



NEA(15)9

Presentation of the ICES Advice to the North-East Atlantic Commission

REPORT OF ICES ADVISORY COMMITTEE
ON
NORTH ATLANTIC SALMON STOCKS
TO
NORTH ATLANTIC SALMON
CONSERVATION ORGANIZATION
NEAC Area
CNL(15)8

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

10.2 With respect to Atlantic salmon in the North-East Atlantic Commission area:

1. Describe the key events of the 2014 fisheries;
2. Review and report on the development of age-specific stock conservation limits;
3. Describe the status of the stocks;
4. Provide catch options or alternative management advice for 2015/16 - 2017/18 fishing seasons, with an assessment of risks relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding;

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

10.2 With respect to Atlantic salmon in the North-East Atlantic Commission area:

5. Advise on options for taking into account the recent genetic analysis that suggests there was a significant contribution of North American origin stocks to historic mixed-stock fisheries in Faroese waters for the provision of catch advice;
6. Update the Framework of Indicators used to identify any significant change in the previously provided multi-annual management advice; and
7. Advise on what data would enhance the development of the catch options.

Composition of NEAC stock complexes

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

Key Events of Fisheries in 2014

- No fishery has been prosecuted at Faroes since 2000
- No changes in gear types reported in the NEAC area in 2014
- Fishing effort continues to decline – ongoing reductions in nets and traps
- Fewer measures of effort for rod fisheries and these more variable (increases in days fished in some countries, decreases in others), but increasing use of C&R
- Range of other restrictions applied – e.g. delayed start to season in 2 areas in Norway; compulsory C&R
- Particularly low flows in 2014 in some Southern NEAC countries likely affected catches and effort

Nominal Catch

**Nominal
catch (t) in
2014**

NEAC

938

Lowest

NEAC North

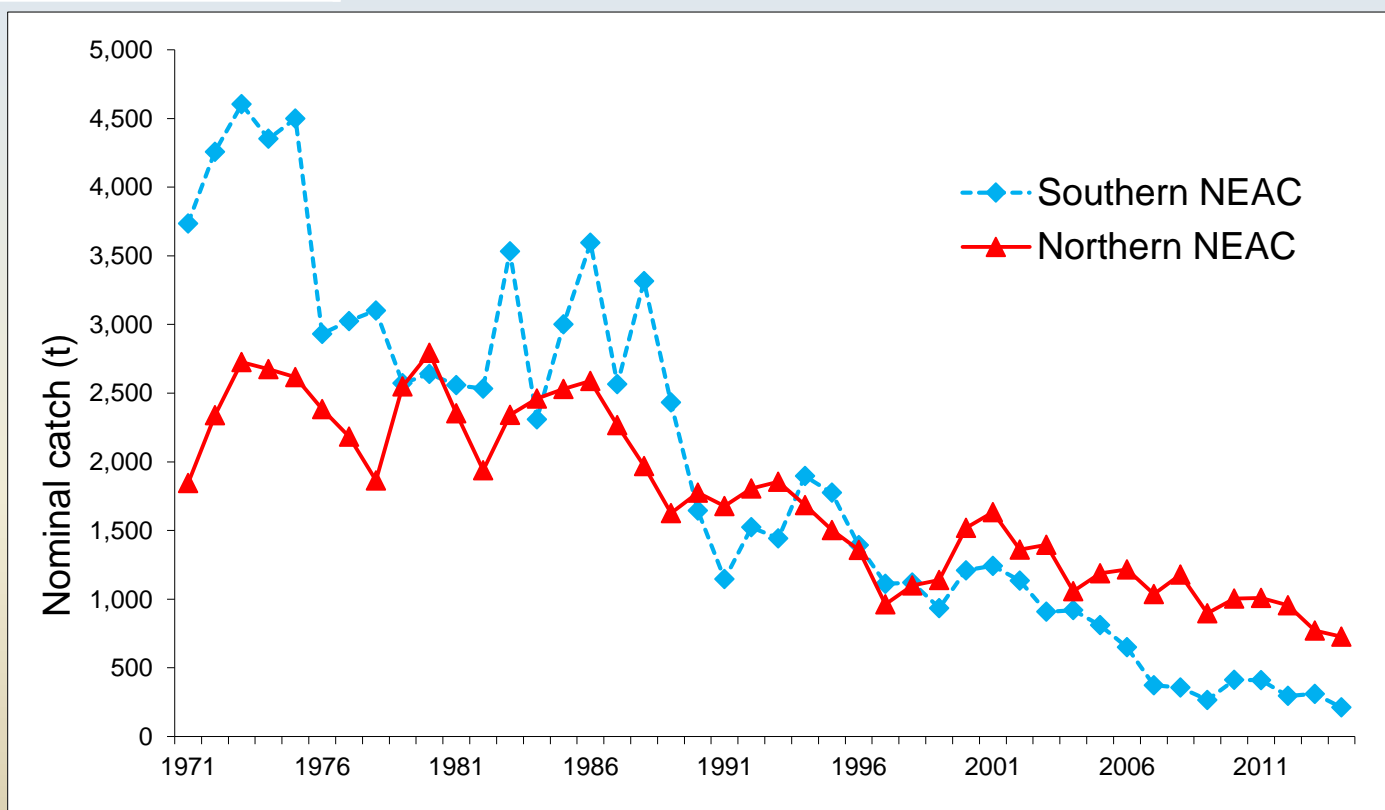
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Lowest

NEAC South

211

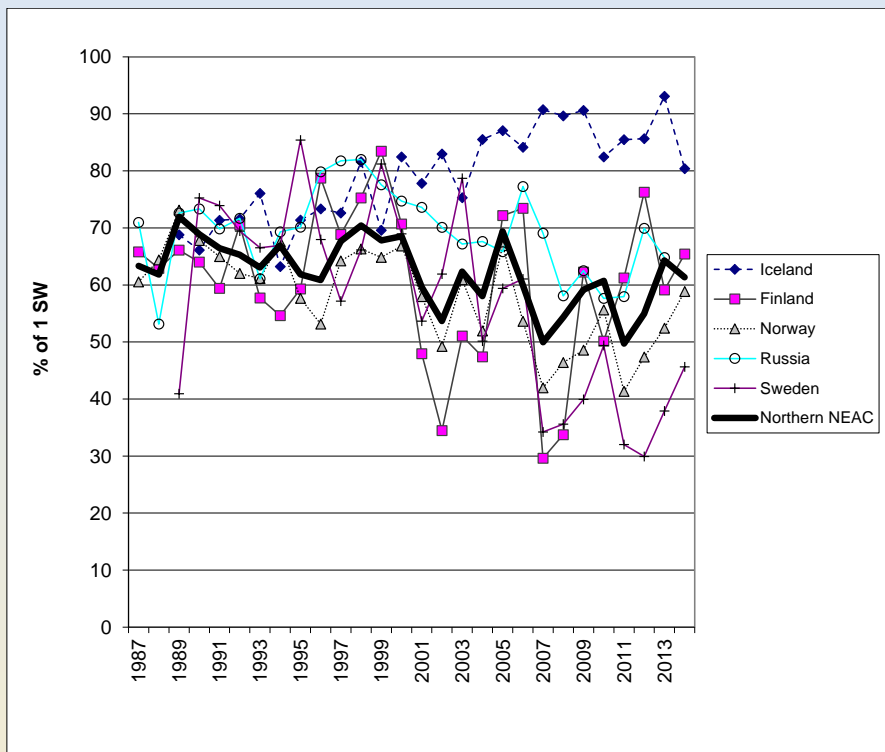
Lowest



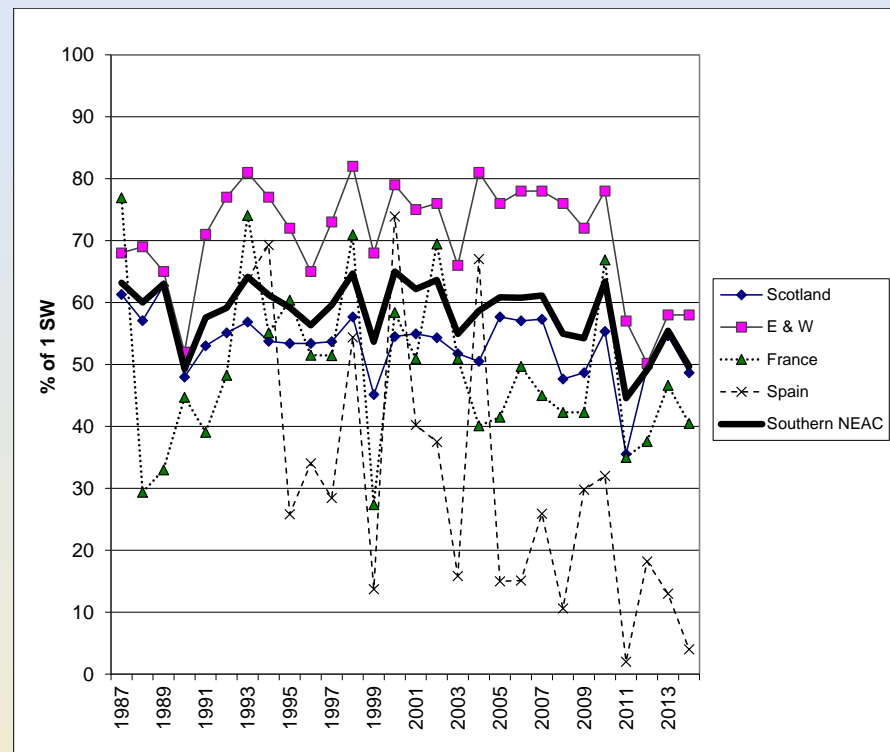
➤ Decline in catches has been more pronounced in Southern NEAC

Composition of Catches

Northern NEAC



Southern NEAC



Age composition

- Similar overall percentages of 1SW salmon in the catches in N. NEAC and S. NEAC
- % 1SW lower in last few years in both areas
- Considerable variability among individual countries; variability increasing in N NEAC

Farmed fish in catches

- Generally low in most countries, with the exceptions of Norway, Iceland and Sweden. Similar levels to previous years.
- Estimated at 5% of Norwegian rod caught fish (lower end of range); samples taken from Norwegian rivers in autumn lowest in time series (10%)
- 283,000 salmon escapees reported from Norwegian farms in 2014 – up from 198,000 in 2013
- Such fish ignored in assessments of national stocks
- Cages holding 250,000 in Ireland damaged. Fate unknown (many may have died) - farmed fish not identified in catches / broodstock from adjacent area

