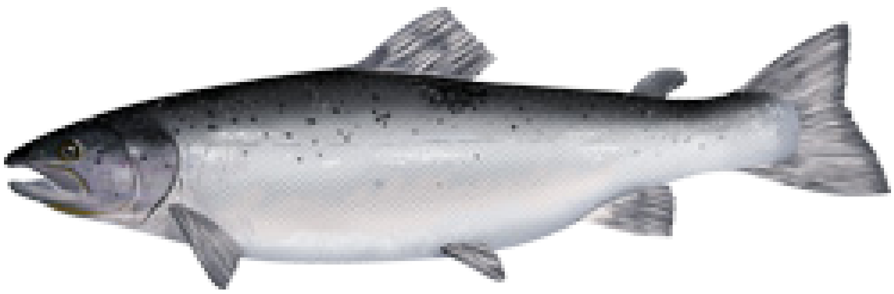
OSPAR COMMISSION

Background Document for Atlantic salmon

Salmo salar



Biodiversity Series

2010

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998.
La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l’Irlande, l’Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d’Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l’Espagne.

Acknowledgement

This report has been prepared by Ms Amelia Curd. The contributions of Dr Peter Hutchinson (NASCO), Pr Jean-Luc Baglinière, Dr Fredrik Arrhenius are gratefully acknowledged by the author

Photo acknowledgement
Cover page: Illustration of Atlantic salmon @ Wikipedia

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Background Document for Atlantic salmon *Salmo salar*

Executive Summary

This Background Document for Atlantic salmon *Salmo salar* has been developed by OSPAR following the inclusion of this species on the OSPAR List of threatened and/or declining species and habitats (OSPAR agreement 2008-6). The document provides a compilation of the reviews and assessments that have been prepared concerning this species since the agreement to include it in the OSPAR List in 2003. The original evaluation used to justify the inclusion of *Salmo salar* in the OSPAR List is followed by an assessment of the most recent information on its status (distribution, population, condition) and key threats prepared during 2009-2010. Chapter 7 provides proposals for the actions and measures that could be taken to improve the conservation status of the species. In agreeing to the publication of this document, Contracting Parties have indicated the need to further review these proposals. Publication of this background document does not, therefore, imply any formal endorsement of these proposals by the OSPAR Commission. On the basis of the further review of these proposals, OSPAR will continue its work to ensure the protection of *Salmo salar*, where necessary in cooperation with other competent organisations. This background document may be updated to reflect further developments or further information on the status of the species which becomes available.

Récapitulatif

Le présent document de fond sur le saumon de l’Atlantique a été élaboré par OSPAR à la suite de l’inclusion de cette espèce dans la liste OSPAR des espèces et habitats menacés et/ou en déclin (Accord OSPAR 2008-6). Ce document comporte une compilation des revues et des évaluations concernant cette espèce qui ont été préparées depuis qu’il a été convenu de l’inclure dans la Liste OSPAR en 2003. L’évaluation d’origine permettant de justifier l’inclusion du saumon de l’Atlantique dans la Liste OSPAR est suivie d’une évaluation des informations les plus récentes sur son statut (distribution, population, condition) et des menaces clés, préparée en 2009-2010. Le chapitre 7 fournit des propositions d’actions et de mesures qui pourraient être prises afin d’améliorer l’état de conservation de l’espèce. En se mettant d’accord sur la publication de ce document, les Parties contractantes ont indiqué la nécessité de réviser de nouveau ces propositions. La publication de ce document ne signifie pas, par conséquent que la Commission OSPAR entérine ces propositions de manière formelle. A partir de la nouvelle révision de ces propositions, OSPAR poursuivra ses travaux afin de s’assurer de la protection du saumon de l’Atlantique, le cas échéant avec la coopération d’autres organisations compétentes. Ce document de fond pourra être actualisé pour tenir compte de nouvelles avancées ou de nouvelles informations qui deviendront disponibles sur l’état de l’espèce.

1. Background Information

Name of species

Salmo salar (Linnaeus, 1758) Atlantic salmon

The Atlantic salmon has an inter-governmental organization, the North Atlantic Salmon Conservation Organization (NASCO), devoted to its conservation, restoration, enhancement and rational management. The work of NASCO is described further in section 2.

Species ecology and breeding biology

The Atlantic salmon is an anadromous species which spawns in freshwater (OSPAR 2006), a requirement that necessitates their return to suitable areas to reproduce.

Atlantic Salmon generally spend at least one half of their lives in freshwater as juveniles prior to migrating to sea where their growth rate increases considerably (five times higher than in freshwater). Eggs are laid in gravel areas by adults in the autumn and winter and the sub-gravel phase generally lasts up until spring depending on the water temperature. The alevins emerge from the gravel and establish territories in fast moving areas of streams (riffles and rapids). Here they can stay for up to 7 years; this is dependant on latitude and other factors and may range from one year in the south to seven years in the north (Baglinière, 1976). A few landlocked strains of Atlantic salmon also exist, for example in Norwegian lakes.

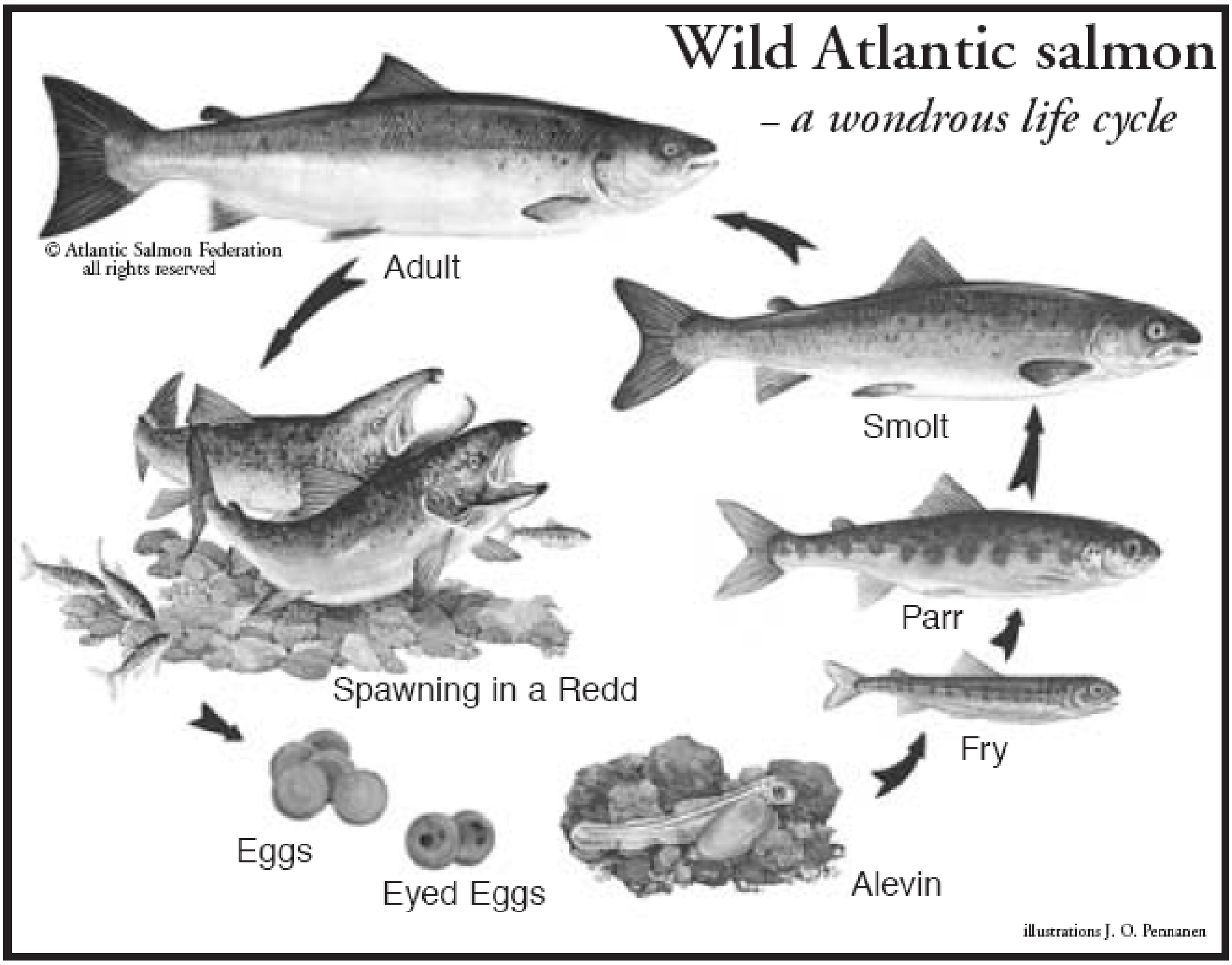

Figure 1: The life cycle of the Atlantic salmon (Porter 2003)

Before and during their spring migration into sea, juvenile salmon undertake a morphological and physiological transformation to allow life in the sea. These salmon are known as smolts. Smolts have a schooling behaviour when they migrate downstream, in an event known as the smolt-run. At the beginning of the marine migration, the post-smolts move away from the shore quickly and grow rapidly They migrate out along the continental shelf in shoals, feeding on sandeel, shrimp and other plankton before reaching their feeding areas in open sea. Salmon return to freshwater after one to three (or occasionally more) years at sea; those that return after one year are referred to as 'one-sea-winter' (1SW) fish or grilse while the older fish are called 'multi-sea-winter' (MSW) salmon.

Salmon return to the same river or stream where they smoltified. Ebbing floodwaters encourage upstream migration and allow adults to negotiate waterfalls and reach the available and suitable spawning areas. Maturation takes place during the upstream migration. Spawning occurs after females have dug holes in the gravel known as redds. The salmon's homing ability is the basis for the classification and the management of the stocks. Over the generations these stocks have developed different inherited characteristics and have thus become adapted to their watercourse through natural selection. Nevertheless, recent studies show that homing is not 100% reliable, as straying to non-natal rivers has been observed.

Salmon occupy a range of freshwater environments across a range of cold and temperate climates but remains a cold water species. Its adaptability to a number of environmental conditions (temperature, hydrological characteristics, and the chemical composition of the water) results in the expression of a range of life history strategies which play an important role in establishing distinct strains of Salmon. These features although not completely understood, indicate the existence of a "safety net" of adaptive genes within stocks of salmon and illustrate important within-species diversity.

2. Original Evaluation against the Texel-Faial selection criteria

List of OSPAR Regions and Dinter biogeographic zones where the species occurs

OSPAR Regions: I, II, III, IV

Dinter biogeographic zones: Warm-temperate waters, Cold-temperate waters, Cold-Arctic waters, Warm-temperate pelagic waters, Lusitanean (Cold/Warm), Lusitanean-boreal, Cold-temperate pelagic waters, Boreal-lusitanean, Boreal, Norwegian Coast (Finnmark), Norwegian Coast (Westnorwegian) , Norwegian Coast (Skagerrak) , South Iceland - Faroe Shelf

List of OSPAR Regions where the species is under threat and/or in decline

All where it occurs. This listing notes that the varying states of the numerous different stocks have to be taken into account.

