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Report of the Workshop on Baltic Salmon Management Plan Request (WKBALSAL)

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ICES International Council for the Exploration of the Sea

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Executive summary

EC requested ICES to provide scientific advice on management of Baltic Sea salmon. This should include a biological evaluation of old SAP (IBSFC) – especially of why some smaller salmon populations did not respond on measures taken under the SAP. It should also provide a range of options (including objectives and measures) for the future management plan for salmon. All options should include consideration of environmental interactions, such as habitat use, predation, genetic aspects and contaminants. The recommendations by the BS RAC served as background information.

Regarding definitions the WKBALSAL proposes that the future Baltic Sea salmon management plan shall define a "wild salmon population" as "wild salmon populations are self-sustaining populations with no or only very limited releases of reared fish".

New corrected assessment runs were made available to the WK compared to those available to the ordinary assessment work by ADGSALM a month ago. These were now regarded as adequately reflecting the individual river/stock status.

WKBALSAL's evaluation of the current Salmon Action Plan is as follows:

- The SAP has been partially successful in achieving its objective of recovering natural smolt production of salmon rivers to 50% of their potential by 2010. Natural smolt production in all of the salmon rivers in Bothnia Bay (assessment unit 1 in the Gulf of Bothnia) is likely to achieve or exceed 50% of its potential by 2010. None of the rivers of the Gulf of Finland and only some of the rivers in the remainder of the Baltic Sea are likely to achieve the objective.
- There is insufficient scientific information upon which to determine if populations are within "safe genetic limits," but there are genetics concerns in light of the estimated small size of spawning populations in the smallest salmon stocks together with large nearby hatchery production.
- While the production of salmon populations of small rivers (length less than 100 km) is usually more variable and more susceptible to natural and human-caused perturbations, there does not seem to be a general reason for the SAP to perform poorly with respect to some of these rivers. Specific factors that adversely affect salmon can be identified for some rivers.
- It is too early to fully evaluate the efforts to re-establish salmon populations, as at least one generation without releases is needed. However, to date there is little evidence of success.
- The ban on driftnet fishing has reduced fishing mortality. Time period closures of trapnet fishing in coastal waters are considered effective. Neither adipose finclipping nor the establishment of terminal fishing areas have been important tools to increase the selective exploitation of reared salmon, and thus reduce pressure on natural production of salmon. The effectiveness of adipose finclipping of reared salmon for management is questionable since it has not been implemented for all reared fish.

Regarding future management plans for salmon, the WKBALSAL states:

- The SAP (as adopted by the IBSFC) has several key weaknesses and it should not be continued in its current form. In particular, the current target of smolt production of 50% of its potential should be increased to at

least 75% if a goal of the plan is to recover salmon populations to the MSY level. In addition, there should be suitable objectives to address the genetic status of salmon populations.

- Another weakness of the SAP is that it primarily influences management measures for open sea fisheries. Managing primarily through measures in the open sea should be rejected since the life cycle of salmon depends on natural and human related factors that occur in river, coastal, and open sea environments.
- Management based on MSY could be applied by limits for any of at least three different approaches; harvest rate, smolt production or spawning stock levels. This implies that in practice management could be based for instance on a spawning stock limit. The exploitation of the stocks within a mixed stock fishery should be based on the weakest stock with the lowest resilience to exploitation. Many of these stocks are located in the southern Baltic.
- Future management of salmon should address the key human related activities that affect salmon, including fishing, habitat alteration, and hatcheries. The role of diseases, predation, and climate change (natural and/or human caused) should be taken into account in the design of future management measures relative to objectives. Management measures for fisheries should be applied to all fisheries (open sea, coastal, in rivers, commercial, and recreational) in a consistent manner. An appropriate monitoring scheme should be implemented to guide management and measure its performance.
- An integrated approach to future management of salmon should include river-specific elements to address the recovery needs of weak populations in small rivers. In addition to controls on fishing, these efforts should address habitat problems. A case-by-case approach will probably be necessary.

1 Introduction

In October 2007 the European Commission requested ICES for a scientific advice concerning revision of the Salmon Action Plan and a development of a new long-term management plan for Baltic salmon. ICES Baltic Salmon and Trout Assessment Working Group Work (WGBAST) was given the task and the Terms of Reference calls for working by correspondence for producing input to the advice on the revision of the Salmon Action plan by June 2008. In addition to working by correspondence, the Commission funded a special workshop (WKBALSAL) 13–16 May 2008 for the WGBAST members to convene and to properly consider the task. The workshop was attended by the following persons:

Janis Birzaks	Latvia
Johan Dannewitz	Sweden (part of meeting)
Mart Kangur	Estonia
Lars Karlsson	Sweden
Polina Levontin	United Kingdom
Tapani Pakarinen	Finland
Stig Pedersen	Denmark (part of meeting)
Wojciech Pelczarski	Poland
Henni Pulkkinen	Finland (part of meeting)
Atso Romakkaniemi (chair)	Finland
Stefan Stridsman	Sweden

In addition, Henrik Sparholt assisted the workshop. A complete list of participants who attended the meeting in can be found in Annex 1.

Request to ICES for advice on the revision of the Salmon Action Plan

The contents of the Commission's special request is the following:

<u>Background</u>

The management of salmon in the Baltic Sea has been covered by the IBSFC Salmon Action Plan (SAP) since 1997. The objective of this plan was to re-establish/recover wild Baltic Salmon to attain for each salmon river a natural production of wild Baltic Salmon of at least 50% until 2010. Based on the life cycle of salmon, measures taken from now on will take effect beyond 2010 which means that the IBSFC plan can be seen as obsolete. Together with the changed political situation in the Baltic through the last accession round, the Commission has therefore decided to develop options for the new SAP during 2008 and to propose a new management framework. The new management regime shall cover all salmon life stages (fresh water vs. marine) and address all human impacts affecting stock dynamics such as habitat condition and professional and recreational fisheries.

In order to define a comprehensive and effective management scheme for the further recovery and the long-term sustainable management of Baltic salmon the following steps are envisaged to establish an information basis for discussions with stakeholders and subsequent drafting of a new management scheme:

- Evaluation of the IBSFC SAP in terms of its objectives and technical efficiency

- Assessment and quantification of the status quo of Salmon and the main factors impacting its stock dynamics
- Advice on the definition of short-term and long-term objectives and respective measures and indicators
- Impact Assessment (economic, social and ecological) of the identified options

These aspects shall be addressed by holistic means therefore ideally considering the whole distribution area of Salmon in the Baltic (including the EU and Russia), all different life stages and habitats (marine and individual rivers) and look at different sources of impacts (marine vs. freshwater fisheries, habitat conditions, aquaculture, climate change, dioxin). For the evaluation of the existing management regime and the advice for a prospective one, the different management competences (national vs. community measures) shall be taken into account.

ICES is inquired for their availability/capacity to provide the biological evaluation of the current management plan and advice for a new SAP. Economic and social impact assessments are expected to be addressed through other means. Terms of reference for this request are outlined below. The deadline for the advice would be end of June 2008.

Biological evaluation of old SAP (IBSFC) – especially asking why some smaller salmon populations did not respond on measures taken under the SAP.

Provide a range of options (including objectives and measures) for the future management plan for salmon.

- The first option should be continuing management as of today
- The second option should explore the consequences of managing only through measures in the marine environment
- Further options should include an integrated approach with management objectives and measures in both, fresh water and marine environment

All options should include consideration of environmental interactions, such as habitat use, predation, genetic aspects and contaminants.

The recommendations by the BS RAC may serve as background information.

2 Evaluation of the IBSFC SAP in terms of its objectives and technical efficiency

2.1 Background

To evaluate the IBSFC SAP, the workshop used the WGBAST reports as the main source of information. The latest WGBAST assessment was, however, further improved by incorporating the latest Swedish Carlin tag recapture data and by treating the River Ume/Vindelälven more similarly in the model as the rest of the rivers, to decrease inconsistencies. A general description of the modeling framework is given by ICES (2007).

IBSFC Salmon Action Plan started in 1997 and the recovery plan has its main objective bound to the wild smolt production in 2010. There is still two more years until this milestone year will be reached and therefore this part of the evaluation is in principal premature. However, at this point only small amount of new data remains unavailable from the period of SAP and its influence on the general results of the evaluation is probably small.

The evaluation of the IBSFC SAP starts with a review on the status of the wild Baltic salmon stocks (next section), after which the five main objectives of the SAP are elaborated (section 2.3), and the special issues concerning the small and weak stocks have been reviewed (section 2.4).

2.2 State of Baltic Sea salmon stocks and the main factors impacting their dynamics

According to the current assessment, wild Baltic salmon rivers (excluding Gulf of Finland) can potentially produce 2.5–5.1 million (most likely 3.45 million) smolts (Table 2.2.1). Total amount of wild smolts has been increasing since the 1990s and is in the year 2007 estimated to be 1.7–3.5 million (most likely 2.4 million) smolts (Figure 2.2.1, Table 2.2.2). Overall, the most northern stocks (AU 1–2) show the most positive trend in smolt abundance over the last ten years and several of these are expected to reach management objectives by 2010. Stocks in assessment units (AU) 4 and 5 have been relatively stable but less abundant during recent years. Some of the stocks in AU 4–5 that had been so depleted at the start of the Salmon Action Plan that they have not been able to recover, and some of stocks have even weakened.

The most of the northern stocks (AU 1 and 2) are either very likely or likely to reach 50% of the smolt production capacity in 2010 (Table 2.2.3, Figure 2.2.2). Only the rivers Lögdeälven (uncertain) and Öreälven and Rickleån (both unlikely) show lower probabilities for reaching the objective of IBSFC SAP. The more southern stocks (AU 3–5) show somewhat more varying probabilities to reach the objective, and six of them (Ljungan, Emån, Pärnu, Daugava, Saka, Nemunas) are uncertain or unlikely to reach it. Because the overall uncertainty in the estimates of certain stocks is very large, it is more uncertain if these stocks will reach 50 % of the smolt production capacity. Most of the stocks are either uncertain or unlikely to reach 75% of the smolt production capacity in 2010.

Post-smolt survival has been gradually decreasing over the last 10–15 years and the lowest survival rate estimated thus far is for the year 2005 (Figure 2.2.3). The recent survival rate (10%) is about half of that prevailed in the late 1980s and the early 1990s.

Despite increases in numbers of wild smolts and rather stable numbers of reared smolts stocked in the Baltic Sea, the total amount of salmon surviving post-smolt phase and recruiting to fishery has not increased but lately even decreased (Figure 2.2.4). Current catches are lower than earlier partly due to the decreased recruitment to fishery (lower abundance) and partly due to decreased harvest rates.

The main factors that have impacted dynamics of Baltic salmon stocks have been fishery and its regulation, M74 syndrome and post-smolt survival (Romakkaniemi *et al.* 2003, ICES 2007). In addition, factors affecting in-river migration possibilities and spawning success seem to affect substantially the dynamics of some of the southern stocks. The stock of the river Emån serves as an example of a river with special problems in salmon migration. In this river most of the production area is above the poorly functioning fish ladders, which is one reason why the stock in this river has been assessed to have such a poor status. Little response of some of the stocks to the applied management may be connected to these special migration problems in rivers, but it is also possible that regional differences occur in the post-smolt survival, which may have masked the positive effects of management on the stocks. Restrictions for marketing of salmon due to high dioxin content and seal damages have caused regional and temporal deterioration in fishing possibilities and thus had an indirect positive effect on salmon populations (ICES 2007).

Table 2.2.1. Posterior probability distributions for the smolt production capacity (* 1000) in different Baltic salmon rivers. The posterior distributions are described in terms of their mode (most likely value), the 95% probability. interval (PI), and the method on how the posterior probability distribution has been obtained (see footnote under the Table 2.2.2). These estimates serve as reference points to evaluate the status of the stock.

		Smolt production capacity (thousand)				Method of estimation
		Mode	**Median**	**Mean**	**95% PI**	
Assessment unit 1						
1	Tornionjoki	1160	1217	1269	865-1968	1
2	Simojoki	40	53	60	32-114	1
3	Kalixälven	1003	1170	1269	551-2527	1
4	Råneälven	35	59	76	24-257	1
	Total assessment unit 1	2457	2591	2674	1635-4087	
Assessment unit 2						
5	Piteälven	22	29	34	18-77	1
6	Åbyälven	14	17	18	8-36	1
7	Byskeälven	123	156	180	83-429	1
8	Rickleån	9	12	13	1-33	1
9	Sävarån	3	4	6	3-16	1
10	Ume/Vindelälven	110	205	259	97-702	1
11	Öreälven	14	21	23	5-69	1
12	Lögdeälven	17	26	35	8-98	1
	Total assessment unit 2	425	518	568	322-1121	
Assessment unit 3						
13	Ljungan	1	2	5	1-20	1
	Total assessment unit 3	1	2	5	1-20	
Assessment unit 4						
14	Emån	15	15	16	11-21	1
15	Mörrumsån	82	84	86	63-119	1
	Total assessment unit 4	98	100	101	78-135	
Assessment unit 5						
16	Pärnu	3.5	3.8	3.9	2-6	2
17	Salaca	30	30	30	26-35	3
18	Vitrupe	4	4	4	2-6	3
19	Peterupe	5	5	5	3-8	3
20	Gauja	24	26	27	15-45	3
21	Daugava	9	10	10	6-18	3
22	Irbe	5	5	5	3-8	3
23	Venta	15	15	16	10-24	3
24	Saka	7	8	8	5-13	3
25	Uzava	4	4	4	3-7	3
26	Barta	4	4	4	3-7	3
27	Nemunas river basin	153	164	167	95-269	3
	Total assessment unit 5	275	282	286	209-394	
Total assessment units 1-5		**3451**	**3572**	**3634**	2482-5140	

Table 2.2.2. Salmon smolt production in Baltic rivers (excluding Gulf of Finland) with natural reproduction of salmon grouped by assessment units. Most probable number (x 1000) of smolts from natural reproduction with the associated uncertainty (95% Probability interval).

