

ICES Scientific Advice to NASCO
Atlantic salmon in the North
Atlantic Area

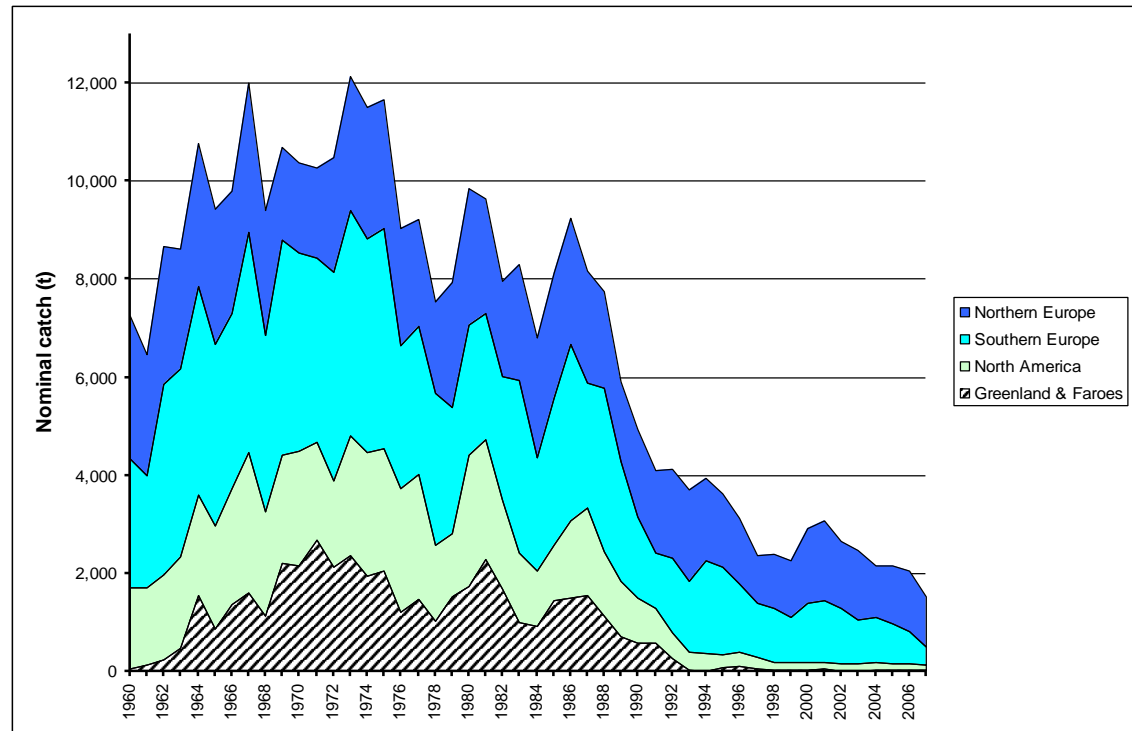
Framework of Indicators

- June 2006
 - Multi-annual regulatory measures for WGC and the NEAC (Faroe Islands)
 - Conditional on a Framework of Indicators (FWI)
 - FWI delivered (ICES 2007c)
- June 2007
 - WGC continued the multi-annual regulatory measures
 - Denmark (in respect of the Faroe Islands and Greenland) opted out of the multi-annual regulatory measures (no FWI)
- Jan 2008
 - FWI applied
 - no change to the previously provided management advice
 - Scientific advice from ICES questions 3.3 and 4.3 were not undertaken
 - Status of stocks and catch advice NAC
 - Status of stocks and catch advice WGC

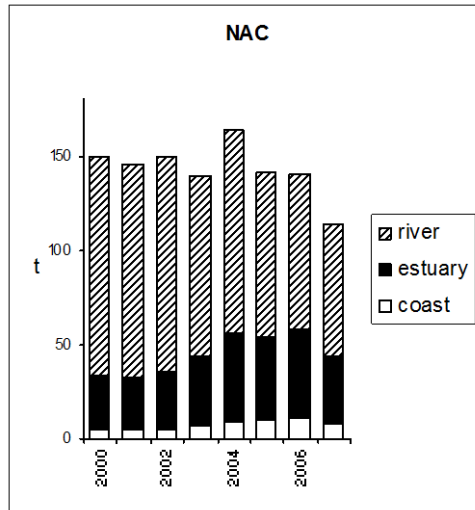
Catches of North Atlantic Salmon

Nominal catch (2007)

- 1533 t
 - lowest in the time series
 - 507 t below updated catch for 2006
 - Below 5 and 10-yr averages
- Lowest on records for 6 countries



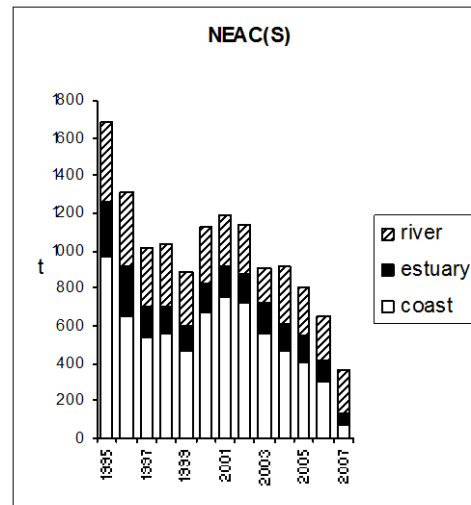
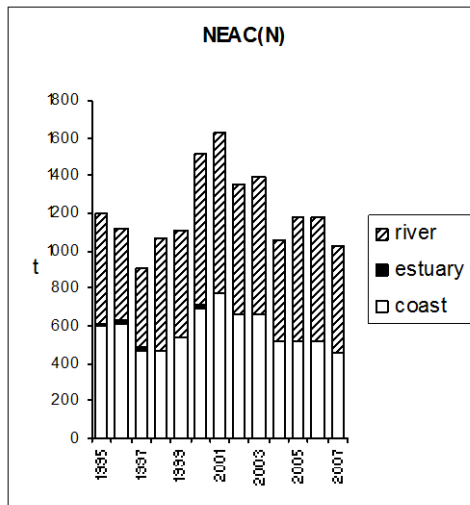
Partitioned nominal catches (2007)



Mixed stock fisheries, primarily coastal fisheries, present particular threats to stock status

North American Commission

- relatively constant
- majority in riverine fisheries
- coastal fisheries are small <11 t), predominantly aboriginal food fisheries



Northern North-East Commission

- fluctuating
- approximately 50:50
 - No coastal harvest in Iceland or Finland

Southern North-East Commission

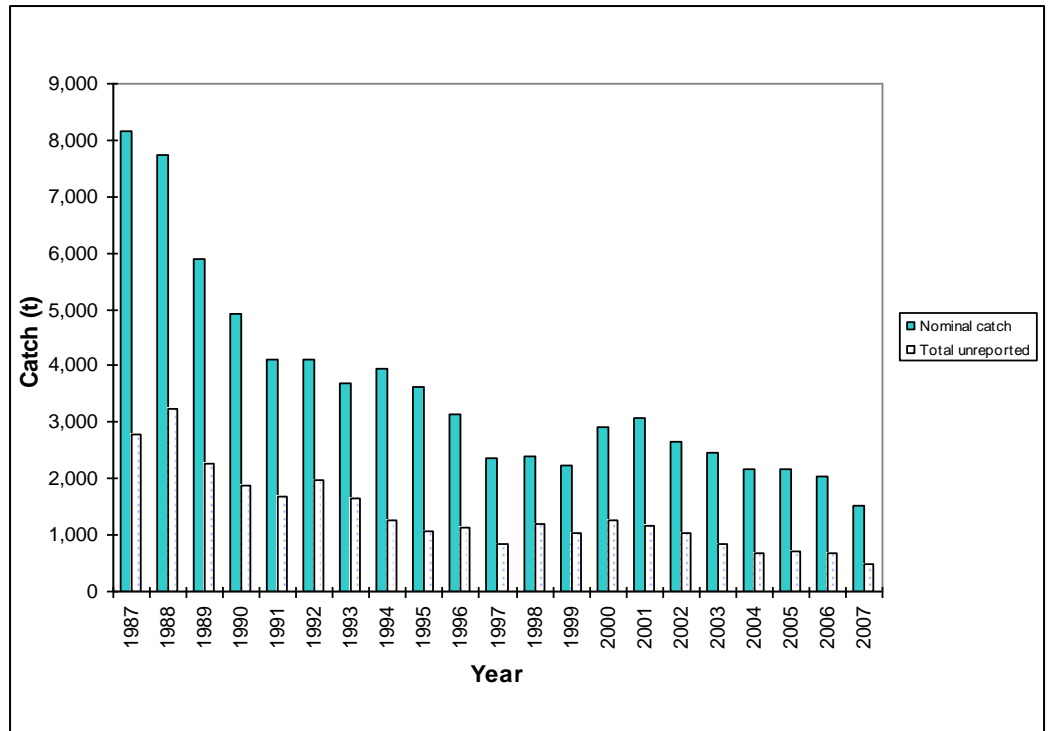
- Large declines - primarily coastal

Catch and release (2007)

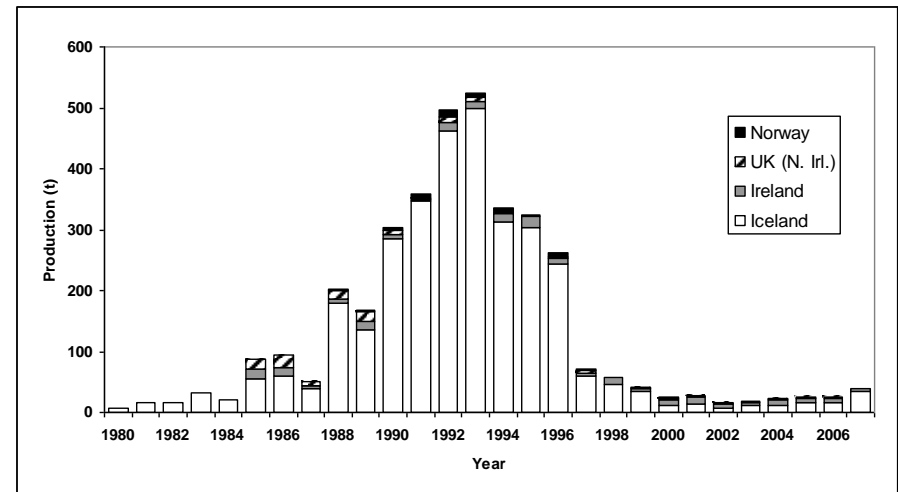
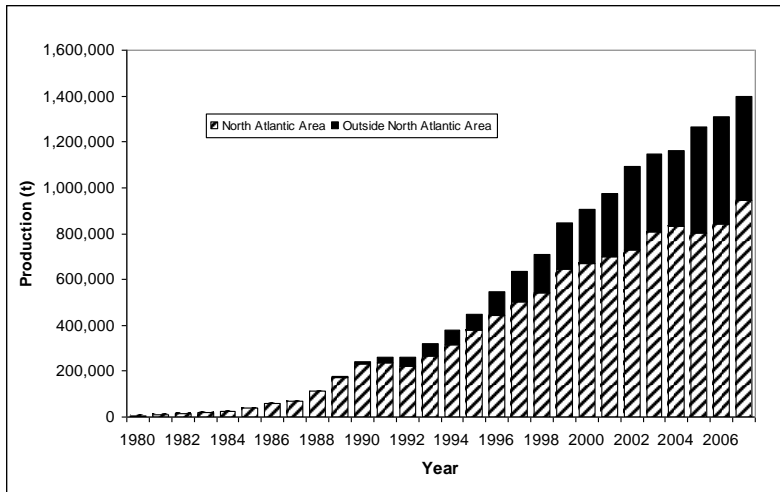
- Not included in nominal catch
- Not formal reported by all countries
- Large differences by country
 - 19% in UK (NI) and 90% in Russia
 - Tending to increase with time
- In total, approximately 178 500 fish released
 - 11 000 greater than 2006 estimate

Unreported catches (2007)

- Estimated to be 475 t
 - 195 t decrease from 2006
- No estimate NAC
 - 56 t in 2006
- 10 t – WG
 - same as 2006
- 465 t - NEAC
 - 139 t decrease from 2006



Farming and sea ranching of Atlantic salmon (2007)



Farmed salmon

- North Atlantic – 947 000 t
- Worldwide - excess of 1 400 000 t
 - both highest in time series
 - >900 times nominal catch

Ranched salmon

- 39 t total
- Time series modified to account for Icelandic 'ranching to the rod'
 - 35 t last year

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

Stock recruitment models and developing conservation limits for Atlantic salmon populations in Norway

- *1st generation* river-specific CLs developed for some Norwegian rivers
 - Stock (eggs) - Recruitment (density of juveniles) models created from data rich rivers
 - Data rich rivers categorized by productivity categories (catch statistics), data poor rivers also characterized and appropriate SR models applied to wetted area estimates

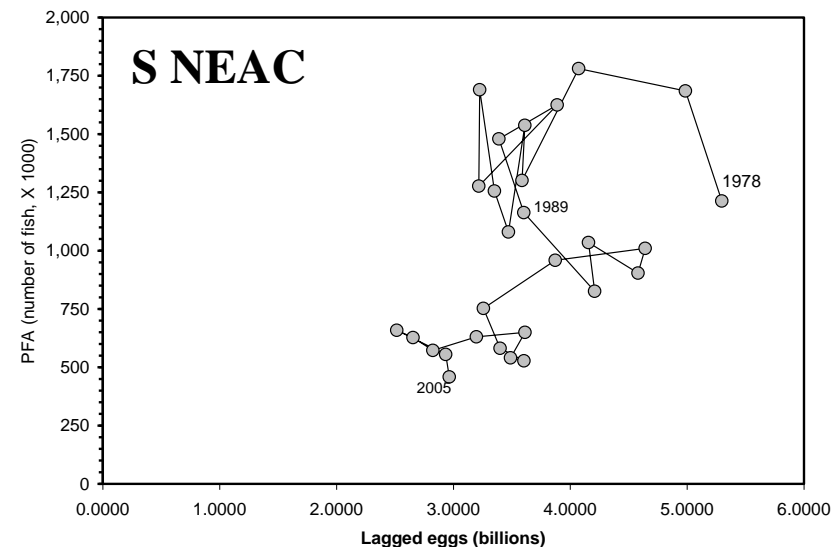
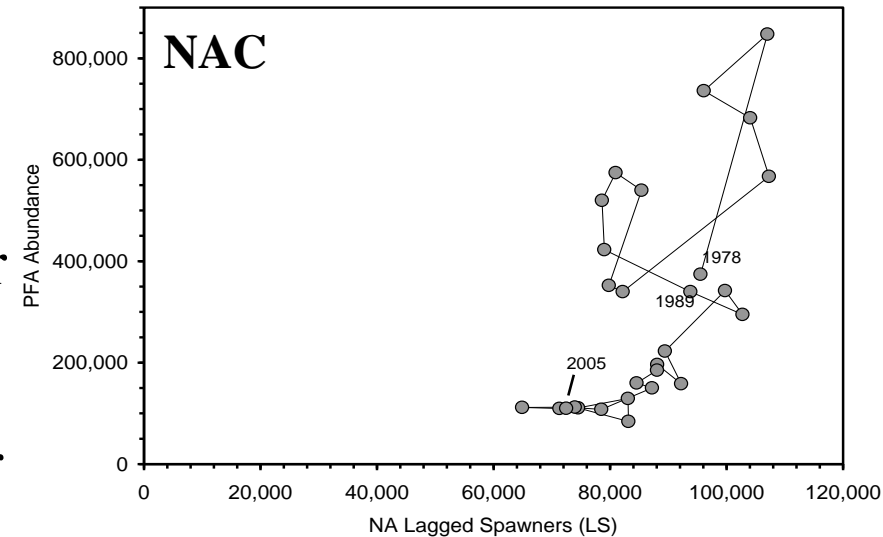


Standardization of run reconstruction models for NAC and NEAC areas

- In interest of exploring Bayesian modeling methods, the NAC and SNEAC run reconstruction models were reviewed
 - Catches in homewaters or returns to rivers worked backwards by adding in catch and natural mortality to estimate PFA
- Suggestions to standardized approaches discussed and decided upon

