REPORT OF ICES ADVISORY COMMITTEE

ON

NORTH ATLANTIC SALMON STOCKS

TO

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

June 4 to 7, 2013

CNL(13)8

Advice generated by ICES in response to terms of reference from NASCO

10.1 North Atlantic - catches, new threats/opportunities, other questions, research

10.2 North East Atlantic Commission – catches, stock status, development of risk-based framework, catch advice

10.3 North American Commission – catches, stock status, catch advice

10.4 West Greenland Commission – catches, stock status, catch advice

Advice generated by ICES in response to terms of reference from NASCO

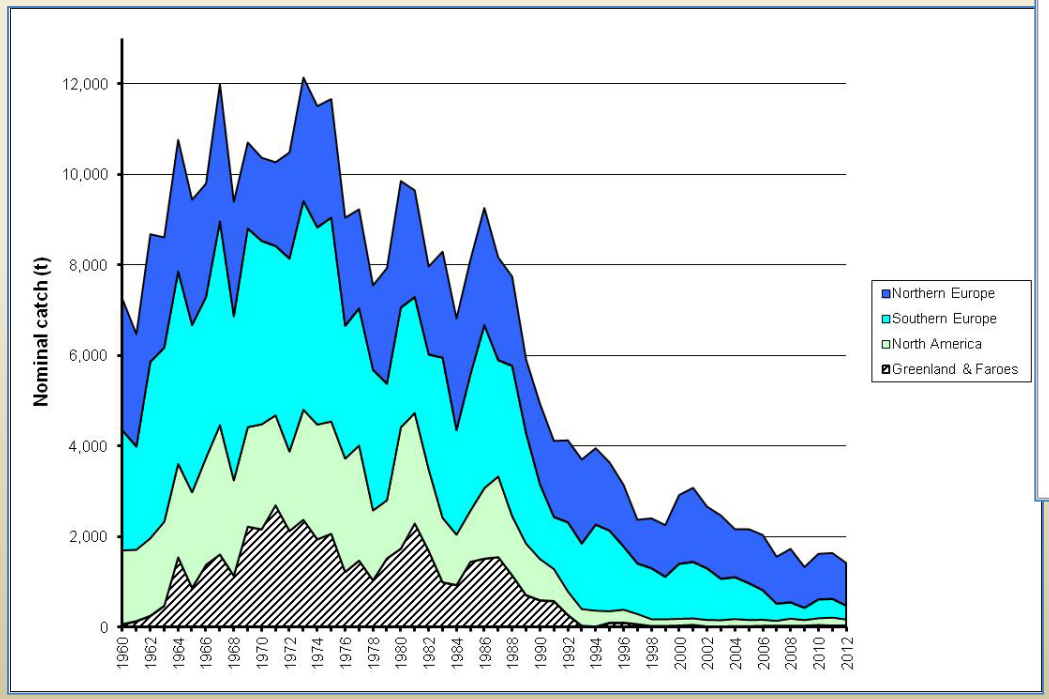
10.1 With respect to salmon in the North Atlantic:

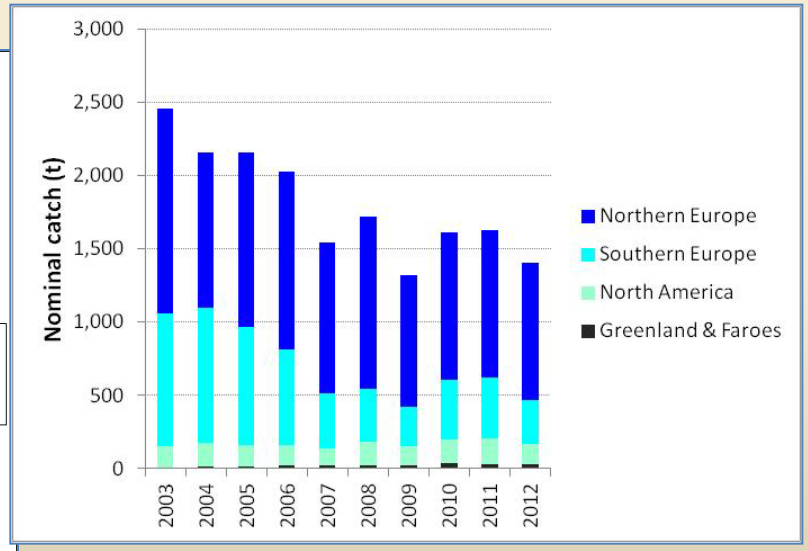
1. Provide an overview of salmon catches, unreported catches, catch and release, and production of farmed and ranched Atlantic salmon
2. Report on significant new or emerging threats to, or opportunities for, salmon conservation and management
3. Report on progress in review of salmon restoration and rehabilitation activities
4. Advise on the potential threats to Atlantic salmon from exotic salmonids
5. Provide compilation of tag releases by country in 2012
6. Summary of data deficiencies, monitoring needs and research requirements

Overview of salmon catches

Nominal catch in 2012 in the North Atlantic = 1409 t

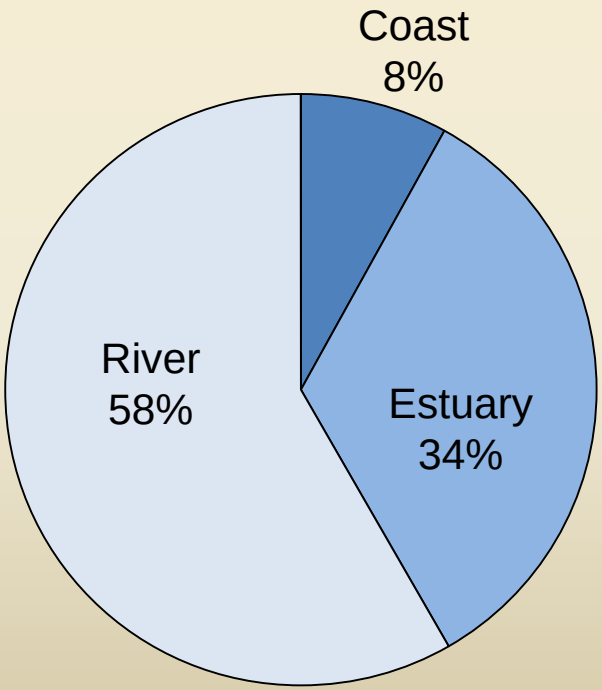
NAC	West Greenland	Southern NEAC	Northern NEAC	NEAC	North Atlantic
136 t	33 t	301 t	939 t	1240 t	1409 t
3rd lowest	15th lowest	2nd lowest	2nd lowest	2nd lowest	2nd lowest