Assessment unit, sub-division, country	Cate gory	Reprod. area (ha, mode)	Potentia l (*1000)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Pred 2008	Pred 2009	Pred 2010	Method of estimation	
																			Pot. prod.	Pres. prod.
Gulf of Bothnia, Sub-div. 30-31:																				
Finland																				
Simojoki	wild	254	40	2	5	7	10	23	43	45	49	39	31	36	33	39	39	35	1	1
95% PI		218-299	32-114	1-5	3-8	5-13	7-16	16-37	33-61	33-67	37-69	29-56	23-43	27-51	26-44	27-59	26-61	23-61		
Finland/Sweden																				
Tornionjoki;Torneälven	wild	4997	1160.01	92	65	126	208	506	659	609	606	598	605	737	790	972	1038	945	1	1
95% PI		3877-6695	865-1968	64-138	46-94	96-176	165-275	407-657	528-843	509-727	471-784	466-783	494-763	583-950	625-1012	763-1270	800-1418	610-1512		
Sweden																				
Kalixälven	wild	2570	1003	109	105	237	443	683	759	790	676	742	820	879	880	940	933	922	1	1
95% PI		2062-3295	551-2527	55-312	45-321	131-603	244-1001	377-1592	420-1671	430-1711	354-1505	400-1695	447-1856	465-2099	484-2126	491-2109	532-2300	483-2363		
Råneälven	wild	384	35	4	3	11	13	19	24	23	18	19	23	28	30	35	35	32	1	1
95% PI		325-462	24-257	2-18	1-14	5-29	6-39	9-43	13-52	12-49	8-40	10-46	13-53	16-58	17-67	20-75	19-84	17-81		
Assessment unit 1, total			**2457**	**222**	**189**	**399**	**697**	**1279**	**1548**	**1516**	**1406**	**1455**	**1536**	**1743**	**1810**	**2076**	**2157**	**2068**		
95% PI			1635-4087	148-425	119-396	271-743	485-1239	934-2156	1146-2441	1100-2418	1015-2213	1042-2387	1095-2563	1261-2969	1303-2981	1496-3234	1603-3492	1416-3491		
Piteälven	wild	425	22	3	3	4	5	6	15	15	12	14	14	18	23	24	23	22	1	1
95% PI		359-511	18-77	2-6	2-6	2-8	3-8	4-11	10-24	11-24	7-19	9-22	9-21	13-28	16-38	18-38	16-41	14-46		
Åbyälven	wild	84	14	3	3	4	6	9	12	11	9	8	8	9	11	12	12	11	1	1
95% PI		67-108	8-36	1-11	1-10	2-12	3-15	5-19	7-26	6-22	5-19	4-18	4-18	5-20	6-24	6-25	7-27	6-24		
Byskeälven	wild	560	123	33	23	45	66	80	100	97	82	92	97	107	119	121	119	113	1	1
95% PI		473-673	83-429	16-79	10-70	24-100	36-138	45-161	64-188	61-196	48-162	55-178	59-197	68-218	69-260	70-255	73-249	68-272		
Rickleån	wild	15	9	0.1	0.0	0.1	0.1	0.1	0.2	0.3	0.2	0.2	0.2	0.2	0.3	0.4	0.5	0.4	1	1
95% PI		9.2-29	1-33	0-0.5	0-0.2	0-0.3	0-0.4	0-0.3	0.1-0.8	0.1-1	0.1-0.7	0.1-0.7	0.1-0.7	0.1-0.7	0.1-1.1	0.2-1.7	0.2-2.3	0.2-2.1		
Sävarån	wild	21	3	1	1	2	2	2	3	3	3	3	4	3	3	3	3	3	1	1
95% PI		13-40	3-16	0.5-3.9	0.3-3.1	0.8-3.9	1.1-4.2	0.8-3.8	1.4-4.8	1.5-5.5	1.4-4.9	1.7-5.1	2.8-4.8	2.4-3.8	2.5-4.4	2.1-6.5	2.3-7.3	2.1-7		
Ume/Vindelälven	wild	1242	110	18	17	23	51	68	91	79	70	65	77	122	137	143	141	142	1	1
95% PI		917-1778	97-702	8-59	8-57	11-62	26-117	34-156	50-192	44-165	35-173	30-154	41-182	74-284	81-345	81-353	84-369	77-369		
Öreälven	wild	105	14	0.7	0.4	0.9	0.9	1.1	1.9	2.2	1.7	1.9	2.2	2.4	3.5	3.9	4.3	4.0	1	1
95% PI		84-135	5-69	0-3	0-2	0-3	0-3	1-4	1-6	1-6	1-5	1-6	1-7	1-7	2-10	2-11	2-13	2-13		
Lögdeälven	wild	104	17	1	1	2	3	3	5	6	4	5	6	7	9	10	10	9	1	1
95% PI		82-136	8-98	1-6	0-4	1-6	1-9	2-10	3-14	3-14	2-12	2-12	3-15	3-17	5-21	5-24	5-25	5-26		
Assessment unit 2, total			**425**	**72**	**60**	**92**	**151**	**187**	**250**	**233**	**203**	**207**	**229**	**295**	**337**	**349**	**353**	**346**		
95% PI			322-1121	44-131	38-114	61-157	104-241	124-307	182-380	169-363	143-317	143-319	160-360	211-475	247-580	250-611	248-582	237-609		
Ljungan	mixed	17	1	0.25	0.18	0.49	0.61	0.83	0.78	0.76	0.57	0.58	0.68	0.73	0.95	0.95	0.95	0.82	1	1
95% PI		9.8-37	1-20	0.1-1.1	0.1-0.9	0.2-1.4	0.3-1.6	0.4-2.1	0.4-2.1	0.4-2.1	0.3-1.8	0.3-1.8	0.3-1.9	0.4-2.1	0.5-2.6	0.5-2.8	0.5-2.7	0.4-2.8		
Assessment unit 3, total			1	**0.25**	**0.18**	**0.49**	**0.61**	**0.83**	**0.78**	**0.76**	**0.57**	**0.58**	**0.68**	**0.73**	**0.95**	**0.95**	**0.95**	**0.82**		
95% PI			1-20	0.1-1.1	0.1-0.9	0.2-1.4	0.3-1.6	0.4-2.1	0.4-2.1	0.4-2.1	0.3-1.8	0.3-1.8	0.3-1.9	0.4-2.1	0.5-2.6	0.5-2.8	0.5-2.7	0.4-2.8		
Total Gulf of B., Sub-divs.30-31			**3004**	**307**	**260**	**502**	**870**	**1481**	**1819**	**1777**	**1631**	**1685**	**1794**	**2074**	**2192**	**2473**	**2551**	**2467**		
95% PI			2052-4897	217-511	180-478	364-854	631-1415	1116-2347	1373-2713	1353-2700	1205-2455	1255-2623	1334-2819	1568-3323	1665-3329	1846-3631	1963-3897	1762-3882		
Assessment unit, sub-division, country	**Cate gory**	**Reprod. area (ha, mode)**	**Potentia l (*1000)**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**Pred 2008**	**Pred 2009**	**Pred 2010**	**Method of estimation**	
																			Pot. prod.	**Pres. prod.**
Sweden																				
Emån	wild	21.7	15	2	4	4	4	5	3	2	2	2	3	3	1	1	1	1	1	1
95% PI			11-21	2-3	3-5	3-5	3-5	4-7	2-4	2-3	2-3	2-3	2-4	2-3	1-1	1-1	1-1	1-2		
Mörrumsån	wild	44	82	38	63	63	73	91	69	66	58	70	59	68	65	65	62	53	1	1
95% PI			63-119	28-55	48-84	49-86	57-101	71-121	52-92	50-87	44-78	55-96	45-80	53-92	50-88	50-89	48-84	32-94		
Assessment unit 4, total			**98**	**41**	**68**	**68**	**77**	**96**	**72**	**68**	**61**	**73**	**62**	**70**	**66**	**66**	**63**	**54**		
95% PI			78-135	31-57	52-89	53-91	61-105	77-126	54-94	52-89	46-80	57-98	48-83	55-94	51-89	51-90	48-85	32-96		
Estonia																				
Pärnu	wild	3	3.5		4.4	0.6	0.3	0.07	0.2	0.2	0.01	0.0102811	0.007	0.01	0.012	0.00116	0.00086	0.00073	2	3, 4
95% PI			2.1-6.2		2-13.9	0.3-2.3	0.1-1	0-0.2	0.1-0.6	0.1-0.6	0-0	0-0	0-0	0-0.1	0-0.1	0-0	0-0	0-0		
Latvia																				
Salaca	wild	47	30	22	23	32	26	20	27	27	24	15	27	25	26	26	25	27	3	2
95% PI			26-35	15-35	15-37	22-53	18-41	14-32	20-40	20-40	17-37	10-23	19-40	14-58	16-62	15-56	12-49	16-62		
Vitrupe	wild	5	4						2	2	2	3	3	3	3	3	3	3	3	5
95% PI			2.6-7.2						2-5	2-4	1-4	2-5	2-5	1-7	1-8	2-7	2-7	2-7		
Peterupe	wild	5	5						3	2	2	3	3	3	3	3	3	3	3	2, 5
95% PI			3-8						2-5	2-5	1-4	2-5	2-5	1-7	1-8	1-8	2-8	2-8		
Gauja	mixed	50	24	15	15	15	13	13	13	13	11	12	12	13	15	15	15	16	3	2, 5
95% PI			15-45	10-24	10-24	10-25	9-22	9-21	9-20	9-19	8-18	8-18	9-19	6-33	7-40	7-37	7-38	7-42		
Daugava***	mixed	20	9						2	2	2	3	3	3	4	4	4	4	3	5, 6
95% PI			6.-18						1-5	1-5	1-4	2-5	2-5	1-10	1-11	1-11	2-12	2-13		
Irbe	wild	10	5						5	5	5	5	5	5	5	5	5	5	3	5
95% PI			3-8						3-9	4-9	3-9	3-8	4-9	2-10	3-12	3-11	3-11	3-12		
Venta	mixed	30	15						11	11	10	11	12	11	12	13	13	13	3	2, 5
95% PI			10-24						7-17	7-17	7-16	7-18	8-18	6-26	7-28	7-28	7-29	7-29		
Saka	wild	20	7						2	2	2	2	2	3	3	3	3	4	3	5
95% PI			5-13						1-4	1-4	1-3	1-4	2-4	1-8	1-9	1-9	1-10	2-10		
Uzava	wild	5	4						2	2	2	3	3	3	3	3	3	3	3	5
95% PI			3-7						2-5	2-5	1-4	2-5	2-5	1-7	1-7	1-7	2-7	2-8		
Barta	wild	10	4						2	2	2	3	3	3	3	3	3	3	3	5
95% PI			3-7						1-4	2-4	1-4	2-4	2-5	1-7	1-7	1-7	2-7	2-8		
Lithuania																				
Nemunas river basin	wild		153	10	9	10	2	7	6	4	2	5	7	4	4	3	5	7	3	3, 4
95% PI			95-269	8-12	8-12	8-12	2-3	6-9	5-7	4-5	2-3	4-6	6-9	2-15	1-15	1-10	2-19	3-28		
Assessment unit 5, total			**275**						**82**	**79**	**70**	**66**	**83**	**87**	**96**	**95**	**96**	**107**		
95% PI			209-394						70-98	67-97	58-85	55-80	71-100	50-141	59-155	60-145	57-147	67-169		
Total Main B., Sub-divs. 22-29			**377**						**155**	**148**	**132**	**141**	**147**	**159**	**164**	**164**	**161**	**165**		
95% PI			298-494						133-182	127-175	113-156	120-168	127-173	121-220	124-228	126-221	123-219	120-242		
Gulf of B.+Main B., Sub-divs. 22-31			**3451**						**1990**	**1950**	**1784**	**1849**	**1970**	**2273**	**2393**	**2655**	**2752**	**2668**		
95% PI			2482-5140						1496-2783	1428-2832	1323-2544	1350-2694	1427-2904	1651-3338	1746-3491	1973-3773	2011-4004	1898-4041		

'+ = Low and uncertain production (not added into sub-totals or totals); '++ = Same method over time series; only the extension backwards preliminary; '* = Tributaries; '**** = Only Latvian part, Lithuanian part of the river needs to be added; n/a No data available.**

Methods of estimating production - Potential production: 1) Bayesian stock-recruit analysis; 2) Accessible linear stream length and production capacity per area; 3) Expert opinion with associated uncertainty.

Present production: 1) Bayesian full life history model (section 6.3.9); 2) Sampling of smolts and estimate of total smolt run size; 3) Estimate of smolt run from parr production by relation developed in the same river; 4) Estimate of smolt run from parr production by relation developed in another river: 5) Inference of smolt production from data derived from similar rivers in the region; 6) Count of spawners; 7) Estimate inferred from stocking of reared fish in the river, 8) Salmon catch, exploitation and survival estimate.

Reared smolts: *=Release river not specified.

Table 2.2.3. Overview of the status of the Gulf of Bothnia and Main Basin stocks in terms of their probability to reach 50 and 75% of the smolt production capacity by 2010. Stocks are considered very likely to reach this objective in case the probability is more than 90%. They are likely to reach the objective in case the probability is between 70 and 90% and unlikely in case the probability is less than 30%. When the probability of reaching the objective lies between 30 and 70%, it is considered uncertain if they will reach the objective in 2010.

		Prob to reach 50%				Prob to reach 75%			
		V.likely	Likely	Uncert.	Unlikely	V.likely	Likely	Uncert.	Unlikely
Unit 1									
	Tornionjoki	X						X	
	Simojoki		X					X	
	Kalixälven	X					X		
	Råneälven		X					X	
Unit 2									
	Piteälven	X						X	
	Åbyälven		X					X	
	Byskeälven	X						X	
	Rickleån				X				X
	Sävarån		X					X	
	Ume/Vindelälven	X						X	
	Öreälven				X				X
	Lögdeälven			X					X
Unit 3									
	Ljungan			X				X	
Unit 4									
	Emån				X				X
	Mörrumsån		X					X	
Unit 5									
	Pärnu				X				X
	Salaca	X					X		
	Vitrupe	X					X		
	Peterupe		X					X	
	Gauja		X					X	
	Daugava			X					X
	Irbe	X					X		
	Venta	X					X		
	Saka			X				X	
	Uzava	X					X		
	Barta	X					X		
	Nemunas				X				X

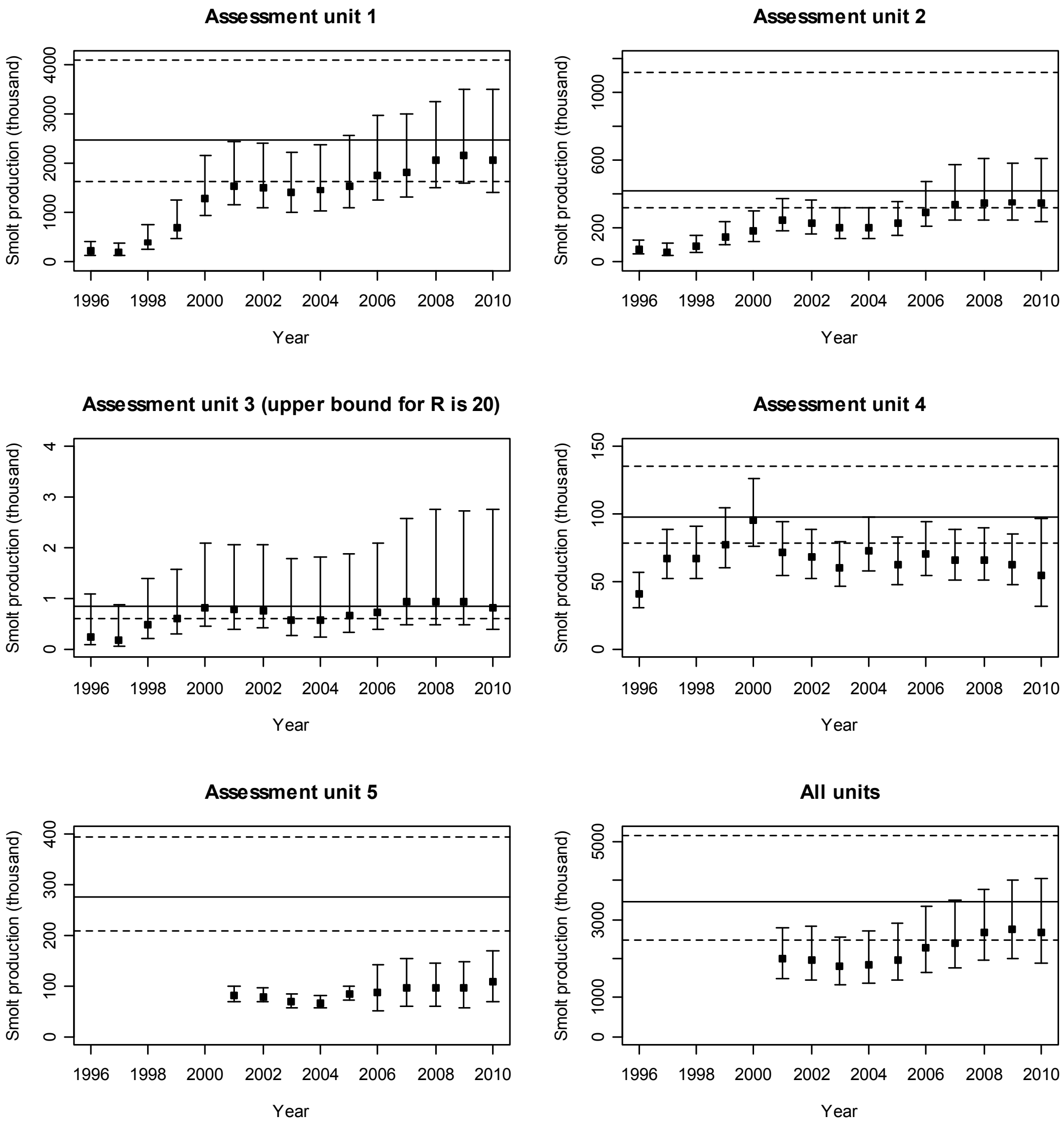


Figure 2.2.1. Posterior probability distribution (mode and 95% PI) of the total smolt production within units 1-5 and for all units together. The solid vertical line represents the mode of the smolt production capacity whereas the dash lines represent the 95% PI of the smolt production capacity.

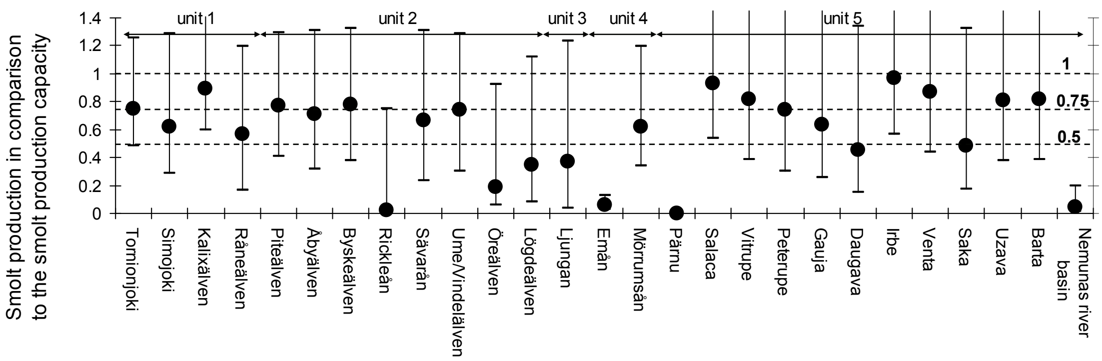


Figure 2.2.2. Smolt production in 2010 in comparison to the natural smolt production capacity for the Gulf of Bothnia and Main Basin stocks (mode and 95% probability interval).

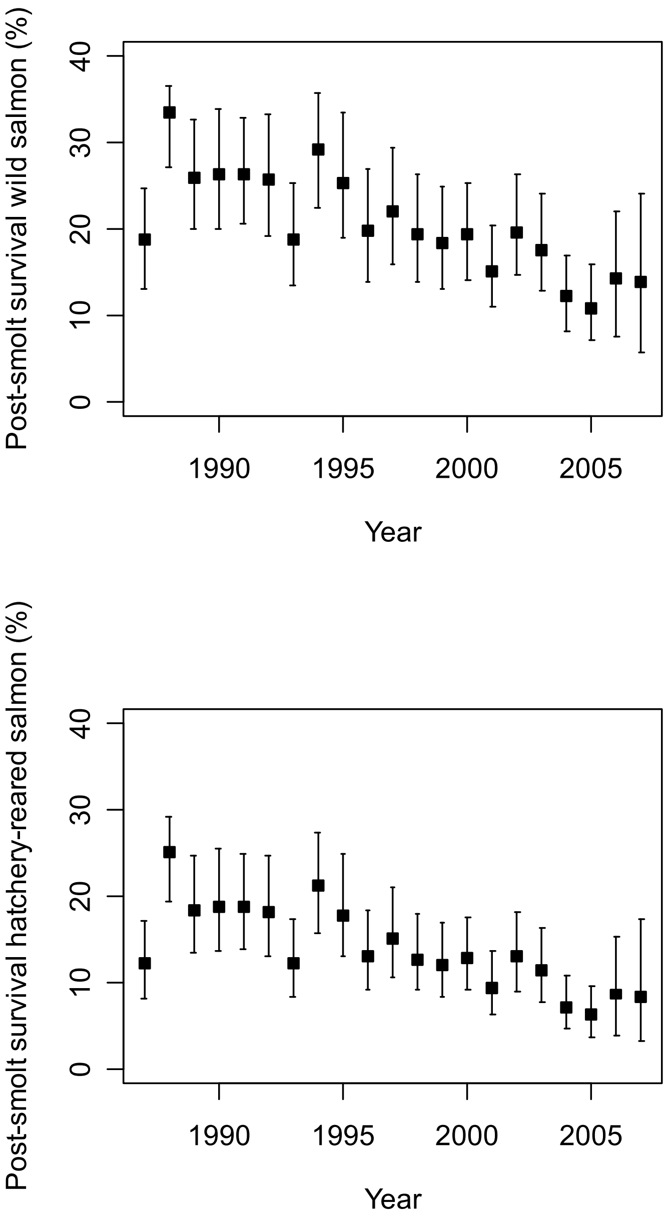


Figure 2.2.3. Post-smolt survival for wild and hatchery-reared salmon.

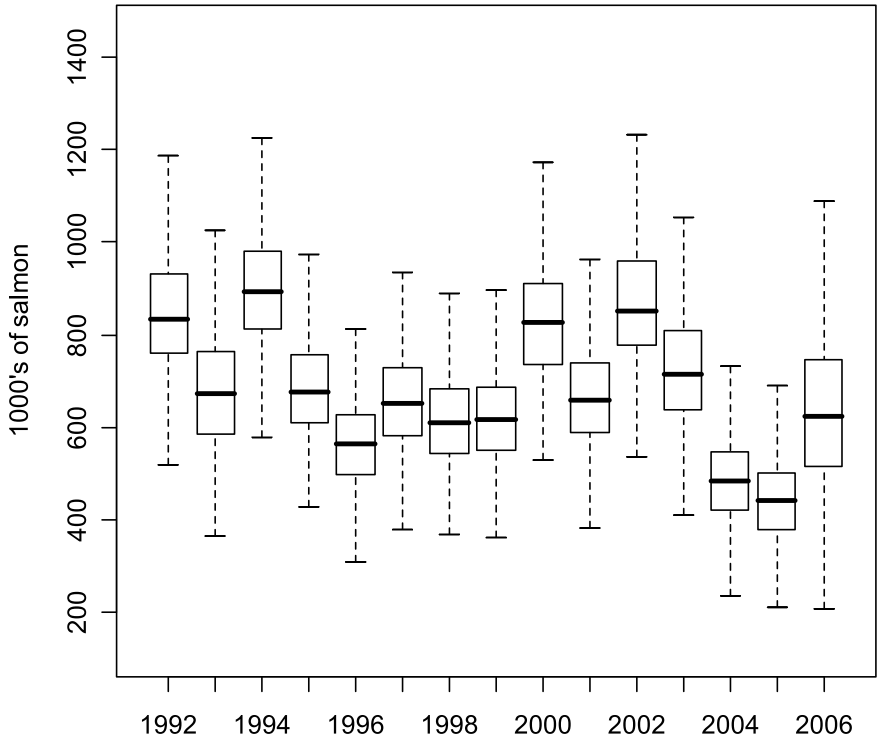


Figure 2.2.4. Annual total amount of feeding young salmon that survived the period of post-smolt mortality in the sea.

2.3 Evaluation of the five main objectives of the IBSFC SAP

2.3.1 "To prevent the extinction of wild populations, further decrease of naturally produced smolts should not be allowed"

Unlike some of the largest rivers with presently high smolt production, a handful of rivers did not respond to the combined beneficial effect from reduced M74 and reductions in the fishery (reduced TAC and economic constraints). Although this was continuously brought to the attention of the IBSFC SAP surveillance group this did not result in changes in management decisions.

In one of the final meetings of the SAP surveillance group it was eventually recognized that these rivers needed special attention as to explain reasons for the apparent inability to respond to reductions in both M74 and in the fishery. Table 2.3.1 illustrates the probabilities of increase in smolt production in the wild salmon rivers in the course of SAP.

Table 2.3.1. Probability of an increase in smolt production from year 1997 to years 2008 and 2010.