Original evaluation against the Texel-Faial criteria for which the species was included on the OSPAR List

S.salar was nominated for inclusion on the OSPAR list on the basis of an evaluation of their status according to the Criteria for the Identification of Species and Habitats in need of Protection and their Method of Application (the Texel-Faial Criteria) (OSPAR 2003), with particular reference to its global/regional importance, decline and sensitivity, with information also provided on threat. Threats have not changed since the species was listed, but are further elaborated upon under section 4 below.

Table 1: Summary assessment of *S.salar* against the Texel-Faial criteria

Criterion	Comments	Evaluation
Global importance	The results of a river-by-river assessment of the status of the Atlantic salmon in Europe and North America concludes that nearly 90% of the known healthy populations of wild salmon are found in Norway, Iceland, Scotland and Ireland (WWF 2001). This makes the OSPAR maritime area of global importance for this species.	Qualifies
Regional importance	In Europe, the historical range of the Atlantic salmon extends from Iceland in the northwest (66°N), to the Barents and Kara Seas in the north-east (70°N, 83°E), and southward along the Atlantic coast, with only minor gaps, to the Minho river, the species present southern limit and boundary between Spain in Portugal (42°N). However, native wild stocks are no longer found in the Elbe and the Rhine (where a successful restoration program is now in progress), or in many rivers draining into the Baltic Sea, which previously had abundant salmon runs. . In recent years many Baltic salmon stocks have recovered in response to a lowered exploitation. The species is also severely depressed or extinct in the rivers of France and Spain. As a result salmon has disappeared from large European basins and the species range has generally contracted and fragmented over the last century and a half due to anthropogenic effects (Stradmeyer 2007). However, there have been recent improvements linked to improved water management with salmon returning for example to the Seine (Perrier et al., 2010).	Qualifies
Rarity	According to the Texel-Faial Criteria, the total population size determines the rarity of a highly mobile species such as the Atlantic salmon. Despite the fact that the stock is close to its historical minimum in most of the distribution area, Atlantic salmon are still present in many areas.	Does not qualify
Sensitivity	The Atlantic salmon is known to be highly sensitive to water quality (estuarine and freshwater zones) particularly in relation to eutrophication, chemical contaminants increased sedimentation and temperature (climate change) (OSPAR 2006). both at the adult stage when migrating up river and at the juvenile stage when growing in nursery zones.	Qualifies – very sensitive
Keystone species	Atlantic Salmon is a cultural icon throughout its North Atlantic range; it is the focus of probably the World's highest profile recreational fishery and is the basis for one of the World's largest aquaculture industries (Stradmeyer 2007). It is also an indicator of healthy aquatic environments (NASCO website).	Qualifies

Decline	Records of the numbers of salmon returning to monitored rivers indicate that, despite drastic reductions in directed fisheries, there has been at least a threefold reduction in marine survival rates since the early 1970s. The reduction in the numbers returning has been accompanied by a marked decline in the proportion of multi sea-winter fish. Such a change in an age distribution is a classic symptom of a sustained increase in mortality rate, a conclusion which is supported by the current relative scarcity of repeat spawners in the returning populations (IASRB SAG(09)9). Furthermore, changes in age composition result in a shortening of the life cycle and a more precocious sexual maturation age which could be an adaptive strategy to more drastic environmental conditions (Baglinière, pers.comm.). The status of salmon populations in both North America and Europe show a clear geographical pattern, with most populations in the southern areas in severe condition; in the north the populations are generally stable while at intermediate latitudes, populations are declining. While many of the problems could be attributed to the construction of dams, pollution (including acid rain), and total dewatering of streams, along with overfishing, and recently, changing ocean conditions and intensive aquaculture, many declines cannot be fully explained (ICES 2007).	Qualifies - severely declined

Relevant additional considerations:

NASCO - Management framework for salmon in the North Atlantic (ICES 2009b)

The North Atlantic Salmon Conservation Organisation (NASCO) was set up in 1984 by an international convention (the Convention for the Conservation of Salmon in the North Atlantic Ocean), with a responsibility for the conservation, restoration, enhancement, and rational management of wild salmon in the North Atlantic[1]. Although sovereign states retain their role in the regulation of salmon fisheries for salmon originating in their own rivers, distant water salmon fisheries, such as those around Greenland and the Faroes, which take salmon originating in rivers of another Party, are regulated by NASCO under the terms of the Convention. NASCO now has seven Parties that are signatories to the Convention: the European Union, Canada, Denmark (in respect of the Faeroe Islands and Greenland, Iceland (although they will be withdrawing on the 31 December 2009), Norway, the Russian Federation and the United States of America. NASCO currently has 35 accredited NGOs that participate in its work. They include organisations such as WWF, the Atlantic Salmon Trust and the Atlantic Salmon Federation. The Council of NASCO has welcomed involvement from these organisations which can contribute on all agenda items (other than financial and administrative matters) and participate in all meetings including inter-sessional working groups and the review groups established to assess the consistency of measures taken by Parties and their jurisdictions with NASCO's agreements. These organisations bring a wealth of experience to NASCO's work. NASCO discharges these responsibilities via three regional Commissions (the North American Commission, the North-East Atlantic Commission and the West Greenland Commission) whose areas are shown below:

[1] Although it is not an area covered by the OSPAR Convention, it is worth noting that until the 31 December 2006 Salmon in the Baltic Sea was managed by the International Baltic Sea Fishery Commission. This inter-governmental organization no longer exists and management is a matter for the EU, its Member States and Russia. The EU is considering the development of a management plan for Baltic salmon.

Figure 2: NASCO's three regional commissions. North-East Atlantic Commission (NEAC), West Greenland Commission (WGC) and North American Commission (NAC).

NASCO's initial work focused on developing regulatory measures for the distant-water fisheries. These measures have resulted in harvests in these fisheries declining from around 3000 tonnes pre-NASCO to a harvest of around 25 tonnes in a subsistence only fishery in recent years. Because of obligations under the Convention, and for domestic reasons, the salmon fisheries in States of Origin have also been dramatically reduced, particularly fisheries in the sea. The organisation is now addressing a wide range of management issues and challenges.

In 1998 NASCO and its Parties agreed to adopt and apply the Precautionary Approach in order to protect the resource and preserve the environments in which it lives. It, therefore reviewed its various agreements to ensure consistency with the Precautionary Approach. The agreements relate to :

- Management of salmon fisheries;
- Habitat protection and restoration;
- Minimising impacts from aquaculture, introductions and transfers;
- Stocking rebuilding programmes;
- Incorporating socio-economic factors in decisions under a Precautionary Approach.

Following a review process that involved open consultation meetings with its stakeholders NASCO adopted a Strategic Approach in 2005 to guide its work. It was recognised that while NASCO had developed good agreements there was a need for further progress in their implementation. Each jurisdiction was therefore asked to develop an Implementation Plan detailing the measures taken to date and those planned over a five year period to implement these agreements. These Plans were reviewed by a Group comprising representatives of the Parties and the NGOs. They can be reviewed at www.nasco.int/nextsteps.html. A progress report on the Implementation Plan is submitted to NASCO each year and on a three year cycle a focus area report is provided to NASCO on either fisheries management, habitat protection and restoration or aquaculture and related activities. These focus area reports are also subject to critical review with the need for additional actions to ensure consistency with NASCO's agreement being identified. Recently NASCO has launched a major research initiative to better understand the factors affecting mortality of salmon at sea (see www.salmonatsea.com).

3. Current status of the species

Distribution in OSPAR maritime area

The current distribution ranges from Northern Portugal to North America (Fig.3). It includes rivers in Spain, France, the UK, Ireland, Norway, Sweden, Finland and other countries draining into the Baltic, Iceland, Greenland, some Canadian provinces, and the northeast USA (Hendry & Cragg-Hine, 2003). Wild Atlantic salmon have disappeared in Germany, Switzerland, the Netherlands, Belgium, the Czech Republic and Slovakia. Salmon are in a precarious state in many other North Atlantic countries to the point where anadromous Atlantic salmon are plentiful today in only a handful of rivers. Atlantic salmon populations are known to be comparatively healthy in only four countries – Norway, Ireland, Iceland and Scotland. Common population sizes range from 20 to 2,000 individuals, and few rivers have more than 10,000 spawners (WWF 2001).

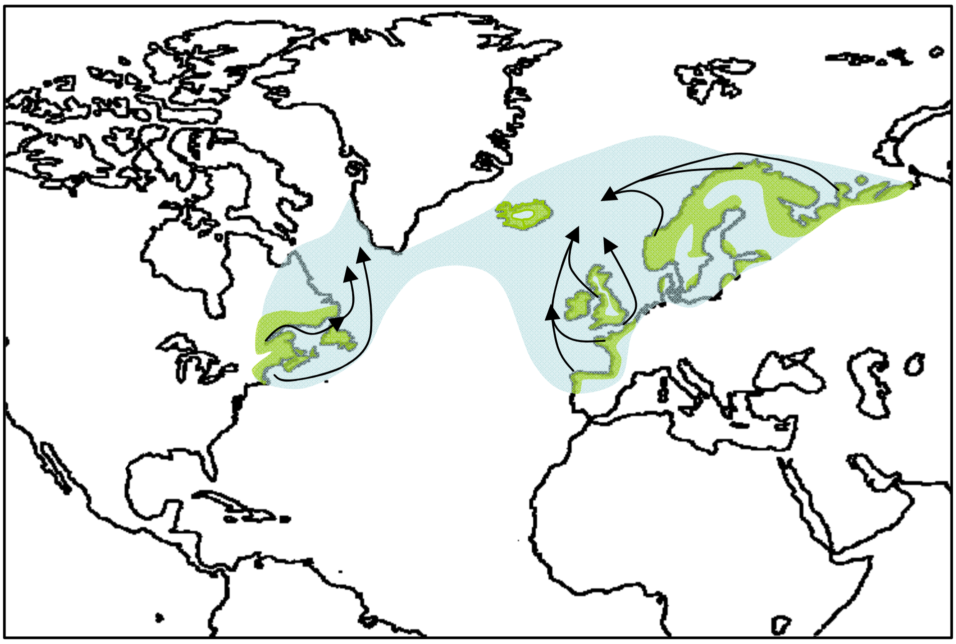

Figure 3: Distribution of the Atlantic salmon *Salmo salar*

The species is divided into four genetic main groups: Baltic salmon in the Baltic Sea, East Atlantic salmon in Europe, West Atlantic salmon in North America and Northern Atlantic salmon in the Barents region. The freshwater conditions of the distribution area, where temperature and ice formation, dissolved oxygen, and favourable substrates for spawning, are considered among the limiting factors, appear to be very important to the species' distribution. In this respect, the northern and southern parts of the distribution range can be considered marginal (WWF 2001).

The overall differentiation between the Eastern and Western Atlantic at allozyme loci has been recently evaluated using a set of representative rivers from across the species range (Figure 4), and shows a large intercontinental divergence compared to the divergence observed among rivers within continents. This supports the view, first expressed by Payne et al., (1971), that there is a deep evolutionary divergence between populations on the two sides of the Atlantic (Stradmeyer et al., 2007).