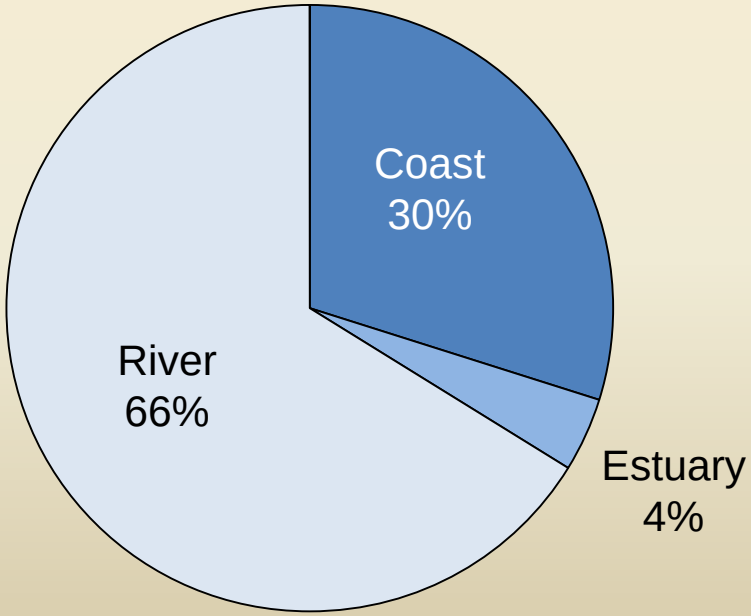


Partitioning of nominal catch into areas fished

- Majority of nominal catch in 2012 was taken in rivers
- Higher proportion of catches from coastal areas in NEAC compared to NAC, higher proportion from estuaries in NAC



NAC

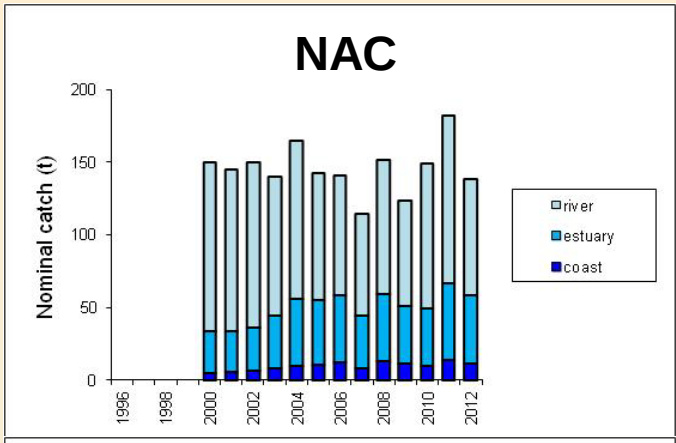


NEAC

Nominal catch by area fished

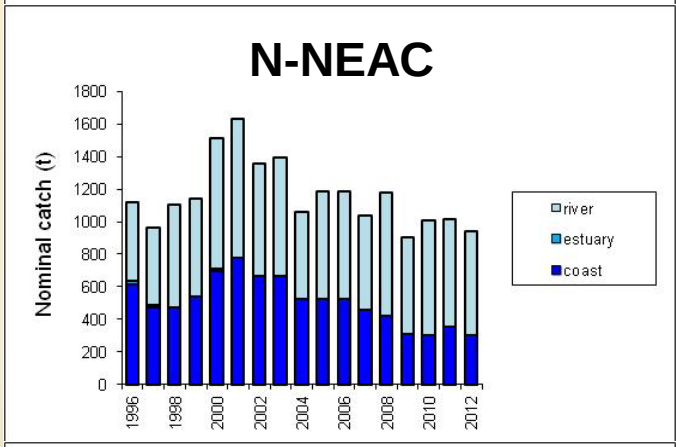
North American Commission

- Total catch relatively constant
- Relatively small coastal catch
- Majority taken in river fisheries



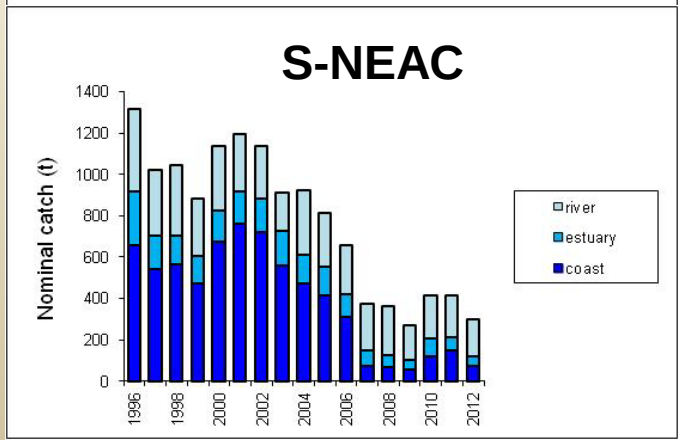
Northern North-East Atlantic Commission

- Approx. equal split river & coastal
- Negligible estuary catch
- Increasing proportion in rivers (68% in 2012)



Southern North-East Atlantic Commission

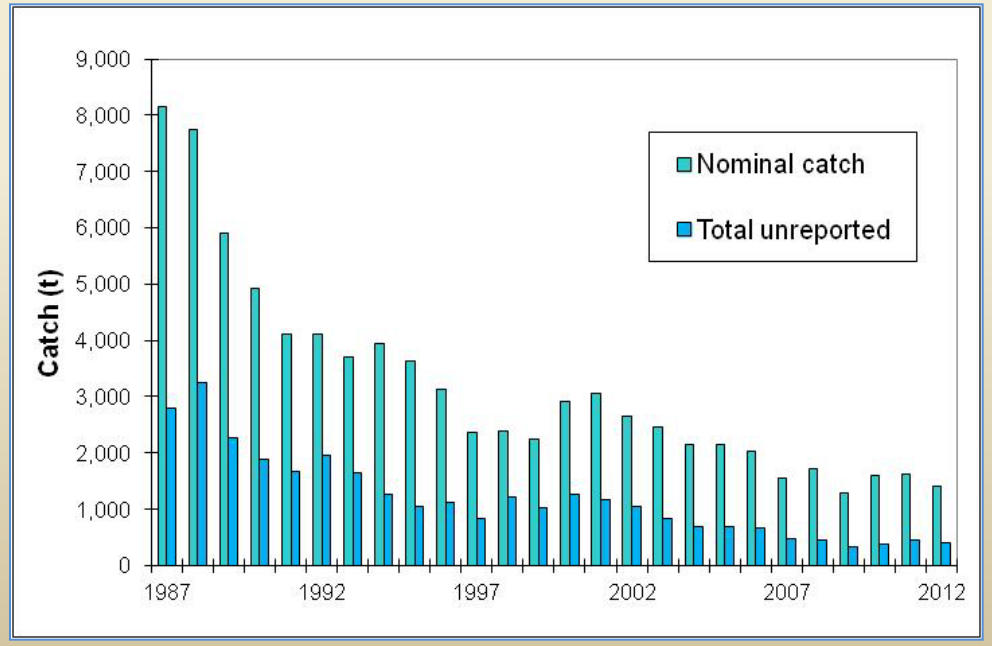
- Large declines in coastal fisheries
- Majority of catch since 2007 taken in rivers (60% in 2012)