Probability of an increase		
River	By 2008	By 2010
Tornionjoki	100%	84%
Simojoki	100%	71%
Kalixälven	100%	65%
Råneälven	100%	74%
Piteälven	100%	61%
Åbyalven	98%	58%
Byskeälven	100%	56%
Rickleån	99%	91%
Sävarån	97%	71%
Ume/Vindelälven	100%	72%
Öreälven	100%	83%
Lögdeälven	100%	76%
Ljungan	97%	58%
Mörrumsån	56%	50%
Emån	0%	82%

2.3.2 "The production of wild Salmon should gradually increase to attain by 2010 for each Salmon river a natural production of wild Baltic Salmon of at least 50% of the best estimate potential and within safe genetic limits, in order to achieve a better balance between wild and reared Salmon"

The method of estimating river specific potential smolt production capacities (PP) was not specified by IBSFC, but left to the expert group to decide. During the implementation of the SAP the potential production estimates were updated several times in accordance with estimated annual smolt numbers. This resulted in constant difficulties in conveying the information on smolt production to managers (SAP surveillance group and IBSFC).

The concept of PP has implicit the assumption that production is constant between years, which is true only if both environmental (water flow, temperature, feeding possibilities, etc.) and habitat conditions (quality and accessibility of spawning grounds, water quality constant, water flow and wetted useable area) are stable.

In addition the use of a new method of calculation (Bayesian), which in itself may have been difficult to understand for managers, resulted in additional difficulties in understanding that historic estimates, for instance of smolt numbers in previous years, could change every year, or whenever new information becomes available.

Estimation of the potential production

The common challenges in estimating potential smolt production for salmon rivers include:

- only short time series of data are available,
- the period for which the data is available may not be informative about the state of unexploited stocks,
- recovering salmon stocks may not be utilising the habitat in an optimal manner thus biasing the estimates,
- the impact of the anthropogenic alterations to the river habitat may be difficult to assess,
- the changes in the marine environment may also affect the 'productivity' of the stocks,
- lack of direct observations on stock and recruitment from the region of interest – there are no such rivers in the Baltic Sea, where both smolts and spawners are counted.

Despite these difficulties, operational objectives for Baltic salmon management call for annual monitoring of smolt production relative to the potential production in individual rivers.

The first step currently taken in order to define 'potential production' quantitatively, in terms of the river-specific number of smolts produced annually, is a synthesis of expert knowledge about the production capacity of each of the modelled rivers (Uusitalo *et al.* 2005; Figure 2.3.2.1). Bayesian Belief Network methodology is used to model expert's beliefs about the factors that influence productivity in each river in order to get a representation of uncertainty in prior knowledge regarding potential production of each river:

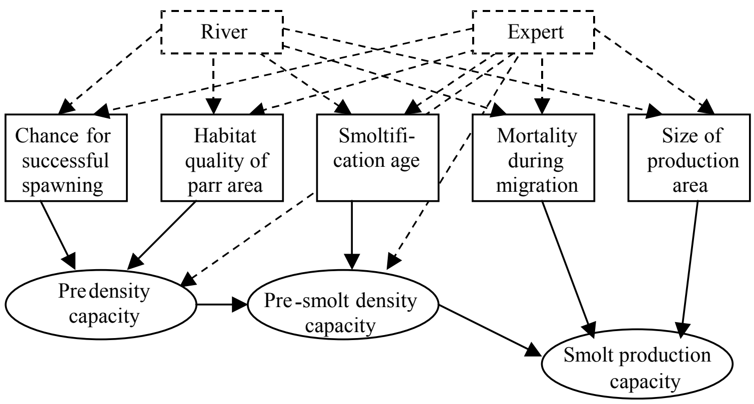


Figure 2.3.2.1. Synthesizing expert's knowledge about productivity of Baltic rivers (Uusitalo et al. 2005).

The resulting distributions representing expert beliefs regarding potential production for each river are imprecise and even after all of the available data are analyzed and the expert knowledge is updated, these distributions are still rather uncertain.

Because experts can disagree on the likely productive potential of the rivers, some of the distribution summarising the prior knowledge are bimodal. For some rivers there is little information in the data to update those beliefs, e.g. Emån. For other data rich rivers, information contained in just one additional year's data can result in large updates in the beliefs about the carrying capacity, e.g. Tornionjoki (Figure 2.3.2.2) on changes in PPs over time. Such updates are particularly pronounced when the data is appended during a period of stock recovery, in such circumstances each new annual observation can set a new high record and push the estimates of potential production still higher than previously believed – hence management are faced with uncertain goal posts that can also unexpectedly shift from year to year.

Further, the estimates of potential production may depend strongly on the assumed stock-recruitment model. For instance, the estimate of the river Emån may be sensitive to the form of the recruitment function. In order to assess if management objectives are likely to be achieved, smolt production needs to be estimated for each river and then compared with the carrying capacity. Annual smolt production, like the carrying capacity, is estimated in stages: first smolt-trapping data available only in three Baltic rivers is analyzed with mark-recapture methods (Mäntyniemi and Romakkaniemi 2002), next these results are extrapolated to most other Baltic rivers using a hierarchical regression analysis based on electrofishing data on parr densities, available for most rivers (ICES 2007). Both potential production estimates and annual smolt production estimates are updated in a state-space life history model yielding more precise distributions.

Current management targets based on 50% of potential production estimates are not consistent with the precautionary approach based on the MSY principle which is generally recognized in various international and European treaties and agreements to be an appropriate basis for management (Nielsen and Holm 2008; Mardle *et al.* 2002; Daw and Gray 2005). Calculations of the proportion of smolts relative to the potential production at MSY show that the management target based on the potential production estimates should be raised (Figure 2.3.2.3 and 2.3.2.4).

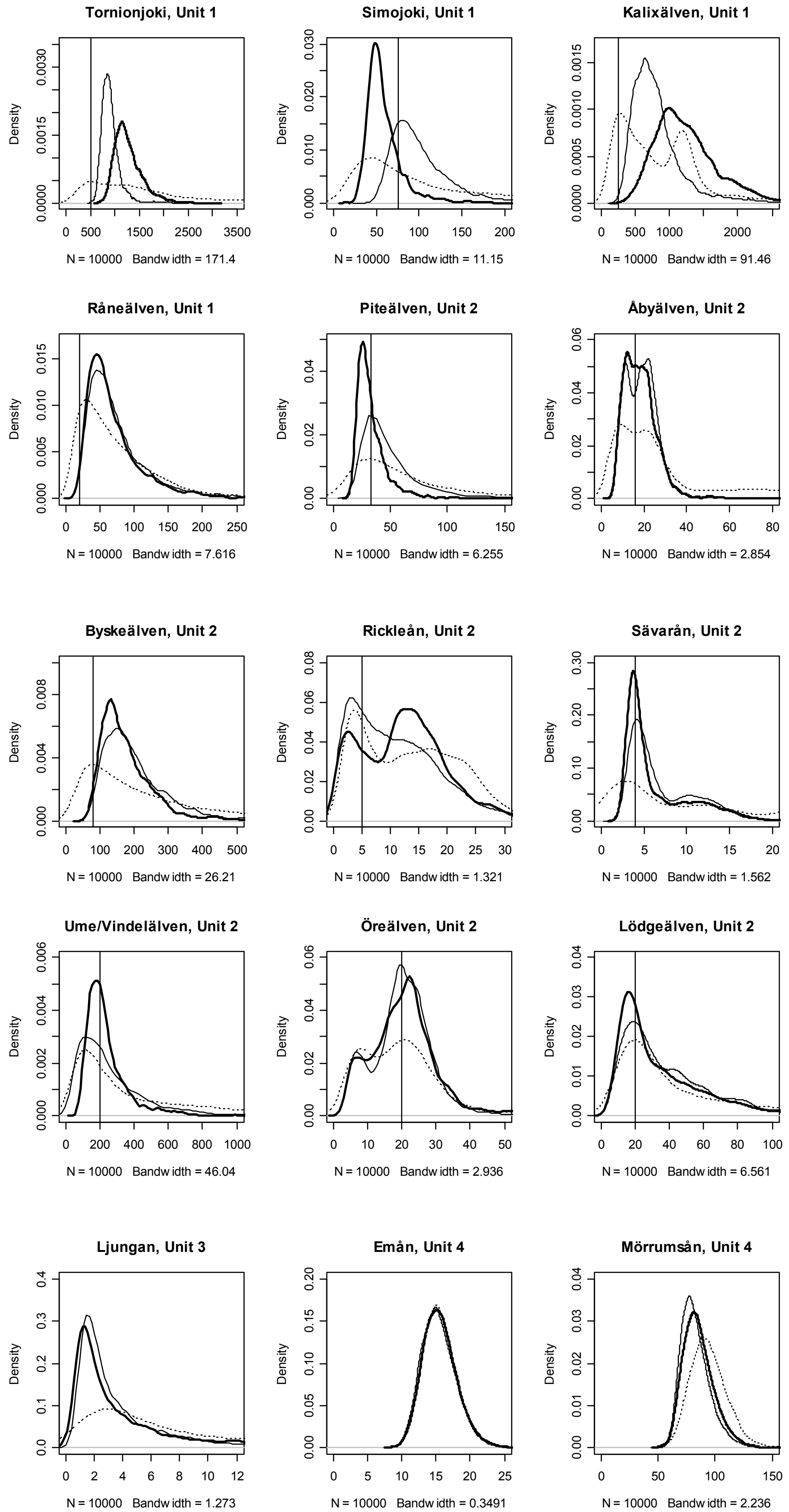


Figure 2.3.2.2. Old point estimates (vertical line), prior probability distributions (dotted line) and posterior probability distributions of the smolt production capacity obtained in the assessment of 2007 (thin line) and 2008 (bold line).

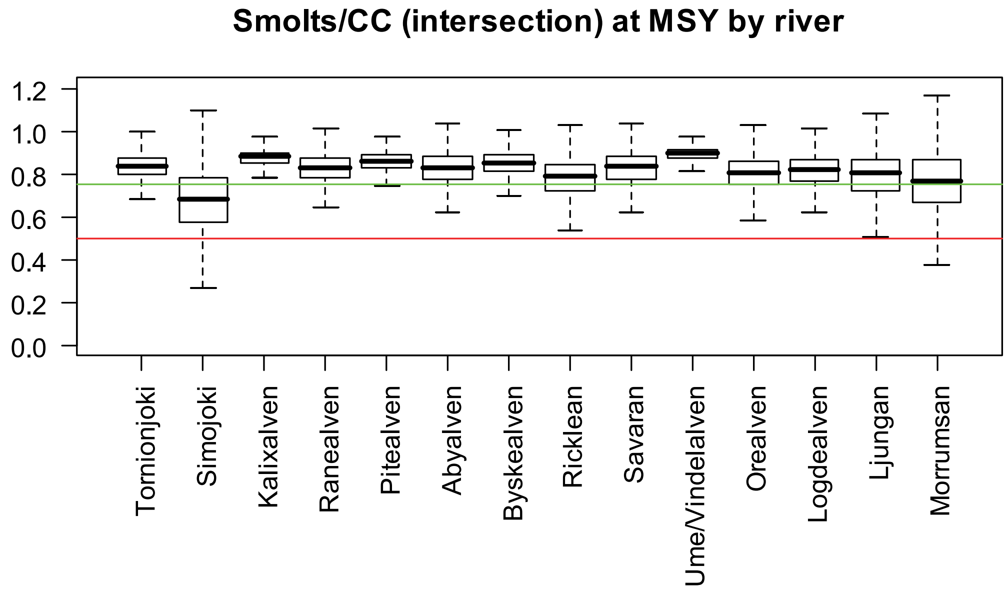


Figure 2.3.2.3. Smolts at MSY as a proportion of the carrying capacity (defined as the intersection of the replacement line and the stock recruit function) for different rivers, corresponding to M74 and Mps as they varied, according to the latest estimates, for the period from 1992 until 2006.

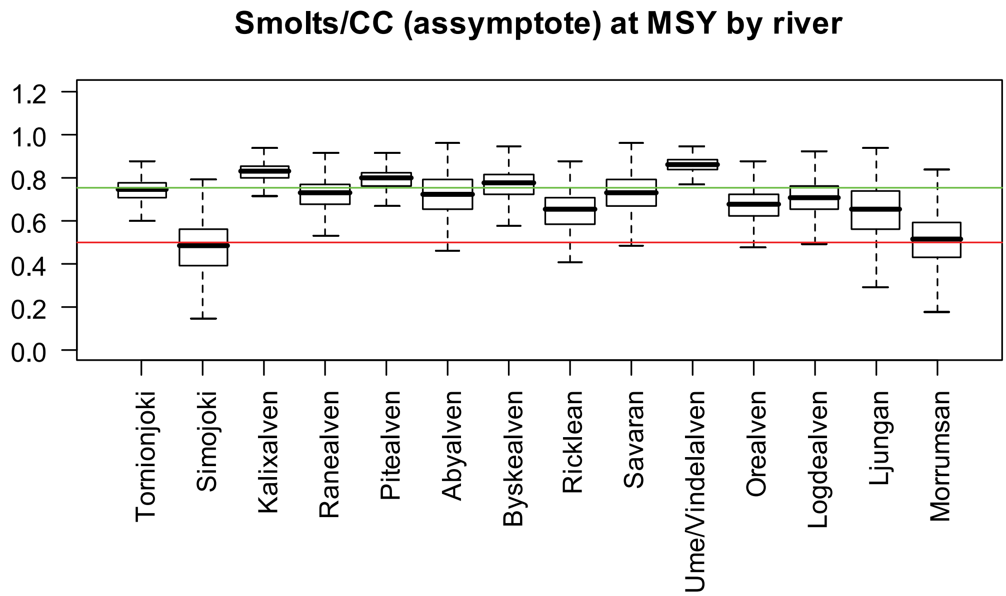


Figure 2.3.2.4. Smolts at MSY as a proportion of the carrying capacity (defined as the asymptote of the stock recruit function) for different rivers, corresponding to M74 and Mps as they varied, according to the latest estimates, for the period from 1992 until 2006.

Genetic diversity in wild stocks

Monitoring of genetic parameters in wild salmon stocks has not been included as an objective in the SAP. Therefore, development of genetic diversity during the SAP period is difficult to evaluate directly. There is a lot of genetic information available in the genetic baseline used as a reference database for the genetic mixed-stock analyses performed within the assessment work of WGBAST. The time period covered by the SAP is, however, too short to be able to say anything conclusive about changes in genetic diversity over time.

An alternative approach is to focus on number of ascending spawners in the rivers. From this information, it is possible to indirectly estimate the effective size of a population. The effective population size (Ne) is a parameter describing the joint effects of population characteristics important for the maintenance of genetic diversity, and it depends on factors such as number of breeders, sex ratio, variance in reproductive success among breeders, and is usually much lower than the census size. Previous studies on salmonid fish species indicate that the effective to census size ratio (Ne/N) is around 0.10–0.40. There are recommendations for how large a population should be in order to be within safe limits for long-term persistence. An effective size of 500 per generation is a rule of thumb that has been used in many conservation programs. At this size, genetic variability lost through genetic drift is assumed to be replaced by new genetic variability generated by mutation.

If we assume an effective to census size ratio of 0.20 and a generation interval of 5 years for the Baltic Salmon, an effective size of Ne=500 would correspond to around 2500 spawners per generation (or 500 spawners per year). Unfortunately, only few rivers have ladders where the whole spawning migration is registered. An alternative approach is to use estimated number of spawners generated from the WGBAST assessment model. Figure 2.3.2.5, which shows the development in estimated number of spawners between 1992 and 2007 in 15 rivers within assessment units 1–4, indicates that the number of spawners has increased for most rivers during the SAP period. Table 2.3.2.1 shows the estimated average number of spawners during the last five years (2003–2007), and estimated effective sizes for the rivers following the assumptions about the effective to census size ratio indicated above. Many rivers are within safe genetic limits, but a few rivers have still very few spawners and small effective sizes, which are lower than general recommendations. Figure 2.3.2.6 indicate a rather weak association between estimated effective size and an index of genetic diversity, but this may be explained by the confounding effects of gene flow between closely situated rivers.

In conclusion, the development of genetic diversity in wild Baltic salmon stocks is poorly known. However, model predictions indicate that number of spawners has increased in most rivers, although a few rivers still have very few spawners and must be regarded as being outside safe genetic limits. In this evaluation, each river was treated as an isolated population. This is not true as we know that straying and geneflow occurs in the wild and many rivers therefore should be regarded as subpopulations belonging to larger meta-populations (for instance some groups of small rivers in Estonia and Latvia). Even a small amount of gene flow between rivers makes the individual rivers less susceptible to erosion of genetic variability. At the moment, however, there is not enough background information regarding population genetic structure of the Baltic salmon, especially for the southern Main Basin, to be able to identify groups of rivers (meta-populations) that are suitable from a conservation genetic perspective. An important part of future management would be to collect genetic information from all rivers with wild production, and based on that information to identify meta-populations on which genetic objectives and limit reference points could be applied.

Table. 2.3.2.1. Average heterozygosity over 8 microsatellite loci, allelic richness, and estimated effective size (Ne) for 16 rivers with wild production. Allelic richness is the average number of gene variants across a number of marker loci, corrected for sample size, and is thus an unbiased estimate of genetic diversity that could be compared between rivers. Ne was estimated from model estimates of number of spawners between 2003 and 2007, where an effective to census size ratio of 0.2 was assumed for each spawning season and the effective size per generation was calculated as the harmonic mean of the individual years times a generation interval of five years.

River	Heterozygosity	Allelic richness	N_e
Tornionjoki	0.68	5.70	27419
Simojoki	0.68	5.41	2213
Kalixälven	0.70	5.70	37070
Raneälven	0.61	4.20	1063
Abyälven	0.74	5.88	507
Byskeälven	0.75	6.19	4788
Vindelälven	0.67	5.03	4224
Öreälven	0.74	5.37	116
Lögdeälven	0.72	5.58	289
Ljungan	0.76	6.27	45
Emån	0.71	5.43	201
Mörrumsån	0.70	5.33	5136
Pärnu	0.68	4.99	3
Gauja	0.64	4.60	1081
Daugova	0.67	4.82	220
Venta	0.68	4.58	975

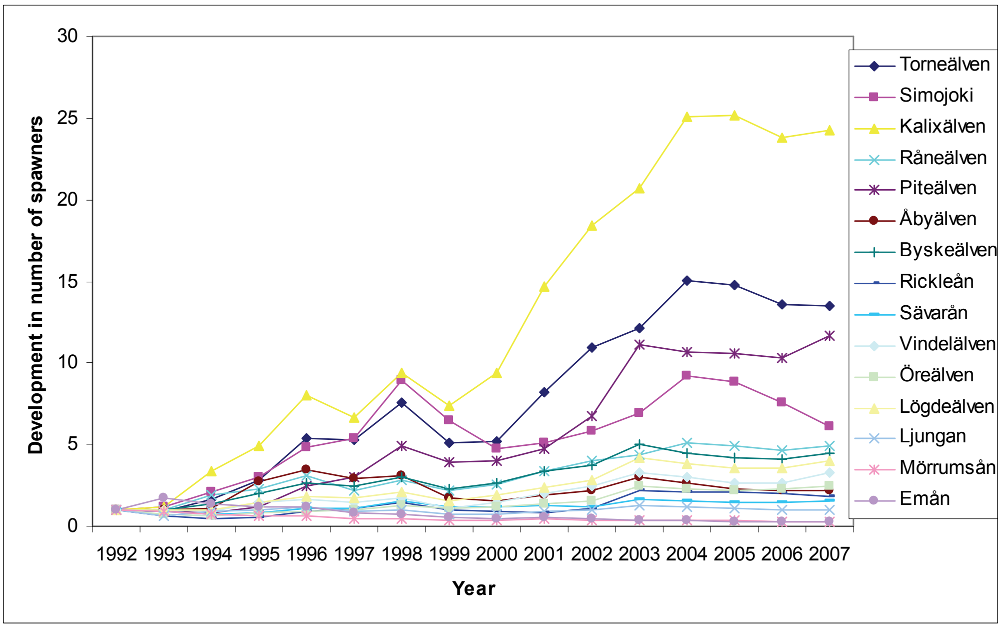


Figure 2.3.2.5. Development in number of spawners (times the value predicted for the spawning season 1992) in 15 rivers with wild salmon production. All rivers except Mörrumsån and Emån show increasing trends in number of returning spawners.

