ICES SGEFISSA Report 2007

ICES Diadromous Fish Committee
ICES CM 2007/DFC:01
REF. ACFM, WGNAS

Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance (SGEFISSA)

27–30 November 2006

Halifax, Canada

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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Recommended format for purposes of citation:

ICES. 2007. Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance (SGEFISSA), 27–30 November 2006, Halifax, Canada. ICES CM 2007/DFC:01. 71 pp. https://doi.org/10.17895/ices.pub.9240
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Executive Summary

- ICES has been asked by NASCO to provide a framework of indicators that would be used to identify any significant change in the previously provided multi-annual management advice for each NASCO Commission area.
- The Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance (SGEFISSA) met and has provided a finalized version of the Framework of Indicators (FWI).
- The FWI relies on informative relationships between historical monitoring metrics and estimates of population abundance to derive current abundance levels from contemporary metric values. These abundance estimates (and therefore the associated metric values) may be characterised as either meeting or failing to meet fishery-specific management objectives.
- The SGEFISSA provided a FWI framework and template that can be applied in the management of the Greenland Fishery to identify any significant change in the previously provided multi-annual management advice.
- The SGEFISSA has also provided a suggested timeline for the incorporation of the FWI into the management process for the Greenlandic and Faroese Atlantic salmon fisheries.
- The SGEFISSA has not provided a similar FWI for the Faroese fishery due to the lack of specific management objectives and quantitative catch advice. Quantitative catch advice for the Faroese fishery is not possible because of the lack of a predicative PFA model for three of the four contributing North-East Atlantic Commission stock complexes plus the absence of a formalized sharing agreement for any harvestable surplus amongst the Parties of NASCO.

1 Introduction

1.1 Main Tasks

At its 2006 Statutory Meeting, ICES resolved (C. Res. 2006/ACFM05) that the Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance [SGEFISSA] (Chair: T. Sheehan, USA) will be established and will meet in Halifax, Canada, from 27 November to 30 November 2006, to consider questions posed to ICES by the North Atlantic Salmon Conservation Organisation (NASCO).

- Provide a framework of indicators which would be used to identify any significant change in the previously provided multi-annual management advice for each NASCO Commission area; The Study Group may consider the following in their response:
    - minimum information needed which would signal a significant change in the previously provided catch advice for each NASCO Commission area
    - a framework of stock abundance indicators which would inform when moving from a state of high PFA abundance to a state of low PFA abundance and vice versa for both NAC and NEAC stock complexes
    - compliance Rules against which to assess indicator states which permit precautionary management of salmon stocks.

The Study Group consisted of 14 participants. A full address list for the participants is provided in Annex 1. The Study Group considered 5 Working Documents submitted by the participants that are listed in Annex 2; other references cited in the report are given in Annex 3. A list of acronyms used within this document is provided in Annex 4.

Participants

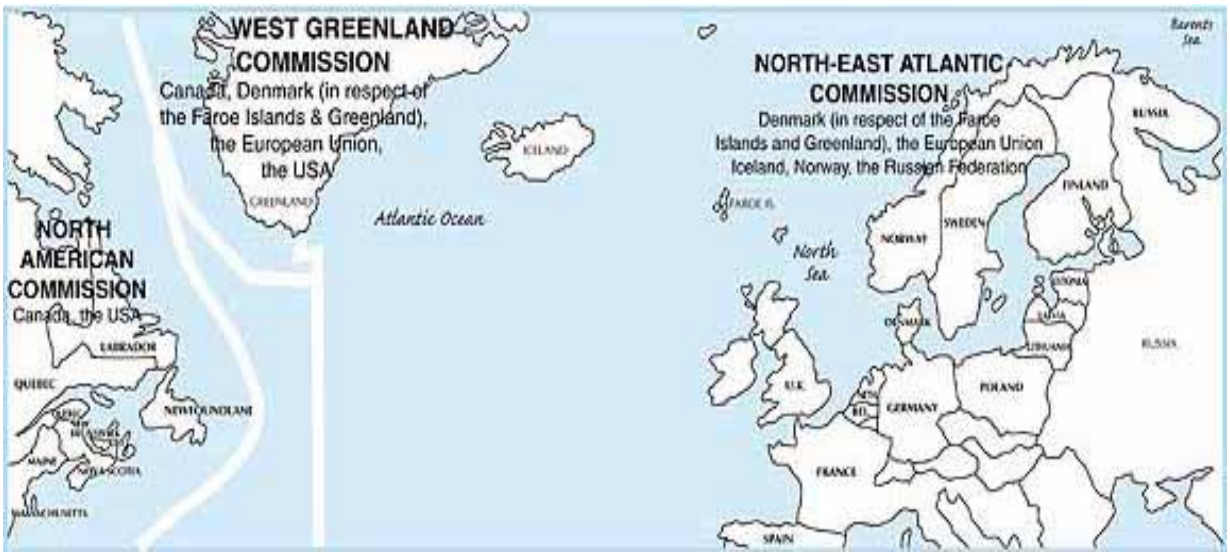
Sheehan, T. (Chair)	USA
Amiro, P.	Canada
Caron, F.	Canada
Chaput, G.	Canada
Claytor, R	Canada
Gibson, J	Canada
Hansen, F. I.*	Denmark
Hansen, L. P.	Norway
Legault, C.	USA
MacLean, J. C.	UK (Scotland)
Ó Maoiléidigh, N.	Ireland
Russell, I.	UK (England & Wales)
Ryall, P.	Canada
Smith, G. W.	UK (Scotland)
Trial, J.	USA

** did not attend SGEFISSA meeting*

1.2 Background

The North Atlantic Salmon Conservation Organisation (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. While sovereign states retain their role in the regulation of salmon fisheries for salmon originating from their own rivers, distant water salmon fisheries, such as those at Greenland and Faroes, which take salmon originating from rivers of another Party are regulated by NASCO under the terms of the Convention. NASCO now has seven Parties that are signatories to the Convention, including the EU which represents its Member States.

NASCO discharges these responsibilities via three Commission areas shown below:



In 2005, ICES was asked to provide annual catch options or alternative management advice for 2006–2008, for all three Commission Areas, if possible based on forecasts of PFA. ICES was also asked to provide an assessment of the minimum information needed to signal a significant change in the previously provided advice for each Commission area (ICES, 2006). These requests were considered to be necessary for the adoption of multi-annual regulatory measures by NASCO contracting parties.

ICES provided multi-annual management advice for all three Commission Areas and made some progress providing an assessment of the minimum information needed to signal a significant change in this advice (ICES, 2006). The approach developed by the Working Group on North Atlantic Salmon (WGNAS) to provide this assessment was termed the Framework of Indicators (FWI) at the 2006 NASCO Annual Meeting. The advice and FWI formed the basis for the multi-annual (3 year) regulatory measures, which were agreed upon in the West Greenland (salmon fishery in the waters off West Greenland; NASCO, 2006a) and North-East Atlantic Commissions (salmon fishery in Faroese waters; NASCO, 2006b). Based on the agreements in both Commission Areas, the second and third year of the regulatory measure is dependant on two factors:

- ICES providing a Framework of Indicators.
- The parties to each Commission Area accepting the Framework of Indicators for use in the interim years (years between the WGNAS conducting a full stock assessment producing multi-year management advice) to identify any significant change in the previously provided management advice.

1.3 NASCO's management objectives

NASCO (NASCO, 1998) has identified the primary management objective of the organisation as:

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

Further, the Agreement on the Adoption of a Precautionary Approach states that an objective for the management of salmon fisheries is to provide the diversity and abundance of salmon stocks" and NASCOs Standing Committee on the Precautionary Approach interpreted this as being "to maintain both the productive capacity and diversity of salmon stocks".

NASCO's Action Plan for Application of the Precautionary Approach (NASCO, 1999) provides interpretation of how this is to be achieved, as follows:

- "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".

1.4 Management reference points

Conservation limits (CLs) for North Atlantic salmon stock complexes have been defined by ICES as the level of stock (number of spawners) that will achieve long term average maximum sustainable yield (MSY). In many regions of North America, the conservation limits are calculated as the number of spawners required to fully seed the wetted area of the

river. In some regions of Europe, pseudo stock-recruitment observations are used to calculate a "hockey stick" relationship, with the inflection point defining the conservation limits Potter et al., 1998). In the remaining regions, the conservation limits are calculated as the number of spawners that will achieve long-term average maximum sustainable yield (MSY), as derived from the adult-to-adult stock and recruitment relationship (Ricker, 1975; ICES, 1993). NASCO has adopted these region specific conservation limits (NASCO, 1998). The conservation limits are limit reference points (S_{lim}), which should be avoided with high probability.

1.5 West Greenland fishery management objectives

For management advice for the West Greenland fishery, NASCO has adopted a precautionary management plan requiring at least a 75% probability of achieving three management objectives:

- Meeting the conservation limits simultaneously in the four northern regions of North America: Labrador, Newfoundland, Quebec, and Gulf.
- For the two southern regions in North America, Scotia-Fundy and USA, where there is a zero chance of meeting conservation limits: achieve increases in returns relative to previous years with the hope of rebuilding the stocks. In 2004, ICES established 1992 to 1996 as the range of years to define the baseline for the Scotia-Fundy and USA regions to assess the pre-fishery abundance of North American stock (PFA_{NA}) and fishery options. Improvements of greater than 10% and greater than 25% relative to returns during this base period are evaluated.
- Meeting the conservation limits for the Southern North-East Atlantic Commission MSW complex.

1.6 Faroese fishery management objectives

For the advice on management of national components in the North-East Atlantic Commission (NEAC), where there are no specific management objectives, NASCO's management objectives (see Section 1.3) have been adopted as the guiding principles.

1.7 Management advice

The run-reconstruction model developed by Rago *et al.* (1993) has been used to estimate the prefishery abundance (PFA) of non-maturing 1SW salmon of North American (NA) origin prior to the fishery at West Greenland. A comparable run-reconstruction model has been developed for the European (EUR) stocks (Potter *et al.*, 1998). Management advice for the West Greenland fishery is generated by combining the PFA_{NA} with the PFA_{EUR} in a risk analysis framework to estimate the probability of meeting conservation limits for contributing populations based on differing levels of harvest (Chaput *et al.*, 2005). Quantitative management advice is not provided for the Faroese fishery because of the lack of a predictive PFA model for three of the four contributing North-East Atlantic Commission (NEAC) stock complexes and the absence of a formalized sharing agreement for any harvestable surplus amongst the Parties of NASCO. Instead, qualitative management advice is given for each NEAC stock complex based on the stock complex being at full reproductive capacity (spawner estimate and 95% confidence interval being above the conservation limit (CL)), at risk of suffering reduced reproductive capacity (spawner estimate being above the CL but the lower bound of the 95% confidence interval being below) or suffering reduced reproductive capacity (spawner estimate and 95% confidence interval being below CL). Details are described in the annual report of the WGNAS (ICES, 2006).

2 Generalized approach

2.1 Overall Approach

ICES was asked to produce a final FWI that could be used to identify any significant change in the previously provided management advice for each NASCO Commission area.

The FWI approach is based on the premise that monitoring program metrics can be informative indicators of stock abundance. Historical relationships between various metric indicators and stock abundance were evaluated to determine those indicators which were informative and, for these, the appropriate metric threshold in relation to the management objective in question. The threshold categorizes metric levels so that in years when the metric measure is above this threshold, high stock abundance levels were present. Conversely, metric levels below this threshold corresponded to low stock abundance levels. This process was duplicated across numerous river-specific monitoring program datasets thereby providing wide spatial coverage across all stock complexes being evaluated. Contemporary monitoring program data can then be evaluated against these historical relationships to provide an early indication as to whether stock abundance levels are higher or lower than previously predicted, and thus provide a check on the reliability of the previously provided multi-annual management advice.

2.2 Terms and Definitions

ICES (2006) has previously defined numerous terms within the FWI (Figure 2.2.1):

- **Management Objective** – Management objectives are pre-agreed criteria, which are considered in the formation of management advice. For the fishery at West Greenland, there are three management objectives related to meeting region-specific CLs or some level of stock abundance increase. The number of adult spawners required to meet these objectives can be calculated. For the fishery at Faroes, there are no specific pre-defined management objectives. NASCO's management objectives (see Section 1.3) have therefore been adopted as the guiding criteria.

- **Variable of interest** - The variable of interest is a measure of adult returns (i.e. adult returns or PFA). Estimates of adult returns can be directly evaluated against a management objective to determine if a harvestable surplus exists within a stock complex (i.e. more fish are estimated to be present than required to meet the management objective). Combining variables of interest provides a means to evaluate if there is likely to be a significant change in the previously provided multi-annual management advice.

- **Threshold value** – The threshold value represents the level of the variable of interest that corresponds to the management objective for the fishery of interest. Thus, estimates of the variable of interest that are above the threshold value indicate that the current management objective might be met and that a harvestable surplus may exist. Estimates below the threshold value indicate that the management objective would not be met and that there is no harvestable surplus.

- **Indicator** – An indicator is any metric of stock performance (returns, return rate, fish size…) or other environmental variable (temperature, prey abundance…) being evaluated as an informative correlate for the variable of interest.

- **Decision rule** – The decision rule is a set value for the indicator, which is informative of the variable of interest relative to meeting the management objective being evaluated. Assuming perfect data, indicator values greater than the decision rule correspond to variables of interest that exceed the threshold value while indicator values that are less than the decision rule correspond to variables of interest

below the threshold value. Variable of interest values that exceed the threshold value suggest that there is a harvestable surplus, while values below suggest that there is no harvestable surplus.

- **Objective function** – The objective function is an unbiased approach to setting the decision rule, which maximizes the number of correct assignments for each indicator/variable of interest combination. Correct assignments occur when an indicator is above the decision rule and the corresponding variable of interest exceeds the threshold value and conversely when an indicator is below the decision rule and the corresponding variable of interest is below the threshold value.

- **True high state** – A true high state corresponds to the indicator suggesting that the variable of interest (returns or PFA value) is greater than the threshold value when in fact it was (i.e. the indicator correctly suggests that the management objective was met).

- **True low state** - A true low state corresponds to the indicator suggesting that the variable of interest (returns or PFA value) is below the threshold value when in fact it was (i.e. the indicator correctly suggests that the management objective was not met).

- **False high state** - A false high state corresponds to the indicator suggesting that the variable of interest (returns or PFA value) is greater than the threshold value when it was not (i.e. the indicator incorrectly suggests that the management objective was met). This represents a scenario of overestimating stock abundance and threatening fisheries conservation if a fishery were allowed to proceed.

- **False low state** – A false low state corresponds to the indicator suggesting that the variable of interest (returns or PFA value) is less than the threshold value when in fact it was above (i.e. the indicator incorrectly suggests that the management objective was not met). This represents a scenario of forgone harvest. Precautionary management would minimize the likelihood of a false high state relative to a false low state conclusion.

2.3 Generalized Process

The process for developing and applying the FWI consists of 6 generalized steps, which are detailed in Section 3:

1) Definition of a significant change - Define measurable criteria for what the statement "a significant change in the previously provided multi-annual management advice" represents.

2) Evaluating historical relationships between indicators and variable of interest - Define and evaluate the historical relationships between numerous indicators and the variable of interest for individual rivers across all stock complexes.

3) Establishing threshold values – Define the threshold level (i.e. variable of interest level) that will satisfy the management objectives for each stock complex.

4) Decision rule determinations – Define and apply a standardized 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.

5) Combining Indicators within the Framework - Define and apply a standardized approach for combining indicator datasets within and across stock complexes for future comparison against contemporary indicator values.

6) 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.

3 Framework of Indicators

3.1 Definition of a significant change

Since 2002, ICES has recommended that no fishery be prosecuted at West Greenland due to the low probability of meeting the management objectives outlined for the fishery. For the Faroese fishery, ICES has recommended that exploitation rates on the contributing stock complexes either be maintained at their current level or reduced in a precautionary manner due to some contributing stock complexes being either at or below their Spawner Escapement Reserve (SER) and/or CL. Since 2002, there have been no commercial fisheries at either West Greenland or the Faroe Islands.

SGEFISSA defines a significant change in the previously provided multi-annual management advice 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.

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 3 objectives could be met simultaneously:

- the conservation limits of the four northern regions of North America (Labrador, Newfoundland, Quebec, and Gulf) were achieved
- there was a 25% increase in returns to the Scotia-Fundy and USA regions relative to the mean returns for the 1992–1996 period
- the conservation limit for the Southern NEAC MSW complex was achieved.

In the absence of explicit management objectives for the fishery at the Faroes, ICES has relied on qualitative evaluation of past stock performance to advise on the risks of prosecuting a fishery. Historically, ICES has advised against a fishery when the 95% confidence interval of the PFA and/or the current estimate of spawners were below their respective SER and CL for any one of the four contributing stock complexes. In recent times, ICES has advised against a fishery at Faroes even when these lower bounds were above their respective limits on the basis that within each stock complex there were rivers known to be below their conservation limit. This advice is in line with the Precautionary Approach, which NASCO adopted in 1999 (NASCO, 1999). In the absence of explicit management objectives and quantative management advice for the Faroese fishery, the SGEFISSA was unable to define a “significant change” in the previously provided management advice for the Faroese fishery.

3.2 Evaluating historical relationships between indicators and variable of interest

A number of variables were considered for inclusion as indicators in the FWI such as adult returns, adult return rates, proportions of older/repeat spawners, oceanographic variables, indices of salmon prey, condition factor indices and in-season returns of small/1SW salmon. Discussions focused on the appropriateness and utility of the variable being informative of stock abundance. Only two of the proposed variables were considered informative enough to be carried forward into the framework:

Adult returns

Estimates of adult returns (returns, catch or estimated PFA) are available for a number of monitored rivers throughout the North Atlantic and can be directly related to the management objectives for each fishery since NASCO management objectives are related to achieving (or maintaining) some level of stock abundance.

When available, both 1SW and 2SW estimates of returns were evaluated for both wild and hatchery stocks. CLs are measured as the number of 2SW spawners required to achieve MSY. Therefore 2SW returns give a direct measure of the likelihood of meeting management objectives. 1SW returns may also be useful as an indicator of abundance assuming some level of correlation between sea survivals of different cohorts in the same year.

Adult return rates

Estimates of adult return rates (i.e. smolt survival rates, marine survival) are available for a number of monitored rivers throughout the North Atlantic and they are directly related to adult returns. ICES has consistently stated that adult returns are strongly influenced by factors in the marine environment and that for many stocks current marine survival estimates are low compared to historic levels (ICES, 2006). When available, both 2SW and 1SW survival rates for wild and hatchery stocks were evaluated.

The data examined included measures of returns to rivers, returns to the coast, angling catches, as well as survivals by size group or sea age group (1SW and 2SW) and origin (wild and hatchery) when available. Data sets were considered relative to the stock and/or geographic areas in the North America (NAC) and North East Atlantic (NEAC) Commissions.

For the **NAC**, a total of 80 data sets (Annex 5) were examined from 38 rivers ranging from the US to Labrador (Figure 3.2.1).