Modeling dynamics of Atlantic salmon in the NAC and NEAC areas

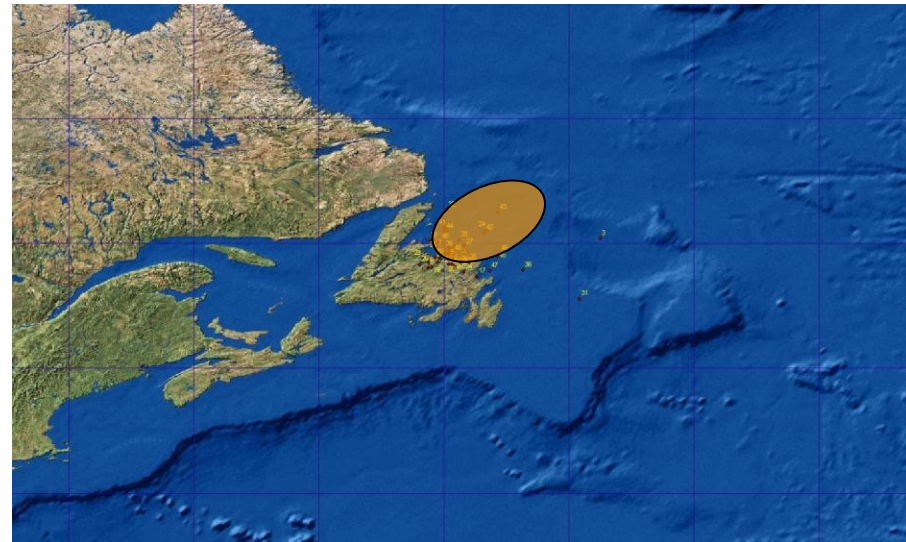
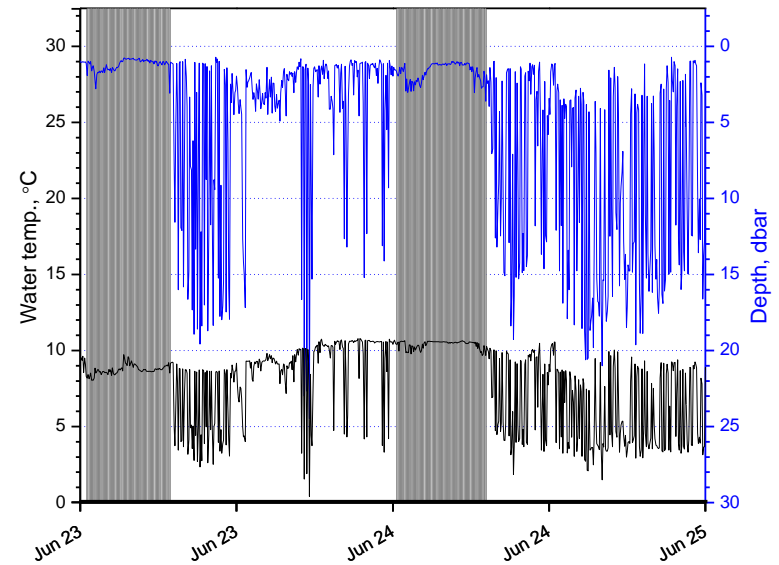
- Parallel declines in productivity for both NAC and S NEAC MSW complexes identified
- Forecast models not available for 3 of the 4 NEAC stock complexes
- Forecast models are available for Greenland fishery
 - Similar approaches
- 2 options presented for modeling lagged spawner/egg to PFA relationship
 - Phase shift and random walk
 - Options to pursue discussed



Thermal habitat and depths experienced by Atlantic salmon kelts migrating from Newfoundland

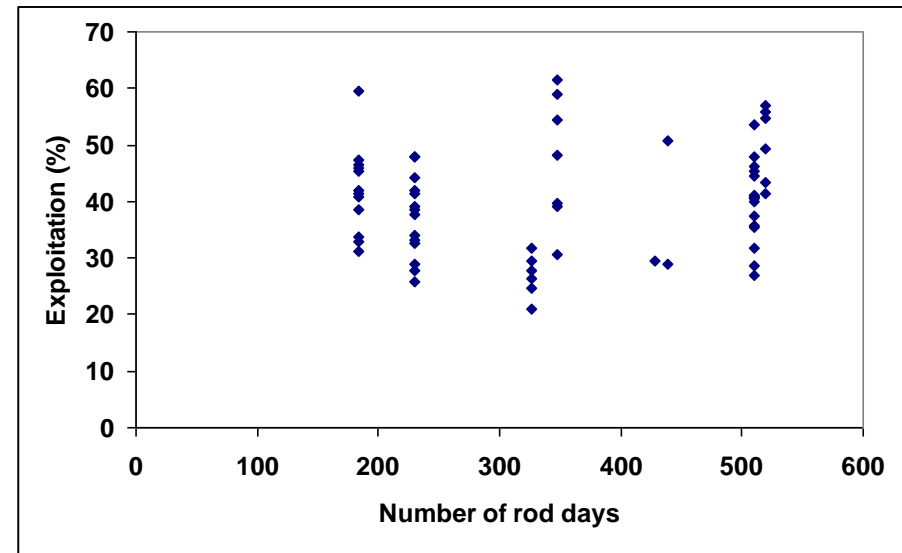
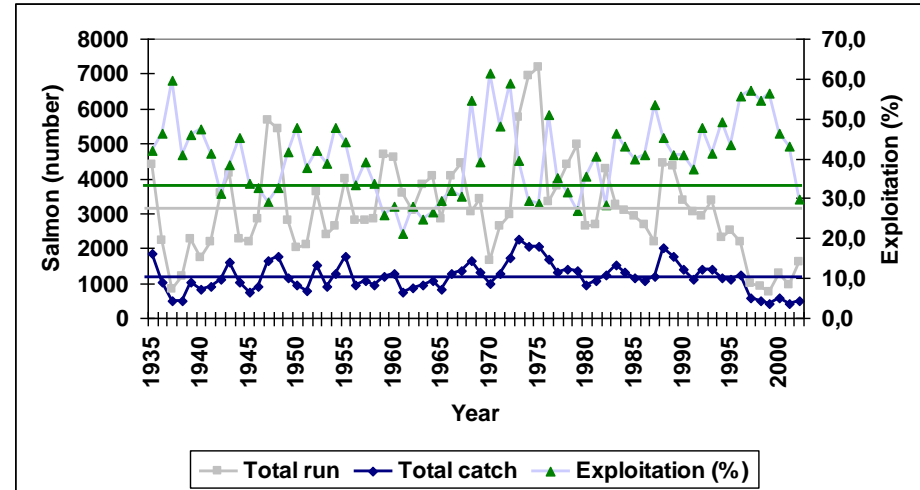
- Newfoundland kelts (26) tagged with LOTEK DSTs-LAT2510 (beta version)
 - Date, time, temp (int & ext), depth and geo-location
- Preliminary results from recoveries (8)
 - 45-81 days
- Novel data regarding migration behavior and location for this life stage/stock

LAT 001 from Campbellton River kelt, 2007



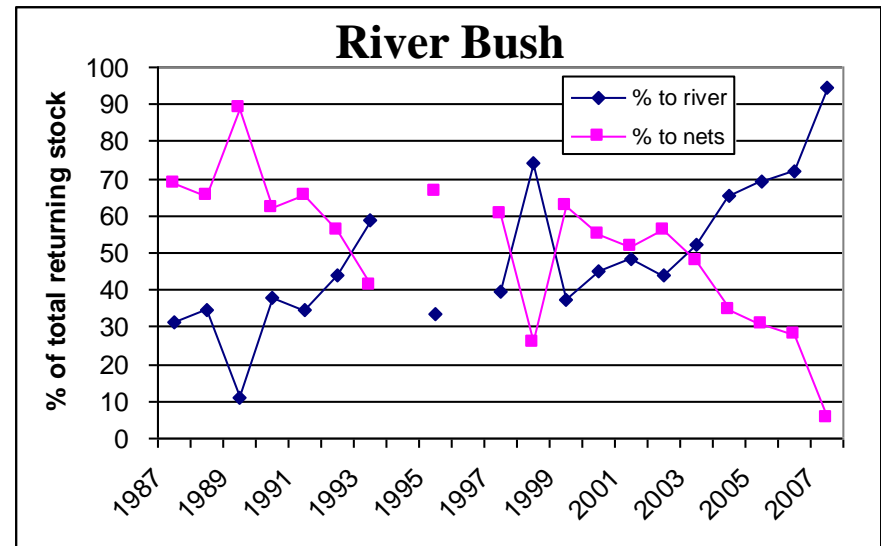
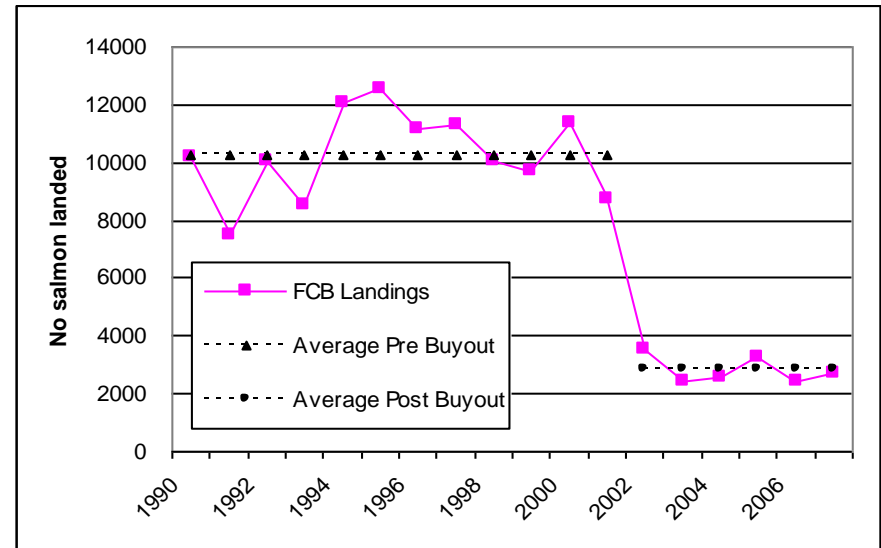
Stock size, catch and effort in the salmon fishery in the River Ellidaar, SW Iceland

- Correlation between run size and catch
 - Based on fish counter data, rod catch and effort data from log books (68 years)
- Exploitation rate didn't relate as well
 - No relationship between exploitation rate and # rods
- Suggests that reducing exploitation rate may not result in catch reductions
 - May need to reduced below recorded range
 - Consider other management measures to reduce catch



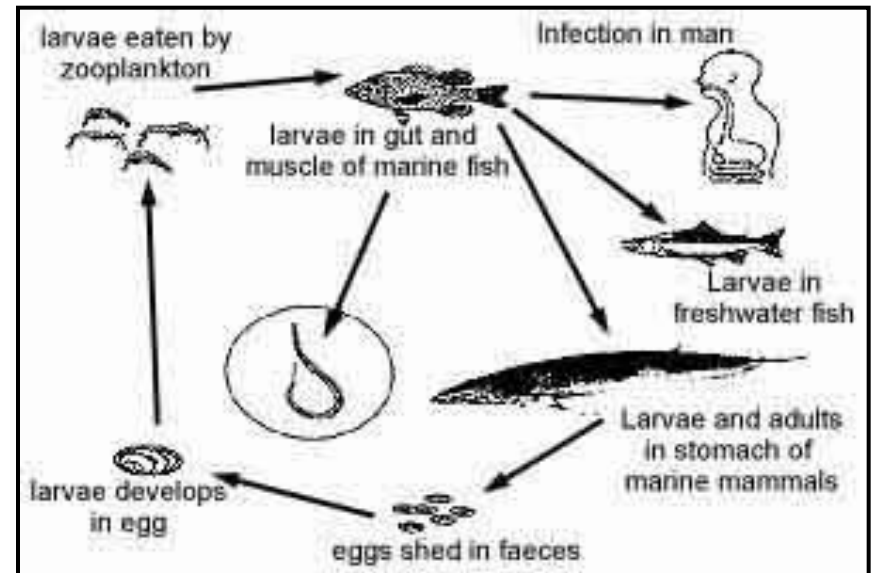
The Assessment of Recent Fishery Management Measures on Salmon Stocks in the River Bush and in UK (N. Ireland) with regard to adjacent Regions

- CWT and catch data used to assess 2002 management measures (voluntary net buyout)
- 72.5% mean reduction in landings (7.4 K fish)
- River Bush exploitation reduced (43% to 17%)
- Estimated 42% of River Bush CL conserved (2002-2007)



Red vent syndrome

- Returns with swollen and/or bleeding vents
 - Noted since 2005, increase across Southern NEAC in 2007
- Linked to presence of a nematod worm (*Anisakis simplex*)
 - Common marine fish parasite
- Affects on survival or spawning unknown



Atlantic salmon stock assessment using DIDSON (Dual-Frequency Identification Sonar)

- DIDSON for monitoring Atlantic salmon escapement
 - produces almost near-video quality images
 - software available to aid processing
- Two projects reported
 - Deel River (Ireland)
 - Eagle River (Canada)
- Has successfully be used for other species in North America



Smolt migration on the River Rhine

- Investigating smolt migration dynamics
 - Final year of data
 - Pre-Haringvliet dam removal
 - Further studies planned post-restoration
-
- 18 % lost in the German Rhine
 - 13 % lost in the Netherlands (Delta)
 - 60% survival to North Sea



European Regulations

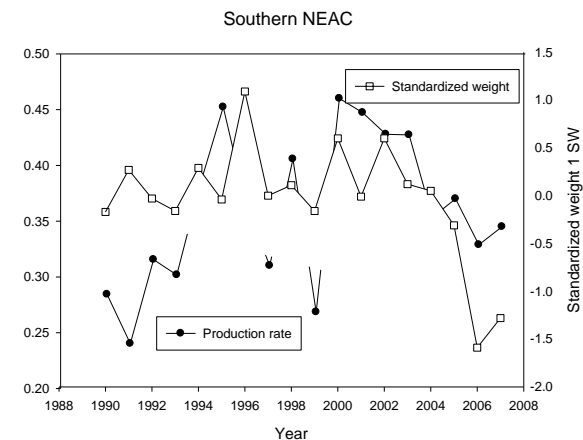
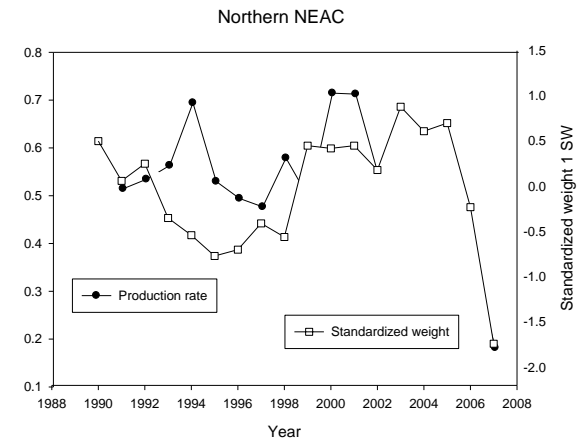
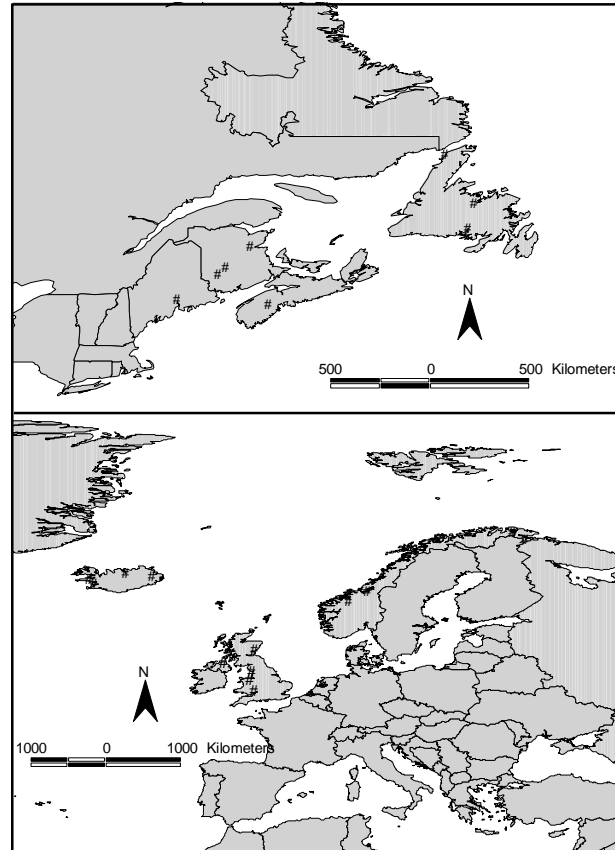
- EU Data Collection Regulation (EU DCR) has been updated and expanded
 - Salmon and eels added
- Increase requirements for at the Community level



**NASCO has asked ICES to examine
and report on associations between
changes in biological characteristics
of all life stages of Atlantic salmon,
environmental changes and
variations in marine survival with a
view to identifying predictors of
abundance**

