BALTIC SALMON AND TROUT ASSESSMENT WORKING GROUP (WGBAST)

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Contents

i Executive summary

The Baltic Salmon and Trout Assessment Working Group [WGBAST] was mandated to assess the status of salmon in Gulf of Bothnia and Main Basin (subdivisions 22–31), Gulf of Finland (Subdivision 32) and sea trout in subdivisions 22–32, and to propose consequent management advices for fisheries in 2022. Salmon in subdivision 22–31 were assessed using Bayesian methodology with a stock projection model (data up to 2020) for evaluating impacts of different catch options on the wild river stocks.

Section 2 of the report covers catches and other data on salmon in the sea, and summarizes information affecting the fisheries and management of salmon. Section 3 reviews data from salmon spawning rivers, stocking statistics and health issues. Status of salmon stocks in the Baltic Sea is evaluated in Section 4. The same section also covers methodological issues of assessment as well as sampling protocols and data needs for assessment. Section 5 presents data and assessed stock status for sea trout.

- Total salmon catches have decreased continuously since the 1990s. The fishery related mortality for salmon in 2020 (including estimates of unreported, misreported and discarded catches and recently revised estimates for recreational trolling) was similar compared to 2019. This is mainly due to significant decrease of misreporting in the open sea fishery. Reported efforts in commercial salmon fisheries have also remained on a low level.
- The level of estimated misreporting of salmon as sea trout remained on a very low level just as in 2019.
- The share of recreational catches of Baltic salmon in sea and rivers has increased over time, and at present they represent about half of the total fishing mortality. In particular, the offshore trolling fishery for salmon has developed rapidly since the 1990s and early 2000s. According to updated estimates, the total landed (retained) catch from recreational trolling has in recent years ranged from about 15 000 to 25 000 salmon per year.
- Since the 1990s, production of wild salmon smolts has gradually increased in the Gulf of Bothnia and Gulf of Finland. For most rivers in Gulf of Bothnia smolt production is predicted to increase slightly in 2021. Long-term trends for smolt production in southern Main Basin rivers have remained stable or slightly decreasing.
- The current (2020) total wild production in all Baltic Sea rivers is about 2.7 million smolts, corresponding to about 71% of overall potential smolt production capacity. In addition, about 4.7 million hatchery reared smolts were released into the Baltic Sea in 2020.
- Out of 17 analytically assessed wild salmon stocks, 7 have reached MSY level with very high certainty, especially in the northern Baltic Sea.
- In the Gulf of Finland, wild Estonian rivers show recovery. As assessed previously, most weak stocks are located in the Main Basin. Several of the rivers in this area are far below a good state and have showed a negative development in recent years.
- The exploitation rate of Baltic salmon in the commercial sea fisheries has been reduced to such a low level that most stocks (for which analytical projections are currently available) are predicted to maintain present status or recover at current levels of fishing pressure and natural mortality. However, due to local environmental issues, many weak stocks are not expected to recover without longer term stock-specific rebuilding measures, including fisheries restrictions in estuaries and rivers, habitat restoration and removal of potential migration obstacles. In particular, nearly all Main Basin stocks require such measures.

- M74-related juvenile salmon mortality increased in hatching years 2016–2018, but is expected to remain very low in spring 2021. It is hard to predict future levels of M74. Recent disease outbreaks and fish with apparent lack of energy, resulting in large numbers of dead spawners and low parr densities in some wild rivers, is another future concern. Most alarming is the situation in Vindelälven and Ljungan where parr densities have collapsed. Despite ongoing research, the reason(s) behind the deteriorating salmon health remains largely unknown.
- Positive development for sea trout in the Gulf of Finland and Baltic Sea eastern region, but many populations are still considered vulnerable. Stocks in the Gulf of Bothnia are particularly weak, although spawner numbers and parr densities show signs of improvement. Negative trend is evident in southern part of the Baltic Sea. Populations in Lithuania and Germany are weak, however, probably in part due to natural causes, but they are also affected by coastal fishing.
- In general, exploitation rates in most fisheries that catch sea trout in the Baltic Sea area should be reduced. This also holds for fisheries of other species where sea trout is caught as bycatch. In regions where stock status is good, existing fishing restrictions should be maintained in order to retain the present situation.

ii Expert group information

Expert group name	Baltic Salmon and Trout Assessment Working Group (WGBAST)
Expert group cycle	Annual
Year cycle started	2021
Reporting year in cycle	1/1
Chair	Martin Kesler, Estonia
Meeting venue and dates	22–30 March 2021, by WebEx (28 participants)

1 Introduction

1.1 Presentation of the working group and report

The Baltic Salmon and Trout Assessment Working Group within ICES (WGBAST) contains around 30 experts from all nine countries surrounding the Baltic Sea. The group is mandated to assess status and propose management advice for salmon in Baltic Main Basin and Gulf of Bothnia (ICES subdivisions 22–31), Gulf of Finland (Subdivision 32) and sea trout in subdivisions 22–32. Compilation of data (biological and fisheries related) and stock assessment is performed annually in relation to a working group meeting. The working group report is externally reviewed before publication, and the status assessment constitutes the basis for ICES advice on fishing possibilities.

The present report contains updated dataseries and results from the last meeting in 2021. Section 1 contains background information and responses to last year's review comments, whereas Section 2 of covers catches and other data on salmon in the sea, and summarizes information affecting the salmon fisheries and management. Section 3 reviews data from salmon spawning rivers, stocking statistics and health issues. Status of salmon stocks in the Baltic Sea is evaluated in Section 4. The same section also covers methodological issues of assessment as well as sampling protocols and data needs for assessment. Section 5 presents data and stock status for sea trout.

In addition to the above sections mainly focused on recent results and long-term trends, various important information of more static nature is presented in the so-called "Stock Annex" (Annex 2). The annex contains background descriptions of Baltic salmon biology, rivers and assessment units, fisheries, data collection, and estimation methods and models used for status assessment. The stock annex is only updated when needed, for example following larger changes to the assessment methodology that have been reviewed separately by external experts (during so-called "benchmarks").

1.2 Terms of reference

2020/2/FRSG01 The following ToRs apply to: AFWG, HAWG, NWWG, NIPAG, WGWIDE, WGBAST, WGBFAS, WGNSSK, WGCSE, WGDEEP, WGBIE, WGEEL, WGEF, WGHANSA and WGNAS.

The working group should focus on:

a) Consider and comment on Ecosystem and Fisheries overviews where available;
b) For the aim of providing input for the Fisheries Overviews, consider and comment on the following for the fisheries relevant to the working group:
   1. descriptions of ecosystem impacts on fisheries;
   2. descriptions of developments and recent changes to the fisheries;
   3. mixed fisheries considerations; and
   4. emerging issues of relevance for management of the fisheries.
c) Conduct an assessment on the stock(s) to be addressed in 2021 using the method (assessment, forecast or trends indicators) as described in the stock annex and produce a **brief** report of the work carried out regarding the stock, providing summaries of the following where relevant:
   1. Input data and examination of data quality; in the event of missing or inconsistent survey or catch information refer to the ACOM document for dealing with COVID-

19 pandemic disruption and the linked template that formulates how deviations from the stock annex are to be reported.

2. Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;
3. For relevant stocks (i.e. all stocks with catches in the NEAFC Regulatory Area), estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in 2020.
4. Estimate MSY reference points or proxies for the category 3 and 4 stocks.
5. Evaluate spawning–stock biomass, total stock biomass, fishing mortality, catches (projected landings and discards) using the method described in the stock annex;
   (i) for category 1 and 2 stocks, in addition to the other relevant model diagnostics, the recommendations and decision tree formulated by WKFORBIAS (see Annex 2 of https://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/Fisheries%20Resources%20Steering%20Group/2020/WKFORBIAS_2019.pdf) should be considered as guidance to determine whether an assessment remains sufficiently robust for providing advice.
   (ii) If the assessment is deemed no longer suitable as basis for advice, consider whether it is possible and feasible to resolve the issue through an inter-benchmark. If this is not possible, consider providing advice using an appropriate Category 2 to 5 approach.
6. The state of the stocks against relevant reference points;

   Consistent with the ACOM 2020 decision, the basis for F_{pa} should be $F_{p.05}$.

   (i) Where $F_{p.05}$ for the current set of reference points is reported in the relevant benchmark report, replace the value and basis of F_{pa} with the information relevant for $F_{p.05}$.
   (ii) Where $F_{p.05}$ for the current set of reference points is not reported in the relevant benchmark report, compute the $F_{p.05}$ that is consistent with the current set of reference points and use as F_{pa}. A review/audit of the computations will be organized.
   (iii) Where $F_{p.05}$ for the current set of reference points is not reported and cannot be computed, retain the existing basis for F_{pa}.
7. Catch scenarios for the year(s) beyond the terminal year of the data for the stocks for which ICES has been requested to provide advice on fishing opportunities;
8. Historical and analytical performance of the assessment and catch options with a succinct description of associated quality issues. For the analytical performance of category 1 and 2 age-structured assessments, report the mean Mohn's rho (assessment retrospective bias analysis) values for time-series of recruitment, spawning–stock biomass, and fishing mortality rate. The WG report should include a plot of this retrospective analysis. The values should be calculated in accordance with the "Guidance for completing ToR viii) of the Generic ToRs for Regional and Species Working Groups - Retrospective bias in assessment" and reported using the ICES application for this purpose.

d) Produce a first draft of the advice on the stocks under considerations according to ACOM guidelines.
   1. In the section 'Basis for the assessment' under input data match the survey names with the relevant "SurveyCode" listed ICES survey naming convention (restricted access) and add the "SurveyCode" to the advice sheet.

e) Review progress on benchmark issues and processes of relevance to the Expert Group.

1. update the benchmark issues lists for the individual stocks;
2. review progress on benchmark issues and identify potential benchmarks to be initiated in 2022 for conclusion in 2023;
3. determine the prioritization score for benchmarks proposed for 2022–2023;
4. as necessary, document generic issues to be addressed by the Benchmark Oversight Group (BOG).

f) Prepare the data calls for the next year's update assessment and for planned data evaluation workshops;

g) Identify research needs of relevance to the work of the Expert Group.

h) Review and update information regarding operational issues and research priorities on the Fisheries Resources Steering Group SharePoint site.

i) If not completed in 2020, complete the audit spread sheet 'Monitor and alert for changes in ecosystem/fisheries productivity' for the new assessments and data used for the stocks. Also note in the benchmark report how productivity, species interactions, habitat and distributional changes, including those related to climate-change, could be considered in the advice.

Information of the stocks to be considered by each Expert Group is available here.

Material and data relevant for the meeting must be available to the group on the dates specified in the 2021 ICES data call. WGBAST will report by 19 April 2021 for the attention of ACOM.

Following correspondence with the ICES ACOM leadership, it was decided that specific ToR b) (planning of a scoping workshop) could be handled via correspondence later in 2021. In the report, generic ToRs for regional and species working groups are addressed primarily in Sections 4 (salmon) and 5 (sea trout). A short summary of the group's response to specific ToR c) on the EU Data Collection Framework and EU-MAP is provided in Appendix 1.

1.3 Participants

The following experts participated at WGBAST in 2021:

Name		Country
Adam Lejk	(participating remotely)	Poland
Anders Kagervall	(participating remotely)	Sweden
Antanas Kontautas	(participating remotely)	Lithuania
Atso Romakkaniemi	(participating remotely)	Finland
Dmitry Sendek	(participating remotely)	Russia
Elin Dahlgren	(participating remotely)	Sweden
Harry Vincent Strehlow	(participating remotely)	Germany
Janis Bajinskis	(participating remotely)	Latvia
Johan Dannewitz	(participating remotely)	Sweden
Katarina Magnusson	(participating remotely)	Sweden

Name		Country
Katarzyna Nadolna-Ałtyn	(participating remotely)	Poland
Martin Kesler	(participating remotely)	Estonia
Marja-Liisa Koljonen	(participating remotely)	Finland
Piotr Debowski	(participating remotely)	Poland
Rafal Bernas	(participating remotely)	Poland
Rebecca Whitlock	(participating remotely)	Sweden
Rūdolfs Tutiņš	(participating remotely)	Poland
Samu Mäntyniemi	(participating remotely)	Finland
Sergey Titov	(participating remotely)	Russia
Stefan Palm	(participating remotely)	Sweden
Stefan Stridsman	(participating remotely)	Sweden
Stig Pedersen	(participating remotely)	Denmark
Simon Weltersbach	(participating remotely)	Germany
Susanne Tärnlund	(participating remotely)	Sweden
Tapani Pakarinen	(participating remotely)	Finland
Tuomas Leinonen	(participating remotely)	Finland
Victoria Amosova	(participating remotely)	Russia

1.4 Code of Conduct

In 2018, ICES introduced a Code of Conduct that provides guidelines to its expert groups on identifying and handling actual, potential or perceived Conflicts of Interest. It further defines the standard for behaviours of experts contributing to ICES science. The aim is to safeguard the reputation of ICES as an impartial knowledge provider by ensuring the credibility, salience, legitimacy, transparency, and accountability in ICES work. Therefore, all contributors to ICES work are required to abide by the ICES Code of Conduct.

At the beginning of the 2021 WGBAST meeting, the chair raised the ICES Code of Conduct with all attending member experts. In particular, they were asked if they would identify and disclose an actual, potential or perceived Conflict of Interest as described in the Code of Conduct. After reflection, none of the members identified a conflict of interest that challenged the scientific independence, integrity, and impartiality of ICES.

1.5 Ecosystem considerations

1.5.1 Salmon and sea trout in the Baltic ecosystem

Salmon (*Salmo salar)* and sea trout (*Salmo trutta)* are among the top fish predators in the Baltic Sea. Together with European eel (*Anguilla anguilla*) and migratory whitefish (*Coregonus lavaretus*/*Coregonus maraena*) they form the group of keystone diadromous species in the Baltic Sea. Annex 2 contains background descriptions related to ecosystem aspects for Baltic salmon, including basic biology, ecological functioning, environmental pressures, disease outbreaks, effects of climate change, and fisheries impacts, whereof most are common for both species. At the beginning of Section 5, a short description is also given on how the life history and ecology of sea trout differs from that of salmon.

2 Salmon fisheries

2.1 Overview of Baltic salmon fisheries

The fishery for Baltic salmon is heterogeneous. Commercial and recreational fisheries occur in the sea (offshore and coast) and in rivers, using a variety of gears. Below follows a brief overview of the most important fisheries and gears. A more comprehensive description of various fisheries including descriptions of gears and methods used is given in the Stock Annex (Annex 2). More extensive descriptions of this, as well as historical gear development in Baltic salmon fisheries, are also available in ICES (2003). Information on catches, effort, discards, unreporting, and misreporting is provided in Sections 2.2–2.4.

Commercial fisheries

Coastal commercial fishing targeting salmon occurs mainly in Gulf of Bothnia and Gulf of Finland, along the coasts of Sweden and Finland, but to some extent also in Estonia and Latvia. Currently, this fishery stands for the majority of the commercial landings. Gears used include different types of trapnets. The fishery occurs during spring and summer and targets salmon on their spawning migration. Some commercial fisheries also exist in fresh water close to river mouths, such as in a few Swedish rivers with reared salmon and in River Daugava, Latvia.

Offshore commercial salmon fishing is mainly carried out in Southern Baltic Sea (Main Basin), although it has periodically occurred also in Southern Gulf of Bothnia. Currently the commercial offshore fishery is more or less limited to vessels from Denmark, Poland, Latvia and Lithuania, whereas earlier several other countries were also involved. Historically, driftnets were the most important gear, but after the driftnet ban was enforced in the Baltic Sea in 2008 commercial offshore fisheries consist mainly of longlining and to some extent anchored floating gillnets. The offshore fishery takes place mainly during the period November to March, and targets non-mature salmon in their feeding areas.

Recreational fisheries

Recreational trolling has become a more and more popular fishing method to catch salmon in the Baltic Sea. Even though, the increase, due to various reasons, has levelled off in the latest years. So far, the trolling fishery is most developed in Sweden, Denmark, Germany and Poland. Also, in Latvia and Lithuania trolling fishery is developing. The trolling season varies between different sea areas and depends on the feeding and spawning migration of salmon and/or seasonal closures. In south-western Baltic Sea and Main Basin, it typically starts in late fall and ends in the middle of May. In the Åland Sea and Gulf of Bothnia, the season starts in the end of May and continues until late summer. Over the past few decades, the trolling fishery has increased, whereas the commercial offshore catches have declined. Thus, the relative importance of the recreational fishery has in a longer perspective increased over time.

The river fishing for salmon in the Baltic Sea region has a very long history. Until the mid-1990s, nets and weirs were used in many rivers throughout the Baltic Sea region. Currently the river fishery for wild salmon is entirely recreational and to a major part restricted to angling (rod and reel fishing). The most productive wild Baltic salmon rivers are by far the Finnish and Swedish large rivers flowing into the Bothnian Bay (SD 31). The main fishing season is between May–September, during the spawning run. Rod fishing for salmon in these rivers is very popular, attracting several thousands of anglers every year. The recreational river fishing for salmon in other countries surrounding the Baltic Sea is more limited, although salmon, to some extent, is caught in Estonian, Lithuanian, Latvian and Polish rivers. Russia has no recreational salmon fishery in their rivers feeding into the Baltic Sea, and no Baltic salmon rivers exist in Denmark and Germany.

While the recreational salmon fisheries is largely dominated by angling (offshore trolling and rod fishing in rivers) there are other types of recreational fisheries carried out in some countries. Where passive gears such as trapnets, gillnets or longlines are being used for catching salmon, either as a target species or bycatch, in both coastal and riverine recreational fisheries. These catches are generally estimated to be of minor importance, in terms of impact on the stocks (i.e. removals).

Brood stock fisheries

Brood stock fisheries are aimed at collecting mature individuals for breeding purposes. Either within sea-ranching programmes, where mature breeders are caught annually to produce salmon for stocking, or to renew closed brood stocks kept in captivity during the whole life cycle. Brood stock fisheries usually occur in rivers with reared salmon, but adult salmon are also caught for breeding purposes in some wild salmon rivers. Catches for breeding purposes are, however, rather limited and occur in Estonia, Finland, Latvia, Lithuania, Poland, Russia and Sweden.

2.2 Catches

This section contains information on commercial and recreational Baltic salmon catches from sea, coast and rivers in 2020 and over time. The catches presented are, unless otherwise stated, landed (retained) salmon.

Commercial catch statistics provided for ICES WGBAST are based on EU logbooks, national reporting system for vessels not obliged carrying logbook, and/or sales notes. As described in more detail in the Stock Annex (Annex 2), non-commercial recreational catches are typically estimated by a combination of different types of national surveys targeting various recreational fisheries (e.g. using access-point surveys, questionnaires, camera surveillance, etc.) and expert evaluations or expert opinion 'guesstimates'. Further details on the collection of salmon catch data in the Baltic Sea (in total and by country) are given in Annex 2.

Due to the increasing share of recreational fishermen practicing catch-and-release, voluntarily or due to regulations, there is a need for separate time-series including released salmon. Further, since the effects of catch-and-release on the management of the stocks largely are unknown, reliable data on survival rates and other effects on fish that have been caught and released are needed.

2020 data presented are principally data delivered in the ICES WGBAST and the WGBAST 2021 data calls respectively when parts of the data were still preliminary. Quality checks during the meeting resulted in a few changes in the dataset. Besides changes in conjunction with further quality checks, any future revision of data over time may e.g. be due to additional landings reported in the commercial fisheries or adjustments of catch estimates in the recreational fisheries.

The following seven tables with salmon catches divided in various ways (as described below) are annually updated and referred to in this report:

- Table 2.2.1.1: nominal reported and total salmon catches in *weight* by country for the years 2001–2020 (including discarded, unreported and misreported fish). Estimates of discards and unreported and misreported catches are presented separately.
- Table 2.2.1.2: corresponding annual catch data as in Table 2.2.1.1 in *numbers*.
- Table 2.2.1.3: nominal reported catches in *weight* from sea, coast and rivers divided by region (SD 22–29, 30–31 and 32) and country for the years 2001–2020.
- Table 2.2.1.4: corresponding annual catch data as in Table 2.2.1.3 in *numbers*.

- Table 2.2.1.5: nominal catches from last year (2020) in *weight* and *numbers* from sea, coast and river, divided by country and by SD.
- Table 2.2.1.6: nominal *commercial landings in numbers* (2001–2020) from sea and coast compared to TAC, divided by fishing nation and region (SD 22–31 and 32).
- Table 2.2.1.7: nominal *recreational (non-commercial) catches in numbers* from sea and coast (pooled) and rivers, divided by country and region (SD 22–31 and 32) in 2001–2020.

In addition to tables, a number of figures on salmon catch data are also presented that illustrate catch development over time.

The estimated discards, unreported and misreported catches are not included in the nominal reported catches, but presented separately. The estimated catches are calculated using conversion factors and reported in terms of the most likely value with a 90% probability interval (PI). More details on the estimating procedures are given in Section 2.3 (see also the Stock Annex, Annex 2, Section B.1.3). In the Stock Annex, an overview of management areas (regions) and rivers is also presented.

2.2.1 Catch development over time

There has been a long-term decline of the total nominal catches in the Baltic Sea, starting from 5636 tonnes in 1990 down to just 926 tonnes in 2010. After that, the catches have remained rather stable up to 2017 when the historically lowest total nominal catch was registered: 797 tonnes. In 2018 catches increased again and in 2020, the total nominal catch was 912 tonnes (Table 2.2.1.1) or 145 294 salmon (Table 2.2.1.2). Where the weight and the numbers were slightly lower than in the previous year.

After the driftnet ban was enforced in 2008, the percentage of the total commercial offshore catch by this gear has been zero. At the same time, commercial catches with trapnets along the coast increased their share. Consequently, the proportion of the coastal catch has gradually increased over time, and in 2020, it was 46% out of the nominal total catch (in weight) (Table 2.2.1.3). In the same year, approximately 69.3% of all commercial catches (in weight) were taken in coastal trap (or fyke) nets.

Over the years, the total share represented by river catches has been fluctuating. However, in the latest years they have remained rather stable, being approximately 30% of the total (in weight). In Table 2.2.1.3 the distribution of total catches (in weight) from offshore, coastal and riverine fisheries are presented (see Table 2.2.1.4 for corresponding catches in numbers). The distribution of nominal catches in 2020 by country, per subdivision, offshore, coast and river are presented in Table 2.2.1.5.

A comparison of landings (coastal and offshore) per country compared to the EU TAC in 2019 is presented in Section 2.2.3. Compiled information on landings versus TAC is also presented in Table 2.2.1.6. Note that data presented in Section 2.2.3 are the latest available. Discards, unreported and misreported catches are not included in the utilisation of the TAC, but in Figure 2.2.1.1 total catches of salmon are presented (as a percentage of TAC) where such catches have been added. In this figure, the recreational landed catches are also included.

A notable change in the catch distribution occurring in the past few decades is that the proportion of non-commercial catches has grown in relation to the commercial catches. The development for the proportion of non-commercial catches (including river catches and expert trolling estimates) from 2001 and onwards is illustrated in Figure 2.2.1.2. In 1994, non-commercial catches comprised just 10% of the total nominal catches (in weight), whereas since 2013 the share has fluctuated between 40 and 50%. Nominal recreational (non-commercial) catches in numbers from sea and coast (pooled) and rivers in 2001–2020, divided by country and regions (SD 22–31 and 32), are presented in Table 2.2.1.7.

In 2020, WGBAST continued the work initiated in 2017 to pay extra attention to the recreational salmon fisheries that are becoming proportionally more important. For the growing trolling fishery, a time-series of trolling catches from an expert elicitation initiated in 2017 (ICES, 2017a; 2017c) was updated (Figure 2.2.1.3). The estimates were partly updated until 2020, to take into account new information from earlier years received from new surveys. The update resulted in a slightly modified time-series compared to in previous years, with lower annual estimates for some years. The estimates are, however, still more than 20 000 salmon larger than previously assumed (i.e. for the 2010–2016 assessments). Trolling catches from the Main Basin (SD 22–28) are dominating, and are only to a lesser degree taken in SD 29–32. Catches in the Main Basin have been declining since 2015, but in 2019, an increase was observed, however in 2020 catches declined again. The 2020 Main Basin estimate was about 19 720 salmon caught and retained, including estimated post-release mortality (Figure 2.2.1.3). In contrast to 2017, when the assessment model for salmon in AU 1–4 did not perform, the new updated trolling catch estimates have been included in later years' stock assessments (Section 4).

In subdivisions 22–31, the total recreational river catch in 2020 was noticeably bigger than in previous years with 37 396 salmon retained. In SD 32, the river catch in 2020 was 438 salmon. Compared to 2019, this was a slight increase, however there is a strong downward trend in the SD 32 recreational river catches since the beginning of the 2000s (Figure 2.2.1.4). No further analysis of the recreational river catches has been made. In Section 3.1, details on specific river catches are presented.

2.2.2 Catches by country (2020)

Denmark: The Danish salmon fishery is an open sea fishery. The total commercial and recreational catches (excluding discards and seal damaged salmon estimates) in 2020 were 11 065 salmon. The amount of discarded BMS salmon was negligible while the number of seal damaged salmon according to logbooks was 1452. All catches, including the recreational, were in ICES SD 24–25. The commercial fishery uses longlines and it takes place from late autumn to spring (October–May). The effort in the commercial salmon fishery has decreased in recent years. Compared to 2019 the effort was reduced by 46%. The most likely reason for this is heavy seal predation. The commercial landings in numbers in 2020 was 3000, which is significantly lower than the 2019 landings (6009). The commercial landings in weight in 2020 was 16.6 tonnes (2019: 29.8 tonnes). The recreational fishery is mainly trolling, but some recreational passive gear fishing, i.e. longlining, also takes place in waters close to Bornholm. It is likely that the effort in this fishery has decreased in recent years with the increasing number of seals around Bornholm. It is guesstimated that catches are very small (<100 salmon per year). An estimate resulting from an Internet based recall survey in 2020 targeting annual licence holders yielded a result of 8065 salmon landed for trolling alone. However, the result is believed to be an overestimate due to recall- and avidity bias as respondents participating in such surveys often are the most avid anglers and the recall period is long (6 month). An on-site survey has been established to adjust the recreational catch estimates from the off-site survey. From the off-site survey the estimated number of salmon caught and released in 2020 was 3835 salmon.

Estonia: There is no specific Estonian salmon fishery. In the coastal fishery, salmon is a bycatch and the main targeted species are sprat, flounder and perch. The share of salmon in the total coastal catch is less than 1%. In 2020, similar to in previous years the Estonian salmon sea catch was below 1 tonne. The coastal catch (commercial and recreational) was 13.3 tonnes, which is slightly higher than 2019 catches (11.6 tonnes). The vast majority of salmon is caught in the Gulf of Finland (SD 32). There are about 570 commercial fishermen in Gulf of Finland, and in addition up to 6433 monthly gillnet licences are distributed annually (standard length of a net is 70 meters). The commercial fishery takes 68% of the total catch. The vast majority of the salmon (88%) is caught in gillnets and the rest in trapnets. About 75% of the annual catch is taken in September, October and November. Nearly all caught salmon are spawners.

Finland: In 2020, Finnish fishers caught a total of 54 211 salmon (384 tonnes) in the Baltic Sea, which was 4% less than in 2019. The landed commercial catch was 28 606 salmon (187 tonnes). The recreational catch (including river catches) was 25 605 salmon (178 tonnes). Practically all commercial catch was taken in the coastal fishery mainly by trapnets and there was no salmon fishing in the southern Baltic Sea by the Finnish vessels. Commercial catch data for the year 2020 are preliminary. Recreational catch estimates in the sea for the years 2018–2020 are based on the results of the Finnish Recreational Fishing 2018 survey. National surveys are carried out every second year and for years with missing data the same sea catch estimates as the latest survey is assumed. Catch estimate of the recreational fishery in the sea was assumed to be the same as for the year 2018 (the latest survey year) and highly uncertain (39 t, CV>50%). River catch was 20 105 (138 tonnes) increasing 20% from 2019.

Finnish professional fishermen mainly use trapnets. In 2020, 158 coastal fishermen caught salmon with 343 trapnets, and total effort in the trapnet fishery was 18 453 gear days, about 6% more than in previous year. Reported discards of seal damages were 2200 salmon (13 tonnes) about the same as in previous year comprising about 7% of the total commercial catch.

Commercial salmon catch in subdivisions 22–31 was 20 589 salmon (132 tonnes) (commercial catch data from the River Iijoki and River Kemijoki is not available yet)). Recreational catch was 25 220 salmon (176 tonnes) of which 19 920 was caught from rivers (most from the River Tornionjoki). According to the national survey in 2018 about two thirds of recreational sea catch was taken from the Gulf of Bothnia (5300 salmon, 39 tonnes, notice high uncertainty CV>50%). In the coastal fishery 127 fishermen caught salmon with 257 trapnets. The total fishing effort was 11 099 trapnet days about the same as year 2019 (data are preliminary). In Åland Islands, about 1250 salmon (10.5 tonnes) were caught with anchored floating nets. Discards of seal damaged salmon were 1450 fish (9 tonnes) comprising 7% of total commercial catch in subdivisions 29–31. The total fishing quota was 24 178 salmon (=22 370 salmon + 1808 salmon of transferred unutilized quota from previous year) in management unit 22–31. The quota was utilised to 85%.

Commercial salmon catch in Subdivision 32 was 8017 salmon (54 tonnes) and it was taken in the coastal fishery. Recreational catch in the area was 385 salmon (2 tonnes). River catch (all recreational) was 185 salmon (1 tonne) and almost all of it was taken from the River Kymijoki. In 2018 (the latest survey year) the recreational catch the Gulf of Finland was very small (200 salmon, 1 tonne, CV>50%) compared to previous estimate in 2016. The 2016 estimate is probably a rich overestimate, and 2018 estimate an underestimate. Practically all commercial salmon catch in the area was taken by trapnets. In all 31 fishermen fished salmon with 86 trapnets with the effort of 7354 trapnetdays being 12% more than in 2019. Discards of the seal damaged salmon were 750 fish (4.5 tonnes) being 9% of the total commercial catch in the area. The fishing quota was utilised to 83% of total 9679 salmon (= 8708 salmon + 971 salmon of transferred unutilized quota from the previous year).

Recreational catch at sea is estimated with a national off-site survey. The last survey covers the year 2018 and was conducted in 2019. The 2020 survey is ongoing and results will be published in October 2021. Salmon and sea trout catch estimates are highly uncertain because these fishers are rare in the total population. Note that in this national survey, salmon (and sea trout) catch estimates are highly uncertain because these fishers are so rare in the total population (just 17 salmon trollers among all respondents). National surveys are carried out every second year. For the missing 'odd' years, the same sea catch estimate as in the preceding year is assumed. The catch estimate in 2016 was 55–137 tonnes (7000–17 000 salmon). Results suggest that almost 90%

of the catch was taken by trolling. In 2017, the Finnish Federation for Recreational Fishing conducted a questionnaire among salmon trolling skippers (92 replies were received). The skippers are considered to represent the most active part of all trolling fishers. An expert estimate of the total number of active trolling boats in Finland is 300–400. In addition, about the same amount of less active boats exist that only go to sea 1–2 days per year (maybe not even for trolling). The responding skippers fished on average eight days in 2017 (range: 0–25 days) and the average catch was 0.2 salmon per fishing day in the Gulf of Finland and 0.4 salmon per fishing day at the Åland Islands and in Gulf of Bothnia. Extrapolation of these parameters to the estimated whole fleet suggests a total catch of about 300–1600 salmon in 2017.

Germany: The total reported commercial salmon catch in 2020 (SD 22–24) in numbers was 512 with a total weight of 25. tonnes (using a mean weight of 5 kg per salmon). In recent years, virtually no German commercial fishery has directly targeted salmon; hence, most of the salmon are caught as bycatch in other fisheries (mainly passive gear fisheries). The German TAC for 2019 was 1996 salmon (total for subdivisions 22–31) and the quota was utilized to 25.4%.

Recreational salmon fishing occurs almost exclusively from trolling boats in the waters off the island of Ruegen (SD 24) in Germany. Since 2017 (pilot in 2016), a regular survey has been established to monitor the recreational salmon trolling fishery in Germany. Recreational salmon boat fishing effort is evaluated by trolling boat trip counting via remote cameras in three relevant marinas on the island of Ruegen (covering ~60 % of the total fishing effort) during the salmon trolling season from December until May (see Kaiser (2016), ICES (2018) and Hartill *et al*. (2020) for details). Salmon trolling effort from marinas not monitored by cameras (n = 4) is extrapolated using monthly (in 2019 every two weeks) instantaneous trolling boat counts covering all marinas and the proportions of boats that went out for fishing derived from the marinas with camera monitoring. The camera monitoring is complemented by random on-site interviews of trolling anglers in four relevant marinas (including the marinas where the trolling boat trip counting was conducted) to determine catch per unit of effort in order to estimate catches and collect biological catch data and socio-economic information. In 2020, a total of 60 random on-site samplings were conducted and 252 trolling boats with 513 anglers targeting salmon were interviewed. The total number of retained salmon was estimated to be 1093 (95% CI: 556–1654) salmon in 2020. In addition, 258 salmon have been released, resulting in a release rate of 2.3%.

There are no data available on freshwater salmon catches. However, commercial and recreational salmon freshwater catches are most likely insignificant as there are no rivers with significant salmon spawning migration and fishery along the German Baltic coast.

Latvia: The Latvian salmon landing statistics are based on the logbooks and landing declarations from the offshore and logbooks from coastal and inland fisheries. Landing data from a small-scale recreational fishing in the river Salaca and Venta are based on questionnaires. In 2020, the total number of Latvian salmon landings (commercial, recreational and brood stock fisheries) was 3585 salmon (15.2 tonnes).

Salmon commercial landings in the open sea (offshore) was 7.4 tonnes which is smaller amount than in 2019. Coastal landings (commercial and recreational) were 3.9 tonnes, which is similar to the last year. Vast majority of salmon was caught in SD 28. Commercial fishermen comprised only 48,5% of the total costal landings in 2020, the rest was taken by recreational fisherman (fisherman without rights to sell the caught fish). In 2020, vast majority of salmon in the sea was caught by longlines and gillnets. In 2020, biggest salmon landings in coastal fisheries registered during March and September, but in the offshore fisheries during March and December.

Small-scale commercial fishery exists in Daugava river up to Rigas HPP and in Daugava river connection with Lielupe river mouth called Buļļupe river (both with reared salmon). Due to large number of grey seal in the Daugava river mouth, catches in this fishery are decreasing.

In the rivers where natural reproduction of salmon occur, all angling and fishing for salmon and sea trout is prohibited with exception of licensed angling for sea trout and salmon kelts during the spring season in the rivers Salaca, Venta and starting from 2020, also Gauja river.

In total 443 retained salmon and 772 retained sea trout kelts were reported in licensed angling in 2020. Biggest share of salmon and sea trout was caught in the Salaca river. From reported 476 salmon and 602 sea trout kelts, 86 salmon and 108 sea trout have been released back alive, the rest were kept. In Gauja river, 53 salmon and 381 sea trout kelts reported in licensed angling from which 103 sea trout have been released back alive.

Lithuania: Lithuanian salmon catch statistics are based on logbooks. In 2020, Lithuanian fishermen caught 2813 salmon (16.4 tonnes). This is a large increase compared to the last year. Largest part was caught in sea: 1.14 tonnes, and the rest (0.15 tonnes) in the Curonian lagoon. Recreational catch in coastal area was 9.6 t (1621 individuals, including trolling) which is higher than in previous years.

Commercial salmon fishery is banned in all Lithuanian rivers. Recreational fishery for salmon is allowed (together with sea trout) only in designated rivers on license basis. In 2020, the number of licences sold for salmon and sea trout is still not reported by the Ministry, the number of licences sold in year 2019 was 24 435.

Poland: Total sea, coastal and river commercial catch was 6705 salmon (37.40 tonnes). Total catch was basically unchanged compared with 2019. Main gears in use for salmon are the same as for sea trout and this is why the vessels have fishing licences for both species. Main gear in salmon fishery was LLD, 77% of offshore catch, and GNS, 85% of coastal catch. Other gears were: fykenets and trawls. Commercial sea and coastal catch statistics are based on e-logbooks of vessels longer than 12 m and on monthly reports of vessels smaller than 12 m. Most of the catch (76%) was taken from Subdivision 26. Out of the total catch, the coastal catch was lower (28%), then offshore (71%). Salmon fishery in Subdivision 24 was occasional. All fish was caught within Polish EEZ.

Until the year 2019, the most important factor to distinguish the coastal vs offshore catches in Polish EEZ was the length of the fishing vessels: coastal if vessels were smaller than 10 m, offshore if vessels were 10 m long or longer. Such a rule does not reflect the reality, because small boats nowadays are able to operate in offshore waters (more than 4 miles from the coast line) and vessels longer than 10 m might operate in coastal waters (up to 4 miles from the coast line). Therefore, it was decided to use the fishing location (statistical fishing squares) as the main factor to distinguish coastal vs offshore catches for 2019 and 2020 data.

Pilot study relating to salmon and sea trout recreational fisheries was conducted in 2017–2019. More details of this work were described in Polish National Report for 2017. Based on the results of the Pilot Study, sampling programme was included into regular sampling since 2020. In 2020, trolling boats have been observed in ten harbors, i.e. Władysławowo, Kuźnica, Jastarnia, Hel, Gdańsk Górki Zachodnie, Gdynia, Łeba, Ustka, Darłowo, Kołobrzeg, Mrzeżyno and Dziwnów with particular importance of Hel, Gdynia, Gdańsk Górki Zachodnie, Kołobrzeg harbours. A total of 125 different active trolling boats had been inventoried in 2020. Number of active trolling boats varied between autumn/winter (87–94) and spring (103–107) seasons with a higher number of trolling boats in spring. On this time, there is no reliable information about CPUE (expressed as a number of fish per boat per day) depends on season and total number of trolling operations (boat-days) per year. The mean CPUE for 2020 was 1.9 salmon per trolling trip/day. The preliminary trolling catch estimates for 2020 are 4750 landed (retained) salmons and 190 released salmons (below minimum landing size fish). Because of COVID-19 issue, the catches have been affected by lower activity of trolling anglers, and national restrictions (lock-down). It is planned to update catch data for 2018–2020, based on obtained results. The estimated sea trout bycatch during salmon trolling trips in 2020 is 132 individuals (retained). The coastal sea trout catch estimates including coastal trolling targeting sea trout for 2020 was 81 713 fish.

A pilot study of estimation of Polish river recreational catches has begun in 2017 and was continued in next three years. First on three rives: Ina (SD 24), Rega and Słupia (SD 25) and from 2018, also on Parsęta River (SD 25). In 2020 three new rivers were added to the survey: Łeba, Reda (SD 25) and Drwęca River (SD 26). The method used is based on catch records provided by fishing users supplemented with data from on-site surveys of anglers carried out according to the same schedule on the rivers studied. The data obtained from the catch records are delayed by two years, which results from the fishing fee system. No river data are submitted to WGBAST yet.

Russia: In 2020, 752 salmon (3.4 tonnes) were caught in Russian fisheries. There is no specific Russian salmon fishery but a small number of salmon (30 fish) was reported as bycatch in the coastal fishery. The largest part of the reported catch is from brood stock fishing in River Neva (322), River Narva (306) and River Luga (31). In addition, 63 salmon were caught in scientific fishing. The catches in recreational fishing is currently unknown.

Sweden: The total salmon catch in 2020 was 56 841 salmon (336 tonnes). In 2020, the total number of salmon in the commercial sea fishery was 23 297 (147 tonnes). Coastal fishery with trap- and fykenets made up more than 99% of the commercial coast and sea salmon catches. In addition, commercial fishing in Additionally, commercial trap net fisheries in freshwater is increasing in SD 31 in river Luleälven were a total of 15 089 salmon were landed. Total weight of the commercial riverine salmon catches were 61.3 tonnes. Besides River Luleälven commercial fishing in freshwater exists in reared rivers in SD 30, but this year’s data were still not available and will be updated in the next data call.

Recreational fishing in Sweden have two main components, angling in rivers and trolling at open sea. River catches are estimated using catch reports from anglers combined with expert evaluations of unreported catch (using local experts). The quality of the data varies a lot and in rivers with developed fishing tourism and active management nearly all of the catch is reported. In other rivers most of the catch numbers are based on the expert evaluation. The 2020 catch of recreational fishers in rivers was 16 039 salmon (112 tonnes).

For the trolling fishing method development continued in 2020 with an on-site interview study in the two most popular harbours Simrishamn and Ystad were surveyed between 2020-03-23 and 2020-05-10. A total of 27 days, when all returning trolling boats were interviewed, was randomly selected and data on catches were obtained. The number of landed salmon during the survey period landed in Simrishamn and Ystad was estimated to 377 (CI 163–592) and 426 (CI 93–760) salmon released. The estimates from Simrishamn and Ystad were the raised to the catch in SD 25–29 during the full year with the assumption that the catch was distributed, in time and space, was distributed in similar way as in earlier studies. This resulted in an estimated total catch of 2416 (15.7 tonnes) salmon landed and 2730 salmon released in SD 25–29.

2.2.3 Landings by country compared with the EU TAC 2020

The total allowable catch (TAC) or fishing opportunity for Baltic salmon in 2020 was stated in COUNCIL REGULATION (EU) 2019/1838 of 30 October 2019. In SD 22-31, 66% of the original TAC of 86 575 individuals was utilized and in SD 32, 97% of the original TAC of 9703 individuals was utilized.

By fishing region and country, the 2020 original national quotas for Baltic salmon were allocated and utilized as follows:

Country	SD 22–31			SD 32		
	Quota 2020 (No.)	Catch[1) 1)] (No.)	Utilized (%)	Quota 2020 (No.)	Catch[1) 1)] (No.)	Utilized (%)
Denmark	17 940	3 000	16.7	-	-	-
Estonia	1 823	400	21.9	995	1 380	138.7
Finland	22 370	20 589	*	8 708	8 017	92.1
Germany	1 996	76	3.8	-	-	-
Latvia	11 411	2 062	18.1	-	-	-
Lithuania	1 341	190	14.2	-	-	-
Poland	5 442	6 705	**	-	-	-
Sweden	24 252	23 297	***	-	-	-
Total EU	86 575	56 319	65.1	9 703	9 397	96.8
Russia [2)]	-	-	-	-	-	-
TOTAL	86 575	56 319	65.1	9 703	9 397	96.8

[1)] N.B Data on landings presented here are the latest available, hence, they have been updated since the WGBAST 2021 data call.

[2)] No international agreed quota between Russia and EC. No reported Russian commercial catches in the Baltic Sea.

As mentioned above, the national quotas presented are the original set ones. A country has the possibility to save a share of its quota from one year and transfer it to the next. Besides transferring quota shares between years, countries can also exchange (swap) quotas from different stocks between each other. Hence, in practice, less than 100% of the final national quotas were utilized in most countries. For example:

* Finland had a final national quota of 24 178 (SD 22–31) and 9679 (SD 32) salmon in 2020, out of which 85% (SD 22–31) and 83% (SD 32) was used. The final quotas were obtained by a transfer of 1808 (SD 22–31) and 971 (SD 32) salmon from 2019 to 2020.
** Poland had, after exchanges with Lithuania (3158 salmon) and additional TAC – EU decision (1144 salmon), a final quota of 9744 salmon and 69% was used.

*** Sweden had a final national quota of 26 991 salmon in 2020, out of which 86% was used. The final quota was obtained by a transfer of 2739 salmon from unutilized quota part 2019 to 2020.

From 1993 and onwards the Baltic salmon TAC is given in numbers. Until 1992, it was given in tonnes. The coastal and offshore commercial official landings in numbers (excluding river catches) compared to the EU TAC 2020, by fishing nations and regions in 2001–2020, are presented in Table 2.2.1.6. See also Figure 2.2.1.1 where the total catch of salmon (including estimated discarding, unreporting and misreporting) are presented as a percentage of TAC.

Finally note that over time the proportion of the annual commercial sea catch (regulated by the TAC) out of the total catch has decreased, at the same time as the proportion of the recreational catch has increased (see Figure 2.2.1.2). Hence, the importance of TAC as a means of fishery control has decreased over time.

2.3 Discards, unreporting and misreporting of catches

Data on discards in the **commercial fisheries** are to some extent reported in the official statistics, and the latest country specific information on this is presented in Section 2.3.2. However, the quality of these data is very unsure. Therefore, additional estimates are made (see below). For obvious reasons, there are no official reports of unreported and misreported catches. However, for some countries, information collected from diverse sources is still available. In Section 2.3.3, the issue of misreporting is elaborated on further.

Data for the period 1981–2000 on discards and unreporting of salmon from different commercial fisheries in the Baltic Sea are incomplete and fragmentary. For years 2001–2020 the estimates for discards and unreporting have been computed with a new method based on updated expert evaluations (adopted in WGBAST 2013). The resulting parameter values for the elicited priors and pooled (average) probability distributions for different conversion factors are given in Table 2.3.1. In WGBAST 2021, mostly the same parameter values were used for 2020 fisheries as for previous years fisheries, because experts saw the situation remained unchanged in terms of discarding, unreporting rates, proportions of BMS salmon and seal damages. Only the rate of unreporting in the Polish coastal fisheries was updated with a slightly lower estimated in 2020 and 2019 from earlier years. For detailed information about estimation procedures for these conversion factors, see Stock Annex (Annex 2, Section B.1.3).

A main part of discards is seal damaged salmon, which occurs in the coastal trapnet and gillnet fishery, but also in the offshore longline fishery (Table 2.3.2.). In the offshore fishery, it is small amounts of undersized salmon that are estimated to be discarded. Since 2015, there has been a landing obligation for the longline fishery; however, it has not been fully implemented since little reporting of such landings has occurred. Estimates for discards, unreporting and misreporting by management area are presented in Table 2.3.3. The estimates are uncertain and should be considered mainly as an order of magnitude.

In the **recreational fisheries** on the other hand, almost no data on discarded (caught and released), unreported and misreported catch are collected, and no estimates are currently made by WGBAST.

2.3.1 Estimated discards

In 2020, approximately 5300 salmon are estimated to have been discarded due to seal damages in the Baltic Sea. About half of discards took place in the fishery in the south Baltic Sea (longline and other gears) and other half in the coastal trapnet fisheries in the northern Baltic Sea (Table 2.3.2). Estimates were based on the observed proportion of seal damaged catch in subsamples that has been extrapolated to the total catch. In this calculation, also potential misreporting and unreporting were accounted in the total catch. In WGBAST 2019, the Danish expert evaluation was updated retrospectively for years 2016 and 2017 using the same estimate as for 2018. Basis for the update was that there were no logbook data on discarded seal damaged salmon from Denmark in 2016–2017 and the previously estimated discard rate of 50% (5–65%) was based on sparse observer data in 2016 (i.e. no data in 2017). In 2018–2020, logbook records on seal damages were available from the Danish and Polish longline fisheries. The amount of seal damaged catches in the Main Basin have increased gradually to significant rates starting around 2013, as a result of increase in grey seal population in the area. In 2020, the proportion of seal damaged salmon in the total catch was 33% in the Danish and 38% in the Polish fisheries.

In the northern Baltic Sea, seal damages started to escalate gradually from 1993, but since the introduction of 'seal safe' trapnets, the catch losses in coastal fisheries have levelled off. In 2020, the total seal damaged discards were about 1900 salmon in the Gulf of Bothnia and 750 salmon in the Gulf of Finland. Most of the damages were reported from Finnish coastal trapnet fisheries. In Finland, data on seal damages are based on logbook records. In Sweden, the level of seal damages is estimated based on data from a voluntary logbook system and available data on seal interaction in the official statistics, for which an additional expert assessment has been made. The reported amounts of seal damaged salmon should, however, be regarded as a minimum estimate.

The reporting rate of the seal damaged catch is assumed to be the same as for the undamaged catch in the coastal fishery. For the time being, logbook-based data on numbers of sea damaged salmon is available from Finland, Sweden and in 2018–2020 also from Denmark and Poland. However, the reported amounts of sea damage salmon are minimum estimates and true volumes are potentially higher. In other countries, estimates are based on proportional damage rates derived from either logbook or expert evaluation.

Dead discards of undersized salmon in 2020 were estimated to about 700 salmon in the whole Baltic Sea (Table 2.3.2). Proportions of undersized salmon in the catches of different fisheries are mainly based on sampling data (Table 2.3.1) and are considered rather accurate. Mortality estimates of the discarded undersized salmon released back to the sea are based on expert opinions. Mortality of the undersized salmon released from longline hooks back to sea is currently assumed to be high (around 80%), but few studies have been carried out on this issue and the true rate is uncertain. In the trapnet fishery, post-release mortality is assumed to be lower (around 20%), but again the true rate is uncertain. Both the experimental design and the settings to study these mortalities are challenging, but such empirical studies are needed in order to get better estimates on the survival rate of salmon discarded.

Post-smolts and adult salmon are frequently caught as bycatch in pelagic commercial trawling for sprat (mostly for supplying fish for production of fishmeal and oil), but are probably often unreported in logbooks because the relative amount of salmon in these catches is low and can be identified only during unloading (ICES, 2011). Because of insufficient data, however, estimates of these potential removals are so uncertain that they are not considered in the present assessment. Only the reported catch from the trawls is accounted for in the catch data, although it has been very low over the years.

2.3.2 Reported information by country

Below follows country specific information on reported discards (seal damaged fish or fish allowed to discard), and for some countries, short general information on seal interactions is also included. If available, any records on eventual unreporting and misreporting of catches are provided.

Denmark has not information from which it is possible to estimate trustworthy discard percentages. Since the quota for salmon in recent years has not been fully utilized, it seems unlikely, however uncertain, that there are unreported catches in the professional salmon fishery. The potential unreported landings would likely be the largest salmon with a weight > 7.9 kg, as these salmon cannot be landed for human consumption.

The bycatch of salmon in other fisheries has been observed to be quite low. Observers from DTU-Aqua participated in the herring and sprat fishery in the Baltic in the winter 2007/2008 for about 50 days, and bycatches of salmon were insignificant in this fishery.

In **Estonia**, the seal damages are serious problem in salmon and sea trout gillnet fishery. According to the personal communications of fishermen damages are very common. Quantitative assessment of damages is not available as fishermen in most cases did not present claims for gear compensation.

In **Finland** reported discards of seal damages were about 2200 salmon (13 t) about the same as in previous year. Seals caused severe damages to all fisheries mainly in subdivisions 29–32 where seal damages comprised about 7% of the total commercial catch in the region. Other discards (seagulls, cormorants, etc.) were 20 salmon. The compensation of seal damages is based on recorded catches (all species accounted), which is considered to improve the catch reporting. The rate of unreporting of catches is considered to have decrease to a very low magnitude as a consequence of the recent developments in the fishing regulations. In 2017, an individual quota system was initiated and since then also all landed salmon have had to carry a landing mark which probably steers to a careful catch reporting. There are no available records of misreporting.

In **Germany** there are no data available on predation by seals. The current seal population in German Baltic waters is small but increasing. No seal damaged salmon have been reported to the authorities in 2020. Concerning the current seal density and the low level of the commercial catches, it seems unlikely that predation by seals is an important issue in the commercial fishery in German waters. However, this situation may change in the future. Furthermore, German commercial fishers reported increased predation rates on salmon longline catches around the island of Bornholm in recent years, which has led to the cessation of the directed salmon fishery by German vessels in 2016.

In **Latvia** information on seal predation in trapnet and gillnet fisheries of salmon and trout is available from coastal fishery logbook statistics. Reported direct catch losses from logbook statistics was 8% of the total salmon catch and 16.5% of the total sea trout catch. The inspection of logbooks reveals also high seasonal and spatial variation of catch damage. This was not considered in estimation of Latvian fishery total catch damage. Thus, the data should be treated with caution. Damaged catch (direct catch loss) for salmon and sea trout in 2020 by numbers were estimated applying average weight of fishes in landings to reported catch damage in logbooks. There is no data on other types of salmon discards.

In **Lithuania**, reported data of seal damages, discards, unreporting and misreporting are not available.

In **Poland**, seal predation of 352 salmons and 235 sea trout were recorded in logbooks in 2020 and reported to Fishery Monitoring Centre (FMC). This is less than 2019 (422 SAL; 258 TRS). In addition, 2802 salmonid fish (both salmon and sea trout) have been reported to the Ministry of Maritime Economy and Inland Waterways in 2020. This is higher than in 2019 when 1978 fish, both salmon and sea trout were reported. Number of reported fish concerns to 268 individual reports. No information on site. Based on Regulation (EU) No 508/2014 of the European Parliament and the European Council, on the European Maritime and Fisheries Fund, this Regulation gives the possibility to EU Member States to finance compensation from EMFF funds for losses caused by birds and mammals in sea areas. The seal damages occurred in 3.7% of fishing trips targeting salmon or sea trout. The mean value (%) of seal damaged salmonid fish in catch where the losses have been reported was 53.7% (median = 50.0%; min = 0.9%; max = 100%). Most of the reports came from the Gulf of Gdańsk. Misreporting of salmon as sea trout in the Polish fisheries is treated below (Section 2.3.3).

In **Russia**, no information on seal damages, discard, unreporting and misreporting is available. However, unofficial information indicates presence of significant poaching of salmon and sea trout, both in the coastal area and in rivers.

In **Sweden**, a total of 437 salmon were reported as seal damaged in 2020, all in the commercial coastal fisheries. In 2019, the total number of reported seal damaged salmon in the Swedish fisheries was 480. Since the possibility to record number of seal damaged fish was initiated, the reported number has been fluctuating and the latest years an increasing trend is seen. If this is due to an actual increase in the damage rate or if the willingness of the fishermen to report seal damaged fish has increased is unclear. If this is due to an actual increase in the damage rate or if the willingness of the fishermen to report seal damaged fish has increased is unclear. Logbook data on discards and seal damage are likely incomplete (see below), therefore earlier estimates of the proportions discard, misreporting and unreporting of total catch are still the best available, see WGBAST 2020 report Table 2.3.1.

In the logbooks, it is possible, but not mandatory, to record seal damaged fish. If you report seal damaged fish they are saved as a special catch category in the official statistics. Seal damaged fish are not counted into the quota and in fisheries where the landing obligation is put in practice, seal damaged salmon do not have to be landed.

Data on seal damages in the Swedish official catch statistics from the commercial coastal (and off-shore) fisheries do not include a quantitative measure of injured fish. Instead, the information requested is whether you have caught any seal damaged fish or if your gear has been seal damaged during a fishing trip. A trip with seal damages is then tagged with a specific "reason code". No information on seal damages is collected from the commercial river fisheries.

2.3.3 Misreporting of salmon as sea trout

From 2019, it has been prohibited to fish for sea trout beyond four nautical miles and to limit bycatches of sea trout to 3% of the combined catch of sea trout and salmon in order to contribute to preventing misreporting of salmon catches as sea trout catches (Council Regulation (EU) 2018/1628 of 30 October 2018 fixing for 2019 the fishing opportunities for certain fish stocks and groups of fish stocks applicable in the Baltic Sea and amending Regulation (EU) 2018/120 as regards certain fishing opportunities in other waters). This regulation in combination with unfavourable weather conditions and increasing seal damages, had a major impact on the Polish fisheries in 2019 and 2020. Both the effort and the total catch in the offshore fishery were reduced and misreporting of salmon as a sea trout disappeared almost completely (estimated misreporting was only 600 and 200 salmon in 2019 and 2020 respectively). The coastal fisheries targeting sea trout, increased in 2019–2020 compared with previous years. Although there is no wild or mixed salmon rivers in Poland, about 1100 salmon were reported in the coastal waters in 2020. Although the sampling intensity is not fully representative for the whole fishery, the limited biological sampling in coastal waters 2019–2020, here scientific observers indicate that only sea trout has been caught and reported.

Misreporting of salmon as sea trout occurs in all countries with different scale, but apart from Poland, provided data have not indicated substantial misreporting. Until 2019, Polish data on catches of salmon and sea trout deviated markedly from corresponding data delivered by other countries fishing with the same gears in southern Main Basin open sea, indicating that salmon have been misreported as sea trout in the Polish offshore fishery. To be able to fit the assessment model to fairly realistic offshore catches of salmon, the working group agreed on estimation procedures that have evolved over the years depending on availability of data. Estimation process is described e.g. in WGBAST 2019.

Misreporting in the coastal gillnet fishery has not been estimated. However, the Polish sampling data suggest very small proportions of salmon in coastal catches (annually maximum 5%).

Last, note that misreporting estimates should be considered as rough order of magnitudes.

2.4 Fishing effort

In the **commercial fisheries**, data on effort are reported in the official catch statistics. Further analysis is needed to evaluate the overall quality and accuracy of available effort data. The total fishing effort by gears in the Main Basin, and in the three main assessment areas for the coastal commercial salmon fishery (AU 1–3), excluding Gulf of Finland, is presented in Table 2.4.1. This table includes Baltic salmon fishery catches offshore and along the coasts in 1987–2020. The coastal fishing effort on AU 1 stocks refers to the total Finnish coastal fishing effort and partly to the Swedish effort in SD 31. The coastal fishing effort on AU 2 stocks refers to the Finnish coastal fishing effort in SD 30 and partly to the Swedish coastal fishing effort in SD 31. The coastal fishing effort on stocks of AU 3 refers to the Finnish and Swedish coastal fishing effort in SD 30. Because sea trout in Poland is targeted with the same gear type as salmon, effort from the Polish fishery targeting sea trout was included in the table before 2003.

The development over time in fishing effort for the commercial offshore fishery is presented in Figure 2.4.1. When the driftnet fishery was closed 2008, the effort in the longline fishery consequently increased. However, in later years the total effort in the longline fishery has levelled off and in last two years the effort decreased to 302 641 hook-days (i.e. number of fishing days times number of hooks) in 2019 and from 1 047 168 in 2018, to be compared with 2 639 116 hook-days in 2010 (Figure 2.4.1 and Table 2.4.1).

An overview of the longline offshore fishery for salmon in SD 22–32 during the latest six years (2014–2020) is presented in Table 2.4.2. Catch per unit of effort (CPUE) by country is also presented in this table. For equivalent information for the years 1999–2013, see WGBAST 2018 report (ICES, 2018a). The total effort decreased in 2019 and 2020 to less than one-third compared to the effort in 2018. This is mainly explained by changes in the fishing activity of the Polish offshore fleet. In Section 2.3.3, reasons for the changes in the Polish fisheries in 2019 and 2020 are described. Besides Poland, also Denmark, Latvia and Lithuania had active vessel(s) in the longline fisheries in 2020. It is not possible to draw any conclusions on the overall number of vessels that were active due to that data on this are only available from Poland.

Unit of effort in the coastal trapnet fisheries is gear-days (number of fishing days times the number of gears). Seen in a longer perspective, effort in the coastal commercial fisheries has decreased markedly. In more recent years, this trend has levelled off (Figure 2.4.2, Table 2.4.1). However, in 2020, the total reported effort in the trapnet fisheries in AU 1, 2 and 3 increased to 42 446 gear-days, almost doubled compared to 22 917 gear-days in 2019.

Table 2.4.3 shows effort and CPUE (number of salmon caught per gear-day) over time (1988–2020) in the Finnish trapnet fishery in Subdivision 32. In 2019 and 2020, CPUE in this fishery was higher (1.21 and 1.02 salmon per gear and day, respectively) than in the nine preceding years (average 0.68). Substantial differences can be seen when comparing CPUE in the Finnish and Swedish Gulf of Bothnia (SD 30–31) trapnet fisheries. Further analyses are needed to evaluate these differences and the quality of current and past effort data in Finnish and Swedish official catch statistics.

For **recreational fisheries** designated data collection of effort data is not yet implemented on any larger scale, and WGBAST is not currently analysing the sparse data that are available.

2.5 Biological sampling of salmon

General information on the structure of data collection in different fisheries, including length of time-series, is presented in the Stock Annex (Annex 2). The national work plans under the EU-MAP include data collected offshore, along the coasts and in rivers. Biological sampling is conducted both in commercial, recreational and brood stock fisheries. Biological sampling is also included in surveys targeting parr and smolts. General and future perspectives on sampling is further elaborated on in Section 4.7.

2.5.1 Age sampling by country (2020)

The table below gives an overview of EU-MAP age samples (biological sampling) collected in 2020. Information on Russian biological sampling in 2020 is also included (although not a member of the EU). In the biological sampling, a set of individual information is typically collected, e.g. scales for age and/or genetic analysis, length, weight, sex and wild/reared origin.

Number of scale samples for ageing collected in 2020 by country and subdivision(s):

Country	Month (No.)	Fishery	Gear(s)	Number of sampled salmon by SD					
				22–28	29	30	31	32	Total
Estonia	5–10	Coastal	trapnets & gillnets					147	**147**
Finland	5–9	coastal	trapnet		150	365	982	480	**1977**
	5–8	River					508		**508**
Germany	1–12	offshore	trolling	60					**60**
Latvia	4–11	offshore	longlines	210					**210**
	4–11	offshore	trolling	28					**28**
	4–11	coastal	gillnets	82					**82**
	4–11	River		101					**101**
Lithuania	9–10	River	gillnets	20					**20**
Poland	1–12	offshore	longlines	100					**100**
Sweden	4–7	River	Various	223		100	451		**774**
Russia	10–11	River	Gillnets					594	**594**
Total				**824**	**150**	**465**	**1941**	**1221**	**4601**

Below follow short country-by-country summaries of biological sampling of salmon in 2020 with some comments:

Denmark: In 2020 there was no biological sampling.

Estonia: in 2020 biological samples of 147 salmon were collected.

Finland: In 2020 catch sampling yielded 1977 salmon scale samples from the Finnish commercial salmon fisheries and 508 samples from recreational river fisheries. All samples were aged by scale reading. The total amount of DNA analysed samples was 796 from the subdivisions 30–31 by EU data collection funding.

Germany: In 2020, a total of 60 random on-site samplings were conducted and 252 trolling boats with 513 anglers targeting salmon were interviewed.

Latvia: Sampling was carried out in offshore and coastal fisheries, trolling and angling in the rivers. In coastal fisheries salmon biological sampling was done from April till November in few locations along the coast of Main Baltic sea and Gulf of Riga. Similar proportions of samples were collected at gillnet fishery at coast of Main Baltic and east coast of Gulf of Riga. 210 salmon sampled in offshore fishery with longlines (SD 28), 28 salmon sampled in offshore trolling. 98 salmon kelts were sampled in licensed angling in Salaca river and 3 in the Gauja river. All fish were aged by scale reading; in total 421 adult salmon.

Lithuania: Data of 20 migrating adult salmon caught in the Curonian lagoon analyzed.

Poland: There was only one sampling from catch on-board and two sampling from landings in 2020. The reason of that was significant harsh weather limiting number of fishing days. In addition, a new sampling plan was implemented by Poland, starting from 2017/2018, in order to move gradually from metier based and purely opportunistic sampling towards the plan based on statistics, with the aim to reach statistically sound sampling scheme (4S) in two–three years' time. New sampling system provided high level of non-responses and refusals to take observers onboard. In addition, COVID-19 issue reduced the fishing effort in a spring time.

Russia: There is no ongoing biological sampling program running in Russia. Despite this, 594 salmon were collected and sampled for age, length and weight from brood stock fishing in 2020. Since Russia is not an EU Member State, the country is not obliged to follow EU regulations.

Sweden: Age sampling of smolts in rivers is included in the Swedish EU-MAP work plan. These data are needed in the WGBAST assessment modelling work; hence, the sampling is motivated on the ground of end-user needs. In 2020, a total of 774 smolt were sampled for age: 223 in Mörrumsån (that flows into SD 25); 100 in Testeboån (SD 30) plus 315 in Ume/Vindelälven and 136 in Åbyälven (i.e. 451 altogether in SD 31).

2.5.2 Growth of salmon

Below a short summary of an ongoing study on growth of Baltic salmon in relation to composition of the overall fish community is presented.

The average weight of salmon by age group increased around year 1990, simultaneously with an increase in sprat abundance (Figure 2.5.2.1). Despite some annual variation, the level of growth has remained rather stable. In 2016–2020, catch samples indicate a slight increase in mean weights by age (particularly in the MSW are groups) which is potentially a result of improved feeding conditions. Despite that salmon shares feeding areas with cod in the southern Baltic Main Basin, there is no clear reduction in the growth rate of salmon as has been observed for cod. The estimated post-smolt survival decreased strongly from the mid-1990s until 2005 (Figure 4.2.3.1) but this cannot be recognised in the growth data. Mortality mechanisms seem to affect salmon populations in such a way that survived individuals grow approximately as large in periods of high mortality as in periods of low mortality.

2.6 Genetic composition of Baltic salmon catches

In this section, results from recent analyses of stock proportions in catches are presented. Description of the genetic methodology used and how results are applied can be found in the Stock Annex (Annex 2).

2.6.1 Salmon stock and stock group proportions in Baltic salmon catches in the Bothnian Bay based on DNA microsatellite and freshwater age information

Combined DNA and smolt-age data have been used to estimate stock and stock group proportions of salmon catches in the Baltic Sea with a Bayesian method since the year 2000 (Pella and

Masuda, 2001; Koljonen, 2006; ICES, 2019). In 2020, Finnish coastal salmon catches from the Gulf of Bothnia were analysed from three fishing zones with temporal regulation of opening days. The regulation of the Finnish salmon fishing in the Gulf of Bothnia was changed in 2017, making it possible to start the fishing earlier (advanced starting date) than in previous years. To provide comparable data for the time-series from previous years, the estimates of stock and stock group proportions in the salmon catches from the fishing regulation zones were analyzed separately for catches preceding and succeeding the pre-2017 opening dates of the temporal regulation (Salmon fishing opening dates in 2016 were: Bothnian Sea: 10.6., the Quark area: 15.6., Bothnian Bay: 20.6., and the northernmost Bothnian Bay: 25.6.).

Methods

The salmon river stock genotype baseline data used for the 2019 catches were also used for analysis of the 2020 catch samples (Table 2.6.1, Figure 2.6.1) (ICES, 2020a). The current baseline river stock data set includes information on 17 DNA microsatellite loci from 39 Baltic salmon stocks from six countries, totalling 4453 individuals (Table 2.6.1).

As the temporal fishing regulation in the Gulf of Bothnia in Finland was changed in 2017, two separate collections of samples have been carried out since. In 2020, one sample (N=444) was collected from the late period, corresponding to the fishing period before the changed regulations in 2017. Another sample (N=352) was from the advanced season, early summer catches in 2020. Both samples were taken from three out of the four fishing zones (Bothnian Sea, the Quark area, Bothnian Bay and Northern Bothnian Bay). In all, scales from 796 salmon were analysed from the catches to produce the stock and stock group estimates.

Because smolt-age information was used for stock proportion estimation, the fish in the catch samples were divided into two smolt-age classes according to the smolt-age information from scale reading: 1–2 year old smolts and 3–5 year old smolts. As all released hatchery smolts are younger than three years, salmon in catch samples with a smolt age of older than two years originated presumably, or *a priori*, from the wild stocks, whereas individuals with a smolt age of one or two years could have originated either from a wild or a reared stock. The same assumption is used in scale reading as well, when differentiating wild and reared fish. Correspondingly, smolt-age distributions were needed for all baseline stocks in addition to genetic data (Table 2.6.2). Smolt age distributions of wild smolts in Tornionjoki, Simojoki, Kalixälven and Råneälven were updated to represent the smolt-age distributions of smolt year classes from 2017 to 2019, of which the catches of adult salmon in 2020 were mainly composed. For the other stocks an average of smolt ages over the years was used (Table 2.6.2).

Results

In the Finnish **Bothnian Bay** salmon catch samples from the latter part of the summer fishing season (comparable to time of sampling in the years before 2017), the proportion of wild stocks was the lowest since 2009 (58% PI: 53–63%) (Table 2.6.3). The proportion of wild fish was about 70% in 2015 and 2016, and even 80% in the maximum year of 2014. The number of hatchery-released fish among smolts has been fairly constant over time, so it can be assumed that the number of wild salmon has decreased in the catches in 2020 compared to the 2018–2019 level, back to the level of the weak years of 2012, 2013 and 2017 (Figure 2.6.2).

During the advanced fishing season in 2020, the proportion of wild fish was about 15 percentage points higher, about 73% (PI: 68–78 %), than during the late fishing season (58% PI: 53–63%) (Table 2.6.3) (Figure 2.6.2). The difference in stock composition between early and late fishing seasons was larger in 2020 than in 2019, similar to the difference in stock composition in 2017 and 2018 (Table 2.6.3) (Figure 2.6.2). The share of hatchery fish increased during the early season. It seems that in the years, when the number of returning wild spawners is low, the difference between early and late season is larger. When there are less wild spawners to return, the catches of the late fishing season include more hatchery fish. The difference between the seasons increases when the number of returning spawners is low. When there are more wild born fish returning, their share in the latter season catches increases as well.

Focusing only on the four years when the early season fishing was allowed (2017–2020), the difference between the wild stock group proportions during the early (77%) and late season (65%) fisheries was still on average 12 percentage points (Table 2.6.4.). The difference is clearest in the northernmost area of the Bothnian Bay, where in the advanced fishing season, from June 9th to June 24th, the proportion of wild stocks, pooled over four years, was 78%, decreasing after the early fishing season to 61%. In the Bothnian Sea catches, the proportion of wild stocks was more constant, and the differences in wild stock proportions between the advanced and late seasons were smaller than in the Bothnian Bay catches (Table 2.6.4) (Figure 2.6.3). The differences between wild stock group proportions in the early and late seasons were also smaller in the Quark (Table 2.6.4, Figure 2.6.3). There were only few individual Swedish hatchery fish (< 1%) in the advanced fishing season catches, while their proportion in the later season was 7%, which also indicates the different migration timing tendencies of wild and reared stock groups.

The individual river stock proportions in the 2020 salmon catches during the late season were very near to the long term (2013–2020) total proportions (Table 2.6.5). The most common stock was the wild born Tornionjoki salmon (40%), the next common were hatchery origin salmon from Tornionjoki (14%), Kalixälven (13%), and Iijoki (12%). When stock proportions of early and late fishing seasons were compared the clearest difference was in the proportions of Kalixälven salmon: 22% in the early season, 13% in the late season (Figure 2.6.4.). Kalixälven salmon seem to leave the Finnish coast early, while the wild Tornionjoki salmon remain to be caught also in the late season. During the early, advanced fishing season, the stock composition of the catches was relatively homogenous in all three fishing zones (Table 2.6.6). Iijoki salmon were less common in the northernmost area than in the southern zones. During the late season Iijoki salmon were less common (9%) in the Bothnian Sea catches than in the more northern zones (15–18%), and Kalixälven salmon less common (8%) in the most northern area, than in the more southern zones (15–19%) (Table 2.6.6). Early season fishery is targeting relatively more the wild-born salmon.

2.7 Management measures influencing the salmon fishery

2.7.1 International regulatory measures

Detailed information and evaluations of international regulatory measures are presented in the Stock Annex (Annex 2).

Exemption from landing obligation. In 2014, the European Commission decided to introduce a discard ban for commercial fisheries, covering all species under TACs (Commission Delegated Regulation (EU) No 1396/2014 of 20 October 2014). Salmon fisheries in the Baltic Sea have an exemption from the landing obligation for salmon caught with trapnets, creels/pots, fykenets and poundnets (see Annex 2 for more details). The exemption for salmon fisheries using particular gears, is based on the assumption that fish caught in these gears has a high likelihood of survival after capture, handling and release (Commission delegated regulation (EU) 2018/211). However, at that time, information about survival rates of released salmon caught in the Baltic Sea commercial fishery, particularly in the most commonly used pontoon/pushup traps, was rather limited.

A review of recent studies carried out in the Baltic Sea (Östergren *et al.*, 2020) indicate that discard mortality in the Baltic salmon coastal fishery is strongly dependent on the type of gear used, as well as emptying procedures and handling time. In addition, external factors, in particular high water temperature and poor health status of the fish, may have a large negative impact on post-release survival. In the studies reviewed by Östergren *et al*. (2020), total discard mortality of salmon caught in pontoon traps varied between studies in the range of 47–88% when the gear was emptied using the traditional technique. These estimates include both immediate mortality, and subsequent post-release mortality (usually only estimated for shorter periods). Recent studies also show that the mortality could be reduced by using emptying procedures where the fish is handled more gently. When a net bag, in Swedish "Vittjanpåse", was attached to Pontoon traps, the total discard mortality was reduced to 17–63%.

The current exemption from the landing obligation for Baltic salmon fisheries will cease to apply on 31 December 2020. Whether there will be a continued exemption from 2021 and onwards will be handled by BALTFISH, STECF and EU COM during spring and summer 2020.

2.7.2 National regulatory measures

National regulatory measures are, unlike the international regulatory measures, updated more often, at times on a yearly basis, and therefore they are presented here and not in the Stock Annex. Effects of national regulatory measures on stock development are generally not evaluated by WGBAST.

In **Denmark**, no new national regulatory measures were implemented in 2020. According to regulations for the period 2014–2020 (BEK nr 212 af 01/03/2017 - Bekendtgørelse om regulering af fiskeriet i 2014–2020) the following rules must be followed:

- All commercial vessels fishing salmon must be registered as salmon fishing boats and have a specific permission for the fishery.
- Discard is not allowed, but seal damaged salmon can be discarded without deduction from the quota.
- Vessels with a catch of ten or more salmon must notify the Fisheries Inspection before entering the harbour.

For recreational trolling fisheries no national legislation is in practice. However, voluntary restrictions are recommended by angler association(s).

Further restrictions: Throughout the year, all streams with outlets wider than 2 m are protected by closed areas within 500 m from the mouth. Otherwise, the closure period is four months at the time of spawning run. Estuaries are usually protected by an extended zone. Gillnetting is not permitted within 100 m of the low waterline. A closed period for salmon (and sea trout) has been established from 16th of November to 15th of January in freshwater. In the sea, this only applies for sexually mature fish in spawning dress (coloured). A maximum of three gillnets and three fykenets/sets of hooks are allowed per fisherman.

Around Bornholm, a maximum of six sets of gear (nets or hooks) are permitted per fisherman. Fishing with hooks is permitted only between 1st of October–1st of May. For each set of hooks, a maximum of 100 hooks is allowed. Maximum length of the six nets allowed is 270 m in total. Between 16th September and the last day in February nets may be combined as follows, either: (A) up to six bottom gillnets, or (B) up to five bottom gillnets and one floating net (maximum 45 m length, maximum height 3 m, minimum mesh size (total) 157 mm (called *'Salmon nets'*) OR five bottom gillnets and one floating net 45 m length and height 12 m with minimum mesh size (total) 57 mm (called *'Bornholmer nets'*), or (C) up to four bottom gillnets and one floating gillnet maximum 45 length and 3 m height, and one 'salmon net'. Between 1st of March and 15th of September, maximum three of the six gillnets allowed can be floating (maximum length 135 m).

Further restrictions around Bornholm: On water with less than 30 m depth: a maximum of three gillnets is allowed (all year). Use of floating gillnets is prohibited from 16 September to the last day of February. Between 1st of March and 30th of April, maximum mesh size (total) is 60 mm in floating gillnets. All year, the use of both *'Bornholmer nets'* and *'Salmon nets'* is prohibited. On water with more than 30 m depth: use of *'Bornholmer nets'* is prohibited between 1st of December and 31st of May. All year only one *'Salmon net'* is permitted. Harvest of sea trout is limited to maximum three fish per man per day (and maximum three per boat per day). No mandatory bag limit exists for salmon, though local trolling fishers have agreed to harvest maximum two salmon per fisher per day, minimum length 75 cm and preferably retain only released (fin-clipped) salmon.

In **Estonia** salmon offshore fishery is regulated by EC regulations, coastal and river fishery also by national rules. No new fishing restrictions was established in 2020. There last new national regulatory measures were implemented in 2019 concerning the recreational sector.

- In river Pühajõgi, Loobu, Selja, Pirita, Vääna and Purtse recreational fishery for salmon and sea trout is closed from 20th of October–30th of November.
- Recreational salmon fishing was banned in Valgejõgi.

In general, since 2011, the following restrictions are in practice:

- no commercial fishery in salmon (and sea trout) spawning rivers is permitted, with the exception of lamprey fishing;
- only licensed angling is permitted.

Some specific management regulations are also in place on a river basis regarding closure periods for angling. A closed period for salmon (and sea trout) angling is established in rivers Narva, Purtse, Kunda, Selja Loobu, Valgejõgi, Jägala, Pirita, Keila, Vasalemma, and Pärnu from 1 September–30 November, and in other rivers from 1 September–31 October. Exceptions for these closures are allowed by decree of the Minister of Environment in rivers with a reared (Narva) or mixed salmon stock (Purtse, Selja, Valgejõgi, Jägala, Pirita and Vääna). Below of dams and waterfalls, all kind of fishing is prohibited at a distance of 100 m. In the River Pärnu, below Sindi dam, this distance is 500 m.

Furthermore, there is an all-year-round closed area of 1000 m radius at the river mouths of the present or potential salmon spawning rivers Purtse, Kunda, Selja, Loobu, Valgejõgi, Jägala, Pirita, Keila, and Vasalemma, and at the river mouths of the sea trout spawning rivers Punapea, Õngu, and Pidula. Since 2011, the closed area for fishing around the river mouth was extended from 1000–1500 m for the time period 1 September–31 October for rivers Kunda, Selja, Loobu, Valgejõe, Pirita, Keila, Vääna, Vasalemma and Purtse. In rivers Selja, Valgejõgi, Pirita, Vääna and Purtse, recreational fishery for salmon (and sea trout) is banned from 15 October to 15 November. In the case of the most important Estonian sea trout spawning rivers (Pada, Toolse, Vainupea, Mustoja, Altja, Võsu, Pudisoo, Loo, Vääna, Vihterpadu, Nõva, Riguldi, Kolga, Rannametsa, Vanajõgi, Jämaja) a closed area of 500 m is established from 15th of August to 1st of December. In most of the salmon (and sea trout) rivers, angling with natural bait is prohibited.

In **Finland,** in the Main Basin salmon fishing has been forbidden for the Finnish vessels from year 2013. Coastal salmon fishing regulation for the Gulf of Bothnia was renewed in 2017. Also, individual quota system was implemented in salmon fishery (and as well as Baltic herring and sprat fishery) in 2017. In Åland Islands prevails a separate regulation.

In the Gulf of Bothnia for commercial fisherman salmon fishing is allowed to start with one trapnet in the following dates in four zones: Bothnian Sea (59°00′N–62°30′N) May 1st, Quark (62°30′N–64°N) May 6th, Southern Bothnian Bay (64°00′N–65°30′N) May 11th and Northern Bothnian Bay (65°30′N–->) May 16th. They can set one more trapnet for fishing in the following dates: Bothnian Sea (59°00′N–62°30′N) June 10th, Quark (62°30′N–64°N) June 15th, Southern Bothnian Bay (64°00′N–65°30′N) June 20th and Northern Bothnian Bay (65°30′N–>) June 25th. After one week from these two, more trapnets are allowed to set for fishing (maximum a total of four trapnets per fisherman).

Also, in terminal fishing areas, the number of trapnets and fishing period was restricted. Earlier in terminal fishing areas the number of trapnets was unlimited and only in Kemi terminal area there was a closure in the early summer. Now the regulation in terminal areas is more similar to the rest of the region. Fishing with one trapnet is allowed to start at the same time as outside the areas, but the number of trapnets can be raised up to three on June 17th and up to eight on June 25th (for fishers with turnover less than equal to 10 000 € up to two and four for respectively).

In the area outside of River Simojoki, salmon fishing may start on July 16th and outside the mouth of river Tornionjoki on June 17th.

All salmon have to be marked with a coded landing mark. In the first period of the season (when one trapnet is allowed) fisher is allowed to utilize of 25% his/her individual quota at maximum. Large trapnets (higher than 1.5 m) are allowed only for commercial fishers.

Salmon fishing with longlines and gillnets is forbidden in the Archipelago Sea and Gulf of Bothnia from April 1st to June 16th–July 1st depending on the area.

In **Germany,** no new national regulatory measures were implemented in 2020. For several years, there is no quota allocated in the commercial sector, i.e. there is no directed commercial salmon fishery anymore. There are two federal states bordering the Baltic coast: Schleswig-Holstein, (SH) and Mecklenburg-Western Pomerania (MV). Commercial (coastal) fishing and recreational fishing is under the jurisdiction of the German federal states. Consequently, marine coastal fishing is managed with different legislation. The fishing season is closed both for commercial and recreational fisheries during autumn, in SH 1st of October–31st of December (only coloured fish) and in MV 15th of September–14th of December. Closed areas in both federal states include protected spawning grounds in coastal waters, 300–400 m around spawning streams/rivers. For commercial fisheries there is also a 200 m gillnet ban in front of the coastline. In MV, trolling fisheries is permitted at a distance >1 km from the coastline between September 15th and March 15th and there is a rod limit of three rods per angler in place. In MV, there is also a bag limit in place allowing landing of three salmonids (sea trout or salmon) per day and angler. Recreational fishery for salmon (and sea trout) is allowed on a licence basis. The minimum landing size is 60 cm in both states.

In **Latvia** in 2020, licensed angling for descending hatchery origin (finclipped) sea trout and salmon kelts was opened also in Gauja river. Similar to the regulations established in Salaca and Venta river, daily bag limit is one sea trout or salmon.

In summary, current national legislation in commercial offshore and in coastal waters includes the following restrictions:

- In the Gulf of Riga, salmon driftnet and longline fishing is not permitted;
- In coastal waters, salmon fishing is prohibited from 1st of October–15th November;
- Salmon fishing in coastal waters has been restricted indirectly, by limiting the number of gears in the fishing season.

In the recreational trolling fishery, one person is allowed to use a maximum number of three fishing rods in the waters of the Baltic Sea and the Gulf of Riga, if each gear has no more than three hooks of any type (including treble hooks), and where more than one treble-hook hook is allowed only if it is free (moving) attached to one artificial bait. It is prohibited to use natural bait for salmon and trout. Daily bag limit is one salmon and one sea trout per person. Minimum size limit is 60 cm for salmon and 50 cm for sea trout.

In the rivers with natural reproduction of salmon, all angling and fishing for salmon and sea trout is prohibited with exception of licensed angling for sea trout and salmon during the spring season in the rivers Salaca and Venta. Daily bag limit is one sea trout or one salmon. Since 2013, all gillnetting is prohibited all year round in a 3 km zone around the River Salaca outlet. In 2004, the restriction zones were enlarged from 1 to 2 km for the rivers Gauja and Venta. In rivers Daugava and Bullupe (connects rivers Lielupe and Daugava) angling and commercial fishing of salmon is allowed since 2007. However, it is prohibited to use gillnets in these rivers.

In **Lithuania** salmon offshore fishery is regulated by EC regulations, coastal and river fishery also by national rules. Most regulatory measures is as it was in previous years. It is some changes for fishing zones in Nemunas river and new requirement for commercial fishery in Curonian lagoon; all (dead or alive) salmon and sea trout caught with fykenets must be released.

The commercial fishery is regulated during time of salmon (and sea trout) migration in the Klaipėda Strait and the Curonian lagoon. Fishing is prohibited all year-round in a predefined part of the Klaipėda strait. From the 1st of September–31st of October, during the salmon (and sea trout) migration, fishing with nets is prohibited on the eastern stretch of the Curonian lagoon between Klaipėda and Skirvytė, at a 2 km distance from the eastern shore.

Recreational salmon (and sea trout) fisheries along the coast are regulated by one set of rules, whereas in inland waters another set of rules regulates the fisheries. For recreational fishing of salmon (and sea trout) in the Baltic Sea, one either needs to buy a fishing ticket or be entitled to special fishing rights to fish. In inland waters, you need a recreational fishing card for fishing. Both in the sea and in inland waters, there is a bag limit of one salmon or sea trout per angler and fishing day. In inland waters, the minimum size has been extended to 65 cm.

In the period September 15th to 31st of October, recreational fishing is prohibited within a 0.5 km radius from the Šventoji and Rėkstyne river mouths, and from the southern and northern breakwaters of Klaipėda Strait. During the same period, commercial fishing is prohibited within a 0.5 km radius from Šventoji River mouth, and 3 km from the Curonian lagoon and Baltic Sea confluence. From 1st of October to 31st of December, all types of fishing are prohibited in 161 streams, because of brown trout and sea trout spawning.

In larger rivers, such as Neris and Šventoji (with twelve rivers/tributaries in total), special protected zones have been selected where schooling of salmon and sea trout occurs. In these selected zones, licensed fishing is only permitted from 16th of September until 15th of October. Last year, the angling of salmon and sea trout in this selected river zones was limited by a 'catch and release' rule (from 1st until 15th October). From 16th of October to 31st of December any kind of fishing is prohibited in these areas. From 1st of January, licensed salmon (and sea trout) kelt fishing is permitted in the Minija, Veiviržas, Skirvytė, Jūra, Atmata, Nemunas, Neris, Dubysa, Siesartis and Šventoji river. Fishing with a licence is allowed from 1st of January to 1st of October in designated stretches of the listed rivers. In the inland waters, regulation of fishing is more complex. In case of retaining a salmon (or sea trout), a specific part of the recreational fishing card must be removed not later than within five minutes. Such a marked recreational fishing card means that you are not allowed to continue fishing there and then.

In **Poland** one national regulatory measure was implemented in 2020: the protective period for salmon and sea trout for recreational fisheries have been shortened compared to the previous one (was: 'between 15th September and 30th November') to the period 'between 15th September and 15th November beyond four nautical miles from the shore'. That regulation has been implemented to unify the legal acts related to the protective period for salmon and sea trout, however, the shortened protective period has been chosen.

In addition to EC measures, seasonal closures and fixed protected areas are in force within territorial waters managed by Regional Fisheries Inspectorates. Fishing for salmon (and sea trout) in the sea is not allowed between 15th of September and 15th of November within a predefined belt along the coastal zone (<4 Nm). A new law for recreational salmon fishing in Polish EEZ was introduced in 2015 including:

- catch quotas (per day/per angler);
- minimum size limits (TL.);
- periods and areas for protected fish species;
- minimum distance between anglers.

Rod fishing (coastal fishing, boat/belly boat fishing, and organized cruises on board fishing vessels) and spear fishing is allowed. Recreational fishing with nets is not allowed. A new system of obtaining fishing licences has been established. Currently, proof of a bank transfer with specified personal information is needed for legal fishing. The permit can be issued for a period of one week, one month or one year.

Since 2005, commercial fisheries for salmon (and sea trout) in rivers is based on new implemented rules. Fisheries opportunities were sold in 2005 by the state on a tender basis, where the bidder had to submit a fishing ten-year operational plan including restocking. Commercial river fisheries directed for sea trout and salmon already exist almost only in the Vistula River. However, salmon are rare. In Pomeranian rivers, some salmon are collected annually for brood stock during spawning run.

In the rivers, angling for salmon and sea trout is forbidden between 1st of October and 31st of December. A fishing licence and permit are needed for fishing in the rivers. Only rod fishing is allowed for fishing for salmon and sea trout in the rivers. In addition, in Rivers Ina, Rega, Parsęta and Słupia, anglers must release all salmon that have been caught.

In **Russia**, no changes in the national regulations have been implemented since 2001. The international fishery rules are extended to the coastline. In all rivers, and within one nautical mile of their mouths, fishing and angling for salmon is prohibited during all year, except fishing for brood stock for hatcheries.

In **Sweden**, for the commercial fisheries in 2020, as in recent years, the Swedish salmon quota was allocated to the coastal fishery as the Swedish offshore fishery targeting salmon and sea trout was phased out in 2012–2013. Management measures for salmon include an early summer ban and a minimum landing size of 60 cm. The aim of the early summer ban in the coastal fishery is to ensure that part of the migrating population of adult salmon ascend rivers before the fishing season starts. Starting dates of the Swedish commercial coastal fishing season in 2020 were the same as in 2019. North of latitude 62º55′N the fishing season started 17 June except in the protection area outside River Umeälven where the starting date was set to 1 July. Exemptions from the seasonal regulation of the salmon fishery was allowed by the local county board to professional fishermen in the area north of latitude 62º55′N up to the border between the counties Västerbotten and Norrbotten (except the protection area outside Umeälven), so that a limited fishery could start 12 June. South of latitude 62º55′N, commercial coastal fishing in 2020 was allowed from 1 April.

Salmon fishing opportunities for Swedish commercial fishermen in 2020 amounted to 26 991 salmon and consisted of the 2020 quota of 24 252 salmon plus an unutilized part (2739 salmon) of the 2019 quota. Of the 26 991 salmon, 591 were reserved for bycatches in fisheries targeting other species and as a buffer if catches would exceed the quota. 26 400 salmon were allocated to the commercial coastal fishery and were divided between ICES subdivisions (SD) in a similar way as in the last few years. In SD 31 the regional quota was set to 19 200 salmon. Among those, 2000 salmon were allocated specifically to the protection area outside River Umeälven, where fishing started 1 July. The aim of the changed regulations outside Umeälven was to protect the (early migrating) weak wild salmon population in the tributary Vindelälven during the spawning migration. In SD 30, the regional quota was set to 7000 salmon. In SD 22–29 the regional quota was set to 200 salmon because of the higher expected proportion of salmon from weaker populations in these catches (as compared to SD 30 and 31). According to the latest information, commercial catches in 2020 were below regional quotas in all three areas (landed share of quota was 68%, 71% and 95% in SD 22–29, SD 30 and SD 31, respectively). The total Swedish coastal catch in 2020 in SD 22–31 (23 292 salmon) corresponded to 88% of the total Swedish quota for the coastal fishery in these three areas (26 400 salmon).

Recreational fisheries in the sea and in rivers are also managed through national regulations. Recreational coastal fisheries with trap nets in the counties of Norrbotten, Västerbotten and part of Västernorrland were, as in latest years, allowed from 1 July until the quota of salmon within the commercial fishery was fulfilled. In SD 31, the salmon fishery was stopped 5 July 2020 when the regional salmon quota was filled. Hence, it was possible to conduct recreational fishing with trapnets in SD 31 between 1 and 4 July, but the recreational fishery using these gears is most likely very small or non-existent due to the ban for recreational fishermen in the Baltic Sea to sell their catches; many recreational trapnet fishermen have applied for a commercial licence and their catches are now included in the quota. The recreational fishery using trapnets in SD 30 is likely also small or non-existent. SLU Aqua plan to carry out an inventory of the recreational coastal fishery for salmon during 2021.

Since 2013, Swedish offshore trolling fisheries (that mainly takes place in the Main Basin) are only allowed to land salmon without an adipose fin (i.e. finclipped reared salmon). In all rivers there is a general bag limit of one salmon and one trout per fisherman and day. Also fishing periods are regulated on a national level. In Gulf of Bothnian wild rivers, for example, angling for salmon is forbidden from 1 September until 31 December, and in some rivers, angling is also forbidden between 1 May and 18 June. In 2019, new regulations were introduced in Vindelälven and Ljungan, including a maximum size limit of 65 cm in Vindelälven and a total ban for catching salmon in Ljungan. These restrictions were introduced to protect the weak wild salmon populations is these rivers. In addition to national regulations, local fishing and management organizations may stipulate more restrictive rules.

The management of fisheries in the boarder river Torneälven, including the coastal area directly outside the river mouth, is handled through an agreement between Sweden and Finland. The Swedish-Finnish agreement includes for example a specified time period within which the commercial coastal fishery in the river mouth is allowed to start. Regulations targeting the river fishery are also handled in the agreement. Deviations from the agreed fishing regulations in this area are negotiated and decided upon on an annual basis by SwAM (according to a Government commission from the Swedish Ministry of Enterprise and Innovation) and the Finnish Ministry of Agriculture and Forestry.

In order to improve the situation for weak sea trout stocks in SD 31, a number of changes have been implemented in recent years. The minimum size for landed sea trout was raised from 40 to 50 cm in the sea 1 July 2006. Furthermore, a ban of fishing with nets in areas with a depth of less than 3 meters during the period 1 April–10 June and 1 October–31 December was implemented in 2006 to decrease bycatch of trout in fisheries targeting other species. Further restrictions for rivers in Bothnian Bay (SD 31) were adopted in 2013, including shortening of the autumn period for fishing with two weeks, restrictions of catch size (window size 30–45 cm), and landing of only one trout per fisherman and day. In River Torneälven, sea trout fishing is forbidden. From 1 September 2019, new fishing regulations were introduced in SD 30 to improve the situation for coastal fish populations in this area. These regulations include a ban for fishing with nets in areas with less than 3 meters depth between 1 September and 10 June, a complete net ban between 15 October and 30 November, increase of the minimum size for sea trout from 40 to 50 cm, and a daily bag limit of one wild sea trout when fishing with sport fishing equipment or fykenets. In

April 2021, a daily bag limit of one wild sea trout when fishing with sport fishing equipment or fykenets was introduced also along the Swedish southeast coast (SD 27–29). The new regulations implemented in 2021 also include a few new protection areas along the southeast coast to protect sea trout during the autumn migration.

In 2020, the Swedish Agency for Marine and Water Management initiated an overview of the fishing regulations in both rivers and coastal areas (see Kagervall *et al*., 2020; Magnusson *et al*., 2020; Dannewitz *et al*., 2020 a, b). This process will likely result in updated regulations/restrictions in the coming years. The aim of the overview is to develop the fishery management to become more stock-specific so that fishing possibilities will be adapted to the status of individual river stocks of salmon and sea trout, and also the situation for other migrating and coastal fish species.

A discard ban for quota-regulated species in the Baltic Sea was implemented by EU 1 January 2015. All salmon and other quota-regulated species caught in fisheries targeting salmon should be landed and registered. Likewise, all salmon taken as bycatch in fisheries targeting other species should be landed and registered. Salmon fisheries in the Baltic Sea have had an exemption from the landing obligation for salmon caught with trapnets, creels/pots, fykenets and poundnets. An exemption makes it possible to release wild salmon back into the sea, as a measure to steer the exploitation towards reared (finclipped) salmon. The possibility to release salmon also makes it possible to catch other species outside the salmon fishing season or when the salmon quota is filled. The exemption from the landing obligation ceased to apply 31 December 2020, and at the time of writing it is unclear whether a new exemption will be decided by EU later this spring or not.

The earlier exemption was based on the assumption that salmon has a high likelihood of survival after capture, handling and release. The knowledge about long-term survival of salmon after release is, however, limited. A review of studies on the subject (Östergren *et al*., 2020), including results from recent studies in Sweden, indicates that the discard mortality in the Baltic salmon coastal fishery is strongly dependent on the type of gear used, as well as handling time and emptying procedures. Baltic salmon captured in the most common gear type (the pontoon trap) typically show physical injuries (e.g. blood in eyes, scale losses) which together with physiological stress increases the risk of discard mortality. In addition, extrinsic factors, in particular high water temperature and poor health, may have a large negative impact on post-release survival. With a modified design of the Pontoon trap, where a net bag ("Vittjanpåse") is attached to the trap, which facilitates gentle handling of the fish, the total discard mortality can be reduced substantially given that the fish are correctly/gently handled.

Member States around the Baltic Sea have, through BALTFISH, produced a Joint recommendation regarding a new discard plan for Baltic salmon and an exemption from the landing obligation for certain fishing gears. The pontoon trap is suggested to be included among gears exempted from the landing obligation only if a "vittjanpåse" is attached to the trap, thereby facilitating gentle handling of the fish. As indicated above, however, EU has not yet taken any decision regarding a new discard plan for Baltic salmon. A landing obligation that would involve also trapnet fisheries would most likely affect the exploitation pattern of both salmon and other species. The estimated share of undersized salmon in coastal fisheries with traps is low, so a discard ban will not have any major impacts on the fishery targeting salmon. However, the possibility of releasing wild salmon back into the sea as a conservation measure to steer the exploitation towards reared (finclipped) salmon will disappear. Also, trapnet fisheries targeting other species may have to be more strongly regulated than today if salmon are taken as bycatch, which will probably have large economic consequences for fishermen in some areas. This effect may at least partly be overcome by the development of selective gears not catching salmon and/or redirecting the fishery with trapnets for other species toward time periods when salmon are less frequent along the coast.

2.8 Other factors influencing the salmon fishery

The incitement to fish salmon is (as for other species) influenced by a number of factors, such as the possibilities for selling the fish and then at which market prize, eventual opportunities to target and catch other species and problems with damages to the catches caused by seals and possibly birds.

Further, the possibilities for selling the fish is evidently affected by co-factors such as levels of contaminants, e.g. dioxin. Detailed information about dioxin contents in Baltic salmon, and how this affects the fishery, is presented in Stock Annex (Annex 2, Section A.2.6). Also, the overall health status of the fish is of importance. See Section 3.4.4 for a summary of disease problems seen in several rivers and areas in later years.

Table 2.2.1.1. Total catch: Nominal reported catches plus discards (incl. seal damaged salmon), unreported and misreported catches of Baltic Salmon in tonnes round fresh weight, from sea, coast and river by country in 2001–2020 in subdivisions 22–32.See ICES (2018) for catches before year 2001.

Year	Country									Reported total catch	Estimated misreported catch	Estimated unreported catch		Estimated discarded catch		Total catch	
	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden			median	90% PI	median	90% PI	median	90% PI
2001	443	16	698	39	136	4	180	37	646	2199	630	277	216-376	207	189-229	3115	3049-3220
2002	334	16	570	29	108	11	197	66	587	1918	575	266	205-366	180	164-199	2767	2702-2873
2003	454	10	472	29	47	3	178	22	445	1660	716	277	216-376	180	164-199	116	87-163
2004	370	7	724	35	34	3	88	16	887	2164	1271	266	205-366	191	173-215	3115	3049-3220
2005	214	9	674	24	23	3	114	15	720	1796	554	219	168-309	221	200-250	2767	2702-2873
2006	178	8	415	18	14	2	117	5	495	1253	234	316	238-457	155	143-171	2635	2577-2731
2007	79	7	452	15	26	2	95	6	469	1150	272	271	208-379	119	110-130	3781	3694-3925
2008	34	9	480	21	9	2	44	6	449	1054	16	197	150-276	93	86-101	2627	2560-2738
2009	82	7	446	14	15	2	49	2	517	1133	333	185	143-253	51	48-56	1696	1647-1778
2010	145	5	286	8	13	1	48	2	419	926	374	198	149-282	65	59-74	1602	1559-1672
2011	105	5	302	7	7	2	31	2	474	934	185	212	158-313	61	54-71	1265	1216-1349
2012	118	7	495	7	8	2	28	2	477	1144	87.5	164	124-238	59	54-66	1692	1636-1795
2013	138	9	392	6	12	1	24	2	401	985	75	175	131-256	54	49-60	1483	1440-1558
2014	143	7	468	6	11	2	15	2	375	1029	68	216	165-299	67	57-78	1318	1273-1399
2015	112	9	383	10	10	13	18	2	382	939	83	146	108-209	60	50-69	1472	1421-1556
2016	94	13	452	8	9	19	18	2	386	1000	130	151	112-214	58	50-65	1238	1200-1301
2017	46	14	357	42	8	8	55	2	265	797	160	138	103-192	57	51-62	1289	1249-1352
2018	76	12	346	49	6	11	68	2	337	907	213	147	109-207	54	46-59	1163	1129-1218
2019	100	13	402	49	19	10	66	3	343	1005	3	87	66-120	33	30-36	1283	1245-1343
2020	85	15	378	11	15	16	48	4	340	912	1	104	78-143	33	31-36	1044	1022-1077

Table 2.2.1.2. Total catch: Nominal reported catches plus discards (including seal damaged salmon), unreported and misreported catches of Baltic Salmon in numbers from sea, coast and river by country in 2001–2020 subdivisions 22–32. See ICES (2018) for catches before year 2001.

Year	Country									Reported	Estimated misreported	Estimated unreported catch		Estimated discarded catch		Total catch	
	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	total catch	catch	median	90% PI	median	90% PI	median	90% PI
2001	90388	3285	135714	7717	29002	1205	35606	7392	159480	469789	126100	61170	47380-83050	41110	37480-45670	17830	13360-25000
2002	76122	3247	116533	5762	21808	3351	39374	13230	146197	425624	115000	6774	6565-7073	41110	37480-45670	17100	12830-23720
2003	108845	2055	112662	5766	11339	1040	35800	4413	119820	401740	143200	61170	47380-83050	38060	34710-42180	19300	14360-27390
2004	81425	1452	143107	7087	7700	704	17650	5480	199335	463940	254300	59300	45650-81710	42840	38730-48060	658300	643600-681600
2005	42491	1721	124427	4799	5629	698	22896	3069	150174	355904	110800	52870	40430-73970	43480	39190-49310	603000	588500-626500
2006	33723	1628	73092	3551	3195	488	22207	1002	102339	241225	46900	67370	50670-97160	30370	27930-33530	603000	589200-625400
2007	16145	1315	83544	3086	5318	537	18988	1408	98076	228417	54310	53690	41130-75030	22470	20800-24550	789400	771100-819900
2008	7363	1890	86749	4151	2016	539	8650	1382	94066	206806	3295	37040	28280-51740	18350	17060-20010	518500	505200-540500
2009	17116	2064	82000	2799	3323	310	9873	584	112971	231040	66510	35710	27580-49130	9723	9200-10490	322700	313600-337900
2010	29714	1459	48281	1520	2307	243	9520	491	84774	178309	74810	37770	28350-54050	13450	12200-15200	315000	306600-328700
2011	21125	1332	52350	1483	1470	317	6149	470	93454	178150	37000	42860	31690-63940	12190	10710-14240	242800	233300-259200
2012	23180	1915	77434	1362	1371	355	5605	412	85834	197468	17500	29970	22690-43240	11490	10520-12830	340100	328600-361600
2013	25461	2426	59764	1210	2842	285	4808	387	62972	160155	15000	31360	23630-45310	9738	8939-10920	282900	275200-296600
2014	24596	2139	71906	1264	2650	388	2999	418	58488	164848	13600	34430	26410-47440	12540	10620-14430	243900	236000-258100
2015	19367	2597	65746	2009	2572	2580	3745	406	63361	162383	16600	22740	16990-32200	10640	8965-12260	246600	238500-259700
2016	17701	3180	65356	1623	2881	3803	3659	419	62549	161171	26000	22080	16390-31110	10640	9274-11810	196100	190300-205700
2017	9644	3005	55193	5632	2435	1702	10760	380	50771	139522	32000	21920	16450-30700	11010	9678-11890	198900	193200-208000
2018	14933	2569	50939	6613	1531	2223	12642	458	60330	144101	42600	22820	17140-32050	10640	9052-11520	199200	193700-208000
2019	15413	2775	58743	6502	4118	1836	12061	602	51361	153411	600	16240	12220-22790	5874	5446-6458	209000	203300-218300
2020	12517	2591	56411	1605	3366	2868	7820	752	57364	145294	200	17830	13360-25000	6989	6733-7366	186600	182500-193200

The catches in sub-divisions 22-23 are normally less than one tonnes.
From 1995 data includes sub-divisions 22-32.
Catches from the recreational fishery are included in reported catches as follows: Finland from 1980, Sweden from 1988, Denmark from 1998.
Other countries have no, or very low recreational catches.
1) In 1993 Fishermen from the Faroe Islands caught 3200 individuals, which is included in the total Danish catches.

Table 2.2.1.3. Nominal catches of Baltic Salmon in tonnes round fresh weight, from offshore, coast and river by country and region in 2001–2020. O=offshore, C=coast, R=river. See ICES (2018) for catches before year 2001.

Year	Main Basin (subdivisions 22–29)																											
	Denmark		Estonia		Finland			Germany		Latvia			Lithuania			Poland			Russia			Sweden			Total			
	O	C	O	C	O	C	R	O	C	O	C	R	O	C	R	O	C	R	O	C	R	O	C	R	O	C	R	GT
2001	433	10	0	4	135	64	0	39	0	66	71	0	1	4	0	165	9	6	33	0		310	2	7	1181	164	13	1358
2002	319	15	0	6	154	51	0	29	0	47	61	0	1	9	0	178	9	10	64	0		225	3	6	1018	153	16	1187
2003	439	15	0	3	115	33	0	29	0	33	14	0	0	3	0	154	22	3	20	0		188	3	3	977	94	6	1076
2004	355	15	0	3	169	74	0	35	0	19	13	2	0	2	0	83	0	5	14	0		410	5	3	1085	112	11	1208
2005	199	15	0	1	188	58	0	24	0	15	8	0	0	2	0	104	5	5	12	0		291	5	2	833	95	8	936
2006	163	15	0	1	105	22	0	18	0	9	5	0	0	2	0	100	12	6	3	0		198	3	1	594	60	7	661
2007	64	15	0	2	158	11	0	15	0	16	3	7	0	2	0	75	15	5	4	0		188	4	2	519	52	14	585
2008	19	15	0	2	46	16	0	21	0	0	5	4	0	2	0	30	8	6	4	0		60	6	2	179	55	11	244
2009	82	0	0	2	39	16	1	14	0	0	10	5	0	1	1	42	8	0	0	0		82	8	1	258	45	7	310
2010	145	0	0	1	36	11	1	8	0	0	4	10	0	1	1	40	7	0	0	0		128	5	1	357	28	12	398
2011	105	0	0	1	38	18	1	7	0	0	4	4	0	0	1	22	9	0	0	0		162	5	1	335	37	7	379
2012	118	0	0	2	23	27	0	7	0	0	2	6	0	1	1	25	3	0	0	0		88	6	2	261	40	10	312
2013	138	0	0	2	0	21	0	6	0	0	6	5	0	0	1	21	3	0	0	0		0	5	1	166	37	7	210
2014	143	0	0	2	1	29	0	6	0	0	5	5	0	1	1	13	3	0	0	0		0	6	1	163	46	8	216
2015	112	0	0	3	2	24	0	10	0	1	6	3	3	0	9	15	3	0	0	0		0	1	2	143	37	15	195
2016	94	0	0	3	1	24	0	8	0	0	7	1	8	0	11	15	3	0	0	0		0	3	1	126	41	13	180
2017	46	0	0	3	0	21	0	42	0	0	5	3	5	0	3	49	6	0	0	0		0	2	0	143	36	6	185
2018	74	0	0	3	0	26	0	49	0	2	1	3	6	1	4	59	7	0	0	0		0	2	0	190	39	8	237
2019	98	0	0	3	0	32	0	49	0	12	4	4	7	1	2	45	20	0	0	0		0	1	1	210	60	7	277
2020	78	0	0	3	0	21	0	9	0	8	4	4	0	10	6	38	10	0	0	0		16	1	1	149	49	11	208

Table 2.2.1.3. Continued.

Year	Gulf of Bothnia (Sub-divisions 30-31)										Main Basin + Gulf of Bothnia (Sub-divisions 22-31) Total			
	Finland			Sweden			Total							
	0	C	R	0	C	R	0	C	R	GT	0	C	R	GT
2001	9	234	26	1	195	117	10	430	143	583	1191	593	157	1941
2002	5	202	20	1	241	101	6	444	121	571	1024	597	137	1758
2003	1	176	25	2	172	73	2	347	98	447	979	441	103	1523
2004	3	309	32	0	368	86	3	677	118	798	1088	789	129	2006
2005	6	239	37	1	286	123	6	525	160	691	839	621	167	1627
2006	1	148	17	6	204	71	7	352	88	448	602	412	96	1109
2007	3	134	27	1	168	101	4	302	128	434	523	354	142	1020
2008	0	209	78	0	208	167	0	417	245	662	179	471	256	906
2009	1	237	43	0	290	127	1	527	170	698	259	572	177	1008
2010	0	151	32	0	208	69	0	359	101	459	357	387	113	857
2011	0	148	37	0	208	81	0	356	118	474	335	393	125	853
2012	0	231	103	0	163	209	0	394	312	706	261	434	322	1018
2013	0	196	73	0	212	179	0	409	252	661	166	446	260	871
2014	0	207	138	0	200	165	0	406	303	710	163	453	311	926
2015	0	175	112	0	189	189	0	364	301	665	143	401	316	860
2016	0	200	149	0	193	188	0	394	337	731	126	435	350	911
2017	0	181	87	0	155	108	0	336	195	532	143	372	202	716
2018	0	185	91	0	192	131	0	378	222	599	190	417	229	836
2019	0	183	120	0	170	167	0	353	287	641	210	413	295	917
2020	0	150	137	0	146	172	0	296	309	605	149	345	319	813

Table 2.2.1.3. Continued.

Year	Gulf of Finland (Sub-division 32)												Sub-division 22-32			
	Estonia			Finland			Russia		Total				Total			
	O	C	R	O	C	R	C	R	O	C	R	GT	O	C	R	GT
2001	0	10	2	14	139	11	0	3	14	150	16	180	1205	743	173	2076
2002	1	10	0	17	46	15	0	2	18	56	16	90	1041	653	154	1848
2003	0	7	0	3	50	8	0	1	3	57	9	70	983	498	113	1593
2004	0	4	0	2	57	9	1	1	3	62	11	75	1091	850	140	2081
2005	0	6	1	3	72	15	1	2	3	79	18	100	842	700	185	1727
2006	0	5	2	3	65	10	1	2	3	70	13	87	605	482	109	1196
2007	0	4	1	3	64	9	0	1	3	69	11	83	527	423	153	1102
2008	0	6	2	2	94	7	1	2	2	100	10	112	180	571	267	1018
2009	0	4	1	1	74	11	1	2	1	79	14	94	260	650	192	1102
2010	0	2	1	1	36	2	0	2	1	39	5	45	358	426	118	902
2011	0	3	1	0	43	3	0	2	0	45	5	51	335	438	131	904
2012	0	4	1	0	85	4	0	2	0	89	6	96	262	523	328	1113
2013	0	7	0	0	78	5	0	2	0	84	7	92	166	530	267	963
2014	0	5	0	0	74	4	0	2	0	79	6	85	163	531	316	1011
2015	0	6	0	0	53	1	0	2	0	59	3	62	143	460	319	922
2016	0	7	2	0	62	1	0	2	0	69	5	74	127	505	355	986
2017	0	9	2	0	53	1	0	2	0	63	4	67	143	435	206	783
2018	0	8	1	1	32	1	0	2	1	40	4	44	190	457	233	880
2019	0	9	1	1	53	0	0	3	1	62	5	67	211	474	299	984
2020	0	11	2	0	55	1	0	3	0	67	6	73	149	412	326	886

Table 2.2.1.4. Nominal catches of Baltic Salmon in numbers, from offshore, coast and river by country and region in 2001–2020 O=offshore, C=coast, R=river. See ICES (2018) for catches before year 2001.

Year	Main Basin (Sub-divisions 22-29)																										
	Denmark		Estonia		Finland			Germany		Latvia			Lithuania			Poland			Russia		Sweden			Main Basin (sub-divisions 22-29) Total			
	O	C	O	C	O	C	R	O	C	O	C	R	O	C	R	O	C	R	O	C	O	C	R	O	C	R	GT
2001	90388	0	122	819	26616	8706	0	7717	0	18194	10808	0	152	1053	0	33017	1764	825	6584	0	82674	485	890	265464	23635	1715	290814
2002	76122	0	0	1171	32870	8003	25	5762	0	11942	9781	85	363	2988	0	35636	1804	1934	12804	0	64275	556	699	239774	24303	2743	266820
2003	108845	0	16	681	24975	5021	25	5766	0	8843	2496	0	74	966	0	30886	4282	632	3982	0	55335	575	469	238722	14021	1126	253869
2004	81425	0	0	594	35567	11024	50	7087	0	4984	2316	400	49	655	0	16539	0	1111	4983	0	######	900	441	251078	15489	2002	268569
2005	42491	0	0	286	36917	7936	25	4799	0	2787	2054	788	0	691	0	20869	1025	1002	2433	0	67961	715	337	178257	12707	2152	193116
2006	33723	0	0	291	19859	3152	20	3551	0	1705	1490	0	9	474	0	19953	1371	883	552	0	47319	546	180	126671	7324	1083	135078
2007	16145	0	0	325	30390	1468	20	3086	0	2960	1478	880	0	529	0	14924	3098	966	888	0	45263	598	243	113656	7496	2109	123261
2008	7363	0	0	432	9277	2324	35	4151	0	0	1410	157	0	518	0	5933	1683	1034	697	0	18602	1040	317	46023	7407	1543	54973
2009	17116	0	0	740	8039	2435	109	2799	0	0	2549	774	0	166	144	8301	1572	0	0	0	24080	1326	154	60335	8788	1181	70304
2010	29714	0	0	538	6966	1587	140	1520	0	0	1092	1215	0	106	137	8029	1491	0	0	0	32857	817	210	79086	5631	1702	86419
2011	21125	0	0	414	7193	2340	140	1483	0	0	1013	457	0	59	258	4429	1720	0	0	0	40157	726	144	74387	6272	999	81658
2012	23180	0	0	713	4088	3560	50	1362	0	0	576	795	0	142	213	5094	511	0	0	0	23798	862	288	57522	6364	1346	65232
2013	25461	0	0	766	66	2699	30	1210	0	0	2038	804	0	72	213	4215	593	0	0	0	2468	724	160	33420	6892	1207	41519
2014	24596	0	0	891	108	3840	15	1264	0	0	1884	766	0	101	287	2494	505	0	0	0	2413	826	147	30875	8047	1215	40137
2015	19367	0	0	1186	235	3081	8	2009	0	137	1923	512	620	72	1888	3180	565	0	0	0	2419	120	212	27967	6947	2620	37534
2016	17701	0	0	1158	152	3196	10	1623	0	0	2728	153	1510	97	2196	3102	557	0	0	0	2409	440	102	26497	8176	2461	37134
2017	9644	0	0	863	0	2978	10	5632	0	0	1864	614	996	48	658	9594	1166		0	0	2405	217	41	28271	7136	1323	36730
2018	14588	0	0	1042	64	3375	0	6586	0	347	937	247	1236	131	600	11021	1300	3	0	0	2407	216	45	36249	7001	895	44145
2019	13805	0	0	1036	13	4155	0	6408	56	2226	1138	753	1287	166	384	7936	3498		0	0	2404	131	100	34079	10180	1237	45496
2020	11065	0	0	727	0	2473	0	1599	0	1517	1158	676	82	1729	1057	6393	1105	27	0	0	2429	126	112	23085	7318	1872	32275

Table 2.2.1.4. Continued.

Year	Gulf of Finland (Sub-division 32)													Sub-divisions 22-32			
	Estonia			Finland			Russia		Total					Total			
	O	C	R	O	C	R	O [1)]	R	O	C	R	GT	O	C	R	GT
2001	62	1965	317	2804	23458	1900	82	726	2866	25505	2943	31314	270357	150224	34290	454871
2002	108	1968	0	3652	8269	3200	18	408	3760	10255	3608	17623	244573	135664	31335	411571
2003	17	1341	0	553	8862	1700	75	356	570	10278	2056	12904	239755	122936	24489	387180
2004	36	822	0	480	9501	1500	183	314	516	10506	1814	12837	252198	169687	26965	448851
2005	34	1298	103	536	12016	2800	213	423	570	13527	3326	17423	179971	128791	33917	342679
2006	48	955	334	506	10431	1700	121	329	554	11507	2363	14425	128537	80972	21226	230735
2007	64	764	162	451	10032	1395	120	400	515	10916	1957	13388	114970	78806	25258	219034
2008	0	1114	344	392	14161	1100	220	465	392	15495	1909	17796	46426	106407	46821	199654
2009	0	1067	257	228	11912	2063	170	414	228	13149	2734	16111	60692	129482	34263	224437
2010	0	736	185	129	5476	400	0	491	129	6212	1076	7417	79217	74830	19506	173553
2011	0	733	185	91	6964	600	0	470	91	7697	1255	9043	74491	76564	21180	172235
2012	0	990	212	62	13285	590	0	412	62	14275	1214	15551	57584	83542	50855	191981
2013	0	1619	41	37	11879	930	0	387	37	13498	1358	14893	33457	82043	40772	156272
2014	0	1185	63	89	11049	505	0	418	89	12234	986	13309	30964	86673	44005	161642
2015	0	1373	38	48	9134	158	46	360	48	10553	556	11157	28024	81202	49835	159061
2016	0	1629	393	51	9228	248	16	403	51	10873	1044	11968	26627	77806	54120	158553
2017	0	1842	300	0	8999	208	0	380	0	10841	888	11729	28271	68747	39831	136849
2018	0	1333	159	114	5487	85	0	458	114	6820	702	7636	36363	66688	42734	145785
2019	0	1486	251	106	8212	60	0	602	106	9698	913	10717	34196	69262	44599	148057
2020	0	1611	253	0	8217	185	72	680	0	9900	1118	11018	23085	63769	53926	140780

Table 2.2.1.5. Nominal catches of Baltic salmon in tonnes round fresh weight and numbers from sea, coast and river, by country and subdivisions in 2020. Subdivisions 22–32. O=offshore, C=coast, R=river, W=weight (tonnes), N=number of fish.

SD	Fishery	-	DE	DK	EE	FI	LT	LV	PL	RU	SE	Grand Total
22	O	W	0									0
		N	14									14
23	O	W										0
		N										0
	C	W									0	0
		N									3	3
24	O	W	9	5					0			14
		N	1163	798					1			1962
	C	W									0	0
		N									1	1
25	O	W		11					2		0	13
		N		2202					246		1	2449
	C	W							0		1	1
		N							45		109	154
	R	W							0		1	1
		N							21		110	131
26	O	W					0	5	11		0	16
		N					82	946	1396		1	2425
	C	W					10	0	10			20
		N					1729	130	1060			2919
	R	W					0		0			0
		N					63		6			69
27	O	W									0	0
		N									1	1
	C	W										0
		N										0
	R	W									0	0
		N									2	2
28	O	W						3			0	3
		N						571			10	581
	C	W			2			4				6
		N			553			1028				1581
	R	W						4				4
		N						676				676
29	O	W										0
		N										0
	C	W			0	21					0	21
		N			174	2473					13	2660
	O	W										0
		N										0
30	C	W				28					35	63
		N				4053					4992	9045
	R	W									52	52
		N									6970	6970
31	C	W				83					111	194
		N				14063					18143	32206
	R	W				137					121	258
		N				19920					24046	43966
32	O	W										0
		N										0
	C	W			11	55				0		66
		N			1611	8217				72		9900
	R	W			2	1				3		6
		N			253	185				680		1118
200	O	W	2	62					25		16	105
		N	422	8065					4750		2416	15653
	R	W					6					6
		N					994					994
300	C	W				39						39
		N				5300						5300
Total 22-31	O+C+R	W	11	78	2	308	10	16	48	0	337	816
		N	1599	11065	727	45809	1874	3351	7525	0	56818	129762
Total 32	O+C+R	W	0	0	13	56	0	0	0	3	0	72
		N	0	0	1864	8402	0	0	0	752	0	11018
	O	W	11	78	0	0	0	8	38	0	16	151
		N	1599	11065	0	0	82	1517	6393	0	2428	23085
	C	W	0	0	13	226	10	4	10	0	147	410
Grand Total		N	0	0	2338	34106	1729	1158	1105	72	23259	63769
	R	W	0	0	2	138	6	4	0	3	174	327
		N	0	0	253	20105	1057	676	27	680	31128	53926
	O+C+R	W	11	78	15	364	16	16	48	3	337	888
		N	1599	11065	2591	54211	2868	3351	7525	752	56815	140780

Table 2.2.1.6. Nominal catches (commercial) of Baltic Salmon in numbers from sea and coast, excluding river catches, by country in 2001–2020 and in comparison with TAC. Subdivisions 22–32. See ICES (2018) for catches before year 2001.

Year	Baltic Main Basin and Gulf of Bothnia (Sub-divisions 22-31)											
	Fishing Nation									Total	TOTAL TAC	Landing of TAC (in %)
	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden			
2001	88388	941	77056	7717	29002	1205	34781	6584	112842	358516	450000	80
2002	73122	1171	82171	5762	21723	3351	37440	12804	100099	337643	450000	75
2003	105845	697	80084	5766	11339	1040	35168	3982	85259	329180	460000	72
2004	78425	594	97162	7087	7300	704	16539	4983	155075	367869	460000	80
2005	39491	286	75481	4799	4841	691	21894	2433	106564	256480	460000	56
2006	30723	291	43220	3551	3195	483	21324	552	70536	173875	460000	38
2007	13145	325	53622	3086	4438	529	18022	888	66763	160818	437437	37
2008	4363	296	44111	4151	1410	518	7616	697	47030	110192	371315	30
2009	14116	740	46855	2799	2549	166	9873	0	68242	145340	309733	47
2010	26714	538	30822	1520	1092	106	9520	0	56778	127090	294246	43
2011	18125	414	33167	1483	1013	59	6149	0	65006	125416	250109	50
2012	20180	713	43448	1362	576	142	5605	0	38125	110151	122553	90
2013	21961	486	29716	1210	1280	72	4808	0	28288	87821	108762	81
2014	21096	563	30059	1264	1112	101	2999	0	28411	85605	106366	80
2015	15867	638	30166	2009	1327	72	3745	0	27907	81731	95928	85
2016	9701	726	24821	1623	1752	97	3659	0	29312	71691	95928	75
2017	3045	593	21878	1176	1210	48	7075	0	23592	58617	95928	61
2018	6029	581	23551	1360	987	367	8557	0	27678	69110	91132	76
2019	6035	544	24377	977	2591	578	6498	0	24021	65621	91132	72
2020	3000	400	20589	512	2062	190	2748	0	23297	52798	86575	61

Table 2.2.1.6. Continued.

Year	Gulf of Finland (Sub-division 32)					
	Fishing Nation		Total	EC	Landing of	Russia
	Estonia	Finland		TAC	TAC (in %)	
2001	2027	12081	14108	70000	20	82
2002	2076	9372	11448	60000	19	18
2003	1358	6865	8223	50000	16	75
2004	858	6891	7749	35000	22	183
2005	1126	9462	10588	17000	62	213
2006	865	10757	11622	17000	68	121
2007	828	10303	11131	15419	72	120
2008	820	13823	14643	15419	95	220
2009	1067	11410	12477	15419	81	170
2010	736	5245	5981	15419	39	0
2011	733	6695	7428	15419	48	0
2012	990	9897	10887	15419	71	0
2013	1254	8466	9720	15419	63	0
2014	908	8408	9316	13106	71	0
2015	896	6452	7348	13106	56	46
2016	1028	6279	7307	13106	56	16
2017	1384	5999	7383	13106	56	0
2018	1043	5401	6444	10003	64	0
2019	1182	8118	9300	9703	96	0
2020	1380	8017	9397	9703	97	72

Table 2.2.1.7. Non-commercial (recreational) catches of Baltic Salmon in numbers from sea, coast and river by country in 2001–2018 in subdivisions 22–31 and Subdivision 32 (O = Offshore, C = Coast, PI = probability interval). See ICES (2018) for catches before year 2001.

Sub-divisions 22-31																				
Year	**Denmark**	**Estonia**		**Finland**		**Germany**	**Latvia**		**Lithuania**		**Poland**		**Russia**		**Sweden**		**O+C**	**River**	**Grand**
	O+C	O+C	River	O+C (95% PI)	River	O+C	O+C	River	O+C	River	O+C	River	O+C	River	O+C	River	**Total**	**Total**	**Total**
2001	2000	na		13450 (±5490)	4610		0	0	0	0	0	0	0	0	14443	22216	29893	26826	56719
2002	3000	na		3640 (±1070)	3592		0	85	0	0	0	0	0	0	17906	16945	24546	20622	45168
2003	3000	na		3640 (±1070)	4493		0	0	0	0	0	0	0	0	14889	13424	21529	17917	39446
2004	3000	na		15820 (±7300)	5992		0	0	0	0	0	0	0	0	22939	14687	41759	20679	62438
2005	3000	na		15820 (±7300)	6715		0	0	0	0	0	0	0	0	17931	15260	36751	21975	58726
2006	3000	na		6180 (±3710)	2610		0	0	0	0	0	0	0	0	12757	12229	21937	14839	36776
2007	3000	na		6180 (±3710)	3541		0	0	0	0	0	0	0	0	11928	14429	21108	17970	39078
2008	3000	136		9090 (±4380)	12027		0	157	0	0	0	0	0	0	13809	24501	26035	36685	62720
2009	3000	na		9090 (±4380)	6957		0	192	0	0	0	0	0	0	19347	18505	31437	25654	57091
2010	3000	na		3270 (±3600)	4884		0	22	0	0	0	0	0	0	14346	9325	20616	14231	34847
2011	3000	na		3270 (±3600)	5521		0	0	0	0	0	0	0	0	11581	9886	17851	15407	33258
2012	3000	na		3090 (±2830)	12975		0	0	0	0	0	0	0	0	10548	25523	16638	38498	55136
2013	3500	280		3090 (±2830)	10635		758	0	0	0	0	0	0	0	6516	22057	14144	32692	46836
2014	3500	328		8550 (±5450)	18880		772	0	0	0	0	0	0	0	6559	19265	19709	38145	57854
2015	3500	548		8550 (±5450)	14420		733	0	620	1749	0	0	0	0	2943	19261	16894	35430	52324
2016	8000	432		8550 (±4000)	19890		976	13	1510	2010	0	0	0	0	2400	18711	21868	40624	62492
2017	6599	270		8550 (±4000)	12893	4456	654		996	562	3685	0	0	0	2400	16094	27610	29549	57159
2018	8595	461		5300 (CV >50%)	13528	5226	297	98	1000	600	3776	0	0	0	2400	15235	27055	29461	56516
2019	7796	492		5300 (CV >50%)	16640	5525	773	184	874	384	4940	0	0	0	2400	12686	28100	29894	57994
2020	8065	327		5300 (CV >50%)	19920	1093	627	443	1620	994	4750	0	0	0	2416	16039	24198	37396	61594

Table 2.2.1.7. Continued.

	Sub-division 32									Sub-division 22-32		
Year	**Estonia**		**Finland**		**Russia**		**O+C**	**River**	**Grand**	**O+C**	**River**	**Grand**
	O+C	River	O+C (95% PI)	River	O+C	River	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
2001	0	na	14180 (±5780)	1900	0	0	1418	1900	3318	31311	28726	60037
2002	0	na	2550 (±750)	3200	0	0	2550	3200	5750	27096	23822	50918
2003	0	na	2550 (±750)	1700	0	0	2550	1700	4250	24079	19617	43696
2004	0	na	3090 (±1430)	1500	0	0	3090	1500	4590	44849	22179	67028
2005	206	103	3090 (±1430)	2800	0	0	3296	2903	6199	40047	24878	64925
2006	138	112	180 (±110)	1700	0	0	318	1812	2130	22255	16651	38906
2007	0	162	180 (±110)	1395	0	0	180	1557	1737	21288	19527	40815
2008	294	268	730 (±350)	1100	0	0	1024	1368	2392	27059	38053	65112
2009	0	257	730 (±350)	2063	0	0	730	2320	3050	32167	27974	60141
2010	0	185	360 (±400)	400	0	0	360	585	945	20976	14816	35792
2011	0	185	360 (±400)	600	0	0	360	785	1145	18211	16192	34403
2012	0	212	3450 (±3170)	590	0	0	3450	802	4252	20088	39300	59388
2013	365	41	3450 (±3170)	930	0	0	3815	971	4786	17959	33663	51622
2014	277	63	2730 (±3270)	505	0	0	3007	568	3575	22716	38713	61429
2015	477	38	2730 (±3270)	158	0	0	3207	196	3403	20101	35626	55727
2016	601	393	3000 (±3270)	248	0	0	3601	641	4242	25469	41265	66734
2017	458	300	3000 (±3000)	208	0	0	3458	508	3966	31068	30057	61125
2018	290	159	200 (CV >50%)	85	0	0	490	244	734	27545	29705	57250
2019	304	251	200 (CV >50%)	60	0	0	504	311	815	28604	30205	58809
2020	231	253	200 (CV >50%)	185	0	0	431	438	869	24629	37834	62463

Table 2.3.1. Summary of the uncertainty associated to fisheries dataseries according to the expert opinions from different countries backed by data (D) or based on subjective expert estimation (EE). The conversion factors (mean) are proportions and can be multiplied with the nominal catch data in order to obtain estimates for unreported catches and discards, which altogether sum up to the total catches. Driftnet fishing has been closed from 2008. Finland and Sweden have had no off-shore fishing for salmon after 2012.

Parameter	Country	Year	Source	min	mode	max	mean	SD
Share of unreported catch in offshore fishery	DK	2001-2020	EE	0.001	0.01	0.10	0.04	0.022
	FI	2001-2012	EE	0.001	0.01	0.10	0.04	0.023
	PL	2001-2013	EE	0.001	0.25	0.40	0.22	0.082
		2014	EE	0.010	0.02	0.10	0.04	0.020
		2015-2016	EE	0.010	0.02	0.08	0.04	0.015
		2017-2020	EE	0.001	0.01	0.05	0.02	0.011
	SE	2001-2012	EE	0.050	0.15	0.25	0.15	0.041
	Others	2001-2020					0.08	0.014
Share of unreported catch in coastal fishery	FI	2001-2014	EE	0.001	0.10	0.15	0.08	0.031
		2015-2020	EE	0.001	0.01	0.10	0.04	0.023
	PL	2001-2012	EE	0.001	0.10	0.20	0.10	0.041
		2013-2018	EE	0.001	0.05	0.10	0.05	0.020
		2019-2020		0.001	0.01	0.05	0.02	0.011
	SE	2001-2012	EE	0.100	0.30	0.50	0.30	0.082
		2013-2014	EE	0.001	0.15	0.30	0.15	0.062
		2015-2020	EE	0.050	0.15	0.25	0.15	0.041
	Others	2001-2020					0.12	0.018
Share of unreported catch in river fishery	FI	2001-2016		0.050	0.20	0.35	0.20	0.062
		2017-2020	EE	0.050	0.15	0.25	0.15	0.041
	PL	2001-2009	EE	0.010	0.10	0.15	0.09	0.029
		2010-2020	EE	0.500	0.80	1.00	0.77	0.103
	SE	2001-2020	EE	0.100	0.20	0.40	0.23	0.062
Average share of unreported catch in river fishery	Others	2001-2020					0.29	0.029
Share of discarded undersized salmon in longline fishery	DK	2001-2007	D, EE	0.100	0.15	0.20	0.15	0.020
		2008-2020	D, EE	0.005	0.03	0.05	0.03	0.009
	FI	2001-2012	D, EE	0.010	0.03	0.05	0.03	0.008
	PL	2001-2012	D	0.010	0.03	0.04	0.03	0.006
		2013-2020	D	0.010	0.02	0.04	0.02	0.006
	SE	2001-2012	D, EE	0.005	0.02	0.03	0.02	0.005
Average share of discarded undersized salmon in longline fishery	Others	2001-2020					0.05	0.004
Mortality of discarded undersized salmon in longline fishery	DK	2001-2020	EE	0.750	0.80	0.85	0.80	0.020
	FI	2001-2012	EE	0.500	0.67	0.90	0.69	0.082
	SE	2001-2012	EE	0.750	0.85	0.95	0.85	0.041
	PL	2001-2020	D, EE	0.600	0.72	0.90	0.74	0.062
Average mortality of discarded undersized salmon in longline fishery	Others	2001-2020					0.77	0.028
Share of discarded undersized salmon in driftnet fishery	DK	2001-2007	EE, D	0.001	0.03	0.05	0.03	0.010
	FI	2001-2007	D	0.001	0.02	0.03	0.02	0.006
Average share of discarded undersized salmon in driftnet fishery	Others	2001-2007					0.02	0.006
Mortality of discarded undersized salmon in driftnet fishery	DK	2001-2007	EE, D	0.600	0.65	0.70	0.65	0.020
	FI	2001-2007	EE	0.500	0.67	0.80	0.66	0.061
Average mortality of discarded undersized salmon in driftnet fishery	Others	2001-2007					0.65	0.032
Share of undersized salmon in trapnet fishery (released back to sea)	FI	2001-2016	EE	0.010	0.03	0.05	0.03	0.008
		2017-2020	D	0.010	0.06	0.15	0.07	0.029
	SE	2001-2020	EE, D	0.010	0.03	0.05	0.03	0.008
Average share of discarded undersized salmon in trapnet fishery	Others	2001-2020					0.04	0.010
Mortality of discarded undersized salmon in trapnet fishery	FI	2001-2020	EE, D	0.100	0.20	0.50	0.27	0.085
	SE	2001-2017	EE, D	0.300	0.50	0.70	0.50	0.082
Average mortality of discarded undersized salmon in trapnet fishery	Others	2001-2020					0.38	0.059
Share of discarded sealdamaged salmon in longline fishery	FI	2001-2007	D	0.001	0.00	0.02	0.01	0.005
		2008-2012	D	0.001	0.03	0.06	0.03	0.012
	SE	2001-2012	EE, D	0.020	0.05	0.08	0.05	0.012
	DK	2001-2007	EE, D	0.001	0.03	0.05	0.03	0.010
		2008-2012	EE	0.001	0.05	0.10	0.05	0.020
		2013-2014	EE, D	0.050	0.15	0.30	0.17	0.051
		2015	EE	0.050	0.20	0.35	0.20	0.061
		2016-2020*)	D	0.050	0.20	0.45	0.33	0.101
	PL	2001-2012	D	0.001	0.01	0.02	0.01	0.004
		2013-2015	EE, D	0.050	0.25	0.65	0.32	0.126
		2016-2020	D	0.050	0.35	0.65	0.35	0.124
	Others	2001-2020					0.16	0.021
Share of discarded sealdamaged salmon in driftnet fishery and other open sea gillnet fishery (GNS in Poland)	DK	2001-2007	EE, D	0.001	0.03	0.05	0.03	0.010
	FI	2001-2007	D	0.010	0.02	0.04	0.02	0.006
	PL	2008-2012		0.001	0.01	0.02	0.01	0.004
		2013-2015	EE,D	0.050	0.25	0.65	0.32	0.125
		2016-2020	D	0.050	0.35	0.65	0.35	0.122
	Others	2001-2007					0.15	0.035
Share of discarded sealdamaged salmon in trapnet fishery	FI	2001-2020	D	0.050	0.09	0.15	0.10	0.021
	SE	2004-2017	EE, D	0.010	0.02	0.04	0.02	0.006
	Others	2001-2020					0.06	0.011

*) updated retrospectively (backwards) for years 2016-2017 in WGBAST 2019

Table 2.3.2. Medians of estimated number of discarded undersized salmon and discarded seal damaged salmon by management unit in 2001–2020. Estimates of discarded undersized salmon are proportional to nominal catches by the conversion factors (see Table 2.3.1). Estimates of seal damages age based partly on the logbook records and partly to the estimates proportional to nominal catches by conversion factors. In 2017–2020 seal damages of other gears includes also part of the seal damages of long-line. Estimates should be considered as a magnitude of discards. Note Total are medians of summary probability distributions of parameters and therefore not an exact sum of the median values in columns.