ORIGIN	Wild	Wild	Wild	Wild	Hatchery	Hatchery
TYPE OF DATA	Return	Return	Survival	Survival	Survival	Survival
SIZE/AGE GROUP	Small/1SW	Large/2SW/ MSW	Small/1SW	Large/2SW	Small/1SW	Large/2SW
Labrador	1	1				
Newfoundland	8		3			
Quebec	15	15	2	2		
Gulf	2	2	1	1		
Scotia-Fundy	7	7		2	2	4
US[1]	1	2[2]			1	1

[1] for US, returns include both wild and hatchery origin fish

[2] in one river (Narraguagus), returns are of age/size groups combined

For **southern NEAC <u>non-maturing</u> stock complex**, a total of 32 data sets were examined from 21 rivers in France, Ireland, UK (N. Ireland), UK (England and Wales), UK (Scotland), and south-west Iceland (Figure 3.2.2**;** Annex 5).

ORIGIN	Wild	Wild	Hatchery	Hatchery
SIZE/AGE GROUP	Small/1SW	Large/2SW/MSW	Small/1SW	Large/2SW
Catch		1		
Return	1	10[1]		
Survival	4	5[2]	10	1
National PFA estimate				

1 for River Test (UK England and Wales), returns are for combined wild and hatchery origin fish

2 for River Nivelle (France) return rates are for all age/size groups combined

For **southern NEAC <u>maturing</u> stock complex**, a total of 31 data sets were examined from 18 rivers in France, Ireland, UK (N. Ireland), UK (England and Wales), UK (Scotland), and south-west Iceland (Figure 3.2.2; Annex 5).

ORIGIN	Wild	Wild	Hatchery	Hatchery
SIZE/AGE GROUP	Small/1SW	Large/2SW/MSW	Small/1SW	Large/2SW
Catch	1	1		
Return	9[1]			
Survival	6	3[2]	11	
National PFA estimate				

1 for River Test (UK England and Wales), returns are for combined wild and hatchery origin fish

2 for River Nivelle (France) return rates are for all age/size groups combined

For **northern NEAC <u>non-maturing</u> stock complex**, a total of 12 data sets were examined from 7 rivers from north-east Iceland, Norway and Finland Figure 3.2.2; Annex 5).

ORIGIN	Wild	Wild	Hatchery	Hatchery
SIZE/AGE GROUP	Small/1SW	Large/2SW/MSW	Small/1SW	Large/2SW
Catch		3		
Return				
Survival		5		3
National PFA estimate		1		

For **northern NEAC <u>maturing</u> stock complex**, a total of 12 data sets were examined from 7 rivers from north-east Iceland, Norway and Finland (Figure 3.2.2; Annex 5).

ORIGIN	Wild	Wild	Hatchery	Hatchery
SIZE/AGE GROUP	Small/1SW	Large/2SW/MSW	Small/1SW	Large/2SW
Catch	3			
Return				
Survival	5		3	
National PFA estimate	1			

3.3 Establishing threshold values

In keeping with the 75% probability of meeting or exceeding the objectives for the West Greenland catch options (see Section 1.5), the 25th percentile of the returns estimates of the six areas in North America (Table 3.3.1) were compared to the corresponding 2SW conservation limits of the four northern areas of North America and to the 25% increase objective for the two southern areas (Table 3.3.2). For the southern NEAC non-maturing component, the 25th percentile of the PFA estimates of the southern NEAC non-maturing complex (Table 3.3.3) were compared to the spawning escapement reserve (SER) for the southern NEAC non-maturing complex (Table 3.3.2).

For the Faroese fishery, the lower bounds of the 95% confidence interval (2.5th percentile) of the corresponding reconstructed PFA values for the southern and northern NEAC maturing and non-maturing stock complexes (Table 3.3.3) were used and compared to the corresponding SER of each complex (Table 3.3.4).

Specifically, the analysis consisted of:

- US - point estimates of the annual returns of 2SW salmon to US were compared to the management objective of achieving returns that are 25% greater than the average returns for the base years 1992 to 1996 (*threshold value = 2,548 fish*)
- Scotia-Fundy (SF) - the 25th percentile of the range of annual returns to SF are compared to the management objective of achieving returns that are 25% greater than the average returns for the base years 1992 to 1996 (*threshold value = 10 976 fish*)
- Gulf - the 25th percentile of the range of annual 2SW returns to Gulf are compared to the management objective of achieving returns that equal or exceed the 2SW conservation limit for Gulf (*threshold value = 30 430 fish*)
- Quebec - the 25th percentile of the range of annual 2SW returns to Quebec are compared to the management objective of achieving returns that equal or exceed the 2SW conservation limit for Quebec (*threshold value = 29 446 fish*)
- Newfoundland - the 25th percentile of the range of annual 2SW returns to Newfoundland are compared to the management objective of achieving returns that equal or exceed the 2SW conservation limit for Newfoundland (*threshold value = 4022 fish*)
- Labrador - the 25th percentile of the range of annual 2SW returns to Labrador are compared to the management objective of achieving returns that equal or exceed the 2SW conservation limit for Labrador (*threshold value = 34 746 fish*)
- Southern NEAC non-maturing complex - the 25th percentile of the PFA estimates for this complex are compared to the spawner escapement reserve (SER) for the complex (*threshold value = 465 498 fish*)
- Southern NEAC maturing complex - the lower limit of the 95% confidence interval of the PFA estimates for this complex are compared to the SER of the complex (*threshold value = 790 817 fish*)
- Northern NEAC non-maturing complex - the lower limit of the 95% confidence interval of the PFA estimates for this complex are compared to the SER of the complex (*threshold value = 240 621 fish*)
- Northern NEAC maturing complex - the lower limit of the 95% confidence interval of the PFA estimates for this complex are compared to the SER of the complex (*threshold value = 348 253 fish*)

3.4 Decision rule determinations

The analysis of the relationships between the indicators and the returns of 2SW salmon or the PFA estimates were similar to those suggested by ICES (2006). The individual river catches, returns or return rates were 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 data set relative to the 2SW returns or the PFA estimates were prepared. Upper and lower halves were 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 corresponded to years when the returns or PFA exceeded the management objectives. Points in the lower half corresponded to years when the returns or PFA were less than the management objective.

Left and right halves were defined by a sliding rule along the indicator range. An objective function that maximized the number of correct assignments (true highs and true lows) was used to define the indicator decision rule. The objective function also minimizes the number of incorrect assignments (false highs and false lows, Figure 2.2.1).

The value of the indicator variable that minimized the sum of the penalty scores (minimize the number of incorrect assignments) was assigned as the decision rule for that data set. Equal penalty weights were assigned to false highs (lower right quadrant) and false lows (upper left

quadrant). Correct assignments were scored as zero. In the case when multiple minima occurred, the lowest indicator value among the low minima values was chosen.

In this analysis, indicators were retained in the framework when they were evaluated as being informative of the magnitude of returns or PFA relative to the management objectives. These informative indicator data sets also had to meet the following two criteria to be retained:

1) Expectation that the indicator variable would be available in the future, and
2) A minimum of five observations were present in each of the correct quadrats (true low; true high)

Indicators that failed these rules were evaluated according to how well they correlated with abundance, either as returns or PFA, but were not kept as part of the FWI. As a preliminary guide to their future use, indices were assigned as either "Informative" (r^2 from 0.202 to 0.842) or "Not informative" (r^2 from 0.000 to 0.179, Tables 3.4.1 – 3.4.4).

3.5 Combining indicators within the Framework

The probabilities of correct assignments were calculated for each of the true low and true high states for each of the indicator datasets retained (Tables 3.5.1–3.5.6). 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 were then pooled according to management objective/stock complex groupings. Each NAC stock complex (n=6) and the Southern NEC non-maturing stock complex was pooled separately as these stock complexes relate to the management objectives of the West Greenland fishery. Conversely, each of the NEAC stock complexes would be pooled separately (n=4) for the Faroese fishery.

3.6 Applying the FWI

To apply the FWI, the most recent year's indicator value for each of the retained indicator datasets would be compared to the decision rule as determined from the historical datasets. If the contemporary indicator value is low relative to the decision rule, it would be assigned a value of -1. If the value was high, it would be 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 would suggest 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 likelihood that all the management objectives for that fishery will be met. Under that scenario, the SGEFISSA suggests that the multi-year management advice be reassessed. When the score(s) for one of more of the groupings is less than zero, the SGEFISSA suggests that there is unlikely to be a significant change in the management advice. Under that scenario, the SGEFISSA suggests that there is no expectation that there would be a significant change in the multi-year management advice and it should not be reassessed.

4 Results

4.1 Indicator dataset selection

For the NAC area, the returns of 2SW salmon have been both above and below the area specific management objectives and a total of 26 indicator data sets were retained in the framework (Tables 3.5.1–3.5.6; Figure 4.1.1). Indicator data sets were frequently not retained because the penalty function was minimized at either the lowest or highest value of the indicator variables or there were insufficient numbers of observations that were correctly classified by the derived indicator decision rule (Tables 3.5.1–3.5.6; Figure 4.1.2). Of the 26 retained indicator data sets, many (over 60%) of them provided high (>80%) probabilities of correct classification (true low or true high) of whether the management objectives for the areas would be achieved. All the indicators retained provided greater than 80% correct classification rate for either the true low or true high states and none of the classification rates were less than 50% (Figure 4.1.3).

For the NEAC indicators analyses, no data sets were retained in the framework. None of the datasets that were considered informative of the magnitude of returns/PFA met the criteria of having a minimum of five observations in each of the correct quadrats. This is due to the lack of true low states since over the time series the PFA estimates have predominately remained above the SER. These datasets should be reconsidered for use in the future, especially if PFA estimates either remain or decline to levels below the limit reference points for each stock complex (Tables 3.4.1–3.4.4; Figures 4.1.4–4.1.5).

4.2 Suggested timeline

Ideally, assessments of the status of Atlantic salmon stocks across the North Atlantic are needed just prior to the initiation of any fishery in order to evaluate if there has been a significant change in the previous multi-annual management advice. However, timing discrepancies between the fisheries, field data collection and the management process make this an unachievable option. The SGEFISSA has developed a FWI, which evaluates if there is likely to be a significant change in the previously provided management advice. The SGEFISSA proposes a timeline to operate the FWI if it was adopted and employed (Figure 4.2.1). This timeline is not year-specific and is flexible enough to be utilized many years into the future.

During May of the first year of the cycle (Year i), ICES would provide NASCO with an updated FWI and three year multi-annual management advice for the fishery in question. During January of Year i+1, the Parties of NASCO would compile the Year i values for the indicator metrics included in the FWI. This dataset would be transcribed into the Excel based Framework of Indicators file provided by ICES (Figure 4.2.2). This Framework file would house the updated FWI and automatically provide the results of the FWI analysis ("Reassess" or “No Significant Change Identified by Indicators") once the Year i indicator values were entered.

Depending on the results of the analysis, two paths could be followed:

1) No Significant Change Identified by Indicators – no further action is required: the FWI suggests that there is no expectation of there being a significant change in the multi-annual management advice, the multi-annual management advice would remain intact and the FWI would remain in place and be applied again in January of the following year.

2) Reassess – further action is required: the FWI suggests that there is some expectation of there being a significant change in the multi-annual management advice and a full re-assessment should be undertaken the following April

In the event of a new assessment being undertaken, ICES would present the results of the new assessment and an updated FWI to NASCO the following May. At this point, the cycle would be re-initiated at Year i. The other way the cycle would be re-initiated would be if the Year variable was equal to four. Under that scenario, it is suggested that a new assessment be undertaken and the FWI be updated the following April with both being presented to NASCO in May.

5 Summary and Conclusions

The SGEFISSA has investigated mechanisms to establish a Framework of Indicators to signal if there is an expectation of a significant change in the previously provided multi-annual management advice for Atlantic salmon stocks across the North Atlantic. A significant change in management advice has been defined 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. The FWI approach relies on the historical relationship between indicator datasets and adult abundance to estimate current spawner abundance levels from contemporary indicator values. Indicator datasets were considered for inclusion in the FWI from most of the monitored rivers across the North Atlantic, thereby maximizing the amount of information available for this evaluation. Additional datasets will be considered for inclusion during future FWI updates.

A total of 135 indicator datasets were examined from 73 rivers across 10 different countries, encompassing all 10 NASCO defined North Atlantic salmon stock complexes. Each dataset was evaluated for inclusion into the FWI according to pre-established criteria. Datasets not included in the FWI were evaluated if they were an informative measure of adult abundance to be considered for inclusion in a future version of the FWI.

The SGEFISSA has developed a FWI for the Greenland fishery based on the seven contributing stock complexes and direct links to the management objectives established by NASCO for this fishery. The FWI for the Greenland fishery incorporates 26 indicator datasets from 5 different stock complexes contributing to the fishery. Based on the available data this FWI will provide an evaluation if there is an expectation that the previously provided management advice for the Greenland fishery is likely to change in the following year.

The SGEFISSA has developed an Excel based Framework of Indicators file for the Greenland fishery (*Greenland Fishery Framework of Indicators.xls*) that provides a simple mechanism for applying the FWI on an annual basis. The underlying variable of interest/ indicator dataset relationships and decision rule are summarized and collated according to the specific management objectives for each fishery. To apply the FWI, a user must enter the indicator values for the most recent year and the required fields are automatically calculated, displayed, summarized in a stock-specific fashion and an overall recommendation is determined.

The SGEFISSA was unable to develop an Excel based Framework of Indicators file for the Faroese fishery. This was caused by a number of different factors:

- None of the available indicator datasets for the contributing stocks to this fishery meet the criteria for the FWI. Many of the datasets evaluated did not show an informative relationship between the indicator and variable of interest. Of the datasets that did show a relationship, they did not meet the criteria for inclusion in the FWI; a minimum of five observations in each of the correct quadrats.
- Providing multi annual management advice is predicated on having a quantitative forecast model for the contributing stock complexes. At a minimum, there is a need to have such a model for the stock complex that is closest to its management objective/threshold value (i.e. the limiting stock complex). In recent times, the

limiting stock complex for this fishery has been the Southern NEAC non-maturing complex for which a quantitative forecast model is available. However, if this stock complex increases in abundance and another contributing stock complex decreases, there may be a situation where providing multi-annual management advise in not feasible. Having quantitative forecast models for all stock complexes contributing to this fishery is the optimal solution.

- A sharing agreement allocating any exploitable surplus within this fishery must be determined prior to providing quantitative catch options for this fishery. There is currently no sharing agreement for this fishery
- Explicit management objectives need to be determined for this fishery. Explicit management objectives allow for the estimation of the stock-specific threshold values used to determine if a harvestable surplus exists.
- In relation to the stock complex that is currently limiting this fishery (Southern NEAC non-maturing complex), in recent years the lower bound of the 95% confidence interval of the PFA has remained either slightly above or slightly below its corresponding Spawner Escapement Reserve. Given these circumstances, the SGEFISSA is of the opinion that multi-year management advice for the Faroese fishery is not appropriate at the present time and recommends that annual assessments be conducted to allow scientists and managers to continue to closely monitor the status of this stock complex.

The SGEFISSA has also provided a suggested timeline for the incorporation of the FWI into the management process for the Greenland and Faroese Atlantic salmon fisheries. The timeline outlines a schedule that allows the most recent year's data to be evaluated in the FWI prior to the Annual NASCO meeting where the management regulations are negotiated. With this schedule, sufficient preparation time exists for ICES if there is a need for full assessment to generate new management advice.

The FWI provided by the SGEFISSA currently stands as a one way test only. It compares the abundance estimate determined from the current indicator value to the threshold value determined by the management objective. If the value is above the threshold, there may be a harvestable surplus. If it is below the threshold value there is unlikely to be a harvestable surplus. Since 2002, ICES has consistently recommended no harvest for either fishery due to the low probability of meeting the stated management objectives.

However, when stock status improves to a level of there being a harvestable surplus and catch options other than zero are indicated, the FWI can be modified to look at the alternative scenario: the potential for an overestimation of stock abundance by the quantitative forecast model and therefore a reduction in the catch option. To accomplish this, the FWI will need to monitor the relative change, both in magnitude and direction, for the region-specific score (average indicator score for that region) from year to year to give an indication of what direction the indicators signal the population is going.

6 Recommendations

- The SGEFISSA recommends that NASCO consider adopting the FWI and employing the *Greenland Fishery Framework of Indicators.xls* worksheet according to the timeline provided
- The SGEFISSA recommends that the ICES WGNAS members collate and update all available datasets that could be considered within the FWI prior to their 2007 meeting. The SGEFISSA also recommends that the FWI be updated and a new *Greenland Fishery Framework of Indicators.xls* worksheet be developed during that meeting.
- The SGEFISSA recommends that previously considered, but not included indicator datasets, be re-valuated during required FWI updates. At that time, the addition of new datasets should also be considered.

- The SGEFISSA recommends that the FWI be modified from a one-way test to a two-way test to evaluate the potential for an overestimation of stock abundance by the quantitative forecast model and therefore a reduction in the catch option. This modification is not currently required but should be conducted during one of the required FWI updates.

Tables and figures

Table 3.3.1. Returns (25th percentile) of 2SW salmon to six geographic areas of NAC. The 25th percentile is calculated from the minimum and maximum ranges for each area, except for US where the values are point estimates.

SMOLT YEAR	YEAR OF 1SW RETURN	YEAR OF 2SW RETURN	USA	SCOTIA-FUNDY	GULF	QUEBEC	NFLD	LAB
1968	1969	1970		15 436				
1969	1970	1971	653	12 493	33 799	33 799	4 021	10 553
1970	1971	1972	1 383	15 454	41 691	41 691	4 134	9 072
1971	1972	1973	1 427	11 468	41 045	41 045	5 128	12 686
1972	1973	1974	1 394	23 694	57 638	57 638	3 104	12 289
1973	1974	1975	2 331	25 832	36 333	36 333	3 660	11 677
1974	1975	1976	1 317	23 785	34 788	34 788	3 675	13 489
1975	1976	1977	1 998	31 258	69 277	69 277	2 946	11 913
1976	1977	1978	4 208	18 350	35 685	35 685	3 092	9 435
1977	1978	1979	1 942	9 964	10 067	10 067	1 727	5 438
1978	1979	1980	5 796	35 129	50 985	50 985	3 769	12 707
1979	1980	1981	5 601	21 315	20 675	20 675	5 597	11 563
1980	1981	1982	6 056	19 183	36 482	36 482	4 439	8 534
1981	1982	1983	2 155	15 921	33 464	33 464	3 996	6 199
1982	1983	1984	3 222	20 428	23 865	23 865	3 440	4 418
1983	1984	1985	5 529	26 827	28 125	28 125	1 483	3 531
1984	1985	1986	6 176	21 852	44 677	44 677	2 515	6 033
1985	1986	1987	3 081	13 817	28 751	28 751	2 110	8 052
1986	1987	1988	3 286	12 735	31 992	31 992	2 440	5 060
1987	1988	1989	3 197	14 409	21 686	21 686	1 098	4 927
1988	1989	1990	5 051	12 404	30 297	30 297	2 110	2 809
1989	1990	1991	2 647	12 431	25 528	25 528	1 648	1 346
1990	1991	1992	2 459	11 447	37 764	37 764	4 972	5 773
1991	1992	1993	2 231	7 728	32 567	32 567	2 397	7 452
1992	1993	1994	1 346	5 016	26 204	26 204	2 428	10 339
1993	1994	1995	1 748	6 158	35 134	35 134	3 566	20 327
1994	1995	1996	2 407	8 540	22 631	22 631	4 431	15 025
1995	1996	1997	1 611	4 357	20 359	20 359	4 736	13 358
1996	1997	1998	1 526	2 562	13 022	13 022	5 414	29 043
1997	1998	1999	1 168	4 259	12 293	12 293	4 365	11 499
1998	1999	2000	533	2 142	13 079	13 079	4 523	13 429
1999	2000	2001	788	3 926	21 239	21 239	3 169	14 992
2000	2001	2002	511	816	10 207	10 207	2 400	8 481
2001	2002	2003	1 192	3 015	20 164	20 164	2 788	6 854
2002	2003	2004	1 283	2 142	20 253	20 253	2 715	9 033
2003	2004	2005	984	1 507	19 917	19 917	3 724	9 336

Table 3.3.2. Management objectives and equivalent number of fish relevant to the development of management advice at West Greenland for the six geographic areas in NAC and the southern NEAC non-maturing complex.