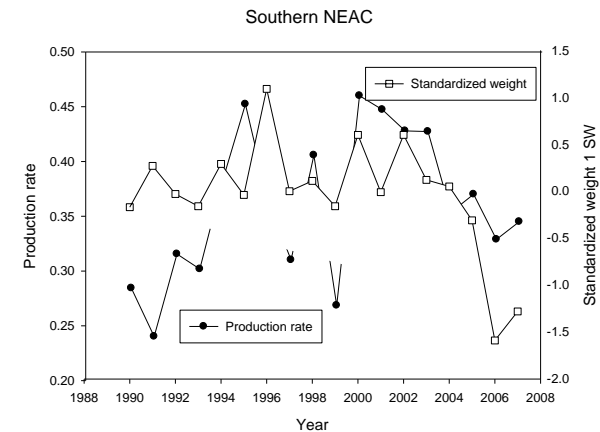
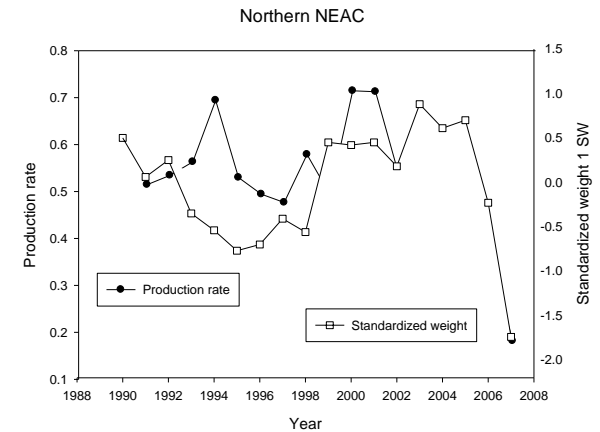
Biological characteristics of salmon across the North Atlantic area

- Adult return characteristics collated from 20 rivers
 - Multiple decades
- Exploratory analysis pursued
- Preliminary results suggest relationship between productivity and salmon size in NNEAC
- Consensus that further efforts should be pursued



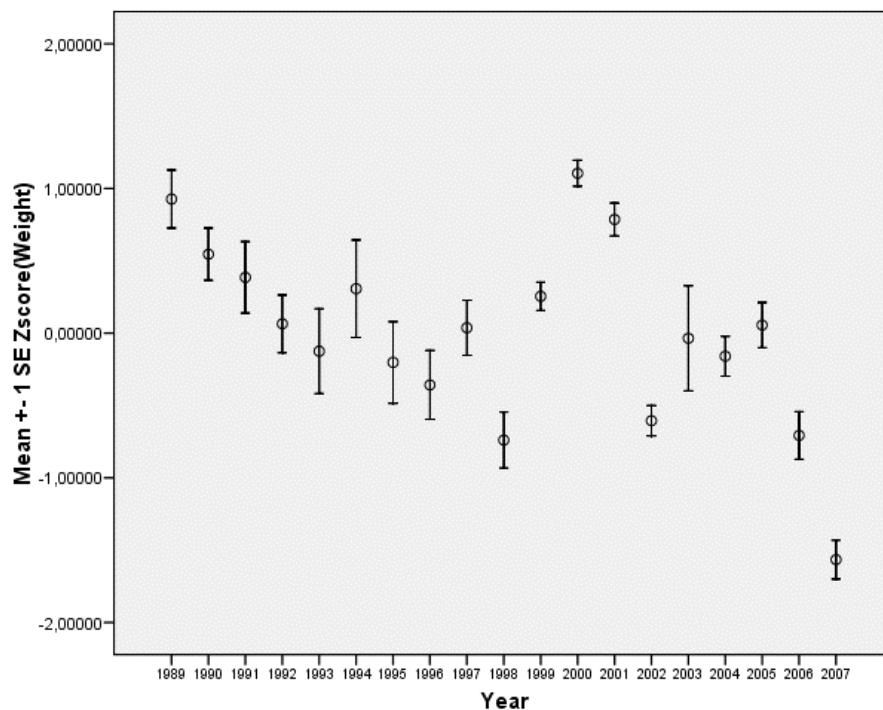
West Greenland biological characteristics database, 1968-2007

- Similar effort/consensus for West Greenland database
 - Represents over 54 K individuals
 - Location, size, age (river and sea), spawning marks and origin
 - Efforts made to standardize and create metadata
 - Database is available for Biological Characteristics efforts, other researchers and to validate various modeling assumptions



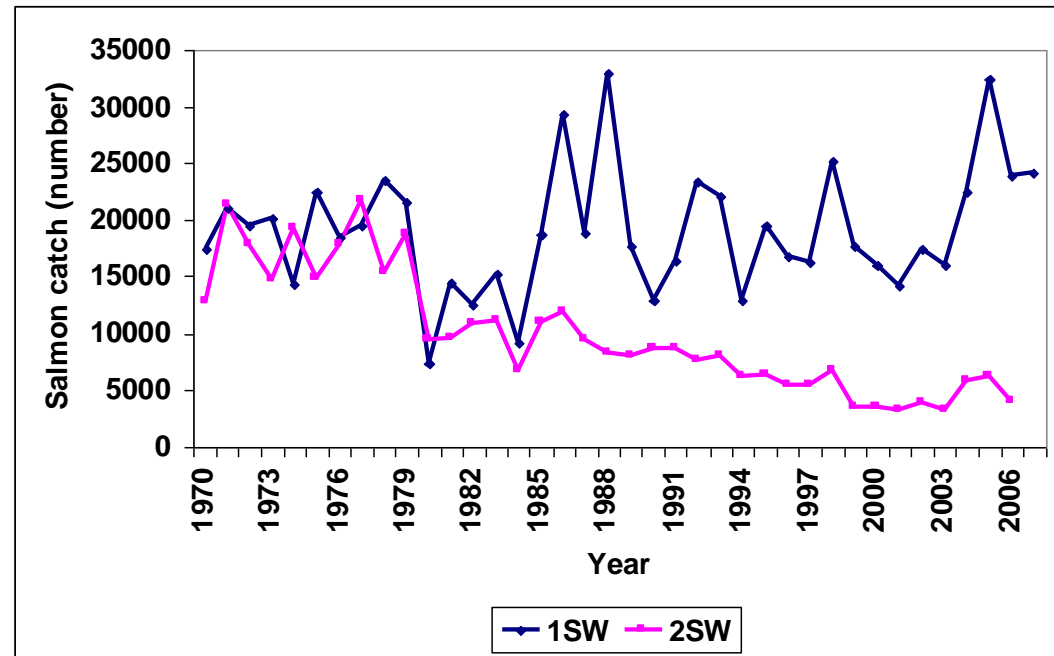
Size of 1SW fish returning to Norway

- Low grilse size and low returns in 2007
 - Catch statistics interpretation may be problematic
 - Grilse size is an indirect measure of growth rate
 - Early marine growth is crucial for size selective mortality
 - Scale pattern analysis may help elucidate this relationship



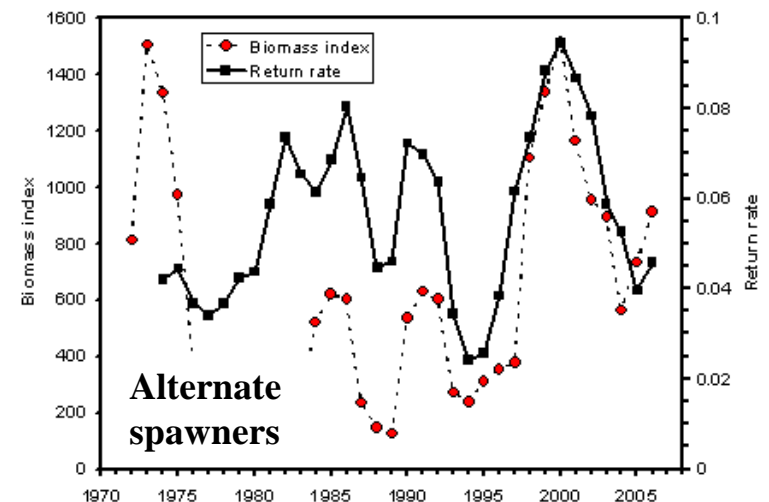
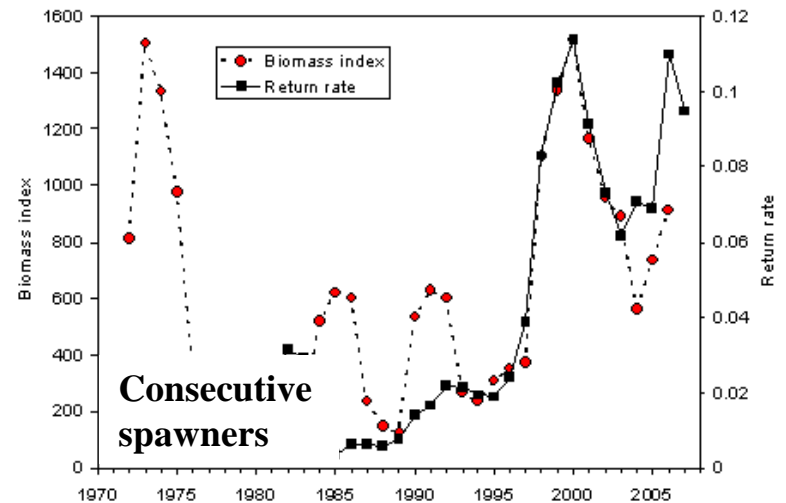
Decline in 2SW salmon stocks in Iceland

- Decline in Icelandic stocks in early 1980s
- Grilse have rebounded
- 2SW haven't
 - In light of 2SW conservation efforts
- 2SW size has also decrease
- May be important indicator in marine survival dynamics given different oceanic feeding environments



Ecosystem driven variations in return rates to a second spawning for Atlantic salmon from the Miramichi River

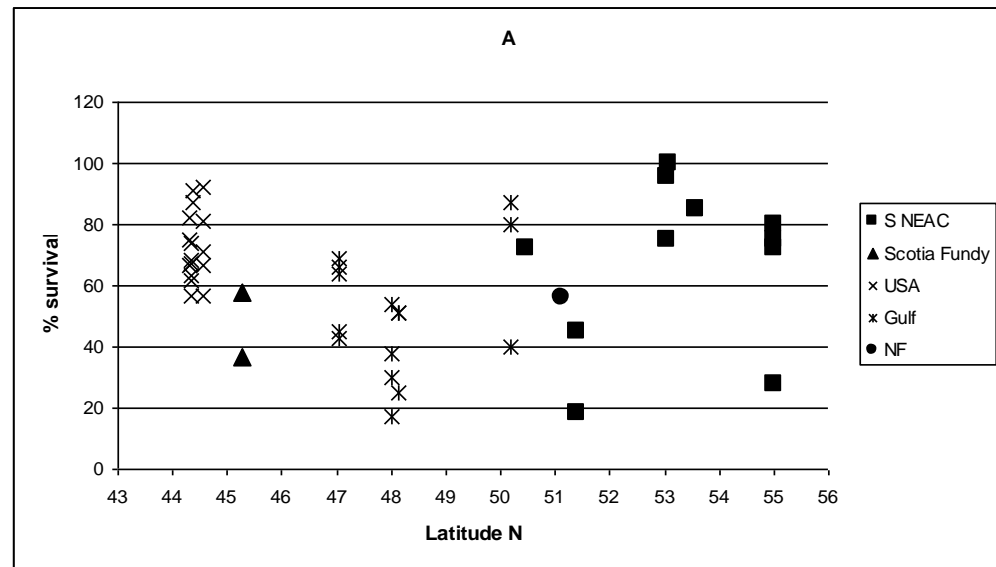
- Significant increase in consecutive spawner return rate
 - Not for alternate spawners
- Correlated with small fish biomass index (Gulf of St Lawrence)
 - Not as strong for alternates
- Small fish biomass increase resulted from groundfish collapses
 - Small fish may help in reconditioning
 - Bigger effect for consecutives
- Further support that food supplies in early period at sea may be critical



**NASCO has asked ICES to describe
the natural range of variability in
marine survival with particular
emphasis on partitioning mortality
to the narrowest geographic scale
possible (estuarine, near-shore,
offshore, etc.)**

Variability in estuarine and early marine survival of smolts

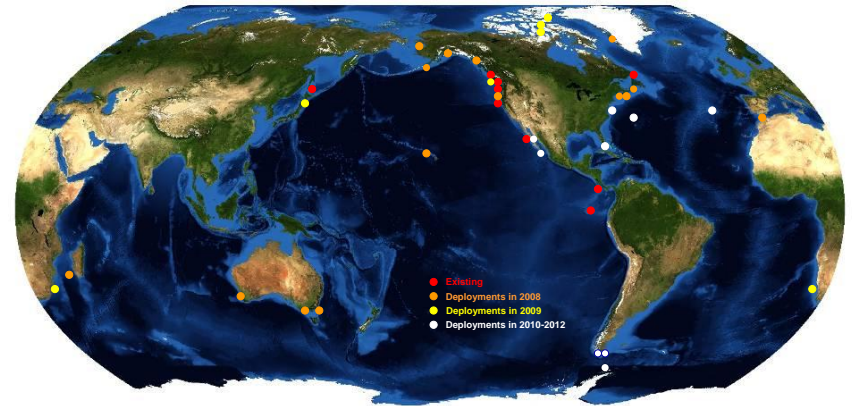
- Summarized available smolt telemetry studies across NA
- Smolt survival is broadly similar across NA
- No changes over time series available
- Higher mortality in longer estuaries



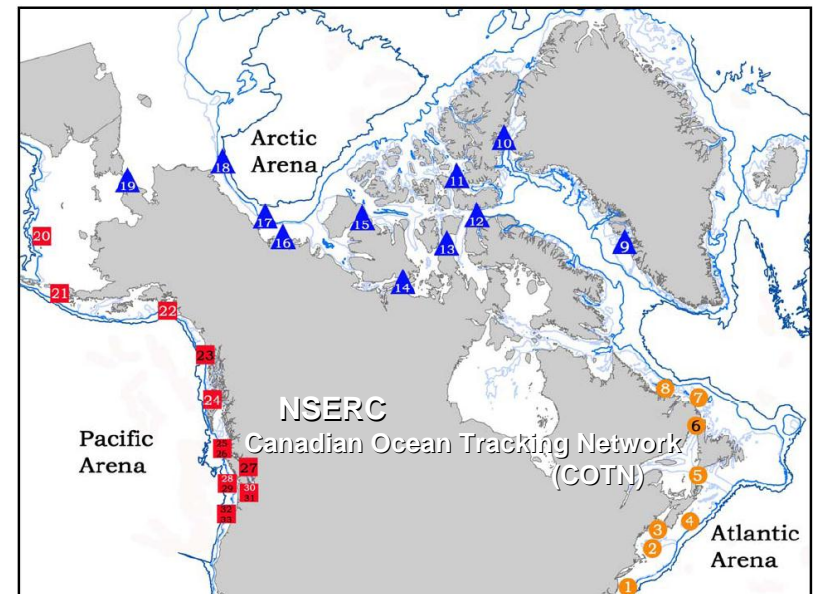
Ocean Tracking Network

- Update on major Canadian initiative to deploy sonic receiver arrays at key points in globe's ocean
- Some arrays will allow for long term tracking of salmon
 - Strait of Belle Isle (2006)
 - Labrador (2008)
 - Halifax (2008-2009)
 - Gulf of Maine (2009)
 - Cabot Strait (2009)
 - Greenland (2010)
 - Europe (????)
- Development of innovative technology (*bioprobes*)

Global Ocean Tracking Network

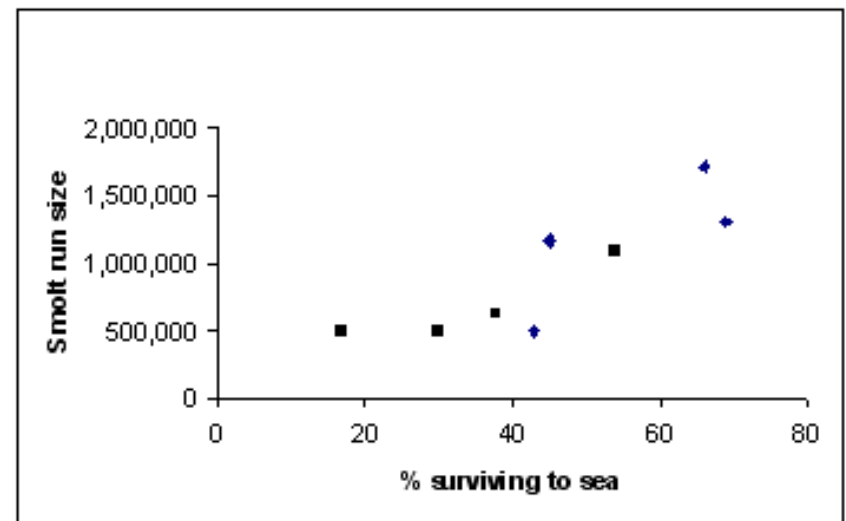
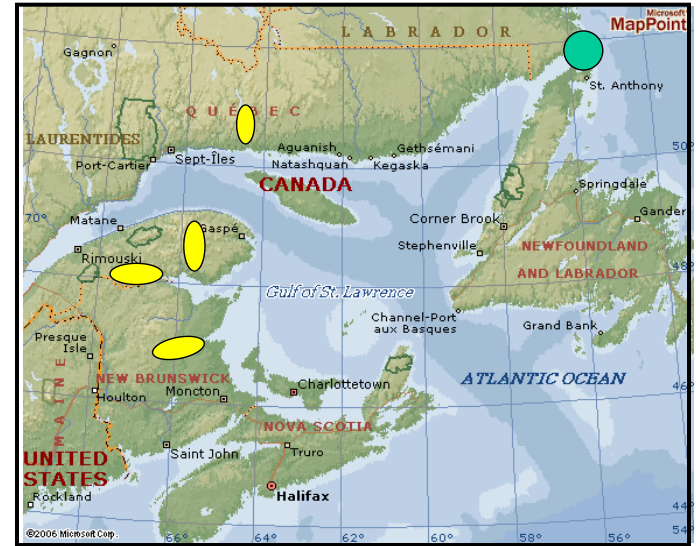