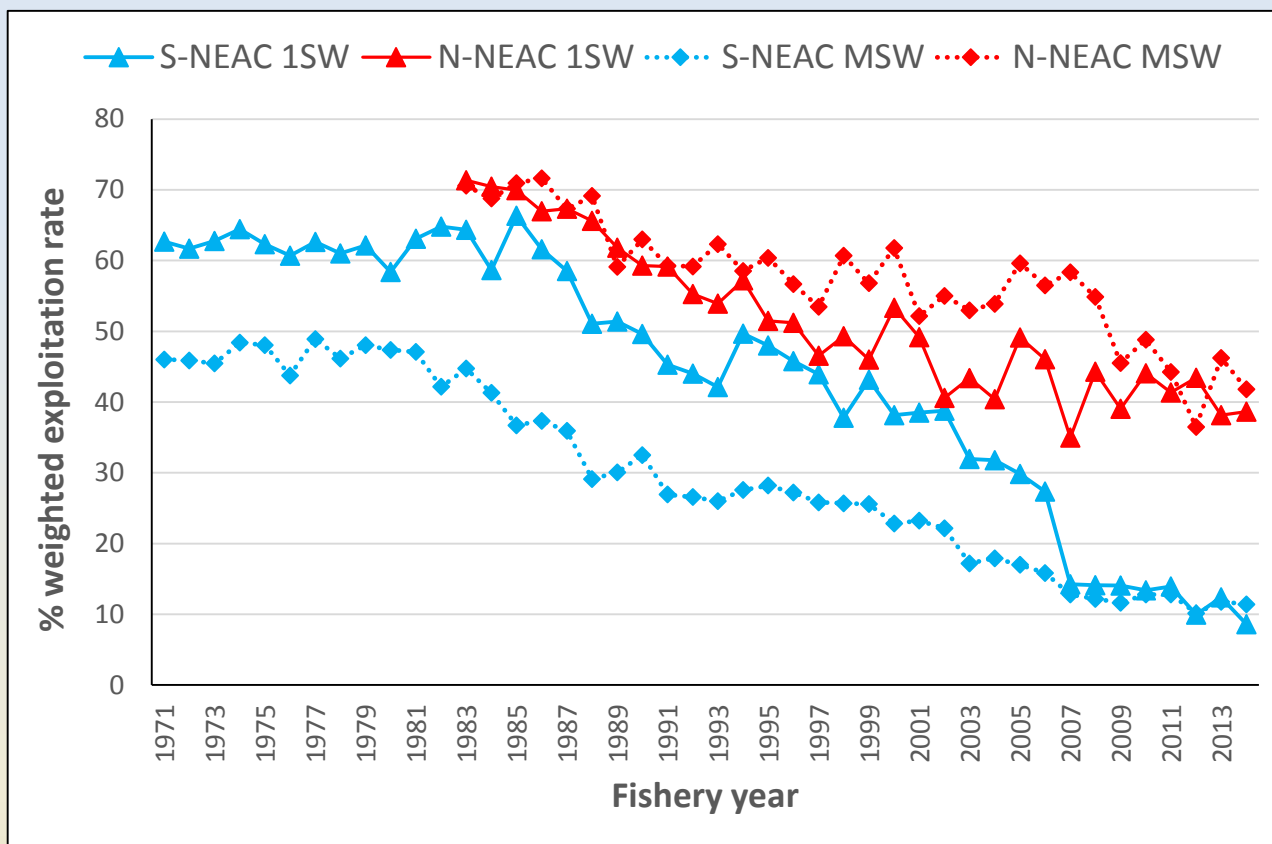
Ranching

- Ranching for rod fisheries in two Icelandic rivers continued into 2014 – 12.5 t were reported as ranched salmon in contrast to 46.5 t harvested as wild
- Swedish catches also split into ranched (19.3 t) and wild (10.6 t)
- Ranching occurs on a much smaller scale in other countries, but not reported separately

Catches of Russian salmon in northern Norway

- Ongoing genetic investigations in this mixed stock fishery (joint Russian / Norwegian research programme)
- Fishing effort reduced, but still significant fisheries in Finnmark County
- Genetic baseline for >180 rivers; >20k samples analysed (2008-2012)
- Salmon originating from Russian rivers contributed >20% of catch. This varied markedly within season and also among regions:
 - highest exploitation of Russian salmon in eastern regions of Finnmark (9% Russian origin fish in catches in western areas, but nearly 50% in Varangerfjord close to Russian border)
 - decreasing trend in exploitation of Russian salmon through the season – e.g. in Varangerfjord, Russian salmon decreased from ~70% in May to ~20% in August. Thus Russian fish more abundant before start of formal fishing season (early June)
- Findings will inform management decisions and should enable improved and more targeted regulations

Exploitation rates (all fisheries)



- Weighted estimates based on national returns (outputs from NEAC PFA run reconstruction model)
- General decline for both areas, but greater in S. NEAC and exploitation rates now substantially lower in S. NEAC
- Sharp drop for 1SW fish in S. NEAC in 2007

Development of age-specific stock conservation limits

- River-specific CLs previously developed and in use in France, Ireland, UK (England & Wales) & Norway. Applied for the first time in UK (N. Ireland) in 2014.

Progress with setting river-specific CLs

- UK (N. Ireland) – new CLs developed for a number of rivers. New approaches (fishery-independent) also being developed for assessing compliance.
- Finland / Norway (River Teno/Tana) - information collected for almost all tributaries (and main stem) to allow CLs to be set (using existing Norwegian method). Population-specific evaluations not yet available for most locations.
- UK (E&W) – updated CL for one river (due to substantial increase in wetted area following barrier removal).
- Iceland – further progress made (assessing productivity, determining wetted areas), but slow process.

Development of age-specific stock conservation limits

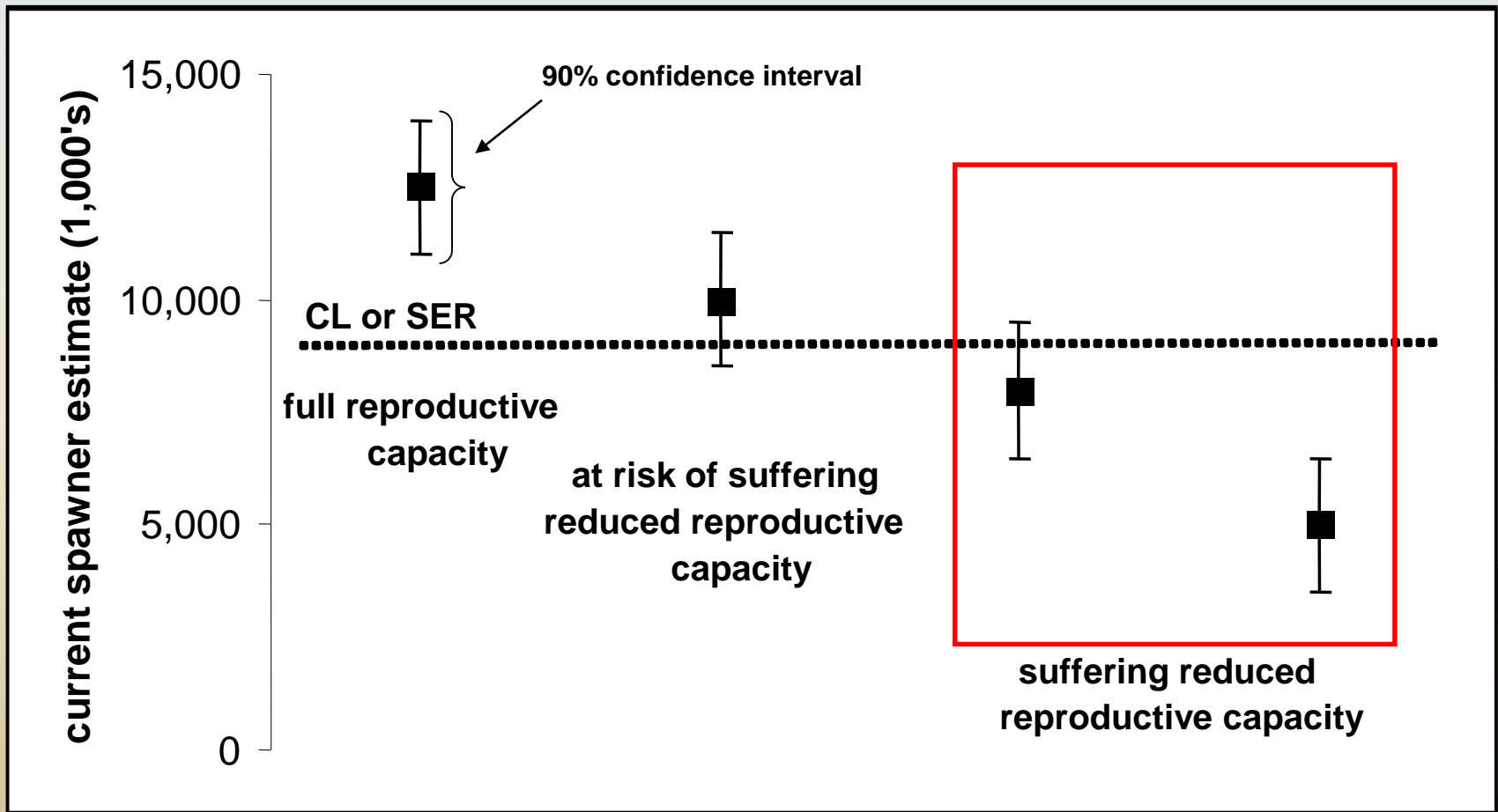
- Where available, river-specific CLs are summed to provide national CLs
- For other countries, an interim ('hockey stick') approach has been developed for estimating national CLs
- National stock CLs are not appropriate for homewater fisheries management:
 - relatively imprecise
 - do not account for differences in status of individual river stocks
- National CLs are summed to develop N. and S. NEAC stock complex CLs by age group
- These used to provide management advice for distant water fisheries

Development of age-specific stock conservation limits

N. NEAC	National model CLs		River-specific CLs		CLs used	
	1SW	MSW	1SW	MSW	1SW	MSW
Finland	18,755	13,819			18,755	13,819
Iceland (N&E)	6,032	1,620			6,032	1,620
Norway			63,939	72,198	63,939	72,198
Russia	67,710	38,913			67,710	38,913
Sweden	1,181	1,196			1,181	1,196
N. NEAC Total					157,617	127,745
S. NEAC	National model CLs		River-specific CLs		CLs used	
	1SW	MSW	1SW	MSW	1SW	MSW
France			17,400	5,100	17,400	5,100
Iceland (S&W)	17,751	1,158			17,751	1,158
Ireland			211,471	46,943	211,471	46,943
UK (E & W)			54,812	30,203	54,812	30,203
UK (NI)			21,649	2,437	21,649	2,437
UK (Scotland)	245,912	187,518			245,912	187,518
S. NEAC Total					568,995	273,360

Conservation Limits & Stock Status

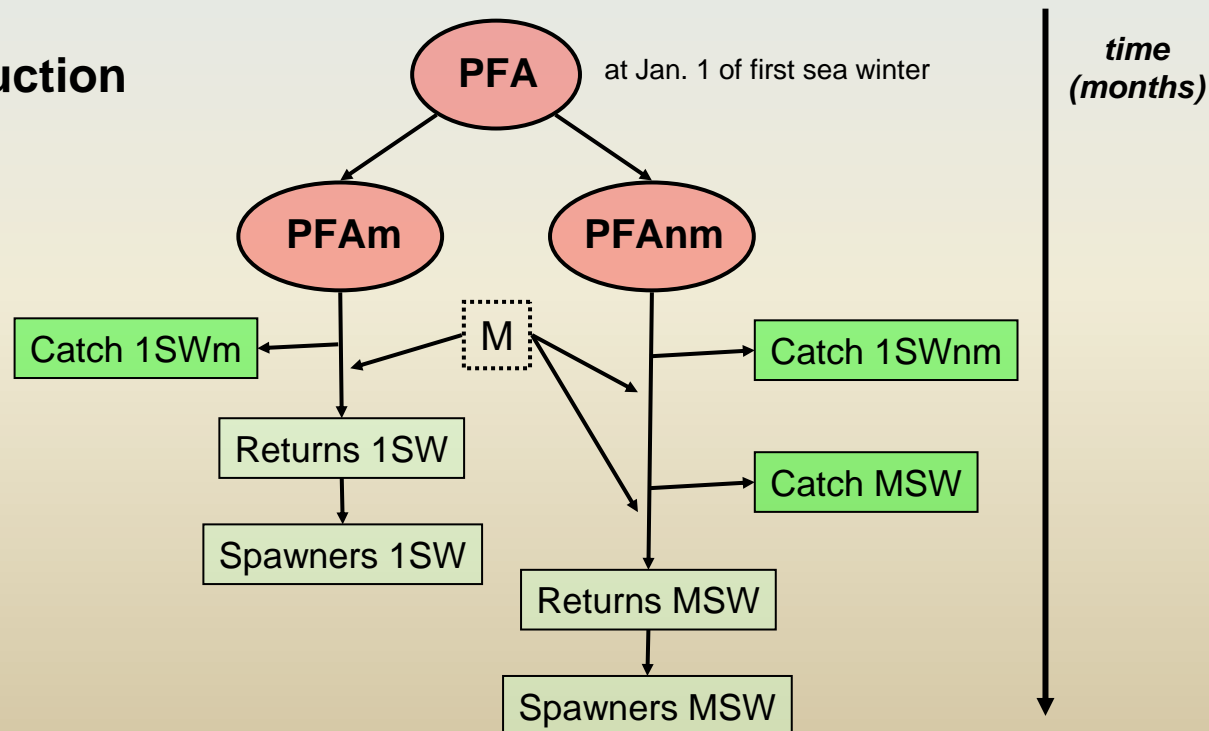
- CLs used to estimate the Spawner Escapement Reserve (SER) - the CL adjusted for natural mortality between recruitment date (1st Jan) & time of return to home waters
- ICES terminology for the assessment of stock status and advice where there are no specific management objectives:



Status of Stocks - PFA

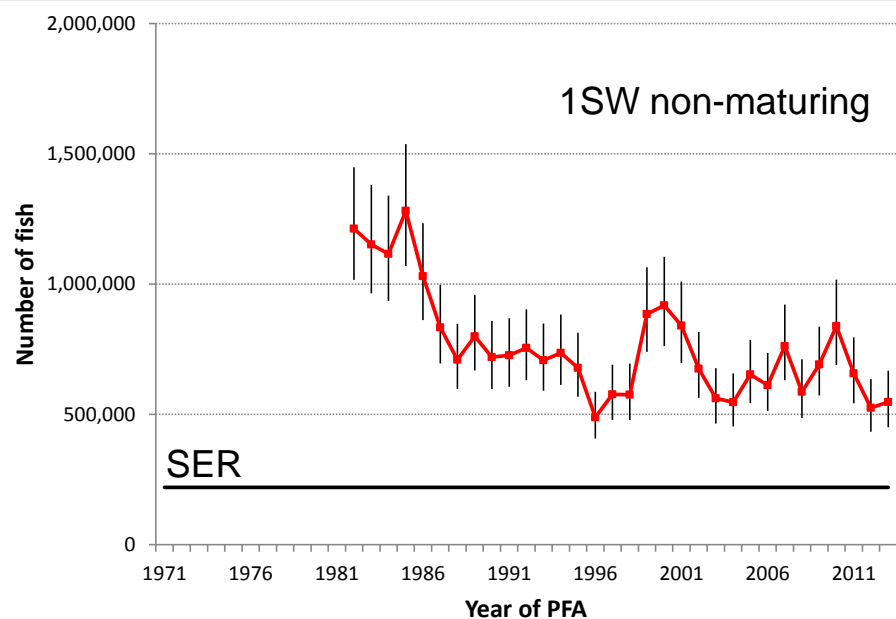
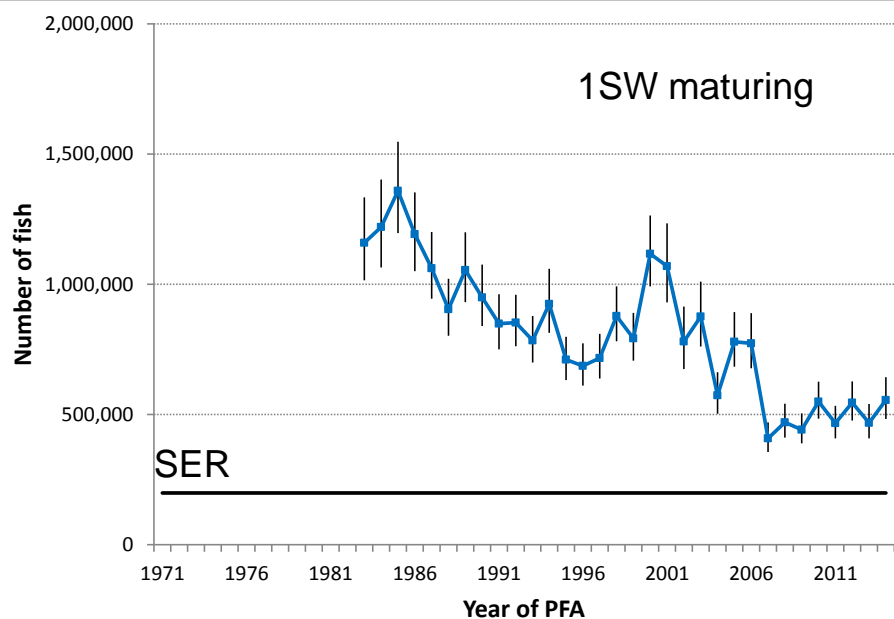
- ❖ PFA = estimated abundance of salmon in first winter at sea (as of 1 Jan)
- ❖ Estimated for 1SW maturing (1SW) and 1SW non-maturing (MSW)
- ❖ Estimated by stock complex (N. NEAC & S. NEAC)

Run reconstruction



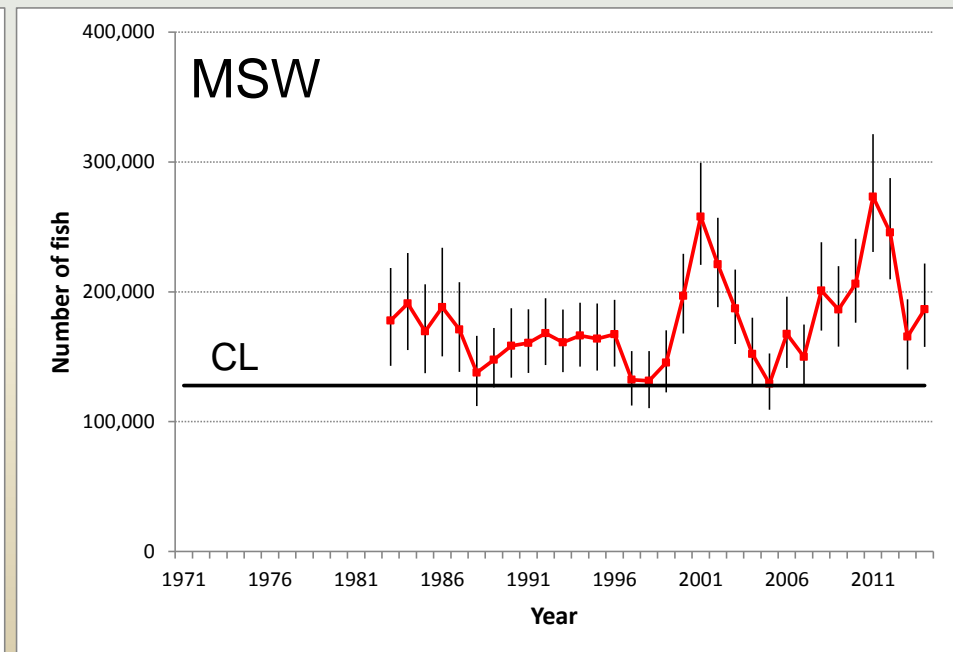
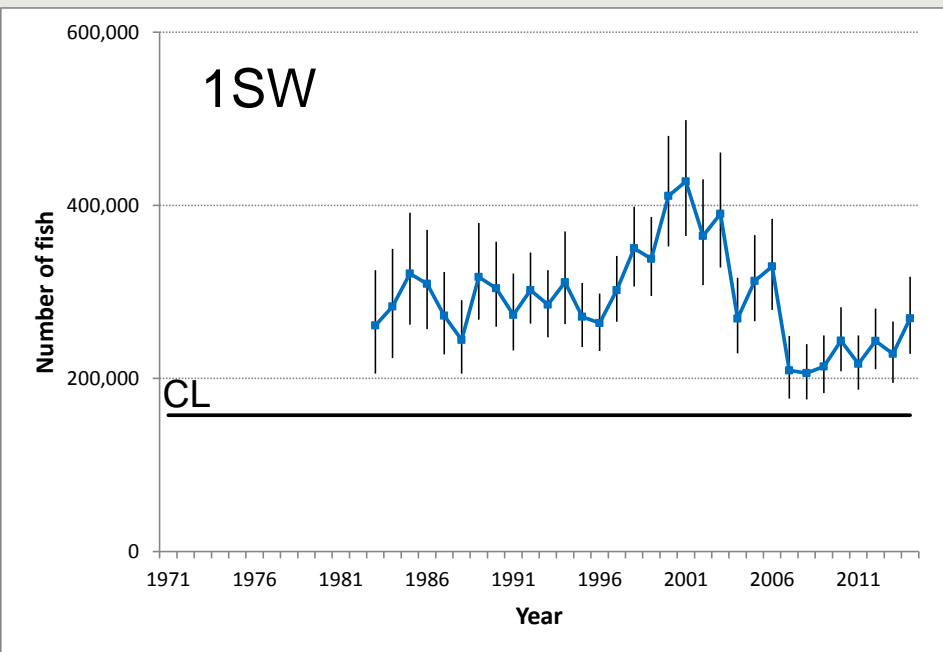
Status of Stocks - Trends in PFA for Northern NEAC

- General decline interrupted by a short period of increased recruitment from 1998 to 2003. Decline more marked in maturing 1SW fish
- Both stock complexes have been at full reproductive capacity prior to the commencement of distant water fisheries throughout time series



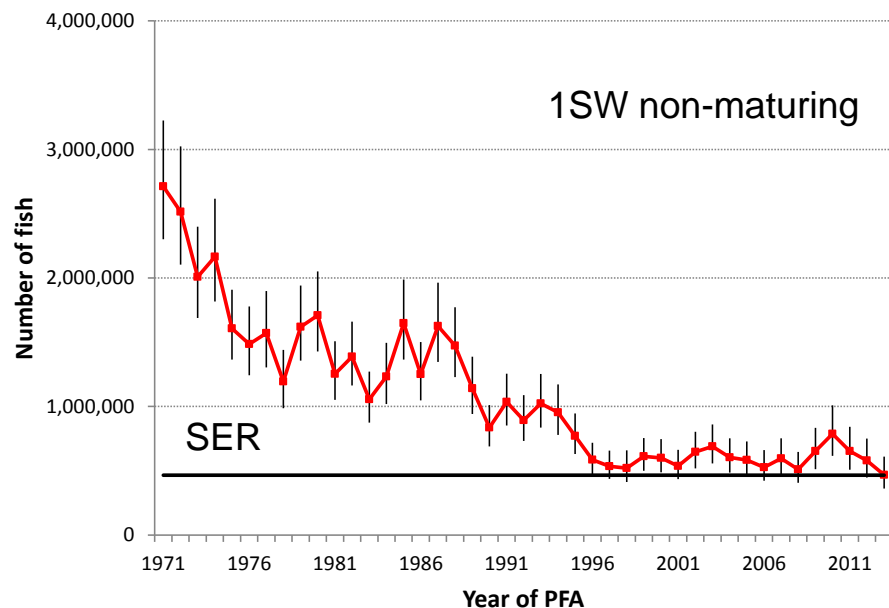
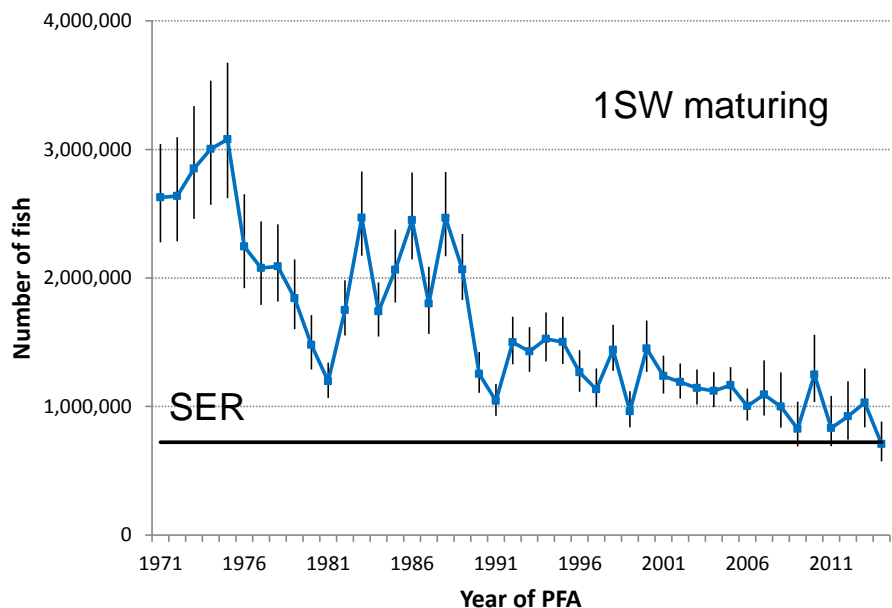
Status of Stocks - Trends in Spawners for Northern NEAC