Management unit	Year	Discard undersized (dead)					Discard seal damaged					Grand Total
		Driftnet	Longline	Trapnet	Other gears	Total	Driftnet	Longline	Trapnet	Other gears	Total	
		Disc_GND	Disc_LLD	Disc_TN	Disc_OT		Seal_GND	Seal_LLD	Seal_TN	Seal_OT		
SD22-31	2001	3138	11840	1102	579	16790	8796	3327	6861	1110	20310	37210
	2002	2210	12340	1248	576	16480	7006	3870	6494	313	17850	34430
	2003	2343	15730	923	417	19510	7123	4433	6041	1603	19350	38990
	2004	2677	13390	1560	744	18540	7776	4503	6799	1363	20690	39370
	2005	1872	7879	850	397	11110	7867	3790	4850	598	17230	28410
	2006	1235	5564	803	234	7903	4587	2836	2495	1609	11630	19580
	2007	1237	3488	792	205	5792	3877	1960	4319	405	10640	16470
	2008		814	796	308	1946		1091	3654	603	5380	7340
	2009		2776	1402	320	4556		3124	3337	385	6886	11500
	2010		3460	859	159	4518		3984	2290	284	6578	11180
	2011		2302	630	165	3131		4849	2257	191	7319	10490
	2012		1486	593	189	2293		2704	3124	362	6221	8552
	2013		973	537	175	1705		6612	3057	245	9932	11660
	2014		812	431	184	1450		5594	2491	304	8405	9879
	2015		754	402	205	1382		5337	2053	504	7904	9291
	2016		768	410	246	1447		6294	1937	563	8803	10260
	2017		730	340	286	1390		5874	2166	280	8329	9727
	2018		991	418	334	1785		196	1837	1512	3551	5343
	2019		204	342	359	929		709	1850	2627	5192	6130
	2020		96	331	191	633		988	1678	2601	5274	5915
SD32	2001	3	59	17	86	168	3	58	2924	714	3698	3870
	2002	10	64	35	90	202	73	176	2832	317	3400	3605
	2003	2	9	2	60	74	20	30	3493	215	3758	3833
	2004	3	5	15	46	69	41	7	3720	246	4015	4085
	2005	3	7	2	62	74	25	37	1618	187	1868	1943
	2006	5	2	10	53	71	92	4	1713	990	2800	2871
	2007	3	3	1	33	41	42	5	1728	47	1824	1865
	2008		9	0	44	53		24	2006	287	2317	2371
	2009		5	4	60	70		1	1622	248	1871	1942
	2010		2	4	24	30		3	896	68	968	998
	2011		2	35	24	61		0	856	72	928	990
	2012		1	81	38	121		0	887	170	1058	1179
	2013		1	249	38	289		2	543	47	593	881
	2014		2	60	33	96		0	635	21	657	753
	2015		1	12	30	43		0	1093	207	1300	1344
	2016		1	17	30	48		0	614	85	699	748
	2017		5	37	39	82		0	766	57	824	907
	2018		3	6	40	49		0	451	26	478	529
	2019		2	4	37	44		0	803	6	811	856
	2020		5	6	55	66		0	779	7	787	856

Table 2.3.3. Estimated number of seal damaged salmon, dead discard of undersized salmon, unreported salmon in sea and river fisheries and misreported salmon by management unit in 2001–2020. Estimates should be considered as order of magnitude.

	Sea fisheries							River fisheries	
	Seal damage		Discards (dead)		Unreported catch		Misreported catch	Unreported catch	
	median	90 % PI	median	90 % PI	median	90 % PI		median	90 % PI
SD22-31									
2001	23100	18300-23100	20200	14100-20200	71100	37300-71100	128100	14800	5400-14800
2002	20200	16200-20200	19800	13900-19800	71300	36500-71300	116800	13000	4900-13000
2003	22100	17400-22100	23800	16200-23800	65600	33000-65600	145500	10500	4100-10500
2004	24100	18400-24100	22900	15400-22900	88200	42500-88200	258400	11300	4600-11300
2005	19100	15900-19100	13500	9300-13500	63500	31100-63500	112600	13900	5700-13900
2006	12900	10700-12900	9400	6700-9400	44100	21600-44100	47700	8900	3300-8900
2007	11700	9900-11700	6900	4900-6900	40100	20000-40100	55200	10800	4300-10800
2008	5800	5100-5800	2400	1600-2400	37100	15600-37100	3300	20500	8300-20500
2009	8000	6200-8000	5800	3700-5800	51800	21200-51800	67600	15200	6200-15200
2010	8200	5600-8200	5800	3600-5800	36500	16800-36500	76000	8400	3700-8400
2011	8400	6700-8400	3900	2500-3900	37700	17100-37700	37600	9300	3900-9300
2012	7300	5600-7300	2800	1900-2800	27700	13100-27700	17800	23100	9400-23100
2013	11700	8100-11700	2200	1400-2200	15700	6400-15700	15200	18400	7600-18400
2014	10000	6800-10000	1900	1100-1900	14500	5500-14500	13800	18700	8100-18700
2015	9000	6600-9000	1800	1100-1800	10500	4700-10500	16900	22400	9700-22400
2016	9600	7500-9600	1900	1100-1900	10400	4600-10400	26400	23700	10400-23700
2017	9100	6800-9100	1800	1100-1800	8400	3700-8400	32500	15900	6700-15900
2018	3700	3500-3700	2300	1400-2300	9700	4300-9700	43300	17200	7200-17200
2019	5300	5100-5300	1300	700-1300	8600	3700-8600	600	16600	7200-16600
2020	5400	5200-5400	900	500-900	7900	3300-7900	200	21000	9000-21000
SD32									
2001	4000	3600-4000	200	100-200	1900	700-1900		1200	500-1200
2002	15900	6700-15900	700	700-700	100	0-100		1600	500-1600
2003	17200	7200-17200	900	800-900	100	0-100		900	300-900
2004	16600	7200-16600	500	500-500	100	100-100		800	300-800
2005	21000	9000-21000	900	800-900	100	0-100		1400	500-1400
2006	4000	3600-4000	800	800-800	100	0-100		1000	400-1000
2007	3600	3300-3600	200	100-200	100	0-100		800	300-800
2008	4000	3600-4000	200	200-200	1900	700-1900		800	400-800
2009	4300	3900-4300	100	100-100	1300	500-1300		1200	500-1200
2010	2000	1800-2000	100	100-100	1200	400-1200		400	200-400
2011	3000	2700-3000	100	100-100	1200	400-1200		500	200-500
2012	2000	1800-2000	100	100-100	1600	500-1600		500	200-500
2013	2500	2200-2500	100	0-100	1800	600-1800		600	200-600
2014	2000	1800-2000	100	0-100	1700	500-1700		400	200-400
2015	1000	900-1000	100	100-100	2400	700-2400		200	100-200
2016	1000	900-1000	0	0-0	2000	600-2000		400	200-400
2017	1100	1000-1100	100	100-100	900	300-900		300	200-300
2018	600	600-600	100	100-100	1200	400-1200		300	100-300
2019	700	600-700	300	300-300	1700	500-1700		400	200-400
2020	1400	1300-1400	100	100-100	1500	500-1500		400	200-400

Table 2.3.3.1. Number salmon and sea trout in the catch of sampled Polish longline vessels in 2009–2020 (SAL=salmon and TRS=sea trout). No sampling in 2018 and 2019.

SamplingType	Year	Month	Trip_id	SAL	TRS	% SAL
Sea sampling	2009	1	146	34	2	94%
			304	141	3	98%
		2	148	264	2	99%
			150	114	7	94%
			305	149	2	99%
			306	92	4	96%
			307	94	3	97%
	2009 Total			**888**	**23**	**97%**
	2010	2	1059	174	1	99%
			1222	509	0	100%
			1228	341	0	100%
		3	1223	102	2	98%
			1224	48	0	100%
	2010 Total			**1173**	**3**	**100%**
	2011	2	1287	81	0	100%
			1288	43	2	96%
		3	1650	169	0	100%
		11	1515	51	1	98%
		12	1528	78	0	100%
			1529	265	0	100%
	2011 Total			**687**	**3**	**100%**
	2012	1	1566	107	0	100%
		3	1639	89	0	100%
		12	1823	128	3	98%
			1827	36	1	97%
	2012 Total			**360**	**4**	**99%**
	2013	1	1830	70	0	**100%**
		1	1844	21	0	**100%**
		1	1845	50	1	**98%**
		1	1846	55	0	**100%**
		1	1877	84	1	**99%**
		2	1879	104	2	**98%**
		1	1880	46	1	**98%**
		1	1881	122	0	**100%**
		12	2076	37	3	**93%**
	2013 Total			**589**	**8**	**99%**
	2014 Total	1-12		**701**	**5**	**99%**
	2015 Total	1-12		**717**	**42**	**94%**
	2016	1		**132**	**2**	**99%**
		2		**589**	**1**	**100%**
		3		**209**	**0**	**100%**
		10		**1**	**0**	**100%**
		12		**12**	**0**	**100%**
	2016 Total			**943**	**3**	**100%**
	2017	1		**240**	**1**	**100%**
		2		**33**	**0**	**100%**
		3		**188**	**2**	**99%**
		4		**67**	**0**	**100%**
		12		**63**	**3**	**95%**
	2017 Total			**591**	**6**	**99%**
	2020 Total	1-12		**100**	**0**	**100%**
Sea sampling Total				**6749**	**97**	**99%**
Market sampling	2009	12	1034	35	1	97%
	2009 Total			**35**	**1**	**97%**
	2010	12	1271	20	0	100%
	2010 Total			**20**	**0**	**100%**
Market sampling Total				**55**	**1**	**98%**
Grand Total				**6804**	**98**	**99%**

Table 2.4.1 Fishing efforts in commercial Baltic salmon fisheries at sea and at the coast in 1987–2020 in subdivisions 22–31 (excluding Gulf of Finland). The fishing efforts are expressed in number of geardays (number of fishing days times the number of gear) per year. The yearly reported total offshore effort refers to the sum of the effort in the second half of the given year and the first half of the next coming year (e.g., effort in second half of 1987 + effort in first half of 1988 = effort reported in 1987, etc.). The coastal fishing effort on stocks of assessment unit 1 (AU 1) refers to the total Finnish coastal fishing effort and partly to the Swedish effort in subdivision (SD) 31. The coastal fishing effort on stocks of AU 2 refers to the Finnish coastal fishing effort in SD 30, and partly to the Swedish coastal fishing effort in SD 31. The coastal fishing effort on stocks of AU 3 refers to the Finnish and Swedish coastal fishing effort in SD 30.

				AU 1		AU 2		AU 3	
Year	Offshore driftnet	Offshore longline	Commercial coastal driftnet	Commercial coastal trapnet	Commercial coastal other gear	Commercial coastal trapnet	Commercial coastal other gear	Commercial coastal trapnet	Commercial coastal other gear
1987	4036455	3710892	328711	71182	263256	43694	243511	42704	526101
1988	3456416	2390537	256387	84962	245228	55659	259404	58839	798038
1989	3444289	2346897	378190	68333	345592	41991	384683	40135	463067
1990	3279200	2188919	364326	111333	260768	71005	233540	68152	279610
1991	2951290	1708584	431420	103077	461053	70979	360360	73177	404327
1992	3205841	1391361	473579	115793	351518	68096	282674	61703	339384
1993	2155440	1041997	621817	119497	288245	76398	161474	79911	215710
1994	3119711	851530	581306	83936	194683	59488	210927	55256	205848
1995	1783889	932314	452858	70670	152529	44607	147259	42165	141905
1996	1288081	1251637	78686	58266	100409	42055	92606	29029	90245
1997	1723492	1571003	118207	63102	107432	44605	81923	34095	84639
1998	1736495	1148336	112393	28644	8391	20204	5449	15771	5221
1999	1644171	1868796	126582	43339	9325	31845	5715	20889	5071
2000	1877308	2007775	107008	34934	8324	23384	5587	20397	5371
2001	1818085	1811282	102657	40595	3879	23743	2661	34886	2514
2002	1079893	1828389	86357	46474	3778	30333	3251	31389	3153
2003	1329494	1439370	95022	47319	8903	27060	7138	37614	9984
2004	1344588	792737	103650	41570	4315	28219	1610	25828	2278
2005	1378762	1099118	84223	45002	5886	33683	4914	30075	5844
2006	1177402	695597	77915	33817	4196	24374	3546	19487	5486
2007	413622	639638	45557	35406	4298	23920	2888	21790	4602
2008	0	1980394	0	27736	10252	16434	3917	25959	5226
2009	0	2135367	0	32676	7062	24174	5149	15718	5411
2010	0	2639116	0	34040	4192	25399	2393	17405	2487
2011	0	1441613	0	27927	3625	18347	2768	15788	3067
2012	0	667347	0	21309	2911	11714	1539	10355	1551
2013	0	1176124	0	20619	3177	13734	2488	11277	2478
2014	0	800824	0	20782	3608	16234	3121	9084	3135
2015	0	1262088	0	16463	3214	11279	2498	7820	2578
2016	0	1506037	0	15931	5701	9068	4154	8565	4813
2017	0	1105411	0	15068	5278	9498	4622	9399	4626
2018	0	377379	0	15028	4964	8909	4572	8917	4553
2019	0	359469	0	10268	5958	5864	5498	6785	5546
2020	0	281040	0	14431	580	21178	939	6837	359

Table 2.4.2. For the commercial out at sea longline salmon fisheries: Effort in hook days (number of hooks x number of days) 2014–2020. The yearly reported effort in longline salmon fisheries refers to the sum of the effort in the given year. And when available, effort in days per ship by country and area (subdivisions 22–31 and Subdivision 32), where number of fishing days divided in five groups, 1–9 fishing days, 10–19 fishing days, 20–39 fishing days, 40–59 fishing days and 60–80 fishing days. CPUE expressed as number of salmon caught per 1000 hooks.

Year	Area	Country	Effort in hook days	CPUE	Effort in days per ship						Comments
					60-79	40-59	20-39	10-19	1-9	Total	
					Number of fishing vessels						
2014	Sub-divisions 22-31	Denmark	173,540	121.6	1	6	5	3	3	18	
		Estonia	0	0	0	0	0	0	0	0	
		Finland	8,213	13.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
		Germany	0	0	0	0	0	0	0	0	
		Latvia	0	0	0	0	0	0	0	0	
		Lithuania	0	0	0	0	0	0	0	0	
		Poland	811,786	2.8	0	4	5	2	31	42	
		Russia	0	0	0	0	0	0	0	0	
		Sweden	0	0	0	0	0	0	0	0	
	Sub-div. 32	Estonia	0	0	0	0	0	0	0	0	
		Finland	10,319	8.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	Sub-divs 22-32	**Total**	1,003,858		1	10	10	5	34	60	
2015	Sub-divisions 22-31	Denmark	132,860	119.1	3	4	1	3	7	18	
		Estonia	0	0	0	0	0	0	0	0	
		Finland	15,470	15.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
		Germany	0	0	0	0	0	0	0	0	
		Latvia	n.a.	n.a.	0	0	0	1	0	0	reported catch, but no information on effort
		Lithuania	0	0	0	0	0	0	0	0	
		Poland	727,889	3.6	0	5	4	7	28	44	
		Russia	0	0	0	0	0	0	0	0	
		Sweden	0	0	0	0	0	0	0	0	
	Sub-div. 32	Estonia	0	0	0	0	0	0	0	0	
		Finland	6,390	7.5	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	Sub-divs 22-32	**Total**	882,609		3	9	5	11	35	62	
2016	Sub-divisions 22-31	Denmark	151,860	63.9	1	1	2	2	7	13	
		Estonia	0	0	0	0	0	0	0	0	
		Finland	16,233	14.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
		Germany	0	0	0	0	0	0	0	0	
		Latvia	0	0	0	0	0	0	0	0	
		Lithuania	0	0	0	0	0	0	0	0	
		Poland	1,054,021	2.1	0	3	9	12	29	53	
		Russia	0	0	0	0	0	0	0	0	
		Sweden	0	0	0	0	0	0	0	0	
	Sub-div. 32	Estonia	0	0	0	0	0	0	0	0	
		Finland	6,820	7.5	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	Sub-divs 22-32	**Total**	1,228,934		1	4	11	14	36	66	
2017	Sub-divisions 22-31	Denmark	90,320	33.6	1	0	3	0	8	12	
		Estonia	0	0	0	0	0	0	0	0	
		Finland	0	0	0	0	0	0	0	0	
		Germany	0	0	0	0	0	0	0	0	
		Latvia	0	0	0	0	0	0	0	0	
		Lithuania	0	0	0	0	0	0	0	0	
		Poland	1,439,987	2.8	0	6	8	9	70	93	
		Russia	0	0	0	0	0	0	0	0	
		Sweden	0	0	0	0	0	0	0	0	
	Sub-div. 32	Estonia	0	0	0	0	0	0	0	0	
		Finland	0	0	0	0	0	0	0	0	
	Sub-divs 22-32	**Total**	1,530,307		1	6	11	9	78	105	
2018	Sub-divisions 22-31	Denmark	96,020	49.7	1	0	2	2	3	8	
		Estonia	0	0	0	0	0	0	0	0	
		Finland	3,370	19.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
		Germany	0	0	0	0	0	0	0	0	
		Latvia	n.a.	n.a.	0	0	0	2	0	0	reported catch, but no information on effort
		Lithuania	14,000	16.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
		Poland	980,764	5.1	0	3	15	18	56	92	
		Russia	0	0	0	0	0	0	0	0	
		Sweden	0	0	0	0	0	0	0	0	
	Sub-div. 32	Estonia	0	0	0	0	0	0	0	0	
		Finland	9,263	12.3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	Sub-divs 22-32	**Total**	1,103,417		1	3	17	22	59	100	
2019	Sub-divisions 22-31	Denmark	76,550	50.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
		Estonia	0	0	0	0	0	0	0	0	
		Finland	1,420	7.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
		Germany	0	0	0	0	0	0	0	0	
		Latvia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	reported catch, but no information on effort
		Lithuania	38,000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	data on number of salmon not available
		Poland	181,029	11.8	0	0	2	7	60	69	
		Russia	0	0	0	0	0	0	0	0	
		Sweden	0	0	0	0	0	0	0	0	
	Sub-div. 32	Estonia	0	0	0	0	0	0	0	0	
		Finland	5,642	16.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	Sub-divs 22-32	**Total**	302,641		0	0	2	7	60	69	
2020	Sub-divisions 22-31	Denmark	41,410	41.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
		Estonia	0	0	0	0	0	0	0	0	
		Finland	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
		Germany	0	0	0	0	0	0	0	0	
		Latvia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	reported catch, but no information on effort
		Lithuania	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	reported catch, but no information on effort
		Poland	224,650	9.3	0	1	6	4	43	54	
		Russia	0	0	0	0	0	0	0	0	
		Sweden	0	0	0	0	0	0	0	0	
	Sub-div. 32	Estonia	0	0	0	0	0	0	0	0	
		Finland	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	Sub-divs 22-32	**Total**	266,060		0	1	6	4	43	54	

Table 2.4.3. Trapnet effort and catch per unit of effort in number of salmon caught in trapnets in the Finnish fisheries in Subdivision 32 (CPUE in number of salmon per trapnet day) 1988–2020.

	Effort	CPUE
1988		0.70
1989		1.00
1990		1.60
1991		1.50
1992		1.50
1993		1.40
1994		0.90
1995		1.20
1996		1.30
1997		1.50
1998		1.30
1999		1.30
2000	12866	0.90
2001	9466	0.90
2002	5362	1.00
2003	8869	0.70
2004	7033	0.90
2005	7391	1.10
2006	7917	1.20
2007	9124	1.10
2008	9902	1.30
2009	9413	1.10
2010	9161	0.50
2011	10818	0.60
2012	11119	0.90
2013	12062	0.70
2014	11199	0.70
2015	9861	0.60
2016	9094	0.70
2017	7614	0.70
2018	6328	0.81
2019	7908	1.21
2020	7354	1.02

Table 2.6.1. List of Baltic salmon river stocks included in the genetic baseline database (17 microsatellites) used to produce stock proportion estimation of catches.

	Salmon riverstocks	Sampling year	Propagation	N
1	Tornionjoki, W	2011	Wild	210
2	Tornionjoki, H	2006, 2013	Hatchery	187
3	Simojoki	2006, 2009, 2010	Wild	174
4	Iijoki	2006, 2013	Hatchery	179
5	Oulujoki	2009, 2013	Hatchery	135
6	Kalixälven	2012	Wild	200
7	Råneälven	2003, 2011	Wild	150
8	Luleälven	2014	Hatchery	90
9	Piteälven	2012	Wild	53
10	Åbyälven	2003, 2005	Wild	102
11	Byskeälven	2003	Wild	105
12	Kågeälven	2009	Wild	44
13	Skellefteälven	2006, 2014	Hatchery	58
14	Rickleå	2012, 2013	Wild	52
15	Säverån	2011	Wild	74
16	Vindelälven	2003	Wild	149
17	Umeälven	2006, 2014	Hatchery	87
18	Öreälven	2003, 2012	Wild	54
19	Lögdeälven	1995, 2003, 2012	Wild	102
20	Ångermanälven	2006, 2014	Hatchery	79
21	Indalsälven	2006, 2013	Hatchery	144
22	Ljungan	2003, 2014	Wild	101
23	Ljusnan	2013	Hatchery	123
24	Testeboån	2014	Wild	104
25	Dalälven	2006, 2014	Hatchery	98
26	Emån	2003, 2013	Wild	148
27	Mörrumsån	2010, 2011, 2012	Wild	185
28	Neva, Fi	2006	Hatchery	149

	Salmon riverstocks	Sampling year	Propagation	N
29	Neva, Rus	1995	Hatchery	50
30	Luga	2003, 2011	Wild, Hatchery	147
31	Narva	2009	Hatchery	109
32	Kunda	2009, 2013	Wild, Hatchery	170
33	Keila	2013	Wild	63
34	Vasalemma	2013	Wild	60
35	Salaca	2007, 2008	Wild	46
36	Gauja	1998	Hatchery	70
37	Daugava	2011	Hatchery	170
38	Venta	1996	Wild	66
39	Neumunas	2002–2010	Hatchery	166
	Total			4453

Table 2.6.2. Prior proportions of 1–2-year-old smolts in the baseline stocks used for Baltic salmon catch composition analysis for the 2020 catches.

	River stock	Smolt age	2,50%	Median	97,50%	Years
1	Tornionjoki, W	1-2 years	1,4	2,2	3,3	2017–2019
2	Tornionjoki, H	1-2 years	99,8	100,0	100,0	All
3	Simojoki	1-2 years	21,4	27,1	33,8	2018–2019
4	Iijoki	1-2 years	99,8	100,0	100,0	All
5	Oulujoki	1-2 years	99,8	100,0	100,0	All
6	Kalixälven	1-2 years	1,2	2,3	3,8	2017–2019
7	Råneälven	1-2 years	0,5	2,3	6,7	2017–2019
8	Luleälven	1-2 years	99,8	100,0	100,0	All
9	Piteälven	1-2 years	16,6	20,0	23,8	All
10	Åbyälven	1-2 years	22,0	30,2	40,0	All
11	Byskeälven	1-2 years	22,4	30,7	39,5	All
12	Kågeälven	1-2 years	21,8	30,3	39,8	All
13	Skellefteälven	1-2 years	99,8	100,0	100,0	All
14	Rickleå	1-2 years	19,7	25,2	31,8	All
15	Säverån	1-2 years	19,6	25,1	31,8	All
16	Vindelälven	1-2 years	30,7	37,0	43,6	All
17	Umeälven	1-2 years	99,8	100,0	100,0	All
18	Öreälven	1-2 years	14,4	21,6	29,4	All
19	Lögdeälven	1-2 years	21,2	29,4	38,4	All
20	Ångermanälven	1-2 years	99,8	100,0	100,0	All
21	Indalsälven	1-2 years	99,8	100,0	100,0	All
22	Ljungan	1-2 years	27,8	37,4	46,4	All
23	Ljusnan	1-2 years	99,8	100,0	100,0	All
24	Testeboån	1-2 years	28,8	37,1	46,4	All
25	Dalälven	1-2 years	99,8	100,0	100,0	All
26	Emån	1-2 years	92,8	97,1	99,3	All
27	Mörrumsån	1-2 years	92,9	97,0	99,3	All
28	Neva, Fi	1-2 years	99,8	100,0	100,0	All

29	Neva, Rus	1-2 years	85,9	90,0	93,3	All
30	Luga	1-2 years	92,8	96,1	98,1	All
31	Narva	1-2 years	99,8	100,0	100,0	All
32	Kunda	1-2 years	97,7	99,0	99,7	All
33	Keila	1-2 years	97,9	99,0	99,6	All
34	Vasalemma	1-2 years	97,8	99,0	99,6	All
35	Salaca	1-2 years	97,9	99,0	99,7	All
36	Gauja	1-2 years	99,8	100,0	100,0	All
37	Daugava	1-2 years	99,8	100,0	100,0	All
38	Venta	1-2 years	99,8	100,0	100,0	All
39	Neumunas	1-2 years	99,8	100,0	100,0	All

Table 2.6.3. Medians and probability intervals of stock group proportion estimates (%) in Finnish salmon catch samples from the Gulf of Bothnia separately for the dates according to the previous fishing season before 2017 from years 2009 to 2020 and for the advanced, early summer catches from 2017 to 2020, based DNA-microsatellite and smolt age class information. Samples from the "Finnish advanced fishing season" are indicated as F_Adv. and previous season as F. (see text for details). The last column (*Scale reading – wild %*) shows the proportion of catch originating in wild stocks, based only on scale reading, without genetic information.

	GoB, WILD	2.5 %	97.5 %	GoB, HATC, FIN	2.5 %	97.5 %	GoB, HATC, SWE	2.5 %	97.5 %	Others	2.5 %	97.5 %	Sample size	*Scale reading - wild %*
Gulf of Bothnia Finnish catch														
2020F_Adv.	**73**	68	78	**26**	21	31	**0**	0	1	**0**	0	1	**352**	*72*
2019F_Adv.	**75**	70	81	**24**	19	30	**0**	0	0	**0**	0	0	**312**	-
2018F_Adv.	**79**	71	86	**20**	13	29	**0**	0	1	**0**	0	1	**156**	-
2017F_Adv.	**83**	76	88	**17**	11	23	**0**	0	1	**0**	0	2	**246**	-
Total	***78***			***22***			***0***			***0***			***1066***	
2020F	**58**	53	63	**36**	31	40	**6**	4	8	**0**	0	1	**444**	*57*
2019F	**72**	67	76	**27**	23	31	**1**	0	0	**0**	0	0	**506**	-
2018F	**66**	58	72	**27**	20	34	**7**	4	11	**0**	0	1	**235**	-
2017F	**61**	55	66	**38**	33	44	**1**	0	3	**0**	0	0	**397**	-
2016F	**70**	64	75	**26**	21	32	**4**	2	7	**0**	0	1	**307**	64
2015F	**69**	62	76	**28**	21	35	**3**	1	6	**0**	0	1	**219**	*64*
2014F	**82**	77	86	**18**	14	23	**0**	0	1	**0**	0	1	**319**	76-77
2013F	**59**	52	66	**39**	33	46	**0**	0	3	**0**	0	2	**220**	*54-55*
2012F	**62**	54	69	**36**	29	43	**2**	1	5	**0**	0	1	**212**	*54-55*
2011F	**78**	71	83	**21**	16	28	**1**	0	2	**0**	0	1	**220**	*70*
2010F	**76**	69	82	**23**	18	30	**0**	0	2	**0**	0	1	**215**	*68*
2009F	**66**	58	73	**32**	25	39	**2**	1	5	**0**	0	1	**252**	*55*
Total	***68***			***29***			***2***			***0***			***3546***	

Table 2.6.4. Median stock group proportion estimates (%) in Finnish salmon catch samples from the Gulf of Bothnia for the three temporal fishing regulation zones in 2017–2020 based on DNA-microsatellite and smolt age class information. Catch samples from the advanced and late (previously normal) fishing season have been analysed separately.

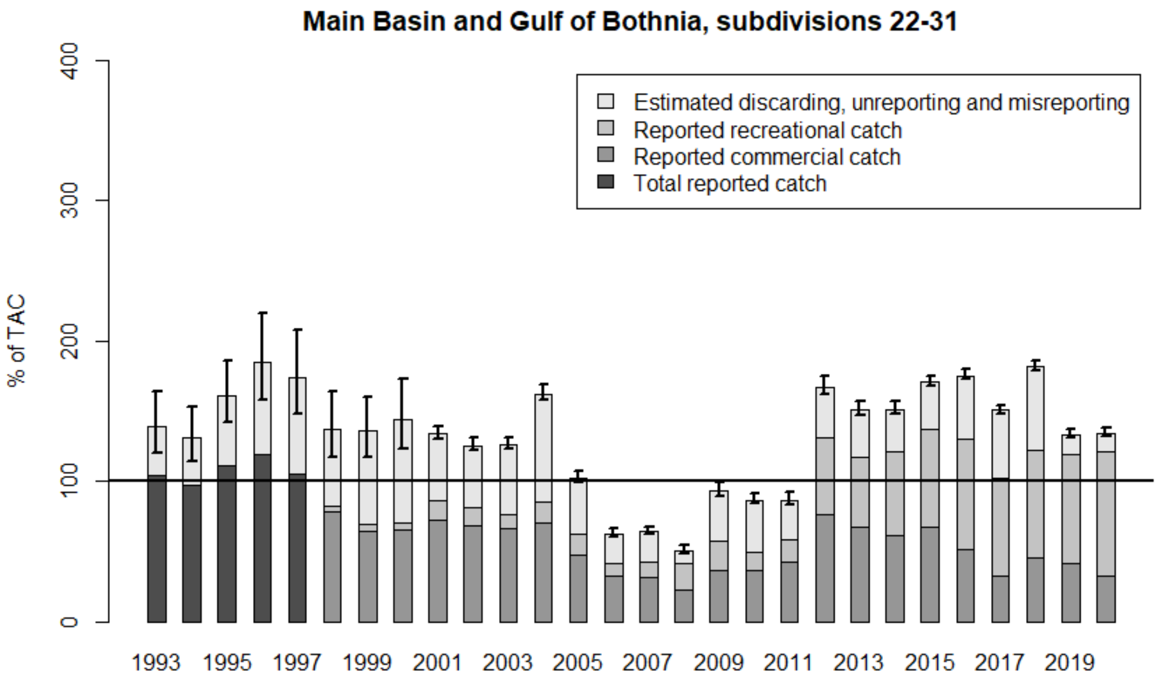
Sea area	Starting date	Finishing date	GoB, WILD	GoB, HATC, FIN	GoB, HATC, SWE	Others	Sample size
Advanced season							
Bothnian Sea	15.5.	9.6.	77	22	0	1	393
Quark area	21.5.	14.6.	76	23	0	0	305
Bothnian Bay North	9.6.	24.6.	78	21	0	0	368
Total			**77**	**22**	**0**	**0**	**1066**
Normal season							
Bothnian Sea	10.6.	17.7.	66	29	4	0	556
Quark area	15.6.	22.7.	67	29	4	0	654
Bothnian Bay North	25.6.	27.7.	61	38	0	0	539
Total			**65**	**32**	**3**	**0**	**1749**

Table 2.6.5. Medians of individual river-stock proportion estimates in Finnish salmon catches from the Gulf of Bothnia calculated separately for the catches from the previous, late fishing season (2013–2020) and the advanced season (2017–2020).

Year/fishery	Tornionj.Wild	Tornionj. Hatch.	Simojoki, W	Iijoki, H	Oulujoki, H	Kalixälven, W	Råne, W	Luleälven, H	Piteälven, W	Åbyälven, W	Byskeälven, W	Kågeälven, W	Skellefteälven, H	Ricleå, W	Sävarån, W	Vindelälven, W	Sample size
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Gulf of Bothnia, Finnish catch																	
2020[Advanced]	48	7	1	17	2	22	0	0	0	0	1	0	0	0	0	1	352
2019[Advanced]	53	5	2	18	1	18	0	0	0	0	0	0	0	0	0	0	312
2018[Advanced]	53	2	4	17	0	21	0	0	0	0	0	0	0	0	0	0	156
2017[Advanced]	49	9	7	7	0	25	0	0	0	0	0	0	0	0	0	0	246
Total advanced season	**50**	**6**	**3**	**15**	**1**	**21**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	1066
2020	40	14	1	12	9	13	0	4	0	1	0	0	2	1	0	1	444
2019	49	9	2	14	4	18	0	0	0	1	0	0	0	0	0	1	506
2018	54	8	1	15	3	9	0	7	0	0	0	0	0	0	0	0	235
2017	43	13	2	17	8	13	0	1	0	0	0	0	0	0	0	0	397
2016	55	0	2	9	17	8	0	3	1	0	0	2	0	0	0	0	307
2015	48	5	2	13	9	18	0	2	0	0	0	0	0	0	0	1	219
2014	45	0	3	7	11	30	0	0	0	0	0	3	0	0	0	0	319
2013	32	0	5	17	21	18	0	0	0	0	3	0	0	0	0	0	220
Total late season	**46**	**7**	**2**	**13**	**10**	**16**	**0**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	2647

Table 2.6.6. Median individual river-stock proportion estimates in Finnish salmon catches from the Gulf of Bothnia from three temporal fishing regulation zones pooled over the last four years (2017–2020). The estimates are based on DNA-microsatellite and smolt age class distribution information, and they are shown separately for the dates according to the previous fishing season and for the advanced fishing season.

Sea area	**Starting date**	**Finishing date**	**Sample size**	**Tornionj. Wild**	Tornionj. Hatch.	Simojoki, W	Iijoki, H	Oulujoki, H	**Kalixälven, W**	Råne, W	Luleälven, H	Piteälven, W	Åbyälven, W	Byskeälven, W	Kågeälven, W	Skellfteälven, H	Ricleå, W	Sävarån, W	Vindelälven, W
Advanced season																			
Bothnian Sea	15.5.	9.6.	393	**44**	6	3	15	0	**27**	0	0	0	0	0	0	0	0	0	0
Quark area	21.5.	15.6.	305	**43**	3	3	16	3	**26**	0	0	0	0	0	0	0	0	0	0
Bothnian Bay North	9.6.	24.6.	368	**54**	9	2	13	0	**21**	0	0	0	0	0	0	0	0	0	0
Total			1066	**47**	**6**	**2**	**14**	**1**	**24**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Normal (late) season																			
Bothnian Sea	10.6.	17.7.	556	**42**	13	2	8	6	**17**	0	3	0	1	0	0	1	0	0	2
Quark area	16.6.	22.7.	654	**48**	3	2	18	7	**14**	0	2	0	0	0	0	1	0	0	0
Bothnian Bay North	25.6.	27.7.	539	**52**	21	0	14	3	**8**	0	0	0	0	0	0	0	0	0	0
Total			1749	**47**	**12**	**1**	**14**	**5**	**13**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**



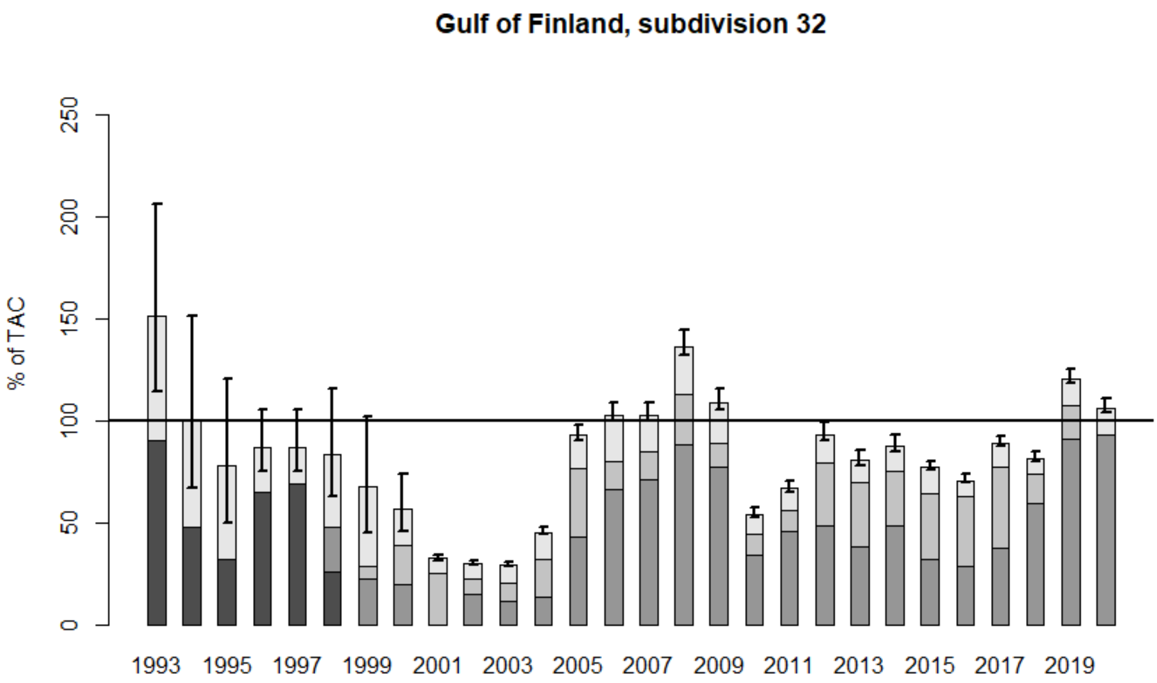


Figure 2.2.1.1. Catches of salmon in % of TAC in 1993-2020. For years 1993–1997 (1993–1998 for Gulf of Finland) it is not possible to divide the total reported catch into commercial and recreational catches. Estimates of discards and unreported catches are presented separately in Table 2.2.1.2.

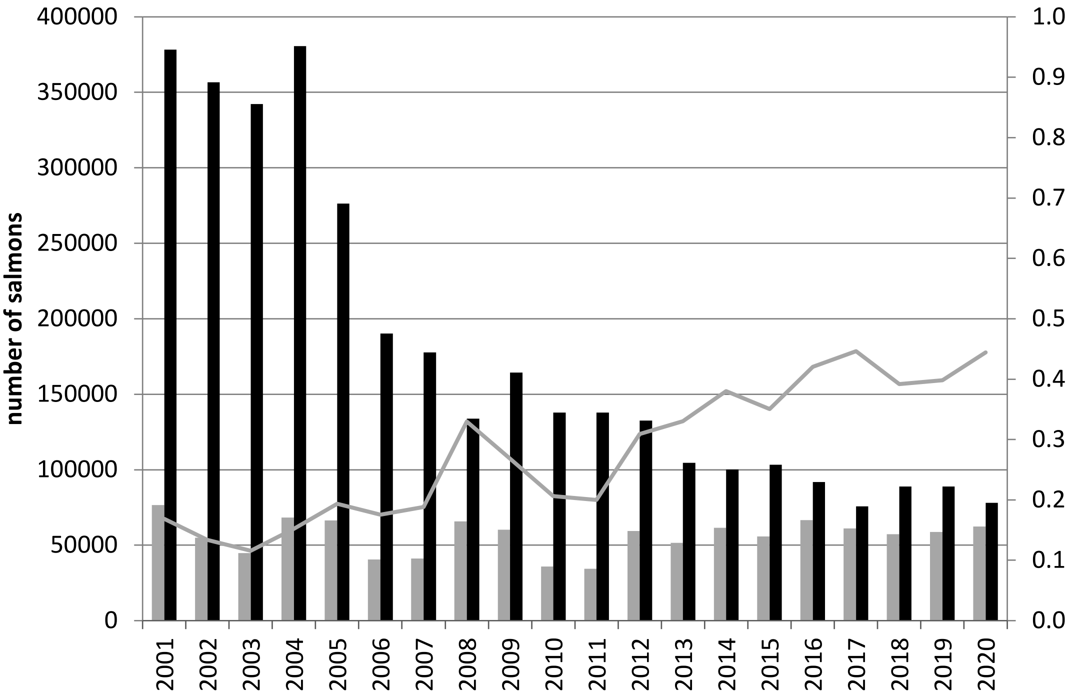
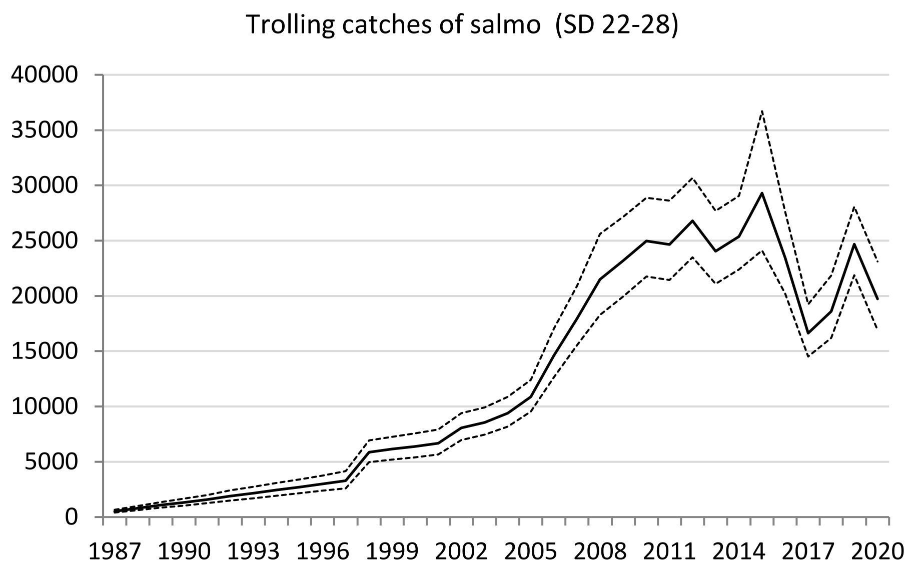
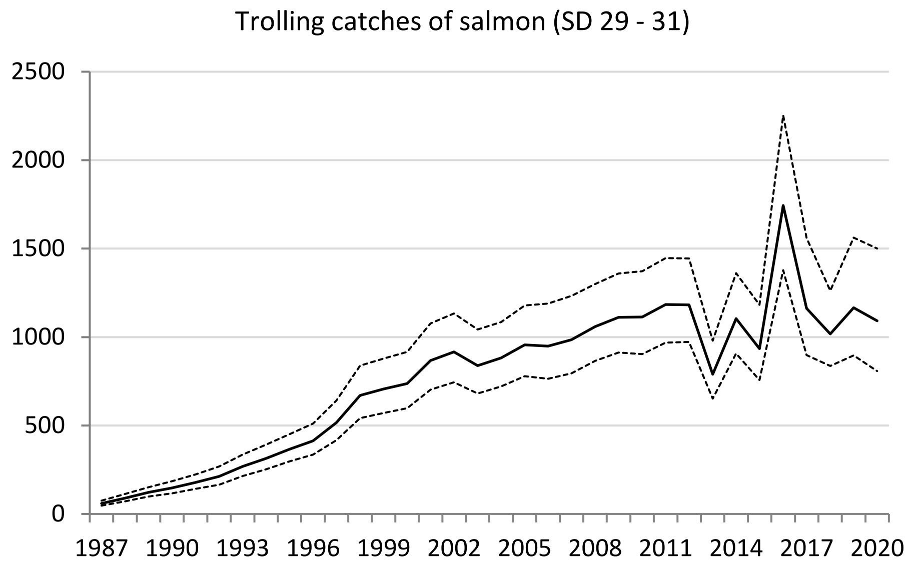


Figure 2.2.1.2. Commercial (black columns) and recreational (grey columns) catches of salmon in numbers in years 2001–2020 for subdivisions 22–32. The recreational catch proportion of the total catch (commercial and recreational) is shown for the same time period (grey line). The recreational catches include all components (river, coastal and sea), also the expert opinion trolling estimates depicted in Figure 2.2.1.3.





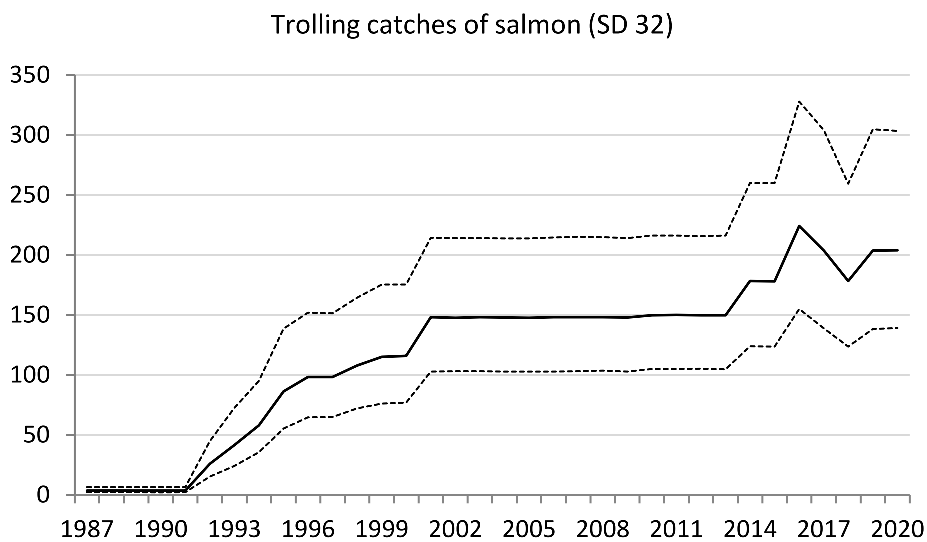


Figure 2.2.1.3. Combined expert estimates of total trolling catches in numbers (including retained fish and a 25% post-release mortality for released fish) for Baltic salmon, 1987–2020 (medians with 95% p.i.).

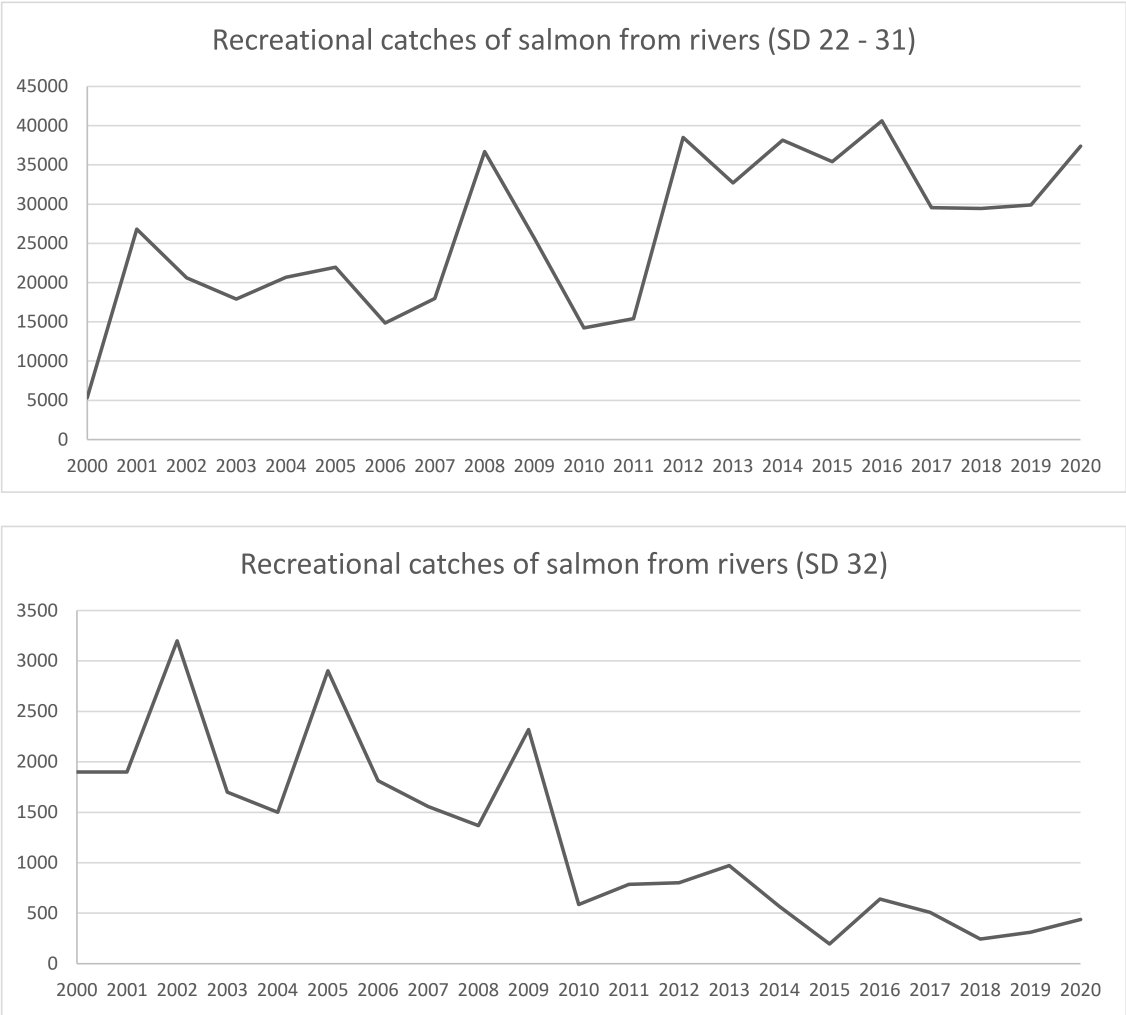


Figure 2.2.1.4. Recreational river catches for Baltic salmon, 2001–2020 (SD 22–31 and SD 32). Catch in numbers.

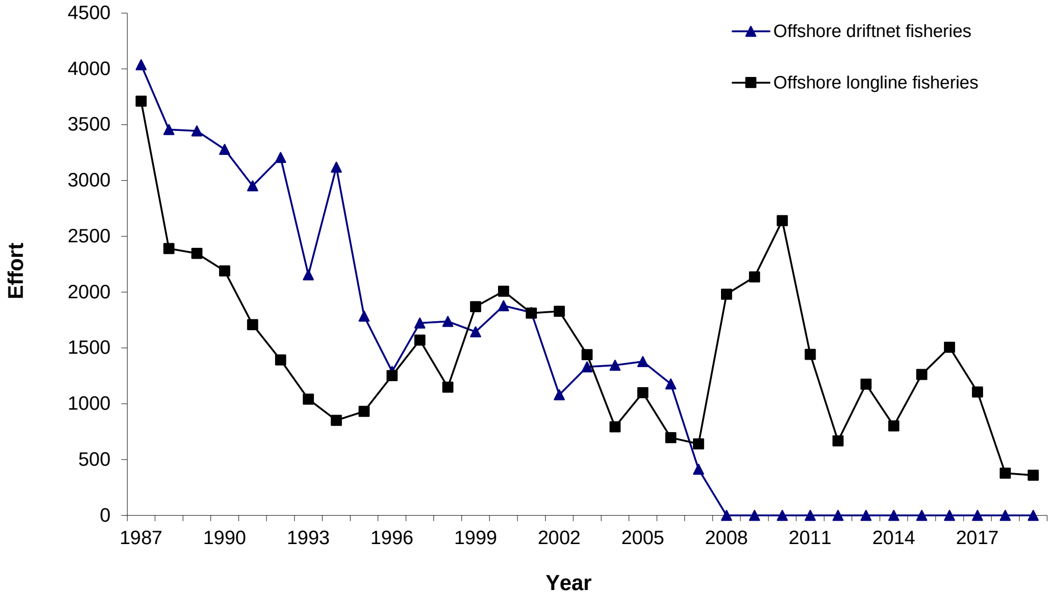


Figure 2.4.1. Fishing effort in Main Basin offshore fisheries (x 1000 geardays) in 1987–2020.

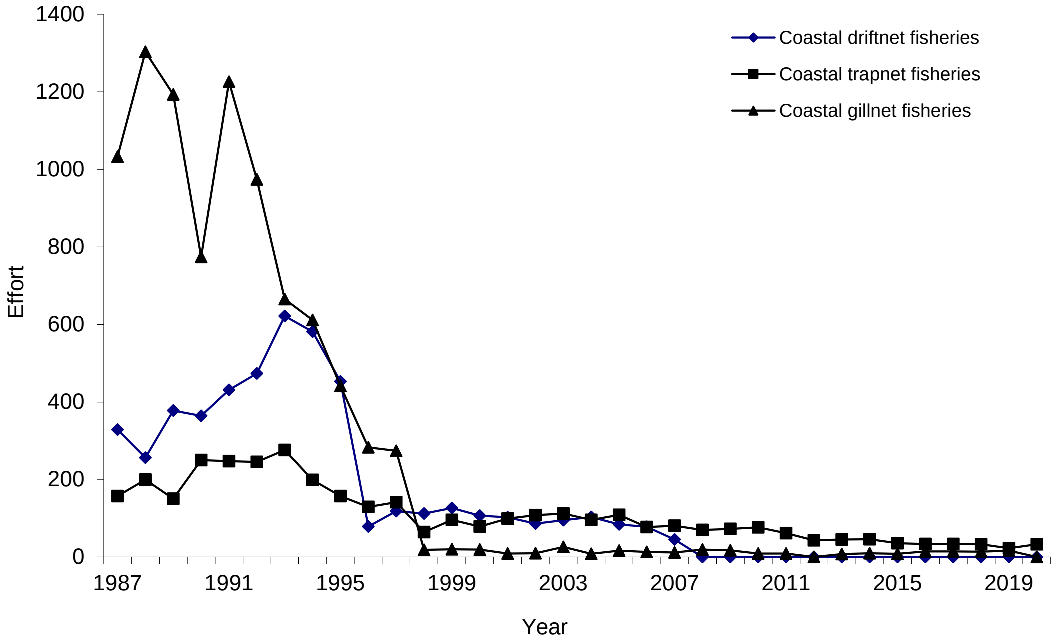


Figure 2.4.2. Effort in Main Basin and Gulf of Bothnia coastal fisheries (x 1000 geardays) in 1987–2020.

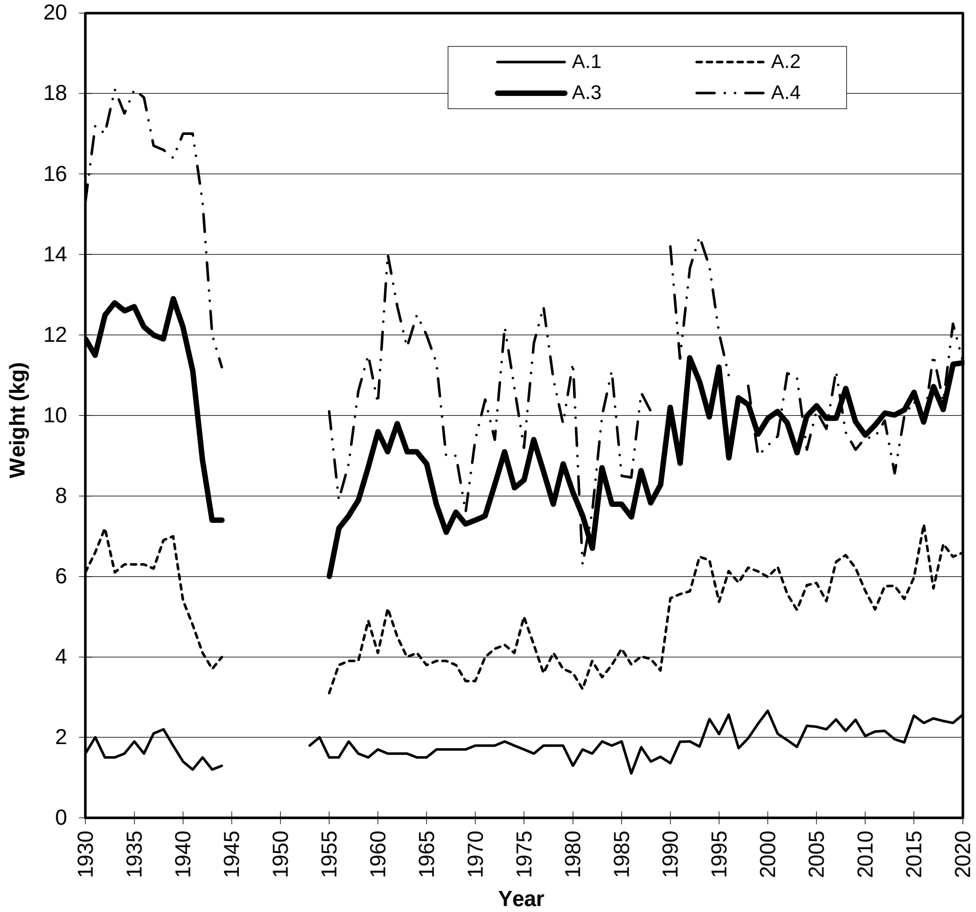


Figure 2.5.2.1. Mean weight of spawners in the Gulf of Bothnia by year. Values in 1930–1944 from catch statistics in the Rivers Oulu and Torne. Values in 1953–1985 are from Swedish tagging records and in 1986–2020 from the Finnish catch sampling data. Weights of A.4 salmon based on sampling performed 1953–2020 (where smaller sample sizes some of the years).

Figure 2.6.1. Neighbour-joining dendrogram (based on Nei's pairwise DA genetic distances) depicting genetic relationships among salmon baseline samples used for catch analysis. Numbers represent percentage support values based on 1000 bootstraps.

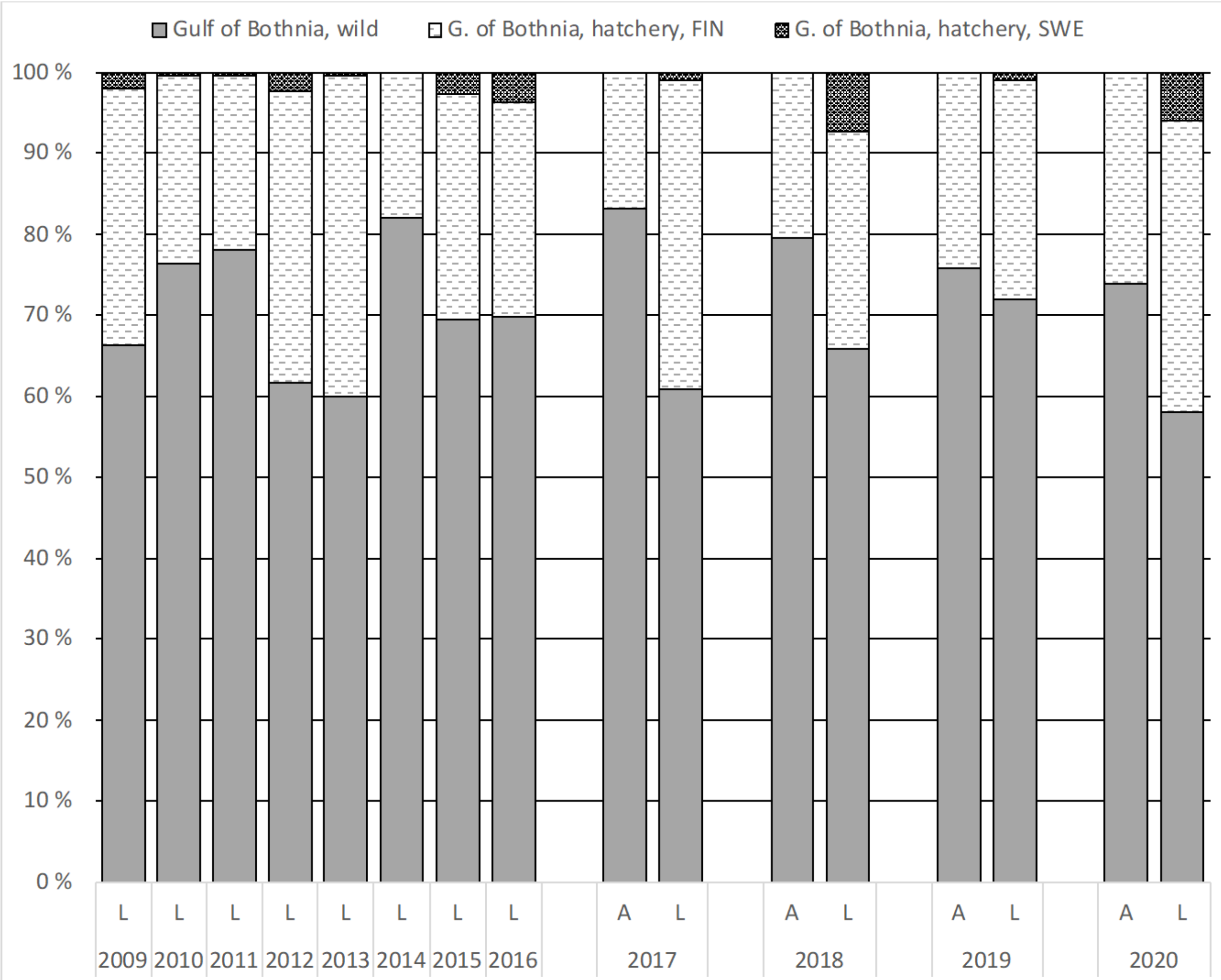


Figure 2.6.2. Proportions of salmon stock groups in Finnish salmon catches in the Gulf of Bothnia from 2009 to 2020. The catches from the advanced fishing season (A) and the normal/late fishing season (L) since 2017 have been analysed separately.

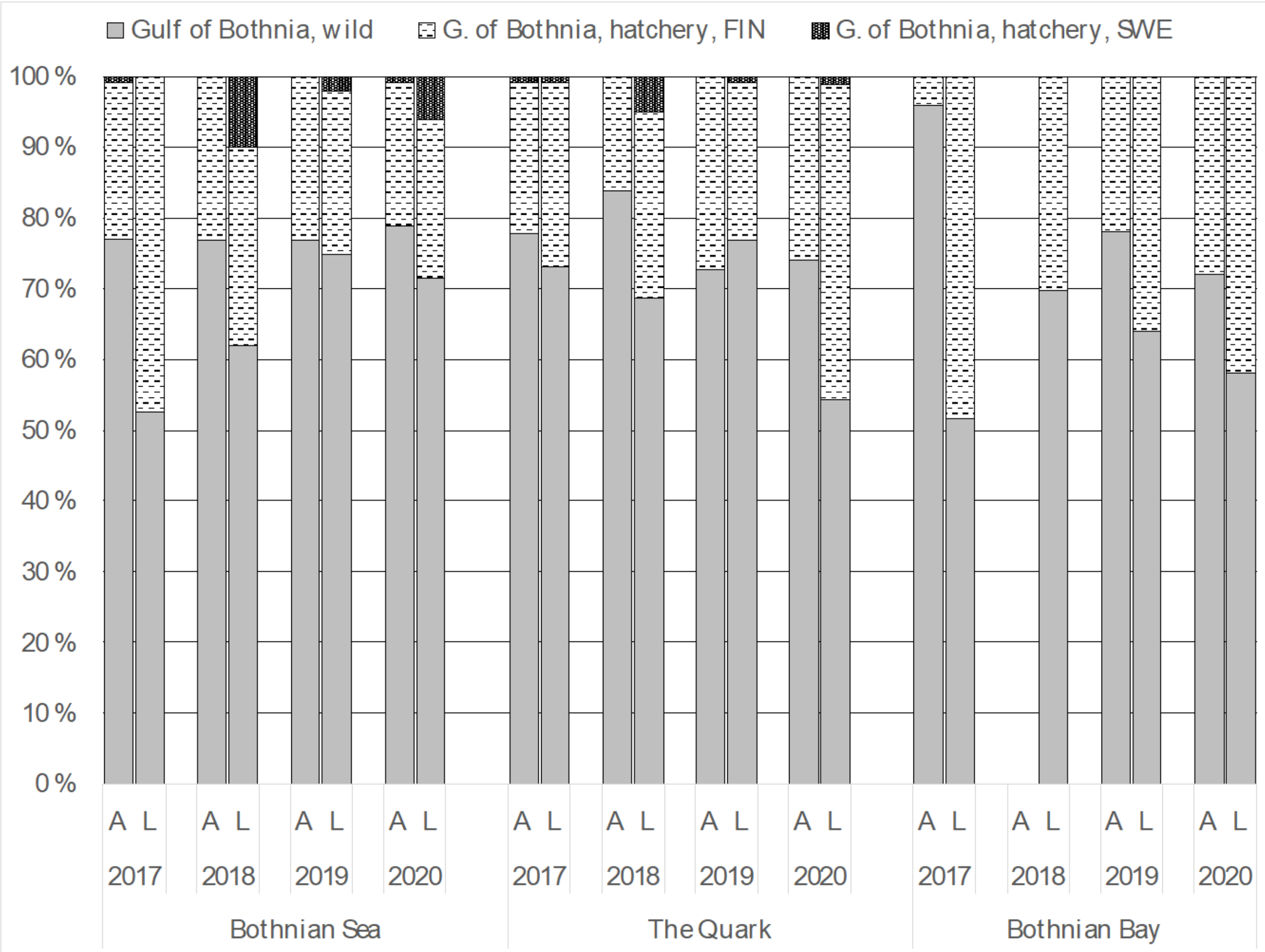


Figure 2.6.3. Proportion of salmon stock groups in Finnish salmon catches in three fishing areas of the Gulf of Bothnia (Bothnian Bay – northern area, The Quark, Bothnian Sea) in 2017–2020. Catches from the advanced (A) and normal/late (L) fishing seasons have been analysed separately.

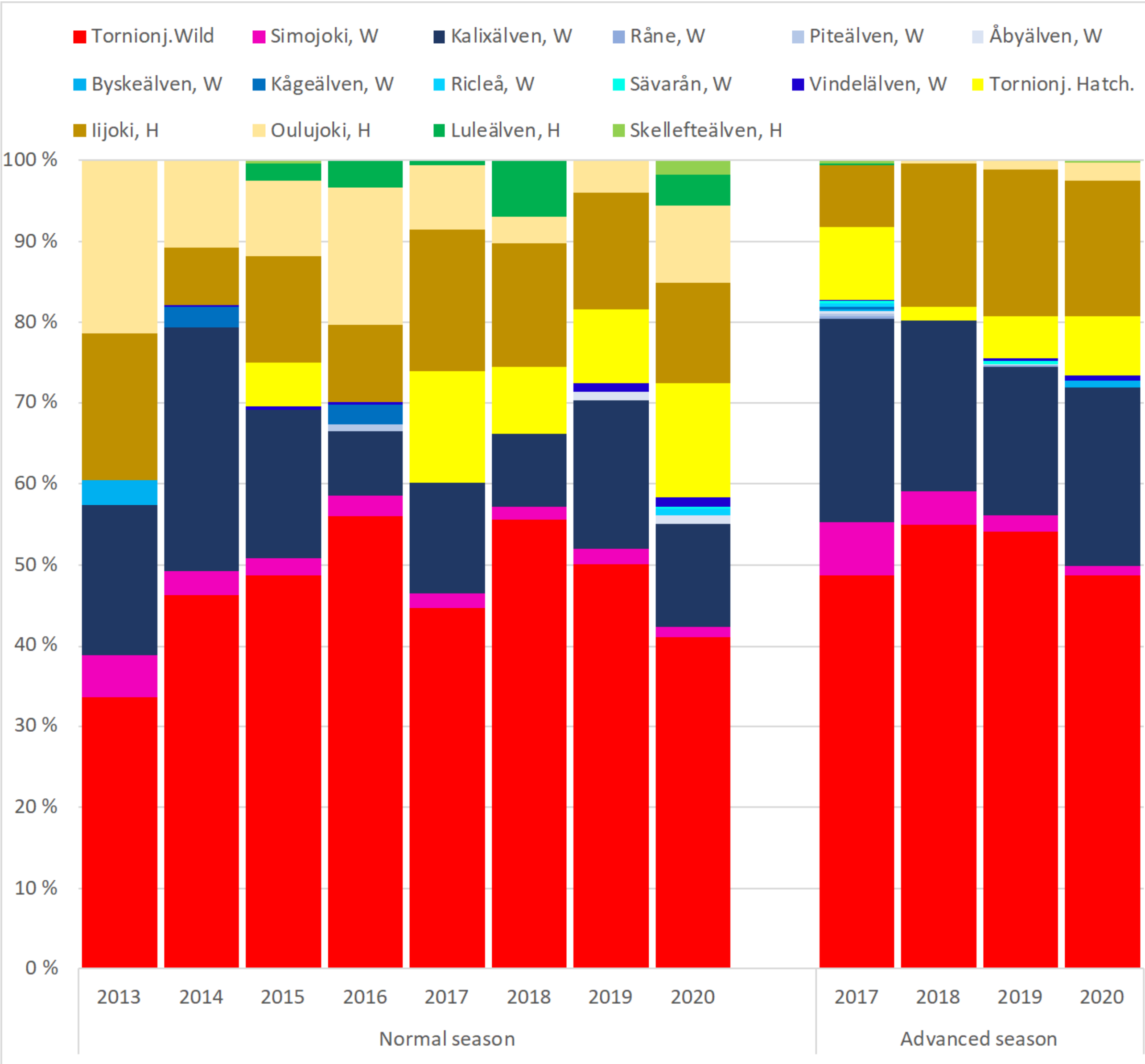


Figure 2.6.4. Proportion of salmon stocks in Finnish salmon catches in the Gulf of Bothnia in 2013–2020. Catches from the advanced and normal (late) fishing seasons have been analysed separately.

3 River data on salmon populations

The Baltic salmon rivers are divided into four main categories: **wild**, **mixed**, **reared** and **potential**. Details on how rivers in countries and assessment units (AUs) are classified into these four river categories are given in the Stock Annex (Annex 2). At present there are 58 salmon rivers out of which 27, 14 and 17 are considered as wild, mixed (i.e. with both natural and reared production) and reared, respectively. In addition, there currently exist 21 potential salmon rivers in five countries (Section 3.2).

Over the years, some rivers have received altered status and further changes are likely to occur in the future. For example, in 2013 and 2014 the formerly potential salmon rivers **Testeboån** (AU 3) and **Kågeälven** (AU 2) in Sweden received status as wild, as they had fulfilled criteria previously set up by WGBAST (ICES, 2008c). Among the 14 rivers currently classified as mixed, the present level of salmon releases in Estonian rivers **Pirita** and **Väänä** (AU 6) are already close to the threshold of less than 10% reared smolt production adopted by WGBAST as a criteria for wild rivers (Annex 2, Table A.1.2.1). Hence, if stocking would be further reduced or stopped, these rivers could become candidates for receiving wild status by WGBAST. Conversely, the previously wild river **Pärnu** in Estonia (AU 5) was listed in 2018 as mixed, because of an ongoing restoration programme that includes substantial annual releases of hatchery-reared juveniles (ICES, 2018a; 2018b). In the coming years, WGBAST plans to review its criteria and update the list of wild, mixed, and potential salmon rivers, according to river specific information, new studies and internationally recognized recommendations.

3.1 Wild salmon populations in Main Basin and Gulf of Bothnia

Current wild salmon rivers in Main Basin and Gulf of Bothnia are listed per country and assessment unit in the Stock Annex (Annex 2).

3.1.1 Rivers in assessment unit 1 (Gulf of Bothnia, SD 31)

River catches and fishery

In 2012, the catch in **Tornionjoki** was three times higher than in 2011 and for the first time since the beginning of the time-series with annual catch statistics, it exceeded 100 tonnes (Table 3.1.1.1). In 2014, the catch increased to 147 tonnes, and in 2016 it reached the present record of 161 tonnes (Table 3.1.1.1). In 2017 and 2018, the catch again declined to around 90 tonnes, but in 2019 and 2020 it increased again, and was 111 and 130 tonnes, respectively. Catch levels similar to those observed in 2012–2020 were observed in the early 20th century (Figure 3.1.1.1). Salmon catches in **Simojoki** did not rise much in 2012–2013, which is partly due to a low fishing effort. However, in 2014 and 2015 there was a clear increase in the catch and the rising trend continued until 2016, when the catch was 1.8 tonnes (Table 3.1.1.1). As in Tornionjoki, 2017 catches dropped also in Simojoki, and they have been between 0.5–1 tonnes in 2017–2019 but increased again in 2020 to 1.5 tonnes. The catches in **Kalixälven** have decreased in later years mostly depending on not functional catch reporting system and they do not correspond to the registered number of salmon that have passed the fishway, totally 250 salmon were caught and out of which 100 were retained.

A special kind of fishing from boat (rod fishing by rowing) dominates the salmon fishing in **Tornionjoki.** This type of fishing also occurs in **Kalixälven,** but there it is not as dominating as in

Tornionjoki. CPUE of this fishery in Tornionjoki has increased tens of times since the late 1980s (Table 3.1.1.1), apparently reflecting the parallel increase in the abundance of spawners in the river. The CPUE has been high (over 1000 grams/fishing day) in 1997, 2008 and 2012–2016, when the total river catches were also peaking. In 2017 CPUE dropped to 860 g/day. In 2018, it increased to 1200 g/day and in 2019 and 2020 the CPUE was 970 g/day and 930 g/day, respectively. Annual changes in CPUE and in total river catch generally follow each other. However, in 2019 and 2020 the CPUE was exceptionally low compared to the total catch.

In **Råneälven**, the local administration has since 2014 utilized a seasonal catch bag limit regulation of maximum of three salmon per person and season. Both obligatory tagging of killed fish (maximum of three tags per person and year) and a digital catch reporting system has been utilized to aid in enforcement. Most (80–90%) of the salmon caught with rod are released back; in 2017 a total of 56 salmon were caught, out of which 45 were released, whereas in 2018 only two salmon were caught and tagged (retained). The catch in 2019 was 45 salmon out of which seven were tagged and retained; in 2020 only two salmon were caught and retained.

Spawning runs and their composition

In **Kalixälven** salmon are counted in the fishway at the waterfall in Jockfall about 100 km from the river mouth. From 2007 to 2012 the mean annual run was 5500 salmon. In 2013, the run increased to the highest observed when more than 15 000 salmon passed the fishway. The counted runs in 2014–2019 stayed at a lower level (between 5000–10 000 salmon). In 2020, nearly 19 000 were registered in the fishcounter (Table 3.1.1.2). Yearly very few reared (adipose finclipped) salmon has been registered in the fish counter. Between 2015 to 2018 no reared salmon was registered in the counter. In 2019, six reared salmon was registered of 9957 salmon, and in 2020 only one salmon with clipped adipose fin was registered of 18 664which results in very low proportion of strayers.

A hydroacoustic split-beam technique was employed in 2003–2007 to count the spawning run in **Simojoki**. It seems evident that these counts covered only a fraction of the total run, as there are irregularities in the river bottom at the counting site, allowing salmon to pass without being recorded. Since 2008, the split-beam technique has been replaced by an echosounder called DIDSON (Dual frequency IDentification SONar) and in 2020 a new generation version of DIDSON (called ARIS) replaced DIDSON. According to monitoring results, the seasonal run size has ranged from less than 1000 up to more than 5000 fish (Table 3.1.1.2). Spawning runs gradually increased from 2004 to 2008–2009, but again dropped in 2010–2011. In 2012, the run increased fourfold from the previous year (to about 3000) and also the runs in 2013–2015 were about as abundant (3000–4000 salmon). The 2016 run was record-high with 5400 salmon counted. In 2017, the run dropped below 2000 salmon but increased in 2018, 2019 and 2020 to about 4000 salmon/year (Table 3.1.1.2). A lot of back-and-forth movement of salmon has been detected in Simojoki, especially in 2018, which erodes the accuracy of the counts. There have also been problems connected to the separation of species.

The spawning runs into **Tornionjoki** have also been monitored using the DIDSON technique since 2009, but in 2019 the old DIDSON units were replaced by ARIS sonars. The observed seasonal run size has ranged from 17 200 (year 2010) to 100 200 (year 2014) salmon (Table 3.1.1.2). Grilse account for a minority (7–24%) of the annual spawning runs. The run size in 2016 (98 300 salmon) was almost as high as in the record year 2014 (101 000 salmon), but as in the Simojoki, the run again dropped in 2017 (to about 41 000 salmon). In 2018 the counted amount increased only slightly (to 47 000 salmon), but in 2019 and 2020 the total count increased further, to 65 500 and 69 100 salmon, respectively.

The Tornionjoki counting site is located about 100 km upstream from the river mouth. Therefore, salmon which are either caught below the site or stay to spawn below the site must be assessed and added into the hydroacoustic count, in order to get an estimate of the total run size into the river (Lilja *et al.*, 2010). Also, according to auxiliary studies, a small fraction of the spawners pass the counting site via the fast-flowing mid-channel without being detected by sonars. The mid-channel seems to be utilised the more by salmon the lower the river water level is (Isometsä *et al.,* 2021). The 2018 and 2019 counts probably represents a smaller-than-normal proportion of the total run size into the river; observations were made of unusually high amounts of salmon staying on the lowermost river until autumn 2018. Moreover, the very low prevailing water level in 2018 and 2019 probably allowed many spawners to pass the hydroacoustic counter via the deepest mid-channel where they may have remained undetected.

In 2014–2019, the spawning run in **Råneälven** has been monitored with an ultra-sound camera (SIMSONAR). The technique is similar to that used in Tornionjoki and Simojoki. The counting site is located about 35 km upstream from the river mouth, and the counts are expected to represent the total run as almost no salmon spawning areas exist downstream. The total counted salmon runs in the period 2014–2019 has varied between 1000–4000 and in 2020 the salmon run was 2461 (Table 3.1.1.3).

Over 13 000 catch samples have been collected from the **Tornionjoki** salmon fishery since the mid-1970s. Table 3.1.1.3 shows sample size, sea age composition, sex composition and proportion of reared fish (identified either by the absence of adipose fin or by scale reading) of the data for the given time periods. Caught fish have generally become older, and the proportion of repeat spawners has increased in parallel with a decreasing sea fishing pressure (see Section 4). The strong spawning runs into Tornionjoki in 2012–2016 were a result of fish from several smolt cohorts. In these years, the proportion of females has been fairly stable, about two thirds of total biomass, but in 2018 and 2019 only about 55% of the total biomass were females. The proportion of repeat spawners has generally been between 5–10% during the last decade. However, a record high proportion of repeat spawners (14%) was observed in 2014, and the proportion was high also in 2018 and 2020 (12% and 11%, respectively). On the contrary, in 2017 and 2019 the proportion of repeat spawners was only 3%, indicating large interannual variation. Very few salmon of reared origin (<1%) have been observed in the Tornionjoki catch samples in the last decade (Table 3.1.1.3).

Parr densities and smolt trapping

The lowest parr densities in AU 1 rivers were observed in the mid-1980s (Table 3.1.1.4, Figures 3.1.1.4 and 3.1.1.5). During the 1990s, densities increased in a cyclic pattern with two 'jumps'. The second, higher jump started in 1996–1997. Between these increases there was a collapse in densities around the mid-1990s, when also the highest M74 mortality was observed (see below). Average parr densities are nowadays 5–60 times higher than in the mid-1980s. Since the turn of the millennium, annual parr densities have varied 2–6 fold. In **Simojoki**, some years with higher-than-earlier densities of 0+ parr have been observed recently, but annual variation has been large and densities of older parr have often not increased in this river after years with high 0+ densities. In the other AU 1 rivers, however, parr densities of all ages have continued to increase rather steadily until in the mid-2010s.

In some years, like in 2003, high densities of parr hatched in **Simojoki, Tornionjoki** and **Kalixälven** despite relatively low preceding river catches (indicating low spawner abundance)**.** Similarly, high densities of 0+ parr were observed in **Tornionjoki** in 2008 and 2011, although river catches and spawners counts in the preceding years were not among the highest. Possible reasons for this inconsistency include exceptionally warm and low summer-time river water, which might have affected fishing success in the river and even measurements of parr densities. In years 2006, 2013, 2014, 2018 and 2019 conditions for electrofishing were favourable because of very low river water levels, whereas they were the opposite in 2004 and 2005. These kinds of changes in electrofishing conditions may have affected the results, and one must therefore be somewhat cautious when interpreting the data obtained.

In **Simojoki**, the mean density of one-summer old parr increased by about 50% from 2015 to 2016 and it continued to increase in 2017 (Table 3.1.1.4). The 2019 density of 0+ parr (40.9 ind./100 sqm) is record high in the time-series, although most of the uppermost sites still lack 0+ parr. In 2020 the 0+ parr density dropped to about half (21.3 ind./100 sqm) of that of 2019, although the number of spawners giving rise to these parr densities was almost identical (Table 3.1.1.2). The density of older parr increased rapidly from 2015 (6.5 ind./100 sqm) to a record high level in 2018 (42 ind./100 sqm). In 2019, however, the density dropped to 14.4 ind./100 sqm and in 2020 the density increased to 19.9 ind./100 sqm. In **Tornionjoki** the densities of 0+ parr in 2014 and 2015 were clearly higher than in any earlier year in the time-series. In 2016, the average density of 0+ parr on the sampled sites was somewhat lower than in 2015. Several flood peaks due to heavy rains prevented electrofishing on the lower and on some of the middle and upper sections of the river system. In 2017, the average density of 0+ parr increased and was the third highest in the time-series (28.5 ind./100 sqm). In 2018 the mean 0+ parr density again dropped to only 18.3 ind./100 sqm, however in 2019 and 2020 the densities were higher: 25.5 and 20.5 ind./100 sqm, respectively. The average density of older parr in 2017 (17.2 ind./100 m^2) dropped from the two earlier years and in 2019 a further decrease (to 15.2 ind./100 sqm) was observed, but there was again an increase in 2020 (19.8 ind./100 sqm). Thus, in Tornionjoki parr production dropped after the record years in the mid-2010s, but again a slight increase is observed during the last 1–2 years.

In **Kalixälven,** the mean density of 0+ stayed at same level in 2020 compared to the average for the five latest years. The density of older parr has been relative stable, varying between 12-26 ind./100 sqm during the five latest year. (Table 3.1.1.4). In **Råneälven** the density of 0+ parr decreased with half compared to densities 2019. The density of older parr increased and was the highest observed so far.

Smolt production has been monitored in **Simojoki** and **Tornionjoki** by annual partial smolt trapping and mark–recapture experiments (see Annex 2 for methodology) since 1977 and 1987, respectively (Table 3.1.1.5). A so-called river model (also referred to as “hierarchical linear regression analysis”) has been applied to combine information from electrofishing and smolt trapping results, to obtain updated estimates of wild smolt production in years when high water flow has prevented complete trapping, including also rivers without smolt trapping (Annex 2).

With a 1–3 year time-lag (needed for parr to transform to smolts) wild smolt runs have followed changes in wild parr densities. In the late 1980s, the annual estimated wild smolt run was only some thousands in **Simojoki** and less than 100 000 in **Tornionjoki** (Table 3.1.1.5). The first increase in the production occurred in the early 1990s, and a second, higher jump occurred in the turn of the millennium. Since then, smolt runs have not increased in **Simojoki**, while in **Tornionjoki** the runs have continued to increase until the late 2010s Since the turn of the millennium, annual estimated runs of wild smolt have exceeded 20 000 and 500 000 smolts with high certainty in **Simojoki** and **Tornionjoki,** respectively. Since 2008, estimates of wild smolt runs have exceeded one million smolts in the **Tornionjoki**.

Smolt trapping in 2020 was unsuccessful in **Tornionjoki**, due to too high and late spring flood, which prevented setting up the trap early enough. The river model updated with the latest parr density and smolt trapping data estimated the 2020 smolt run to be approximately 1.4 million smolts (median value, 90% PI’s 1.2–1.8 million). The river model predicts about 1.5–1.8 million smolts for 2021–2022.

Smolt trapping in **Simojoki** was conducted successfully in 2020, although the trap was set up relatively late in comparison to the water temperature. This together with daily catches being record high soon after the starting date indicate that some smolts had already migrated to the sea before trapping started. The trapping with mark–recapture experiments resulted in an estimate of about 30 000 smolts (median value, 95% PI's 19 400–49 300). The river model with electrofishing and smolt trapping data up to 2020 updated the smolt run estimate to about 38 000 smolts for 2020 (median value, 90% PI's 27 100–53 800 inds.). Moreover, the river model predicts an increase to approx. 50 000 smolts/year for the years 2021–2022.

3.1.2 Rivers in assessment unit 2 (Gulf of Bothnia, SD 31)

River catches and fishery

The 2020 catches in **Piteälven** and **Åbyälven** stayed at the same low level as in previous years. The retained catch in **Byskeälven** was 29 in 2020 compared to 98 in 2019. (Table 3.1.1.1). In **Kågeälven** (wild river since 2014) the sport fishery was regulated in 2012 by the local administration to become 100% catch and release, with all fish released to be registered in an obligatory reporting system. In the period 2015–2019 on average about 75 salmon per year (range: six to 92) have been caught and released in Kågeälven. In 2020, 26 salmon were caught and released.

In **Rickleån** only six salmon were retained in 2020 compared with six in 2019 and two salmon in 2018 and 2017. In the period 2008–2016 the retained catches varied between 10–20 salmon with releases ranging from 13 to 23.

In **Sävarån** the catches have been very low in recent years only seven salmon were retained in 2020. No (four released) salmon where retained in 2019 and in 2018, only five salmon were caught and released. In 2017, no salmon were caught, compared to in 2016 when 13 salmon were caught and released. The catch in **Ume/Vindelälven** increased to 900 salmon compared with 2019 when 300 salmon was retained. All reported caught salmon in the five latest year showed signs of disease. In **Öreälven** the catch in 2017 decreased to 95 salmon (whereof 60 released) compared to 600 (whereof 400 released) in 2016. No salmon was retained in 2018 (four released). In 2019, the catch was 106 salmon whereof 29 were retained and in 2020 the catches increased when 300 salmon were caught and retained. In **Lögdeälven** the catches from 2016 and onwards has varied from 80 to 143 whereof about half has been released. In 2020 the retained catches increased to 276 salmon.

Spawning runs and their composition

In the fishway in **Piteälven** the counted salmon run in 2020 was 1006 which is half of the run in 2019 when 2089 salmon were recorded. In 2018, the run was 1431, which is the same amount as in 2017 (Table 3.1.1.2, Figure 3.1.1.3).

In 2020, the counted salmon in the fishway at the hydropower station in **Åbyälven** was 55, which is half of the amount in 2019 when 93 salmon were registered, which is at the same level as the three previous year (Table 3.1.1.2, Figure 3.1.1.3). In 2018, the hydropower station owner has sent in an application to the environmental court asking for reconstruction of the fishway to achieve a higher passage efficiency.

In the two fishways at Fällforsen in **Byskeälven**, the total counted salmon run increased in 2020 to 6675 registrered salmon compared with the three previous years (Table 3.1.1.2, Figure 3.1.1.3). The counter (Riverwatcher) in the fishway where a majority of the salmon run occurs had breaks due to problems with different hardware issues and high water level. During those periods, the run was extrapolated by the company Fiskevårdsteknik AB, who is responsible for analysing the registrations.

In **Rickleån** a total of 57 salmon passed the fishways in 2020, which is the same amount as in 2019. In 2017, a total of 15 salmon passed the fishways, which is at the same level as in the two previous years (Table 3.1.1.2).

In **Ume/Vindelälven** a total of 12 911 salmon passed the fishway in 2020 which is at the same level as in the two previous years, whereof a high portion were MSW (78%). In 2017, the run was only 4100 salmon (Table 3.1.1.2, Figure 3.1.1.3). Severe disease outbreaks have occurred in Ume/Vindelälven since 2015 and very few females passed the fishway in 2018, but in 2019, the number of females increased to earlier level (see Section 3.4.4). In 2019, modification was carried in the very last pool of the technical fishway so that fish more efficiently can detect the next pool and continue the upstream migration. In the beginning of the run season 2019 and 2020, a large proportion of adult salmon suffered of some form of disease and died in the fishway or soon after passing the fishway, this also occurred previous year. In the middle of the summer, very few salmon passed the fishway. From August and onwards the salmon run increased, the signs that salmon were suffering from visible diseases more or less disappeared, at the same time as the performance in the fishway improved.

In **Öreälven** the control of ascending fish ended in 2000 (Table 3.1.1.2). The reason was high water levels that destroyed the part of the dam where the fish trap was located.

Parr densities and smolt trapping

Densities of salmon parr in electrofishing surveys in AU 2 rivers (Gulf of Bothnia, ICES SD 31) are shown in Table 3.1.2.1 and in Figures 3.1.2.1 and 3.1.2.2. In the summers of 2006, 2013 and 2014 conditions for electrofishing were extraordinary because of very low water levels, opposite to the conditions prevailing in 2004–2005. For the electrofishing carried out in 2009, 2010, 2012 and 2015, the water levels were normal, but in 2011 and 2016 high water levels due to rain prevented surveys in several rivers. In 2020, the water levels were normal from late summer into autumn.

Due to problems to electrofish large parts of **Piteälven**, only the number of ascending adults is used for indirectly estimating smolt abundance (details in Section 4.2.1). No consistent electrofishing surveys were made in the 1990s. The density of 0+ parr has been rather low in most of the years (Table 3.1.2.1). No surveys were done in 2011 and 2012 due to high water levels. In 2014 the densities of 0+ parr was the highest recorded (12 ind./100 sqm). In 2016, the average density increased compared to in the previous year. The density of older parr has also been low, varying between 4–9 ind./100 sqm the latest four years. No surveys were carried out in 2017, 2018, 2019 and 2020.

In **Åbyälven**weighted mean densities, including sites above the hydropower station and also the extended electrofishing surveys below the hydropower station, have served as input in the river model used to calculate prior smolt abundances. The consecvense of using weighted mean densities results in lower mean densties of 0+ and older parr compared with mean densites from using only the sites below the hydropower station. The mean densities of 0+ parr in the latest five years has varied betveen 12 to 23 ind./100 sqm. In 2020 the densities decrased to 7 ind./100 sqm which id half of the densites in previous year. For older parr the mean densities for the latest five latest years has been stable and varied between 8-11 ind./100 sqm. . Weighted mean densities, including sites above the hydropower station and also the extended electrofishing surveys, have served as input in the river model used to calculate prior smolt abundances (Table 3.1.2.1). In Åbyälven smolt have been counted 2018-2020. The 2018 smolt trapping appeared successful, but the salmon smolt estimate was surprisingly low in relation to previous estimates based on parr densities and production areas. Subsequent analyses of daily smolt counts in relation to water temperature also indicated that the earliest part of the run may have been missed. In 2019 the Åbyälven total salmon smolt estimate was higher, but still below previous expectations. The smolt count in 2020 was again lower

In **Byskeälven**, the mean densities of 0+ parr in 1989–1995 were about five ind./100 sqm. In 1996–1997 the densities increased to about 11 ind./100 sqm, and in 1999 and 2000 the 0+ parr densities increased further (they were about 70% higher than in 1996–1997). During the 2000s, the densities have been on rather high levels with a few exceptions, and in 2016 the 0+ density increased to the so far highest recorded level (43 ind./100 sqm) and it stayed at the same high level in 2017. In 2018, the densities decreased with half compared with the two previous years. In 2019 the 0+ density increased to the highest recorded (52 ind./100 sqm) so far but dropped with half in 2020. The densities of older parr have remained rather stable during previous years with a mean around 20 ind./100 sqm (Table 3.1.2.1).

In **Kågeälven**, the last releases of reared salmon parr were made in 2004, which means that the wild-born 0+ observed in 2013 were mainly offspring of spawners which themselves were wild-born. Stable occurrence of parr in recent years with means around 11 ind./100 sqm has decreased with half three years in a rowfor 0+ and the densities of older parr increased in 2020 compared with previous year(Table 3.1.2.1) indicates that the population has become self-sustaining.. Spawning also occurs along the whole river stretch available for salmon.

In **Rickleån**weighted mean densities, including sites above the three hydropower stations, have served as input in the river model used to calculate prior smolt abundances (for more details see Section 4.2.2 in ICES, 2015). The consecvense of using weighted mean densities results in lower mean densties of 0+ and older parr compared with mean densites from using only the sites below the hydropower station. The mean density of 0+ parr were less than 3 ind./100 sqm in 1988–2014, whereas since 2015 the mean density has been around 6 ind./100 sqm (Table 3.1.2.1). The mean density of older parr the latest five years has been 4 ind./100 sqm. In Table 3.1.2.1 also average densities from extended electrofishing surveys in Rickleån are presented, including sites in the upper part of the river that was recently colonized.

In 2014–2017, smolts of salmon and sea trout were counted during their downstream migration in Rickleån using a smolt wheel (‘Rotary-Screw-trap’) and mark–recapture experiments. The trap was positioned close to the river mouth. In 2014, a total of 434 salmon smolts were caught. The calculated recapture rate for tagged salmon was 20.3%, which was used to estimate a total smolt production of 2149 (Table 3.1.1.5). Because of many breaks when drifting the screw-trap in 2015, no reliable estimate of the smolt production could be obtained in that year. In 2016 and 2017, the estimated total run was about 4000 and 4800 salmon smolts, respectively (Table 3.1.1.5). No smolt trapping was performed in 2018 -2020 (the trap was moved to Råneälven).

In **Sävarån** the mean densities of 0+ parr in 1989–1995 were about 1.4 ind./100 sqm. In 1996, the average density increased to 10.3 ind./100 sqm, and in 2000 to 12.8 ind./100 sqm. No electrofishing was made in 2001 and 2004. The 0+ density in 2015 was the so far highest recorded (45 ind./100 sqm) followed by the highest for older parr in 2016 (34 ind./100 sqm). The densities of 0+ parr have decreased in the four lasts years, and in 2019 the density was 9 ind./100 sqm, but in 2020 the densities increased to 37 ind./100 sqm Also the density of older parr significantly decreased in 2019 compared to in previous years but slightly increased in 2020 (Table 3.1.2.1).

From 2005 to 2013, smolts of salmon and sea trout were caught in Sävarån on their downstream migration from mid-May to mid-June using a smolt wheel (originally two parallel wheels were used). The trapping site was positioned 15 km from the river mouth. Estimates of total salmon smolt production are presented in Table 3.1.1.5. On average ca. 470 wild salmon smolts per year were caught. Smolts were measured for length and weight, with scale samples taken for age determination and genetic analyses. The dominating age group was three years. The proportion of recaptured tagged fish in the trap varied between 4–31 % corresponding to an average estimated annual smolt abundance close to 3000 (Table 3.1.1.5). No trapping of smolts has been carried out since 2014, as the smolt trap was moved and used in Rickleån during 2014–2017 (see above).

In **Ume/Vindelälven**, mean densities of 0+ parr in the 1990s were only about 0.8 ind./100 sqm. During the 2000s, densities have fluctuated within the range of 5–25 ind./100 sqm. No surveys were carried out in 2011 due to high water level. In 2014, the density of 0+ parr increased to the so far highest recorded (39 ind./100 sqm) followed by a decrease in 2015 with almost 50%. In years 2016-2019 the mean 0+ parr density has declined to very low values (<5 ind./100 sqm), levels not seen in the river since the peak years of M74 (fry mortality) in the early 1990s. In 2018, only two 0+ parr were caught across 27 electrofished sites. The reason for the very low density seems to be linked to the record small proportion of females passing the fish ladder in Stornorrfors in 2017 and 2018 and also in 2015 and 2016 (Table 3.1.1.2; Figure 3.1.2.3) combined with a low survival rate after having passed the ladder. In recent years, a large proportion of the ascending spawning fish have suffered from (a still unknown) disease followed by secondary fungus (Section 3.4.4). The establishment of fungus has weakened the fish and resulted in high mortality, which has been observed in the fishway, at the intake grid to the hydropower station, and in the hatchery facilities where fish have died long before spawning time. In addition, the M74-frequency increased in the spawning years 2015–2017 (Section 3.4). These factors combined probably have led to a low egg deposition in autumns 2015, 2016, 2017 and 2018 and to the very low densities of 0+parr seen in 2016–2019. In 2020 the densities of 0+ parr increased to 20 ind./100 sqm including the extended electrofishing sites. The densities of older parr has also decreased because of the low 0+ parr densties latest years.

In Table 3.1.2.1, average densities from extended electrofishing surveys in Vindelälven are also shown, including additional sites from upper parts in the river that recently have been colonized (see Section 4.2.2 in ICES, 2015). Since some years, weighted mean densities including these extended electrofishing surveys have served as input in the river model used to calculate prior smolt abundances.

A smolt fykenet for catching smolts, similar to the one used in Tornionjoki, was operated in Vindelälven between 2009 and 2015. The entire smolt production area is located upstream of the trapping site. On average around 2500 salmon smolts were caught, and the annual proportion of recaptured tagged fish varied between 2.2–3.6%. In 2009, the trap was operated from end of May to beginning of July, and smolts were likely caught during the whole time period with a peak in mid-June. In 2010, a pronounced spring flood caused problems to set up the fykenet and a considerable part of the smolt run was missed. In 2011, a period with very high water flow late during the season again prevented smolt trapping. Although the break was rather short (six days) a very high smolt catch the day immediately before the break indicated presence of a significant ‘peak’ that was likely missed. In 2012–2015, several episodes of high water flow again resulted in repeated breaks, and for those years, it was difficult to even produce crude guesses of the proportion of the total smolt run that was missed.

Due to the above mentioned interruptions in the function of the trap, direct smolt estimates from the mark–recapture experiments with the fykenet have not been possible to produce. However, estimates have still been obtained based on data for returning 1SW adults (grilse) that can be identified from their smaller body size even without age data. Since 2010, all captured smolts have been marked using PIT-tags. VAKI counters and PIT-antennas in the Ume/Vindelälven fishway record all marked and unmarked wild returning spawners. Assuming a common smolt-to-adult survival rate for marked and unmarked grilse, the size of a given smolt cohort has thus been possible to estimate indirectly (see Table 3.1.1.5) and used as prior information for the river model.

Since 2016, the Vindelälven smolt trapping has been moved to a newly built permanent smolt trap within the fishway at Stornorrfors (hydropower dam that must be passed by down-migrating smolts) just a few kilometres downstream the former trapping site. In 2016–2018, however, there have been technical problems with the new smolt trap, and as a consequence only few smolts were caught and marked. During 2019 and 2020 the smolt trapping improved and wild smolt where pit tag marked. In 2020, a total of 4168 smolts were caught in the fishway and released downstream afterwards tagging.

In **Öreälven**, mean densities of 0+ parr in 1986–2000 were very low, just about 0.5 ind./100 sqm. The densities increased somewhat during the early 2000s, and then stayed around 3–10 ind./100 sqm until in 2015 when the density increased by three times compared with earlier to the highest value recorded so far (21.6 ind./100 sqm). In 2018 the mean density decreased to only 1.6 ind./100 sqm. In 2020, the densities of 0+ increased to 33 ind./100 sqm the highest observed when the extended sites are included (Table 3.1.2.1). Densities of older parr has stayed at the same mean level (four ind./100 sqm) during 2017–2020. In Table 3.1.2.1, average densities from extended electrofishing surveys in Öreälven are shown, including sites from upper parts of the river that recently have been colonised (see Section 4.4.2 in ICES, 2017a). Since the 2018 assessment, weighted mean densities including these extended electrofishing surveys have served as input in the river model used to calculate prior smolt abundances.

In **Lögdeälven**, mean densities of 0+ parr in 1990s were about 1.5 ind./100 sqm. Densities during the 2000s have fluctuated between three and almost 15 ind./100 sqm. In 2017, the mean 0+ density decreased with about 50% compared to in the three previous years, and in 2018 the densities decreased to a very low level (1.5 ind./100 sqm), similar to as in the 1990s. In 2019 and 2020 the densities of 0+ increased to highest recorded at 20 ind./100 sqm (Table 3.1.2.1). In Table 3.1.2.1 also average densities from extended electrofishing surveys in Lögdeälven are shown, including sites from upper parts of the river that recently have been colonised (see Section 4.4.2 in ICES, 2017a). Since the 2018 assessment, weighted mean densities including these extended electrofishing surveys have served as input in the river model used to calculate prior smolt abundances.

In 2015–2016, a smolt wheel was operated in Lögdeälven, close to the river mouth. The number of caught salmon smolts were 299 (2015) and 463 (2016), with 11% and 10% of the marked smolts being recaptured. In 2015, the trap had to be closed before the migration was finished, and the total smolt run for this year was therefore likely underestimated. In 2016, however, the whole run was monitored, yielding an estimate of about 5200 smolts. No smolt trapping was done from 2017 and onwards (Table 3.1.1.5).

3.1.3 Rivers in assessment unit 3 (Gulf of Bothnia, SD 30)

Spawning runs and their composition

In **Testeboån**, an electronic fish counter was installed in late August 2015 in the new built fishway; a total of five salmon and 54 sea trout were counted in that incomplete season. In 2016, 2017 and 2018, a total of 73, 67 and 21 salmon were registered in the fishway, respectively. In 2019, the counted number of salmon in Testeboån was the highest recorded so far even though fish could pass through the spill gates during a period of one month in the beginning of the spawning run (Table 3.1.1.2). In 2020, the counted number of salmon decreased, totally 104 where registered in the fishcounter. In 2016, salmon may have passed beside the counter in early June during high water flow, but on the other hand, salmon migration may not have started at that time of the year. In 2017, 2018 and 2020, in principle the entire run salmon passed through the fishway.

River catches and fishery

In **Ljungan**, only one salmon was caught and retained in 2020 compared with 2019 when 95 salmon were caught and all were released. In 2018, 210 salmon were caught whereof 190 released. Compared to an average annual total catch of 220 salmon in the period 2010–2016. In general, the catches have increased since the early 2000s, but in the last year, the catch decreased to a level similar to that in the early 2000s. As detailed below, Ljungan is one of the wild salmon rivers where considerable disease problems have occurred in recent years. In **Testeboån** (wild river since 2013) landing of salmon is not allowed.

Parr densities and smolt trapping

Parr densities from **Ljungan** are missing for several years, due to high water levels in late autumn making electrofishing impossible. For example, the relatively high value for 2012 only mirrors data from one electrofishing site (Table 3.1.3.1) as the other sites could not be fished due to high water levels. Recorded average densities of 0+ salmon varied markedly from three to 45 ind./100 sqm between 1990 and 2008, but without any clear trend (Table 3.1.3.1 and Figure 3.1.3.1). However, in 2012, 2014 and 2015 (especially) parr densities showed signs of increase. In 2017, the mean 0+ density in Ljungan dropped markedly to just 0.8 ind./100 sqm and in 2018 no 0+ parr were caught. In 2019 and 2020 the densities of 0+ was low (4 ind./100 sqm). The densities of older parr from 2018-2020 has been very low, in average 0.5 ind./100 sqm. This low density likely reflects that many adults died before spawning in the preceding autumn (Section 3.4.4).

Testeboån received status as a wild salmon river by WGBAST in 2013. The latest releases of reared salmon (fry) in the river occurred in 2006, which means that the wild-born 0+ parr observed at electrofishing from 2012 and onwards most likely were offspring to salmon which themselves were wild-born. Fairly stable levels of 0+ parr densities in recent years, except for in 2008 when 0+ parr were absent due to a very poor spawning run in 2007, indicates that the population is self-sustaining (Table 3.1.3.1). The mean density of 0+ parr decreased in 2014 compared to in the four previous years, but after that it increased, and in 2016, it was the so far highest recorded (about 28 ind./100 sqm). From 2017 to 2019, the average 0+ density has decreased to about five ind./100 sqm. In 2020 the densities increased to the highest observed of 28 ind./100 sqm (Table 3.1.3.1).

Smolt trapping using a smolt wheel has taken place in Testeboån since 2014. In 2015, the river was equipped with permanent facilities for counting of both smolts and ascending adults. Hence, since 2018, Testeboån represents a full index river. Annual estimates of the total smolt runs in 2014–2017 have varied in the range from about 2000 to 4300 smolts. In index river Testeboån, smolt counting could not be carried out in 2018–2019 due to high water levels (spring floods). In 2020, the total smolt catch in the smolt wheel was 207 smolts and all were tagged, and those 16 were recaptured.

3.1.4 Rivers in assessment unit 4 (Western Main Basin, SD 25 and 27)

River catches and fishery

In **Emån**, anglers have increasingly applied catch and release over the past 10–15 years, and the river fishery is nowadays basically a 'no-kill fishing'. Therefore, the retained catches have decreased markedly, from more than 100 salmon fish per year in the early 2000s to nearly zero in recent years. In 2020, only two salmon were caught and retained. In 2019, a total of 105 salmon were caught whereof five salmon were retained.

In **Mörrumsån** the retained salmon catch in 2020 was 110 salmon. In 2019, the catch was 490 salmon whereof 95 was retained. Between 2010 and 2017 the total river catch has on average been 777 salmon, with large annual variation (range: 462–1511). Similar to in Emån, anglers have increasingly applied catch and release, which largely explains a decline in retained catches seen in recent years.

Parr densities and smolt trapping

For **Emån** the Table 3.1.4.1 contains average densities from surveys below the first partial obstacle, and also densities calculated across all sections in Emån that are accessible for salmon, including sites above partial obstacles (dams with fish ladders) located in habitats that currently seem to be recolonized. For the present assessment, these weighted mean densities were used as input in the recently developed Southern river model (ICES, 2017c) to calculate prior AU 4 smolt abundances (Section 4).

The densities of 0+ parr in the lowermost part of the river varied between 13–71 ind./100 sqm during 1992–2007, with a mean density of 43. The highest 0+ density so far occurred in 1997. The density of 0+ parr was 53 ind./100 sqm in 2016 and stayed at about the same level in 2017, which is just over the mean value for earlier years in the time-series. In 2018, the densities of 0+ parr decreased to the lowest, nine ind./100 sqm, recoded since electrofishing surveys started. In 2019 and 2020, the densities of 0+ increased and was even slightly higher when extended sites were included compared to only "old" sites (30 ind./100 sqm). The densities of older parr, extended sites including, have varied from 1–8 ind./100 sqm during the period 1992–2020 with a mean value of two ind./100 sqm in recent two years.

The estimated smolt production in River Emån has appeared very low compared to the presumed production capacity. In 2007, an overview of the conditions in the river concluded that probably the difficulties for particularly salmon spawners, and to a minor extent also sea trout, to ascend fishways may give rise to low production of juveniles above the fishways. Electrofishing sites in these upstream areas do therefore normally show low juvenile abundance. On the other hand, there is a highly successful sea trout and salmon fishery in the lower part of the river (at Em), and this fishery has not shown signs of lesser abundance of either species. On the contrary, salmon seems to have increased in abundance.

Monitoring of salmon migration in one fishway during 2001–2004 also suggested that very few salmon could reach some of the upstream potential spawning areas. In 2006, the lowermost dam (at Emsfors) was opened permanently, and since then increased electrofishing densities for salmon have been recorded at the closest upstream electrofishing site. Activities are also ongoing to facilitate up- and downstream migration at the second dam counted from the sea, above which significant habitats regarded suitable for salmon reproduction are located.

In **Mörrumsån** the Table 3.1.4.1 also contains average densities calculated across all sections in Mörrumsån (weighted according to relative habitat areas) that are currently accessible for salmon, including sites in upstream habitats that recently have been recolonized following the construction of two fishways in 2004 (see below). For the present assessment, these weighted mean densities have been used as input for the recently developed Southern river model (ICES, 2017c) to calculate prior AU 4 smolt abundances (Section 4). The 0+ parr densities increased (119 ind./100 sqm) in 2019 to the highest observed since 1998. The 0+ parr densities in the period 1973–2011 varied between 12–307 ind./100 sqm (Table 3.1.4.1, Figures 3.1.4.1 and 3.1.4.2). The by far highest average density so far was observed in 1989 (>300 ind./100 sqm). At that time, however, substantial supplementary hatchery releases based on smolts from returning spawners were ongoing, with aim to support the fishery.

In 2011, the average 0+ density decreased to 36 ind./100 sqm, the lowest value since the mid-1990s. One reason for the low density in 2011 could be high water level, as only part of the survey sites was possible to electrofish. However, it should be noted that the number of ascending salmon counted in the preceding autumn (2010) was also the lowest recorded at the Marieberg power plant, ca. 13 kilometres from the sea, since an electronic counter was installed in the fishway in 2002. In Mörrumsån, 12 km from the river mouth, the hydropower station in Marieberg was removed in 2020 allowing fish to freely pass. Test with counting fish further downstream from the previous hydropower station was carried out 2020 with video and ecosounder registration. During 2021 these tests will continue. The future aim is to install counters and cover the whole spawning.

Since 2015, the average parr densities in Mörrumsån has decreased, and in 2018, the 0+ density decreased more than half of the mean for the years 2012–2014. The recent decline may reflect current disease problems, with a large number of dead and affected salmon and sea trout in the river since 2014. Notably, however, this decrease cannot be seen in the average densities for all river sections (above). For several years, a slight decline in average parr densities could be seen in the downstream river sections, whereas the uppermost (most recently accessible) part seemed to be in a building-up phase with increasing densities. Therefore, two contrasting trends were partly counteracting each other in the weighted averages used for computing smolt prior estimates. Since the health problems accelerated in 2014, however, the most marked decreases in parr densities have be seen above the first migration obstacle (Marieberg dam), which may indicate that spawners in poor condition have not managed to migrate upstream.

In Mörrumsån, hybrids between salmon and trout have been found during electrofishing since the early 1990s. In 1993–1994, at a period with high levels of M74-mortality and disease problems, the proportion of hybrids was high, up to over 50% in some sampling sites. After that, the occurrence of hybrids has varied. In 1995 and 1996, it was only some percent of the total catch. In 2005, the density of 0+ hybrids were 14 ind./100 sqm which is higher than in the three years before. The amount of hybrids has decreased during 2006–2019. In 2019, the densities of hybrids were 0.6 ind./100 sqm. Occasionally over the years, genetic markers have been used to evaluate identifications made in the field of salmon/trout hybrid parr; in a majority of those cases identifications were found to be correct.

In 2004, two new fishways were built at the power plant station about 20 km from the river mouth, which opened up about 9 km of suitable habitat for salmon, including about 16–21 ha of production area. In 2009–2020, a smolt wheel has been operated in Mörrumsån, ca. 12 km upstream from the river mouth. About 55% of the total production area for salmonids is located upstream the trap. A main reason for choosing this upstream, location was that ascending adults are counted in a nearby fishway close to the smolt trap site, which should allow comparisons among numbers of ascending spawners and smolts from the upper part of Mörrumsån. So far however, only preliminary numbers of ascending adult spawners exist; to obtain such reliable estimates, further work will be needed that accounts for (i) a relatively large share of missing or unclear species identifications (due to absent or low quality camera images from the fishway) and (ii) the fact that a rather large proportion of salmon–trout hybrids exists in the river (Palm *et al.*, 2013).

In 2009–2012, the estimated smolt production in the upstream parts of the river was lower than expected (ca. 2000–8000 per year). As a comparison, Lindroth (1977) performed smolt trapping in 1963–1965 at a site close to the one currently used, and estimated the average annual salmon smolt production to 17 600 (range 12 400–25 000). However, since 2013, the smolt production in the monitored upper reaches of Mörrumsån has increased. In 2013, it was estimated to ca. 15 000, and in 2014, it was estimated to be the highest recorded so far (ca. 21 400). In 2015, the estimated smolt production decreased to ca. 10 000, but in 2016, it again increased to ca. 18 000. In 2017, the smolt production decreased to 10 200 and has after that continued to decline to only 3 000 smolt in 2019 but in 2020 the smolt production increased to 7900 smolt.

3.1.5 Rivers in assessment unit 5 (Eastern Main Basin, SD 26 and 28)

Estonian rivers

The River **Pärnu** flows into the Gulf of Riga and is the only Estonian salmon river in the Main Basin. The first obstacle for salmon migrating in the river is the Sindi dam, located 14 km from the river mouth. The fish ladder at the dam has not been effective due to its small size and the location of the entrance. The quality of spawning areas above the dam is relatively good, and parr abundancy is associated with poor accessibility.

Electrofishing surveys on the spawning and nursery ground below the dam have been performed since 1996; the number of ind./100 sqm has been very low during the whole period (Table 3.1.5.1 and Figure 3.1.5.1). No salmon parr were found in 2003, 2004, 2007, 2008, 2010 and 2011. In 2018, the 0+ parr density below Sindi dam was 1.4 ind./100 sqm. The habitat quality below the dam is poor, and that is the main cause for the low parr density. Since 2013, electrofishing is also carried out upstream from the Sindi dam. Above the dam salmon parr have been found only in some years, and densities have been very low. In 2017, however, average 0+ parr density (four sites electrofished) was 26 parr/100 m^2. In 2018, 13 sites were electrofished upstream the dam; salmon parr were found at only two of these, with an average density of 0.1 parr/100 m^2. In 2019, average 0+ parr density was 6.5 ind./100 sqm and increased in 2020 to 8.1 ind./100 sqm.

In autumn 2018, removal of the Sindi dam started, and ascending salmon were able to pass the dam in November same year. As salmon now has free access to all spawning grounds, the population should be able to recover. A juvenile supplemental release programme was also initiated in 2012 aimed at assisting population recovery. The first juvenile salmon were released in 2013, and as pointed out initially in this section, under present conditions with large numbers of juveniles being stocked every year, Pärnu should be considered as a mixed river.

Latvian rivers

There are seven wild salmon rivers in Latvia, mainly flowing into the Gulf of Riga. Some rivers have been annually stocked with hatchery-reared parr and smolts, and salmon in these rivers thus consist of a mixture of wild and reared fish. In 2018, salmon parr were found at 31 sites (15 rivers) sampled by electrofishing. Parr densities are presented in Table 3.1.5.1 and Figure 3.1.5.2.

The wild salmon population in river **Salaca** has been monitored by smolt trapping since 1964 and by parr electrofishing since 1993. From 2000, no releases of artificially reared salmon have been carried out. High water level in Salaca River during the monitoring week, may have affected the electrofishing results in 2020 when eleven sites were electrofished in the river Salaca and its tributaries. All sites in the main river hold 0+ age salmon parr. The 0+ salmon parr were present in the Salaca tributaries - Jaunupe, Svētupe and also Korģe which is considered a sea trout river. Average density of 0+ salmon parr in the whole river Salaca basin (including tributaries) was greater than in 2019 - 80,2 ind./100 sqm and density of older salmon parr was 0,9 ind./100 sqm. Smolt trap in the Salaca river was operated between April 21st and June 4th 2020. There were a few days when smolt trap was not set due to hydrological conditions or strong flow of woody debris. Data for such days were interpolated. Highest salmon and sea trout smolt run amount was registered on 10th of April. In total 904 salmon and 552 sea trout smolts were caught and 266 salmon and 134 sea trout smolts were marked using streamer tags for trap efficiency estimation. Smolt trap efficiency in Salaca River ranged from 5 to 20,6 % (on average 14% for salmon smolts and 10,7% for sea trout). Total salmon smolt production was calculated from the numbers of smolts captured and the trap efficiency. Total smolt run in 2020 was estimated to be 12,8 (±4,2) thousand salmon and 4,8 (±1,3) thousand sea trout smolts that migrated from Salaca river to the Gulf of Riga.

Disregarding the recommendations of the Institute BIOR to start works not earlier than on June 1st, in 2020 during the smolt migration time, dredging works of the Salacgriva Port were carried out. The works were performed in the period from 10th of May to 20th of August, using a self-propelled type dredger. Dredging works were carried out during daylight hours below smolt trap. It could have a negative effect on smolt run, but the exact magnitude of the impact is unknown. The damage to fish resources was estimated at EUR 3836.91 to be compensated by the port authority.

At the beginning of August 2020, the counting of ascending salmon was started in Salaca river 3 km upstream from the river mouth using Riverwatcher (Vaki Ltd) fish counter installed in the resistance board weir. Due to technical problems with Riverwatcher, counting was stopped at the end of the August, and it was not possible to continue even after receiving the replacement part from Vaki - there was a unexpectedly large increase in water level. During the one month operation period 15 ascending salmon females, two salmon males and four sea trout females were registered.

In 2021, it is planned to move the fish counter ~2 km upstream from previous site to more calm and shallower site, which unfortunately excludes the salmon population of Jaunupe River.

In river **Venta**, wild salmon parr were found above the Rumba waterfall because of a high water level in the autumn of 2017. In 2020 only 4 ind./100 sqm 0+ and 0.1 ind./100 sqm 1+ and older parr were caught in river Venta. Average parr production has negative trend due to high water temperatures and low water level in recent summers.

In river **Gauja,** 2020 wild salmon 0+ parr production decreased (1.8 ind./100 sqm) compared to in 2019 (6.2 ind./100 sqm). In **Amata,** which is a tributary to Gauja, salmon 0+ parr production increased to 9.2 ind./100 sqm compared to previous year when the densities were (0.9 ind./100 sqm).

In 2020, wild salmon parr were also found in the small Gulf of the Riga rivers **Vitrupe, Aģe** and **Pēterupe**. Age structures of parr in these rivers testify that salmon reproduction does not occur in every year. Parr production seems to be most stable an on a higher level in **Aģe**.

Wild 0+ salmon parr were also detected in **Užava**, **Irbe**, **Tebra** and **Durbe** river (Saka river basin) and in some of their tributaries. Older salmon parr were not present in these rivers. In the Durbe river after habitat mapping two sampling stations were established in representative rapid sections.

In 2018, habitat mapping was initiated to re-evaluate productive habitat sizes in Latvian rivers. According to the first results from river **Bārta**, the total area of riffles suitable for salmon spawning and nursery constituted only 0.6 ha in the river section from the Latvian-Lithuanian border to Lake Liepājas, which is many times less than the 10 ha estimated earlier. None of the mapped riffles were evaluated to have high or good quality, 67% of the habitats had moderate quality, whereas the remaining ones had poor quality. Problems with habitat siltation and overgrowing are common in the river.

In 2019, habitat re-assessment was carried out in the **Irbe**, **Užava** river and **Saka** river basin. In the **Irbe** river deposition of sand and silt in rapids suitable for salmon reproduction is visible problem. Rapids and riffles suitable for salmon spawning and nursery constitute 0.21 ha instead of 10 ha assumed previously. Habitat mapping in **Užava** river show that canalisation in 1960s has left considerable effect on available habitats in this river. Total available and suitable habitats constitute only 0.59 ha (0.46 ha with good quality). The size of the reproduction area was previously thought to be 5 ha. In the **Saka** river basin, upper parts of **Tebra** 2.4 ha of suitable habitats for salmon spawning and nursery areas was found. Previous estimate was 20 ha.

Lithuanian rivers

Lithuanian salmon rivers are listed in the Annex 2. Salmon inhabits 12 tributaries in the **Nemunas** river basin and river **B. Šventoji** that flows directly into the Baltic Sea. Purely natural salmon population inhabits only the Nemunas tributary **Žeimena** and its tributaries **Mera** and **Saria**. The index river Žeimena has never been stocked with artificially reared salmonids. Its tributary Mera is a typical sea trout river, and therefore has the salmon production been very low all the time. Mixed populations are found in the **B. Šventoji** (river that flows directly in to the Baltic Sea) and the following tributaries of river Nemunas; **Neris**, **Šventoji**, **Vilnia**, **Dubysa**, **Siesartis**,

Širvinta, **Virinta**, **Minija**, **Vokė**. Reared populations occur in the Nemunas tributary river **Jūra** and some smaller tributaries. In these rivers, salmon releases have been made regularly for several years.

Electrofishing is the main monitoring method for evaluation of occurrence and densities of 0+ and older salmon parr. Parr densities in Lithuanian rivers are presented in Table 3.1.5.2 and Figures 3.1.5.3 and 3.1.5.4. The abundance of salmon parr depends on hydrological conditions, spawning success, and protection of spawning grounds.

In 2020, the average density of salmon 0+ parr in the index river **Žeimena** increased to 11.7 ind./100 sqm and the densities of older parr was 0.1 ind./100 sqm. The 2020 density is above the mean values for the whole survey period. Parr density in **Neris** in 2020 stayed on a highest observed level. Average 0+ parr density was 11 ind./100 m^2 and older parr density was 0.2 ind./100 m^2 (Table 3.1.5.2).

The correlation between salmon juvenile density and water temperature during July, the warmest month of the year, has been investigated in two rivers characterized by different thermal regimes; Neris (r = -0,530, p =0,035) and Žeimena (r = -0,555, p =0,021). It was found that during a period of several years, water temperatures in July varied within a range of a few degrees (19.1°C on average). However, in 2010 the water temperature reached 22.6°C, which could have had a lethal impact on some of the weaker juveniles in the river. In that year, the parr density was also estimated to be the lowest in Žeimena recorded so far; only 0.2 ind./100 sqm. The average temperature during July in Neris is 20.9°C. Temperatures above the 'stress level' (>22°C) were seen seven times during a period of 17 years; in 2001, 2002, 2006, 2010, 2012, 2014 and 2018. These results illustrate that the thermal regime is a very important determinant for salmon production in Lithuanian rivers. Other concerns include pollution, and that rivers are of lowland type with scarce parr rearing habitats. Finally, quite high mortality rates are expected due to predation; densities of several predators are significantly higher than in more northern Baltic salmon rivers.

3.1.6 Rivers in assessment unit 6 (Gulf of Finland, SD 32)

All three wild salmon populations in the Gulf of Finland area are located in Estonia: **Kunda**, **Keila** and **Vasalemma**. These rivers are small and their potential production is small. In addition, there is natural reproduction supported with regular releases in ten other rivers: **Kymijoki**, **Gladyshevka**, **Luga**, **Purtse**, **Selja**, **Loobu**, **Valgejõgi**, **Jägala**, **Pirita** and **Vääna**. In these mixed rivers, natural reproduction is variable, and enhancement releases have been carried out since year 2000. The salmon in rivers **Narva, Neva** and **Vantaanjoki** are of reared origin.

Status of wild and mixed AU 6 populations

Parr density in the wild river **Keila** started to increase significantly in 2005 and has increased furthermore since 2013. The parr density has remained on a high level in recent years. Therefore, it can be stated that the river Keila population is in a good and seemingly stable state (Figure 3.1.6.1). The parr densities in river **Kunda** have been varying and a positive trend is only evident in the past six years (Table 3.1.6.2). In comparison, the river **Vasalemma** is in a more precarious state, although some stronger year classes have occurred. The average 0+ density in 2017 increased to 52 ind./100 sqm but again decreased to 17 ind./100 sqm in 2019 and increased slightly in 2020. In 2018, the Vanaveski dam in river Vasalemma was opened, and salmon gained access to all spawning and rearing areas. Previously only 2.4 ha of spawning areas below the dam were accessible, but now the total spawning area is at least 5 ha (the exact size of the added habitat area needs to be investigated). Despite free access no salmon parr was found upstream of the Vanaveski dam in 2019.

The most important change in the 1990s was the occurrence of salmon spawning in the Estonian mixed rivers **Selja**, **Valgejõgi** and **Jägala**, after many years without natural reproduction. In 2006, wild salmon parr were also found in rivers **Purtse** and **Vääna**. Since then, a low and varying wild reproduction has occurred in all these mixed rivers (Table 3.1.6.3). In the period 2012–2015, parr densities increased to relatively high levels in these rivers. However, in 2016 parr densities were very low. In 2016, the Kotka dam in river **Valgejõgi** broke, and has not been rebuilt. Thus, in autumn of 2016, salmon were able to ascend to potential spawning areas that before were not accessible, and a considerable increase in salmon abundance may be expected but so far parr densities in upstream areas has remained very low.

Salmon releases are carried out annually in **Valgejõgi** (since 1996), in **Selja** (since 1997), in **Jägala** and **Pirita** (since 1998), in **Loobu** (since 2002) and in **Purtse** (since 2005). According to the rearing programme by Estonian Ministry of Environment (for the period 2011–2020) releases will be continued in these rivers. Salmon used for stocking in late 1990s originated from spawners caught in the rivers Narva and Selja broodstock fisheries. In addition, salmon from the Neva strain were imported as eyed eggs from a Finnish hatchery in 1995–1999. In 2003–2009, brood fish were again caught from river Narva. A captive broodstock based on salmon from wild river **Kunda** was established in 2007 at Polula Fish Rearing Centre, and all current salmon releases in Estonia (SD 32) are based on that stock. In river **Vääna**, releases were carried out from 1999 to 2005. The stocking was stopped due to the high risk of returning reared adults to stray into neighbouring river **Keila**, which is considered as a wild salmon river.

On the north side of AU 6, all wild salmon populations in Finland were lost in the 1950s due to gradual establishment of a paper mill industry and construction of hydroelectric dams. The geographically nearest available strain, Neva salmon, was imported from Russia in the late 1970s, and releases into rivers Kymijoki and Vantaanjoki started in 1980. The water quality in the mixed river **Kymijoki** has improved significantly since the early 1980s. Reproduction areas exist on the lowest 40 kilometres of the river. Water conditions in winter influence the hatching success in productions areas below the lowest dams. In general, parr densities have been on a moderate level, but some improvement has occurred over time (Table 3.1.6.3). In 2011 and 2012, parr densities were low because of exceptional flow conditions, whereas higher water levels in mild and rainy winters were followed by high parr densities. The annual average densities of wild salmon parr in the lower reaches of the Kymijoki (Subdivision 32) have in 2015–2020 ranged between 11 and 113 parr/100 sq.m, the record high density being observed in 2015. In general, there is an increasing trend in parr densities.

Despite rainy autumns, most of the nursery areas in the lower part of Kymijoki dry out, because of water regulation between the power plants. Good quality habitats are located above the lowest power plants, but currently spawners can only access those areas via two river branches with dams equipped with fishways. The fish ladders in the Langinkoski branch do not function well, and salmon can ascend the dam only in rainy summers when the discharge is high. Because of higher outflow, usually most of the spawning salmon ascend to the Korkeakoski branch, where a fish pass at the hydropower station was finished in 2016. So far, the smolt production areas beyond the dams are only partially utilized. The new fish pass is expected to allow access of a much larger number of spawners to the better spawning and rearing habitats located upstream. If the fish pass will work well, it is anticipated to increase the natural smolt production of the river significantly. However, in autumns 2016–2018 only some tens of adult salmon passed the new fish pass, although a much larger number of spawners were observed below the dam. Korkeakoski fish pass functioned much better in 2019 but in 2020 the numbers of salmon were low again. The overall number of spawners that pass the lower Kymijoki dams in 2016–2020 has been between 300–700. In 2019, more salmon ascended in the ladder than years before (Figure 2.7). The low salmon run in 2020 was as a result flow distribution between river branches and poor fucctionality of fishway in the prevailed water flow conditions. In Langinkoski branch a varying number of salmon has ascended into the fishway (at Koivukoski power plant) depending on the water flow. Kymijoki flows to sea in three branches of which Langinkoski and Korkeakosi have partial migration obstacle and Ahvenkoski is still a total block (since 1930s).

Natural smolt production in Kymijoki has been estimated to vary between 7000 and 78 000 in the last fifteen years. Along with the gradual increase in natural production, smolt releases have been decreased in the last few years. The released number of smolts (on average 81 000 per year, 2014–2017) is, however, still clearly larger than the estimated natural production (on average 38 000 smolts per year, 2015–2020). The broodstock of salmon is held in hatcheries, and it has frequently been partially renewed by ascending spawners.

An inventory of rearing habitats in the river Kymijoki suggests 75 ha of smolt production area in the eastern branches of the river, between the sea and Myllykoski (40 km from the river outlet). Out of this total, about 15 ha of the rapids are situated in the lower reaches with no obstacles for migration, whereas about 60 ha are located beyond dams. Potential smolt production has been assessed based on assumed parr density and smolt age distribution. The annual mean potential was calculated to 1.34 smolts per ha, yielding a total potential of the river of about 100 000 smolts per year. From this potential, annually about 20 000 smolts could be produced in the lower reaches and 80 000 in the upper reaches of the river (Table 4.2.3.3).

In the river **Vantaanjoki**, electrofishing surveys in 2010–2014 have shown only sporadic occurrence of salmon parr at just a few sites.

In Russia, **Luga** and **Gladyshevka** are the only rivers with natural Baltic salmon reproduction. In Luga, the salmon population is supported by large and long-term releases. The released smolts are based on ascending Luga and Narva river spawners, as well as on a broodstock of mixed origin. In the mixed River Luga, a smolt trapping survey has been conducted since 2001. The natural production has been estimated to vary from about 2000 to 8000 smolts per year. In 2019, the estimated smolt number was 8800 which is close to the long-term average. In 2020, the estimated smolt production was 6300. The total potential smolt production of the river has been assessed to be about 100 000–150 000 smolts, and the current wild reproduction is thus very far from its expected maximum level. The main reason for this poor situation in believed to be intensive poaching in the river.

3.2 Potential salmon rivers

3.2.1 General

The definition of a potential salmon river is a river with potential for establishment of natural reproduction of salmon (ICES, 2000). For most potential rivers there exists documentation of historical salmon occurrence. The current status of restoration programmes in Baltic Sea potential salmon rivers is presented in Table 3.2.1.1. Releases of salmon fry, parr and smolt have resulted in natural reproduction in some rivers (see Table 3.2.2.1). Reproduction and occurrence of wild salmon parr has, in some potential rivers, occurred for at least one salmon generation. However, before any of these rivers may be transferred to the wild salmon river category, the Working Group needs more information on river-specific stock status and rearing practices. Such evaluations were made in 2013 and 2014, when the formerly potential salmon rivers Kågeälven and Testeboån in Sweden were assessed as wild, as they had fulfilled the criteria for wild salmon rivers.

3.2.2 Potential rivers by country

Finland

Eight potential salmon rivers are listed in Table 3.2.1.1. Out of these three rivers **Kuivajoki**, **Kiiminkijoki** and **Pyhäjoki** were selected to be included in the Finnish Salmon Action Plan (SAP) programme. These SAP rivers are all located in AU 1 (Subdivision 31). Densities of wild salmon parr in electrofishing surveys in the SAP rivers are presented in Table 3.2.2.1.

Hatchery reared parr and smolts have been stocked annually in the rivers since the 1990s. Due to poor success of stock rebuilding to date, especially in the Pyhäjoki and Kuivajoki, the monitoring activities and stocking volumes have been decreased. Current activities include regular salmon releases only in Kiiminkijoki. In 2020, 27 000 smolts and 5000 one-year old parr of the river Iijoki origin were stocked in the Kiiminkijoki.

Electrofishing is currently conducted in **Kiiminkijoki**, when water level allows. In 1999–2020, the average densities of wild 0+ (one-summer old) parr have ranged between 0.7–8.2 ind./100 sqm (Table 3.2.2.1). There was no electrofishing in 2015–2017 due to high summer water levels in the river. In 2018, average 0+ parr density was low but in 2019 close to the long-term average observed in this river. In 2018–2020, the older parr originating from natural reproduction could be identified because of the finclipping of the stocked parr. The densities of these wild parr were 3.8, 0.7 and 1.5 ind./100 sqm in 2018, 2019 and 2020, respectively.

In rivers **Kuivajoki** and **Pyhäjoki**, the observed densities in 1999–2007 ranged from 0–3.2 and 0–1.9 parr/100 m^2, respectively. The poor success of stock rebuilding is probably due to a combination of fishing pressure, insufficient quality of water and physical habitat in rivers and their temporally low flow, which together keep the lifetime survival and reproductive success of salmon low.

Small-scale natural reproduction has also been observed in rivers Merikarvianjoki and Harjunpäänjoki (tributary of Kokemäenjoki at the Bothnian Sea, Subdivision 30) and in the rivers Kiskonjoki (Subdivision 29), Vantaanjoki, Urpalanjoki, Rakkolanjoki and Soskuanjoki at the Gulf of Finland (Subdivision 32).

Lately, plans have emerged for building up fish ladders and rebuilding migratory fish stocks in the large, former Finnish salmon rivers. Projects are underway to study the preconditions for these activities in the rivers Kemijoki, Iijoki, Oulujoki and Kymijoki. Observed densities of the 0+ parr in River Kymijoki in 1991–2020 ranged from 2,3-113. During recent years, the trend has been increasing. For instance, salmon have been caught from the mouths of Iijoki and Kemijoki and they have been tagged with radio transmitters, transported and released to the upstream reproduction areas. In the River Oulujoki, a catching cage for spawners has been constructed in 2017 at the Montta hydro-power station. From the cage spawners are transported by a truck into two upstream tributaries. The in-river behaviour of these salmon was monitored until the spawning time. Also, downstream migration and survival of smolts through dams have been studied in these rivers.

Sweden

Three potential Swedish salmon rivers are listed in Table 3.2.1.1: **Moälven**, **Alsterån** and **Helgeån**. Densities of wild salmon parr in electrofishing surveys in Alsterån are presented in Table 3.2.2.1.

Restoration efforts are ongoing at the regional–local level in several of the remaining potential Swedish salmon rivers. However, so far recent stocking activities and/or too low natural production have prevented them from having their status upgraded. Until next year (2022), the intention is to review and potentially update the list of Swedish potential salmon rivers.

Lithuania

Two potential Lithuanian salmon rivers, **Sventoji** and **Minija/Veivirzas**, are listed in Table 3.2.1.1.

In May 2020, 73 000 salmon smolts were released into five rivers: Neris, Šventoji (Neris basin), Dubysa, Minija, and Jūra. A total of 133 000 salmon fry were released divided as follows: 38 000 into Neris basin (Neris, Muse, Vokė, Dūkšta, Kena Nemenčia); Šventoji basin - 42 000 into (Šventoji, Širvinta, Siesartis, Virinta, Armona); Dubysa basin - 17 000 to (Kražantė, Luknė); Minija basin - 15 000 ; Jūra basin - 13 000 into (Jūra, Ančia, Akmena). The survey indicates that in larger rivers mortality of juveniles is greater, although the estimation error is also expected to be higher.

Electrofishing densities of wild salmon parr in potential (mixed) Lithuanian rivers are presented in Table 3.2.2.1. In some larger tributaries of Neris and Šventoji, salmon densities in 2020 were higher relatively to the long-term average. Parr densities in Šventoji basin increased compared to in the previous year to the highest observed so far. In the Siesartis tributary, the average density of salmon juveniles has increased and in 2019, the densities was the highest observed so far.. In Virinta the density in 2020 of 0+ stayed at same level as in 2019 (2.2 ind./100 sqm) also the older parr increased (2.3 ind./100 sqm).

In Vilnia and Vokė, the density of 0+ salmon decreased compared to the previous year and was (16 ind. /100 sqm in Vilnia and 10 ind. /100 sqm in Vokė). In western Lithuania, the potential salmon river B. Šventoji showed same low 0+ parr density compared to in the previous year (2 ind./100 sqm.). In Dubysa the densities decreased to the highest observed (4.3 ind./100 sqm) and Minija the densities of 0+ parr increased to (4.5 ind./100 sqm).

Poland

Restoration programmes for salmon in seven potential Polish rivers (Table 3.2.1.1) were started in 1994, based on releases of hatchery reared Daugava salmon. To date, however, there is no good evidence of a successful re-establishment of any self-sustaining salmon population.

In 2020, Polish hatcheries almost exclusively based on eggs obtained from reared broodstock of River Daugava origin, except salmon released to Parsęta River where stocking based on fish collected in this river. Total number of released hatchery reared alevins was 29 000, fry - 642 000 and one-year smolts - 360 000. 52% of smolts and 45% of younger fish were released to Pomeranian rivers (SD 25). The total number of released fish was higher than in 2019. Since at least 2011, salmon spawners have been observed in the **Vistula** river system, but there are still no data on wild progeny.

In almost all Pomeranian rivers, ascending and spent adult salmon have been observed and caught by anglers, but so far wild parr has only been found in the **Slupia River** (but no electrofishing there in 2019) and for the first time in lower Łupawa River (SD 25).

Salmon spawning has been observed in the **Drawa River** (Odra R. system) for some years, but the number of redds has stayed on a low level (not higher than ten per year). Until present, there is only one piece of evidence of a few wild salmon progeny born in the river (result from spawning in 2013). In 2020, nine salmon were recorded by a fish counter in a new fishpass on Drawa River and four salmon redds were found below the dam. Only one fish was recorded in a fishpass on Parseta River, one in Slupia River and no one in Vistula in Wloclawek.

Russia

The **Gladyshevka** River was selected as a potential river for the Russian Salmon Action Plan and is listed in Table 3.2.1.1. Stocking of salmon with hatchery-reared (Neva origin) young salmon is ongoing in this river. Since 2001, a total of nearly 190 000 salmon parr and smolts has been released in the river. About 15 000 of one-year old salmon were released in 2020.

Densities of wild salmon parr from electrofishing surveys in **Gladyshevka** are presented in Table 3.2.2.1. Since 2004, wild salmon parr have occurred in the river. In 2015, the average density increased to the highest observed so far: 24 parr/100 m^2. No electrofishing surveys were carried out in 2016 due to high water level. In 2017, the densities stayed at almost the same level as previous year 18.4 parr/100 m^2. No electrofishing surveys were carried out in 2018. In 2019, the densites of 0+ parr increased to the highest observed so far (51 ind./100 sqm) and in 2020, the densities of 0+ decreased to 4.8 ind./100 sqm. Older parr stayed at same level as in previous year (4.5 ind./100 sqm).

