Stock Annex: Atlantic salmon (*Salmo salar*)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Atlantic salmon
Working Group	Working Group on North Atlantic Salmon (WGNAS)
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1. General

1.1. Stock definition

1.1.1. Background

Atlantic salmon, *Salmo salar* L., have a wide range of life-history strategies. Most forms are anadromous, however, with a juvenile phase in freshwater followed by a period at sea feeding and growing, during which the fish undergo extensive migrations in the open ocean, before they migrate back to freshwater to breed. Most Atlantic salmon return to their river of origin to spawn. This precise homing behaviour has resulted in groups of fish originating in different rivers or tributaries becoming genetically distinct as they adapt to the particular conditions that they face in their home river and along their migration routes. As a result, fish from one river or tributary can differ from fish originating in other rivers/ tributaries which have become adapted to a different set of conditions. These subgroups comprise genetically distinct 'populations' and these are regarded as the basic biological units of the Atlantic salmon species.

Large rivers and their tributaries can support several, genetically distinct populations, each with separate spawning areas within the main-stem of the river or its tributaries. In most instances, however, it is not possible to demarcate clear population boundaries within a river, and managing stocks and fisheries at this level of detail would be very complex. Thus, while there is a need to protect the sustainability of these units, the primary management unit (e.g. for reporting catch statistics and regulating fishing) is generally taken to be the river stock, comprising all fish originating in eggs laid within the river.

Atlantic salmon are native to the temperate and Subarctic regions of the North Atlantic Ocean and there are over 2000 rivers draining into the North Atlantic that support the fish, about 1500 of which discharge into the Northeast Atlantic. In this area, salmon distribution extends from northern Portugal to northern Russia and Iceland, while in the Northwest Atlantic, the species ranges from northeastern USA (Connecticut) to northern Canada (Ungava Bay).

Ideally, the management of all individual river stocks, and the fisheries that exploit them, might be based upon the status of each individual population. This is not always practical, however, particularly where decisions relate to the management of distant water salmon fisheries, which exploit large numbers of stocks originating in broad geographic areas. WGNAS has therefore had to consider how populations or river stocks should be grouped in providing management advice. For this purpose, groups have been established which fall within the meaning of a stock as 'an exploited or managed unit' (Royce, 1984) and that are consistent with the ICES (1996) definition of salmon 'stocks' as 'units of a size (encompassing one or more populations) which provide a practical basis for the fishery manager'. The issues around the grouping of Atlantic salmon stocks for the provision of management advice are reviewed in detail in Crozier *et al*. (2003). Such stock groupings have typically been referred to as stock complexes.

Salmon mature at various sea ages, typically returning to freshwater to spawn after one to three years at sea, but also sometimes at older sea ages; this varies widely between populations. Those salmon that return after one year at sea are referred to as one-sea-winter (1SW) salmon, or grilse, with older fish categorised as 2SW, 3SW, etc. In practice, however, for management purposes these older sea age fish are typically aggregated and collectively referred to as multi-sea-winter (MSW) salmon. The sea age when salmon become sexually mature depends on genetics as well as growing conditions in the sea, and possibly freshwater, although the precise proximate factors initiating homeward migration are unknown (Hansen and Quinn, 1998). The sea age of Atlantic salmon is important in the context of stock definition since these different groups of fish have different migration routes, return at different times and are differentially exploited in fisheries. Thus, for example, it is only potential MSW salmon that are exploited in the distant water salmon fishery that operates off the west coast of Greenland.

1.1.2. Management framework for salmon in the North Atlantic

The advice generated by WGNAS is in response to Terms of Reference posed by the North Atlantic Salmon Conservation Organisation (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. NASCO now has six Parties that are signatories to the Convention, Canada, Denmark (in respect of Faroe Islands and Greenland), the EU (which represents its Member States), Norway, Russia and the USA. While sovereign states retain their role in the regulation of salmon fisheries for salmon originating in their own rivers, fisheries within the jurisdiction of one Party that exploit salmon originating in the rivers of another Party may be regulated by NASCO under the terms of the Convention. This is currently the case for the distant water salmon fisheries at Greenland and Faroes.

NASCO discharges these responsibilities via three Commission areas shown below:

While homewater fisheries are not regulated directly by NASCO, national/ regional jurisdictions seek to comply with NASCO agreements and guidelines in exercising their responsibilities. In particular, NASCO's Agreement on the Adoption of a Precautionary Approach states that an objective for the management of salmon fisheries is to maintain 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, 1999) 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".

In requesting scientific advice from ICES, NASCO asks for an annual review of events in the salmon fisheries and of the status of salmon stocks around the North Atlantic; NASCO also requests management advice for stocks in each of the Commission Areas. In fulfilling these requirements, three specific purposes have been identified for which stock groupings may be required (Crozier *et al*., 2003):

- providing descriptions of the status of stocks;
- developing models to estimate and/or forecast pre-fishery abundance (PFA); and
- developing management advice for the distant water fisheries.

Crozier *et al.* (2003) further noted that there is no reason to assume that the same stock groupings should be used for all these purposes, indeed both the criteria used (e.g. geographical or biological features) and the resulting groups are likely to differ.

1.1.3. Stock groupings used by WGNAS in providing management advice

As noted above, Atlantic salmon would, ideally, be assessed and managed on the basis of river-specific stock units. In reality, <25% of the rivers with salmon populations in the North Atlantic are so assessed (Chaput, 2012; ICES, 2013). Consequently, stock status is often, of necessity, assessed at broader regional, national and subcontinental scales. While there might be merit in grouping stocks according to biological criteria (which could cross jurisdictional boundaries), it has generally been considered that the difficulties of collecting data in a similar format in different jurisdictions is likely to outweigh the benefits of using such groups (Crozier *et al*., 2003). It is also recognised that compilations of data on stocks within each jurisdiction are of importance to regional / national managers. As such, regional / national stock groups are typically used by ICES in providing advice on the status of stocks, with additional information compiled on biological groups (e.g. sea ages) as required.

ICES has previously provided information on the status of stocks in the Northeast Atlantic Commission (NEAC) area by region or by country (as well as sea age). For the North American Commission (NAC) area similar information is provided for the USA and the five main provincial regions in eastern Canada: Labrador, Newfoundland, Québec, Gulf and Scotia-Fundy.

In providing management advice for the mixed-stock distant-water fisheries, broader scale stock groupings have been considered appropriate. For the NAC area this is based on the six geographic regions of North America detailed above. For the NEAC area, the following national groupings have been used in recent years to provide NASCO with catch advice or alternative management advice for the distant-water fisheries at West Greenland and Faroes.

Southern NEAC countries	Northern NEAC countries
France	Russia
Ireland	Finland
UK (Northern Ireland)	Norway
UK (England & Wales)	Sweden
UK (Scotland)	Iceland (north/east regions)[1]
Iceland (south/west regions)1	

[1] The Iceland stock complex was split into two groups for stock assessment purposes in 2005 (ICES, 2005), largely on the basis of tag–recapture information. Prior to 2005, all regions of Iceland were considered part of the Northern NEAC stock complex.

These groups were deemed appropriate by WGNAS as they fulfilled an agreed set of criteria for defining stock groups for the provision of management advice that were considered in detail at the 2002 WGNAS meeting (ICES, 2002) and re-evaluated at the 2005 WGNAS meeting (ICES, 2005). ICES subsequently noted, however, that provision of catch advice for NEAC stocks in the distant water fisheries should preferably be based on a larger number of smaller management units, similar to those used in the NAC area (ICES, 2010a; 2011). Such an approach was developed at the 2013 WGNAS meeting (ICES, 2013) and indicative catch advice was provided at the country level as well as the Southern and Northern NEAC stock complexes. ICES is awaiting feedback from NASCO on the choice of management units.

Salmon from most NEAC stocks mix in the Norwegian Sea in autumn and winter, and are exploited by the fishery at Faroes. While there is evidence that some salmon from NAC rivers have been caught in the Norwegian Sea, they are currently not considered in the NEAC assessments, although this is now under review. Recent genetic information suggests that more North American fish than previously thought were exploited in the fishery at Faroes. Further details on the results of these investigations are provided in Section 3.3.3 of this report and potential options tor accounting for these fish in future catch advice is provided in Section 3.6. To date, consideration of the level of exploitation of national stocks in the Faroes fishery (ICES, 2005) resulted in the proposal that catch advice for the fishery should be based upon all NEAC area stocks and both 1SW and MSW fish.

In contrast, the fishery to the west of Greenland operates in an area where salmon from all North America and some Northeast Atlantic stocks mix in their second summer at sea. Catch advice for this fishery is thus based on non-maturing (potential MSW) fish from all regions of North America, while consideration of the level of exploitation of national stocks in the fishery from NEAC, resulted in catch advice being based upon only Southern NEAC non-maturing 1SW (potential MSW) fish (ICES, 2005).

1.2. Fisheries

Most exploitation of Atlantic salmon is restricted to fisheries close to or within the rivers of origin of the stocks; these homewater fisheries take adult fish that are mainly returning to these rivers to spawn. As noted above, these fisheries are not directly regulated by NASCO since the Parties retain responsibility for the regulation of fisheries for salmon originating in their own rivers. However, NASCO can regulate fisheries undertaken by a Party that take salmon originating in another Party's rivers, such as is the case for the distant-water fisheries at Greenland and Faroes. These fisheries take salmon originating in a large number of rivers over a wide geographical range.

1.2.1. The Northern Norwegian Sea Fishery

A longline fishery for salmon in parts of the Norwegian Sea, north of latitude 67°N, commenced in the early 1960s. Several countries participated in this fishery and the pattern of fishing, area of operation and catches changed markedly over the years. At its peak in 1970 this fishery harvested almost 1000 tonnes of salmon.

The Convention for the Conservation of Salmon in the North Atlantic Ocean, which resulted in the formation of NASCO, came into force in October 1983. The Convention created a large protected zone, free of targeted fisheries for Atlantic salmon in most areas beyond 12 nautical miles from the coast. An immediate effect was the cessation of the salmon fishery in the Northern Norwegian Sea outside the Faroes EEZ, with the last catches in this area reported in 1984 (ICES, 2013).

In the late 1980s and early 1990s, NASCO acted through diplomatic initiatives to address fishing for salmon in international waters by vessels registered to non-NASCO Parties. There have been no reports of such activities since this period.

1.2.2. The Faroes fishery

The fishery in the Faroes area commenced in 1968 with a small number of vessels fishing up to 70 miles north of the Faroes; initially catches increased slowly up to 40 tonnes in 1977. Danish vessels participated in the fishery between 1978 and 1982 and, at the same time, catches started to increase rapidly, peaking at 1025 tonnes in 1981. Several factors contributed to this increase: the season was extended, more vessels entered the fishery, and the fishery shifted northwards.

From 1982, the Faroese Government agreed to a voluntary quota system, involving a total catch of 750 tonnes in 1982 and 625 tonnes in 1983 (255 boats allowed 25 tonnes each). Since NASCO's establishment, regulatory measures or decisions have been agreed by the Northeast Atlantic Commission in most years (Table 1.2.2.1). These have resulted in greatly reduced allowable catches in the Faroese fishery, reflecting declining abundance of the salmon stocks. There has been no commercial salmon fishery targeting salmon around the Faroes since the early 1990s. Catches in the fishery are presented in Figure 1.2.2.1.

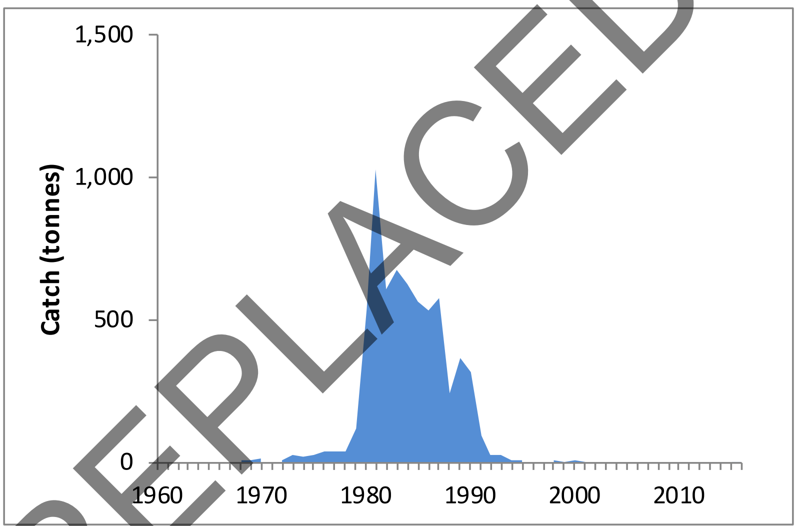

Figure 1.2.2.1. Nominal catch of salmon (tonnes, round fresh weight) in the Faroese longline fishery, 1960–2016.

Table 1.2.2.1. Summary of Regulatory Measures agreed by NASCO for the Faroese Salmon Fishery (courtesy of NASCO).

Year	Allowable catch (tonnes)	Comments/other details in the measures/decisions
1984–1985	625	
1986	-	
1987–1989	1790	Catch in any year not to exceed annual average (597t) by more than 5%.
1990–1991	1100	Catch in any year not to exceed annual average (550t) by more than 15%.
1992	550	
1993	550	
1994	550	
1995	550	
1996	470	No more than 390 tonnes of the quota to be allocated if fishing licences issued.
1997	425	No more than 360 tonnes of the quota to be allocated if fishing licences issued.
1998	380	No more than 330 tonnes of the quota to be allocated if fishing licences issued.
1999	330	No more than 290 tonnes of the quota to be allocated if fishing licences issued.
2000	300	No more than 260 tonnes of the quota to be allocated if fishing licences issued.
2001–2003	No quota set	It is the intention of the Faroese authorities to manage the fishery in a precautionary manner with a view to sustainability, and to make management decisions with due consideration to the advice from ICES concerning status of stocks contributing to the fishery.
2004–2006	No quota set	It is the intention of the Faroese authorities to manage the fishery on the basis of the advice from ICES concerning status of stocks contributing to the fishery in a precautionary manner with a view to sustainability and taking into account relevant factors such as socio-economic needs and other fisheries on mixed-stocks.
2007	No quota set	It is the intention of the Faroese authorities to manage any salmon fishery on the basis of the advice from ICES regarding the stocks contributing to the Faroese salmon fishery in a precautionary manner and with a view to sustainability, taking into account relevant factors such as socio-economic needs.

Year	Allowable catch (tonnes)	Comments/other details in the measures/decisions
2008	No quota set	It is the intention of the Faroese authorities to manage any salmon fishery on the basis of the advice from ICES regarding the stocks contributing to the Faroese salmon fishery in a precautionary manner and with a view to sustainability, taking into account relevant factors such as socio-economic needs.
2009	No quota set	It is the intention of the Faroese authorities to manage any salmon fishery on the basis of the advice from ICES regarding the stocks contributing to the Faroese salmon fishery in a precautionary manner and with a view to sustainability, taking into account relevant factors such as socio-economic needs.
2010	No quota set	It is the intention of the Faroese authorities to manage any salmon fishery on the basis of the advice from ICES regarding the stocks contributing to the Faroese salmon fishery in a precautionary manner and with a view to sustainability, taking into account relevant factors such as socio-economic needs.
2011	No quota set	It is the intention of the Faroese authorities to manage any salmon fishery on the basis of the advice from ICES regarding the stocks contributing to the Faroese salmon fishery in a precautionary manner and with a view to sustainability, taking into account relevant factors such as socio-economic needs.
2012	No quota set	It is the intention of the Faroese authorities to manage any salmon fishery on the basis of the advice from ICES regarding the stocks contributing to the Faroese salmon fishery in a precautionary manner and with a view to sustainability, taking into account relevant factors such as socio-economic needs.
2013–2015	No quota set	It is the intention of the Faroese authorities to manage any salmon fishery on the basis of the advice from ICES regarding the stocks contributing to the Faroese salmon fishery in a precautionary manner and with a view to sustainability, taking into account relevant factors such as socio-economic needs.
2015/2016–2017/2018	No quota set	It is the intention of the Faroese authorities to manage any salmon fishery on the basis of the advice from ICES regarding the stocks contributing to the Faroese salmon fishery in a precautionary manner and with a view to sustainability, taking into account relevant factors such as socio-economic needs

Note: The quotas for the Faroe Islands detailed above for the period 1984–2000 were agreed as part of effort limitation programmes (limiting the number of licences, season length and maximum number of boat fishing days) together with measures to minimise the capture of fish less than 60 cm in length. The measure for 1984/1985 did not set limits on the number of licences or the number of boat fishing days.

The Faroes salmon fishery operated over winter from November through to May. The salmon caught in the fishery originated almost entirely from European countries with salmon from many countries being present in the area (Jacobsen *et al*., 2001). Small numbers of tagged fish originating in North America were also recaptured in the fishery (e.g. ICES, 1991), but excluded from catch advice. Genetic investigations, based on salmon scales removed from fish caught in the fishery in the 1980s and 1990s, suggested North American fish may make a larger contribution to the Faroes fishery than originally indicated (ICES, 2015). 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. (ICES, 2015). WGNAS has been asked to consider the implications of the findings in providing future catch advice to NASCO.

The fishery exploited mainly 2SW fish, although some 1SW and 3SW fish were also caught. Small salmon (<60 cm total length) in their first winter at sea were required to be discarded. Large numbers of farmed salmon were also observed at Faroes and there is evidence that farmed salmon escaping from net pens in Norway entered this area (Hansen *et al.*, 1987; Hansen and Jacobsen, 2003). Such farmed fish accounted for a significant proportion of the catch; in the early 1990s, the proportion of farmed fish in this area was estimated at between 25 and 40% (Hansen *et al.*, 1999).

Tagging studies (of adult fish caught in the fishery) have indicated that some fish caught at Faroes were apparently on their way westwards, as they were reported from West Greenland later the same year (Jákupsstovu, 1988). However, salmon tagged at West Greenland were also reported in the area north of the Faroes the following year (ICES, 1984). Thus, salmon of European origin are believed to move through the Faroese area on their way to the feeding areas in the West Atlantic as well as on their return to homewaters.

1.2.3. The Greenland fishery

Limited fishing at West Greenland is reported as far back as the early 1900s, although the present fishery dates from 1959 when local fishers began setting fixed gillnets from small boats in certain fjords around Maniitsoq (Shearer, 1992). Rapid expansion along the coast followed and from the mid-1960s Faroese and Norwegian fishers introduced offshore driftnets, followed soon by fishermen from Greenland and Denmark. At around the same time improvements in gear (the introduction of light monofilament nets) enabled fishing in daylight and improved the efficiency of the gear. As a consequence, catches rose quickly reaching a peak of almost 2700 tonnes in 1971. Fishing by non-Greenlandic vessels was phased out in 1972–1975. However, the total catch remained at around 2000 tonnes until 1976 when a TAC of 1190 tonnes was set; the fishery has been regulated since this time. Small catches of salmon are also made on the east coast of Greenland although these are sporadic and restricted by the small number of communities in this area and by drifting polar ice.

Regulatory measures have been agreed by the West Greenland Commission for most of the years since NASCO's establishment (Table 1.2.3.1). These have resulted in greatly reduced allowable catches in the West Greenland fishery, reflecting declining abundance of the contributing salmon stocks. In all but two years since 1998, the fishery has been restricted to an internal-use fishery and commercial export of salmon is not permitted. Catches in the Greenland fishery are presented in Figure 1.2.3.1.

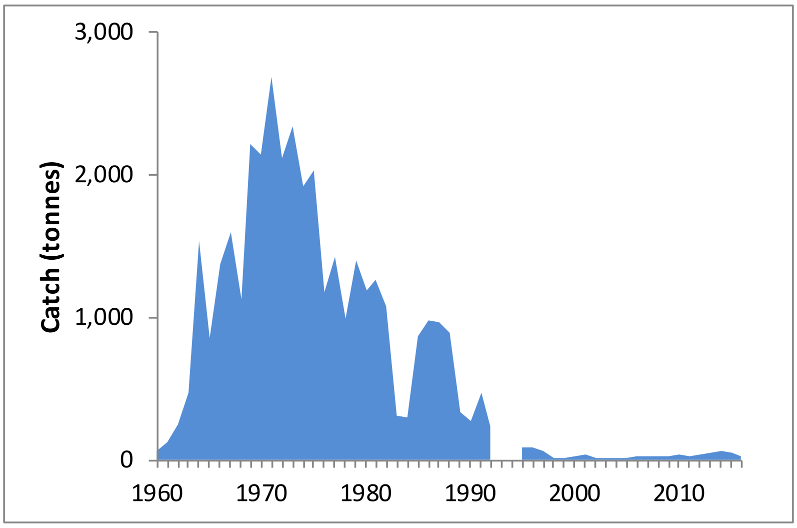

Figure 1.2.3.1. Nominal catch of salmon (tonnes, round fresh weight) in the Greenland salmon fishery, 1960–2016.

The Greenland salmon fishery operates in summer, with a fairly large proportion of the catch commonly being taken in the weeks after the opening of the season in August. Both drift and fixed gillnets continue to operate. The salmon caught in the fishery to the west of Greenland originate in both North America and the Northeast Atlantic. Data on continent of origin in the catch indicate a reasonably even split between fish from North America and Europe in the early 1990s (ICES, 2013). However, the proportion of North American fish in the catch has increased steadily since this time with North American fish comprising 80–90% of the fish caught in recent years.

The salmon caught at West Greenland are almost exclusively fish in their second summer at sea, however, these are non-maturing 1SW salmon destined to return to homewaters as 2SW, or older, fish. Fish from all parts of North America are taken in the fishery, while it is primarily only potential MSW salmon from southern countries in Europe (UK, Ireland and France) that are exploited here. Very few salmon of farmed origin appear in the catches at Greenland, and these are not taken into account in assessments.

Table 1.2.3.1. Summary of Regulatory Measures agreed by NASCO for the West Greenland Salmon Fishery (courtesy of NASCO).

Year	Allowable catch (tonnes)	Comments/other details in the measures
1984	870	
1985	-	Greenlandic authorities unilaterally established quota of 852 t.
1986	850	Catch limit adjusted for season commencing after 1 August.
1987	850	Catch limit adjusted for season commencing after 1 August.
1988–1990	2520	Annual catch in any year not to exceed annual average (840 t) by more than 10%. Catch limit adjusted for season commencing after 1 August.
1991	-	Greenlandic authorities unilaterally established quota of 840 t.
1992	-	No TAC imposed by Greenlandic authorities but if the catch in first 14 days of the season had been higher compared to the previous year a TAC would have been imposed.
1993	213	An agreement detailing a mechanism for establishing annual quota in each of the years 1993 to 1997 was adopted by the Commission.
1994	159	
1995	77	
1996	-	Greenlandic authorities unilaterally established a quota of 174 t.
1997	57	An addendum to the 1993 Agreement was agreed by the Commission.
1998	Internal consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20 t.
1999	Internal consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20 t.
2000	Internal consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20 t. A Resolution Regarding the Fishing of Salmon at West Greenland was agreed by the Commission.
2001	28–200	Under an *ad hoc* management programme the allowable catch will be determined on the basis of cpue data obtained during the fishery.

Year	Allowable catch (tonnes)	Comments/other details in the measures
2002	20–55	Under an *ad hoc* management programme the allowable catch will be determined on the basis of cpue data obtained during the fishery.
2003–2008	Internal consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20 t.
2009–2011	Internal consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20 t.
2012–2014	Internal consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20 t.
2015–2017	Internal consumption fishery only. Greenland unilaterally committed limit the total annual catch for all components of the fishery to 45 t in 2015, 2016 and 2017.	The fishery will open no earlier than 1 August and close no later than 31 October each year. Any overharvest in one year will result in an equal reduction in the catch limit the following year. Efforts will be made to identify and implement temporal or spatial harvest restrictions that would provide increased protection for weaker stocks. Greenland will further improve the monitoring, management control and surveillance of its salmon fishery in accordance with the Plan for Implementation and Control Measures in the Salmon Fishery at West Greenland with the objective of achieving full catch accountability. All Members of the Commission will implement the six tenets. Greenland will inform NASCO, in a timely manner, of any modifications to the management of the West Greenland salmon fishery, of the outcome of the 2015, 2016 and 2017 fisheries and of progress with the implementation and effectiveness of its Plan for Implementation of Monitoring and Control Measures in the Salmon Fishery at West Greenland. States of origin will explore opportunities to share experiences with Greenland on monitoring, management control and surveillance in the salmon fishery. A quota of 32 tonnes was set for 2016 fishery. The Commission agreed to review the measure prior to the 2017 fishery.

1.3. Ecosystem aspects

Over the past 20 to 30 years, there has been a marked decline in the abundance of Atlantic salmon across the species' distributional range. Wild Atlantic salmon populations are declining across most of their home range and, in some cases, disappearing (ICES, 2008). Generally, populations on the southern edge of the distribution seem to have suffered the greatest decline (Parrish *et al.*, 1998; Jonsson and Jonsson, 2009; Vøllestad *et al*., 2009), which may be linked to climatic factors. The decline in salmon abundance has coincided with a variety of environmental changes linked to an increase in greenhouse gases and a corresponding increase in temperatures (IPCC, 2001), which is most likely to have manifest effects at the edge of the species range. However, these areas are often also the ones with higher human population densities and therefore, typically, where potential impacts on the freshwater environment may also be greater. A range of factors in freshwater are known to affect stocks including, for example, contaminants, river obstructions, and changing river flows and temperatures (ICES, 2009b; 2010b; Russell *et al.*, 2012). Such factors have potential implications for the survival of juvenile salmon and their resulting fitness when they migrate to sea as smolts (e.g. Fairchild *et al*., 2002).

Atlantic salmon occupy three aquatic habitats during their life cycle: freshwater, estuarine and marine. Similar factors contribute to mortality in each of these habitats - competition, predation and environmental factors - but despite occurring in different habitats, these are not independent. Conditions experienced within the freshwater environment can affect the survival of emigrating smolts and marine conditions may subsequently modify the spawning success of fish in freshwater.

The decline in salmon populations has occurred despite significant reductions in exploitation, although this does not preclude possible fishery effects. An underlying cause has been a marked increase in the natural mortality of salmon at sea; the proportion of fish surviving between the smolts' seaward migration and their return to freshwater as adult fish (e.g. Peyronnet *et al*., 2008; Chaput, 2012). For many stocks, return rates are now at the lowest levels in the time-series, even after the closure of marine fisheries. This reduced survival is thought to reflect climatic factors and broad-scale changes in ocean ecosystems as well as factors in freshwater. The exact processes controlling marine survival are relatively poorly understood (Friedland, 1998), although there is growing support for the hypotheses that survival and recruitment is mediated by growth during the post-smolt year, for European stocks at least (Friedland *et al*., 2009).

Although their habitats are widely separated geographically, there is strong coherence in recruitment patterns between North American and European stock complexes. Recent research suggests recruitment is correlated with ocean temperature variation associated with the Atlantic Multidecadal Oscillation (AMO) (Friedland *et al.*, 2013). It further appears that there are differences in the mechanisms affecting stocks in the Northwest and Northeast Atlantic, with ocean climate variability during the first spring months of post-smolt life most important to the survival of North American stocks, while summer climate variation appears to be more important to adult recruitment variation for European stocks (Friedland *et al.*, 2013). It has been speculated that this may be related to the varying roles of predation pressure and size-related mortality on the two continental stock complexes.

In addition to changes in climate and potential issues operating in both freshwater and marine environments, various other factors have been postulated as possibly contributing to the decline in stock abundance, including predation, aquaculture impacts and the effects of fisheries. Huge increases in aquaculture production of Atlantic salmon over recent decades (see Section 2.2.1 of the WGNAS report) have created some concerns for wild populations. The main potential impacts include: (i) genetic impacts on wild fish; (ii) discharge of organic material and other wastes; (iii) transmission of diseases and parasites (particularly sea lice) to wild populations; and (iv) concerns about obtaining adequate feed resources from an already heavily exploited marine ecosystem. For example, recent investigations in Norway have demonstrated that gene pools of wild salmon populations in a number of rivers have been gradually changed through introgression of genetic material from escaped farmed salmon (Glover et *al.*, 2012; Glover et *al.*, 2013). Sea lice also continue to be regarded as a serious problem for wild salmonids (Skilbrei *et al.*, 2013; Krkošek *et al.*, 2013) affecting their survival and perhaps also their life-history characteristics (Vollset *et al.*, 2014).

As well as declines in abundance, changes in salmon life histories are also widely reported throughout the geographic range of the species, affecting factors such as sea age composition, size at age, age-at-maturity, condition, sex ratio and growth rates (e.g. Nicieza and Braña, 1993; Hutchings and Jones, 1998; Niemelä *et al*., 2006; Peyronnet *et al*., 2007; Aprahamian *et al*., 2008; Todd *et al*., 2008). Changes are also manifest in freshwater stages, affecting factors such as the size and growth of parr and the age of smolting (e.g. Davidson and Hazelwood, 2005; Jutila *et al*., 2006) and run timing (Kennedy and Crozier, 2010; Otero *et al*., 2013).

2. Data

2.1. Introduction

Assessment of Atlantic salmon differs from the approaches commonly adopted for other species, for example in respect of the need for at sea surveys and collection of commercial catch per unit of effort (cpue) data. Instead, the assessment of salmon is based mainly on data collected on individual river stocks (e.g. catches and counts of returning fish), which are raised and aggregated to provide estimates of the number of fish returning to homewaters for different stock groupings. These estimates are used, in turn, to estimate abundance at earlier points in the life cycle of the fish and to inform the development of catch advice.

The provision of management advice for the mixed-stock fisheries at Faroes and West Greenland is based on assessments of the status of stocks at broad geographic scales. The North American Commission (NAC) area is divided into six management units, and the Northeast Atlantic (NEAC) Commission area is divided into 19 regions. Assessment of the status of the stocks in these areas is based on estimates of the total abundance - the pre-fishery abundance (PFA) - of different cohorts of salmon at a stage before the distant water fisheries operate. PFA is defined as the cohorts of salmon maturing as 1SW and MSW fish that are alive prior to all the marine fisheries for 1SW salmon (Rago *et al.*, 1993a). The catch advice for the NEAC area is then provided for the northern (N-NEAC) and southern (S-NEAC) stock complexes and for countries.

The models to estimate the PFA of salmon from different areas are typically based on the catch in numbers of one-sea-winter (1SW) and multi-sea-winter (MSW) salmon in each country or region, which are then raised to take account of estimates of non-reported catches and exploitation rates on the two age groups. In some cases, particularly in the NAC area, returns to homewater are estimated by alternative methods, such as counts at fishways and counting fences, or from mark and recapture studies. The estimates of fish numbers returning to homewaters are then raised to take account of the natural mortality (M) between the date that the fish are deemed to recruit to the particular fishery of interest and the midpoint of the timing of the respective national fisheries. A value of 0.03 per month is assumed for M (Section 3.2.3). The date of recruitment of NAC stocks (and thus the PFA date) is taken as August 1st in the second summer at sea because these fish are first exploited in the distant water fishery at West Greenland. However, NEAC stocks recruit to the Faroes fishery during their first sea winter and so PFA is calculated at January 1st (i.e. eight months earlier) for these stocks.

2.2. Input data for assessments-NEAC area

PFA for NEAC stocks is estimated using the run-reconstruction approach described by Potter *et al*. (2004). The model estimates the PFA of both maturing and non-maturing 1SW salmon because both stock components may be caught in the Faroes fishery, and data for both the Faroes and West Greenland fisheries are incorporated into the model.

In order to run the NEAC PFA model, each country provides time-series (beginning in 1971) of catch in numbers, non-reporting rates and exploitation rates for 1SW and MSW salmon. Best estimates and a measure of the uncertainty or error are provided for the non-reporting and exploitation rate data in order to obtain a measure of the uncertainty in the PFA estimates, since these data are commonly derived from expert opinion. The latest data input variables used in running the NEAC assessment are listed at Appendix 3.

In some instances, the above information has been supplied in two or more regional blocks per country. In these instances, the model output is provided for the regions and is also combined to provide one set of output data for the country as a whole.

The input data for Finland consists solely of catches from the River Tana/Teno. These comprise both Finnish and Norwegian net and rod catches, as the river marks the border between these countries. The Norwegian catches from the river are not included in the input data for Norway.

Where possible, when the input data are themselves derived from other data sources, the raw data are included in the model. This allows the uncertainty in these analyses to be incorporated into the modelling approach. Thus, the catch and sample data used to estimate the catches of Scottish fish in the northeast English coastal fishery are incorporated into the assessments for both UK (England and Wales) and UK (Scotland). For Greenland, catch data are input in the form of harvests (reported and unreported) in weight, along with data from the West Greenland sampling programme.

Descriptions of how the model input data have been derived are presented below for different countries (updated from Crozier *et al*., 2003; ICES, 2002). The methods used to derive the PFA input data for NEAC countries and options for improving the data are also discussed in Crozier *et al*. (2003).

2.2.1. Median dates of return to homewater fisheries

NEAC stocks recruit to the Faroes fishery during their first sea winter and so the date of recruitment (and thus the PFA date) is calculated at January 1st. In deriving PFA from the estimates of fish numbers returning to homewaters, it is necessary to take account of natural mortality between the date that the fish recruit to the particular fishery of interest and the midpoint of the timing of the respective national fisheries. The median return date for 1SW and MSW fish for each country/region are provided in the table below. Thus there is about a six to nine month period between the PFA date and the median time of return to homewaters for maturing 1SW fish and 17 to 20 months for non-maturing fish.

Table 2.2.1.1. Midpoint of recruitment to homewater fisheries for NEAC countries/regions.

NEAC Country/ region	1SW	MSW
Northern NEAC		
Russia - Pechora River	8	8
Russia - Archangel / Karelia	7.5	8
Russia - Kola / White Sea	8.5	7.5
Russia - Kola / Barents Sea	7	6.5
Finland	6.5	6
Iceland - north & east	7	6
Norway	8	5
Sweden	8.5	6.5
Southern NEAC		
Iceland - south & west	7	6
UK (Scotland - east)	8	5
UK (Scotland - west)	8	7
UK (N. Ireland - Fo area)	7	5.5
UK (N. Ireland - FB area)	6.5	6
Ireland	8	5
UK (England & Wales)	8	5
France	8.5	8.5

2.2.2. Data inputs for Northern NEAC countries

2.2.2.1. Finland

Catch: The catch input to the model of Finland represents an estimate based on catch enquiries and the total number of licences issued. The Norwegian catch from the River Teno has been included in the Finnish catch, which results in a set of input data that effectively represents a single river system. Catch composition is estimated based on catch samples and corresponding scale analyses.

Level of unreported catch: Unreported catch is estimated by extrapolating the catches of the fishers that failed to report their catches, as reporting is not mandatory.

Exploitation rates: Exploitation rates in the river fisheries are derived from radio tagging studies in 1992–1993 and 1995, when 70–100 adult fish (1SW and MSW) were tagged yearly in the estuary. Most of the important river fisheries were covered by these experiments.

2.2.2.2. Norway

Area split: Salmon catches in Norway are split into four regions on the basis of climatic differences and oceanographic differences among the areas. The areas are: (1) southeast Norway from the Swedish border to the border between Rogaland and Hordaland counties, (2) southwest Norway from the border between Rogaland and Hordaland counties to Stad (3) mid Norway from Stad to Lofoten, and (4) north Norway from Lofoten to the border with Russia.

Catch: Nominal catches of salmon in the four regions are used. In recent years there have been improvements in declaring catches. From 1979 there was a weight split

1SW/MSW (<3 kg/>3 kg). From 1993 the split was changed to 1SW/2SW/3SW (<3 kg/3–7 kg/>7 kg). Mean weight was provided for most groups and used to estimate numbers in the early part of the time-series, but in recent years the reported nominal catch (reported number of killed salmon in river and sea fisheries summed) is being used. In the input to the PFA model salmon smaller than 3 kg are regarded as 1 SW fish, whereas salmon larger than 3 kg are regarded as MSW fish. The two largest size groups are thus summed into MSW salmon. In the PFA model input the Norwegian catch data for the River Teno have been removed from the Norwegian catches and incorporated in the Finnish catches.

Unreported catch: No systematic effort is used to estimate unreported catches. Inputs are guesstimates based on occasional reports from test fishing, surveillance reports, and questionnaires. Currently there is no evidence that the level of unreported catches differs between the four regions. These estimates are provided by the management authorities.

Exploitation rates: The rates for the national model are guesstimates. For parts of southeast and southwest Norway they are derived from estimated marine exploitation rates from the River Imsa and the River Drammen. In recent years (from 2009 onwards) exploitation rates for many rivers (>50) have been taken into consideration. These exploitation rates have been obtained using a multitude of methods, mainly from drift counts of spawners or results from counting facilities combined with reported catches in the rivers. The exploitation rates have been adjusted in relation to reduced fishing effort. At present different exploitation levels are used for the different regions, reflecting different harvest regimes in the regions.

For Norway, only data from 1983 onwards have been used for assessment purposes.

2.2.2.3. Russia

Area split: The Atlantic salmon rivers of northwest Russia are split into the following four regions: Kola Peninsula - Barents Sea basin; Kola Peninsula - White Sea basin; Archangelsk Region and the Karelia; and the Pechora River region. The split is based on four regions with separate catch statistics and different biological characteristics of the stocks. For example, the difference in age composition and relative abundance of summer and autumn salmon evident among these four regions has influenced the split.

Catch: The declared catch data, in numbers, is available for the full time period (1971 onwards) for all four regions. Catches were allocated to 1SW or MSW age groups on the basis of commercial and scientific catch sampling programmes.

Level of unreported catch: Unreported catches in legal fisheries are estimated from logbooks and catch statistics, by comparing catch survey results with reported catch. Illegal catch is guesstimated and based on local knowledge of fisheries. The major component of the illegal catch in the Barents Sea basin (Kola Peninsula and Pechora River) comes from in-river fisheries and a considerable part of the illegal catch in the White Sea basin (Kola Peninsula and Archangelsk region) comes from coastal areas and this contributes the greatest uncertainties. There is a particular problem with illegal catches on the Pechora River where scientific sampling programmes suggest that the illegal catch on this river is very high. The level of non-reporting increased considerably in the early 1990s due to the economic changes in Russia and temporary reduction of control and enforcement. Since late 2000s the higher level of non-reporting occurred in recreational fisheries due to unclear legislation for reporting.

All these factors have been considered in deriving the level of unreported catch for the PFA model.

Exploitation rates: Information on exploitation rates is derived from several fisheries in the Kola Peninsula where counting fences are operated and from mark–recapture exercises on the rivers with recreational fisheries. Exploitation rates in Archangelsk and Pechora are guesstimated. These are the basis of the inputs to the model, regional sea age differences being adjusted on the basis of local knowledge from estimated stock levels.

2.2.2.4. Sweden

Catch: The catch input to the model is based on annual reported commercial salmon catch on the Swedish west coast, and on voluntary reporting from sport fishing in rivers. This reporting is detailed and considered accurate and is handled by the government agency "Swedish Agency for Marine and Water Management" (commercial catches) and the Swedish University of Agricultural Sciences (non-commercial catches). Unfortunately, reporting of catches from non-commercial fishing for salmon with gillnets or rod and line on the coast is lacking. However, due to fishing regulations these catches are small (permits required for trapnets, ban on gillnets in deeper waters, restrictions on the use of gillnets in shallow waters, limited fishing season, large marine protected areas, ban on selling fish, etc.).

There is a large proportion (ca. 60–70%) of reared fish in catches and stocks as a result of compensatory releases of reared smolts (ranching). As all ranched salmon are finclipped the catches of reared fish can be treated separately in the catch statistics. In the reporting from the commercial fishing the catch is not separated into wild and reared fish. The proportion of wild salmon is instead estimated from catch statistics in nearby rivers. Stocking of reared salmon is done in three rivers; all of these also have wild stocks in tributaries.

Catch-and-release is practised in most rivers (only rod-and-line fishing allowed in rivers) but the extent of C&R is not always known. Reported catch is landed fish, but in most rivers a proportion of the fish is released back alive and any subsequent mortality is not accounted for.

Level of unreported catch: Unreported catch, i.e. non-commercial catch of salmon in the coastal area with gillnets and rod and line, is estimated from guesstimates based on expert judgement from regional fishery officers and the Swedish University of Agricultural Sciences. These estimates are supported with catch inventories carried out in 1999 (Thörnqvist, unpublished), 2004 (Swedish Agency for Marine and Water Management), 2008 (Thörnqvist, unpubl.). Generally, the unreported catch is estimated to be 5–10% of the reported catch.

Exploitation rates: Few fish counters are present and tagging data exist mainly for reared stocks, where the fishing pressure is higher than for wild stocks. Input for the PFA model is based on guesstimates. In the index River Ätran, data on size and composition of the spawning run and estimates of exploitation are developed at present. Since 2000, a fish ladder with an automatic counter has provided data on the spawning run in this river. Counter data in combination with results from small-scale tagging in this river are used to provide estimates of exploitation rates. One problem is that exploitation rates differ considerably between rivers. During the period 2000–2014 the average exploitation rates for the Swedish stock as a whole have been estimated at 34% for 1SW and 39% for MSW. The exploitation rate has increased in 2011-

2014 due to increased gillnet fishing on the coast. This fishery has been closed and exploitation is expected to decrease in future.

2.2.2.5. Iceland

Area split: The input data for the PFA model is divided into two areas. Rivers in the west and south of Iceland are combined into one area and rivers in the north and east into another. This is done on the basis of historic tag recoveries in ocean fisheries (which occurred in different areas) and different climate and oceanic conditions affecting the salmon life cycle, e.g. run-timing, smolt age, and sea age. The southern and western parts of Iceland fall within the NEAC southern area, while the northern and eastern parts of Iceland fall within the NEAC northern area.

Catch: Age-class information is available from individual catch records from logbooks used in the rod fishery. The division into sea age classes is based on a bimodal weight distribution. The 1SW females are <3.5 kg and 2SW females >3.5 kg, while 1SW males are <4 kg and 2SW >4 kg. Scale analyses have shown that the presence of salmon having spent more than two winters at sea and of previous spawners is uncommon and that the categorisation into 1SW and 2SW age classes by weight is regarded as fairly accurate. The net catches are recorded on a daily basis. The age split in the net fishery is derived from the weight distribution in the rod fishery from the same river system or from rivers in the same area.

In the River Ranga in southern Iceland substantial smolt releases have occurred since the early 1990s and have now reached a level of 300 000 to 500 000 smolts annually. Originally, the River Ranga had a small salmon stock with an annual catch of 10 to 90 fish until 1990. The river has very limited habitat for salmon production, but these 'ranched' fish now support a substantial rod fishery. The catch in the River Ranga comprised 23% (18–27%) of the total reported salmon rod catch in Iceland between 2009 and 2013. Since these fish are expected to have very low spawning success in the river they are excluded from the PFA catch input data.

Level of unreported catch: The fishing rights in Icelandic salmon rivers belong to landowners who must, by law, form a fishery association to manage the fishing right. The rod fishing rights are leased to the highest bidder. No ocean or estuary fisheries are allowed. The unreported catch was originally believed to be low with a guesstimate value of 2% applied. With increased use of midwater trawls in pelagic fisheries off the coast of Iceland, new information was provided which suggested an increased level of salmon bycatch. Based on a questionnaire survey, the value of unreported catch was therefore revised after 1995 to a value of 10% of the declared salmon catch. However, more recent analyses of DNA, as well as scale analyses, from salmon sampled as bycatch by Icelandic fishing vessels, indicates a low percentage of Icelandic salmon. Based on this, and other available information, a new estimate of unreported catch is now applied for Iceland at 4% of the declared catch for 1SW and MSW salmon.

Exploitation rates: Rates of rod exploitation are based on rivers with fish counters and catch records from logbooks. The estimates of exploitation are 40–50% for 1SW salmon and 50% to over 70% for 2SW salmon. The exploitation estimate for an in-river gillnet fishery is 39% to 52%, with a higher exploitation rate on larger fish. Information on the number of fish subject to catch and release in rod fisheries is also available from logbooks. The proportion of released fish has been increasing since 1996. The reduced exploitation due to catch and release is taken into account in the annual estimate of exploitation for both 1SW and 2SW stock components in the PFA model inputs.

Median return date of 1SW and MSW: Run timing can vary both between years and between areas. The median return date of 1SW and 2SW salmon in south and west Iceland is mid-June and early June respectively. The median date of return is later in the north and east of Iceland, mid-June for MSW and early July for 1SW salmon.

2.2.2.6. Denmark

The Working Group collects and routinely reports the annual catch of salmon taken in Denmark. However, the small Danish catches are not included in the assessment process used in developing catch advice for the distant water fisheries.

Catch: The catch input is based on continuously collected reports of salmon taken in the recreational fishery in Danish west coast streams (from Internet sources), which all hold populations of wild salmon. In four of these, where salmon populations have always been found, there is a large proportion of reared (finclipped) salmon in the catch, but these are all F1 offspring from the original populations. In the one catchment in eastern Denmark (Gudenå), where the salmon population is not genetically native to the stream, the annual catch is guesstimated.

Level of unreported catch: Unreported catch is expected to be negligible in the western streams because the fishing is closely regulated and controlled by the anglers. In the eastern stream (Gudenå) unreported catch is guesstimated.

Exploitation rates: Exploitation rates may be derived from the total catch related to estimates of the total run (calculated by mark–recapture surveys on a three-year cycle in the four streams with original populations on the west coast).

2.2.3. Data inputs for Southern NEAC countries

2.2.3.1. France

Catch: The estimation of salmon catch in France comes from two main sources: (1) mandatory declaration of rod and line catches and from the Adour nets operating in the lower river (scales are sampled from each fish caught) to the Office National de l'Eau et des Milieux Aquatiques (ONEMA), under the Ministère de l'Ecologie, which assumed responsibility from the Conseil Supérieur de la Pêche (CSP) in 2006; and (2) mandatory declaration of catches made by professional net fishers to Affaires Maritimes, under the Ministère de la Mer, who since 2008 have delegated responsibility for collection and first processing of catch data to the Regional Boards for Sea Fisheries and Aquaculture Catch. At the same time, catches at sea are declared to the Institut Français de Recherches pour l'Exploitation de la Mer (Ifremer), who are responsible for archiving and scientific processing of all fisheries data. Salmon and sea trout catches have not been reliably collated and made available until recently. Since 1985, the 1SW/MSW split has been based on scale interpretation of the in-river catch (based on scale reading) and on a categorisation based on length thresholds for catches in estuaries and at sea. The figures prior to 1985 are not considered as reliable as the later ones.

Level of unreported catch: Unreported legal catch for the rod and line fishery has been estimated by catch inquiries made by environmental inspectors of ONEMA on each river. These procedures are still operating in some areas, but estimates are considered less reliable in recent years. The estimation of the professional net fishery catch (Adour Basin) is thought to be reliable and no unreported legal catch is considered to apply.

For most years, the unreported illegal catch is not assessed and a minimal value is provided on a precautionary basis. This unreported illegal catch has been assessed in some years by *ad hoc* inquiries in the estuary of a number of rivers in Brittany (e.g. in 2001) and on the coast (e.g. Baie of Mont Saint-Michel in 2000). The "unreported catch" is included in the nominal catch. No estimates of unreported catch are available for the early part of the time-series (prior to 2001). Thus, the rates input to the model for 1SW and MSW for the early period are near zero and range from -0.00001 to 0.00001. Higher values in the range 20% to 40% for 1SW and 15% to 30% for MSW fish are applied more recently.

Exploitation rates: Exploitation rates are derived from the index River Scorff in Brittany. This is an in-river rate, by rods only, where there are no, or very few, fish thought to be caught on the estuary or coast. Rates are also derived for the Adour river system, where a rough estimation is provided by using the lower values of adult run estimates through facilities in the three rivers flowing to Adour, and the declared catches on the coast, estuary and river, respectively by nets and rods. Some caution is necessary regarding these rates from the Adour given the uncertainties in the different estimates. The rod catch on the index River Nivelle is very small and the probable net exploitation in the estuary and coast is unknown, so exploitation rates are not used for this system. Some data on exploitation rates are also collected by ONEMA on the index River Bresle, but sea trout are the dominant angled species in this river.

2.2.3.2. Ireland

Catch: The data are derived from annual declared catches within fisheries districts, management units implemented by Regional Fisheries Boards. Since 2007 river and estuarine specific angling and commercial catch data have been complied. The Fisheries Boards were amalgamated into a single body, Inland Fisheries Ireland, in 2010 which currently takes responsibility for compiling catch statistics. Catches are split by age on the basis of a reported age distribution from 1980 to 1988. In the absence of any other information the mean proportion of 2SW salmon in the series (7.5%) has been used since 1988 and a mean of 10% has been used prior to 1980. Since the introduction of a carcass tagging and logbook scheme for angling and commercial fisheries in Ireland in 2002, sea age classes in the time-series since 2007 have been determined based upon catch dates and weights in accordance with national river stock assessments. The catch is not corrected for returns from releases of smolts for ranching or enhancement but these are not a major component of the catch.

Level of unreported catch: The values are guesstimated from local reports and knowledge achieved during catch sampling and fisheries protection activities.

Exploitation rates: A coded-wire tagging (CWT) programme has been operated in several rivers in Ireland since 1980. Up to 300 000 hatchery smolts and up to 5000 wild smolts are tagged and released annually. There is also a substantial dataset on wild salmon from the monitored River Burrishoole, providing a further index of wild returns and exploitation rates. Overall, there are estimates of exploitation rates available for three wild stocks and seven hatchery stocks for both 1SW and 2SW salmon. Up to the closure of the marine mixed-stock fishery in 2006, the annual mean of the 1SW wild exploitation index is used as the input data for the lower range of exploitation in the PFA model while the mean of the 1SW hatchery index is used as the upper range. The annual mean of the 2SW wild and hatchery exploitation index was used as the input data for the upper and lower range of exploitation in the PFA model depending on which is higher or lower in that year. Since 2006 the main exploitation input has been from the rod catch which is estimated from coded wire tags estimates for some rivers and also rivers with counters.

2.2.3.3. UK (England & Wales)

Catch: Nominal catches for UK (England & Wales) have been derived from the catch returns submitted by netsmen and anglers and split into 1SW and MSW categories using two different methods. Since 1992, monthly age–weight keys derived from salmon caught in the River Dee trap (an index river) have been used to estimate the age of all rod-caught fish where a weight and date of capture have been provided. This has then been scaled up to the total catch (rods and nets combined) on a pro-rata basis. In earlier years (1971–1991), the age composition of the total catch has been estimated using the mean weight of the fish caught and the mean weight of 1SW and MSW salmon recovered in tagging programmes.

As the contribution of farmed and ranched salmon to the national UK (England & Wales) catch is negligible, the occurrence of such fish is ignored in the assessments of the status of national stocks. However, a large proportion of the fish taken in the northeast coast fishery are destined for Scottish rivers, and these are deducted from the returning stock estimate for UK (England & Wales) and added to the data for UK (Scotland) in the ICES assessment. This proportion is estimated to have declined from 95% of the northeast net catch in the early part of the time-series to 75% in the late 1990s and to around 65% since 2003. This reflects both the steady improvement in the status of the stocks in northeast England and the phase out of the English drift-net fishery since 2003.