- 1SW spawners have been at full reproductive capacity throughout the time series, albeit at lower levels in more recent years
- MSW spawners at full reproductive capacity in most years (and consistently in last 7 years), but at risk of suffering reduced reproductive capacity in some earlier years



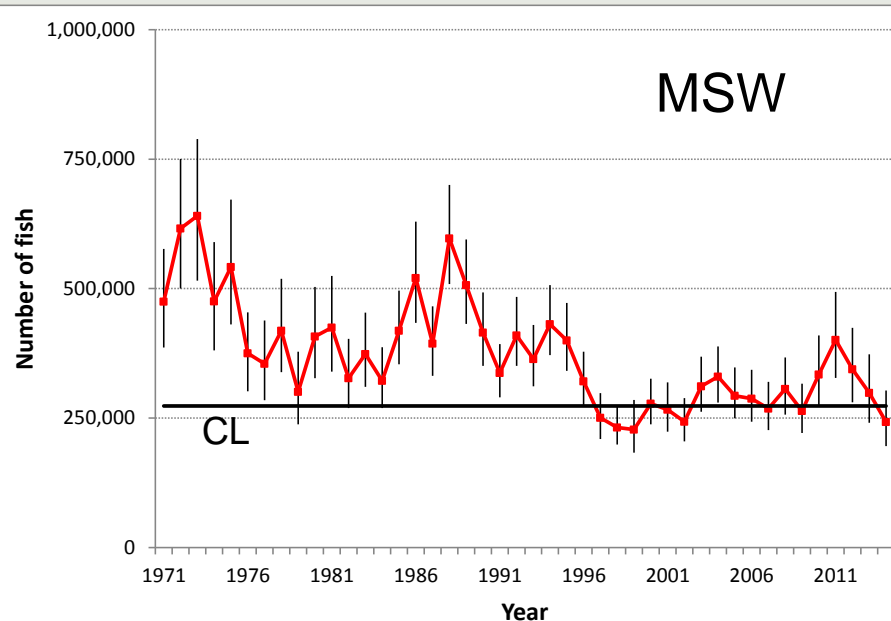
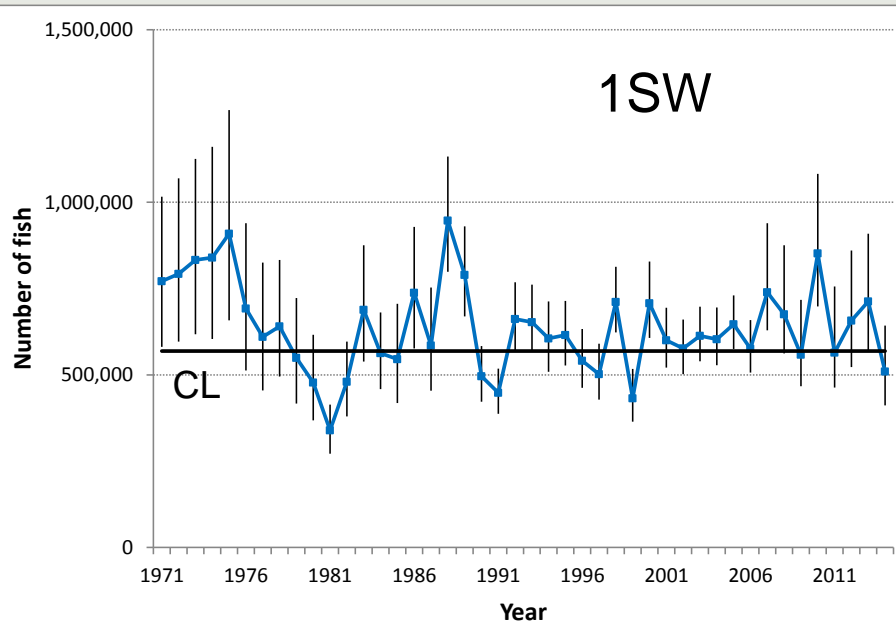
Status of Stocks - Trends in PFA for Southern NEAC

- Marked declines for both age groups
- Maturing 1SW stock at full reproductive capacity prior to commencement of distant water fisheries over most of time period
- Maturing 1SW fish at risk of suffering reduced reproductive capacity for first time in 2009 and suffering reduced reproductive capacity for first time in 2014
- Non-maturing 1SW stock at full reproductive capacity before 1996 but at risk of suffering reduced reproductive capacity in the majority of years since, including the latest PFA year



Status of Stocks - Trends in Spawners for Southern NEAC

- Decline in both 1SW and MSW, but particularly MSW spawners
- 1SW stock has been at risk of suffering reduced reproductive capacity or suffering reduced reproductive capacity for most of the time series
- MSW stock mainly at full reproductive capacity until 1997. Mainly at risk of, or suffering, reduced reproductive capacity since this time
- Both 1SW and MSW below CLs in 2014



Status of Stocks – Country level

Summary of stock assessments for individual countries prior to the commencement of distant water fisheries (PFA) and for spawners for maturing and non-maturing 1SW salmon

	Maturing 1SW		Non-maturing 1SW	
	PFA	Spawners	PFA	Spawners
Southern NEAC				
UK (England & Wales)	Suffering	Suffering	At risk	At risk
UK (Northern Ireland)	At risk	At risk	Full	Full
UK (Scotland)	At risk	At risk	At risk	Suffering
Ireland	Suffering	Suffering	Suffering	Suffering
France	Suffering	Suffering	Full	At risk
Northern NEAC				
Russia	Full	Full	Full	Suffering
Finland	Full	At risk	Full	Suffering
Norway	Full	Full	Full	Full
Sweden	Full	Full	Full	Full
Iceland	Full	Suffering	Full	Full

Compliance with river-specific CLs

Country	No. rivers	No. with CL	No. assessed for compliance	% attaining CL
S. NEAC				
UK (E&W)	64	64	64	19
UK (NI)	15	10	9	44
UK (Scotland)	398	0	0	NA
Ireland	141	141	141	39
France (1SW)	42	33	30	90
France (MSW)	42	33	30	73
N. NEAC				
Russia	112	80	7	86
Finland/Nor	1	1	1	0
Norway	439	439	191	50
Sweden	23	22	22	36
Iceland	100	0	0	NA

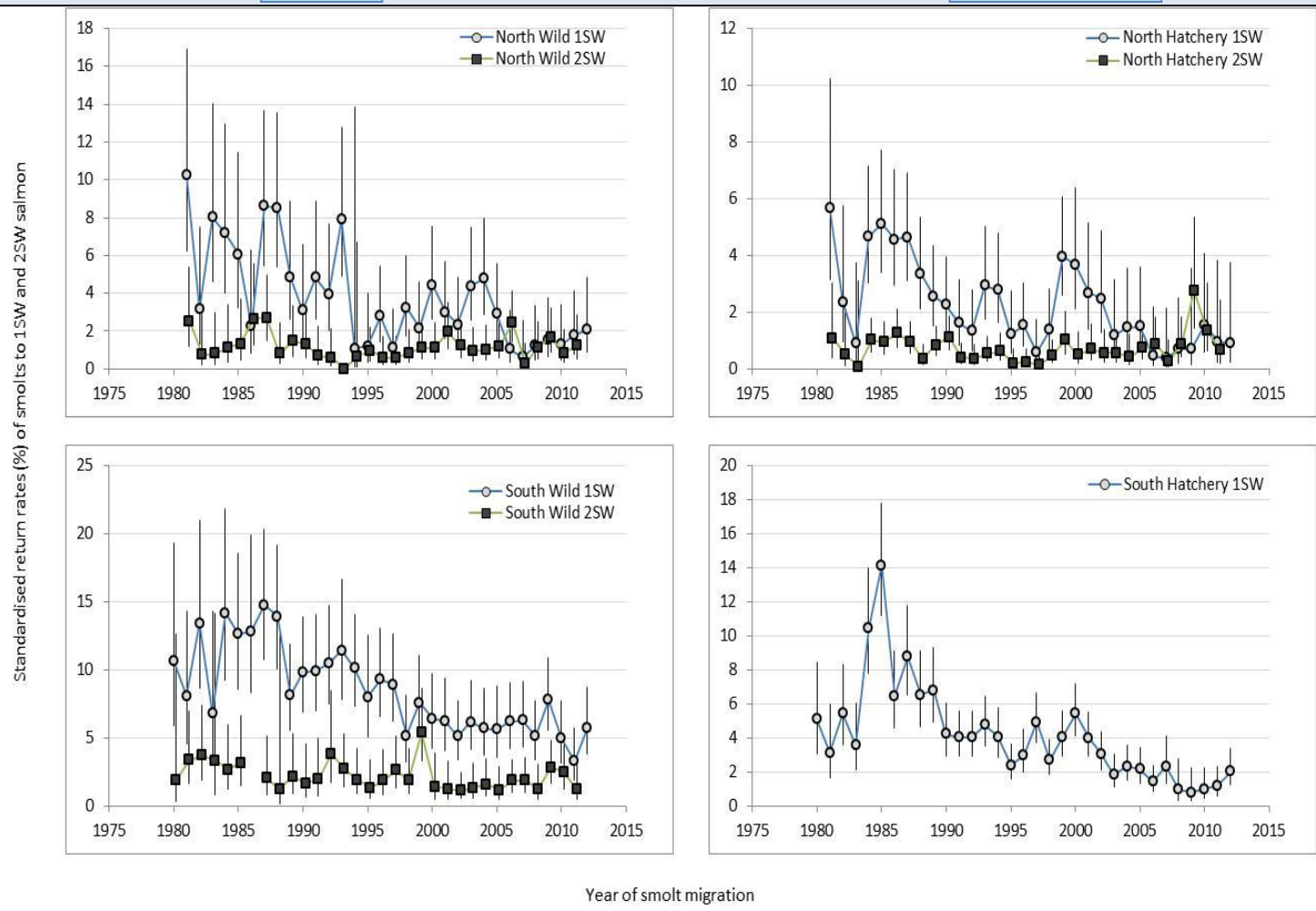
Status of Stocks - Marine Survival

Wild

Hatchery

N NEAC

S NEAC



- General decline in marine survival, particularly marked for 1SW fish
- Broadly consistent with observed declines in PFA - returns influenced strongly by factors in the marine environment

Overview of Status of Stocks

- Despite management measures aimed at reducing exploitation in recent years there has been little improvement in the status of stocks
- The continued low abundance of wild Atlantic salmon is mainly a consequence of continuing poor survival in the marine environment and pressures in freshwater

Catch options & management advice

NASCO has asked ICES to provide catch options or alternative management advice for 2015/16 - 2017/18 fishing seasons, with an assessment of risks relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding.