Estonia

No potential salmon rivers have been listed in Estonia.

Latvia

No potential salmon rivers have so far been listed in Latvia. However, rivers **Lielā Jugla** and **Mazā Jugla** in the lower part of the river Daugava system are regularly stocked by one summer salmon and sea trout parr. Electrofishing and habitat mapping are carried out, and the mapped potential reproduction areas in these rivers are 41 ha and 38 ha respectively.

Germany

No potential Baltic salmon rivers have been listed in Germany. So far, no rivers with outlet into the Baltic Sea exist with a known (former) wild salmon population. However, in recent years very few salmon were caught during upriver spawning migration in the river Warnow (W. Loch, pers. comm.). Nevertheless, those fish are most likely strayers and there is potentially no significant natural salmon smolt production in the German Baltic catchment area.

Denmark

No potential Baltic salmon rivers have been listed in Denmark.

3.3 Reared salmon populations

3.3.1 Releases

The total number of salmon smolts released in reared rivers around the Baltic Sea in 2020 is presented in Table 3.3.1.1 In AU 1–5 (subdivisions 22–31), about 3.7 million smolt were released, with an additional 0.9 million in AU 6 (Subdivision 32), making a grand total of 4.6 million smolts released in 2019.

Releases of younger life stages (eggs, alevins, fry, parr) are presented in Table 3.3.1.2. These releases have in many cases consisted of hatchery surplus, often carried out at areas with poor rearing habitats. In such cases, mortality among parr is high and releases correspond only to small amounts of smolts. On the other hand, when releases have taken place in potential, mixed or wild salmon rivers with good rearing habitats, they have had a true contribution to the smolt production. When comparing the total annual number of releases (of younger life stages) in the last two years, the number has stayed at the same level AU 1–3, whereas in AU 5–6, the releases has increases. In AU 4, there have been no releases since in 2012.

Seen from a longer perspective, releases of younger life stages have decreased in the majority of the assessment units, with exception of AU 5 where the observed trend is not as evident. Roughly, these releases are expected to produce less than 100 000 smolts in the next few years. However, the stocking statistics available to the working group do not allow distinction between single rivers and release categories (age stages), and therefore the corresponding number of smolts expected from releases of younger life stages has not been possible to estimate properly.

The yield from salmon smolt releases has decreased in the Baltic Sea during the last 10–15 years, according to results from ongoing national tagging studies (Figures 3.3.3.1–3.3.3.3). Possible explanations for lower catches include decreased offshore fishing and strong regulations in the coastal fishery. Initially, no substantial surplus of fish was observed in the rivers where compensatory releases were carried out, which most likely was due to decreased post-smolt survival. In recent years (2010–2019), however, the amount of salmon returning to reared rivers has increased, in some cases even considerably. In 2020, however, there was a decline in the amount of returning salmon to some Swedish rivers with compensatory releases that may partly be connected to the health issues described in Section 3.4.4.

In line with an increased wild smolt production since the mid-1990s, catch samples from the years 2000–2020 indicate that the proportion of reared salmon has decreased over time; currently reared salmon represents well below 50 percent of adults caught in most Baltic Sea fisheries (see Figure 4.2.3.9).

Releases country by country

Most releases in **Sweden** are regulated through water-court decisions. Since the reared (and wild) stocks were severely affected by the M74-syndrome in the early 1990s, the number of Swedish compensatory released salmon smolts in 1995 were only 60–70 percent of the intended amount. However, already in 1996, the releases increased to the levels set in the water-court decisions. From that year and onwards, the releases have been kept close to the intended level each year.

In 2020, a total of 1.67 million salmon smolts were released in Swedish AU 2, AU 3 and AU 4 rivers. The releases in AU 4 are minor and amounts to less than one percent of the total Swedish releases (Table 3.3.1.1). The number of one-year-old salmon smolts released in Sweden has increased over time, especially in the most southern rivers; in the period 2007–2020 the share of one-year old smolts has increased from 23% to 60% of the total releases. This development reflects a combination of high-energy feed (faster growth) and longer growth seasons due to early springs and warm and long autumns.

Many broodstock traps in Swedish reared rivers were previously operated with equal intensity throughout the fishing season. The catch could therefore be considered as a relative index of escapement. A reduced fishing intensity in most rivers with smolt releases reflects the increasing abundance of returning adults during the last ten years. Broodstock fishing at low intensity during the migrating season is nowadays sufficient to get the amount of spawners (eggs) needed to fulfil terms in court decisions, but the broodstock catches cannot be used as indices of spawning run strengths.

In **Finland**, the production of smolts is based on broodstocks reared from eggs and kept in hatcheries. The number of captive spawners is high enough to secure the whole smolt production. A partial renewal of the broodstocks has been regarded necessary in order to avoid inbreeding, and is consequently enforced occasionally by broodstock fishing in the specific river. In 2020, the total Finnish releases in AU 1 and AU 3 were 1.2 million smolts and in AU 6 it was 134 000 smolts (Table 3.3.1.1). When the Finnish compensatory release programmes were enforced in the early 1980s, the total annual salmon smolt releases were about 2 million in total, whereof 1.5 million released in AU 1 and AU 3, and 0.5 million in AU 6. In recent years, the releases have gradually been reduced. As in Sweden, the reared stocks in Finland have been affected by M74 over the years.

In **Russia** there are annual releases in AU 6; in 2020 a total of 519 000 reared smolts were stocked.

In **Estonia** a rearing programme using the Neva salmon stock was started in 1994. Eggs were collected from the reared Narva stock and the mixed Selja stock. In the late 1990s, eggs were also imported from Finland. A captive stock based on spawners from river Kunda was established in 2007. One hatchery is at present engaged in salmon rearing. In 2020, the total annual smolt production was 19 000 smolts released in AU 6 (Table 3.3.1.1).

In **Latvia,** the artificial reproduction is based on sea-run wild- and hatchery-origin salmon broodstock. The broodstock fishery is carried out in the coastal waters of the Gulf of Riga in October–November, as well as in the rivers Daugava and Venta. The mortality of yolk-sac fry has been low, indicating that M74 might be absent in this region. In 2018, the annual smolt production in Latvian hatcheries was 787 000 (Table 3.3.1.1). It is 200 thousand more than in 2018, but still below the average number of releases during the last decade. Earlier, from 1987 and onwards, the annual Latvian releases ranged up to 1.1 million smolts in several years. In 2020, the releases were 730 000 smolts. Occasionally, also **Lithuania** makes annual releases of a smaller number of smolts in AU 5; in 2020 a total of 73 000 smolts were released (Table 3.3.1.1).

In **Poland**, the last wild salmon population became extinct in the mid-1980s. A restoration programme was started in 1984, when eyed eggs of Daugava salmon were imported from Latvia. Import of eggs continued until 1990. In 1988–1995, eggs for rearing purposes were collected from a salmon broodstock kept in sea cages located in the Bay of Puck. In subsequent years, eggs have been collected from returning spawners caught in Polish rivers, besides from spawners reared in the Miastko hatchery. Spawners are caught mainly in the Wieprza River and in the mouth of Wisla River, but also from rivers Drweca, Parseta, Rega and Slupia. The yearly production amounts to 2.5–3.0 million eggs. Stocking material (smolts, one-year old parr and one summer old parr) are reared in five hatcheries. In 2020, the total smolt production was 360 000 released in AU 5 (Table 3.3.1.1). Starting from 1994, the annual releases have fluctuated between 24 000 and 0.5 million smolts.

In **Germany**, no regular release programme for salmon exists in the Baltic region, as there are no known natural populations. Consequently, there were no official releases of salmon in rivers with outlet into the Baltic Sea in 2019. However, a few irregular releases have been reported recently and in the past (e.g. in rivers Trave and Warnow). There is a controversy regarding the potential historic existence of wild Baltic salmon populations in some German rivers.

Until 2005, a rearing programme was run in **Denmark** in a hatchery on the Island of Bornholm using the river Mörrumsån stock (AU 4). The last year releases occurred was 2005. No new releases have been planned.

3.3.2 Straying

Observations on straying rates of released salmon vary between areas. The level of straying is evidently dependent on several factors. For example, in Finland rearing of smolts is based on broodstock kept in hatcheries, whereas in Sweden it is based on annual broodstock fishing (‘sea ranching’). These differences in rearing practices may also influence straying rates. Strayers are often observed in the lower stretches of the rivers into which they have strayed. This may indicate that not all strayers necessarily enter the spawning grounds and contribute to spawning, but instead that a proportion of them may only temporally visit the ‘wrong’ river. This also implies that the place and time of collecting observations about straying is expected to influence obtained estimates of straying rate. More information is needed to study these aspects of straying.

According to scale analysis of catch samples collected from the Tornionjoki river fishery in 2000–2011, only eight salmon out of a total of 4364 analysed were identified as potential strayers from releases in other Baltic rivers. This indicates that about 0.2% of the salmon run into Tornionjoki were from other (reared) rivers, which corresponds to about 100 strayers per year, if one assumes an average spawning run into Tornionjoki of about 50 000 salmon. Tag–recapture data of compensatory releases in the Finnish Bothnian Bay indicate that the straying rate of these reared fish to other rivers is 3–4%. From all these releases, however, strayers were found only among the Tornionjoki hatchery strain stocked into the mouth of Kemijoki, and all these strayers were observed in the Tornionjoki. Using these tag recaptures to calculate the amount of strayers in the Tornionjoki, assuming no strayers from the Swedish releases, there would be annually about 200 strayers in the Tornionjoki spawning run (corresponding to 0.4% straying into the river, again assuming a spawning run of about 50 000 salmon).

In Sweden, tag recoveries indicate that the average straying rate of reared salmon into other rivers has been 3.5–4.0% on average, but for some releases, the straying rate has been as high as 10–30%. Highest straying rate of tagged salmon is often observed in reared rivers with annual releases, due to a high total exploitation rate from the commercial, recreational and broodstock collection, and probably also because broodstock fisheries are carried out close to river mouths.

3.3.3 Tagging data

Tagging data, mainly from external Carlin tags, have been used historically within the Baltic salmon assessment, to estimate population parameters as well as exploitation rates by different fisheries (see Annex 2 for further details). Both wild and reared salmon of different ages may be tagged, but a majority of the fish tagged over the years represent hatchery-reared smolts. For various reasons, the number of tag returns has become very sparse after 2009, and therefore, in later years, tag return data have not been used in the assessment. As the tagging used are from external tags, it is vital that fishermen find and report tags. However, earlier reports (summarised in e.g. ICES, 2014) indicate an obvious unreporting of tags.

As the tag return data influence e.g. the annual post-smolt survival estimates, which is a key parameter in the Baltic salmon assessment, there is a need to supplement or replace the sparse tagging data in the near future. The WGBAST 2010 (ICES, 2010) dealt with potential measures to improve and supplement the tagging data, including alternative tagging methods and supplementary catch sample data. In 2010, the WG also noted need for a comprehensive study to explore potential tagging systems, before a change to a new system in the Baltic Sea may be considered.

Since smolt abundance is included as a parameter in the EU-MAP, tagging has to be carried out as part of the data collection (for mark–recapture experiments) (Table 3.3.3.1). Furthermore, salmon smolts are tagged for other monitoring purposes. In 2020, the total number of Carlin tagged reared salmon released in the Baltic Sea was 6998 (Table 3.3.3.2), which was similar to 2018 and 2019. Number of Carlin tagged salmon smolts was 22% less than in 2017.Carlin tagged salmon smolts were only released only by Finland and Sweden. As alternative methods, T-bar anchor tags are also used for tagging of smolts in Estonia. Furthermore, in Sweden internal PIT-tags have also been used in several wild (index) rivers and also in reared rivers (Table 3.3.4.2) and for tagging adult fish e.g. in Poland in the previous years. In addition, a batch marking method with alizarin red S dye was used in Finland in 2020 for experimental marking of stocked fish in the early development stages of salmon embryos and alevins (Table 3.3.4.2). Part of fin-clipped parr was additionally tagged with acoustic tags and released into Dalälven (Sweden).

As mentioned above, tag return rates show decreasing trends, as illustrated in Figures 3.3.3.1 and 3.3.3.2 for salmon tagged and released in the Gulf of Bothnia and Gulf of Finland, respectively. Since 2015, the return rate of Finnish Carlin tagged reared salmon smolts released in the Gulf of Bothnia and Gulf of Finland varied between 0.04–0.43% and 0.03–1.55% for 1-year and 2-year old smolts, respectively (Figure 3.3.3.1). The return rate of 1-year old Carlin tagged salmon smolts in the Gulf of Finland in Estonian experiments varied around 0.2% in years 2000–2004. There were no returns of tags in 2006, but in the following year, the recapture rate exceeded 0.8%. Because of the low recapture rate and changes in stocking practices, no 1-year-old salmon smolts have been Carlin tagged in Estonia since 2012. The mean recapture rate of 2-year-olds in Estonian experiments for years 2001–2008 was 0.7% and varied between 0.03–0.1% in years 2009–2014 (Figure 3.3.3.2). Since 2015, only T-bar anchor tags are used in Estonian experiments for tagging of salmon smolts. The recapture rate for fish from the 2015 cohort was around 0.39%. For fish from the 2016 cohort, the tag–recapture rate increased significantly compared to in the last years and was around 0.68%. But for fish from the cohort 2017, 2018 and 2019 it again decreased to 0.3%, 0.35 and 0.15% respectively. A similarly low recapture rate has been seen for Polish Carlin tags, where the reporting rate was around 1.5–2.0% in 2000–2008, whereas it decreased below 0.5% since 2009 (Figure 3.3.3.3). No salmon mass tagging with Carlin tags or other tagging methods was conducted in Poland in 2019, because of low recapture rates in previous years.

3.3.4 Finclipping

Finclipping makes it possible to distinguish between reared and wild salmon in catches. Such information has been used, e.g. to estimate proportion of wild and reared salmon in different mixed-stock fisheries. However, since not all Baltic salmon smolts released are finclipped, this type of information is not directly utilised in the WGBAST assessment model.

Since 2005, it has been mandatory in Sweden to finclip all released salmon (and sea trout). All reared Estonian and Latvian salmon smolts released in 2020 were also finclipped. A part of 1000 salmon smolts were finclipped and released in Lithuania for experimental purposes. In Poland, all types of tagging were stopped in 2013 and 2014, because of national veterinarian's objections. In 2015, tagging was again permitted in Poland; however, since 2016 finclipping of smolts has not continued. From 2017 and onwards, all salmon released in Finland are finclipped (except releases for enhancement purposes, mostly parr). Salmon smolts released 2020 in Russia, Lithuania (most part), Poland, Germany and Denmark were not finclipped.

In Table 3.3.4.1 information on the total number of released adipose finclipped young salmon in years 1987–2020 is presented together with data on the proportion of adipose finclipped adult salmon in Latvian offshore catches in the period 1984–2007. In 2020, the total number of finclipped young salmon released was 3 849 160, and it was 5% smaller compared with 2019. Out of this, 26 700 were parr and 3 822 460 smolts (Tables 3.3.4.1 and 3.3.4.2). The numer of finclipped smolts increase of 2% compared to 2019. At the same time, the numer of finclipped and released salmon parr decreased of 30% compared to 2019. Most finclipping (in numbers) were carried out in SD 30–32, but part of the finclipped fish were also released in SD 267–29 (Table 3.3.4.2).

3.4 M74, dioxin and disease outbreaks

In this section updated information is provided on monitoring of M74, dioxin and disease outbreaks. See Stock Annex (Annex 2) for further background information.

3.4.1 M74 in Gulf of Bothnia and Bothnian Sea

The reproductive disorder "M74" causes mortality among yolk-sac fry of Baltic salmon. The development of M74 is linked with a deficiency in the salmon eggs of antioxidants, such as thiamine (vitamin B1), together with signs of oxidative stress and an unbalance in fatty acids of the parental fish. The ultimate cause of M74 is unclear, but seems to be coupled to the species composition and flow of thiamine in the Baltic Sea food web (Keinänen *et al.*, 2012; Ejsmond *et al.*, 2019; Majaneva *et al.*, 2020). More background information about the M74 syndrome can be found in the Stock Annex (Annex 3).

When calculated from Swedish and Finnish data combined, the proportion of salmon females whose offspring hatched in 2020 displayed increased mortality was on average 1%, compared to 6% in the preceding year (Table 3.4.1.1). The M74 incidences presented in Table 3.4.1.1 predominantly represent the percentage of females in a hatchery with a recorded increase in offspring mortality. In the rivers Simojoki, Tornionjoki, Kemijoki and Iijoki, however, mortalities are reported for the proportion of females affected by M74 and the mean percentage yolk-sac fry mortality (Table 3.4.1.2). In Swedish hatcheries, where only the proportion of females affected is registered (and not the mean percentage yolk-sac fry mortality), the average proportion of offspring groups with increased M74-like mortality in 2020 across hatcheries was 1% (range 0–4%), compared to 7% (0–24%) in 2019 and 18% (11–22%) in 2018 (Table 3.2.1.1). Thus, the incidence of the M74 syndrome has decreased to the same low level as in the reproductive periods 2011/2012–2013/2014, when no M74-related mortality was reported in the Finnish M74 monitoring data (Table 3.4.1.2) and historically low proportions of affected females were reported from Swedish hatcheries (Table 3.4.1.3).

In Finnish data, annual M74 estimates are based on female-specific experimental incubations in which M74 symptom-related mortality has been ascertained by observations of yolk-sac fry (until the reproductive period 2009/2010) and/or comparing mortalities with the thiamine concentration of eggs (from 1994/1995 and onwards) (Figure 3.4.1.1). From 2011/2012 to 2017/2018, Finnish data of the incidence of M74 are principally based on the free thiamine concentration of unfertilized eggs, which has a strong correlation with M74-related mortality of yolk-sac fry (Vuorinen and Keinänen, 1999; Keinänen *et al*., 2014; 2018). However, control female-specific incubations have been run at a hatchery (Vuorinen *et al*., 2014). Two type of results are presented: (1) the average yolk-sac fry mortality, and (2) the proportion of females with offspring affected by M74, (Keinänen *et al*., 2000; 2008; 2014; 2018; Vuorinen *et al*., 2014).

In line with the recent decrease in M74, the thiamine concentration in unfertilized eggs in autumn 2020 (reproductive period 2020/2021), computed as a mean for females from Finnish Bothnian Bay rivers, continued to increase compared to the preceding year (Figure 3.4.1.1); the concentration was of the approximately magnitude as in the reproductive periods 2011/2012–2013/2014, when no M74-related mortality was reported in the Finnish M74 monitoring data (Table 3.4.1.2). A yearly prognosis for the incidence of M74 in offspring groups (females) is carried out based on the concentration of free thiamine in eggs vs. yolk-sac fry mortality (%) relating to thiamine deficiency in female-specific laboratory incubations (in Finnish M74 monitoring data from the reproduction period 1995/1996–2009/2010, n = 1009). The limit values of free thiamine used in prognosis are: for 100% mortality ≤0.2 nmol/g, for occurrence of M74 mortality ≤0.5 nmol/g, but excluding possible late M74 (M74?) ≤1.0 nmol/g. The prognosis for the proportions of M74 mortality among offspring groups hatching in spring 2021 was 0% (Table 3.4.1.1).

Mean annual yolk-sac fry mortalities and proportions of M74 females correlate significantly, but the M74 frequency has usually been somewhat higher than the offspring M74 mortality, especially in years when many offspring groups with mild M74 occur, i.e. when only a proportion of yolk-sac fry die. In years when the M74 syndrome is moderate in most offspring groups, the difference between the proportion of M74 females and mean yolk-sac fry mortality can exceed 20 percentage units (Keinänen *et al*., 2008). Currently (from 2019/2020 and onwards) the incidence of M74 in Finnish M74-monitoring is exclusively determined from the concentrations of free thiamine in unfertilized eggs. Proportions of M74 females and offspring mortalities are derived from the model by relating the free thiamine concentrations with yolk-sac fry mortalities from laboratory incubations in the spawning years 1994–2009 from the Finnish M74 monitoring data. As mentioned above, in contrast to in Finland, Swedish data across the time-series are based only on the proportion of females whose offspring display increased mortality regardless of the proportion dying (Table 3.4.1.3).

In the hatching years 1992–1996, the M74 syndrome resulted in a high mortality of salmon yolk-sac fry with an M74 frequency (i.e. the proportion of the females whose offspring were affected) over 50% in most Swedish and Finnish rivers (Table 3.4.1.1). Since then the incidence of M74 has on average decreased. However, it has varied greatly even between successive years with elevated mortalities in some years (e.g. 1999, 2002, and 2006–2007) compared to others with low or non-existent mortalities (e.g. 1998, 2003–2005 and 2011–2015). In the reproductive period 2011/2012, the incidence of M74 could be considered as non-existent for the first time since the large outbreak in the 1990s. However, M74 returned in the reproductive period 2015/2016.

In years with a high M74 incidence, there has been a tendency that estimates of M74 mortality have been higher in Finland than in Sweden, but this difference seems to have disappeared in the years when the mortality has been low (Figure 3.4.1.2). The difference may be due to the fact that, in Finland all females caught for M74 monitoring have been included, whereas in Sweden females that have displayed uncoordinated swimming (wigglers) have been excluded from incubation.

Wiggling females are known to inevitably produce offspring that all die from M74. The proportion of wiggling females was high in the early and mid-1990s (Fiskhälsan, 2007). Trends and annual fluctuations in average proportions of M74-affected females have been very similar in Swedish and Finnish rivers (Figure 3.4.1.2). However, in some years M74 has been insignificant or absent in the Finnish M74 monitoring, whereas rather high M74 frequencies have been reported from some Swedish rivers. It seems that those Swedish results may rather result from technical failures or too high or variable water temperatures, as reported by Börjeson (2013).

In the ongoing Finnish M74 monitoring the estimated mortality and proportions of females affected have been ascertained by measuring the thiamine concentration of eggs (Figure 3.4.1.1). Between 2015/2016 and 2018/2019, corresponding information was also obtained from two Swedish hatcheries (ICES, 2020a). In the Finnish M74 data, the annual M74 incidence among the monitored Bothnian Bay rivers has been very similar. Therefore, it is relevant to express the proportion of M74 females and annual M74 mortality as an average of all individual monitored salmon females (and respective offspring groups) that ascended those rivers (Keinänen *et al*., 2014). However, there may be some differences between salmon populations from rivers in the Bothnian Bay and in the Bothnian Sea, if migration routes and feeding grounds during the whole feeding migration differ, as reported by Jacobson *et al*. (2020). This could also explain different mortalities, reported during the early 1990s (Table 3.4.1.1), among offspring of salmon from the River Mörrum in AU 4, from where smolts descend directly into the Baltic Proper.

As described above, the incidence of M74 decreased and was virtually non-existent in 2012–2015. However, the thiamine concentrations in unfertilized eggs of salmon ascended the rivers of the Gulf of Bothnia decreased in autumn 2015, and were even lower in salmon ascended in autumn 2016. Thus, after several favourable years, M74 again impaired salmon yolk-sac fry survival in 2016–2018. As detailed in the Stock Annex (Annex 3), the level of M74 in salmon shows a positive correlation to the abundance of important prey species in the Baltic, especially young sprat. The return of M74 in 2016–2018 thus has been suggested to be the consequence of an exceptionally strong year class of sprat hatched in 2014 (ICES, 2017b). Young sprat were exceptionally numerous in the northern areas of the Baltic Proper and Gulf of Finland. Moreover, the year class of herring (*Clupea harengus*) in 2014 was strong, e.g. in the Bothnian Sea (Raitaniemi, 2018).

In unfertilized eggs of salmon having ascended the Lithuanian River Neris in autumn 2017, the free thiamine concentrations were considerably higher compared to salmon of the Gulf of Bothnian rivers, and the incidence of M74 in hatching years 2018–2020 was very low or almost insignificant (albeit based on a small number of sampled fish). Apparently, those salmon have been feeding in the southern Baltic Proper, where the presence of cod, contrary to the northern Baltic Sea, has reduced sprat from its exceptionally high year class 2014 (ICES, 2017b). Thus, young sprat from the year 2014 have been less numerous in the southern Baltic Proper than in the northern areas of the Baltic Sea (Raitaniemi, 2018), and the herring biomass as food for salmon, e.g. in SD 25, has been higher than that of sprat (Jacobson *et al*., 2018).

In the Stock Annex (Annex 3, Section C.1.6), a description is given of a Bayesian hierarchical model applied to the Gulf of Bothnian (GoB) monitoring data (Tables 3.4.1.2 and 3.4.1.3) of M74 occurrence from rivers in Finland and Sweden, to obtain annual estimates of the M74-derived yolk-sac fry mortality. This information is needed to fully assess the effects of M74 on the reproductive success of spawners. Besides annual estimates of M74 mortality in the rivers, where such has been recorded, the model provides annual estimates of the mortality for any GoB river, in which no monitoring has been carried out (Table 4.2.2.2, Figure 4.2.2.2). Most of the wild stocks, including all smaller wild rivers in the GoB, belong to this group. The results demonstrate that in some years, the actual M74 mortality among offspring has been lower than the proportion of M74 females indicated, which apparently is related (see above) to mildness of the syndrome, i.e. to partial mortalities in offspring groups.

3.4.2 M 74 in Gulf of Finland and Gulf of Riga

In the River Kymijoki in AU 6 (Gulf of Finland) the incidence of M74 has in many years been lower than in the northern AU 1 rivers Simojoki and Tornionjoki (Table 3.4.1.1; Keinänen *et al*., 2008; 2014). However, in the reproductive period 1997/1998, for example, when M74 mortalities among salmon yolk-sac fry of the Gulf of Bothnia rivers were temporarily low, the situation was the opposite; evidently this reflected variation in sprat abundance between the main feeding areas, i.e. the Baltic Proper and the Gulf of Finland. The long-term tendency has however, been roughly similar. The River Kymijoki of the Gulf of Finland, with introduced salmon originating from the Neva stock, was included in the Finnish M74 monitoring programme from the year 1995, but no data for the years 2008–2013 and 2015–2019 exist, because of problems in salmon collection for monitoring. Therefore, the latest mortality data from the R. Kymijoki are from spring 2007 (Table 3.4.1.1). However, in autumn 2013 a few Kymijoki salmon females were caught for renewing of the broodstock. Based on relatively high concentrations of free thiamine in unfertilized eggs (mean 3.2 ± 1.1 nmol/g, N = 5) of all five females, M74 mortalities in spring 2014 were unlikely.

In Estonia, M74 has been observed in hatcheries in some years during the period 1997–2006, but the mortality has not exceeded 15%. A small number of spawners is collected for broodstock from river Kunda since 2013, and no fry mortality has been observed. However, in 2016 the eggs from one female (out of four) displayed mortality after hatching. This recent observation indicates that the incidence of M74 may have increased also in the Gulf of Finland, apparently as a consequence of the exceptionally strong 2014 year class of sprat (ICES, 2017b). In autumn 2019, salmon of the River Kymijoki were again caught for renewing of the broodstock. Similarly, to salmon of the River Tornionjoki, the concentrations of free thiamine in eggs of salmon ascending the River Kymijoki were relatively high (mean 3.02 ± 0.31 nmol/g, N = 15). Thus, significant M74 mortalities were not expected in spring 2020 (Table 3.4.1.1).

There is no evidence to suggest that M74 occur in Latvian salmon populations. In the main hatchery Tome, the mortality from hatching until the start of feeding varied in the range of 2–10% in the years 1993–1999. In addition, parr densities in Latvian river Salaca did not decrease during the period in the 1990s when salmon reproduction in the Gulf of Bothnia was negatively influenced by M74 (Table 3.1.5.1). Before ascending the river, salmon from Daugava and Salaca feed in the Gulf of Riga, where the main prey species of salmon was herring during the years 1995–1997 (Karlsson *et al*., 1999; Hansson *et al*., 2001). Although sprat was the dominant prey species in the Baltic Proper during that time period, the salmon diet in the Gulf of Riga did not include sprat. Furthermore, in contrast to salmon feeding in the Baltic Proper or in the Bothnian Sea, the proportion of other prey species, such as sand eel (Ammodytes spp.), perch (*Perca fluviatilis*), smelt (*Osmerus eperlanus*) and cod, was considerable in the Gulf of Riga (Karlsson *et al*., 1999; Hansson *et al*., 2001). Salmon in River Daugava moreover ascended later than salmon in Gulf of Bothnia rivers (Karlsson *et al*., 1999).

3.4.3 Dioxin

In Sweden, the National Food Agency (NFA) is responsible for sampling, analysing and providing dietary recommendations regarding dioxins and other toxic substances in fish. The NFA monitoring of dioxin and dioxin-like PCBs in salmon and sea trout demonstrate a tendency towards lowered concentrations during 2014–2019 (Bergkvist and Aune, 2020). The Swedish control programme is set up in accordance with EU regulation 589/2014. Limits are set out in EU Regulation 1881/2006 with updates in EU Regulation 1259/2011. Sweden has an exception to the limits of dioxin when it comes to salmon and a few other fish species in the Baltic Sea (and in Lakes Vänern and Vättern). In 2018, EFSA (European Food Safety Authority) altered its statement on the risk posed to humans by dioxins and PCBs, something that has yet to be implemented by the Swedish National Food Agency. EFSA is in the process of performing a larger risk-benefit study about fish consumption and exposure to contaminants, which may have effects on guidelines for human consumption. Also, Finland has an exemption to the EC regulation 1259/2011 which allows selling of Baltic salmon and sea trout on the domestic market. No export of wild-caught salmon or sea trout is allowed. According to the Finnish survey for EU reporting (Airaksinen *et al*., 2018) the concentrations of dioxins in salmon decreased approximately with 50% during the 2000s. However, dioxin concentrations in salmon sampled in 2016 still exceeded the maximum allowable value set by the EU (Airaksinen *et al*., 2018).

In Denmark, the following restrictions for marketing of salmon (and sea trout) were enforced from December 5th, 2016: Salmon ≤5.5 kg gutted weight caught in ICES subdivisions 24–26 must be trimmed (deep-skinned) before marketing. In the same SDs, salmon weighing >5.5 kg and <7.9 kg can be marketed, if trimmed and the ventral part of the fish is removed. Each batch of salmon >2.0 kg caught in ICES SD 27–32 must also be analysed for dioxin before marketing. Dioxin concentrations in samples taken in 2006 and 2013 were comparable, while samples from 2011 contained slightly lower concentrations of dioxin.

3.4.4 Disease outbreaks

Since 2014, an increasing number of reports from fishermen and local administrators of dying or dead salmon have come from Swedish and Finnish salmon rivers, spanning from Tornionjoki to Mörrumsån. Health issues for salmon have also been reported from other countries around the Baltic, and to some extent from the Atlantic. There are similarities between these reports, but also differences, and there is a need for further research and evaluations before any overall conclusions for the current health status of Baltic salmon can be drawn. The main type of health problem observed (with an unknown cause) was recently defined as Red Skin Disease (RSD, Weichert *et al*., 2020). RSD is associated with external clinical signs like haemorrhage, erosions and ulcerative/necrotic skin conditions in returning adults, typically followed by secondary fungal infections causing death.

The disease prevalence has varied considerably between both rivers and years. In some rivers, there are so far no reports of elevated levels of elevated salmon death. The poor health of returning adult Baltic salmon continued in 2020, although to a lesser extent. Symptoms resembled those in previous years, again with large variation among rivers (SVA, 2020 in preparation, Baltic Sea Salmon Foundation, 2021). In addition to reports of dead or dying salmon, individuals with deviating behaviour have occasionally been observed (swimming close to river surface, not afraid of boats, etc.). Severe disease outbreaks have so far occurred in Tornionjoki (2014–2015, 2019), Kalixälven (2015), Ume/Vindelälven (2015–2020), Ljungan (2016, 2018) and Mörrumsån (2014–2018). In several cases, the number of dead salmon (and other species) has been considerable, although quantitative estimates of total death rates are missing. However, in Mörrumsån it has been noted that following years with larger disease outbreaks very few overwintered salmon spawners (kelts) seem to have remained according to river catches in the following spring. Results received in 2018 and 2019 within an ongoing radio-tagging study of spawning migrating salmon (and sea trout) further revealed an alarmingly high proportion of salmon caught in the Torneälven/Tornionjoki estuary with "red bellies" or other skin-damages. In both years, a majority of the tagged salmon also left the river after having spent just some weeks in its lowermost part, i.e. long before the spawning period (Huusko *et al.*, 2020).

In Ljungan, very low 0+ salmon densities were observed in 2017–2019, coinciding with recent health problems among adults (especially in 2016 and 2018). A minor increase in parr densities was observed in 2020, but the level is still far below what was observed before the period of health problems.

In Vindelälven, the average 0+ parr density also declined and remained very low in 2016–2019. In 2020, however, the 0+ parr density increased to historically rather high levels. The low salmon production in Vindelälven in 2016–2019 reflects a combination of few ascending MSW spawners, low proportion of female spawners, elevated M74-mortality (Sections 3.1.2 and 3.4) and observed and presumed additional mortality among spawners after having passed the Norrfors fishway (where counting takes place). In 2019 and 2020, the health situation was likely better as higher amounts of ascending MSW salmon (with an increased proportion of females) were observed. The higher parr density in 2020 is a direct consequence of more and healthier MSW spawners in 2019 in combination with low M74 mortality among offspring in 2020. It should be noted that in the past two decades the proportion of females in Ume/Vindelälven has decreased markedly over time; a development not yet seen in Torneälven/Tornionjoki (Figure 3.1.2.3) or in other rivers (with more scattered data) with less pronounced salmon health problems.

The effects of health problems in Ume/Vindelälven in recent years are particularly evident from tagging studies. In studies carried out in 2017 only one out of 400 salmon (0.25%) tagged at the river mouth managed to pass the counter in the Norrfors fishway. Most of these tagged fish stayed further downstream in the river for some time, without managing to migrate further upstream, before finally leaving the river (Kjell Leonardsson, SLU, pers. comm.). In 2018, the proportion of tagged salmon passing the counter was higher (15%), but still low compared to most previous years with tagging experiments. In 2019 and 2020, not a single individual of the tagged salmon passed the fish counter, but the very poor results were not representative for the entire migration season during these two years; all tagged salmon were handled relatively early, when the health situation in Vindelälven was bad (many dead or dying salmon and few females). However, later during the migration season in 2019 and 2020, when the tagging studies had been ended, the situation improved and the number of MSW salmon (including females) passing the fishway increased significantly.

During 2015, 2016, 2018 and 2020 ascending salmon were investigated for health-related symptoms, including RSD, in rivers Mörrumsån, Torne- and Ume/Vindelälven. The work was carried out in collaboration between SVA, Ruokavirasto, Luke, Gothenburg University and SLU (SVA, 2017, 2019, 2020 in prep.). The sampling conducted by SVA is part of a newly initiated Swedish national monitoring program targeting salmon health. There are several potential factors associated with the RSD, and it is not clear what is driving the problem. Thus, so far, the monitoring has been focused on collection of samples for future research. In addition, the value of various methods of data collection without sampling fish materials is evaluated, such as questionnaires to anglers in rivers, information from compensatory hatcheries, camera surveillance (detection of unhealthy fish via fish counters), and inventories at spawning areas. More extensive analyses of collected material, that hopefully will provide more knowledge on the cause of RSD, will be performed during 2021. In 2020, salmon biologists and veterinarians in Finland and Sweden jointly monitored and investigated the health status of Tornionjoki/Torneälven salmon. The work comprised documentation of the external condition of salmon over the migration season, studying the behaviour of radio-tagged salmon, and collecting tissue samples of salmon from different periods of the season followed by laboratory analyses.

So far, there have been no reports of RSD or UDN-like disease problems in Russian or Estonian salmon rivers. Late in 2017, pre-spawning mortality in salmon (and sea trout) was reported for the first time from river Gauja in Latvia. Similar to in Swedish rivers, the fish were described as apathetic; they showed slow response to irritants and were easily caught. There were also multiple observations of skin wounds with fungal infections. Studies on presence of infectious viruses and bacteria on salmon and sea trout, as well as histological examinations, did not reveal the cause of pre-spawning mortality. No new reports on health-related mortality in adult salmonids were received from Latvian anglers in 2018–2020, and no further veterinarian investigations have been conducted. In 2018, elevated mortality among adult salmon (mainly) and sea trout was also reported from tributaries within the Neris catchment (Nemunas river system) in Lithuania. Fish were observed to die from skin infections of fungal and/or bacterial origin, possibly reflecting secondary infections associated with UDN (not confirmed). In some cases, the proportion of affected individuals during and after the spawning period exceeded 90%. In 2019 and 2020, however, only few reports of affected or dead salmonids (no more than five fish per year) have been received from Lithuanian rivers.

Besides national sampling programmes, the ICES Working Group on Pathology and Diseases of Marine Organisms (WGPDMO) has Baltic salmon health issues listed in its ToRs for the period 2019–2021; a synthesis with recommendations related to this ToR is planned for 2021. In addition, with funding from the Nordic Council of Ministers, a research project targeting networking activities and a joint research study on RSD in salmon in relation to pathology, gene expression and means for non-lethal sampling will be conducted during 2021–2023. Participating countries are Sweden, Finland, Norway, Denmark and Iceland.

Potential consequences of health-related problems for the future development of wild salmon stocks, and how such extra mortality may be monitored and handled in stock assessment is briefly discussed in Section 4.7. See Section 5.8 for additional observations on health issues related to sea trout.

3.5 Summary of the information on wild and potential salmon rivers

Wild smolt production in relation to the smolt production capacity is one of the ultimate measures of management success. Among the wild rivers flowing into the Gulf of Bothnia and the Main Basin (assessment units 1–5), smolt abundance is measured directly in the current index rivers **Simojoki** and **Tornionjoki/Torneälven** (AU 1), **Vindelälven** (AU 2), **Testeboån** (AU 3), **Mörrumsån** (AU 4) and in **Salaca** (AU 5). In addition, 1–2 years of smolt counting has also been performed in **Lögdeälven** (AU 2) and **Emån** (AU 4) (Sections 3.1.2–3.1.4) and counting in additional rivers **Råneälven** initiated in 2019 and **Åbyälven** in 2018**.** The river model (Annex 2), which utilises all available juvenile abundance data, is a rigorous tool for formal assessment of current smolt production.

Differences in the status of wild stocks are apparent, not only in terms of the level of smolt production in relation to potential production (Section 4.2), but also in terms of trends for various abundance indices. Differences in trends are clear between regions: most Northern Gulf of

Bothnia (AU 1–3) rivers have shown increases in abundance while many of the Southern Main Basin (AU 4–5) rivers have shown either decreasing or stable abundances, whereas the development in the AU 6 rivers generally falls between these two regions.

Rivers in the Gulf of Bothnia (assessment units 1–3)

The parr production in the hatching years of 1992–1996 was as low as in the 1980s (Tables 3.1.1.4, 3.1.2.1 and 3.1.3.1, and Figures 3.1.1.4, 3.1.1.5, 3.1.2.1, 3.1.2.2 and 3.1.3.1), although the spawning runs were apparently larger (Tables 3.1.1.1, 3.1.1.2, and Figures 3.1.1.2, 3.1.1.3). In those years, the M74 syndrome caused high mortality (Table 3.4.1.1 and Figure 3.4.1.1), which decreased parr production considerably. In the hatching years 1997–1999, parr densities increased to higher levels, about five to ten times higher than in the earlier years. These strong year classes resulted from large spawning runs in 1996–1997 and a simultaneous decrease in the level of M74. The large parr year classes hatching in 1997–1998 resulted in increased smolt runs in 2000 and 2001 (Table 3.1.1.5).

Despite some reduction in parr densities during 1999–2002, parr densities and subsequent smolt runs stayed on elevated levels compared to the situation in the mid-1990s. In 2003, densities of one-summer old parr increased in some rivers back to the peak level observed around 1998, while no similar increase was observed in other rivers. From 2004–2006, densities of one-summer old parr showed a yearly increase in most of the rivers, but in 2007 the densities of one summer old parr again decreased. Despite the relative high spawning run in 2009 the densities of one summer old parr in 2010 decreased substantially in most rivers, compared to the densities in 2009. The densities of one summer old parr in 2012 stayed at the same level as in 2011, or even increased, despite the relatively weak 2011 spawning run. The increased spawning run in 2012 did not substantially increase the densities of one summer old parr in 2013, whereas the increased spawning runs in 2013 and 2014 resulted in elevated densities of one summer old parr. The lower spawning run in 2017, 2018 and 2019 resulted in decreased densities of one summer old parr in 2018, 2019 and 2020.

Catch statistics and fishway counts also indicate some differences among rivers in the development in number of ascending spawners. To some extent, these differences may reflect problems with fish passages through fishways in certain rivers. For example, a survey in 2015 and 2016 of the efficiency of the fishway in Piteälven indicated a large delay in the spawning run and loss of salmon that didn't pass the fishway at the hydropower station located below the spawning areas. Similar observations have also been identified in Åbyälven (Section 3.1.2).

There has been pronounced annual variation in the indices of wild reproduction of salmon both between and within rivers. Variation in abundance indices might partly be explained to extreme summer conditions in the rivers during some years, e.g. in 2002–2003 and in 2006, which might have affected river catches and the fish migration in some fishways. Counted number of salmon in 2007 increased with about 50% compared to 2006. The additional increase in fishway counts in 2008 is in agreement with increased river catches, which more than doubled in 2008 compared to 2007 and were almost as high as in the highest recorded years (1996 and 1997). The spawner counts in 2010 and 2011 in combination with information on river catches indicated weak spawning runs in those years. The large increased spawning run in Tornionjoki in 2012, 2013, 2014 and 2016, as compared to 2011, resulted in increased total river catches with 40–70% compared to the two previous years. The spawning run in 2018 and 2019 was relatively weak in many rivers, and one reason could be that salmon was suffering from some kind of disease and relative high water temperatures during the summer in 2018. Likely for the same reasons, most river catches decreased.

Most data from the Gulf of Bothnia rivers indicate an increasing trend in salmon production. Rivers in AU 1 have shown the most positive development, while stocks in the small rivers in

AUs 2–3 have yet not shown as strong positive development. These small rivers are located on the Swedish coast close to the Quark area (northern Bothnian Sea, southern Bothnian Bay). The recent period with historically low M74-levels close to zero in spawning years 2010 to 2015 and low levels in previous years (Figure 3.4.1.3) most likely affected the wild production positively. After that, slightly higher M74 frequencies have followed. Preliminary data from thiamine analyses of eggs from two Swedish and two Finnish stocks indicate that M74-mortality among offspring hatching in 2021 (from spawning 2020) will further decrease somewhat; preliminary results from, Tornionjoki, Kemijoki, Ume/Vindelälven and Dalälven indicate that offspring mortality for those rivers may be around 5–15%. Disease outbreaks seen in recent years in several rivers is another mortality factor that may have a negative impact on future stock development (Sections 3.4 and 4.4.1).

Rivers in the Main Basin (assessment units 4–5)

The status of the Swedish AU 4 salmon populations in rivers **Mörrumsån** and **Emån** in the Main Basin differ, but they both show a similar slight negative trend in average parr densities (Table 3.1.4.1 and Figures 3.1.4.1 and 3.1.4.2). The outbreak of M74 mortality in the early 1990s might have decreased smolt production in mid-1990s, after reaching the historical highest parr densities in Mörrumsån at the turn of the 1980s and 1990s. In Emån, the smolt production has for long been far below the required level, which is most likely a result of insufficient numbers of spawners that so far have managed to find their way to reproduction areas further upstream in the river.

Updated production capacity priors for Mörrumsån and Emån (ICES, 2015) and smolt estimates from the river model tailored for southern rivers (ICES, 2017c) are now used in the full life-history model. The improvements allow more reliable status assessment of stocks in these rivers (Section 4.4). High disease related mortality among spawners in Mörrumsån (but not yet in Emån) in recent years is another factor that also may affect the future stock development (Sections 3.4 and 4.4.1). According to results from analytical assessment, present stock status is higher in Mörrumsån than in Emån (Section 4). Although average parr densities have not increased since the mid-1990s in Mörrumsån. Smolt trapping results for the production in the upper part of Mörrumsån showed a generally positive trend from 2009 and onwards. In 2019, however, the production decreased to the lowest observed during the nine latest years but increased slightly in 2020 (Section 3.1.4).

Among rivers in AU 5, the **Pärnu** river exhibit the most precarious state: no parr at all were found in the river in 2003–2004. In 2005–2006, the densities increased slightly, but in 2007, 2008, 2010 and 2011 again no parr were found. Reproduction occurred in 2008, 2011 and 2012 resulting in low densities of parr in 2009 and 2012–2016. Parr density was remarkably high in 2017 but again decreased in 2018 to increase again in 2019, staying at same level in 2020 (Table 3.1.5.1, Figure 3.1.5.1). There has been very large annual variation in parr densities, both within and between rivers in AU 5. Since 1997, parr densities in the river **Salaca** in Latvia have been on relatively high levels (Table 3.1.5.1, Figure 3.1.5.2), but in 2010 and 2011 the densities decreased to the lowest observed level since the mid-1990s. In 2015 the density increased to the highest observed so far, and in 2017 the densities increased compared with previous year. However, in 2018 one summer parr densities dropped significantly, most likely due to high water temperatures and low water levels in summer. In 2020 the densities of one summer parr again increased. In river **Gauja**, parr density levels have been very low since 2004. In 2014, the 0+ parr density increased to a slightly higher level and it also increased in 2019 to the highest observed so far. In 2020 the densites of 0+ decreased. It seems that in some of the AU 5 salmon rivers (**Saka**, **Užava** and **Irbe**) reproduction occurs only occasionally, as the salmon 0+ parr densities in some years are close to zero or zero.

Although only relatively short time-series of parr and smolt abundances are available from Lithuanian salmon rivers, the latest monitoring results (Table 3.1.5.2) indicate somewhat similar variation in juvenile production as seen in Latvian rivers. The observed parr densities are very low in relation to observed parr densities in most other Baltic rivers. This illustrates the poor state of several wild salmon stocks in AU 5. These stocks might have a higher risk of extinction than any of the stocks in AU 1–3 (Gulf of Bothnia). In Lithuania, various measures have been carried out since 1998 to assist the salmon populations (Section 3.1.5). The implemented measures have stabilized the populations in Lithuanian rivers, but production in different rivers and years still show significant fluctuations. Variation in climatic and ecological factors are believed to influence salmon parr densities and levels of smolt production. Pollution also affects the salmon rivers. Another important factor in Lithuanian rivers, which are of lowland type, is lack of suitable habitats for salmon parr.

Besides regulation of fisheries, many of the salmon rivers in the Main Basin (AU 4–5) may need habitat restoration and re-established connectivity, to stabilize and improve natural reproduction. For instance, in the **Pärnu** River, the Sindi dam prevented access to over 90% of the potential reproduction areas until 2018. Now salmon has access to all spawning areas in the river. In **Mörrumsån** and **Emån,** new fish passes have significantly increased the available reproduction areas for salmon. In summer 2020, the dam in Marieberg in Mörrumsån was removed making free access for salmonids to reach the spawning and nursery habitats above the removed dam.

Rivers in assessment unit 6 (Gulf of Finland, Subdivision 32)

The 0+ parr densities in Estonian wild rivers **Kunda** and **Keila** were high in 2017–2020. In **Vasalemma,** the 0+ parr density was on an average level in 2020. The status of river Keila and Kunda is considered to be good, whereas improvement has been modest in river Vasalemma. In 2018, a dam was opened in river Vasalemma, yet no salmon parr was found upstream of the dam in 2020. Because of highly variable annual parr densities in Vasalemma and Kunda, the status of these wild populations must still be considered uncertain.

In the Estonian mixed rivers **Purtse**, **Selja**, **Loobu**, **Valgejõgi**, **Jägala**, **Pirita** and **Vääna**, wild parr densities mostly decreased in 2016. However, in the preceding three years (2012–2015) parr density stayed above the long-term average in all of these rivers. In 2017 and 2018, parr densities increased to very high levels. The clearest positive trend can be seen in Selja, Valgejõgi, Loobu and Pirita. However, because of the high fluctuations in recruitment, the status of these populations remains uncertain. To safeguard these stocks additional regulatory measures were enforced in 2011 and more recently in 2019 (see Section 2.7.2) and positive effect of these measures can be seen as increases in wild parr densities and as a relatively satisfactory amount of ascending spawners to R. Pirita in recent years (2014–2020).

In Russia, wild salmon reproduction occurs in rivers **Luga** and **Gladyshevka**. The status of both these stocks is considered very uncertain. However, high densities of 0+ salmon parr occurred in Gladyshevka in 2015, 2017 and 2019. Since 2003, there is no information that suggests natural salmon reproduction in river **Neva**.

In Finland, natural reproduction in the mixed river **Kymijoki** has increased during the last ten years. However, reproduction varies a lot between years and it mainly takes place on the lower part of the river, although possibilities for salmon to access above the first dams have been improved. Smolt production still remains well below the river's potential (Section 3.1.6).

Total natural smolt production in Estonian, Finnish, and Russian rivers in the Gulf of Finland area was estimated to about 52 600 in 2018. In 2019, the estimated wild AU 6 smolt production decreased to about 48 000. It is estimated that the wild smolt production will increase to 99 000 in 2020. The AU 6 smolt releases since year 2000 have been on a stable level. The exception was year 2011, when releases were reduced with almost 50% (Table 3.3.1).

Table 3.1.1.1. Salmon catches (in kilos) in four rivers of the Subdivision 31, and the catch per unit of effort (CPUE) of the Finnish salmon rod fishing in the river Tornionjoki/Torneälven.

	Simojoki (au1) catch, kilo	Kalixälven (au1) catch, kilo	Byskeälven (au2) catch, kilo	Tornionjoki/ Torneälven (au 1) Finnish catch, kilo	Swedish catch, kilo	Total catch, kilo	CPUE grams/day
1970	1330						
1971							
1972	700						
1973							
1974				7950			
1975				3750			
1976				3300			
1977				4800			
1978				4050			
1979	400			5850			
1980				11250	7500	18750	
1981	200	4175	531	3630	2500	6130	
1982		1710	575	2900	1600	4500	
1983	50	3753	390	4400	4300	8700	9
1984	100	2583	687	3700	5000	8700	8
1985		3775	637	1500	4000	5500	14
1986	200	2608	251	2100	3000	5100	65
1987		2155	415	2000	2200	4200	33
1988		3033	267	1800	2200	4000	42
1989		4153	546	6200	3700	9900	65
1990	50	9460	2370	8800	8800	17600	113
1991		5710	1857	12500	4900	17400	106
1992		7198	1003	20100	6500	26600	117
1993		7423	2420	12400	5400	17800	100
1994[1)]	400	0	109	9000	5200	14200	97
1995	1300	3555	1107	6100	2900	9000	115
1996	2600	8712	4788	39800	12800	57600[4)]	561[2)]/736[3)]
1997	3900	10162	3045	64000	10300	74300	1094
1998	2800	5750	1784	39000	10500	49500	508
1999	1850	4610	720	16200	7760	27760	350
2000	1730	5008	1200	24740	7285	32025	485
2001	2700	6738	1505	21280	5795	27075	327
2002	700	10478	892	15040	4738	19778	300
2003	1000	5600	816	11520	3427	14947	320
2004	560	5480	1656	19730	4090	23820	520
2005	830	8727	2700	25560	12840	38400	541
2006	179	3187	555	11640	4336	15976	311
2007	424	5728	877	22010	13013	35023	553
2008	952	10523	2126	56950	18036	74986	1215
2009	311	4620	1828	30100	7053	37153	870
2010	300	1158	1370	23740	7550	31290	617
2011	334	1765	870	27715	15616	43331	773
2012	588	3855	2679	84730	37236	121966	1253
2013	260	4570	1664	57990	14313	72303	1322
2014	1205	3652	1388	124025	22707	146732	2210
2015	1500	2809	1480	101713	29300	131013	1252
2016	1800	1523	1179	125980	34995	160975	1662
2017	600	200	171	71320	3080	74400	860
2018	750	542	58	74934	12511	87445	1200
2019	940	480	940	88809	14419	103228	970
2020	1500	910	180	107531	22100	129631	930

1) Ban of salmon fishing 1994 in Kalixälven and Byskeälven and the Swedish tributaries of Torneälven.

2) Calculated on the basis of a fishing questionnaire similar to years before 1996.

3) Calculated on the basis of a new kind of fishing questionnaire, which is addressed to fishermen, who have bought a salmon rod fishing licence.

4) Five tonnes of illegal/unreported catch are included in total estimate.

Table 3.1.1.2. Numbers of wild salmon (MSW=MultiSeaWinter) in fishways and hydroacoustic counting in the rivers of the assessment units 1, 2, 3 and 4 (subdivisions 30–31, Gulf of Bothnia) and (subdivisions 25 and 27, Western Main Basin).

Year	Number of salmon																		
	Simojoki (au 1)		Tornionjoki (au 1)		Kalixälven (au 1)		Råneälven (au 1)	Piteälven (au 2)		Åbyälven (au 2)		Byskeälven (au 2)		Rickleån (au 2)	Ume/Vindelälven (au 2)			Testeboån (au3)	Mörrumsån (au4)
	MSW	Total	MSW	Total	MSW	Total	Total	MSW	Total	MSW	Total	MSW	Total	Total	MSW	Females	Total	Total	Total
1973									45										110
1974									15							716	1,583		129
1975																193	610		no control
1976																319	808		109
1977																456	1,221		90
1978																700	1,634		30
1979																643	2,119		38
1980					62	80									842	449	1,254		47
1981					79	161									293	196	638		115
1982					11	45									216	139	424		105
1983					132	890									199	141	401		288
1984					no control										222	177	443		247
1985					no control				30						569	330	904		190
1986					no control				28						175	128	227		262
1987					no control				18						193	87	246		404
1988					no control				28						367	256	446		502
1989					no control				19						296	191	597		1,685
1990					139	639			130						767	491	1,572		1,450
1991					122	437			59						228	189	356		771
1992					288	656		57	115						317	258	354		no control
1993					158	567		14	27				227		921	573	1,663		no control
1994					144	806		14	30				258		984	719	1,309		no control
1995					736	1,282		23	66			157	786		619	249	1,164		no control
1996					2,736	3,781		89	146	1	1	2,421	2,691		1,743	1,271	1,939		no control
1997					5,184	5,961		614	658	38	39	1,025	1,386		1,602	1,064	1,780		no control
1998					1,525	2,459		147	338	12	15	707	786		447	233	1,154		no control
1999					1,515	2,013		185	220	10	14	447	721		1,614	802	2,208		no control
2000					1,398	2,459		204	534	10	31	908	1,157		946	601	3,367		no control
2001					4,239	8,890		668	863	40	95	1,435	2,085		1,373	951	5,476		no control
2002					6,190	8,479		1,243	1,378	49	81	1,079	1,316	17	3,182	2,123	6,052		902
2003	936	n/a			3,792	4,607		1,305	1,418	14	18	706	1,086	0	1,914	1,136	2,337		438
2004	680	n/a			3,206	3,891		1,269	1,628	23	43	1,331	1,707	2	1,717	663	3,292		497
2005	756	n/a			4,450	6,561		897	1,012	16	80	900	1,285	1	2,464	1,480	3,537		557
2006	765	n/a			2,125	3,163		496	544	20	27	528	665	6	1,733	1,093	2,362		392
2007	970	n/a			4,295	6,489		450	518	62	93	1,208	2,098	7	2,636	1,304	4,023		923
2008	1,004	1,235			6,165	6,838		471	723	158	181	2,714	3,409	5	3,217	2,167	5,157		968
2009	1,133	1,374	26 358	31 775	4,756	6,173		904	1,048	180	185	1,186	1,976	0	3,861	2,584	5,902		666
2010	699	888	16 039	17 221	2,535	3,192		473	532	47	47	1,460	1,879	0	2,522	1,279	2,697		232
2011	791	1,167	20,326	23,076	2,202	2,562		571	597	36	36	1,187	1,433	0	3,992	1,505	4,886		547
2012	2,751	3,630	52,828	59,606	7,708	8,162		1,196	1,418	74	88	2,033	2,442	0	5,842	1,765	8,058		1,407
2013	2,544	3,121	46,580	52,268	12,247	15,039		1,168	1,343	92	113	3,137	3,761	0	10,002	5,058	13,604		1,762
2014	3,322	3,816	92,167	100,210	7,343	7,638	3,756	1,221	1,339	94	94	5,417	5,888	27	7,852	2,633	10,407		1,185
2015	2,549	2,950	45,456	57,152	5,221	8,288	1,004	1,566	1,907	78	80	4,224	5,311	13	2,781	790	7,521		1,057
2016	5,125	5,435	91,137	98,338	6,368	8,439	1,454	1,609	2,009	116	155	5,533	7,280	17	4,238	2,741	9,134	73	712
2017	1,642	1,918	36,409	40,952	4,687	5,174	1,781	1,335	1,455	108	108	3,465	4,125	15	2,582	908	4,100	67	980
2018	3,231	4,016	35,866	47,028	5,409	7,215	4,184	1,222	1,431	113	113	1,305	2,168	36	2,777	728	12,754	21	183
2019	3,749	4,039	52,738	65,520	8,681	9,957	2,132	1,922	2,089	81	93	4,578	5,306	55	9,668	3,389	12,683	159	no control
2020	3,707	4,124	56,716	69,149	12,336	18,664	2,461	759	1,006	52	55	4,297	6,675	57	10,024	3,921	12,911	104	no control

Table 3.1.1.3. The age and sex composition of ascending salmon caught by the Finnish river fishery in the River Tornionjoki since the mid-1970s.

	Year(s)											
	1974-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015	2016	2017	2018	2019	2020
N:o of samples	728	283	734	2114	2170	1879	2988	849	432	413	448	508
A1 (Grilse)	9%	53%	35%	7%	20%	8%	10%	6%	11%	37%	17%	25%
A2	60%	31%	38%	59%	50%	53%	43%	76%	69%	30%	60%	39%
A3	29%	13%	24%	28%	26%	31%	38%	11%	18%	21%	21%	27%
A4	2%	2%	3%	4%	3%	6%	6%	5%	1%	10%	3%	7%
>A4	0%	1%	<1 %	2%	2%	2%	3%	1%	1%	2%	0%	2%
Females, proportion of biomass	About 45 %	49%	75%	71%	65%	67%	62%	67%	64%	55%	54%	58%
Proportion of repeat spawners	2%	2%	2%	6%	6%	8%	9%	8%	3%	12%	3%	11%
Proportion of reared origin	7%	46 %*	18%	15%	9%	1%	0.3%	0.3%	0.5%	0.2%	0.0%	0.0%

* An unusually large part of these salmon were not fin-clipped but analysed as reared on the basis of scales (probably strayers). A bulk of these was caught in 1989 as grilse.

Table 3.1.1.4. Densities and occurrence of wild salmon parr in electrofishing surveys in the rivers of the assessment unit 1 (Subdivision 31).

River year	Number of parr/100 m² by age group 0+	1+	2+ & older	>0+ (sum of two previous columns)	Sites with 0+ parr (%)	Number of sampling sites	Notes
Simojoki							
1982	3.90			1.50	50%	14	No age data of older parr available
1983	0.75			2.20	57%	14	No age data of older parr available
1984	0.53			2.29	44%	16	No age data of older parr available
1985	0.10			0.98	8%	16	No age data of older parr available
1986	0.19			0.53	19%	16	No age data of older parr available
1987	0.74			0.71	27%	22	No age data of older parr available
1988	2.01	2.30	0.24	2.54	36%	22	
1989	2.32	1.15	0.34	1.49	41%	22	
1990	1.71	1.74	0.56	2.30	36%	25	
1991	3.67	1.74	0.65	2.38	32%	28	
1992						0	No sampling because of flood.
1993	0.08	0.35	0.86	1.21	19%	27	
1994	0.39	0.47	0.53	1.00	16%	32	
1995	0.66	0.32	0.13	0.45	31%	29	
1996	2.09			0.76	28%	29	No age data of older parr available
1997	10.98	1.39	0.28	1.67	72%	29	
1998	10.22	3.47	0.46	3.94	100%	17	Flood; only a part of sites were fished.
1999	20.77	10.39	2.41	12.80	93%	28	
2000	15.76	12.17	2.95	15.12	84%	30	
2001	9.03	7.38	3.29	10.67	67%	31	
2002	15.44	8.56	3.30	11.85	81%	31	
2003	19.97	5.38	1.44	6.82	84%	30	
2004	12.97	7.68	1.30	8.98	74%	19	Flood; only a part of sites were fished.
2005	18.49	7.46	1.89	9.35	70%	27	Flood; only a part of sites were fished.
2006	35.82	12.37	6.14	18.51	83%	36	
2007	4.47	2.61	1.21	3.82	37%	35	
2008	17.75	3.19	1.40	4.60	72%	36	
2009	28.56	13.14	2.15	15.29	76%	36	
2010	13.15	8.26	2.45	10.71	80%	35	
2011	27.93	6.87	2.58	9.45	83%	35	
2012	14.98	10.09	1.43	11.52	83%	36	
2013	11.32	10.60	3.64	14.24	78%	36	
2014	34.30	4.94	2.96	7.90	75%	36	
2015	18.55	5.70	0.80	6.50	86%	36	
2016	28.08	10.19	3.54	13.73	83%	35	
2017	38.06	19.07	8.68	28.38	86%	37	
2018	30.60	25.62	16.37	41.99	83%	36	
2019	40.93	7.22	7.15	14.37	83%	36	
2020	21.27	13.41	6.51	19.92	83%	36	
Tornionjoki							
1986	0.52	0.89	0.23	1.12		30	
1987	0.38	0.31	0.48	0.79		26	
1988	0.73	0.60	0.46	1.06	46%	44	
1989	0.58	0.68	0.64	1.32	47%	32	
1990	0.52	0.82	0.36	1.18	40%	68	
1991	2.35	0.63	0.48	1.12	69%	70	
1992	0.24	1.80	0.36	2.16	16%	37	Flood; only a part of sites were fished.
1993	0.52	0.44	2.49	2.94	44%	64	
1994	1.02	0.49	1.35	1.84	43%	92	
1995	0.49	1.45	0.65	2.10	48%	72	
1996	0.89	0.33	0.82	1.15	39%	73	
1997	8.05	1.35	0.74	2.09	78%	100	
1998	12.95	4.43	0.53	4.96	92%	84	
1999	8.37	8.83	4.23	13.06	85%	98	
2000	5.90	4.70	6.81	11.51	83%	100	
2001	5.91	3.13	3.82	6.94	78%	101	
2002	7.23	6.03	3.92	9.94	78%	101	
2003	16.09	4.19	2.93	7.12	81%	100	
2004	5.79	4.99	1.27	6.25	80%	60	Flood; only a part of sites were fished.
2005	8.60	2.86	4.28	7.15	81%	87	
2006	13.33	10.57	5.44	16.01	83%	80	
2007	10.33	8.62	5.61	14.23	75%	81	
2008	26.00	10.66	8.70	19.36	94%	81	
2009	19.71	11.65	5.63	17.27	96%	79	
2010	14.42	11.39	6.89	18.28	89%	81	
2011	22.18	14.35	10.06	24.41	90%	78	
2012	19.47	8.04	4.96	13.00	92%	79	
2013	24.13	11.04	6.14	17.18	95%	81	
2014	36.08	10.82	4.41	15.23	97%	75	
2015	40.61	16.96	5.29	22.25	99%	80	
2016	25.24	3.85	3.93	22.46	98%	61	Flood; only a part of sites were fished.
2017	28.52	9.59	7.58	17.18	99%	80	
2018	17.60	10.86	5.33	16.20	92%	79	
2019	25.48	9.53	5.63	15.16	94%	78	
2020	20.45	14.19	5.64	19.84	99%	79	

table continues on next page

Table 3.1.1.4. Continued.

River year	Number of parr/100 m2 by age group 0+	1+	2+ & older	>0+ (sum of two previous columns)	Sites with 0+ parr (%)	Number of sampling sites	Notes
Kalixälven							
1986	0.55	1.59	4.10	5.69	50%	6	
1987	0.40	1.11	1.64	2.75	33%	9	
1988	0.00	0.87	2.08	2.95	0%	1	
1989	2.82	0.99	1.86	2.85	75%	24	
1990	4.96	5.67	2.1	7.77	91%	11	
1991	6.19	1.37	1.09	2.46	79%	19	
1992	1.08	3.54	1.87	5.41	54%	11	Flood; only a part of sites were fished.
1993	0.59	0.66	3.05	3.69	42%	19	
1994	2.84	1.16	3.08	4.24	69%	26	
1995	1.10	3.16	0.94	4.10	67%	27	
1996	2.16	0.77	1.15	1.92	71%	28	
1997	10.16	2.98	1	3.98	86%	28	
1998	31.62	9.81	2.6	12.41	78%	9	Flood; only a part of sites were fished.
1999	4.41	7.66	6.36	14.02	87%	30	
2000	10.76	4.99	8.31	13.30	93%	29	
2001	5.60	5.48	6.3	11.78	79%	14	
2002	6.21	6.22	3.77	9.99	93%	30	
2003	46.94	12.51	5.2	17.71	87%	30	
2004	13.58	14.65	3.25	17.90	88%	24	
2005	15.34	5.53	8.63	14.16	87%	30	
2006	15.96	19.33	8.32	27.65	90%	30	
2007	11.63	7.65	6.53	14.18	80%	30	
2008	25.74	15.91	8.40	24.31	97%	30	
2009	28.18	10.17	5.76	15.93	80%	30	
2010	14.87	10.96	4.71	15.67	83%	30	
2011	36.92	29.62	15.68	45.30	89%	9	Flood; only a part of sites were fished.
2012	16.07	10.07	6.42	16.49	87%	30	
2013	29.51	15.45	11.95	27.40	100%	30	
2014	25.69	14.44	6.03	20.47	100%	30	
2015	48.84	15.27	5.87	21.14	93%	30	
2016	14.80	11.75	6.18	17.93	100%	30	
2017	17.21	5.88	5.72	11.60	97%	30	
2018	26.15	11.56	7.22	18.78	83%	30	
2019	19.56	10.75	3.76	14.51	90%	30	Ordinary sites
2019	19.86	10.30	3.71	14.01	85%	40	Extended sites included
2020	25.06	18.44	7.13	25.57	100%	30	Ordinary sites
2020	24.26	18.92	7.48	26.40	100%	40	Extended sites included
Råneälven							
1993	0.00	0.08	0.83	0.91	0%	9	
1994	0.17	0	0.27	0.27	22%	9	
1995	0.06	0.13	0.21	0.34	18%	11	
1996	0.52	0.38	0.33	0.71	25%	12	
1997	3.38	1.00	1.14	2.14	90%	10	
1998	2.22	0.35	0.35	0.70	100%	1	Flood; only a part of sites were fished.
1999	1.05	2.22	1.66	3.88	50%	12	
2000	0.98	1.67	1.99	3.66	69%	13	
2001	0.23	0.53	2.39	2.92	40%	10	
2002	1.65	0.92	1.32	2.24	43%	14	
2003	4.71	3.34	1.11	4.45	57%	14	
2004						0	No sampling because of flood.
2005	2.83	1.14	2.10	3.24	64%	14	
2006	6.75	4.06	5.12	9.18	50%	14	
2007	2.74	2.36	2.83	5.19	57%	14	
2008	6.25	1.83	3.64	5.47	64%	14	
2009	4.13	4.66	3.67	8.33	86%	7	
2010	5.87	3.57	7.79	11.36	64%	14	
2011	2.92	2.52	2.63	5.15	57%	14	
2012	3.30	2.16	3.21	5.37	71%	14	
2013	8.19	4.15	7.76	11.91	79%	14	
2014	7.42	3.85	4.12	7.97	79%	14	
2015	9.61	5.47	4.02	9.49	79%	14	
2016	4.66	5.16	5.75	10.91	86%	14	
2017	3.41	2.64	4.86	7.50	100%	5	Flood; only a part of sites were fished.
2018	3.86	1.79	5.85	7.64	64%	14	
2019	9.15	3.47	1.98	5.45	86%	14	
2020	5.71	10.62	3.13	13.74	79%	14	

Table 3.1.1.5. Estimated number (modal value) of smolts by smolt trapping in the rivers Simojoki and Tornionjoki (assessment unit 1), and Sävarån, Ume/Vindelälven, Rickleån, Lögdeälven and Åbyälven (assessment unit 2). The estimates and their coefficient of variation (CV) have been derived from the mark–recapture model (Mäntyniemi and Romakkaniemi, 2002) for the last years of the time-series. In the Ume/Vindelälven, however, another technique has been applied, in which smolts are tagged during the smolt run and recaptures has been monitored from adults ascending the year 1–2 years later. The ratio of smolts stocked as parr/wild smolts in trap catch is available in some years even though total run estimate cannot be provided (e.g. in the cases of too low trap catches). The number of stocked smolts is based on stocking statistics.

	Tornionjoki (AU 1)				Simojoki (AU 1)				Sävarån (AU 2)		Ume/Vindelälven (AU 2)		Rickleån (AU 2)		Lögdeälven (AU 2)		Åbyälven (AU 2)	
	Smolt trapping, original estimate	CV of estimate	Ratio of smolts stocked as parr/wild smolts in catch	Number of stocked reared smolts (point estimate)	Smolt trapping, original estimate	CV of estimate	Ratio of smolts stocked as parr/wild smolts in catch	Number of stocked reared smolts (point estimate)	Smolt trapping, original estimate	CV of estimate	Smolt trapping, original estimate	CV of estimate	Smolt trapping, original estimate	CV of estimate	Smolt trapping, original estimate	CV of estimate	Smolt trapping, original estimate	CV of estimate
1977	n/a				29,000				n/a		n/a		n/a		n/a		n/a	
1978	n/a				67,000				n/a		n/a		n/a		n/a		n/a	
1979	n/a				12,000				n/a		n/a		n/a		n/a		n/a	
1980	n/a				14,000				n/a		n/a		n/a		n/a		n/a	
1981	n/a				15,000				n/a		n/a		n/a		n/a		n/a	
1982	n/a				n/a				n/a		n/a		n/a		n/a		n/a	
1983	n/a				n/a				n/a		n/a		n/a		n/a		n/a	
1984	n/a				19,000				n/a		n/a		n/a		n/a		n/a	
1985	n/a				13,000				n/a		n/a		n/a		n/a		n/a	
1986	n/a				2,200				n/a		n/a		n/a		n/a		n/a	
1987	50,000 *)		1.11	32,129	1,800		1.78	14,800	n/a		n/a		n/a		n/a		n/a	
1988	66,000		0.37	11,300	1,500		3.73	14,700	n/a		n/a		n/a		n/a		n/a	
1989	n/a		1.22	1,829	12,000		0.66	52,841	n/a		n/a		n/a		n/a		n/a	
1990	63,000		0.20	85,545	12,000		1.41	26,100	n/a		n/a		n/a		n/a		n/a	
1991	87,000		0.54	40,344	7,000		1.69	60,916	n/a		n/a		n/a		n/a		n/a	
1992	n/a		0.47	15,000	17,000		0.86	4,389	n/a		n/a		n/a		n/a		n/a	
1993	123,000		0.27	29,342	9,000		1.22	5,087	n/a		n/a		n/a		n/a		n/a	
1994	199,000		0.16	17,317	12,400		1.09	14,862	n/a		n/a		n/a		n/a		n/a	
1995	n/a		0.38	61,986	1,400		7.79	68,580	n/a		n/a		n/a		n/a		n/a	
1996	71,000		0.60	39,858	1,300		28.5	140,153	n/a		n/a		n/a		n/a		n/a	
1997	50,000 **)			20,004	2,450		6.95	144,939	n/a		n/a		n/a		n/a		n/a	
1998	144,000		0.57	60,033	9,400		2.28	75,942	n/a		n/a		n/a		n/a		n/a	
1999	175,000	17%	0.67	60,771	8,960		0.75	66,815	n/a		n/a		n/a		n/a		n/a	
2000	500,000	39%	0.17	60,339	57,300		0.48	50,100	n/a		n/a		n/a		n/a		n/a	
2001	625,000	33%	0.09	4,000	47,300		0.15	49,111	n/a		n/a		n/a		n/a		n/a	
2002	550,000	12%	0.08	3,998	53,700		0.29	51,300	n/a		n/a		n/a		n/a		n/a	
2003	750,000	43%	0.06	4,032	63,700		0.26	18,912	n/a		n/a		n/a		n/a		n/a	
2004	900,000	33%	0.02	4,000	29,100		0.30	1,900	n/a		n/a		n/a		n/a		n/a	
2005	660,000	25%	0.00	4,000	17,500	28%	0.10	4,800	3,800	15%	n/a		n/a		n/a		n/a	
2006	1,250,000	35%	0.00	3,814	29,400	35%	0.11	809	3,000	12%	n/a		n/a		n/a		n/a	
2007	610,000	48%	0.00	8,458	23,200	20%	0.01	8,000	3,100	18%	n/a		n/a		n/a		n/a	
2008	1,490,000	37%	0.00	6,442	42,800	29%	0.00	4,000	4,570	18%	n/a		n/a		n/a		n/a	
2009	1,090,000	42%	0.00	4,490	22,700	29%	0.00	1,000	1,900	49%	n/a		n/a		n/a		n/a	
2010	n/a		0.00	4,965	29,700	28%	0.00	23,240	1,820	32%	193,800	21%	n/a		n/a		n/a	
2011	1,990,000	27%	0.00	3,048	36,700	13%	0.00	0	1,643	28%	210,000	14%	n/a		n/a		n/a	
2012	n/a		0.00	4,437	19,300	37%	0.00	0	n/a		352,900	19%	n/a		n/a		n/a	
2013	n/a		0.00	5,300	37,000	11%	0.00	500	3,548	31%	302,600	25%	n/a		n/a		n/a	
2014	n/a		0.00	4,800	36,600	19%	0.00	0	n/a		180,600	13%	2,149	16%	n/a		n/a	
2015	2,032,000	47%	0.00	0	n/a		0.00	0	n/a		186,000	13%	n/a		n/a		n/a	
2016	2,914,000	27%	0.00	0	29,900	7%	0.00	0	n/a		n/a		3,961	15%	5,211	22%	n/a	
2017	952,000	27%	0.00	0	n/a		0.00	0	n/a		243,800	20%	4,794	22%	n/a		n/a	
2018	n/a		0.00	0	41,300	18%	0.00	0	n/a		148,400	27%	n/a		n/a		n/a	
2019	1,857,000	29%	0.00	0	20,400	18%	0.00	0	n/a		n/a		n/a		n/a		6,453	29%
2020	n/a		0.00	0	27,900	25%	0.00	0	n/a		n/a		n/a		n/a		1,934	65%

***) trap was not in use the whole period; value has been adjusted according to assumed proportion of run outside trapping period.**

****) Most of the reared parr released in 1995 were non-adipose finclipped and they left the river mainly in 1997. Because the wild and reared production has been distinguished on the basis of adipose fin, the wild production in 1997 is overestimated. This was considered when the production number used by WG was estimated.**

Table 3.1.2.1. Densities and occurrence of wild salmon parr in electrofishing surveys in the rivers of the assessment unit 2 (subdivisions 30–31). Detailed information on the age structure of older parr (>0+) is available only from Piteälven, Åbyälven and Byskeälven.

	Number of parr/100 m²								Sites with 0+ parr (%)	Number of sampling sites	Notes
River year	0+	1+	≥2+	>0+	*) 0+	*) 1+	*) ≥2+	*) >0+			
Piteälven											
1990	0.00		0.00	0.00						1	
1991											No sampling
1992											No sampling
1993	0.00		0.00	0.00						1	
1994	0.00		0.00	0.00						4	
1995											No sampling
1996											No sampling
1997	0.31		0.20	0.20						2	
1998											No sampling because of flood.
1999											No sampling
2000											No sampling
2001											No sampling
2002	5.37		1.24	1.24						5	
2003											No sampling
2004											No sampling
2005											No sampling
2006	3.92	1.39	0.30	1.69					71%	7	
2007	0.00	2.08	0.42	2.50					0%	5	
2008	5.06	0.81	1.04	1.85					100%	6	
2009											No sampling
2010	2.22	1.69	0.99	2.68					86%	7	
2011											No sampling because of flood.
2012											No sampling because of flood.
2013	6.56	6.55	2.08	8.63					100%	7	Varjisån included
2014	12.15	6.39	2.92	9.31					100%	5	
2015	4.87	3.57	0.69	4.26					100%	7	
2016	7.64	4.73	1.22	5.95					100%	4	
2017											No sampling
2018											No sampling
2019											No sampling
2020											No sampling

*) No extended electrofishing surveys exist in Piteälven

Table 3.1.2.1. Continued.

River year	Number of parr/100 m² 0+	1+	≥2+	>0+	*) 0+	*) 1+	*) ≥2+	*) >0+	Sites with 0+ parr (%)	Number of sampling sites	Notes
Åbyälven											
1986	1.11	1.15	0.00	1.15	0.70	0.72	0.00	0.72	100%	2/*3	
1987	1.69	0.75	0.79	1.54	1.06	0.47	0.50	0.97	100%	4/*5	
1988	0.28	0.11	0.69	0.80	0.18	0.07	0.43	0.50	67%	3/*4	
1989	2.62	0.17	2.26	2.43	1.65	0.11	1.42	1.53	100%	4/*5	
1990	0.90	2.13	0.25	2.38	0.57	1.34	0.16	1.50	50%	4/*5	
1991	5.36	0.00	4.47	4.47	3.38	0.00	2.82	2.82	100%	2/*3	
1992	2.96	3.65	0.17	3.82	1.86	2.30	0.11	2.41	100%	1/*2	
1993	1.01	0.56	4.62	5.18	0.64	0.35	2.91	3.26	75%	4/*5	
1994	1.53	0.67	1.95	2.62	0.96	0.42	1.23	1.65	67%	6/*7	
1995	3.88	1.53	1.42	2.95	2.44	0.96	0.89	1.86	86%	7/*8	
1996	3.77	3.89	1.1	4.99	2.38	2.45	0.69	3.14	71%	7/*9	
1997	3.09	1.99	3.06	5.05	1.95	1.26	1.93	3.19	67%	7/*8	
1998											No sampling because of flood.
1999	16.51	6.57	1.74	8.31	10.41	4.15	1.11	5.25	71%	7/*8	
2000	5.85	4.43	3.62	8.05	3.70	2.80	2.29	5.09	57%	10/*14	
2001	6.31	1.58	3.76	5.34	3.98	1.00	2.37	3.36	57%	4/*7	
2002	8.16	1.63	2.1	3.73	5.17	1.03	1.33	2.35	79%	10/*14	
2003	2.93	3.73	0.83	4.56	1.88	2.36	0.53	2.89	71%	10/*14	
2004	5.40	0.49	0.83	1.32	3.41	0.32	0.53	0.85	57%	10/*14	
2005	6.36	1.4	0.62	2.02	4.10	0.88	0.40	1.28	79%	10/*14	
2006	27.18	10.37	2.77	13.14	17.19	6.55	1.75	8.30	71%	10/*14	
2007	5.26	6.3	4.76	11.06	3.34	3.98	3.00	6.98	71%	10/*14	
2008	12.48	2.19	3.95	6.14	7.88	1.38	2.49	3.87	64%	10/*14	
2009	16.79	4.21	3.24	7.45	10.67	2.67	2.05	4.72	86%	10/*14	
2010	7.16	3.83	2.06	5.89	4.67	2.43	1.30	3.73	86%	10/*14	
2011	27.01	9.07	5.65	14.72	17.04	5.78	3.59	9.37	86%	10/*14	
2012	12.82	7.54	4.36	11.90	8.11	4.75	2.76	7.51	79%	10/*14	
2013	16.29	7.32	5.22	12.54	10.37	4.65	3.29	7.94	86%	10/*14	
2014	28.73	6.73	5.67	12.40	18.13	4.24	3.58	7.83	86%	10/*14	
2015	18.82	9.79	3.33	13.12	12.07	6.22	2.12	8.34	100%	10/*14	
2016	37.04	8.33	6.18	14.51	23.45	5.37	3.92	9.29	86%	10/*14	
2017	33.11	11.88	5.42	17.30	21.21	7.52	3.47	10.99	100%	10/*14	
2018	22.96	7.43	10.21	17.64	14.93	4.79	6.49	11.28	93%	10/*14	
2019	21.11	10.76	5.08	15.42	13.64	6.82	3.28	10.10	95%	10/*20	
2020	9.78	9.06	5.52	14.58	7.32	5.44	3.23	8.67	100%	10/*20	

*) Average densities from extended electrofishing surveys in Åbyälven, also including areas and sites in the upper parts of the river which have recently been colonized by salmon (for more details se section 4.2.2). These average densities are used as input in the river model (see stock annex).

Table 3.1.2.1. Continued.

River year	Number of parr/100 m²								Sites with 0+ parr (%)	Number of sampling sites	Notes
	0+	1+	≥2+	>0+	*) 0+	*) 1+	*) ≥2+	*) >0+			
Byskeälven											
1986	0.10	0.85	0.54	1.39					29%	7	
1987											No sampling
1988											No sampling
1989	2.39	0.48	1.15	1.63					75%	8	
1990	1.45	1.14	0.39	1.53					80%	5	
1991	5.14	1.25	0.83	2.08					73%	11	
1992	1.46	5.85	2.65	8.5					50%	10	
1993	0.43	0.21	1.35	1.56					57%	7	
1994	2.76	0.97	2.50	3.47					80%	10	
1995	3.42	2.15	1.42	3.57					91%	11	
1996	8.64	2.53	1.26	3.79					83%	12	
1997	10.68	4.98	1.18	6.16					100%	12	
1998											No sampling because of flood.
1999	16.28	7.45	4.55	12					100%	15	
2000	8.72	8.38	3.72	12.1					100%	12	
2001											No sampling because of flood.
2002	15.84	4.3	2.25	6.55					93%	14	
2003	33.83	4.89	1.70	6.59					93%	15	
2004	12.32	6.83	2.33	9.16					93%	15	
2005	26.18	8.78	7.02	15.80					100%	15	
2006	13.20	14.39	4.01	18.40					87%	15	
2007	6.76	5.49	6.09	11.58					93%	15	
2008	20.49	6.80	5.61	12.41					93%	15	
2009	36.59	10.55	4.28	14.83					100%	15	
2010	18.71	9.14	3.47	12.61					93%	15	
2011											No sampling because of flood.
2012	18.35	5.50	3.77	9.27					93%	15	
2013	24.00	14.27	9.48	23.75					93%	15	
2014	37.78	6.79	6.19	12.98					100%	15	
2015	35.86	13.95	5.08	19.03					100%	15	
2016	43.11	14.58	6.76	21.34					100%	15	
2017	40.10	15.51	7.04	22.55					100%	15	
2018	24.10	13.10	9.54	22.64					100%	15	
2019	52.35	9.07	6.34	15.41					93%	15	
2020	25.04	14.40	4.72	19.12					93%	15	

*) No extended electrofishing surveys exist in Byskeälven

Table 3.1.2.1. Continued.

River year	Number of parr/100 m²								Sites with 0+ parr (%)	Number of sampling sites	Notes
	0+	1+	≥2+	>0+	*) 0+	*) 1+	*) ≥2+	*) >0+			
Kågeälven											
1987	0.00			0.00					0%	5	
1988	0.00			0.00					0%	1	
1989	0.00			0.00					0%	3	
1990	0.00			0.00					0%	1	
1991	0.51			0.00					25%	4	
1992	1.62			0.54$^{\alpha}$					50%	2	
1993	0.00			1.13$^{\alpha}$					0%	5	
1994	0.00			0.46$^{\alpha}$					0%	5	
1995											No sampling
1996											No sampling
1997											No sampling
1998											No sampling
1999	19.74			14.07$^{\alpha}$					58%	26	
2000	1.46			3.02$^{\alpha}$					30%	10	
2001	9.47			7.05$^{\alpha}$					33%	9	
2002	8.73			5.64$^{\alpha}$					54%	26	
2003	8.34			1.17$^{\alpha}$					46%	26	
2004	7.00			6.17$^{\alpha}$					44%	25	
2005	13.95			1.52$^{\alpha}$					58%	26	
2006	30.65			27.03$^{\alpha}$					82%	17	
2007	4.10			6.20					40%	25	
2008	2.49			7.07					29%	14	
2009	8.16			2.87					85%	12	
2010	5.81			2.69					69%	12	
2011	2.76			2.09					38%	12	
2012	18.10			10.34					69%	12	
2013	10.02			14.03					92%	12	
2014	26.35			9.78					100%	13	
2015	19.79			14.98					100%	13	
2016	8.09			4.25					90%	10	
2017	17.47			12.98					100%	7	
2018	13.40			18.38					90%	11	
2019	7.52			4.02					75%	12	
2020	4.88			7.45					91%	11	

α) stocked and wild parr. Not possible to distinguish stocked parr from wild.

*) No extended electrofishing surveys exist in Kågeälven

Table 3.1.2.1. Continued.

River year	Number of parr/100 m² 0+	1+	≥2+	>0+	*) 0+	*) 1+	*) ≥2+	*) >0+	Sites with 0+ parr (%)	Number of sampling sites	Notes
Rickleån											
1988	0.00			0.23	0.00			0.11	0%	2	
1989	0.34			0.00	0.16			0.00	33%	6	
1990	0.69			0.24	0.32			0.11	29%	7	
1991	0.30			0.09	0.14			0.04	29%	7	
1992	0.22			0.05	0.10			0.02	43%	7	
1993	1.63			0.18	0.77			0.08	50%	8	
1994	0.63			1.18	0.30			0.56	38%	8	
1995	0.64			0.23	0.30			0.11	50%	8	
1996	0.00			0.10	0.00			0.05	0%	7	
1997	0.17			0.90	0.08			0.43	29%	7	
1998	2.56			0.99	1.21			0.47	86%	7	
1999	2.32			0.49	1.10			0.23	86%	7	
2000	3.41			4.04	1.61			1.90	100%	7	
2001											No sampling because of flood.
2002	2.42			2.58	1.14			1.22	43%	7	
2003	1.05			0.39	0.50			0.19	43%	7	
2004	1.13			3.24	0.53			1.53	43%	7	
2005	4.88			0.34	2.30			0.16	43%	7/*11	
2006	3.88			5.70	1.83			2.69	86%	7	
2007	0.00			0.19	0.00			0.09	0%	7/*11	
2008	4.16			2.16	1.96			1.02	43%	7/*11	
2009	1.09			0.00	0.51			0.00	57%	7	
2010	3.73			6.23	1.76			2.94	100%	7	
2011	0.00			0.97	0.00			0.46	0%	7	
2012	0.91			1.96	0.43			0.98	86%	7/*14	
2013	4.94			2.98	2.59			2.01	57%	7/*13	
2014	2.66			0.77	1.56			0.65	86%	7/*9	
2015	14.60			4.69	8.08			2.58	100%	7/*9	
2016	11.77			7.80	5.85			3.92	100%	7/*11	
2017	9.20			8.78	4.62			4.63	100%	7/*11	
2018	4.83			13.21	2.50			7.04	57%	7/*12	
2019	19.64			2.75	11.06			1.41	100%	7/*12	
2020	14.90			5.10	11.32			4.05	100%	7/*13	

*) Average densities from extended electrofishing surveys in Rickleån, also including areas and sites in the upper parts of the river which have recently been colonized by salmon (for more details se section 4.2.2). These average densities are used as input in the river model (see stock annex).

Table 3.1.2.1. Continued.

River year	Number of parr/100 m² 0+	1+	≥2+	>0+	*) 0+	*) 1+	*) ≥2+	*) >0+	Sites with 0+ parr (%)	Number of sampling sites	Notes
Sävarån											
1989	0.60			0.90					25%	4	
1990	1.50			3.10					56%	9	
1991	0.70			4.50					29%	7	
1992	0.20			3.00					43%	7	
1993	1.80			1.90					29%	7	
1994	1.50			2.90					33%	6	
1995	0.40			1.00					33%	9	
1996	10.30			2.50					44%	9	
1997	0.40			3.50					33%	9	
1998	2.70			2.70					63%	8	
1999	0.80			5.00					44%	9	
2000	12.80			7.40					100%	4	
2001											No sampling because of flood.
2002	4.60			5.20					63%	8	
2003	2,30			4.40					56%	9	
2004											No sampling because of flood.
2005	3.30			3.80					56%	9	
2006	12.49			16.89					67%	9	
2007	4.70			9.20					67%	9	
2008	7.30			8.10					78%	9	
2009	10.22			12.06					78%	9	
2010	4.99			14.09					67%	9	
2011	6.87			8.46					67%	9	
2012	14.43			21.70					89%	9	
2013	20.17			18.31					89%	9	
2014	11.49			10.58					78%	9	
2015	45.30			34.31					100%	9	
2016	32.18			38.61					100%	9	
2017	21.58			34.47					89%	9	
2018	14.69			31.72					100%	12	
2019	8.87			15.18					75%	12	
2020	36.74			19.68					100%	13	

*) No extended electrofishing surveys exist in Sävarån

Table 3.1.2.1. Continued.

River year	Number of parr/100 m² 0+	1+	≥2+	>0+	*) 0+	*) 1+	*) ≥2+	*) >0+	Sites with 0+ parr (%)	Number of sampling sites	Notes
Ume/Vindelälven											
1989	1.57			1.97	1.13			1.41	67%	3	
1990	0.57			2.91	0.41			2.09	50%	12	
1991	2.28			1.11	1.64			0.80	50%	6	
1992											
1993	0.29			0.99	0.21			0.71	33%	6	
1994	0.51			1.10	0.37			0.79	24%	25	
1995	0.39			0.23	0.28			0.17	37%	19	
1996	0.30			0.95	0.94			0.69	14%	21	
1997	17.23			1.82	12.40			1.31	79%	19	
1998	21.59			11.12	15.53			8.00	100%	6	Part of sites were fished due to flood.
1999	3.29			16.88	2.36			12.14	28%	18	
2000	4.53			3.99	3.26			2.87	75%	12	
2001	3.54			8.10	2.54			5.83	72%	18	
2002	21.95			18.21	15.79			13.10	89%	18	
2003	24.00			3.84	17.27			2.76	89%	18	
2004	12.09			10.36	8.69			7.45	83%	18	
2005	3.71			4.32	2.67			3.11	79%	19	
2006	16.44			9.52	11.83			6.85	63%	19/*25	
2007	15.30			8.43	11.00			6.07	79%	19/*25	
2008	8.46			5.55	6.09			3.99	79%	19/*25	
2009	15.05			5.42	10.86			4.23	74%	19/*30	
2010	12.60			18.48	9.11			13.67	100%	19/*32	
2011											No sampling because of flood.
2012	21.15			11.65	15.25			8.71	95%	19/*25	
2013	15.78			17.83	11.35			12.83	95%	19/*26	
2014	39.35			11.82	30.76			9.34	100%	18/*34	
2015	20.47			10.62	16.18			10.99	95%	19/*31	
2016	1.05			3.77	0.75			3.76	47%	19/*29	
2017	4.24			3.92	3.05			3.91	78%	9/*15	9 of 19 sites were fished due to flood
2018	0.15			2.11	0.11			1.57	10%	20/*27	
2019	3.52			1.42	2.77			1.02	50%	20/*28	
2020	26.58			4.75	19.86			3.63	71%	20/*28	

*) Average densities from extended electrofishing surveys in Vindelälven, also including areas and sites in the upper parts of the river which have recently been colonized by salmon (for more details se section 4.2.2). These average densities are used as input in the river model (see stock annex).

Table 3.1.2.1. Continued.

River year	Number of parr/100 m² 0+	1+	≥2+	>0+	*) 0+	*) 1+	*) ≥2+	*) >0+	Sites with 0+ parr (%)	Number of sampling sites	Notes
Öreälven											
1989	0			0.01	0.00			0.00	0%	14	
1990	0			0.00	0.00			0.00	0%	8	
1991	0			0.25	0.00			0.12	0%	8	
1992	0			0.25	0.00			0.12	0%	6	
1993	0			0.03	0.00			0.01	0%	13	
1994	0			0.00	0.00			0.00	0%	8	
1995	0.21			0.04	0.10			0.02	30%	10	
1996	0.44			0.00	0.22			0.00	30%	10	
1997	0.23			0.70	0.38			0.37	50%	10	
1998	1.02			0.34	1.03			0.21	75%	8	
1999	0.44			0.47	1.01			0.29	40%	10	
2000	0.60			0.80	1.35			0.48	67%	9	
2001											No sampling because of flood.
2002	6.73			1.35	4.92			0.79	60%	10	
2003	3.39			2.62	3.53			1.44	60%	10	
2004	2.12			0.16	3.16			0.24	56%	9	
2005	8.02			1.41	6.35			0.88	44%	9	
2006	5.91			4.84	5.98			2.14	60%	10	
2007	1.36			0.39	3.58			0.42	30%	10	
2008	1.16			1.09	3.74			0.78	40%	10	
2009	10.69			1.64	8.73			1.08	100%	10/*20	
2010	3.59			2.45	4.53			2.50	80%	10/*21	
2011	3.69			1.06	3.33			1.17	89%	9	
2012	7.35			4.32	3.90			2.14	80%	10/*15	
2013	3.96			1.89	3.06			1.13	56%	9/*13	
2014	6.04			2.05	6.25			1.59	100%	10/*14	
2015	21.64			7.35	20.97			4.46	100%	10/*13	
2016	17.50			9.13	12.90			5.79	80%	10/*13	
2017	15.29			7.67	11.27			4.87	80%	10	
2018	1.67			6.38	1.16			4.90	50%	10/*16	
2019	19.85			2.92	18.70			1.70	100%	10/*16	
2020	20.18			10.92	33.46			2.48	100%	10/*15	

*) Average densities from extended electrofishing surveys in Öreälven also including areas
and sites in the upper parts of the river which have recently been colonized by salmon (for more details se section 4.2.2).
These average densities are used as input in the river model (see stock annex).

Table 3.1.2.1. Continued.

River year	Number of parr/100 m²								Sites with 0+ parr (%)	Number of sampling sites	Notes
	0+	1+	≥2+	>0+	*) 0+	*) 1+	*) ≥2+	*) >0+			
Lögdeälven											
1989	0.69			0.53	0.25			0.30	50%	8	
1990	2.76			0.46	1.00			0.26	44%	9	
1991	3.16			0.37	1.14			0.21	88%	8/*9	
1992	0.14			0.79	0.05			0.45	38%	8	
1993	0.53			0.79	0.19			0.45	38%	8	
1994	0.42			0.66	0.20			0.45	38%	8	
1995	2.17			1.71	1.05			1.16	88%	8	
1996	2.64			0.87	1.28			0.59	89%	9	
1997	2.59			2.79	1.42			1.96	88%	8	
1998	13.7			3.69	5.31			2.21	100%	6	
1999	5.67			0.48	3.25			1.97	100%	8	
2000	4.80			4.10	2.41			2.59	86%	7	
2001											No sampling because of flood.
2002	5.01			1.54	3.44			1.42	100%	7	
2003	11.14			3.47	5.23			2.40	100%	8	
2004	13.26			3.64	6.16			2.56	100%	8	
2005	11.19			5.06	7.61			3.31	100%	8	
2006	6.73			3.91	5.35			2.75	88%	8	
2007	2.86			2.70	3.42			2.15	63%	8	
2008	9.68			3.76	7.30			2.79	100%	8	
2009	11.63			5.72	8.53			3.92	100%	8/*12	
2010	12.19			2.44	10.85			3.15	100%	8/*18	
2011	10.9			2.93	9.44			3.53	88%	8	
2012	5.42			3.20	5.80			3.80	100%	8/*19	
2013	9.55			1.49	11.22			3.87	100%	8/*14	
2014	14.85			7.43	11.98			5.48	100%	8/*14	
2015	16.53			7.97	14.99			11.27	100%	8/*11	
2016	16.93			9.44	13.90			7.95	100%	8/*11	
2017	8.50			12.60	6.98			10.61	100%	8	
2018	1.90			8.94	9.70			9.25	100%	8/*13	
2019	14.36			7.83	20.48			6.81	100%	8/*13	
2020	14.40			12.61	20.57			13.08	92%	8/*13	

*) Average densities from extended electrofishing surveys in Lögdeälven also including areas
and sites in the upper parts of the river which have recently been colonized by salmon (for more details se section 4.2.2).
These average densities are used as input in the river model (see stock annex).

Table 3.1.3.1. Densities and occurrence of wild salmon parr in electrofishing surveys in the assessment unit 3 (Subdivisions 30). Detailed information on the age structure of older parr (>0+) is not available.

River year	Number of parr/100 m² by age group 0+	1+	2+ & older	>0+	Sites with 0+ parr (%)	Number of sampling sites	Notes
Ljungan							
1990	5.5			4.8	67%	3	
1991	16.5			0.6	100%	3	
1992							
1993							
1994	6.9			0.2	100%	3	
1995	11.9			0.9	100%	3	
1996	8.6			6.5	100%	3	
1997	19.6			2.1	100%	6	
1998						0	No sampling because of flood
1999	17.4			7.9	80%	5	
2000	10.6			6.5	86%	7	
2001						0	No sampling because of flood
2002	23.9			2.6	100%	8	
2003	11.6			0.2	100%	8	
2004	3.1			1.4	56%	9	
2005	45.3			2.3	100%	9	
2006						0	No sampling because of flood
2007	7.7			2.0	89%	9	
2008	18.9			0.3	100%	3	Flood; only a part of sites were fished.
2009						0	No sampling because of flood
2010						0	No sampling because of flood
2011						0	No sampling because of flood
2012	91.1			5.6		1	Only one site fished because of flood
2013							No sampling because of flood
2014	48.9			0.7	100%	6	
2015	107			12.2	100%	9	
2016	26.8			4.5	100%	9	
2017	0.8			2.3	20%	10	
2018	0.0			0.2	0%	6	
2019	3.4			0.0	80%	10	
2020	4.2			1.6	73%	11	
Testeboån							
2000	17.6			n/a		10	
2001	32.7			n/a		10	
2002	40.0			n/a		10	
2003	16.7			n/a		10	
2004	17.8			n/a		10	
2005	12.3			n/a		5	
2006	8.2			n/a		5	
2007	10.8			17.8		10	
2008	0.0			4.9		11	
2009	8.8			0.8		11	
2010	12.3			6.9		11	
2011	11.1			2.4		11	
2012	10.2			6.0		11	
2013	15.7			9.9		11	
2014	5.2			7.9		11	
2015	11.1			0.8	73%	11	
2016	27.8			6.0	73%	11	
2017	6.6			6.7	64%	11	
2018	4.9			5.7	73%	11	
2019	2.7			3.9	55%	11	
2020	28.2			1.9	91%	11	

n/a = reared parr, which are stocked, are not marked;
natural parr densities can be monitored only from 0+ parr

Table 3.1.4.1. Densities of wild salmon parr in electrofishing surveys in the rivers of the assessment unit 4 (subdivisions 25–26, Baltic Main Basin).

River year	Number of parr/100 m²		Number of sampling sites	Number of parr/100m², extended sites included.		Number of sampling sites from extended survays	Notes
	0+	>0+		*) 0+	*) >0+		
Mörrumsån							
1973	32	33					
1974	12	21					
1975	77	13					
1976	124	29					
1977	78	57					
1978	145	49					
1979	97	65					
1980	115	60					
1981	56	50					
1982	117	31					
1983	111	74					
1984	70	67					
1985	96	42		33	15	6	
1986	132	39		53	14	5	
1987							No sampling
1988							No sampling
1989	307	42	11	116	15	6	
1990	114	60	11	61	18	6	
1991	192	55	11	116	18	5	
1992	36	78	11	24	26	5	
1993	28	21	11	25	9	6	
1994	34	8	11	23	5	6	
1995	61	5	11	47	3	9	
1996	53	50	11	37	18	9	
1997	74	15	14	44	12	9	
1998	120	29	9	63	16	10	
1999	107	35	9	58	20	10	
2000	108	21	9	55	12	10	
2001	92	22	9	49	13	10	
2002	95	14	9	49	9	10	
2003	92	28	9	51	16	10	
2004	80	21	7	51	16	6	
2005	98	29	9	56	16	10	
2006	61	34	9	36	19	10	
2007	54	10	4				Flood, only a part of sites were fished.
2008	102	16	9	60	8	10	
2009	61	14	8	48	7	10	
2010	97	27	8	69	15	11	
2011	36	18	5	27	9	8	
2012	96	14	5	45	7	14	
2013	99	30	7	64	16	18	
2014	95	23	8	48	14	17	
2015	81	31	8	56	25	14	
2016	72	20	8	38	11	18	
2017	58	14	9	40	12	18	
2018	39	15	8	26	11	17	
2019	119	6	8	65	3	18	
2020	37	13	8	36	13	18	

*) Average densities in Mörrumsån from extended electrofishing surveys also including areas and sites in the upper parts of the river which have recently been colonized by salmon. These weighted averages are used as input in the river model (see stock annex)

Table 3.1.4.1. Continued.

River year	Number of parr/100 m²		Number of sampling sites	Number of parr/100m², extended sites included.		Number of sampling sites from extended survays	Notes
	0+	>0+		*) 0+	*) >0+		
Emån							
1967	52	4					
1980-85	52	8					
1992	49	10					
1993	37	9	2	7	3	2	
1994	24	7	2	3	1	5	
1995	32	4	4	10	1	4	
1996	34	8	4	13	2	5	
1997	71	6	4	23	1	4	
1998	51	6	2	33	3	5	
1999	59	7	4	17	1	5	
2000	51	3	4	8	0	8	
2001	37	3	4	18	1	3	
2002	57	4	4	21	1	5	
2003	46	4	7	20	1	5	
2004	45	4	6	22	2	5	
2005	60	4	7	28	2	8	
2006	13	1	7	9	1	9	
2007	36	2	5	27	1	5	
2008	35	3	6	25	2	8	
2009	61	3	4	45	5	8	
2010							No sampling due to flood
2011	25	2	6	26	3	7	
2012	47	4	4	28	3	10	
2013	30	10	4	23	8	9	
2014	27	3	7	31	4	9	
2015	25	5	7	32	6	9	
2016	53	8	7	53	8	11	
2017	48	7	7	41	6	11	
2018	9	4	7	8	4	12	
2019	27	2	7	30	1	11	
2020	21	2	7	29	2	11	

*) Average densities in Emån from extended electrofishing surveys also including areas and sites in the upper parts of the river which have recently been colonized by salmon. These weighted averages are used as input in the river model (see stock annex)

Table 3.1.5.1. Densities of wild salmon parr in electrofishing surveys in the Latvian and Estonian wild salmon rivers of the assessment unit 5 (Gulf of Riga. Subdivision 28).

River year	Number of parr/100 m² by age group 0+	>0+	Number of sampling sites
Pärnu			
1996	3.8	0.0	1
1997	1.0	0.1	1
1998	0.0	0.0	1
1999	0.2	0.4	1
2000	0.8	0.4	1
2001	3.1	0.0	1
2002	4.9	0.0	1
2003	0.0	0.0	1
2004	0.0	0.0	1
2005	9.8	0.0	1
2006	4.2	0.0	1
2007	0.0	0.0	1
2008	0.0	0.0	1
2009	18.4	0.0	1
2010	0.0	0.0	1
2011	0.0	0.0	1
2012	1.7	0.0	1
2013	1.0	0.1	5
2014	0.5	0.0	5
2015	5.4	0.2	6
2016	0.1	0.3	6
2017	22.8	0.2	5
2018	0.6	0.1	14
2019	6.5	0.0	5
2020	8.1	0.0	5
Salaca			
1993	16.7	4.9	5
1994	15.2	2.6	5
1995	12.8	2.8	5
1996	25.3	0.9	6
1997	74.4	3.1	5
1998	60.0	2.8	5
1999	68.7	4.0	5
2000	46.3	0.8	5
2001	65.1	4.4	5
2002	40.2	10.3	6
2003	31.5	1.3	5
2004	73.8	2.7	5
2005	129.4	3.8	5
2006	69.7	17.9	5
2007	69.6	6.9	5
2008	92.3	4.9	5
2009	70.1	10.3	5
2010	26.5	7.4	5
2011	34.5	1.2	5
2012	72.2	1.9	5
2013	43.4	10.4	5
2014	59.1	3.8	5
2015	137.6	5.7	5
2016	67.7	5.5	5
2017	99.9	7.3	5
2018	21.3	8.2	5
2019	67.6	0.5	5
2020	112.6	2.2	5

Table 3.1.5.1. Continued.

Gauja			
2003	0.0	0.0	1
2004	6.0	0.3*	6
2005	0.0	0.0	1
2006	0.2	0.0	5
2007	0.0	0.0	5
2008	0.1	0.1	3
2009	0.7	0.3	3
2010	0.1	0.9	3
2011	0.4	1.6	3
2012	0.8	0.0	3
2013	0.3	0.1	4
2014	3.9	0.1	4
2015	1.8	1.6	4
2016	0.3	0.1	4
2017	4.4	0.4	4
2018	5.2	0.1	4
2019	6.2	0.1	4
2020	1.8	0.0	5
Venta			
2003	0.5	0.2	7
2004	20.8	5.6	7
2005	29.9	1.1	6
2006	2.6	2.9	5
2007	10.1	0.1	5
2008	18.0	1.5	5
2009	9.7	0.1	5
2010	0.2	0.2	5
2011	4.4	0.0	5
2012	12.3	0.7	5
2013	6.0	0.1	5
2014	10.9	0.4	5
2015	16.7	0.1	5
2016	3.8	0.1	5
2017	5.3	0.2	5
2018	0.8	0.0	5
2019	3.0	0.1	5
2020	4.4	0.1	5
Amata[2)]			
2003	0.0	4.1*	3
2004	7.9	3.4*	3
2005	2.7	1.3	3
2006	16.7	3.4	3
2007	0.0	5.8	3
2008	6.2	1.8	3
2009	8.5	6.3	3
2010	3.3	3.9	3
2011	1.2	0.5	3
2012	1.0	1.4	3
2013	4.6	2.1	3
2014	15.6	3.5	3
2015	12.1	1.2	3
2016	0.0	0.9	3
2017	1.7	0.8*	3
2018	15.0	1.3	3
2019	0.9	0.8	3
2020	9.2	1.2	3

[2)] tributaries to Gauja

*) reard fish

Table 3.1.5.2. Densities of salmon parr in electrofishing surveys in rivers in Lithuanian of the assessment unit 5 (Baltic Main Basin).

River	Number of parr/100 m² by age group		Number of sampling sites
year	0+	>0+	
Neris			
2000	0.19	0.06	10
2001	2.51	0.00	10
2002	0.90	0.00	11
2003	0.27	0.00	11
2004	0.41	0.05	10
2005	0.10	0.03	9
2006	0.06	0.02	9
2007	1.68	0.36	9
2008	7.44	0.32	9
2009	7.31	0.27	9
2010	0.10	0.16	9
2011	1.19	0.16	10
2012	3.30	0.20	9
2013	0.56	0.02	10
2014	0.90	0.01	12
2015	4.60	0.15	11
2016	1.52	0.30	11
2017	3.00	0.20	11
2018	3.46	0.70	11
2019	12.95	0.03	11
2020	10.50	0.17	11
Žeimena			
2000	4.10	0.46	7
2001	1.40	0.10	7
2002	0.66	0.00	6
2003	0.72	0.00	6
2004	3.10	0.30	6
2005	1.33	0.47	5
2006	2.52	0.06	5
2007	4.20	0.80	5
2008	2.80	0.10	7
2009	3.50	0.40	7
2010	0.20	0.00	7
2011	5.70	1.20	5
2012	1.40	0.60	6
2013	2.37	0.30	6
2014	2.90	0.90	6
2015	9.20	0.00	6
2016	3.30	0.40	6
2017	2.80	0.00	6
2018	6.20	2.50	6
2019	8.18	0.00	6
2020	11.70	0.10	6

River	Number of parr/100 m² by age group		Number of sampling sites
year	0+	>0+	
Mera			
2000	0.13	0.00	3
2001	0.27	0.00	3
2002	0.08	0.00	4
2003	0.00	0.00	4
2004	0.00	0.00	3
2005	0.00	0.00	2
2006	0.00	0.05	2
2007	0.22	0.22	2
2008	0.00	0.50	2
2009	0.00	0.25	3
2010	0.00	0.00	3
2011	0.00	0.05	3
2012	0.00	0.00	3
2013	0.08	0.00	3
2014	0.00	0.30	4
2015	0.00	0.00	3
2016	0.00	0.17	3
2017	0.00	0.00	4
2018	0.17	0.08	3
2019	0.59	0.09	3
2020	0.00	0.00	3
Saria			
2000	2.5	0.00	1
2001	0.7	0.00	1
2002	0.00	0.00	1
2003	0.4	0.00	1
2004	3.00	0.00	1
2005	0.00	0.4	1
2006	n/a	n/a	
2007	0.00	0.00	1
2008	n/a	n/a	
2009	1.96	0.00	1
2010	n/a	n/a	
2011	n/a	n/a	
2012	0.8	0.00	2
2013	n/a	n/a	
2014	n/a	n/a	
2015	1.05	0.15	2
2016	n/a	n/a	
2017	n/a	n/a	
2018	0.55	0.55	1
2019	0.00	0.00	1
2020	n/a	n/a	

Table 3.1.6.1. Estonian wild and mixed salmon rivers in the Gulf of Finland.

River	Wild or mixed	Water quality[1)]	Flow m³/s		First obstacle km	Undetected parr cohorts 1997-2020	Production of >0+ parr 1997-2020
			mean	min			
Purtse	mixed	IV	6.7	3.7	4.9	1 (since 2006)	0–8.4
Kunda	wild	III	4.3	0.8	2	1	0.4–49.3
Selja	mixed	V	2.4	0.8	42	6	0–7.7
Loobu	mixed	II	2.0	0.3	10	2	0–16.6
Valgejõgi	mixed	IV	3.4	0.6	85	2	0.8–7.2
Jagala	mixed	II	7.3	0.7	2	7	0–0.9
Pirita	mixed	V	6.8	0.4	70	4	0–8.8
Vaana	mixed	V	1.9	0.3	21	9	0–4.2
Keila	wild	V	6.2	0.5	2	3	0–48.9
Vasalemma	wild	II	3.5	0.2	34.8	3	0–8.9

[1)] **Classification of EU Water Framework Directive.**

Table 3.1.6.2. Densities of salmon parr rivers with only wild salmon populations, Subdivision 32.

River year	Number of parr/100 m2 by age group 0+	>0+	Number of sampling sites
Kunda			
1992	8.3	7.7	1
1993	0.0	5.3	1
1994	3.1	0.0	1
1995	19.5	3.6	1
1996	28.6	16.2	1
1997	1.9	25.4	1
1998	17.5	1.0	1
1999	8.2	21.4	1
2000	26.4	8.9	1
2001	38.4	17.4	1
2002	17.0	5.9	1
2003	0.8	4.3	1
2004	30.1	0.4	1
2005	5.0	49.3	1
2006	27.2	14.6	3
2007	5.5	5.8	3
2008	5.5	0.4	1
2009	46.5	0.8	1
2010	2.5	1.2	1
2011	16.6	14.6	1
2012	12.1	13.8	1
2013	13.5	6.5	3
2014	29.0	8.9	1
2015	105.8	14.1	1
2016	177.2	25.5	1
2017	139.6	20.2	1
2018	268.5	29.9	1
2019	246.9	15.8	1
2020	140.1	37.7	1
Keila			
1994	1.2	1.1	1
1995	8.9	0.4	1
1996	14.9	1.3	1
1997	0.0	6.2	1
1998	0.0	6.6	1
1999	120.3	1.5	1
2000	4.8	5.4	1
2001	0.0	1.5	1
2002	8.4	0.4	1
2003	0.0	0.0	1
2004	0.6	0.0	1
2005	31.9	3.0	1
2006	6.3	8.0	1
2007	18.9	2.8	1
2008	44.2	4.3	1
2009	55.8	25.8	1
2010	110.1	12.3	1
2011	25.0	24.7	1
2012	43.5	3.9	3
2013	157.1	33.8	1
2014	82.2	48.9	1
2015	111.8	18.1	1
2016	107.6	25.8	1
2017	283.1	27.0	1
2018	179.5	40.6	1
2019	233.7	23.4	1
2020	207.5	31.7	1
Vasalemma			
1992	4.3	3.1	1
1993	*	*	0
1994	2.4	0.0	1
1995	23.7	0.5	1
1996	6.1	5.9	1
1997	0.0	1.8	1
1998	0.0	0.1	1
1999	17.1	0.0	1
2000	4.4	2.0	1
2001	0.5	1.0	1
2002	8.9	0.4	1
2003	0.0	0.0	1
2004	0.0	0.0	1
2005	21.4	0.0	1
2006	9.9	1.0	2
2007	5.2	0.3	2
2008	2.5	1.1	2
2009	37.6	0.0	2
2010	26.0	1.9	2
2011	7.3	4.1	2
2012	6.8	1.1	2
2013	39.8	3.5	2
2014	26.1	4.2	2
2015	2.1	6.4	2
2016	18.2	0.5	2
2017	52.4	4.4	2
2018	27.8	8.9	2
2019	16.7	2.6	4
2020	24.7	6.3	4

*) = no electrofishing

Table 3.1.6.3. Densities of wild salmon parr in rivers where supportive releases are carried out, Subdivision 32.

River year	Number of parr/100 m^2 by age group 0+	>0+	Number of sampling sites
Purtse			
2005	0.0	0.0	2
2006	3.5	1.1	2
2007	12.5	0.2	3
2008	0.6	4.9	3
2009	1.8	4.1	3
2010	0.1	0.7	3
2011	0.0	2.1	3
2012	36.3	0.0	3
2013	15.3	8.4	3
2014	36.6	5.7	3
2015	8.4	4.0	3
2016	3.7	2.5	3
2017	43.9	1.7	3
2018	76.2	7.5	3
2019	25.5	6.8	3
2020	48.1	3.8	3
Selja			
1995	1.7	7.7	1
1996	0.0	0.5	1
1997	0.0	0.0	1
1998	0.0	0.0	1
1999	0.0	2.3	7
2000	1.5	0.3	3
2001	1.8	4.4	2
2002	0.0	0.0	2
2003	0.0	0.1	3
2004	0.0	0.9	2
2005	5.2	2.1	4
2006	0.9	0.2	3
2007	0.3	0.1	4
2008	19.3	5.1	3
2009	19.8	4.9	4
2010	9.3	1.4	4
2011	1.9	1.0	4
2012	22.8	3.4	4
2013	38.2	4.0	4
2014	14.6	4.4	3
2015	37.8	0.7	3
2016	1.9	0.7	3
2017	131.2	0.5	3
2018	122.5	6	3
2019	66.4	2.8	3
2020	55.0	2.0	3

*) = no electrofishing

River year	Number of parr/100 m^2 by age group 0+	>0+	Number of sampling sites
Valgejõgi			
1998	0	0	2
1999	1.7	0.9	6
2000	0.3	0.7	5
2001	2.4	0.7	4
2002	8.9	0.0	1
2003	0.1	0.3	3
2004	0.8	3.6	2
2005	7.4	3.3	3
2006	12.4	3.0	3
2007	8.8	6.7	3
2008	8.5	5.2	3
2009	20.2	5.7	3
2010	5.6	7.2	3
2011	0	3.6	3
2012	11	0.8	3
2013	19.2	3.5	3
2014	21.6	5.1	3
2015	16.8	6.8	3
2016	0.6	3	3
2017	13	2	5
2018	7.1	1.1	11
2019	13.2	1.6	6
2020	30	3.1	6
Jägala			
1998	0.0	0.0	1
1999	1.3	0.0	1
2000	0.0	0.0	1
2001	18.9	0.0	1
2002	0.0	0.0	1
2003	0.0	0.1	1
2004	0.6	0.0	1
2005	4.4	0.0	1
2006	0.0	0.2	1
2007	0.0	0.0	1
2008	6.6	0.0	1
2009	0.4	0.9	1
2010	4.4	0.0	1
2011	0.0	0.0	1
2012	11.6	0.0	1
2013	0.3	0.0	1
2014	1.5	0.0	1
2015	0.0	0.0	1
2016	3.2	0.0	1
2017	1.3	1.3	1
2018	1.2	0.0	1
2019	0.0	0.0	1
2020	1.7	0.0	1

Table 3.1.6.3. Continued.

River year	Number of parr/100 m^2 by age group		Number of sampling sites
	0+	>0+	
Loobu			
1994			
1995	1.5	3.3	2
1996	2.9	0.7	2
1997	0.0	1.9	3
1998	0.0	0.0	1
1999	0.2	0.0	2
2000	6.3	0.5	4
2001	0.5	0.7	4
2002	0.0	0.3	4
2003	0.2	0.1	3
2004	0.0	2.4	4
2005	1.5	4.2	4
2006	3.0	7.8	5
2007	0.8	1.7	5
2008	3.1	0.0	5
2009	17.7	0.2	4
2010	26.8	15.0	4
2011	57.1	6.4	4
2012	0.4	5.1	4
2013	28.3	3.9	4
2014	64.5	5.0	4
2015	1.8	16.6	4
2016	37.6	1.2	4
2017	4.3	9.0	4
2018	36.3	0.9	4
2019	64.0	10.2	4
2020	52.7	9.5	4
	72.7	10.0	4
Kymijoki			
1991			
1992	4.1	NA	5
1993	24.1	NA	5
1994	5.8	NA	5
1995	4.3	NA	5
1996	24.8	NA	5
1997	2.9	NA	5
1998	4.0	NA	5
1999	2.3	NA	5
2000	18.0	NA	5
2001	19.0	NA	5
2002	29.7	NA	5
2003	19.4	NA	5
2004	9.1	NA	5
2005	34.3	NA	5
2006	59.5	NA	5
2007	28.5	NA	5
2008	17.5	NA	5
2009	15.7	NA	5
2010	36.6	NA	5
2011	37.8	NA	5
2012	13.0	NA	5
2013	12.7	NA	5
2014	23.1	NA	5
2015	54.0	NA	5
2016	112.7	NA	5
2017	33.7	NA	5
2018	11.0	NA	5
2019	95.2	NA	5
2020	62.8	NA	5
*) = no elect	94.0	NA	5

River year	Number of parr/100 m^2 by age group		Number of sampling sites
	0+	>0+	
Pirita			
1992	2.4	0.8	1
1993	*	*	0
1994	0.0	0.0	1
1995	0.0	0.0	1
1996	0	0.1	1
1997	*	*	0
1998	0	0	6
1999	7.7	0.1	5
2000	0.0	0.6	4
2001	1.5	0.1	6
2002	0.0	0.3	6
2003	0.0	2.8	6
2004	0.2	0.8	4
2005	24.0	8.7	4
2006	8.9	3.0	4
2007	3.2	3.4	4
2008	14.6	5.8	4
2009	23.1	6.5	7
2010	12.2	5.4	4
2011	0.6	1.8	4
2012	11.2	0.3	8
2013	38.3	8.1	4
2014	15.8	3.7	4
2015	49.3	2.3	4
2016	3.0	8.8	4
2017	81.4	1.9	4
2018	27.9	8.2	4
2019	23.9	3.2	4
2020	52.2	2.5	4
Väana			
1998	0.0	0.1	5
1999	0.0	0.4	4
2000	0.1	0.0	4
2001	0.0	0.0	2
2002	0.0	0.2	4
2003	0.0	0.0	4
2004	0.0	0.0	2
2005	0.0	0.0	4
2006	17.6	0.0	4
2007	0.0	0.6	3
2008	12.1	0.0	3
2009	9.0	4.2	3
2010	0.0	1.1	3
2011	0.0	0.3	3
2012	3.3	0.0	3
2013	4.7	0.6	3
2014	12.1	1.5	3
2015	0.0	1.5	3
2016	0.0	0.2	3
2017	10.8	0.1	3
2018	12.2	1.8	3
2019	6.2	0.3	3
2020	9.5	2.1	3

Table 3.2.1.1. Current status of reintroduction programme in Baltic Sea potential salmon rivers. Potential production estimates are uncertain and currently being re-evaluated.

River	Description of river						Restoration programme						Results of restoration			
	Country	ICES sub-division	Old salmon river	Cause of salmon population extinction	Potential production areas (ha)	Potential smolt production (num.)	Officially selected for reintroduction	Programme initiated	Measures	Releases	Years with releases	Origin of population	Parr and smolt production from releases	Spawners in the river	Wild parr production	Wild smolt production
Moälven	SE	31	yes	3.4	7	2000	no	yes	c,l	2	2	Byskeälven	yes	yes	>0	>0
Alsterån	SE	27	yes	2.3	4	4000	no	no	c,g,l	4	2	**	**	yes	>0	>0
Helgeån	SE	25	yes	2.3	7	3200	no	yes	c,e,m	2	3	Mörrumsån	yes	yes	>0	>0
Kuivajoki	FI	31	yes	1.2	58	17000	yes	yes	b,c,f	1. 4	4	Simojoki	no	no	no	0
Kiiminkijoki	FI	31	yes	1.2	110	40000	yes	yes	b,c,d,f	2	5	Iijoki	yes	yes	yes	>0
Siikajoki	FI	31	yes	1.2.3	32	15000	no	yes	b,g,m	1. 4	4	Mixed	no	*	0	0
Pyhäjoki	FI	31	yes	1.2.3	98	35000	yes	yes	b,c,d,f,m	1. 4	5	Tornionjoki/Oulujoki	no	no	no	0
Kalajoki	FI	31	yes	1.2.3	33	13000	no	yes	b,e, m	1. 4	2		no	*	*	*
Perhonjoki	FI	31	yes	1.2.3	5	2000	no	yes	b,f	1. 4	4	Tornionjoki/Oulujoki	yes	*	*	*
Merikarvianjoki	FI	30	yes	1.2.3	8	2000	no	yes	b,c,f,e	1. 4	5	Neva	yes	yes	>0	*
Kiskonjoki	FI	29	no?	2.3	2	2000	no	yes	b,c f,i,l	2	1	Neva	yes	yes	>0	*
Uskelanjoki	FI	29	no?	2.3	6	3000	yes	yes	b,c,f,i,m	1	5	Neva	yes	yes	*	*
Vantaanjoki	FI	32	no?	2.3.4	16	10000	no	yes	b,c,f,i,m	1	5	Neva	yes	yes	>0	>0
Porvoonjoki	FI	32	no?		6	5000	no	yes	b,c f,l	1	2	Neva	yes	yes	0	*
Koskenkylänjoki	FI	32	no?	2.3	6.5	5000	yes	yes	b,c f,l	1	2	Neva	yes	yes	>0	*
Urpalanjoki	FI	32	yes	2.3	2.3	2000	yes	yes	a,b,c,f,i,m	1	2	Neva	yes	yes	>0	*
Rakkolanjoki	FI	32	no?	2.3.4	2.5	2500	no	yes	a,b,c,f,i,m	1	2	Neva	yes	yes	>0	*
Sventoji	LI	26	yes	2.3	7	15000	yes	yes	m,c	2	*	Nemunas	yes	yes	6020	2730
Minija/Veivirzas	LI	26	yes	*	6	30000	yes	yes	c	2	*	Nemunas	no	no	0	0
Wisla/Drweca	PL	26	yes	1.2.3.4	*	*	yes	yes	b,m	2	5	Daugava	yes	yes	*	*
Slupia	PL	25	yes	1.2.3.4	*	*	yes	yes	b,m	2	5	Daugava	yes	yes	yes	*
Wieprza	PL	25	yes	1.2.3.4	*	*	yes	yes	b,m	2	5	Daugava	yes	yes	*	*
Łeba	PL	25	yes	1.2.3.4	*	*	yes	yes	b,m	2	3	Daugava	yes	yes	*	*
Parseta	PL	25	yes	1.2.3.4	*	*	yes	yes	b,m	2	5	Daugava	yes	yes	*	*
Rega	PL	25	yes	1.2.3.4	*	*	yes	yes	b	2	5	Daugava	yes	yes	*	*
Odra/Notec/Drawa	PL	24	yes	1.2.3.4	*	*	yes	yes	b,m	2	5	Daugava	yes	yes	*	*
Reda	PL	24	yes?	1.2.3.4	*	*	yes	yes	b	2	5	Daugava	yes	yes	*	*
Gladyshevka	RU	32	yes	1.2.4	1.5	1500	no	yes	a,g,k,n	2	4	Neva	yes	yes	>0	>0

Notes to Table 3.2.1.1.

Cause of salmon popul. extinction	**Measures**			**Releases**
1 Overexploitation	Fisheries			1 Has been carried out, now finished
2 Habitat degradation	a Total ban of salmon fishery in the river and river mouth			2 Going on
3 Dam building	b Seasonal or areal regulation of salmon fishery			3 Planned
4 Pollution	c Limited recreational salmon fishery in river mouth or river			4 Not planned
	d Professional salmon fishery allowed in river mouth or/and river			**Years with releases**
* No data	Habitat restoration	Dam removal	Fish ladder	1 Releses 0-5 years
** Not applicable	e partial	i planned	l planned	2 Releses 6-10 years
	f completed	j completed	m completed	3 Releses 11-15 years
	g planned	k not needed	n not needed	4 Releses 16-20 years
	h not needed			5 Releses >20 years
				*) add if not releases every year

Table 3.2.2.1. Densities of wild salmon parr in electrofishing surveys in potential rivers. Note that all the Lithuanian rivers listed are currently stocked (and therefore could be called 'mixed').

Country	Assess-ment unit	Sub-div	River and year	Number of parr /100 m²		Number of sampling sites
				0+	>0+	
Sweden	4	27	**Alsterån**			
			1997	13.3	0	1
			1998	23.8	5.4	1
			1999	6.8	7	1
			2000	8	3.4	1
			2001	1.5	1.3	1
			2002	36.2	0.4	1
			2003	0	4.4	1
			2004	0	0	1
			2005	13.2	0	1
			2006	0	3.6	1
			2007	0	0	1
			2008	0	0	1
			2009	0	0	1
			2010			no sampling
			2011	8.5	6	1
			2012	0	4.3	1
			2013	0	0	1
			2014	1.9	0	1
			2015	4.6	0	1
			2016			no sampling
			2017			no sampling
			2018			no sampling
			2019	0	0	1
			2020			no sampling
Finland	1	31	**Kuivajoki**			
			1999	0	n/a	
			2000	0	n/a	8
			2001	0	n/a	16
			2002	0.2	n/a	15
			2003	0.4	n/a	15
			2004	0.5	n/a	15
			2005	0.6	n/a	14
			2006	3.2	n/a	14
			2007	0.2	n/a	14
			2008-2020			no sampling
Finland	1	31	**Kiiminkijoki**			
			1999	1.8	n/a	
			2000	0.8	n/a	31
			2001	1.9	n/a	26
			2002	1.5	n/a	47
			2003	0.7	n/a	42
			2004	3.9	n/a	46
			2005	8.2	n/a	45
			2006	2.3	n/a	41
			2007	0.7	n/a	17
			2008	2.3	n/a	18
			2009	3.8	n/a	19
			2010	2	n/a	19
			2011			no sampling
			2012	6.6	n/a	2
			2013	3	n/a	20
			2014	1.8	n/a	12
			2015			no sampling
			2016			no sampling
			2017			no sampling
			2018	1.2	3.8*	15
			2019	3.2	0.7*	14
			2020	1.5	1.5*	14

table continues next page

* = adipose fin clipping enabled separation of wild-origin older parr from reared (

n/a = reared parr, which are stocked, are not marked;

natural parr densities can be monitored only from 0+ parr

Table 3.2.2.1. Continued.

Country	Assess-ment unit	Sub-div	River and year	Number of parr /100 m²		Number of sampling sites
				0+	>0+	
Finland	1	30	**Pyhäjoki**			
			1999	0.3	n/a	
			2000	0.2	n/a	23
			2001	0.9	n/a	18
			2002	1.9	n/a	20
			2003	0	n/a	22
			2004	0.2	n/a	13
			2005	0.7	n/a	16
			2006	0.2	n/a	17
			2007	0	n/a	13
			2008			no sampling
			2009	0.2	0	6
			2010	0	0.4	6
			2011	0	0	4
			2012-2020			no sampling
Russia	6	32	**Gladyshevka**			
			2001	0	0	2
			2002	0	0	2
			2003	0	0	3
			2004	6	0	2
			2005	15.6	4.1	3
			2006	7.7	6.2	2
			2007	3.1	3.7	4
			2008	0	2	1
			2009	0.9	0.3	1
			2010	1.2	2	4
			2011			no sampling
			2012			no sampling
			2013	3	3	3
			2014	2	3	3
			2015	24.3	9.2	4
			2016			no sampling
			2017	12.5	0	4
			2018			no sampling
			2019	51	4.6	4
			2020	4.8	4.5	3

table continues next page

Table 3.2.2.1. Continued.

Country	Assess-ment unit	Sub-div	River year	Number of parr/100 m^2 by age group		Number of sampling sites
				0+	>0+	
Lithuania	5	26	**Šventoji**			
			2000	1.9	0	6
			2001	0.25	0	6
			2002	2	0.1	6
			2003	0.1	0	6
			2004	0.62	0.28	6
			2005	0.5	0.46	4
			2006	3.15	1.35	4
			2007	4.8	0.1	4
			2008	5.8	0.3	5
			2009	6.1	1.4	5
			2010	0.94	0.84	5
			2011	6.3	2.3	5
			2012	4	1.5	5
			2013	4.8	0.8	5
			2014	5.32	0.08	5
			2015	8.23	2.7	5
			2016	3.12	1.7	5
			2017	0.54	0.1	5
			2018	3.4	1.4	5
			2019	10.73	0.9	6
			2020	4.26	0.63	6
Lithuania	5	26	**Siesartis**			
			2000	1.84	0	2
			2001	3.35	0.35	2
			2002	2.5	0	2
			2003	0.45	0	2
			2004	3.4	0	3
			2005	7.3	3	2
			2006	0.27	0.9	2
			2007	6.3	1.2	2
			2008	18.9	17.5	2
			2009	44.1	4	2
			2010	0.15	3.4	2
			2011	6.8	1.9	3
			2012	0.6	3.1	3
			2013	5	1.3	3
			2014	11.95	5.1	4
			2015	6.2	2.3	4
			2016	5.9	3.2	4
			2017	3.1	1.8	4
			2018	2.9	3.8	4
			2019	26.6	1.7	4
			2020	19.4	4.3	4
Lithuania	5	26	**Virinta**			
			2003	0.95	0	2
			2004	0.17	0	2
			2005	0.55	0.49	2
			2006	0.14	0	2
			2007	0	0	2
			2008	0	0	2
			2009	6.8	3.6	2
			2010			no sampling
			2011	13.7	0.38	2
			2012	0	0.5	2
			2013	2.4	0	2
			2014	5	0	2
			2015	1.5	0.9	2
			2016	3.7	1.0	2
			2017	0.35	0	2
			2018	6.3	1.9	2
			2019	1.4	0	2
			2020	2.17	2.33	2

Table 3.2.2.1. Continued.

Country	Assess-ment unit	Sub-div	River year	Number of parr/100 m² by age group 0+	>0+	Number of sampling sites
Lithuania	5	26	**Širvinta**			
			2004	1	0	2
			2005	1	0	2
			2006	0	0	2
			2007	6.35	0.35	2
			2008	10.9	0	2
			2009	11.2	0	2
			2010			no sampling
			2011	4.7	0.3	2
			2012	0	0	2
			2013	0.8	0	2
			2014	2.7	0.15	2
			2015	1.6	0	1
			2016	1.6	0.4	1
			2017	4.5	0	2
			2018	5.3	0.4	1
			2019	0	0	1
			2020	7.8	0	1
Lithuania	5	26	**Vilnia**			
			2000	0	0	3
			2001	0.7	0	3
			2002	1.3	0	4
			2003	0	0	3
			2004	0.36	0.15	3
			2005	4.48	0.13	3
			2006	0.49	2.63	3
			2007	0.58	0	3
			2008	1.53	0.28	3
			2009	3.1	2.14	3
			2010	3.6	1	5
			2011	3.3	1.6	3
			2012	3.5	1	3
			2013	3.7	1.7	3
			2014	31.4	2.3	4
			2015	8.8	3.75	4
			2016	14.9	3.2	4
			2017	16.7	6.3	4
			2018	2.1	2.7	4
			2019	28.7	0.2	4
			2020	15.5	6.0	4
Lithuania	5	26	**Vokė**			
			2001	4.3	0	2
			2002	0.16	0	2
			2003	0	0	2
			2004	9.5	0	2
			2005	0.77	0	2
			2006	0	0.8	2
			2007	4.1	0	2
			2008	4.50	0	2
			2009	3.4	0.5	2
			2010			no sampling
			2011	3.8	0	2
			2012	5.2	0.8	2
			2013	3.4	0.7	2
			2014	9.5	3.8	2
			2015	2.2	1.45	2
			2016	1.6	2.85	2
			2017	6.8	1.7	2
			2018	0.5	6.7	2
			2019	11.0	3.0	2
			2020	9.5	5.35	2

Table 3.2.2.1. Continued.

Country	Assess-ment unit	Sub-div	River year	Number of parr/100 m² by age group 0+	>0+	Number of sampling sites
Lithuania	5	26	**B. Šventoji**			
			2003	1.12	0	8
			2004	2.52	0	8
			2005	0	0.22	9
			2006			no sampling
			2007	0.02	0	5
			2008	0.02	0	3
			2009	2.6	0	4
			2010	0.59	0	4
			2011	2.94	0.15	2
			2012	3	0	2
			2013	2.8	0.33	2
			2014	8	0.8	2
			2015	8.7	1.5	2
			2016	0.41	0	4
			2017	3.3	0.54	3
			2018	0.8	0.5	2
			2019	1.48	0.12	2
			2020	2.02	0.52	2
Lithuania	5	26	**Dubysa**			
			2003	2.12	0	9
			2004	0.75	0	9
			2005	1.47	0	8
			2006	0	0.06	9
			2007	0.02	0	8
			2008	0.53	0.09	10
			2009	0.79	0	7
			2010	2.79	0	5
			2011	0.52	0.29	3
			2012	1.1	0.5	2
			2013	3.7	1	3
			2014	9	0.3	8
			2015	5.1	0.8	7
			2016	0.22	0.53	10
			2017	10.2	0.74	4
			2018	5.23	2.18	6
			2019	11.04	2.56	3
			2020	11.66	1.67	5
Lithuania	5	26	**Minija**			
			2009	0	0.01	7
			2010	2.38	0	4
			2011	11.54	0.78	4
			2012	1.4	1.8	4
			2013	6.7	0	3
			2014	3.5	0.1	6
			2015	3.95	0.54	6
			2016	1.2	0.2	11
			2017	3.6	0.3	5
			2018	0.29	0.36	2
			2019	1.73	0.1	3
			2020	4.45	1.03	5

Table 3.3.1.1. Salmon smolt releases by country and assessment units in the Baltic sea (x1000) in 1987–2020.

