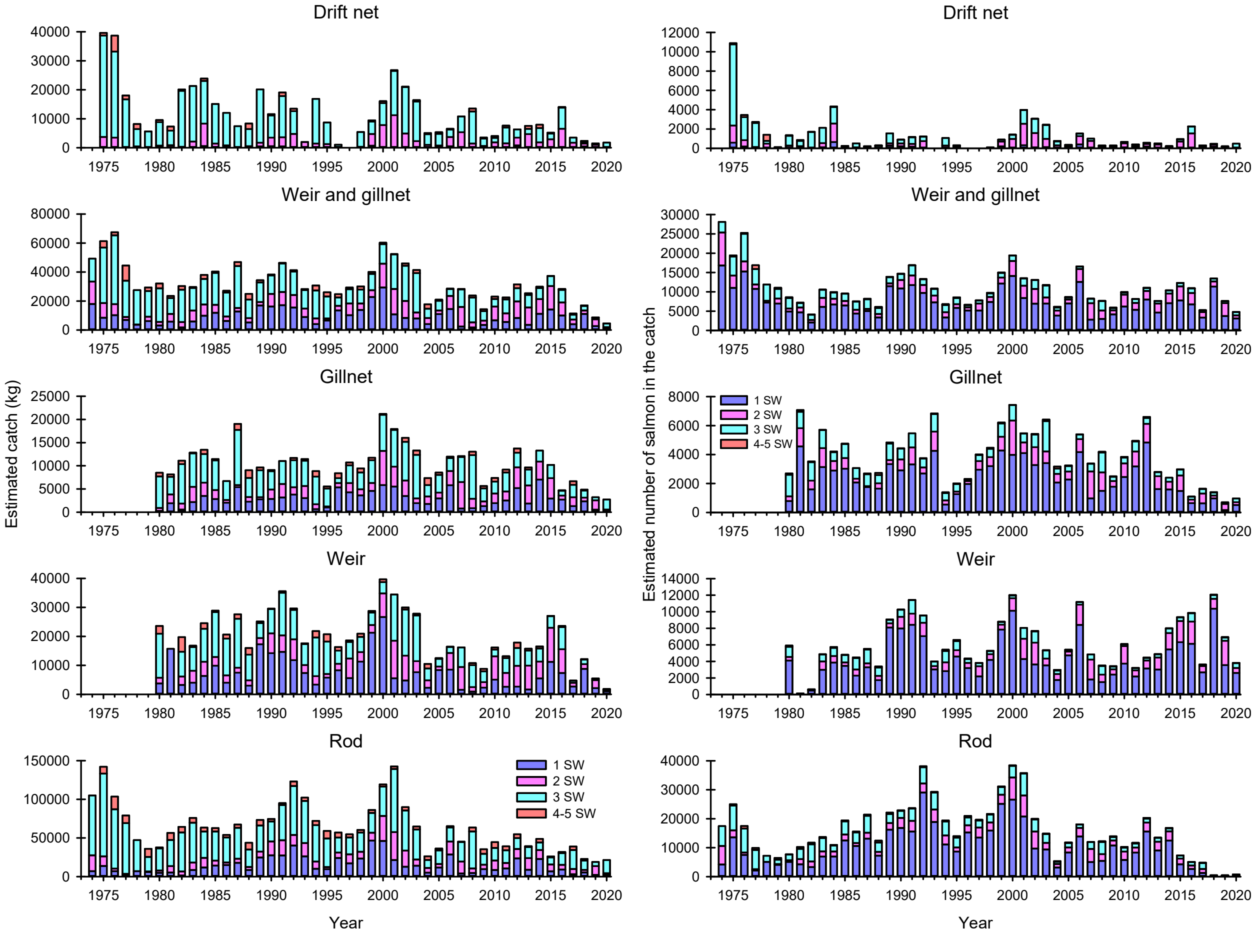

Figure 8. Estimated weights (figure on the left) and numbers (figure on the right) of 1SW, 2SW, 3SW and 4SW-5SW first time spawning salmon in the annual rod, weir, gillnet, weir/gillnet and driftnet catches in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

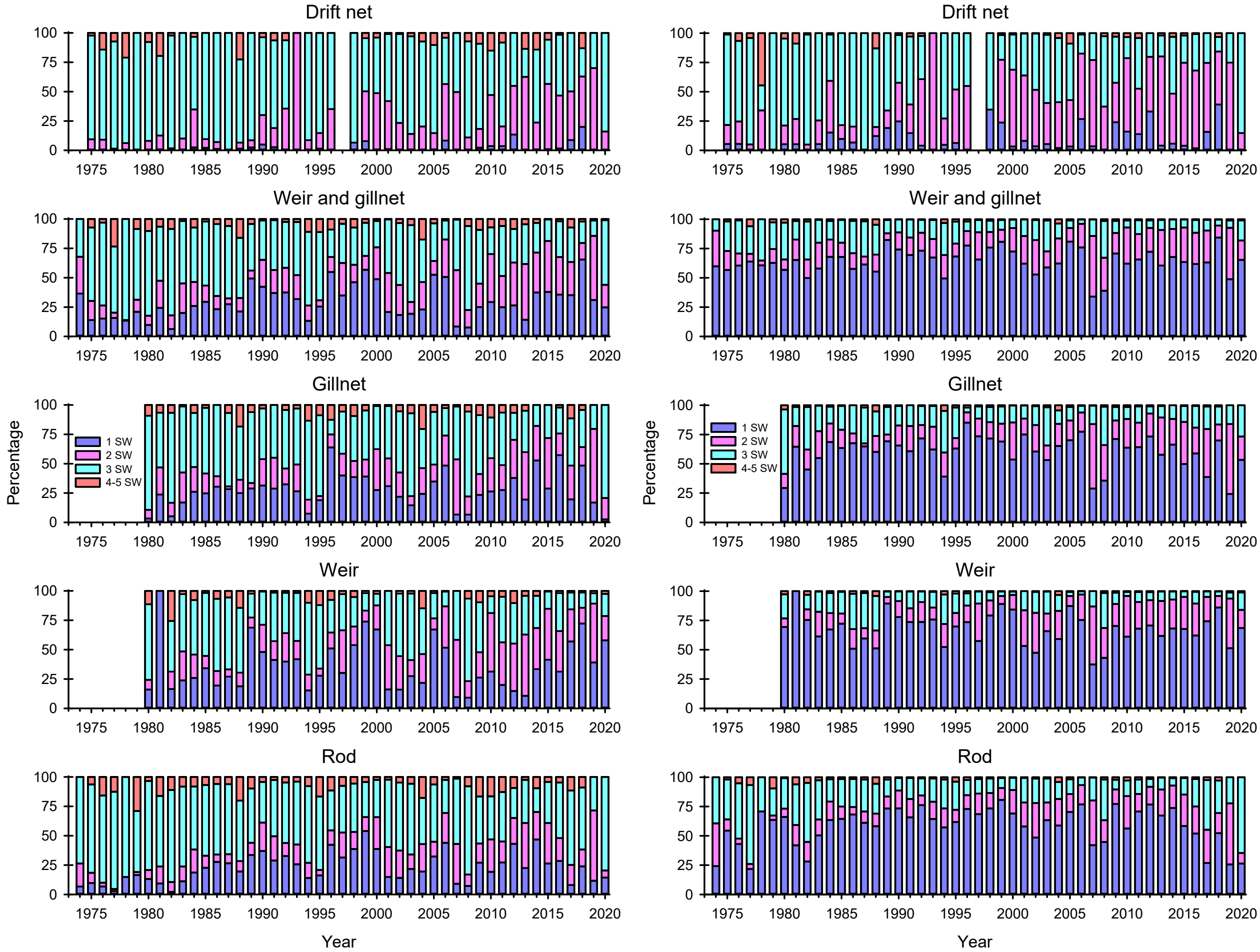

Figure 9. Annual proportions of 1SW, 2SW, 3SW and 4SW-5SW first time spawning salmon from the estimated weights (figure on the left) and numbers (figure on the right) in the rod, weir, gillnet, weir/gillnet and driftnet catches in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

3. Long-term fluctuations in the numbers and proportions of 1SW, 2SW, 3SW, 4SW-5SW and previous spawning salmon in the estimated total catches in the River Tana watershed

Historically, the highest salmon catches in terms of weight, have been close to 240 tons and in terms of numbers, close to 60 000 fish in the River Tana watershed (Figs. 10-14). The catch numbers of males have exceeded the numbers of females every year. Catch fluctuations have been simultaneous for females and males. Catches in terms of weights have usually been larger for females but, in those years when 3SW female stocks have been low the weights of males have exceeded that of females.

The proportions, as well as the numbers of 3SW salmon have declined in the long-term catches. Especially for female salmon the declining has been obvious. The proportions of previous spawners have been higher in females than in males. In male salmon catches, in terms of weights, 1SW salmon have represented approx. 50% in the total catch with remarkable annual variations. In female salmon catches, in terms of weights, 1SW salmon have been between 5% and 15% in females total catches with clear annual variations. In female catch proportions, 3SW salmon have shown a dramatic decline and at the same time, the proportions of 2SW female salmon have increased.

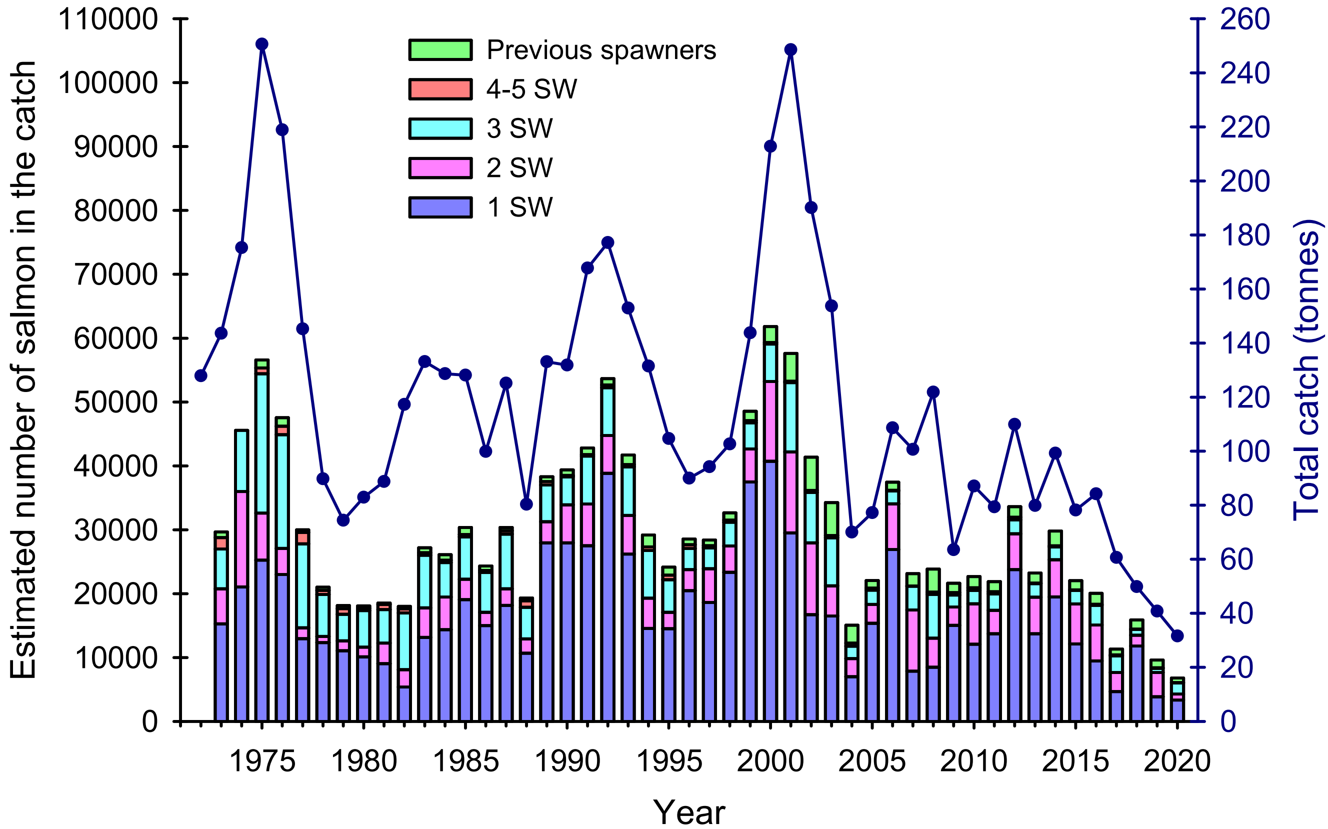

Figure 10. Annual salmon catches in numbers for 1SW, 2SW, 3SW, 4-5SW and previous spawning fish and total catch in tons in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

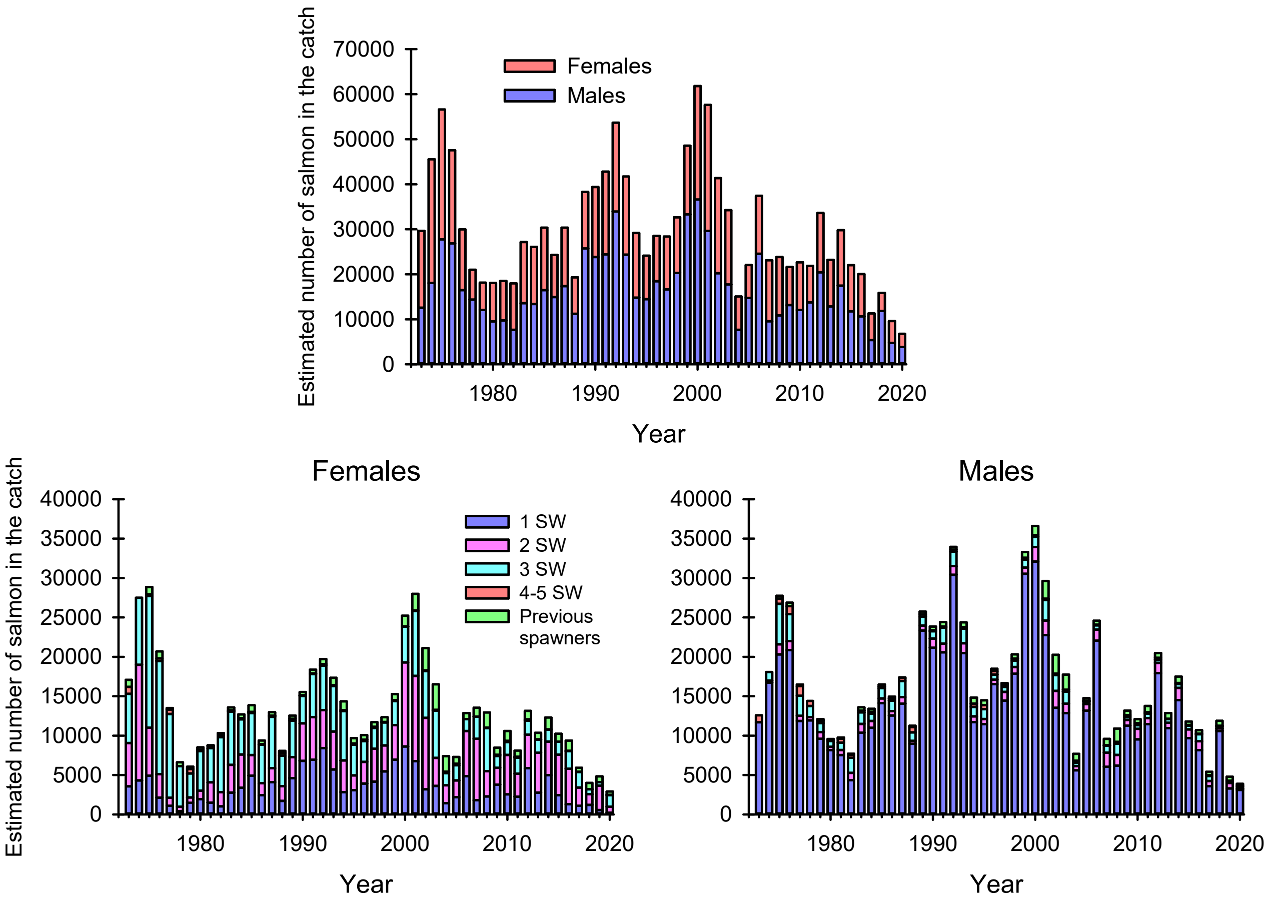

Figure 11. Annual female and male salmon catches in numbers for 1SW, 2SW, 3SW, 4-5SW and previous spawning fish and total catch in numbers in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

Figure 12. Proportions of 1SW, 2SW, 3SW, 4-5SW and previous spawning fish in the annual female and male salmon catches from the numbers in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

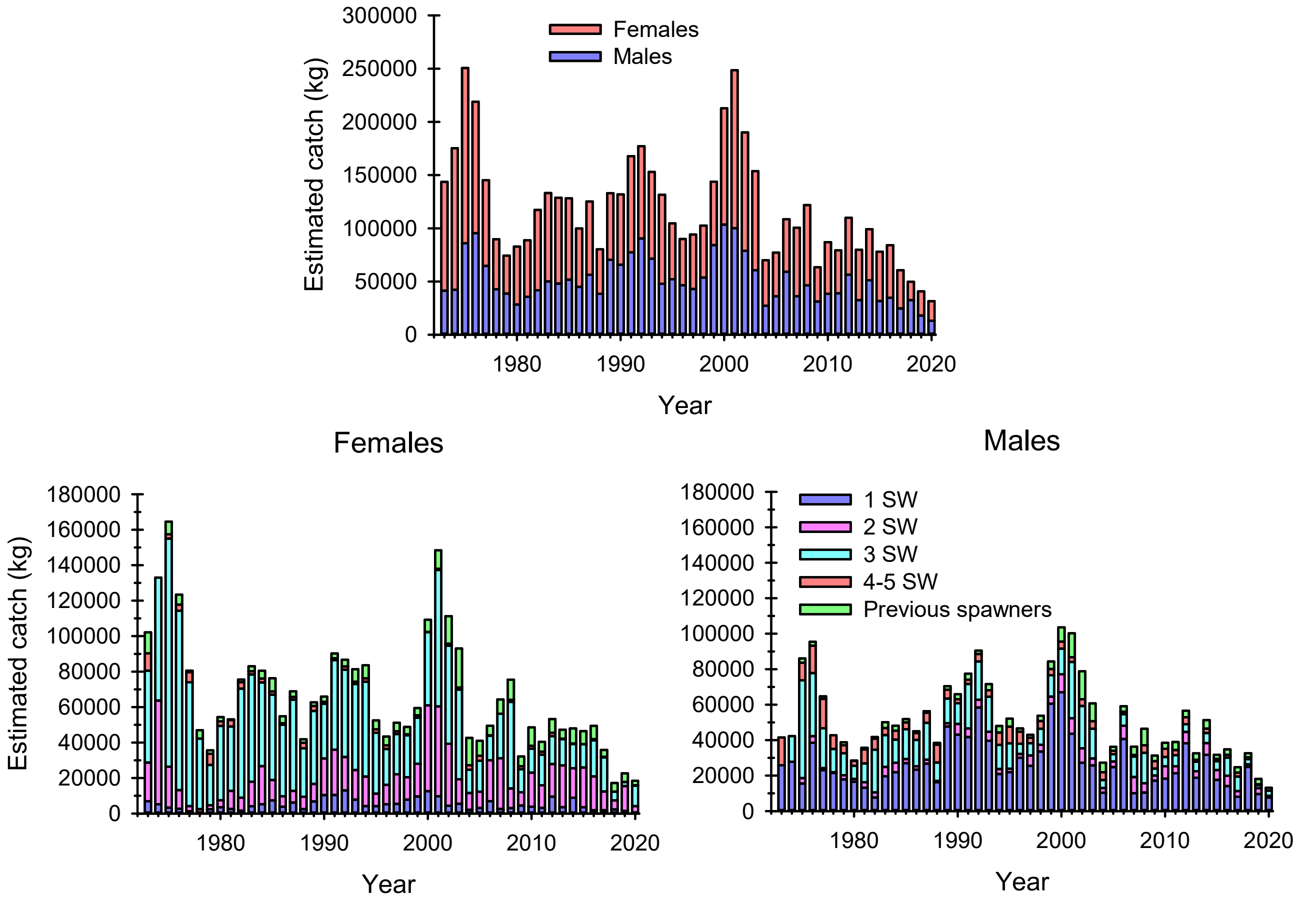

Figure 13. Annual female and male salmon catches in weights for 1SW, 2SW, 3SW, 4-5SW and previous spawning fish and total catch in tons in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

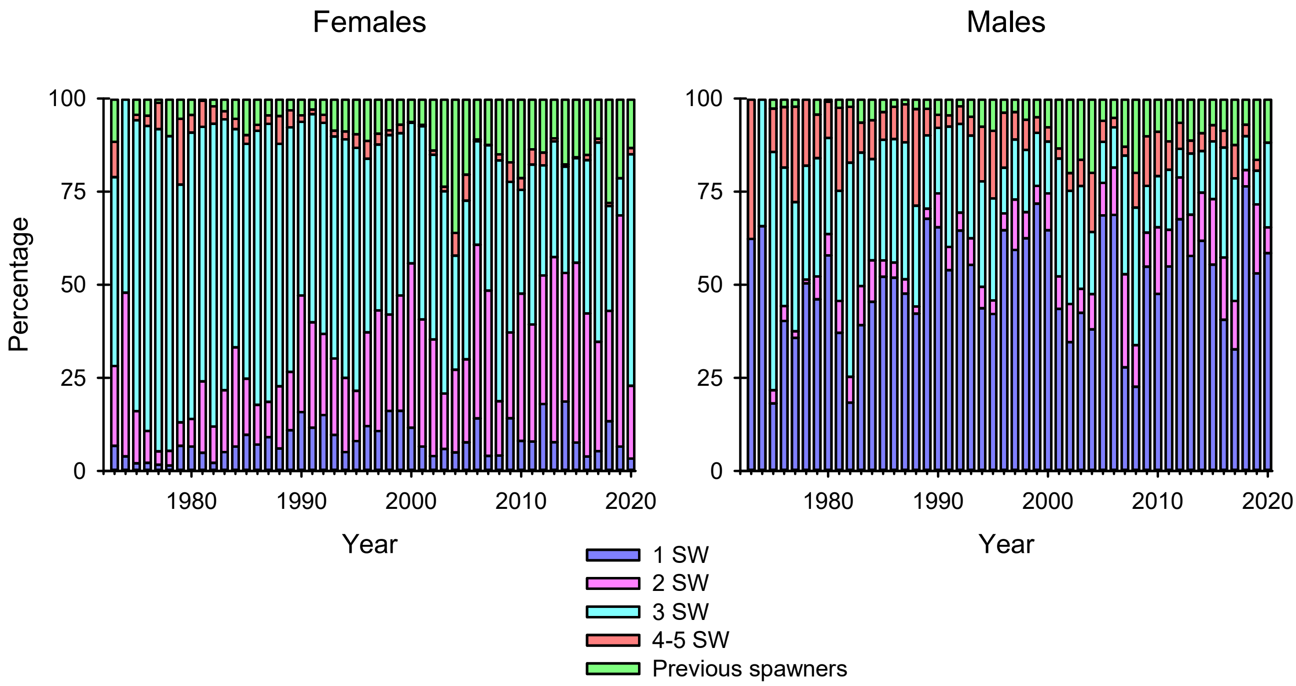

Figure 14. The proportions of 1SW, 2SW, 3SW, 4-5SW and previous spawning fish in the annual female and male salmon catches from the weights in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

Annual variations are notably in the estimated numbers and weights of 1SW, 2SW, 3SW, 4-5SW and previous spawning salmon, which are typical for all wild salmon stocks in all the rivers. In the River Tana watershed, these fluctuations have earlier been regular but, after the year 2000, clear annual fluctuations have more or less disappeared (Figs. 15-22). In the period 1974-2020, changes in the numbers between 1SW and 2SW, 2SW and 3SW salmon in the catches have taken place. That means: for example, good 1SW salmon catches in the year 1990 reflected to good 2SW catches one year later in the year 1991, good 2SW salmon catches in the year 1991 reflected to good 3SW catches one year later in the year 1992. This kind of relationship has been a general model and it has been working also in those periods when 1SW, 2SW and 3SW salmon have been declining in successive years.

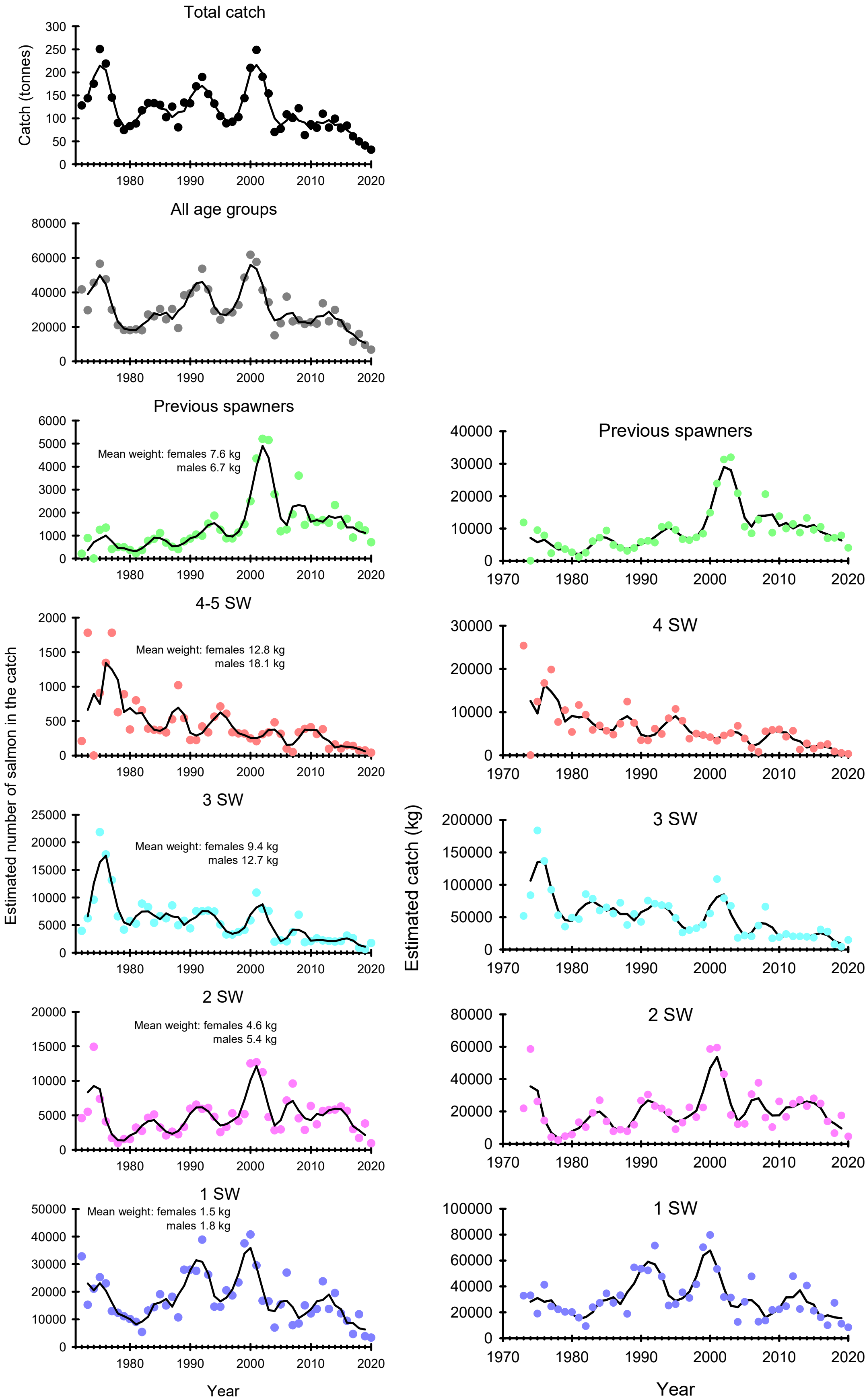

Figure 15. Annual salmon catches in numbers (figure on the left) and weights (figure on the right) for 1SW, 2SW, 3SW, 4-5SW and previous spawning fish and mean weights for females and males in each sea-age groups in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

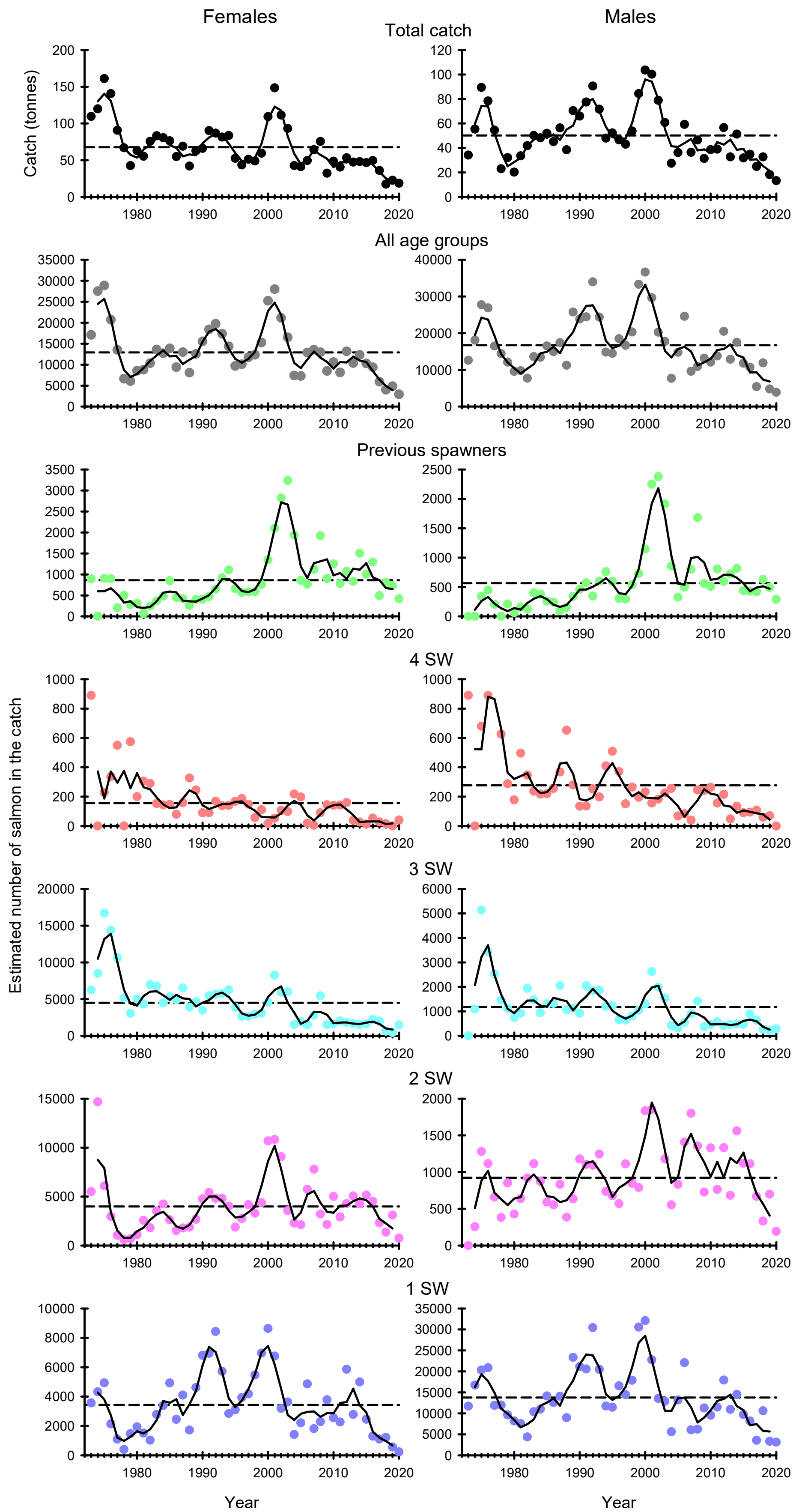

Figure 16. Annual salmon catches in numbers with long-term mean numbers for females and males in 1SW, 2SW, 3SW, 4-5SW and previous spawning fish in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

Figure 16 proves that large annual variations are true for all female and male salmon in all sea-age groups. It also proves that fluctuations have been exactly simultaneously between sexes. Figure 16 shows the long-term mean catches and, especially the decline of 3SW female and male salmon since the last peak in early 2000's.

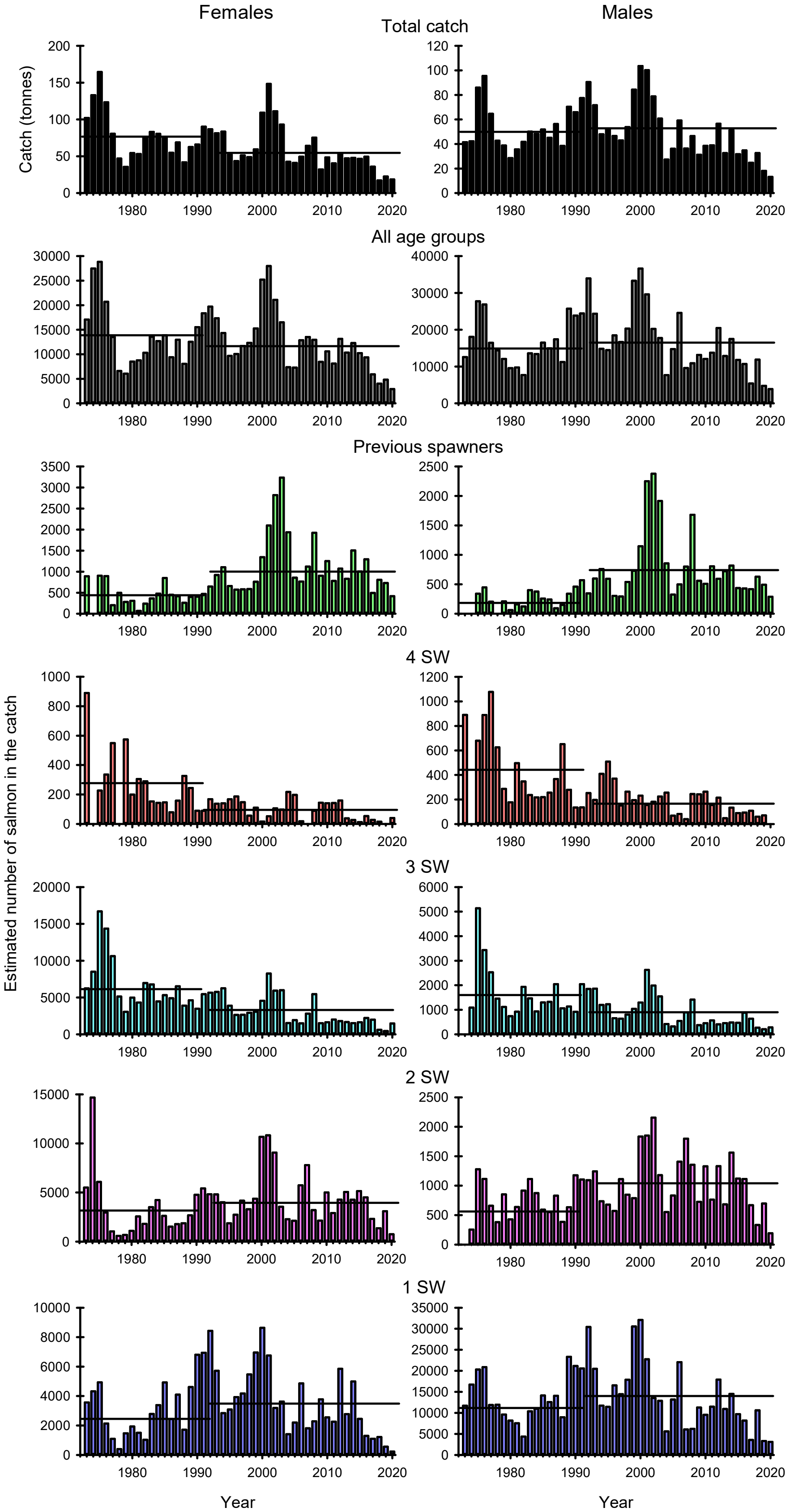

Figure 17. Annual salmon catches in numbers for females and males in 1SW, 2SW, 3SW, 4-5SW and previous spawning fish, sea-ages combined and the total salmon catches in tons in the River Tana watershed. Horizontal lines indicate mean catches in the River Tana before and after the closure of driftnet fishery at sea in Northern Norway in 1988, combined with the introduction of new salmon fishing agreement and fishing rules in the River Tana in the year 1990. Source: Luke (Finland),TF organization (Norway).

The introductions of the prohibition to use driftnet fishing at sea in Northern Norway, combined with the new Tana fishing agreement and fishing rules, resulted in the clear increased catches in 1SW, 2SW and previouos spawning female and male salmon in the River Tana watershed (Fig. 17).

Drift net fishery at sea targetted mainly into 1SW and 2SW salmon and therefore it is understandable that those sea-age groups increased in the River Tana catches. But, after some years the numbers of female and male salmon in the catches declined in all sea-age groups, especially towards the last peak in salmon stocks early in 2000's.

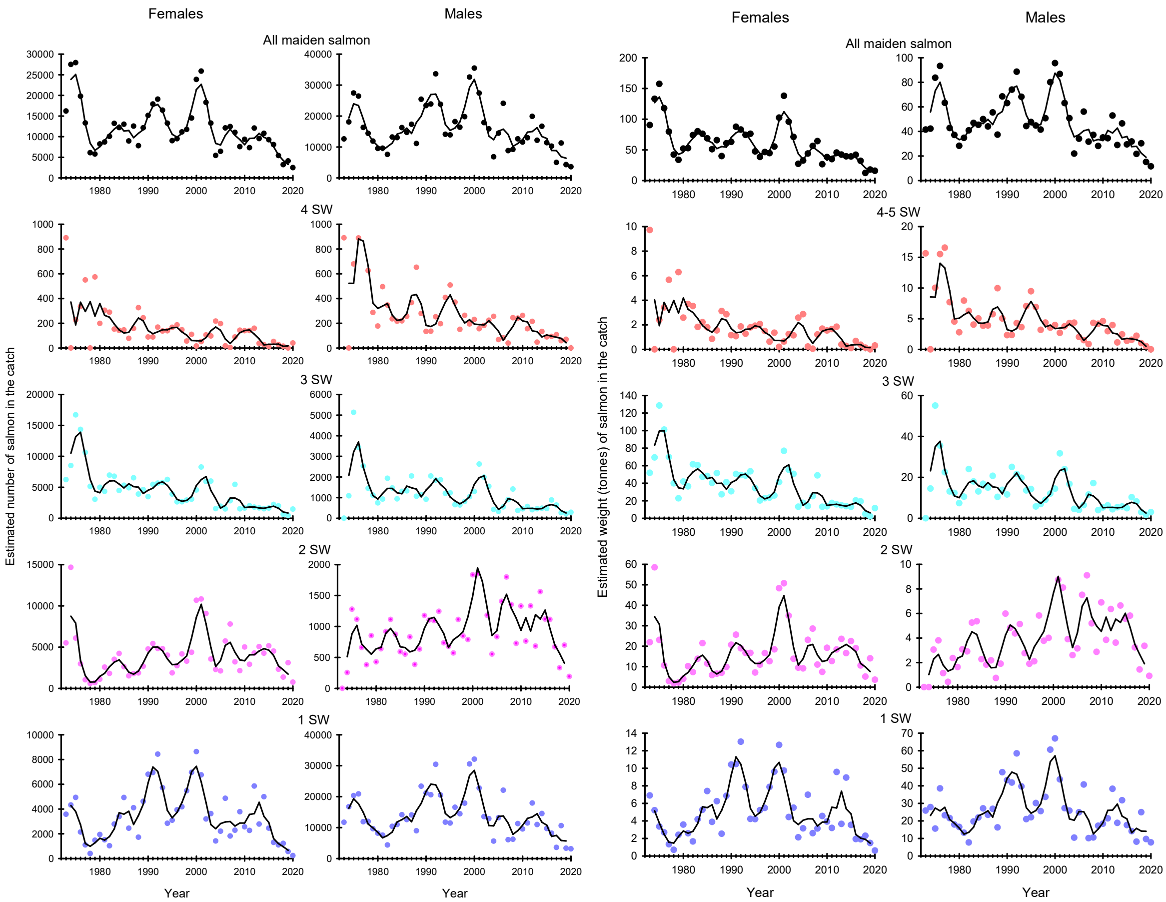

Figure 18. Annual salmon catches in numbers (figure on left) and in weights (figure on right) for females and males in 1SW, 2SW, 3SW and 4SW first time spawning fish in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

Figures 18-21 are highlighting the magnitude between the annual variations in the numbers and weights of salmon catches. The time period to be dealt with must cover tens of years before it is possible to detect significant changes and deviations in the catches for all the sea-age groups. In the River Tana watershed, the length of one salmon generation takes many years, depending on the smolt ages for 1SW salmon (5, 6, or 7 years), for 2SW salmon (6, 7, or 8 years), for 3SW salmon (7, 8 or 9 years) and for 4SW salmon (8, 9 or 10 years). The length of salmon generations in northern rivers, from the birth of a salmon to its first spawning, is long. This can be observed in the annual stock size variations between peak years.