Level of unreported catch: All licence holders are required to provide the Environment Agency with details of their catch of salmon and migratory trout and the number of days fished on each river or, for nets, each fishery at the end of the season. Catch returns are received from all net licence holders and from ~90% of full season anglers, and the latter account for the majority of fish caught in a catchment, typically 96–98%. The main correction for underreporting is therefore currently made in respect of perceived inaccuracies in the returns, although more substantial corrections have applied in the past.

There are few independent measures of underreporting in the rod fishery, but these indicate that the level is currently small. A value of 10% is applied for correction purposes based on the method of Small (1991). Historically, underreporting was a much more serious problem. As a result of changes in the licensing and associated catch return system covering UK (England & Wales) in the early 1990s, the percentage of underreporting in the rod catch was estimated to have decreased from ~ 50% to ~20%. Since the mid-1990s, awareness campaigns and enhanced catch reminder systems have further reduced underreporting to the levels currently estimated.

For the net fishery, a figure of 8% has been used in recent years to adjust for the level of underreporting, based on the outcome of surveillance operations. The level may have been substantially higher in the past in certain fisheries, possibly as much as 50%. However, following the successful introduction of logbooks and a carcass tagging scheme in 2009, there is now considered to be minimal underreporting in net fisheries. A figure of 2% has been assumed since 2009.

An earlier questionnaire survey of Environment Agency enforcement staff suggested illegal catches were around 12% of the declared net and rod catch. However, since the introduction of a carcass tagging scheme and a ban on the sale of rod caught fish in 2009, it has been substantially more difficult to dispose of illegally caught fish. Since this time, illegal catches have been estimated to have been reduced to 6% of the declared catch.

Exploitation rates: Exploitation rates for a number of monitored fisheries in UK (England & Wales) are derived annually. National exploitation rates have then been estimated by deriving time-series of 'standard fishing units' employed in the salmon fisheries for the period 1971 to the present. For the period 1971 to 1997, these are calculated from the numbers of licences issued weighted by their relative catching power, which is estimated from historic cpue data; and for the period 1998 to the present, they are calculated from the numbers of days fished by different net categories weighted in the same way. The annual exploitation rates are then estimated by referencing the number of 'standard fishing units' employed over the two periods relative to average age-specific exploitation estimates derived for the 1997 and 1998 seasons.

Additional information: Further details on the derivation of estimates within UK (England & Wales) are available in the annual stock status reports (e.g. Cefas, Environment Agency and Natural Resources Wales, 2014), available at:

http://www.cefas.defra.gov.uk/publications/files/SalmonReport2013-final.pdf

2.2.3.4. UK (Northern Ireland)

Area split: Originally, a single assessment was carried out for UK (Northern Ireland). However, the data used were derived from two fishery management areas (Foyle and Fishery Conservancy Board (FCB) areas), which publish separate catch statistics and have differing fishing regulations. On the basis that stock status in the two areas may differ (Crozier *et al*., 2003) the two areas were assessed separately from 2001.

Catch: As no commercial fishing has been conducted in the Loughs Agency area since 2010 and in the DCAL area since 2012 the Northern Ireland catch statistics currently (since 2014) rely solely on rod catches. Overall UK (Northern Ireland) rod catch estimates are available since the introduction of a carcass-tagging scheme in 2001. These catch statistics are used as an input in the model. Estimates of sea age composition of the catch for the time-series are based on 1SW/MSW data from adults returning to the River Bush (an index river).

Level of unreported catch: Estimates of unreported catch, as a result of illegal fishing, are based on intelligence reports from DCAL and Loughs Agency fishery officers. These are guesstimates only, with no verification possible. Annual adjustments in unreported catches have been used since tagging programmes started in the mid-1980s. Prior to that, a constant under reporting figure is used, as no annual data are available. The introduction of the carcass tagging scheme in 2001 has led to a reduction in unreported catches.

Exploitation rates: Estimates of exploitation rates were historically based on the River Bush microtagging programme. Exploitation from this monitored river (which is in the DCAL fishery area) was used as an input figure for all UK (Northern Ireland) fisheries (Foyle and DCAL areas). However, as currently no commercial fishery for salmon exists in the DCAL and Loughs Agency areas, exploitation rates are based on rod exploitation in the DCAL and Loughs Agency alone.

Possible improvements: A possible improvement would be to have better data available on sea age composition of all Northern Irish fish. Currently the River Bush estimate is applied to all Northern Irish data, but independent data from large river systems like the Bann and Foyle would result in a more reliable country wide estimate. In addition, a higher return rate for the carcass tagging scheme would result in more reliable estimates of exploitation rates. Recently the carcass tagging return rate in UK (Northern Ireland) has varied between 14% and 55%.

2.2.3.5. UK (Scotland)

Area split: The country is divided into eleven regions for the purposes of collating and publishing salmon and sea trout fishery statistics (Marine Scotland Science, 2012). Within the PFA run-reconstruction model, UK (Scotland) is divided into two broad areas (east and west), the split being influenced by the contrasts in climate, river size and the timing and sea age of returning fish. The east grouping comprises the east, northeast, Moray-Firth, and north statistical regions, the remaining regions comprise the west grouping.

Catch: Catches were collated according to the area split defined above. Reported retained catches of wild salmon, taken by both net and rod fisheries, are provided separately for two age classes, one sea-winter and multi sea-winter fish. Catch sampling programmes have shown that there is a variable (by region, year, and fishery) proportion of 1SW salmon categorised as MSW salmon in the reported catches. Catch data used in the model are not currently corrected to account for such misreporting.

Level of unreported catch: The ranges used in the national model are based on previous guesstimates made by local managers in some eastern areas of the country (MAFF, 1991). The differences in the ranges used for the east and west groupings are based on a subjective view that unreported catches in the west area are likely to be greater than in the east area. It is thought that human population densities are lower in the west and therefore there is likely to be less surveillance over the reporting of salmon catches. Further, west coast rivers are generally smaller and more numerous than east coast rivers, leading to a greater number of locations where unreported catches may be taken. Ranges provided are a subjective estimate of uncertainty in these parameters.

Exploitation rates: Rates for the national model are guesstimates derived from estimated exploitation rates over a range of fisheries in the early part of the time-series (Shearer, 1992), and the time-series of exploitation rates derived from the River North Esk (Marine Scotland Science, 2010), together with reported net effort indices and the proportion of rod caught fish which were subsequently released (e.g. Marine Scotland Science, 2013).

2.2.3.6. Spain

The Working Group collects and routinely reports the annual catch of salmon taken in the recreational rod fisheries in Spain (mainly Asturias). However, the small Spanish catches are not included in the assessment process used in developing catch advice for the distant water fisheries.

2.2.4. Data inputs for Faroes and West Greenland fisheries

2.2.4.1. Faroes

Reported catch: Catches are derived from the landings of salmon caught in the commercial and research fisheries that operated in the Faroes EEZ and the northern Norwegian Sea. Catches for each season (i.e. November in year n to May in year n+1) are assigned to the second year (i.e. year n+1). These fish are classified into 1SW and

MSW age groups according to their age (or potential age) on January 1st during the fishery (i.e. a post-smolt caught in November is classified as 1SW).

Unreported catch: All fish less than 63 cm total length have been discarded in this fishery and so an unreporting rate of 10–15% (with an error of +/- 5%) has been used for 1SW fish; there is thought to have been negligible non-reporting of MSW fish.

Catch composition: Estimates of the proportion of farmed fish in the catch for the period 1981 to 1995 have been derived from scale reading (ICES, 1996; Hansen *et al.*, 1997); prior to 1981 all fish are assumed to have been wild, and since 1997 a value of 0.8 has been used.

Tagged fish originating in North America have been recaptured in the fishery (e.g. ICES, 1991), but excluded from catch advice.

The country of origin of the catch had been estimated based on tagging studies undertaken in the early 1990s (Hansen *et al*., 1999). These were subsequently replaced by estimates based on genetic analysis.

Genetic investigations, based on salmon scales removed from fish caught in the fishery in the 1980s and 1990s provided an estimated proportion of North American fish in the catches at Faroes. Estimates of 5.7% (1SW) and 20.5% (MSW) have been used in subsequent analyses (ICES, 2015).

The composition of the European component was investigated using individual genetic assignments and gave an overall 1SW stock composition of 84.2% Southern European, 9.0% Northern Europe, 1.2% Icelandic and 5.7% North American (ICES, 2015). The overall composition of the MSW catch was determined as 20.9% Southern European, 58.0% Northern Europe, 0.6% Icelandic and 20.5% North American (ICES, 2015).

It was not possible to use the genetic assignments to estimate the composition of the catches to country/regional level, but they suggested that the composition within the stock complexes was 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 (ICES, 2015). Sources of uncertainty in these estimates are described in ICES (2015).

2.2.4.2. West Greenland

Catch: The total nominal catch (i.e. tonnes round fresh weight) in the West Greenland fishery is reported and converted to numbers using a mean weight obtained from the sampling programme.

Unreported catch: Estimates of unreported catch were not provided for the period from 1993 to 1999; an annual estimate of non-reported catch, varying from 5 to 20 tonnes was provided by the Greenland representative. Since 2000 a nominal figure of 10 t per year has been provided.

Efforts have been made to provide further information on the level of unreported catch at West Greenland. Since 2002, some assessment of the unreported catch, primarily for commercial landings, has been provided by comparing the weight of salmon seen by samplers involved in the international sampling programme and the corresponding community-specific reported landings. However, since sampling only occurs during a portion of the fishing season, these are considered to be minimum estimates for unreported catch. In addition, there is currently no quantitative approach for estimating the unreported catch for the private fishery. A telephone survey of fishers was carried out following the 2014 and 2015 seasons and provisional findings were provided to WGNAS in 2015 and 2016. These are discussed further in Section 5.1 of the Working Group report (see above); such investigations may provide a basis for revising estimates of unreported catch in future.

Continent of origin: The catch at West Greenland was divided into NAC and NEAC components using scale characteristics until around 2000 and since that time genetic analysis has been used. For the period when scale characteristics were used, the input data to the model are the minimum and maximum estimates of the proportion of NAC fish (from which minimum and maximum proportions of NEAC fish are calculated). For the subsequent period, the inputs are the numbers of NAC and NEAC fish identified in the samples.

2.2.5. Improvements to NEAC input data

NEAC countries have made ongoing efforts to improve the input data used in assessments. Modifications to input variables are reported by WGNAS in the year in which they are first implemented.

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). However, the methods used to derive estimates of unreported catch vary markedly between countries. For example, some countries include only illegally caught fish in the unreported catch, while other countries include estimates of unreported catch by legal gear as well as illegal catches in their estimates.

Descriptions of the national approaches used for evaluating unreported catches have been reported at various WGNAS meetings (e.g. ICES, 1996; 2000; 2002; 2010a). In addition, detailed reports describing national procedures for evaluating illegal and unreported catch, and efforts to minimise this, were submitted by parties to NASCO in 2007 in support of a special theme session on this issue. Full details are available at: *http://www.nasco.int/pdf/2007%20papers/CNL(07)26.pdf*.

Input data commonly rely on rod catches and the practice of catch and release has become increasingly important in recent years to reduce levels of exploitation on stocks. In the NEAC areas, catch and release estimates from the rod fisheries are not available from all countries and, when they are, corrections for catch and release mortality are commonly not applied. As the practice of catch and release is increasing, WGNAS have previously recommended (ICES, 2010a) that consideration should be given to incorporating mortality associated with this practice in river-specific, regional and national assessments.

The procedures currently used to incorporate catch and release and unreported catches into regional, national and international assessments are summarised in Appendix 1 (from ICES, 2010a).

One weakness of the NEAC model is that it is heavily dependent upon catch data and estimates of exploitation rate. In most salmon fisheries in the NEAC area, more than half the catch is reported, and in many cases it approaches 100%. However, as stocks have declined, exploitation rates have been reduced to very low levels, and estimates of abundance are therefore becoming increasingly sensitive to this parameter. This inevitably means that uncertainty in the estimates is increasing, and it therefore strengthens the need to make use of alternate sources of information on stock abundance, such as adult counts.

2.3. Input data for assessments-NAC area

The run-reconstruction model for NAC developed by Rago *et al.* (1993a) is used to estimate the PFA of non-maturing 1SW salmon of North American origin (beginning in 1971). Only the West Greenland fishery is of relevance in the context of distant water exploitation of NAC stocks. This fishery exploits predominantly (>95%) 1SW non-maturing salmon (destined to return primarily as 2SW salmon) and hence it is only necessary to estimate the abundance of this age group prior to the fishery at Greenland. The other fish taken in the fishery represent 2SW and older non-maturing salmon and previous spawners (ICES, 2003). However, PFA estimates for maturing 1SW salmon as well as large salmon (containing all MSW age groups of salmon including repeat spawners) can be derived from the run-reconstruction model.

The starting point for the reconstruction requires estimation of the returns of 2SW salmon and large salmon to the six regions in eastern North America: Labrador, Newfoundland, Québec, Gulf, Scotia-Fundy, and USA. With the progressive closure of commercial fisheries (1984 for the Gulf and Scotia-Fundy regions; 1992 for Newfoundland; and 1998–2000 for Labrador and Québec) abundance estimates have relied less on harvests and increasingly on estimated returns to rivers raised to production areas. The returns for each region are estimated with the uncertainty defined by a range of minimum and maximum values based on the best information available for each region (Chaput *et al.*, 2005).

The annual pre-fishery abundance of non-maturing 1SW fish for year i, destined to be 2SW returns (excluding 3SW and previous spawners), represents the estimated number of salmon at West Greenland prior to the start of the fishery on August 1st. Definitions of the input variables used in the model are given in Table 2.3.1. The PFA estimate is constructed by summing 2SW returns in year i+1 [NR2(i+1)], 2SW salmon catches in commercial and Aboriginal peoples' food fisheries in Canada [NC2(i+1)], and catches in year i from fisheries on non-maturing 1SW salmon in Canada [NC1(i)] and Greenland [NG1(i)].

Table 2.3.1. Definitions of key variables used in continental run-reconstruction models for North American salmon.

i	Index for PFA year corresponding to the year of the fishery on 1SW salmon in Greenland and Canada
M	Natural mortality rate (0.03 per month)
t1	Time between the midpoint of the Canadian fishery and return to river = 1 month
S1	Survival of 1SW salmon between the homewater fishery and return to river {exp-M * t1}
H_s(i)	Number of “Small” salmon caught in Canada in year i; fish <2.7 kg
H_l(i)	Number of “Large” salmon caught in Canada in year i; fish >=2.7 kg
AH_s	Aboriginal and resident food harvests of small salmon in northern Labrador
AH_l	Aboriginal and resident food harvest of large salmon in northern Labrador
f_imm	Fraction of 1SW salmon that are immature, i.e. non-maturing: range = 0.1 to 0.2
af_imm	Fraction of 1SW salmon that are immature in native and resident food fisheries in N Lab
q	Fraction of 1SW salmon present in the large size market category; range = 0.1 to 0.3
MC1(i)	Harvest of maturing 1SW salmon in Newfoundland and Labrador in year i
i+1	Year of fishery on 2SW salmon in Canada
MR1(i)	Return estimates of maturing 1SW salmon in Atlantic Canada in year i
NN1(i)	Pre-fishery abundance (PFA) of non-maturing 1SW + maturing 2SW salmon in year i
NR(i)	Return estimates of non-maturing + maturing 2SW salmon in year i
NR2(i+1)	Return estimates of maturing 2SW salmon in Canada
NC1(i)	Harvest of non-maturing 1SW salmon in Nfld + Labrador in year i
NC2(i+1)	Harvest of maturing 2SW salmon in Canada
NG(i)	Catch of 1SW North American origin salmon at Greenland
T2	Time between the start of the fishery at West Greenland (August 1) and return to the coast of North America = 10 months
S2	Survival of 2SW salmon between August 1 (at West Greenland) and return to the coast of North America {exp-M * t2}
MN1(i)	Pre-fishery abundance of maturing 1SW salmon in year i

2.3.1. Data inputs for NAC

The latest data input variables used in running the NAC assessment are listed at Appendix 4. More detailed descriptions of how the model input data have been derived for each region of North America are presented below.

2.3.1.1. Labrador

For Labrador stocks, it was thought to be inappropriate to develop total recruits from angling catches and exploitation rates similar to techniques used for rivers in insular Newfoundland. The problem with using angling catches to derive returns for Labrador is, that until 1994, there were no estimates of exploitation rates available other than for the salmon population of Sand Hill River and these were 20 years out of date. Also, because Labrador coastal rivers are isolated, the exploitation rates are low and highly variable depending on the presence of an angling camp and its success in attracting guests as well as the nearness of local communities. Thus, exploitation rates would depend, and vary from one year to the next, on the success of angling camps in attracting anglers and may not be applicable to other Labrador rivers. Thus, all estimates of returns and spawners until 1998 were based on commercial catches as the only source available of usable continuous time-series of data.

Before 1998

The general approach is to use exploitation rates to convert commercial catches of small and large salmon in Labrador to total population prior to the commercial fishery. River returns and spawners were estimated by subtracting the commercial catch from these populations, and accounting for non-Labrador interceptions. The estimated number of Labrador origin large returns is calculated as:

$$LR = (CC*PL) / u \qquad (1)$$

where,

LR = Labrador returns, PL = proportion Labrador origin, CC = commercial catch, and u = exploitation rate

The estimated number of Labrador origin small returns is determined from equation (1) but using commercial catches of small salmon.

Parameter values for sea age and the proportion of salmon of Labrador origin comes from the sampling program in the commercial fishery, 1974–1991. In 1997, commercial sampling resumed with samples being collected throughout the fishery at Makkovik and Rigolet in SFA 1 and Cartwright and St Lewis/Fox Harbour in SFA 2. River age distribution of commercial samples of small and large salmon from Labrador have been found to consist, on average, of about 75–80% river age 4 and older in SFAs 1 & 2. The commercial samples came from commercial catches sampled in Labrador at several sites along the Labrador coast including Square Islands (SFA 2) and at Nain (SFA 1) (Anon, 1993b). In total, 46 320 salmon were sampled for scales and aged. Labrador salmon stocks are thought to contribute about 70% of the total production of four year, and older, river age salmon, with the other 30% coming from northern Québec. Thus, when non-Labrador salmon are factored in at 30% applied to the river age distribution, then 60–80% of the harvest of small and large salmon (PL) in Labrador are of Labrador origin (Anon, 1993b). In 1997, in SFA 1, the percentage of the commercial catch that was of Labrador origin was for large salmon 68% (95% C. I. 64.3–72.5%); whereas for small salmon it was 39% (95% C.I. 35.6%–41.6%). In 1997, in SFA 2, the percentage of the commercial catch that was Labrador origin was for large salmon 92% (95% C. I. 88.4–95.2%); whereas for small salmon it was 80% (95% C.I. 74.8%–85.0%).

Exploitation rates (u) were calculated from the smolt tagging study in 1969–1973 on Sand Hill River (Reddin, 1981; Reddin and Dempson, 1989). Exploitation rates of 0.28 to 0.51 for small salmon and 0.83 to 0.97 for large salmon from the tagging study were changed to base exploitation rates of 0.3 to 0.5 on small salmon and 0.7 to 0.9 on large salmon and were assumed to apply to all of the salmon populations in SFAs 1, 2, and 14B for the period of 1969–1991 (Anon., 1993b). After 1991, due to the Management Plans for the commercial fishery in Labrador and Newfoundland, several changes occurred that would reduce exploitation of Labrador origin salmon. These changes include: (1) reductions in effort as commercial salmon fishers chose to sell their licences from a buy-out agreement begun in 1992, (2) a moratorium on commercial fishing in Newfoundland would increase the number of Labrador salmon in Labrador coastal waters, and (3) season reductions due to the varying opening dates and early closures from the quotas applied in 1995 and 1996. The effects of these changes were quantified in the exploitation model as follows:

$$u=1-e^{-aF} \quad (2)$$

where: a = fraction of the 1991 licensed effort remaining in 1992–1996.

In 1994–1996, the licensed effort for all of Labrador was 37% of the 1991 level of 570 licences, in 1993 it was 55%, and in 1992 it was 87%. In any given year, it was assumed that 90% of licensed fishers were active. Fishermen reported during public consultations that in 1995 and 1996 many licensed salmon fishers did not fish for salmon in 1995–1996 but fished for crab instead. This was verified by Fisheries Officers who reported that of the 218 licensed salmon fishers only 132 were active in 1996. Another method of obtaining actual effort information is also available since, beginning in 1993 commercial fishing vessel (CFV) numbers have been recorded on sales receipts issued to fishers by fish plants. Enumeration of licensed salmon fishers actively fishing was made by determining the number of CFVs in the Statistics Branch catch records. Active effort in 1991 and 1992 was assumed to be 90% as it was in 1993 and 1994 from the CFV file. Thus, the exploitation rates (u) were modified due to effort reductions in equation (2) using estimated active licences from 1991 as a base and the number of active licences in 1995, 1996 and 1997. The modified exploitation rates (ue) for 1992–1997 used the licensed effort in equation (2).

The tagging study on Sand Hill River, 1969–1973 showed that Labrador small and large salmon were not only caught in Labrador, but also in the commercial fisheries along the northeast coast of Newfoundland (both small and large) and at West Greenland (large only) (Anderson, 1985). For small salmon, out of a total of 100 (1SW) tag returns there were 24 from Newfoundland. For large salmon, out of a total of 137 (2SW) tag returns there were 41 from Newfoundland.

For 1992–1997: the moratorium on commercial fishing in Newfoundland would have released small and large salmon to Labrador. The effect of salmon released from Newfoundland in 1992–1996 was evaluated against the exploitation rates as follows:

$$un = (1-((24 * (1 - ue))/100)) * ue, \text{ for small salmon, and}$$
$$un = (1-((41 * (1 - ue))/137)) * ue, \text{ for large salmon} \quad (3)$$

The new estimates of fishing mortality (un) in 1992–1994 included adjustments for the closure of the commercial fishery in Newfoundland based on the results of the Sand Hill River tagging study. Season reductions due to the varying opening dates and early closures from the quotas applied in 1995 and 1996. In 1995, adjustments were made to account for the new opening date for the commercial fishery in Labrador of July 3 changed from June 20 the previous year. For 1995, the accumulative effect of these, weighted to SFA catches, was to reduce the catch so that for small salmon the current catch represents 86.0% of small salmon and 62.7% of large salmon. In 1996, the opening date reverted to June 20 but the quota levels resulted in early closures in SFA 2 of 2A - July 10, 2B - July 8, and 2C - July 2 while SFA 1 and 14B did not close. For 1996, the accumulative effect of these weighted to SFA catches was to reduce the catch so that for small salmon the current catch represents 53% of small salmon and 61% of large salmon. In 1997, the opening date remained at June 20 but the quota levels resulted in early closures in SFA 2 of 2A -July 12, 2B - July 15, and 2C - July 13 while SFA 1 closed on October 15 as the quota was not caught. For 1997, the accumulative effect of these early closures was to reduce the catch so that for small salmon the current catch represents 47% of small salmon and 64% of large salmon. The season changes reduce catches and hence lower exploitation rates. The effect of shorter seasons in 1995, 1996 and 1997 was evaluated against the exploitation rates in section B as follows:

$US = UN * SC$, for small salmon, where SC is season change, and
$US = UN * SC$, for large salmon (4)

The new estimates of fishing mortality including effort reductions, adjustments for the closure of the commercial fishery in Newfoundland, and shorter seasons due to opening dates and quotas results in the following exploitation rates which were applied to catches. The cumulative effect of factors A, B, and C is to reduce exploitation on Labrador origin salmon.

Labrador origin 2SW returns (LR2SW) were derived from eq. 1 by:

$$LR2SW = LR * P2SW \quad (5)$$

where: P2SW = proportion of the large salmon that is 2SW salmon.

The SR1SW were calculated as in equation (5) but using P1SW which is the proportion of the catch that is 1-sea winter in age and maturing to enter freshwater and spawning in the year of capture. The parameter values for P1SW of 0.1 to 0.2 come from Anon. (1991).

The 2SW component was estimated separately for salmon caught in SFA 1, 2 and 14B. In SFA 1, commercial sampling at Nain of large salmon showed the proportion of 2SW were on average about 84% (n=6542), 1977–1991. Thus, a range of 0.7–0.9 was used for SFA 1. In SFA 2, commercial sampling of large salmon averaged 69% (n=4793) 2SW salmon, 1977–1991. There were no commercial samples available for SFA 14B. Thus, for SFAs 2 & 14B a range of 0.6–0.8 was used. For the 1SW component, commercial samples at Nain in SFA 1 of small salmon showed the proportion of 1SW salmon were on average about 94% (n=4757). In SFA 2 the 1SW component was on average about 97% (n=8872) of small salmon. There were no samples from commercial sampling in SFA 14B. In 1997, aged commercial samples indicated that the previous range was acceptable.

Total river returns of 2SW salmon (TRR) were calculated as follows:

$$TRR = LR2SW / (1\text{-}us) \quad (6)$$

The total river returns of small salmon are also calculated by equation 6 but from SR.

Spawning escapement (SE) or spawners was calculated according to the formula:

$$SE = TRR - AC, \quad (7)$$

where:

AC = angling catch which includes retained catch plus 10% of hook & released mortality for released salmon.

A couple of modifications were made to the estimation procedure for Labrador in 1997. First, determination of exploitation rates were calculated separately for SFA 1, 2 and 14B using the active effort individually for each SFA. For SFA 1, the active number of licences declined from 141 in 1991 to 39 in 1997. For SFA 2, the active number of licences declined from 320 in 1991 to 99 in 1997. For SFA 14B, active licences declined from 52 in 1991 to 0 in 1997 when the fishery was closed. Exploitation rates determined as in equations 2, 3 and 4 are: SFA 1 - small was 0.0735 to 0.1399 and - large was 0.2221 to 0.3959; and SFA 2 - small was 0.0384 to 0.0728 and - large was 0.1589 to 0.2799.

Numbers of small and large salmon for SFAs 1 & 2 were estimated from the exploitation model while for SFA 14B the results of assessments on Forteau Brook and Pinware River were expanded to include all the watersheds in SFA 14B. Returns to SFA 14B were 663 to 1545 small salmon and 146 to 327 large salmon.

Total mortalities of small and large salmon were accounted for by summing commercial catches of small salmon in Labrador and Newfoundland, large salmon in Labrador, Newfoundland, and Greenland, angling catches in Labrador of small and large salmon including 10% of the hook and released salmon, and small and large spawners. All of the above mortality estimates except catches of Labrador salmon in Newfoundland, 1969–1991 and Greenland could be obtained from equations 1 to 7. Catches in Newfoundland and Greenland were assessed as follows:

Greenland: for 1969–1992 and 1995–2004, removals of Labrador salmon by the Greenland fishery were assessed from data based on the sampling program in commercial fish plants at West Greenland (Anon, 1996). The Greenland fishery catches salmon that would have returned to homewaters as large salmon in the year following the Greenland fishery. Numbers of Labrador salmon were determined by converting catches in kg to numbers of salmon of 1SW North American origin that were of river age 4 and older. The number of Labrador salmon were estimated by assuming that 70% of the production of 4-year and older river age salmon are from Labrador (Anon, 1993b).

Newfoundland: for 1969–1991, catches of Labrador small and large salmon in Newfoundland were included in total mortalities as the product of the ratio of tags caught in Newfoundland to Labrador and the catch in Labrador. For small salmon the ratio was (24/(100-24)) = 0.32 and for large salmon it was (41/(137-41) = 0.43.

1998–2001

For the years, 1998–2001 when only one or two counting projects took place in Labrador, the raising factors previously used and explained of 1.04 to 1.49 for small salmon and 1.05 to 1.27 for large salmon were used to estimate returns and spawners for Labrador from the overall PFA minus catches in Greenland, as was the case in previous years. However, in this case returns to rivers were derived for Labrador by subtracting landings in food fisheries. Also, catches in 1994–2006 were updated to reflect changes made to catch statistics in Labrador from the Licence Stub Return System. Procedures for the collection and compilation of commercial and angling fishery data are described in Ash and O'Connell (1987) for fishery years 1974–1996. For years 1969–1974, commercial catch data came from Anon. (1978). In 1997, the angling catch statistics were converted to a licence stub system (O'Connell *et al*., 1998) which continues to present.

2002–present

Counting projects occur on three to four Labrador rivers; out of about 100 extant salmon rivers. Because they occur on the same rivers each year, it is possible to extrapolate from abundance for small and large salmon per accessible drainage areas in these monitored rivers to unsurveyed ones in the remainder of Labrador. The accessible drainage areas were 9267 km^2 for Lake Melville (SFA 1A), 25 485 km^2 for Northern Labrador (SFA 1B), 28 160 km^2 for Southern Labrador (SFA 2), and 2651 km^2 for the Straits Area (SFA 14B). Accessible drainage area in the counting facility rivers was 1878 km^2 resulting in an expansion factor of 35 to one. Not all rivers in Lake Melville were included due to a lack of information on presence of salmon populations in rivers in this region of Labrador. Lake Melville rivers whose drainage areas were included are Sebaskachu, Cape Caribou, Goose, MacKenzie, Kenamu, Caroline and Traverspine.

Abundances for SFAs 1A and 1B were derived from English River returns with maximum and minimum values developed using the observed variability of relative abundances in SFA 2. Total returns and spawners for Labrador are estimated by Monte Carlo simulation based on 10 000 random draws from the range of values assuming abundances per km^2 of accessible drainage were uniformly distributed. The relative abundances (per km^2) for each SFA were then multiplied by the total accessible drainage area to derive total returns of small and large salmon. Ranges of values were developed to convert numbers of small and large salmon to numbers of 1SW and 2SW salmon from scale age information collected from counting fences and angling fisheries in Labrador. A bootstrap procedure was used to develop estimates of the proportions of sea age 1 salmon in estimates of small salmon returns and spawners, proportions of sea age 2 salmon in estimates of large salmon returns and spawners and proportions of sea age 1 salmon in the estimates of large salmon returns.

Sea age correction factors were:

Small to 1SW - 96 to 100%
Large to 2SW - 60 to 71%
Small overlap in large - 12 to 21%

Spawners of 1SW and 2SW salmon were derived by subtraction of angling catches including an estimate of hook and release mortalities (10%) from the returns.

2.3.1.2. Newfoundland

Inputs for the run-reconstruction model for Newfoundland include estimates of small, large and 2SW returns and spawners to rivers (minimum and maximum). The methods used to estimate returns and spawners to the rivers in Newfoundland are described by Reddin and Veinott (2010). In brief, returns and spawner estimates were derived from recreational fishery exploitation rates of retained small salmon for rivers with enumeration facilities; and ratios of large to small salmon were utilized to estimate large salmon. Exploitation rates were then applied to all rivers with reported angling catches. A non-parametric bootstrap technique was used, whereby exploitation rates and ratios of large to small salmon from rivers with enumeration facilities were chosen at random with replacement. The 95th confidence interval from 500 iterations of the weighted exploitation rate and ratio of large to small salmon was applied to angling catches on a Salmon Fishing Area (SFA) basis. The midpoint of the 95th confidence interval was used as the minimum and maximum estimate returns of large and small salmon in each SFA. Estimates of 2SW returns are based on the expected proportion of 2SW in the large salmon category (≥63 cm). Commercial and recreational angling catches were derived as described for Labrador (2.3.1.1). Spawners in all years were determined as the returns to rivers minus angling catches including an adjustment for hook-and-release mortality.

2.3.1.3. Québec

In order to estimate abundance of stocks, rivers were classified into six categories (C1–C6) depending on the information available to estimate salmon returns (according to the method of Caron and Fontaine, 1999), with C1 being the most reliable evaluation and C6 the least. C1 corresponds to a river where the evaluation of the returns is based on a counting method, either from a fence or from a visual count through snorkelling or from a canoe. C2 uses the same evaluation, but without knowing the number of small and large salmon, which is then estimated from proportions reported in the sport fishing landings and, if necessary, the catch and release. Salmon returns on C3 rivers are determined based on multiple correlation factors, using catch number, fishing effort, season duration and river accessibility distance (Guillouët, 1993).

When estimation of the returns using a C1–C3 category is not possible, and when data of returns from previous years are available, the C4 category is used. C4 assumes that interannual variations in salmon returns in the targeted river are approximately the same as variations observed in the other rivers of the corresponding region. Category C5 is for rivers where only landings data are available. In these rivers the salmon run is estimated from the average regional exploitation rate. Finally, a few small rivers have essentially no available data. C6 then assumes that the run is related to the available river salmon habitat and is estimated with respect to rivers of the same area for which run estimates and salmon habitat area are known. Estimated numbers of returns from C4 to C6 cannot be used to assess relative to attainment of conservation limits. However, they provide at least approximate numbers to estimate returns and spawners for salmon rivers in Québec.

The evaluation of the uncertainty associated with return estimates depends on the river category. For C1 and C2 rivers, the correction factor for the minimum and maximum number of returns is +5% and +10% for all rivers with a fish ladder and for all others in zones Q1 to Q3 and Q10. The correction factor for rivers with darker water from zones Q5, Q6 and Q7 is rather +10% and +30%. For the other categories, an uncertainty of ±25% is associated with salmon return estimates, except for category C3 where calculation depends on the method of Guillouët (1993).

The number of spawners is obtained using the return estimate minus all river catches, which include landings and other types of removal. In most cases, river catches include landings from sport fishing only, which may be conducted by native people such as that on the Betsiamites River. The other types of removal are of limited number and include mainly natural mortality, salmon captured for hatchery use and subsistence fishing when practised in river.

Overall return estimates for all Québec rivers are obtained by adding in-river salmon returns, commercial fishing (when operated), native people subsistence fishing when practised in estuaries and an estimate of non-registered landings. However, little scientific data are available on non-registered landings and thus, estimates are based on good judgment, following consultations with regional biologists.

2.3.1.4. Gulf

Estimation of returns and spawners are developed for the four salmon fishing areas of Gulf Region (SFAs 15 to 18).

SFA 15

The major river in this area is the Restigouche River. The returns and spawners are estimated for the Restigouche River exclusive of returns to the Matapedia River, which are included in Québec zone Q1. The Restigouche River stock assessment is based on angling catch with assumed exploitation rates between 30% (min.) and 50% (max) with estuary catches added back after the estimates of returns. Return and spawner estimates for SFA 15 are based on Restigouche River data, scaled up for SFA 15 using angling data. The return and spawner estimates for SFA 15 are derived from the return and spawner estimates for Restigouche (New Brunswick). The minimum and maximum return and spawner estimates are derived from the minimum and maximum ratios of angling catch in all of SFA15 relative to angling catch in Restigouche (New Brunswick) (min = 1.117; max = 1.465). Harvests represent retained angling catch plus 6% catch and release mortality for released fish. The proportion of 2SW in large salmon numbers is based on aged scale samples from angling, trapnets, and broodstock. In the years when no scale samples analysis is available, a mean value of 0.65 is used.

SFA 16

The most important Atlantic salmon river in SFA 16 is the Miramichi River. The Miramichi makes up 91% of total rearing area of SFA 16 and returns to the river are assessed annually. For 1971 to 1991, minimum and maximum values are based on capture efficiencies of the Millbank estuary trapnet representing a lower CI of -20% of the estimate and upper CI of 33% of the estimate. For 1992 to 1997, minimum and maximum are lower and upper CI and based on estimate bounds of -18.5% to +18.5%. Since 1998 to the present, minimum and maximum are 5th and 95th percentile range from a Bayesian hierarchical model used in the assessment. Returns to SFA 16 are Miramichi returns (Minimum, Maximum) / 0.91. Proportion 1SW in small salmon is from scale ageing; proportions have varied from 0.97 to 1.0. Proportion 2SW in the large salmon category is obtained from scale ageing. Spawners are returns minus harvests. For 1998 to 2011, the harvest of large salmon is estimated as the sum of the aboriginal fisheries harvests for large salmon and 1% of the large salmon catch (30% exploitation rate, 3% catch and release mortality). The harvest of small salmon is estimated as 30% of the small salmon return plus the harvest from the aboriginal fisheries.

SFA 17

For 1970–1994, small returns are estimated from retained small salmon catch in the Morell River divided by the river-specific exploitation rate. Salmon catch in the Morell River was estimated in 1970–1990 by DFO Fisheries Officers; and in 1991, 1992, and 1994 by angler mail-out surveys. The number of small retained salmon in 1993 was not recorded, so the number used is the mean for 1986–1992. For 1970–1993, exploitation rate was taken as the mean of exploitation rates estimated for 1994, 1995, and 1996 (0.317). For 1994, exploitation rate was 0.34. The min and max of small returns are calculated using exploitation +/- 0.1; e.g. 0.34 +/- 0.1 gives 0.24 and 0.44. Large returns = (number of small returns/proportion small) - number of small returns. For 1970–1980, proportion small is calculated from numbers of small and large salmon in the angling catch of each year. For 1981–1994, proportion small is taken from counts at the Leards Pond trap on the Morell River. Small spawners = number of small recruits-number of small retained. Large spawners = number of large recruits - number of large retained.

Spawner estimates for 1995 to the present are derived from redd counts in 23 rivers. For years and rivers in which redd counts are unavailable, redd numbers are estimated by linear interpolation from the preceding and succeeding count year. Redd numbers in years prior to the first count are taken as the first count. Redd numbers in years after the last count are taken as the last count. Female spawners are estimated from the ratio of 3.357 redds/female spawner, measured in the West River in 1990. Total spawners are estimated from size-specific sex ratios derived from counts at Leards and Mooneys Ponds, Morell River, in 1986–2001. The proportion of salmon that are large is taken as 0.5 in the Cains, Carruthers, Trout (Coleman), Morell, Cardigan, West, and Dunk Rivers, and 0.9 in all other rivers. Spawners are presented as Min (estimated spawners -20%) and Max (estimated spawners + 20%). Returns are spawners + total estimated fishing mortality, including angler catches, hook-and-release mortality, and native harvests. Angler catches and hook-and-release mortality are estimated from angler card surveys. Returns are presented as Min (estimated returns -20%) and Max (estimated returns + 20%). It is assumed that large salmon and 2SW salmon are equivalent.

SFA 18

Returns and spawners to SFA 18 are derived from estimates of returns and spawners to the Margaree River, adjusted for the ratio of the SFA 18 angling catch to the Margaree River catch. For small salmon, the ration of SFA 18 catch to Margaree catch varies between 1.15 and 2.71 for years 1984 to 2004. For large salmon, the ratio of SFA 18 catch to Margaree catch varies between 1.08 and 2.32 for years 1984 to 2004. Returns to Margaree River are estimated using various techniques.

- 1970 to 1983 angling catch divided by range of exploitation rates with maximum exploitation rate of 0.37 and minimum exploitation rate of 0.215;
- 1984 to 1986 based on annual assessments;
- 1987 to present angling catch and effort data from logbooks and provincial licence stubs are used to derive the returns. The catchability coefficient per rod day is estimated from angling catch and effort data for the years 1988 to 1996 when mark and recapture programmes were used to estimate returns, independently from angling data.

Spawners for 1970–1983 equal returns minus removals. Spawners for 1984 to the present equal returns minus catch for small salmon and returns minus catch, corrected for 5% mortality, for large salmon. 2SW salmon represent between 0.77 and 0.87 of large salmon returns and spawners.

2.3.1.5. Scotia–Fundy

Salmon originating in rivers of the Atlantic coast of Nova Scotia and southwest New Brunswick in Salmon Fishing Areas (SFAs) 19–21 and the portion of SFA 23 outside the inner Bay of Fundy comprise the Scotia-Fundy stocks. With the exception of at least one stock in SFA 19, they have a large salmon component that migrates to the North Atlantic/Labrador Sea (Amiro *et al*., 2008). Estimates of returns and spawning escapement for the Scotia-Fundy stocks are provided as inputs to the run-reconstruction model. Inner Bay of Fundy Atlantic Salmon (SFA 22 and part of SFA 23) have been federally listed as endangered under the Canadian Species at Risk Act and are not included as inputs into the run-reconstruction model. With the exception of one population, inner Bay of Fundy stocks have a localized migration strategy while at sea and an incidence of maturity after one winter at sea.

Consistent with the requirements of the model, a range (minimum to maximum) of returns and spawning escapement for the Scotia-Fundy stocks is provided for the run-reconstruction model. The methods used to estimate total returns and spawners are described by Amiro *et al*. (2008). In brief, for SFAs 19–21, the escapement is based on the count of small and large salmon at the Morgan Falls fish-way on the LaHave River from 1970 to the present year, scaled up to the region using the relationship between this count and the recreational catch data for rivers in SFA 19 to 21 from 1970 to 1997 and a catch rate for the LaHave River from 1970 to 1997. Estimates of the returns also include estimates of landings in the commercial salmon fisheries in SFA 19–21 from 1970 to 1983. The model is fitted using maximum likelihood, and the 90% confidence limits are carried forward as the minimum and maximum values. In SFA 23 from 1970 until 1992, estimates of total 1SW and large wild-origin salmon returns are based on the estimated number of returns destined for tributaries above Mactaquac Dam on the Saint John River; this includes in-river and outer-Fundy commercial landings (1970–1971 and 1981–1983), in-river aboriginal harvests (since 1974), and counts at Mactaquac Dam. These estimates are raised by the proportion of the total accessible productive habitat in SFA 23 that is upstream of Mactaquac Dam (0.4–0.6). Hatchery-origin returns were attributed to above Mactaquac Dam only and no hatchery 1SW and MSW returns were estimated for other rivers within SFA 23 (outer Fundy). Since 1993 the estimates of 1SW and MSW returns to the Nashwaak River have been used to estimate the wild production from tributaries of the Saint John River below Mactaquac Dam. The estimated 1SW and MSW returns to the Nashwaak River (above Counting Fence), is raised by the proportion of the total production area accounted for below Mactaquac (0.21–0.3) and then added to the above Mactaquac totals.

2.3.1.6. USA

Total salmon returns and spawners for USA rivers are based on trap and weir catches and for the small rivers in Maine that do not have fish counting facilities, estimates of spawners were based on redd counts.

2.3.2. Improvements to NAC input data

Modifications to input variables used in assessments for the NAC area are reported by WGNAS in the year in which they are first implemented.

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). However, the methods used to derive estimates of unreported catch vary markedly between countries. For example, some countries include only illegally caught fish in the unreported catch, while other countries include estimates of unreported catch by legal gear as well as illegal catches in their estimates.

Descriptions of the national approaches used for evaluating unreported catches have been reported at various WGNAS meetings (e.g. ICES, 1996; 2000; 2002; 2010a). In addition, detailed reports describing national procedures for evaluating illegal and unreported catch, and efforts to minimise this, were submitted by parties to NASCO in 2007 in support of a special theme session on this issue. Full details are available at: http://www.nasco.int/pdf/2007%20papers/CNL(07)26.pdf

Input data commonly rely on rod catches and the practice of catch-and-release has become increasingly important in recent years to reduce levels of exploitation on stocks. As the practice is increasing, WGNAS have previously recommended (ICES, 2010a) that consideration should be given to incorporating mortality associated with this practice in river-specific, regional and national assessments.

The procedures currently used to incorporate catch-and-release and unreported catches into regional, national and international assessments are summarised at Appendix 1 (from ICES, 2010a).

2.4. Biological and other data requirements

As noted previously, many of the 'conventional' data requirements (e.g. marine survey data and commercial cpue) used in the assessment of other commercially important fish species are inappropriate to salmon. A range of biological, catch and exploitation rates and other data pertinent to appropriate stock assessments are however, collected and made available to WGNAS to help inform assessments and to aid in responding to the various questions posed by NASCO.

Appendix 2 of this Stock Annex provides an overview of current and possible future data requirements for Atlantic salmon assessment/ scientific advice. This was compiled at a recent meeting of WGNAS (ICES, 2013) in relation to monitoring requirements under the European Data Collection Framework (DCF) and following a more detailed review of the data requirements under DCF (ICES, 2012c). This table illustrates the type of information collected/available, but is provided for illustrative purposes only. It should be noted that many Atlantic salmon producing countries fall outside the DCF provisions, which only relate to countries within the European Union. Further, Sovereign states are responsible for the regulation of salmon fisheries within their areas of jurisdiction. Formal ICES catch advice is only required for the distant water salmon fisheries, which take salmon originating in rivers of another party.

3. Assessment methods

In managing Atlantic salmon fisheries, NASCO has adopted a fixed escapement strategy (Potter, 2001), in recognition of the importance of the spawning stock to subsequent recruitment. Therefore, in managing the distant water fisheries at Faroes and West Greenland, the spawning requirements of the rivers contributing to these fisheries must be defined. Management advice, expressed as allowable harvest (tonnes), is then predicated on a forecast of salmon abundance prior to the fishery such that the spawning requirements of the contributing stocks can be achieved. The provision of catch advice thus proceeds through a number of steps:

The definition of spawning objectives;

The development of a measure of abundance prior to the fishery; i.e. the pre-fishery abundance or PFA;

A measure of the spawning stock contributing to the PFA;

A model to forecast the PFA;

The development of a risk analysis framework for the catch advice.

These steps are described in detail in the following sections, subdivided as necessary for the different distant water fisheries and the various stock complexes which contribute to the two fisheries (Greenland and Faroes).

3.1. Definition of spawning objectives

3.1.1. Management objectives and reference points

Conservation limits (CLs) for North Atlantic salmon have been defined by ICES as the stock level that will achieve long-term average maximum sustainable yield (MSY). NASCO has adopted the following definition of CLs (NASCO, 1998): ‘The CL is a limit reference point; having populations fall below these limits should be avoided with high probability.’

Atlantic salmon has characteristics of short-lived fish stocks; mature abundance is sensitive to annual recruitment because there are only a 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 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 there is a high probabaility that this escapement can be achieved. The escapement level should be set so there is a low risk of future recruitment being impaired, similar to the basis for estimating B_{pa} in the precautionary approach. In short-lived stocks, where most of the annual surplus production is from recruitment (not growth), MSY $B_{escapement}$ and B_{pa} might be expected to be similar.

It should be noted that this is equivalent to the ICES precautionary target reference points (S_{pa}). Therefore, stocks are regarded by ICES as being at full reproductive capacity only if they are above the precautionary target reference point. This approach parallels the use of precautionary reference points used for the provision of catch advice for other fish stocks in the ICES area.

For the assessment of the status of stocks and advice on management of national components and geographical groupings of the stock complexes, where there are no specific management objectives:

- ICES requires that the lower bound of the 90% confidence interval of the current estimate of spawners is above the CL for the stock to be considered at full reproductive capacity (equivalent to a probability of at least 95% of meeting the CL).
- When the lower bound of the confidence limit 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 be suffering reduced reproductive capacity.

Ideally, Atlantic salmon should be assessed and managed on the basis of river-specific stock units, the scale corresponding best to the spawner to recruitment dynamic (Chaput, 2012). In reality, this is not the case for the majority of rivers, although efforts are continuing to develop river-specific CLs and assessment protocols and developments are reported annually to WGNAS (e.g. ICES, 2013).

The risk assessment frameworks applied by WGNAS directly evaluate the risk of meeting or exceeding the stock complex objectives. Managers can choose the risk level which they consider appropriate. ICES considers however that to be consistent with the MSY and the precautionary approach, and given that the CLs are considered to be limit reference points and to be avoided with a high probability, then managers should choose a risk level that results in a low chance of failing to meet the CLs. ICES recommends that the probability of meeting or exceeding CLs for individual stocks should be greater than 95% (ICES, 2012b).

3.1.2. Reference points in the NEAC area

River-specific CLs have been derived for salmon stocks in some countries in the NEAC area (France, Ireland, UK (England & Wales) and Norway). An interim approach has been developed for estimating national CLs for countries that cannot provide one based upon river-specific estimates. This approach is based on the establishment of pseudo stock–recruitment relationships for national salmon stocks (Potter *et al*., 2004).

The NEAC-PFA run reconstruction model (see below) provides a means of relating estimates of the numbers of recruits to the numbers of spawners. The numbers of 1SW and MSW spawners are converted into numbers of eggs deposited using the proportion of female fish in each age class and the average number of eggs produced per female. The egg deposition in year 'n' is assumed to contribute to the recruitment in years "n+3" to "n+8" in proportion to the numbers of smolts produced of ages 1 to 6 years respectively. These proportions are then used to estimate the 'lagged egg deposition' contributing to the recruitment of maturing and non-maturing 1SW fish in the appropriate years. The plots of lagged eggs (stock) against the 1SW adults in the sea (recruits) are presented as 'pseudo stock–recruitment' relationships for each homewater country or region that is unable to provide river-specific CLs. In countries where with more than one region, the analysis is carried out for each region separately and the resulting estimates are summed to provide a national figure.

As noted previously, ICES currently define the CL for salmon as the stock size that will result in the maximum sustainable yield (MSY) in the long term. However, it is not straightforward to estimate this point on the stock–recruitment relationships established by the national PFA run-reconstruction models, as the replacement line (i.e. the line on which 'stock' equals 'recruits') is not known for these relationships. This is because the stock is expressed as eggs, while the recruits are expressed as adult salmon. To address this, WGNAS has developed a method for setting biological reference points from the national/ regional pseudo stock–recruitment datasets (ICES, 2001). This model assumes that there is a critical spawning stock level below which recruitment decreases linearly towards zero and above which recruitment remains constant. The position of this critical stock level is determined by searching for the stock value that provides the line of best fit for the stock and recruitment data provided by the PFA run-reconstruction model as determined by the residual sum of squares. This point is a proxy for S_{lim} and is therefore defined as the CL for the stock, and is indicated by the inflection point in the hockey-stick relationship (e.g. see example at Figure 3.1.2.1).

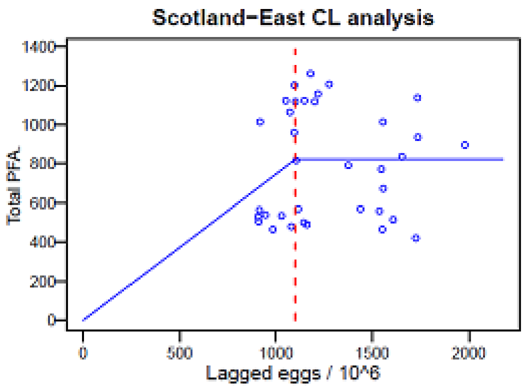

Figure 3.1.2.1. Pseudo stock–recruitment relationship for UK (Scotland) eastern region (from ICES, 2013).

Where river-specific estimates of CLs have been derived for all the rivers in a country or region, these are aggregated to provide national estimates. For countries where the development of river-specific CLs has not been completed, the method described above has been used (see example in Table 3.1.2.1, from ICES, 2013). The estimated national CLs are then summed to provide aggregate CLs for the northern and southern NEAC stock complexes (Table 3.1.2.1).

The CLs have also been used to estimate the spawning escapement reserves (SERs). These represent the CLs increased to take account of natural mortality between the recruitment date, 1st January, and the return to homewaters for maturing and non-maturing 1SW salmon from the northern NEAC and southern NEAC stock complexes (Table 3.1.2.1).

Table 3.1.2.1. Conservation limits (CLs) for NEAC countries and stock complexes estimated from river-specific values, where available, or the national PFA run-reconstruction model. Spawner escapement reserves (SERs) are also included for each stock complex (ICES 2016).

