Baltic Sea Environment Proceedings No. 126A

Salmon and Sea Trout Populations and Rivers in the Baltic Sea

HELCOM assessment of salmon (*Salmo salar*) and sea trout (*Salmo trutta*) populations and habitats in rivers flowing to the Baltic Sea.

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Executive summary

The state of Baltic Sea salmon and sea trout populations vary from a very healthy state to being at the verge of extinction. The river habitats of salmonids have in many cases been destroyed or have deteriorated and have often been blocked for passage of fish when they are harnessed for hydropower production.

This report presents an overview, inventory and classification of salmon and sea trout populations in rivers flowing to the Baltic Sea and makes recommendations for measures for the restoration of river habitats and waters, opening of passage in rivers and fisheries management measures in rivers. The report proposes a definition of a salmonid habitat in good state. It also proposes that an assessment should be made of the possibilities of opening passage through rivers that have man-made migration hindrances. Also it is proposed that a set of effective and proportionate fishing rules is developed based on a participatory and open process. These measures are intended to improve the status of Baltic Sea salmon and sea trout populations and restore the natural fish production capacity of riverine habitats.

The report has identified that the original salmon populations of the rivers Daugava, Emån, Gauja, Göta älv (tributaries Brattorpsån, Grönån, Lärjeån, Säveån and Västerlandaån), Keila, Kunda, Kungsbackaån, Luga, Löftaån, Nissan (tributary Sennan), Pärnu, Rickleån, Rönne å, Saka, Tvååkersån, Vasalemma, Öreälven and the tributaries of the Nemunas river system Šventoji, Žeimena, Vilia, Vilnia and Neris are in urgent need of recovery measures. These populations should be the focus of immediate and effective conservation measures that allow them to recover towards a state of Maximum Sustainable Yield. Progress towards this goal will be publicly available on a red list of salmon rivers displayed on a GIS-map at the HELCOM website. The report also identifies that a total of 299 original sea trout populations are in urgent need of recovery measures.

The report also makes the observation that the original salmon populations of the rivers Dalälven, Iijoki, Indalsälven, Ljusnan, Luleälven, Skellefteälven and Ångermanälven are currently maintained as brood stocks and do not reproduce in the riverine habitats. These populations should where appropriate be re-established in their native rivers or a nearby river in the same assessment unit.

Furthermore the report identifies that the rivers Kymijoki, Kemijoki and Oulujoki have lost their original salmon populations, but as river habitats still have a large potential smolt production capacity. Passage for salmonids through these rivers or the transport of spawners to reproduction areas should be provided where an assessment shows that mobilising the reproductive areas in these rivers is justified. The reared populations mentioned above and the salmon rivers mentioned in this paragraph are defined as potential salmon populations and rivers.

With the view of implementing the recommendations of this report and the commitments of the HELCOM Baltic Sea Action Plan, it is recommended that the original salmon populations/rivers of Daugava, Emån, Gauja, Kunda, Luga, Nemunas (tributaries Neris, Šventoji, Žeimena, Vilnia and Vilia), Pärnu, Rickleån, Rönne å and Saka (preliminary list) and the potential salmon populations/rivers of Iijoki, Kemijoki, Kymijoki, Ljusnan, Luleälven and Ångermanälven are selected for a second phase project to be coordinated by HELCOM. The final list of the original salmon populations would be decided at the beginning of such a project. The project would have the objective of producing restoration and development plans that could serve as the basis for a third phase of practical implementation.

1 Introduction

The drainage area of the Baltic Sea is more than four times larger than the sea area itself. As a consequence a large number of rivers and streams have formed to channel water into the Baltic Sea. These rivers and streams serve as a habitat for migratory fish species which in addition to their marine life either reproduce (anadromous species) or feed (catadromous species) in freshwater habitats. Baltic salmon (*Salmo salar*), sea trout (*Salmo trutta*), whitefish (*Coregonus* sp.) and river lamprey (*Lampetra fluviatilis)* are examples of important anadromous fish species, while the eel (*Anguilla anguilla*) is a catadromous species.

The overall ecological condition of the Baltic rivers and the status of their fish populations have deteriorated from their pristine state. This is a consequence of anthropogenic impacts caused by many activities in the drainage area, in the rivers and in the Baltic Sea. In the rivers, the most detrimental activities have been damming, dredging and channelizing rivers for hydropower, log driving and agricultural purposes. Also indirect impacts of human activities such as elevated nutrient and sediment loads from agriculture and forestry practices and from discharges of domestic sewage have adversely affected the ecological condition of Baltic rivers.

This report is based on the HELCOM SALAR project that focused on the state of salmon (*Salmo salar*) and sea trout (*Salmo trutta*) populations in rivers flowing into the Baltic Sea. The project was funded through a co-financing agreement between the European Commission (DG MARE) and HELCOM. It forms a basis for implementing some of the fisheries actions in the strategic HELCOM Baltic Sea Action Plan (BSAP) to radically reduce pollution to the sea and restore the good ecological status of the marine environment by 2021. The BSAP sets the target to reach a salmon smolt production of at least 80% of the potential or for weaker populations 50% of the potential production.

The report presents an overview, inventory and classification of Baltic rivers with salmon and/or sea trout populations. The report also recommends measures for the restoration of river habitats and waters, opening of passage and fisheries management measures in rivers for the improvement of the status of salmon and sea trout populations. A prioritization of Baltic salmon and sea trout populations in need of urgent actions for their recovery is also included. The recommendations and prioritizations will allow for the development of international and national programs for the planning, funding and systematic realization of these actions.

The report's recommendations relate only to the riverine areas, in accordance with the project agreement between the European Commission and HELCOM. The management of salmon fisheries in the marine area of the Baltic Sea is subject to definition and implementation of management measures by the European Union and the Russian Federation.

The report has been prepared in co-operation with nominated salmonid and river habitat experts of the Baltic Sea countries as mentioned on the second page. The work is based on an agreed common format for reporting on the state of salmonid populations and habitats. In addition to this report, the project has produced descriptions of individual salmon and sea trout rivers (BSEP 126B) as well as data in excel sheets on salmonid populations and habitats. These descriptions and data have been produced by the nominated experts and edited by the project staff. The river descriptions are available as web publications at www.helcom.fi as well as a GIS map on salmon rivers. The excel sheets are available from the HELCOM Secretariat and at the institutions of the nominated experts.

2 Status of salmon and sea trout populations in the Baltic Sea

2.1 Salmon rivers

Baltic salmon populations reproduce in at least 43 river systems (Annex 1) of which at least 29 rivers hold an original salmon population or are partly mixed with other populations following stocking practices. River systems are defined as a river or a group of rivers having an outlet to the sea. There are wild salmon rivers in all sub-basins of the Baltic. The Kattegat is not generally considered as part of the Baltic Sea for the purpose of fisheries management. In this report and in accordance with the definitions of HELCOM, the rivers flowing to the Kattegat are, however, included.

The overall development of salmon populations since the mid-1990s has been encouraging. Many rivers have shown an increased production of smolts and of ascending spawners. This positive trend has, however, not been observed for many small salmon rivers (ICES 2010a).

Unfortunately, many Baltic rivers have lost their original wild salmon populations. The main reason for the loss has been the damming of rivers for hydropower and dredging of rapids and riffles (salmon reproduction areas) for log driving purposes. Dams

were constructed mainly in the mid-20th century as a response to the growing demand for electricity. Many dams were subsequently fitted with fishways and again support salmon populations, although the original strain may have been lost. They may hold salmon populations from a nearby wild population or from other populations that are available for restocking purposes.

2.1.1 Salmon population trends

Population indicators

The information on the abundance and exploitation of wild salmon in the Baltic is mainly based on electrofishing for parr, smolt trapping and counts of returning adults in the rivers, and catch and effort data from the commercial and recreational fisheries.

Parr and smolt production are important indicators of the status of salmon populations. Data on sea survival of young salmon (post-smolts) is also an important indicator as the survival rate strongly affects the development of populations.

Towards the later part of the life-cycle, monitoring the number of salmon ascending rivers is an important indicator, since it reflects the size of the spawning stock. Other important indicators are catches offshore, at the coast and in rivers. Salmon are caught in commercial fisheries in the sea and recreational fisheries both in the sea and rivers.

The Baltic salmon populations are separate entities which are optimally assessed on a river-by-river basis. The International Council for the Exploration of the Sea (ICES) has used six assessment units for the Baltic salmon stocks (Figure 2.1). The division is based on biological and genetic characteristics of the stocks. Stocks of a particular unit have genetic proximity and are assumed to exhibit similar migration patterns. It can, therefore, be assumed that they are subjected to the same fisheries, experience the same exploitation rates, and could be managed in the same way (ICES 2010a). The development of salmon populations in the assessment units is the most important population status indicator.

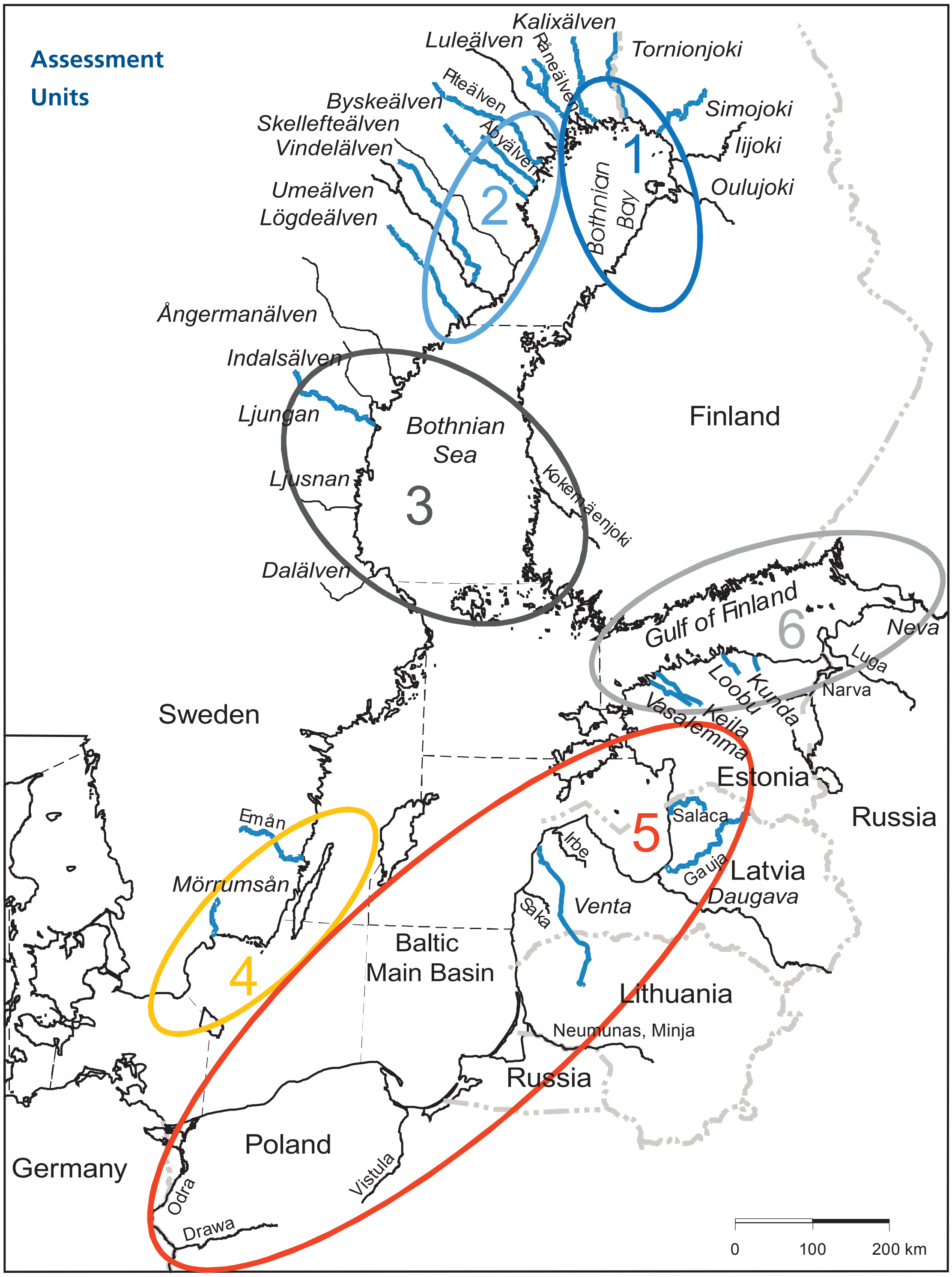

Figure 2.1. The ICES assessment units (1–6) for the salmon stocks in the Baltic Sea, based on management objectives and biological and genetic characteristics of the stocks contained in a unit (ICES 2010a).

Parr density and smolt production

The ICES Baltic Salmon and Trout Assessment Working Group (WGBAST) report of 2010 (ICES 2010a) presents data on the density of salmon parr in 40 Baltic rivers. The parr are divided into first summer parr (0+) and parr of 1–4 years (> 0+). Since the end of the 1990s, the density of parr has increased markedly within rivers of assessment units 1 and 2. In assessment units 3 and 4 the densities have not shown the same increase, but in assessment unit 5 increases in parr densities have been observed since 2003. In assessment unit 6, parr densities have shown large variation (Table 2.1 and Figure 2.2).

Table 2.1. Densities of >0+ salmon parr in five rivers of assessment units 1–5 (ICES 2010a).

	Number of parr/ 100 m²				
Year	Simojoki (unit 1)	Åbyälven (unit 2)	Ljungan (unit 3)	Mörrumsån (unit 4)	Salaca (unit 5)
1990	2.55	2.38	4.8	60	No data
1991	2.63	4.47	0.6	55	No data
1992	No data	3.82	No data	78	No data
1993	1.33	5.18	No data	21	4.9
1994	1.11	2.62	0.2	8	2.6
1995	0.49	2.95	0.9	5	2.8
1996	0.76	4.99	6.5	50	0.9
1997	1.85	5.05	2.1	15	3.1
1998	4.34	No data	No data	29	2.8
1999	14.16	8.31	7.9	35	4
2000	16.65	8.05	6.5	21	0.8
2001	11.48	5.34	No data	22	4.4
2002	12.69	3.73	2.6	14	10.3
2003	7.41	4.56	0.2	28	1.3
2004	8.8	1.32	1.4	21	2.7
2005	10.3	2.02	2.3	29	3.8
2006	20.47	13.14	No data 2.0	34	17.9
2007	4.22	11.06	2.0	10	6.9
2008	5.12	6.14	0.3	16	4.9
2009	15.58	7.45	No data	14	10.3

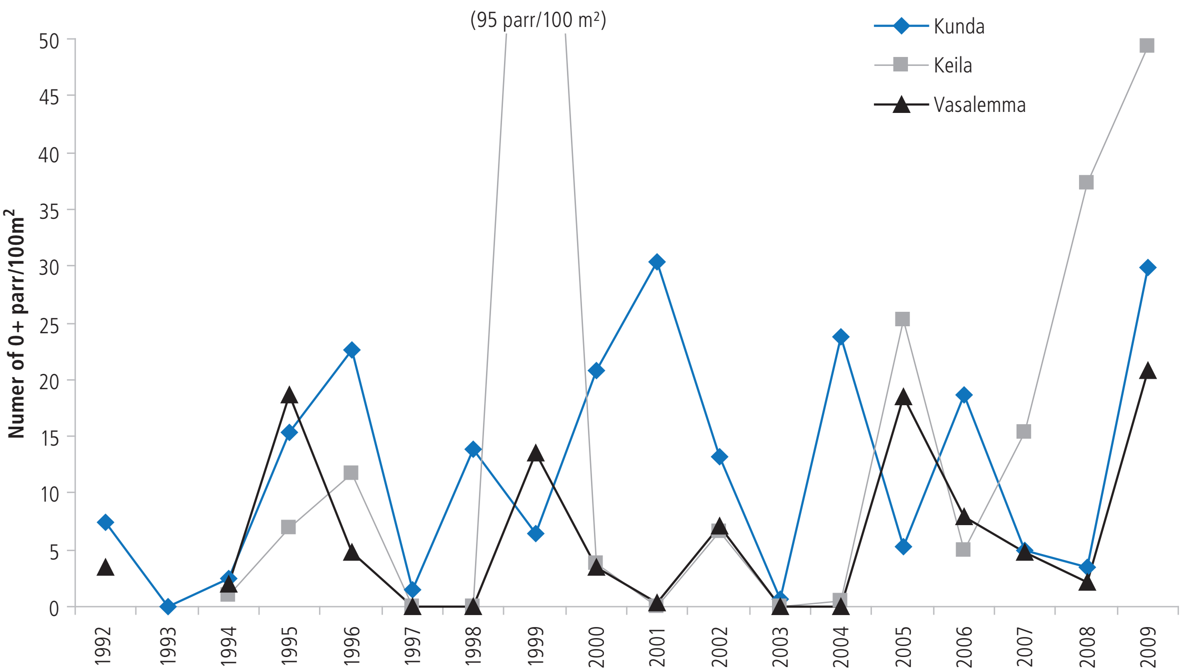

Figure 2.2. Densities of 0+ salmon parr in the three wild Estonian salmon rivers (ICES 2010a).

ICES (2010a) reports that the smolt production of the 27 assessed rivers in the Main Basin and the Gulf of Bothnia has increased by more than 60% since 2003. The production in 2009 was estimated to be about 70% of the potential smolt production capacity (PSPC) of these rivers. The total wild smolt production has increased almost tenfold in assessment units 1–2 since 1997 (Figure 2.3). The largest and most productive rivers are in these units. The trend in smolt production has

Salmon smolt production in the Baltic Sea

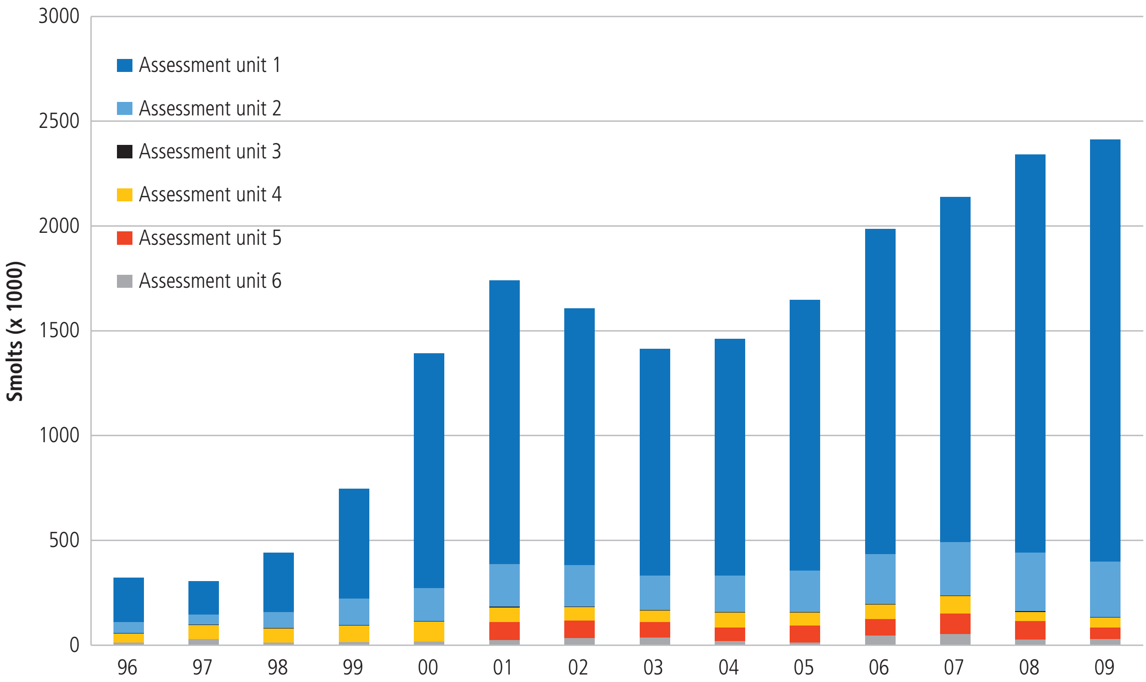

Figure 2.3. Natural salmon smolt production in the Baltic Sea during 1996–2009 by ICES assessment unit. Data for assessment unit 5 from 1996–2000 is lacking (ICES 2010a).

been more varied and modest within the other assessment units.

To evaluate the current state of the stocks, ICES (2010a) uses the smolt production relative to the PSPC on a river-by-river basis. Stocks are considered very likely to reach the reference points of 50% or 75% of PSPC when the probability is more than 90%; they are considered likely to reach the reference points when the probability is between 70% and 90% and it is considered uncertain if the reference point will be achieved when the probability is between 30% and 70%. When the probability of reaching the reference point is less than 30%, it is considered unlikely that the reference point will be achieved.

According to ICES (2010a), 11 of the 27 assessed rivers are likely or very likely to reach the 50% target in the short-term, while 8 rivers are unlikely and 8 rivers uncertain to reach the 50% target. The reference points of the natural production capacity are more likely to be met in the productive rivers flowing into Bothnian Bay.

There are 16 original salmon populations in the Swedish rivers flowing to the Kattegat. The production of smolts in these rivers is estimated to be about 125,000 smolts (mean of years 2005–2009) which represents 52% of the estimated PSPC of the rivers (figures provided by Erik Degerman, Swedish Board of Fisheries).

Post-smolt survival

The survival of young salmon during their first months in the sea strongly influences the abundance of stocks (Suuronen and Jounela 2010). It is assumed that most of the young salmon die at this early stage, either as prey for larger predators (seals, predatory fish, cormorants and other seabirds) or following low food availability. The exact reasons for the marked decrease in post-smolt survival since the mid 1980s (Figure 2.4) are still uncertain, but post-smolt survival was found to be negatively correlated with seal and smolt abundance and positively correlated with the abundance of young herring in the Gulf of Bothnia (ICES 2009a and 2010a). ICES (2010a) concluded that there is a strong negative correlation between post-smolt survival and seal abundance in the period 1987–2009, although causality cannot be shown.

Furthermore, the quality of reared smolts has been suggested as a reason for low survival rates (ICES 2009a). Reared salmon may have reduced migration abilities and are more vulnerable to predation. The high fat and energy contents of the feed have resulted in increased growth and size of reared smolts. It has been hypothesised that such large and fatty smolts are less fit for the challenges in the natural environment, although large smolts have been shown to perform well (Vehanen et al. 1993). Research on smolt quality has, however, not yet provided conclusive answers for the high mortality rates.

Number of salmon ascending rivers

The number of salmon entering rivers is an indication of the spawning stock size. Therefore, counting of spawners is an important element in monitoring salmon populations and regulating salmon fisheries.

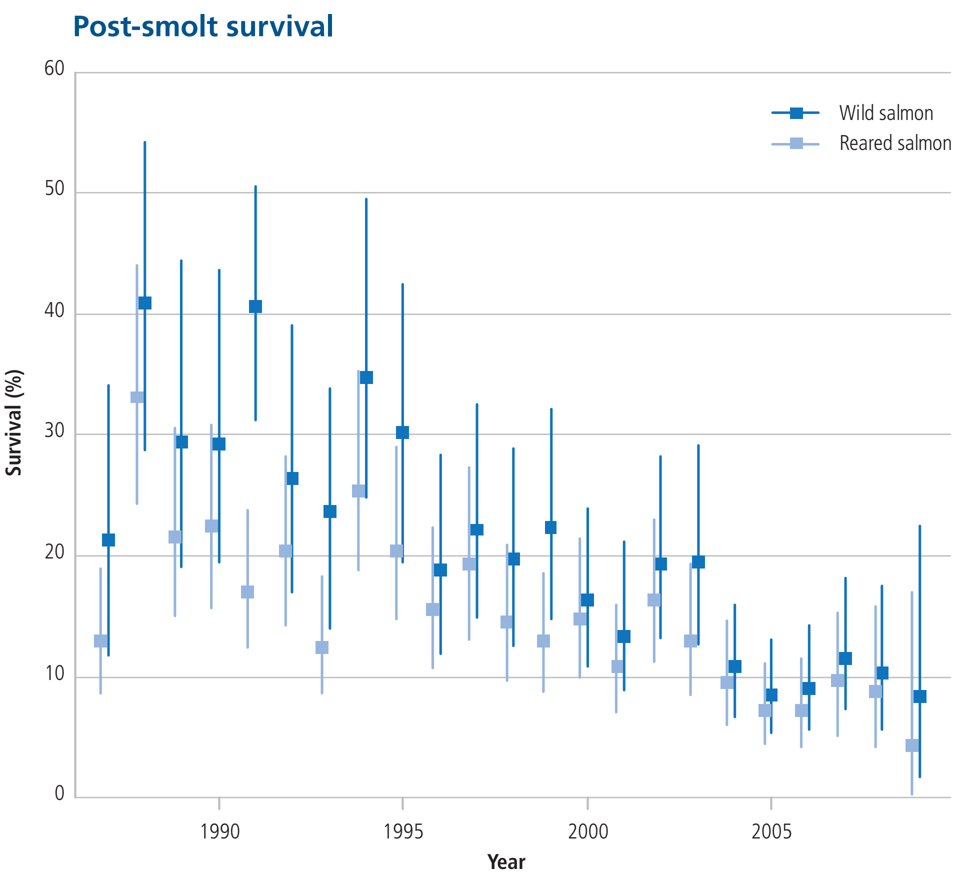

Figure 2.4. Post-smolt survival for wild and hatchery-reared salmon (ICES 2010a).

In the Baltic rivers, counting of salmon is currently undertaken in nine rivers. A new DIDSON (Dual frequency IDentification SONar) echo sounder has been used in the river Simojoki since 2008 and in the river Tornionjoki since 2009. Infrared fish counters (Riverwatcher) situated in fish ladders are used in the rivers Piteälven, Åbyälven, Byskeälven, Rickleån, Kalixälven and Slupia. In the rivers Kalixälven and Slupia, fish are also recorded using video camera to enable species identification. In the river Ume/Vindelälven salmon are trapped and counted manually at the fish ladder.