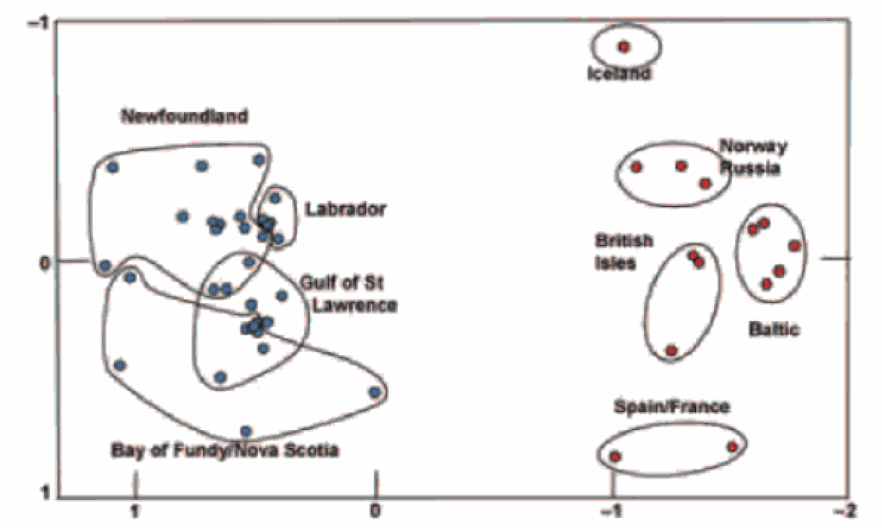

Figure 4: A two-dimensional multidimensioncal scaling (MDS) plot of genetic distance between Eastern and Western Atlantic Ocean populations of Atlantic Salmon estimated from the analysis of allozyme loci. From Verspoor (2005) in Stradmeyer 2007.

Population (current/trends/future prospects)

The salmon's homing behaviour results in relatively distinct groups of individuals returning to reproduce in their natal rivers and streams. Within any given river, subgroups may also develop (e.g. within tributaries), and natural selection acts to adapt the salmon of these groups to the conditions that they will face in the home river and along their migration routes. As a result, they become the best equipped to survive and reproduce, and they may differ from fish originating in other tributaries which have become adapted to a different set of conditions. These sub-groups comprise genetically distinct 'populations'.

The 'population' is therefore the basic biological unit of the salmon species, and might ideally be defined as the fundamental management unit. However, in most instances it is not possible to demarcate clear population boundaries within a river, and even the number of distinct populations that are present is difficult to determine. Furthermore, recent studies show populations colonizing nearby rivers are not genetically different which implies that the management unit is not the river but a set of rivers geographically close. Thus, while there is a need to protect the sustainability of these units, in order to maintain the diversity and differentiation of the species, they do not generally provide practical units for management purposes. A range of 'stock' units have been used in the management of salmon stocks in the North Atlantic, but the primary management unit (e.g. for reporting statistics and regulating fishing) is generally taken to be the 'river stock', comprising all fish originating from eggs laid within the river. This is generally the lowest level at which catches in most fisheries could practically be differentiated. There are of the order of 2200 salmon river stocks around the North Atlantic, with about 800 (36%) in EU Member States. While larger assemblages of fish, such as those exploited by the West Greenland fishery, may also be termed a 'stock' in the context of the management of that fishery, they are more often referred to as 'stock complexes' or 'stock groupings' to avoid confusion (Potter and Ó Maoiléidigh, 2006). While this is generally true, management by run-timing group aimed at reducing the exploitation of spring salmon takes place in Scotland and is a practical example of management at the sub-catchment scale based on an assessment of the status of stocks from both fish counter & fishery data.

Selection of a source population is an important issue in the management of threatened species, and it has been suggested that translocations should not take place between two genetically different populations. Translocation can lead to outbreeding depression through loss of local adaptations or disruption of co-adapted gene complexes (Leary, Allendorf & Sage, 1995; Templeton, 1996 in Grandjean et al., 2009). NASCO has developed Guidelines for Stocking Atlantic Salmon.

Regarding the conservation of Atlantic salmon, a recent study by Grandjean et al. (2009) showed that habitat restoration could be very effective to recreate new populations in rivers from which salmon had disappeared. This study revealed that natural recolonisation can be fast and effective in terms of a genetic diversity similar to that of the wild populations. These recolonisations were possible because of the existence of geographically close and healthy wild populations, suggesting that translocation of salmon, should be used only if natural recolonisation does not occur (Grandjean et al., 2009). Similar conclusions are drawn by Perrier et al. (2010) who observed a natural recolonisation of the Seine River by adult salmon of multiple origins owing to the improvement of the water quality.

ICES classifies the status of stock complexes prior to the commencement of distant water fisheries with respect to the SER[2] requirements as follows:

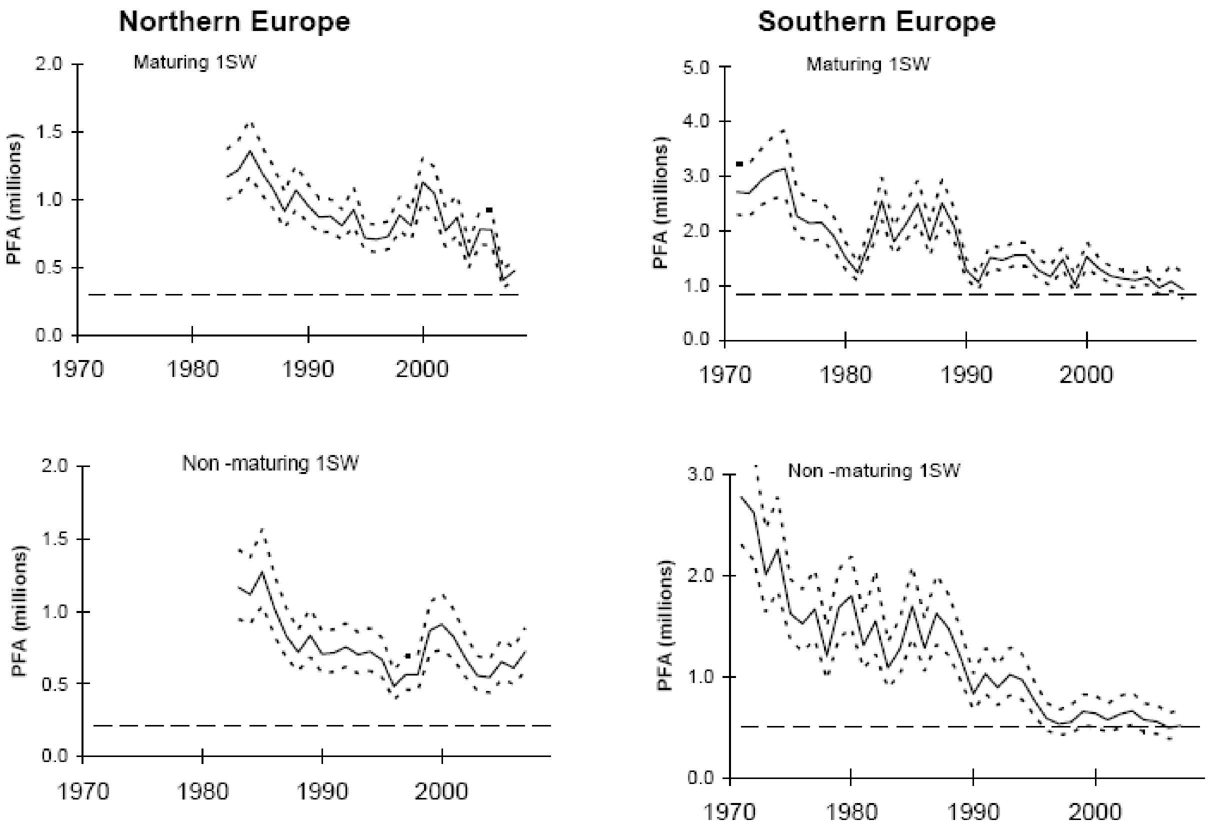

Figure 5: Estimated Pre-Fishery Abundance (PFA) (recruits) with 95% confidence limits, for maturing 1SW and non-maturing 1SW salmon in Northern and Southern Europe (ICES 2009a).

Northern European 1SW and MSW stocks: Recruitment patterns of maturing 1SW salmon and of non-maturing 1SW recruits for Northern Europe (Figure 5) demonstrate broadly similar patterns. The general decline over the period is interrupted by a short period of increased recruitment from 1998 to 2003. Both stock complexes have been at full reproductive capacity prior to the commencement of distant water fisheries throughout the time-series. Trends in spawner number for the Northern stock complexes for both 1SW and MSW are similar. Throughout most of the time-series, both 1SW and MSW spawners have been either at full reproductive capacity or at risk of reduced reproductive capacity. However, in both 2007 and 2008, the 1SW spawner estimate indicated that the stock complex was suffering reduced reproductive

[2] SER *(Spawning Escapement Reserve)* The Conservation Limit increased to take account of natural mortality between the recruitment date (1st January) and return to home waters.

capacity. These patterns are broadly consistent with the general pattern of decline in marine survival of 1SW and 2SW returns in most monitored stocks in the area.

Southern European 1SW and MSW stocks: Recruitment patterns of maturing 1SW salmon and of non-maturing 1SW recruits for Southern Europe (Figure 5) demonstrate broadly similar declining trends over the period. The maturing 1SW stock complex has been at full reproductive capacity over most of the period with the exception of 2006 and 2008 when it was at risk of suffering reduced reproductive capacity prior to the commencement of distant water fisheries. The non-maturing 1SW stock has been at full reproductive capacity over most of the period but has been at risk of suffering reduced reproductive capacity before homewater fisheries took place in nine of the twelve years between 1996 and 2007 and was suffering reduced reproductive capacity for the first time in 2006. Declining trends in spawner number are evident in the Southern stock complexes for both 1SW and MSW. However the 1SW stock has been at risk of reduced reproductive capacity or suffering reduced reproductive capacity for most of the time-series. In contrast, the MSW stock has been at full reproductive capacity for most of the time-series until 1997 when the stock was either at risk of reduced reproductive capacity or suffering reduced reproductive capacity. This is broadly consistent with the general pattern of decline in marine survival of 1SW and 2SW returns in most monitored stocks in the area (ICES 2009a).

Estimated exploitation rates have generally been decreasing over the period for both 1SW and MSW stocks in Northern and Southern areas covered by NASCO's NEAC. Exploitation on Northern 1SW stocks is higher than on Southern 1SW and considerably higher for MSW stocks. The current estimates of abundance for both stock complexes are among the lowest in the time series. Despite management measures aimed at reducing exploitation in recent years there has been little improvement in the status of stocks over time. This is mainly as a consequence of continuing poor survival in the marine environment attributed to climate effects. Efforts continue to improve our understanding of causal relationships contributing to marine mortality (ICES 2009a).

Condition (current/trends/future prospects)

Wild salmon: Table 2 illustrates the reported total nominal catch of salmon to ICES in four North Atlantic areas. Reported catches in tonnes for the three NASCO Commission Areas for 1999–2008 are provided below (ICES 2009).

Area	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
NEAC	2073	2736	2876	2495	2303	1977	1998	1870	1409	1519
NAC	154	155	150	150	144	164	142	140	114	151
WGC	19	21	43	9	9	15	15	22	25	26
Total	2246	2913	3069	2654	2456	2156	2155	2032	1548	1696

Table 2: Total nominal Atlantic salmon catch (t) for the three NASCO Commission areas for 1999-2008: North-east Atlantic Commission, the North American Commission and the West Greenland Commission.

