

REPORT ON STATUS OF STOCKS IN 2007

3. STATUS OF STOCKS

3.1 *Measures of abundance/escapement*

3.1.1 *Adult fish returning to rivers*

Electronic fish counters are operated on a number of catchments in England and Wales to provide estimates of the upstream run of adult salmon and sea trout. Where it is possible to separate the species, the counts have been adjusted to provide estimates of the numbers of returning salmon, and values for several counters in some years have also been adjusted retrospectively to accommodate new efficiency estimates. In 2007, the time series of counts for the River Fowey have been corrected to provide salmon-only values (previously these data had included large sea trout). Time-series of counts, or other estimates of in-river stocks, are presented in Table 27 and Figure 12.

Data for 2007 show that runs into freshwater were below the recent 5-year mean in 9 of the 11 catchments for which data are available. Over the available time series, data show a recent increasing trend on some rivers (Tees, Fowey, Lune and Kent), no substantive change in others (Dee, Tamar, Test and Caldew), and a declining trend in others (Thames, Itchen and Frome). Only one salmon was recorded in the adult trap on the Thames in 2007.

There have been growing concerns about increasing levels of salmon mortality at sea. However, few data are available to evaluate long-term trends in marine survival for salmon stocks in England and Wales. Marine survival estimates for the River Corrib (Ireland), River Bush (Northern Ireland) and River North Esk (Scotland) are shown in Table 28 (data from ICES, 2007). These data confirm patterns seen elsewhere in the North Atlantic, which indicate that marine survival can be quite variable between stocks and between years, but has generally decreased since 1987. Shorter time series for the Rivers Dee (Wales) and Tamar are also included in Table 28, together with the 95% confidence limits. These indicate similar low levels of marine survival in recent years.

3.1.2 *Spawning escapement*

ICES and NASCO require countries with natural stocks of Atlantic salmon to set criteria against which to give advice on stock status and to manage and conserve individual river stocks. In England and Wales, conservation limits (CLs) have been developed that indicate the minimum spawning stock levels below which stocks should not be allowed to fall. Full details of the process for setting CLs and assessing compliance with these biological reference points are given in Annex 2. The CL for each river is set at a stock size (defined in terms of eggs deposited – Table 29) below which further reductions in spawner numbers are likely to result in significant reductions in the number of juvenile fish produced in the next generation. In reviewing management options and regulations, the Environment Agency also uses an over-arching management objective that a river's stock should be meeting or exceeding its CL in at least four years out of five (i.e. >80% of the time). A management target (MT) is set for each river, representing a spawning stock level for managers to aim at in order to meet this objective: CLs and MTs for 64 principal salmon rivers are provided in Table 29.

Table 27. Validated counts and run estimates of salmon smolts and adults in rivers, 1986-2007.

Stage:	Smolts				Adults							
Region:	Southern	Thames	Southern		SW			Wales	NW		NE	
River:	Test#	Thames#	Test	Itchen	Frome	Tamar	Fowey	Dee	Lune	Kent	Caldew	Tees
Method:	Run estimate	T	RSE ¹	RSE ¹	RSE ¹	RSE ¹	C	RSE ²	RSE ¹	RSE ¹	T**	T***
1986		81										
1987		41										
1988		288	1,507	1,336	3,614							
1989		91	1,730	791	3,156				4,931	1,137		
1990		63	790	367	1,917				5,311	2,216		
1991		36	538	152	861				5,277	1,736		
1992	11,967	247	488	305	871			4,643	3,916	1,816		
1993	7,131	259	920	646	1,291			9,757	7,586	1,526		
1994	3,381	143	618	311	1,141	6,359		5,285	5,970	2,072	1,461	
1995	6,853	162	517	798	1,102	5,637	756	5,703	4,437	2,762	1,456	87
1996	4,712	122	515	386	1,499	3,988	669	4,931	4,605	3,246	1,202	98
1997	7,229	25	317	232	1,207	2,989	467	5,496	3,121	1,473	831	125
1998	14,672	6	748	412	1,307	4,176	521	6,661	7,457	2,166	1,042	224
1999	4,085	35	777	207	827	3,588	713	3,664	4,846	1,023	969	141
2000	3,516	53	537	204	660	3,539	745	3,751	8,262	2,354	1,288	152
2001	2,625	9	408	214	672	4,184	717	4,766	6,195	2,882		163
2002	2,190	22	1,046	239	883	6,053	935	7,216	7,603	3,149	1,231	239
2003	7,585	18	367	169	582	4,835	741	4,915	6,895	2,741	759	126
2004	5,024	7	1,129	410	715	4,938	1,301	7,123	12,781	2,982	1,579	571
2005	7,580	0	1,117	411	550	4,921	1,046	5,435	9,824	3,082	1,031	171
2006	6,118	0	1,058	419	754	4,821	930	5,663	7,443	2,625	1,242	209
2007 *	13,400	1	646	301	655	3,599	796	5,839	11,166	2,304	1,017	422
Mean (2002-06)	5,699	9	943	330	697	5,114	991	6,070	8,909	2,916	1,143	263

*Key to methods:**T = adult trap.**C = adult salmon count.**RSE¹ = returning stock estimate (validated count + catch below counter).**RSE² = returning stock estimate (mark/recapture estimate).**Key: # Denotes stock supported by large-scale stocking from hatchery programme.*** Provisional**** Data adjusted for multiple entry (re-entry rate of 6.6% in 2002). Data relate to spawning year, i.e. 12 month period from March to February***** Index of run only - based on adult trap in barrage.**Note: Some data corrected from those reported previously.*

Annual compliance with the CL is estimated using egg deposition figures derived from returning stock estimates (Table 27), where such data are available. For rivers without traps or counters, the usual procedure for estimating egg deposition derives run size from rod catch using estimates of exploitation, which do not take into account annual changes in fishing effort. In years when effort was low - such as the 'low-flow' year of 2003 and the foot-and-mouth disease year of 2001 - this approach has probably resulted in rod exploitation being over-estimated on a number of rivers and hence escapement and egg deposition being under-estimated. An improved procedure is being developed by the Environment Agency to take account of annual changes in fishing effort, as well as partitioning effort between salmon and sea trout (no distinction is currently made between these species when reporting fishing effort, but see analysis in Section 1.2.4). This procedure will be used to improve assessments in future reports. Many rivers, and particularly some of the smaller catchments on the west coast of Wales, support relatively small salmon stocks and are principally regarded as sea trout rivers. Current procedures may also fail to take adequate account of this.

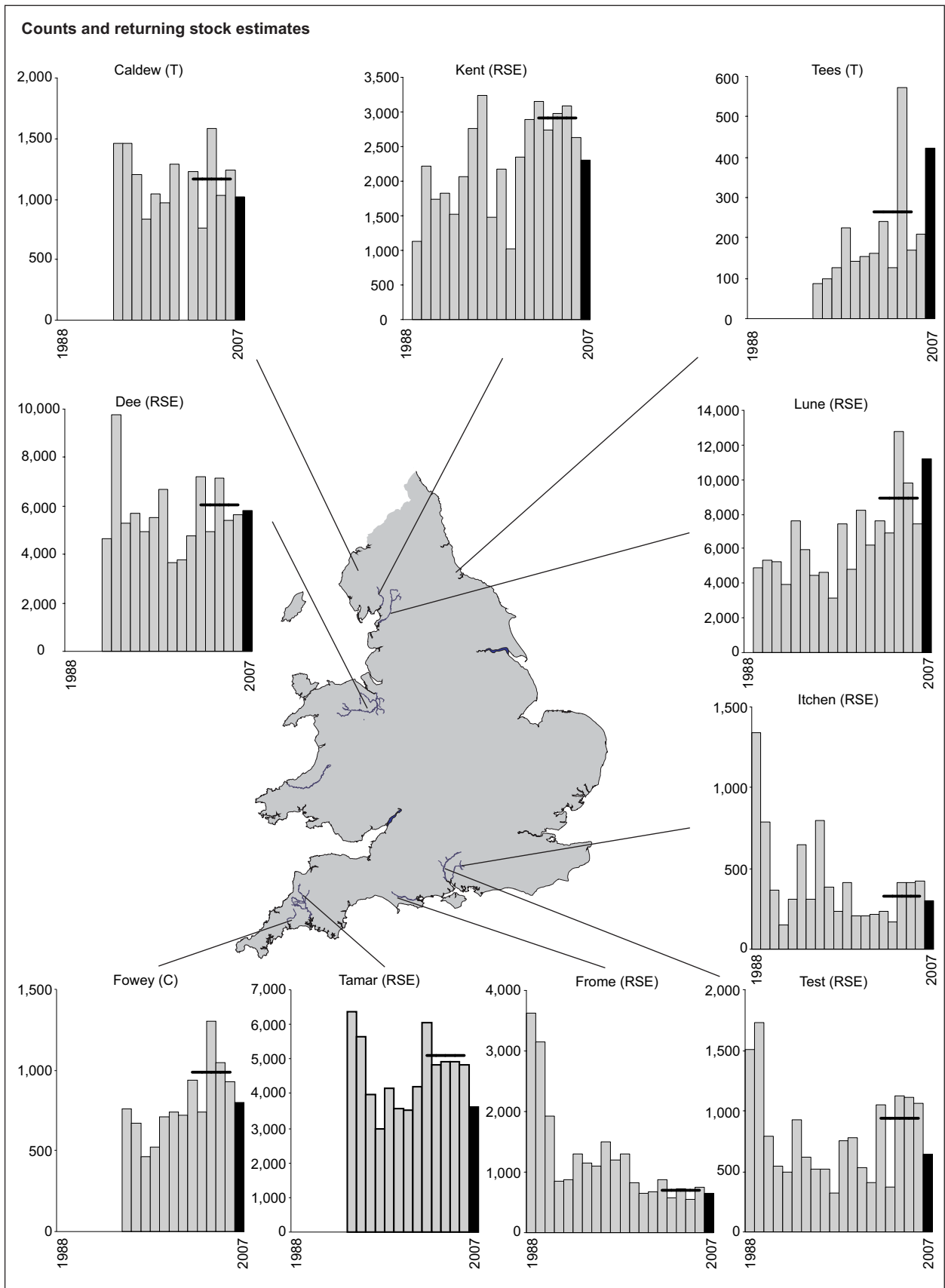


Figure 12. Counts from electronic counters (C) and monitoring traps (T), and returning stock estimates (R) (based on trapping and tagging, or validated counts plus catch below counter) for selected salmon stocks, 1988 to 2007, together with the five-year mean for the period 2002-2006 (displayed as a horizontal line). Note that the histograms are not drawn to the same scale.

Table 28. Estimated survival of wild smolts (%) to return to homewaters (prior to coastal fisheries) for index rivers in the UK and Ireland (from ICES, 2007 and Environment Agency data), 1984-2006.

Smolt migration year	Ireland		UK (N. Ireland)		UK (Scotland)		UK (England and Wales)							
	River Corrib		River Bush*		River North Esk**		River Dee***				River Tamar			
	1SW	2SW	1SW	2SW	1SW	MSW	1SW	95% CL	MSW	95% CL	1SW	95% CL	MSW	95% CL
1984	26.2	2			10.5	6.8								
1985	18.9	1.8			19.6	8.6								
1986			31.3											
1987	16.6	0.7	35.1		16.2	5.9								
1988	14.6	0.7	36.2											
1989	6.7	0.7	25.0		10.0	6.9								
1990	5.0	0.6	34.7		10.5	5.5								
1991	7.3	1.3	27.8		13.2	5.7								
1992	7.3		29.0											
1993	10.8	0.1					6.3	± 3.6	2.5	± 2.2				
1994	9.8	1.4	27.1		14.1	5.1	1.3	± 1.2	1.2	± 1.3				
1995	8.4	0.1			14.0	7.2	2.7	± 1.8	0.4	± 0.7				
1996	6.3	1.2	31.0		13.1	6.5	4.8	± 1.7	2.1	± 1.3				
1997	12.7	0.8	19.8		14.0	8.6	6.2	± 2.9	3.4	± 1.9				
1998	5.5	1.1	13.4				2.3	± 2.4	3.7	± 3.6				
1999	6.4	0.9	16.5				5.0	± 8.3	12.4	± 11.8				
2000	9.4	0.0	10.1		9.0	4.6	2.0	± 1.1	0.9	± 0.8				
2001	7.2	1.1	12.4		8.5	4.9	4.3	± 5.1	0					
2002	6.0	0.5	11.3		6.4	6.0	2.9	± 1.4	0.7	± 0.9	3.6	± 2.1	1.4	± 0.8
2003	8.3	2.1	6.8				2.6	± 1.7	0.4	± 0.4	6.1	± 2.0	1.7	± 1.0
2004	6.3	0.8	6.8		18.0	11.7	4.5	± 1.1	1.0	± 0.5	6.0	± 2.3	1.5	± 0.9
2005			5.9		12.8		5.1	± 1.6	0.5	± 0.4	6.4	± 1.6	0.7	± 0.5
2006 #							4.3	± 1.2			3.4	± 1.2		
Mean (5 year)	7.4	0.9	9.5		10.5	6.8	3.9		0.5		5.1		1.3	
Mean (10 year)	7.7	0.8	14.2		11.9	7.1	3.9		2.5					

Key: * Based on microtagging, corrected for tagging mortality

** Based on tagging with Carlin tags, not corrected for tagging mortality

*** Based on microtagging with a 90% tag retention rate, not corrected for tagging mortality

Provisional

Since 2006, the Environment Agency has been working to validate the Knapp Mill fish counter on the lower Hampshire Avon. Validated upstream adult salmon counts for 2006 and 2007 are now available and have been used to calculate egg deposition estimates on the Hampshire Avon and Dorset Stour for these years (Table 29). This method replaces the earlier one which used exploitation estimates for the Christchurch Harbour nets from the late 1980s (Solomon, 1990), along with net catches, to derive numbers of returning adults. Due to clear reductions in fishing effort, particularly since 2002, and changes to the run timing of 1SW fish in the intervening years, this approach is no longer considered reliable. The validation of the Knapp Mill fish counter is a continuous and iterative process, therefore run figures and egg deposition estimates may change retrospectively as understanding of the counter performance improves.

Egg deposition estimates for each of the 64 main salmon rivers in England and Wales are given in Table 29, and values for 2007, expressed as the proportion of the CL attained, are illustrated in Figure 13. Summary data for 2007, in comparison with previous years, are presented in Table 30 and discussed in Section 3.1.4. Compliance with the 'management objective' (i.e. that the stock should be meeting or exceeding its CL in at least four years out of five) for the 64 principal river stocks rivers in England and Wales in 2007 is also provided in Table 29 (full details in Annex 2) and illustrated on a catchment basis in Figure 14. In summary, compliance with the management objective in 2007 was:

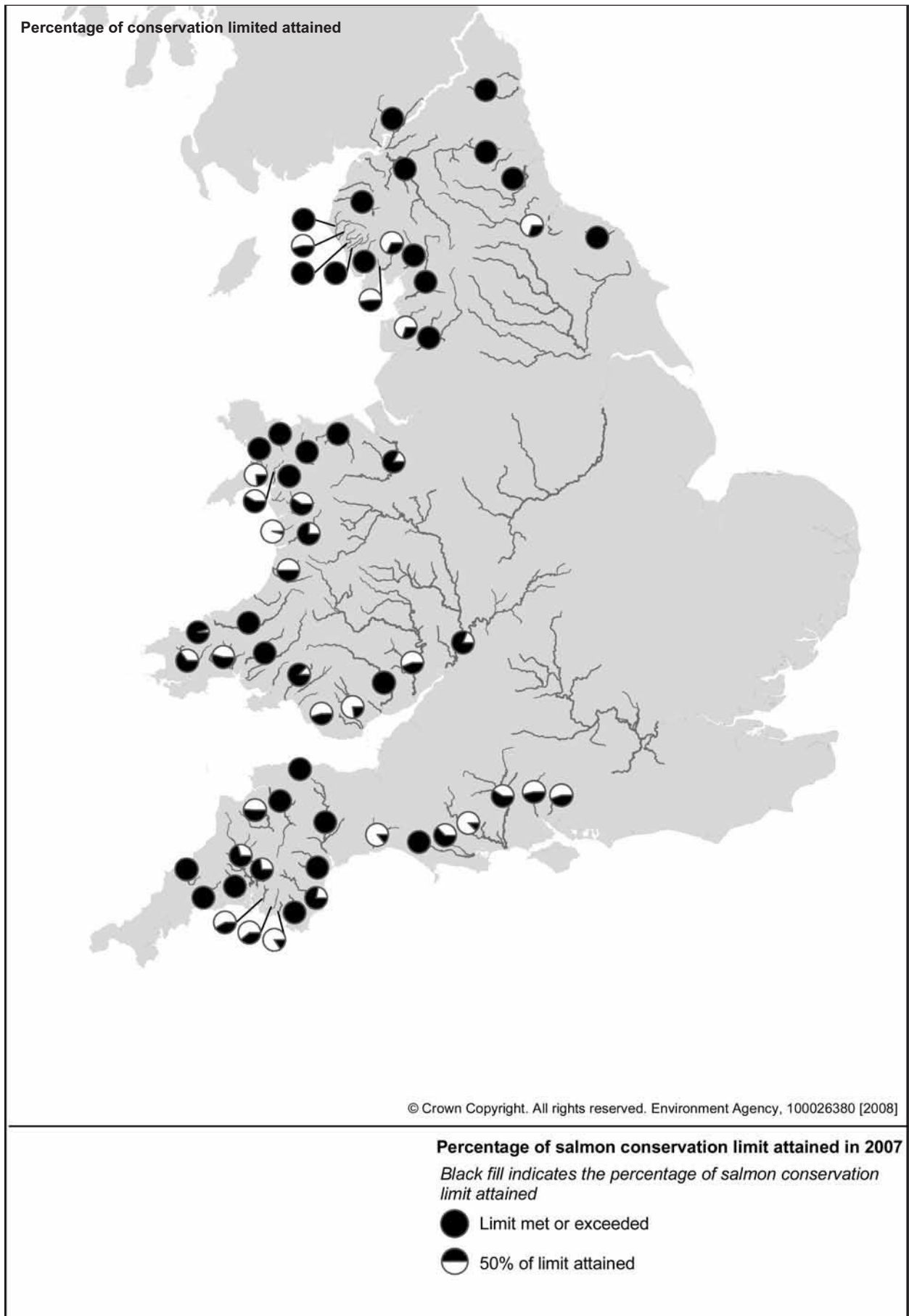


Figure 13. Pie charts for individual rivers for which conservation limits (CLs) have been set showing the % of the CL attained in 2007. A black circle indicates that the limit was met or exceeded.