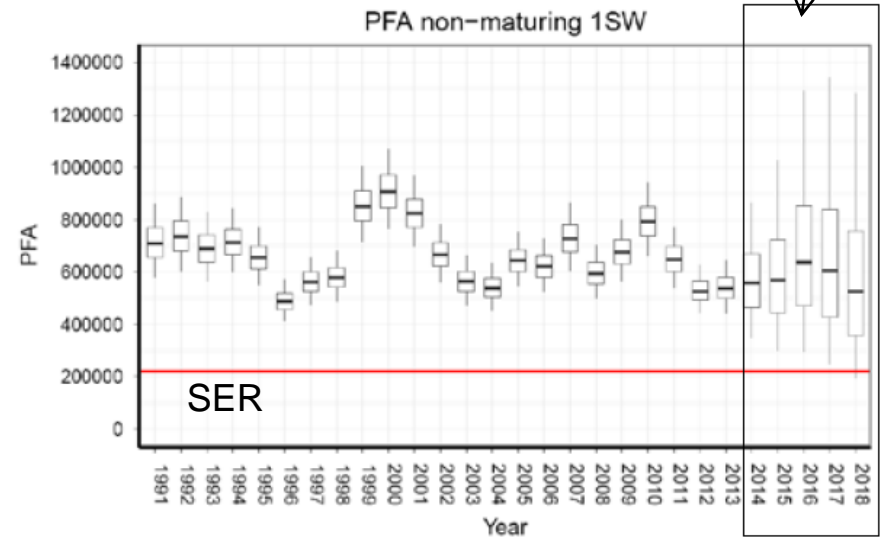
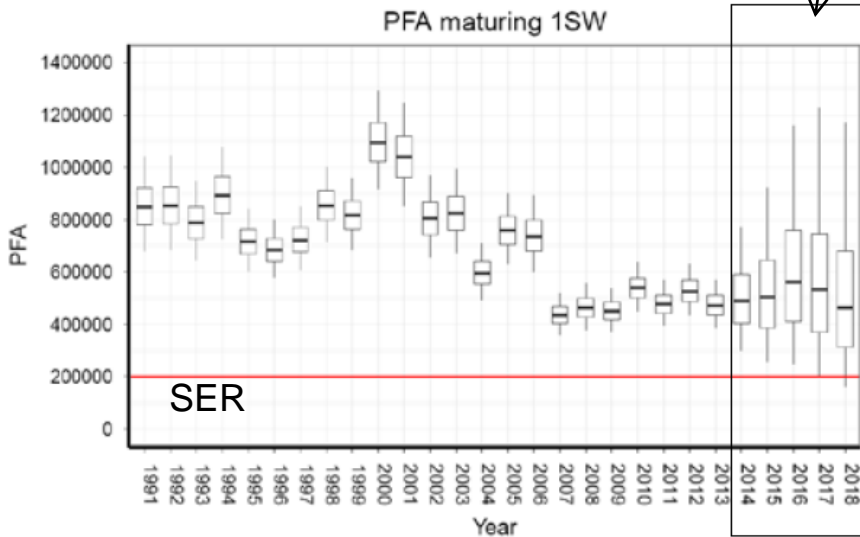
Catch options for 2015/16 - 2017/18 generated using forecast models:

- **Combined sea age models for S. & N. NEAC**
- **Maturing & non-maturing PFA modelled together simultaneously**
- **Same approach used at stock complex and country level**

Northern NEAC PFA Forecast

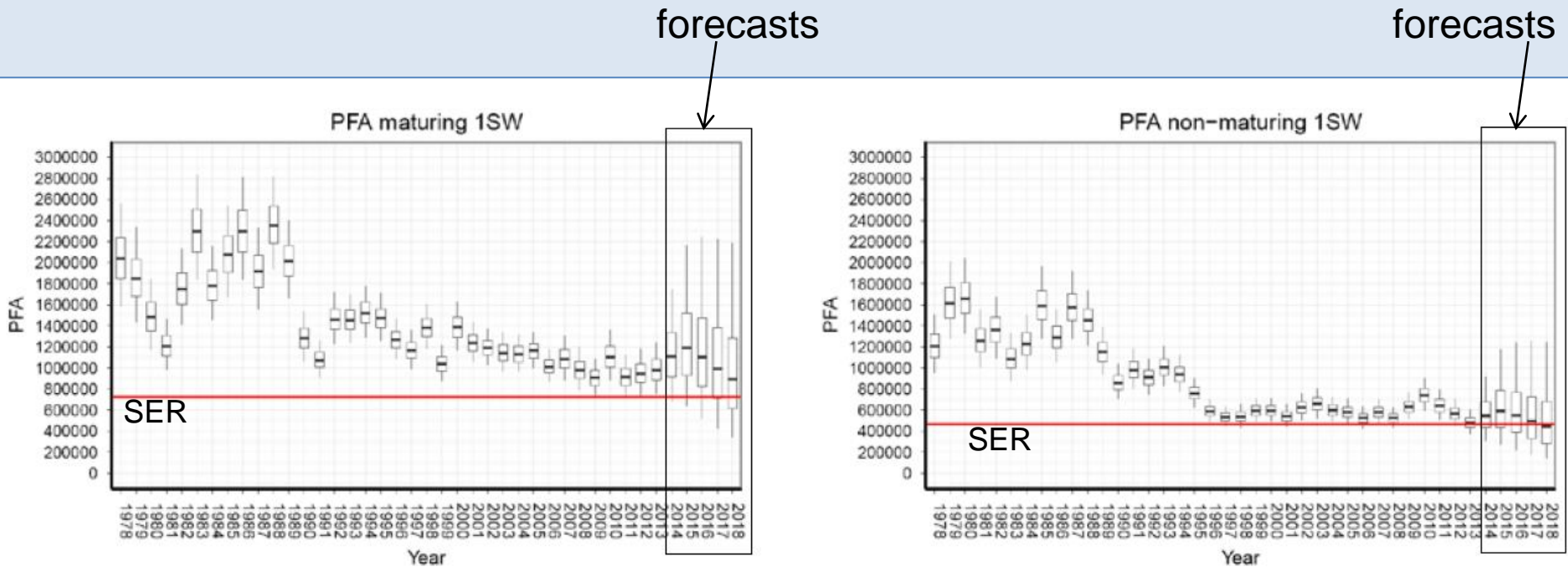
forecasts

forecasts



- Decline in PFA for maturing 1SW – 2013 value among lowest in time series. Non-maturing PFA relatively stable
- 2014 forecasts predicted to be similar to 2013 values, with subsequent small increase to 2016 followed by decline
- Uncertainties increase as forecast years progress
- >95% probabilities of meeting SERs, except in 2018

Southern NEAC PFA Forecast



- Declines in PFA for both maturing & non-maturing fish; 2013 values lowest or among lowest in time series
- Small increase predicted for first 2 forecast years (to 2015), but with subsequent decline; uncertainties increase as forecast years progress
- <95% probabilities of meeting SERs in all forecast years

Probabilities of meeting SERs – stock complexes

Probabilities that forecast PFA greater than SER in 2014 to 2018:

- ❖ S. NEAC 1SW maturing 66-94%
- ❖ S. NEAC 1SW non-maturing 47-69%
- ❖ N. NEAC 1SW maturing 91-100%
- ❖ N. NEAC 1SW non-maturing 93-100%

	Southern NEAC			Northern NEAC	
	1SW Maturing	1SW Non-maturing		1SW Maturing	1SW Non-maturing
SER	723 008	465 646		199 279	219 540
PFA Year	Probability of forecast PFA meeting SER				
2014	0.936	0.692		0.998	0.999
2015	0.912	0.708		0.985	0.989
2016	0.838	0.626		0.979	0.984
2017	0.745	0.541		0.957	0.966
2018	0.657	0.473		0.913	0.925

Probabilities of meeting SERs – countries

N. NEAC Countries

Maturing	Finland	Iceland-NE	Norway	Russia	Sweden
SER	22,819	7,450	81,397	86,086	1,527
PFA Year	Probability of PFA meeting SER				
2014	0.858	0.993	0.994	0.947	0.937
2015	0.642	0.979	0.981	0.897	0.920
2016	0.627	0.954	0.973	0.882	0.937
2017	0.598	0.908	0.947	0.862	0.877
2018	0.608	0.859	0.905	0.769	0.886
Non-Maturing	Finland	Iceland-NE	Norway	Russia	Sweden
SER	23,788	2,788	120,589	70,285	2,090
PFA Year	Probability of PFA meeting SER				
2014	0.809	0.993	0.997	0.963	0.999
2015	0.583	0.975	0.990	0.907	0.996
2016	0.582	0.949	0.985	0.885	0.996
2017	0.556	0.906	0.965	0.862	0.982
2018	0.569	0.858	0.927	0.771	0.980

Probabilities of meeting SERs – countries

S. NEAC Countries

Maturing	France	Iceland-SW	Ireland	UK (E&W)	UK (NI)	UK (Scot)
SER	17,400	17,751	211,471	54,812	21,649	245,912
PFA Year	Probability of PFA meeting SER					
2014	0.383	0.996	0.526	0.500	0.586	0.845
2015	0.355	0.990	0.491	0.515	0.693	0.814
2016	0.398	0.957	0.479	0.442	0.693	0.738
2017	0.416	0.869	0.459	0.397	0.563	0.668
2018	0.387	0.941	0.346	0.322	0.601	0.617
Non-Maturing	France	Iceland-SW	Ireland	UK (E&W)	UK (NI)	UK (Scot)
SER	5,100	1,158	46,943	30,203	2,437	187,518
PFA Year	Probability of PFA meeting SER					
2014	0.807	0.995	0.065	0.852	0.981	0.571
2015	0.714	0.980	0.113	0.811	0.965	0.598
2016	0.710	0.934	0.151	0.723	0.941	0.541
2017	0.700	0.854	0.170	0.652	0.868	0.497
2018	0.648	0.911	0.141	0.557	0.868	0.466

Catch options developed using Faroes risk framework

- ❑ Framework for Faroes catch advice not yet formally adopted by NASCO
- ❑ Initial risk framework developed by ICES in 2010; developed further at subsequent ICES meetings
- ❑ Based on method used for W. Greenland fishery, which involves estimating the uncertainty in meeting defined management objectives at different catch levels (TAC options)
- ❑ A number of decisions required by managers to enable risk framework to be finalised. Specifically:
 - Season (Jan - Dec or Oct - May) to which any TAC should apply;
 - Share arrangement for the Faroes fishery (i.e. the proportion of any harvestable surplus within the NEAC area available to Faroes through the TAC);
 - Choice of management units for NEAC stocks; and
 - Specification of management objectives.

ICES recommendations:

- ☐ **Season** - Fishery managed on the basis of fishing season operating from Oct to June - catch advice provided on this basis.
- ☐ **Share allocation** – apply allocation of 8.4% to Faroes (based on the 1984–1988 baseline period) in the absence of other proposals.
- ☐ **Management Units** - provide catch options tables for the 10 NEAC countries and the 2 stock complexes for the two sea-age groups.
- ☐ **Management Objectives** – management decisions to be based principally on a 95% probability of attainment of CLs for each stock complex individually. Simultaneous attainment probability to be used as a guide.