OCEAN
TRACKING NETWORK



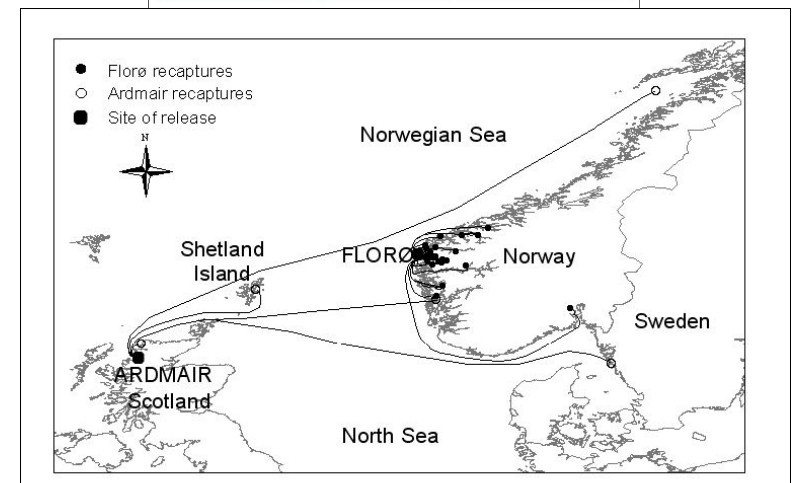
Sonic tracking of North American Atlantic salmon smolts to sea

- Reviewed progress for ongoing telemetry projects on 5 Canadian rivers
 - Smolt/postsmolt migration across >1000 km
- Preliminary results suggest shared migratory pathways and synchronization of timing
- Possible link between smolt abundance and survival



NASCO has asked ICES to compile information on the marine migration and dispersal of escaped farmed salmon with particular emphasis on movements between countries

- Update on 2006 experimental release (Scotland and Norway)
 - 5 Scottish tags (0.7%) recovered
 - 42 Norwegian tags (7%) recovered
- Higher survival/recovery rate for and local migration patten for Norway fish
- Scottish migration patterns plausibly explained by prevailing ocean currents



Update on marine research initiatives in the North Atlantic

Irish post-smolt survey (2007)

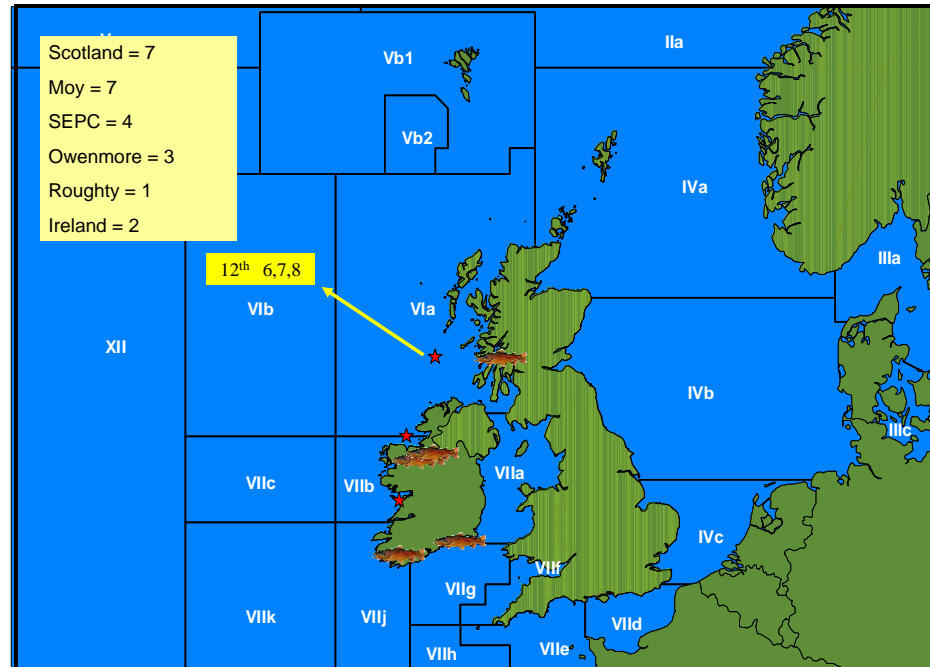
- Genetic Stock Identification captured postsmolt reported

SALSEA

- SALSEA-Merge
- SALSEA North America
- SALSEA West Greenland

Marine research in the Barents Sea

- Collaborative research project (2007-2010) involving Norway, Finland, Russia and Canada investigating the marine ecology of northern salmon
 - Trophic ecology (stable isotopes), DSTs, satellite tags, estimates of marine survival...



NASCO has asked ICES to provide a compilation of tag releases by country in 2007 and advise on progress with compiling historical tag recovery data from oceanic areas

Compilation of tag releases and fin clip data by ICES member countries in 2007

- Finalized (separate report)

Workshop on Salmon Historical Information – New Investigations from Old Tagging Data (WKSHINI)

- Build on progress made in WKDUHSTI by developing testable hypotheses of salmon migration and behaviour

NASCO has requested ICES to identify relevant data deficiencies, monitoring needs and research requirements taking into account NASCO's international Atlantic salmon research board's inventory of on-going research relating to salmon mortality in the sea

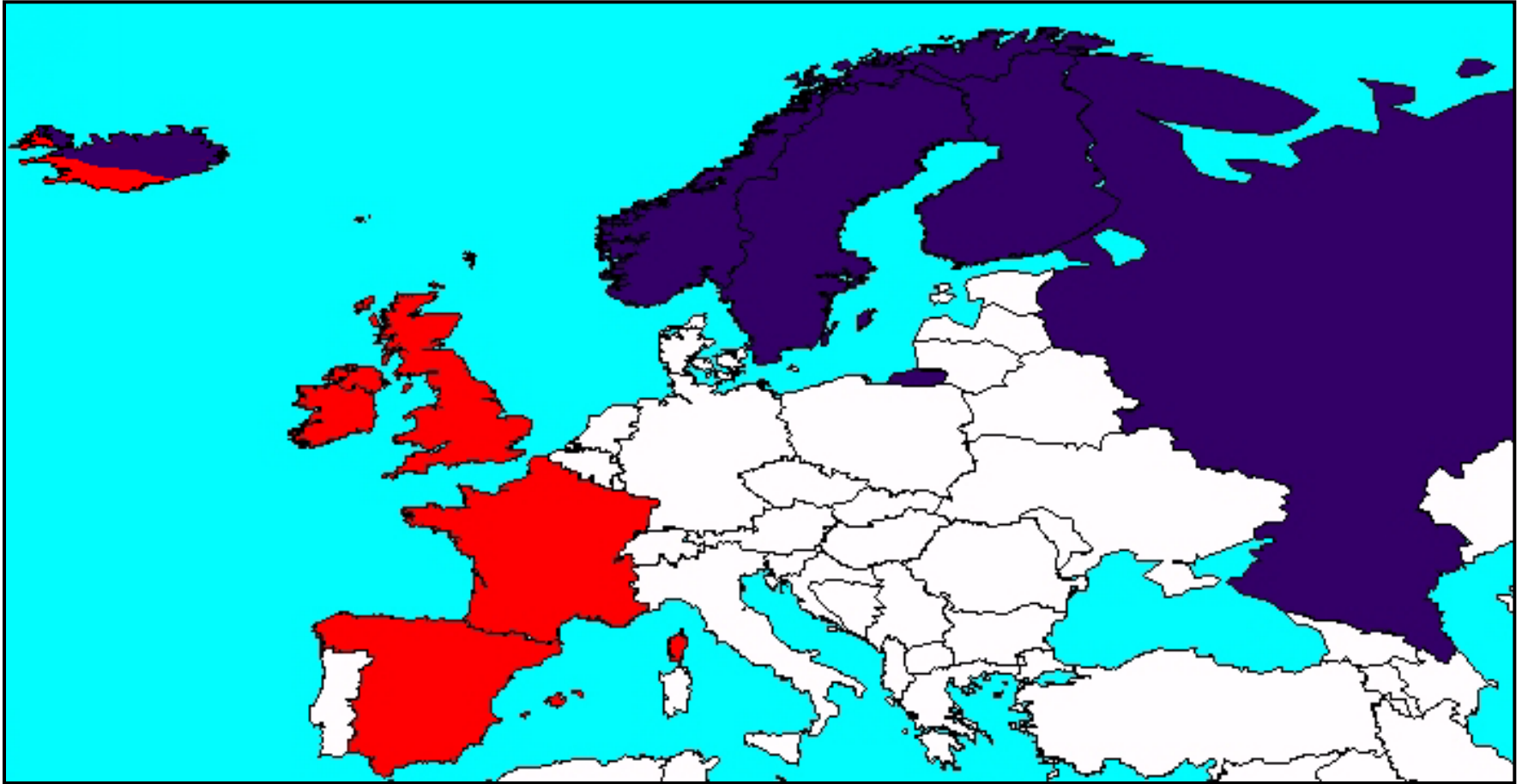
Prioritized list of recommendations

- Study group to further pursue the biological characteristics-survival relationship
- Study group to facilitate the PFA model development for both NAC and NEAC prior to the 2009 WGNAS
- Expanded monitoring programmes across both stock complexes in support of river-specific management
- Completion of metadata directory for West Greenland fishery sampling databases in support of the biological characteristics-survival question
- Re-examination of allocation of Faroese catch to home water countries
 - WKSHINI will aid this recommendation

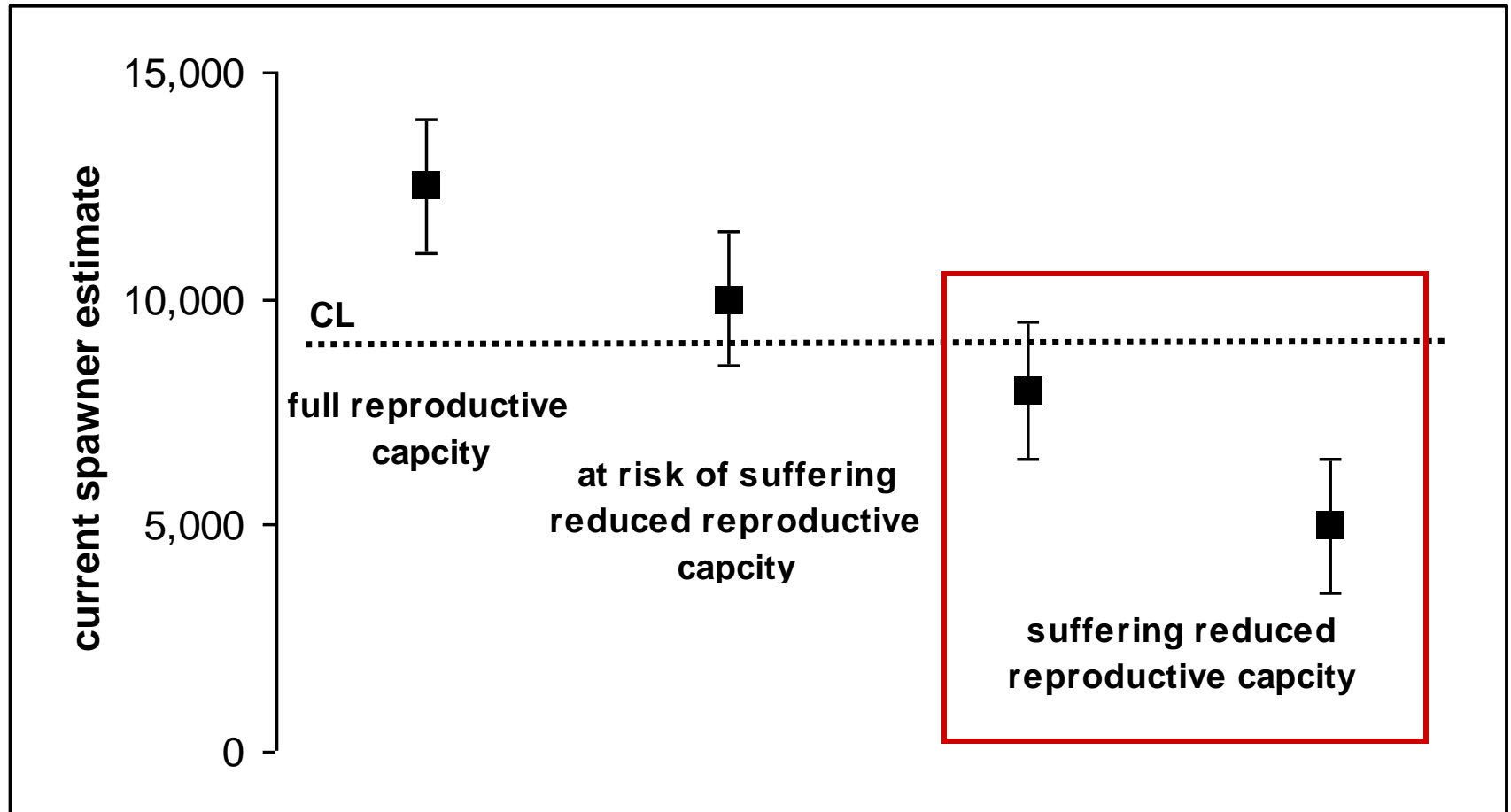
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NEAC stock complex composition