Unreported Catches

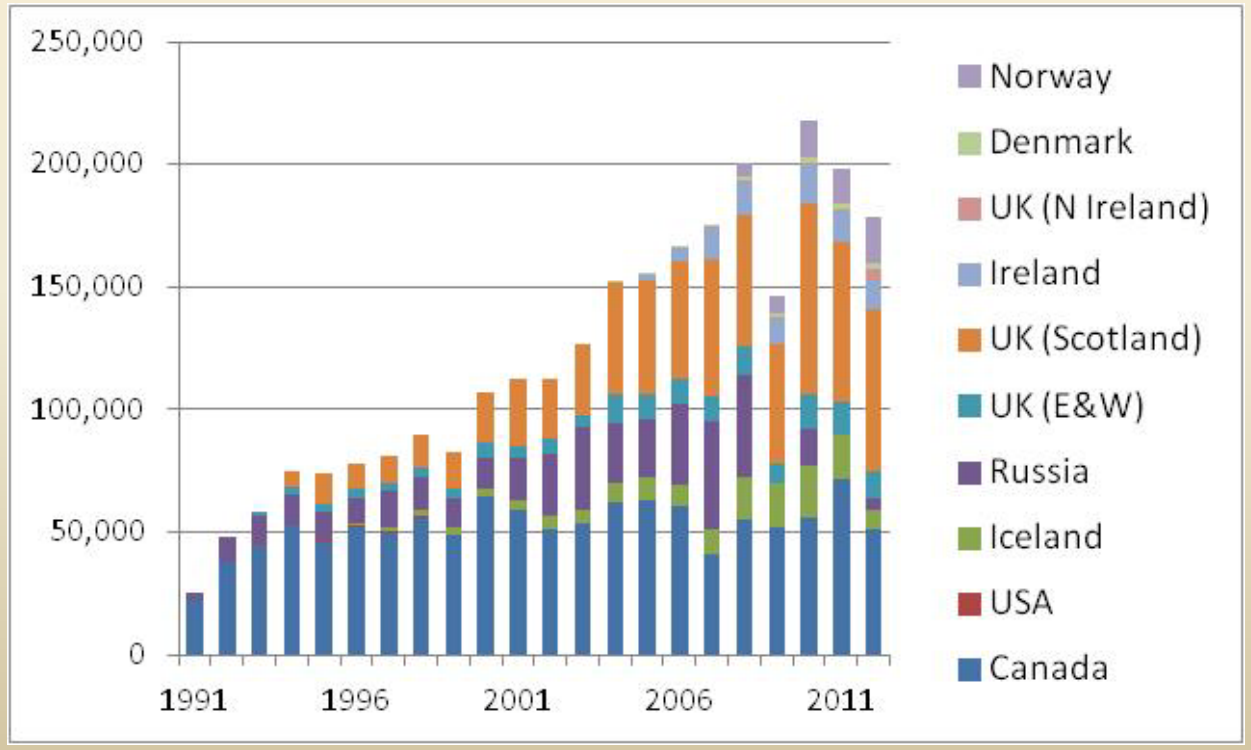
- Estimated at 403 t in 2012:
  - 363 t from NEAC
  - 31 t from NAC
  - 10 t from West Greenland
- No unreported estimates from Russia, St. Pierre & Miq, Spain in 2012
- Unreported catches declined from peak values of 3000 t in late 1980s to about 700 t in 2005-2006 (last years when reports available from all areas)
- Unreported catch 23% to 34% of nominal catch from 1987 to 2006


Illegal net seized in UK (England & Wales)
photo courtesy of Environment Agency



Catch and release (C&R) fishing

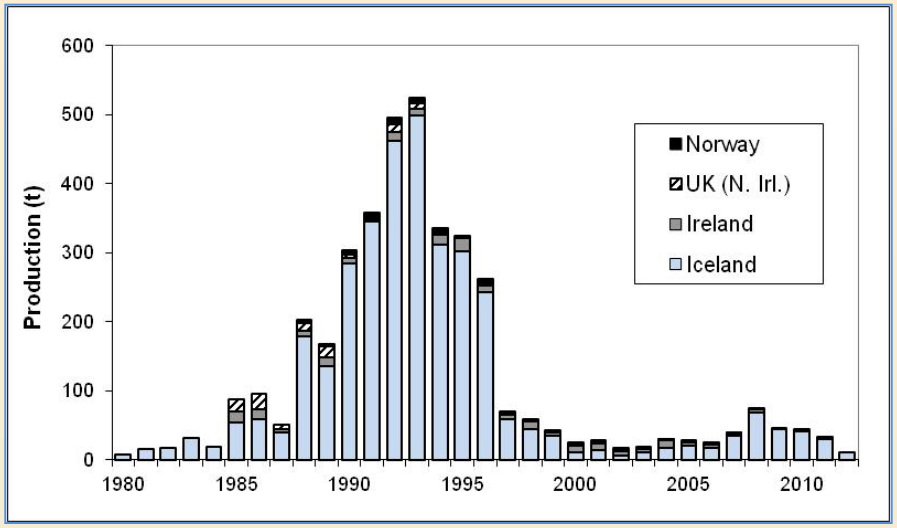
- Not included in nominal catch
- Practice increasing in popularity & more countries are reporting (9 in 2012)
- C&R in 2012 ranged from 14% for Norway (minimum fig) to 74% in UK(Scotland)
- Data incomplete for many countries, not a reporting requirement
- In 2012, 173 000 fish were released

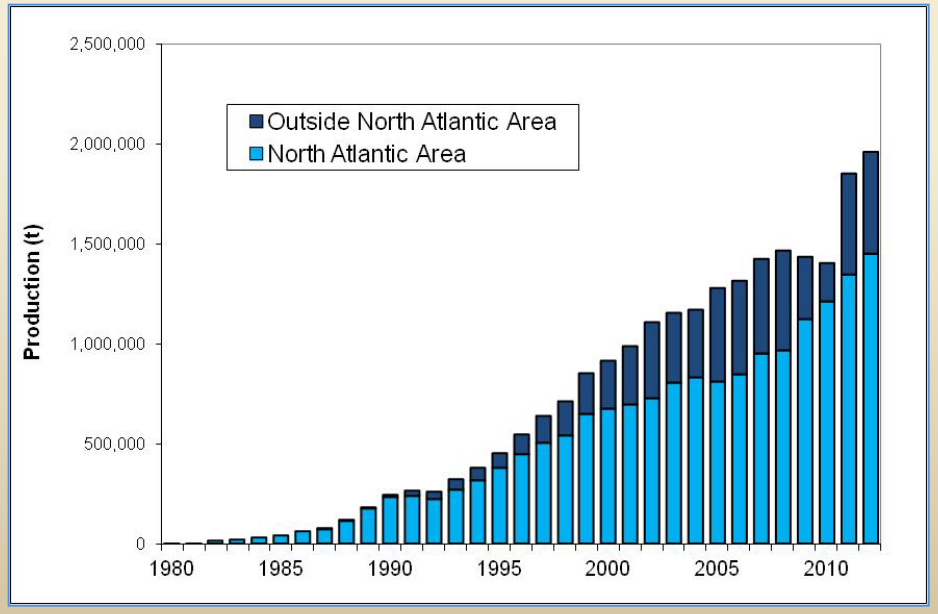


Farming and Sea Ranching

Farmed production in 2012

- North Atlantic = 1 450 kt
  - 79% from Norway
  - 11% from UK (Scotland)
- Worldwide = 1 960 kt
  - > 1 million t produced since 2002
  - >1300 times the 2012 nominal catch