			Year																																	
Assessment unit	**Country**	**Age**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
1	Finland	2yr	1301	1703	1377	1106	1163	1273	1222	1120	1440	1394	1433	1528	1542	1679	1630	1541	1361	1541	1205	1439	1406	1340	1182	1165	1189	1155	1164	1135	1082	1063	1302	1265	1155	1171
		3yr			21	5			0.3			1	1	1			1						1	1												
1 Total			1301	1703	1398	1111	1163	1273	1223	1120	1440	1395	1434	1529	1542	1679	1630	1541	1361	1541	1205	1439	1407	1340	1182	1165	1189	1155	1164	1135	1082	1063	1302	1265	1155	1171
2	Sweden	1yr	292			8					22						5							84	98	150	195	194	207	252	320	404	378	270	265	204
		2yr	976	901	771	813	809	816	901	804	675	711	786	803	784	693	795	802	758	748	779	685	780	784	698	680	648	550	502	530	405	454	355	437	472	517
2 Total			1267	901	771	821	809	816	901	804	698	711	786	803	784	693	800	802	758	748	779	685	780	867	795	830	843	744	709	782	725	859	733	707	737	722
3	Finland	1yr	3							73														0.2	67	2										
		2yr	435	454	313	277	175	178	135	201	235	257	125	188	202	189	235	211	155	163	252	239	237	250	266	196	117	188	207	117	69	114	61	49	47	51
		3yr	19																			0.4														
	Sweden	1yr			10	12	11	41	10		103	43	69	43	38	35	47	84	162	96	273	268	391	564	628	688	711	847	795	818	869	887	860	822	645	902
		2yr	1026	983	1170	973	962	1024	1041	808	457	1011	1063	1072	864	1060	933	867	902	808	888	719	494	461	361	322	250	173	164	81	97	45	55	29	133	31
3 Total			1484	1437	1492	1261	1148	1242	1185	1083	794	1311	1257	1303	1104	1284	1215	1161	1218	1067	1414	1227	1122	1275	1322	1207	1078	1207	1166	1016	1034	1047	975	900	824	984
4	Denmark	1yr	62	60	46	60	13	64	80		70		103	30	35	72			14	13	16															
		2yr	8	10	10	12	11																													
	EU	1yr		25	107	60	109	40				7																								
		2yr		26	192	149	164	124	332	165	2	28																								
	Sweden	1yr	117	89	136	96	41	84	103	14	12	37	55	3		11		1				20							15	15	13	12	18	18	12	22
		2yr	129	113	18	58	69	25	33	68	3	4	9	2		1	9	5	5	6	7	8	31	8	17	20	11	9	3	3	3					
4 Total			317	323	509	435	407	337	548	246	87	76	167	35	35	84	9	7	19	19	23	28	31	8	17	20	11	9	18	18	16	12	18	18	12	22
5	Estonia	1yr			17	18	15	18	15																							11				34
		2yr																														10	11			6
	Poland	1yr		1						22	129	40	280	458	194	309	230	186	262	207	161	385	310	374	463	380	275	155	325	359	176	249	43	237	217	360
		2yr								2	107	77	30	80	175	60	24	86	53	58	69	79	98	30	32	41	31	11	55	12	12	10		1		
	Latvia	1yr	686	1015	1145	668	479	580	634	616	793	699	932	902	1100	1060	1069	867	961	777	566	814	868	944	752	756	394	649	737	738	675	614	678	569	787	730
		2yr	224	49	39	36	31	34	86	58	33	60	8	49	41	46		64	34	38	175	61	5	23	7											
	Lithuania	1yr													11				9	4	11	30			38		25	25	10	20	23	21	22	20	21	73
5 Total			910	1065	1201	722	525	632	735	698	1062	876	1250	1489	1521	1475	1324	1203	1317	1084	983	1371	1281	1371	1292	1177	724	839	1127	1128	886	914	753	827	1025	1203
Assessment units 1-5 Total			**5278**	**5429**	**5371**	**4350**	**4052**	**4300**	**4592**	**3950**	**4081**	**4369**	**4893**	**5158**	**4986**	**5215**	**4977**	**4713**	**4673**	**4460**	**4403**	**4750**	**4621**	**4862**	**4608**	**4399**	**3845**	**3954**	**4184**	**4079**	**3743**	**3894**	**3780**	**3716**	**3752**	**4101**
6	Estonia	1yr							22	33		30	18	52	36	69	129	101	86	82	96	125	80	122	125	77	64				32	22	37	80	34	9
		2yr		1									29	90	58	35	34	40	35	46	46	48	0	49	45	33	26	53	32	35	42	27	32	33	29	10
	Finland	1yr	156	26	23	30	67	26	120	66	63	45		15				65	80	58	84	13														
		2yr	429	415	372	363	349	315	190	198	284	346	222	253	326	362	400	338	266	275	325	276	222	337	266	271	146	218	199	150	79	99	103	145	183	134
		3yr	12																						3											
	Russia	1yr	85	113	81	100	102	13	128	78	124	102	174	85	165	77	103	136	70	271	233	247	278	270	230	238	129	315	466	427	352	450	377	373	662	519
		2yr	3	2	2	30			9	22	18	18	6	12	12	41	135	1	107	85	81	33	55	1	31		1		1	0.4						
6 Total			**686**	**556**	**478**	**524**	**518**	**354**	**470**	**398**	**489**	**542**	**449**	**507**	**597**	**584**	**801**	**681**	**644**	**817**	**865**	**742**	**635**	**778**	**700**	**617**	**366**	**586**	**697**	**613**	**505**	**598**	**549**	**631**	**908**	**672**
Grand Total			**5964**	**5986**	**5849**	**4874**	**4569**	**4654**	**5061**	**4347**	**4571**	**4911**	**5342**	**5665**	**5583**	**5799**	**5778**	**5394**	**5317**	**5277**	**5268**	**5492**	**5256**	**5639**	**5308**	**5016**	**4211**	**4540**	**4881**	**4692**	**4248**	**4492**	**4329**	**4347**	**4660**	**4773**

Table 3.3.1.2. Releases of salmon eggs, alevin , fry and parr to the Baltic Sea rivers by assessment unit in 1996–2020.

Assessment unit	year	age								
		eyed egg	alevin	fry	1s parr	1yr parr	2s parr	2yr parr	fry	2s
1	1996	73	278	92	338	685	15			
	1997		1033	459	321	834	14			
	1998		687	198	690	582				
	1999		1054	25	532	923	15			
	2000		835	27	402	935				
	2001				98	1079				
	2002			19	145	775	5			
	2003					395	10			
	2004				63	266				
	2005		98		96	451	15	21		
	2006		330	11	14	896				
	2007		201	30	82	482				
	2008		89	220	19	489				
	2009		210			212				
	2010		354	1		172				
	2011	22	614			68				
	2012		556			64				
	2013		129		1	63	0.3			
	2015		296		10	67				
	2016					69				
	2017					50				
	2018		300			73				
	2019		455			33				
	2020		200			296				
2	1996			362	415	117				
	1997			825	395	87				
	1998			969	394	190	3			
	1999			370	518	67	4			
	2000			489	477	71				
	2001			821	343	83				
	2002			259	334	127				
	2003			443	242	45				
	2004			200	155					
	2005			712	60					
	2006				80	36				
	2007				41	57				
	2017	300								
	2018	300		1		118				
	2019	20		146						
	2020				8					
3	1996	255		614	414	43	61			
	1997	482	2	596	390	60	93			
	1998	691		468	359	99	184			
	1999	391		16	443	4	29			
	2000	516		158	239	30	34			
	2001	177		736	263		16			
	2002	74		810	161		17			
	2003			655	56	0	31			
	2004			503	6		7			
	2005			151	2	48	27			
	2006			295		18	4			
	2007			126	43	28	7			
	2008			210		101	4			
	2009			174	8	22	5			
	2010		74	215	5	15	5			
	2011	86		61	79	40				
	2012			573	116	60				
	2013				216	79				
	2014			22	155	444				
	2015				133	6				
	2016			77		31				
	2017			5		16				
	2018			20		17				
	2019	19		36		60				
	2020	168				19				

Table 3.3.1.2. Continued.

4	1996			114	7	20	56			
	1997			159						
	1998				7		4			
	1999					3	1			
	2001			40			2			
	2002			88						
	2003			42						
	2005			70						
	2006			45						
	2007			69						
	2008			145						
	2012				20					
5	2001			100	96	14				
	2002			160	106	33				
	2003			109	515					
	2004			120	52	11	10			
	2005		420	199	224					
	2006		30	376	236	1				
	2007		200	418	125					
	2008		364	295	483	17				
	2009		240	863	81	56				
	2010		31	639	81	84				
	2011		50	866	441	25				
	2012		201	645	194	128				
	2013			522	381	16				
	2014			354	282	62				
	2015		40	495	218	2				
	2016		10	159	148	5				
	2017			247		61				
	2018			519	237					
	2019		35	649	196		13		5	
	2020		29	775	147	12				
6	1996	449	20		15	124				
	1997		8		6	236				
	1998	514		50		166				
	1999		277			267				
	2000	267	51			233				
	2001		74			250				
	2002	20	102		640	272	13	5		
	2003	21	120	120	240	248	35			
	2004		294		229	208	3			
	2005	80	26		263	110				
	2006				197					
	2007		98		90	148	28			
	2008		6		355	50	40			
	2009	610			260	63	143			
	2010				560	41	138			
	2011	94			212	55				
	2012				199	70	75			
	2013			99	112	95	7	28		
	2014			98	22	15	24			
	2015			99	127	5	89	4		
	2016				86	18				
	2017	56			55	120	21			
	2018			75	62	110	9			
	2019	48		47	52	126	6	13		4
	2020		22		40	162				

Table 3.3.3.1. Number of tagged hatchery-reared and wild salmon smolts released in assessment units 1, 2 or 3 and used in the salmon assessment (data not updated since 2012).

RELEASE YEAR	Reared salmon stocked in rivers without natural reproduction			Reared salmon stocked in rivers with natural reproduction			Wild salmon
	AU1	AU2	AU3	AU1	AU2	AU3	AU1
1987	29267	13258	23500	6900	1987	1994	629
1988	25179	13170	31366	4611	1989	2983	771
1989	11813	13157	36851	6428	2910	0	0
1990	9825	12824	31177	7467	3995	1996	0
1991	8960	13251	36655	7969	3990	1997	1000
1992	8920	12657	34275	5348	1996	1999	574
1993	7835	12656	34325	5968	1999	1991	979
1994	8077	12964	28717	5096	1997	2000	1129
1995	6988	12971	21877	6980	2000	0	0
1996	7967	13480	22429	6956	1000	1000	0
1997	6968	13403	23788	7981	1982	1997	0
1998	6929	13448	23547	5988	1974	994	1364
1999	7908	13445	23203	8925	2005	1996	2759
2000	7661	12018	26145	8484	2000	1000	3770
2001	7903	13498	16993	8412	2000	1000	4534
2002	7458	13992	18746	5969	2000	0	3148
2003	7233	13495	21485	8938	1997	1000	6299
2004	6946	12994	21987	6922	1981	1000	9604
2005	6968	13250	19478	9994	2000	1000	6607
2006	7933	13499	22755	10644	1650	1000	8034
2007	6982	7000	17804	10701	2000	1000	7069
2008	6998	7000	22047	9929	2000	1000	7105
2009	9924	7000	20000	4988	2000	1000	4177
2010	8566	7000	23145	6352	2000	1000	3772
2011	16924	7000	22985	2000	2000	0	6064
2012	15972	7000	18982	2205	2000	0	4993

Table 3.3.3.2. Number of Carlin-tagged salmon released into the Baltic Sea in 2020.

Country	24	25	26	27	28	29	30	31	32	Total
Denmark										0
Estonia										0
Finland								1,998		1,998
Sweden								5,000		5,000
Poland										0
Russia										0
Lithuania										0
Germany										0
Latvia										0
Total	0	0	0	0	0	0	0	6,998	0	6,998

Table 3.3.4.1. Releases of adipose finclipped salmon in the Baltic Sea and the number of adipose finclipped salmon registered in Latvian (subdivisions 26 and 28) offshore catches.

Year	Releases of adipose fin clipped salmon, subdivs. 24–32		Latvian offshore catches Sub-divs. 26 and 28	
	Parr	Smolt	Adipose fin clipped salmon in %	Sample N
1984			0.6	1,225
1985			1.0	1,170
1986			1.2	1,488
1987	43,149	69,000	0.6	1,345
1988	200,000	169,000	1.2	1,008
1989	353,000	154,000	1.5	1,046
1990	361,000	401,000	0.8	900
1991	273,000	319,000	1.4	937
1992	653,000	356,000	5.0	1,100
1993	498,000	288,000	7.8	900
1994	1,165,000	272,000	1.6	930
1995	567,470	291,061	2.0	855
1996	903,584	584,828	0.6	1,027
1997	1,626,652	585,630	4.4	1,200
1998	842,230	254,950	4.8	543
1999	1,004,266	625,747	4.4	1100
2000	1,284,100	890,774	7.2	971
2001	610,163	816,295	6.0	774
2002	536,800	733,191	2.5	883
2003		324,002	2.4	573
2004	10,000	648,563	3.2	621
2005	794,500	2,124,628	3.0	546
2006	258,714	1,753,543	2.4	250
2007	148224	2,126,906	0.0	100
2008	95,984	2,450,774	---	---
2009	72,731	2,325,750	---	---
2010	15,123	2,084,273	---	---
2011	127,496	2,341,228	---	---
2012	185,094	1,971,281	---	---
2013	13,200	1,768,083	---	---
2014	119,670	2,038,400	---	---
2015	142,361	2,690,095	---	---
2016	93,113	2,777,782	---	---
2017	166,364	3,728,054	---	---
2018	268,905	3,767,308	---	---
2019	89,800	3,743,215	---	---
2020	26,700	3,822,460	---	---

Table 3.3.4.2. Adipose finclipped salmon released in the Baltic Sea area in 2020 (and clipped or unclipped tagged using other methods).

Country	Species	Stock	Age	Number		River	Sub-division	Other tagging
				parr	smolt			
Estonia	salmon	Daugava	1 yr		33,700	Pärnu	28	
	salmon	Daugava	1 yr	11,600		Pärnu	28	
	salmon	Daugava	2 yr		6,300	Pärnu	28	600 T-bar
	salmon	Kunda	2 yr		3,300	Purtse	32	500 T-bar
	salmon	Kunda	1 yr	7,900		Purtse	32	
	salmon	Kunda	1 yr		4,300	Purtse	32	
	salmon	Kunda	1 yr		4,500	Valgejõgi	32	
	salmon	Kunda	2 yr		3,300	Valgejõgi	32	500 T-bar
	salmon	Kunda	1 yr	7,200		Valgejõgi	32	
	salmon	Kunda	2 yr		3,200	Jägala	32	500 T-bar
Finland	salmon	Tornionjoki	2 yr		3,800	Aurajoki	29	
	salmon	Simojoki	2 yr		5,600	Eurajoki	30	
	salmon	Tornionjoki	2 yr		32,600	Kokemäenjoki	30	
	salmon	Tornionjoki	1 yr			Kokemäenjoki	30	18 800 parr alizarin dye
	salmon	Iijoki	2 yr		27,000	Kiiminkijoki	31	
	salmon	Iijoki	2 yr		265,000	Iijoki	31	
	salmon	Iijoki	alevin			Iijoki	31	200 000 alizarin dye
	salmon	Oulujoki	2 yr		284,100	Oulujoki	31	
	salmon	Oulujoki	1 yr			Oulujoki	31	31 300 parr alizarin dye
	salmon	Neva	2 yr		2,900	at sea	32	
	salmon	Iijoki	2 yr		595,000	Kemijoki	31	
	salmon	Iijoki	1 yr			Kemijoki	31	259 400 parr alizarin dye
	salmon	Neva	2 yr		110,300	Kymijoki	32	
	salmon	Neva	2 yr		21,200	Karjaanjoki	32	
	salmon	Neva	2 yr		9,300	Kisko-Perniönki	32	
Sweden	salmon	Luleälven	1 yr		66,963	Luleälven	31	
	salmon	Luleälven	2 yr		466,135	Luleälven	31	5 000 Carlin
	salmon	Skellefteälven	1 yr		125,436	Skellefteälven	31	
	salmon	Skellefteälven	1 yr		6,320	Gideälven	30	
	salmon	Umeälven	1 yr		11,673	Umeälven	31	11 673 PIT-tag
	salmon	Umeälven	2 yr		51,246	Umeälven	31	27 954 PIT-tag
	salmon	Ångermanälven	1 yr		221,674	Ångermanälven	30	
	salmon	Ångermanälven	2 yr		15,528	Ångermanälven	30	
	salmon	Indalsälven	1 yr		306,046	Indalsälven	30	
	salmon	Ljusnan	1 yr		157,964	Ljusnan	30	
	salmon	Dalälven	1 yr		209,761	Dalälven	30	2 700 PIT-tag
	salmon	Dalälven	2 yr		15,514	Dalälven	30	140 PIT-tag (all of these with additional acoustic tag)
	salmon	Dalälven	1 yr		12,000	Stockholms ström	27	
	salmon	Dalälven	1 yr		3,000	Nyköpingsån	27	
	salmon	Dalälven	1 yr		7,000	Coastal site (in Bråviken)	27	
Poland	salmon	Daugava	1 yr			Drawa	24	500 PIT-tag (smolts)
	salmon	Daugava	1 yr			Parsęta	25	600 PIT-tag (smolts)
Lithuania	salmon	Nemunas	1 yr		1,000	Neris	26	
Latvia	salmon	Daugava	1 yr		490,200	Daugava	28	
	salmon	Venta	1 yr		88,200	Venta	28	
	salmon	Gauja	1 yr		145,700	Gauja	28	
	salmon	Daugava	1 yr		5,700	Lielā Jugla	28	
Total salmon				**26,700**	**3,822,460**			

Table 3.4.1.1. The M74 incidence (in %) as a proportion of M74 females (partial or total offspring M74 mortality) or the mean offspring M74 mortality (see annotation 2) of sea run female spawners, belonging to populations of Baltic salmon, in hatching years 1985−2020. The data originate from hatcheries, laboratory monitoring or from the free thiamine concentration of unfertilized eggs (see annotation 3). Prognosis for 2021 is based on the free thiamine concentration in unfertilized eggs of autumn 2020 spawners and, moreover, on the number of wiggling females (none in autumn 2020).

River	SD	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Simojoki (2)	31		*7*	3	7	*1*	*14*	4	53	74	*53*	92	*86*	91	31	60	44	42	42
Tornionjoki(2)	31				5	6	1	29	70	76	89	76			*25*	*61*	34	41	*62*
Kemijoki	31																		
Iijoki	31																		
Luleälven	31								58	66	62	50	52	38	6	34	21	29	37
Skellefteälven	31								40	49	69	49	77	16	5	42	12	17	19
Ume/Vindelälven	30	40	20	25	19	16	31	45	77	88	90	69	78	37	16	53	45	39	38
Angermanälven	30								50	77	66	46	63	21	4	28	21	25	46
Indalsälven	30	4	7	8	7	3	8	7	45	72	68	41	64	22	1	20	22	6	20
Ljungan	30								64	*96*	*50*	56	28	29	10	25	10	0	55
Ljusnan	30							17	33	75	64	56	72	22	9	41	25	46	32
Dalälven	30	28	8	9	20	11	9	21	79	85	56	55	57	38	17	33	20	33	37
Mörrumsan	25	47	49	65	46	58	72	65	55	90	*80*	63	*56*	23					
Neva/Åland (2)	29									70	50								
Neva/Kymijoki (2)	32								45	60-70		57	*40*	*79*	42	*42*	23		*43*
Mean River Simojoki and Tornionjoki			7	3	6	4	8	17	62	75	71	84	86	91	28	61	39	42	52
Mean River Luleälven, Indalsälven, Dalälven		16	8	9	14	7	9	14	61	74	62	49	58	33	8	29	21	23	31
Mean total		**30**	**18**	**22**	**17**	**16**	**23**	**27**	**56**	**77**	**66**	**59**	**61**	**38**	**15**	**40**	**25**	**28**	**39**

River	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Simojoki (2)	6	7	3	*18*	29	10	10	3	3	*0*	*0*	*0*	0	4	33	16			
Tornionjoki(2)	0	*0*		*27*	9	*10*	4	*10*		*0*	0					16	1	0	0
Kemijoki				38	*54*	*25*	30	7	*6*								8		
Iijoki							23								*41*				
Luleälven	4	4	1	18	21	10	16	34	2	2	1	2	2	11	25	20	6	4	
Skellefteälven	7	0	2	3	13	0	0	5	3	3	22	2	2	4	30	22	24	0	
Ume/Vindelälven	15	4	0	5	14	4	25	24	11	0	8	20	0	19	45	21	6	0	
Angermanälven	13	4	3	28	30	16	8	23	7	1	4	4	0	24		11	7	0	
Indalsälven	4	0	3	18	16	18	14	11	5	0	0	4	3	15	7		2	1	
Ljungan	0																		
Ljusnan	17	0	0	25	15	9	16	10	3	0	2	4	2	39	36	13	0	0	
Dalälven	13	4	7	15	18	7	24	18	4	0	3	13	7	34	58	21	2	4	
Mörrumsan																			
Neva/Åland (2)																			
Neva/Kymijoki (2)	*11*	*6*	*6*	*0*	26													0	
Mean River Simojoki and Tornionjoki	3	4	3	23	19	10	7	7	3	0	0	0	0	4	33	16	1		
Mean River Luleälven, Indalsälven, Dalälven	7	3	4	17	18	12	18	21	4	1	1	6	4	20	30	21	3	3	
Mean total	**8**	**3**	**3**	**18**	**22**	**11**	**15**	**15**	**5**	**1**	**4**	**6**	**2**	**19**	**34**	**18**	**6**	**1**	

1) All estimates known to be based on material from less than 20 females in italics.

2) The estimates in the rivers Simojoki, Tornionjoki/Torne älv and Kymijoki are since 1992, 1994 and 1995, respectively, given as the proportion of females (%) with offspring affected by M74 and before that as the mean yolk-sac-fry mortality (%).

3) From 2019 on the data for the Rivers Tornion-, Simo-, Kemi-, Ii- and Kymijoki are derived from the free thiamine concentration of unfertilized eggs.

Table 3.4.1.2. Summary of M74 data for Atlantic salmon (*Salmo salar*) stocks of the Rivers Simojoki, Tornionjoki and Kemijoki or Iijoki (hatching years 1986–2020), indicating the total average yolk-sac fry mortality (YSFM, %) among offspring of sampled females, the percentage of females with offspring that display M74 symptoms (%) and the percentage of females with 100% mortality among offspring (%). Data from 2019 on are based on the concentration of free thiamine (THIAM) in unfertilized eggs and derived from the model by relating the THIAM concentrations with YSFMs from laboratory incubations in the spawning years 1994–2009 from the Finnish M74 monitoring data. Data from less than 20 females is given in italics. NA = not available.

	Total average YSFM (%)			Proportion of females with offspring affected by M74 (%)			Proportion of females without surviving offspring (%)		
	Simojoki	Tornionjoki	Kemijoki/Iijoki	Simojoki	Tornionjoki	Kemijoki/Iijoki	Simojoki	Tornionjoki	Kemijoki/Iijoki
1986	*7*	NA		NA	NA		NA	NA	
1987	3	NA		NA	NA		NA	NA	
1988	7	5		NA	NA		NA	NA	
1989	*1*	6		NA	NA		NA	NA	
1990	*14*	1		NA	NA		NA	NA	
1991	4	29		NA	NA		NA	NA	
1992	52	70		53	NA		47	NA	
1993	75	76		74	NA		74	NA	
1994	*55*	84		*53*	89		*53*	64	
1995	76	66		92	76		58	49	
1996	*67*	NA		*86*	NA		*50*	NA	
1997	71	NA		91	NA		50	NA	
1998	19	*26*		31	*25*		6	*19*	
1999	55	*62*		60	*61*		39	*56*	
2000	38	34		44	34		25	24	
2001	41	35		42	41		27	21	
2002	31	*61*		42	*62*		25	*54*	
2003	2	4		6	0		0	0	
2004	4	*2*		7	*0*		0	*0*	
2005	5	NA		3	NA		3	NA	
2006	*11*	*9*	25	*18*	*27*	38	*6*	*0*	19
2007	26	8	*40*	29	9	*54*	16	5	*31*
2008	14	*21*	*18*	10	*10*	*25*	7	*10*	*6*
2009	11	7	21	10	4	30	7	0	7
2010	10	14	8	3	10	7	0	3	4
2011	3	NA	*6*	3	NA	*6*	0	NA	*6*
2012	*2*	*1*	NA	*0*	*0*	NA	*0*	*0*	NA
2103	*4*	*5*	NA	*0*	*0*	NA	*0*	*0*	NA
2014	6	NA	NA	0	NA	NA	0	NA	NA
2015	2	NA	NA	0	NA	NA	0	NA	NA
2016	7	NA	NA	4	NA	NA	4	NA	NA
2017	19	NA	*34*	33	NA	*41*	18	NA	*29*
2018	28	8	NA	16	16	NA	8	5	NA
2019	NA	5	8	NA	1	5	NA	0	0
2020	NA	3	NA	NA	0	NA	NA	0	NA

Table 3.4.1.3. Summary of M74 data for nine different Swedish Baltic salmon stocks (hatching years 1985−2020), in terms of the number of females sampled with offspring affected by the M74 syndrome in comparison to the total number of females sampled from each stock.

	Luleälven		Skellelteälven		Ume/Vindel älven		Angermanälven		Indalsälven		Ljungan		Ljusnan		Dalälven		Mörrumsån	
	M74	Total	M74	Total	M74	Total	M74	Total	M74	Total	M74	Total	M74	Total	M74	Total	M74	Total
1985	NA	NA	NA	NA	14	35	NA	NA	9	219	NA	NA	0	78	19	69	23	50
1986	NA	NA	NA	NA	16	82	NA	NA	18	251	NA	NA	0	49	4	49	24	50
1987	NA	NA	NA	NA	16	64	NA	NA	20	245	NA	NA	0	84	8	88	32	50
1988	NA	NA	NA	NA	12	64	NA	NA	15	202	NA	NA	0	75	16	79	23	50
1989	NA	NA	NA	NA	6	38	NA	NA	6	192	NA	NA	0	78	7	65	29	50
1990	NA	NA	NA	NA	18	59	NA	NA	15	198	NA	NA	0	86	4	45	39	55
1991	NA	NA	NA	NA	32	71	NA	NA	14	196	NA	NA	14	88	16	78	35	55
1992	161	279	16	40	55	71	78	157	85	190	14	22	29	89	50	63	33	60
1993	232	352	44	89	60	68	98	128	149	206	5	5	89	119	69	81	54	60
1994	269	435	54	78	146	164	52	79	148	208	6	12	105	163	70	126	4	5
1995	209	418	38	77	148	215	58	126	97	237	15	27	79	142	22	40	17	27
1996	202	392	54	70	68	87	36	57	107	167	6	22	92	128	102	178	10	18
1997	156	409	8	50	26	71	38	183	39	178	5	17	28	130	360	159	5	22
1998	22	389	2	48	6	37	3	81	2	155	2	20	7	82	14	83	NA	NA
1999	108	316	22	53	27	51	30	108	25	126	5	20	19	46	27	82	NA	NA
2000	67	320	7	57	27	60	29	136	27	125	1	10	29	114	36	131	NA	NA
2001	96	322	9	51	24	62	31	122	7	100	0	10	47	102	27	82	NA	NA
2002	119	300	8	42	20	53	56	122	25	123	6	11	23	60	56	150	NA	NA
2003	12	270	4	60	8	53	15	120	5	128	0	2	17	100	22	164	NA	NA
2004	10	270	0	59	2	56	4	114	0	125	NA	NA	0	47	5	112	NA	NA
2005	3	250	1	58	0	55	4	114	4	128	NA	NA	0	7	11	151	NA	NA
2006	40	228	1	40	2	39	19	67	18	98	NA	NA	15	60	25	132	NA	NA
2007	45	219	5	40	5	37	24	79	17	105	NA	NA	8	55	17	93	NA	NA
2008	22	212	0	40	2	50	13	80	19	106	NA	NA	7	81	8	108	NA	NA
2009	33	212	0	40	13	50	6	80	5	108	NA	NA	14	85	32	131	NA	NA
2010	78	226	2	40	9	38	17	74	13	120	NA	NA	9	90	24	136	NA	NA
2011	5	220	1	40	5	44	5	76	6	120	NA	NA	3	93	5	128	NA	NA
2012	5	260	1	40	0	50	1	80	0	120	NA	NA	0	92	0	111	NA	NA
2013	2	220	10	45	5	60	2	80	0	120	NA	NA	2	92	3	121	NA	NA
2014	4	220	1	50	12	60	3	80	5	125	NA	NA	4	92	13	103	NA	NA
2015	5	202	1	50	0	60	0	80	3	120	NA	NA	2	92	6	85	NA	NA
2016	21	184	2	50	7	36	19	78	18	120	NA	NA	36	92	33	98	NA	NA
2017	51	206	15	50	10	22	NA	NA	8	120	NA	NA	31	85	41	92	NA	NA
2018	36	180	11	50	3	14	2	19	NA	NA	NA	NA	7	53	20	97	NA	NA
2019	10	180	12	50	3	48	3	45	2	100	NA	NA	0	92	2	118	NA	NA
2020	5	112	0	50	0	52	0	45	1	100	NA	NA	0	80	4	111	NA	NA

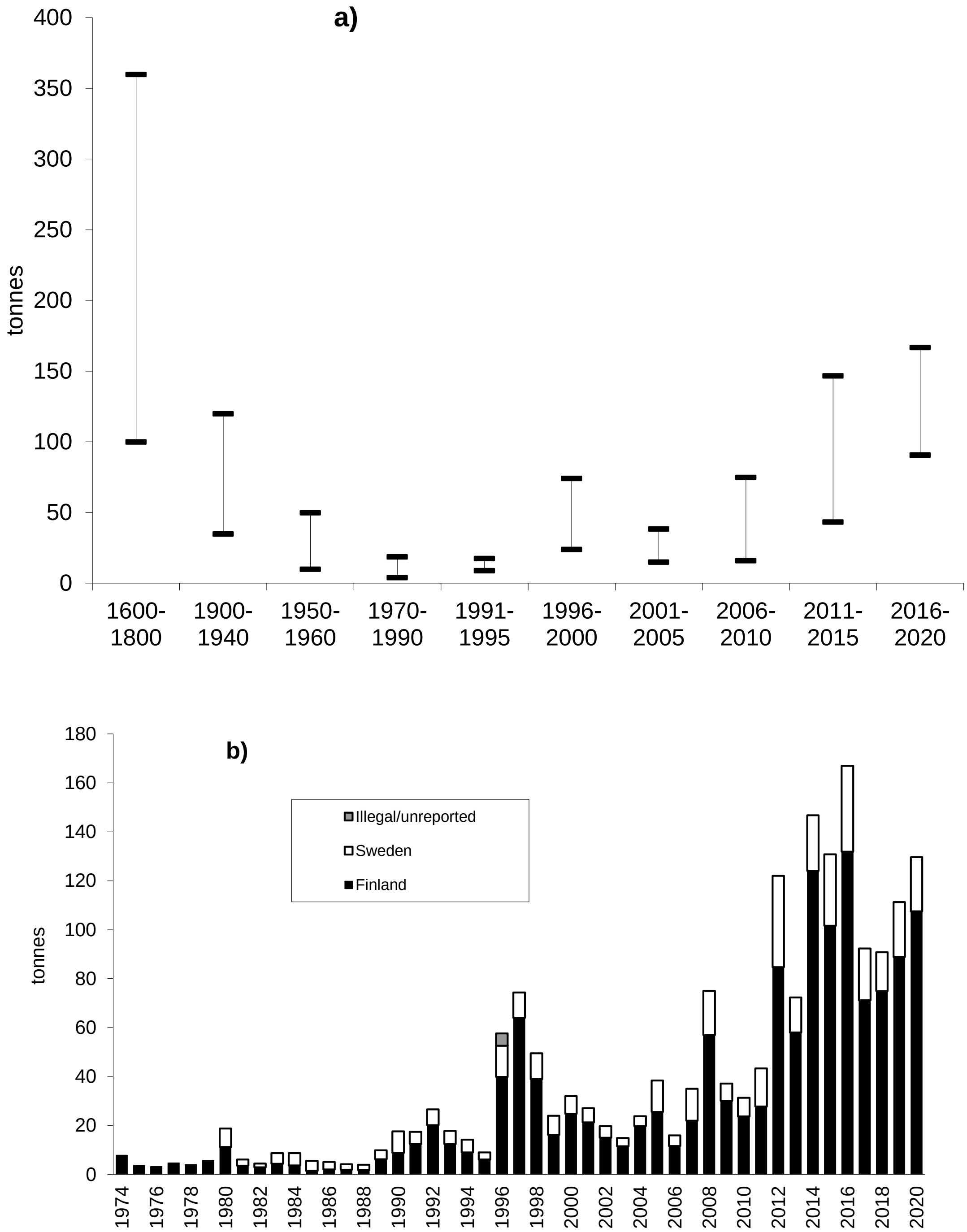


Figure 3.1.1.1. Total river catches in the River Tornionjoki (assessment unit 1). a) Comparison of the periods from 1600 to present (range of annual catches). b) from 1974 to present. Swedish catch estimates are provided from 1980 onwards.

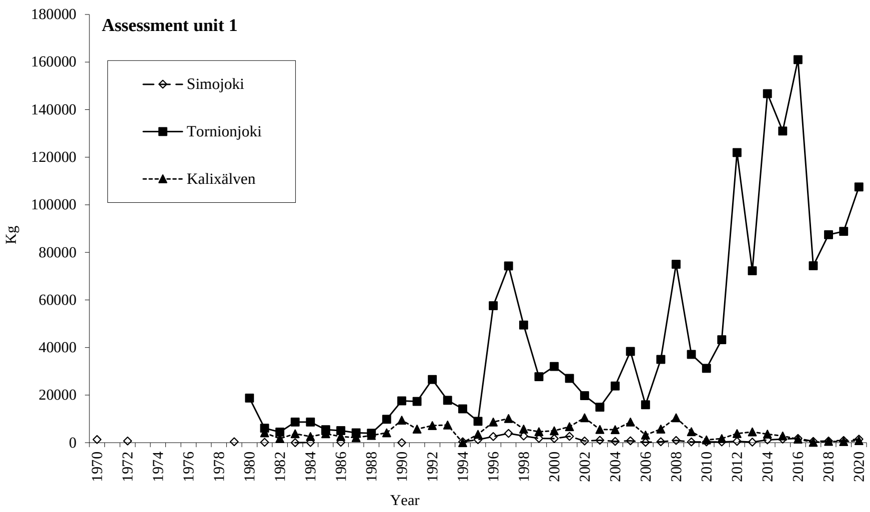


Figure 3.1.1.2 Salmon catch in the rivers Simojoki, Tornionjoki (finnish and swedish combined) and Kalixälven, Gulf of Bothnia, assessment unit 1, 1970-2020. Ban of salmon fishing 1994 in the river Kalixälven.

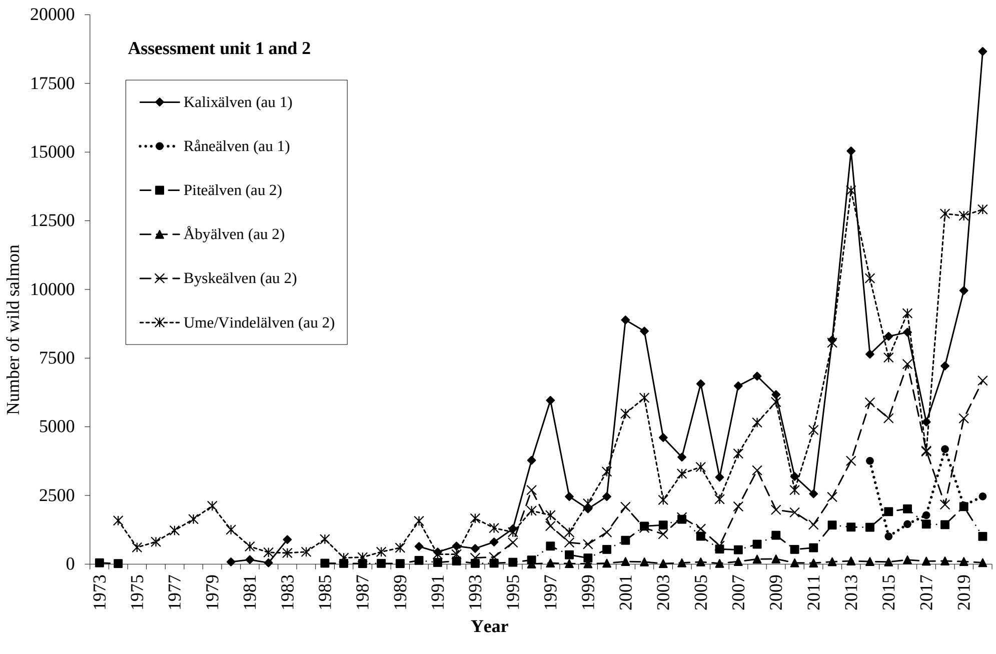


Figure 3.1.1.3. Salmon run in fish ways (ecosounder in Råneälven) in rivers in assessment unit 1 and 2, in 1973-2020.

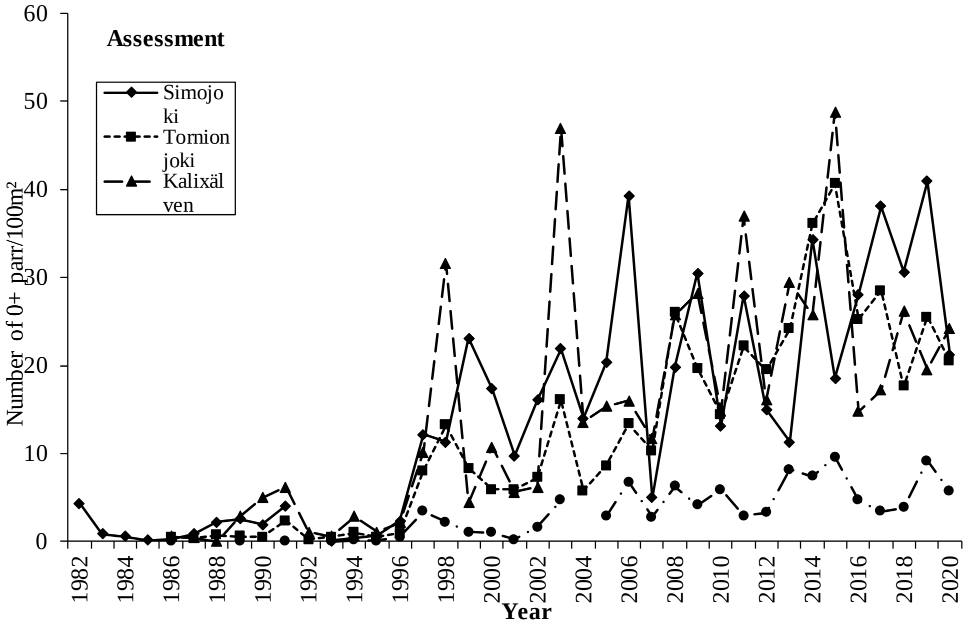


Figure 3.1.1.4 Densities of 0+ parr in rivers in Gulf of Bothnia (Sub-division 31), assessment unit 1, in 1982-2020.

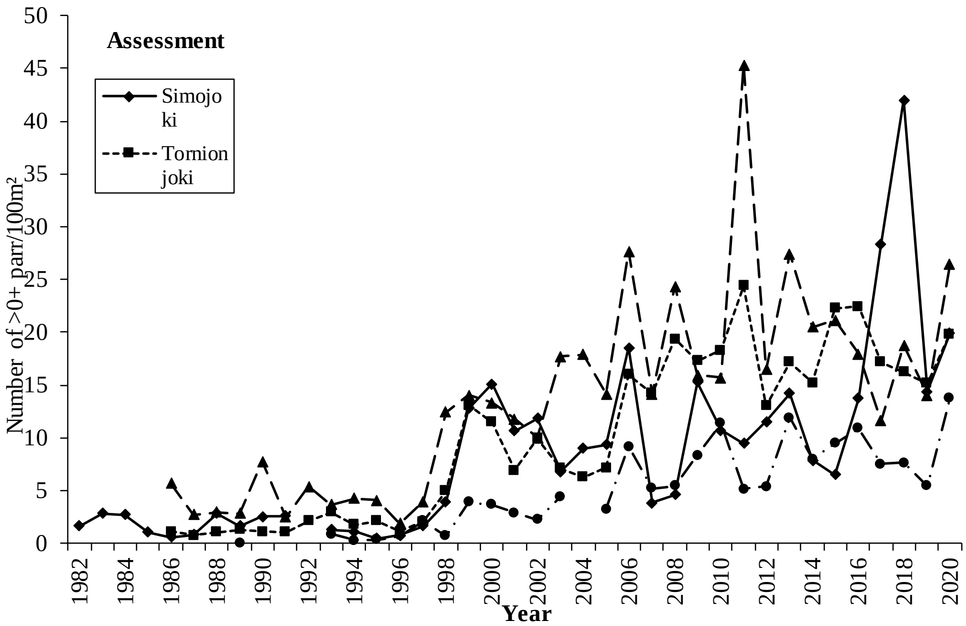


Figure 3.1.1.5 Densities of >0+ parr in rivers in Gulf of Bothnia (Sub-division 31), assessment unit 1, in 1982-2020.

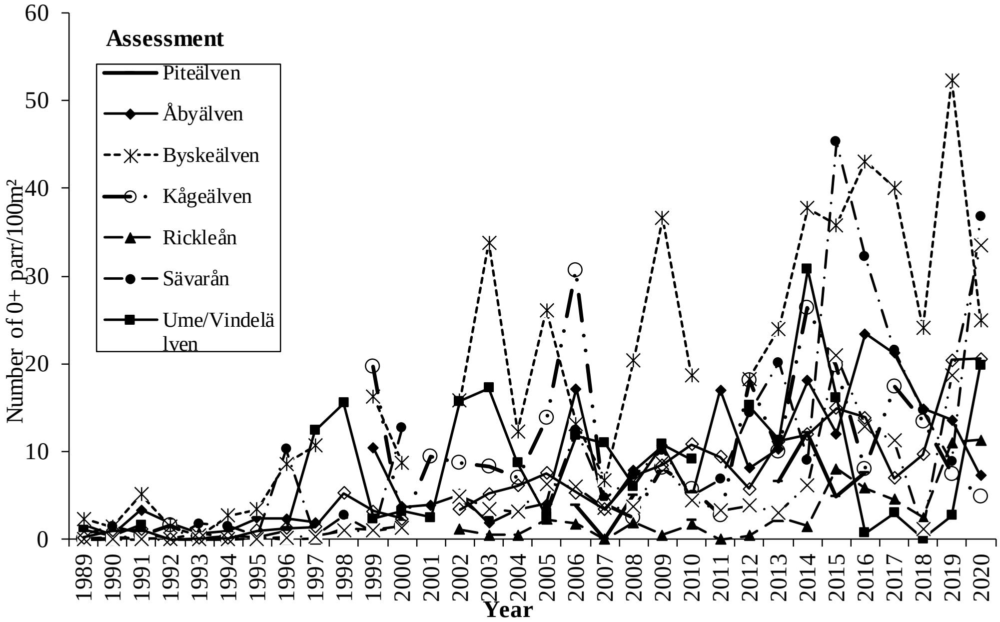


Figure 3.1.2.1 Densities of 0+ parr in rivers in Gulf of Bothnia (Sub-division 31), assessment unit 2, in 1989-2020.

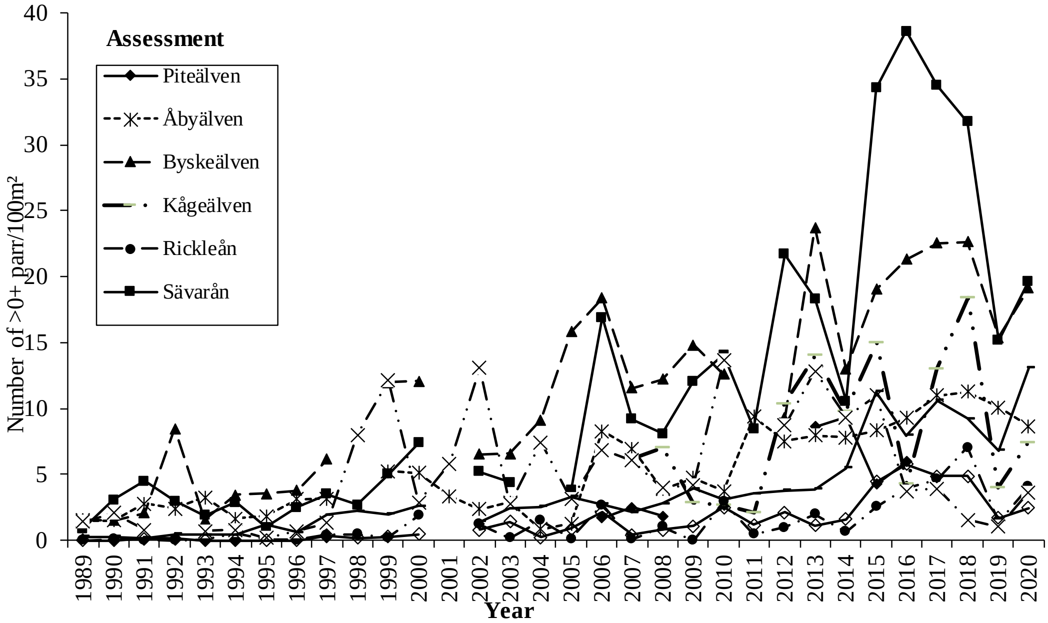


Figure 3.1.2.2 Densities of >0+ parr in riveres in Gulf of Bothnia (Sub-division 31), assessment unit 2, in 1989-2020.

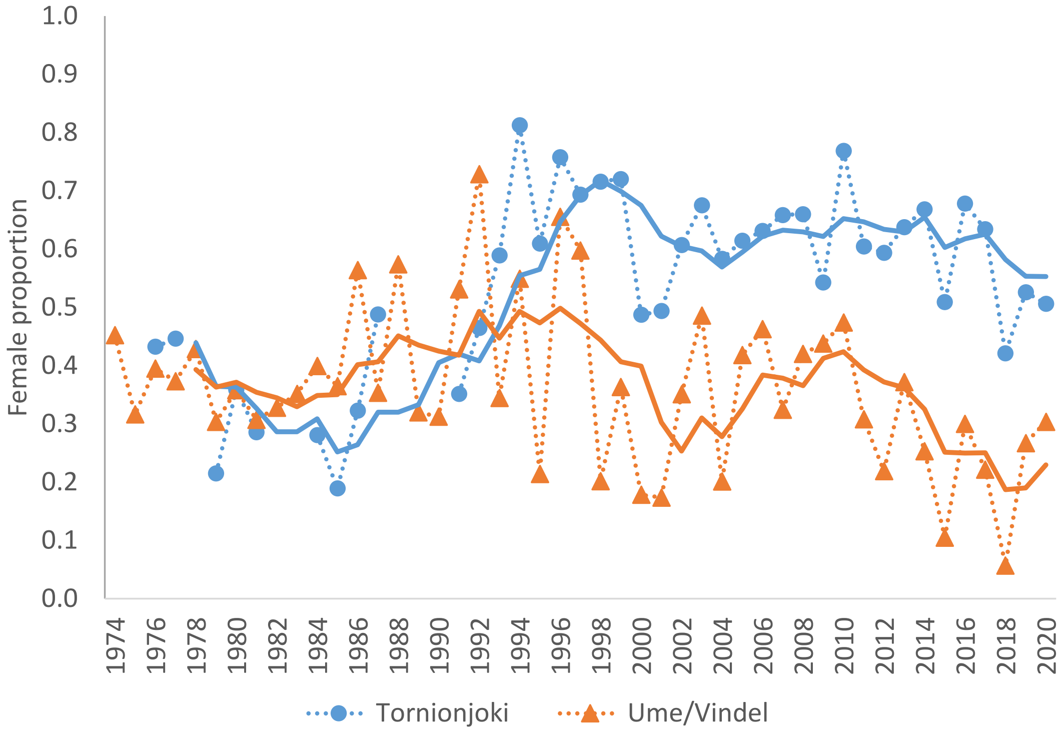


Figure 3.1.2.3. Observed female proportions in Tornionjoki (catch samples) and Ume/Vindelälven (fish ladder data) with moving five-year averages.

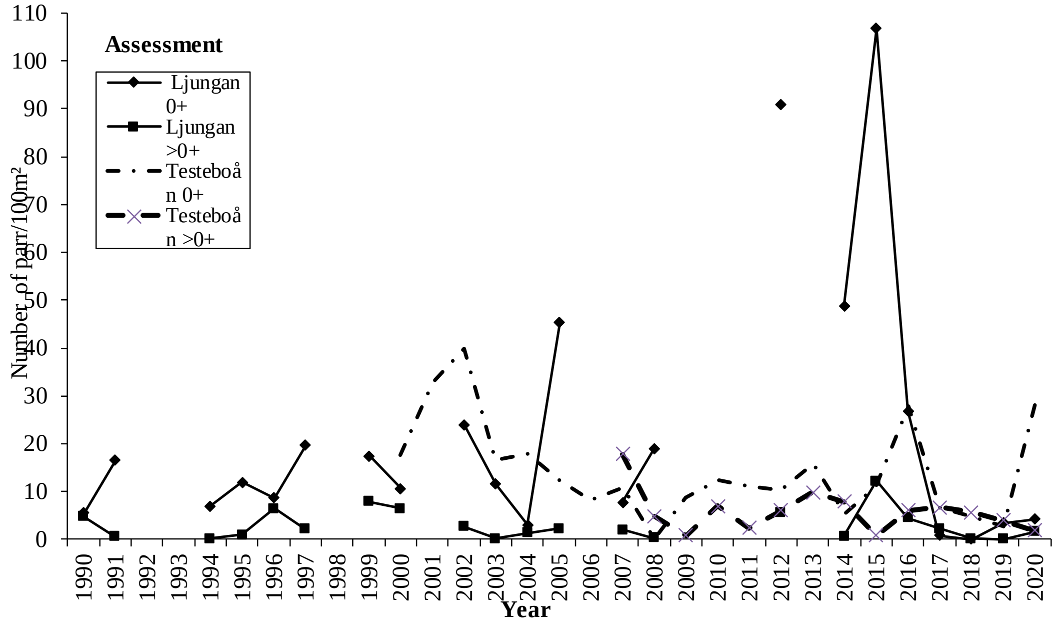


Figure 3.1.3.1 Densites of parr in Ljungan and Testeboån in the Gulf of Bothnia (Sub-division 30), assessment unit 3, in 1990-2020.

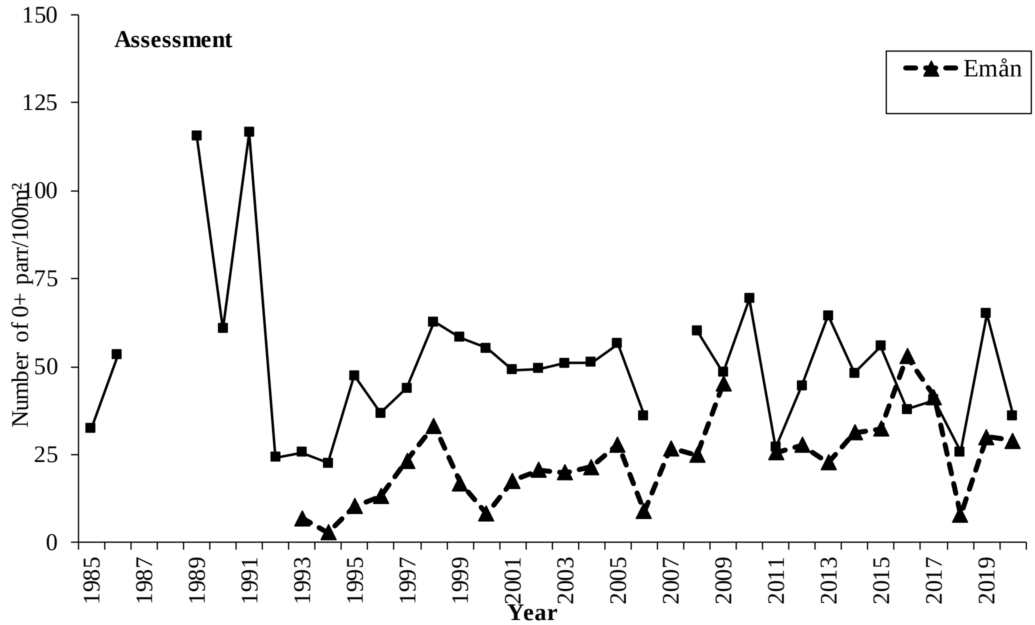


Figure 3.1.4.1 Densities of 0+ parr in rivers in the Main Basin (Sub-division 25-27), assessment unit 4, in 1985-2020.

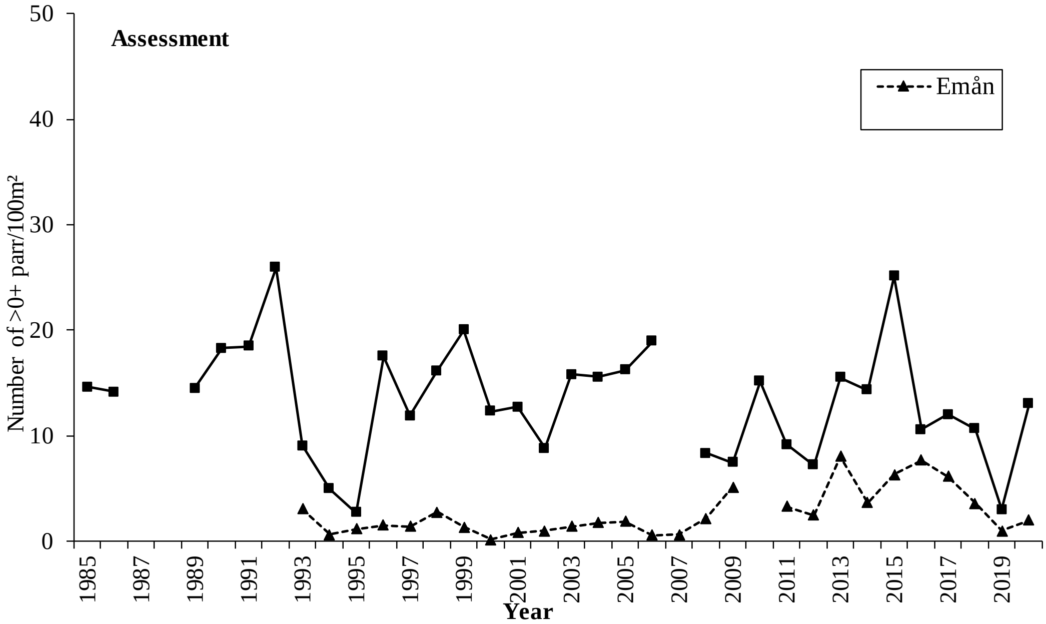


Figure 3.1.4.2. Densities of >0+ parr in rivers in the Main Basin (Sub-division 25-27), assessment unit 4, in 1985-2020.

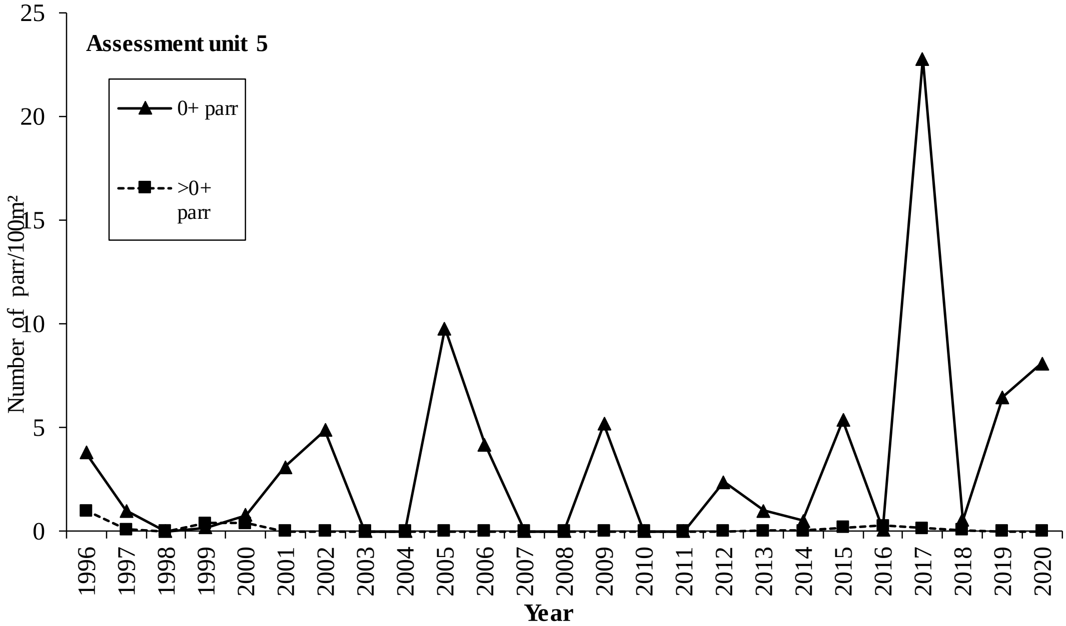


Figure 3.1.5.1 Densities of parr in the river **Pärnu** Main Basin (Sub-division 22-29) assessment unit 5, in 1996-2020

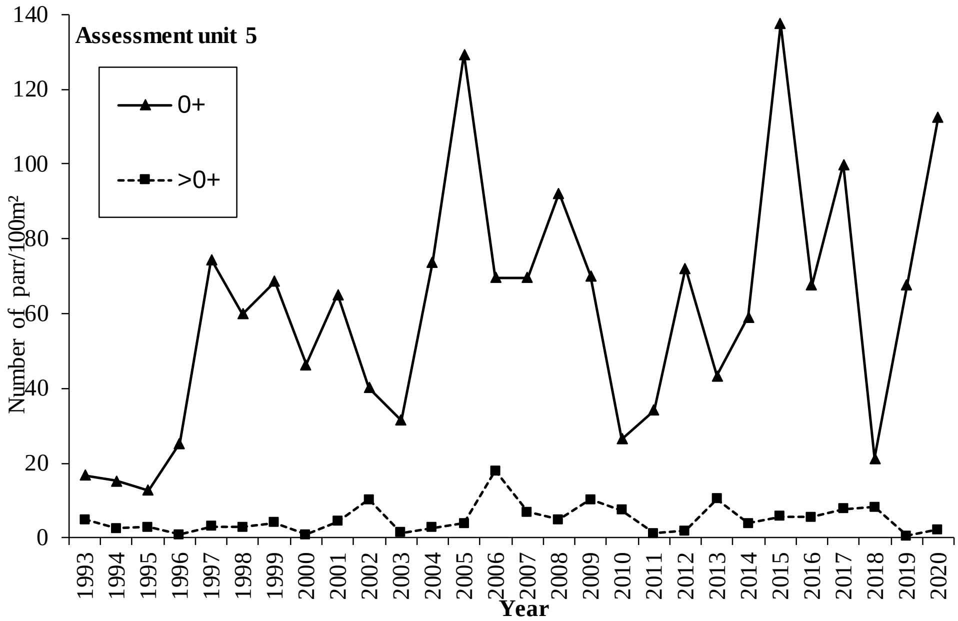


Figure 3.1.5.2. Densites of parr in the river **Salaca**, Main Basin (Sub-division 22-29) assessment unit 5, in 1993-2020.

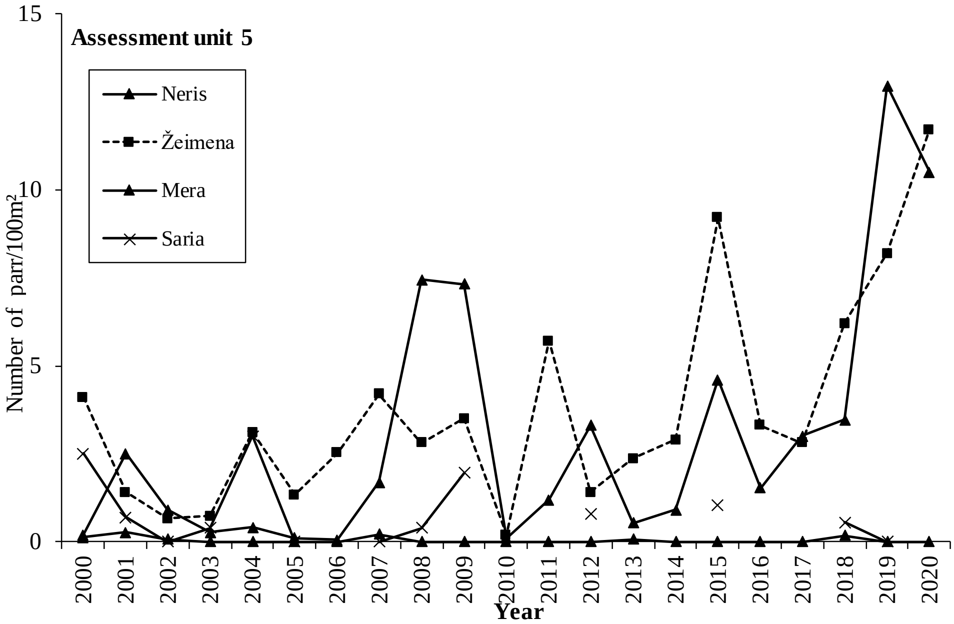


Figure 3.1.5.3. Densites of 0+ parr in Lithuanian rivers in Main Basin (Sub-division 22-29) assessment unit 5, in 2000-2020.

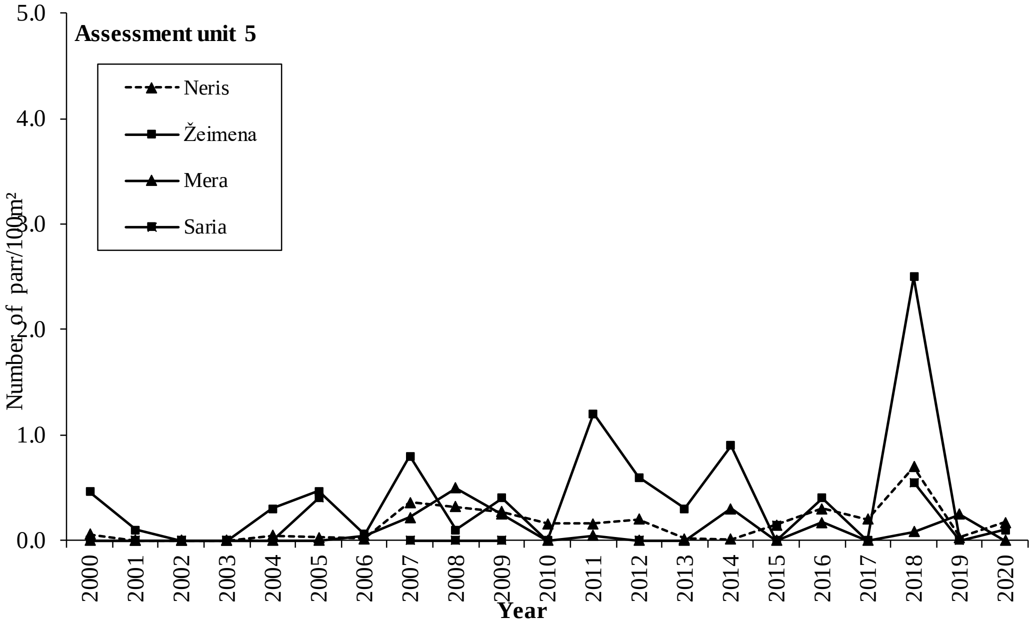


Figure 3.1.5.4 Densities of >0+parr in Lithuanian rivers in Main Basin (Sub-division 22-29) assessment unit 5, in 2000-2020.

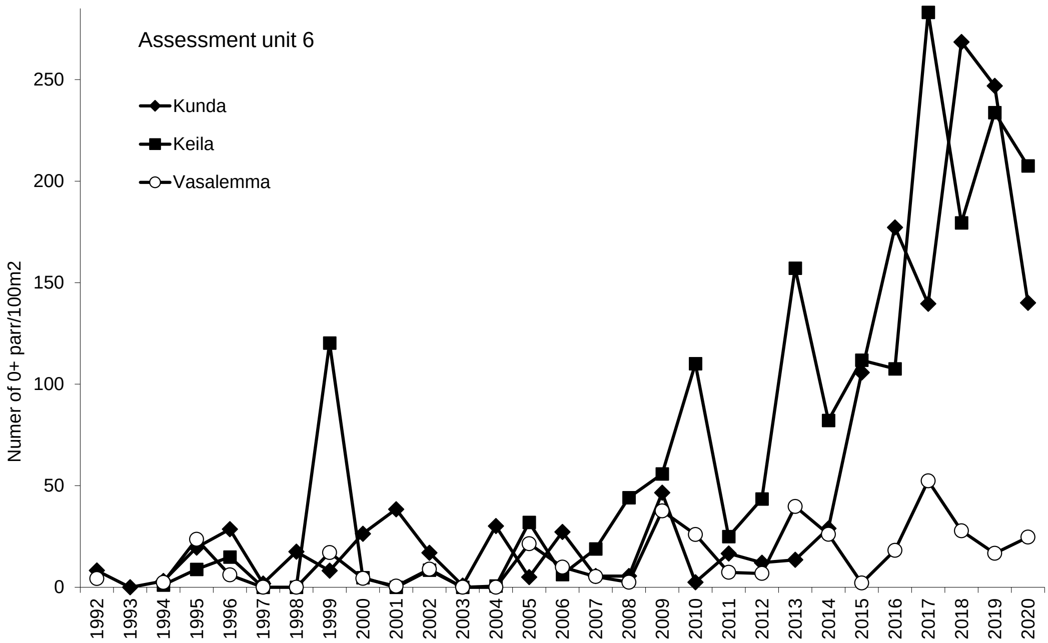


Figure 3.1.6.1. Densities of 0+ (one-summer old) salmon parr in the three wild Estonian salmon rivers

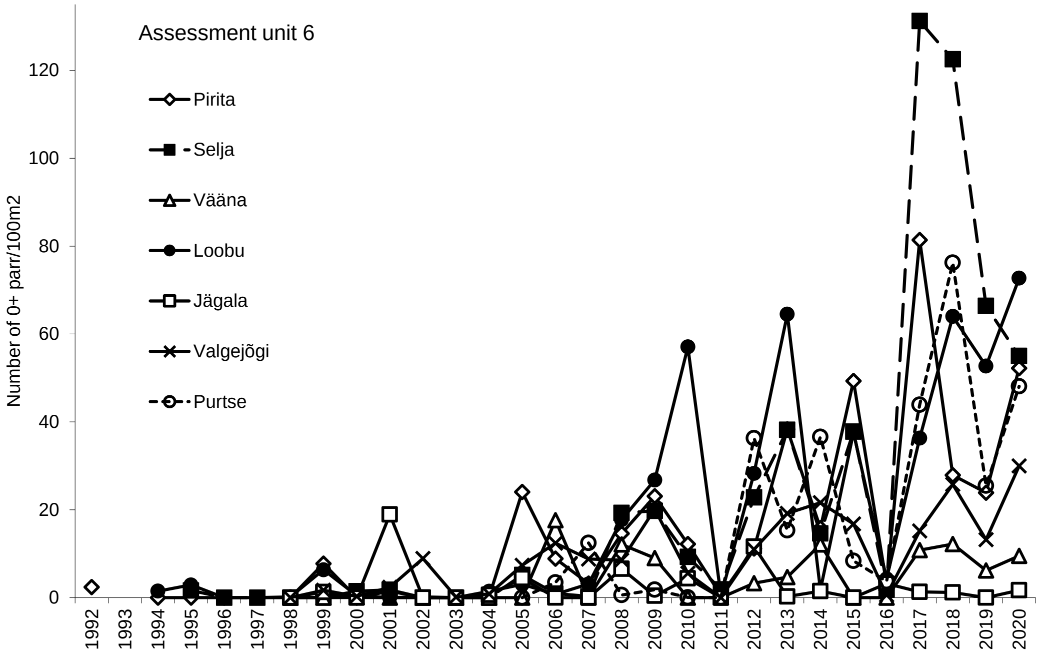


Figure 3.1.6.2. Densities of 0+ (one-summer old) salmon parr in seven Estonian salmon rivers were suportive

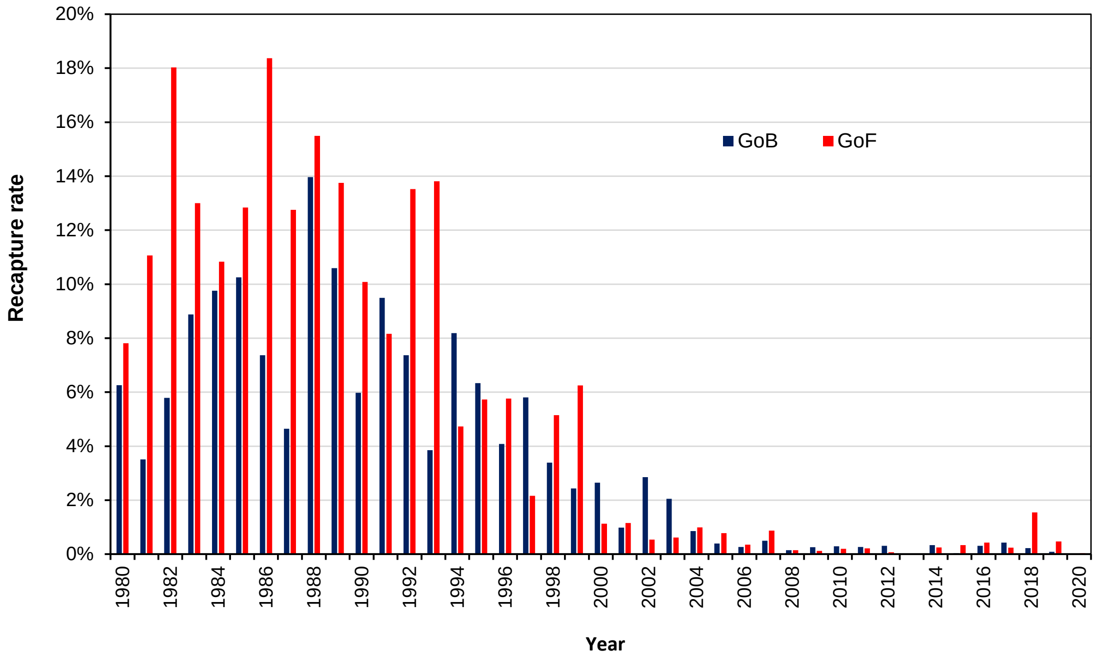


Figure 3.3.3.1. Return rates of Finnish Carlin tagged reared salmon released in Gulf of Bothnia and Gulf of Finland in 1980–2020 (updated in March 2021).

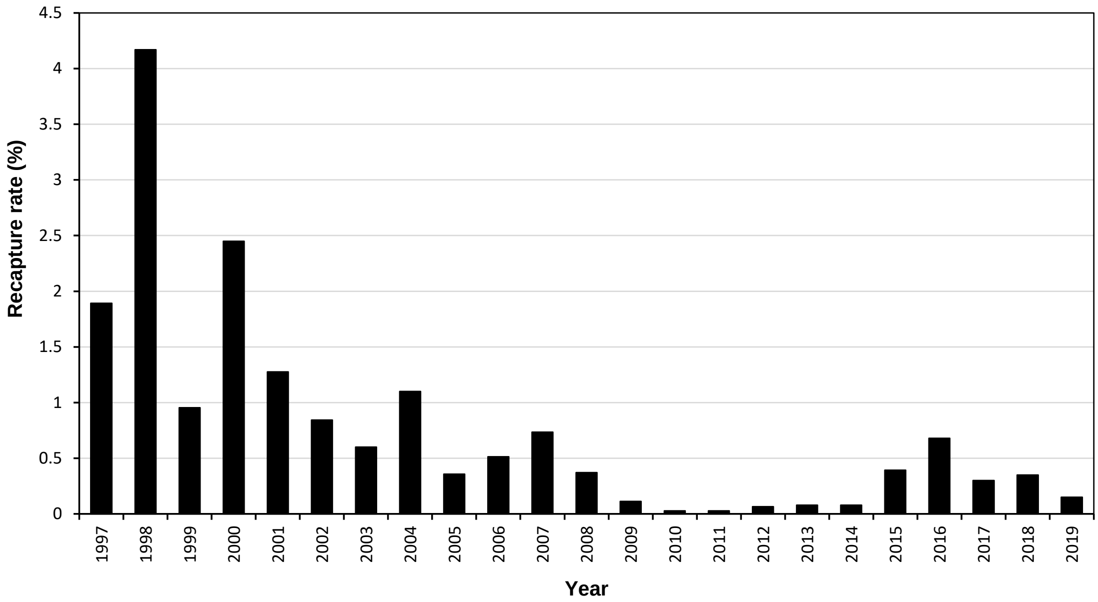


Figure 3.3.3.2. Recapture rate (%) of two-year-old Estonian Carlin tagged salmon in the Gulf of Finland. Carlin tagged from 1997–2014 and T-bar anchor tags since 2015 (updated in March 2021, no returns from 2020 cohort). Year on x-axis is a tagging year.

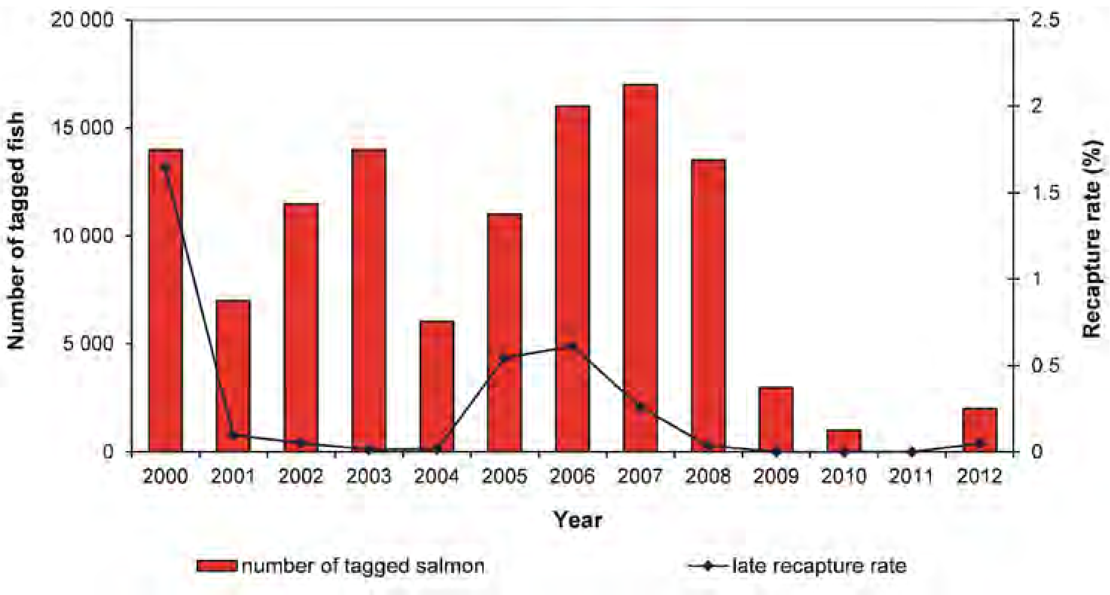


Figure 3.3.3.3. Number of Polish Carlin tagged salmon and return rate (%) for salmon in 2000–2012 (updated in March 2021; no tagging after 2012).

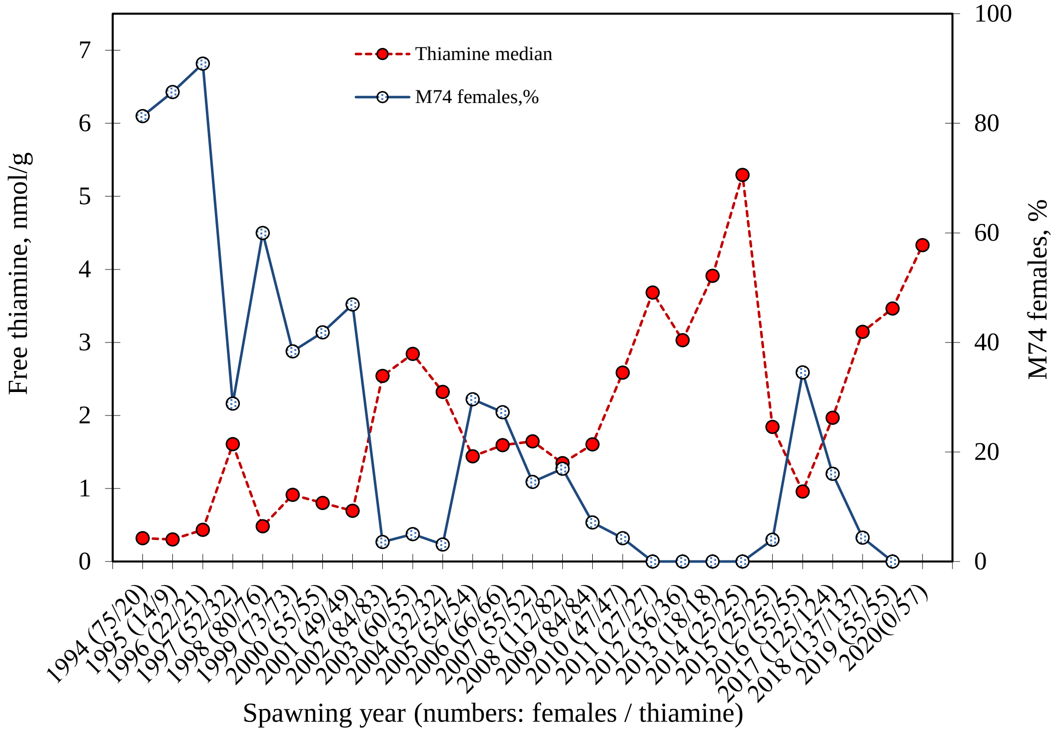


Figure 3.4.1.1. Relationship between the proportion of M74 females and the median concentration of free thiamine in unfertilized eggs of all M74-monitored salmon of the Rivers Simojoki, Torniojoki and Kemijoki (Vuorinen *et al.*, unpubl.)

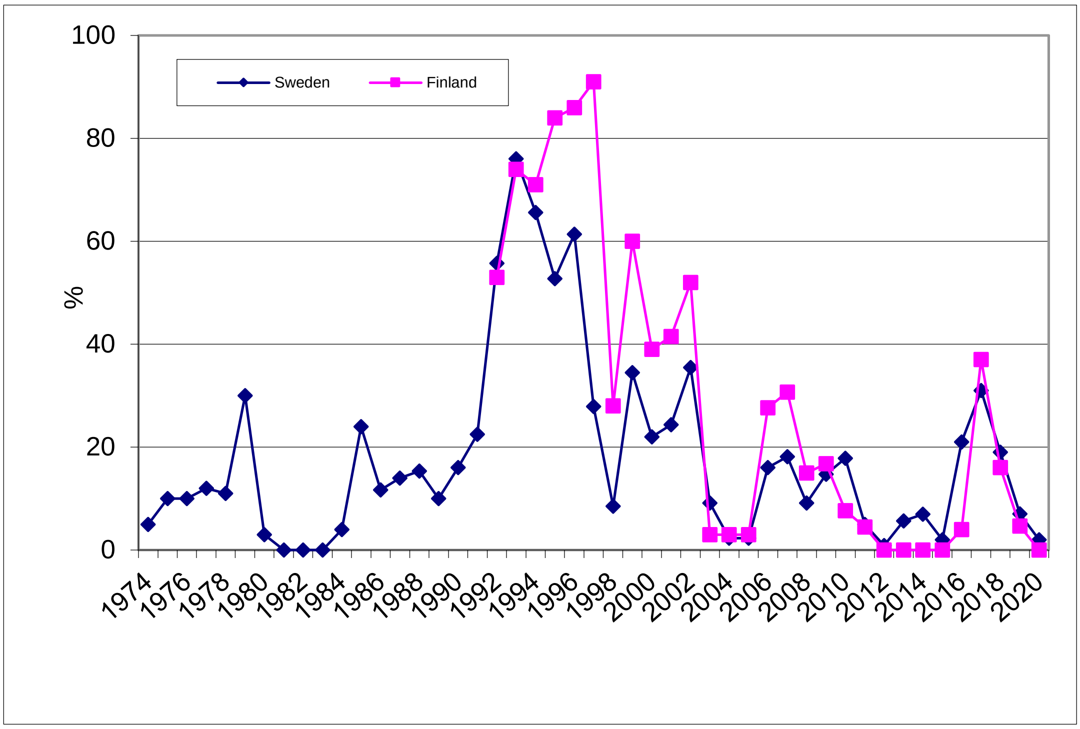


Figure 3.4.1.3. Proportion of M74 positive females in Swedish and Finnish hatcheries (hatching years are given below the x-axis).

4 Reference points and assessment of salmon

4.1 Introduction

In this section results of the assessment model and alternative future projections of salmon stocks in assessment units (AU) 1–4 are presented. Furthermore, the current status of salmon stocks in AUs 5–6 is evaluated against their reference points. The methodological basis and details of the assessment model and stock projections are given in the Stock Annex (Annex 3). Below we only describe methodological updates introduced this year.

Section 4.2 contains results showing the historical development of stocks, including estimation of stock–recruit dynamics and reference points, as well as assessment of the current stock status. In Section 4.3 the basis for the choice of scenarios and scenario results are presented, including scenario specific catch possibilities with associated development of stock status. Section 4.4 contains discussion about additional information which is either important for proper interpretation of the modelling results or serves as a critical accompaniment to them. Section 4.5 focuses on issues relevant for the future management of Baltic salmon, including fishing possibilities under alternative management strategies. Section 4.6 summarizes the earlier sections and draws conclusions. The two last sections (4.7 and 4.8) bring up methodological and data related needs in order to further develop assessment of the Baltic salmon.

In this year's assessment, stock-specific MSY-based reference points R_{lim} and R_{MSY} are adopted for the first time, instead of the targets related to PSPC (50% and 75% of PSPC, the latter of which is also considered to be a proxy for MSY among the Baltic salmon stocks). The 75% PSPC target has been used for many past years to evaluate stock status (e.g. ICES 2020c). Annex 3 describes the methodology used to derive the new reference points and how they relate to the previously used reference point.

4.2 Historical development of Baltic salmon stocks (assessment units 1–6)

4.2.1 Changes in the assessment methods

Compared to the last full assessment of Baltic salmon by WGBAST in 2019, the simulation model has been changed to allow annual variation in offshore fisheries. More specifically, offshore recreational trolling is now modelled as a separate fishery by assuming a mean reverting autoregressive process with a lag of one year (AR(1)) for the annual harvest rates. The trolling harvest rates are assumed to be zero for post-smolt salmon and the same annual harvest rates are assumed for salmon at age 2SW or older and for wild and reared salmon. For the sake of consistency, the longline and driftnet fisheries were also changed to allow annually changing harvest rates, by assuming similar AR(1)-structure as that of trolling harvest rates for the catchabilities of these fisheries. For both longlining and driftnetting, the post-smolt catchability has the previous form without annual variability, the values being close to zero. The annual longline catchabilities are the same for salmon of age 2SW or older, as well as for wild and reared salmon. For driftnetting, the annual catchabilities vary for 2SW and MSW salmon. The annual driftnet catchabilities are assumed the same for wild and reared salmon.

A minor change has also been made for the parameterisation of maturation rates. In the current version, the random variation takes place only across the years, instead of across both years and age groups as before. This change diminishes the amount of uncertainty in the estimates of maturation rates, and it also has a positive impact on the computational performance of the simulation.

In addition, some river specific changes have been made:

For **Åbyälven**, 2019–2020 smolt trapping estimates are included in the river model (see details in Section 4.2.2).

For **Testeboån,** a less informative prior is applied for the proportion of ascending adult fish that find their way up to the spawning areas and pass the fish counter.

The last benchmark of Baltic salmon (WKBaltSalmon) took place in early 2017 (ICES, 2017c), during which alternative parameterizations for the stock–recruitment function were explored and reviewed. Up to and including 2020s assessment, status has been assessed using a proxy for MSY of $0.75R_0$, where R_0 (or PSPC) denotes smolt production at the unfished demographic equilibrium. After reparameterization of the stock–recruit function, R_0 varies by year. In 2019 assessment, the annual R_0 from the final year of the assessment period was used. Starting from 2020 assessment R_0 refers to smolt production at the long-term equilibrium with no fishing, obtained from simulation. Small changes to the model are also routinely made between stock assessments to reflect newly acquired knowledge, correct earlier minor errors, etc. These small changes are generally not expected to make significant changes to estimated stock status.

4.2.2 Submodel results

The **river model** (also called **hierarchical linear regression analysis** with its two versions, one of which is for the northern and the other for the southern rivers, see Stock Annex, Section C.1.5) provides input about smolt production as likelihood approximations (these are sometimes called also 'pseudo observations' in the literature, but for simplicity they are usually called 'smolt priors' in this report) into the life cycle model, by analysing all the juvenile survey data from the rivers in AUs 1–4. For rivers in AUs 5–6, other methods are used to estimate smolt production (see Stock Annex, Section C.1.5 and ICES, 2017c).

Results of the river model indicate a substantial increase in smolt abundance in AU 1–2 rivers since the late 1990s. Currently (2019-2020), smolt abundance has temporarily declined in most of these rivers, after the record high levels taking place some years ago. Smolt abundance is predicted to increase again in 2021 and 2022 (Table 4.2.2.1). In Ume/Vindelälven smolt production has severely dropped for the period 2019–2021, apparently due to the health problems of salmon in this stock, which some years ago crashed the number of spawners and the consequent parr densities. However, smolt abundance in Ume/Vindelälven is predicted to substantially increase again starting from 2022. The long-term increase in smolt production in AU 3 (Ljungan and Testeboån) is less apparent and varies more from year to year than the smolt production in the AU 1–2 rivers. No parr were observed in Ljungan during the 2018 electrofishing and the parr densities were low also in 2019-2020, therefore smolt abundance in this river is very low currently and in the near future. In AU 4, smolt production in Emån is estimated to have gradually increased until 2017, after which the abundance dropped in 2018-2019. Smolt production in Mörrumsån has been more stable and without any obvious trends since the late 1990s. Smolt production in the AU 4 rivers have not been predicted more than only one year ahead, because of the younger age structure of smolts in these southern rivers than in the northern rivers.

For the rivers Tornionjoki, Simojoki, Ume/Vindelälven, Rickleån, Sävarån, Testeboån, Mörrumsån and now also Åbyälven (see below) the results of the river model are more informative than for the other rivers, because of the availability of smolt trapping data from two or several years. Also, smolt estimates of years without smolt trapping have become somewhat more precise in these rivers. Smolt trapping has been conducted only in one year in Lögdeälven and Emån, which increases the precision of smolt abundance mainly in that specific year.

This year, some important modifications to the river model indata for **Åbyälven (AU 2)** were made. The salmon habitats in this river consist of two main sections - below and above the Hednäs hydropower dam, located 36 km from the river mouth. The power plant was constructed in 1920, rebuilt in 1977, and equipped with a fish ladder in 1995. Earlier, salmon and sea trout could only reproduce below the dam. The amount of adult salmon passing Hednäs has increased over time (see Section 3.1.2), but the number of fish counted in the ladder is perceived low in relation to the amount of available habitat located in the upstream part of the river. The reason seems to be migration problems for ascending adults at the dam combined with very high mortality (>90%) among smolts when passing the reservoir, turbines and the fish ladder (Gustafsson, 2010).

Since the early 2000s, a total of 14 (20 since 2019) electrofishing stations have been fished annually, whereof four are located above the dam. Although parr abundance in both river sections (below/above Hednäs) show positive trends, average parr densities have remained clearly higher in the downstream section (Table 3.1.2.1). Following a recent review of why results from smolt trapping 2018–2020 yielded markedly lower estimates of smolt abundance in Åbyälven compared to results from the river model (in which smolt trapping data have not been included in previous assessments), it was revealed that only the ten (16 since 2019) downstream electrofishing stations have so far been used in the model. In contrast, spawning habitats located below and above Hednäs are included in the total river habitat that goes into the model. This may explain why the river model estimates of smolt abundance for Åbyälven have been much higher than indicated by the smolt counting.

To adjust this previous mismatch, combined parr densities for the two river sections, weighted according to relative estimated habitat areas (63% below and 37% above Hednäs), were used as input data for the 2021 river model. For years before 1995, when salmon could not pass the Hednäs power station, average parr densities for the upper section were set to zero. Before weighting, the high estimated mortality (93%) among smolts from the upper river section was accounted for by multiplying the corresponding average parr density with 0.07. In addition to updated parr densities, smolt trapping estimates from 2019 and 2020 are now included in the river model, whereas the 2018 estimate was omitted as the earliest part of the Åbyälven smolt run in that year may have been missed.

Until next year, the plan is to revisit estimated sizes of salmon habitats in Åbyälven, including the relative proportion below and above Hednäs. In addition, the prior distribution for carrying capacity (K) needs to be updated using the same approach as has recently been used for other salmon rivers. Development of a more refined method to model the high mortality for smolts when passing Hednäs would also be desirable.

A **model for M74 mortality** provides input about fry mortality due to M74 into the life cycle model by analysing all data on incidence of M74 in the stocks (see Stock Annex, Section C.1.6). Figure 4.2.2.1 shows the estimates for M74 mortality (median and 95% probability interval); within the last ten years, the mortality decreased until the spawning years 2015–2016 when it increased to the level of magnitude of 5–20%. The results from the spawning in 2017, 2018 and 2019 (Figure 4.2.2.1) and the predictions made for 2020 spawning (Section 3.4) show a return to the low level prevailed in the early 2010s. In general, the percentage of females with offspring affected by M74 overestimates the M74 mortality due to the fact that part of the offspring will die due to normal yolk-sac-fry mortality, unrelated to M74. Also, not all offspring necessarily die when affected by M74. Because of the decreasing trend in mortality among offspring of females affected by M74, the data on proportion of females affected by M74 especially overestimate M74 mortality in recent years. Data on the total average yolk-sac-fry mortality are much better at tracking the general trend but overestimate the actual M74 mortality, because these data do not distinguish between normal yolk-sac-fry mortality and yolk-sac-fry mortality caused by the M74 syndrome. Table 4.2.2.2 shows the actual values of the M74 mortality for the different salmon stocks. Figure 4.2.2.2 illustrates the probability that offspring of M74-affected females would die, which has been possible to calculate for Simojoki, Tornionjoki and an "unsampled salmon stock".

4.2.3 Status of the assessment unit 1–4 stocks and development of fisheries in the Gulf of Bothnia and the Main Basin

The full life-history model (FLHM) was run with two chains for 675 000 iterations after an adaptive phase of 10 000 iterations. The first 150 000 iterations were discarded as burn-in and the chains were thinned with an interval of 350 to yield a final sample size of 3000 (1500 iterations from each of two chains). Inspection of traceplots and Gelman-Rubin diagnostics indicated poor convergence for many parameters. On closer inspection it became apparent that one of the chains (chain one) was getting stuck at implausible values for many variables. It was therefore decided to base results on only one chain for this year's assessment as in 2019. In order to ensure that the most representative chain was selected for each parameter and variable in the model, the means from each chain were compared to posterior means from a longer converged run of 2020s assessment model, and the chain with the closest mean was selected for that parameter/variable. Starting with chain two as the default, this resulted in 9219 parameter/variables being substituted in from chain one, out of a possible 19 606 in the longer converged run. Some caution must therefore be taken in the interpretation of results. In the text and figures that follow, medians and 90% probability intervals (PI's) are used where possible as statistics of posterior probability distributions.

The results indicate a decreasing long-term trend in the post-smolt survival until mid-2000, after which survival has generally somewhat improved (Figure 4.2.3.1). The lowest overall survival was estimated for salmon that smolted in years 2005–2006 (median estimate around 8–10% among wild and 5% among reared smolts), and survival was relatively low also in 2007–2009. Low survivals were estimated for either wild or reared smolts also in some years of the last decade, but the average survival in that decade was higher than in 2005–2009: 15% for wild smolts and 9% for reared smolts (median estimates ranging from 11–19% and 3–14% among wild and reared post-smolts, respectively). Survival was relatively high especially among wild salmon that smolted in 2010–2012 and 2014 (Figure 4.2.3.1). After the relatively high survival among 2017 wild smolts (16%) and poor survival among 2018 wild smolts (11%), survival is currently close to its average level (14% in 2019, which is the last smolting year with data to estimate).

The adult natural annual survival of wild salmon (median 91%, PI 86–95%) is estimated to be clearly higher than that of reared salmon (median 76%, PI 71–85%). Thus, the difference in total sea survival back to the spawning/stocking site for wild and reared salmon is large because of the survival difference both at post-smolt and at later marine stages.

Maturation (homing rate) of 1-sea winter salmon (grilse) has in most years been around 10–20% (average of medians over the whole time-series is 16%) and 20–50% (average of medians over the whole time-series is 34%) among wild and reared individuals, respectively (Figure 4.2.3.2). Differences between wild and reared salmon are smaller among multi-sea winter salmon, but in each sea age reared salmon has on average higher maturation rate. Generally, 30–60%, 60–70% and 50–70% of 2SW, 3SW and 4SW feeding salmon have matured, respectively. The estimated maturation rates of four-sea winter are on average lower than those of three-sea winter salmon. This is against intuition but might be an artefact due to the inconsistency between current model assumptions (no repeat spawners, all fish mature at latest after five sea winters) and the biology of salmon (some repeat spawners exist and some salmon have a longer lifespan than five years at sea). Maturation rates of reared salmon have generally increased over time, but no similar trend is visible among wild salmon. Maturation rates were generally on the lowest levels around 2010–2012.

The full life-history model allows estimation of the stock-specific stock–recruit relationships, which are presented as summary statistics (Tables 4.2.3.1 and 4.2.3.2) and graphically (Figures 4.2.1.1, 4.2.3.3 and 4.2.3.4). Table 4.2.3.2 and Figure 4.2.3.4 also show the estimates of the stock-specific reference points (R_{lim} and R_{MSY}), which are used to assess stock status. "Equilibrium smolt production" corresponds to the Potential Smolt Production Capacity PSPC, i.e. the average smolt production that can be reached in the long term without fishing. It is important to note, that these PSPC estimates are not directly comparable to the PSPC estimates presented in earlier years' assessments (e.g. ICES, 2019), where estimated PSPCs from the final year of the assessment period were used. In this year's assessment, PSPCs from simulation are used (as in 2020), assuming reversion to long-term average vital rates (covering the whole historical time-series) for most time-varying parameters into the future. Among stocks the point values of R_{lim} and R_{MSY} range from 15–40% and 60–85% of their corresponding PSPC's point values, respectively (Table 4.2.3.2). Figure 4.2.3.3 gives an indication of river-specific stock–recruit curves. The blue clouds in the figure panels indicate posterior probability distributions of all the historical estimates of yearly egg deposition and corresponding smolt abundance (the density of the cloud indicates the probability). Curves added in the figure panels are draws from the posterior distribution of the Beverton–Holt stock–recruit function. Figure 4.2.3.4 illustrates how uncertainty related to the estimates of PSPC, R_{lim} and R_{MSY} vary between stocks. It is difficult to fully explain the between-stock variation in the level of uncertainty, but it is likely an outcome of several factors like stock-specific assumptions about vital rates, the amount of stock-specific data, the coherence of data and the amount of contrast existing in the data in relation to the stock size. The total combined PSPC estimate containing all the AU 1-4 stocks is about 3.1 million (median, 90% PI's 2.5-4.1 million) smolts (Table 4.2.3.2). Of this, AU 1 stocks account for about 80%, and AU 2 stocks account for about 18%. When adding the point estimates of PSPC shown in the Table 4.2.3.3 for the AU 5 (301 000 smolts) and AU 6 (273 000 smolts), which are based of expert judgments, the total combined PSPC of all the assessed Baltic Sea salmon stocks is about 3.7 million smolts.

Since the mid-1990s, the status of many wild salmon populations in the Baltic Sea has improved, and the total wild production has increased from less than 0.5 to about three million smolts (Figure 4.2.3.5, Table 4.2.3.3). After the record year 2017 (with median estimate of 3.14 million smolts) the total wild production has somewhat declined and it was 2.75 million smolts (median estimate) in 2020. Since the mid-2010s, the total smolt production of the AU 1 stocks has been clearly above the median estimates of both the combined R_{lim} and R_{MSY} of AU 1, and it has been fluctuating close to the median estimate of combined PSPC (R_0) of these stocks. In AU 2, the combined smolt production has been fluctuating around the median estimate of the combined R_{MSY} of AU 2 stocks. Also, in the AU 3 and AU 4 total smolt production has been recently near the median estimates of the combined R_{MSY} of the respective AU's. Since the mid-2010s, the total combined AU 1–4 smolt production has been fluctuating between the median estimates of the total combined R_{lim} and R_{MSY} of all these AUs (Figure 4.2.3.5).

There are regional differences in trends in smolt production. For the wild salmon stocks of AUs 1–2, the very fast recovery of smolt production indicates high steepness for stock–recruit relationships in these rivers. The recovery is most pronounced in the largest rivers, but recently the salmon stocks spawning in smaller 'forest rivers' of the region (Åbyälven, Rickleån, Sävarån, Öreälven, Lögdeälven) have speeded up their recovery. However, their stock status (current production level against MSY) is assessed to be lower than that of the larger salmon rivers, as discussed below. The two wild stocks in AU 3 have also recovered, but the estimates of the current and/or the potential smolt production of Ljungan and Testeboån are highly uncertain. In AU 4 the Mörrumsån stock has stayed relatively stable, while the abundance in Emån has been gradually increasing. The AU 5 stocks are characterized by large interannual variation in smolt production and varying trends in the production. Smolt production in the Nemunas river system has been increasing especially in the latest years, while in Salaca and Gauja the production has been fluctuation without clear trends. Smolt production in Venta shows a decreasing trend. Many AU 5 rivers are very small and their estimated PSPC is in some thousands of smolts only; the existing data from these rivers are fragmentary and typically indicate zero or near-zero annual smolt production (see more details in Section 4.2.4).

By comparing the final year (2020) posterior smolt production (Table 4.2.3.3) against the estimated reference points R_{lim} and R_{MSY}, it is possible to evaluate the current status of the AU 1–4 stocks in terms of their probability to reach the reference points (Table 4.2.3.4a). Table 4.2.3.4b contains wild and mixed AU 5–6 stocks, which are currently not included in the FLHM. These stocks have not been analytically derived, but expert judgments are used to classify their current status in relation to their PSPC. Because the estimates of annual smolt production vary greatly among AU 5–6 stocks (partly an artefact caused by assuming that all smolts are 2-year olds), the current status assessment is calculated in two ways: 1) by using only the 2020 smolt production estimate, and 2) by using the average of the 2018–2020 smolt production estimates.

Out of the 17 assessed stocks in AU 1–4, nine have reached R_{lim} with >95% probability, three stocks have reached R_{lim} with 70–95% probability, two stocks have reached R_{lim} with 50–70% probability, and three stocks have reached R_{lim} with <50% probability (Table 4.2.3.4a). All stocks in the AU 1 are estimated to have reached their R_{lim} with 99–100% probability, and the corresponding probabilities of having reached their R_{MSY} vary between 60–80%. In AU 2, three stocks (Piteälven, Byskeälven and Vindelälven) have reached their R_{lim} with >95% probability, while among the rest of the AU 2 rivers the corresponding probabilities range from 40% (Lögdeälven) to 89% (Sävarån). The probabilities for having reached R_{MSY} vary between 9% (Rickleån and Lögdeälven) and 77% (Piteälven). In AU 3, Ljungan has a low probability (< 40%) of having reached either of the reference points, while Testeboån has likely (with >70% probability) reached both reference points. A similar divided status prevails among the AU 4 stocks, where Mörrumsån has likely reached both R_{lim} (100% probability) and R_{MSY} (76% probability), whereas Emån has unlikely reached either of them (28% and 9% corresponding probabilities). As discussed in Section 4.4.2, current stock status of Piteälven (AU 2) and Testeboån (AU 3) is most likely overestimated.

Among the twelve AU 5 stocks, the wild Salaca (2020 and 2018–2010 average smolt production is 43% and 40% of PSPC, respectively) and mixed Nemunas (2020 and 2018–2010 average smolt production is 32% and 21% of PSPC, respectively) stocks have the highest current status. Among the remaining wild and mixed AU 5 stocks, current smolt production is <10% of the respective PSPC (Table 4.2.3.4b).

A large majority of the twelve AU 6 stocks has reached a higher proportion of their PSPC than the AU 5 stocks. Smolt production in the Kunda stock has reached 100% of its PSPC, and the production in the Keila stock is also very high (2020 and 2018–2010 average smolt production is 88% and 96% of PSPC, respectively). The current smolt production is <10% of the PSPC in the mixed stocks of Luga, Valgejögi, Jägala and Vääna (Table 4.2.3.4b).

The full life-history model (FLHM) captures quite well the overall historic fluctuation of catches in various fisheries, especially from the last ten years (Figure 4.2.3.6). However, catches from the first decade of this millennium tend to become underestimated for most of the years and fisheries. The model also does not fully capture the high river catches of the years 2008–2009 (Figure 4.2.3.6).

The model is fitted to the proportion of wild and reared salmon (separately for ages 2SW and 3SW) in the offshore catches. The posterior estimates of wild vs. reared proportions follow rather closely the observed proportions (Figure 4.2.3.7).

An increasing long-term trend in the number of spawners is seen in most of the rivers of the AUs 1–4 (Figure 4.2.3.18). Spawner abundance increased particularly in the years 2012–2014. In Simojoki, the very high estimates of spawners around the turn of the millennium are a result of very intensive stocking of hatchery-reared parr and smolts in the river during the late 1990s. The model captures trends seen in fish ladder counts, even short-term variation in rivers where the data are not used for model fitting (e.g. Byskeälven). Annual variation in river conditions affect the success of fish to pass through ladders and, therefore, the ladder counts themselves are not ideal indices of spawner abundance.

In Kalixälven, Åbyälven and Rickleån the development of spawner abundance estimated by the model appears more optimistic than the development observed in the fish ladder counts. In Kalixälven, the counter is located about 100 km from the river mouth with large spawning areas downstream. In Åbyälven and Rickleån fish ladders were constructed around the turn of the millennium and salmon are gradually repopulating the upstream sections above the dams. Therefore, counts in these rivers account for a small fraction of the total spawner population, and the counts may not well represent the actual development of these river stocks.

Unlike in the other AU 1–3 stocks, the amount of spawners dramatically dropped in Ume/Vindelälven for the years 2015–2018. Since 2014, the fish ladder counts in this river have not been as low as the model estimated numbers of spawners (Figure 4.2.3.8 vs. Table 3.1.1.2 and Figure 3.1.1.3). This is due to the need to accommodate Ume/Vindel stock dynamics in the FLHM to the extra losses among female salmon to reach spawning grounds in this river (see Section 4.2.1 and Stock Annex, Section C.1.9). The drop in spawner abundance in Ume/Vindelälven is dramatically decreasing the current and near-future smolt production (Table 4.2.3.3 and Figure 4.2.3.8b). However, the most recent (2019–2020) spawning runs into the river have been abundant and the smolt production is expected to increase rapidly starting 2022.

The general synchronous drops and increases in the observed spawner counts are well-captured by the model, also the most recent drop observed from 2016 to 2017–2018. This is probably a consequence of fitting the model to spawner counts in combination with assuming annually varying maturation rates; maturation rates are estimated to be lower preceding poor spawning runs and higher preceding high spawning runs (Figure 4.2.3.2 vs. Figure 4.2.3.8). Also, the effect of annually varying post-smolt survival is visible in spawner counts and estimates, e.g. the low survival of the 2016 smolt cohort contribute to the low spawner abundance especially in 2018. For 2021, the FLHM predicts moderate spawner abundance in most rivers. This prediction must, however, be taken with caution, because the prediction is very uncertain, and e.g. natural conditions at sea during the spring 2021 (not currently well known/predicted) are expected to modify the spawning run strength via maturation rates and run timing.

Despite some fluctuations, there was a strong long-term decreasing trend in the harvest rate of driftnets until the total ban of this gear type in 2008 (Figure 4.2.3.9a). The harvest rate of longlining has been fluctuating a lot (between less than 0.05 to about 0.3 among MSW salmon). After the peaks in 2003–2005 and again in 2011, this harvest rate dropped to about 0.1 and for the two last years (2019–2020) the harvest rate dropped further to below 0.05. The harvest rate in trolling increased from the 1990s until 2007–2010, when it was 0.07–0.08 (Figure 4.2.3.9b). During the last decade this harvest rate has been on the level of 0.03–0.05. The combined offshore harvest rate (driftnetting, longlining and trolling) shows a clearly decreasing trend from about 0.5 in the early 1990s to below 0.1 in the last two years (Figure 4.2.3.10). Since the early 2000s, the coastal harvest rate, which predominantly consists of trapnet fishing, has decreased almost continuously (Figure 4.2.3.9c). Currently the harvest rate of this fishery is about 0.15 for the AU 1 salmon (which has the highest coastal harvest rate of all Baltic salmon) (Figures 4.2.3.9c and 4.2.3.10). Estimates of harvest rates in the rivers are inaccurate and lack a clear trend (Figure 4.2.3.9d). River-specific data indicate that there can be substantial variation in the harvest rate between rivers (Section 3.1), which is currently not taken into account in the FLHM.

4.2.4 Status of the assessment unit 5–6 stocks

Since salmon in AU 5 and 6 are yet without an analytical assessment, it has not been possible to evaluate river specific reference points related to MSY (i.e. R_{lim} and R_{MSY}). Therefore, for these stocks the previously used targets related to expert elicited potential smolt production capacity (50% and 75% of PSPC) are still referred to.

Smolt production in relation to PSPC in the **AU 5 stocks** shows a negative trend in almost every wild and mixed river (Figures 4.5.1 and 4.5.2). During the last decade, smolt production dropped from 50% or higher to below 50% of PSPC. Thereafter smolt production has stayed on this low level except for in 2015–2016, when a sudden temporal increase was observed in most rivers. A similar increase can also be expected in 2021 (Figure 4.5.1). From 2017 to 2020, most AU 5 rivers were estimated to produce only about 10–30% of their PSPCs and they are therefore unlikely to have reached 50% target (given the associated uncertainties in estimation; Table 4.2.3.4b). In river Pärnu, the smolt production has shown small signs of improvement. Also, in Nemunas a positive development can be seen. This is a large watercourse with several tributaries, and many of them have been subject to long-term restoration efforts (habitat restorations, stocking, etc. see ICES, 2018a. Observed smolt production in the Nemunas in relation to PSPC has remained far below 50% level of PSPC, but the prediction for 2021 is to be just above 50% of PSPC.

Rivers Salaca (AU 5) and Mörrumsån (AU 4) are both well-known salmon rivers with the most extensive and longest time-series of monitoring data in the Main Basin area (Sections 3.1.4 and 3.1.5). The developments of parr densities in these two rivers roughly resemble each other since the early 1990s; an increase in the densities from the early to the late 1990s and a subsequent decrease starting in the early 2000s. Smolt production in Salaca from 2017 to 2020 was mostly below 50% of PSPC. Prediction for Salaca smolt production in 2021 is to be above 50% of PSPC.

Smolt production in the **AU 6 stocks** shows positive trends in most rivers but also a large inter-annual variation, especially in the smallest rivers (Figures 4.2.4.3 to 4.2.4.5). Among wild (Figure 4.2.4.3) and mixed (Figure 4.2.4.5) Estonian stocks the clearest positive trend exists in two of the wild ones (Keila and Kunda) which have reached 75% of their PCPCs. Smolt production in wild Vasalemma has also increased in recent years, however it has remained below 50% of PSPC (Figure 4.2.4.3, Table 4.2.3.4b). In 2018, the Vanaveski dam was opened and salmon got access to additional spawning areas upstream. Therefore, PSPC in Vasalemma is now estimated to be higher than in previous years which consequently has caused a drop in the stock status. However, the electrofishing data indicate a gradual colonialization occurring in these new rearing habitats and a continuous improvement of the Vasalemma stock status is expected.

In the small Estonian mixed rivers, the smolt production was mostly low in 2017–2018, but in recent years production levels have improved (Figure 4.2.4.4, Table 4.2.3.4b). Current PSPC in some of these small rivers is severely limited by migration barriers, and parr densities show a lot of interannual variation. As a result of dam removal in mixed river Valgejõgi the estimated PSPC has increased markedly since 2016 (from 1500 to 16 500 smolts), because salmon regained access to all potential historical spawning and rearing areas.

In the Finnish mixed river Kymijoki, a positive trend can be seen, although some variation in year classes have occurred. The smolt production has varied around 50% of PSPC in the last three years (43–65%). In Russian river Luga, wild smolt production is stable but low, and it has remained below 10% of PSPC despite large-scale annual smolt releases using salmon of local origin (Figure 4.2.4.5, Table 4.2.3.4b).

4.2.5 Harvest pattern of wild and reared salmon in AU 6

About 90% of the salmon catches in Gulf of Finland are taken from the northern coast by the Finnish commercial coastal fishery. Genetic analyses of the stock composition of Finnish commercial catches show that the largest stock contribution (50%) was from locally released reared Neva salmon, whereas wild stocks originating from the Gulf of Bothnia contributed with 30% and released Gulf of Bothnia stocks with about 15%. The share of Eastern Main Basin stocks was less than 5%. It should be noted, however, that there were pronounced differences between sampling sites and sampling times between the years. The share of Gulf of Bothnian salmon was clearly higher during the early fishing season (June), whereas the share of Gulf of Finland Neva salmon was high later in the season. The proportion of other Gulf of Finland stocks (Russian and Estonian) in the genetically analysed catch samples from the northern Gulf of Finland have been estimated to zero or close to zero (<0.5% Kunda in 2017, ICES, 2019).

Stock composition of Estonian coastal catches from 2016–2018 was for the first time genetically studied in WGBAST 2019 report. The catch composition differed substantially from the Finnish coastal catches from the northern Gulf of Finland. On average over 80% of the catches consisted of local wild and released stocks, whereas Eastern Main Basin stocks contributed with about 10% on average and Gulf of Bothnian stocks contributed with less than 5%.

These results suggest that the main salmon fishery in Gulf of Finland that takes place at the Finnish coast has little effect on the Estonian wild populations. In contrast, the small and geographically restricted Estonian coastal fishery mainly harvests Estonian wild stocks. The present harvest rate seems to be on a sustainable level, as the Kunda and Keila populations are estimated to have good status. An increase in smolt production has also occurred in river Vasalemma.

Salmon fishing on Russian coast is not allowed. Despite this, the river Luga stock has remained on a very low level over the years. Circumstantial data indicate a high level of poaching at the river mouth and in the river, which may be a main reason for the low stock status.

4.3 Stock projection of Baltic salmon stocks in assessment units 1–4

4.3.1 Assumptions regarding development of fisheries and key biological parameters

Table 4.3.1.1 provides a summary of assumptions on which the stock projections are based. The fishing scenarios differ from the ones in previous assessments, but the overall structure is similar to, for example, the previous full assessment (ICES, 2019). Furthermore, the reference year for assessing the effects of different fishing options in the advice year on smolt production has been shifted one year earlier, as explained below. This was done due to the recent successive change in fishing pattern towards harvesting mature (instead of immature) salmon to higher extent than in the past.

Fishing scenarios

Scenario 1 illustrates stock development in case all fishing (both at sea and in rivers) is closed, whereas scenario 2 is similar with the exception that only sea fisheries (both recreational and commercial) are closed but fishing is allowed in all rivers except those where it is currently banned (Kågeälven, Ljungan, Testeboån and Emån). Scenarios 3–6 illustrate fishing scenarios with the current fishing pattern and a differing degree of total removal at sea (both recreational and commercial). Note that there is no longer a scenario corresponding to a "base case", i.e. the same future removal as advised by ICES for the current year (total commercial sea catch of 116 000 salmon in 2021), as in earlier assessments. Scenarios 7–10 introduce a new fishing pattern in which offshore fisheries (both recreational and commercial) are closed, and coastal fisheries in SD29-31 would be allowed with a differing amount of total removal. In scenarios 3–10 river fisheries are taking place similarly as in scenario 2.

As in previous years, fisheries in the interim year (2021) follow the scenarios, except for longline fishing during the first months of the year, which is estimated based on the effort observed during the corresponding months of 2020.

Scenarios were modified to account for annually varying harvest rates in recreational trolling and catchabilities in commercial longlining. We assumed that the longline catchability in the future will remain the same as in the last observed year (2020). Similarly, the harvest rate estimated for trolling in 2020 was used also for future years. To obtain the desired total removal for each fishing scenario, the effort values from 2020 were given for the future years, and optimization was performed to find an effort multiplier that resulted in a total sea catch corresponding to the desired (scenario-specific) total removal in the advice year (2022). Total sea catch was obtained as the sum of catches from coastal trapnet, offshore longline and recreational trolling fisheries. The same multiplier was used for coastal trapnet, offshore longline and recreational trolling in scenarios 3–6. In scenarios 7–10 an effort multiplier was applied only for coastal trapnetting, whereas harvest rates for offshore fisheries were set to zero. It should be noted that the current methodology keeps the fishing pattern the same between the scenarios in terms of relative differences in harvest rates, not in catches. Thus, in scenarios with high total removal, a greater share of the catch will be taken in the offshore areas compared to ones with lower removal, because offshore fisheries are first in order in the fishing pattern.

The recreational trolling fishery is now handled in a slightly different way to earlier years, since it has been added as a separate fishery to the scenarios. Earlier (e.g. in 2019), it was included as a part of the offshore longline fishery and it was assumed that the recreational sea effort would stay the same over all scenarios, while the number of salmon available to the fishery varied according to the commercial removal.

Because the scenarios are technically defined in terms of future fishing effort, the predicted catches have probability distributions according to the estimated population abundance, age-specific catchabilities and assumed fishing effort. Scenarios 3–6 assume the same fishing pattern in commercial fisheries (division of effort between fishing grounds) as realized in 2020. Figure 4.3.2.8a–c shows the harvest rates prevailing in scenarios 4, 6, 7 and 10.

Survival parameters

In both the M74 and the post-smolt mortality (Mps) projections, an autoregressive model with one year lag (AR(1)) is fitted at the logit-scale with the historical estimates of the survival parameters. Mean values of the mean of the post-smolt survival over years 2016–2019 (16%), variance over the same time-series and the autocorrelation coefficient are taken from the historical analysis into the future projections. The method for M74 is similar, but the stable mean for the future is taken as the mean over the whole historical time-series. In addition, the forward projection for Mps is started from 2019 to replace the highly uncertain model estimate of the last year of the historical model and the future uncertainty is adjusted to accommodate the range of historical variation in M74. The starting point of M74 projections is 2021. Time-series for Mps and M74 survival are illustrated in Figure 4.3.2.1.

Adult natural mortality (M) is assumed to stay constant in future, equalling the values estimated from the historical assessment. Different fisheries occur at different points in time and space, and many catch only maturing salmon, which have been subject to several months' natural mortality within a year. Thus, to increase comparability of abundances and catches, the abundances at sea have been calculated by letting M first decrease the PFA (stock size at the beginning of year) of multi-sea-winter salmon for six months. Moreover, the stock size of grilse has been presented as the abundance after the period of post-smolt mortality and four months of adult natural mortality. This period is considered because the post-smolt mortality period ends in April, after which eight months of that calendar year remain during which grilse are large enough to be fished. Half of that period, i.e. four months, is considered to best represent the natural mortality that takes place before the fishing.

Maturation

Annual sea-age group-specific maturation rates are given as the average level computed over the historical period, separately for wild and reared salmon. This projection starts from 2022, as the maturation rates of 2021 can be predicted based on sea surface temperature (SST) information from early 2021 (ICES, 2014, Annex 4). The time series of maturation rates are presented in Figure 4.3.2.2.

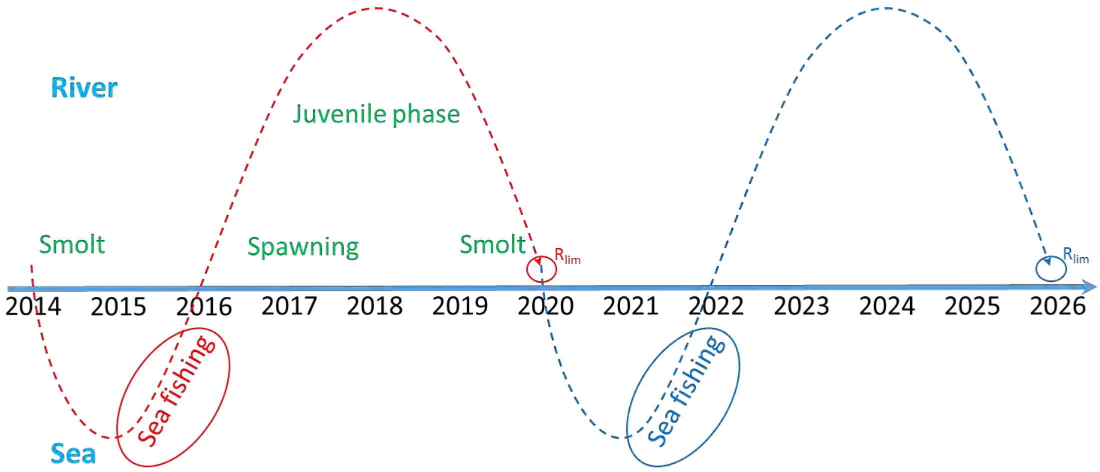
Releases of reared salmon

The number of released reared salmon per assessment unit is assumed to remain at the same level in the future as in 2020 (Table 3.3.1).

Evaluation of stock status under various catch options for 2022

For other fish stocks assessed by ICES, biological reference points often apply to spawning stock (typically expressed in terms of biomass, SSB) at the end of the advice year. For Baltic salmon, however, there is a half-century-long tradition of using smolt production as the main metric of abundance (ICES 2020b). Accordingly, reference points and stock status for Baltic salmon are expressed and evaluated in terms of smolts (i.e. recruits produced by a certain spawning stock) rather than the spawning stock itself. Because of the time lag between spawning and smoltification, fishing in any specific year will not affect smolt production until some years later.

The schematic and approximate figure below illustrates how sea fishing for Baltic salmon in a particular calendar year affects future smolt production and status (e.g. evaluated using R_{lim}). As shown by blue arrows, fishing in 2022 will mainly affect smolt production in 2026 (or 2025, depending on the AU), whereas current stock status – i.e. smolt production in 2020 (last year with data) – reflects past fishing and spawning stocks (mainly 2016).



Based on results for the 10 fishing scenarios presented earlier, stock status corresponding to smolt production in 2026 (AU 1-3) or 2025 (AU 4) is evaluated below (Section 4.3.2). The one-year difference between AU's reflects latitudinal differences in average smolt age. Note that the time lag of 3 or 4 years from the advice year until smoltification is one year shorter than what has been used for corresponding evaluations in previous years. The reason for this change is the recent shift in fishing pattern with an increased share of coastal catches from the Gulf of Bothnia, targeting only maturing salmon during their spawning migration. In the past, when fishing on the Main Basin feeding grounds was taking a much larger part of the total sea catch than at present, using smolt runs 4-5 years ahead from the advice year as reference years was considered more accurate, as fishing was then targeting a larger share of immature salmon. Also, note that the new scenarios 7-10 (added this year) are entirely based on Gulf of Bothnian coastal fishing on spawning migrating salmon.

4.3.2 Results

According to the projections, stock size on the feeding grounds (pre-fishery abundance, PFA) will be about 1.15 (0.48–2.6) million salmon (wild and reared, 1SW and MSW fish in total) in 2022 (Figure 4.3.2.3a–b). Of this amount, MSW salmon (i.e. fish which stay on the feeding area at least one and a half years after smolting) will account for 0.53 (0.22–1.16) million salmon. These MSW fish will be fully recruited to offshore and coastal fisheries in 2022. From the predicted amount of 1SW salmon (0.59 million, 0.21–1.49 million) at sea in spring 2022, a fraction (most likely 15–30%) is expected to mature and become recruited to coastal and river fisheries, while the rest of the 1SW salmon will stay on the feeding grounds and will not become recruited to the fisheries until next winter.

According to median values for 1SW and MSW wild salmon combined (Figure 4.3.2.3 a–c) the abundance of wild salmon at sea fluctuated between 0.4–0.9 million without any apparent trend until the last decade. During the 2010s, the abundance increased and was mostly on the level of 0.8–0.9 million fish. For the years 2021–2022 the abundance has somewhat dropped (to about 0.7 million), but after 2022 the abundance is expected to increase back to the level estimated for the 2010s. However, the uncertainty associated with the current and future abundance estimates are much larger than the uncertainty associated with the estimates of the past years. Except for the highest fishing scenario (scenario 6), the abundance of wild salmon is predicted to stay on this elevated level or somewhat increase in the future.

In contrast to wild salmon, the abundance at sea of reared salmon strongly decreased from the mid-1990s to 2006–2007, mainly due to the decline in post-smolt survival. Substantial amounts of reared salmon are assessed to have recruited to the fisheries for short periods both in the early and the late 2010s, but the current abundance is estimated low and it is also predicted to stay low during the coming years. The combined wild and reared abundance (PFA) also declined substantially from mid-1990s until 2006–2007, but thereafter the total abundance has somewhat increased (Figure 4.3.2.3a–c).

Because one of the simplifying assumptions of the modelled life cycle is that all salmon die after spawning, a lower maturation rate will increase the survival of the cohort to the next year compared to years with the same abundance but with average maturation. Similarly, a high maturation rate will decrease the abundance of MSW salmon in following years. Because of this feature, it is important to note that the predicted abundance may easily become over- or underestimated because of the (predicted) development of maturation rates.

Table 4.3.2.1a shows the predicted catches by scenario for the year 2022. The table also shows the predicted fishing mortalities, as well as the predicted number of spawners and number of non-harvested (surplus) reared salmon in 2022 for each scenario.

How the catch in each scenario would become divided between various fisheries and their components (commercial, recreational, reported, unreported etc.) depends on the applied management. Table 4.3.2.1b and Figure 4.3.2.9 show how the catch components have developed and what they were in the latest year (2020) with the available information. For instance, from the total combined sea and freshwater catch in 2020, 42%, 16% and 42% were taken by commercial, recreational sea and recreational river fisheries, respectively. During the last five years these proportions have been fluctuating without any trend, but the share of both types of recreational catches have increased so that in 2016–2018 their combined share was close to 40%, while in 2019–2020 their share exceeded 50%. From the total sea catch in 2020, commercial catch accounted for 73% (ranging between 73–84% during the last five years). Reported commercial catch accounted for about 81% (ranging from 55–83% during the last five years) of the total commercial sea catch (i.e. total fishery related mortality). Unreporting, misreporting and discarding in 2020 are considered to have taken 6%, 0.2% and 8% shares of the total commercial sea catch, respectively. Among these catch components, only misreporting has been varying considerably during the last five years (between 0.2–28%).

The scenarios 7–10 consider a situation, in which sea fisheries take place only on coastal waters, which means that almost the whole sea catch would be caught in subdivisions 29–31. In this sea area, about 90% of the total sea catch has been taken by commercial fisheries during the last five years. About 84% of this has been reported commercial catch. Among the rest of the components of commercial catch, unreporting has been accounting for the largest share (8–9%) (Table 4.3.2.1b).

Figure 4.3.2.4 illustrates the longer term development of future sea catches given each scenario. Note that in the scenarios 3–6 the sea catches are taken both by offshore and coastal fisheries, while in the scenarios 7–10 only coastal fisheries exist. In scenarios 3–6 the current fishing pattern is applied by keeping the relative differences between the harvest rates of various fisheries constant. Because of the sequential nature of fisheries, this application results in changes to the relative share of catches between fisheries: the higher the total removal, the higher the proportion of catch taken by offshore fisheries (which catch fish first). This phenomenon does not occur in the scenarios 7–10.

Figures 4.3.2.5a–d present the stock-specific annual probabilities to meet R_{MSY} under the scenarios 1–6, while Figures 4.3.2.5e–h present the corresponding probabilities under the scenarios 7–10. Tables 4.3.2.2 to 4.3.2.5 show stock-specific probabilities to meet R_{lim} and R_{MSY} in the smolt production in the years 2026/2025 and five generations (G=6 years for the AU 4 stocks and 7 years for the AU 1–3 stocks) ahead from 2020, whose smolt production is used to evaluate current stock status. As explained earlier (section 4.3.1), the stocks status measured from the smolt production in 2026/2025 reflects the direct, immediate effects of the 2022 fishing on salmon reproduction. Finally, Table 4.3.2.6 shows, what proportions of the 17 assessed stocks reach R_{lim} in 2026/2025 and 5 generations ahead from 2020, given different levels of certainty.

As expected, the lower the harvesting, the higher is the status of stocks. For some of the stocks, river fishing alone (scenario 2) has a visible effect on the probability to reach the reference points compared to zero fishing scenario (scenario 1). This is the case especially among the stocks with the weakest status; therefore restrictions or ban of river fishing (like already enforced in Kågeälven, Ljungan, Testeboån and Emån) are likely to improve the status of the weakest stocks. However, for most of the stocks there is little difference in the predicted stock development among the scenarios with no fishing or removals below 100 000 salmon, i.e. in the scenarios 1–3 and 7-9. The effects of harvesting on future development and stock status become widely significant in scenario 6, in which total sea removal is assumed as high as 200 000 salmon. For a number of stocks, the future probabilities to reach R_{lim} and R_{MSY} notably decrease under this scenario. The scenarios 4–5 with total sea removals of 100 000 and 150 000 respectively, which roughly correspond to the most recent harvest levels, indicate gradual improvements (higher probabilities to reach R_{lim} and R_{MSY} compared to the year 2020) for most of the stocks, whereas some of the healthiest ones maintain their current high status.

All the stocks are expected to reach R_{lim} with >0.5 probability by 2026/2025 in the scenarios 1–3 and 7-9 (Table 4.3.2.2). Five salmon generations ahead from 2020 R_{lim} is predicted to be reached with >0.5 probability in all other stocks and scenarios, except in Ljungan under the scenario 6 (Table 4.3.2.3). Moreover, the probability to reach R_{lim} is predicted to mostly increase in all other scenarios except in the scenario 6. The long-term prediction indicates, which level of harvesting allows stocks to gradually continue their recovery, as summarized in the above paragraph.

As expected, R_{MSY} has been and will be reached by lower probabilities than R_{lim} (Table 4.3.2.4). Decreases in the probability of some rivers to reach R_{MSY} in 2026/2025 and 5 generations ahead compared with the current situation occur mainly in the scenario 6, but in some cases also in the scenario 5 and in a couple of cases even in all the scenarios (Table 4.3.2.4-5). In the other scenarios than 5 and 6, the drop in the probability is so small that it is explained by more accurate estimates of smolt runs in 2020 (from which year data exists) than in the future (which are predictions) (Figure 4.3.2.6).

Among the scenarios 7–10, which assume no offshore fishing and therefore in practice move sea harvesting to the spawning runs of AU 1–3 stocks, there are only small and sometimes almost unnoticeable differences in the AU 1–3 stocks' status with the given range of removals (from 25 000 to 100 000 salmon). This results from the altered size/age selectivity of this fishing pattern, as well as it indicates a greater resilience among the northern (AU 1–3) stocks to harvesting, compared to the southern (AU 4, possibly also AU 5) stocks which are not harvested at sea in these scenarios. Within the Gulf of Bothnia, the weakest stocks of the Gulf are located in the AUs 2-3, which are not harvested by coastal fishing as much as the AU 1 stocks because fishing within the Gulf is aggregated to the coastal stretches where only AU 1 stocks are present (section 4.5.3.2). This further explains why the coastal fishing scenarios do not result in more negative effects among these stocks. Instead, the scenarios 7-10 predict somewhat stronger improvements to the status of the southern stocks than the scenarios with the current fishing pattern and similar levels of total removal (scen 3 vs. scen 8 and scen 4 vs. scen 10; Tables 4.3.2.2–4.3.2.5, Figure 4.2.3.5a–h).

When comparing the total smolt production in each AU in the year 2020, 2026/2025 and five generations ahead from 2020 vs. the combined total AU specific R_{lim}, all AUs have reached R_{lim} in 2020 with high probability (prob 0.86–1) and they are predicted to maintain high status also in the future (Tables 4.3.2.2 and 4.3.2.3). However, in the scenarios 5–6 the probability for AU 3 to reach R_{lim} somewhat decreases. When comparing the smolt production in each AU with R_{MSY}, the corresponding probabilities are clearly lower than those for R_{lim} both in the current and the future situations (Tables 4.3.2.4 and 4.3.2.5). The probabilities mostly increase (or stay on the current level) in scenarios 1–4 and 7–10, while in scenario 6 probabilities decrease in most of the AUs.

Currently (year 2020), 53% and 82% of the 17 assessed stocks have reached R_{lim} with probabilities above 90% and 50%, respectively (Table 4.3.2.6). Interestingly, the proportion of stocks which have reached R_{lim} with at least 50% probability is predicted to increase substantially even in the scenarios with the highest fishing mortality. The proportion is predicted to increase especially over the long term (after five generations this proportion is 94% in the scenario 6, for example). On the other hand, the proportion of stocks which will be above R_{lim} with high (>90%) probability is predicted to decrease in the scenario 6. Of the scenarios with the most similar removals to the 2021 advice (4 and 5), the scenario 4 allows two additional stocks and the scenario 5 allows one additional stock to reach R_{lim} with 90% probability in 2026/2025 (compared with current status). The proportion of stocks having very high (>95%) probability to be above R_{lim} increases in the scenarios 1-3 and 7-9, but this proportion begins to decrease in the rest of the scenarios. Among the scenarios 7-10 with only coastal fishing the proportions to reach R_{lim} increase in all except one case: in short-term the proportion of stocks exceeding Rlim with >95% decreases by one stock in the scenario 10. To summarize, these results show how most of the stocks which are currently recovering tend to recover also in the future, whilst increases in harvesting generally prevent stocks to hold high status with very high probability.

As expected, changes in fishing have the smallest effect on those stocks that are close to their PSPC (Tornionjoki, Kalixälven, Piteälven, Byskeälven, Mörrumsån). Because the overall level of harvesting is low or moderate in these scenarios compared to historical levels, the examined range of fishing mortalities (except the most extreme scenarios 1, 2 and 6) only results in modest impacts on the chances of reaching the reference points. Future predictions about smolt abundance are naturally more uncertain than the estimated abundance until 2020 (Figure 4.3.2.6). However, in those stocks which are close to their PSPC, also the predictions are rather certain, indicating that smolt abundance will stay close to PSPC in these rivers under different fishing scenarios.

Figure 4.3.2.7a-d shows longer term predictions in the river-specific smolt and spawner abundances for three scenarios (1=zero fishing; 4= 100 000 sea catch; and 6= 200 000 sea catch). The two most extreme scenarios (1 and 6) illustrate the predicted effects of contrasting amounts of fishing.

4.4 Additional information affecting perception of stock status

This section focuses on auxiliary information of importance for a complete evaluation of the current stock status. In particular, we highlight information about diseases and other factors that may affect development in stock status, but which are not fully taken into consideration in the current modelling. Likewise, weaknesses in input data and/or difficulties to take into account certain river-specific issues in the modelling might affect the precision of status evaluations, and in the worst case introduce biases. Such shortcomings in the current assessment model are also discussed in this section.

4.4.1 Potential effects of M74 and disease on stock development

Many of the M74-fluctuations seen since the early 1990s have tended to last for some years before changing in direction (Figure 3.4.1.3). After a period with very low M74 abundance in 2011–2015, mortalities increased to higher levels in 2016–2018. In 2019, M74 related mortalities decreased considerably, and mortalities among offspring hatched in 2020 were even lower. The latest thiamine analyses of eggs spawned in 2020 indicate that M74 mortality among offspring is predicted to decline to close to zero in 2021. Despite the recent positive development, the future occurrence and development of M74 is difficult to predict, which introduces uncertainty in forecasts of the development of salmon stocks. The disease outbreaks reported in several rivers in recent years (Section 3.4.4) is also a concern for the future. The cause(s) of the disease is still unknown, and to accurately quantify the amount of affected or dead salmon in a river appears difficult, if at all possible.

To quantify the effects of health issues among spawners on the recruitment in rivers is difficult. Existing information indicates that M74 or disease among spawners mainly affect number of eggs deposited or hatched or the number of dispersing fry. That is, losses seem to take place before the offspring reach stages with highest density-dependent mortality. Therefore, a stock with high status is expected to show more resilience against various events that negatively affects early reproduction (i.e. from egg deposition to dispersal of fry), because these effects may partly be compensated by reduced density-dependent mortality among the offspring. In contrast, weaker populations are not expected to have similar 'buffers' against such losses.

Average salmon 0+ parr densities in many rivers decreased in 2016–2018 compared to the historically high densities observed around year 2015. In 2019 and 2020, parr densities again increased in many rivers. Part of these fluctuations may be explained by generation effects, i.e. variation in year-class strength among spawners, but mortality due to M74 and/or other disease outbreaks is likely also part of the explanation. Compared to other rivers, the very low parr densities recently observed in **Vindelälven** and **Ljungan** are exceptional. In **Vindelälven**, the average 0+ density dropped drastically, from ca. 40 parr/100 m^2 in 2015 to only one parr/100 m^2 in 2016, and remained at very low levels until 2019 (Table 3.1.2.1). The decline likely reflects a combination of factors. In 2015, only 790 females were counted in the Norrfors fish ladder, which represented 18% among MSW salmon and 11% of the total spawning run (if assuming 6% females among grilse). In 2016, the number of females counted was higher (2741), but a large proportion of the salmon passing the ladder had severe skin problems (fungus infections) and many died soon after having been counted. Female numbers again decreased to 908 in 2017 and 728 in 2018, which represented only 32% and 26%, respectively, among MSW salmon. There are no observations of such skewed sex ratios in the sea or at the river mouth of Umeälven, or in other rivers. Hence, the recent disease problems in Ume/Vindelälven seem to have prevented particularly females from reaching the spawning areas.

In 2019, the number of MSW Vindelälven salmon counted at Norrfors increased significantly. In total 3389 females, representing 33% of the MSW salmon, passed the counting site. Salmon still expressed symptoms of having health problems, but these were mainly observed during the early part of the migration period. The increase of female MSW salmon in 2019, resulted in a pronounced increase in densities of 0+ salmon in 2020. In 2020, the number of ascending MSW females increased further, indicating that the negative trend in recruitment observed in recent years has likely reversed into recovery phase. Furthermore, as described above, the M74 situation has generally improved with low fry mortalities in 2020 (Table 3.4.1.1) and even lower predicted mortalities in 2021, which will likely improve possibilities for recovery of this river stock.

Also, in **Ljungan** average 0+ salmon densities in 2017 and 2018 were exceptionally low (<1 parr/100 m^2) compared to other rivers in Gulf of Bothnia. There was a slight increase in 2019 and

2020, but the abundance of 0+ parr is still low compared to that of the preceding years (average density of 61 0+ salmon in 2014–2016; Table 3.1.3.1). Notably, the collapsed parr density in 2017 followed after a year with many dead salmon observed in the river, combined with a high expected level of M74-mortality. The very low parr densities in **Vindelälven** (2016–2019) and **Ljungan** (2017–2020) are expected to result in a successive reduction in smolt production from 2019 and a few years onwards, affecting pre-fishery abundance of salmon from these two rivers from 2021. Because of the exceptional situation for these two rivers, local fishing restrictions, aimed at protecting ascending spawners in the estuarine sea during upstream migration, were enforced in 2019 and were in operation also in 2020. Most likely, these fishing restrictions will continue in 2021.