The total nominal catch for 2008 was 1696 tonnes, 148 t above the updated catch for 2007 (1548 t) and the second lowest in the time series. The 2008 catch was over 370 t below the average of the last five years (2069 t), and over 660 t below the average of the last 10 years (2362 t). Catches were below the previous five and ten year averages in all southern NEAC countries and in two of the countries in northern NEAC.

ICES recognises that mixed stock fisheries present particular threats to stock status. These fisheries predominantly operate in coastal areas and NASCO specifically requests that the nominal catches in homewater fisheries be partitioned according to whether the catch is taken in coastal, estuarine or riverine areas. The 2008 nominal catch (in tonnes) was partitioned accordingly and is shown below for NEAC's southern and northern areas (Fig.6).

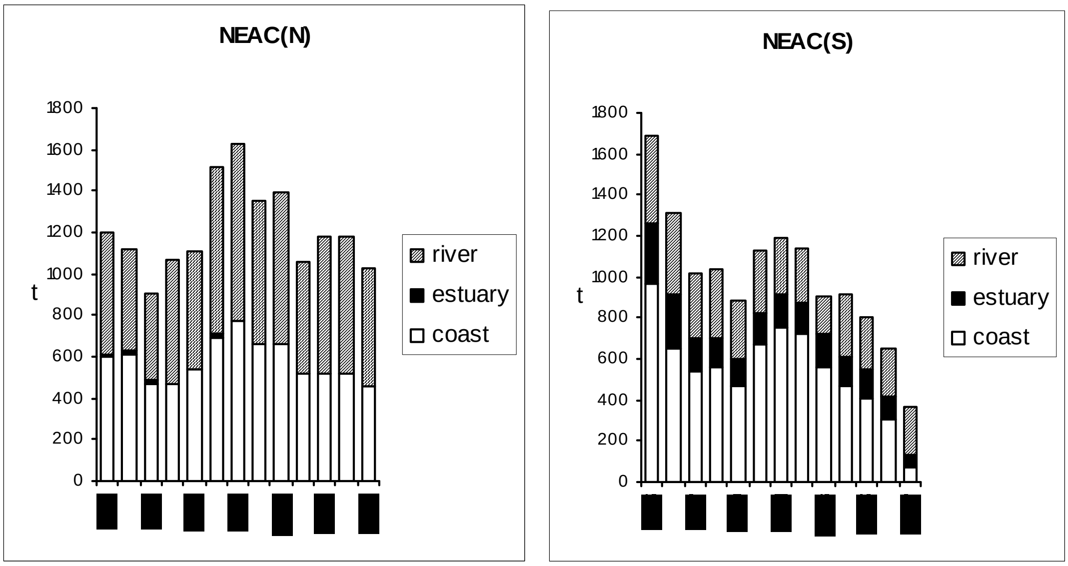

Figure 6: Nominal catch in tonnes taken in coastal, estuarine, and riverine fisheries for the NEAC northern and southern areas.

In the NEAC Northern area (composed of Finland, Norway, Russia, Sweden & Iceland north and east regions), catches since 1995 have fluctuated with no apparent trend (Figure 6). Typically about half the catch has been taken in rivers and half in coastal waters (although there are no coastal fisheries in Iceland and Finland), with estuarine catches representing a negligible component of the catch in this area. In Southern Europe (Ireland, France, UK and Iceland south and west regions), catches in all fishery areas have declined over the period and, while coastal fisheries have historically made up the largest component of the catch, these fisheries have declined substantially, reflecting widespread measures to reduce exploitation in a number of countries. In 2007, the majority of the catch in this area was taken in fresh water.

Farmed Atlantic salmon: Farming of Atlantic salmon commenced in Norway in 1969. Over the past 30 years the industry has expanded exponentially and world wide production of farmed Atlantic salmon has been in excess of one million tonnes since 2002. It is difficult to source reliable production figures for all countries outside the North Atlantic area and it has been necessary to use 2007 estimates for some countries in deriving a worldwide estimate for 2008. Noting this caveat, total production in 2008 is provisionally estimated at around 1482 kt (Figure 7), a 6% increase on 2007 and the highest in the time series (ICES 2009b). The major producers were Chile (estimated as counting for 34% of worldwide production), Norway, Scotland, Faroes, Iceland, Ireland and North America. World-wide production of farmed Atlantic salmon in 2008 was thus over 870 times the reported nominal catch of Atlantic salmon in the North Atlantic (ICES 2009b).

The physical nature of marine net cages is such that escapes from confinement inevitably occur. Although improvements in cage design and husbandry have resulted in proportionally less escapement, the increasing scale of the industry means that substantial numbers of fish still escape. Concern has arisen to the potential detrimental genetic changes that may occur in wild populations as a result of escaped farm salmon entering rivers and interacting with wild populations, particularly given the endangered status of many populations (WWF 2001). The threats caused by fish farming are further elaborated under section 4.

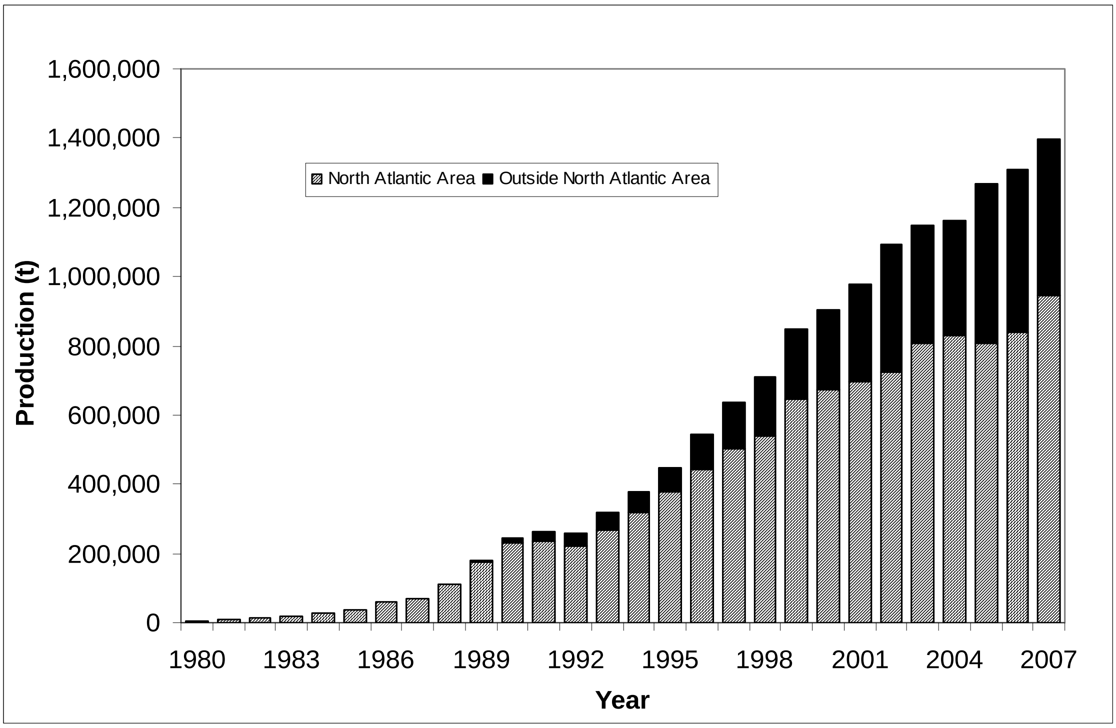

Figure 7: World-wide production of farmed Atlantic salmon, 1980-2007.

The provisional estimate of farmed Atlantic salmon production in the North Atlantic area for 2008 is 981 000 tonnes. This represents a 5% increase on 2007 and a 16% increase on the previous 5 year mean. Production increased slightly in Norway (up 3% on 2007) and UK (Scotland; up 5% on 2007), and these two countries continue to produce the majority of the farmed salmon in the North Atlantic (76% and 14% respectively).

There is considerable evidence that in some areas the escapes are becoming significant populations in their own right. Over the last 10 years (1999 to 2008) farmed salmon & grilse have comprised between 1% and 4% of the total reported catch in the west coast regions of Scotland. For the whole of Scotland, a total of 251 fish of farmed origin were reported in 2008, a decline of 22% compared to the previous 5-year average. Salmon and grilse of farmed origin represented 0.3% of the total number of salmon and grilse caught in 2008 (Marine Scotland).In some of Norway's rivers, there are as many as four escaped farmed salmon for every wild one (Ellis and Associates 1996). Reported escapes for Scotland in 2008 totalled 58641 (Marine Scotland). While this number shows a decline in escapes (it was estimated that half a million salmon escaped off the Scottish coast in 2000) farmed fish and wild fish may be interbreeding. As farmed fish are selectively bred for characteristics favourable for aquaculture, breeding between the two populations could alter the genetic makeup of wild fish and decrease their fitness to survive in the wild environment (WWF, 2005).

Limitations in knowledge

Marine mortality of salmon in the North Atlantic has increased markedly over the last thirty years despite major reductions in marine fisheries for salmon. It is expected that many factors affect smolt survival and therefore the return of adult salmon, however these factors are poorly documented. Nevertheless, smolt size appears to play an important role in the adult survival rate at sea. Research on this subject has been strongly recommended by a number of organisations, but it was only recently that there were systematic efforts to sample salmon and especially post-smolts at sea (Lear, 1976; Reddin, 1985; Reddin and Short, 1991; Holst *et al.,* 1993; Shelton *et al*., 1997; Holm *et al.,* 2000, in ICES 2007). Results from these studies together with the development of new techniques to analyse life history signals from scales, bones and tissue of salmon have improved our understanding of the biology of salmon post-smolts, but there are still major knowledge gaps (ICES 2007).

In response to this situation, in 2000 NASCO established an International Atlantic Salmon Research Board (IASRB) to promote collaboration and cooperation on research into the causes of marine mortality of salmon and the opportunities to counteract it. The Board established an inventory of Research Relating to Salmon Mortality in the Sea, which is updated annually, and is an essential tool in the development of research priorities for potential funding and in better coordinating existing research efforts. Projects in the inventory are allocated to one of the following five topic areas:

- long-term monitoring
- life history/biological processes
- distribution/migration in the sea
- development of methods
- specific natural and anthropogenic factors

The 2009 inventory includes 47 on-going projects, with expenditure of approximately €6,5 million per annum. The full 2009 research inventory can be viewed under the following link: http://www.nasco.int/sas/pdf/sag%2809%292.pdf

The Inventory allowed the Board to identify gaps in the research programme and research priorities. In 2005 a comprehensive, innovative research programme, SALSEA, was adopted involving freshwater, estuarine, nearshore and offshore components. While much of the freshwater and inshore work is being funded by the jurisdictions, a public-private partnership was needed to fund the offshore components. These involve marine surveys in 2008 and 2009 in both the North-East and Northwest Atlantic and enhanced sampling of the West Greenland subsistence catch in 2009 and 2010.