Table 3.2.2.1. Conservation limit options for NEAC stock groups

	National Model CLs		River Specific CLs		Conservation limit used		SER	
	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
Northern Europe								
Finland			14,271	9,562	14,271	9,562	17,336	16,386
Icland (north & east)	5,854	1,678			5,854	1,678	7,218	2,876
Norway			60,614	72,747	60,614	72,747	77,009	120,991
Russia	62,752	34,506			62,752	34,506	79,785	61,997
Sweden			2,099	2,583	2,099	2,583	2,707	4,492
			Stock Complex		**145,590**	**121,075**	**184,055**	**206,742**

	National Model CLs		River Specific CLs		Conservation limit used		SER	
	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
Southern Europe								
France			17,400	5,100	17,400	5,100	22,440	9,419
Icland (south & west)	17,790	1,171			17,790	1,171	21,935	2,006
Ireland			211,471	46,943	211,471	46,943	268,672	78,075
UK (E & W)			53,988	29,918	53,988	29,918	68,591	51,271
UK (NI)			19,911	3,280	19,911	3,280	24,365	5,504
UK (Sco)	256,548	182,741			256,548	182,741	325,942	310,205
			Stock Complex		**577,107**	**269,153**	**731,946**	**456,480**

WGNAS considers the current CL and SER levels may be less appropriate to evaluating the historical status of stocks (e.g. pre-1985), that in many cases have been estimated with less precision.

3.1.3. Reference points in the NAC area

In many regions of North America, the CLs are calculated as the number of spawners required to fully seed the wetted area of the river. The methods and values used to derive the egg and spawner conservation requirements for Atlantic Canada are documented in O'Connell *et al.* (1997). CLs have generally been derived using freshwater production dynamics translated to adult returns to estimate the spawning stock for maximum sustainable yield (MSY). Data were available for a limited number of stocks and these values were transported to the remaining rivers using information on habitat area and the age composition of the spawners. A similar procedure was used to determine the CLs for rivers in the USA (ICES, 1995). In Québec, adult-to-adult stock–recruitment relationships for six rivers were used to define the CLs for the other rivers (Caron *et al.*, 1999). 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. Revised reference points are expected to be developed.

The NAC conservation requirements for 2SW salmon (only these are required in developing catch options for the West Greenland fishery) are summarised in Table 3.1.3.1 (from ICES, 2013). These are calculated from the adult age structure within the different regions and total 123 349 2SW salmon for Canada and 29 199 2SW salmon for the USA, for a combined total of 152 548.

Table 3.1.3.1. 2SW Conservation limits (CLs) for the six regions in the NAC area estimated from river-specific values.

Country and Comission Area	Stock Area	2SW spawner requirement
	Labrador	34 746
	Newfoundland	4022
	Gulf of St Lawrence	30 430
	Québec	29 446
	Scotia-Fundy	24 705
Canada Total		123 349
USA		29 199
North American Total		152 548

3.2. Estimating PFA

Estimates of PFA are derived by run-reconstruction methods. These work back in time from estimates of abundance in homewaters to earlier periods of the salmon's life cycle by adding in catches at appropriate times and adjusting for survival. The run-reconstruction approach was first presented at ICES in 1992 and was subsequently adopted for stocks on both sides of the Atlantic (Rago *et al.*, 1993a; Potter and Dunkley, 1993; Potter *et al.*, 1998; 2004). The main advantage of backwards-running, run-reconstruction models over alternative forward-running approaches is that more extensive data are available on adult returns (e.g. traps, counters and catch data) than on freshwater production of juveniles. In addition, rates of natural mortality (M) were thought to be lower and more stable for large salmon after their first winter in the sea than during the post-smolt phase (Potter *et al.*, 2003).

The models used to estimate PFA take the generalised form:

$$PFA = Nh * \exp(Mt_h) + \sum_i C_i * \exp(Mt_i)$$

Where: Nh is the number of adult fish returning to homewaters, C_i the catch of fish from the stock in each interception fishery i (operating before the fish return to homewaters), M the monthly instantaneous rate of natural mortality of salmon in the sea after the first sea-winter, t_i the time in months between the PFA date and the midpoint of fishery i, and t_h is the time in months between the PFA date and the midpoint of the return of fish to homewaters. Coastal catches are also added to the estimate where appropriate.

3.2.1. NEAC area run reconstruction model

The original model used to estimate the PFA of salmon from countries in the NEAC area was described by Potter *et al*. (2004); modifications have been described in subsequent WGNAS reports. PFA in the NEAC area is defined as the number of 1SW recruits on January 1st in the first sea winter. As there are relatively few fish of sea age three or more in most stocks, the model caters for two age groups, 1SW and MSW, the latter including all fish of sea age two or more that are treated as a single cohort. The model is therefore based on the annual catch in numbers of 1SW and MSW salmon in each country. These are raised to take account of minimum and maximum estimates of non-reported catches and exploitation rates of these two sea-age groups.

Thus, for each country (or region) c in year y, the total number of fish of sea age a caught in homewater fisheries ($Ch_{a,y,c}$) is calculated by dividing the declared catch ($Cd_{a,y,c}$) by the non-reporting rate ($1 - U_{a,y,c}$):

$$Ch_{a,y,c} = Cd_{a,y,c} / (1 - U_{a,y,c})$$

where: $U_{a,y,c}$ is the estimated proportion of the total catch that is unreported or discarded. The number of fish returning to homewaters ($Nh_{a,y,c}$) is estimated by dividing the total homewater catch by the exploitation rate ($H_{a,y,c}$):

$$Nh_{a,y,c} = Ch_{a,y,c} / H_{a,y,c}$$

As the model provides estimates of total returns and total catch (including non-catch fishing mortality), it is then also possible to estimate the spawner escapement ($Ns_{a,y,c}$):

$$Ns_{a,y,c} = Nh_{a,y,c} - Ch_{a,y,c}$$

Total catches in the Faroese ($Cf_{a,y}$) and West Greenland ($Cg_{a,y}$) fisheries are similarly calculated by correcting the declared catches for non-reporting, but they are not raised for the exploitation rate, because the uncaught fish are accounted for from the returns to homewaters. The West Greenland fishery only exploits salmon that would otherwise mature as MSW fish, although the majority are 1SW fish in the summer that they are caught; for the purpose of the model, all are classed as 1SW. The Faroese fishery exploits predominantly MSW salmon, but also a small number of 1SW fish, 78% of which have been estimated to be maturing (ICES, 1994). Over the past two decades, a substantial proportion of the fish caught in the Faroese fishery have been escapees from salmon farms, and these are discounted from the assessment of wild stocks on the basis of data from Hansen *et al*. (1999). The incidence of farm escapees in the West Greenland catch is thought to be <1.5% (Hansen *et al*., 1997), so this portion is ignored in the model. The total estimated catches of wild fish in both distant-water fisheries are assigned to the PFA for different countries on the basis of historic tagging studies (Potter, 1996).

The returns to homewaters and catches in the distant-water fisheries of 1SW and MSW salmon are then raised to take account of the marine mortality between January 1st in the first sea winter (the PFA date) and the mid-point of the period over which the respective national fisheries operate. WGNAS determined a natural mortality value of 0.03 per month to be the most appropriate (ICES, 2002) and a range 0.02 to 0.04 is applied within the model in a Monte Carlo simulation. Thus, the PFA of maturing 1SW fish (PFAm), survivors of which will return to homewaters as 1SW adults, is:

$$PFAm_{y,c} = Nh_{1,y,c} * \exp(Mt_{h,1,c}) + 0.78 * Cf_{1,y} * w_y * pf_{1,c} * \exp(Mt_{f,1,c})$$

and the PFA of non-maturing 1SW fish (PFAn), survivors of which will return to homewaters as MSW adults, is:

$$PFAn_{y,c} = Nh_{2,y+1,c} * \exp(Mt_{h,2,c}) + Cg_{1,y} * pg_{1,c} * \exp(Mt_{g,1,c}) + 0.22 * Cf_{1,y} * w_y * pf_{1,c} * \exp(Mt_{f,1,c}) + Cf_{2,y+1} * w_{y+1} * pf_{2,c} * \exp(Mt_{f,2,c})$$

where indices y and c represent year and country/region, indices 1 and 2 the 1SW and MSW sea age groups, w is the proportion of the Faroese catch that is of wild origin, pf and pg are the proportion of the catches in the Faroese and West Greenland fisheries originating in each country (as indexed), and t_h, t_f and t_g are the times in months between the PFA date and the midpoints of the homewater fisheries, the Faroese fishery, and the West Greenland fishery, respectively, for the year classes and country/region as indexed.

Total 1SW recruitment for the NEAC area in year y is therefore the sum of the maturing 1SW and non-maturing 1SW recruitments for that year for all countries:

$$PFA_y = \sum_c PFAm_{y,c} + \sum_c PFAn_{y,c}$$

The non-reporting rates, exploitation rates, natural mortality, and migration times in the above equations cannot be estimated precisely, so national experts provide minimum and maximum values based upon best available knowledge that are considered likely to be centred on the true values (ICES, 2003). A Monte Carlo simulation (12 000 trials) is used to estimate confidence intervals on the stock estimates.

Where appropriate to the provision of management advice, the national outputs from the model are combined into stock complexes, such as those for southern and northern NEAC (ICES, 2002). The confidence limits for these combined estimates are derived from the sum of the national variances obtained from the MCS (the covariances are assumed to be small). This model has provided time-series of PFA estimates for NEAC salmon stocks from 1971 to the present.

The model was initially run using 'Crystal Ball' (CB) in Excel (Decisioneering, 1996). However, an updated version of the model which runs in the 'R' programming language (R Development Core Team, 2007) was developed in 2011 (ICES, 2011). This provided a more flexible platform for the further development of the model and to allow its integration with the Bayesian forecast model for the development of catch options (see below). In 2012, the outputs of the CB and 'R' models were compared to examine the approaches taken and to validate the outputs (ICES, 2012a). Since 2013, the run-reconstruction analysis has been completed by WGNAS using the 'R' programme (ICES, 2013). This has also enabled additional sources of uncertainty to be incorporated into the modelling approach (ICES, 2013).

The full set of country-specific data inputs, as used in the most recent assessment (ICES, 2016) is provided at Appendix 3. The 'R' code used for running the model and the additional data input file required to run the model, are available on the ICES WGNAS SharePoint site.

3.2.2. NAC area run reconstruction model

The run–reconstruction model developed by Rago *et al*. (1993a) and described in previous WGNAS reports (ICES, 2008; 2009a) and in the primary literature (Chaput *et al*., 2005) is used to estimate returns and spawners by size (small salmon, large salmon) and sea age group (2SW salmon) to the six geographic regions of NAC from 1971 to the present. The model takes the form:

$$PFA_{year(i)} = [NR2_{year(i+1)} * e^{MX1} + NC2_{year(i+1)}] * e^{MX10} + NC1_{year(i)} + NG1_{year(i)}$$

where: $NR2_{year(i+1)}$ is the sum of 2SW returns to six regions of North America in year i + 1, $NC2_{year(i+1)}$ is the catch of 2SW salmon in Newfoundland and Labrador commercial fisheries in year i + 1, $NC1_{year(i)}$ is the catch of 1SW non-maturing salmon in Newfoundland and Labrador commercial fisheries in year i, $NG1_{year(i)}$ is the catch of 1SW non-maturing salmon of North American origin in the Greenland fishery in year i, and M is the monthly instantaneous natural mortality of 0.03.

The reconstruction begins with the estimation of returns of 2SW salmon in year i + 1 to six regions in eastern North America: Labrador, Newfoundland, Québec, Gulf, Scotia-Fundy, and USA. For the four southern regions, the regional returns include the harvest in the coastal commercial fisheries but this is not the case for Newfoundland and Labrador. For Labrador, the returns to rivers are estimated from the commercial harvest factored by an exploitation rate. The harvest of 2SW salmon in the Newfoundland and Labrador mixed-stock fisheries in year i + 1 is added to the sum of the returns to the six regions (prorated backward for one month of natural mortality - equates to 1st June of year i + 1) to produce the returns to North America. Finally, the harvests of North American origin salmon in the Greenland fisheries in year i and the harvest of non-maturing 1SW salmon in the Newfoundland and Labrador commercial fisheries in year i are added to the prorated returns to North America (ten months between abundance at Greenland on 1st August year i and North America on 1st June year i + 1) to produce the pre-fishery abundance of non-maturing 1SW salmon of North American origin. An instantaneous natural mortality rate of 0.03 per month is assumed for salmon in the second year at sea for all years (ICES, 2002). Adjustments to the input data resulting from reductions and subsequent closures of commercial fisheries in North America are summarized by Friedland *et al*. (2003).

Following earlier WGNAS recommendations (ICES, 2008), the run–reconstruction model since 2009 has been developed using Monte Carlo simulation (OpenBUGS; http://mathstat.helsinki.fi/openbugs/; Lunn *et al*., 2000). This is similar to the approach applied for the NEAC area.

The PFA of the non-maturing component of 1SW fish, destined to be 2SW returns (excluding 3SW and previous spawners) is the estimated number of salmon in the North Atlantic on August 1st of the second summer at sea. As this requires estimates of 2SW returns to rivers, there is always a lag in providing this figure (PFA estimates for year n require 2SW returns to rivers in North America in year n + 1).

The full set of data inputs, as used in the most recent assessment (ICES, 2015) is provided at Appendix 4. The 'R' code used for running the model is available on the WGNAS SharePoint site.

3.2.3. Instantaneous natural mortality rate (M)

The natural mortality rate for salmon after they recruit to the distant water fisheries has been the subject of much discussion. WGNAS originally used a value of 0.01 per month, based upon Doubleday *et al*. (1979), but this was modified to 0.03 per month following a detailed review as part of the EU SALMODEL project (Crozier *et al*., 2003; ICES, 2002) on the basis of inverse-weight and maturity-schedule models. The rate is assumed to have been constant over the time-series. While mortality may be expected to vary among years and may also be different for maturing and non-maturing 1SW recruits, WGNAS has not had data on which to base the use of different values, or values that change over time. The assumption is, therefore, that the mortality of adult fish after the first winter at sea has not changed and that all the variability of marine mortality has occurred at the post-smolt stage. Efforts are continuing to explore levels of mortality and to better partition this between different stages of the life cycle. The issue was also subject to further investigation within the EU ECOKNOWS project and Bayesian modelling may provide alternative approaches in future.

3.3. PFA forecast models

3.3.1. Introduction

The provision of quantitative catch advice for the distant water fisheries requires estimates of abundance before the fisheries take place. While there has been some use of in-season surveys in the management of these fisheries (NASCO, 2001), such methods are considered too impractical and costly to implement on a widespread scale (Potter *et al*., 2004). Models have therefore been developed by WGNAS which relate abundance estimates obtained at other life stages to the PFA. The objective has been to account for this relationship in terms of biological or environmental factors that affect natural mortality, and to use this to forecast future stock levels.

An initial PFA forecast model for North American stocks (Rago *et al*., 1993b) utilised indices of thermal habitat in relation to historically observed PFA (from the run-reconstruction model) to predict future PFA. Similar approaches were explored by Crozier *et al*. (2003) for NEAC stocks. However, while statistically significant temperature indices could be constructed, the relationships were not always consistent or intuitively correct. Alternative approaches were therefore explored for NEAC; these are described by Potter *et al*. (2004). More recently work by the ICES Study Group on Salmon Stock Assessment and Forecasting (SGSSAFE) has, however, resulted in the development of Bayesian forecast models for both NAC and NEAC (ICES, 2009a; 2011; Chaput, 2012).

In the latest models, PFA dynamics by complex are modelled using the estimates of adult spawners, adjusted to the number of eggs per fish based on life-history characteristics of the age groups within each region of the stock complexes (ICES, 2011; Chaput, 2012). The spawner to PFA dynamic is modelled as:

$$PFA_y = e^{\alpha_y} LE_y e^{\varepsilon}$$

where: α_y is the productivity parameter from eggs (×1000) to PFA (number of fish) for PFA year *y* (on a log-scale), LE_y the estimated lagged eggs (×1000) corresponding to the PFA cohort in year *y*, and the progress of α_y is modelled as $a_{y+1} = a_y + \varepsilon$, *with* $\varepsilon \sim N(0,\sigma^2)$.

Productivity is modelled as an integration of survival in freshwater and during the first year at sea. An important assumption is the absence of heritability of age at maturity, i.e. all eggs are considered equivalent regardless of the age of the spawners. Lagged eggs refer to the adjustment of the egg depositions to correspond to the expected age at smoltification. Spawners in year 'n' contribute to recruitment in years 'n+3' to 'n+8' depending upon the relative proportions of one to six year-old smolts that they produce. For example, spawners in year 'n' produce eggs that hatch in year 'n+1' and may produce one year-old smolts in year 'n+2', which would become 1SW recruits in year 'n+3'. Any two year-old smolts from the same spawners would produce 1SW recruits in year 'n+4', etc.

At the stock complex level, lagged eggs are the sum of the eggs from the spawners in year *y* - (*s* + 2) weighted by the proportion of the smolts produced at age *s* in region *k* summed over regions in the complex. Two years are added to the smolt age, for the spawning year and smolt migration year, to lag the eggs to the corresponding year of PFA:

$$LE_y = \sum_k \sum_s Eggs_{y-(s+2),k} * \mathrm{prop}_{s,k}$$

3.3.2. NEAC PFA Forecast model

A forecast model to estimate PFA for all four NEAC stock complexes has been developed in a Bayesian framework by the Study Group on Salmon Stock Assessment and Forecasting (SGSSAFE). The model was originally reported to WGNAS in 2009 (ICES, 2009a), but was subsequently refined and has been in use by WGNAS in its present form since 2011 (ICES, 2011). The models for the northern and southern NEAC stock complexes have exactly the same structure and are run independently. A Directed Acyclical Graph (DAG) for the models is provided in Figure 3.3.2.1. The model considers both the maturing *PFA* (denoted *PFAm*) and the non-maturing PFA (denoted *PFAnm*). The full code used for running the model is available on the WGNAS SharePoint site.

A disaggregated version of the Bayesian model has since been developed using the same structure to provide forecasts at a country level, for all countries in both southern and northern NEAC model implementations (ICES, 2013). In these, countries are linked hierarchically only through the variance on the productivity parameter "a". There is no modelling linkage between the northern and southern complexes.

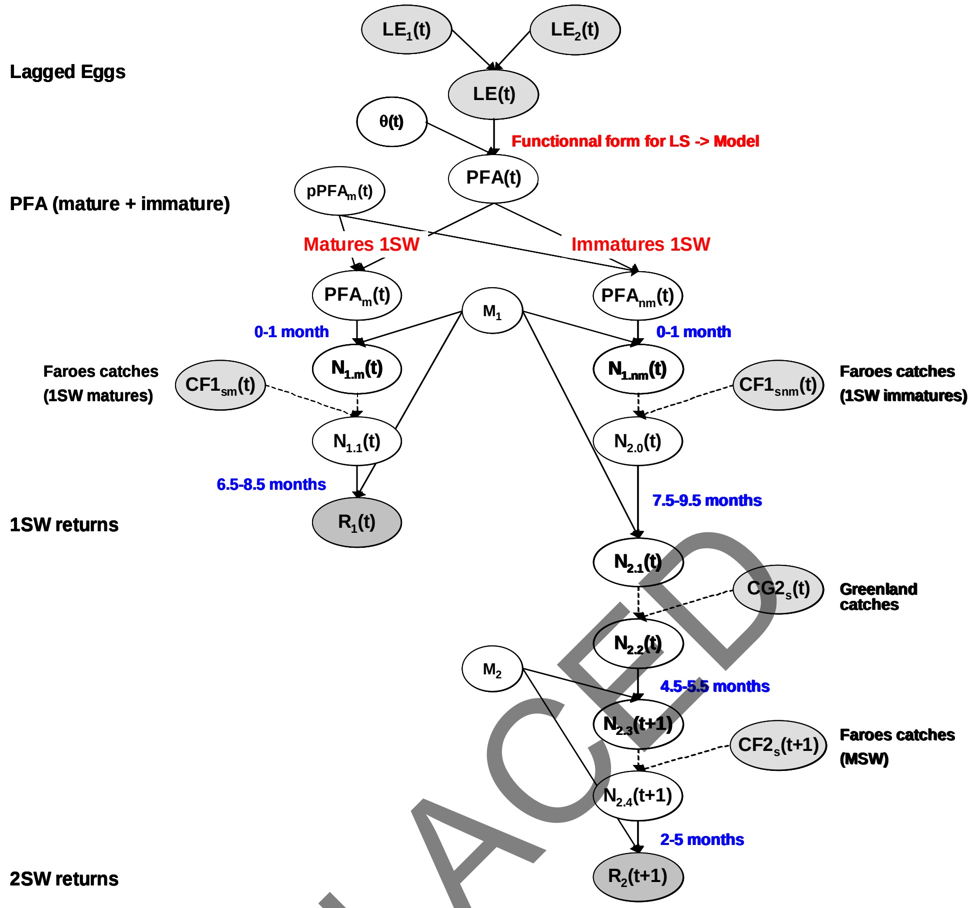

Figure 3.3.2.1. Directed Acyclical Graph (DAG) of the structure of the combined sea age model for the southern NEAC and northern NEAC forecast models. Ellipses in grey are observations (or pseudo-observations) derived from sampling programmes or from submodels (run-reconstruction).

The *PFA* is modelled using the summation of lagged eggs from 1SW and MSW fish (*LE*) for each year *t* and an exponential productivity parameter (*a*).

$$PFAt = LEt * exp(at)$$

The productivity parameter (*a)* is the proportionality coefficient between lagged eggs and PFA. This is forecasted one year at a time (a_{t+1}) in an auto correlated random walk, using the previous year's value (*a*) as the mean value in a normal distribution, with a common variance for the time-series of *a*.

$$at+1 = at + \varepsilon; \quad \varepsilon \sim N(0, a.\sigma2)$$

The maturing *PFA* (denoted *PFAm*) and the non-maturing *PFA* (denoted *PFAnm*) recruitment streams are subsequently calculated from the proportion of *PFA* maturing (*p.PFAm*) for each year *t*. *p.PFAm* is forecast as an autocorrelated value from a normal distribution based on a logit scale, using the previous year's value as the mean and a common variance across the time-series of *p.PFAm*.

$$logit.p.PFAmt+1 \sim N(logit.p.PFAmt\ ,\ p.\sigma2)$$
$$logit.p.PFAmt = logit\ (p.PFAmt)$$

Uncertainties in the lagged eggs were accounted for by assuming that the lagged eggs of 1SW and MSW fish were normally distributed with means and standard deviations derived from the Monte-Carlo run-reconstruction at the scale of the stock complex. The uncertainties in the maturing and non-maturing PFA returns are derived in the Bayesian forecast models through the pseudo-observation method proposed by Michielsens *et al*. (2008), as used in the NAC model.

The natural mortality in the post-PFA time point was assumed constant among years, centred on an instantaneous rate value of 0.03 per month with a 95% confidence interval range of 0.02 to 0.04.

Catches of salmon at sea in the West Greenland fishery (as 1SW non-maturing salmon) and at Faroes (as 1SW maturing and MSW salmon) were introduced as covariates and incorporated directly within the inference and forecast structure of the model. For southern NEAC, the data are available for a time-series of lagged eggs and returns commencing in 1978. Although the return estimates to southern NEAC begin in 1971, the lagged eggs are only available from 1978 due to the smolt age distributions (one to five years). For northern NEAC, data are available for a shorter time-series. Return and spawner estimates begin in 1983, but due to the smolt age distributions (one to six years), the lagged eggs are only available from 1991 onward. The models are fitted and forecasts derived in a consistent Bayesian framework.

The model provides forecasts for maturing and non-maturing stocks for both southern and northern NEAC complexes (and countries) for five years. Risks are defined each year as the posterior probability that the PFA would be greater than or equal to the age and stock complex/ country specific Spawner Escapement Reserves (SERs), under the scenario of no exploitation.

The country disaggregated version of the Bayesian NEAC inference and forecast model incorporates country specific catch proportions at Faroes, lagged eggs and returns of maturing and non-maturing components. Model structure and operation is as described above, incorporating country and year indexing. Linkage between countries in the model is through the common variance parameter associated with the productivity parameter (*a*) (the proportionality coefficient between lagged eggs and PFA), which is forecast forward and used along with the forecast proportion maturing to estimate the future maturing and non-maturing PFAs. The evolution of *a* is independent between countries with the exception of its associated variance. Evolution of the proportion maturing (*p.PFAm*) is also independent for each country, as is its variance.

3.3.3. NAC PFA Forecast model

WGNAS (ICES, 2009; 2012a) developed forecasts of the pre-fishery abundance for the non-maturing 1SW salmon (PFA) using a Bayesian framework that incorporates the estimates of lagged spawners and works through the fisheries at sea to determine the corresponding returns of 2SW salmon, conditioned by fisheries removals and natural mortality at sea. This model considers regionally-disaggregated lagged spawners and returns of 2SW salmon for the six regions of North America. The model is summarised in the Directed Acyclical Graph in Figure 3.3.1.1. The year is identified by the i index. The full code used for running the model is available on the WGNAS SharePoint site.

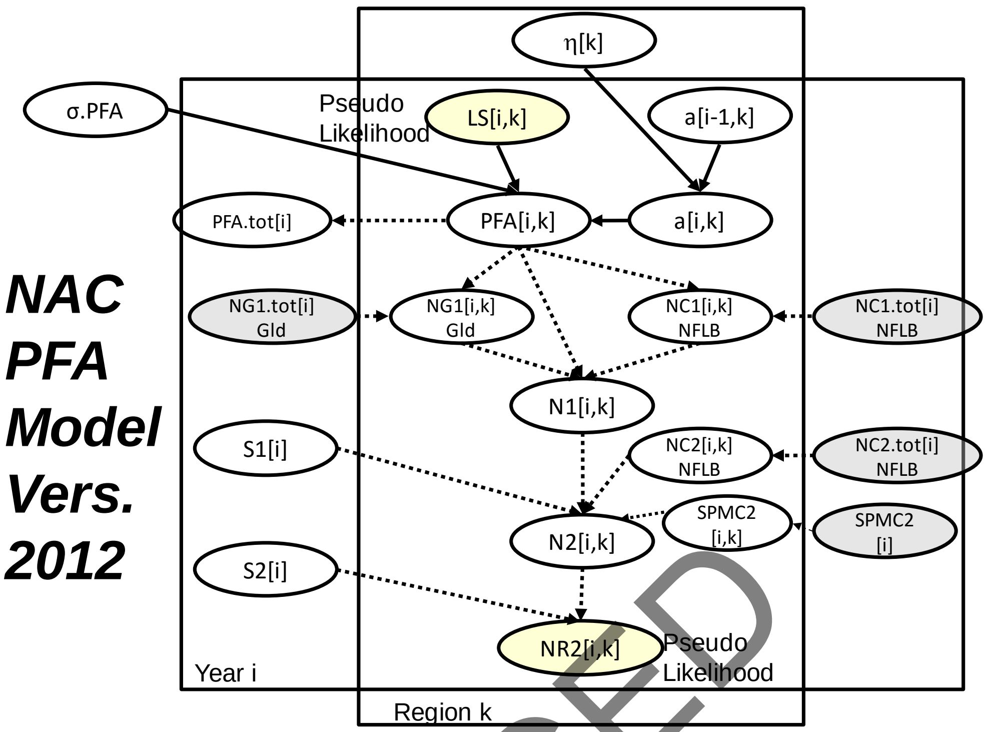

Figure 3.3.1.1. Directed Acyclical Graph (DAG) of the structure of the region disaggregated forecast model for 2SW salmon of North American origin. Ellipses in grey are observations (or pseudo-observations) derived from sampling programmes or from submodels (run-reconstruction).

Lagged spawners $LS_{i,k}$ represent the sum of smolt age adjusted annual spawners by region (k) that would be expected to contribute to the recruitment at sea prior to the fisheries (PFA) for year i. $LS_{i,k}$ are not directly observed but are estimated from the run-reconstruction submodel used to estimates returns and spawners to each of the six regions.

The probability distributions of LS (and returns of 2SW) by region are used as likelihood functions expressing comparative degrees of belief given the data and a probability model not explicitly specified in the current model. The probability distributions were drawn from the Monte Carlo simulations and assumed to be normal with known mean (LS.m) and precision (1/variance) (tau.LS). The use of this distribution as a likelihood function is equivalent to assuming a pseudo-observation equal to LS.m issuing from a sampling distribution with mean and precision equal to LS and tau.LS (Michielsens *et al.*, 2008).

$$LS.m_{i,k} \sim N\,(LS_{i,k},\ tau.LS_{i,k})$$

The $LS.m_i$,k (mean) and $tau.LS_{i,k}$ (precision) were derived assuming the lagged spawner values issued from a normal distribution characterized by the 95% confidence interval range statistics retained from the Monte Carlo simulations of returns.

Similarly, the returns of 2SW salmon to the six regions ($NR2_{i,k}$) are not directly observed, but estimated from the run-reconstruction model. The probability distributions were assumed to be normal with known mean NR2.m and variance tau.NR2. As with the LS variable, the NR2 were treated as pseudo-observations equal to NR2.m issuing from normal sampling distributions with means and variances equal to NR2 and tau.NR2.

$NR2.m_{i,k} \sim N(NR2_{i,k}, tau.NR2_{i,k})$

In between the lagged spawners and returns as 2SW salmon, the catches in the various sea fisheries and conditioning for natural mortality as the fish move from the time of the PFA to homewaters, are incorporated (Figure 3.3.1.1). The catches in the commercial fisheries of West Greenland and the Newfoundland and Labrador commercial and coastal fisheries (NG1.tot, NC1.tot and NC2.tot) are not directly observed, but estimated with error. The catches are converted to numbers of fish of 1SW non-maturing and 2SW fish based on the characteristics of the fish in the catch. Their (prior) probability distributions are obtained from catch statistics according to a formal structure included in the model.

Catches of large salmon (assumed to be 2SW salmon) from the St Pierre & Miquelon fisheries (SPMC) are also included in the model as point estimates.

The natural mortality in the post-PFA time point was assumed constant between years, centred on an instantaneous rate value of 0.03 per month (95% confidence interval range of 0.02 to 0.04).

For the NAC 2SW component, the model is fitted to an historical dataseries of lagged eggs starting from 1978. Although the return and spawner estimates for NAC begin in 1971, the lagged eggs are only available from 1978 due to the smolt age distributions (one to six years).

The years are modelled independently conditionally on the lagged spawners and yearly productivity parameters. The lagged spawners to PFA ratios (productivity) are modelled dynamically, i.e. assuming they are sequentially dependent within a region and attempts to take into account the most significant sources of uncertainty. The DAG for the model is shown in Figure 2.

PFA is assumed to be proportional to lagged-spawners (LS), with i.i.d. lognormal errors, and is modelled separately for each region (k = 6). The first year in the time-series (t) is 1978 for lagged spawners (due to the range of smolt ages 1 to 6 for NAC and the start of the spawner time-series in 1970) and the last year of lagged spawner data is for the 2017 PFA year. The PFA can be modelled for 1978 to 2013 (the last PFA year for which returns of 2SW salmon have been estimated back to rivers in 2014).

$$PFA_{i,k} = LogN(\overline{PFA_{i,k}}, \sigma.PFA^2)$$
$$\overline{PFA_{i,k}} = \log(LS_{i,k}) + a_{i,k} + \varepsilon_{i,k}$$
$$\varepsilon_{i,k} \overset{iid}{\sim} N(0, \sigma.PFA^2)$$

The total PFA is calculated as the sum of the regional PFA's (k = 6). The proportion of the total PFA in each region is calculated directly as:

$p.PFA_{i,k} = PFA_{i,k} / PFA.tot_i$

A non-informative prior is assumed for $\sigma.PFA^2$ $(1/\sigma.PFA^2 \sim gamma(0.01, 0.01)$

The proportionality coefficient (log) $a_{i,k}$ between $LS_{i,k}$ and $PFA_{i,k}$ for each region is modelled dynamically as a random walk with a year and region residual variation ($\eta_{i,k}$) assumed multivariate normal (MVN). The variance covariance matrix ($\sum$) allows for correlations among regional productivity values reflecting that the fish share a common marine environment during part of their life cycle and that there are regional specificities in the evolution of the freshwater or the marine coastal environment.

$$a_{i+1,k} = a_{i,k} + \eta_{i,k}$$
$$\eta_{i,k} \overset{iid}{\sim} MVN(0, \Sigma)$$

The common yearly evolution of a_i is the mean of annual a across regions:

a.y_i <- mean($a_{i,k}$)

This parameterization of the covariance of the proportionality coefficient differs from an earlier version of the model for which the proportionality (log) coefficient $a_{i,k}$ between $LS_{i,k}$ and $PFA_{i,k}$ for each region dynamically as a random walk model with the addition of a regionally common annually varying parameter (e.y_i).

$$a_{i+1,k} = a_{i,k} + e.y_{i+1} + \omega_{i,k} \qquad with \quad \omega_{i,k} \overset{i.i.d}{\sim} N(0, a.\sigma_k^2)$$
$$e.y_i \overset{i.i.d}{\sim} N(0, y.\sigma^2)$$

The correlation matrix of *a* among the regions is calculated from the covariance matrix:

1) the precision matrix is inverted to produce the covariance matrix;
2) the covariance matrix is transformed to the correlation matrix.

The positive-definite matrix (T, the precision matrix) is inverted:

covariance matrix <- solve(T)

correlation matrix <- cov2cor(b)

The dynamic component of the model requires initialization for the first year (i = 1978) and an uninformative prior is assumed:

$$a_{1,k} \overset{i.i.d}{\sim} N(0, 100)$$

The models are fitted and forecasts derived in a consistent Bayesian framework under the OpenBUGS 3.0.3 software (http://mathstat.helsinki.fi/openbugs/; Lunn *et al.*, 2000).

3.3.4. Summary of NAC and NEAC forecast models

The data inputs and models currently used by WGNAS for forecasting and provision of catch advice differ between the Commission areas; outline details are summarised in the text table below.

FORECAST MODELS		
	NAC	**NEAC**
Data inputs		
Time period of data	1978 on	1978 on for southern NEAC 1991 on for northern NEAC
Spatial aggregation	Separately for six regions of North America	By southern and northern stock complexes & NEAC countries
Age components	2SW salmon component only	1SW and MSW age components
Spawners	Lagged spawners by region for 2SW salmon only	Lagged eggs by sea age component for the southern and northern complexes/ country
Returns	Returns by region of 2SW salmon only	Returns of 1SW and MSW age components by stock complex / country
Model structure		
Spatial aggregation	Spawners and returns of 2SW salmon for six regions	Spawners and returns for two sea age components for the southern and northern NEAC complexes / countries
Dynamic function	Random walk dynamic	Random walk dynamic
	Region-specific recruitment rates linked with an annual recruitment rate variable	Sea age specific recruitment rates linked with a probability of maturing variable
Latent variables of interest	PFA 1SW non-maturing Recruitment rate by region and year	PFA 1SW maturing and PFA 1SW non-maturing by stock complex/ country Recruitment rate by sea age component and the probability of maturing variable
Forecast years	Four years	Five years; i.e. the present year -1, the present year, and the next three years (y-1 is a forecast, as the MSW stock component is yet to return).

3.4. The development of a risk analysis framework for catch advice

3.4.1. Introduction

The provision of catch advice in a risk framework involves incorporating the uncertainty in all the factors used to develop the catch options (ICES, 2002). The ranges in the uncertainties of all the factors will result in assessments of differing levels of precision. The analysis of risk involves four steps:

1) identifying the sources of uncertainty;

2) describing the precision or imprecision of the assessment;

3) defining a management strategy; and

4) evaluating the probability of an event (either desirable or undesirable) resulting from the fishery action.

The uncertainties have been identified and quantified in the assessment of PFA for salmon stocks in both the NAC and NEAC areas. NASCO's strategy for the management of salmon fisheries is based upon the principle of ensuring that stocks are above CLs (defined in terms of spawner escapement or egg deposition) with a high probability. The undesirable event to be avoided is that the spawning escapement after the fisheries will be below the CLs.

3.4.2. Catch advice and risk analysis framework for the West Greenland fishery

A risk framework for the provision of catch advice for the West Greenland fishery has been applied since 2003 (ICES, 2003) and has been subject to a number of subsequent updates. The current procedure is outlined below. This involves estimating the uncertainty in meeting defined management objectives at different levels of catch (catch options). The risk framework has been formally accepted by NASCO.

Two stock complexes are of relevance to the management of the West Greenland fishery; non-maturing 1SW fish from North America and non-maturing 1SW fish from southern NEAC. The risk assessments for the two stock complexes are developed in parallel and then combined at the end of the process into a single summary plot or catch options table. The risk analysis proceeds as illustrated in the flowchart in Figure 3.4.2.1).

The primary inputs to the risk analysis for the complex at West Greenland are:

- PFA forecast for the year of the fishery; PFA_{NA} and PFA_{NEAC};
- Harvest level being considered (t of salmon);
- Conservation spawning limits or alternate management objectives; and
- The post-fishery returns to each region.

The risk analysis of catch options incorporates the following input parameter uncertainties: (i) the uncertainty of the pre-fishery abundance forecast, (ii) the uncertainty in the biological parameters used to translate catches (weight) into numbers of salmon, and (iii) the uncertainty in attaining the conservation requirements simultaneously in different regions.

The uncertainty in the PFA_{NA} and PFA_{NEAC} is accounted for in the forecast approach described above. The number of 1SW non-maturing fish of North American and European origin in a given catch (t) is conditioned by the continent of origin of the fish ($prop_{NA}$, $prop_{E}$), by the average weight of the fish in the fishery ($Wt_{Allages}$), and by the proportion 1SW non-maturing fish in the respective continent of origin catches. These parameters define how many fish originating in North America and Europe are expected in the fishery harvests. For a level of fishery under consideration, the weight of the catch is converted to number of fish of each continent of origin using the following equation:

$$C1SW_c = \frac{t\ X\ propC}{ACF * \ (propNA\ X\ Wt1SW_{NA} + propE\ X\ Wt1SW_E)}$$

where: $C1SW_C$ is the catch (number of fish) of 1SW salmon originating in continent C (either North America or Europe), t is the fishery harvest at West Greenland in kg, $propC$ is the proportion of the 1SW salmon harvest which originates from continent C, $Wt1SW_{NA}$ and $Wt1SW_E$ are the average weight (kg) in the fishery of a 1SW salmon of North American and European origin, respectively, and ACF is the age correction factor by weight for salmon in the fishery which are not at age 1SW.

Since these parameters are not known for the forecast years of interest, they are estimated from previous values. Thus, $prop_{NA}$ (and $prop_{NEAC}$ as 1 - $prop_{NA}$) are drawn randomly from observed values of the past five years taking account of uncertainty due to sample sizes. For the other parameters, it is assumed that the parameters for $Wt_{Allages}$ and the proportion non-maturing 1SW in the catch by continent of origin could vary uniformly within the values observed in the past five years.

For a level of fishery under consideration, the weight of the catch is converted to fish of each continent of origin and subtracted from one of the simulated forecast values of PFA_{NA} and PFA_{NEAC}. The fish that escape the Greenland fishery are immediately discounted by the fixed sharing fraction (F_{na}) historically used in the negotiations of the West Greenland fishery. The sharing fraction chosen is the 40%:60% West Greenland:North America split. The same sharing arrangement has been used for NEAC stocks (ICES, 2003). [Any sharing fraction could be considered and incorporated at this stage of the risk assessment].

After the fishery, fish returning to homewaters are discounted for natural mortality from the time they leave West Greenland to the time they return to rivers. For North America this is a total of eleven months at a rate of M = 0.03 (equates to 28.1% mortality). For southern NEAC stocks this is a total of eight months at a rate of M = 0.03 (equates to 21% mortality). The fish that survive to North American homewaters are then distributed among the regions based on the regional proportions of lagged spawners for the last five years when estimates of spawners were available. The uncertainty in the regional proportions is characterised by drawing at random from a uniform distribution defined by the minimum and maximum regional ranges from the five years and calculating the average proportion for each of the six regions in North America.

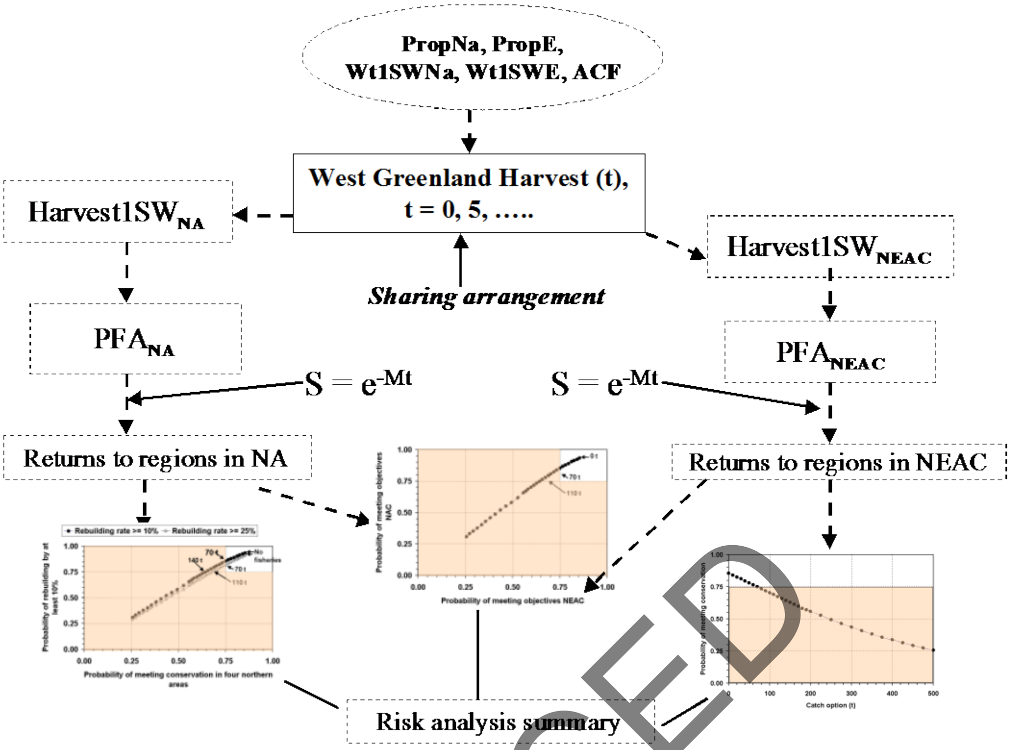

Figure 3.4.2.1. Flow chart summarising risk analysis for catch options at West Greenland using the PFANA and the PFANEAC predictions for the year of the fishery. Inputs with solid borders are considered known without error. Estimated inputs with observation error that is incorporated in the analysis have dashed borders. Solid arrows are functions that introduce or transfer without error whereas dashed arrows transfer errors through the components.

The final step in the risk analysis of the catch options involves combining the conservation requirement or alternate management objectives with the probability distribution of the returns to North America for different catch options. Estimated 2SW returns to each region are compared to the conservation objectives of Labrador, Newfoundland, Québec, and Gulf. Estimated returns for Scotia-Fundy are compared to the objective of achieving an increase of 25% relative to average returns of the base period, 1992–1996. For the USA, the management objective was revised in 2014 (ICES, 2014). Estimated returns for the USA are now compared to the objective of achieving 2SW adult returns of 4549 or greater. The advice to fisheries managers is presented as a probability plot (or table) of meeting or exceeding the objectives relative to increasing harvest levels at West Greenland.

ICES has adopted, a risk level of 75% of simultaneous attainment of seven management objectives (ICES, 2003) as part of an agreed management plan for the West Greenland fishery. The same level of risk aversion is applied for catch advice for homewater fisheries on the North American stock complex.

The catch advice for the West Greenland fishery is currently tabulated to show the probability of each management unit achieving its CL (or alternative reference level) individually and the probability of this being achieved by all management units simultaneously (i.e. in the same given year) (e.g. ICES, 2012a). This allows managers to evaluate both individual and simultaneous attainment levels in making their management decisions. Table 3.4.2.1 provides an example of catch options for West Greenland for the years 2012 to 2014 (ICES, 2012a). An updated catch options table for 2015 to 2017 is provided in Section 5.3 of the 2015 Working Group report (see above).

The models currently used by WGNAS in developing catch advice are considered to provide consistent characterisation of the status and expectations for Atlantic salmon in the North Atlantic. Compared to previous models used by WGNAS prior to 2009, the Bayesian models provide more flexibility, are consistent with the emerging emphasis on such approaches in natural resource assessment, and can provide management advice consistent with the probability of achieving management objectives.

Table 3.4.2.1. Catch options tables for mixed-stock fishery at West Greenland by year of PFA, 2012 to 2014.

2012 Catch option (t)	Probability of meeting or exceeding region–specific management objectives							
	LAB	**NFLD**	**QC**	**GULF**	**SF**	**USA**	**S-NEAC**	**ALL**
0	0.45	0.86	0.71	0.50	0.15	0.89	0.98	0.06
10	0.42	0.84	0.67	0.48	0.14	0.88	0.98	0.05
20	0.40	0.83	0.63	0.45	0.13	0.87	0.98	0.05
30	0.38	0.81	0.59	0.42	0.12	0.85	0.98	0.04
40	0.36	0.78	0.54	0.40	0.12	0.83	0.98	0.04
50	0.34	0.76	0.50	0.38	0.11	0.81	0.98	0.03
60	0.32	0.73	0.46	0.36	0.10	0.79	0.98	0.03
70	0.30	0.70	0.42	0.33	0.09	0.77	0.98	0.03
80	0.28	0.67	0.39	0.31	0.08	0.74	0.98	0.03
90	0.26	0.64	0.35	0.29	0.08	0.72	0.97	0.02
100	0.24	0.60	0.32	0.27	0.07	0.68	0.97	0.02
2013 Catch Option (t)	Probability of meeting or exceeding region-specific management objectives							
	LAB	NFLD	QC	GULF	SF	USA	S-NEAC	ALL
0	0.48	0.78	0.73	0.50	0.25	0.75	0.95	0.08
10	0.46	0.76	0.70	0.48	0.24	0.73	0.95	0.07
20	0.44	0.75	0.67	0.46	0.23	0.72	0.95	0.06
30	0.42	0.73	0.63	0.44	0.22	0.70	0.95	0.06
40	0.41	0.70	0.60	0.42	0.21	0.68	0.95	0.06
50	0.39	0.68	0.56	0.40	0.20	0.66	0.94	0.05
60	0.37	0.65	0.53	0.38	0.19	0.64	0.94	0.05
70	0.35	0.63	0.50	0.36	0.18	0.62	0.94	0.05
80	0.33	0.60	0.47	0.34	0.17	0.59	0.94	0.04
90	0.31	0.57	0.44	0.32	0.16	0.57	0.94	0.04
100	0.30	0.54	0.41	0.31	0.15	0.55	0.94	0.04
2014 Catch Option (t)	Probability of meeting or exceeding region-specific management objectives							
	LAB	NFLD	QC	GULF	SF	USA	S-NEAC	ALL
0	0.56	0.78	0.75	0.55	0.20	0.86	0.94	0.08
10	0.55	0.77	0.73	0.53	0.20	0.85	0.94	0.08
20	0.53	0.75	0.70	0.51	0.19	0.84	0.94	0.07
30	0.52	0.73	0.67	0.49	0.18	0.83	0.94	0.07
40	0.50	0.71	0.64	0.47	0.17	0.82	0.94	0.06
50	0.48	0.69	0.62	0.46	0.17	0.81	0.94	0.06
60	0.46	0.67	0.59	0.44	0.16	0.79	0.94	0.06

2012 Catch option (t)	Probability of meeting or exceeding region-specific management objectives							
	LAB	NFLD	QC	GULF	SF	USA	S-NEAC	ALL
70	0.45	0.65	0.56	0.42	0.16	0.77	0.94	0.05
80	0.43	0.63	0.54	0.41	0.15	0.76	0.94	0.05
90	0.42	0.61	0.51	0.39	0.14	0.74	0.94	0.05
100	0.40	0.59	0.49	0.38	0.14	0.72	0.94	0.05

3.4.3. Catch advice and risk analysis framework for the Faroes fishery

3.4.3.1. Outline of the risk framework and management decisions required

There is currently no agreed framework for the provision of catch advice for the Faroes fishery adopted by NASCO. However, NASCO has asked ICES, for a number of years, to provide catch options or alternative management advice with an assessment of risks relative to the objective of exceeding stock conservation limits for salmon in the NEAC area. An initial risk framework that could be used to provide and evaluate catch options for the Faroes fishery was outlined by WGNAS in 2010 (ICES, 2010a). This was based on the method currently used to provide catch advice for the West Greenland fishery, which involves estimating the uncertainty in meeting defined management objectives at different catch levels (TAC options). The Faroes risk framework was developed further at subsequent WGNAS meetings (ICES, 2011; 2012a) and the current proposed procedure is outlined below.

A number of decisions are required by managers before full catch advice could be provided (ICES, 2011; 2012a). Specifically, ICES has indicated that NASCO would need to agree upon the following issues before the risk framework could be finalised:

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

In developing an indicative risk framework, WGNAS has made pragmatic choices regarding these issues:

Faroes fishing season: A decision is required on the period to which any TAC for the Faroes fishery would 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 (e.g. two cohorts of 1SW salmon, etc.) were exploited under each TAC. ICES (2011) recommended that NASCO manage any fishery on the basis of fishing seasons operating from October to June, and catch advice should be provided on this basis.

Sharing agreement: The 'sharing agreement' establishes the proportion of any harvestable surplus within the NEAC area that could be made available to the Faroes fishery through the TAC. In effect, for any TAC option being evaluated for the Faroes, it is assumed that the total harvest would be the TAC divided by the Faroes share. WGNAS has proposed using a share allocation derived using the same approach and baseline period (1986–1990) as for West Greenland (ICES, 2010a). This gave a potential share allocation of 7.5% to Faroes. Following discussion within NASCO, one Party proposed an alternative baseline period of 1984–1988, which would give a share allocation of 8.4% to Faroes. In the absence of further advice from NASCO, WGNAS has applied a value of 8.4%.

Choice of management units: ICES (2010a) noted that the stock complexes currently 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. Basing an assessment of stock status on these large units greatly increases the risks to individual NEAC river stocks or groups of stocks that are already in a more depleted state than the average.

For the provision of catch advice on the West Greenland fishery, the total CL for NAC (2SW salmon only) of about 152 000 fish is assessed in six management units, which means that each unit has an average CL of about 25 000 salmon. In contrast, the total CLs for each of the NEAC stock complexes are:

Northern NEAC 1SW–	158 223
Northern NEAC MSW–	131 356
Southern NEAC 1SW–	565 183
Southern NEAC MSW–	275 549

The NEAC stock complexes are therefore between eight and 25 times the size of the average NAC ones. There is also wide variation in the size and status of stocks both within and among the NEAC national stock groups. WGNAS recommended (ICES, 2012a) that the NEAC catch advice should be based on more management units than are used at present, but also noted that there are practical limitations on the extent to which the assessments can be disaggregated, since the availability of information on the composition of the catch at Faroes constrained the selection of management units. In 2013, WGNAS (ICES, 2013) proposed a method to estimate the stock composition of the Faroes catch at a national level based on tag returns and the PFA estimates, but did not consider it appropriate to extend this to stock complexes smaller than this. Genetic stock assignment studies are underway to analyse scale samples collected at Faroes, but these are not expected to facilitate disaggregation below this level. In addition, other parameter values used in the assessment are currently only available for the total fishery and not smaller stock complexes.

