8.3.3.3 Request to ICES for advice on management of Baltic Sea salmon

The European Commission (EC) requested ICES to provide scientific advice on the management of Baltic Sea salmon. The management of salmon in the Baltic Sea is subject to the Salmon Action Plan (SAP) adopted by the International Baltic Sea Fisheries Commission (IBSFC) in 1997. Since the time period covered by SAP will end in 2010 and the plan is already obsolete relative to fishing, the European Commission has decided to develop options for a new SAP to address all life stages of salmon and all human impacts on salmon. EC requested ICES to provide scientific advice on management of Baltic Sea salmon according to the following Terms of Reference (ToRs):

- 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 EC's request noted that recommendations by the BS RAC may serve as background information. The Baltic RAC recommendations on "Elements of the future management plan for salmon", numbered I–XVII, included *inter alia* three points on the science: X (improving initial survival of smolts), XI (Establishment of index rivers), and XII (finclipping programme). Furthermore, recommendation XIII calls for further analysis of the interactions between the environmental degradation and the salmon production potential and XV calls for analysing the interaction between salmon and seal populations.

ICES response

The ICES response is organized according to the ToRs of the request. For each element of the ToRs, a concise response is given followed by discussion to support the response. Additional information is contained within the Report of the Workshop on Baltic Salmon Management Plan Request (WKBALSAL – ICES, 2008a).

A. Biological evaluation of the current Salmon Action Plan

Response

The main IBSFC SAP objective is

> *"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"*

This SAP objective has been interpreted in terms of smolt production. Another objective of the SAP is to re-establish wild salmon populations in rivers with the potential to support salmon. SAP also has the objective of maximizing the yield from fisheries within constraints necessary to achieve the other objectives of the Plan (e.g., 50% of the potential production of smolts).

ICES 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. Some of the rivers in the remainder of the Baltic Sea are unlikely to achieve the objective of 50%. None of the rivers of the Gulf of Finland 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 large hatchery production relative to natural production in rivers with depleted salmon stocks.
- 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.
- TAC recommendations from ICES have been consistent with the objective of achieving a smolt production at 50% of its potential by 2010. However, the agreed TAC has often been higher, and especially so in the last few years. Reported landings have been substantially lower than the TAC in recent years.
- The effectiveness of other salmon management measures varies. The ban on driftnet fishing has reduced fishing mortality. Limits on the number of trapnets in coastal waters are considered ineffective, while time period closures are 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.

Discussion

The IBSFC SAP is a TAC-based fisheries plan for the IBSFC Baltic Sea up to the shoreline. ICES advises on Baltic Sea salmon TACs according to the objective of the SAP. Advice is based on reports of the Baltic Salmon and Trout Assessment Working Group (ICES, 2008b).

TACs regulate the survival of spawners which in turn regulates the smolt production two to five years after the spawner run. Therefore, the fishery from the present point in time onward has very little influence on the achievement of the smolt production objective of the SAP by 2010.

The Baltic salmon is assessed in six units, see Figure 8.3.3.3.1.

Smolt production

Estimation of the potential smolt production in Baltic salmon rivers is difficult due to limitations in the amount of relevant information in most of the rivers. During the implementation of the SAP the potential production estimates were updated several times in accordance with estimated annual smolt numbers. The potential smolt production obviously varies among years with varying 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). However, the present set of estimates is considered well founded and suitable for management purposes.

Smolt production in most of the salmon stocks of the Main Basin and Gulf of Bothnia is expected to exceed the 50% target of potential smolt production by 2010, despite the low post-smolt survival of recent years. However, all assessment units, except Unit 1 for the Bothnia Bay, have a few stocks which are unlikely to reach the 50% target. The stocks in the Gulf of Finland have not improved and the 50% smolt production target will not be reached for any of the stocks in rivers discharging into the Gulf of Finland.

