10 North Atlantic salmon stocks

10.1 Introduction

10.1.1 Main tasks

At its 2014 Statutory Meeting, ICES resolved (C. Res. 2014/2/ACOM10) that the Working Group on North Atlantic Salmon [WGNAS] (chaired by Ian Russell, UK) should meet in Moncton, Canada, 17–26 March 2015 to consider questions posed to ICES by the North Atlantic Salmon Conservation Organization (NASCO).

The sections of the report that provide the responses to the terms of reference are identified below.

a)		With respect to Atlantic salmon in the North Atlantic area:	Section 10.1
	i)	provide an overview of salmon catches and landings, including unreported catches by country, catch and release, and production of farmed and ranched Atlantic salmon in 2014[1];	10.1.5
	ii)	report on significant new or emerging threats to, or opportunities for, salmon conservation and management[2];	10.1.6
	iii)	provide a review of examples of successes and failures in wild salmon restoration and rehabilitation and develop a classification of activities which could be recommended under various conditions or threats to the persistence of populations[3];	10.1.7
	iv)	provide a compilation of tag releases by country in 2014; and	10.1.9
	v)	identify relevant data deficiencies, monitoring needs, and research requirements.	10.1.8 & 10.1.13
b)		With respect to Atlantic salmon in the Northeast Atlantic Commission area:	Section 10.2
	i)	describe the key events of the 2014 fisheries[4];	10.2.1
	ii)	review and report on the development of age-specific stock conservation limits;	10.2.1
	iii)	describe the status of the stocks;	10.2.1
	iv)	provide catch options or alternative management advice for the 2015/16–2017/18 fishing seasons, with an assessment of risks relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding[5];	10.2.1
	v)	advise on options for taking into account the recent genetic analysis that suggests there was a significant contribution of North American origin stocks to the historical mixed-stock fisheries in Faroese waters for the provision of catch advice[6];	10.1.10
	vi)	update the Framework of Indicators used to identify any significant change in the previously provided multi-annual management advice; and	10.2.1
	vii)	advise on what data would enhance the development of the catch options.	10.1.11

c)	With respect to Atlantic salmon in the North American Commission area:		Section 10.3
	i)	describe the key events of the 2014 fisheries (including the fishery at St Pierre and Miquelon)[4];	10.3.1
	ii)	update age-specific stock conservation limits based on new information as available;	10.3.1
	iii)	describe the status of the stocks;	10.3.1
	iv)	provide catch options or alternative management advice for 2015–2018 with an assessment of risks relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding[5];	10.3.1
	v)	update the Framework of Indicators used to identify any significant change in the previously provided multi-annual management advice;	10.3.1
	vi)	considering the available contemporary data on stock origin of salmon in the Labrador fisheries, estimate the catches by stock origin and describe their spatial and temporal distribution; and	10.1.12
	vii)	considering the available contemporary data on stock origin of salmon in the Saint-Pierre and Miquelon fishery, estimate the catches by stock origin and describe their spatial and temporal distribution.	10.1.12
d)	With respect to Atlantic salmon in the West Greenland Commission area:		Section 10.4
	i)	describe the key events of the 2014 fisheries[4];	10.4.1
	ii)	describe the status of the stocks[7];	10.4.1
	iii)	provide catch options or alternative management advice for 2015–2017 with an assessment of risks relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding[5];	10.4.1
	iv)	update the Framework of Indicators used to identify any significant change in the previously provided multi-annual management advice; and	10.4.1
	v)	considering the available contemporary data on stock origin of salmon in the West Greenland fishery, estimate the catches by stock origin and describe their spatial and temporal distribution.	10.1.12

Notes:

1. With regard to question a) i, for the estimates of unreported catch the information provided should, where possible, indicate the location of the unreported catch in the following categories: in-river; estuarine; and coastal. Numbers of salmon caught and released in recreational fisheries should be provided.
2. With regard to question a) ii, ICES is requested to include reports on any significant advances in understanding of the biology of Atlantic salmon that is pertinent to NASCO, including information on any new research into the migration and distribution of salmon at sea and the potential implications of climate change for salmon management.
3. With regards to question a) iii, NASCO is particularly interested in case studies highlighting successes and failures of various restoration efforts employed across the North Atlantic by all Parties/jurisdictions and the metrics used for evaluating success or failure.
4. In the responses to questions b) i, c) i and d) i, ICES is asked to provide details of catch, gear, effort, composition and origin of the catch and rates of exploitation. For home-water fisheries, the information provided should indicate the location of the catch in the following categories: in-river; estuarine; and coastal. Information on any other sources of fishing mortality for salmon is also requested.
5. In response to questions b) iv, c) iv, and d) iii, provide a detailed explanation and critical examination of any changes to the models used to provide catch advice and report on any developments in relation to incorporating environmental variables in these models.
6. In response to question b) v, this should include consideration of the implications of the new genetic results with regard to the factors previously identified by ICES as requiring management decisions for the finalization of the risk framework for the provision of catch advice for the Faroes fishery (i.e. annual or seasonal catch advice, sharing agreement, choice of management units to consider, and specified management objectives).
7. In response to question d) ii, ICES is requested to provide a brief summary of the status of North American and Northeast Atlantic salmon stocks. The detailed information on the status of these stocks should be provided in response to questions b) iii and c) iii.

In response to the terms of reference, the Working Group considered 35 Working Documents. A complete list of acronyms and abbreviations used in this report is provided in Annex 1. References cited are listed in Annex 2.

10.1.2 Management framework for salmon in the North Atlantic

The advice generated by ICES is in response to the terms of reference posed by the North Atlantic Salmon Conservation Organization (NASCO), pursuant to its role in international management of salmon. NASCO was set up in 1984 by 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. 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 at Greenland and Faroes, which take salmon originating in rivers of another Party, are regulated by NASCO under the terms of the Convention. NASCO now has six Parties that are signatories to the Convention, including the EU which represents its Member States.

NASCO discharges these responsibilities via the three Commission areas shown below:

10.1.3 Management objectives

NASCO has identified the primary management objective of that organization as:

"To contribute through consultation and co-operation to the conservation, restoration, enhancement and rational management of salmon stocks taking into account the best scientific advice available".

NASCO further stated that "the Agreement on the Adoption of a Precautionary Approach states that an objective for the management of salmon fisheries is to provide the diversity and abundance of salmon stocks", and NASCO's Standing Committee on the Precautionary Approach interpreted this as being "to maintain both the productive capacity and diversity of salmon stocks" (NASCO, 1998).

NASCO's Action Plan for Application of the Precautionary Approach (NASCO, 1998) provides an interpretation of how this is to be achieved:

- "Management measures should be aimed at maintaining all stocks above their conservation limits by the use of management targets".
- "Socio-economic factors could be taken into account in applying the precautionary approach to fisheries management issues".
- "The precautionary approach is an integrated approach that requires, *inter alia*, that stock rebuilding programmes (including as appropriate, habitat improvements, stock enhancement, and fishery management actions) be developed for stocks that are below conservation limits".

10.1.4 Reference points and application of precaution

Atlantic salmon has characteristics of short-lived fish stocks: mature abundance is sensitive to annual recruitment because there are only few age groups in the adult spawning stock. Incoming recruitment is often the main component of the fishable stock. For such fish stocks, the ICES maximum sustainable yield (MSY) approach is aimed at achieving a target escapement (MSY $B_{escapement}$, the amount of biomass left to spawn). No catch should be allowed unless this escapement can be achieved. The escapement level should be set so there is a low risk of future recruitment being impaired.

ICES considers that to be consistent with the MSY and the precautionary approach, fisheries should only take place on salmon from rivers where stocks have been shown to be at full reproductive capacity. Furthermore, due to differences in the status of individual stocks within stock complexes, mixed-stock fisheries present particular threats.

Conservation limits (CLs) for North Atlantic salmon stock complexes have been defined by ICES as the level of stock (number of spawners) that will achieve long-term average maximum sustainable yield. In many regions of North America, the CLs are calculated as the number of spawners required to fully seed the wetted area of the rivers. The definition of conservation in Canada varies by region and in some areas, historically, the values used were equivalent to maximizing/optimizing freshwater production. These are used in Canada as limit reference points and they do not correspond to MSY values. Reference points for Atlantic salmon are currently being reviewed for conformity with the Precautionary Approach policy in Canada and revised reference points are expected to be developed. In some regions of Europe, pseudo stock–recruitment observations are used to calculate a hockey-stick relationship, with the inflection point defining the national CLs. In the remaining regions, the CLs are calculated as the number of spawners that will achieve long-term average MSY, as derived from the adult-to-adult stock and recruitment relationship (Ricker, 1975; ICES, 1993). NASCO has adopted the region-specific CLs (NASCO, 1998). These CLs are limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability.

Management targets have not yet been defined for all North Atlantic salmon stocks. When these have been defined they will play an important role in ICES advice.

Where there are no specific management objectives for the assessment of the status of stocks and advice on management of national components and geographical groupings of the stock complexes in the NEAC area, the following shall apply:

- ICES considers that if the lower bound of the 90% confidence interval of the current estimate of spawners is above the CL, then the stock is at full reproductive capacity (equivalent to a probability of at least 95% of meeting the CL).
- When the lower bound of the confidence interval is below the CL, but the midpoint is above, then ICES considers the stock to be at risk of suffering reduced reproductive capacity.
- Finally, when the midpoint is below the CL, ICES considers the stock to suffer reduced reproductive capacity.

For catch advice on the mixed-stock fishery at West Greenland (catching non-maturing 1SW fish from North America and non-maturing 1SW fish from Southern NEAC), NASCO has adopted a risk level (probability) of 75% of simultaneous attainment of management objectives in seven geographic regions (ICES, 2003) as part of an agreed management plan. NASCO uses the same approach for catch advice for the mixed-stock fishery, affecting six geographic regions for the North American stock complex. ICES notes that the choice of a 75% risk (probability) for simultaneous attainment of six or seven stock units is approximately equivalent to a 95% probability of attainment for each individual unit (ICES, 2013).

There is no formally agreed management plan for the fishery at Faroes. However, ICES has developed a risk-based framework for providing catch advice for fish exploited in this fishery (mainly MSW fish from NEAC countries). Catch advice is provided at both the stock complex and country level and catch options tables provide the probability of meeting CLs in the individual stock complexes or countries, and in all the stock complexes or countries simultaneously. ICES has recommended (ICES, 2013) that management decisions should be based principally on a 95% probability of attainment of CLs in each stock complex/country individually. The simultaneous attainment probability may also be used as a guide, but managers should be aware that this will generally be quite low when large numbers of management units are used.

Recent genetic investigations have indicated that North American origin fish contributed a higher proportion of the catch in the historical mixed-stock fishery at Faroes than previously thought. In light of these findings, ICES has been asked to advise on management options that take the North American fish into account; further details are provided in Section 10.1.10 of this report.

10.1.5 Catches of North Atlantic salmon

10.1.5.1 Nominal catches of salmon

Figure 10.1.5.1 displays reported total nominal catch of salmon in four North Atlantic regions from 1960 to 2014. Nominal catches of salmon reported for countries in the North Atlantic for 1960–2014 are given in Table 10.1.5.1. Catch statistics in the North Atlantic include fish farm escapees, and in some Northeast Atlantic countries also ranched fish.

Icelandic catches have traditionally been split into two separate categories, wild and ranched, reflecting the fact that Iceland has been the main North Atlantic country where large-scale ranching has been undertaken with the specific intention of harvesting all returns at the release site, and with no prospect of wild spawning success. The release of smolts for commercial ranching purposes ceased in Iceland in 1998, but ranching for rod fisheries in two Icelandic rivers continued into 2014 (Table 10.1.5.1). Catches in Sweden have also now been split between wild and ranched categories over the entire time-series. The latter fish represent adult salmon which have originated from hatchery-reared smolts and which have been released under programmes to mitigate for hydropower development schemes. These fish are also exploited very heavily in home waters and have no possibility of spawning naturally in the wild. While ranching does occur in some other countries, this is on a much smaller scale. Some of these operations are experimental and at others harvesting does not occur solely at the release site. The ranched component in these countries has therefore been included in the nominal catch.

Reported catches in tonnes for the three NASCO Commission Areas for 2005–2014 are provided below.

Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NEAC	1998	1867	1409	1533	1163	1415	1419	1250	1092	938
NAC	142	140	114	162	129	156	182	129	143	109
WGC	15	22	25	26	26	40	28	33	47	58
Total	2156	2029	1548	1721	1318	1610	1629	1412	1282	1106

The provisional total nominal catch for 2014 was 1106 t, 176 t below the updated catch for 2013 (1282 t). The 2014 catch was the lowest in the time-series and followed the previous lowest in the time-series in 2013. Catches were at or below the previous five- and ten-year averages in the majority of countries, except Sweden, Finland, France, Spain, and Greenland.

ICES considers 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 2014 nominal catch (in tonnes) was partitioned accordingly and is shown below for the NEAC and NAC Commission Areas. Figure 10.1.5.2 and Table 10.1.5.2 present these data on a country-by-country basis. There is considerable variability in the distribution of the catch among individual countries. In most countries the majority of the catch is now taken in freshwater, and the coastal catch has declined markedly. However, nominal catches in freshwater have also declined in many countries as a result of increasing use of catch-and-release in rod fisheries.

AREA	COAST		ESTUARY		RIVER		TOTAL
	Weight	%	Weight	%	Weight	%	Weight
NEAC	325	35	52	6	562	60	939
NAC	10	9	40	37	59	54	109

Coastal, estuarine, and riverine catch data aggregated by region are presented in Figure 10.1.5.3. In Northern NEAC, about half the catch has typically 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. There has been a steady reduction in the proportion of the catch taken in coastal waters over recent years. In Southern NEAC, catches in all fishery areas have declined dramatically over the period. While coastal fisheries have historically made up the largest component of the catch, these fisheries have declined the most, reflecting widespread measures to reduce exploitation in a number of countries. Since 2007, the majority of the catch in Southern NEAC has been taken in freshwater.

In North America, the total catch over the period 2004–2014 has been fluctuating around 140 t. The majority of the catch in this area has been taken in riverine fisheries; the catch in coastal fisheries has been relatively small in any year (15 t or less).

10.1.5.2 Unreported catches

The total unreported catch in NASCO areas in 2014 was estimated to be 287 t. There was no estimate for Russia, or for Spain and St. Pierre and Miquelon, although catches in the latter two areas are small. The unreported catch in the NEAC area in 2014 was estimated at 256 t, and that for the West Greenland and North American Commission areas at 10 t and 21 t, respectively. The following table shows unreported catch by NASCO commission areas in the last ten years:

Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NEAC	605	604	465	433	317	357	382	363	272	256
NAC	85	56	-	-	16	26	29	31	24	21
WGC	10	10	10	10	10	10	10	10	10	10

The 2014 unreported catch by country is provided in Table 10.1.5.3. It has not been possible to separate the unreported catch into that taken in coastal, estuarine, and riverine areas. Over recent years efforts have been made to reduce the level of unreported catch in a number of countries (e.g. through improved reporting procedures and the introduction of carcass tagging and logbook schemes).

10.1.5.3 Catch-and-release

The practice of catch-and-release (C&R) in rod fisheries has become increasingly common as a salmon management/conservation measure in light of the widespread decline in salmon abundance in the North Atlantic. In some areas of Canada and USA, C&R has been practised since 1984, and in more recent years it has also been widely used in many European countries, both as a result of statutory regulation and through voluntary practice.

The nominal catches do not include salmon that have been caught and released. Table 10.1.5.4 presents C&R information from 1991 to 2014 for countries that have records; C&R may also be practised in other countries while not being formally recorded. There are large differences in the percentage of the total rod catch that is released, in 2014 ranging from 19% in Norway (this is a minimum figure, as statistics were collected on a voluntary basis) to 82% in UK (Scotland), reflecting varying management practices and angler attitudes among countries. C&R rates have typically been highest in Russia (average of 84% in the five years 2004 to 2008) and are believed to have remained at this level. However, there were no obligations to report C&R fish in Russia in 2009 and records since 2010 are incomplete. Within countries, the percentage of fish released has tended to increase over time. There is also evidence from some countries that larger MSW fish are released in higher proportions than smaller fish. Overall, more than 135 000 salmon were reported to have been caught-and-released around the North Atlantic in 2014.

10.1.5.4 Farming and sea ranching of Atlantic salmon

The provisional estimate of farmed Atlantic salmon production in the North Atlantic area for 2014 is 1555 kt. The production of farmed salmon in this area has been over one million tonnes since 2009. The 2014 total represents a 4% increase on 2013 and a 16% increase on the previous five-year mean. Norway and UK (Scotland) continue to produce the majority of the farmed salmon in the North Atlantic (79% and 10%, respectively). Farmed salmon production in 2014 was above the previous five-year averages in all North Atlantic salmon producing countries except Ireland.

Worldwide production of farmed Atlantic salmon has been in excess of one million tonnes since 2002 and has been over two million tonnes since 2012. The total worldwide production in 2014 is provisionally estimated at around 2171 kt (Figure 10.1.5.4), a 3% increase on 2013. Production outside the North Atlantic is estimated to have accounted for 22% of the total in 2014. Production outside the North Atlantic is dominated by Chile.

The worldwide production of farmed Atlantic salmon in 2014 was over 1900 times the reported nominal catch of Atlantic salmon in the North Atlantic.

The total harvest of ranched Atlantic salmon in countries bordering the North Atlantic in 2014 was 21 t, taken in Iceland, Sweden, and Ireland (Figure 10.1.5.5). No estimate of ranched salmon production was made in Norway in 2014, where such catches have been very low in recent years (< 1 t), and in UK (Northern Ireland) where the proportion of ranched fish has not been assessed since 2008 due to a lack of microtag returns.

10.1.6 NASCO has asked ICES to report on significant, new, or emerging threats to, or opportunities for, salmon conservation and management

10.1.6.1 Interactions between farmed and wild salmon – UK (Northern Ireland)

In UK (Northern Ireland) a study was finished in 2014 using genetic methods to detect the presence of farm-escaped fish in samples taken from the commercial fishery in 2006 and 2007. The study used genetic assignment techniques to assign a sample of 1100 individuals taken along the Northern Irish coast between Downhill and Cushendun to a genetic baseline consisting of 1100 juveniles from ten regional rivers, as well as a sample (350 individuals) from two commonly used Norwegian origin aquaculture strains. All samples were genotyped for a suite of 17 microsatellite loci and a panel of 90 Single Nucleotide Polymorphism (SNP) markers. Assignments were performed using various genetic assignment software packages utilizing Bayesian, frequency-based, and maximum likelihood methods to assign samples to baseline populations. There were two assignment groups: 'wild' and 'farmed'. The percentage of samples assigned to the 'farmed' group using the various methods ranged from 0.7% to 2.9% for the microsatellites, and 1.2% to 1.7% for SNPs.

10.1.6.2 Tracking and acoustic tagging studies in Canada

There is growing interest in the development of techniques to help investigate salmon mortality at sea and to better partition mortality between different periods of the marine phase of the life-cycle. To this end, NASCO's International Atlantic Salmon Research Board (IASRB) adopted a resolution in 2014 to further support the development of telemetry programmes in the ocean.

ICES reviewed the results of ongoing projects led by the Atlantic Salmon Federation (ASF) in collaboration with the Ocean Tracking Network, Miramichi Salmon Association (MSA), Restigouche River Watershed Management Committee, Department of Fisheries and Oceans (DFO) and others, to assess estuarine and marine survival of tagged Atlantic salmon released in rivers of the Gulf of St Lawrence (GoSL), Canada. More than 2300 smolts from four rivers (Cascapedia, Restigouche, and the southwestern and northwestern branches of the Miramichi) have been tagged with acoustic transmitters over a period of twelve years, 2003 to 2014. A number of kelts have also been tagged. Acoustic arrays to detect tagged fish have been positioned at the head of tide of each river, at the exit from the bays to the GoSL and at the Strait of Belle Isle (SoBI) leading to the Labrador Sea, more than 800 km from the point of release.

A statistical model has been developed to better distinguish the imperfect detection of tagged smolts on the sonic arrays from apparent survival during their out migration. The model has reduced uncertainty in expected values of the annual and river-specific detection probabilities at the head of tide and bay exit arrays. However, it was not possible to distinguish the probabilities of detection from the probabilities of survival at the last array (SoBI). The head of tide and outer bay arrays were in place in all years. The SoBI array has been deployed since 2007, so the probabilities of detection at the bay exits were estimated using the years 2007 to 2013 when the SoBI array was operational. The predicted posterior probability distributions for the bay arrays were used as probability distributions of detection in the years when the SoBI array was not in place (2003 to 2006). The probabilities of detection and survival to SoBI can only be estimated with a prior assumption at this array. The prior was derived using sentinel tags (fixed tags adjacent to SoBI receivers) placed at three distances near two receivers.

The probability of smolt survival through freshwater (Figure 10.1.6.1a) was high for Cascapedia (median range 0.94 to 0.95) and highly variable in SW Miramichi (0.71 to 0.89) and Restigouche (0.72 to 0.91). The survival rate through freshwater was negatively associated with migration duration. The survival rates from release to the outer bays leading to the GoSL (Figure 10.1.6.1b) varied annually, ranging between 0.50 and 0.80, except for the NW Miramichi where estimated survival decreased below 0.30 over the last two years. The contribution of smolts to the diet of striped bass is being examined in this area where the spatial and temporal overlap of the two species has been documented (using acoustic tags); investigations are continuing. The inferred survival rates through the GoSL to the Labrador Sea were highly variable (Figure 10.1.6.1c).

The SoBI receiver array (between Labrador and Newfoundland) appears to be the primary route for smolts and kelts exiting the GoSL. The only other possible exit is through the Cabot Strait, and this array has been in place since 2012. Only two smolt tags were detected on the Cabot array (originating from Miramichi in 2012 and Cascapedia in 2013).