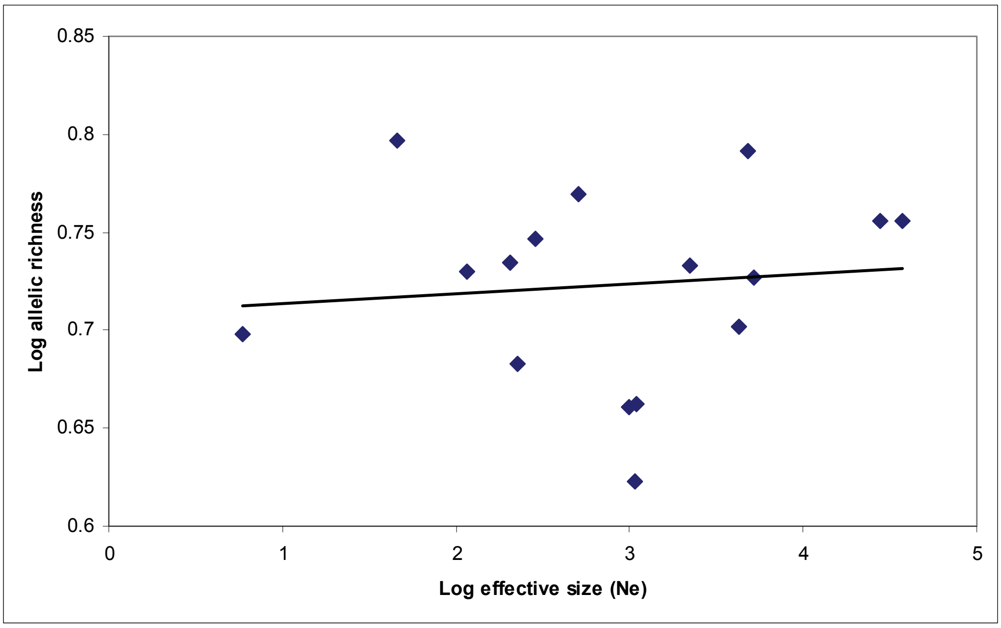


Figure 2.3.2.6 Association between estimated effective size and allelic richness for individual wild rivers.

Balance between the wild and reared salmon

The proportion of wild and reared fish in the catches has changed as the result of the increase in wild populations in the AU 1 and 2. These have decreased the proportion of reared fish in the catch in these areas as well as in other coastal areas in the Gulf of Bothnia (Figures 2.3.2.7, 2.3.2.8 and 2.3.2.9). Both the results of the assessment model (Figure 2.3.2.8, lower panel) and the results of the stock composition analysis of catch samples (Figure 2.3.2.10) suggest that 50-60% of harvested salmon in the sea are wild fish. In coastal areas around the Main Basin there is no evidence to suggest that the proportion of wild fish has changed. In the Gulf of Finland, the production of wild fish has not changed to any great extent since the late 1990s. However Estonian releases of reared smolts have increased. These may have contributed to an increase in the proportion of reared fish in the area. The fish that are released are of mixed origin (mixture of the local stocks including Neva and potentially strain of Daugava). It is highly likely that fluctuations in wild stocks affect recruitment to fisheries more than earlier. When wild stocks increase, the recruitment to the fisheries will become more variable due to the variable stock size of wild populations. This is particularly easy to observe in the Gulf of Bothnia.

In order to facilitate effective utilization of reared spawners the terminal fishing areas has been established close to rivers where releases take place. The boundaries and fishing regulations in these areas are intended to reduce interaction of reared salmon with wild salmon populations.

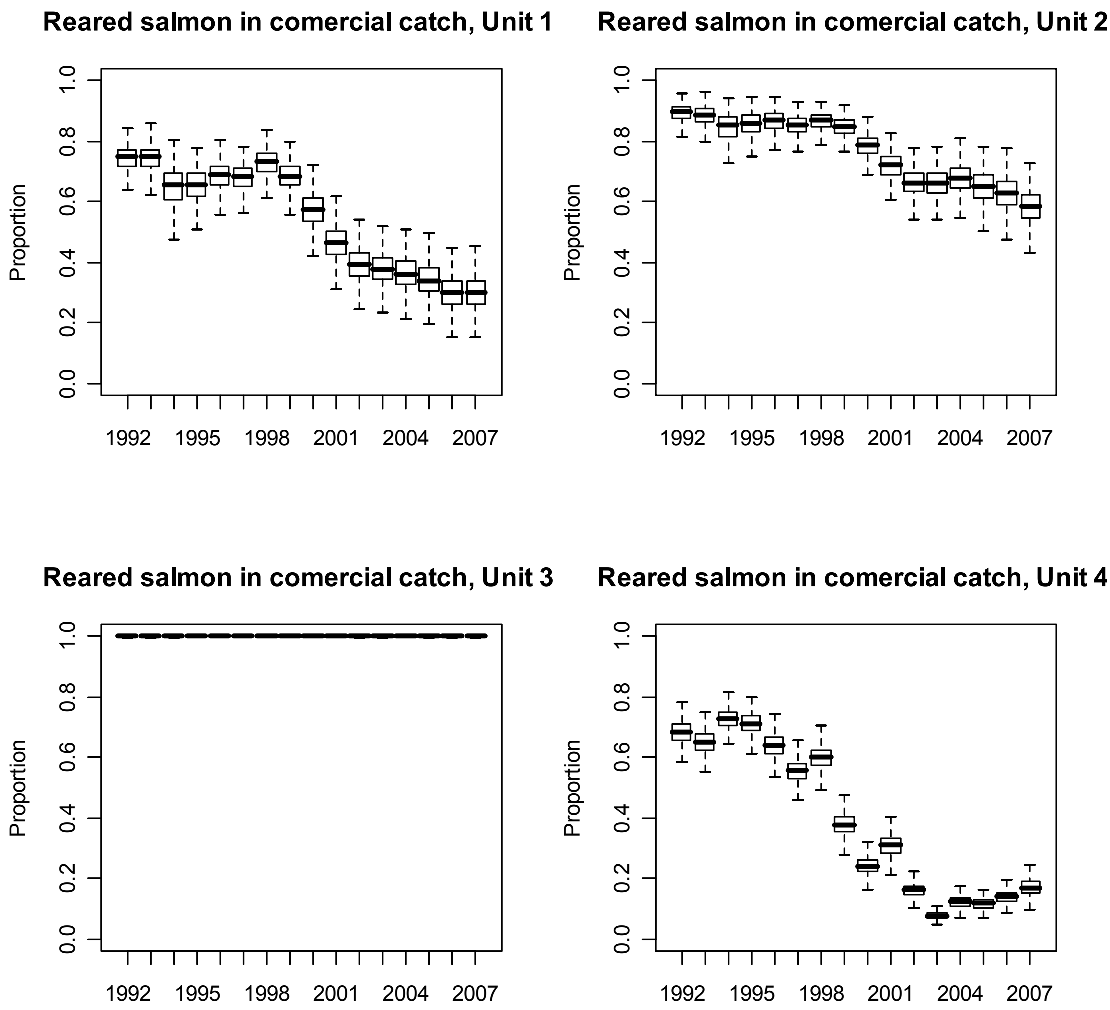


Figure 2.3.2.7. Model estimated proportions of reared salmon in the catches from the Baltic Sea (i.e. excluding river fishery), by assessment unit.

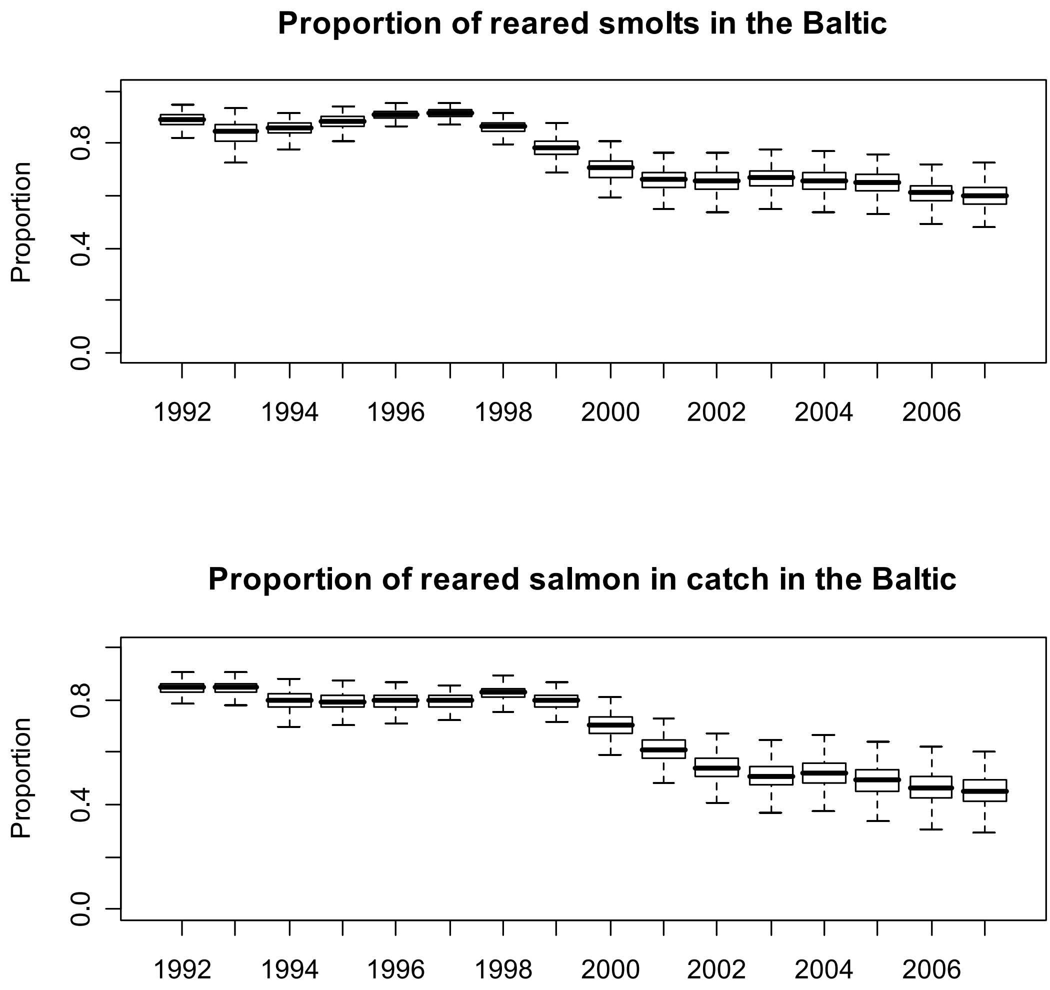


Figure 2.3.2.8. Proportions of reared salmon in the numbers of smolts and in the combined offshore and coastal catch, from assessment units 1-4, as estimated by the model.

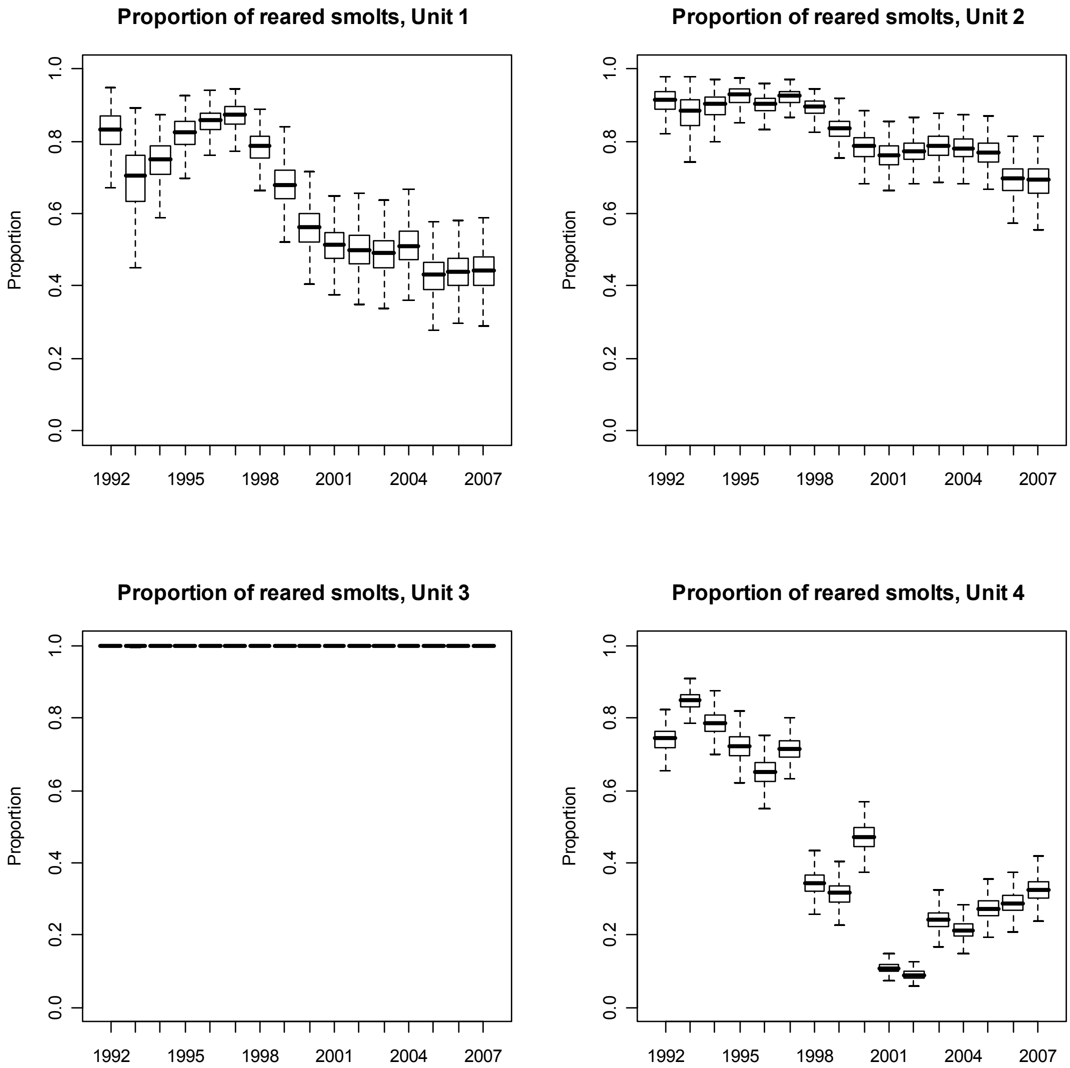


Figure 2.3.2.9. Model estimated proportions of reared smolts from the total numbers of smolts, by assessment unit.

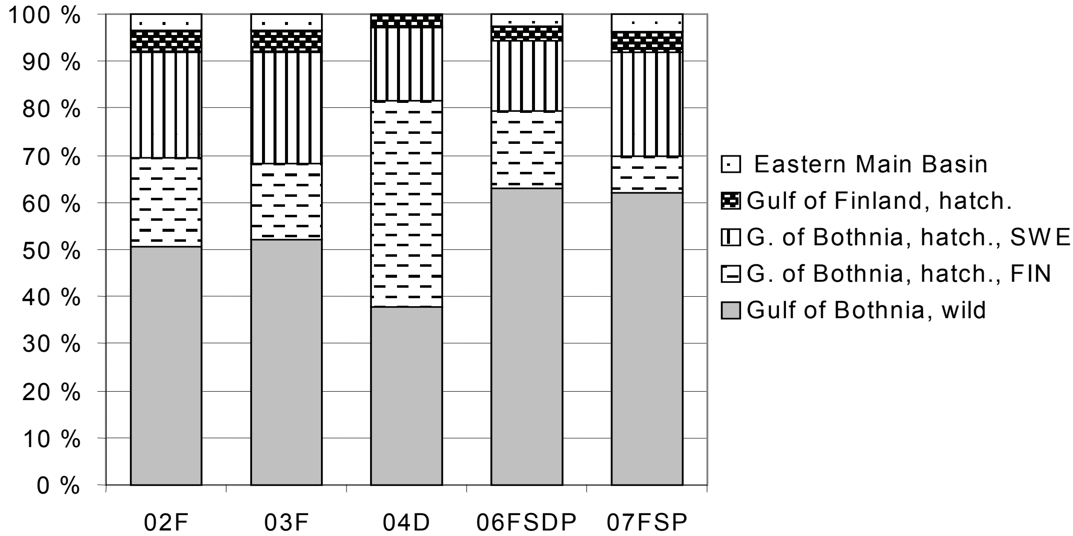


Figure 2.3.2.10. Stock group proportions estimates in salmon catch samples in the Main Basin in 2002–2007 based on DNA microsatellite data (F=Finnish catch sample, D=Danish sample, S=Swedish sample and P= Polish sample; 2006-2007 are pooled samples).

2.3.3 "Wild Salmon populations shall be re-established in potential Salmon rivers"

In the former IBSFC Salmon Action Plan countries have officially appointed potential salmon rivers. These rivers are mostly old salmon rivers that have lost their salmon population.

Following potential rivers have been selected by the countries:

Finland: Kuivajoki, Kiiminkijoki and Pyhäjoki.
Estonia: Valgejõgi, Jägala and Vääna.
Lithuania: Shventoji, Siesartis, Virinta, Vilnia, Voke, Dubysa, Baltic Shventoji and Minija.
Russia: Gladyshevka.
Poland: No rivers are officially stated as potential rivers however, restoration programme has been carried out in seven rivers Wisla/Drweca, Slupia, Wieprza, Parseta, Rega, Odra/Notec/Drawa and Reda.
Sweden: Kågeälven and Testeboån. Moälven, Alsterån and Helgeån have local restoration efforts.

The goal for the potential rivers was to re-establish natural reproduction of salmon. Measures that have been carried out are releases of salmon fry, parr and smolt, restoration of habitats and other rebuilding efforts. It is too early to conduct a full evaluation of success, as at least one generation without releases is needed.

These measures have been successful in Gladyshevka and Kågeälven and resulted in natural salmon spawning; increasing densities of parr were observed in previous years. Stocking of parr and smolt is still continuing in Gladyshevka but in Kågeälven stocking ended in 2004. Catches of salmon started to occur again in river Kågeälven in the end of 1990s but has since then been very low; catches varied between 10–40 salmon yearly, which is comparable to earlier years when salmon catches were very rare, except for 1991 when higher catches were recorded. In river Kågeälven the catches of salmon kelts during the springtime sea trout fishing have exceeded the reported catches of salmon for every year since 2000, indicating either a rather low efficiency in angling on ascending salmon or high survival after spawning. This also indicates higher number of spawners than catch numbers suggest. Stocking, which ended in 2006 in river Testeboån, has also resulted in quite high densities of parr although only a few fish have been caught every year in the trap for ascending fish. Old catch data from 1904–1940 states salmon catches of 150 kg/year and in 1910 totally 853 kg were caught. No salmon catches has been reported in Testeboån within the latest 10 years due to a ban on salmon fishing.

Most of the other potential rivers show only low and irregular wild reproduction in spite of even massive stocking programmes and other measures. Several problems in various phases of salmon life cycle may adversely affect restoration measures, but their relative importance is difficult to assess.

In the Finnish potential rivers Kuivajoki, Kiiminkijoki and Pyhäjoki, hatchery reared parr and smolts have been annually stocked since the 1990s. The densities of one-summer old parr have been very low during the monitoring period. 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 temporally low discharge, which may hinder the spawning migration of adult salmon. In the last four years the river catches have been highest in Kiiminkijoki and varied between 77–715 kg. In Kuivajoki the catches have varied between 0–235 kg and in Pyhäjoki between 0–67 kg.