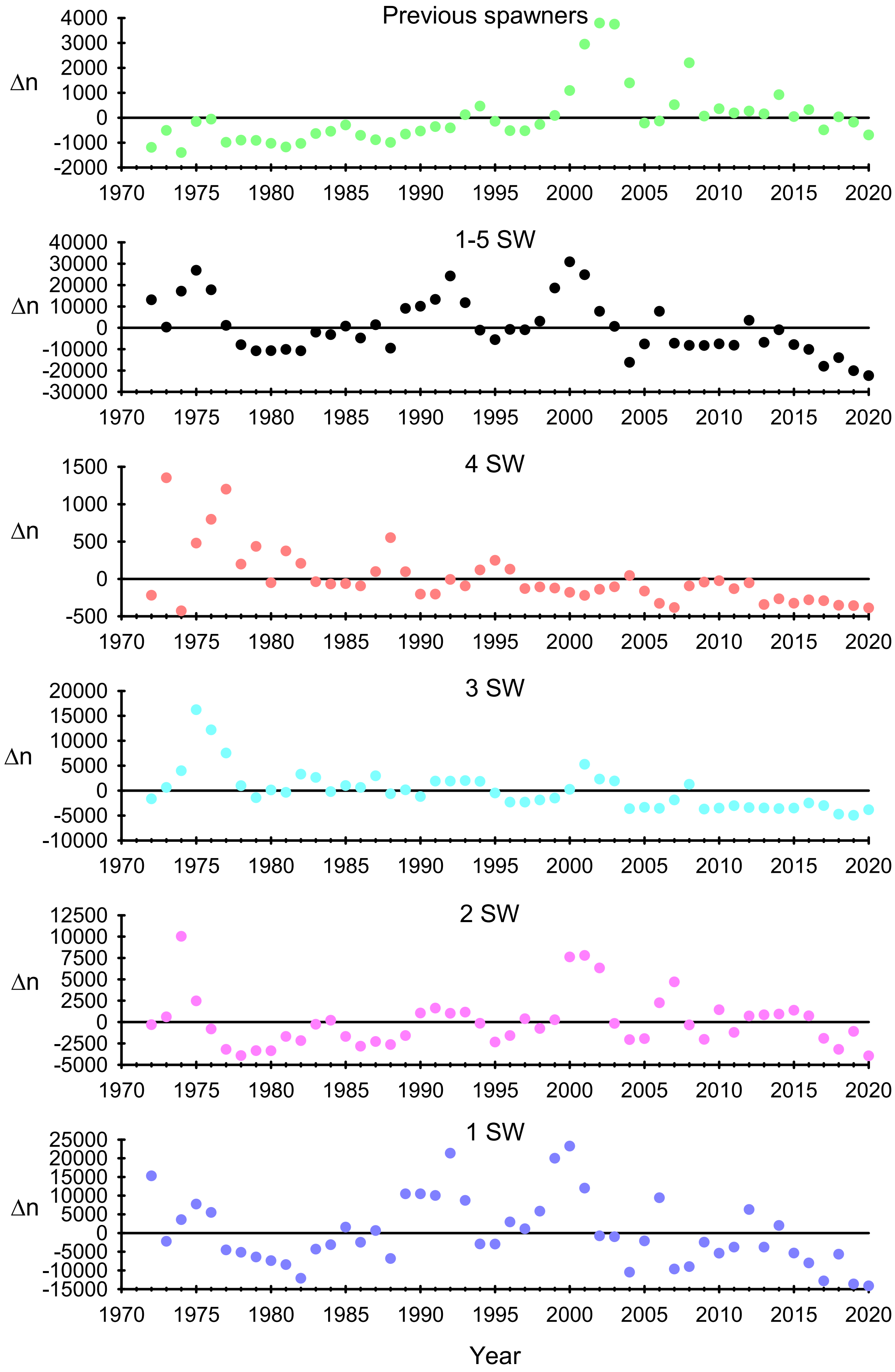

Figure 19. Annual deviations from the long-term mean numbers of salmon in the catches in the years 1972-2020 for 1SW, 2SW, 3SW, 4SW, 1SW-5SW, first time spawner and for previous spawner salmon in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

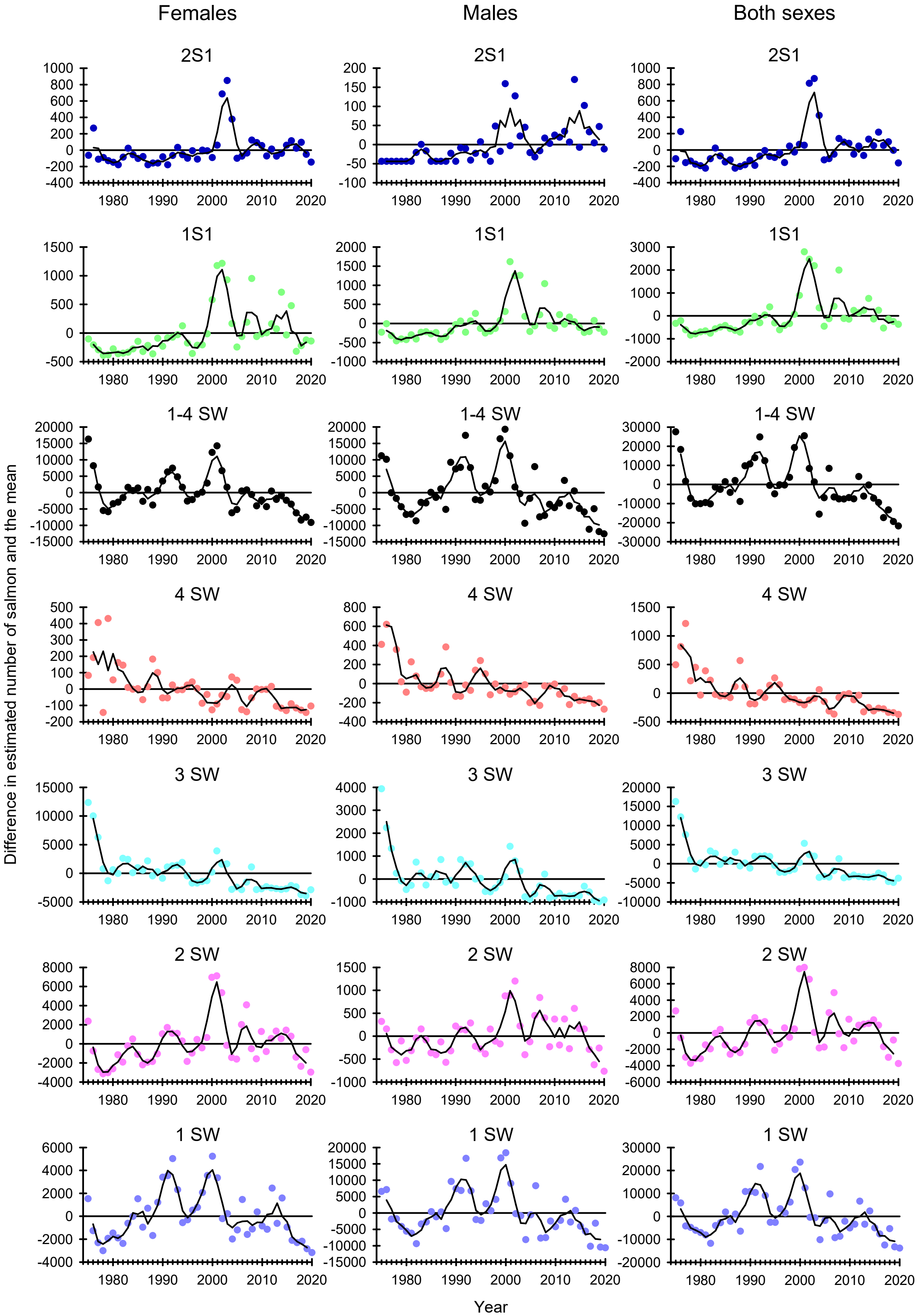

Figure 20. Annual deviations from the long-term mean numbers of salmon in the catches in the years 1975-2020 for female and male 1SW, 2SW, 3SW, 4SW, 1SW-4SW first time spawner and for previous spawner 1S1 and 2S1 salmon in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

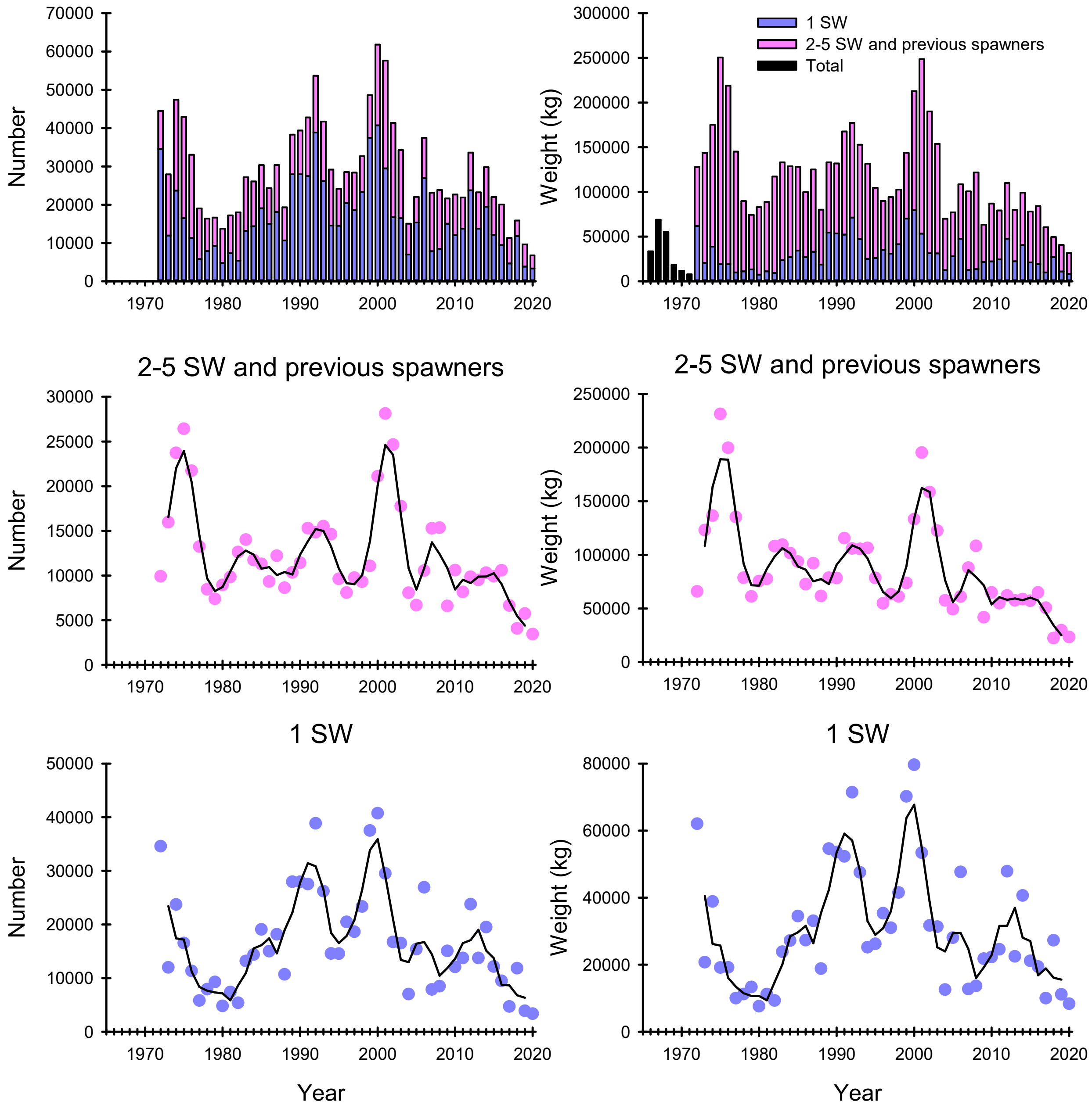

Figure 21. Annual salmon catches in numbers and weights for 1SW and multi-sea-winter salmon (2-5SW+ previous spawner salmon) in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

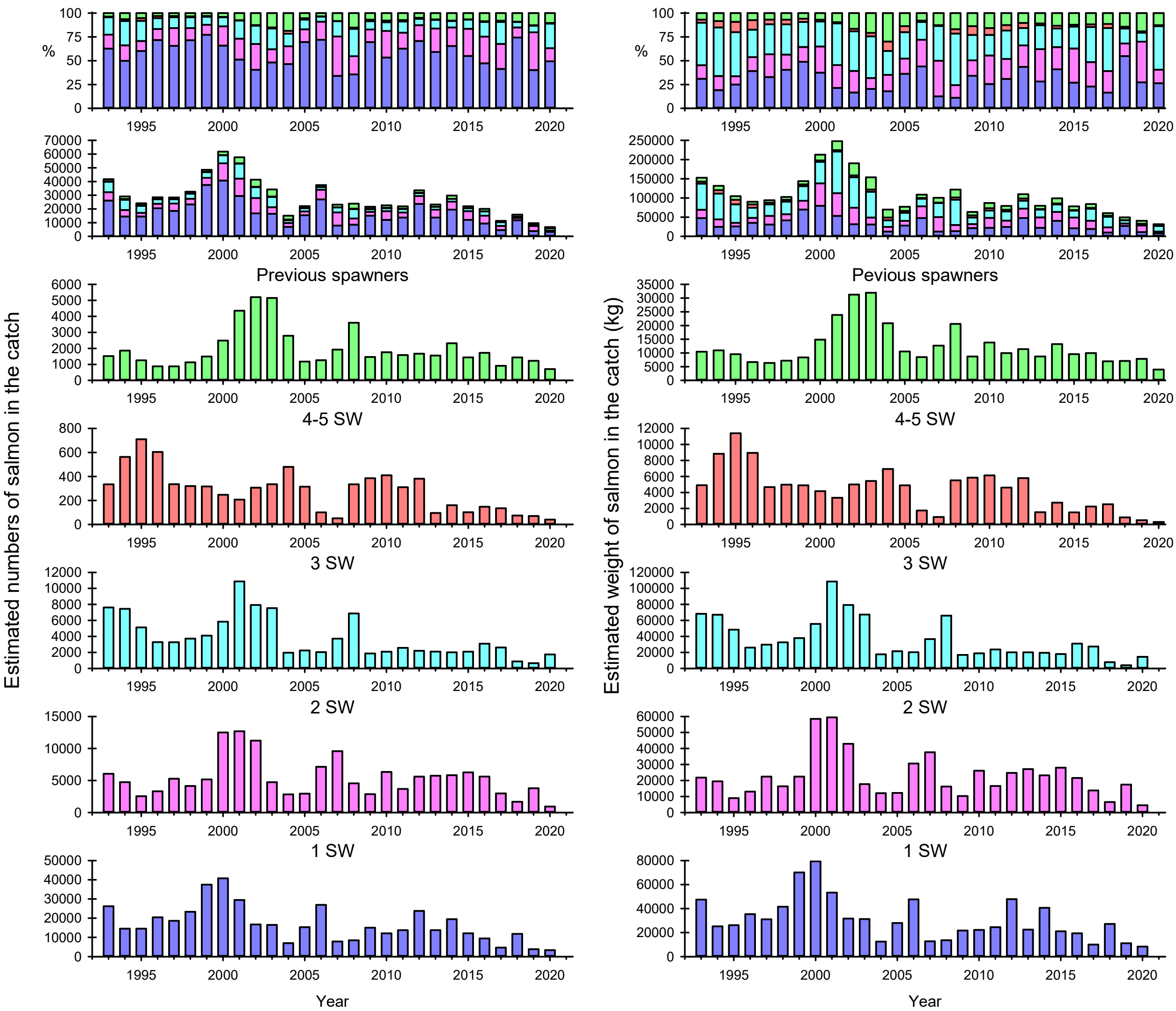

Figure 22. Annual salmon catches in numbers (figure on the left) and in weights (figure on the right) with annual sea-age distributions for 1SW, 2SW, 3SW and 4SW-5SW and previous spawner fish in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

Salmon fishery had new management measures in the River Tana early in 1990’s together with the total moratorium of driftnet fishery at sea in Northern Norway in the end of 1980’s. It was expected that the spawning stocks should increase after these remarkable fishing restrictions, at least in the following salmon generations. Figure 22 shows the catch developments after new major management measures at sea and in the River Tana watershed. Reasons for the improved 1SW, 2SW, 3SW and 4SW salmon catches in the years 1999-2004 can be diverse, affected by improved management measures at sea and in the River Tana watershed combined with better survival of post smolts at sea, increased sea temperatures in the feeding grounds of salmon, resulting in increased food available for salmon.

4. Annual variations in the sea-age distributions in the tributary rivers and in the River Tana mainstream in Norway and Finland

In the River Tana watershed, the sea-age groups of the first time spawners 1SW, 2SW, 3SW, 4SW and of the previous spawners 1S1, 2S1 and 3S1 are occurring every year in the catches. The oldest first time spawner salmon (5SW) is quite seldom found in the scale samplings but, it will most likely occur in the spawning stock in the River Tana mainstream. Salmon with the sea ages 1SW and 2SW is occurring in all salmon stocks within the River Tana watershed together with previous spawner 1S1 salmon (Fig. 23).

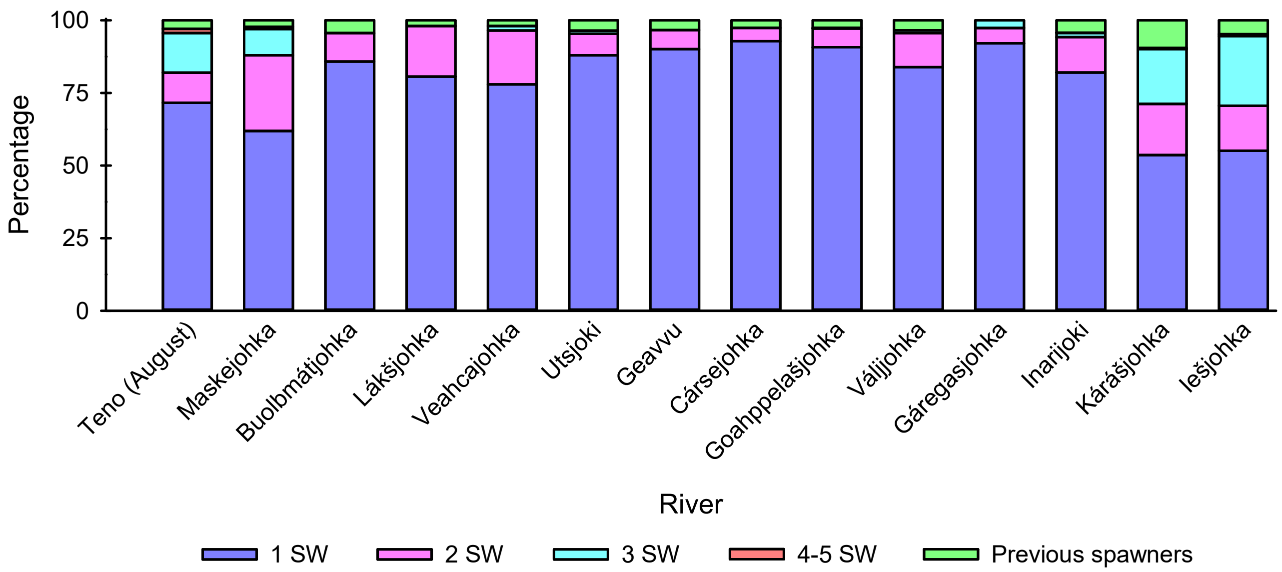

Figure 23. Sea-age distributions for salmon stocks in the River Tana watershed. Material is collected in the years 1972-2016. Source: Luke (Finland),TF organization (Norway).

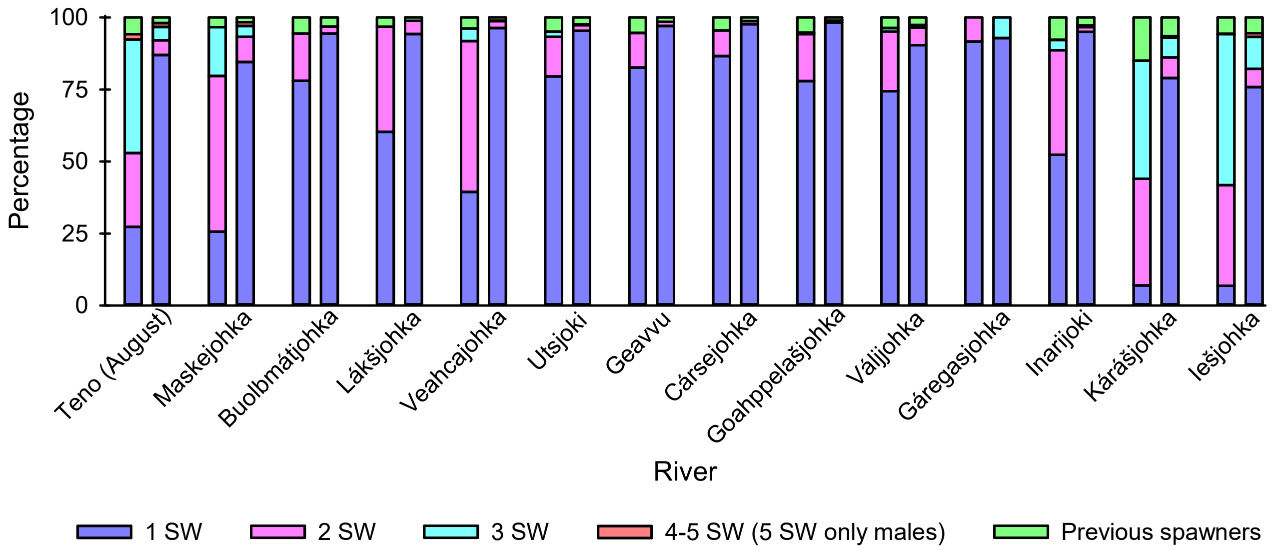

Figure 24. Sea-age distributions for female (bars on the left) and male (bars on the right) salmon stocks in the River Tana watershed. Material is collected in the years 1972-2016. Source: Luke (Finland),TF organization (Norway).

In all genetically diverse salmon stocks in the River Tana watershed, the proportions of 1SW males are exceeding the proportions of other sea-age groups compared to sea-age distributions in female salmon (Fig. 24).

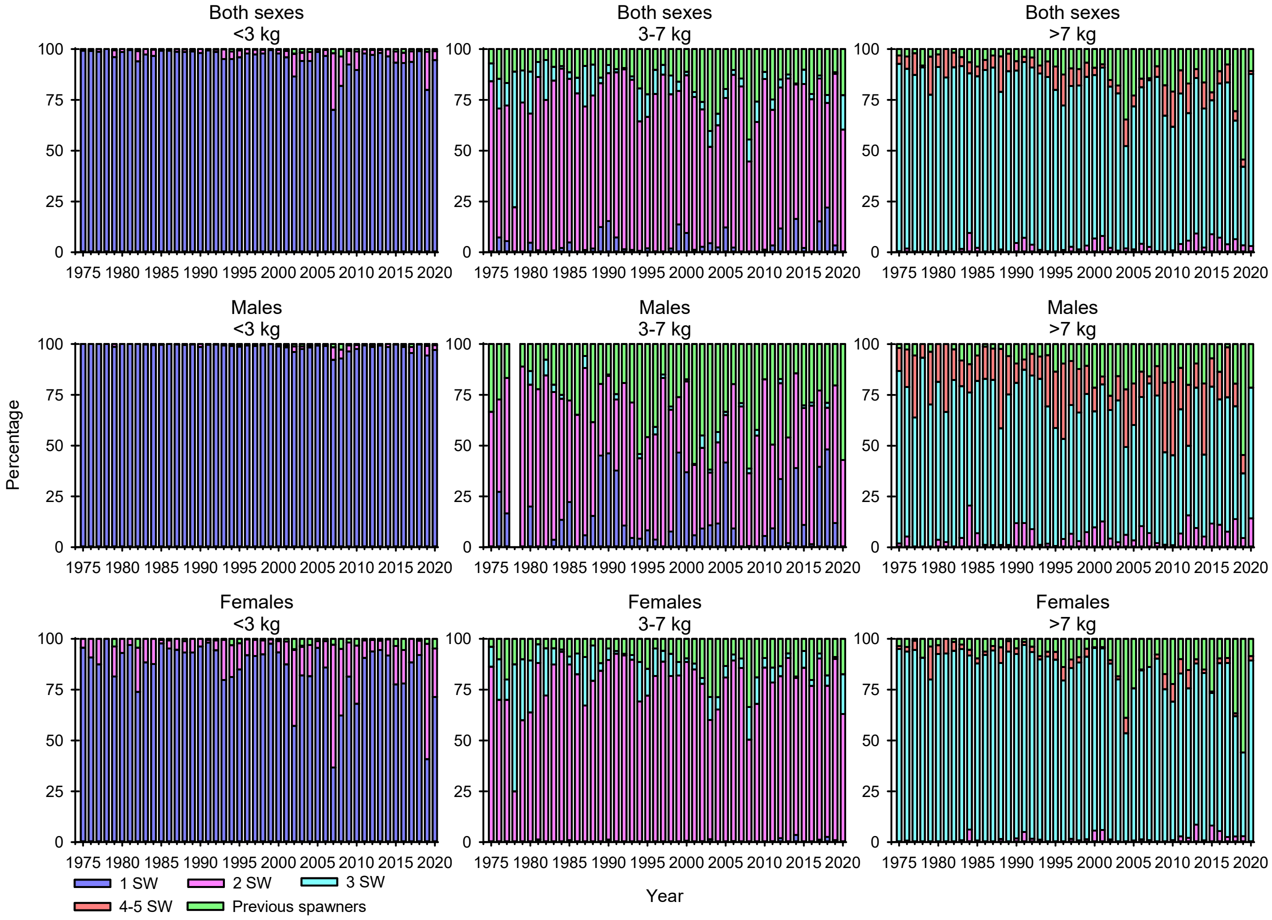

Figure 25. Proportions of 1SW, 2SW, 3SW, 4SW-5SW salmon and previous spawner salmon in three size groups of salmon in the River Tana in the Finnish catches. Catch data is from the numbers of salmon. Catch data from the years 2018-2020 is from the River Tana in the Norwegian catches. Source: Luke (Finland),TF organization (Norway).

In catch reporting in Norway, fishermen have to inform about their daily catches devided into three size groups (<3 kg, 3-7 kg, >7 kg). This size classification does not explain the annual changes in the salmon ecology. Figures 25 and 26 clearly show that each size group includes more than three sea-age groups when various age groups from previous spawners are included.

It is noteworthy to observe that for example previous spawners have made up more than 50% from the weight of 2SW male salmon catches in many years. Also previous spawners have made important contribution in the catches for salmon larger than 7 kilos (Fig. 26).

Figures 27-31 are illustrating annual variations of the sea-age groups in the norwegian catches in terms of numbers and weights in the River Tana watershed, on the Finnish side of the River Tana watershed and separately in the tributaries on the Finnish side.

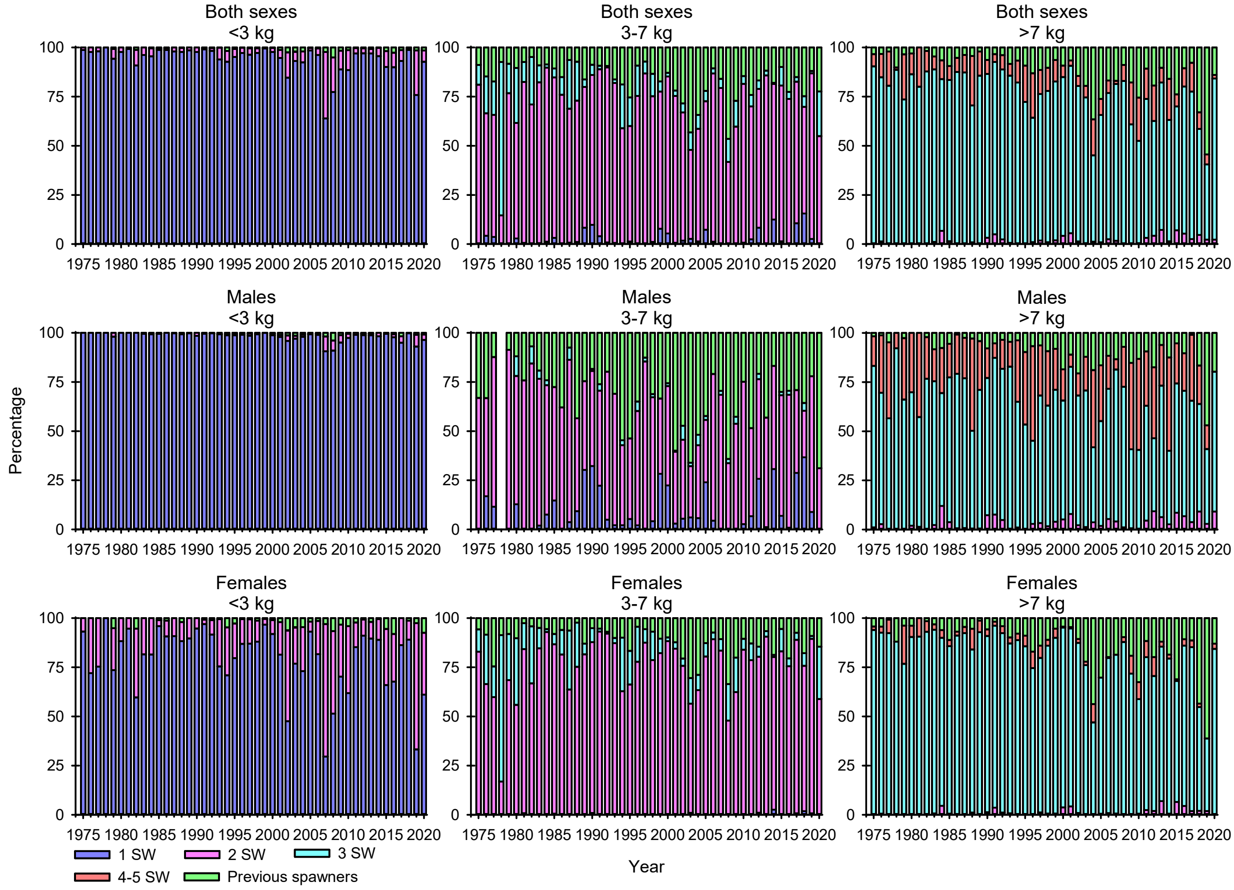

Figure 26. Proportions of 1SW, 2SW, 3SW, 4SW-5SW salmon and previous spawner salmon in three size groups of salmon in the River Tana in the Finnish catches. Catch data is from the weights of salmon. Catch data from the years 2018-2020 is from the River Tana in the Norwegian catches. Source: Luke (Finland),TF organization (Norway).

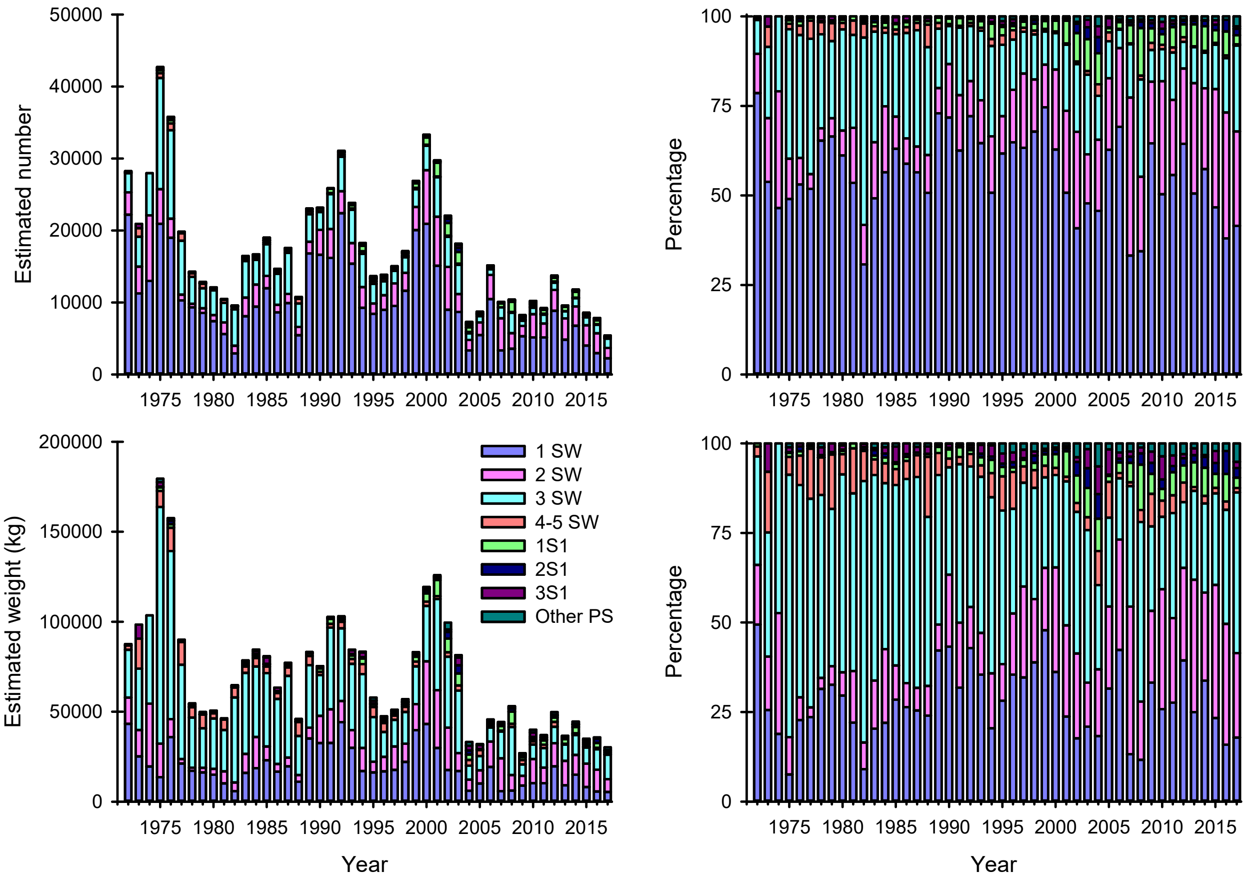

Figure 27. Annual proportions of 1SW, 2SW, 3SW, 4SW-5SW salmon and 1S1, 2S1, 3S1 previous spawner salmon and other previous spawner salmon groups in the catches for weights and numbers in Norway in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

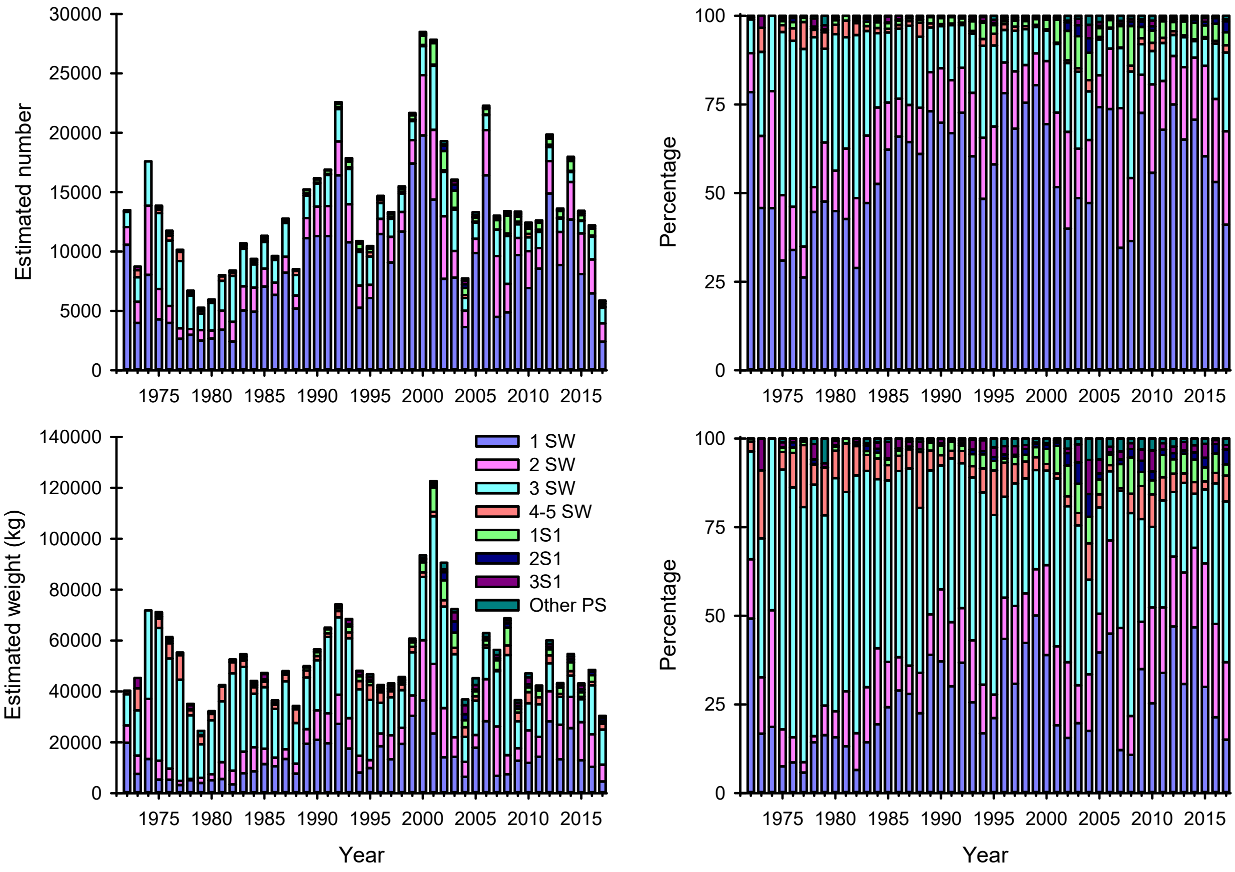

Figure 28. Annual proportions of 1SW, 2SW, 3SW, 4SW-5SW salmon and 1S1, 2S1, 3S1 previous spawner salmon and other previous spawner salmon groups in the catches for weights and numbers in Finland in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

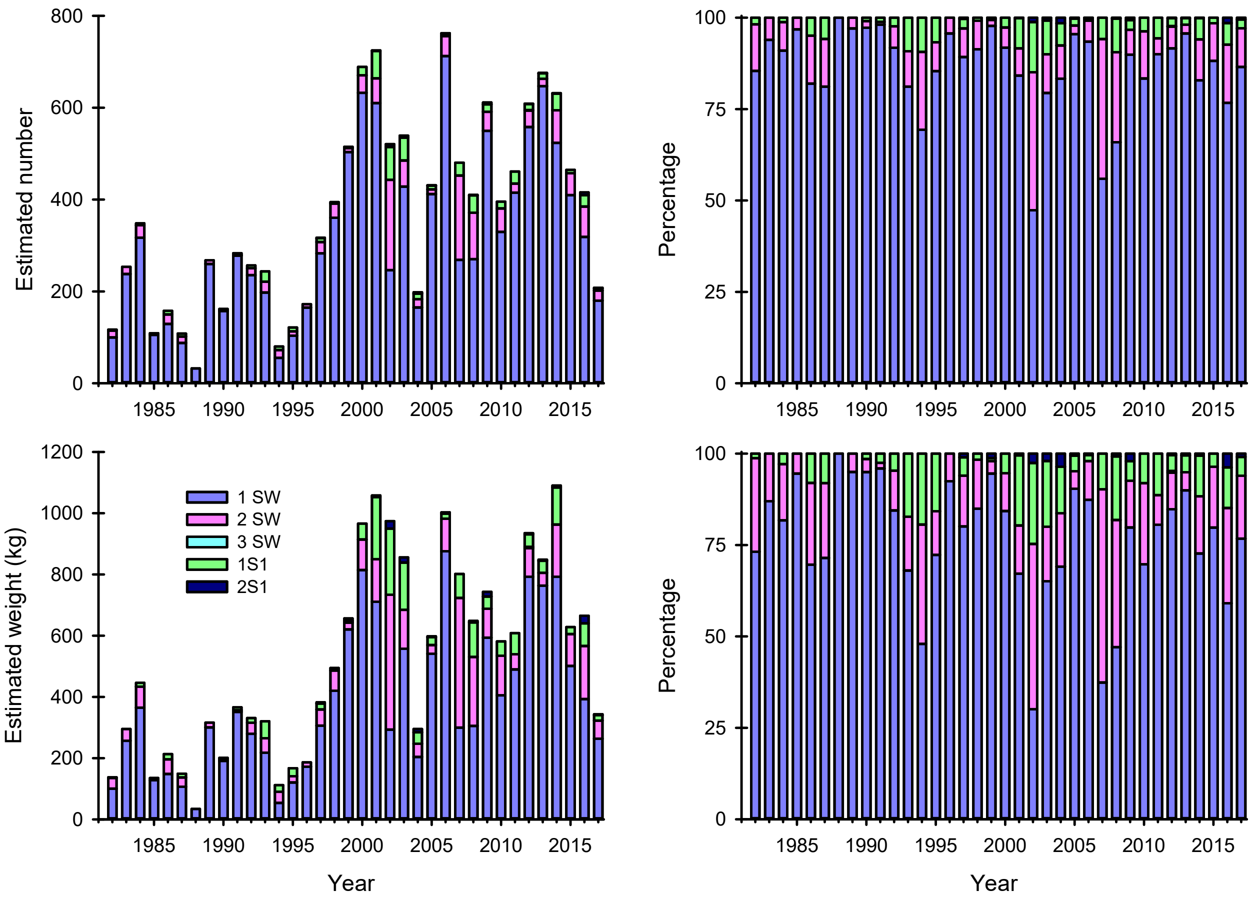

Figure 29. Annual proportions of 1SW, 2SWand 3SW salmon and 1S1and 2S1 previous spawner salmon in the catches for weights and numbers in Finland in the River Buolbmatjohka. Source: Luke (Finland),TF organization (Norway).