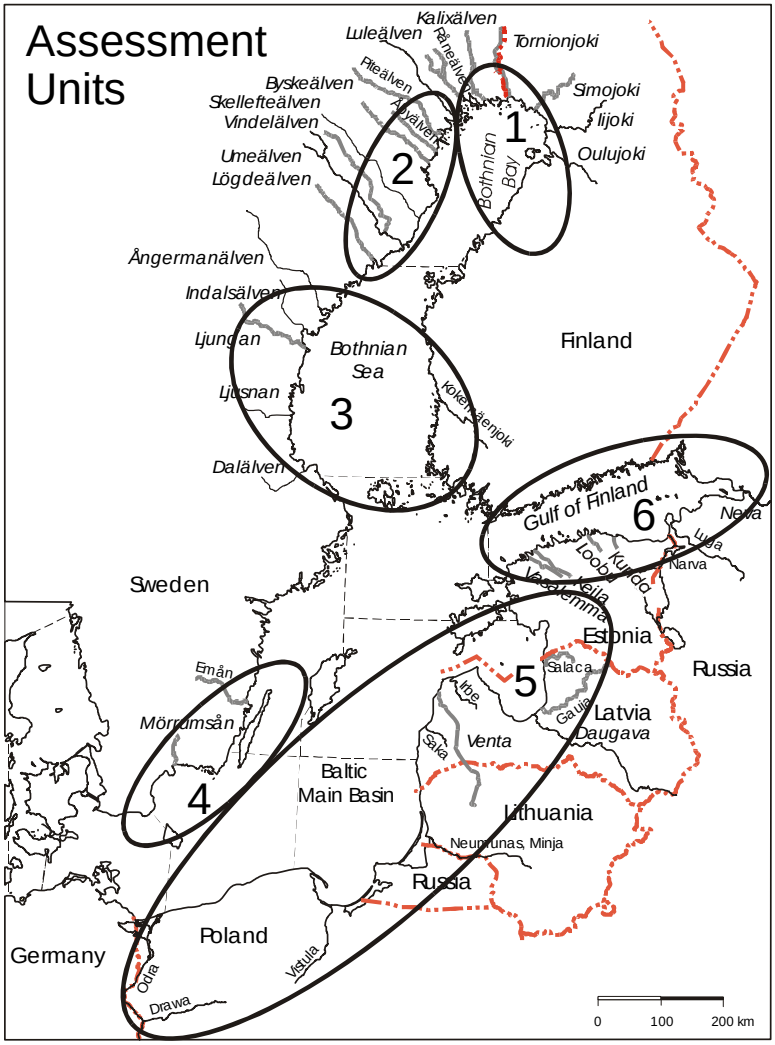

Figure 8.3.3.3.1 The six assessment units used for Baltic salmon.