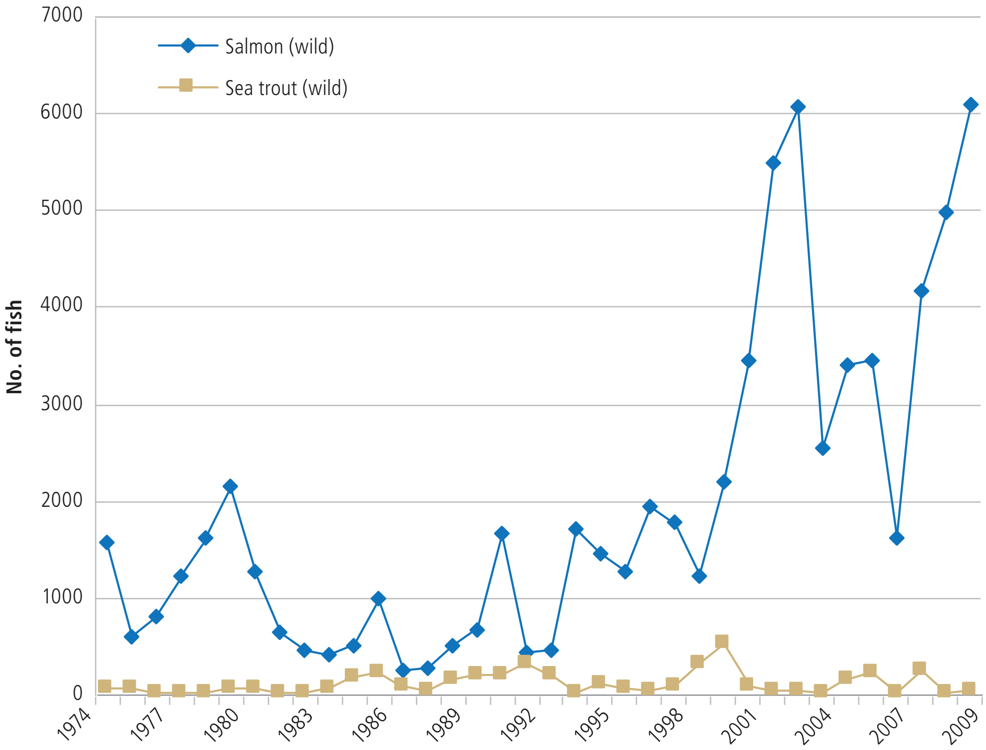

Figure 2.5. **The number of ascending wild salmon and sea trout at the Stornorrforsen fish ladder of Ume/Vindelälven in 1974–2009 (Swedish University of Agricultural Science, Umeå).**

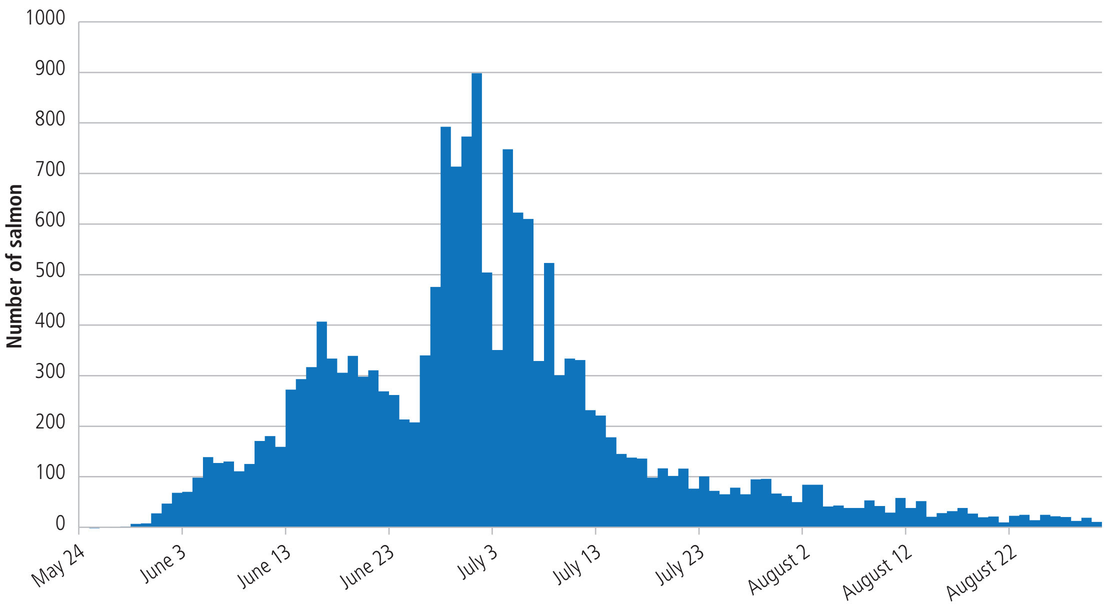

Figure 2.6. **The daily number of ascending wild salmon and sea trout in the river Tornionjoki in 2010 (Finnish Game and Fisheries Research Institute).**

In Figure 2.5 the increasing trend of ascending salmon since the millenium shift in the Ume/Vindelälven is shown. Figure 2.6 shows the daily number of ascending salmon and sea trout in the river Tornionjoki in 2010. The location of the DIDSON echo sounder in Tornionjoki is in the Kattilakoski rapids located 100 km from the sea. The salmon that stayed downstream of Kattilakoski or that where caught in this area of the river were not detected and the total number of ascending salmon is, therefore, somewhat higher than the detected number.

In 2010, the numbers of ascending salmon in the rivers of the Gulf of Bothnia decreased to approximately half the numbers counted in 2009. In 2008, a peak was observed in the numbers of ascending salmon.

Catches of salmon

Salmon are fished in offshore areas as well as in coastal and river areas. They are the target of both commercial and recreational fisheries. The total harvest has decreased since the 1990s (Figure 2.7).

The nominal catch of salmon in the whole Baltic Sea (including rivers) has declined significantly from 5,633 tonnes in 1990 to 1,103 tonnes in 2009 (Table 2.2). A decreasing proportion of the total salmon catch has been taken in the offshore areas while the proportions taken in the coastal fisheries and recreational river fisheries have increased.

Fishing for salmon has decreased as a consequence of fishing regulations and natural causes such as seal predation. Fishing with driftnets was phased out within the EU during the years 2005–2007 and prohibited in 2008. Consequently, the main fishing gear and technique used in the offshore fisheries was eliminated.

The natural causes for decreased catches appear to be the increased seal population and low post-smolt survival. The increased grey seal population (*Halichoerus grypus*) has both caused damage to fishing gear and fish catches and reduced the effectiveness of fishing gear (Fjälling 2005, Kauppinen et al. 2005 and Jounela et al. 2006). Adult salmon have been observed to be a common prey for seals in the Gulf of Bothnia (Lundström et al. 2007).

2.1.2 Management of salmon fisheries

From IBSFC to the Common Fisheries Policy

Salmon fisheries as well as other major fisheries in the Baltic were for over two decades regulated by the International Baltic Sea Fisheries Commission (IBSFC). Following the accession of Finland and Sweden to the European Union in 1995 and the accession of Estonia, Latvia, Lithuania and Poland

Table 2.2. **Nominal catches of Baltic salmon (tonnes) round fresh weight from the sea, coast and rivers in 1990-2009 in subdivisions 22-32. Data is taken from the WGBAST Report (ICES 2010a).**

REPORTED CATCHES (TONNES)										
Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	Total
1990	729	93	2,294	36	607	66	195	148	1,468	5,636
1991	625	86	2,171	28	481	62	77	177	1,096	4,803
1992	645	32	2,121	27	278	20	170	66	1,189	4,548
1993	575	32	1,626	31	256	15	191	90	1,134	3,966
1994	737	10	1,209	10	130	5	184	45	851	3,181
1995	556	9	1,324	19	139	2	133	63	795	3,040
1996	525	9	1,316	12	150	14	125	47	940	3,138
1997	489	10	1,357	38	170	5	110	27	824	3,030
1998	495	8	850	42	125	5	118	36	815	2,494
1999	395	14	720	29	166	6	135	25	672	2,162
2000	421	23	757	44	149	5	144	27	771	2,342
2001	443	16	606	39	136	4	180	37	616	2,076
2002	334	16	509	29	108	11	197	66	572	1,841
2003	454	10	410	29	47	3	198	22	454	1,627
2004	370	7	654	35	34	3	88	16	879	2,087
2005	214	8	616	24	23	3	114	15	719	1,736
2006	178	8	370	18	14	2	117	5	497	1,208
2007	79	7	408	15	26	2	95	6	484	1,123
2008	34	9	451	25	9	2	44	6	460	1,039
2009	78	7	434	9	15	1	51	2	507	1,103

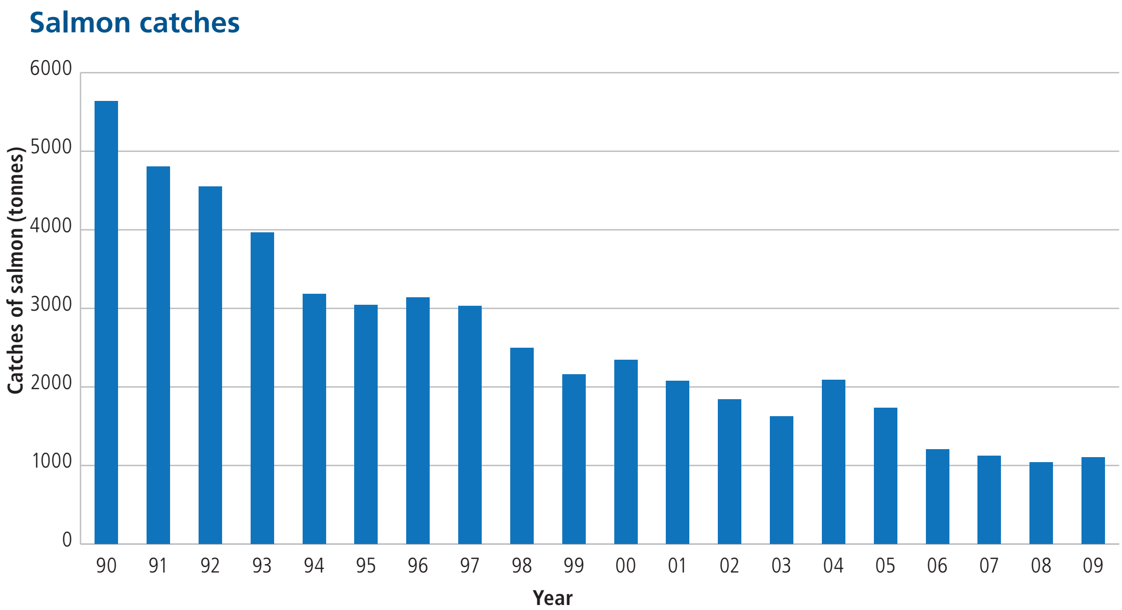

Figure 2.7. **Total reported catches of Baltic salmon in 1990–2009 (ICES 2010a).**

in 2005, the IBSFC ceased to exist at the end of 2005. Since then, fisheries management in the Baltic Sea is a matter for the European Union, in accordance with its Common Fisheries Policy, and for the Russian Federation. In 2009, the EU and Russia signed an agreement on cooperation on Baltic fisheries. The agreement provides the basis for a comprehensive management of Baltic fisheries, including salmon and sea trout.

In 1997, the IBSFC adopted a Salmon Action Plan (SAP) 1997 - 2010. The plan was progressive as it was the first multi-annual fisheries management plan in the Baltic. The principal aim of the SAP was to reach a production level of wild smolts that corresponded to at least 50% of the estimated production capacity of rivers. The SAP also included the objective of re-establishing salmon populations in potential rivers and maintaining the salmon fisheries.

The IBSFC made recommendations for total allowable catch (TAC) levels, their allocation as quotas among contracting parties and technical measures for salmon fisheries. Among the technical measures employed were summer closures, closures for drift netting and long-lining, minimum landing sizes and restrictions on the number and size of long-line hooks and total length of driftnets.

The European Union has agreed decisions on TACs and technical measures for salmon fisheries. There has, however, not been a formal salmon management plan, since the SAP was never incorporated as part of the Common Fisheries Policy. However, the European Commission is developing a proposal for a multiannual management plan for salmon stocks in the Baltic Sea. The proposal will be subject to a co-decision procedure by the European parliament and the Council and the adopted regulation will provide for the management of salmon stocks by the EU.

The most significant decision on salmon management taken by the EU in recent years is the ban on driftnets from the start of 2008. Driftnets had been the principal fishing gear in the Main Basin since the 1960s and the prohibition had a major impact on salmon fisheries and catches. In 2008 and 2009 salmon catches shifted from offshore to coastal areas and rivers.

The member States of the European Union and the Russian Federation have implemented national management measures for salmon fisheries. These include technical measures and spatial/temporal measures, such as the delayed opening of the fisheries during the spawning migration in the Gulf of Bothnia and closed areas outside many salmon rivers.

2.1.3 Re-establishment of salmon in potential rivers

The Salmon Action Plan also included the objective of re-establishing self-sustaining salmon stocks in potential rivers, where salmon stocks existed in the past, but had been lost. The rivers selected by the countries as potential rivers are:

Estonia
Valgejõgi, Jägala and Vääna

Finland
Kiiminkijoki, Kuivajoki and Pyhäjoki

Lithuania
Šventoji, Siesartis, Virinta, Vilnia, Vokė, Jura, Neris, Dubysa, Baltic Šventoji and Minija.

Poland
No potential rivers were selected, but releases of salmon have been made in the rivers Vistula, Odra and Pomeranian rivers.

Russia
Gladyshevka

Sweden
Kågeälven and Testeboån

There has been some success in achieving wild production in the potential rivers, but in general the numbers of spawners have been low and parr abundance has remained lower than for wild salmon rivers. The reasons are attributed to lower productivity of salmon in potential rivers than in wild salmon populations. The low productivity is in part due to poor habitat conditions (ICES 2010b). Moreover, reared salmon of non-native origin must normally be stocked in order to initiate the natural life-cycle of salmon in potential rivers. Survival and reproductive fitness of reared salmon have been shown to be inferior to those of wild salmon, and the use of non-native strains for re-establishment further reduces performance (Fleming and Petersson 2001, Araki et al. 2007, Romakkaniemi 2008). As a result, establishment of natural reproduction in a potential river is expected to be a slow and unstable process.

2.2 Sea trout rivers

The Baltic Sea contains approximately 1,000 sea trout populations of which about 500 reproduce naturally in Baltic rivers (Annex II). These populations do not include resident populations of brown trout. Rivers and tributaries with landlocked populations above man-made migration barriers are listed as potential rivers. A large majority of the sea trout rivers flow into the Main Basin. There are no estimates of the historical numbers of sea trout populations or quantitative observations of the historical total natural smolt production.

2.2.1 Sea trout population trends

Population indicators
The sea trout populations in the Baltic are assessed using the same indicators as salmon populations described above. The sea trout populations are monitored for each Baltic Sea basin. The development in the overall situation of the wild sea trout populations is summarised below.

Table 2.3. Nominal catches of sea trout (tonnes) round fresh weight from the Baltic Sea in 1990-2009 in subdivisions 22–32 (ICES 2010a).

	CATCHES (TONNES)								
Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Total
1990	48	4	841	21	7	na	488	154	1,563
1991	48	3	829	7	6	na	309	171	1,373
1992	27	9	837	na	6	na	281	249	1,409
1993	59	15	1,250	14	17	na	272	138	1,865
1994	33	8	1,150	15	18	na	222	161	1,607
1995	69	6	502	13	13	3	262	125	993
1996	71	16	333	6	10	2	240	166	844
1997	53	10	297	<1	7	2	280	156	805
1998	60	8	460	4	7	na	468	145	1,158
1999	110	10	440	9	10	1	626	115	1,321
2000	58	14	445	9	14	1	812	99	1,452
2001	54	10	363	10	12	1	716	85	1,252
2002	35	16	196	12	13	2	863	76	1,215
2003	40	9	183	9	6	<1	823	65	1,136
2004	46	10	145	12	7	1	764	61	1,045
2005	14	10	159	15	9	2	586	61	855
2006	44	20	260	12	7	1	530	60	934
2007	26	17	266	9	8	1	525	55	906
2008	18	14	252	13	8	2	172	65	545
2009	12	16	253	4	11	2	389	70	756

Parr density

The ICES Baltic Salmon and Trout Assessment Working Group (WGBAST) report of 2010 (ICES 2010a) presents data on the density of sea trout parr. In general, the densities of parr are low in the Gulf of Bothnia and Gulf of Finland. There are, however, some positive exceptions of rivers with higher parr densities. The situation in the Main Basin is much more favourable. Data on sea trout smolt production is lacking.

Number of ascending sea trout

The number of ascending sea trout is monitored in the same rivers as described for salmon.

Catches of sea trout

Sea trout are mainly fished in coastal and river areas and only to some extent in the offshore areas. They are the target of both commercial and recreational fisheries. The overall trend of sea trout catches has been decreasing since 1990 (Figure 2.8). The nominal catches of sea trout in the whole Baltic Sea (including rivers) have declined from 1,563 tonnes in 1990 to 756 tonnes in 2009 (Table 2.3). The largest proportion of the total catch is taken in the Main Basin, while the Gulf of Bothnia and Gulf of Finland are other important fishing areas.

Sea trout catches

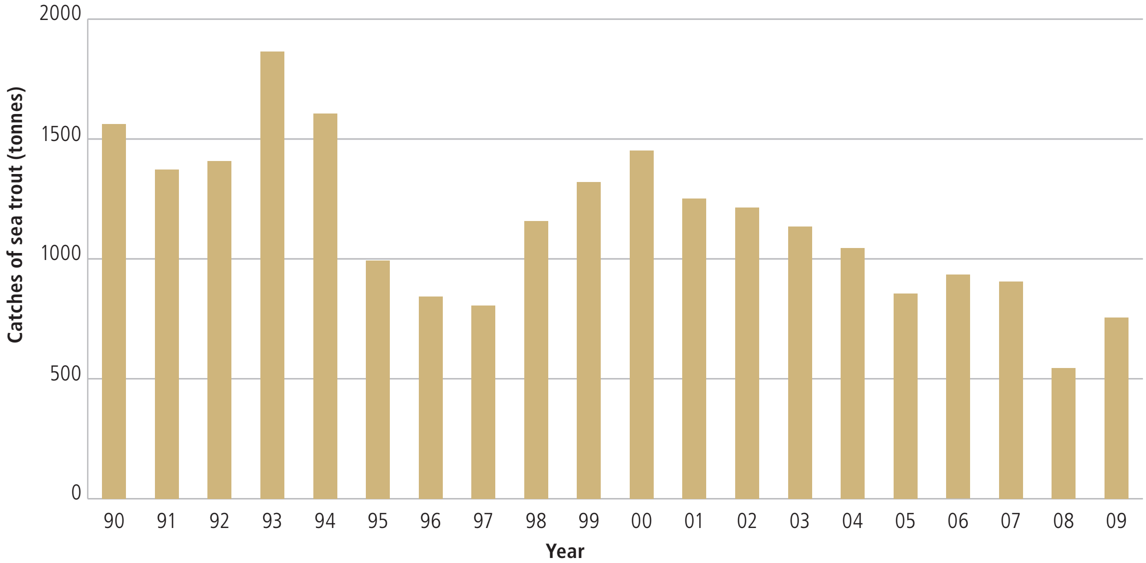

Figure 2.8. Nominal catches of sea trout in the Baltic Sea in 1990–2009 (ICES 2010a).

2.3 Stocking of salmon and sea trout

Stocking of salmon and sea trout is widely practised with the aim of increasing their production. Stocking can be undertaken using eggs, alevin or parr into the nursery areas in rivers or by releasing smolts in the river or the river mouth area.

Stocking can be based on mandatory court rulings as compensation for the damming of rivers. It can also be undertaken in order to enhance the development of a wild population in need of recovery or for the establishment or reintroduction of a salmon population in a potential or former salmon river. Stocking is also currently undertaken with the sole purpose of increasing the future catch possibilities.

Since 1990, salmon smolts have been stocked into the Baltic Sea at levels varying from 4.3 to 5.8 million smolts per year while sea trout stocking has increased from 1.6 to 3.6 million smolts per year (Table 2.4).

Table 2.4. Salmon and sea trout smolt releases to the Baltic Sea excluding the Kattegat (ICES 2010a).

	Salmon smolts released (x 1000)			Sea trout smolts released (x 1000)			
Year	MB, BS and BB*	GF*	Total	MB*	GB*	GF*	Total
1990	4,350	524	4,874	282	1,042	260	1,584
1991	4,052	518	4,569	246	1,118	270	1,634
1992	4,300	354	5,654	208	1,147	330	1,685
1993	5,592	470	5,061	192	942	318	1,452
1994	3,950	398	4,347	263	1,001	287	1,551
1995	4,081	489	4,570	243	1,159	348	1,750
1996	4,369	542	4,911	245	1,244	177	1,666
1997	4,893	449	5,342	289	1,087	331	1,707
1998	5,158	507	5,665	305	939	331	1,575
1999	4,986	597	5,583	386	923	398	1,707
2000	5,215	584	5,799	1,396	901	380	2,677
2001	4,977	801	5,778	1,421	982	427	2,830
2002	4,713	681	5,394	1,935	911	373	3,219
2003	4,673	644	5,317	1,925	890	329	3,144
2004	4,460	817	5,277	1,921	681	291	2,893
2005	4,403	865	5,268	2,322	776	198	3,296
2006	4,750	742	5,492	2,513	1,072	301	3,886
2007	4,621	635	5,256	2,406	1,113	364	3,883
2008	4,865	778	5,643	2,439	1,086	352	3,877
2009	4,608	700	5,308	2,242	1,018	322	3,582

*MB= Main Basin, BS=Bothnian Sea, BB=Bothnian Bay, GF=Gulf of Finland, GB=Gulf of Bothnia

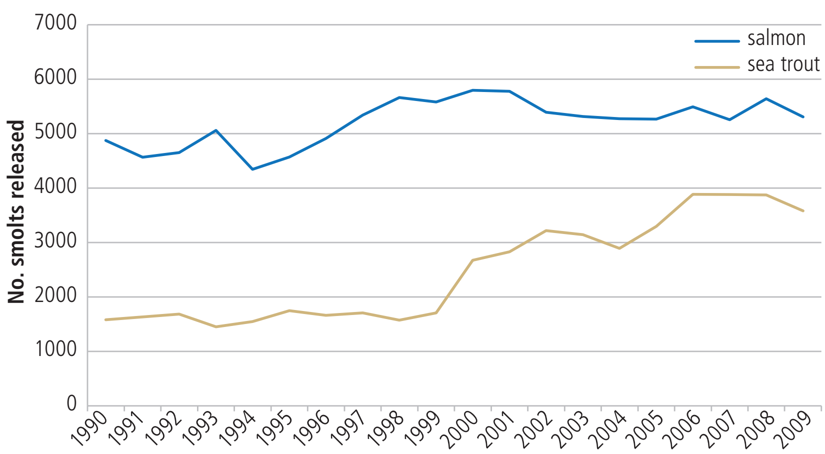

Figure 2.9. **Releases of salmon and sea trout smolts (x 1000) to the Baltic Sea excluding the Kattegat (ICES 2010a).**

3 Habitat and water quality requirements of Baltic salmon and sea trout populations

Baltic salmon and sea trout inhabit freshwater and marine habitats. They may swim hundreds of kilometers during their migration, encountering different environments during their lives. Several studies have attempted to categorize salmonid habitats, since they have a direct applicability to the conservation and reintroduction of stocks (e.g. Bardonnet and Bagliniere 2000, Armstrong et al. 2003, Gibson 1993, Heggenes et al. 1999, Heggenes 1991).

One way to understand the habitat requirements of salmon and sea trout is to consider these at each life stage. In fresh water, the life stages during which salmon and sea trout are most prone to mortality are the early juvenile stages (Huusko et al. 2007). A common factor to all life stages is that fish need refuges in which to hide from predators. Refuges are created by vegetation, river banks, fallen trees, debris, stones, turbulence and deep pools. Refuges also provide protection against water current in rivers (Cowx and Welcomme 1998).

The life cycle is similar for salmon and sea trout (Figure 3). Both species spawn and deposit eggs in the autumn. The fry hatch in the spring in rivers and streams. Alevins (i.e. the fry or larvae) have a yolk sack attached to them constituting their food reserve. After emergence from the gravel the fry and then parr feed on invertebrates of aquatic and terrestrial origin. After 1–4 years in the rivers the parr become smolts which are silvery in color and physiologically adapted to marine life. In the spring, the smolts migrate to sea. The length of the marine life phase varies from one to a few years. From the spring to the fall adult salmon and sea trout return to their home rivers to spawn. Subsequent to spawning Baltic salmon males often migrate to sea

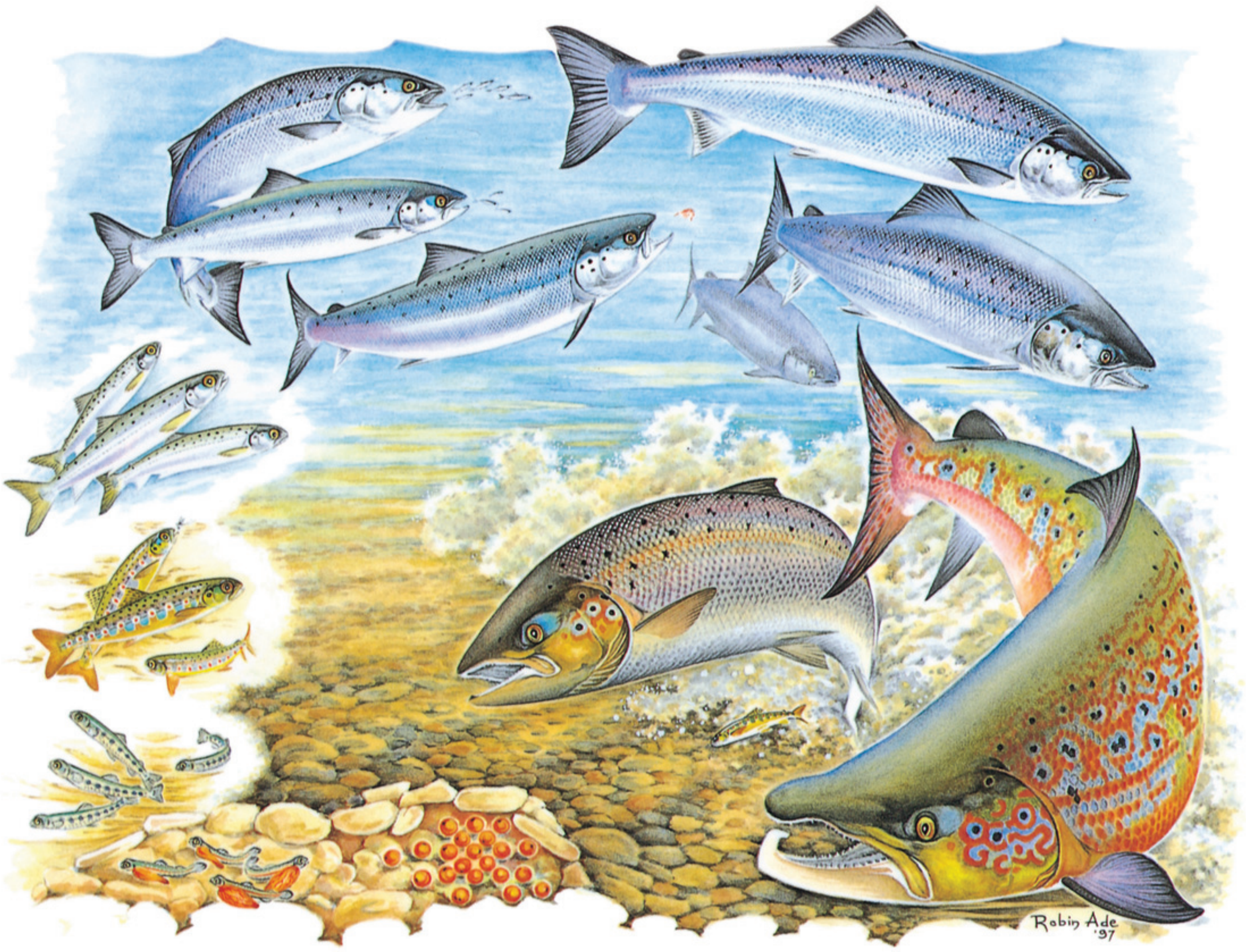

Figure 3. **Life cycle of Atlantic Salmon (Source: Atlantic Salmon Trust).**

(Österdahl 1969). A lot of energy is spent on spawning, and many salmon and sea trout die after it. Adult salmon normally die after having returned to sea (Jonsson et al. 1991). Some individuals succeed to spawn a second or even third time. Salmon and trout are iteroparous species meaning that they can spawn several times (Klemetsen et al. 2003). A proportion of male salmon and trout parr mature in the river and do not migrate to the sea.

3.1 Life in the sea

Baltic salmon spend from one to four years in the sea before their first spawning, and those that survive to second or third spawning may spend additional years at sea. Generally, sea trout exhibit a similar length of the marine life to the salmon, but iteroparous individuals are more common and a wider range of marine life history patterns are found among sea trout. During life at sea, growth is rapid due to a diet consisting mainly of fish.

Sea trout mostly spend time in littoral areas feeding on invertebrates and fish. The marine feeding ecology of sea trout is not fully understood (Rikardsen et al. 2006), but according to the studies conducted to date Baltic herring (*Clupea harengus membras*) are the main component of the diet. Sea trout may also occasionally utilize pelagic areas for feeding (Rikardsen and Amundsen 2005). Sea trout are visual and opportunistic (diet varies between individuals) feeders (Klemetsen et al. 2003) and turbidity, due to eutrophication, may alter its diet (Stuart-Smith et al. 2004).