“SALSEA-Merge” is the North-East Atlantic component of SALSEA which aims to investigate the migration and distribution of salmon in the North-East Atlantic using fine-scale analyses of growth to investigate spatial and temporal trends. It involved three marine surveys in both 2008 and 2009 that were conducted by Irish, Faroese and Norwegian research vessels and took place off the west coasts of Ireland and Scotland, in the mid-Norwegian Sea in areas where post-smolts have been captured previously and in the Northern Norwegian Sea in areas where there has been little previous survey work for salmon. The origin of the sampled fish will be determined using the latest genetic stock identification techniques (NASCO website). SALSEA-Merge involves a consortium of twenty partner organizations, from the public and private sectors, including the IASRB, listed in table 3.

The findings of the SALSEA programme will be presented at a “Salmon Summit” to be held in 2011. More information on SALSEA-Merge can be obtained from: http://www.nasco.int/sas/pdf/salseamerge.pdf

Particpant No.	Participant organisation Name (*non contracting partners)	Country
1 (Coordinator)	Institute of Marine Research (IMR)	Norway
2	Marine Institute (MI)	Ireland
3	Fisheries Research Services (FRS)	UK
4	Norwegian Institute for Nature Research (NINA)	Norway
5	University of Exeter (UE)	UK
6	National University of Ireland, Cork (NUIC)	Ireland
7	Queen's University Belfast (QUB)	UK
8	University of Wales, Swansea (UWS)	UK
9	Danish Institute for Fisheries Research (DIFRES)	Denmark
10	Institute of Freshwater Fisheries (IFL)	Iceland
11	University of Turku (UT)	Finland
12	University of Oviedo (UO)	Spain
13	Geneindex (GENI)	France
14	Finnish Game and Fisheries Research Institute (FGFRI)	Finland
15	*Faroese Fisheries Laboratory (FFL)	Faroes
16	*Atlantic Salmon Trust (AST)	UK
17	*North Atlantic Salmon Conservation Organisation (NASCO)	UK
18	*Total Foundation (TOTAL)	France
19	*Conservatoire du Saumon Sauvage (CSS)	France
20	*Loughs Agency	UK

Table 3: List of Participants in the “Advancing understanding of Atlantic Salmon at Sea: Merging Genetics and Ecology to Resolve Stock-specific Migration and Distribution patterns” SALSEA-Merge research programme[3]

4. Evaluation of threats and impacts

Marine Phase

In the marine phase there is concern over recent declines in post-smolt marine survival rates. Several potential reasons have been put forward, including the following:

Changes in sea surface temperatures with reduced areas of suitable habitat and hence increased intra-specific competition; Changes in temperature, currents or food items resulting from global warming and in an overall decrease of primary production.

Fish farming or non-native fish restocking. Caged salmon escape virtually everywhere that salmon are farmed. The introduction of a species to an area inevitably has unforeseen consequences. Salmon that escape from aquaculture operations can cause a wide range of impacts including competition for food and spawning habitat with both wild salmon and other species. Escapes can interbreed and cause genetic pollution that reduces the fitness of wild salmon (McGinnity *et al*., 2003). Also, they can spread diseases that either did not previously exist in the area or were not previously a problem for wild populations. There are large numbers of escapes. In Norway as many as 1.3 million salmon escape each year, and one in four salmon spawning in coastal rivers are of escaped origin (WWF 2005).

Disruption of habitat: Ecological impacts from escaped farmed fish include the effects of the introduced species on the local fauna and flora and the subsequent alteration of the habitat. In addition, farmed females often produce eggs which, while numerous, are relatively small. Smaller eggs result in smaller fry that have a reduced ability to survive (Einum and Fleming, 2000). As the farmed salmon is much more aggressive and grows very quickly, it has both a higher competing level and a higher mortality rate (McGinnity et al., 2003). This means that the offspring of farmed fish might out-compete its wild relatives while it is still young, but that its overall survival rate is low. Over time, a high number of farmed fish can have a significant impact on the survival of the wild fish (WWF 2003).

[3] Participant n°3 has changed names: on April 1 2009, Fisheries Research Services (FRS) was merged with the Scottish Fisheries Protection Agency (SFPA) and the Scottish Government Marine Directorate to form Marine Scotland Science.

Dilution of gene pool and decrease in fitness of wild fish: a review of the literature on the genetic effects following releases of non-native salmonid populations suggested that fitness losses in wild populations must be expected due to interbreeding with escaped farm salmon (Hindar et al., 1991 in Stradmeyer 2007; McGinnity et al., 2003 et 2004). Two broad conclusions were drawn:

- The genetic effects of (intentionally or accidentally) released salmonids on natural populations are typically unpredictable; they vary from no detectable effect to complete introgression or displacement.
- Where genetic effects on performance traits have been detected, they appear to be always negative in comparison with the unaffected native populations.

Diseases and parasites:

- Red Vent Syndrome (RVS)
  Over recent years, there have been reports from both the NEAC and NAC areas of salmon returning to rivers with swollen and/or bleeding vents. The condition, known as red vent syndrome (RVS), has been noted since 2005, and has been linked to the presence of a nematode worm, Anisakis simplex. It remains unclear whether RVS affects the survival of the fish or their spawning success (ICES 2009b). However, affected fish have been taken for use as broodstock in a number of countries, successfully stripped of their eggs, and these have developed normally in hatcheries. Provisional results also suggest no significant differences in the condition factors of affected and unaffected fish. (ICES 2009b)
- The salmon louse *Lepeotheirus salmonis*
  The intensive nature of the marine fish farming industry has been implicated in the spread of sea lice infestations to wild salmon stocks affecting their survivability (OSPAR 2006). The number of lice reported by fish farmers on a monthly basis demonstrates that the number of adult lice on salmon in late 2008 and early 2009 were higher in several areas in Norway than in the previous two years (www.lusedata.no). This, together with a sudden increase in incidence of treatment failure and indications of resistance give cause for concern and could have severe consequences for wild salmon smolts should resistant lice become widespread (Lees *et al*., 2008). It should be noted that the problem of lice infestation is 10 times greater with the sea trout *Salmo trutta* who remain in coastal waters, whereas Atlantic salmon post-smolts only pass through areas close to fish farms (WWF 2005).

In Norway, concerns have also been raised about exotic diseases becoming established in farmed cod which could pose a threat to salmon (NASCO – CNL(09)16).

Fishing

- indirectly:, through over-exploitation of their food source (e.g. sand eel fishery),
- directly: post-smolts can be inadvertently netted as by-catch in mixed herring and mackerel fisheries. Fishing techniques (high sea interceptory net fisheries, coastal drift nets, coastal fixed nets). Over-fishing at sea, especially seine or drift-netting. In accordance with the NASCO Convention, vessels registered in EU Member States are not permitted to fish for salmon outside 12 mile limits or land salmon caught in such areas. However, some EU Member States permit the operation of fisheries within their 12 miles limits which harvest salmon originating from rivers in other Member States in addition to local stocks. Since these fisheries do not generally take salmon from the rivers of other Contracting Parties to NASCO (EU is a single Party), they are not subject to NASCO regulatory measures. Particular concerns have been expressed about fisheries that may be taking salmon from rivers whose stocks are outside precautionary limits (Potter and Ó Maoiléidigh, 2006).

Increased predation by seals (Scottish Office 1997).

Freshwater phase

There are many factors that can adversely affect salmon populations in fresh waters. They are summarised in table 4.

Table 4. Summary of key threats and impacts to *S.salar,* during their freshwater phase

Type of impact	Cause of threat	Comment	Scale of threat
Obstacles blocking access to spawning grounds	Development: Building of dams and navigation weirs/lochs	Features such as weirs and dams, may impede migration to spawning grounds. In this context, the restoration of the connectivity between water bodies required by the European water framework directive is presently contradicting the renewable energy directive (2009/28/EC) which potentially encourages the construction of more hydroelectric dams.	High
Poor water quality	Water pollution: sewage, pesticides/herbicides, heavy metal contamination, hormones, eutrophication	Pollution from agriculture, industry and road and other hard surface run-off. Increased toxicity from pesticides especially in the upper catchments in summer Impact of PCBs present in the substrate.Eutrophication acts in a similar way to other forms of pollution. Lush growths of algae and bacteria associated with increased nutrients smother both the spawning gravels (preventing spawning or killing eggs), creating anoxic conditions there.	High
Loss of substrate for spawning	Riverbed engineering schemes	River engineering schemes (e.g. for flood defence or navigation), result in direct habitat loss (e.g. through channel deepening) and disconnection of the main river from the complex of floodplain habitats (e.g. ox bow lakes, channels and islands). Habitat degradation also occurs through the resulting changes in ecological processes such as nutrient cycling, sedimentation and flooding (WWF 2001).	High
Overfishing	Fishing	Estuarine commercial nets, recreational estuarine nets, putchers (fish traps), rods and poachers. An additional consideration is the drift net fisheries that target salmon around the entrances to rivers so they are unable to reach spawning grounds (OSPAR 2006).	High
Juvenile mortality	Climate change	Considering the thermal niche of Atlantic salmon and given the preponderant influence of water temperature on salmonid growth and life history, it is likely that one of the main consequences of global climatic changes will be a northward shift in the overall distribution of a species such as the Atlantic salmon (Lassale et al., 2009). Nevertheless, before the change of distribution area, juvenile Atlantic salmon displayed some changes in life history strategy related both to the warming of river water and to the increase of river primary productivity (Rivot et al., 2009). Species establish in new regions more readily than they evolve a new range of climate tolerances (Davis and Shaw 2001). As part of the climate response, within rivers in the more southerly parts of the range, populations may be lost from warmer tributaries; in more northern parts, tributaries previously too cold, such as those feed by glacial melt waters, may be colonised and new populations established. The result of the range shift will be that total genetic diversity within species will be reduced for a number of	Low

Type of impact	Cause of threat	Comment	Scale of threat
		reasons. One will be due to the loss of older, established and more diverse southern populations; these may be replaced by new populations in the north but, established by limited numbers of founders, they can be expected to be less variable. Populations at the warming southern limit edge of the species distribution will have no more capacity to adapt with no possibility of adaptive gene flow from populations adapted to warmer conditions (Stradmeyer, 2007).	
Juvenile mortality	Acidification	Acid rain, resulting from emission of pollutants from industrial areas , is a serious problem in North America and Scandinavia associated with the premature mortality of wild Atlantic salmon and extirpation of some populations. Liming of watersheds and watercourses is recognized as an acidification mitigation technique.	Locally high
Loss of freshwater habitats	Hydrological manipulation	Deepening and straightening river channels has been the traditional flood control technique intended to direct floodplain drainage and reduce of bank erosion. Reservoirs may inundate spawning gravel and reduce oxygen levels; interbasin transfers may affect river water quality and natural runoff and temperature regimes may be altered. Such changes may reduce salmon reproduction and survival in the river. Straightening river channels increases water velocity, thus facilitating transportation of sediments from the swift upper areas to be deposited in the lower reaches. The result may be a homogenous channel that is no longer suitable as salmon habitat (WWF 2001).	High
Parasitism: *Gyrodactylus salaris*	Introduced through aquaculture	*Gyrodactylus salaris* is a freshwater parasite which was spread in the alien range mainly by anthropogenic movement of infected fish between hatcheries/fish farms/rivers and by migration of infected fish in rivers and in brackish water in fjords to rivers in Norway, Sweden and Russia. In Norway, catastrophic losses of Atlantic salmon were seen following the introduction of *G. salaris* to the country in the 1970s. Existing measures are in place concerning restrictions on movements of live fish and eggs and baitfish (see Annex I) .In Norway there is also a concern that sea lice may be a carrier and vector of several fish diseases including new pathogens such as microsporidium (NASCO – CNL(09)16).	High

5. Existing Management measures

The Atlantic salmon is listed on Annexes IIa of the EC Habitats Directive and Annex III of the Bern Convention (although the provisions for this appendix do not apply to salmon in sea waters). It was classified as Least Concern by IUCN in 1994.