Salmon kelts have been acoustically tagged since 2008 (272 from Miramichi and 42 from Restigouche). In the Miramichi, 32 kelts have also been tagged with satellite archival pop-up tags (2012 to 2014). Detections through the freshwater and bays were high in most years (> 0.80), with the exception of 2014 (Restigouche = 0.60, Miramichi = 0.76).

ICES encourages the continuation of this tracking programme as information from it is expected to be useful in the assessment of marine mortality of North American salmon stocks. ICES also notes that these techniques are being proposed for other areas in line with the NASCO IASRB resolution.

10.1.6.3 Diseases and parasites

Update on the Red Vent Syndrome

Over recent years, there have been reports from a number of countries in the NEAC and NAC areas of salmon returning to rivers with swollen and/or bleeding vents (ICES, 2014a). The condition, known as red vent syndrome (RVS or Anasakiasis), has been noted since 2005, and has been linked to the presence of a nematode worm, *Anisakis simplex* (Beck *et al.,* 2008). A number of regions within the NEAC area observed a notable increase in the incidence of salmon with RVS in 2007 (ICES, 2008). Levels in the NEAC area were typically lower from 2008 (ICES, 2009; 2010b; 2011).

Trapping records for rivers in UK (England & Wales) and France suggested that levels of RVS increased again in 2013, with the observed levels being the highest in the time-series for some of the monitored stocks. In 2014, three rivers in UK (England & Wales) were monitored for the presence of RVS (Tyne, Dee, and Lune). In the Tyne and the Dee levels were 8% and 25% respectively, both near the top end of the ranges recorded for these rivers. For the Lune, levels dropped significantly to 10%; however, the sample size was small.

In France, the level of infestation continued to be monitored in the Bresle and Scorff rivers in 2014. In the river Bresle, less than 10% of the fish were “moderately” affected, compared with an average of 25% in this category in previous years. In the river Scorff, 29% were “moderately” affected in 2014, compared with an average of 22% in previous years.

There is no clear indication that RVS affects either the survival of the fish in freshwater or their spawning success. Recent results have also demonstrated that affected vents show signs of progressive healing in freshwater (ICES, 2014a).

Update on sea lice investigations in Norway

The surveillance programme for sea lice infection on wild salmon smolts and sea trout at specific localities along the Norwegian coast continued in 2014 (Nilsen *et al.,* 2014). For most areas sea lice infestation rates were low to moderate in the salmon smolt migration period as a result of coordinated efforts among fish farms to reduce infestation levels at this time. In two areas, Romsdalsfjord and Vikna, salmon smolts were probably exposed to elevated levels of sea lice, especially late-migrating smolts.

In general, sea lice are still regarded as a serious problem for salmonids in Norway (Skilbrei *et al.,* 2013; Krkošek *et al.,* 2013), and especially for sea trout (Nilsen *et al.,* 2014). The use of chemicals to keep lice levels below a threshold value of 0.5 mature female lice per salmon has shown a sharp increase in recent years, as sea lice have developed resistance towards one or more of the most commonly used chemical agents. Multi-resistant sea lice are now present in all areas except Finnmark County in northernmost Norway (Aaen *et al.*, 2015; www.fhi.no). A recent study demonstrated how resistance to the most commonly used pesticide, emamectin benzoate, spread rapidly through the panmictic North Atlantic sea lice population from 1999 (Besnier *et al.,* 2014).

Norway has a regime of “National salmon fjords” that restrict salmon farming and other activities close to “National salmon rivers”. A recent study has evaluated the effect of such protected areas on the effects of sea lice from fish farms on salmon and sea-trout (Serra-Llinares *et al.,* 2014). When the size and shape of protected areas are such that fish farms are kept at a minimum distance (in the study calculated to at least 30 km), wild fish seem unaffected by the direct lice infection pressure imposed by fish farms (Serra-Llinares *et al.*, 2014). However, this distance is considered likely to be site-dependent.

10.1.6.4 Progress with implementing the Quality Norm for Norwegian salmon populations

In August 2013, a management system – The Quality Norm for Wild Populations of Atlantic Salmon (“Kvalitetsnorm for ville bestander av atlantisk laks (*Salmo salar*)”) – was adopted by the Norwegian government (Anon., 2013). This system was based on an earlier proposal by the Norwegian Scientific Advisory Committee for Atlantic Salmon Management (Anon., 2011a). A more detailed description of the Quality Norm is given in ICES (2014a). Recent progress in 2014 involved establishing a preliminary classification according to the conservation limit and the harvest potential dimension of the Quality Norm, based on assessments for the period 2010–2013. The first classification of populations based on both dimensions (conservation limit and harvest potential, and genetic integrity) is planned for 2015.

10.1.6.5 Changing biological characteristics of salmon

ICES has previously reported changes in the biological characteristics of salmon, including the size of returning 1SW fish (ICES, 2010a; 2013). For example, decreasing mean fork lengths have been observed in returning adult 1SW fish in the rivers Bush and Bann in UK (Northern Ireland) since 1973 (ICES, 2013).

In 2014, ICES noted anecdotal reports of some very small 1SW salmon returns from various areas in NAC. However, available evidence from traps and counting facilities did not indicate below-average return size on monitored rivers in 2014 (e.g. Miramichi, Nashwaak, La Have, Sandhill). Stocks will continue to be monitored in 2015.

10.1.6.6 Determining sex ratios in Atlantic salmon populations

The sex ratio of Atlantic salmon spawners is a key parameter for estimating egg deposition rates and assessing the status of salmon populations. The monitoring of out-migrating smolts or returning adults both provide opportunities for assessing sex ratios. However, accurate sexing of out-migrating smolts requires lethal sampling. For returning adults, external examination can provide an indication of a fish’s sex, particularly with the onset of male kype formation for fish sampled in the autumn. However, accurate sexing of adult salmon during the summer spawning migration ideally also requires lethal sampling. Given that lethal sampling is never desirable, and is often impossible in small and threatened populations, a simple non-lethal method to determine salmon sex is preferred. Recent work has identified sex-determining genomic regions in Atlantic salmon (Yano *et al*., 2012, 2013; Eisbrenner *et al.,* 2014). Use of the *sdY* locus (Yano *et al*., 2013) has allowed accurate sexing of Atlantic salmon in Newfoundland and Labrador populations. As expected, comparison with visual external sexing during the summer migration revealed significant discrepancies (males mis-sexed as female).

ICES welcomed the development of this new genetic-based tool for refining sex ratios and production estimates in Atlantic salmon populations, particularly for populations in which abundance of salmon is very low and sacrificing individual fish is not justifiable.

10.1.6.7 Update on EU project ECOKNOWS – embedding Atlantic salmon stock assessment at a broad ocean scale within an integrated Bayesian life-cycle modelling framework

Within the Atlantic salmon case study of the EU-FP7 ECOKNOWS project (http://www.ecoknows.eu/), a hierarchical Bayesian life-cycle model was developed that captures the joint dynamics of the five regional stock units considered by ICES for stock assessment in the Southern European stock complex: France, UK (England & Wales), Ireland and UK (Northern Ireland), Southwest Iceland, and UK (Scotland) (Massiot-Granier *et al*., 2014). The new modelling approach provides improvement to models currently used by ICES, and potentially paves the way toward harmonizing the stock assessment models used in the Atlantic (WGNAS) and the Baltic (WGBAST).

- The existing biological knowledge on Atlantic salmon demography is first integrated into an age- and stage-based life-cycle model, which explicitly incorporates the variability of life histories (river and sea ages) and accounts for natural and fishing mortality due to the sequential fisheries along the migration routes.
- The model is built in a full Bayesian probabilistic rationale. Uncertainties are accounted for in both estimations and forecasting.
- The model provides a framework for harmonizing the structure and parameterization between different stock units, while maintaining the specificities and associated levels of detail in data assimilation.
- The hierarchical structure provides a tool for separating out signals in the variability of demographic traits at different spatial scales: (1) common trends shared by the five stock units of the Southern European stock complex, and (2) fluctuations specific to each stock unit.

The life-cycle model is expandable and provides a framework for structuring further research and data collection:

- It offers possibilities for extending the model by incorporating additional sources of data: (1) time-series of egg-to-smolt data to provide information on density-dependent egg-to-smolt survival rates and smolt age composition, and (2) smolt tagging and recapture data to improve the estimates of return rates.
- It would enable trends in survival and proportion maturing to be correlated with environmental factors likely to influence populations at various spatial scales (global versus local influence).
- It could be used to assess how management and environmental scenarios can affect population dynamics at the scale of all stock complexes in the North Atlantic Ocean.

It has not been possible for ICES to utilize the model as yet. Ongoing issues include: (1) improving the computational tractability of the model (running time is still too long), and (2) assessing the possibility of transferring the methodology to the stock assessment model for North America. Continued efforts are being made to address these issues.

10.1.6.8 New opportunities for sampling salmon at sea

Knowledge of the salmon's marine life-cycle, including migration routes and feeding areas for salmon from different parts of the distribution range is still limited, even though recent projects such as the EU-funded SALSEA–Merge project have provided much valuable information. To advance our understanding of salmon at sea further sampling is needed, but with the low density of salmon in the ocean obtaining such samples is costly. Thus, opportunities to obtain samples from research cruises targeting other species provides a potential cost-effective alternative to targeted studies.

The International Ecosystem Survey of the Nordic Seas (IESSNS) is a collaborative programme involving research vessels from Iceland, the Faroes, and Norway; surveys are carried out annually in July–August and present such an opportunity. The area surveyed (2.45 million km^2 in 2014) overlaps in time and space with the known distribution of post-smolts in the North Atlantic, and as these cruises target pelagic species such as herring and mackerel, bycatch of salmon post-smolts and adult salmon is not uncommon. ICES has been in contact with the coordinator of the IESSNS surveys, who is keen to facilitate collaboration with WGNAS. Preliminary discussions have taken place to clarify sampling protocols and to identify appropriate individuals to carry out subsequent analysis of any salmon samples. These are expected to provide valuable information on the distribution of salmon at sea, the size, sex, and diet of individual fish and will also enable stock origin to be investigated using genetic techniques. Furthermore, the IESSNS survey data will provide information on salmon distribution in relation to other pelagic species, to hydrography, and to plankton abundance.

10.1.6.9 New opportunities for collecting information on salmon bycatch in pelagic fisheries

ICES has received information from the Institute of Marine Research (IMR), Bergen, Norway, related to a new tagging initiative and a wide-scale tag screening programme in the Northeast Atlantic. The tagging programme is directed at pelagic species (herring and mackerel) using glass-encapsulated passive integrated transponder (PIT) tags/RFID tags (radio frequency identity tags). Tag detection relies on the installation of antenna-reader systems at ports of landing. To date, such detectors have been installed at eight factories processing herring and mackerel; these are located in Norway (1), Iceland (1, with 2 more planned), Faroes (1), and Scotland (5, with 1 more planned). Further detectors are also planned in Ireland (3) and Denmark (1). By end 2015, there may be as many as 22 RFID detector systems screening herring and mackerel catches around Europe.

PIT/RFID tags are also widely used in juvenile salmon, and to some extent also in adult salmon. ICES received reports of 29 895 salmon being tagged with PIT/RFID tags in 2014 (4951 adults, 21 814 smolts, 3130 parr). The tag detectors will thus be able to detect such tags should post-smolt or adult salmon be taken as bycatch in the mackerel and herring fisheries. ICES has contacted the programme coordinators at IMR and has been advised that all tag detections will be registered and stored in an IMR database, and that information on any salmon caught will be available. ICES will therefore provide IMR with details of the tag number series used in salmon PIT/RFID tagging investigations, and relevant contact details, so that tag recapture details (date, location, etc.) can be reported back to appropriate researchers.

10.1.7 NASCO has asked ICES to provide a review of examples of successes and failures in wild salmon restoration and rehabilitation and to develop a classification of activities which could be recommended under various conditions or threats to the persistence of populations

The Working Group on the Effectiveness of Recovery Actions for Atlantic Salmon (WGERAAS) had its second meeting on 12–16 May 2014 at ICES HQ in Copenhagen. WGERAAS has focused on the evaluation of case studies and development of a river-specific database (Database on Effectiveness of Recovery Actions for Atlantic salmon, DBERAAS) to support the case studies by providing an overview of the impact of a list of stressors and the effect of recovery actions across the species range. An interim report has been produced (ICES, 2014b) presenting eight case studies and an analysis of a partially completed database using data from rivers that were the focus of recovery or rebuilding action investigations. The results from the analysis showed the potential of a complete DBERAAS for analysis of population stressors and recovery and rebuilding actions, and for assessing the effects of such actions across varying spatial scales.

For 2015, WGERAAS aims to collect more case studies, specifically on populations impacted by stressors such as invasive species and diseases, as well as populating DBERAAS. Analysis of both DBERAAS and case studies will indicate under what conditions recovery actions are successful and when they are unsuccessful. Recommendations on future recovery and restoration actions for Atlantic salmon will be based on this analysis. WGERAAS plans to meet during the second part of 2015 and report to ICES in 2016.

10.1.8 Reports from ICES expert groups relevant to North Atlantic salmon

WGRECORDS

The Working Group on the Science Requirements to Support Conservation, Restoration and Management of Diadromous Species (WGRECORDS) was established to provide a scientific forum in ICES for work on diadromous species. The role of the Group is to coordinate work on these species, organize expert groups, theme sessions for ICES Annual Science Conference, and symposia, and help to deliver the ICES Science Plan.

WGRECORDS held an informal meeting in June 2014, during the NASCO Annual Meeting in St Malo, France. The requirements for expert groups to address new and ongoing issues related to diadromous species were discussed, as were issues arising from the NASCO Annual Meeting. The annual meeting of WGRECORDS was held in September 2014, during the ICES Annual Science Conference (ASC) in Á Coruna, Spain. Updates were received from expert groups of particular relevance to North Atlantic salmon which had been established by ICES following proposals by WGRECORDS. The following are the ongoing, recently held, or proposed expert groups which WGRECORDS has proposed to ICES:

- Ongoing – Working Group on Effectiveness of Recovery Actions for Atlantic Salmon (WGERAAS). Next meeting in autumn 2015. An update is provided in Section 10.1.7.
- Recent – Workshop on Lampreys and Shads (WKLS) held in October 2014.
- Proposed – Working Group on Data-Poor Diadromous Fish (WGDAM) to be held in October 2015.
- Proposed – Workshop of a Planning Group on the Monitoring of Eel Quality: "Development of standardized and harmonized protocols for the estimation of eel quality".
- Proposed – Joint Workshop of the Working Group on Eel and the Working Group on Biological Effects of Contaminants: "Are contaminants in eels contributing to their decline?".

Theme sessions and symposia may be developed and proposed by WGRECORDS. In 2014, a theme session proposed by WGRECORDS was held at the ICES ASC entitled: "Analytical approaches to using telemetry data to assess marine survival of diadromous and other migratory fish species".

This theme session focused particularly on approaches for estimating mortality of fish using electronic tags. In particular, the theme session highlighted the benefits of cooperation between research groups in North America, including Ocean Tracking Network (OTN), Atlantic Cooperative Telemetry network (ACT), and Florida Atlantic Coast Telemetry network (FACT), and the opportunities for researchers in Europe to start applying these techniques. An international salmon telemetry programme, which is being supported by NASCO and developed by NASCO Member States, was outlined at the session. The aim of the programme is to describe the migration pathways of Atlantic salmon in the sea and to help in partitioning the marine mortality of salmon populations from different regions in space and time.

Of particular relevance to NASCO is the theme session developed by WGRECORDS for the ICES Annual Science Conference in September 2015, entitled: "Practical application of genetic stock identification for the conservation, management, and restoration of diadromous fish species".

A theme session has also been proposed for the ICES ASC in 2016, entitled: "Planning the future for diadromous and other migratory fish – What can be done to respond to climate change and other processes potentially affecting natural mortality over broad geographic scales?".

10.1.9 NASCO has asked ICES to provide a compilation of tag releases by country in 2014

Data on releases of tagged, fin-clipped, and otherwise marked salmon in 2014 were provided by ICES and are compiled as a separate report (ICES, 2015a). A summary of tag releases is provided in Table 10.1.9.1.

10.1.10 NASCO has asked ICES to advise on options for taking into account the recent genetic analysis that suggests there was a significant contribution of North American origin stocks to historical mixed-stock fisheries in Faroese waters for the provision of catch advice

In the context of this question, NASCO has asked ICES to consider the implications of the new genetic results with regard to the factors previously identified by ICES as requiring management decisions for the finalization of the risk framework for the provision of catch advice for the Faroes fishery (i.e. annual or seasonal catch advice, sharing arrangement, choice of management units to consider, and specified management objectives).

10.1.10.1 New estimates of the composition of the Faroes catch

A number of studies have indicated that some North American salmon migrate to the northeast Atlantic and that North American fish were caught in the Faroes fishery when it operated in the 1970s and 1980s. ICES (2007) reported the recapture in the Faroes fishery of about six salmon tagged as smolts in Canada in the 1970s and 1980s. It is difficult to use these results to estimate the proportion of North American fish in the total Faroes catch because of differences in tagging programmes in different countries, but they suggested that few North American fish were caught at the Faroes at that time. Based on the recapture of 87 salmon tagged in the Faroes fishery area between November 1992 and March 1995, Hansen and Jacobsen (2003) estimated that 6.9% (95% Cl – 1.6% to 13.6%) of all the tagged fish originated from Canada. Tucker *et al.* (1999) measured the ^{137}Cs concentrations in adult salmon that had returned to the St. Marguerite River, Canada, and found that 43% of the samples had concentrations characteristic of the Faroe, Norwegian, North, and Irish seas. However, these results do not provide a clear basis for estimating the contribution of North American fish to the Faroes catches.

Genetic analysis of scale samples collected at the Faroes has provided new information on the stock composition of salmon catches in the area. DNA was extracted from 656 scale samples (87 1SW and 487 MSW non-farm origin fish and 82 farmed escapees), collected during the 1993/94 and 1994/95 research fisheries and analysed against the genetic baseline of European salmon developed during the EU SALSEA–Merge project (Anon., 2011b).

A total of 105 fish (5 1SW and 100 MSW non-farm origin fish) were identified as probably being of North American origin, 61 using unique alleles at the SsaD486 microsatellite locus (and confirmed by exclusion analysis) and 44 by exclusion analysis alone (Vasemägi *et al.,* 2001). These results were confirmed by cluster analysis (Pritchard *et al.,* 2000; Jombart and Ahmed, 2011) and by conformation analysis. North American fish therefore accounted for 5.7% of the 1SW non-farmed origin fish overall, but were only identified in February 1994, in which month they accounted for 11.9% of the non-farmed origin 1SW fish in the samples. However, in most months the samples of 1SW fish were very small and so the results provide no clear evidence of any seasonal trend in the proportion of North American fish in the catches. MSW North American fish accounted for 20.5% of all MSW non-farmed origin fish in the samples, with the percentages varying between 11.1% in March 1994 and 29.9% in February 1995 (Figure 10.1.10.1). This partly reflected a difference in the proportions between the two fishing seasons, with 14.5% of the samples being identified as North American in the 1993/94 season compared to 25.6% in the 1994/95 season. There was no consistent seasonal trend in the estimated proportion of North American fish in the catches at Faroes and so the overall percentages for 1SW (5.7%) and MSW (20.5%) salmon have been used in subsequent analyses.

After the putative North American fish were removed from the analysis, the composition of the European component was investigated using the remaining 551 fish (82 1SW and 387 MSW non-farmed origin and 82 farmed). Individual genetic assignments of the EU fish were performed using the Bayesian assignment method implemented in the GENECLASS2 software package (Rannala and Mountain, 1997; Piry *et al*., 2004), and mixed-stock analysis was undertaken using the conditional maximum likelihood method as implemented in the ONCOR software package (Millar, 1987; Kalinowski *et al*., 2007). These methods were both used to assign fish to four hierarchical levels of regional assignment units (RAUs). At the broad geographical scale (Level 1), there were three RUAs, namely, Iceland, Northern Europe, and Southern Europe, while at the finest supportable scale (Level 4), 17 RAUs could be distinguished (Gilbey *et al.,* submitted).

At Level 1, 89.3% of the 1SW wild European fish (n = 82) were assigned to Southern Europe, 9.5% to Northern Europe, and 1.2% to Iceland using the ONCOR analysis. The number of 1SW fish in each monthly sample was ≤ 7 except in February 1994 (n = 31) and December 1994 (n = 37); in these months 94% and 89%, respectively, of the samples were assigned to Southern Europe (by GENECLASS2). The data therefore provide no evidence of any change in the proportion of Northern and Southern European fish through the season.

The Level 1 ONCOR assignment of the MSW non-farmed origin European salmon showed a decreasing trend in the proportion of Southern European fish and an increasing trend in the proportion of Northern European fish over the course of the 1993/94 and the 1994/95 seasons (Figure 10.1.10.2). For the two seasons combined the mean estimate of the proportion of Southern European fish declined from 55.8% in November to 15.4% in March, while the proportion of Northern European fish increased from 43.3% in November to 84.6% in March, with a clear trend in the stock composition during the course of the fishing season. Icelandic MSW fish were only identified (by GENECLASS2 analysis) in November (1%) and December (3%) samples. In view of this, the overall monthly results for the two seasons combined were used in the subsequent analysis.

The geographic areas covered by the Level 3 and Level 4 RAUs (Figure 10.1.12.1) do not align closely with the national/regional areas used by ICES for the assessment of pre-fishery abundance (PFA) and the provision of catch advice (ICES, 2014a) and in some areas the RAUs overlap geographically (e.g. in UK and Ireland). In addition, the sample sizes for some groups in the genetic analysis were very small (e.g. 1SW fish from Northern Europe). It is therefore not possible to use the genetic results to estimate the composition of the Faroes catch based on the PFA assessment areas. However, an approximate comparison suggests that the genetic assignment proportions broadly match the relative estimates of PFA within the assessment areas.