Northern NEAC vs Southern NEAC

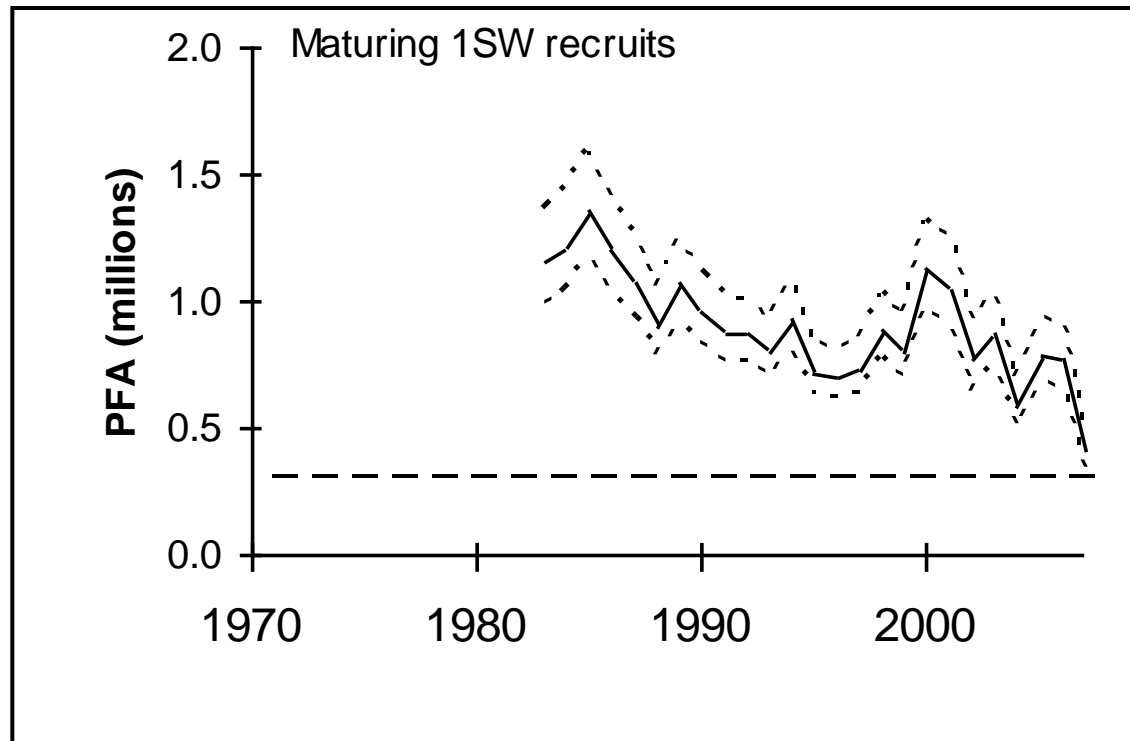


Assessment of Stock Status



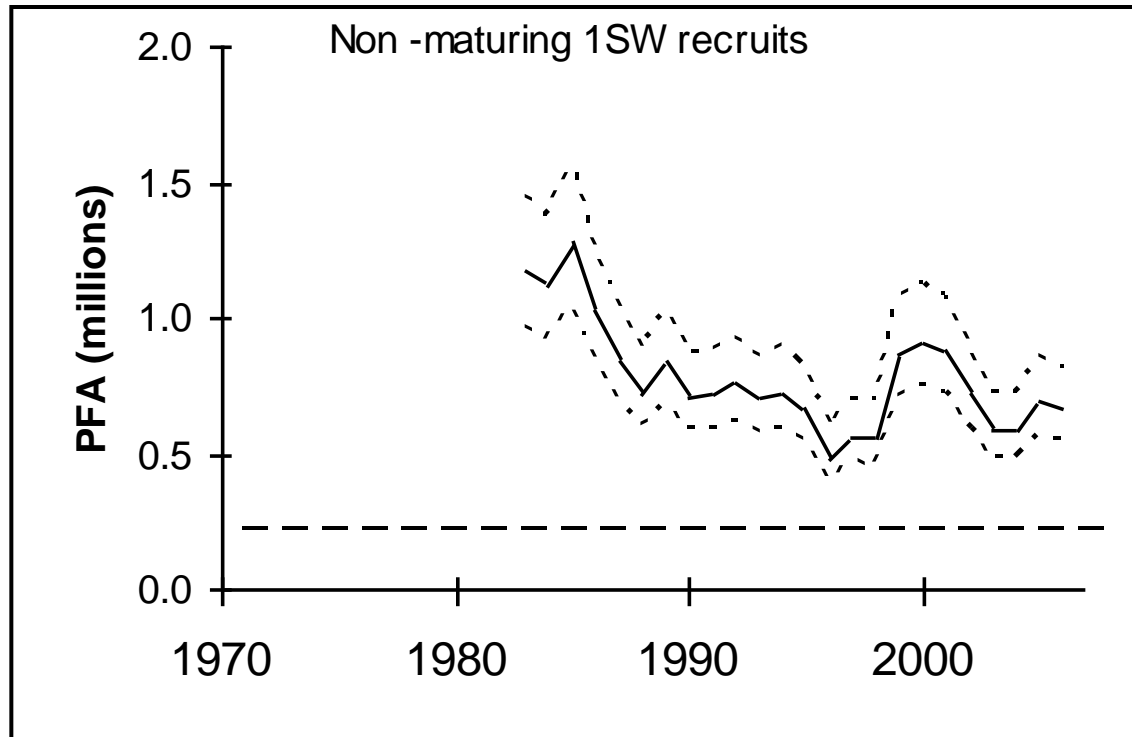
Status of stocks/exploitation (Prior to the commencement of distant water fisheries)

Northern European 1SW stock complex is considered to be at full reproductive capacity



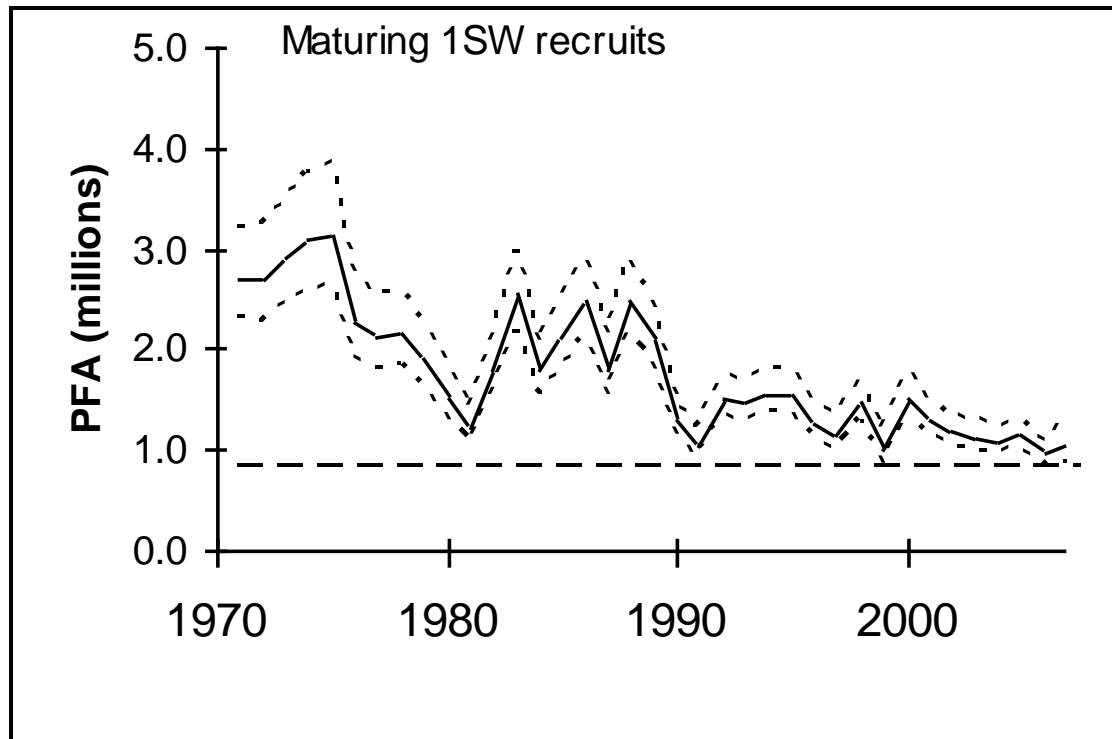
Status of stocks/exploitation
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Northern European MSW stock complex is
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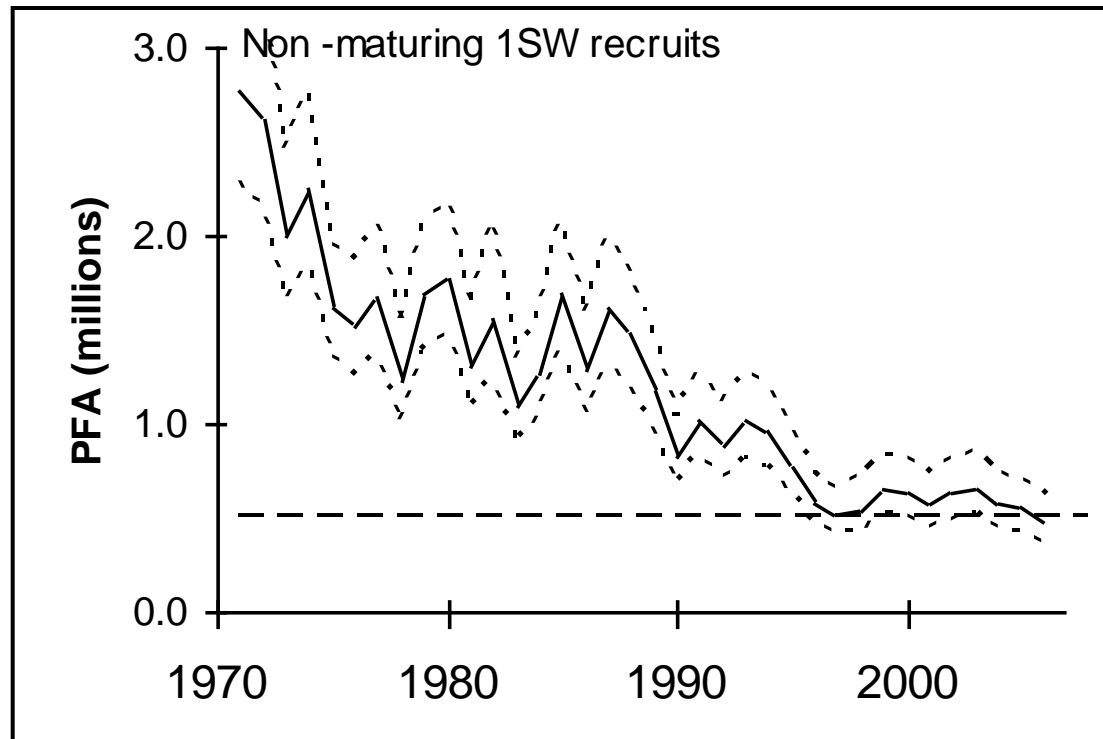
Status of stocks/exploitation
(Prior to the commencement of distant water fisheries)

Southern European 1SW stock complex is
considered to be at full reproductive capacity



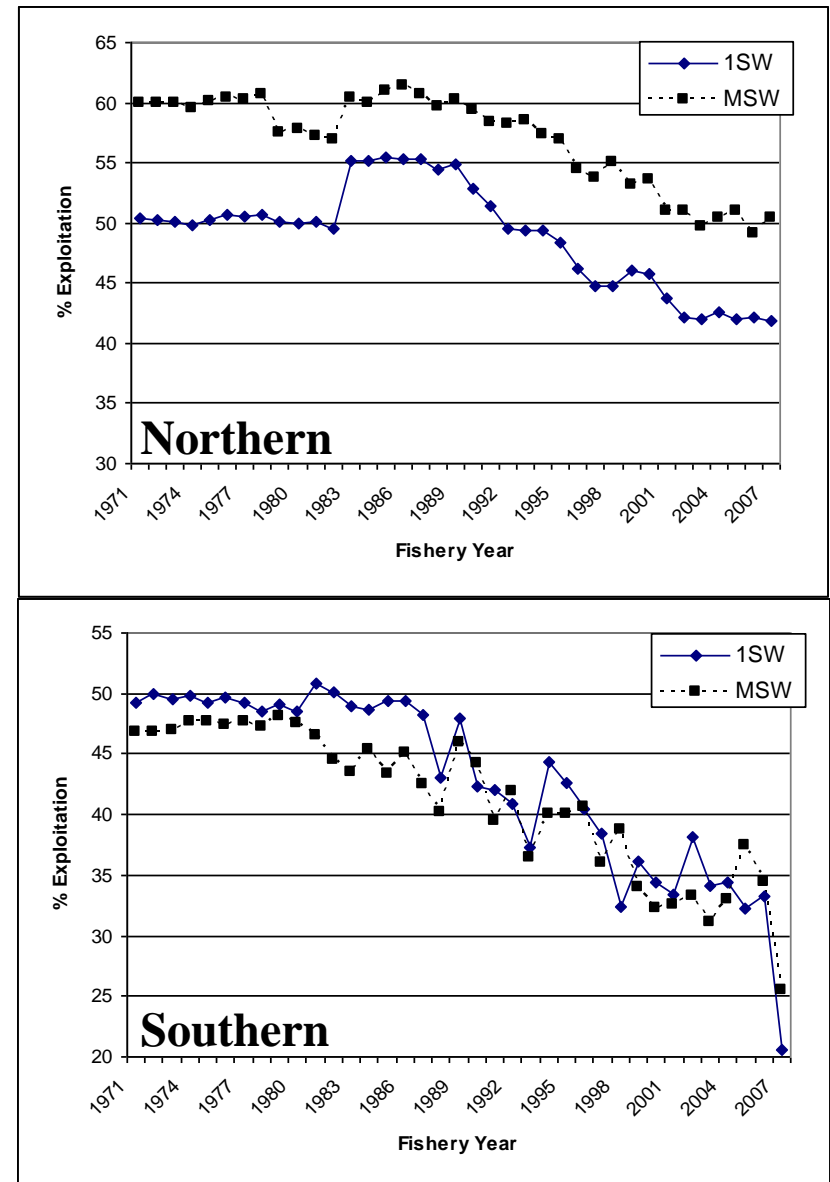
Status of stocks/exploitation (Prior to the commencement of distant water fisheries)

Southern European MSW stock complex is considered to be suffering reduced reproductive capacity



Status of stocks (Exploitation)

- Decreasing exploitation over the time period
- Northern 1SW higher than Southern 1SW
 - Much higher for MSW



Reference Points

- No changes to National CLs model
- Progress with setting river-specific CLs
 - UK (E&W) – partitioning salmon vs. sea trout effort
 - UK (Scot) – continued refinement of useable wetted area transport model
 - Iceland – initial efforts to develop CLs for data rich rivers via various datasets and techniques
 - Norway – transportation of S-R models from data rich to data poor



Management Advice

Northern European maturing 1SW stocks

Northern European maturing MSW stocks

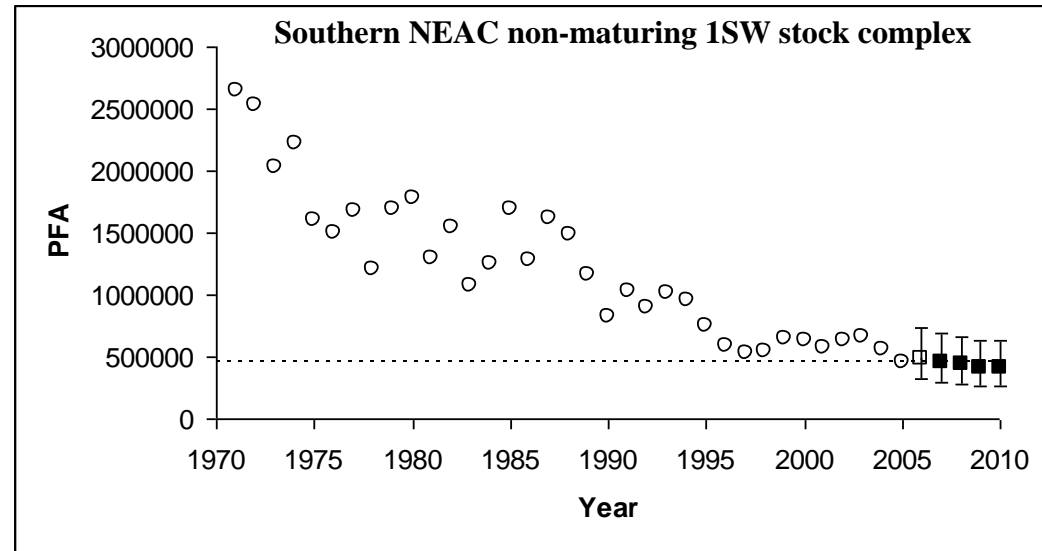
Southern European maturing 1SW stocks

- In absence of management objectives for these stocks
 - Precautionary approach is to only fish from rivers at full reproductive capacity
- Mixed stock fisheries present particular threats to stock status
- In addition, for both 1SW stocks, reductions in exploitation are needed to increase probability of these complexes meeting their CLs

Management Advice

Southern European maturing MSW stocks

- No fishing on this complex at West Greenland or Faroes
 - PFA midpoint forecasts (2008-2011) are below SER
 - Only fish from rivers at full reproductive capacity
- Reductions in exploitation are needed to increase probability of the complex meeting its CL
- Mixed stock fisheries present particular threats to stock status



Comparison with previous assessment

National PFA model and national CL model

- Provisional 2006 catch data updated
- Closure of Irish drift net fishery
 - spawner and return data is now estimated from rod catch
- Icelandic exploitation rate data
 - modified to account for increased catch and release
- Greenland unreported catch time series modified

PFA forecast model

- Updated PFA forecasts (2007-2010)
 - within 3% of previous forecasts

Key events of the 2007 fisheries

Fishing at Faroes in 2006/2007

- No fishing since 2000

Significant events in NEAC homewater fisheries

- UK (E&W) - continued net reductions
- UK (NI) – reductions in mixed stock fisheries and bag limits
- IRE - closure of driftnet fishery