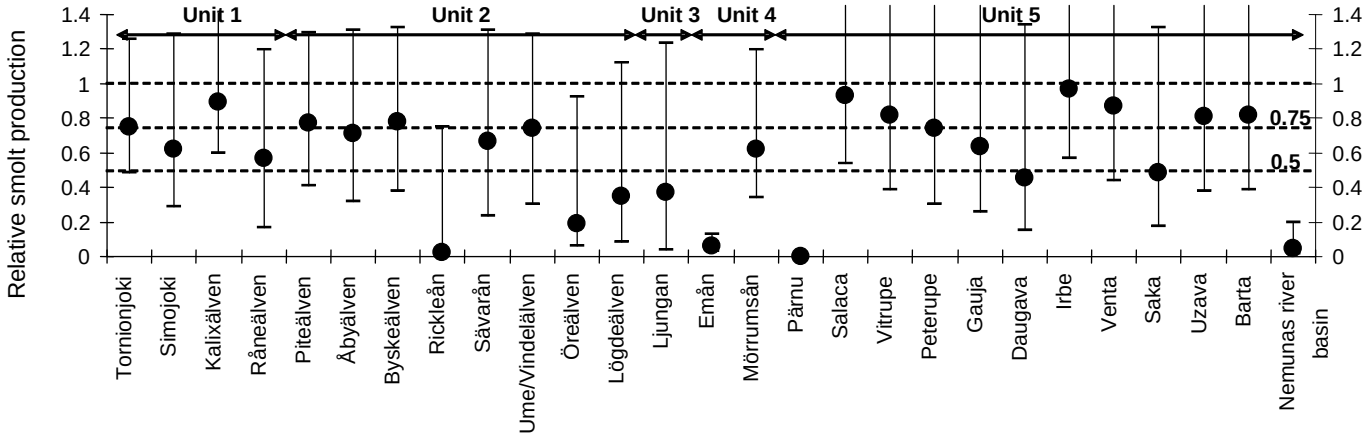

Figure 8.3.3.3.2 Smolt production estimates in 2010 relative to the natural smolt production capacity for the Gulf of Bothnia and Main Basin stocks (mode and 95% probability interval).

The number of spawners returning to the rivers of the Units 1–4 has increased, except for Mörrumsån and Emån (Figure 8.3.3.3.3).

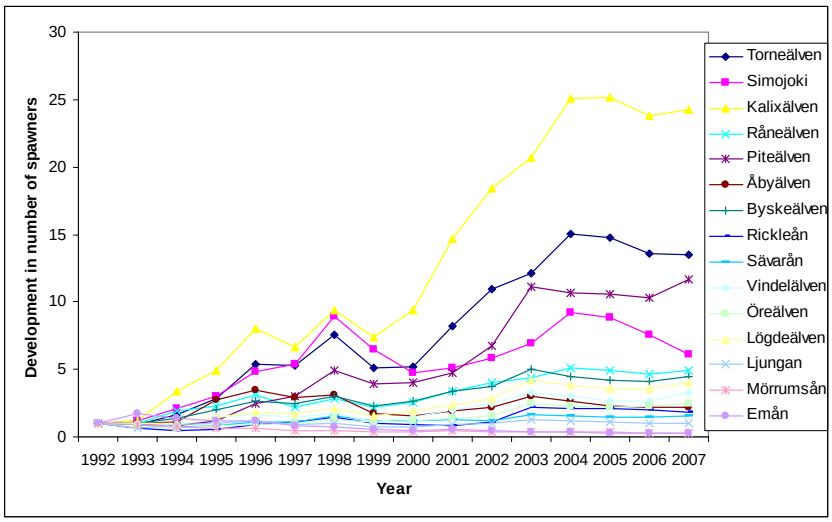

Figure 8.3.3.3.3 **N**umber of spawners (relative to the spawning season 1992) in 15 rivers (Units 1–4) with wild salmon production in the period 1992–2007. All rivers except Mörrumsån and Emån show increasing trends in number of returning spawners.

Genetic consideration

Annually, 6–7 million smolts are released in the Baltic, which is almost three times the natural production of smolts. The potential impact on the genetic robustness of wild populations of salmon is unknown, but it is a concern.

Salmon populations of small rivers

About half (~20) of the Baltic wild salmon rivers are small rivers of lengths <100 km and with a catchment area <1000 km^2. The potential smolt production of these rivers is only a small proportion of the total for the Baltic Sea system. Most of these small rivers show only irregular or very low smolt production. These small rivers are sensitive to fluctuations of environmental conditions and anthropogenic pressures. Low discharge, high water temperature, and inadequate water quality delay entry of adult salmon and negatively affect the spawning success in small rivers. Eutrophication, acidification, pollution, siltation, and other changes (e.g. erosion, deforestation, etc.) in a river's riparian zone are all anthropogenic impacts decreasing the 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.

Local conditions seem to be of particular importance in small rivers. For some of these, e.g. Öreälven (Unit 2) and Emån (Unit 4), inefficient fishladders and fishways are probably restricting population growth. However, it is not possible to identify general causes for how these weak salmon stocks react; the causes need to be investigated river-by-river.