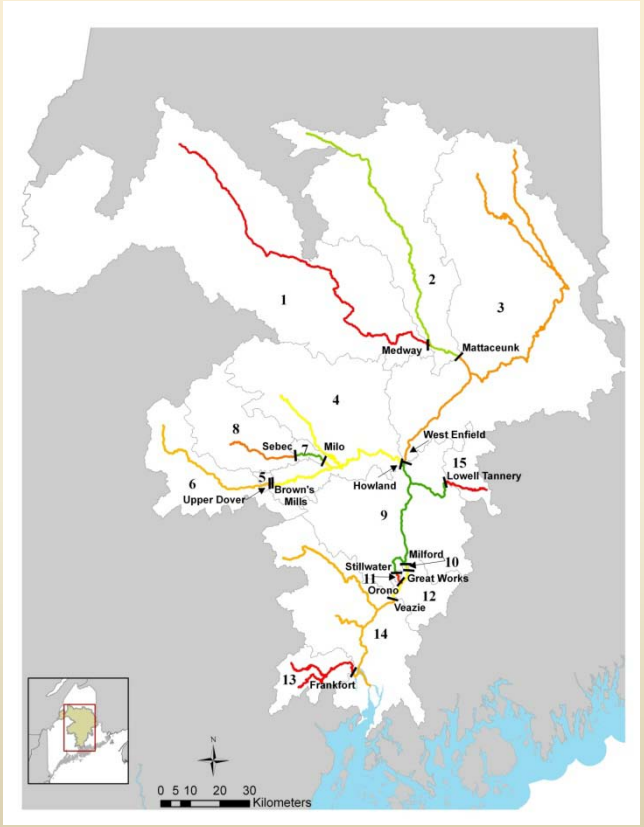
Sea ranching in 2012

- 12 t – all from Iceland as ranching to rod fisheries
- Very small quantities elsewhere, but no data for 2012

Report on significant new or emerging threats to, or **opportunities** for, salmon conservation and management

Dam impact analysis model for salmon in the Penobsot River (USA)

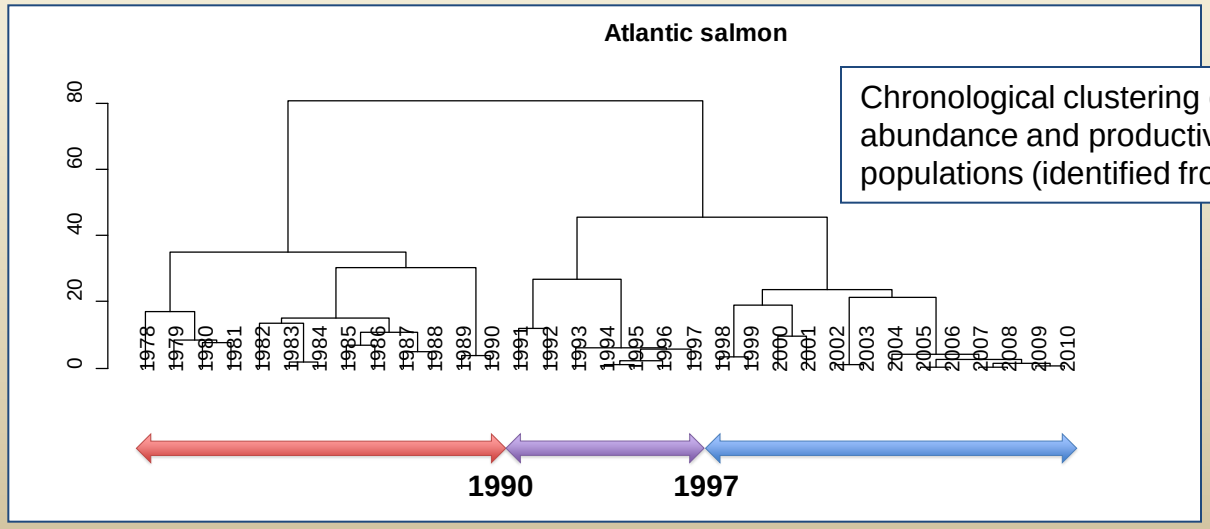
- Population viability analysis to better understand impact of dams on production potential of salmon
- Dams identified as major contributor to historic decline of this population segment (listed as endangered – since 2000)
- Life history modeling approach developed – various scenarios explored
- Model results most sensitive to marine survival & downstream passage dam survival rates
- Model being used to inform management decisions and to prioritise remedial actions



Report on significant new or emerging threats to, or **opportunities** for, salmon conservation and management

Marine influences on N. American Atlantic salmon populations

- Dynamic factor analysis confirmed coherent changes across N America (consistent with common factors acting in the marine envt.)
- Major changes identified in 1990 & 1997 using cluster analysis
- These linked to changes in climate, and physical & biological conditions in the marine ecosystem - both direct and bottom-up processes operating
- Poor trophic conditions and warming temperatures constraining productivity

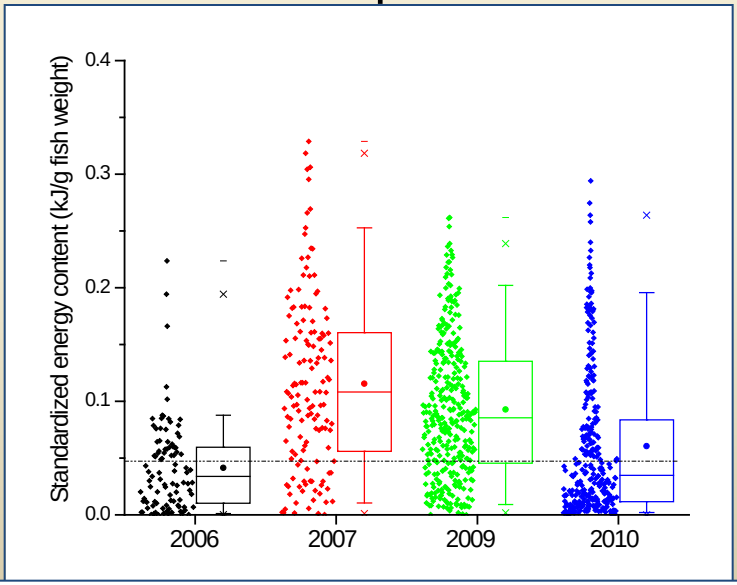


Chronological clustering of common trends in abundance and productivity of Atlantic salmon populations (identified from dynamic factor analysis)