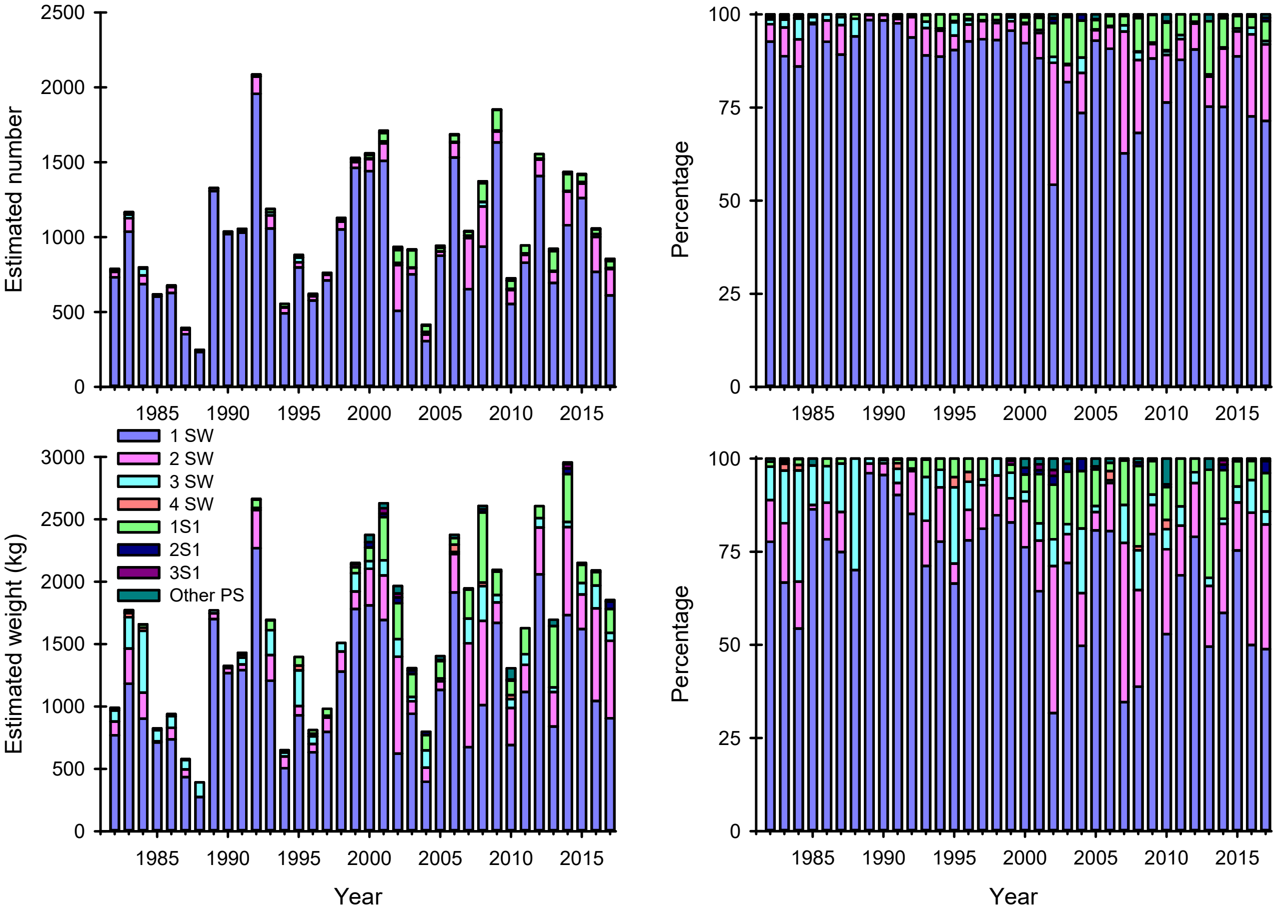

Figure 30. Annual proportions of 1SW, 2SW, 3SW and 4SW salmon and 1S1, 2S1, 3S1 previous spawner salmon and other previous spawner salmon groups in the catches for weights and numbers in Finland in the River Utsjoki. Source: Luke (Finland),TF organization (Norway).

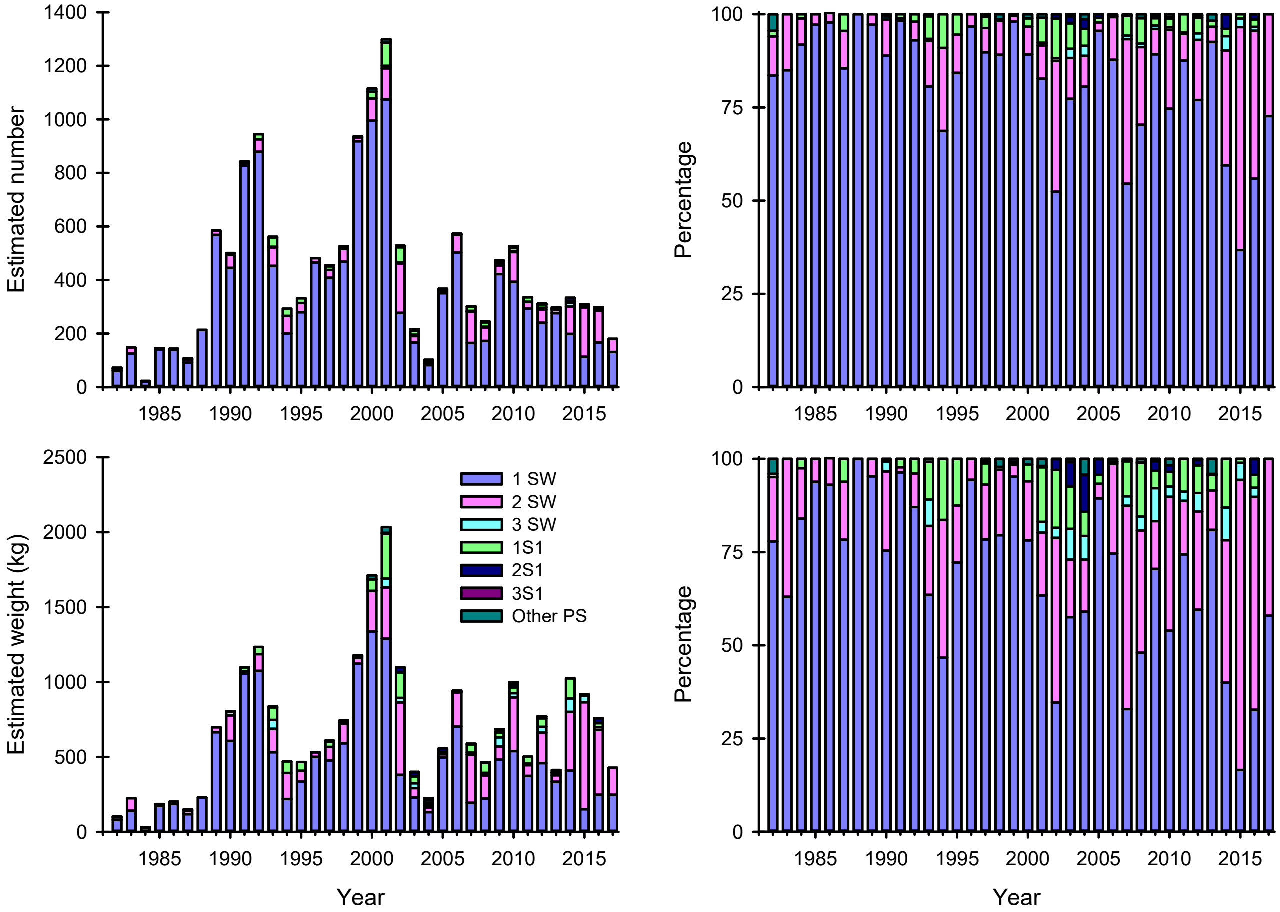

Figure 31. Annual proportions of 1SW, 2SW and 3SW salmon and 1S1, 2S1, 3S1 previous spawner salmon and other previous spawner salmon groups in the catches for weights and numbers in Finland in the rivers Vetsijoki, Kuoppilasjoki, Akujoki and Karigasjoki. Source: Luke (Finland),TF organization (Norway).

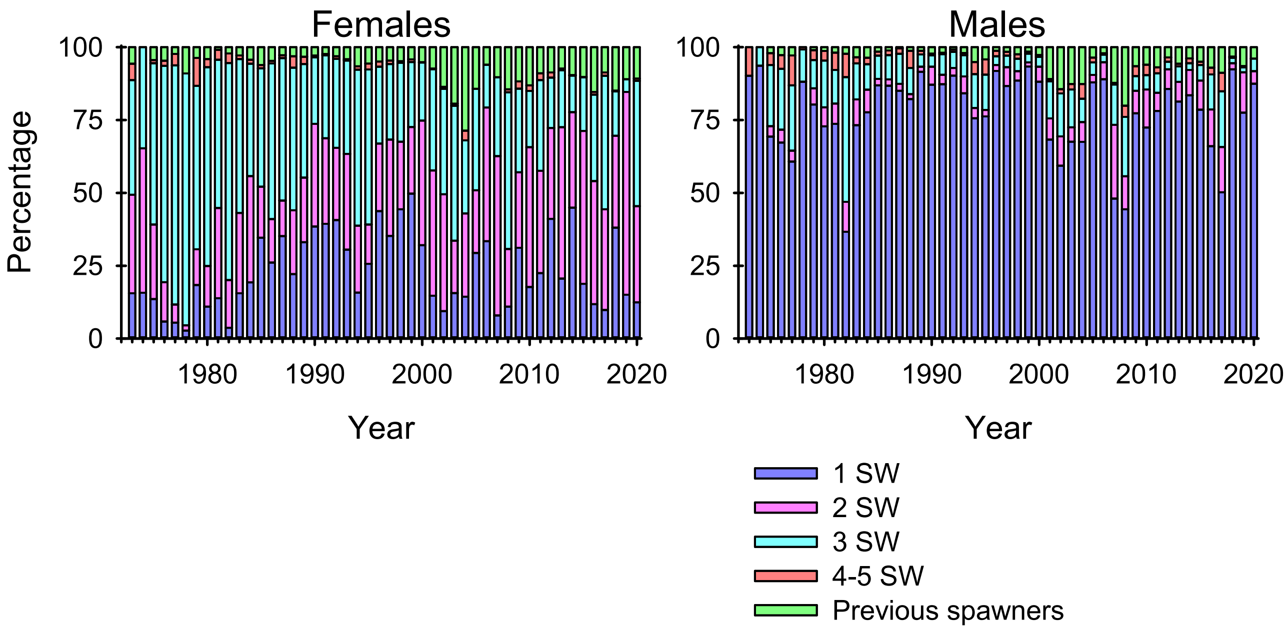

Figure 32. Long-term changes in sea-age distributions for female and male salmon caught on the Finnish side in the River Tana mainstream. Sea-age distributions indicate changes in the numbers of salmon. Salmon scale material and sea-age distributions in the years 2018-2020 are from Norway. Source: Luke (Finland),TF organization (Norway).

Sea-age distributions in the River Tana mainstream are indicating significant differences between the years and especially in female salmon (Fig. 32). In males, annual differences in sea-age distributions are not as remarkable as in females. In female salmon catches, the proportions of 3SW salmon have had significant decline over the years. In long-term, the mean proportion of 3SW females in the River Tana mainstream in female salmon catches has been 42%, out from the first time female spawners and in the recent years it has clearly continued to diminish (Fig. 33).

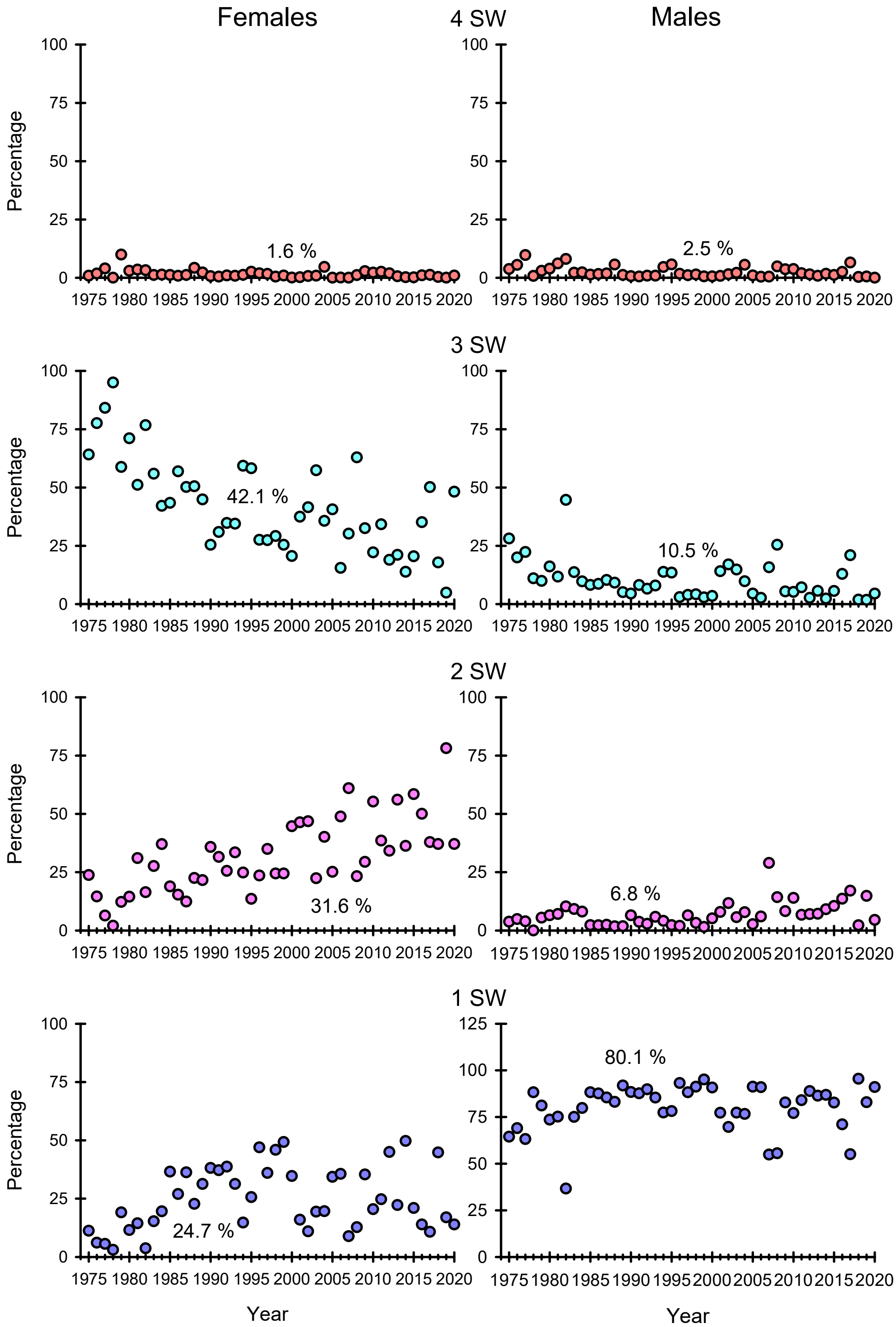

Figure 33. Proportions and mean percentages of first-time spawner 1SW, 2SW, 3SW and 4SW female and male salmon in the River Tana mainstem on the Finnish side. Salmon scale material and sea-age distributions in the years 2018-2020 are from Norway. Source: Luke (Finland),TF organization (Norway).

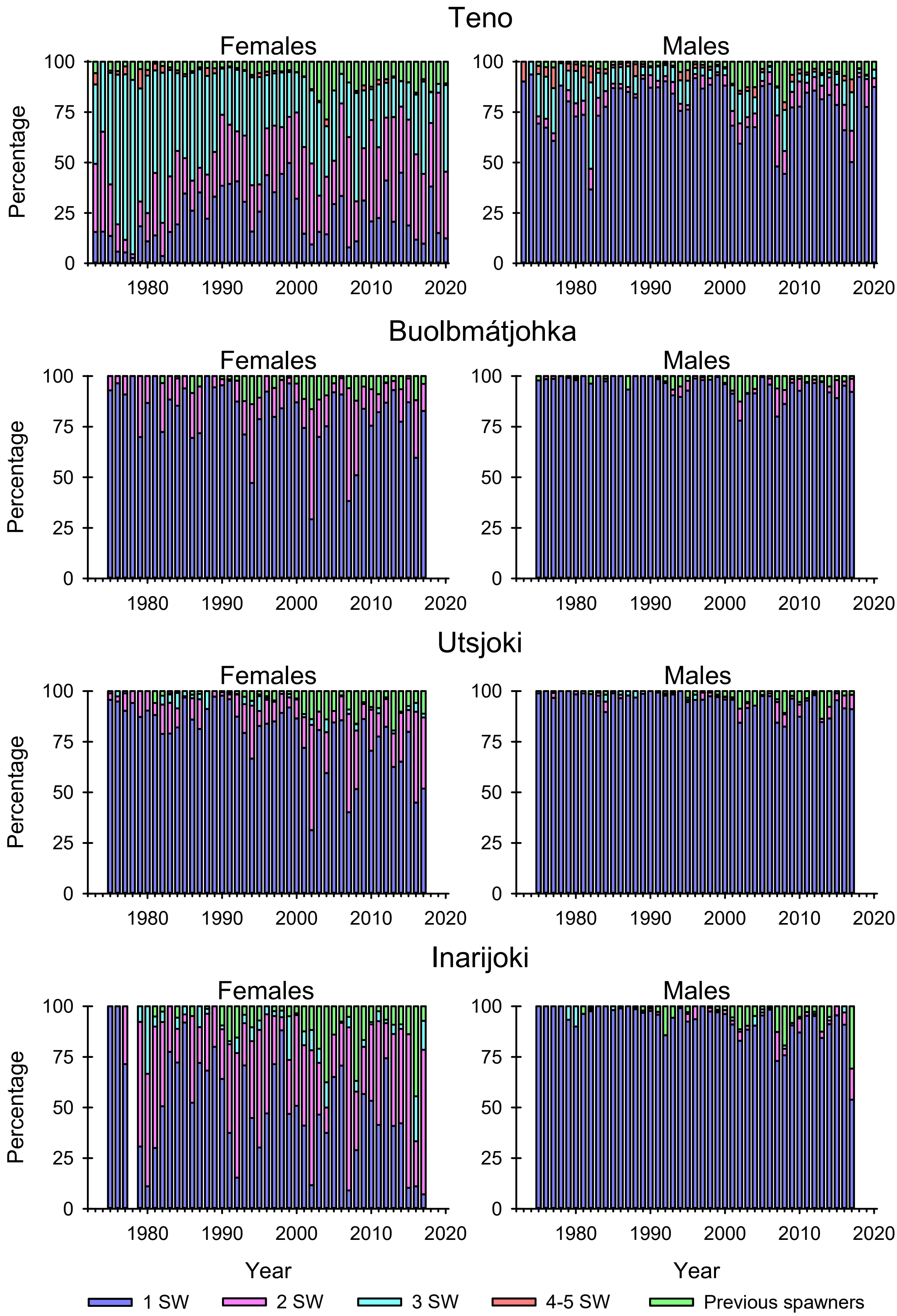

Figure 34. Long-term changes in the sea-age distributions for female and male salmon caught on the Finnish side in the River Tana mainstream and in the tributaries Buolbmatjohka, Utsjoki and Inarijoki. Sea-age distributions indicates changes in the numbers of salmon. Salmon scale material and sea-age distributions in the years 2018-2020 is from Norway. Source: Luke (Finland),TF organization (Norway).

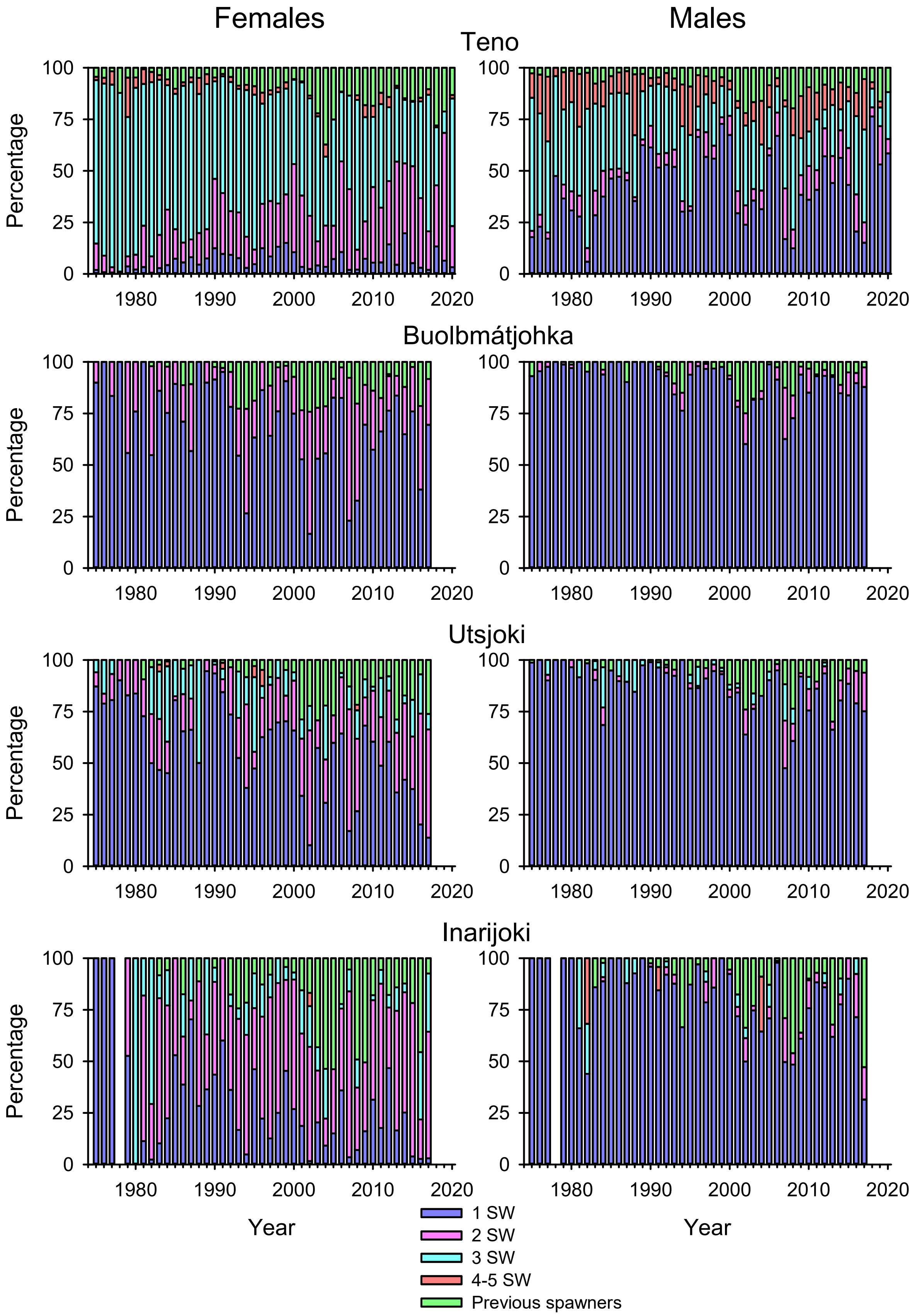

Figure 35. Long-term changes in the sea-age distributions for female and male salmon caught on the Finnish side in the River Tana mainstream and in the tributaries Buolbmatjohka, Utsjoki and Inarijoki. Sea-age distributions indicates changes in the weights of salmon. Salmon scale material and sea-age distributions in the years 2018-2020 is from Norway. Source: Luke (Finland),TF organization (Norway).

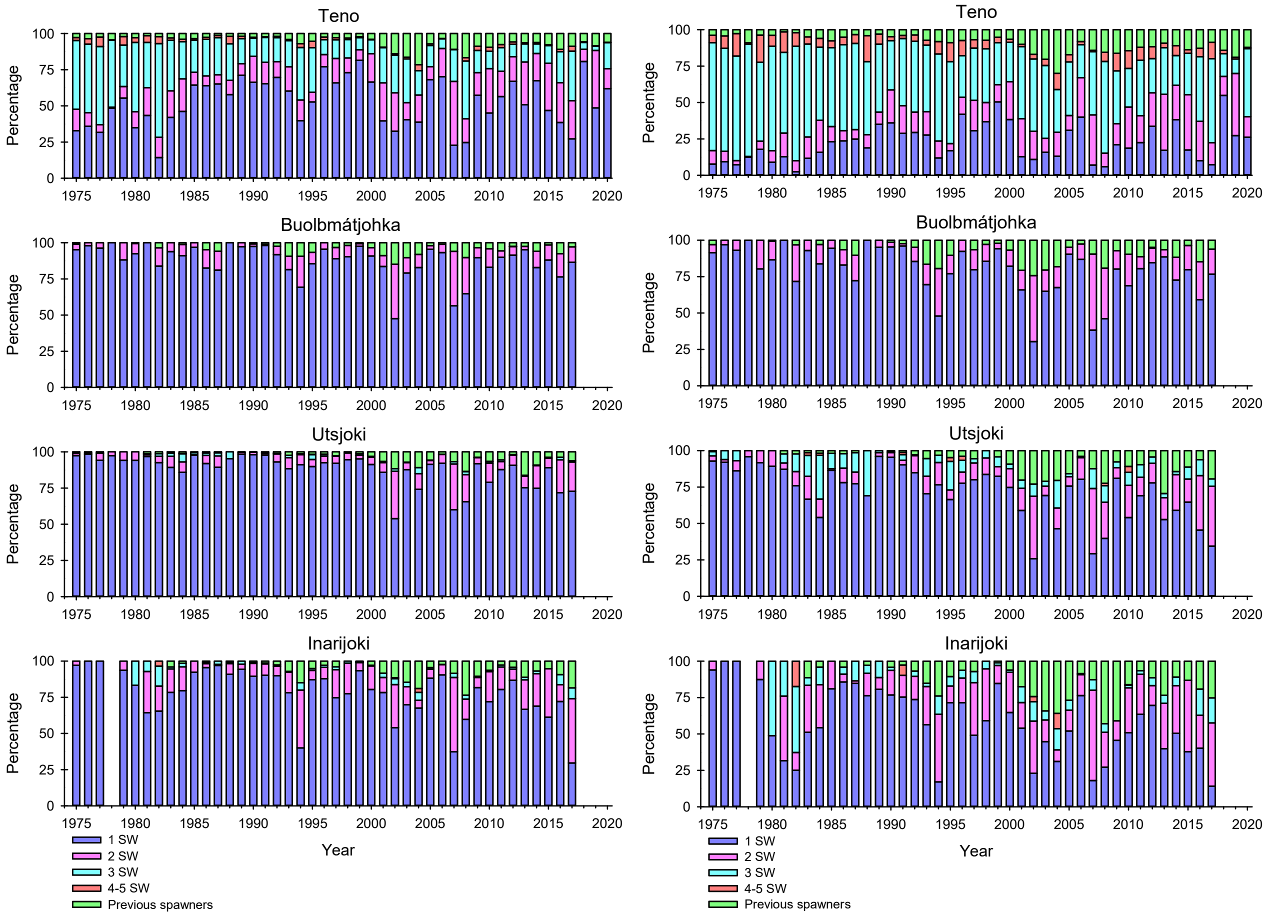

Figure 36. Long-term changes in the sea-age distributions for salmon, sexes combined, caught on the Finnish side in the River Tana mainstream and in the tributaries Buolbmatjohka, Utsjoki and Inarijoki. Number of salmon is on the left and weight of salmon is on the right. Salmon scale material and sea-age distributions in the years 2018-2020 are from Norway. Source: Luke (Finland),TF organization (Norway).

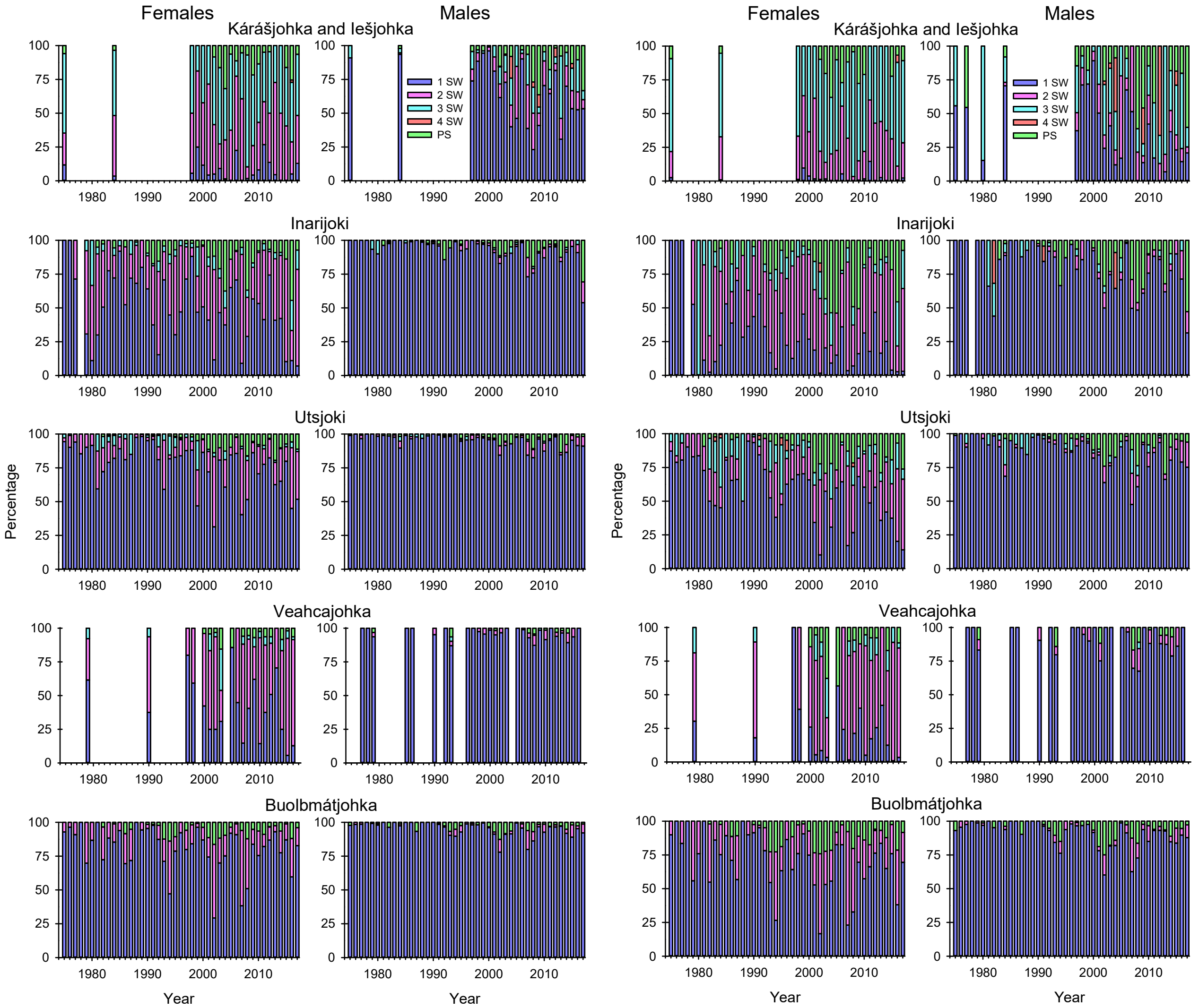

Figure 37. Long-term changes in the sea-age distributions for female and male salmon in the rivers Karasjohka/Iesjohka, Inarijoki, Utsjoki, Veahcajohka and Buolbmatjohka. Percentages from the numbers of salmon sea-ages are on the left and from the weight are on the right. Source: Luke (Finland),TF organization (Norway).

5. Salmon catches in Norway

Figure 38 shows the catch distributions and clear annual variations between rivers for small, medium and large sized salmon in Norway in the entire Tana watershed. The proportions in the numbers and weights of salmon in all size groups of salmon has increased in the border area in the River Tana mainstream. The main reason for that is the declining catch in the combined catches in the River Tana mainstream below the border area. From the total salmon catch caught outside the River Tana mainstream, it looks like it is more stabile than catches in the River Tana mainstream in terms of percentages. Catches outside the River Tana mainstream has contributed with maximum 25% from the total Tana watershed catches in Norway. From the large salmon catches caught outside Tana mainstream most have been caught in the rivers Karasjohka and Iesjohka, especially for large salmon. Catches in the year 2017 and after, have declined due to the general weakening of salmon stocks and due to the new salmon fishing restrictions introduced in the year 2017 in the River Tana watershed.

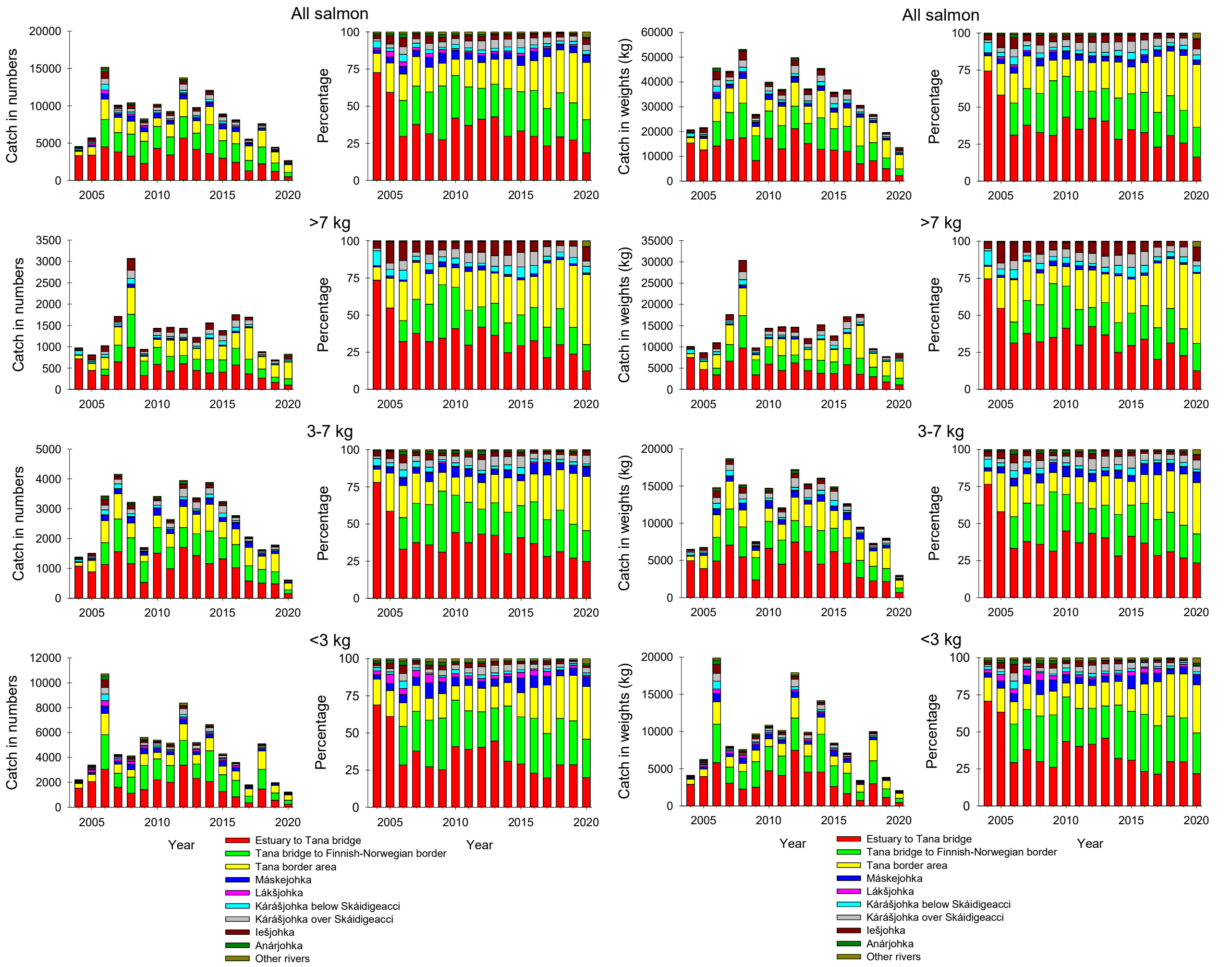

Figure 38. Long-term salmon catches in terms of numbers (figure on the left) and weights (figure on the right) for small, medium and large sized salmon in the River Tana watershed divided between fishing areas in Norway. Source: TF organization (Norway).

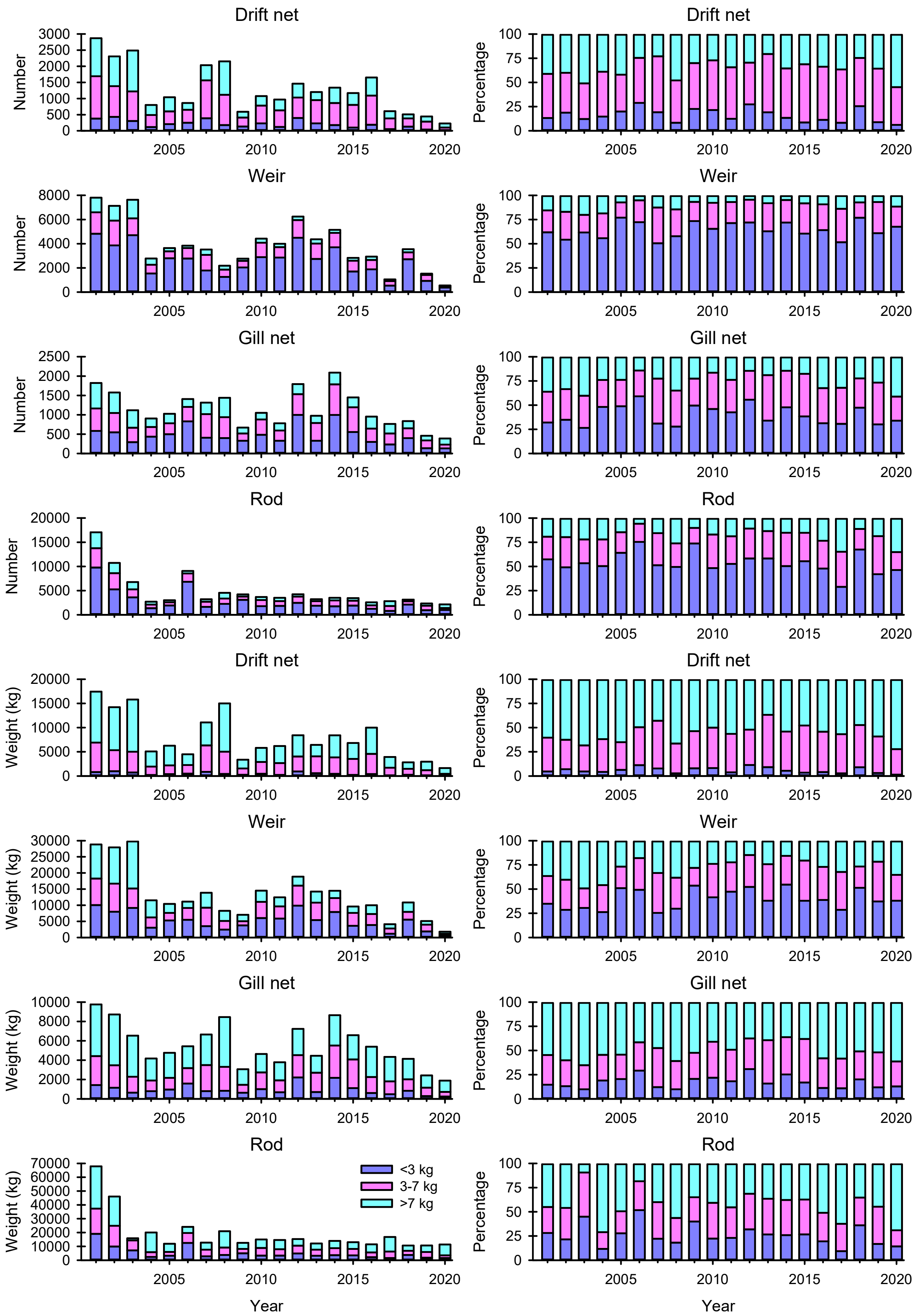

Figure 39. Long-term salmon catches for various fishing methods in terms of numbers, weights and percentages for small, medium and large sized salmon in the River Tana watershed in Norway. Source: TF organization (Norway), SSB.

In Norway, in the entire Tana watershed, total catches caught with traditional fishing methods have clear annual variations. Catches have annual variations also in the separate fishing methods. In the catches measured in weights and in percentages, large salmon (larger than 7 kilos) makes up approx. 75% in drift net catches and 30% in rod fishing catches (Fig. 39).