AREA	OBJECTIVE	NUMBER OF FISH
US	25% increase from 2SWreturns during 1992 to 1996	2,548
Scotia-Fundy	25% increase from 2SWreturns during 1992 to 1997	10,976
Gulf	2SW conservation limit	30,430
Quebec	2SW conservation limit	29,446
Newfoundland	2SW conservation limit	4,022
Labrador	2SW conservation limit	34,746
Southern NEAC non-maturing complex	Spawner escapement reserve	465,498

Table 3.3.3. Reconstructed PFA estimates (25th percentile; lower bound of the 95% C.I.) of maturing and non-maturing salmon from the southern and northern NEAC areas.

			SOUTHERN NEAC		NORTHERN NEAC	
SMOLT YEAR	YEAR OF PFA	YEAR OF 2SW RETURN	25TH PERCENTILE NON-MATURING	LOWER BOUND OF 95% CI MATURING	LOWER BOUND OF 95% CI NON-MATURING	LOWER BOUND OF 95% CI MATURING
1968	1969	1970				
1969	1970	1971				
1970	1971	1972	2 457 544	2 548 535		
1971	1972	1973	2 344 351	2 516 938		
1972	1973	1974	1 877 942	2 733 972		
1973	1974	1975	2 062 522	2 880 549		
1974	1975	1976	1 499 717	2 930 497		
1975	1976	1977	1 396 069	2 114 387		
1976	1977	1978	1 553 913	2 007 852		
1977	1978	1979	1 121 413	2 030 778		
1978	1979	1980	1 572 965	1 792 062		
1979	1980	1981	1 656 987	1 420 633		
1980	1981	1982	1 214 172	1 164 731		
1981	1982	1983	1 413 156	1 696 797		
1982	1983	1984	1 003 710	2 409 490	1 054 407	1 095 269
1983	1984	1985	1 161 939	1 702 431	1 000 424	1 146 687
1984	1985	1986	1 564 265	2 003 007	1 139 608	1 283 484
1985	1986	1987	1 187 440	2 354 560	912 840	1 134 864
1986	1987	1988	1 500 150	1 713 219	750 878	1 021 558
1987	1988	1989	1 373 563	2 367 038	643 185	861 441
1988	1989	1990	1 073 394	1 983 227	745 602	1 010 235
1989	1990	1991	763 401	1 218 407	641 373	906 285
1990	1991	1992	957 507	1 004 004	655 044	825 205
1991	1992	1993	831 029	1 443 366	692 420	830 486
1992	1993	1994	929 936	1 393 568	641 817	767 121
1993	1994	1995	879 825	1 480 961	658 093	875 245
1994	1995	1996	693 247	1 476 287	607 101	675 149
1995	1996	1997	532 040	1 206 438	444 488	668 749
1996	1997	1998	484 803	1 096 005	516 372	687 809
1997	1998	1999	493 188	1 399 548	514 792	835 656
1998	1999	2000	594 988	949 522	792 951	763 765
1999	2000	2001	576 818	1 439 554	834 919	1 070 252
2000	2001	2002	522 338	1 240 535	810 354	984 810
2001	2002	2003	571 544	1 106 797	656 210	718 764
2002	2003	2004	603 124	1 062 820	535 391	819 843
2003	2004	2005	485 698	1 024 501	524 912	542 904
2004	2005	2006		1 006 462		730 521

Table 3.3.4. Spawner escapement reserve values for the NEAC stock complexes.

COMPLEX	AGE GROUP	NUMBER OF FISH
Southern NEAC	maturing	790,817
	non-maturing	465,498
Northern NEAC	maturing	348,253
	non-maturing	240,621

Table 3.4.1. Summary of indicators examined for 1SW and 2SW wild and hatchery returns to rivers in Southern NEAC countries relative to estimated pre-fishery abundance of the Southern NEAC non-maturing stock complex. Number of years refers to the number of years that an indicator and corresponding return estimate are available for the time period 1971 to 2005.

Indicators that are not used in the framework but are informative of Southern NEAC non-maturing pre-fishery abundance.

COUNTRY	AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	AVERAGE LEVEL OF INDICATOR 1996-2005	R^2
UK (Scotland)	2SW fem.	Return	Wild	Dee (Baddoch)	1989	2005	17	16	0.540
UK (Scotland)	2SW fem.	Return	Wild	Dee (Girnock)	1972	2005	34	23	0.401
UK (Scotland)	2SW	Return	Wild	North Esk	1972	2005	34	6 422	0.376
UK (Engl & Wales)	2SW	Return	Wild	Itchen	1988	2005	18	67	0.720
UK (Engl & Wales)	2SW	Return	Wild/ Hatc	Test	1988	2005	18	160	0.312
UK (Engl & Wales)	2SW	Return	Wild	Frome	1973	2005	33	513	0.355
Iceland	2SW	Catch	Wild	Ellidaar	1972	2005	34	17	0.521
Iceland	2SW	Survival	Wild	Ellidaar	1986	2005	17	6.0%	0.501
Ireland	1SW	Survival	Wild	Corrib	1981	2005	24	8.0%	0.456
Ireland	1SW	Survival	Hatc	Galway	1983	2005	15	3.0%	0.254
Ireland	1SW	Survival	Hatc	Screebe	1985	2005	18	2.4%	0.311
Ireland	1SW	Survival	Hatc	Erne	1985	2005	15	3.8%	0.421
UK (N. Ireland)	1SW	Survival	Wild	Bush	1987	2005	16	15.2%	0.515
UK (N. Ireland)	1SW	Return	Wild	Bush	1987	2005	15	2 361	0.659
UK (N. Ireland)	1SW 1+ smolts	Survival	Hatc	Bush	1984	2005	20	2.0%	0.311
UK (N. Ireland)	1SW 2+ smolts	Survival	Hatc	Bush	1984	2005	19	3.5%	0.353
France	All	Survival	Wild	Nivelle	1987	2005	18	2.0%	0.345

Table 3.4.1. continued. Indicators that are not informative of Southern NEAC non-maturing pre-fishery abundance.

COUNTRY	AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	REASON FOR EXCLUDING THE INDICATOR IN THE FRAMEWORK (R^2)
UK (Engl & Wales)	2SW	Return	Wild	Dee	1992	2005	14	Cannot define indicator relationship (R^2 = 0.003)
France	2SW	Return	Wild	Bresle	1987	2005	18	Cannot define indicator relationship (R^2 = 0.06)
France	2SW	Return	Wild	Oir	1987	2005	19	Cannot define indicator relationship (R^2 = 0.018)
France	2SW	Return	Wild	Scorff	1995	2004	10	Short and recent time series
France	2SW	Survival	Wild	Scorff	1995	2004	10	Short and recent time series
Ireland	2SW	Survival	Wild	Corrib	1981	2005	24	Cannot define indicator relationship (R^2 = 0.161)
Ireland	2SW	Survival	Hatc	Shannon	1981	2005	25	Cannot define indicator relationship (R^2 = 0.107)
Ireland	1SW	Survival	Hatc	Burrishoole	1981	2005	24	Cannot define indicator relationship (R^2 = 0.104)
Ireland	1SW	Survival	Wild	Burrishoole	1981	2005	25	Cannot define indicator relationship (R^2 = 0.179)
Ireland	1SW	Survival	Hatc	Corrib/Cong	1981	2005	17	Cannot define indicator relationship (R^2 = 0.066)
Ireland	1SW	Survival	Hatc	Delphi / Burrishoole	1992	2005	13	Cannot define indicator relationship (R^2 = 0.003)
Ireland	1SW	Survival	Hatc	Delphi	1991	2005	14	Cannot define indicator relationship (R^2 = 0.114)
Ireland	1SW	Survival	Hatc	Bunowen	1993	2005	13	Cannot define indicator relationship (R^2 = 0.097)
UK (Scotland)	1SW	Survival	Wild	North Esk	1982	2005	16	Cannot define indicator relationship (R^2 = 0.111)
UK (Scotland)	2SW	Survival	Wild	North Esk	1982	2005	15	Cannot define indicator relationship (R^2 = 0.155)

Table 3.4.2. Summary of indicators examined for 1SW and 2SW wild and hatchery returns to rivers in Southern NEAC countries relative to estimated pre-fishery abundance of the Southern NEAC maturing stock complex. Number of years refers to the number of years that an indicator and corresponding return estimate are available for the time period 1971 to 2005.

Indicators that are not used in the framework but are informative of Southern NEAC maturing pre-fishery abundance.

COUNTRY	AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS[1]	AVERAGE LEVEL OF INDICATOR 1996-2005	R^2
UK (Scotland)	1SW	Return	Wild	North Esk	1981	2005	25	12 320	0.473
UK (Engl & Wales)	1SW	Return	Wild	Itchen	1988	2005	18	227	0.628
UK (Engl & Wales)	1SW	Return	Wild/ Hatc	Test	1988	2005	18	506	0.382
UK (Engl & Wales)	1SW	Return	Wild	Frome	1973	2005	33	491	0.261
Iceland	1SW	Catch	Wild	Ellidaar	1971	2005	35	604	0.626
Iceland	1SW	Rate	Wild	Ellidaar	1976	2005	19	6.5%	0.492
Ireland	1SW	Rate	Wild	Corrib	1981	2005	24	8.0%	0.303
Ireland	2SW	Rate	Wild	Corrib	1981	2005	24	0.7%	0.256
Ireland	1SW	Rate	Hatc	Corrib/Galway	1983	2005	15	3.0%	0.237
Ireland	1SW	Rate	Hatc	Erne	1985	2005	15	3.8%	0.519
UK (N. Ireland)	1SW	Rate	Wild	Bush	1987	2005	17	14.2%	0.338
UK (N. Ireland)	1SW	Return	Wild	Bush	1987	2005	16	2,118	0.591
France	All	Rate	Wild	Nivelle	1987	2005	18	2.0%	0.202

Table 3.4.2. continued. Indicators that are not informative of Southern NEAC maturing pre-fishery abundance.

COUNTRY	AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	REASON FOR EXCLUDING THE INDICATOR IN THE FRAMEWORK (R^2)
UK (Engl & Wales)	1SW	Return	Wild	Dee	1992	2005	14	Cannot define indicator relationship (R^2 = 0.025)
France	1SW	Return	Wild	Bresle	1987	2005	18	Cannot define indicator relationship (R^2 = 0.007)
France	1SW	Return	Wild	Oir	1987	2005	19	Cannot define indicator relationship (R^2 = 0.014)
France	1SW	Return	Wild	Scorff	1995	2004	10	Short and recent time series
France	1SW	Rate	Wild	Scorff	1995	2004	10	Short and recent time series
Ireland	1SW	Rate	Hatc	Shannon	1981	2005	25	Cannot define indicator relationship (R^2 = 0.031)
Ireland	1SW	Rate	Hatc	Burrishoole	1981	2005	24	Cannot define indicator relationship (R^2 = 0.038)
Ireland	1SW	Rate	Wild	Burrishoole	1981	2005	25	Cannot define indicator relationship (R^2 = 0.075)
Ireland	1SW	Rate	Hatc	Corrib/Cong	1981	2005	17	Cannot define indicator relationship (R^2 = 0.083)
Ireland	1SW	Rate	Hatc	Screebe	1985	2005	18	Cannot define indicator relationship (R^2 = 0.141)
Ireland	1SW	Rate	Hatc	Delphi / Burrishoole	1992	2005	13	Cannot define indicator relationship (R^2 = 0.000)
Ireland	1SW	Rate	Hatc	Delphi	1991	2005	14	Cannot define indicator relationship (R^2 = 0.020)
Ireland	1SW	Rate	Hatc	Bunowen	1993	2005	13	Cannot define indicator relationship (R^2 = 0.017)
UK (N. Ireland)	1+ smolts 1SW	Rate	Hatc	Bush	1984	2005	20	Cannot define indicator relationship (R^2 = 0.152)
UK (N. Ireland)	2+ smolts 1SW	Rate	Hatc	Bush	1984	2005	19	Cannot define indicator relationship (R^2 = 0.147)
UK (Scotland)	1SW	Rate	Wild	North Esk	1982	2005	16	Cannot define indicator relationship (R^2 = 0.106)
UK (Scotland)	2SW	Rate	Wild	North Esk	1982	2005	15	Cannot define indicator relationship (R^2 = 0.152)

Table 3.4.3. Summary of indicators examined for 1SW and 2SW wild and hatchery returns to rivers in Northern NEAC countries relative to estimated pre-fishery abundance of the Northern NEAC non-maturing stock complex. Number of years refers to the number of years that an indicator and corresponding return estimate are available for the time period 1971 to 2005.

Indicators that are not used in the framework but are informative of Northern NEAC non-maturing pre-fishery abundance.

COUNTRY	AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	AVERAGE LEVEL OF INDICATOR 1996-2005	R^2
Norway	2SW	Return	Wild	Norway pfa	1993	2005	13	181 790	0.622
Norway	2SW	Rate	Hatc	Drammen	1986	2005	20	0.7%	0.570

Table 3.4.3. continued. Indicators that are not informative of Northern NEAC non-maturing pre-fishery abundance.

COUNTRY	AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	REASON FOR EXCLUDING THE INDICATOR IN THE FRAMEWORK (R^2)
Finland	2SW	Return	Wild	Tana catch	1981	2005	25	Cannot define indicator relationship (R^2 = 0.061)
Iceland	2SW	Return	Wild	Vesturdalsa catch	1980	2005	26	Cannot define indicator relationship (R^2 = 0.028)
Iceland	2SW	Return	Wild	Midfjardara catch	1981	2005	25	Cannot define indicator relationship (R^2 = 0.081)
Iceland	2SW	Rate	Wild	Vesturdalsa	1991	2005	14	Cannot define indicator relationship (R^2 = 0.022)
Iceland	2SW	Rate	Wild	Midfjardara	1989	1999	11	Short and discontinued time series
Norway	2SW	Rate	Wild	Halselva	1989	2005	17	Cannot define indicator relationship (R^2 = 0.064)
Norway	2SW	Rate	Hatc	Halselva	1990	2005	14	Cannot define indicator relationship (R^2 = 0.169)
Norway	2SW	Rate	Wild	Imsa	1983	2005	21	Cannot define indicator relationship (R^2 = 0.036)
Norway	2SW	Rate	Hatc	Imsa	1983	2005	21	Cannot define indicator relationship (R^2 = 0.049)
Norway	2SW	Rate	Wild	Figgjo	1983	2005	20	Cannot define indicator relationship (R^2 = 0.007)

Table 3.4.4. Summary of indicators examined for 1SW and 2SW wild and hatchery returns to rivers in Northern NEAC countries relative to estimated pre-fishery abundance of the Northern NEAC maturing stock complex. Number of years refers to the number of years that an indicator and corresponding return estimate are available for the time period 1971 to 2005.

Indicators that are not used in the framework but are informative of Northern NEAC maturing pre-fishery abundance.

COUNTRY	AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	AVERAGE LEVEL OF INDICATOR 1996-2005	R^2
Norway	1SW	Return	Wild	Norway pfa	1991	2005	15	421 424	0.842
Norway	1SW	Rate	Wild	Imsa	1982	2005	23	5.0%	0.216
Norway	1SW	Rate	Hatc	Halselva	1990	2005	14	1.1%	0.224

Table 3.4.4. continued. Indicators that are not informative of Northern NEAC maturing pre-fishery abundance.

COUNTRY	AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS[2]	REASON FOR EXCLUDING THE INDICATOR IN THE FRAMEWORK (R^2)
Finland	1SW	Return	Wild	Tana catch	1981	2005	25	Cannot define indicator relationship (R^2 = 0.007)
Iceland	1SW	Return	Wild	Vesturdalsa catch	1981	2005	25	Cannot define indicator relationship (R^2 = 0.004)
Iceland	1SW	Return	Wild	Midfjardara catch	1981	2005	25	Cannot define indicator relationship (R^2 = 0.068)
Iceland	1SW	Rate	Wild	Vesturdalsa	1984	2005	15	Cannot define indicator relationship (R^2 = 0.003)
Iceland	1SW	Rate	Wild	Midfjardara	1988	1999	12	Short and discontinued time series
Norway	1SW	Rate	Wild	Halselva	1989	2005	17	Cannot define indicator relationship (R^2 = 0.001)
Norway	1SW	Rate	Hatc	Imsa	1982	2005	24	Cannot define indicator relationship (R^2 = 0.117)
Norway	1SW	Rate	Wild	Figgjo	1982	2005	23	Cannot define indicator relationship (R^2 = 0.007)
Norway	1SW	Rate	Hatc	Drammen	1986	2005	20	Cannot define indicator relationship (R^2 = 0.083)

Table 3.5.1. Summary of indicators examined for 1SW and 2SW wild and hatchery returns to rivers in the US area which could be used in the framework. Number of years refers to the number of years that an indicator and corresponding return estimate are available for the time period 1971 to 2005. All indicators considered for the US area were incorporated into the framework.

Indicators that can be used in the framework.

AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	AVERAGE RETURNS 1996-2005	DECISION RULE BASED ON OBJECTIVE FUNCTION	INDICATOR LOW (TRUE LOW)	INDICATOR HIGH (TRUE HIGH)
2SW	Return	W & H	Penobscott	1971	2005	35	811	1,415	100% (22)	92% (13)
	Survival	H	Penobscott	1971	2005	35	0.125%	0.24%	100% (14)	57% (21)
1SW	Return	W & H	Penobscott	1971	2005	35	271	496	81% (27)	88% (8)
	Survival	H	Penobscott	1971	2005	35	0.048%	0.07%	83% (23)	67% (12)
All SW	Return	W	Narraguagus	1972	2005	34	26	100	94% (16)	61% (18)

Table 3.5.2. Summary of indicators examined for 1SW and 2SW wild and hatchery returns to rivers in the Scotia-Fundy area which could be used in the framework. Number of years refers to the number of years that an indicator and corresponding return estimate are available for the time period 1971 to 2005.

Indicators that can be used in the framework.

AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	AVERAGE RETURNS 1996-2005	DECISION RULE BASED ON OBJECTIVE FUNCTION	INDICATOR LOW (TRUE LOW)	INDICATOR HIGH (TRUE HIGH)
Large	Return	Wild	Saint John	1970	2005	36	661	2 310	100% (12)	92% (24)
Large	Return	Wild	Lahave	1973	2005	27	155	302	100% (14)	100% (13)
Large	Return	Wild	North	1984	2005	22	251	510	93% (13)	100% (8)
Large	Return	Wild	St. Mary's	1974	2005	32	147	225	100% (10)	89% (38)
Small	Return	Wild	Saint John	1970	2005	35	856	2 277	80% (15)	90% (20)
Small	Return	Wild	Lahave	1973	2005	26	960	1 974	87% (14)	91% (12)
Small	Return	Wild	St. Mary's	1974	2005	31	1 025	1 584	92% (12)	84% (19)
2SW	Survival	Hatch	Saint John	1976	2005	30	0.13	0.23%	86% (14)	88% (16)
1SW	Survival	Hatch	Saint John	1976	2004	30	0.46	0.76%	80% (15)	87% (15)
1SW	Survival	Hatch	LaHave	1974	2004	31	0.88	1.02%	100% (10)	81% (21)

Table 3.5.2. continued. Indicators that cannot be used in the framework.

AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	REASON FOR EXCLUDING THE INDICATOR IN THE FRAMEWORK
Large	Return	Wild	Nashwaak	1972	2005	16	Insufficient (<5) observations in the correct quadrats
Large	Return	Wild	Middle	1990	2005	16	Insufficient (<5) observations in the correct quadrats
Large	Return	Wild	Baddeck	1993	2005	10	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Nashwaak	1972	2005	15	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Middle	1990	2005	16	Insufficient (<5) observations in the correct quadrats
Small	Return	Wild	Baddeck	1993	2005	9	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	North	1984	2005	21	Insufficient (<5) observations in the correct quadrats
2SW	Survival	Wild	Nashwaak	2000	2004	5	Short and recent time series
2SW	Survival	Wild	LaHave	1998	2005	8	Short and recent time series
2SW	Survival	Hatch	LaHave	1974	2004	32	Series discontinued
2SW	Survival	Hatch	East Sheet Hbr.	1976	2001	26	Series discontinued
2SW	Survival	Hatch	Liscomb	1980	2007	18	Series discontinued

Table 3.5.3. Summary of indicators examined for 1SW and 2SW wild and hatchery returns to rivers in the Gulf area which could be used in the framework. Number of years refers to the number of years that an indicator and corresponding return estimate are available for the time period 1971 to 2005.

Indicators that can be used in the framework.

AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	AVERAGE RETURNS 1996-2005	DECISION RULE BASED ON OBJECTIVE FUNCTION	INDICATOR LOW (TRUE LOW)	INDICATOR HIGH (TRUE HIGH)
2SW	Return	Wild	Miramichi	1971	2005	35	9 651	18 120	95% (20)	100% (15)
1SW	Return	Wild	Miramichi	1971	2005	34	30 873	33 610	91% (11)	61% (23)

Table 3.5.3. continued. Indicators that cannot be used in the framework.

AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	REASON FOR EXCLUDING THE INDICATOR IN THE FRAMEWORK
Large	Return	Wild	Margaree	1984	2005	22	Insufficient (<5) observations in the correct quadrats
2SW	Survival	Wild	Miramichi	2003	2003	3	Short and recent time series
Small	Return	Wild	Margaree	1984	2004	21	Insufficient (<5) observations in the correct quadrats
1SW	Survival	Wild	Miramichi	2000	2004	5	Short and recent time series

Table 3.5.4. Summary of indicators examined for 1SW and 2SW wild and hatchery returns to rivers in the Quebec area which could be used in the framework. Number of years refers to the number of years that an indicator and corresponding return estimate are available for the time period 1971 to 2005.

Indicators that can be used in the framework.

AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	AVERAGE LEVEL OF INDICATOR 1996-2005	DECISION RULE BASED ON OBJECTIVE FUNCTION	INDICATOR LOW (TRUE LOW)	INDICATOR HIGH (TRUE HIGH)
Large	Return	Wild	Bonaventure	1984	2005	22	1 532	1 480	71% (7)	87% (15)
Large	Return	Wild	Grande Rivière	1984	2005	22	396	438	100% (7)	100% (15)
Large	Return	Wild	Saint-Jean	1982	2005	24	715	737	83% (7)	88% (17)
Large	Return	Wild	Dartmouth	1984	2005	22	664	758	70% (10)	100% (12)
Large	Return	Wild	Sainte-Anne	1984	2005	22	374	338	100% (5)	88% (17)
Large	Return	Wild	Cap-chat	1984	2005	22	188	160	56% (9)	85% (13)
Large	Return	Wild	Godbout	1986	2005	20	496	544	71% (7)	85% (13)
Large	Return	Wild	De la Trinite	1980	2005	26	290	252	83% (6)	88% (20)

Table 3.5.4. continued. Indicators that cannot be used in the framework.

AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	REASON FOR EXCLUDING THE INDICATOR IN THE FRAMEWORK
Large	Return	Wild	Matapedia	1984	2005	22	Minimum penalty at lowest or highest indicator value
Large	Return	Wild	Cascapedia	1984	2005	22	Insufficient (<5) observations in the correct quadrats
Large	Return	Wild	York	1984	2005	22	Insufficient (<5) observations in the correct quadrats
Large	Return	Wild	Madeleine	1984	2005	22	Insufficient (<5) observations in the correct quadrats
Large	Return	Wild	Matane	1984	2005	22	Insufficient (<5) observations in the correct quadrats
Large	Return	Wild	Mitis	1984	2005	22	Insufficient (<5) observations in the correct quadrats
1SW	Survival	Wild	De la Trinite	1991	2005	21	Insufficient (<5) observations in the correct quadrats
2SW	Survival	Wild	De la Trinite	1986	2005	21	Insufficient (<5) observations in the correct quadrats
Large	Return	Wild	Aux Rochers	1984	2005	22	Stock in restoration
Small	Return	Wild	Matapedia	1984	2005	22	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Cascapedia	1997	2005	9	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Bonaventure	1984	2005	22	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Grande Rivière	1984	2005	22	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Saint-Jean	1981	2005	25	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	York	1984	2005	22	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Dartmouth	1984	2005	22	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Madeleine	1984	2005	22	Insufficient (<5) observations in the correct quadrats
Small	Return	Wild	Sainte-Anne	1984	2005	22	Insufficient (<5) observations in the correct quadrats
Small	Return	Wild	Cap-chat	1984	2005	22	Insufficient (<5) observations in the correct quadrats
Small	Return	Wild	Matane	1984	2005	22	Insufficient (<5) observations in the correct quadrats
Small	Return	Wild	Mitis	1984	2005	22	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Godbout	1986	2005	20	Insufficient (<5) observations in the correct quadrats
Small	Return	Wild	De la Trinite	1984	2005	22	Insufficient (<5) observations in the correct quadrats
Small	Return	Wild	Aux Rochers	1984	2005	22	Minimum penalty at lowest or highest indicator value
1SW	Survival	Wild	Saint-Jean	1989	2005	16	Insufficient (<5) observations in the correct quadrats
2SW	Survival	Wild	Saint-Jean	1990	2005	15	Insufficient (<5) observations in the correct quadrats

Table 3.5.5. Summary of indicators examined for 1SW and 2SW wild and hatchery returns to rivers in the Newfoundland area which could be used in the framework. Number of years refers to the number of years that an indicator and corresponding return estimate are available for the time period 1971 to 2005. Except for Labrador, the data were not adjusted for the assumed/estimated exploitation rates in the coastal commercial fisheries prior to 1992.

Indicators that can be used in the framework.

AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	AVERAGE RETURNS 1996-2005	DECISION RULE BASED ON OBJECTIVE FUNCTION	INDICATOR LOW (TRUE LOW)	INDICATOR HIGH (TRUE HIGH)
Small	Return	Wild	Middle Brook	1978	2005	27	1 641	1 752	86% (21)	83% (6)

Table 3.5.5. continued. Indicators that cannot be used in the framework.

AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	REASON FOR EXCLUDING THE INDICATOR IN THE FRAMEWORK
Small	Return	Wild	Highlands	1993	2005	12	Insufficient (<5) observations in the correct quadrats
Small	Return	Wild	Conne	1986	2005	19	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Terra Nova	1978	2005	27	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Exploits	1978	2005	27	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Gander	1989	2005	16	Insufficient (<5) observations in the correct quadrats
Small	Return	Wild	Torrent	1984	2005	21	Insufficient (<5) observations in the correct quadrats
Small	Return	Wild	Western Arm Brook	1971	2005	34	Minimum penalty at lowest or highest indicator value
Small	Survival	Wild	Western Arm Brook	1972	2005	33	Minimum penalty at lowest or highest indicator value
Small	Survival	Wild	NE Trepassey	1987	2005	18	Minimum penalty at lowest or highest indicator value
Small	Survival	Wild	Conne	1988	2005	17	Minimum penalty at lowest or highest indicator value

Table 3.5.6. Summary of indicators examined for 1SW and 2SW wild and hatchery returns to rivers in the Labrador area which could be used in the framework. Number of years refers to the number of years that an indicator and corresponding return estimate are available for the time period 1971 to 2005. Except for Labrador, the data were not adjusted for the assumed/estimated exploitation rates in the coastal commercial fisheries prior to 1992.

It was determined that no indicators from Labrador could be used in the framework.

Table 3.5.6. continued. Indicators that cannot be used in the framework

AGE / SIZE GROUP	INDICATOR TYPE	WILD / HATC	RIVER NAME	START	END	NUMBER OF YEARS	REASON FOR EXCLUDING THE INDICATOR IN THE FRAMEWORK
Large	Return	Wild	Sand Hill (LAB)	1971	2005	10	Minimum penalty at lowest or highest indicator value
Small	Return	Wild	Sand Hill (LAB)	1971	2005	10	Minimum penalty at lowest or highest indicator value

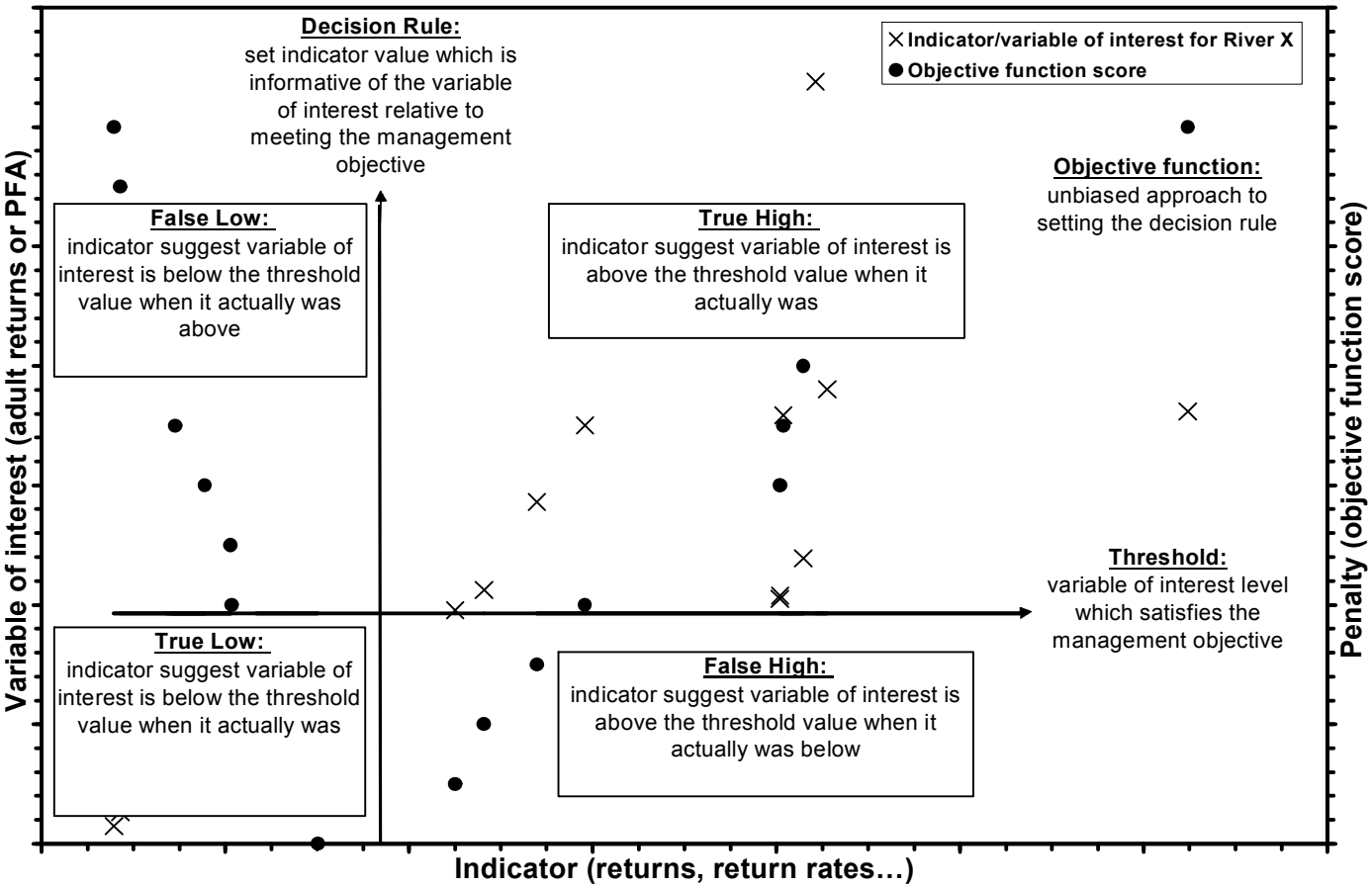


Figure 2.2.1. Example of Indicator/Variable of Interest exploratory graph identifying the threshold value, decision rule, penalty function and the 4 states (true high, true low, false high and false low).

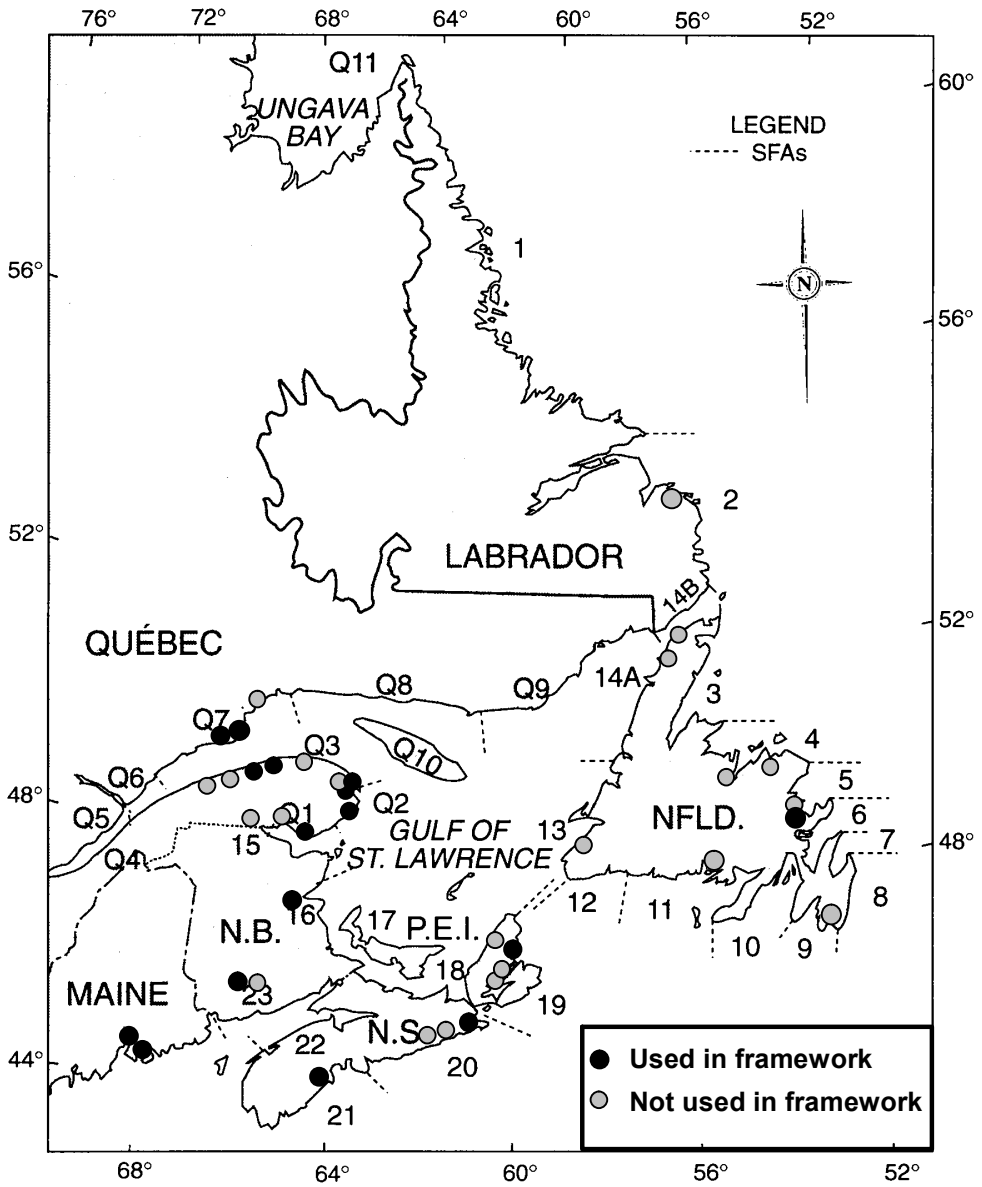


Figure 3.2.1. Geographic position of all indicator rivers where data sets originated from and were considered for inclusion into the Framework of Indicators from North American Commission area. Black dots identify rivers where the data were incorporated for at least one stock complex and grey dots identify rivers where the data were not incorporated for any of the available stock complexes.