Table 29. Conservation Limits (CL) and the proportion of the CL attained for the period 1998-2007 for the principal salmon rivers of England and Wales. Current compliance against the management objective and predicted compliance in 2012 are shown in the right hand columns (see Annex 2 for details). Data for 2007 are provisional.

Region/ River	Accessible wetted area (ha)	CL eggs/ 100m ²	CL eggs (x10 ⁶)	Mgmt Target eggs (x10 ⁶)	2007 egg depo- sition (x10 ⁶)	Proportion of Conservation Limit attained (%) *											Current compliance #	Predicted compliance # in 2012
						1998	1999	2000	2001	2002	2003	2004	2005	2006	2007			
NE																		
Coquet	144	218	3.14	5.73	7.99	219	158	245	249	283	242	455	462	280	255	Pass	Pass	
Tyne	542	208	11.25	23.99	49.81	241	307	355	421	427	356	677	533	601	443	Pass	Pass	
Wear	232	250	5.80	8.71	11.42	99	82	153	118	133	147	261	238	204	197	Pass	Pass	
Tees	620	240	14.90	15.76	4.44	27	25	23	16	15	20	37	17	21	30	Fail	Fail	
Esk-Yorks	86	236	2.02	2.68	2.44	22	14	28	36	52	34	85	93	107	121	Uncertain	Pass	
Southern																		
Test	138	246	3.40	4.01	1.58	56	56	39	29	75	26	81	82	76	46	Fail	Uncertain	
Itchen	69	234	1.63	1.85	0.73	62	26	28	32	30	31	62	62	63	45	Fail	Uncertain	
SW																		
Avon-Hants	369	175	6.48	7.61	3.83	28	40	64	58	95	30	51	26	56	59	Fail	Fail	
Stour	142	149	2.12	2.19	0.27	7	8	14	12	19	6	10	5	12	13	Fail	Fail	
Piddle	18	177	0.31	0.40	0.20	113	103	165	54	77	53	67	51	71	63	Fail	Fail	
Frome	88	171	1.50	1.91	1.65	200	131	95	97	137	95	124	98	142	110	Uncertain	Uncertain	
Axe	83	175	1.45	1.65	0.20	20	28	19	25	70	34	22	10	31	14	Fail	Fail	
Exe	282	253	7.14	11.63	12.20	196	255	298	150	137	111	317	154	113	171	Uncertain	Uncertain	
Teign	98	251	2.47	3.37	3.23	88	76	134	87	58	50	199	99	102	131	Uncertain	Uncertain	
Dart	137	218	2.98	3.51	2.33	51	53	67	49	39	34	106	47	55	78	Fail	Uncertain	
Avon-Devon	35	202	0.70	0.90	0.90	62	59	72	78	126	122	103	117	162	129	Pass	Pass	
Erme	20	180	0.37	0.58	0.06	59	120	65	36	237	38	124	13	129	15	Fail	Fail	
Yealm	11	212	0.24	0.34	0.09	163	17	91	91	67	10	28	54	55	39	Fail	Fail	
Plym	29	188	0.55	0.65	0.23	69	33	57	41	57	21	18	17	78	42	Fail	Fail	
Tavy	68	201	1.37	1.90	0.99	182	79	82	68	20	19	80	101	88	72	Fail	Uncertain	
Tamar	293	395	11.56	13.69	8.17	78	84	68	84	127	118	96	121	108	71	Uncertain	Uncertain	
Lynher	29	233	0.68	0.94	1.11	155	63	130	60	58	52	151	144	111	162	Uncertain	Uncertain	
Fowey	42	207	0.86	1.38	2.24	152	221	222	225	311	255	414	318	279	260	Pass	Pass	
Camel	56	176	0.98	1.49	2.32	184	131	185	180	214	258	320	277	309	237	Pass	Pass	
Taw	274	211	5.78	10.03	15.46	213	200	353	98	123	101	238	92	133	268	Uncertain	Uncertain	
Torrige	198	207	4.10	5.09	2.11	95	47	84	17	38	26	102	66	65	51	Fail	Uncertain	
Lyn	27	359	0.97	1.58	1.82	172	208	360	293	247	208	320	118	195	188	Uncertain	Uncertain	
Midlands																		
Severn	898	143	12.85	16.86	10.44	72	72	93	116	70	137	128	178	140	81	Uncertain	Uncertain	

Wales																
Wye \$	1,610	221	35.66	39.55	15.50	61	60	46	65	28	49	71	63	63	43	Fail
Usk	407	248	10.11	13.66	21.10	148	153	209	216	174	89	197	124	189	209	Uncertain
Taff & Ely	146	219	3.19	3.44	0.71	19	36	15	7	18	26	11	9	9	22	Fail
Ogmore	61	180	1.10	1.36	0.50	76	61	77	62	46	26	117	34	30	45	Fail
Tawe	88	211	1.85	2.29	1.62	43	32	21	64	78	31	83	87	97	87	Uncertain
Tywi	500	226	11.30	14.76	15.58	78	71	89	44	67	85	162	108	127	138	Uncertain
Taf	90	189	1.70	2.53	0.91	54	85	107	133	48	32	226	136	117	54	Uncertain
E&W Cleddau	87	179	1.55	1.71	1.01	44	30	50	39	26	28	41	32	29	65	Fail
Telfi	326	265	8.65	12.43	11.04	132	145	143	164	128	89	286	128	139	128	Uncertain
Rheidol	31	222	0.68	0.80	0.34	60	56	51	48	30	27	98	70	52	50	Fail
NeVERN	19	259	0.48	0.61	0.46	36	50	69	71	40	85	103	63	140	95	Uncertain
Dyfi	179	235	4.21	5.26	3.21	83	58	72	85	27	28	97	75	125	76	Uncertain
Dyisinni	31	216	0.68	0.75	0.03	40	8	23	6	26	4	18	6	6	4	Fail
Mawddach	57	242	1.37	1.65	0.80	107	117	67	80	79	69	133	83	75	59	Fail
Dwyrdd	9	201	0.19	0.45	0.29	281	140	79	234	497	251	630	286	353	155	Uncertain
Glaslyn	25	191	0.48	0.59	0.28	72	39	24	42	52	15	108	36	57	59	Uncertain
Dwyfawr	33	258	0.86	1.04	0.20	35	35	47	34	28	20	106	35	46	23	Fail
Selont	21	226	0.48	1.16	1.06	198	111	214	242	69	85	645	375	342	222	Uncertain
Ogwen	24	362	0.87	1.61	2.41	336	165	279	392	195	137	367	396	153	278	Uncertain
Conwy	50	127	0.63	1.20	2.28	267	173	345	430	214	304	552	344	315	361	Pass
Clwyd	84	237	1.99	2.66	3.07	128	77	63	81	60	46	90	24	40	154	Fail
Dee	617	248	15.30	17.63	12.60	107	81	61	85	114	88	121	83	101	82	Uncertain
NW																
Ribble	351	242	8.49	10.42	9.34	63	63	81	38	71	71	97	123	113	110	Uncertain
Wyre	67	70	0.47	0.60	0.14	96	15	14	35	41	9	96	13	18	30	Fail
Lune	423	280	11.84	17.04	27.59	120	95	165	130	154	142	264	198	151	233	Pass
Kent	68	223	1.52	2.97	4.93	366	117	271	414	472	429	467	486	403	324	Pass
Leven	46	182	0.83	0.99	0.27	56	31	92	81	68	81	73	81	61	32	Fail
Crake	16	194	0.32	0.42	0.15	109	32	64	71	58	6	108	117	72	47	Uncertain
Duddon (& Lickle)	26	121	0.31	0.68	1.13	200	77	69	116	115	52	345	351	380	364	Uncertain
Esk	20	181	0.37	0.77	1.87	161	173	261	116	89	59	192	251	278	505	Uncertain
Irt	35	198	0.69	1.03	0.80	157	47	120	35	90	54	170	179	200	116	Uncertain
Ehen	41	230	0.94	1.69	2.55	253	52	343	101	306	101	275	243	225	272	Uncertain
Calder	13	261	0.33	0.52	0.15	220	26	176	235	183	57	140	85	124	46	Uncertain
Denwent	213	185	3.93	7.36	12.73	146	144	299	235	209	125	440	357	215	324	Pass
Eden	688	200	13.75	20.24	16.96	95	92	101	108	107	87	252	212	152	123	Uncertain
Esk-Border	306	255	7.79	9.66	8.47	85	63	102	75	120	69	135	147	114	109	Uncertain
E & W Total			262.53	351.91	330.36											

Footnotes * Estimates include eggs contributed by rod-released fish.
Basis for current and predicted compliance explained in Annex 2. The 'uncertain' category includes stocks assessed as 'probably at risk' and 'probably not at risk'.
\$ Egg deposition estimates now based on rod catch data and assumed exploitation rate - counter data and returning stock estimate considered too unreliable.
Prior to 1 April 2005, Border Esk egg deposition estimates were based only on English rod catch and likely to be underestimates.
Some entries in this table have been updated from that presented in previous reports as a result of river-specific refinements and corrections.
Egg deposition estimates for the NE Rivers Coquet, Tyne and Wear have been revised as part of a 5-year review of the SAPs on these rivers.

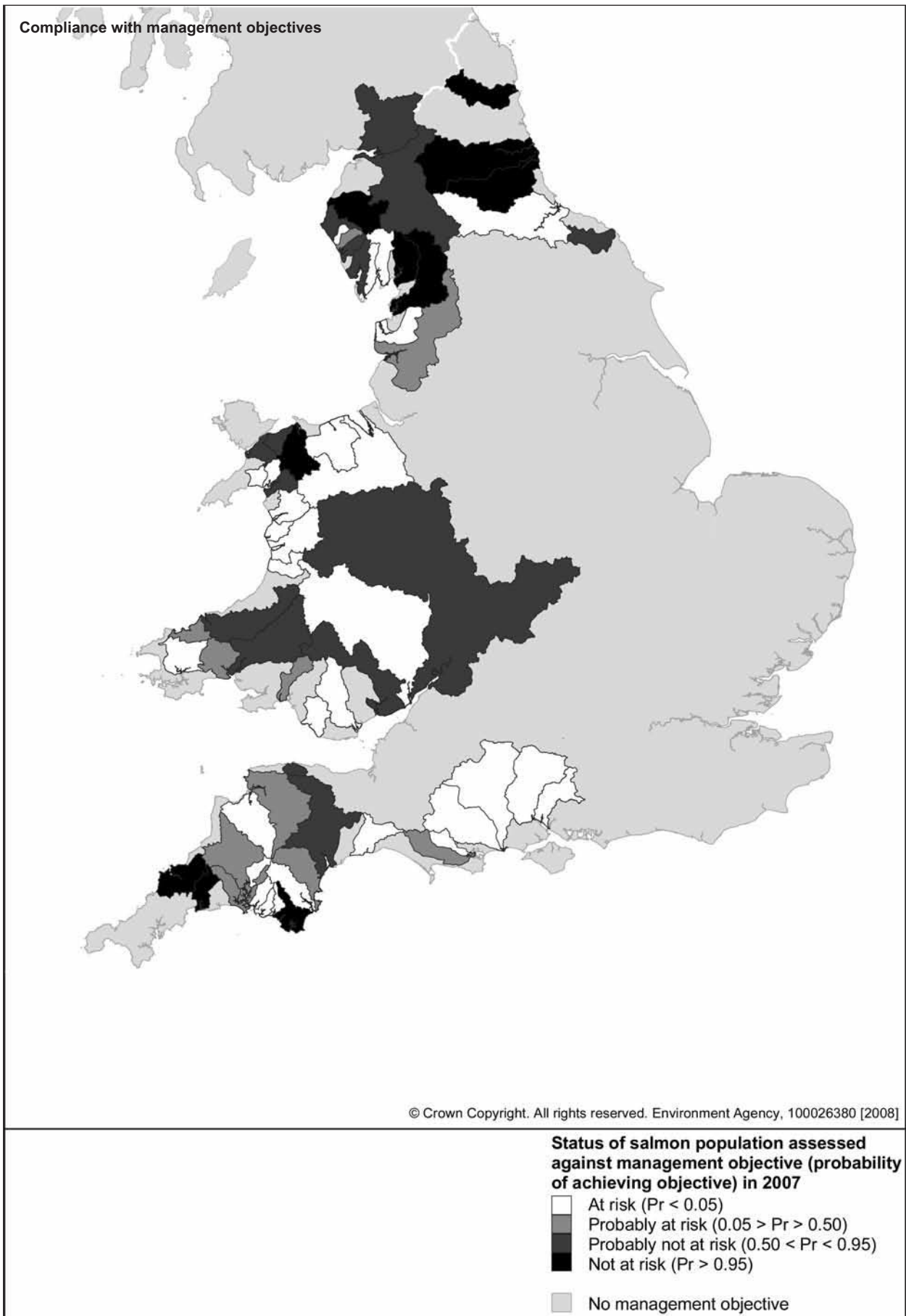


Figure 14. Status of river catchments in 2007 assessed against their management objective (i.e. that the CL is met or exceeded in at least 4 years out of 5, on average).

- 10 rivers (16%) were classified as ‘not at risk’ – i.e. had a high probability (> 95%) of meeting the management objective;
- 15 rivers (23%) were classified as ‘probably not at risk’ – i.e. had a probability of between 50% and 95% of meeting the management objective;
- 10 rivers (16%) were classified as ‘probably at risk’ – i.e. had a probability of between 5% and 50% of meeting the management objective;
- 29 rivers (45%) were classified as ‘at risk’ – i.e. had a very low probability (<5%) of meeting the management objective.

It should be noted that for some rivers that have consistently exceeded their CL over recent years (e.g. Lyn, Exe, Ogwen) the compliance assessment in 2007 is still ‘uncertain’ (N.B. the ‘uncertain’ category includes all rivers categorised as ‘probably at risk’ and ‘probably not at risk’) (Table 29). This reflects the level of variability in the egg deposition estimates and the way in which the compliance procedure works; further explanation is provided in Annex 2.

The probability of each of these stocks meeting the management objective in 2012 is also included in Table 29; forecasting compliance in 2012 inevitably carries greater uncertainty. In summary:

- 11 rivers (17%) are classified as ‘not at risk’;
- 18 rivers (28%) are classified as ‘probably not at risk’;
- 16 rivers (25%) are classified as ‘probably at risk’;
- 19 rivers (30%) are classified as ‘at risk’.

3.1.3 Juvenile fish

The Environment Agency monitors both stocks and fishery performance in most of its salmon rivers. The current juvenile monitoring programme samples the same 380 quantitative sites each year to identify temporal trends in abundance, and 3,030 sites are sampled semi-quantitatively once every five years to identify spatial variation in the juvenile population. The habitat at all sites is assessed using the model HABSCORE (Milner *et al.*, 1998), which provides reference conditions against which the abundance of the juvenile salmon population at any site can be compared.