Figures 40 and 41 are indicating that catches, in terms of weights and numbers, for small, medium and large sized salmon, have clearly noticeable annual variations in the fishery of drift net, weir, gillnet and rod between the years 2001-2020. In 2017, rod fishery catches made up more than 50% of the total catches measured in weight and that was true in all size groups of salmon. The proportions of tourist fishery catches with rod increased significantly after the new fishing restrictions in the year 2017. The decline in catches, in terms of weights and precentages, in net fishing methods, can be explained by the introduction of new restrictions in the fishery.

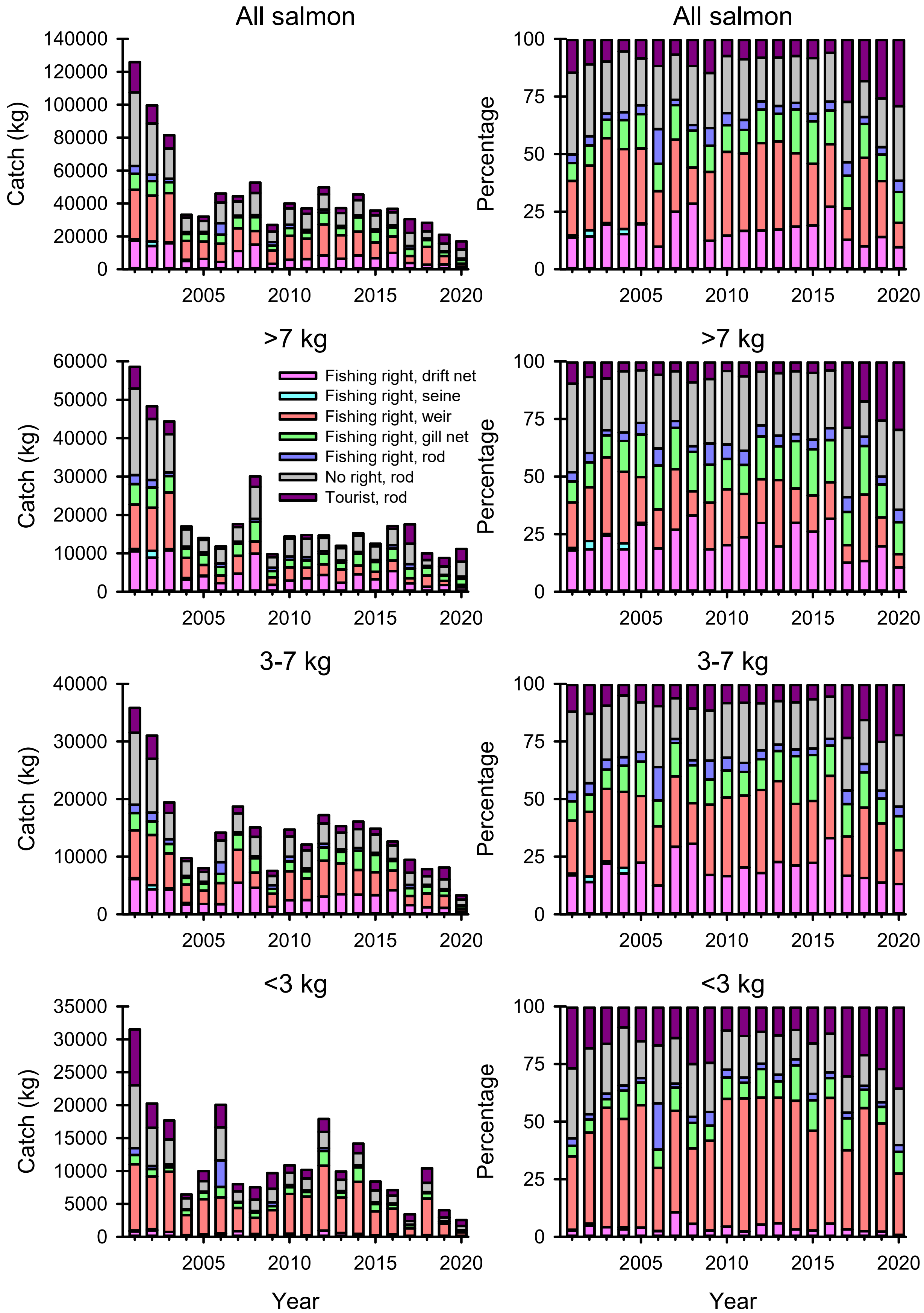

Figure 40. Long-term salmon catches in terms of weights of salmon and percentages for various fishing methods caught by local fishermen with and without fishing rights and by tourist fishers. Catches are for small, medium and large sized salmon in the River Tana watershed in Norway. Source: TF organization (Norway), SSB.

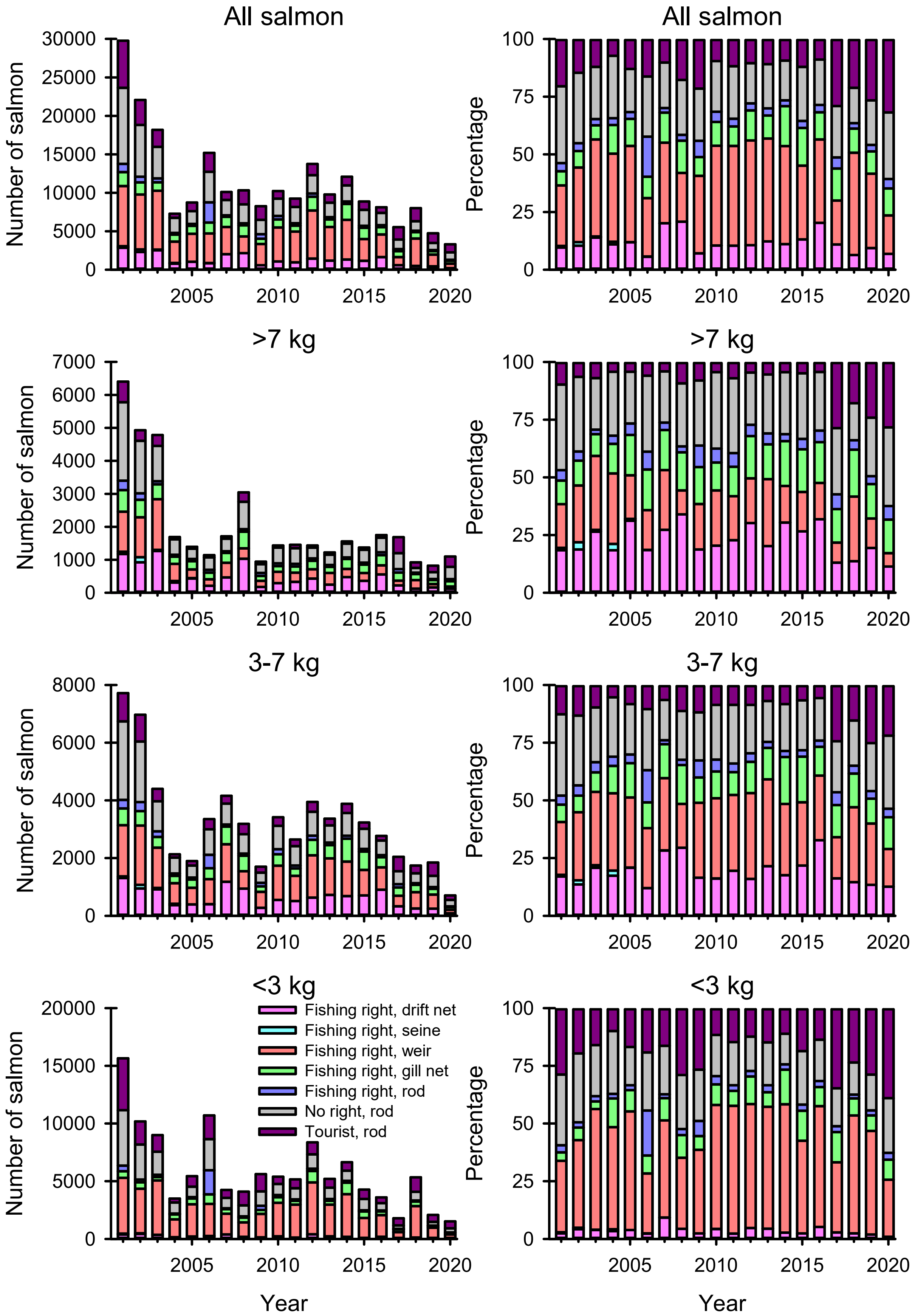

Figure 41. Long-term salmon catches in terms of numbers of salmon and percentages for various fishing methods caught by local fishermen with and without fishing rights and by tourist fishers. Catches are for small, medium and large sized salmon in the River Tana watershed in Norway. Source: TF organization (Norway), SSB.

6. Salmon catches in Finland

In the salmon catches in the rivers Tana and Inarijoki, clear and regular annual catch fluctuations can be observed. These annual fluctuations are obvious and simultaneous in all separate areas (Nuorgam, Vetsikko, Utsjoki, Outakoski, Inarijoki) in the border river. These simultaneous fluctuations are indicating that salmon stocks have been better, even during the years of increased the fishing efforts, in all the geograhpical and administrative areas mentioned. Peaks in salmon catches have been occurring in steady time intervals. The first clear and historically high peak took place in the River Tana watershed in the years 1974-1976 (see figs.1, 3, 6, 8, 10, 11). In the Finnish catches, the size of peaks, in terms of weight, has increased peak after peak (Fig. 42), ending with the largest peak catches in the years 2000-2002. After the latest peak in the years 2000-2002, a normal peak was expected in the years 2006-2008, but it did not happen. The expected peak in 2006-2008 was based on the assumption that the preceding extra high peak in the years 2000-2002, with high numbers of spawners, should result in similar peaks in the following years. Instead of having any peaks in the latest decades, salmon catches have declined alarmingly in the entire Tana watershed.

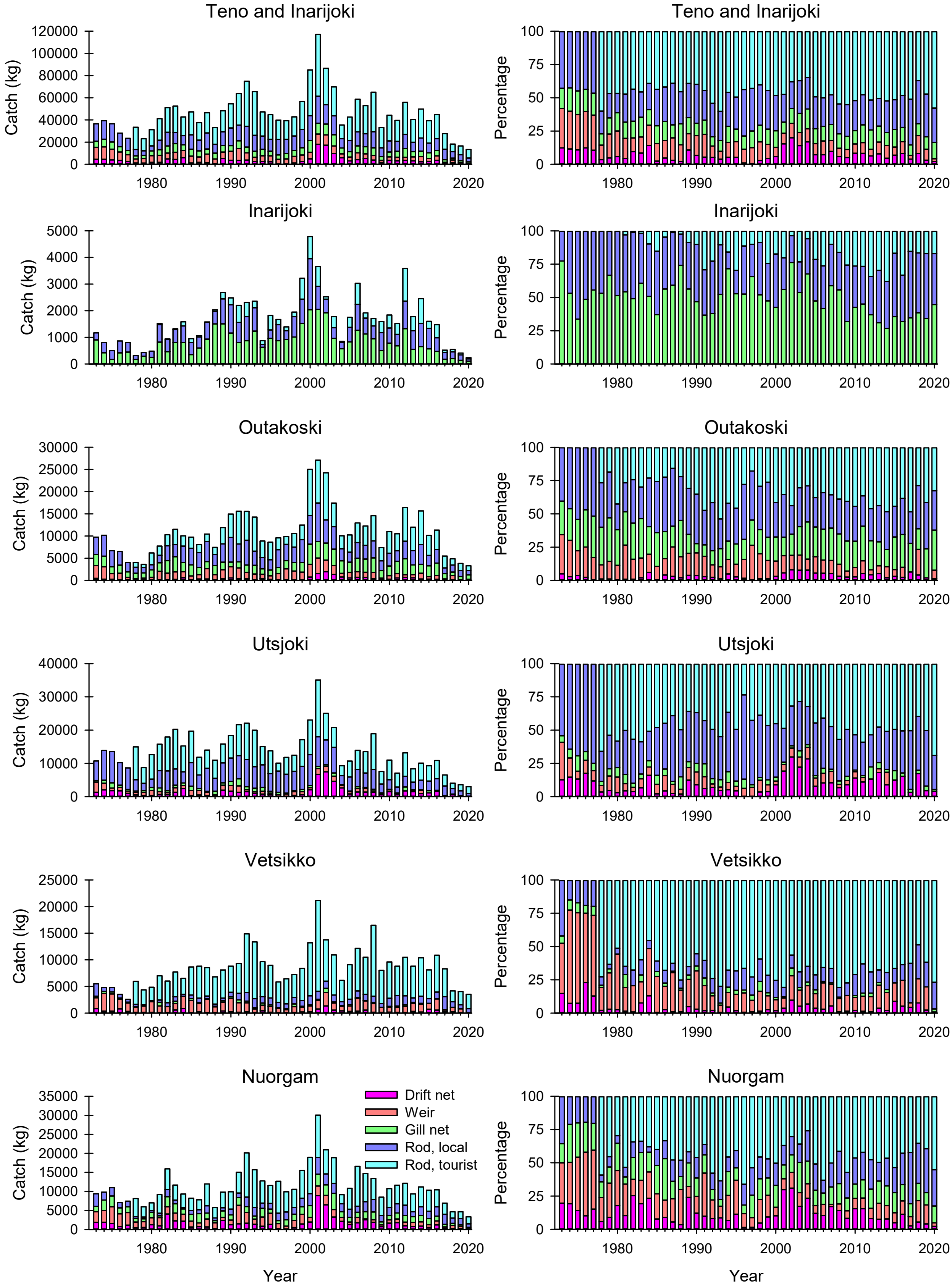

Figure 42. Annual salmon catches In Finland in weights and proportions divided between fishing methods and for tourists in rod fishing in the River Tana mainstream and in the River Inarijoki in Finland. Areas Nuorgam, Vetsikko, Utsjoki and Outakoski are local fishing organizations and their water areas. The figure does not include catches in the tributary rivers. Source: Luke (Finland).

7. Tourist fishery and catches in the rivers Tana and Inarijoki in Finnland

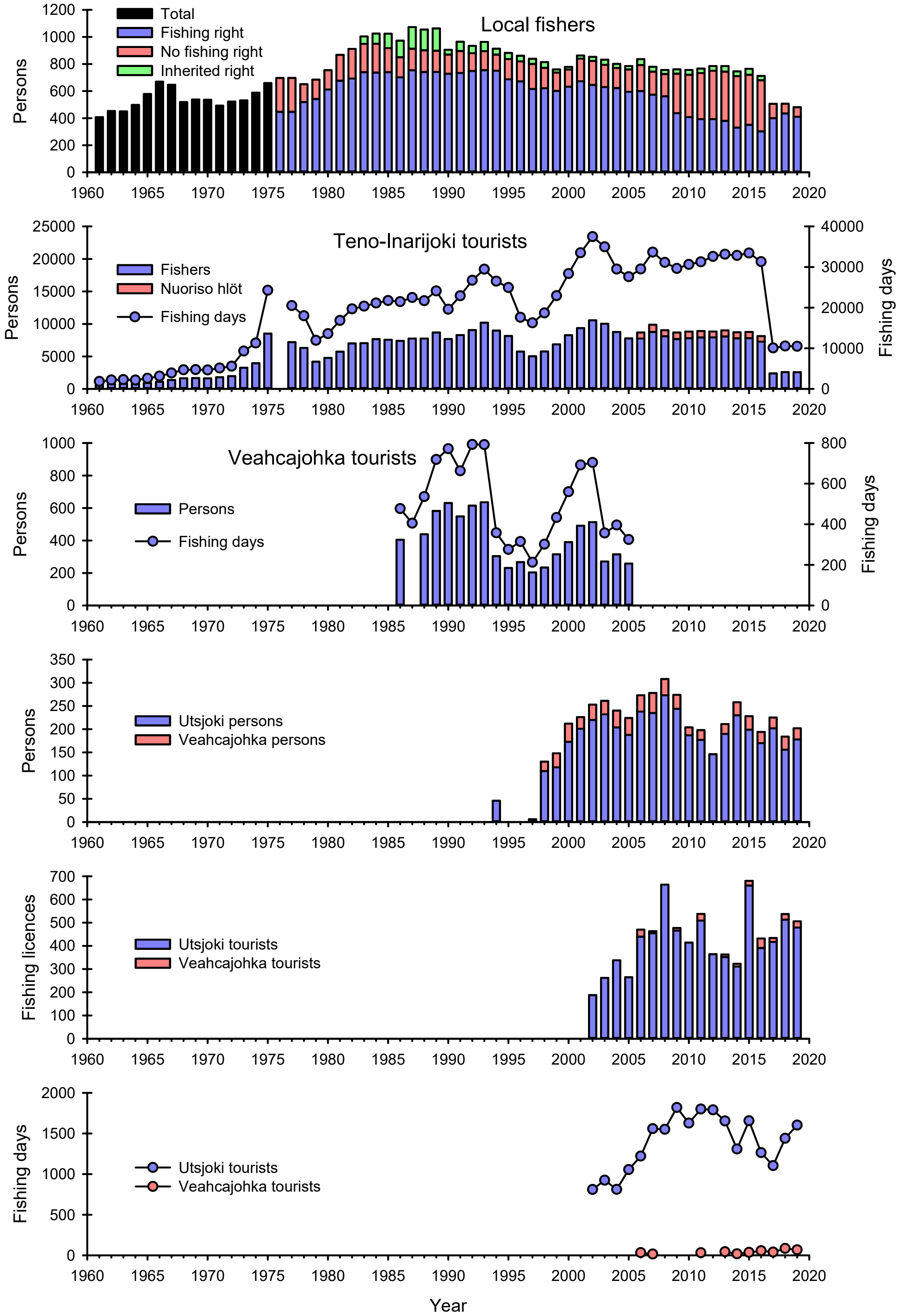

Figure 43. Fishing efforts in terms of numbers of persons, numbers of fishing days, numbers of fishing licenses on the Finnish side of the River Tana watershed. Source: Luke (Finland).

Fishing effort and annual changes in it, can be measured in terms of numbers of fishers and in days of fishing. In Finland, within the River Tana watershed, the highest numbers of local fishers took place in 1980's. From the early 1990's the numbers of local persons have declined steadily and especially since 2017, when the new Tana fishing agreement was implemented. After that, the numbers of persons without fishing right dropped, at least in statistics (Fig. 43).

Tourist fishery on the Finnish side of the River Tana, was initiated after the road was built in the middle of the 1950's, a road that connected the Utsjoki village in Tana river valley to Lapland county. Early in the 1960's, some hundreds of tourist fishing licenses was sold per year. The first real peak in the salmon stocks in the River Tana watershed in the year 1975-1976, caused the invasion of Finnish tourist fishers to Tana river valley. The number of salmon fishers in the River Tana mainstream during those years exceeded 8000-9000 persons. In the following years, the numbers of Finnish salmon fishing tourists slightly increased, reaching the highest numbers in 2002 with appr. 11 500 persons and with 25 000 fishing days (Fig. 43) in the rivers Tana and Inarijoki together.

Tourist fishermen have caught appr. 50% of the reported total salmon catches on the Finnish side in the River Tana watershed, in the last four decades (Fig. 44). There have been only minor annual changes in the proportions of salmon caught by local fishers and tourists, although some restrictions have been introduced into the tourist fishery. In the tributary rivers Veahcajohka and Utsjoki, the so-called tourist fishery has increased and in many years their catch proportions have made up the majority of the total reported catches, especially in the River Veahcajohka and in some years also in the River Utsjoki.

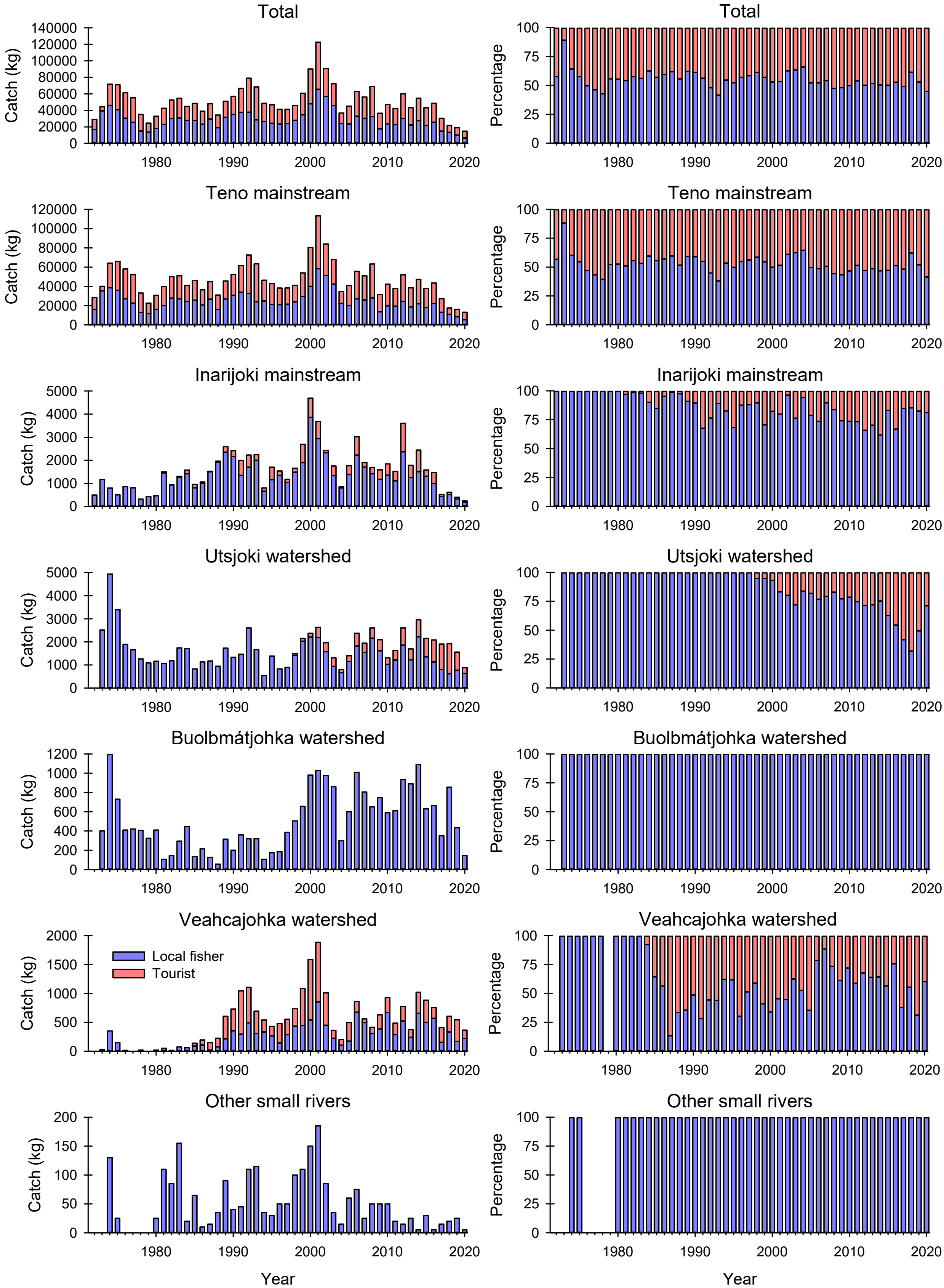

Figure 44. Annual salmon catches in weights and proportions for local fishers and tourist fishers in Finland. Teno mainstream and Inarijoki mainstream are including catches from local and tourist fishers. Areas Utsjoki watershed, Buolbmatjohka watershed, Veahcajohka watershed and other small rivers are including catches of local fishers and tourist fishers in these tributaries. Source: Luke (Finland).

Figures 46-49 are showing in details the annual catches caught by tourist fishers in the border river Tana-Inarijoki in Finland. The figures are showing long-term annual fluctuations and developments in the numbers and weights of female and male salmon in 1SW, 2SW, 3SW, 4-5SW and previous spawning salmon in the catches. Tourist catches are also indicating clear repeated peaks in the catches, like the fluctuations in the local catches. The proportions of salmon larger than 7 kilos and the sea-age of 3SW salmon have significantly declined from the year 1975 to the year 2017. That indicates the disappearence of the most reproductive female salmon stocks in the entire Tana watershed.

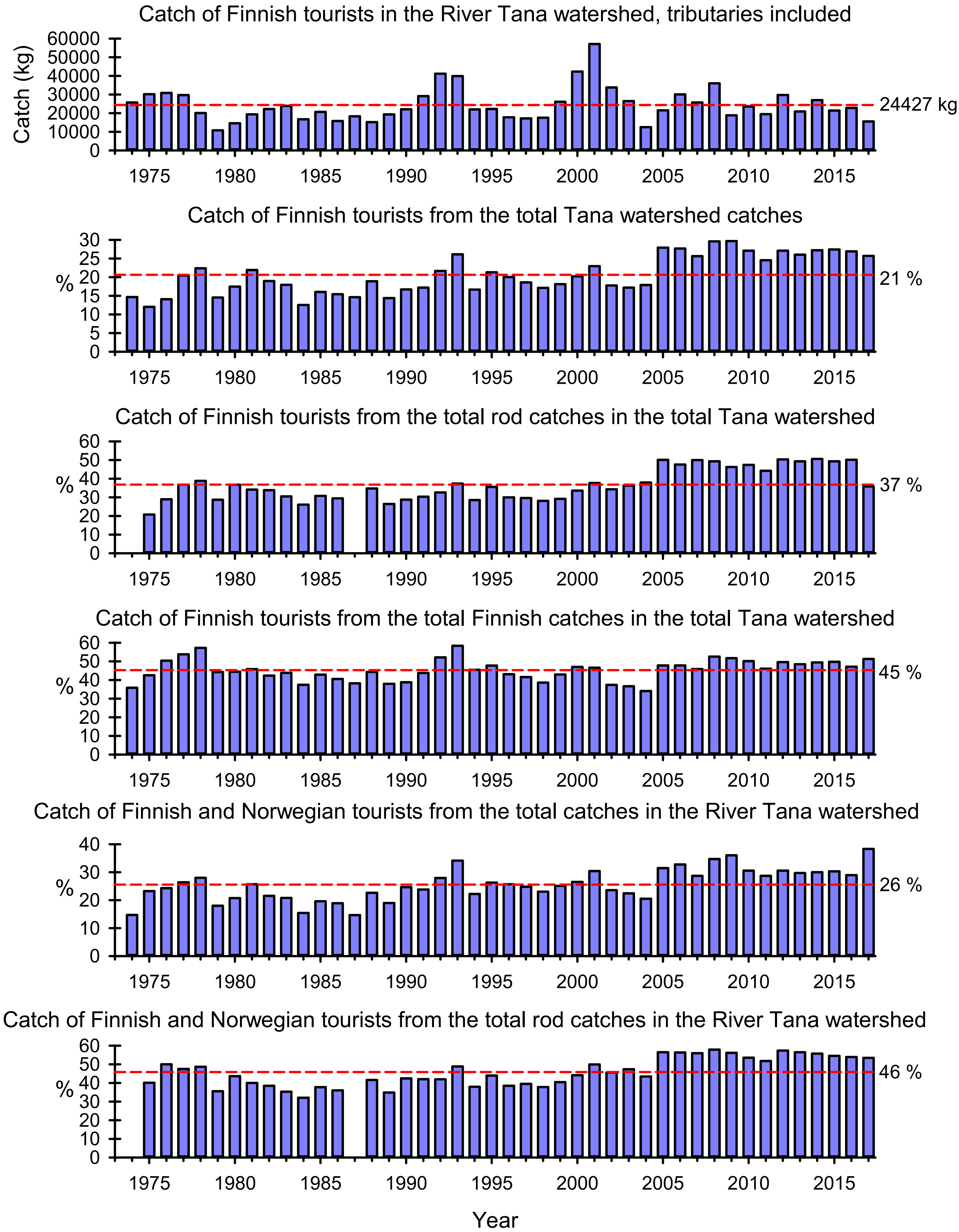

Figure 45. The proportions of salmon catches caught by tourist fishers in the River Tana watershed. Source: Luke (Finland).

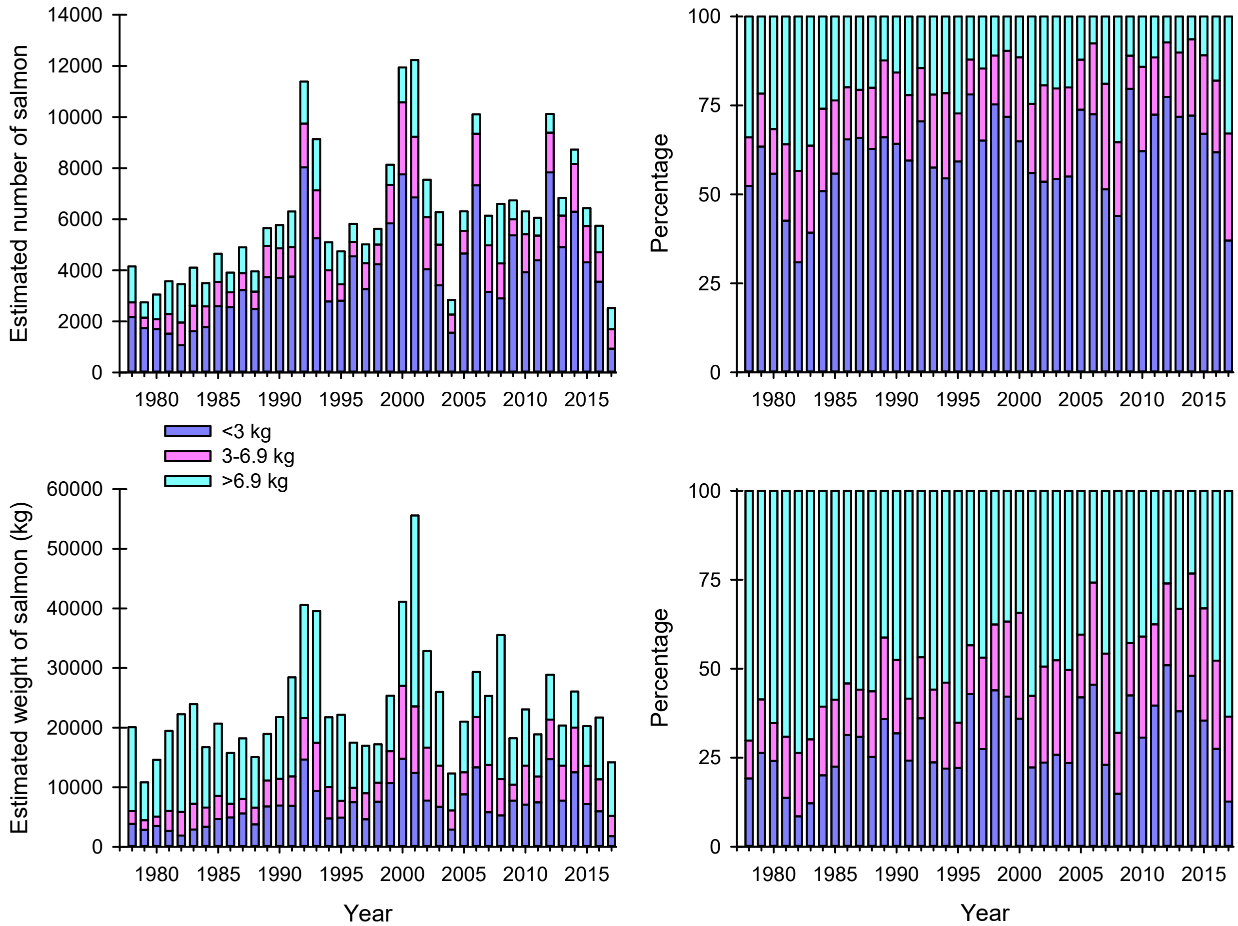

Figure 46. Annual numbers and weights of small, medium and large sized salmon in the tourist catches in the rivers Tana and Inarijoki mainstreams. Source: Luke (Finland).

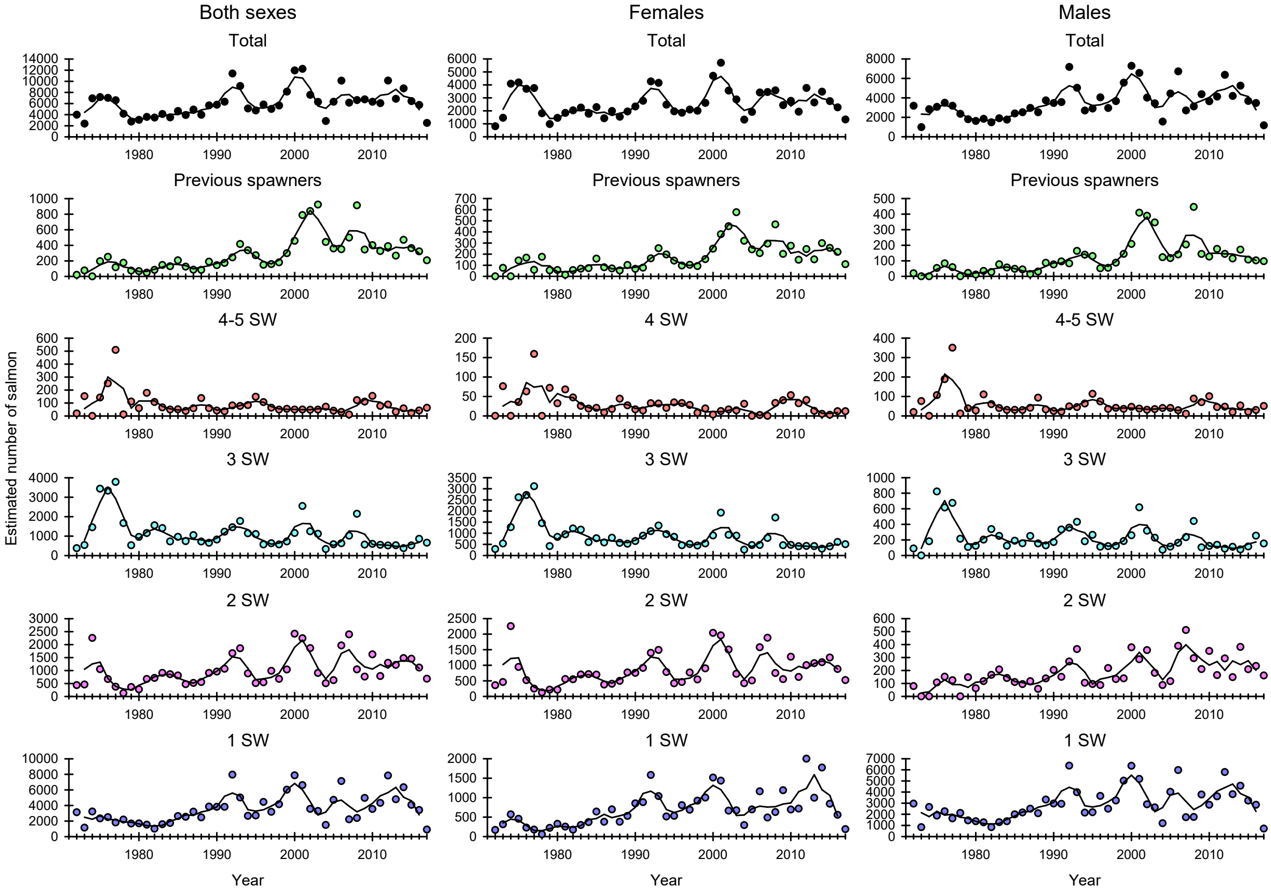

Figure 47. Annual numbers of female and male 1SW, 2SW, 3SW, 4SW-5SW and previous spawned salmon in the Finnish tourist catches in the rivers Tana and Inarijoki mainstreams. Source: Luke (Finland).

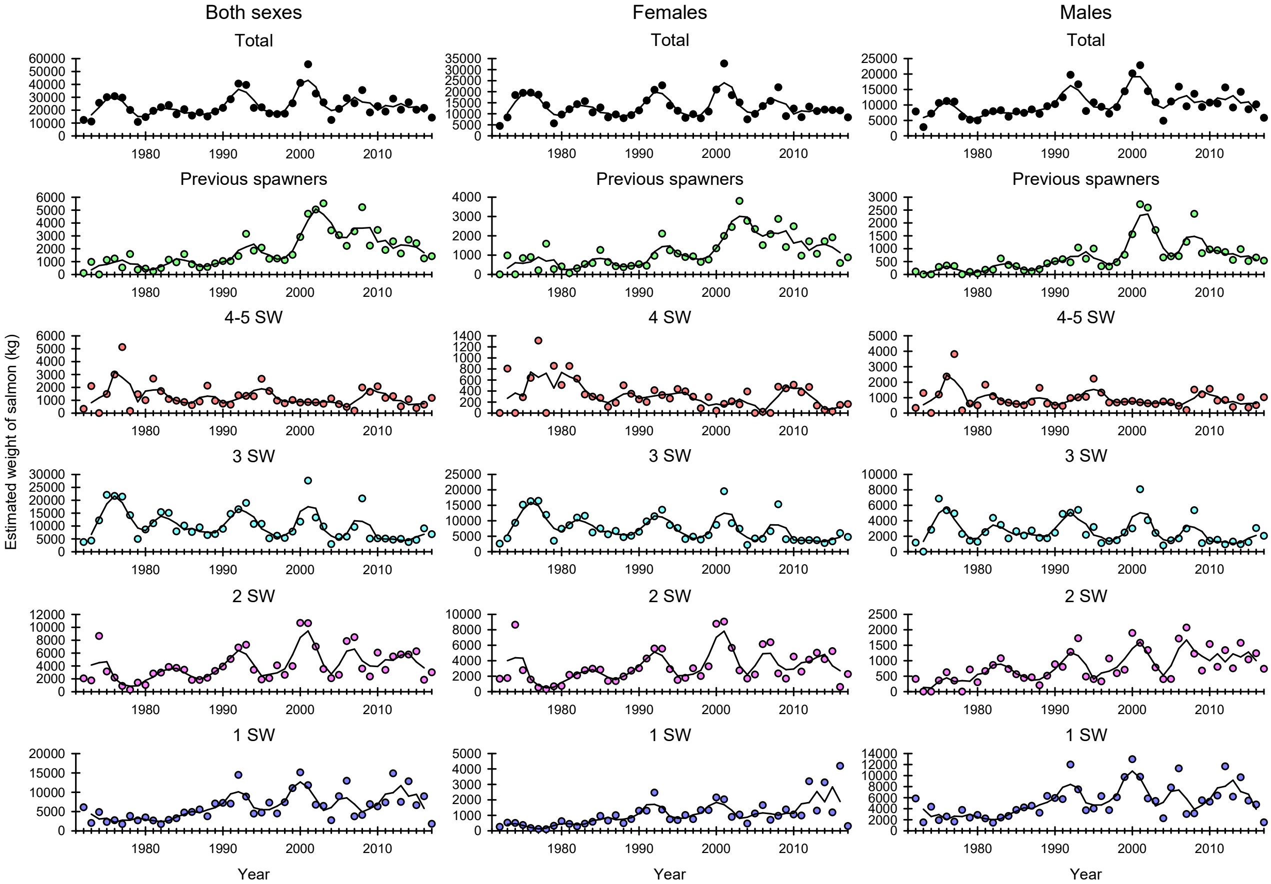

Figure 48. Annual weights of female and male 1SW, 2SW, 3SW, 4SW-5SW and previous spawner salmon in the Finnish tourist catches in the rivers Tana and Inarijoki mainstreams. Source: Luke (Finland).