In Lithuanian potential rivers stocking of salmon fry, parr and smolt have been carried out since 1998. The results of stocking vary in different years but overall the densities have been low.

Although Poland has not officially stated potential rivers, a programme for re-establishment of self-sustaining salmon population started in 1994 in 7 rivers. The programme is based on stocking of fry, parr and smolt. No evidence of self-sustaining population has been detected so far, even though natural spawning has been observed. Reasons for this situation are not clear. Certainly inaccessibility of historical spawning grounds and low environmental quality of existing habitats are the main probable causes. Also very low level of tag returns from stocked salmon smolts hints their low survival.

In order to fully evaluate the success of re-establishment of salmon to former salmon rivers, a time period of one generation is needed after the last release. At present it is too early to make such evaluation in any of the potential salmon rivers. Preliminary results, however suggest that there are only few rivers, which have a promising development, meanwhile most of the rivers do not show any signs of success.

In general the objective to re-establish self-sustaining salmon populations in the former salmon rivers is consistent with the objectives of the EU Water Framework Directive (WFD). In addition to improving the water quality in the surface waters, the directive supports the attempts to improve also the migration possibilities of the fish in the dammed rivers.

2.3.4 "The level of fishing should be maintained as high as possible. Only restrictions necessary to achieve the first three objectives should be implemented"

The statement in the last part of this objective suggests that the other three management objectives are more important. This is an important qualification stating that the recovery of salmon populations is more important than the catch level. As a result we would expect a TAC-level that allows preferably all salmon rivers to attain a smolt production rate of at least 50% of the potential.

The proportion of the salmon-TAC in the Baltic Main Basin and Gulf of Bothnia that has been utilized has gradually decreased from the start of the SAP-period. In year 2007 reported catch made up 42% of the TAC and the corresponding figure in the Gulf of Finland was 74%.

The main factors that have contributed to this development are: the content of dioxin in salmon that has prevented some fishery, increasing seal problems particularly in the coastal fishery, increased fishing costs (e.g. fuel) and low salmon prices.

As the fishery has decreased to lower levels than those suggested by the TAC, this objective has not been fulfilled successfully. It has not been estimated what the status of the salmon stocks would have been if the TAC had been fully utilized during the entire period. On the other hand it is evident that the lower exploitation resulting from lower catches has contributed to restoration of wild salmon stocks, but all salmon stocks have still not achieved 50% of their potential.

Terminal fishing areas

Terminal fishing areas have been established for a particularly intense fishery of reared spawners. They are located close to rivers where releases take place. Their boundaries and fishing regulations should be designed to reduce interaction with wild salmon populations. Terminal fishing areas have been created in Sweden (3 areas), Finland (3 areas) and Latvia (all stopped in 2006). In Sweden there are three different terminal fishing areas, the development of the proportion of trap nets in these areas compared to other coastal areas show no evidence of change in the period from 1999 to 2007 (Table 2.3.4.1). On the contrary the proportion of trap nets in protected areas outside wild salmon rivers have increased substantially. This is mainly due to an increase in trap nets outside River Kalixälven and Torneälven. In Finland the corresponding information on the development of number of trapnets in the terminal fishing areas and outside the wild salmon rivers is not available. Catch samples collected from the terminal fishing areas (in Finland) suggest that in the outmost parts of the areas has about the same proportion of wild salmon in the catches as the other areas in along the coast.

Table 2.3.4.1. Development of number of trap nets along Swedish part of Gulf of Bothnia in 1999-2007. County of Stockholm is excluded.

Year	Coast	Protected area	Terminal fishing area	Total	% in terminal fishing area	% in protected area
1999	322	280	200	802	25%	35%
2003	198	265	171	634	27%	42%
2007	188	315	158	661	24%	48%

Fin clipping as a management tool

Adipose fin clipping of reared salmon smolts was implemented by Sweden in 2005, by Estonia in 1997 and by Poland in 2007. Of the countries having major releases of reared fish, it has not been implemented by Finland and Latvia (only partly).

There has not been any general design of fishing regulations in Sweden in order to use adipose fin clipping as a management tool. There are several reasons to this lack of implementation. For instance the new seal-safe push-up trap nets have not been designed for release of the fish caught. Secondly the increased proportion of wild fish in the catch in many areas has made the fin clipping less suitable as a sorting tool. Thirdly as adipose fin clipping has not been implemented in Finland, it would mean that coastal fishermen would release reared fish of Finnish origin.

Adipose fin clipping has been used in one river (Ume/Vindelälven) to distinguish and separate wild and reared components of the stock. Furthermore in the areas outside the rivers Umeälven, Ljungan and Kalixälven fish lacking adipose fins can be caught, even when catch of fish with adipose fin was banned. It has also been useful for estimation of proportions of reared salmon and sea trout straying to rivers with wild production.

2.3.5 "Reared smolts and releases of earlier salmon life stage shall be closely monitored"

Considerable releases of different life stages have carried out all around the Baltic Sea. The release programs started gradually in the 1950s along with the development of the water power plants and releases leveled off to about 6–7 million smolts in the 1980s.

In the 1980s a special release technique was developed in Sweden, the delayed release of salmon. The principle behind delayed release is the release of larger salmon "smolt" – or rather salmon in the post smolt stage. This release method resulted to an increased survival and higher returns, and improved profitability from releases significantly. The delayed releases were used experimentally in Sweden, Denmark and in Finland. Analyses results, however, showed that straying high from delayed releases, and therefore these releases were gradually stopped for salmon. However, coastal and delayed releases are in use for sea trout.

There has been also a concern that the straying of fish from river releases may begin to increase in magnitude when the exploitation rate started to decrease as a consequence of fishing restrictions. The argument was that large amounts of non-exploited reared spawners may turn up in their home areas and they would spread to other neighbouring rivers. Studies in several rivers, however, showed that substantial amounts of reared spawners did not turn up in their home rivers. This was at least partly due to a decreasing survival starting from the beginning of the SAP-period. An analysis of Carlin tagging data did not suggest that the straying had increased as a result of decreased exploitation (ICES 2001).

Enhancement releases have been carried out in many countries around the Baltic Sea in order to support weak populations. According to the management plan such releases were meant to be time-limited. Considerable amounts of fish, however, are still released to support the populations. It was also stated in the instructions from the SAP surveillance group that it was preferable to use younger life stages than smolts for enhancement. For example in Sweden most of the releases for re-establishment and enhancement of populations have gradually been terminated (Figure 2.3.5.1). In Finland enhancement releases have been carried also in wild salmon rivers but there releases have been stopped now. In the potential salmon rivers enhancement releases are still carried out.

Tagging has been carried out primarily by tagging with external Carlin tags. The proportion of tagged smolts has been about 0.5–4 % of the total number of released smolts by country and this ratio has degreased slightly in many countries in the last ten years. The most important change concerning the Carlin tagging is without doubt the change in management of the Swedish tagging database. In 2001 the Swedish power companies took over the database. In the period since then much data has accumulated that shows an improper handling of the database. This includes slow or no response to fishermen and to corresponding tagging institutions in other countries, exclusion of data from the database and sometime low accuracy and precision in how data are treated. There may have been an improvement in the handling of the database in the last two years. There is now evidence that the reporting rate of tags have decreased in the last few years (ICES 2008). It is possible, but uncertain if this is related to the treatment of the Swedish tagging database as Swedish and some Finnish fishermen are not given the same feedback as they were earlier.

A number of experimental releases with other kinds of tags have been carried out primarily in Finland and Sweden. These have given results that in several cases are of importance for management of salmon stocks.

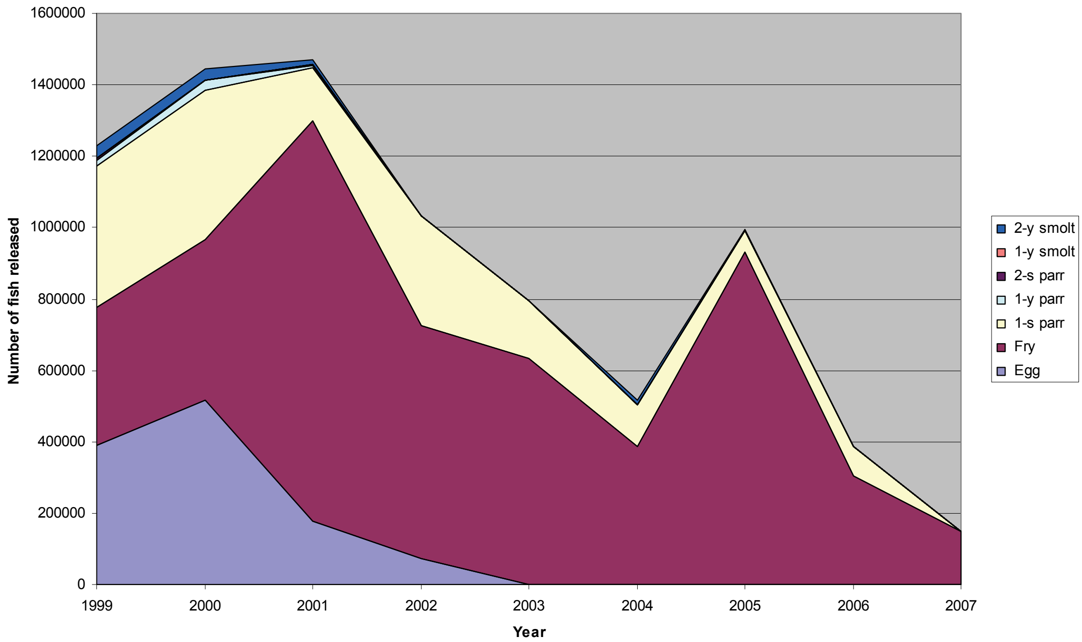


Figure 2.3.5.1. Enhancement and re-establishment within Swedish SAP 1999-2007.

2.4 Special questions concerning small and weak salmon populations

Several of the small salmon rivers in the Gulf of Bothnia are often regarded as having had no positive reaction to the decreased exploitation. When the results from electrofishing surveys are looked upon more in detail it can be seen that there is a trend of increasing parr densities, but it is limited and when compared to the development in large rivers, it may be easily overseen. For some rivers, such as Öreälven (AU 2) and Emån (AU 4) it seems highly likely that problems for fish to ascend fishladders and fishways may be causing the problems for the population to respond to the decreasing exploitation.

It is evident that particularly in cases where the response has been less than expected, local conditions may be of major importance. The nature of these in each individual river remains to be determined.

There are at least 37 rivers/river systems with natural reproduction of salmon entering the Baltic Sea. Most of them (~20) are small rivers with length <100km and catchment area <1000km2. Most of these rivers show only irregular or very low salmon parr and smolt production, also the production potential of these rivers are negligible in comparison with larger salmon rivers. Typically parr production in these rivers not exceed 1–5 individuals per 100m2 of habitat, smolt production being 0.5–2 thousands per river per year. Large rivers potentially would produce all together 2 million salmon smolt, meanwhile the total potential smolt production of small rivers (AU 4–6) is only 0,2 million or 10% of the total potential production in the Baltic Sea.

Stable and high smolt production in each river is one of the objectives of present salmon management. For rivers in assessment units 1–3 the recent smolt production demonstrated some success of management because in total salmon smolt abundance has increased in these rivers. On the contrary the situation in most small salmon rivers (AU 4–6) has not displayed significant positive changes, and smolt production tends to decrease or stay low.

Contrary to the large rivers, small streams are more sensitive to fluctuations of environmental conditions and anthropogenic pressures. Unfavorable low discharge, high water temperature and inadequate water quality delay the adult salmon entry and spawning success in small rivers. Water nutrification, acidification, pollution, siltation and unfavorable changes (e.g. erosion, deforestation, etc) in the rivers riparian zone are main anthropogenic impacts decreased all together quality of physical and chemical habitat of salmon. Weak salmon populations in small rivers are more sensitive to illegal fisheries in comparison with large rivers. The numerous small salmon populations seem to be affected by the local factors in inland and coastal waters. Thus would be reason that present management measures are not effective in case of small rivers salmon populations. There are no useful data on number of ascending spawners, M74 impact and post-smolt survival rate in small salmon stocks. Most of data comes from salmon parr electrofishing and hereof estimation of river smolt production. Partly due to these reasons many of the small salmon rivers (Assessment Units 5-6) have not been included in assessment model.

Supposedly, fishery management measures suitable for large rivers need to be complemented by other measures for populations in small rivers. These will need local management plans that are targeted to meet the requirements for a particular river. Such plans should use local habitat/restoration/improvement efforts to get the population in a river to fulfill both international and national fisheries management objectives.

2.5 Conclusions

- Despite a low post-smolt survival in recent years, smolt production in many salmon stocks in the Gulf of Bothnia is expected to exceed the 50% target of potential smolt production in 2010. Most salmon stocks in southern Baltic do not show significant positive development and many of them will not reach the 50% target (Section 2.2 and 2.3.2).
- The total amount of salmon surviving post-smolt phase and recruiting to fishery has not increased but lately even decreased. Current catches are lower than earlier partly due to the decreased recruitment to fishery and partly due to decreased harvest rates (Section 2.2).
- A group of small rivers did not respond to the decreased fishing pressure and low level of M74. These rivers need special attention as to explain their apparent inability to respond with an increase of the salmon stock. (Section 2.3.1).

- In order to estimate when salmon stocks achieve the reference production level it has been necessary to estimate the potential smolt production level. It has been difficult to estimate the potential smolt production in Baltic salmon rivers due to limited amount of relevant information (Section 2.3.2).
- It was not an objective in the SAP to study genetic diversity in wild Baltic salmon stocks. However, model predictions indicate that the situation has improved in most rivers, although a few rivers still have very few spawners and must be regarded as being outside safe genetic limits (Section 2.3.2).
- An important part of future management would be to collect genetic information from all rivers with wild production, and based on that information, identify meta-populations on which genetic objectives and limit reference points could be applied (Section 2.3.2).
- The proportion of wild and reared fish in the catches has changed due to the increasing wild populations in the northern Gulf of Bothnia (AU 1 and 2). Also in the Main Basin the proportion of wild fish has increased substantially. The change in other areas is smaller, but increased Estonian releases have probably lead to higher proportion of reared fish in Gulf of Finland (Section 2.3.2).
- Programs have been operating to re-establish salmon in a number of potential salmon rivers. It is still premature to make a final evaluation of these programs, but with a few notable exceptions (e.g., Kågelälven) the success has been limited to date. (Section 2.3.3).
- Fishery has been below the levels dictated by the TAC. This suggests that the fishing regulations are not fully responsible for the decreased exploitation and the consequent positive development of wild salmon stocks. Neither adipose fin clipping nor the establishment of terminal fishing areas have been important tools to increase the exploitation of reared salmon. (Section 2.3.4).
- Annually 6–7 million smolts are released in the Baltic. Reared salmon is no longer used for delayed release, due to increased straying. Tagging of reared fish has decreased slightly throughout the SAP-period and there are indications of decreasing quality of the tag recapture data (Section 2.3.5).
- For many of the small salmon rivers where the positive development of the stock has been less than expected, local conditions may be of major importance. The nature of these in each individual river must be studied and a program including habitat/restoration/improvement actions is needed to improve the population status. Such a program should also assess the possibility that the potential productivity of the river has been over estimated (Section 2.4).

3 Evaluation of alternatives for future management

3.1 Principal objectives

The primary objective of salmon management is to conserve within safe biological limits individual strains of salmon in the Baltic Area. Management action must ensure the conservation of genetic variation and future evolutionary potential in wild salmon populations.

In addition to fisheries itself the management should encompass also all phases of the salmon life-cycle subjected to human influence.

A management plan for the salmon should both encompass the recovery of populations below reference points and ensure the continued maintenance of all existing salmon populations

3.2 Schedules for management: recovery phase and maintenance phase

The future management of salmon in the Baltic Sea could be divided into two phases: a period of recovery, followed by a maintenance phase. The aim of the recovery phase is to enable rivers to reach a desired level of productivity. It is expected that the length of the recovery phase will differ between rivers (Figure 3.2.1). The future levels of post-smolt survival and M74 have a strong influence on the recovery. This is illustrated in Table 3.2.1 that shows the number of rivers which are likely to reach 75% of the carrying capacity in 2015, under different scenarios of M74 and post-smolt survival while assuming no fishing pressure from 2008 onwards. For a number of rivers, the recovery phase will span several salmon generations - a few rivers will most likely fail to reach the objective even given a 30-year respite from fishing (Table 3.2.2). If fishing is allowed, the recovery will take longer still (Figure 3.2.2). Assuming fishing effort will stay constantly on the current (2008) level, only 4 out of 15 rivers will likely reach 75% of carrying capacity in 2037, as compared to 10 rivers if the fishing ceases, according to simulations scenarios with a medium post-smolt mortality and a variable M74 level.

Enhancement of wild populations by stocking salmon in order to speed up a recovery has not been found effective (Fleming and Petersson, 2001; Romakkaniemi *et. al.*, 2003).

Simulations don't account for repeat spawning; this is likely to make those simulations too pessimistic.

When a stock has reached a desired abundance level, management enters a maintenance phase. During this phase, management actions are needed to keep the stocks at the desired abundance levels with adopted reference points. The optimal level of exploitation is dynamically dependant on M74 and Mps survival parameters. We calculated the harvest rates, number of spawners and catch levels that would enable an individual river stock to remain at three alternative reference levels given historical levels of M74 and Mps survivals, as illustrated for River Simojoki in the Figure 3.2.3.

Following the precautionary approach, the exploitation of the stocks within a mixed stock fishery should be based on the weakest stock with the lowest resilience to exploitation. Even though other stocks could sustainably be exploited at higher harvest rates, the mixed stock fishery would need to be restricted in order to preserve the weakest stock. For the remaining stocks, individual additional precautionary fishing mortality reference points can be set for the river fisheries. The lower productivity of salmon stocks in the Southern Baltic Sea (e.g. Emån and Mörrumsån) implies that these stocks can not support harvest rates that are as high as for the northern stocks. The general differences in the shape of the stock-recruit functions between the southern and the northern stocks reveal the likely explanation for the phenomenon. The steeper rise of the S/R function among northern stocks implies higher sensitivity to recruitment increase as the number of spawners rise. Instead, the southern stocks react slower to changes in harvest rates. This puts the Baltic countries which have only mixed stock offshore fisheries at a disadvantage (Michielsens *et al.*, manuscript). Prévost *et al.* (2003) found that also among the rivers flowing into the Atlantic Ocean southern salmon stocks are less productive, i.e., tolerate lower harvest rates, than the northern stocks.

Table 3.2.1. The number of rivers out of 15 which are likely (the probability is more than 70%) to reach 75% of the carrying capacity by 2015 with different combinations of Mps and M74 survival with no fishing.

	M74 Survival varies	M74 Survival 40%	M74 Survival 90%
Mps Survival low	8	6	10
Mps Survival medium	8	6	10
Mps Survival high	9	6	11

Table 3.2.2. The number of rivers out of 15 which are likely (the probability is more than 70%) to reach 75% of the carrying capacity by 2037 with different combinations of Mps and M74 survival with no fishing.