Re-establishing wild salmon populations in potential salmon rivers

Re-establishment and restoration efforts have been made in 27 rivers around the Baltic Sea. The goal for the restoration efforts was to re-establish natural reproduction of salmon in the rivers. Measures include 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. However, the success has been poor to date.

There has been some success re-establishing salmon populations in Gladyshevka (Russia) and Kågeälven (Sweden). Most of the other potential rivers show only low and irregular wild reproduction in spite of massive stocking programmes in some cases. Several problems in various phases of salmon life cycle may adversely affect restoration measures, but their relative importance is difficult to assess.

Yield to the fisheries

ICES has advised on catch levels consistent with the smolt production target (at least 50% of the potential smolt production by 2010) to be realized. Furthermore, ICES has advised on specific measures aimed at rebuilding the so-called "weak stocks". The utilization of the salmon-TAC in the Baltic Main Basin and Gulf of Bothnia has gradually decreased between 1997 and 2007. In 2007 only 42% of the Subdivision 22–31 TAC and 74% of the Gulf of Finland Subdivision 32 TAC were taken. The main factors that have contributed to this situation are: TACs set too high; restrictions for marketing of salmon due to high dioxin content; increasing seal damages to fishing gear and caught fish causing regional and temporal deterioration in fishing possibilities, particularly in the coastal fishery; increased fishing costs (e.g. fuel); and low salmon prices.

Other management measures

In addition to the management measures already discussed, the IBSFC SAP has used a variety of management measures, including:

- Technical measures (minimum hook size) and effort regulations in the open-sea fishery;
- Terminal fishing areas;
- Delayed release.

Effort regulations are used in combination with salmon TACs. For the sea fisheries they include vessel licensing, limited numbers of fishing days including closed seasons, and gear use limitations (i.e. driftnet ban). In coastal fisheries (trapnets), some periods are closed to fishing and a limited number of trapnets is allowed per fisher. Limiting the number of trapnets is considered ineffective, while closed periods have proven effective in limiting effort in the salmon fisheries.

Effort measures in recreational and river fishing vary in different countries, from a total ban on river catches to seasonal and weekly closures, and gear regulations together with daily bag limits.

Technical regulations include minimum landing size and gear restrictions. These are considered in ICES (2008a).

Terminal fishing areas have been established for a particularly intense fishery of reared spawners. They are located close to rivers where releases take place. However, catch samples collected from the terminal fishing areas (in Finland) suggest that in the outermost parts of the areas, the proportion of wild salmon in the catches is the same as in other areas along the coast. Latvia decided not to use this approach after 2006. The technique of terminal fishing areas does not seem to be efficient in protecting wild salmon while allowing at the same time a directed fishery on reared salmon.

Adipose finclipping of reared salmon smolts was implemented by Estonia in 1997, by Sweden in 2005, 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). The intention is to easily identify reared from wild salmon in the catches and to retain the reared salmon while releasing the wild salmon.

There is no information available that allows an evaluation of the efficiency of the finclipping programme because the programme has never been introduced for all releases of reared salmon. Not having been introduced for all reared salmon, its effectiveness is questionable. However, adipose finclipping has made it easier to identify reared fish entering wild populations, and may therefore be an effective tool for detecting ecological and genetic interactions between reared and wild fish in the future.

B. Options for the future management plan for salmon

Response

ICES proposes that the future Baltic Sea salmon management plan shall define a "wild salmon population" as follows:

Wild salmon populations are self-sustaining populations with no or only very limited releases of reared fish.

In response to the elements of the ToR related to the future management plan for salmon, ICES advises as follows:

- 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. The option of 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.
- Future management should include an integrated approach that addresses factors controlling the dynamics of salmon populations throughout their life cycle and the multitude of economic and social benefits that may be derived from salmon.[1]
- 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.