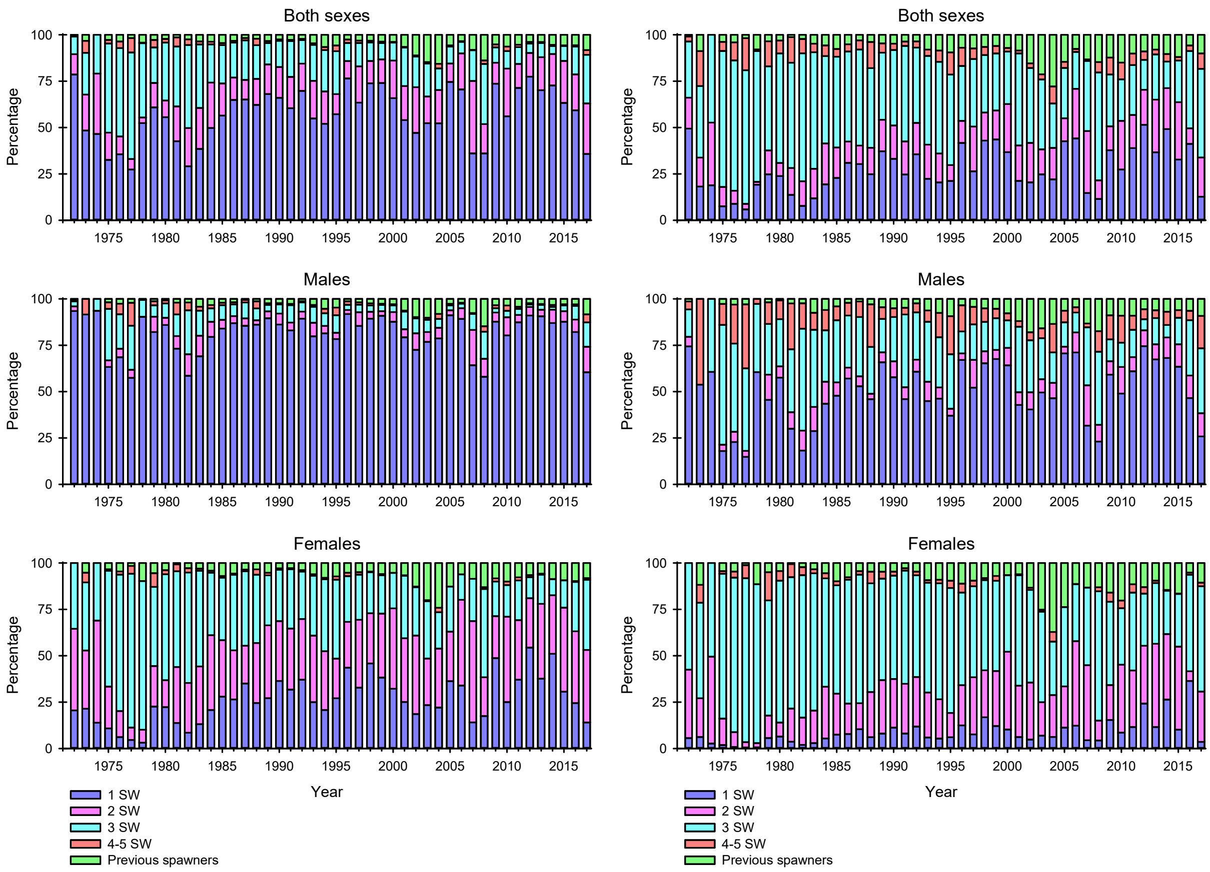

Figure 49. Annual proportions of female and male 1SW, 2SW, 3SW, 4SW-5SW and previous spawner salmon from the numbers (figure on the left) and from the weights (figure on the right) in the Finnish tourist catches in the rivers Tana and Inarijoki mainstreams. Source: Luke (Finland)

8. Differences in the annual and monthly sea-age distributions between female and male salmon catches in traditional fishing methods in the River Tana mainstream in Finland

Figures 50-58 make a conclusion from the long-term developments and annual variations in the sea-age distributions (1SW, 2SW, 3SW, 4SW-5SW, previous spawners) in the traditional fishing catches in the Finnish salmon fishing in the River Tana mainstream. The reseach period over 45 years include numerous fishery management introductions, like Tana fishing agreement in the year 1979, NASCO convention prohibiting salmon fishing in high seas in the year 1984, prohibition of drift net fishing at sea in Norway in the year 1988 and Tana fishing agreement in the year 1990.

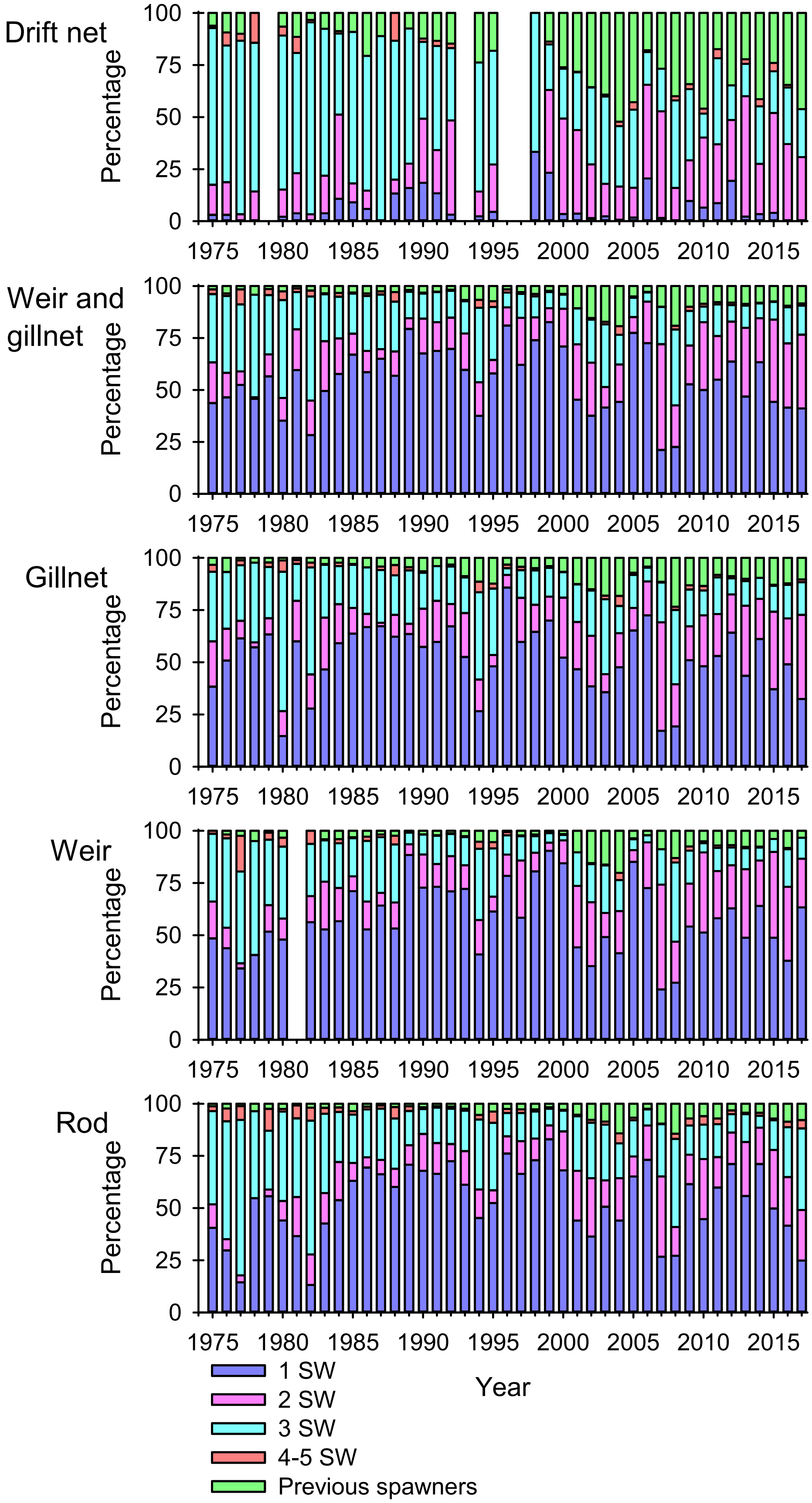

Figure 50. Sea-age distributions of salmon sexes combined in terms of numbers caught during the entire summer (June, July, August) with traditional fishing methods in the River Tana mainstream in Finland. Source: Luke (Finland).

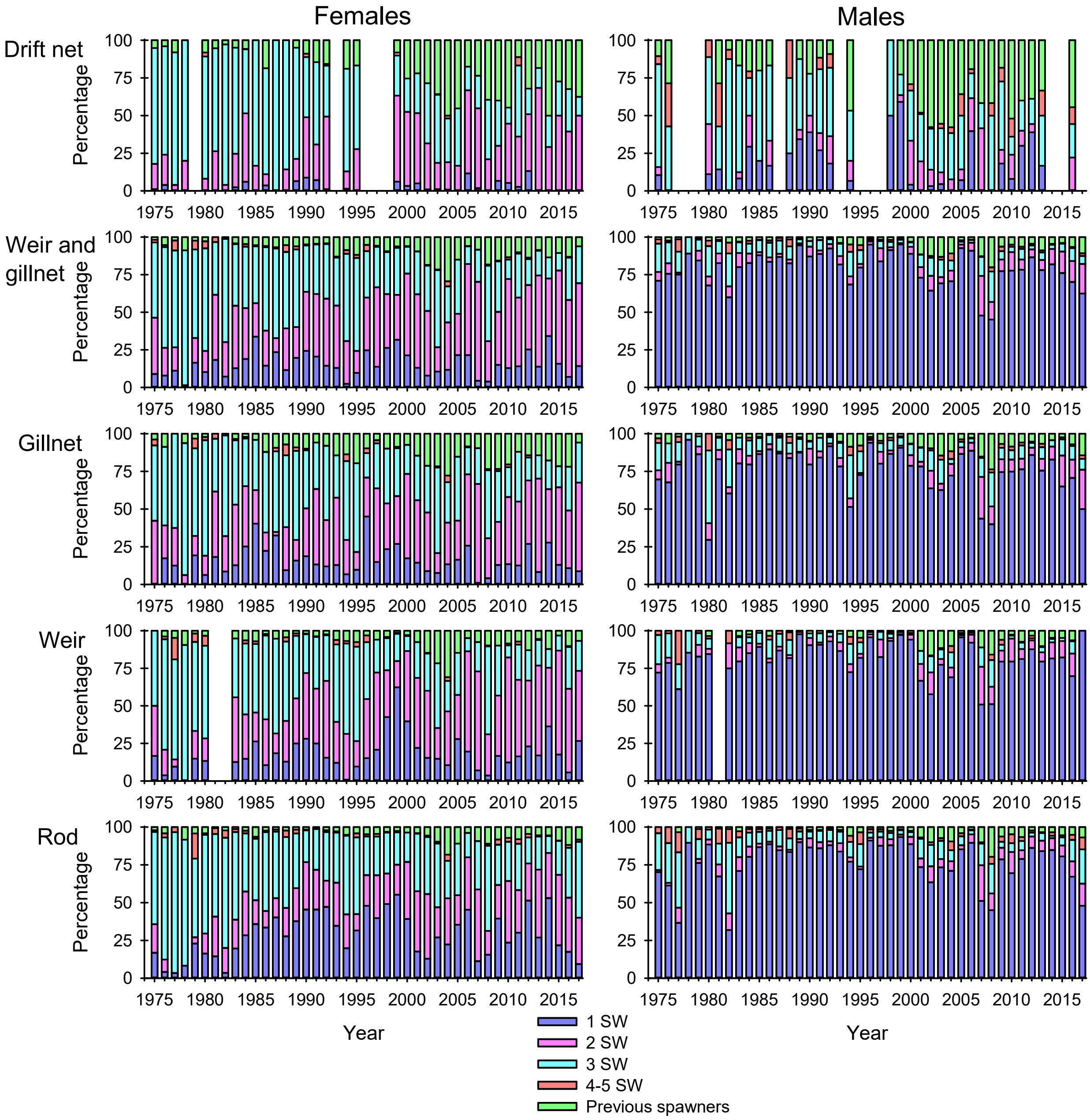

Figure 51 Sea-age distributions of female and male salmon in terms of numbers caught during the entire summer (June, July, August) with traditional fishing methods in the River Tana mainstream in Finland. Source: Luke (Finland).

Figure 52. Sea-age distributions of salmon sexes combined in terms of numbers caught in June, July and August with traditional fishing methods in the River Tana mainstream in Finland. Source: Luke (Finland).

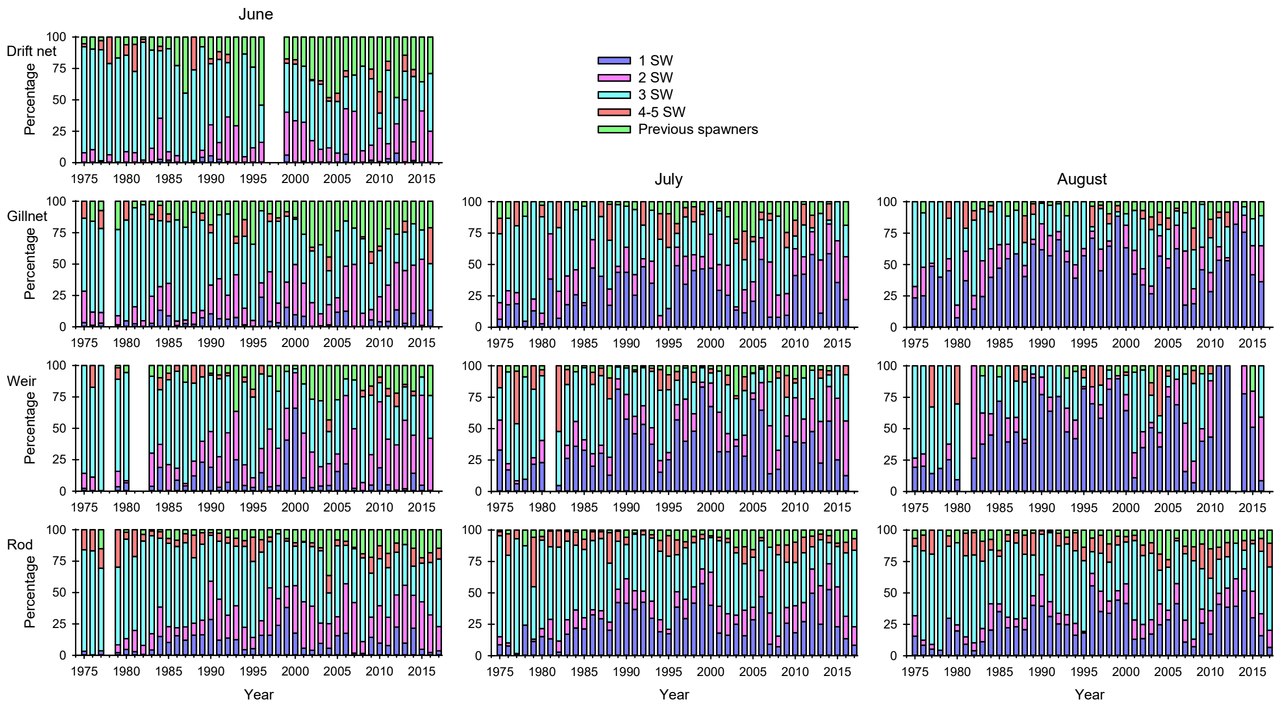

Figure 53. Sea-age distributions of salmon sexes combined in terms of weight caught in June, July and August with traditional fishing methods in the River Tana mainstream in Finland. Source: Luke (Finland).

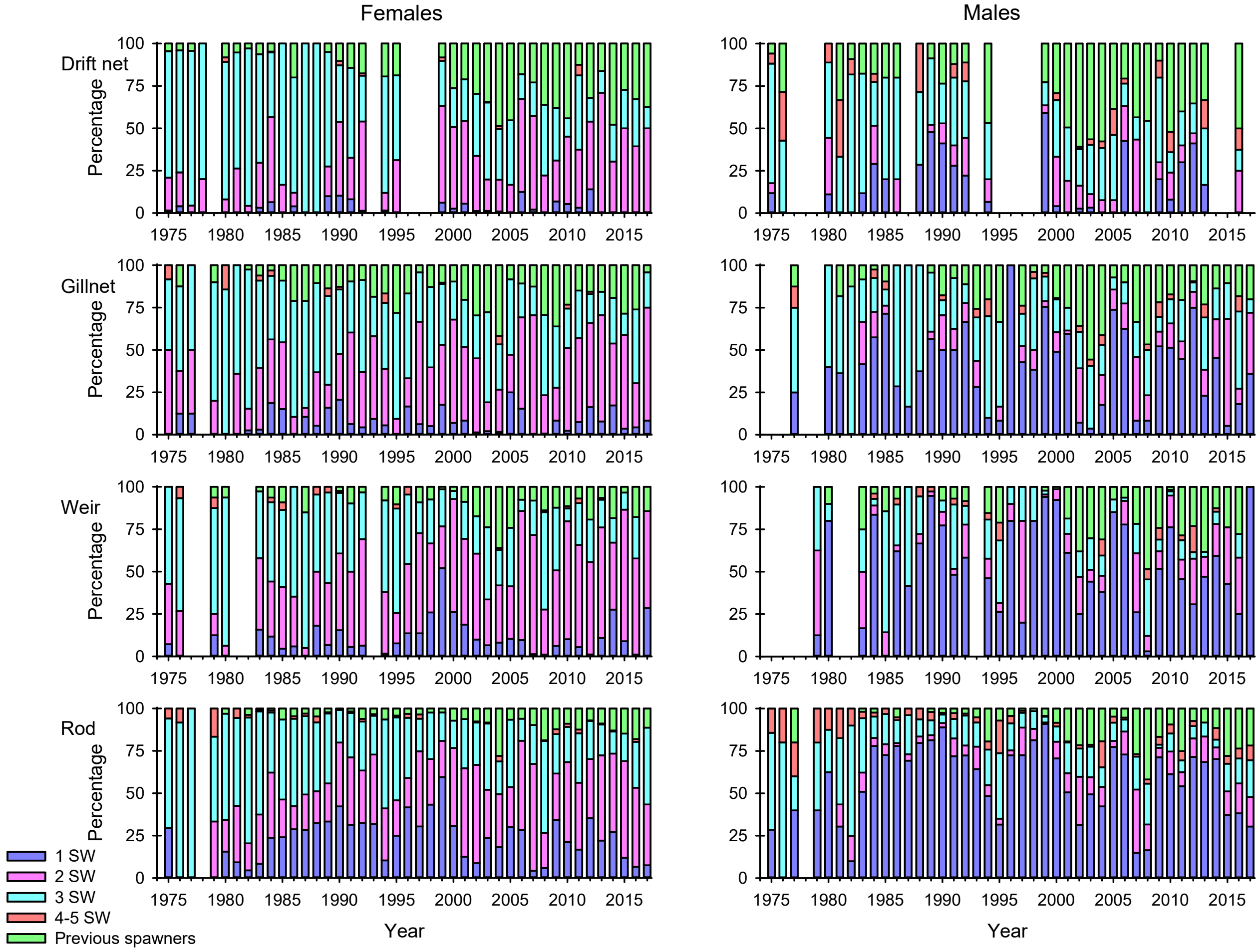

Figure 54. Sea-age distributions of female and male salmon from the numbers of fish in the catches caught in June with traditional fishing methods in the River Tana mainstream in Finland. Source: Luke (Finland).

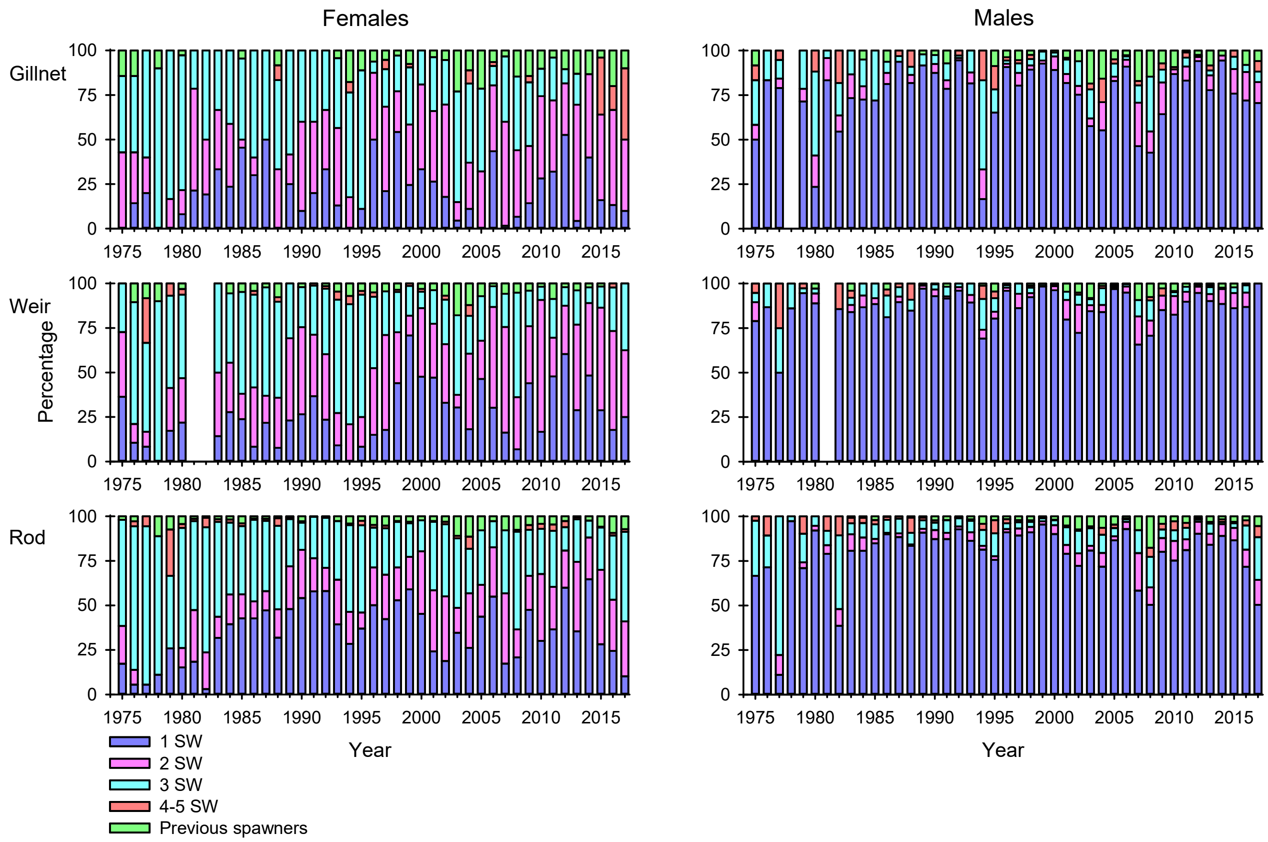

Figure 55. Sea-age distributions of female and male salmon from the numbers of fish in the catches caught in July with traditional fishing methods in the River Tana mainstream in Finland. Source: Luke (Finland).

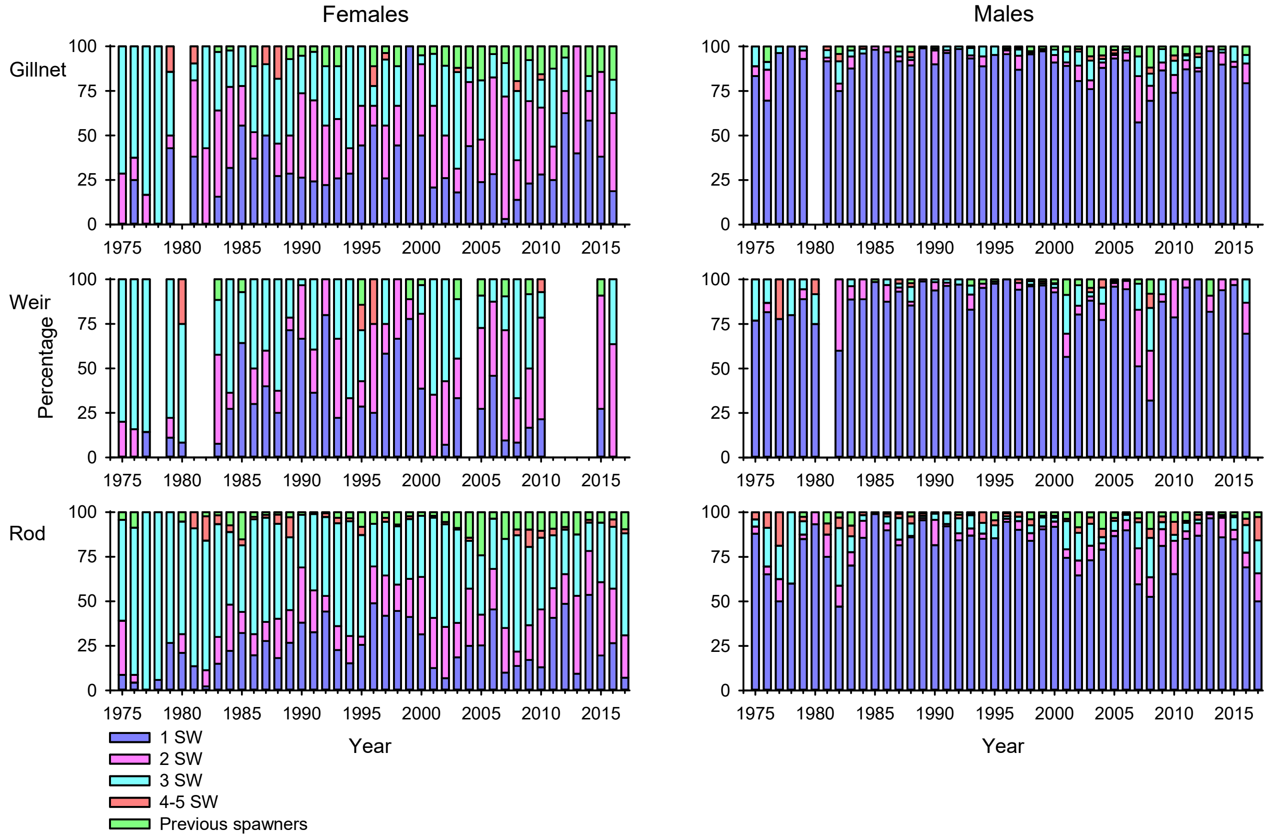

Figure 56. Sea-age distributions of female and male salmon from the numbers of fish in the catches caught in August with traditional fishing methods in the River Tana mainstream in Finland. Source: Luke (Finland).

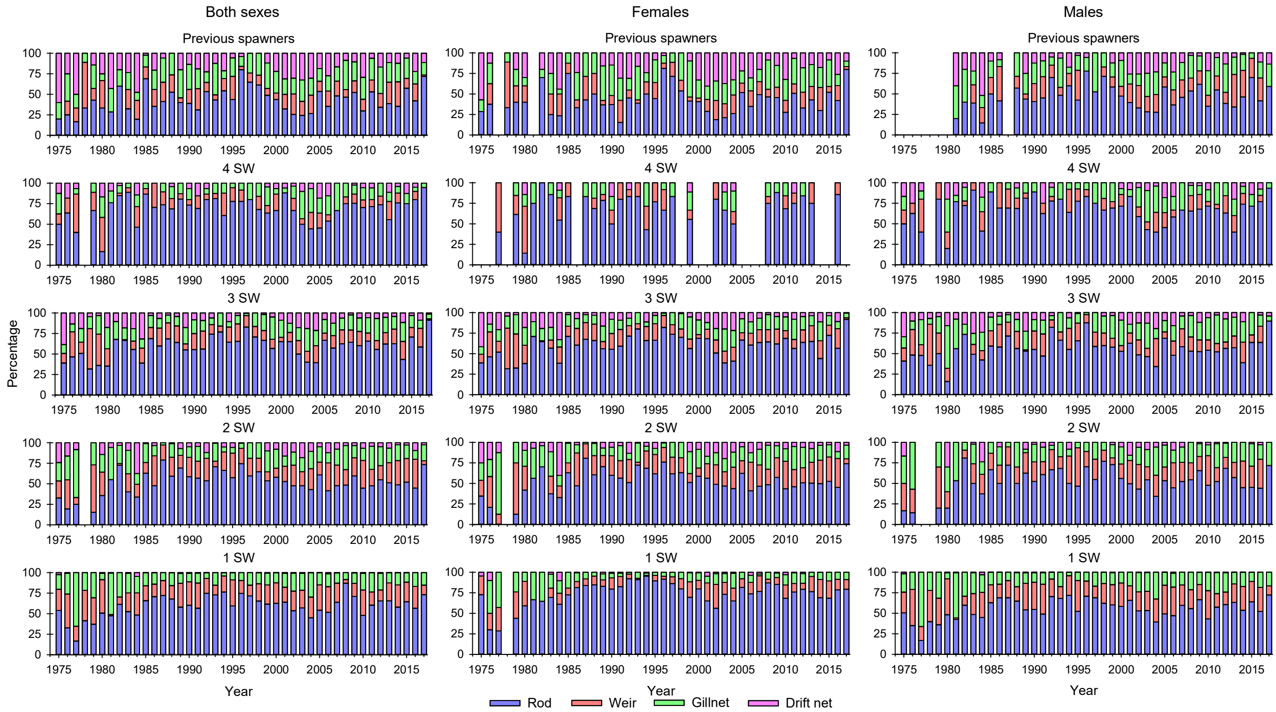

Figure 57. Proportions of salmon caught during the entire summer with rod, weir, gillnet and driftnet in the catches of 1SW, 2SW, 3SW, 4SW and previous spawners in the River Tana mainstream in Finland. Source: Luke (Finland).

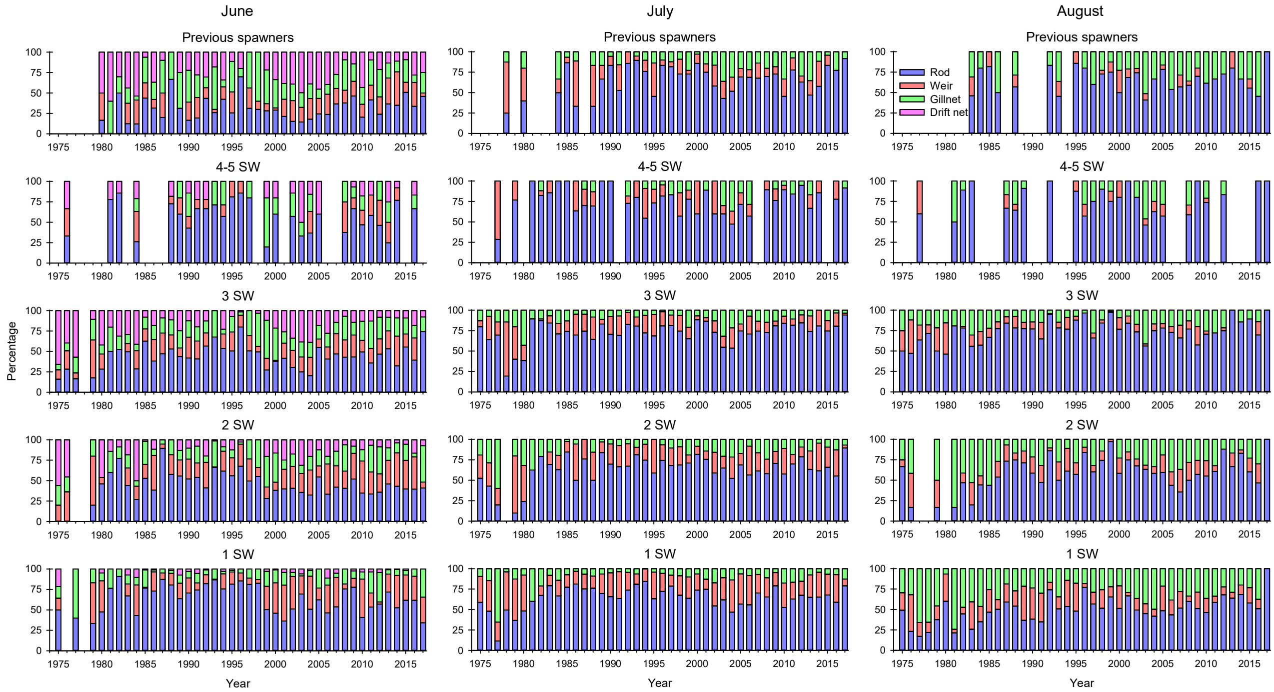

Figure 58. Proportions of salmon caught in June, in July and in August with rod, weir, gillnet and driftnet in the catches of 1SW, 2SW, 3SW, 4SW and previous spawners in the River Tana mainstream in Finland. Source: Luke (Finland).

9. Timing of catches are differing between the sea-ages of salmon in the River Tana mainstream and in all tributaries

The timing of salmon catches, especially in the lowermost area in the River Tana, illustrates the migration periods for small, medium and large sized salmon. the temporal differences in the proportions of 1SW, 2SW, 3SW, 4SW-5SW and previous spawning salmon in the catches, say even more about the timing of migrations. Since 2017 and in the following years, the catch timing data and timing figures are not any more complete for all sea-age groups and cannot be compared to the earlier years because of the new fishery management measures that restricted the fishery in early June. Figures 59-63 show that previous spawners are migrating into the River Tana earliest together with 2SW and 3SW salmon. The smallest salmon, (< 3 kg), mainly belongs to the sea-age group 1SW, and starts to migrate into the River Tana in the second half of June. Depending on the ice-breaking-up dates and the water temperature in the River Tana, multi-seawinter salmon, 2SW-5SW and previous spawner salmon, can start migrations even early in May.

A new phenomenon is particularly interesting; the sea-age groups of previous spawners and their occurrence and especially their increased proportions in the catches in June and in July (Figs. 54-56).

Annual differences in the cumulative catches and in the median dates of capture show clear variations in the timing of salmon migrations into the River Tana (Figs. 61-63). These annual variations in the migration periods are driven by annual changes in the sea-temperatures, spatial and temporal changes in the efforts of the coastal salmon fishery with bag nets and bend nets (bend nets until the year 2021). In the River Tana, environmental circumstances, like ice breaking-up dates, water temperatures and water levels are affecting the successful use of traditional fishery and thus to the timing of catches (Figs. 64-65).

Multi-seawinter salmon have made the majority in the catches in terms of weight in the River Tana mainstream and in the rivers Karasjohka and Iesjohka in the periods 2004-2016 (Fig. 66). Further, after the new management introduction in 2017, multi-seawinter salmon has made up the majority in salmon catches in weights in Norway in the years 2017-2020 (Fig. 67). When comparing temporal size distributions in terms of weights, fishery in the uppermost areas in Karasjohka below and above Skaidigeacci and in Iesjohka has targeted mainly the multi-seawinter salmon. Based on the size distribution of salmon in the catches in the upper areas (Karasjohka and Iesjohka) in the River Tana watershed, it is definite clear that those areas are the most important reproduction areas for multi-seawinter salmon, together with the River Tana mainstream (Figs.68, 69).

Figures 70 and 71 are showing salmon catches in a five days period in the Finnish fishery in the River Tana mainstream. Figure 72 gives an overview of the entire Tana watershed, with the distributions of percentage proportions in five days periods for 1SW, 2SW, 3SW, 4SW and previous spawning salmon.

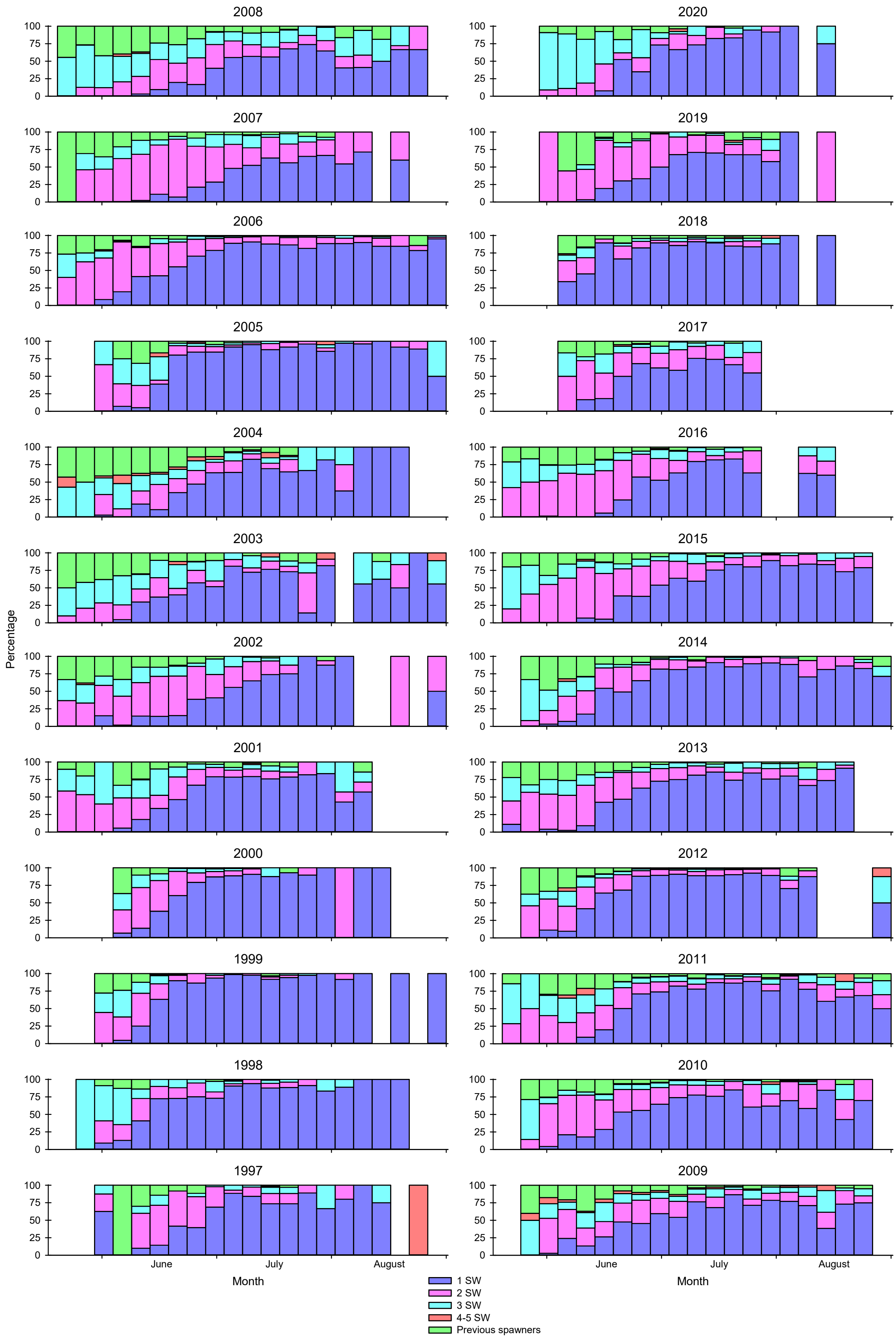

Figure 59. Sea-age distributions in the catches in five days periods during the summer are illustrating the annual timing of 1SW, 2SW, 3SW, 4SW-5SW and previous spawning salmon entering the lower areas in the River Tana mainstream in Norway. Source: Source: TF organization (Norway).

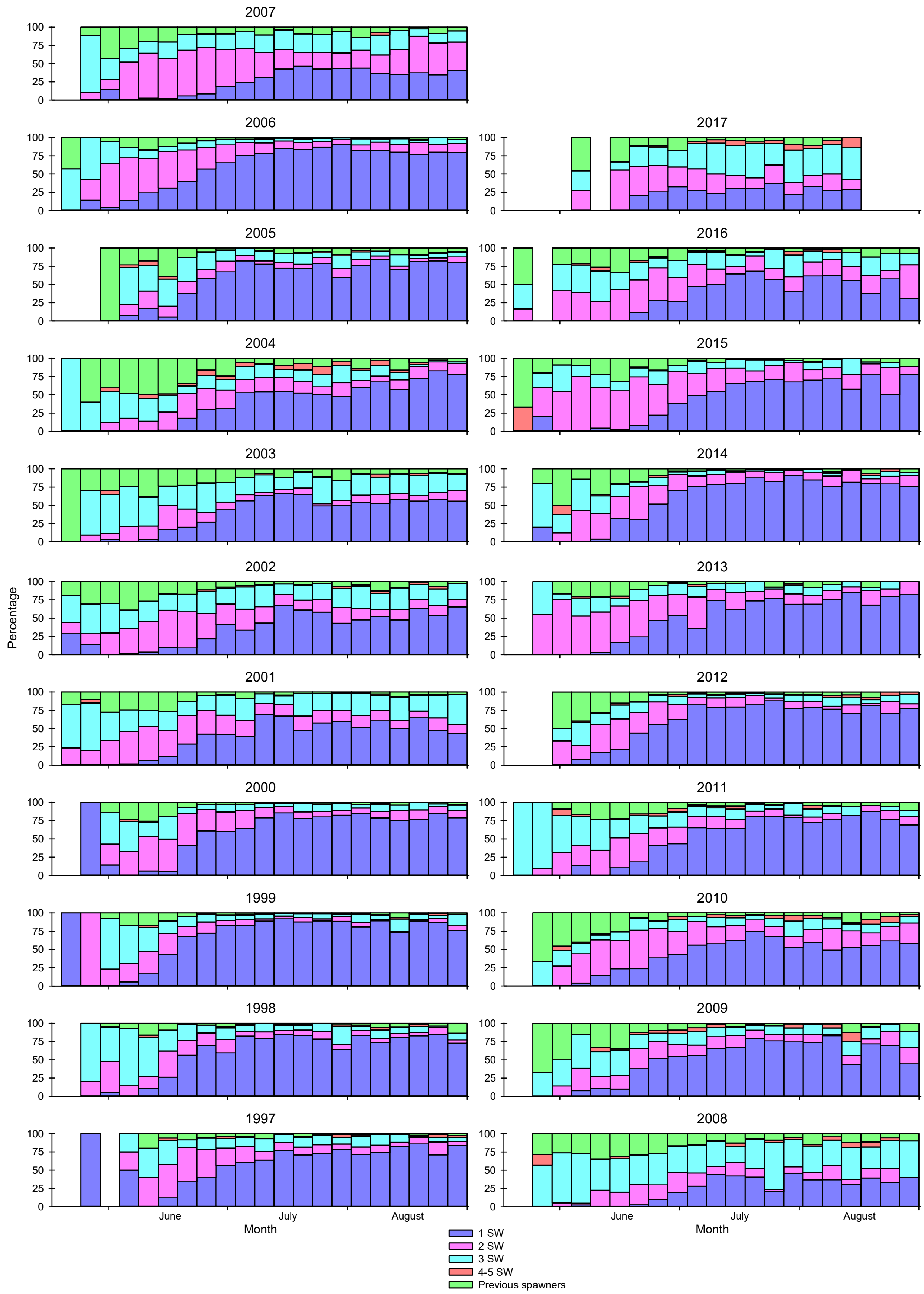

Figure 60. Sea-age distributions in the catches in five days periods during the summer are illustrating the annual timing of 1SW, 2SW, 3SW, 4SW-5SW and previous spawning salmon entering the common border area in the River Tana mainstream in Finland. Source: Source: Luke (Finland).