Salmon, on the other hand, are most often found in pelagic waters feeding on sprat shoals (*Sprattus sprattus*). They also feed on herring and three-spined sticklebacks (*Gasterosteus aculeatus*) and may occasionally eat sandeel (*Ammodytes* spp.), cod (*Gadus morhua*) and garfish (*Belone belone*) (Karlsson et al. 1999). The salmon migrate greater distances than sea trout. For example, salmon populations from northern rivers in the Bothnian Bay migrate as far as the southern Baltic Sea. Baltic salmon populations predominantly migrate to the Main Basin for feeding, but the migratory behavior is stock specific and some stocks (e.g. the Neva stock used to stock the river Kymijoki in the Gulf of Finland) undertake more limited migrations (Ikonen 2006).

3.2 Upriver migration

When surface water temperature and day length increase in the spring, maturing salmon and sea trout migrate from their offshore and coastal feeding areas in the Baltic Sea into their native rivers to spawn. Salmonids use olfactory cues during the final stage of their migration to find their home streams, which is one reason that sufficient water flow is important. The exact mechanism used by salmonids in locating their home streams is not fully understood (Limburg et al. 2001, Hasler 1971).

Environmental conditions are very different in rivers compared with those in the sea. Fish have to adapt physiologically to changes in salinity, and to adjust their swimming behavior to the shallow depth and unidirectional water current. During the upstream migration, salmon cease to feed and spend time in sheltered pools, sometimes called “holding pools” (Bardonnet and Bagliniere 2000). In France, salmon may spend several months in the holding pools, but in Baltic rivers the migration to spawning grounds is generally more rapid. The quantity and quality of holding pools probably represent an important habitat feature influencing the safe upstream migration of adult salmon. Holding pools are characterized by deep, still and cool waters and some cover.

3.3 Spawning

Salmon and sea trout spawn during the autumn and winter months. In the fall, salmon and sea trout move to the spawning grounds, and females excavate nests of around 20 cm or even deeper in the substrate. Males court females, and the females lay a small quantity of large eggs in several egg pockets. A series of nests is called “a redd”. The redds can cover large areas, in some cases up to 11 m^2. During the egg stage, mortality is often low because the embryos are well protected in the substrate. However, the rate of interstitial water flow, presence of various toxic materials, sedimentation and low oxygen concentrations can affect egg survival negatively. Also, in the northernmost latitudes of the Baltic area, the movement of gravel beds in association with ice formation, ice break-ups, and high flows may wash out eggs (Huusko et al. 2007).

The duration of the spawning period varies from two weeks to seven months depending on latitude, altitude and temperature (Armstrong et al. 2003, Bardonnet and Bagliniere 2000). The females leave after spawning, but males remain at the redd sites. Eggs incubate in the gravel and the embryos develop during the following spring (Klemetsen et al. 2003).

Salmon prefer to spawn in shallow areas near the river bank, with swift-running water (Bardonnet and Bagliniere 2000, Barlaup et al. 2008). A good spawning substrate for salmon has been found to consist of 40–80% gravel and 10–40% cobble (Semple 1991). Silt and sand contents of 20% in the spawning substrate can be detrimental to embryonic survival (Malcolm et al. 2003). The water depth in spawning sites varies between 25 cm to 50 cm (Armstrong et al. 2003, Heggberget 1991, Moir et al. 1998, Beland et al. 1982). Mean water velocity for spawning salmon in Norway has been measured as 40 cm/s (Heggberget 1991), but higher velocities (up to 53.6 cm/s) have been recorded in Scotland and Canada (Moir et al. 1998, Beland et al. 1982). Sea trout tend to spawn earlier than salmon, and primarily in smaller headwaters (Armstrong et al. 2003).

3.4 Embryo development

Embryos develop within redds for several months. Substrate composition and the location of the redds are important for the survival of the embryos (Bardonnet and Bagliniere 2000). The substrate should be permeable, so that the embryos obtain enough oxygen and the fry can emerge (Bardonnet and Bagliniere 2000). Oxygen is essential for the survival and development of alevins. Substrate quality (especially the proportion of fine particles), temperature, water velocity, and discharge all influence oxygen availability (Armstrong et al. 2003, Rubin and Glimsäter 1996).

3.5 Early life

Hatching occurs after one or more months. The time from spawning to hatching is dependent on temperature, and stress or environmental disturbance may cause eggs to hatch earlier. The larvae, called alevins, live for several weeks in the gravel nourished by their yolk sacs. Salmon alevins emerge later and disperse further from the spawning area, but trout may remain in the redds until the yolk is consumed completely (Bardonnet and Bagliniere 2000, Klemetsen et al. 2003). The period of a few weeks following emergence is critical for the strength of the year-class, since mortality at this stage can be very high.

For salmon parr, water velocity is considered to be the environmental variable of primary importance, since they feed on organisms drifting with the current (Armstrong et al. 2003). For sea trout, water depth is considered as the most important habitat variable, sufficient areas with low water flows also being important (Heggenes et al. 1999). The preferred habitats of juvenile salmonids are often size dependent. Larger and older parr prefer deeper areas and tolerate faster water velocity than younger and smaller parr. Older parr can also feed in wider range of flows than young parr (Heggenes et al. 1999).

During their first year, young sea trout and salmon prefer shallow areas located along the river bank with moderate to fast flows. Small trout parr are typically found in water depths of 20–30 cm with flows of 10–50 cm/ s and cobble substrates. Young sea trout parr have been found to migrate to the Baltic Sea already during their first summer. The early migration may be an adaptation to the brackish water conditions of the Baltic Sea (Landergren 2001 and 2004, Landergren and Vallin 1998, Limburg et al. 2001). Young salmon parr inhabit riffles in or near the redd site (Bardonnet and Bagliniere 2000, Klemetsen et al. 2003) and prefer coarse substrate and water velocities of 30–50cm/s. As they grow older and larger, salmon and trout move into deeper water. The distribution of different age classes occupying different habitats is probably due to competition between older and younger parr. Older parr displace the fry and restrict their habitat choice (Heggenes 1991, Heggenes et al. 1999, Klemetsen et al. 2003, Armstrong et al. 2003).

Juvenile salmon and sea trout establish and defend territories. The size of the territory depends on many factors (food abundance, fish size, morphology, substrate, gradient, water quantity and quality, turbidity etc.), and the total availability of habitats for all freshwater life stages determines the production capacity of the river (Grant 1993, Grant and Kramer 1990, Grant et al. 1998). Where the two species coexist, there is often competition for habitats. Sea trout are generally described as being more aggressive and may limit the habitat available to salmon (Heggenes 1991). Salmon and sea trout normally reproduce in different parts of the northern Baltic Sea rivers, salmon in the main stem and sea trout in the tributaries. Therefore, competition for space is less intense in this area than in southern rivers where reproduction areas overlap.

There are seasonal changes in habitat use in both species related to water temperature (Heggenes et al. 1999, Heggenes 1991). Winter survival of juvenile salmonids has been found to be rather low. For example, in Danish rivers an average survival of 40% has been estimated over the first winter. However, there is variation between years and between locations. Winter mortality occurs due to predation and the depletion of energy reserves, often in combination with harsh physical conditions (Huusko et al. 2007).

The M74 syndrome is a reproductive disorder of Baltic salmon, which causes mortality of yolk-sac fry. The syndrome has adversely affected Baltic salmon populations since 1990. During 2003-2005, the situation improved, and M74 mortality was less than 5% in the rivers flowing into the Gulf of Bothnia. The mortality rate is highly variable and cannot be predicted. The typical symptoms are loss of negative phototaxis, lethargy, lack of coordination and precipitates in the yolk sac as well as erratic swimming (such as spiral swimming), convulsing and swimming upside down. The exact cause of M74 is still unknown but it results in a thiamin deficiency in fish eggs (Keinänen et al. 2000 and 2008). The frequency of M74 is lower in wild populations compared to reared strains and in more southern populations (ICES 2010a).

3.6 Smolting and smolt run

Juveniles remain in their natal rivers from one to more than four years. In the spring, the older parr undergo smolting. In the smolting process, fish become physiologically adapted to marine life (their salt tolerance increases) and gain a silvery color. Hormones, such as growth hormone and cortisol, are responsible for the physiological and morphological changes associated with smolting. The thyroid hormones and the insulin-like growth factor-I are also important hormones influencing the smolting process (McCormick et al. 2002). For instance, the thyroid hormones have a direct role in the silvering of the smolts (Hutchison and Iwata 1998).

A marked increase in day length is generally considered to be the main environmental cue for smolting (Sigholt et al. 1998). Temperature is also important, but its role is more complicated (McCormick et al. 2002). The smolt run (i.e. the time of the migration of smolts to the sea) is mainly controlled by temperature (Jonsson and Jonsson 2009). Mortality at sea is believed to be highest during the first weeks and months, i.e. during the post-smolt stage (Salminen et al. 1995, Hansen and Quinn 1998, Crozier et al. 2003). Smolts initially feed on insects trapped in the water surface but soon adopt a diet of small fish (Ikonen 2006). Smolts migrate towards the feeding areas in the Baltic Sea, where they remain until as adults they begin their spawning migration.

4 The influence of climate change on the populations of Baltic salmon and sea trout

4.1 Climate change in the Baltic Sea region

Climate has a profound effect on the hydrology, hydrography, and consequently the marine environment of the Baltic Sea. Due to its geographical location, variable topography, and land-sea contrasts, the climate of the Baltic Sea basin is characterized by large seasonal contrasts. The natural variability in the climate is mainly caused by the North Atlantic Oscillation (NAO). The NAO affects the atmospheric circulation and precipitation in the Baltic Sea basin (HELCOM 2009, HELCOM 2007).

In recent decades, the annual surface water temperature in the southern Baltic Sea has increased by approximately 1° C, whereas in the northern Baltic Sea the observed changes are mainly seasonal (HELCOM 2009). At the same time, the period of ice cover has decreased by 14–44 days and ice

thickness in many rivers of the Basin has decreased. There has also been a decrease in the frequency of salt-water pulses from the North Sea into the Baltic Sea (HELCOM 2009), and an increase in the length of the growing season has been observed in the area (HELCOM 2007). The observed changes point to the considerable impacts that climate-related factors have on the Baltic Sea biodiversity (HELCOM 2009, BACC Author Team 2008).

Globally, ecosystem effects of climate change have been observed. Rising water temperatures have caused regime shifts in some freshwater and marine systems (IPCC 2007). Regime shifts refer to abrupt and persistent changes in ecosystem functioning that occur at a large spatial scale and are observed at different trophic levels (deYoung et al 2004). In the central Baltic and in the North Sea, synchronous ecological regime shifts were observed in the late 1980s. In the central Baltic Sea phytoplankton biomass increased, the growing season was extended and changes occurred in the abundance of the dominant copepod species of the central Baltic (*Pseudocalanus* sp., *Temora longicornis* and *Acartia* spp). These copepods are the main food items for the larvae of cod, herring and sprat. *T. longicornis* and *Acartia* spp. increased dramatically in the 1980s whereas *Pseudocalanus* sp. initially increased and then decreased in abundance. At higher trophic levels, cod abundance reached historic low values in the 1990s while Baltic sprat thrived (Alheit et al. 2005) and formed the dominant predator. This regime shift has been demonstrated to cascade through trophic levels in the open pelagic areas of the Baltic Sea (Casini et al. 2008) affecting zoo- and phytoplankton biomasses.

It is predicted that during the 21st century temperature will continue to rise in all of sub-regions of the Baltic Sea. Regional modeling studies, suggest an increase in the mean annual temperature in the order of 3–5° C during the century. Consequently, the surface water temperatures of the Baltic Sea could increase by approximately 2–4° C (HELCOM 2009). A dramatic decrease in the ice cover is expected to occur in parts of the area as a result of the increased temperatures. The length of the ice season may decrease by 1–2 months in the northern parts of the Baltic Sea and by 2–3 months in the central parts. Winters are expected to become shorter and milder, and growing seasons longer in the region (HELCOM 2009, BACC Author Team 2008). The frequency of extreme weather events and their severity of are expected to increase resulting in increased floods and periods of droughts (IPCC 2007). An increase in the water temperature may increase bacterial activity, which may affect the recycling and biological uptake of nutrients. Higher summer temperatures and milder winters may result in the establishment of new species and the extinction of some native species or ecosystem functions (HELCOM 2009).

Increase in precipitation, particularly in the north is expected. In the south, summers would become drier. The higher precipitation is projected to increase winter runoff, by an average of 15% for Baltic Sea area. As a consequence, salinity would decline and there would be higher nutrient loads from the surrounding catchment area (HELCOM 2009). Together with the warming of the surface water of the Baltic Sea, the increased nutrient runoff could increase eutrophication (HELCOM 2007).

Acidification (declining pH) of sea water is associated with increased atmospheric CO2 concentrations. Oceans are a major sink for CO2, storing about 30% of the anthropogenic CO2 emissions. The IPCC predicts that by 2100 the pH of world oceans will fall by 0.30 assuming an increase of atmospheric CO2 concentration to 650 ppm (HELCOM 2009). Acidification of seawater leads first to a decrease of calcification and, eventually, to dissolution of calcified structures of, for example, certain plankton groups, bivalves and snails. In the Baltic Sea, where calcification is already low because of low salinity, this effect may be more pronounced than in the oceans. Over the past 20–30 years, acidification of 0.15 pH units has been detected in the Baltic Sea (HELCOM 2009). In conjunction with climate change, acidification may alter the conditions of the Baltic Sea ecosystem profoundly.

The possible reduction in salinity related to freshwater run-off may have a direct influence on the phytoplankton species composition (HELCOM 2007). Freshwater species are likely to increase at the expense of marine species. Phytoplankton communities are expected to change towards warm-water species. Salinity also controls biodiversity and species composition of zooplankton. The surface community consists mainly of cladocerans, smaller copepods and rotifers, whereas the deeper more saline waters are inhabited by the large and fatty marine copepods (such as *Pseudocalanus* sp. and *T. longicornis*) (HELCOM 2007).

Changes in the salinity towards a fresh-water ecosystem are expected to influence the species composition of zooplankton so that freshwater species become more common and marine species become less common. *Pseudocalanus* sp. and *T. longicornis* are important food items of the Baltic herring and sprat, respectively. During the last two decades, the Bothnian Sea has undergone changes in the food web composition driven primarily by decreasing salinity and increasing temperature (HELCOM 2007). In the 1990s, the Baltic herring in the Bothnian Sea has experienced decreased growth rates that may be related to the decrease in the abundance of *Pseudocalanus* sp. and an increase of herring density (ICES 2009, HELCOM 2007). This illustrates the effects that climate changes can have through the food web.

4.2 Influence of climate change on Baltic salmon and sea trout

The influence of climate change on fish is the subject of increasing research. Climate change may influence species distribution and abundance through changes in growth, survival, reproduction, or through responses to changes at other trophic levels (Brander 2010, Perry et al. 2005). Shifts in

geographical distribution of fish occur in response to climate change and are generally most evident near the northern or southern boundaries of the geographic range of a species. Such shifts have been observed in the North Sea and other parts of Europe (Pörtner and Peck 2010).

As ectothermic animals salmonids are affected by temperature in terms of their rate of development and growth as well as migration behaviour. The anadromous salmonids are affected by climatic factors during their different life stages including the embryo development, hatching, juvenile stages, smolting and migration (Jonsson and Jonsson 2009, Elliott and Hurley 1998). Salmonids are cold water species with high oxygen demands, and the expected temperature rise may extirpate populations especially at the southern end of their distribution range (Jonsson and Jonsson 2009).

Recent scientific reviews suggest that climate change may have a range of effects on salmon and sea trout (Jonsson and Jonsson 2009, Pankhurst and King 2010, Todd et al. 2010, Jonsson et al. 2005). The distribution range of salmon could move north- and eastwards in Europe due to altered temperature, rainfall and runoff. Arctic rivers that are currently unsuitable for salmonids could become habitable while the salmonid production decreases in the southern part of the distribution range. Several fish diseases may become more virulent while the salmonids become stressed by high temperatures and their disease resistance drops (Jonsson and Jonsson 2009).

Also, population traits of salmon and sea trout may be altered by the climate change. For example, the time of spawning could be delayed, feeding opportunities for fry could be improved and winter mortality in northern rivers may increase. Shifts in time of smolting and seaward migration as well as upstream migration may occur, post-smolts may experience reduced growth and higher mortality, and warmer temperatures may result in younger sea age at maturity (Jonsson and Jonsson 2009). At the very end, it is the sum of the local anthropogenic disturbances and the natural environmental fluctuations that determine the final state of populations (Walther et al. 2002, HELCOM 2007).

In the Baltic Sea the expected changes in the plankton communities may affect the entire food chain. During their marine phase, salmon and sea trout feed on sprat and herring. If herring and sprat stocks are weakened through changes in the zooplankton community that they feed on, there may be adverse effects on salmon and sea trout stocks that prey on these fish species.

Groups of species that would be expected to benefit from the warming of the Baltic Sea are cyprinids and perciformes (e.g. *Sander lucioperca*). Eutrophication may enable these species to expand their reproduction areas in the shallow coastal zones. Increased precipitation may intensify eutrophication in the Baltic Main Basin as a result of increased runoff and nutrient loads. Cyprinids and perciformes may, therefore, compete more efficiently with, in particular, sea trout smolts for prey such as crustaceans (e.g. *Gammarus* and *mysid* sp.). *Mysids*, that are bottom feeding organisms, may also be further limited due to increased oxygen deficit events.

It can be hypothesized how higher runoff may influence sea trout and salmon. For example, sea trout spawning in smaller headwater streams might increase flow conditions favored upstream migration. Longer growing seasons may also reduce the time required to reach the smolt stage leading to earlier migration to sea (phone conversation with Ari Saura, March 19, 2010). On the other hand, increased levels of nutrients and sediment in the water may have a negative impact on spawning. For example, eroded clay and sand may hinder nest construction in spawning areas or reduce oxygen supply to the eggs and alevins. These impacts have already been observed in some areas near the Gulf of Finland. Long, dry summers could also negatively affect spawning, through delaying riverine entry (phone conversation with Ari Saura, March 19, 2010) and production. A reduction in available habitats has already been observed in Denmark. Also extreme flow conditions (low/high) due to heavy rainfall or droughts may cause high mortality levels. Small streams may be seriously damaged through hydraulic overload as a result of more frequent heavy rainfall.

5 Categorisation of salmon and sea trout populations in the Baltic Sea

The Baltic Salmon and sea trout populations can be categorised in various ways, depending on the purpose of the categorisation. Such categorisation can be developed based on a large variety of factors.

In this report the categorisation is based on

- The historical occurrence of salmon/sea trout populations in the river
- The level of natural production
- The origin of the population
- Stocking activities
- Current occurrence of habitats suitable for reproduction

Using these criteria, the salmon and sea trout populations have been grouped into eight categories as follows:

Category	Status of salmon/ sea trout in river	WILD smolt production
1.	Wild self-sustaining production of original strain	River with natural reproduction of salmon and/or sea trout of original strain, no releases of reared fish during the latest ten years.
2.	Wild self-sustaining production of introduced strain	River with natural reproduction of salmon and/or sea trout of introduced strain, no releases of reared fish during the latest ten years.
3.	Wild production	River with natural reproduction of salmon and/or sea trout and without large continuous releases of reared fish. Of the total smolt production > 90% are wild.
4.	Mixed production	River with natural reproduction and with large continuous releases of reared fish. Of the total smolt production 10–90% are wild.
5.	Mixed, some wild production documented	River with large continuous releases of reared fish and smoe natural reproduction. Of the total smolt production 0.1–10% are wild.
6.	Potential	River with possibilities for natural reproduction and potential (river not irreversibly destroyed for salmon/sea trout) of becoming one of the Wild -categories.
7.	Reared	River with no or almost no natural reproduction, with significant migratory hindrances and limited reproductive areas and with large continuous releases of reared fish. Of the total smolt production < 0.1% are wild and there is no potential for significant wild smolt production.
8.	Historical	River with natural reproduction of salmon and/or sea trout in the past, but currently unsuitable for the fish. The original strain is probably lost, and the river is without potential, so no or only minor releases are made and no wild smolts are documented.

Based on the categorisation and the latest information on the population status, the salmon and sea trout populations in the Baltic Sea fall into categories as indicated in Annexes I and II.

6 European Union and Russian Federation legislation concerning river and sea waters

The European Union has adopted legislation that aims at achieving a good status of the waters in the rivers and in sea areas. These are Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive) and the Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for Community action in the field of marine environmental policy (Marine Strategy Framework Directive).

The Water Framework Directive (WFD) sets the goal of achieving a good quality of all European surface freshwaters and ground water bodies by 2015. The freshwater bodies include lakes, streams, rivers, estuaries, and coastal waters, which should all reach "a good ecological and chemical status" in terms of low levels of chemical pollution and in terms of a healthy ecosystem. Each Member State of the European Union is required to establish River Basin Management Plans with actions for the development of water status. The actions of the plans include some measures that benefit salmonid populations, both with regard to habitat conditions and migratory passage.

The goal of the Marine Strategy Framework Directive is to achieve "a good environmental status" in the marine environment by the year 2020. According to the directive, marine waters reach a good environmental status when "they provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations". The goal of the Marine Strategy Framework Directive is in line with the objectives of the Water Framework Directive. It requires Member States to draw up marine strategies with actions for the development of the state of the marine environment. Member States shall cooperate through regional sea conventions, where they share a marine region. In the Baltic Sea this has been done in HELCOM through the process of adopting the Baltic Sea Action Plan.

The Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora or the Habitats Directive (together with the Birds Directive) forms the cornerstone of Europe's nature conservation policy. It is built around two pillars: the Natura 2000 network of protected sites and the strict system of species protection. In total, the Directive protects over 1,000 animals and plant species and over 200 so called "habitat types" (e.g. special types of forests, meadows, wetlands, etc.), which are of European importance.

Freshwater populations of salmon (with the exception of Finnish populations) are listed as a species of European importance in the Habitats Directive. This requires EU Member States to designate special areas of conservation in order for the species to be restored and maintained at a favourable conservation status. The latest Article 17 Report on the implementation of the Habitats Directive assessed salmon as having an unfavorable conservation status across the bioregions in the Baltic Sea catchment.

The Russian Federation has two areas with Baltic salmon and sea trout rivers; the Kaliningrad Oblast and the St. Petersburg area. The Water Code was adopted by the Russian Federation in 1995 and amended in 2001–2005. In contrast to the WFD, the focus of the Water Code is on resources, rather than on the ecological status. The Water Code does not define the basic management unit as the WFD defines the river basin. The Water Code also lacks the mechanisms of realization, such as the provisions determining aims, organizational basis, economic and financial provisions and terms for achievement of the target indicators (Alexeev 2008).

7 Overview of salmon and sea trout populations and rivers in the Baltic Sea countries

7.1 Belarus

7.1.1 State of the salmonid habitats in Belarus

Belarus is landlocked and does not have a Baltic coastline but it has numerous tributaries with salmonid spawning habitats; mainly the upstream areas of the western river Dvina/Daugava and of the river Neman/Nemunas. Dams built on the rivers of the Western Dvina and Neman in the 1950s and 1960s block access to former upstream spawning areas in Belarusian territory beyond the Latvian and Lithuanian borders. No fishways have been constructed, and there is no legislation requiring their construction in the rivers of Belarus.

Salmon migration had been observed in the river Neman and its tributaries prior to the installation of the Kaunas Dam in 1959. Since then, salmon has not been documented in the Belarus official fish records. Salmon is considered extinct in the rivers of Belarus.

Free passage for salmon remains throughout the river Neris, a tributary of the river Nemunas at Kaunas. The river Nemunas changes its name to Vilia at the border of Lithuania and Belarus. Until recently there have been no observations of salmon migration further upstream into the river Vilia.

Baltic salmon migrate 500–600 km upstream in the river Neman basin to enter spawning sites in the River Vilia and its tributaries of Petropolsky brook, Tartak, Senkanka, Gazovka, Dudka, Unnamed brook, and Kemelina. The tributaries are mainly small and shallow rivers located in the Ostrovets District of the Grodno Oblast. The rivers Oshmjanka and Stracha have been regulated with dams since the early 1970s preventing salmon from reaching their natural spawning grounds further upstream. The river Stracha has the greatest potential as a salmon river. It has more than 15 km of potential spawning habitat above the dam. The river Oshmjanka is affected by industrial pollution.

Beaver dams on small rivers are a serious problem to salmonids. During the winter of 2009/2010 it was reported that beavers built two dams on the river Tartak, which is less than 5 km long. About half of the river Senkanka is not accessible to migrating salmonids due to beaver dams.

7.1.2 State of the salmon populations in Belarus

The current population of Baltic salmon in Belarus is at a critically low level. The most dramatic decrease in population size occurred during the 1950s and 1960s as a result of dam installations and intensive poaching activities. There has been no comprehensive investigation of the salmon populations in the river Vilia and its tributaries.

Since 2005, ichthyologists of the Academy of Sciences have undertaken monitoring of salmonids in some tributaries of the river Vilia. Baltic salmon are far less numerous than sea trout in Belarus. The unusually warm weather in December 2004 is thought to have prevented salmon reaching the rivers Senkanka, Tartak and Unnamed brook. No salmon spawning sites have been observed in these areas. There is a significant annual variation in the numbers of returning spawners within and between rivers.

In September 2009, permission to use electrofishing equipment was granted for the first time by the Belarusian authorities. The staff of the Academy of Sciences of Belarus was to conduct monitoring in the Vilia basin for several days. The monitoring covered a relatively large area including a 1 km long section of the river Vilia (downstream of the Oshmianka tributary), the Oshmianka tributary itself, the river Tartak and the river Dudka. No salmon were found in the rivers Osmianka and Tartak, but some were found in the river Dudka.

7.1.3 State of the sea trout populations in Belarus

Sea trout is regularly observed in the tributaries of the river Vilia in Belarus. The estimate of sea trout individuals is based on the numbers of redds observed in the spawning rivers. The highest densities of trout have been observed in the river Kemelina, with regular observations in the rivers Tartak, Senkanka and Unnamed brook.

During the first week of September 2010, joint salmonid monitoring was organized by Lithuanian and Belarusian specialists. Electrofishing equipment was provided by Lithuanian specialists. Unfortunately the weather conditions were not favorable due to heavy rains which caused the water level in the Vilia tributaries to rise by 60 - 80 cm. The amount of monitoring planned was limited due to the weather and the high water flow in the tributaries. However, data collected from the monitoring that was undertaken in 2010 shows that the highest density of sea trout is found in the river Tartak. Additional observations were made in the rivers Kemelina, Dudka and Senkanka. The majority of fish observed were smolts of ages 1+ and 2+. No observations were made in rivers Stracha, Vilia and Sorochanka.

7.1.4 Fishing regulations in the Belarusian rivers

Poaching is a significant problem in Belarus and has historically been a major factor affecting the numbers of salmon in the rivers. Poaching is thought to have peaked in the 1950s and 1960s when explosives where used to catch fish. According to local people, poaching using harpoon and electrofishing still occur during the migration season.

According to the enforcement officer, there are difficulties in preventing such activities and with enforcing the regulatory system. Many poaching sites are extremely isolated and issuing a notice does not seem to be a deterrent.

Both sea trout and Baltic salmon are listed in the 2004 Belarus National Red Data book. Fishing for salmon is prohibited. However, enforcement measures for poaching and illegal activities are poorly defined. Official statistics showed that only one person was charged with illegal electrofishing in the Vilia basin in 2005 (Polutskaya 2005).

The Action Plan for the protection of Baltic salmon and sea trout in the Ostrovets District of the Grodno Oblast was adopted in 2008 by the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus. This Plan is approved by the State Wildlife Inspectorate under the President of Belarus, the State Bioresources Research Centre under the Academy of Sciences of Belarus, the Ostrovets District Administration and the NGO Ecohome. The plan includes the monitoring of spawning sites, investigation of fish-ladder construction, actions to eliminate beaver dams in spawning areas, protection against poachers and communication of activities to the media. A similar plan for 2010-2011 has been developed by the Ministry but has not yet been adopted (MNREPRB 2008).