Although the FLHM cannot in its current form incorporate all details of the specific events affecting salmon stocks in Ume/Vindelälven and Ljungan, their consequences for recruitment are incorporated mainly via the time-series of smolt production (including predictions of the near-future production) based on parr densities fed into the river model, as explained and shown in the Section 4.2.2. Also, the recent low success of females to reach spawning grounds in the Ume/Vindelälven is incorporated, but currently there are no methods for predicting the future development of health problems.

4.4.2 Biases in stock status evaluations

The precision in status evaluations of individual river stocks depends to a large extent on the amount of available data. Data from several life stages (parr densities, smolt numbers and number of ascending spawners) and long time-series increase the possibility for an accurate status evaluation, whereas status evaluations of river stocks for which only information on parr densities and/or short time-series is available becomes more uncertain. Also, river-specific factors may introduce uncertainties and/or biases in status evaluations. Migration obstacles, for example fish ways at dams, affect migration possibilities and/or survival of spawners and smolts to a varying extent. If not accounted for (e.g. because of lack of information), such factors may introduce biases in status evaluations. For most stocks included in the FLHM, status evaluations are thought to be reasonably accurate without any severe biases. A few exceptions exist, however, among which particularly Testeboån and Piteälven stand out. A common denominator of these two rivers is the occurrence of dams which (to a largely unknown extent) affect migration possibilities and survival of both upstream and downstream migrating salmon. Weaknesses in input data and difficulties to take into account such river-specific issues in the modelling of these two stocks are discussed in more detail below. Although the status evaluations for Testeboån and Piteälven seem to be particularly affected by problems related to migration obstacles, similar issues may at least to some extent exist also in other rivers.

Testeboån was included in the FLHM for the first time in the assessment carried out in 2019. As described in ICES (2019), the PSPC posterior was heavily updated downwards, which resulted in a surprisingly high status of this new wild salmon river, given that salmon parr densities are still comparably low in substantial parts of the river system. The updated PSPC was thought to result from the omission of spawner count data at that time. In 2020, the FLHM was not updated. This year, spawner count data for years 2016–2020 have been included in the model for the first time, but the PSPC posterior was again heavily updated downwards, resulting in high estimated stock status, similar to the 2019 assessment results. Expert opinions on PSPC in combination with empirical data on the amount of out-migrating smolts, indicate that smolt production in recent years has fluctuated between 20–40% of the PSPC, which clearly deviates from the assessment results suggesting that current smolt production has already approached the river's production potential.

The reason for the biased results is still not fully understood. A possible explanation is that the time-series on spawner counts is still too short (2016–2020) to provide enough information on the stock–recruit relationship in the river (there are currently only two spawner-recruit data pairs, since only offspring from reproduction in 2016 and 2017 have so far (2020) left the river system as smolts). The possibility for ascending spawners to find their way up and past the power plant in Strömsbro (where the fish counter is situated) to reach the main reproduction areas probably varies considerably between years depending on variation in water flow and operation of the power plant. Thus, recruitment of smolts may to a large extent be dependent on migration possibilities rather than the absolute number of spawners that entered the river mouth a few years earlier. The FLHM may interpret this apparent lack of correlation between ascending spawners and subsequent smolt production as if stock status is high (a smolt production close to PSPC). If so, the posterior PSPC may then be updated downwards to match smolt abundances backed up by empirical data. It is also possible that a lack of flexibility in the FLHM when it comes to stock-specific differences in vital rates may affect estimation of stock–recruit parameters for river stocks with few stock–recruitment observations. Spawner counts in 2018 (n=22) and 2019 (n=177) represent rather extreme values from a historical perspective, and the resulting smolt production in 2021 and 2022 will hopefully provide useful information on the stock–recruit dynamics, which, in turn, may result in more realistic estimates of the production potential and stock status in the coming years. Until then, status evaluations and projection results for Testeboån must be viewed with caution.

In the 2019 assessment, the modelling of **Piteälven** was changed so that observations on spawner counts were used directly in the FLHM instead of using them to produce smolt production priors as earlier. The reason for this change was to avoid making assumptions about stock–recruitment parameters outside the model when converting from spawners to smolts. As a consequence of this change, estimates of spawner and smolt abundances as well as stock–recruit parameters were significantly updated (higher stock–recruit steepness, lower PSPC), resulting in changes in status evaluation as compared to the previous year's assessment. Based on fragmented independent data currently not used in the model, there is a concern that the status for Piteälven is biased upwards. The reason behind this bias is not known, but similarly as for Testeboån, it may be partially explained by insufficient flexibility in modelling of vital rates and between-river variability in the FLHM, which means that smolt-spawner survival is driven by data from other, not necessarily similar rivers. It is also possible that migration problems at the dam at Sikfors (located below the reproduction areas) introduce a similar phenomenon as in Testeboån, i.e. that annual variation in recruitment of parr and smolts to a large extent depends on varying migration possibilities for spawners in the river rather than the absolute number of ascending spawners at the river mouth. As discussed above, the resulting weak correlation between ascending spawners and subsequent recruitment may be interpreted by the model as if the production level is close to PSPC. Although the working group has planned to evaluate the way Piteälven is handled in the FLHM and explore alternative modelling options, this work has not yet been carried out due to time constrains. Therefore, status evaluations and projection results for Piteälven should be viewed with caution.

Independent information, such as river catches and results from genetic mixed-stock analyses from the Main Basin (ICES, 2014), indicate that the smolt production in **Ljungan** is likely underestimated by the assessment model, which may also affect status evaluations to an unknown extent. The main reason for the bias is that Ljungan is difficult to electrofish and it is unclear to what extent electrofishing data represent the true abundance of salmon parr. As only electrofishing data is currently available from this river, the plan is to start counting smolts in the near future. Until then, smolt production estimates and status evaluations of this river stock should be viewed with caution.

4.5 Future management of Baltic salmon fisheries

4.5.1 Current management system

The current management of Baltic salmon is based on two management areas, only one quota (TAC) in each of them, which regulate sea and coastal mixed-stock fisheries targeting both weak and strong wild stocks as well as reared salmon. All wild salmon stocks were heavily overfished and severely depleted less than three decades ago, after which they have recovered thanks to strengthened fishing regulations. However, many (weak) stocks are still in their recovery phase. So far, no 'rules' or guidelines exist for how fast (within which time frames) weak salmon stocks should recover, or when a certain proportion of all stocks should have obtained their management goal. Therefore, the ICES catch advice for the commercial mixed-stock fishery on Baltic salmon has for many years been associated with some degree of subjective consideration regarding trade-offs between time to fulfil management objectives and exploitation possibilities. The biological basis for the advice has been that the commercial sea fishery should be kept low enough to allow for a gradual recovery of all wild stocks, including the weakest ones. The advised fishery has not been zero, however, thus allowing for some exploitation which likely has slowed down the recovery rate.

As presented in Section 4.2, the latest status evaluations show that six of the 17 analytically assessed stocks in AU 1–4 are at or above the stock-specific MSY level (R_{MSY}) with relatively high (>70%) probability, while weaker stocks, which have not yet obtained their management objectives have had a positive development and are expected to show continued recovery under the current exploitation rate and fishing pattern. A few exceptions exist, represented by stocks that have been affected by health problems in recent years (Section 4.4.1). The temporal decline in production in these rivers is, however, not fishery related and would likely have been of similar magnitude also in a situation with a lower exploitation rate.

In contrast to AU 1–4, salmon stocks in AU 5 are not analytically assessed, and a majority have not responded positively to previous reductions in fisheries exploitation. Status evaluations of AU 5 stocks are uncertain and to a large extent dependent on expert opinions, and stock projections needed to evaluate effects of different exploitation levels on stock development are thus not possible. In addition, problems in the freshwater environment such as reduced migration possibilities, poaching, poor spawning and rearing habitats, eutrophication, and bad water quality, are likely affecting the stock status and development of many AU 5 stocks (e.g. ICES, 2014). This raises questions to what extent salmon stock dynamics in AU 5 are regulated by riverine conditions in relation to sea survival. This distinction is critical in order to steer management actions towards either improving riverine conditions (which, except poaching, falls more on environmental management), or implementing further measures by international fisheries management.

Recent calculations based on limited data from four AU 5 stocks (ICES, 2020b, see below) demonstrated some positive correlation between sea survival and recruitment (parr densities), indicating that sea survival probably has played a role in explaining the dynamics of at least some AU 5 stocks. These calculations further showed that for the period up to and including 2018, around 1000–1500 wild AU 5 spawners were annually harvested by offshore fishing in the Main Basin, whereas 3000–4000 salmon returned to the rivers (ICES, 2020b). Thus, a complete phasing out of this sea fishery would likely result in a significant increase in spawner numbers. Note, however, that the latest estimates of harvest rate in offshore fishing (which catches also AU 5 stocks) in 2019 and 2020 are significantly lower than for previous years (Figure 4.2.3.9). Furthermore, pronounced annual variation in recruitment indicates that also river conditions play a significant role. It is therefore likely that different areas/rivers need different measures to improve the situation for weak AU 5 stocks, of which reduced exploitation at sea constitute one of several possible management actions. Non-fishery related actions are likely also required to enable these stocks to recover.

So far, salmon stocks in AU 6 (Gulf of Finland) are also without an analytical assessment. In contrast to the situation in AU 5, the wild AU 6 stocks have shown a positive development since the late 2000s with a presumed high current stock status. Little is known about the harvest rates of AU 6 salmon at sea. However, various pieces of information indicate that these stocks have different migration routes than salmon in the other AUs, as they mainly seem to stay for feeding in the Gulf of Finland or further to the north in the Main Basin.

4.5.2 Evaluation of a new multiannual management plan

During the years 1997–2010, the management of salmon in the Baltic Sea was covered by the IBSFC Salmon Action Plan (SAP). The objective of this plan was to re-establish/recover wild Baltic salmon to attain, for each salmon river, a natural smolt production of at least 50% of the river-specific (best estimate of) PSPC until 2010. In 2008, the SAP had already become obsolete relative to fishing, and the European Commission decided to develop options for a new SAP to address all life stages of salmon and all human impacts. Based on the results of an ICES workshop (ICES 2008) and a subsequent consultation process, an EC proposal for a multiannual plan was presented in 2011 (EC, 2011). This proposal was never realized, due mainly to political reasons.

A few years ago, managers from Baltic Sea countries (BALTFISH) finalized an updated draft of the original EC proposal from 2011. In 2018, ICES received a special request from the EC to evaluate parts of the plan proposed by BALTFISH. The work to respond to the special request was carried out in an ICES workshop (WKBaltSalMP; ICES, 2020b) that included two meetings attended by scientific experts, national managers and stakeholder representatives. As requested, existing and alternative reference points for the assessment of stock status and fishing opportunities were examined. The existing targets formulated in terms of smolt production (50% and 75% of PSPC) were found to be inconsistent with the overall objective in the draft plan of achieving MSY, as they in most cases deviate from the stock-specific targets corresponding to this level (R_{MSY}). A precautionary reference point (R_{lim}) was further evaluated, defined as the lowest level of smolt production from which a stock is expected to recover to R_{MSY} in one salmon generation, if all fishing was completely closed (ICES, 2020b). Based on these results, ICES advised to use stock-specific smolt production targets (R_{MSY} and R_{lim}) as future reference points for Baltic salmon (ICES, 2020c).

A further request to ICES was to evaluate the recovery rate of individual wild salmon stocks under alternative fishing scenarios. Simulations developed specifically for the workshop allowed evaluation of such rates for river stocks with analytical assessment. Neither the EC request nor the draft multiannual plan specified criteria for when targets have been reached (i.e. the probability of achieving the target). Therefore, ICES was not in a position to advise on when (or if) a stock had met one or several of the alternative targets. Instead, the probabilities of the smolt production being above alternative reference points for each stock were provided for a range of fishing scenarios. For river stocks without analytical assessment, correlative analyses between total estimated sea survival and recruitment over generations were performed in order to evaluate to what extent sea fisheries may affect dynamics of these stocks.

A simplified stable state population dynamics model was constructed to study trade-offs between mixed (sea) and stock-specific (river) fisheries in terms of achievable catches and proportions of stocks above/below reference points. This analysis illustrated that when the mixed-fishery harvest rate is kept low, all river stocks may achieve MSY, whereas when this harvest rate increases, less resilient stocks fall below this target. However, the fact that less productive river stocks fall below MSY (and may go towards extinction if the fishing mortality increases) does not make a noticeable difference to the total yield. Hence, there exists an inbuilt conflict between overall production and conservation aims that can only be resolved if mixed-stock fisheries for Baltic salmon are kept at a low level. The most efficient way to utilise the total resource is a stock-specific management, where stocks are harvested separately according to their respective characteristics and capacities.

Finally, the report from WKBaltSalMP also contained general comments on the draft management plan. The workshop identified that the draft had a strict focus on commercial sea fisheries, although the relative importance of recreational fisheries for Baltic salmon has increased significantly over time. The current two management units for EU commercial fisheries (Subdivision 22 to 31 and Subdivision 32) were also maintained in the draft, whereas evidence is accumulating that salmon are migrating between these areas more than previously recognized. The draft plan further did not address management of hatchery reared Baltic salmon more than marginally, despite large ongoing releases for various purposes in most countries.

In 2020, the European Commission decided to withdraw its originally proposed multiannual management plan for Baltic salmon from 2011 (EC, 2020). At present, it is unclear if, or when, a new proposal may be developed, and to what extent such a new draft will contain elements from the previous ones.

4.5.3 Fishing possibilities under alternative management strategies

Managing the Baltic salmon, with its many genetically distinct river stocks with varying status, is a challenge. The species is exploited both in the sea, along the coasts and in rivers, where the sea and coastal fisheries mainly target mixed stocks. Despite this complexity, the current management system is based on only two TACs, one for SD 22-31 and one for SD 32. As indicated above, under current conditions with considerable variation in stock status, this rather blunt management system is associated with a difficult trade-offs between exploitation possibilities, the time required to achieve management objectives, and protection of weak stocks. Many of these difficulties may be overcome by the development of a more stock-specific management system, enabling fishing opportunities to be better-adapted to the situation for individual stocks. This could be achieved by **spatial management** of the sea and coastal fisheries, with the aim to steer exploitation towards harvesting of reared salmon and stronger wild stocks, thereby reducing the exploitation of weak stocks.

The current assessment results with future projections (Section 4.2–4.3) and analyses carried out in WKBaltSalMP show that virtually all river stocks in AU 1–4 are expected to have a positive future development under the current (historically low) fishing pressure. At the same time, for weak stocks it may take considerable time (more than five salmon generations) until recovery to R_{MSY} with high probability, also in a situation with no fishing at sea. For some rivers, there are additional river-specific factors (e.g. disease outbreaks) explaining the currently low status and slow recovery rate, which are likely of larger importance than fishing mortality for the future development of these stocks. For the weak AU 5 stocks, the lack of an analytical assessment precludes reliable status evaluations and future stock projections under different fishing scenarios. However, as mentioned in Section 4.5.1, there are reasons to believe that a reduced offshore fishing pressure in the sea would improve recovery rate of these stocks, although management measures in the freshwater environment may be of equal or even larger importance for some rivers.

Under current conditions, one spatial management option could be to phase out commercial and recreational mixed-stock offshore fisheries in the Main Basin (that harvest all the weak stocks) while keeping exploitation in the Gulf of Bothnia at the current level. As AU 4-5 stocks are not present in Gulf of Bothnia during the fishing season (see Section 4.5.3.1 for a review of genetic mixed stock analyses), such a change of the fishing pattern would reduce the exploitation of these weak stocks to a minimum without jeopardizing the management objectives of the generally healthier AU 1–3 stocks (see scenarios 7–10 above). With respect to the recreational trolling fishery at sea in the Main Basin, which is a pure mixed-stock fishery that has expanded over time, one management option instead of a total ban could be to only allow landing of fin-clipped (reared) salmon. Such a measure has been implemented in Sweden since 2013. If followed by additional countries, the fishing mortality on several of the weakest wild salmon stocks would likely be reduced (although levels of post-release mortality for salmon caught in trolling are largely uncertain, and studies of this topic are warranted).

The coastal fishery may also be managed spatially to become more stock-specific than at present. In Gulf of Bothnia, this can be achieved by steering the coastal fishery towards estuaries of salmon rivers with healthy stocks and/or coastal areas where salmon from weak stocks is rare according to model results based on genetic data and other information (Whitlock *et al.*, 2018; Dannewitz *et al.*, 2020a,b; Section 4.5.3.2). Coastal fisheries in the Main Basin may also be managed spatially to avoid exploitation of weak stocks. However, there is a lack of knowledge about the mixture of salmon stocks in space and time in this area, and studies similar to those carried out in the Gulf of Bothnia (Whitlock *et al.*, 2018; Section 4.5.3.2) are needed to evaluate how different coastal fishing scenarios in the Main Basin may affect the development of weak stocks.

In addition to the above management considerations regarding recovery of weak wild salmon stocks, the presence of a significant portion of reared salmon in the Baltic Sea should also be accounted for. As shown in Table 4.3.2.1, the different exploitation scenarios evaluated result in different "surpluses" of reared salmon spawners returning to rivers without being utilised in the fishery. As an example, the expected surplus of reared salmon in 2022 under a no-fishing scenario in the sea is about 51 000 salmon, whereas the expected surplus under scenario 4, which roughly corresponds to the realised exploitation rate in 2020, is approximately 25% lower (Table 4.3.2.1). As outlined below, the main purpose of the substantial releases of reared salmon is to compensate for lost fishing opportunities due to hydropower exploitation. However, continuous large-scale releases are also associated with genetic and ecological risks for wild salmon stocks. One management option aimed at increasing the relative exploitation of reared salmon could be to exclude certain fisheries (e.g. in estuaries of reared rivers) from the quota system, given that solid scientific information exists showing that reared salmon completely dominate in those catches.

4.5.3.1 Genetic mixed-stock analyses of Baltic salmon – a review

Stock proportions in commercial salmon catches from the Baltic Sea have been analysed as a part of annual WGBAST reports since 2005. Stock proportions have been analysed yearly for Finnish catches from the Gulf of Bothnia. Swedish catches from the Gulf of Bothnia were also analysed yearly as a part of the WGBAST reports until 2017 (ICES, 2017a). Stock proportions in Swedish coastal salmon catches have further been analysed for national reports in 2014 and 2015 (Östergren *et al.*, 2014; 2015). Finnish and Estonian commercial catches from the Gulf of Finland were most recently analysed in 2019 (ICES 2019). Stock proportions in the commercial catches from the Main Basin have been analysed for the 2015 and 2017 WGBAST reports (ICES, 2015; 2017a). In addition, the presence of salmon from individual stocks in either commercial or experimental catches from the Baltic Sea have been analysed and presented in several peer-reviewed publications (Koljonen and McKinnell, 1996; Koljonen and Pella, 1997; Pella and Masuda, 2001; Koljonen *et al.*, 2005; Koljonen, 2006; Palm *et al.*, 2008; Vuori *et al.*, 2012; Whitlock *et al.*, 2018).

The estimates of stock proportions in commercial catches of the Baltic Sea as reported in the annual WGBAST reports (ICES, 2005–2020) are based on stock assignment with DNA-microsatellite data. In short, each sampled fish from commercial catches is genotyped with 17 microsatellite loci and the smolt age of each sampled fish is determined. The genotypes and smolt age are then compared to a baseline dataset, which consists of genotypes and smolt age distributions of different salmon stocks from different spawning rivers around the Baltic Sea. Based on the comparison of genotypes and smolt age with the baseline data, each salmon from commercial catches is then assigned the most probable stock of origin. Presently, the baseline dataset consists of 4453 individual salmon from 39 individual stocks from six different countries, each genotyped with 17 microsatellite loci. The stock assignment is based on Bayesian inference as implemented in the software BAYES (Pella and Masuda, 2001), which allows integrating smolt age information into the stock assignment, making especially the distinction between wild and hatchery origin stocks more reliable (Koljonen, 2006).

In general, the reliability of stock assignment with 17 microsatellite markers combined with smolt-age data is quite high. For example, the mean proportion of times an individual was assigned to a particular stock in 1 000 iterations of MCMC in the 2017 Gulf of Finland catch samples was 0.95 (N = 411 individual salmon). In the Bothnian Bay catch samples from 2020, the mean proportion of assignment to a certain stock was slightly lower, 0.88 (N = 111 individual salmon, regular fishing season), due to the genetic similarity of wild stocks from the Kalixälven and Tornionjoki rivers (see Miettinen *et al.*, 2021) as well as the mixed genetic background of the river IIjoki hatchery stock (Säisä *et al.*, 2003). It must also be noted that stock proportion estimates prior to 2008 were based on eight microsatellite markers, which is likely to reduce their power of resolution, especially of genetically similar stocks.

The most comprehensive data on stock proportions in commercial catches are from the Gulf of Bothnia, where the stock proportions in Finnish catches from three fishing areas along the coast have been estimated annually for the past 20 years. In summary, the data show that the great majority of salmon caught by the Finnish commercial fisheries originate from wild stocks of rivers Tornionjoki and Kalixälven, and hatchery stocks with their genetic origin in the river Tornionjoki (means in the regular fishing season 2009-2020: 68% wild stocks and 29% hatchery stocks). In addition, a small proportion of the catches originate in Swedish hatchery stocks (mean 2009–2020: 2%). Salmon originating in Swedish wild stocks other than river Kalixälven are only caught occasionally; their total proportion of the Finnish salmon catch in the Gulf of Bothnia always has been <1%. No salmon from AUs 4–6 have been encountered in the commercial catches from the Gulf of Bothnia. The proportion of wild stock salmon from the rivers Tornionjoki and Kalixälven has increased following the change in temporal fishing regulations implemented in Finland since 2017, which has allowed an earlier start of fishing with limited number of fykenets (mean proportion of wild stock salmon in the advanced fishing season catches 2017–2020: 78%). There is, however, annual variation in the proportions of wild and hatchery origin stocks in the catches (proportions in regular season catches from 2009–2020: wild origin 58%–82%, hatchery origin 18%–38%).

Stock proportions in Swedish commercial catches from the Gulf of Bothnia were last reported in the 2017 WGBAST report (ICES, 2017a). As for the Finnish Gulf of Bothnia catches, a large proportion of the caught salmon originated in the wild northernmost Bothnian Bay rivers Tornionjoki and Kalixälven (63% in 2013–2016 Finnish catches, 38% in 2013–2016 Swedish catches). Compared to the Finnish catches, there were less salmon from the Finnish hatchery stocks (rivers Kemijoki, Simojoki, Iijoki, and Oulujoki). The other main difference was that in these Swedish catches, there were salmon from additional wild Swedish rivers, especially Byskeälven and Vindelälven (mean proportions in 2013–2016: 12% and 10%, respectively). In total, the proportion of wild salmon has been higher in the analysed Swedish catches from the Gulf of Bothnia (mean 2009–2016: 82%) than in the Finnish catches (mean 2009–2016: 70%) (ICES, 2017a). It must be noted, however, that the Swedish catch data analysed until 2017 was just collected from a limited number of fishing sites, and that the stock composition estimates from the western Gulf of Bothnia are much more influenced by the geographic position than on the eastern side along the Finnish coast, where a more homogenous stock mixture is harvested (ICES, 2017a; below). Salmon from the weakest Swedish stocks have only appeared once in Swedish commercial catches in 2006–2016 in the Gulf of Bothnia (Ljungan: 1% in 2010). The only stock from AUs 4–6 that has been caught by the Swedish fishery in 2006–2016 in the Gulf of Bothnia has been the Finnish hatchery stock genetically originating in the river Neva (2% in 2007).

Stock proportions in the Swedish coastal fishery in 2013–2014 have been reported in a national report by Östergren *et al.* (2015). Compared to the above ICES-analyses, a significantly larger number of fishing sites distributed along the Swedish coastline were included (18 sites, whereof eight were sampled in both 2013 and 2014, comprising a total of 2 850 individuals; Östergren *et al.*, 2015). The same genetic data from 2014 have also been analysed by Whitlock *et al.* (2018; in press) in peer-reviewed methodological studies on the integration of genetic analysis of mixed stocks with a population dynamics model. In these analyses, samples from the Finnish coastal fishery in the same fishing year were also included. The genetic data from 2013 and 2014 (in combination with catch data from 2019) have also been analysed, using the same model, in a national report focusing on stock composition in Swedish coastal catches (Dannewitz *et al.*, 2020b, see Section 4.5.3.2).

The main difference between the stock abundance estimates in catches presented by Östergren *et al.* (2015), Whitlock *et al.* (2018) and Dannewitz *et al.* (2020b) compared to those for Finnish and Swedish sea catches reported in earlier WGBAST reports was that the coastal Swedish catches were mainly composed of salmon from the rivers (wild or reared) closest to the catch sites. Also, the river Kalixälven and Tornionjoki wild stocks, which dominate the Finnish and Swedish catches reported by WGBAST, were nearly absent in the Swedish coastal catches (other than in the catches from near their own river mouths). Whitlock *et al.* (2018) further showed that the migration patterns can vary greatly among different Baltic Sea salmon stocks, meaning that there may exist strong variation in stock compositions at different times in a given area. Combining genetic marker data with information on population dynamics and movement provides a means for temporal and spatial regulation of fishing efforts to target reared and healthy wild stocks while avoiding weak ones (Whitlock *et al.*, 2018). See Section 4.7.1 for a discussion on future potentials of including results from the Whitlock *et al.* (2018) coastal model as prior information into the regular WGBAST stock assessment.

Estimates of stock proportions in Finnish commercial catches from the Åland Sea are available from 2000–2016 (ICES, 2017a). Again, the largest proportions in the catches are from the rivers Kalixälven and Tornionjoki wild stocks (means 2000–2016: 23% and 34%, respectively). There are also small, but yearly varying proportions of salmon from the northern Bothnian Bay stocks as well as from the stocks from Swedish rivers (all means 2000–2016: 0–6%).

Stock proportion estimates from catches in the Gulf of Finland have been last reported in the 2019 WGBAST report (ICES, 2019) and include Estonian (2016–2018) and Finnish (2009–2018) coastal fisheries. The stock with the largest proportion in the Estonian catches has been the river Kunda stock, which includes both wild and hatchery origin fish (mean 2016–2018: 40%). The catches have also included salmon from rivers Keila (wild origin, mean 2016–2018: 17%) and Narva (hatchery origin, mean 2016–2018: 12%). The Estonian catches have further included salmon from the wild and hatchery stocks from AU5: Salaca (wild origin, mean 2016–2018: 3%) and Daugava (hatchery origin, mean 2016–2018: 6%). The Finnish coastal catches from the Gulf of Finland are mainly comprised of stocked salmon of river Neva origin (mean 2009–2018: 49%) and salmon from the northern Bothnian Bay rivers (Tornionjoki, Kalixälven, Oulujoki, mean 2009–2018: 43%). Salmon from other Swedish rivers have only been found occasionally in these

Finnish catches (<1%), and salmon from AU5 and AU6 rivers only have been found in the 2018 Finnish catch: Daugava, AU5, hatchery origin: 3% (95% Confidence bounds: 1–5%); Keila, AU6, wild origin: 1% (95% Cb: 0–2%).

Stock proportion estimates for the Main Basin salmon fishery include data from commercial catches in selected years from Danish (2006, 2010–2016), Finnish (2006–2007, 2009–2012), Latvian (2006), Polish (2006–2016), and Swedish (2006–2007, 2010–2012) offshore catches. Catch data from different countries have been pooled and analysed together for each year. The stocks with largest proportions in the Main Basin salmon catches have been the wild stocks from rivers Kalixälven and Tornionjoki (means 2006–2016: 14% and 37%, respectively) (ICES, 2017a). The rest of the catches have been mainly composed of salmon from Swedish wild and reared river stocks (mean proportions for each stock in 2006–2016: 1–6%). The catches from the Main Basin have also included a few salmon from the AU5 hatchery stocks of rivers Gauja, Daugava, and Neumunas (2006–2016 means: 0–1%; 95% confidence bounds always including zero). Salmon from the wild Salaca (AU5) and mixed Luga (AU6) stocks have also been found in low proportions (1–2%) in the Main Basin catches from 2006–2007 and 2010–2011 (ICES, 2017a).

Stock proportion estimates for different areas of the Baltic Sea have also been published in peer-reviewed publications by Koljonen (2006), Palm *et al.*, (2008), Vuori *et al.* (2012), and Whitlock *et al.* (2018). Koljonen (2006) analysed stock proportions in catches from the Gulf of Bothnia, Gulf of Finland, Åland Sea, and the Main Basin with 8 microsatellite markers, and with a baseline of 32 stocks. The data are in large part the same that have been published in the WGBAST reports in 2005 and 2006 (ICES, 2005–2006). The catch data in the WGBAST reports are based on sampling of commercial catches in open sea fisheries in winter and early spring in the Main Basin and coastal fisheries in summer in other areas. Palm *et al.* (2008) used a slightly extended baseline data from Koljonen *et al.* (2008) to estimate stock proportions in catches taken in late autumn in 2002–2003 from the Main Basin. Their stock proportion estimates were very similar to those in Koljonen *et al.* (2006): most of the salmon were from the Bothnian Bay stocks. There were no salmon from the currently weak stocks of river Ljungan or Emån. The only AU 4–6 stocks that were present in the catches were the hatchery stocks of rivers Neva (stocked into Finnish rivers; 1%; PI: 0–3%) and Gauja (1%: PI: 0–3%).

Vuori *et al.* (2012) have in addition analysed stock proportions of salmon catches in late autumn and winter from the Bothnian Sea, Gulf of Finland, and the Main Basin. The catch data analysed by Vuori *et al.* (2012) are a combination of commercial catches and samples collected for scientific purposes in 2006–2007. The data in Vuori *et al.* (2012) provide information on migration patterns of salmon from Baltic Sea stocks, but does not reflect the proportions of different stocks in today's commercial catches as there is no longer commercial fishing of salmon in autumn and winter in the middle and northern Main Basin and northern Baltic Sea. The largest numbers of salmon in the samples from the Main Basin were from the river Tornionjoki wild and hatchery stocks (63/141 salmon, 45%). The number of samples from the Bothnian Sea was low (n = 31) and included individual fish (1–6) from wild and hatchery stocks of Finnish and Swedish rivers, and a few fish from the mixed stock of the Russian river Luga (n = 2) and hatchery stocks of the Latvian rivers Gauja and Daugava (n = 1 and n = 3, respectively). The most numerous stocks in the samples from the Gulf of Finland were the Finnish river Neva hatchery stock (30/55 salmon) and the mixed stock from the river Luga (15/55 salmon). The rest of the salmon in the Gulf of Finland catch samples were from hatchery stocks of rivers Narva (n = 2), Gauja (n = 1), and Daugava (n = 7).

Whitlock *et al.* (2018) estimated stock proportions in catches from 18 coastal fishing sites in Finland and Sweden. Their findings also followed those reported in the annual WGBAST reports: stock composition along the Finnish coastline was dominated by the wild Tornionjoki stock, while the catches on the Swedish side were more mixed, local stocks well presented in the catches.

In summary, mixed stock genetic analyses of Baltic Sea salmon catches performed over several years show that salmon from the AU 4–6 stocks do not occur in catches of Åland Islands and Gulf of Bothnian coastal salmon fisheries that take place only in summer. The WGBAST full life-history model (that currently includes only AU1–AU4 stocks) is constructed accordingly (see Stock Annex). In the Gulf of Finland commercial fishery, AU5 and AU6 fishes occur in small proportions in Estonian catches. In the main basin, AU5 and AU6 fish are also caught only occasionally in very small proportions by the commercial fisheries. The weak stocks of the Swedish rivers Ljungan and Emån have only been present in the catches near their respective river mouths. Fisheries in these weak rivers are presently closed.

4.5.3.2 A model predicting stock composition and catches of individual stocks in the coastal fishery in Gulf of Bothnia

A modelling tool for utilizing genetic data to learn about spatial patterns in stock-specific abundances (Whitlock *et al.*, 2018) can be used to support interpretation of genetic mixed-stock analyses for stocks in assessment units 1–4. This model takes into account a prior probability weighting based on stock-specific migration patterns to probabilistically assign individuals to stocks, which is expected to be more robust than assignment with an uninformative prior (Whitlock *et al.*, 2018). This "multistock migration model" has now been extended to a multiple year version that includes an observation model for catches in the Swedish and Finnish commercial coastal trapnet fisheries, allowing estimation of stock-specific catches and harvest rates in time and space (Whitlock *et al.*, in press). It is important to note that the results from this model are not currently used in the assessment, but their incorporation is planned as a key model development task for the future (see Section 4.7).

The model currently estimates stock-specific abundances in time and space for 17 wild and ten hatchery-reared Baltic salmon (*S. salar*) stocks, including all wild stocks in assessment units 1–4. It spans the coastal fishing period, following the population dynamics of migrating reproductively mature salmon between April 15th and August 18th in each year in 48 spatial areas, as they migrate north from feeding areas in the Southern Baltic (Main Basin), along the Swedish and Finnish coasts to their natal rivers for spawning. An observation model for microsatellite allele frequency data at 17 loci, sampled at multiple locations over the fishing season is used together with a genetic baseline to learn about stock composition in time and space.

The latest version of the multistock migration model can be used for exploring stock-specific migration paths, abundances and stock compositions of catches from different areas and times. As an example, Figures 4.5.3.2.1a–d show estimated spatio-temporal distributions of the abundance of maturing salmon from four river stocks (one per AU) during six consecutive fortnights. From such heat maps, it is evident that the spawning migration paths of different river stocks differ in time and space and become increasingly unique when salmon are approaching their natal rivers. Hence, stock compositions of catches are highly dependent on when and where those catches have been taken.

As another example, Figure 4.5.3.2.2 shows total and stock specific catches in 2019. The upper left panel shows total reported catches and illustrates the pronounced differences between coastal sections, with the largest catches taken close to the most productive wild and reared rivers in the north. The other three panels in Figure 4.5.3.2.2 show estimated numbers of salmon in the same total (2019) catches for the three weakest river stocks in each of AUs 1–3 respectively (Simojoki, Lögdeälven, Ljungan). In total, the proportion of salmon from those weaker river stocks is just approximately 1% or lower, and in some areas a particular stock may not be caught at all. For example, salmon from Lögdeälven and Ljungan are estimated to be absent in the large catches taken from the northernmost Gulf of Bothnia (Figure 4.5.3.2.2).

4.5.4 Challenges for Baltic salmon management

Both the management and scientific advice process related to Baltic salmon would benefit from a decided framework including rules and guidelines on management objectives for this species. Such elements may be regulated within a multiannual management plan, or as a part of the process when EC request advice from ICES. Regardless, a sustainable management of Baltic salmon and its mixed-stock sea and coastal fisheries, that accounts for both conservation needs and exploitation possibilities, requires that the following aspects or trade-offs are carefully considered:

- **Time for recovery**. Fishing mortality is a factor that determines the recovery rate of weak river stocks. If the main goal is to reach management objectives as fast as possible, fishing mortality must be as low as possible. However, if the goal is to combine recovery with some continued exploitation, time for recovery will be longer (as shown in Section 4.3). This trade-off between conservation and exploitation needs to be decided by managers in terms of acceptable time frames with respect to recovery, which, in turn, is a prerequisite for the formulation of appropriate advice on fishing opportunities (given the decided time frames). A related, more technical aspect, which also needs to be considered, is with which probability management objectives should be fulfilled, as this will determine the risk to fall below the management target (note that the Baltic salmon assessment to a large extent accounts for uncertainties in data and model parameters, which needs to be considered when deciding upon appropriate probability limits).
- **Proportion of stocks above management target**. Independent of exploitation rate and time frames for recovery, some wild river stocks will likely remain below management targets for various fishery-independent reasons, such as local environmental problems, health issues or because they represent "new" wild rivers stocks added into the assessment (e.g. previously potential rivers) with initially low status. In addition, colonization of new river areas (due to e.g. dam removals) will affect the production potential of a river. This affects stock status, because status is evaluated based on comparisons between current smolt production and R_{MSY}, of which the latter is expected to be updated upwards when the estimated smolt production potential increases in the future. Therefore, managers need to decide on what may be perceived as an acceptable share of river stocks which, at any given time, are not likely to reach their management objective for reasons as those mentioned above.
- **MSY vs. conservation targets**. The concept of maximum sustainable yield (MSY) aims at producing a long-term sustainable catch as large as possible, and it does not explicitly account for conservation aspects. Thus, when a river stock is assessed to be below R_{MSY} or R_{lim}, this does not necessarily mean that it is 'threatened' by extinction; in the case of R_{MSY} it simply means that it cannot produce a sustainable catch of the same magnitude as the potential maximum. To evaluate the level of threat and what constitutes a minimum viable population size (MVP), additional biological factors need to be accounted for in a formal population viability analysis (PVA). Although no such analyses have so far been carried out for Baltic salmon, it seems likely that the number of spawners corresponding to MSY (and R_{lim}) in large salmon rivers is located above any minimum conservation target. For certain small rivers it is possible, though, that a higher target than stipulated by MSY may be needed to reduce risks for local extinction or loss of genetic variation.
- **Releases of reared salmon**. The total amount of reared salmon released annually in the Baltic Sea (between 4 and 7 million smolts) has for several decades outnumbered the

amount of wild salmon smolts produced in rivers. Continuous releases of this magnitude are associated with biological risks, through genetic and ecologic interactions between reared and wild salmon and spread of disease (e.g. Araki and Schmid, 2010; ICES, 2016; Hagen *et al.*, 2019; Östergren *et al.*, 2021). The bulk of releases in the Baltic Sea area are carried out in rivers exploited by hydropower, with the aim to compensate fisheries for the loss of natural production and fishing opportunities. To decrease risks associated with such releases, it is important that release volumes are adapted to the exploitation level in the fishery, to reduce the amount of unutilised reared salmon that may interact with wild conspecifics. As reared salmon is an important resource for Baltic Sea fisheries that at the same time constitutes a biological risk for wild salmon, Member States in the Baltic Sea area should agree on how stocking activities with different purposes should be managed in the future, based on scientific information (ICES, 2020b). Such a long-term plan should also provide recommendations/guidelines for management of hatchery populations and stocking activities so that negative impacts on wild stocks are minimized.

- **Bycatches of salmon**. Salmon is by-caught in several Baltic Sea fisheries targeting other species, but such catch data are sparse and estimates of their true magnitude highly uncertain. In coastal fisheries with passive gears (nets, trapnets, etc.) the amount of by-caught salmon varies depending on place and time of the year. As an example, in the Swedish coastal fishery for whitefish (with trapnets), which takes place mainly during summer months, salmon are by-caught to an uncertain but probably large extent (Dannewitz *et al.*, 2020b). These salmon must be released back if caught outside the salmon fishing season. Recent studies indicate that catch and release from the most commonly used gear (Pontoon traps) results in reduced survival probabilities (Östergren *et al.*, 2020). Therefore, a better understanding of the amount of by-caught salmon in different fisheries targeting other species is important to evaluate effects on the development of salmon stocks. Salmon is also bycaught in the pelagic trawling fishery for herring and sprat, but again reported bycatches likely represent gross underestimates of true levels. One main reason may be that the smaller salmon (post-smolts) remain unnoticed. A crude extrapolation, based on data from scientific pelagic trawl surveys, suggested that the annual bycatch of salmon in the commercial pelagic fishery may have ranged from around 50 000 individuals in the 1980s to almost 200 000 in the 2000s (ICES, 2011). A majority of these estimated by-caught salmon comprised post-smolts, although a considerable portion of larger adults also existed in the scientific trawl catches. Updated and more refined estimates of the amount of salmon taken as bycatch in the commercial trawling catches appear warranted, especially given plans to commence large-scaled pelagic trawling for three-spined stickleback to reduce biomass of that species (such pilot studies are currently planned) that may increase the amount of bycatch even further.

4.6 Conclusions

The pre-fishery abundance is expected to show a minor decline in 2021 and 2022, followed by a gradual increase in line with the projected smolt production. Therefore, with stable fishing mortality, a somewhat smaller catch would be caught in 2021-2022 than before or after these years.

Out of the 17 analytically assessed stocks, three (Lögdeälven in AU 2, Ljungan in AU 3, and Emån in AU 4) were below their R_{lim} in the year 2020 (Table 4.2.3.4a). Results from the stock projections indicate, however, that exploitation similar to the current realized total catch (most similar to scenario 4) will result in either a maintained or positive trend in status for almost all AU 1–4 stocks (Section 4.3.2). Positive or maintained trends in the status of the AU 1-3 stocks have been seen already in the past years (e.g. Figure 4.3.2.5a–e), apparently due to the gradually decreased overall exploitation (Figure 4.2.3.10). The development of a few river stocks, in particular

Vindelälven and **Ljungan**, is expected to show a somewhat delayed and slower increase due to disease problems in recent years. For Vindelälven, however, two years of increased numbers of returning MSW females indicate that the health situation in this river may be improving.

All the AU 1–4 stocks are predicted to reach >50% of their R_{lim} in the scenarios 1–3 and 7–10 (Table 4.3.2.2). In other words, a total catch of at least 50 000 (scen 3) but less than 100 000 (scen 4) could be harvested in 2022 with the current fishing pattern to allow all the AU 1–4 stocks to reach their R_{lim} in the 2025/2026 smolt production. However, the current analytical assessment does not include the AU 5 stocks, for which sea migrations are restricted to the Main Basin (and partly the Gulf of Finland; see Section 4.5.3.1). Most of the wild stocks in this AU are considered to currently be below R_{lim}, according to expert based elicitations. Analyses performed in 2020 (ICES, 2020b,c) indicated that maintaining a mixed-stock fishery in the Main Basin would likely negatively affect the recovery of these weak wild stocks.

According to new scenarios added this year (7–10), evaluating consequences of a sea fishery confined to Åland Sea and Gulf of Bothnia where only AU 1–3 salmon are harvested during their spawning migration, up to 75 000 salmon could be harvested. Under this exploitation rate and a fishing pattern with no Main Basin offshore fisheries, R_{lim} is expected to be reached in the 2025/2026 for all the analytically assessed stocks (AU 1–4). Such a change in the sea fishery would also increase the protection of the weakest AU 5 stocks.

As observed in earlier assessments, projections under different exploitation rates (+/-50 000 salmon compared to the approximate current level of removal) indicate that such changes in the sea fishery are not expected to result in large changes on the status development of the AU 1–4 stocks, with differences mainly manifesting for weak stocks. This further indicates that fishing mortality is currently at a relatively low level in comparison to other (natural) sources of mortality affecting the stock development. Obviously, probabilities to reach the smolt production targets are higher for scenarios with lower exploitation, but differences between scenarios are relatively small except for the ones with a drastically reduced or increased fishing (i.e. scenarios 1, 2 and 6).

Although the AU 5 stocks are not analytically assessed, data on recruitment combined with expert evaluations on production potential indicate no obvious recovery; most of these stocks are currently (year 2020) believed to be far below their MSY-level and most of them are also likely below their R_{lim}. AU 5 stocks have not generally responded positively to previous reductions in fisheries exploitation, although indications exist about positive effects of temporally increasing overall sea survival (survival from both the natural and fishing induced mortalities) on the recruitment among these stocks (ICES, 2020b). AU 5 stocks are exploited in the Main Basin by offshore commercial and recreational fisheries and in rivers by angling, indicating that current exploitation and natural mortality rates (at sea and/or in freshwater) has not allowed for their recovery. One management option to assist the recovery of the AU 5 stocks is to reduce or phase out the Main Basin offshore fisheries (as indirectly seen for AU 4 stocks, with similar migration pattern at sea, in the scenarios 7–10). As discussed above, however, several environmental factors acting during the freshwater phase are believed to affect the development of the AU 5 salmon stocks negatively in addition to sea fishing. Therefore it should be noted, that even without any fishery it may still take considerable time (several salmon generations) until the currently weakest river stocks will recover.

In contrast to AU 5 stocks, wild AU 6 stocks have shown a positive development in recent years. The stocks of Kunda and Keila are with high certainty above their MSY level (considering that their current smolt production is at or near 100% of their expert elicited PSPC), whereas the stock status of Vasalemma is rapidly increasing. This indicates that the current exploitation level allows a successful recovery of the AU 6 stocks.

Following a temporary and modest increase in M74 in recent years, this mortality factor has again decreased to a very low level. Another factor influencing stock development is the health problem affecting adults that have been observed in certain rivers since 2014 (Sections 3.4.4 and 4.4.1). If these health-related problems should prevail or increase further this may result in decreased status, particularly for weaker stocks, as well as reduced fishing possibilities, and may easily counteract any positive effects of e.g. good post-smolt survival.

For some weak stocks, additional measures (on top of restrictions through the TAC system) may need to be implemented on the national level to increase the number of spawners, for example by reducing fisheries in rivers or coastal areas where these stocks are currently harvested. For instance, fishing restrictions have been enforced in Vindelälven and Ljungan due to health problems among ascending adults in recent years. Similarly, in Emån and in the recently appointed wild salmon rivers Testeboån and Kågeälven, a fishing ban on salmon has prevailed for many years to increase the recovery rate of these river stocks. A comparison of scenarios 1 (no fishing at all) and 2 (only river fishing allowed) illustrates the positive effects of river fishing regulations. Measures focused on the freshwater environment, such as work to improve river habitats and migration possibilities, may also be necessary. Thus, special actions directed to the weakest stocks which are not only fishery-related ones are likely required at any advised TAC level, especially in AU 5 but also for a few weak rivers in other AUs, to enable these stocks to recover. Such work is already ongoing in several countries (see Chapters 2 and 3).

Several of the northern stocks are assessed to be close to or above the MSY-level, and the surplus produced by these stronger stocks could in theory be directed towards stock-specific fisheries. However, the current management system, with a single TAC for SD 22–31 that is set at a relatively low level (from a historical perspective) to safeguard weaker salmon stocks, prevents much of this surplus to be utilised by the commercial sea fishery. Similarly, a large proportion of reared salmon cannot be utilised today because reared salmon is included in the same TAC as wild salmon. Some of the advantages of changing the current management system can be seen in scenarios 7–10, in which the exploitation is focused on reared salmon and the strongest and largest wild stocks in AU 1–3, while the harvesting of the weakest stocks which are located in AU 4–5 is kept close to zero (at much lower levels as compared to under the current fishing pattern; scenarios 3–6).

Consequently, Baltic salmon fisheries management could be developed to become more stock-specific, by implementing more flexible systems for the regulation of fisheries with the aim of steering exploitation towards harvesting of reared salmon and stronger wild stocks and avoiding weak ones. This could be achieved through spatial management, e.g. by implementing area-specific quotas and/or exclusion of certain single-stock fisheries from the quota system (such as fisheries in estuaries of rivers with reared stocks). Integration of genetic data into population dynamics models can provide information about stock-specific abundance patterns and harvest rates in time and space, allowing evaluation of spatio-temporal management measures. This creates the potential to move towards stock-specific management whilst maintaining some level of catches in mixed-stock fisheries, since fishing mortality can be directed towards certain stocks (and away from others) using knowledge of stock-specific migration patterns. Such tools are now available and have been applied to the coastal fisheries in Finland and Sweden (Section 4.5.3.2); these tools could be adapted to form part of the WGBAST assessment framework in the future. In contrast, the increasing recreational trolling in Main Basin is a true mixed-stock fishery where fully stock-specific harvesting is not possible. Regulations that only allow the landing of fin-clipped (reared) salmon, such as has been implemented in Sweden since 2013, may reduce fishing mortality of wild stocks by trolling if the post-release mortality is relatively low.

As outlined in Section 4.5, the current management of Baltic salmon lacks specific ‘rules’ or guidelines for how fast (within which time frames) weak salmon stocks should recover, and what proportion of all stocks should have obtained their management goal within a certain time. Therefore, under current conditions with only TAC regulated commercial sea fisheries and river stocks with varying status, any catch advice for the mixed-stock fishery on Baltic salmon will be associated with some degree of subjective consideration of trade-offs. Sustainable management of Baltic salmon and its mixed-stock fisheries, which accounts for both conservation needs and exploitation possibilities, requires that management accounts for the above and other aspects or trade-offs discussed in Section 4.5. A clarified framework on how to manage Baltic salmon, e.g. formulated within a multiannual management plan, would also be beneficial for the biological advice process related to this species.

4.7 Ongoing and future development of the stock assessment

4.7.1 Road map for development of the assessment

The tasks listed below refer to ongoing, planned and potential updates of the assessment methodology. The "Ongoing and short-term tasks" below are intended to be undertaken as part of routine assessment model development, while some of the longer term tasks may require eventual benchmarking. A list of tasks for the next benchmark can be found in Annex 3. That list relates to evaluation of the methodology for assessing stock status including the new reference points, as well as development of an analytical model for AU 6 stocks.

Ongoing and short term

- *Incorporating estimates of stock-specific exploitation rates in the coastal fishery*. There is a need to replace the present (crude) assumptions about how coastal fisheries affect development of the river stocks with more precise stock-specific estimates as input in the assessment model. Stock-specific harvest rate estimates from a spatially and temporally-structured Bayesian mixed-stock analysis (MSA)/population dynamics model for the coastal migration of spawning Baltic salmon (Whitlock *et al.*, 2018) are now available (Whitlock *et al.*, in press). Some development of the MSA model is first needed to ensure that data in the FLHM are not used twice (the current version of the MSA model uses posterior distributions for natural mortality and pre-season abundances from the FLHM).
- *Improvement of the fishing scenarios*. The current method to set up the fishing scenarios enables maintaining the same relative differences between harvest rates of different fisheries. However, it would be more practical to be able to maintain this pattern in terms of the relative differences between the catches. Also, the amount of uncertainty related to each harvest rate/catch at different fisheries and scenarios should be made more consistent, as in the current method, uncertainty increases heavily when higher removal is assumed. The magnitude of the uncertainty has a direct effect on the probability of meeting the reference points at each scenario.
- *Investigating the reasons for implausible status evaluations in rivers Testeboån and Piteälven*. More analysis is needed to understand the implausibly high-status evaluations for rivers Testeboån and Piteälven. This will be initiated by comparing model structures with increased stock-specific variability in vital rates, to see whether such increased flexibility can offer any improvements.
- *Adding annual variation to the catchability parameters of coastal trapnet and gillnet fisheries.* Annual variation in these parameters would be allowed by utilising autoregressive processes with a lag of one year similarly as has now been done for offshore fisheries. However, an assumption of equal catchabilities for wild and reared salmon cannot be applied

to the coastal fisheries, which may require testing several types of parameterisation to find a suitable version.

- *Improved description of river fisheries in the FLHM and scenarios*. River harvest rates are currently assumed to be equal for all wild stocks (and all reared stocks) in the FLHM and scenarios code. This is an unrealistic assumption and makes evaluation of probabilities to reach management targets under different fishing scenarios problematic, if the true river harvest rate is higher than that assumed. Improving the description of river fisheries will be a long-term process, but could be started over the next year (assembling available data, etc.)
- Development of an analytical assessment of AU 6 stocks. See Annex 3 (tasks for benchmarking.
- *Improvement of computation and model convergence*. Work is ongoing to improve convergence times for the JAGS model and test other softwares for inference. One promising candidate is the R package Nimble that allows compilation of the model in C++ for increased speed. A Nimble version of the FLHM has now been developed, and early indications are that significant reductions in model run time can be made. The Nimble version of the FLHM will be run in parallel to the JAGS version in 2022.

Medium-term, important issues planned to be dealt with in the next 2–3 years

- *Adding repeat spawners to the FLHM*. Salmon are currently assumed to die after first spawning in the FLHM. This assumption is known to be unrealistic (repeat spawners in some stocks now account for ~10% of all spawners). This is likely to cause bias in some parameter estimates e.g. stock–recruit parameters such as steepness, with implications for management reference points. A version of the FLHM that accounts for repeat spawners has been developed. The repeat spawning model uses observations on the proportions of maiden spawners by year and sea-winter to learn about the propensity for repeat spawning by sea-age. The model structure is now ready, but further input is needed to parameterize the population dynamics of repeat spawning salmon This work is expected to be completed until 2022s or 2023s assessment.
- *Refine the two river models to improve smolt priors used in the FLHM*. The present river models (northern and southern version) do not account for annual fluctuations in smolt age structure, which may result in biases. Development of the river models to account for fluctuations in parr growth rates and length-specific smoltification probabilities to improve estimates of smolt age structure would help solve this issue.
- *Continuing the work of including data from established index rivers and expanding data collection in other rivers*. Some of the datasets collected in index rivers are still not used in the assessment model, such as e.g. spawner count data from River Mörrumsån. To improve precision in assessment results, there is also a need to increase collection of abundance data in non-index rivers. Therefore, an ongoing 'rolling' sampling programme that regularly collects smolt abundance data from rivers with limited data was established in Sweden in 2018.
- *Improving precision in short-term projections by including covariates for sea survival*. The potential for incorporating covariates such as herring recruitment strength and sea surface temperatures should be investigated, as means to increase precision in short-term projections.
- *Inclusion of AU 5 stocks in the full life-history model*. At present, these stocks are treated separately from the AU 1–4 stocks. Inclusion in the full life-history model will require updated information regarding e.g. smolt age distributions, maturation rates, exploitation rates and post-smolt survival. In addition, increased amounts of basic biological data (e.g. smolt and spawner counts, updating of habitat size estimates, additional electrofishing sites) may be needed for some rivers. The smolt production model ("river model")

for southern stocks that has been developed could be expanded to also include AU 5 stocks in future, to produce smolt production priors and estimates for the full life-history model.

Long-term and/or less urgent issues, good to keep in mind

- *Allow for fluctuations in the stock–recruitment carrying capacity (K) over time in rivers.* Changes in physical river characteristics (e.g. habitat restoration and removal of obstacles to migration) have very likely led to increases in K over the assessment period for some rivers. K is time-invariant in the current model version, which may lead to biases in estimates of stock–recruit parameters and stock development for affected rivers.
- *Inclusion of data on composition of stocks at sea*: The life-history model is already fitted to information on proportions of wild and reared salmon in Main Basin, as determined from scale readings. A next step would be to include genetic information on proportions of fish from different AUs in catches, separating also wild and reared salmon from those areas. Subsequently, information on the representation of single-stocks may be included. See more on possible future utilisation of MSA-results in ICES (2015, Section 4.7).
- *Further use of scale-reading data*: In addition to wild/reared proportions, age data from catch samples could be used to get improved knowledge of year-class strength, maturation and natural mortality rates.

4.8 Needs for improving the use and collection of data for assessment

Because requirements for data will always exceed available resources, preferences must be given. The identification and prioritisation of new data collection is of importance with respect to the European data collection framework (EU-MAP). Modifications to ongoing monitoring work should be based on end-user needs, particularly those related to ICES assessment.

Over the years, WGBAST has repeatedly highlighted and discussed various needs for data collection (e.g. ICES, 2014; 2015; 2016). For example, the need for genetic analysis to study stock composition in catch samples (MSA) has been reviewed (ICES, 2015), with suggestions provided regarding future studies. Comments have also been given to a comprehensive list of proposals for Baltic salmon data collection produced at an earlier ICES workshop in 2012 (ICES, 2016). Further, the need for at least one wild index river per assessment unit has been highlighted, with suggestions given on potential candidates in AUs 5–6. As a part of the last benchmark for Baltic salmon (WKBALTSalmon; ICES, 2017c) all different types of information needed as input for the Baltic salmon stock assessment (fisheries statistics, biological data, etc.) were reviewed with respect to needs, availability and quality. Data issues and questions listed in that benchmark report are rather extensive and prioritizations will thus be needed before decisions on data collection included in EU-MAP.

In brief, WKBALTSalmon highlighted the below data needs and development areas. WGBAST encourage Member States to include these elements into their national data collection programmes.

River data

Biological monitoring

- Expansion of networks for electrofishing sites, to cover also recently populated river stretches;

- Updates of size estimates for river-specific reproduction areas using standardised methodology;
- Inventories of habitat quality, particularly in 'weak' salmon rivers (i.e. those with low stock status);
- Compilation of stocking data on young life stages combined with information that enables estimation of survival for these releases until the smolt stage;
- Counting data of ascending spawners from additional rivers. Guidelines to assure comparability of such data should also be compiled. In rivers where counting is ongoing but data are yet not used in the assessment, additional information may be needed (e.g. from tagging studies).

River fisheries

- The amount and quality of catch statistics varies considerably between rivers and countries. There is a general need for improvement and harmonisation of methods used for data collection, including estimates of unreporting;
- River-specific salmon catches should be included in InterCatch (ICES database);
- Available effort data from river fisheries should be evaluated.

Sea fisheries data

- The level of misreporting of salmon as sea trout may be underestimated. For the Polish coastal fishery, no misreporting is accounted for so far, although it potentially may occur in substantial amounts there. Data on proportions of sea trout and salmon in catches should be provided to the working group to facilitate estimation of the development of misreporting.
- Recreational trolling open sea catches have been estimated to be higher than previously recognised. Initiated work to improve methods and estimates should continue. Time-series of country-specific catch estimates by three main fishing areas should be added into InterCatch;
- Also estimates of other recreational salmon sea catches (i.e. from coastal fishing in Sweden and Finland) should be added into InterCatch;
- Unreporting of catches is challenging to estimate, and it is possible that higher than currently estimated unreporting takes place in some countries and fisheries. An expert elicitation covering all relevant fisheries is needed in order to update unreporting estimates. Also, discards (e.g. undersized and seal-damaged catch, or wild salmon when only fishing on reared salmon is allowed due to local/national regulations) may be substantially underestimated and studies on these (including post-release mortality) are needed;
- Shortcomings in currently available fisheries data may cause bias in mortality estimates (F and M). At present, the possible magnitude of such bias, and consequently its potential impact on conclusions regarding stock status and catch advice, has not been evaluated. The present assessment model is assumed to estimate the magnitude of total mortality reasonably reliably. However, an exercise exploring extra uncertainties emerging from data deficiencies, currently not accounted for, and how these may influence the catch advices (both qualitatively and quantitatively) should be carried out.

Table 4.2.2.1. Likelihood approximations for the wild smolt production (*1000) in the Baltic salmon rivers, which are fed as "priors" into the Full Life-History Model (FLHM). The values are derived from the river model (i.e. the Hierarchical linear regression analysis, see the Stock Annex), which utilises both the existing electrofishing data and the smolt trapping data. The distributions are described in terms of their median and 90% probability interval (PI). Updated estimates ("posteriors") derived from the FLHM are presented in Section 4.2.3.

Wild smolt production (thousand)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Assessment unit 1																		
1 Tornionjoki	71	81	77	80	91	94	139	215	147	106	94	136	212	655	864	632	648	679
90% PI	43-114	51-125	42-131	52-120	61-133	55-151	94-199	147-313	90-232	72-152	60-140	95-192	162-274	506-837	686-1094	532-748	514-824	539-861
2 Simojoki	2	2	11	11	7	14	10	11	2	1	3	9	10	42	46	46	47	30
90% PI	1-3	0-3	6-19	6-19	4-12	8-25	5-16	6-20	0-3	0-2	1-4	4-15	5-17	26-67	30-70	30-71	30-74	19-48
3 Kalixälven	176	109	95	73	136	99	175	101	103	93	63	109	258	341	351	329	279	382
90% PI	44-707	26-420	23-326	20-220	36-440	28-288	52-527	27-307	29-302	24-292	17-189	31-324	63-919	108-989	115-983	107-920	89-779	121-1118
4 Råneälven	28	18	15	8	7	7	7	6	2	2	3	7	12	21	23	18	13	19
90% PI	2-214	1-128	1-116	0-73	0-57	0-48	0-36	0-30	0-14	0-10	0-14	0-27	2-45	4-67	5-72	3-62	2-44	3-62
Total AU1	**307**	**230**	**218**	**186**	**254**	**227**	**341**	**348**	**264**	**208**	**170**	**269**	**502**	**1082**	**1313**	**1042**	**1009**	**1134**
90%PI	**140-901**	**119-581**	**116-488**	**112-358**	**139-567**	**134-429**	**200-698**	**231-571**	**158-480**	**125-409**	**104-300**	**172-491**	**290-1167**	**775-1747**	**979-1981**	**781-1644**	**749-1532**	**807-1891**
Assessment unit 2																		
5 Piteälven*)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
90% PI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6 Åbyälven	1	1	0	0	1	1	1	2	1	1	1	2	1	2	4	2	1	1
90% PI	0-5	0-5	0-3	0-3	0-4	0-5	0-9	0-11	0-5	0-5	0-7	0-8	0-7	0-11	0-14	0-11	0-7	0-7
7 Byskeälven	20	15	13	11	13	15	39	21	22	21	21	38	54	72	80	64	55	56
90% PI	3-79	2-58	2-52	1-40	2-51	2-52	9-126	4-74	4-70	4-67	4-69	8-122	14-169	21-207	24-225	18-182	16-157	15-164
8 Kågeälven	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
90% PI	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9 Rickleån	2	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
90% PI	0-23	0-13	0-9	0-5	0-3	0-2	0-1	0-1	0-3	0-2	0-2	0-3	0-3	0-5	0-7	0-8	0-9	0-7
10 Sävarån	2	1	1	1	1	1	1	0	0	0	0	1	1	1	1	2	2	2
90% PI	0-16	0-12	0-9	0-6	0-5	0-6	0-4	0-3	0-4	0-3	0-3	0-7	0-6	0-7	0-7	0-9	0-10	0-10
11 Ume/Vindelälven	54	36	40	48	49	35	29	26	20	10	11	17	80	188	166	137	132	121
90% PI	15-174	8-127	7-156	10-187	15-148	9-105	7-84	6-74	5-54	1-32	2-32	4-43	26-210	90-392	74-356	64-290	65-269	56-234
12 Öreälven	2	1	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3
90% PI	0-25	0-13	0-7	0-3	0-2	0-3	0-3	0-2	0-1	0-2	0-2	0-6	0-7	0-10	0-12	0-16	0-19	0-23
13 Lögdeälven	0	0	0	0	0	0	0	0	0	1	0	1	2	2	3	3	2	2
90% PI	0-6	0-5	0-1	0-2	0-2	0-2	0-3	0-3	0-3	0-5	0-4	0-7	0-9	0-11	0-14	0-13	0-11	0-12
Total AU2	**102**	**70**	**67**	**69**	**74**	**60**	**81**	**59**	**51**	**39**	**41**	**68**	**156**	**287**	**279**	**230**	**215**	**205**
90%PI	**44-244**	**44-245**	**44-246**	**44-247**	**44-248**	**44-249**	**44-250**	**44-251**	**44-252**	**44-253**	**44-254**	**44-255**	**44-256**	**44-257**	**44-258**	**44-259**	**44-260**	**44-261**
Assessment unit 3																		
14 Ljungan	0	0	0	0	1	0	0	0	0	0	1	0	1	1	1	1	0	0
90% PI	0-6	0-6	0-5	0-7	0-7	0-5	0-6	0-4	0-2	0-3	0-6	0-5	0-9	0-11	0-10	0-7	0-5	0-4
15 Testeboån	3	3	2	1	0	0	0	0	0	0	0	0	0	1	1	1	2	2
90% PI	0-40	0-40	0-19	0-7	0-6	0-6	0-7	0-5	0-5	0-6	0-6	0-6	0-6	0-7	0-8	0-11	0-13	0-13
Total AU3	**4**	**4**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	**3**
90%PI	**0-42**	**0-46**	**0-35**	**0-21**	**0-21**	**0-17**	**0-19**	**0-16**	**0-13**	**0-14**	**0-19**	**0-18**	**0-22**	**0-23**	**0-23**	**0-24**	**0-24**	**0-25**
Assessment unit 4																		
16 Emån	3	3	0	0	0	0	1	1	0	1	1	2	2	1	1	1	2	2
90% PI	0-35	0-36	0-5	0-2	0-1	0-2	0-7	0-6	0-5	0-8	0-9	0-11	0-12	0-7	0-6	0-8	0-10	0-10
17 Mörrumsån	9	9	48	63	49	69	33	20	14	32	33	34	45	43	37	32	35	37
90% PI	1-70	1-70	15-143	21-191	19-133	25-198	12-84	6-56	4-44	8-104	12-85	12-92	18-126	16-114	14-98	13-84	13-95	15-93
Total AU4	**16**	**16**	**49**	**64**	**50**	**70**	**35**	**22**	**15**	**34**	**36**	**37**	**49**	**45**	**39**	**35**	**38**	**40**
90%PI	**3-98**	**3-100**	**16-144**	**21-191**	**20-133**	**25-199**	**13-88**	**7-59**	**5-45**	**10-107**	**14-88**	**15-97**	**20-132**	**18-116**	**16-100**	**14-88**	**15-99**	**17-97**

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Assessment unit 1																			
1 Tornionjoki	677	735	808	1130	1294	1423	1609	1681	1588	1434	1474	1784	1924	1864	1595	1443	1527	1753	1492
90% PI	544-837	570-954	626-1029	904-1423	1056-1588	1160-1741	1335-1950	1385-2047	1270-1992	1159-1770	1206-1810	1490-2141	1565-2346	1430-2488	1292-1996	1163-1800	1241-1866	1349-2292	919-2641
2 Simojoki	22	31	27	38	22	32	37	26	37	38	29	30	34	46	32	38	51	48	28
90% PI	14-31	20-47	20-36	26-56	14-33	21-46	30-45	16-39	31-43	29-49	14-56	26-33	18-62	35-58	23-43	27-53	29-85	23-93	8-81
3 Kalixälven	552	472	682	477	621	532	571	728	627	711	640	668	677	515	529	464	649	703	526
90% PI	173-1677	156-1309	224-1934	159-1314	207-1732	179-1461	193-1576	237-2135	211-1732	237-1974	214-1768	223-1850	228-1866	169-1422	175-1462	151-1302	211-1872	228-2045	138-1816
4 Råneälven	31	29	35	38	34	42	51	44	42	43	47	56	66	60	45	37	62	79	66
90% PI	7-97	6-95	9-104	10-114	8-104	11-125	14-150	12-130	11-123	11-126	13-136	16-160	20-188	16-177	11-135	9-111	17-186	22-241	14-260
Total AU1	**1301**	**1295**	**1577**	**1721**	**2003**	**2065**	**2312**	**2523**	**2340**	**2260**	**2233**	**2578**	**2752**	**2551**	**2251**	**2024**	**2333**	**2660**	**2255**
90%PI	**877-2435**	**901-2157**	**1054-2853**	**1281-2600**	**1482-3141**	**1576-3044**	**1787-3369**	**1889-3965**	**1750-3504**	**1670-3572**	**1674-3415**	**1989-3805**	**2114-4011**	**1908-3656**	**1722-3249**	**1550-2932**	**1752-3601**	**1941-4105**	**1402-4130**
Assessment unit 2																			
5 Piteälven*)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
90% PI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6 Åbyälven	1	1	3	5	3	3	3	4	5	6	5	6	7	8	7	4	7	5	4
90% PI	0-6	0-5	0-13	0-17	0-14	0-12	0-13	0-16	1-18	1-19	1-17	1-20	1-22	1-24	4-11	1-9	1-22	1-19	0-18
7 Byskeälven	80	90	120	99	88	95	106	115	99	122	104	135	151	170	170	144	168	152	104
90% PI	22-244	28-250	37-344	31-271	27-243	29-268	32-308	36-328	31-271	39-342	33-286	42-381	49-419	56-467	57-464	48-390	54-475	49-431	25-351
8 Kågeälven	NA	NA	NA	11	11	7	5	5	7	12	13	20	17	16	17	12	12	8	6
90% PI	NA	NA	NA	1-47	1-43	0-34	0-26	0-24	0-32	1-52	2-51	3-71	3-64	2-62	3-64	1-49	1-46	0-36	0-37
9 Rickleån	1	0	1	1	0	0	1	1	1	2	1	4	5	4	4	2	3	4	3
90% PI	0-7	0-4	0-7	0-6	0-5	0-5	0-8	0-8	0-7	1-2	0-7	3-5	3-7	0-18	0-19	0-13	0-17	0-21	0-23
10 Sävarån	4	3	3	5	3	2	2	4	4	6	7	9	12	14	14	12	8	10	9
90% PI	3-4	2-3	2-4	3-6	1-5	1-3	1-3	0-14	2-6	1-18	1-21	2-25	3-33	4-37	4-36	3-33	2-25	2-31	1-30
11 Ume/Vindelälven	173	168	137	126	141	156	186	273	230	164	167	220	223	142	74	35	38	132	168
90% PI	91-308	90-299	73-246	66-226	79-238	116-207	150-229	208-355	168-313	133-200	137-201	135-343	170-289	96-205	30-156	12-79	13-85	53-313	60-453
12 Öreälven	3	3	5	4	4	4	6	5	5	5	4	7	13	14	13	7	9	16	12
90% PI	0-20	0-22	0-26	0-25	0-23	0-22	0-31	0-28	0-29	0-26	0-26	0-39	1-60	2-60	2-56	0-35	0-45	1-80	1-67
13 Lögdeälven	3	4	5	4	4	4	5	6	7	6	7	6	13	15	14	11	15	18	15
90% PI	0-14	0-16	0-18	0-17	0-16	0-17	0-18	1-21	1-23	1-22	1-24	4-8	3-35	4-40	3-39	2-33	4-40	5-48	2-50
Total AU2	**284**	**290**	**295**	**263**	**261**	**277**	**322**	**428**	**369**	**322**	**309**	**409**	**445**	**390**	**322**	**233**	**269**	**380**	**362**
90%PI	**44-262**	**44-263**	**44-264**	**44-265**	**44-266**	**44-267**	**44-268**	**44-269**	**44-270**	**44-271**	**44-272**	**44-273**	**44-274**	**44-275**	**44-276**	**44-277**	**44-278**	**44-279**	**44-280**
Assessment unit 3																			
14 Ljungan	0	0	1	1	0	0	0	0	0	1	0	1	2	1	0	0	0	0	0
90% PI	0-5	0-3	0-10	0-6	0-3	0-6	0-6	0-6	0-7	0-9	0-5	0-12	0-17	0-10	0-4	0-0	0-2	0-2	0-3
15 Testeboån	2	3	4	3	1	2	2	3	3	3	2	2	3	4	2	2	4		
90% PI	0-14	0-19	0-15	0-14	0-5	0-9	0-8	0-9	0-10	1-5	1-3	1-2	2-4	0-13	0-10	1-5	0-20		
Total AU3	**3**	**3**	**6**	**5**	**1**	**3**	**3**	**4**	**4**	**4**	**2**	**4**	**6**	**6**	**3**	**2**	**5**		
90%PI	**0-26**	**0-31**	**1-28**	**1-20**	**0-11**	**0-17**	**0-15**	**0-16**	**0-18**	**1-15**	**0-9**	**0-15**	**1-20**	**1-21**	**0-14**	**0-6**	**0-24**		
Assessment unit 4																			
16 Emån	2	2	1	2	3	4	3	3	4	3	4	4	6	4	1	2	3		
90% PI	0-10	0-9	0-6	1-3	0-16	0-21	0-17	0-14	0-20	0-16	0-19	0-20	0-22	0-18	0-8	0-13	0-16		
17 Mörrumsån	37	43	32	27	26	26	34	18	30	48	35	43	28	26	18	35	29		
90% PI	16-94	17-110	13-76	10-71	8-78	10-68	15-86	9-41	17-68	25-111	16-88	24-92	14-65	12-64	6-49	12-101	10-78		
Total AU4	**40**	**45**	**33**	**29**	**31**	**32**	**39**	**22**	**36**	**53**	**41**	**49**	**36**	**32**	**20**	**39**	**34**		
90%PI	**18-99**	**19-114**	**14-78**	**13-73**	**11-86**	**14-78**	**18-92**	**11-47**	**20-78**	**28-118**	**20-97**	**28-103**	**18-77**	**15-73**	**8-54**	**15-106**	**13-86**		

***) No comparable data exist from Piteälven to produce likelihood approximations.**

Table 4.2.2.2. Median values and coefficients of variation of the estimated M74 mortality for different Atlantic salmon stocks (spawning years 1985–2019). The values in bold are based on observation data from hatchery or laboratory monitoring in the river and year concerned. Grey cells represent predictive estimates for years from which no monitoring data were available.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Simojoki	**9**	**3**	**6**	**3**	**11**	**4**	**43**	**64**	**50**	**63**	**52**	**54**	**8**	**44**	**25**	**26**	**23**	**1**	**2**	**2**	**4**	**13**	**7**	**6**	**4**	**2**	**0**	**1**	**1**	**0**	**4**	**9**	**4**	**1**	**1**
cv	0.60	0.88	0.58	0.96	0.51	0.71	0.17	0.14	0.17	0.10	0.16	0.14	0.30	0.11	0.21	0.22	0.22	0.62	0.60	0.90	0.49	0.30	0.47	0.47	0.61	0.72	1.92	1.36	1.15	1.60	0.70	0.33	0.42	1.19	1.63
Tornionjoki	11	8	**10**	**7**	**12**	**15**	**43**	**62**	**75**	**53**	**42**	**24**	**7**	**43**	**21**	**25**	**35**	**0**	**0**	2	**5**	**6**	**7**	**4**	**7**	**4**	**0**	**0**	**3**	**1**	**10**	**12**	**3**	**0**	**0**
cv	0.75	0.84	0.76	0.90	0.72	0.66	0.31	0.25	0.07	0.10	0.31	0.47	0.43	0.18	0.22	0.22	0.24	1.06	1.39	1.31	0.50	0.49	0.63	0.61	0.47	1.00	1.99	1.43	1.09	1.45	0.72	0.63	0.35	0.88	1.80
Kemijoki	11	8	10	7	12	15	43	61	59	43	42	24	4	31	17	19	23	1	1	2	**10**	**21**	**13**	**14**	**6**	**3**	0	2	4	1	10	12	5	1	1
cv	0.76	0.83	0.75	0.92	0.71	0.66	0.31	0.24	0.23	0.30	0.31	0.47	0.88	0.40	0.52	0.50	0.45	1.09	1.38	1.28	0.32	0.29	0.41	0.31	0.52	0.71	1.88	1.32	1.09	1.44	0.71	0.62	0.75	0.63	1.65
Iijoki	11	9	10	7	13	15	44	62	60	43	42	24	4	31	17	19	24	1	1	2	5	11	8	**12**	9	4	0	2	3	1	10	**14**	**5**	**1**	**1**
cv	0.76	0.82	0.75	0.90	0.72	0.65	0.31	0.24	0.23	0.30	0.31	0.47	0.87	0.39	0.52	0.51	0.45	1.10	1.39	1.30	0.73	0.62	0.80	0.33	0.72	0.99	1.84	1.35	1.09	1.46	0.73	0.35	0.76	1.19	1.59
Luleälven	11	8	10	7	12	15	**46**	**56**	**54**	**38**	**35**	**28**	**2**	**27**	**14**	**21**	**25**	**1**	**1**	**1**	**5**	**10**	**7**	**9**	**21**	**1**	**1**	**1**	**1**	**1**	**7**	**8**	**5**	**1**	**2**
cv	0.75	0.85	0.77	0.90	0.73	0.65	0.13	0.16	0.08	0.13	0.20	0.16	0.36	0.12	0.18	0.15	0.20	0.62	0.43	0.65	0.41	0.24	0.24	0.22	0.20	0.42	0.58	0.74	0.59	0.57	0.39	0.47	0.44	0.47	0.58
Skellelteälven	11	8	10	7	12	15	**34**	**44**	**60**	**38**	**52**	**14**	**2**	**33**	**9**	**13**	**14**	**1**	**0**	**1**	**2**	**7**	**1**	**2**	**4**	**2**	**1**	**10**	**1**	**1**	**4**	**10**	**5**	**6**	**1**
cv	0.76	0.84	0.76	0.89	0.72	0.66	0.20	0.18	0.10	0.17	0.20	0.31	0.63	0.17	0.32	0.29	0.32	0.72	1.46	0.87	0.70	0.40	0.88	0.80	0.54	0.72	0.99	0.47	0.82	0.91	0.61	0.49	0.47	0.44	0.98
Ume/Vindelälven	**16**	**17**	**14**	**11**	**23**	**31**	**60**	**73**	**77**	**51**	**52**	**27**	**5**	**40**	**28**	**26**	**24**	**2**	**1**	**0**	**2**	**8**	**4**	**14**	**13**	**6**	**0**	**4**	**10**	**0**	**11**	**14**	**5**	**2**	**0**
cv	0.23	0.33	0.29	0.43	0.26	0.32	0.14	0.16	0.07	0.13	0.19	0.21	0.45	0.15	0.20	0.19	0.25	0.65	0.72	1.38	0.62	0.40	0.55	0.27	0.32	0.41	1.97	0.56	0.43	1.55	0.46	0.50	0.58	0.63	1.66
Ångermanälven	11	8	10	7	12	15	**40**	**65**	**58**	**35**	**43**	**16**	**2**	**23**	**14**	**18**	**28**	**2**	**1**	**2**	**7**	**15**	**11**	**5**	**13**	**4**	**1**	**1**	**2**	**0**	**14**	**12**	**5**	**2**	**0**
cv	0.75	0.84	0.76	0.92	0.71	0.67	0.15	0.16	0.10	0.16	0.21	0.20	0.57	0.17	0.21	0.19	0.22	0.60	0.56	0.59	0.43	0.27	0.28	0.37	0.27	0.42	0.97	0.75	0.62	1.50	0.39	0.63	0.75	0.63	1.76
Indalsälven	**6**	**6**	**6**	**3**	**6**	**6**	**36**	**61**	**62**	**31**	**44**	**17**	**1**	**17**	**14**	**6**	**14**	**1**	**0**	**2**	**5**	**8**	**12**	**3**	**7**	**3**	**0**	**0**	**2**	**1**	**9**	**12**	**5**	**1**	**1**
cv	0.23	0.33	0.29	0.45	0.30	0.37	0.15	0.16	0.08	0.15	0.20	0.20	0.64	0.19	0.22	0.33	0.25	0.70	1.51	0.59	0.44	0.30	0.25	0.41	0.30	0.40	1.95	1.41	0.56	0.65	0.40	0.61	0.77	0.72	0.94
Ljungan	11	8	10	7	13	15	**48**	**70**	**50**	**42**	**25**	**22**	**4**	**23**	**12**	**9**	**29**	**1**	1	2	5	11	7	8	9	4	0	2	4	1	10	12	5	1	1
cv	0.75	0.83	0.76	0.90	0.72	0.66	0.19	0.20	0.20	0.19	0.30	0.32	0.61	0.29	0.49	0.56	0.30	1.14	1.40	1.27	0.73	0.61	0.80	0.73	0.72	0.97	1.85	1.32	1.06	1.45	0.73	0.62	0.75	1.18	1.63
Ljusnan	2	1	1	1	1	**12**	**28**	**63**	**56**	**42**	**48**	**17**	**3**	**33**	**17**	**31**	**24**	**2**	**0**	**1**	**7**	**8**	**6**	**9**	**6**	**2**	**0**	**1**	**2**	**1**	**22**	**12**	**4**	**0**	**0**
cv	0.81	0.91	0.85	0.98	0.80	0.37	0.19	0.16	0.09	0.15	0.20	0.22	0.45	0.18	0.21	0.16	0.24	0.61	1.43	1.29	0.44	0.36	0.36	0.28	0.35	0.52	1.98	0.75	0.58	0.74	0.36	0.47	0.52	1.27	1.70
Dalälven	**8**	**7**	**15**	**8**	**8**	**15**	**61**	**71**	**49**	**41**	**39**	**28**	**6**	**27**	**18**	**23**	**23**	**2**	**1**	**4**	**5**	**9**	**5**	**13**	**11**	**2**	**0**	**1**	**7**	**4**	**19**	**19**	**6**	**1**	**2**
cv	0.42	0.40	0.27	0.42	0.45	0.35	0.14	0.16	0.10	0.18	0.20	0.18	0.38	0.17	0.20	0.19	0.22	0.58	0.52	0.45	0.41	0.29	0.35	0.21	0.26	0.42	2.03	0.66	0.44	0.53	0.36	0.45	0.44	0.72	0.62
Mörrumsån	**36**	**41**	**31**	**39**	**52**	**42**	**44**	**74**	**62**	**46**	**39**	**19**	4	31	17	20	23	1	1	2	5	11	7	8	9	4	0	2	4	1	10	12	5	1	1
cv	0.17	0.28	0.22	0.28	0.21	0.31	0.17	0.16	0.18	0.18	0.25	0.33	0.87	0.40	0.52	0.50	0.44	1.13	1.40	1.26	0.74	0.62	0.80	0.74	0.71	0.98	1.88	1.33	1.07	1.47	0.73	0.62	0.74	1.19	1.62
Unsampled stock	11	8	10	7	12	15	43	62	59	43	42	24	4	30	17	20	24	1	1	2	5	11	8	8	9	4	0	2	4	1	10	12	5	1	1
cv	0.76	0.83	0.75	0.90	0.72	0.66	0.31	0.24	0.23	0.30	0.31	0.47	0.87	0.40	0.52	0.50	0.44	1.12	1.38	1.23	0.74	0.61	0.81	0.73	0.72	1.00	1.88	1.32	1.08	1.45	0.73	0.62	0.74	1.18	1.65

Table 4.2.3.1. Posterior probability distributions of alpha, beta and K parameters of the Beverton–Holt stock–recruit relationship for Baltic salmon stocks included in the Full Life-History Model (FLHM). Posterior distributions are summarised in terms of their mean, CV (%) and 90% probability intervals.

		Alpha parameter			Beta parameter			K		
		Mean	cv	90%PI	Mean	cv	90%PI	Mean	cv	90%PI
Assessment unit 1										
1	Tornionjoki	48	14%	37-62	0.00054	9%	4.5E-04 - 6.1E-04	1876	9%	1641-2246
2	Simojoki	149	26%	92-219	0.0152	20%	9.7E-03 - 2.0E-02	69	26%	50-103
3	Kalixälven	28	37%	13-48	0.0015	14%	1.1E-03 - 1.8E-03	697	14%	544-879
4	Råneälven	61	37%	29-101	0.0148	30%	8.2E-03 - 2.2E-02	75	41%	45-121
Assessment unit 2										
5	Piteälven	14	32%	8-22	0.0375	9%	3.2E-02 - 4.3E-02	27	9%	23-31
6	Åbyälven	103	41%	38-174	0.1017	47%	3.0E-02 - 1.9E-01	14	88%	5-34
7	Byskeälven	47	51%	14-91	0.0071	25%	4.2E-03 - 1.0E-02	152	31%	99-238
8	Kågeälven	149	70%	29-356	0.0240	34%	1.3E-02 - 3.9E-02	47	36%	26-76
9	Rickleån	114	19%	82-154	0.0797	38%	4.0E-02 - 1.4E-01	14	40%	7-25
10	Sävarån	115	22%	77-158	0.0634	51%	2.1E-02 - 1.2E-01	22	67%	9-48
11	Ume/Vindelälven	18	26%	11-26	0.0036	13%	2.8E-03 - 4.4E-03	283	14%	229-361
12	Öreälven	83	26%	49-119	0.0251	65%	7.0E-03 - 5.9E-02	60	73%	17-143
13	Lögdeälven	124	20%	84-165	0.0201	68%	5.5E-03 - 4.8E-02	76	76%	21-183
Assessment unit 3										
14	Ljungan	239	43%	48-392	0.4906	93%	6.0E-02 - 1.4E+00	5.3	118%	1-17
15	Testeboån	43	75%	8-108	0.2991	27%	1.5E-01 - 4.2E-01	3.7	48%	2-7
Assessment unit 4										
16	Emån	285	22%	193-394	0.0457	41%	2.2E-02 - 8.0E-02	26	40%	12-45
17	Mörrumsån	92	82%	4-244	0.0237	22%	1.4E-02 - 3.2E-02	44	26%	32-68

Table 4.2.3.2. Summary statistics for probability distributions of the smolt production at maximum sustainable yield (x 1000), smolt production corresponding to recovery to the maximum sustainable yield level in one generation time (limit smolt production) (x 1000), and long-term equilibrium unfished smolt production (R0) (x 1000) in the AU 1–4 rivers. These estimates serve as reference points to evaluate the status of the stocks (Table 4.2.3.4). The posterior distributions are summarized in terms of their median, mean and 90% probability interval (PI). MSY, maximum sustainable yield.

		MSY smolt production, thousands			Limit smolt production, thousands			Equilibrium smolt production, thousands		
		Median	Mean	90%PI	Median	Mean	90%PI	Median	Mean	90%PI
Assessment unit 1										
1	Tornionjoki	1303	1317	1121-1564	403	405	314-509	1700	1722	1510-2047
2	Simojoki	32	32	23-45	16	17	12-25	48	49	37-67
3	Kalixälven	540	547	411-707	123	123	71-175	660	670	522-849
4	Råneälven	46	50	28-82	15	17	9-29	61	67	39-108
	Total assessment unit 1	1937	1946	1651-2278	562	562	441-680	2493	2508	2206-2879
Assessment unit 2										
5	Piteälven	22	22	19-27	4	4	2-6	26	26	23-31
6	Åbyälven	6	8	3-19	2	3	1-8	8	11	4-27
7	Byskeälven	102	109	66-178	29	31	17-49	131	140	89-223
8	Kågeälven	22	23	9-37	10	10	5-18	32	33	16-53
9	Rickleån	7	8	4-14	3	4	2-6	11	11	6-20
10	Sävarån	9	11	5-24	4	5	2-12	14	16	7-36
11	Ume/Vindelälven	159	160	126-200	68	69	53-90	227	229	189-282
12	Öreälven	29	37	10-89	12	14	4-35	41	51	14-122
13	Lögdeälven	31	39	12-91	15	19	5-44	46	58	17-135
	Total assessment unit 2	410	417	319-543	157	160	126-205	568	577	462-733
Assessment unit 3										
14	Ljungan	0.9	1.5	0.4-4.7	0.6	1	0.1-3.3	1.5	2.5	0.5-7.8
15	Testeboån	2.1	2.2	1.5-3.1	0.8	0.8	0.4-1.5	2.8	3	2.1-4.4
	Total assessment unit 3	3.2	3.7	2.0-7.2	1.5	1.8	0.7-4.2	4.6	5.5	3.0-11.3
Assessment unit 4										
16	Emån	8	9	3-17	5	6	2-10	13	14	5-27
17	Mörrumsån	28	28	20-36	9	9	2-16	36	37	30-47
	Total assessment unit 4	36	36	25-49	15	15	7-23	50	51	38-69
Total assessment units 1-4		2397	2403	2047-2772	738	739	613-867	3130	3142	2772-3558

Table 4.2.3.3. Wild smolt production in Baltic rivers (year 2000 and onwards) with natural reproduction of salmon grouped by assessment units: posterior probability estimates derived from the Full Life-History Model (FLHM) for the AU 1–4 rivers, and estimates derived by other means (inferred from parr densities, smolt trapping, etc.) for the rest of the rivers. Median estimates (x 1000) of smolts with the associated uncertainty (90% Probability interval) are shown. Also, the river-specific reproductive areas and the potential smolt production capacities (PSPC's) are shown as medians and 90% PIs. Note that estimates of the smolt production is not available from many AU 5 and some AU 6 rivers from the early and middle parts of the time-series; however, based on the available information these rivers account for only a very small proportion of the total AU specific (and grand total) smolt production. PSPC for Piteälven and Testeboån, and smolt production estimates for Ljungan, are most likely underestimated (see Section 4.4.2).

Assessment unit, sub-division, country	Cate-gory	Reprod. area (ha, median)	PSPC (x 1000)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Pred 2021	Pred 2022	Pred 2023	Method of estimation: Pot. prod.	Method of estimation: Pres. prod.
Gulf of Bothnia, Sub-div. 30-31:																													
Finland																													
Simojoki	wild	252	48	26	40	46	44	38	30	34	29	42	32	33	36	30	37	38	35	31	51	46	36	38	40	38	42	1	1
90% PI		222-284	37-67	18-36	30-51	35-60	34-58	29-50	23-39	26-45	23-36	33-54	25-42	26-42	31-43	23-40	32-43	31-48	25-49	28-35	38-67	37-57	29-45	30-49	30-55	27-52	30-60		
Finland/Sweden																													
Tornionjoki;Torneälven	wild	5562	1700	680	795	692	765	777	728	917	909	1163	1260	1251	1357	1465	1450	1363	1360	1598	1725	1711	1549	1485	1533	1663	1653	1	1
90% PI		4405-6985	1510-2047	561-827	653-947	595-813	621-930	634-951	607-876	750-1117	751-1103	980-1397	1055-1491	1051-1473	1154-1575	1256-1732	1218-1721	1160-1620	1133-1618	1365-1856	1443-2040	1393-2111	1282-1872	1225-1769	1298-1837	1352-2060	1197-2259		
Sweden																													
Kalixälven	wild	2612	660	585	534	460	462	593	618	684	543	568	631	562	539	568	543	541	567	572	648	654	676	612	626	628	643	1	1
90% PI		2129-3208	522-849	415-804	385-738	320-654	317-658	403-888	427-886	484-963	390-767	407-790	440-903	411-778	383-740	408-789	392-772	384-755	400-787	403-816	460-891	460-937	473-952	426-886	427-904	436-930	429-921		
Råneälven	wild	387	61	24	28	21	20	25	29	37	33	42	38	34	37	40	44	43	45	51	57	57	54	51	54	56	59	1	1
90% PI		333-451	39-108	13-43	15-48	11-36	11-34	14-41	17-47	23-56	21-49	28-62	24-57	22-55	24-57	27-60	29-67	28-64	30-66	33-78	36-90	36-89	34-86	33-83	34-85	35-90	36-97		
Assessment unit 1, total			**2493**	**1323**	**1398**	**1226**	**1298**	**1443**	**1410**	**1676**	**1523**	**1833**	**1967**	**1898**	**1977**	**2110**	**2078**	**2006**	**2016**	**2264**	**2498**	**2481**	**2329**	**2200**	**2269**	**2405**	**2409**	1	1
90% PI			**2206-2879**	**1105-1575**	**1196-1643**	**1057-1442**	**1087-1533**	**1197-1766**	**1181-1716**	**1402-2036**	**1290-1819**	**1571-2139**	**1690-2320**	**1628-2186**	**1709-2270**	**1852-2467**	**1798-2435**	**1710-2307**	**1730-2353**	**1963-2597**	**2144-2887**	**2107-2956**	**1971-2737**	**1866-2596**	**1953-2668**	**2005-2876**	**1892-3081**		
Piteälven	wild	576	26	17	29	28	17	19	20	21	23	23	24	22	21	22	26	26	26	26	26	24	24	25	25	25	26	1	1
90% PI		482-670	23-31	11-24	21-41	22-37	12-23	14-26	14-28	15-28	17-30	17-30	17-32	17-29	15-28	16-29	19-34	20-34	19-35	19-36	20-34	17-33	17-33	18-36	18-35	18-36	18-36		
Åbyälven	wild	84	8	3	4	3	2	3	3	4	4	5	4	3	3	4	5	4	5	6	6	6	6	6	6	6	7	1	1
90% PI		69-102	4-27	2-6	2-8	1-5	1-5	1-5	1-5	2-7	2-6	3-8	2-6	2-6	2-6	2-6	3-7	3-7	3-7	4-9	4-10	4-10	5-9	4-9	4-9	4-10	4-13		
Byskeälven	wild	564	131	95	97	85	77	93	101	113	96	115	111	101	112	111	107	106	112	123	133	125	128	122	124	125	126	1	1
90% PI		483-658	89-223	60-140	65-143	54-127	47-117	62-140	67-146	79-163	66-140	79-168	76-163	69-149	74-161	76-158	74-155	72-155	76-162	84-184	92-199	84-195	88-199	82-185	83-185	82-189	83-203		
Rickleån	wild	34	11	0.3	0.9	0.9	0.8	0.8	0.6	0.7	1.0	2.2	1.7	1.3	1.2	1.2	1.7	2.1	2.7	3.8	4.7	4.2	3.6	3.9	4.3	5.1	7.0	1	1
90% PI		24-49	6-20	0-1	0-2	0-2	0-1	0-2	0-1	0-1	0-2	1-4	1-3	1-2	1-2	1-2	1-3	2-3	2-4	3-5	4-6	3-7	2-6	2-6	3-7	3-8	4-11		
Sävarån	wild	23	14	2	3	2	1	2	4	3	3	5	3	3	3	4	5	4	5	6	8	9	8	8	8	8	10	1	1
90% PI		14-35	7-36	1-3	1-5	1-3	1-3	1-4	3-4	3-4	2-4	4-6	2-5	2-4	2-4	3-6	3-6	3-7	3-8	4-9	5-12	6-13	5-12	5-13	5-12	5-14	6-19		
Ume/Vindelälven	wild	1806	227	185	160	77	139	151	176	216	193	186	194	181	207	279	231	170	180	221	238	181	153	125	53	125	208	1	1
90% PI		1432-2272	189-282	145-234	123-210	56-105	107-179	111-205	131-240	164-286	149-252	137-249	146-249	145-220	173-245	228-340	183-289	143-201	151-215	167-293	194-288	142-233	109-212	84-183	30-87	83-183	149-293		
Öreälven	wild	244	41	1	2	1	1	1	2	3	3	4	3	3	3	5	7	6	7	10	14	15	14	15	15	18	23	1	1
90% PI		200-297	14-122	0-2	1-3	0-2	0-2	1-3	1-3	1-6	1-5	2-8	2-6	1-5	2-7	3-9	3-12	4-12	4-13	5-18	8-23	9-26	8-25	8-26	8-27	10-32	12-45		
Lögdeälven	wild	210	46	2	3	2	1	2	3	4	4	5	3	3	4	5	7	6	7	7	12	14	13	13	13	14	21		
90% PI		172-256	17-135	1-5	1-6	1-3	1-3	1-4	1-6	2-8	2-6	3-8	2-6	2-5	2-7	3-9	4-11	4-10	4-11	5-10	8-19	9-23	8-22	8-22	8-22	'9-23	13-35		
Kågeälven	wild	96	32	na	na	na	na	na	na	na	na	12	11	7	5	5	7	11	11	17	20	18	16	16	17	19	24	1	1
90% PI		67-138	16-53	na	na	na	na	na	na	na	na	3-57	3-49	1-30	1-27	1-23	2-32	3-37	3-37	5-66	9-36	8-32	7-30	7-31	8-33	9-35	12-43		
Assessment unit 2, total			**568**	**308**	**302**	**200**	**242**	**276**	**311**	**369**	**331**	**367**	**363**	**329**	**365**	**441**	**401**	**343**	**362**	**432**	**468**	**403**	**375**	**342**	**272**	**351**	**464**	1	1
90% PI			**462-733**	**249-378**	**247-368**	**156-250**	**193-304**	**221-343**	**249-391**	**301-449**	**270-402**	**299-457**	**295-448**	**276-395**	**315-430**	**376-522**	**340-478**	**293-404**	**311-427**	**355-535**	**402-557**	**340-494**	**308-460**	**275-430**	**216-342**	**286-440**	**378-584**		
Ljungan	wild	19	1.5	0.7	0.7	0.5	0.5	0.5	0.5	0.6	0.4	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.7	0.7	0.5	0.4	0.4	0.5	0.7	1	1
90% PI		11-34	0,5-7,8	0-2	0-2	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-2		
Testeboån	wild	11	2.8	0.6	0.9	1.7	2.2	2.0	2.4	3.3	3.8	2.5	2.2	2.3	2.3	2.6	2.4	2.5	2.2	2.1	2.8	2.5	2.3	2.4	1.6	2.9	2.7	1	1
90% PI		9-13	2,1-4,4	0-13	0-15	0-52	0-35	0-25	0-22	0-32	1-25	1-4	1-4	1-4	1-4	1-4	1-4	2-4	1-3	2-3	2-4	1-4	1-3	2-3	1-3	2-5	2-4		
Assessment unit 3, total			**5**	**1.5**	**1.8**	**2.3**	**2.7**	**2.5**	**2.9**	**4.0**	**4.3**	**3.2**	**2.7**	**2.8**	**2.8**	**3.0**	**2.8**	**3.0**	**2.7**	**2.6**	**3.5**	**3.2**	**2.8**	**2.9**	**2.1**	**3.5**	**3.5**	1	1
95% PI			**3-11**	**0-14**	**1-16**	**1-53**	**1-35**	**1-26**	**1-22**	**1-33**	**1-25**	**2-5**	**1-4**	**1-4**	**1-4**	**2-5**	**2-4**	**2-4**	**2-4**	**2-3**	**3-5**	**2-5**	**2-4**	**2-4**	**1-3**	**2-5**	**2-5**		
Total Gulf of B., Sub-divs.30-31			**3078**	**1638**	**1712**	**1445**	**1554**	**1732**	**1734**	**2058**	**1860**	**2202**	**2335**	**2232**	**2346**	**2556**	**2491**	**2349**	**2380**	**2702**	**2965**	**2888**	**2707**	**2549**	**2547**	**2764**	**2882**	1	1
90% PI			**2726-3504**	**1400-1911**	**1490-1973**	**1264-1691**	**1327-1816**	**1482-2058**	**1487-2049**	**1782-2430**	**1612-2167**	**1937-2517**	**2047-2697**	**1959-2524**	**2080-2645**	**2277-2917**	**2197-2851**	**2055-2670**	**2082-2731**	**2381-3059**	**2613-3364**	**2507-3369**	**2351-3124**	**2210-2944**	**2226-2951**	**2355-3251**	**2344-3568**		

Table 4.2.3.3. Continued.

Assessment unit, sub-division, country	Cate-gory	Reprod. area (ha, median)	PSPC (x 1000)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Pred 2021	Pred 2022	Pred 2023	Method of estimation: Pot. prod.	Method of estimation: Pres. prod.
Sweden																													
Emån	wild	41	13	2.9	1.2	1.4	1.7	2.5	3.4	1.8	2.5	2.4	2.0	2.5	2.1	2.7	2.3	2.2	3.3	4.8	4.8	3.9	3.2	3.6	4.6	6.4	6.2	1	1
90% PI		29-59	5-27	1-7	0-3	1-3	1-3	1-5	2-6	1-4	1-4	2-4	1-4	1-5	1-4	1-5	1-4	1-4	2-6	3-8	3-9	2-7	2-6	2-7	2-9	3-12	3-12		
Mörrumsån	wild	49	36	39	35	36	36	35	35	32	35	34	31	31	31	30	31	33	34	37	34	33	32	34	33	35	35	1	1
90% PI		35-69	30-47	28-56	25-49	26-50	26-50	25-50	25-50	22-45	25-48	25-48	22-44	21-44	20-45	21-42	21-44	23-46	24-47	27-51	25-48	24-46	22-45	23-47	24-47	25-50	25-49		
Assessment unit 4, total			**50**	**42**	**36**	**37**	**38**	**38**	**39**	**34**	**37**	**37**	**34**	**34**	**33**	**33**	**34**	**35**	**37**	**43**	**40**	**37**	**35**	**38**	**38**	**42**	**41**	1	1
90% PI			**38-69**	**30-60**	**26-50**	**27-52**	**27-51**	**27-54**	**29-54**	**24-47**	**27-51**	**27-50**	**24-46**	**24-47**	**23-47**	**24-45**	**24-46**	**25-49**	**27-51**	**32-57**	**30-54**	**28-51**	**25-49**	**27-51**	**28-52**	**31-58**	**30-58**		
Estonia																													
Pärnu	mixed	50***	30***	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5	0.0	0.0	0.7			2	3, 4
Latvia																													
Salaca	wild	47	30	18	30	24	22	3	26	25	11	25	18	11	2.1	4.9	9.5	5.7	17	38	9.7	18	5.1	13	21			2	2
Vitrupe	wild	5	4	na	na	na	na	0.0	na	na	0.4	0.0	0.3	0.0	na	na	0.1	0.1	0.4	1.4	0.0	0.0	0.1	0.0	3.0			4	4
Peterupe	wild	5	5	na	na	na	na	na	na	na	0.0	na	0.0	0.0	na	na	0.0	0.0	1.1	0.0	0.0	0.0	0.2	0.0	0.9			4	4
Gauja	mixed	50	29	na	na	0.3	na	0.0	2.9	0.7	2.4	0.2	1.1	1.0	0.2	0.2	0.2	0.4	2.9	1.0	0.1	1.7	1.6	1.0	1.4			4	4
Daugava****	mixed	20	11	na	na	na	na	0.0	na	0.0	na	0.0	0.0	0.0	na	na	na	0.0	0.0	0.0	0.0	0.0	0.0	na	0.0			4	4
Irbe	wild	10	4	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			4	4
Venta	mixed	30	15	na	na	0.0	0.0	0.0	7.4	17.2	2.0	0.6	1.8	1.9	0.0	0.7	1.8	1.3	2.5	5.3	0.7	1.3	0.1	0.5	0.7			4	4
Saka	wild	20	8	na	na	na	na	na	na	na	0.0	0.0	0.4	0.3	0.0	na	na	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1			4	4
Uzava	wild	5	4	na	na	na	na	na	na	na	na	na	0.1	0.0	na	na	na	0.0	0.1	na	0.0	0.0	0.0	0.0	0.0			4	4
Barta	wild	0.6	0.2	na	na	na	na	na	na	0.0	0.0	na	na	na	na	na	na	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			4	4
Lithuania																													
Nemunas river basin	mixed	na	164	2	5	8	4	2	6	7	5	13	42	48	7	28	14	13	36	37	26	20	32	53	93			3	3, 4
Assessment unit 5, total			**301**	**20**	**35**	**33**	**26**	**6**	**43**	**50**	**21**	**39**	**64**	**63**	**9**	**34**	**26**	**20**	**61**	**82**	**38**	**43**	**39**	**67**	**121**				
Total Main B., Sub-divs. 22-29 (AU's 4-5)			**351**	**62**	**71**	**70**	**63**	**44**	**81**	**84**	**58**	**76**	**98**	**96**	**42**	**66**	**59**	**56**	**98**	**125**	**78**	**80**	**75**	**105**	**158**				
				50-80	**113-137**	**116-141**	**107-131**	**86-112**	**108-134**	**101-124**	**83-107**	**95-118**	**120-142**	**110-133**	**56-81**	**76-97**	**71-93**	**59-83**	**111-135**	**138-163**	**81-105**	**80-104**	**63-87**	**94-119**	**149-173**				
Assessment unit, sub-division, country	**Cate-gory**	**Reprod. area (ha, median)**	**PSPC (x 1000)**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Pred 2021**	**Pred 2022**	**Pred 2023**	**Method of estimation: Pot. prod.**	**Method of estimation: Pres. prod.**
Finland:																													
Kymijoki	mixed	15*+60**	20*+80**	2	12	13	20	13	6	24	41	20	12	11	25	26	9	29	16	37	78	23	8	66	44			2	4
Russia:																													
Neva	mixed	0	0	7	6	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			2	5
Luga	mixed	40	100	5.0	2.5	8.0	7.2	2.0	2.6	7.8	7.0	3.0	4.0	6.7	4.3	6.3	5.0	6.6	7.0	5.3	2.0	5.8	8.8	6.3				4	2
Gladyshevka	mixed			na	na	na	na	na	na	na	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0	0.4	0.4					
Estonia:																													
Purtse	mixed	7.6	7.6	na	na	na	na	na	na	na	na	0.05	2.6	2.2	0.4	1.1	0	4.3	3.1	2.1	1.3	0.9	4.0	3.6	2.6			2	4
Kunda	wild	1.9	2,1(3,7)	2.8	1.2	2.3	0.8	0.6	0.1	2.2	1.9	0.9	0.1	0.1	0.2	2.1	2.0	1.0	1.3	2.1	3.7	3.0	3.1	2.5	6.0			2	3
Selja	mixed	11.3	11.0	2.3	0.3	0	0	0.1	0.9	2.1	0.2	0.1	4.0	3.9	1.1	0.8	2.7	3.1	3.4	0.6	0.5	0	4.8	2.2	1.7			2	4
Loobu	mixed	12	12.0	0.5	0.7	0.3	0.1	2.4	4.2	7.8	1.7	0.0	0.1	10.5	4.5	3.5	2.7	3.5	11.6	0.8	2.0	0.6	7.1	6.7	7.0			2	4
Pirita	mixed	10	12.0	0.1	0.6	0.1	0.3	2.8	0.8	3.0	1.6	2.5	5.7	8.5	1.6	1.9	5.6	5.1	3.5	10.4	1.7	11.3	3.0	6.0	2.7			2	2, 3
Vasalemma	wild	5***	4***	0	0.3	0.2	0.1	0	0	0.0	0.2	0.0	0.2	0.1	0.3	0.7	0.2	0.6	0.7	1.1	0 .1	0.7	1.5	1.0	2.2			2	4
Keila	wild	3.5	5,4 (12)	0.4	1.3	0.4	0.1	0	0	0.7	2.0	0.7	1.1	6.3	3.0	6.0	1.0	8.3	12.0	4.4	6.3	6.6	6.0	5.7	7.8			2	4
Valgejõgi	mixed	19***	16.5***	0.1	0.1	0.1	0	0.03	0.4	0.3	0.3	0.7	0.5	0.6	0.8	0.4	0.1	0.4	0.5	0.7	0.2	0.4	0.4	0.4	0.9			2	4
Jägala	mixed	0.3	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			2	4
Vääna	mixed	2	2.0	0	0	0	0	0	0	0	0	0.2	0	0.6	0.2	0.1	0	0.2	0.3	0.2	0	0	0.3	0.1	0.4			2	4
Assessment unit 6, total			**273**	**20**	**25**	**30**	**34**	**21**	**15**	**48**	**56**	**28**	**30**	**51**	**42**	**49**	**29**	**62**	**60**	**65**	**96**	**53**	**47**	**101**	**75**				
Grand total			**3704**	**1721**	**1807**	**1545**	**1651**	**1800**	**1832**	**2190**	**1976**	**2306**	**2464**	**2378**	**2431**	**2670**	**2581**	**2469**	**2538**	**2891**	**3139**	**3022**	**2828**	**2754**	**2781**				
90% PI				**1483-1995**	**1582-2072**	**1366-1794**	**1424-1917**	**1545-2123**	**1579-2142**	**1911-2560**	**1728-2281**	**2039-2617**	**2170-2822**	**2100-2671**	**2164-2733**	**2391-3028**	**2280-2940**	**2168-2793**	**2238-2886**	**2571-3248**	**2788-3533**	**2636-3501**	**2467-3247**	**2415-3150**	**2461-3186**				

Table 4.2.3.4.a. Overview of current status for wild Baltic salmon stocks with analytical assessment (AU 1–4) in terms of their probability to reach R_{lim} and R_{MSY} in 2020 (compared to PSPC in that year).

		Prob. to reach R_{lim}					Prob. to reach R_{msy}				
	Stock	Prob.	>95%	70-95%	50-70%	<50%	Prob.	>95%	70-95%	50-70%	<50%
AU 1	Tornionjoki	1.00	X				0.79		X		
	Simojoki	0.99	X				0.80		X		
	Kalixälven	1.00	X				0.68			X	
	Råneälven	0.99	X				0.60			X	
AU 2	Piteälven*	1.00	X				0.77		X		
	Åbyälven	0.88		X			0.44				X
	Byskeälven	1.00	X				0.74		X		
	Kågeälven	0.78		X			0.28				X
	Rickleån	0.65			X		0.09				X
	Sävarån	0.89		X			0.37				X
	Vindelälven	0.97	X				0.19				X
	Öreälven	0.62			X		0.17				X
	Lögdeälven	0.40				X	0.09				X
AU 3	Ljungan	0.38				X	0.21				X
	Testeboån*	0.99	X				0.75		X		
AU 4	Emån	0.28				X	0.09				X
	Mörrumsån	1.00	X				0.76		X		

* Status uncertain and most likely overestimated, see Section 4.4.2 for additional information.

Table 4.2.3.4.b. Overview of current status of wild and mixed Baltic salmon stocks in assessment units 5 and 6.

	Stock	Category	Average smolt production (2018-2020) in relation to PSPC	Current smolt production (2020) in relation to PSPC
Unit 5	Pärnu	mixed	< 1 %	3%
	Salaca	wild	40%	43
	Vitrupe	wild	1%	1%
	Peterupe	wild	2%	< 1 %
	Gauja	mixed	4%	3%
	Daugava	mixed	< 1 %	NA
	Irbe	wild	3%	9%
	Venta	mixed	4%	5%
	Saka	wild	< 1 %	< 1 %
	Uzava	wild	< 1 %	3%
	Barta	wild	< 1 %	< 1 %
	Nemunas	mixed	21%	32%
Unit 6	Kymijoki	mixed	32%	66%
	Luga	mixed	7%	6%
	Purtse	mixed	22%	28%
	Kunda	wild	100%	100%
	Selja	mixed	21%	20%
	Loobu	mixed	46%	64%
	Pirita	mixed	63%	60%
	Vasalemma	wild	27%	55%
	Keila	wild	96%	88%
	Valgejögi	mixed	2%	2%
	Jägala	mixed	< 1 %	< 1 %
	Vääna	mixed	7%	5%

Table 4.3.1.1. Key assumptions underlying the stock projections. The same post-smolt survival scenario and M74 scenario are assumed for all effort scenarios. Survival values represent the medians to which Mps and M74 are expected to return.

Scenario	Total removal (dead catch) for year 2022
1	Zero (sea and river)
2	Zero (sea)
3	50 000 (current fishing pattern)
4	100 000 (current fishing pattern)
5	150 000 (current fishing pattern)
6	200000 (current fishing pattern)
7	25000 (without offshore fishing)
8	50 000 (without offshore fishing)
9	75 000 (without offshore fishing)
10	100 000 (without offshore fishing)
	In scenarios 2–10 river catches are assumed zero for Ljungan, Emån, Kågeälven and Testeboån in 2021–2033.
Post-smolt survival of wild salmon	
Average survival between 2016–2019 (16%)	
Post-smolt survival of reared salmon	
Same relative difference to wild salmon as on average in history	
M74 survival	
Historical median (Figure 4.3.2.2)	
Releases	
Same number of annual releases in the future as in 2020	
Maturation	
Age group specific maturation rates in 2021 are predicted using January–March 2021 SST data. For other years, average maturation rates over the time-series are used, separately for wild and reared salmon.	
Ume/Vindelälven	
Average proportions 2018-2020 for MSW sex ratio passing ladder	
Average proportions 1992–2020 for no. spawners passing ladder and extra mortality after ladder	

Table 4.3.2.1a Estimates (in thousands of fish) of total removal in the sea fisheries by scenario in 2022. The table shows also the predicted total river catch, total number of spawners and reared surplus in 2022 (in thousands). All values refer to medians unless stated otherwise.

Scenario	Total sea catch (comm. + recr.) 2022	inst. F of total catch at sea	River catch 2022	Spawners 2022	Reared surplus 2022
1	0.0	0.00	0.0	194.2	64.3
2	0.0	0.00	52.0	156.4	51.1
3	50.0	0.04	45.7	137.3	44.9
4	100.0	0.09	40.0	119.4	38.9
5	150.0	0.14	34.1	102.2	33.2
6	200.0	0.19	28.5	84.6	27.6
7	25.0	0.02	47.8	143.8	46.7
8	50.0	0.04	43.5	130.9	42.2
9	75.0	0.07	39.4	118.9	38.0
10	100.0	0.09	35.1	106.3	34.0

Table 4.3.2.1b Catch components and their shares in 2016–2020 in the Main Basin and Gulf of Bothnia combined and separately in the Gulf of Bothnia only.

Main Basin and Gulf of Bothnia (SD22-31)

Year	Commercial at sea						Recreational at sea	In river		% commercial at sea	% recreational at sea	% river
	Reported	Discarded BMS		Seal damaged	Unreported	Misreported		Reported	Unreported			
		alive	dead									
2016	71700	1293	1447	8803	6761	26000	21820	53201	14642	56.4 %	10.6 %	33.0 %
2017	58620	1674	1390	8329	5431	32000	27570	38942	9771	58.5 %	15.0 %	26.5 %
2018	69040	1904	1785	3551	6269	42600	27060	42296	10540	61.0 %	13.2 %	25.8 %
2019	65560	1573	929	5192	5530	600	28080	43355	10398	49.2 %	17.4 %	33.3 %
2020	52350	1426	633	5274	5031	200	24200	52637	12952	42.0 %	15.6 %	42.4 %
	Catches at sea only, shares							Total				
2016	52.0 %	0.9 %	1.0 %	6.4 %	4.9 %	18.9 %	15.8 %	84.2 %				
2017	43.4 %	1.2 %	1.0 %	6.2 %	4.0 %	23.7 %	20.4 %	79.6 %				
2018	45.4 %	1.3 %	1.2 %	2.3 %	4.1 %	28.0 %	17.8 %	82.2 %				
2019	61.0 %	1.5 %	0.9 %	4.8 %	5.1 %	0.6 %	26.1 %	73.9 %				
2020	58.7 %	1.6 %	0.7 %	5.9 %	5.6 %	0.2 %	27.2 %	72.8 %				
	Commercial cathes at sea only, shares											
2016	61.8 %	1.1 %	1.2 %	7.6 %	5.8 %	22.4 %						
2017	54.6 %	1.6 %	1.3 %	7.8 %	5.1 %	29.8 %						
2018	55.2 %	1.5 %	1.4 %	2.8 %	5.0 %	34.0 %						
2019	82.6 %	2.0 %	1.2 %	6.5 %	7.0 %	0.8 %						
2020	80.6 %	2.2 %	1.0 %	8.1 %	7.8 %	0.3 %						

Gulf of Bothnia (SD 29-31)

Year	Commercial at sea						Recreational at sea	In river		% commercial at sea	% recreational at sea	% river
	Reported	Discarded BMS		Seal damaged	Unreported	Misreported		Reported	Unreported			
		alive	dead									
2016	54130	1035	525	2458	5779	0	8700	50730	13728	46.6 %	6.3 %	47.0 %
2017	45470	1410	528	2412	4724	0	8700	37670	9404	49.4 %	7.9 %	42.7 %
2018	51230	1558	634	2116	5454	0	5500	41190	10216	51.7 %	4.7 %	43.6 %
2019	48400	1477	626	2102	4847	0	5500	42550	10166	49.7 %	4.8 %	45.6 %
2020	43890	1363	485	2008	4603	0	5500	51050	12450	43.1 %	4.5 %	52.3 %
	Catches at sea only, shares							Total commercial				
2016	74.5 %	1.4 %	0.7 %	3.4 %	8.0 %	0%	12.0 %	88.0 %				
2017	71.9 %	2.2 %	0.8 %	3.8 %	7.5 %	0%	13.8 %	86.2 %				
2018	77.0 %	2.3 %	1.0 %	3.2 %	8.2 %	0%	8.3 %	91.7 %				
2019	76.9 %	2.3 %	1.0 %	3.3 %	7.7 %	0%	8.7 %	91.3 %				
2020	75.9 %	2.4 %	0.8 %	3.5 %	8.0 %	0%	9.5 %	90.5 %				
	Commercial cathes at sea only, shares											
2016	84.7 %	1.6 %	0.8 %	3.8 %	9.0 %	0%						
2017	83.4 %	2.6 %	1.0 %	4.4 %	8.7 %	0%						
2018	84.0 %	2.6 %	1.0 %	3.5 %	8.9 %	0%						
2019	84.2 %	2.6 %	1.1 %	3.7 %	8.4 %	0%						
2020	83.8 %	2.6 %	0.9 %	3.8 %	8.8 %	0%						

Table 4.3.2.2. River- and AU-specific probabilities in scenarios 1-10 to meet R_{lim} in year 2026 (AU 1-3) or 2025 (AU4). Current status refers to 2020 (last year with data). Colours mark probabilities lower than 50% (red), between 50 and 70% (yellow), between 70 and 95% (light green) and above 95% (dark green).

AU	River	Current status	Probability to meet R_{lim} Scenario 1	2	3	4	5	6	7	8	9	10
1	Tornionjoki	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Simojoki	0.99	0.99	0.97	0.97	0.95	0.93	0.88	0.97	0.96	0.95	0.94
	Kalixälven	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Råneälven	0.99	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00
2	Piteälven*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Åbyälven	0.88	0.98	0.97	0.96	0.95	0.93	0.91	0.96	0.96	0.95	0.95
	Byskeälven	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Kågeälven	0.78	0.92	0.92	0.90	0.87	0.83	0.80	0.91	0.90	0.88	0.86
	Rickleån	0.65	0.95	0.91	0.89	0.86	0.81	0.75	0.90	0.89	0.87	0.84
	Sävarån	0.89	0.97	0.95	0.94	0.92	0.89	0.85	0.94	0.94	0.93	0.91
	Vindelälven	0.97	1.00	0.99	0.99	0.99	0.98	0.96	0.99	0.99	0.99	0.98
	Öreälven	0.62	0.95	0.91	0.89	0.87	0.84	0.80	0.90	0.89	0.87	0.86
	Lögdeälven	0.40	0.81	0.75	0.72	0.67	0.62	0.55	0.73	0.72	0.69	0.66
3	Ljungan	0.38	0.54	0.54	0.52	0.49	0.46	0.42	0.53	0.51	0.51	0.49
	Testeboån*	0.99	0.99	0.99	0.98	0.98	0.97	0.96	0.99	0.98	0.98	0.98
4	Emån	0.28	0.54	0.54	0.51	0.49	0.46	0.43	0.54	0.54	0.54	0.54
	Mörrumsån	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.99	0.99	0.99	0.99
AU 1 total		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AU 2 total		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AU 3 total		0.86	0.89	0.89	0.89	0.87	0.85	0.83	0.89	0.89	0.88	0.87
AU 4 total		1.00	0.99	0.98	0.98	0.98	0.97	0.97	0.98	0.98	0.98	0.98

* Status uncertain and most likely overestimated, see Section 4.4.2 for additional information.

Table 4.3.2.3. River- and AU-specific probabilities in scenarios 1-10 to meet R_{lim} in year 2055 (AU 1-3) or 2050 (AU 4), i.e. approximately five salmon generations ahead from 2020. Current status refers to 2020 (last year with data). Colours mark probabilities lower than 50% (red), between 50 and 70% (yellow), between 70 and 95% (light green) and above 95% (dark green).

AU	River	Current status	Probability to meet R_{lim} Scenario 1	2	3	4	5	6	7	8	9	10
1	Tornionjoki	1.00	1.00	1.00	1.00	1.00	0.99	0.98	1.00	1.00	1.00	1.00
	Simojoki	0.99	0.99	0.96	0.91	0.85	0.75	0.57	0.94	0.92	0.89	0.85
	Kalixälven	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Råneälven	0.99	1.00	1.00	0.99	0.99	0.98	0.95	0.99	0.99	0.99	0.99
2	Piteälven*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Åbyälven	0.88	0.99	0.98	0.97	0.94	0.90	0.82	0.97	0.97	0.96	0.96
	Byskeälven	1.00	1.00	1.00	1.00	0.99	0.99	0.98	1.00	1.00	1.00	1.00
	Kågeälven	0.78	0.97	0.94	0.91	0.86	0.79	0.69	0.94	0.91	0.90	0.88
	Rickleån	0.65	0.99	0.98	0.96	0.93	0.88	0.79	0.98	0.97	0.96	0.95
	Sävarån	0.89	1.00	0.98	0.96	0.94	0.89	0.77	0.98	0.97	0.96	0.95
	Vindelälven	0.97	1.00	0.99	0.98	0.96	0.93	0.86	0.98	0.98	0.97	0.97
	Öreälven	0.62	1.00	0.99	0.99	0.98	0.96	0.92	0.99	0.99	0.98	0.98
	Lögdeälven	0.40	0.99	0.97	0.95	0.91	0.84	0.72	0.96	0.96	0.95	0.93
3	Ljungan	0.38	0.86	0.78	0.71	0.62	0.52	0.41	0.76	0.74	0.71	0.67
	Testeboån*	0.99	0.99	0.98	0.97	0.95	0.92	0.87	0.98	0.98	0.97	0.96
4	Emån	0.28	0.89	0.82	0.78	0.72	0.64	0.54	0.82	0.82	0.82	0.82
	Mörrumsån	1.00	0.99	0.98	0.97	0.96	0.95	0.92	0.98	0.98	0.98	0.98
AU 1 total		1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00
AU 2 total		1.00	1.00	1.00	0.99	0.99	0.97	0.95	1.00	0.99	0.99	0.99
AU 3 total		0.86	0.97	0.94	0.92	0.88	0.82	0.74	0.94	0.93	0.91	0.90
AU 4 total		1.00	0.99	0.98	0.96	0.95	0.93	0.91	0.98	0.98	0.98	0.98

* Status uncertain and most likely overestimated, see Section 4.4.2 for additional information.

Table 4.3.2.4. River- and AU-specific probabilities in scenarios 1-10 to meet R_{msy} in year 2026 (AU 1-3) or 2025 (AU 4). Current status refers to 2020 (last year with data). Colours mark probabilities lower than 50% (red), between 50 and 70% (yellow) and between 70 and 95% (light green).

AU	River	Current status	Probability to meet R_{MSY} Scenario 1	2	3	4	5	6	7	8	9	10
1	Tornionjoki	0.79	0.86	0.81	0.78	0.73	0.69	0.62	0.79	0.77	0.74	0.71
	Simojoki	0.80	0.83	0.74	0.68	0.59	0.50	0.39	0.71	0.66	0.60	0.54
	Kalixälven	0.68	0.81	0.80	0.77	0.75	0.71	0.66	0.78	0.77	0.75	0.73
	Råneälven	0.60	0.83	0.77	0.73	0.68	0.61	0.53	0.75	0.72	0.69	0.64
2	Piteälven*	0.77	0.76	0.74	0.73	0.71	0.70	0.68	0.74	0.73	0.72	0.71
	Åbyälven	0.44	0.73	0.65	0.62	0.57	0.52	0.45	0.64	0.61	0.59	0.56
	Byskeälven	0.74	0.83	0.80	0.79	0.76	0.72	0.67	0.79	0.78	0.77	0.75
	Kågeälven	0.28	0.62	0.62	0.58	0.52	0.46	0.38	0.60	0.58	0.54	0.51
	Rickleån	0.09	0.48	0.37	0.32	0.27	0.22	0.16	0.35	0.32	0.29	0.26
	Sävarån	0.37	0.68	0.58	0.53	0.48	0.41	0.33	0.56	0.52	0.49	0.45
	Vindelälven	0.19	0.77	0.67	0.63	0.57	0.49	0.40	0.65	0.62	0.59	0.55
	Öreälven	0.17	0.50	0.41	0.38	0.32	0.27	0.23	0.39	0.37	0.33	0.30
	Lögdeälven	0.09	0.36	0.27	0.24	0.20	0.17	0.13	0.26	0.23	0.21	0.19
3	Ljungan	0.21	0.38	0.38	0.35	0.32	0.28	0.24	0.36	0.35	0.33	0.31
	Testeboån*	0.75	0.80	0.80	0.78	0.76	0.72	0.66	0.80	0.78	0.77	0.75
4	Emån	0.09	0.28	0.28	0.26	0.24	0.22	0.20	0.28	0.28	0.28	0.28
	Mörrumsån	0.76	0.81	0.75	0.74	0.72	0.70	0.68	0.75	0.75	0.75	0.75
AU 1 total		0.82	0.90	0.86	0.84	0.80	0.75	0.67	0.85	0.83	0.81	0.77
AU 2 total		0.16	0.75	0.64	0.58	0.50	0.42	0.33	0.61	0.57	0.53	0.48
AU 3 total		0.41	0.54	0.54	0.52	0.48	0.44	0.39	0.53	0.52	0.50	0.48
AU 4 total		0.55	0.67	0.61	0.59	0.57	0.54	0.52	0.61	0.61	0.61	0.61

* Status uncertain and most likely overestimated, see Section 4.4.2 for additional information.

Table 4.3.2.5. River- and AU-specific probabilities in scenarios 1-10 to meet R_{msy} in year 2055 (AU 1-3) or 2050 (AU 4), i.e. approximately five salmon generations ahead from 2020. Current status refers to 2020 (last year with data). Colours mark probabilities lower than 50% (red), between 50 and 70% (yellow) and between 70 and 95% (light green).

AU	River	Current status	Probability to meet R_{MSY} Scenario 1	2	3	4	5	6	7	8	9	10
1	Tornionjoki	0.79	0.86	0.83	0.79	0.74	0.66	0.54	0.82	0.79	0.77	0.73
	Simojoki	0.80	0.88	0.79	0.70	0.58	0.42	0.26	0.76	0.70	0.65	0.58
	Kalixälven	0.68	0.84	0.81	0.79	0.74	0.69	0.62	0.80	0.79	0.77	0.75
	Råneälven	0.60	0.88	0.84	0.80	0.73	0.64	0.51	0.82	0.80	0.76	0.73
2	Piteälven*	0.77	0.78	0.77	0.75	0.73	0.70	0.66	0.76	0.76	0.75	0.74
	Åbyälven	0.44	0.88	0.82	0.76	0.69	0.59	0.47	0.80	0.78	0.75	0.72
	Byskeälven	0.74	0.84	0.81	0.78	0.74	0.69	0.61	0.80	0.78	0.77	0.75
	Kågeälven	0.28	0.86	0.79	0.71	0.63	0.52	0.39	0.77	0.73	0.70	0.66
	Rickleån	0.09	0.89	0.81	0.75	0.66	0.55	0.40	0.79	0.77	0.73	0.69
	Sävarån	0.37	0.89	0.82	0.74	0.66	0.54	0.39	0.79	0.76	0.73	0.69
	Vindelälven	0.19	0.89	0.84	0.79	0.71	0.60	0.44	0.83	0.80	0.77	0.74
	Öreälven	0.17	0.91	0.86	0.82	0.74	0.64	0.50	0.84	0.83	0.81	0.77
	Lögdeälven	0.09	0.88	0.80	0.73	0.64	0.51	0.37	0.77	0.74	0.71	0.68
3	Ljungan	0.21	0.76	0.65	0.56	0.45	0.36	0.24	0.63	0.60	0.56	0.51
	Testeboån*	0.75	0.88	0.82	0.78	0.71	0.64	0.54	0.80	0.79	0.78	0.75
4	Emån	0.09	0.80	0.69	0.62	0.54	0.46	0.38	0.69	0.69	0.69	0.69
	Mörrumsån	0.76	0.83	0.78	0.76	0.73	0.69	0.64	0.78	0.78	0.78	0.78
AU 1 total		0.82	0.92	0.88	0.84	0.79	0.70	0.58	0.87	0.85	0.82	0.79
AU 2 total		0.16	0.94	0.89	0.84	0.75	0.64	0.49	0.87	0.85	0.83	0.78
AU 3 total		0.41	0.83	0.74	0.67	0.57	0.47	0.35	0.72	0.70	0.66	0.63
AU 4 total		0.55	0.87	0.78	0.74	0.70	0.62	0.55	0.78	0.78	0.78	0.78

* Status uncertain and most likely overestimated, see Section 4.4.2 for additional information.

Table 4.3.2.6. Proportion of river stocks above R_{lim} in year 2025/2026 (AU4/AU 1–3) and in 2050/2055 (approx. five salmon generations ahead from 2020, last year with data) for scenarios 1–10, as determined using different probability limits (Plim). Current situation refer to 2020 smolt production. Number of stocks with analytical assessment is 17.

	Current situation	Future	Scenario									
Plim	(2020)	(years)	1	2	3	4	5	6	7	8	9	10
0.50	82%	2025/2026	100%	100%	100%	88%	88%	88%	100%	100%	100%	94%
		2050/2055	100%	100%	100%	100%	100%	94%	100%	100%	100%	100%
0.70	71%	2025/2026	88%	88%	88%	82%	82%	82%	88%	88%	82%	82%
		2050/2055	100%	100%	100%	94%	88%	76%	100%	100%	100%	94%
0.90	53%	2025/2026	82%	82%	71%	65%	59%	53%	76%	65%	65%	65%
		2050/2055	88%	88%	88%	76%	59%	41%	88%	88%	76%	76%
0.95	53%	2025/2026	65%	59%	59%	53%	47%	47%	59%	59%	59%	47%
		2050/2055	88%	82%	71%	53%	35%	24%	76%	76%	71%	65%

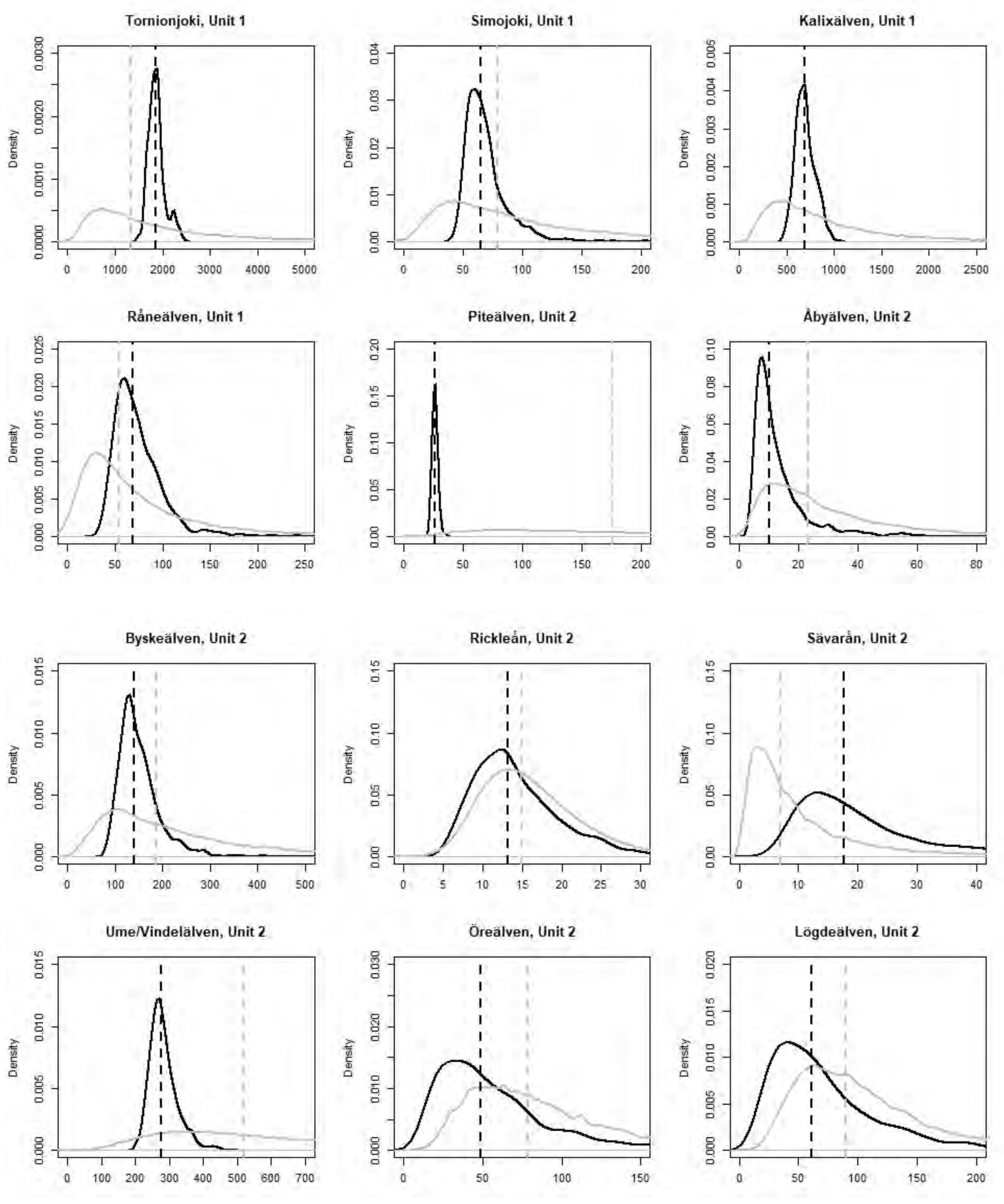


Figure 4.2.1.1a. Prior (grey line) and posterior (black line) distributions for K (maximum recruitment). Dashed vertical lines indicate prior medians (grey) and posterior medians (black).

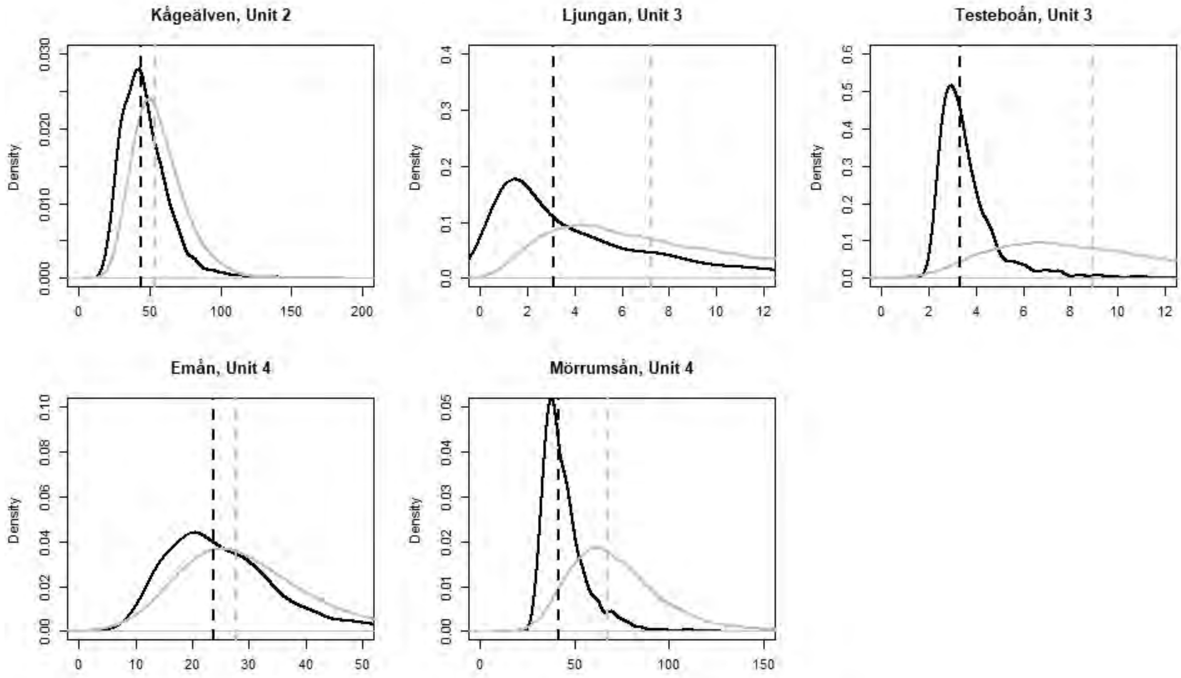


Figure 4.2.1.1b. Prior (grey line) and posterior (black line) distributions for K (maximum recruitment). Dashed vertical lines indicate prior medians (grey) and posterior medians (black).