The scale samples analysed in this study were collected in November, December, February, and March. This did not reflect the full seasonal extent of the Faroes commercial fishery, which generally operated from November until at least April. The fishery followed a similar pattern each year, with catches increasing from November to December and then again from January to February, before declining towards the end of the fishing season. The genetic assignments provide no evidence that the proportion of the Faroes 1SW catch originating from Southern Europe, Northern Europe, and Iceland changed over the course of the season and so the proportions derived from the ONCOR analysis were combined with the proportion from North America to give an overall 1SW stock composition of: 84.2% Southern European, 9.0% Northern Europe, 1.2% Icelandic, and 5.7% North American (Table 10.1.10.1).

As there was a temporal trend in the genetic assignment proportions to Northern and Southern Europe for the samples from non-farmed origin MSW salmon (Figure 10.1.10.2), the monthly proportions (for the 1993/94 and 1994/95 seasons combined) therefore have to be applied to the average seasonal breakdown of the MSW catch for the 1983/84 to 1990/91 commercial fishery seasons to estimate the overall composition for the MSW catch. The genetic assignments for November and December samples have been applied to the commercial catches for the same months, the February samples to the catches in January and February, and the March samples to the catches between March and the end of the fishing season. This provides an estimate of the overall composition of the MSW catch of: 20.9% Southern European, 58.0% Northern Europe, 0.6% Icelandic, and 20.5% North American (Table 10.1.10.2).

As indicated above, it is not possible to use the genetic assignments at Levels 3 and 4 to estimate the composition of the catches to country/regional level, but they suggest that the composition within the stock complexes is broadly similar to the relative proportions of the PFA estimates and so the breakdown of catches at this level can be made by applying the relative proportions of PFA.

Uncertainty in the estimates

While the new genetic results are thought to provide the best available data on the contribution of North American salmon to the Faroes fishery, it is important to note the following uncertainties:

1. The samples were collected more than 20 years ago. Since that time there has been a substantial change in the proportions of North American and European fish in the catches at West Greenland, with the proportion from North America increasing from around 60% in the early 1990s to

over 80% in recent years. There may have been similar changes, in either direction, in the proportions migrating to the Northeast Atlantic.

2. A significant proportion of the fish sampled from the Faroes fishery are thought to have been fish farm escapees, based on scale reading using the method of Hansen *et al.* (1999). It might have been expected that the genetic analysis would assign these fish to Norwegian regions, the area from which many farmed stocks originated, but while none of these fish was identified as being of North American origin, 25% were assigned to Southern Europe. This may be because there were no farmed fish samples in the baseline used in the genetic analysis, but it could also indicate errors in the identification of farm escapees.
3. The samples were collected from a research fishery. The vessels that were fishing had previously operated in the commercial fishery and there should not have been any differences in the fishing methods used, but this cannot be discounted entirely.
4. Scales have only been analysed from two seasons in the 1990s. Between 11% and 30% of the samples from eight months were identified as North American, but it is possible that these were not representative years.
5. The new results suggest that the overall exploitation rate on the North American stock may have been similar to that on the Northern European stock complex and considerably higher than that on the Southern European stock complex. This is a surprising finding which requires further validation.

There has been some independent confirmation of the genetic identification of North American fish; four of the fish tagged in the fishery and recaptured in North America were included in the genetic analysis and were identified as North American. The DNA samples identified as being North American have been sent to a Canadian laboratory to be run against a North American baseline; this work has not yet been completed.

While the continent of origin of these samples requires further confirmation, ICES agreed that the result provided the best available estimate of the proportion of North American fish that might be caught in a fishery at the Faroes. The remainder of this section is based on the assumption that significant numbers of North American fish may be vulnerable to a fishery at the Faroes. If the Faroes fishery re-opens, it is important that new samples should be collected and genetically analysed against both European and North American baselines.

10.1.10.2 Options and implications of using the new genetic results

In the context of the ICES advice to NASCO, the presence of North American fish in the Faroes catches has implications for the assessment of PFA of both NEAC and NAC stocks and the provision of catch advice for the Faroes fishery.

PFA assessment for NEAC

ICES (2012a) has previously estimated that none of the 1SW salmon, but 2.5% of the MSW salmon caught in the Faroes fishery originated from North America. Therefore, since 2012, the MSW catch figures have been reduced by 2.5% before estimating the PFA of European stocks and developing catch advice for the Faroes fishery. Based on the results of the new genetic studies these proportions have been increased to 5.7% and 20.5% for 1SW and MSW salmon, respectively. This has reduced the estimated catch of European stocks in the fishery and, as a consequence, reduced the estimated PFA of non-maturing 1SW salmon in the NEAC area by up to about 2% in the early 1980s when the Faroes fishery was at its height. As the fishery has not operated since 2001, PFA estimates for the years since then will not have been affected.

PFA assessment for NAC

The Working Group does not currently take into account the catch of North American fish in the Faroes fishery when estimating the PFA of North American stocks. If 5.7% of the 1SW fish and 20.5% of the MSW fish caught at the Faroes were North American, it would mean that an average of 270 1SW and 23 700 MSW North American fish were caught each season between 1983/84 and 1990/91. Including these data in the stock assessment would increase the estimated PFA of maturing 1SW North American salmon by an average of about 330 fish per year between 1984 and 1995, and the estimated PFA of non-maturing 1SW

North American salmon by an average of 28 800 fish per year between 1983 and 1994. As the Faroes fishery has not operated since 2001, the PFA estimates since that time would not have been affected.

10.1.10.3 NEAC catch options

ICES has previously proposed a framework for the provision of catch advice for the Faroes fishery and used this to provide advice in 2013; ICES has applied the same approach in the present advice. ICES (2011, 2012a, 2013, 2014a) also noted that NASCO would need to agree upon the following issues before the risk framework could be formally adopted:

- choice of management units (MUs);
- specification of management objectives;
- share arrangement for the Faroes fishery; and
- season to which any TAC should apply (January to December or October to May).

NASCO has asked ICES to comment on the implications of the new genetic results with regard to these factors.

Choice of management units

The stock complexes previously used for the provision of NEAC catch advice (Southern NEAC and Northern NEAC) are significantly larger than each of the six management units used for North American salmon (2SW only) in the catch advice for the West Greenland fishery, and ICES (2010b) has advised that the NEAC catch advice should ideally be based on smaller management units. ICES (2012a) proposed a method to estimate the stock composition of the Faroes catch at a national level based on tag returns and the PFA estimates, and was thereby able to run the risk framework using management units based on countries as well stock complexes. The new genetics results are thought to provide improved estimates of the composition of European stocks in the Faroes catches and also indicate that the contribution of North American fish may be greater than for many European countries. The options for taking this new information into account are:

a) Continue using only NEAC MUs in the risk framework

In this case, the estimated catch of North American salmon would be removed from each TAC option, and the estimated catches of salmon from European stock complexes or countries would be reduced overall because of the increased North American component. There have also been some changes in the relative proportions among the European management units (complexes or countries) such that the estimated catches from individual management units may go up or down. Thus, while the overall estimated impact of a Faroes TAC on European stocks may be expected to decrease as a result of the new genetic results, the effects on individual management units (complexes or countries) may increase or decrease.

If North American salmon were not included in the risk framework, the status of North American stocks could still be taken into account as independent information influencing the overall catch advice.

b) Add North America as a single 'region' in the risk framework

North America could be added to the NEAC risk framework as a single region with one (MSW only) or two (1SW and MSW) additional management units. Only MSW salmon (non-maturing 1SW PFA) are considered in the West Greenland risk framework, and this may also be appropriate for NEAC, where the catch of 1SW North American fish appears to be very small. PFA forecasts for North America could be included in the risk assessment in the same way as for the NEAC management units (see Section 10.2, Table 10.2.1), and the advice could be provided in the same format with an additional column for North America.

c) Adding six North American 'regions' in the risk framework

This option is similar to option 'b', but the North American stocks would be split into the six management units currently used for the West Greenland catch advice. This would result in six additional management units if only MSW stocks were included and 12 additional management units if both 1SW and MSW stocks were included, although not all regions would have to be included if it was found that North American salmon from some regions do not migrate to the Faroes area. The West Greenland catch advice is based only on the MSW management units, and as the catches of 1SW at the Faroes appear to be very small, the same may be appropriate for the Faroes catch advice. The average size of these management units would be similar to the size of the Icelandic management units and larger than the management units for France, Sweden, and UK (Northern Ireland), although some North American management units are very small (e.g. USA).

ICES has previously advised that it is desirable to go down to country/region level. However, at present there is very limited information on the proportions of the North American fish caught at Faroes originating from the different management units, and it would not be appropriate to adopt this option before more information is obtained on the North American fish found in the Faroes area. It is hoped that the planned genetic analysis of the Faroes samples against a North American genetic baseline will begin to provide such information. ICES therefore considers that option (b) may be the most appropriate at the current time.

Specification of management objectives

The management objectives provide the basis for determining the risks to stocks in each management unit associated with different TAC options in the Faroes fishery. ICES currently provides catch option tables showing the probabilities of each management unit meeting or exceeding its spawner escapement reserve (SER) individually and the probability of simultaneous attainment of this management objective within all of the management units (ICES, 2013). ICES recommendation is that management decisions are based principally on a 95% probability of attainment of SERs in each management unit (stock complex or country) individually. If North American management units were added to the Faroes risk framework the same management objective could be applied to each management unit. If North American stocks were included as a single stock complex, this could be based on the sum of the CLs for the four northern regions and the rebuilding requirements for USA and Scotia–Fundy, or using an alternative approach.

Share allocation for the Faroes fishery

The Faroes 'sharing allocation' establishes the proportion of any harvestable surplus within the NEAC area that could be made available to the Faroes fishery through the TAC. Thus for any TAC option being evaluated for the Faroes, the risk assessment is based on the total combined harvest (Faroes plus home-water fisheries) being equal to the TAC divided by the Faroes share. This approach assumes that homewater countries then have the option to manage exploitation of individual river stocks on the basis of their status. The share allocation has to be determined before the catch advice is developed in order that the current risk framework can be run.

ICES previously proposed that the share allocation could be derived using the same approach as for West Greenland, where the allocation (0.4) is based on the proportion of the total harvest of North American fish that was taken at West Greenland between 1986 and 1990. There is no biological basis for this choice, and European stocks/fisheries were not taken into account in setting this share agreement, although the status of European stocks is taken into account in the catch advice.

ICES (2010b) proposed using the same approach and baseline period to establish the share allocation for the Faroes fishery. This gave a potential share allocation of 0.075 to the Faroes, being the proportion of the total harvest of European fish that was taken at the Faroes between 1986 and 1990. Following discussion within NASCO, one Party proposed an alternative baseline period of 1984–1988, which would give a share allocation of 0.084 to the Faroes; in the absence of further advice from NASCO, ICES used this value (ICES, 2012a, 2013). The calculation of the share agreement on this basis (i.e. excluding North American fish) would not be affected by the new genetic results.

If one or more North American management units was included in the NEAC risk framework, the share agreement could continue to be based only on NEAC stocks (in a similar way to West Greenland) or it could be calculated based on the share of the total catch of salmon from all management units that was taken at Faroes during a reference period. Alternatively, two share allocations could be agreed, with the 'expected' total harvest of North American and European fish under any TAC calculated separately before the risk analysis was conducted, or another approach might be used.

Season to which any TAC should apply

The Faroes fishery has historically operated between October/November and May/June, but the historical TACs applied to a calendar year. This means that two different cohorts of salmon of each age class were exploited under each TAC. ICES (2011) recommended that NASCO manage any fishery on the basis of fishing seasons (i.e. October to June) and that catch advice should be provided on this basis. The new genetic results have no implications for this decision.

10.1.11 NASCO has asked ICES to advise on what data would enhance the development of the NEAC catch options

10.1.11.1 Modelling approach for the catch options risk framework

The model for assessing catch options for the Faroes fishery relies on assessment of the biological characteristics of a catch that would occur at the Faroes consequent on the allocation of a given TAC. The TAC option (tonnes) is converted to numbers of fish using the mean weights of salmon caught in the Faroes fishery and then converted to numbers of wild fish, using an estimate of the proportion of fish farm escapees in the catch. Numbers by sea-age class (1SW and MSW) are estimated according to the proportion of each age group observed in historical catch sampling programmes at the Faroes. In the past, there has also been a requirement to discard any fish less than 60 cm total length caught in the Faroes fishery. The proportion of the 1SW catch subsequently discarded is derived from historical surveys and, as 80% of these fish were estimated to die (ICES, 1986), these mortalities are included as fishery losses. Finally, the 1SW fishery losses are reduced to take account of the proportion that will not mature as 1SW fish (Youngson and Webb, 1993). The survivors from this group are accounted for in the MSW fish taken in the following year.

This derived catch, by sea-age group, is allocated to management units (currently individual countries or country aggregations) based on genetic analysis of historical scale samples of the Faroes fishery and relative PFA. For each management unit, the catch is raised by the Faroes share allocation to give the total potential harvest of fish. Harvests are adjusted for natural mortality and subtracted from the stock forecasts, which are then compared with the spawner escapement reserves to evaluate attainment of the management objective.

10.1.11.2 Derivation of parameters currently used to characterize the Faroes fishery

The data used to determine the biological characteristics of the Faroes fishery are largely taken from sampling programmes conducted in commercial and research fisheries in Faroese waters in the 1980s and 1990s (Table 10.1.11.1). Improvements to these data may be possible by subjecting existing samples to techniques not available when the samples were originally analysed. Thus, for example, as genetic analyses are being used to provide more reliable estimates of the stock composition of the catch, it may also be also possible to use such techniques to estimate the proportion of fish farm escapees in the catch.

Improvements to parameter estimates could also be achieved by collecting contemporary data to reliably characterize a possible future fishery. In addition, the value of such a programme would be to test the extent to which contemporary samples fall within the range already seen in the historical data. Such a sampling programme should be designed to adequately cover the spatial and temporal range likely to be found in a commercial fishery. Fishing methods, including vessel and gear specifications, should also be consistent with the methods used in a commercial fishery.

10.1.11.3 Derivation of parameters currently used to assess the status of stocks

The allocation of a TAC depends upon the management objectives being met for relevant management units. In general, the run-reconstruction and forecast models used to estimate stock abundance in the NEAC area rely on reported catch raised by estimates of unreported catch and exploitation rates to provide estimates of the numbers of fish returning to home waters and subsequently escaping to spawn. Estimates of lagged eggs, derived from estimates of sex ratio, fecundity, and smolt ages, provide PFA forecasts used in the catch advice.

In this regard, improvements to the estimation of these data inputs and parameters would enhance the advice which ICES is able to provide. Similarly, improvements might be expected from developments in the modelling process, which would reduce the dependence on reported catch data by allowing the integration of more reliable abundance indicators, such as counter and trap data, where available.

With respect to biological reference points, increasing the number of countries able to provide river-specific CLs and thus reducing the reliance on the 'pseudo' stock–recruitment relationships currently used would increase the reliability of the advice provided by ICES.

10.1.11.4 Estimates of natural marine mortality

Estimates of natural marine mortality (M) are used to raise estimates of home-water returns to PFA in both the run-reconstruction and forecast models. Currently, a constant marine mortality rate (0.03 per month) is used both throughout the time-series and throughout the period after the first sea winter. Estimates of marine mortality which more accurately characterize variation over the time-series or partition mortality through the migration would also enhance the advice which ICES is able to provide.

10.1.12 NASCO has asked ICES to estimate catches by stock origin and describe their spatial and temporal distribution, considering the available contemporary data on stock origin of salmon in various mixed-stock fisheries

ICES was asked to consider the available contemporary data on stock origin of salmon, to estimate the catches by stock origin, and to describe the spatial and temporal distribution of salmon from the Labrador subsistence fisheries as well as for the fisheries in Saint Pierre and Miquelon (SPM) and at West Greenland. The Labrador and SPM fisheries are of relevance to stocks in the NAC area, while the West Greenland fishery exploits fish from both NAC and NEAC areas.

Recent genetic stock identification efforts provide an opportunity to identify the origin of North American salmon caught in the Labrador and SPM fisheries, and of both North American and European Atlantic salmon sampled from the fishery at West Greenland. The stock composition and variation in composition of salmon harvested in these mixed-stock fisheries has been determined based on a recently developed North American genetic baseline for Atlantic salmon, which allows assignment to regional reporting groups (Bradbury *et al.*, 2014a; Moore *et al.*, 2014), and a similar baseline for European origin salmon (Gilbey *et al.*, submitted). For North America, twelve regional groups can be reliably identified using 15 microsatellite loci (Figure 10.1.12.1) and these largely approximate regional clusters identified in landscape analyses of population structure (Dionne *et al.*, 2008; Bradbury *et al.*, 2014b). For Europe, 14 regional groups can be reliably identified (Figure 10.1.12.1).

For the North American samples, assignment to the 12 reporting groups was based on mixture analysis using the Bayesian mixture model from Pella and Masuda (2001) as implemented in cBAYES (Neaves *et al.*, 2005). The accuracy of assignment (94.5%) in these analyses was very high. The power of the baseline to resolve rare contributions was examined using simulations; accurate estimation of the rare stock contributions was possible when these represented from 0.5% to 1.0% and above. For the European samples, regional assignments were made using the GENECLASS2 individual assignment algorithm (Piry *et al.,* 2004). In both NAC and NEAC, the regional groups from the genetic assignments do not correspond directly to the regions used by ICES to characterize stock status and to provide catch advice.

10.1.12.1 Labrador fishery origin and composition of the catches

Tissue samples from salmon sampled from the Labrador subsistence fisheries during 2006 to 2014 were genetically typed to the twelve regional groups. The estimated proportional contributions of the twelve groups based on combined samples for 2006 to 2011 and for 2012 to 2014 are shown in Table 10.1.12.1.

The Labrador Central (LAB) regional group represents the majority (almost 92–96%) of the salmon caught in the Labrador subsistence fishery, with minor contributions from all the other regional groups (Table 10.1.12.1; Bradbury *et al.*, 2014a). Raised to estimated catches of salmon in 2012 to 2014, the Central Labrador regional group represented 96% of the catch, followed by Ungava/Northern Labrador (UNG), Quebec/Labrador South (QLS), and Newfoundland (NFL) at about 1% each (Table 10.1.12.2). No USA origin salmon were identified in the mixed-stock analysis of samples from 2012 to 2014 and raised catches for those years are essentially zero. However, Bradbury *et al.* (2014a) previously reported the presence of USA origin salmon in the samples from the fisheries in 2006 to 2011 with raised harvest estimates of 30 to 40 fish per year. The annual catch estimates differ somewhat if annual sampling results are used (as opposed to aggregated results); because of the smaller annual sample sizes the estimates of raised catches are more uncertain.

10.1.12.2 Saint Pierre and Miquelon (SPM) fishery origin and composition of the catches

Sampling of the salmon catches was conducted in 2004, 2011, 2013, and 2014. The number of tissue samples collected for these years was 138, 73, 71, and 71, respectively, for a total of 353 individual samples over the four years. Estimates of stock composition showed consistent dominance of three regions: Gulf of St. Lawrence, Gaspé Peninsula, and Newfoundland (Figure 10.1.12.2).

Raised to estimated catches of salmon in 2004 to 2014, the origin of the catches at SPM is dominated by three regional groups: Gulf of St. Lawrence (GUL) at 38%, Quebec (GAS, QUE) at 32% and Newfoundland (NFL) at 24% (Table 10.1.12.3). The Scotia-Fundy area of Canada has comprised about 3% of the catch, on average, whereas salmon of US origin have not occurred in the fishery. The annual values differ somewhat if annual sampling results are used because of the smaller annual sample sizes and the estimates of raised catches are more uncertain.

ICES welcomed the analysis of the catches at SPM which has addressed gaps identified in the previous sampling activities (ICES, 2011, 2012a). The ongoing collaboration between French and Canadian researchers was encouraged to ensure that adequate samples are collected and that the North American genetic baseline is used in the analysis of these samples. Continued analysis of additional years will be informative of the characteristics of the salmon age and size structure, the origin of the fish, and variation in the stock-specific characteristics of the catches.

10.1.12.3 West Greenland fishery origin and composition of the catches

Continent of origin spatial and temporal distribution

Continent of origin contributions to the West Greenland fishery vary annually, but have generally increased for North America over the time-series (1982–2014). Mean North American contributions have increased from 52% in the 1980s to 71% in the 1990s, on to 74% in the 2000s and 81% since 2010. Spatial trends are difficult to discern as data are not available for all NAFO Divisions in all years due to resource limitations of the sampling programme (Figure 10.1.12.3).

There appears to be a temporal pattern of increasing European contribution to the fishery as the fishing season progresses (Figure 10.1.12.4). According to the available sample data, the European contribution to the harvest is estimated to be approximately 18% for the first month of the fishery (August) and 34% during the last month of the fishery (October). However, the beginning and end of the fishing season are characterized by low sample sizes. Caution is advised in interpreting Figure 10.1.12.4 as the results may be biased by the number of samples, the NAFO Division where the samples were collected, and the standard week when the samples were collected. Available samples are not uniformly distributed across all NAFO Divisions and standard weeks of the fishing season.

Region of origin spatial and temporal distribution

Tissue samples from salmon sampled in the West Greenland fishery were genetically typed to continent of origin and the 2011–2014 North American origin samples and the 2002 and 2004–2012 European origin samples were assessed against regional baselines.