7.2 Denmark

7.2.1 State of the salmonid habitats in Denmark

Denmark has several hundred sea trout rivers and one former salmon river in the HELCOM area. The majority of the sea trout streams are small (less than 2 m wide).

Historically, practically all Danish streams were subject to regulation (canalization, alignment, deepening and damming for construction of water mills, hydropower stations or fish farms). Until a few decades ago many steams were also subject to substantial organic pollution. As a consequence of canalization and deepening of the streams, large parts of the gravel areas needed for spawning of trout and salmon were lost. Weirs at hydropower stations and weirs built for regulation of water level in the surrounding agricultural land created barriers to upstream migration (either because fish passes were not functional or were lacking) and resulted in elevated mortality during downstream migration as the fish passed through artificial lakes at weirs and dams. This resulted in a depletion of stocks and indeed, in many streams, in combination with frequent pollution incidents, the loss of trout populations.

The only salmon population in the HELCOM area was found in the Gudenå, which is the longest river in Denmark. This population had its main spawning area in parts of the river to which access was effectively blocked by the construction of a hydropower station in 1921.

In recent years, many of the migration barriers have been removed or fish passes have been improved. Restoration work in many streams has improved both the accessibility and the possibilities for spawning by the addition of spawning gravel in suitable places. In a few places, larger projects have been carried out involving the hydrological system also in the surrounding meadows. Restoration processes have in many cases been led by local sports fishing associations that have been very active both in promoting projects and in actually carrying out restoration projects on their own.

In spite of this, the conditions are in many places still far from optimal with respect to all phases of the salmonid life cycle. Many barriers still exist and canalized streams often do not offer suitable habitats for young trout.

In a number of streams, artificial lakes in the lowermost part of the stream have been constructed with the purpose of reducing the level of nutrient transport (mainly nitrogen) to coastal areas. Such lakes have been demonstrated to have a devastating effect on migratory salmonids, resulting in heavy smolt loss during seaward migration. It has been demonstrated that the mortality level during passage through a new artificial lake was so high that a sea trout population could exist. Several projects involving these lakes are planned for the future.

In large areas erosion of sand from areas around the streams (fields, roads, urban areas, construction sites etc.) and heavy sediment transport results in sand smothering the spawning gravel and reducing the available habitat. Sedimentation of the spawning gravel results in the loss of spawning possibilities, severely reduced egg survival and loss of habitats for young trout. Habitat variation is reduced when sand covers the entire bottom of the stream resulting in a reduction of suitable habitats for fry.

Climate change is predicted to result in more precipitation and in turn in higher river discharge, especially during winter when the flow is generally at its highest. During the summer, heavy rainfall in connection with thunderstorms is predicted to increase and dry periods are expected to become longer.

A general higher flow has already been observed in some parts of the country, and also the frequency of the hydraulic overload of small streams from heavy rainfall during the summer appears to be increasing. This increase in flow, results in significant increases in erosion and sediment transport. Longer periods without precipitation will result in a reduction of the size of the reproduction area and consequently reduced smolt production.

A number of streams are affected by water extraction for consumption, especially near larger cities and on some of the Danish islands. This results in reduced minimum flows, in some places compensated by artificially releases of water to the streams during critical periods.

The maintenance of streams, such as cutting stream macrophytes, removal of accumulated sediments and removal of woody debris, is undertaken in most streams regularly according to the regulations for the individual streams. In recent years the maintenance has become increasingly environmentally friendly. However, in many streams the maintenance is still unnecessarily heavy. In the coming Water Management Plans a reduced, or more lenient, maintenance is proposed as a way to improve the river habitat quality.

The majority of the land used for agriculture has been drained, and together with large areas with solid surface (roads etc.) and rapid run-off through ditches, results in large fluctuations in discharge.

These fluctuations have a negative impact on salmon and sea trout populations, especially in the smaller catchment areas.

Point emissions of sewage and industry are not a general problem, but have been observed locally in the upper reaches and tributaries. Sudden and heavy pollution with organic material from farms occur from time to time, either when semi-liquid manure is spread on the fields as fertilizer or as a result of mishaps at the farms. Occasionally pollution from industry is observed resulting in fish kills.

7.2.2 State of the salmon populations in Denmark

The only Danish salmon population (Gudenå) in the HELCOM area was lost after the construction of a hydropower station at Tange in 1921. The station has a non-functional fish pass some 36 km upstream from the outlet. Upstream from the power plant a 13 km long lake has drowned out the previous spawning grounds. Attempts to improve the fish pass have had little effect. Very high mortalities have been found for smolt migrating through the lake.

There have been attempts to restore the salmon population in the stream by stocking, but the majority of suitable habitat is situated upstream of the power plant. Occasional spawning has been observed both in the lower parts of the river and in small tributaries.

7.2.3 State of the sea trout populations in Denmark

In general, the Danish sea trout populations have developed positively during the last couple of decades, showing a steady increase in population size. In short, the main reasons for this are improved water quality, improved habitat conditions as a result of restoration work, improved marine survival as a result of fishing regulations and restocking by releases of fish derived from wild spawners.

Since the 1970s, the water quality has improved significantly due to the construction of effective sewage treatment plants and significant reductions in pollution from farms. In a large number of smaller streams, restoration works have been carried out. Barriers have been removed or made passable by constructing faunal passages, thus providing access to areas that were for many years inaccessible. Gravel has been added in many places where it had previously been removed during regulation of the streams.

In the sea, the survival of sea trout has improved significantly through regulation of the fishery; most importantly by the establishment of a 100-m zone closed for net fishing along the coast, and by the establishment of larger closed areas around the river mouths.

By planned and closely managed releases, by taking the observed population into account and in recent years by using only fish originating from wild spawners, stocking has increased the size of many trout populations. In recent years the trend has been a gradual replacement of releases with restoration of suitable streams.

While the general trend in the development of the trout populations has been positive for the last couple of decades, this has not been the case in all parts of the country. Even in the parts of the country where the development is positive the total production is still considerably below the potential if habitats and accessibility to spawning and nursery areas were optimal. The development has been particularly positive in many streams along the Southern and Central East coast of Jutland, in parts of the islands Funen and Zealand, and on the island of Bornholm.

In the rest of the country (inside the HELCOM area), the sea trout populations have responded less positively. The main reasons are that less restoration work has been carried out; maintenance of the streams is relatively severe or natural conditions for the trout are not as favourable as in the most productive streams.

7.2.4 Fishing regulations in Danish rivers

The minimum legal harvestable size forsalmon is 60 cm and 40 cm for sea trout. The closed season is 15 November – 15 January (in most rivers a voluntarily extended period of 1 November – 28/29 February applies). Two-thirds of the main stream must be kept open when fishing with fixed gear. The minimum distance between fixed gears in streams is 100 m. The mesh size (bar length) in the cod end of fyke nets must be at least 32 mm. Around the fish passages 50 m both upstream and downstream are closed to fishing. Only landowners, or long term leasers of the land, are allowed to use fixed gears. the river There are closed areas in the estuaries.

If the river at the outlet is at least 2 m wide, the closed area has a radius of 500 m and is permanently closed all year. In many of the larger streams, the closed area is expanded, and some derogation for fishing inside such areas exist. If the river at the outlet is less than 2 m wide, the closed area has a radius of 500 m in which fishing is generally prohibited from 16 September – 15 March. Closed areas in the sea at the outlet of streams are published on maps on the internet at: http://fredning.fd.dk/. In lakes larger than 10 ha on streams with a width of at least 1 m, fishing is not allowed inside an area with a radius of 50 m both at the inlet and outlet of the stream. In addition to the above rules, there are rules allowing authorities to require fish passes at stems and turbines, and requiring installation of grids at turbines and at fish farms etc.

7.3 Estonia

7.3.1 State of the salmonid habitats in Estonia

The most profound impact on salmonid habitat availability is from hydropower development, and artificial migration obstacles are common in most of the rivers. However, habitat reduction has been particularly severe in the large rivers like Narva, Pärnu and Jägala resulting in little or no wild salmonid recruitment. In the salmon rivers alone (sea trout rivers not included) there are about 30 man-made migration obstacles preventing migration to about 70% of the historical habitat. Presently there is only one largely ineffective fishway at the Sindi dam on the Pärnu River. Therefore, improving the fish passage at these dams would be the most efficient way to enhance salmonid recruitment.

In the past, poor water quality in the rivers Purtse, Selja, Loobu, Valgejõgi, Vääna and Keila severly reduced salmonid production. The situation has, however, improved, but is still not ideal, and presently salmonid production occurs regularly in all of these rivers. Further improvement is still needed.

Habitat degradation (channelization and deepening of the river bed) has mainly occurred in some streams and small rivers and, therefore, affects the sea trout populations. Dredging has resulted in a shortened but higher spring flow period and a longer and lower flow period in the summer. Habitat restoration work has to date been rare and further such work is needed.

7.3.2 State of the salmon populations in Estonia

Historically there were 12 salmon populations in Estonia. In the rivers Narva and Jägala the populations are maintained by regular releases of reared fish and only minor irregular wild reproduction occurs in the River Jägala. In the rivers Purtse, Selja, Loobu, Valgejõgi and Pirita modest but regular wild reproduction occurs, however enhancement releases are carried out regularly in all of these rivers. Wild reproduction without releases occurs only in the Kunda, Keila, Vääna, Vasalemma and in Pärnu. The situation is most favourable in the River Keila and the least favourable in the River Pärnu which is presently at risk of extinction. Except for the River Pärnu, the situation has somewhat improved in recent years. However all populations are still considered to be in a poor state.

7.3.3 State of the sea trout populations in Estonia

Estonia has about 75 sea trout rivers. Most of them (40) are located in the Gulf of Finland area, 19 in the Gulf of Riga area and 16 in the Baltic Main Basin area. In general, the status of these stocks is the same in all areas. One third of the populations presently have smolt production above 50% of the potential and the remaining remain below 50%. As for the salmon, the main problem is the loss of habitat by damming. Some streams are also dredged and thus have reduced habitat quality. Sea trout is also prone to overfishing in the coastal areas where an intensive gillnet fishery takes place.

7.3.4 Fishing regulations in Estonian rivers

The legal harvestable size for salmon in the sea and rivers is 60 cm and for sea trout 50 cm.

The following fishing rules apply in the Estonian rivers:

- Gillnets and trapnets are forbidden in all salmon and sea trout rivers;
- In the salmon rivers, rod fishing for salmon and sea trout is forbidden from 1 October – 30 November (except with special licence in the rivers Narva, Purtse, Selja, Valgejõgi, Jägala, Pirita and Vääna);
- In the sea trout rivers, rod fishing for sea trout is forbidden from 1 September – 31 October;
- Wading is forbidden in rivers with salmonid spawning during the closed season;
- Fishing in 26 rivers and brooks is forbidden throughout the year;
- Fishing in 11 rivers is forbidden downstream from the first definite migration obstacle;
- Fishing in fish ladders and within 50 m upstream of them is forbidden;
- Fishing downstream of dams is forbidden for a distance of 100 – 500 m.

7.4 Finland

7.4.1 State of the salmonid habitats in Finland

Almost all large Finnish rivers flowing to the Baltic Sea have been dammed for hydropower production. The remaining nursery habitats in the former salmon rivers are often partially or totally isolated from the sea by dams and by river impoundments.

In the watersheds that have not been harnessed for hydropower production habitats are in a moderate condition. The sediment load in the catchment areas has decreased the quality of the reproduction habitats in many rivers because of heavy forestry operations (above all the transformation of 6 million hectares of wetlands into productive forest). Large scale ditching of the catchment areas has also had negative impacts on the hydrology and water quality in the salmon rivers. Few rivers in Finland have been totally channelized but most of the Finnish rivers were dredged for timber floating 50–100 years ago. Today, most of these dredged rivers have been restored, but their recovery towards a natural habitat structure will take decades.

The state of the Finnish salmon and sea trout rivers in the Northern Bothnian Bay area is mainly satisfactory. However, the catchment areas are affected by large scale ditching due to forestry and peat mining and agriculture. The human impacts, together with the fact that the water has always been rich in humus, mean that the survival or recovery of salmon and sea trout stocks in these rivers requires both control of the fishing and restoration of the river habitats.

Habitats have been restored in many rivers after the dredging of rapids for timber floating, but the protection of the catchment areas must be raised to a high status in the future. Silting of the spawning grounds, eutrophication and the excessive water level fluctuation may be detrimental for natural reproduction of salmonids in these rivers. This should be taken into account in the future when nationwide Water Management Plans are being designed.

In the Southern Bothnian Bay and the Quark area, the sulphate soil in the catchment area is the main problem since sulphate increases water acidity.

Compared to the northern rivers the human impact in this area is even higher, which together with the acidity problem impedes natural spawning of salmonids almost completely in most of these rivers. In the Water Resources Management Program, the sulphate soil problem will be considered seriously, although the problem cannot be removed but only mitigated by good planning of ditching and ground utilization. The recovery of salmon and sea trout populations in this area is thus not certain. In the rivers where sea trout still exist, only very strict control of fishing together with habitat and water quality protection will prevent their extinction.

Most rivers flowing to the Gulf of Finland and to the Archipelago Sea have very few lakes in the catchment area. Therefore, the water flow in these rivers varies greatly. The majority of the Finnish population lives in the South and Southwest of the country. Hence pollution from municipal waste waters is in many places reducing the water quality of the rivers. The rivers also flow through areas with intense farming and agriculture, and large quantities of nutrients enter the water. Because of the additional nutrients that end up in the river systems, the primary production level in the rivers is very high. The soil consists of clay and silt which also causes the water to be turbid, especially during periods of heavy rains when increased sediment loading often occurs. The water in the upper parts of the catchment areas is clearer because the rivers typically emerge from the esker area, and the pH regime is generally stable. The growing season in Southern Finland is longer than it is in the North.

7.4.2 State of the salmon populations in Finland

The status of the remaining Finnish wild salmon stocks in the Baltic Sea has improved since the mid-1990s, and this is reflected by increases in the number of ascending spawners, parr densities and number of smolts in the rivers. ICES (2010a) concludes that the river Simojoki is likely and the river Tornionjoki is very likely to have reached 50% of the potential smolt production capacity in 2010. However, it is uncertain whether either of these wild rivers has reached the higher target of 75% of the potential smolt production capacity applied by ICES.

The fishery and its regulation, the level of the M74 syndrome and the development in post-smolt survival rate are the main factors affecting the dynamics of the wild Baltic salmon stocks. The positive development of the wild stocks during the last 15 years is mainly due to reduced exploitation levels in the sea and coastal fisheries (Romakkaniemi et al 2003, Jokikokko and Jutila 2005). In addition to the regulation of fisheries, reduction in the price of salmon, dioxin regulations and an increasing seal population are regarded as factors which have reduced the exploitation rate (ICES 2010a). At the same time, the post-smolt survival has decreased successively, and this has suppressed the recovery rate of salmon stocks.

Efforts for the re-establishment of natural reproduction of salmon in the Finnish rivers which have lost their original salmon stocks have not resulted in similar positive trends for reproduction as seen in the wild salmon rivers. Most of the potential rivers reveal only low and irregular wild reproduction despite large-scale stocking programmes. Only in the river Kymijoki has the natural reproduction of salmon been increasing, although this particular river has so far not been officially listed as a target of re-establishment efforts. The poor success of stock rebuilding is probably due to a combination of high exploitation in mixed-stock fisheries, insufficient quality of water and physical habitat in rivers and their temporally low flow, which may hinder the spawning migration of adult salmon (ICES 2010a).

7.4.3 State of the sea trout populations in Finland

There are five Finnish river systems in the Gulf of Bothnia area with wild sea trout populations. The status of all these populations is precarious.The stocks are threatened by over-fishing. Sea trout are mainly caught as by-catch in the sea by net fishing targeting other species, such as whitefish and perch. Sea trout populations are also affected by human activities influencing freshwater habitats, mostly through damming, dredging, pollution and siltation of rivers (ICES 2010a). In some rivers which have lost their original sea trout populations, there have been efforts to re-establish wild reproduction of sea trout. The success of stock rebuilding has been at least as poor as the success of stock rebuilding in potential salmon rivers.

The situation for the sea trout populations in the Gulf of Finland resembles that in the Gulf of Bothnia. The main factors influencing the status of stocks are overexploitation, habitat degradation, migration barriers and variation in water flow. As in the Gulf of Bothnia, sea fishing (especially the gillnet fishery) targeting other species such as whitefish and pikeperch, can catch up to 80% of the fish in the sea before they have reached maturity. Tagging experiments reveal that the average age of recaptured trout has decreased considerably during the last ten years. The post-smolt survival has also decreased dramatically (ICES 2010a).

7.4.4 Fishing regulations in the Finnish rivers

The government sets the general fishing rules in the sea and in fresh water. Local fishing right owners or associations of fishing right owners may strengthen the rules in their own waters, for example by setting a minimum mesh size in the gillnet fishery. Moreover, the government has set some additional rules for salmon fishing in the sea and in the wild salmon rivers Tornionjoki and Simojoki. Hence, fishing rules vary between rivers.

At sea, the minimum size of salmon and sea trout generally follow the international Baltic fishing rules (Council Regulation (EC) No 2187/2005). However, the minimum size of sea trout is nationally set at 50 cm.

For about two decades, there has been an early season ban on coastal salmon fishing in the Gulf of Bothnia. The length of the ban has varied. Terminal fishing areas with relaxed fishing rules have been established outside rivers that have dams with large-scale compensatory stocking (rivers Kemijoki, Iijoki and Oulujoki). In the terminal fishing area of Kemi, salmon fishing may start on 11 June, but there is no closed period set for fishing on the other terminal areas. There are closed areas for fishing in the estuaries of the rivers Simojoki and Tornionjoki, and the early season ban is extended to zones next to the closed areas. In the area outside the estuary of the River Simojoki, salmon fishing may start on 16 July and outside the river Tornionjoki a limited fishing by commercial fishers may start on 27 June.

Fishing for sea trout and salmon is always prohibited in fresh water during the spawning period, but the dates may vary depending on the river. Generally the closed season is 11 September – 15 November. A bag limit is seldom used in the national regulation of the fishery, but only one salmon per fisherman per day is allowed for rod and line fishing in the wild salmon rivers. Net fishing for salmon and sea trout is generally forbidden in the rivers with wild populations. However, fishing is allowed with special kinds of traditional nets (drifting nets, special seines) but strictly restricted in the river Tornionjoki.

7.5 Latvia

7.5.1 State of the salmonid habitats in Latvia

The total area of salmon spawning and nursery habitat in the rivers of Latvia is estimated to be roughly 60–100 ha (main rivers without tributaries).

An estimated 60% of the country territory is inaccessible to migratory fish species due to artificial obstacles e.g. the main salmon river Daugava was blocked by a cascade of hydropower dams, when the last stations were built in 1974. Thereafter, the river lost all salmon habitat.

The water quality is estimated according to the standards of the EC Directive 78/659/EEC (FD). None of the Latvian salmon rivers meet the criteria of the FD water quality requirements. Nevertheless, monitoring data demonstrates than the main environmental requirements of Baltic Salmon, such as oxygen content, acidity and temperature are adequate. Together the loss of habitat and the development of the hydropower industry are the main reasons for the decline of the wild salmon populations in the Latvian rivers.

7.5.2 State of the salmon populations in Latvia

There are 10 rivers in Latvia where spawning of salmon occurs regularly. The rivers Gauja, Irbe, Peterupe, Saka, Salaca, Venta, Vitrupe and Uzava are classified as having at least some wild production. The river Daugava has a reared salmon stock. Stocking of hatchery reared parr and smolt is carried out annually, and hence the stocks are a mixture of wild and reared fish.

The wild stock of the river Salaca has been monitored by smolt trapping since 1964 and by electrofishing for parr since 1992, and the status of the stock is stable. The status of the other populations is not known due to the lack of regular monitoring, habitat inventory and mapping. Parr electrofishing results demonstrate that salmon reproduction occurs regularly in the rivers Vitrupe, Gauja, Venta, Užava and Saka.

7.5.3 State of the sea trout populations in Latvia

In Latvia, the exact number of sea trout populations is not known. Sea trout occur in the same river basins as salmon, and also exist in tens of small rivers and brooks.

Sea trout occur in 15 rivers and in tens of small rivers and brooks discharging into the Gulf of Riga and Baltic Main Basin. The rivers Salaca, Gauja and Venta have the highest wild smolt production. Sea trout populations have been supported by releases of reared fry, parr and smolt mostly into the upper sections of dammed rivers. Wild sea trout parr were monitored by electrofishing surveys in the rivers Salaca, Gauja, Venta, Saka, Vitrupe, and Riva basins and by smolt trapping in the river Salaca. Estimated production in all Latvian rivers was about 61,000 smolts in 2009; the same as in 2007 and 2008. In the river Salaca, the number of sea trout smolts has decreased during the last decade.

7.5.4 Fishing regulations in Latvian rivers

The commercial fishing and angling at sea, and in coastal and inland waters are regulated by the Latvian government. Salmon and sea trout fishing in Latvian rivers is not permitted except in the rivers Daugava and Bullupe that have reared stocks. The brood stock fishery carried out in the rivers Venta and Gauja is limited by the number of gear units, and there is a daily catch limit. Fishing for special purposes (e.g. brood stock and research) is allowed with the permission of the Ministry of Agriculture and Environment.

Angling of sea trout and salmon is allowed in the rivers Salaca and Venta by a special license (fee) in springtime, i.e. angling of kelts is allowed. The number of licenses is limited. In coastal waters and in the rivers Daugava and Bullupe, salmon and sea trout angling is allowed throughout the year. The legal size which applies for all fisheries and waters is 60 cm for salmon and 50 cm for sea trout. All large and mid-sized rivers have closed areas at their outlets where fishing and angling are not allowed. The bag limit for anglers is one salmon or sea trout per day. The closed season for salmon and sea trout in coastal waters of Latvia is 1 October – 15 November.

7.6 Lithuania

7.6.1 State of the salmonid habitats in Lithuania

Lithuanian rivers are lowland rivers with turbid, warm and slow-flowing waters. Only some river stretches are suitable for salmonids. The water temperature in the Lithuanian rivers was well above the yearly average during the past few years and the water levels were below the yearly average.

Pollution remains one of the main concerns in the salmon rivers, but the water quality is improving since the implementation of the Water Framework Directive. Severe problems still exist e.g. due to the lack of sewage water treatment in cities and nutrient load from agriculture which affect water quality in many places.

Another problem is the rather high mortality rate of salmon and sea trout due to predation. Typical predators are otter, mink, pike, pikeperch, cormorant and heron. Also beaver dams cause indirect mortality.

7.6.2 State of the salmon populations in Lithuania

In total, 12 rivers in Lithuania have salmon populations, but the status of the populations varies. The river Žeimena (with its tributaries Mera and Saria) has an original salmon population. Mixed populations are found in the rivers Neris, Šventoji, Vilnia, B. Šventoji, Dubysa, Siesartis, Širvinta and Vokė. The rivers Virinta, Jūra and Minija (and some of their smaller tributaries) have reared salmon populations. In these rivers artificially reared salmon juveniles have been released for several years.

The salmon restocking program in Lithuania started in 1998 and several measures are implemented every year to enhance the salmon populations. These measures include, for example, artificial rearing, construction of fish ladders, protection of spawning grounds, stock monitoring, and others. Despite these actions, the smolt production in the Nemunas basin has increased very slowly. Large increases in production were observed only during recent years; the smolt production increased from 13,900 to 35,937 during 2007–2009. Despite the delayed improvement of the status of the stocks, the measures of the restocking program helped to stabilize the salmon population and prevented it from becoming extinct.

The largest increases in smolt production were observed in the rivers Neris, Žeimena, Šventoji and Siesartis which together account for for 96% of the total smolt production of the Lithuanian rivers. The smolt production in the other salmon rivers is significantly lower and ranges from 0–1,352 individuals.

7.6.3 State of the sea trout populations in Lithuania

The status of sea trout in Lithuania is better than that of salmon. Wild and mixed stocks of sea trout are found in many of the tributaries of the Nemunas Basin, and in the rivers Bartuva, Šventoji (Baltic Sea), Šventoji, Dubysa, Akmena-Dangė, Smiltelė, Venta, Minija and Žeimena. The stocks of the five latter rivers are original and self-sustaining wild populations. Sea trout have been introduced to the rivers Šventoji and Dubysa as enhancement releases from the Jūra strain, and the stocks are, therefore, mixed.

In surveys conducted at 104 sites, the mean density of juveniles varied from 3.7–58.3/100 m^2 (with a mean of 19.7 individuals/100 m^2). Sea trout smolt production was 32,000 in both 2009 and 2010. The Minija river basin has a particularly strong sea trout stock, with an average parr density of 15.6 individuals/100m^2 and a smolt production of 12,500 individuals.

In recent years, the sea trout smolt production varied substantially in other rivers basins, but remained relatively low. The average production of sea trout smolts in the Neris, Šventoji, Dubysa river basins was 5,100 – 4,600 per year. In the Žeimena basin the production was about 2,000. In the river basins of Bartuva, Akmena-Dangė, Šyša, B. Šventoji, Jūra and Venta the sea trout smolt production was significantly lower and varied from 200–1,000 per year.

Smolt production mainly depends on the ecological conditions of the river and on spawner abundance. Monitoring of salmonids in small streams and rivers is carried out each year and the smolt production of all streams and small rivers is estimated to be larger than 10,000–15,000, giving a total smolt production of 42,000–47,000.

7.6.4 Fishing regulation in Lithuanian rivers

During spawning of salmonids (from 1 October – 31 December) all fishing is prohibited in 161 streams. In larger rivers such as the Neris and Šventoji special zones are designated where shoaling of salmon and sea trout occurs. In these selected places only licensed fishing is permitted from 16 September – 15 October and from 16 October – 31 December respectively, all fishing is prohibited. From 1 January, licensed salmon and sea trout fishing for kelts is permitted in Minija, Veiviržas, Skirvytė, Jūra, Atmata, Nemunas, Neris, Dubysa, Siesartis and Šventoji rivers. Licensed fishing is permitted from 1 January – 1 October in designated stretches of the listed rivers. A bag limit of one salmon or sea trout per angler and licence is applied. In 2009, a total of 1,199 licenses were sold for salmon and sea trout, but the number of fish caught is unknown. The minimum size of salmon and sea-trout for the commercial fishery is 60 cm.

7.7 Poland

7.7.1 State of the salmonid habitats in Poland

There are two large regions inhabited by salmonid fishes in Poland: one mountainous upland region in southern Poland (in the upper sections of the biggest river systems of Vistula and Odra), and another in the moraine hills in northern Poland that are drained by tributaries of the lower Vistula and Odra and by rivers flowing directly into the sea.

The rivers in the southern region are affected by many barriers to salmonid migration. In the Odra system, the barriers are mainly located in the tributaries of the upper part, and some of the barriers are more than one hundred years old. In the Vistula there are also some dams in the upper tributaries. The main hindrance is, however, the hydropower station and dam of Włocławek that was built in 1969 in the middle section of the river. Almost none of these barriers are equipped with effective fishways. A new fishway at the Włocławek dam is currently in the design phase, as are some others.

The rivers in the northern region have several hydropower stations that were generally built in the beginning of the 20th century, often to replace older structures. Some of them have fishways, but only a few are effective. The accessibility of all of the rivers in the region is, at least, partly limited.

Many rivers, especially the smaller rivers in the southern region, are regulated or channelized and have an altered substratum. The river bed has been destroyed by removal of gravel in mountain areas, and the dynamics of the river flow are unnatural because of impoundments and changes of character of the drainage area. The quality of water used to be very poor in the past, especially in the bigger rivers and in southern Poland, but it has very much improved in recent years.

7.7.2 State of the salmon populations in Poland

The main spawning grounds of salmon in the Vistula river system used to be in the Carpathian tributaries. The salmon stocks gradually diminished during the 20th Century and the last spawning salmon were observed in the Vistula in the 1950s.