European Legislation

Council Regulation (EC) No 199/2008 concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy

The EU data collection regulation (DCR) has been updated and expanded recently to include both salmon and eels and extended to inland waters. This will have impacts at Community level relating specifically to the requirement for a multiannual Community programme for collection, management and use of biological, technical, environmental, and socio-economic data concerning:

a. commercial fisheries carried out by Community fishing vessels:

   i. within Community waters and commercial fisheries for eels and salmon in inland waters;

   ii. outside Community waters;

b. recreational fisheries carried out within Community waters and recreational fisheries for eels and salmon in inland waters;

c. aquaculture activities related to marine species, including eels and salmon, carried out within the Member States and the Community waters;

d. industries processing fisheries products–these to be defined in accordance with the procedure referred to in Article 27(2).

Other EU legislation

Implementation of Water Framework Directive (WFD) requirements should lead to improvements in water quality attributes in estuaries and rivers. This may, in turn, facilitate habitat use by diadromous fish. In addition, physical barriers to upstream migration may also come under scrutiny under WFD, which requires that ‘connectivity’ exist in watercourses. Such geomorphological connectivity would benefit biological connectivity and would benefit all life history stages of all diadromous fish species.

The Common Fisheries Policy only applies to salmon fisheries in fully marine areas.

For the EU Habitats Directive, it should be noted that salmon is an Annex II species only in freshwaters throughout the EU, and therefore marine and estuarine sites are excluded from selection. While the Special Areas of Conservation series makes a contribution to securing favourable conservation status for this Annex II species, wider measures are also necessary to support its conservation in the EC.

Responsible Aquaculture Practices

In 2003 NASCO adopted a Resolution (the ‘Williamsburg Resolution’) designed to minimise impacts of aquaculture, introductions and transfers and transgenics on the wild stocks. The Resolution was developed in consultation with the industry and the outcome of three international symposia co-convened by NASCO and ICES. NASCO also has a liaison group with the international salmon farming industry.

The International Salmon Farming Association (ISFA)/NASCO Task Force on best practice in aquaculture to address impacts on wild salmon stocks noted a number of international initiatives concerning the development of best practice guidance and measures. These include:

- NASCO’s Williamsburg Resolution which includes guidelines on containment of farmed salmon, the FARs and the work of the Task Force;
- WWF Salmon Aquaculture Dialogue which is developing measurable environmental standards for salmon aquaculture;
- International Standards Organization (ISO) Standards for Aquaculture is developing traceability standards for cage technology and monitoring benthic impacts;

- the Global Aquaculture Alliance (GAA) which seeks to establish standards of good practice for responsible aquaculture. Standards for salmon aquaculture are being developed;

This Task Force has developed Guidance on Best Practice in relation to sea lice and containment. In 2010 NASCO will review the progress made in implementing the Williamsburg Resolution.

Various quality schemes now exist which are variously designed to improve the quality, safety, welfare, and environmental sustainability of farmed Atlantic salmon. These include:

- Industry-led schemes, e.g. Scottish Quality Salmon.
- Retailer-led schemes, e.g. UK supermarket quality schemes; the Label Rouge government-led scheme in France (www.agriculture.gouv.fr).
- Niche market schemes (e.g. Organic salmon schemes, welfare schemes such as Freedom Foods).

Most producing countries are governed by regulations that aim to protect the environment, the fish, and the consumer. For specific details contact the relevant Government authority.

Non Member-States management measures

Norwegian and Icelandic national management plans are reviewed in Annex 1: Overview of information and data provided by Contracting Parties.

Gyrodactylus salaris legislative control

Within the European Community, the Directive 2006/88/EEC “on animal health requirements for aquaculture animals and products thereof, and on the prevention and control of certain diseases in aquatic animals” updates, recasts and consolidates the animal health rules in relation to the trade in aquaculture products (fish, molluscs and crustaceans), including prevention and control of diseases affecting these animals and their products.

The Directive establishes:

- animal health requirements for the placing on the market, importation and transit of aquaculture animals and their products;
- minimum measures to prevent diseases in aquaculture animals;
- minimum measures to be taken in response to suspected or established cases of certain diseases in aquatic animals.

Monitoring for the parasite and strict control of the movement of stocks between rivers has been an integral part of the Norwegian strategy to prevent the spread of *G. salaris*. Monitoring programmes to demonstrate freedom from *G. salaris* are being planned or executed by an increasing number of countries. These programmes can be complicated by difficulties in identifying *Gyrodactylus* specimens to species level.

6. Conclusion on overall status

Despite management measures aimed at reducing exploitation in recent years there has been little improvement in the status of stocks over time. This is mainly because of continuing poor survival in the marine environment attributed to climate effects. Efforts continue to improve our understanding of causal relationships contributing to marine mortality (ICES 2009a).

Recent studies on the few available long-term catch data for Norwegian and Scottish salmon populations (Vøllestad et al., 2009) suggest a multiplicity of effects, highlighting the challenges for managing this species.

The development of representative long-term data sets on all salmon life stages is essential for the adequate management of the species. In addition, data on the quantity and quality of the habitat required for various life stages will greatly enhance the ability to understand population fluctuations and the environmental drivers that influence salmon stocks (Hendry & Cragg-Hine, 2003).

7. Action to be taken by OSPAR

Action/measures that OSPAR could take, subject to OSPAR agreement

As set out in Article 4 of Annex V of the Convention, OSPAR has agreed that no programme or measure concerning a question relating to the management of fisheries shall be adopted under this Annex. However where the Commission considers that action is desirable in relation to such a question, it shall draw that question to the attention of the authority or international body competent for that question. Where action within the competence of the Commission is desirable to complement or support action by those authorities or bodies, the Commission shall endeavour to cooperate with them.

OSPAR should work with NASCO to:

a. enhance cooperation (possibly through reciprocal observer status at meetings)

b. conserve marine ecosystems in the North-East Atlantic

c. increase awareness among OSPAR's Contracting Parties of the status of salmon, threats to it and measures taken by NASCO and its parties

d. develop a common strategy with other North Atlantic fisheries organisations for minimizing pelagic by-catch. NASCO and OSPAR should work closely with NEAFC to develop joint strategies for minimizing by-catch of salmon in fisheries managed by these organizations.

e. encourage Contracting Parties to fully implement NASCO's agreements and report on progress

f. support implementation of research priorities for salmon identified by NASCO (including support with funding authorities).

OSPAR should contact the European Commission and the standing committee of the Bern Convention to:

a. notify them of the listing under OSPAR, threats facing the species, and the willingness of OSPAR to co-operate in developing conservation measures;

b. request information on the effectiveness of any measures taken for the protection of this species;

OSPAR should work with relevant Contracting Parties (see Table 5 below) to:

a. raise awareness of status and threats to the species among both management authorities, fishermen, retailers and the general public.

b. improve communication and information exchanges between *S.salar* researchers and authorities by developing a communication network which would facilitate dialogue between scientists and managers.

c. improve communication between North American and OSPAR region research and management initiatives and results;

Actions/measures for relevant Contracting Parties

OSPAR should recommend that relevant Contracting Parties (see Table 3 below):

a. adopt NASCO guidelines and precautionary approach

b. organise a reporting scheme so that the accidental by-catch of salmon smolts at sea in mixed fisheries is logged systematically in order to further knowledge on the routes used by postmolt and subadults during their sea migration. Prior consultation would be needed with scientists and marine fisheries interests to determine value of information that would be obtained and practicality of implementation.

OSPAR should establish a mechanism by which Contracting Parties report back on the implementation of the above recommendations so that the development of the necessary measures can be evaluated. As a first step Contracting Parties who have *S.salar* present in their coastal waters and river basins should make an assessment of the effectiveness of the regulations they already have in place for its protection and for the restoration or supplementation of populations, consider how those regulations might be made more effective through improved monitoring, control and surveillance and report the results to the OSPAR Commission.

Suggestions for further research

OSPAR should emphasise to relevant scientific funding bodies and existing national monitoring programmes the following research needs with respect to *S.salar:*

a. further development of decision-support tools such as microsatellite markers, isotopic analysis, biogeographical and niche models. The use of microsatellite markers may allow a better definition of populations, metapopulations and management units.

b. further data collection, harmonisation and collation to increase the baseline data collection where resources allow. In this context, it is necessary to augment and maintain the functioning of long-term observation systems (i.e. river indices) including estuarine and freshwater bodies, to create other ones and to facilitate the development of international networks. Such networks including rivers located in different geographical and anthropogenic pressure contexts might allow a clearer analysis of the role that natural and anthropogenic factors play.

c. further data on the marine phase to understanding the role of the sea life on the all life cycle (survival, life history strategy).

d. research relevant to the reintroduction of Atlantic salmon to sites from which it has been excluded by pollution, dams and weirs

The following inset summarises the most recent request agreed by NASCO during their twenty-sixth annual commission meeting for scientific advice from ICES:

NASCO Request for Scientific Advice from ICES (CNL(09)10)

1. With respect to Atlantic salmon in the North Atlantic area:

1.1 provide an overview of salmon catches and landings, including unreported catches by country and catch and release, and production of farmed and ranched Atlantic salmon in 2009;

1.2 report on significant new or emerging threats to, or opportunities for, salmon conservation and management;

1.3 continue the work already initiated to investigate associations between changes in biological characteristics of all life stages of Atlantic salmon, environmental changes and variations in marine survival with a view to identifying predictors of abundance;

1.4 describe how catch and release mortality and unreported catch are incorporated in national and international stock assessments and indicate how they can best be incorporated in future advice to NASCO;

1.5 further develop approaches to forecast pre-fishery abundance for North American and European stocks with measures of uncertainty;

1.6 provide a compilation of tag releases by country in 2009 and advise on progress with analysing historical tag recovery data from oceanic areas;

1.7 identify relevant data deficiencies, monitoring needs and research requirements4.

2. With respect to Atlantic salmon in the North-East Atlantic Commission area:

2.1 describe the key events of the 2009 fisheries;

2.2 review and report on the development of age-specific stock conservation limits;
2.3 describe the status of the stocks and provide annual catch options or alternative management advice for 2011-2013, with an assessment of risks relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding6;
2.4 further investigate opportunities to develop a framework of indicators or alternative methods that could be used to identify any significant change in previously provided multi-annual management advice.

Table 5: Summary of key threats and existing protection for *Salmo salar*

Key threats	Habitat alteration, pollution, activities that result in altered river flow rate, obstacles to migration Fish farming: diseases and parasites, gene pool dilution Overfishing of smolts in mixed fisheries Climate change	
Relevant Contracting Parties	Iceland, UK, Ireland, Belgium, the Netherlands, Germany, Denmark, Norway, Sweden, France, Spain, Portugal	
Other responsible authorities	NASCO, EC, FAO, RFMOs	
Already protected? **Measures adequate?**	Habitat & Species Directive Annex IIa Bern Convention Annex III* (the provisions for this appendix shall not apply to salmon in sea waters) Barcelona Convention Annex III IUCN Red List LC (Least Concern)	One of the first steps Contracting Parties are recommended to take is an assessment of the effectiveness of the regulations they already have in situ, and how those regulations might be made more effective through improved monitoring, control and surveillance.