In providing indicative catch advice with the new framework, WGNAS considered that it would be informative to managers to provide catch options tables for the ten NEAC countries as well as for the four stock complexes and has therefore run the risk framework using management units based on countries.

Management objectives: The management objectives provide the basis for determining the risks to stocks in each management unit associated with different catch options. The NASCO agreement on the adoption of a Precautionary Approach (NASCO, 1998) calls for the 'formulation of pre-agreed management actions in the form of procedures to be applied over a range of stock conditions', indicating that the management objectives (e.g. the required probability of exceeding the CL) should be agreed in advance of specific management proposals being considered.

At the request of NASCO, WGNAS considered the implications of applying probabilities of achieving CLs to separate management units vs. the use of simultaneous probabilities; this issue was outlined in detail in ICES (2013).

The probability of simultaneous attainment of management objectives in a number of separate management units is roughly equal to the product of the probabilities of individual attainment for each management unit. The probability threshold for each individual management unit might reasonably be set at a fixed level unless there are specific reasons for adopting an alternative (e.g. for stock rebuilding). ICES (2012) recommended that an appropriate probability level for individual stock complexes would be 95%. This individual probability level can be applied to each management unit regardless of the number of units used; however, this is less obvious for the probability of simultaneous attainment, as explained next.

Management decisions for the West Greenland fishery have been based on a 75% probability of simultaneous attainment of CLs. For a given probability of achieving individual stock CLs, the probability of simultaneous attainment decreases rapidly as the number of management units considered increases. For the example of 20 management units (e.g. two age groups from each of ten countries), the use of the simultaneous probability level applied for West Greenland (75%) would correspond to the probability of individual stocks meeting the CLs being 98.6% or higher, assuming the same individual probability for all stocks. The use of a 95% probability level for meeting the CLs individually in the 20 management unit example, implies a simultaneous attainment probability of about 36%, i.e. there would be a 64% chance that at least one stock failed to meet its CL in any given year. On the other hand, the use of a 75% probability of simultaneous attainment could result in a fishery being advised when the individual probability of one management unit is as low as 75% if all the other management units have a 100% chance of meeting the CL (as in that case, the probability of simultaneous attainment would still be 75%). This may not be an acceptable risk for managing multiple river stocks.

WGNAS considered that the probability of simultaneous attainment can provide useful information to managers of the risk of failing to meet CLs in at least one stock in the MSF. However, as the management units being considered by NASCO for managing the MSF at Faroes are still very large and each unit encompasses a large number of individual river stocks, choosing a high probability level (such as 95%) of attaining CLs in individual units would be less risky to individual stocks than the use of a simultaneous attainment objective set at the value used for the West Greenland fishery.

On the basis of these considerations, WGNAS provided both individual probabilities and the probability of simultaneous attainment of the management units in the catch options tables (ICES, 2013). ICES recommends that management decisions should be based principally on a 95% probability of attainment of CLs in each stock complex 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 (as illustrated above, in the example with 20 management units).

3.4.3.2. Modelling approach for the catch options risk framework

The basic model for assessing each catch option within the risk framework is the same for both stock complexes and at a country level (ICES, 2013). The PFA forecasts derived in the Winbugs model are transferred to the risk framework model run in 'R'. The estimates and distributions of the PFA estimates used in the risk framework are derived by taking the first 50 000 values from the Winbugs posterior forecast simulations. Parameters in the following description that are marked with an '*' in the equations have uncertainty around them generated by means of 50 000 random draws from the annual values observed from the sampling programmes conducted in the Faroes between the 1983/1984 and 1990/1991 fishing seasons. They therefore contribute to the estimation of the probability density function around the potential total harvest arising from each TAC option. When the assessment is run at a national level, the number of draws has to be limited to 25 000 because of memory limitations in 'R'.

The modelling procedure involves:

- estimating the total number of 1SW and MSW salmon that could be killed as a result of any TAC at Faroes, including catches in homewaters;
- adjusting these to their equivalent numbers at the time of recruitment to the Faroes fishery;
- subtracting these from the PFA estimates for maturing and non-maturing 1SW salmon in the appropriate years;
- assessing the results against the SERs (i.e. the CLs adjusted to the time of recruitment to the Faroes fishery).

The TAC option (T) is first divided by the mean weight (Wt*) of salmon caught in the Faroes fishery to give the number of fish that would be caught, and this value is converted to numbers of wild fish (Nw) by multiplying by one minus the proportion of fish-farm escapees in samples taken from the Faroes catch (pE*) observed in historical sampling programmes. A correction factor (C = 0.63) is applied to the proportion of fish-farm escapees to take account of reductions in the numbers of farm escapees over the past 20 years based on observations in Norwegian coastal waters:

$$Nw = T / Wt^* \times (1 - (pE^* \times C))$$

This value is split into numbers by sea age classes (1SW and MSW) according to the proportion of each age group (pAi*, where 'i' is 1SW or MSW) observed in historical catch sampling programmes at 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, and 80% of these fish were estimated to die, so these mortalities are also added to the 1SW catch. Thus:

$$Nw1SW = Nwtotal \times pA1SW^* + (Nwtotal \times pD^* / (1 - pD^*) \times 0.8)$$

and

$$NwMSW = Nwtotal \times pAMSW^*$$

where: pD* is the proportion of the total catch that is discarded (i.e. fish <60 cm total length).

Further corrections are made to the 1SW and MSW numbers to reduce the 1SW total to take account of the proportion that will not mature as 1SW fish and to add the survivors from this group to the MSW fish in the following year. For the first catch advice year the number added to the MSW total is adjusted to the TAC of the current season (i.e. zero in 2012/2013). Thus:

$$Nw1SW = Nw1SW \times pK^*$$

and

$$NwMSW = NwMSW + Nw1SW \times (1-pK^*)$$

where 'pK' is the proportion of 1SW salmon that are expected to mature in the same year (0.78) derived from experimental studies conducted in the 1980s (Youngson and Webb, 1993).

The numbers in each age group are then divided among the management units by multiplying by the appropriate proportions (pUij), where 'i' denotes the age groups and 'j' denotes the management units, and each of these values is raised by the Faroes share allocation (S) to give the total potential harvest (Hij) of fish from each management unit and sea age group:

Nwij = (Nwi x pUij) / S

Finally, these values are adjusted for natural mortality so that they can be compared with the PFA forecasts and SER values from the mid-date of the fishery to the recruitment date by using an instantaneous monthly rate of mortality of 0.03.

These harvests are then subtracted from the stock forecasts (PFAij) for the management units and sea age groups and compared with the Spawner Escapement Reserves (SERij) to evaluate attainment of the management objective. In practice, the attainment of the management objective is assessed by determining the probability that PFAij – Hij – SERij is greater than zero. The SER is the number of fish that need to be alive at the time of the Faroes fishery to meet the CL when the fish return to homewaters; this equals the CL raised by the mortality over the intervening time. CLs and SERs are currently estimated without uncertainty.

3.4.3.3. Input data for the risk framework

The analysis estimates probability of each management unit achieving its SER (the overall abundance objective) for different catch options in the Faroes fishery (from 0 to 200 t). The analysis assumes:

- no fishery operated in the 2012/2013 season;
- the TAC allocated to Faroes is the same in each year and is taken in full;
- homewater fisheries also take their catch allocation in full.

The analysis requires the following input data for the catch that would occur at the Faroes if a TAC was allocated (full details are provided in ICES, 2013):

- mean weights;
- proportion by sea age;
- discard rates (fish less than 60 cm total length);
- proportion of fish-farm escapees;
- composition of catches by management unit;
- proportion of 1SW fish not maturing.

3.4.3.4. Indicative catch advice

Table 3.4.3.4.1 provides an example of catch options for the Faroes fishery for the seasons 2013/2014 to 2015/2016 (ICES, 2013). Equivalent tables were provided for both 1SW and MSW salmon for all NEAC countries, and WGNAS also estimates the exploitation rates that these TAC options would impose on each stock complex or national stock (ICES, 2013). Updated catch options tables for the seasons 2015/2016 to 2017/2018 are provided in Section 3.5 of the 2015 Working Group report (see above).

Table 3.4.3.4.1. Probability of northern and southern NEAC - 1SW and MSW stock complexes achieving their SERs independently and simultaneously for different catch options for the Faroes fishery in the 2013/2014 to 2015/2016 fishing seasons.

Catch options for 2013/14 season:	TAC option (t)	NEAC-N-1SW	NEAC-N-MSW	NEAC-S-1SW	NEAC-S-MSW	All complexes
	0	96.2%	99.8%	74.3%	75.6%	56.8%
	20	96.2%	99.2%	74.2%	69.8%	52.7%
	40	96.2%	98.2%	74.2%	63.9%	48.2%
	60	96.1%	96.3%	74.1%	57.9%	43.3%
	80	96.1%	93.4%	74.1%	52.1%	38.1%
	100	96.1%	89.3%	74.0%	46.6%	32.9%
	120	96.0%	84.3%	74.0%	41.7%	28.1%
	140	96.0%	78.4%	73.9%	36.8%	23.4%
	160	95.9%	71.6%	73.9%	32.5%	19.2%
	180	95.9%	64.6%	73.8%	28.5%	15.4%
	200	95.8%	57.6%	73.8%	25.0%	12.2%
Catch options for 2014/15 season:	**TAC option (t)**	**NEAC-N-1SW**	**NEAC-N-MSW**	**NEAC-S-1SW**	**NEAC-S-MSW**	**All complexes**
	0	94.6%	99.2%	75.4%	79.6%	59.0%
	20	94.6%	98.2%	75.3%	75.3%	55.8%
	40	94.6%	96.6%	75.3%	70.8%	52.0%
	60	94.5%	94.2%	75.2%	66.4%	48.0%
	80	94.4%	90.9%	75.2%	61.8%	43.6%
	100	94.4%	86.8%	75.1%	57.3%	38.9%
	120	94.3%	82.1%	75.1%	53.1%	34.4%
	140	94.3%	76.8%	75.0%	49.0%	30.1%
	160	94.3%	71.2%	75.0%	45.0%	25.9%
	180	94.2%	65.5%	74.9%	41.5%	22.1%
	200	94.2%	59.6%	74.9%	38.0%	18.6%
Catch options for 2015/16 season:	**TAC option (t)**	**NEAC-N-1SW**	**NEAC-N-MSW**	**NEAC-S-1SW**	**NEAC-S-MSW**	**All complexes**
	0	94.6%	98.5%	70.1%	79.7%	55.2%
	20	94.6%	97.2%	70.1%	76.0%	52.4%
	40	94.5%	95.1%	70.0%	72.2%	49.2%
	60	94.5%	92.3%	70.0%	68.4%	45.6%
	80	94.5%	89.0%	69.9%	64.6%	41.9%
	100	94.4%	85.0%	69.9%	60.7%	38.0%
	120	94.4%	80.6%	69.8%	57.1%	34.2%
	140	94.3%	75.7%	69.8%	53.5%	30.4%
	160	94.3%	70.6%	69.7%	50.0%	26.7%
	180	94.2%	65.4%	69.7%	46.8%	23.4%
	200	94.2%	60.4%	69.7%	43.7%	20.4%

3.5. Development of indicator frameworks to identify significant changes in previously provided multiannual management advice

3.5.1. Background

In support of the multiannual management advice that is provided for all three NASCO Commission Areas, NASCO asked ICES to provide an assessment of the minimal information needed to signal an unforeseen change in productivity for stocks contributing to fisheries within each Commission area. A particular concern was that an increase in productivity may alter the reliability of the previously provided multiyear catch options and could result in unrealised harvest within various mixed-stock fisheries. Initial progress on this issue was presented to WGNAS in 2006 (ICES, 2006) and further developments were made by the Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance [SGEFISSA] which met in November 2006 (ICES, 2007b) and reported to WGNAS in 2007 (ICES, 2007a). This resulted in the development of a suggested framework (Framework of Indicators - FWI) which could be used to indicate if any significant change in the status of stocks had occurred and thus confirm whether the previously provided multi-annual management advice was still appropriate.

The initial FWI was developed with both the Greenland and Faroes fisheries in mind, although the methodology only proved suitable for the West Greenland fishery and an alternative approach was subsequently developed for the NEAC area (ICES, 2011; 2012a; 2013). Thus, FWIs are now routinely applied in the interim (non-assessment) years of multiyear agreements for both NAC and NEAC to facilitate the management of the West Greenland and Faroes fisheries respectively. Both operate according to the timeline outlined in Figure 3.5.1.1. Outline descriptions of the two different schemes are provided below.

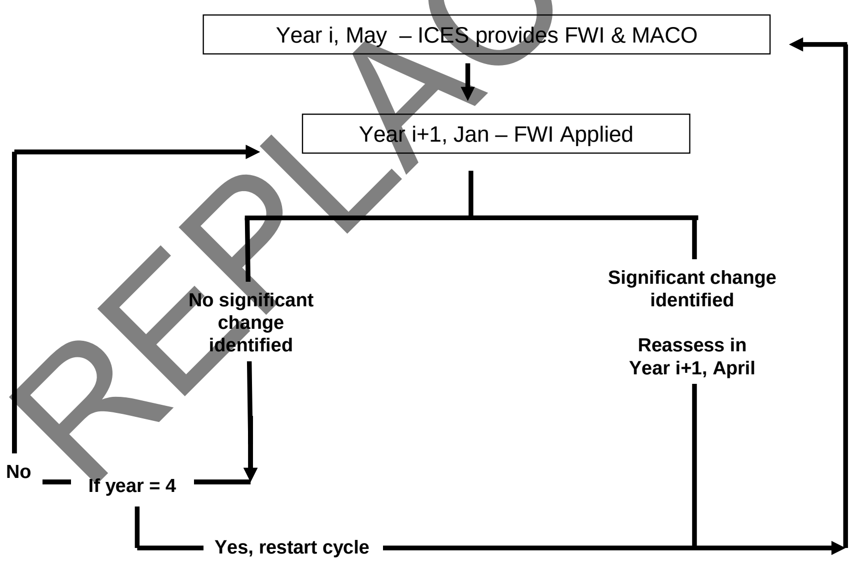

Figure 3.5.1.1. Timeline for employment of the Framework of Indicators (FWI). In Year i, ICES provides an updated FWI which re-evaluates the updated datasets and is summarized in an Excel worksheet. In January of Year i+1 the FWI is applied and two options are available depending on the results. If no significant change is detected, no re-assessment is necessary and the cycle continues to Year i+2. If no significant change is detected in Year i+2, the cycle continues to Year i+3. If a significant change is detected in any year, then reassessment is recommended. In that case, ICES would provide an updated FWI the following May. ICES would also provide an updated FWI if year equals 4. [MACO = multi-annual catch options].

3.5.2. Framework of Indicators (FWI) for the West Greenland Fishery

The process for developing and applying the FWI for the Greenland fishery consists of six general steps:

- Definition of a significant change - Define measurable criteria for what the statement "a significant change in the previously provided multi-annual management advice" represents.
- Evaluating historical relationships between indicators and variables of interest - Define and evaluate the historical relationships between numerous indicators and the variable of interest for individual rivers across all stock complexes.
- Establishing threshold values - Define the threshold level (i.e. variable of interest level) that will satisfy the management objectives for each stock complex.
- Decision rule determinations - Define and apply a standardised approach for determining the appropriate decision rule value. The decision rule should provide a signal if the variable of interest will be greater than or less than the threshold level with high precision.
- Combining Indicators within the Framework - Define and apply a standardised approach for combining indicator datasets within and across stock complexes for future comparison against contemporary indicator values.
- Applying the FWI - Define and apply a standard approach to input contemporary indicator values into the FWI to determine if there is likely to be a significant change in the previously provided management advice.

Each of these is considered in turn; full details are available in ICES (2007b).

3.5.2.1. Definition of a significant change

A significant change in the previously provided multiannual management advice is regarded as an unforeseen change in stock status that would alter the previously provided advice based on analysis of current population data obtained from various monitored populations across the North Atlantic. This would be indicated by a situation where stock abundance has increased to a level where a fishery could be recommended when no catch had previously been advised, or a decrease in stock abundance when catch options had been chosen.

For the fishery at West Greenland, ICES would recommend that a harvestable surplus exists within the West Greenland stock complex if there was a high probability (75%) that the following three objectives could be met simultaneously:

> The conservation limits of the four northern regions of North America (Labrador, Newfoundland, Québec, and Gulf) were achieved.
>
> There was a 25% increase in returns to the Scotia-Fundy region relative to the mean returns for the 1992–1996 period. For the USA, the management objective was revised in 2014 to correspond to recover objectives defined in the recovery plan for endangered Atlantic salmon stocks in the USA (ICES, 2014), this now requires that estimated 2SW adult returns are 4549 or greater.
>
> The conservation limit for the Southern NEAC MSW complex was achieved.

3.5.2.2. Evaluating historical relationships between indicators and variable of interest

A number of variables were considered for inclusion as indicators in the FWI, but only two were considered sufficiently informative to be carried forward into the framework: adult returns (returns, catch or estimated PFA) and return rates (i.e. smolt survival rates, marine survival). These are available, by sea age class, for a number of monitored rivers throughout the North Atlantic and can be directly related to the management objectives for the fishery.

3.5.2.3. Establishing threshold values

In keeping with the 75% probability of meeting or exceeding the objectives for the West Greenland catch options (see above), the 25th percentile of the return estimates of the six areas in North America are compared to the corresponding 2SW conservation limits of the four northern areas of North America, to the 25% increase objective for the Scotia- Fundy area, and to management objective of achieving 4549 or greater 2SW adult returns for the USA. For the southern NEAC non-maturing component, the 25th percentile of the PFA estimate of the southern NEAC non-maturing complex is compared to the spawning escapement reserve (SER) for the southern NEAC non-maturing complex.

3.5.2.4. Decision rule determinations

The procedure for analysing the relationships between the indicators and the returns of 2SW salmon or the PFA estimates was originally suggested by ICES (2006). The individual river catches, returns or return rates are lagged to correspond to the same smolt cohort for the 2SW returns to North America or to the PFA estimates for NEAC complexes. Bivariate plots of each indicator dataset relative to the 2SW returns or the PFA estimates are prepared. Upper and lower halves are defined by the management objective value for the corresponding geographic area in North America or the NEAC stock complexes as outlined above. Estimates of returns of 2SW or PFA estimates in the upper half correspond to years when the returns or PFA exceed the management objectives. Points in the lower half correspond to years when the returns or PFA are less than the management objective.

Left and right halves are defined by a sliding rule along the indicator range. An objective function that maximises the number of correct assignments (true highs and true lows) is used to define the indicator decision rule. The objective function also minimises the number of incorrect assignments (false highs and false lows, Figure 3.5.2.4.1).

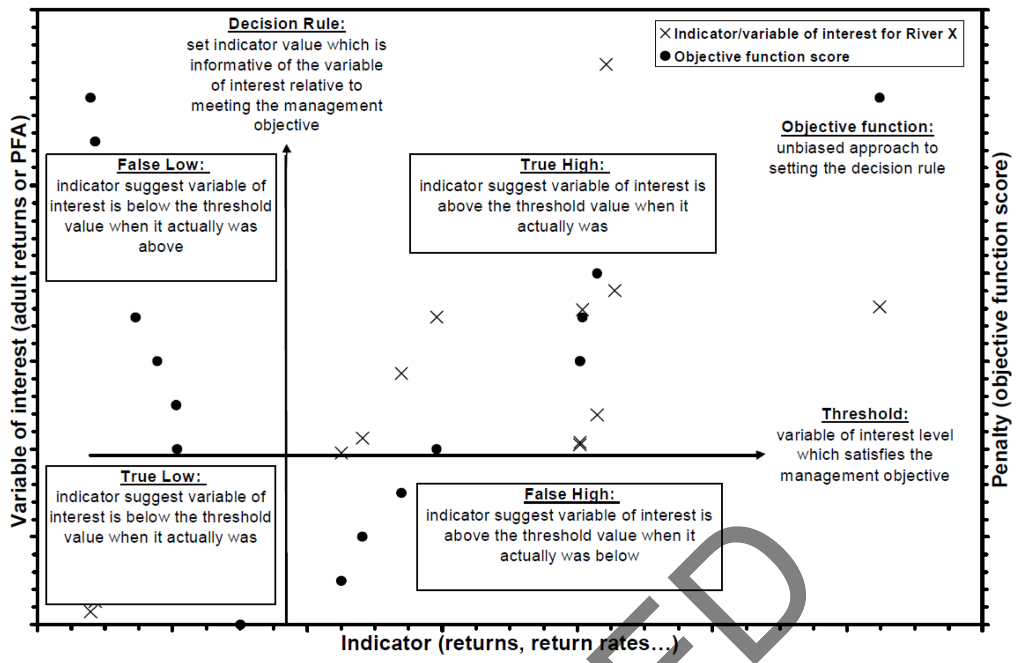

Figure 3.5.2.4.1. Example of Indicator/Variable of Interest exploratory graph identifying the threshold value, decision rule, penalty function and the four states (true high, true low, false high and false low).

The value of the indicator variable that minimises the sum of the penalty scores (i.e. minimises the number of incorrect assignments) is assigned as the decision rule for that dataset. Equal penalty weights are assigned to false highs (lower right quadrant) and false lows (upper left quadrant). Correct assignments are scored as zero. In the case when multiple minima occurred, the lowest indicator value among the low minima values is chosen.

Indicators are retained in the framework when they are evaluated as being informative of the magnitude of returns or PFA relative to the management objectives. These informative indicator datasets also have to meet the following two criteria to be retained:

- Expectation that the indicator variable would be available in future (in January), and
- A minimum of five observations are present in each of the correct quadrats (true low; true high).

3.5.2.5. Combining Indicators within the Framework

The probabilities of correct assignments are calculated for each of the true low and true high states for each of the indicator datasets retained. The respective probabilities correspond to the ratio of the correct assignment to all observations within the respective low and high indicator halves:

$P(State_{low} \mid Indicator_{low})$ (i.e. true low) = $N(State_{low} \mid Indicator_{low})$ / N $Indicator_{low}$

$P(State_{high} \mid Indicator_{high})$ (i.e. true high) = $N(State_{high} \mid Indicator_{high})$ / N $Indicator_{high}$

Indicator datasets are then pooled according to management objective/stock complex groupings. Each NAC stock complex (n=6) and the southern NEC non-maturing stock complex are pooled separately as these stock complexes relate to the management objectives for the West Greenland fishery.

3.5.2.6. Applying the FWI

To apply the FWI, the most recent year's indicator value for each of the retained indicator datasets is compared to the decision rule as determined from the historical datasets. If the contemporary indicator value is low relative to the decision rule, it is assigned a value of -1. If the value is high, it is assigned a score of +1. Multiple indicators within the stock complex groupings are then combined by arithmetic average of the product of the indicator value (-1, +1) and the probability of a correct assignment corresponding to the true low or true high states. An average geographic area or stock complex score equal to or greater than zero suggests there is a likelihood of meeting the management objective for that grouping based on the historic relation between the variable of interest (adults returns or PFA) and the indicators evaluated.

If the scores for all the groupings within a fishery complex are greater than zero, then there is a likelihood that all the management objectives for that fishery will be met. Under that scenario, the multiyear management advice should be reassessed. When the score(s) for one or more of the groupings is less than zero, there is unlikely to be a significant change in the management advice and there would be no need for a reassessment.

SGEFISSA (ICES, 2007b) developed a spreadsheet template FWI (see example at Figure 3.5.2.6.1) in which the underlying variable of interest/ indicator dataset relationships and decision rules are summarised and collated according to the specific management objectives for each fishery. This provides one of two conclusions for the user:

1) No significant change identified by the indicators;

2) Reassess.

Catch Advice	Catch option > 0 (Yes = 1, No = 0)	0

Overall Recommendation

No Significant Change Identified by Indicators

Geographic Area	River/ Indicator	2011 Value	Ratio Value to Threshold	Threshold	True Low	True High	Indicator State	Probability of Correct Assignment	Indicator Score	Management Objective Met?
USA	Penobscot 2SW Returns	2368	167%	1415	100%	92%	1	0.92	0.92	
	Penobscot 1SW Returns	741	197%	377	83%	88%	1	0.88	0.88	
	Penobscot 2SW Survival (%)	0.39	170%	0.23	100%	60%	1	0.6	0.6	
	Penobscot 1SW Survival (%)	0.12	133%	0.09	85%	73%	1	0.73	0.73	
	Narraguagus Returns	196	196%	100	95%	61%	1	0.61	0.61	
	possible range				*-0.93*	*0.75*				
	Average		173%						**0.75**	**Yes**
Scotia-Fundy	Saint John Return Large	294	9%	3 329	96%	100%	-1	0.96	-0.96	
	Lahave Return Large	146	51%	285	77%	85%	-1	0.77	-0.77	
	St. Mary's Return Large	14	6%	221	100%	73%	-1	1	-1	
	North Return Large	1 193	168%	712	95%	67%	1	0.67	0.67	
	Saint John Return 1SW	582	26%	2 276	86%	80%	-1	0.86	-0.86	
	LaHave Return 1SW	565	34%	1 679	94%	67%	-1	0.94	-0.94	
	St. Mary's Return 1SW	331	16%	2 038	95%	93%	-1	0.95	-0.95	
	Saint John Survival 2SW (%)	0.13	59%	0.22	95%	81%	-1	0.95	-0.95	
	Lahave Survival 2SW (%)	0.88	367%	0.24	81%	81%	1	0.81	0.81	
	Saint John Survival 1SW (%)	0.12	16%	0.76	86%	73%	-1	0.86	-0.86	
	Lahave Survival 1SW (%)	0.72	50%	1.44	92%	78%	-1	0.92	-0.92	
	Liscomb Survival 2SW (%)	0.03	60%	0.05	86%	91%	-1	0.86	-0.86	
	East Sheet Harbour Survival 2SW (%)	0.005	25%	0.02	67%	82%	-1	0.67	-0.67	
	possible range				*-0.88*	*0.81*				
	Average		68%						**-0.64**	**No**
Gulf	Miramichi Return 2SW	28 977	183%	15 800	100%	85%	1	0.85	0.85	
	Miramichi Return 1SW	45 880	110%	41 790	89%	67%	1	0.67	0.67	
	possible range				*-0.95*	*0.76*				
	Average		147%						**0.76**	**Yes**
Quebec	Cascapédia Return Large	3 815	167%	2 280	69%	92%	1	0.92	0.92	
	Bonaventure Return Large	1 259	85%	1 479	75%	81%	-1	0.75	-0.75	
	Grande Rivière Return Large	533	121%	442	100%	94%	1	0.94	0.94	
	Saint-Jean Return Large	688	91%	758	86%	89%	-1	0.86	-0.86	
	Dartmouth Return Large	1 171	155%	756	86%	89%	1	0.89	0.89	
	Madeleine Return Large	996	153%	653	70%	93%	1	0.93	0.93	
	Sainte-Anne Return Large	871	201%	433	67%	88%	1	0.88	0.88	
	Godbout Return Large	694	108%	641	86%	100%	1	1	1	
	De la Trinite Return Large	317	82%	385	75%	100%	-1	0.75	-0.75	
	York Return Return Large	1 585	113%	1405	63%	83%	1	0.83	0.83	
	Grande Rivière Return Small	237	119%	199	59%	80%	1	0.8	0.8	
	Saint-Jean Return Small	343	87%	394	53%	80%	-1	0.53	-0.53	
	Godbout Return Small	623	123%	508	85%	92%	1	0.92	0.92	
	De la Trinite Return Small	949	238%	399	89%	83%	1	0.83	0.83	
	De la Trinite Survival Large (%)	0.76	155%	0.49	88%	96%	1	0.96	0.96	
	De la Trinite Survival Small (%)	2.54	170%	1.49	63%	89%	1	0.89	0.89	
	Saint-Jean Survival Small (%)	1.86	258%	0.72	100%	64%	1	0.64	0.64	
	possible range				*-0.77*	*0.88*				
	Average		143%						**0.50**	**Yes**
Newfoundland	Exploits Return Small	34 085	137%	24 924	83%	56%	1	0.56	0.56	
	Middle Brook Return Small	2 642	141%	1 868	84%	63%	1	0.63	0.63	
	Torrent Return Small	2 784	67%	4 154	94%	64%	-1	0.94	-0.94	
	possible range				*-0.87*	*0.61*				
	Average		115%						**0.08**	**Yes**
Labrador										
	possible range									
	Average								**NA**	**Unknown**
Southern NEAC										
	possible range									
	Average								**NA**	**Unknown**

Figure 3.5.2.6.1. Framework of indicators spreadsheet for the West Greenland fishery. For illustrative purposes, the 2011 value of returns or survival rates for the 40 retained indicators is entered in the cells corresponding to the annual indicator variable values.

If no significant change has been identified by the indicators, then the multiyear catch advice for the year of interest could be retained. If a significant change is signalled by the indicators, the response is to reassess.

The framework spreadsheet is designed to capture both fishing and non-fishing scenarios:

- Multiyear advice provides no catch options greater than zero but indicators are suggesting that the management objectives may be met (conclusion: Reassess);
- Multiyear advice provides catch options greater than zero but the indicators suggest the management objectives may not be met (conclusion: Reassess).

There are two steps required by the user to run the framework. The first step in the framework evaluation is to enter the catch advice option (i.e. tonnes of catch) for the West Greenland fishery. This feature provides the two way evaluation of whether a change in management advice may be expected and a reassessment would be required. The second step is to enter the values for the indicator variables in the framework for the year of interest. The spreadsheet evaluation update is automated and the conclusion is shown in the row underneath “Overall Recommendation”.

The conclusions from the framework evaluation are based on whether there is simultaneous achievement of the management objectives in the six stock areas of North America and the southern NEAC 1SW non-maturing complex. If there are no indicator variables for a geographic area, the attainment of the management objectives is evaluated as unknown and that area or complex is not used in the decision structure of the framework.

Within the geographic areas for which indicator variables are retained, all the available indicators are used to assess the indicator score. If an update value for an indicator variable is not available for the year of interest, the indicator variable is not used to quantify the indicator score for that area.

The West Greenland FWI was updated during the 2015 WGNAS meeting and an updated spreadsheet produced. Details are provided in Section 5.8 of the Working Group report (see above).

3.5.3. Framework of Indicators (FWI) for the Faroes Fishery

3.5.3.1. Background

The original FWI applied to the West Greenland fishery (ICES, 2007b) was not applicable for the Faroese fishery for a number of different reasons. Among these were the lack of quantitative catch advice, the absence of specific management objectives and a sharing agreement for this fishery and the fact that none of the available indicator datasets met the criteria for inclusion in the FWI.

In 2011, WGNAS re-evaluated the approach for developing a FWI for the Faroese fishery (ICES, 2011). Since over the available time-series the PFA estimates for the NEAC stock complexes have predominately remained above the SER, the Working Group suggested a different set of decision rules for this FWI. It was suggested that the status of stocks should be re-evaluated if the FWI suggests that the PFA estimates are deviating substantially from the median values from the forecast.

3.5.3.2. Description of the FWI

It was initially suggested that the 95% confidence interval range for the mean of the indicator prediction, relative to the median forecast value, be used to compute the decision thresholds for whether the indicator suggests a reassessment or not (ICES, 2011). The limits should be computed at the median values of the PFA forecasts in each of the years in multiyear advice. However, the 95% criterion was subsequently re-examined (ICES, 2012a) and it was recommended that the upper and lower 75% confidence limits of the individual predictions be used for comparison (Figure 3.5.3.2.1). WGNAS recognised that this was a relaxation of the decision rule suggested in 2011, and will lead to a larger interval, and thus a lower chance of a reassessment than the approach suggested in 2011. However, this was considered to be a more realistic confidence level given the relatively wide variability of the indicator datasets, and was also consistent with the approach adopted by NAC.

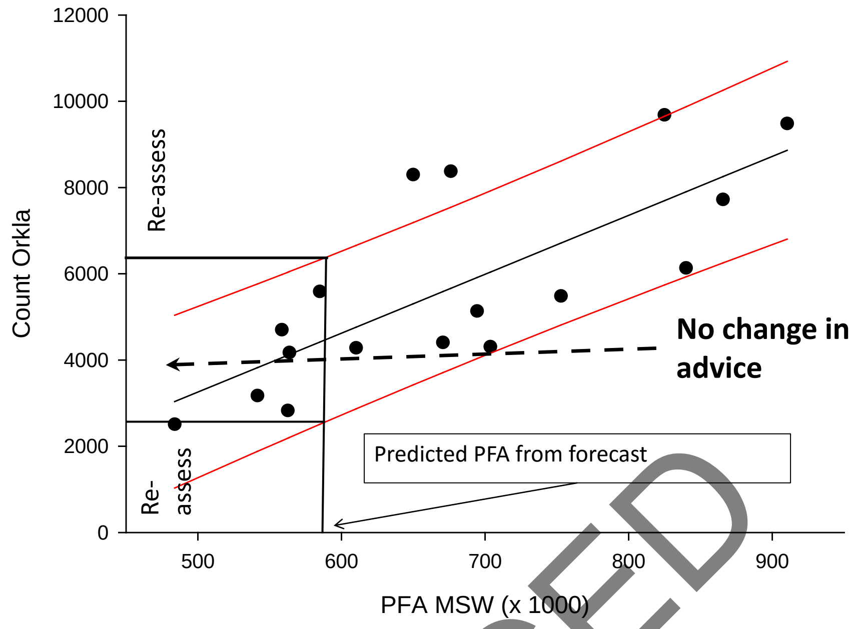

Figure 3.5.3.2.1. Example of how the reassessment intervals for the indicators are computed. The values of an indicator (counts) are plotted against the PFA. The regression line is shown in black and 75% confidence limits for the individual estimates are shown in red. From the forecasted PFA in the year in question the values of the indicator corresponding to the upper and lower 75% confidence interval are estimated. If the indicator value falls outside these limits a reassessment is recommended by this particular indicator.

When the stocks are divided into smaller management units, potential indicators for each management unit become relatively scarce. Therefore, the Working Group recommended that the FWI be regressed against the stock complexes that they belong to. For example, MSW indicators from Norway should be regressed against PFA MSW for northern NEAC.

In 2012, the FWI was applied as a two-tailed test (ICES, 2012a). However, it was subsequently agreed that, in the event of a closed fishery, the indicators should only be compared to the upper 75% confidence limit (i.e. a one-tailed test). This means that for a closed fishery, a reassessment is only triggered where the forecast appeared to be an underestimate and there may be a possibility of a harvest being denied. In the case of an open fishery they should be compared to both the upper and lower 75% confidence limits. In this case, if the FWIs suggest that the forecasted PFA is either an underestimation or an overestimation of the realised PFA in any of the four stock complexes, then this should trigger a reassessment.

ICES further advised (ICES, 2015) that, in the case of closed fisheries, the FWI should only be applied to those stock complexes which had previously signalled zero catch options at Faroes. This was agreed by NASCO (NEA(16)11) and applied in January 2017.

WGNAS developed a FWI spreadsheet (ICES, 2011) to provide an automatic evaluation of the need for a reassessment once the new indicator values are available in January; this has been updated in subsequent years (ICES, 2012a; 2013, 2015). An example spreadsheet is provided at Figure 3.5.3.2.2.

The following summarizes the main steps performed by the spreadsheet following updating of the relevant data for the variable of interest by adding the latest year's number:

- Regression analysis with the dataset *x* to determine its power to predict PFA in the forecasted years.
- Calculation of the 75% confidence intervals of individual predictions of the regression for dataset *x*. An indicator value below the 75% individual confidence interval (CI) is interpreted as indicative of an overestimation of the PFA, while a point above the 75% individual confidence interval is interpreted as indicative of an underestimation of PFA.
- A dataset is considered informative and should be kept as an indicator in the FWI if the following conditions are met: sample size (n) ≥ 10; r^2 ≥0.2; dataset updated annually and new value available by January 15. Datasets that do not meet these criteria are discarded.
- Apply a binary score to each indicator value. Thus, for dataset *x*, if the current year's indicator value is outside the 75% individual regression point estimate CI (below or above) then that indicator receives a score of 1. If the indicator is within the 75% CI, then the indicator receives a score of -1. In the absence of an indicator datapoint for any year, a score of zero is applied. Whether the indicator value is above or below the upper and lower CI values is checked separately in two spreadsheet columns and a decision whether the indicator value is within the CI is assessed by combining the information in the two columns.
- Separate columns are used to sum the scores for all the indicator datasets within each stock complex. This is done separately for points that fall above the CI and those that fall below. In the case of a two-sided approach (open fishery), if the sum of these columns is ≥0, then the spreadsheet signals "REASSESS"; if the sum is <0, then it signals "No significant OVERestimation of PFA identified by indicators, do not reassess" for indicator values that fall below the CI, and "No significant UNDERestimation of PFA identified by indicators, do not reassess" for indicator values that are above the CI. In case of a one-sided approach (closed fishery), only underestimation will signal a "REASSESS".
- FWI results are generated for each stock complex (northern NEAC maturing and non-maturing, and southern NEAC maturing and non-maturing). A score of ≥0 for any of these stock complexes would signal a reassessment.

WGNAS reassessed the effects of applying stricter criteria than r^2 ≥0.2 for inclusion of indicators in the FWI. As stricter criteria are used, the number of indicators included reduces rapidly. It was therefore concluded to keep the criterion of r^2 ≥0.2 in order to obtain a sufficient number of indicators to be able to use the FWI even in the event of one or more indicators being unavailable by the time the FWI is applied each year. The r^2 value of 0.2 corresponds to a value slightly lower than what is considered to be a "large" effect size (r = 0.5, r^2 = 0.25) by Cohen (1988). Although a criterion of $r^2 \geq 0.2$ gives each indicator little predictive power alone (Prairie, 1996), the approach of using a suite of indicators is more similar to meta-analysis (Rosenthal, 1984) meaning that the outcome of the FWI is not dependent on the result of one indicator in isolation, but rather on the combined performance of the indicator set.

The Faroes FWI was updated during the 2015 WGNAS meeting and an updated spreadsheet produced. Details are provided in Section 3.7 of the Working Group report (see above). In evaluating all the time-series, it was noted that the lower 12.5 % CL, which is used to determine which indicator values are outside the 75% CI on the lower side, was negative for some regression relationships for predicted PFA values in 2015 and 2016. Since this would invalidate the use of such indicators (they would not indicate that predicted PFA values are overestimates regardless of how small they are), an additional (fourth) criterion was established as a requirement for including time-series in the FWI. This requires that the lower 12.5% confidence limit for an indicator time-series should be positive for any values of PFA included in the FWI.

FWI NEAC 2012 — Indicators suggest: REASSESS

An example

Indicators for Northern NEAC 1SW PFA

										Reassess in year 2012? Outside 75% conf.lim.		Outside 75% confidence limits	
		Insert data from 2011 here	N reg	Slope	Intercept	r^2	Median PFA	12.5%ile	87.5%ile	below	above	below	above
1	Returns all 1SW NO PFA est	171994	22	0.530320	-68503.69	0.91	366400	79749.32	171861.94	-1	1	NO	YES
2	Survivals W 1SW NO Imsa	1.8	27	0.000012	-4.13	0.40	366400	-4.52	5.27	-1	-1	NO	NO
3	Survivals H 1SW NO Imsa	2.3	28	0.000006	-1.21	0.26	366400	-2.31	4.35	-1	-1	NO	NO
4	Counts all NO Øyensåa (1SW)	1446	12	0.002637	316.65	0.29	366400	-28.89	2594.93	-1	-1	NO	NO
5	Counts all NO Nausta (1SW)	1824	13	0.002934	-903.82	0.51	366400	-771.96	1114.67	-1	1	NO	YES
								Sum of scores		-5	-1		
												Indicators do not suggest that the PFA forecast is an overestimation.	Indicators do not suggest that the PFA forecast is an underestimation.

Indicators for Northern NEAC MSW PFA

										Reassess in year 2012? Outside 75% conf.lim.		Outside 75% conf.lim.	
		Insert data from 2011 here	N reg	Slope	Intercept	r^2	Median PFA	12.5%ile	87.5%ile	below	above	below	above
1	PFA-MSW-Coast Norway	285788	22	0.340604	-9302.74	0.70	575800	155137.47	218496.75	-1	1	NO	YES
2	Orkla counts	6131	16	0.015027	-4373.19	0.62	575800	2401.72	6156.64	-1	-1	NO	NO
3	Målselv counts	2899	20	0.004227	-196.54	0.24	575800	1147.60	3326.79	-1	-1	NO	NO
4	Counts all NO Nausta	1824	13	0.004430	-1755.77	0.35	575800	-224.55	1814.61	-1	1	NO	YES
								Sum of scores		-4	0		
												Indicators do not suggest that the PFA forecast is an overestimation.	Indicators suggest that the PFA forecast is an underestimation. REASSESS

Indicators for Southern NEAC 1SW PFA

										Reassess in year 2012? Outside 75% conf.lim.		Outside 75% conf.lim.	
		Insert data from 2011 here	N reg	Slope	Intercept	r^2	Median PFA	12.5%ile	87.5%ile	below	above	below	above
1	Ret. W 1SW UK(E&W) Itchen M	474	23	0.000372	-171.97	0.43	842600	-58.54	340.89	-1	1	NO	YES
2	Ret. W 1SW UK(E&W) Frome M	675	38	0.000507	47.11	0.31	842600	-93.23	1041.10	-1	-1	NO	NO
3	Ret. W 1SW UK(Sc.) North Esk M	8103	30	0.005915	5535.57	0.50	842600	7125.86	13913.14	-1	-1	NO	NO
4	Ret. W 1SW UK(NI) Bush M	2578	17	0.004451	-2473.57	0.61	842600	-641.31	3195.82	-1	-1	NO	NO
5	Ret. Freshw 1SW UK(NI) Bush	471	36	0.000634	559.00	0.21	842600	275.86	1910.38	-1	-1	NO	NO
								Sum of scores		-5	-3		
												Indicators do not suggest that the PFA forecast is an overestimation.	Indicators do not suggest that the PFA forecast is an underestimation.

Indicators for Southern NEAC MSW PFA

										Reassess in year 2012? Outside 75% conf.lim.		Outside 75% conf.lim.	
		Insert data from 2011 here	N reg	Slope	Intercept	r^2	Median PFA	12.5%ile	87.5%ile	below	above	below	above
1	Ret. W 2SW UK(Sc.) Baddoch NM	40	23	0.000033	2.78	0.46	613000	9.57	37.00	-1	1	NO	YES
2	Ret. W 2SW UK(Sc.) North Esk NM	16215	30	0.003880	4121.60	0.31	613000	3708.32	9291.16	-1	1	NO	YES
3	Ret. W 1SW UK(Sc.) North Esk NM	16832	29	0.006428	8249.22	0.37	613000	8413.37	15965.65	-1	1	NO	YES
4	Ret. W MSW UK(E&W) Itchen NM	223	23	0.000288	-99.96	0.73	613000	10.38	142.47	-1	1	NO	YES
5	Ret. W 1SW UK(E&W) Itchen NM	613	22	0.000411	-5.05	0.26	613000	32.79	460.48	-1	1	NO	YES
6	Ret. W MSW UK(E&W) Frome NM	731	38	0.000727	109.23	0.44	613000	19.68	1090.22	-1	-1	NO	NO
7	Ret. W 1SW UK(E&W) Frome NM	730	38	0.000707	128.83	0.37	613000	27.72	1096.76	-1	-1	NO	NO
8	Catch W MSW Ice Ellidaar NM	11	39	0.000091	-20.32	0.55	613000	-22.79	93.39	-1	-1	NO	NO
9	Ret. Freshw 2SW UK(NI) Bush	178	35	0.000156	41.08	0.24	613000	-5.01	278.28	-1	-1	NO	NO
10	Ret. W 1SW UK(NI) Bush NM	2578	17	0.005636	-831.45	0.67	613000	942.10	4305.27	-1	-1	NO	NO
11	Count MSW UK(E&W) Fowey NM	65	14	0.000477	-200.69	0.65	613000	66.46	116.94	1	-1	YES	NO
								Sum of scores		-9	-1		
												Indicators do not suggest that the PFA forecast is an overestimation.	Indicators do not suggest that the PFA forecast is an overestimation.

Figure 3.5.3.2.2. Output of the spreadsheet for the test of FWIs for NEAC for 2012 based on the values of the indicators from 2011. Because the indicators suggest that the forecast for northern NEAC MSW was an underestimate, the overall advice from the spreadsheet is reassess.

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Appendices to Stock Annex

Appendix 1 (a): Description of how catch-and-release mortality is incorporated in regional and national stock assessments

Commission Area	Country/Region	How it is used in regional and national assessments	Future developments / improvements
NAC	Canada-Quebec	C&R has become more popular in the region and C&R only angling licenses are sold. C&R data are incomplete as there is no requirement to report C&R numbers. Generally, C&R mortality is considered in the assessment but the majority of the assessments are conducted as spawner counts after the fisheries so any losses due to C&R mortality are accounted for in the spawner estimates but not in the returns (which are the sum of known losses and spawning escapement).	New studies of the contribution of C&R fish to spawning success have been initiated. C&R monitoring is becoming more complete. Consideration will be given in the future to incorporating these losses in the returns and in the assessments based on angling catches, especially as reporting improves.
	Canada-Newfoundland & Labrador	Catch and release mortality is included in estimates of spawners. Spawning escapement is reduced by 5-15% (mean 10%) of the released catch.	No plans for further development.
	Canada - Gulf	Assessments of spawners are adjusted by mortality rates of 3% to 6% of the total C&R estimates of small and large salmon. The rates vary by river according to angling seasons, and the occurence of other factors such as disease which can affect survival of salmon.	Catch and release mortality is known to be affected by the water temperatures when fish are angled. In some cases, angling fisheries are closed when water temperatures are high in the summer to reduce the losses of fish from C&R. Methods to determine catch and release numbers vary by river and in some cases, the number of released fish is estimated from returns and historical creel survey data. As the practice of C&R becomes more popular, estimation methods for C&R values will have to be revisited.
	Canada – Scotia/Fundy	Assessments are currently adjusted by 4% of the C&R fish to correct for C&R mortality.	Numbers of C&R fish are currently low (retention fisheries are closed). If C&R catches increase, further research on the correction factor would be warranted.
	USA	No correction for mortality due to C&R used in estimating spawner numbers. However, all fisheries have been closed and the number of fish caught relative to stock size is very small.	
NEAC	Russia	With increasing C&R the retained catch for similar effort is reduced. Therefore the exploitation rate for retained fish is lower. The increase in C&R in recent years is incorporated into the national run-reconstruction model by reducing the exploitation rate value used in the model input. This is assessed qualitatively. No correction for increased C&R mortality is applied when estimating the spawning escapement.	If C&R information is incorporated into formal assessments then muliple recaptures should be taken into account. C&R mortality should be incorporated into estimates of spawning escapement.
	Norway		
	Sweden		
	Iceland		
	UK(Scotland)		
	Ireland	No correction for mortality due to C&R used in estimating spawner numbers or in the national run-reconstruction model.	Incorporation of formal method for estimating the effect of C&R on number of returning fish. Incorporation of C&R mortality in estimates of spawning escapement
	UK(England & Wales)	With increasing C&R the retained catch for similar effort is reduced. Therefore the exploitation rate for retained fish is lower. The increase in C&R in recent years is incorporated into the national run-reconstruction model by reducing the exploitation rate value used in the model input. This is assessed qualitatively. 20% mortality of C&R fish used in assessing compliance with river-specific conservation	If C&R information is incorporated into formal assessments then multiple recaptures should be taken into account.
	UK(N. Ireland)	Returns are estimated by raising the reported net catch by exploitation rate. No correction for increased C&R mortality is applied when estimating the spawning escapement.	If C&R information is incorporated into formal assessments then multiple recaptures should be taken into account. C&R mortality should be incorporated into estimates of spawning escapement.
	Denmark	C&R rates recorded, but no national run-reconstruction assessment applied.	
	Finland	No record of C&R	If C&R information is collected, it should be incorporated into formal assessments and multiple recaptures should be

Appendix 1 (b): Description of how unreported catch is incorporated in regional, national and international stock assessments

Commission Area	Country/Region	How it is used in regional and national assessments	How used in international assessments	Future developments / improvements
NAC	Canada-Quebec	Unreported catches are based on historical estimates relative to stock size or are provided by field conservation and protection staff. Unreported catches when available are included in the regional assessment of returns and spawners.	Unreported catches which occur in marine waters outside the jurisdiction of the regions are not included in the run reconstruction models.	If unreported catch estimates were provided they could be incorporated in the regional assessments and in the continent estimates of abundance and spawners. Unreported catch may be accounted for in either the returns or the spawners, depending upon when and where the illegal activity occurs relative to the location and time of the assessment model.
	Canada-Newfoundland & Labrador	Catch statistics include estimates of harvests by log book non-respondents. Therefore they are included in the regional assessments and the PFA estimate. No account is taken of illegal fisheries.		
	Canada - Gulf	Unreported catches are sometimes provided by Conservation and Protection Personnel and are estimates of illegal fishing removals within specific regions. Unreported catches have not been used in the assessments of returns or spawners.		
	Canada – Scotia/Fundy	No adjustment made, with the exception of the Saint John River where returns/spawners are adjusted for estimated bycatch and poaching. In other rivers where assessments directly quantify spawners, returns would be underestimated if catch is under reported.		
	USA	Unreported catch is estimated to be zero and therefore has no effect on national assessments.		
NEAC	Russia	Minimum and maximum estimates of the unreporting rate are used in deriving national PFA estimates from the catch of 1SW & MSW salmon.	National estimates (which incorporate unreported ctaches) are aggregated to provide PFA, return and spawner estimates for stock complexes.	Incorporate revised estimates of minimum and maximum estimates of unreporting rate as national estimates are improved.
	Finland			
	Norway			
	Sweden			
	Iceland			
	Ireland			
	UK(Scotland)			
	UK(England & Wales)			
	UK(N. Ireland)			
	France			
	Denmark	No national assessment		
NEAC	Faroes	Not applicable	Assumed to be negligible unreported catch. Estimate of discard mortality for 1SW fish is incorporated in stock assessments.	Sampling programme if fishery resumes.
W. Greenland	W. Greenland	Not applicable	Unreported catch at West Greenland is incorporated in assessments for both the NAC and NEAC areas. Since 1993, this has been provided by the Greenlandic authorities. Prior to this time, no unreported catch component is included in the models.	Annual variation in unreported catch estimates would be incorporated into the model.