For the North American samples, the estimated proportional contributions of each of the twelve groups for individual year samples (2011–2014) and overall (combined years) are shown in Table 10.1.12.4.

The number of salmon from each regional group in the harvest of North American origin Atlantic salmon during 2011–2014 were estimated using the mixture analysis. Three regional groups in NAC contribute the majority of the North American origin salmon in the West Greenland fishery: Quebec (UNG, QUE, GAS, ANT), Gulf of St. Lawrence (GUL), and Labrador (LAB, QLS) (Table 10.1.12.4). Smaller contributions are from Newfoundland (NFL, AVA), Scotia–Fundy (NOS, FUN), and USA. These estimates raised to estimated catches in West Greenland are shown in Table 10.1.12.5 (based on assignments for all years combined). The values differ somewhat if annual sampling results are used, but because of the smaller sample sizes annually these estimates of raised catches are more uncertain.

For the European samples, the estimated proportional contributions of each of the 14 groups for all years combined are shown in Table 10.1.12.6. More than 90% of the harvested European fish were assigned to three regions: N Scotland and N&W Ireland, Irish Sea, and S&E Scotland. The S&E Scotland region, which includes some of the east coast of England, is considerably the largest contributor to the West Greenland fishery, representing almost 40% of the European fish caught. Substantial numbers of fish were also assigned to the Irish Sea (26.6%), which are principally fish originating in English (west coast), Welsh, and Scottish (Solway) rivers, and in the large rivers of Ireland's east and south coast. The region delineated on the basis of the west and north coasts of Ireland and Scotland represents an additional 25.2% of the total. Overall, Scotland appears to be a major contributor to the fishery with almost 70% of the fish being assigned.

The number of salmon from each regional group in the harvest of European origin Atlantic salmon during the 2002 and 2004–2012 fisheries were deterministically estimated by applying both year-specific and overall contribution estimates to the estimated number of European origin fish harvested. Estimated catches based on the overall values are presented in Table 10.1.12.7. The primary contributor (S&E Scotland) contributed between 239 and 1036 fish annually. Rivers in northern Europe contributed small numbers to the harvest annually (approximately 8%); stocks from France and Spain contributed approximately 2% overall. While there is some annual variation, the contributions by regional group have not varied substantially between 2002 and 2012. As with the North American results, the annual estimates differ when using year-specific estimates versus overall estimates. Due to the smaller sample sizes of the year-specific values, the estimates of raised catches are more uncertain.

North American estimated annual regional contributions were compared in samples collected before and after 15 September; these were consistent between the two time periods. Dates of capture for the European origin samples were not available to ICES and therefore similar analysis was not possible.

10.1.13 NASCO has requested ICES to identify relevant data deficiencies, monitoring needs, and research requirements

ICES recommends that the Working Group on North Atlantic Salmon (WGNAS) should meet in 2016 (Chair: Jonathan White, Ireland) to address questions posed by ICES, including those posed by NASCO. The Working Group intends to convene at ICES Headquarters in Copenhagen, Denmark. The meeting will be held from 30 March to 8 April 2016.

List of recommendations

1) ICES recommends that sampling and supporting descriptions of the Labrador and Saint-Pierre & Miquelon mixed-stock fisheries be continued and expanded (i.e. sample size, geographic coverage, tissue samples, seasonal distribution of the samples) in future years to improve the information on biological characteristics and stock origin of salmon harvested in these mixed-stock fisheries.
2) ICES recommends that additional monitoring be considered in Labrador to better estimate salmon returns in that region.
3) ICES recommends further analysis of the data collected in 2015 from fishers in the West Greenland fishery following a phone survey, and continuation of this survey programme in future years. Information gained on the level of total catches for this fishery will provide for a more accurate assessment of the status of stocks and assessment of risk with varying levels of harvest.
4) ICES recommends that efforts to improve the Greenland catch reporting system continue and that detailed statistics related to catch and effort should be made available to the Working Group for analysis.
5) ICES recommends a continuation and expansion of the broad geographic sampling programme at West Greenland (multiple NAFO divisions including factory and non-factory landings) to

more accurately estimate continent and region of origin and biological characteristics of the mixed-stock fishery.

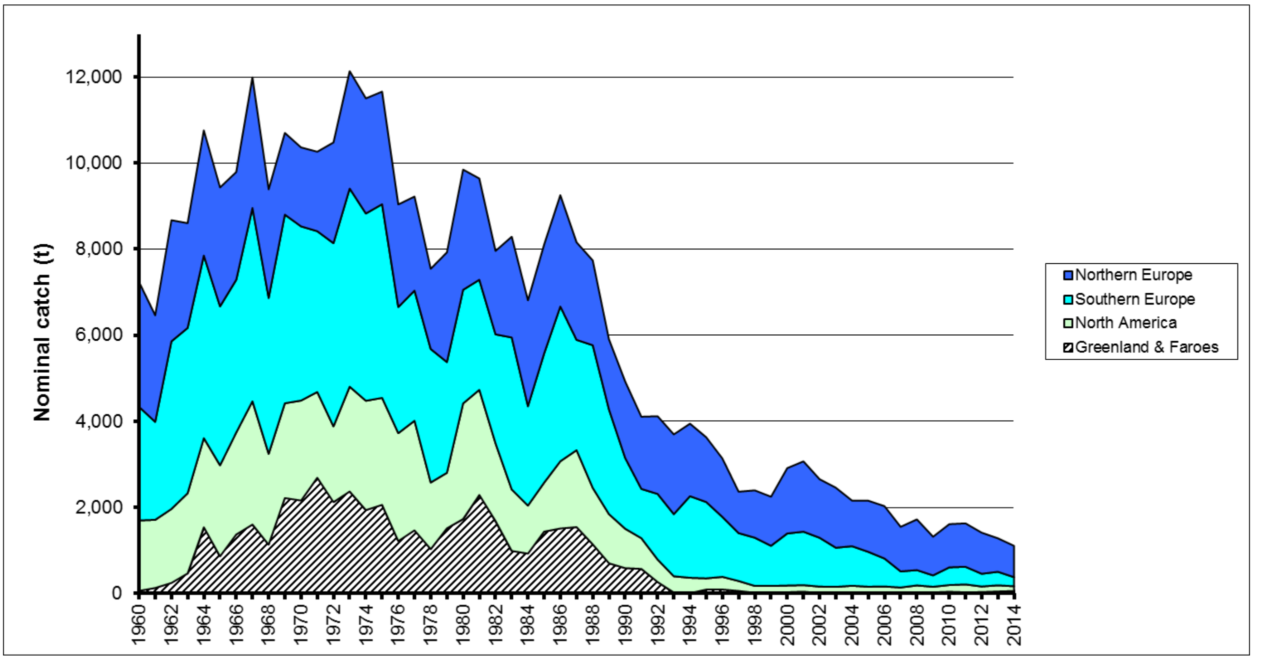

Figure 10.1.5.1 Reported total nominal catch of salmon (tonnes round fresh weight) in four North Atlantic regions, 1960 to 2014.

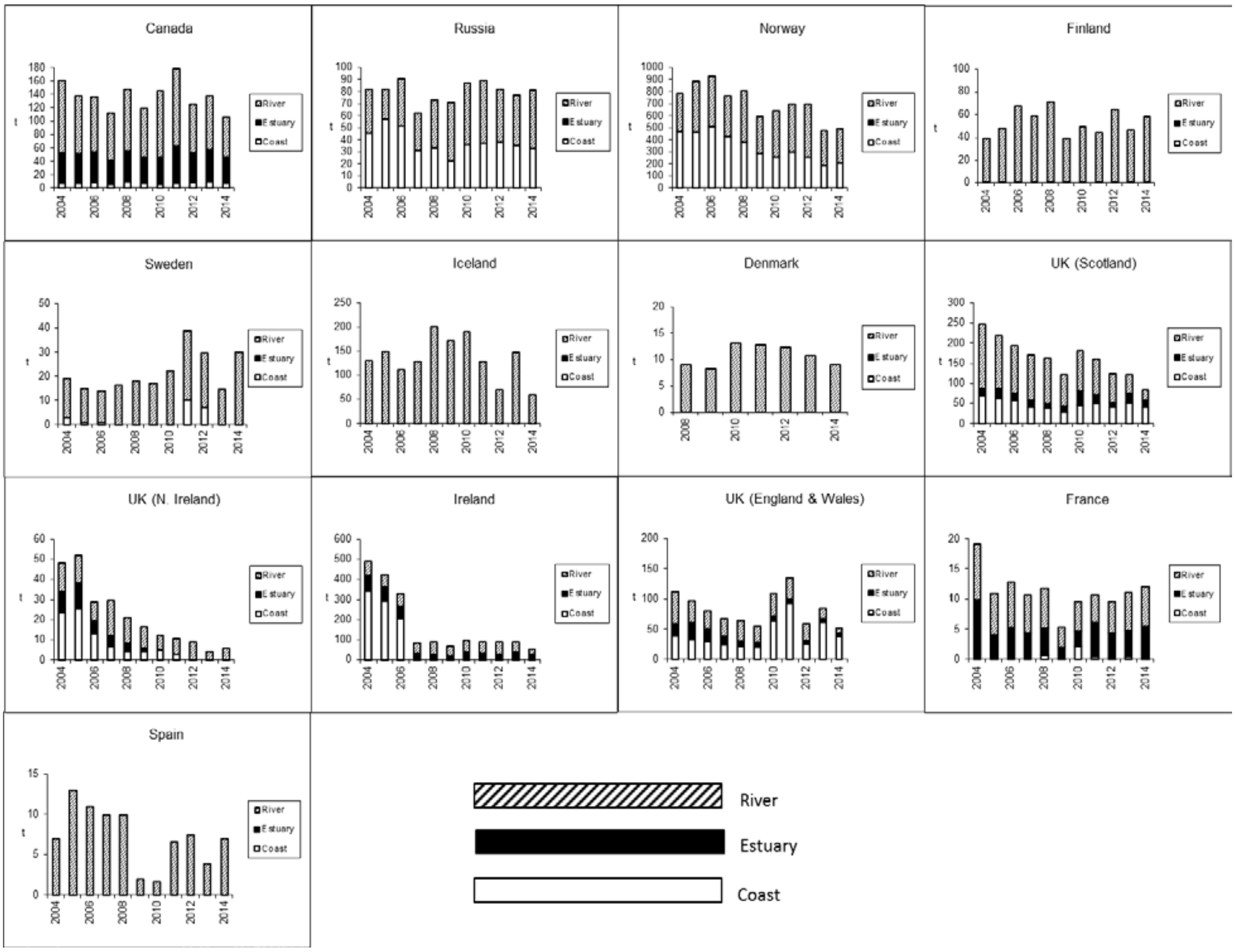

Figure 10.1.5.2 Nominal catch (t) by country taken in coastal, estuarine, and riverine fisheries, 2004–2014 (for Denmark: 2008–2014). Note that the scales on the *y*-axes vary.

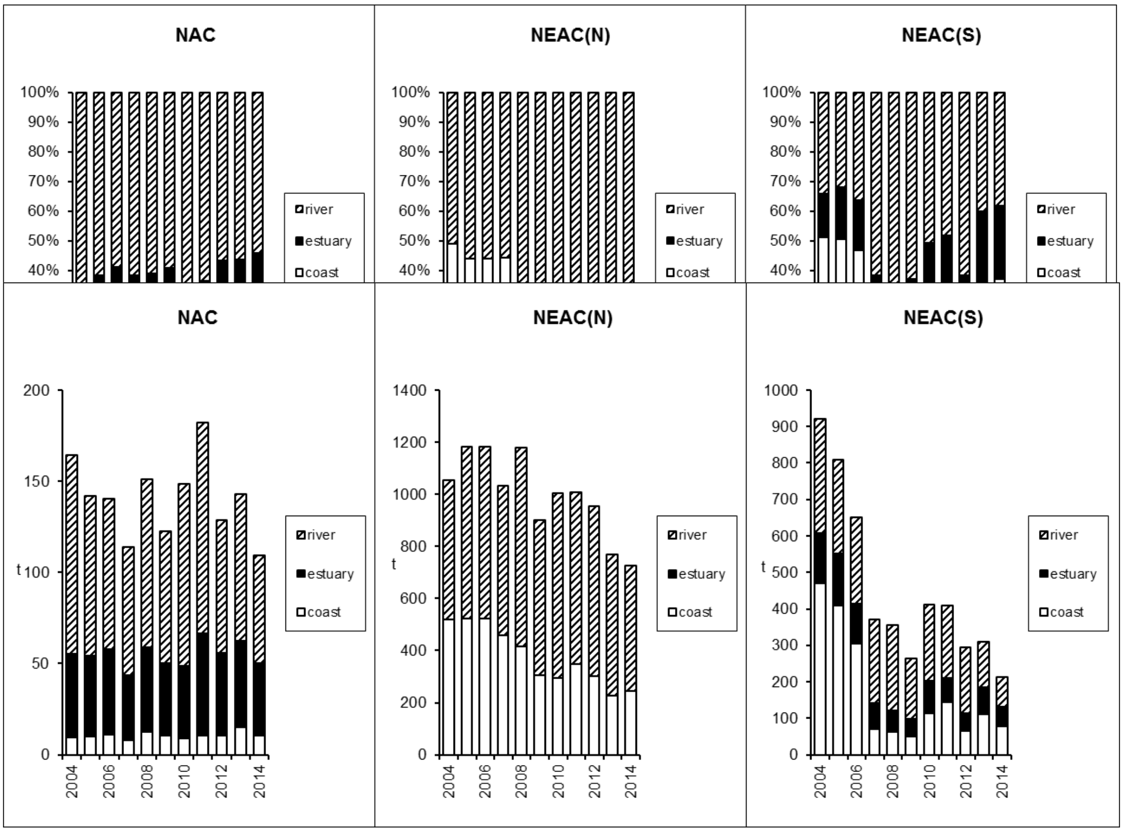

Figure 10.1.5.3 Percentages of nominal catch (top panel) and nominal catch in tonnes (bottom panel) taken in coastal, estuarine, and riverine fisheries for the NAC area, and for the Northern and Southern NEAC areas, 2004–2014. Note that the scales of the *y*-axes vary in the bottom panels.

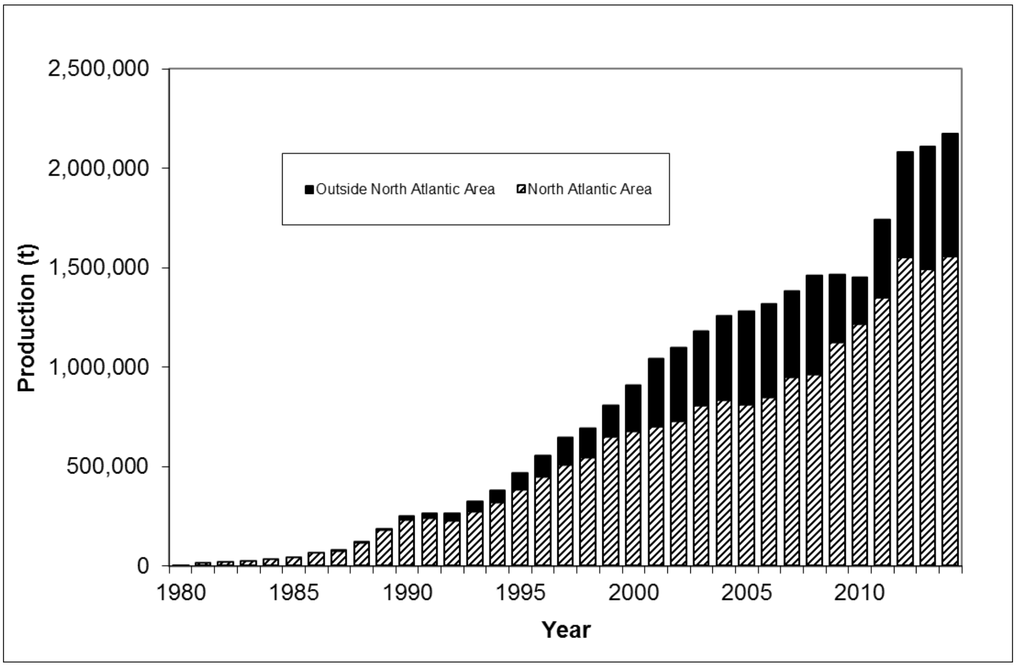

Figure 10.1.5.4 Worldwide production of farmed Atlantic salmon, 1980 to 2014.

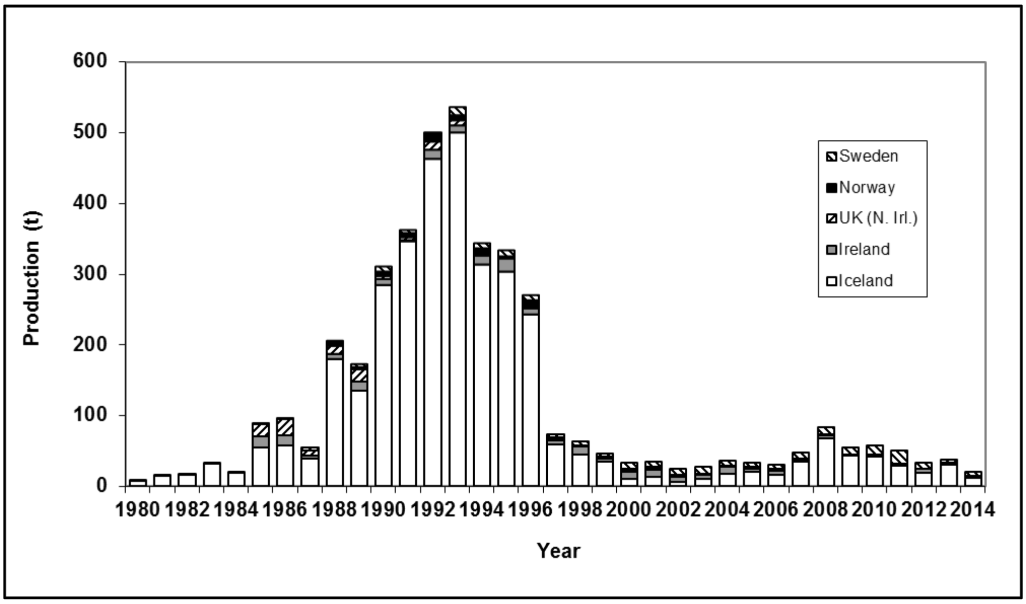

Figure 10.1.5.5 Production of ranched Atlantic salmon (tonnes round fresh weight) in the North Atlantic, 1980 to 2014.

(a)

(b)

(c)

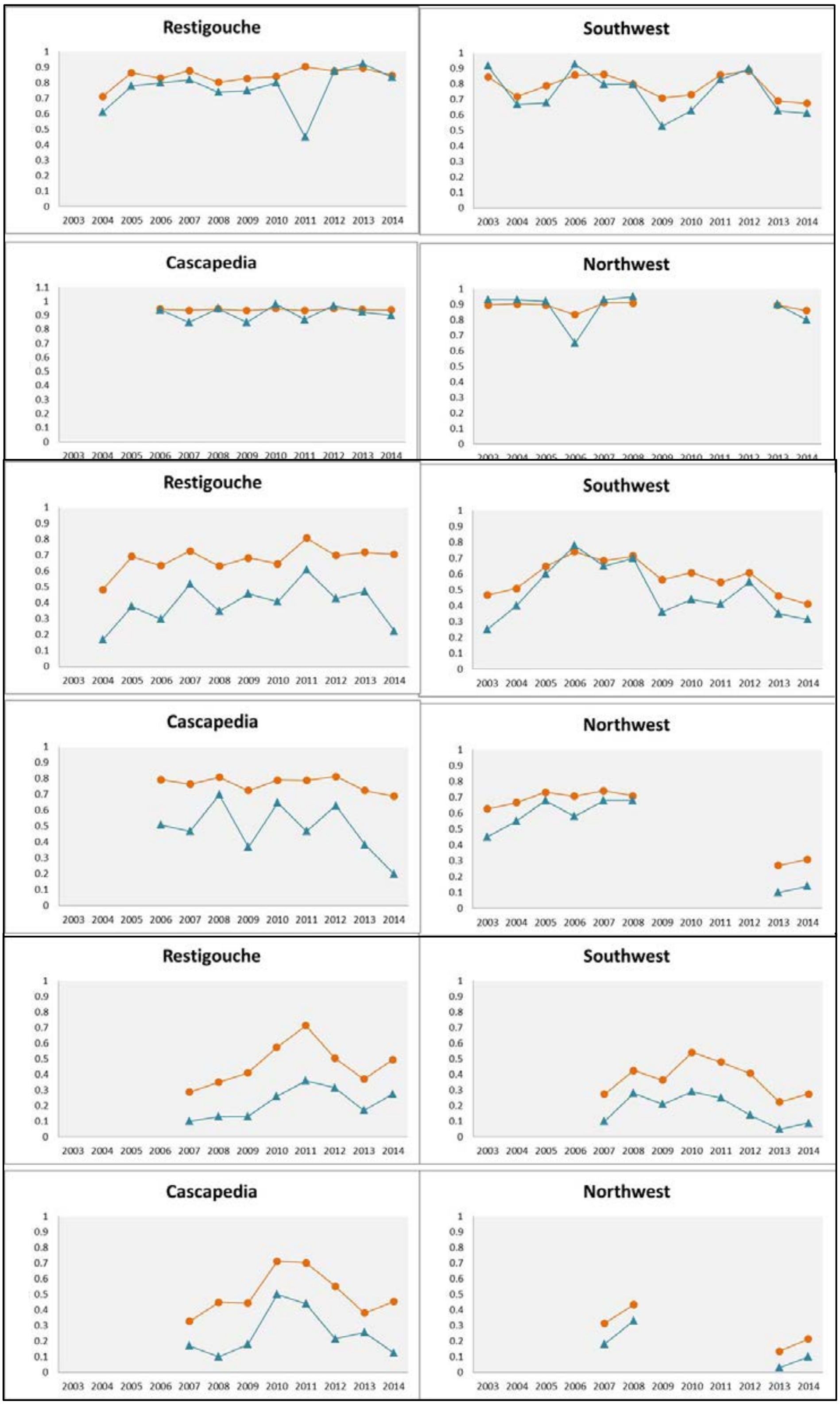

Figure 10.1.6.1 The proportion of tags detected (blue triangle) versus the estimated probability of survival (corrected for incomplete detections, orange circle) for acoustically tagged Atlantic salmon smolts from their release site to: (a – top panels) the head of tide; (b – middle panels) the exit into the Gulf of St. Lawrence; and (c – bottom panels) the Strait of Belle Isle (exit of the Gulf of St. Lawrence to the Labrador Sea).