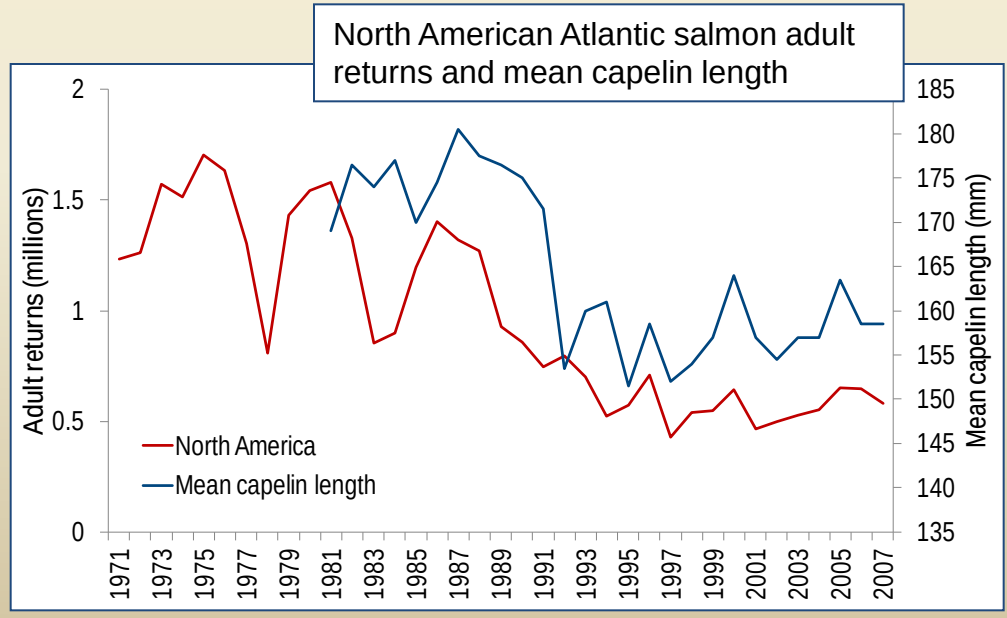
Report on significant new or emerging threats to, or **opportunities** for, salmon conservation and management

West Greenland foraging ecology & implications for survival

- Stomach samples (1345) collected at W Greenland as part of SALSEA W Greenland (2006-07 & 2009-11)
- Energy equivalents of stomach contents calculated & scaled relative to body weight – revealed substantial year to year variation
- Declines in capelin size concurrent with salmon declines



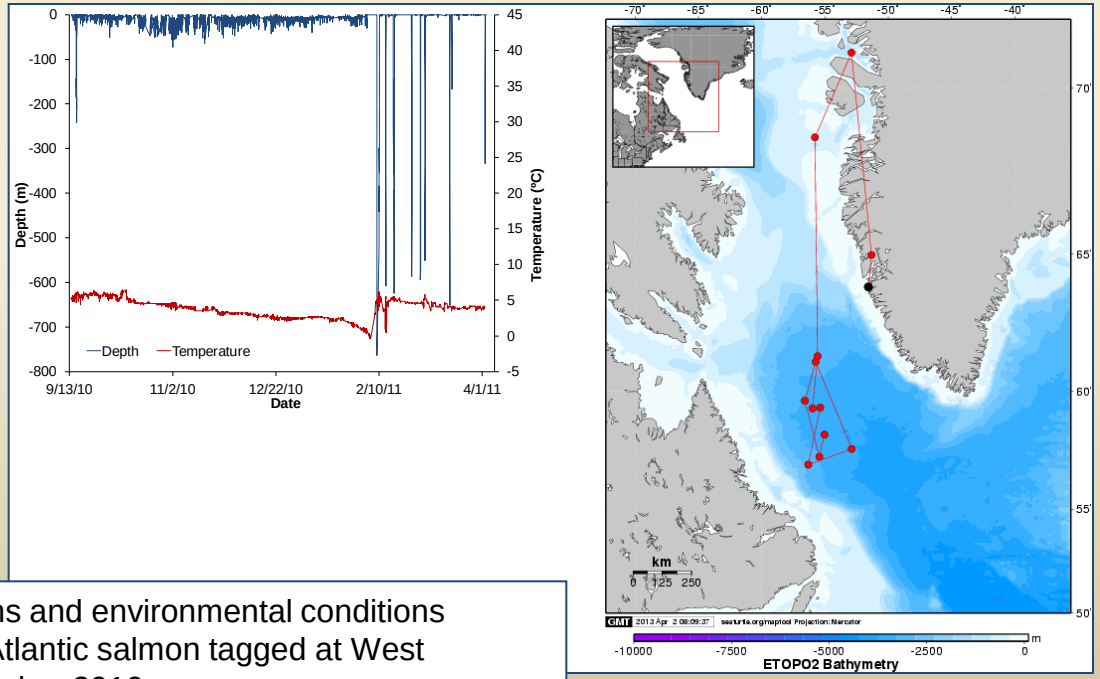
Standardised energy content (kJ/g fish weight) of stomach contents from Atlantic salmon sampled at W. Greenland



Report on significant new or emerging threats to, or **opportunities** for, salmon conservation and management

Tracking & acoustic tagging studies – (1) PSATs at W. Greenland

- Pop-up satellite tags (PSATs) attached to 25 adult salmon at W. Greenland in Sept 2010-12
- Only 2 tags stayed on to full term (April 1); 3 predated (inferred from tag data); 1 exceeded emergency pop-off depth; 7 popped-off for unknown reasons; 12 never detected
- Provides high quality data on movement patterns, winter locations & environmental conditions experienced by fish
- ICES recommends that consideration be given to further ultrasonic tracking investigations at Greenland

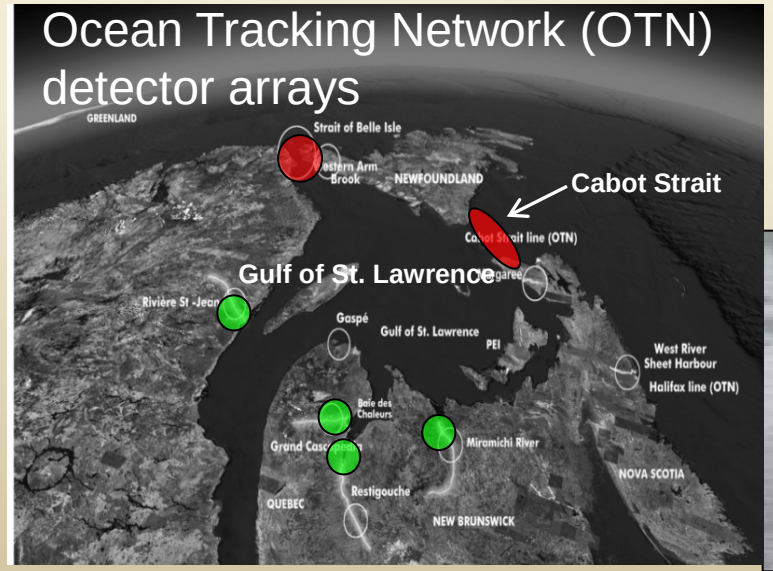


Geolocation positions and environmental conditions experienced by an Atlantic salmon tagged at West Greenland in September 2010