Appendix 2: Overview of current DCF and future data needs for Atlantic salmon assessment/ scientific advice

Type of data	Collected under DCF	Available to WG	Reviewed and evaluated by WG	Used in current assessment models	Future plans
How to be filled	Yes/ No/ Partially	Yes/ No/ Partially	Yes/ No/ Partially	Yes/ No/ Partially used	Keep as current DCF/ Improve sampling intensity/ No need to be collected/ (other free text)
Fleet capacity	No **	No *	No	No	No need to be collected
Fuel consumption	No **	No *	No	No	No need to be collected
Fishing gear and effort	Partially **	Partially	Partially	Partially, but information requested by NASCO	Use for estimation of exploitation rates. Improve coverage and sampling intensity in DC-MAP
Landings	Partially **	Yes	Yes	Yes	Improve coverage in DC-MAP

Type of data	Collected under DCF	Available to WG	Reviewed and evaluated by WG	Used in current assessment models	Future plans
Discards	No **	No *	No	No	No need to be collected
Recreational fisheries	Partially **	Yes	Yes	Yes	Improve coverage in DC-MAP
Catch & Release	No **	Partially	Partially	No - but data requested by NASCO	Include collection in DC-MAP
cpue dataseries	Partially **	Partially	Partially	Partially	Improve sampling intensity in DC-MAP

Type of data	Collected under DCF	Available to WG	Reviewed and evaluated by WG	Used in current assessment models	Future plans
Age composition	Partially ** Some ageing based on fish lengths or weights	Yes	Yes	Yes	Improve coverage and sampling intensity in DC-MAP
Wild/reared origin (scale reading)	No **	Partially from other sources	Partially	Partially used - information on farmed fish is requested by NASCO	Improve sampling intensity in DC-MAP
Length and weight-at-age	Partially **	Partially	Yes	Yes - but some ageing based on fish lengths or weights	Improve sampling coverage in DC-MAP
Sex ratio	No **	Yes- from other sources	Partially	Yes	Modify sampling intensity in DC-MAP

Type of data	Collected under DCF	Available to WG	Reviewed and evaluated by WG	Used in current assessment models	Future plans
Maturity	Not known **	No *	No	No	No need to be collected – all returning adults are mature
Fecundity	No **	Yes	Partially	Yes	Include collection in DC-MAP
Data processing industry	No **	No **	No	No	No need to be collected
Juvenile surveys (Electrofishing)	Partially ** but not requested for Atlantic salmon in DCF	Yes	Partially	Partially	Include collection in DC-MAP
Adult census data (Counters, fish ladders, etc.)	Partially ** but not requested for Atlantic salmon in DCF	Yes	Partially	Yes	Include collection in DC-MAP

Type of data	Collected under DCF	Available to WG	Reviewed and evaluated by WG	Used in current assessment models	Future plans
Index river data (Smolt & adult trapping; tagging programmes; etc.)	Partially ** but not requested for Atlantic salmon in DCF	Yes	Partially	Yes	Include collection in DC-MAP
Genetic data (for mixed-stock analysis)	No **	Partially	Partially - for some mixed-stock fisheries	Not currently	Include collection in DC-MAP - sampling in mixed-stock fisheries every five years
Economic data	Not known **	No *	No	No - but data are of use to NASCO	
Aquaculture data	Not known **	Partially - marine farm production collected	Yes	No - but information on farm production is requested by NASCO	

Add other data type to the cells with a light blue shading, if needed.

*** Not asked for by the ICES WGNAS.**

****) Not mandatory for some or all areas/stocks/fisheries under the current DCF.**

Appendix 3: Input data for NEAC Pre Fishery Abundance analysis using Monte Carlo simulation

Finland

Annual input data for NEAC PFA run-reconstruction & NCL models for FINLAND (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	8,422	8,538	35	5	35	5	50	10	55	15
1972	32,789	8,950	35	5	35	5	50	10	55	15
1973	15,261	14,402	35	5	35	5	50	10	55	15
1974	21,057	24,508	35	5	35	5	50	10	55	15
1975	25,242	31,347	35	5	35	5	50	10	55	15
1976	23,000	24,561	35	5	35	5	50	10	55	15
1977	12,958	17,035	35	5	35	5	50	10	55	15
1978	12,338	8,670	35	5	35	5	50	10	55	15
1979	11,071	7,078	35	5	35	5	50	10	45	15
1980	10,097	7,994	25	5	25	5	50	10	45	15
1981	9,049	9,476	25	5	25	5	50	10	45	15
1982	5,379	12,628	25	5	25	5	50	10	45	15
1983	13,156	14,013	25	5	25	5	50	10	45	15
1984	14,371	11,718	25	5	25	5	50	10	45	15
1985	19,058	11,299	25	5	25	5	50	10	45	15
1986	15,005	9,320	25	5	25	5	50	10	45	15
1987	18,151	12,208	25	5	25	5	50	10	45	15
1988	10,676	8,631	25	5	25	5	50	10	45	15
1989	27,956	10,337	25	5	25	5	60	10	55	15
1990	27,955	11,423	25	5	25	5	60	10	55	15
1991	27,513	15,287	25	5	25	5	60	10	55	15
1992	38,843	14,826	25	5	25	5	60	10	55	15
1993	26,195	15,517	25	5	25	5	60	10	55	15
1994	14,555	14,621	25	5	25	5	60	10	55	15
1995	14,525	9,625	25	5	25	5	60	10	55	15
1996	20,466	8,079	25	5	25	5	50	10	45	15
1997	18,621	9,764	25	5	25	5	50	10	45	15
1998	23,336	9,307	25	5	25	5	50	10	45	15
1999	37,495	11,071	25	5	25	5	60	10	50	10
2000	40,730	21,088	25	5	25	5	60	10	50	10
2001	29,501	28,112	25	5	25	5	60	10	50	10
2002	16,721	24,642	25	5	25	5	50	10	50	10
2003	16,497	17,751	25	5	25	5	50	10	50	10
2004	7,002	8,062	25	5	25	5	50	10	50	10
2005	15,366	6,685	25	5	25	5	50	10	50	10
2006	26,916	10,533	25	5	25	5	50	10	50	10
2007	7,862	15,269	25	5	25	5	50	10	50	10
2008	8,481	15,355	25	5	25	5	50	10	50	10
2009	15,042	6,587	25	5	25	5	50	10	50	10
2010	12,085	10,590	25	5	25	5	50	10	50	10
2011	13,727	8,152	25	5	25	5	50	10	50	10
2012	23,764	9,851	25	5	25	5	50	10	50	10
2013	13,724	9,494	25	5	25	5	50	10	50	10
2014	19,495	10,302	25	5	25	5	50	10	50	10
2015	12,127	9,905	25	5	25	5	50	10	50	10
2016	9,470	10,584	25	5	25	5	50	10	50	10

France

Annual input data for NEAC PFA run-reconstruction & NCL models for FRANCE. (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	1,740	4,060	NA	NA	NA	NA	3.5	1.5	37.5	12.5
1972	3,480	8,120	NA	NA	NA	NA	3.5	1.5	37.5	12.5
1973	2,130	4,970	NA	NA	NA	NA	3.5	1.5	37.5	12.5
1974	990	2,310	NA	NA	NA	NA	3.5	1.5	37.5	12.5
1975	1,980	4,620	NA	NA	NA	NA	3.5	1.5	37.5	12.5
1976	1,820	3,380	NA	NA	NA	NA	3.5	1.5	37.5	12.5
1977	1,400	2,600	NA	NA	NA	NA	3.5	1.5	37.5	12.5
1978	1,435	2,665	NA	NA	NA	NA	3.5	1.5	37.5	12.5
1979	1,645	3,055	NA	NA	NA	NA	3.5	1.5	37.5	12.5
1980	3,430	6,370	NA	NA	NA	NA	3.5	1.5	37.5	12.5
1981	2,720	4,080	NA	NA	NA	NA	3.5	1.5	35	15
1982	1,680	2,520	NA	NA	NA	NA	3.5	1.5	35	15
1983	1,800	2,700	NA	NA	NA	NA	3.5	1.5	35	15
1984	2,960	4,440	NA	NA	NA	NA	3.5	1.5	35	15
1985	1,100	3,330	NA	NA	NA	NA	3.5	1.5	35	15
1986	3,400	3,400	NA	NA	NA	NA	7	5	35	15
1987	6,013	1,806	NA	NA	NA	NA	7	5	35	15
1988	2,063	4,964	NA	NA	NA	NA	7	5	35	15
1989	1,124	2,282	NA	NA	NA	NA	7	5	35	15
1990	1,886	2,332	NA	NA	NA	NA	7	5	35	15
1991	1,362	2,125	NA	NA	NA	NA	7	5	35	15
1992	2,490	2,671	NA	NA	NA	NA	7	5	35	15
1993	3,581	1,254	NA	NA	NA	NA	7	5	35	15
1994	2,810	2,290	NA	NA	NA	NA	7	5	30	10
1995	1,669	1,095	NA	NA	NA	NA	12.5	7.5	30	10
1996	2,063	1,943	NA	NA	NA	NA	12.5	7.5	30	10
1997	1,060	1,001	NA	NA	NA	NA	12.5	7.5	30	10
1998	2,065	846	NA	NA	NA	NA	12.5	7.5	30	10
1999	690	1,831	NA	NA	NA	NA	12.5	7.5	30	10
2000	1,792	1,277	NA	NA	NA	NA	12.5	7.5	30	10
2001	1,544	1,489	NA	NA	NA	NA	12.5	7.5	30	10
2002	2,423	1,065	30	10	22.5	7.5	12.5	7.5	30	10
2003	1,598	1,540	30	10	22.5	7.5	12.5	7.5	30	10
2004	1,927	2,880	30	10	22.5	7.5	12.5	7.5	30	10
2005	1,256	1,771	30	10	22.5	7.5	12.5	7.5	30	10
2006	1,763	1,785	30	10	22.5	7.5	12.5	7.5	30	10
2007	1,378	1,685	30	10	22.5	7.5	12.5	7.5	30	10
2008	1,365	1,865	30	10	22.5	7.5	12.5	7.5	30	10
2009	389	863	30	10	22.5	7.5	12.5	7.5	30	10
2010	1,313	711	30	10	22.5	7.5	12.5	7.5	30	10
2011	899	1,998	30	10	22.5	7.5	12.5	7.5	30	10
2012	974	1,585	30	10	22.5	7.5	12.5	7.5	30	10
2013	1,371	1,632	30	10	22.5	7.5	12.5	7.5	30	10
2014	1,217	2,027	30	10	22.5	7.5	12.5	7.5	30	10
2015	1,124	2,286	30	10	22.5	7.5	12.5	7.5	30	10
2016	1,017	972	30	10	22.5	7.5	12.5	7.5	30	10

Iceland (South and West)

Annual input data for NEAC PFA run-reconstruction & NCL models for ICELAND (SOUTH-WEST). (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	30,618	16,749	2	1	2	1	50	10	70	10
1972	24,832	25,733	2	1	2	1	50	10	70	10
1973	26,624	23,183	2	1	2	1	50	10	70	10
1974	18,975	20,017	2	1	2	1	50	10	70	10
1975	29,428	21,266	2	1	2	1	50	10	70	10
1976	23,233	18,379	2	1	2	1	50	10	70	10
1977	23,802	17,919	2	1	2	1	50	10	70	10
1978	31,199	23,182	2	1	2	1	50	10	70	10
1979	28,790	14,840	2	1	2	1	50	10	70	10
1980	13,073	20,855	2	1	2	1	50	10	70	10
1981	16,890	13,919	2	1	2	1	50	10	70	10
1982	17,331	9,826	2	1	2	1	50	10	70	10
1983	21,923	16,423	2	1	2	1	50	10	70	10
1984	13,476	13,923	2	1	2	1	50	10	70	10
1985	21,822	10,097	2	1	2	1	50	10	70	10
1986	35,891	8,423	2	1	2	1	50	10	70	10
1987	22,302	7,480	2	1	2	1	50	10	70	10
1988	40,028	8,523	2	1	2	1	50	10	70	10
1989	22,377	7,607	2	1	2	1	50	10	70	10
1990	20,584	7,548	2	1	2	1	50	10	70	10
1991	22,711	7,519	2	1	2	1	50	10	70	10
1992	26,006	8,479	2	1	2	1	50	10	70	10
1993	25,479	4,155	2	1	2	1	50	10	70	10
1994	20,985	6,736	2	1	2	1	50	10	70	10
1995	25,371	6,777	4	1	4	1	50	10	70	10
1996	21,913	4,364	4	1	4	1	50	10	70	10
1997	16,007	4,910	4	1	4	1	50	10	70	10
1998	21,900	3,037	4	1	4	1	50	10	70	10
1999	17,448	5,757	4	1	4	1	49	10	68	10
2000	15,502	1,519	4	1	4	1	49	10	66	10
2001	13,586	2,707	4	1	4	1	48	10	67	10
2002	16,952	2,845	4	1	4	1	48	10	65	10
2003	20,271	4,751	4	1	4	1	48	10	68	10
2004	20,319	3,784	4	1	4	1	48	10	67	10
2005	29,969	3,241	4	1	4	1	48	10	65	10
2006	21,153	2,689	4	1	4	1	48	10	65	10
2007	23,728	1,679	4	1	4	1	47	9	66	10
2008	28,774	1,659	4	1	4	1	47	10	57	10
2009	33,190	2,838	4	1	4	1	48	10	63	10
2010	33,318	6,061	4	1	4	1	47	10	65	10
2011	23,436	2,934	4	1	4	1	47	10	62	10
2012	13,312	1,429	4	1	4	1	47	10	53	10
2013	39,637	4,105	4	1	4	1	47	10	55	10
2014	9,551	2,281	4	1	4	1	46	10	50	10
2015	26,082	2,197	4	1	4	1	45	10	53	10
2016	16,473	2,976	4	1	4	1	45	10	47	10

Iceland (North and East)

Annual input data for NEAC PFA run-reconstruction & NCL models for ICELAND (NORTH-EAST). (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation)

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	4,610	6,625	2	1	2	1	50	10	70	10
1972	4,223	10,337	2	1	2	1	50	10	70	10
1973	5,060	9,672	2	1	2	1	50	10	70	10
1974	5,047	9,176	2	1	2	1	50	10	70	10
1975	6,152	10,136	2	1	2	1	50	10	70	10
1976	6,184	8,350	2	1	2	1	50	10	70	10
1977	8,597	11,631	2	1	2	1	50	10	70	10
1978	8,739	14,998	2	1	2	1	50	10	70	10
1979	8,363	9,897	2	1	2	1	50	10	70	10
1980	1,268	13,784	2	1	2	1	50	10	70	10
1981	6,528	4,827	2	1	2	1	50	10	70	10
1982	3,007	5,539	2	1	2	1	50	10	70	10
1983	4,437	4,224	2	1	2	1	50	10	70	10
1984	1,611	5,447	2	1	2	1	50	10	70	10
1985	11,116	3,511	2	1	2	1	50	10	70	10
1986	13,827	9,569	2	1	2	1	50	10	70	10
1987	8,145	9,908	2	1	2	1	50	10	70	10
1988	11,775	6,381	2	1	2	1	50	10	70	10
1989	6,342	5,414	2	1	2	1	50	10	70	10
1990	4,752	5,709	2	1	2	1	50	10	70	10
1991	6,900	3,965	2	1	2	1	50	10	70	10
1992	12,996	5,903	2	1	2	1	50	10	70	10
1993	10,689	6,672	2	1	2	1	50	10	70	10
1994	3,414	5,656	2	1	2	1	50	10	70	10
1995	8,776	3,511	4	1	4	1	50	10	70	10
1996	4,681	4,605	4	1	4	1	50	10	70	10
1997	6,406	2,594	4	1	4	1	50	10	70	10
1998	10,905	3,780	4	1	4	1	50	10	70	10
1999	5,326	4,030	4	1	4	1	48	10	65	10
2000	5,595	2,324	4	1	4	1	48	10	64	10
2001	4,976	2,587	4	1	4	1	47	10	62	10
2002	8,437	2,366	4	1	4	1	46	10	60	10
2003	4,478	2,194	4	1	4	1	46	10	53	10
2004	11,823	2,239	4	1	4	1	45	10	55	10
2005	10,297	2,726	4	1	4	1	44	10	54	10
2006	11,082	2,179	4	1	4	1	45	10	45	10
2007	8,046	1,672	4	1	4	1	44	10	36	10
2008	7,021	2,693	4	1	4	1	42	10	45	10
2009	10,779	1,735	4	1	4	1	40	10	36	10
2010	8,621	2,602	4	1	4	1	40	10	38	10
2011	6,759	2,596	4	1	4	1	38	10	34	10
2012	3,699	1,419	4	1	4	1	40	10	33	10
2013	8,375	1,528	4	1	4	1	38	10	31	10
2014	3,953	1,778	4	1	4	1	38	10	30	10
2015	10,209	1,803	4	1	4	1	35	10	32	10
2016	7,870	3,361	4	1	4	1	44	10	44	10

Ireland

Annual input data for NEAC PFA run-reconstruction & NCL models for IRELAND. (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation)

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon	Declared net catch 1SW salmon	Declared net catch MSW salmon	Catch and release 1SW salmon	Catch and release MSW salmon	1SW salmon in Small rivers	MSW salmon in Small rivers	1SW salmon in closed rivers	MSW salmon in closed rivers
1971	409,965	46,594	37.5	7.5	37.5	7.5	62.5	12.5	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1972	437,089	49,863	37.5	7.5	37.5	7.5	62.5	12.5	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1973	476,131	54,008	37.5	7.5	37.5	7.5	62.5	12.5	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1974	542,124	60,976	37.5	7.5	37.5	7.5	62.5	12.5	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1975	598,524	68,260	37.5	7.5	37.5	7.5	62.5	12.5	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1976	407,018	47,358	37.5	7.5	37.5	7.5	62.5	12.5	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1977	351,745	41,256	37.5	7.5	37.5	7.5	62.5	12.5	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1978	307,569	35,708	37.5	7.5	37.5	7.5	62.5	12.5	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1979	282,700	32,144	37.5	7.5	37.5	7.5	62.5	12.5	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1980	215,116	35,447	37.5	7.5	37.5	7.5	62.5	12.5	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1981	137,366	26,101	37.5	7.5	37.5	7.5	75.7	11.4	47.5	12.5	NA	NA	NA	NA	NA	NA	NA	NA
1982	269,847	11,754	37.5	7.5	37.5	7.5	71.9	10.8	36.7	8.3	NA	NA	NA	NA	NA	NA	NA	NA
1983	437,751	26,479	37.5	7.5	37.5	7.5	66.1	9.9	40.1	7.5	NA	NA	NA	NA	NA	NA	NA	NA
1984	224,872	20,685	37.5	7.5	37.5	7.5	64.6	9.7	43.5	6.5	NA	NA	NA	NA	NA	NA	NA	NA
1985	430,315	18,830	37.5	7.5	37.5	7.5	74.6	11.2	36.1	3.4	NA	NA	NA	NA	NA	NA	NA	NA
1986	443,701	27,111	37.5	7.5	37.5	7.5	68.7	10.3	46.0	9.0	NA	NA	NA	NA	NA	NA	NA	NA
1987	324,709	26,301	30	10	30	10	69.8	10.5	32.2	4.7	NA	NA	NA	NA	NA	NA	NA	NA
1988	391,475	22,067	30	10	30	10	62.0	9.3	37.4	5.6	NA	NA	NA	NA	NA	NA	NA	NA
1989	297,797	25,447	30	10	30	10	65.7	9.9	47.2	8.8	NA	NA	NA	NA	NA	NA	NA	NA
1990	172,098	15,549	30	10	30	10	60.7	9.1	59.9	6.1	NA	NA	NA	NA	NA	NA	NA	NA
1991	120,408	10,334	30	10	30	10	59.5	8.9	26.5	3.5	NA	NA	NA	NA	NA	NA	NA	NA
1992	182,255	15,456	30	10	30	10	62.1	9.3	51.5	3.8	NA	NA	NA	NA	NA	NA	NA	NA
1993	150,274	13,156	25	10	25	10	58.6	8.8	42.0	18.0	NA	NA	NA	NA	NA	NA	NA	NA
1994	234,126	20,506	25	10	25	10	71.4	10.7	40.5	2.5	NA	NA	NA	NA	NA	NA	NA	NA
1995	232,480	20,454	25	10	25	10	63.5	9.5	41.8	1.2	NA	NA	NA	NA	NA	NA	NA	NA
1996	203,920	18,021	25	10	25	10	59.9	9.0	55.1	3.2	NA	NA	NA	NA	NA	NA	NA	NA
1997	170,774	14,724	25	10	15	5	50.1	7.5	30.8	12.2	NA	NA	NA	NA	NA	NA	NA	NA
1998	191,868	17,269	25	10	15	5	53.7	8.1	61.9	1.4	NA	NA	NA	NA	NA	NA	NA	NA
1999	158,818	14,801	25	10	15	5	47.8	7.2	34.1	18.1	NA	NA	NA	NA	NA	NA	NA	NA
2000	199,827	16,848	25	10	15	5	43.2	6.5	31.0	4.5	NA	NA	NA	NA	NA	NA	NA	NA
2001	218,715	18,436	7.5	2.5	7.5	2.5	48.0	7.2	35.0	8.0	NA	NA	NA	NA	NA	NA	NA	NA
2002	198,719	16,702	7.5	2.5	7.5	2.5	49.9	7.5	27.5	7.5	NA	NA	NA	NA	NA	NA	NA	NA
2003	161,270	13,745	7.5	2.5	7.5	2.5	41.3	6.2	21.5	5.5	NA	NA	NA	NA	NA	NA	NA	NA
2004	142,251	12,299	7.5	2.5	7.5	2.5	49.5	7.5	35.0	8.0	NA	NA	NA	NA	NA	NA	NA	NA
2005	127,371	10,716	7.5	2.5	7.5	2.5	44.5	6.5	23.5	3.5	NA	NA	NA	NA	NA	NA	NA	NA
2006	101,938	9,740	7.5	2.5	7.5	2.5	46.5	6.5	29.5	13.5	NA	NA	NA	NA	NA	NA	NA	NA
2007	17,863	2,867	7.5	2.5	7.5	2.5	15.5	8.4	23.9	9.1	8,177	666	12,137	988	0	0	24,433	158
2008	31,843	3,935	7.5	2.5	7.5	2.5	15.5	8.4	23.9	9.1	8,233	670	12,071	1,492	0	0	23,259	213
2009	24,268	4,675	7.5	2.5	7.5	2.5	15.5	8.4	23.9	9.1	6,248	509	9,812	1,610	0	0	30,008	1,873
2010	32,981	4,497	7.5	2.5	7.5	2.5	15.5	8.4	23.9	9.1	13,093	1,066	13,325	1,817	0	0	30,605	616
2011	28,105	4,889	7.5	2.5	7.5	2.5	15.5	8.4	23.9	9.1	11,071	902	11,031	1,657	0	0	28,504	765
2012	29,979	4,197	7.5	2.5	7.5	2.5	15.5	8.4	23.9	9.1	9,542	777	10,429	1,463	0	0	24,517	1,213
2013	24,029	4,831	7.5	2.5	7.5	2.5	15.5	8.4	23.9	9.1	13,378	747	8,821	1,861	0	0	23,836	1,250
2014	13,787	4,063	7.5	2.5	7.5	2.5	15.5	8.4	23.9	9.1	9,173	397	5,107	1,430	0	0	20,110	1,210
2015	20,835	4,272	7.5	2.5	7.5	2.5	15.5	8.4	23.9	9.1	7,396	295	7,810	1,573	0	0	25,834	1,147
2016	21,084	3,783	7.5	2.5	7.5	2.5	15.5	8.4	23.9	9.1	5,755	1,162	8,890	1,391	0	0	23,952	1,657

Norway (Southeast)

Annual input data for NEAC PFA run-reconstruction & NCL models for NORWAY (SOUTH-EAST). (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation)

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1972	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1973	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1974	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1975	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1976	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1977	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1978	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1979	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1981	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1982	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1983	9,039	9,004	50	10	50	10	70	10	65	10
1984	11,402	11,527	50	10	50	10	70	10	65	10
1985	18,699	11,883	50	10	50	10	70	10	65	10
1986	23,089	12,077	50	10	50	10	70	10	65	10
1987	19,601	14,179	50	10	50	10	70	10	65	10
1988	17,520	9,443	50	10	50	10	70	10	65	10
1989	23,965	12,254	50	10	50	10	65	10	60	10
1990	25,792	11,502	50	10	50	10	65	10	60	10
1991	21,064	10,753	50	10	50	10	65	10	60	10
1992	26,044	15,332	50	10	50	10	65	10	60	10
1993	23,070	12,596	40	10	40	10	65	10	60	10
1994	23,987	9,988	40	10	40	10	65	10	60	10
1995	21,847	11,630	40	10	40	10	65	10	60	10
1996	20,738	13,538	40	10	40	10	65	10	60	10
1997	21,121	7,756	35	10	35	10	60	10	60	10
1998	32,586	10,396	35	10	35	10	60	10	60	10
1999	23,904	6,664	35	10	35	10	60	10	60	10
2000	43,151	14,261	35	10	35	10	60	10	60	10
2001	47,339	19,210	35	10	35	10	60	10	60	10
2002	33,087	14,400	35	10	35	10	60	10	60	10
2003	33,371	20,648	30	10	30	10	60	10	60	10
2004	28,506	15,948	30	10	30	10	60	10	60	10
2005	40,628	14,628	30	10	30	10	60	10	60	10
2006	30,979	21,192	30	10	30	10	60	10	60	10
2007	15,735	18,130	30	10	30	10	60	10	60	10
2008	15,696	16,678	30	10	30	10	55	10	50	10
2009	15,584	11,995	30	10	30	10	55	10	50	10
2010	22,139	12,175	30	10	30	10	50	10	40	10
2011	15,773	28,589	30	10	30	10	50	10	40	10
2012	18,582	23,389	30	10	30	10	50	10	40	10
2013	16,702	13,564	30	10	30	10	50	10	40	10
2014	15,389	13,699	30	10	30	10	40	10	35	10
2015	17,188	17,079	30	10	30	10	50	10	40	10
2016	14,670	18,579	30	10	30	10	50	10	40	10

Norway (Southwest)

Annual input data for NEAC PFA run-reconstruction & NCL models for NORWAY (SOUTH-WEST) (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation)

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1972	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1973	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1974	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1975	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1976	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1977	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1978	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1979	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1981	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1982	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1983	31,845	28,601	50	10	50	10	80	10	80	10
1984	23,428	27,641	50	10	50	10	80	10	80	10
1985	29,857	25,515	50	10	50	10	80	10	80	10
1986	29,894	30,769	50	10	50	10	80	10	80	10
1987	30,005	26,623	50	10	50	10	80	10	80	10
1988	36,976	28,255	50	10	50	10	80	10	80	10
1989	19,183	13,041	50	10	50	10	70	10	65	10
1990	18,490	14,423	50	10	50	10	70	10	65	10
1991	9,759	8,323	50	10	50	10	70	10	65	10
1992	6,448	8,832	50	10	50	10	70	10	65	10
1993	11,433	10,239	40	10	40	10	70	10	65	10
1994	18,597	10,961	40	10	40	10	70	10	65	10
1995	10,863	13,122	40	10	40	10	70	10	65	10
1996	7,048	12,546	40	10	40	10	70	10	65	10
1997	10,279	7,194	35	10	35	10	60	10	60	10
1998	5,726	6,583	35	10	35	10	60	10	60	10
1999	7,357	3,219	35	10	35	10	60	10	60	10
2000	11,538	7,961	35	10	35	10	60	10	60	10
2001	12,109	10,716	35	10	35	10	60	10	60	10
2002	6,000	7,145	35	10	35	10	60	10	60	10
2003	8,269	7,602	30	10	30	10	60	10	60	10
2004	7,180	6,420	30	10	30	10	60	10	60	10
2005	10,370	7,334	30	10	30	10	60	10	60	10
2006	5,173	9,381	30	10	30	10	60	10	60	10
2007	2,630	6,011	30	10	30	10	60	10	60	10
2008	3,143	4,807	30	10	30	10	55	10	50	10
2009	3,069	3,792	30	10	30	10	55	10	50	10
2010	3,450	2,447	30	10	30	10	50	10	35	10
2011	2,888	4,409	30	10	30	10	45	10	30	10
2012	4,171	5,733	30	10	30	10	45	10	30	10
2013	3,111	3,581	30	10	30	10	45	10	30	10
2014	3,029	2,717	30	10	30	10	40	10	25	10
2015	4,721	3,953	30	10	30	10	45	10	30	10
2016	3,262	5,671	30	10	30	10	45	10	30	10

Mid-Norway

Annual input data for NEAC PFA run-reconstruction & NCL models for NORWAY (MID AREA) (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation)

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1972	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1973	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1974	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1975	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1976	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1977	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1978	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1979	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1981	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1982	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1983	121,221	74,648	50	10	50	10	75	10	75	10
1984	94,373	67,639	50	10	50	10	75	10	75	10
1985	114,613	56,641	50	10	50	10	75	10	75	10
1986	106,921	77,225	50	10	50	10	75	10	75	10
1987	83,669	62,216	50	10	50	10	75	10	75	10
1988	80,111	45,609	50	10	50	10	75	10	75	10
1989	94,897	30,862	50	10	50	10	65	10	65	10
1990	78,888	40,174	50	10	50	10	65	10	65	10
1991	67,370	30,087	50	10	50	10	65	10	65	10
1992	51,463	33,092	50	10	50	10	65	10	65	10
1993	58,326	28,184	40	10	40	10	65	10	65	10
1994	113,427	33,520	40	10	40	10	65	10	65	10
1995	57,813	42,696	40	10	40	10	65	10	65	10
1996	28,925	31,613	40	10	40	10	65	10	65	10
1997	43,127	20,565	35	10	35	10	60	10	60	10
1998	63,497	26,817	35	10	35	10	60	10	60	10
1999	60,689	28,792	35	10	35	10	60	10	60	10
2000	109,278	42,452	35	10	35	10	60	10	60	10
2001	88,096	52,031	35	10	35	10	60	10	60	10
2002	42,669	52,774	35	10	35	10	60	10	60	10
2003	91,118	46,963	30	10	30	10	60	10	60	10
2004	38,286	49,760	30	10	30	10	60	10	60	10
2005	63,749	37,941	30	10	30	10	60	10	60	10
2006	46,495	47,691	30	10	30	10	60	10	60	10
2007	26,608	33,106	30	10	30	10	60	10	60	10
2008	31,936	34,869	30	10	30	10	55	10	45	10
2009	26,267	30,715	30	10	30	10	55	10	45	10
2010	37,557	30,524	30	10	30	10	50	10	45	10
2011	20,932	37,272	30	10	30	10	50	10	45	10
2012	22,368	28,265	30	10	30	10	50	10	45	10
2013	25,121	17,727	30	10	30	10	45	10	40	10
2014	25,349	14,199	30	10	30	10	35	10	32	10
2015	30,932	30,457	30	10	30	10	45	10	40	10
2016	20,498	26,325	30	10	30	10	45	10	40	10

Norway North

Annual input data for NEAC PFA run-reconstruction & NCL models for NORWAY (NORTH) (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1972	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1973	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1974	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1975	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1976	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1977	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1978	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1979	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1981	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1982	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1983	104,040	49,413	50	10	50	10	80	10	80	10
1984	150,372	58,858	50	10	50	10	80	10	80	10
1985	118,841	58,956	50	10	50	10	80	10	80	10
1986	84,150	63,418	50	10	50	10	80	10	80	10
1987	72,370	34,232	50	10	50	10	80	10	80	10
1988	53,880	32,140	50	10	50	10	80	10	80	10
1989	42,010	13,934	50	10	50	10	70	10	70	10
1990	38,216	17,321	50	10	50	10	70	10	70	10
1991	42,888	21,789	50	10	50	10	70	10	70	10
1992	34,593	19,265	50	10	50	10	70	10	70	10
1993	51,440	39,014	40	10	40	10	70	10	70	10
1994	37,489	33,411	40	10	40	10	70	10	70	10
1995	36,283	26,037	40	10	40	10	70	10	70	10
1996	40,792	36,636	40	10	40	10	70	10	70	10
1997	39,930	30,115	35	10	35	10	70	10	70	10
1998	46,645	34,806	35	10	35	10	70	10	70	10
1999	46,394	46,744	35	10	35	10	70	10	70	10
2000	61,854	51,569	35	10	35	10	70	10	70	10
2001	46,331	54,023	35	10	35	10	70	10	70	10
2002	38,101	43,100	35	10	35	10	70	10	70	10
2003	44,947	35,972	30	10	30	10	70	10	70	10
2004	34,640	28,077	30	10	30	10	70	10	70	10
2005	45,530	33,334	30	10	30	10	70	10	70	10
2006	48,688	39,508	30	10	30	10	70	10	70	10
2007	28,748	44,550	30	10	30	10	70	10	70	10
2008	34,338	40,553	30	10	30	10	65	10	65	10
2009	22,511	28,241	30	10	30	10	65	10	65	10
2010	29,836	28,611	30	10	30	10	65	10	55	10
2011	26,813	27,233	30	10	30	10	65	10	55	10
2012	28,289	28,000	30	10	30	10	65	10	55	10
2013	20,021	24,689	30	10	30	10	65	10	55	10
2014	35,171	23,816	30	10	30	10	65	10	55	10
2015	25,426	23,890	30	10	30	10	65	10	55	10
2016	23,589	33,607	30	10	30	10	65	10	55	10

Russia (Archangelsk and Karelia)

Annual input data for NEAC PFA run-reconstruction & NCL models for RUSSIA (ARCHANGLE/KORELIA). (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	134	16,592	10	5	10	5	60	20	60	20
1972	116	14,434	10	5	10	5	60	20	60	20
1973	169	20,924	10	5	10	5	60	20	60	20
1974	170	21,137	10	5	10	5	60	20	60	20
1975	140	17,398	10	5	10	5	60	20	60	20
1976	111	13,781	10	5	10	5	60	20	60	20
1977	78	9,722	10	5	10	5	60	20	60	20
1978	82	10,134	10	5	10	5	60	20	60	20
1979	112	13,903	10	5	10	5	60	20	60	20
1980	156	19,397	10	5	10	5	60	20	60	20
1981	68	8,394	10	5	10	5	60	20	60	20
1982	71	8,797	10	5	10	5	60	20	60	20
1983	48	11,938	10	5	10	5	60	20	60	20
1984	21	10,680	10	5	10	5	60	20	60	20
1985	454	11,183	10	5	10	5	60	20	60	20
1986	12	12,291	10	5	10	5	60	20	60	20
1987	647	8,734	10	5	10	5	60	20	60	20
1988	224	9,978	10	5	10	5	60	20	60	20
1989	989	10,245	10	5	10	5	60	20	60	20
1990	1,418	8,429	15	5	15	5	60	20	60	20
1991	421	8,725	20	5	20	5	60	20	60	20
1992	1,031	3,949	25	5	25	5	60	20	60	20
1993	196	4,251	30	5	30	5	60	20	60	20
1994	334	5,631	35	5	35	5	60	20	60	20
1995	386	5,214	45	5	45	5	60	20	60	20
1996	231	3,753	55	5	55	5	60	20	60	20
1997	721	3,351	55	5	55	5	60	20	60	20
1998	585	4,208	55	5	55	5	60	20	60	20
1999	299	3,101	55	5	55	5	60	20	60	20
2000	514	3,382	55	5	55	5	60	20	60	20
2001	363	2,348	55	5	55	5	60	20	60	20
2002	1,676	2,439	55	5	55	5	60	20	60	20
2003	893	2,041	55	5	55	5	60	20	60	20
2004	990	3,761	55	5	55	5	60	20	60	20
2005	1,349	4,915	55	5	55	5	60	20	60	20
2006	2,183	2,841	55	5	55	5	60	20	60	20
2007	1,618	2,621	55	5	55	5	60	20	60	20
2008	332	2,496	55	5	55	5	60	20	60	20
2009	252	2,214	55	5	55	5	60	20	60	20
2010	397	3,823	55	5	55	5	60	20	60	20
2011	313	2,585	55	5	55	5	60	20	60	20
2012	1,332	2,446	55	5	55	5	60	20	60	20
2013	2,296	3,480	55	5	55	5	60	20	60	20
2014	2,084	3,463	55	5	55	5	60	20	60	20
2015	2,071	3,542	55	5	55	5	60	20	60	20
2016	3,042	2,221	55	5	55	5	60	20	60	20

Russia (Kola Peninsula: Barents Sea Basin)

Annual input data for NEAC PFA run-reconstruction & NCL models for RUSSIA (KOLA-BARENT SEA). (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation)

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	4,892	5,979	15	5	15	5	45	5	45	5
1972	7,978	9,750	15	5	15	5	45	5	45	5
1973	9,376	11,460	15	5	15	5	40	5	40	5
1974	12,794	15,638	15	5	15	5	40	5	40	5
1975	13,872	13,872	15	5	15	5	45	5	45	5
1976	11,493	14,048	15	5	15	5	55	5	55	5
1977	7,257	8,253	15	5	15	5	50	5	50	5
1978	7,106	7,113	15	5	15	5	55	5	55	5
1979	6,707	3,141	15	5	15	5	40	5	40	5
1980	6,621	5,216	15	5	15	5	40	5	40	5
1981	4,547	5,973	15	5	15	5	40	5	40	5
1982	5,159	4,798	15	5	15	5	35	5	35	5
1983	8,504	9,943	15	5	15	5	35	5	35	5
1984	9,453	12,601	15	5	15	5	35	5	35	5
1985	6,774	7,877	15	5	15	5	35	5	35	5
1986	10,147	5,352	15	5	15	5	40	5	40	5
1987	8,560	5,149	15	5	15	5	40	5	40	5
1988	6,644	3,655	15	5	15	5	35	5	35	5
1989	13,424	6,787	15	5	15	5	40	5	40	5
1990	16,038	8,234	15	5	15	5	40	5	40	5
1991	4,550	7,568	15	5	15	5	30	5	30	5
1992	11,394	7,109	15	5	15	5	30	5	30	5
1993	8,642	5,690	15	5	15	5	30	5	30	5
1994	6,101	4,632	15	5	15	5	30	5	30	5
1995	6,318	3,693	15	5	15	5	30	5	30	5
1996	6,815	1,701	20	5	20	5	25	5	25	5
1997	3,564	867	25	5	25	5	15	5	15	5
1998	1,854	280	35	5	35	5	13	3	13	3
1999	1,510	424	40	5	40	5	8	3	8	3
2000	805	323	50	5	50	5	6	2	6	2
2001	591	241	60	5	60	5	4	2	4	2
2002	1,436	2,478	50	10	50	10	10	5	20	5
2003	1,938	1,095	50	10	50	10	10	5	20	5
2004	1,095	850	50	10	50	10	10	5	20	5
2005	859	426	60	10	60	10	10	5	20	5
2006	1,372	844	60	10	60	10	10	5	20	5
2007	784	707	60	10	60	10	10	5	20	5
2008	1,446	997	60	10	60	10	15	5	20	5
2009	2,882	1,080	60	10	60	10	15	5	20	5
2010	3,884	1,486	60	10	60	10	20	5	25	5
2011	3,861	1,407	60	10	60	10	20	5	25	5
2012	2,708	1,027	60	10	60	10	20	5	25	5
2013	939	904	60	10	60	10	20	5	25	5
2014	969	789	60	10	60	10	20	5	25	5
2015	727	494	60	10	60	10	20	5	25	5
2016	380	625	60	10	60	10	20	5	25	5

Russia (Kola Peninsula: White Sea Basin)

Annual input data for NEAC PFA run-reconstruction & NCL models for RUSSIA (KOLA-WHITE SEA). (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Catch 1SW following-year spawners	Catch MSW following-year spawners	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	67,845	29,077	0	0	3	2	3	2	50	10	60	10
1972	45,837	19,644	0	0	3	2	3	2	50	10	60	10
1973	68,684	29,436	0	0	3	2	3	2	50	10	60	10
1974	63,892	27,382	0	0	3	2	3	2	50	10	60	10
1975	109,038	46,730	0	0	3	2	3	2	50	10	60	10
1976	76,281	41,075	0	0	3	2	3	2	50	10	60	10
1977	47,943	32,392	0	0	3	2	3	2	50	10	60	10
1978	49,291	17,307	0	0	3	2	3	2	50	10	60	10
1979	69,511	21,369	0	0	3	2	3	2	50	10	60	10
1980	46,037	23,241	0	0	3	2	3	2	50	10	60	10
1981	40,172	12,747	0	0	3	2	3	2	50	10	60	10
1982	32,619	14,840	0	0	3	2	3	2	50	10	60	10
1983	54,217	20,840	0	0	3	2	3	2	50	10	60	10
1984	56,786	16,893	0	0	3	2	3	2	50	10	60	10
1985	87,274	16,876	0	0	3	2	3	2	50	10	60	10
1986	72,102	17,681	0	0	3	2	3	2	50	10	60	10
1987	79,639	12,501	0	0	3	2	3	2	50	10	50	10
1988	44,813	18,777	0	0	3	2	3	2	45	5	45	5
1989	53,293	11,448	0	0	8	3	8	3	45	5	45	5
1990	44,409	11,152	0	0	13	3	13	3	45	5	45	5
1991	31,978	6,263	0	0	18	3	18	3	35	5	35	5
1992	23,827	3,680	0	0	23	3	23	3	25	5	25	5
1993	20,987	5,552	0	0	25	5	25	5	25	5	25	5
1994	25,178	3,680	0	0	30	5	30	5	25	5	15	5
1995	19,381	2,847	0	0	35	5	35	5	25	5	15	5
1996	27,097	2,710	0	0	35	5	35	5	25	5	15	5
1997	27,695	2,085	0	0	35	5	35	5	25	5	15	5
1998	32,693	1,963	0	0	35	5	35	5	25	5	15	5
1999	22,330	2,841	0	0	35	5	35	5	25	5	15	5
2000	26,376	4,396	0	0	35	5	35	5	25	5	15	5
2001	20,483	3,959	0	0	35	5	35	5	15	5	15	5
2002	19,174	3,937	0	0	35	5	35	5	15	5	15	5
2003	15,687	3,734	0	0	35	5	25	5	15	5	15	5
2004	10,947	1,990	0	0	35	5	35	5	15	5	15	5
2005	13,172	2,388	1,212	878	35	5	35	5	15	5	15	5
2006	15,004	2,071	3,852	399	35	5	35	5	15	5	15	5
2007	7,807	1,404	2,264	852	35	5	35	5	15	5	15	5
2008	8,447	4,711	3,175	832	35	5	35	5	15	5	15	5
2009	5,351	3,105	5,130	1,710	35	5	35	5	15	5	15	5
2010	6,731	4,158	3,684	1,228	35	5	35	5	15	5	15	5
2011	7,363	4,325	3,082	1,027	35	5	35	5	15	5	15	5
2012	10,398	1,431	2,267	756	35	5	35	5	15	5	15	5
2013	8,986	1,660	2,203	734	35	5	35	5	15	5	15	5
2014	8,593	1,674	3,307	1,102	35	5	35	5	15	5	15	5
2015	9,115	1,179	2,964	1,217	35	5	35	5	15	5	15	5
2016	5,969	848	1,526	626	35	5	35	5	15	5	15	5

Russia (Pechora River)

Annual input data for NEAC PFA run-reconstruction & NCL models for RUSSIA (PECHORA RIVER). (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Return estimate 1SW salmon	Return estimate MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	605	17,728	NA	NA	20	10	20	10	65	15	65	15
1972	825	24,175	NA	NA	20	10	20	10	65	15	65	15
1973	1,705	49,962	NA	NA	20	10	20	10	65	15	65	15
1974	1,320	38,680	NA	NA	20	10	20	10	65	15	65	15
1975	1,298	38,046	NA	NA	20	10	20	10	65	15	65	15
1976	991	34,394	NA	NA	20	10	20	10	65	15	65	15
1977	589	20,464	NA	NA	20	10	20	10	65	15	65	15
1978	759	26,341	NA	NA	20	10	20	10	65	15	65	15
1979	421	14,614	NA	NA	20	10	20	10	65	15	65	15
1980	1,123	39,001	NA	NA	20	10	20	10	65	15	65	15
1981	126	20,874	NA	NA	20	10	20	10	65	15	65	15
1982	54	13,546	NA	NA	20	10	20	10	65	15	65	15
1983	598	16,002	NA	NA	20	10	20	10	65	15	65	15
1984	1,833	15,967	NA	NA	20	10	20	10	65	15	65	15
1985	2,763	29,738	NA	NA	20	10	20	10	65	15	65	15
1986	66	32,734	NA	NA	20	10	20	10	65	15	65	15
1987	21	21,179	NA	NA	20	10	20	10	65	15	65	15
1988	3,184	12,816	NA	NA	20	10	20	10	65	15	65	15
1989	NA	NA	24,596	27,404	10	5	10	5	65	15	65	15
1990	NA	NA	50	49,950	10	5	10	5	65	15	65	15
1991	NA	NA	7,975	47,025	10	5	10	5	65	15	65	15
1992	NA	NA	550	54,450	10	5	10	5	65	15	65	15
1993	NA	NA	68	67,932	10	5	10	5	65	15	65	15
1994	NA	NA	3,900	48,100	10	5	10	5	65	15	65	15
1995	NA	NA	9,280	70,720	10	5	10	5	65	15	65	15
1996	NA	NA	8,664	48,336	10	5	10	5	65	15	65	15
1997	NA	NA	1,440	38,560	10	5	10	5	65	15	65	15
1998	NA	NA	780	59,220	10	5	10	5	65	15	65	15
1999	NA	NA	2,120	37,880	10	5	10	5	65	15	65	15
2000	NA	NA	84	83,916	10	5	10	5	65	15	65	15
2001	NA	NA	2,244	41,756	10	5	10	5	65	15	65	15
2002	NA	NA	405	44,595	10	5	10	5	65	15	65	15
2003	NA	NA	1,650	31,350	10	5	10	5	65	15	65	15
2004	NA	NA	6,075	20,925	10	5	10	5	65	15	65	15
2005	NA	NA	2,852	28,148	10	5	10	5	65	15	65	15
2006	NA	NA	1,472	30,528	10	5	10	5	65	15	65	15
2007	NA	NA	817	42,183	10	5	10	5	65	15	65	15
2008	NA	NA	300	49,700	10	5	10	5	65	15	65	15
2009	NA	NA	1,116	47,384	10	5	10	5	65	15	65	15
2010	NA	NA	1,096	53,704	10	5	10	5	65	15	65	15
2011	NA	NA	2,990	56,810	10	5	10	5	65	15	65	15
2012	NA	NA	4,424	27,176	10	5	10	5	65	15	65	15
2013	NA	NA	4,225	30,983	10	5	10	5	65	15	65	15
2014	NA	NA	2,251	31,349	10	5	10	5	65	15	65	15
2015	NA	NA	4,626	34,574	10	5	10	5	65	15	65	15
2016	NA	NA	4,260	31,840	10	5	10	5	65	15	65	15

Sweden

Annual input data for NEAC PFA run-reconstruction & NCL models for SWEDEN. (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	6,220	254	30	15	30	15	52.5	12.5	57.5	12.5
1972	4,943	201	30	15	30	15	52.5	12.5	57.5	12.5
1973	6,124	895	30	15	30	15	52.5	12.5	57.5	12.5
1974	8,870	563	30	15	30	15	52.5	12.5	57.5	12.5
1975	9,620	160	30	15	30	15	52.5	12.5	57.5	12.5
1976	5,420	480	30	15	30	15	52.5	12.5	57.5	12.5
1977	2,453	206	30	15	30	15	52.5	12.5	57.5	12.5
1978	2,903	254	30	15	30	15	52.5	12.5	57.5	12.5
1979	2,988	661	30	15	30	15	52.5	12.5	57.5	12.5
1980	3,842	1,283	30	15	30	15	52.5	12.5	57.5	12.5
1981	7,013	284	30	15	30	15	52.5	12.5	57.5	12.5
1982	6,177	1,381	30	15	30	15	52.5	12.5	57.5	12.5
1983	8,222	903	30	15	30	15	52.5	12.5	57.5	12.5
1984	11,584	1,266	30	15	30	15	52.5	12.5	57.5	12.5
1985	13,810	470	30	15	30	15	52.5	12.5	57.5	12.5
1986	14,415	240	30	15	30	15	52.5	12.5	57.5	12.5
1987	11,450	1,084	30	15	30	15	52.5	12.5	57.5	12.5
1988	9,604	1,160	30	15	30	15	52.5	12.5	57.5	12.5
1989	2,803	4,044	30	15	30	15	52.5	12.5	57.5	12.5
1990	6,839	2,249	15	10	15	10	45	15	50	15
1991	8,599	3,033	15	10	15	10	45	15	50	15
1992	9,550	4,205	15	10	15	10	45	15	50	15
1993	9,468	4,762	15	10	15	10	45	15	50	15
1994	7,347	3,628	15	10	15	10	45	15	50	15
1995	8,933	1,528	15	10	15	10	37.5	12.5	42.5	12.5
1996	5,318	2,507	15	10	15	10	37.5	12.5	42.5	12.5
1997	2,415	1,809	15	10	15	10	37.5	12.5	42.5	12.5
1998	1,953	1,000	15	10	15	10	37.5	12.5	42.5	12.5
1999	3,075	712	15	10	15	10	37.5	12.5	42.5	12.5
2000	5,660	2,546	15	10	15	10	37.5	12.5	42.5	12.5
2001	3,504	3,026	15	10	15	10	37.5	12.5	42.5	12.5
2002	3,374	2,075	15	10	15	10	37.5	12.5	42.5	12.5
2003	1,833	496	15	10	15	10	37.5	12.5	42.5	12.5
2004	1,537	1,528	15	10	15	10	37.5	12.5	42.5	12.5
2005	1,503	1,027	15	10	15	10	37.5	12.5	42.5	12.5
2006	1,676	1,069	15	10	15	10	37.5	12.5	42.5	12.5
2007	521	1,001	15	10	15	10	37.5	12.5	42.5	12.5
2008	615	1,112	12.5	7.5	12.5	7.5	27.5	12.5	32.5	12.5
2009	651	979	12.5	7.5	12.5	7.5	27.5	12.5	32.5	12.5
2010	1,111	1,139	12.5	7.5	12.5	7.5	27.5	12.5	32.5	12.5
2011	1,460	3,100	17.5	7.5	17.5	7.5	45	15	50	15
2012	1,336	3,130	12.5	7.5	10	5	27.5	12.5	32.5	12.5
2013	874	1,431	10	5	10	5	30	15	35	15
2014	2,347	2,797	12.5	7.5	12.5	7.5	30	12.5	35	12.5
2015	1,028	2,569	12.5	7.5	12.5	7.5	30	12.5	30	12.5
2016	554	910	10	7.5	10	7.5	25	10	25	10

UK (England and Wales)

Annual input data for NEAC PFA run-reconstruction & NCL models for UK(ENGLAND AND WALES). (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation)