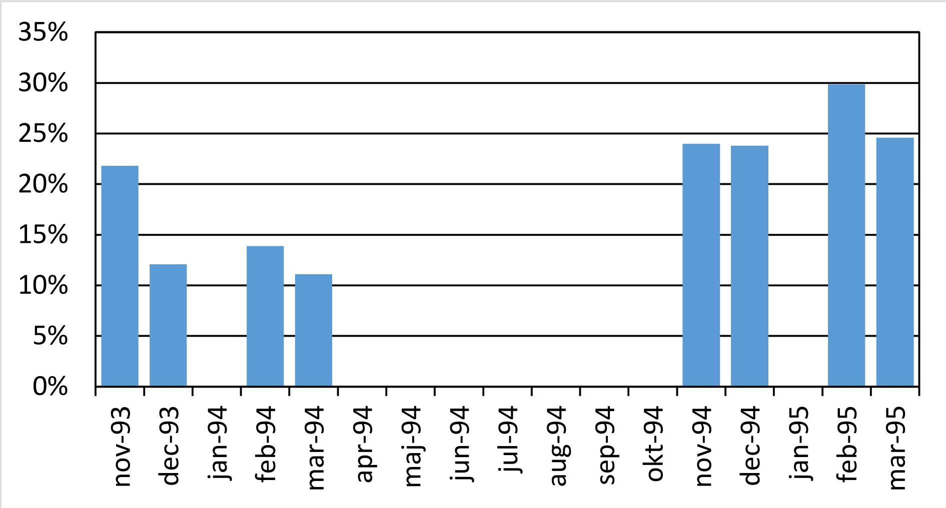

Figure 10.1.10.1 Proportion of North American fish in monthly samples of salmon scales collected from non-farmed origin MSW salmon caught in the Faroes research fishery between November 1993 and March 1995.

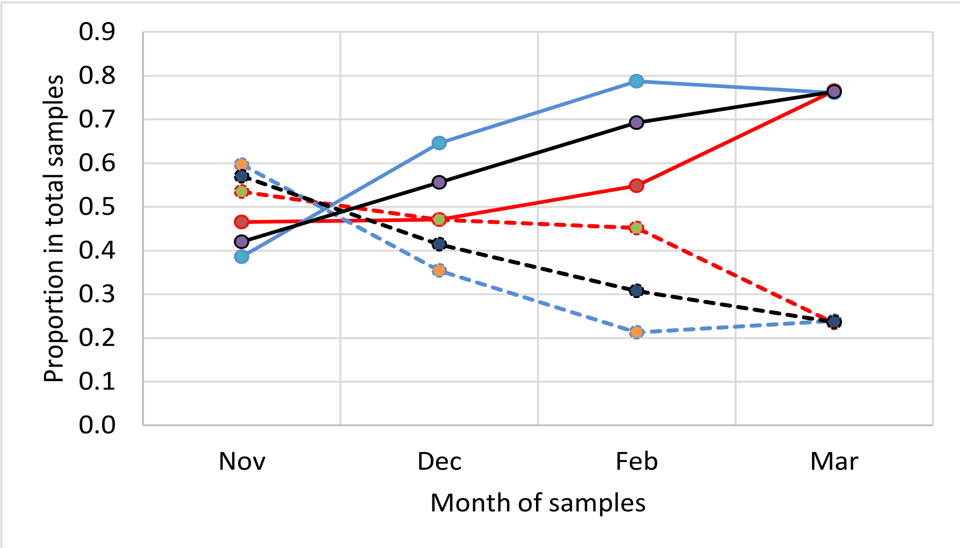

Figure 10.1.10.2 Proportions of Northern European (solid lines) and Southern European (dashed lines) salmon identified in monthly samples of scales collected from non-farmed origin MSW fish caught in the Faroes research fishery in the 1993/94 (blue line) and 1994/95 (red lines) seasons, and for both seasons combined (black lines).

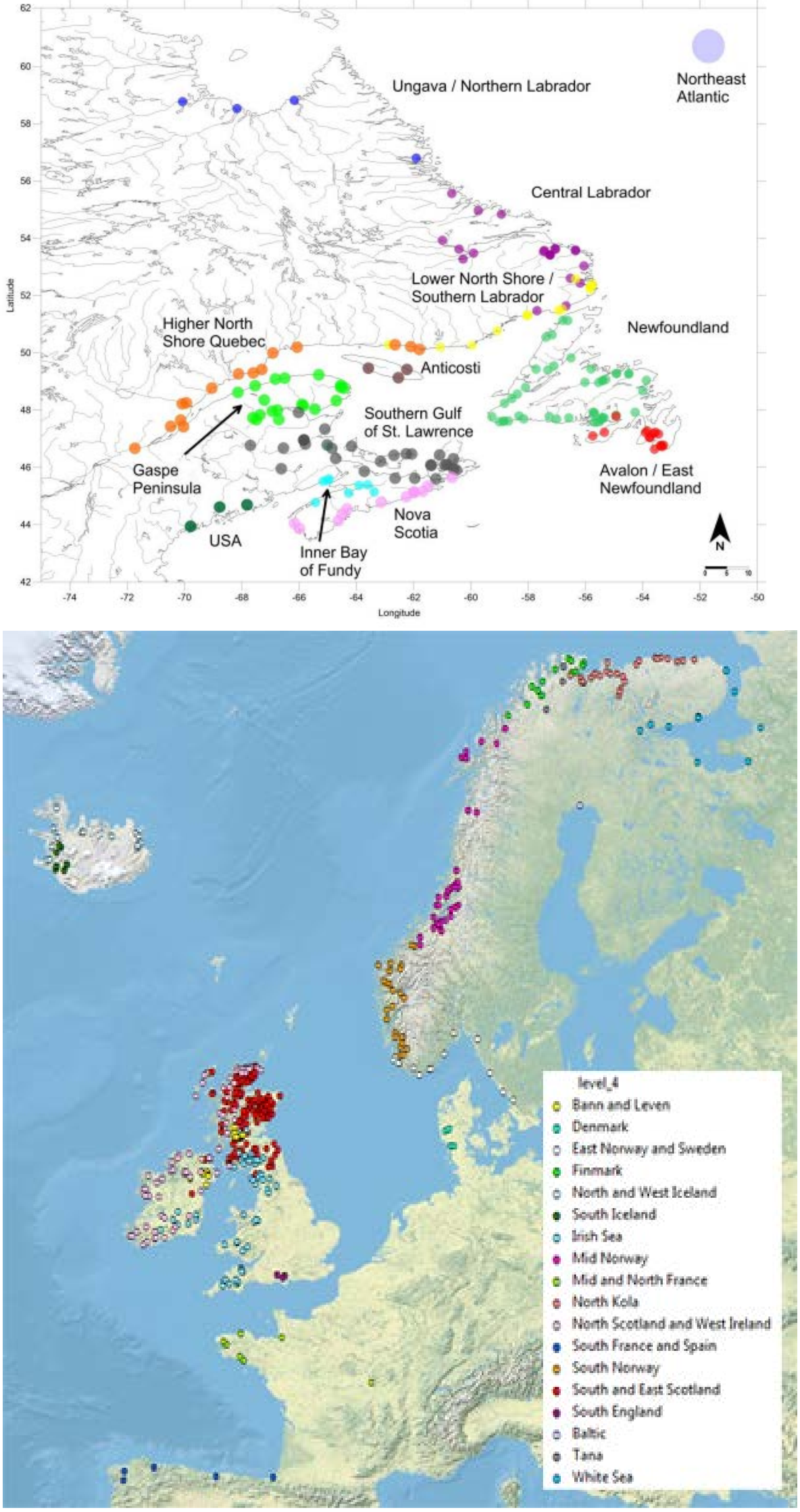

Figure 10.1.12.1 Regional assignment groups for the North American (top) and European (bottom) origin salmon.

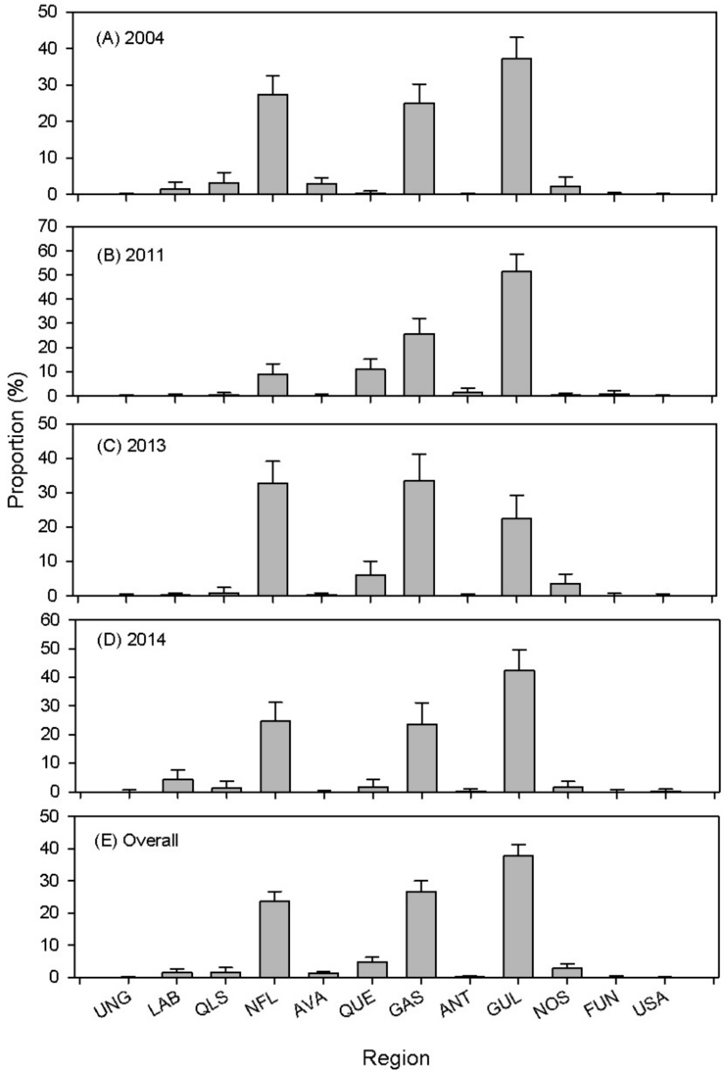

Figure 10.1.12.2 Genetic mixture estimates of composition of samples from the Saint Pierre and Miquelon Atlantic salmon fishery by year: (A) 2004, (B) 2011, (C) 2013, (D) 2014, and (E) overall. Error bars represent standard error of the estimates. Baseline locations refer to the regional assignment groups shown in Figure 10.1.12.1.

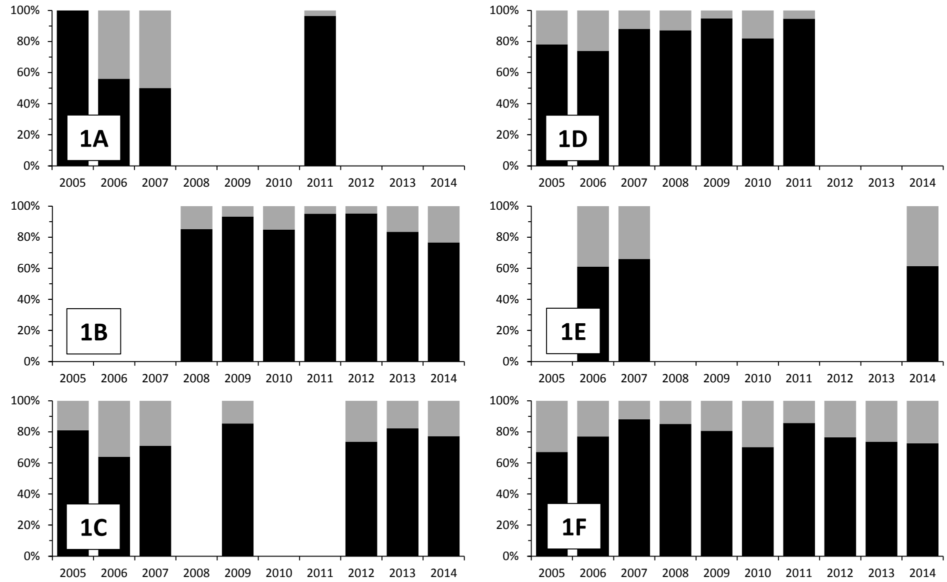

Figure 10.1.12.3 Year- and division-specific estimates of continent of origin contributions (%) to the 2005–2014 harvests in the West Greenland fishery. Data represent year and division combinations where samples are available.

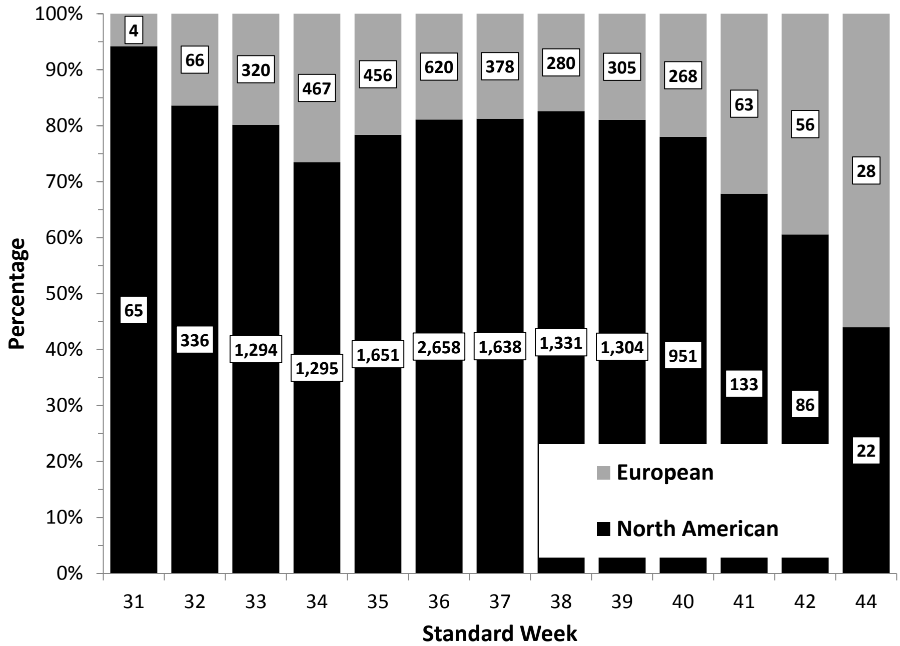

Figure 10.1.12.4 Continent of origin estimates by standard week for the 2005–2014 combined harvests at West Greenland. Sample sizes are provided in the text boxes.

Table 10.1.5.1 Reported total nominal catches of salmon by country (in tonnes round fresh weight), 1960 to 2014 (2014 figures include provisional data).

Year	NAC Area			NEAC (N. Area)								NEAC (S. Area)						Faroes & Greenland				Total	Unreported catches	
	Canada (1)	USA	St. P&M	Norway (2)	Russia (3)	Iceland Wild	Iceland Ranch (4)	Sweden Wild	Sweden Ranch (15)	Denmark	Finland	Ireland (5,6)	UK (E & W)	UK (N.Irl.) (6,7)	UK (Scotl.)	France (8)	Spain (9)	Faroes (10)	East Grld.	West Grld. (11)	Other (12)	Reported Nominal Catch	NASCO Areas (13)	International waters (14)
1960	1,636	1	-	1,659	1,100	100	-	40	0	-	-	743	283	139	1,443	-	33	-	-	60	-	7,237	-	-
1961	1,583	1	-	1,533	790	127	-	27	0	-	-	707	232	132	1,185	-	20	-	-	127	-	6,464	-	-
1962	1,719	1	-	1,935	710	125	-	45	0	-	-	1,459	318	356	1,738	-	23	-	-	244	-	8,673	-	-
1963	1,861	1	-	1,786	480	145	-	23	0	-	-	1,458	325	306	1,725	-	28	-	-	466	-	8,604	-	-
1964	2,069	1	-	2,147	590	135	-	36	0	-	-	1,617	307	377	1,907	-	34	-	-	1,539	-	10,759	-	-
1965	2,116	1	-	2,000	590	133	-	40	0	-	-	1,457	320	281	1,593	-	42	-	-	861	-	9,434	-	-
1966	2,369	1	-	1,791	570	104	2	36	0	-	-	1,238	387	287	1,595	-	42	-	-	1,370	-	9,792	-	-
1967	2,863	1	-	1,980	883	144	2	25	0	-	-	1,463	420	449	2,117	-	43	-	-	1,601	-	11,991	-	-
1968	2,111	1	-	1,514	827	161	1	20	0	-	-	1,413	282	312	1,578	-	38	5	-	1,127	403	9,793	-	-
1969	2,202	1	-	1,383	360	131	2	22	0	-	-	1,730	377	267	1,955	-	54	7	-	2,210	893	11,594	-	-
1970	2,323	1	-	1,171	448	182	13	20	0	-	-	1,787	527	297	1,392	-	45	12	-	2,146	922	11,286	-	-
1971	1,992	1	-	1,207	417	196	8	17	1	-	-	1,639	426	234	1,421	-	16	-	-	2,689	471	10,735	-	-
1972	1,759	1	-	1,578	462	245	5	17	1	-	32	1,804	442	210	1,727	34	40	9	-	2,113	486	10,965	-	-
1973	2,434	3	-	1,726	772	148	8	22	1	-	50	1,930	450	182	2,006	12	24	28	-	2,341	533	12,670	-	-
1974	2,539	1	-	1,633	709	215	10	31	1	-	76	2,128	383	184	1,628	13	16	20	-	1,917	373	11,877	-	-
1975	2,485	2	-	1,537	811	145	21	26	0	-	76	2,216	447	164	1,621	25	27	28	-	2,030	475	12,136	-	-
1976	2,506	1	3	1,530	542	216	9	20	0	-	66	1,561	208	113	1,019	9	21	40	<1	1,175	289	9,327	-	-
1977	2,545	2	-	1,488	497	123	7	9	1	-	59	1,372	345	110	1,160	19	19	40	6	1,420	192	9,414	-	-
1978	1,545	4	-	1,050	476	285	6	10	0	-	37	1,230	349	148	1,323	20	32	37	8	984	138	7,682	-	-
1979	1,287	3	-	1,831	455	219	6	11	1	-	26	1,097	261	99	1,076	10	29	119	<0,5	1,395	193	8,118	-	-
1980	2,680	6	-	1,830	664	241	8	16	1	-	34	947	360	122	1,134	30	47	536	<0,5	1,194	277	10,127	-	-
1981	2,437	6	-	1,656	463	147	16	25	1	-	44	685	493	101	1,233	20	25	1,025	<0,5	1,264	313	9,954	-	-
1982	1,798	6	-	1,348	364	130	17	24	1	-	54	993	286	132	1,092	20	10	606	<0,5	1,077	437	8,395	-	-
1983	1,424	1	3	1,550	507	166	32	27	1	-	58	1,656	429	187	1,221	16	23	678	<0,5	310	466	8,755	-	-
1984	1,112	2	3	1,623	593	139	20	39	1	-	46	829	345	78	1,013	25	18	628	<0,5	297	101	6,912	-	-
1985	1,133	2	3	1,561	659	162	55	44	1	-	49	1,595	361	98	913	22	13	566	7	864	-	8,108	-	-
1986	1,559	2	3	1,598	608	232	59	52	2	-	37	1,730	430	109	1,271	28	27	530	19	960	-	9,255	315	-
1987	1,784	1	2	1,385	564	181	40	43	4	-	49	1,239	302	56	922	27	18	576	<0,5	966	-	8,159	2,788	-
1988	1,310	1	2	1,076	420	217	180	36	4	-	36	1,874	395	114	882	32	18	243	4	893	-	7,737	3,248	-
1989	1,139	2	2	905	364	141	136	25	4	-	52	1,079	296	142	895	14	7	364	-	337	-	5,904	2,277	-
1990	911	2	2	930	313	141	285	27	6	13	60	567	338	94	624	15	7	315	-	274	-	4,925	1,890	180-350

Table 10.1.5.1 continued.