Brief summary of proposed monitoring system

In order to design a holistic marine monitoring and assessment strategy for Atlantic salmon which is not dependant on commercial fisheries, close cooperation between OSPAR and NASCO is required.

Annex 1: Overview of data and information provided by Contracting Parties

Contracting Party	**Feature occurs in CP's Maritime Area**	**Contribution made to the assessment (e.g. data/information provided)**	**National reports References or weblinks**
Belgium			
Denmark	Y	Y	http://www.nasco.int/pdf/implementation_plans/IP_Denmark.pdf http://www.nasco.int/pdf/far_fisheries/FisheriesFAR_Denmark.pdf
European Commission			http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:015:0001:0023:EN:PDF http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:015:0001:0023:EN:PDF http://ec.europa.eu/fisheries/publications/factsheets/legal_texts/mixed_stock_salmon_fisheries_en.pdf http://wwz.ifremer.fr/envlit/content/download/32661/272609/version/1/file/Council_Directive_28011991.pdf
France	Y	Y	http://www.nasco.int/pdf/implementation_plans/IP_France.pdf http://www.onema.fr/IMG/pdf/Plan_Francais_de_mise_en_oeuvre_NASCO.pdf
Germany	Y	Y	http://www.nasco.int/pdf/implementation_plans/IP_Germany.pdf
Iceland	Y	Y	http://www.fisheries.is/the-main-species/diadromous-fish/atlantic-salmon/ http://www.nasco.int/pdf/far_fisheries/FisheriesFAR_Iceland.pdf
Ireland	Y	Y	http://www.npws.ie/en/media/NPWS/Publications/CA/Media,6136,en.pdf http://www.nasco.int/pdf/implementation_plans/IP_Ireland.pdf http://www.nasco.int/pdf/far_fisheries/FisheriesFAR_Ireland.pdf
Netherlands			
Norway	Y	Y	http://www.nasco.int/pdf/far_habitat/HabitatFAR_Norway.pdf http://www.nasco.int/pdf/far_fisheries/FisheriesFAR_Norway.pdf
Portugal			
Spain	Y		
Sweden	Y	Y	http://www.nasco.int/pdf/implementation_plans/IP_Sweden.pdf http://www.nasco.int/pdf/far_fisheries/FisheriesFAR_Sweden.pdf

UK	Y	Y	Joint Nature Conservation Committee. 2007. Second Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2001 to December 2006. Peterborough: JNCC. Available from: www.jncc.gov.uk/article17 http://www.nasco.int/pdf/implementation_plans/IP_EnglandWales.pdf http://www.nasco.int/pdf/implementation_plans/IP_NIreland.pdf http://www.nasco.int/pdf/implementation_plans/IP_Scotland.pdf http://www.nasco.int/pdf/far_fisheries/FisheriesFAR_EnglandWales.pdf http://www.nasco.int/pdf/far_fisheries/FisheriesFAR_NIreland.pdf http://www.nasco.int/pdf/far_fisheries/FisheriesFAR_Scotland.pdf http://www.nasco.int/pdf/far_habitat/HabitatFAR_EnglandWales.pdf http://www.nasco.int/pdf/far_habitat/HabitatFAR_NIreland.pdf http://www.nasco.int/pdf/far_habitat/HabitatFAR_Scotland.pdf

*Salmo salar was n*ominated in 2001 by the UK & WWF. Contact Persons:

- Sabine Christiansen, North-East Atlantic Marine Ecoregion Programme, Hongkongstr.7 D-20457 Hamburg, Germany
- Paul Knapman, English Nature, Northminster House, Peterborough PE1 1UA, United Kingdom

Summaries of country-specific information provided

The links to the national implementation plans can be found in the overview table above

Belgium, the Netherlands and Germany: The following text is an extract from WWF's 2001 report "the status of wild Atlantic salmon: a river by river assessment."

In Belgium, Netherlands and Germany historic salmon rivers had entirely lost their wild salmon populations by 1960. The last known captured salmon in the Meuse Basin of Belgium and Netherlands was reported in 1942, and Dutch salmon fisheries had completely died out by the 1950s. Germany's Rhine had lost its salmon population by 1958 (Chicester, 1997). Alongside with habitat restoration activities attempts to reintroduce Atlantic salmon started in 1978 in both the Meuse and Rhine rivers. However, today's reality is that a number of important habitats have been restored successfully, but so far no self-sustaining population of Atlantic Salmon has been established.

UK – Scotland: The Salmon (Fish Passes and Screens) (Scotland) Regulations 1994 does attempt to ensure that both Salmon, sea trout and other migratory species have physical access to their spawning rivers and burns. Other relevant acts include the Salmon and Freshwater (Protection) (Scotland) Act 1951, the Freshwater and Salmon Fisheries (Scotland) Act 1976, the Salmon Act 1986 and the Aquaculture and Fisheries act 2007 (http://www.opsi.gov.uk/legislation/scotland/acts2007/pdf/asp_20070012_en.pdf). A Strategic Framework for Scottish Freshwater Fisheries has been developed following consultation between government and key stakeholders and a number of priorities for action have been identified and are being addressed including:

- Development of a code of good practice in fisheries management
- Developing a strategy for mixed stock fisheries
- Review of collection and dissemination of fishery statistics

http://www.scotland.gov.uk/Publications/2008/06/26110733/0

http://www.scotland.gov.uk/Topics/Fisheries/Salmon-Trout-Coarse/FFF/SFIG

UK – England and Wales: Salmon Action Plans (SAPs) are the means by which the Environment Agency (EA) aims to meet the objectives of its National Salmon Management Strategy (launched in 1996) at a local level. The programme of SAPs for the 62 principal salmon rivers in England and Wales was completed in April 2004. More information on Salmon Action Plans can be found at www.environment-agency.gov.uk.

Amongst other things, the SAPs set specific spawning targets for individual rivers, against which stock and fishery performance are assessed. This provides a more objective approach than has previously been applied to salmon management in England and Wales and has been advocated by NASCO to facilitate salmon management in the international context. Each river's SAP contains a range of actions to help achieve spawning targets, such as reducing exploitation, improving habitat and water quality and minimising obstructions to migration. In delivering each SAP the Agency seeked the support of local fishery and other interests. This collaborative approach is vital to secure the best way forward for the management of salmon rivers. The Environment Agency has recently developed a New Sea Trout and Salmon Fisheries strategy - (http://publications.environment-agency.gov.uk/pdf/GEHO0608BNWT-e-e.pdf?lang=_e). Rod-caught salmon and sea trout can no longer be sold in England and Wales. The only wild fish that can be sold legally must be net-caught, and, if they are caught in England and Wales, they must possess an Environment Agency carcass tag.

Where national or local byelaws and fishery rules permit, anglers may still take rod-caught fish for themselves or to give away to family and friends. However, they must not sell or offer for them for sale. The new measures aim to protect salmon and sea trout stocks, which remain depleted in many rivers. Despite an encouraging picture in 2008, one in five of England and Wales principal salmon rivers is predicted to still be at risk of not supporting sustainable salmon stocks by 2013.

UK – Northern Ireland: A salmon management plan has been under development in the Fisheries Conservancy Board area of Northern Ireland since 1999, supported by funding from the European Union. The two project staff have mainly been working on GIS-based habitat surveys of salmon rivers and the development of a network of fish counters. The habitat surveys are being used to build up a database to identify areas requiring rehabilitation, and to form the basis for developing appropriate spawning and egg deposition targets. The purpose of the fish counter programme is to provide a means of monitoring adult salmon runs to determine if spawning targets are being met, and counters have now been installed on three rivers. Application is to be made for further funding from the EU to enable the programme to be expanded so that the NASCO requirement for a target-based approach to stock management can be fully met. There is also an annual electrofishing survey of 6 index systems for the status of freshwater phase of the stock (AFBI pers.comm.).

Iceland: Salmon catches resulting from enhancement of rivers with salmon smolts has increased and accounts for 35% of the total catch in 2008. Some marine gillnet fisheries were conducted for salmon until 1998. Now all of the fisheries are either for sport or limited gillnet fisheries in rivers. The sport catch is about 30 to 40 thousand individuals while about 6,000 are fished with gillnets. The gillnet catch has been declining from about 20,000 individuals in 1975, while the long term average is stable in sport fisheries.

Ireland: In 2005, an Irish Government decision was taken to end the at sea mixed stock fisheries (predominantly drift nets) in 2007 and to operate fisheries only on single river stocks, which were shown to be meeting conservation limits. This was to align with best international practice, comply with scientific advice from ICES, meet NASCO objectives and to afford greater protection to stocks designated under the EU Habitats Directive.In 2006 the terms of reference for the Standing Scientific Committee were amended so that their advice would be provided on an individual catchment basis rather than a district basis. This advice was taken into account for the 2007 salmon season which saw an end to mixed stock salmon fisheries at sea and a complete ban on drift net fishing. In 2006, drift nets accounted for 64.5% of the total commercial catch. The 2007 statistics show that the total number of salmon harvested by all methods was 28,273 – which represent a drop of 74% on the total catch recorded in 2006. Overall, the number of salmon harvested by all methods has dropped by nearly 89% from 2001 to 2007.

(http://www.cfb.ie/fisheries_protection/salmon_tagging/salmonstats0607.htm)

France: On the 21st and 22nd of October 2009 a colloquium entitled “Atlantic Salmon: For Better Management of Habitats and Salmon Farms for Re-Stocking » was held. This colloquium is part of the French plan to implement the recommendations of the North Atlantic Salmon Conservation Organization (NASCO). The conclusions of this colloquium will contribute to the development of the national policy for the management of migratory diadromous fish, according to the principles of the “Grenelle” environmental talks on the protection of species and the environment, and the preservation or the reestablishment of the ecological continuity of habitats (http://colloque-saumon.oieau.fr/).

Otherwise, the GENESALM program carried out a first summary report on wild Atlantic salmon genetics and an analysis of restocking practices at the national level (a restitution seminar was held in March 2008). As a main conclusion, the GESALM program proposed the development of a national strategy for suing good restocking practices.

Currently there are four index rivers, as recognised by the ICES working group on North Atlantic Salmon (WGNAS) in France: The Bresle in Upper Normandy, Oir in Lower Normandy, Scorff in Brittany and Nivelle on the basque coast. All four rivers are managed by the INRA and ONEMA.

Norway: In the 1960s, about 88% of the salmon in northern Norway were caught in the sea. Although fishing with drift nets has been carried out for at least 80 years, large-scale drift netting offshore commenced in 1960. The number of drift nets increased rapidly thereafter, and catches peaked at 1007 t in 1979. In 1989 the coastal drift net fishery was banned (Jensen et al 1999).

Main features of Norwegian policy for the preservation of wild salmon

1. Introduction and background

In February 2003 the Storting (parliament) designated 37 national salmon watercourses and 21 national salmon fjords while establishing ground rules for this management scheme and guidelines for follow-up, on the basis that additional river systems and fjord areas would be included in due course.