Odra salmon became extinct in the upper part of the river system a few hundred years ago but survived in some tributaries of the lower Odra until the end of the 1980s when the last spawners were observed in river Drawa. Historically there were also salmon populations in some of the Pomeranian rivers flowing directly to the sea, but they were smaller than the sympatric sea trout population. These populations became extinct probably between 1950–1970.

A salmon restoration program started in the mid-1990s and the stocking was based on the Daugava salmon strain. The upper part of the Vistula system has been stocked with fry and parr, and the lower Vistula and some of its tributaries mainly with smolts. In the Odra system, stocking has been conducted mainly in the river Drawa. Some Pomeranian rivers have also been stocked. The released fish are offspring of the hatchery broodstock and spawners caught in some rivers. The stocking resulted in catches of returning salmon by anglers in some Pomeranian rivers (Reda, Słupia, Wieprza, Parsęta and Rega) and for breeding purposes in the lower Vistula, Wieprza, Parsęta and Rega. Salmon redds were observed in a few rivers but wild offspring were caught only in the Słupia.

7.7.3 State of the sea trout populations in Poland

The Włocławek dam cut off the main sea trout spawning grounds in the Vistula River system in the Carpathian tributaries. Among a few tributaries of the lower section of the Vistula, only Drwęca has accessible but has very limited spawning areas. In fact, the existence of sea trout in the Vistula and some tributaries is a result of a large-scale stocking effort of about 0.8 – 1 million smolts and more than 2 million parr and fry that were released mainly into the lower Vistula. There is commercial net fishing in the lower Vistula and angling in some of the tributaries. The opening of the Włocławek dam would improve the situation dramatically.

A few small mixed populations exist in the tributaries of the lower Odra. Most sea trout populations are found in the rivers flowing directly to the sea. It is estimated that there are a total of 15 populations. Their sizes range from a few tens of spawners in the smallest streams to more than 10,000

spawners in the largest streams (Słupia, Wieprza, Parsęta and Rega). In all of them, the accessibility of historical/potential spawning grounds is very limited and the populations are supported by intense stocking of 0.4 million smolts and 5 – 6 million parr and fry. The six largest rivers are stocked with offspring of spawners caught in these rivers and the others by spawners caught in the neighbouring rivers. Some of the populations are believed to be self-sustaining. There is intensive angling in the majority of the Pomeranian rivers focused mainly on kelts.

7.7.4 Fishing regulations in Polish rivers

The common regulation for salmon and sea trout in the Polish rivers are:

- A closed season from 1 October – 31 December for all rivers except Vistula (in Vistula the closure applies from 1 October – 31 December from Thursday to Sunday and from 1 December – 28/29 February from Friday to Sunday above the Włocławek dam, and from 1 March – 31 December below the Włocławek dam);
- The minimum legal size for sea trout and salmon is 35 cm;
- Only fishing with rod and artificial lure is allowed;
- A maximum daily catch of two fish (sea trout and salmon) is allowed.

7.8 Russia

7.8.1 State of the salmonid habitats in Russia

Russia has only four salmon rivers in the HELCOM area; the rivers Narva, Neva, Luga and Gladyshevka. The river Narva is completely blocked by dams, and due to the lack of fishways in the main channel, salmonids cannot reach the former spawning areas. The river used to have a significant salmon population before hydropower development but currently the natural spawning grounds of salmon have been totally destroyed. Upstream of the dam there are no salmon spawning grounds. In the potential salmon river of Gladyshevka, channelization for timber floating affects salmon production.

In the main part of the salmon and sea trout rivers the overall water quality is sufficiently good. However, deforestation and clearing of bushes near the river increase the sediment and nutrient load into the water. Nutrients may reach the river systems from pig and poultry farms situated along the rivers. In almost all rivers there are currently no industrial sites along the rivers that would pose a risk to the water quality.

In all of the salmon rivers the spawning and nursery areas for wild salmon should be restored. In more than 50 sea trout streams it has been estimated that no more than 15% of the river length is affected by dams or channelization and clearing of stones. Restoration work has not been carried out yet.

Summing up, channelization, clearing of rivers, the lack of proper buffer zones and deforestation are the major problems to salmonid habitat in the Russian rivers.

7.8.2 State of the salmon populations in Russia

The river Luga is the only river located in the Russian part of the Baltic Sea which has a wild salmon population. At present the annual smolt run is about 2,500 – 8,000 wild smolts (on average 5,000 individuals per year). Luga salmon reproduce only along the main river and in the lowest part of the river Vruda, one of the Luga tributaries. The river Luga salmon forms an important part of the salmon production of the entire Gulf of Finland. However, the reproduction of wild salmon has been decreasing since the 1950s, mainly due to illegal fishing.

At the present time there is no natural reproduction of salmon in the rivers Narva and Neva. The salmon stocks of these rivers are supplemented only by stocking of hatchery-reared parr and smolts.

The River Gladyshevka has been selected as a potential river for the Russian Salmon Action Plan. Its salmon stock consists of the reared Neva strain. During the last 10 years (2000–2009) about 100,000 parr and smolts were released in the river. Since 2004 natural reproduction has taken place in the river each year. Monitoring of parr densities have shown that the status of the stock has, however, been very poor.

7.8.3 State of the sea trout populations in Russia

In Russia, sea trout is more widespread than salmon. Currently sea trout is found in more than 50 rivers (including the local populations in the main tributaries). Nine sea trout rivers flow into the Gulf of Gdansk (Kaliningrad region) and 44 into the Gulf of Finland (St. Petersburg area). All of these rivers have an original wild sea trout stock but only about 20% of them are in a favourable state. In the rivers flowing to the Gulf of Finland, the status of the sea trout stocks is better than in the rivers of the Kaliningrad region.

The largest sea trout stock (consisting of some local populations) is found in the River Luga. At present the annual smolt run is about 5,000 individuals per year. Sea trout is a protected species in Russia and it is included in the Red List of the Russian part of the Baltic Sea (the Red List covers the rivers and the open sea).

7.8.4 Fishing regulations in Russian rivers

Fishing of salmon in all the rivers is prohibited during the whole year and is only allowed for brood stock collection. The minimum size of salmon is 60 cm.

7.9 Sweden

7.9.1 State of the salmonid habitats in Sweden

Sweden has 43 former or present salmon rivers in the HELCOM area. Of these eleven lack fishways in the main channel and dams block access to former spawning areas. Some of these rivers are large and had significant salmon production before the development of hydropower production. Overall, artificial migration obstacles are common. For example, in the River Emån there are as many as 240 obstacles and 150 of them are not passable. Thirty-eight of these obstacles are significant migration hindrances for salmon and sea trout. It was recently estimated by the Environmental Protection Agency that there is the need for 6,000 new fishways in Sweden. Furthermore, downstream migration at most power plants and dams needs to be enhanced.

Due to Swedish legislation, hydropower development has increased substantially in recent years. A few salmon rivers still lack hydropower plants, e.g. the rivers Kalixälven, Råneälven, Kågeälven, Lögdeälven, Törlan, Himleån and Löftaån. The remaining 84% have hydropower plants, often several, and beside the problems with fish passage and lost habitat, there are problems with the flow regulation that affects salmon production and is reported from 65% of the salmon rivers.

In 98% of the Swedish salmon rivers channelization for timber floating, hydropower development or drainage of agricultural areas affect salmon production. Restoration of the river habitat has been carried out in parts of 84% of these rivers, but further restoration is required in all. For sea trout streams, it has been estimated that 64% of them are affected by channelization and clearing of stones (Degerman et al. 2005). Although much restoration work has been carried out, only a small portion of streams have been restored (op. cit.).

In agricultural areas, recurring clearing of streams is carried out, according to water court decisions, to improve drainage capacity, without a proper consideration of fauna or habitat diversity. Several catchments have also been subject to land draining and lake lowering for the benefit of agriculture and forestry. This has led to large fluctuations and lowering of the water table, which has a negative impact on salmon and sea trout populations, especially in the smaller catchments. In 42% of the salmon rivers this has been identified as a problem, and in sea trout streams the situation is probably even more pronounced, but exact data are missing. The occurrence of extreme low flow conditions that has arisen should in the short- term be prevented by regulation of the usage of water for irrigation purposes, and in the long- term by hydrological restoration of affected catchments.

Excessive load of nutrients and sediment was reported from roughly 50% of the salmon rivers. For sea trout streams, 38% are so eutrophied that it affects trout production (Degerman et al. 2005). The water quality could be improved at low cost by establishing buffer zones along the rivers. Increased buffer zones would also provide shade, leaf litter and large woody debris – all essential for a good ecological status. However, 36% of visited sites in sea trout streams investigated throughout the country had no or very small riparian buffer zones (op. cit.)

Point emissions of sewage and waste from industry is not a general problem, and was reported from only 14% of sea trout streams (op. cit.). Upper parts and tributaries of two of the salmon rivers are thought to have some local problems with mine effluents.

Acidification from air-borne pollutants is still a significant problem in Sweden. 79% of the salmon rivers had liming operations to improve water quality for sea trout and salmon. Earlier studies have shown that half of the salmon smolt production on the Swedish west coast would be lost without liming (Appelberg et al. 1989). Although the acid load has declined, liming will be required for several decades, especially in south-western Sweden.

In summary, the lost connectivity with large areas of habitat being inaccessible, channelization and clearing of rivers, flow regulation, drainage of the landscape for agriculture and forestry, the lack of proper buffer zones and acidification are the major problems affecting the salmonid habitat in Sweden.

7.9.2 State of salmon populations in Sweden

The status of the remaining Swedish wild salmon stocks in the Baltic Sea has generally improved since the mid-1990s and this is reflected by increases in the number of ascending spawners and parr densities in many rivers, particularly in the large or medium-sized rivers in the Gulf of Bothnia. ICES (2010a) concludes that among the 14 Swedish rivers included in the assessment of Baltic salmon stocks, from the river Tornionjoki in the north to the river Mörrumsån in the south, eight are likely or very likely to reach 50% of the potential smolt production capacity by 2010, whereas it is uncertain or unlikely if the remaining six stocks will reach this target. However, in 2010, none of the 14 rivers are likely to reach the higher target of 75% of the potential smolt production capacity now applied by ICES, which is based on the MSY concept.

The fishery and its regulation, the level of the M74 syndrome and the development in post-smolt survival rate are the main factors affecting the dynamics of the wild Baltic salmon stocks. The positive development of many wild stocks during the last 15 years is mainly due to reduced exploitation levels in the sea and coastal fisheries, in combination with relatively low M74 levels. National regulations, such as time period closures, and reduced fishing opportunities due, for example to the dioxin regulations and an increasing seal population, are regarded as the main reasons for the reduction in exploitation rate. At the same time, the post-smolt survival has decreased successively during the same time period, and this has suppressed the recovery rate of salmon stocks. The fact that some rivers have not responded positively to the decrease in M74 and exploitation rate at sea indicate problems in the freshwater environment, for example impediments to migration (see above).

On the Swedish west coast, Atlantic salmon stocks have been declining since the beginning of the 1990s, and electrofishing data from a number of

Swedish streams show that parr densities have dropped dramatically during this time period. This decline in stock status has been observed around the North Atlantic area, despite the fact that exploitation in the sea fishery has declined markedly. It appears that growth mediated mortality may be responsible, possibly because of a warmer climate affecting food abundance for post-smolts (Friedland et al. 2009).

7.9.3 State of the sea trout populations in Sweden

Sweden has a long coast with hundreds of sea trout streams. In general, the stocks are in a good state in the Main Basin and in the Kattegat. Investigations of parr densities (recruitment) have shown that the stocks have been stable during the last decade. Locally some streams may show low recruitment, often due to problems with the habitat or stream connectivity.

In Bothnian Bay, stocks are threatened by overfishing (ICES 2010a), and trout is mainly caught as by-catch in net fishing aimed at whitefish or perch. In the Bothnian Sea the status of the stocks is better than in the Bothnian Bay, but not as good as in southern Sweden. A reason may be that also in this area trout is by-catch in the coastal net fishing for other species (ICES 2010a).

7.9.4 Fishing regulations in Swedish rivers

The government sets the fishing rules in the sea and in fresh waters up to the first definitive migration barrier for salmonids. Local fishing right owners or associations of fishing right owners may strengthen the rules in their own waters, e.g. by establishing bag limits. Hence, fishing rules vary between rivers, although a basic set of national rules always applies.

The minimum size of salmon is 60cm in the Baltic and 45 cm in the Kattegat area. Recently the minimum size of sea trout was raised from 40 to 50 cm in Bothnian Bay (ICES subdivision 31). Presently the minimum size is, therefore, 50 cm in the whole Swedish part of the Baltic Sea, except in the Bothnian Sea (ICES subdivision 30) where it remains 40 cm. In the Kattegat, the minimum size is 45cm for trout. In fresh water the minimum size

of salmon in Baltic streams and rivers is generally 50 cm. For sea trout it is 35 cm (Bothnian Bay and Sea), 45 cm (Kattegat rivers) or 50 cm (rivers and streams of the Baltic Main Basin). The low size of 35 cm in some areas is being reviewed by the Swedish Board of Fisheries.

In the Main Basin (subdivisions 23–29), closed areas are frequent in the estuaries during the spawning migration. In the Bothnian Sea (30) and Bothnian Bay (31), normally only larger salmon rivers have closed areas. Instead all rivers and streams have an area of 200m radius from the mouth were fishing is prohibited during 1 September – 31 December.

Fishing for trout and salmon is always prohibited during spawning in fresh water, but the dates differ. There is a general ban on net fishing in fresh water (rivers) where salmon and sea trout are present. However, in the larger salmon rivers of the Bothnian Bay there are areas, lake-like sections, where fishing for other species (perch, whitefish) is allowed.

A bag limit is seldom used in the national regulation of the fishery, but only one salmon per fisherman per day is allowed for rod and line fishing in northern salmon rivers. It has been suggested that this limit also be applied to trout fishing in fresh waters in the Bothnian Bay area because of the weakness of the stocks.

8 Synthesis on the state of salmon and sea trout populations and river habitats in the Baltic Sea

8.1 Salmon populations

The overall state of the Baltic salmon populations has developed positively since 1995 (ICES 2010a and 2010b). This encouraging development is seen in the natural reproduction of salmon populations. In 2009, the 27 stocks in the Main Basin and Gulf of Bothnia and the 13 stocks in the Gulf of Finland that are assessed by ICES together produced slightly more than 2.5 million smolts (ICES 2010a and 2010b). This is about 65% of the total PSPC of these rivers, which is assessed at roughly 3.8 million smolts. In 1996 the total smolt production of these rivers was about 0.4 million smolts. The production has, therefore, increased more than six fold in 13 years. In the Kattegat the development has been less encouraging. The smolt production (mean of 2005–2009) has been estimated to be about 50% of the PSPC of the Kattegat rivers (figures by Erik Degerman, Swedish Board of Fisheries).

Such developments can be seen as a success story in the management of commercially exploited fish stocks. This particularly holds for the larger salmon populations in rivers flowing to the northern Bothnian Bay in ICES assessment unit 1. The overall picture, however, disguises the situation for individual salmon stocks, where a more varied situation prevails. Of the total Baltic production of roughly 2.5 million wild smolts about 90% stem from the Bothnian Bay and about 75% from the two biggest rivers, Tornionjoki and Kalixälven. Tornionjoki alone produces almost half of the total production in the Baltic Sea. Tornionjoki is an example of salmon production increasing dramatically when a sufficient number of spawners inhabit the available spawning areas.

Furthermore, in assessment unit 2, in the western part of Bothnian Bay, the overall situation has improved. In 2009, the production was estimated to be about 270,000 smolts, which represents 62% of the total PSPC in this area (429,000 smolts). In the Bothnian Sea, only one river, the Ljungan is included in the assessment. Ljungan produced about 1,300 smolts in 2009, which is at the same level as its estimated production capacity of 1,000 smolts.

The situation in ICES assessment units 4–5 of the Main Basin is less encouraging, although the total smolt production level increased around the turn of the century. The level of smolt production initially stabilised but has decreased in recent years. In 2009, the production was estimated at about 100,000 smolts, which represents less than 30% of the total PSPC in this area of approximately 380,000 smolts.

Since the turn of the century the smolt production in the assessment unit 6 (the Gulf of Finland) has increased, although the production has varied remarkably. In 2009, the production was estimated at 30,000 smolts, which represents 12% of the total PSPC of 250,000 smolts. In the Gulf of Finland, the River Kymijoki dominates the overall picture, as it produces the majority of the smolts, albeit of the introduced Neva strain. The Russian Luga River and many Estonian rivers have low levels of production, although a few Estonian rivers have increasing trends in recent years.

One of the major factors that has promoted the recovery of salmon populations is the application of fisheries management measures. Fishing for salmon has decreased as a consequence of fishing regulations. Fishing with driftnets, the main fishing gear, was phased out within the EU during the years 2005–2007 and prohibited from 2008. Long-lining for salmon is now the only offshore fishing technique and to date catches have been lower than with drift nets, although long-lining has increased during 2008 and 2009.

Also the application of closed seasons during the spawning run has been a significant measure supporting the recovery. A summer closure applies for the EU Member States beyond 4 nautical miles from the baselines. Additional closed seasons are applied both along the Finnish and Swedish coasts up to the shoreline in the Gulf of Bothnia. Many countries also apply fishing prohibitions or restrictions outside river mouths and nearby coastal areas. The objective of these measures is to allow for the salmon spawning migration before the fisheries are opened. Together with a decreasing number of professional fishermen, these measures have played an important role in the recovery of salmon populations in the Gulf of Bothnia (Romakkaniemi et al. 2003).

These developments have been partly offset by a decreasing post-smolt survival rate. The declining survival rate has adversely affected both salmon catches and the number of adult salmon ascending rivers to form the spawning population. Also the increased size of the seal population has had an impact as salmon are an important prey item for seals. For these reasons, the increase in the smolt production has not resulted in a comparable increase in salmon catches and the size of the spawning run.

In 2010, the number of ascending salmon in the rivers of the Gulf of Bothnia decreased to roughly half the number detected in 2009. In 2008, a peak was observed in the numbers of ascending salmon. There is a large variation between years which has also been observed as catch fluctuations in e.g. North Atlantic rivers such as the large Tana river. The reasons for the fluctuations are difficult to identify, but they can be related to natural variations, environmental conditions, post-smolt mortality, increased fishing effort or predation.

8.2 Sea trout populations

The state of the sea trout populations exhibits large variations between different regions of the Baltic Sea (ICES 2010a). The overall picture, based on electrofishing surveys of parr densities in the nursery areas, indicates that stock status is poorest in eastern (ICES subdivisions 26 and 28) and northern (ICES subdivisions 29–32) areas of the Baltic Sea, while it is better in south-western areas (ICES subdivisions 22–27).

In the Gulf of Bothnia, the sea trout populations are in an endangered state. This has been observed both as low parr densities, low smolt numbers, low catches, and as a decline in age of fish caught and the number of ascending fish. The sea trout populations in the Gulf of Finland are also in an adverse state. The reasons are due to both excessive fishing pressure, obstacles to migration and habitat degradation. Nevertheless, there are some rivers and streams with populations in a more satisfactory state.

In the Main Basin area, sea trout populations have, in general, a better status than in the northern areas of the Baltic but there is also variation with migration barriers and poor habitat being the main problems.

8.3 Salmon and sea trout passage in rivers, river habitats, hydrology and water quality

Free passage to spawning grounds is fundamental for migratory species such as salmon and sea trout. Juveniles and smolts also need access to nursery areas and as smolts their free passage to the sea is vital.

Most of the rivers emptying into the Baltic Sea have reduced salmonid accessibility. This is a result of the harnessing of rivers for energy production, which established barriers to migration. Hydropower dams and mill or irrigation dams are commonly found in all the Baltic countries. Most countries have made large efforts and investments in fishways, ladders and passes to allow fish to pass such dams. Some fishways function well, but in many cases they are only partly effective because of factors such as design, siting, water level and flow. Many important rivers are still inaccessible due to migratory hindrances and important reproduction areas are either totally or partly excluded from salmonid production. Dams and other barriers may also affect kelts and smolts during their downstream migration towards the sea. The hydropower turbines are known to cause high mortality rates for fish passing through.

High quality river habitats are also a precondition for salmonid reproduction. The quantity and flow of water, the meandering or sinuosity of rivers, the substrate, the water quality and the riverside vegetation all influence salmon and sea trout adults and juveniles. The conditions in river habitats vary largely between regions and countries. Rivers were used for log driving until the 1970s particularly in Sweden and Finland. River beds, commonly rapids and riffles, were dredged or excavated to remove stones and boulders to allow for smooth transport of logs. This had destructive effects since these areas form important spawning and nursery habitats. Major efforts to restore such areas have been undertaken, but many areas are still suffering damage resulting from the log driving period.

In many rivers the amount of water is a limiting factor. Rivers can have large natural variation in flow, with periods of low flow during summer or winter. Effects of hydropower use and the use of water for irrigation or for drinking often result in insufficient water in the rivers for salmonid migration, spawning and juvenile survival. Furthermore, the water quality in many rivers has declined due to nutrient and sediment loads from agriculture, forestry, peat mining and sewage sources. The presence of contaminants and the acidification of waters are also threats to many salmonid populations. Littering is also a negative anthropogenic factor in rivers running through cities and towns.

9 Defining criteria for prioritising populations/rivers and recommending actions

9.1 Criteria for prioritising populations/rivers

9.1.1 Original populations in their native rivers

The salmon and sea trout populations in the Baltic Sea exhibit highly varying status. Some populations are in a very healthy state and already produce smolts at a level at or close to Maximum Sustainable Yield (MSY), which is the highest average catch that in the long run can be taken from a fish stock without lowering its productive potential for future years. Other populations are on the verge of extinction. The International Community including the EU and its Member States have set MSY as the objective for fish stock management. At the World Summit for Sustainable Development in Johannesburg in 2002, it was agreed to maintain or restore stocks to MSY levels with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 2015. MSY requires sufficient spawning stock sizes and successful reproduction.

The objective of managing fish stocks at MSY level could be set in terms of the size of spawning runs, harvest rates or smolt production. The IBSFC SAP set its objective for stock rebuilding in terms of smolt production, and this has also by ICES been proposed for future salmon management (ICES 2008). The estimated production of smolt at MSY varies among rivers from about 60% to 80% of the potential smolt production. An objective of recovering or maintaining smolt production at or above 75% of the potential smolt production, approximately corresponds to MSY management (ICES 2008). The HELCOM BSAP has set as the target attainment of at least 80% of the PSPC and for weak populations of at least 50 % of the PSPC, and these have consequently been adopted as target levels for prioritising rivers in the recommendations below.

Populations with low reproduction levels should be prioritised for recovery measures. The level of reproduction can objectively be measured as smolt production in relation to the PSPC of the river. In accordance with the targets of the HELCOM BSAP a production of less than 50% of the PSPC can be used as a criterion for low reproduction. Where the level of reproduction reaches dangerously low levels there is a need for urgent and effective recovery measures. In order to identify this group

of rivers a dangerously low level has been defined as a reproduction level of 20% or less of the PSPC. In such situations the recommended fisheries management measures and measures for the restoration of habitats are more stringent than otherwise.

Aside from the reproduction level criteria the essential criteria of biodiversity can also be derived from principles formed by the International Community in the form of the Convention on Biological Diversity (CBD) from 1992. The principal objective of the Convention is to conserve biological diversity, both intra- and inter- specific diversity. On this basis an original salmonid population in its original river can and should objectively be prioritised over introduced populations or populations based on reared and stocked individuals.

Data on the reproductive state of original populations is available in the ICES reports (ICES 2010a) and data gathered in the HELCOM SALAR project by salmon experts of the states around the Baltic Sea.

The two objective criteria:

• Population productive level <50% of the PSPC
• Original population strain

can be combined in order to develop a priority list of populations and their rivers. A river with an original salmonid population with low reproduction would thereby be included in the top priority list. This priority list of populations and rivers should be the target of urgent implementation of the recommended recovery and restoration measures.

State of Baltic Salmon Populations, Grouped by MSY Traffic Lights

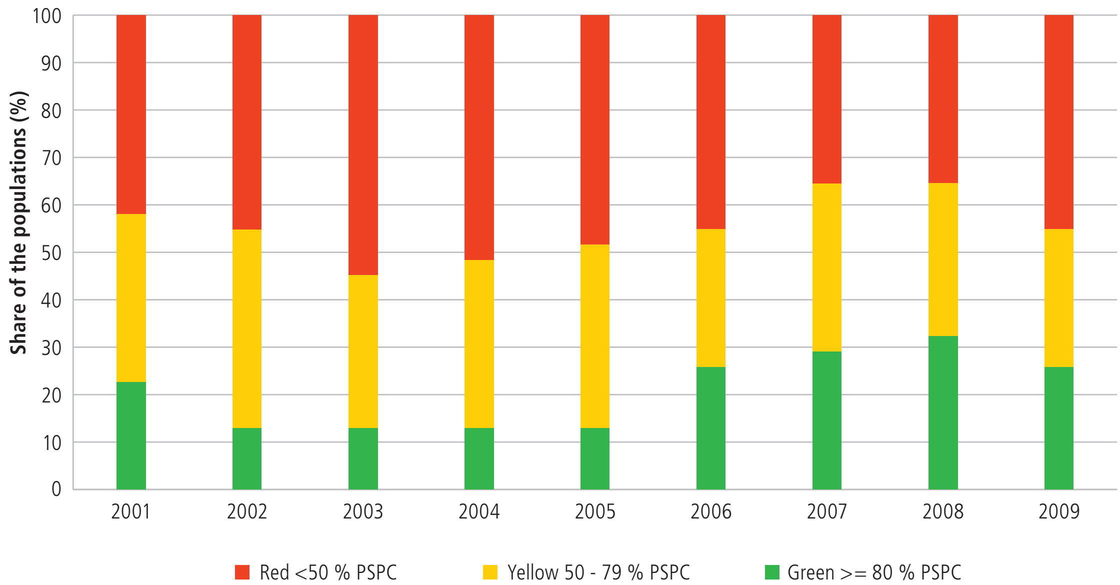

Figure 9.1. Overview of the state of 31 Baltic salmon populations based on the number of smolts produced (mode value) for each year of observation. The state is presented based on the MSY traffic lights. The rivers flowing into the Kattegat are not included while the large tributaries of Nemunas are included as one river system.

State of Baltic Salmon Populations Grouped by MSY Traffic Lights

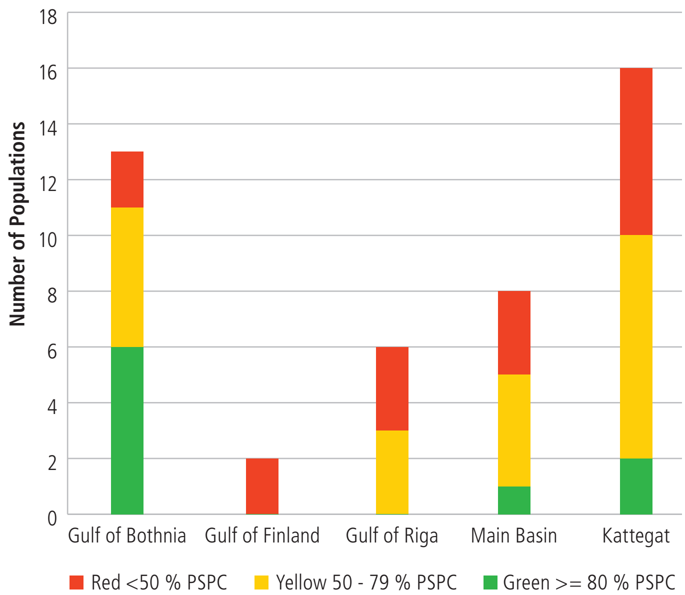

Figure 9.2. Overview of the state of 31 Baltic and 16 Kattegat salmon populations based on the smolt production as a mean of the mode values for the three latest observed years (2007-2009). The state is presented based on the MSY traffic lights separately for each sea basin.