Between 2001 and 2007, reliable data were obtained from 4,743 sites over all rivers shown in Figure 2. The data were assessed using a classification scheme that produces one juvenile salmon density score for each site, using average values for the early 1990s as a baseline (Mainstone *et al.*, 1994). The proportion of sites falling into different salmon abundance classes (Classes A to F) provides a measure of the health of the juvenile salmon populations for each river. Sites are typically grouped into those that are at or above average (Classes A to C), below average (Class D) and well below average or fishless (Classes E or F). Figure 15 presents the proportion of sites in each catchment that fall into the highest of these juvenile abundance categories (Classes A to C). Thus for catchments shaded black, less than 25% of sites fall within this category, while for those shaded white (only one catchment) more than 75% of sites are at or above average. The majority of catchments between 2001 and 2007 fall between these extremes (i.e. between 25 and 75% of sites being classified as Classes A to C).

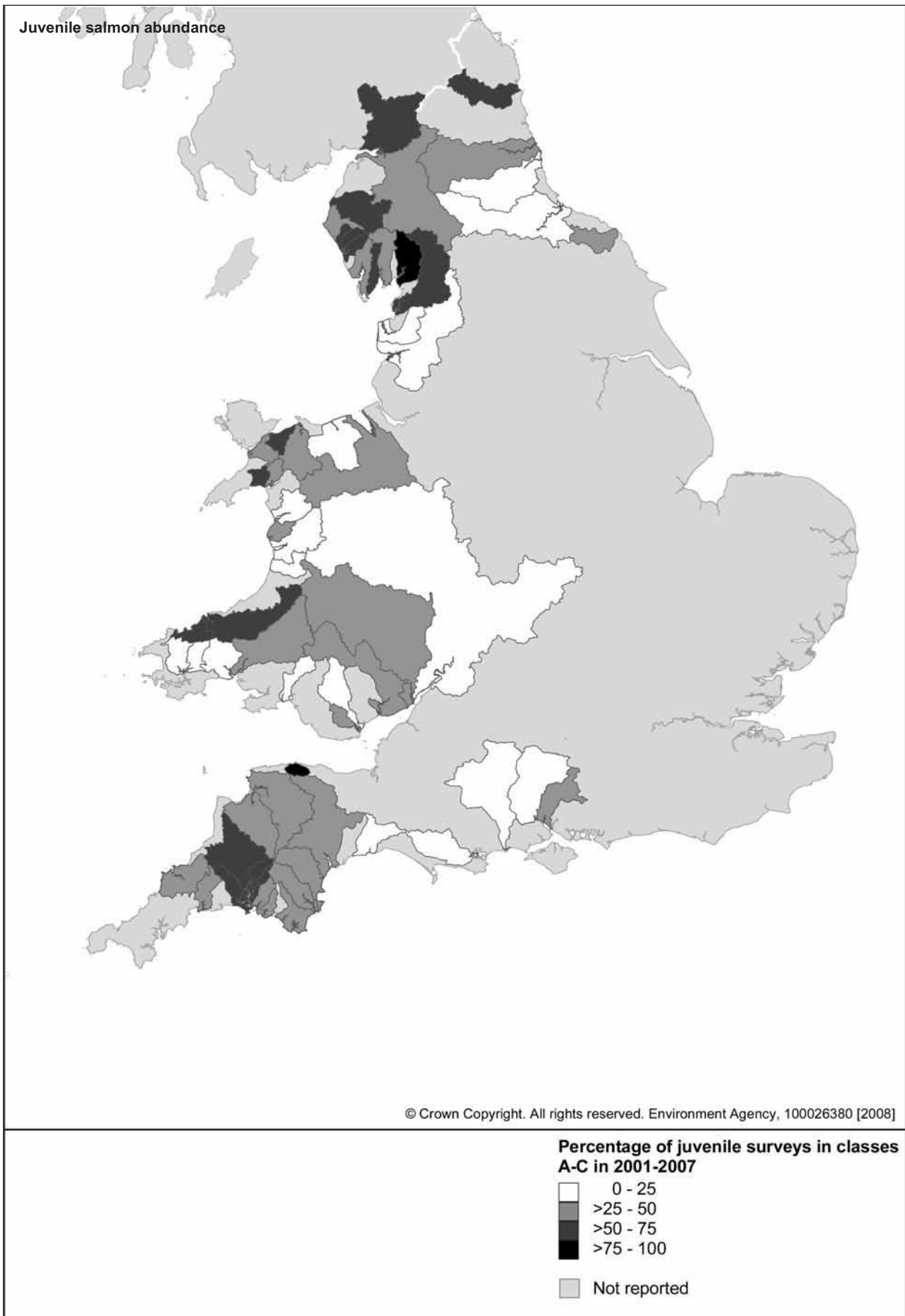


Figure 15. Juvenile salmon abundance indices for each catchment, presented as percentage of surveys in classes A-C only, 2002-2007.

An alternative assessment of juvenile salmon densities is provided in Figure 16. This presents the mean percentage habitat utilisation index (HUI) for 0+ juvenile salmon in rivers where ten or more juvenile survey sites have been assessed each year over the period 2001 to 2006 (this assessment is only repeated every 6 years). The HUI values provide an index, where values of 1 (or greater) signify full usage of available habitat in the sampled sites. The data indicate relatively good habitat usage in the majority of the sampled sites, although with substantial under-utilisation in some catchments, including the south coast chalkstreams. Although covering a relatively restricted number of catchments, these data are in broad agreement with the egg deposition estimates (Figure 13).

It is necessary to be cautious when drawing conclusions from these data. Fish populations vary considerably with time and location, and only when several more years' surveys have been completed will it be possible to detect any meaningful trends. Work is continuing to revise and update the procedures for collecting and interpreting juvenile data. For example, the Environment Agency has completed an R&D project to develop a "River Fish Habitat Inventory" (RFHI). This methodology combines statistical modelling techniques with a Geographical Information System (GIS) for producing a quantitative inventory of the juvenile salmonid habitat and populations present within a catchment. Further details are provided in Annex 2.

3.1.4 2007 stock status assessment

For comparison with previous years' assessments, Table 30 gives the number of rivers with egg deposition estimates above their respective CL in 2007, between 50% and 100% of their CL, and below 50% CL. This shows a decrease in the number of rivers that were above their CL from 39 in 2006 (59%) to 31 in 2007 (48%), whilst the proportion that were below 50% of their CL increased from 10 (16%) in 2006 to 18 (28%) in 2007. The proportion of rivers with egg deposition estimates above their CL in 2007 is just above the time series mean (46%).

River-to-river variation in the proportion of the CL attained (Figure 13) indicates an overall pattern in England and Wales in 2007, which is broadly similar to that in recent years. Spawning escapement remained below the CL in most of the south coast chalkstreams and in some of the rivers in southwest England and Wales, with a higher proportion of rivers in northern England exceeding their CL. The juvenile habitat utilisation data (Figure 16) are broadly in line with these findings.

Although salmon have been returning strongly to some historically polluted rivers (e.g. Tyne, Wear, Ogmere), there is concern about chronic environmental degradation in others, mainly in rural areas, caused by changing land use practices, especially agriculture and forestry. Issues of particular concern are siltation resulting from soil erosion, pesticides from sheep dip chemicals, acidification and changes in river flows. The relative importance of these effects vary around the country, but clusters of high pesticide levels have been found in Welsh upland streams, and acidification still occurs in the uplands of Wales and the North West. Salmon runs in the chalkstreams of Southern Region have declined since the 1980s, but the reasons for this are not clear. The extent and nature of soil erosion impacts are being investigated and national water abstraction licence legislation is under review. Attempts to restore salmon to the Thames have been frustrated by water quality problems in the estuary exacerbated by low flow conditions in many years. Earlier investigations (Alabaster and Gough, 1986) indicated that a freshwater discharge in excess of 650 megalitres per day (MLD) was needed at the tidal limit to enable salmon to pass through the Thames tideway. Summer flows were below this level in 2005 and 2006, and there were significant fish mortalities in 2004. However, in 2007, flows were high throughout the main period of the

Table 30. Number and percentage of salmon river stocks above their conservation limits (CL), between 50% and 100% of the CL, and less than 50% of the CL, 1993-2007.

Year	>CL		50-100% CL		<50% CL	
	No.	%	No.	%	No.	%
1993	33	54	13	21	15	25
1994	41	65	14	22	8	13
1995	26	41	21	33	16	25
1996	31	49	15	24	17	27
1997	21	33	25	39	18	28
1998	30	47	23	36	11	17
1999	20	31	23	36	21	33
2000	26	41	25	39	13	20
2001\$	20	34	18	31	20	34
2002	26	41	21	33	17	27
2003	18	28	18	28	28	44
2004	41	64	15	23	8	13
2005	31	48	18	28	15	23
2006	38	59	16	25	10	16
2007*	31	48	15	23	18	28
Average %						
1993-2006		45.5		30.0		24.5

Key: \$ No CL possible for 6 rivers due to impact of foot and mouth disease.

* Provisional

expected run (June to October), with flood conditions for an extended period in the summer. This resulted in low trap efficiency, as evidenced by the fact that the adult trap retained only one of the seven fish caught in the river; the full extent of the adult run is not known.

Changes in the British climate are predicted to become more pronounced (Hulme *et al.*, 2002) and the most likely scenarios are for higher temperatures, wetter winters, drier summers and more extreme events of flooding and drought. Changes in climate are global and the increased natural mortality of salmon at sea in recent years may also be linked to climate change.

3.2 Changes in biological characteristics

NASCO have recently asked ICES to examine associations between changes in biological characteristics of all life stages of Atlantic salmon and variations in marine survival. The purpose is to determine whether declines in marine survival coincide with changes in the biological characteristics of juveniles in fresh water or are related to characteristics of adult fish (size at age, age at maturity, condition, sex ratio, growth rates, etc.). Changes in the sea age composition and run timing of salmon have been reported for numerous populations throughout their geographic range, including populations in England and Wales (e.g. Anon., 1994; Aprahamian *et al.*, 2008).

Figure 17, for example, illustrates changes in the mean weights of 1SW and 2SW salmon from the Rivers Tamar, Dee and Lune over the last 40 years. Mean weights in this example are based on net and trap caught fish sampled from June to August. In-keeping with observations elsewhere (ICES, 2007; Todd *et al.*, 2008), the mean weights of 1SW fish in 2006 were the lowest recorded in each of the time-series for these three rivers (indicated by the black symbols in Figure 17). However, it is also apparent that similarly low mean weights (below ~2.50kg) have been recorded at other times (e.g. in the mid-1980s). The downturn in size-at-return of grilse in 2006 has not continued on the Dee in 2007 - where the mean weight of fish (2.65kg) was within the usual range [mean weight data from the Tamar and Lune for 2007 are not yet available].

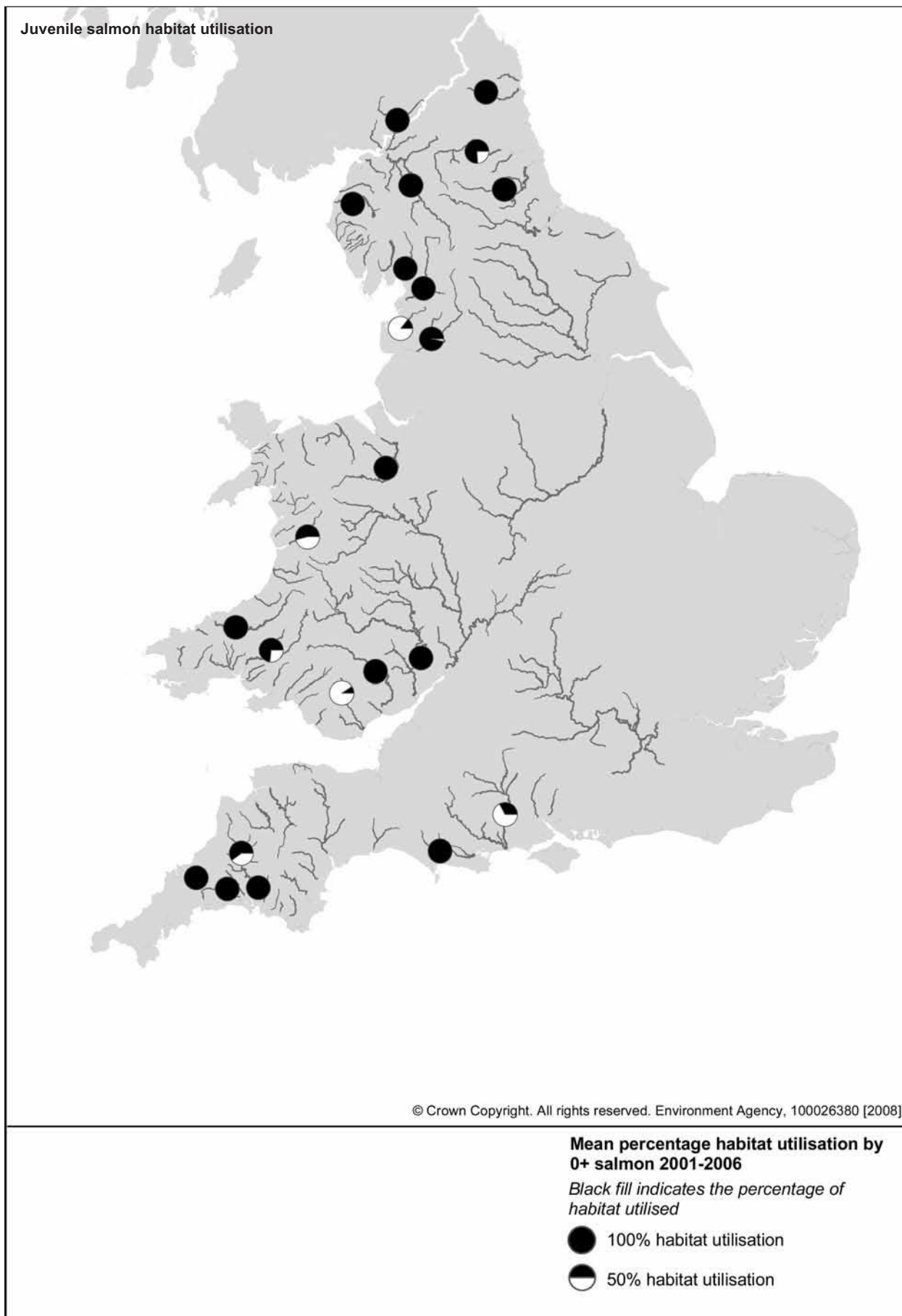


Figure 16. Pie charts showing mean percentage habitat utilisation, 2001-2006, for 0+ salmon in river catchments where 10 or more survey sites have been sampled.

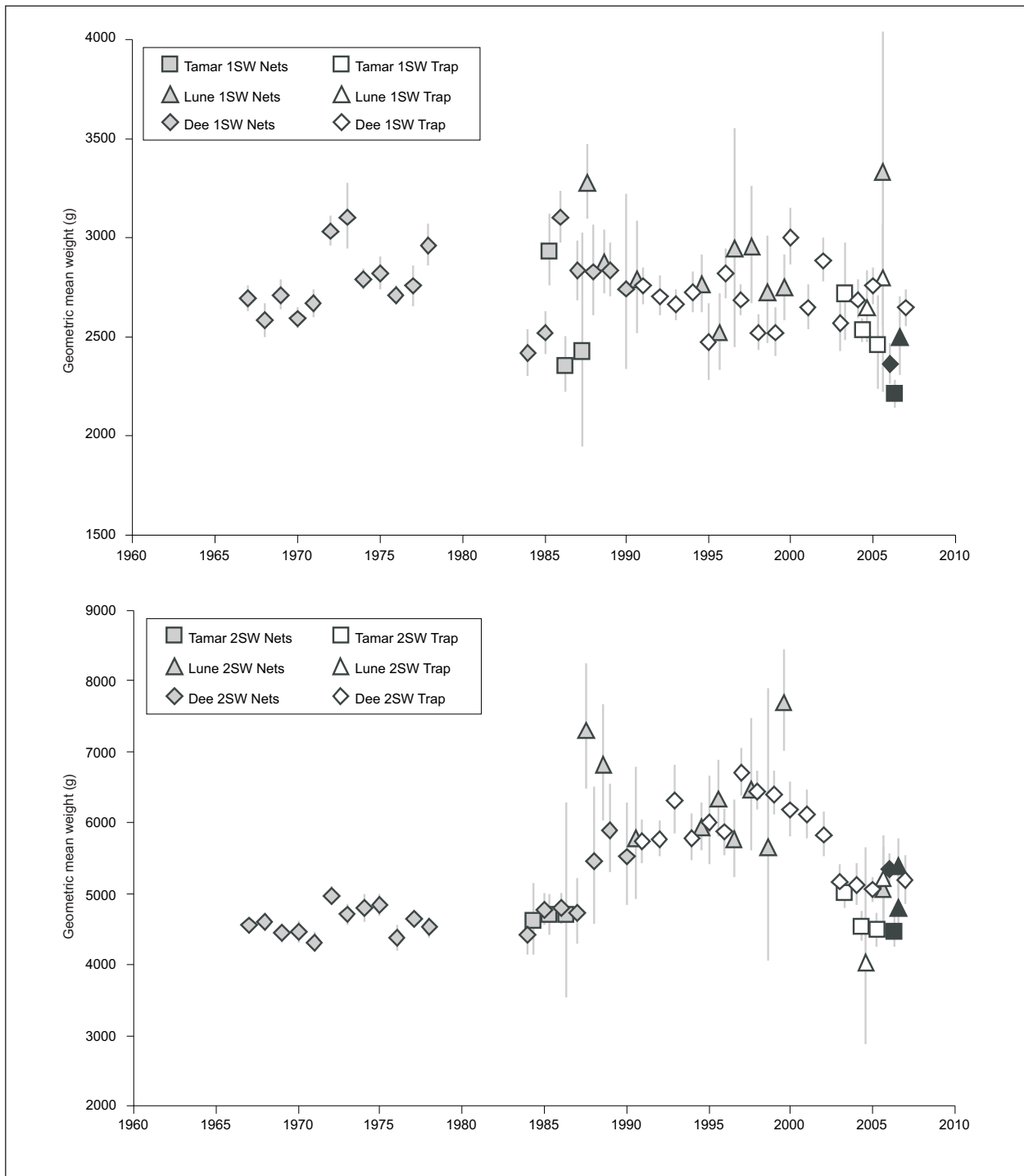


Figure 17. Variation in the mean weights of 1SW and 2SW salmon returning to the Rivers Tamar, Dee and Lune, 1967-2007 (error bars indicate 95% confidence limits).