Year	Declared total catch	Estimated proportion 1SW (total)	Declared catch in NE coastal fishery - total	Declared catch in NE coastal fishery - drift nets	Declared catch in NE coastal fishery - T/J nets	Estimated proportion 1SW (NE fishery)	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon	Estimated % unreported catch in NE fishery	Estimated proportion Scottish fish in NE fishery (total)	Estimated proportion Scottish fish in NE fishery (drift)	Estimated proportion Scottish fish in NE fishery (T/J nets)
1971	109,861	0.55	60,353	NA	NA	0.55	38.3	9.6	38.3	9.6	57.3	10	42.5	10	32.3	0.95	NA	NA
1972	108,074	0.42	51,681	NA	NA	0.42	39	9.7	39	9.7	51.3	10	37.8	10	32.3	0.95	NA	NA
1973	114,786	0.53	62,842	NA	NA	0.53	38.4	9.6	38.4	9.6	50.6	10	37.3	10	32.3	0.95	NA	NA
1974	104,325	0.65	52,756	NA	NA	0.65	39.3	9.8	39.3	9.8	50.2	10	37	10	32.3	0.95	NA	NA
1975	113,062	0.59	53,451	NA	NA	0.59	38.5	9.6	38.5	9.6	49.8	10	36.7	10	32.3	0.95	NA	NA
1976	54,294	0.64	15,701	NA	NA	0.64	36.8	9.2	36.8	9.2	50.3	10	37.1	10	32.3	0.94	NA	NA
1977	94,282	0.62	52,888	NA	NA	0.62	39	9.8	39	9.8	50.4	10	37.2	10	32.3	0.93	NA	NA
1978	93,125	0.69	51,630	NA	NA	0.69	38.4	9.6	38.4	9.6	49.1	10	36.2	10	32.3	0.92	NA	NA
1979	75,386	0.81	43,464	NA	NA	0.81	38.6	9.6	38.6	9.6	47.7	10	35.2	10	32.3	0.91	NA	NA
1980	90,218	0.55	45,780	NA	NA	0.55	39.1	9.8	39.1	9.8	47.8	10	35.2	10	32.3	0.90	NA	NA
1981	121,039	0.48	69,113	NA	NA	0.48	38.3	9.6	38.3	9.6	47.4	10	34.9	10	32.3	0.89	NA	NA
1982	80,289	0.67	50,167	NA	NA	0.67	38.3	9.6	38.3	9.6	47.3	10	34.8	10	32.3	0.88	NA	NA
1983	116,995	0.72	77,277	NA	NA	0.72	37.1	9.3	37.1	9.3	47.1	10	34.7	10	32.3	0.87	NA	NA
1984	94,271	0.74	59,295	NA	NA	0.74	36.5	9.1	36.5	9.1	47.4	10	34.8	10	32.3	0.86	NA	NA
1985	95,531	0.66	57,356	NA	NA	0.66	38.9	9.7	38.9	9.7	47.5	10	34.9	10	32.3	0.85	NA	NA
1986	110,794	0.62	63,425	NA	NA	0.62	38	9.5	38	9.5	46.9	10	34.3	10	32.3	0.84	NA	NA
1987	83,439	0.68	36,143	NA	NA	0.68	38.2	9.5	38.2	9.5	46.1	10	33.7	10	32.3	0.83	NA	NA
1988	110,163	0.69	NA	47,465	3,384	0.69	39.7	9.9	39.7	9.9	45.5	10	33.5	10	32.3	NA	0.82	0.50
1989	83,668	0.65	NA	36,236	5,217	0.65	36.9	9.2	36.9	9.2	45.3	10	33.3	10	32.3	NA	0.81	0.50
1990	86,676	0.52	NA	48,219	3,311	0.52	36.7	9.2	36.7	9.2	45.3	10	33.2	10	31.3	NA	0.80	0.50
1991	51,649	0.71	NA	22,463	2,966	0.71	37.3	9.3	37.3	9.3	44.0	10	32.3	10	29.7	NA	0.79	0.50
1992	44,586	0.77	NA	17,574	2,570	0.77	39.8	10	39.8	10	43.5	10	31.8	10	28	NA	0.78	0.50
1993	69,177	0.81	NA	39,224	2,576	0.81	38	9.5	38	9.5	40.6	10	29.5	10	26.3	NA	0.77	0.50
1994	88,121	0.77	NA	41,298	5,256	0.77	23.9	6.0	23.9	6	40.5	10	29.5	10	24.4	NA	0.76	0.50
1995	80,478	0.72	NA	48,005	5,205	0.72	22.3	5.6	22.3	5.6	37.6	10	27.1	10	22.5	NA	0.75	0.50
1996	46,696	0.65	NA	15,172	3,409	0.65	20.6	5.1	20.6	5.1	35.8	10	25.8	10	20.6	NA	0.75	0.50
1997	41,374	0.73	NA	19,241	2,681	0.73	18.8	4.7	18.8	4.7	33.4	10	23.9	10	18.5	NA	0.75	0.50
1998	36,917	0.82	NA	17,328	937	0.82	18.9	4.7	18.9	4.7	31.4	10	22.4	10	18.5	NA	0.75	0.50
1999	41,094	0.68	NA	24,812	2,021	0.68	17.4	4.4	17.4	4.4	29.5	10	17.9	9	17.1	NA	0.75	0.50
2000	60,953	0.79	NA	40,059	3,295	0.79	14.9	3.7	14.9	3.7	29.7	10	15	7.5	13.1	NA	0.75	0.50
2001	51,307	0.75	NA	32,374	3,741	0.75	14.8	3.7	14.8	3.7	27.9	10	14.3	7.1	13.1	NA	0.75	0.50
2002	45,669	0.76	NA	27,685	3,295	0.76	15.3	3.8	15.3	3.8	27.8	10	14.1	7	13.9	NA	0.75	0.50
2003	22,206	0.66	NA	5,511	4,924	0.66	17.4	4.4	17.4	4.4	21.4	10	10.7	5.3	17.1	NA	0.75	0.50
2004	30,559	0.81	NA	5,921	5,096	0.81	17.7	4.4	17.7	4.4	22.1	10	10.6	5.3	17.1	NA	0.75	0.50
2005	26,162	0.76	NA	5,607	3,380	0.76	17.6	4.4	17.6	4.4	21.8	10	10.6	5.3	17.1	NA	0.75	0.50
2006	22,056	0.78	NA	4,040	3,526	0.78	17.6	4.4	17.6	4.4	19.5	9.8	9.1	4.6	17.1	NA	0.75	0.50
2007	19,914	0.78	NA	4,894	2,197	0.78	17.7	4.4	17.7	4.4	17.9	9	8.4	4.2	17.1	NA	0.75	0.50
2008	19,036	0.76	NA	3,649	2,592	0.76	17.8	4.4	17.8	4.4	17.6	8.8	8.2	4.1	17.1	NA	0.75	0.50
2009	13,910	0.72	NA	2,590	2,805	0.72	11.4	2.9	11.4	2.9	17.4	8.7	8.2	4.1	7.4	NA	0.75	0.50
2010	32,695	0.78	NA	12,214	7,768	0.78	10.8	2.7	10.8	2.7	17.5	8.8	8	4	7.4	NA	0.75	0.50
2011	34,575	0.57	NA	14,915	9,233	0.57	10.1	2.5	10.1	2.5	20.8	10	10.2	5.1	7.4	NA	0.64	0.37
2012	14,926	0.50	NA	3,571	3,705	0.50	11.2	2.8	11.2	2.8	16.8	8.4	8	4	7.4	NA	0.62	0.37
2013	22,608	0.58	NA	7,964	8,679	0.58	9.5	2.4	9.5	2.4	17.4	8.7	8.5	4.3	7.4	NA	0.63	0.37
2014	14,219	0.54	NA	6,974	3,826	0.54	9.3	2.3	9.3	2.3	15.8	7.9	8	4	7.4	NA	0.64	0.37
2015	19,262	0.47	NA	9,233	6,657	0.47	12.9	3.2	12.9	3.2	15.2	7.6	7.7	3.9	7.4	NA	0.64	0.37
2016	22,471	0.41	NA	10,811	7,956	0.41	11.9	3	11.9	3	14.8	7.4	7.5	3.7	7.4	NA	0.63	0.37

UK (Northern Ireland)-Foyle Fisheries Area

Annual input data for NEAC PFA run-reconstruction & NCL models for UK(NORTHERN IRELAND) (FOYLE). (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation)

Year	Declared net catch 1SW salmon	Declared net catch MSW salmon	Declared rod catch 1SW salmon	Declared rod catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	78,037	5,874	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1972	64,663	4,867	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1973	57,469	4,326	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1974	72,587	5,464	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1975	51,061	3,843	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1976	36,206	2,725	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1977	36,510	2,748	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1978	44,557	3,354	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1979	34,413	2,590	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1980	45,777	3,446	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1981	32,346	2,435	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1982	55,946	4,211	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1983	77,424	5,828	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1984	27,465	2,067	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1985	37,685	2,836	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1986	43,109	3,245	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5
1987	17,189	1,294	NA	NA	21.5	11.5	21.5	11.5	69	7	46	5
1988	43,974	3,310	NA	NA	21.5	11.5	21.5	11.5	65	7	36	4
1989	60,288	4,538	NA	NA	23.5	13.5	23.5	13.5	89	9	60	6
1990	39,875	3,001	NA	NA	13.5	3.5	13.5	3.5	62	6	38	4
1991	21,709	1,634	NA	NA	13.5	3.5	13.5	3.5	65	7	43	4
1992	39,299	2,958	NA	NA	16.5	6.5	16.5	6.5	56	6	33	3
1993	35,366	2,662	NA	NA	13.5	3.5	13.5	3.5	41	4	12	1
1994	36,144	2,720	NA	NA	19	9	19	9	70	7	40	4
1995	33,398	2,514	NA	NA	13.5	3.5	13.5	3.5	67	7	42	4
1996	28,406	2,138	NA	NA	15	5	15.0	5	57	10	34	10
1997	40,886	3,077	NA	NA	10	5	10	5	60	10	34	10
1998	37,154	2,797	NA	NA	10	5	10	5	25	5	22.5	7.5
1999	21,660	1,630	NA	NA	10	5	10	5	63	5	32.5	7.5
2000	30,385	2,287	NA	NA	10	5	10	5	58	5	32.5	7.5
2001	21,368	1,608	NA	NA	5	5	5	5	50	5	30	5
2002	37,914	2,854	9,163	690	2.5	2.5	2.5	2.5	15	3	15	3
2003	30,441	2,291	4,576	344	0.5	0.5	0.5	0.5	15	3	15	3
2004	20,730	1,560	4,570	344	0.5	0.5	0.5	0.5	15	3	15	3
2005	23,746	1,787	7,079	533	0.5	0.5	0.5	0.5	15	3	15	3
2006	11,324	852	4,886	368	0.5	0.5	0.5	0.5	15	3	15	3
2007	5,050	322	9,530	608	0.5	0.5	0.5	0.5	15	3	15	3
2008	3,880	292	4,755	304	0.5	0.5	0.5	0.5	15	3	15	3
2009	1,743	194	3,640	405	0.5	0.5	0.5	0.5	15	3	15	3
2010	0	0	3,488	388	0.5	0.5	0.5	0.5	15	3	15	3
2011	0	0	2,276	759	1	1	1	1	15	5	15	5
2012	0	0	4,781	1,594	1	1	1	1	10	7.5	10	7.5
2013	0	0	5,030	498	1	1	1	1	10	7.5	10	7.5
2014	0	0	2,029	225	1	1	1	1	10	7.5	10	7.5
2015	0	0	1,998	250	1	1	1	1	10	7.5	10	7.5
2016	0	0	3,457	432	1	1	1	1	10	7.5	10	7.5

UK (Northern Ireland)-DAERA area.

Annual input data for NEAC PFA run-reconstruction & NCL models for UK(NORTHERN IRELAND) (DAERA Region) (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation)

Year	Declared net catch 1SW salmon	Declared net catch MSW salmon	Declared rod catch 1SW salmon	Declared rod catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon	Count River Bush	Estimated proportion (%) 1SW in Bush	Count River Bann	Estimated proportion (%) 1SW in Bann	Count upscaling factor (%) 1SW	Uncertainty in upscaling factor (%) 1SW	Count upscaling factor (%) MSW	Uncertainty in upscaling factor (%) MSW
1971	35,506	2,673	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1972	34,550	2,601	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1973	29,229	2,200	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1974	22,307	1,679	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1975	26,701	2,010	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1976	17,886	1,346	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1977	16,778	1,263	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1978	24,857	1,871	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1979	14,323	1,078	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1980	15,967	1,202	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1981	15,994	1,204	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1982	14,068	1,059	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1983	20,845	1,569	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1984	11,109	836	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1985	12,369	931	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1986	13,160	991	NA	NA	21.5	11.5	21.5	11.5	80	5	50	5	0	0	0	0	NA	NA	NA	NA
1987	9,240	695	NA	NA	21.5	11.5	21.5	11.5	69	7	46	5	2,530	83	0	0	10	2	9.5	2
1988	14,320	1,078	NA	NA	21.5	11.5	21.5	11.5	64.5	6.5	36	4	2,832	96	0	0	10	2	9.5	2
1989	15,081	1,135	NA	NA	23.5	13.5	23.5	13.5	89	9	60	6	1,029	82	0	0	10	2	9.5	2
1990	9,499	715	NA	NA	13.5	3.5	13.5	3.5	62	6	38	4	1,850	87	0	0	10	2	9.5	2
1991	6,987	526	NA	NA	13.5	3.5	13.5	3.5	64.5	6.5	43	4	2,341	87	0	0	10	2	9.5	2
1992	9,346	703	NA	NA	16.5	6.5	16.5	6.5	56	6	33	3	2,546	84	0	0	10	2	9.5	2
1993	7,906	595	NA	NA	13.5	3.5	13.5	3.5	41	4	12	1	3,235	93	0	0	10	2	9.5	2
1994	11,206	843	NA	NA	19	9	19	9	70	7	40	4	2,010	88	0	0	10	2	9.5	2
1995	11,637	876	NA	NA	13.5	3.5	13.5	3.5	67	7	42	4	1,521	92	0	0	10	2	9.5	2
1996	10,383	781	NA	NA	15	5	15	5	57	10	34	10	1,097	87	0	0	10	2	9.5	2
1997	10,479	789	NA	NA	10	5	10	5	60	10	34	10	1,677	85	6,541	85	67	5	61	5
1998	9,375	706	NA	NA	10	5	10	5	25	5	22.5	7.5	2,995	95	11,462	95	67	5	61	5
1999	9,011	678	NA	NA	10	5	10	5	63	5	32.5	7.5	977	90	3,599	90	67	5	61	5
2000	10,598	798	NA	NA	10	5	10	5	58	5	32.5	7.5	950	91	5,979	91	67	5	61	5
2001	8,104	610	NA	NA	5	5	5	5	50	5	30	5	913	97	5,771	97	67	5	61	5
2002	3,315	249	2,218	167	2.5	2.5	2.5	2.5	13.7	8.8	13.7	8.8	835	95	5,037	95	67	5	61	5
2003	2,236	168	1,884	141	2.5	2.5	2.5	2.5	12.3	6.6	12.3	6.6	723	96	4,147	96	67	5	61	5
2004	2,411	181	3,053	230	0.5	0.5	0.5	0.5	18.3	9.7	18.3	9.7	878	92	9,050	92	67	5	61	5
2005	3,012	227	1,791	135	0.5	0.5	0.5	0.5	11.9	7.1	11.9	7.1	1,151	91	6,609	91	67	5	61	5
2006	2,288	172	1,289	97	0.5	0.5	0.5	0.5	12.4	8	12.4	8	1,074	87	7,410	87	67	5	61	5
2007	2,533	162	2,427	155	0.5	0.5	0.5	0.5	11	3.6	11	3.6	2,584	94	7,008	94	67	5	61	5
2008	1,825	116	2,444	156	0.5	0.5	0.5	0.5	13.9	7.1	13.9	7.1	1,712	90	0	0	10	2	9.5	2
2009	1,383	154	1,457	162	0.5	0.5	0.5	0.5	9.9	3	9.9	3	726	83	3,838	83	67	5	61	5
2010	1,723	191	1,327	147	0.5	0.5	0.5	0.5	14.6	2.5	14.6	2.5	1,045	78	6,426	70	67	5	61	5
2011	857	285	1,132	378	1	1	1	1	15	5	15	5	649	73	6,130	76	67	5	61	5
2012	15	5	263	87	1	1	1	1	10	5	10	5	926	74	5,319	71	67	5	61	5
2013	9	1	46	5	1	1	1	1	0.6	0.4	0.6	0.4	1,644	92	5,866	91	67	5	61	5
2014	0	0	143	40	2.5	2.5	2.5	2.5	0.6	0.4	0.6	0.4	963	76	4,335	91	67	5	61	5
2015	0	0	20	6	2.5	2.5	2.5	2.5	0.6	0.4	0.6	0.4	1,005	83	6,235	86	67	5	61	5
2016	0	0	124	279	2.5	2.5	2.5	2.5	0.6	0.4	0.6	0.4	2,015	85	15,936	86	67	5	61	5

UK (Scotland)-East

Annual input data for NEAC PFA run-reconstruction & NCL models for SCOTLAND (EAST) (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	216,873	135,530	25	10	25	10	75.4	12.6	49.9	10
1972	220,106	183,875	25	10	25	10	76.8	12.8	51.5	10.3
1973	259,773	204,826	25	10	25	10	74.9	12.5	49.9	10
1974	245,424	158,959	25	10	25	10	82.0	13.7	56.4	11.3
1975	181,940	180,828	25	10	25	10	80.5	13.4	55.1	11
1976	150,069	92,179	25	10	25	10	76.6	12.8	50.7	10.1
1977	154,306	118,645	25	10	25	10	81.4	13.6	55.8	11.2
1978	158,859	139,763	25	10	25	10	75.6	12.6	51	10.2
1979	160,796	116,559	25	10	25	10	78.4	13.1	53.9	10.8
1980	101,665	155,646	17.5	7.5	17.5	7.5	76.8	12.8	52	10.4
1981	129,690	156,683	17.5	7.5	17.5	7.5	75.9	12.7	51.2	10.2
1982	175,374	113,198	17.5	7.5	17.5	7.5	71.1	11.8	45.3	9.1
1983	170,843	126,104	17.5	7.5	17.5	7.5	77.0	12.8	49.4	9.9
1984	175,675	90,829	17.5	7.5	17.5	7.5	70.1	11.7	43.9	8.8
1985	133,119	95,044	17.5	7.5	17.5	7.5	61.9	10.3	38.9	7.8
1986	180,292	128,654	17.5	7.5	17.5	7.5	59.5	9.9	37.6	7.5
1987	139,259	88,531	17.5	7.5	17.5	7.5	64.5	10.8	40.5	8.1
1988	118,620	91,167	17.5	7.5	17.5	7.5	40.3	6.7	29.2	5.8
1989	143,063	85,399	10	5	10	5	37.5	6.3	28	5.6
1990	63,352	73,974	10	5	10	5	39.8	6.6	28.7	5.8
1991	53,861	53,693	10	5	10	5	36.8	6.1	27.5	5.5
1992	79,906	67,979	10	5	10	5	32.1	5.4	25.9	5.2
1993	73,413	60,498	10	5	10	5	35.3	5.9	26.9	5.4
1994	80,429	72,758	10	5	10	5	33.1	5.5	26.1	5.2
1995	73,020	69,055	10	5	10	5	30.9	5.2	25.4	5.1
1996	56,627	50,365	10	5	10	5	28.8	4.8	24.5	4.9
1997	37,448	34,850	10	5	10	5	30.6	5.1	25.1	5
1998	44,952	32,231	10	5	10	5	24.2	4	22.9	4.6
1999	20,907	27,011	10	5	10	5	24.8	4.1	23.3	4.7
2000	36,871	31,280	10	5	10	5	21.9	3.6	22.3	4.5
2001	36,646	30,470	10	5	10	5	20.4	3.4	21.6	4.5
2002	26,616	21,740	10	5	10	5	19.3	3.2	21.2	4.2
2003	25,871	24,270	10	5	10	5	17.3	2.8	19.3	4.3
2004	31,667	30,773	10	5	10	5	17.3	2.8	19.3	4.3
2005	31,597	23,676	10	5	10	5	17.3	2.8	19.3	4.3
2006	30,739	22,954	10	5	10	5	15.3	2.8	16.5	3.5
2007	26,015	19,444	10	5	10	5	13.8	2.8	15	3.5
2008	18,586	20,757	10	5	10	5	10.8	2.8	14	3.5
2009	14,863	15,042	10	5	10	5	9.8	2.8	13	3.5
2010	28,161	22,861	10	5	10	5	9.8	2.8	13	3.5
2011	12,495	24,218	10	5	10	5	9.3	2.8	12.5	3.5
2012	16,117	16,165	10	5	10	5	8.3	2.8	11.5	3.5
2013	18,400	14,901	10	5	10	5	7.3	2.8	11	3.5
2014	10,924	11,798	10	5	10	5	5.8	2.3	9.5	3
2015	12,223	7,789	10	5	10	5	5.8	2.3	9.5	3
2016	4,015	4,013	10	5	10	5	2	0.5	5	1

UK (Scotland)-West

Annual input data for NEAC PFA run-reconstruction & NCL models for SCOTLAND (WEST) (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch 1SW salmon	Declared catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	Estimated % unreported catch of MSW salmon	Uncertainty in % unreported catch of MSW salmon	Estimated exploitation rate (%) - 1SW salmon	Uncertainty in exploitation rate (%) - 1SW salmon	Estimated exploitation rate (%) - MSW salmon	Uncertainty in exploitation rate (%) - MSW salmon
1971	45,287	26,071	35	10	35	10	37.7	6.3	24.9	5
1972	31,358	34,148	35	10	35	10	38.4	6.4	25.7	5.1
1973	33,317	33,094	35	10	35	10	37.5	6.2	24.9	5
1974	43,992	29,369	35	10	35	10	41	6.8	28.2	5.6
1975	40,217	27,060	35	10	35	10	40.2	6.7	27.5	5.5
1976	38,254	22,292	35	10	35	10	38.3	6.4	25.3	5.1
1977	39,739	20,286	35	10	35	10	40.7	6.8	27.9	5.6
1978	45,342	23,085	35	10	35	10	37.8	6.3	25.5	5.1
1979	26,284	15,923	35	10	35	10	39.2	6.5	26.9	5.4
1980	19,654	16,882	27.5	7.5	27.5	7.5	38.4	6.4	26	5.2
1981	20,642	17,896	27.5	7.5	27.5	7.5	38	6.3	25.6	5.1
1982	32,352	15,005	27.5	7.5	27.5	7.5	35.5	5.9	22.6	4.5
1983	38,406	19,778	27.5	7.5	27.5	7.5	38.5	6.4	24.7	4.9
1984	37,262	16,321	27.5	7.5	27.5	7.5	35.1	5.8	21.9	4.4
1985	24,648	19,521	27.5	7.5	27.5	7.5	30.9	5.2	19.5	3.9
1986	22,483	19,507	27.5	7.5	27.5	7.5	29.8	5	18.8	3.8
1987	25,388	15,446	27.5	7.5	27.5	7.5	32.3	5.4	20.3	4.1
1988	30,312	20,972	27.5	7.5	27.5	7.5	20.2	3.4	14.6	2.9
1989	31,788	18,474	20	5	20	5	18.8	3.1	14	2.8
1990	17,729	13,942	20	5	20	5	19.9	3.3	14.4	2.9
1991	19,727	11,500	20	5	20	5	18.4	3.1	13.7	2.7
1992	21,770	14,862	20	5	20	5	16.1	2.7	12.9	2.6
1993	21,104	11,228	20	5	20	5	17.7	2.9	13.5	2.7
1994	18,234	12,304	20	5	20	5	16.5	2.8	13	2.6
1995	16,784	9,133	20	5	20	5	15.5	2.6	12.7	2.5
1996	9,537	7,463	20	5	20	5	14.4	2.4	12.2	2.5
1997	9,059	5,504	20	5	20	5	15.3	2.6	12.6	2.5
1998	8,369	6,150	20	5	20	5	12.1	2	11.5	2.3
1999	4,147	3,588	20	5	20	5	12.4	2.1	11.7	2.3
2000	6,974	5,301	20	5	20	5	10.9	1.8	11.1	2.2
2001	5,603	4,191	20	5	20	5	10.2	1.7	10.8	2.3
2002	4,691	4,548	20	5	20	5	9.6	1.6	10.6	2.1
2003	3,536	3,061	20	5	20	5	4.8	0.8	5.3	1.3
2004	5,836	6,024	20	5	20	5	7	1	7.5	1.5
2005	7,428	4,913	20	5	20	5	7	1	7.5	1.5
2006	5,767	4,403	20	5	20	5	7	1	7.5	1.5
2007	6,178	4,468	20	5	20	5	7	1	7.5	1.5
2008	4,740	4,853	20	5	20	5	7	1	7.5	1.5
2009	3,250	4,095	20	5	20	5	6	1	6.5	1.5
2010	5,107	4,051	20	5	20	5	6	1	6.5	1.5
2011	3,206	4,246	20	5	20	5	5.5	1	6	1.5
2012	3,239	3,392	20	5	20	5	4.5	1	5	1.5
2013	2,342	2,286	20	5	20	5	4	1	4.8	1.5
2014	1,653	1,519	20	5	20	5	3.5	1	4.5	1.5
2015	1,429	1,335	20	5	20	5	3.5	1	4.5	1.5
2016	278	137	20	5	20	5	0.7	0.3	0.5	0.3

Faroes

Annual input data for NEAC PFA run-reconstruction & NCL models for Faroes. (Uncertainty values define uniform distribution around estimate used in Monte Carlo simulation)

Year	Catch 1SW salmon	Catch MSW salmon	Estimated % unreported catch of 1SW salmon	Uncertainty in % unreported catch of 1SW salmon	% wild	Natural mortality after 1st sea winter (M)
1971	2,620	105,796	10	5	1	0.03
1972	2,754	111,187	10	5	1	0.03
1973	3,121	126,012	10	5	1	0.03
1974	2,186	88,276	10	5	1	0.03
1975	2,798	112,984	10	5	1	0.03
1976	1,830	73,900	10	5	1	0.03
1977	1,291	52,112	10	5	1	0.03
1978	974	39,309	10	5	1	0.03
1979	1,736	70,082	10	5	1	0.03
1980	4,523	182,616	10	5	1	0.03
1981	7,443	300,542	10	5	1	0.03
1982	6,859	276,957	10	5	1	0.03
1983	15,861	215,349	10	5	1	0.03
1984	5,534	138,227	10	5	1	0.03
1985	378	158,103	10	5	0.9	0.03
1986	1,979	180,934	10	5	1	0.03
1987	90	166,244	10	5	1	0.03
1988	8,637	87,629	10	5	0.9	0.03
1989	1,788	121,965	10	5	0.8	0.03
1990	1,989	140,054	10	5	0.5	0.03
1991	943	84,935	10	5	0.5	0.03
1992	68	35,700	10	5	0.6	0.03
1993	6	30,023	10	5	0.7	0.03
1994	15	31,672	10	5	0.7	0.03
1995	18	34,662	10	5	0.8	0.03
1996	101	28,381	10	5	0.8	0.03
1997	0	0	0	0	0	0.03
1998	339	1,424	15	5	0.8	0.03
1999	0	0	0	0	0	0.03
2000	225	1,765	15	5	0.8	0.03
2001	0	0	0	0	0	0.03
2002	0	0	0	0	0	0.03
2003	0	0	0	0	0	0.03
2004	0	0	0	0	0	0.03
2005	0	0	0	0	0	0.03
2006	0	0	0	0	0	0.03
2007	0	0	0	0	0	0.03
2008	0	0	0	0	0	0.03
2009	0	0	0	0	0	0.03
2010	0	0	0	0	0	0.03
2011	0	0	0	0	0	0.03
2012	0	0	0	0	0	0.03
2013	0	0	0	0	0	0.03
2014	0	0	0	0	0	0.03
2015	0	0	0	0	0	0.03
2016	0	0	0	0	0	0.03

West Greenland

Annual input data for NEAC PFA run-reconstruction & NCL models for WEST GREENLAND. (Uncertainty values define uniform distribution around estimates used in Monte Carlo simulation]

Year	Declared catch (t)	Estimated unreported catch (t)	Wean weight	Estimated min' proportion of NAC fish (from scale analysis)	Estimated max' proportion of NAC fish (from scale analysis)	Proportion 1SW in NAC fish	Proportion 1SW in NEAC fish	No. Fish identified as NAC (from genetic analysis)	No. Fish identified as NEAC (from genetic analysis)
1971	2,689	0	3.14	0.28	0.4	0.945	0.964	NA	NA
1972	2,113	0	3.44	0.34	0.37	0.945	0.964	NA	NA
1973	2,341	0	4.18	0.39	0.59	0.945	0.964	NA	NA
1974	1,917	0	3.58	0.39	0.46	0.945	0.964	NA	NA
1975	2,030	0	3.12	0.4	0.48	0.945	0.964	NA	NA
1976	1,175	0	3.04	0.38	0.48	0.945	0.964	NA	NA
1977	1,420	0	3.21	0.38	0.57	0.945	0.964	NA	NA
1978	984	0	3.35	0.47	0.57	0.945	0.964	NA	NA
1979	1,395	0	3.34	0.48	0.52	0.945	0.964	NA	NA
1980	1,194	0	3.22	0.45	0.51	0.945	0.964	NA	NA
1981	1,264	0	3.17	0.58	0.61	0.945	0.964	NA	NA
1982	1,077	0	3.11	0.6	0.64	0.945	0.964	NA	NA
1983	310	0	3.10	0.38	0.41	0.945	0.964	NA	NA
1984	297	0	3.11	0.47	0.53	0.945	0.964	NA	NA
1985	864	0	2.87	0.46	0.53	0.925	0.95	NA	NA
1986	960	0	3.03	0.48	0.66	0.951	0.975	NA	NA
1987	966	0	3.16	0.54	0.63	0.963	0.98	NA	NA
1988	893	0	3.18	0.38	0.49	0.967	0.981	NA	NA
1989	337	0	2.87	0.52	0.6	0.923	0.955	NA	NA
1990	274	0	2.69	0.7	0.79	0.957	0.963	NA	NA
1991	472	0	2.65	0.61	0.69	0.956	0.934	NA	NA
1992	237	0	2.81	0.5	0.57	0.919	0.975	NA	NA
1993	0	12	2.73	0.5	0.76	0.95	0.96	NA	NA
1994	0	12	2.73	0.5	0.76	0.95	0.96	NA	NA
1995	83	20	2.56	0.65	0.72	0.968	0.973	NA	NA
1996	92	20	2.88	0.71	0.76	0.941	0.961	NA	NA
1997	58	5	2.71	0.75	0.84	0.982	0.993	NA	NA
1998	11	11	2.78	0.73	0.84	0.968	0.994	NA	NA
1999	19	13	3.08	0.84	0.97	0.968	1	NA	NA
2000	21	10	2.57	0	0	0.974	1	344	146
2001	43	10	3.00	0.67	0.71	0.982	0.978	1	1
2002	10	10	2.90	0	0	0.973	1	338	163
2003	12	10	3.04	0	0	0.967	0.989	1212	567
2004	17	10	3.18	0	0	0.97	0.97	1192	447
2005	17	10	3.31	0	0	0.924	0.967	585	182
2006	23	10	3.24	0	0	0.93	0.988	857	326
2007	25	10	2.98	0	0	0.965	0.956	917	206
2008	29	10	3.08	0	0	0.974	0.988	1593	260
2009	28	10	3.50	0	0	0.934	0.894	1483	138
2010	43	10	3.42	0	0	0.982	0.975	991	249
2011	27	10	3.40	0	0	0.939	0.831	888	72
2012	35	10	3.44	0	1	0.932	0.98	1121	252
2013	48	10	3.35	0	1	0.949	0.966	938	211
2014	70	10	3.32	0	1	0.913	0.961	660	260
2015	61	10	3.37	0	1	0.97	0.982	1337	337
2016	30	10	3.18	0	1	0.935	0.955	864	438

Stock composition

Country	MSW
France	0.027
Finland	0.001
Iceland	0.001
Ireland	0.147
Norway	0.028
Russia	0.000
Sweden	0.003
UK(England & Wales)	0.149
UK(Northern Ireland)	0.000
UK(Scotland)	0.644
Other	
Total	1.000

Appendix 4: Input data for Atlantic salmon used to do the run-reconstruction and estimates of returns and spawners by size group and age group for North America

Appendix 4.i. Input data for the fishery at West Greenland used in the run-reconstruction model.

Year of the fishery	Harvest in tonnes of salmon at West Greenland for assessment	Unreported harvest in tonnes at West Greenland	Mean weight of salmon in the harvest	Prop. of harvest of NAC origin (min based on scales)	Prop. of harvest of NAC origin (max based on scales)	Prop. of NAC origin salmon that are 1SW	Prop. of NEAC origin salmon that are 1SW	Number of genetic samples that are NAC origin	Number of genetic samples that are NEAC origin
Year	WG.harv	WG.unharv	WG.meanwt	WG.propNAC_min	WG.propNAC_max	WG.prop1SWNAC	WG.prop1SWNEAC	WG.sampleNAC	WG.sampleNEAC
1971	2689	0	3.14	0.28	0.40	0.945	0.964	0	0
1972	2113	0	3.44	0.34	0.37	0.945	0.964	0	0
1973	2341	0	4.18	0.39	0.59	0.945	0.964	0	0
1974	1917	0	3.58	0.39	0.46	0.945	0.964	0	0
1975	2030	0	3.12	0.40	0.48	0.945	0.964	0	0
1976	1175	0	3.04	0.38	0.48	0.945	0.964	0	0
1977	1420	0	*3.21*	0.38	0.57	0.945	0.964	0	0
1978	984	0	3.35	0.47	0.57	0.945	0.964	0	0
1979	1395	0	3.34	0.48	0.52	0.945	0.964	0	0
1980	1194	0	3.22	0.45	0.51	0.945	0.964	0	0
1981	1264	0	3.17	0.58	0.61	0.945	0.964	0	0
1982	1077	0	3.11	0.60	0.64	0.945	0.964	0	0
1983	310	0	3.10	0.38	0.41	0.945	0.964	0	0
1984	297	0	3.11	0.47	0.53	0.945	0.964	0	0
1985	864	0	2.87	0.46	0.53	0.925	0.950	0	0
1986	960	0	3.03	0.48	0.66	0.951	0.975	0	0
1987	966	0	3.16	0.54	0.63	0.963	0.980	0	0
1988	893	0	3.18	0.38	0.49	0.967	0.981	0	0
1989	337	0	2.87	0.52	0.60	0.923	0.955	0	0
1990	274	0	2.69	0.70	0.79	0.957	0.963	0	0
1991	472	0	2.65	0.61	0.69	0.956	0.934	0	0
1992	237	0	2.81	0.50	0.57	0.919	0.975	0	0
1993	0	12	2.73	0.50	0.76	0.95	0.96	0	0
1994	0	12	2.73	0.50	0.76	0.95	0.96	0	0
1995	83	20	2.56	0.65	0.72	0.968	0.973	0	0
1996	92	20	2.88	0.71	0.76	0.941	0.961	0	0
1997	58	5	2.71	0.75	0.84	0.982	0.993	0	0
1998	11	11	2.78	0.73	0.84	0.968	0.994	0	0
1999	19	12.5	3.08	0.84	0.97	0.968	1.000	0	0
2000	21	10	2.57	0	0	0.974	1.000	344	146
2001	43	10	3.00	0.67	0.71	0.982	0.978	0	0
2002	9.8	10	2.90	0	0	0.973	1.000	338	163
2003	12.3	10	3.04	0	0	0.967	0.989	1212	567
2004	17.2	10	3.18	0	0	0.970	0.970	1192	447
2005	17.3	10	3.31	0	0	0.924	0.967	585	182
2006	23.0	10	3.24	0	0	0.930	0.988	857	326
2007	24.8	10	2.98	0	0	0.965	0.956	917	206
2008	28.6	10	3.08	0	0	0.974	0.988	1593	260
2009	28.0	10	3.50	0	0	0.934	0.894	1483	138
2010	43.1	10	3.42	0	0	0.982	0.975	991	249
2011	27.4	10	3.40	0	0	0.939	0.831	888	72
2012	34.6	10	3.44	0	0	0.932	0.980	1121	252
2013	47.7	10	3.35	0	0	0.949	0.966	938	211
2014	58.2	10	3.32	0	0	0.913	0.961	660	260
2015	55.9	10	3.37	0	0	0.970	0.982	1337	337

Appendix 4.ii. Input data for sea fisheries on large salmon and small salmon from Newfoundland and Labrador used in the run reconstruction model. Labrador represents harvests from Labrador in aboriginal fisheries for food, social and ceremonial purposes and the resident food fishery beginning in 1998.

	Harvests of large salmon (number)			Harvests of small salmon (number)		
	Salmon fishing areas 1 to 7	Salmon fishing areas 8 to 14a	Labrador subsistence fisheries	Salmon fishing areas 1 to 7	Salmon fishing areas 8 to 14a	Labrador subsistence fisheries
Year	Nlg_LBandNF1to7	Nlg_NF8to14a	Nlg_LBFSC	Nsm_LBandNF1to7	Nsm_NF8to14a	Nsm_LBFSC
1970	0	0	0	0	0	0
1971	199176	0	0	158896	70936	0
1972	144496	42861	0	143232	111141	0
1973	227779	43627	0	188725	176907	0
1974	196726	85714	0	192195	153278	0
1975	215025	72814	0	302348	91935	0
1976	210858	95714	0	221766	118779	0
1977	231393	63449	0	220093	57472	0
1978	155546	37653	0	102403	38180	0
1979	82174	29122	0	186558	62622	0
1980	211896	54307	0	290127	94291	0
1981	211006	38663	0	288902	60668	0
1982	129319	35055	0	222894	77017	0
1983	108430	28215	0	166033	55683	0
1984	87742	15135	0	123774	52813	0
1985	70970	24383	0	178719	79275	0
1986	107561	22036	0	222671	91912	0
1987	146242	19241	0	281762	82401	0
1988	86047	14763	0	198484	74620	0
1989	85319	15577	0	172861	60884	0
1990	59334	11639	0	104788	46053	0
1991	39257	10259	0	89099	42721	0
1992	32341	0	0	24249	0	0
1993	17096	0	0	17074	0	0
1994	15377	0	0	8640	0	0
1995	11176	0	0	7980	0	0
1996	7272	0	0	7849	0	0
1997	6943	0	0	9753	0	0
1998	0	0	2269	0	0	2988
1999	0	0	1084	0	0	2739
2000	0	0	1352	0	0	5323
2001	0	0	1721	0	0	4789
2002	0	0	1389	0	0	5806
2003	0	0	2175	0	0	6477
2004	0	0	3696	0	0	8385
2005	0	0	2817	0	0	10436
2006	0	0	3090	0	0	10377
2007	0	0	2652	0	0	9208
2008	0	0	3909	0	0	9834
2009	0	0	3344	0	0	7988
2010	0	0	3725	0	0	9867
2011	0	0	4451	0	0	11138
2012	0	0	4228	0	0	9977
2013	0	0	6479	0	0	7185
2014	0	0	3994	0	0	8958
2015	0	0	6146	0	0	8923

Appendix 4.iii. Input data for sea fisheries on large salmon and small salmon from St Pierre & Miquelon used in the run-reconstruction model.

Year of the fishery	Reported harvest (kg)	Number of salmon	Number of large salmon	Number of small salmon
1970	0	0	0	0
1971	0	0	0	0
1972	0	0	0	0
1973	0	0	0	0
1974	0	0	0	0
1975	0	0	0	0
1976	3000	1331	333	998
1977	0	0	0	0
1978	0	0	0	0
1979	0	0	0	0
1980	0	0	0	0
1981	0	0	0	0
1982	0	0	0	0
1983	3000	1331	333	998
1984	3000	1331	333	998
1985	3000	1331	333	998
1986	2500	1109	277	832
1987	2000	887	222	665
1988	2000	887	222	665
1989	2000	887	222	665
1990	1900	843	211	632
1991	1200	532	133	399
1992	2300	1020	255	765
1993	2900	1287	322	965
1994	3400	1508	377	1131
1995	800	355	89	266
1996	1600	710	177	532
1997	1500	665	166	499
1998	2300	1020	255	765
1999	2322	1030	258	773
2000	2267	1006	251	754
2001	2155	956	239	717
2002	1952	866	217	650
2003	2892	1283	321	962
2004	2784	1235	309	926
2005	3287	1458	365	1094
2006	3555	1577	394	1183
2007	1947	864	216	648
2008	3540	1571	393	1178
2009	3460	1535	384	1151
2010	2780	1233	308	925
2011	3757	1667	417	1250
2012	1450	643	161	482
2013	5300	2351	588	1764
2014	3810	1690	423	1268
2015	3510	1557	500	1057

Appendix 4.iv. Input data for large salmon for Labrador used in the run-reconstruction.

	Large Salmon																	
	Commercial harvest (number of fish)			FSC Fishery	Proportion Labrador origin						Exploitation rate		Proportion 2SW		Returns to Labrador rivers		Angling catches	
	SFA 1	SFA 2	SFA 14B	ALL	SFA 1		SFA 2		SFA 14B		All SFAs				number of fish		number of fish	
Year				Number of fish	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Retained	Released
1970	25127	64806	13673		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	562	0
1971	21599	55708	11753		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	486	0
1972	30204	77902	16436		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	424	0
1973	13866	93036	15863		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	1009	0
1974	28601	71168	14752		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	803	0
1975	38555	77796	15189		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	327	0
1976	28158	70158	18664		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	830	0
1977	30824	48934	11715		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	1286	0
1978	21291	27073	3874		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	767	0
1979	28750	87067	9138		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	609	0
1980	36147	68581	7606		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	889	0
1981	24192	53085	5966		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	520	0
1982	19403	33320	7489		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	621	0
1983	11726	25258	6218		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	428	0
1984	13252	16789	3954		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	510	0
1985	19152	34071	5342		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	294	0
1986	18257	49799	11114		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	467	0
1987	12621	32386	4591		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	633	0
1988	16261	26836	4646		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	710	0
1989	7313	17316	2858		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	461	0
1990	1369	7679	4417		0.6	0.8	0.6	0.8	0.6	0.8	0.7	0.9	0.70	0.90	0	0	357	0
1991	9981	19608	2752		0.6	0.8	0.6	0.8	0.6	0.8	0.580	0.830	0.70	0.90	0	0	93	0
1992	3825	9651	3620		0.6	0.8	0.6	0.8	0.6	0.8	0.38	0.62	0.70	0.90	0	0	781	10
1993	3464	11056	857		0.6	0.8	0.6	0.8	0.6	0.8	0.29	0.50	0.70	0.90	0	0	378	91
1994	2150	8714	312		0.6	0.8	0.6	0.8	0.6	0.8	0.14	0.25	0.70	0.90	0	0	455	347
1995	1375	5479	418		0.6	0.8	0.6	0.8	0.6	0.8	0.13	0.23	0.70	0.90	0	0	408	508
1996	1393	5550	263		0.6433	0.7247	0.8839	0.9521	0.6	0.8	0.17	0.30	0.70	0.90	0	0	334	489
1997	*6943*				1	1	1	1	1	1	0.17	0.30	0.60	0.71	0	0	158	566
1998	0	0	0	2269	1	1	1	1	1	1	0.17	0.30	0.60	0.71	7374	19486	231	814
1999	0	0	0	1084	1	1	1	1	1	1	0.17	0.30	0.60	0.71	8827	23328	320	931
2000	0	0	0	1352	1	1	1	1	1	1	0.17	0.30	0.60	0.71	12052	31850	262	1446
2001	0	0	0	1721	1	1	1	1	1	1	0.17	0.30	0.60	0.71	12744	33677	338	1468
2002	0	0	0	1389	1	1	1	1	1	1	0.17	0.30	0.60	0.71	9076	24769	207	978
2003	0	0	0	2175	1	1	1	1	1	1	0.17	0.30	0.60	0.71	6676	21689	222	1326
2004	0	0	0	3696	1	1	1	1	1	1	0.17	0.30	0.60	0.71	10964	23092	259	1519
2005	0	0	0	2817	1	1	1	1	1	1	0.17	0.30	0.60	0.71	11159	30796	291	1290
2006	0	0	0	3090	1	1	1	1	1	1	0.17	0.30	0.60	0.71	12414	29783	227	1133
2007	0	0	0	2652	1	1	1	1	1	1	0.17	0.30	0.60	0.71	11887	31913	235	1222
2008	0	0	0	3909	1	1	1	1	1	1	0.17	0.30	0.60	0.70	14700	37677	200	1461
2009	0	0	0	3344	1	1	1	1	1	1	0.2	0.4	0.60	0.70	18643	60062	216	1219
2010	0	0	0	3725	1	1	1	1	1	1	0.2	0.4	0.60	0.70	10764	26828	197	1080
2011	0	0	0	4451	1	1	1	1	1	1	0.2	0.4	0.60	0.70	30198	85085	0	2233
2012	0	0	0	4228	1	1	1	1	1	1	0.2	0.4	0.60	0.70	19062	48538	0	1072
2013	0	0	0	6479	1	1	1	1	1	1	0.2	0.4	0.60	0.70	36859	91394	0	2433
2014	0	0	0	3994	1	1	1	1	1	1	0.2	0.4	0.60	0.70	36055	87989	0	1385
2015	0	0	0	6146	1	1	1	1	1	1	0.2	0.4	0.60	0.70	49662	127898	0	1028

Appendix 4.v. Input data for small salmon for Labrador used in the run-reconstruction.

	Small salmon															
	Commercial harvest (number of fish)			FSC Fishery	Proportion Labrador origin						Exploitation rate		Returns to Labrador rivers		Angling catches	
	SFA 1	SFA 2	SFA 14B	ALL	SFA 1		SFA 2		SFA 14B		All SFAs		number of fish		number of fish	
Year				Number of fish	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Retained	Released
1970	19109	38359	11212		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	4013	0
1971	14303	28711	8392		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	3934	0
1972	3130	6282	1836		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	2947	0
1973	9848	37145	9328		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	7492	0
1974	34937	57560	19294		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	2501	0
1975	17589	47468	13152		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	3972	0
1976	17796	40539	11267		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	5726	0
1977	17095	12535	4026		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	4594	0
1978	9712	28808	7194		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	2691	0
1979	22501	72485	8493		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	4118	0
1980	21596	86426	6658		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	3800	0
1981	18478	53592	7379		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	5191	0
1982	15964	30185	3292		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	4104	0
1983	11474	11695	2421		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	4372	0
1984	15400	24499	7460		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	2935	0
1985	17779	45321	8296		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	3101	0
1986	13714	64351	11389		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	3464	0
1987	19641	56381	7087		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	5366	0
1988	13233	34200	9053		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	5523	0
1989	8736	20699	3592		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	4684	0
1990	1410	20055	5303		0.6	0.8	0.6	0.8	0.6	0.8	0.3	0.5	0	0	3309	0
1991	9588	13336	1325		0.6	0.8	0.6	0.8	0.6	0.8	0.22	0.39	0	0	2323	0
1992	3893	12037	1144		0.6	0.8	0.6	0.8	0.6	0.8	0.13	0.25	0	0	2738	251
1993	3303	4535	802		0.6	0.8	0.6	0.8	0.6	0.8	0.10	0.19	0	0	2508	1793
1994	3202	4561	217		0.6	0.8	0.6	0.8	0.6	0.8	0.07	0.13	0	0	2549	3681
1995	1676	5308	865		0.6	0.8	0.6	0.8	0.6	0.8	0.04	0.07	0	0	2493	3302
1996	1728	8025	332		0.3557	0.4163	0.748	0.85	0.6	0.8	0.05	0.08	0	0	2565	3776
1997	*9753*				1	1	1	1	1	1	0.05	0.08	0	0	2365	2187
1998	0	0	0	2988	1	1	1	1	1	1	0.05	0.08	97408	205197	2131	3758
1999	0	0	0	2739	1	1	1	1	1	1	0.05	0.08	94894	199901	2076	4407
2000	0	0	0	5323	1	1	1	1	1	1	0.05	0.08	117063	246602	2561	7095
2001	0	0	0	4789	1	1	1	1	1	1	0.05	0.08	93660	197301	2049	4640
2002	0	0	0	5806	1	1	1	1	1	1	0.05	0.08	62321	142951	2071	5052
2003	0	0	0	6477	1	1	1	1	1	1	0.05	0.08	48256	122813	2112	4924
2004	0	0	0	8385	1	1	1	1	1	1	0.05	0.08	69808	120244	1808	5968
2005	0	0	0	10436	1	1	1	1	1	1	0.05	0.08	160038	281401	2007	7120
2006	0	0	0	10377	1	1	1	1	1	1	0.05	0.08	132205	294669	1656	5815
2007	0	0	0	9208	1	1	1	1	1	1	0.05	0.08	131895	257360	1762	4641
2008	0	0	0	9834	1	1	1	1	1	1	0.05	0.08	142851	264694	1936	5917
2009	0	0	0	7988	1	1	1	1	1	1	0.07	0.14	55307	149372	1355	3396
2010	0	0	0	9867	1	1	1	1	1	1	0.07	0.14	78560	165165	1477	4704
2011	0	0	0	11138	1	1	1	1	1	1	0.07	0.14	137465	356791	1628	5340
2012	0	0	0	9977	1	1	1	1	1	1	0.07	0.14	105443	241754	1376	3302
2013	0	0	0	7185	1	1	1	1	1	1	0.07	0.14	83556	227719	1389	4167
2014	0	0	0	8958	1	1	1	1	1	1	0.07	0.14	175938	359832	1370	3797
2015	0	0	0	8923	1	1	1	1	1	1	0.07	0.14	174788	339699	1139	3970

Appendix 4.vi. Input data for returns of small salmon and large salmon for Salmon Fishing Areas 3 to 8 in Newfoundland used in the run-reconstruction.