	NAC Area			NEAC (N. Area)								NEAC (S. Area)						Faroes & Greenland				Total	Unreported catches	
Year	Canada (1)	USA	St. P&M	Norway (2)	Russia (3)	Iceland Wild	Iceland Ranch (4)	Sweden Wild	Sweden Ranch (15)	Denmark	Finland	Ireland (5,6)	UK (E & W)	UK (N.Irl.) (6,7)	UK (Scotl.)	France (8)	Spain (9)	Faroes (10)	East Grld.	West Grld. (11)	Other (12)	Reported Nominal Catch	NASCO Areas (13)	International waters (14)
1991	711	1	1	876	215	129	346	34	4	3	70	404	200	55	462	13	11	95	4	472	-	4,106	1,682	25-100
1992	522	1	2	867	167	174	462	46	3	10	77	630	171	91	600	20	11	23	5	237	-	4,119	1,962	25-100
1993	373	1	3	923	139	157	499	44	12	9	70	541	248	83	547	16	8	23	-	-	-	3,696	1,644	25-100
1994	355	0	3	996	141	136	313	37	7	6	49	804	324	91	649	18	10	6	-	-	-	3,945	1,276	25-100
1995	260	0	1	839	128	146	303	28	9	3	48	790	295	83	588	10	9	5	2	83	-	3,629	1,060	-
1996	292	0	2	787	131	118	243	26	7	2	44	685	183	77	427	13	7	-	0	92	-	3,136	1,123	-
1997	229	0	2	630	111	97	59	15	4	1	45	570	142	93	296	8	4	-	1	58	-	2,364	827	-
1998	157	0	2	740	131	119	46	10	5	1	48	624	123	78	283	8	4	6	0	11	-	2,395	1,210	-
1999	152	0	2	811	103	111	35	11	5	1	62	515	150	53	199	11	6	0	0	19	-	2,247	1,032	-
2000	153	0	2	1,176	124	73	11	24	9	5	95	621	219	78	274	11	7	8	0	21	-	2,912	1,269	-
2001	148	0	2	1,267	114	74	14	25	7	6	126	730	184	53	251	11	13	0	0	43	-	3,069	1,180	-
2002	148	0	2	1,019	118	90	7	20	8	5	93	682	161	81	191	11	9	0	0	9	-	2,654	1,039	-
2003	141	0	3	1,071	107	99	11	15	10	4	78	551	89	56	192	13	9	0	0	9	-	2,457	847	-
2004	161	0	3	784	82	111	18	13	7	4	39	489	111	48	245	19	7	0	0	15	-	2,157	686	-
2005	139	0	3	888	82	129	21	9	6	8	47	422	97	52	215	11	13	0	0	15	-	2,156	700	-
2006	137	0	3	932	91	93	17	8	6	2	67	326	80	29	192	13	11	0	0	22	-	2,029	670	-
2007	112	0	2	767	63	93	36	6	10	3	58	85	67	30	171	11	9	0	0	25	-	1,548	475	-
2008	158	0	4	807	73	132	69	8	10	9	71	89	64	21	161	12	9	0	0	26	-	1,721	443	-
2009	126	0	3	595	71	126	44	7	10	8	36	68	54	17	121	4	2	0	0	26	-	1,318	343	-
2010	153	0	3	642	88	147	42	9	13	13	49	99	109	12	180	10	2	0	0	40	-	1,610	393	-
2011	179	0	4	696	89	98	30	20	19	13	44	87	136	10	159	11	7	0	0	28	-	1,629	421	-
2012	126	0	3	696	82	50	20	21	9	12	64	88	58	9	124	10	8	0	0	33	-	1,412	403	-
2013	137	0	5	475	78	125	29	10	4	11	46	87	84	6	123	11	4	0	0	47	-	1,282	306	-
2014	106	0	4	490	81	47	13	24	6	9	58	52	52	5	83	12	7	0	0	58	-	1,106	287	-
Average																								
2009-2013	144	0	4	621	82	109	33	14	11	11	48	86	88	11	141	9	4	0	0	35	-	1,450	373	-
2004-2013	143	0	3	728	80	110	33	11	9	8	52	184	86	23	169	11	7	0	0	28	-	1,686	484	-

Key:

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Before 1966, sea trout and sea charr included (5% of total).
3. Figures from 1991 to 2000 do not include catches taken in the recreational (rod) fishery.
4. From 1990, catch includes fish ranched for both commercial and angling purposes.
5. Improved reporting of rod catches in 1994 and data derived from carcase tagging and log books from 2002.
6. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
7. Angling catch (derived from carcase tagging and log books) first included in 2002.
8. Data for France include some unreported catches.
9. Weights estimated from mean weight of fish caught in Asturias (80-90% of Spanish catch).
10. Between 1991 & 1999, there was only a research fishery at Faroes. In 1997 & 1999 no fishery took place; the commercial fishery resumed in 2000, but has not operated since 2001.
11. Includes catches made in the West Greenland area by Norway, Faroes, Sweden and Denmark in 1965-1975.
12. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
13. No unreported catch estimate available for Canada in 2007 and 2008. Data for Canada in 2009 and 2010 are incomplete. No unreported catch estimate available for Russia since 2008.
14. Estimates refer to season ending in given year.
15. Catches from hatchery-reared smolts released under programmes to mitigate for hydropower development schemes; returning fish unable to spawn in the wild and exploited heavily.

Table 10.1.5.2 The catch (tonnes round fresh weight) and % of the nominal catch by country taken in coastal, estuarine, and riverine fisheries, 2004–2014.

Country	Year	Coast		Estuary		River		Total
		Weight	%	Weight	%	Weight	%	Weight
Canada	2004	7	4	46	29	109	67	161
	2005	7	5	44	32	88	63	139
	2006	8	6	46	34	83	60	137
	2007	6	5	36	32	70	63	112
	2008	9	6	47	32	92	62	147
	2009	7	6	40	33	73	61	119
	2010	6	4	40	27	100	69	146
	2011	7	4	56	31	115	65	178
	2012	8	6	45	36	73	58	126
	2013	10	7	47	35	80	58	137
	2014	7	6	40	38	59	56	106
Finland	2004	0	0	0	0	39	100	39
	2005	0	0	0	0	47	100	47
	2006	0	0	0	0	67	100	67
	2007	0	0	0	0	59	100	59
	2008	0	0	0	0	71	100	71
	2009	0	0	0	0	38	100	38
	2010	0	0	0	0	49	100	49
	2011	0	0	0	0	44	100	44
	2012	0	0	0	0	64	100	64
	2013	0	0	0	0	46	100	46
	2014	0	0	0	0	58	100	58
France	2004	0	0	10	51	9	49	19
	2005	0	0	4	38	7	62	11
	2006	0	0	5	41	8	59	13
	2007	0	0	4	42	6	58	11
	2008	1	5	5	39	7	57	12
	2009	0	4	2	34	3	62	5
	2010	2	22	3	26	5	52	10
	2011	0	3	6	54	5	43	11
	2012	0	1	4	44	5	55	10
	2013	0	3	4	40	6	57	11
	2014	0	2	5	43	7	55	12
Iceland	2004	0	0	0	0	130	100	130
	2005	0	0	0	0	149	100	149
	2006	0	0	0	0	111	100	111
	2007	0	0	0	0	129	100	129
	2008	0	0	0	0	200	100	200
	2009	0	0	0	0	171	100	171
	2010	0	0	0	0	190	100	190
	2011	0	0	0	0	128	100	128
	2012	0	0	0	0	70	100	70
	2013	0	0	0	0	147	100	147
	2014	0	0	0	0	59	100	59
Ireland	2004	342	70	76	16	71	15	489
	2005	291	69	70	17	60	14	421
	2006	206	63	60	18	61	19	327
	2007	0	0	31	37	52	63	83
	2008	0	0	29	33	60	67	89
	2009	0	0	20	30	47	70	67
	2010	0	0	38	39	60	61	99
	2011	0	0	32	37	55	63	87
	2012	0	0	28	32	60	68	88
	2013	0	0	38	44	49	56	87
	2014	0	0	26	49	27	51	53

Country	Year	Coast		Estuary		River		Total
		Weight	%	Weight	%	Weight	%	Weight
Norway	2004	469	60	0	0	316	40	785
	2005	463	52	0	0	424	48	888
	2006	512	55	0	0	420	45	932
	2007	427	56	0	0	340	44	767
	2008	382	47	0	0	425	53	807
	2009	284	48	0	0	312	52	595
	2010	260	41	0	0	382	59	642
	2011	302	43	0	0	394	57	696
	2012	255	37	0	0	440	63	696
	2013	192	40	0	0	283	60	475
	2014	213	43	0	0	277	57	490
Russia	2004	46	56	0	0	36	44	82
	2005	58	70	0	0	25	30	82
	2006	52	57	0	0	39	43	91
	2007	31	50	0	0	31	50	63
	2008	33	45	0	0	40	55	73
	2009	22	31	0	0	49	69	71
	2010	36	41	0	0	52	59	88
	2011	37	42	0	0	52	58	89
	2012	38	46	0	0	45	54	82
	2013	36	46	0	0	42	54	78
	2014	33	41	0	0	48	59	81
Spain	2004	0	0	0	0	7	100	7
	2005	0	0	0	0	13	100	13
	2006	0	0	0	0	11	100	11
	2007	0	0	0	0	10	100	10
	2008	0	0	0	0	10	100	10
	2009	0	0	0	0	2	100	2
	2010	0	0	0	0	2	100	2
	2011	0	0	0	0	7	100	7
	2012	0	0	0	0	8	100	8
	2013	0	0	0	0	4	100	4
	2014	0	0	0	0	7	100	7
Sweden	2004	3	16	0	0	16	84	19
	2005	1	7	0	0	14	93	15
	2006	1	7	0	0	13	93	14
	2007	0	1	0	0	16	99	16
	2008	0	1	0	0	18	99	18
	2009	0	3	0	0	17	97	17
	2010	0	0	0	0	22	100	22
	2011	10	26	0	0	29	74	39
	2012	7	24	0	0	23	76	30
	2013	0	0	0	0	15	100	15
	2014	0	0	0	0	30	100	30
UK England & Wales	2004	39	35	19	17	53	47	111
	2005	32	33	28	29	36	37	97
	2006	30	37	21	26	30	37	80
	2007	24	31	13	18	30	51	67
	2008	22	34	8	13	34	53	64
	2009	20	37	9	16	25	47	54
	2010	64	59	9	8	36	33	109
	2011	93	69	6	5	36	27	136
	2012	26	45	5	8	27	47	58
	2013	61	73	6	7	17	20	84
	2014	38	74	4	8	9	17	52

Country	Year	Coast		Estuary		River		Total
		Weight	%	Weight	%	Weight	%	Weight
UK N. Ireland	2004	23	48	11	22	14	29	48
	2005	25	49	13	25	14	26	52
	2006	13	45	6	22	9	32	29
	2007	6	21	6	20	17	59	30
	2008	4	19	5	22	12	59	21
	2009	4	24	2	15	10	62	16
	2010	5	39	0	0	7	61	12
	2011	3	24	0	0	8	76	10
	2012	0	0	0	0	9	100	9
	2013	0	1	0	0	4	99	4
	2014	0	0	0	0	6	100	6
UK Scotland	2004	67	27	20	8	160	65	247
	2005	62	29	27	12	128	59	217
	2006	57	30	17	9	119	62	193
	2007	40	24	17	10	113	66	171
	2008	38	24	11	7	112	70	161
	2009	27	22	14	12	79	66	121
	2010	44	25	38	21	98	54	180
	2011	48	30	23	15	87	55	159
	2012	40	32	11	9	73	59	130
	2013	50	42	26	22	44	37	120
	2014	41	49	17	20	26	31	83
Denmark	2008	0	1	0	0	9	99	9
	2009	0	0	0	0	8	100	8
	2010	0	1	0	0	13	99	13
	2011	0	0	0	0	13	100	13
	2012	0	2	0	0	12	98	12
	2013	0	0	0	0	11	100	11
	2014	0	0	0	0	9	100	9
Totals								
NEAC	**2014**	**325**	**35**	**52**	**6**	**562**	**60**	**939**
NAC	**2014**	**10**	**9**	**40**	**37**	**59**	**54**	**109**

Table 10.1.5.3 Estimates of unreported catches by various methods, in tonnes by country within national EEZs in the North East Atlantic, North American, and West Greenland Commissions of NASCO, 2014.

Commission Area	Country	Unreported Catch t	Unreported as % of Total North Atlantic Catch (Unreported + Reported)	Unreported as % of Total National Catch (Unreported + Reported)
NEAC	Denmark	6	0.4	40
NEAC	Finland	6	0.4	9
NEAC	Iceland	2	0.1	3
NEAC	Ireland	6	0.4	10
NEAC	Norway	210	15.1	30
NEAC	Sweden	3	0.2	9
NEAC	France	3	0.2	20
NEAC	UK (E & W)	10	0.7	16
NEAC	UK (N.Ireland)	0	0.0	6
NEAC	UK (Scotland)	10	0.7	11
NAC	USA	0	0.0	0
NAC	Canada	21	1.5	17
WGC	West Greenland	10	0.7	15
	Total Unreported Catch *	287	20.6	
	Total Reported Catch of North Atlantic salmon	1,107		

* No unreported catch estimate available for Russia in 2014.
Unreported catch estimates not provided for Spain & St. Pierre et Miquelon

Table 10.1.5.4 Numbers of fish caught and released in rod fisheries along with the % of the total rod catch (released + retained) for countries in the North Atlantic where records are available, 1991–2014. Figures for 2014 are provisional.

Year	Canada [4]		USA		Iceland		Russia [1]		UK (E&W)		UK (Scotland)		Ireland		UK (N Ireland) [2]		Denmark		Norway [3]	
	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch	Total	% of total rod catch
1991	22,167	28	239	50			3,211	51												
1992	37,803	29	407	67			10,120	73												
1993	44,803	36	507	77			11,246	82	1,448	10										
1994	52,887	43	249	95			12,056	83	3,227	13	6,595	8								
1995	46,029	46	370	100			11,904	84	3,189	20	12,151	14								
1996	52,166	41	542	100	669	2	10,745	73	3,428	20	10,413	15								
1997	50,009	50	333	100	1,558	5	14,823	87	3,132	24	10,965	18								
1998	56,289	53	273	100	2,826	7	12,776	81	4,378	30	13,464	18								
1999	48,720	50	211	100	3,055	10	11,450	77	4,382	42	14,846	28								
2000	64,482	56	0	-	2,918	11	12,914	74	7,470	42	21,072	32								
2001	59,387	55	0	-	3,611	12	16,945	76	6,143	43	27,724	38								
2002	50,924	52	0	-	5,985	18	25,248	80	7,658	50	24,058	42								
2003	53,645	55	0	-	5,361	16	33,862	81	6,425	56	29,170	55								
2004	62,316	57	0	-	7,362	16	24,679	76	13,211	48	46,279	50					255	19		
2005	63,005	62	0	-	9,224	17	23,592	87	11,983	56	46,165	55	2,553	12			606	27		
2006	60,486	62	1	100	8,735	19	33,380	82	10,959	56	47,669	55	5,409	22	302	18	794	65		
2007	41,192	58	3	100	9,691	18	44,341	90	10,917	55	55,660	61	13,125	40	470	16	959	57		
2008	54,887	53	61	100	17,178	20	41,881	86	13,035	55	53,347	62	13,312	37	648	20	2,033	71	5,512	5
2009	52,151	59	0	-	17,514	24			9,096	58	48,418	67	10,265	37	847	21	1,709	53	6,696	6
2010	55,895	53	0	-	21,476	29	14,585	56	15,012	60	78,357	70	15,136	40	823	25	2,512	60	15,041	12
2011	71,358	57	0	-	18,593	32			14,406	62	64,813	73	12,753	39	1,197	36	2,153	55	14,303	12
2012	43,287	57	0	-	9,752	28	4,743	43	11,952	65	63,370	74	11,891	35	5,014	59	2,153	55	18,611	14
2013	50,630	59	0	-	23,133	34	3,732	39	10,458	70	54,003	80	10,682	37	1,507	64	1,932	57	15,953	15
2014	39,534	59	0	-	14,017	44	8,479	52	7,368	77	37,139	82	5,400	35	1,065	50	1,918	61	20,281	19
5-yr mean 2009-2013	54,664	57			18,094	29	7,687	46	12,185	63	61,792	73	12,145	38	1,878	41	2,092	56	14,121	12
% change on 5-year mean	-28	3			-23	51	10	13	-40	22	-40	13	-56	-7	-43	22	-8	9	44	63

Key:

[1] Since 2009 data are either unavailable or incomplete, however catch-and-release is understood to have remained at similar high levels as before.

[2] Data for 2006-2009 is for the DCAL area only; the figures from 2010 are a total for UK (N.Ireland).

[3] The statistics were collected on a voluntary basis, the numbers reported must be viewed as a minimum.

[4] Released fish in the kelt fishery of New Brunswick are not included in the totals for Canada.

[5] 2014 information based on Loughs Agency, DCAL area only.

Table 10.1.9.1 Summary of Atlantic salmon tagged and marked in 2014 – 'Hatchery' and 'Wild' juvenile refers to smolts and parr.

		Primary Tag or Mark				
Country	Origin	Microtag	External mark[2]	Adipose clip	Other Internal[1]	Total
Canada	Hatchery Adult	0	2,559	288	1,350	**4,197**
	Hatchery Juvenile	0	17	328,318	65	**328,400**
	Wild Adult	0	2,294	0	170	**2,464**
	Wild Juvenile	0	8,906	17,971	372	**27,249**
	Total	**0**	**13,776**	**346,577**	**1,957**	**362,310**
Denmark	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	102,450	0	328,000	10,000	440,450
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	0	0
	Total	**102,450**	**0**	**328,000**	**10,000**	**440,450**
France	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile[3]	0	0	469,738	0	469,738
	Wild Adult[3]	620	0	0	0	620
	Wild Juvenile	3,101	3,000	0	0	6,101
	Total	**3,721**	**3,000**	**469,738**	**0**	**476,459**
Iceland	Hatchery Adult	0	72	0	0	72
	Hatchery Juvenile	24,755	0	0	0	24,755
	Wild Adult	0	34	0	0	34
	Wild Juvenile	5,357	0	0	0	5,357
	Total	**30,112**	**106**	**0**	**0**	**30,218**
Ireland	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	194,102	0	0	0	194,102
	Wild Adult	0	0	0	0	0
	Wild Juvenile	5,164	0	0	0	5,164
	Total	**199,266**	**0**	**0**	**0**	**199,266**
Norway	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	84,634	3,798	0	0	88,432
	Wild Adult	0	179	0	0	179
	Wild Juvenile	768	3,204	0	0	3,972
	Total	**85,402**	**7,181**	**0**	**0**	**92,583**
Russia	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	1,532,971	0	1,532,971
	Wild Adult	0	1,751	0	0	1,751
	Wild Juvenile	0	0	0	0	0
	Total	**0**	**1,751**	**1,532,971**	**0**	**1,534,722**
Spain	Hatchery Adult	0	0	0	0	**0**
	Hatchery Juvenile	77,333	0	202,564		**279,897**
	Wild Adult	0	0	0	0	**0**
	Wild Juvenile	0	0	0	0	**0**
	Total	**77,333**	**0**	**202,564**	**0**	**279,897**
Sweden	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile[4]	0	4000	167,665	0	171,665
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	500	0	0	500
	Total	**0**	**4,500**	**167,665**	**0**	**172,165**
UK (England &	Hatchery Adult	0	0	0	0	0
Wales)	Hatchery Juvenile	0	0	64,121	0	64,121
	Wild Adult	0	630	0	48	678
	Wild Juvenile	1,981	0	9,052	58	11,091
	Total	**1,981**	**630**	**73,173**	**106**	**75,890**
UK (N. Ireland)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	11,664	0	39,606	0	51,270
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	0	0
	Total	**11,664**	**0**	**39,606**	**0**	**51,270**
UK (Scotland)	Hatchery Adult	0	0	0	0	0
	Hatchery Juvenile	0	0	202,373	257	202,630
	Wild Adult	0	282	0	107	389
	Wild Juvenile	3,832	0	281	2,346	6,459
	Total	**3,832**	**282**	**202,654**	**2,710**	**209,478**
USA	Hatchery Adult	0	616	0	2,542	3,158
	Hatchery Juvenile	0	92,354	164,815	2,027	259,196
	Wild Adult	0	0	0	0	0
	Wild Juvenile	0	0	0	50	50
	Total	**0**	**92,970**	**164,815**	**4,619**	**262,404**
All Countries	Hatchery Adult	0	3,247	288	3,892	7,427
	Hatchery Juvenile	494,938	100,169	3,500,171	12,349	4,107,627
	Wild Adult	620	5,170	0	325	6,115
	Wild Juvenile	20,203	15,610	27,304	2,826	65,943
	Total	**515,761**	**124,196**	**3,527,763**	**19,392**	**4,187,112**

[1] Includes other internal tags (PIT, ultrasonic, radio, DST, etc.)
[2] Includes Carlin, spaghetti, streamers, VIE etc.
[3] Includes external dye mark.
[4] The 4000 external tagged hatchery juveniles also adipose fin-clipped

Table 10.1.10.1 Estimation of the overall Level 1 composition of 1SW catch at the Faroes.

Geographic Region		Estimated proportion by continent	Genetic assignments within Europe	Overall genetic assignments
Southern NEAC	)		89.3%	84.2%
Northern NEAC	)	94.3%	9.5%	9.0%
Iceland	)		1.2%	1.2%
North America		5.7%		5.7%

Table 10.1.10.2 Estimation of the overall Level 1 composition of MSW catch at the Faroes.

Catch/ assignments	Region	Months				Total season	
		Nov	Dec	Jan-Feb	Mar-June		
Mean MSW catch	Fishery	7,671	27,809	28,865	51,466	115,812	
Proprtion NA	N America	-	-	-	-	20.5%	
Genetic assignment proportions	Southern NEAC	55.8%	37.6%	27.0%	15.4%		
	Northern NEAC	43.3%	59.5%	73.0%	84.6%		
	Iceland	1.0%	3.0%	0.0%	0.0%		
Overall composition of landed catch	Southern NEAC	3,403	8,313	6,196	6,301	24,213	**20.9%**
	Northern NEAC	2,641	13,155	16,752	34,615	67,162	**58.0%**
	Iceland	61	663	0.00	0.00	724	**0.6%**
	North America	1,573	5,701	5,917	10,551	23,741	**20.5%**

Table 10.1.11.1 Derivation of parameters currently used in the catch options analysis.