In the case of 2SW salmon (Figure 17), mean weights increased in the decade beginning in the mid-1980s and have subsequently declined from the mid-1990s to the present. Current values are similar to levels recorded from the 1960s up to the mid 1980s.

Similar patterns in size-at-return to those described above were evident on a monthly basis both within and outside the June-August period. This was the case (from data examined for the Dee) for both 1SW and 2SW salmon, and for male and female fish in these two sea age groups. The condition of fish, as expressed by Fulton's condition factor, appears to have remained relatively stable throughout the time-series.

On the Hampshire Avon there is evidence to suggest that the run timing of grilse is shifting. Here, the peak run of 1SW fish in the late 1980s used to occur in early to mid July, before the end of the netting season on the river, with net catches falling away quite sharply by the end of the netting season on July 31. However, in the past few years, the grilse run has peaked a few weeks later, with increasing numbers of grilse entering the river during September. Grilse catches on the rod fishery at the bottom of the river had a median capture date of 14 July in the period 1986-1990, while for the period 2002-05 the median capture date was 2 August. Similarly, evidence from the trapping at Chester Weir on the River Dee indicates that the arrival of the first grilse in the river has got later over the period since 1992 by around 20 days. However, the median (50%tile) capture date for both 1SW and 2SW salmon on the Dee has remained relatively stable over the last 17 years (Figure 18), with the run tending to be more 'compressed' into the summer and autumn period. [The sharp increase in the median capture date for 2SW salmon in 2007 may have been influenced by exceptional spates in June and July which are likely to have significantly reduced trap efficiency in these months below normal levels.]

In addition to these well publicised changes in age composition and run timing of adult fish, there is increasing evidence that progressive changes are also occurring in other biological characteristics. For example, there is evidence of change in the size and growth of parr and in the age of smolting. Figure 19 illustrates changes in the mean smolt age of adult salmon returning to the Rivers Wye, Severn and Dee over the available time series, highlighting the progressive reduction in the mean smolt age of salmon that survive to become adults.

Table 31 provides a preliminary inventory of data sets in England and Wales that provide information on various biological characteristics of particular stocks over extended time series, many in excess of 15 years.



Salmon with red vent syndrome (photo courtesy of Richard Cove, Environment Agency).

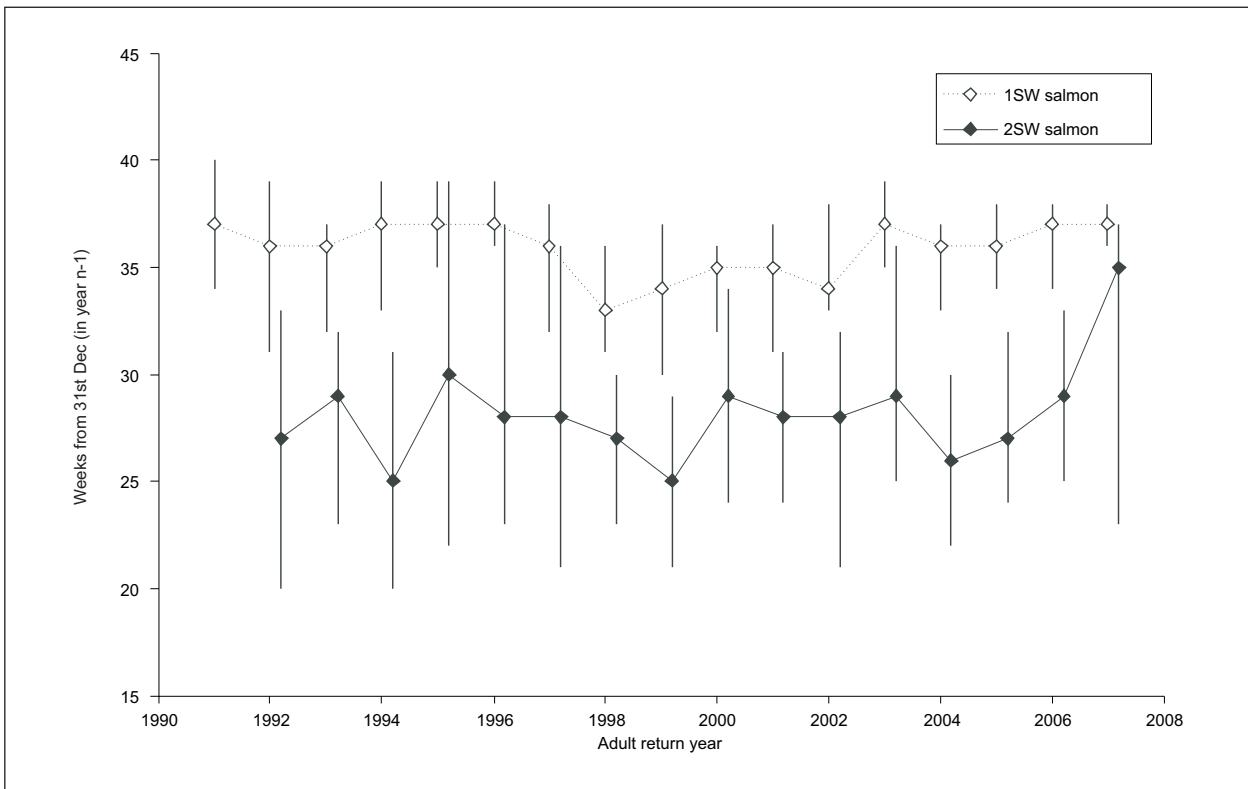


Figure 18. Run timing of 1SW and 2SW salmon from extrapolated weekly trap catches at Chester Weir on the River Dee, 1991-2007. (Symbols indicate ~50% and error bars 25% and 75% annual total catch).

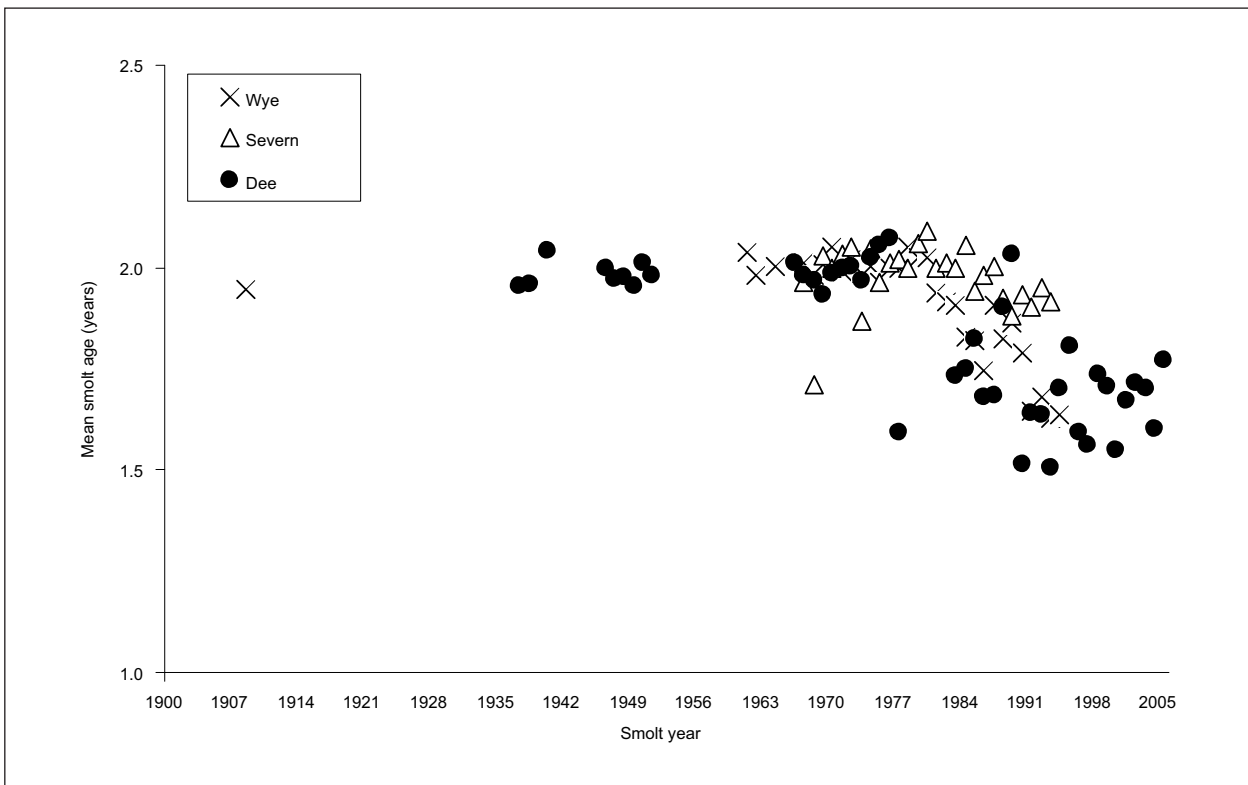


Figure 19. Mean smolt age of adult salmon returning to the Rivers Wye, Severn and Dee, over available time series. From Davidson et al., 2006.

Table 31. Preliminary inventory of information on data relating to biological characteristics of salmon stocks in England & Wales.

Life-stage/Parameter	River/Stock	Time series (adult return year)	Data source	Publications/Agency
Juveniles				
Size at age (freshwater growth)	Wye	1909, 1981-1996	Adult scales	Davidson & Hazelwood, 2005
	Dee	1937, 1938, 1968, 1970, 1984 on	Adult scales	Jones (1939), Lees (1972), Davidson & Hazelwood (2005), Davidson <i>et al.</i> (2006), Aprahamian <i>et al.</i> (2008), Environment Agency (unpublished)
	Lune	1987-1999	Adult scales	Davidson & Hazelwood, 2005
	Frome	1970s on	Adult scales	CEH unpublished
Smolt age composition	Severn	1968-1994	Adult scales	Davidson & Hazelwood, 2005
	Tamar			
	Wye	1909, 1962-1996	Adult scales	Davidson & Hazelwood, 2005
	Dee	1937-1951, 1967-1978, 1984 on	Adult scales	Jones (1939 and 1949), Lees (1972), Woodland (1972), Davidson & Hazelwood (2005), Davidson <i>et al.</i> (2006), Cragg-Hine <i>et al.</i> , (2006), Aprahamian <i>et al.</i> (2008), Environment Agency (unpublished)
	Lune	1987-1999	Adult scales	Davidson & Hazelwood, 2005
	Frome	1970s on	Adult scales	CEH unpublished
Smolt run timing	Wear	1985-95	Trapping	Cefas unpublished data
	Test	1992 on	Trapping	EA/Cefas unpublished data
Adults				
Post smolt growth	Thames	1982-1999	Adult scales	Davidson & Hazelwood, 2005
	Wye	1908, 1909, 1981-1996	Adult scales	Davidson & Hazelwood, 2005
	Dee	1937, 1938, 1968, 1970, 1984 on	Adult scales	Jones (1939), Lees (1972), Davidson & Hazelwood (2005), Aprahamian <i>et al.</i> (2008), Environment Agency (unpublished)
	Lune	1987-1999	Adult scales	Davidson & Hazelwood, 2005
Sea age composition/size at return	Frome	Early 1970s on	Counter/catch	Welton <i>et al.</i> , 1999; CEH unpublished
	Dee	1934 on	Net catch/trap	Davidson & Cove (2006), Aprahamian <i>et al.</i> (2008), Environment Agency (unpublished)
	Tamar	1985-1987, 2000 on	Trap	Environment Agency (2006), Environment Agency (unpublished)
	Exe	1910 -91	Net catch	Anon., 1999
	Eden	1936-91	Rod catch	Anon., 1999
	Test	1920-91	Rod catch	Anon., 1999
	Usk	1910 -91	Rod catch	Anon., 1999
	Severn	1970-88	Rod & net catches	Churchward & Hickley, 1991
	Derwent	1923-89	Rod catch	Ball & Aprahamian, 1993
	Wye (& others)	1952-90	Rod & net catches	Gough <i>et al.</i> , 1992
	23 rivers (~37k fish)		1970 on	Various Summary in Davidson & Hazelwood, 2005
Run timing	Frome	Early 1970s on	Counter	Welton <i>et al.</i> , 1999
	11 rivers	Mid 1980s on	Counters/traps	Table 19 - this report; EA/CEH data

The occurrence of salmon returning to rivers in England and Wales with swollen and/or bleeding vents has been noted since 2005. The condition, referred to as red vent syndrome, was even more prevalent in 2007 with fish having the condition being reported from 24 rivers throughout the country. Evidence from Environment Agency fish traps indicated quite a high incidence of the condition, for example 27% of fish screened on the River Dee (N. Wales) in 2007 (379 fish) had swollen vents (up from 9% in 2006 and 3% in 2005), while 24% of fish screened on the River Lune (North West Region) and 56% of those on the River Tamar (South West Region) also displayed the condition. Records of fish with swollen vents were highest in August and September, coinciding with the main grilse run. In some rivers, almost all the fish caught at this time were affected. The condition affects grilse as well as MSW salmon and the majority of affected fish appear to be female, although this may reflect sampling bias. There was no significant difference in the condition factor of affected fish and unaffected fish from the River Dee.

The cause of the condition has been linked to the presence of a nematode worm, *Anisakis simplex*. This is a common parasite of marine fish and is also found in migratory species. However, the larval nematodes are usually found spirally coiled on the mesenteries, internal organs and less frequently in the somatic muscle of fish and it is unusual for them to be located in the muscle and connective tissue surrounding the vent. The reason for the occurrence of the nematodes in the vents of migrating wild salmon, and whether this might be linked to possible environmental factors, is unclear. The potential significance of the swollen vents, or whether the severity of the vent damage could impair spawning, is also unclear. However, a number of affected fish have been taken for use as broodstock, successfully stripped of their eggs, and these have developed normally in hatcheries. An affected salmon tagged on the River Dee in 2006 was also recaptured in spring 2007 as a kelt; the fish appeared to have spawned successfully and recovered condition.

The pathology of the condition has been researched extensively, and a peer-reviewed paper submitted for publication. A press release was also issued to advise anglers about the condition and to provide guidance on human health issues. The Environment Agency have maintained a national log of occurrences and plan to continue to monitor the condition in the future.

3.3 Salmon conservation and stock status reviews

A number of reviews have been implemented in England and Wales in recent years in order to assess salmon stock status and to inform management. The following provides a brief summary of these:

Salmon Action Plan (SAP) Review

The programme of developing SAPs for all 64 principal salmon rivers in England and Wales was completed in 2004 (see Annex 2). Each Plan contains an agreed list of actions with a 5 year planning horizon. Some of the earlier SAPs have now been reviewed (the Wye, Tamar, Test and Itchen, and Leven and Crake), in consultation with fisheries interests and other stakeholders. Several other reviews are in preparation and these will incorporate requirements of the European Water Framework, Habitats and Strategic Environment Assessment Directives. Further details on these European Directives and their implications for salmon management are provided in Annex 1.