	M74 Survival varies	M74 Survival 40%	M74 Survival 90%
Mps Survival low	10	5	13
Mps Survival medium	10	7	13
Mps Survival high	13	10	14

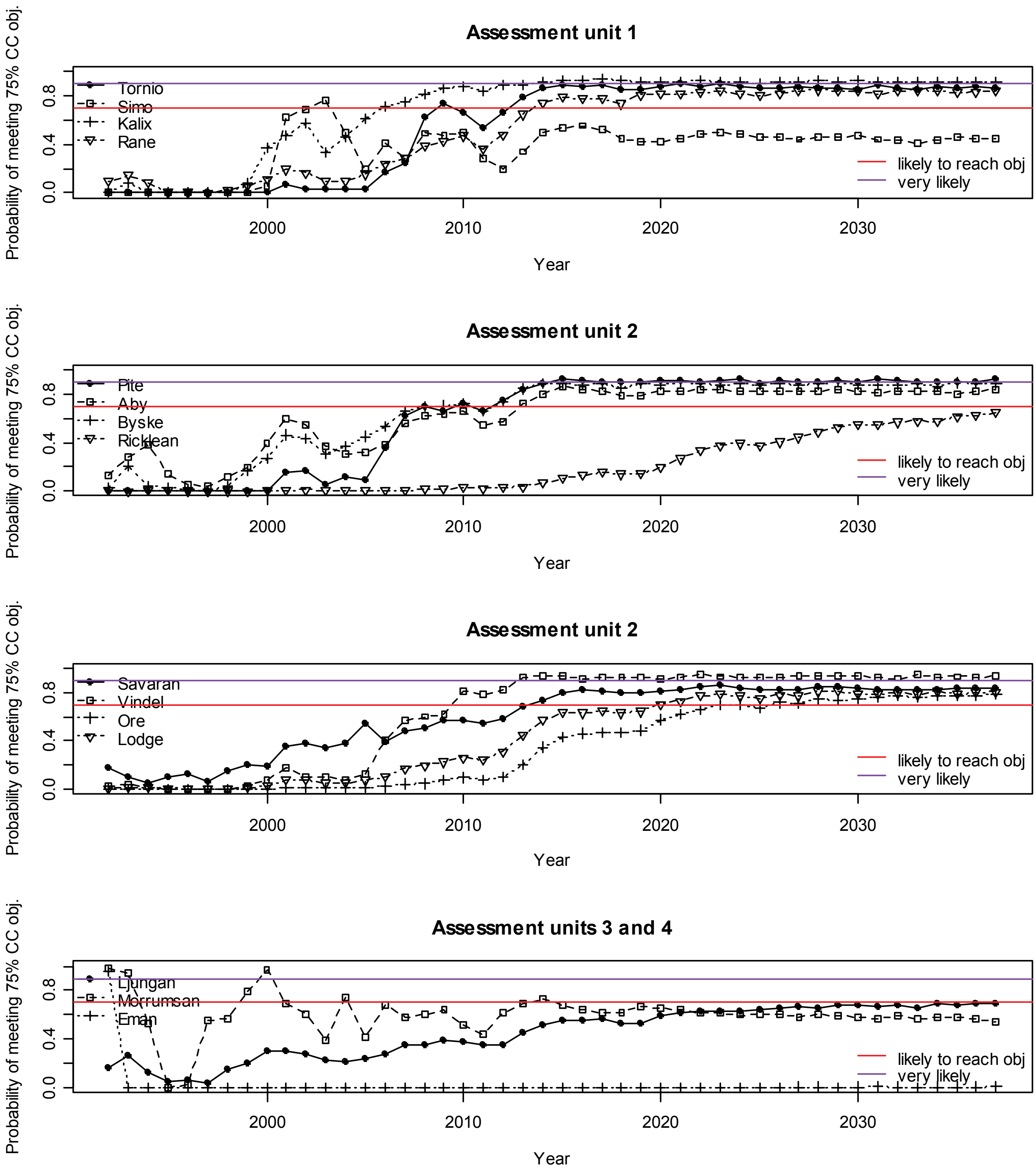


Figure 3.2.1. Probabilities for different stocks to reach 75% smolt production capacity in a scenario with no fishing, medium (2003-2006 average) post-smolt survival and variable M74 survival.

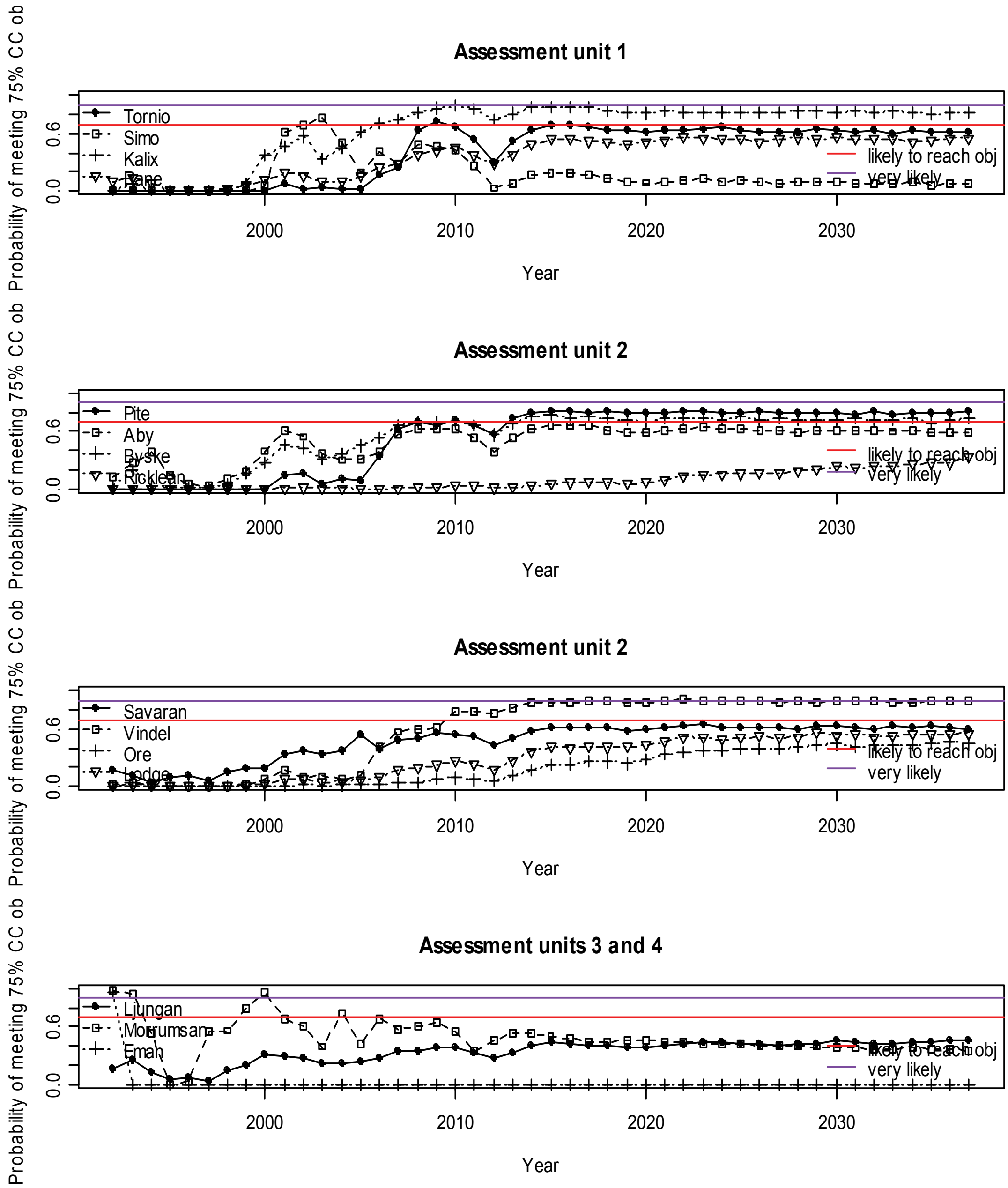
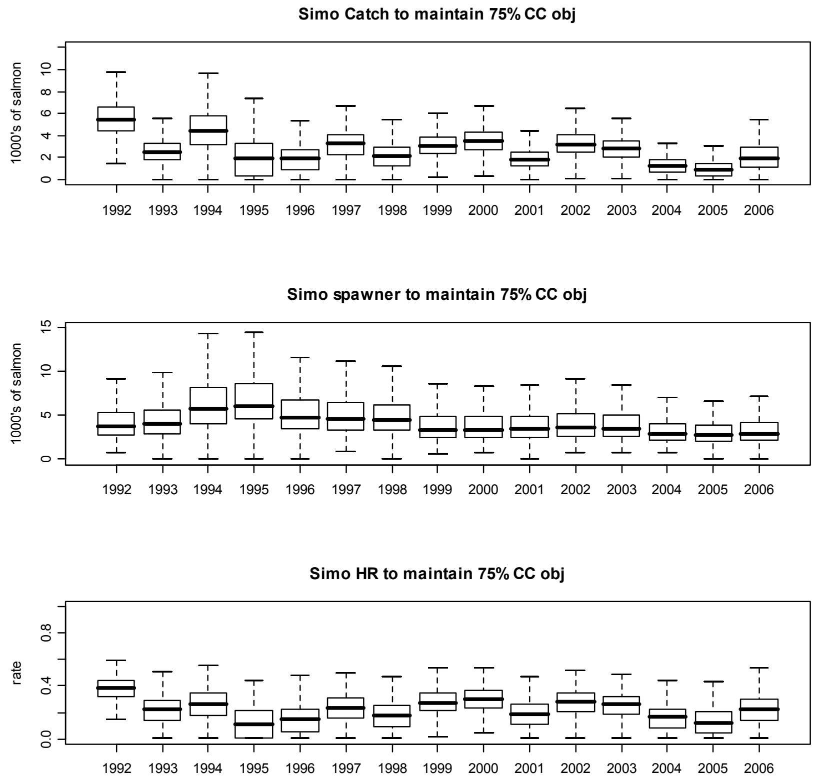
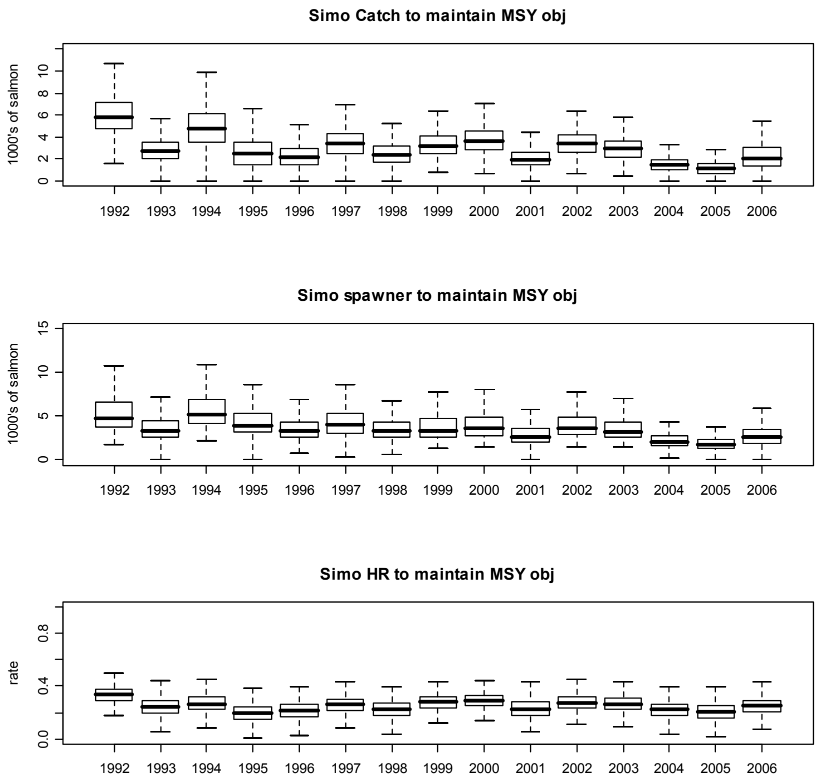


Figure 3.2.2. Probabilities for different stocks to reach 75% smolt production capacity in a scenario with continuation of 2008 fishing effort, medium (2003-2006 average) post-smolt survival and variable M74 survival.

a)


Simo Catch to maintain 75% CC obj
1000's of salmon
Simo spawner to maintain 75% CC obj
1000's of salmon
Simo HR to maintain 75% CC obj
rate
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006

b)


Simo Catch to maintain MSY obj
1000's of salmon
Simo spawner to maintain MSY obj
1000's of salmon
Simo HR to maintain MSY obj
rate
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006

c)

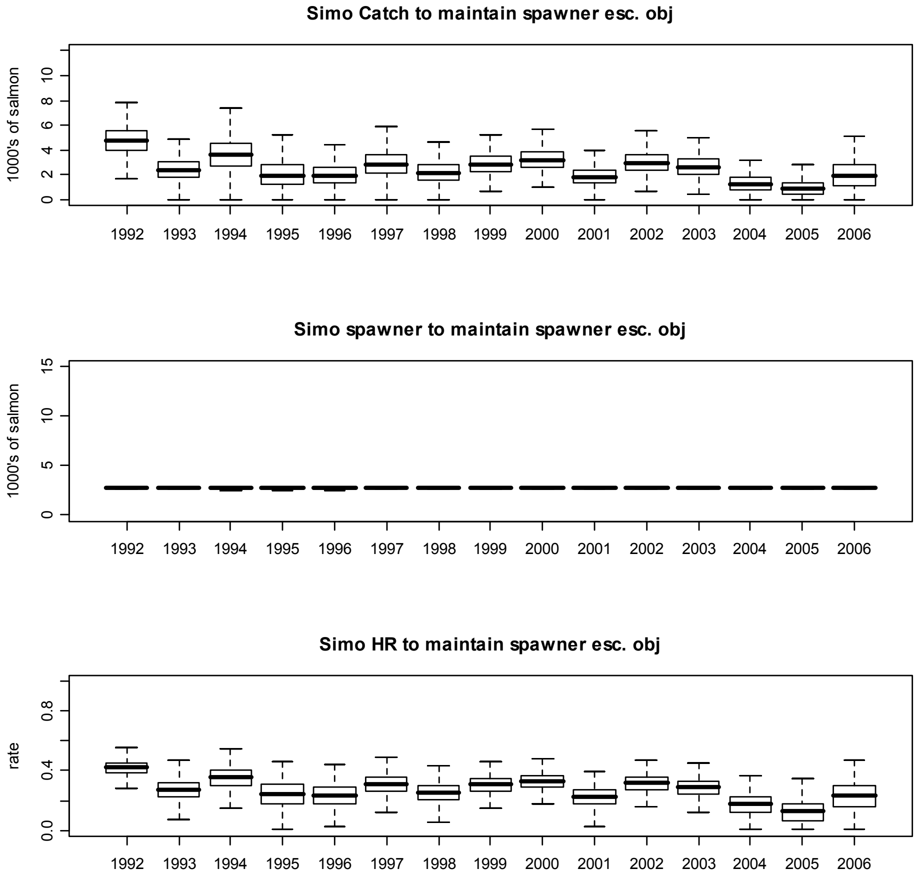


Figure 3.2.3. The harvest rates, number of spawners and catch levels that would have enabled the salmon stock of river Simojoki to a) remain at 75% of the carrying capacity; b) maintain MSY; c) maintain fixed spawner escapement, given historical levels of M74 and Mps survival. For each simulation salmon stock has been artificially set to the abundance level corresponding the objective in concern.

3.3 Methods for evaluation

3.3.1 Qualitative evaluation

Qualitative evaluations are made by experts with long experience in the field and knowledge about the associated literature. Workshop members represented a good range of relevant expertise. ICES' scientific documents, proceedings and publications of relevant research projects and workshops were also relied upon in the qualitative analysis.

3.3.2 Evaluation by simulation

A few scenarios were run for illustrative purposes. The model used to perform simulations is the same as the one used by the working group for stock projections (ICES 2008). Wild and reared salmon in four stock units that are exploited by six fisheries are considered explicitly within a multiple-life history population model, while salmon from units 5 and 6 are only included in the calculations of catches (based on estimates of proportions of unit 5 and 6 salmon in observed catches). The fisheries are modelled as sequential, so that time and migration status of the fish determine in which fishery it might be harvested.

The scenarios encompass different simulated levels of M74, Mps and selective exclusions of fisheries.

3.4 Alternatives for biological management objectives and the corresponding reference points

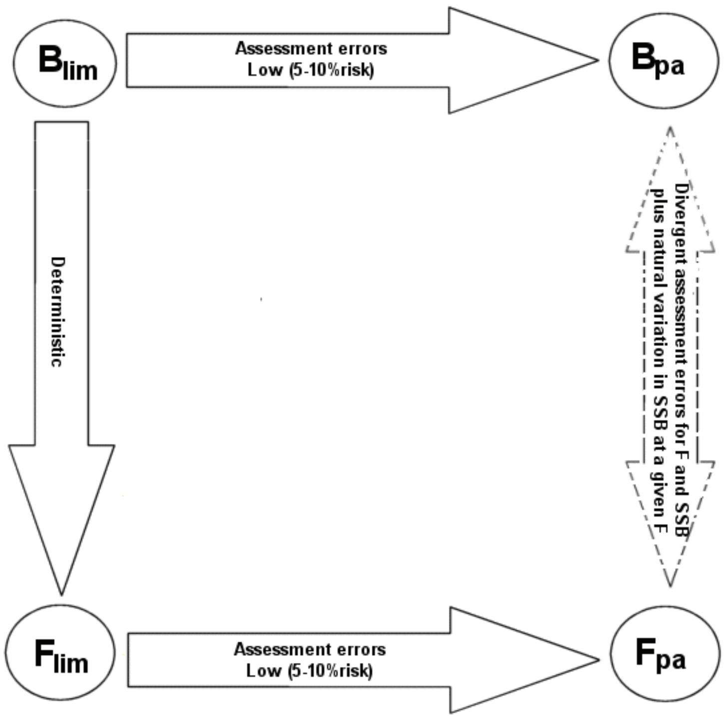
3.4.1 Management alternatives based on MSY

The fishing mortality rate which generates a maximum sustainable yield (MSY) as well as stocks sizes related to MSY should be regarded as a minimum standard for limit reference points (UN Fish Stocks Agreement 1995, UN Johannesburg Summit 2002, Potter et al. 2003, Crozier *et al*. 2003). For North Atlantic salmon stocks a limit reference point (or conservation limit, CL) has been set at the spawning stock size that gives maximum sustainable yield (Potter et al. 2003). The UN's Johannesburg agreement states that in order to achieve sustainable fisheries, fish stocks be maintained or restored to levels that can produce MSY, with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 2015. Consequently, there are strong arguments for managing Baltic salmon stocks based on the concept of MSY and allow only a low risk for the stocks to fall below the point of MSY.

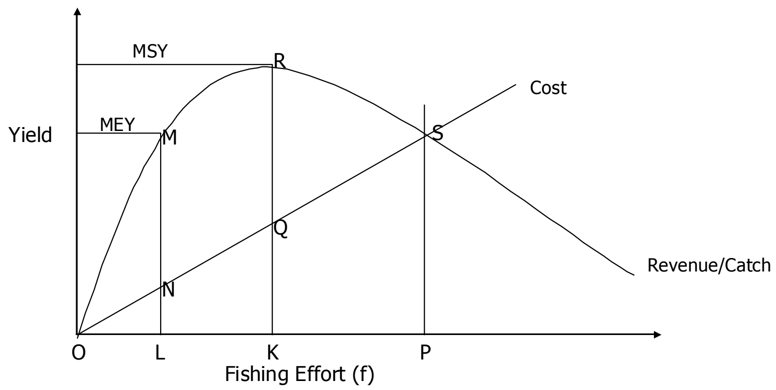
Using the latest stock assessment results, including stock-recruit information, it is possible to calculate the MSY based reference points for the salmon stocks of the Baltic Sea (Figures 2.3.2.3 and 2.3.2.4, Table 3.4.1.1). The reference points can be presented in various ways, like limit harvest rates, limit number of spawners or limit number of smolts (see next sections). The concept of MSY implies that survival parameters both in freshwater and in the sea affect the point at which the MSY is reached, making the associated reference points temporally varying. The large variation in post-smolt and M74 mortalities affect more the variability in the abundance levels at which MSY is reached than they do the variability of the MSY harvest rates (Figure 3.2.2).