Parameter	Derivation
Mean weight of salmon in the fishery	Drawn randomly from the observed values of the 1985/1986 to 1990/1991 fishing seasons.
Proportion by sea age	Estimated from scale samples collected in the fisheries between fishing seasons 1985/1986 and 1990/1991.
Discard rates	Estimated from the proportions of fish less than 60 cm in catch samples between fishing seasons 1982/1983 and 1994/1995.
Mortality rates of discarded fish	Estimated from experimental fisheries conducted within the 1985/1986 to 1990/1991 fishing seasons.
Proportions of fish farm escapees	Estimated from samples taken in the 1980/1981 to 1994/1995 fishing seasons (ICES, 1996), corrected to take account of the reduction in the proportion of farm escapees in Norwegian coastal waters between 1989 and 2008 (ICES, 2013).
The proportion of the 1SW catch that will not mature as 1SW fish	Derived from samples collected in the fisheries between 1985/1986 and 1990/1991.
Proportions of catches by management unit	Genetic analysis of scales collected in the fisheries between 1993 and 1995 are used to assign catch to stock complexes (Northern and Southern NEAC and NAC). Within NEAC stock complexes, relative PFA estimates between 2001 and 2013 are used to assign catch to countries.

Table 10.1.12.1 Contributions of regional groups (percentages, mean and standard error) to the Labrador subsistence fisheries catches based on mixture analysis of samples in 2006 to 2011 (Bradbury *et al.*, 2014) and in 2012 to 2014.

Region code	Region name	2006 to 2011	2012 to 2014
UNG	Ungava–Northern Labrador	0.48 (0.27)	2.67 (0.71)
LAB	Central Labrador	96.03 (0.715)	95.31 (0.93)
QLS	Lower North Shore–Southern Labrador	1.34 (0.49)	0.02 (0.10)
NFL	Newfoundland	0.86 (0.36)	1.05 (0.44)
AVA	Avalon–East Newfoundland	0.002 (0.04)	0.001 (0.05)
QUE	Higher North Shore Quebec	0.30 (0.27)	0.04 (0.11)
GAS	Gaspe	0.35 (0.34)	0.23 (0.27)
ANT	Anticosti	0.001 (0.05)	0.000 (0.03)
GUL	Southern Gulf of St Lawrence	0.36 (0.21)	0.66 (0.37)
NOS	Nova Scotia	0.01 (0.05)	0.004 (0.06)
FUN	Inner Bay of Fundy	0.01 (0.05)	0.002 (0.04)
USA	USA	0.28 (0.16)	0.01 (0.06)

Table 10.1.12.2 Estimated annual catches (number of fish – median, 10th to 90th percentiles) by regional group of North American origin salmon in the Labrador subsistence fisheries (aboriginal and resident), 2012 to 2014, based on genetic stock identification of combined samples (2012–2014). Regional groups are shown in Figure 10.1.12.1.

Acronym	2012	2013	2014	Average (prop.)
Catch (number)	14 204	13 538	12 968	13 570
UNG	365 (256–501)	352 (246–487)	338 (233–473)	351 (0.026)
LAB	13 543 (13 363–13 704)	12 904 (12 741–13 060)	12 368 (12 208–12 509)	12 938 (0.957)
QLS	0 (0–9)	0 (0–6)	0 (0–4)	0 (0)
NFL	145 (77–243)	139 (74–228)	128 (69–209)	137 (0.010)
AVA	0 (0–0)	0 (0–0)	0 (0–0)	0 (0)
QUE	0 (0–21)	0 (0–18)	0 (0–17)	0 (0)
GAS	20 (2–81)	18 (1–80)	16 (1–79)	18 (0.001)
ANT	0 (0–0)	0 (0–0)	0 (0–0)	0 (0)
GUL	86 (34–169)	78 (29–163)	80 (32–150)	81 (0.006)
NOS	0 (0–0)	0 (0–0)	0 (0–0)	0 (0)
FUN	0 (0–0)	0 (0–0)	0 (0–0)	0 (0)
USA	0 (0–1)	0 (0–2)	0 (0–1)	0 (0)

Table 10.1.12.3 Estimated annual catches (number of fish – median, 10th to 90th percentiles) by regional group of North American origin salmon in the Saint Pierre and Miquelon salmon fishery, 2004 to 2014, based on genetic stock identification of combined samples (2004, 2011, 2013, 2014). Regional groups are shown in Figure 10.1.12.1.

Acronym	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average (prop.)
Samples											335	
Catch (number)	1 235	1 458	1 577	863	1 570	1 535	1 233	1 666	643	2 351	1 690	1 438
UNG	0 (0–2)	0 (0–2)	0 (0–2)	0 (0–1)	0 (0–2)	0 (0–2)	0 (0–2)	0 (0–2)	0 (0–1)	0 (0–3)	0 (0–2)	0 (0)
LAB	16 (4–36.1)	18 (5–41)	19 (6–46)	11 (3–26)	20 (6–46)	18 (5–42)	15 (4–34)	22 (5–46)	8 (2–18)	29 (9–67)	20 (6–48)	17 (0.013)
QLS	15 (3–41)	18 (3–52)	19 (3–52)	11 (2–30)	19 (3–53)	17 (4–50)	16 (3–42)	20 (4–62)	7 (1–23)	28 (6–79)	20 (3–58)	17 (0.012)
NFL	292 (246–339)	340 (288–396)	371 (310–433)	204 (169–239)	371 (313–429)	360 (305–414)	289 (245–336)	392 (332–452)	151 (127–179)	550 (471–632)	400 (339–458)	338 (0.239)
AVA	12 (4–25)	14 (4–32)	15 (5–33)	8 (2–18)	15 (5–34)	16 (4–33)	12 (4–27)	16 (5–35)	6 (1–14)	23 (7–48)	16 (5–35)	13 (0.010)
QUE	54 (33–82)	65 (39–97)	71 (41–108)	38 (23–59)	71 (43–105)	70 (42–105)	56 (34–83)	76 (48–114)	28 (17–44)	107 (65–159)	75 (46–115)	64 (0.046)

Table 10.1.12.3. (continued).

Acronym	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average (prop.)
GAS	326 (276–377)	385 (332–442)	417 (358–480)	229 (196–268)	418 (357–479)	408 (345–467)	327 (278–377)	441 (377–509)	170 (144–198)	627 (537–720)	449 (384–513)	381 (0.270)
ANT	1 (0–8)	1 (0–10)	1 (0–9)	1 (0–6)	1 (0–11)	1 (0–10)	1 (0–8)	1 (0–11)	0 (0–5)	2 (0–14)	2 (0–10)	1 (0.001)
GUL	467 (418–523)	550 (490–620)	597 (531–661)	324 (289–361)	591 (529–656)	581 (520–643)	464 (415–517)	630 (561–695)	242 (213–272)	887 (796–980)	641 (573–704)	543 (0.384)
NOS	32 (15–58)	38 (18–70)	42 (20–74)	23 (10–42)	41 (20–75)	41 (20–75)	33 (15–58)	43 (20–78)	18 (8–32)	63 (31–111)	44 (21–79)	38 (0.027)
FUN	0 (0–6)	0 (0–6)	0 (0–7)	0 (0–4)	0 (0–7)	0 (0–6)	0 (0–6)	0 (0–7)	0 (0–2)	0 (0–9)	0 (0–6)	0 (0)
USA	0 (0–2)	0 (0–2)	0 (0–2)	0 (0–1)	0 (0–2)	0 (0–2)	0 (0–2)	0 (0–2)	0 (0–1)	0 (0–3)	0 (0–2)	0 (0)

Table 10.1.12.4 Contributions of North American origin regional groups (percentages, mean and standard error) from mixture analysis of genetic samples collected from the 2011 to 2014 West Greenland fisheries. Year-specific results and overall results for all years combined are shown. Contributions of shaded regions are indistinguishable from zero. Regional groups are shown in Figure 10.1.12.1.

Region code	Region name	2011	2012	2013	2014	Overall
UNG	Ungava–Northern Labrador	4.74 (0.52)	1.60 (0.58)	4.49 (1.10)	7.47 (1.31)	5.84 (1.19)
LAB	Central Labrador	19.91 (1.07)	17.05 (1.69)	21.23 (2.26)	21.26 (2.31)	21.76 (2.28)
QLS	Lower North Shore–Southern Labrador	4.21 (0.75)	1.45 (1.08)	4.56 (1.55)	4.95 (1.60)	5.78 (1.64)
NFL	Newfoundland	4.47 (0.74)	4.95 (1.36)	5.49 (1.71)	3.49 (1.46)	6.90 (1.72)
AVA	Avalon–East Newfoundland	0.03 (0.05)	0.05 (0.11)	0.04 (0.09)	0.05 (0.11)	0.08 (0.19)
QUE	Higher North Shore Quebec	5.36 (0.81)	7.20 (1.54)	7.10 (1.69)	3.39 (1.44)	5.38 (1.68)
GAS	Gaspe	28.98 (1.41)	33.79 (2.50)	24.32 (2.79)	24.57 (2.77)	28.95 (2.90)
ANT	Anticosti	1.02 (0.29)	0.89 (0.44)	1.40 (0.64)	0.72 (0.50)	1.18 (0.65)
GUL	Southern Gulf of St Lawrence	29.33 (1.35)	30.47 (2.33)	28.28 (2.77)	33.50 (2.73)	22.86 (2.65)
NOS	Nova Scotia	0.85 (0.3)	0.85 (0.52)	1.93 (0.87)	0.18 (0.35)	0.17 (0.37)
FUN	Inner Bay of Fundy	0.05 (0.09)	0.05 (0.12)	0.28 (0.49)	0.13 (0.27)	0.08 (0.19)
USA	USA	1.07 (0.27)	1.66 (0.55)	0.88 (0.50)	0.31 (0.32)	1.03 (0.56)

Table 10.1.12.5 Estimated catches (number of fish – median, 10th to 90th percentiles) of North American origin salmon at West Greenland in 2011 to 2014, based on genetic stock identification using all samples processed from the 2011 to 2014 sampling. Regional groups are shown in Figure 10.1.12.1.

Acronym	Region name	2011	2012	2013	2014	Average of medians (proportion of total)
Number of NAC tissue samples					1 984	
North American origin estimated catch		6 800	7 800	11 500	12 800	9 725
UNG	Ungava–Northern Labrador	320 (273 to 374)	369 (316 to 424)	541 (463 to 623)	609 (527 to 701)	459 (0.05)
LAB	Central Labrador	1 350 (1 260 to 1 446)	1 558 (1 455 to 1 669)	2 291 (2136 to 2449)	2 543 (2 373 to 2 711)	1 935 (0.20)
QLS	Lower North Shore–Southern Labrador	286 (221 to 356)	327 (255 to 401)	476 (378 to 603)	538 (418 to 666)	406 (0.04)
NFL	Newfoundland	304 (240 to 371)	349 (270 to 429)	511 (410 to 618)	564 (456 to 690)	431 (0.04)
AVA	Avalon–East Newfoundland	0 (0 to 6)	0 (0 to 6)	1 (0 to 10)	1 (0 to 9)	0 (0.00)
QUE	Higher North Shore Quebec	360 (297 to 439)	414 (334 to 505)	606 (504 to 742)	683 (558 to 820)	515 (0.05)
GAS	Gaspe	1 973 (1 853 to 2 079)	2 256 (2 126 to 2 390)	3 324 (3 132 to 3 525)	3 706 (3 518 to 3 933)	2814 (0.29)
ANT	Anticosti	68 (44 to 97)	77 (50 to 111)	113 (77 to 162.1)	125 (85 to 180)	95 (0.01)
GUL	Southern Gulf of St Lawrence	1 993 (1 879 to 2 109)	2 284 (2 165 to 2 406)	3 382 (3 189 to 3 554)	3 746 (3 545 to 3 961)	2 851 (0.29)
NOS	Nova Scotia	54 (31 to 86)	62 (37 to 100)	93 (56 to 143)	104 (62 to 158)	78 (0.01)
FUN	Inner Bay of Fundy	1 (0 to 9)	1 (0 to 11)	1 (0 to 15)	1 (0 to 19)	1 (0.00)
USA	USA	72 (49 to 98)	81 (57 to 115)	120 (84 to 167)	134 (91 to 183)	101 (0.01)

Table 10.1.12.6 Overall contributions of European origin regional groups for samples collected during the 2002 and 2004–2012 fisheries. Regional groups are shown in Figure 10.1.12.1.

Acronym	Region name	Overall
NW Icld.	Iceland NW	0.2%
N Kola	N. Kola	0.5%
Finnmark	Finnmark	0.0%
E Nor. & Swd.	E. Norway and Sweden	0.8%
Mid Nor.	Mid Norway	1.5%
S Nor.	S. Norway	0.6%
Den.	Denmark	0.2%
N Scot. & N&W Ire.	N. Scotland and N&W Ireland	25.2%
BannLev	BannLev	2.2%
Irish Sea	Irish Sea	26.6%
S&E Scot.	S&E Scotland	39.9%
S. Eng.	South England	0.3%
N&W Fra.	N&W France	1.8%
S Fra. & Spn.	S. France and Spain	0.1%

Table 10.1.12.7 Estimated catches (number of fish) by regional group of European origin salmon at West Greenland in 2002 and 2004–2012, based on genetic stock identification. The overall estimated contributions of regional groups from the time periods 2002 and 2004–2012 were deterministically applied to the estimated harvest of European origin salmon. Regional groups are shown in Figure 10.1.12.1.

Year	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012
Estimated NEAC catch	1 000	1 500	1 200	1 800	1 900	1 300	800	2 600	600	2 100
Iceland NW	2	3	2	3	3	2	1	5	1	4
N. Kola	5	8	6	9	10	7	4	13	3	11
Finnmark	0	1	1	1	1	1	0	1	0	1
E. Norway and Sweden	8	12	9	14	15	10	6	20	5	16
Mid Norway	15	23	18	27	29	20	12	39	9	32
S. Norway	6	10	8	12	12	8	5	17	4	13
Denmark	2	3	3	4	4	3	2	6	1	5
N. Scotland and N&W Ireland	252	378	302	454	479	328	202	655	151	529
BannLev	22	32	26	39	41	28	17	56	13	45
Irish Sea	266	399	319	479	505	346	213	691	160	558
S&E Scotland	399	598	478	717	757	518	319	1 036	239	837
South England	3	5	4	6	6	4	3	8	2	7
N&W France	18	28	22	33	35	24	15	48	11	39
S. France and Spain	1	2	2	2	3	2	1	4	1	3

Annex 1 Glossary of acronyms and abbreviations

1SW *(One-Sea-Winter).* Maiden adult salmon that has spent one winter at sea.

2SW *(Two-Sea-Winter).* Maiden adult salmon that has spent two winters at sea.

ACOM *(Advisory Committee)* of ICES. The Committee works on the basis of scientific assessment prepared in the ICES expert groups. The advisory process includes peer review of the assessment before it can be used as the basis for advice. The Advisory Committee has one member from each ICES Member Country under the direction of an independent chair appointed by the Council.

BCI *(Bayesian Credible Interval).* The Bayesian equivalent of a confidence interval. If the 90% BCI for a parameter A is 10 to 20, there is a 90% probability that A falls between 10 and 20.

BHSRA *(Bayesian Hierarchical Stock and Recruitment Approach)*. Models for the analysis of a group of related stock–recruitment datasets. Hierarchical modelling is a statistical technique that allows the modelling of the dependence among parameters that are related or connected through the use of a hierarchical model structure. Hierarchical models can be used to combine data from several independent sources.

C&R *(Catch and Release).* Catch and release is a practice within recreational fishing intended as a technique of conservation. After capture, the fish are unhooked and returned to the water before experiencing serious exhaustion or injury. Using barbless hooks, it is often possible to release the fish without removing it from the water (a slack line is frequently sufficient).

CL, i.e. S_{lim} *(Conservation Limit).* Demarcation of undesirable stock levels or levels of fishing activity; the ultimate objective when managing stocks and regulating fisheries will be to ensure that there is a high probability that undesirable levels are avoided.

COSEWIC *(Committee on the Status of Endangered Wildlife in Canada).* COSEWIC is the organization that assesses the status of wild species, subspecies, varieties, or other important units of biological diversity, considered to be at risk of extinction in Canada. COSEWIC uses scientific, Aboriginal traditional, and community knowledge provided by experts from governments, academia, and other organizations. Summaries of assessments on Atlantic salmon are currently available to the public on the COSEWIC website (www.cosewic.gc.ca).

CPUE *(Catch Per Unit of Effort).* A derived quantity obtained from the independent values of catch and effort.

CWT *(Coded Wire Tag).* The CWT is a length of magnetized stainless steel wire 0.25 mm in diameter. The tag is marked with rows of numbers denoting specific batch or individual codes. Tags are cut from rolls of wire by an injector that hypodermically implants them into suitable tissue. The standard length of a tag is 1.1 mm.

DFO *(Department of Fisheries and Oceans).* DFO and its Special Operating Agency, the Canadian Coast Guard, deliver programmes and services that support sustainable use and development of Canada's waterways and aquatic resources.

DNA *(Deoxyribonucleic Acid).* DNA is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms (with the exception of RNA – Ribonucleic Acid viruses). The main role of DNA molecules is the long-term storage of information. DNA is often compared to a set of blueprints, like a recipe or a code, since it contains the instructions needed to construct other components of cells, such as proteins and RNA molecules.

DST *(Data Storage Tag).* A miniature data logger with sensors including salinity, temperature, and depth that is attached to fish and other marine animals.

ECOKNOWS *(Effective use of Ecosystems and biological Knowledge in fisheries).* The general aim of the ECOKNOWS project is to improve knowledge in fisheries science and management. The lack of appropriate calculus methods and fear of statistical over-partitioning in calculations, because of the many biological and environmental influences on stocks, has limited reality in fisheries models. This reduces the biological credibility perceived by many stakeholders. ECOKNOWS will solve this technical estimation problem by using an up-to-date methodology that supports more effective use of data. The models will include important knowledge of biological processes.

ENPI CBC *(European Neighbourhood and Partnership Instrument Cross-Border Cooperation).* ENPI CBC is one of the financing instruments of the European Union. The ENPI programmes are being implemented on the external borders of the EU. It is designed to target sustainable development and approximation to EU policies and standards; supporting the agreed priorities in the European Neighbourhood Policy Action Plans, as well as the Strategic Partnership with Russia.

FWI *(Framework of Indicators).* The FWI is a tool used to indicate if any significant change in the status of stocks used to inform the previously provided multi-annual management advice has occurred.

GRAASP *(Genetically based Regional Assignment of Atlantic Salmon Protocol).* GRAASP was developed and validated by twelve European genetic research laboratories. Existing and new genetic data were calibrated and integrated in a purpose-built electronic database to create the assignment baseline. The unique database created initially encompassed 32 002 individuals from 588 rivers. The baseline data, based on a suite of 14 microsatellite loci, were used to identify the natural evolutionary regional stock groupings for assignment.

ICPR *(The International Commission for the Protection of the River Rhine).* ICPR coordinates the ecological rehabilitation programme involving all countries bordering the river Rhine. This programme was initiated in response to catastrophic river pollution in Switzerland in 1986 which killed hundreds of thousands of fish. The programme aims to bring about significant ecological improvement of the Rhine and its tributaries, enabling the re-establishment of migratory fish species such as salmon.

ISAV *(Infectious Salmon Anaemia Virus).* ISAV is a highly infectious disease of Atlantic salmon caused by an enveloped virus.

LE *(Lagged Eggs)*. The summation of lagged eggs from 1- and 2-sea-winter fish is used for the first calculation of PFA.

LMN *(Labrador Métis Nation).* LMN is one of four subsistence fisheries harvesting salmonids in Labrador. LMN members are fishing in southern Labrador from Fish Cove Point to Cape St Charles.

MSY *(Maximum Sustainable Yield).* The largest average annual catch that may be taken from a stock continuously without affecting the catch of future years; a constant long-term MSY is not a reality in most fisheries, where stock sizes vary with the strength of year classes moving through the fishery.

MSW *(Multi-Sea-Winter).* A MSW salmon is an adult salmon which has spent two or more winters at sea and may be a repeat spawner.

NG *(Nunatsiavut Government).* NG is one of four subsistence fisheries harvesting salmonids in Labrador. NG members are fishing in the northern Labrador communities.

NSERC *(Natural Sciences and Engineering Research Council of Canada)*. NSERC is a Canadian government agency that provides grants for research in the natural sciences and in engineering. Its mandate is to promote and assist research. Council supports a project to develop a standardized genetic database for North America.

OSPAR (*Convention for the Protection of the Marine Environment of the North-East Atlantic*). OSPAR is the mechanism by which fifteen Governments of the west coasts and catchments of Europe, together with the European Community, cooperate to protect the marine environment of the Northeast Atlantic. It started in 1972 with the Oslo Convention against dumping. It was broadened to cover land-based sources and the offshore industry by the Paris Convention of 1974. These two conventions were unified, updated, and extended by the 1992 OSPAR Convention. The new annex on biodiversity and ecosystems was adopted in 1998 to cover non-polluting human activities that can adversely affect the sea.

PFA *(Pre-Fishery Abundance).* The numbers of salmon estimated to be alive in the ocean from a particular stock at a specified time. In the previous version of the stock complex Bayesian PFA forecast model two productivity parameters are calculated, for the *maturing* (PFAm) and *non-maturing* (PFAnm) components of the PFA. In the updated version only one productivity parameter is calculated and used to calculate total PFA, which is then split into PFAm and PFAnm based upon the *proportion of PFAm* (p.PFAm).

PGA *(The Probabilistic-based Genetic Assignment model).* An approach to partition the harvest of mixed-stock fisheries into their finer origin parts. PGA uses Monte Carlo sampling to partition the reported and unreported catch estimates to continent, country, and within-country levels.