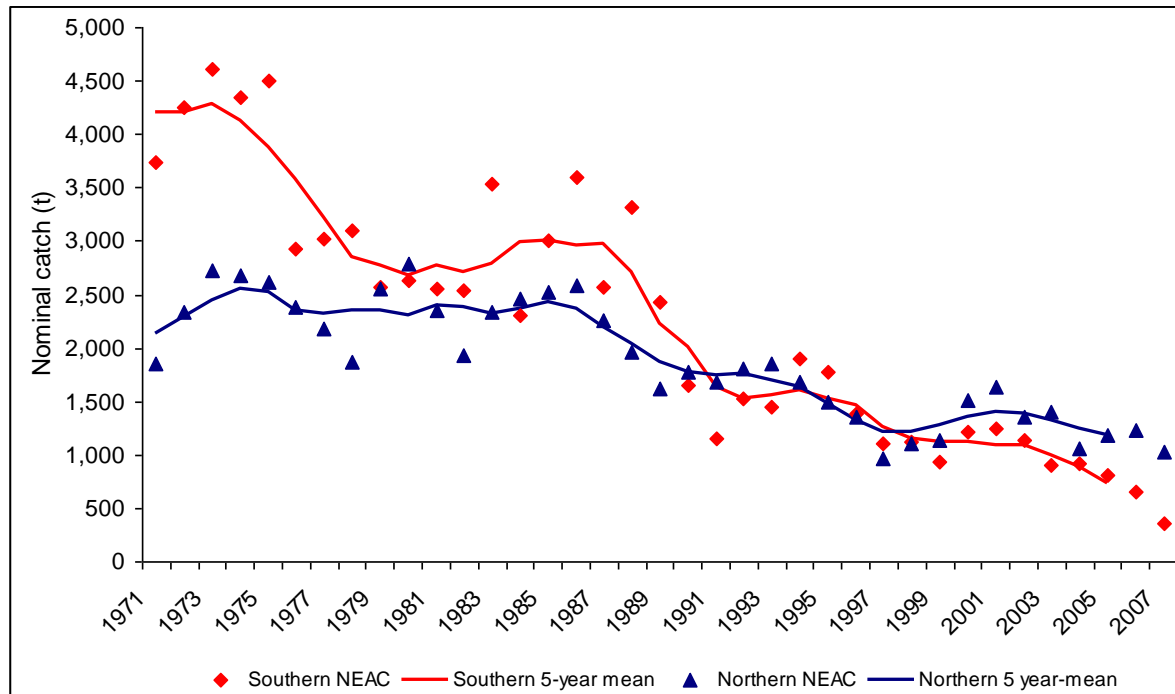
Gear and effort

- No significant changes in gear
- General downward trend in effort
 - IRE driftnet fishery effort completely removed
- No such consistent trends for rod effort

Key events of the 2007 fisheries

Catches

- NEAC – 1394 t
 - Northern – 1029 t
 - Southern – 365 t
 - substantial decrease from 2006 (1878 t) and the previous 5 year mean



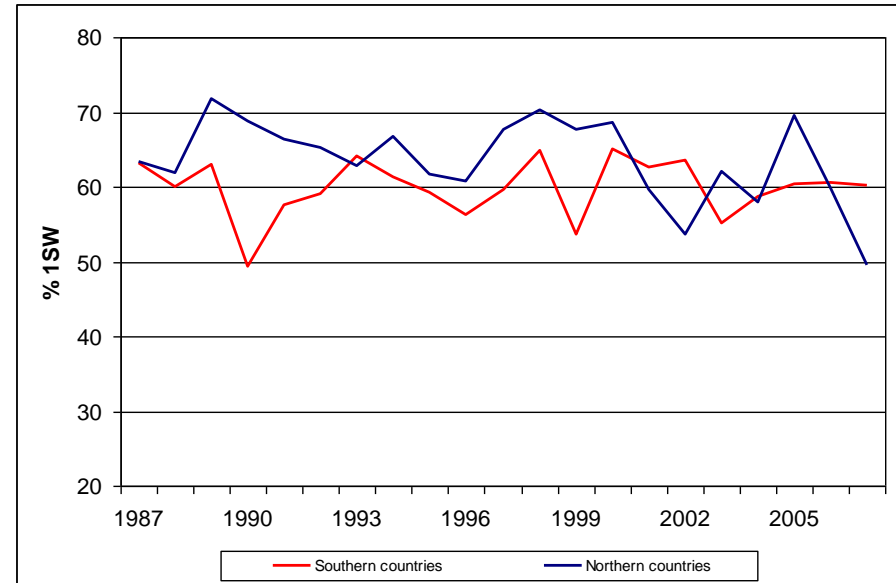
Key events of the 2007 fisheries

Catch per unit effort (CPUE)

- Most down and lower than 5 yr mean

Age composition of catches

- Northern
 - 1SW comprised 50% of catch
 - Below 5 and 10 yr mean
- Southern
 - 1SW comprised 60%
 - Same as 5 and 10 yr mean



Farmed and ranched salmon in catches

- Remains low in most countries (<2% of catch)
- Exception is Norway
 - coastal (29%), fjordic (30%) and rod (9%))

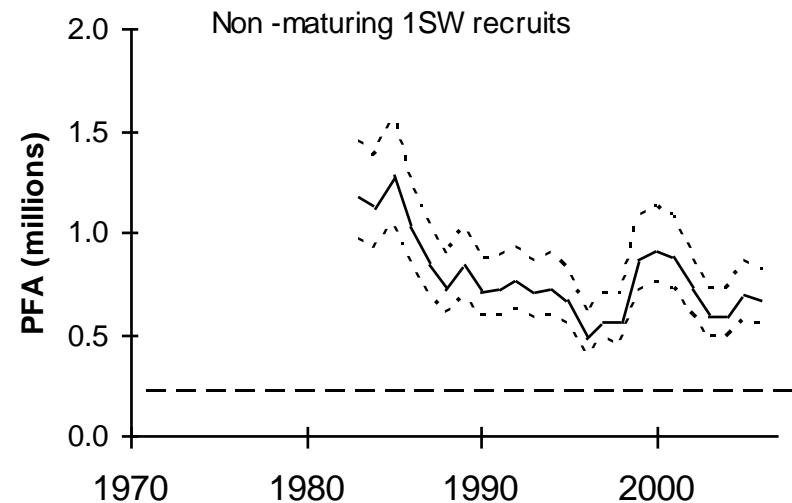
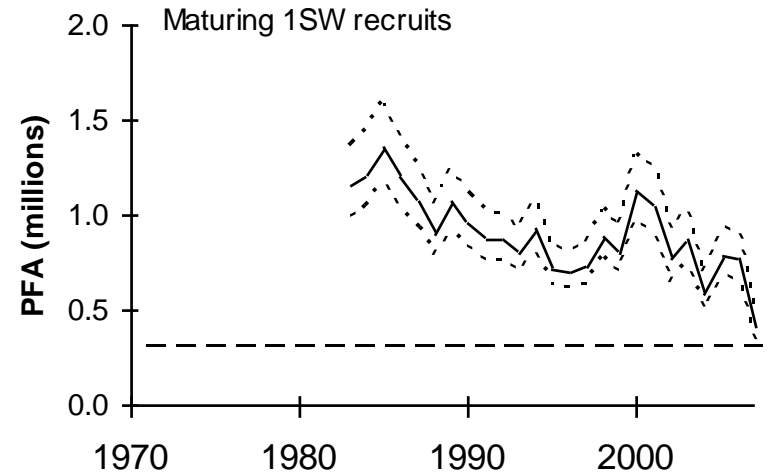
National origin of catches

- With closure of Irish drift net fisheries, essentially no recoveries to report

Trends in PFA

Northern European stocks (recruits)

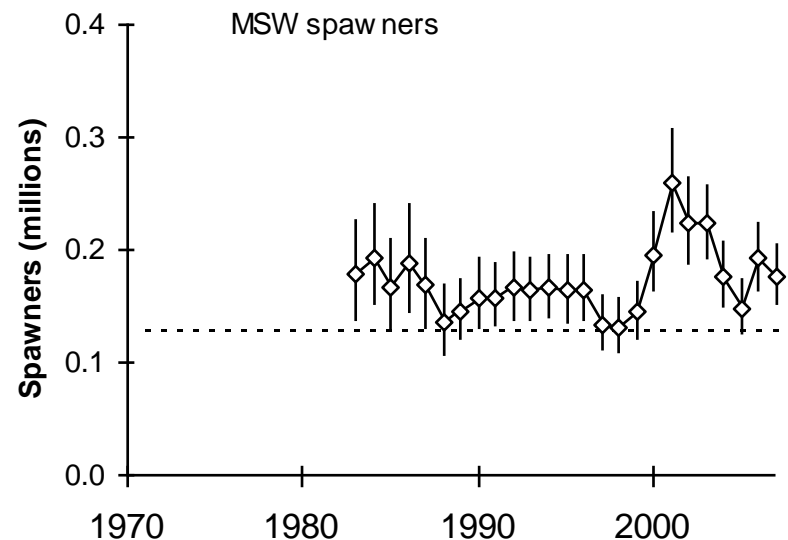
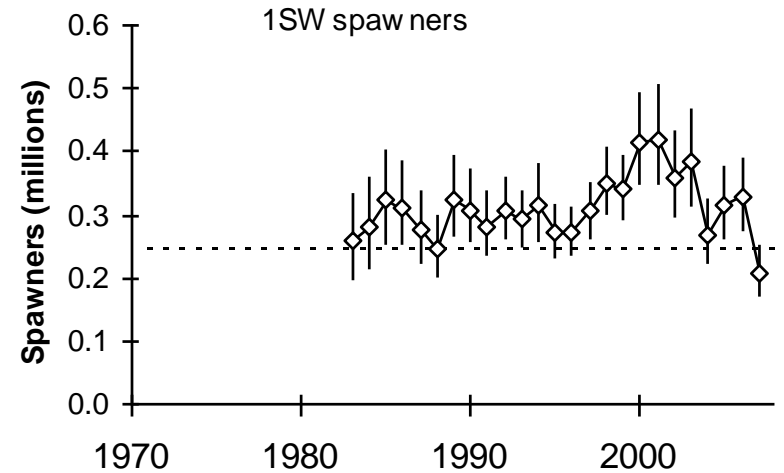
- Broadly similar patterns
- Generally declining
 - brief increase in 1998-2003
- Remained at full reproductive capacity throughout



Trends in PFA

Northern European stocks (spawners)

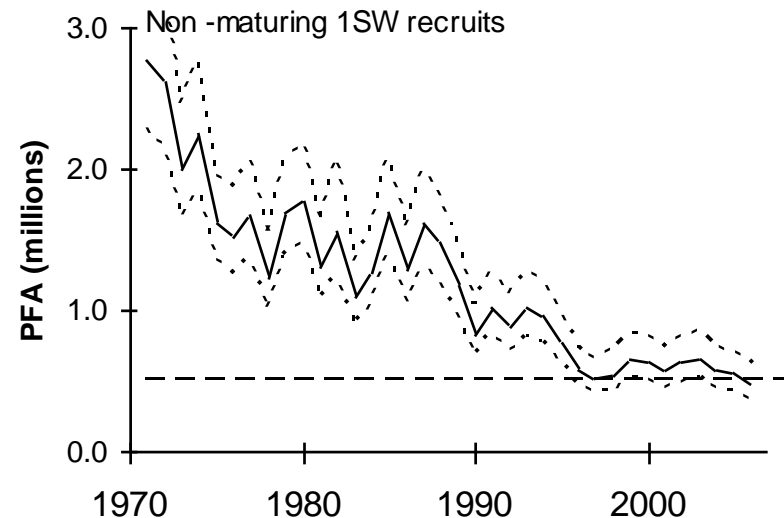
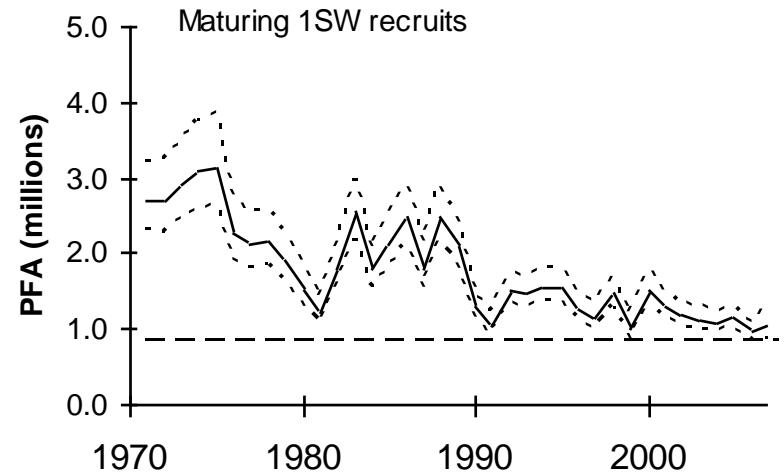
- Broadly similar patterns
- Full or at risk of suffering reproductive capacity
 - 2007 1SW was suffering reproductive capacity
- Broadly consistent with patterns of decline in marine survival



Trends in PFA

Southern European stocks (recruits)

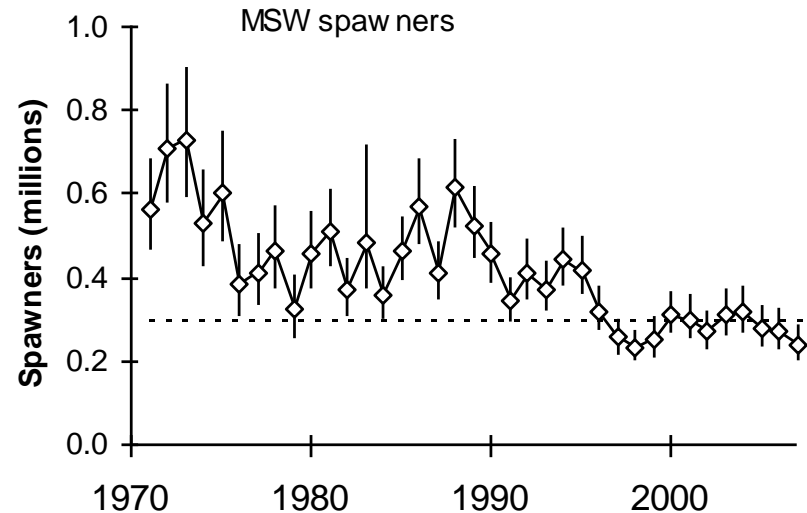
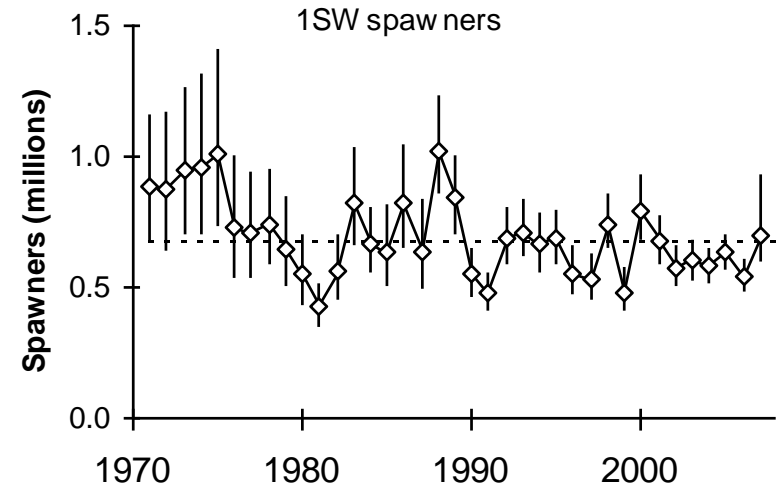
- Broadly similar patterns
- Generally declining
- Maturing has been at full reproductive capacity (minus 1 year)
- Non-maturing was at full reproductive until 1997



Trends in PFA

Southern European stocks (spawners)

- Broadly similar patterns
- Generally declining
 - Especially MSW
- 1SW at risk or suffering reproductive capacity most of the time series
- MSW at full capacity till 1997
- Broadly consistent with patterns of decline in marine survival



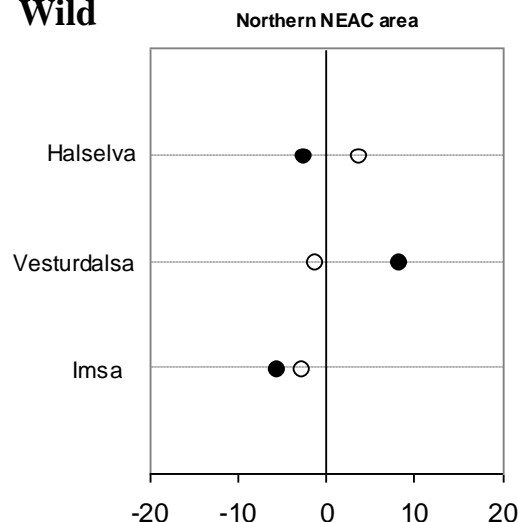
Survival indices for NEAC stocks



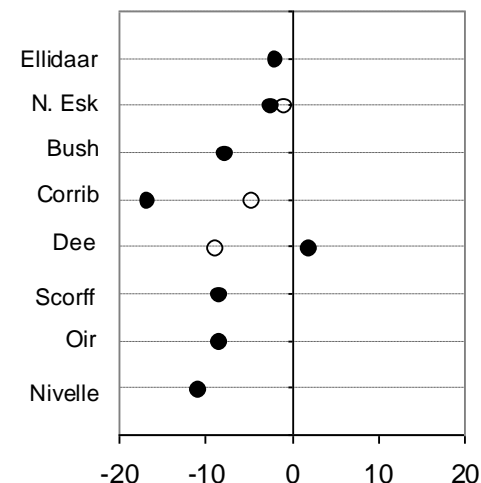
Overall

- Annual rates of change in marine survival
- Annual decline (1-20%)