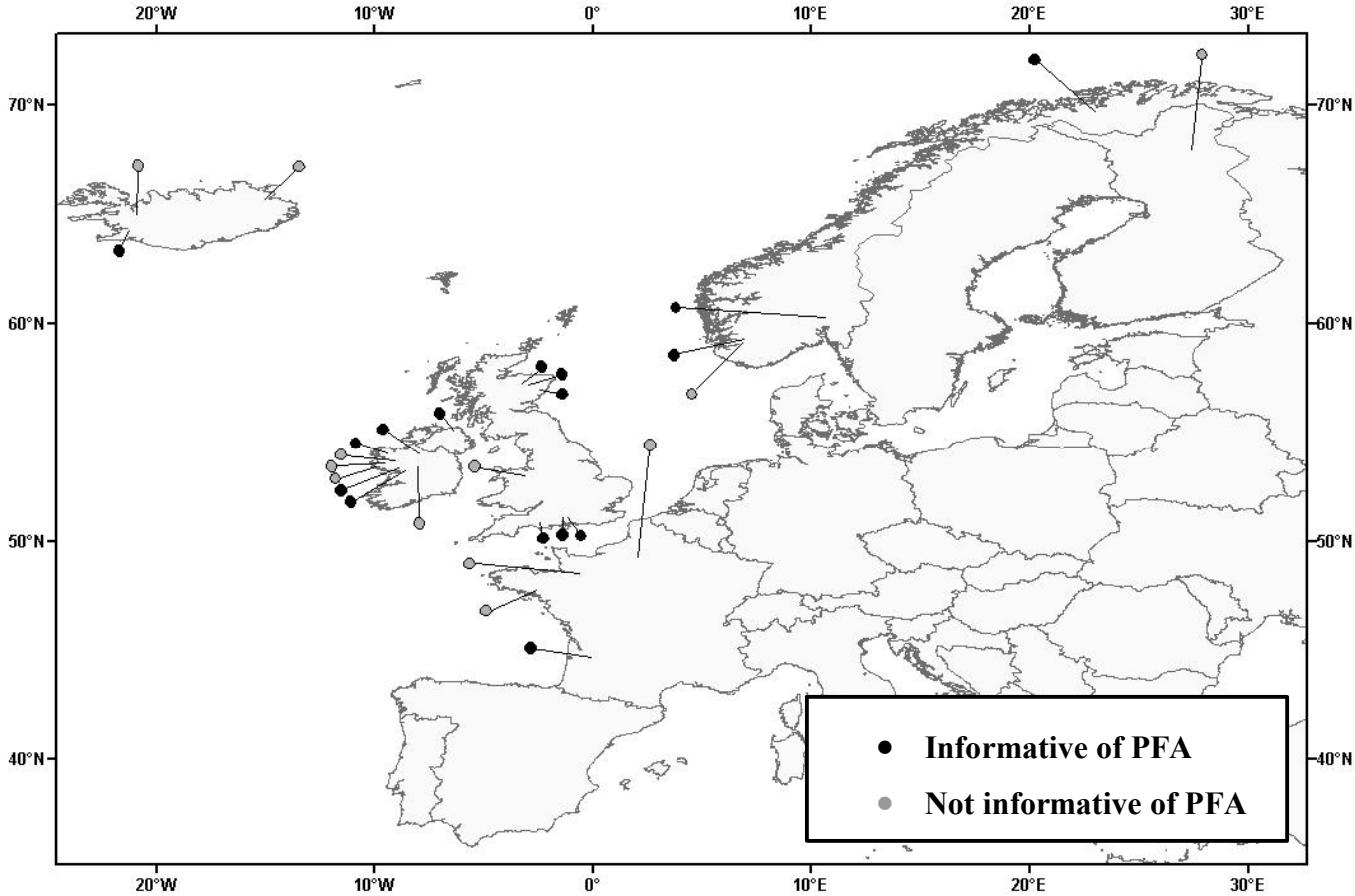


Figure 3.2.2. Geographic position of indicator rivers where data sets originated from and were considered for inclusion into the Framework of Indicators from the North-East Atlantic Commission area. Black dots identify sites where the data considered proved to be "informative" for at least one stock complex and grey dots identify sites where the data proved to be "uninformative" for all of the available stock complexes.

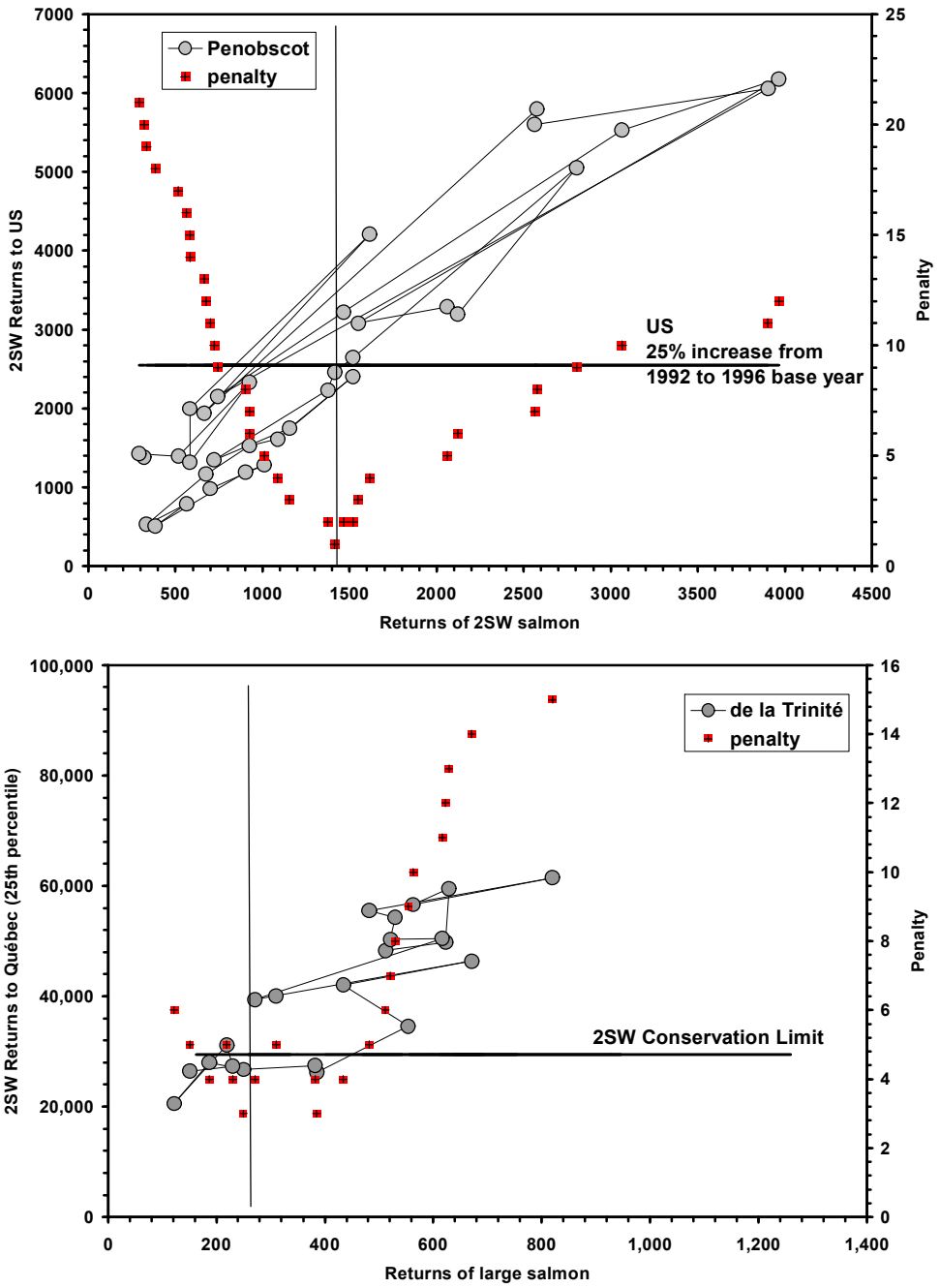


Figure 4.1.1. Examples of indicator data sets which are used in the framework for West Greenland multi-year management advice.

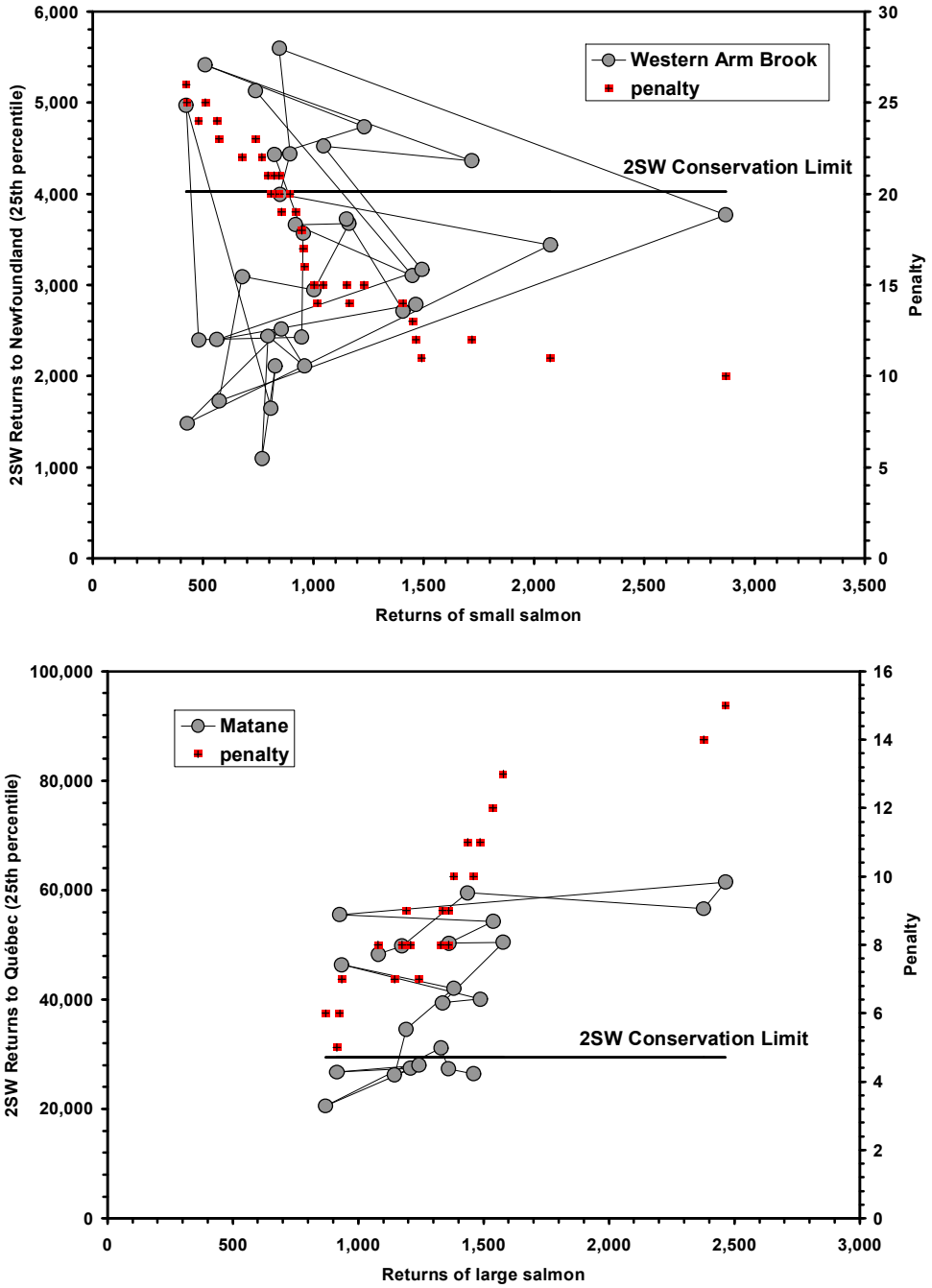


Figure 4.1.2. Examples of indicator data sets which are not used in the framework for West Greenland multi-year management advice.

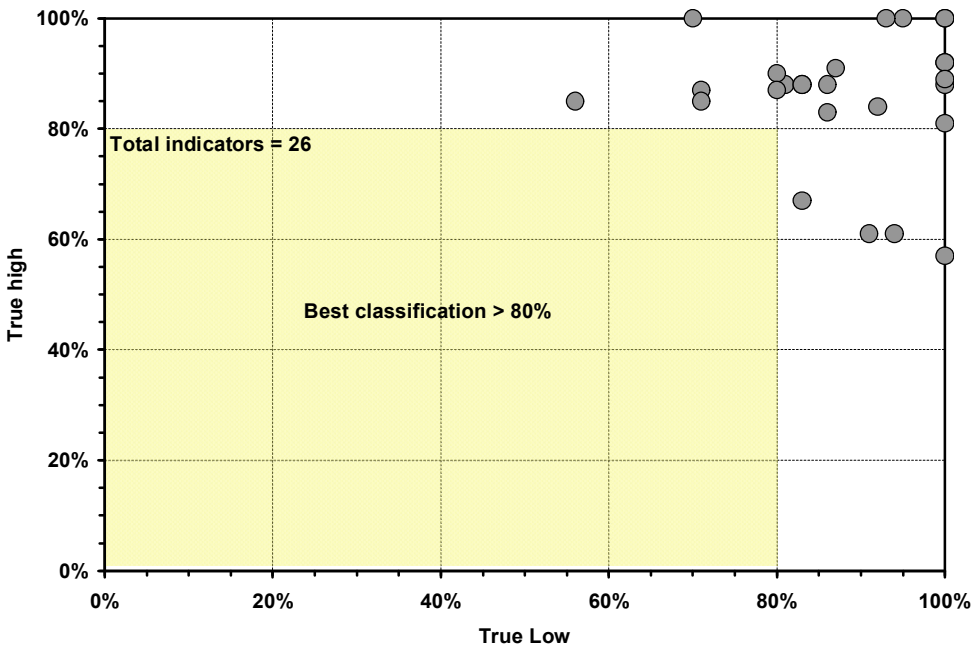


Figure 4.1.3. Comparative performance of the retained indicators (N = 26) at identifying a true low (i.e. management objective will not be met) and a true high (i.e. management objective will be met) for the West Greenland multi-year catch advice framework.

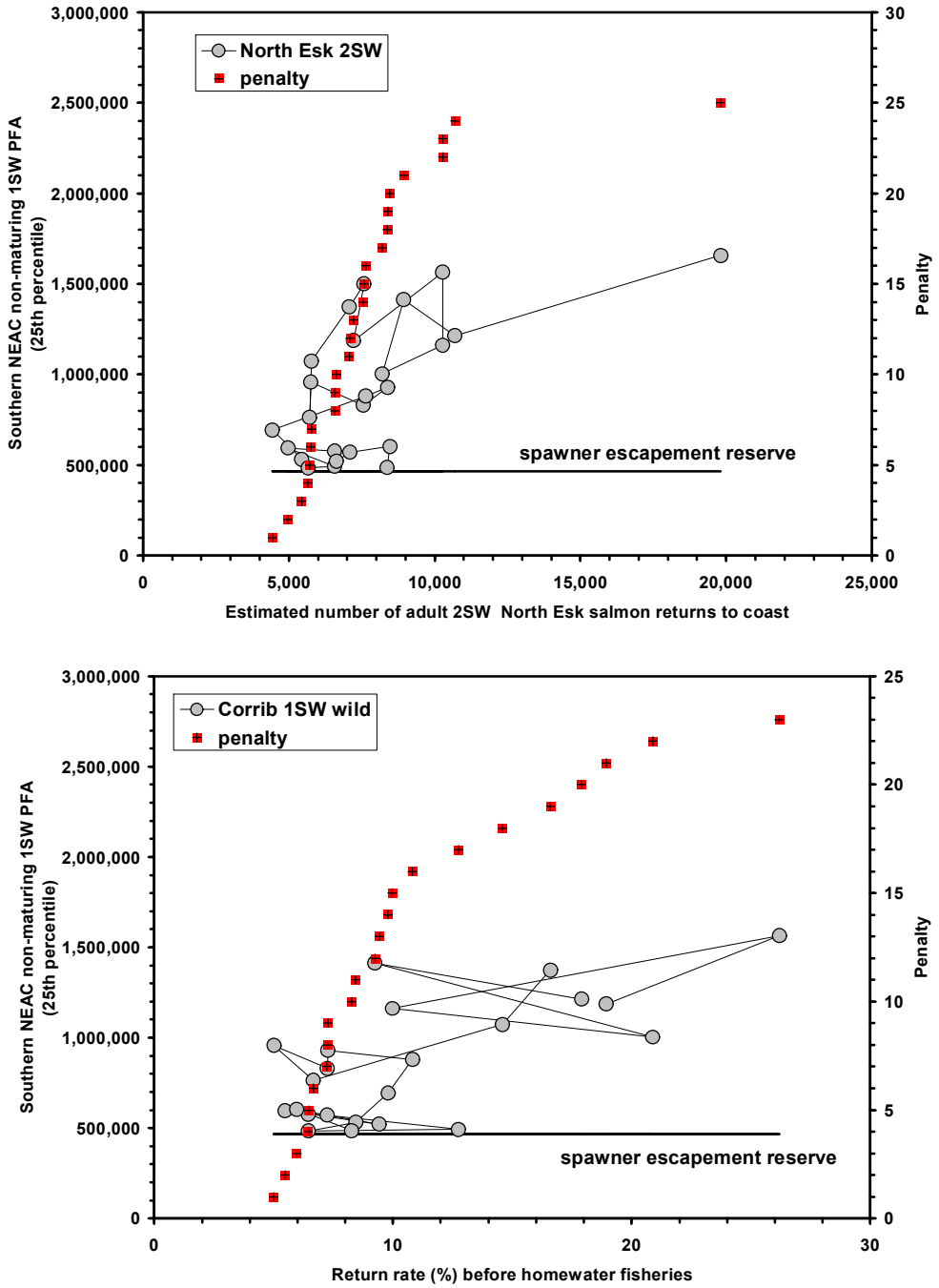


Figure 4.1.4. Examples of indicator data sets from NEAC area which are not used in the framework but which are informative of PFA abundance.

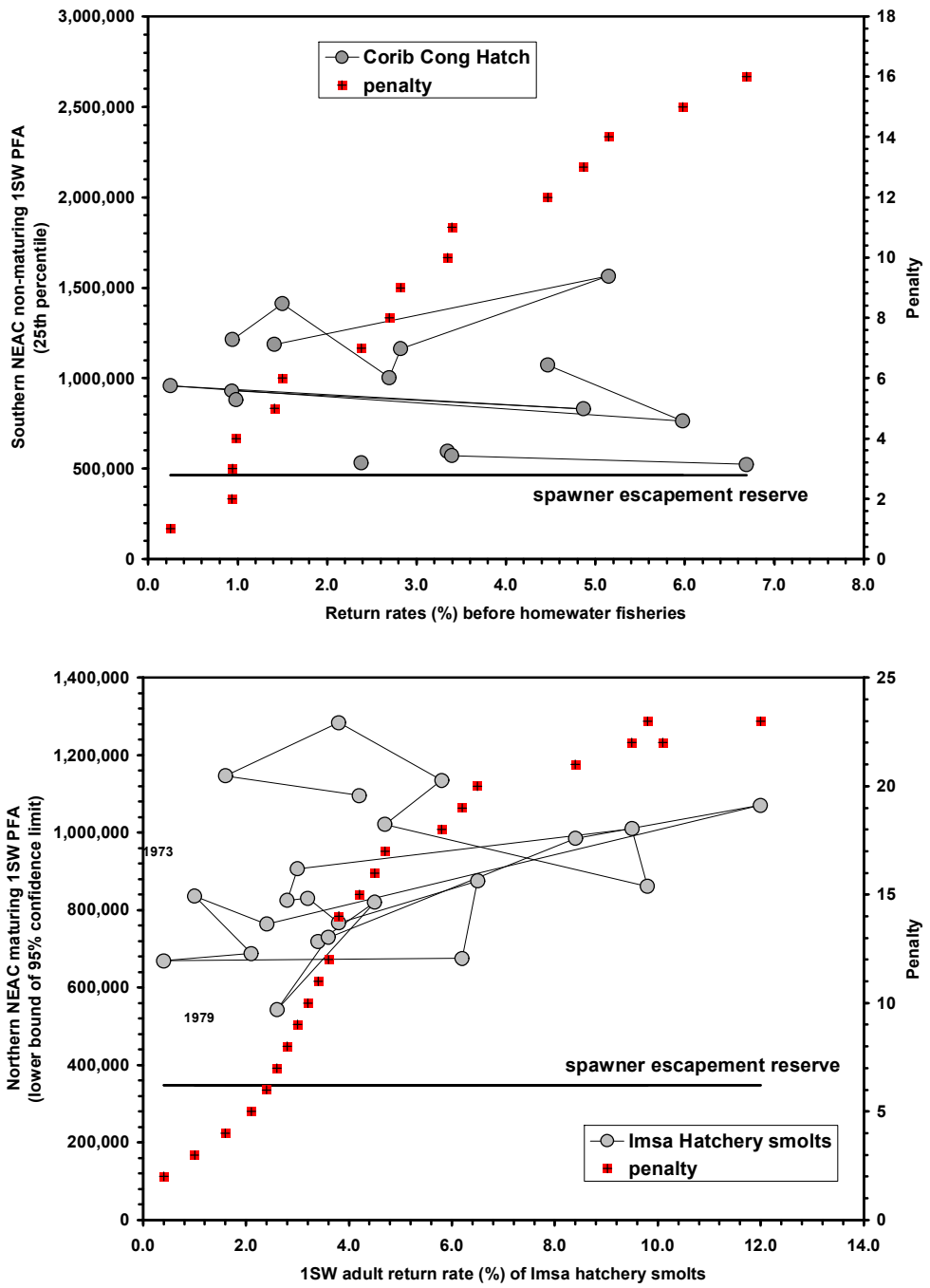


Figure 4.1.5. Examples of indicator data sets from NEAC area which are not used in the framework and which are not informative of PFA abundance.