Because of the uncertainty in the stock-recruit estimates and the life-history parameters, the biological reference points are quite uncertain. The choice of what percentile of this distribution to use as a precautionary reference point depends on the risk managers or politicians are willing to take to over-exploit the stocks (Michielsens *et al*., manuscript). In the presentation of MSY calculations we chose a 25% risk level.

Reference points based on MSY differ in their robustness to the uncertainties in Baltic salmon stock assessment – smolt production and harvest rate targets at MSY are more robust than spawner or catch targets (Levontin 2008). Due to the dynamic nature of MSY it may be difficult to directly employ this management alternative in a transparent and easily understood manner. It is hardly a sensible approach to strive for annual updates in MSY and the related reference points. Instead, less frequent updates could be applied in the practical management. Management can also indirectly fulfil the requirements of reaching the MSY level; objectives can principally be selected on other basis than MSY but these objectives may at the same time be set to stock levels which meet or exceed MSY.



A schematic presentation of the links between reference points, and the related sources of uncertainty and risk. Report of The Study Group On Precautionary Reference Points For Advice On Fishery Management. ICES Headquarters, 24–26 February 2003. ICES CM 2003/ACFM:15.



The MSY concept applied to Ricker type of stock-recruit function (note: the S/R function applied for Baltic salmon is asymptotically increasing Beverton and Holt type). When the Fishing Effort is zero there is of course no yield. When the Fishing Effort is very large there is no yield neither in the long term as the stock has been depleted. Somewhere in between these extremes in Fishing Effort there must be an optimum (MSY). The cost of fishing is shown as a line increasing with Fishing Effort. MEY is where the profit is maximum.

Table 3.4.1.1. Overview of different biological reference points for salmon stocks within the Baltic Sea in terms of thousands of salmon when assuming long term average M74 mortality (1998–2007) and short term (2004–2007) average post-smolt mortality and accepting 25% risk to overfish the stocks (Michielsens *et al.*, manuscript). It is important to note that these calculations are tentative and are especially sensitive to the assumptions about survival parameters.

Reference points Stock	Optimum harvest rate at MSY	Extinction Risk (%)	Optimum smolt abundance at MSY	Optimum prefishery abundance at MSY	Optimum spawning stock at MSY or Conservation Limit (CL)	50% of the smolt production capacity	Optimum smolt abundance at MSY in comparison to smolt production capacity (%)
Tornionjoki	0.70	0	1166	146	38.63	705	83
Simojoki	0.36	0	41	5.52	2.82	33	62
Kalixälven	0.80	0	1327	153.20	26.16	749	89
Råneälven	0.66	0	72	8.71	2.51	44	83
Piteälven	0.77	0	32	3.89	0.82	19	85
Åbyälven	0.64	0	18	2.20	0.67	11	81
Byskeälven	0.72	0	174	21.19	5.23	106	82
Rickleån	0.57	0	14	1.54	0.58	9	78
Sävarån	0.66	0	6	0.71	0.24	4	76
Ume/Vindelälven	0.84	0	253	29.89	3.93	140	91
Öreälven	0.61	0	21	2.60	0.86	13	79
Lögdeälven	0.64	0	38	4.50	1.44	24	79
Ljungan	0.53	0	4	0.45	0.20	3	74
Mörrumsån	0.40	0	70	9.23	4.47	47	75
Emån	0.00	50	4	0.52	0.47	8	24

3.4.2 Management alternatives based on smolt production requirements

During the former recovery IBSFC Salmon Action Plan 1997–2010 it was stated that the production of wild salmon should gradually increase to attain by 2010 for each salmon river a natural production of at least 50 % of the estimated potential production. Many of the rivers have during the recovery plan reached a level of at least 50% of the estimated potential wild smolt production (Section 2.2 and 2.3.2). In the new management plan the *limit* of the natural smolt production should not be lower then 75% of the estimated potential smolt production capacity of each river. When considering the *target* level of production of wild Baltic salmon smolt, a higher level, even 100 %, can be chosen. It is important to stress that too high a *limit* of production will be difficult to achieve in unfavourable environmental conditions, but a 75% level may be realistic. However, it may be unrealistic for some of the smaller rivers with weak salmon stocks to reach a 75% productivity level.

The earlier limit of 50% level of the potential production could have jeopardized genetic diversity in small rivers. The proposal of a limit of 75 % will increase the possibility for small weak populations to increase the effective population size (Ne), which would help small weak rivers to maintain safe genetic diversity in long term.

The Johannesburg Declaration, September 2002, stated that the environment continues to suffer. Loss of biodiversity continues and fish stocks continue to be depleted. The limit of 75% as the lower smolt production level will increase the number of ascending spawners to the weak rivers affecting the status of those rivers to reach higher production and minimize the risk to be depleted.

The 75 % limit of the natural smolt production is consistent with the recommendation of the Baltic Sea Regional Advisory Council (Bs RAC). Bs RAC recommend 2007 for the salmon management plan that the production of wild salmon should gradually increase to attain by 2020 in the salmon rivers (List A) a production of wild Baltic salmon of at least 75 % of the estimated potential and reproduction of at least 50% in salmon rivers of list B.

The 75 % limit of the natural smolt production is almost consistent with the recommendation Coalition Clean Baltic (CCB) recommend 2007 for the future management plan for salmon that the production of wild salmon should gradually increase to attain by 2020 in the salmon rivers (List A) a production of wild Baltic salmon of at least 80 % of the estimated potential and a production of at least 50% in salmon rivers of list B.

It should be noted that a target or limit regarding smolt production can be translated into a spawning stock target that can be used for operational purposes and harvest control. The present surveys counting smolt will together with electrofishing and spawner counting improves the estimation of production level.

In contradiction with large rivers and river systems small streams are more vulnerable to environmental conditions fluctuations and anthropogenic pressures. Low water level delays the entering of adult fishes in the rivers, decreased the reproduction and nursery areas and determines the unfavourable conditions for embryonic development of salmon and parr survival. In most cases the smolt production of small salmon rivers are negligible and below the safe limits for populations existence.

The salmon habitat area in small rivers commonly not exceeds few hectares. As result of eutrophication salmon spawning and nursery grounds overgrown or covers by organic components. Large part of salmon habitat in these rivers was loosed due to construction of mill or HPS dams. Agriculture, deforestation, communal and industrial sewages decline the water quality in the rivers.

Thus the further management of small and weak salmon populations should include the measures for:

- habitat improvement and/or restoration (both physical habitat and water quality);
- rivers riparian zone improvement and or/restoration;
- providing the efforts for rivers accessibility, obstacles removing, fish ladders etc.;
- implementation of separate rivers SAP's.

3.4.3 Management alternatives based on spawning stock requirements

There is considerable information available concerning management regimes based on spawning stock requirements. In 1999, the North Atlantic Salmon Conservation Organisation (NASCO) produced an interpretation of **the precautionary approach (PA)**, as applied to Atlantic salmon management. This defined the precautionary approach to international salmon management as being achieved mainly through the use of river specific (and sea age specific) **conservation limits** (CLs) for salmon spawners. An EU concerted action, SALMODEL, investigated a coordinated approach towards development of a scientific basis for management of wild Atlantic salmon in the North-East Atlantic. The project was operating in 2000-02 with members from countries around the North-East Atlantic. In this project many different aspects of management based on spawning stock size were investigated (Crozier *et al.* 2003). As four of the countries in the Baltic region (Denmark, Finland, Russia and Sweden) have salmon rivers in the North Atlantic area outside the Baltic and thus have implemented or should start using the approach, a similar approach in the Baltic could be particularly appropriate to them. A similar system in both areas would also improve the possibilities of comparing development of stocks and techniques used.

Management based on spawning stock size should take into account sex and size (age) of spawners as stated by NASCO. It is important to monitor the spawning stock as good as possible. This has become easier to achieve in recent years with technical development of equipment to automatically register fish ascending fish ladders. Technical improvements of the sonar technique have also made it possible to monitor and count free-swimming ascending fish in small or large rivers.

It is also important to have a good control over river fishery and catches. This area has not had any high priority among countries around the Baltic, but if management based on spawning stock size would be implemented, high quality catch statistics need to be developed.

Rivers with weak salmon stocks constitute a major problem, as for all different management alternatives. An additional difficulty may be that it is difficult to motivate investments to monitor the spawning stock in these rivers. It will likely be necessary to rely more heavily on monitoring by electrofishing in these rivers.

At present reproduction of salmon in small rivers is occasional and/or non- effective. The real number of adult salmon ascending small rivers are unknown but seems to be not sufficient because the monitoring results demonstrated very low salmon parr densities in comparison with large rivers in same region.

The management measures should include:

- establishing of spatial or temporal closures for salmon fisheries near small rivers outlets;
- limitations for fisheries and/or angling of salmon in small rivers;
- increase effort for control of illegal fisheries and poaching.

A monitoring of the spawning stock is not able to take into account the M74-mortality of newly hatched fry. The M74-mortality should be monitored in hatcheries and in case of indications of a high mortality extra-ordinary measures must be implemented. Electrofishing surveys and counting of smolts are important tools to keep track of the freshwater production.

Monitoring of spawning stock size can be used as an operational translation from a target or limit based on smolt production levels.

3.4.4 Incorporation of genetic conservation aspects

Genetic limit reference point

An effective population size of at least 500 per generation has been suggested as a minimum level for long-term persistence of an isolated population (e.g. Franklin 1980). The idea behind this recommendation is that at this effective size, mutations are assumed to generate genetic variation at the same rate as genetic variation is lost through genetic drift. In this evaluation of the future management of the wild Baltic salmon, we suggest including a specific limit reference point for effective size with the main objective of maintaining genetic variability and secure future evolutionary potential in all rivers with wild salmon production.

What is a population?

The first step when using this approach is to define what a population is. A species is often divided into a number of more or less isolated groups of individuals. Because gene flow is more or less restricted between these groups, genetic differences will develop over time as a result of genetic drift, selection and mutation. The critical question is then: when are these groups of individuals different enough to be considered different populations? A commonly applied rule of thumb states that one migrant per generation between subpopulations is sufficient to minimize loss of genetic polymorphism within subpopulations and at the same time allow for divergence in allele frequencies among subpopulations, assuming no effects of selection and mutation. Although this principle has been applied in a number of conservation programmes, its generality and ability to capture real-world complexities has been debated, and many conservation geneticists suggest that the figure should be adjusted upwards.

Mills & Allendorf (1996) used simulated data and concluded that the transition from genetic dependence to independence among groups of individuals takes place at a level of between 1 and 10 effective migrants per generation. Choice of any particular value within this range becomes somewhat arbitrary. As substantial allele frequency differences between subpopulations can occur under a scenario with one migrant per generation, we have chosen to use 10 migrants as the predefined level when identifying salmon populations in the Baltic Sea. The amount of genetic divergence among subpopulations (F_{ST}) is approximately

$$F_{ST} \approx 1/(4N_e m+1)$$

where m is the proportion of migrants in a subpopulation, and N_e is the local effective population size. If N_e equals the census size, N_em is simply the actual number of migrants entering a subpopulation each generation. This formula can be used to identify the level of genetic divergence that corresponds to a certain number of migrants per generation. In the case of 10 migrants (see above), $F_{ST}\approx0.025$. When F_{ST} exceeds 0.025, the subpopulations start to behave more or less genetically independently and should be treated as separate populations. On the other hand, if F_{ST} is less than 0.025, the allele frequencies among groups become more correlated, and the risk of fixation of alleles in subpopulations is small. In that case, the subpopulations could be treated as smaller units within a single metapopulation.

Metapopulation units *vs*. management units

As discussed above, metapopulations are defined based on the amount of genetic divergence at which subpopulations become genetically and evolutionarily independent. This criterion makes sense in conservation genetic work, where the aim is to maintain genetic variability and secure future evolutionary potential. From a management perspective, however, this criterion may not be very suitable for several reasons. As an example, imagine a population consisting of a number of less differentiated subpopulations. The migration rate is, say, 15 individuals per generation, which is enough to make these subpopulations genetically dependent with correlated allele frequencies. From a genetic or evolutionary perspective, these units would belong to the same metapopulation (see above). Now, imagine that 50% of the subpopulations go extinct. This will not necessarily result in any losses of total genetic variability in the metapopulation. However, the productivity of the metapopulation as a whole will be heavily affected. The reason is that the migration rate is still low enough to make the different subpopulations more or less demographically independent, and natural recolonization may take several generations to accomplish. For that reason, it may be wiser to base the definition of management units on the migration rate at which populations become demographically independent.

The work by Hastings (1993) suggests that the transition from demographic dependence to independence takes place at migration rates around 10%. At these high levels of migration, genetic methods have usually relatively little power which means that they may not be very useful to identify suitable management units. In most cases, the number of managements units will be larger than the number of identified metapopulations. In the case of salmon in the Baltic Sea, it is therefore relevant to keep the river-specific management to secure productivity in all rivers, and at the same time apply genetic limit reference points to larger metapopulation units (which include several genetically connected rivers) that are relevant from a conservation genetic point of view. One further advantage of using relatively small management units is that unrecognised local adaptations would be less likely to disappear.

Identification of salmon metapopulations and application of the genetic limit reference point

Genetic information is not available for all wild salmon rivers in the Baltic Sea. Therefore, it is not possible to make a complete division of rivers into suitable metapopulation units at the moment. However, just to illustrate the idea, we have included the rivers for which genetic information is available and grouped them into larger metapopulation units following the approach described above (i.e. by using F_{ST}=0.025 as the level where subpopulations become genetically independent, which corresponds to 10 effective migrants per generation). The groups are listed in Table

3.4.4.1. Some rivers for which genetic data was not available has been included and given group identity based on geographical proximity to other rivers. However, genetic information is missing for all except four of the small salmon rivers in the southern main basin, and these are not included in this table. This division is preliminary, and only serves to illustrate how large the metapopulations are likely to be.

An important first step in the future management plan of the Baltic salmon is to collect genetic data from all wild populations. The idea is then to apply the limit reference point of an effective size of 500 on these metapopulation units. Effective size of individual rivers will be estimated from molecular data and data on number of ascending spawners. One suggestion is to perform detailed genetic monitoring in a smaller number of index rivers, and for those rivers estimate effective size following e.g. the temporal method (e.g. Jorde & Ryman 1995). The relation between effective and census size in these index rivers, in combination with information from previous case studies on salmonid fish (e.g. Dannewitz *et al*. 2004), is then used to indirectly estimate effective size for the rest of the salmon rivers from observations or model estimates of number of spawners. The total effective size of each metapopulation is then estimated using data on the relative productivity of the individual rivers and the geneflow between them (following methods reviewed in e.g. Waples 2002).

Table 3.4.4.1. A preliminary division of rivers into metapopulations on which genetic limit reference points are to be applied. The level of genetic differentiation used to define whether rivers should be included in the same metapopulation or not corresponds to 10 effective migrants per generation. Most of the rivers in the southern main basin are not included, because genetic information for those is missing.

Metapopulation	Rivers included
1	Torniojoki, Kalixälven, Simojoki
2	Råneälven, Piteälven*
3	Åbyälven, Byskeälven
4	Vindelälven/Rickleån*/Sävarån*
5	Öreälven, Lögdeälven
6	Ljungan
7	Mörrumsån, Emån
8	Daugava, Gauja, Venta
9	Pärnu

*** Genetic data is missing in the present genetic database. Groups only preliminary based on geographical distance.**

3.5 Management tools and harvest control rules

3.5.1 TAC control

Quotas like TAC are easy to implement for managers and can be negotiated between stakeholders. The use of TAC is experienced as more appropriate for single-species fisheries like salmon fisheries. The main disadvantage of TAC, however, is that it controls the landings but not the catches.

TAC system for Baltic salmon fishery management was implemented for the first time in 1993 by IBSFC on recommendation of WGBAST. Since then, the TAC was reduced gradually from about 650 000 salmon to the 379 811 salmon for 2008. In the last years, due to different reasons, total TAC was not fully utilized.

Presently, salmon TAC applies only for commercial coastal and offshore catch. From the scientific point of view TAC should cover all kinds of catches, both in rivers and at sea, in order to be able controlling the whole exploitation of salmon. In some countries estimated catches in the river and recreational fisheries in sea exceeds over 100 tons and is not covered in quota system. For this reason recreational and river catches together with unreported catch and discards estimates should be taken into account in setting TAC both on international and national levels.

Furthermore, necessary tools should be established on EC and national level to estimate and control the level of recreational and river catches as a part of TAC.

Some amount of salmon, taken in recreational fishery as a non-commercial catch, therefore not reported, is sold on the market, which should be also restricted. It also gives negatively impact on price of fish from commercial catch.

Unreported/misreported catch, which are the additional substantial catch, special studies within DCR should be carried out to evaluate the magnitude of these catches Also more strict control of fisheries, should be carried out within next years to reduce the unreporting. Results of such actions will improve the regular stock assessment.

3.5.2 Effort control

Use of fin-clipping in fishery and assessment (the above tools may include use of ITQ, ITE, limits/targets for harvest rates etc.)

Presently, effort regulations are used in combination with salmon quota. Main effort measures are: vessel licensing, limited numbers of fishing days including closed seasons, and gear use limitations (i.e. driftnet ban) together with technical measures, as minimum landing size and gear regulations. Due to ban on drift net since January 1, 2008, harvesting of feeding salmon will be reduced to a very limited amount compared to previous years, when the proportion of salmon catch taken by offshore fishing have been around 70%.

For controlling number of days at sea on national level the Vessel Monitoring System (VMS) is used in conjunction with logbooks in case of offshore fishing and some coastal fishing. Assuming that VMS is working well, the results of effort control for that part of fisheries will be satisfactory enough for management purposes.

In the costal fishery, where commercial salmon fishery is carried out mainly by trap nets, effort regulatory measures that has taken place consisting mainly of fishing time limitations and maximum number of trapnets allowed per fisherman. The number of gear regulation in the coastal fishery, however, is a robust measure. The catch per unit of effort per one trapnet varies substantially depending on the fishing site and also to some extent on the type of trapnet. The potential effect of limitation in number of trapnets is therefore difficult to evaluate reliably. Practical implications of such limitations usually lead to a reduction of only the least productive fishing sites and therefore being rather ineffective measure. The limitation of the fishing time (closed periods), in stead, has proved to be effective measure and should be considered as management tool also in the future.

Effort measures in recreational and river fishing varies in different countries from total ban on river catches to seasonal and weekly closures, gear regulations together with daily bag limits. Although implemented, these measures do not fully satisfactorily consolidate achieving of SAP objectives.

3.5.3 Technical regulations

Technical regulations as a management tool of the salmon fishery could encompass a number of measures taken. The most obvious technical measures to implement is variations (or changes) in the minimum landing size, restrictions in the type(s) of gear used or closure of the fishery in certain time periods as well as selective fishing on reared (fin clipped) salmon only.

Minimum size

An increase in the minimum landing size from the present 60 cm to 65 or 70 cm would reduce the proportion of the salmon caught that may be landed. Salmon weight at 60 cm is around 2 kg and at 70 cm it is around 3.3 kg.

Size distribution of the salmon catch in Poland in 2007 shows that this would result in a reduction of the proportion of salmon that could be landed by some 14% (ICES 2008). In Denmark it would reduce the part of the salmon that could be landed with between 40 and 50 %. This would most likely result in a total stop for the Danish salmon fishery, which is already reduced significantly to about 1/5'th of the level just a few years ago. The reason for this difference is that dioxin-contents restrict the sizes of salmon that can be sold in Denmark, while this is not the case in Poland.

Size distributions in other countries salmon fisheries were not available, but a reduction in the proportion of catches that can be landed is most likely similar to the results from Poland.