Stock Conservation Review

Following NASCO guidance, the Environment Agency carried out a review of salmon stock conservation in 2004, assessing the status and trends in salmon stocks in England and Wales and progress with SAPs. The review demonstrated that, whilst many conservation measures had

been implemented, the majority of stocks remained below the river CL and a significant number were in decline. It highlighted that the key pressures on salmon fisheries require concerted and integrated action at a broad scale to address such issues as deficiencies in land management, degradation of in-river salmon habitat and effects of diffuse pollution and siltation. An Action Plan has been drawn up to take forward the Review's recommendations and an updated version is included at Annex 2. Many facets of this plan are also addressed as part of the England and Wales NASCO Implementation Plan.

The review also concluded that, whilst additional controls on exploitation were not by themselves a solution, in some instances further controls would be appropriate to protect stocks in decline and under significant pressures. To assist in applying fisheries regulations in a logical and consistent manner, and consistent with NASCO guidance, a "decision structure for determining fishing controls on salmon fisheries in England and Wales" has been produced. This tool focuses on an assessment of the probability of achieving the management target for a given river's salmon stock (taking into account habitat and exploitation) and indicates the level of change in exploitation rate required in order to improve failing rivers. The decision structure is used as part of an annual process and it is followed when existing regulations – both NLOs and byelaws – are reviewed. Most recently it was applied to the Christchurch (Avon and Stour) and Poole Harbour (Piddle and Frome) NLO reviews. A schematic representation of the decision structure is provided at Annex 2.

4. THE ICES ASSESSMENT OF THE STATUS OF SALMON STOCKS IN ENGLAND AND WALES

4.1 *Description of the assessment methodology*

Each year, the ICES North Atlantic Salmon Working Group makes an assessment of the status of the salmon stocks in the Northeast Atlantic (NEAC) area as a basis for advising managers. A key part of this assessment is the estimation of the pre-fishery abundance (PFA) of all NEAC stocks. The PFA of salmon from countries in the NASCO-NEAC area is defined as the number of fish alive in the sea on January 1 in their first sea winter. This is split between maturing (potential 1SW) and non-maturing (potential MSW) fish. ICES uses estimates of PFA for the period 1971 to the present to investigate the effect of fisheries and other natural and anthropogenic factors on stocks. ICES has also used these estimates to develop a forecast of PFA for coming seasons in order to advise on management actions.

The model that ICES uses to estimate PFA for NEAC countries first estimates the returns of salmon to freshwater, and then back-calculates the numbers of fish that must have been alive in the sea to generate these returns. The numbers of returning fish are estimated using the catch data for each country, which are raised to take account of non-reported catches and exploitation rates for 1SW and MSW fish. These values are then further raised to take account of catches in the distant water fisheries and natural mortality between January 1 in the first sea winter and their return to homewaters. Ranges of values are used for some of the input data in order to obtain a measure of the uncertainty in the PFA estimates. In order to run the NEAC PFA model, each country requires time-series (beginning in 1971) of catch in numbers, non-reporting rates and exploitation rates for 1SW and MSW salmon.

For England & Wales, nominal catches have been derived from the catch returns submitted by netmen and anglers and split into 1SW and MSW categories using two different methods. Over the period 1992-2007, monthly age-weight keys derived from salmon caught in the River Dee trap have been used to estimate the age of all rod-caught fish where a weight and date of capture have been provided. This has then been scaled up to the total catch (rods and nets combined) on a pro-rata basis. In earlier years (1971-1991), the age composition of the total catch has been estimated using the mean weight of the fish caught and the mean weight of 1SW and MSW salmon recovered in tagging programmes. Estimates of unreported and illegal catches have been made on the basis of consultation with regional fisheries personnel and according to the approach described in Section 2.3.

As the contribution of farmed and ranched salmon to the national England and Wales catch is negligible (see Section 2.6), the occurrence of such fish is ignored in the assessments of the status of national stocks. However, a large proportion of the fish taken in the north east coast fishery are destined for Scottish rivers, and these are deducted from the returning stock estimate for England and Wales and added to the data for Scotland in the ICES assessment. This proportion is estimated to have declined from 95% of the north east net catch in the early part of the time-series to 75% more recently and to around 65% since 2003. This reflects both the steady improvement in the status of the stocks in north east England and the phase out of the fishery in 2003 (Section 2.1.3). The latter resulted in a major overall reduction in the fishery, with the majority of the remaining netmen now fishing close inshore using T- or J-nets. Previous tagging studies have shown that these inshore nets exploit a much higher proportion of local fish (Anon., 1991).

Exploitation rates for a number of monitored fisheries in England and Wales are given in Section 2.7.1. National exploitation rates have then been estimated by deriving a time-series of 'standard fishing units' employed in the salmon fisheries for the period 1971 to the present. These are calculated from the numbers of licences issued (Section 1.2.1) weighted by their relative catching power, which is estimated from historic CPUE data. The annual exploitation rates are then estimated by referencing the number of 'standard fishing units' employed relative to age-specific exploitation estimates derived for the 1998 season. Finally, ICES has agreed to apply a natural mortality rate of 3% per month in back-calculating the PFA of salmon in the sea, on the basis of studies undertaken on a range of stocks (ICES, 2002, 2003, 2004, 2005, 2006 and 2007).

Whilst this model is acknowledged as containing a number of uncertainties, it provides our best interpretation of available information on salmon stocks at a national level. Efforts are being made to improve the input data and we hope that progress in that direction is apparent in this and previous annual reports.

4.2 Results of the pre-fishery abundance assessment

The output from the ICES-NEAC model for England and Wales is summarised in Figure 20(a) to (e). The model endeavours to provide our best interpretation of what the available catch and effort data may tell us about changes in the status of the total national stock of salmon over the past three and a half decades. It is important to note that the overall trends may not reflect the patterns of change in any individual river. Indeed, while many river stocks in England and Wales have declined substantially in the past 30 years, there are others, like the Tyne and Wear, that have shown great improvements: the model sums all of these trends. Furthermore, the model is likely to provide a more reliable picture of the medium-term trends than of the year-to-year fluctuations.

The model output suggests that the overall PFA of salmon from England and Wales has declined by almost 70% from the early 1970s to the present time (Figure 20c, in which no estimate is available for MSW fish in 2007). The decrease has been greater in the non-maturing (i.e. potential MSW) component of the PFA, which is thought to have declined by over 80%, whilst the maturing (i.e. potential grilse) component has declined by over 45%. The results also suggest that there was a marked decline in PFA around 1990, which is consistent with the general perception of a decrease in the marine survival for many stocks around the North Atlantic at about this time.

The estimated number of salmon returning to England and Wales (prior to exploitation in home-water fisheries) and the total spawning escapement show similar trends to the PFA (Figure 20a), although the declines are less marked due to the reductions in net exploitation both in distant water and homewater fisheries, and in rod fisheries. Thus, numbers of returning fish are estimated to have declined by around 55% between the early 1970s and the present time, and the spawning escapement by about 40%. However, as with the PFA, the decline in MSW components has been greater than that of 1SW components, by over twice as much in the case of the spawning escapement, and this will have had a disproportionate effect on egg deposition. Figure 20a indicates that there was a slight improvement in the return and spawner numbers in 2000 and 2001, but the general trend has been downward since the late 1980s.

The results also provide an estimate of the total catches in England and Wales, including the non-reported and illegal catches (Figure 20b), and the consequent overall trends in exploitation (Figure 20d). Overall exploitation probably remained at around 40-45% for most of the 1970s and 1980s but has been reduced to around 25% for MSW fish and 15% for 1SW fish in the last decade due to the measures taken to control both legal and illegal fisheries.

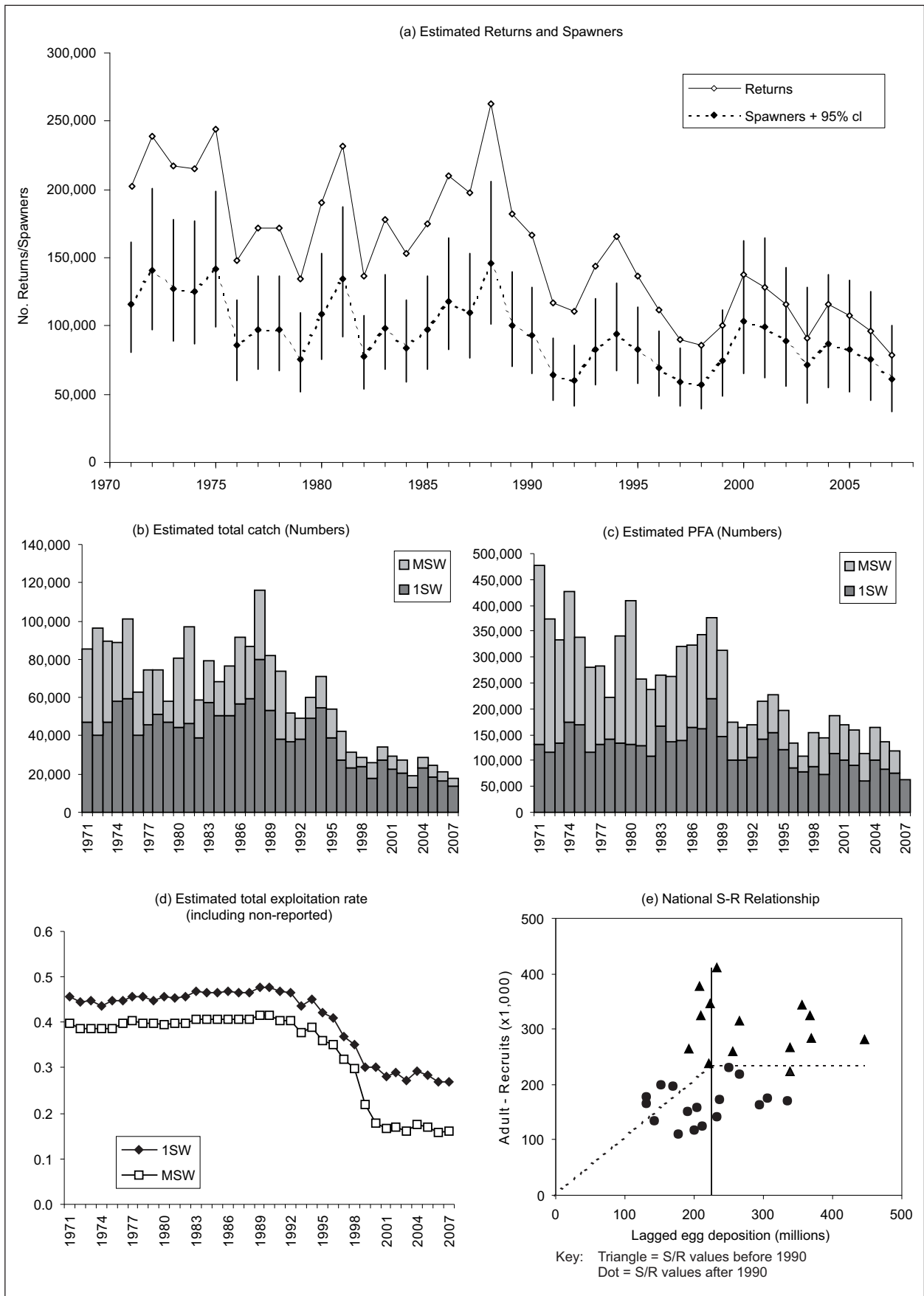


Figure 20(a-e). Summary output from the ICES-NEAC PFA model for UK (England & Wales) for 2007.

Figure 20e shows the relationship between the numbers of spawners (the lagged egg deposition, expressed as millions of eggs) for the national stock and the subsequent production in the next generation (the recruits = PFA). As expected, production (recruits) appears to have been reduced in years of poor spawner abundance (low egg deposition), but there is also evidence of lower recruitment at all levels of egg deposition since 1990 (dots) compared with earlier years (triangles). This possibly reflects an increase in marine mortality at about this time.

4.3 Management measures taken to conserve salmon stocks

The preliminary assessment for ICES has indicated that the estimated number of salmon returning to England and Wales has declined by around 55% between the early 1970s and the present time, and the decline in MSW fish has been substantially greater than that of 1SW fish.

As noted above, total exploitation was probably at around 40 to 45% for most of the 1970s and 1980s, but has been reduced by approaching 60% for MSW fish and 40% for 1SW fish over the last fifteen to twenty years. This has been due to the measures taken to control both legal and illegal fisheries in England and Wales and to eliminate mixed stock fisheries. These have included the introduction of phase outs for 17 fisheries, the first of which started in 1993, and which by 2007 had achieved the aim of zero effort in all but 6 cases. In 9 fisheries, the phase out has been accelerated by buy outs using both private and government funds. Since 1993, the number of net licences has declined by 51% and, in many of the remaining fisheries, the open season for taking salmon has been severely curtailed (especially since 1999 when nets were prohibited from taking salmon prior to June 1st). As a consequence, net catches comprised 36% of total catches of salmon in England and Wales (including released fish) in 2007, compared to 82% in 1989. The increase in catch and release in rod fisheries from 10% in 1993 to around 50% since 2002 has also contributed substantially to the reduction in exploitation levels.

In 2004, the Environment Agency carried out a Salmon Stock Conservation Review (SSCR) that aimed to estimate the extent to which each of the principal salmon rivers in England and Wales will achieve compliance with their CL by 2008 and in the longer term. It concluded, at that time, that only 19 rivers in England and 6 in Wales (out of 62) were expected to exceed their CLs in 2008 with high probability, whilst a further 8 may do so but with a greater degree of uncertainty. The current assessment of compliance suggests that only 11 rivers in England and Wales (out of 64) have a high probability of meeting the management objective in 2012 (i.e. meeting or exceeding the CL in 4 years out of 5, on average), with a further 34 rivers having neither a clear pass nor failure. A key concern is that the trend in estimated egg deposition on many rivers, particularly in the South and West of England and parts of Wales, is currently downwards.

The SSCR also concluded, that although exploitation within catchments was not generally considered a primary factor limiting salmon spawning in most rivers, further reductions in exploitation may be necessary to help sustain and improve stocks. Measures applying in 2007 are outlined in Section 1.2. To assist in applying fisheries regulations in a logical and consistent manner, the use of a decision structure has now become part of an annual process (Annex 2).

The Irish drift net fishery has been a significant exploiter of some salmon stocks on the west and south coasts, and the closure of this fishery in 2007 is expected to have benefited these stocks (Section 2.7.2). Water quality problems (attributed to industrial discharges, agricultural pollution, metal mining, sewerage and acidification) also affect many rivers, as does reduced flow rate. Channel structure and siltation due to intensive agriculture, forestry and the downstream impacts of water supply reservoirs were perceived as a key problem in all rivers, whilst obstructions had substantial effects on some rivers. In contrast, rivers in the North East and some in the North

West are showing an upward trend in salmon runs, the former clearly benefiting from improved estuarine water quality and, more recently, from the buy out of the majority of the north east coast drift nets (see Section 2.1.3).

5. REFERENCES

- ALABASTER, J.S. AND GOUGH, P.J., 1986. The dissolved oxygen and temperature requirements of Atlantic salmon, *Salmo salar* L., in the Thames Estuary. *Journal of Fish Biology* 29: 613-621.
- ANON., 1991. Salmon Net Fisheries: Report of a review of salmon net fishing in the areas of the Yorkshire and Northumbria regions of the National Rivers Authority and the salmon fishery districts from the River Tweed to the River Ugie. MAFF and Scottish Office, 224 pp.
- ANON., 1994. Run timing of salmon. Report of the Salmon Advisory Committee. MAFF Publications, London, 55 pp.
- ANON., 1997. Report of the Technical Working Group on the English North East Coast Salmon Fishery. Report prepared by MAFF, SOAEFD and EA scientists following a meeting held at Nobel House, London on 17 December 1996.
- ANON., 1999. Run timing of salmon. Report of the Salmon Advisory Committee. Ministry of Agriculture, Fisheries and Food, Scottish Office Agriculture and Fisheries Department, Welsh Office Agriculture Department, 55 pp.
- APRAHAMIAN, M.W., DAVIDSON, I.C. AND COVE, R.J., 2008. Life history changes in Atlantic salmon from the River Dee, Wales. *Hydrobiologia* 602, 61-78.
- BALL M. AND APRAHAMIAN M.W. 1993. An analysis of salmon rod catch data from Castle Fisheries, River Derwent, 1923-1989. Technical report NRA/NW/FTR/93/13, Environment Agency, Bristol, 51 pp.
- CHURCHWARD, A.S. AND HICKLEY, P. 1991. The Atlantic salmon fishery of the River Severn (UK). *In* Catch effort sampling strategies, their application in freshwater fisheries management. Edited by I.G. Cowx. Fishing news Books, Oxford., 1-14.
- COOKE, S.J. and SUSKI, C.D. 2004. Are circle hooks an effective tool for conserving marine and freshwater recreational catch and release fisheries? *Aquatic Conservation: Marine and Freshwater Ecosystems* 14: 299-326.
- CRAGG-HINE, D., BRADLEY, D.C. AND HENDRY, K. 2006. Changes in salmon smolt ages in the Welsh River Dee over a 66 year period. *Journal of Fish Biology.*, 68: 1891-1895.
- CROZIER, W.W., POTTER, E.C.E., PREVOST, E., SCHON, P-J. AND O'MAOILEIDIGH, N. (EDITORS) 2003. A coordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the North-East Atlantic (SALMODEL). Queens University of Belfast, Belfast. 431 pp.
- DANIE, D.S., TRIAL, J. G. AND STANLEY, J. G. 1984. Species profiles: life histories and environmental requirements of coastal fish and invertebrates (North Atlantic) — Atlantic salmon. U.S. Fish & Wildlife Service. FWVOBS-82/11.22. U.S. Army Corps of Engineers, TR EL-82-4. 19 pp.