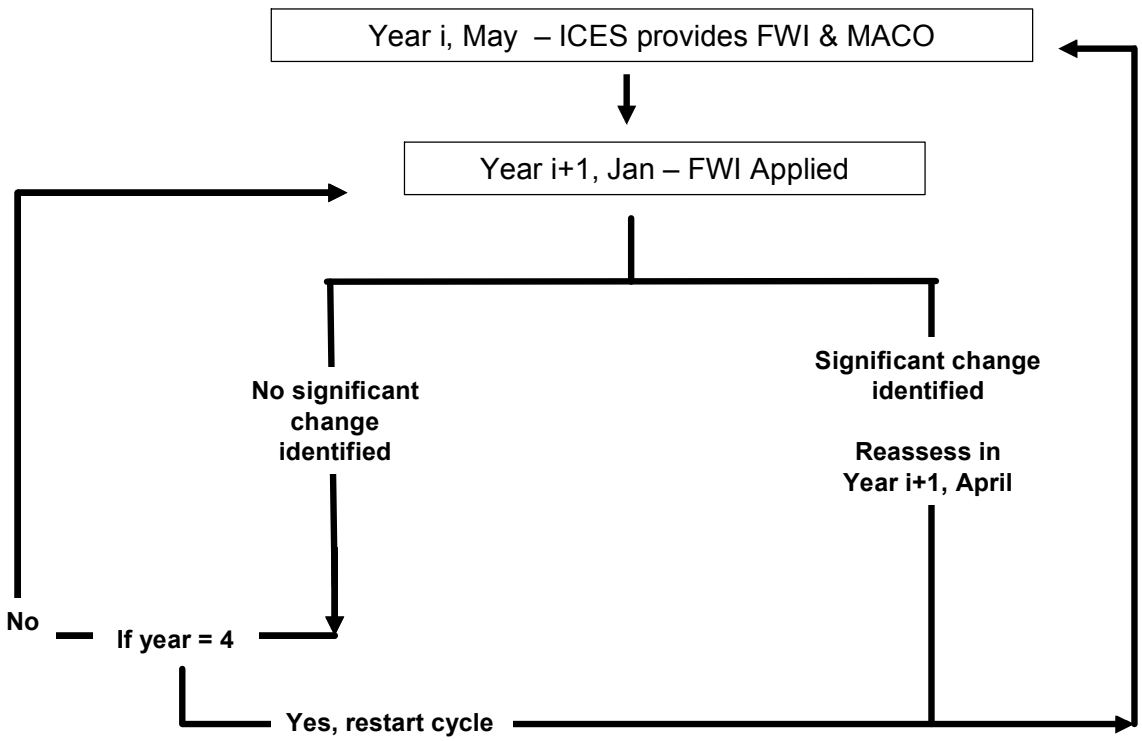


Figure 4.2.1. Suggested timeline for employment of the Framework of Indicators (FWI) in evaluating multi-annual catch advice (MACO). In Year i, ICES provides an updated FWI which re-evaluates the inclusions of all available datasets and is summarized in an Excel worksheet while also providing MACO. In 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 and MACO the following May. ICES would also provide an updated FWI and MACO if year equals 4.

Overall Recommendation
Reassess

Geographic Area	River/Indicator	2006 Indicator Value	Threshold Value	Ratio of Indicator to Threshold	True Low classification accuracy	True Low classification accuracy	Indicator State	Probability of Correct Assignment	Indicator Score	Management Objective Met?
USA	Penobscot 2SW Returns		1415		100%	92%				
	Penobscot 2SW Rate		0.240		100%	57%				
	Penobscot 1SW Returns		496		88%	81%				
	Penobscot 1SW Rate		0.068		83%	67%				
	Narraguagus Returns		100		94%	61%				
	possible range									
	Average								**NA**	**Unknown**
Scotia-Fundy	Saint John Return Large		2,310		100%	92%				
	Lahave Return Large		302		100%	100%				
	North Return Large		510		93%	100%				
	St. Mary's Return Large		225		100%	89%				
	Saint John Return Small		2,277		80%	90%				
	Lahave Return Small		1974		87%	91%				
	St. Mary's Return Small		1584		92%	84%				
	Saint John Surv 2SW		0.23		86%	88%				
	Saint John Surv 1SW		0.76		80%	87%				
	LaHave Surv 1SW		1.02		100%	81%				
	possible range									
	Average								**NA**	**Unknown**
Gulf	Miramichi 2SW		18,120		95%	100%				
	Miramichi 1SW		84,817		64%	100%				
	possible range									
	Average								**NA**	**Unknown**
Quebec	Bonaventure Large		1480		71%	87%				
	Grande Rivière Large		438		100%	100%				
	Saint-Jean Large		737		83%	88%				
	Dartmouth Large		758		70%	100%				
	Sainte-Anne Large		338		100%	88%				
	Cap-chat Large		160		56%	85%				
	Godbout Large		544		71%	85%				
	De la Trinite Large		252		83%	88%				
	possible range									
	Average								**NA**	**Unknown**
Newfoundland	Middle Brook Small		1,752		86%	83%				
	possible range									
	Average								**NA**	**Unknown**
Labrador										
	possible range									
	Average								**NA**	**Unknown**
Southern NEAC										
	possible range									
	Average								**NA**	**Unknown**

Figure 4.2.2. Example of FWI spreadsheet for the Greenland fishery (*Greenland Fishery Framework of Indicators.xls*). The required contemporary indicator values are entered into the shaded cells (2006 Indicators Value), which are linked to the summary information for each indicator and stock complex. A final assessment is calculated and displayed in the second line ("Reassess" or "No Significant Change Identified by Indicators").

Annex 1: List of participants the Study Group on Establishing a Frame-work of Indicators of Salmon Stock Abundance, 2006

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Annex 2: Working Documents submitted to the Study Group on Establishing a Frame-work of Indicators of Salmon Stock Abundance, 2006

1) Chaput G. Follow-up on WP41 from ICES WGNAS 2006.

2) Chaput G. Analysis of returns and return rates of salmon to monitored rivers of eastern North America as indicators of PFA levels.

3) Smith, G. W. Analysis of returns, return rates, and biological variables of salmon to monitored rivers of the eastern Atlantic Ocean as indicators of PFA levels.

4) Chaput G. Proposal for a multi-year catch advice indicator framework for Atlantic salmon at West Greenland

5) Hansen, L. P. Developments of models to predict marine survival and return of salmon to Norway.

Annex 3: References Cited by the Study Group on Establishing a Frame-work of Indicators of Salmon Stock Abundance, 2006

Chaput, G., Legault, C. M., Reddin, D. G., Caron, F. and Amiro, P. G. 2005. Provision of catch advice taking into account of non-stationarity in productivity of Atlantic salmon (*Salmo salar* L.) in the Northwest Atlantic. ICES Journal of Marine Science, 62: 131–143.

Crozier, W. W., Potter, E. C. E., Prévost, E., Schon, P–J., and Ó Maoiléidigh, N. 2003. A co-ordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the north-east Atlantic (SALMODEL – Scientific Report Contract QLK5–1999–01546 to EU Concerted Action Quality of Life and Management of Living Resources). Queen's University of Belfast, Belfast. 431 pp.

ICES. 1993. Report of the North Atlantic Salmon Working Group. Copenhagen, 5–12 March 1993. ICES CM 1993/Assess: 10.

ICES. 2006. Report of the Working Group on North Atlantic Salmon (WGNAS), 4–13 April 2006, Copenhagen, Denmark. ICES CM 2006/ACFM:23. 254 pp.

NASCO. 1998. North Atlantic Salmon Conservation Organisation. Agreement on the adoption of a precautionary approach. Report of the 15th annual meeting of the Council. CNL(98)46. 4 pp.

NASCO. 1999. North Atlantic Salmon Conservation Organisation. Action plan for the application of the precautionary approach. CNL(99)48. 14 pp.

NASCO 2006a. Regulatory Measure for the Fishing of Salmon at West Greenland for 2006, with possible application in 2007 and 2008. WGC(06)06. 2 pp.

NASCO 2006b. Decision regarding the salmon fishery in Faroese water 2007, with possible application in 2008 and 2009. NEA(06)06. 2 pp.

Potter, E. C. E., Hansen, L. P., Gudbergsson, G., Crozier, W. W., Erkinaro, J., Insulander, C., MacLean, J., Ó Maoiléidigh, N. S., and Prusov, S. 1998. A method for estimating preliminary CLs for salmon stocks in the NASCO–NEAC area. ICES CM 1998/T:17. 11 pp.

Rago, P.J., Reddin, D. G., Porter, T. R.,Meerburg, D. J., Friedland, K. D., and Potter, E. C. E. 1993. A continental run reconstruction model for the non-maturing component of North American Atlantic salmon: analysis of fisheries in Greenland and Newfoundland-Labrador, 1974-1991. ICES CM 1993/M:25.

Ricker, W. E. 1975. Stock and recruitment. J. Fish. Res. Bd. Can. 11:559-623.

Annex 4: Glossary of Acronyms Used by the Study Group on Establishing a Frame-Work of Indicators of Salmon Stock Abundance, 2006

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

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

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

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

MSW *(Multi-Sea-Winter)* An adult salmon which has spent two or more winters at sea or a repeat spawner.

NAC (*North American Commission Area*) One of the three regional groupings of Atlantic salmon management as defined by NASCO. The USA and Canada are both parties to the NAC.

NASCO (*North Atlantic Salmon Conservation* Organization*)* International treaty organization responsible for the conservation, restoration, enhancement, and rational management of wild salmon in the North Atlantic.

NEAC (*North-East Atlantic Commission Area*) One of the three regional groupings of Atlantic salmon management as defined by NASCO. Denmark (in respect of the Faroe Islands and Greenland), the European Union, Iceland, Norway and the Russian Federation are all parties to the NEAC.

PFA *(Pre-Fishery Abundance)* The numbers of salmon estimated to be alive in the ocean from a particular stock at a specified time.

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

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

This glossary has been extracted from various sources, but chiefly the EU SALMODEL report (Crozier et al., 2003).

Annex 5(i): Indicator data sets examined for Labrador geographic area within the NAC (n=2)

			TYPE	Return	Return	Return	Return
			ORIGIN	W	W	W	W
			AGE GROUP	Small	Small	Large	Large
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	LAB	LAB	LAB	LAB
			RIVER	Sand Hill	Sand Hill	Sand Hill	Sand Hill
			UNIT	Number	Number[1] *(adjusted)*	Number	Number[1] *(adjusted)*
1968	1969	1970				138	690
1969	1970	1971		3 600	6 000	266	1 330
1970	1971	1972		3 596	5 993	175	875
1971	1972	1973		2 038	3 397	504	2 520
1972	1973	1974		4 761	7 935		
1973	1974	1975					
1974	1975	1976					
1975	1976	1977					
1976	1977	1978					
1977	1978	1979					
1978	1979	1980					
1979	1980	1981					
1980	1981	1982					
1981	1982	1983					
1982	1983	1984					
1983	1984	1985					
1984	1985	1986					
1985	1986	1987					
1986	1987	1988					
1987	1988	1989					
1988	1989	1990					
1989	1990	1991					
1990	1991	1992					
1991	1992	1993					
1992	1993	1994				730	1 217
1993	1994	1995		2 180	2 565	560	700
1994	1995	1996		2 796	3 107	414	505
1995	1996	1997		3 319	3 512		
1996	1997	1998					
1997	1998	1999					
1998	1999	2000					
1999	2000	2001					
2000	2001	2002				561	561
2001	2002	2003		3 141	3 141	627	627
2002	2003	2004		3 171	3 171	604	604
2003	2004	2005		4 008	4 008	875	875

[1] For Sand Hill River (Labrador), marine exploitation rates were applied to the count data (grey columns) as determined by the exploitation rate estimates (assumptions) of the Labrador fishery and as applied in the run-reconstruction model of ICES.

Annex 5(ii): Indicator data sets examined for Newfoundland geographic area within the NAC (n=11)

			TYPE	Return	Return	Return	Return	Return	Return	Return	Return
			ORIGIN	W	W	W	W	W	W	W	W
			AGE GROUP	Small	Small	Small	Small	Small	Small	Small	Small
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	NFLD	NFLD	NFLD	NFLD	NFLD	NFLD	NFLD	NFLD
			RIVER	Highlands	Conne	Terra Nova	Exploits	Middle Brook	Gander	Torrent	Western Arm Brook
			UNIT	Number	Number	Number	Number	Number	Number	Number	Number
1968	1969	1970									
1969	1970	1971									
1970	1971	1972									1 149
1971	1972	1973									738
1972	1973	1974									1 449
1973	1974	1975									920
1974	1975	1976									1 162
1975	1976	1977									1 004
1976	1977	1978									678
1977	1978	1979				1 171	4 707	1 692			573
1978	1979	1980				880	8 089	1 371			2 869
1979	1980	1981				1 140	13 344	2 113			845
1980	1981	1982				1 544	9 672	2 848			895
1981	1982	1983				1 233	9 124	1 654			849
1982	1983	1984				1 492	8 259	1 470			2 075
1983	1984	1985				1 534	19 028	1 675		1 805	427
1984	1985	1986				2 012	17 555	1 283		1 621	855
1985	1986	1987			8 302	1 459	10 343	1 547		3 155	960
1986	1987	1988			10 155	1 404	9 481	1 053		2 647	795
1987	1988	1989			7 627	2 114	9 496	1 337		2 388	767
1988	1989	1990			4 968	1 377	7 577	626	14 078	1 510	827
1989	1990	1991			5 368	1 518	6 995	1 070	14 073	2 518	807
1990	1991	1992			2 411	1 127	5 659	763	12 264	1 590	424
1991	1992	1993			2 523	1 780	13 508	1 563	18 179	2 829	480
1992	1993	1994		137	2 703	3 050	22 253	2 247	26 205	4 215	947
1993	1994	1995		145	1 533	1 809	17 603	1 751	18 494	3 737	954
1994	1995	1996		172	3 502	2 515	16 226	1 390	22 432	6 346	823
1995	1996	1997		199	4 440	2 251	30 425	2 044	24 191	7 475	1 230
1996	1997	1998		398	3 200	1 732	15 263	1 352	10 637	4 158	509
1997	1998	1999		96	2 931	1 868	27 093	2 625	19 060	5 388	1 718
1998	1999	2000		146	2 358	1 892	28 802	1 948	18 742	4 857	1 046
1999	2000	2001		58	5 177	1 629	12 063	1 749	14 074	4 154	1 492
2000	2001	2002		75	1 503	2 261	19 370	1 525	12 517	2 637	563
2001	2002	2003		169	2 573	1 435	15 589	916	13 444	4 861	1 465
2002	2003	2004		294	1 953	2 271	29 198	1 183	13 657	3 955	1 406
2003	2004	2005		507	3 818	2 999	27 093	1 504	18 521	5 069	1 151

			TYPE	Survival	Survival	Survival
			ORIGIN	W	W	W
			AGE GROUP	Small	Small	Small
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	NFLD	NFLD	NFLD
			RIVER	Conne	Northeast Trepassey	Western Arm Brook
			UNIT	%	%	%
1968	1969	1970				
1969	1970	1971				
1970	1971	1972				
1971	1972	1973				7.08
1972	1973	1974				6.69
1973	1974	1975				5.96
1974	1975	1976				5.39
1975	1976	1977				5.75
1976	1977	1978				5.99
1977	1978	1979				3.18
1978	1979	1980				12.07
1979	1980	1981				5.57
1980	1981	1982				3.14
1981	1982	1983				3.34
1982	1983	1984				9.14
1983	1984	1985				2.23
1984	1985	1986				2.26
1985	1986	1987				3.93
1986	1987	1988			8.15	2.47
1987	1988	1989		10.23	6.91	2.48
1988	1989	1990		7.56	3.66	2.97
1989	1990	1991		7.28	4.16	3.89
1990	1991	1992		4.23	5.21	2.21
1991	1992	1993		3.38	2.56	3.57
1992	1993	1994		3.96	4.72	6.15
1993	1994	1995		2.75	5.35	7.10
1994	1995	1996		5.76	8.47	8.87
1995	1996	1997		7.20	9.22	8.12
1996	1997	1998		3.40	2.86	3.51
1997	1998	1999		2.90	4.98	7.20
1998	1999	2000		3.38	4.92	6.10
1999	2000	2001		8.13	5.85	11.05
2000	2001	2002		2.47	3.22	4.43
2001	2002	2003		2.96	7.10	9.15
2002	2003	2004		2.39	5.54	9.37
2003	2004	2005		5.34	6.58	9.52

Annex 5(iii): Indicator data sets examined for Quebec geographic area within the NAC (n=34)