	Salmon Fishing Area 3				Salmon Fishing Area 4				Salmon Fishing Area 5				Salmon Fishing Area 6				Salmon Fishing Area 7				Salmon Fishing Area 8			
	Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon	
	Returns		Returns		Returns		Returns		Returns		Returns		Returns		Returns		Returns		Returns		Returns		Returns	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Bugs label	SFA3Sm_L[]	SFA3Sm_H[]	SFA3Lg_L[	SFA3Lg_H	SFA4Sm_	SFA4Sm_	SFA4Lg_L	SFA4Lg_H	SFA5Sm_	SFA5Sm_	SFA5Lg_L	SFA5Lg_H	SFA6Sm_	SFA6Sm_	SFA6Lg_L	SFA6Lg_H	SFA7Sm_	SFA7Sm_	SFA7Lg_L	SFA7Lg_H	SFA8Sm_	SFA8Sm_	SFA8Lg_L	SFA8Lg_H
1970	2613	5227	155	737	16163	32327	957	4559	7420	14840	439	2093	280	560	17	79	67	133	4	19	62	123	4	17
1971	2473	4947	146	698	12610	25220	746	3557	5600	11200	331	1579	183	367	11	52	133	267	8	38	83	167	5	24
1972	1660	3320	98	468	11480	22960	679	3238	6317	12633	374	1782	397	793	23	112	203	407	12	57	93	187	6	26
1973	3960	7920	234	1117	22367	44733	1324	6308	7040	14080	417	1986	833	1667	49	235	437	873	26	123	313	627	19	88
1974	2797	5593	322	645	17910	35820	2065	4131	5457	10913	629	1258	1010	2020	116	233	443	887	51	102	170	340	20	39
1975	3690	7380	520	1041	19810	39620	2794	5587	6627	13253	935	1869	313	627	44	88	133	267	19	38	290	580	41	82
1976	3157	6313	380	760	22277	44553	2683	5365	6327	12653	762	1524	823	1647	99	198	100	200	12	24	267	533	32	64
1977	5100	10200	482	964	27987	55973	2645	5290	15387	30773	1454	2908	1337	2673	126	253	260	520	25	49	270	540	26	51
1978	2527	5053	150	299	29247	58493	1731	3461	9527	19053	564	1128	987	1973	58	117	330	660	20	39	147	293	9	17
1979	6800	13600	390	779	26753	53507	1533	3067	4437	8873	254	509	813	1627	47	93	417	833	24	48	333	667	19	38
1980	5810	11620	261	522	31380	62760	1410	2819	9007	18013	405	809	1067	2133	48	96	340	680	15	31	400	800	18	36
1981	7860	15720	1045	2090	45120	90240	5998	11996	11627	23253	1546	3091	2017	4033	268	536	410	820	55	109	257	513	34	68
1982	8780	17560	212	424	33243	66487	802	1604	8110	16220	196	391	960	1920	23	46	517	1033	12	25	283	567	7	14
1983	5390	10780	247	495	29847	59693	1370	2740	7857	15713	361	721	987	1973	45	91	463	927	21	43	137	273	6	13
1984	3532	7526	55	540	34933	74436	548	5337	9538	20323	150	1457	1101	2346	17	168	339	722	5	52	279	594	4	43
1985	4772	9879	72	683	44408	91931	671	6352	12692	26275	192	1816	1563	3235	24	224	408	845	6	58	375	777	6	54
1986	2826	5898	70	413	34015	70993	840	4977	14835	30963	366	2170	1629	3400	40	238	373	779	9	55	505	1054	12	74
1987	2218	4458	57	318	21485	43175	556	3078	6556	13175	170	939	540	1085	14	77	110	222	3	16	169	340	4	24
1988	6624	13644	159	956	37171	76566	892	5367	15715	32370	377	2269	1618	3333	39	234	483	995	12	70	298	614	7	43
1989	3004	6114	90	461	15409	31367	461	2365	5767	11740	172	885	1001	2038	30	154	269	547	8	41	403	820	12	62
1990	6750	11816	236	920	22244	38934	776	3033	9485	16602	331	1293	1312	2297	46	179	193	337	7	26	338	591	12	46
1991	5650	9281	193	750	21005	34499	718	2788	8793	14443	301	1167	799	1312	27	106	155	254	5	21	47	78	2	6
1992	11418	22836	416	4095	38670	77339	1408	13867	14189	28377	516	5088	1681	3363	61	603	292	585	11	105	0	0	0	0
1993	11793	22699	415	1614	45610	87791	1605	6242	16661	32071	586	2280	2574	4954	91	352	462	890	16	63	422	813	15	58
1994	13082	28738	769	3268	29401	64585	1729	7343	9740	21395	573	2433	539	1183	32	135	64	141	4	16	111	243	7	28
1995	10205	24587	609	2665	31439	75745	1877	8211	11108	26762	663	2901	386	931	23	101	233	560	14	61	185	446	11	48
1996	19519	43650	1439	4273	52515	117438	3870	11497	17384	38875	1281	3806	643	1438	47	141	151	338	11	33	224	500	16	49
1997	11763	21437	1226	3970	24074	43872	2509	8125	6468	11786	674	2183	235	429	25	79	60	110	6	20	60	110	6	20
1998	19617	27571	1956	6992	52347	73573	5219	18658	11863	16673	1183	4228	538	756	54	192	249	350	25	89	161	227	16	58
1999	13981	20350	1286	4196	62141	90450	5717	18651	10474	15245	964	3143	405	589	37	122	69	100	6	21	151	220	14	45
2000	19313	26033	1466	3728	37551	50618	2850	7248	12414	16734	942	2396	1128	1520	86	218	159	214	12	31	106	143	8	20
2001	11754	15383	907	2104	39901	52218	3080	7143	10007	13095	773	1791	296	387	23	53	53	69	4	9	20	26	2	4
2002	10500	15736	684	2006	34310	51418	2234	6556	3870	5799	252	739	241	361	16	46	0	0	0	0	72	108	5	14
2003	21615	26166	1092	3485	74615	90328	3768	12032	6583	7970	332	1062	458	555	23	74	104	126	5	17	52	63	3	8
2004	7992	12452	396	1686	49598	77280	2455	10464	8385	13065	415	1769	180	281	9	38	0	0	0	0	41	64	2	9
2005	6421	18899	487	2678	36753	108180	2790	15329	5309	15627	403	2214	114	336	9	48	0	0	0	0	26	76	2	11
2006	10757	17194	1251	3239	42745	68322	4971	12872	8571	13700	997	2581	69	110	8	21	0	0	0	0	172	275	20	52
2007	10422	21117	1182	3828	36934	74834	4188	13567	8734	17696	990	3208	78	157	9	28	129	262	15	47	17	35	2	6
2008	13901	23285	1062	3396	63476	106328	4851	15508	11459	19195	876	2800	330	552	25	81	84	141	6	21	196	329	15	48
2009	13313	24903	787	5088	59555	111403	3518	22760	10610	19847	627	4055	485	908	29	185	0	0	0	0	135	252	8	52
2010	21058	26262	1610	4596	79694	99392	6094	17393	23093	28801	1766	5040	997	1243	76	218	211	263	16	46	110	137	8	24
2011	15720	26791	1308	6277	60515	103137	5033	24165	14418	24574	1199	5758	850	1448	71	339	100	170	8	40	272	464	23	109
2012	23561	33459	1662	4417	72540	103017	5117	13600	16241	23065	1146	3045	827	1174	58	155	112	159	8	21	408	580	29	77
2013	9283	13679	518	4063	53415	78712	2983	23377	17957	26461	1003	7859	860	1267	48	376	291	429	16	127	126	185	7	55
2014	13868	20877	1086	2787	66006	99367	5170	13266	17550	26420	1374	3527	835	1257	65	168	318	479	25	64	102	154	8	21
2015	20844	35159	1717	5144	83603	141016	6886	20631	17154	28934	1413	4233	1158	1952	95	286	279	470	23	69	357	602	29	88

Appendix 4.vi. (Continued). Input data for returns of small salmon and large salmon for Salmon Fishing Areas 9 to 14A in Newfoundland used in the run-reconstruction.

	Salmon Fishing Area 9				Salmon Fishing Area 10				Salmon Fishing Area 11				Salmon Fishing Area 12				Salmon Fishing Area 13				Salmon Fishing Area 14A			
	Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon	
	Returns		Returns		Returns		Returns		Returns		Returns		Returns		Returns		Returns		Returns		Returns		Returns	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Bugs label	SFA9Sm_	SFA9Sm_	SFA9Lg_L	SFA9Lg_H	SFA10Sm	SFA10Sm	SFA10Lg_	SFA10Lg_	SFA11Sm	SFA11Sm	SFA11Lg_	SFA11Lg_	SFA12Sm	SFA12Sm	SFA12Lg_	SFA12Lg_	SFA13Sm	SFA13Sm	SFA13Lg_	SFA13Lg_	SFA14ASm_	SFA14ASm_H	SFA14ALg_L	SFA14ALg_H
1970	6310	12620	373	1780	2003	4007	119	565	16760	33520	992	4727	2497	4993	148	704	25942	38282	3251	5060	14817	29633	365	2571
1971	5400	10800	320	1523	3093	6187	183	872	13533	27067	801	3817	1513	3027	90	427	26011	40151	2678	4750	12523	25047	308	2173
1972	3797	7593	225	1071	1890	3780	112	533	16350	32700	968	4611	3093	6187	183	872	23526	37589	3107	5169	8057	16113	198	1398
1973	7200	14400	426	2031	5950	11900	352	1678	16187	32373	958	4565	2153	4307	127	607	27287	40227	3303	5200	17607	35213	433	3055
1974	4980	9960	574	1149	4040	8080	466	932	14920	29840	1720	3441	2193	4387	253	506	19274	28824	2913	4257	10400	20800	902	1805
1975	6240	12480	880	1760	1423	2847	201	401	15003	30007	2116	4232	1700	3400	240	479	33671	54424	4497	7424	16060	32120	507	1015
1976	5410	10820	651	1303	2433	4867	293	586	13880	27760	1671	3343	990	1980	119	238	29382	46902	3378	5488	24603	49207	1437	2874
1977	3600	7200	340	680	3657	7313	346	691	13653	27307	1290	2581	1860	3720	176	352	17610	25240	2877	3598	19023	38047	666	1331
1978	4343	8687	257	514	5317	10633	315	629	13320	26640	788	1576	1220	2440	72	144	17807	27681	4716	5289	10803	21607	266	532
1979	5680	11360	326	651	2830	5660	162	324	11433	22867	655	1311	2443	4887	140	280	20372	31829	1183	1862	21927	43853	233	467
1980	7930	15860	356	712	5080	10160	228	456	16897	33793	759	1518	2733	5467	123	246	26538	38871	5236	5913	12477	24953	694	1388
1981	6207	12413	825	1650	4390	8780	584	1167	23540	47080	3129	6258	3533	7067	470	939	31359	45989	5148	7452	19607	39213	1090	2180
1982	6083	12167	147	293	4187	8373	101	202	24460	48920	590	1180	5183	10367	125	250	31628	46698	3442	3831	15877	31753	3094	6189
1983	7677	15353	352	705	3800	7600	174	349	15897	31793	730	1460	2223	4447	102	204	20828	31701	4465	5100	12667	25333	1704	3407
1984	7989	17023	125	1221	5141	10955	81	785	24767	52774	389	3784	6782	14451	106	1036	26184	37852	2296	3710	16962	36143	266	2591
1985	6375	13198	96	912	4831	10000	73	691	21213	43914	320	3034	3996	8273	60	572	16028	25505	1375	2508	13209	27345	199	1890
1986	8411	17555	208	1231	5619	11727	139	822	20300	42368	501	2970	3433	7166	85	502	22881	36916	2079	3649	18411	38426	455	2694
1987	3416	6865	88	489	1690	3397	44	242	15087	30317	391	2162	3274	6580	85	469	19629	32325	1546	3022	18203	36580	471	2608
1988	5179	10668	124	748	4308	8873	103	622	18985	39106	456	2741	5330	10979	128	770	26162	43480	1950	3917	23580	48570	566	3405
1989	5352	10895	160	821	3655	7440	109	561	12047	24524	360	1849	2279	4640	68	350	10154	16156	849	1565	13036	26537	390	2001
1990	7332	12834	256	1000	3281	5743	115	447	17470	30578	610	2382	3363	5887	117	459	21518	31183	1778	3084	19843	34732	693	2706
1991	2404	3949	82	319	988	1622	34	131	7956	13068	272	1056	2765	4542	95	367	16225	20945	1709	2433	15307	25141	523	2031
1992	5044	10088	184	1809	1791	3582	65	642	16615	33231	605	5958	4671	9342	170	1675	25990	44119	3087	8928	34927	69854	1271	12525
1993	11402	21948	401	1560	5578	10736	196	763	24574	47301	865	3363	5936	11426	209	812	27523	46889	2618	4746	31116	59893	1095	4258
1994	3007	6607	177	751	2544	5588	150	635	7649	16803	450	1910	2761	6066	162	690	22103	37166	3476	5879	13321	29263	783	3327
1995	5321	12821	318	1390	4371	10532	261	1142	10757	25916	642	2809	2294	5527	137	599	27022	49781	1843	5096	20840	50209	1244	5443
1996	6015	13450	443	1317	8245	18438	608	1805	18938	42350	1396	4146	5025	11238	370	1100	36576	67672	3479	7132	32761	73263	2415	7172
1997	3636	6627	379	1227	5071	9242	528	1712	16648	30339	1735	5619	4556	8303	475	1538	31402	46494	4240	8521	25241	45998	2630	8519
1998	4694	6597	468	1673	7821	10992	780	2788	8467	11900	844	3018	2360	3318	235	841	21816	27955	3194	7080	23995	33724	2392	8552
1999	4015	5844	369	1205	5113	7443	470	1535	9643	14036	887	2894	1139	1658	105	342	32407	40858	3878	7739	26960	39241	2480	8091
2000	7850	10582	596	1515	7639	10297	580	1475	17260	23266	1310	3332	2634	3551	200	509	54330	67784	5519	10048	36819	49632	2795	7107
2001	2043	2674	158	366	2924	3826	226	523	9396	12296	725	1682	2201	2880	170	394	37393	45761	3749	6510	20775	27188	1604	3719
2002	1917	2873	125	366	3713	5565	242	709	9011	13505	587	1722	2321	3478	151	443	34070	46011	3452	6469	26558	39801	1729	5075
2003	2229	2699	113	359	3771	4565	190	608	14208	17201	718	2291	5917	7163	299	954	50367	57997	4421	8434	40802	49395	2061	6579
2004	1926	3001	95	406	3697	5760	183	780	13762	21443	681	2903	3131	4879	155	661	49924	66549	4308	9118	30057	46833	1488	6341
2005	1948	5734	148	813	2779	8180	211	1159	6260	18425	475	2611	2686	7905	204	1120	40658	88340	4595	12966	17340	51040	1316	7232
2006	4355	6960	506	1311	5344	8542	622	1609	11033	17634	1283	3322	3460	5530	402	1042	53311	74546	8499	15058	28081	44883	3266	8456
2007	2377	4817	270	873	3497	7086	397	1285	5650	11449	641	2076	2808	5689	318	1031	33808	59140	4691	10959	19966	40454	2264	7334
2008	3944	6606	301	963	4786	8016	366	1169	11136	18654	851	2721	2610	4373	200	638	51933	75122	3901	9668	25802	43220	1972	6304
2009	3445	6443	203	1316	5137	9608	303	1963	7536	14097	445	2880	1746	3266	103	667	36368	55458	3722	10806	21146	39555	1249	8081
2010	6597	8227	504	1440	8168	10187	625	1783	8024	10008	614	1751	2999	3740	229	654	57930	67116	5798	11067	31675	39504	2422	6913
2011	5271	8983	438	2105	9015	15364	750	3600	6897	11755	574	2754	2489	4243	207	994	40348	68766	3356	16112	24110	41092	2005	9628
2012	6717	9539	474	1259	8422	11960	594	1579	6727	9554	475	1261	2624	3726	185	492	50082	71123	3533	9390	35229	50030	2485	6605
2013	4760	7015	266	2083	8060	11876	450	3527	7372	10863	412	3226	2043	3011	114	894	33752	49737	3478	13815	13924	20518	778	6094
2014	5147	7749	403	1034	5934	8933	465	1193	4408	6637	345	886	1754	2640	137	352	22066	33219	2786	5928	17772	26754	1392	3572
2015	4795	8089	395	1183	4883	8235	402	1205	6057	10217	499	1495	2167	3655	178	535	50174	84630	5627	14188	32463	54756	2674	8011

Appendix 4.vii. Input data for spawners of small salmon and large salmon for Salmon Fishing Areas 3 to 8 in Newfoundland used in the run-reconstruction.

	Salmon Fishing Area 3				Salmon Fishing Area 4				Salmon Fishing Area 5				Salmon Fishing Area 6				Salmon Fishing Area 7				Salmon Fishing Area 8			
	Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon	
	Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
	SFA3SSm_L[]	SFA3SSm_H[]	SFA3SLg_	SFA3SLg	SFA4SSm	SFA4SSm	SFA4SLg_	SFA4SLg	SFA5SSm	SFA5SSm	SFA5SLg_	SFA5SLg	SFA6SSm	SFA6SSm	SFA6SLg_	SFA6SLg	SFA7SSm	SFA7SSm	SFA7SLg_	SFA7SLg	SFA8SSm	SFA8SSm	SFA8SLg_	SFA8SLg_
1970	1829	4443	154	736	11314	27478	910	4512	5194	12614	404	2058	196	476	14	76	47	113	3	18	43	105	0	13
1971	1731	4205	135	687	8827	21437	688	3499	3920	9520	293	1541	128	312	10	51	93	227	8	38	58	142	0	15
1972	1162	2822	98	468	8036	19516	655	3214	4422	10738	354	1762	278	674	23	112	142	346	12	57	65	159	6	26
1973	2772	6732	232	1115	15657	38023	1275	6259	4928	11968	405	1974	583	1417	49	235	306	742	26	123	219	533	15	84
1974	1958	4754	318	641	12537	30447	1983	4049	3820	9276	608	1237	707	1717	115	232	310	754	49	100	119	289	20	39
1975	2583	6273	520	1041	13867	33677	2628	5421	4639	11265	912	1846	219	533	43	87	93	227	19	38	203	493	41	82
1976	2210	5366	379	759	15594	37870	2495	5177	4429	10755	697	1459	576	1400	97	196	70	170	12	24	187	453	32	64
1977	3570	8670	478	960	19591	47577	1559	4204	10771	26157	1410	2864	936	2272	107	234	182	442	24	48	189	459	26	51
1978	1769	4295	149	298	20473	49719	1229	2959	6669	16195	536	1100	691	1677	51	110	231	561	19	38	103	249	9	17
1979	4760	11560	390	779	18727	45481	1206	2740	3106	7542	234	489	569	1383	45	91	292	708	24	48	233	567	19	38
1980	4067	9877	224	485	21966	53346	903	2312	6305	15311	376	780	747	1813	34	82	238	578	14	30	280	680	18	36
1981	5502	13362	1042	2087	31584	76704	5637	11635	8139	19765	1511	3056	1412	3428	239	507	287	697	53	107	180	436	34	68
1982	6146	14926	124	336	23270	56514	544	1346	5677	13787	143	338	672	1632	6	29	362	878	2	15	198	482	0	5
1983	3773	9163	245	493	20893	50739	1073	2443	5500	13356	191	551	691	1677	35	81	324	788	0	9	96	232	1	8
1984	2531	6525	55	540	25033	64536	533	5322	6835	17620	149	1456	789	2034	12	163	243	626	1	48	200	515	4	43
1985	3462	8569	72	683	32218	79741	671	6352	9208	22791	192	1816	1134	2806	24	224	296	733	6	58	272	674	6	54
1986	2054	5126	70	413	24722	61700	840	4977	10782	26910	366	2170	1184	2955	40	238	271	677	9	55	367	916	12	74
1987	1655	3895	57	318	16032	37722	556	3078	4892	11511	170	939	403	948	14	77	82	194	3	16	126	297	4	24
1988	4868	11888	159	956	27317	66712	892	5367	11549	28204	377	2269	1189	2904	39	234	355	867	12	70	219	535	7	43
1989	2266	5376	90	461	11623	27581	461	2365	4350	10323	172	885	755	1792	30	154	203	481	8	41	304	721	12	62
1990	5032	10098	236	920	16583	33273	776	3033	7071	14188	331	1293	978	1963	46	179	144	288	7	26	252	505	12	46
1991	4334	7965	193	750	16113	29607	718	2788	6745	12395	301	1167	613	1126	27	106	119	218	5	21	36	67	2	6
1992	9844	21262	415	4094	33228	71898	1407	13866	12175	26363	516	5088	1450	3132	61	603	252	545	11	105	0	0	0	0
1993	10054	20961	400	1599	39162	81344	1590	6226	14370	29779	576	2270	2243	4623	90	351	404	831	16	63	369	760	15	58
1994	9146	24802	749	3247	20576	55760	1644	7259	6855	18510	560	2420	381	1026	30	133	46	122	4	16	79	212	6	27
1995	7409	21791	580	2636	22872	67179	1801	8135	8122	23776	642	2880	287	831	23	100	173	501	14	60	135	397	11	48
1996	15729	39860	1412	4247	42346	107268	3757	11383	14095	35586	1263	3787	522	1317	46	139	124	311	11	33	180	457	16	48
1997	9422	19095	1209	3954	19309	39107	2467	8083	5228	10547	668	2177	190	384	24	79	49	99	6	20	48	98	6	20
1998	16390	24345	1933	6969	43559	64785	5160	18599	9943	14753	1155	4201	455	673	53	191	212	313	25	88	135	201	16	57
1999	11804	18173	1279	4189	52390	80698	5650	18583	8832	13603	947	3126	343	528	37	121	58	90	6	21	119	188	14	45
2000	17003	23723	1449	3711	32879	45946	2803	7201	10897	15217	923	2377	993	1386	84	217	140	195	12	31	88	125	8	20
2001	9861	13489	892	2089	33365	45682	3023	7086	8344	11433	767	1786	250	342	23	53	42	59	4	9	17	23	2	4
2002	8620	13856	671	1994	28099	45208	2175	6498	3194	5124	250	737	199	319	15	45	0	0	0	0	55	91	5	14
2003	19386	23938	1085	3478	67026	82739	3738	12001	5926	7312	331	1060	412	508	23	74	94	116	5	17	47	58	3	8
2004	6942	11402	390	1680	43104	70785	2430	10438	7307	11987	412	1766	158	259	9	38	0	0	0	0	35	58	2	9
2005	5056	17534	473	2664	28896	100323	2695	15235	4200	14518	394	2205	92	314	8	47	0	0	0	0	18	69	2	11
2006	9402	15839	1228	3216	37156	62732	4925	12825	7495	12623	969	2554	61	102	8	20	0	0	0	0	141	244	20	52
2007	9147	19842	1171	3818	32243	70143	4122	13501	7641	16603	978	3196	68	148	8	28	112	245	12	45	15	33	2	6
2008	11799	21183	1045	3379	53591	96443	4745	15402	9669	17405	867	2791	274	497	22	78	69	125	4	18	159	292	15	48
2009	11205	22795	779	5080	49881	101728	3491	22732	8828	18065	622	4049	412	834	28	185	0	0	0	0	111	228	7	51
2010	18364	23569	1595	4581	69075	88772	6006	17304	20114	25822	1754	5028	874	1120	76	217	183	235	16	46	93	120	8	24
2011	13193	24264	1291	6261	50806	93428	4789	23920	12075	22230	1176	5734	716	1314	70	339	83	153	8	39	220	412	22	108
2012	21149	31048	1639	4394	64959	95436	5046	13528	14554	21377	1140	3039	738	1086	57	154	100	147	8	21	361	533	25	73
2013	7822	12219	495	4039	44838	70136	2889	23284	15027	23531	976	7833	721	1128	44	373	241	379	16	127	102	162	7	55
2014	11442	18452	1074	2775	54396	87757	5068	13164	14519	23389	1345	3497	693	1115	62	165	255	416	24	63	83	134	8	21
2015	18245	32560	1690	5117	73398	130811	6786	20531	15040	26820	1392	4213	1019	1814	94	284	238	429	23	68	301	546	29	88

Appendix 4.vii. (Continued). Input data for spawners of small salmon and large salmon for Salmon Fishing Areas 9 to 14A in Newfoundland used in the run-reconstruction.

	Salmon Fishing Area 9				Salmon Fishing Area 10				Salmon Fishing Area 11				Salmon Fishing Area 12				Salmon Fishing Area 13				Salmon Fishing Area 14A			
	Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon		Small salmon		Large salmon	
	Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners		Spawners	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
H[]	SFA9SSm	SFA9SSm	SFA9SLg_	SFA9SLg_	SFA10SSı	SFA10SSı	SFA10SLç	SFA10SLç	SFA11SSı	SFA11SSı	SFA11SLç	SFA11SLç	SFA12SSı	SFA12SSı	SFA12SLç	SFA12SLç	SFA13SSı	SFA13SSı	SFA13SLç	SFA13SLç	SFA14ASSm	SFA14ASSm_l	SFA14ASLg_	SFA14ASLg_H
1970	4417	10727	361	1768	1402	3406	112	558	11732	28492	918	4653	1748	4244	69	625	16203	28543	1608	3417	10372	25188	134	2340
1971	3780	9180	301	1504	2165	5259	166	855	9473	23007	736	3752	1059	2573	74	411	16489	30629	1633	3705	8766	21290	0	1850
1972	2658	6454	217	1063	1323	3213	108	529	11445	27795	882	4525	2165	5259	163	852	15125	29188	2004	4066	5640	13696	83	1283
1973	5040	12240	406	2011	4165	10115	310	1636	11331	27517	923	4530	1507	3661	102	582	17019	29959	1911	3808	12325	29931	91	2713
1974	3486	8466	565	1140	2828	6868	452	918	10444	25364	1682	3403	1535	3729	240	493	12085	21635	1997	3341	7280	17680	789	1692
1975	4368	10608	874	1754	996	2420	192	392	10502	25506	2076	4192	1190	2890	220	459	21668	42421	3611	6538	11242	27302	417	925
1976	3787	9197	639	1291	1703	4137	283	576	9716	23596	1629	3301	693	1683	114	233	18999	36519	2752	4862	17222	41826	1337	2774
1977	2520	6120	331	671	2560	6216	341	686	9557	23211	1272	2563	1302	3162	128	304	10898	18528	1828	2549	13316	32340	194	859
1978	3040	7384	240	497	3722	9038	273	587	9324	22644	770	1558	854	2074	52	124	12518	22392	3861	4434	7562	18366	194	460
1979	3976	9656	311	636	1981	4811	154	316	8003	19437	648	1304	1710	4154	130	270	14363	25820	1070	1749	15349	37275	174	408
1980	5551	13481	295	651	3556	8636	201	429	11828	28724	715	1474	1913	4647	94	217	18625	30958	4243	4920	8734	21210	514	1208
1981	4345	10551	773	1598	3073	7463	555	1138	16478	40018	3088	6217	2473	6007	453	922	22059	36689	4485	6789	13725	33331	953	2043
1982	4258	10342	114	260	2931	7117	91	192	17122	41582	537	1127	3628	8812	110	235	22062	37132	2847	3236	11114	26990	2987	6082
1983	5374	13050	281	634	2660	6460	95	270	11128	27024	703	1433	1556	3780	94	196	14491	25364	3855	4490	8867	21533	1635	3338
1984	5725	14759	120	1216	3684	9498	79	783	17748	45755	374	3769	4860	12529	38	968	18413	30081	1987	3401	12155	31336	179	2504
1985	4625	11448	96	912	3505	8674	73	691	15390	38091	320	3034	2899	7176	57	569	10726	20203	1349	2482	9583	23719	197	1887
1986	6113	15257	208	1231	4084	10192	139	822	14754	36822	501	2970	2495	6228	81	499	15535	29570	2013	3583	13381	33396	445	2683
1987	2549	5998	88	489	1261	2968	44	242	11258	26488	391	2162	2443	5749	82	466	13611	26307	1512	2988	13583	31960	467	2604
1988	3806	9295	124	748	3166	7731	103	622	13952	34073	456	2741	3917	9566	126	767	17945	35263	1909	3877	17329	42319	549	3388
1989	4037	9580	160	821	2757	6542	109	561	9087	21564	360	1849	1719	4080	67	349	6980	12982	836	1552	9833	23334	385	1996
1990	5466	10968	256	1000	2446	4908	115	447	13024	26132	610	2382	2507	5031	114	456	14866	24531	1744	3051	14793	29682	679	2692
1991	1844	3389	82	319	758	1392	34	131	6103	11215	272	1056	2121	3898	93	365	11037	15757	1689	2413	11742	21576	512	2020
1992	4334	9378	183	1809	1496	3287	65	642	14239	30854	605	5958	3985	8657	162	1667	20506	38635	2992	8833	30096	65023	1234	12488
1993	9956	20502	400	1559	4809	9967	194	761	21423	44150	861	3359	5176	10666	207	810	22341	41708	2544	4673	27010	55787	1058	4221
1994	2124	5723	172	746	1804	4848	144	630	5295	14449	430	1891	1949	5253	154	681	15381	30444	3207	5611	9385	25327	742	3286
1995	3887	11386	304	1376	3218	9378	253	1133	7770	22930	625	2792	1689	4922	130	592	20570	43329	1607	4860	15218	44587	1187	5385
1996	4868	12304	431	1304	6687	16880	592	1789	15226	38638	1362	4113	4082	10295	358	1088	29056	60152	3199	6852	26584	67085	2357	7115
1997	2927	5918	372	1221	4086	8257	519	1702	13304	26995	1718	5602	3655	7401	464	1527	25508	40599	3985	8266	20359	41117	2578	8467
1998	3937	5840	458	1663	6606	9777	771	2779	7024	10457	836	3009	1968	2925	225	831	18279	24417	3031	6918	19992	29721	2347	8507
1999	3401	5230	359	1195	4313	6642	455	1520	8086	12478	881	2889	958	1477	102	339	28647	37098	3760	7621	22659	34941	2402	8013
2000	6913	9645	581	1501	6664	9322	534	1429	14895	20901	1288	3310	2291	3208	195	504	48055	61508	5250	9779	32314	45127	2731	7044
2001	1709	2339	151	359	2436	3338	215	513	7804	10704	714	1671	1818	2497	162	386	31037	39405	3536	6297	17331	23744	1559	3674
2002	1562	2518	118	360	3049	4901	231	699	7347	11840	581	1716	1896	3053	147	439	28083	40025	3313	6330	21764	35007	1668	5013
2003	1985	2454	109	355	3368	4162	185	603	12701	15693	703	2276	5282	6528	288	943	45027	52657	4206	8218	36597	45189	1988	6506
2004	1674	2749	91	402	3210	5273	177	774	11863	19544	660	2882	2704	4452	149	655	43889	60513	4074	8883	26116	42892	1429	6282
2005	1478	5264	130	794	2171	7572	194	1142	4827	16992	456	2591	2062	7282	191	1107	33349	81031	4320	12691	13676	47376	1246	7163
2006	3791	6397	498	1302	4627	7824	602	1590	9554	16155	1271	3310	2986	5056	392	1032	46296	67532	8247	14807	24532	41334	3210	8400
2007	2063	4502	263	867	3047	6636	387	1275	4907	10706	636	2071	2442	5323	314	1027	29402	54734	4511	10780	17446	37934	2222	7293
2008	3285	5948	293	955	3971	7202	351	1154	9314	16832	841	2711	2178	3940	193	631	43277	66465	3580	9346	21887	39305	1915	6246
2009	2835	5834	198	1311	4193	8665	298	1957	6203	12763	442	2877	1450	2970	100	664	31106	50196	3526	10610	17820	36229	1200	8032
2010	5703	7334	496	1432	7062	9081	616	1774	6859	8842	604	1742	2606	3347	226	651	49703	58889	5478	10747	27468	35298	2358	6848
2011	4364	8077	433	2099	7477	13826	716	3566	5696	10554	564	2744	2074	3827	203	990	33849	62267	3160	15915	20249	37231	1953	9575
2012	5898	8720	471	1256	7488	11027	581	1566	5993	8819	468	1255	2348	3450	184	490	44778	65820	3395	9251	31467	46268	2451	6571
2013	3973	6228	254	2071	6681	10498	424	3502	6130	9621	398	3213	1701	2668	104	885	28314	44299	3301	13638	11746	18341	734	6050
2014	4174	6776	400	1031	4862	7861	431	1158	3602	5830	340	881	1445	2331	134	349	18039	29192	2707	5849	14639	23622	1361	3541
2015	4169	7462	385	1173	4265	7618	389	1192	5250	9410	489	1485	1891	3379	167	524	43908	78364	5419	13980	28414	50707	2619	7956

Appendix 4.viii. Input data for 2SW salmon returns and spawners for Salmon Fishing Areas 3 to 8 in Newfoundland used in the run-reconstruction.

	Salmon Fishing Area 3				Salmon Fishing Area 4				Salmon Fishing Area 5			
	2SW		2SW		2SW		2SW		2SW		2SW	
	Returns		Spawners		Returns		Spawners		Returns		Spawners	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Bugs labels	SFA3R2_L[]	SFA3R2_H[]	SFA3S2_L[]	SFA3S2_H[]	SFA4R2_L[]	SFA4R2_H[]	SFA4S2_L[]	SFA4S2_H[]	SFA5R2_L[]	SFA5R2_H[]	SFA5S2_L[]	SFA5S2_H[]
1970	15	147	15	147	96	912	91	902	44	419	40	412
1971	15	140	14	137	75	711	69	700	33	316	29	308
1972	10	94	10	94	68	648	66	643	37	356	35	352
1973	23	223	23	223	132	1262	127	1252	42	397	40	395
1974	32	129	32	128	207	826	198	810	63	252	61	247
1975	52	208	52	208	279	1117	263	1084	93	374	91	369
1976	38	152	38	152	268	1073	249	1035	76	305	70	292
1977	48	193	48	192	264	1058	156	841	145	582	141	573
1978	15	60	15	60	173	692	123	592	56	226	54	220
1979	39	156	39	156	153	613	121	548	25	102	23	98
1980	26	104	22	97	141	564	90	462	40	162	38	156
1981	104	418	104	417	600	2399	564	2327	155	618	151	611
1982	21	85	12	67	80	321	54	269	20	78	14	68
1983	25	99	25	99	137	548	107	489	36	144	19	110
1984	6	108	6	108	55	1067	53	1064	15	291	15	291
1985	7	137	7	137	67	1270	67	1270	19	363	19	363
1986	7	83	7	83	84	995	84	995	37	434	37	434
1987	6	64	6	64	56	616	56	616	17	188	17	188
1988	16	191	16	191	89	1073	89	1073	38	454	38	454
1989	9	92	9	92	46	473	46	473	17	177	17	177
1990	24	184	24	184	78	607	78	607	33	259	33	259
1991	19	150	19	150	72	558	72	558	30	233	30	233
1992	42	819	42	819	141	2773	141	2773	52	1018	52	1018
1993	42	323	40	320	161	1248	159	1245	59	456	58	454
1994	46	457	45	455	104	1028	99	1016	34	341	34	339
1995	37	373	35	369	113	1150	108	1139	40	406	39	403
1996	86	598	85	595	232	1610	225	1594	77	533	76	530
1997	74	556	73	554	151	1138	148	1132	40	306	40	305
1998	117	979	116	976	313	2612	310	2604	71	592	69	588
1999	77	587	77	586	343	2611	339	2602	58	440	57	438
2000	88	522	87	520	171	1015	168	1008	57	335	55	333
2001	39	196	38	194	132	664	130	659	33	167	33	166
2002	29	187	29	185	96	610	94	604	11	69	11	69
2003	47	324	47	323	162	1119	161	1116	14	99	14	99
2004	17	157	17	156	106	973	104	971	18	165	18	164
2005	21	249	20	248	120	1426	116	1417	17	206	17	205
2006	54	301	53	299	214	1197	212	1193	43	240	42	237
2007	51	356	50	355	180	1262	177	1256	43	298	42	297
2008	46	316	45	314	209	1442	204	1432	38	260	37	260
2009	34	473	33	472	151	2117	150	2114	27	377	27	377
2010	69	427	69	426	262	1618	258	1609	76	469	75	468
2011	56	584	56	582	216	2247	206	2225	52	535	51	533
2012	71	411	70	409	220	1265	217	1258	49	283	49	283
2013	22	378	21	376	128	2174	124	2165	43	731	42	728
2014	47	259	46	258	222	1234	218	1224	59	328	58	325
2015	74	478	73	476	296	1919	292	1909	61	394	60	392

	Salmon Fishing Area 6				Salmon Fishing Area 7				Salmon Fishing Area 8			
	2SW		2SW		2SW		2SW		2SW		2SW	
	Returns		Spawners		Returns		Spawners		Returns		Spawners	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Bugs labels	SFA6R2_L	SFA6R2_H[]	SFA6S2_L	SFA6S2_H[]	SFA7R2_L	SFA7R2_H	SFA7S2_L	SFA7S2_H	SFA8R2_L	SFA8R2_H	SFA8S2_L	SFA8S2_H
1970	2	16	1	15	0	4	0	4	0	3	0	3
1971	1	10	1	10	1	8	1	8	0	5	0	3
1972	2	22	2	22	1	11	1	11	1	5	1	5
1973	5	47	5	47	3	25	3	25	2	18	1	17
1974	12	47	12	46	5	20	5	20	2	8	2	8
1975	4	18	4	17	2	8	2	8	4	16	4	16
1976	10	40	10	39	1	5	1	5	3	13	3	13
1977	13	51	11	47	2	10	2	10	3	10	3	10
1978	6	23	5	22	2	8	2	8	1	3	1	3
1979	5	19	4	18	2	10	2	10	2	8	2	8
1980	5	19	3	16	2	6	1	6	2	7	2	7
1981	27	107	24	101	5	22	5	21	3	14	3	14
1982	2	9	1	6	1	5	0	3	1	3	0	1
1983	5	18	4	16	2	9	0	2	1	3	0	2
1984	2	34	1	33	1	10	0	10	0	9	0	9
1985	2	45	2	45	1	12	1	12	1	11	1	11
1986	4	48	4	48	1	11	1	11	1	15	1	15
1987	1	15	1	15	0	3	0	3	0	5	0	5
1988	4	47	4	47	1	14	1	14	1	9	1	9
1989	3	31	3	31	1	8	1	8	1	12	1	12
1990	5	36	5	36	1	5	1	5	1	9	1	9
1991	3	21	3	21	1	4	1	4	0	1	0	1
1992	6	121	6	121	1	21	1	21	0	0	0	0
1993	9	70	9	70	2	13	2	13	1	12	1	12
1994	2	19	2	19	0	2	0	2	0	4	0	4
1995	1	14	1	14	1	9	1	8	1	7	1	7
1996	3	20	3	19	1	5	1	5	1	7	1	7
1997	1	11	1	11	0	3	0	3	0	3	0	3
1998	3	27	3	27	1	12	1	12	1	8	1	8
1999	2	17	2	17	0	3	0	3	1	6	1	6
2000	5	30	5	30	1	4	1	4	0	3	0	3
2001	1	5	1	5	0	1	0	1	0	0	0	0
2002	1	4	1	4	0	0	0	0	0	1	0	1
2003	1	7	1	7	0	2	0	2	0	1	0	1
2004	0	4	0	4	0	0	0	0	0	1	0	1
2005	0	4	0	4	0	0	0	0	0	1	0	1
2006	0	2	0	2	0	0	0	0	1	5	1	5
2007	0	3	0	3	1	4	1	4	0	1	0	1
2008	1	7	1	7	0	2	0	2	1	4	1	4
2009	1	17	1	17	0	0	0	0	0	5	0	5
2010	3	20	3	20	1	4	1	4	0	2	0	2
2011	3	32	3	31	0	4	0	4	1	10	1	10
2012	3	14	2	14	0	2	0	2	1	7	1	7
2013	2	35	2	35	1	12	1	12	0	5	0	5
2014	3	16	3	15	1	6	1	6	0	2	0	2
2015	4	27	4	26	1	6	1	6	1	8	1	8

Appendix 4.viii. (Continued). Input data for 2SW salmon returns and spawners for Salmon Fishing Areas 9 to 14A in Newfoundland used in the run-reconstruction.

	Salmon Fishing Area 9				Salmon Fishing Area 10				Salmon Fishing Area 11				Salmon Fishing Area 12				Salmon Fishing Area 13				Salmon Fishing Area 14A			
	2SW		2SW		2SW		2SW		2SW		2SW		2SW		2SW		2SW		2SW		2SW		2SW	
	Returns		Spawners		Returns		Spawners		Returns		Spawners		Returns		Spawners		Returns		Spawners		Returns		Spawners	
Year	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Bugs labels	SFA9R2_L[]	SFA9R2_H[]	SFA9S2_L[]	SFA9S2_H[]	SFA10R2_L	SFA10R2_H[	SFA10S2_L	SFA10S2_H[	SFA11R2_L	SFA11R2_H[	SFA11S2_L	SFA11S2_H[	SFA12R2_	SFA12R2_H	SFA12S2_	SFA12S2_H	SFA13R2_L[]	SFA13R2_H[]	SFA13S2_L[]	SFA13S2_H[]	SFA14AR2_L	SFA14AR2_H[	SFA14AS2_L	SFA14AS2_H[
1970	37	356	36	354	12	113	11	112	99	945	92	931	15	141	7	125	1300	3036	643	2050	36	514	13	468
1971	32	305	30	301	18	174	17	171	80	763	74	750	9	85	7	82	1071	2850	653	2223	31	435	0	370
1972	22	214	22	213	11	107	11	106	97	922	88	905	18	174	16	170	1243	3101	802	2439	20	280	8	257
1973	43	406	41	402	35	336	31	327	96	913	92	906	13	121	10	116	1321	3120	764	2285	43	611	9	543
1974	57	230	57	228	47	186	45	184	172	688	168	681	25	101	24	99	1165	2554	799	2005	90	361	79	338
1975	88	352	87	351	20	80	19	78	212	846	208	838	24	96	22	92	1799	4454	1445	3923	51	203	42	185
1976	65	261	64	258	29	117	28	115	167	669	163	660	12	48	11	47	1351	3293	1101	2917	144	575	134	555
1977	34	136	33	134	35	138	34	137	129	516	127	513	18	70	13	61	1151	2159	731	1530	67	266	19	172
1978	26	103	24	99	31	126	27	117	79	315	77	312	7	29	5	25	1886	3173	1544	2660	27	106	19	92
1979	33	130	31	127	16	65	15	63	66	262	65	261	14	56	13	54	473	1117	428	1049	23	93	17	82
1980	36	142	30	130	23	91	20	86	76	304	71	295	12	49	9	43	2094	3548	1697	2952	69	278	51	242
1981	83	330	77	320	58	233	55	228	313	1252	309	1243	47	188	45	184	2059	4471	1794	4073	109	436	95	409
1982	15	59	11	52	10	40	9	38	59	236	54	225	13	50	11	47	1377	2298	1139	1941	309	1238	299	1216
1983	35	141	28	127	17	70	10	54	73	292	70	287	10	41	9	39	1786	3060	1542	2694	170	681	163	668
1984	13	244	12	243	8	157	8	157	39	757	37	754	11	207	4	194	918	2226	795	2041	27	518	18	501
1985	10	182	10	182	7	138	7	138	32	607	32	607	6	114	6	114	550	1505	540	1489	20	378	20	377
1986	21	246	21	246	14	164	14	164	50	594	50	594	8	100	8	100	832	2190	805	2150	45	539	44	537
1987	9	98	9	98	4	48	4	48	39	432	39	432	8	94	8	93	618	1813	605	1793	47	522	47	521
1988	12	150	12	150	10	124	10	124	46	548	46	548	13	154	13	153	780	2350	764	2326	57	681	55	678
1989	16	164	16	164	11	112	11	112	36	370	36	370	7	70	7	70	339	939	334	931	39	400	39	399
1990	26	200	26	200	11	89	11	89	61	476	61	476	12	92	11	91	711	1851	698	1830	69	541	68	538
1991	8	64	8	64	3	26	3	26	27	211	27	211	9	73	9	73	684	1460	676	1448	52	406	51	404
1992	18	362	18	362	7	128	6	128	60	1192	60	1192	17	335	16	333	1235	5357	1197	5300	127	2505	123	2498
1993	40	312	40	312	20	153	19	152	86	673	86	672	21	162	21	162	1047	2848	1018	2804	110	852	106	844
1994	11	105	10	104	9	89	9	88	27	267	26	265	10	97	9	95	1390	3528	1283	3366	47	466	44	460
1995	19	195	18	193	16	160	15	159	39	393	38	391	8	84	8	83	737	3058	643	2916	75	762	71	754
1996	27	184	26	183	36	253	35	250	84	580	82	576	22	154	22	152	1391	4279	1280	4111	145	1004	141	996
1997	23	172	22	171	32	240	31	238	104	787	103	784	28	215	28	214	1696	5113	1594	4960	158	1193	155	1185
1998	28	234	27	233	47	390	46	389	51	422	50	421	14	118	13	116	1278	4248	1212	4151	144	1197	141	1191
1999	22	169	22	167	28	215	27	213	53	405	53	404	6	48	6	48	1551	4643	1504	4573	149	1133	144	1122
2000	36	212	35	210	35	206	32	200	79	466	77	463	12	71	12	71	2208	6029	2100	5867	168	995	164	986
2001	7	34	7	33	10	49	9	48	31	156	31	155	7	37	7	36	697	2324	658	2248	69	346	67	342
2002	5	34	5	33	10	66	10	65	25	160	25	160	6	41	6	41	642	2309	616	2260	74	472	72	466
2003	5	33	5	33	8	57	8	56	31	213	30	212	13	89	12	88	822	3011	782	2934	89	612	85	605
2004	4	38	4	37	8	73	8	72	29	270	28	268	7	61	6	61	801	3255	758	3171	64	590	61	584
2005	6	76	6	74	9	108	8	106	20	243	20	241	9	104	8	103	855	4629	804	4531	57	673	54	666
2006	22	122	21	121	27	150	26	148	55	309	55	308	17	97	17	96	1581	5376	1534	5286	140	786	138	781
2007	12	81	11	81	17	119	17	119	28	193	27	193	14	96	13	95	872	3912	839	3849	97	682	96	678
2008	13	90	13	89	16	109	15	107	37	253	36	252	9	59	8	59	726	3451	666	3337	85	586	82	581
2009	9	122	9	122	13	183	13	182	19	268	19	268	4	62	4	62	692	3858	656	3788	54	752	52	747
2010	22	134	21	133	27	166	26	165	26	163	26	162	10	61	10	61	1078	3951	1019	3837	104	643	101	637
2011	19	196	19	195	32	335	31	332	25	256	24	255	9	92	9	92	144	1498	136	1480	86	895	84	890
2012	20	117	20	117	26	147	25	146	20	117	20	117	8	46	8	46	152	873	146	860	107	614	105	611
2013	11	194	11	193	19	328	18	326	18	300	17	299	5	83	4	82	854	3687	814	3621	33	567	32	563
2014	17	96	17	96	20	111	19	108	15	82	15	82	6	33	6	32	763	2482	741	2448	60	332	59	329
2015	17	110	17	109	17	112	17	111	21	139	21	138	8	50	7	49	1219	4526	1169	4446	115	745	113	740

Appendix 4.ix. Input data for small salmon returns to Québec by category of data used in the run-reconstruction.

	Small returns								Small returns									
	Minimum								Maximum									
Year	C1	C2	C3	C4	C5	C6	FN Harvest	Other rivers	C1	C2	C3	C4	C5	C6	FN Harvest	Other rivers	FN	Commercial
Bugs labels	QCSmC1_L[]	QCSmC2_L[]	QCSmC3_L[]	QCSmC4_L[]	QCSmC5_L[]	QCSmC6_L[]	QCSmFn_L[]	QCSmO_L[]	QCSmC1_H[]	QCSmC2_H[]	QCSmC3_H[]	QCSmC4_H[]	QCSmC5_H[]	QCSmC6_H[]	QCSmFn_H[]	QCSmO_H[]	QCFnSm[]	QCCmSm[]
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	3830	5434	2955	460	1670	5160	267	31	4085	5639	6053	792	2784	8599	445	52	357	794
1985	5266	2271	1767	210	5449	4384	267	40	5869	2336	3586	352	9224	7307	445	67	273	2093
1986	8648	5193	2396	63	6719	5133	267	77	9471	5321	4895	107	11198	8555	445	129	372	3707
1987	10043	4775	3852	327	8396	5501	267	71	10869	4910	7875	546	13993	9168	445	118	366	2992
1988	11190	5968	4404	468	8440	6423	267	85	12244	6133	8962	780	14067	10705	445	142	397	4760
1989	10121	4743	2924	301	6744	5622	267	68	10910	4878	5940	503	11240	9369	445	113	196	2615
1990	12245	7332	4377	694	7096	2976	377	77	13278	7511	8917	1158	11826	4960	628	129	108	3425
1991	9554	5851	3776	349	5009	2001	256	57	10249	5987	7679	584	8348	3336	426	95	265	3282
1992	9188	6928	4567	428	5131	3462	243	70	9847	7144	9297	715	8552	5770	405	117	120	3849
1993	8143	6325	3973	1029	4315	1447	525	55	8883	6517	8075	1717	7192	2412	875	92	7	3627
1994	8707	5928	3840	1051	4011	437	408	30	9442	6129	7828	1753	6686	729	681	50	161	3861
1995	6943	3439	2697	1017	3853	434	184	30	7538	3527	5471	1696	6422	723	306	50	353	3915
1996	15010	1809	3600	477	4666	500	120	5	16122	1923	7370	797	7816	833	200	8	72	4532
1997	11491	201	3457	292	3529	462	58	563	12089	242	7049	487	5882	770	97	938	35	3531
1998	11285	1183	3578	328	5121	1127	58	0	11849	1406	7347	555	8536	1878	97	0	35	1068
1999	10877	708	3194	1868	5401	1429	0	0	11556	741	6536	3098	9002	2382	0	0	710	814
2000	11886	429	1116	602	7399	633	0	0	12635	458	2284	1004	14050	1055	0	0	821	0
2001	8050	185	2632	266	3225	728	0	0	8588	228	5392	443	5374	1213	0	0	770	0
2002	14599	31	3189	689	4333	1448	0	0	15494	36	6530	1149	7222	2414	0	0	1672	0
2003	11362	0	3203	721	3566	1512	0	0	11903	0	6538	1201	5944	2520	0	0	972	0
2004	13747	107	6526	284	4889	1639	0	0	14177	127	13104	474	8149	2731	0	0	1158	0
2005	8771	0	3689	794	3353	1508	0	0	9188	0	7485	1323	5588	2513	0	0	909	0
2006	12762	0	3736	1800	2944	1455	0	0	13369	0	7584	2999	4907	2426	0	0	1117	0
2007	8515	0	3758	1710	1830	1024	0	0	8964	0	7631	2850	3051	1707	0	0	869	0
2008	16445	0	5542	2266	3144	1401	0	0	17350	0	11261	3776	5240	2336	0	0	1171	0
2009	8872	0	3601	903	1907	1056	0	0	9315	0	7306	1505	3178	1759	0	0	1141	0
2010	12889	0	4801	993	1675	1081	0	0	13538	0	9746	1655	2792	1802	0	0	1057	0
2011	17993	0	5120	1365	4441	1694	0	0	18899	0	10386	2276	7402	2824	0	0	1205	0
2012	9566	0	3615	584	3550	1228	0	0	10038	0	7332	973	5916	2047	0	0	1239	0
2013	7219	88	3185	411	2466	1401	0	0	7574	104	6461	685	4111	2335	0	0	1177	0
2014	9193	0	3945	676	2412	2341	0	0	9647	0	8003	1127	4020	3901	0	0	1240	0
2015	15694	0	5843	1396	4254	1359	0	0	16764	0	11853	2295	7089	2266	0	0	1246	0

Appendix 4.ix. (Continued). Input data for large salmon returns to Québec by category of data used in the run-reconstruction.