The original salmonid populations that are reproducing at more secure levels can be grouped into two categories. These relate to the target of the HELCOM BSAP to reach a productive level of at least 80% of the PSPC. Hence populations would according to their state be grouped into three groups and given traffic lights (figures 9.1. and 9.2.) as follows:

- < 50% of PSPC — Red Light
- 50% – 79,9% of PSPC — Yellow Light
- At least 80% of PSPC — Green Light

In order to moderate the variations in production between years a mean of the mode value for smolt production for the three latest observed years is used. For some salmon populations and for the sea trout populations smolt production observations are not available. In such cases, the production in relation to PSPC should be based on the best available information and estimation by experts.

9.1.2 Potential populations and rivers

Original populations maintained as brood stocks and by stocking

Some original populations of salmon or sea trout are only maintained as brood stocks and/or by releases of hatchery reared smolts as their native rivers are blocked to migratory fish and the reproduction areas are partly or totally lost. Providing passage and restoring spawning and nursery areas in such rivers would provide for natural reproduction of these original population strains. The original strain of these populations makes them comparable to the populations reproducing naturally. The reintroduction of original salmon and sea trout populations into their natural habitats is consistent with the Convention on Biological Diversity.

It is therefore recommended that these populations are safeguarded and where an assessment justifies it re-established in their native river or a nearby potential river in the same assessment unit. The assessment should be conducted for the whole river system and may include elements such as the cost-efficiency of re-establishment, estimated natural smolt production, alternative solutions for accessibility (e.g. fishways or transport of spawners/smolts), effects on native fish populations, mortality during up- and downstream migration and migratory behavior. The assessment should include mapping of the quality and quantity of suitable spawning and nursery areas.

Salmon rivers with large potential for reproduction

The original salmon or sea trout populations of some rivers have been lost although the river itself may provide a suitable habitat for salmonid reproduction. Rivers that currently have natural smolt production of an introduced strain and that e.g. with the removal of man-made migration obstacles have the largest PSPC should be selected for a list of the three salmon rivers with the greatest potential for restoration. Passage for salmonids through these rivers should be provided where an assessment for the whole river system shows that opening of the remaining reproductive areas in these rivers is justified. The assessment should be conducted for the whole river system as described above.

Both the salmon populations for re-establishment and salmon rivers with large potential are defined in this report as potential salmon rivers. This relates to the commitment of the HELCOM Baltic Sea Action Plan to reintroduce native Baltic Sea salmon to at least four potential salmon rivers.

9.2 Criteria for and description of appropriate actions

The recommendations for actions for all the individual salmon and sea trout populations/rivers have been made for the following three main factors:

1. River water and habitat
2. Passage in rivers
3. River fisheries management

No priority is assigned to these factors and it is for the competent authorities to decide on which measures should be implemented based on legislative provisions and nationally defined priorities.

The basis for these actions is the supporting data (ICES 2010a and 2010b and HELCOM SALAR data) concerning river waters and habitats, migratory barriers and state of the salmon and sea trout populations as well as the opinions of salmon and sea trout experts from Member States that have participated in the HELCOM SALAR project.

River water and habitat

A good state of the riverine habitats is a precondition for successful salmonid reproduction. The recommendations for the restoration of river waters and habitats are based on the following definition of salmonid river habitat in good state:

- The river has a natural meandering that provides for diversity of habitats;
- The quantity and velocity of waters are sufficient and the flow is maintained at an adequate level corresponding to the needs of salmon and sea trout eggs as well as young and adult fish;
- The water is cool and well oxygenated and stays within a limited pH range;
- There are spawning and nursery areas with the necessary bottom substrates (permeable gravel, cobble and sand);
- There are both deep pools and large boulders and stones as well as large woody debris suitable as hiding and resting sites for salmonids;
- The load of nutrients, organic substances, sediments and sand from the river banks is low and littering or contaminants do not affect the waters or bottoms;

• Vegetation along the river provides for shade and predator protection for fish as well as habitats for insects that may disperse over the water as suitable food items for salmonids;
• The growth of vegetation in the rivers is not excessive.

Where for instance the data or available information indicates that the water quality is low due to nutrient and sediment loading from agriculture, the recommendation is hence to establish effective protection zones along agricultural lands by the river. Other measures to reduce nutrient loading from the agriculture sector are beyond the scope of this report. Where there are problems due to acidification the recommendation is to apply liming operations or to avoid causing leaching of acid soils. If water quantities and flow are insufficient and pose a risk for or impair the reproduction of salmonids the recommendation is to provide for a minimum flow or to reduce possibilities for rapid surface runoff.

Where the spawning or nursery habitats need restoration or a minimum water flow to be guaranteed, such measures are hence recommended. Where rivers are straightened and riverbanks lack vegetation the recommendation is to restore the meandering of rivers and to allow for bushes and shrubs to grow along riverbanks and provide both shade for fish and a habitat and source for insects as food items for salmonids.

Passage in rivers

Free passage within the river up to the headwaters and in the spawning tributaries is another precondition for successful salmonid reproduction. The recommendations for the accessibility of rivers are based on the following elements:
• The river system is free from physical, chemical or biological barriers that prevent or impede ascending or descending salmonids, or
• Where there are man-made migration hindrances an assessment should be made for the whole river system of the feasibility of removing them, providing fishways over them and/or transporting fish over the dams or of enhancing the functioning of current fishways. The assessment may include elements such as the cost-efficiency of re-establishment, estimated natural smolt production, options for improving accessibility (e.g. fishways or transport of spawners/smolts), effects on existing fish populations, mortality during up- and downstream migration and migration behaviour. The assessment should include mapping of the quality and quantity of suitable spawning and nursery areas. Passage in the river should be provided where the results of the assessment justifies it.

Where, because of man-made obstacles to migration, salmonids are unable to successfully ascend rivers to the spwaning areas, juveniles are unable to inhabit nursery areas or smolts/kelts are unable to migrate to the sea, the recommendation is to assess the removal of the obstacles, building fishways over them or transporting fish over the dams. An assessment should also cover the possibilities of improving the effectiveness of existing fishways. These measures should be undertaken where the assessment shows a clear benefit for the state of salmonid populations and the overall assessment justifies it. The possibilities to enhance the natural reproduction of original salmonid populations in their native rivers should be given high priority.

The restoration of habitats and migratory routes also support the rebuilding of other populations of migratory fish such as eel, river lamprey and whitefish.

River fisheries management

The recommendations for fisheries management are, in accordance with the project agreement, confined to the rivers. The recommendations are based on the state of the naturally reproducing salmonid populations. Where the population reproduces at a level of over 20% of PSPC the recommendation is to apply a set of effective and proportionate fishing rules based on the state of the population and the local conditions that will enhance the development of the populations towards MSY. The fishing rules should be designed through a participatory and open process to include local stakeholder views and thereby gain acceptance and practical significance. In many cases, rules already exist, but they may need amendment and thorough discussion with all stakeholders. The set of fishing rules could be based on, *inter alia,* the following elements:

Fishing regulations and culture

- The development of a sportfishing culture to allow large wild individuals of salmon and sea trout to be released back to the river;
- Where appropriate, a ban on fishing and keeping of large wild salmon and sea trout;
- Where needed a total fishing ban on salmon and/or sea trout;
- The definition of appropriate catch sizes (minimum/maximum size) to protect juveniles or mature fish (e.g. salmon over 10 kg);
- A prohibition on the use of barbed hooks and restrictions on the number of hooks and their size;
- The introduction of a rule that requires salmonids that are hooked outside the mouth to be released and to eliminate 'foul hooking';
- The introduction of a bag limit (maximum catch) of one or more salmon or sea trout per fisher per day;
- The introduction of a closed season during the spawning and smolt migration period and other important conservation periods or areas;
- The application of a scheme for regulating fishing effort by licensing or other means;
- The regulation of gillnetting in the river when and where salmon or sea trout are present;

Fish stock management, enforcement and sanctions

- Setting of targets for the number of spawners for each river/large tributary in addition to the level of smolt production in relation to PSPC;
- The use of original strains and as early life stages (eggs, alevins, parr) as possible when stocking salmonids;
- The clipping of the adipose fin of reared salmonids to be stocked;
- The application of selective fishing methods that target reared fish (e.g. finclipped) or that allow the release of wild fish;
- Arrangements for the reporting of catches in river fisheries;
- Targeted inspection programs during important conservation periods;
- The effective enforcement and control of rules and the application of deterring sanctions when they are breached.

Where the population reproduces at a dangerously low level defined as 20% or less of the PSPC, the above recommendations are modified to advice for a set of strict fishing rules (e.g. a ban on fishing of large wild individuals of salmon and sea trout) that in the short-term will enhance the recovery of the population towards MSY. In such cases, in addition to fisheries management measures where applicable measures should be introduced as a matter of urgency for the restoration of habitats and opening of passage in rivers. This would specifically apply for populations where the numbers of fish that participate in the spawning and/or the production of smolts are at a dangerously low level. This is relevant for many naturally reproducing sea trout populations that on the basis of available information are in a critical state. Where the number of smolts cannot be verified by counting of individual fish the applicability of the 20% PSPC level should be based on the best available knowledge and estimates of experts.

The importance of large specimens of wild salmon or sea trout is emphasised since large salmonid females have high fecundity with crucial importance for the successful reproduction of the population and both females and males genes for rapid growth (Gjerde et al. 1994). Where fish populations experience high fishing pressure, the larger older individuals have a higher probability of being removed from the population. Large individuals are, therefore, more susceptible to fishing and often make an attractive target in sportfishing. The classification of salmon or sea trout as large individuals depends on both the region of the river and the characteristics of the population. Therefore, a uniform definition is not proposed as the issue is more appropriately decided on a case-by-case basis by the competent authority.

The set of fishing rules outlined above includes elements that allow for the release of fish with as little injury as possible. When using only one barbless hook, the lure is easier to release from the fish and it causes less damage to its tissues. The rules on hook size and numbers and the mandatory release of fish hooked outside the mouth are needed to eliminate the destructive fishing practice of trying to hook the fish by dragging large hooks through pools with dense shoals of fish (foul-hooking).

The fishing rules also include elements to reduce fishing effort. They could apply at all times as a one fish rule or during spawning times as a closed season. In some cases a licensing scheme may be needed to reduce the overall fishing pressure. Similarly, clipping of the adipose fin allows the fisher to identify wild individuals and thereby the development of selective fishing practices that reduce overall fishing pressure. Fishing practices which do not select for species or sizes and easily injure fish such as fishing with nets may need to be prohibited as they easily entangle salmonids.

The effectiveness of fishing rules depends on the acceptance of them among fishers and the possibility for them to participate in their development. Fishers are much more likely to breach rules that have been imposed on them through a top-down procedure. Controlling the compliance with rules and finding resources for controls is a huge challenge due to the large number and long stretches of rivers. For these reasons the fishing rules are best developed through a participatory and open process based on the elements outlined above. There is nevertheless, a need to enforce the rules and apply deterring sanctions when they are breached. These elements should therefore always form a part of the set of fishing rules.

Management measures in the marine area of the EU will be based on the multiannual salmon management plan that will be adopted for Baltic salmon stocks and on national measures in accordance with it. The Russian Federation applies its own management measures. Where the EU and the Russian Federation have agreed on common measures, these will be adopted and applied by both parties. The sea trout stocks are mainly subject to national management measures.

10 Recommendations

10.1 Salmon populations/ rivers

10.1.1 Original salmon populations in their native rivers

In accordance with the objective criteria presented under section 9, original salmon populations with low or impaired reproduction form the top priority list of populations to be the target of recovery or development measures.

Based on the ICES data and the data gathered in the HELCOM SALAR project the original salmon populations in the MSY traffic light red list to the left are recommended to be prioritised for recovery and restoration actions. They should thereby be the target of immediate and effective conservation measures.

To follow-up the development of these populations/rivers, it is recommended that they are included in a red list of salmon populations/rivers. The populations/rivers will be removed from the red list and put either on a yellow or green list where data or estimates indicate that they have recovered to a level of at least 50% or 80% of PSPC. The lists are to be displayed on a GIS-map at the HELCOM website and made publicly available. The MSY traffic light yellow list is to the left and the green list is on page 58.

Original salmon populations in the MSY traffic light red list

Population/river	Sea Basin	Attainment level of PSPC (mean of modal values of the estimates for 2007-2009 (Kattegat rivers 2005-2009))
Pärnu	GoR	<1%
Vilia*	MB	<1%
Luga	GoF	6%
Rickleån	BB	9%
Vasalemma	GoF	11%
Šventoji*	MB	12%
Emån	MB	14%
Žeimena*	MB	17%
Vilnia*	MB	19%
Keila	GoF	20%
Göta älv tributaries**	KG	22%
Öreälven	BS	23%
Neris*	MB	23%
Kunda	GoF	25%
Saka	MB	29%
Daugava	GoR	30%
Nissan (trib. Sennan)	KG	32%
Löftaån	KG	33%
Tvååkersån	KG	33%
Rönne å	KG	35%
Kungsbackaån	KG	36%
Gauja	GoR	44%

* Tributaries of the Nemunas river system
** The Göta älv tributaries are Brattorpsån, Grönån, Lärjeån, Säveån and Västerlandaån

Original salmon populations in the MSY traffic light yellow list

Population/river	Sea Basin	Attainment level of PSPC (mean of modal values of the estimates for 2007-2009 (Kattegat rivers 2005-2009))
Ätran	KG	50%
Genevadsån	KG	52%
Peterupe	GoR	53%
Törlan	KG	53%
Ume/Vindelälven	BB	56%
Lagan	KG	59%
Viskan	KG	59%
Sävarån	BB	61%
Fylleån	KG	62%
Siesartis*	MB	63%
Lögdeälven	BB	64%
Rolfsån	KG	65%
Barta	MB	67%
Uzava	MB	67%
Vitrupe	GoR	67%
Mörrumsån	MB	71%
Salaca	GoR	73%
Venta	MB	74%
Suseån	KG	76%
Tornionjoki	BB	78%
Simojoki	BB	78%

* Tributary of the Nemunas river system

The acronyms for the sea basins stand for the Main Basin (MB), Bothnian Bay (BB), Bothnian Sea (BS), Gulf of Finland (GoF), Gulf of Riga (GoR) and the Kattegat (KG). PSPC indicates potential smolt production capacity.

Figure 10.1. Map of Baltic Sea rivers with original salmon populations coloured according to the MSY traffic lights.

Original salmon populations in the MSY traffic light green list

Population/river	Sea Basin	Attainment level of PSPC (mean of modal values of the estimates for 2007-2009 (Kattegat rivers 2005-2009))
Himleån	KG	82%
Åbyälven	BB	82%
Kalixälven	BB	85%
Stensån	KG	85%
Byskeälven	BB	90%
Irbe	MB	93%
Piteälven	BB	102%
Råneälven	BB	113%
Ljungan	BS	132%

Original salmon populations available in hatcheries for possible re-establishment

Population/river	Sea Basin	PSPC or reproduction area that may be mobilised
Dalälven	BS	41 ha
Iijoki	BB	600 ha
Indalsälven	BS	Unknown (470 ha available before damming)
Ljusnan	BS	487 ha (840 ha available before damming)
Luleälven	BB	464 ha (1,431 ha available before damming)
Skellefteälven	BB	Unknown
Ångermanälven	BS	Unknown (729 ha available before damming)

Salmon rivers with large potential that may be restored for salmon production

Population/river	Sea Basin	PSPC or reproduction area that may be mobilised
Kymijoki	GoF	100,000–200,000 smolts
Kemijoki	GoB	1,864 ha (in the tributary Ounasjoki)
Oulujoki	BB	50 ha

10.1.2 Potential salmon populations and rivers

The salmon populations and rivers in the two lowest tables are defined as potential salmon populations/rivers based on the availability of the original population and the large potential for reproduction in the river.

An assessment concerning man-made migration hindrances as proposed under section 9.2 (passage in rivers) should be made for rivers into which populations are planned to be re-established and for rivers with large potential. Passage in the rivers should be provided where the results of the assessment justifies it.

Stocking of salmon or sea trout for enhancement purposes should be conducted on a temporary basis until natural reproduction reaches stable levels in these rivers. The stocked fish should be derived from the original strain or if not available from a nearby salmon population with genetic proximity and similar ecological conditions.

10.1.3 Other salmon populations

The salmon populations and rivers that have not been referred to above are nonetheless important to maintain and develop in accordance with the recommendations for the three main factors.

10.2 Sea trout populations/ rivers

The objective criteria described for salmon populations under section 9 are also valid for original sea trout populations of the Baltic Sea. The data on sea trout populations is however insufficient and their assessment must, therefore, be based on the best available information and estimates of experts.

Based on available information and expert opinions the original sea trout populations in Annex III are deemed to be below 50% of the PSPC of their native rivers (MSY traffic light red list). The Annex lists 299 populations of which slightly over 100 are in Sweden and over 50 in Denmark and Estonia each. Russia has close to 50 populations in the Annex. The sea trout populations in Annex III are recommended to be prioritised for recovery and restoration actions. They should therefore be the target of immediate and effective conservation measures.

10.3 River waters, habitats and accessibility

It is recommended that river waters and habitats are restored with the aim of achieving the definition of a salmonid habitat in good state as presented under section 9. Recommendations for targeted actions concerning river waters and habitats are presented for each river or group of rivers in the separate reports for each Member State (BSEP 126B).

The restoration of waters and habitats should be a priority in the rivers that hold salmon or sea trout populations in the MSY traffic light red list starting with rivers that have populations reproducing at a level of 20% or less of PSPC. If these rivers are not in need of restoration the focus should be on other rivers with natural reproduction or with significant potential for natural reproduction.

Where rivers have man-made migration hindrances it is recommended that an assessment as presented under section 9.2 (passage in rivers) should be made concerning them. Passage in the river should be provided where the results of the assessment justifies it.

10.4 River fisheries management

It is recommended that fisheries management measures in salmonid rivers would be based on a set of fishing rules as presented under section 9. The fishing rules should be designed through a participatory and open process to include local

stakeholder views so as to gain acceptance and ensure practical significance. In many cases rules already exist, but they may need amendments and thorough discussions among stakeholders.

The fishing rules should reflect the state of the salmonid population that is subject to fishing and enhance the development of the stock towards MSY. Where the population reproduces at a level of over 20% of the PSPC the recommendation is to apply a set of effective and proportionate fishing rules and when the level is 20% or less of PSPC the recommendation is to apply a set of strict fishing rules.

10.5 Restoration and development plans for salmon rivers

With a view to implementing the recommendations of this report and the commitment of the HELCOM Baltic Sea Action Plan to conserve at least ten and reintroduce at least four salmon populations and to develop restoration plans, it is recommended that salmon populations/rivers are selected for a second phase project to be coordinated by HELCOM.

Based on the salmon populations in the MSY traffic light red list, the original salmon populations for re-establishment and the salmon rivers with large potential as well as the state of the waters and habitats and the accessibility of rivers, it is recommended that the following ten original (preliminary list) and six potential populations/rivers are selected for a HELCOM salmon river restoration and development project.

Original salmon populations in their native rivers (preliminary list)

Daugava
Emån
Gauja
Kunda
Luga
Pärnu
Rickleån
Rönne å
Saka
Nemunas (tributaries Neris, Šventoji, Žeimena, Vilnia and Vilia).

The final list of the ten original salmon populations to be covered by a second phase project should be decided through a dialog with the national administrations and research institutes at the start of such a project.

Potential salmon populations and rivers

Original salmon populations for possible re-establishment

Iijoki
Ljusnan
Luleälven
Ångermanälven

Salmon rivers with large potential that may be mobilised for reproduction

Kemijoki
Kymijoki

Restoration and development plans for these populations and rivers should be urgently advanced. Where applicable, the plans should include the recommended assessment concerning man-made migration hindrances and the mapping of the quality and quantity of suitable spawning and nursery areas.

11 Implementation of actions in the HELCOM Baltic Sea Action Plan relevant for salmon and sea trout populations

Based on the reasoning and objective criteria described under section 9, the salmon populations and rivers listed in the recommendations under section 10 are proposed as a response for the implementation of the BSAP commitment of:

- The active conservation of at least ten endangered/threatened wild salmon river populations in the Baltic Sea region as well as the reintroduction of native Baltic Sea salmon in at least four potential salmon rivers, and
- The development of restoration plans (including restoration of spawning sites and migration routes) in suitable rivers to reinstate migratory fish species.

The targets for these commitments in the BSAP are:

- By 2015, as the short-term goal, to reach production of wild salmon at least 80%, or at least 50% for some very weak salmon river populations, of the best estimate of potential production, and within safe genetic limits, based on an inventory and classification of Baltic salmon rivers.

The BSAP furthermore urges the competent fisheries authorities to take all the necessary measures:

- To ensure that, by 2021, populations of all commercially exploited fish species are within safe biological limits, reach Maximum Sustainable Yield, and are distributed through their natural range, and contain full size/age range,
- For continued designation of additional/improved spatial and/or temporal closures of sufficient size and duration for fisheries to prevent capture of spawning and juvenile fish, and
- The further development and application in all cases of appropriate breeding and restocking practices for salmon and sea trout to safeguard the genetic variability of native wild stocks, by 2012.

The actions that are recommended in this report would contribute to the achievement of these measures as they would increase smolt production towards MSY, introduce new and targeted fishing restrictions in rivers and safeguard the original strains of salmon and sea trout populations as well as the production of restoration plans for prioritized rivers.

12 References

Alexeev, F. E. (2008). Water resources management in the Kaliningrad Oblast; expedience and perspectives of applying the principles and norms of the EU Water Frame Directive. Chapter 2 in the Transboundary waters and basins in the South-East Baltic, Chubarenko, B (editor). Kalingrad, Terra Baltica. Russian Academy of Sciences, P.P. Shirshov, Institute of Oceanology, Atlantic Branch, 305 pp.

Alheit, J., Möllmann, C., Dutz, J., Kornilovs, G., Loewe, P., Mohrholz, V., Wasmund, N. (2005). Synchronous ecological regime shifts in the central Baltic and the North Sea in the late 1980s. ICES Journal of Marine Science 62: 1205–1215.

Appelberg, M., Degerman, E., Johlander, A. & Karlsson, L. (1989). Liming increases the catches of Atlantic salmon on the west coast of Sweden. Nordic Journal of Freshwater Research 65: 44–53.

Araki, H., Cooper, B., Blouin, M. S., 2007. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science 318, 100-103.

Armstrong, J. D., Kemp, P. S., Kennedy, G. J. A., Ladle, M., Milner, N. J. (2003). Habitat requirements of Atlantic salmon and brown trout in rivers and streams. Fisheries Research 62: 143-170.

BACC Author Team (2008). Assessment of Climate Change for the Baltic Sea Basin. Series: Regional Climate Studies. Springer-Verlag, Berlin Heidelberg. 473 pp.

Bardonnet, A., Bagliniere, J. L. (2000). Freshwater habitat of Atlantic salmon (Salmo salar). Canadian Journal of Fisheries and Aquatic Sciences 57: 497-506.

Barlaup, B. T., Gabrielsen, S. E., Skoglund, H, Wiers T. (2008). Addition of spawning gravel - A means to restore spawning habitat of Atlantic salmon (*Salmo salar* L.), and anadromous and resident brown trout (*Salmo trutta* L.) in regulated rivers. River Research and Applications 24 (5): 543-550.

Beland, K. F., Jordan, R. M., Meister, A. L. (1982). Water depth and velocity preferences of spawning Atlantic salmon in Maine rivers. North American Journal of Fisheries Management 2: 11-13.

Brander, K. (2010). Impacts of climate change on fisheries. Journal of Marine Systems 79: 389-402.

Casini M., Lövgren J., Hjelm J., Cardinale M., Molinero J. and Kornilovs G. (2008). Multi-level trophic cascades in a heavily exploited open marine ecosystem. Proceedings of the Royal Society, Biological sciences 275, 1793-1801.

Cowx, I. G., Welcomme, R. L. (editors) (1998). Rehabilitation of rivers for fish. FAO Fishing News Books. Alden Press. Great Britain. 260 p. European Commission (2010). Website: http://ec.europa.eu/environment/water/participation/map_mc/map.html (viewed 7 April, 2010)

Crozier W. W., Potter E. C. E., Prévost E., Schön P.-J., Ó Maoiléidigh N. E., 2003. A coordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the North-East Atlantic (SALMODEL). Queen's University of Belfast, Belfast.

Degerman, E., Beier, U., Bergquist, B. (2005). Bedömning av miljötillstånd i kustvattendrag med hjälp av fisk. Finfo 2005: 1, 66 s.

deYoung, B., Harris, R., Alheit, J., Beaugrand, G., Mantua, N., Shannon, L. (2004). Detecting regime shifts in the ocean: data considerations. Progress in Oceanography 60: 143–164.

Elliott, J. M., Hurley, M. A. (1998). An individual-based model for predicting the emergence period of sea trout fry in a Lake District stream. Journal of Fish Biology 53: 414-433.

Fleming, I. A. Petersson, E., 2001. The ability of released, hatchery salmonids to breed and contribute to the natural productivity of wild populations. Nordic J. Freshw. Res. 75, 71-98.

Fjälling, A. (2005). The estimation of hidden seal-inflicted losses in the Baltic Sea set-trap salmon fisheries. ICES Journal of Marine Science 62:1630–1635.

Friedland, K. D., MacLean, J. C., Hansen, L. P., Peyronnet, A. J., Karlsson, L., Reddin, D. G., Ó Maoiléidigh, N., McCarthy, J. L. (2009). The recruitment of Atlantic salmon in Europe. ICES Journal of Marine Science 66: 289–304.

Gibson, R. J. (1993). The Atlantic salmon in fresh water: spawning, rearing and production. Reviews in Fish Biology and Fisheries 3: 39-73.

Gjerde B., Simianer H., Refstie T. (1994). Estimates of genetic and phenotypic parameters for body weight, growth rate and sexual maturity in Atlantic salmon. Livestock Production Science 38:133-143.

Grant, J.W.A (1993). Self-thinning in stream-dwelling salmonids. Canadian Special Publication of Fisheries and Aquatic Sciences 118:99-102.

Grant, J.W.A., Kramer, D.L. (1990). Territory size as a predictor of the upper limit to population density of juvenile salmonids in streams. Canadian Journal of Fisheries and Aquatic Sciences 47:1724-1737.

Grant, J.W.A., Steingrimsson, S.O., Keeley, E.R. (1998). Implications of territory size for the measurement and prediction of salmonid abundance in streams. Canadian Journal of Fisheries and Aquatic Sciences 55:181-190.

Hansen L. P., Quinn T. P., 1998. The marine phase of the Atlantic salmon (Salmo salar) life cycle, with comparison to Pacific salmon. Can. J. Fish. Aquat. Sci. 55, 104–118.

Hasler, A. D. (1971). Orientation and fish migration. Fish Physiology 6: 420–510.

Heggberget, T. G. (1991). Some environmental requirements for Atlantic salmon. American Fisheries Society Symposium 10: 132-135.

Heggenes, J. (1991). Comparisons of habitat availability and habitat use by an allopatric cohort of juvenile Atlantic salmon Salmo salar under conditions of low competition in a Norwegian stream. Holarctic Ecology 14: 51-62.

Heggenes, J., Bagliniere, J. L., Cunjak, R. A. (1999). Spatial niche variability for young Atlantic salmon (*Salmo salar*) and brown trout (*S. trutta*) in heterogeneous streams. Ecology of Freshwater Fish 8: 1-21.

HELCOM (2007). Climate change in the Baltic Sea Area. HELCOM Thematic Assessment in 2007. Baltic Sea Environment Proceedings No. 111. 49 pp.

HELCOM (2009). Biodiversity in the Baltic Sea: An integrated thematic assessment on biodiversity and nature conservation in the Baltic Sea. Baltic Sea Environmental Proceedings No 116B. Helsinki Commission, Helsinki. 188 pp. Available at: http://www.helcom.fi/stc/files/Publications/Proceedings/bsep116B.pdf (viewed 11 March, 2010)

Huusko, A., Greenberg, L., Stickler, M., Linnansaari, T., Nykänen, M., Vehanen, T., Koljonen, S., Louhi, P., Alfredsen, K. (2007). Life in the ice lane: the winter ecology of stream salmonids. River Research and Applications 23: 469-491.