Discussion

The salmon life cycle includes both a fresh-water and a marine phase. Human activities impact the salmon life cycle in all its stages and the future salmon management plan should include regulation of human impacts regardless of whether they occur in rivers, in coastal areas, or in the open sea. Fisheries management should consider all removals in all areas, be they by recreational or by commercial fishing.

A management plan for the salmon should consider not only the recovery of populations below reference points but also ensure that salmon stocks at or above the reference level are not depleted. Future management of Baltic salmon could therefore be divided into two phases: a recovery period, followed by a maintenance phase.

Management objectives based on an MSY policy

A range of objectives is possible, depending on the policies guiding management. The MSY policy, as addressed by the European Commission (2006) in its communication on implementing sustainability in EU fisheries through maximum sustainable yield, can be used to set objectives for Baltic Sea salmon management. The objective could be set in terms of the size of spawning runs, harvest rates, or smolt production (recruitment to the at-sea phase of the life cycle). The current SAP sets its objective in terms of smolt production, and this is also appropriate for future salmon management.

The estimated production of smolt at MSY varies among rivers from about 60% to 80% of the potential smolt production. An objective of recovering or maintaining smolt production at or above 75% of the potential smolt production approximately corresponds to MSY management. The 75% level may be viewed as either a target or a limit reference point, depending on the degree of caution desired in the future management plan. Since estimation of the smolt production in individual rivers is imprecise, it is appropriate to assess and manage salmon fisheries in larger units, such as the six units currently used (Figure 8.3.3.3.1).

It should be noted that the level of smolt production associated with MSY is dynamic, with a variability in the post-smolt survival rate and the occurrence of the M74 syndrome (which causes mortality in larval salmon) having important effects. Outbreaks of the M74 syndrome are occasional, while the post-smolt survival rate has generally decreased from 1997 to 2007 (Romakkaniemi *et al.*, 2003; ICES, 2007). These factors cannot be controlled but should be taken into account in setting and updating reference levels for management objectives when trends persist.

Management objective for the conservation of genetic diversity

To maintain the future evolutionary potential of wild salmon the conservation of genetic diversity in Baltic Sea salmon should also be an operational objective of future management. Based on the level of genetic connectivity between salmon rivers, meta-population units should be defined to which a genetic limit reference point may be applied. A preliminary analysis of meta-populations populations was conducted by the Workshop (ICES, 2008a), but more data and analysis is needed.

To secure maintenance of genetic variability and evolutionary potential, a preliminary (pending further study) genetic limit reference point of an effective size of 500 wild spawners per generation could be applied to meta-population units.

[1] ICES understands that social and economic considerations are beyond its ToR for this advice, but it would be improper to ignore them in the development of an integrated approach to management.

In addition to conservation of genetic diversity through a limit reference point for the number of spawners, the implications of hatchery production of salmon on the population genetics of natural populations should be considered in future management.

Monitoring genetic information from all rivers with wild production should be part of a future management. Based on this information, the performance of the management plan should be evaluated relative to conservation of genetic diversity. The data should also be used to refine the identification of meta-populations, genetic objectives, and limit reference points.

Fishery management measures

The open sea fishery dealt with by IBSFC was dominated by driftnetting. The open sea fishery has declined and driftnets are banned from 1 January 2008. Therefore, harvesting of salmon at sea is reduced to low levels compared to previous years, when the proportion of salmon catch taken by offshore fishing has been around 70%. The fishery that will be regulated under the future salmon management plan therefore differs from that experienced with the IBSFC SAP.

In recent years offshore driftnetting has been harvesting annually about 20% and longlining 5–10% of the feeding salmon. With the driftnet ban the exploitation on the feeding grounds is expected to decrease to the level indicated by the harvest rate of longlining. Other fisheries (coastal and river) partly benefit from this reduction in the offshore fishing and the effect of the driftnet ban on the total exploitation level of a particular salmon stock depends on how much the stock is exposed to other fisheries. If efforts in other fisheries do not vary greatly from the current level, the total annual harvest rate will decrease by about 40% for the southern stocks and by 25–35% for the northern stocks.