PGCCDBS *(The Planning Group on Commercial Catches, Discards and Biological Sampling)*.

PGNAPES *(Planning Group on Northeast Atlantic Pelagic Ecosystem Surveys)*. PGNAPES coordinates international pelagic surveys in the Norwegian Sea and to the west of the British Isles, directed in particular towards Norwegian spring-spawning herring and blue whiting. In addition, these surveys collect environmental information. The work in the group has progressed as planned.

PIT *(Passive Integrated Transponder).* PIT tags use radio frequency identification technology. PIT tags lack an internal power source. They are energized on encountering an electromagnetic field emitted from a transceiver. The tag's unique identity code is programmed into the microchip's non-volatile memory.

PSAT (*Pop-up Satellite Archival Tags*). Used to track movements of large, migratory, marine animals. A PSAT is an archival tag (or data logger) that is equipped with a means to transmit the data via satellite.

PSU *(Practical Salinity Units).* PSU are used to describe salinity: a salinity of 35‰ equals 35 PSU.

Q Areas for which the Ministère des Resources naturelles et de la Faune manages the salmon fisheries in Québec.

RFID *(Radio-frequency identification)*. RFID is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags. Such tags are commonly used on fish, including salmon.

RR model *(Run-Reconstruction model).* RR model is used to estimate PFA and national CLs.

RVS *(Red Vent Syndrome).* This condition has been noted since 2005, and has been linked to the presence of a nematode worm, *Anisakis simplex*. This is a common parasite of marine fish and is also found in migratory species. The larval nematode stages in fish are usually found spirally coiled on the mesenteries, internal organs, and less frequently in the somatic muscle of host fish.

SALSEA (*Salmon at Sea*). SALSEA is an international programme of cooperative research designed to improve understanding of the migration and distribution of salmon at sea in relation to feeding opportunities and predation. It differentiates between tasks which can be achieved through enhanced coordination of existing ongoing research, and those involving new research for which funding is required.

SARA *(Species At Risk Act).* SARA is a piece of Canadian federal legislation which became law in Canada on December 12, 2002. It is designed to meet one of Canada's key commitments under the International Convention on Biological Diversity. The goal of the Act is to protect endangered or threatened organisms and their habitats. It also manages species which are not yet threatened, but whose existence or habitat is in jeopardy. SARA defines a method to determine the steps that need to be taken in order to help protect existing relatively healthy environments, as well as recover threatened habitats. It identifies ways in which governments, organizations, and individuals can work together to preserve species at risk and establishes penalties for failure to obey the law.

SCICOM *(Science Committee)* of ICES. SCICOM is authorized to communicate to third-parties on behalf of the Council on science strategic matters and is free to institute structures and processes to ensure that *inter alia* science programmes, regional considerations, science disciplines, and publications are appropriately considered.

SER *(Spawning Escapement Reserve).* The CL increased to take account of natural mortality between the recruitment date (assumed to be 1st January) and the date of return to home waters.

SFA *(Salmon Fishing Areas).* Areas for which the Department of Fisheries and Oceans (DFO) Canada manages the salmon fisheries.

SGBICEPS *(The Study Group on the Identification of Biological Characteristics For Use As Predictors Of Salmon Abundance).* The ICES study group established to complete a review of the available information on the life-history strategies of salmon and changes in the biological characteristics of the fish in relation to key environmental variables.

SGBYSAL *(Study Group on the Bycatch of Salmon in Pelagic Trawl Fisheries).* The ICES study group that was established in 2005 to study Atlantic salmon distribution at sea and fisheries for other species with a potential to intercept salmon.

SGEFISSA (*Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance*). SGEFISSA is a study group established by ICES which met in November 2006.

SGERAAS (*Study Group on Effectiveness of Recovery Actions for Atlantic Salmon*). SGERAAS is the previous acronym for WGERAAS (*Working Group on Effectiveness of Recovery Actions for Atlantic Salmon*).

SGSSAFE (*Study Group on Salmon Stock Assessment and Forecasting*). The study group established to work on the development of new and alternative models for forecasting Atlantic salmon abundance and for the provision of catch advice.

S_{lim}, i.e. CL *(Conservation Limit).* Demarcation of undesirable stock levels or levels of fishing activity; the ultimate objective when managing stocks and regulating fisheries will be to ensure that there is a high probability that the undesirable levels are avoided.

SSGEF *(SCICOM Steering Group on Understanding Ecosystem Functioning).* SSGEF is one of five Steering Groups of SCICOM (Science Committee of ICES). Chair: Graham Pierce (UK); term of office: January 2012–December 2014.

SST (*Sea surface temperatures*). SST is the water temperatures close to the surface. In practical terms, the exact meaning of surface varies according to the measurement method used. A satellite infrared radiometer indirectly measures the temperature of a very thin layer of about 10 micrometres thick of the ocean which leads to the phrase skin temperature. A microwave instrument measures sub-skin temperature at about 1 mm. A thermometer attached to a moored or drifting buoy in the ocean would measure the temperature at a specific depth, (e.g. at one meter below the sea surface). The measurements routinely made from ships are often from the engine water in-takes and may be at various depths in the upper 20 m of the ocean. In fact, this temperature is often called sea surface temperature, or foundation temperature.

SVC *(Spring Viraemia of Carp)*. SVC is a contagious and potentially fatal viral disease affecting fish. As its name implies, SVC may be seen in carp in spring. However, SVC may also be seen in other seasons (especially in autumn) and in other fish species, including goldfish and the European wells catfish. Until recently, SVC had only been reported in Europe and the Middle East. The first cases of SVC reported in the United States were in spring 2002 in cultivated ornamental common carp (Koi) and wild common carp. The number of North American fish species susceptible to SVC is not yet known.

TAC *(Total Allowable Catch).* TAC is the quantity of fish that can be taken from each stock each year.

WFD *(Water Framework Directive).* European Council Directive 2000/60/EC (WFD) aims to protect and enhance the water environment, updates all existing relevant European legislation, and promotes a new approach to water management through river-based planning. The Directive requires the development of River Basin Management Plans (RBMP) and Programmes of Measures (PoM) with the aim of achieving Good Ecological Status or, for artificial or more modified waters, Good Ecological Potential.

WGBAST *(Assessment Working Group on Baltic Salmon and Trout*). The Assessment Working Group on Baltic Salmon and Trout assesses the status and trends of salmon and sea trout stocks in the Baltic Sea and provides annual catch advice on salmon. The latest WGBAST meeting took place in Aarhus, Denmark, 26 March–2 April 2014, and was chaired by Tapani Pakarinen (Finland).

WGERAAS *(Working Group on Effectiveness of Recovery Actions for Atlantic Salmon).* The task of the Working Group is to provide a review of examples of successes and failures in wild salmon restoration and rehabilitation and develop a classification of activities which could be recommended under various conditions or threats to the persistence of populations. The Working Group held its first meeting in Belfast in February 2013. The latest meeting was held 12–16 May 2014 at ICES in Copenhagen.

WGF *(West Greenland Fishery).* Regulatory measures for the WGF have been agreed by the West Greenland Commission of NASCO for most years since the establishment of NASCO. These have resulted in greatly reduced allowable catches in the WGF, reflecting declining abundance of the salmon stocks in the area.

WGRECORDS *(Working Group on the Science Requirements to Support Conservation, Restoration and Management of Diadromous Species)*. WGRECORDS was reconstituted as a Working Group from the Transition Group on the Science Requirements to Support Conservation, Restoration and Management of Diadromous Species (TGRECORDS).

WKADS *(Workshop on Age Determination of Salmon).* WKADS took place in Galway, Ireland, 18–20 January 2011, with the objectives of reviewing, assessing, documenting and making recommendations on current methods of ageing Atlantic salmon. The Workshop focused primarily on digital scale reading to measure age and growth with a view to standardization.

WKADS2 (*A second Workshop on Age Determination of Salmon*). The Workshop took place 4–6 September 2012 in Londonderry, Northern Ireland to addressed recommendations made at the previous WKADS meeting in 2011 (ICES CM 2011/ACOM:44) to review, assess, document, and make recommendations for ageing and growth estimations of Atlantic salmon using digital scale reading, with a view to standardization. Available tools for measurement, quality control, and implementation of inter-laboratory QC were considered.

WKDUHSTI (*Workshop on the Development and Use of Historical Salmon Tagging Information from Oceanic Areas*). This workshop, established by ICES, was held in February 2007.

WKSHINI (*Workshop on Salmon historical information – new investigations from old tagging data*). This workshop met 18–20 September 2008 in Halifax, Canada.

WKLUSTRE *(Workshop on Learning from Salmon Tagging Records).* This ICES Workshop established to complete compilation of available data and analyses of the resulting distributions of salmon at sea.

This glossary has been extracted from various sources. It was initially based on the EU SALMODEL report, but has subsequently been updated at successive Working Group meetings.

Annex 2 References

Aaen, S. M., Helgesen, K. O., Bakke, M. J., Kaur, K., and Horsberg, T. E. 2015. Drug resistance in sea lice: a threat to salmonid aquaculture. Trends in Parasitology, 31(2): 72–81.

Anon. 2011a. Kvalitetsnormer for laks – anbefalinger til system for klassifisering av villaksbestander. Temarapport fra Vitenskapelig råd for lakseforvaltning 1: 1–105. www.vitenskapsradet.no.

Anon. 2011b. Advancing understanding of Atlantic salmon at sea: merging genetics and ecology to resolve stock-specific migration and distribution patterns. SALSEA–Merge, Project 21 25 29 EU/FP7 Final Report. 79 pp.

Anon. 2013. Kvalitetsnorm for ville bestander av atlantisk laks (*Salmo salar*). Lovdata, 2013(13). FOR-2013-09-20-1109.

Beck, M., Evans, R., Feist, S. W., Stebbing, P., Longshaw, M., and Harris, E. 2008. *Anisakis simplex* sensu lato associated with red vent syndrome in wild Atlantic salmon *Salmo salar* in England and Wales. Diseases of Aquatic Organisms, 82: 61–65.

Besnier, F., Kent, M., Skern-Mauritzen, R., Lien, S., Malde, K., Edvardsen, R., Taylor, S., Ljungfeldt, L., Nilsen, F., and Glover, K. 2014. Human-induced evolution caught in action: SNP-array reveals rapid amphi-atlantic spread of pesticide resistance in the salmon ectoparasite *Lepeophtheirus salmonis*. BMC Genomics, 15: 937. doi:10.1186/1471-2164-15-937.

Bradbury, I., Hamilton, L., Rafferty, S., Meerburg, D., Poole, R., Dempson, J. B., *et al*. 2014a. Genetic evidence of local exploitation of Atlantic salmon in a coastal subsistence fishery in the Northwest Atlantic. Canadian Journal of Fisheries and Aquatic Sciences, 72: 83–95.

Bradbury, I. R., Hamilton, L. C., Robertson, M. J., Bourgeois, C. E., Mansour, A., and Dempson, J. B. 2014b. Landscape structure and climatic variation determine Atlantic salmon genetic connectivity in the northwest Atlantic. Canadian Journal of Fisheries and Aquatic Sciences, 71: 1–13.

Dionne, M., Caron, F., Dodson, J. J., and Bernatchez, L. 2008. Landscape genetics and hierarchical genetic structure in Atlantic salmon: the interaction of gene flow and local adaptation. Molecular Ecology, 17: 2382–2396.

Eisbrenner, W. D., Botwright, N., Cook, M., Davidson, E. A., Dominik, S., Elliott, N. G., *et al*. 2014. Evidence for multiple sex-determining loci in Tasmanian Atlantic salmon (*Salmo salar*). Heredity, 113: 86–92.

Gilbey, J., Coughlan, J., Wennevik, V., Prodohl, P., McGinnity, P., Cauwelier, E., *et al.* Submitted. A microsatellite baseline for genetic stock identification of European Atlantic salmon (*Salmo salar* L.). Submitted to Molecular Ecology Resources.

Hansen, L. P., Jacobsen, J. A., and Lund, R. A. 1999. The incidence of escaped farmed Atlantic salmon, *Salmo salar* L., in the Faroese fishery and estimates of catches of wild salmon. ICES Journal of Marine Science, 56: 200–206.

Hansen, L. P., and Jacobsen, J. A. 2003. Origin and migration of wild and escaped farmed Atlantic salmon, *Salmo salar* L., in oceanic areas north of the Faroe Islands. ICES Journal of Marine Science, 60: 110–119.

ICES. 1986. Report of the meeting of the Special Study Group on the Norwegian Sea and Faroes Salmon Fishery, 15–16 March 1986, Copenhagen, Denmark. ICES CM 1986/M:8. 61 pp.

ICES. 1993. Report of the North Atlantic Salmon Working Group (WGNAS), 5–12 March 1993, Copenhagen, Denmark. ICES CM 1993/Assess: 10. 211 pp.

ICES. 1996. Report of the North Atlantic Salmon Working Group (WGNAS), 10–19 April 1996, Moncton, Canada. ICES CM 1996/Assess: 11. 228 pp.

ICES. 2003. Report of the Working Group on North Atlantic Salmon (WGNAS), 31 March–10 April 2003, ICES Headquarters, Copenhagen, Denmark. ICES CM 2003/ACFM:19. 297 pp.

ICES. 2004. Report of the Working Group on North Atlantic Salmon (WGNAS), 29 March–8 April, Halifax, Canada. ICES CM 2004/ACFM:20. 286 pp.

ICES. 2005. Report of the Working Group on North Atlantic Salmon (WGNAS), 5 March–14 April, Nuuk, Greenland. ICES CM 2005/ACFM:17. 290 pp.

ICES. 2007. Report of the Working Group on North Atlantic Salmon (WGNAS), 11–20 April 2007, ICES Headquarters. ICES CM 2007/ACFM:13. 253 pp.

ICES. 2008. Report of the Working Group on North Atlantic Salmon (WGNAS), 1–10 April, Galway, Ireland. ICES CM 2008/ACOM:18. 235 pp.

ICES. 2009. Report of the Working Group on North Atlantic Salmon (WGNAS), 30 March–8 April 2009, ICES Headquarters, Copenhagen, Denmark. ICES CM 2009/ACFM:06. 283 pp.

ICES. 2010a. Report of the Study Group on Biological Characteristics as Predictors of Salmon Abundance (SGBICEPS), 24–26 November 2009, ICES Headquarters, Copenhagen, Denmark. ICES CM 2010/SSGEF:03. 158 pp.

ICES. 2010b. Report of the Working Group on North Atlantic Salmon (WGNAS), 22–31 March 2010, Copenhagen, Denmark. ICES CM 2010/ACOM:09. 302 pp.

ICES. 2011. Report of the Working Group on North Atlantic Salmon (WGNAS), 22–31 March 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:09. 284 pp.

ICES. 2012a. Report of the Working Group on North Atlantic Salmon (WGNAS), 26 March–4 April 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:09. 322 pp.

ICES. 2012b. North Atlantic Salmon Stocks. *In* Report of the ICES Advisory Committee, 2014. ICES Advice 2012, Book 10. 99 pp.

ICES. 2013. Report of the Working Group on North Atlantic Salmon (WGNAS), 3–12 April 2013, Copenhagen, Denmark. ICES CM 2013/ACOM:09. 380 pp.

ICES. 2014a. Report of the Working Group on North Atlantic Salmon (WGNAS), 19–28 March 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:09. 431 pp.

ICES. 2014b. Interim report of the Working Group on the Effectiveness of Recovery Actions for Atlantic Salmon (WGERAAS). ICES CM 2014/SSGEF:03. 43 pp.

ICES. 2015a. ICES Compilation of Microtags, Finclip and External Tag Releases 2014. Addendum to Report of the Working Group on North Atlantic Salmon (WGNAS), 17–26 March, Moncton, Canada. ICES CM 2015/ACOM:09, WGNAS Addendum. 22 pp.

ICES. 2015b. Report of the Working Group on North Atlantic Salmon (WGNAS), 17–26 March, Moncton, Canada. ICES CM 2015/ACOM:09. 332 pp.

Jombart, T., and Ahmed, I. 2011. *adegenet 1.3-1*: new tools for the analysis of genome-wide SNP data. Bioinformatics, 27: 3070–3071. ISSN: 1367-4803.

Kalinowski, S. T., Manlove, K. R., and Taper, M. L. 2007. ONCOR: a computer program for genetic stock identification. Department of Ecology, 310 Lewis Hall, Montana State University. Available from http://www.montana.edu/kalinowski/Software/ONCOR.htm.

Krkošek, M., Revie, C. W., Gargan, P. G., Skilbrei, O. T., Finstad, B., and Todd, C. D. 2013. Impact of parasites on salmon recruitment in the Northeast Atlantic Ocean. Proceedings of the Royal Society B: Biological Sciences, 280: 20122359. http://dx.doi.org/10.1098/rspb.2012.2359.

Massiot-Granier, F., Prévost, E., Chaput, G., Potter, T., Smith, G., White, J., Mäntyniemi, S. and Rivot. E. 2014. Embedding stock assessment within an integrated hierarchical Bayesian life cycle modelling framework: an application to Atlantic salmon in the Northeast Atlantic. ICES Journal of Marine Science: doi.10.1093/icesjms/fst240.

Millar, R. B. 1987. Maximum Likelihood Estimation of Mixed Stock Fishery Composition. Canadian Journal of Fisheries and Aquatic Sciences, 44: 583–590.

Moore, J-S., Bourret, V., Dionne, M., Bradbury, I., O'Reilly, P., Kent, M., Chaput, G., and Bernatchez, L. 2014. Conservation genomics of anadromous Atlantic salmon across its North American range: outlier loci identify the same patterns of population structure as neutral loci. Molecular Ecology, 23: 5680–5697.

NASCO. 1998. Agreement on Adoption of the Precautionary Approach. Report of the Fifteenth Annual Meeting of the Council. Edinburgh, UK, June 1998. CNL(98)46.

Neaves, P. I., Wallace, C. G., Candy, J. R., and Beacham, T. D. 2005. CBayes: computer program for mixed stock analysis of allelic data. http://www.pac.dfo-mpo.gc.ca/sci/mgl/Cbayes_e.htm.

Nilsen, R., Bjørn, P. A., Serra-Llinares, R. M., Asplin, L., Johnsen, I. A., Skulstad, O. F., *et al*. 2014. Lakselusinfeksjonen på vill laksefisk langs norskekysten i 2014. Rapport fra Havforskningen, 36-2014: 1–43 + 11 sider vedlegg.

Pella, J., and Masuda, M. 2001. Bayesian methods for analysis of stock mixtures from genetic characters. Fishery Bulletin. 99: 151–160.

Potter, E. C. E., Crozier, W. W., Schön, P-J., Nicholson, M. D., Prévost, E., Erkinaro, J., *et al*. 2004. Estimating and forecasting pre-fishery abundance of Atlantic salmon (*Salmo salar* L.) in the northeast Atlantic for the management of mixed stock fisheries. ICES Journal of Marine Science, 61: 1359–1369.

Pritchard, J. K., Stephens, M., and Donnelly, P. 2000. Inference of Population Structure Using Multilocus Genotype Data. Genetics, 155: 945–959.

Piry, S., Alapetite, A., Cornuet, J. M., Paetkau, D., Baudouin, L., and Estoup, A. 2004. GENECLASS2: A software for genetic assignment and first-generation migrant detection. Journal of Heredity, 95: 536–539.

Rannala, B., and Mountain, J. L. 1997. Detecting immigration by using multilocus genotypes. Proceedings of the National Academy of Science, USA, 94: 9197–9201.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada, No. 191. Ottawa. 382 pp.

Serra-Llinares, R. M., Bjørn, P. A., Finstad, B., Nilsen, R., Harbitz, A., Berg, M., and Asplin, L. 2014. Salmon lice infection on wild salmonids in marine protected areas: an evaluation of the Norwegian "National Salmon Fjords". Aquaculture Environment Interactions, 5: 1–16.

Skilbrei, O. T., Finstad, B., Urdal, K., Bakke, G., Kroglund, F. and Strand, R. 2013. Impact of early salmon louse, *Lepeophtheirus salmonis*, infestation and differences in survival and marine growth of sea-ranched Atlantic salmon, *Salmo salar* L., smolts 1997–2009. Journal of Fish Diseases, 36: 249–260. doi:10.1111/jfd.12052.

Tucker, S., Pazzia, I., Rowan, D., and Rasmussen, J. B. 1999. Detecting pan-Atlantic migration in salmon (*Salmo salar*) using ^{137}Cs. Canadian Journal of Fisheries and Aquatic Sciences, 56: 2235–2239.

Yano, A., Guyomard, R., Nicol, B., Jouanno, E., Quillet, E., Klopp, C., *et al*. 2012. An Immune-Related Gene Evolved into the Master Sex-Determining Gene in Rainbow Trout, *Oncorhynchus mykiss*. Current Biology, 22: 1423–1428.

Yano, A., Nicol, B., Jouanno, E., Quillet, E., Fostier, A., Guyomard, R., and Guiguen, Y. 2013. The sexually dimorphic on the Y-chromosome gene (sdY) is a conserved male-specific Y-chromosome sequence in many salmonids. Evolutionary Applications, 6: 486–496.

Youngson, A. F., and Webb, J. H. 1993. Thyroid hormone levels in Atlantic salmon (*Salmo salar*) during the return migration from the ocean to spawn. Journal of Fish Biology, 42: 293–300.

Vasemägi, A., Gross, R., Paaver, T., Kangur, M., Nilsson, J., and Eriksson, L. O. 2001. Identification of the origin of an Atlantic salmon (*Salmo salar* L.) population in a recently recolonized river in the Baltic Sea. Molecular Ecology, 10: 2877–2882.