A locally reduced minimum size is already implemented in the Gulf of Bothnia, where the minimum landing size is 50 cm. The reason for this is that the larger part of the catch in this area is salmon migrating towards the home rivers, and a part of the catch consists of grilse with lengths below 60 cm. Because there is not additional growth potential in these fish and because they are less important as spawners (from a genetic point of view), the national authorities have allowed a fishery for these. The implications of this measure are judged to be quite limited. A few not maturing salmon with lengths below 60 cm may be caught in the area, but the impact from this is estimated to be insignificant.

If a general reduction in minimal size was implemented it is estimated that this would result in a slight increase in fishing mortality in the Main Basin, compared to the present situation. This would be the result of Danish fishermen increasing their catches of smaller salmon, because these may be marketed without restrictions due to dioxin content.

The estimated increase in catch is probably very little, because many skilled salmon fishermen have left the trade and since the boats have been taken out from active fishing the potential for increase is limited. In addition to this the size group is usually caught only in very limited numbers.

Also in other fisheries the catch of undersized fish would go up somewhat, but it is very unlikely that total catches would reach the level prior to the ban on drift nets.

Gear

The traditional gear in the offshore fishery is longlines i.e. hooks baited with sprat (and the now prohibited driftnets). Until 2005 the minimum hook size was a size 6/0 with 19 mm gap. At the moment there is no size restriction in hooks, but the existing gear with size 6/0 hooks is still in use.

The effect on the catch composition using hook sizes with gap between 13.5 (size 2/0) and 19 mm investigated in the 1950'ies and 60'ies was not significant (Thurow 1964, ICES 1979). Salmon from about 30 cm length has a mouth width enabling them to swallow bait in the size normally used (sprat with lengths 11.5 – 12.5 cm), and to get hooked on a size 6/0. It is unknown if experiments with different bait sizes have been conducted.

The use of a different type of hooks, circle hooks, where the hook point is pointing back at the hook shaft is used in the American pacific salmon fishery (Anon. 2003). A higher proportion of fish caught on this type of hooks have been found to be hooked in the jaw resulting in an increased survival in released pacific salmon, in contrast to the usual "J"-type hooks (Cooke & Suski 2004). This would allow a reduced mortality in the release of a specific group of salmon. This could be undersized or wild salmon if a distinction between these was possible (fin clipping released fish).

A considerable technical development has taken place in coastal trapnets in recent years. Seal safe trapnets have been developed. Two types are found: easy-to-use 'push up' trapnets made of seal safe material (dynema) and traditionally shaped floating trapnets also made of seal safe material. This has resulted in an increase in the coastal fishery for salmon on spawning migration in the Gulf of Bothnia as well as in the Gulf of Finland.

It cannot be ruled out that further technological development is still possible, for example with seal safe doors into the traps, allowing a higher useable catch and reduced losses due to seal damages.

Technical possibilities for limiting the catch of salmon in the trap net fishery could include opening and closing of the fishery to allow parts of the bypassing wild salmon populations on spawning migration to pass the area. It could also include lowering the upper edge of the leading net or the use of a deflecting net near the entrance of the trap. This type of measures has proved to reduce catch of migrating smolts in pound nets in Denmark (Dieperink & Rasmussen 1997). It might, however, result in reduced efficiency for other target species in this fishery (whitefish), resulting in a reduced profitability and a reduction in fishing effort.

Open and closed periods

The subject of using open and closed periods in the coastal fishery was discussed above, but the method could be particularly useful in the fishery in rivers and close to river mouths, where salmon from the local population is targeted exclusively.

If the run of spawners into the river is monitored continuously opening of a fishery could be delayed or limited until the number of spawners in the river is sufficiently high for reproduction.

Regulation of the fishery in a specific river could (on a longer time scale – season) be regulated in conjunction with observed parr densities, limiting the possibilities for catch when parr densities observed the previous year are not satisfactory. This type of regulation could also be enforced if knowledge on the expected level of M74 in the population was known in advance from samples taken either in the offshore or the coastal fishery.

3.5.4 Interplay between international vs. national management

It is of course important that any management plan for Baltic salmon is decided upon on in fully agreement by EU and Russia. At present the annual international management is handled mainly by agreements on a TAC. As the catch levels allowed by the TAC have not been approached in the last few years, there is no effective TAC-management at present. However it is expected that the ban on salmon drift nets will be an important international management measure. Unless the longline fishery will escalate considerably, the offshore fishery will be on a small scale in the future. This may decrease the importance of international management regimes on catch levels. National management will increase in importance with decreasing offshore fishery. If any of the alternatives in 3.4.1-3 will be implemented in the new management program, there is a need for a joint international-national approach to management. It is suggested that ICES will continue to do annual or biannual assessments of the status of stocks. One possibility would be to use a set of indicators on stock status to decide upon if a meeting and a new assessment is needed.

3.6 Wild and reared fish

The SAP plan started with a number of definitions. Among other things there were definitions of wild and reared salmon. It can be noted that the definition of “wild salmon” was discussed by ICES salmon working groups after the SAP Plan was established and they later came up with a definition differing slightly from the one in the SAP. The ICES definition means that it is not sufficient that a fish is the result of natural reproduction for it to be called wild, but its parents must also be the result of natural reproduction.

In addition to a definition of the term wild salmon it would be suitable to include a definition of the term “wild salmon population” in the new management plan. A suggestion is that this is a self-sustaining population where no or only very limited releases of reared fish take place as shown in the text table below.

Annual releases in the order of 6-7 million reared salmon smolts take place in the Baltic, while the wild smolt production is much lower. There are interactions between wild and reared salmon stocks in a number of different areas, such as releases in rivers with wild production, via straying, diseases and fishery. It is evident that at least some of these interactions need to be taken into account in a management plan even if the plan is mainly dealing with wild salmon stocks. It would also be appropriate to raise the issue of the magnitude of releases. At present the value of reared fish catch is less than the cost of rearing and releasing them and if the fishery decreases it will become even less profitable. The interaction between wild and reared salmon populations would decrease if the number of reared fish in the Baltic decreased.

For the management plan it would be suitable to consider a scheme where all salmon rivers are divided into four different categories based on whether the fish are of wild or reared origin and whether re-establishment is taking place.

Category of salmon river	Management plan for salmon stock in the river	Releases	Criteria for wild smolt production
Wild	Self-sustaining	Not continuous releases	>90% of total smolt prod.
Mixed	Not self-sustaining at these prod. levels	Releases occur	10-90% of total smolt prod.
Reared	Not self-sustaining	Releases occur	<10% of total smolt prod.
Potential leading to category wild	Lead to self-sustaining population	Releases occur during re-establishment	Long term >90% wild smolt prod.
Potential leading to category mixed	Not self-sustaining population	Releases occur	Long term 10-90% of total smolt prod.

3.7 Conclusions

- The primary objective of salmon management (or alternatively: a salmon action plan - SAP) is to conserve within safe biological limits individual strains of salmon in the Baltic Area.
- Further recovery is needed for most or all Baltic salmon stocks in order to achieve internationally agreed objectives. Future management of Baltic salmon could therefore be divided into two phases: a recovery period, followed by a maintenance phase.
- Following the precautionary approach, the exploitation of the stocks within a mixed stock fishery should be based on the weakest stock with the lowest resilience to exploitation. Many of these stocks are located in the southern Baltic.
- Stock size at MSY should be regarded as a minimum standard for limit reference points with the aim of achieving restoration of depleted stocks not later than 2015. In management the risk level should be maximally 25%.
- A limit reference point at 75% of the potential smolt production would be in line with a management based on MSY. The actual stock size at MSY typically varies among rivers from about 60 to 80% of the potential production. A level below 60%, such as the IBSFC SAP target of 50%, is therefore clearly below the acceptable long-term stock size.
- A target level may be established at a suitable production level higher than MSY (or 75% of smolt production).
- Management based on MSY could be applied by limits for any of at least three different approaches; harvest rate, smolt production or spawning stock levels. This implies that in practice management could be based for instance on a spawning stock limit.
- Management based on limits for the spawning stock size has several advantages. It is used in the North Atlantic area, it is easy to understand for laymen, and technological development is making it easier to apply than earlier.
- Small and weak salmon populations are more vulnerable than major populations to environmental fluctuations and anthropogenic impact. Management of weak populations must include locally adapted programs taking into account needs for habitat restoration and other improvements.
- To secure maintenance of genetic variability and evolutionary potential, it is relevant to apply a genetic limit reference point of an effective size of 500 per generation to larger metapopulation units (which include several genetically connected rivers). Further genetic studies are needed to define suitable metapopulations.
- The M74-syndrome and post-smolt survival affect MSY and as a result a new management regime must be able to adapt to major changes in mortality. This suggests that a management regime should strive for improving predictions in these fields.
- A future TAC needs to cover all fisheries including commercial and recreational fishery in offshore areas, along coasts and in rivers.
- Effort control systems in fisheries could be strengthened and better implemented to regulate fisheries via improved control on a national level.

- Future TAC needs to cover all fisheries including commercial and recreational fishery in offshore areas, along coasts and in rivers.
- International and national technical regulations shall be adapted according to details of new management plan
- National management plans should be improved and better harmonised with the international management plans, because of the expected increase in importance of nationally managed fisheries.
- A definition of the term “wild salmon population” is proposed for the new management plan: it is a self-sustaining population where no or only very limited releases of reared fish take place
- The current high number of released salmon implies that interactions between wild and reared salmon stocks need to be taken into account in a management plan, possibly including the adjustments of stocking volumes and practices.
- Stock specific management requires improvement in current monitoring system mainly by establishing index rivers with a reliable smolt and spawner counts in each assessment unit.

4 Monitoring

The main sources of monitoring information needed for salmon management can be divided into three groups according to the area where data is collected (e.g., ICES 2007):

1) River surveys: parr density estimates, smolt trapping, monitoring of spawning runs and river catches, and genetic monitoring..
2) Sea surveys: catch data, fishing effort data and stock-proportion estimates.
3) Joint river and sea surveys: tagging data (tagging in rivers, recaptures from sea and river fishery).

For the future management of salmon in the Baltic Sea it is a high priority to establish at least one index river in each Assessment Unit. In these rivers information on parr densities, smolt counts and number of spawners should be collected. As stock-recruit data are not available from Baltic rivers, it is essential to carry out all three surveys (parr, smolt and spawner) to further improve the quality and precision of productivity estimates. Electrofishing surveys in these rivers should preferably cover more sites than in non-index rivers and they need to be distributed over parr rearing habitat of different quality to make these surveys more representative. Tagging of smolts is also of high priority. Genetic monitoring should be carried out to be able to estimate the genetically effective size and the effective to census size ratio. This information could then be used to get indirect estimates of the effective size of all non-index rivers.

Electrofishing surveys in non-index rivers should be carried out but in the present assessment system it is not necessary to carry out annual surveys. A decision whether monitoring in a particular year would be carried out or not may not be influenced by expected changes in abundance of salmon. Smolt trapping in combination with electrofishing surveys may be carried out in a river for a couple of years and then the trapping may move to another river. This could have a higher priority when compared to annual high intensity electrofishing surveys.

For future management it is important that the amount of information available from individual rivers does not differ between Assessment Units.

River specific management requires monitoring of individual rivers and the kind of data needed does of course depend on what kind of analysis is carried out. For instance hierarchical linear regression analysis is used to estimate wild smolt production modes for different stocks. This requires time series of parr abundance indices for all rivers considered and time series of smolt abundance for as many rivers as possible. More specifically, the annual number of sampling sites electrofished and the corresponding densities of age 0+, 1+ and >1+ parr are needed.

As the requirement for data will always exceed the available resources, preferences must be stated. The decisions regarding which investigations should be prioritised are normally made on a national, regional or local level and they are usually based on several factors. The working group may assist in giving guidelines on data collection. Such guidelines should be based on an evaluation of how data may contribute to an improvement of accuracy and precision of the assessment results, with the aim of keeping the collection of long-term high quality datasets at a high priority. In rivers where little data is available basic surveys are needed.

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Annex 1: List of Participants

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Annex 2: Technical minutes from the Baltic Salmon Review Group

- RGBALSAL
- By Correspondence 22–23 May 2008
- Participants: Michael Sissenwine (Chair), Henrik Swedäng (Sweden), Hans Lassen (ICES Secretariat)

Review of ICES WKBALSAL Report 2008: Report of the Workshop on Baltic Salmon Management Plan Request

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In October 2007 the European Commission requested ICES for a scientific advice concerning revision of the Salmon Action Plan and a development of a new long-term management plan for Baltic salmon.

In order to assess the outcome of the management plan in relation to its objectives, smolt production would preferably be estimated for each river and compared with the carrying capacity. However, neither smolt production nor potential production is in most cases satisfactorily estimated, although modelled with Bayesian statistics (basic knowledge too low?). Would it be possible to alter the assumptions underlying the Bayesian model, just for comparison reasons? Maybe it should be pointed out more clearly that all trends in smolt production and potential production are indicative, whereas the level is imprecisely determined.

Overall, it seems difficult to evaluate the effects increased postsmolt mortality, or decreased fishing mortality, or other regulatory factors as the most important population parameters for different river populations are not described with sufficient precision. Is the lack of response in some small salmon rivers in the Gulf of Bothnia due to improper estimation of number of parr or due to some unknown process that just takes place in small rivers? I think it would be very helpful if it was made crystal clear which estimates are reliable and which are not.

Monitoring of genetic diversity is important and should be prioritized as the salmon stock in the Baltic is subdivided into several minor populations units (which might confront periods of very low effective population sizes (Ne)) and is affected by massive stockings of reared smolts. The application of the concept of “metapopulation” seems to be a bit arbitrary, and possibly misleading, as the number of salmon populations in different rivers is quite stable and the amount of straying between is moderate. However, the use of this concept was mitigated as it was further on stated that preservation of self-sustaining salmon populations will be kept as the main objective.

Conclusions: I think my main advice for the report writers would be: limit the number of conclusions (and advice to the managers) to what is really important: Which parameter could be estimated with sufficient precision and cost efficient and at the same time give the most important pieces of information to the managers on stock development and genetic diversity? Is the smolt production or the number of ascending (or descending) adults by river the parameter to go for? Is the potential smolt production really a workable parameter? Would it from a biological and conservationist point of view be better to more or less stop releasing reared smolts or not? I think for the latter question it should be spelled out clearly as possible.

Last but not least, everything related to fishing mortality (which is the thing we really can influence in a short term perspective) should be kept together, aiming at the fact that at times of varying M74-mortality and postsmolt mortality the only way of securing the low productive populations will be by decreasing fishing mortality.

Review of the Report of the Workshop on Baltic Salmon Management Plan Request 13–16 May 2008

Hans Lassen
28 May 2008

1) The report is a compilation of analyses largely taken from work presented in various WGBAST reports and occasionally with elements from the scientific literature. There is no new analysis nor does the report include syntheses that have not been presented and reviewed elsewhere e.g. the material from WGBAST has already been reviewed most recently by the ICES review group on the WGBAST 2008 report (April 2008) in particular I find that the comments on the assessment model should be recalled. This recent review was rather critical pointing out two main issues:

   a) Use of the time series of Carlin tags in the assessment model. The review group on the WGBAST 2008 report concluded "The WG needs to take an objective look at where taggings are still useful in a quantitative context" and in the discussion of the post smolt mortality "the estimates of the post smolt mortality are sensitive to changes in the reporting rates." It seems clear that a management plan based on information from the Carlin tagging programme will run into difficulties although this conclusion is not drawn in the workshop report.

   b) The IBSFC SAP is based on rive-by-river approach and the Review group on WGBAST "advised against using the river specific estimates in the advice. Instead, a roll-up by Unit should be used."

   Therefore, the results of the workshop are reviewed from the point of view whether the conclusions on the proposed management plan are satisfactorily based on the analyses presented.

2) Section 2 is an evaluation of IBSFC SAP 1997-2005. This is a summary of what has previously been discussed.

   a) The status of the salmon wild populations has become better but some small rivers are still far from the target established in the IBSFC SAP and the target (50% of potential smolt production) will not be reached by 2010.

   b) The report is rather vague on whether improvement in the population status has been achieved with the largest possible catch – which was the other IBSFC SAP objective. The analysis presented seems to assume that the largest possible catch would have been the IBSFC TAC or the ICES advice. The TAC has not been fully fished in all years. The report does not conclude if the TAC regime is actually controlling the fishery or whether the decrease in catches is a result of a completely different process. This obviously has implication for the new management plan whether that should be built on a TAC regime or not.

c) The IBSFC SAP is defined in term of smolt production and there is little analysis if this objective is appropriate and also if the 50% target by individual river has been effective. However, as the overall target was an improvement of population status so in that perspective the IBSFC SAP was success.

d) The report includes an interesting discussion whether the new Salmon Management plan shall continue to formulate its objectives in smolt production or in terms of spawners. I cannot find a conclusion of this discussion; the genetic sections seem inclined to use number of returning spawners while much of the discussion is on that the old 50% target is not appropriate. The section 3 concludes "Management based on limits for the spawning stock has several advantages…" and points to technological developments that make such data more readily available than previously was the case.

e) The evaluation discusses a number of measures that were used in the implementation of the IBSFC SAP 1) delayed release, 2) terminal fishing areas, and 3) fin clipping. The report would benefit from a clear distinction between objectives and implementation.

f) The discussion on the enhancement programme would have benefited from a clear conclusion whether such programmes should be part of the future management plan. The evaluation does not suggest very much success with these programmes.

g) The same comment as made under f) applies for the discussion in section 2.3.3 on re-establishment of salmon runs in potential salmon rivers.

h) In conclusion, even though there as mentioned above are a number of issues where more analysis would have been helpful I find that the set of conclusions in section 2.5 is a sound basis for drafting an answer on evaluation of the IBSFC SAP for the Commission

The requests asks for an evaluation of which are the main drivers for salmon population dynamic and the request particular mentions

a) Commercial fishing
b) Recreational fishing
c) Habitats

The report does not provide an answer to this question. There are no data presented on the recreational fishing. It follows presumably from Figure 2.2.2 that the carrying capacity of the habitat has not been reached for all rivers – the level of the smolt production capacity (Table 2.2.1) has not been reached and that therefore the fishery still has major impact on the system. This conclusion is not obvious as there clearly are environmental drivers on post smolt mortality see figure 2.2.3 and I cannot find an analysis that negates that the drop in post smolt survival is the cause why we have not reached the full production potential.

Drift nets were banned in the Baltic Sea at the start of 2008 and as the commercial sea fishery was using driftnets it might be considered that these fisheries would see major changes. Therefore, it is surprising that no attempt is made to assess the impact on the future fishery save a minor comment.

This question is central to the proposal for a new management plan and should be answered clearly at the start of the advice. I think that the conclusion from reading the report should be

> *A new management plan should remain focused on fisheries, however the removals that shall be considered include all life stages and should be a plan that – as an extension of the IBSFC plan – deals with removal also in rivers. The competence of IBSFC was up to the shoreline.*

The report is focused on the Salmon in Subdivisions 24-31 while Salmon in the Gulf of Finland (Subdivision 32) is not explicitly discussed. It is not clear from the report whether the approach to salmon in this area should be part of the same plan as for Salmon 24-31 or not. A part of that consideration may be linked to the discussion in the report of salmon in "weak" rivers. Obviously, the rivers in the Gulf of Finland fall under this category.

In conclusion I find that section 3.7 lists relevant issues that the advice drafting group should consider. However, this list does not include answers on e.g. if the TAC regulation is the appropriate management method and a conclusion on how an objective might be structured. Furthermore, it is not clear whether measures used in implementing IBSFC SAP, e.g. enhancement, terminal fishing should be part of the new plan or not. I do not find that the list forms a comprehensive and well structured proposal for an answer to the Commission.

Also the short text on monitoring is relevant for an advice drafting group but the process to develop a consistent proposal for the consideration of the Commission has not been concluded. This shall be the task for the advice drafting group.