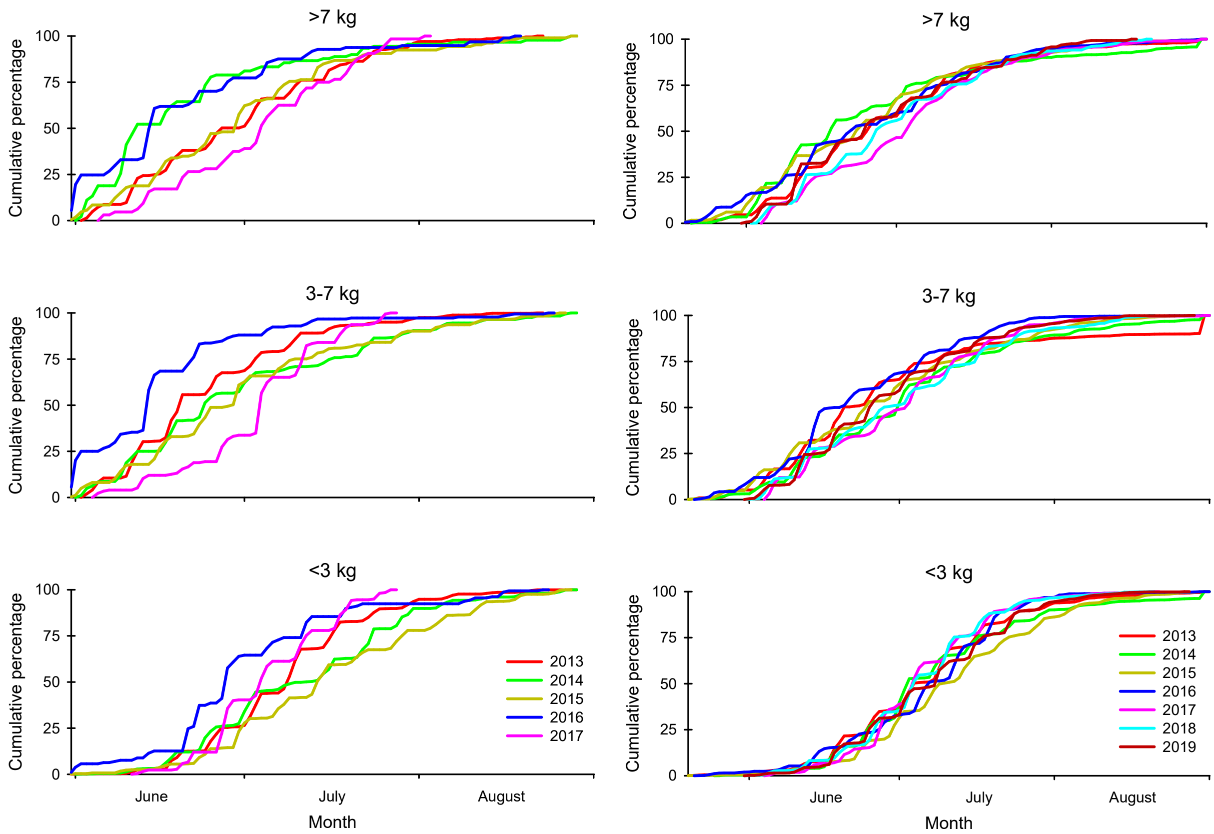

Figure 61. Annual cumulative catches of small, medium and large sized salmon caught in Norway in the River Tana between Tana river mouth and the border in Nuorgam between Norway and Finland. Figure on the left is based on the salmon scale collection from the traditional salmon fishery. Figure on the right is based on the daily catch reports from all salmon fishers. Source: TF organization (Norway).

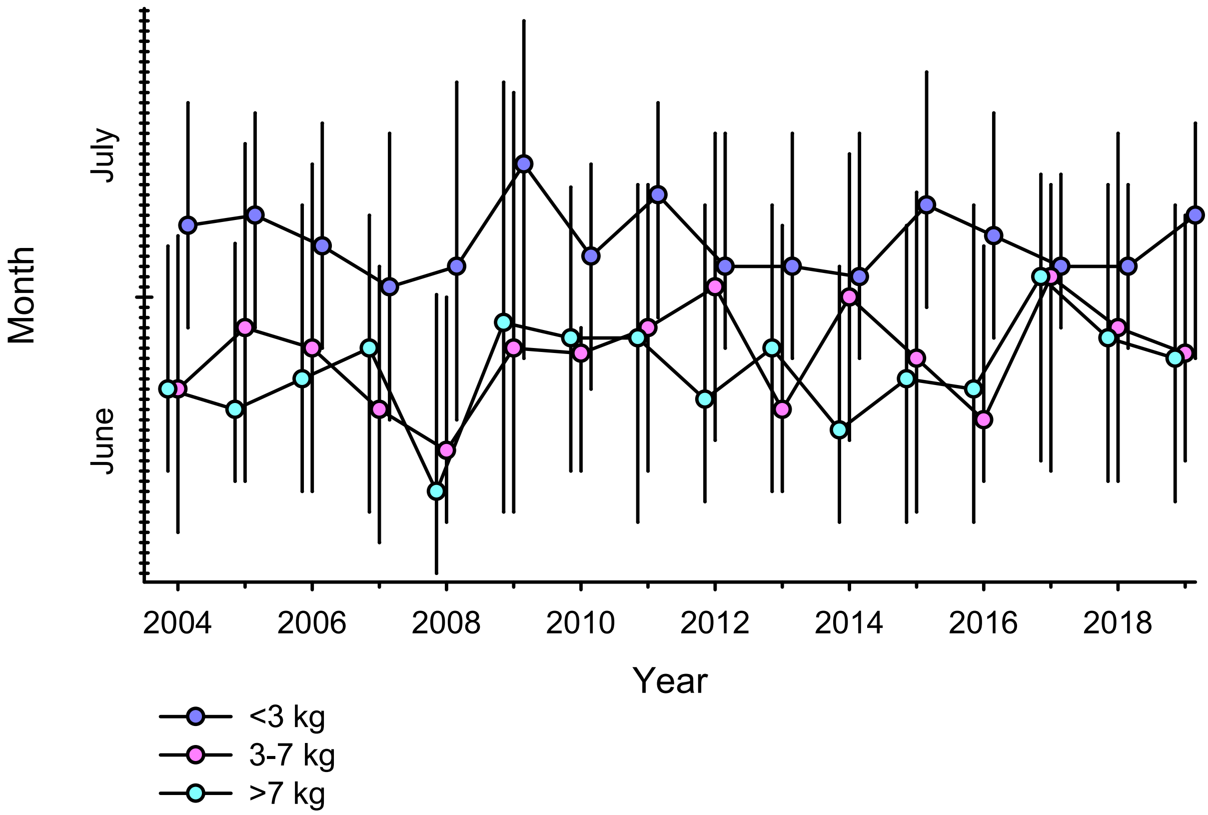

Figure 62. Median dates of capture with lower and upper quartiles for small, medium and large sized salmon caught in the River Tana between Tana river mouth and border in Nuorgam between Norway and Finland. Figure is based on the daily catch reports all traditional fishing methods included. Source: TF organization (Norway).

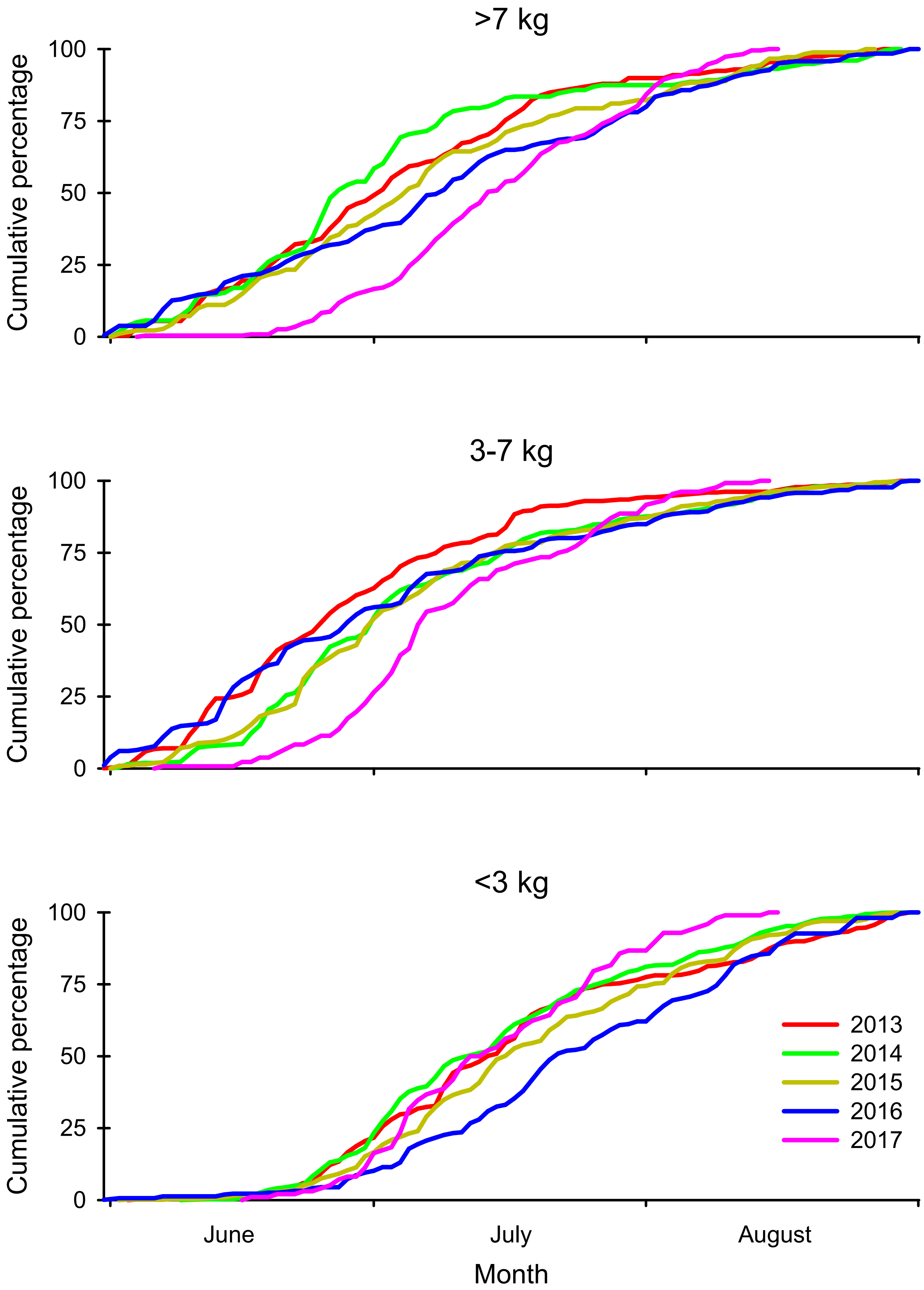

Figure 63. Cumulative catches in the River Tana (Teno) mainstream on the Finnish side in the common Finnish-Norwegian border area. Figure is based on the salmon scale collection form the traditional fishery. Source: Source: Luke (Finland).

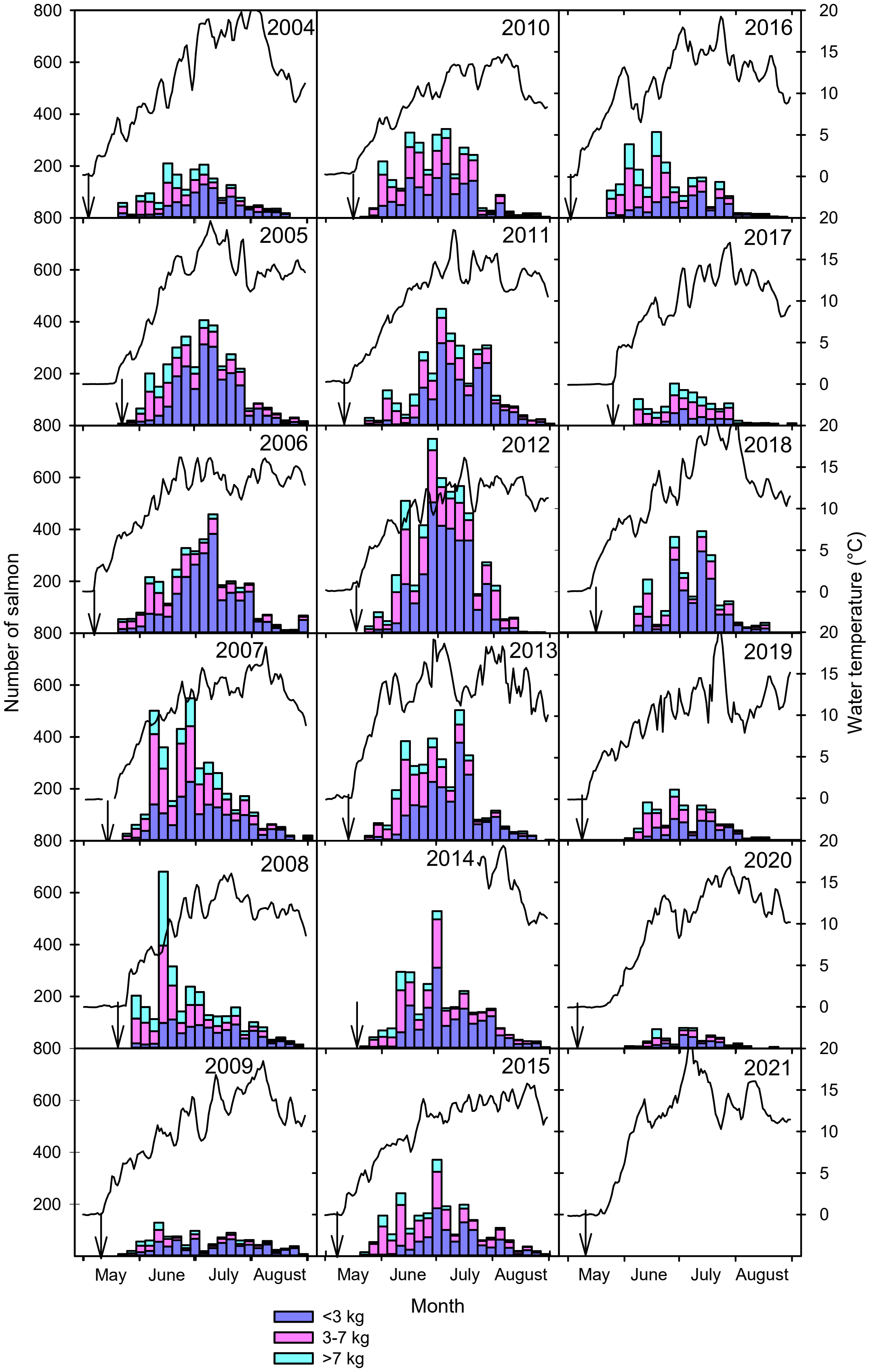

Figure 64. Annual reported salmon numbers in catches in five days periods for three size groups of salmon in Norway in the area from Tana rivermouth to Tanabru, daily water temperatures (Polmak station) and ice breaking-up dates (arrow) in Langnes close to Tana rivermouth. Source: TF organization (Norway).

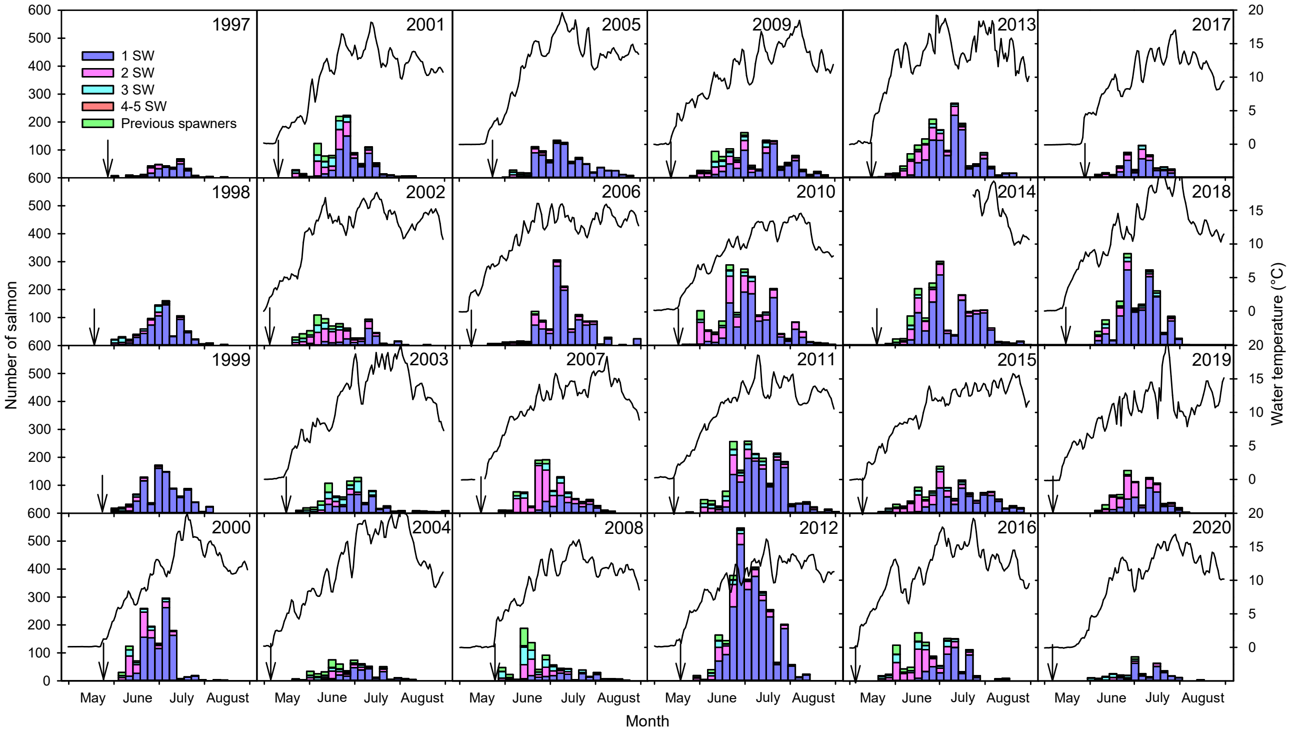

Figure 65. Annual numbers of 1SW, 2SW, 3SW, 4SW-5SW and previous spawning salmon in five days periods from salmon scale sampling program in Norway in the area from Tana rivermouth to Tanabru, daily water temperatures (Polmak station) and ice breaking-up dates (arrow) in Langnes close to Tana rivermouth. Source: TF organization (Norway). NVE (Norway).

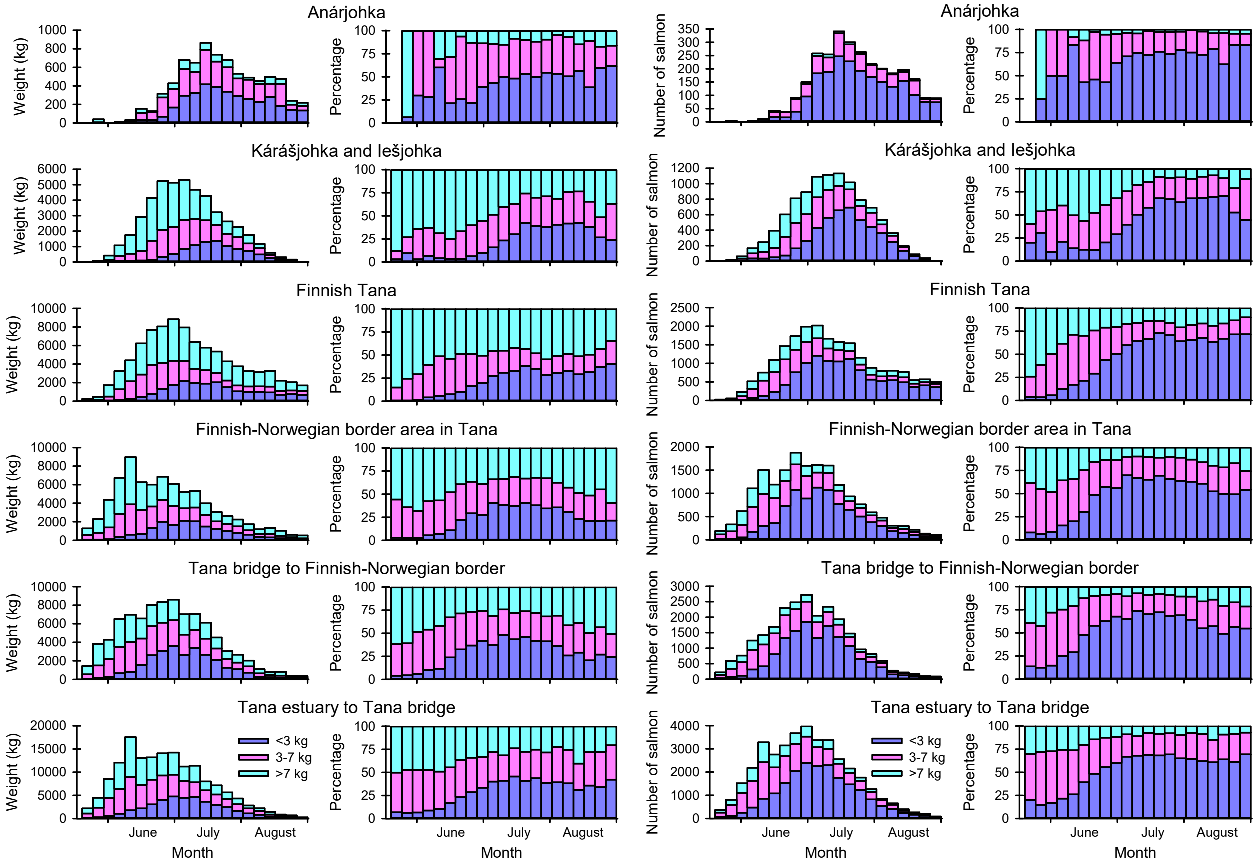

Figure 66. Weights (figure on the left) and numbers (figure on the right) of small, medium and large sized salmon in five days periods in two restricted fishing areas in the River Tana mainstream in Norway and in the common border area Norwegian catches only, Finnish catch in the River Tana mainstream, in Inarijoki (Anarjohka) and in Karasjohka/Iesjohka in the years 2004-2016. Source: TF organization (Norway), Luke (Finland).

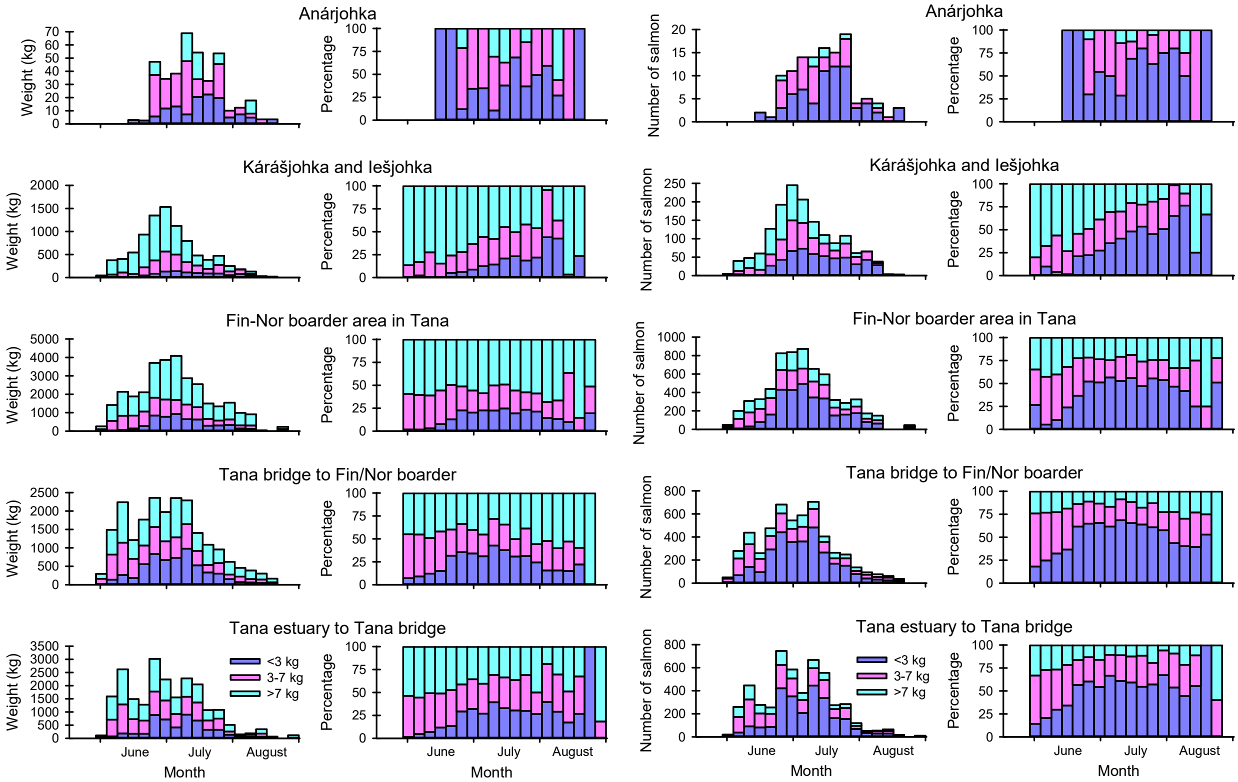

Figure 67. Weights (figure on the left) and numbers (figure on the right) of small, medium and large sized salmon in five days periods in two restricted fishing areas in the River Tana mainstream in Norway, in the common boarder area Norwegian catches, in Inarijoki (Anarjohka) and in Karasjohka/Iesjohka in the years 2017-2020. Source: TF organization (Norway).

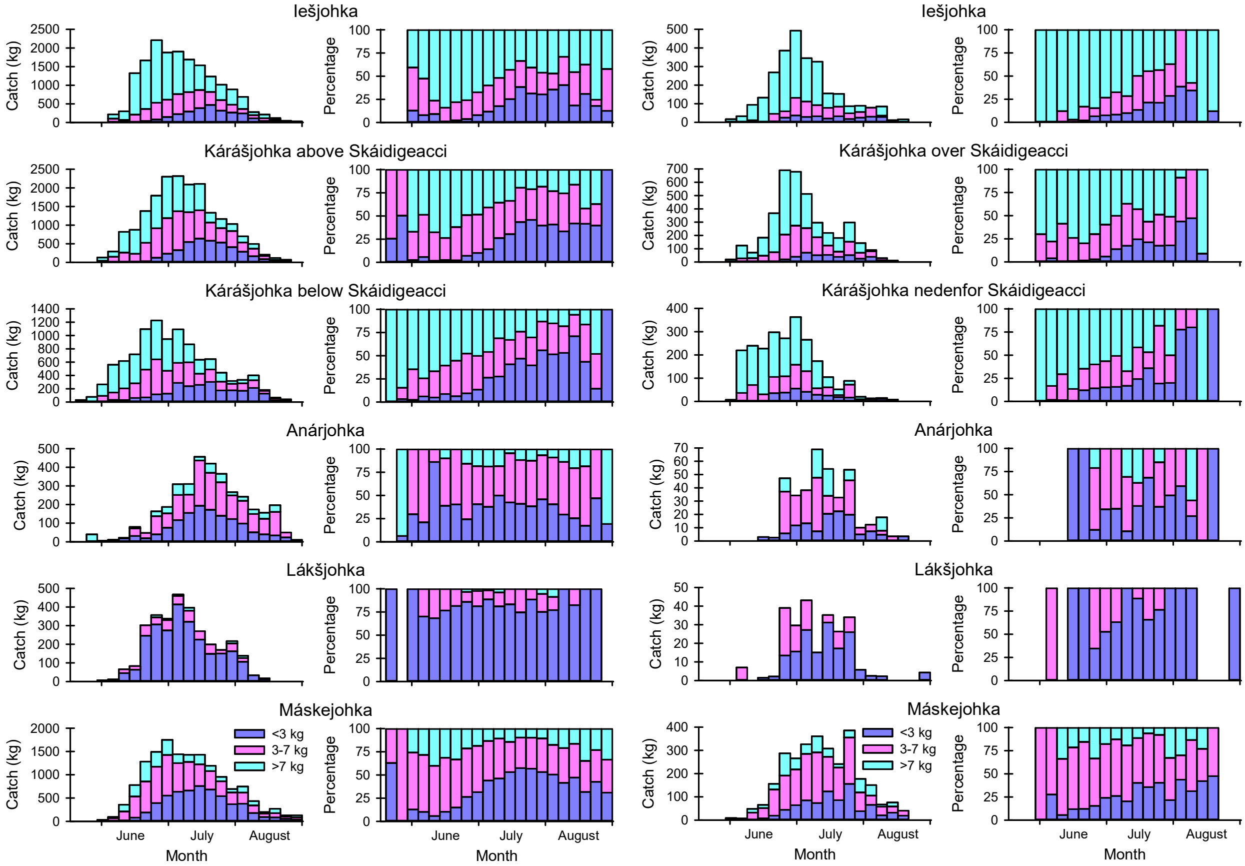

Figure 68. Weights of salmon in the years 2004-2016 (figure on the left) and in the years 2017-2020 (figure on the right) of small, medium and large sized salmon in five days periods in Norwegian tributaries in the River Tana watershed. Source: TF organization (Norway).

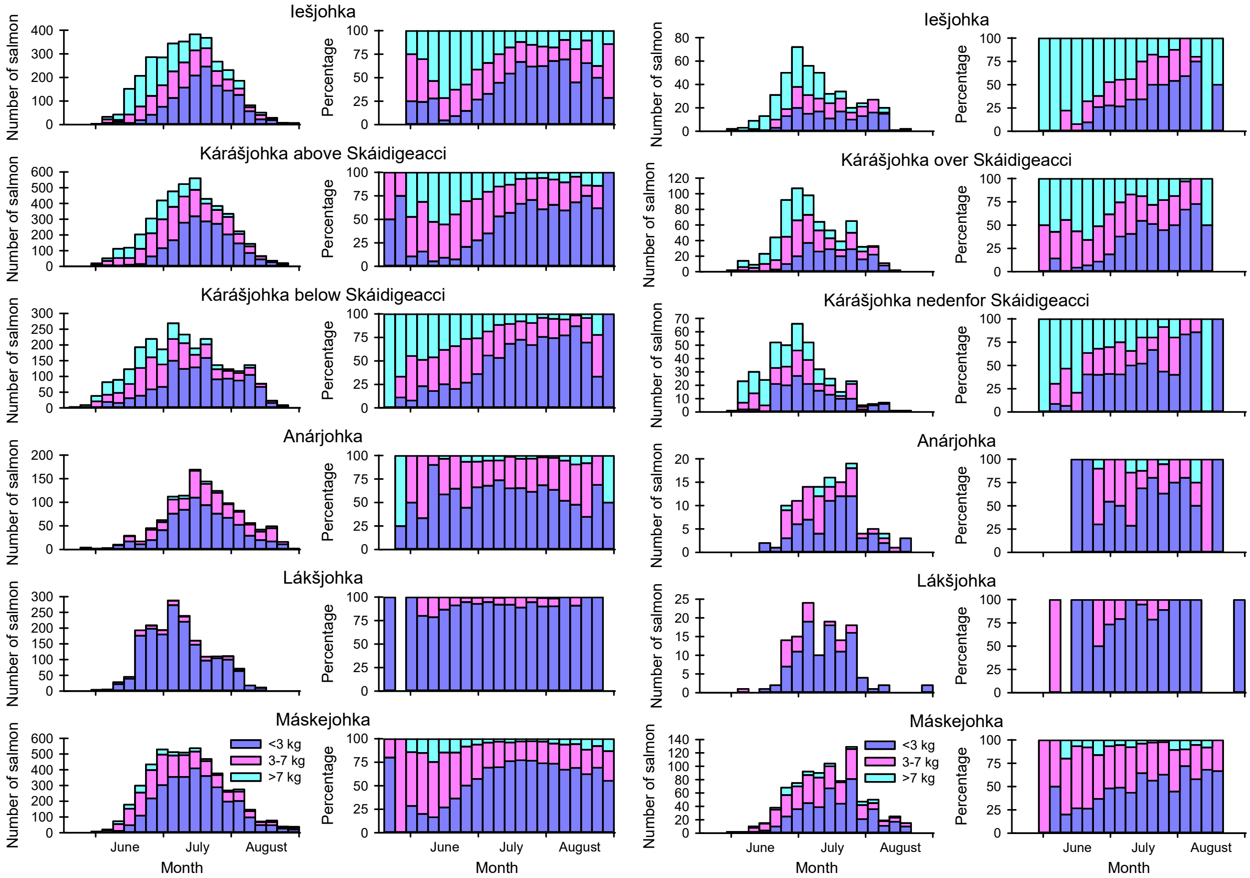

Figure 69. Numbers of salmon in the years 2004-2016 (figure on the left) and in the years 2017-2020 (figure on the right) of small, medium and large sized salmon in five days periods in Norwegian tributaries in the River Tana watershed. Source: TF organization (Norway).

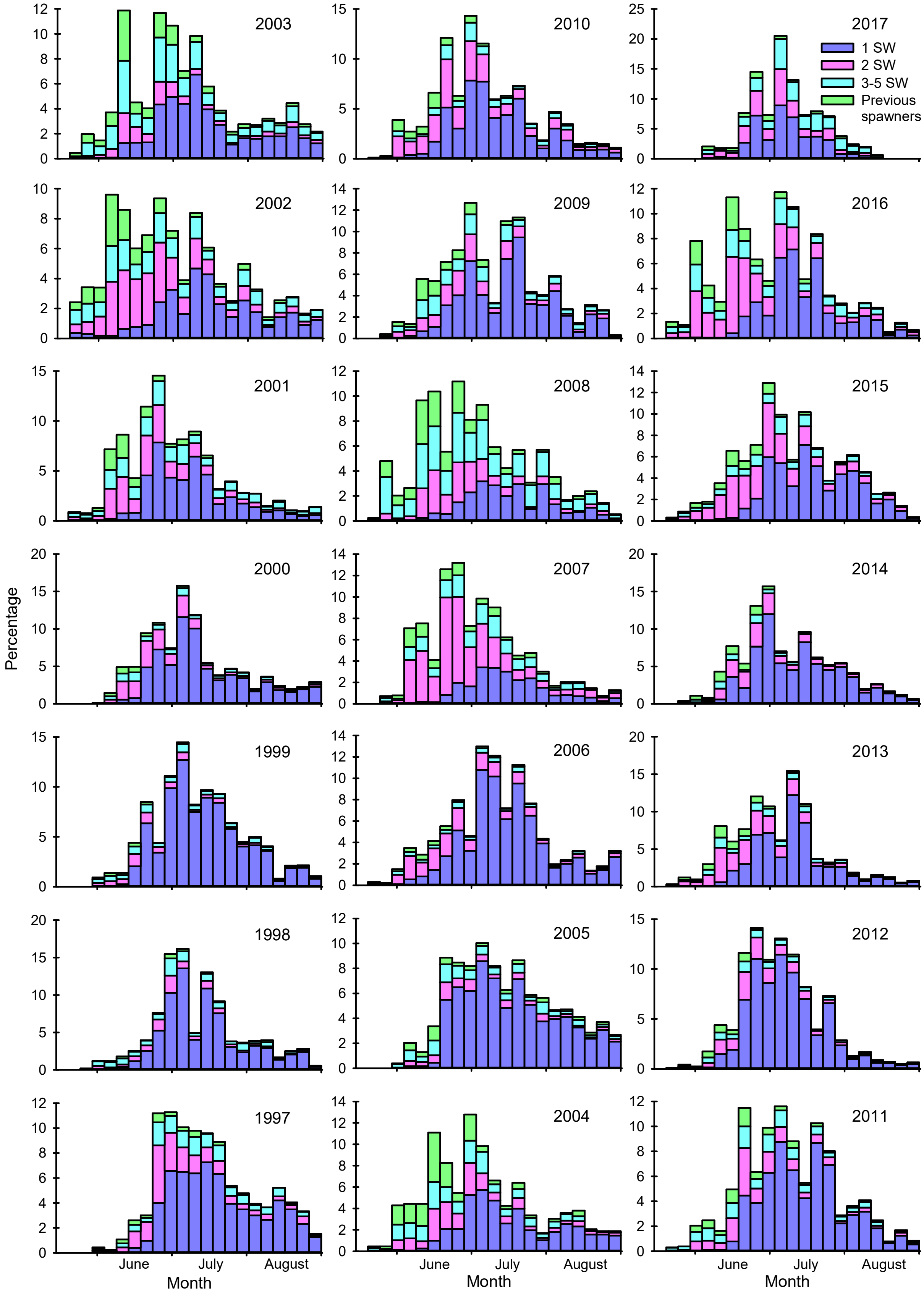

Figure 70. Annual numbers of 1SW, 2SW, 3SW-5SW and previous spawning salmon in five days periods in the salmon scale sampling program in Finland in the River Tana mainstream. Source: Luke (Finland).

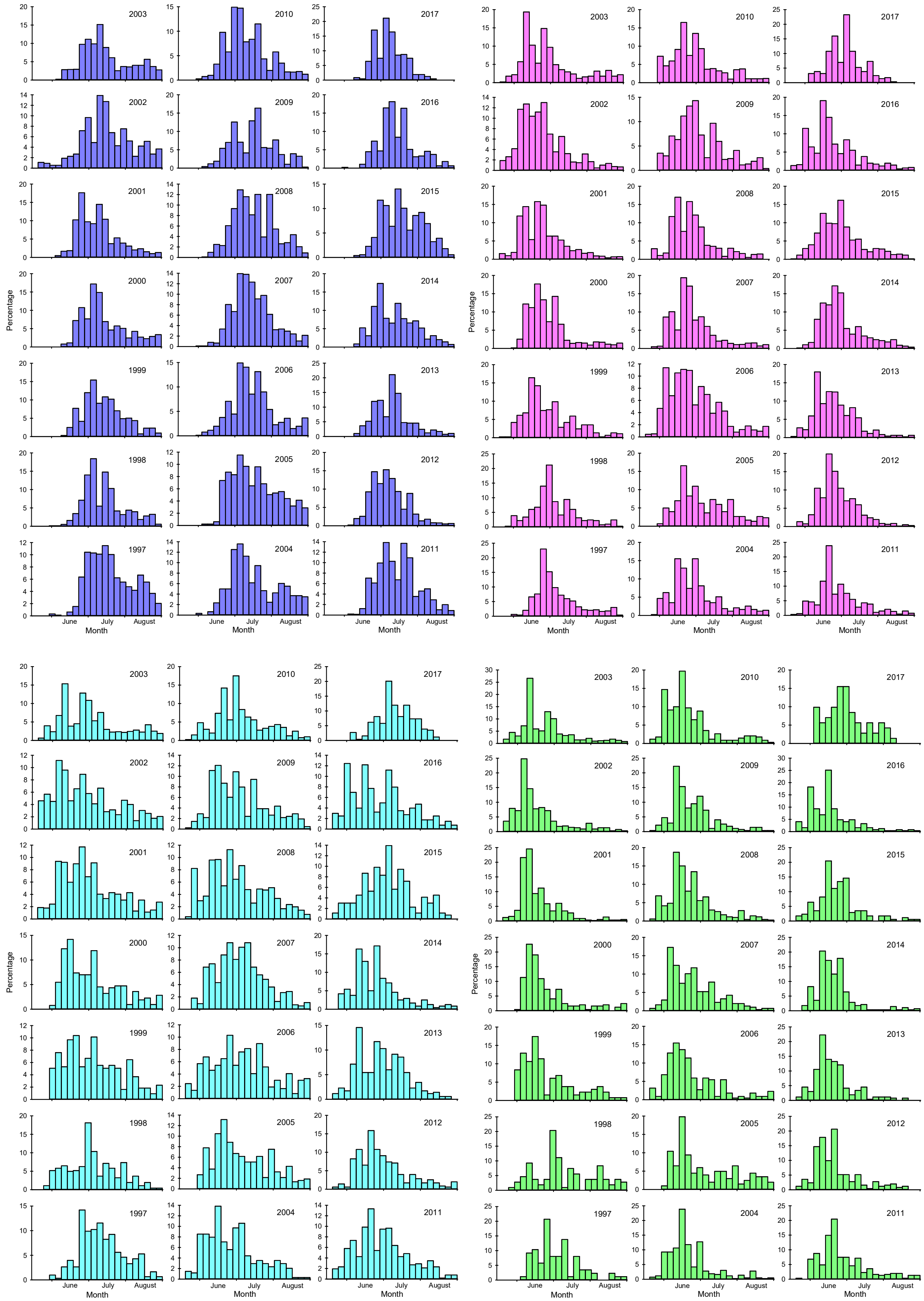

Figure 71. Annual numbers of 1SW, 2SW, 3SW and previous spawning salmon in five days periods in the salmon scale sampling program in Finland in the River Tana mainstream. Graph in the upper figure; 1SW on the left, 2SW on the right. Graph in the lower figure; 3SW on the left, previous spawners on the right. Source: Luke (Finland).Source: Luke (Finland).