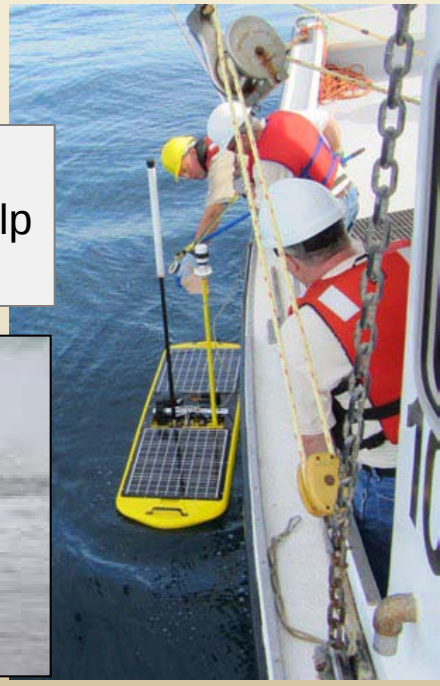
Report on significant new or emerging threats to, or **opportunities** for, salmon conservation and management

Tracking & acoustic tagging studies – (2) Acoustic tracking update for Canada

- Tracking projects led by Atlantic Salmon Federation (ASF) – 291 smolts acoustically tagged in 2012 in 4 rivers; also 35 kelts (10 of these with archival pop-up tags)
- Continued time series of estimates of survival at various locations – to head of tide, through estuary and exiting Gulf of St Lawrence – to help partition early marine mortality



- New approaches using seal 'bioprobes' and wave glider to help improve detection rates



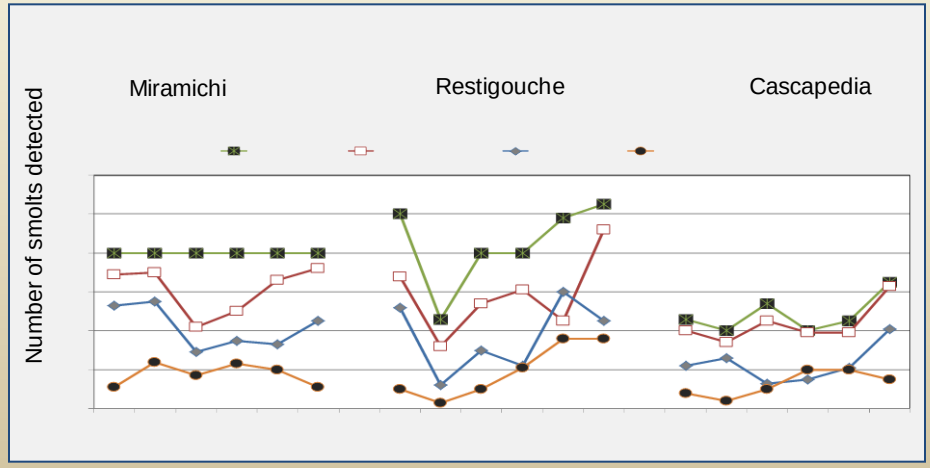
Report on significant new or emerging threats to, or **opportunities** for, salmon conservation and management

Tracking & acoustic tagging studies – (3) Modelling inter-stage survival rates and detection probabilities for acoustically tracked salmon smolts & post smolts

- A number of studies in NAC area are using acoustic tracking and arrays of detector buoys to 'gate' migration routes in the early part of the ocean life
- Aim is to better understand and partition marine mortality
- New Bayesian model developed to provide better mortality estimates by disentangling imperfect detection rates at sonic arrays from apparent survival
- Model tested on data from 3 rivers and 6 years

❖ Model provides a flexible framework for analysing multi-year, multi-array and multi-river designs

❖ Also a good basis for exploring the effect of other variables (e.g. smolt size, envt'l variables, date of release, etc)



Report on significant new or emerging **threats** to, or opportunities for, salmon conservation and management

The impact of artificial night light on salmon fry dispersal and the onset of smolt migration

❖ Use of artificial light increasing and modern replacement lamps emit more light across visible spectrum

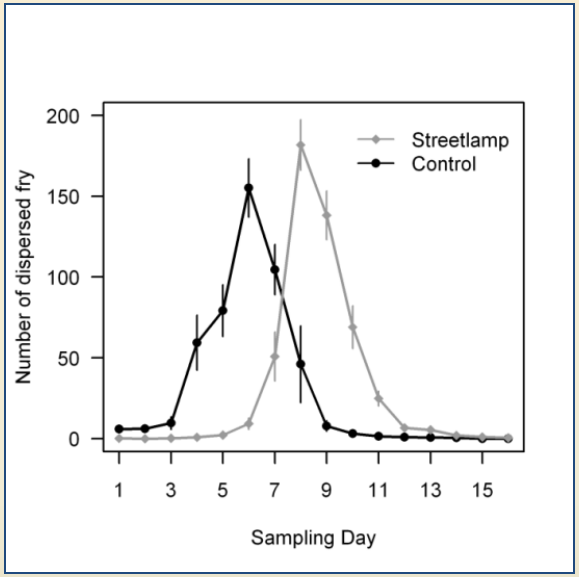
Broader spectrum street light at ecologically relevant light intensity levels:

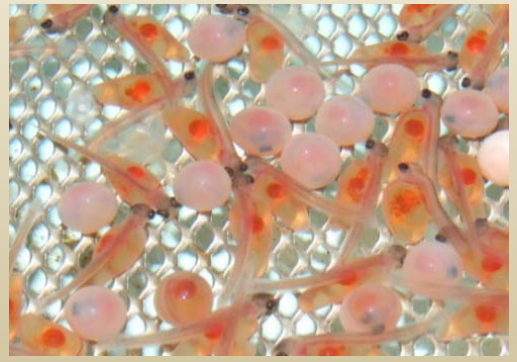
❖ Delays & disrupts salmon fry dispersal & results in dispersal of smaller fry

❖ Disrupts onset of smolt migration

❖ Timing of both - predator avoidance tactics

❖ Critical life-history stages when mortality can be high with implications for strength of the cohort





Report on significant new or emerging threats to, or **opportunities** for, salmon conservation and management

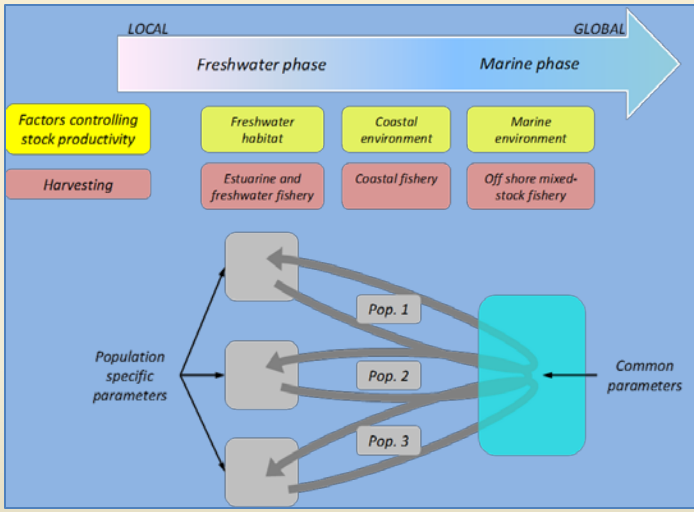
Stock identification of salmon caught in the Faroes salmon fishery