ICES (2008). Report of the Workshop on Baltic Salmon Management Plan Request (WKBALSAL), 13–16 May, 2008. ICES CM 2008/ACOM:55.

ICES (2009a). Report of the Baltic Salmon and Trout Assessment Working Group (WGBAST), 24–31 March 2009, Oulu, Finland. ICES CM 2009/ACOM:05. 280 pp.

ICES (2009b). Advice Book 8. Herring in Subdivision 30, (Bothnian Sea). Available at: http://www.ices.dk/committe/acom/comwork/report/2009/2009/Her-30.pdf.

ICES (2010a). Report of the Working Group on Baltic Salmon and Trout (WGBAST), 24-31 March 2010, St Petersburg, Russia. ICES CM 2010/ACOM: 08. 253 pp.

ICES (2010b). Advice Book 8. Salmon in the Main Basin and the Gulf of Bothnia (Subdivisions 22-31). Available at: http://www.ices.dk/committe/acom/comwork/report/2010/2010/sal-2231.pdf

IPCC (2007). Fourth Assessment Report: Climate Change 2007. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. Impacts, Adaptation and Vulnerability. Parry, M. L., Canziani, O.F., Palutikof, J. P., Van Der Linden, P. J., and Hanson, C. E. (eds.). Cambridge University Press, Cambridge, UK and New York, NY, USA. Available at: http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html (viewed 25 March, 2010).

Hutchison, M. J., Iwata, M. (1998). Effect of thyroxine on the decrease of aggressive behavior of four salmonids during the parr-smolt transformation. Aquaculture 168: 169-175.

Ikonen, E. (2006). The role of the feeding migration and diet of Atlantic salmon (Salmo salar L.) in yolk-sack-fry mortality (M74) in the Baltic Sea. Academic dissertation. The Department of Biological and

Environmental Sciences, Faculty of Biosciences, University of Helsinki, Finland.

Jokikokko, E., Jutila, E. (2005). Effect of fishing regulation on the occurrence of repeat spawners and age distribution of Atlantic salmon in a northern Baltic river. Fisheries Management and Ecology 12: 341–347.

Jonsson, B., Jonsson, N. (2009). Review paper: A review of the likely effects of climate change on anadromous Atlantic salmon *Salmo salar* and brown trout *Salmo trutta*, with particular reference to water temperature and flow. Journal of Fish Biology 75: 2381-2447.

Jounela, P., Suuronen, P., Millar, R.B. and Koljonen, M-L. (2006). Interactions between grey seal (*Halichoerus grypus*), Atlantic salmon (*Salmo salar*), and harvest controls on the salmon fishery in the Gulf of Bothnia. ICES Journal of Marine Science: Journal du Conseil 2006 63(5):936-945.

Karlsson, L., Ikonen, E., Mitans, A., Hansson, S. (1999). The diet of salmon (*salmo salar*) in the Baltic Sea and connections with the M74 Syndrome. Ambio 28 (1): 37-42.

Kauppinen T., Siira A., Suuronen P. (2005). Temporal and regional patterns in seal-induced catch and gear damage in the coastal trap-net fishery in the northern Baltic Sea: effect of netting material on damage. Fisheries Research 73:99–109.

Keinänen, M., Uddström, A., Mikkonen, J., Rytilahti, J., Juntunen, E.-P., Nikonen, S. & Vuorinen, P. J.(2008). The M74 syndrome of Baltic salmon: the monitoring results from Finnish rivers up until 2007. Riista- ja kalatalous – Selvityksiä 4/2008. 21 s.

Keinänen M., Tolonen T., Ikonen E., Parmanne R., Tigerstedt C., Rytilahti J., Soivio A., Vuorinen P. J. (2000). Reproduction disorder of Baltic salmon (the M74 syndrome): research and monitoring (Itämeren lohen lisääntymishäiriö - M74). Riista- ja kalatalouden tutkimuslaitos, Kalatutkimuksia - Fiskundersökningar 165, 38 pp.

Klemetsen, A., Amundsen, P-A-. Dempson, J. B., Jonsson, B., Jonsson, N., O'Connell, M. F., Mortensen, E. (2003). Atlantic salmon *Salmo salar* L., brown trout *Salmo trutta* L. and Arctic charr *Salvelinus alpinus* (L.): a review of aspects of their life histories. Ecology of Freshwater Fish 12: 1-59.

Landergren, P. (2001). Survival and growth of sea trout parr in fresh and brackish water. Journal of Fish Biology 58: 591-593.

Landergren, P. (2004). Factors affecting early migration of sea trout *Salmo trutta* parr to brackish water. Fisheries Research 67: 283-294.

Landergren, P., Vallin, L. (1998). Spawning of sea trout, *Salmo trutta* L., in brackish waters: lost effort or successful strategy? Fish Res 35:229-236.

Limburg, K. E., Landergren, P., Westin, L., Elfman, M., Kristiansson, P. (2001). Flexible modes of anadromy in Baltic sea trout: making the most of marginal spawning streams. Journal of Fish Biology 59: 682-695.

Lundström, K., Hjerne, O., Alexandersson, A. and Karlsson O. (2007). Estimation of grey seal (Halichoerus grypus) diet composition in the Baltic Sea. NAMMCO Sci. Publ. 6:177–196.

Malcolm, I.A., Youngson, A.F., Soulsby, C. (2003). Survival of salmonid eggs in a degraded gravel-bed stream: effects of groundwater-surfacewater interactions. River research and Applications 19: 303-316.

McCormick S. D., Shrimpton, M., Moriyama, S., Björnsson B. T. (2002). Effects of an advanced temperature cycle on smolt development and endocrinology indicate that temperature is not a zeitgeber for smolting in Atlantic salmon. The Journal of Experimental Biology 205: 3553-3560.

MNREPRB (Ministry of Natural Resources and Environmental Protection of the Republic of Belarus) (2008). Plan of measures to protect Baltic salmon and Sea Trout in the Ostrovets District of the Grodno Oblast. (Translation from Russian).

Moir, H. J., Soulsby, C., Youngson, A. (1998). Hydraulic and sedimentary characteristics of habitat utilized by Atlantic salmon for spawning in the Girnock Burn, Scotland. Fisheries Management and Ecology 5: 241-254.

Pankhurst, N. W., King, H. R. (2010). Temperature and salmonid reproduction: implications for aquaculture. Journal of Fish Biology 76 (1): 69-85.

Perry, A. L., Low, P. J., Ellis, J. R., Reynolds, J. D. (2005). Climate Change and Distribution Shifts in Marine Fishes. Science 308: 1912-1915.

Polutskaya, N (2005). Atlantic Salmon in Rivers of Belarus. Neman Environmental Group. Coalition Clean Baltic.

Pörtner, H.O., Peck, M.A. (2010). Climate change effects on fishes and fisheries: towards a cause-and-effect understanding. Journal of Fish Biology 77: 1745-1779.

Rikardsen, A. H., Amundsen, P.-A. (2005). Brief communications: Pelagic marine feeding of Arctic charr and sea trout. Journal of Fish Biology 66: 1163-1166.

Rikardsen, A. H., Amundsen, P-A., Knudsen, R., Sandring, S. (2006). Seasonal marine feeding and body condition of sea trout (*Salmo trutta*) at its northern distribution. ICES Journal of Marine Science 63: 466-475.

Romakkaniemi, A., Perä, I., Karlsson, L., Jutila, E., Carlsson, U., and Pakarinen, T. (2003). Development of wild Atlantic salmon stocks in the rivers of the northern Baltic Sea in response to management measures. ICES Journal of Marine Science 60: 329-342.

Romakkaniemi, A. 2008. Conservation of Atlantic salmon by supplementary stocking of juvenile fish. Ph.D. thesis. University of Helsinki, Department of Biological and Environmental Sciences, Faculty of Biosciences, and Finnish Game and Fisheries Research Institute.

Rubin, J.F., Glimsäter, C. (1996). Egg-to-fry survival of the sea trout in some streams of Gotland. Journal of Fish Biology 48 (4): 585-606.

Salminen M., Kuikka S., Erkamo E., 1995. Annual variability in survival of sea-ranched Baltic salmon, Salmo salar L.: significance of smolt size and marine conditions. Fisheries Management and Ecology 2, 171–184.

Semple, J. R. (1991). Atlantic salmon habitat survey: enhancement opportunities and problems in the Dunbar stream, Naswaak river, New Brunswick. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2076: 1-35.

Sigholt, T., Åsgård, T., Staurnes, M. (1998). Timing of parr-smolt transformation in Atlantic salmon (*Salmo salar*): effects of changes in temperature and photoperiod. Aquaculture 160 (1-2): 129-144.

Stuart-Smith, R. D., Richardson, A. M. M., White, R. W. G. (2004). Increasing turbidity significantly alters the diet of brown trout: a multi-year longitudinal study. Journal of Fish Biology 65 (2): 376-388.

Suuronen, P., Jounela, P. (2010). Introducing run-size driven fisheries management for the coastal fishery of Atlantic salmon: Preseason forecasts for policy makers. Marine Policy 34 (3): 679-689.

Todd, C.D., Friedland, K. D., MacLean, J. C., Hazon, N., Jensen, A. J. (2010). Atlantic Salmon Ecology: Change in Freshwater and Marine Environments (Chapter 16). Blackwell Publishing Ltd. 496 pp.

Vehanen, T., Aspi, J. and Pasanen, P. (1993). The effect of size, fin erosion, body silvering and precocious maturation on recaptures in Carlin-tagged Baltic salmon (*Salmo salar* L.). Ann. Zool. Fenn. 30: 277–285.

Walther, G-R., Post, E., Convey, P., Menzel, A., Parmesank, C., Beebee, T. J. C., Fromentin, J-M., Hoegh-Guldberg, O., Bairlein, F. (2002). Ecological responses to recent climate change. Nature 416: 389-395.

Österdahl, L. (1969). The smolt run of a small Swedish river. In: Northcote TG (ed) Salmon and trout in streams. HR MacMillan Lectures in Fisheries, University of British Columbia, Vancouver.

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HELCOM has the sole responsibility for this report and the European Commission is not responsible for any use that may be made of the information contained therein.

Annex I

Salmon populations in rivers flowing to the Baltic Sea by country and category (p. 27).

ESTONIA	Category
1. Jägala	7
2. Keila	1
3. Kunda	1
4. Loobu	4
5. Narva	7
6. Pirita	4
7. Purtse	5
8. Pärnu	1
9. Selja	4
10. Valgejõgi	5
11. Vasalemma	1
12. Vääna	3

FINLAND	Category
13. Aurajoki	7
14. Eurajoki	6
15. Fiskarsinjoki	8
16. Halikonjoki	8
17. Iijoki watercourse	6
18. Kalajoki watercourse	6
19. Karjaanjoki	6
20. Karvianjoki watercourse	5
21. Kemijoki watercourse	6
22. Kiiminkijoki watercourse	5
23. Kiskonjoki watercourse	8
24. Kokemäenjoki watercourse	7
25. Koskenkylänjoki	6
26. Kuivajoki	5
27. Kymijoki watercourse	5
28. Kyrönjoki	6
29. Lapuanjoki	8
30. Lestijoki	6
31. Mynäjoki	8
32. Oulujoki watercourse	7
33. Paimionjoki watercourse	8
34. Perhonjoki watercourse	6
35. Porvoonjoki	6
36. Pyhäjoki	5
37. Siikajoki	6
38. Simojoki	3
39. Tornionjoki watercourse	1
40. Uskelanjoki	8
41. Vantaanjoki	6
42. Ähtävänjoki	8

LATVIA	Category
43. Barta-Bartuva	6
44. Daugava	7
45. Gauja	4/5
46. Irbe	3
47. Peterupe	3
48. Riva	
49. Saka	3
50. Salaca	1
51. Uzava	3
52. Venta	4/5
53. Vitrupe	3

LITHUANIA	Category
54. Dubysa (Nemunas)	4
55. Mera (Nemunas)	1
56. Neris - Vilia (Belarus) (Nemunas)	4
57. Siesartis (Nemunas)	4
58. Širvinta (Nemunas)	4
59. Šventoji	4
60. Šventoji (Nemunas)	4
61. Venta	No data
62. Vilnia (Nemunas)	4
63. Virinta (Nemunas)	4
64. Vokė (Nemunas)	4
65. Žeimena (Nemunas)	1

POLAND	Category
66. Brda (Vistula)	7
67. Drawa (Odra)	6
68. Drwęca (Vistula)	6
69. Gwda (Odra)	7
70. Ina (Odra)	6
71. Łeba	6
72. Łupawa	8
73. Odra	7
74. Parsęta	6
75. Reda	6
76. Rega	6
77. Słupia	5
78. Vistula	7
79. Wda (Vistula)	7
80. Wieprza	6
81. Wierzyca (Vistula)	7

RUSSIA	Category
82. Gladyshevka	6
83. Luga	4
84. Narva	7
85. Neva	7

SWEDEN	Category
86. Alsterån	2
87. Byskeälven	1
88. Dalälven	5
89. Emån	1
90. Fylleån	1
91. Genevadsån	1
92. Gideälven	5
93. Göta älv	7
94. Helgeån	3
95. Himleån	1
96. Hörnån	6
97. Indalsälven	7
98. Kalixälven	1
99. Kungsbackaån	1
100. Kågeälven	2
101. Lagan	7
102. Ljungan	3
103. Ljusnan	7
104. Luleälven	7
105. Löftaån	1
106. Lögdeälven	3
107. Moälven	6
108. Mörrumsån	1
109. Nissan	5
110. Piteälven	1
111. Rickleån	3
112. Rolfsån	1
113. Råneälven	1
114. Rönne å	1
115. Sangisälven	6
116. Skellefteälven	7
117. Stensån	1
118. Suseån	1
119. Sävarån	3
120. Testeboån	3
121. Torneälven	1
122. Tvååkerån	1
123. Törlan	1
124. Umeälven	7
125. Vindelälven (Umeälven)	1
126. Viskan	1
127. Åbyälven	1
128. Ångermanälven	7
129. Ätran	1
130. Öreälven	3

BELARUS	Category
131. Vilia	6

Annex II

Sea trout populations in rivers flowing to the Baltic Sea by country and category (p. 27). If the river is a tributary, the name of its main branch is given in brackets.

BELARUS

River name	River ID	Category
Vilia/Neris	-	-
Petrapolsky brook	-	6
Kemelina	-	1
Tartak	-	1
Senkanka	-	1
Stracha	-	6
Oshmjanka	-	6
Gazovka	-	1
Dudka	-	1

DENMARK

River name	River ID	Category
Askebæk	926	3
Åstrup Bæk	1177	2
Avbæk	1155	3
Avlby Mølleå	1005	3
Avnsbæk	1225	3
Baggeå	103	1
Bangsbo Å	1708	4
Barritskov Bæk	1226	3
Binderup Mølleå	1202	3
Blå Å	1144	3
Blykobbe Å	104	1
Bobbe Å	133	3
Bøgelunds Bæk	1154	2
Brende Å	1012	3
Brøndstrup Mølleå	1425	1
Brorsbøl Bæk	1174	3
Byåen	105	3
Bybæk	1001	3
Bygholm Å	1307	4
Dalby Mølleå	1204	3
Dammebæk	116	1
Døndals Å	136	1
Drikkær Bæk	1312a	1
Dyrbæk	1147	2
Dyrhave Bæk	1155a	3
Egå	1321	4
Elbæk	1128a	2
Elling Å	1713	4
Elsted Bæk	1158	4
Elverdamsåen	334	3
Erritsø Bæk	1209	1
Esrum Å	204	6
Fakse Å	519	4
Fiskbæk	1136	3
Fiskebæk	1304	3
Fiskebæk	1309	3
Fladså	625	1
Fruerbæk	1130	2
Gårdbæk	1129	2
Geelså	915	4
Giber Å	1317	4
Grenå	1417	4
Græse Å	306	4
Grødeby Å	112	3
Grønnebæk	1114	3
Grønsbæk	1201b	6
Grubbe Mølleå	940	3
Gudenå	1506-3	4
Gudsø Bæk	1208	3
Gudsø Mølleå	1207	3
Gyldenså	123	3
Haderslev Å	1176	4
Haldrup Bæk	1310	5
Halleby Å	419	5
Hammerbro Bæk	931	4
Hårby Å	1018	3
Hattebæk	942	3
Havelse Å	305	4
Havmølle Å	1412	4
Hede Å	1214	3
Hellebjerg Bæk	1228	3
Henrikebæk	114	1
Herredsbæk	521	1
Hevring Å	1430	3
Hjortshøj Bæk	1322	3
Hoed Å	1413	3
Højbro Å	201	3
Hulebæk	524	3
Humlegårds Bæk	1175	3
Hundbjerg Bæk	1134	3
Hundekilde Å	1104	6
Hundstrup Å	937	3
Hygind Bæk	1010	3
Ibæk	1215	3
Kæmpeå	102	1
Kær-Mølleå	1183	3
Kampeløkke Å	142	3
Karls Møllebæk	1613	1
Kastbjerg Å	1604	3
Kavslunde Å	921	8
Kelse Å	128	3
Kighanerende	213	6
Klokkedal Å	1305	3
Knudbæk	1181	1
Kobbe Å	131	4

Kolå	1403	3
Kolding Å	1205	3
Kongshøj Å	925	3
Kornerup Å	315	4
Korup Å	1617	4
Krambæk	1139	5
Krobæk	522	1
Kruså	1128	3
Køge Å	508	4
Læså	111	3
Lilleå	109	3
Lillebæk	930	4
Lollike Bæk	704	1
Lunde Å	909	3
Made Bæk	1213	3
Malskær Bæk	1314	6
Marenmølle Bæk	1606	3
Melsted Å	132	3
Melved Bæk	1111	3
Mern Å	531	1
Mølleå	1153	3
Mølleå	1408	1
Møllebæk	703	3
Møllebæk	1156	3
Møllebæk	1312	3
Nejs Møllebæk	1137a	6
Nivå	211	1
Nybøl Bæk	1137	3
Odder Å	1316	1
Odderbæk	1201a	3
Odense Å	912	4
Øleå	115	1
Onsild Å	1610	3
Ørbæk Å	924	3
Ørredbæk	1004	3
Ørum/Rhoden Å	1220	3
Pugemølle Å	1014	3
Ringe Å	904	6
Ringsgård Bæk	936	8
Ris Møllebæk	1508	4
Rislebæk	938	3
Rønnebæk	624	1
Rørmose Bæk	1146a	2
Rosenvold Å	1222	3
Rudbæk	1148	2
Sæby Å	1706	6
Sælsbæk	1159	3
Saltbæk	1214b	3
Saltø Å	621	3
Sejet Nørremark Bæk	1303x	3
Sellerup Skovbæk	1214a	3
Sillebro Å	307	3
Sillerup Bæk	1180	2
Skæring Bæk	1323	3
Skelbæk	1002	3
Skelbækken	1303	1
Skjold Å	1301	3

Skovsholm Bæk	120	1
Snogbæk	1141	3
Suså	622	4
Søbæk	119	1
Sølyst Bæk	125	1
Søvind Bæk	1311	3
Spang Å	1212	3
Spangsbæk	1172	1
Stambæk	1408a	1
Stavids Å	911	3
Stengård Møllebæk	941	3
Stensby Møllebæk	705	1
Stokkebæk	927	3
Stolbro Bæk	1105	3
Storå	1003	3
Storå	1162	4
Store Handsted Å	1308	3
Strømmen	1103	4
Stutteribækken	1006	6
Sulbæk	1707	3
Tange Å	928	3
Taps Å	1182	2
Tejn Å	139	3
Tejn Møllebæk	140	3
Tirsbæk	1218	3
Treå	1426	3
Tryggevælde Å	511	4
Tubæk	525	3
Tude Å	605	4
Tuse Å	335	3
Tvede Å	1512	3
Ultang Møllebæk	1169	3
Valsgård Bæk	1612	1
Vandløb fra Kelstrup	1165	1
Vandløb fra Nygård	1178	2
Vandløb vest for Løjt	1173	3
Vaseå	122	1
Vedbæk	1161	3
Vedskølle Å	510	4
Vejle Å	1216	3
Vejrup Å	913	4
Vejstrup Å	932	3
Vellens Å	108	3
Viby Å	1007	3
Villestrup Å	1614	3
Vindinge Å	923	3
Vintersbølle Bæk	707	3
Vive Møllebæk	1615	1
Vivede Mølleå	518	4
Voers Å	1701	4
Å-Å	1016	3
Åkær Å	1313	3
Ålebæk	901	2
Ålebæk	1013	2
Alling Å	1504	4
Århus Å	1320	3

ESTONIA

River name	River ID	Category
Narva	622	8
Tõrvajõgi	657	1
Purtse	682	1
Kunda	729	1
Selja	746	3
Sõmeru	756	1
Muru	-	1
Loobu	779	1
Valgejõgi	792	1
Jägala	835	8
Pirita	892	3
Kuivajõgi	905	1
Tuhala	914	1
Angerja	917	1
Leiva	922	1
Vääna	945	1
Vanamõisa	958	1
Keila	961	1
Vasalemma	992	1
Pärnu	1235	8
Reiu	1454	1

FINLAND

River name	River ID	Category
Tornionjoki watercourse	FI 67	4
Tornionjoki (border river section)	FI 67.1-2	3
Muonionjoki (Tornionjoki)	FI 67.3-5	1
Könkämäeno (Tornionjoki)	FI 67.6	1
Lätäseno (Tornionjoki)	FI 67.7	1
Jietajoki (Tornionjoki)	FI 67.53	5
Palojoki (Tornionjoki)	FI 67.57	5
Pakajoki (Tornionjoki)	FI 67.49	3
Äkäsjoki (Tornionjoki)	FI 67.34	4
Liakanjoki (Tornionjoki)	FI 67.111	6
Martimojoki (Tornion-joki)	FI 67.14	-
Naamijoki (Tornionjoki)	FI 67.8	5
Olosjoki (Tornionjoki)	FI 67.88	4
Naalastojoki (Tornionjoki)	FI 67.87	4
Ylläsjoki (Tornionjoki)	FI 67.37	5
Niesajoki (Tornionjoki)	FI 67.36	4
Kuerjoki (Tornionjoki)	FI 67.345	4
Kangosjoki (Tornionjoki)	FI 67.48	4
Jerisjoki (Tornionjoki)	FI 67.47	5
Tarvantojoki (Tornionjoki)	FI 67.56	4
Maljasjoki (Tornionjoki)	FI 67.55	5
Olhavanjoki	FI 62	6
Iijoki watercourse	FI 61	6
Iijoki	FI 61.1-3	6
Siuruanjoki (Iijoki)	FI 61.4	-
Livojoki (Iijoki)	FI 61.5	6
Pärjänjoki (Iijoki)	FI 61.59	6
Korpijoki (Iijoki)	FI 61.7	6
Kisosjoki (Iijoki)	FI 61.29	6
Loukusanjoki	FI 61.27	6
Kostonjoki (Iijoki)	FI 61.6	6
Kiiminkijoki watercourse	FI 60	5
Kiiminkijoki	FI 60.01-04	5
Nuorittajoki (Kiiminkijoki)	FI 60.06-07	6
Oulujoki watercourse	FI 59	7
Oulujoki	FI 59.1-2	7
Sanginjoki (Oulujoki)	FI 59.14-15	6
Muhosjoki (Oulujoki)	FI 59.16-17	6
Utosjoki (Oulujoki)	FI 59.22-24	6
Kutujoki (Oulujoki)	FI 59.26	6
Siikajoki	FI 57	6
Olkijoki	FI 84.035	6
Pattijoki	FI 84.034	6
Piehinkijoki	FI 56	6
Pyhäjoki	FI 54	6
Kalajoki watercourse	FI 53	6
Kalajoki	FI 53.01-04	6
Vääräjoki (Kalajoki)	FI 53.09	6
Siiponjoki	FI 53.015-016	7
Lestijoki	FI 51	5
Perhonjoki watercourse	FI 49	6
Perhonjoki	FI 49.01-02	6
Halsuanjoki (Perhonjoki)	FI 49.03	6
Ullavanjoki (Perhonjoki)	FI 49.05	6
Köyhäjoki (Perhonjoki)	FI 49.06	6
Ähtävänjoki	FI 47	8
Lapuanjoki	FI 44	8
Kyrönjoki	FI 42	6
Karvianjoki watercourse	FI 36	5
Merikarvianjoki	FI 36.3	5
Pohjajoki	FI 36.2	5
Eteläjoki (-Kristiskerinjoki)	FI 36.1	8
Kokemäenjoki watercourse	FI 35	6
Kokemäenjoki	FI 35.1	-
Harjunpäänjoki (Kokemäenjoki)	FI 35.14	6
Eurajoki	FI 34	6
Mynäjoki	FI 30	6
Aurajoki	FI 28	6
Paimionjoki watercourse	FI 27	6
	FI 27.01-05	-
Vähäjoki (Paimionjoki)	FI 27.014	-
Halikonjoki	FI 26	6
Uskelanjoki	FI 25	3
Kiskonjoki watercourse	FI 24	3
Kiskonjoki	FI 24.01	-
	FI 24.04	-
Fiskarsinjoki (Kiskonjoki)	FI 82.001	3

Karjaanjoki watercourse	FI 23	6
Karjaanjoki	FI 23	6
Mustionjoki	FI 23.01-02	6
Nummenjoki	FI 23.07	-
Karjaanjoki-Vanjoki	FI 23.04	-
Vihtijoki	FI 23.09	-
Vantaanjoki watercourse	FI 21	6
Vantaanjoki	FI 21.01-02	6
Keravanjoki (Vantaanjoki)	FI 21.09	6
Porvoonjoki	FI 18	6
Koskenkylänjoki	FI 16	6
Kymijoki watercourse	FI 14	5
Viantienjoki	FI 84.054	6
Kaakamojoki	FI 66	-
Akkunusjoki	FI 65.111	-
Kemijoki watercourse	FI 65	6
Kemijoki	FI 65.1-2	6
Ounasjoki (Kemijoki)	FI 65.5	6
Runkausjoki (Kemijoki)	FI 65.18	6
Vähäjoki (Kemijoki)	FI 65.17	6
Suolijoki (Kemijoki)	FI 65.174	6
Raudanjoki (Kemijoki)	FI 65.7	6
Marrasjoki (Kemijoki)	FI 65.55	6
Molkojoki (Kemijoki)	FI 65.58	6
Lainiojoki (Kemijoki)	FI 65.56	6
Loukinen (Kemijoki)	FI 65.69	6
Seurujoki (Kemijoki)	FI 65.697	6
Syvä Tepastojoki (Kemijoki)	FI 65.68	6
Kuiva Tepastojoki (Kemijoki)	FI 65.686	6
Käkkälöjoki (Kemijoki)	FI 65.67	6
Närpiönjoki	FI 39	-
Teuvanjoki	FI 38	-
Isojoki	FI 37	-
Kärjenjoki (Isojoki)	FI 37.06	-
Karijoki (Isojoki)	FI 37.04	-
Heikkilänjoki (Isojoki)	FI 37.05	-
Laajoki	FI 31	-
Mynäjoki	FI 30	6
Hirvijoki	FI 29	-
Fiskarsinjoki	FI 82.001	3
Ingarskilanjoki	FI 81.064	-
Kocksbybäcken (Ingarskilanjoki)	-	-
Solbergå (Ingarskilanjoki)	-	-
Siuntionjoki	FI 22	-
Kirkkojoki (Siuntionjoki)	FI 22.006	-
Kvarnbäcken (Siuntionjoki)	-	-
Mankinjoki	FI 81.057	-
Gumbölenjoki (Mankinjoki)	-	-
Espoonjoki	FI 81.055	-
Glomså (Espoonjoki)	-	-
Glimså (Espoonjoki)	-	-
Vantaanjoki	FI 21	6
Longinoja (Vantaanjoki)	-	-
Keravanjoki (Vantaanjoki)	FI 21.09	-
Tuusulanjoki (Vantaanjoki)	FI 21.08	-
Luhtajoki (Vantaanjoki)	FI 21.05	-
Palojoki (Vantaanjoki)	FI 21.07	-
Paalijoki	FI 21.025	-
Sipoonjoki	FI 20	-
Byabäcken (Sipoonjoki)	FI 20.004	-
Mustijoki	FI 19	-
Isoniitynoja (Mustijoki)	FI 19.008	-
Kungsbäcken (Mustijoki)	FI 19.009	-
Porvoonjoki	FI 18	6
Pikkujoki (Porvoonjoki)	FI 18.013	-
Ilolanjoki	FI 17	-
Koskenkylänjoki	FI 16	6
Loviisanjoki	FI 81.027	-
Taasianjoki	FI 15	-
Summanjoki	FI 13	-
Vehkajoki	FI 12	-
Ravijoki	FI 81.07	-
Virojoki	FI 11	-
Saarasjärvenoja (Vironjoki)	FI 11.005	-
Vaalimaanjoki	FI 10	-
Urpalanjoki	FI 09	-
Vilajoki	FI 08	-
Tervajoki	FI 07	-
Hounijoki	FI 06	-
Mustajoki	FI 05.001	-
Alhonpuro	-	-
Pölkkyoja	-	-
Soskuanjoki	-	-