Wild



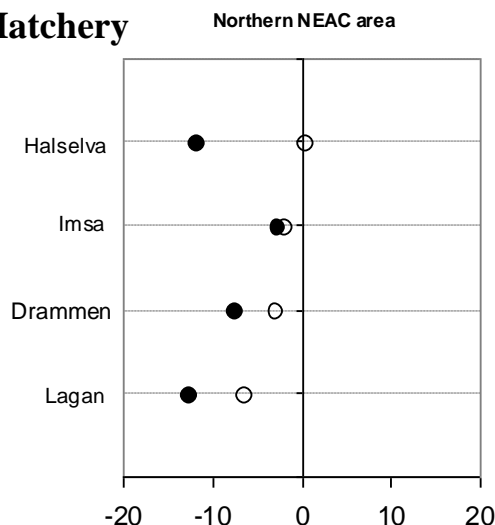
Southern NEAC area



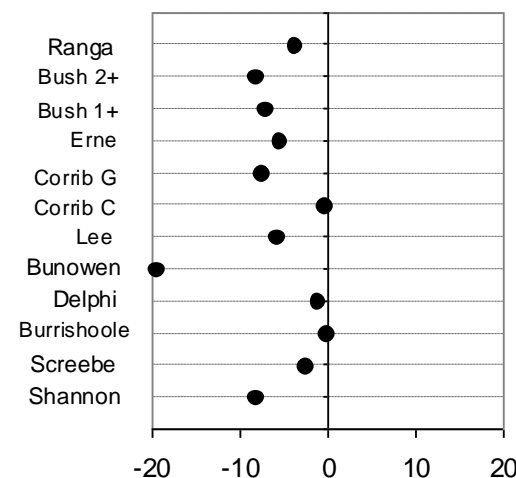
Individual rivers

- Most 2007 estimates
 - lower than 2006
 - Lower than 5 and 10 yr means
 - R. Bush the exception

Hatchery



Southern NEAC area



NASCO has requested ICES to provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved

International, national and local management measures have aimed to:

- Reduce levels of exploitation
- Increase freshwater escapement
- In some cases, meet river-specific CLs

Summary of national objectives, recent management measures and attainment of objectives is provided in Table 3.9.1

ICES Scientific Advice to NASCO
Atlantic salmon in North
American Commission

Scientific Advice from ICES

- **June 2007**
 - Request for Scientific Advice from ICES adopted (CNL(07)14)
 - Describe stock status and provide catch options question dependant on outcome of Framework of Indicators (FWI)
- **January 2008**
 - FWI - no change to the management advice previously provided
 - Question 3.3 not undertaken

NASCO has requested ICES to update age-specific stock conservation limits based on new information as available

- No changes recommended in the 2SW CLs

NASCO has requested ICES to describe the key events of the 2007 fisheries (including the fishery at St Pierre and Miquelon)

- The majority of harvest fisheries were directed to small salmon
- Total harvest was 47 796 salmon in 2007
 - down 21% from the 5 year mean
- Catches remain low relative to pre-1990 values

Key events of the 2007 fisheries (Gear and effort)

Canada

- No commercial harvest
- 3 user groups
 - Aboriginal peoples' food fisheries (gillnet)
 - Residents fishing for food in Labrador (gillnet)
 - Recreational fishers (rod)

USA

- No commercial fisheries
 - 1 month, 1 river recreational catch and release fishery

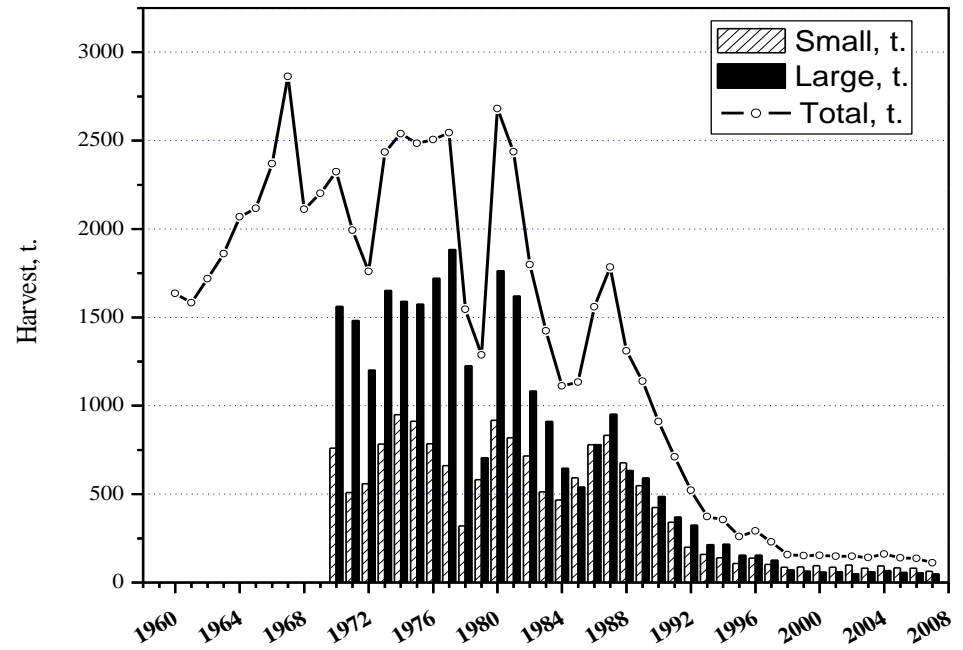
Saint-Pierre and Miquelon

- No information received on number of commercial and recreational licenses issued (gillnet)

Key events of the 2007 fisheries (Catches)

Canada

- Provisional harvest of 112 t (18% decreased)
 - 37 540 small salmon (20% decrease)
 - 10 256 large salmon (7% increase)
- Aboriginal people's food fishery
 - 47.6 t (22% decrease)
- Residents fishing for food
 - 1.7 t (733 fish)
- Recreational fisheries
 - ~63 t (18% decrease)
 - ~42 820 salmon caught and released
 - approximately 60% total caught
 - ~54% large
- No unreported catch provided



Key events of the 2007 fisheries (Catches)

USA

- 0 t and 0 t unreported catch

Saint-Pierre and Miquelon

- 1.95 t (lowest since 1997)
- No unreported catch provided

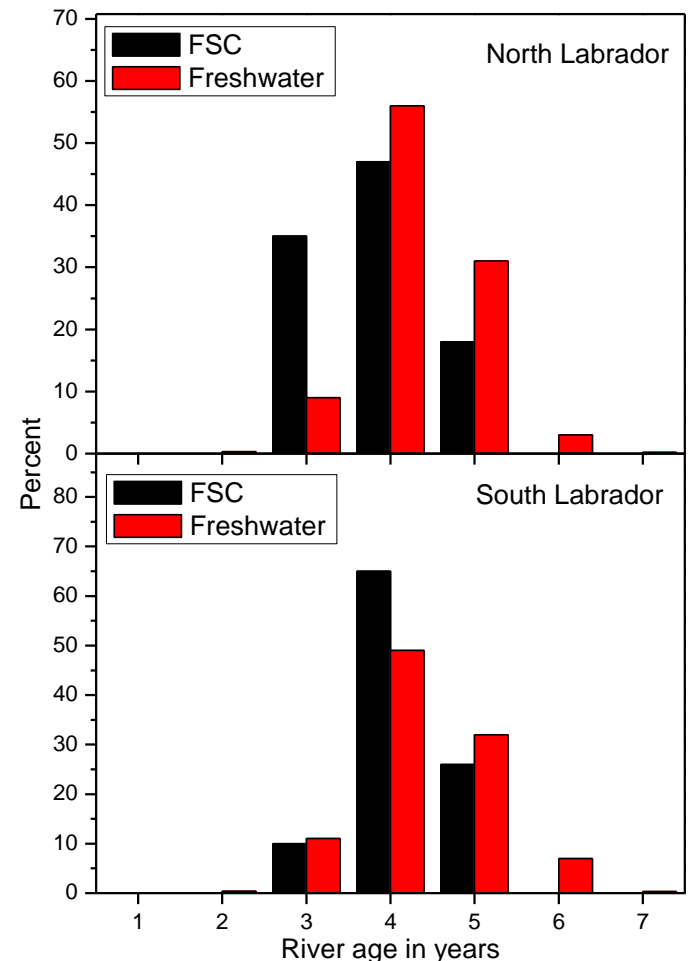


NASCO has requested ICES to report on the biological characteristics (size, age, origin) of the catch in coastal fisheries and potential impacts on non-local salmon stocks

- Aboriginal People's and resident food fisheries intercepted 1 tagged salmon
 - Miramichi salmon spawner
- Only 12 fish sampled from Saint-Pierre et Miquelon
 - No tags reported
 - No tissue samples taken

Sampling program for Labrador subsistence fisheries

- Opportunistic sampling in 2007 (n=196)
- Sea ages
 - 82% 1SW, 10% 2SW and 8% ps
- Freshwater ages from assessment facilities compared to subsistence fisheries samples (FSC purposes)
 - No difference between freshwater north and south
 - Statistical difference (freshwater vs. FSC) in north but not south
 - Few age 1 and 2 smolts suggest southern NAC stocks not contributing
 - Presence of age 5-7 suggest northern (predominately Labrador) stocks contributing
 - Presence of relatively high number of age 3 suggest other regions in Canada contributing



NASCO has requested ICES to evaluate the extent to which the objectives of any significant management measures introduced in recent years have been achieved

- No significant management measures introduced

ICES Scientific Advice to NASCO
Atlantic salmon in West
Greenland Commission

NASCO has requested ICES to describe the key events of the 2007 fishery

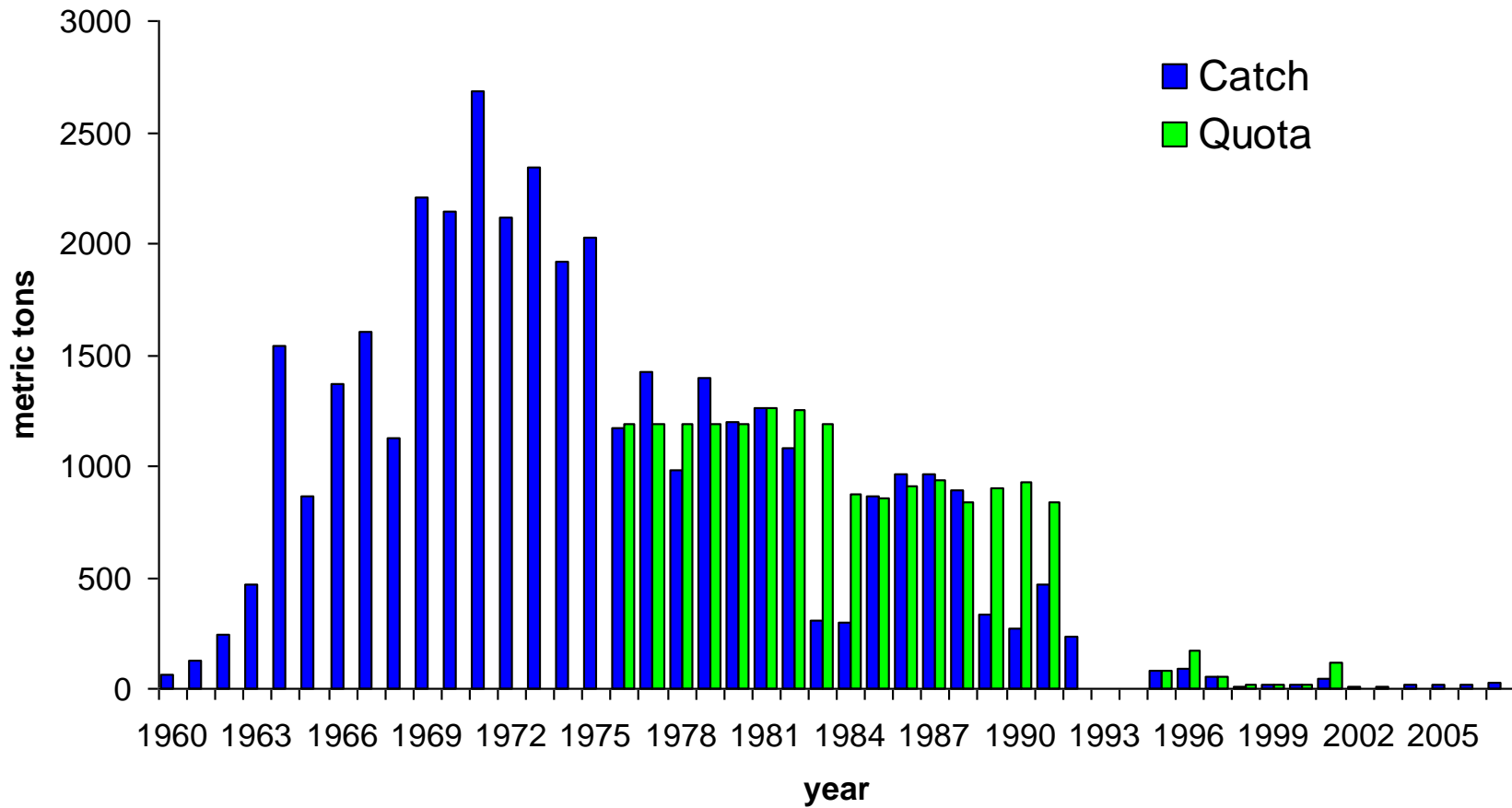
- **May 2007**
 - ICES recommends zero quota (2007-2009)
- **June 2007**
 - NASCO (WGC) agreed to continue the multi-annual regulatory measures
 - fishery restricted to that used for of internal consumption (~20 mt)
 - Greenlandic Authorities set commercial quota to nil
 - Sale for export forbidden
 - West Greenland Fishery Sampling Agreement adopted (WGC(07)05)
 - Request for Scientific Advice from ICES adopted (CNL(07)14)
 - Describe stock status and provide catch options question dependant on outcome of Framework of Indicators (FWI)
- **January 2008**
 - FWI - no change to the management advice previously provided
 - Question 4.3 not undertaken
- **August – October 2007**
 - Internal use fishery and International sampling effort

Key events of the 2007 fisheries

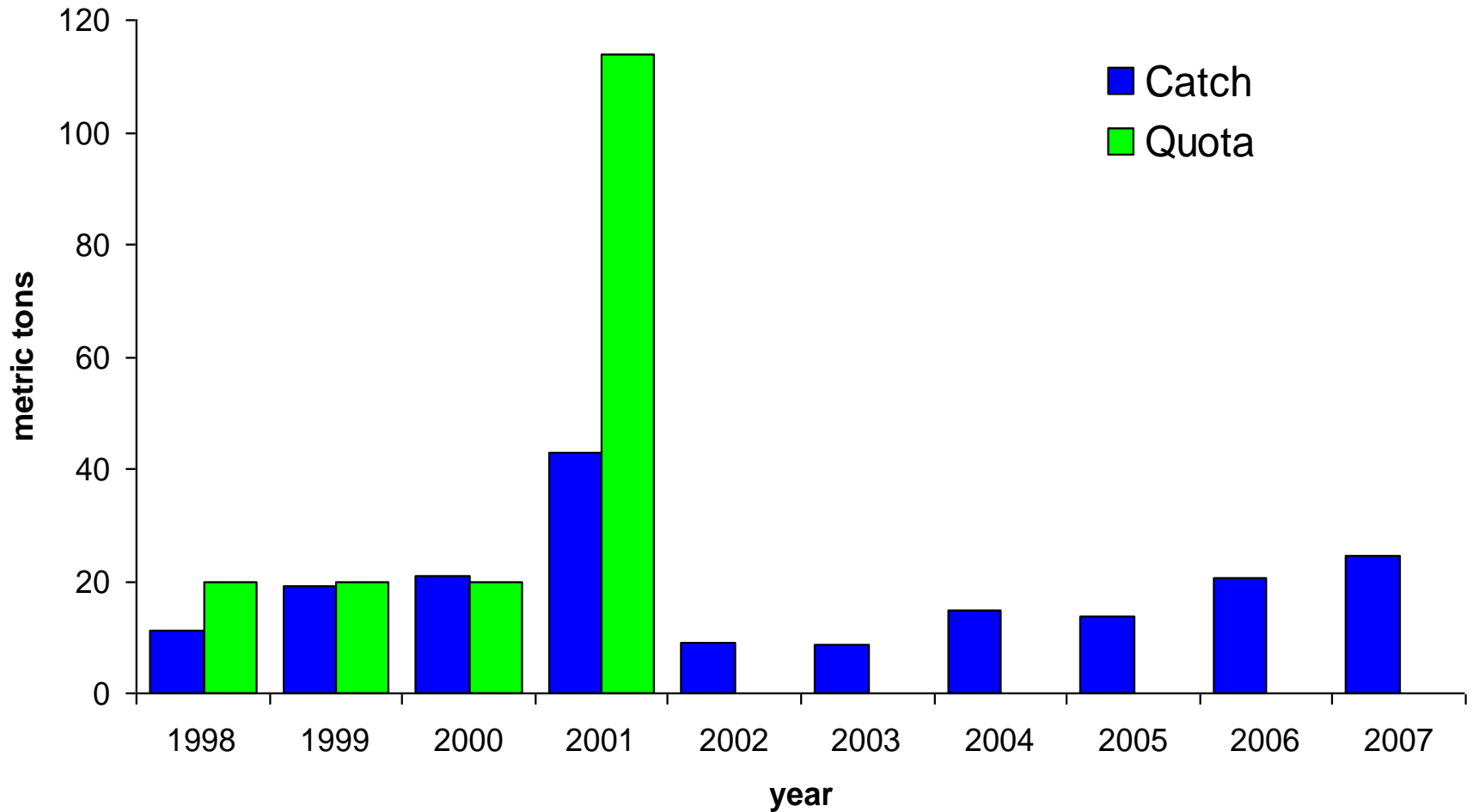
- 24.6 t reported
 - Unreported catch estimated at 10mt
- 2005 and 2006 landings mistakenly reported to ICES as gutted weight
 - Corrected for – all landings currently represent whole weight
- Seasonal distribution of catches no longer provided
 - Reporting requirements do not support this breakdown