In addition to open sea fisheries management, salmon fishing is regulated by national regulations of fisheries in rivers and in river mouths. Such regulations shall be either included in the future management plan or implemented in a manner consistent with the overall objectives of the management plan.

Needless (but important) to say, control and enforcement to avoid IUU fishing both in the commercial as well as in the recreational fishing must be part of the future plan if it is to be effective. In that context, the misreporting of salmon as sea trout should be prevented.

Presumably TACs, effort regulations, and technical measures will all be elements of the future management plan for salmon. These need to be designed to achieve the specific objectives of the plan.

Management of weak river populations

Fishery management measures suitable for large rivers need to be complemented by other measures for populations in small rivers. The so-called “weak rivers” (i.e. small rivers that have not experienced the increase in smolt production seen elsewhere) should receive special attention in the new management plan. The measures should be river-specific, with the cause for the lack of response investigated on a case-by-case basis. Habitat and environmental conditions affecting salmon populations should receive particular attention. These factors are probably important in understanding why the salmon populations in these rivers do not respond to decreased exploitation at sea.

The salmon habitat area in small rivers commonly does not exceed a few hectares. As result of eutrophication, salmon spawning and nursery grounds have been overgrown or covered by organic material. Greater parts of the salmon habitat in these rivers were lost due to the construction of mill or hydroelectric power generation dams. Agriculture, deforestation, and communal and industrial sewages also degrade the water quality of some rivers with weak populations. The management of small and weak salmon populations should therefore include measures for:

a) habitat improvement and/or restoration (both physical habitat and water quality);
b) improvement and or/restoration of the rivers’ riparian zone;
c) providing river accessibility, removal of obstacles, fish ladders, etc.

The implementation of the overall plan requires local management plans that are targeted at meeting the requirements for a particular river. Such plans should use local habitat/restoration/improvement efforts to raise the population in a river to a level which meets both international and national fisheries management objectives.

Reared salmon releases

A small percentage of reared salmon stray and have the potential to adversely affect the genetic integrity of the weak wild salmon populations. This needs to be taken into account in the future management plan by including measures to reduce or eliminate the adverse genetic effects of reared salmon on weak wild salmon populations.

Monitoring

Stock-specific management requires improvement in the current monitoring system. There should be annual monitoring of returning spawners and of migration of smolts to the Baltic Sea. Index rivers should be established for more detailed research studies. Reliable smolt and spawner counts in each assessment unit are needed.

There is little information on recreational catches and effort. This needs to be addressed in the future.

Sources of information

European Commission. 2006. Communication from the Commission to the Council and the European Parliament: Implementing sustainability in EU Fisheries through maximum sustainable yield. COM (2006) 360 final.

ICES. 2007. Report of the Baltic Salmon and Trout Assessment Working Group. ICES CM 2007/ACFM:12.

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

ICES. 2008b. Report of the Baltic Salmon and Trout Assessment Working Group. ICES CM 2008/ACFM:05.

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

ANNEX to Section 8.3.3.3

The European Commission (EC) requested ICES to provide scientific advice on the management of Baltic Sea salmon (ICES Advice 2008 section 8.3.3.3, delivered June 2008). As a follow-up and to assist the Commission in providing *an impact assessment of different possible management options*, the EC asked ICES (18 July 2008) to comment on three options for Baltic Salmon Management:

- Option 1: continuation with management as today (no plan)
- Option 2: ICES' proposal (ICES Advisory Report 2008, section 8.3.3.3) already provided
- Option 3: continuation of the IBSFC plan (SAP)

ICES comments

ICES assumes that the management objective is still the rebuilding of the salmon populations toward the potential capacity of each river. This objective is quantified as a measure of the smolt production relative to the potential capacity on a river-by-river basis.