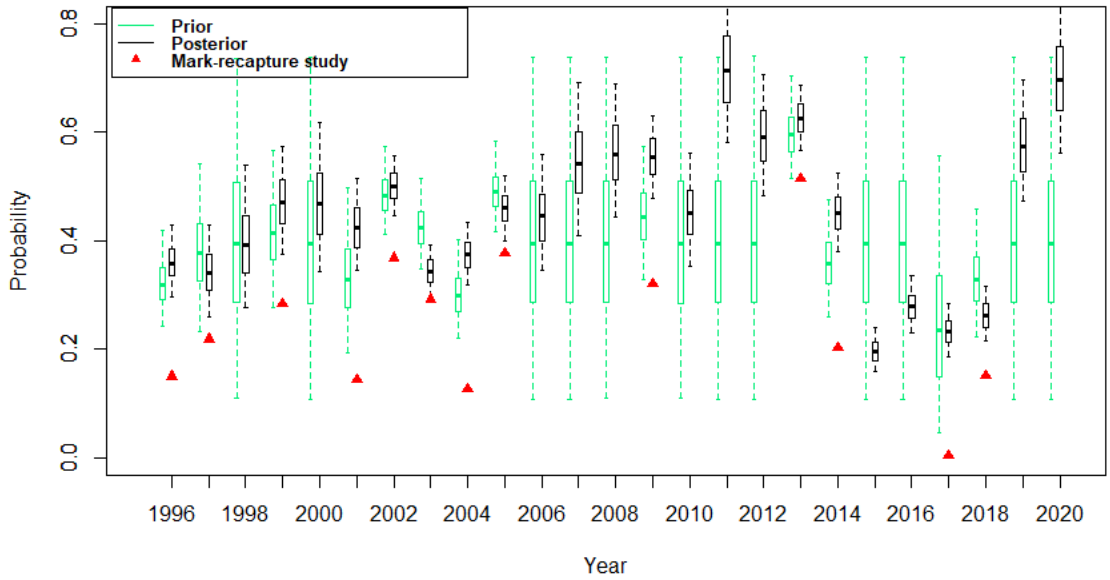


Figure 4.2.1.2.

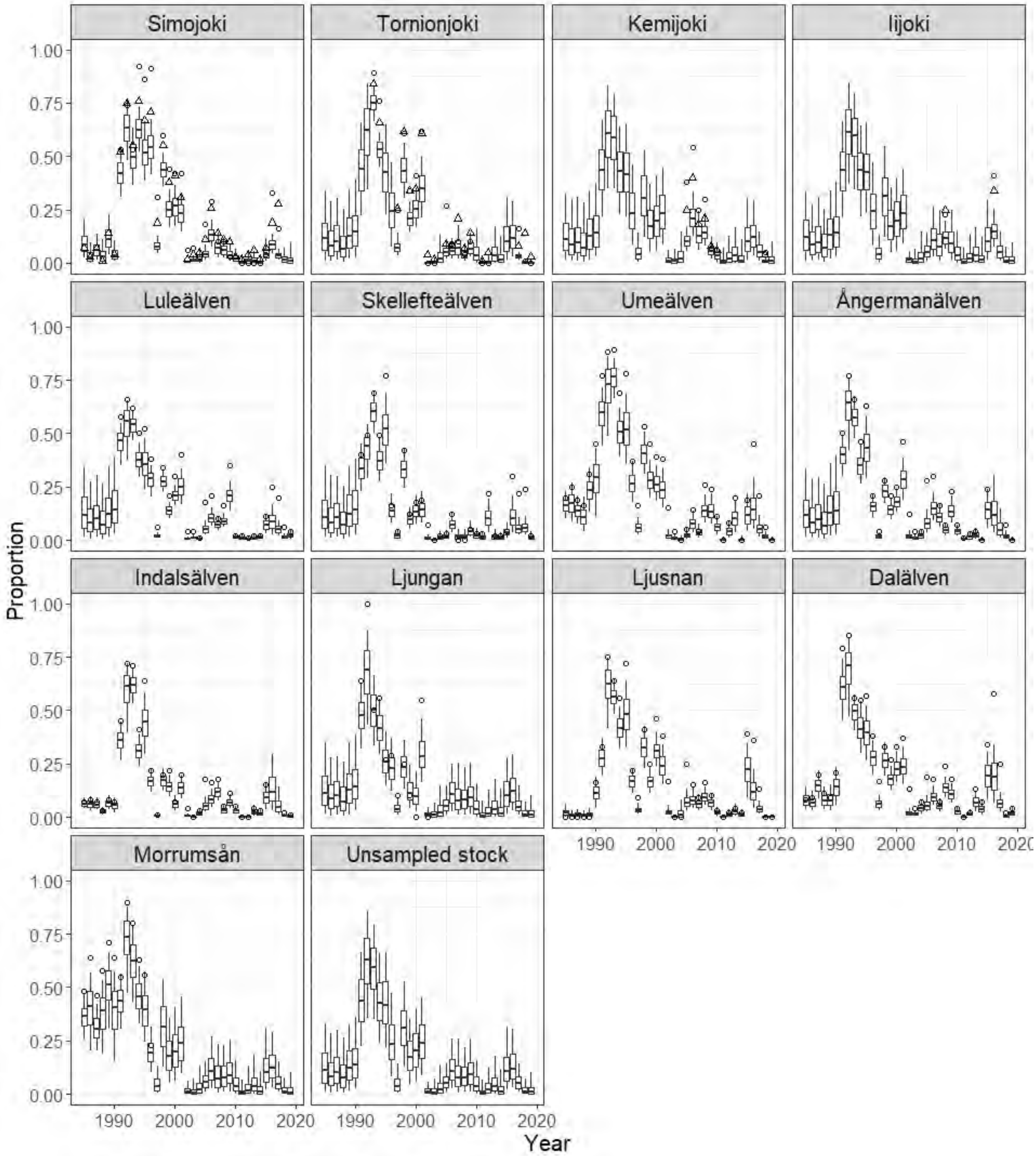


Figure 4.2.2.1. M74 mortality among Atlantic salmon stocks within the Baltic Sea by spawning year class in 1985–2019. Boxplots illustrate medians, 50% and 95% probability intervals of the estimated M74 mortality. Open circles illustrate the proportion of females with offspring affected by M74 and triangles the total average yolk-sac-fry mortality among offspring.

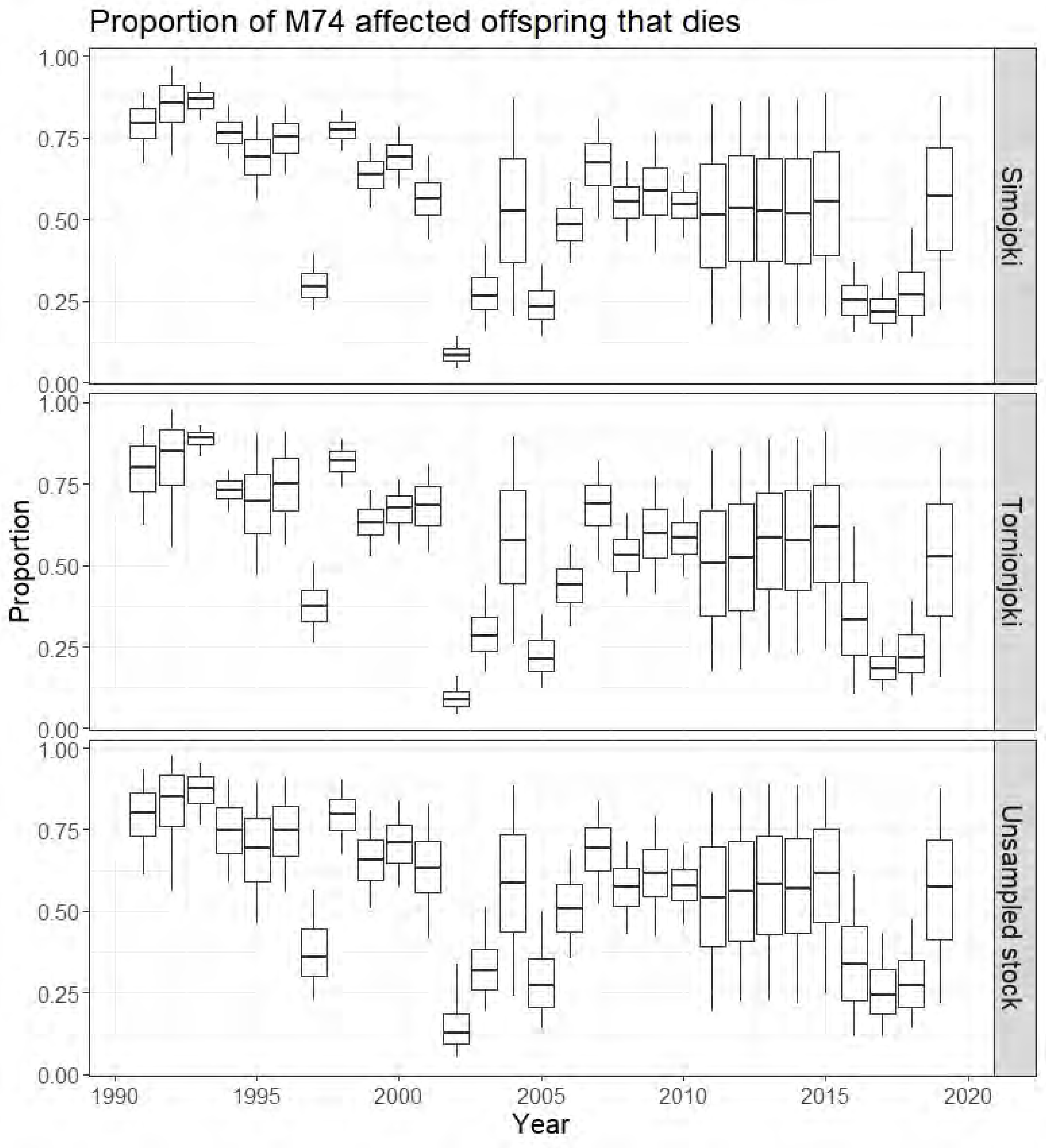


Figure 4.2.2.3. Estimated proportion of M74-affected offspring that die (i.e. mortality among those offspring that are from M74 affected females) by spawning year class in 1985–2019. Boxplots illustrate medians and 50% and 95% probability intervals.

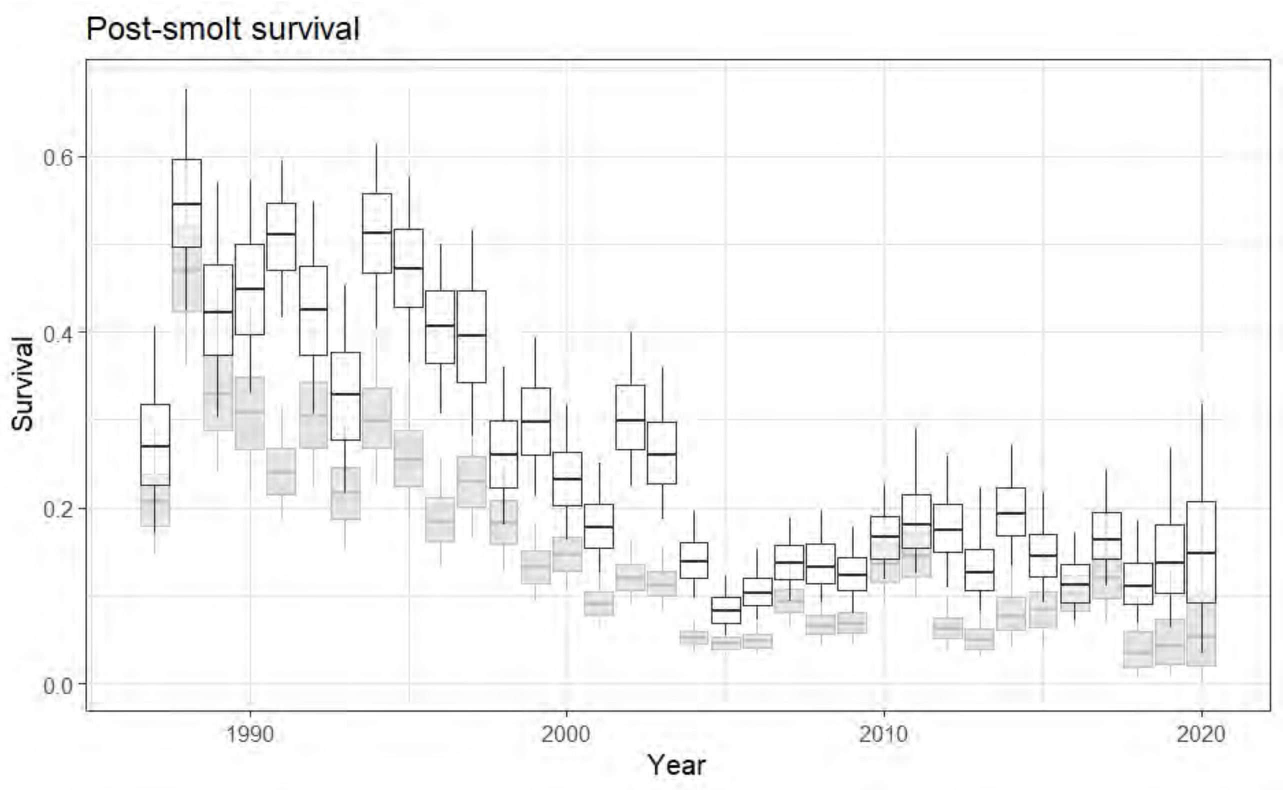


Figure 4.2.3.1. Post-smolt survival for wild (black) and hatchery-reared salmon (grey). Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

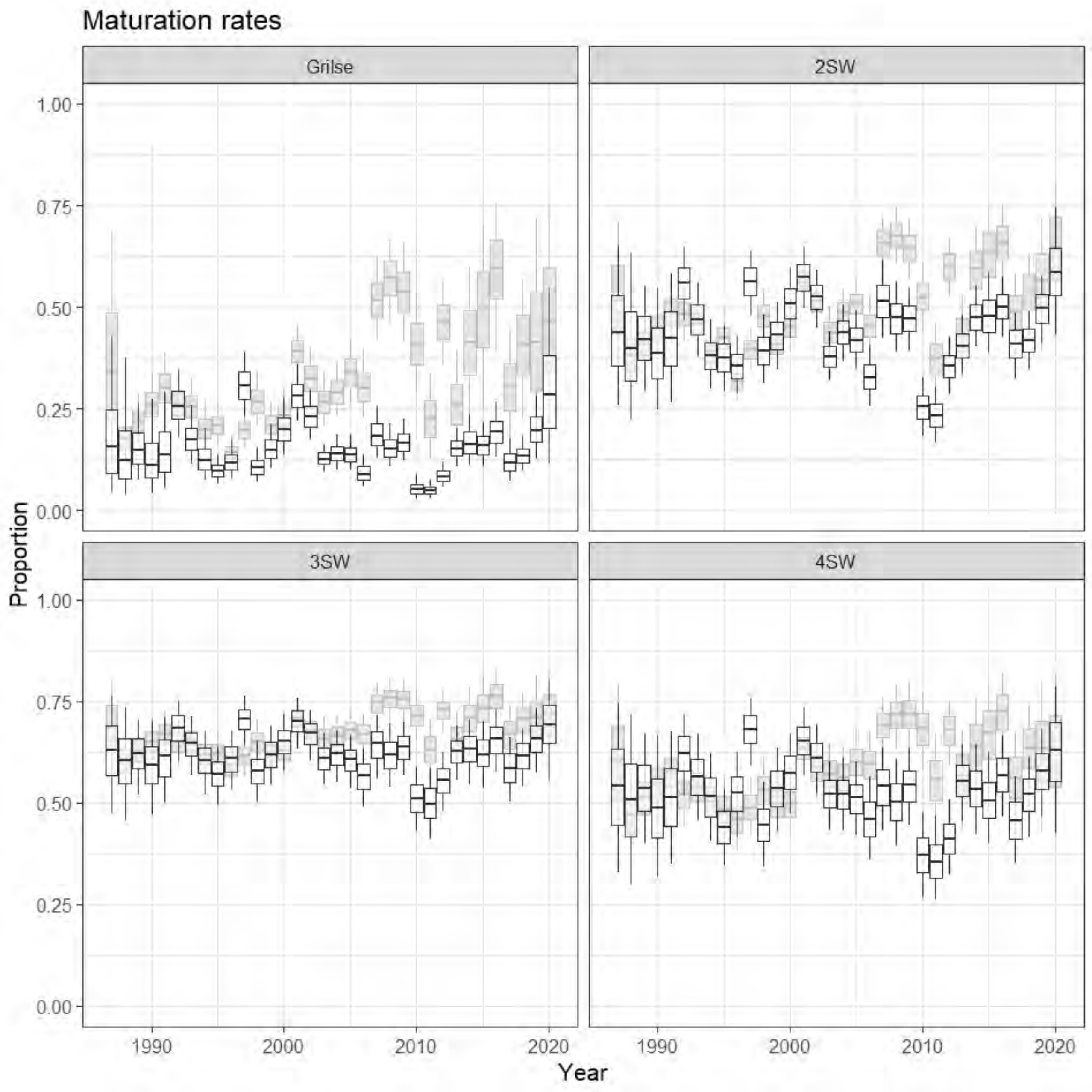


Figure 4.2.3.2. Proportion maturing per age group and per year for wild (black) and reared salmon (grey). Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

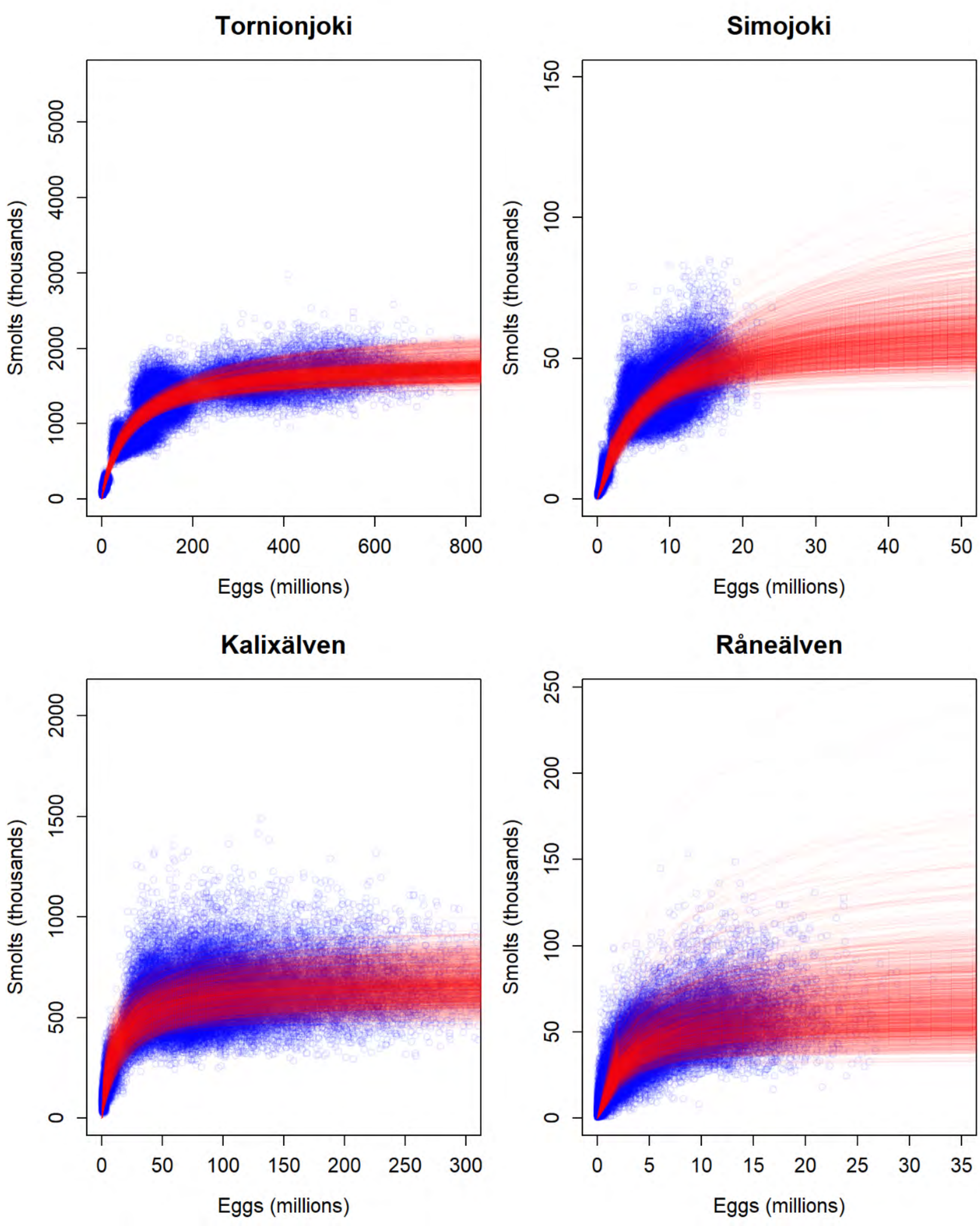


Figure 4.2.3.3a. Distributions for egg abundance (million), plotted against the smolt abundance (thousand) for stocks of assessment units 1–4. Blue dots present the posterior distributions of annual smolt and egg abundances, red curves indicate the distributions of stock–recruit relationship.

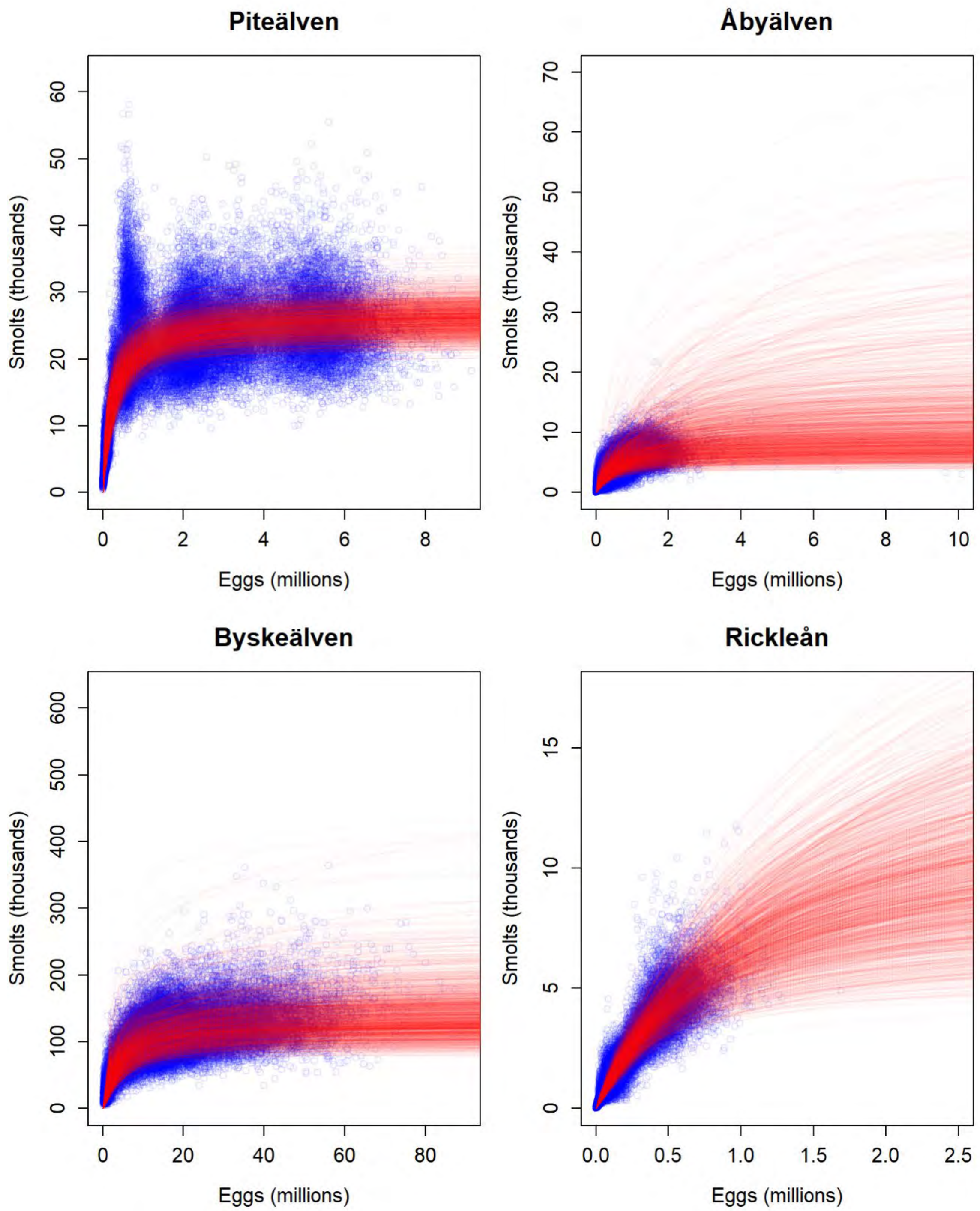


Figure 4.2.3.3b. Distributions for egg abundance (million), plotted against the smolt abundance (thousand) for stocks of assessment units 1–4. Blue dots present the posterior distributions of annual smolt and egg abundances, red curves indicate the distributions of stock–recruit relationship.

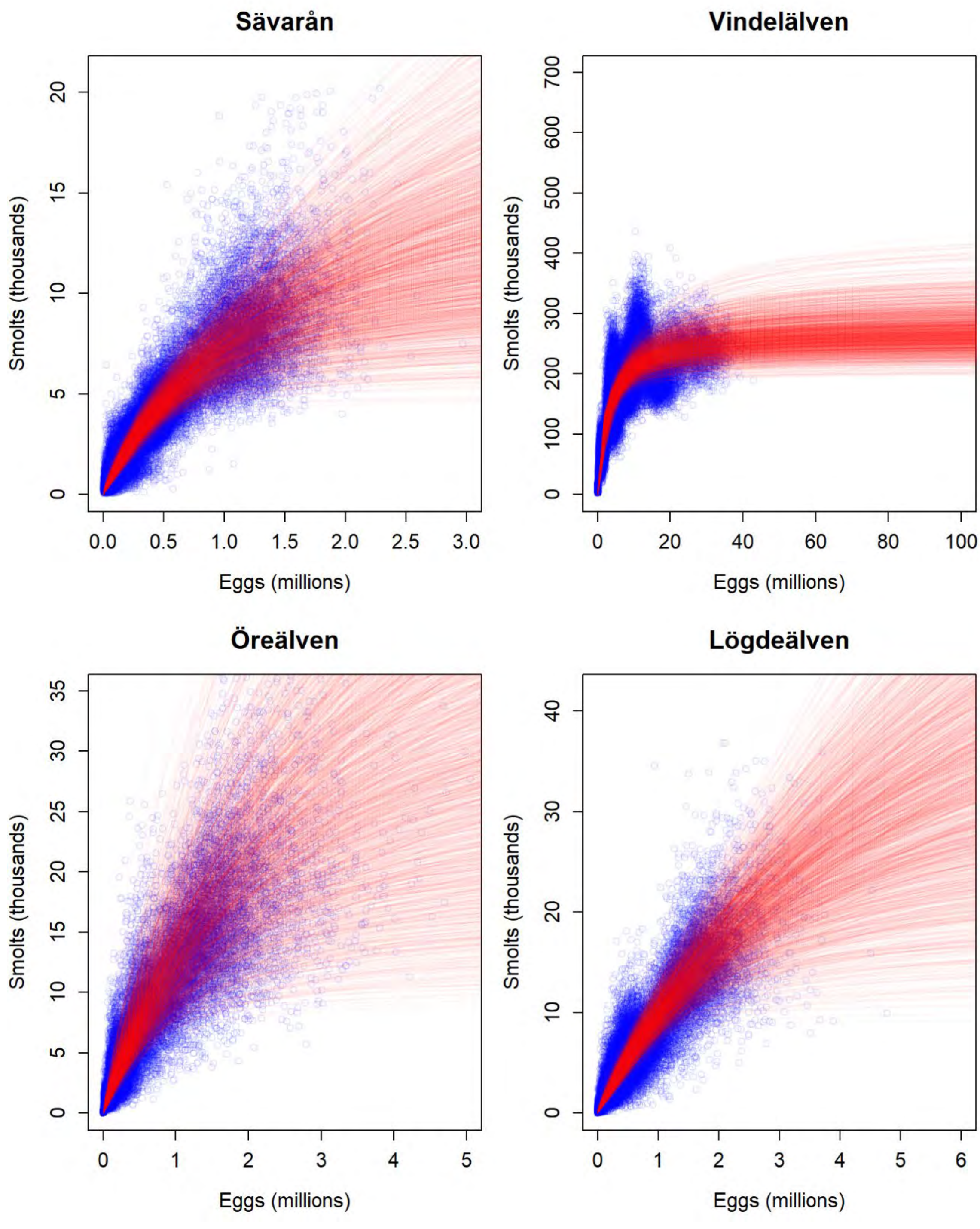


Figure 4.2.3.3c. Distributions for egg abundance (million), plotted against the smolt abundance (thousand) for stocks of assessment units 1–4. Blue dots present the posterior distributions of annual smolt and egg abundances, red curves indicate the distributions of stock–recruit relationship.

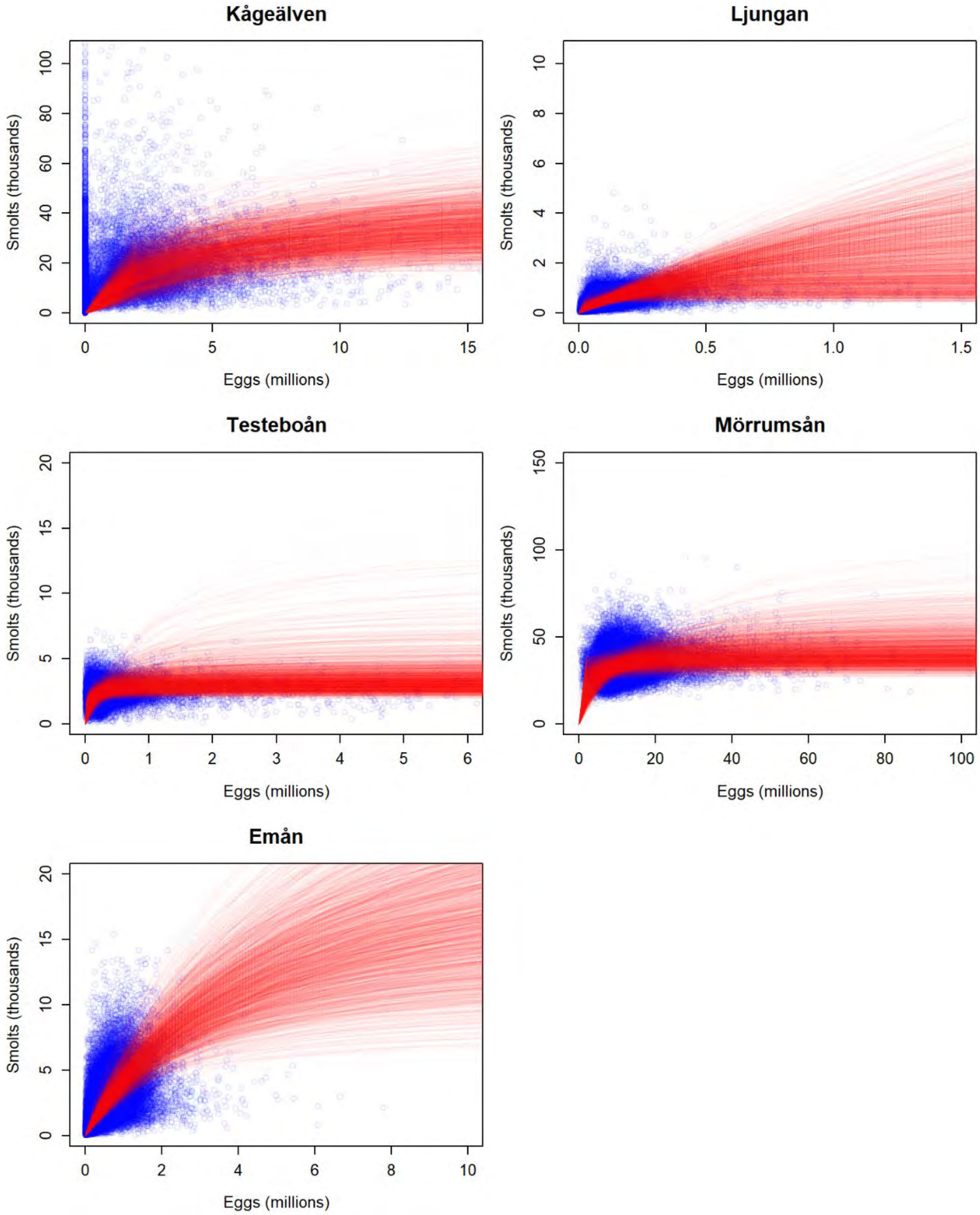


Figure 4.2.3.3d. Distributions for egg abundance (million), plotted against the smolt abundance (thousand) for stocks of assessment units 1–4. Blue dots present the posterior distributions of annual smolt and egg abundances, red curves indicate the distributions of stock–recruit relationship.

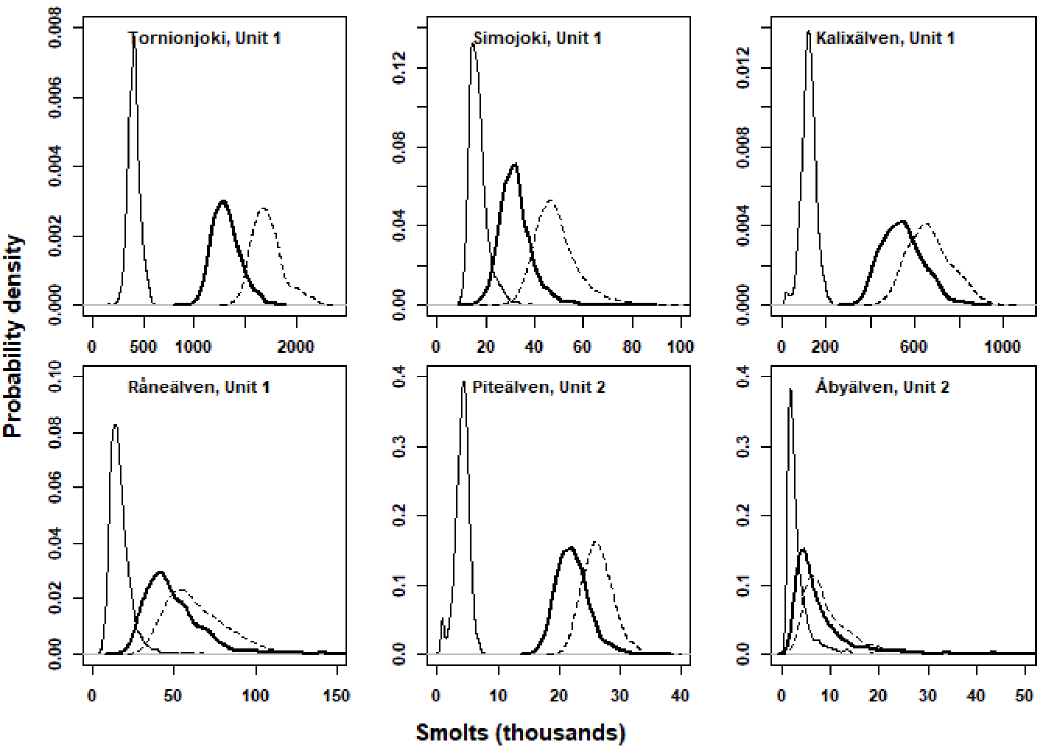


Figure 4.2.3.4a. Probability distributions for smolt production corresponding to maximum sustainable yield, MSY (thick black line), limit smolt production (recovery to the MSY level in one generation time, thin black line) and smolt production at the unfished demographic equilibrium (R_0), dashed black line.

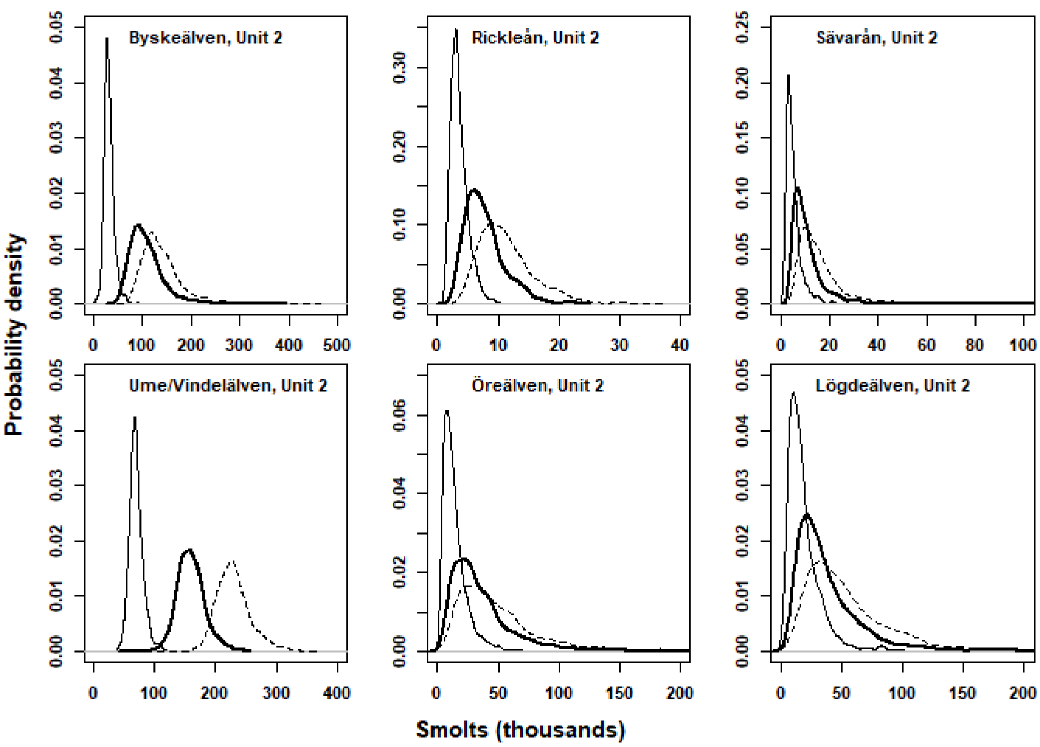


Figure 4.2.3.4b. Probability distributions for smolt production corresponding to maximum sustainable yield, MSY (thick black line), limit smolt production (recovery to the MSY level in one generation time, thin black line) and smolt production at the unfished demographic equilibrium (R_0), dashed black line.

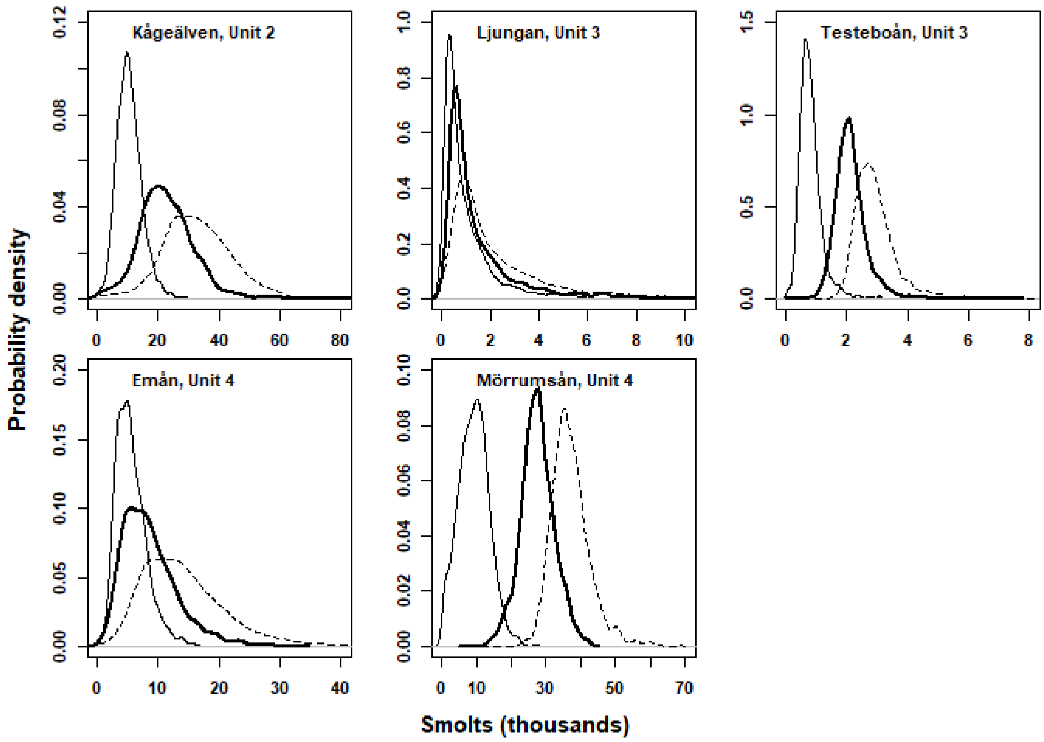


Figure 4.2.3.4c. Probability distributions for smolt production corresponding to maximum sustainable yield, MSY (thick black line), limit smolt production (recovery to the MSY level in one generation time, thin black line) and smolt production at the unfished demographic equilibrium (R_0), dashed black line.

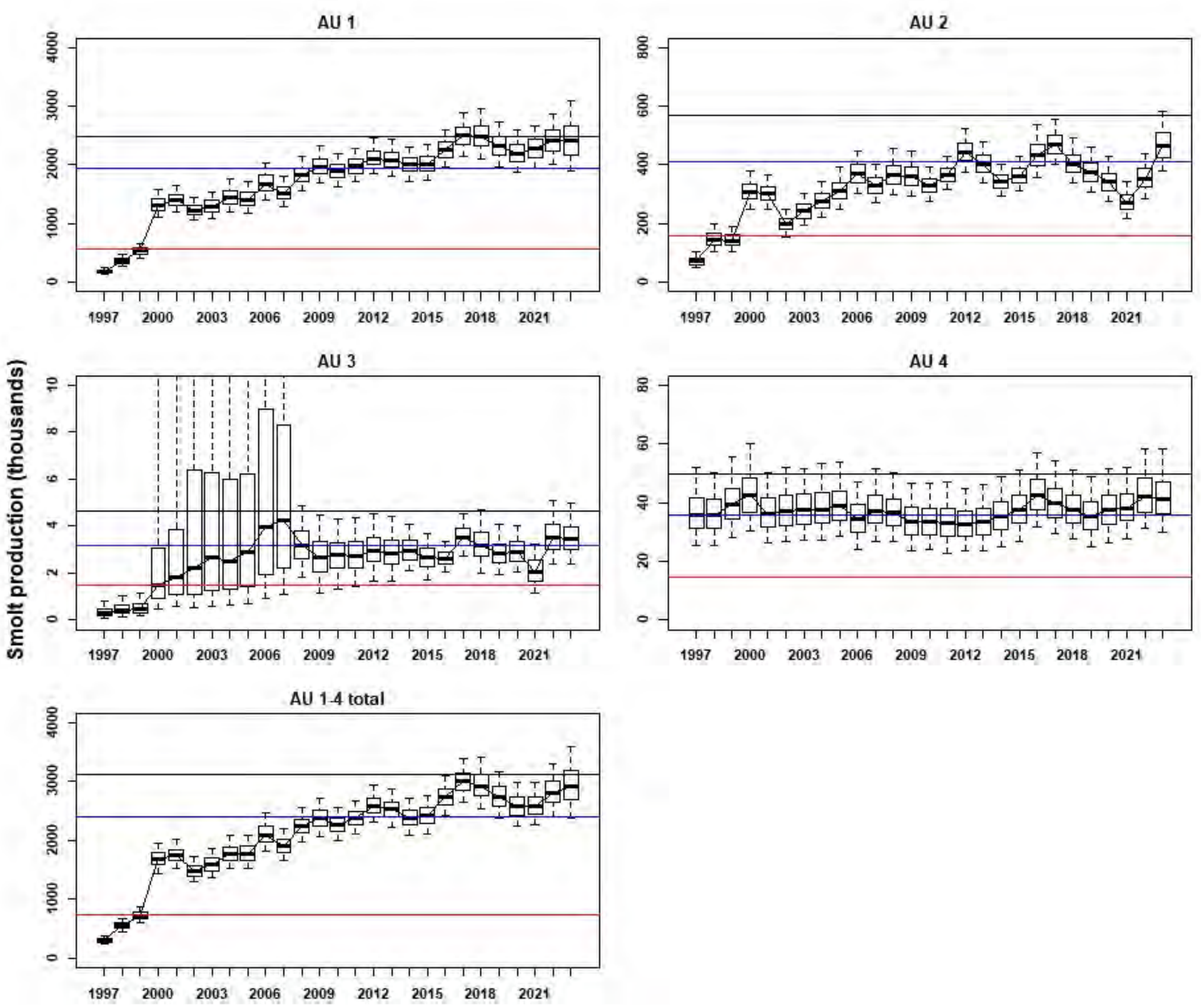


Figure 4.2.3.5. Posterior probability distributions for the total smolt production in assessment units (AU) 1 to 4 and all units combined. Horizontal lines within each box show the median (solid line); whiskers denote the 90% PI for smolt production. Solid horizontal lines denote the posterior median for the unit-specific R_0 (black line), R_{MSY} (blue line) and R_{lim} (red line).

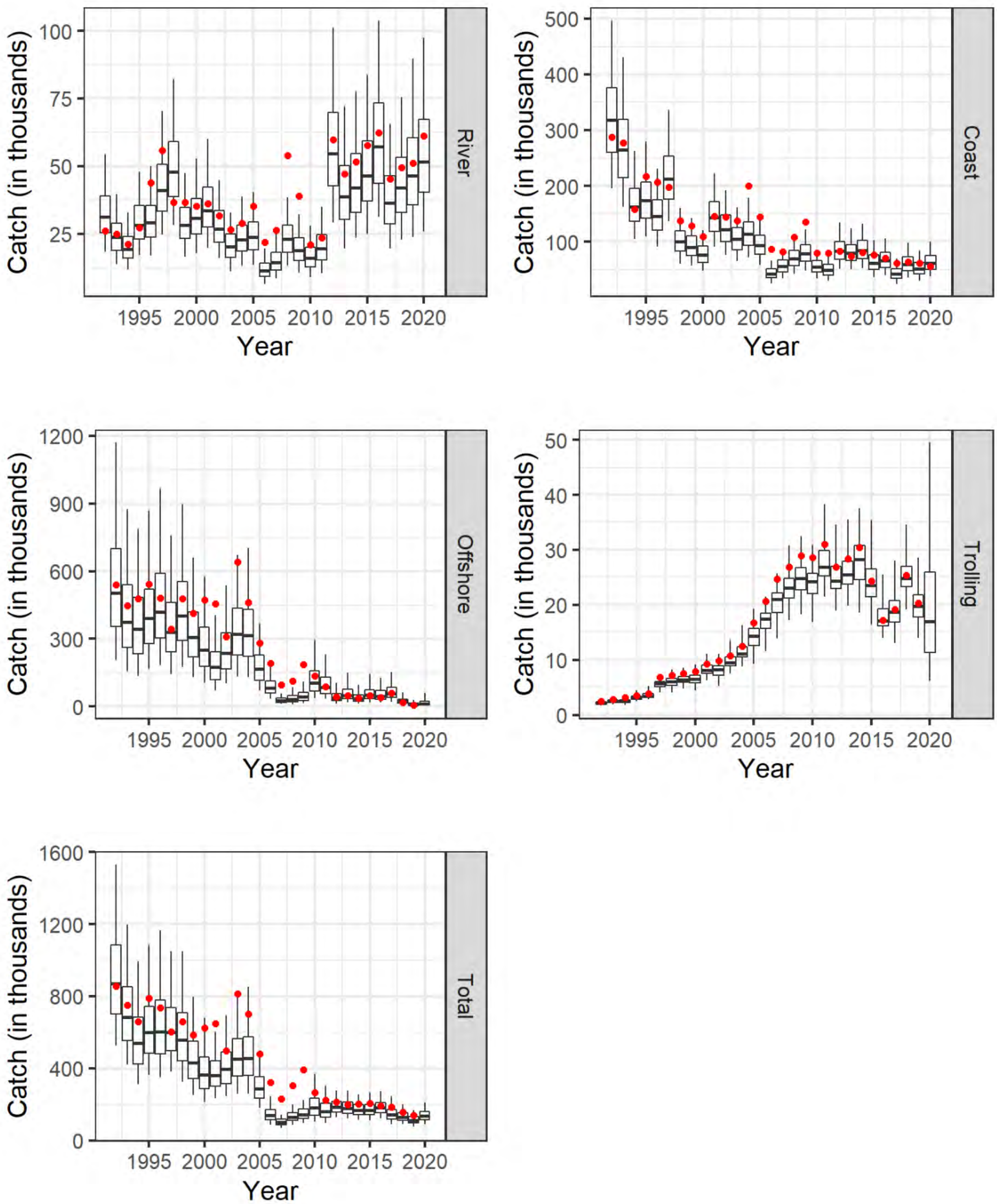


Figure 4.2.3.6. Estimated posterior distributions of catches compared with corresponding observed catches (boxplots with medians, 5%, 25%, 75% and 95% quantiles). Offshore catches cover both commercial fisheries and recreational trolling. Observed catches have been recalculated to account for unreporting.

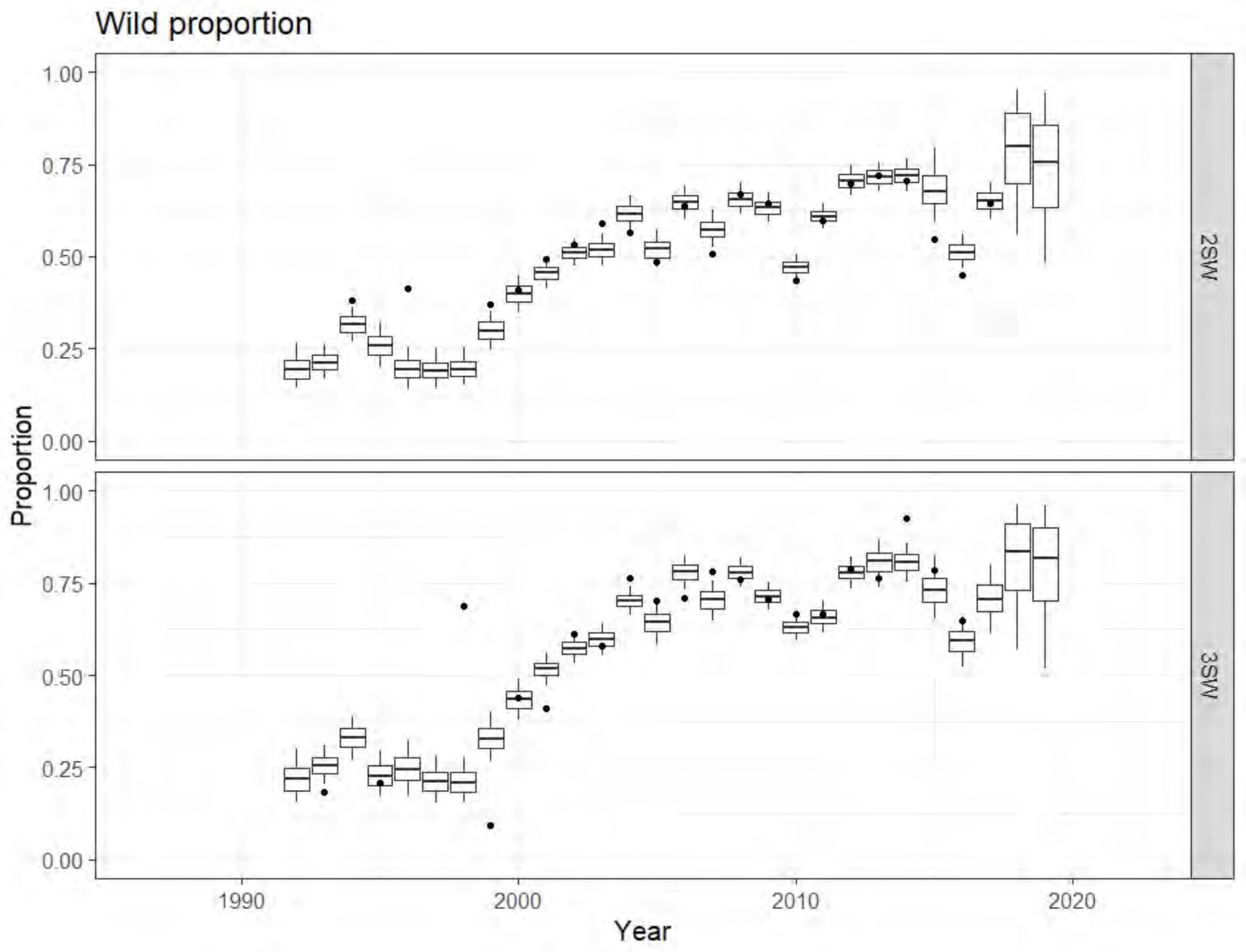


Figure 4.2.3.7. Estimated proportions of wild salmon in offshore catches in comparison to wild proportions observed in catch samples among 2SW and 3SW salmon. Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

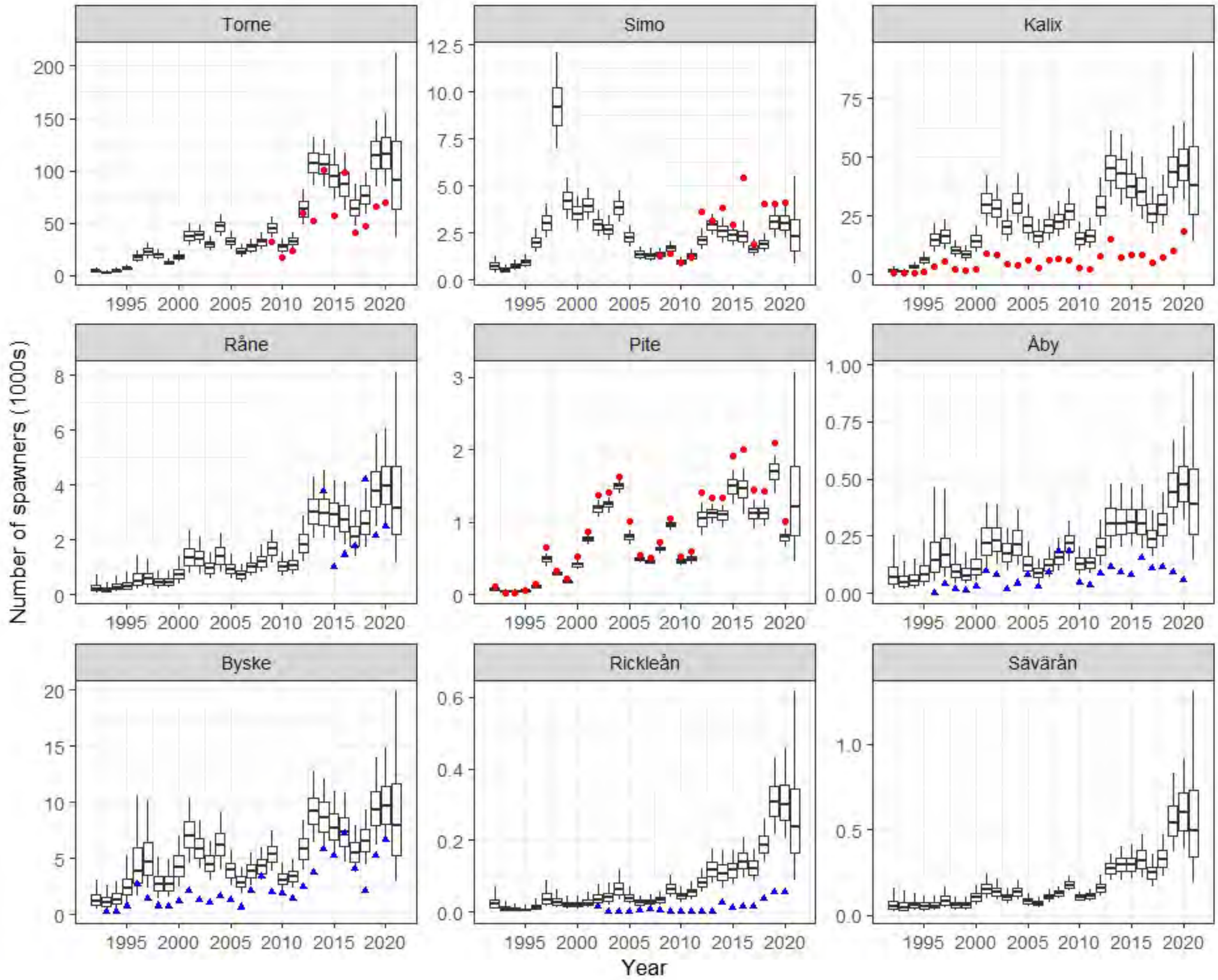


Figure 4.2.3.8a. Estimated posterior distributions of the number of spawners (in thousands) in each river versus numbers observed in fish counters. Observations indicated with dots are used as an input in the full life-history model whereas the ones indicated with triangles are so far not used as an input. Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

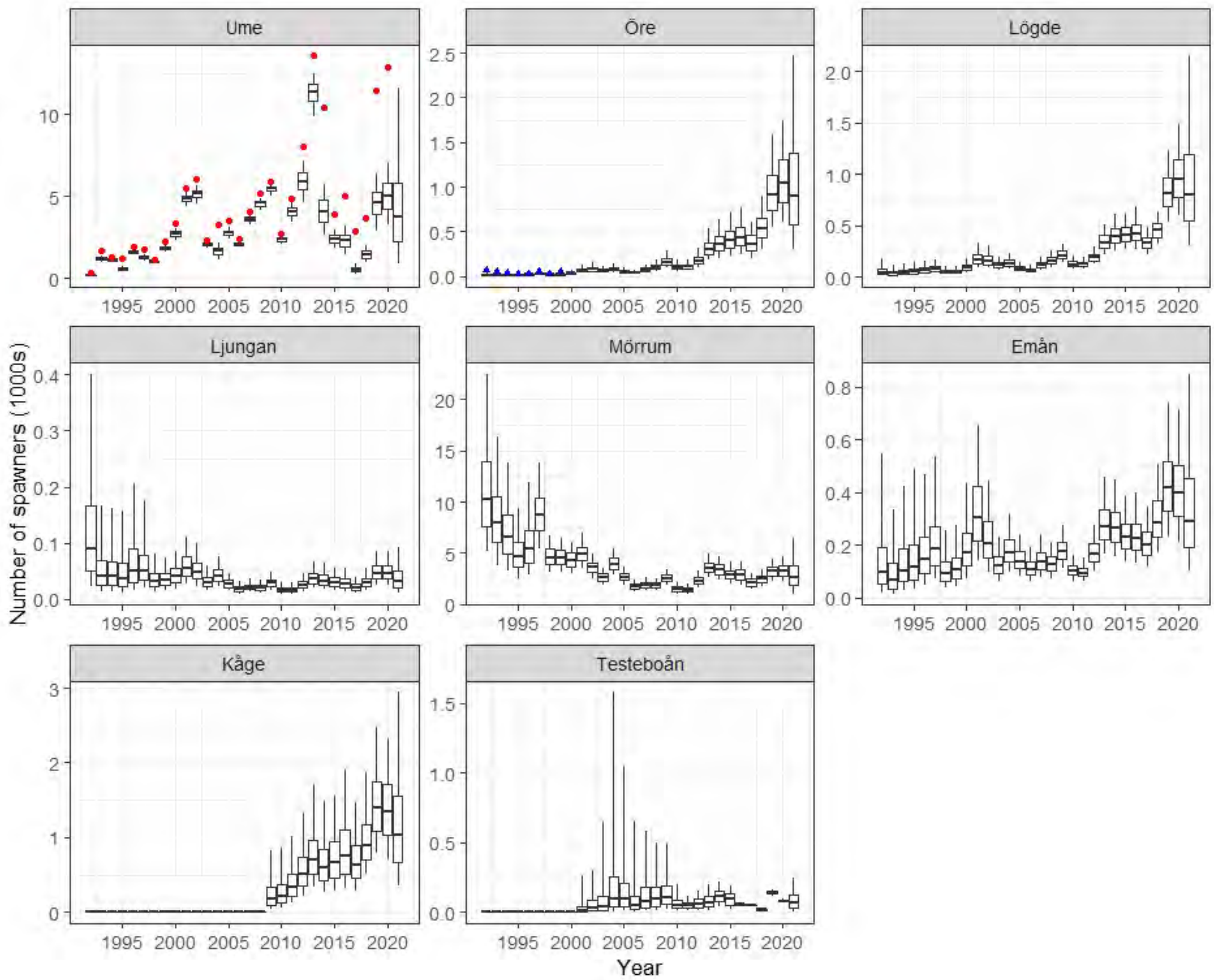


Figure 4.2.3.8b. Estimated posterior distributions of the number of spawners (in thousands) in each river versus numbers observed in fish counters. Observations indicated with dots are used as an input in the full life-history model whereas the ones indicated with triangles are so far not used as an input. Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

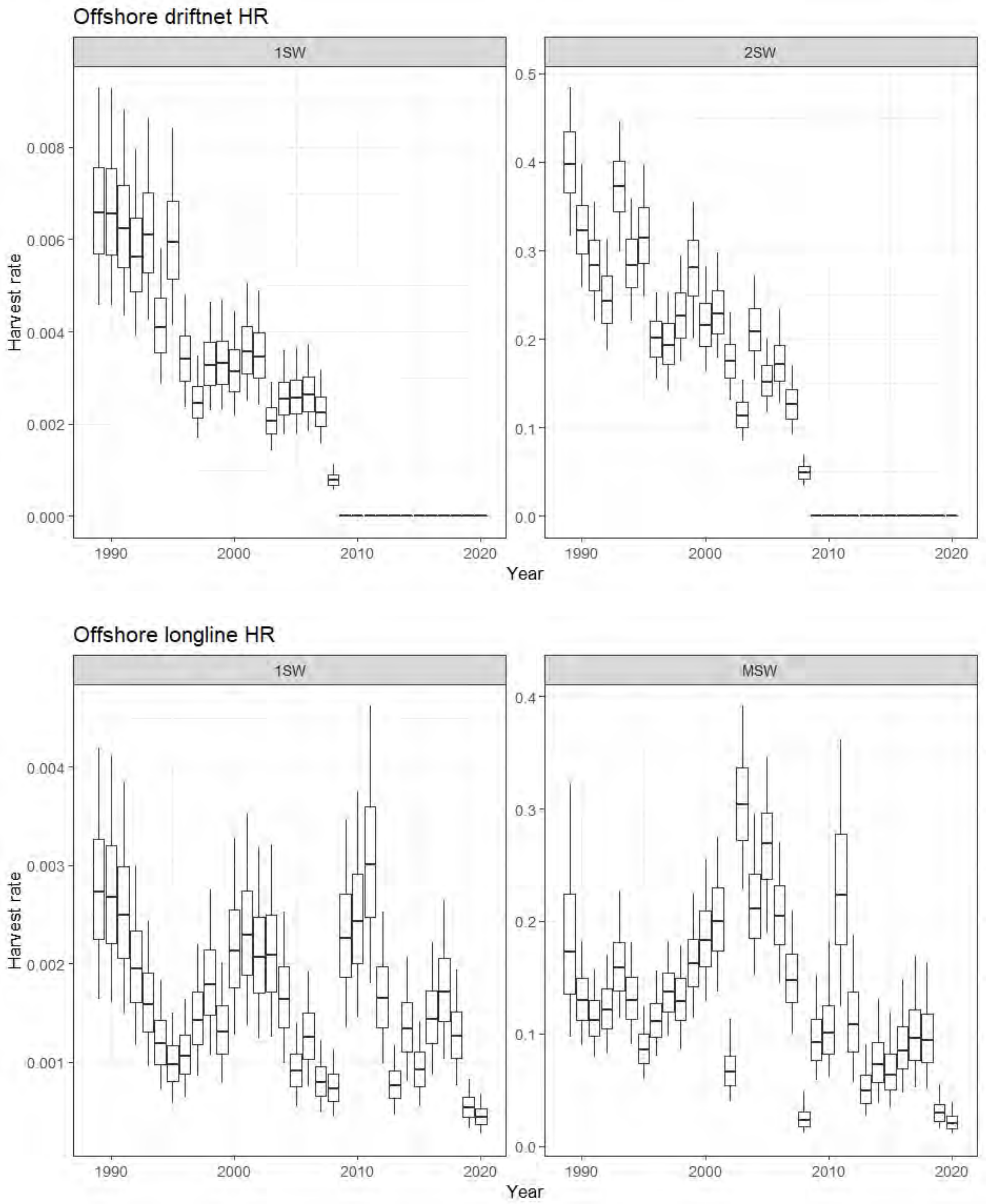


Figure 4.2.3.9a. Estimated posterior distributions of the harvest rates (harvested proportion of the available population) in offshore driftnet fishery for one-sea-winter and two-sea-winter salmon and in offshore longline fishery for one-sea-winter and multi-sea-winter salmon. Note that the driftnet harvest rate in 2008 is not zero, since due to computational reasons it contains fishing effort from the second half of year 2007. Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

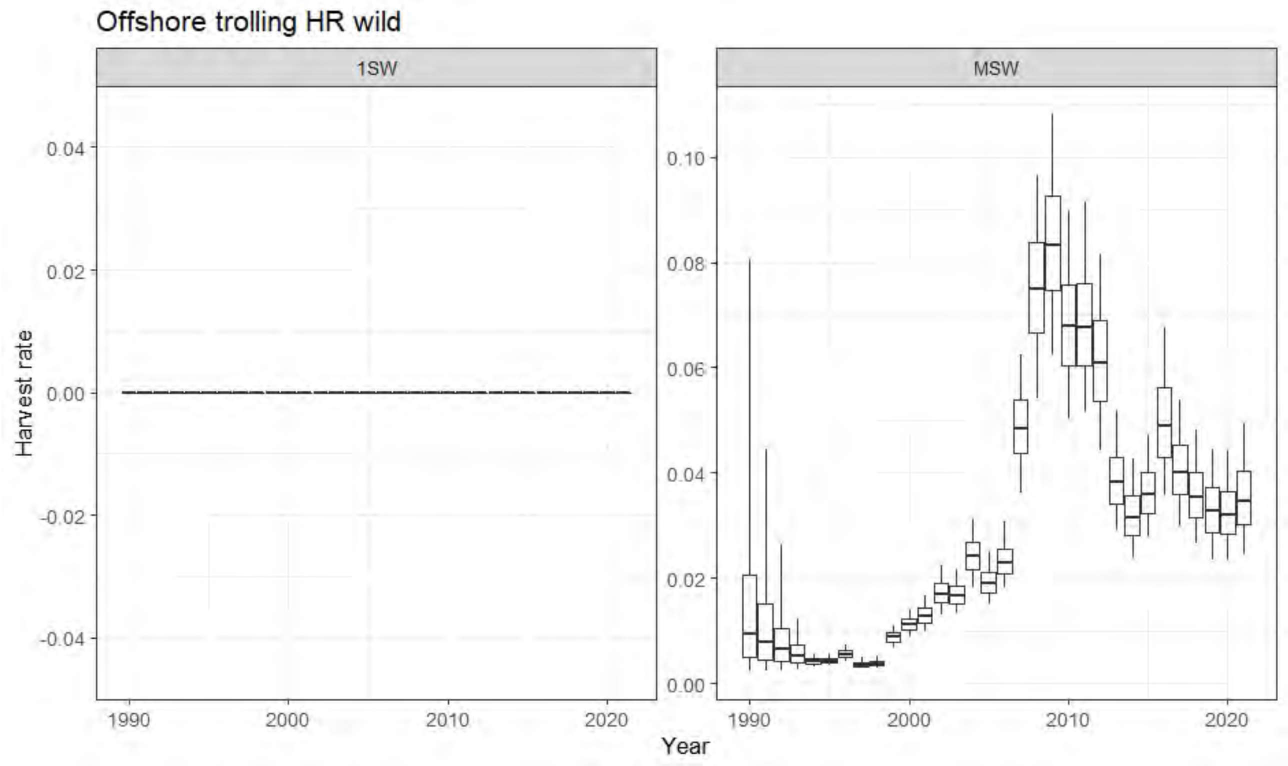


Figure 4.2.3.9b. Estimated posterior distributions of the harvest rates (harvested proportion of the available population) in offshore recreational trolling fishery separately for one-sea-winter and multi-sea-winter salmon. Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

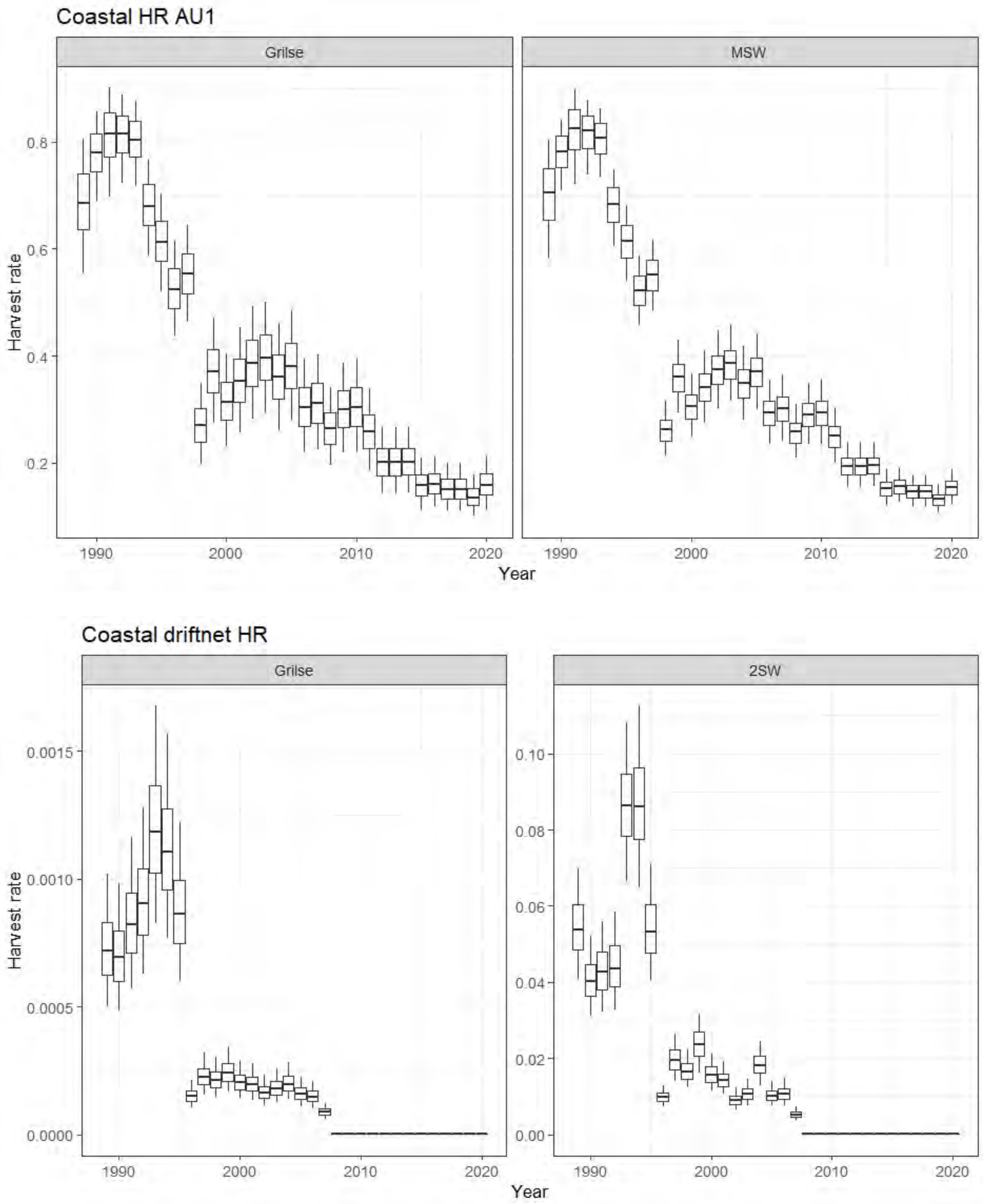


Figure 4.2.3.9c. Estimated posterior distributions of the harvest rates (harvested proportion of the available population) in other coastal fisheries than driftnetting in AU 1) separately for one-sea-winter and multi-sea-winter salmon and in coastal driftnetting (all AUs together) separately for one-sea-winter and two-sea-winter salmon. Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

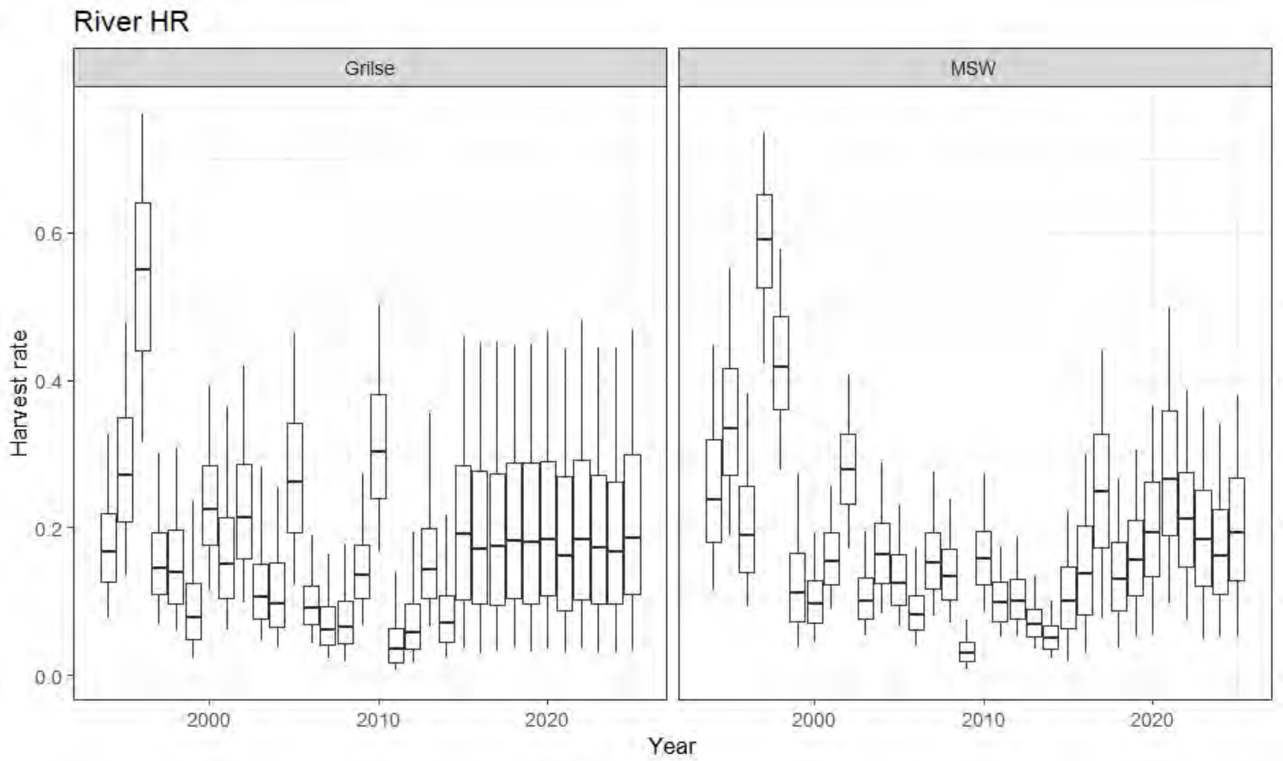


Figure 4.2.3.9d. Estimated posterior distributions of the harvest rates (harvested proportion of the available population) in the river fishery separately for one-sea-winter and multi-sea-winter salmon. Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

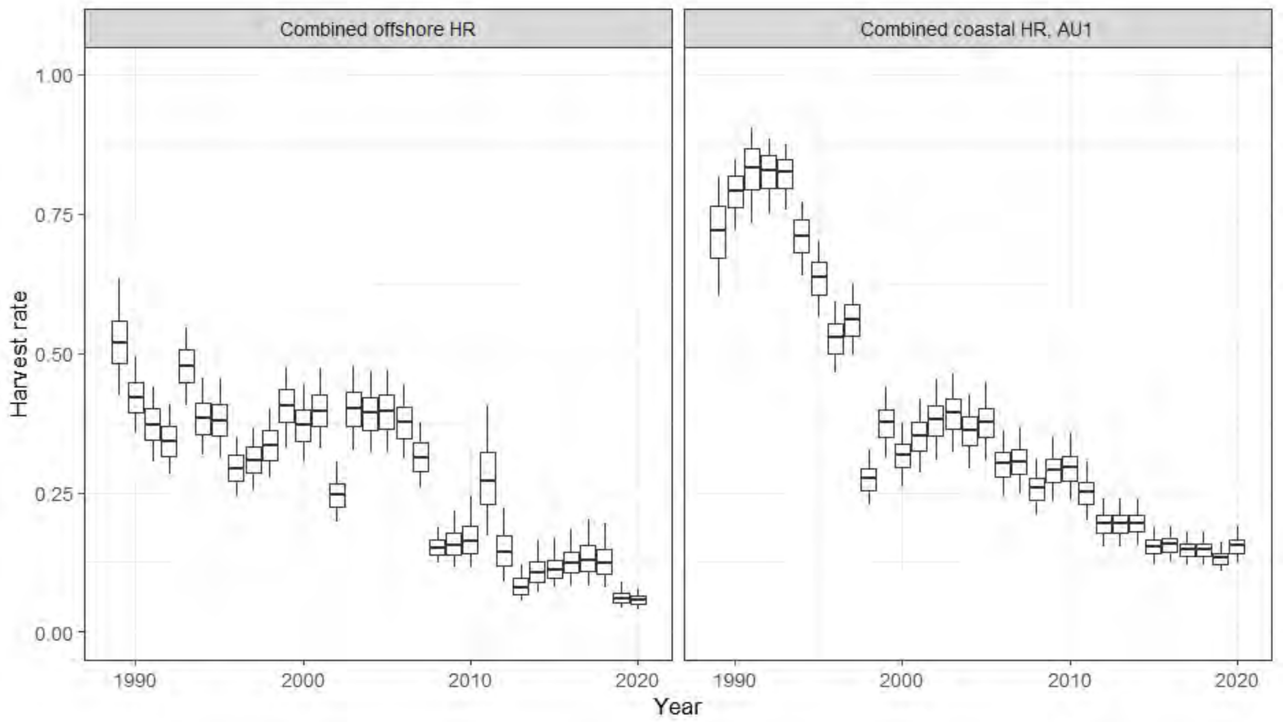


Figure 4.2.3.10. Combined harvest rates (harvested proportion of the available population) for offshore and coastal fisheries for MSW wild salmon in 1989–2020. Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

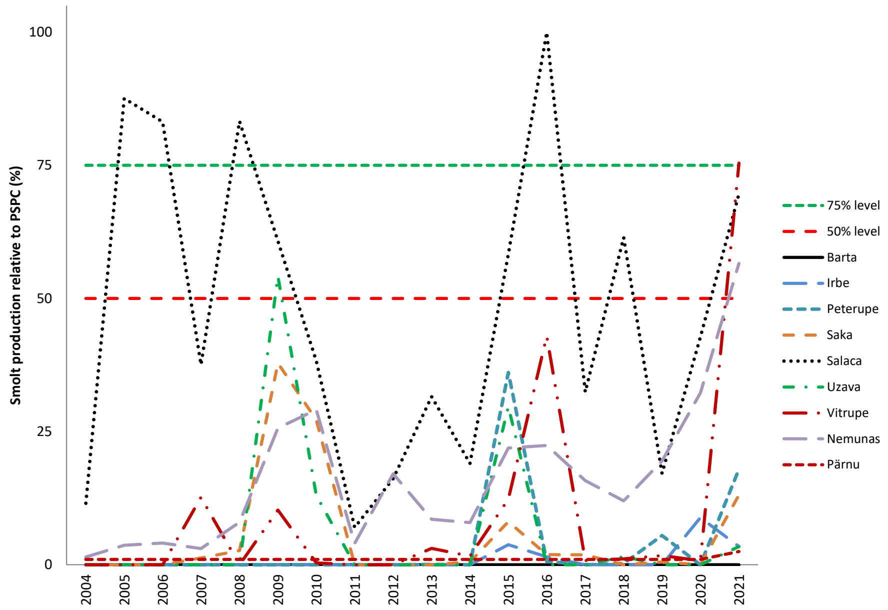


Figure 4.2.4.1.

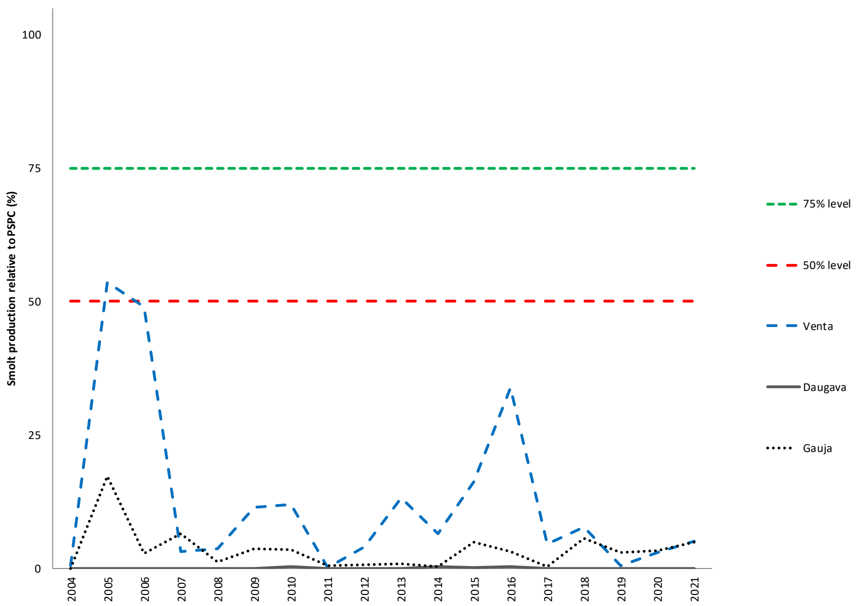
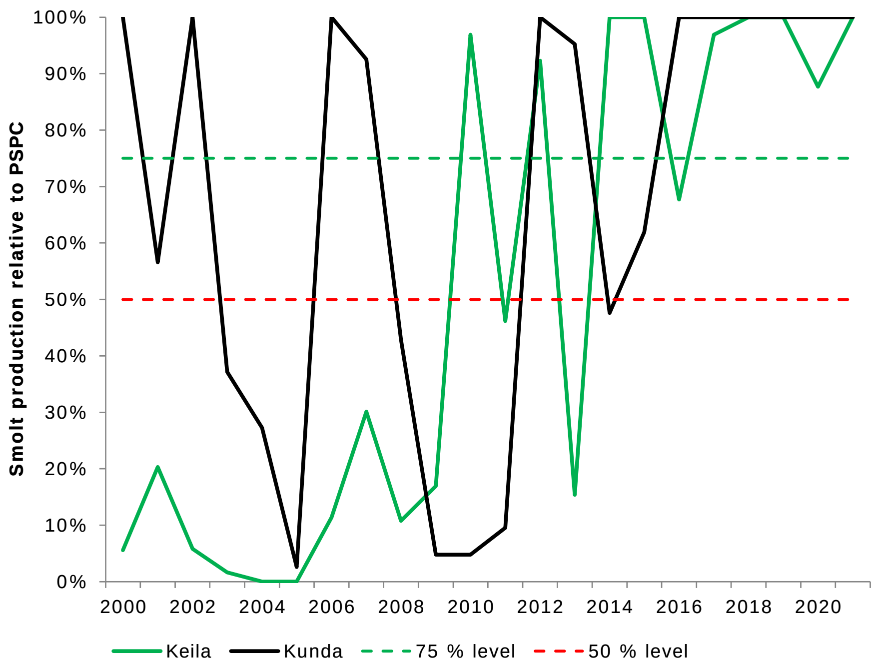


Figure 4.2.4.2.

A



B

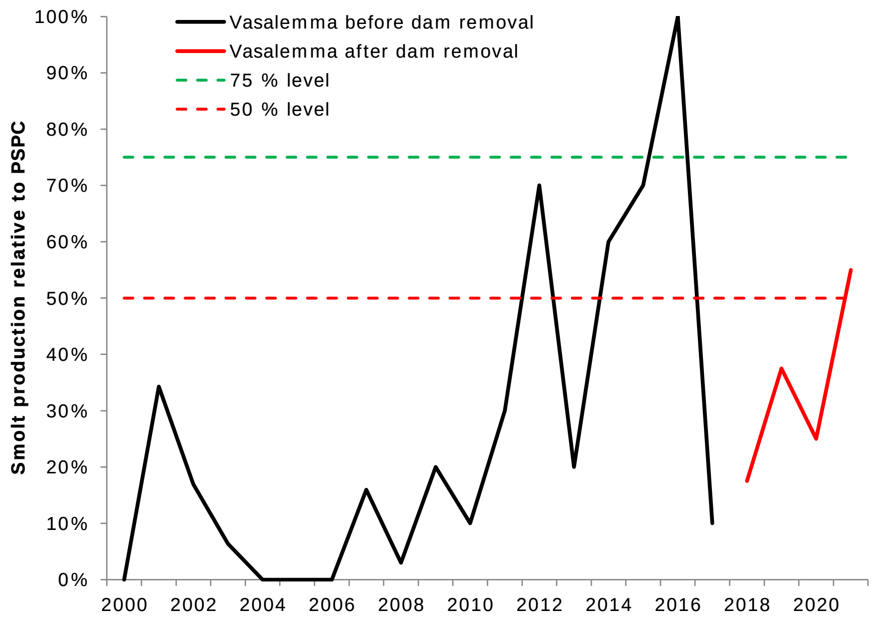
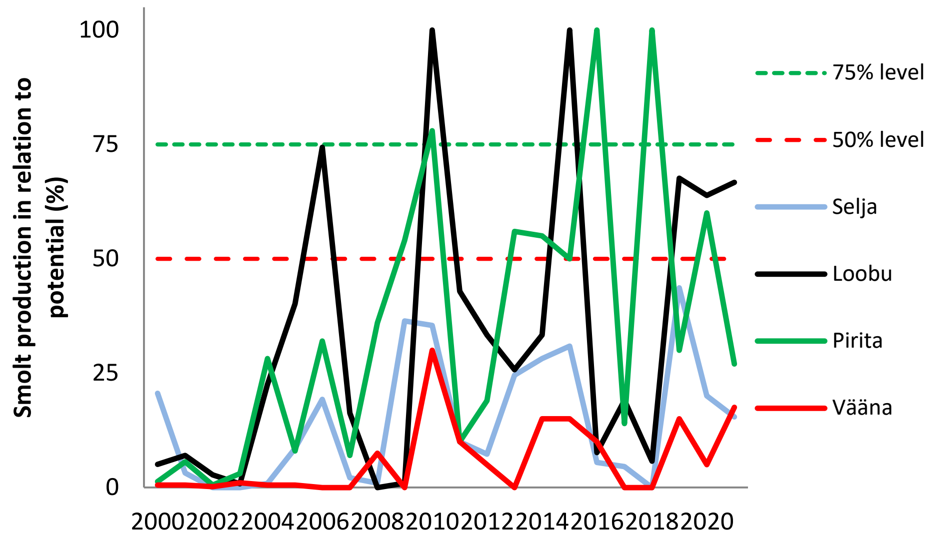


Figure 4.2.4.3. Smolt production level in relation to the potential in AU 6 wild salmon populations. Note that the PSPC is calculated only to the accessible rearing habitat, areas above migration obstacles are excluded. In 2018 a dam was removed in Vasalemma and the PSPC increased considerably. Therefore, the actual smolt production in relation to PCPS is low despite the increase in actual smolt production from 2018 onwards.

A



B

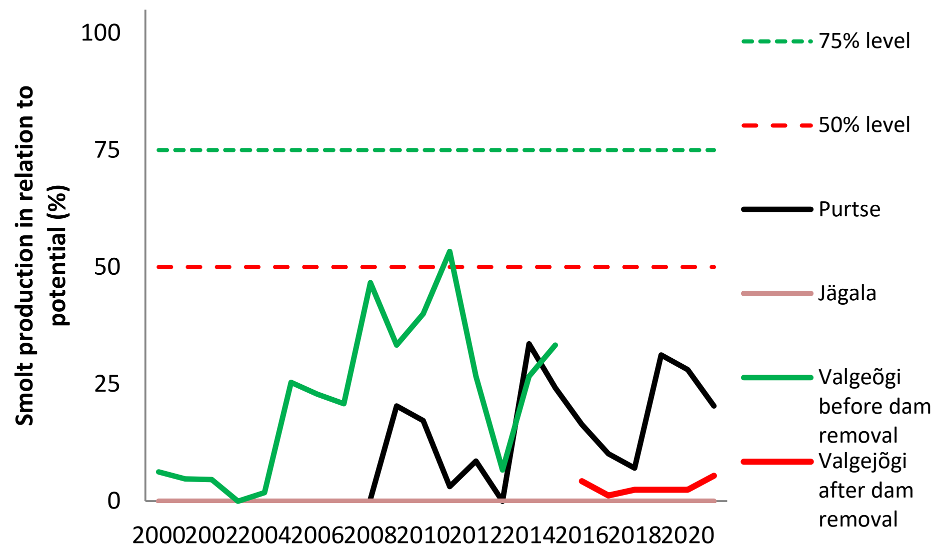


Figure 4.2.4.4. Smolt production level in relation to the potential in Estonian AU 6 mixed salmon populations. Note that the potential is calculated only up to the lowermost impassable migration obstacle and that many rivers have considerably higher total potential.

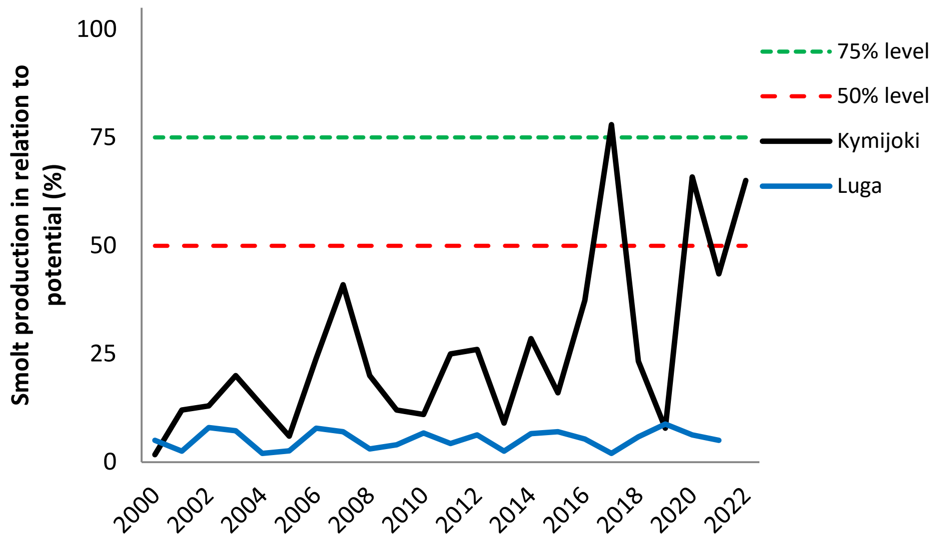


Figure 4.2.4.5. Wild smolt production level compared to potential in river Kymijoki (Finland) and in river Luga (Russia).

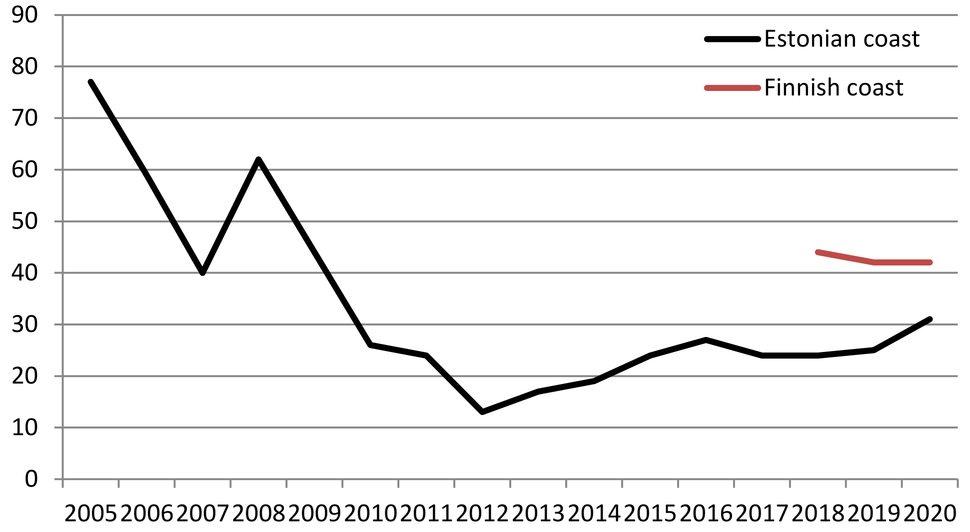


Figure 4.2.4.6. Share of adipose finclipped salmon caught on Estonian coast (black) and Finnish coast (red) of the Gulf of Finland.

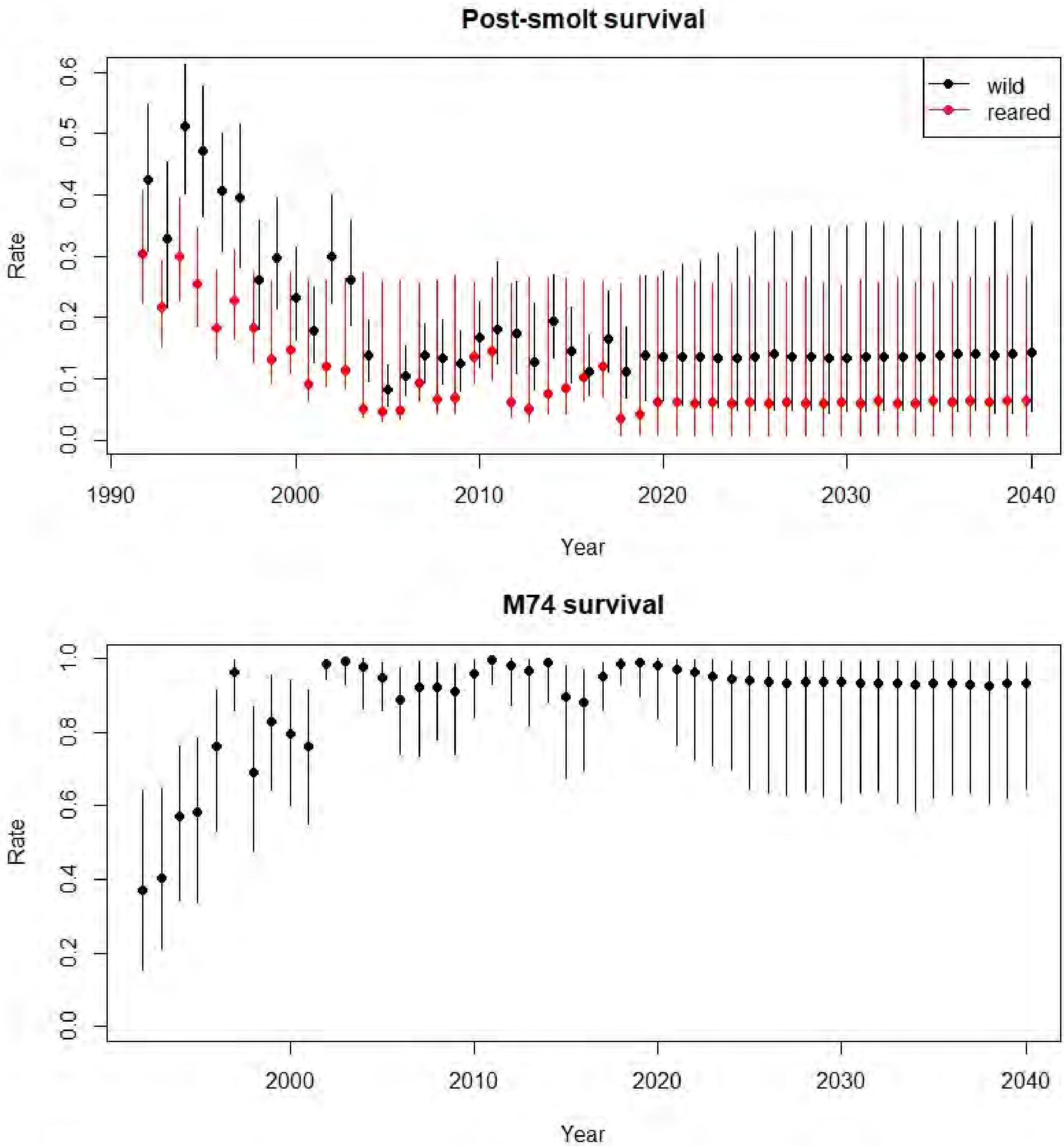


Figure 4.3.2.1. Median values and 90% probability intervals for post-smolt survival of wild and reared salmon and M74 survival assumed in all scenarios.

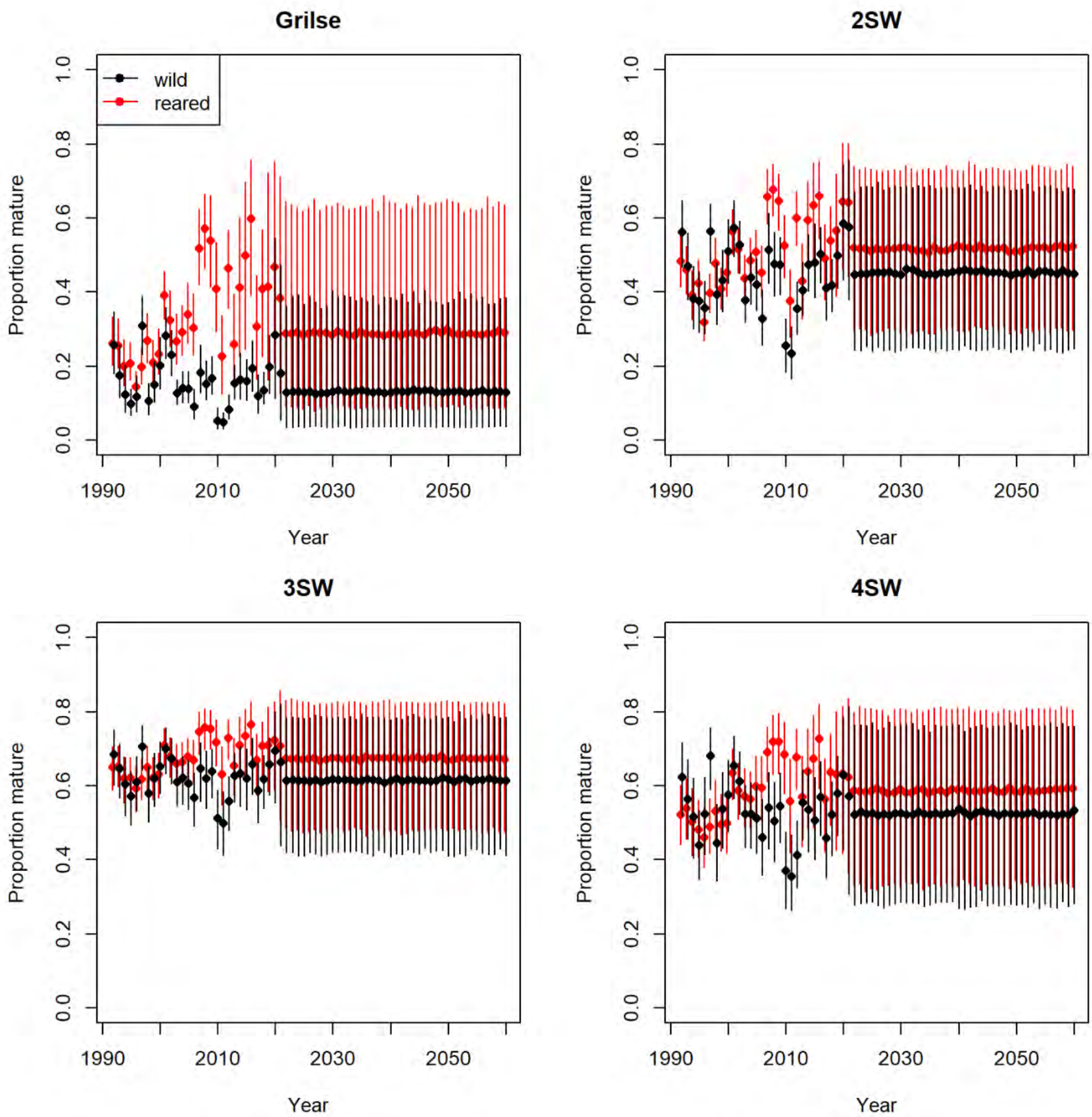


Figure 4.3.2.2. Median values and 90% probability intervals for annual proportions maturing per age group for wild and reared salmon in all scenarios.

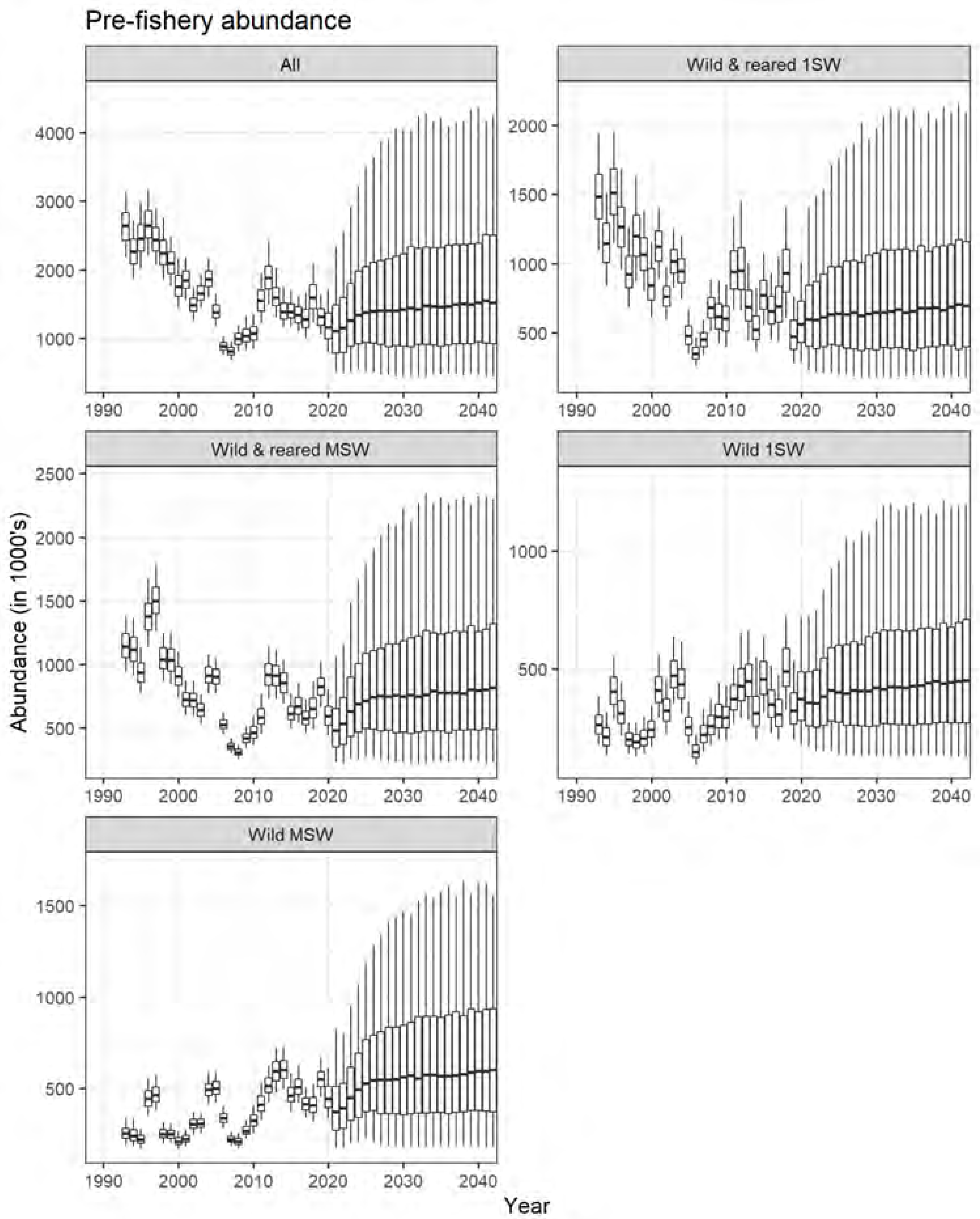


Figure 4.3.2.3a. Pre-fishery abundances of MSW and 1SW wild salmon and wild and reared salmon together based on scenario 1 (zero fishing) (medians with 90% probability intervals). PFAs reflect the abundance that is available to the fisheries. In case of MSW salmon natural mortality is taken into account until end of June of the fishing year and in case of post-smolts, until end of August (four months after post-smolt mortality phase). See text for details.

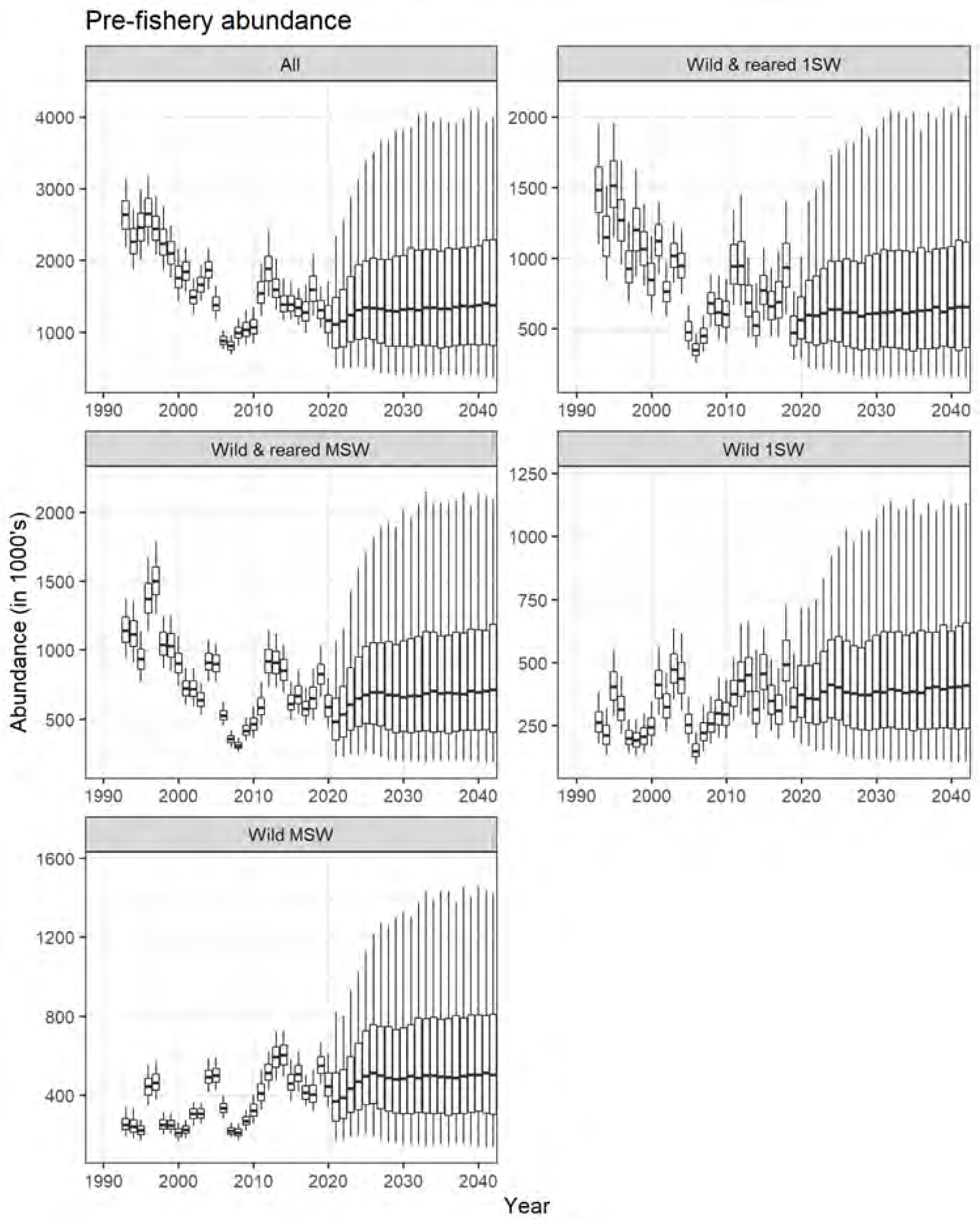


Figure 4.3.2.3b. Pre-fishery abundances of MSW and 1SW wild salmon and wild and reared salmon together based on scenario 4 (medians with 90% probability intervals). PFAs reflect the abundance that is available to the fisheries. In case of MSW salmon natural mortality is taken into account until end of June of the fishing year and in case of post-smolts, until end of August (four months after post-smolt mortality phase). See text for details.

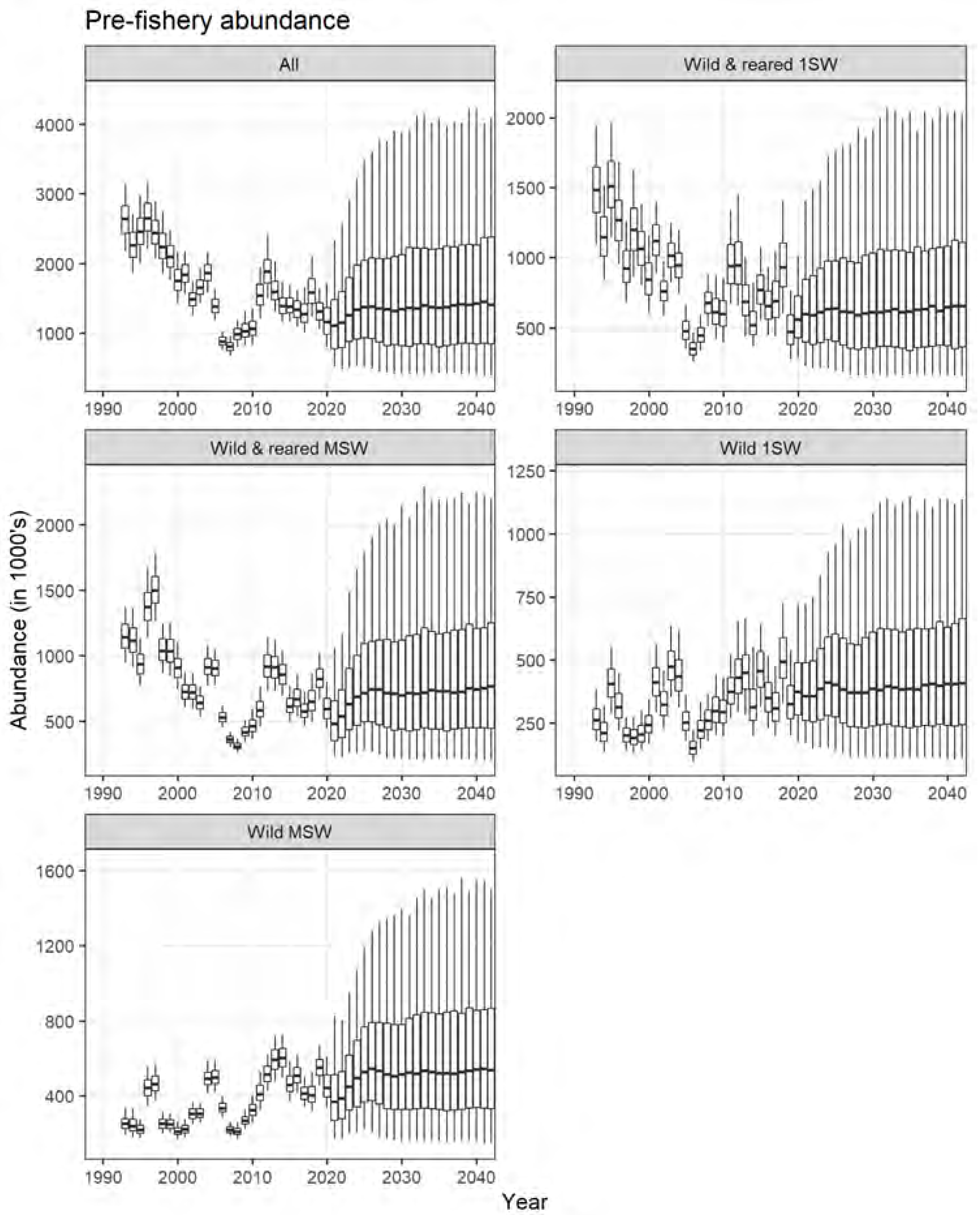


Figure 4.3.2.3c. Pre-fishery abundances of MSW and 1SW wild salmon and wild and reared salmon together based on scenario 10 (medians with 90% probability intervals). PFAs reflect the abundance that is available to the fisheries. In case of MSW salmon natural mortality is taken into account until end of June of the fishing year and in case of post-smolts, until end of August (four months after post-smolt mortality phase). See text for details.

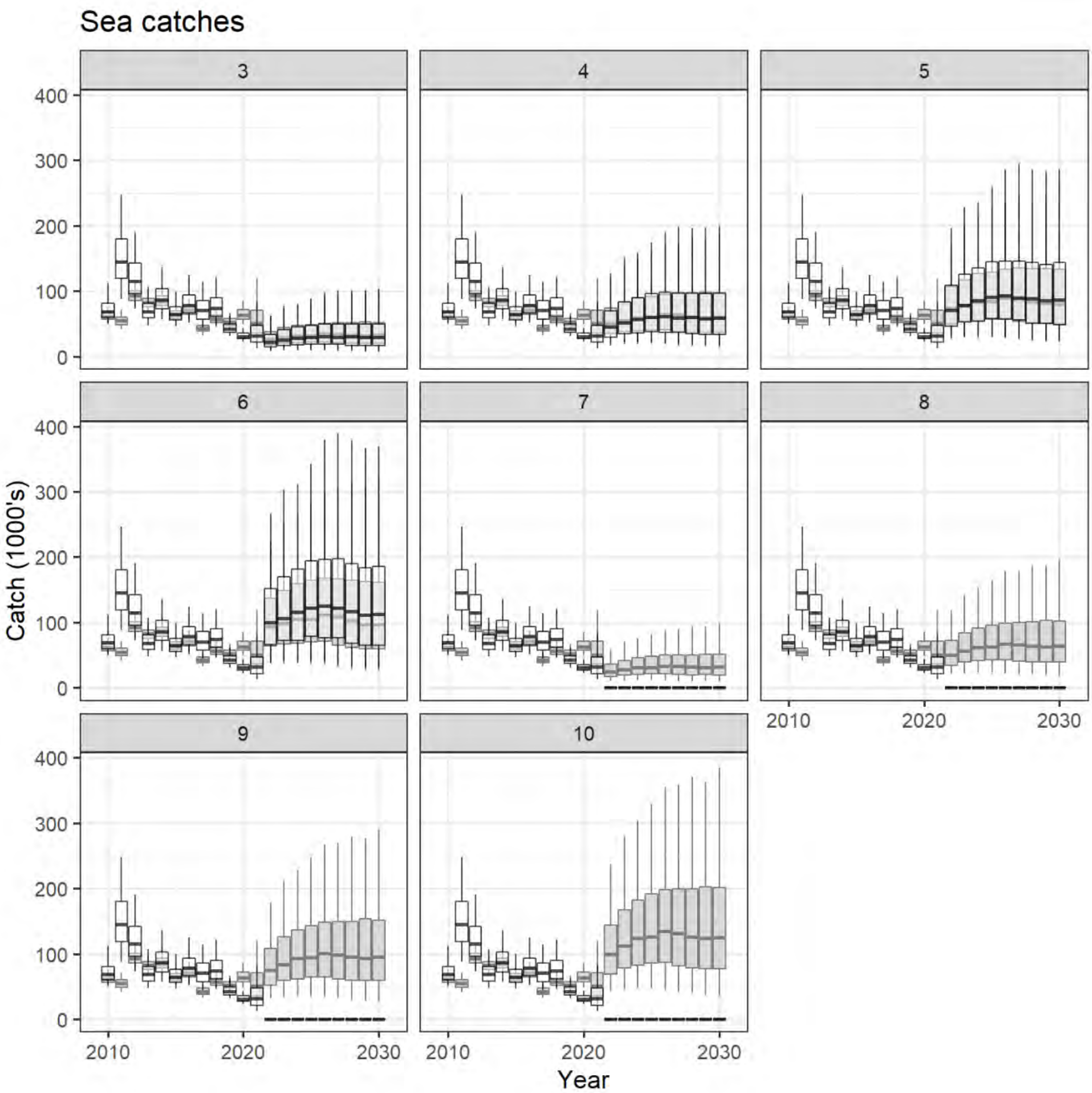


Figure 4.3.2.4. Estimated total removal at sea (black boxplots) and at coastal areas (grey boxplots) based on scenarios 3–10. Boxplots show medians with 5%, 25%, 75% and 95% quantiles.

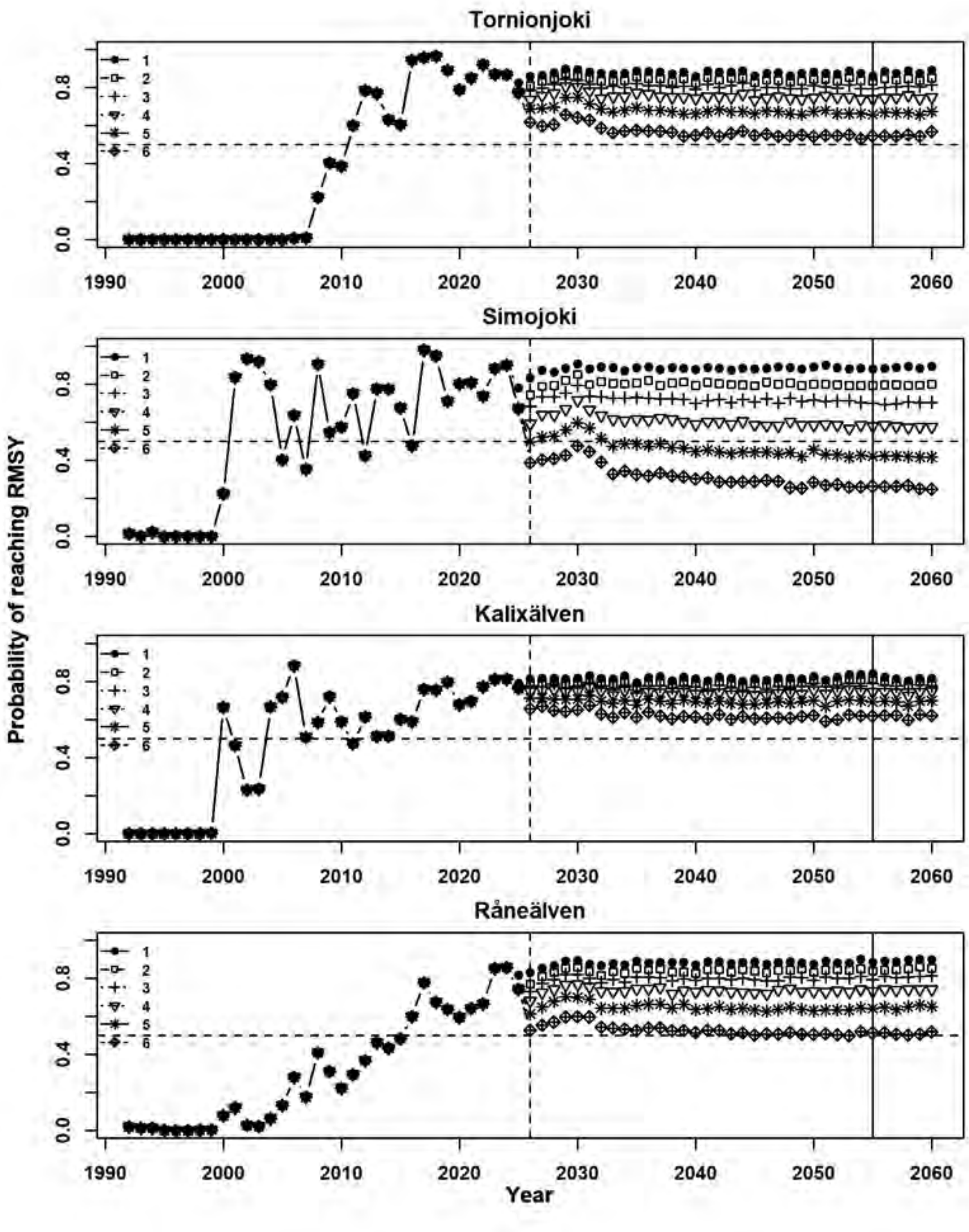


Figure 4.3.2.5a. Probabilities for different stocks to meet an objective of smolt production corresponding to maximum sustainable yield under scenarios 1–6. Fishing in 2022 primarily affects years 2025 (AU 4) and 2026 (AUs 1–3).

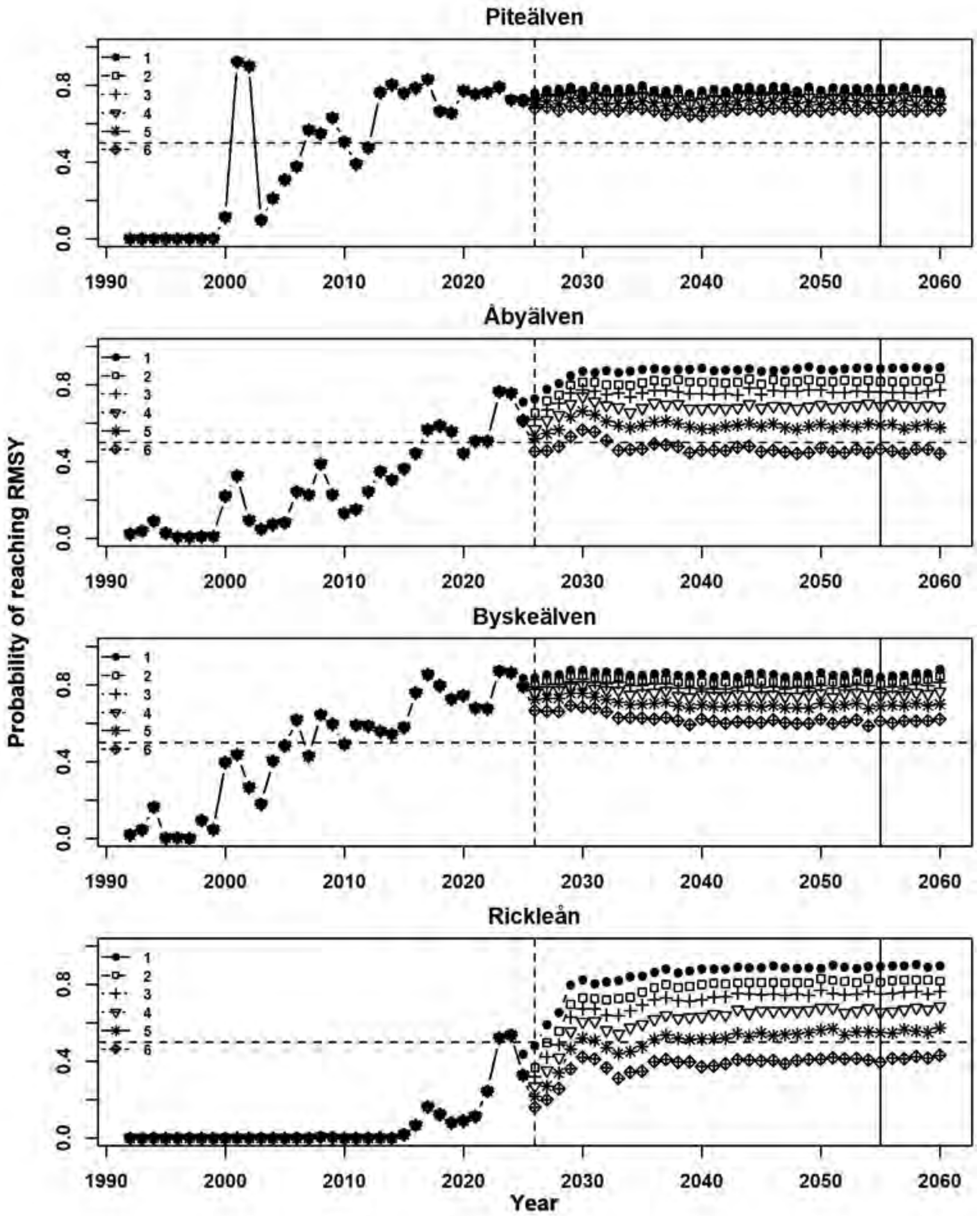


Figure 4.3.2.5b. Probabilities for different stocks to meet an objective of smolt production corresponding to maximum sustainable yield under scenarios 1–6. Fishing in 2022 primarily affects years 2025 (AU 4) and 2026 (AUs 1–3).

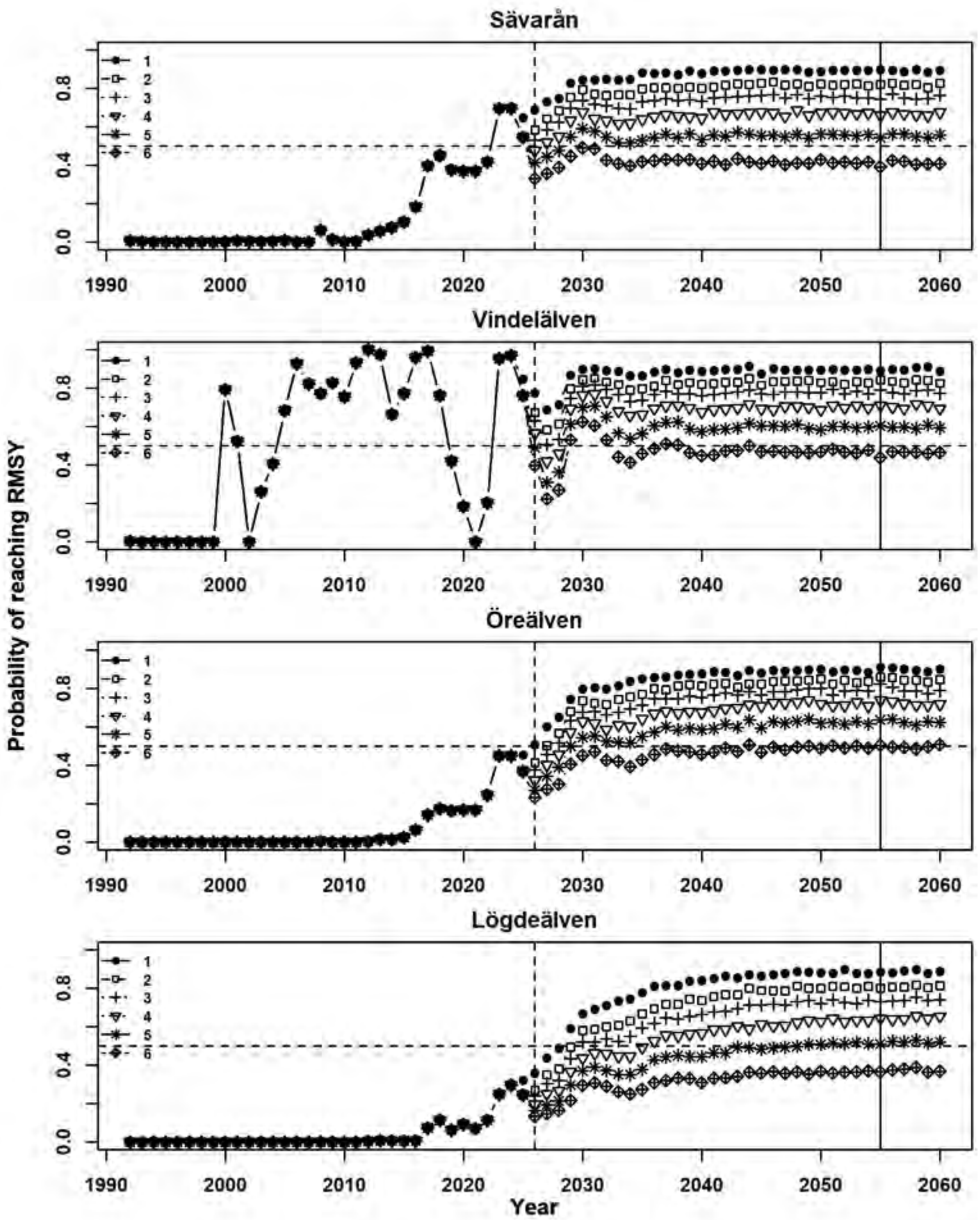


Figure 4.3.2.5c. Probabilities for different stocks to meet an objective of smolt production corresponding to maximum sustainable yield under scenarios 1–6. Fishing in 2022 primarily affects years 2025 (AU 4) and 2026 (AUs 1–3).

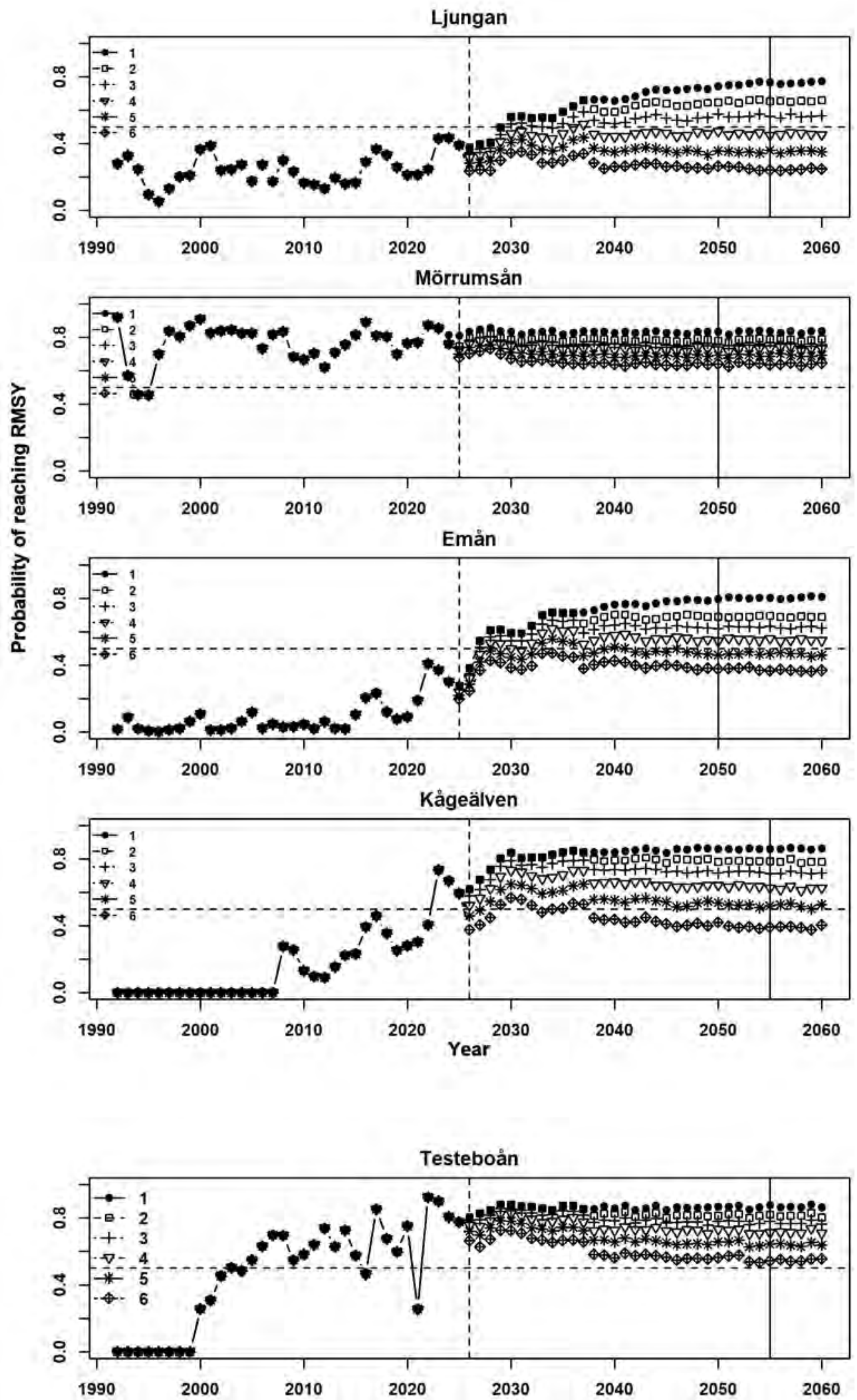


Figure 4.3.2.5d. Probabilities for different stocks to meet an objective of smolt production corresponding to maximum sustainable yield under scenarios 1–6. Fishing in 2022 primarily affects years 2025 (AU 4) and 2026 (AUs 1–3).

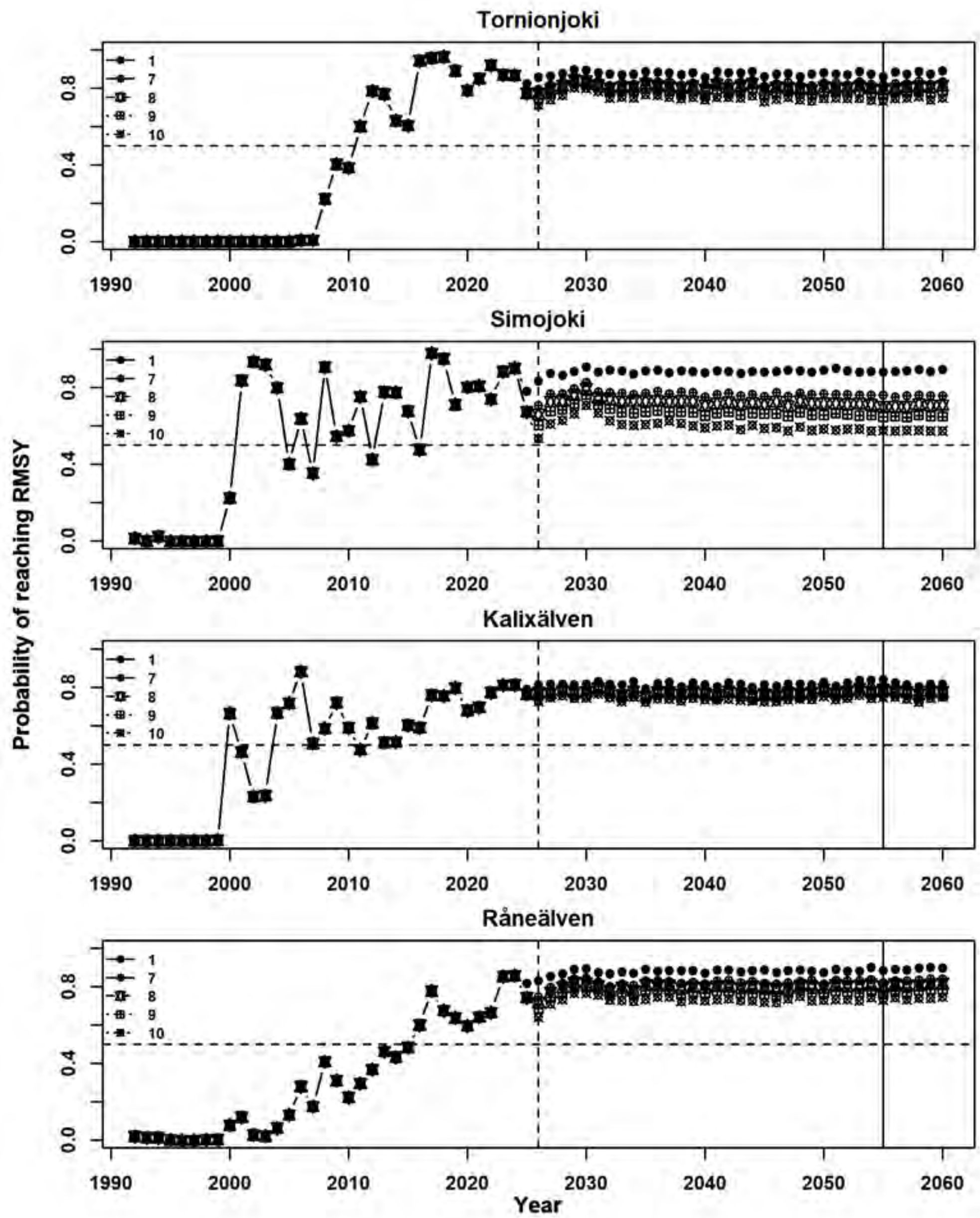


Figure 4.3.2.5e. Probabilities for different stocks to meet an objective of smolt production corresponding to maximum sustainable yield under scenarios 1, 7, 8, 9 and 10. Fishing in 2022 primarily affects years 2025 (AU 4) and 2026 (AUs 1–3).