In its proposal St.prp. no. 32 (2006-2007), the Ministry of Environment has set out the Government's policy for the preservation and strengthening of Norway's salmon stocks and recommendations for the establishment of 15 new national salmon watercourses (river systems) and 8 new salmon fjords. The proposal is based on established criteria for selecting salmon stocks for the management scheme, a comprehensive technical report, comments on the report following consultations, recommendations from the Directorate for Nature Management, and a balanced assessment of other relevant sectors.

The Storting endorsed this proposal on May 15th, and the scheme now comprises 52 national salmon river systems and 29 national salmon fjords.

2. Summary of St.prp. nr. 32 (2006-2007)

Preservation and strengthening of the wild salmon stocks

The Government aims to protect and regenerate salmon stocks to a level and composition that will maintain diversity within the species while exploiting its productive potential. As the responsibility for achieving this objective is divided between several sectors, cooperation in salmon management will be improved.

National salmon rivers and salmon fjords comprises an essential measure aimed at protecting wild salmon. However, action is equally necessary in other areas involving for example fish farming, salmon river management, combating *Gyrodactylus salaris*, liming, operation of gene banks, research and development, monitoring, and salmon fishery management.

Measures involving aquaculture

Escapees from salmon aquaculture (farmed salmon which have escaped or been released into the natural environment) are one of the most serious threats to wild salmon. Efforts to limit escapes will be intensified on the basis of the fisheries authorities' action plan "Visjon nullflukt" ("Vision 'No Escapees'"). Work on potentially useful new technologies and production methods, the use of sterile fish and the development of systems for tracing fish will also be intensified.

Infestations with salmon lice is also a serous threat to wild salmon. Efforts to reduce the infection pressure on outgoing smolt will therefore be intensified through a national action plan to combat this parasite. Regulations will be strengthened, as will efforts to develop vaccines and schemes for coordinated delousing.

Gyrodactylus salaris

Next to aquaculture escapees, the greatest threat to wild salmon is the parasite *Gyrodactylus salaris*. Combating this parasite will be a high priority, with the aim to eradicate the parasite where possible and minimize the risk of transmission to new areas. Measures will be based on the best available technology and systematic follow-up.

Watercourses

Protection of salmon habitats in the rivers will be strengthened. Habitats in good condition will be safeguarded, and those which are not optimal for production of wild salmon will be restored. The interests of the wild salmon itself, other stakeholders in the watercourses and cost-efficiency combined calls for scrupulous and systematic implementation. Restoration work will therefore be based on a comprehensive national plan for the preservation and renewal of salmons habitats.

New encroachments in connection with the production of hydroelectric power shall not cause significant damage to salmon production. In new hydropower projects affecting salmon river systems, emphasis will be put on avoiding harmful effects to wild salmon through adaptation and/or compensation measures.

In relation to hydroelectric power, the situation for wild salmon can be improved mainly through revision and renewal processes for hydropower licences. These instruments will therefore be used to improve conditions for wild salmon in affected river systems.

Regulations in salmon fisheries

Substantial restrictions in salmon fisheries will be necessary in the on-coming regulations for the period 2008-2012. The regulations will be based on international scientific advice and criteria which presuppose mainly that mixed stocks fisheries must be curtailed. In practice, this can only be achieved by reducing fishing pressure in the sea water fisheries and probably also phasing out this type of fishing in certain areas. In addition, regulations will be introduced with the aim of meeting spawning stock targets and reducing the relative abundance of escapees from aquaculture.

The new regulations in salmon fisheries will be developed with contributions from the various interest groups, in particular the owners of fishing rights in rivers and fjords, the Sami (Laplanders), recreational fishers, and local enterprises that may be indirectly affected. The aim is a new regulatory regime well adjusted to the situation of the wild salmon, where the over all consequences for the interested parties are acceptable.

Liming, releasing fish and gene banks

Liming is currently carried out in 22 salmon rivers; these liming projects will continue. Over time, liming projects may be extended to additional salmon rivers.

Release of salmon is currently carried out as a compensatory measure in hydroelectric power projects. In many cases such releases are not particularly effective, and quality control and assessment will therefore be strengthened.

Material from 169 salmon stocks are maintained in frozen gene banks, and 22 stocks are preserved in living gene banks. To date, the salmon stocks included in the gene banks are at risk from either *Gyrodactylus salaris* or acid rain. As a result of the additional need to protect stocks that are threatened by escaped salmon from aquaculture, an expansion of the gene bank programme is in preparation.

Research and monitoring

Salmon management requires a good basis in scientific information, i.a. on stock development and biological and environmental conditions for salmon production. Research and monitoring will therefore be priorities in the future.

National salmon river systems and salmon fjords

The aim of national salmon river systems and salmon fjords is to offer special protection to 52 of the most important salmon stocks in Norway. These salmon stocks will be protected from encroachment and activities in the watercourses and in the nearby fjords and coastal areas.

In the national salmon rivers no permission will be given to new enterprises or activities that might harm the wild salmon. In the salmon fjords no additional salmon aquaculture plants will be established. Existing installations will be subject to more stringent standards for preventing escapes and controlling sea lice and other deseases. The stocks included will also be prioritized for other measures aimed at strengthening the wild salmon.

The national salmon rivers and salmon fjords will encompass about three-quarters of the Norwegian wild salmon resource. The scheme will include large and abundant stocks with high productivity or with a potential for high productivity as well as stocks of "storlaks" ("big salmon", weighing 7 kg or more) and stocks with special genetic characteristics. The selection of stocks will have a good geographic distribution.

The management system involving national salmon rivers and salmon fjords has been designated by the Storting in plenary session. This system will later be legally based in the Act relating to salmonids and freshwater fish and in regulations under other relevant legislation. Necessary legislative changes are to be proposed to the Storting once the scheme has been adopted.

The regulations concerning national salmon rivers and salmon fjords are administered according to the prevailing division of responsibility in central government. Local authorities and owners of fishing rights will also be involved in the administration of this scheme.

The national salmon rivers and salmon fjords will be a permanent scheme. However, new information, new technologies and new general framework conditions might require regulatory changes in the management of watercourses and fjord areas over time. The scheme will therefore be evaluated ten years after implementation at the latest.

The stocks involved in the scheme will have priority in general activities aimed at strengthening wild salmon stocks. This will involve i.a. measures to combat *Gyrodactylus salaris*, habitat restoration, revision of licenses and compensatory measures in regulated watercourses, liming, and monitoring of stocks. In addition, other measures for protection of wild salmon will include reduction of escapees from aquaculture, minimizing sea lice and improved regulations in salmon fisheries.

Changes in the protection regime for salmon fjords

As a consequence of changes in aquaculture regulations since the salmon fjords were established, the Storting endorsed an updating of the existing protection regime for national salmon fjords. In addition, all salmon aquaculture will be terminated in the established salmon fjord Tanafjorden outside the Tana river, which is one of the World`s richest salmon rivers. Apart from that, the new scheme does not include any relocation of aquaculture plants. However, voluntary agreements to move aquaculture installations out of national salmon fjords is a relevant option.

The protection regime sets out guidelines for aquaculture operations in the salmon fjords and also allows for flexibility in the event of future developments.

Portugal: The following text is an extract from WWF's 2001 report "the status of wild Atlantic salmon: a river by river assessment."

Portugal represents the southern limit of distribution of Atlantic salmon in Europe. Wild salmon formerly spawned in the major rivers of the north of the country in watersheds shared with Spain – the rivers Minato, Dour and To (the To being the Southern limit of distribution). The Minato, which constitutes the northern border between Portugal and Spain, flows from Spain, where the main part of the watershed is located.

Salmon also occurred in the smaller rivers Nevi, Lima, Caved and Ave located between the Minato and To rivers.

The Portuguese Nature Conservation Services had classified salmon as “endangered” according to IUCN criteria by the early 1990s (Anon., 1991), but the situation has deteriorated since then.

By 1990, Atlantic salmon populations could be found only in the Minato and the Lima, having become extinct elsewhere. Since the early 1990s, salmon specimens have been identified only occasionally in the Dour (Anon., 1991) and Caved (Pereira, 1994; Correia and Fidalgo, 1995). Since 1991, a hydro dam has blocked fish passage on the Lima River near the estuary, and consequently salmon runs have declined to the point where (although a few stragglers still enter the river each year) the population is considered to be Extinct.

By the early 1990s, salmon catches in the Minato had been reduced by more than 97 percent from 1,400 in 1914 to fewer than 50 in 1989 (Correia and Fidalgo,1995). This population has continued to decrease (Correia and Fidalgo,1995), and is therefore categorized as being in Critical condition.

Thus, of seven historic Portuguese salmon rivers, six are now categorized as Extinct, and the seventh is categorized as having a population in Critical condition.

Spain: The following text is an extract from WWF’s 2001 report “the status of wild Atlantic salmon: a river by river assessment.”

Wild stocks of Atlantic salmon have declined precipitously in many Spanish rivers in recent decades, particularly in the north, due to a combination of overexploitation and habitat degradation. Declines have been associated with a reduction in sea age and the numerical size of returns (Brana *et al*., 1995a). Stocking programs, based mainly on native fish, began early in the 20^{th} century, but have relied on eggs imported from Scotland since the early 1970s. However, this practice failed to contribute significantly to production in the angling fisheries in Cantrabria and risked potentially negative genetic impacts on native salmon (Verspoor and Garcia de Leaniz, 1997) A number of Spanish rivers now have populations that are close to extinction, and very few have populations that are not endangered.

Sweden: The following text is an extract from WWF’s 2001 report “the status of wild Atlantic salmon: a river by river assessment.”

Natural stocks of Atlantic salmon exist in 23 rivers on the Swedish West Coast (Fiskeriverket, 1999).

These salmon populations spend their oceanic phase in the same areas as the other Atlantic salmon populations in the North Atlantic. At the beginning of the 20th century, hydroelectric power schemes soon limited the habitat available for wild salmon spawning. In the 1970s, acid rain decreased pH levels and further limited the survival of wild salmon. The exploitation of mixed salmon fisheries in the North Atlantic has also reduced salmon stocks on Sweden’s West coast. The situation is further exacerbated by escaped farmed salmon and a spread of the parasite *Gyrodactylus salaris* (Fiskeriverket, 1999). The catch of salmon on the Swedish West Coast dropped from around 90 tonnes annually (Fiskeriverket, 1999) in the 19th century to about 10 tonnes at the beginning of the 1980s (NASCO, 1999).Active liming measures in rivers and stock enhancement (habitat restoration and releases of farmed smolt) helped to partially restore the salmon stocks in this area. By the mid-1990s the catches had increased to between 30 and 55 tonnes a year, but since then, there has been a dramatic reduction in the catches of salmon on the Swedish West Coast (NASCO, 1999). This reduction in salmon stocks has created a very grave situation for many wild salmon on the Swedish West Coast.

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OSPAR COMMISSION

New Court
48 Carey Street
London WC2A 2JQ
United Kingdom

t: +44 (0)20 7430 5200
f: +44 (0)20 7430 5225
e: secretariat@ospar.org
www.ospar.org

OSPAR's vision is of a clean, healthy and biologically diverse North-East Atlantic used sustainably

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