- DAVIDSON, I.C. AND HAZELWOOD, M.S., 2005. Effect of climate change on salmon fisheries. Environment Agency Science Report W2-047/SR. Environment Agency, Bristol.
- DAVIDSON, I.C. AND COVE R.J. 2006 Dee Stock Assessment Programme Annual Report 2005. Environment Agency, National Fisheries Technical Team.
- DAVIDSON, I.C., HAZELWOOD, M.S. AND COVE, R.J. 2006. Predicted growth of juvenile trout and salmon in four rivers in England and Wales based on past and possible future temperature regimes linked to climate change. *In* Sea Trout: biology, conservation and management. Edited by G.S. Harris & N.J. Milner. Proceedings of First International Sea Trout Symposium, Cardiff, July 2004. Fishing News Books, Blackwell Scientific Publications, Oxford: 401-416.
- ENVIRONMENT AGENCY, 1998. Salmon Action Plan Guidelines Version 1, Environment Agency.
- ENVIRONMENT AGENCY, 2003(a). "Review of the Spring Salmon Measures" a Regional Fisheries Ecology & Recreation Advisory Committee Discussion paper, June 2003 available at www.environment-agency.gov.uk/fish.
- ENVIRONMENT AGENCY, 2003(b). Salmon Action Plan Guidelines, Version 2, Environment Agency, April 2003.
- ENVIRONMENT AGENCY, 2005. Fisheries Statistics 2004 - Salmonid and freshwater fisheries statistics for England and Wales, 2004, 34 pp.
- ENVIRONMENT AGENCY, 2006 Monitoring salmon and sea trout in the River Tamar: River Tamar Index report three - 2005. Environment Agency, Ecological Appraisal Team/FRB Team, Cornwall Area.
- ENVIRONMENT AGENCY, 2007 Summary of significant water management issues consultation. http://www.environment-agency.gov.uk/subjects/waterquality/955573/1001324/1321809/1603386/1954818/?version=1&lang=_e
- GOUGH, P.G., WINSTONE A.J. AND HILDER, P.G. 1992. Spring salmon: a review of factors affecting the abundance and catch of spring salmon from the River Wye and elsewhere, and proposals for stock maintenance and enhancement. National Rivers Authority Welsh Region Technical Fisheries Report No. 2. National Rivers Authority, Bristol, 57 pp.
- HARRIS, G., 1994. The identification of cost-effective stocking strategies for migratory salmonids. Environment Agency, R&D Report No. 353, 150 pp.
- HULME, M., JENKINS, G. J., LU, X., TURNPENNY, J. R., MITCHELL, T. D., JONES, R. G., LOWE, J., MURPHY, J. M., HASSELL, D., BOORMAN, P., MCDONALD, R. AND HILL, S. 2002. Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report. Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia. Norwich, U.K. 112 pp.
- ICES., 2002. Extract of the report of the Advisory Committee on Fishery Management - North Atlantic Salmon Stocks. ICES CNL(02)10.
- ICES., 2003. Report of the Working Group on North Atlantic Salmon. ICES C.M. 2003/ACFM:19.

- ICES., 2004. Report of the Working Group on North Atlantic Salmon. ICES C.M. 2004/ACFM:12.
- ICES., 2005. Report of the Working Group on North Atlantic Salmon. ICES C.M. 2005/ACFM:17.
- ICES., 2006. Report of the Working Group on North Atlantic Salmon. ICES C.M. 2006/ACFM:23.
- ICES., 2007. Report of the Working Group on North Atlantic Salmon. ICES C.M. 2007/ACFM:13.
- JONES, J.W. 1939. Salmon of the Cheshire Dee, 1937 and 1938. Transactions of the Liverpool Biological Society 52: 19-79.
- JONES, J.W. 1949. Studies of the scales of young salmon (*Salmo salar* L. (Juv.)) in relation to growth, migration and spawning. Fisheries Investigations Series 1, V.
- LEES, P.R. 1972. The salmonid fish of the rivers Dee and Clwyd. Ph.D. Thesis, University of Liverpool, Liverpool.
- MAINSTONE, C. P., BARNARD, S. AND WYATT, R. J., 1994. Development of a fisheries classification scheme. National Rivers Authority R & D Project 244/7/Y. Environment Agency, Bristol, 220 pp.
- MILNER, N. J., WYATT, R. J. AND BROAD, K., 1998. HABSCORE – applications and future developments of related models. Aquatic Conservation: Marine and Freshwater Ecosystems, 8: 633-644.
- MILNER, N., DAVIDSON, I., EVANS, R., LOCKE, V. AND WYATT, R., 2001. The use of rod catches to estimate salmon runs in England and Wales. Paper for Atlantic Salmon Trust Workshop, Lowestoft, November 2001.
- MILNER, N.J. AND EVANS, R., 2003. The incidence of escaped Irish farmed salmon in English and Welsh rivers. Fisheries Management & Ecology, 10, 403-406.
- NASCO., 2002. Decision Structure for management of North Atlantic salmon fisheries, CNL31.332, November 2002, available at www.nasco.int
- RIVER TWEED COMMISSION, 2007. Annual Report.
http://www.rtc.org.uk/2007_Annual_Report/2007_annual_report.html
- RUSSELL, I.C., IVES, M.J., POTTER, E.C.E., BUCKLEY, A.A. AND DUCKETT, L., 1995. Salmon and migratory trout statistics for England and Wales, 1951-1990. MAFF Directorate of Fisheries Research, Data Report No. 38, 252 pp.
- RUSSELL, I.C. AND POTTER, E.C.E., 1996. Interception salmon fisheries - assessing their impact on national stocks. Proceedings of the IFM Study Course, Cardiff, Sept. 1993.
- SMALL, I., 1991. Exploring data provided by angling for salmonids in the British Isles. In: I.G. Cowx (ed.) Catch effort sampling strategies. Their application in freshwater fisheries management. Oxford: Fishing News Books, pp 81-91.
- SOLOMON D.J., 1990. River Avon salmon radio tracking: Report for 1989. National Rivers Authority (Wessex Region).

- TODD, C.D., HUGHES, S.L., MARSHALL, C.T., MACLEAN, J.C., LONERGAN, M.E. AND BIUW, E.M., 2008. Detrimental effects of recent ocean surface warming on growth condition of Atlantic salmon. *Global Change Biology*, 14, 1-13.
- WEBB, J., 1998(a). Catch and Release: behaviour and summary of research findings. In: Atlantic Salmon Trust, Progress Report. December 1998.
- WEBB, J., 1998(b). Catch and release: the survival and behaviour of Atlantic salmon angled and returned to the Aberdeenshire Dee, in spring and early summer. Scottish Fisheries Research Report Number 62/1998.
- WELTON, J.S., BEAUMONT, W.R.C. AND LADLE, M. 1999. Timing of migration and changes in age structure of Atlantic salmon, *Salmo salar* L., in the River Frome, a Dorset chalk stream, over a 24-year period. *Fisheries Management & Ecology*, 6: 437-458.
- WHORISKEY, F.G., PRUSOV, S. AND CRABBE, S., 2000. Evaluation of the effects of catch and release angling on the Atlantic salmon of the Ponoj River, Kola Peninsula, Russian Federation. *Ecology of Freshwater Fish*, 2000: 9: 118-125.
- WOOLLAND, J.V. 1972. Studies on Salmonid Fishes in Llyn Tegid and the Welsh Dee. Ph. D. Thesis, University of Liverpool, Liverpool.
- WYATT, R. J. 2002. Estimating riverine fish population size from single-and multiple-pass removal sampling using a hierarchical model. *Canadian Journal of Fisheries and Aquatic Sciences*, 59: 695-706.
- WYATT, R. J. 2003. Mapping the abundance of riverine fish populations: integrating hierarchical Bayesian models with a geographic information system (GIS). *Canadian Journal of Fisheries and Aquatic Sciences*, 60: 997–1006.
- WYATT, R. J. 2005. River Fish Habitat Inventory Phase 2: Methodology development for juvenile salmonids. Science Report SC9800006/SR. Environment Agency, Bristol.

GLOSSARY – Terms and abbreviations used in this report

This glossary has been extracted from various sources, but chiefly the EU SALMODEL report (Crozier *et al.*, 2003) and the Environment Agency's SAP reports.

Adult Salmon after the middle of the first sea-winter, after which the main categorisation is by sea-age, measured in sea-winters (e.g. two sea winter, or 2SW).

Abstraction Taking water, either permanently or temporarily, from a water source (river, stream, spring, pond, lake or groundwater).

Anadromous fish Fish, born in freshwater, that migrates to sea, to grow and mature, and then returns to freshwater as an adult to spawn (e.g. salmon, sea trout).

Buy out Payment made to a net fisherman to permanently relinquish their fishing licence.

Buy off Payment made to net fishermen to cease fishing (for all or part of the fishing season) on a temporary basis. The fisherman retains entitlement to a licence and a licence is issued to him each season.

By-catch The capture of non-targeted fish.

Catchment The area of land draining to a defined point.

Conservation Limit (CL) The minimum spawning stock levels below which stocks should not be allowed to fall. The CL for each river is set at a stock size (defined in terms of eggs deposited) below which further reductions in spawner numbers are likely to result in significant reductions in the number of juvenile fish produced in the next generation.

Dissolved oxygen The amount of oxygen dissolved in water, one of the features that is used to classify water quality.

Distant-water fisheries Fisheries in areas outside the jurisdiction of the country of origin. With respect to the NASCO convention, this specifically refers to the fisheries under the jurisdiction of the Faroe Islands and Greenland.

EU Directive A European Union (formerly EC - European Community) legal instruction, binding on Member States, but which must be implemented through national legislation within a prescribed time-scale.

Escapement Salmon or sea trout that survive to spawn after exploitation.

Exploitation Removal of fish from a stock by fishing.

Extant exploitation rate Catch of fish from a particular stock divided by the number of fish from that stock estimated to be alive at the time of the fishery.

Fishery The area where it is, or may be, lawful to fish and where the resource is exploitable.

Fixed engine (FE) The term fixed engine is an ancient one used in England and Wales as a general descriptor of stationary fishing gears.

Fry Young salmonids that have hatched out in the current year, normally in May for salmon and trout, at the stage from independence on yolk sac as the primary source of nutrition up to dispersal from spawning areas.

Grilse Adult salmon that have spent only one winter feeding at sea (1SW salmon) before returning to freshwater to spawn; normally only applied to salmon in homewaters.

Homewater fisheries Fisheries within the jurisdiction of the countries of origin (within 12 miles).

MAFF The former Ministry of Agriculture, Fisheries and Food; incorporated in June 2001 into the Department for Environment, Food and Rural Affairs (Defra).

Management target (MT) A spawning stock level for managers to aim at in order to meet the management objective. The 'management objective' used for each river in England and Wales is that the stock should be meeting or exceeding its CL in at least four years out of five (i.e. >80% of the time).

Microtag A coded wire tag 1.1 mm long and 0.25 mm diameter, inserted into the nasal cartilage (snout) of fish and detectable in live fish, but only readable after removal from the carcass.

Mixed stock fishery A fishery exploiting a significant number of salmon from two or more river stocks (NASCO Decision Structure, 2002). The policy in England and Wales is to move to close net fisheries that exploit predominantly mixed stocks where the capacity to manage individual stocks is compromised.

Multi-Sea-Winter (MSW) salmon An adult salmon that has spent two or more winters at sea.

NLO – Net Limitation Order Mechanism within the Salmon and Freshwater Fisheries Act whereby the competent authority may apply to limit the number of nets fishing a public fishery.

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

Parr Juvenile salmonid in the stage following fry until its migration as a smolt or, for non-migratory forms, until it becomes an adult. Salmon parr are typically <16 cm long and have parr-marks (dark vertical bars) on the sides of the body.

Post-smolt Young salmon, at the stage from leaving the river until the middle of its first winter in the sea.

Precautionary approach A concept enshrined in Principle 15 of the Rio Declaration of the UN Conference on Environment and Development, which states: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

Pre-fishery abundance (PFA) The PFA of salmon from England and Wales is defined as the number of fish alive in the sea on January 1 in their first sea winter. This is split between maturing (potential 1SW) and non-maturing (potential MSW) fish.

Production The assimilation of nutrients to produce growth in a population over a given period.

Radio tag An electronic transmitter which emits radio frequencies and is attached to a fish to enable its position to be determined in freshwater.

Recruits The abundance of fish measured at a particular point in the life cycle, e.g. at the juvenile stages, the smolt stage, at the stage of recruitment to the fishery, or as returning spawners.

Reference point An estimated value derived from an agreed scientific procedure and/or model which corresponds to a state of the resource and/or of the fishery and can be used to assess stock status or inform management decisions.

Run The number of adult salmon ascending, or smolts descending, a river in a given year. The main smolt run takes place in spring, whereas adult salmon runs may occur in spring, summer, autumn or winter.

Special Areas of Conservation (SACs) To comply with the EU Habitats Directive (92/43/EEC) on Conservation of Natural Habitat and of Wild Fauna and Flora, which stipulates that member states maintain or restore habitats and species to favourable conservation status, a number of rivers in England and Wales that support important populations of vulnerable qualifying species have been designated SACs. Where salmon is a “qualifying species”, additional protection measures specifically for salmon are required.

Salmon Action Plan (SAP) An agreed list of actions that the Environment Agency, in partnership with outside interests who support the plan, is committed to address in order to meet the objectives of its National Salmon Management Strategy (launched in 1996) at a local level.

Salmonid A fish belonging to the family *Salmonidae*, which includes the Atlantic salmon (*Salmo salar*), trout (*Salmo trutta*), charr (*Salvelinus alpinus*) and rainbow trout (*Oncorhynchus mykiss*).

Sea age The number of winters that a salmon has remained at sea.

Sea trout Anadromous form of the trout (*Salmo trutta*) from the post-smolt stage; the brown trout remains in freshwater throughout its life

Smolt At a particular stage of their development, salmon parr undergo physiological changes, they become silver in appearance and migrate to sea, and are known as smolts. Salmon smolts are typically 12–16 cms long.

Smolt age The number of winters that a salmon remained in freshwater prior to emigration as a smolt (this does not include the winter in which the egg was laid).

Spring salmon Multi-sea-winter salmon which return to freshwater early in the year, usually before the end of May.

Stock A management unit comprising one or more salmon populations, which may be used to describe those salmon either originating from or occurring in a particular area. Thus, salmon from separate rivers are referred to as “river stocks”.

Stocking The intentional release of fish into an ecosystem.

Sustainable use The use of a biological resource in a way and at a rate that does not lead to the long-term decline of its potential to meet the needs and aspirations of present and future generations. Sustainable is not meant to imply that abundance is constant.

ANNEX 1 – International Organisations and European Directives affecting salmon management

North Atlantic Salmon Conservation Organisation

The North Atlantic Salmon Conservation Organisation (NASCO) was established in 1984 following calls for international co-operation on the management of salmon stocks. It is an international body with the objective of contributing through consultation and co-operation to the conservation and rational management of salmon stocks taking account of the best available scientific evidence. NASCO therefore seeks scientific advice on the status of salmon stocks and fisheries and their management from the International Council for the Exploration of the Sea (ICES) (see below). The Contracting Parties to the NASCO Convention are: Canada; Denmark (in respect of the Faroe Islands and Greenland); European Union; Iceland; Norway; the Russian Federation; and the USA. Much of the business of the organisation is conducted by three regional Commissions: the North American Commission; the North East Atlantic Commission; and the West Greenland Commission. One of the main functions of these Commissions is to propose regulatory measures for fisheries of one Party to the NASCO Convention, which exploit salmon originating in the rivers of other Parties. The main fisheries of relevance for the management of European stocks are those operated on the west coast of Greenland and within Faroese waters. In 1998, NASCO adopted the Agreement on the Adoption of a Precautionary Approach; this requires that more caution be exercised when information is uncertain, unreliable or inadequate, and that the absence of adequate scientific information is not to be used as a reason for postponing or failing to take conservation and management measures.