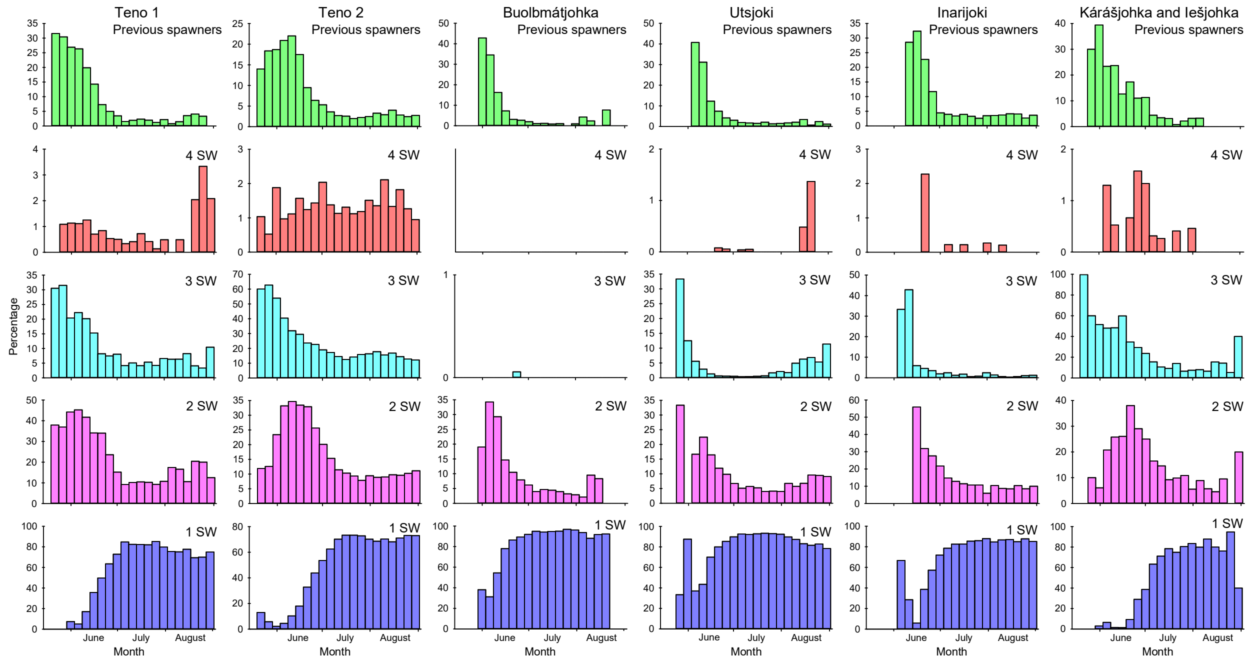

Figure 72. Proportions of 1SW, 2SW, 3SW, 4SW and previous spawning salmon in the same five days periods during the entire fishing season from the beginning of June to the end of August. Teno 1 is the Norwegian area from the Tana river mouth to the Finnish -Norwegian border in Nuorgam. Teno 2 is the common Finnish-Norwegian area in the River Tana mainstream. Source: Luke (Finland), TF organization (Norway).

10. Mean smolt ages and annual smolt age variations of salmon in the River Tana watershed

The annual growth of juvenile salmon in the rivers depends especially on the availability of food and water temperatures during their growth season in June, July, and August. The density of juveniles in their habitats in running waters also affect the intra-species competition from the territories and thus, reflecting to the growth. In principle, juveniles in cold rivers grow slower than juveniles in warmer water. These differences in temperature conditions combined with the feeding activity are determining the smolt ages. In each salmon population in the River Tana watershed juvenile salmon from each spawning year are reaching smolt phase after 3, 4, 5 and 6 years. Thus, each spawning generates smolts which are migrating to sea in the successive four years. If water temperatures in the rivers are cold, combined with low bottom animal production as a food source during juvenile growth periods, then there are less smolts with the smolt age of three years but, the proportions of 5, 6, 7 and 8 years is increasing. These kind of clear annual variations in the smolt age distributions are noticeable in all tributaries in the River Tana watershed, like in the river Tana mainstream and in the tributaries Inarijoki, Utsjoki, Buolbmatjohka. Annual variations in the smolt age distributions are thus reflecting into the mean smolt ages.

Figures 74-76 are showing the long-term annual variations in the mean smolt ages for 1SW, 2SW, 3SW and 4SW salmon in the River Tana watershed. Mean smolt ages are increasing and decreasing in the same years in all rivers. These simultaneous changes in the mean smolt ages are also taking place between all sea ages and between females and males. In many years, females have higher mean smolt ages than males, which might come from the fact that some juvenile males reach maturity already in the river phase. These male juveniles are called precocious parr. This early maturation might result in high mortality after spawning during the following winter. Therefore, the mean smolt age of males is somewhat lower than the smolt age of females. Thus, each spawning generates smolts which are migrating to sea in the successive four years.

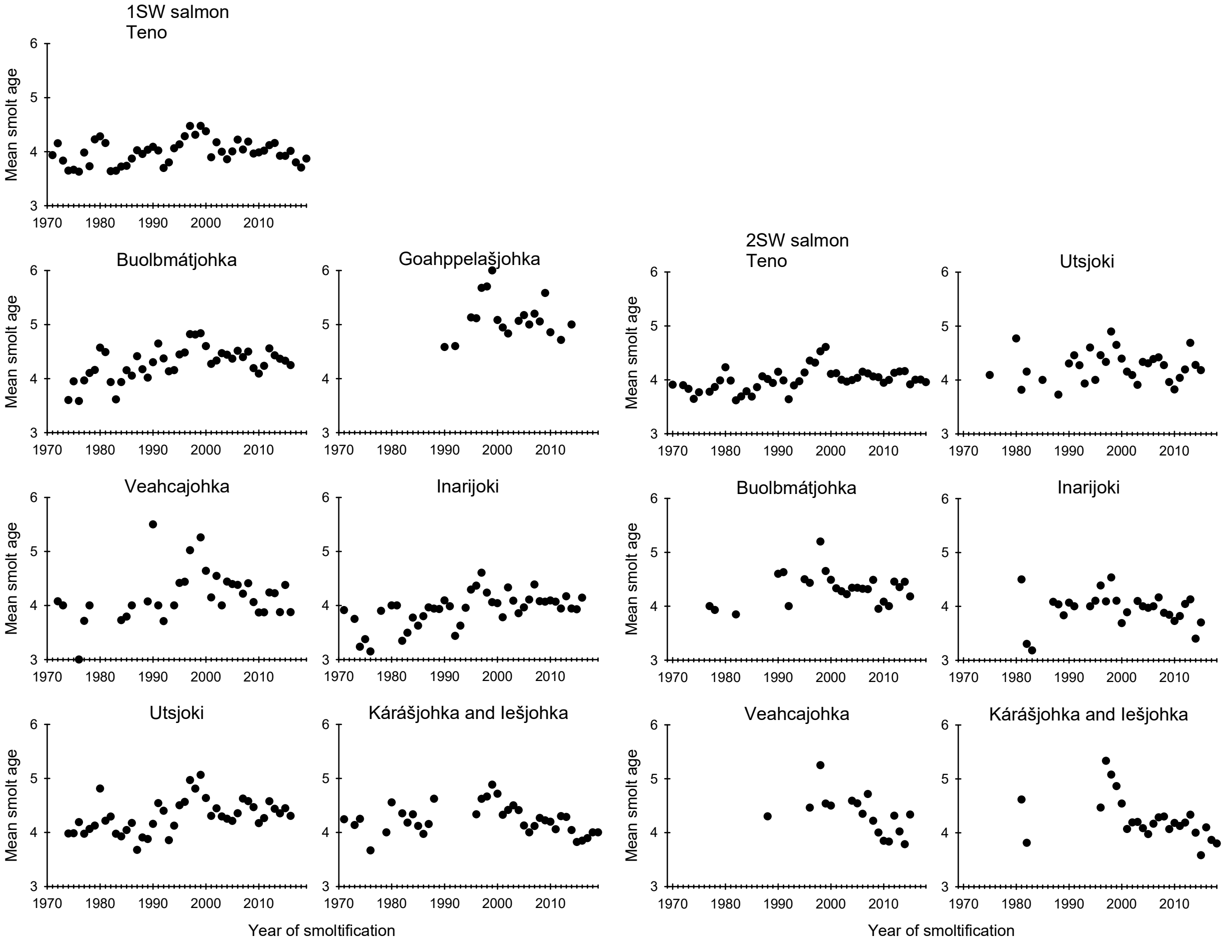

Figure 73. Mean annual smolt ages for 1SW salmon in the rivers Tana (Teno), Buolbmatjohka, Goahppelasjohka, Veahcajohka, Inarijoki, Utsjoki, Karasjohka/Iesjohka (figure on the left) and for 2SW salmon in the rivers Tana (Teno), Utsjoki, Buolbmatjohka, Inarijoki, Veahcajohka, Karasjohka/Iesjohka (figure on the right). Source: Luke (Finland),TF organization (Norway).

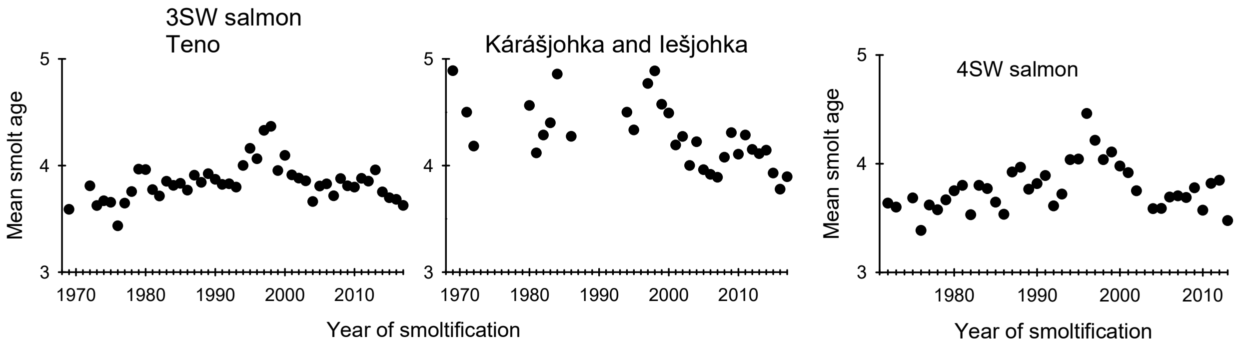

Figure 74. Mean annual smolt ages for 3SW salmon in the rivers Tana (Teno) and Karasjohka/Iesjohka (figure on the left) and for 4SW salmon in the River Tana (Teno) (figure on the right). Source: Luke (Finland),TF organization (Norway).

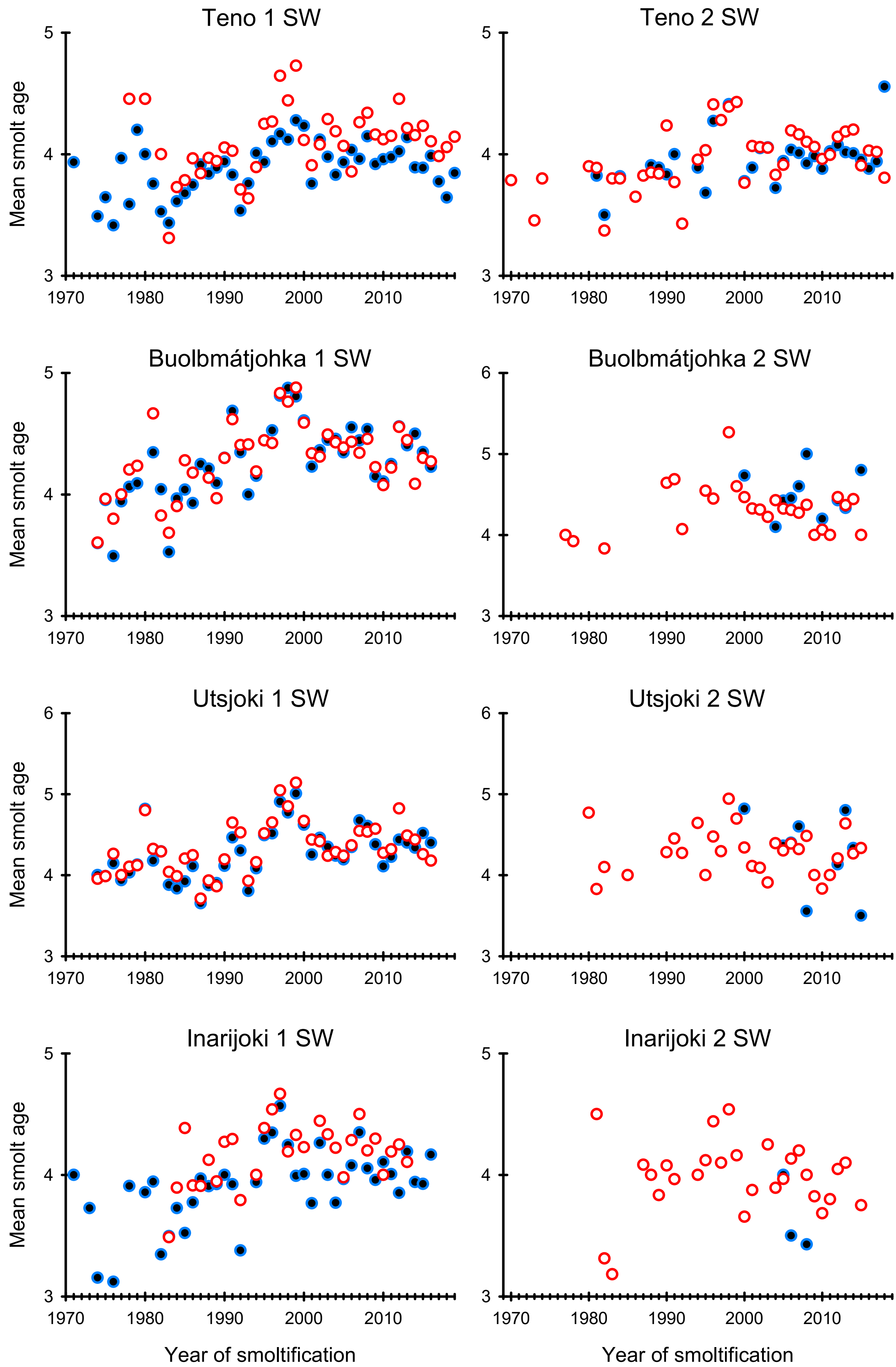

Figure 75. Mean annual smolt ages for females (red circles) and males (blue circles) in 1SW salmon and in 2SW salmon in the rivers in Tana watershed. Source: Luke (Finland).

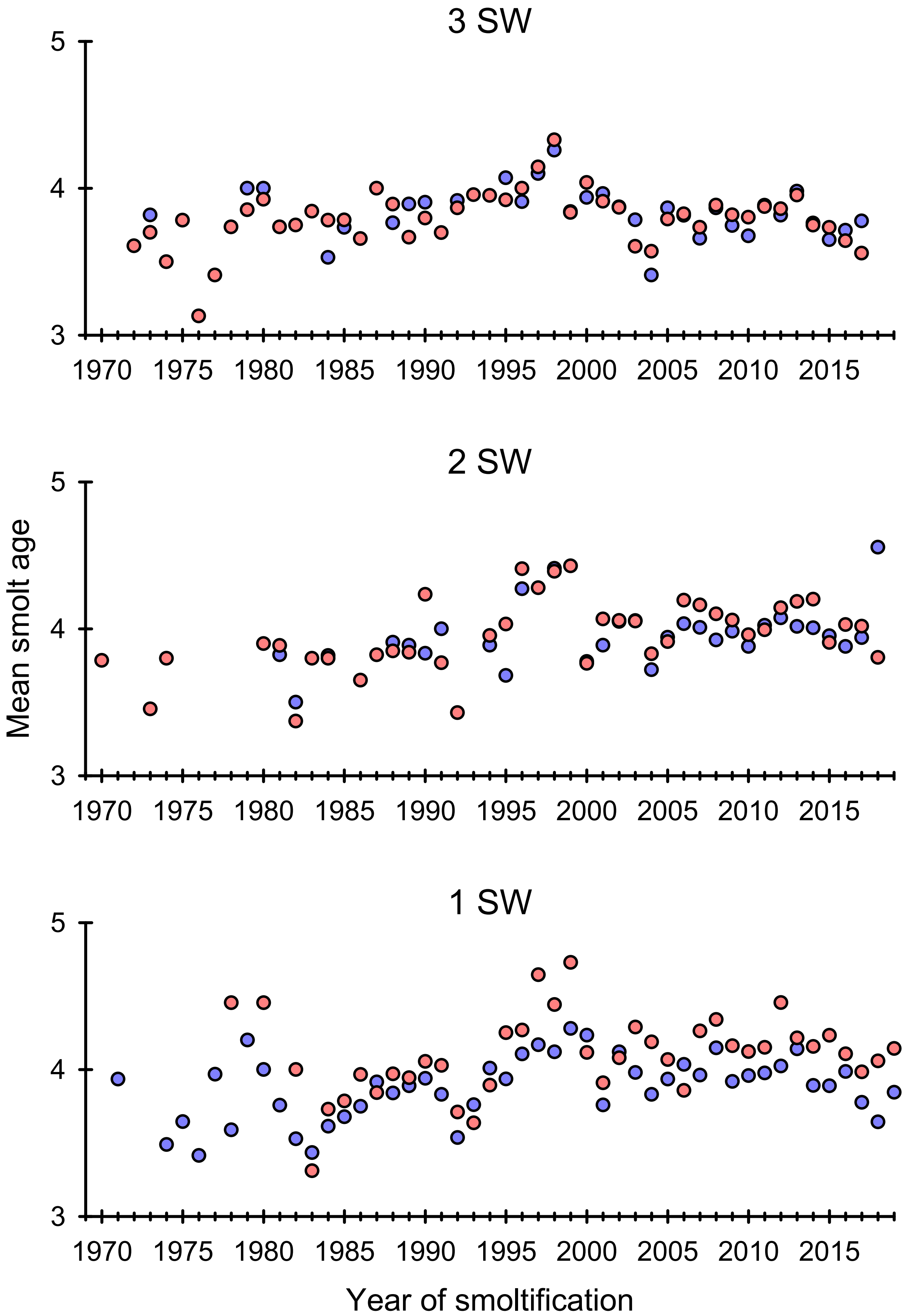

Figure 76. Annual variations in the mean smolt ages for females (red circles) and males (blue circles) in 1SW, 2SW and 3SW salmon in the River Tana mainstream. Source: Luke (Finland).

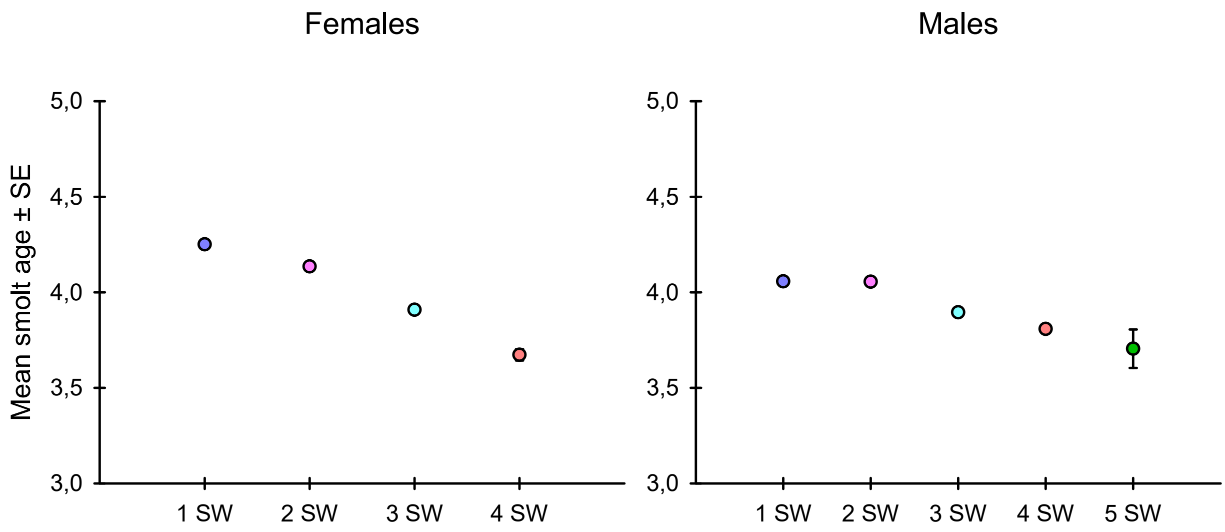

Figure 77. Mean smolt ages in 1SW, 2SW, 3SW and 4SW female and male salmon in the River Tana mainstream. Source: Luke (Finland).

Mean smolt age of 1SW salmon is higher than that in 2SW, 3SW and 4SW salmon and especially in female salmon, which have been caught in the River Tana mainstream (Fig.77). In males, mean smolt ages are declining when the adult age is increasing. Smolt age distributions are fluctuating in long-term simultaneous between the sea-ages 1SW, 2SW, 3SW and 4SW in the River Tana mainstream and between the tributary rivers Inarijoki, Utsjoki and Buolbmatjohka (Figs. 78- 82). Figure 83 shows that there are differences in the smolt age distributions between the rivers in the River Tana watershed. Especially, the smolt age distribution in the River Goahppelasjohka is indicating that the river is colder than other tributaries. In all rivers in the River Tana watershed, it can be observed that the proportions of 5 year old smolts increased clearly, 6 year and older smolts increased slighly and 3 year old smols declined from the middle of 1980's to 2000's. This indicates cold water period in the River Tana watershed and aclear occurrence of 6-8 year old smolts in salmon populations.

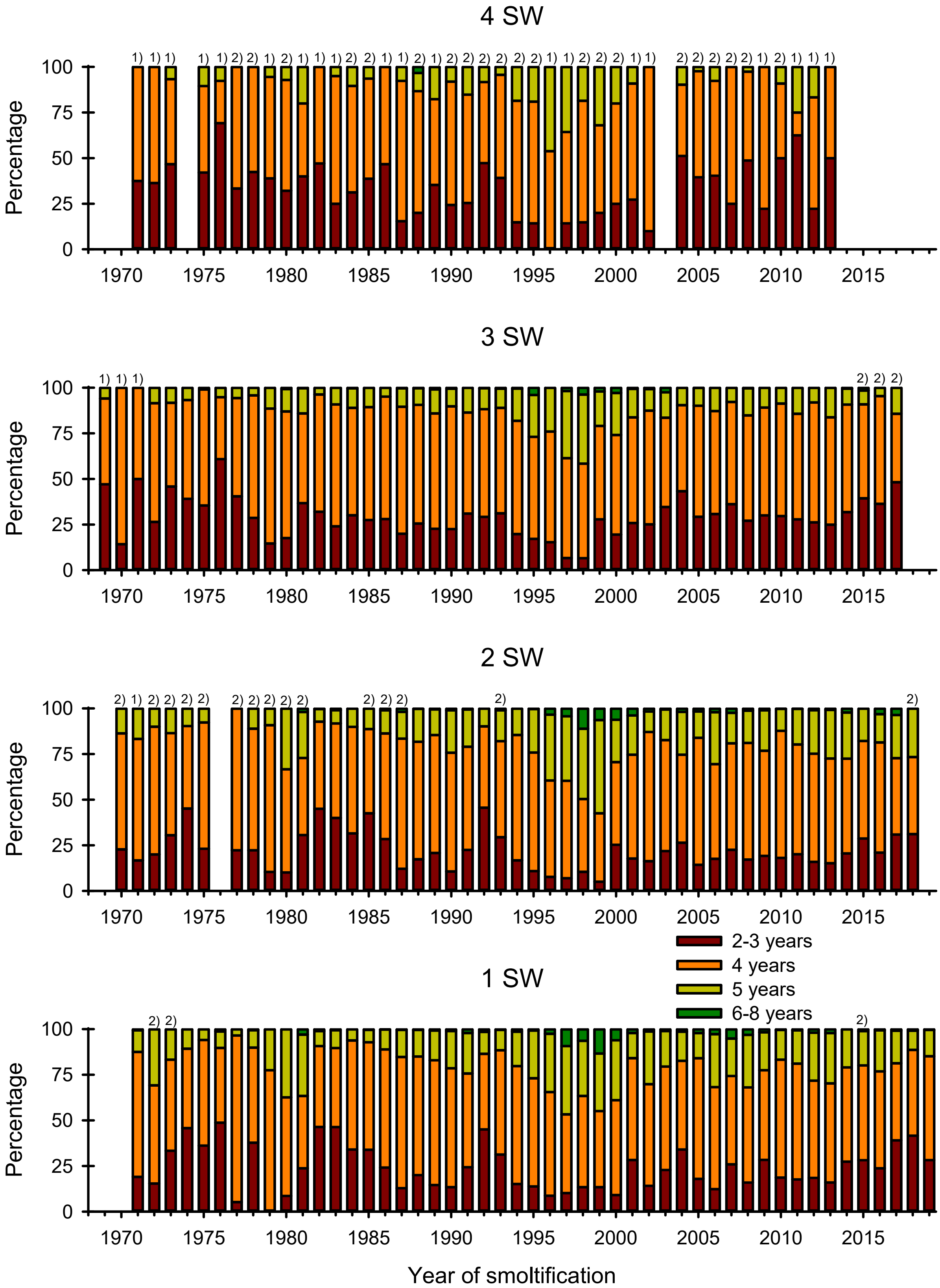

Figure 78. Smolt age distributions in 1SW, 2SW, 3SW and 4SW salmon sexes combined in the River Tana mainstream. Scale material covers the entire summer period. Source: Luke (Finland).

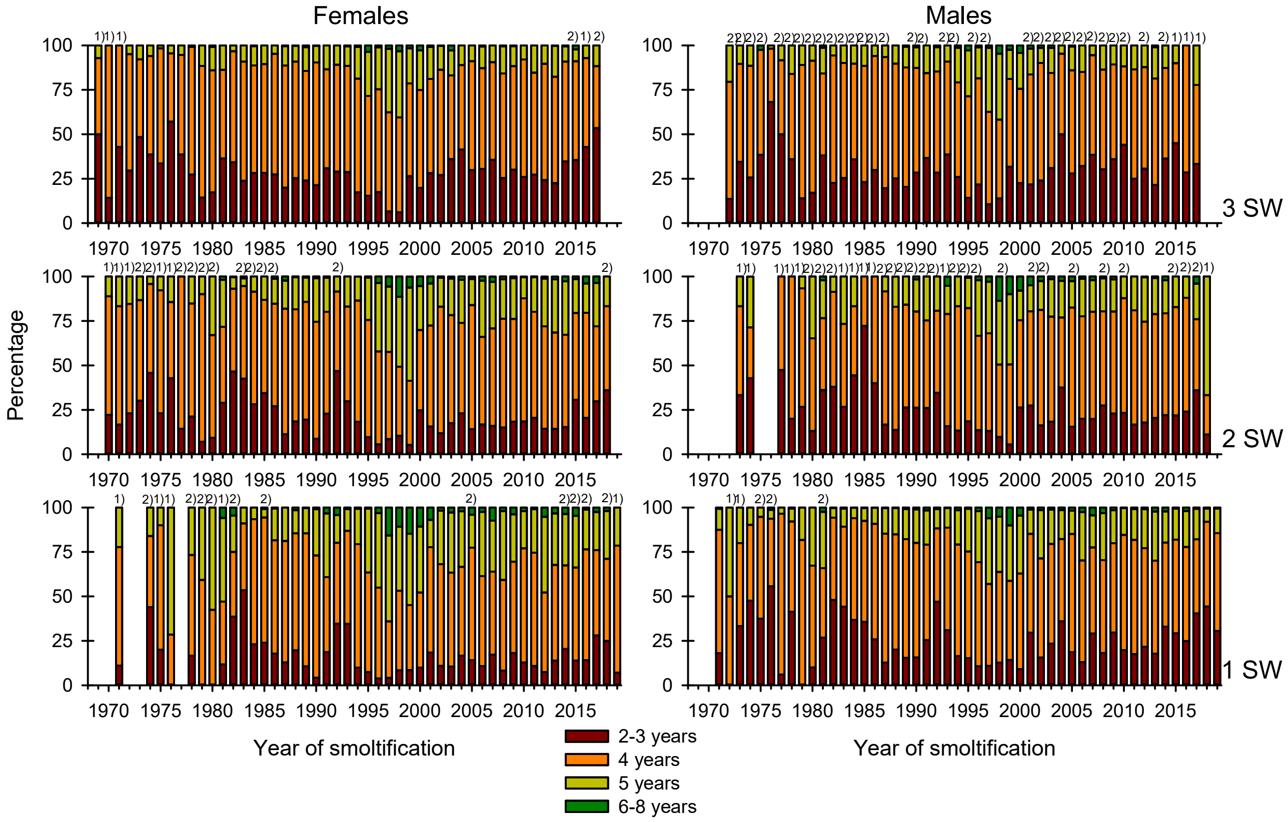

Figure 79. Smolt age distributions in 1SW, 2SW and 3SW female and male salmon in the River Tana mainstream. Scale material covers the entire summer period. Source: Luke (Finland).

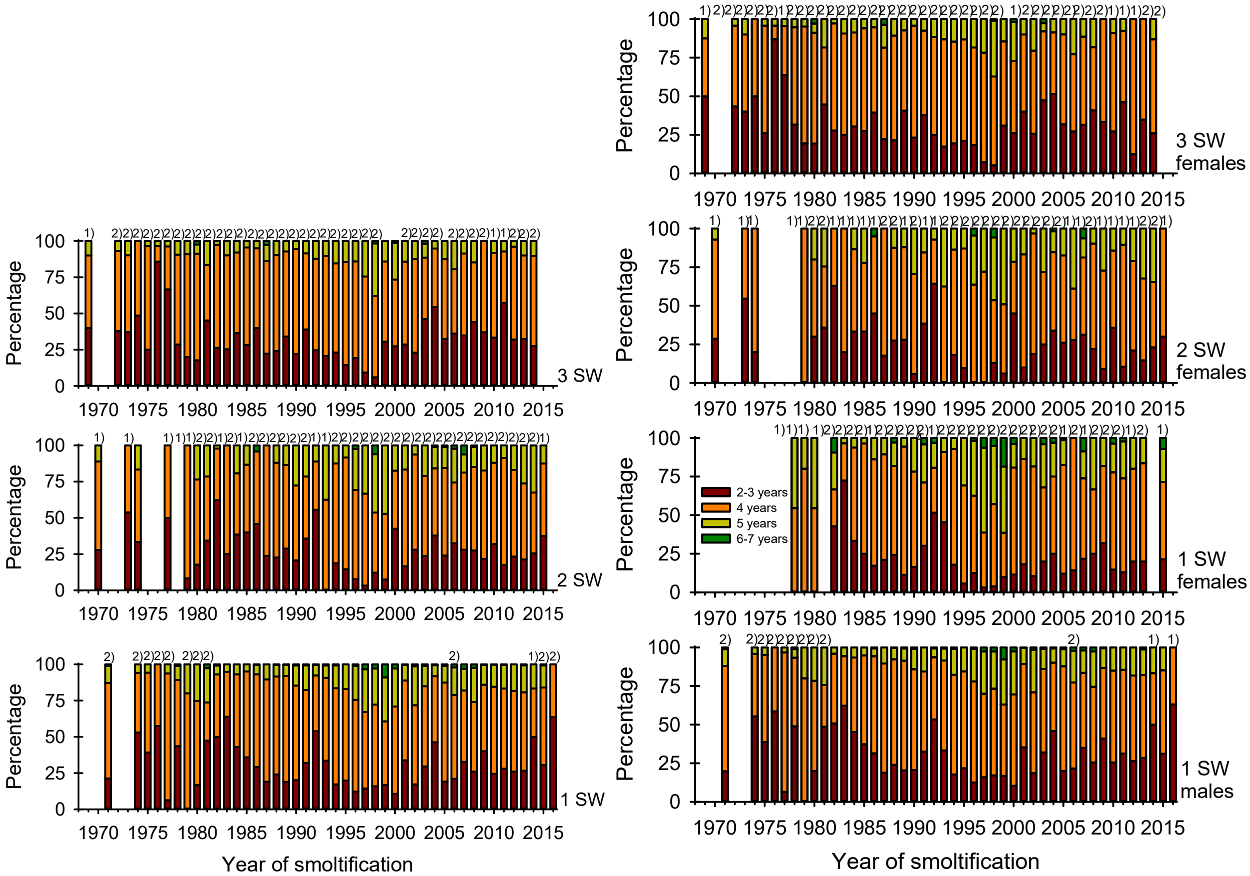

Figure 80. Smolt age distributions in August in the River Tana mainstream in 1SW, 2SW and 3SW salmon sexes combined (figure on the left) and smolt age distributions in 1SW females and males, 2SW females and 3SW females (figure on the right). Figure indicates smolt ages for salmon which are spawning in the River Tana mainstream and doesn't include fishes from tributary rivers. Source: Luke (Finland).

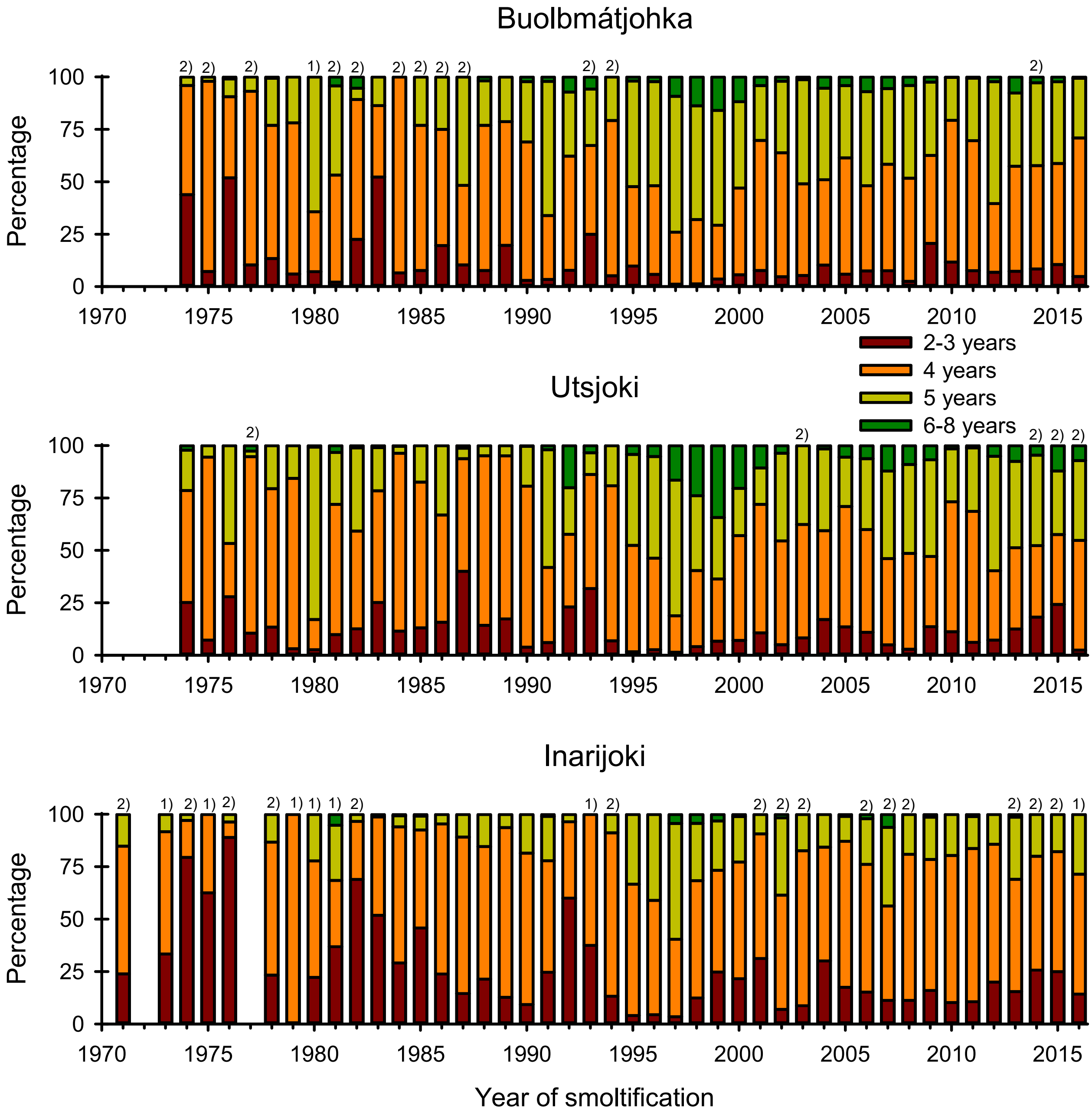

Figure 81. Annual smolt age distributions sexes combined in 1SW salmon in the rivers Buolbmatjohka, Utsjoki and Inarijoki. Source: Luke (Finland).

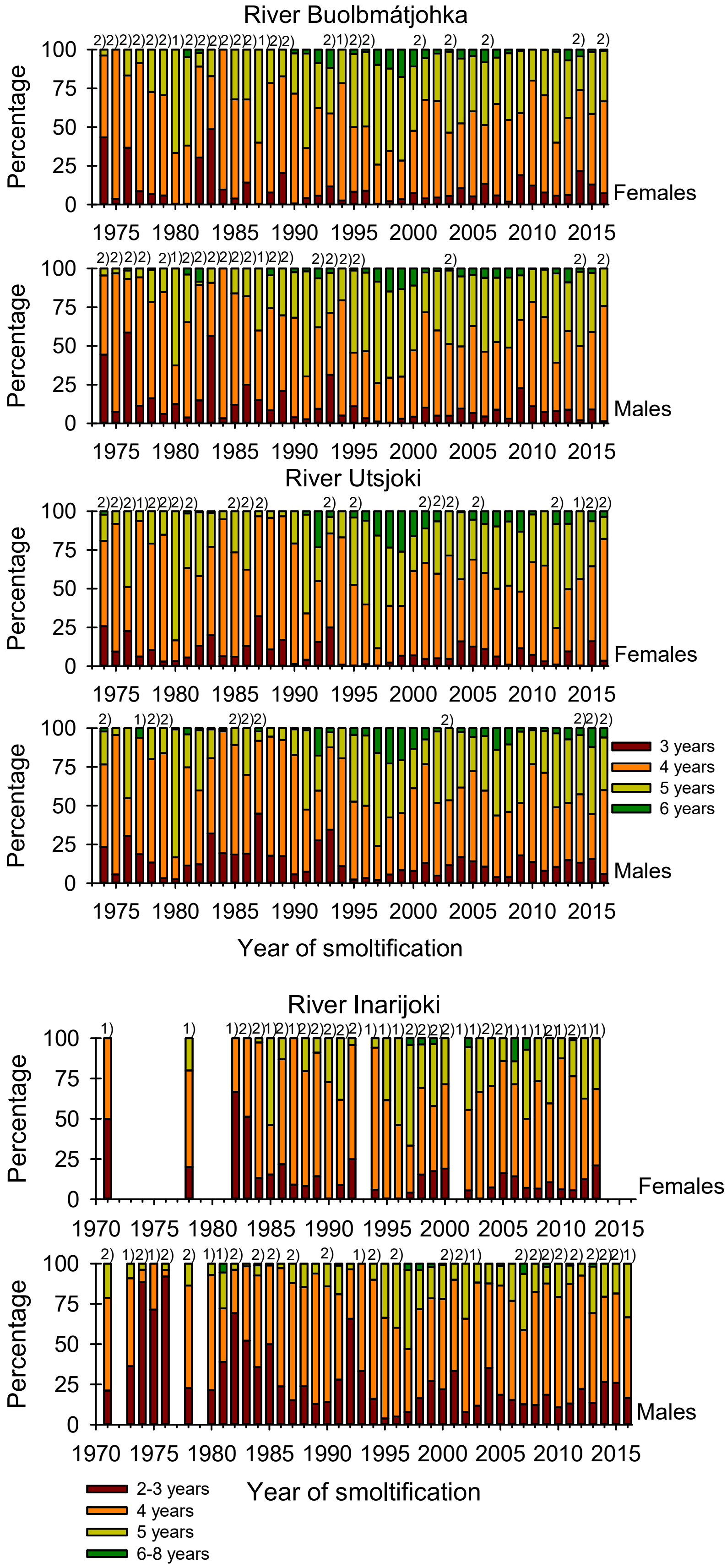

Figure 82. Annual smolt age distributions in 1SW female and male salmon in the rivers Buolbmatjohka, Utsjoki and Inarijoki. Source: Luke (Finland).