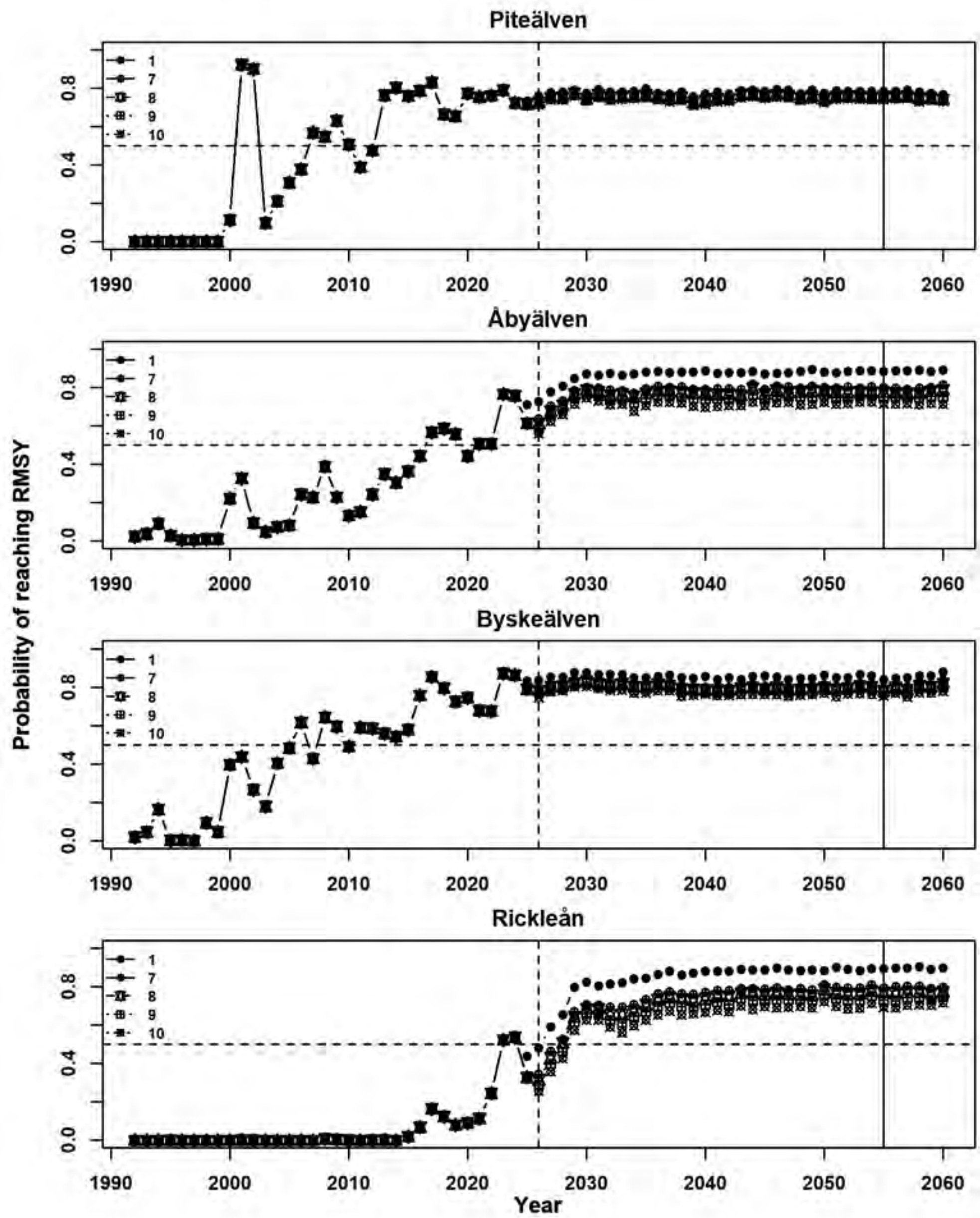


Figure 4.3.2.5f. Probabilities for different stocks to meet an objective of smolt production corresponding to maximum sustainable yield under scenarios 1, 7, 8, 9 and 10. Fishing in 2022 primarily affects years 2025 (AU 4) and 2026 (AUs 1–3).

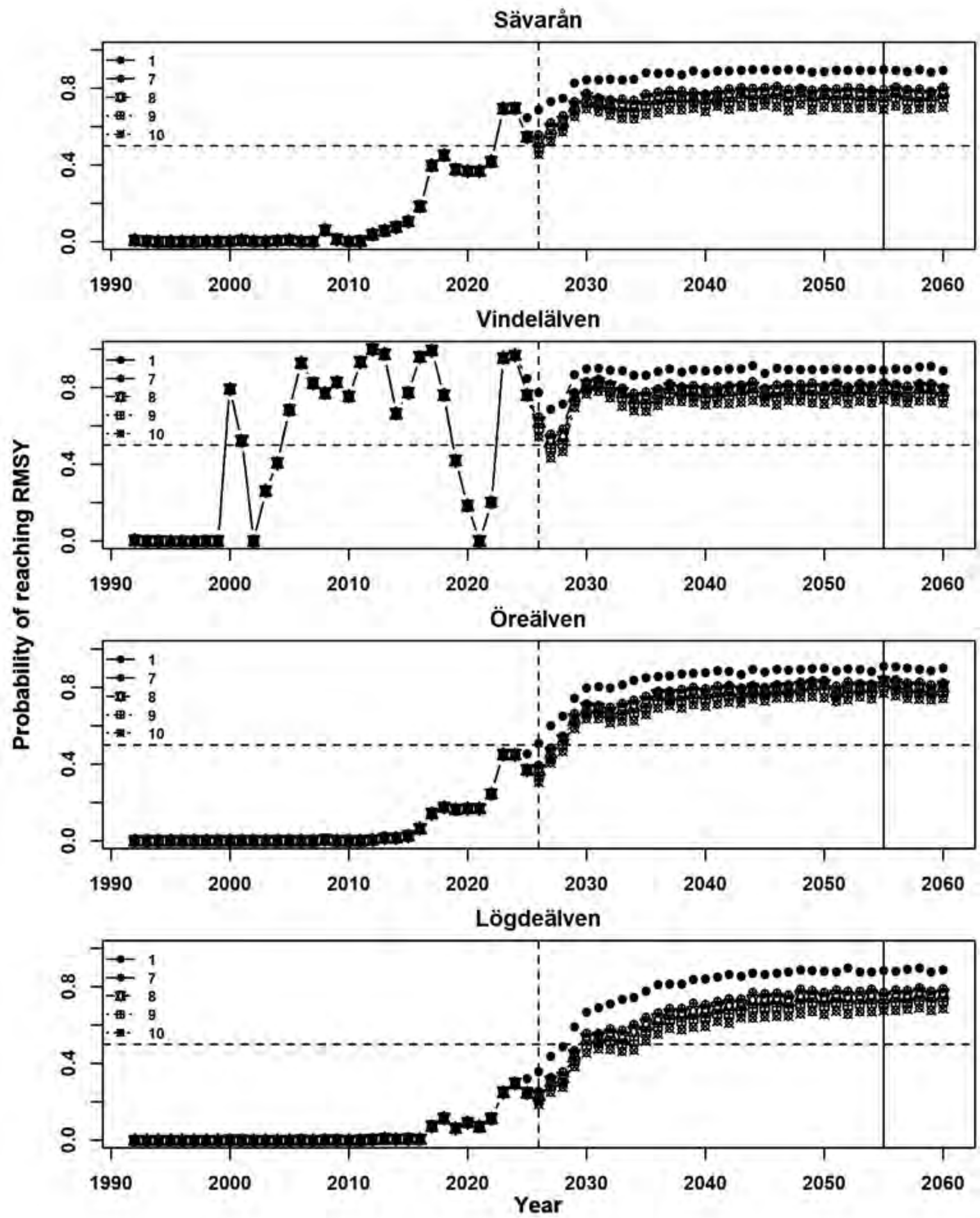


Figure 4.3.2.5g. Probabilities for different stocks to meet an objective of smolt production corresponding to maximum sustainable yield under scenarios 1, 7, 8, 9 and 10. Fishing in 2022 primarily affects years 2025 (AU 4) and 2026 (AUs 1–3).

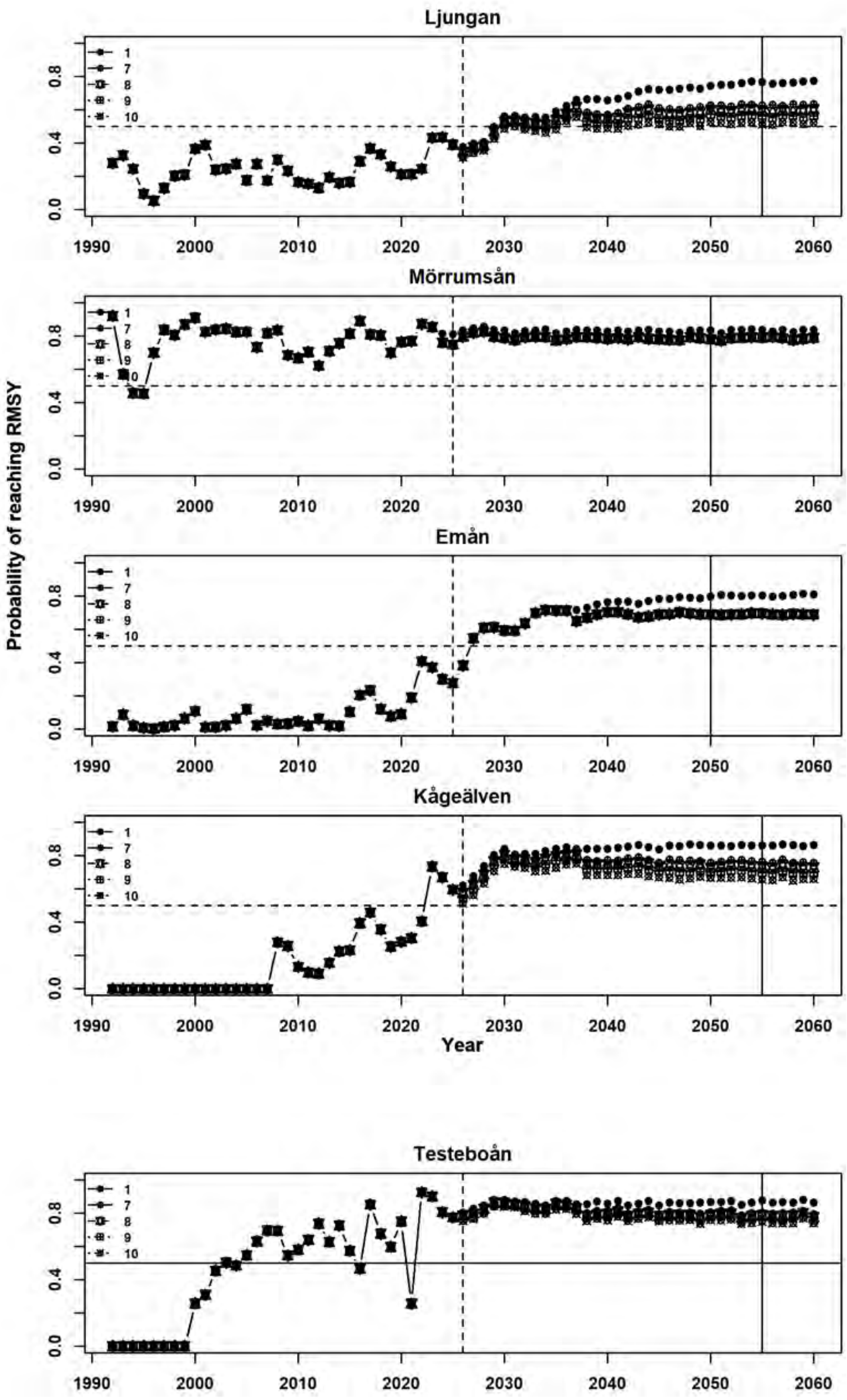


Figure 4.3.2.5h. Probabilities for different stocks to meet an objective of smolt production corresponding to maximum sustainable yield under scenarios 1, 7, 8, 9 and 10. Fishing in 2022 primarily affects years 2025 (AU 4) and 2026 (AUs 1–3).

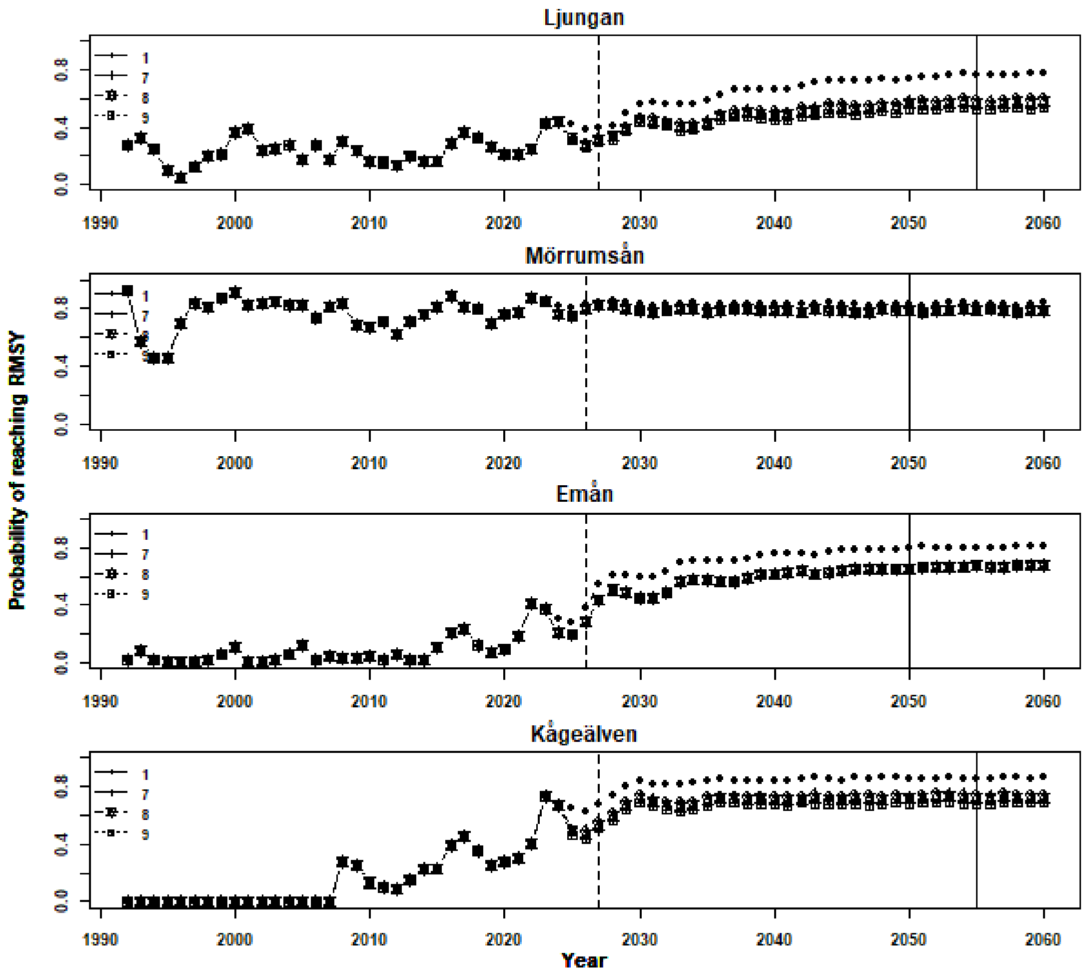


Figure 4.3.2.5i. Probabilities for different stocks to meet an objective of smolt production corresponding to maximum sustainable yield under scenarios 1, 7, 8 and 9. Fishing in 2021 primarily affects years 2025–2026.

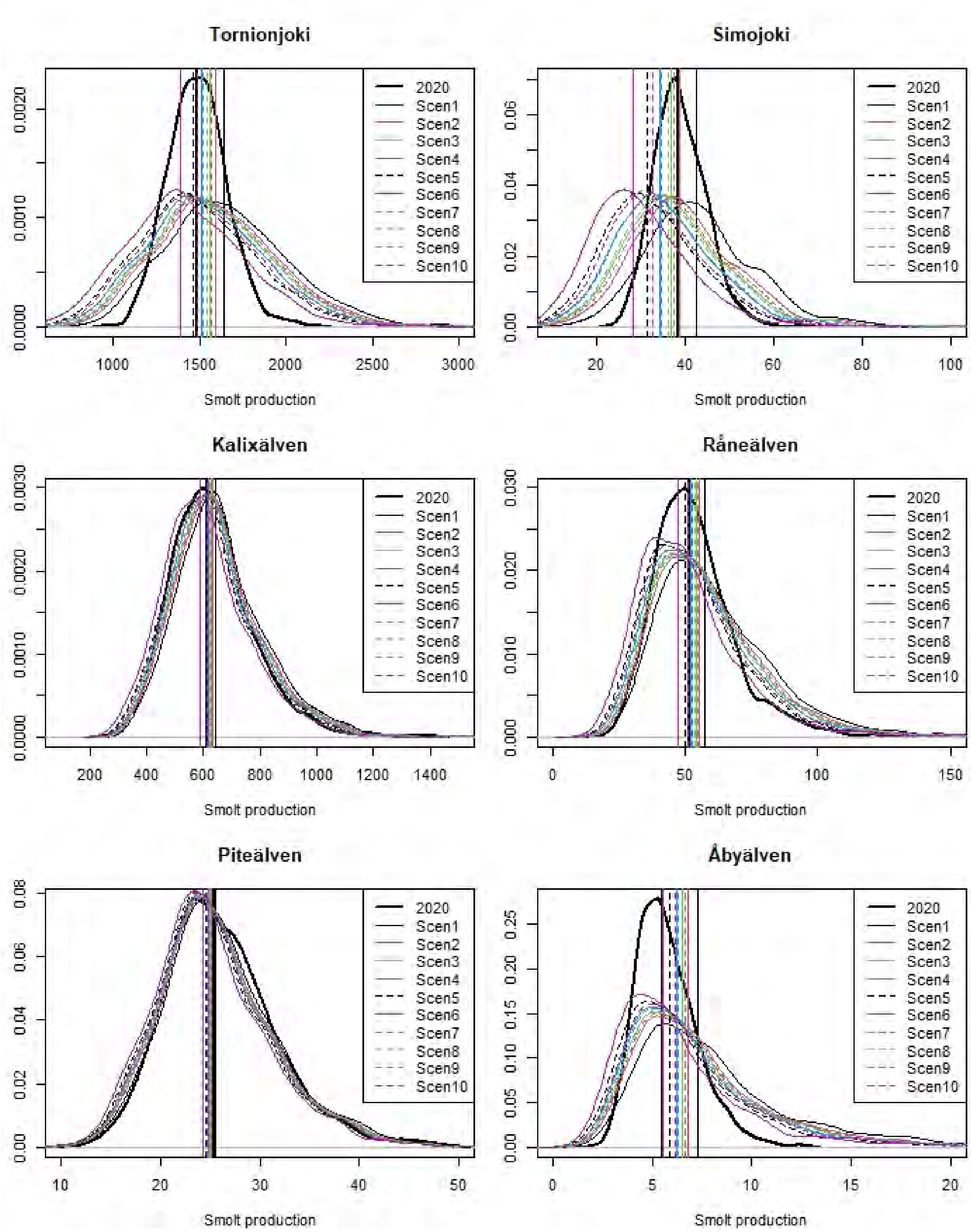


Figure 4.3.2.6.a. Predicted smolt production in 2026 under fishing scenarios 1–10 (thin lines) compared to estimated production in 2020 (bold line). Vertical lines illustrate medians of the distributions.

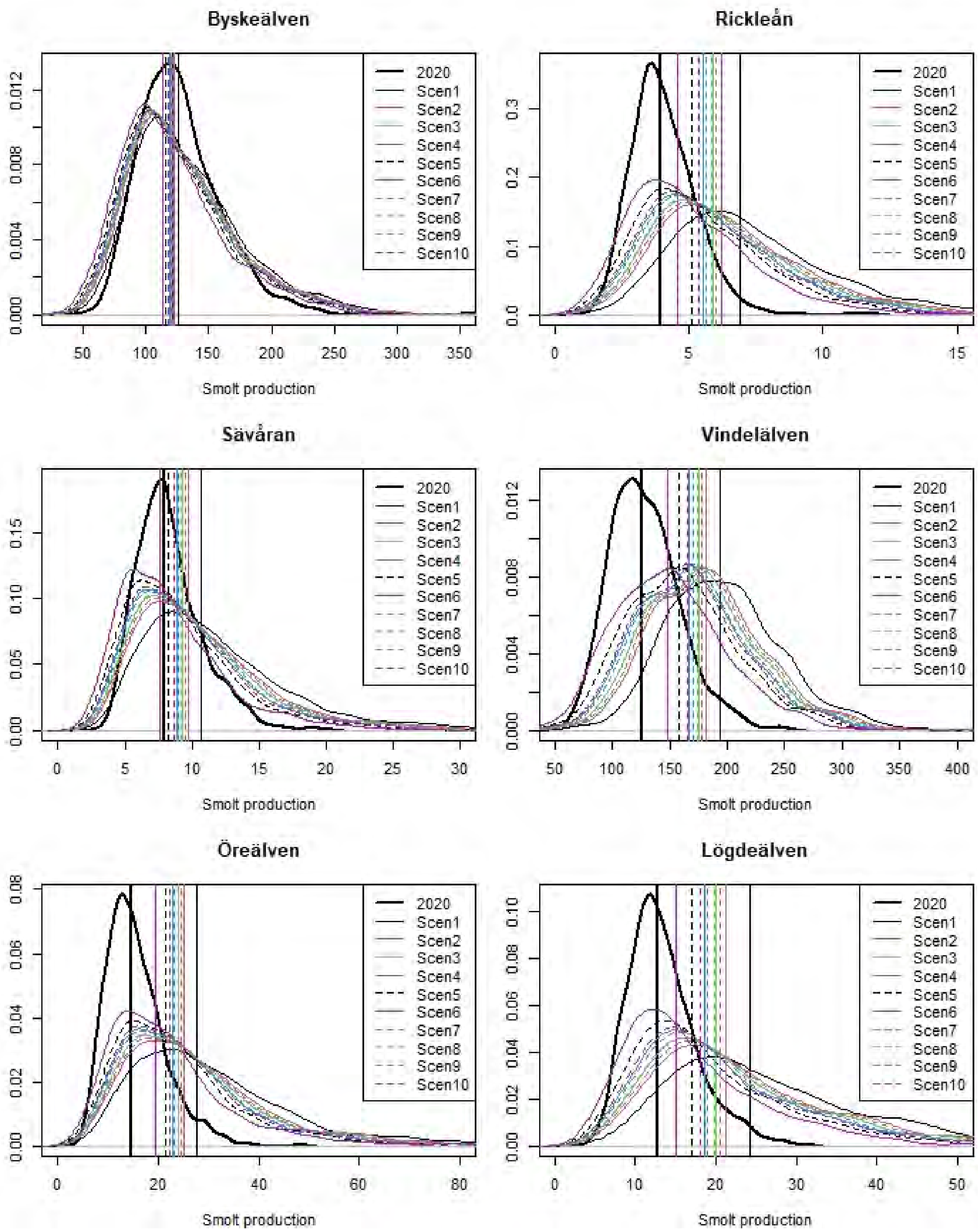


Figure 4.3.2.6.b. Predicted smolt production in 2026 under fishing scenarios 1–10 (thin lines) compared to estimated production in 2020 (bold line). Vertical lines illustrate medians of the distributions.

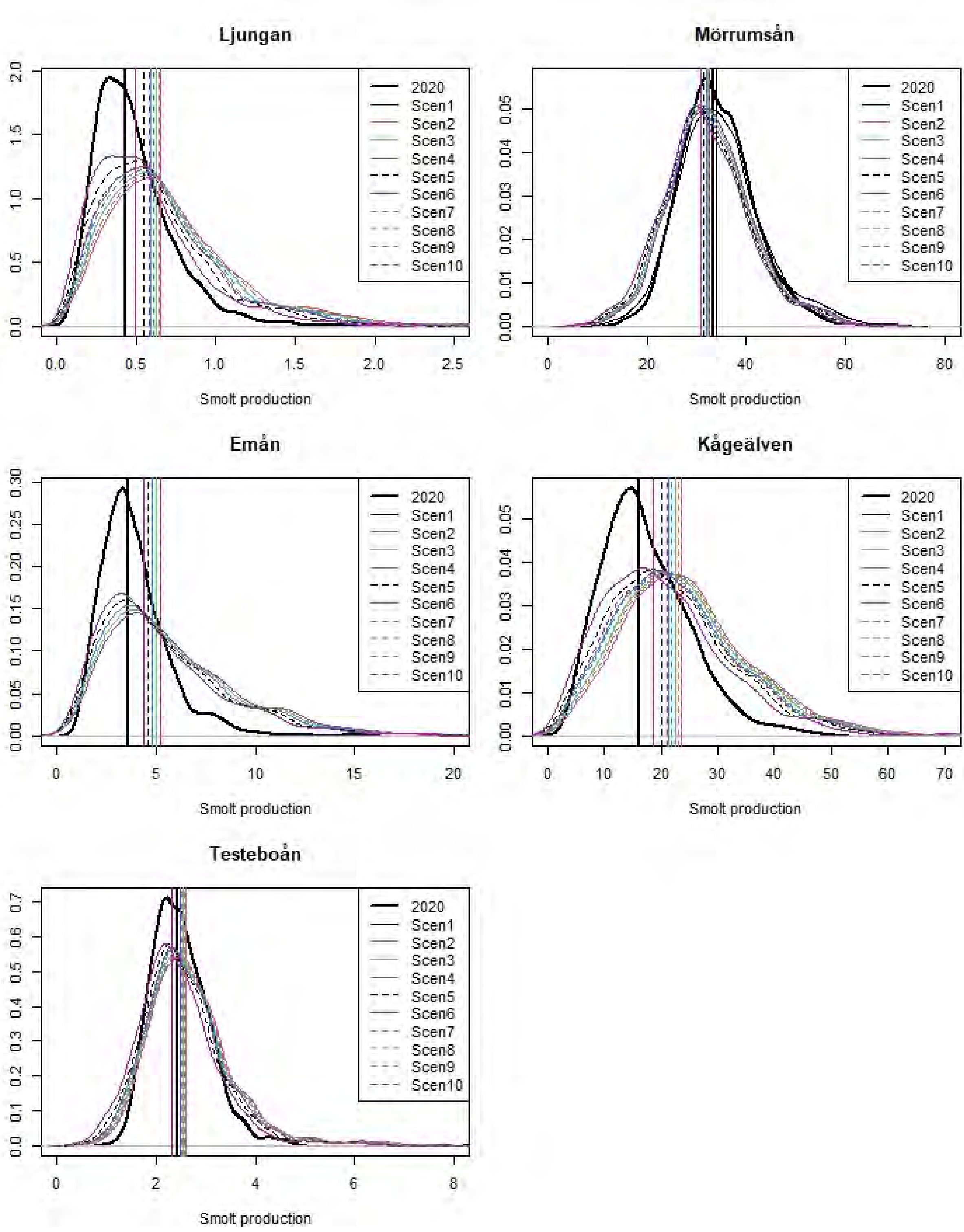


Figure 4.3.2.6.c. Predicted smolt production in 2026 (or 2025 for Emån and Mörrumsån) under fishing scenarios 1–10 (thin lines) compared to estimated production in 2020 (bold line). Vertical lines illustrate medians of the distributions.

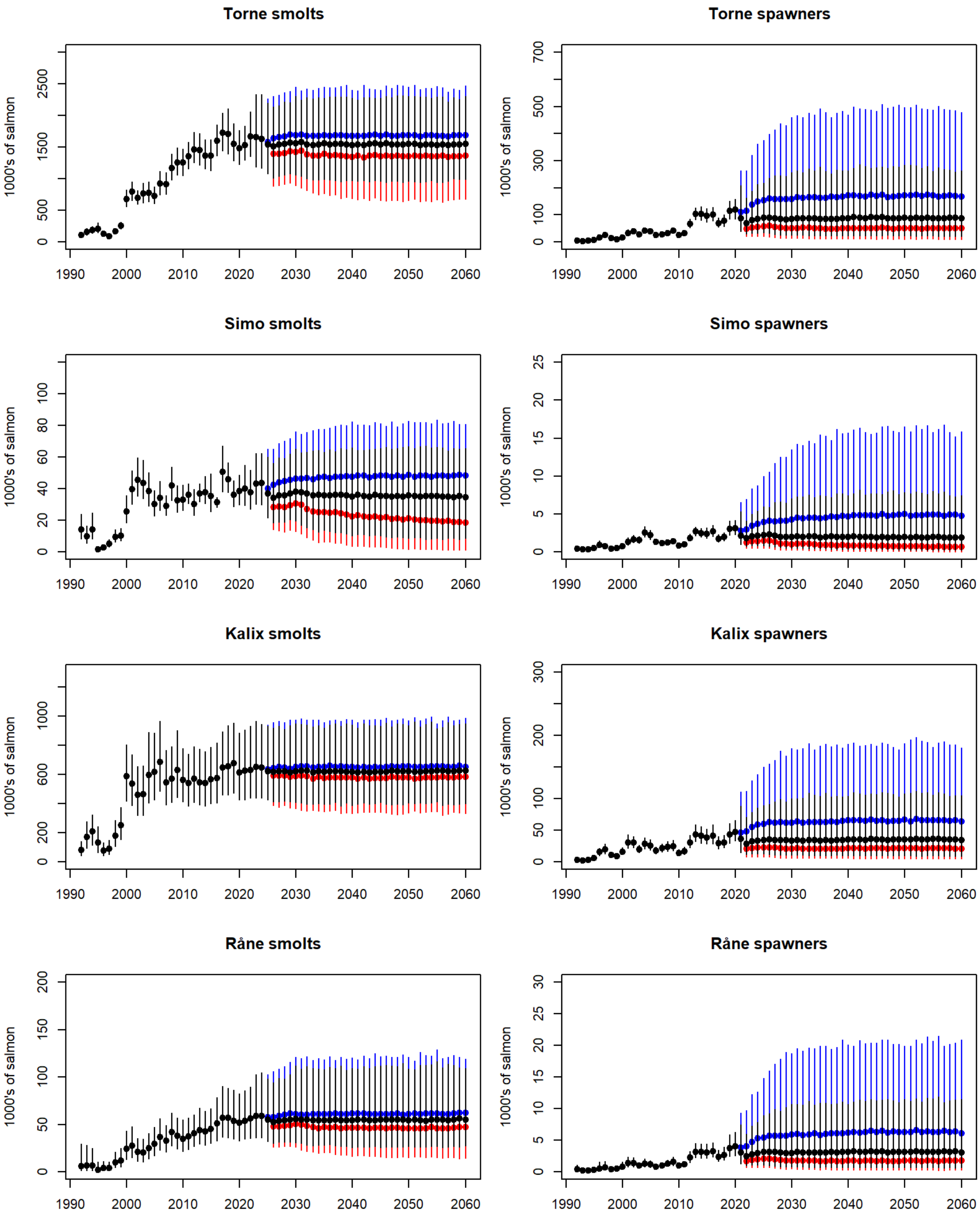


Figure 4.3.2.7a. Long-term predictions of river-specific smolt and spawner abundances for three scenarios. Blue, scenario 1 (zero fishing); black, scenario 4 (100 000 sea catch); red, scenario 6 (200 000 sea catch). The two most extreme scenarios (1 and 6) illustrate the predicted effects of contrasting amounts of fishing.

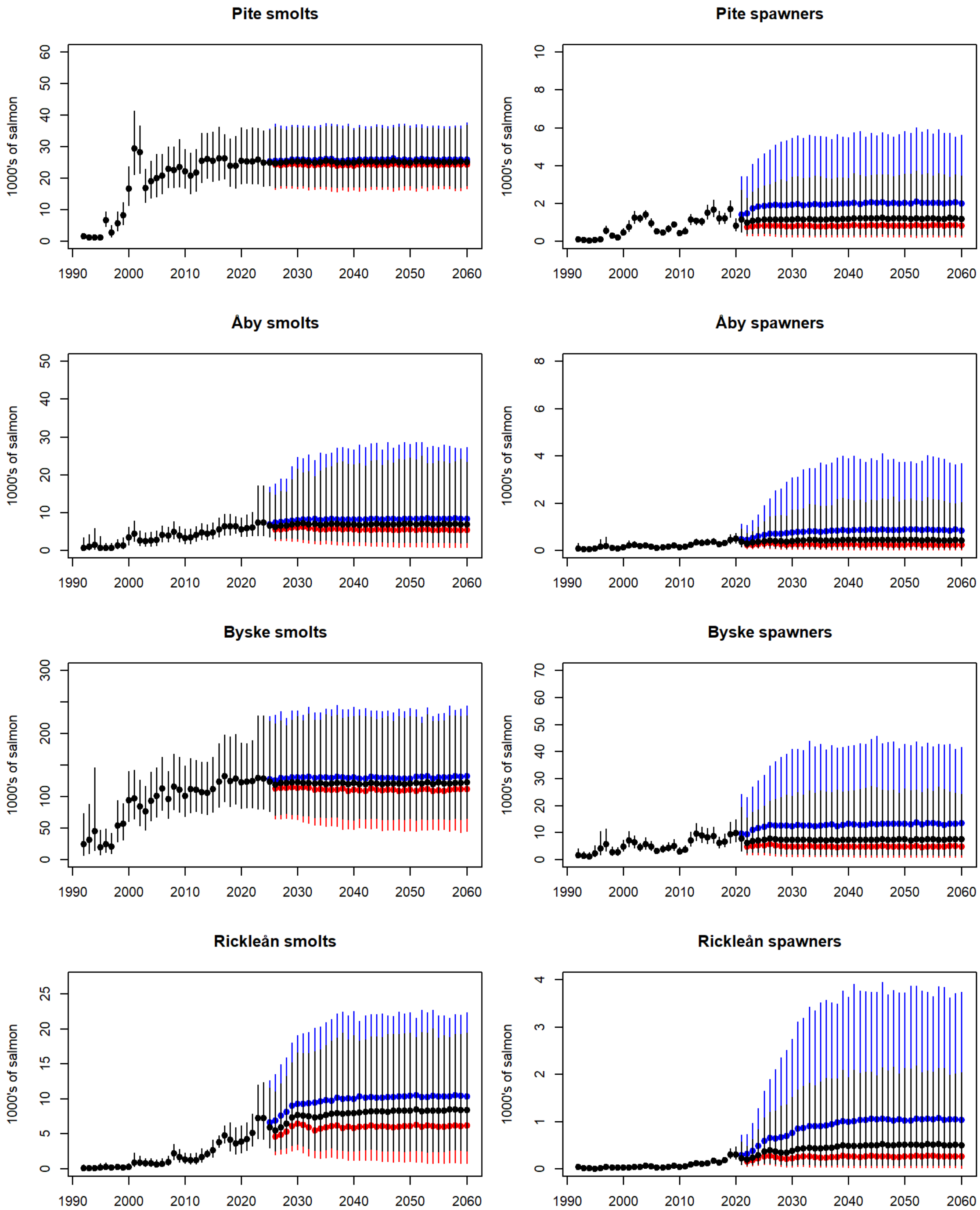


Figure 4.3.2.7b. Long-term predictions of river-specific smolt and spawner abundances for three scenarios. Blue, scenario 1 (zero fishing); black, scenario 4 (100 000 sea catch); red, scenario 6 (200 000 sea catch). The two most extreme scenarios (1 and 6) illustrate the predicted effects of contrasting amounts of fishing.

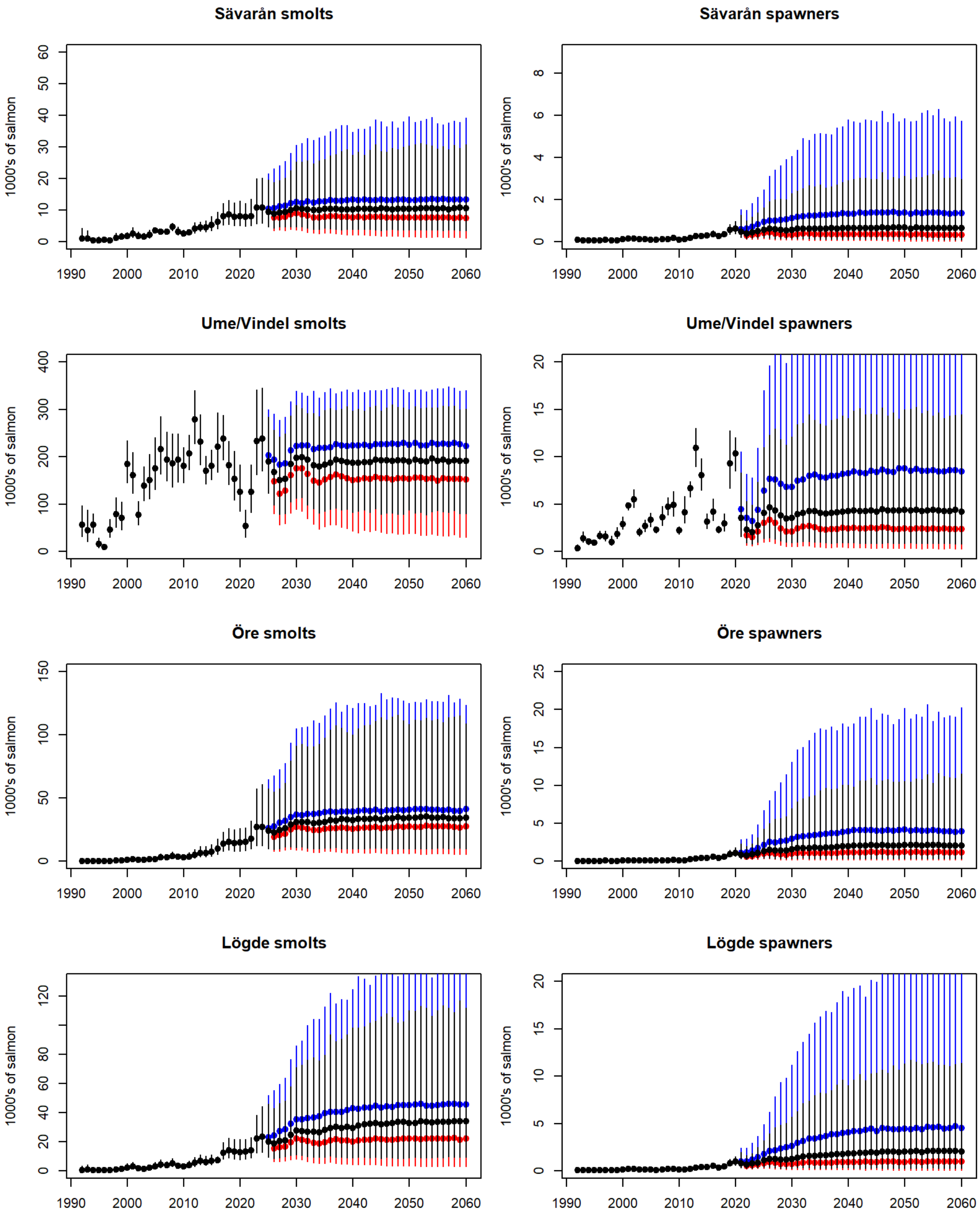


Figure 4.3.2.7c. Long-term predictions of river-specific smolt and spawner abundances for three scenarios. Blue, scenario 1 (zero fishing); black, scenario 4 (100 000 sea catch); red, scenario 6 (200 000 sea catch). The two most extreme scenarios (1 and 6) illustrate the predicted effects of contrasting amounts of fishing.

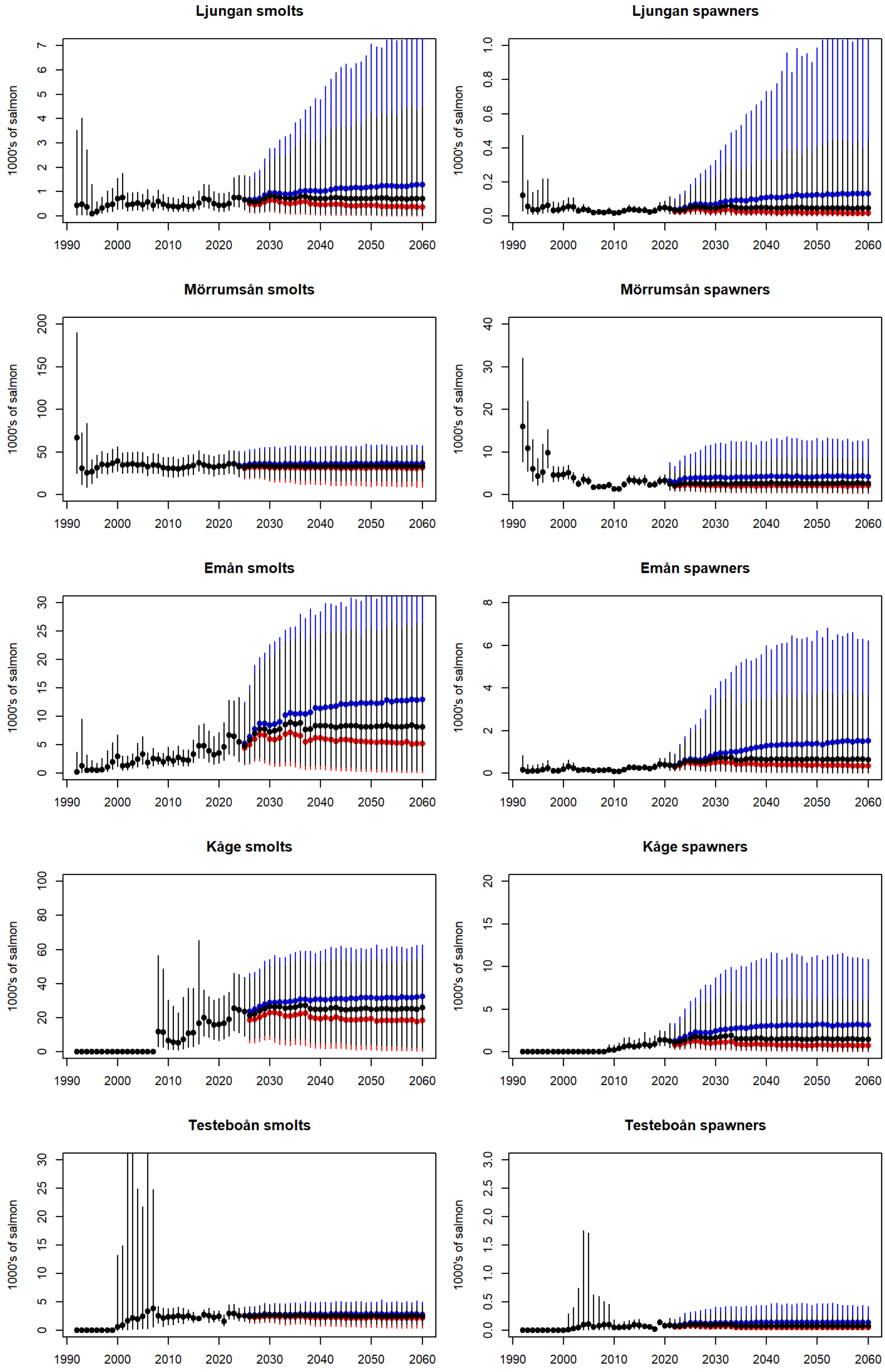


Figure 4.3.2.7d. Long-term predictions of river-specific smolt and spawner abundances for three scenarios. Blue, scenario 1 (zero fishing); black, scenario 4 (100 000 sea catch); red, scenario 6 (200 000 sea catch). The two most extreme scenarios (1 and 6) illustrate the predicted effects of contrasting amounts of fishing.

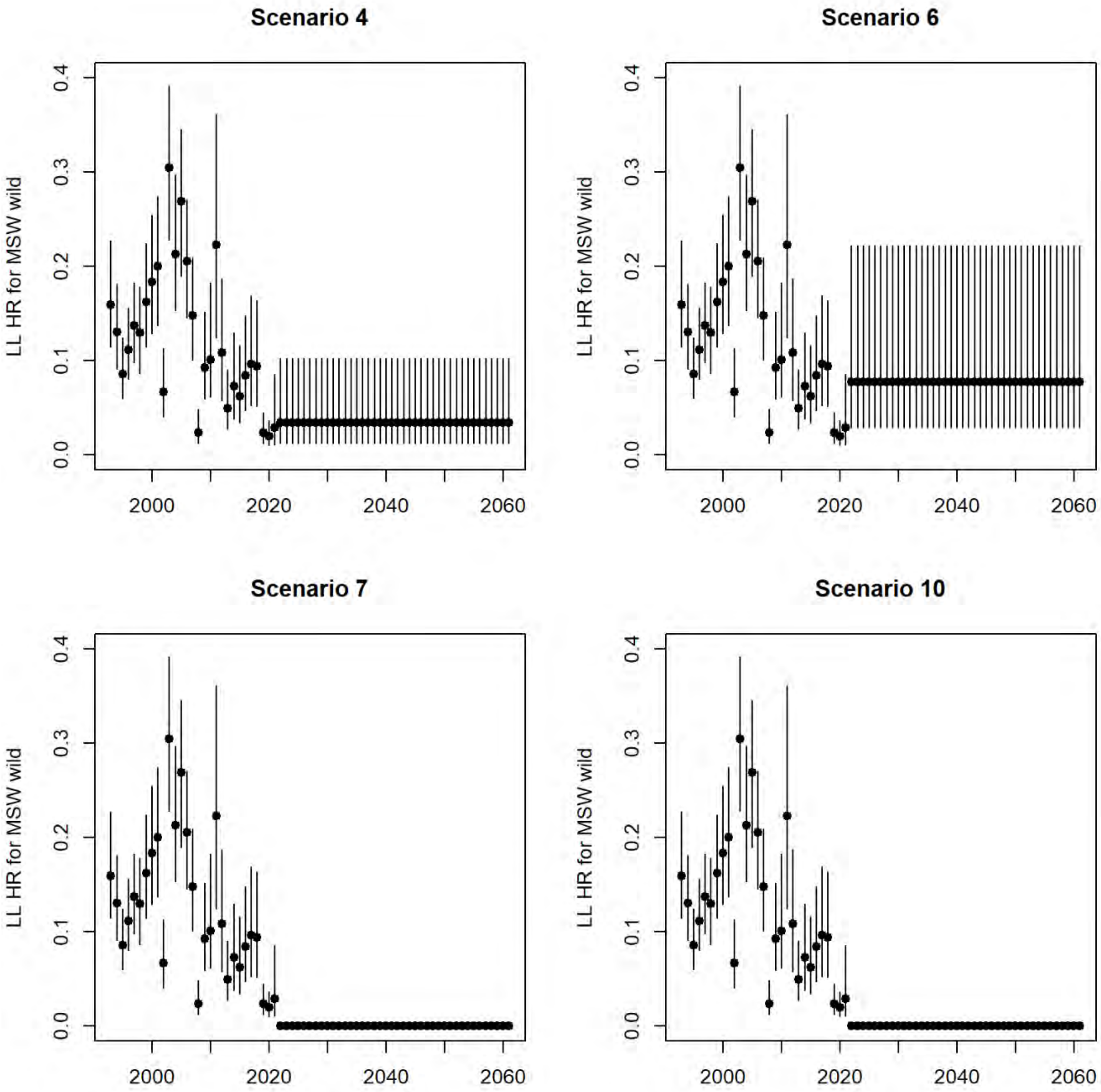


Figure 4.3.2.8a. Harvest rates (median values and 90% probability intervals) for wild multi-sea winter salmon in offshore longline fishery within scenarios 4, 6, 7 and 10.

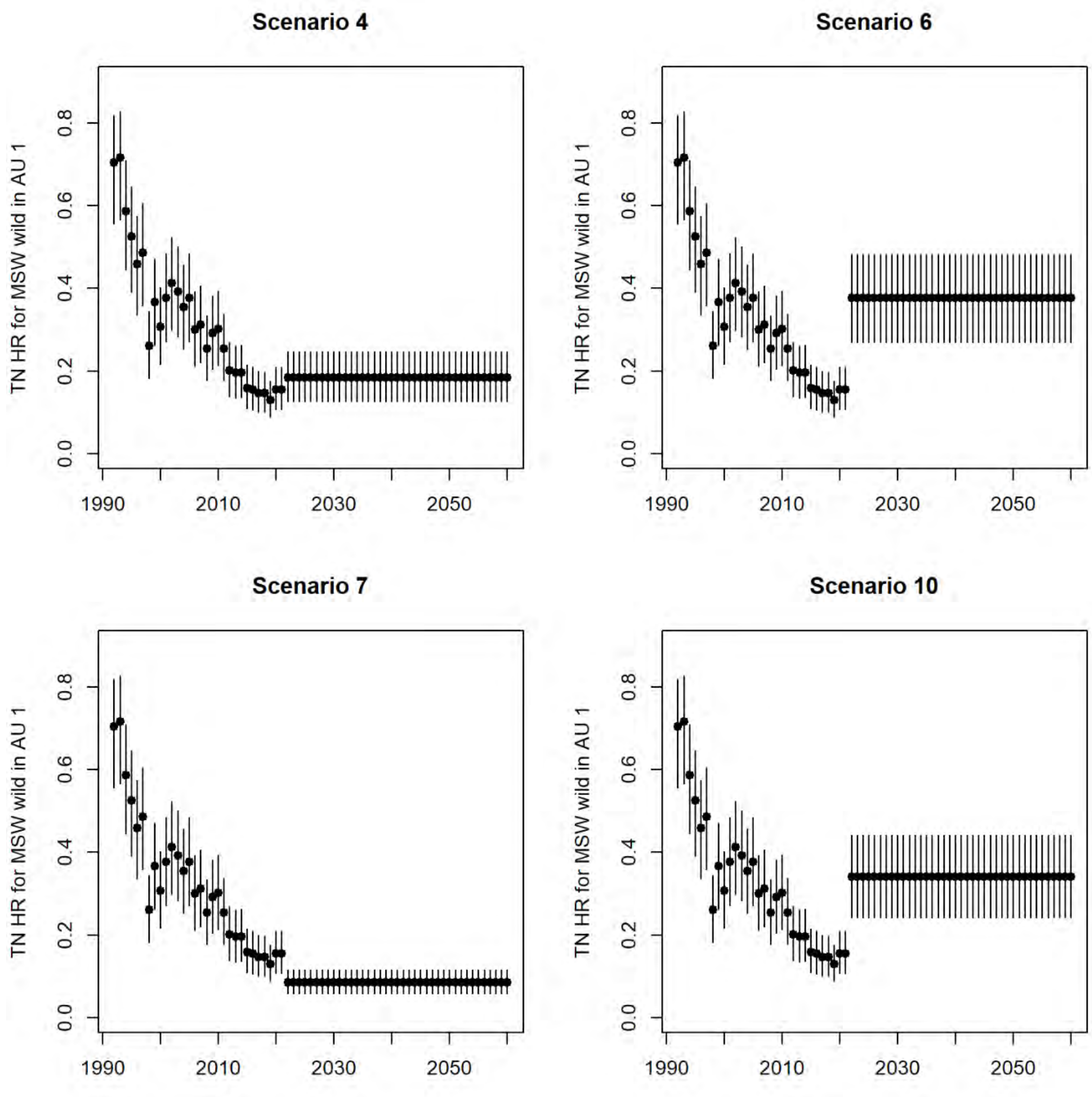


Figure 4.3.2.8b. Harvest rates (median values and 90% probability intervals) for wild multi-sea winter salmon in coastal trapnet fishery within scenarios 4, 6, 7 and 10.

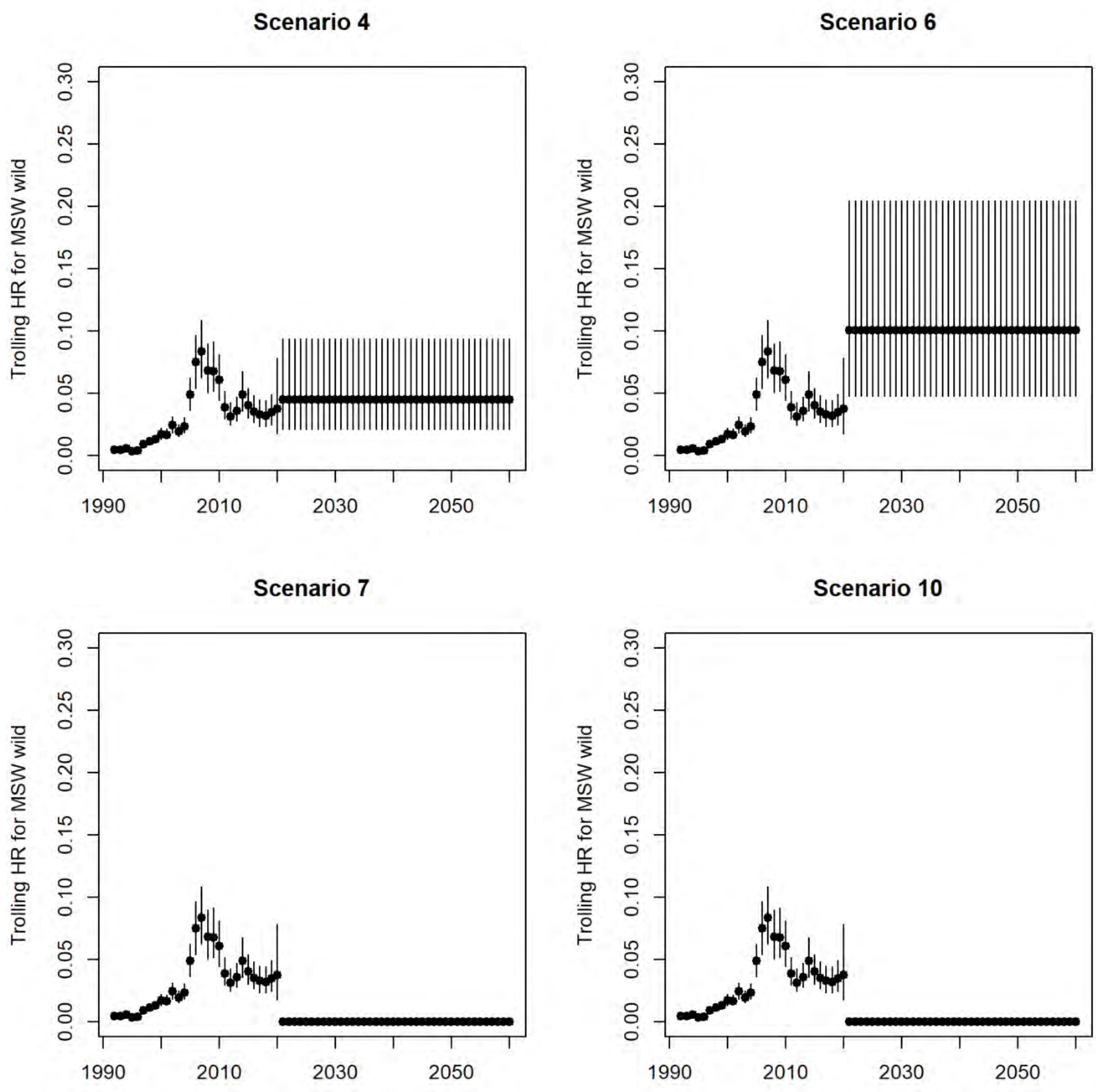


Figure 4.3.2.8c. Harvest rates (median values and 90% probability intervals) for wild multi-sea winter salmon in recreational trolling fishery within scenarios 4, 6, 7 and 10.

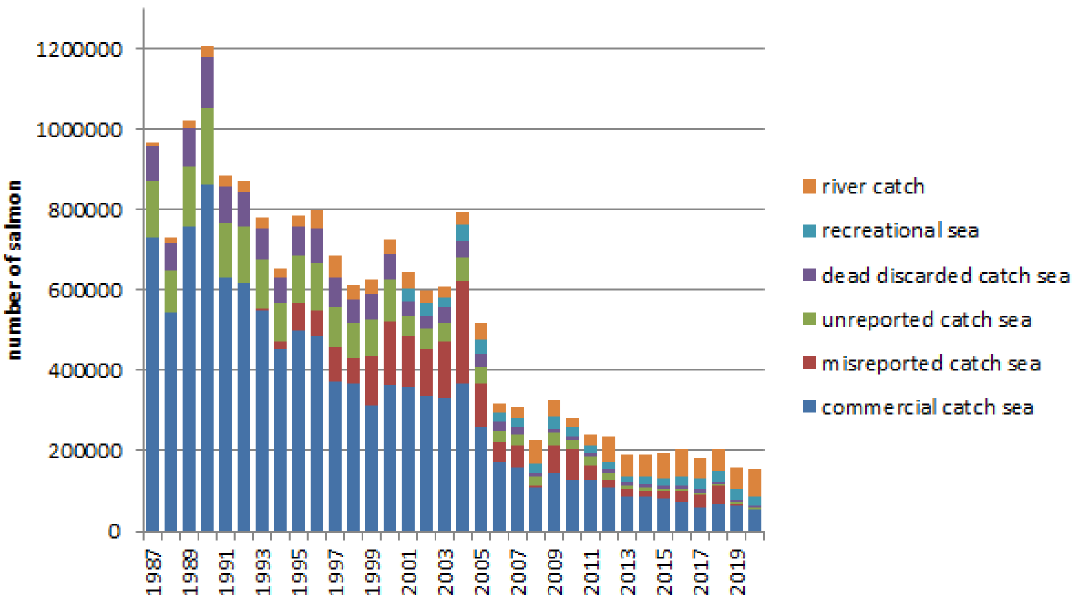


Figure 4.3.2.9. Share of commercial and recreational catches at sea, river catches (river catches include unreporting and also some commercial fishing), and discard/unreporting/misreporting of total sea catches in subdivisions 22–31 in years 1987–2020.

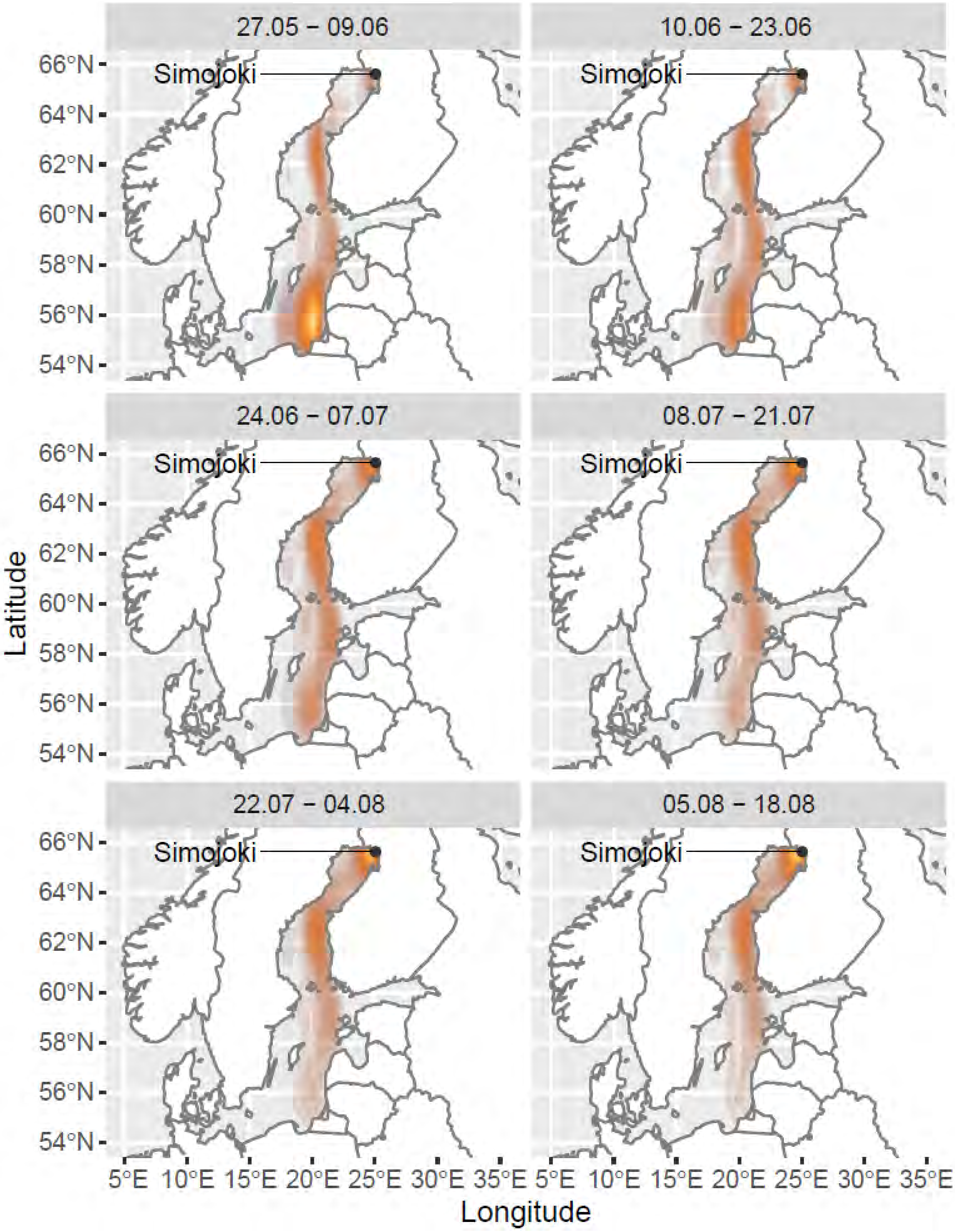


Figure 4.5.3.2.1a. Heat maps showing the spatial distribution of reproductively mature Simojoki salmon (AU 1) at subsequent fortnights during the main spawning migration (late May until mid-August), as estimated by the multi-stock migration model (Whitlock *et al.*, 2018; Whitlock *et al.*, in press). Pale yellow indicates the highest abundance, while brown indicates the lowest abundance.

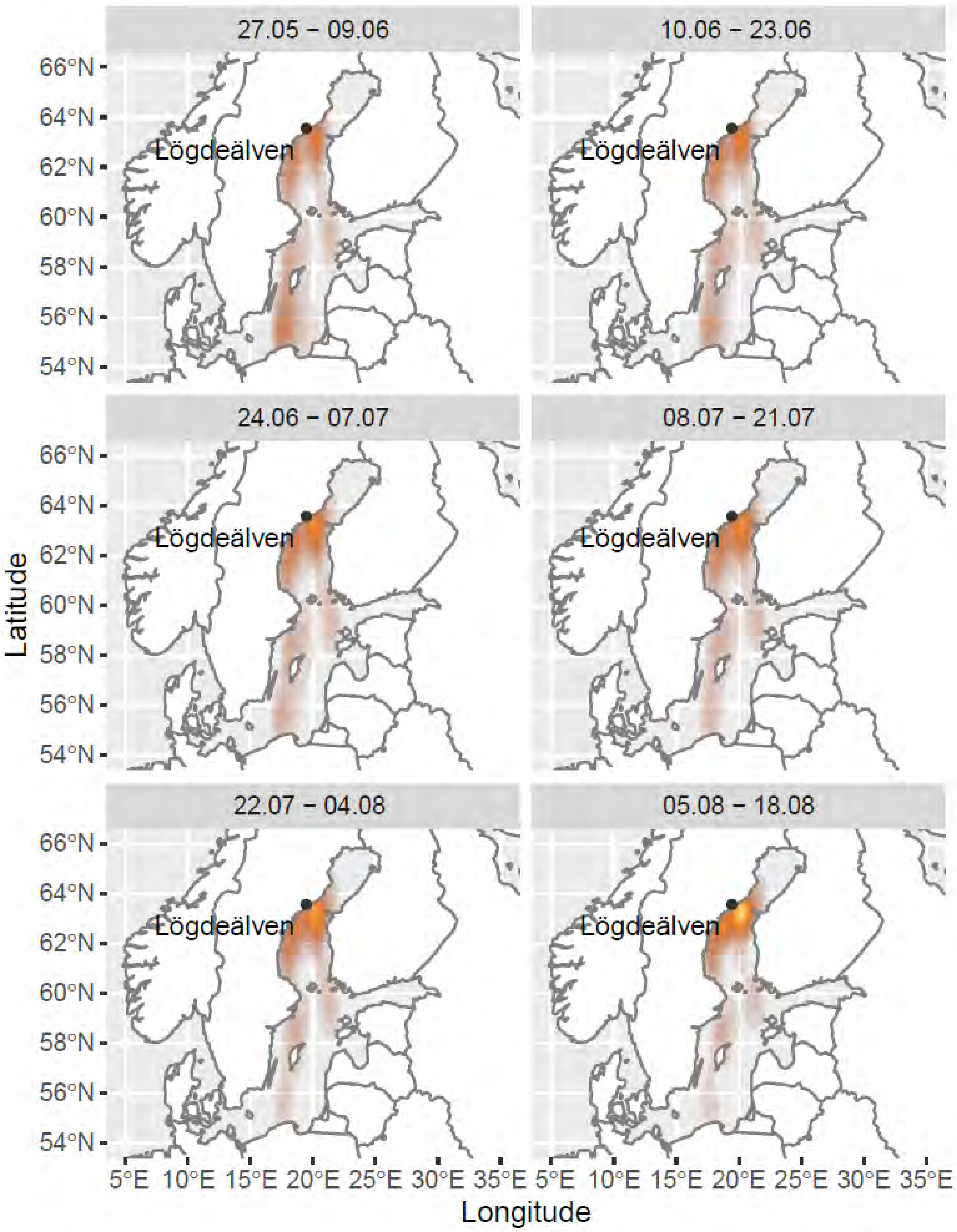


Figure 4.5.3.2.1b. Heat maps showing the spatial distribution of reproductively mature Lögdeälven salmon (AU 2) at subsequent fortnights during the main spawning migration (late May until mid-August), as estimated by the multi-stock migration model (Whitlock *et al.*, 2018; Whitlock *et al.*, in press). Pale yellow indicates the highest abundance, while brown indicates the lowest abundance.

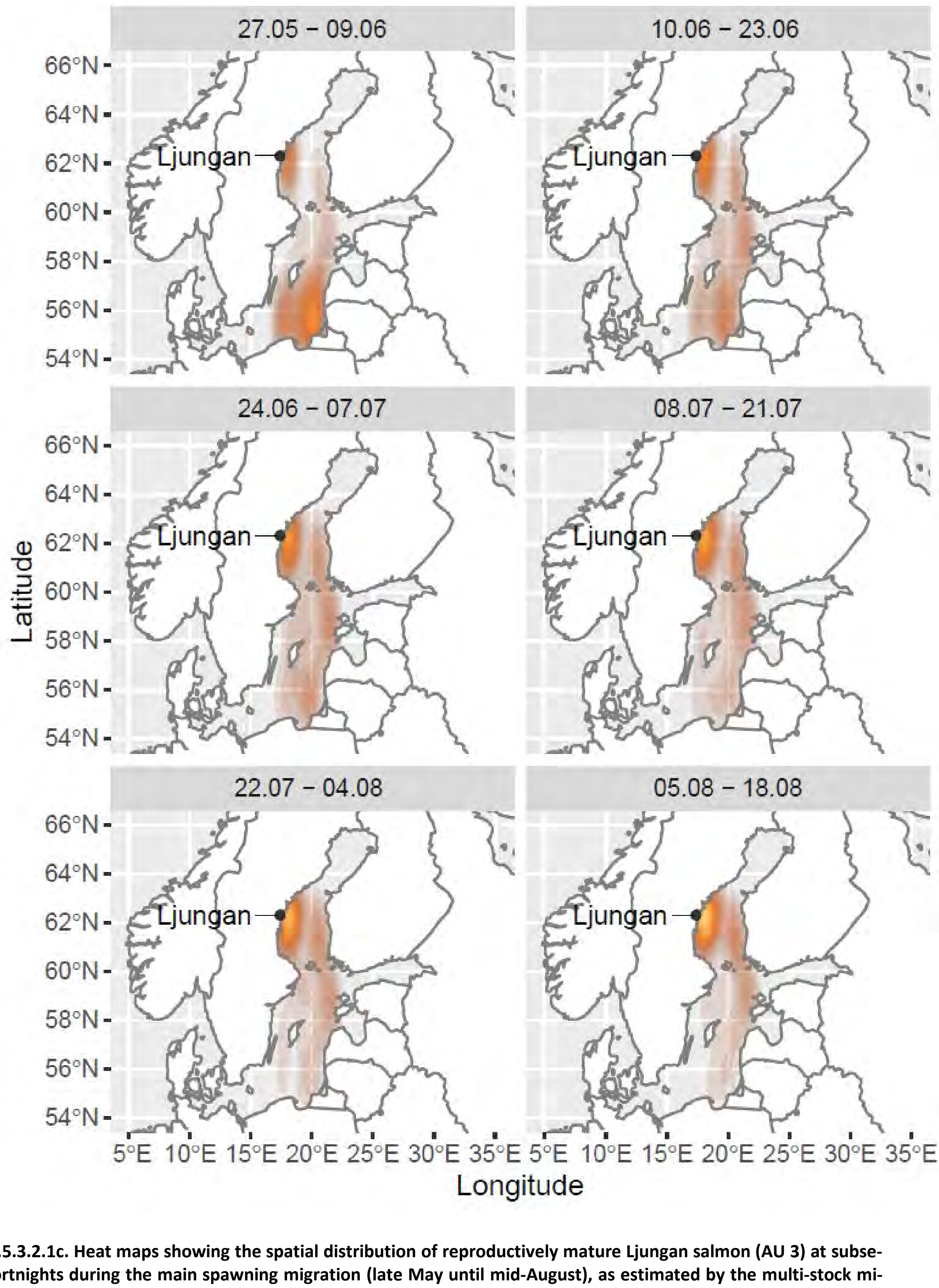


Figure 4.5.3.2.1c. Heat maps showing the spatial distribution of reproductively mature Ljungan salmon (AU 3) at subsequent fortnights during the main spawning migration (late May until mid-August), as estimated by the multi-stock migration model (Whitlock *et al.*, 2018; Whitlock *et al.*, in press). Pale yellow indicates the highest abundance, while brown indicates the lowest abundance.

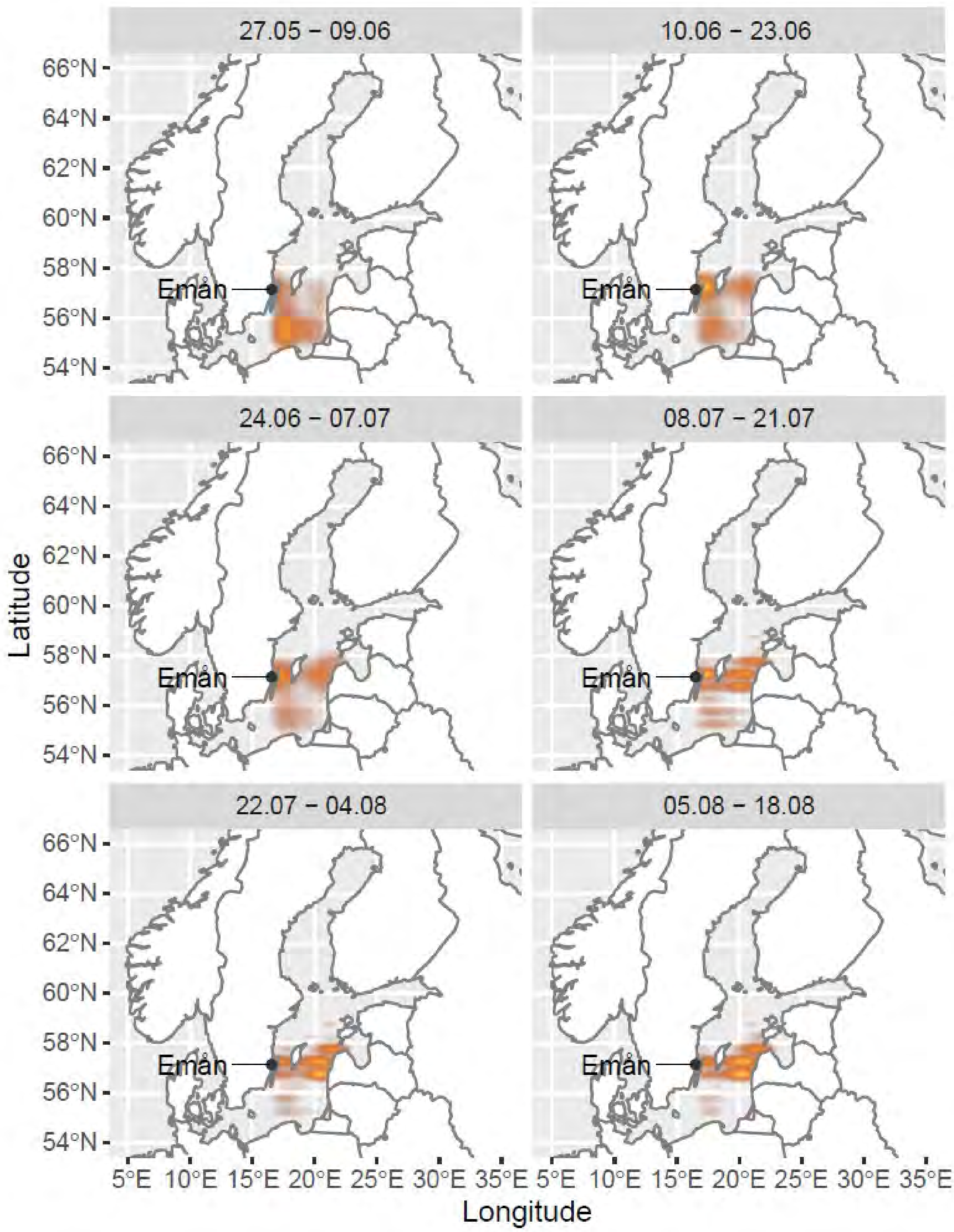


Figure 4.5.3.2.1d. Heat maps showing the spatial distribution of reproductively mature Emån salmon (AU 4) at subsequent fortnights during the main spawning migration (late May until mid-August), as estimated by the multi-stock migration model (Whitlock *et al.*, 2018; Whitlock *et al.*, in press). Pale yellow indicates the highest abundance, while brown indicates the lowest abundance.

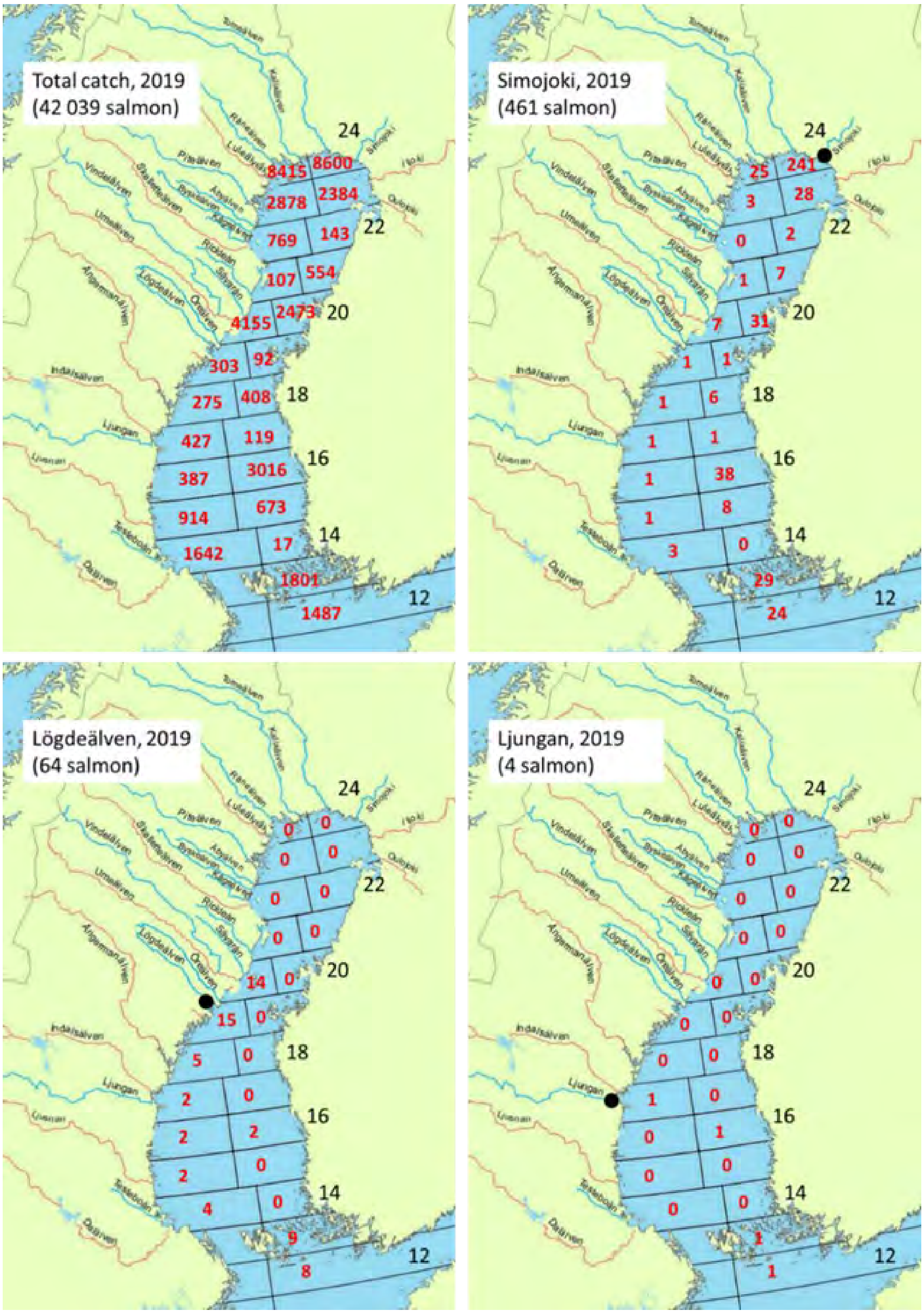


Figure 4.5.3.2.2. Spatial distribution of catches (number of salmon) from the multi-stock migration model (Whitlock *et al.*, 2018; Whitlock *et al.*, in press) in the Åland Sea and Bothnian Bay coastal fishery in 2019. The upper left panel shows total catches, followed by number of salmon in the same catches estimated separately for the Simojoki, Lögdeälven and Ljungan river stocks (figures from Dannewitz *et al.*, 2020b). Black dots indicate river mouths. Numbers in black denote "latitudinal bands" used in the multi-stock migration model. Sizes of Swedish and Finnish catches are displayed in the western and eastern box at each band, respectively, except for the eastern box at band 24 (outside Torneälven/Tornionjoki and Kalixälven) that represents combined Swedish and Finnish catches. Also note that the Finnish catch at latitudinal band no. 13 is largely taken to the west of the Åland Islands. Further, smolt production in Ljungan is likely underestimated in the current full life-history model used by WGBAST (see Section 4.4.2). Hence, abundance and total catch estimates for the Ljungan river stock are likely underestimated also in the migration model (where FLHM estimates are used as prior information).

5 Sea trout

Sea trout basically has the same life cycle as salmon. The most important difference is that most strains do not migrate as far as the salmon. Instead, they spend the time at sea in coastal waters where the majority of sea trout from a specific strain stay within a few hundred kilometres from their home river. Some specimens, however, migrate further and in some strains in the Southern Baltic, most sea trout seem to migrate longer distances into the open sea. Sea trout spawn and live during the first period of life in smaller streams than salmon. In the Baltic Sea area, sea trout are found in a much larger number of streams than salmon.

The assessment of sea trout populations in the Baltic is partly based on a model developed by the Study Group on Data Requirements and Assessment Needs for Baltic Sea Trout, SGBALANST (ICES, 2011), first implemented at the assessment in 2012 (ICES, 2012). For the evaluation of model results, other basic observations such as tagging data, count of spawners and catch statistics are also taken into account.

Below follows subsections on sea trout catches, fisheries, and biological monitoring data followed by descriptions of assessment methods and results.

5.1 Baltic Sea trout catches

5.1.1 Commercial fisheries

Nominal commercial catches of sea trout in the Baltic Sea are presented in Table 5.1.1.1. The total catch was slightly lower than in last year and amounted to 148 tonnes in 2020. A majority (80%) of this catch was caught in the Main Basin.

In the Main Basin, the catch decreased from 954 tonnes in 2002 to 236 tonnes in 2008. After two years (2009–2010) of somewhat higher catches, around 450 tonnes, the total commercial catch again fell, reaching a minimum of 145 tonnes in 2015. In 2016, the total Main Basin commercial catch again increased somewhat to 184 tonnes (where it remained in 2017) and in 2018, it increased further to 274 tonnes. In 2019, catches decreased here about 45% and reached only 123 tonnes. As in previous years, the majority of this catch was from the Polish fishery (74%). In 2020 catches were slightly lower than in 2019 and amounted to 116 tonnes.

The total nominal commercial catch of trout in the Gulf of Bothnia was 19 tonnes in 2019, which is similar to 2018 (22 tonnes) and below the ten-year average catch (46 tonnes). In 2020, the level of catches decreased slightly to 16 tonnes. All commercial catches in Gulf of Bothnia were from coastal fisheries.

In the Gulf of Finland, the total commercial sea trout catch in 2019 was 17 tonnes (Table 5.1.1.1), which is below the average for the last ten years (21 tonnes). In 2020, catches was similar to the previous year and amounted to 16 tonnes.

5.1.2 Recreational fisheries

Recreational sea trout catches (landed) in the Baltic Sea are presented in Table 5.1.2.1. In 2020, the total catch increased to 656 tonnes, from 589 tonnes in 2019. However, the catch was lower than in 2016–2017 when about 750 tonnes were reported. A majority (85%) of this catch was caught in the Main Basin.

Recreational river catches in 2020 were 37 tonnes, and were taken mainly in Swedish Gulf of Bothnia rivers. This is a smaller river catch than the ten years average (43 tonnes; Table 5.1.2.1). Most of the recreational catch in the coastal zones of the Gulf of Bothnia and the Gulf of Finland was taken by Finnish fishermen (64 tonnes), similar to the last years.

Data on recreational coastal catches from the Main Basin in 2018 were available from Estonia, Latvia, Lithuania, Finland, Poland, Sweden and partially from Denmark and Germany (Table 5.1.2.1). From the last several years, results from questionnaires on Danish that coastal recreational catches increased from 224 tonnes in 2011 to 521 tonnes in 2014. Until 2016, they decreased to 323 tonnes, which constituted about 55% of the total Baltic Sea recreational catch of sea trout. In 2017–2019 this share is lower (about 30–40%). In the current year, the data have been upgraded with the results of Polish recreational sea fishing for 2017–2020 years.

5.1.3 Total nominal catches

The highest combined commercial and recreational nominal catches, above 1300 tonnes, were taken in the early and late 1990s (Table 5.1.3.1). Since 2001, they have been decreasing to the level of 700–800 tonnes in recent years (Tables 5.1.1.1 and 5.1.2.1 combined). In 2020, the combined catch reached 804 tonnes, and was higher by approximately 40% than in 2019. Note that when taking estimated levels of misreporting of salmon as sea trout in the Polish sea fishery into account (Section 2.3.3), the overall reported commercial sea trout catches have been much too high. However, in last year, according to new regulation in Polish fisheries, the level of misreported catch has dropped almost to zero. This situation continued in 2020. A column with yearly estimates of salmon catches misreported as sea trout (in weight) in the last ten years were added to Table 5.1.1.1.

5.1.4 Biological catch sampling

Strategies for biological sampling of sea trout and procedures are very similar to those for salmon (Annex 2, Section 2.5). In total, 1424 sea trout were sampled in 2020, similar to in 2019 (Table 5.1.4.1). Most samples were collected from Latvian (n=716) and Swedish (n=243) catches. In addition, 150 samples were collected from Estonian catches in the Gulf of Finland (SD 32), and 95 from Finnish catches in SD 29–32. Polish samples originated from river catches (n=100) in the Rega River and from the sea (n=27). Additionally, 25 sea trout were sampled in Germany and only four in Lithuania.

5.2 Data collection and methods

5.2.1 Monitoring methods

Monitoring of sea trout populations is carried out in all Baltic Sea countries. The intensity and period during which monitoring has been going on varies (ICES, 2008c). Some countries started their monitoring in recent years, while very long dataseries exist for a few streams in others (ICES, 2008c). From 2016, a new European Union (EU) regulation (2016/1251) adopting a multi-annual program for the collection, management and use of data in the fisheries and aquaculture, obligated EU countries to collect sea trout catch data.

Most monitoring of sea trout is carried out by surveying densities of trout parr in nursery streams by electrofishing. In Denmark, only a few sites in Baltic streams are monitored annually. In addition, a rolling scheme is used for electrofishing-monitoring of sea trout on the national level. Due to the large time lap between fishing separate rivers these are not directly useable for assessment, but the results are used as background information on the status of populations as such. In a couple of countries, sampling of parr densities are used to calculate smolt production by a relation of parr to smolt survival, either developed in the same stream or in some other (ICES, 2008a). In most countries (but not in Denmark and Poland) electrofishing is supplemented with annual monitoring of smolt escapement by trapping and counting in one or more streams. In total, smolt production estimates exist for 12–13 rivers in the entire Baltic area, but the length of the time-series varies very much.

In only three streams/rivers (Mörrumsån and Testeboån in Sweden and Pirita in Estonia) both numbers of spawners and smolts are monitored. Adult counts are determined by trapping or recording of ascending sea trout using automatic counters. In 24 rivers (nine in Sweden, three in Poland, eight in Germany, one in Estonia and three in Finland) the numbers of spawners are monitored by automatic fish counters or video systems. In three rivers, the total run of salmonids is determined using echosounder systems. However, this technique does not allow strict discrimination between sea trout and salmon (or other fish species of similar size).

An indication of the spawning intensity can also be obtained by counting of redds. Such information is collected from a number of sea trout streams in Poland, Lithuania and Germany (ICES, 2008a). In a couple of streams in Denmark, the catch in sports fisheries has been used to estimate the development of the spawning run. Catch numbers are also available from some Swedish rivers. Tagging and marking are furthermore used as methods to obtain quantitative and qualitative information on trout populations (see below). Evaluation of sea trout status in rivers is done based on national expert opinions, as well as on factors influencing status. Such evaluations are updated irregularly.

5.2.2 Assessment of recreational sea trout fisheries

There is a highly developed recreational fishery targeting sea trout in many countries. Angling (rod-and-line fishing) accounts for the majority of the catches. The most common methods are spin and fly fishing from the shore or in rivers, and trolling with small boats at sea. The shore-based fishery along coasts and in rivers is highly diffuse and variable with strong local and regional variations depending on weather conditions and season. In the southern Baltic Sea, recreational fishing on sea trout takes places during the whole year with distinct activity peaks in spring and autumn, some night fishing occurs in summer.

While the recreational catches of sea trout are largely dominated by rod-and-line fisheries, there are other types of fisheries carried out in some countries. To a smaller extent passive gears such as trapnets, gillnets or longlines are being used for catching sea trout, either as a target species or as bycatch in other coastal recreational fisheries. Except for in northern Gulf of Bothnia, the catches from this type of fishing is estimated to be of minor importance in terms of impact on the stocks, i.e. removals.

Monitoring of the recreational fisheries is carried out in different ways. Below follows a description of methods and activities in the Baltic countries.

Since 2009, recreational catches of sea trout in Denmark have been estimated based on an interview-based recall survey, which is conducted by DTU Aqua in cooperation with Statistics Denmark. Information is collected two times per year. In addition, during spring 2017, a project on the recreational sea trout coastal rod-and-line fishery was carried out on the island Funen in SD 22. Two different approaches were applied: 1) on-site interviews (rowing creel) collected information on i.a. catch, release rates and effort, and 2) by aerial survey, information on effort was obtained. Furthermore, information on motivation and satisfaction was collected.

In Estonia, catch reporting has been mandatory since 2005. The data are reported to and stored in the Estonian Fisheries Information System (EFIS) for passive gears (gillnets, longlines) and salmon and sea trout rod-and-line fishing in rivers. The latest recreational fishery survey was carried out in 2016, based on a phone call approach.

Since 2002, the official catch estimates of the recreational sea trout fishery in Finland are based on a national recreational fisheries survey. Biannual surveys are conducted to estimate participation, fishing effort and catches of the recreational fishery (http://stat.luke.fi/en/recreational-fishing). A stratified sample of about 7500 household dwellings is contacted with response rates of around 40–45% after a maximum of three contacts. Afterwards, a telephone interview is done for a sample of the non-respondents. Harvested and released catch is measured separately by species. The latest estimate of recreational sea trout catch is for 2018 year and being 64 (CV>50%) tonnes. Due to methodical reasons, the catch estimate varies significantly between the recent and older surveys. Other information, however, does not indicate such a large variation in the true catches between the years. In the WGBAST catch data, the Finnish recreational catch estimates before the year 2002 is relative to the commercial catch by assumption that recreational catch constituted about 75% (derived from the tag return data) of the total catch (re-evaluation is considered). Since year 2002, the estimates have been based on the Finnish Recreational Fishing Survey results. The 2020 survey is ongoing and results will be published in October 2021.

In Germany, a nationwide telephone-diary survey with quarterly follow-ups was conducted in 2014/2015, contacting 50 000 German households to collect representative data on catch and effort, and social, economic and demographic parameters for the German marine recreational fishery, covering also the recreational sea trout fishery. However, to collect more detailed information on the recreational sea trout fishery an additional pilot study (diary recall survey) was conducted. During this study, a bus route intercept survey was used to recruit diarists, collect biological samples (length, weight, scales, and tissue samples), and socio-economic data. Ongoing analyses aim to combine both studies to provide a full picture of the recreational sea trout fishery in Germany. Anecdotal information showed that recreational sea trout catches in freshwater are small and probably insignificant compared to marine catches. The results of the survey conducted in 2015 were considered to be a reliable level of recreational fishing and their result (151 tonnes) was also adopted for the years 2016–2019. An update of the recreational sea trout catches is expected to be available in 2021.

In Latvia, a first attempt to estimate total sea trout catches from angling was done in 2018 using Internet questionnaires. The main aim was to get general information about angling places, gears and efforts. In a second part of the questionnaire, information about sea trout, salmon, cod and eel catches were collected. The total estimate received of sea trout caught in the recreational fishery was deemed highly unrealistic, amounting to 51 978 individuals (156 tons), and should not be used in further analyses. Sea trout angling from coast is not popular in Latvia due to an unfavourable coastline (most of the coast consists of sandy beaches, no islands or archipelagos) and ice coverage in winter. However, all landings in the Latvian "self-consumption fishery" are reported in logbooks. According to this logbook information landings of seatrout in 2018 were 1957 individuals. Additionally, according to official reports from the licensed fishery, 103 sea trout were caught. This estimate does not include angling in Daugava River (no licensing, because Daugava stock consists mainly from reared salmon and sea trout) or angling from the coast. In 2019 recreational coastal (1277), recreational offshore (10) and river angling (172) landed 1459 sea trout. In the rivers, where natural reproduction of salmon occurs, all angling and fishing for salmon and sea trout is prohibited with exception of licensed angling for sea trout and salmon kelts during the spring season. This encompass the rivers Salaca, Venta and from 2020 also Gauja River. In total, 772 retained sea trout kelts were reported in licensed angling in 2020. The large increase in reported retained salmon and sea trout in the Salaca River can be explained by more active and accurate data registration and submission. Submission of data has improved due to amendments to the rules of licensed angling – anglers cannot buy a new licence without submitting a report about previous one.

In Lithuania, recreational sea trout fishing is mainly conducted in rivers. Since 2015, recreational (anglers) sea trout catches are estimated by an online survey, a face-to-face interview survey, and individual interviews and catch reporting with diaries of selected anglers and experts. CPUE data (ind/person/day) are estimated from survey data, and combined with number of licences sold to anglers to calculate the total catch. In 2015, the online survey, face-to-face interview survey, and individual angler interviews were conducted, whereas in 2016 and 2017 only online surveys were carried out.

Pilot study relating to salmon and sea trout recreational fisheries was conducted in 2017–2019. Based on the results of the pilot study, sampling programme was included into regular sampling since 2020. In 2020, trolling boats have been observed in ten harbours with particular importance of Hel, Gdynia, Gdańsk Górki Zachodnie, Kołobrzeg harbours. A total of 125 different active trolling boats had been inventoried in 2020. Number of active trolling boats varied between autumn/winter (87–94) and spring (103–107) seasons with a higher number of trolling boats in spring. Because of COVID-19 issue, the catches have been affected by lower activity of trolling anglers, and national restrictions (lock-down). It is planned to update catch data for 2018–2020, based on obtained results. The estimated sea trout by-catch during salmon trolling trips in 2020 is 132 individuals (retained). The coastal sea trout catch estimates including coastal trolling targeting sea trout for 2020 was 81 713 fish.

A pilot study of estimation of Polish river recreational catches has begun in 2017 and was continued in next three years. First on three rives: Ina (SD 24), Rega and Słupia (SD 25) and from 2018 also on Parsęta River (SD 25). In 2020 three new rivers were added to the survey: Łeba, Reda (SD 25) and Drwęca River (SD 26). The method used is based on catch records provided by fishing users supplemented with data from on-site surveys of anglers carried out according to the same schedule on the rivers studied. The data obtained from the catch records are delayed by two years, which results from the fishing fee system. The results obtained with the method developed in the pilot study indicate that in 2018, 2330 sea trout were caught in the seven analysed rivers, which, assuming an average weight of 3 kg of sea trout, gives about 7 tons.

Results from on-site surveys performed in 2017–2020 show that the average catch per angler ranged from 0.9 sea trout (2016–2017) to 2.9 for (2019–2020) per year. It was also observed that these values were higher for the Parsęta River. In 2020, the average number of fishing occasions per respondent was 28. The vast majority of surveys were for local anglers. According to the questionnaire, half of the surveyed anglers prefer to practise catch and release. It has also been shown, that periods of intensity of sea trout fishing can vary significantly between rivers. In the Ina, Rega and Łeba rivers, the main fishing season is winter, while the rest of the fishing season is spread over time with peak just before spawning.

There are about ten rivers with similar intensity of sea trout/salmon fishing in Poland, so, taking into consideration underestimation of registers, recreational catch in Polish rivers can be roughly estimated for 40–80 specimens of salmon and 5–10 tons of sea trout yearly. As a result of the pilot study a method for catches estimation on main sea trout rivers was proposed. Based on the proposed method, it is planned to upgrade river catch data for earlier years in 2021.

In Russia, sea trout was previously a protected species in the Baltic Sea, and recreational fishers were not allowed to target sea trout in the sea nor in rivers. As from March 2020, sea trout fishing was allowed, but statistics for the catch have not been available.

In Sweden, recreational fishery for sea trout is very popular. Since there is no commercial fishing specifically targeting the species, commercial catches are low and most catches are from recreational fisheries. A major part of the Swedish recreational catch is taken along the Baltic coast

(>2400 km, including islands of Öland and Gotland), in particular by angling from shore or small boats, and from use of gillnets. Offshore recreational fisheries are in most cases done by trolling targeting salmon, with sea trout caught only occasionally. However, trolling closer to the coast targeting sea trout is starting to be popular in some areas. Swedish data on recreational sea trout river catches are almost only collected in larger salmon rivers, and therefore river catch statistics are far from complete. However, as mentioned, the largest proportion of the catch is assumed to be taken in coastal waters where no surveys specifically targeting sea trout are in place so far. Currently the best source for catch statistics comes from an annual national mail survey conducted by the Swedish Agency for Marine and Water Management (SWaM), the authority responsible for fisheries management. The survey is sent to about 17 000 randomly selected persons each year, and it collects statistics on different aspects of recreational fishing (catches, expenditures, fishing days, etc.) for all species. However, this survey can neither estimate trout catches with good precision nor on the geographic scale needed for effective management. To obtain catch statistics with better precision and finer geographic resolution, a specific survey programme needs to be developed.

5.2.3 Marking and tagging

The total number of finclipped sea trout released in 2020 in the Baltic Sea area was 1 328 632 smolts and 33 045 parr, similar to the previous year (Table 5.2.2.1). Finclipping of hatchery-reared smolts is mandatory in Sweden, Finland and Estonia. The largest number of finclipped smolts was released in Sweden (598 760) followed by Latvia (369 972) and Finland (359 400). All released sea trout smolts have been finclipped in the Gulf of Finland since 2014 and in the Gulf of Bothnia since 2016. Finclipping was not performed in Poland in 2020, and stocked sea trout smolt were not finclipped in Denmark, Germany, Russia, Estonia or Lithuania. In 2020, the total number of Carlin tagged sea trout was only 2000 all released in Subdivision 31 (Table 5.2.2.1). The number of sea trout tagged with passive integrated transponders (PIT) increases every year. In 2020, 19 520 sea trout were tagged internally; the majority was tagged by Poland and Sweden as reared smolts. Polish smolt were released in the Vistula basin (6000) in Subdivision 26 and into the Parseta River (5000 smolts, SD 25). In subdivisions 31 and 30, smolts tagged with PITs were stocked in rivers Umeälven (2000) and Dalälven (6520) (Table 5.2.2.1). In Finland 511 700 eyed egg and fry of sea trout were marked with Alizarin Red Staining solution and released in subdivisions 29–31 (Table 5.2.2.1).

5.3 Assessment of recruitment status

5.3.1 Methods

Recruitment status

The SGBALANST (ICES, 2008c; 2009b) screened available data on sea trout populations around the Baltic Sea, and proposed an assessment method (ICES, 2011). The basic method, theory and development is fully described in ICES (2011; 2012), and the slightly adjusted method applied since the assessment in 2012 is briefly summarized below, together with modifications applied in the present assessment.

Through screening of data availability, (ICES, 2008a; 2009a; 2011) it was found that only abundance of trout from electrofishing were available from all countries. Together with habitat data, trout densities are collected annually from specific sites every year in most countries. However, at the time of the screening, the number of sites was highly variable and mostly sparse in many parts of the Baltic. From a few countries, directly useable data were not available, either because there was no electrofishing programme at all, or because the information collected was not sufficiently detailed. It was also found that only little and scattered information existed on other life stages (sea migration, abundance of spawners, smolt production and survival). Likewise, information on human influence, such as sea and river catches (especially recreational ones), was sparse.

An assessment model using electrofishing data together with habitat information collected at the same sites was proposed focusing on *recruitment status* as the basic assessment tool (reference point). Recruitment status was defined as the *observed recruitment* (observed densities) relative to the *potential maximal recruitment* (maximal densities that could be expected under the given habitat conditions, i.e. the predicted densities, see below) of the individual sea trout populations.

Due to the significant climatic (e.g. temperature and precipitation) and geological differences found across the Baltic area, as well as the huge variation in stream sizes, the model proposed is constructed to take variables quantifying such differences into account. Differences in habitat qualities (suitability for trout) influence trout parr abundance, given that stock status is below carrying capacity and spawning success is not limited by environmental factors such as migration obstacles downstream to monitored sites.

To allow comparison of trout abundances between sites with different habitat quality, a submodel was used, i.e. the **Trout Habitat Score (THS)**. THS is calculated by first assigning values (scores) for the following relevant (and available) habitat parameters for 0+ trout: *average/dominating depth, water velocity, dominating substrate, stream wetted width, slope* (where available) and *shade*. Scores assigned range between 0 for sites with poor conditions and 2 for best conditions (assessed from suitability curves and in part by expert estimates; see details in ICES, 2011). THS is then calculated by addition of score values resulting in a total score that can vary between 0 (very poor conditions) and 12 (10 if *slope* is omitted) for sites with very good habitat conditions. Finally, the THS values obtained were grouped in four **Habitat Classes** ranging between 0 (poorest) and 3 (best (ICES, 2011).

The potential maximum recruitment for sites with a given habitat quality used in this year's assessment was the same as in 2015 (ICES, 2015). In calculations, observed parr abundance was transformed using Log10 (x+1) to minimize variation and improve fit to a normal distribution.

Predicted maximum densities were determined by a multiple linear regression analysis based on select sites displaying expected "optimal densities" (see Section 5.6.2. in ICES, 2015). The analysis found the variables *log (width), average annual air temperature, latitude, longitude and THS* to be significant in determining optimal densities of 0+ trout (r^2=0.5, Anova; $F_{2,254}$=51.8, p<0.001) according to the following relation:

1. Log10 (*0+optimal density*) = 0.963 - (0.906**logwidth*) + (0.045**airtemp*) - (0.037**longitude*) + (0.027**latitude*) + (*THS**0.033).

This multiple regression relation 1) was used for calculating the potential maximal densities at the individual fishing occasions, with current **Recruitment Status** 2) calculated as:

2. Recruitment status = (Observed density / Predicted maximal density) * 100.

   Note that for two reasons, it is possible that single observed densities can sometimes by higher than the predicted mean, resulting in a recruitment status somewhat above 100%. First, as described above, predicted maximal densities are calculated using multiple regression based on observations that show variation around the mean. The maximum values used to assess status thus represent average densities across several sites with a given habitat quality score (THS), and individual observations may occasionally exceed the predicted (average) maximum. Second, the calculation of predicted maximal densities have not been updated since the construction of the present model in 2015, taking more recent observations into account.

Mean recruitment status was calculated for each Assessment Area (see below and Figure 5.3.2.1), each ICES subdivision (SD) and by SD and country combined. Recruitment status was calculated separately for 2019 and for the three last years (2017–2019). Assessment Areas were defined according to the below table:

Assessment area	SD
Gulf of Bothnia (GoB)	30–31
Gulf of Finland (GoF)	32
Western Baltic Sea (West)	27 & 29
Eastern Baltic Sea (East)	26 & 28
Southern Baltic Sea (South)	22–25

Recruitment trends

An indicator of **Recruitment Trend** was calculated as the bivariate correlation between annual recruitment status (see above) and sampling year (ICES, 2012), illustrated using the slope from a linear regression with 95% CI. Recruitment over time was assessed for the last five-year period (2016–2020) in order to illustrate the most recent development in change of status. Only sites where a calculated status was available for all years in the last five-year period were used when trends were calculated (Figure 5.3.2.2).

Both recruitment status and trend were calculated as average values for each of the following units of analysis: **Assessment Area**, **ICES** s**ubdivision** (SDs) and, where more countries have streams in one SD, for **individual countries**.

For a final assessment, the results from the above status and trend analyses were combined with additional information gathered, most markedly from fisheries and count of spawners (where available).

5.3.2 Data availability for status assessment

Information on densities of 0+ trout from 337 fishing occasions in 2020, at sites with good or intermediate water quality and without stocking, was available for calculation of recruitment status. For the trend analysis, 206 sites that had been fished continuously in the latest five years period (2016–2020) were included (Table 5.3.2.1).

The geographical distribution of fishing occasions used for evaluation of status is shown in Figure 5.3.2.1, whereas the corresponding distribution of sites for trend analysis is shown in Figure 5.3.2.2. Some new sites, previously not available electrofishing data have been included in the assessment over time. In the same way information from some sites that were previously included in the assessment were not available. Most markedly, no information has been available from Schleswig-Holstein (Germany).

5.4 Data presentation

5.4.1 Trout in Gulf of Bothnia (SD 30 and 31)

Sea trout populations are found in a total of 67 Gulf of Bothnia rivers, of which 32 have wild and 35 have mixed populations (Tables 5.4.1.1 and 5.4.2.1).

The status of sea trout populations in Swedish rivers is in general considered to be uncertain. Populations are affected by human activities influencing freshwater habitats, mostly through overexploitation, damming, dredging, pollution and siltation of rivers (Table 5.4.1.2).

Average 0+ parr densities for Swedish and Finnish rivers in the area are presented in Figure 5.4.1.1. Swedish rivers are divided into bigger, salmon rivers, which have been reported in previous years, and trout rivers which are new for this report. The densities in salmon rivers have been low for many years and densities in trout rivers are high and increasing since a beginning of this century. The SD 30–31 electrofishing results from Finland include three rivers (Lestijoki, Isojoki, and some tributaries of Tornionjoki). Densities of 0+ parr have remained low in Lestijoki, but increased after a few years drop in Isojoki and in some Tornionjoki tributaries (Figure 5.4.1.1).

Sea trout smolt runs (trapped and estimated) in the period 2002–2020 are presented in Table 5.4.1.3. In river Tornionjoki (SD 31) smolt trapping during the whole migration period for sea trout has only been possible in some years, because the trout smolt run is earlier than for salmon, and in most years the trout smolt run is already ongoing when river conditions allow start smolt-trapping; the six annual estimates available for Tornionjoki range from about 11 000 to 23 000 sea trout smolts with maximum amount in 2019 (Table 5.4.1.3). In the two smaller SD 31 rivers, Sävarån and Rickleån, where trapping ended in 2013 and 2017, yearly production estimates have varied from ca. 200–2100 and 300–600 smolts, respectively. A screw trap has started in Isojoki (SD 30) in 2019 and a number of smolts was estimated to 6084 in 2020, c 1200 less than in 2019 (Table 5.4.1.3).

The number of sea trout spawners recorded by fish counters is low in most larger 'salmon rivers' in Sweden (Figure 5.4.1.2). The average number of sea trout counted in River Kalixälven increased somewhat after 2012, to a maximum of above 300. In River Byskeälven, the number increased to almost 300 fish in 2016, followed by a decrease to 50 in 2018 and increase back to 300 in 2020. From 2011, the annual number of ascending sea trout in River Vindelälven has varied within the range 100–300. However, the number increased considerably in 2019 to almost 500 fish, followed by a decrease to less than 400 fish in 2020. In contrast, River Piteälven has shown a positive trend that has lasted since the beginning of the century, with over 1800 sea trout spawners recorded in 2020.

River catches of wild sea trout in SD 30–31 since 2013 do not reflect actual runs, because of implemented restrictions (size and catch limits, in R. Torne a complete ban on harvest of sea trout, etc.). However, during last three years catches in SD 30 and 31 has increased from the lowest recorded level of ca. 500 to ca. 2000 fish (Figure 5.4.1.4) despite the drop of River Kalixälven catch to zero in 2017 (Figure 5.4.1.3) and thanks to increase of River Piteälven catch, mainly.

Returns from Carlin tagged sea trout have showed a rapid decrease since the 1990s, and after 2003, the average return rate has been below 1% (Figure 5.4.1.5). For trout tagged in Gulf of Bothnia rivers, a large and increasing proportion of the recaptures, often a majority, are caught already as post-smolts during their first year in sea. Sea trout are mainly bycatch in whitefish fisheries with gillnets and fykenets. Based on tagging data, the proportion of fish caught as undersized fish during the first sea year has been fluctuating around 50% in the last decades (Figure 5.4.1.6), and the proportional distribution of recaptures in different fishing gears has been relatively stable (Figure 5.4.1.7).

According to tagging results, the survival rate of released smolts is at present lower than the long-term average. Furthermore, tagging data show that Finnish sea trout migrate partly to the Swedish side of the Gulf of Bothnia (ICES, 2009a), whereas Swedish sea trout have been caught at the Finnish coast. There is no more recent information available.

A Bayesian mark–recapture analysis based on tagging data (Whitlock *et al.*, 2017) has recently been conducted for reared sea trout in two Finnish rivers in SD 30 and 31 (Isojoki and Lestijoki, 1987–2011). The results of this study indicate substantial fishing mortality for sea trout aged three years and older from both stocks, but particularly in the case of Isojoki (Figure 5.4.1.8). Annual total fishing mortality rate estimates ranged from 1 to 3 in most years for sea trout aged 3 and older in both rivers, corresponding to harvest rates between 0.63 and 0.95. Total fishing mortality for the Isojoki stock showed a decreasing pattern over time, while the temporal pattern was fairly stable for Lestijoki sea trout. Fishing mortality was considerably higher for sea trout of age 3 compared with fish of age 2 in both stocks (Figure 5.4.1.8). A decreasing pattern of survival in the first year at sea was also estimated (results not shown). Sustained high rates of fishing mortality have likely contributed to the poor status and limited reproduction of wild sea trout stocks in the Isojoki and Lestijoki rivers (Whitlock *et al.*, 2017).

5.4.2 Trout in Gulf of Finland (SD 32)

The number of streams with sea trout in Gulf of Finland was partly updated in 2018. It is now estimated that there are 100 rivers and brooks with sea trout in this region; out of these 92 have wild stocks, the rest are supported by releases (Tables 5.4.1.1 and 5.4.2.1). The situation for populations is uncertain in 36 rivers and very poor in 20 (with current smolt production below 5% of the potential).

In Estonia, sea trout populations are found in 39 rivers and brooks in the Gulf of Finland region, of which 38 have wild populations (Table 5.4.1.1). Electrofishing data from Estonian rivers show densities of up to 140 0+ parr per 100 m² in the 1980s. In more recent years, densities have in general been below 40 0+ parr per 100 m² (Figure 5.4.2.1). Estonian rivers with higher smolt production are situated in the central part of the north coast. Smolt runs in River Pirita during the period 2006–2019 have varied between around 100 and 4000, and after three years of high amounts, dropped to around 600 in 2019 and to a very few in 2020 (Table 5.4.1.3). The number of spawners recorded by a fish counter in this river has varied between 26 and 125 fish during 2014–2020 (Figure 5.4.2.2).

Parr densities for sea trout in the Finnish rivers in the Gulf of Finland varied but with an increasing trend since 2003 with the value above 60 in 2020 (Figure 5.4.2.1). The recapture rate of Carlin tagged sea trout in Gulf of Finland shows a continued decreasing trend for more than 20 years; in recent years, it has been close to zero (Figure 5.4.1.5). Tagging results have shown that in Finnish catches in general, about 5–10% of the tag recoveries are from Estonia and some also from Russia. These migration patterns have been confirmed in a genetic mixed-stock analysis (Koljonen *et al.*, 2014).

In Russia, wild sea trout populations are found in at least 48 rivers and brooks, including main tributaries (Tables 5.4.1.1 and 5.4.2.1). A majority of these populations are situated in rivers or streams along the Russian northern Gulf of Finland coast, but the rivers with highest smolt production are located along the south coast. In most recent years, average 0+ parr densities have in general been below ten individuals per 100 m² (Figure 5.4.2.1) with very high variations in some tributaries of River Luga. The smolt run in River Luga during the period 2002–2014 varied between 2000 and 8000 wild trout smolts (Table 5.4.1.3). After increasing to a record level of 11 600 smolts in 2015, almost three times higher than the average for the total monitoring period (ca. 4000 smolts), it again decreased to 3600 in 2019 and 2020. Total production in the Russian part of

Gulf of Finland has been estimated to about 15 000–20 000 smolts per year. Genetic studies have shown that 6–9% of the sea trout caught along the southern Finnish coast was of Russian origin (Koljonen *et al*., 2014).

5.4.3 Trout in Main Basin (SD 22–29)

In the Main Basin, when including tributaries in larger water systems (Odra, Vistula and Nemunas), there are 541 rivers and streams with sea trout populations, out of which 476 are wild (Tables 5.4.1.1 and 5.4.2.1). However, these figures do not include Germany; the actual number of German sea trout streams/rivers has not yet been evaluated, although it has been estimated that it could be close to 90.

In Sweden, 207 sea trout rivers are found in the entire Main Basin. Out of these, 200 have wild sea trout populations whereas seven are supported by releases. In Denmark, 139 out of 173 trout rivers are wild, with a majority classified as being in good condition. In Poland, the number of populations was revised in 2018; sea trout are found in 26 rivers (whereof 12 in SD 26), mainly in Pomeranian rivers (eleven) but also in the Vistula (six) and Odra (six) systems (including the main rivers). All Polish sea trout populations but two are mixed due to supplemental stocking since many years. There are three Russian sea trout rivers flowing into the Main Basin (in the Kaliningrad Oblast). All are wild and their status is uncertain. In Lithuania, sea trout are found in 19 rivers, whereof eight belong to the Nemunas drainage basin. In eight Lithuanian rivers, there are wild populations, while the rest are supported by releases. In Latvia, sea trout populations are found in 54 rivers, 49 of them wild. In Estonia, sea trout occurs in 36 rivers and brooks discharging into the Main Basin. All of them are small with wild populations.

Main Basin East (SD 26 and 28)

In Latvia, average densities of 0+ parr have varied from 6 to 40 per 100 m^2 with highest recorded value 45 in 2020 (Figure 5.4.3.1). In Salaca, estimated smolt numbers from smolt-trapping have varied between 2500 and 19 000 in the period 2002–2016. In 2017, it dropped to below 6000 and since then, stayed on this level with the minimum of ca. 3200 in 2019 and a little increase to 4800 in 2020 (Table 5.4.1.3).

In Lithuania, average parr densities for 0+ trout have varied from five to 19 individuals per 100 m^2 with the maximum in 2020 (Figure 5.4.3.1). The estimated total natural smolt production in 2020 was 59 260, similar to 2019 and more than ten-year average.

In Poland, average densities of 0+ parr in SD 26 rivers have been generally high but variable, with densities of up to more than 90 individuals per 100 m^2 in some years. After four years (2013–2016) with high (70–90) and stable densities, the average 0+ density dropped to level of 30–50 lately (Figure 5.4.3.1). Number of adult sea trout migrating upstream recorded by an electronic counter (VAKI) in a fish-pass at the Wloclawek dam in Vistula River decreased from 1554 in 2015 to only 173 in 2017 and stay on a low level till 2020 (Figure 5.4.2.2).

There are only a few small streams on the east coast of Gotland Island in SD 28 in Sweden. Average densities of 0+ parr have been extremely variable there, from 12 to 362 individuals per 100 m^2 with low value of 41 in 2020 (Figure 5.4.2.2).

Main Basin West (SD 27 and 29)

Average 0+ parr densities in western Estonian rivers (SD 29) have increased during the 20th century, from close to zero to almost 50 per 100 m^2 in 2018 and 2020 (they are monitored every second year) (Figure 5.4.3.2). In Swedish salmon river Emån, the average parr density decreased from above 40 to close to 0 in 1990s and has been varying between one and 15 in 20th century. Densities of parr in small Swedish trout streams in this area have been much higher, above 70 in

2020, but with some drops to around 20, in 2019 lately (Figure 5.4.3.2). Nominal (landed) river catches of sea trout in Emån are presented in Figure 5.4.1.4. The sport fishing harvest of sea trout in Emån has been declining to only a few fish. However, since catch and release is not included, this does not give a correct picture of the total catch.

Main Basin South (SD 22-25)

Average parr density in Swedish trout streams was around 25 individuals per 100 m², one-third of ten years average, what reflects decreasing trend in the area. In salmon river Mörrumsån density of trout parr have been much lower, usually below 10, and gained its minimum of less than 2 in 2020 (Figure 5.4.3.4). Results from smolt trapping in this river shows that the production in the upper half of the river (the smolt trap is located approximately 11 km from the outlet) has varied between 2100 and 10 200 smolts during the last ten years, with the smallest number seen in 2019 and increase to over 4000 in 2020 (Table 5.4.1.3). Number of spawners recorded in River Mörrumsån has been decreasing since 2012, when it was more than 1000 and only 118 fish were counted in 2018; the counter didn't work in 2019 and 2020 (Figure 5.4.2.2). The sport fishing harvest of sea trout has declined markedly in the past decade; in 2020, it was a few fish (Figure 5.4.1.4). However, since catch and release is not included, this does not give a correct picture of the total catch in Mörrumsån.

The total number of wild sea trout smolts produced in Danish rivers (SD 22–25) is at present estimated to around 493 000 per year. In most previous years, electrofishing data from Danish streams have showed average parr densities between 50 and 200 0+ per 100 m², after few years' decrease increased in 2019 to almost 100 and decrease back to 50 in 2020 (Figure 5.4.3.4). Annual smolt migration in one stream on the Island of Bornholm (Læså, length 17 km, productive area 2.46 ha) was on average 6300 individuals in the period 2007–2013; however, with very high variation among years (1687–16 138), due to variations in the productive area as a result of variations in precipitation (Jespersen *et al.* 2021) (Table 5.4.1.3). Smolt-trapping in Læså has not continued after 2013.

The average parr abundance in Germany has been decreasing from 68 in 2014 to 4 in 2019 and increased back to 20 in 2020 (Figure 5.4.3.4), but the set of electrofished sites has been changed in every year. Spawners numbers have been collected by video counting in six German streams in SD 22 and 24 with wild populations. In four streams in 2019 there were no or only a few fish. In Peezer Bach (SD 24) number of spawners was in 2019 around 400, close to the last few years, and in Hellbach (SD 22) almost 1400 (Figure 5.4.2.2). Data from German counters in season 2020/2021 are not available. Since spawning season 2011, an increasing number of fungal infected sea trout have been reported from the Trave River, the largest Baltic Sea discharging river in German Schleswig-Holstein. As a consequence, project-based research (2017–2019) on the health status of sea trout in the Trave has been launched.

Average densities of 0+ parr on spawning sites in Polish rivers in SD 25 have shown a decreasing trend, from 114 in 2004 to 25 in 2020 (Figure 5.4.3.4). Spawning runs have been monitored by fish counting in the Slupia River since 2006 and till 2013 was varying between 3500 and 7500 fish, then dropped below 400 in 2017 and increased in three last year to around 2500 in 2020. Another counter has been operating since 2018 in River Parseta 54 km from its mouth; it recorded above 4000 spawners in 2019 and 2020 (Figure 5.4.2.2). Severe disease problems have occurred in all Polish Pomeranian sea trout rivers since 2007. The affected sea trout display UDN-like skin damages followed by fungal infections, high mortality and lack of kelts. In 2020, it was observed in most of rivers, also between fresh, silver fish entering river in a summer.

In summary, parr densities and numbers of migrating spawners in southwestern Baltic rivers (SD 22–25) demonstrate a decreasing trend during the last several years.

5.5 Recruitment status and trends in development

Results from the updated analyses of recruitment status and trends for sea trout in rivers and streams around the Baltic Sea are shown in Figures 5.5.1 to 5.5.6. The number of sites available for calculation of recruitment status in 2020 was 337 (598 in 2019). The number available for calculation of the five-year trend (identical sites fished every year 2016–2020) was 205 (215 in 2019) (Table 5.3.2.1).

In the **Gulf of Bothnia** assessment area (SD 30–31) the recruitment status was in 2020 on average 60% (Figures 5.5.1 to 5.5.3), with a decreasing trend over the last five-year period (Figure 5.5.4).

The average status was clearly better in SD 30 (98 %) compared to SD 31 (36%). In SD 31 the five-year trend indicates a negative, but not statistically significant, development in the recruitment status.

In SD 31, the status in Sweden was higher (42%) than in Finland (28%) (Figure 5.5.3), but the difference is not significant. The five-year trend was negative for both countries.

In SD 30, the status was good in both countries, but better in Finland (130%) than in Sweden (85%), but the difference is not significant (Figure 5.5.3). The five-year trend was neutral (Figure 5.5.6).

In the **Gulf of Finland** assessment area (SD 32) the overall status is good (Figure 5.5.1), and the five-year trend is positive (Figure 5.5.4).

Status is good in both Finland (107%) and Estonia (135%), but considerably lower in Russia (average 51%) (Figure 5.5.3).

In assessment area **East** (SD 26 and 28; Figure 5.3.2.1) the overall status is good (average 84%) (Figure 5.5.1) having improved considerably since 2019 (60%). Also, the five-year trend indicates a positive, but not statistically significant, development in the recruitment status. (Figure 5.5.4).

The recruitment status was much higher in SD 28 (average 139%) compared to SD 26 (average 55%) (Figure 5.5.2).

In SD 26, the low status is due to a large number of sites with a relatively low status in Lithuania (average 53%), while status in Polish rivers is relatively good (70%) (Figure 5.5.3). It can be added, that the average recruitment status in Lithuanian streams, are considerably higher in sites positioned in the lower part of the Nemunas river system (69%), compared to sites further upstream (37%) (data not shown).

In SD 28, status was very good in both Estonian (average 133%) and Latvian (143%) streams, and also good in the one Swedish stream on the east coast of Gotland (78%).

In assessment area **West** (SD 27 and 29; Figure 5.3.2.1) the average status was reasonably good (64%).

The level of the recruitment status was almost similar in both subdivisions. The five-year trend indicates a slightly negative (but not statistically significant) trend.

In assessment area **South** (SD 22–25; Figure 5.3.2.1) the overall status is low (average 50%) (Figure 5.5.1), however with large variations between both subdivisions and countries (Figures 5.5.2 and 5.5.3). The overall five-year trend was negative.

In Subdivision 22, the overall average status was very low (28%) (Figure 5.5.2), being relatively good in Denmark (78%), but very low in German streams (22%). In both countries the overall trend indicated the situation to be stable (FF556).

In SD 23, with only Swedish sites in this area, the average status was good (86%) (Figure 5.5.2), however with considerable variation between sites.

In SD 24, the overall average status was low (54%) (Figure 5.5.2). The situation varies considerably between countries (Figure 5.5.3), with a low status in Germany (48%), relatively good in the one Danish stream (73%) and good in both Swedish (85%) and Polish (average 81%) streams.

In SD 25, the status was on average reasonable in both the two Swedish river (68%) included, and in the Polish streams (68%) in this SD. However, the 5-year trend was negative (Figure 5.5.5) due to a negative trend in Poland (Figure 5.5.6).

5.6 Reared smolt production

Total number of reared sea trout smolts released 2020 in the Baltic Sea (SD 22–32) was 3 279 000, which is more than in last year (2 768 000) and close to the last ten-year average. Out of this total, 2 426 000 smolts were released into the Main Basin, many more than in 2019 (1 766 000), 805 000 into the Gulf of Bothnia, less than in the last year (875 000) and 48 000 into the Gulf of Finland, much less than in 2019 (127 000) and only 1/5 of the last ten-year average (Table 5.6.1).

In Finland, trout smolt production is mainly based on reared broodstocks supplemented by spawners caught in rivers. In the past ten years, the average number of smolts released has decreased and was 508 000 in 2020, whereof 71% were stocked into the Gulf of Bothnia and 9% into the Gulf of Finland.

In Sweden, the number of trout smolts stocked in 2020 was 602 000, close to the average level in the last few years. A majority of the Swedish smolts were released into Gulf of Bothnia (73%).

Estonia has stopped all sea trout releases in 2018 with an incidental small release of parr into Gulf of Finland last year.

In Poland, juvenile fish are reared from spawners caught in each Pomeranian river separately but almost the entire Vistula stocking is of reared broodstock origin. A total of 1 077 000 smolts were released into Polish rivers in 2020, close to the ten years average.

Denmark released 687 000 smolts in 2020, two times more than in 2019 and more than the average in the past ten years.

Latvia released 370 000 smolts in 2020, more than in 2019 and previous years.

Lithuania released 26 000 smolts in 2020, more than in 2019 and close to the average.

Russia released 31 000 smolts in 2020 into the Gulf of Finland, less than in 2019 and below of the average.

Germany released 10 000 smolts, a little less than average but more than in 2019.

In addition to direct smolt releases, trout are also released as eggs, alevins, fry and parr (Table 5.6.2). The estimated number of smolts originating from these releases of younger life stages over time (‘smolt equivalents’, calculated as described in Table 5.6.2) is presented in Table 5.6.3. In 2020, the estimated smolt number expected from releases of younger life stages in previous years was around 154 000, mainly in Main Basin rivers, much less than in previous years (ten years average 246 000). The prediction for 2021 is approximately 187 000 smolts for the whole Baltic, of which 164 000 will migrate into the Main Basin. Total number of smolt equivalents from enhancement releases in 2020 was lower than from releases in 2019 and also much lower than in the very beginning of the 20th century (Table 5.6.3).

5.7 Recent management changes and additional information

5.7.1 Management changes

According to the Council Regulation (EU) 2018/1628 of 30 October 2018, fixing for 2019 the fishing opportunities for certain fish stocks and groups of fish stocks applicable in the Baltic Sea, and, amending Regulation (EU) 2018/120 as regards certain fishing opportunities in other waters, most of the sea trout in the Baltic Sea is exploited in coastal areas. Therefore, it was prohibited to fish for sea trout beyond four nautical miles and to limit bycatches of sea trout to 3% of the combined catch of sea trout and salmon, in order to contribute to preventing misreporting of salmon catches as sea trout catches. That regulation in combination with unfavourable weather conditions and increasing seal damage, affected with serious changes in Polish fisheries. The offshore fisheries (both catch and effort) was reduced and the issue of misreporting salmon as a sea trout dropped.

Additionally, in Sweden, from 1 September 2019, new fishing regulations were introduced in SD 30 to improve the situation for coastal fish populations in this area. These regulations include a ban for fishing with nets in areas with less than 3 meters depth between 1 September and 10 June, a complete net ban between 15 October and 30 November, increase of the minimum size for sea trout from 40 to 50 cm, and a daily bag limit of one wild sea trout when fishing with sport fishing equipment or fykenets. In April 2021, a daily bag limit of one wild sea trout when fishing with sport fishing equipment or fykenets was introduced also along the Swedish southeast coast (SD 27–29). The new regulations implemented in 2021, also include a few new protection areas along the southeast coast to protect sea trout during the autumn migration.

5.7.2 Additional information

In recent years in Poland, measures of stocking efficiency have been conducted, involving genetic parental assignment techniques. In 2020, 200 sea trout, returning to the Rega for reproduction, were collected and genotyped. Molecular analyses, focused on 13 microsatellite loci, were supposed to indicate the descendants of fish used for artificial spawning in 2016, among the sea trout returning to the rivers in 2020. The genotypic parental database of spawners from 2016, was composed of 429 fish used for artificial spawning in the Rega River that year. Analysis of parenthood, performed for fish caught in 2020 in the Rega, indicated that at least 40% of fish originated from the 2016 artificial spawners database.

Trout parr otolith core strontium/calcium (Sr:Ca) ratios have been used to determine whether parr has an anadromous or resident maternal parent The study was carried out in some Estonian and Finnish short, coastal streams (ICES, 2018a).

In 2014/2015, a national probability-based telephone-diary survey was conducted aimed at providing information on the marine recreational fishery in Germany, covering also sea trout. To collect more detailed information on the recreational sea trout fishery, an additional pilot study (diary recall survey) was conducted. During this study, a bus route intercept survey was used to recruit diarists, collect biological samples (length, weight, scales, and tissue samples), and socio-economic data. The ongoing analyses aim to combine both these studies to provide a full picture of the recreational sea trout fishery in Germany. The majority of research activities in Germany was, and still are, short- or medium-term projects, mostly funded on federal state authority level or externally through angling licence funds. This has as consequence that the delivery of information for assessment is uncertain.

For the assessment in the coming years, there is concern about data availability from Schleswig-Holstein (S-H), Germany. As an example, information from Schleswig-Holstein, Germany, information was for a number of years provided from a time-limited project. However, this project was discontinued, resulting in a regrettable lack of information on sea trout in western Germany. In contrast, it is very positive that information has been provided from Mecklenburg-Vorpommern, Germany.

5.8 Assessment result

While a positive development has been observed in more recent years (2015–2017) in many sea trout populations around most of the Baltic Sea, a general slight decline in status was observed in both 2018 and 2019, followed by a more stable situation in 2020. While the situation is still worrying in some areas, and variable in others overall final conclusion is, trout populations are within safe limits and that the development in the populations is not alarming. In spite of the overall improvement or stable situation for the populations in recent years, populations in some areas are still considered to be fragile being below expected levels, and many uncertainties remain.

Sea trout in **Gulf of Bothnia** (SD 30 and 31) is still considered as vulnerable, and it is recommended to maintain the present restrictions in the region, and strengthen the implementation of restrictions in the gillnet fishery for other species, in order to minimize the bycatch of young sea trout. Spawner counts in the western part of the area showing a continued moderate to strong increase, indicates a positive effect from both fishing restrictions and habitat improvements. However, absolute spawner numbers are still low considering the size of these northern rivers. Parr densities in a number of streams indicate populations to be stronger in the Bothnian Sea (SD 30), but still low in the Bothnian Bay (SD 31). Tag recovery data suggest a decreasing trend of post-smolt catches from bottom gillnets, but the relative share is still rather large. However, in recent years, an increasing part of all recoveries, originate from angling. The continued fishery for other species (e.g. whitefish) with fine meshed gillnets that also catch post-smolts and young sea trout is problematic, and it is recommended that, in relevant areas and time of year, restrictions are expanded to further reduce net fishing with mesh sizes catching young sea trout.

The restrictions in the Swedish sea fishery in Bothnian Bay (gillnetting ban in shallow waters in SD31), which has now been in effect for a number of years, and a more recent complete ban of harvest of wild (not finclipped) sea trout in Finnish waters, is expected to contribute to a continuous positive future development in the area. However, the prevailing fishery is still considered to be problematic, and can be expected to either limit or at least delay the recovery of wild sea trout populations in the area.

The relatively high recruitment status for sea trout in Finnish SD 30 is currently based on data from the only wild sea trout river (Isojoki) existing in the area.

In the **Gulf of Finland**, a positive development has been observed in Estonia and Finland, where trout populations in general seem to be in a good shape, however with a relatively low number of smolt in the Pirita. In 2020 trout smolt were not observed in this river.

In Russia, recruitment status has, in recent years been fluctuating. In Luga, the number of smolt has in recent years been very low taking the size of the river into consideration. The reason is most likely that most subpopulations in the tributaries are much below their potential levels. In Russia, illegal catch of sea trout may be one of several reasons (including habitat conditions and pollution) for the continued poor status for the populations in this area.

In Russia the catch of sea trout was previously prohibited, but was legalized as from March 2020. However, the effect from this on populations is presently uncertain. It is recommended to continue with the present management restrictions in both Finland and Estonia.

In the **Western Main Basin** (assessment area West, SD 27 and 29). Although average densities have been very variable in recent years, and recruitment status is not optimal no particular problems have been described for this area.

In the **Eastern Main Basin** (assessment area East, SD 26 and 28), both parr densities and status are rather good in Estonia, and presently the situation does not raise concern.

In Latvia, both status and average densities were high. Comparison to previous levels is not directly possible, because fishing sites have changed. The smolt run in Latvian river Salaca has in recent years been variable, but without signs of any significant change. Many of the sea trout streams in Latvia are highly affected by beaver activities which reduces migration opportunities. Beaver dams often also reduces water-covered habitats downstream and it can be especially devastating for smaller streams particularly in years with high temperatures. Overall the situation does not raise concern.

In Lithuania (SD 26) both average densities and recruitment status are low, but stable after some years with a decrease in status. Densities and status were lower in the eastern part of the country, compared to in the western part. It is believed, that elevated summer temperature is the main reason for this longitudinal difference, but higher mortality during migration is also a likely factor. Smolt counts are low in most rivers. Several reasons are likely to influence populations negatively. Low water flows during the spawning period in recent years, possible shortage of spawning possibilities in all areas, and likely also the long distance to the sea from most spawning and rearing areas. In addition, sea catch is, although limited, considered potentially problematic. In future, spawner counts in two streams (tributaries to Nemunas) are expected to provide information on the actual amount of spawning, which in turn, will improve the basis for recommendations for the area.

In Eastern Poland (SD 26), the situation for trout populations seems to be stable the situation does not raise concern in the smaller SD 26 rivers. In the river Vistula, however, in spite of heavy stocking, the number of spawners has been dramatically reduced in the last few years (Dębowski, 2018).

In the **Southern Baltic Sea** (SD 22, 23, 24 and 25), the overall recruitment status covers several countries. Danish sea trout populations are subject to a considerable (mainly) recreational fishery, especially in the sea. In the streams, spawning possibilities are in many places still considered to be insufficient, in spite of significant restoration works in recent years. However, presently the situation does not raise concern.

No information was available from Schleswig-Holstein in Germany, where status in previous years was assessed as relatively good.

In the German SD 22 streams, recruitment status in Mecklenburg-Western Pomerania is low. The main reason is believed to be high summer temperatures and low water levels in recent years, and, in this area, beaver populations are presently increasing, creating migration barriers in the streams. Sea trout are also subject to fisheries both in the sea and in rivers.

Status in German populations further east (SD 24) is on average also low. This is likely the result of a combination of several factors, one of which is fishing. Sea trout are caught both by anglers (rod and line), and in fixed gears. Also, in this area high temperatures, dry periods resulting in reduced area for production, and, in some streams elevated mortality due to predation during smolt migration influences populations negatively. In order to strengthen wild populations river maintenance work (restoration) has been carried out to improve habitat quality.

In western Poland (SD 25) recruitment status is relatively stable, and presently it does not raise concern. The continuous decrease in count of spawners in river Slupia, is believed to be related to the cessation of stocking of smolts some years ago, and problems with intensive UDN, now observed for several years. This affects also other Pomeranian rivers, however, with varying intensity.

In Sweden (SD 25) status in the streams included is reasonably good or good. While sea trout populations in general seems to be good shape, the number of smolts is relatively low, being lower than what could be expected considering the size of the river.

In SD 23 sea trout populations seem to be in good shape.

5.8.1 Future development of model and data improvement

In 2017, the ICES Working Group WGTRUTTA (Working Group with the Aim to Develop Assessment Models and Establish Biological Reference Points for Sea Trout (anadromous *Salmo trutta*) Populations) was established. In 2021, the group will apply for EU-funding to connect graduate students to the network (Innovative training network ITN). The group has gathered and summarized available sea trout data and information on life history (created a database and publications), and examined S–R relationships and modelling options. One modelling approach that has been evaluated is similar to the one currently employed in WGBAST, and based on electrofishing data. Reference points for expected fry density is estimated using breakpoints in cumulative distribution of 0+ trout, and used as a proxy for ‘reference’ 0+ density under the different THS scores and classes. It is expected that the outcome from this work can be used in future as a basis for development of the current sea trout assessment.

5.9 Recommendations

- Total population size of 0+ and older parr, as well as estimated total production of smolt should be calculated for rivers where data are available. Especially important are values for index rivers.
- Total production area available for sea trout should be provided for streams where data are available. If possible, the areas should be divided into habitat quality classes.
- Sufficient data coverage of sea trout parr densities from typical trout streams should be collected in all countries. Presently no information was available from Schleswig-Holstein.
- Sea trout index-rivers should be established to fulfil assessment requirements with respect to geographical coverage and data collection needs.
- Data on recreational sea trout catches should be consistently collected, taking into account the potentially high impact of recreational fisheries on sea trout stocks and the lack of these data in several countries.

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Table 5.1.1.1. Nominal commercial catches (in tonnes round fresh weight) of sea trout in the Baltic Sea (2001–2020). S=Sea, C=Coast and R=River.