	Large returns								Large returns									
	Minimum								Maximum									
Year	C1	C2	C3	C4	C5	C6	FN Harvest	Other rivers	C1	C2	C3	C4	C5	C6	FN Harvest	Other rivers	FN	Commercial
Bugs labels	QCLgC1_L[]	QCLgC2_L[]	QCLgC3_L[]	QCLgC4_L[]	QCLgC5_L[]	QCLgC6_L[]	QCLgFn_L[]	QCLgO_L[]	QCLgC1_H[]	QCLgC2_H[]	QCLgC3_H[]	QCLgC4_H[]	QCLgC5_H[]	QCLgC6_H[]	QCLgFn_H[]	QCLgO_H[]	QCFnLg[]	QCCmLg[]
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	14119	9501	2922	3407	3712	5071	329	108	15631	9788	6035	6477	6187	8452	548	181	4530	13053
1985	14015	7028	3836	345	9215	3351	329	76	15611	7281	7809	577	15827	5586	548	127	3623	16619
1986	18589	8598	6152	35	5877	4971	329	89	20602	8839	12596	61	9795	8284	548	149	4519	20889
1987	17574	6715	5178	273	6335	3012	329	82	19017	6889	10575	458	10558	5019	548	137	4466	22745
1988	21445	6432	7540	346	6789	4781	329	98	22979	6618	15336	576	11315	7969	548	164	4747	19750
1989	20278	8503	5530	278	5718	4567	329	106	21906	8736	11252	465	9531	7611	548	176	2905	18175
1990	17098	10803	8164	1365	5179	2424	442	112	18222	11041	16613	2276	8631	4040	737	187	2900	16092
1991	19112	6988	7183	696	3856	357	242	101	20443	7192	14602	1161	6427	595	403	168	4335	16372
1992	18392	7360	7930	372	2687	1503	461	76	19578	7560	16149	622	4478	2505	769	127	4550	15851
1993	14578	10133	2866	373	2649	333	423	52	15454	11463	5849	624	4414	555	705	87	3976	11242
1994	16538	9172	2644	506	2853	145	427	60	17594	10241	5411	845	4755	242	712	100	4496	10424
1995	21658	9598	1926	813	4390	154	246	31	22968	10936	3915	1358	7317	256	410	52	6194	10038
1996	22679	5822	3843	577	2486	135	113	4	24117	6941	7844	964	4155	225	189	7	6113	7454
1997	18106	4221	2816	333	2865	138	48	9	19154	5154	5768	553	4775	229	80	15	4875	7202
1998	13180	4927	2861	347	2790	291	48	0	13891	5962	5907	592	4649	485	80	0	4875	1038
1999	16912	842	2554	3661	3870	492	0	0	17700	995	5232	6103	6450	838	0	0	3683	471
2000	14568	619	3901	560	6420	563	0	0	15300	669	7947	933	10700	949	0	0	3818	0
2001	17837	633	5320	241	3988	556	0	0	18889	879	10914	402	6647	926	0	0	3574	0
2002	12335	8	4515	339	2103	345	0	0	13001	9	9277	565	3505	575	0	0	3164	0
2003	21853	0	5787	269	4889	384	0	0	22893	0	11779	449	8148	641	0	0	3541	0
2004	18369	107	4870	357	4432	401	0	0	19043	126	9170	595	7387	668	0	0	3558	0
2005	19154	0	3204	734	4815	351	0	0	20066	0	6515	1223	8025	585	0	0	3062	0
2006	16704	0	3387	901	3945	403	0	0	17500	0	6904	1502	6575	672	0	0	3512	0
2007	14832	0	3638	1301	3171	305	0	0	15604	0	7406	2168	5285	508	0	0	2932	0
2008	15216	0	5187	1328	5423	390	0	0	16002	0	10595	2213	9038	649	0	0	2971	0
2009	18479	0	3727	950	4556	275	0	0	19412	0	7589	1584	7594	458	0	0	2752	0
2010	21375	0	4488	1047	3656	338	0	0	22454	0	9157	1744	6093	564	0	0	2362	0
2011	26977	0	4697	1571	6007	483	0	0	28373	0	9529	2619	10011	805	0	0	3216	0
2012	17918	0	3665	904	4488	313	0	0	18837	0	7434	1507	7481	522	0	0	3023	0
2013	22026	205	4171	989	3938	339	0	0	23135	242	8461	1648	6563	565	0	0	2895	0
2014	10954	0	2400	695	1593	1035	0	0	11504	0	4869	1159	2655	1725	0	0	2908	0
2015	18085	0	3995	1812	5048	568	0	0	19007	0	8104	2965	8414	946	0	0	2765	0

Appendix 4.ix. (Continued). Input data for small salmon spawners to Québec by category of data used in the run-reconstruction.

	Small spawners						Small spawners					
	Minimum						Maximum					
Year	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**
Bugs labels	QCSSmC1_L[	QCSSmC2_L[	QCSSmC3_L[	QCSSmC4_L[	QCSSmC5_L[	QCSSmC6_L[	QCSSmC1_H[	QCSSmC2_H[	QCSSmC3_H[	QCSSmC4_H[	QCSSmC5_H[	QCSSmC6_H[
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	3061	4342	1915	415	1264	5160	3316	4547	5013	747	2378	8599
1985	3960	1622	1025	209	4241	4384	4563	1687	2844	351	8016	7307
1986	6337	3827	1499	63	5151	5133	7160	3955	3998	107	9630	8555
1987	7493	3489	2365	291	6411	5501	8319	3624	6388	510	12008	9168
1988	8173	4188	2738	419	6432	6423	9227	4353	7296	731	12059	10705
1989	7779	3810	1878	273	5149	5622	8568	3945	4894	475	9645	9369
1990	8735	5757	2822	604	5437	2976	9768	5936	7362	1068	10167	4960
1991	7247	4551	2465	316	3827	2001	7942	4687	6368	551	7166	3336
1992	5989	4841	2937	370	3957	3462	6648	5057	7667	657	7378	5770
1993	4852	4311	2524	747	3339	1447	5592	4503	6626	1435	6216	2412
1994	5506	3996	2501	894	3089	437	6241	4197	6489	1596	5764	729
1995	5348	2835	1760	877	2956	434	5943	2923	4534	1556	5525	723
1996	10636	1330	2260	372	3678	500	11748	1444	6030	692	6828	833
1997	8238	142	2250	266	3074	462	8836	178	5842	461	5426	770
1998	7734	995	2347	289	4229	1124	8298	1218	6116	516	7643	1875
1999	8155	509	2495	1653	4581	1426	8834	542	5837	2883	8182	2379
2000	8291	372	693	519	5900	583	9040	401	1861	921	12551	1005
2001	5329	143	1870	263	2579	658	5867	186	4140	440	4729	1137
2002	9296	31	2231	658	3405	1448	10191	36	5572	1118	6294	2414
2003	8180	0	2269	661	2826	1509	8721	0	5604	1141	5204	2517
2004	9030	29	5574	278	3962	1639	9460	49	12152	468	7222	2731
2005	6339	0	3025	716	2709	1506	6756	0	6821	1245	4945	2511
2006	8628	0	3159	1691	2372	1455	9235	0	7007	2890	4335	2426
2007	5768	0	3226	1511	1501	1024	6217	0	7099	2651	2722	1707
2008	10562	0	4882	1756	2522	1401	11467	0	10601	3266	4618	2336
2009	6293	0	3115	764	1633	1056	6736	0	6820	1366	2904	1759
2010	8860	0	4289	914	1311	1080	9509	0	9234	1576	2428	1801
2011	12143	0	4496	1116	3674	1688	13049	0	9762	2027	6635	2818
2012	6620	0	3152	472	2924	1225	7092	0	6869	861	5290	2044
2013	4959	88	2840	328	2131	1401	5314	104	6116	602	3776	2335
2014	6579	0	3239	560	2127	2175	7033	0	7297	1011	3735	3735
2015	10718	0	4709	1109	3457	1352	11518	0	10719	2008	6292	2259

Appendix 4.ix. (Continued). Input data for large salmon spawners to Québec by category of data used in the run-reconstruction.

	Large spawners						Large spawners					
	Minimum						Maximum					
Year	C1	C2	C3	C4	C5	C6	C1	C2	C3	C4	C5	C6
Bugs labels	QCSLgC1_L[	QCSLgC2_L[	QCSLgC3_L[	QCSLgC4_L[	QCSLgC5_L[	QCSLgC6_L[	QCSLgC1_H[	QCSLgC2_H[	QCSLgC3_H[	QCSLgC4_H[	QCSLgC5_H[	QCSLgC6_H[
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	10421	7648	1861	2357	2815	5071	11933	7935	4974	5427	5290	8452
1985	9985	4991	2125	340	7214	3351	11581	5244	6098	572	13826	5586
1986	13659	5804	3695	35	4498	4971	15672	6045	10139	61	8416	8284
1987	13432	4791	3025	246	4830	3012	14875	4965	8422	431	9053	5019
1988	15535	4258	4381	312	5172	4781	17069	4444	12177	542	9698	7969
1989	14645	6742	3239	253	4375	4567	16273	6975	8961	440	8188	7611
1990	12398	8463	4557	1228	3950	2424	13522	8701	13006	2139	7402	4040
1991	14061	5019	3970	596	2940	357	15392	5223	11389	1061	5511	595
1992	12850	4819	4492	325	2044	1503	14036	5019	12711	575	3835	2505
1993	9848	6936	1809	282	2038	333	10724	8266	4792	533	3803	555
1994	10468	5920	1693	448	2173	145	11524	6989	4460	787	4075	242
1995	16562	8323	1321	781	3367	154	17872	9661	3310	1326	6294	256
1996	16431	4417	2389	394	1924	135	17869	5536	6390	781	3593	225
1997	13433	3393	1744	308	2237	138	14481	4326	4696	528	4147	229
1998	10402	4429	1849	302	2213	290	11113	5464	4895	547	4073	484
1999	14169	747	1962	3100	2956	491	14957	900	4640	5542	5536	837
2000	11937	570	3322	491	5096	363	12669	620	7368	864	9376	749
2001	14527	505	4281	239	2980	348	15579	751	8986	400	5639	717
2002	10843	8	4071	313	1500	344	11509	9	8833	539	2902	574
2003	18832	0	5164	267	3763	383	19872	0	11156	447	7022	640
2004	15558	107	4231	355	3268	401	16232	126	8531	593	6223	668
2005	16485	0	2901	719	3556	351	17397	0	6212	1208	6766	585
2006	14977	0	3055	872	2863	403	15773	0	6572	1473	5493	672
2007	12470	0	3203	1287	2444	303	13242	0	6971	2154	4558	506
2008	13725	0	4676	1266	4296	390	14511	0	10084	2151	7911	649
2009	16489	0	3188	849	3588	275	17422	0	7050	1483	6626	458
2010	19170	0	3926	1023	3017	338	20249	0	8595	1720	5454	564
2011	24130	0	4180	1497	4579	479	25526	0	9012	2545	8583	801
2012	16098	0	3221	868	3685	313	17017	0	6990	1471	6678	522
2013	19804	205	3701	920	2925	338	20913	242	7991	1579	5550	564
2014	10089	0	2138	664	1206	740	10639	0	4607	1128	2268	1430
2015	16672	0	3560	1749	4427	557	17594	0	7669	2902	7793	935

Appendix 4.ix. (Continued). Year specific returns and spawner data for Québec for years when category splits are not available (1970 to 1983) used in the run-reconstruction.

	These data are specific to the 1970 to 1983 period when detailed returns by river category are not available.							
	Small returns		**Large returns**		**Small spawners**		**Large spawners**	
Year	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Bugs labels	QCSm_L[]	QCSm_H[]	QCLg_L[]	QCLg_H[]	QCSSm_L[]	QCSSm_H[]	QCSLg_L[]	QCSLg_H[]
1970	18904	28356	82680	124020	11045	16568	31292	46937
1971	14969	22453	47354	71031	9338	14007	16194	24292
1972	12470	18704	61773	92660	8213	12320	31727	47590
1973	16585	24877	68171	102256	10987	16480	32279	48419
1974	16791	25186	91455	137182	10067	15100	39256	58884
1975	18071	27106	77664	116497	11606	17409	32627	48940
1976	19959	29938	77212	115818	12979	19469	31032	46548
1977	18190	27285	91017	136525	12004	18006	44660	66990
1978	16971	25456	81953	122930	11447	17170	40944	61416
1979	21683	32524	45197	67796	15863	23795	17543	26315
1980	29791	44686	107461	161192	20817	31226	48758	73137
1981	41667	62501	84428	126642	30952	46428	35798	53697
1982	23699	35549	74870	112305	16877	25316	36290	54435
1983	17987	26981	61488	92232	12030	18045	23710	35565
1984	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0

Appendix 4.x. Input data for 2SW salmon returns to Salmon Fishing Areas 15 to 23 for Canada and for USA used in the run-reconstruction.

	Returns of 2SW												
	SFA 15		**SFA 16**		**SFA 17**		**SFA 18**		**SFA 19-21**		**SFA 23**		**USA**
Year of return to rivers	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Point estimate**
Winbugs labels	SF15R2_L[]	SF15R2_H[]	SF16R2_L[]	SF16R2_H[]	SF17R2_L[]	SF17R2_H[]	SF18R2_L[]	SF18R2_H[]	SF19_21R2_L[]	SF19_21R2_H[]	SF23R2_L[]	SF23R2_H[]	**USAR2[]**
1970	8243	10576	42901	45798	31	60	4744	6836	5600	7447	8540	12674	0
1971	3587	4616	26038	30669	29	29	1891	2782	4120	5215	7155	10536	653
1972	4980	9756	29092	43510	402	402	4693	6024	5744	6993	7869	11368	1383
1973	6211	12009	26599	40492	206	206	4140	5481	6922	8659	4205	6036	1427
1974	7264	14570	39270	60090	386	386	5481	6928	13138	15363	10755	14988	1394
1975	4353	7922	25889	39325	345	345	3452	4340	12261	13797	13107	18578	2331
1976	7293	14416	20448	30758	575	578	2755	3674	8607	10104	14274	20281	1317
1977	9174	18077	49881	73330	606	606	3985	5463	10872	12851	16869	23995	1998
1978	5458	10749	19504	26041	0	0	4585	6265	8272	9779	8225	11294	4208
1979	1472	2535	6501	9306	459	463	1290	2014	3781	4879	5165	7207	1942
1980	7102	14045	35163	48457	2	5	3732	5177	14094	17318	19056	26865	5796
1981	4572	7357	11144	19268	40	77	2490	3769	8662	11471	11026	15267	5601
1982	4314	6313	21442	41643	16	31	4135	5901	4458	5353	9782	13871	6056
1983	3453	5280	16349	28419	17	32	3733	5241	4134	5356	9662	13836	2155
1984	3329	6092	12216	31455	13	26	2391	3573	1758	2854	15706	22627	3222
1985	4805	9500	14614	37625	8	15	921	4481	6894	12124	16541	23828	5529
1986	7831	15403	21617	55640	5	11	2274	11479	6755	11878	9891	14261	6176
1987	4836	9123	12524	32224	66	128	2611	10422	3748	6591	6922	10043	3081
1988	7152	13998	14384	36938	96	185	2533	10205	4393	7735	4716	6697	3286
1989	4390	8492	9113	23385	149	287	2108	8600	4808	8469	6560	9437	3197
1990	4326	8369	14269	36639	284	545	1893	7684	3591	6320	5486	7918	5051
1991	2387	4668	14685	37736	188	361	2350	9628	2960	5213	7337	10563	2647
1992	4002	7787	21381	30728	95	183	2374	9577	2633	4634	6878	9809	2459
1993	1395	2684	15579	60246	22	43	1341	5317	2542	4470	4345	4820	2231
1994	3960	7745	13652	24887	169	310	1981	8094	1360	2396	3084	3495	1346
1995	2713	5333	25593	37215	384	576	1498	6160	2253	3969	3439	3998	1748
1996	3917	7754	11126	19117	394	591	3247	13507	3000	5278	4729	5397	2407
1997	2488	4898	8545	14244	387	581	3421	14254	1163	2045	2769	3176	1611
1998	1687	3260	6292	10783	385	577	2055	8560	924	1270	1372	1642	1526
1999	1780	3425	7098	11206	383	575	1557	6596	1419	1951	2375	2640	1168
2000	2270	4410	7560	11744	378	566	1467	6302	1078	1483	988	1206	533
2001	3779	7442	14257	19289	376	564	1689	7251	1822	2506	1938	2279	788
2002	2335	4540	5572	9079	372	557	1228	5307	382	525	483	548	504
2003	3947	7778	10991	16823	371	557	2380	10207	1854	2548	1056	1198	1192
2004	3005	5886	10596	18488	367	550	2639	11397	1028	1413	1335	1605	1283
2005	3422	6725	11310	19988	373	560	2217	9293	662	906	809	1012	984
2006	2551	4973	9779	17103	392	587	2114	9010	1263	1734	922	1171	1023
2007	4267	8422	9451	15183	412	618	1353	6122	603	825	616	736	954
2008	2848	5572	5811	11066	429	644	2020	9357	1793	2465	812	1042	1764
2009	3948	7781	10580	17076	402	602	1524	7251	827	1135	1485	1886	2069
2010	2978	5831	7804	11581	439	658	2049	9574	934	1277	829	992	**1078**
2011	7265	14445	21216	48573	653	980	3633	16729	1489	2044	2486	3259	3045
2012	3230	6338	7987	15163	653	980	831	4118	623	849	268	331	879
2013	5324	10544	7493	15865	993	1487	1871	8797	2075	2852	420	543	525
2014	2704	5282	5694	11356	713	1067	1266	6044	415	569	172	217	334
2015	3292	6462	9692	16220	799	1195	1880	9068	335	460	248	314	761

Appendix 4.x. (continued). Input data for large salmon returns to Salmon Fishing Areas 15 to 23 for Canada and for USA used in the run-reconstruction.

	Returns of large salmon												
	SFA 15		SFA 16		SFA 17		SFA 18		SFA 19-21		SFA 23		USA
Year of return to rivers	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Point estimate
Winbugs labels	SF15Lg_L[]	SF15Lg_H[]	SF16Lg_L[]	SF16Lg_H[]	SF17Lg_L[]	SF17Lg_H[]	SF18Lg_L[]	SF18Lg_H[]	SF19_21Lg_L[]	SF19_21Lg_H[]	SF23Lg_L[]	SF23Lg_H[]	**USALg[]**
1970	12681	16270	46462	49599	31	60	6161	7858	7273	9671	9691	13945	0
1971	5518	7102	28365	33409	29	29	2456	3198	5350	6773	8056	11573	653
1972	8441	16536	30146	45087	402	402	6095	6924	7460	9082	8890	12536	1383
1973	8393	16229	27771	42276	206	206	5376	6299	8049	10069	4760	6638	1427
1974	9950	19959	43249	66179	386	386	7119	7963	13138	15363	12187	16444	1394
1975	5510	10028	29826	45305	345	345	4483	4989	12261	13797	14829	20351	2331
1976	9596	18969	23943	36016	575	578	3578	4223	8873	10416	16128	22175	1317
1977	11053	21779	52673	77434	606	606	5175	6280	14119	16690	19165	26183	1998
1978	7277	14332	22653	30245	0	0	5954	7201	10471	12378	9335	12342	4208
1979	2886	4971	9435	13507	459	463	1676	2315	5180	6684	5856	7903	1942
1980	8768	17340	37014	51008	2	5	4846	5951	16388	20137	21464	29480	5796
1981	9729	15652	16708	28887	40	77	3234	4332	11706	15501	12481	16743	5601
1982	7311	10700	26504	51475	16	31	5370	6783	9485	11390	11147	15303	6056
1983	5852	8950	20309	35304	17	32	4848	6024	6562	8501	10908	15235	2155
1984	4214	7711	12941	33321	13	26	3105	4107	2408	3909	17706	24992	3222
1985	7627	15080	16798	43247	8	15	1196	5150	8512	14968	18582	26289	5529
1986	10305	20267	25342	65228	5	11	2953	13195	10722	18854	11142	15761	6176
1987	7556	14255	15734	40483	66	128	3391	11980	5950	10462	7865	11116	3081
1988	9933	19441	17627	45267	96	185	3289	11729	7321	12891	5360	7312	3286
1989	7701	14898	13955	35812	149	287	2738	9885	6969	12275	7393	10380	3197
1990	6362	12307	23164	59479	284	545	2458	8832	6191	10897	6235	8710	5051
1991	4773	9335	24273	62373	188	361	3052	11066	4112	7240	8312	11659	2647
1992	7411	14420	34573	49686	95	183	3083	11008	3657	6437	7749	10726	2459
1993	3487	6711	22602	87407	22	43	1742	6112	3218	5658	5260	5980	2231
1994	6600	12908	18098	32992	169	310	2573	9303	1743	3071	3659	4155	1346
1995	4171	8199	30324	44094	384	576	1946	7081	2532	4460	3728	4289	1748
1996	6026	11929	16317	28035	394	591	4217	15526	3571	6283	5535	6365	2407
1997	3828	7535	14711	24521	387	581	4443	16384	1550	2726	3210	3678	1611
1998	2595	5015	15207	26060	385	577	2669	9839	1359	1867	2032	2437	1526
1999	2738	5269	14585	23026	383	575	2022	7581	1709	2350	2734	3090	1168
2000	3493	6785	15950	24778	378	566	1905	7244	1315	1809	1189	1430	533
2001	5815	11449	22082	29875	376	564	2194	8335	1980	2724	2113	2501	797
2002	3592	6985	11094	18077	372	557	1595	6100	749	1029	639	752	526
2003	6072	11966	18783	28749	371	557	3091	11732	1952	2682	1128	1289	1199
2004	4623	9055	18589	32435	367	550	3427	13100	1302	1789	1402	1698	1316
2005	5265	10346	17008	30057	373	560	2879	10682	860	1177	890	1121	994
2006	3924	7651	18805	32890	392	587	2746	10356	1559	2141	997	1276	1030
2007	6565	12957	16018	25734	412	618	1757	7037	701	959	689	841	958
2008	4382	8572	10377	19761	429	644	2623	10755	1928	2650	858	1105	1799
2009	6074	11970	17065	27543	402	602	1979	8335	1034	1418	1678	2158	2095
2010	4581	8972	15301	22708	439	658	2662	11005	1061	1451	1117	1398	1098
2011	11177	22223	24960	57144	653	980	4718	19229	1504	2065	2598	3421	3087
2012	4969	9750	11411	21661	653	980	1080	4733	788	1075	335	422	913
2013	8190	16222	10860	22992	719	1077	2430	10112	2184	3002	503	660	525
2014	4160	8126	8448	16849	491	735	1645	6947	415	569	230	299	340
2015	5064	9942	14152	23686	564	846	2442	10423	375	515	257	326	771

Appendix 4.x. (continued). Input data for small salmon returns to Salmon Fishing Areas 15 to 23 for Canada and for USA used in the run-reconstruction.

	Returns of small salmon												
	SFA 15		SFA 16		SFA 17		SFA 18		SFA 19-21		SFA 23		USA
Year of return to rivers	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Point estimate
Winbugs labels	SF15Sm_L[]	SF15Sm_H[]	SF16Sm_L[]	SF16Sm_H[]	SF17Sm_L[]	SF17Sm_H[]	SF18Sm_L[]	SF18Sm_H[]	SF19_21Sm_L[]	SF19_21Sm_H[]	SF23Sm_L[]	SF23Sm_H[]	**USASm[]**
1970	2834	6279	47779	67697	0	0	264	1073	16177	24106	5306	7521	0
1971	2113	4681	38388	54120	0	0	65	265	11911	18004	3248	4541	32
1972	2185	4699	48886	69270	0	0	131	530	11587	17992	1831	2506	18
1973	3010	6668	47190	66835	5	9	516	2095	14169	22159	5474	7012	23
1974	2226	4895	78091	110470	0	0	187	757	25032	39058	10195	12901	55
1975	2393	5298	69993	98443	0	0	112	454	10860	15753	18022	23101	84
1976	8667	14696	96504	136107	14	28	299	1212	21071	33009	22835	28864	186
1977	6085	12084	30621	42689	0	0	215	871	24599	37314	13738	16671	75
1978	4350	7749	29783	39927	0	0	78	316	7621	10023	6271	7695	155
1979	4378	9495	50667	70714	2	5	1857	7536	24298	37514	15356	20517	250
1980	7994	15278	41687	58839	12	23	520	2108	34377	50250	25139	31483	818
1981	9380	17119	63278	108226	259	498	2797	11348	31204	48945	16826	21803	1130
1982	6541	13383	78072	133171	175	336	2150	8722	17619	27075	11811	15636	334
1983	2723	4638	24585	41332	17	32	212	858	9313	14068	9270	12592	295
1984	12003	15867	28714	49595	17	32	460	1867	18382	29867	15556	21678	598
1985	7003	15516	53393	92224	113	217	730	3167	24384	39541	13056	17928	392
1986	10813	23926	103230	178295	566	1088	965	3854	24369	39663	14274	20183	758
1987	9630	21220	74485	128644	1141	2194	1646	5713	27269	44266	13358	17662	1128
1988	13168	29092	107071	184904	1542	2963	1381	4833	24509	39750	16381	23084	992
1989	6357	13900	66069	114097	400	770	893	3208	25602	41557	17579	24521	1258
1990	7880	17314	73020	126115	1842	3539	983	3528	29471	48039	13820	19176	687
1991	4441	9828	53453	92327	1576	3028	1160	4166	9762	15955	13041	17685	310
1992	8853	19614	142416	204708	1873	3599	994	3531	13754	22269	13563	18404	1194
1993	5783	12812	70090	175096	1277	2454	1146	3892	13297	21681	7610	8828	466
1994	9136	20208	41773	59888	210	385	671	2425	3154	5393	5770	6610	436
1995	2902	6429	44357	63453	658	987	543	1985	8397	13873	8265	9458	213
1996	6034	13370	32067	45995	710	1065	2431	8958	13120	22293	12907	15256	651
1997	5797	12845	14377	24122	517	776	561	2134	3410	5863	4508	4979	365
1998	6288	13932	21965	32523	508	762	633	2419	8833	11927	9203	10801	403
1999	4936	10929	21494	29707	413	620	705	2681	3971	5337	5508	6366	419
2000	7459	16520	31923	42435	395	593	615	2428	6155	8312	4796	5453	270
2001	4947	10953	26496	36655	415	622	822	3205	2326	3138	2513	2862	266
2002	11719	25958	40432	54790	390	585	844	3319	5197	7015	3501	3991	450
2003	3119	6904	26530	39772	515	773	773	3088	2844	3837	2292	2716	237
2004	12091	26783	43242	62082	330	495	1092	4339	3847	5192	3454	4297	319
2005	4117	9116	28441	47190	343	514	781	3015	2870	3871	3597	4640	319
2006	8724	19322	30671	52560	331	497	869	3406	5144	6940	3720	4743	450
2007	4259	9430	23038	44016	275	413	718	2820	4198	5664	2466	3136	297
2008	13601	30129	25722	46587	298	447	1245	5061	7282	9831	5924	7691	814
2009	5169	11445	10819	21456	233	350	302	1417	2066	2788	1603	2027	241
2010	8187	18132	48123	67747	258	387	877	3672	3686	4975	9114	11994	525
2011	10234	22668	39511	67884	291	436	1248	5124	3615	4878	4466	5943	1080
2012	4350	9631	6914	13254	291	436	211	1077	346	466	178	219	26
2013	4661	10320	10106	20216	274	410	429	3006	922	1244	894	1151	78
2014	3697	8183	6528	11411	222	332	219	1744	529	713	677	910	110
2015	6228	13793	25575	34516	235	349	757	5522	1961	2648	1677	2131	150

Appendix 4.x. (continued). Input data for 2SW salmon spawners to Salmon Fishing Areas 15 to 23 for Canada and for USA used in the run-reconstruction.

	Spawners of 2SW												
	SFA 15		**SFA 16**		**SFA 17**		**SFA 18**		**SFA 19-21**		**SFA 23**		**USA**
Year of return to rivers	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Point estimate**
Winbugs labels	SF15S2_L[]	SF15S2_H[]	SF16S2_L[]	SF16S2_H[]	SF17S2_L[]	SF17S2_H[]	SF18S2_L[]	SF18S2_H[]	SF19_21S2_L[]	SF19_21S2_H[]	SF23S2_L[]	SF23S2_H[]	USAS2[]
1970	1156	3252	5346	8242	18	47	304	1587	2388	4234	1536	4846	0
1971	510	1434	6724	11354	0	0	133	694	1418	2513	3612	6576	490
1972	2367	6656	17031	31450	0	0	148	775	1616	2865	6472	9806	1038
1973	2873	8081	19277	33170	0	0	165	863	2246	3984	2752	4412	1100
1974	3620	10183	31192	52012	0	0	151	790	2878	5103	8123	12046	1147
1975	1769	4975	18536	31972	0	0	91	473	1987	3523	10987	16209	1942
1976	3530	9928	11842	22152	1	4	116	604	1935	3432	10071	15583	1126
1977	4412	12408	30623	54071	0	0	198	1033	2559	4539	12013	18568	643
1978	2622	7375	6998	13535	0	0	223	1166	1948	3455	5346	8076	3314
1979	527	1482	3000	5806	3	7	115	598	1419	2517	3772	5650	1509
1980	3440	9677	17667	30961	1	4	198	1033	4170	7394	12023	19005	4263
1981	1380	3880	2392	10515	36	73	196	1027	3631	6439	3642	7014	4334
1982	991	2786	8418	28619	8	23	253	1322	1158	2053	4475	7939	4643
1983	906	2547	5516	17586	15	30	210	1100	1579	2800	468	3561	1769
1984	2656	5402	11650	30889	13	26	259	1148	1416	2512	12280	18798	2547
1985	4514	9180	14019	37030	8	15	871	4359	6761	11990	11885	18624	4884
1986	7279	14804	20606	54630	5	11	2164	11213	6624	11748	7224	11280	5570
1987	4122	8383	11414	31114	66	128	2534	10189	3676	6519	5628	8597	2781
1988	6582	13386	13801	36355	96	185	2451	9954	4322	7664	3420	5248	3038
1989	3944	8021	8466	22739	149	287	2042	8397	4735	8396	6310	9158	2800
1990	3886	7903	13669	36039	284	545	1829	7491	3530	6260	4926	7292	4356
1991	2193	4460	14200	37251	188	361	2275	9399	2912	5165	6080	9158	2416
1992	3639	7400	20770	30116	95	183	2291	9324	2588	4589	5826	8633	2292
1993	1239	2521	15239	59907	22	43	1296	5180	2493	4421	3291	3654	2065
1994	3639	7401	13418	24653	166	307	1920	7907	1339	2375	2387	2680	1344
1995	2519	5124	25326	36949	380	576	1453	6022	2218	3934	3126	3652	1748
1996	3688	7502	10743	18662	388	591	3166	13262	2946	5224	4009	4585	2407
1997	2316	4710	8106	13754	385	581	3334	13988	1140	2022	2219	2565	1611
1998	1512	3076	6098	10548	382	577	2000	8390	915	1261	1068	1302	1526
1999	1581	3217	6589	10660	379	575	1523	6493	1409	1941	1934	2181	1168
2000	2057	4184	7262	11408	376	566	1438	6214	1072	1477	805	1004	1587
2001	3521	7161	13688	18674	374	564	1654	7143	1812	2497	1699	2008	1491
2002	2120	4312	5332	8808	371	557	1203	5230	378	521	317	356	511
2003	3683	7491	10593	16372	368	557	2333	10063	1834	2528	878	998	1192
2004	2770	5633	10144	17965	365	550	2581	11219	1017	1401	1238	1492	1283
2005	3175	6457	10755	19354	371	560	2162	9124	646	890	726	914	1088
2006	2329	4737	9336	16594	390	587	2062	8851	1248	1720	796	1023	1419
2007	3994	8124	8963	14644	409	618	1320	6023	587	809	530	633	1189
2008	2618	5325	5376	10584	429	644	1961	9180	1778	2450	736	953	2809
2009	3684	7494	10062	16500	401	602	1481	7122	811	1118	1391	1774	2292
2010	2743	5580	7335	11078	438	658	1998	9419	910	1253	726	877	1482
2011	6902	14038	20445	47555	652	980	3543	16455	1467	2023	2430	3196	3872
2012	2988	6077	7603	14713	652	980	816	4070	601	828	238	298	2020
2013	5019	10208	6909	15204	989	1483	1826	8662	2057	2834	405	526	525
2014	2478	5040	5606	11217	709	1063	1245	5977	410	564	163	208	566
2015	3048	6199	9518	15988	791	1187	1842	8953	332	457	244	309	1509

Appendix 4.x. (continued). Input data for large salmon spawners to Salmon Fishing Areas 15 to 23 for Canada and for USA used in the run-reconstruction.

	Spawners of large salmon												
	SFA 15		SFA 16		SFA 17		SFA 18		SFA 19-21		SFA 23		USA
Year of return to rivers	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Point estimate
Winbugs labels	SF15SLg_L[]	SF15SLg_H[]	SF16SLg_L[]	SF16SLg_H[]	SF17SLg_L[]	SF17SLg_H[]	SF18SLg_L[]	SF18SLg_H[]	SF19_21SLg_L[]	SF19_21SLg_H[]	SF23SLg_L[]	SF23SLg_H[]	**USASLg[]**
1970	1779	5003	5790	8926	18	47	395	1824	3101	5499	1451	5705	0
1971	785	2207	7324	12369	0	0	173	797	1841	3264	3888	7405	490
1972	4011	11282	17648	32589	0	0	193	891	2099	3721	7246	10892	1038
1973	3883	10920	20126	34632	0	0	215	992	2612	4632	3050	4928	1100
1974	4960	13949	34352	57282	0	0	196	908	2878	5103	9090	13347	1147
1975	2239	6297	21355	36834	0	0	118	544	1987	3523	12335	17857	1942
1976	4644	13063	13867	25940	1	4	151	694	1995	3538	11183	17230	1126
1977	5315	14949	32337	57097	0	0	257	1187	3324	5895	13452	20470	643
1978	3496	9833	8128	15720	0	0	290	1340	2466	4373	5948	8955	3314
1979	1033	2906	4355	8426	3	7	149	688	1944	3448	4217	6264	1509
1980	4248	11947	18597	32590	1	4	257	1187	4849	8598	13190	21206	4263
1981	2935	8256	3586	15765	36	73	255	1181	4907	8702	3794	8056	4334
1982	1679	4723	10405	35376	8	23	329	1519	2464	4369	4903	9059	4643
1983	1535	4317	6852	21846	15	30	273	1264	2506	4445	92	4419	1769
1984	3362	6838	12341	32721	13	26	337	1320	1940	3441	13675	20961	2547
1985	7164	14571	16114	42563	8	15	1131	5010	8347	14803	13104	20811	4884
1986	9577	19479	24157	64044	5	11	2811	12889	10515	18647	8004	12623	5570
1987	6441	13099	14340	39088	66	128	3291	11711	5835	10347	6343	9594	2781
1988	9141	18592	16913	44553	96	185	3183	11442	7203	12773	3835	5787	3038
1989	6919	14072	12965	34822	149	287	2652	9651	6862	12168	7099	10086	2800
1990	5715	11623	22190	58504	284	545	2376	8611	6087	10793	5576	8051	4356
1991	4386	8920	23472	61572	188	361	2955	10803	4045	7173	6833	10180	2416
1992	6738	13704	33583	48697	95	183	2976	10717	3594	6374	6511	9488	2292
1993	3099	6302	22109	86914	22	43	1683	5953	3156	5596	4026	4746	2065
1994	6065	12334	17787	32682	166	307	2493	9088	1717	3045	2827	3273	1344
1995	3873	7877	30007	43778	380	576	1887	6922	2492	4420	3362	3923	1748
1996	5674	11541	15755	27367	388	591	4112	15244	3507	6219	4688	5497	2407
1997	3563	7247	13955	23677	385	581	4330	16078	1520	2696	2565	3028	1611
1998	2326	4732	14737	25493	382	577	2597	9643	1346	1854	1675	2074	1526
1999	2433	4948	13539	21905	379	575	1979	7464	1697	2338	2251	2601	1168
2000	3165	6437	15321	24069	376	566	1867	7142	1307	1801	975	1216	1587
2001	5417	11018	21201	28923	374	564	2148	8210	1970	2714	1831	2210	1491
2002	3261	6633	10618	17538	371	557	1562	6011	741	1021	442	542	511
2003	5666	11525	18102	27978	368	557	3029	11567	1931	2661	919	1074	1192
2004	4261	8666	17796	31517	365	550	3351	12895	1287	1774	1287	1574	1283
2005	4884	9934	16172	29104	371	560	2807	10487	839	1156	791	1012	1088
2006	3583	7288	17954	31911	390	587	2678	10174	1541	2123	847	1113	1419
2007	6145	12498	15191	24820	409	618	1715	6923	683	941	586	726	1189
2008	4028	8192	9601	18901	429	644	2547	10551	1912	2634	767	1007	2231
2009	5668	11529	16229	26612	401	602	1924	8186	1014	1398	1565	2034	2318
2010	4221	8584	14382	21722	438	658	2595	10826	1034	1424	996	1275	**1502**
2011	10619	21597	24053	55948	652	980	4601	18913	1482	2043	2532	3353	3914
2012	3230	6338	10861	21019	652	980	1059	4679	761	1048	300	387	2054
2013	7721	15704	10013	22035	717	1075	2372	9956	2165	2983	486	643	525
2014	3812	7754	8318	16642	489	733	1616	6870	410	564	220	289	572
2015	4689	9537	13899	23347	562	844	2393	10291	371	511	252	321	1519

Appendix 4.x. (continued). Input data for small salmon spawners to Salmon Fishing Areas 15 to 23 for Canada and for USA used in the run-reconstruction.

	Spawners of small salmon												
	SFA 15		**SFA 16**		**SFA 17**		**SFA 18**		**SFA 19-21**		**SFA 23**		**USA**
Year of return to rivers	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Point estimate**
Winbugs labels	SF15SSm_L[]	SF15SSm_H[]	SF16SSm_L[]	SF16SSm_H[]	SF17SSm_L[]	SF17SSm_H[]	SF18SSm_L[]	SF18SSm_H[]	SF19_21SSm_L[]	SF19_21SSm_H[]	SF23SSm_L[]	SF23SSm_H[]	**USASSm[]**
1970	1417	4396	25958	45876	0	0	167	842	9429	17358	3886	6101	0
1971	1056	3277	22463	38195	0	0	41	208	7246	13339	1216	2509	29
1972	1034	3208	27639	48023	0	0	82	416	7616	14021	0	1	17
1973	1505	4668	31703	51349	3	7	325	1645	9502	17492	4037	5575	13
1974	1098	3405	57376	89755	0	0	118	595	16680	30706	8071	10777	40
1975	1195	3707	50438	78888	0	0	71	357	5819	10712	15363	20442	67
1976	2480	7692	64526	104130	8	22	188	951	14196	26134	17572	23601	151
1977	2467	7653	13270	25338	0	0	135	684	15120	27835	9196	12129	54
1978	1398	4337	14689	24833	0	0	49	248	2857	5259	4256	5680	127
1979	2104	6528	31829	51876	1	4	1170	5915	15716	28932	11640	16801	247
1980	2996	9293	27791	44943	7	18	327	1655	18876	34749	19597	25941	722
1981	3183	9874	35423	80370	151	390	1762	8908	21096	38837	7805	12782	1009
1982	3038	9027	51324	106423	102	263	1354	6847	11244	20700	6532	10357	290
1983	820	2486	13298	30045	10	25	133	674	5653	10408	5132	8454	255
1984	1620	4971	7389	28271	10	25	177	1200	13658	25143	10290	16412	540
1985	3557	10936	32275	71106	66	170	145	1788	18024	33181	8164	13036	363
1986	5589	16990	71918	146983	330	852	63	1729	18187	33481	10725	16634	660
1987	4867	14920	49971	104131	665	1718	527	3075	20213	37210	10257	14561	1087
1988	6664	20468	71967	149800	899	2320	344	2388	18125	33366	13061	19764	923
1989	3191	9741	37696	85724	233	603	232	1650	18973	34928	13124	20066	1080
1990	3996	12190	46902	99996	1074	2771	229	1750	22080	40648	10025	15381	617
1991	2215	6872	39648	78522	919	2371	271	2068	7363	13556	9495	14139	235
1992	4426	13728	116657	178949	1092	2818	189	1634	10125	18640	9485	14326	1124
1993	2891	8968	52050	157056	745	1922	261	1805	9970	18354	5762	6868	444
1994	4554	14125	25649	43764	118	292	179	1266	2661	4900	4965	5738	427
1995	1451	4501	34650	53746	250	375	148	1055	6512	11988	8025	9218	213
1996	3017	9359	19511	29260	258	387	1005	5596	10909	20082	11576	13892	651
1997	2899	8991	8702	15524	256	384	203	1290	2917	5370	3971	4433	365
1998	3144	9752	13997	21387	255	382	228	1464	8818	11912	8775	10348	403
1999	2465	7646	12193	17943	253	380	347	1837	3895	5261	5196	6048	419
2000	3727	11560	18837	26196	252	378	314	1717	6148	8305	4455	5087	270
2001	2470	7663	15703	22815	250	376	403	2217	2315	3127	2210	2530	266
2002	5857	18166	25458	35509	249	373	426	2334	5180	6998	3232	3689	450
2003	1557	4829	15727	24997	248	371	396	2201	2829	3822	2069	2469	237
2004	6043	18744	27425	40613	246	369	496	2934	3833	5178	3229	4039	319
2005	2056	6377	17065	30189	246	368	300	1881	2854	3855	3433	4450	319
2006	4359	13522	19763	35085	247	370	358	2201	5119	6915	3528	4501	450
2007	2127	6597	14420	29105	248	372	330	1905	4176	5642	2305	2937	297
2008	6798	21086	16299	30904	249	373	451	3189	7252	9801	5729	7467	814
2009	2581	8007	5867	13313	233	350	105	953	2051	2773	1472	1864	241
2010	4090	12688	30506	44243	256	384	387	2516	3674	4963	9032	11901	**525**
2011	5114	15864	25264	45125	290	435	562	3506	3601	4864	4391	5867	1080
2012	2172	6738	3457	7895	290	435	119	860	343	463	167	208	26
2013	2328	7220	5360	12437	272	408	188	2095	919	1241	870	1127	78
2014	1845	5724	3943	7361	220	330	104	1310	527	711	669	900	110
2015	6036	13539	24339	33200	229	343	394	4151	1960	2647	1654	2108	150

Appendix 5: Model walkthroughs

Summaries of the data preparation, model running and output processing were presented at a one-day workshop prior to the 2014 WGNAS meeting and provided step by step walkthroughs of the assessment processes. Where appropriate these have been updated in 2017.

NEAC pre-fishery abundance and national conservation limit model in R

[NB: Instructions apply to model version: "NEAC_PFA_CL_RR_model_2015-varM_v12" as used in 2015]

1) Introduction

This program performs the run-reconstruction estimation of pre-fishery abundance (PFA) of maturing and non-maturing 1SW salmon for each country (and region) in the NASCO-NEAC area. PFA is estimated for January 1st in the first sea winter. The program also establishes the pseudo stock–recruitment (S–R) relationship between lagged egg deposition and Total 1SW PFA, and applies a hockey-stick S–R analysis to estimate the National/Regional Conservation Limit where river-specific CLs are not available. The original model is described by Potter *et al.* (2004); minor changes to the estimation approach used for different countries and regions have been reported in the annual reports of WGNAS.

The model also estimates the proportion (mean and SE) of the Faroes catch originating in different countries/regions based on the genetic analysis of scales collected in the fishery between 1993 and 1995 and the estimated PFA for each country/region since 2001, when no fishery has been operating at Faroes. This requires the model to be run once to provide the catch proportions and then run a second time to provide a full PFA assessment. The catch proportions are also used in the Catch Options model.

2) To get started

- 2.1) Load RStudio or R;
- 2.2) Set up a folder from which you will run the program;
- 2.3) Use folder and file names without spaces;
- 2.4) Put the program, the input files (annual and multiannual) and the summary data file (see 6f) in this folder.

3) Input Data

- 3.1) Annual data (filenames: Annual-data-XX-YY.txt)
  - 3.1.1) There is a file for each country (XX) and region (YY) which contains the 40+ year time-series of data on catches, exploitation rates and non-reporting rates (plus additional data for some countries).
  - 3.1.2) To read the .txt files, it is easiest to open them from within Excel. i.e.
    - Open Excel;
    - select the correct folder;
    - click on 'Open'
    - You will probably need to change the setting in the lower right corner of the open box from 'Excel files' to 'All files';

- Double-click on the file you want to open and it should open the 'Text Import Wizard';
- select 'finish' (If this doesn't work reopen the file, but select 'Delimited' at step 1, 'Tab' at step 2 and 'General' at step 3.)

3.1.3) Do not add any formatting to the file. If loading a new version of a file that has been saved in Excel (e.g. after addition of a new year's data), re-save the file by clicking 'Save As' and selecting 'Text (Tab delimited)' from the 'Save as type' list. This will remove the formatting and add the .txt extension.

3.1.4) Do not change the file name.

3.1.5) Close and save the file before running the programme. You will be prompted to confirm that you want to lose the formatting; click 'yes'.

3.2) Multiannual-data (file-name: 'Multiannual-data.txt' or similar)

3.2.1) This file contains most of the other parameters used in the model including: smolt age composition, fecundity and sex ratios by region, M, etc.

3.2.2) The second value listed is the 'lastdatayear' which needs to be updated to the latest year for which data are provided in the Annual-data-XX files.

3.2.3) The file is not formatted in columns so can be read easily in Notebook, which should be selected automatically if you click on the file to open it. (NB: If you open the file in Excel, don't save it because it will probably add " " marks to each line.

3.2.4) All blank lines and lines starting with '#' are ignored in this file. Apart from these:

- The first line must start with 'list(
- The last line must be ')'
- All other lines must be 'variable name' <- number, followed by a comer (except for the last data line which has no comer).

3.2.5) If the module estimating the composition of the Faroes catch is run (see below) the new values must be inserted at the end of the multiannual data file in place of the current ones.

3.2.6) Save the file before running the model.

4) Model structure

4.1) Introductory section: contains working directory, source files and various parameters controlling the way the program runs (some of these will need to be changed for your laptop (see below).

4.2) Functions: functions are sections of code that the program calls up to repeat the same job. They have to be run before they are first called by the program; this is achieved by placing them at the beginning of the code. The main functions run the hockey-stick analysis for the NCL model and output certain figures and tables.

4.3) Faroes and Greenland sections: these sections calculate the harvest in the distant water fisheries.

- 4.4) NEAC country/regions sections: there is a section for each country (in alphabetic order) and region to calculate the main outputs of the R-R model.
- 4.5) Output summaries: this section creates NEAC summary figures and tables and the country/region data files for the Winbugs Forecast Model.
- 4.6) Faroes catch composition: The final section estimates the proportion (mean and SE) of the Faroes catch originating in different countries/regions. This requires the model to be run once to provide the catch proportions and then run a second time to provide a full PFA assessment.

5) Running the code from RStudio

- 5.1) Open R Studio
- 5.2) Select "File/Open File" and use the browser to select and open the code file; the code should open in the Top left panel. The code will have a name like "NEAC_PFA_CL_RR_model_2015_xxx"
- 5.3) If you have been using the code recently, you can select "File/Recent Files" and select the file from the drop-down list (if it is there); you can open several code files simultaneously and they appear as tabs above the Top Left panel.
- 5.4) To set up the code for your PC/laptop, R-click on the code and scroll down to:

  line 40 -enter the full path name of the working directory (replace the text between the parentheses with the full pathname of the folder containing the code on your laptop (e.g. "D:/Modelling_NEAC/PFA_NCL_R/2014").

  line 45 -ensure that the text between the parentheses shows the correct filename for the multi-annual data file.

  lines 77–86 -select which countries you wish to run the assessment for by setting "run-XX": 1 = run country XX; 0 = do not run. The summaries will only be run if all countries are set to 1.

  line 82 -set "PrintFigs" equal to '1' to output the summary figures (or any other value not to output them); otherwise "0".

  line 89 -set "WinbugsFiles" equal to '1' to output the data files for the Bayesian forecast model (or any other value not to output them) ; otherwise "0"..

  line 92 -set "PrintCountryTables" equal to '1' to output summary output data for each region that is run (or any other value not to output them) ; otherwise "0"..

  line 98 -set "RunFaroeseCatchSplitEstimation" equal to "TRUE" to run the estimation of the Faroes catch composition; otherwise "FALSE".

- 5.5) You do not need to save your changes before you run the code. [If you wish to save any changes, use "File/Save" or "File/Save As" as normal. It's a good idea to include the extension ".R". NB: You will be prompted to save the file before you close it.]

  5.5.1) To clear the 'console' area (lower left panel) press "Ctrl-L"

5.5.2) To run the program press "Ctrl-Alt-R"

5.5.3) You will see when part of the code run in console area. Errors will show in red. The run is complete when the final line shows ">"

6) Running the program from R

6.1) Open R Studio

6.2) Select "File/Open script" and use the browser to select and open the code file; the code should open in a separate panel. The code is currently called "NEAC_PFA_CL_RR_model_2014"

6.3) To set up the code for your PC/laptop, R-click on the code and scroll down to:

SET WORKING DIRECTORY (wd): In line starting "wd <-" replace the text between the parentheses with the full pathname of the folder containing the code on your laptop (e.g. "D:/Modelling_NEAC/PFA_NCL_R/2014").

SET "run_XX": in the lines starting "run_XX <-" select which countries you wish to run the assessment for by setting "run-XX": 1 = run country XX; 0 = do not run. The summaries will only be run if all countries are set to 1.

SET 'PrintFigs': set "PrintFigs" equal to '1' to output the summary figures (or any other value not to output them).

SET 'WinbugsFiles: set "WinbugsFiles" equal to '1' to output the data files for the Bayesian forecast model (or any other value not to output them).

SET 'PrintCountryTables': set "PrintCountryTables" equal to '1' to output summary output data for each region that is run (or any other value not to output them).

SET 'RunFaroeseCatchSplitEstimation': set "RunFaroeseCatchSplitEstimation" equal to "TRUE" to run the estimation of the Faroes catch composition; otherwise "FALSE" [SEE BELOW]

6.4) You do not need to save your changes before you run the code, but you may wish to save a version to be safe. To do this use "File/Save" or "File/Save As" as normal. It's a good idea to include the extension ".R". NB: You will be prompted to save the file before you close it.

6.5) To run the program select "Edit/run all"

6.6) You will see when the code runs in the 'R console' panel. Errors will show in red. The run is complete when the final line shows ">"

7) Running the Faroes stock composition

7.1) The 'Multiannual-data' file contains the latest estimates of the composition of the Faroes catch by European country/regions based on the results of the genetics analysis reported in the 2015 WGNAS report and the 2001-14 PFA outputs. These estimates may be updated if new genetics data are provided or additional years of PFA estimates are to be included.

7.2) To run the estimation, ensure that all “Annual-data-XX” files have been updated.

7.3) SET 'RunFaroeseCatchSplitEstimation' to “TRUE” and run the model.

7.4) The new stock composition parameters will be output in the file “Faroes_split_estimate.txt”; these data should be copied into the end of the “Multiannual-data” file to replace the values already there. These data are also required for the Catch Options models.

7.5) Reset SET 'RunFaroeseCatchSplitEstimation' to “FALSE” and run the model again to produce full updates of the PFA estimates.

8) Output files

The program produces the following outputs (if requested):

8.1) National plots: (filenames “Figure-XX”)

PDF files showing the national plots currently used in the WG report. This includes: maturing and non-maturing 1SW PFA; returns and spawners for 1SW and MSW; homewater exploitation rates; and total catches (incl. non-reported) for each country (XX). It also shows the pseudo stock–recruitment hockey-stock plots for each region; these show the estimated CL, where this is used in the assessment.

8.2) Regional data: (filenames “Region_data_XX_YY”)

Excel files showing PFA, returns, catch, exploitation rates and spawners for 1SW and MSW fish and total eggs and lagged egg estimates for each country (XX) and region (YY).

8.3) Input files for Forecast analysis: (filenames: “Winbugs_Data_XX_YY”)

Excel files for each country/region containing mean and s.d. estimates for the simulations for lagged eggs, 1SW returns and MSW returns.

8.4) Summary tables by country:

- Median spawner numbers
- Conservation limits and SERs
- Maturing 1SW PFA
- 1SW returns
- 1SW spawners
- Non-maturing 1SW PFA
- MSW returns
- MSW spawners

8.5) Summary plot for N-NEAC and S-NEAC

8.6) A formatted Excel workbook is set up to link to the output files and format the tables ready for use in the WGNAS report.

9) Common problems

9.1) The code will crash if an output file (Figure or Table) is left open. The error message (in red) may say:

- Error .... : cannot open file 'Fig-XX' or

- Error in .... : cannot open file 'Region_data_XX.csv': Permission denied

9.2) It doesn’t matter if an input file is open, but the program may not read the latest version if it has not been saved.

More problems to be added .... when they are found!