Latest assessment:

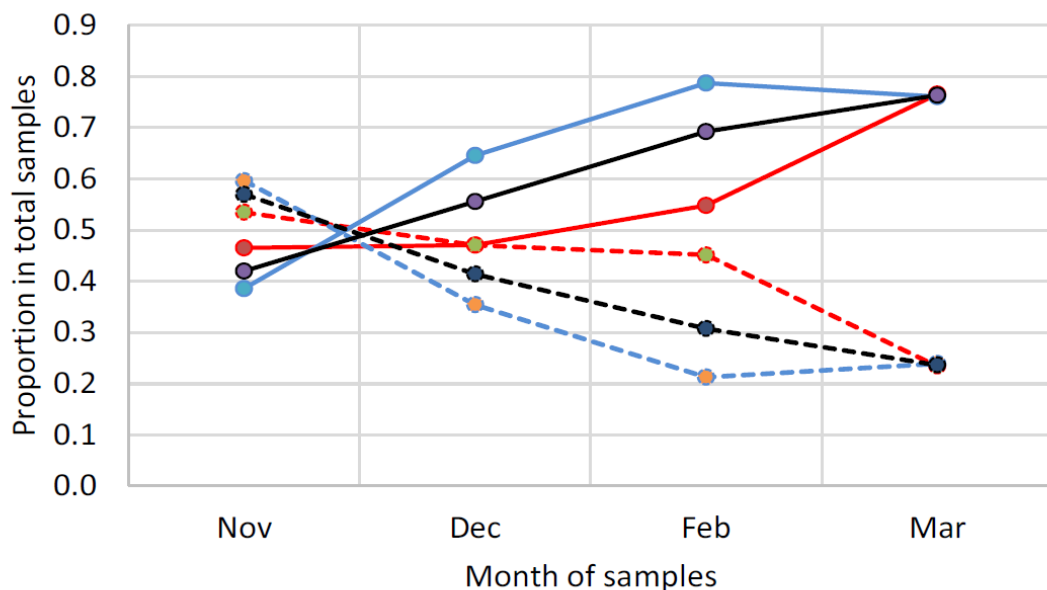
- ☐ **The only change to the assessment method applied previously is the inclusion of revised estimates of the composition of the catch in Faroes based on new genetic results**

New genetic analysis

- New information available on stock composition of salmon catches at Faroes
- DNA extracted from 656 scale samples (87 1SW & 487 MSW non-farm origin fish and 82 farmed escapees) from 1993/94 and 1994/95 research fisheries
- 105 fish (5 1SW & 100 MSW) identified as probably of NA origin
- NA fish - 5.7% of 1SW & 20.5% of MSW non-farmed origin fish in samples
- No seasonal trend of NA fish in catches, so overall percentages used in analyses
- Composition of the European component investigated using the remaining 551 fish (82 1SW and 387 MSW non-farmed origin and 82 farmed)
- Samples assigned using the genetic baseline of European salmon developed during the EU SALSEA-Merge project
- Four assignment levels possible, but at finer resolution do not align closely with the national/regional areas used by ICES for assessing PFA and providing catch advice
- Therefore, not possible to use the genetic results to estimate the composition of the Faroes catch based on the PFA assessment areas (although indicative of broad agreement)

New genetic analysis

- Temporal trend apparent in genetic assignment proportions to N. & S. Europe – increasing proportion of N NEAC fish through season.
- Monthly proportions therefore used to estimate the overall composition for the MSW catch - genetic assignments for Nov & Dec applied to catches for same months; Feb samples to catches in Jan & Feb, and March samples to catches between March and end of fishing season.
- Uncertainties with these new results, but ICES considers these provide better estimates of stock composition of catches as based on larger samples (previously relatively small sample of tagged fish).



Proportions of N. NEAC (solid lines) and S. NEAC (dashed lines) salmon in monthly scale samples collected from non-farmed origin MSW fish caught in the Faroes research fishery in the 1993/94 (blue line) and 1994/95 (red lines) seasons, and for both seasons combined (black lines)

New genetic analysis

Uncertainties

- Samples collected >20 years ago – substantial change in proportions of NA and European fish in catches at W. Greenland since this time.
- Significant proportion of fish sampled at Faroes thought to have been fish farm escapees (based on scale reading). Expected that genetic analysis would assign these fish to Norwegian regions, but 25% assigned to S. NEAC. May reflect absence of farmed fish in baseline, but could also indicate errors in initial identification.
- Samples collected from research fishery. The vessels that were fishing had previously operated in the commercial fishery and fishing methods likely consistent, but differences cannot be discounted entirely.
- Scales only analysed from two seasons in the 1990s. Between 11% and 30% of the samples from eight months were identified as North American, but it is possible that these were not representative years.
- The new results suggest that the overall exploitation rate on NA stock may have been similar to that on the N. NEAC stock complex and considerably higher than that on the S. NEAC stock complex. Surprising finding which requires further validation.

Faroes Catch Options

N. NEAC stock complexes

Have a high probability (>95%) of achieving their CLs for TACs at Faroes of up to ~20t in 2015/16 and 2016/17 seasons, but only non-maturing 1SW will exceed SER in 2017/18 with a TAC of <20t

S. NEAC stock complexes

Both have less than 95% probability of achieving their SERs in each year and at every TAC option

There are therefore no catch options that ensure >95% probability of each stock complex achieving its SER, and none that gives >59% probability of simultaneous attainment of all CLs in all stock complexes.

Catch options for 2015/16	TAC option (t)	NEAC-N- 1SW	NEAC-N- MSW	NEAC-S- 1SW	NEAC-S- MSW	All complexes simultaneous
	0	98%	99%	83%	70%	59%
	20	98%	97%	83%	67%	56%
	40	98%	94%	82%	64%	51%
	60	98%	89%	82%	61%	46%
	80	98%	81%	82%	57%	40%
	100	98%	73%	81%	54%	34%
	120	98%	63%	81%	51%	28%
	140	98%	54%	81%	48%	23%
	160	98%	46%	80%	45%	18%
	180	98%	38%	80%	43%	14%
	200	98%	31%	80%	40%	11%

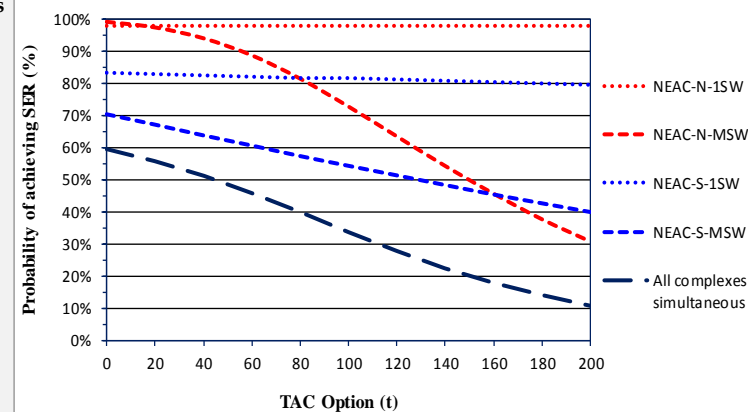
Catch options for 2016/17	TAC option (t)	NEAC-N- 1SW	NEAC-N- MSW	NEAC-S- 1SW	NEAC-S- MSW	All complexes simultaneous
	0	96%	98%	74%	62%	47%
	20	96%	97%	74%	59%	44%
	40	96%	94%	73%	56%	41%
	60	96%	89%	73%	53%	37%
	80	96%	84%	72%	51%	33%
	100	96%	77%	72%	48%	29%
	120	95%	70%	72%	45%	25%
	140	95%	63%	71%	43%	21%
	160	95%	56%	71%	40%	18%
	180	95%	49%	70%	38%	15%
	200	95%	43%	70%	36%	12%

Catch options for 2017/18	TAC option (t)	NEAC-N- 1SW	NEAC-N- MSW	NEAC-S- 1SW	NEAC-S- MSW	All complexes simultaneous
	0	91%	97%	65%	54%	35%
	20	91%	94%	64%	51%	32%
	40	91%	89%	64%	48%	30%
	60	91%	84%	64%	46%	26%
	80	91%	78%	63%	44%	23%
	100	91%	71%	63%	41%	20%
	120	91%	64%	62%	39%	17%
	140	91%	57%	62%	37%	15%
	160	91%	51%	62%	35%	12%
	180	91%	45%	61%	33%	11%
	200	91%	39%	61%	31%	9%

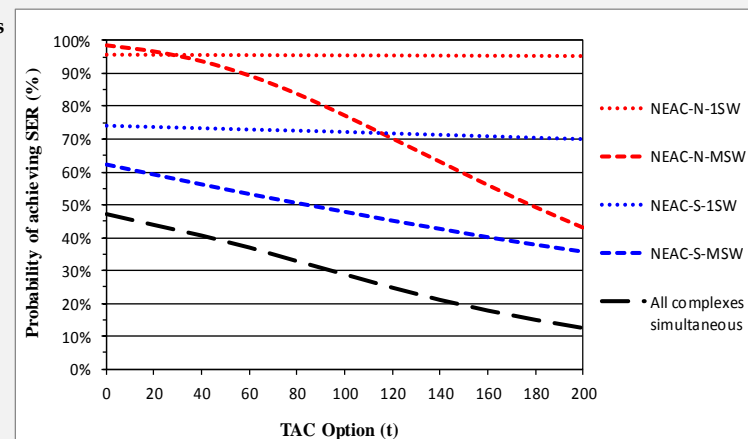
Faroes Catch Options

- Flatness of risk curves for 1SW stocks indicates risk to these MUs is affected very little by harvest at Faroes, mostly because exploitation rate on this stock component in the fishery is very low.

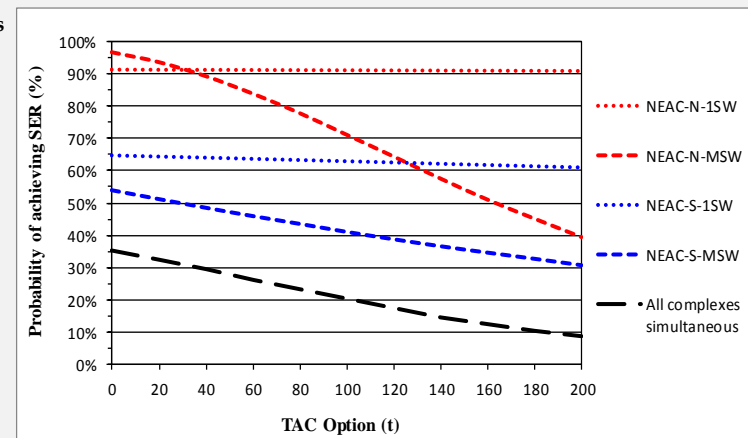
Catch options
for 2015/16
season:



Catch options
for 2016/17
season:



Catch options
for 2017/18
season:



Faroes Catch Options – exploitation rates

- Values for Faroes only (i.e. taking account of share allocation). Total exploitation rate (assuming full exploitation of homewater allocation) would be ~12x higher
- Exploitation rate on maturing 1SW fish is very low

Catch options for 2015/16	TAC option (t)	NEAC-N-1SW	NEAC-N-MSW	NEAC-S-1SW	NEAC-S-MSW
season:	0	0.0%	0.0%	0.0%	0.0%
	20	0.0%	0.7%	0.0%	0.3%
	40	0.0%	1.4%	0.1%	0.5%
	60	0.0%	2.1%	0.1%	0.8%
	80	0.0%	2.8%	0.1%	1.1%
	100	0.0%	3.4%	0.2%	1.4%
	120	0.1%	4.1%	0.2%	1.6%
	140	0.1%	4.8%	0.2%	1.9%
	160	0.1%	5.5%	0.2%	2.2%
	180	0.1%	6.2%	0.3%	2.4%
	200	0.1%	6.9%	0.3%	2.7%

Catch options for 2016/17	TAC option (t)	NEAC-N-1SW	NEAC-N-MSW	NEAC-S-1SW	NEAC-S-MSW
season:	0	0.0%	0.0%	0.0%	0.0%
	20	0.0%	0.6%	0.0%	0.3%
	40	0.0%	1.2%	0.1%	0.6%
	60	0.0%	1.8%	0.1%	0.9%
	80	0.0%	2.5%	0.1%	1.2%
	100	0.0%	3.1%	0.2%	1.5%
	120	0.1%	3.7%	0.2%	1.7%
	140	0.1%	4.3%	0.2%	2.0%
	160	0.1%	4.9%	0.3%	2.3%
	180	0.1%	5.5%	0.3%	2.6%
	200	0.1%	6.2%	0.3%	2.9%

Catch options for 2017/18	TAC option (t)	NEAC-N-1SW	NEAC-N-MSW	NEAC-S-1SW	NEAC-S-MSW
season:	0	0.0%	0.0%	0.0%	0.0%
	20	0.0%	0.7%	0.0%	0.3%
	40	0.0%	1.3%	0.1%	0.6%
	60	0.0%	2.0%	0.1%	1.0%
	80	0.0%	2.6%	0.2%	1.3%
	100	0.1%	3.3%	0.2%	1.6%
	120	0.1%	3.9%	0.2%	1.9%
	140	0.1%	4.6%	0.3%	2.3%
	160	0.1%	5.2%	0.3%	2.6%
	180	0.1%	5.9%	0.3%	2.9%
	200	0.1%	6.5%	0.4%	3.2%

Catch options - NEAC countries

Maturing 1SW

- Probabilities of country stocks achieving SERs in 2015/16 vary between 41% & 99%; probabilities hardly affected by increasing TAC options at Faroes.
- Probability of simultaneous attainment in all 10 stock complexes is <3% in every year.