LATVIA

River name	River ID	Category
Salaca	-	4
Svētupe	-	4
Vitrupe	-	4
Aġe	-	4
Pēterupe	-	4
Gauja	-	5
Roja	-	4
Irbe	-	4
Venta	-	5
Užava	-	4
Rīva	-	4
Saka	-	4
Bārta	-	4

LITHUANIA

River name	River ID	Category
Neris (Nemunas)	LT1	-
Žeimena (Nemunas)	LT2	1
Vilnia (Nemunas)	LT3	-
Vokė (Nemunas)	LT4	-
Mera (Nemunas)	LT5	-
Šventoji (Nemunas)	LT6	4/5
Siesartis (Nemunas)	LT7	-
Širvinta (Nemunas)	LT8	-
Virinta (Nemunas)	LT9	-
Dubysa (Nemunas)	LT10	4/5
Šventoji	LT11	-
Akmena-Dangė	-	1
Bartuva	-	-
Jūra	-	-
Kena (Nemunas)	-	-
Minija	-	1
Musė (Nemunas)	-	-
Smiltelė	-	1
Šyša	-	-
Venta	-	1

POLAND

River name	River ID	Category
Bauda	PL558	5
Błotnica	PL432	5
Brda (Vistula)	PL292	7
Czarna Woda	PL47734	4
Drawa (Odra)	PL1888	4
Drwęca (Vistula)	PL28	5
Gowienica	PL314	4
Gwda (Odra)	PL1886	7
Ina (Odra)	PL198	5
Łeba	PL476	5
Łupawa	PL474	7
Odra	PL1	7
Parsęta	PL44	4
Pasłęka	PL56	7
Piaśnica	PL4772	4
Radunia (Vistula)	PL4868	5
Reda	PL478	5
Rega	PL42	5
Słupia	PL472	4
Vistula	PL2	7
Wda (Vistula)	PL294	7
Wieprza	PL46	5
Wierzyca (Vistula)	PL298	7
Wołczenica	PL352	6
Zagórska Struga	PL4792	1

RUSSIA

River name	River ID	Category
Solka (Luga)	-	1
Azika (Luga)	-	1
Vruda (Luga)	-	3
Lemovzha (Luga)	-	1
Lubenka (Luga)	-	1
Khrevitsa (Luga)	--	1
Oredezh (Luga)	-	1
Vidon (Luga)	-	1
Chornaja (Khabolovka)	-	1
Sista	-	1
Voronka	-	1
Gladyshevka	-	1
Roschinka (Gladyshevka)	-	1
Ptichja (Gladyshevka)	-	1
Malinovka	-	1
Petrovka	-	1
Seleznevka	-	1
Gusinaja (Seleznevka)	-	1
Velikaja	-	1
Peschanaja	-	1
Serga	-	1
Polevaja	-	1
Römpöti brook	-	1
Gorokhovka	-	1
Karasiovka	-	1
Chasovoi brook	-	1
Kriven brook	-	1
Lososinka (Seleznevka)	-	1
Maiskii brook	-	1
Jukkola (west) brook	-	1
Jukkola (middle) brook	-	1
Jukkola (east) brook	-	1
Privetnaja	-	1
Ushkovski brook	-	1
Bystryi brook	-	1
Huumosenoja brook	-	1
Bannyi brook	-	1
Lososinka	-	1
Kuokkala brook	-	1
Pastorski brook	-	1
Maiak brook	-	1
Razinskii brook	-	1
Sestra	-	1
Smoliachkov brook	-	1

SWEDEN

River Name	River ID	Category
Ylinen Kihlankijoki (Torneälven)	001_1_2	1
Parkajoki (Torneälven)	001_1_3	1
Merasjoki (Torneälven)	001_1_4	1
Alanen Kihlankijoki (Torneälven)	001_1_1	1
Skrövån (Kalixälven)	004_1_1	1
Vettasjoki (Kalixälven)	004_1_2	1
Valtiojoki (Kalixälven)	004_1_2_1	1
Tolkkijoki (Kalixälven)	004_1_2_1_1	1
Ala-Leipojoki (Kalixälven)	004_1_3	1
Kutsasjoki (Kalixälven)	004_1_4	1
Vassara älv (Kalixälven)	004_1_5	1
Töre älv	005	1
Vitån	006	1
Norr-Lillån (Råneälven)	007_1	1
Borgforsälven (Piteälven)	013_1	1
Lillpiteälven	014	1
Rokån	015	1
Tvärån (Åbyälven)	017_1	1
Malbäcken (Åbyälven)	017_2	1
Byskebäcken (Byskeälven)	018_1	1
Tvärån (Byskeälven)	018_2	1
Kyrkbäcken (Byskeälven)	018_2_1	1
Storbäcken	1819	1
Lillträskbäcken (Kågeälven)	019_1	4
Bure älv	021	3
Tryssjöbäcken (Rickleån)	024_1	1
Storbäcken	025_1	1
Pålböleån (Sävarån)	026_1	1
Klappmarksbäcken (Sävarån)	026_2	1
Gravån (Sävarån)	026_3	1
Gärssjöbäcken (Sävarån)	026_4	1
Brännbäcken (Sävarån)	026_5	1
Malbäcken (Sävarån)	026_5_1	1
Fällforsån/Tavelån	027	1
Smörbäcken (Umeälven)	028_1	1
Idebäcken /Västanbäcken (Umeälven)	028_2	1
Sörmjöleån	28291	1
Nättingtjärnbäcken	28292	1
Norrmjöleån	28293	1
Degerbäcken (Hörnån)	029_1	1
Lillån (Öreälven)	030_1	1
Forstjärnbäcken (Öreälven)	030_2	1
Kälkvattsbäcken (Öreälven)	030_3	1
Prästbäcken	30311	1
Levarbäcken	30312	1
Torsbäcken	30313	1
Sågbäcken (Lögdeälven)	032_1	1
Stockbäcken (Lögdeälven)	032_2	1
Rundbäcken (Lögdeälven)	032_3	1
Bladtjärnsbäcken (Lögdeälven)	032_4	1
Mjösjöån (Lögdeälven)	032_5	1
Saluån	32331	1
Stridbäcken	32332	1
Skravelbäcken	32333	1
Snörbäcken	32334	1
Aspan	32335	1
Husån	033	2
Dombäcksbäcken	3334	1
Svartvattbäcken /Flärkån (Gideälven)	3435	1
Idbyån	035	1
Galasjöån (Moälven)	036_2	1
Forsån (Moälven)	036_3	1
Utterån (Moälven)	036_4	1
Dalsjöbäcken	37381	1
Näskeån	37382	1
Kälaviksbäcken	37383	1
Gålsjöbäcken	37384	1
Vedån	37386	1
Inviksån	37387	1
Dockstaån/Utanskogså	37388	1
Björkån (Ångermanälven)	038_1	1
Strinneån (Ångermanälven)	038_2	1
Älandsån	38391	1
Utansjöån	38392	1
Edsån	38393	1
Vålångersbäcken	38394	1
Överdalsån	38395	1
Bollstaån	38396	1
Gådeån	039	1
Byån	39401	1
Norrån	39402	1
Sörån	39403	1
Ljustorpsån (Indalsälven)	040_1	1
Aspån (Indalsälven)	040_1_1	1
Havstobäcken	40411	1
Bänkåsbäcken	40412	1
Bredsandsbäcken	40413	1
Slädabäcken	40414	1
Selångersån	041	1
Vapelbäcken	4142	1
Gnarpsån	043	1
Harmångersån	044	3
Tomashamnsbäcken	44451	1
Pulsarvsbäcken	44452	1
Storsandsbäcken	44453	1
Halstaån	44454	1
Björnbäcken	44455	1
Medskogtjärnsbäcken	44456	1
Hornån	44457	2

Hällkroksbäcken	44458	1
Kolarviksbäcken	44459	1
Delångersån	045	3
Enångersån	4647	3
Lötån	047	1
Söderhamnsån	4748	1
Kvarnån	48491	1
Bäck Billingen-Järvs	48492	1
Skärjån	049	3
Hamrångerån	050	1
Hilleviksbäcken/Björkeån	5051	1
Gävleån	052	3
Hemlingbybäcken/ Järvstabäcken	5253	1
Forsmarksån	055	1
Gråskaån	56571	3
Lavaröån	56572	2
Skeboån	057	3
Bodaån	57581	2
Norsjöbäcken	57582	2
Tullviksbäcken	57583	1
Broströmmen	058	2
Norrtäljeån	059	2
Penningbyån	59601	1
Enviksbäcken	59602	1
Bergshamraån	59603	2
Loån	59604	2
Ullnaån	6061	3
Erstaviksbäcken	6162	1
Tyresån	062	3
Kvarnbäcken	62631	2
Åbyån	62632	1
Ånäsbäcken	62633	3
Bränningeån	62634	3
Husbyån	62635	3
Vinåkersbäcken	62636	1
Skillebyån	62637	3
Åvaån	62638	1
Träskbäcken	62639	1
Fitunaån	626311	1
Moraån	626312	2
Muskån	626313	1
Sandemarsbäcken	626314	3
Kagghamraån	626315	1
Ålbergaån	066	1
Vretaån	066_1	1
Kvarsebobäcken	66671	1
Svintunaån	66672	1
Djupviksbäcken	66673	1
Kolmårdsbäcken	66674	1
Pjältån	66675	1
Torshagsån	66676	1
Getåbäcken	66678	1
Vadsbäcken	6768	1
Storån	068	1
Fredriksnäsbäcken	68692	1
Börrumsån	68693	1

Bäck till Yxeltorpav	68694	1
Vammarsmålaån	68695	1
Passdalsån	68696	1
Rävbrinksbäcken	68697	1
Vindån	069	1
Verkebäcksån	70711	1
Gamlebyån	70712	1
Blekhemsån (Almvikså	70713	1
Loftaån	70714	1
Marströmmen	072	1
Virån	073	1
Lillån	7475	1
Ljungbyån	077	4
Hagbyån	078	1
Halltorpsån	7879	1
Bruatorpsån	079	1
Brömsebäcken	7980	1
Lyckebyån	080	3
Silletorpsån	8081	2
Nättrabyån	081	3
Heabybäcken	81821	1
Listerbyån	81822	1
Angelån	81823	1
Ronnebyån	082	7
Sörbybäcken	082_1	2
Vierydsån	083	2
Bräkneån	084	3
Siggarpsån	8485	1
Mieån	085	2
Västra Orlundsån	86871	1
Östra Orlundsån	86872	1
Gallån	86873	1
Skräbeån	087	1
Forsakarsbäcken / Igelgrop (Helgeån)	088_1	1
Mjöån (Helgeån)	088_2	1
Vinne å (Helgeån)	088_4	1
Vramsån (Helgeån)	088_3	1
Bäck vid Brantevik	88891	1
Kvarnbybäcken	88892	1
Kabusaån	88893	1
Kylsbäcken	88894	1
Knäbäcken	88895	1
Kungabäcken	88896	1
Rörums Södra å	88897	1
Segesholmsån	88898	1
Mölleån	88899	1
Norre å	888910	1
Verkaån	888911	1
Tommarpsån	888912	1
Kippersbäcken	888913	1
Oderbäcken	888914	1
Rörums Norra å	888915	1
Hannasån	888916	1
Klammersbäck	888917	1
Julebodaån	888918	1
Komstadsån	888919	1

Nybroån	089	1
Sänkebäck	89901	1
Strandhemsbäcken	89902	1
Bäck vid Gislövsläge	89903	1
Albäcken	89904	1
Dybäcksån	89905	1
Bäck 2 km V Vellinge	89906	1
Sjötorpsbäcken	89907	1
Bäck vid Bernstorp	89908	1
Charlottenlundsbäcke	89909	1
Gessiebäcken	899010	1
Svartån	899011	1
Ståstorpsån	899012	1
Dalköpingeån	899013	1
Tullstorpsån	899014	1
Skivarpsån	899015	1
Rosbäcken Biflöde svartån)	899011_1	1
Hunnestadbäcken (biflöde svartån)	899011_2	1
Sege å	090	1
Höje å	091	1
Kävlingeån	092	1
Bråån	092_1	1
Saxån	093	1
Säbyholmsån	93941	1
Säbybäcken	93942	1
Rydebäcken	93943	1
Råån	094	1
Bäck vid utvälinge	94951	1
Hittarpsbäcken	94952	1
Skälebäcken	94953	1
Döshultsbäcken	94954	1
Bäck vid vattenmölla	94955	1
Vege å	095	1
Ängelbäcken	96971	1
Appelrydsbäcken	96972	1
Hovallshamnbäcken	96973	1
Hovbäcken	96974	1
Ripgårdsbäcken	96975	1
Segeltorpsbäcken	96976	1
Bäck vid vejbystrand	96977	1
Myltebäck	96978	1
Smårydsbäcken	96979	1
Vadbäcken	969710	1
Möllebäcken	969711	1
Skintan	1021031	1
Långasandsbäcken	1021032	1
Hulabäck	1021031	1
Killebäcken	1021032	1
Nyrebäcken	1021031	1
Knebildstorpsbäcken	1021032	1
Kvarnabäcken	1021031	1
Skreastrandsbäcken	1021031	1
Ringsegårdsbäcken	1021032	1
Vrångabäcken	1031043	1
Nygårdsbäcken	1031044	1

Nisebäcken	1041051	1
Kråkebäcken	1041052	1
Paradisbäcken	1041053	1
Lundaån	1051061	1
Kvarnabäcken	1051062	1
Ströan	1051063	1
Torpaån	1051065	1
Haga å	1071081	1
Smalholmsbäcken	1071082	1
Stockaån	1071083	1
Kläppabäcken	1071084	1
Kyviksbäcken	1071085	1
Veån	1071086	1
Lerkilsbäcken	1071087	1
Krogabäcken	1071088	1
Knapabäcken	1071089	1
Gothemsån	117	1
Storsundsån	1171181	1
Hugraifsån	1171182	1
Histillesån	1171183	1
Gartarveån	1171184	1
Nygårdsån	1171185	1
Halsegårdaån	1171186	1
Svajdeån	1171187	1
Snoderån	118	1
Brusebobäcken	1181171	1
Kioskbäcken	1181172	1
Hyluån	1181174	1
Kohlens kvarnbäcken	1181175	1
Lergravsbäcken	1181176	1
Bångån	1181177	1
Robbjänsån	1181178	1
Hultungsån	1181179	1
Kopparviksbäcken	11811710	1
Lummelundaån	11811711	1
Ireån	11811712	1
Idån	11811713	1
Själsöån	11811714	1
Åbybäcken	119	1

Annex III

Red List sea trout rivers (reproduction level < 50% of the potential smolt production capacity) listed by country.

Estonia
Altja oja
Ikla pkr
Jägala jõgi
Järveoja
Kabli oja
Kadaka oja
Karepa oja
Karilepa oja
Keila jõgi
Kiruma pkr
Kloostri jõgi
Kunda jõgi
Künnima oja
Küti oja
Leisi jõgi
Lemmejõgi
Ligeoja
Lindi oja
Loo jõgi
Loobu jõgi
Lõuka peakraav
Meriküla oja
Narva jõgi
Nõva jõgi
Oju pkr
Paadrema jõgi
Pada jõgi
Pirita jõgi
Poama oja
Poolnõmme peakraav
Punapea jõgi
Purtse jõgi
Pühajõgi
Pärnu jõgi
Riguldi jõgi
Selja jõgi
Soonda
Sõreda oja
Sõtke jõgi
Taaliku pkr
Tirtsi jõgi
Tõrvanõmme peakraav
Tõstamaa jõgi
Treimani oja
Tuuraste oja
Udria oja
Vasalemma jõgi
Vesiku oja
Veskijõgi
Vihterpalu jõgi
Voka jõgi
Võlupe jõgi

Finland
Espoonjoki
Isojoki
Kiskonjoki
Lestijoki
Mankinjoki
Mustajoki
Sipoonjoki
Siuntionjoki
Tornionjoki
Urpalanjoki
Virojoki

Sweden
Ala-Leipojoki
Alanen Kihlankijoki
Albäcken
Bodaån
Bollstaån
Broströmmen
Brännbäcken
Bränningeån
Bure älv
Byskebäcken
Bångån
Bäck Billingen-Järvs
Bäck till Yxeltorpav
Delångersån
Djupviksbäcken
Dockstaån/Utanskogså
Edsån
Enviksbäcken
Erstaviksbäcken
Forsmarksån
Forstjärnbäcken
Fredriksnäsbäcken
Fällforsån/Tavelån
Gessiebäcken
Gravån
Gråskaån
Halstaån
Hamrångerån
Heabybäcken
Hilleviksbäcken/Björkeån
Histillesån
Hittarpsbäcken
Husbyån
Hyluån
Höje å
Inviksån
Killebäcken
Kioskbäcken
Knäbäcken
Komstadsån
Kutsasjoki
Kvarnbäcken
Kvarnån
Kyrkbäcken
Kävlingeån
Lavaröån
Lillpiteälven
Lillträskbäcken
Lillån
Lillån
Ljungbyån
Ljustorpsån
Lundaån
Långasandsbäcken
Lötån
Marströmmen
Merasjoki
Norr-Lillån
Norrmjöleån
Norrån
Norsjöbäcken
Näskeån
Oderbäcken
Parkajoki
Penningbyån
Pålböleån
Ringsegårdsbäcken
Robbjänsån
Rokån
Ronnebyån
Rosbäcken(Bifl. svartån)
Rävbrinksbäcken
Sege å
Skeboån
Skrövån
Skärjån
Smalholmsbäcken
Storbäcken
Strandhemsbäcken
Strinneån
Säbybäcken
Sörmjöleån
Tolkkijoki
Tomashamnsbäcken
Tullstorpsån
Tullviksbäcken
Tvärån
Töre älv
Ullnaån
Utterån
Vadbäcken
Vadsbäcken
Valtiojoki
Vapelbäcken
Vassara älv
Vettasjoki
Vindån
Vinåkersbäcken
Vitån
Vrångabäcken
Ylinen Kihlankijoki
Ånäsbäcken

Denmark
Alling Å
Askebæk
Bobbe Å
Drikkær Bæk
Elverdamsåen
Erritsø Bæk
Giber Å
Grenå
Gudenå
Gudsø Bæk
Haderslev Å
Hede Å
Hoed Å
Hundstrup Å
Hygind Bæk
Højbro Å
Kær-Mølleå
Knudbæk
Kolding Å
Kolå

Kongshøj Å
Korup Å
Kruså
Køge Å
Made Bæk
Møllebæk
Nivå
Odder Å
Odense Å
Pugemølle Å
Rudbæk
Saltø Å
Sillebro Å
Sillerup Bæk
Skelbæk
Snogbæk
Spang Å
Store Handsted Å
Suså
Tange Å
Taps Å
Tryggevælde Å
Ultang Møllebæk
Vandløb fra Kelstrup
Vejle Å
Vejstrup Å
Voers Å
Århus Å
Å-Å
Ørbæk Å
Ørum/Rhoden Å
Ultang Møllebæk
Vandløb fra Kelstrup
Vejle Å
Vejstrup Å

Poland

Bauda
Błotnica
Brda
Czarna Woda
Drawa
Drwęca
Gowienica
Gwda
Ina
Łeba
Łupawa
Odra
Parsęta
Pasłęka
Piaśnica
Radunia
Reda
Rega
Słupia
Vistula
Wda
Wieprza
Wierzyca
Wołczenica
Zagórska Struga

Lithuania

Jura
Mera
Muse
Siesartis
Voke
Zeimena

Russia

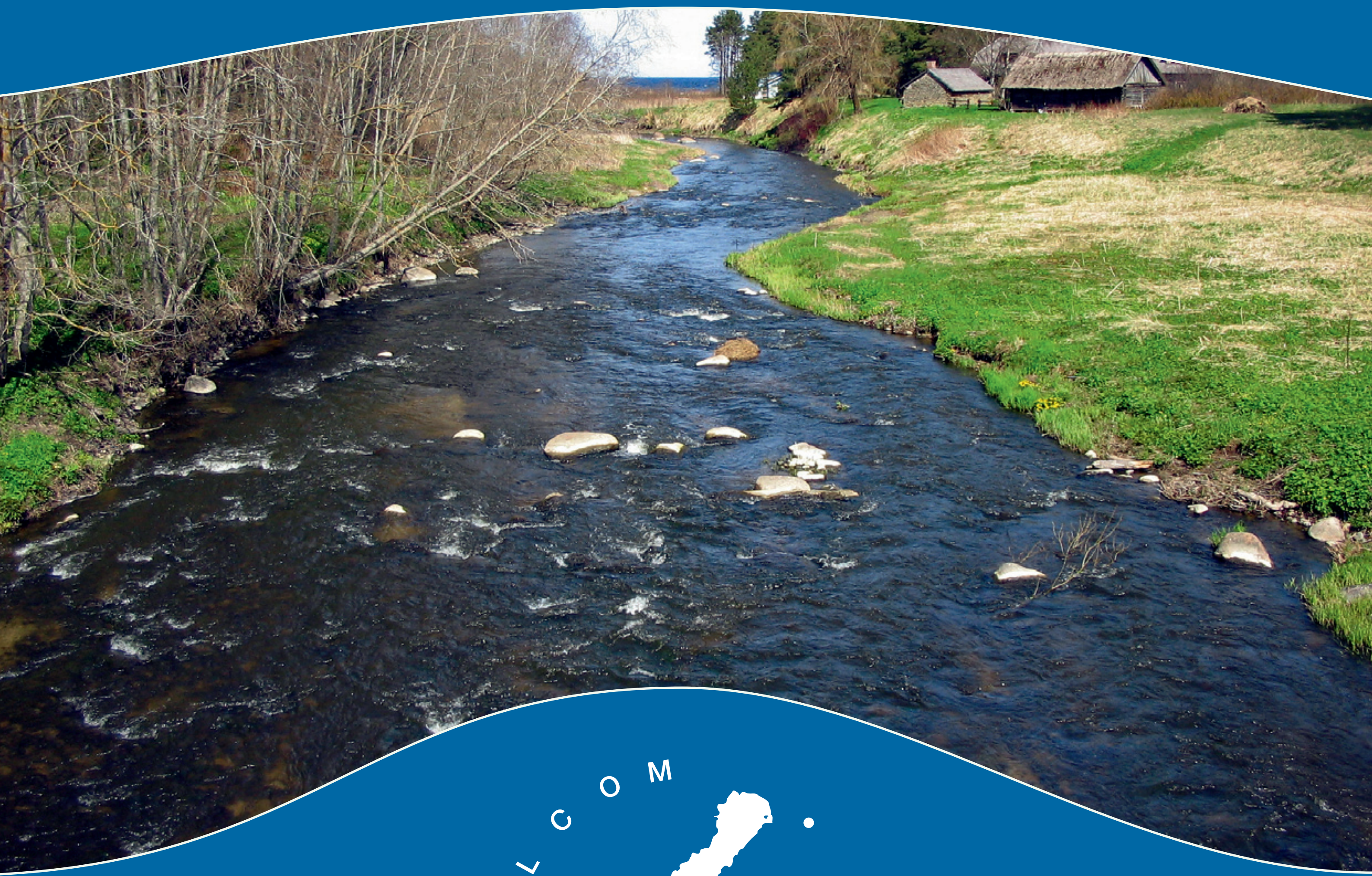
Azika
Bannyi brook
Bystryi brook
Chasovoi brook
Chornaja
Gladyshevka
Gorokhovka
Gusinaja
Huumosenoja brook
Jukkola (east) brook
Jukkola (middle) brook
Jukkola (west) brook
Karasiovka
Khrevitsa
Kriven brook
Kuokkala brook
Lemovzha
Lososinka
Lososinka
Lubenka
Maiak brook
Maiskii brook
Malinovka
Oredezh
Pastorski brook
Peschanaja
Petrovka
Polevaja
Privetnaja
Ptichja
Razinskii brook
Roschinka
Römpöti brook
Seleznevka
Serga
Sestra
Sista
Smoliachkov brook
Solka
Ushkovski brook
Velikaja
Vidon
Voronka
Vruda

Latvia

Aģe
Rīva
Užava

Further information on Danish rivers and streams

	Stream	River ID	Number of sections/tributaries		Year
			with prod. < 50%	total in stream	observed
1.	Alling Å	1504	1	7	2003
2.	Askebæk	926	1	1	2008
3.	Bobbe Å	133	1	1	1989/1997
4.	Drikkær Bæk	1312a	1	1	2003
5.	Elverdamsåen	334	1	2	2005
6.	Erritsø Bæk	1209	1	1	2008
7.	Giber Å	1317	1	6	2006
8.	Grenå	1417	2	14	2009
9.	Gudenå	1506-3	8	30	2003
10.	Gudsø Bæk	1208	1	1	2002
11.	Haderslev Å	1176	2	4	2003
12.	Hede Å	1214	1	1	2008
13.	Hoed Å	1413	2	2	2003
14.	Hundstrup Å	937	1	2	2008
15.	Hygind Bæk	1010	1	2	2008
16.	Højbro Å	201	1	1	2005
17.	Knudbæk	1181	1	1	2003
18.	Kolding Å	1205	8	17	2008
19.	Kolå	1403	1	2	2003
20.	Kongshøj Å	925	1	3	2008
21.	Korup Å	1617	1	4	2008
22.	Kruså	1128	1	1	2009
23.	Kær-Mølleå	1183	1	2	2008
24.	Køge Å	508	1	3	2005
25.	Made Bæk	1213	1	1	2008
26.	Møllebæk	1156	1	1	2003
27.	Nivå	211	2	6	2005
28.	Odder Å	1316	1	6	2008
29.	Odense Å	912	1	18	2008
30.	Pugemølle Å	1014	1	5	2008
31.	Rudbæk	1148	1	1	2003
32.	Saltø Å	621	1	2	2005
33.	Sillebro Å	307	1	1	2005
34.	Sillerup Bæk	1180	2	3	2003
35.	Skelbæk	1002	1	2	2008
36.	Snogbæk	1141	1	1	2009
37.	Spang Å	1212	1	9	2008
38.	Store Handsted Å	1308	2	11	2003
39.	Suså	622	1	6	2005
40.	Tange Å	928	1	1	2008
41.	Taps Å	1182	2	9	2008
42.	Tryggevælde Å	511	1	5	2005
43.	Ultang Møllebæk	1169	1	1	2003
44.	Vandløb fra Kelstrup	1165	1	1	2003
45.	Vejle Å	1216	2	28	2008
46.	Vejstrup Å	932	1	2	2008
47.	Voers Å	1701	1	11	2004
48.	Ørbæk Å	924	1	2	2008
49.	Ørum/Rhoden Å	1220	6	11	2008
50.	Århus Å	1320	4	11	2003
51.	Å-Å	1016	1	2	2008



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