International Council for the Exploration of the Sea

The International Council for the Exploration of the Sea (ICES) provides biological information and advice on a wide range of fish stocks in order to help fisheries managers maintain viable fisheries within sustainable ecosystems. Information is compiled and assessments are conducted by Working Groups, which are comprised of national experts on the specific fish stocks. The Working Group reports are passed to the Advisory Committee on Fisheries Management (ACFM) for peer review and to prepare the advice to managers. The advice may take many forms, but in general it involves: assessments of stock dynamics; evaluation of the status of the stocks; projections of various stock parameters into the future; and management options. For Atlantic salmon, ICES provides advice relating to the list of questions posed by NASCO (Annex 3). The assessment of salmon stocks and their fisheries presents particular problems to the ICES scientists both because of the highly migratory nature of the fish and because they comprise a large number of distinct river stocks which must, to some extent at least, be managed separately.

Habitats Directive

The EU Habitats Directive 92/43/EEC, on Conservation of Natural Habitat and of Wild Fauna and Flora, stipulates that member states maintain or restore habitats and species to favourable conservation status. To comply with this Directive, a number of rivers in England and Wales have been designated Special Areas of Conservation (SACs) because they support important populations of vulnerable qualifying species.

The following rivers in England and Wales are SACs and have salmon as a “qualifying species”, which confers additional protection measures specifically for salmon in these rivers and associated on-line lakes:

Southern Region: Itchen.

South West Region: Hampshire Avon, Camel, Dartmoor Headwaters (Dart, Teign, Erme, Taw, Tavy, Walkham and Yealm).

Wales: Wye, Usk, Teifi, Dee (and Bala Lake), Gwyrfai (and Llyn Cwellyn) and Eden (West Gwynedd - part of the Mawddach catchment).

North West Region: Derwent (and Bassenthwaite Lake), Eden and Ehen.

Only two of these rivers (Camel and Derwent) are currently considered to be complying with the management objective of passing their conservation limit 4 years out of 5.

Water Framework Directive

Salmon management in England and Wales is becoming increasingly linked with the Water Framework Directive (Directive 2000/60/EC) (WFD), and its 6 year planning cycle. The WFD aims to protect and enhance our water environment, updates all existing relevant European legislation, and promotes a new approach to water management through river-based planning. The Directive requires the drawing up of River Basin Management Plans (RBMP) and Programmes of Measures (PoM) with the aim of achieving Good Ecological Status or, for artificial or more modified waters, Good Ecological Potential.

England and Wales has been divided into nine River Basin Districts (RBDs), which are being 'characterised' by assessing the pressures and impacts on the water environment, such as overuse or pollution. Once that is complete, a RBMP for each District will be prepared setting out how these impacts will be reduced through its PoM. Monitoring programmes will then chart progress towards achievement of Good Ecological Status. RBMPs and PoMs need to be agreed, finalised and published by December 2009 for the first round of the WFD planning cycle. The second round plans are to be published in 2015. In the meantime, the supporting environmental monitoring programmes were established by December 2006, and an interim overview of the significant water management issues (SWMI) in each RBD was published for general consultation from July 2007 to January 2008 (Environment Agency, 2007).

Whilst details are still being resolved, the status of salmon stocks will be one important element to take into account. The Environment Agency is taking steps to align its planning processes for salmon with those needed to implement this Directive.

Strategic Environment Assessment Directive

Directive 2001/42/EC (the SEA Directive) requires responsible authorities (public bodies) to undertake Strategic Environmental Assessment (SEA) of the effects of certain categories of plans and programmes. SEA is a tool for integrating wider environmental considerations into the preparation and adoptions of plans thus helping to promote sustainable development.

United Kingdom Biodiversity Action Plan

In 2007, salmon was added to the list of priority species under the UK Biodiversity Action Plan. This will give added emphasis to efforts to conserve and improve salmon populations. Listing brings with it a need for programmes to be developed and delivered by partnerships of statutory, voluntary, academic and business organisations and for status and trends to be recorded and reported.

Summary of Regulatory Measures agreed by NASCO for the West Greenland Salmon Fishery

Year	Allowable catch (tonnes)	Comments/other measures
1984	870	
1985	–	Greenlandic authorities unilaterally established quota of 852t.
1986	850	Catch limit adjusted for season commencing after 1 August.
1987	850	Catch limit adjusted for season commencing after 1 August.
1988–1990	2520	Annual catch in any year not to exceed annual average (840t) by more than 10%. Catch limit adjusted for season commencing after 1 August.
1991	–	Greenlandic authorities unilaterally established quota of 840t.
1992	–	No TAC imposed by Greenlandic authorities but if the catch in first 14 days of the season had been higher compared to the previous year a TAC would have been imposed.
1993	213	An agreement detailing a mechanism for establishing annual quota in each of the years 1993 to 1997 was adopted by the Commission.
1994	159	
1995	77	
1996	–	Greenlandic authorities unilaterally established a quota of 174t.
1997	57	An addendum to the 1993 Agreement was agreed by the Commission.
1998	Internal consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20t.
1999	Internal consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20t.
2000	Internal consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20t. A Resolution Regarding the Fishing of Salmon at West Greenland was agreed by the Commission.
2001	28 – 200	Under an ad hoc management programme the allowable catch will be determined on the basis of CPUE data obtained during the fishery.
2002	20 – 55	Under an ad hoc management programme the allowable catch will be determined on the basis of CPUE data obtained during the fishery.
2003	Internal subsistence consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20t.
2004	Internal subsistence consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20t.
2005	Internal subsistence consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20t.
2006–2008	Internal subsistence consumption fishery only	Amount for internal consumption in Greenland has been estimated in the past to be 20t. The measure applies to 2006 and will also apply in 2007 and 2008 if ICES provides a framework of indicators for use in identifying any significant change in the previously provided multi-annual advice, which is accepted by the Parties. In 2007, ICES provided a framework of indicators that was accepted by the West Greenland Commission. The framework of indicators confirmed that no change in the previously provided multi-annual advice was warranted for 2008 so the multi-annual regulatory measure agreed in 2006 will apply to the 2008 fishery.

Information supplied courtesy of NASCO.

Summary of Regulatory Measures agreed by NASCO for the Faroese Salmon Fishery

Year	Allowable catch (tonnes)	Comments/other measures
1984–85	625	
1986	–	
1987–89	1790	Catch in any year not to exceed annual average (597t) by more than 5%.
1990–91	1100	Catch in any year not to exceed annual average (550t) by more than 15%.
1992	550	
1993	550	
1994	550	
1995	550	
1996	470	No more than 390 tonnes of the quota to be allocated if fishing licences issued.
1997	425	No more than 360 tonnes of the quota to be allocated if fishing licences issued. 1998380 No more than 330 tonnes of the quota to be allocated if fishing licences issued.
1999	330	No more than 290 tonnes of the quota to be allocated if fishing licences issued.
2000	300	No more than 260 tonnes of the quota to be allocated if fishing licences issued.
2001–2003	No quota set	It is the intention of the Faroese authorities to manage the fishery in a precautionary manner with a view to sustainability, and to make management decisions with due consideration to the advice from ICES concerning status of stocks contributing to the fishery.
2004–2006	No quota set	It is the intention of the Faroese authorities to manage the fishery on the basis of the advice from ICES concerning status of stocks contributing to the fishery in a precautionary manner with a view to sustainability and taking into account relevant factors such as socio-economic needs and other fisheries on mixed stocks.
2007	No quota set	It is the intention of the Faroese authorities to manage any salmon fishery on the basis of the advice from ICES regarding the stocks contributing to the Faroese salmon fishery in a precautionary manner and with a view to sustainability, taking into account relevant factors such as socio-economic needs. The decision applies to 2007 and will also apply in 2008 and 2009 if ICES provides a framework of indicators for use in identifying any significant change in the previously provided multi-annual advice, which is accepted by the Parties.
2008	No quota set	It is the intention of the Faroese authorities to manage any salmon fishery on the basis of the advice from ICES regarding the stocks contributing to the Faroese salmon fishery in a precautionary manner and with a view to sustainability, taking into account relevant factors such as socio-economic needs.

Note: The quotas for the Faroe Islands detailed above for the period 1984-2000 were agreed as part of effort limitation programmes (limiting the number of licences, season length and maximum number of boat fishing days) together with measures to minimise the capture of fish less than 60cm in length. The measure for 1984/85 did not set limits on the number of licences or the number of boat fishing days.

Information supplied courtesy of NASCO.

ANNEX 2 – Salmon management procedures/developments in England and Wales

The Environment Agency's catch return system

The Environment Agency and its predecessor the National Rivers Authority have operated a national catch return system since 1995. The first national catch reminder was issued to anglers (regardless of whether a return had already been made) in January 1995, in respect of the 1994 season. For 1995, the reminder was brought forward to November, closer to the end of the fishing season in most regions. The reporting and reminder system has been subject to a number of difficulties, not least the problem of collating licence counterfoils from over 17,000 outlets and inputting details onto a database in time for the November reminder. In 2001, improvements to the database enabled more effective targeting of reminders. These improvements also made possible the issue of a second reminder (sent to all anglers who had not sent in a return by 11 January), in line with NASCO recommendations, in order to reduce the level of unreported catch. This was undertaken nationwide for the first time early in 2002, in respect of catches for the 2001 season, and has continued in 2003–2007. In 2005 a further improvement resulted from the electronic issuing of licences by the Post Office. This provided a more up-to-date and accurate database for issuing reminders.

Conservation Limits and Management Targets

Setting conservation limits

The use of conservation limits (CLs) in England and Wales has developed in line with the requirement of ICES and NASCO to set criteria against which to give advice on stock status and the need to manage and conserve individual river stocks. CLs indicate the minimum desirable spawning stock levels below which stocks should not be allowed to fall. The CL is set at a stock size below which further reductions in spawner numbers are likely to result in significant reductions in the number of juvenile fish produced in the next generation.

Two relationships are required to derive the CLs:

- (i) a **stock-recruitment curve** – defining, for the freshwater phase of the life cycle, the relationship between the number of eggs produced by spawning adults (stock) and the number of smolts resulting from those eggs (recruits).
- (ii) a **replacement line** – converting the smolts emigrating from freshwater to surviving adults (or their egg equivalents) as they enter marine homewaters. This relationship requires an estimate of the survival rate at sea.

The model used by the Environment Agency to derive a stock-recruitment curve for each river assumes that juvenile production is at a 'pristine' level for that river type (i.e. is not affected by adverse water quality, degraded physical habitat, etc).

Similarly, in deriving the replacement line, marine survival rates for most river stocks were assumed to be equivalent to the rates estimated on UK monitored rivers (such as the North Esk) in the 1960s and 1970s. Default survival values recommended for this purpose were 25% for 1SW salmon and 15% for MSW fish (Environment Agency, 1998). However, that period is thought

to be one of high sea survival, and new default values of 11% for 1SW salmon and 5% for MSW fish which are more representative of sea survival over the last 20 years were introduced by the Environment Agency in April 2003 (Environment Agency, 2003b).

These rates have now been applied in calculating CLs for all rivers with Salmon Action Plans (SAPs). Since 2003, the CLs for all principal salmon rivers for which egg deposition estimates are included in this report have incorporated the new lower marine survival estimates. The net effect of these changes has been to reduce the CLs: the scale varies from river to river, but resulted in a 26% reduction, on average, in England and Wales from values used prior to 2003.

Introducing marine survival rates which are intended to be closer to those currently experienced by UK salmon stocks will reduce the effect of high mortality at sea as a cause of failing CLs. This will help managers focus on other issues over which they have more control (e.g. poor environmental quality in-river, over-exploitation by net and rod fisheries, etc.) when compliance failure occurs. The reduction in CLs means, however, that lower levels of spawning escapement are accepted before the stock is considered to be threatened. The Environment Agency also uses the 'management objective' for each river (e.g. in reviewing management actions and regulations) that the stock should be meeting or exceeding its CL in at least four years out of five. This management objective is built into statistical procedures for assessing compliance with CLs (below).

Compliance assessment

The performance of salmon stocks in England and Wales is assessed using a compliance scheme designed to give an early warning that a river has fallen below its CL. An approach introduced in 2004 provides a way of summarising the performance of a river's salmon stock over the last 10 years (including the current year), in relation to its CL. Bayesian regression analyses are applied to egg deposition estimates from the last 10 years, on the assumption that there might be an underlying linear trend over the period. The method fits a 20 percentile regression line to the data and calculates the probability that this regression line is above the CL, and thus that the CL will be exceeded four years out of five (the management objective). If there is a low probability (less than 5%) that the 20 percentile regression line is above the CL, the river fails to comply (is regarded 'at risk'). If the probability is high (more than 95%), the river complies in that year (is 'not at risk'), whereas between these probability values we cannot be certain of the stock status (the river is assessed as either 'probably at risk' ($5\% < p < 50\%$) or 'probably not at risk' ($50\% \leq p < 95\%$)). The results are in broad agreement with the previous compliance scheme. The current scheme also allows the 20 percentile regression line to be extrapolated beyond the current year in order to predict the likely future performance of the stock relative to its CL, and so assess the likely effect of recent management intervention and the need for additional measures.

The compliance plots for the Rivers Yorkshire Esk, Ogwen, Calder and Tawe are shown in Figure 21 as examples. These include individual egg deposition estimates (black dots on the graphs) for the years 1998-2007, the 20 percentile regression lines and (shaded) 90% confidence intervals, and the CL lines (represented by up to three symbols: X, O and Δ).

When the upper bound (95 percentile) of the regression line confidence interval is below the CL line the river is judged to be failing its CL (i.e. there is a $\geq 95\%$ probability of failure or the river is 'at risk'). For example, this is the case on the Yorkshire Esk from 1998 to 2005 and is indicated by the X symbol on the CL line. When the lower bound (5 percentile) of the regression line confidence interval is above the CL line the river is judged to be passing its CL (i.e. there is a $\leq 5\%$ probability of failure and the river is 'not at risk'). This is the case on the Yorkshire Esk from 2009 to 2012 and is indicated by the Δ symbol on the CL line. Between these two extremes, the shaded con-

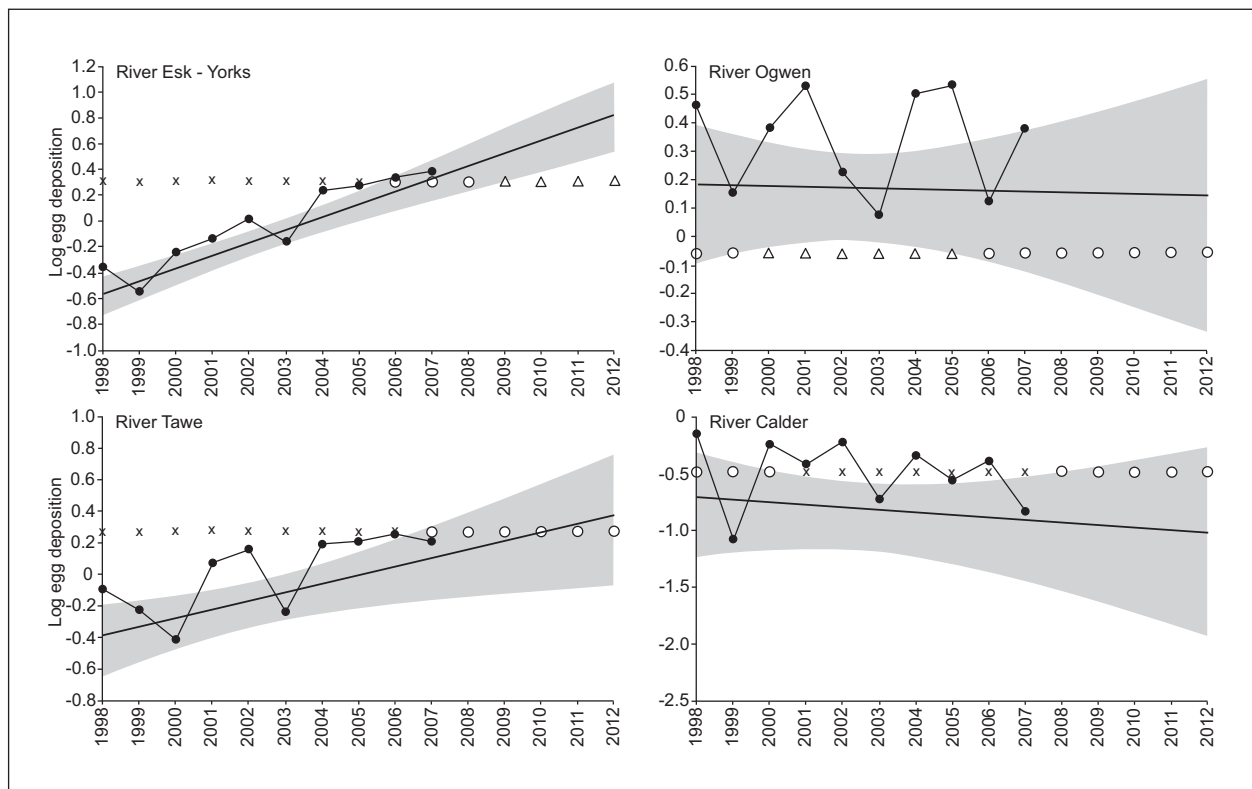


Figure 21. Example compliance plots for the Rivers Yorkshire Esk, Ogwen, Calder and Tawe, based on egg deposition estimates for 1998-2007.

confidence interval of the regression line overlaps the CL line and so the status of the river is judged as 'uncertain' (i.e. the probability of failure is >5% but <95%, and the river is either 'probably at risk' or 'probably not at risk'). This is the case on the Yorkshire Esk from 2006 to 2008 and is indicated by the O symbol on the CL line.