Catch options for 2015/16 season:	TAC option (t)	Russia	Finland	Norway	Sweden	Iceland	Scotland	N. Ireland	Ireland	England & Wales	France	All 1SW MUs simultaneous
	0	88%	63%	97%	94%	99%	74%	70%	48%	44%	41%	2.2%
	20	88%	63%	97%	94%	99%	74%	70%	48%	44%	41%	2.1%
	40	88%	63%	97%	94%	99%	74%	69%	47%	44%	41%	2.1%
	60	88%	63%	97%	94%	99%	73%	69%	47%	44%	40%	2.1%
	80	88%	62%	97%	94%	99%	73%	69%	47%	43%	40%	2.0%
	100	88%	62%	97%	93%	99%	73%	68%	47%	43%	40%	2.0%
	120	87%	62%	97%	93%	99%	73%	68%	46%	43%	40%	1.9%
	140	87%	62%	97%	93%	99%	72%	68%	46%	43%	40%	1.8%
	160	87%	62%	97%	93%	99%	72%	67%	46%	43%	40%	1.8%
	180	87%	62%	97%	93%	99%	72%	67%	46%	42%	40%	1.8%
	200	87%	62%	97%	93%	99%	71%	67%	45%	42%	40%	1.7%

Catch options for 2016/17 season:	TAC option (t)	Russia	Finland	Norway	Sweden	Iceland	Scotland	N. Ireland	Ireland	England & Wales	France	All 1SW MUs simultaneous
	0	86%	60%	95%	88%	96%	67%	57%	46%	40%	43%	1.3%
	20	86%	60%	95%	88%	96%	67%	56%	46%	40%	42%	1.3%
	40	86%	60%	95%	88%	96%	67%	56%	45%	39%	42%	1.2%
	60	86%	60%	95%	87%	96%	66%	56%	45%	39%	42%	1.2%
	80	86%	60%	94%	87%	96%	66%	55%	45%	39%	42%	1.2%
	100	86%	60%	94%	87%	96%	66%	55%	45%	39%	42%	1.2%
	120	85%	59%	94%	87%	96%	65%	55%	44%	39%	42%	1.1%
	140	85%	59%	94%	87%	96%	65%	54%	44%	38%	42%	1.1%
	160	85%	59%	94%	87%	96%	65%	54%	44%	38%	42%	1.1%
	180	85%	59%	94%	87%	96%	65%	54%	44%	38%	41%	1.1%
	200	85%	59%	94%	87%	96%	65%	54%	44%	38%	41%	1.0%

Catch options for 2017/18 season:	TAC option (t)	Russia	Finland	Norway	Sweden	Iceland	Scotland	N. Ireland	Ireland	England & Wales	France	All 1SW MUs simultaneous
	0	77%	61%	90%	89%	98%	62%	61%	34%	32%	39%	0.6%
	20	76%	61%	90%	89%	98%	62%	60%	34%	32%	39%	0.6%
	40	76%	61%	90%	88%	98%	61%	60%	34%	32%	39%	0.6%
	60	76%	61%	90%	88%	98%	61%	60%	34%	32%	39%	0.5%
	80	76%	61%	90%	88%	98%	61%	59%	34%	32%	39%	0.5%
	100	76%	61%	90%	88%	98%	61%	59%	33%	31%	39%	0.5%
	120	76%	60%	90%	88%	98%	60%	59%	33%	31%	39%	0.5%
	140	76%	60%	90%	88%	98%	60%	59%	33%	31%	39%	0.5%
	160	76%	60%	90%	88%	98%	60%	58%	33%	31%	39%	0.4%
	180	76%	60%	90%	88%	98%	60%	58%	33%	31%	39%	0.4%
	200	76%	60%	90%	88%	98%	59%	58%	33%	30%	38%	0.4%

Catch options - NEAC countries

Non-maturing 1SW (MSW)

➤ Probabilities of achieving CLs in 2015/16 vary between 11% & 100%, with decreasing probabilities for increasing TAC options at Faroes.

➤ Probability of simultaneous attainment in all 10 complexes is <2% in every year.

Catch options for 2015/16 season:	TAC option (t)	Russia	Finland	Norway	Sweden	Iceland	Scotland	N. Ireland	Ireland	England & Wales	France	All MSW MUs simultaneous
	0	91%	58%	99%	100%	100%	60%	97%	11%	81%	71%	1.9%
	20	85%	50%	97%	99%	100%	58%	96%	11%	80%	70%	1.3%
	40	77%	43%	95%	99%	100%	56%	95%	10%	78%	69%	0.9%
	60	68%	37%	91%	98%	99%	53%	95%	10%	76%	67%	0.6%
	80	60%	32%	86%	97%	99%	51%	94%	10%	74%	66%	0.3%
	100	51%	28%	80%	96%	98%	49%	93%	9%	72%	64%	0.2%
	120	43%	24%	74%	94%	98%	47%	93%	9%	70%	63%	0.1%
	140	36%	21%	67%	93%	97%	45%	92%	9%	69%	62%	0.1%
	160	29%	19%	60%	91%	96%	43%	91%	9%	67%	60%	0.0%
	180	24%	16%	54%	89%	95%	41%	90%	8%	65%	59%	0.0%
	200	19%	14%	48%	87%	94%	39%	89%	8%	63%	58%	0.0%

Catch options for 2016/17 season:	TAC option (t)	Russia	Finland	Norway	Sweden	Iceland	Scotland	N. Ireland	Ireland	England & Wales	France	All MSW MUs simultaneous
	0	89%	58%	99%	100%	99%	54%	94%	15%	73%	71%	1.8%
	20	83%	52%	97%	99%	99%	52%	93%	15%	70%	70%	1.4%
	40	77%	46%	95%	99%	98%	50%	93%	14%	68%	68%	1.0%
	60	70%	41%	92%	98%	97%	48%	92%	14%	66%	67%	0.7%
	80	63%	37%	88%	97%	97%	46%	91%	13%	65%	66%	0.4%
	100	55%	33%	84%	97%	95%	44%	90%	13%	63%	65%	0.3%
	120	49%	29%	80%	96%	94%	42%	90%	13%	61%	64%	0.2%
	140	43%	26%	75%	95%	93%	41%	89%	12%	59%	63%	0.1%
	160	37%	24%	70%	93%	92%	39%	88%	12%	57%	62%	0.1%
	180	32%	21%	65%	92%	90%	38%	87%	12%	55%	61%	0.1%
	200	27%	20%	61%	91%	89%	36%	86%	12%	54%	60%	0.0%

Catch options for 2017/18 season:	TAC option (t)	Russia	Finland	Norway	Sweden	Iceland	Scotland	N. Ireland	Ireland	England & Wales	France	All MSW MUs simultaneous
	0	87%	56%	97%	98%	97%	50%	87%	17%	66%	70%	1.5%
	20	81%	50%	94%	97%	96%	48%	86%	17%	63%	69%	1.0%
	40	75%	45%	90%	96%	95%	46%	84%	16%	61%	68%	0.7%
	60	68%	40%	86%	94%	93%	44%	83%	16%	59%	66%	0.5%
	80	62%	37%	82%	93%	91%	42%	82%	16%	58%	65%	0.4%
	100	56%	33%	77%	92%	90%	41%	80%	15%	56%	65%	0.3%
	120	50%	30%	72%	90%	88%	39%	79%	15%	54%	64%	0.2%
	140	45%	27%	67%	88%	86%	38%	78%	14%	52%	63%	0.1%
	160	40%	25%	62%	86%	84%	36%	77%	14%	51%	62%	0.1%
	180	35%	23%	58%	85%	82%	35%	76%	14%	49%	61%	0.1%
	200	31%	21%	53%	83%	80%	33%	75%	14%	47%	60%	0.0%

Catch advice

- ☐ In the absence of any fisheries in the fishing seasons 2015/2016 to 2017/2018, there is a less than 95% probability of meeting the CLs for the two age groups of the S. NEAC stock complex.
- ☐ Therefore, in the absence of specific management objectives, ICES advises that there are no mixed-stock fisheries options on the NEAC complexes at the Faroes in the fishing seasons 2015/2016 to 2017/2018.
- ☐ In the absence of any fisheries in these seasons, the probabilities of individual countries meeting their CLs range from 32% to 99% for maturing 1SW salmon and 11% to 100% for salmon maturing as MSW.

Relevant factors to be considered in management

- ❖ ICES advises that when the MSY approach is applied, fishing should only take place on salmon from rivers where stocks have been shown to be at full reproductive capacity.
- ❖ Because of the different status of individual stocks within stock complexes, mixed-stock fisheries present particular threats.
- ❖ The management of a fishery should ideally be based upon the status of all river stocks exploited in the fishery.

Larger number of N. American fish than previously thought may have been caught in Faroes in the past. NA fish not taken into account in current catch advice pending a decision from NASCO on how they wish this to be undertaken

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

Consider implications of the new genetic results with regard to factors previously identified by ICES as requiring management decisions for the finalisation of the risk framework for the provision of catch advice for the Faroes fishery:

- annual or seasonal catch advice;*
- sharing agreement;*
- choice of management units;*
- specified management objectives.*

North American fish at Faroes

- Previous studies have indicated some NA fish migrate to NE Atlantic (e.g. tag recoveries, ^{137}Cs)
- Recent genetic investigations of salmon caught in Faroes fishery in 1990s indicate that proportion of NA fish may be greater than previously thought
- Scales from 1993/94 and 1994-/95 research fishery suggest 5.7% of 1SW and 20.5% of MSW fish may be from NA
- Requires further confirmation, but WG recognised this provided best available estimate

North American fish at Faroes

New information has implications for assessment of PFA for both NEAC & NAC

NEAC

- Previously estimated that no 1SW, but 2.5% MSW were from NA. Since 2012, 2.5% removed from MSW catch before estimating NEAC PFA and developing catch advice.
- Proportions now increased to 5.7% 1SW & 20.5% MSW.
- This has reduced estimated catch of European stocks in the fishery and has consequently reduced estimated PFA of non-maturing 1SW salmon in the NEAC area by up to 2% in early 1980s (when Faroes fishery at its height).
- PFA unaffected since 2001, as no fishery has operated.