Historic Commercial Atlantic Salmon Fishery at Greenland (1960-2007)

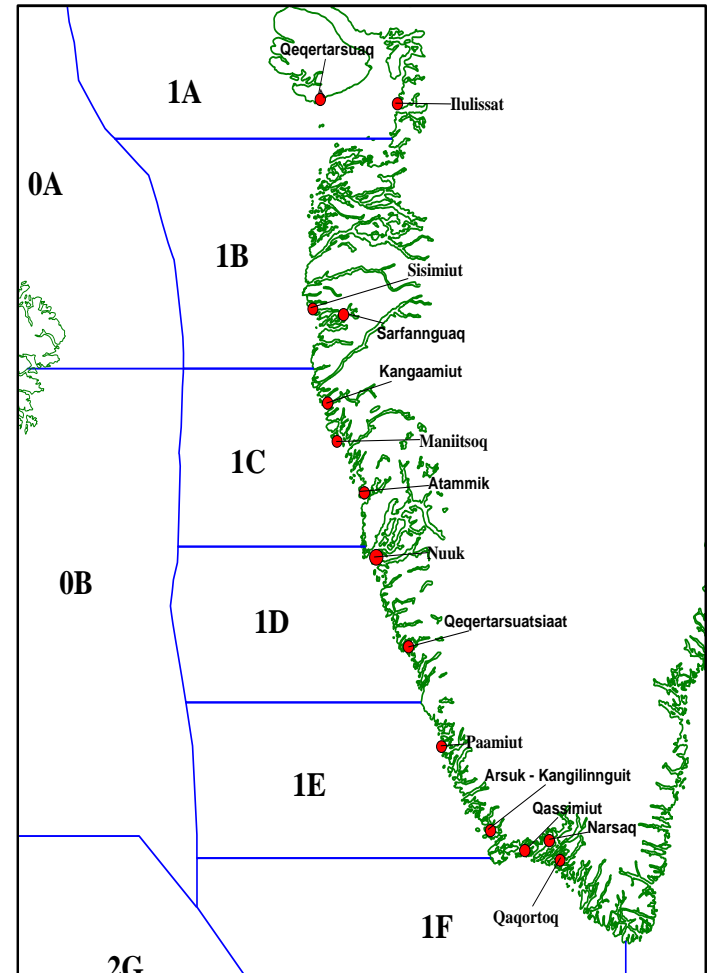
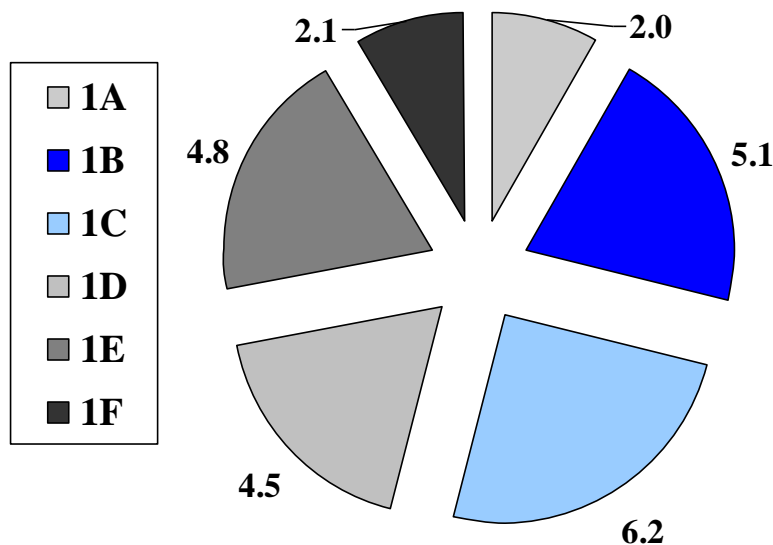


Contemporary Commercial Atlantic Salmon Fishery at Greenland (1998-2007)



Spatial Distribution of Reported Landings

- Distributed across all 6 NAFO divisions
 - 80% of landings from Divisions 1B-1E



International Sampling Program

- 8 Samplers - 2 USA, 2 CAN, 1 UK(E&W), 1 UK(SCOT), 1 IRE, and 1 DEN
 - 5 out of 6 NAFO Divisions sampled
 - 12 out of 13 NAFO weeks sampled
 - ~121 sampling days
- 1,162 fish handled (1,126 sampled) - 16% of total weight
 - Biological characteristics (length and weight)
 - Age and growth (scale) and origin (tissue) samples
 - 150 disease samples (ISAv)
 - 150 feeding habits (stomach) and parasite (intestine) samples (*processing is ongoing*)
 - 150 lipid/stable isotope samples (liver, dorsal and caudal muscle) (*preliminary results*)



‘Over’ Sampling of Reported Catch

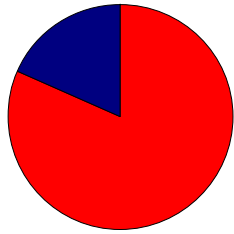
NAFO Division	2002 Landings		2003 Landings		2004 Landings		2005 Landings	
	Reported	Adjusted	Reported	Adjusted	Reported	Adjusted	Reported	Adjusted
1A	14	14	619	619	3,476	3,476	1,166	1,166
1B	78	78	17	17	611	611	2,811	2,811
1C	2,100	2,100	1,621	1,782	3,516	3,516	2,018	2,018
1D	3,752	3,752	648	2,709	2,433	4,929	681	2,730
1E	1,417	1,417	1,274	1,274	2,609	2,609	2,646	2,646
1F	1,661	2,408	4,516	5,912	2,068	2,068	4,465	4,465
Total	9,022	9,769	8,694	12,312	14,712	17,209	13,786	15,835

NAFO Division	2006 Landings		2007 Landings	
	Reported	Adjusted	Reported	Adjusted
1A	4,889	4,889	2,019	2,019
1B	2,352	2,352	5,089	5,089
1C	3,085	3,085	6,148	6,148
1D	4,262	4,262	4,470	4,470
1E	2,375	2,375	4,828	4,828
1F	3,777	3,777	2,093	2,252
Total	20,740	20,740	24,647	24,806

Continent of Origin of Sampled fish

OVERALL

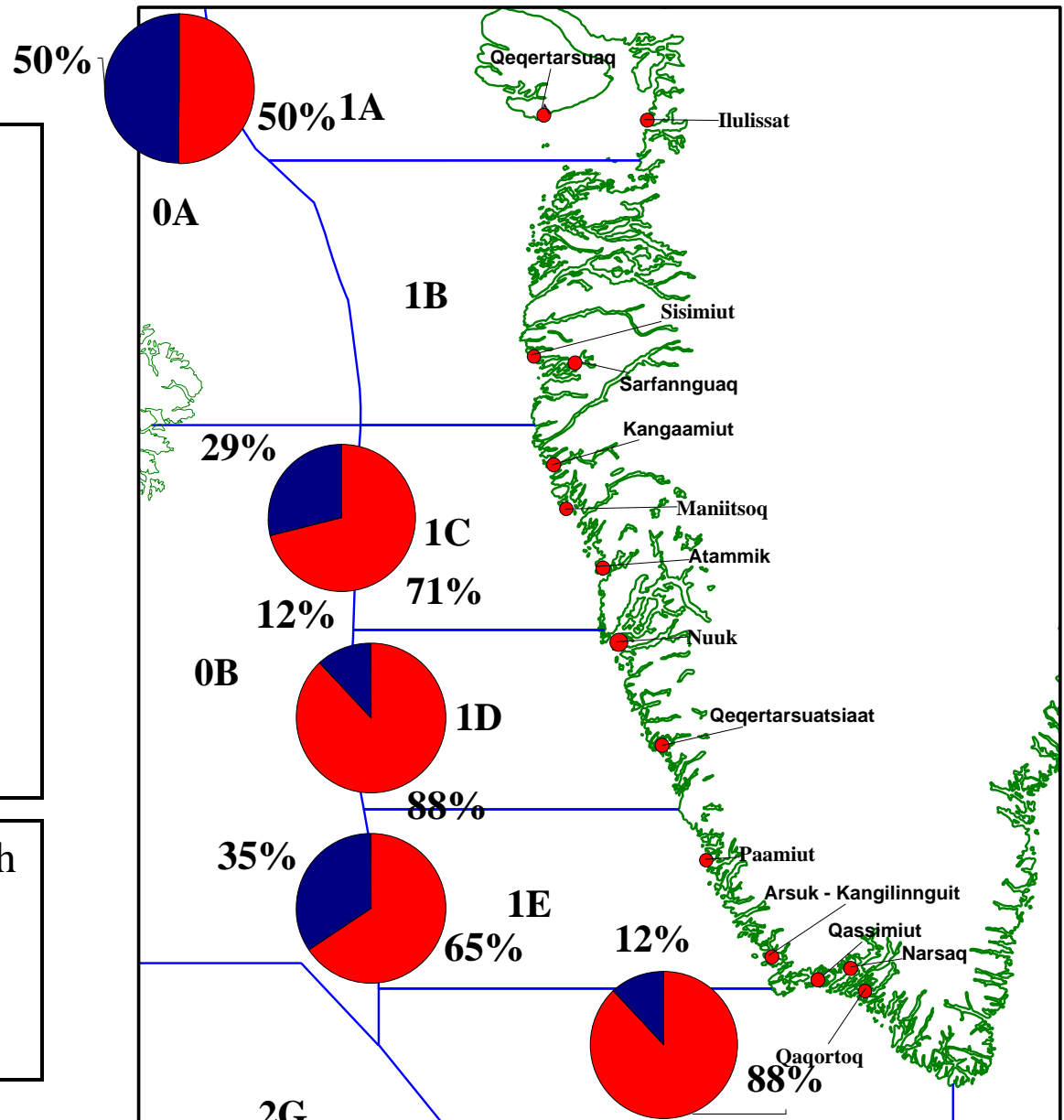
18%



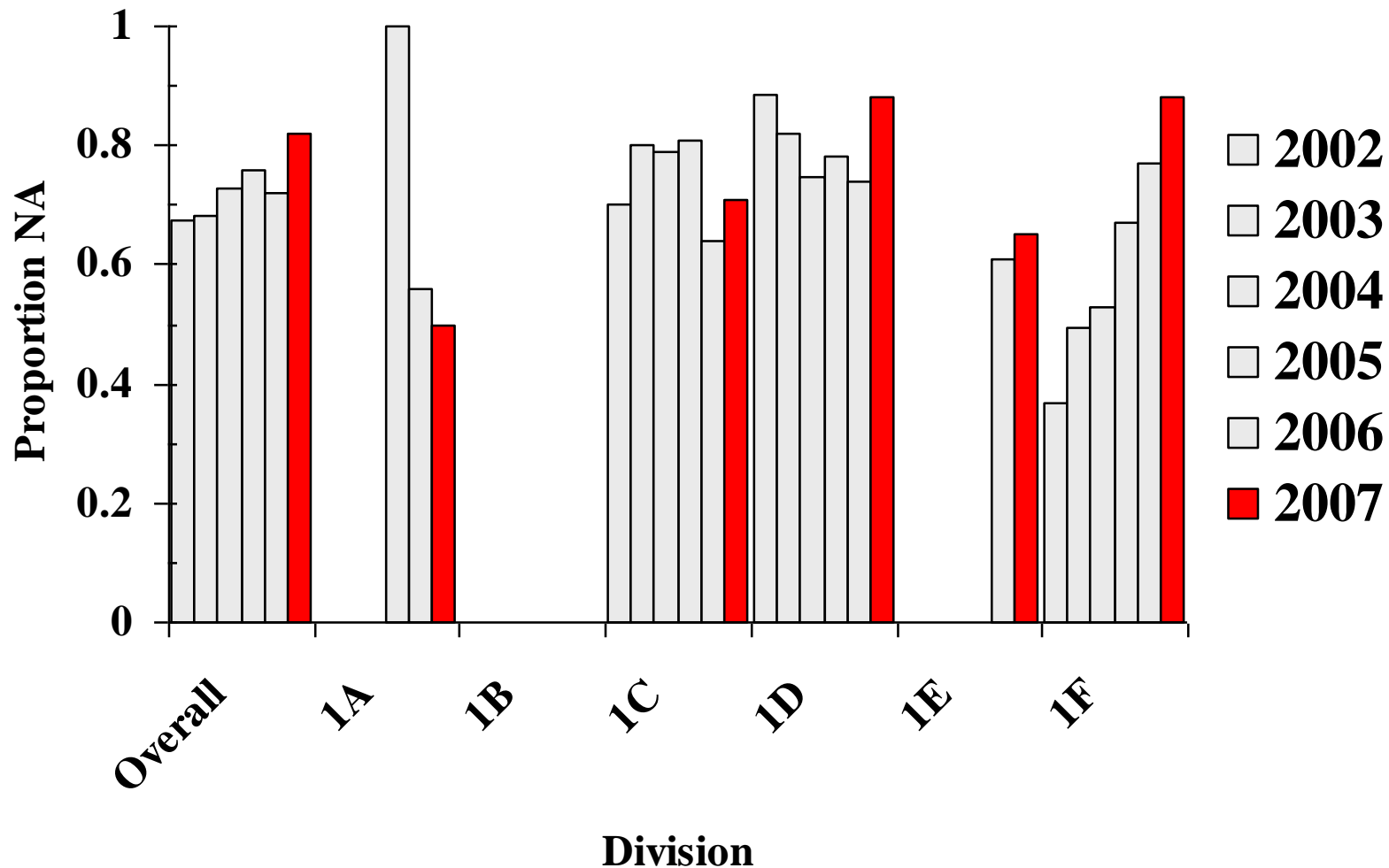
82%

- North American Origin
- European Origin

- 18.5 t North American fish harvested (~6100 fish)
- 6.3 t of European fish harvested (~1900 fish)



2002-2007 Continent of Origin by Division



Disease (ISAv only) Screening

- 150 disease samples obtained
 - Fish purchased from fishermen
 - Assayed by RTPCR for ISAv only
 - Cell culture is impractical

ISA virus infected fish with external hemorrhages



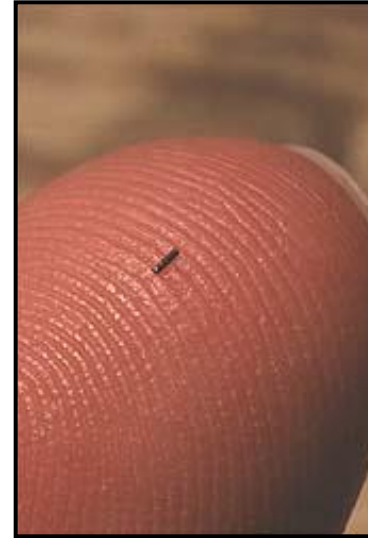
ISA virus infected fish with internal hemorrhages



All test results were negative

2007 Tag Recoveries (n=5)

- 1 Carlin
 - Miramichi River (Canada)
- 1 Streamer
 - Cains River (Canada)
- 2 Visual Implant Elastomer
 - Penobscot River (USA)
- 1 CWT
 - Ulla River (Spain)



NASCO has requested ICES to evaluate the extent to which the objectives of any significant management measures introduced in recent years have been achieved

- Not possible to assess