- Faroes fishery exploited salmon from Northern & Southern European stock complexes in the 1980s & 1990s & fishery could reopen if stocks recover
- NASCO has asked ICES to develop a risk-based framework for the provision of catch advice for this fishery, but data on stocks exploited is limited
- New DNA profiling and statistical genetic approaches provide an opportunity to look at historic scale samples
- Approx 750 scales from the fishery (1983-85 and 1991-93) selected for analysis
- Preliminary results suggest significant degradation of DNA in some samples, but others better and modified protocols suggest DNA extraction techniques might be improved
- No assignment analysis yet, but some samples have been identified with alleles only expected to occur in N. American salmon

Report on significant new or emerging threats to, or **opportunities** for, salmon conservation and management

ECOKNOWS progress

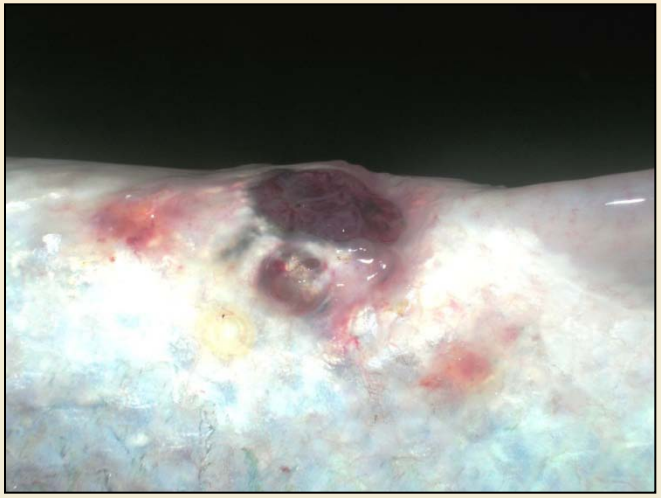
- EU 7th framework project (2010-2014) - to develop models and algorithms that make use of all types of relevant biological knowledge in fisheries science
- Structured in a Bayesian environment
- Generic assessment tools are being applied to different case studies - one focusing on the salmon assessment and forecast models presently used in Baltic and N. Atlantic.
- Life cycle approach proposed - follow cohorts through river parr and smolt classes, sea ages and returns
- ECOKNOWS commitment to report regularly to ICES (North Atlantic & Baltic Groups)
- Progress reported on both:
  - **an integrated life-cycle model - alternative approach to PFA modelling (model has been applied to E. Scotland stock complex)**
  - **a meta-analysis of egg-to-smolt survival**



Schematic of the multi-scale modelling approach used

Report on significant new or emerging **threats** to, or opportunities for, salmon conservation and management

Diseases and parasites (1)



1. Red vent syndrome (RVS)

- Characterised by swollen and/or bleeding vents;
- Noted in Atlantic salmon since 2005, linked to the presence of nematode, *Anisakis simplex;*
- No indication that RVS affects survival or spawning success;
- Affected vents show signs of progressive healing in freshwater
- Incidence appears to be reduced in last few years

2. 'New' parasite in 2011 *Paragnathia formica*

- Estuarine crustacean isopod detected on 5% of salmon caught at trap on Scorff River (France)
- Symptoms include inflammation in the vent area and on fins; may be mistaken for sea lice damage or RVS
- **Not reported in 2012**

Report on significant new or emerging **threats** to, or opportunities for, salmon conservation and management

Diseases and parasites (2)

3. Sea Lice monitoring

- Relatively few studies on sea lice prevalence and intensity on Atlantic salmon in areas prior to or without aquaculture
- Routine monitoring (May - Oct; 2005 - 2011) on Miramichi (Canada):
  - No marine finfish aquaculture in southern Gulf of St Lawrence
  - Developed indices of abundance (5 categories)
  - Prevalence lowest in June and increased over summer, generally highest in August (consistent with fish 'staging' in Miramichi Bay?)
  - Numbers of lice could be quite high in some years (as many as 5% of fish having >50 lice per fish)
- Monitoring at W Greenland (SALSEA W. Greenland)
  - 1166 fish sampled 2009-2011
  - On average, 30% of fish had no lice
  - Average presence of 2.7 lice per fish (range 2.3 – 3.0)
- Improved monitoring of lice in different areas important to gain picture of 'natural' state of association between Atlantic salmon and sea lice and how this might vary with environmental conditions

Report on significant new or emerging **threats** to, or opportunities for, salmon conservation and management

Changing biological characteristics

- Trends in various biological characteristics of salmon were previously reported in the ICES SGBICEPS report (ICES 2010)
- Decreasing mean fork lengths of returning 1SW fish in River Bush, UK (N. Ireland) since 1973. Same trend observed for 1SW adults on River Bann, UK (N. Ireland).
- Notable increase in numbers of 2SW returns to the River Bush in UK (N. Ireland) and the increase in the relative proportion of 2SW vs. 1SW since 2003.
- A similar change in 1SW:MSW ratios observed in Norwegian stocks; from the 2004 smolt cohort onwards the estimates for the proportion returning as 1SW decreased to about 15% and has remained low. Abundance of 2SW & 3SW has increased
- Above observations could indicate a shift in life history strategy from 1SW to MSW in some N. & S. NEAC stocks, possibly due to poor growth in the first season at sea
- Evidence from UK (England & Wales) that mean smolt age (which has been decreasing in many places) may be increasing again

Report on significant new or emerging threats to, or **opportunities** for, salmon conservation and management

New initiatives in relation to management of mixed stock fisheries (MSFs) in northern Norway

- Comprehensive genetic baseline established for salmon populations in northern Europe (SALSEA-Merge & other projects)
- Being applied in management of MSFs in Norway – approximately 50% of samples from coastal fisheries can be reliably assigned to rivers
- Provides reliable estimates of the proportion of Russian fish in the catches
- However, need identified for improvement in spatial coverage of baseline and increased sampling to improve assignment probabilities
- New initiative between Russian Federation, Norway & Finland aims to address this
- Over 17,000 samples collected from coastal fisheries in N. Norway in 2011 & 2012 - currently being analysed
- Work also progressing to identify new genetic markers – single nucleotide polymorphisms (SNPs)