Under options 1 and 3, Baltic salmon is managed primarily through measures affecting the open sea fisheries and both these two options are unlikely to produce the desired population status for all rivers because the life cycle of salmon depends on natural and human related factors that occur in river, coastal, and open sea environments. Future management of salmon should address all human activities that affect salmon, *inter alia* fishing, habitat alteration, and release of reared salmon from hatcheries. Regulation of the open sea fisheries alone means that obstacles to population improvements are not all addressed and therefore the objectives are not met.

ICES (Option 2) advocates an integrated approach to management of salmon which include river-specific elements to address the recovery needs of weak populations in small rivers. In addition to controls on fishing whether in rivers, in coastal areas or in the open sea, management efforts should address habitat problems. Management measures for fisheries should be applied to all fisheries (open sea, coastal, in rivers, commercial, and recreational) in a consistent manner. A case-by-case approach will probably be necessary.

There is insufficient scientific information to determine if populations are within "safe genetic limits," but there are genetics concerns in light of the large hatchery production relative to natural production in rivers with depleted salmon stocks.

It is too early to fully evaluate the efforts to re-establish salmon populations by salmon releases, as at least one generation without releases is needed. However, to date there is little evidence of success; to re-establish salmon populations will be difficult under all three options.

Option 1: continuation with management as today (no plan)

TACs and technical regulations of the open sea fishery set at the levels seen 2006-2008 will probably lead to a halt of the improvement in the salmon population because the potential for improvement through regulation of open sea fisheries has been realised and further improvements depends on regulation of the conditions in other parts of the life cycle (fishing in coastal and river areas, status of river habitats, etc.).

TACs in the period 2006-2008 have been set at levels above those recommended by ICES – corresponding to the IBSFC SAP 50% target smolt production level - but the TACs have not been fully taken. Improvements in the population status have been achieved in recent years, but this would not have been possible if the TACs had been fully taken.

Option 2: ICES proposal (ICES Advisory Report 2008, section 8.3.3.3) already provided

This type of management would be river specific and is expected to generally improve the status of populations in the major rivers to allow rebuilding of the populations in the weak rivers.

Improvement in the general population status depends on the target smolt production level. ICES proposes that this target be increased from at least 50% to at least 75%.

This management option includes an integrated approach that addresses factors controlling the dynamics of salmon populations throughout their life cycle and the multitude of economic and social benefits that may be derived from salmon. It is thereby possible to address river specific issues and remove bottlenecks that slow or halt the desired population development. Experience with the IBSFC SAP suggests that an integrated approach is of particularly importance for the Gulf of Finland populations.

Option 3: continuation of the IBSFC Salmon Action Plan (SAP)

In this situation the 50% target smolt production level of the IBSFC SAP for rebuilding of salmon populations remains and the target year is specified 10-15 years into the future. However, as noted above the key issue is to include a number of management measures into the plan that addresses habitat and fisheries in coastal and river areas, management elements that because of the competence of IBSFC as a fisheries organisation could not be addressed under the SAP in a consistent manner.

As for option 1 the continuation of the IBSFC SAP will not allow further general improvement of the current status of salmon populations. Overall the target smolt production level has been reached but there are rivers that have not reached the target.

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 IBSFC SAP to perform poorly with respect to some of these rivers. Specific factors that adversely affect salmon can be identified for some rivers. There may be a slow improvement in population status of also the weak rivers but the 50% target is not likely to be reached.

TAC recommendations from ICES have been consistent with the objective of achieving a smolt production at least 50% of its potential by 2010. However, the agreed TAC has often been higher, and especially so in the last few years. Reported landings have been substantially lower than the TAC in recent years and it is expected that this will be the case also in the near future. As it seems that there are specific factors which adversely affect salmon development in some of the small rivers recovery to the 50% is unlikely.

The populations in the Gulf of Finland have not reacted as hoped for and management should continue with very restricted fishing – (ICES advises in 2008 that until the population status improves fisheries should only be permitted at sites where there is no chance of taking wild salmon from the Gulf of Finland stocks along with reared salmon).