			TYPE	Return	Return	Return	Return	Return	Return	Return	Return
			ORIGIN	W	W	W	W	W	W	W	W
			AGE GROUP	Large	Large	Large	Large	Large	Large	Large	Large
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	Quebec	Quebec	Quebec	Quebec	Quebec	Quebec	Quebec	Quebec
			RIVER	Matapédia	Cascapedia	Bonaventure	Grande Rivière	Saint-Jean	York	Dartmouth	Madeleine
			UNIT	Number	Number	Number	Number	Number	Number	Number	Number
1968	1969	1970									
1969	1970	1971									
1970	1971	1972									
1971	1972	1973									
1972	1973	1974									
1973	1974	1975									
1974	1975	1976									
1975	1976	1977									
1976	1977	1978									
1977	1978	1979									
1978	1979	1980									
1979	1980	1981									
1980	1981	1982									
1981	1982	1983									
1982	1983	1984		1 249	1 378	1 517	455	1 116	1 290	669	709
1983	1984	1985		1 699	1 283	858	729	795	903	498	614
1984	1985	1986		2 403	1 866	1 901	446	819	1 066	602	836
1985	1986	1987		1 924	1 946	1 588	472	1 066	1 551	961	1 286
1986	1987	1988		2 483	2 659	2 610	838	1 943	2 150	1 248	1 137
1987	1988	1989		3 094	3 186	2 647	914	1 391	1 845	1 214	1 127
1988	1989	1990		2 317	2 752	2 633	667	774	1 230	788	1 134
1989	1990	1991		2 212	2 368	2 368	655	1 487	1 453	1 169	957
1990	1991	1992		2 086	2 507	2 284	910	1 479	1 655	1 282	890
1991	1992	1993		1 305	2 565	1 770	743	1 106	1 320	1 069	979
1992	1993	1994		2 293	2 311	2 800	602	1 258	1 592	1 071	1 111
1993	1994	1995		3 319	2 452	2 609	564	1 138	1 515	1 001	740
1994	1995	1996		3 749	2 552	1 440	567	802	1 440	811	1 144
1995	1996	1997		2 682	1 671	1 493	477	598	1 137	789	692
1996	1997	1998		2 084	1 224	1 090	414	431	813	392	599
1997	1998	1999		2 591	2 042	1 699	437	736	1 405	620	583
1998	1999	2000		2 583	1 367	1 915	239	418	741	356	653
1999	2000	2001		3 869	1 444	1 448	299	880	1 348	756	744
2000	2001	2002		2 292	1 291	1 043	281	687	987	485	299
2001	2002	2003		3 615	2 755	2 243	619	1 013	1 853	1 072	619
2002	2003	2004		2 983	1 720	1 465	239	677	1 272	657	631
2003	2004	2005		3 102	2 535	1 479	384	908	1 338	699	693

			TYPE	Return	Return	Return	Return	Return	Return	Return	Return
			ORIGIN	W	W	W	W	W	W	W	W
			AGE GROUP	Large	Large	Large	Large	Large	Large	Large	Small
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	Quebec	Quebec	Quebec	Quebec	Quebec	Quebec	Quebec	Quebec
			RIVER	Sainte-Anne	Cap-chat	Matane	Mitis	Godbout	de la Trinité	Aux Rochers	Matapedia
			UNIT	Number	Number	Number	Number	Number	Number	Number	Number
1968	1969	1970									
1969	1970	1971									
1970	1971	1972									
1971	1972	1973									
1972	1973	1974									
1973	1974	1975									
1974	1975	1976									
1975	1976	1977									
1976	1977	1978									
1977	1978	1979									
1978	1979	1980									
1979	1980	1981									
1980	1981	1982									
1981	1982	1983									
1982	1983	1984		687	82	1 080	447		512	107	
1983	1984	1985		556	38	1 174	410		623	138	636
1984	1985	1986		693	108	1 436	461	1 620	629	202	612
1985	1986	1987		612	162	2 378	517	1 671	563	170	725
1986	1987	1988		946	129	2 465	424	1 490	820	271	1 178
1987	1988	1989		928	181	926	530	1 422	482	145	1 347
1988	1989	1990		640	181	1 538	384	1 256	530	195	1 147
1989	1990	1991		1 260	339	1 362	457	1 219	521	569	1 649
1990	1991	1992		598	416	1 578	712	1 017	617	591	1 064
1991	1992	1993		469	373	1 337	389	699	271	400	1 320
1992	1993	1994		754	393	1 487	401	654	310	320	1 595
1993	1994	1995		653	191	934	225	806	671	666	1 206
1994	1995	1996		594	288	1 381	415	849	434	449	1 006
1995	1996	1997		349	173	1 191	478	511	554	420	2 012
1996	1997	1998		276	109	1 145	241	563	385	527	1 201
1997	1998	1999		259	116	1 209	369	472	382	657	1 473
1998	1999	2000		337	159	915	237	268	250	517	1 600
1999	2000	2001		296	152	1 242	407	501	187	532	1 586
2000	2001	2002		162	134	870	239	243	122	260	1 541
2001	2002	2003		525	188	1 330	211	427	219	439	2 540
2002	2003	2004		543	343	1 360	677	583	230	642	1 046
2003	2004	2005		400	221	1 460	450	542	151	485	2 047

			TYPE	Return	Return	Return	Return	Return	Return	Return	Return
			ORIGIN	W	W	W	W	W	W	W	W
			AGE GROUP	Small	Small	Small	Small	Small	Small	Small	Small
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	Quebec	Quebec	Quebec	Quebec	Quebec	Quebec	Quebec	Quebec
			RIVER	Cascapedia	Bonaventure	Grande rivière	Saint-Jean	York	Dartmouth	Madeleine	Sainte-Anne
			UNIT	Number	Number	Number	Number	Number	Number	Number	Number
1968	1969	1970									
1969	1970	1971									
1970	1971	1972									
1971	1972	1973									
1972	1973	1974									
1973	1974	1975									
1974	1975	1976									
1975	1976	1977									
1976	1977	1978									
1977	1978	1979									
1978	1979	1980									
1979	1980	1981									
1980	1981	1982					400				
1981	1982	1983					236				
1982	1983	1984					106				
1983	1984	1985			163	64	113	104	39	130	46
1984	1985	1986			368	74	61	132	59	286	44
1985	1986	1987			821	85	155	196	121	734	302
1986	1987	1988			1 237	139	563	467	518	606	451
1987	1988	1989			1 173	337	436	436	293	731	305
1988	1989	1990			878	292	262	248	190	686	223
1989	1990	1991			1 291	418	512	388	485	651	744
1990	1991	1992			1 329	188	437	292	369	659	252
1991	1992	1993			1 160	423	559	566	411	737	211
1992	1993	1994			826	299	619	433	372	694	251
1993	1994	1995			918	179	494	451	337	624	229
1994	1995	1996			336	111	245	223	185	442	160
1995	1996	1997			555	309	341	432	340	500	202
1996	1997	1998		186	771	187	304	375	236	466	131
1997	1998	1999		208	864	198	483	351	284	432	151
1998	1999	2000		188	1 311	157	324	302	177	356	186
1999	2000	2001		252	898	102	370	518	425	422	112
2000	2001	2002		144	661	69	268	325	198	431	156
2001	2002	2003		410	1 583	219	520	543	450	576	300
2002	2003	2004		231	874	140	394	324	216	502	324
2003	2004	2005		248	1 544	301	384	620	440	635	332

			TYPE	Return	Return	Return	Return	Return	Return
			ORIGIN	W	W	W	W	W	W
			AGE GROUP	Small	Small	Small	Small	Small	Small
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	Quebec	Quebec	Quebec	Quebec	Quebec	Quebec
			RIVER	Cap-chat	Matane	Mitis	Godbout	de la Trinité	aux Rochers
			UNIT	Number	Number	Number	Number	Number	Number
1968	1969	1970							
1969	1970	1971							
1970	1971	1972							
1971	1972	1973							
1972	1973	1974							
1973	1974	1975							
1974	1975	1976							
1975	1976	1977							
1976	1977	1978							
1977	1978	1979							
1978	1979	1980						1 068	
1979	1980	1981						2 036	
1980	1981	1982						2 498	
1981	1982	1983						2 606	
1982	1983	1984						991	
1983	1984	1985		18	1 019	76		1 805	73
1984	1985	1986		15	917	149		1 093	48
1985	1986	1987		24	2 431	626	1 325	1 603	127
1986	1987	1988		37	1 033	265	1 367	1 352	143
1987	1988	1989		95	934	371	1 477	1 696	231
1988	1989	1990		150	1 221	236	1 578	1 892	247
1989	1990	1991		125	1 269	426	1 574	2 049	335
1990	1991	1992		153	1 596	236	1 010	1 349	369
1991	1992	1993		238	2 015	476	833	633	443
1992	1993	1994		272	1 831	583	572	410	211
1993	1994	1995		126	1 189	222	535	579	284
1994	1995	1996		51	1 221	449	660	348	249
1995	1996	1997		136	1 571	698	697	662	330
1996	1997	1998		116	1 685	282	452	393	480
1997	1998	1999		51	1 433	544	504	524	632
1998	1999	2000		75	1 046	411	450	399	748
1999	2000	2001		73	1 708	503	244	250	531
2000	2001	2002		70	957	436	284	100	198
2001	2002	2003		194	1 768	325	442	404	380
2002	2003	2004		144	1 502	544	393	385	376
2003	2004	2005		217	1 931	603	508	334	422

			TYPE	Survival	Survival	Survival	Survival
			ORIGIN	W	W	W	W
			AGE GROUP	1SW	2SW	1SW	2SW
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	Quebec	Quebec	Quebec	Quebec
			RIVER	de la Trinité	de la Trinité	Saint-Jean	Saint-Jean
			UNIT	%	%	%	%
1968	1969	1970					
1969	1970	1971					
1970	1971	1972					
1971	1972	1973					
1972	1973	1974					
1973	1974	1975					
1974	1975	1976					
1975	1976	1977					
1976	1977	1978					
1977	1978	1979					
1978	1979	1980					
1979	1980	1981					
1980	1981	1982					
1981	1982	1983					
1982	1983	1984					
1983	1984	1985		1.61	1.66		
1984	1985	1986		2.43	1.60		
1985	1986	1987		1.40	1.29		
1986	1987	1988		2.19	1.22		
1987	1988	1989		3.67	1.71		
1988	1989	1990		2.57	2.00	0.55	1.52
1989	1990	1991		2.69	2.32	0.45	1.41
1990	1991	1992		1.56	0.58	0.49	0.90
1991	1992	1993		0.81	0.50	0.40	0.73
1992	1993	1994		0.67	0.72	0.35	0.77
1993	1994	1995		0.62	0.68	0.33	0.95
1994	1995	1996		0.92	0.50	0.57	0.90
1995	1996	1997		0.65	0.54	0.29	0.38
1996	1997	1998		1.66	1.07		
1997	1998	1999		1.39	0.75	0.34	0.40
1998	1999	2000		0.45	0.25	0.32	0.72
1999	2000	2001		0.25	0.12	0.53	1.18
2000	2001	2002		0.58	0.25	0.47	0.91
2001	2002	2003		0.87	0.46	0.55	0.87
2002	2003	2004		0.63	0.18	0.64	1.39
2003	2004	2005		1.03	0.68	0.67	1.72

Annex 5(iv): Indicator data sets for examined Gulf geographic area within the NAC (n=6)

			TYPE	Return	Return	Survival	Return	Return	Survival
			ORIGIN	W	W	W	W	W	W
			AGE GROUP	2SW	Large	2SW	1SW	Small	1SW
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	Gulf	Gulf	Gulf	Gulf	Gulf	Gulf
			RIVER	Miramichi	Margaree	Miramichi	Miramichi	Margaree	Miramichi
			UNIT	Number	Number	%	Number	Number	%
1968	1969	1970							
1969	1970	1971		22 405					
1970	1971	1972		28 033			35 673		
1971	1972	1973		26 044			46 275		
1972	1973	1974		38 674			44 545		
1973	1974	1975		25 013			73 418		
1974	1975	1976		19 472			64 902		
1975	1976	1977		49 094			91 580		
1976	1977	1978		21 088			27 743		
1977	1978	1979		6 238			24 287		
1978	1979	1980		34 502			50 965		
1979	1980	1981		10 793			41 588		
1980	1981	1982		24 883			65 273		
1981	1982	1983		22 479			80 379		
1982	1983	1984		14 289	380		25 184		
1983	1984	1985		18 042	1 391		29 707	504	
1984	1985	1986		26 686	3 525		60 800	838	
1985	1986	1987		15 459	3 991		117 549	1 096	
1986	1987	1988		17 744	1 580		84 816	1 478	
1987	1988	1989		11 239	2 264		121 919	2 209	
1988	1989	1990		17 602	4 791		75 231	768	
1989	1990	1991		18 119	3 230		83 500	1 977	
1990	1991	1992		22 883	5 955		60 900	1 909	
1991	1992	1993		24 124	3 606		152 600	1 645	
1992	1993	1994		15 800	2 862		95 000	2 087	
1993	1994	1995		27 020	2 333		43 571	708	
1994	1995	1996		12 569	2 614		46 458	737	
1995	1996	1997		9 526	4 941		33 610	1 685	
1996	1997	1998		6 104	3 148		16 139	667	
1997	1998	1999		6 851	1 897		23 143	764	
1998	1999	2000		7 343	1 634		23 121	667	
1999	2000	2001		13 576	2 005		32 031	551	4.10
2000	2001	2002		5 250	1 434		28 664	792	4.70
2001	2002	2003		11 330	2 671	2.00	44 864	790	6.20
2002	2003	2004		12 655	2 723	1.40	30 264	705	2.20
2003	2004	2005		11 305	3 345	2.20	43 999	1 144	4.30

Annex 5(v): Indicator data sets for examined Scotia-Fundy geographic area within the NAC (n=22)

			TYPE	Return	Return	Return	Return	Return	Return	Return
			ORIGIN	W	W	W	W	W	W	W
			AGE GROUP	Large	Large	Large	Large	Large	Large	Large
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	SF	SF	SF	SF	SF	SF	SF
			RIVER	Saint John	Nashwaak	LaHave	St. Mary's	Middle	Baddeck	North
			UNIT	Number	Number	Number	Number	Number	Number	Number
1968	1969	1970		5 712						
1969	1970	1971		4 715						
1970	1971	1972		4 899	859					
1971	1972	1973		2 518	1 956	36				
1972	1973	1974		5 811		22	722			
1973	1974	1975		7 441	1 036	55	242			
1974	1975	1976		8 177		76	427			
1975	1976	1977		9 712		135	528			
1976	1977	1978		4 021		162	427			
1977	1978	1979		2 754		171	290			
1978	1979	1980		10 924		843	669			
1979	1980	1981		5 766		855	1 197			
1980	1981	1982		5 528		591	268			
1981	1982	1983		5 783		539	787			
1982	1983	1984		9 779		808	767			368
1983	1984	1985		10 436		1 330	2 853			1 038
1984	1985	1986		6 128		1 248	3 147			2 460
1985	1986	1987		4 352		1 090	1 070			1 330
1986	1987	1988		2 625		804	2 313			1 303
1987	1988	1989		4 072		829	1 540			974
1988	1989	1990		3 329		804	913	1 030		1 486
1989	1990	1991		4 491		482	880	437		865
1990	1991	1992		4 104		450	507	445		1 340
1991	1992	1993		2 958	405	234	1 320	421		392
1992	1993	1994		1 844	355	266	100	110	125	236
1993	1994	1995		1 654	416	301	437	423	265	509
1994	1995	1996		2 309	599	241	590	328	271	302
1995	1996	1997		1 128	339	145	110	473	177	334
1996	1997	1998		320	309	141	74	346	150	253
1997	1998	1999		837	275	178	150	155		110
1998	1999	2000		277	192	137	46	362	162	66
1999	2000	2001		644	271	207	193	221		146
2000	2001	2002		199	73	79	29	131	85	112
2001	2002	2003		240	109	206	221	104	305	395
2002	2003	2004		400	203	135	41	554	70	382
2003	2004	2005		251	159	86	15	320	220	409

			TYPE	Survival	Survival	Survival	Survival	Survival	Survival	Survival	Survival
			ORIGIN	H	W	W	H	H	H	H	H
			AGE GROUP	2SW	2SW	2SW	2SW	2SW	2SW	1SW	1SW
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	SF	SF	SF	SF	SF	SF	SF	SF
			RIVER	Saint John	Nashwaak	LaHave	LaHave	East Sheet Harbour	Liscomb	Saint John	LaHave
			UNIT	%	%	%	%	%	%	%	%
1968	1969	1970									
1969	1970	1971									
1970	1971	1972									
1971	1972	1973									
1972	1973	1974					0.22				2.64
1973	1974	1975					0.27				3.14
1974	1975	1976		0.68			0.23	0.03		1.89	1.58
1975	1976	1977		0.84			0.41	0.02		2.80	6.76
1976	1977	1978		0.85			0.40	0.01		2.35	2.58
1977	1978	1979		0.41			0.21	0.02		1.04	1.02
1978	1979	1980		1.53			0.76	0.01	0.11	1.95	2.06
1979	1980	1981		1.12			1.23	0.02	0.08	4.42	1.75
1980	1981	1982		0.76			0.32	0.00	0.15	2.42	2.80
1981	1982	1983		0.58			0.28	0.10	0.15	1.61	2.58
1982	1983	1984		0.56			1.65	0.04	0.10	0.91	1.13
1983	1984	1985		0.55			0.33	0.01	0.08	0.98	1.72
1984	1985	1986		0.35			1.23	0.09	0.22	0.92	2.25
1985	1986	1987		0.45			2.15	0.03	0.18	0.87	5.19
1986	1987	1988		0.35			0.26	0.04	0.23	1.17	3.69
1987	1988	1989		0.33			1.01	0.06	0.23	0.67	5.00
1988	1989	1990		0.17			0.36	0.01	0.05	0.76	2.62
1989	1990	1991		0.17			0.26	0.01	0.08	0.40	2.94
1990	1991	1992		0.26			0.19	0.05	0.05	0.65	
1991	1992	1993		0.15			0.48	0.00	0.05	0.69	4.51
1992	1993	1994		0.22			0.24	0.01	0.03	0.41	1.26
1993	1994	1995		0.19			0.21	0.02	0.03	0.39	0.62
1994	1995	1996		0.27			0.23	0.06	0.02	0.66	1.44
1995	1996	1997		0.19			0.23	0.00	0.03	1.14	2.26
1996	1997	1998		0.08		0.26	0.13	0.01		0.56	0.47
1997	1998	1999		0.20		0.53	0.17	0.01		0.75	0.87
1998	1999	2000		0.06	0.67	0.43	0.11	0.00		0.47	0.34
1999	2000	2001		0.16	0.84	0.97	0.21	0.00		0.46	0.79
2000	2001	2002		0.05	0.28	0.23	0.07			0.27	0.43
2001	2002	2003		0.15	0.90	0.63	0.13			0.45	0.87
2002	2003	2004		0.11	1.26	0.56	0.17			0.34	0.64
2003	2004	2005		0.06		0.24	0.09			0.32	0.72

			TYPE	Return	Return	Return	Return	Return	Return	Return
			ORIGIN	W	W	W	W	W	W	W
			AGE GROUP	Small	Small	Small	Small	Small	Small	Small
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	SF	SF	SF	SF	SF	SF	SF
			RIVER	Saint John	Nashwaak	LaHave	St. Mary's	Middle	Baddeck	North
			UNIT	Number	Number	Number	Number	Number	Number	Number
1968	1969	1970								
1969	1970	1971		3 057						
1970	1971	1972		1 709						
1971	1972	1973		908	259					
1972	1973	1974		2 070	596					
1973	1974	1975		3 656			3 227			
1974	1975	1976		6 858	1 223		558			
1975	1976	1977		8 147			2 763			
1976	1977	1978		3 977			2 128			
1977	1978	1979		1 902			1 138			
1978	1979	1980		6 828		2 180	4 889			
1979	1980	1981		8 482		3 957	12 840			
1980	1981	1982		6 614		4 366	3 549			
1981	1982	1983		5 174		1 933	3 213			
1982	1983	1984		4 555		2 407	4 246			
1983	1984	1985		8 311		4 785	3 453			130
1984	1985	1986		6 526		3 551	3 654			324
1985	1986	1987		7 904		4 134	7 353			470
1986	1987	1988		5 909		6 236	1 744			452
1987	1988	1989		8 930		5 638	6 675			270
1988	1989	1990		9 522		5 274	1 715	90		324
1989	1990	1991		7 263		4 659	6 010	256		536
1990	1991	1992		6 256		1 122	4 998	73		372
1991	1992	1993		6 683		4 409	1 583	111		448
1992	1993	1994		3 213	828	1 973	2 697	34		164
1993	1994	1995		2 276	617	1 366	462	47	30	148
1994	1995	1996		2 168	899	1 385	2 038	51	108	336
1995	1996	1997		1 326	1 662	1 931	1 535	126	68	348
1996	1997	1998		343	332	766	709	68	60	140
1997	1998	1999		341	1 256	1 469	1 926	89	62	216
1998	1999	2000		472	661	652	559	90		70
1999	2000	2001		1 343	509	1 024	572	47	18	64
2000	2001	2002		686	242	388	580	47		74
2001	2002	2003		634	342	870	400	51	23	68
2002	2003	2004		381	287	476	1 092	61	36	168
2003	2004	2005		864	574	639	843	68	35	142