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

- The Working Group on Effectiveness of Recovery Actions for Atlantic Salmon [WGERAAS] met in Belfast in February 2013 – 22 delegates from 11 countries (Chair Dennis Ensing – UK (N. Ireland)). ToR:
  1. Develop a classification system for recovery / re-building programmes for Atlantic salmon, including threats to populations, population status, life history attributes, actions taken to re-build populations, programme goals, and metrics for evaluating the success of re-building programmes.
  2. Populate the system by collecting data on recovery / re-building programmes for Atlantic salmon populations from around the North Atlantic.
  3. Summarise the resulting data set to determine the conditions under which various recovery / re-building actions are successful and when they are not.
  4. Provide recommendations on appropriate recovery / rebuilding actions for Atlantic salmon given threats to populations, status and life history.
- Range of initial case studies explored, but work at an early stage. Plans to develop a database including information on stressors / recovery actions & collate wide range of case studies prior to more detailed assessment
- Second WGERAAS meeting scheduled for Jan 2014

Advise on the potential threats to Atlantic salmon from exotic salmonids, including rainbow trout & brown trout where appropriate

Pacific origin species

	American Brook Trout (*Salvelinus fontinalis*)	Lake Trout (*Salvelinus namaycush*)	Rainbow trout (*Oncorhynchus mykiss*)	Pink salmon (*Oncorhynchus gorbuscha*)	Coho Salmon (*Oncorhynchus kisutch*)	Chinook salmon (*Oncorhynchus tshawytscha*)	Landlocked Atlantic salmon (*Salmo salar*)	Brown trout (*Salmo trutta*)
NEAC								
Russia								
Iceland								
Finland								
Norway								
Sweden								
Ireland								
UK (Scotland)								
UK (E & W)								
UK (N. Ire)								
France								
NAC								
Labrador								
Newfoundland								
Quebec								
Gulf								
Scotia Fundy								
USA								

Native species

No history of use - excludes occ. captures

Introduced at some time – not necessarily established / still present

Advise on the potential threats to Atlantic salmon from exotic salmonids, including rainbow trout & brown trout where appropriate

Rainbow trout

- Widely introduced
- Despite long history of use, little establishment in NEAC countries
- In contrast, self-sustaining populations occur throughout most of the NAC area
- Lack of establishment in Europe thought to reflect biotic resistance from native spp, parasites/diseases, angling mortality (rather than temp/flow) – could change in future

Main Threats

- Transfer of diseases / parasites (e.g. RT have high susceptibility to both salmon lice & *Gyrodactylus salaris*)
- Damage to redds – most RT strains spawn in spring, so any spawning activity could impact on Atlantic Salmon (or brown trout) redds before fry emerge (has been observed). Some strains in N. America also spawn in autumn, so possible increased risk.
- Predation
- Competition for resources

Advise on the potential threats to Atlantic salmon from exotic salmonids, including rainbow trout & brown trout where appropriate

Brown trout

- Widely introduced - self-sustaining populations occur throughout most of NAC area
- Expansion continuing
- Mechanisms determining invasion success/failure are unclear – but thought to be highly context specific (e.g. the degree of inter-specific competition)
- Few studies on ecological impact carried out

Main Threats

- Competition and displacement of native species
- Hybridisation with Atlantic salmon – hybridisation rates are higher where one of the species is exotic than where both are native
- Predation

Advise on the potential threats to Atlantic salmon from exotic salmonids, including rainbow trout & brown trout where appropriate

Pink salmon

- Strict 2-year life cycle, so have reproductively isolated odd- and even- year populations
- Introduced to White Sea Basin in Russia from 1950s (~ 20 years without establishing populations). Later introduction in 1985 (1 year), with fish from more northerly part of species native range, resulted in establishment of self-sustaining odd-year populations
- Introduction of even-year population (from same source population) led to high returns in first generation, but not established populations
- Adult returns in odd years fluctuate between 60,000 & 700 000 fish (catch of 139t in 2009 was twice the catch of Atlantic salmon)
- Has established in 11 rivers in N. Norway (catches up to 20t); incidental captures reported from many countries
- Introduced in Newfoundland in 1950s/60s – not established

Main Threats

- Competition for spawning sites / holding areas

Advise on the potential threats to Atlantic salmon from exotic salmonids, including rainbow trout & brown trout where appropriate

Potential threat	Rainbow trout	Pink salmon	Brown trout
Spread of parasites	Very likely	Not evidenced	Not evidenced
Spread of diseases	Likely	Not evidenced	Not evidenced
Damage to redds	Evidenced	Unlikely	Possible
Competition for resources & areas	Likely	Likely (for short periods)	Likely
Predation	Likely	Unlikely	Likely
Hybridisation	Unlikely	Unlikely	Evidenced

Reports from ICES Expert Groups relevant to North Atlantic salmon

Working Group on the Science Requirements to Support Conservation, Restoration and Management of Diadromous Species

- Coordinate work on diadromous species; organise expert groups, theme sessions & symposia

Second Workshop on Age Determination of Salmon

- Met September 2012 to address issues regarding protocols, inter-laboratory calibration and quality control as they relate to the interpretation of age and calculation of growth and other features from scales
- Provided various recommendations:
  - inter-lab calibration exercise
  - reference scale images on ICES website
  - methodology / best practice

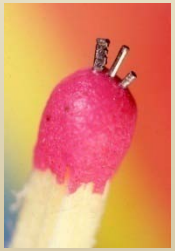
Workshop on Salmon Tagging Archive

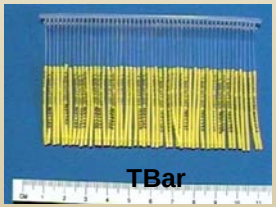
- Met in June 2012 – continuing to work by correspondence to develop an ICES Cooperative Research Report

Provide a compilation of tag releases by country in 2012

- Compilation of releases of tagged, fin-clipped, and otherwise marked salmon in 2012 provided as a separate report (ICES 2013)
- About 3.7 million salmon were released with marks in 2012 (down from ~ 4 million in 2011)
- Most marks were applied to hatchery-origin juveniles (3.6 million)
- Since 2003, marks have been applied to farmed salmon in Iceland, these are included in the compilation

- Broad range of tag types and increasing numbers of PIT, acoustic, radio, and DST tags being used





Identify relevant data deficiencies, monitoring needs & research requirements

NASCO Sub-Group on the Future Direction of Research on Marine Survival of Salmon

- Sub-group report considered separately
- ICES reviewed the proposals from the sub-group & recommends that the IASRB support the further development of the proposed investigations

Workshop on Eel and Salmon Data Collection Framework

- Met in July 2012. Salmon (& eel) covered by DCF, but requirements not suitable for assessments. Opportunity to influence improvements in DC-MAP
- Number of recommendations and report submitted to EU
- In 2013, ICES further developed a summary table indicating the compatibility of data currently collected under DCF with the data available
- Specific requirements likely to be agreed by Regional Coordination Groups – ICES recommended possible specific RCG for diadromous species

Stock annex

- ICES plans to compile a complete description of the methodology used in conducting assessments and providing catch advice

Advice generated by ICES in response to terms of reference from NASCO

Supporting information and details in the report of the ICES Working Group on North Atlantic Salmon available at:
http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2013/WGNAS/wgnas_2013.pdf

Acknowledgements

Members (20) of participating countries (11) to the Working Group on North Atlantic Salmon, 3 – 12 April, 2013

Section sub-group chair: Niall Ó Maoiléidigh (Ireland)