NAC

- No account currently taken of NA fish in Faroes when estimating PFA of NA stocks.
- Based on new proportions, an average of 270 1SW and 23,700 MSW NA origin fish would have been caught each season between 1983/84 and 1990/91.
- Including these fish in assessments would increase the estimated PFA of maturing 1SW salmon by an average of ~330 fish between 1984 and 1995 and for non-maturing 1SW fish by an average of ~28,800 between 1983 and 1994.
- PFA unaffected since 2001, as no fishery has operated.

Choice of Management Units

- NEAC stock complexes are much larger than NA MUs (2SW only) used for WG and ICES has advised that NEAC catch advice should ideally be based on smaller MUs
- Method developed for estimating catch contribution at Faroes previously based on tag returns & PFA estimates to enable risk framework at country level
- New genetic results provide better estimates of contribution of European fish in Faroes catches.

Future options:

Option 1 - Continue using only NEAC MUs

- ❖ remove NA fish from each TAC option
- ❖ estimated catches from Europe would be reduced because of higher NA proportion
- ❖ could still take account of NA fish as an additional consideration in the management advice, but outside the risk framework

North American fish at Faroes

Option 2 - Add NA as single 'region' in risk framework

- ❖ could add single NA 'region' with either one (MSW only) or two (1SW & MSW) MUs
- ❖ only MSW fish considered in the W. Greenland framework and this may also be appropriate for Faroes
- ❖ PFA forecast for NA included in risk framework in same way as NEAC MUs and advice provided in same format (i.e. extra column in catch options table)

Option 3 - Add six NA 'regions' in risk framework

- ❖ as above, but NA would be split into the 6 regions currently used for WG catch advice resulting in either 6 (MSW only) or 12 (1SW & MSW) new MUs (could be interim levels if no fish from some regions)
- ❖ only MSW fish considered in the W. Greenland framework and this may also be appropriate for Faroes
- ❖ At present very limited information on regional composition, so not appropriate to adopt this option without further information (planned genetic investigations will start to address this)

ICES considers option 2 may be most appropriate at the current time

Specification of Management Objectives

- MOs provide basis for determining the risks to stocks in each MU.
- ICES currently provides catch option tables based on probabilities of each MU meeting or exceeding its SER individually and the probability of simultaneous attainment of all MUs meeting objectives.
- ICES has recommended that management decisions should be based principally on a 95% probability of attainment of SERs in each MU.
- If a N American MU was added, the same management objective would apply to each MU – e.g. if added as single stock complex this could be based on sum of region CLs / stock rebuilding targets.

Share allocation for Faroes fishery

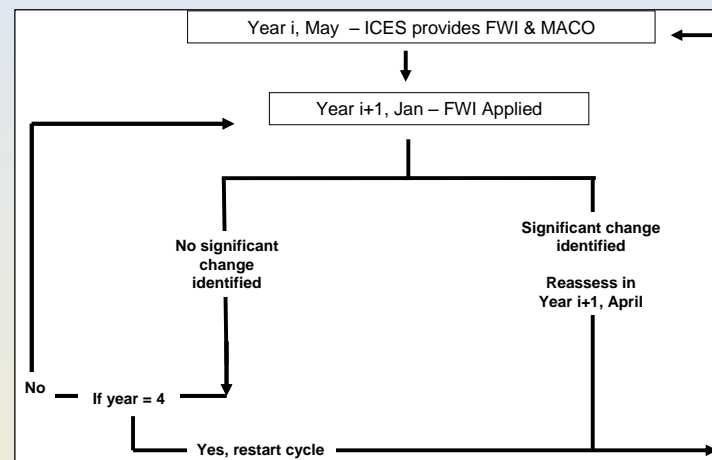
- Establishes the proportion of any harvestable surplus within the NEAC area that could be made available to the Faroes fishery through the TAC.
- For any TAC option at Faroes, the risk assessment is based on the total harvest (Faroes + homewaters).
- ICES proposed that same approach could be used as for W. Greenland (proportion of NA fish taken at WG during baseline period -1986 to 1990).
- ICES originally proposed same baseline period for Faroes (7.5%), this modified, following discussion with NASCO, to suggested 1984-88 baseline (8.4%). This value applied subsequently.
- A share agreement on this basis (i.e. excluding NA fish) is not affected by the new genetic results.
- If one or more NA MUs included in risk framework, share agreement could continue to be based on European fish (as with WG approach), or it could be based on total catch taken at Faroes from all MUs during a reference period. Alternatively, two share allocations could be agreed for NAC / NEAC.

Season to which any TAC should apply

- Fishery has historically operated between Oct/Nov and May/June, but historical TACs applied to calendar year.
- As such, two different cohorts were exploited under each TAC.
- ICES recommended managing a fishery on the basis of fishing seasons (i.e. Oct to June) and catch advice is provided on this basis.
- New genetic results have no implications for this decision.

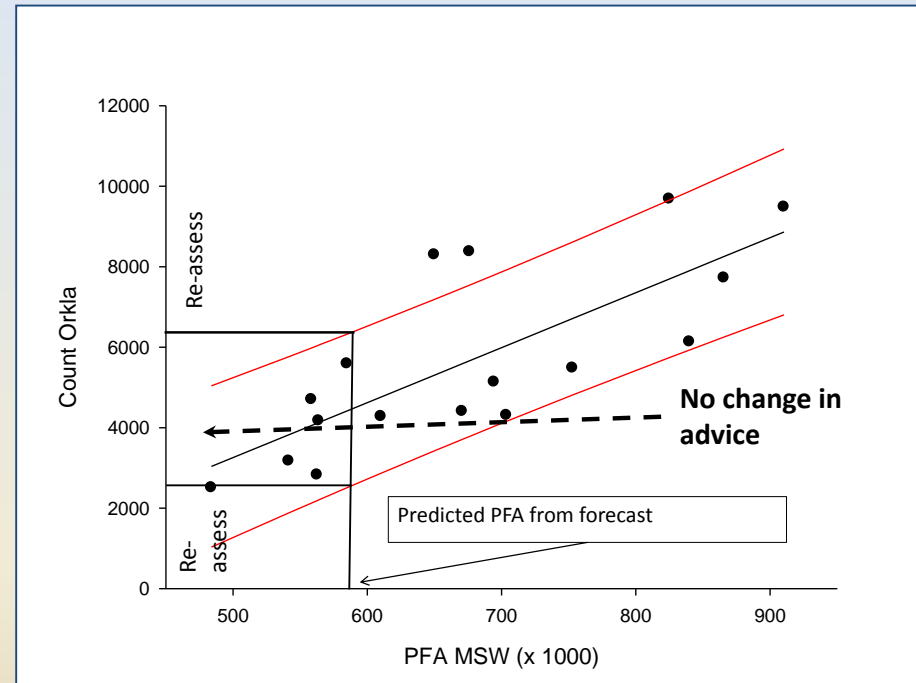
NASCO has asked ICES to update the FWI used to identify any significant change in the previously provided multi-annual management advice

- FWI applied in January to provide check on previous catch advice
- If significant change identified, then ICES would provide updated catch advice; otherwise existing advice continues to apply
- FWI developed by ICES in 2012 and first applied in Jan 2013 to evaluate the appropriateness of the 2013/2014 advice.
- 2013 FWI signaled a reassessment as suggested PFA forecast had been over-estimated.
- FWI modified in 2013 to include a rule that if the fishery is open, a 2-sided test should be applied, while if the fishery is closed a 1-sided test is appropriate. The rationale was that if the fishery is closed there is no reason to reassess if the FWI suggests that the PFA forecast is an overestimate.
- FWI applied again in Jan 2014 in relation to 2014/2015 advice. No reassessment.



NEAC Framework of Indicators (FWI)

- Based on relationship between various indicator data sets (e.g. counts, return rates) and PFA
- Regression relationships explored to determine power of indicator to predict PFA in forecasted years
- Binary scores applied to each indicator value. Indicators outside the CIs (below or above) score 1. Those within the CIs score -1. [Zero if no data]
- Binary scores summed separately for each stock complex and age group
- A score of ≥ 0 for any of the stock complexes would signal a reassessment (but only if an under-estimation indicated in event of a closed fishery)



Progress in 2015

- FWI updated – some new indicator variables explored, some discontinued and removed. All others updated and re-examined to assess whether they were ‘informative’
- Criteria for inclusion:

- at least 10 data points;
- $R^2 > 0.2$ for regression between indicator & PFA;
- regression significant at 0.05 probability level;
- data available in mid January.

- Updated spreadsheet FWI set up and includes:

N. NEAC

6 x 1SW indicators

S. NEAC

5 x MSW indicators

7 x 1SW indicators

10 x MSW indicators

- FWI available for use in 2016 and 2017 to enable intermediate assessments if new multi-annual agreement in place.

[illegible]

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

Data to improve catch options

Data currently used to characterise Faroes fishery

PARAMETER	DERIVATION
Mean weight of salmon in the fishery	Based on values observed in the 1985/1986 to 1990/1991 fishing seasons
Proportion by sea age	Estimated from scale samples collected in the fisheries between 1985/1986 and 1990/1991.
Discard rates	Estimated from proportions of fish <60 cm in catch samples between 1982/1983 and 1994/1995 seasons
Mortality rates of discarded fish	Estimated from experimental fisheries during 1985/1986 to 1990/1991 fishing seasons.
Proportions of fish-farm escapees	Estimated from samples taken in 1980/1981 to 1994/1995 fishing seasons, corrected to take account of the reduction in the proportion of farm escapees in Norwegian coastal waters between 1989 and 2008.
The proportion of the 1SW catch that will not mature as 1SW fish	Derived from samples collected in the fisheries between 1985/1986 and 1990/1991.
Proportions of catches by management unit	Genetic analysis of scales from fisheries in 1993-95 used to assign catch to stock complexes. Within NEAC stock complexes, relative PFA estimates between 2001 and 2013 used to assign catch to countries.

Uncertainties in genetic analysis

- Samples collected >20 years ago – substantial change in proportions of NA and European fish in catches at W. Greenland since this time.
- Significant proportion of fish sampled at Faroes thought to have been fish farm escapees (based on scale reading). Expected that genetic analysis would assign these fish to Norwegian regions, but 25% assigned to S. NEAC. May reflect absence of farmed fish in baseline, but could also indicate errors in initial identification.
- Samples collected from research fishery. The vessels that were fishing had previously operated in the commercial fishery and fishing methods likely consistent, but differences cannot be discounted entirely.
- Scales only analysed from two seasons in the 1990s. Between 11% and 30% of the samples from eight months were identified as North American, but it is possible that these were not representative years.
- The new results suggest that the overall exploitation rate on NA stock may have been similar to that on the N. NEAC stock complex and considerably higher than that on the S. NEAC stock complex. Surprising finding which requires further validation.

Data to improve catch options

For Faroes fishery data, improvements possible from:

- ☐ Application of new techniques to existing samples (e.g. genetics)
- ☐ Contemporary data from new sampling programme

The following improvements would also enhance the development of catch options:

- ☐ Improvements in estimates for data inputs used in PFA run-reconstruction and forecast models
- ☐ Improvements in modelling process (e.g. incorporating more reliable abundance indicators)
- ☐ More countries able to provide river-specific CLs
- ☐ Estimates of M which more accurately characterise variation over time or partition mortality through the life-cycle

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/publications/library>**

Acknowledgements

**Members (24) of participating countries (10) to the Working
Group on North Atlantic Salmon, 17-26 March 2015,
Moncton, Canada**

NEAC sub-group chair: Jaakko Erkinaro (Finland)