Annex 5(vi): Indicator data sets examined for USA geographic area within the NAC (n=5)

			TYPE	Return	Return	Return	Survival	Survival
			ORIGIN	W & H	W & H	W & H	H	H
			AGE GROUP	2SW	1SW	All	2SW	1SW
SMOLT YEAR	1SW / SMALL YEAR	2SW / LARGE YEAR	AREA	US	US	US	US	US
			RIVER	Penobscott	Penobscott	Narraguagus	Penobscott	Penobscott
			UNIT	Number	Number	Number	%	%
1968	1969	1970						
1969	1970	1971		91	7		0.95	0.074
1970	1971	1972		321	21	265	1.09	0.021
1971	1972	1973		292	11	129	0.55	0.014
1972	1973	1974		517	10	135	0.70	0.029
1973	1974	1975		925	31	348	0.85	0.045
1974	1975	1976		583	45	100	0.56	0.068
1975	1976	1977		584	75	389	0.53	0.019
1976	1977	1978		1 617	44	417	0.66	0.036
1977	1978	1979		667	135	182	0.20	0.100
1978	1979	1980		2 576	210	361	1.27	0.220
1979	1980	1981		2 564	686	229	0.83	0.152
1980	1981	1982		3 904	754	248	0.67	0.078
1981	1982	1983		745	236	282	0.35	0.054
1982	1983	1984		1 466	196	259	0.42	0.054
1983	1984	1985		3 064	280	179	0.65	0.040
1984	1985	1986		3 966	279	345	0.59	0.092
1985	1986	1987		1 550	542	210	0.25	0.129
1986	1987	1988		2 061	769	110	0.34	0.133
1987	1988	1989		2 122	733	122	0.37	0.126
1988	1989	1990		2 805	950	201	0.37	0.103
1989	1990	1991		1 521	530	74	0.26	0.041
1990	1991	1992		1 415	218	56	0.24	0.139
1991	1992	1993		1 376	962	87	0.19	0.042
1992	1993	1994		723	371	52	0.08	0.046
1993	1994	1995		1 155	313	56	0.19	0.028
1994	1995	1996		1 521	163	64	0.21	0.085
1995	1996	1997		1 087	495	37	0.16	0.044
1996	1997	1998		926	247	22	0.14	0.041
1997	1998	1999		676	269	32	0.10	0.039
1998	1999	2000		334	272	23	0.05	0.029
1999	2000	2001		564	183	32	0.08	0.034
2000	2001	2002		385	216	8	0.06	0.067
2001	2002	2003		903	377	21	0.15	0.040
2002	2003	2004		1 011	202	12	0.17	0.050
2003	2004	2005		700	281	13	0.12	0.050

Annex 5(vii): Indicator data sets examined for southern non-maturing (1SW) and maturing (2SW) stock complexes within the NEAC (n=33)

			TYPE	Return	Return	Return	Return	Return	Return to coast	Return
			ORIGIN	W	W			W		W
			AGE GROUP	1SW	1SW	1SW	1SW	1SW	1SW	2SW
			COUNTRY	UK (England & Wales)	UK (England & Wales)	UK (England & Wales)	UK (England & Wales)	UK (Scotland)	UK (N. Ireland)	UK (Scotland)
SMOLT YEAR	YEAR OF PFA AND 1SW RETURN	YEAR OF 2SW RETURN	RIVER	Itchen	Test	Frome	Dee	North Esk	Bush	Baddoch
			UNIT	Number	Number	Number	Number	Number	Number	Number
1968	1969	1970								
1969	1970	1971								
1970	1971	1972								
1971	1972	1973								
1972	1973	1974				1 766				
1973	1974	1975				981				
1974	1975	1976				1 110				
1975	1976	1977				376				
1976	1977	1978				709				
1977	1978	1979				687				
1978	1979	1980				1 535				
1979	1980	1981				505				
1980	1981	1982				1 352		14 145		
1981	1982	1983				966		19 702		
1982	1983	1984				743		18 639		
1983	1984	1985				1 406		21 471		
1984	1985	1986				1 465		15 423		
1985	1986	1987				1 632		18 418		
1986	1987	1988				2 396		14 359	5 797	
1987	1988	1989		916	1 133	2 354		18 908	7 744	48
1988	1989	1990		543	1 301	1 600		21 535	8 269	43
1989	1990	1991		114	594	1 124		9 160	4 428	41
1990	1991	1992		59	405	577		10 953	5 912	23
1991	1992	1993		209	367	460	3 114	18 614	5 055	26
1992	1993	1994		530	692	720	7 836	13 981		28
1993	1994	1995		112	465	605	4 091	18 251		15
1994	1995	1996		511	415	595	4 287	13 652	3 766	24
1995	1996	1997		243	439	824	3 645	12 128		5
1996	1997	1998		159	261	655	4 492	12 297	3 853	6
1997	1998	1999		387	672	704	4 986	11 280	3 592	19
1998	1999	2000		170	483	418	1 886	9 373	1 964	7
1999	2000	2001		177	449	363	2 842	11 796	1 949	13
2000	2001	2002		178	291	361	3 409	14 411	1 657	8
2001	2002	2003		196	793	573	5 860	11 517	1 838	23
2002	2003	2004		117	153	337	3 204	9 675	1 308	30
2003	2004	2005		349	908	374	5 137	17 139	1 318	23

			TYPE	Return	Return	Return	Return	Return	Return	Catch
			ORIGIN	W	W	W	W			
			AGE GROUP	2SW	2SW	MSW	MSW	MSW	MSW	MSW
			COUNTRY	UK (Scotland)	UK (Scotland)	UK (England & Wales)	UK (England & Wales)	UK (England & Wales)	UK (England & Wales)	Iceland
SMOLT YEAR	YEAR OF PFA AND 1SW RETURN	YEAR OF 2SW RETURN	RIVER	Girnock	North Esk	Itchen	Test	Frome	Dee	Ellidaar
			UNIT	Number	Number	Number	Number	Number	Number	Number
1968	1969	1970								
1969	1970	1971								
1970	1971	1972		72						112
1971	1972	1973		119				2 061		109
1972	1973	1974		102				1 123		247
1973	1974	1975		62				1 174		318
1974	1975	1976		83				569		159
1975	1976	1977		43				809		172
1976	1977	1978		15				799		131
1977	1978	1979		45				1 472		107
1978	1979	1980		108				608		122
1979	1980	1981		37	19 812			1 299		104
1980	1981	1982		37	10 696			1 046		106
1981	1982	1983		25	8 937			939		204
1982	1983	1984		55	8 208			1 454		153
1983	1984	1985		27	10 275			1 551		132
1984	1985	1986		60	10 273			1 689		92
1985	1986	1987		107	7 216			2 426		69
1986	1987	1988		104	7 577	420	374	2 279		66
1987	1988	1989		28	7 068	248	429	1 908		87
1988	1989	1990		27	5 776	253	196	1 240		136
1989	1990	1991		53	5 718	93	133	575		90
1990	1991	1992		32	5 749	96	121	538	1 337	60
1991	1992	1993		20	7 549	116	228	778	1 654	45
1992	1993	1994		35	8 396	199	153	611	1 039	52
1993	1994	1995		65	7 641	287	102	623	1 322	55
1994	1995	1996		41	4 440	143	76	835	1 113	33
1995	1996	1997		9	5 434	73	56	671	817	32
1996	1997	1998		9	5 659	25	76	722	1 614	9
1997	1998	1999		18	6 572	37	294	445	1 672	19
1998	1999	2000		17	4 967	27	88	354	804	4
1999	2000	2001		18	6 577	36	117	369	1 186	5
2000	2001	2002		20	6 632	43	253	568	1 244	23
2001	2002	2003		18	7 099	52	214	360	1 590	10
2002	2003	2004		56	8 471	62	221	447	1 859	13
2003	2004	2005			8 371	169	206	358	1 159	19

			TYPE	Survival	Survival	Survival	Survival	Survival	Survival	Survival
			ORIGIN	W	W	W	W	W	W	W
			AGE GROUP	ALL	1SW	1SW	1SW	1SW	1SW	2SW
			COUNTRY	France	Ireland	Ireland	UK (N. Ireland)	UK (Scotland)	Iceland	Ireland
SMOLT YEAR	YEAR OF PFA AND 1SW RETURN	YEAR OF 2SW RETURN	RIVER	Nivelle	Burrishoole	Corrib	Bush	North Eske	Ellidaar	Corrib
			UNIT	%	%	%	%	%	%	%
1968	1969	1970								
1969	1970	1971								
1970	1971	1972								
1971	1972	1973								
1972	1973	1974								
1973	1974	1975								
1974	1975	1976								
1975	1976	1977								
1976	1977	1978								
1977	1978	1979								
1978	1979	1980								
1979	1980	1981								
1980	1981	1982			10.3	17.9				1.1
1981	1982	1983			15.9	9.2		11.6		3.8
1982	1983	1984			19.3	20.9		10.5		3.3
1983	1984	1985			11.3	10.0				1.8
1984	1985	1986			25.9	26.2		7.8		2.0
1985	1986	1987			26.0	18.9		19.9	9.4	1.8
1986	1987	1988		15.1	28.8		31.3			0.0
1987	1988	1989		2.6	39.7	16.6	35.1	11.9		0.7
1988	1989	1990		2.4	33.5	14.6	36.2		12.7	0.7
1989	1990	1991		3.5	10.8	6.7	25.0	7.0	8.1	0.7
1990	1991	1992		1.8	29.6	5.0	34.7	6.4	5.4	0.6
1991	1992	1993		9.2	24.8	7.3	27.8	9.6	8.8	1.3
1992	1993	1994		8.9	19.4	7.3	29.0		9.6	
1993	1994	1995		7.2	23.9	10.8			9.8	0.1
1994	1995	1996		2.3	26.9	9.8	27.1	13.7	9.0	1.4
1995	1996	1997		4.4	14.6	8.4		9.8	9.4	0.1
1996	1997	1998		3.4	18.3	6.5	31.0	9.3	4.6	1.2
1997	1998	1999		2.7	15.6	12.7	19.8	9.6	5.3	0.8
1998	1999	2000		1.9	12.4	5.5	13.4		5.3	1.1
1999	2000	2001		2.8	14.9	6.4	16.5		7.7	0.9
2000	2001	2002		3.3	22.5	9.4	10.1	5.9	6.3	0.0
2001	2002	2003		0.4	16.6	7.2	12.4	9.0	5.1	1.1
2002	2003	2004		0.8	12.3	6.0	11.3	3.2	4.4	0.5
2003	2004	2005		0.5	19.4	8.3	6.8	9.6	9.1	0.5

			TYPE	Survival	Survival	Survival	Survival	Survival	Survival	Survival
			ORIGIN	W	H	H	H	H	H	H
			AGE GROUP	2SW	1SW	1SW	1SW	1SW	1SW	1SW
			COUNTRY	UK (Scotland)	Ireland	Ireland	Ireland	Ireland	Ireland	Ireland
SMOLT YEAR	YEAR OF PFA AND 1SW RETURN	YEAR OF 2SW RETURN	RIVER	North Eske	Burrishoole	Corrib / Cong	Corrib / Galway	Screebe	Delphi / Burrishoole	Delphi
			UNIT	%	%	%	%	%	%	%
1968	1969	1970								
1969	1970	1971								
1970	1971	1972								
1971	1972	1973								
1972	1973	1974								
1973	1974	1975								
1974	1975	1976								
1975	1976	1977								
1976	1977	1978								
1977	1978	1979								
1978	1979	1980								
1979	1980	1981								
1980	1981	1982			3.3	0.9				
1981	1982	1983		5.2	6.9	1.5				
1982	1983	1984		5.0	8.2	2.7	16.1			
1983	1984	1985				2.8	4.1			
1984	1985	1986		3.5	23.5	5.2	13.2	10.4		
1985	1986	1987		5.8	26.3	1.4	14.5	12.3		
1986	1987	1988			7.6		7.7	0.4		
1987	1988	1989		3.1	11.2		2.2	8.4		
1988	1989	1990			13.8	4.5		9.2		
1989	1990	1991		4.2	7.9	6.0	4.8	1.8		
1990	1991	1992		2.9	7.1	0.2	2.3			0.2
1991	1992	1993		4.2	12.5	4.9	4.0	0.3	11.3	6.2
1992	1993	1994			6.3	0.9	0.6	1.3	10.7	1.9
1993	1994	1995			12.0	1.0		3.4	14.0	6.4
1994	1995	1996		2.3	14.3		5.3	1.9	3.9	2.7
1995	1996	1997		3.7	6.6	2.4		4.1	3.4	1.7
1996	1997	1998		3.4	5.3			1.8	10.1	6.6
1997	1998	1999		4.4	13.3			0.4	16.2	5.5
1998	1999	2000			4.9	3.3	2.9	1.3	7.0	3.0
1999	2000	2001			8.1		3.6	2.8	15.4	7.1
2000	2001	2002		2.3	11.8	6.7		3.8	15.9	12.0
2001	2002	2003		3.2	9.7	3.4		2.5	17.2	7.4
2002	2003	2004		2.5	9.2		2.0	4.1	11.5	4.6
2003	2004	2005			6.0		1.2		3.7	1.5

			TYPE	Survival	Survival	Survival	Survival	Survival
			ORIGIN	H	H	H	H	H
			AGE GROUP	1SW	1SW	1SW	2SW	2SW
			COUNTRY	Ireland	Ireland	UK (N. Ireland)	Ireland	UK (N. Ireland)
SMOLT YEAR	YEAR OF PFA AND 1SW RETURN	YEAR OF 2SW RETURN	RIVER	Bunowen	Erne	Bush	Shannon	Bush
			UNIT	%	%	%	%	%
1968	1969	1970						
1969	1970	1971						
1970	1971	1972						
1971	1972	1973						
1972	1973	1974						
1973	1974	1975						
1974	1975	1976						
1975	1976	1977						
1976	1977	1978						
1977	1978	1979						
1978	1979	1980						
1979	1980	1981						
1980	1981	1982					8.6	
1981	1982	1983					2.8	
1982	1983	1984					4.0	
1983	1984	1985				1.9	3.9	8.1
1984	1985	1986			9.4	13.3	5.0	
1985	1986	1987			8.2	15.4	17.8	17.5
1986	1987	1988			10.8	2.0	2.1	9.7
1987	1988	1989			7.0	6.5	4.7	19.4
1988	1989	1990			2.9	4.9	4.9	6.0
1989	1990	1991			1.2	8.1	5.0	23.2
1990	1991	1992			2.6	5.6	1.3	5.6
1991	1992	1993			1.3	5.4	4.2	8.8
1992	1993	1994		4.2		6.0	4.4	7.8
1993	1994	1995		5.4		1.1	2.9	5.8
1994	1995	1996		10.8		1.6	5.2	
1995	1996	1997		3.5		3.1	3.6	2.4
1996	1997	1998		3.4		2.0	2.9	2.3
1997	1998	1999		5.3	7.7		6.0	4.1
1998	1999	2000		2.9	2.6	2.3	3.1	4.5
1999	2000	2001		2.0	3.3	2.7	1.0	5.8
2000	2001	2002		5.4	4.0	2.8	1.2	4.4
2001	2002	2003		3.2	6.0	1.1	2.0	2.2
2002	2003	2004		2.0	1.9	0.7	1.0	3.1
2003	2004	2005		1.6	1.0	2.5	1.2	1.9

Annex 5(viii): Indicator data sets examined for northern non-maturing (1SW) and maturing (2SW) stock complexes within the NEAC (n= 7)

			TYPE	Return	Survival	Catch	Return	Survival	Survival	Catch
			ORIGIN	ALL	H	W	ALL		H	ALL
			AGE GROUP	2SW	2SW	2SW	1SW	1SW	1SW	1SW
			COUNTRY	Norway	Norway	Finland	Norway	Norway	Norway	Finland
SMOLT YEAR	YEAR OF PFA AND 1SW RETURN	YEAR OF 2SW RETURN	RIVER	PFA estimate	Drammen	*not applicable*	PFA estimate	Imsa	Imsa	*not applicable*
			UNIT	Number	%	Number	Number	%	%	Number
1968	1969	1970								
1969	1970	1971								
1970	1971	1972								
1971	1972	1973								
1972	1973	1974								
1973	1974	1975								
1974	1975	1976								
1975	1976	1977								
1976	1977	1978								
1977	1978	1979								
1978	1979	1980								
1979	1980	1981				9 835				7 386
1980	1981	1982				12 826		17.3	10.1	2 163
1981	1982	1983				13 990		5.3	4.2	10 680
1982	1983	1984				13 262		13.5	1.6	11 942
1983	1984	1985				10 339		12.1	3.8	18 039
1984	1985	1986			3.0	9 028		10.2	5.8	16 389
1985	1986	1987			1.9	11 290		3.8	4.7	20 950
1986	1987	1988			2.2	7 231		17.3	9.8	10 019
1987	1988	1989			0.7	10 011		13.3	9.5	28 091
1988	1989	1990			0.3	12 562		8.7	3.0	26 646
1989	1990	1991			1.3	15 136	541 687	3.0	2.8	32 423
1990	1991	1992			0.4	16 158	508 745	8.7	3.2	42 965
1991	1992	1993		130 362	0.1	18 720	414 460	6.7	3.8	30 197
1992	1993	1994		139 827	0.6	15 521	506 878	15.6	6.5	12 016
1993	1994	1995		147 518	1.0	9 634	401 593		6.2	11 801
1994	1995	1996		134 348	0.9	6 956	310 579	1.8	0.4	22 799
1995	1996	1997		101 379	0.3	10 083	298 965	3.5	2.1	19 481
1996	1997	1998		129 063	0.2	8 497	449 409	1.7	1.0	22 460
1997	1998	1999		133 477	0.2	8 854	435 236	7.2	2.4	38 687
1998	1999	2000		240 468	0.7	19 707	642 574	4.1	12.0	40 654
1999	2000	2001		301 462	1.6	28 337	571 051	12.5	8.4	18 372
2000	2001	2002		219 708	0.6	22 717	317 347	4.1	3.4	10 757
2001	2002	2003		216 396	1.1	16 093	458 938	5.8	4.5	12 699
2002	2003	2004		176 952	0.7	7 718	267 001	3.5	2.6	4 912
2003	2004	2005		164 649	0.6	5 969	463 135	6.0	3.6	12 499