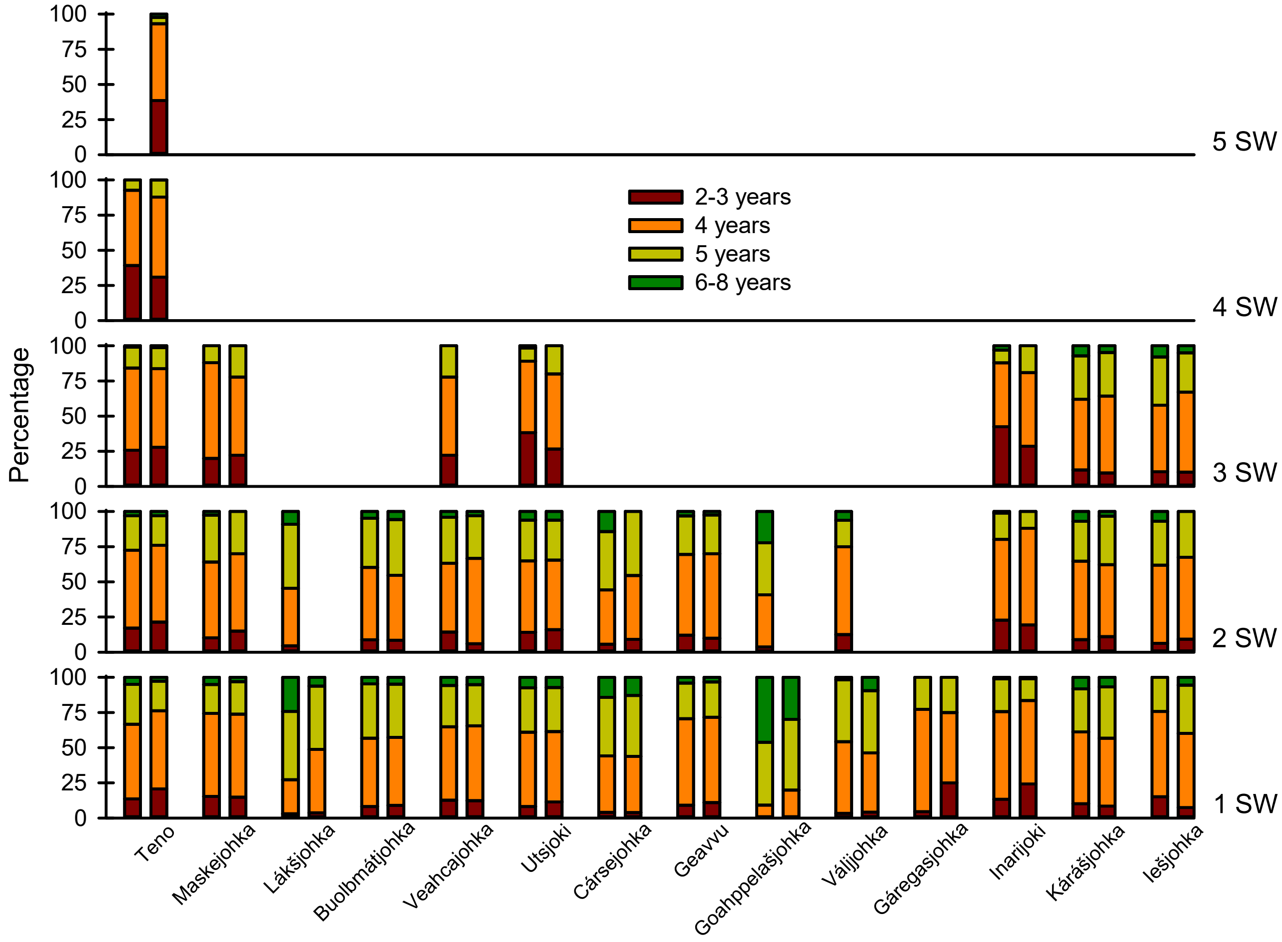

Figure 83. Smolt age distributions in the River Tana mainstream and in the tributary rivers for females (figure on the left) and males (figure on the right) in 1SW, 2SW, 3SW and 4SW salmon. Source: Luke (Finland).

11. Stability in sex distributions in 1SW, 2SW and 3SW salmon and clear differences between sea-age groups

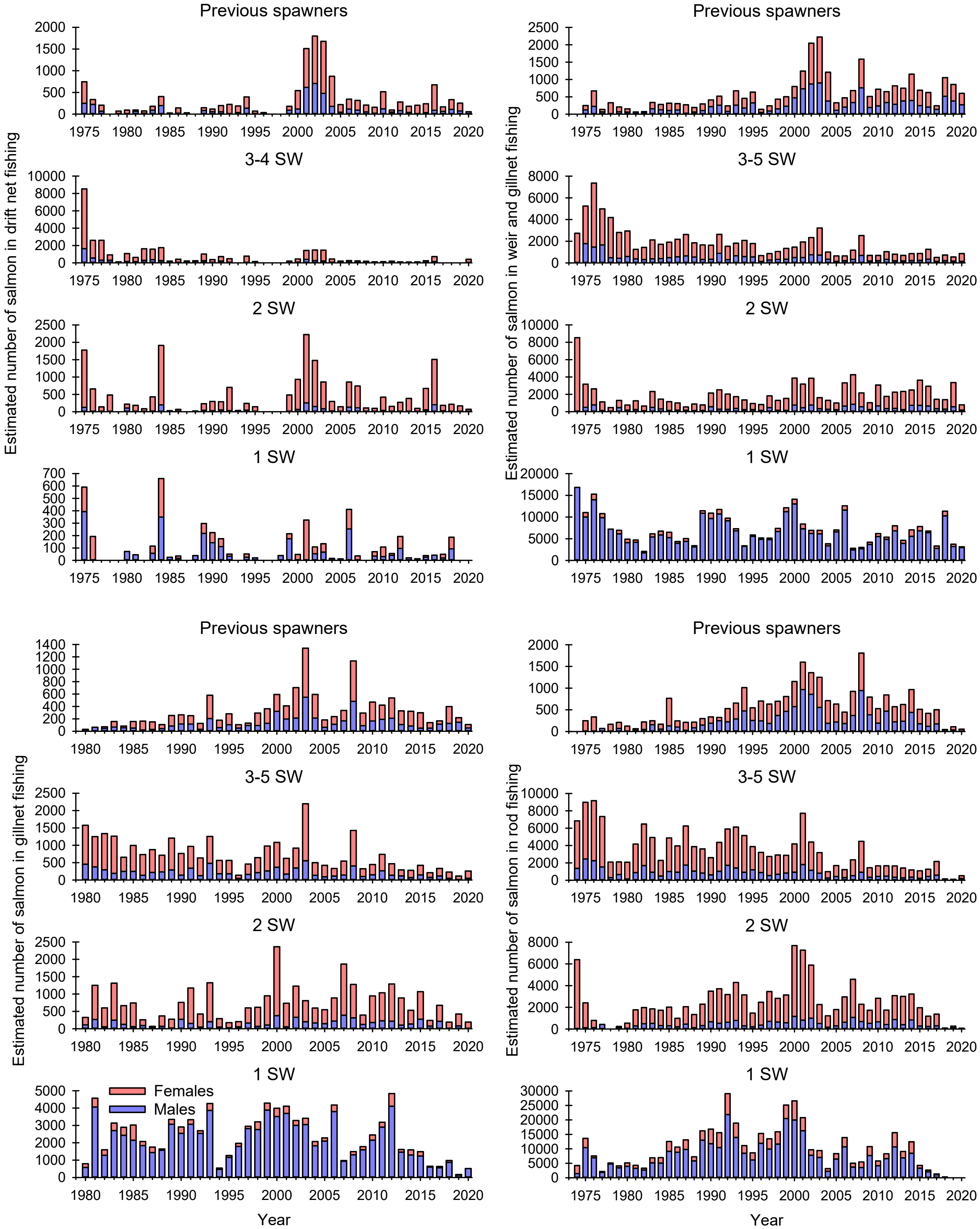

Figure 84. Annual numbers of female and male 1SW, 2SW, 3SW-5SW and previous spawning salmon in the gillnet fishing, rod fishing, drift net fishing and in the combined gillnet and weir fishing catches in the River Tana watershed. Source: Luke (Finland),TF organization (Norway).

Males have been the major sex in the catches in terms of numbers of fish in the River Tana mainstream. There has been, however, clear annual variations in the proportions of females and males. Especially in those years when the stocks of 1SW salmon are high, the proportions of females in the catches are low. This can be explained by the fact that in 1SW salmon catches in the River Tana mainstream, males are clearly dominating. In long-term, the mean proportion of females is 46% in the numbers of salmon but in terms of weight of salmon catch, females are dominating with 59% (Figs. 85, 86). The proportions of females have in long-term declined in the catches in the River Tana mainstream in terms of numbers and weights, recognizing also the clear annual variations.

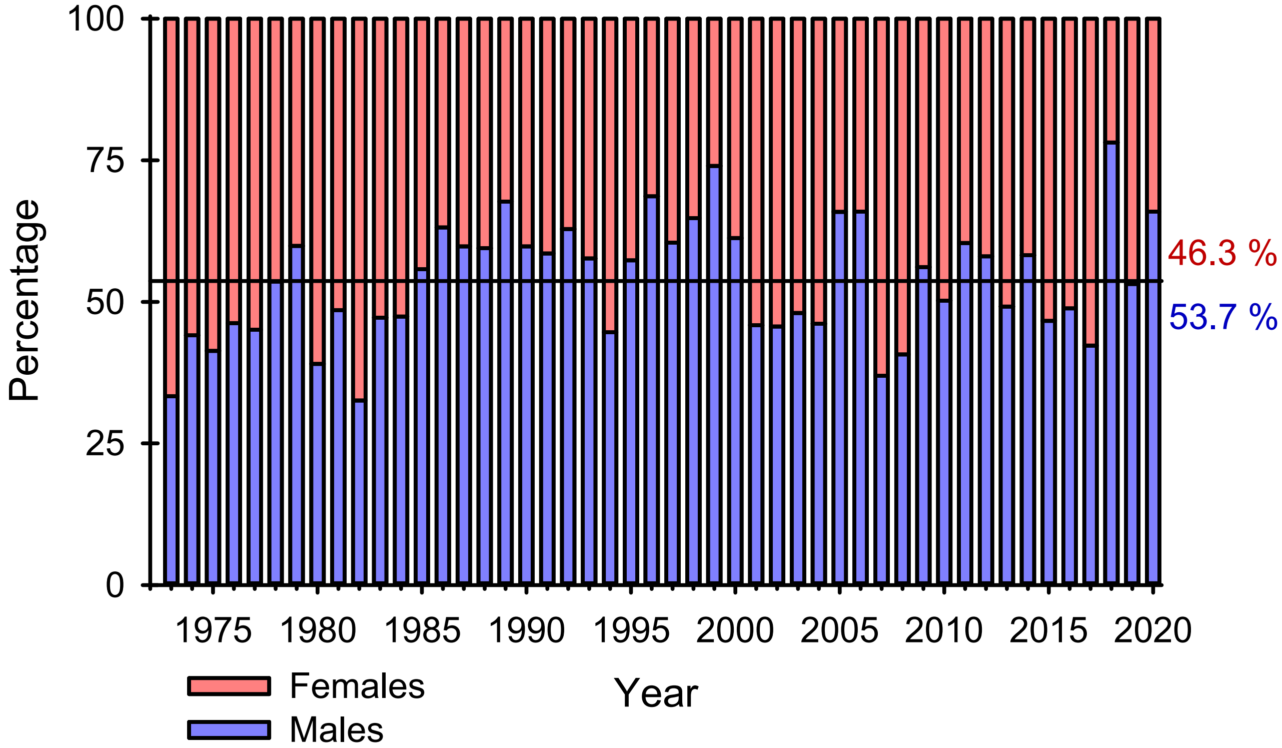

Figure 85. Annual proportions of females and males from the numbers of salmon all sea-ages combined and caught in the River Tana in Finland. Source: Luke (Finland).

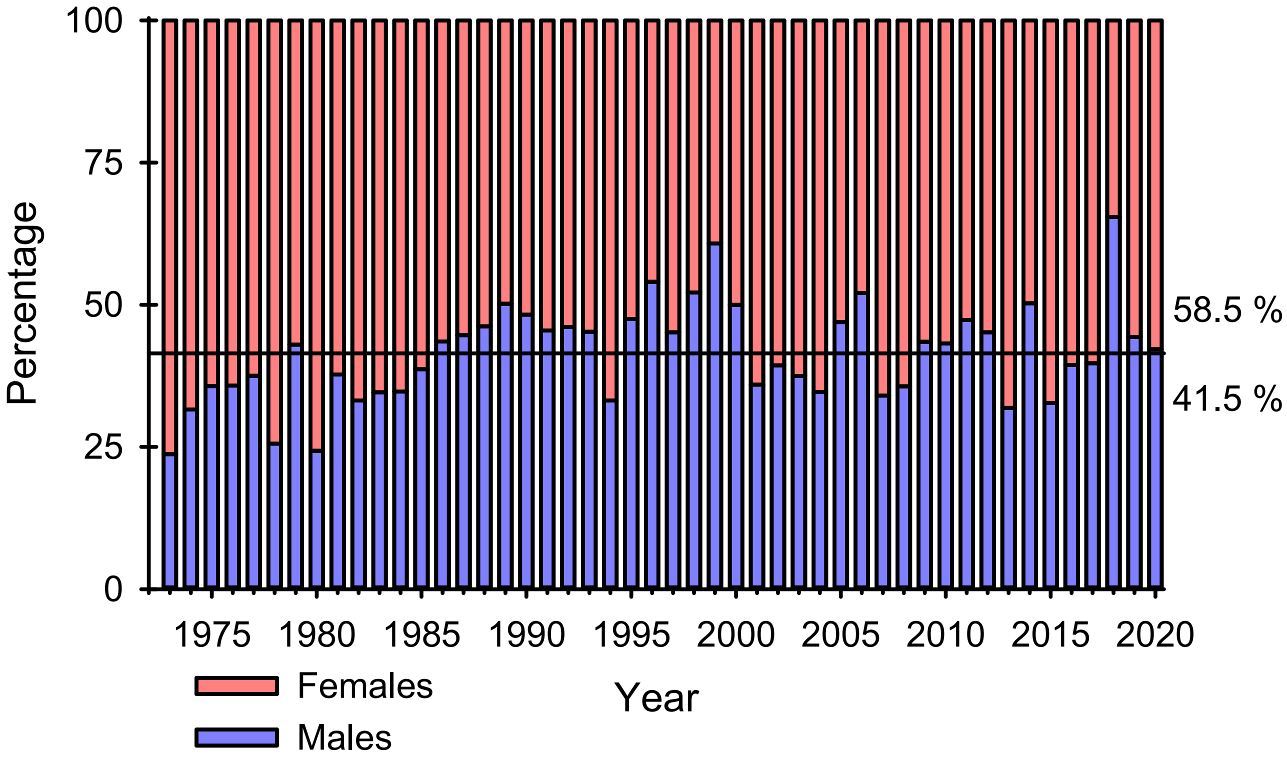

Figure 86. Annual proportions of females and males from the weights of salmon, all sea-ages combined and caught in the River Tana in Finland. Source: Luke (Finland).

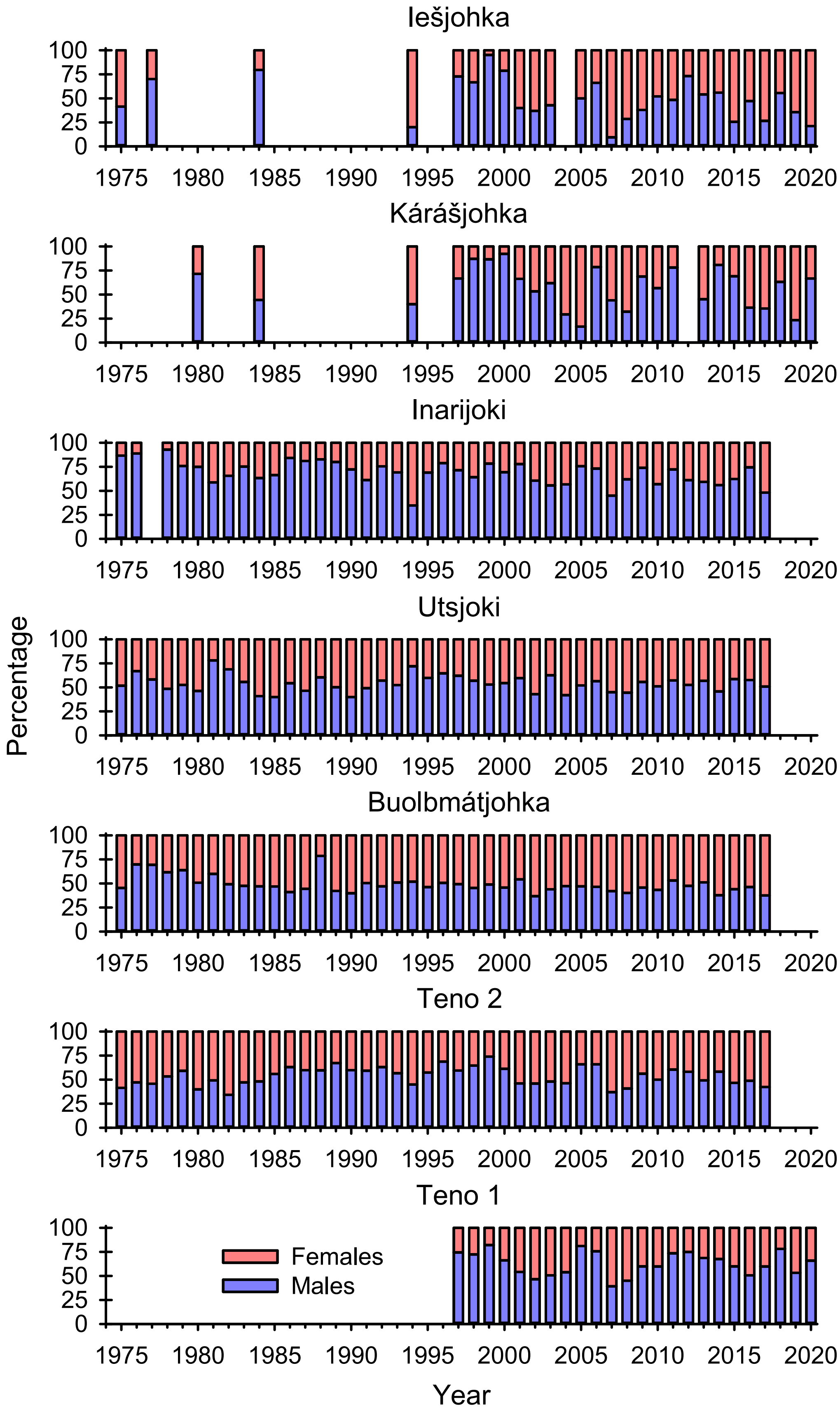

Figure 87. Annual proportions of females and males from the numbers of salmon, all sea-ages combined and caught in the River Tana watershed in Finland and in Norway. Teno 1 is the areas from the Tana river mouth to the Finnish-Norwegian border in Nuorgam. Teno 2 is the common Finnish-Norwegian border areas in the River Tana. Source: Luke (Finland),TF organization (Norway).

Sex proportions have been annually quite stable in all rivers in the River Tana watershed when all virgin sea-ages are combined. Annual sex proportions in the small tributary rivers are in the long-term stable, because the 1SW salmon is the dominating sea-age there (Fig. 87). Females are the dominating sex in the catches early in the summer. Usually in large rivers, 2SW and 3SW salmon are the first catches and females exceeds the numbers of males in those sea-ages (Figs. 88, 89). In 1SW salmon, males are the dominating sex with appr.75-85% in the River Tana mainstream (Fig. 89). In the tributary rivers Buolbmatjohka and Utsjoki, the proportions of females in 1SW salmon is appr. 50%, with small annual variations (Fig. 90). In 2SW salmon the proportions of females is in the entire Tana watershed between 15% and 20%. Annual variations in the proportions of females might depend on the numbers of fish studied.

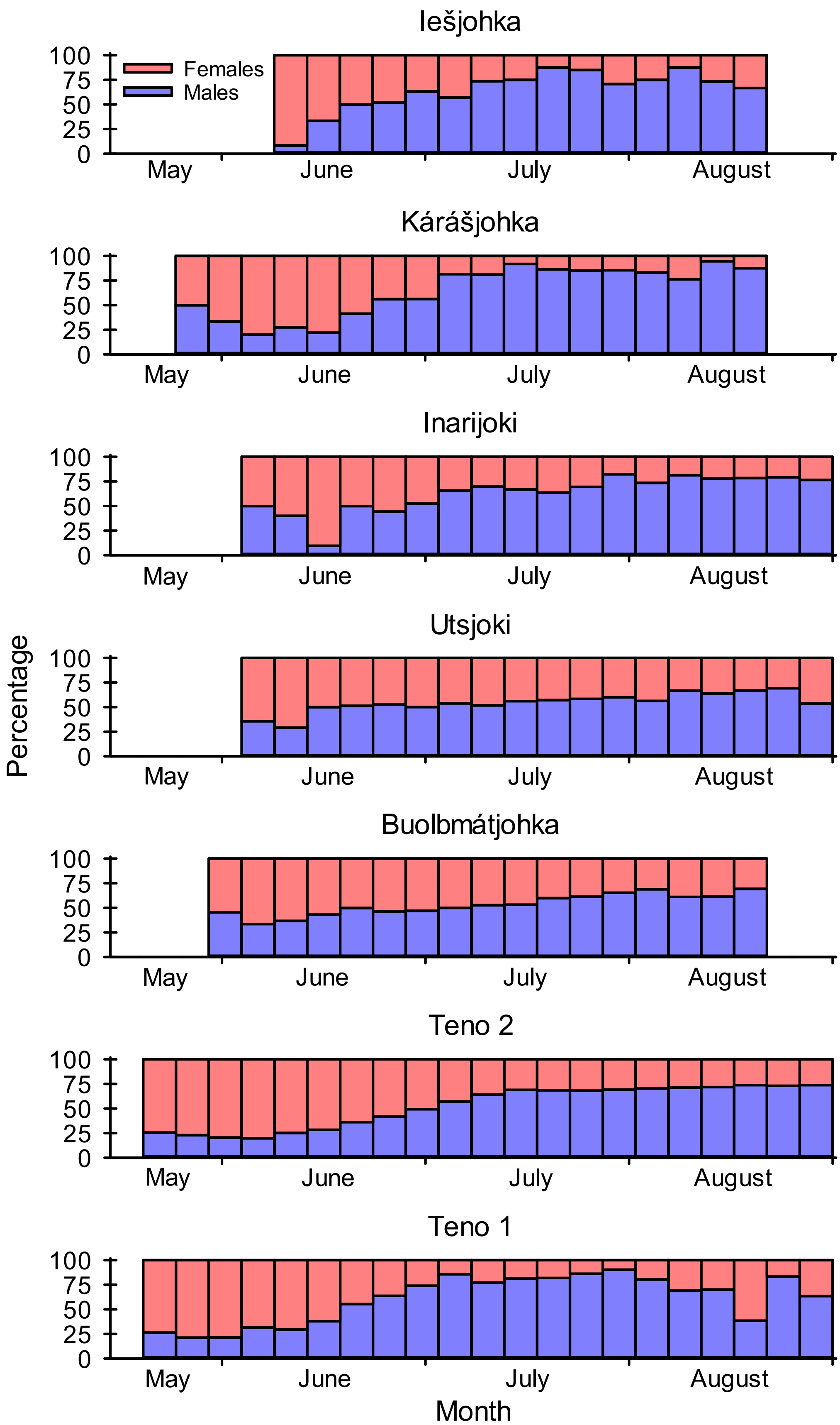

Figure 88. Temporal development in five days periods in the proportions of females and males from the numbers of salmon all sea-ages combined and caught in the River Tana watershed in Finland and in Norway. Teno 1 is the areas from the Tana river mouth to the Finnish-Norwegian border in Nuorgam. Teno 2 is the common Finnish-Norwegian border areas in the River Tana. Source: Luke (Finland),TF organization (Norway).

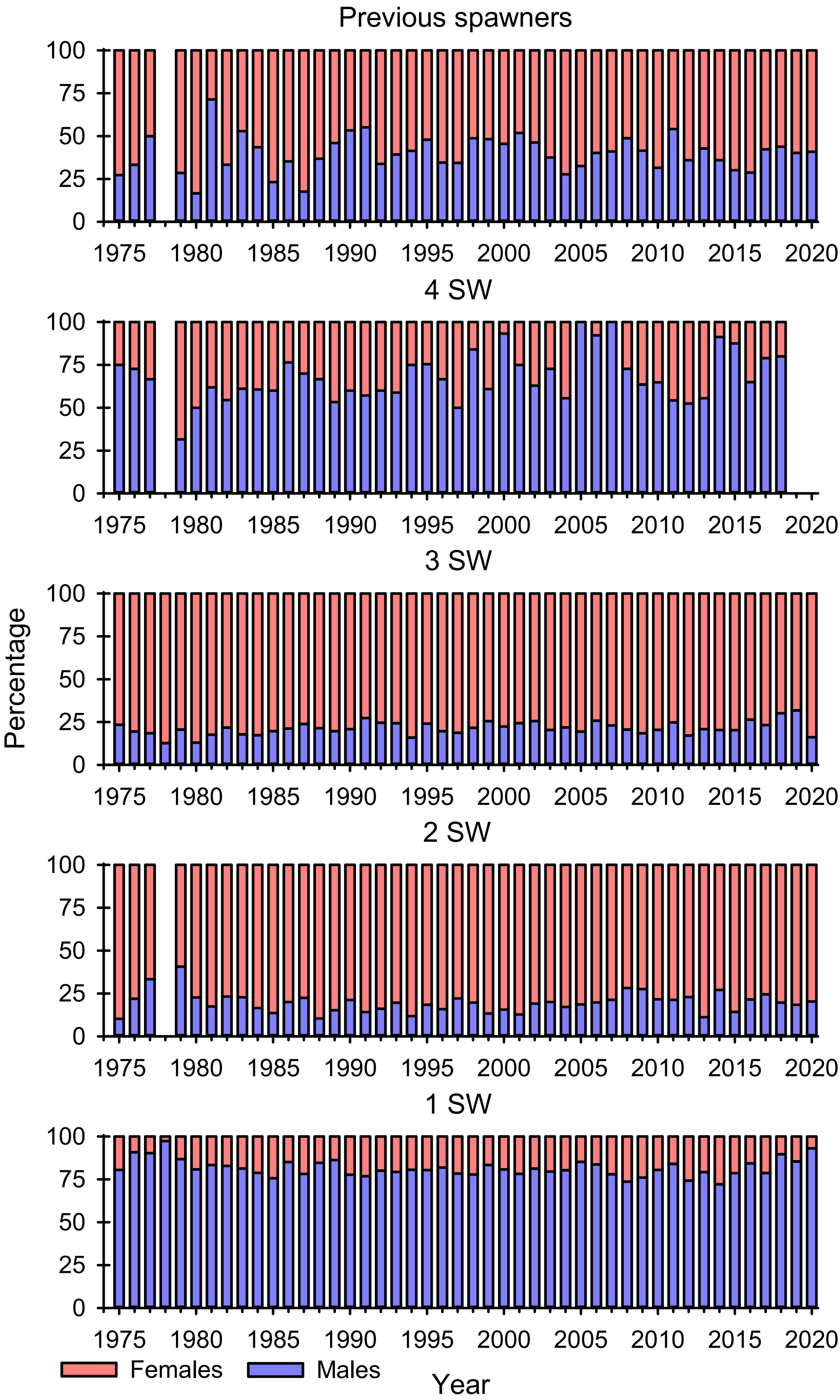

Figure 89. Annual proportions of females and males from the numbers of fish in 1SW, 2SW, 3SW. 4SW salmon and previous spawners caught in the River Tana mainstream in Finland. Source: Luke (Finland).

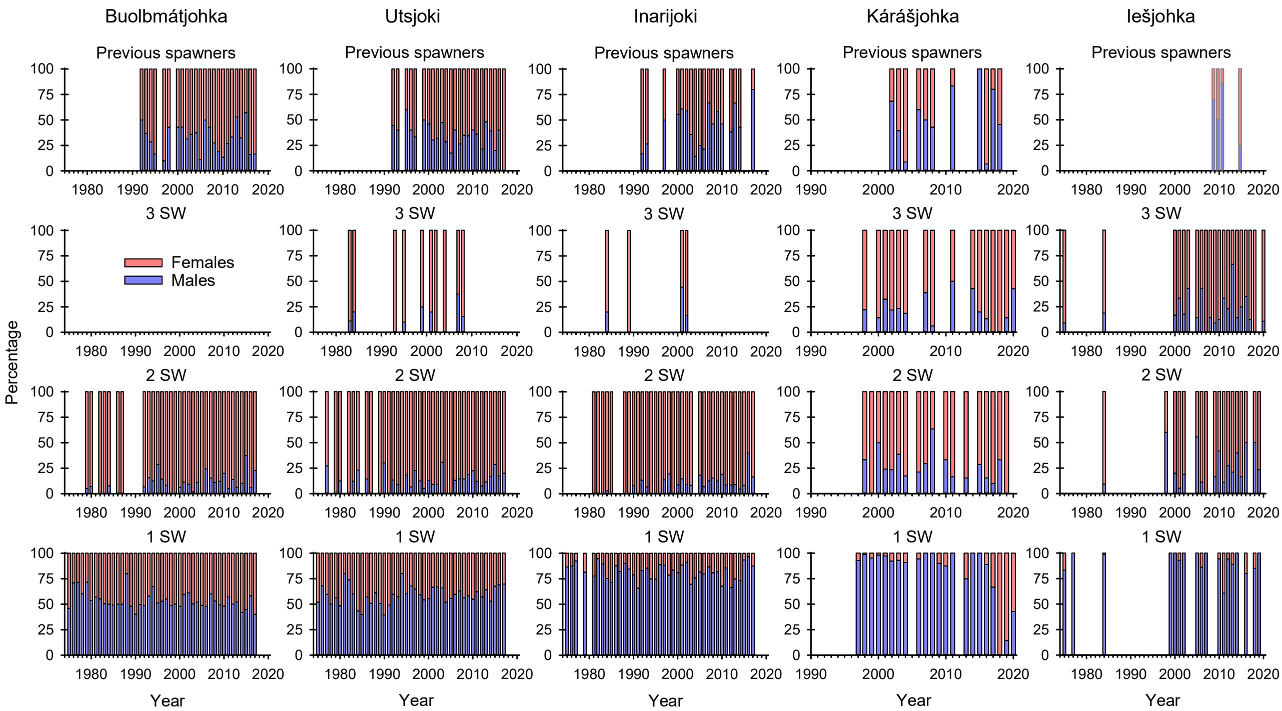

Figure 90. Annual proportions of females and males from the numbers of fish in 1SW, 2SW, 3SW salmon and previous spawners caught in the tributary rivers within the River Tana watershed in Finland and in Norway. Source: Luke (Finland),TF organization (Norway).

12. Annual variations in the mean lengths and weights of 1SW, 2SW, 3SW and 4SW salmon are indicating changes in ocean conditions

Lengths and weights of adult salmon are indicating changes in their ocean environment, where they are growing continuously from one to five year without visiting the river. Some changes in the mean lengths and weights can be caused by selective fishing with net fishing methods. In the River Tana watershed, the mean lengths and weights in 1SW, 2SW, 3SW and 4SW show clear annual fluctuations. These fluctuations are taking place simultaneously in females and males in all sea-age groups. Simultaneous fluctuations can be observed also between sea-age groups and especially between 1SW and 2SW salmon. These simultaneous changes in the mean lengths and weights are due to the ocean temperatures, which are affecting the primary production at sea and finally the nourishment of salmon.

In the River Tana watershed, mean lengths and weights of 1SW salmon have increased significantly towards the year 2017, when they were the largest since early 1970's (Figs. 91-93).

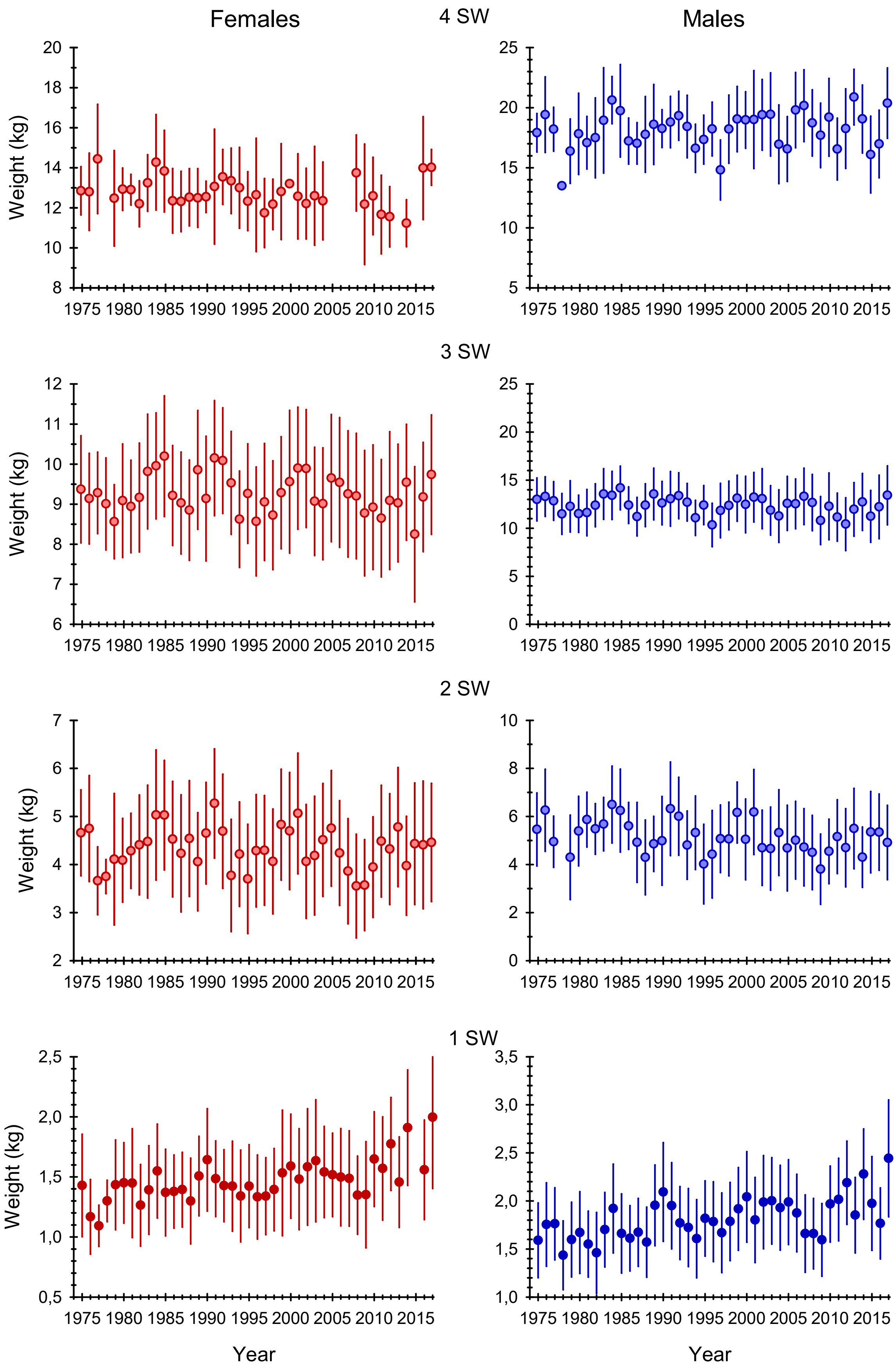

Figure 91. Annual mean weights (SD) for 1SW-4SW female and male salmon in the River Tana. Source: Luke (Finland).

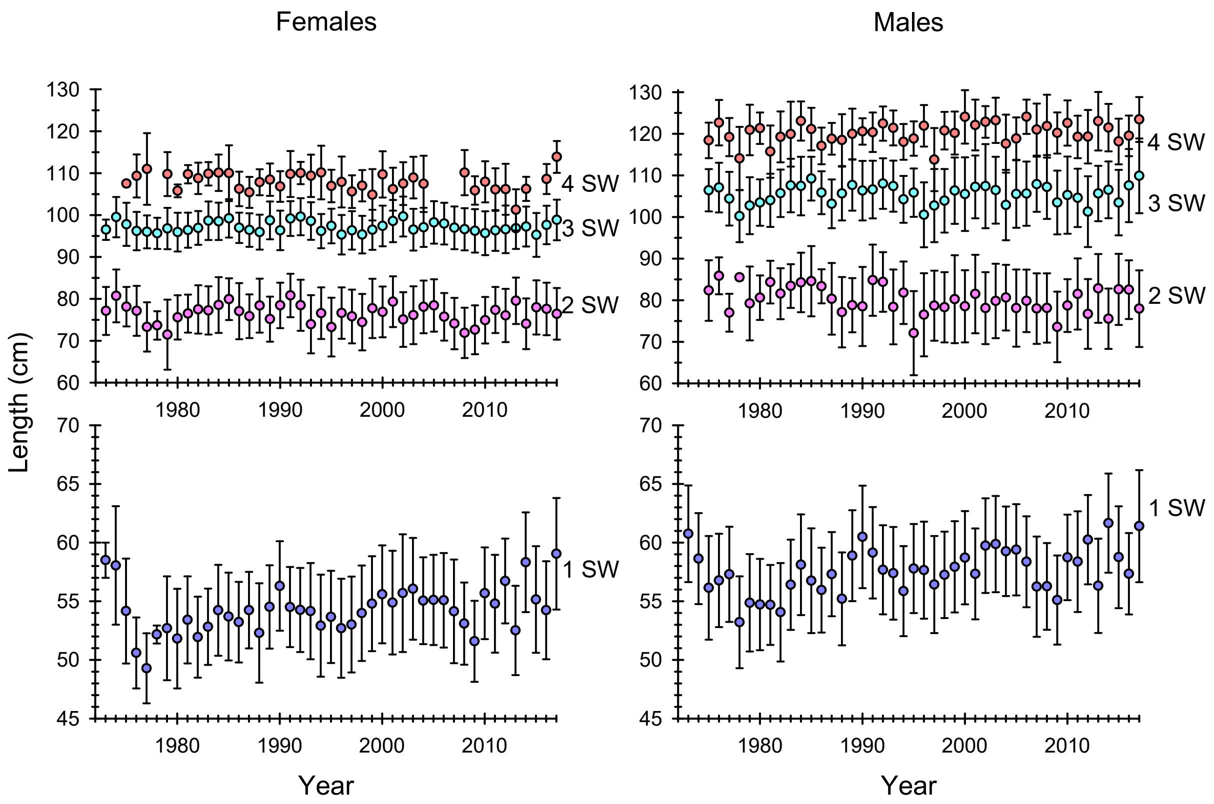

Figure 92. Annual mean lengths (SD) for 1SW-4SW female and male salmon in the River Tana. Source: Luke (Finland).

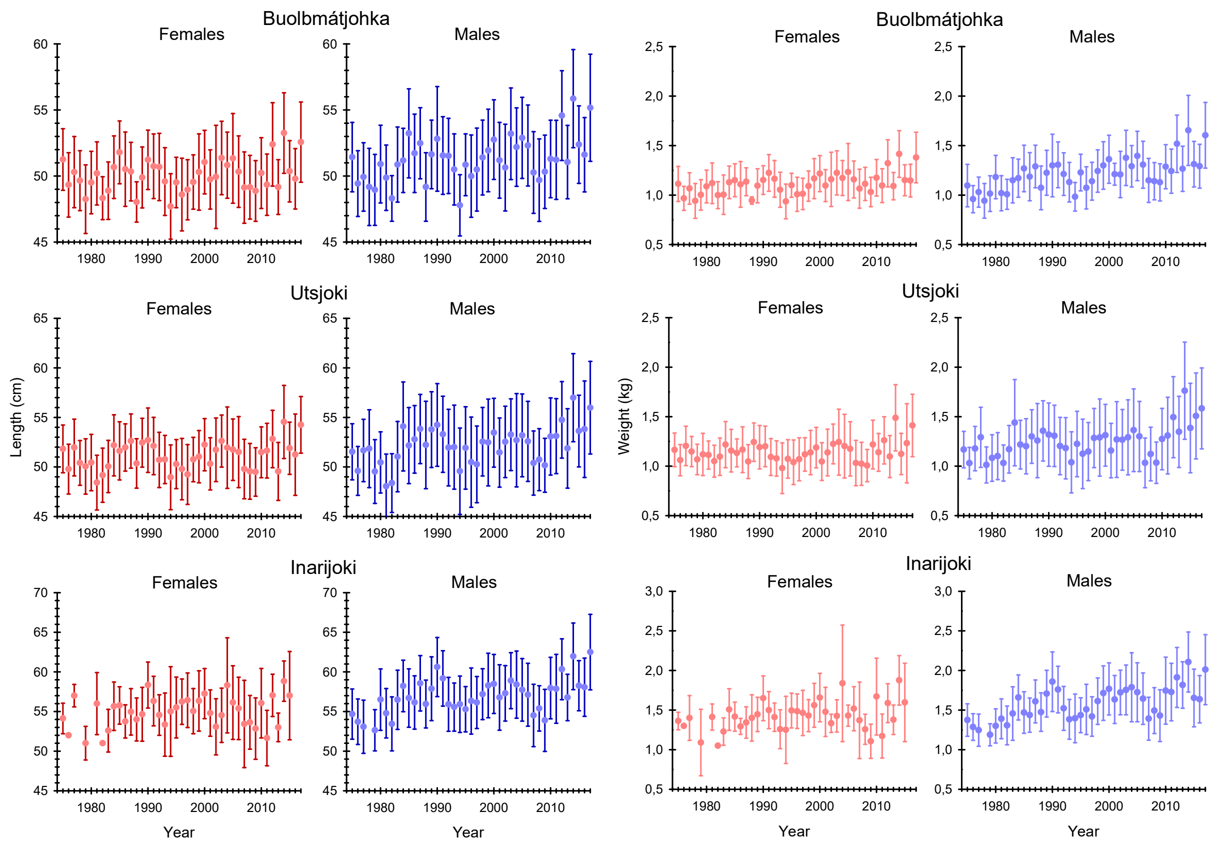

Figure 93. Annual mean lengths (SD) (figure on the left) and mean weights (SD) (figure on the right) for 1SW female and male salmon in the rivers Inarijoki, Utsjoki and Buolbmatjohka in the River Tana watershed. Source: Luke (Finland).