Year	Main Basin																	Total	Gulf of Bothnia				Total	Gulf of Finland				Total	Grand	Estimated
	Denmark	Estonia	Finland		Germany	Latvia			Lithuania			Poland			Sweden			Main	Finland		Sweden		Gulf of	Estonia	Finland		Russia	Gulf of	Total	misreported
	S	C	S	C	S C	S	C	R	S	C	R	S	C	R	S	C	R	Basin	S	C	C	R	Bothnia	C	S	C	R	Finland		catch*
2001	54	2	5	14	10	1	11	0	0	2	0	486	219	11	23	2	3	844	2	54	16	44	115	8	0	17		25	984	
2002	35	5	2	8	12	0	13	0	0	2	0	539	272	53	11	2	0	954	0	49	25		74	11	0	11		23	1051	
2003	40	2	1	4	9	1	5	0	0	0	0	583	169	32	8	3	0	858	0	41	21	0	62	7	0	7		14	934	
2004	46	3	1	5	12	0	7	0	0	1	0	606	122	36	9	3	0	851	1	39	21	0	61	7	0	7		14	926	
2005	14	4	1	7	14	0	7	1	0	1	0	480	86	20	5	3	0	644	0	46	24	0	70	6	0	11		18	732	
2006	44	10	1	10	12	0	7	0	0	1	0	414	98	17	6	2	0	623	1	40	20	0	61	9	0	13		23	707	
2007	26	4	2	8	9	0	8	0	0	1	0	354	133	39	6	3	0	592	0	45	15	0	61	13	0	12		26	678	
2008	18	4	1	11	13	0	8	0	0	2	0	34	90	48	4	3	0	236	0	47	19	0	67	8	0	18		26	328	
2009	12	7	1	8	4	0	10	0	0	2	0	259	103	26	3	3	0	439	0	46	17	1	64	11	0	17		28	530	266
2010	8	5	0	6	3	0	5	0	0	2	0	343	81	30	2	3	0	489	0	37	20	1	58	11	0	10		22	568	299
2011	6	5	0	5	3	0	0	6	0	2	0	139	65	39	1	2	0	275	0	33	18	1	53	12	0	10		22	350	148
2012	11	8	0	5	18	0	4	1	0	3	0	37	74	26	0	3	0	191	0	41	18	2	61	14	0	16	0	29	281	70
2013	4	7	0	6	14	0	5	1	0	11	0	43	44	8	0	3	0	148	0	29	14	1	44	12	0	9	0	21	212	60
2014	10	5	0	6	14	0	5	1	0	5	0	21	72	28	0	3	0	170	0	22	11	0	33	10	0	7	0	17	220	54
2015	8	5	0	4	14	0	4	0	0	6	0	13	83	7	0	2	0	145	0	16	13	1	30	11	0	6	0	17	192	66
2016	1	6	0	3	12	0	5	0	0	4	0	62	86	3	0	2	0	184	0	18	10	0	29	14	0	6	0	20	232	104
2017	6	5	0	3	9	0	4	0	0	1	0	111	41	1	0	3	0	184	0	16	9	16	41	13	0	6	0	19	244	128
2018	3	7	0	1	10	0	6	1	0	0	7	179	55	3	0	2	0	274	0	13	9	0	22	10	0	6	0	16	312	170
2019	3	6	0	2	10	0	4	1	0	8	0	3	82	3	0	1	0	123	0	12	7	0	19	11	0	6	0	17	159	2
2020	2	6	0	7	2	0	5	0	0	0	6	1	77	8	0	1	0	116	0	10	6	0	16	11	0	5	0	16	148	1

*calculated from number of misreported salmon, substracted from total catch.

Table 5.1.2.1. Nominal landed recreational catch (in tonnes round fresh weight) of sea trout in the Baltic Sea (2001–2020). S=Sea, C=Coast and R=River. N.a. data not available.

	Main Basin									Total	Gulf of Bothnia			Total	Gulf of Finland		Total	Whole of the Baltic	Grand
	Denmark	Estonia	Finland	Germany	Latvia		Lithuania	Poland	Sweden	Main	Finland	Sweden		Gulf of	Estonia	Finland	Gulf of	Finland	Total
Year	C+R	C	R	C	C	R	O+R	C+O	R	Basin	R	C	R	Bothnia	C+R	R	Finland	C	
2001	n.a.	n.a.	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	7.0	n.a.	n.a.	7.0	0.0	3.0	3.0	324.0	334.0
2002	n.a.	n.a.	0.2	n.a.	n.a.	n.a.	n.a.	n.a.	2.8	3.0	6.5	0.0	38.4	44.9	0.0	2.6	2.6	116.0	166.5
2003	n.a.	n.a.	0.2	n.a.	n.a.	n.a.	n.a.	n.a.	3.6	3.8	11.1	0.0	31.5	42.6	0.0	1.6	1.6	116.0	164.0
2004	n.a.	n.a.	0.5	n.a.	n.a.	n.a.	n.a.	n.a.	2.6	3.1	10.6	0.0	28.2	38.8	0.0	2.1	2.1	80.0	123.9
2005	n.a.	n.a.	0.5	n.a.	n.a.	n.a.	n.a.	n.a.	1.5	2.0	10.6	0.0	30.9	41.5	0.0	2.7	2.7	80.0	126.2
2006	n.a.	n.a.	0.1	n.a.	n.a.	n.a.	n.a.	n.a.	1.3	1.4	5.3	0.0	32.5	37.8	0.0	3.3	3.3	187.0	229.4
2007	n.a.	n.a.	0.3	n.a.	n.a.	n.a.	n.a.	n.a.	1.3	1.6	8.2	0.0	31.5	39.6	0.0	3.1	3.1	187.0	231.3
2008	n.a.	n.a.	0.2	n.a.	n.a.	n.a.	n.a.	n.a.	2.6	2.7	8.9	0.0	39.7	48.6	0.0	2.3	2.3	163.0	216.6
2009	n.a.	n.a.	0.4	n.a.	n.a.	n.a.	n.a.	n.a.	2.3	2.7	10.6	0.0	45.8	56.4	0.0	5.5	5.5	163.0	227.6
2010	346.0	n.a.	0.4	n.a.	0.0	0.1	n.a.	1.6	3.3	351.3	7.3	0.0	39.1	46.4	0.0	1.2	1.2	56.0	454.9
2011	224.0	n.a.	0.4	n.a.	0.0	0.0	n.a.	1.7	2.2	228.3	7.5	1.7	39.3	48.5	0.0	2.2	2.2	56.0	335.0
2012	260.0	n.a.	0.3	n.a.	0.0	0.0	n.a.	2.4	2.2	264.9	10.6	2.5	38.9	51.9	0.0	3.8	3.8	109.0	429.6
2013	301.0	1.4	0.2	n.a.	3.0	0.0	n.a.	n.a.	1.3	306.9	10.6	1.5	46.2	58.3	3.3	3.8	7.1	109.0	481.3
2014	521.0	1.5	0.3	n.a.	3.8	0.0	n.a.	n.a.	0.7	527.3	5.2	1.4	43.0	49.6	3.1	2.2	5.3	71.0	653.3
2015	395.7	1.7	0.3	151.1	2.9	0.0	n.a.	n.a.	0.6	552.3	1.7	0.0	27.6	29.3	4.6	1.0	5.6	71.0	658.2
2016	323.1	2.3	0.2	151.1	5.0	0.1	n.a.	n.a.	0.4	482.3	1.8	0.0	21.7	23.6	4.9	0.5	5.4	232.0	743.2
2017	202.7	1.9	0.3	151.1	3.7	0.0	n.a.	144.6	0.1	504.5	3.9	0.0	15.5	19.4	4.3	0.3	4.6	232.0	760.5
2018	178.5	0.0	0.0	151.1	7.7	0.0	n.a.	92.4	0.0	429.7	3.0	0.0	15.5	18.5	6.4	0.7	7.0	64.0	519.3
2019	161.7	3.0	0.0	151.1	0.0	0.5	5.5	169.6	0.2	491.7	2.6	0.0	26.0	28.6	4.8	0.3	5.1	64.0	589.4
2020	179.1	2.3	NA	151.1	2.3	1.8	8.8	215.3	2.3	563.1	NA	0.0	24.2	24.2	4.1	0.4	4.5	64.0	655.7

Table 5.1.3.1. Nominal catches (commercial + recreational; in tonnes (rounded) fresh weight) of sea trout in the Baltic Sea in years 1979–2000. Commercial and recreational catches after year 2000 are presented in Tables 5.1.1.1 and 5.1.2.1. S=Sea, C=Coast and R=River.

Year	Main Basin																Total	Gulf of Bothnia						Total	Gulf of Finland				Total	Grand
	Denmark[1,4]	Estonia	Finland[2]			Germany[4]	Latvia		Lithuania		Poland			Sweden[4]			Main	Finland[2]			Sweden			Gulf of	Estonia	Finland[2]			Gulf of	Total
	S + C	C	S	S + C	R	C	S + C	R	C	R	S[9]	S + C	R	S[6]	C[6]	R	Basin	S	C	R	S[6]	C[6]	R	Bothnia	C	S	C	R	Finland	
1979	3	na		10		na	na		na		na	81[3]	24	na	na	3	121		6	na	na	na	na	6	na		73	0	73	200
1980	3	na		11		na	na		na		na	48[3]	26	na	na	3	91		87	na	na	na	na	87	na		75	0	75	253
1981	6	na		51		na	5		na		na	45[3]	21	na	na	3	131		131	na	na	na	na	131	2		128	0	130	392
1982	17	na		52		1	13		na		na	80	31	na	na	3	197		134	na	na	na	na	134	4		140	0	144	475
1983	19	na		50		na	14		na		na	108	25	na	na	3	219		134	na	na	na	na	134	3		148	0	151	504
1984	29	na		66		na	9		na		na	155	30	na	na	5	294		110	na	na	na	na	110	2		211	0	213	617
1985	40	na		62		na	9		na		na	140	26	na	na	13	290		103	na	na	na	na	103	3		203	0	206	599
1986	18	na		53		na	8		na		na	91	49	7	9	8	243		118	na	1	24	na	143	2		178	0	180	566
1987	31	na		66		na	2		na		na	163	37	6	9	5	319		123	na	1	26	na	150	na		184	0	184	653
1988	28	na		99		na	8		na		na	137	33	7	12	7	331		196	na	na	44	42	282	3		287	0	290	903
1989	39	na		156		18	10		na		na	149	35	30	17	6	460		215	na	1	78	37	331	3		295	0	298	1,089
1990	48[3]	na		189		21	7		na		na	388	100	15	15	10	793		318	na	na	71	43	432	4		334	0	338	1,563
1991	48[3]	1		185		7	6		na		na	272	37	26	24	7	613		349	na	na	60	54	463	2		295	0	297	1,373
1992	27[3]	1		173		na	6		na		na	221	60	103	26	1	618		350	na	na	71	48	469	8		314	0	322	1,409
1993	59[3]	1		386		14	17		na		na	202	70	125	21	2	897		160	na	na	47	43	250	14		704[7]	0	718	1,865
1994	33[8,3]	2		384		15[8]	18		+		na	152	70	76	16	3	769		124	na	na	24	42	190	6		642	0	648	1,607
1995	69[8,3]	1		226		13	13		3		na	187	75	44	5	11	647		162	na	na	33	32	227	5		114	0	119	993
1996	71[8,3]	2		76		6	10		2		na	150	90	93	2	9	511		151	25	na	20	42	238	14		78	3	95	844
1997	53[8,3]	2		44		+	7		2		na	200	80	72	7	7	474		156	12	na	16	54	238	8		82	3	93	805
1998	60	8		103		4	7		na		208	184	76	88	3	6	747		192	12	0	9	39	252	6		150	3	159	1,158
1999	110[8,3]	2		84		9	10		1		384	126	116	51	2	3	898		248	12	0	18	41	319	8		93	3	104	1,321
2000	58	4		64		9	14		1		443	299	70	42	4	3	1,011		197	12	0	14	36	259	10		56	3	69	1,339

¹ Additional sea trout catches are included in the salmon statistics for Denmark until 1982 (Table 3.1.2).

² Finnish catches include about 70% non-commercial catches in 1979–1995, 50% in 1996–1997, 75% in 2000–2001.

³ Rainbow trout included.

⁴ Sea trout are also caught in the Western Baltic in subdivisions 22 and 23 by Denmark, Germany and Sweden.

⁵ Preliminary data.

⁶ Catches reported by licensed fishermen and from 1985 also catches in trapnets used by non-licensed fishermen.

⁷ Finnish catches include about 85% non-commercial catches in 1993.

⁸ ICES subdivisions 22 and 24.

⁹ Catches in 1979–1997 included sea and coastal catches, since 1998 coastal (C) and sea (S) catches are registered separately.

na=Data not available.

\+ Catch less than 1 tonne.

Table 5.1.4.1. Biological sea trout samples collected in 2020.

				Number of sampled fish by subdivision					
Country	Month (number)	Fisheries	Gear	22–28	29	30	31	32	Total
Estonia	1–12	Coastal	Gillnet					150	160
Finland	4–9	Coastal	All gears		6	27	83	33	149
Latvia	4–11	Coastal, River	Gillnet, trapnet	716					716
Lithuania	1–12	Coastal	All gears	4					4
Poland	1–12	Coastal, River	Gillnets, electrofishing	127					127
Germany	1–12	Coastal	Rod, nets	35					35
Sweden	6–9	River	All gears	176		25	42		243
Total									1424

Table 5.2.2.1. Adipose finclipped and tagged sea trout released in the Baltic Sea area in 2020.

Country	Sub-	River	Age	Number			Tagging	Other Methods		
	division			fry	parr	smolt	Carlin	T-bar Anch	PIT	ARS (1)	Acoustic
Poland	25	Parseta	1yr						5,000		
Sweden	25	Listerbyån	1yr			500					
Sweden	25	Lyckebyån	1yr			3,000					
Poland	26	Vistula	2yr						2,500		
Poland	26	Drweca	2yr						3,500		
Sweden	27	Stockholm various places	1yr			117,400					
Sweden	27	Stockholm various places	2yr			10,000					
Sweden	27	Bråviken (coastal site)	1yr			5,000					
Sweden	27	Trosaån	1yr			3,500					
Sweden	27	Nyköpingsån	1yr			7,000					
Sweden	27	Nyköpingsån	2yr			14,000					
Latvia	28	Venta	1yr			42,102					
Latvia	28	Gauja	1yr			55,410					
Latvia	28	Gauja	2yr			10,020					
Latvia	28	Daugava	1yr			223,684					
Latvia	28	Daugava	2yr			18,807					
Latvia	28	Salaca	2yr			10,787					
Latvia	28	Roja	1yr			5,162					
Latvia	28	Brasla	1yr			4,000					
Finland	29	at sea	2yr parr			2,800					
Finland	29	at sea	2yr			28,900					
Finland	30	at sea	2yr			13,700					
Finland	30	Lapväärtinjoki	2yr			5,800					
Finland	30	Kokemäenjoki	eyed egg							13,100	
Finland	30	Kokemäenjoki	2yr			20,300					
Finland	30	Lapinjoki	1yr parr							3,000	
Sweden	30	Gideälven	1yr			7,333					
Sweden	30	Ångermanälven	2yr			48,038					
Sweden	30	Indalsälven	1yr			100,796					
Sweden	30	Ljungan	1yr parr		33,045						
Sweden	30	Ljungan	1yr			31,300					
Sweden	30	Ljusnan	1yr			10,736					
Sweden	30	Ljusnan	2yr			44,447					
Sweden	30	Gavleån	2yr			200					
Sweden	30	Dalälven	1yr			18,209			5,000		
Sweden	30	Dalälven	2yr			50,758			1,520		20
Finland	31	Perhojoki	2yr			7,600					
Finland	31	Perhojoki	eyed egg							13,800	
Finland	31	Lestijoki	fry							11,000	
Finland	31	Siikajoki	2yr			1,000					
Finland	31	Oulujoki	2yr			96,500					
Finland	31	Kiiminkijoki	2yr			20,000					
Finland	31	Iijoki	2yr							76,000	
Finland	31	Iijoki	2yr parr							100	
Finland	31	Iijoki	alevin							50,000	
Finland	31	Olhavanjoki	alevin							18,000	
Finland	31	Kemijoki	2yr			75,000					
Finland	31	Kemijoki	1yr parr							54,700	
Finland	31	Tornionjoki	2yr			7,700					
Finland	31	at sea	2yr			31,600					
Finland	31	Kruunupyynjoki	2yr			300					
Sweden	31	Luleälven	1yr			8,355					
Sweden	31	Luleälven	2yr			74,164	2,000				
Sweden	31	Skellefteälven	1yr			25,253					
Sweden	31	Ume/Vindelälven	1yr			3,393			1,000		
Sweden	31	Ume/Vindelälven	2yr			15,878			1,000		
Finland	32	Vaalimaanjoki	1yr parr							2,600	
Finland	32	Vehkajoki	1yr parr							2,600	
Finland	32	Summajoki	2yr			1,200					
Finland	32	Kymijoki	2yr			22,900					
Finland	32	Taasianjoki	eyed egg							43,100	
Finland	32	Koskenkylänjoki	eyed egg							62,700	
Finland	32	Ilolanjoki	eyed egg							12,000	
Finland	32	Porvoonjoki	eyed egg							89,500	
Finland	32	Mustijoki	eyed egg							50,000	
Finland	32	Loviisanjoki	eyed egg							9,500	
Finland	32	at sea	2yr			24,100					
Total sea trout				**-**	**33,045**	**1,328,632**	**2,000**	**-**	**19,520**	**511,700**	**20**

(1) ARS = Alizarin Red Staining, *single marked, released as fry.

Table 5.3.2.1. Number of fishing occasions/sites in 2020 available for assessment of trout recruitment status, distributed on ICES subdivisions (SD), and number of sites available for trend analysis (sites fishes all years 2016–2020).

ICES SD	Recruitment 2020	Trend 2020
22	40	4
23	9	6
24	100	1
25	31	18
26	97	74
27	11	8
28	51	7
29	4	4
30	38	24
31	36	19
32	49	40
Total	337	205

Table 5.4.1.1. Status of wild and mixed sea trout populations. Partial update in 2021.

Area	Country	Potential smolt production (x1000)	Smolt production (% of potential production)									
			<5 %		5-50 %		> 50 %		Uncertain		Total	
			wild	mixed	wild	mixed	wild	mixed	wild	mixed	wild	mixed
Gulf of Bothnia	Finland	< 1									0	0
		1-10	1	3	1						2	3
		11-100*			1						1	0
		> 100									0	0
		Uncertain									0	0
	Total		1	3	2	0	0	0	0	0	3	3
	Sweden	< 1									0	0
		1-10									0	0
		11-100									0	0
		> 100									0	0
		Uncertain							25	26	25	26
	Total		0	0	0	0	0	0	25	26	25	26
Total			1	3	2	0	0	0	25	26	28	29
Gulf of Finland	Estonia	< 1	1		2		4		12		19	0
		1-10			6	1	11				17	1
		11-100					2				2	0
		> 100									0	0
		Uncertain									0	0
	Total		1	0	8	1	17	0	12	0	38	1
	Finland**	< 1	1	1							1	1
		1-10	2	2	5	0					7	2
		11-100				2					0	2
		> 100									0	0
		Uncertain									0	0
	Total		3	3	5	2	0	0	0	0	8	5
	Russia	< 1	1		3		2		2		8	0
		1-10	7		2				2		11	0
		11-100*	1	1	1						2	1
		> 100									0	0
		Uncertain							19		19	0
	Total		9	1	6	0	2	0	23	0	40	1
Total			13	4	19	3	19	0	35	0	86	7

Table 5.4.1.1. Continued.

Main Basin	Denmark	< 1	39	4	27	2	72	2			138	8
		1-10	2	2	9	7	28	6			39	15
		11-100		1	1	3	2	5			3	9
		> 100									0	0
		Uncertain									0	0
	Total		41	7	37	12	102	13	0	0	180	32
	Finland	< 1									0	0
		1-10									0	0
		11-100	1								1	0
		> 100									0	0
		Uncertain									0	0
	Total		1	0	0	0	0	0	0	0	1	0
	Estonia	< 1	7		4		12		5		28	0
		1-10	1		4		3				8	0
		11-100									0	0
		> 100									0	0
		Uncertain									0	0
	Total		8	0	8	0	15	0	5	0	36	0
	Latvia	< 1							10		10	0
		1-10									0	0
		11-100				1					0	1
		> 100									0	0
		Uncertain							39	5	39	5
	Total		0	0	0	1	0	0	49	5	49	6
	Lithuania	< 1			2	2	1	1			3	3
		1-10				1	1	1			1	2
		11-100				1	1				1	1
		> 100*									0	0
		Uncertain									0	0
	Total		0	0	2	4	3	2	0	0	5	6
	Poland	< 1				3	1			1	1	4
		1-10			1			1			1	1
		11-100		3		4		1			0	8
		> 100		1							0	1
		Uncertain									0	0
	Total		0	4	1	7	1	2	0	1	2	14
	Russia	< 1									0	0
		1-10									0	0
		11-100									0	0
		> 100									0	0
		Uncertain							3		3	0
	Total		0	0	0	0	0	0	3	0	3	0
	Sweden	< 1									0	0
		1-10									0	0
		11-100									0	0
		> 100									0	0
		Uncertain							200	7	200	7
	Total		0	0	0	0	0	0	200	7	200	7
Total			50	11	48	24	121	17	257	13	476	65
Grand total			64	18	69	27	140	17	317	39	590	101

*** Includes data from large river systems.**

**** In seven wild rivers, it is not known if releases are carried out.**

Table 5.4.1.2. Factors influencing status of sea trout populations. Partly updated for WGBAST 2021.

Area	Country	Potential smolt production	Number of populations					
			Over exploitation	Habitat degradation	Dam building	Pollution	Other	Uncertain
Gulf of Bothnia*	Finland	< 1	0	0	0	0	0	0
		1-10	5	5	4	1	0	0
		11-100	1	1	0	0	0	0
		> 100	0	0	0	0	0	0
		Uncertain	0	0	0	0	0	0
	Total		6	6	4	1	0	0
Total			6	6	4	1	0	0
Gulf of Finland	Finland	< 1	2	2	1	0	0	0
		1-10	9	9	7	0	0	0
		11-100	2	2	1	1	0	0
		> 100	0	0	0	0	0	0
		Uncertain	0	0	0	0	0	0
	Total		13	13	9	1	0	0
	Russia	< 1	5	5	0	4	0	0
		1-10	11	9	2	7	0	0
		11-100	3	3	1	3	0	0
		> 100	0	0	0	0	0	0
		Uncertain	11	11	3	8	0	0
	Total		30	28	6	22	0	0
	Estonia	< 1	1	5	0	0	0	0
		1-10	4	3	1	4	0	0
		11-100	2	0	2	0	0	0
		> 100	0	0	0	0	0	0
		Uncertain	0	0	0	0	0	0
	Total		7	8	3	4	0	0
Total			50	49	18	27	0	0
Main Basin*	Finland	< 1	0	0	0	0	0	0
		1-10	0	0	0	0	2	0
		11-100	1	1	1	0	0	0
		> 100	0	0	0	0	0	0
		Uncertain	0	0	0	0	0	0
	Total		1	1	1	0	2	0
	Estonia	< 1	29	29	0	0	0	0
		1-10	6	6	0	0	0	0
		11-100	1	0	0	0	0	0
		> 100	0	0	0	0	0	0
		Uncertain	0	0	0	0	0	0
	Total		36	35	0	0	0	0
	Latvia	< 1	3	7	2	0	0	0
		1-10	0	0	0	0	0	0
		11-100	0	0	0	0	0	0
		> 100	0	0	0	0	0	0
		Uncertain	8	17	12	0	0	0
	Total		11	24	14	0	0	0
	Lithuani	< 1	0	0	0	0	0	0
		1-10	0	4	5	2	0	0
		11-100	0	1	2	1	0	0
		> 100	0	1	1	1	1	0
		Uncertain	0	0	0	0	0	0
	Total		0	6	8	4	1	0
	Poland	< 1	0	4	3	1	1	0
		1-10	0	1	2	0	0	0
		11-100	5	3	8	1	1	0
		> 100	1	1	1	1	1	0
		Uncertain	0	0	0	0	0	0
	Total		6	9	14	3	3	0
	Russia	< 1	0	0	0	0	0	0
		1-10	0	0	0	0	0	0
		11-100	0	0	0	0	0	0
		> 100	0	0	0	0	0	0
		Uncertain	3	2	0	2	0	0
	Total		3	2	0	2	0	0
	Denmar	< 1	0	51	62	0	0	0
		1-10	0	39	35	0	0	0
		11-100	0	0	0	0	0	0
		> 100	0	0	0	0	0	0
		Uncertain	0	0	0	0	0	0
	Total		0	90	97	0	0	0
Total			57	167	134	9	6	0
Grand total			113	222	156	37	6	0

*** data from Sweden were unavailable.**

Table 5.4.1.3. Sea trout smolt estimates for the period 2002–2019.

SD	**24**	**25**	**26**	**26**	**26**	**26**	**28**	**28**	**30**	**31**	**31**	**31**	**32**	**32**	**32**	**32**
Country	DK	SE	LT	LT	LT	LT	LV	LV	FIN	SE	SE	FIN	RU	RU	EE	EE
River name	Læså	Mörrum	R. Mera	R. Mera	R. Siesartis	R. Siesartis	R. Salaca	R. Salaca	R. Isojoki	Sävarån	Rickleån	Tornionjoki	Luga	Luga	Pirita	Pirita
Method	1	2	5	6	5	6	3	4	14	7	8	9	10	11	12	13
2002			12				13100						8200			
2003			11				11000						2500			
2004			11				2500					12510	2500			
2005			0		5		7700						5000			
2006	4543		3		8		10400			510		12640	2800			
2007	2481		32		104		15200			10851			5000			
2008	16138		170		95		15800			2124		10810	2500		884	772
2009	1687	6995	11		163		16900			1848			6900		2138	1945
2010	2920	3526	3		73		19400			1232			3300		2301	2198
2011	8409	5086	584	n.d.	243	n.d.	4900			637		19420	3100		832	153
2012	8702	5517	606	33	576	40	11400			231			2000		766	740
2013	5326	10220	422	0	186	2	9600			1600			2100		1769	1429
2014	n.d.	6867	344	98	559	6	3100	265		n.d.	348	n.d.	6200	190	260	227
2015	n.d.	3612	0	226		23	12100	712		n.d.	n.d.	n.d.	11600		1020	687

SD	24	25	26	26	26	26	28	28	30	31	31	31	32	32	32	32
Country	DK	SE	LT	LT	LT	LT	LV	LV	FIN	SE	SE	FIN	RU	RU	EE	EE
River name	Læså	Mörrum	R. Mera	R. Mera	R. Siesartis	R. Siesartis	R. Salaca	R. Salaca	R. Isojoki	Sävarån	Rickleån	Tornionjoki	Luga	Luga	Pirita	Pirita
Method	1	2	5	6	5	6	3	4	14	7	8	9	10	11	12	13
2016	n.d.	5298	768	306	537	95	17500	1369		n.d.	604	17350	2600		3830	3771
2017	n.d.	3461	1866	91	676	8	5400	540		n.d.	470	n.d.	3500		2241	1410
2018	n.d.	3173	379	n.d.	792	n.d.	5999	594		n.d.	n.d.	n.d.	5800		3346	3783
2019	n.d.	2126	745	38	654	n.d.	3158	302	7300	n.d.	n.d.	23 270	3600		684	554
2020	n.d.	4357	867	67	798	n.d	4800	552	6084	n.d.	n.d.	n.d.	3600		n.d.	n.d.

n.d.= no data.

1) based on smolt trap - directly counted number of smolts, varying efficiency over years due to water level (probability level data available).

2) Median values of Bayesian estimates are only for the upper part of the river!

3) estimated smolt output on the base of counted smolts and mean trap efficiency (2014=8.5%; 2015=5.9%; 2016=9.5%).

4) directly counted number of smolts during trapping season.

5) estimated output derived by electrofishing data. (assumed survival probabilities to smolts: 0+ --> 40%; >0+ --> 60%).

6) counted number of individuals smolts in trap. Assumed trap efficiency almost 100%.

7) "simple" Peterson estimates - trap moved to river Ricklean in Year 2014.

8) Trap located close to river mouth, so this is the total estimated production.

9) estimated smolt output. Trap efficiency in 2016 from efficiency for salmon smolt.

10) estimated number of smolt output based on results of floating trap-netting- 2.9% in 2016, due to high water only part of migration period covered.

11) directly counted number of smolts in trap.

12) Original estimates based on smolt trapping.

13) Estimates based on a Bayesian model *) due to high water level counts individual numbers presumably too low.

14) Partial smolt trapping (screwtrap) and mark–recapture experiments.

Table 5.4.2.1. Status of wild and mixed sea trout populations in large river systems.

Country	River (Area)	Potential smolt production	Smolt production (% of potential production)									
			<5 %		5-50 %		> 50 %		Uncertain		Total	
			wild	mixed	wild	mixed	wild	mixed	wild	mixed	wild	mixed
Lithuania	Nemunas	< 1				2	1	1			1	3
	(Main	1-10					1	1			1	1
	Basin)	11-100				1	1				1	1
		> 100									0	0
		Uncertain									0	0
Total			0	0	0	3	3	2	0	0	3	5
Poland	Odra	< 1									0	0
	(Main	1-10				3					0	3
	Basin)	11-100		1		1					0	2
		> 100									0	0
		Uncertain									0	0
Total			0	1	0	4	0	0	0	0	0	5
Poland	Vistula	< 1									0	0
	(Main	1-10								1	0	1
	Basin)	11-100		3		1					0	4
		> 100									0	0
		Uncertain									0	0
Total			0	3	0	1	0	0	0	1	0	5
Russia	Luga	< 1	1		1						2	0
	(Gulf of	1-10	1		1						2	0
	Finland)	11-100	1			1					1	1
		> 100									0	0
		Uncertain							1		1	0
Total			3	0	2	1	0	0	1	0	6	1
Finland	Tornion-	< 1	1		1						2	0
	joki	1-10		5	1						1	5
	(Gulf of	11-100		1	1						1	1
	Bothnia)	> 100									0	0
		Uncertain									0	0
Total			1	6	3	0	0	0	0	0	4	6

Table 5.6.1. Sea trout smolt releases (x1000) into the Baltic Sea by country and subdivision in 1988–2019. Note that project based fisheries enhancement releases included.

			year																																
	country	age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Main Basin 22-29	DK	1yr	5	1	4	4	4	19	17	177	177	177	196	196	19	751	634	614	562	562	398	387	387	365	261	281	272	272	333	313	589	591	550	322	687
		2yr															30	30	30	30	21	9	9	2	2	2	2	2	0	0	0	0	0	0	
	EE	1yr	50	5		5																	3												
		2yr			5	6	10	10	16	28	30	32	30	32	30	32	30	23	25	2	21	20	17	21	26	21		5							
	FI	1yr			11				1	0		4		26		28	1		15		35	52	45	52	18	115		40	5	30	14		15		
		2yr		129	169	165	123	103	171	144	181	153	182	168	258	197	131	134	244	303	164	187	218	136	113	121	76	107	123	93	97	103	92	87	97
		3yr		35	16	0		26	1	8	0	13	17	25	35	34	24	9	16	16	15		8	14	4		0								
	LT	1yr						5	5	4	4	10											23	58	45		11	10	23	29	32	32	31	11	26
		2yr								3														1						0					
	LV	1yr	1	1	6	26	44	26	24	20	1	1	7	25		114	160	170		74	91	113	63	50	153	236	270	161	115	98	308	391	296	187	341
		2yr	1	4	6	7	5	2					11	29		2	10	67		116	177	112	132	65					8	69			13	33	29
	PL	1yr	51	85	102	2	148	140	266	483	298	492	330	138	151	211	30	16	46	322	455	188	358	434	267	132	174	243	289	328	301	546	1024	431	787
		2yr	857	847	498	248	376	845	523	642	821	1028	1001	924	845	733	739	804	765	843	968	1261	1021	834	1060	936	981	1046	888	619	634	651	8	515	290
	SE	1yr	13	9	8	19	41	18	6		4	23	19	90	7	10	108	10	116	11	131	15	76	180	129	170	118	138	207	156	183	156	144	156	131
		2yr	32	51	78	61	44	46	84	90	60	95	87	76	100	93	40	48	103	44	36	63	78	31	31	27	35	20	20	30	17	33	40	17	29
	DE	1yr																					14	14	14	13	15	14	15	14	15	15		7	10
Main Basin Total			1010	1167	903	544	795	1239	1114	1600	1576	2029	1880	1730	1445	2204	1935	1925	1921	2322	2513	2406	2453	2255	2123	2052	1953	2058	2025	1779	2190	2518	2214	1766	2426
Gulf of Bothnia 30-31	FI	1yr			9							7		1		5						33						125							
		2yr		358	579	700	716	527	525	510	663	639	483	540	462	478	503	451	305	358	477	541	608	676	426	519	472	503	493	477	411	417	458	401	363
		3yr		99	30	5	18	39	15	1	28	12	49	10	34	75	28	11	15	6	27	9	27	20	4	4	8	3		1	1	1	1		
	SE	1yr			19	7				6			1										40	61	55	110	197	181	219	239	253	220	198	215	205
		2yr	445	392	406	406	413	376	460	642	554	429	407	372	405	424	380	428	361	413	569	530	410	428	400	420	395	311	293	230	190	276	295	259	236
Gulf of Bothnia Total			445	848	1042	1118	1147	942	1001	1159	1244	1087	939	923	901	982	911	890	681	776	1072	1113	1086	1184	885	1052	1071	1123	1005	947	855	913	952	875	805
Gulf of Finland 32	EE	2yr																14	6	8	9	12	10	6	6	15	13	8	5	6	3	3			
	FI	1yr		5		22			4	5	15	12	13	5		38		4				11													
		2yr		191	260	249	306	312	284	342	128	228	277	386	355	372	367	290	281	190	279	247	316	291	213	239	216	242	173	132	194	178	143	73	48
		3yr			0		24	6		1	33	92	40	7	24	18	6	16					0	0									0		
	RU	1yr																4	3		13	95	25	10	3	7	64	44	74		88	82	84	55	
		2yr																1		0								1	0						
Gulf of Finland Total				197	261	270	330	318	287	348	177	331	331	398	380	427	373	329	291	198	301	364	352	308	222	260	292	294	253	138	285	263	227	127	48
Grand Total			1455	2212	2205	1932	2272	2499	2402	3106	2997	3447	3150	3050	2726	3613	3219	3144	2893	3296	3886	3883	3890	3747	3229	3365	3315	3475	3283	2863	3330	3694	3392	2768	3279

Table 5.6.2. Release of sea trout eggs, alevins, fry and parr into Baltic rivers in 2020. The number of smolts is added to Table 5.6.3 as enhancement.

Region	Egg	Alevin	Fry	Parr				Smolt			
				1-s old	1-y old	2-s old	3-s old	2021	2022	2023	Total
Sub-divs. 22-29	(1)	(1)	(4)	(6)	(9)	(10)	(10)				
Denmark	-	-	2,600	7,500	3,300	-	-	396	528	-	924
Estonia	-	-	-	-	-	-	-	-	-	-	-
Finland	-	-	-	-	-	72,300	-	10,845	-	-	10,845
Germany	-	-	575,000	-	-	-	-	-	17,250	-	17,250
Latvia	-	-	-	-	-	-	-	-	-	-	-
Poland	-	3,062,200	1,887,500	-	50,000	-	-	6,000	87,247	-	93,247
Sweden	-	-	2,000	-	-	-	-	-	60	-	60
Lituania	-	-	154,000	-	-	-	-	-	4,620	-	4,620
Total	-	3,062,200	2,621,100	7,500	53,300	72,300	-	17,241	109,705	-	126,946
Sub-divs. 30-31	(2)	(3)	(5)	(7)	(8)	(8)	(10)				
Finland	26,900	116,700	11,000	-	68,700	100	-	-	8,256	2,105	10,361
Sweden	40,000	-	57,700	-	84,800	-	-	-	10,176	1,354	11,530
Total	66,900	116,700	68,700	-	153,500	100	-	-	18,432	3,459	21,891
Sub-div. 32	(1)	(1)	(4)	(6)	(9)	(10)	(10)				-
Estonia	-	-	-	6,000	-	-	-	-	360	-	360
Finland	273,500	-	-	-	10,700	-	-	1,284	2,735	-	4,019
Russia	-	-	-	-	-	-	-	-	-	-	-
Total	273,500	-	-	6,000	10,700	-	-	1,284	3,095	-	4,379
Grand total Sub-divs. 24-32	340,400	3,178,900	2,689,800	13,500	217,500	72,400	-	18,525	131,232	3,459	153,216

Table 5.6.3. Estimated number of sea trout smolts originating from eggs, alevins, fry and parr releases in 2001–2020.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Sub-divs. 22-29																							
Denmark	25555	45759	7912	17790	17508	13695	13695	13704	12540	12540	10737	9177	9606	9240	9246	9519	518	518	518	453	930	528	0
Estonia	0	2100	1200	400	1110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	22670	33965	19550	18735	160	0	0	0	11445	13815	10350	8100	14375	16260	17787	14349	18313	16141	15990	12264	10845	0	0
Germany	24900	61200	72240	27240	36900	32550	38400	29640	29910	40800	34500	29400	34650	32700	32580	31860	35874	29550	24129	5250	19500	17250	0
Latvia	8644	11007	960	5340	15227	6462	3189	19015	6840	17664	30595	5987	15300	28913	7787	11621	6000	6828	0	8400	0	0	0
Poland	148500	84240	68400	91000	63236	77690	61459	107686	84901	108422	114982	95939	103756	130787	133965	120012	143635	127479	167504	87693	126736	87247	0
Sweden	39333	42690	5320	29335	2055	27700	4425	1623	2210	898	0	2385	1737	2940	3258	1368	1380	2379	2346	2373	1845	60	0
Lituania	0	0	0	1670	2400	4350	7440	18180	12990	8040	6750	5370	10935	8580	6300	4560	4680	3840	6120	2820	4530	4620	0
Total	269602	280961	175582	191510	138596	162447	128608	189847	160836	202179	207914	156358	190359	229420	210924	193289	210400	173268	216607	119253	164386	109705	0
Sub-divs. 30-31																							
Finland	80662	26523	42828	36670	1890	31362	11787	22704	29892	32550	46753	39285	25881	22595	18782	12878	12879	21328	16284	15761	11295	12906	2105
Sweden	78440	43614	24092	22921	36170	20207	22756	24561	16690	16497	12811	13026	5456	21906	9073	25850	12996	17203	11003	14220	7902	13031	1354
Total	159102	70137	66920	59591	38060	51569	34543	47265	46582	49047	59564	52311	31337	44501	27855	38728	25875	38531	27287	29981	19197	25936	3459
Sub-div. 32																							
Estonia	0	0	2412	2532	4407	2100	420	0	0	1536	2098	6552	9486	3519	840	1020	618	0	0	0	0	360	0
Finland	5500	2049	419	340	3429	345	11574	8997	4353	5919	5233	291	1747	1632	1050	7716	2409	2722	1384	4529	3865	2735	0
Russia	3630	7800	200	1630	1281	6690	3924	0	312	9381	126	3441	1746	3	2910	0	0	0	0	0	0	0	0
Total	9130	9849	3031	4502	9117	9135	15918	8997	4665	16836	7457	10284	12979	5154	4800	8736	3027	754	1384	4529	3865	3095	0
Grand total																							
Sub-divs.	392476	360947	245533	255603	185773	223151	179069	246108	212083	268061	274935	218953	234675	279075	243578	240753	239301	212554	245278	153762	187448	138736	3459

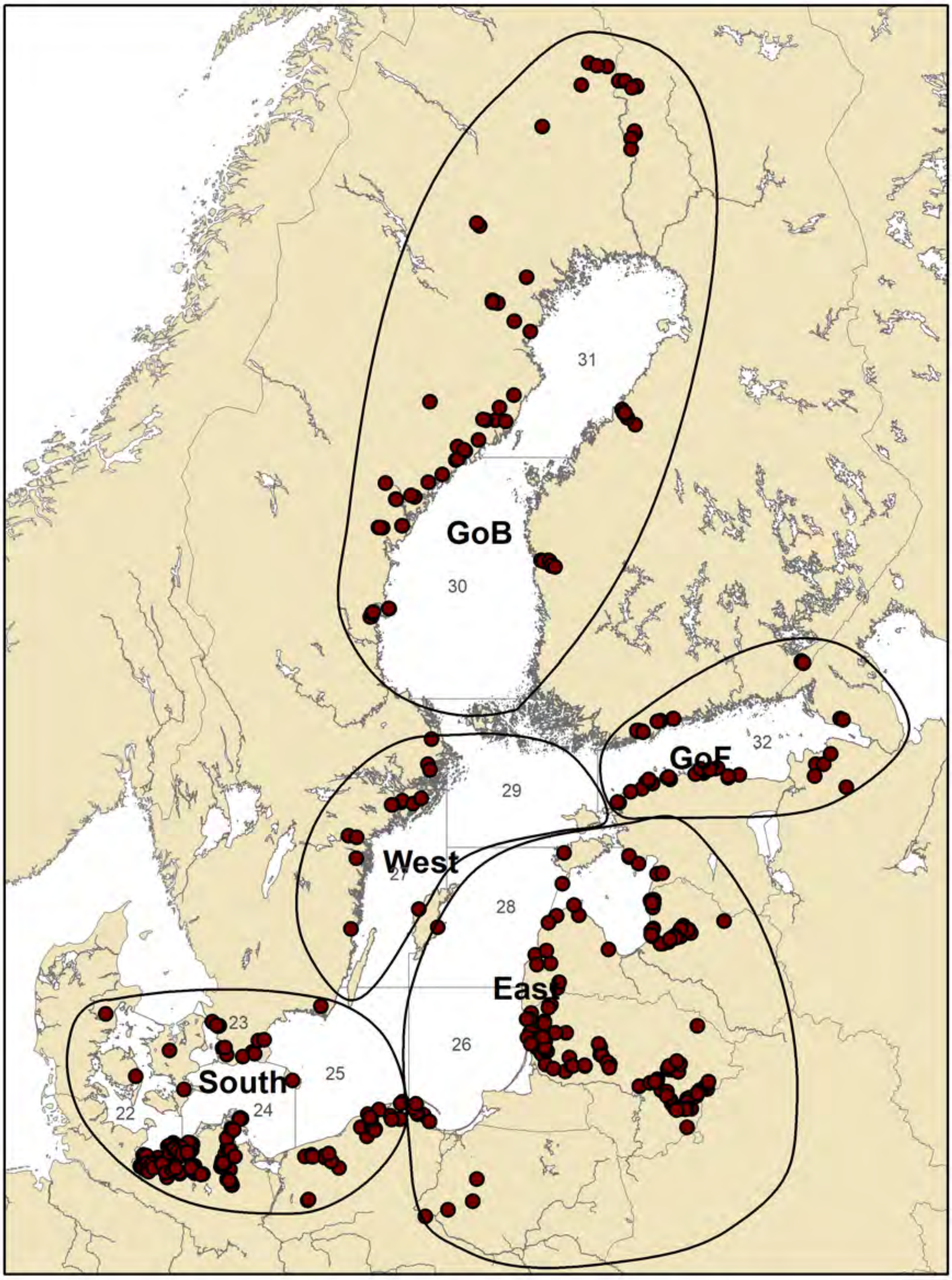

Figure 5.3.2.1. Electrofishing sites in subdivisions 22–32 used for assessment of sea trout recruitment status.

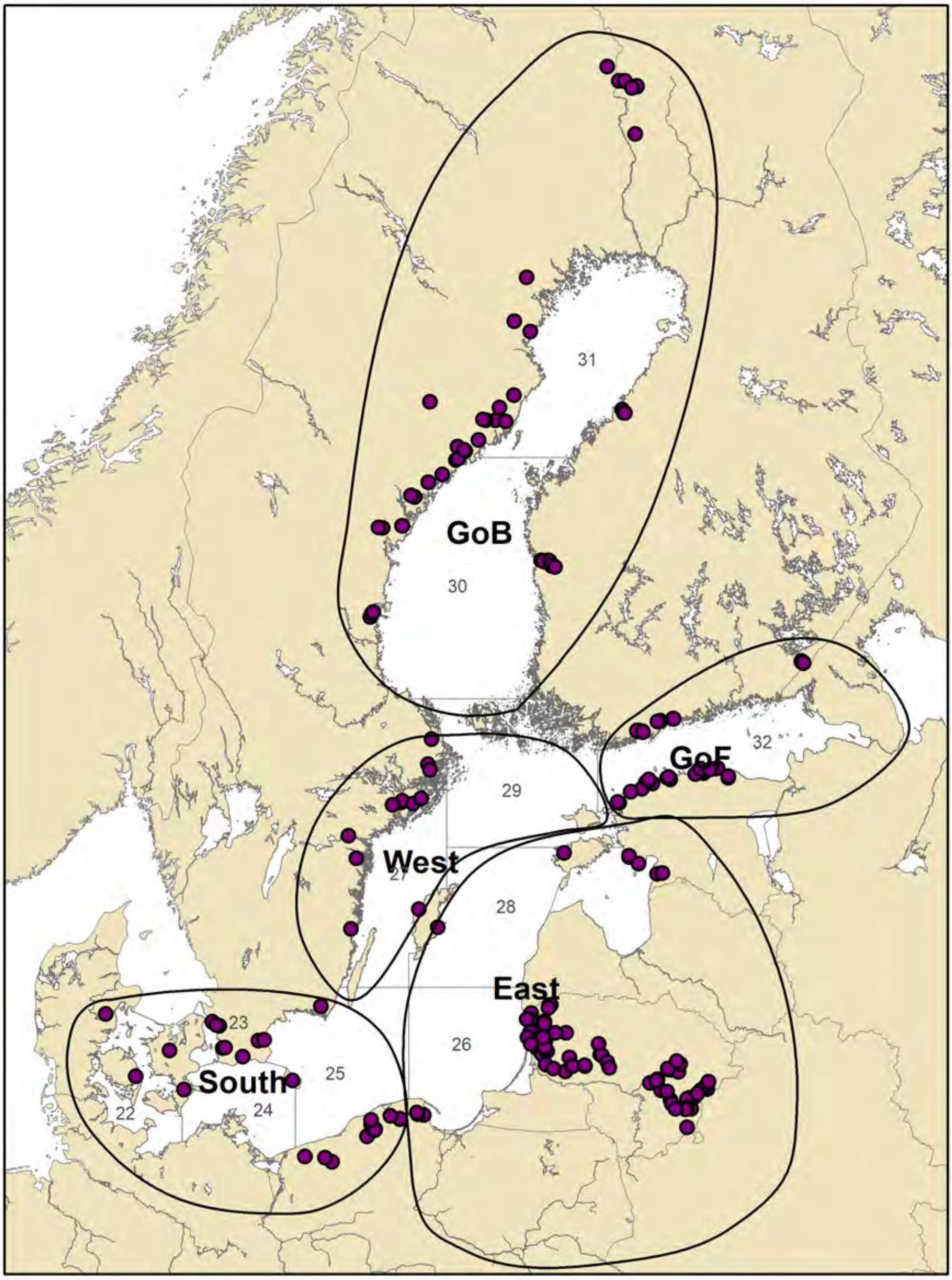

Figure 5.3.2.2. Electrofishing sites in subdivisions 22–32 used for trend analysis of sea trout recruitment status.

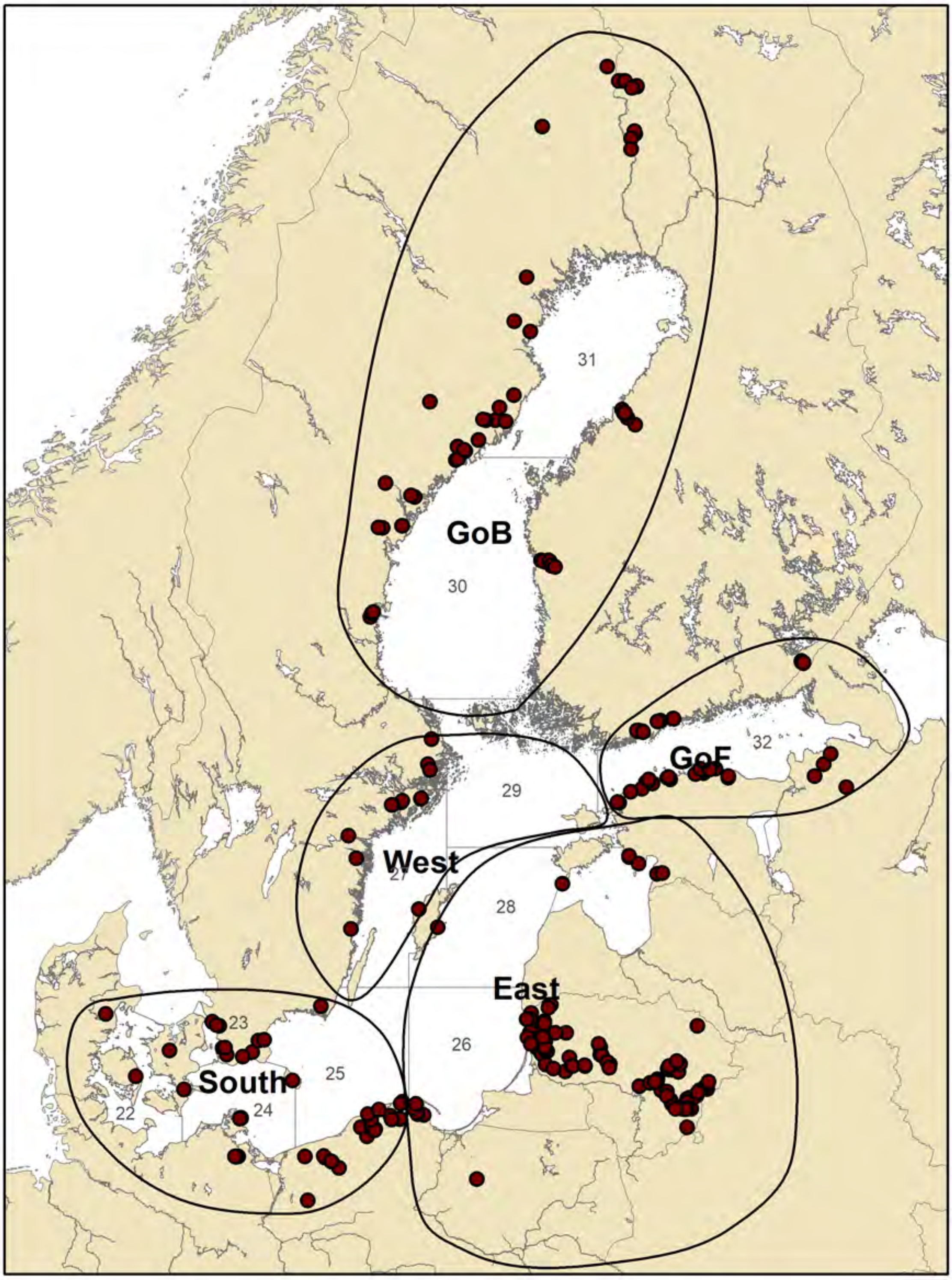

Figure 5.3.2.3. Electrofishing sites in subdivisions 22–32 used for calculating three-year averages for analysis of sea trout recruitment status.

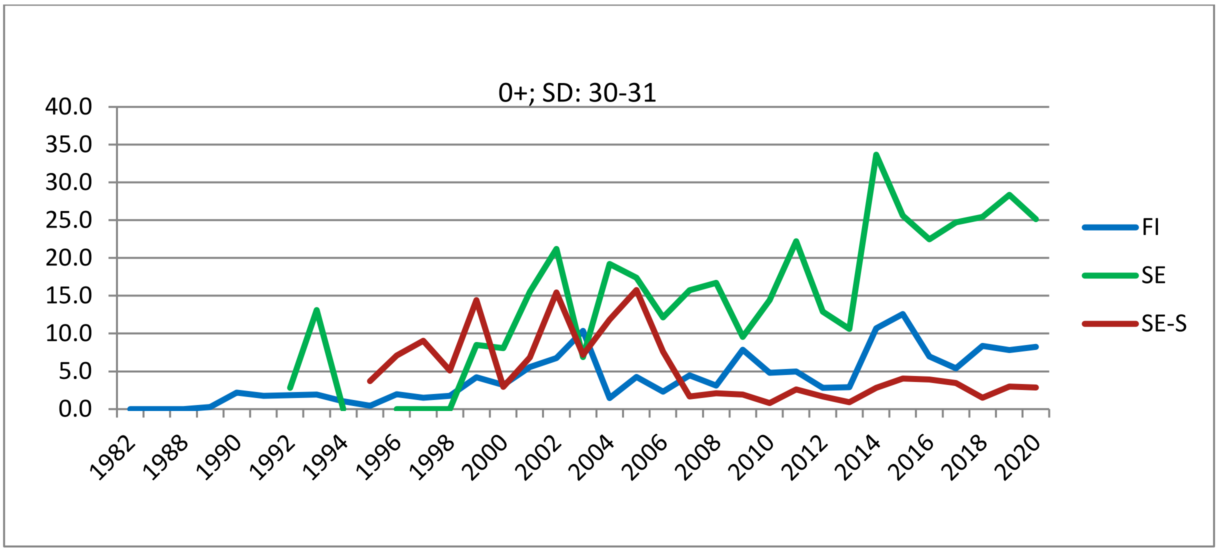

Figure 5.4.1.1. Average densities of 0+ trout in Finnish (FI) and Swedish trout (SE) and Swedish salmon (SE-S) rivers in ICES SD 30–31.

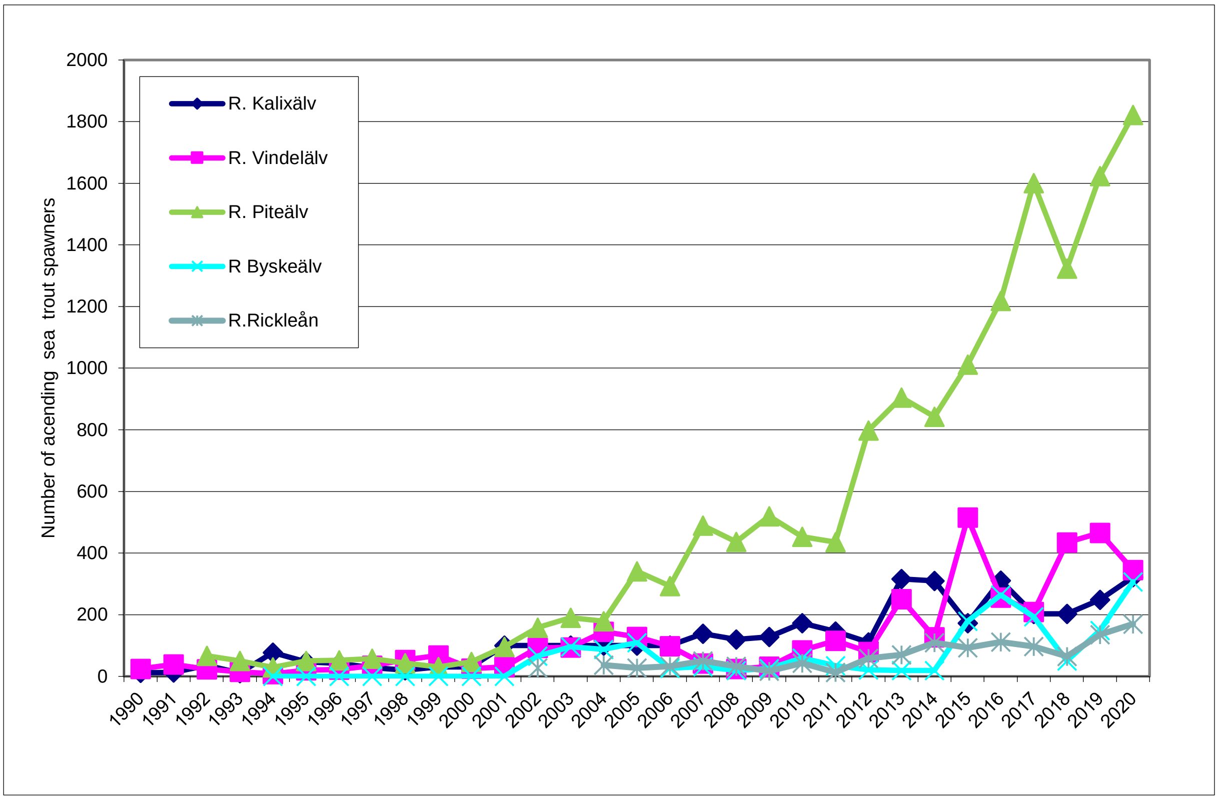

Figure 5.4.1.2. Number of ascending sea trout spawners from fish counters in four Swedish rivers debouching in the Bothnian Bay.

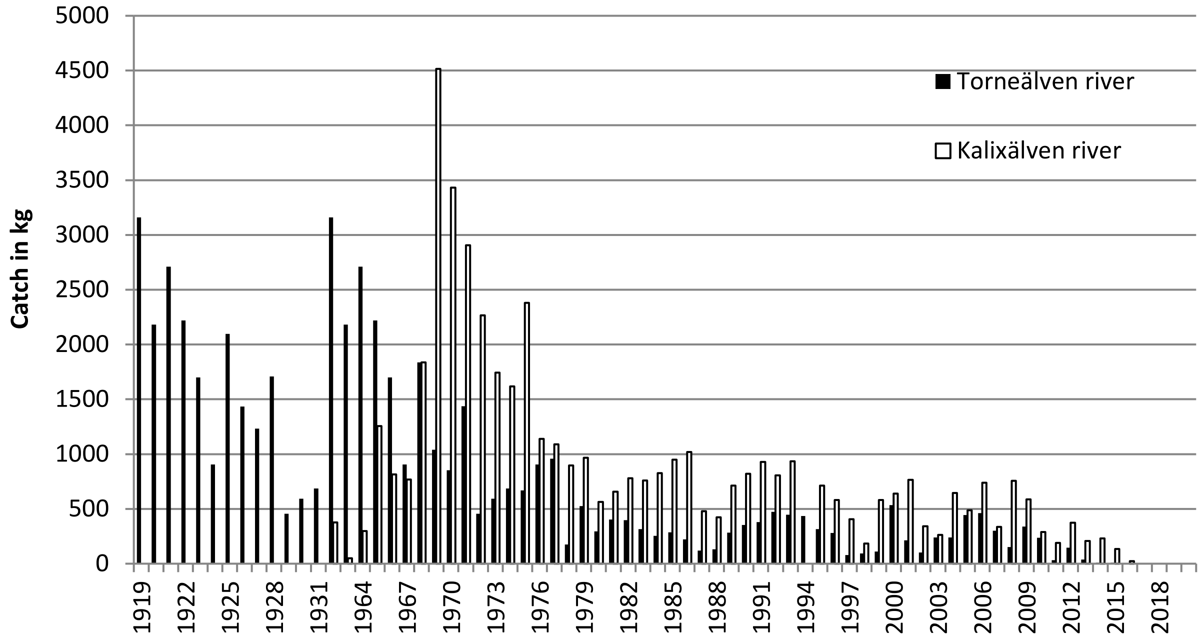

Figure 5.4.1.3. Swedish sea trout catches (landed, in kilos) in rivers Kalixälven and Torneälven (SD 31). Note that since 2013 there is a ban for landing of sea trout in Torneälven (updated for WGBAST 2021).

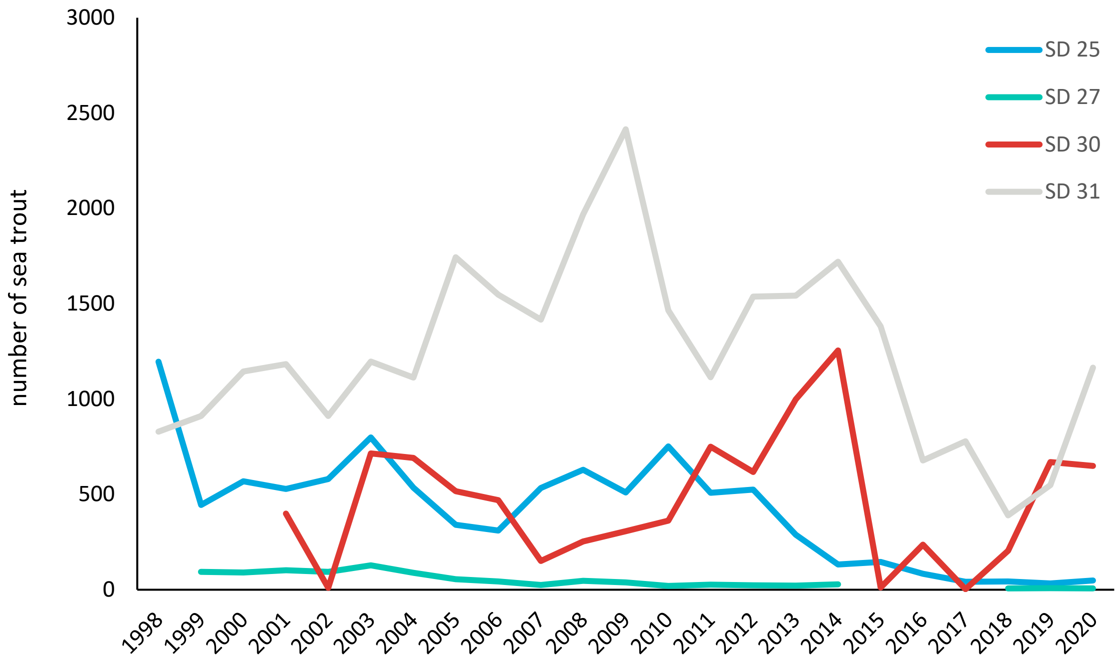

Figure 5.4.1.4. Nominal catches (in numbers) of sea trout in Swedish wild rivers (ICES SD 25–31). Only landed catches are included (no catch and release).

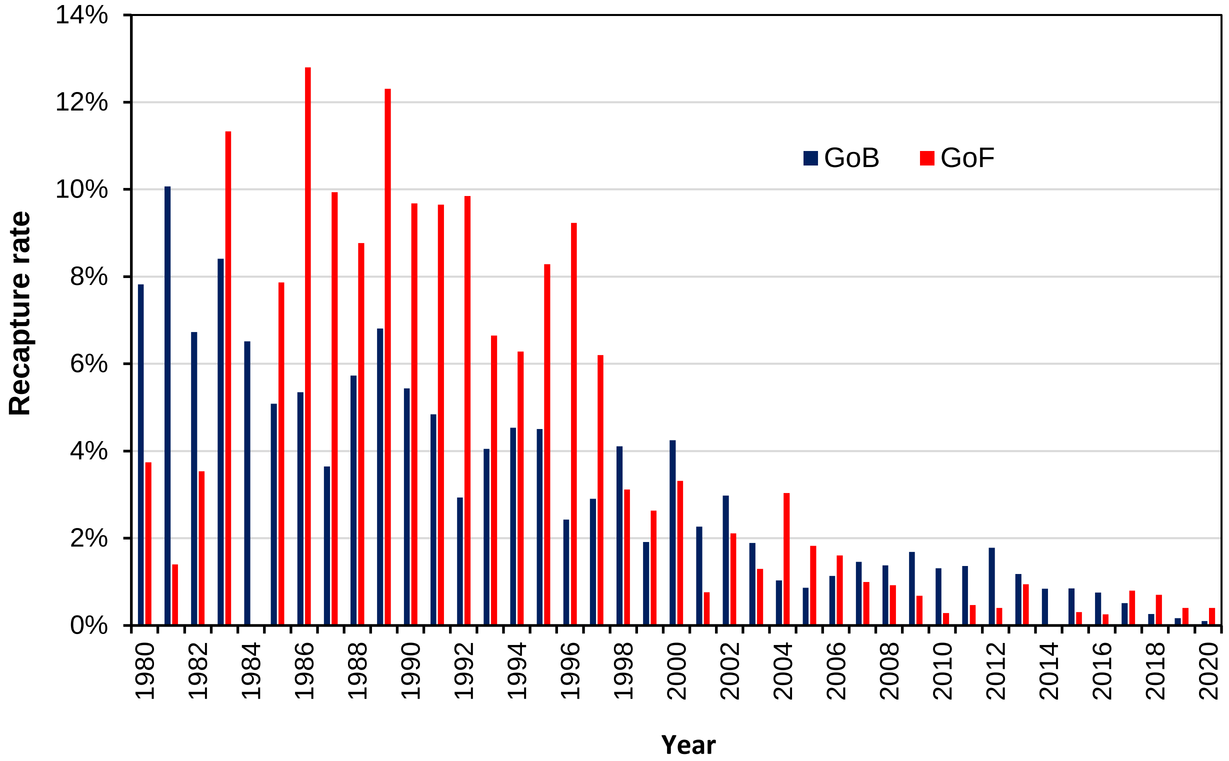

Figure 5.4.1.5. Return rates of Carlin tagged sea trout released in Gulf of Bothnia and Gulf of Finland in 1980–2020 (updated in March 2021).

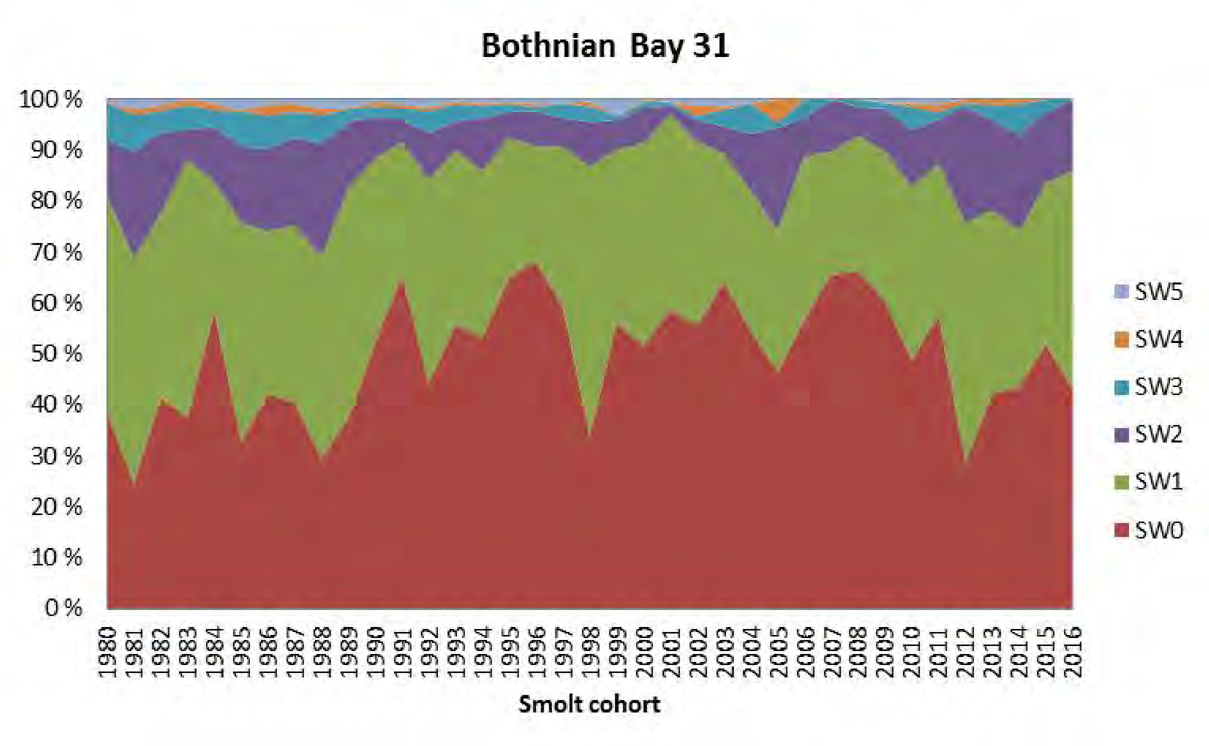

Figure 5.4.1.6. Age distribution of recaptured Carlin-tagged sea trout released in the Bothnian Bay (Subdivision 31) area in Finland, 1980–2016 (not updated for WGBAST 2021).

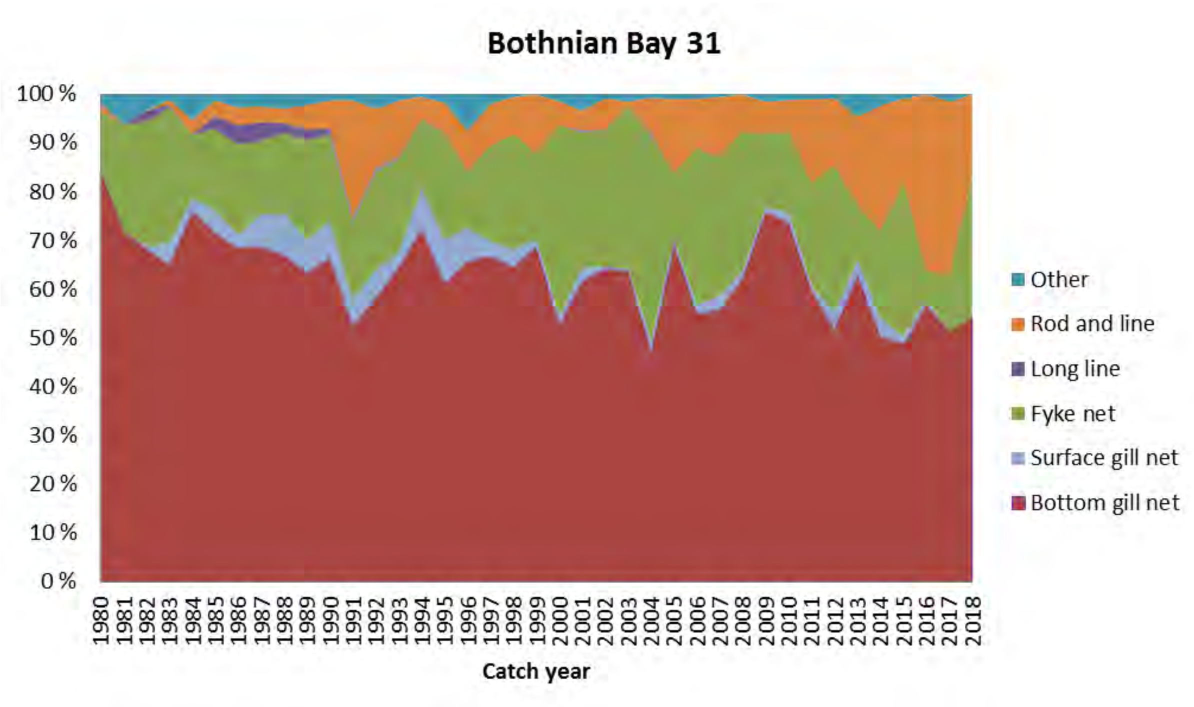

Figure 5.4.1.7. Distribution of fishing gear in recaptures of recaptured Carlin-tagged sea trout caught in the Bothnian Bay (Subdivision 31) area in Finland in 1980–2018. (not updated for WGBAST 2021).

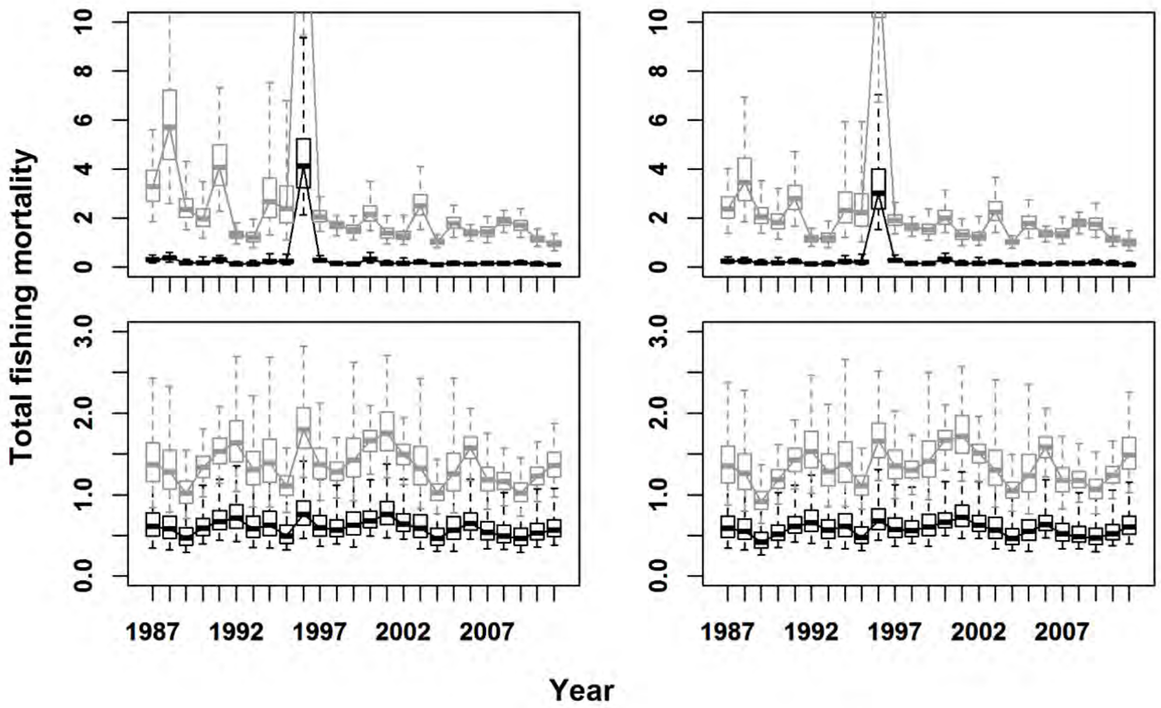

Figure 5.4.1.8. Posterior estimates of total annual instantaneous fishing mortality (F, summed over gear types/fleets) for sea trout from the Isojoki (top panels) and Lestijoki (lower panels) stocks with a time-invariant recreational tag reporting rate (left-hand panels) and time-varying recreational tag reporting rate (right-hand panels). Survival from fishing =exp(-F) and harvest rate=1-exp(-F). Black boxes, age 2; grey boxes, ages 3+. The horizontal line in the center of each box denotes the median, the ends of the box denote the interquartile range and the whiskers extend to the 2.5th and 97.5th percentiles.

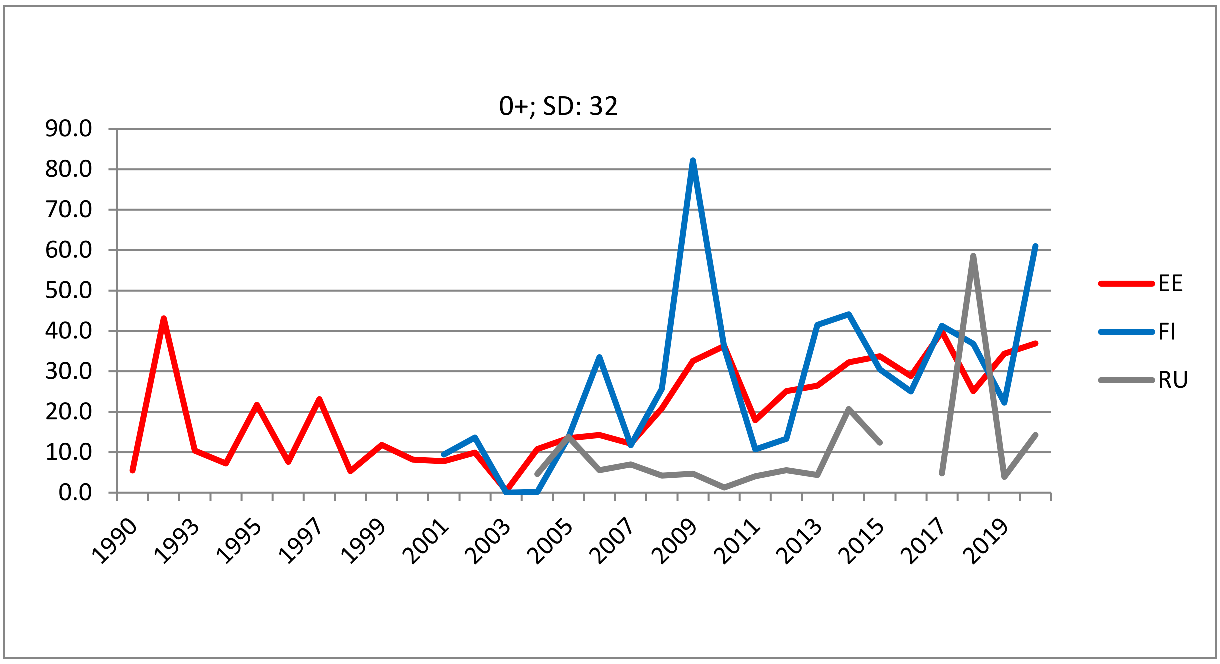

Figure 5.4.2.1. Average densities of 0+ trout in Estonian (EE), Finnish (FI) and Russian (RU) rivers in the Gulf of Finland (ICES SD 32).

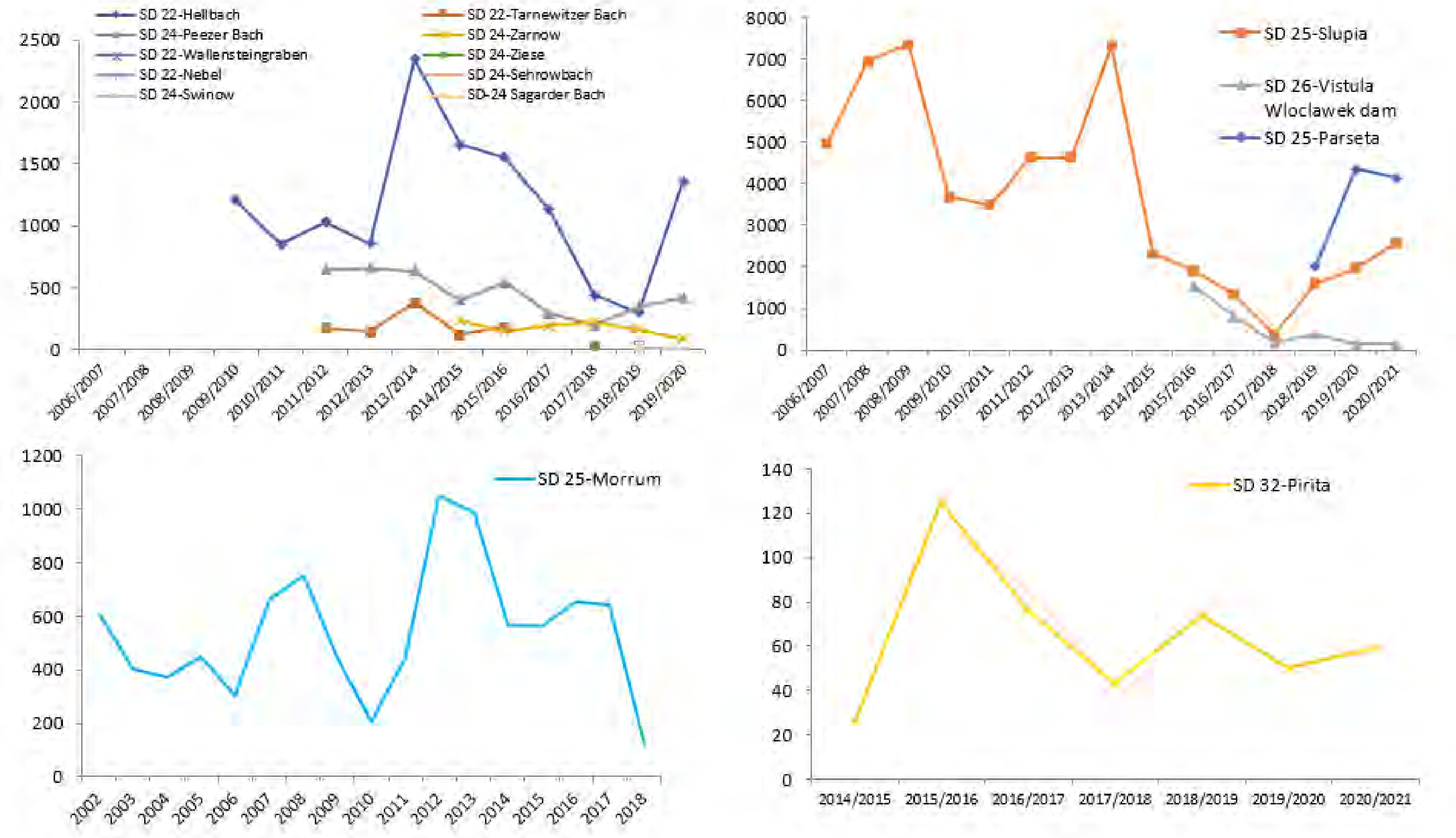

Figure 5.4.2.2. Video monitoring based on spawners counts in German small river systems, not updated for WGBAST 2021 (SD 22 and 24). Vaki counter numbers from Polish rivers (SD 25 and 26), Morrum SD 25 (in 2019 and 2020 counter not operated) and Estonian Pirita River SD 32.

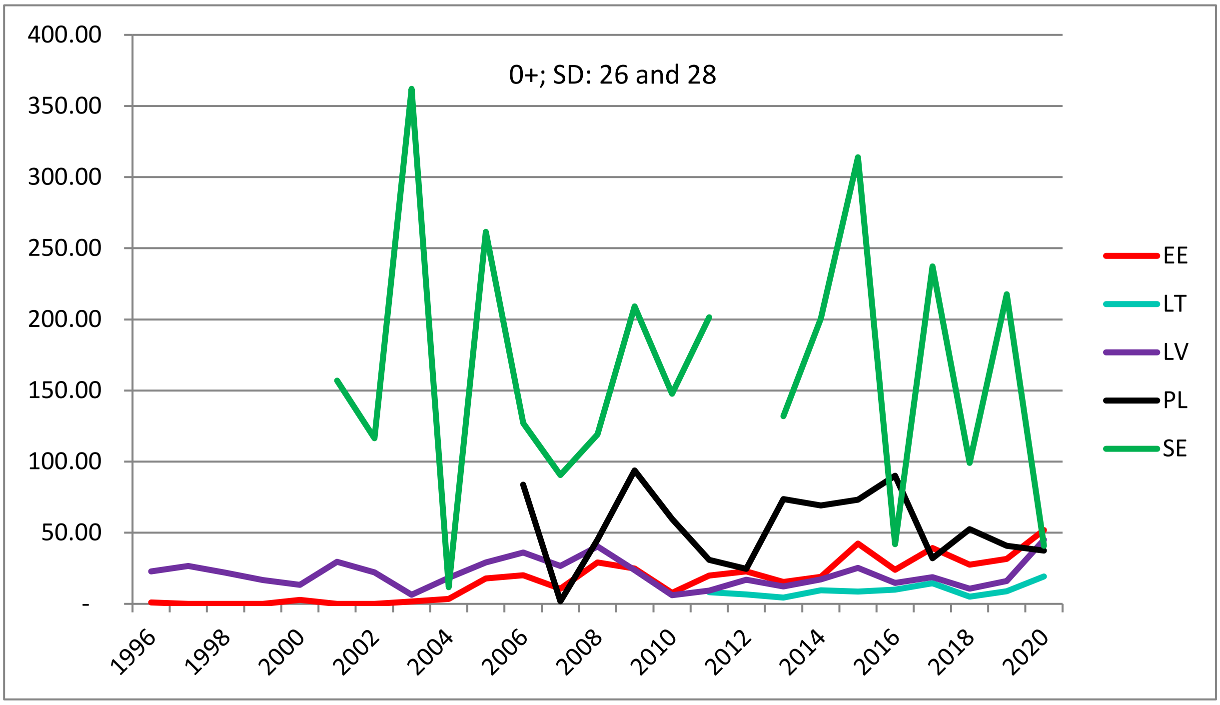

Figure 5.4.3.1. Average densities of 0+ trout in Estonian (EE), Lithuanian (LT), Latvian (LV), Polish (PL) and Swedish (SE) rivers in ICES SD 26 and 28.

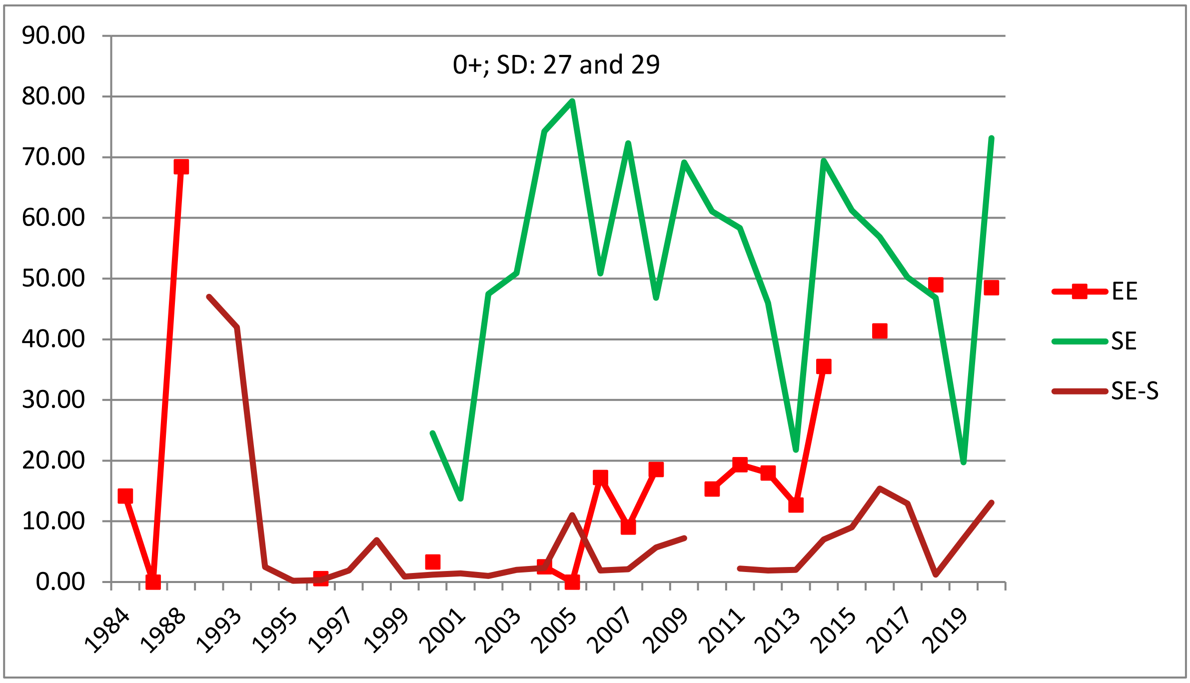

Figure 5.4.3.2. Average densities of 0+ trout in Estonian (EE), Swedish salmon (SE-S) and Swedish trout (SE) rivers in ICES SD 27 and 29.

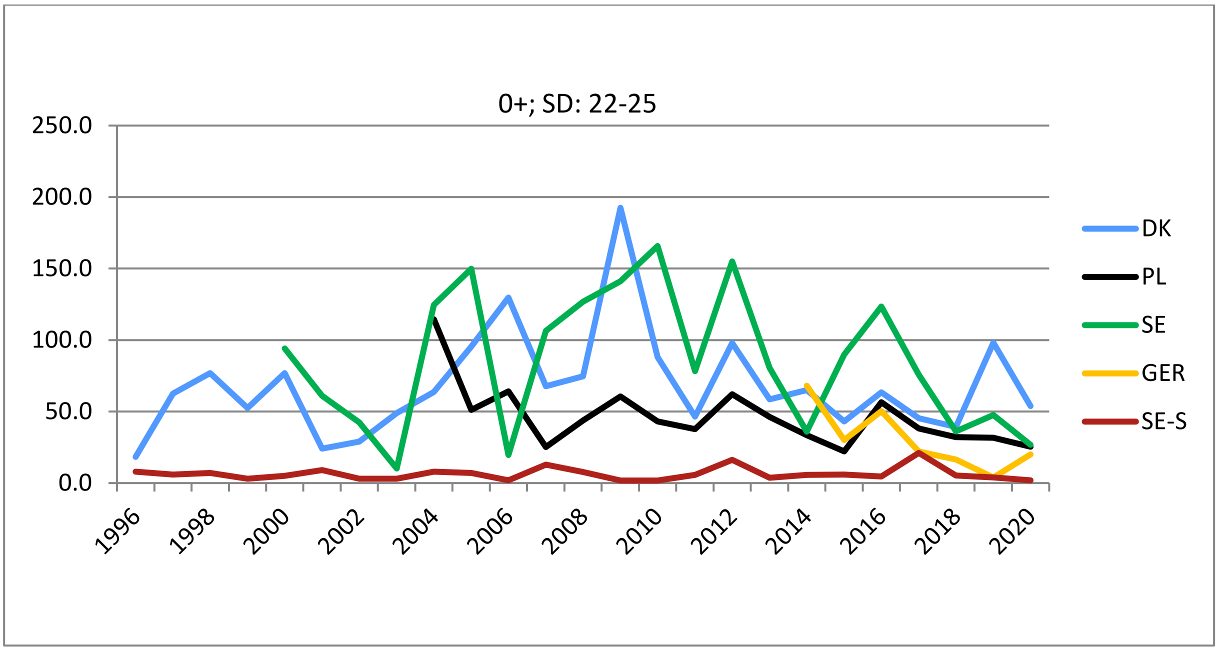

Figure 5.4.3.4. Average densities of 0+ trout in Danish (DK), Polish (PL), German (GER), Swedish salmon (SE-S) and Swedish trout (SE) rivers in ICES SD 22–25.

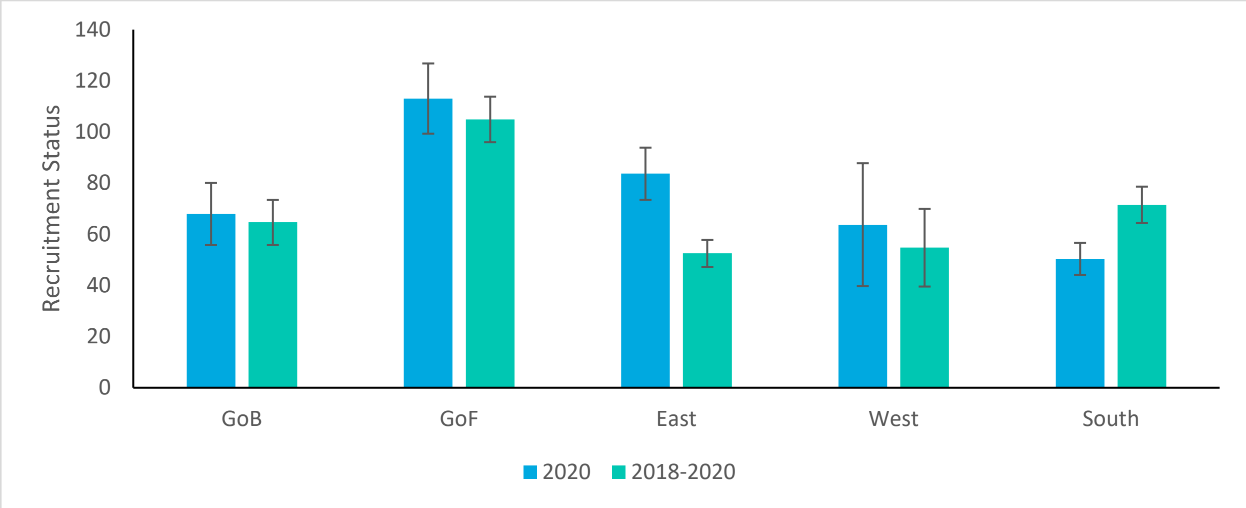

Figure 5.5.1. Recruitment status for 0+ trout by Assessment Area Division (95% CL) in 2020 and the last three years (2018–2020).

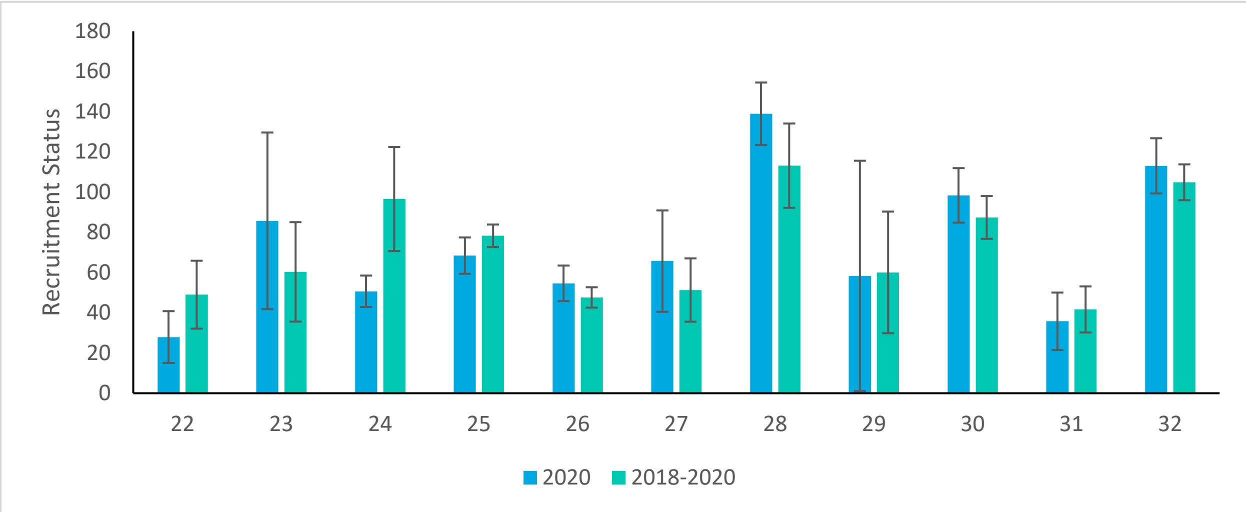

Figure 5.5.2. Recruitment status for 0+ trout by ICES SD (95% CL) in 2020 and the last three years (2018–2020).

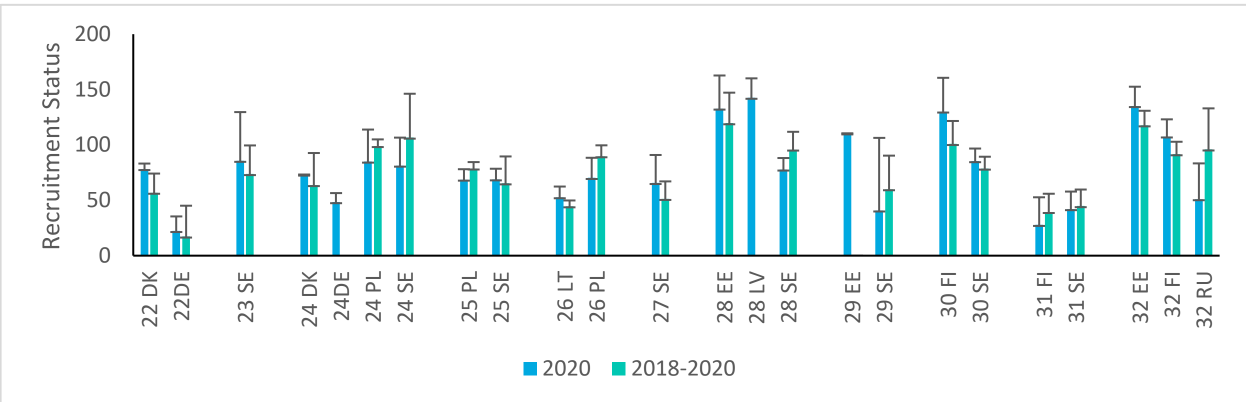

Figure 5.5.3. Recruitment status for 0+ trout by ICES SD and individual countries within SD (95% CL, only positive value displayed) in 2020 and the last three years (2018–2020).

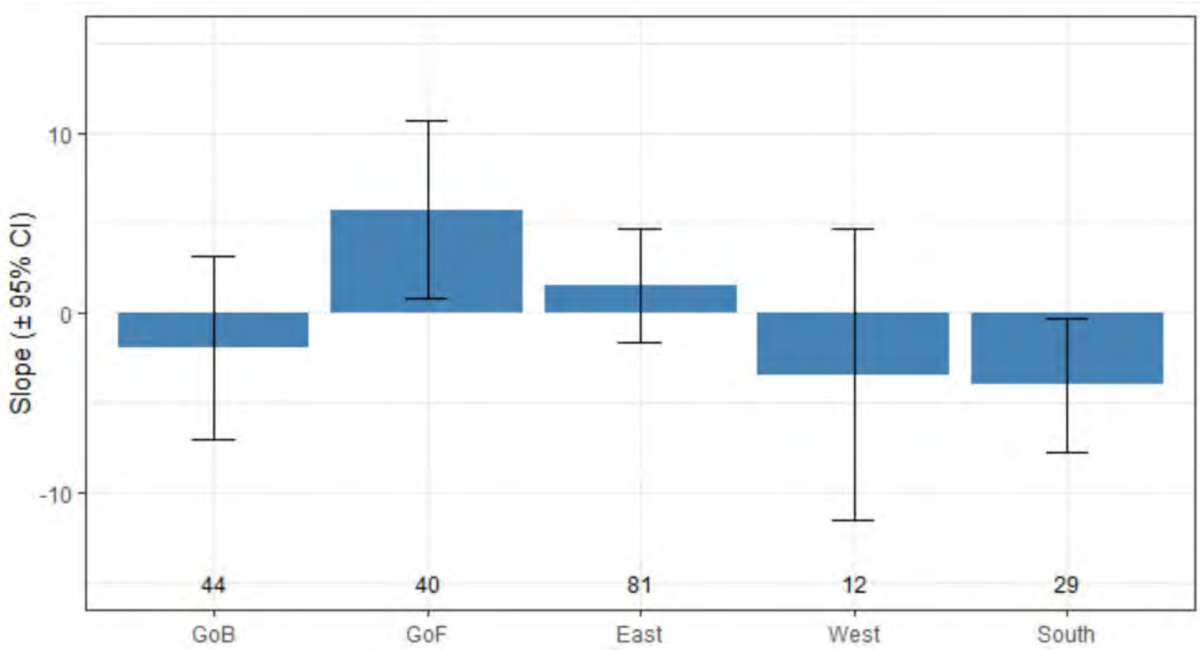

Figure 5.5.4. Trend (linear regression slope with 95% CI) in 0+ trout recruitment status in the last five years by Assessment Area Division (number of sites is denoted above the x-axis). Note that trends are calculated by assessment area and not by individual sites.

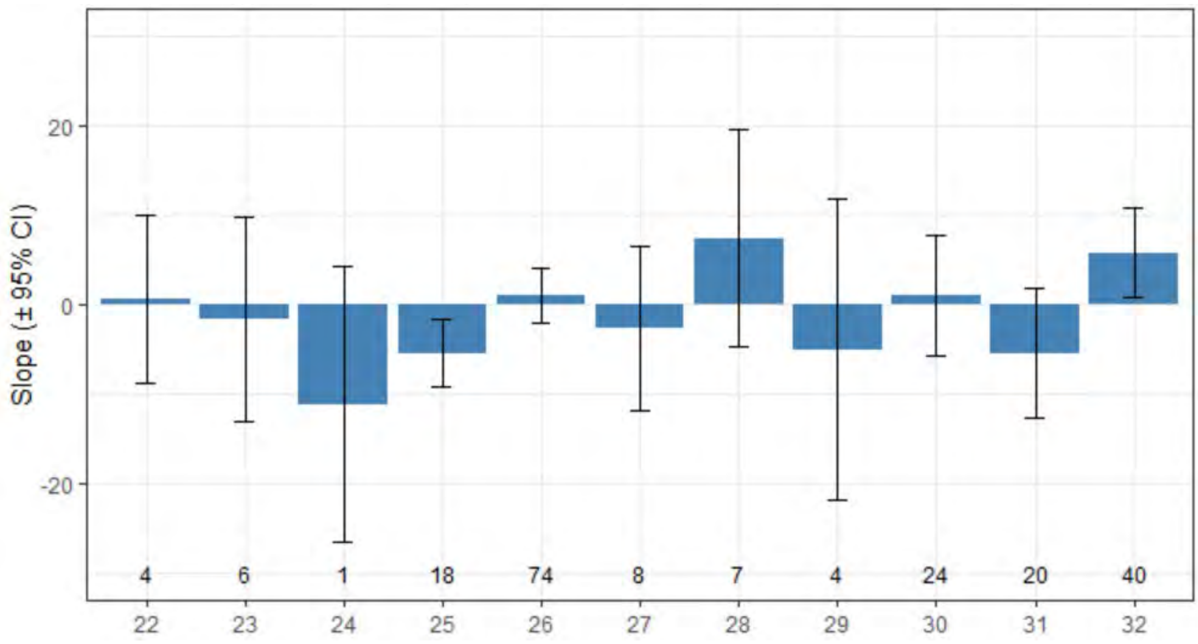

Figure 5.5.5. Trend (linear regression slope with 95% CI) in 0+ trout recruitment status in the last five years by ICES SD (number of sites is denoted above the x-axis). Note that trends are calculated by ICES SD and not by individual sites.

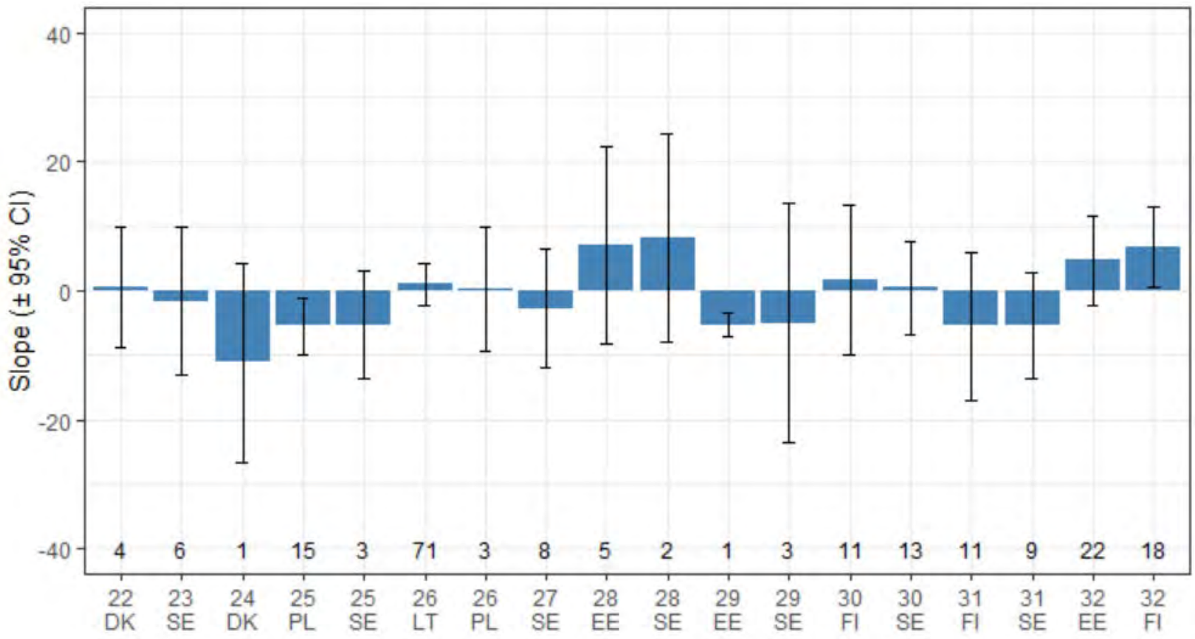

Figure 5.5.6. Trend (linear regression slope with 95% CI) in 0+ trout recruitment status in the last five years by ICES SD and individual countries (number of sites is denoted above the x-axis). Note that trends are calculated by ICES SD and country and not by individual sites.

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Annex 2: Stock annex for Salmon (*Salmo salar*) in subdivisions 22–31 (Main Basin and Gulf of Bothnia) and Subdivision 32 (Gulf of Finland)

The table below provides an overview of the WGBAST Stock Annex. Stock Annexes for other stocks are available on the ICES website Library under the Publication Type "Stock Annexes". Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year*, *ecoregion*, *species*, and *acronym* of the relevant ICES expert group.

Stock ID	Stock name	Last up-dated	Link
Sal-2431+sal-32	Salmon (*Salmo salar*) in subdivisions 22–31 (Main Basin and Gulf of Bothnia) and subdivision 32 (Gulf of Finland)	April 2021	Baltic Salmon

Annex 3: Recommendations

The Working Group recommends following actions in order to fulfil the shortcomings in the present data and knowledge regarding the Baltic Sea salmon and sea trout to further improve the stock assessment and also, potentially support the management of Baltic salmon and sea trout.

Recommendation	Adressed to
1. Catch estimates of recreational salmon and sea trout fisheries are uncertain, incomplete or totally missing for several countries. Studies and methods to estimate these catches are needed.	ICES Baltic Sea Member States, RCG Baltic Sea (DSG), ICES WGRFS
2. Issues related to salmon sampling: In Sweden and Finland, in the coastal trapnet fishery, salmon are released back to sea during part of fishing season because of quota fulfillment or fishing regulations. Reported and non-reported amounts of these discarded salmon and their survival rate should be evaluated. Counting of ascending adults should be performed in all salmon index rivers. Quality of data on amounts and areal distribution of seal damaged salmon and other dead discards by fisheries should be evaluated and improved in countries where these data are found to be defective.	ICES Baltic Sea Member States, RCG Baltic Sea (DSG), ICES PGDATA
3. Issues related to sea trout sampling: Total population size of 0+ and older parr, as well as estimated total production of smolt should be calculated for rivers where data are available. Especially important are values for index rivers. If possible the areas should be divided into habitat quality classes. Total production area available for sea trout should be provided for streams where data are available. Sufficient data coverage of sea trout parr densities from typical trout streams should be collected in all countries. Presently no information was available from Schleswig-Holstein and Kaliningrad region. Sea trout index rivers should be established to fullfil assessment requirements with respect to geographical coverage and data collection needs.	ICES Baltic Sea Member States, RCG Baltic Sea (DSG), ICES PGDATA
4. Data on proportions of sea trout and salmon in catches should be provided to the working group to facilitate estimation of the development of misreporting. ICES Baltic Sea Member States should provide catch composition data from coastal and offshore fisheries (as defined in the EU regulation) covering all main gears.	ICES Baltic Sea Member States

Annex 4: Change in reference points for the status evaluation of Baltic salmon in assessment units 1–4

Background

The European Commission made a request to ICES in 2008 to provide scientific advice on future management of Baltic Sea salmon stocks, in the form of a new management plan to address "all life stages of salmon and all human impacts on salmon". The request came as the former Salmon Action Plan (SAP) was due to end in 2010. The SAP's main objective was as follows:

"The production of wild Salmon should gradually increase to attain by 2010 for each Salmon river a natural production of wild Baltic Salmon of at least 50% of the best estimate potential [R_0] and within safe genetic limits, in order to achieve a better balance between wild and reared Salmon."

Suitable management reference points to replace the 50% R_0 limit were explored in the *Report of the Workshop on Baltic Salmon Management Plan Request* (ICES, WKBALSAL 2008). MSY-based reference points were calculated using results from the latest stock assessment (including stock–recruit information). Since many of the rivers assessed by ICES had reached a level of at least 50% of the estimated R_0 by 2008, it was proposed (ICES, 2008), that the limit of natural smolt production should not be lower than 75% of the estimated R_0 for each river. Since then, Atlantic salmon stocks in the Baltic Sea have been assessed using 75% of smolt production at the demographic equilibrium with no fishing (R_0 or PSPC) as a proxy for smolt production at maximum sustainable yield (MSY). However, it was already recognized by WKBALSAL that owing to variation in river-specific conditions and vital rates, MSY will be achieved at different proportions of R_0 for different stocks. Hence, using the same proxy for all stocks can be expected to lead to overutilization of some river stocks and underutilization of others. Stock-specific smolt production at MSY has been calculated earlier using simulation methods (Table 3.4.1.1, ICES, 2008; Table 3.1, ICES, 2017) but was not adopted as a target reference point in assessments.

A few years ago, managers from Baltic Sea countries (BALTFISH) finalized an updated draft of the original EC proposal from 2011. In 2018, ICES received a special request from the EC to evaluate parts of the plan proposed by BALTFISH. The work to respond to the special request was carried out in an ICES workshop (ICES 2020a, WKBaltSalMP) that included two meetings attended by scientific experts, national managers and stakeholder representatives. As requested, existing and alternative reference points for the assessment of stock status and fishing opportunities were examined. The existing target formulated in terms of smolt production (75% of R_0 or PSPC, used as a proxy for MSY), was found to be inconsistent with the overall objective in the draft plan of achieving MSY, since in most cases it does not correspond to the true stock-specific recruitment at MSY (R_{MSY}). A precautionary reference point (R_{lim}) was further evaluated, defined as the lowest level of smolt production from which a stock is expected to recover to R_{MSY} in one salmon generation, if all fishing was closed (ICES, 2020a). Based on these results, ICES advised use of stock-specific smolt production targets (R_{MSY} and R_{lim}) as future reference points for Baltic salmon (ICES, 2020b). Reference points for WKBaltSalMP were calculated using the median values of parameters of the Beverton–Holt stock–recruitment function, thus achieving point estimates for stock-specific R_{MSY} and R_{lim}.

Reference points in 2021

In 2021, WGBAST evaluated stock status using R_{MSY} and R_{lim} as reference points. Full distributions for both reference points were derived for each stock in AU 1–4 to be able to evaluate risk (probabilities to reach targets or exceed limits), as has been done with the MSY proxy in earlier years. In deriving full distributions, care was taken to maintain correlations between the reference points and their comparand (in this case smolt abundance).

Methods

Derivations of R_{MSY} and R_{lim}

Assuming a Beverton–Holt stock–recruitment function, as in the full life-history model for Baltic salmon (FLHM), MSY can be defined as the maximum surplus smolt production, i.e. the maximum difference between the replacement line and stock–recruitment curve. MSY can be found analytically, using the Beverton–Holt function, or using simulations to find the fishing mortality rate that maximizes the average long-term catch. The analytical method was used for derivation of both R_{MSY} and R_{lim} in the 2021 assessment, although both methods are described below for completeness.

Analytical solution for R_{MSY}

The analytical solution for R_{MSY} makes use of the properties of the Beverton–Holt stock–recruit function. By differentiating the surplus production function (Figure A1b), the egg and smolt production corresponding to MSY can be found at the point where the derivative equals 0 (Figure A1c). This method requires a distribution for R_0 from simulation, together with posterior distributions for stock-recruit parameters from the FLHM; α (maximum egg survival) and K, the maximum recruitment. R_0 distributions were obtained by running the scenarios code with 0 fishing mortality for 271 years into the future. The average of smolt production over the last 200 years of the simulation was taken as an approximation of R_0 for each stock. Egg production at the unfished demographic equilibrium E_0, can then be found as:

$$E_0 = \frac{R_0}{\left(\alpha * \left(1 - \frac{R_0}{K}\right)\right)}$$

E_{MSY} can then be found as:

$$E_{MSY} = \frac{-\delta + \sqrt{(\delta^2 - 4\alpha\gamma)}}{2\alpha}$$

where $\delta = 2\frac{K}{\alpha}$ and $\gamma = \left(\frac{K}{\alpha}\right)^2 - K\left(\frac{K}{\alpha}\right)\left(\frac{E_0}{R_0}\right)$. R_{MSY} is then given by:

$$R_{MSY} = \frac{E_{MSY}K}{\frac{K}{\alpha} + E_{MSY}}$$

In addition to E_{MSY} and R_{MSY}, MSY can be found analytically as:

$$MSY = R_{MSY} - \frac{R_0 E_{MSY}}{E_0}$$

This corresponds to the maximum yield in numbers that could be obtained if all salmon could be harvested instantaneously on recruitment (i.e. as smolts).

During calculations of R_{MSY} it was discovered that for some posterior samples, the value of R_0 from simulations was greater than or equal to the value of K. This occurred since the stock–recruitment errors in the FLHM and scenarios projections are assumed to arise from a Lognormal distribution with median of 1, rather than a mean of 1. As a result, the mean of this distribution will be slightly higher than 1, so that for stocks with high steepness where equilibrium smolt abundance is close to K, even when annual smolt abundance were averaged over a long time period, R_0 rose above K in a few trajectories. The mean of the stock–recruit error distribution will be corrected to 1 in the FLHM and scenarios in 2022. In 2021, two additional steps were taken to allow analytical calculation of R_{MSY} when R_0 went above K. These were 1) an *ad hoc* correction factor was applied to K:

$$K' = \exp\left(\log(K) + \frac{0.5}{\tau}\right)$$

where τ is the precision of the Lognormal distribution for stock–recruitment errors, and 2) any remaining R_0 values that were higher than K were substituted with $0.999K$.

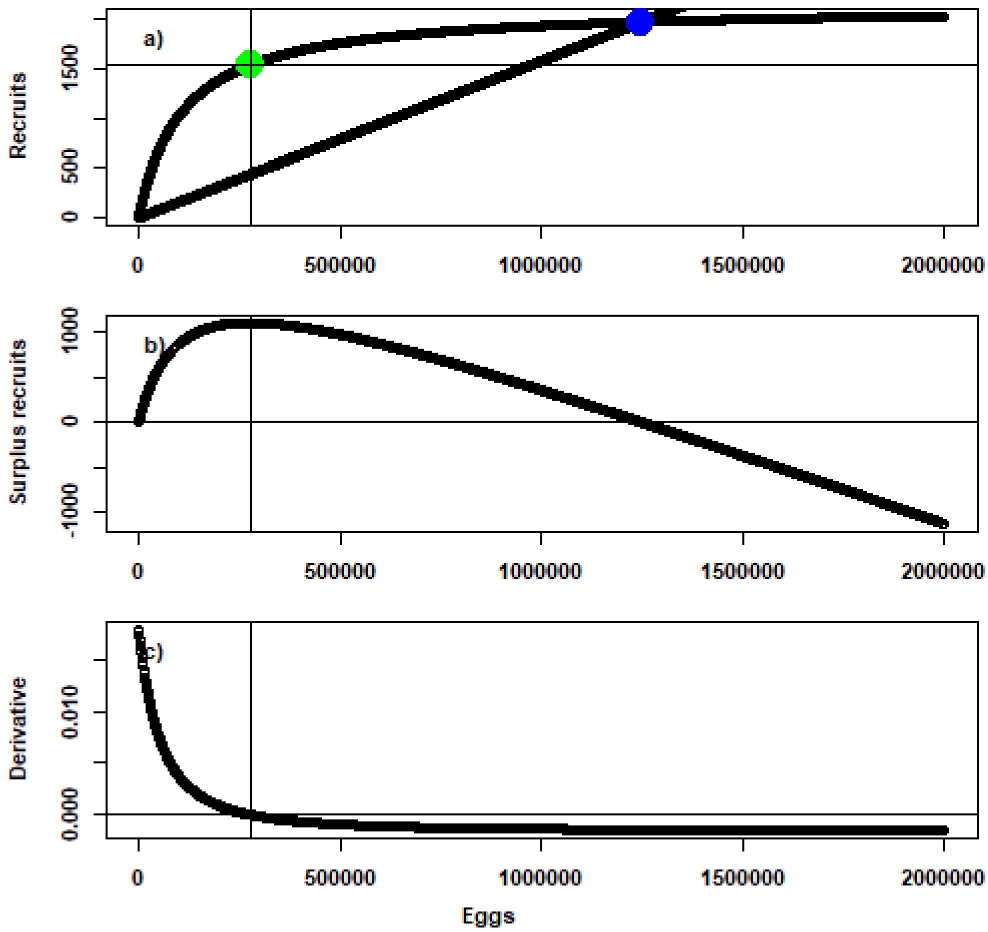

Figure A1. a) Beverton–Holt stock–recruitment function. Equilibrium unfished recruitment (R_0) occurs where the replacement line and stock–recruit curve cross, indicated by a blue circle. Recruitment at MSY is indicated by the green

circle. b) Surplus recruitment (the difference between the replacement line and stock–recruit curve. c) Derivative of surplus recruitment. The point at which the derivative is equal to 0 corresponds to egg and smolt production at MSY.

R_{MSY} from simulations

The scenarios code that is used to perform forward projections for Baltic salmon was modified to find the fishing effort level that maximizes the long-term catch. Optimization was performed in R using the optimize() function. In order to obtain full distributions for MSY quantities, optimization was performed for each of 1000 posterior samples. This was implemented in parallel using the parLapply() function from the parallel package in R. Note that alternative distributions of fishing effort across fisheries for immature vs. mature fish may result in different estimates of MSY and associated measures of abundance (Goodyear, 1996; Powers, 2004). In simulations to find MSY, the *status quo* distribution of effort was assumed, meaning that the relative levels of fishing mortality between different fishing fleets were assumed to be the same as that in 2020. Forward projections were conducted separately for each stock and sample from the posterior distribution. A projection period of 70 years was used, and the average of catch, smolt production, spawner abundance and fishery-specific harvest rates were taken over the final 20 years of the projection period. Values assumed for parameters related to survival and maturation in projections are reported in Table 4.3.1.1.

Analytical solution for R_{lim}

R_{lim} can also be found analytically using the Beverton–Holt stock–recruit function, where the point $[R_{lim}, E_{lim}]$ can be defined as the limit recruitment and egg production from which the stock can recover to the MSY-level in one generation with no fishing. Supposing that R_{MSY} and E_{MSY} are known, then:

$$R_{lim} = E_{MSY} \frac{R_0}{E_0}$$

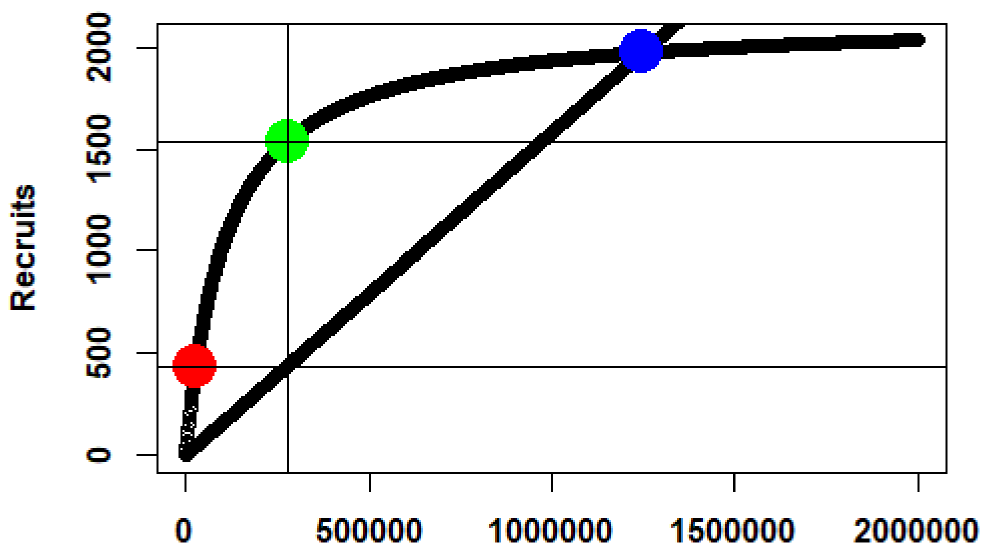

Figure A2. a) Beverton–Holt stock–recruitment function. Equilibrium unfished recruitment (R_0) occurs where the replacement line and stock–recruit curve cross, indicated by a blue circle. Recruitment at MSY is indicated by the green circle. R_{lim} is indicated by the red circle.

R_{lim} from simulations

R_{lim} can also be found using simulations to find the smolt production that yields MSY smolt production in one generation time, with no fishing. This was implemented by modifying the scenarios forward projection code with 0 fishing, so that the smolt abundances in years 2011 to 2021 were set equal to the candidate smolt production level, and finding the smolt production level during those years that yielded the MSY smolt production level in one generation time. This method was tested for the Torne River salmon stock, using a generation time of six years, which was found to be the length of time corresponding to the period from hatching to the sea winter age with modal egg production. Optimization was performed in R using the parallel computation with the optimize() function, as for R_{MSY}.

Key differences between approaches

R_{MSY}

There are several differences between the outputs that can be obtained from analytical and simulation methods. For example, using simulation can take account of the fishing pattern over ages, or selectivity, for different fishing fleets. The analytical R_{MSY} corresponds to the situation where all fish would be harvested as recruits. It is also possible to obtain distributions for fishery-specific harvest rates at MSY from simulation, as well as catch accounting for the selectivity pattern of different fisheries. An important practical consideration is the computation time required: the analytical method takes a matter of seconds, whereas the computation required for simulation and optimization take in the region of 24 hours for all stocks.

R_{lim}

The main difference between analytical and simulation approaches to derive R_{lim} is probably the fact that direct use of the Beverton–Holt stock–recruit curve does not currently account for random annual variability in recruitment, but implicitly assumes that average recruitment will be realized. Recruitment deviations are included in the scenarios code used for simulation and are likely to result in greater uncertainty in calculated R_{lim}. A further possible difference in the current implementation of R_{lim} from simulation is the generation time within which smolt production at MSY should be attained. Currently, smolt production in one future year is compared to MSY smolt production in simulations, but to be directly comparable to the analytical method a weighted average smolt production during several future years could be used, corresponding to the distribution of egg production over sea winter ages in an unfished situation.

Results and comparison of status evaluations in 2020 using different reference points

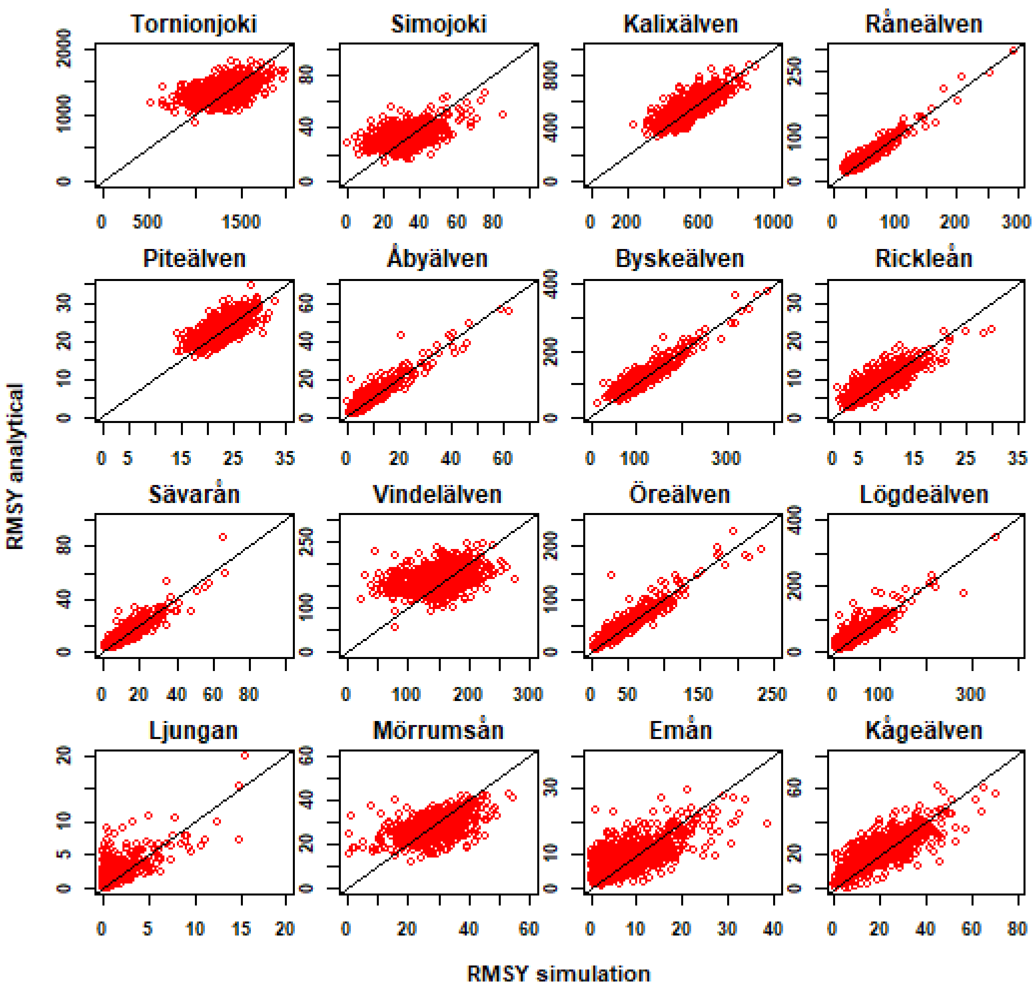

Figure A3. Scatterplots of R_{MSY} from simulation versus R_{MSY} using the analytical method. The diagonal lines indicate a 1:1 relationship.

Table A1. Stock-specific probabilities of reaching targets computed for a range of reference points. R_{lim}, Limit smolt production (analytical); R_{MSY}, smolt production at maximum sustainable yield (analytical); R_{MSY} sim, smolt production at maximum sustainable yield from simulation; $0.75R_0$, proxy for maximum sustainable yield using R0 from simulation (as used in the 2020 assessment); $0.75R_0$ 2020, proxy for maximum sustainable yield using annual R_0 from the final year in the assessment (as used in the 2019 assessment).

	R_{lim}	R_{MSY}	R_{MSY} sim	$0.75R_0$	$0.75R_0$ 2020
Tornionjoki	1.00	0.79	0.73	0.83	0.81
Simojoki	0.99	0.80	0.72	0.62	0.38
Kalixälven	1.00	0.68	0.70	0.79	0.79
Råneälven	0.99	0.60	0.59	0.60	0.58
Piteälven	1.00	0.77	0.77	0.91	0.92
Åbyälven	0.88	0.44	0.46	0.40	0.35
Byskeälven	1.00	0.74	0.74	0.81	0.82
Rickleån	0.65	0.09	0.13	0.05	0.02
Sävarån	0.89	0.37	0.37	0.28	0.26
Vindelälven	0.97	0.19	0.29	0.12	0.31
Öreälven	0.62	0.17	0.19	0.16	0.14
Lögdeälven	0.40	0.09	0.13	0.06	0.06
Ljungan	0.38	0.21	0.31	0.17	0.13
Mörrumsån	1.00	0.76	0.68	0.78	0.74
Emån	0.28	0.09	0.20	0.04	0.02
Kågeälven	0.78	0.28	0.31	0.23	0.20
Testeboån	0.99	0.75	0.75	0.71	0.70

Outstanding issues and future work

Further work is needed in relation to a number of issues regarding formulation of advice for Baltic salmon stocks using R_{MSY} and R_{lim} reference points. Many of these would be suitable for inclusion in the next benchmark.

Computation of reference points

Results from simulation analyses indicate that R_{MSY} changes with the selectivity pattern, since the spawning potential ratio (ratio of lifetime egg production with fishing to that under unfished conditions) is altered. This is not accounted for by the analytical method, so further investigation is needed to establish the potential magnitude of changes in R_{MSY} according to changes in fishing selectivity pattern. ICES stipulates that reference points should be formulated according to status quo fishing pattern, however this may not be appropriate where changes in evaluated fishing patterns effect appreciable changes in reference points.

R_{lim} reference points from simulation could also be compared with analytical ones to check the effect of accounting for random variability in recruitment strength and/or a correction could be applied to analytically derived R_{lim} to account for this.

It was noted in the 2021 assessment that in some simulated future trajectories the stock–recruit steepness dropped below 0.20, meaning that the population could go extinct even in the absence of fishing. Such trajectories accounted for up to ~10% of simulated future trajectories for stocks with low estimated stock–recruit steepness stocks such as Ljungan and Emån. Both the analytical and simulation methods produce an R_{MSY} number for these trajectories. Further investigation is thus needed into evaluated status in such cases, to establish whether these should be excluded from status evaluations, since the concept of MSY is arguably meaningless in such cases. The proportion of simulations where steepness goes below 0.20 could also be reported as an indicator of stock vulnerability to collapse in the absence of fishing, as an additional metric of risk.

Effects of assumed future vital rates on targets

Between the 2019 and 2020 assessments, a change was made between using R_0 from the final year of the assessment, to using R_0 from long-term simulations in status evaluations. This change was made since by definition, R_0 is the smolt production at equilibrium which should correspond to a long-term average, rather than reflecting the conditions in any particular year, which would not be realized as the long-term equilibrium value. However, this change has some attendant consequences, namely that the assumed vital rates far ahead in the future used to calculate R_0 do not necessarily reflect current conditions. This can lead to targets that can never be attained with high probability, or conversely, targets that would be met with misleadingly high probability if survival is expected to decline in future. While this is a natural consequence of the assessment framework, review of assumptions about survival rates and other vital rates contributing to lifetime egg production in forward projections, is warranted to ensure that they are based on the best available science and knowledge.

Effects of fishing pattern on generation interval and thereby future projections

In 2021, the same generation time within assessment unit groups (seven years for AU 1–3, six years for AU4) was used for different stocks. It is possible that slightly different generation times may be suitable for some stocks where differences in lifetime egg production occur e.g. Ume-Vindelälven. This and possible implications for status evaluations could be checked in a benchmark.

How many years to use when evaluating current stock status

Owing to inherent variation in multiple parameters, estimated smolt production in rivers fluctuates from year to year in addition to more long-term trends. So far, WGBAST has focused on smolt production in single years when assessing status. Focusing on average smolt production across several years is expected to result in more stable assessment results, but it remains unclear how many years should be used. As part of a benchmark process, alternative options could be compared and evaluated.

Assessing stock status based on adults rather than smolts

In the Baltic Sea region, there is a half-century long tradition of using smolt production as the main metric of abundance, productivity and status of salmon stocks. However, it would be possible to evaluate the MSY and limit reference points for adults instead of smolts (as done for North Atlantic salmon), using either simulation methods, or possibly analytically, given some assumptions to convert egg production to numbers of adult fish. This would mean a move from smolt production targets to spawning stock targets. If this approach would be adopted, then one would expect to see larger interannual variation in the stock status compared to using smolts; spawning stock size is not only influenced by the total abundance of immature fish, but also by the interannual variation in maturation rates. In order to avoid unnecessary short-term variation in status assessments, using several years' spawning runs in status assessments would help, as discussed for smolts above.

Assessing status at assessment unit level

Probabilities to reach targets at an assessment unit level were computed in the 2021 assessment. The possibility of assessing status at the level of stock complexes (as is done for e.g. North Atlantic salmon stocks) should be given further consideration as an alternative for Baltic salmon stocks, as that would not require every river stock to be above the target with the specified probability. Careful consideration is needed on the details of how this should be implemented, in order that the status assessment and criteria to meet target(s) would be transparent and understandable.

Effect of level of uncertainty admitted in the assessment

The Baltic salmon assessment is comprehensive in the degree of uncertainty admitted. Uncertainties are accounted for in nearly all model parameters, as well as in many processes, including post-smolt survival, recruitment, maturation and catchabilities and in observations of data (i.e. sampling error). While Baltic salmon in general is a data-rich system, there are large differences among stocks in the amount of data available. Expert knowledge together with hierarchical structures that allow flow of information between rivers are used to learn about data-poor salmon stocks. There are two important considerations here. Firstly, taking the assessment as a whole, the level of uncertainty admitted is likely exceptional among ICES assessments, which should be taken into account when setting probabilities with which targets should be met. Secondly, there is variation among stocks in the level of uncertainty, such that data-poor stocks can have a lower probability to reach targets regardless of their true status. This could imply that not all stocks should be required to reach the same target within a given time frame.

Formulation of reference points for AU 5–6 stocks

Extending the FLHM to include those Baltic salmon stocks (AU 5–6 stocks) which are presently not in FLHM would enable comparable calculations of their stock-specific R_{lim} and R_{MSY}, and consequent status evaluations. An assessment model for AU 6 has now been developed from most of its parts, but it requires evaluation and checking before it can be used (see details in Appendix 2). The AU 6 model will not be integrated to the AU 1–4 assessment in the first phase, but will be run as a separate unit of stocks. However, the model takes into account migrations of salmon between the assessment units, which will to some extent link the assessments of the AU 1–4 salmon and AU 6 salmon together. For the AU 5 stocks, their inclusion in the same model with the AU 1–4 stocks would be desirable, as AU 5 stocks fulfil their life cycle in the same management area as the AU 1–4 stocks.

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Annex 5: Review of Section 4 “Reference points and assessment of salmon” of the 2021 report of the Baltic Salmon and Trout Assessment Working Group (WGBAST)

The Review Group finds the information in chapter 4 to be clearly presented, scientifically sound and to constitute a good and sufficient basis for ICES to provide advice on fishing opportunities for Baltic salmon stocks.

Review by Eskild Kirkegaard, independent consultant

Overall, I found Section 4 of the WGBAST 2021 report to be well-written, comprehensive and consistent. It contains the information required for ICES to provide advice on the Baltic salmon stocks consistent with ICES framework for advice on fishing opportunities and the reference points recommended by ICES in 2020 in its evaluation of the draft multiannual management plan.

The assessment model used by the Group contains a number of changes compared to the previous one from 2019. The changes seem appropriate and especially the inclusion of the offshore trolling fishery as a separate fishery and the changes allowing the three offshore fisheries (longlining, driftnetting and trolling) to be addressed consistently are valuable, allowing separate evaluation of the impact of the fisheries on the stocks and catches.

The discussion of the estimation of the smolt production in Section 4.2.2 including the model for estimating M74 mortality is very informative.

In the first paragraph of Section 4.2.3 on the results of the assessment for unit 1–4 stocks, the Group explain how the FHLM was run. I am not able to judge if the approach taken in selecting the most representative chain was appropriate.

The presentation and discussion of the assessment results in Sections 4.2.3, 4.2.4 and 4.2.5 (including tables and figures) are very comprehensive and informative, and give the reader a good basis for understanding the results and the uncertainties linked to the assessment of the stocks in the different AUs.

The section on projection of AU 1–4 stocks is again comprehensive and informative giving a good description of the assumptions and the results. The ten fishing scenarios presented, seem appropriate.

I am lacking a section addressing the stocks in AU 5 and 6. I recognise that in absence of analytical assessment of the stocks, it may be difficult to comment on future fishing opportunities. However, the Group clearly have good knowledge on the status of the stocks in the two assessment units, and some management considerations for the stocks in AU 5 and 6 are presented in Section 4.5 on future management. It would have been useful with a separate section addressing the future perspectives for these stocks.

Section 4.4 “Additional information affecting perception of stock status” is again very informative and useful in evaluating the quality of the assessments.

I find Section 4.5 on future management of Baltic salmon fisheries very interesting, although not that relevant for the advice on short-term fishing opportunities. The information and the discussions presented in the section would be a good basis for a discussion with ICES clients and stakeholders on future management of Baltic salmon stocks.

Review by Sten Karlsson, independent consultant

I have been asked to review Section 4 as an expert in population genetics of Atlantic salmon, and because of my limited experience and background knowledge of the previous work of ICES on giving fishing advices of Baltic salmon, I regard myself as not qualified for a critical review on many of the issues in the report. Nevertheless, my overall impression is that the Section 4 in the report is well written, and makes use of current knowledge to give the best possible advice for a sustainable fishing of the Baltic salmon.

1. Is the analysis technically correct?

   I am not qualified for evaluating all the analyses in the report, but I find the approach of using both genetic assignment and smolt age very solid, and that it makes a crucial contribution in approaching stock specific management plans. The inclusion of smolt age data for the genetic assignment increase the power and precision and as pointed out by the authors, it makes it easier to possibly separate between wild and hatchery salmon. The most comprehensive work on genetic assignment is done for catches in the Gulf of Bothnia, and I expect that there will be more information also from the catches in the rest of the Baltic. So far there are 39 genetic baseline populations used for genetic assignment, and I guess the most important salmon populations are included among these, but it might be a good idea to try to expand this baseline?

2. Is the scope and depth of the science appropriate?

   Yes, I find the depth and scope of the science appropriate. It was not clear to me how information about hatchery or wild origin was included in the advice, and if it is advisable and possible to implement different harvest pressure on these types?

3. Does it contain the knowledge to sufficiently provide the basis for ICES advice?

   Yes, the knowledge base is solid and supported by several peer reviewed papers and non-peer reviewed reports.