Egg deposition estimates for a river may be consistently above the CL but status may still be uncertain. This is the case on the Ogwen from 1998 to 1999 and from 2006 to 2012 (O symbol on the CL line). In part, this reflects the marked year-to-year variation in egg deposition estimates on this river, which produces a broad confidence interval around the regression line, but also arises because of the increasing uncertainty associated with all regressions once extrapolated beyond the data set.

As well as providing an assessment of the status of a river in relation to its CL, the direction of the trend in the 10-year time-series of egg deposition estimates and its statistical significance may also serve as an important indicator of the need to take management action and of the degree of intervention required. For example, CL compliance projections for the Rivers Tawe and Calder both indicate 'uncertain' status in the latter part of the time series: 2007 to 2012 for the Tawe and 2008 to 2012 for the Calder (in both cases the upper 95 percentile of the regression line confidence interval is close to the CL), but the negative trend on the Calder, in contrast to the positive trend on the Tawe, would give additional cause for concern.

The Management Target (MT) for each river is a spawning stock level for managers to aim at, to ensure that the objective of exceeding the CL is met four years out of five in the long run (i.e. 80% of the time). The value of the MT has been estimated using the standard deviation (SD) of egg deposition estimates for the last 10 years, where: $MT = CL + 0.842 * SD$. The constant 0.842 is taken from probability tables for the standard normal distribution, such that the CL forms the 20 percentile of a distribution, the average (or 50 percentile) of which equates to the MT.

CLs and MTs form only one part of the assessment of the status of a stock, and management decisions are never based simply on a compliance result alone. Because stocks are naturally variable, the fact that a stock is currently exceeding its CL does not mean that there will be no need for any management action. Similarly, the fact that a stock may fall below its CL for a small proportion of the time may not mean there is a problem. Thus, a range of other factors are taken into account, particularly the structure of the stock and any evidence concerning the status of particular stock components, such as tributary populations or age groups, based for example on patterns of run timing and the production of juveniles in the river sub-catchments. These data are provided by a programme of river catchment monitoring (Section 3.1.3).

The Environment Agency is continuing to review and revise its procedures for using reference points and other modelling techniques in the assessment and management of salmon stocks. Work is underway to better reflect real exploitation rates, where these are available, in stock assessments, and to review the balance between use of default (generic) and river-specific data. The assessment approach described above is now incorporated into the national decision structure (see flow chart below) for guiding decisions on fishery regulations.

Salmon Action Plans

A programme of Salmon Action Plans (SAPs) for the principal salmon rivers in England and Wales was finalised in April 2004; there are 64 SAP rivers (see Figure 2). SAPs are the means by which the Environment Agency aims to meet the objectives of its National Salmon Management Strategy (launched in 1996) at a local level. Each SAP is the result of responses to a Consultation Document that reviewed stock and fishery status, identified factors limiting these, and listed a series of costed options to address them. These were circulated to outside interests to seek their opinion and support for the plan. The Final Plan contains an agreed list of actions that the Environment Agency, in partnership with others, is committed to address in the five year lifetime of the plan. Progress against these actions is reviewed annually at both regional and national levels, but is not included in this report. The SAPs are now progressively being reviewed to ensure that they continue to match current circumstances and provide a realistic programme to address the issues facing each river.

River Fish Habitat Inventory

The Environment Agency has completed an R&D project to develop a "River Fish Habitat Inventory" (RFHI). This project developed a methodology that combines statistical modelling techniques with a Geographical Information System (GIS) for producing a quantitative inventory of the juvenile salmonid habitat and populations present within a catchment.

The models for quantifying habitat were calibrated on reference sites throughout England and Wales that were not considered to be impacted by factors such as access for migratory adults, water quality or sedimentation problems. The models operate at two levels: one is based on a very simple assessment of map-based variables from GIS, such as altitude and catchment area; and the other includes field-based variables from habitat surveys, such as substrate and flow types (Wyatt, 2005). The primary application for these models will be to improve the basis for setting salmon CLs (Wyatt, 2005).

The models for quantifying juvenile populations are based on annual electrofishing data, and interpolate/extrapolate these data throughout a catchment using the habitat models described above (Wyatt, 2003). The method can be applied to sites that have been sampled by either single or mul-

multiple pass removal, by using the capture probabilities from the multiple-pass sites to help interpret the catches at the single-pass sites (Wyatt, 2002). The primary application for these models will be the quantitative assessment of freshwater impacts on juvenile salmonids at a catchment scale.

Stock Conservation Review and Decision Structure

The following table details the actions resulting from the Environment Agency's 2004 Salmon Stock Conservation Review and the progress in addressing these up to March 2008. The schematic flow chart following this illustrates the new decision structure for assessing the need for fishing controls, together with explanatory notes for its use. Other management measures for salmon are set out in the UK(England and Wales) NASCO Implementation Plan.

ENVIRONMENT AGENCY – SALMON STOCK CONSERVATION IN ENGLAND AND WALES

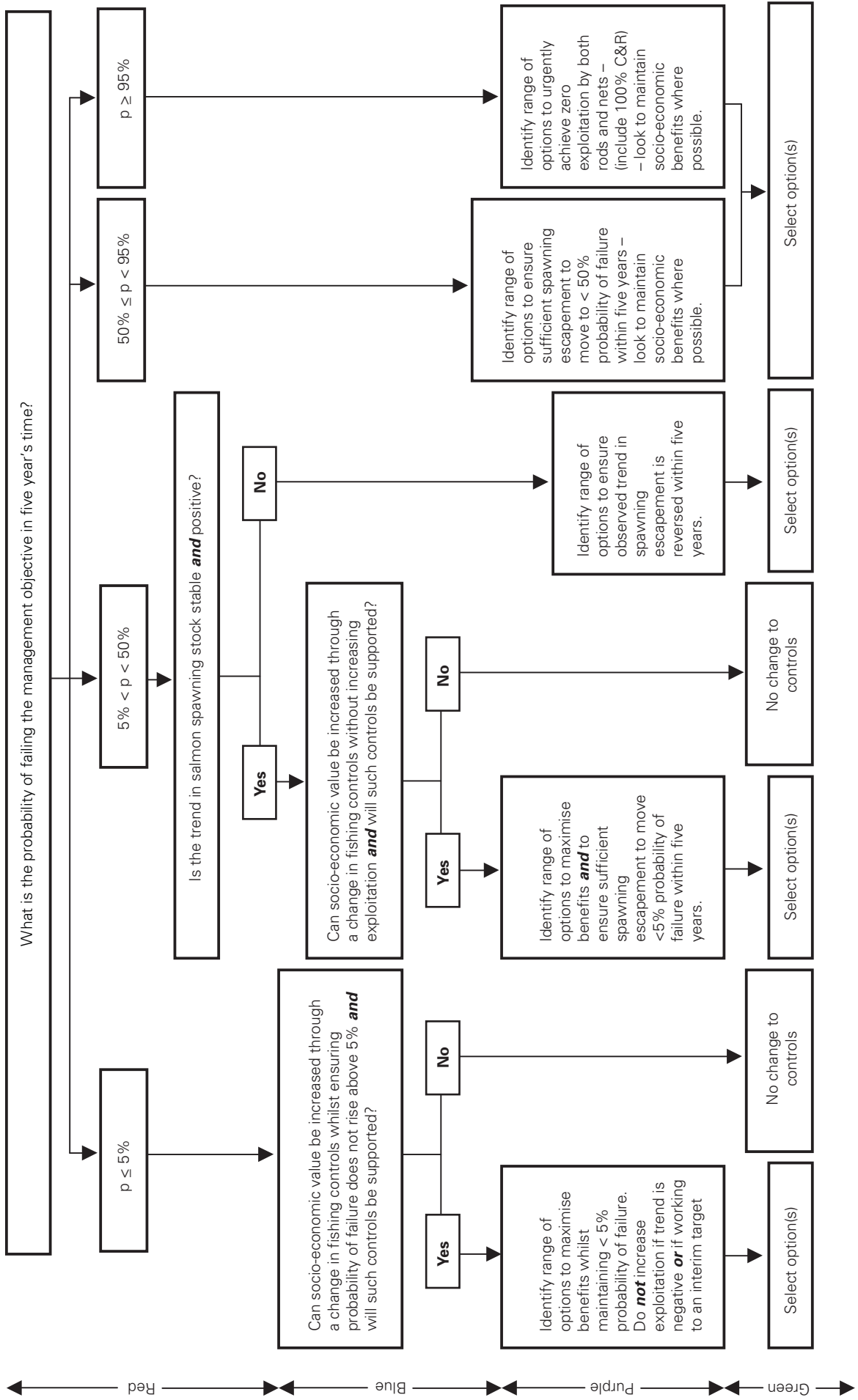
Action Plan resulting from 2004 Review - with progress to December 2007

Organisations & individuals	Key actions required	Suggested Timescale	Progress to December 2007
<p>NASCO (EU delegation)</p>	<ul style="list-style-type: none"> - Help to maintain lowest possible exploitation of salmon in Greenland, Faroes and international waters. - Co-ordinate research into cause of reduced marine survival. 	<p>On-going</p>	<ul style="list-style-type: none"> - The current exploitation rate of the Greenland fishery on English and Welsh salmon is insignificant - less than one percent. There was no salmon fishing in the Faroes during the previous six winters to 2006/07 and none expected to 2009 - except possibly some small-scale research fishing. - A steering group with representatives of 5 NASCO Parties and 5 NGOs is responsible for promotion and fund-raising for a major phase of marine work. Governments have been asked to allocate time within research vessel schedules in 2008 and 2009 to support the programme. EU funding has been secured.
<p>UK Governments (Defra and WAG)</p>	<p>Irish drift net fishery:</p> <ul style="list-style-type: none"> - Seek reduction in exploitation of English and Welsh salmon to a negligible level (less than 1%). The Agency will continue to provide supporting information. (UK Government and the European Commission lead in international affairs.) <p>Riverine habitat:</p> <ul style="list-style-type: none"> - continue and expand the range of initiatives to bring about significant changes in land use, in particular agriculture, and factors causing diffuse pollution (including siltation and pesticides) - including agri-environment schemes, information campaigns and tighter regulation. <p>Legislation & funding:</p> <ul style="list-style-type: none"> - improve legislation and funding arrangements to support reductions in exploitation in some estuaries and improvements in riverine environment. 	<p>Completed</p> <p>Urgent</p> <p>Urgent</p>	<p>Irish drift net fishery:</p> <ul style="list-style-type: none"> - The Irish Government adopted the key recommendations of the 2006 report by its Independent Working Group on Salmon. This included the closure of the Irish drift net fishery with effect from the 2007 season <p>Riverine habitat:</p> <ul style="list-style-type: none"> - Defra have introduced funding for Catchment officers (see below) and associated grant schemes as part of their Catchment Sensitive Farming Programme. In Wales WAG are running two pilot Catchment Sensitive Farming projects, as well as funding Catchment Officers. WAG continue to contribute substantial funding to the Sustainable Fisheries Programme which contribute to habitat restoration projects in Wales. <p>Legislation & funding:</p> <ul style="list-style-type: none"> - A programme of fisheries legislative development has been started. This is to be delivered through a mix of new primary (the Marine Bill) and secondary (byelaws and orders) laws.
<p>Environment Agency</p>	<p>Exploitation in home waters:</p> <ul style="list-style-type: none"> - Prepare a schedule of measures, voluntary and/or mandatory to reduce exploitation, where needed, on a river by river basis, within legislative and funding constraints and review on an annual basis. - Promote a byelaw for England banning the use of a taller. (Prohibition of the use of tallers is under consideration by Government for inclusion in proposed new national legislation.) <p>Improve assessments of stock status:</p> <ul style="list-style-type: none"> - Continue to enhance methods of setting conservation limits and assessing compliance. <p>Riverine habitat:</p> <ul style="list-style-type: none"> - Inform English and Welsh Governments that salmon targets are unlikely to be met primarily through restrictions on exploitation. 	<p>Annually (in April)</p> <p>At next opportunity</p> <p>Ongoing</p> <p>Immediate</p>	<p>Exploitation in home waters:</p> <ul style="list-style-type: none"> - Annual assessments are carried out on each river as to whether further regulatory measures are required using the compliance assessments and decision structure referred to elsewhere in this report under "Status of Stock" - A taller ban is included in the Government's plans for new fisheries laws within the Marine Bill. <p>Improve assessments of stock status</p> <ul style="list-style-type: none"> - Work continues on developing the Salmon Lifecycle Model and other improvements - for example in exploitation estimates. The latter are to be used in assessments for future reports. <p>Riverine habitat:</p> <ul style="list-style-type: none"> - This was done in 2005

Organisations & individuals	Key actions required	Suggested Timescale	Progress to December 2007
<p>Environment Agency (continued)</p>	<ul style="list-style-type: none"> - Continue and expand, within resources and with available partners, the range of initiatives to bring about significant changes in land use, in particular agriculture, and diffuse pollution (such as siltation and pesticides) – including agri-environment schemes, information campaigns and tighter regulation. - Develop and implement a project to describe the extent and nature of salmon habitat to help target habitat improvement. Link with local Rivers Trusts and Associations - Deliver significant efficiencies and seek other sources of funding, with partners. - Advisory Committee papers on (i) River Habitat Objectives; and (ii) Agri-environment & diffuse pollution. - Collate priorities for salmon habitat improvement from Salmon Action Plans into 3-year strategic regional plans. - Focus available resources on priorities. Integrate with other biodiversity work. Link with local Rivers Trusts and Associations. - Continue to prepare for compliance for salmon with Habitats Directive and Water Framework Directive. 	<p>Ongoing</p> <p>Ongoing</p> <p>Ongoing</p> <p>April 2005</p> <p>March 2005</p> <p>Ongoing</p> <p>2006 2015</p> <p>By 2007</p>	<ul style="list-style-type: none"> - Work continues on this at all levels from catchment scale upwards. Catchment Officers have been appointed in key catchments to encourage landowners to take advantage of Government incentive schemes to introduce more catchment sensitive farming. Under the Water Framework Directive, work is in progress to identify Programmes of Measures to tackle the widely identified issue of diffuse pollution and the key risk of failing good ecological status. - Work has been progressed in several catchments to describe salmon habitat and target priorities in many cases in partnership or led by Rivers Trusts. The Environment Agency contributed to conferences on this topic hosted by the Association of Rivers Trusts and Atlantic Salmon Trust in 2006 and 2007. - This is ongoing, strengthened by the Memorandum of Understanding between the Environment Agency and Association of Rivers Trusts signed in September 2006 - This was done in 2005 - This has been achieved for many but not all SAP rivers - This is ongoing as described elsewhere in this section - A "Salmon Management in the Water Framework Directive" planning model has been developed and the Environment Agency's National Salmon Strategy is being revised to take these drivers into account. <p>Interim conservation limits:</p> <ul style="list-style-type: none"> - None have so far been set. <p>Exploitation in home waters:</p> <ul style="list-style-type: none"> - Examples of such schemes can be found on the Rivers Wye, Usk, Tywi, Tamar, Exe, Dart, Teign, Test, Itchen, Hants Avon and Frome <p>Riverine habitat:</p> <ul style="list-style-type: none"> - This approach has spread to more rivers in recent years and is proving very successful. Examples include the Wye & Usk, Pembrokeshire, Ribble, West Country, and Tyne Rivers Trusts – there are many more. <p>Exploitation in home waters:</p> <ul style="list-style-type: none"> - Catch and Release nationally has declined from 56% to 54% (provisionally) in 2007, although is as high as 100% on some rivers. More needs to be done – particularly on those rivers that have been identified as "At Risk".
<p>Fishery Owners/ Angling Associations/ Rivers Trusts</p>	<p>Exploitation in home waters:</p> <ul style="list-style-type: none"> - promote voluntary measures to increase levels of catch and release on under-performing rivers and where relevant, contributions to netting buy outs. <p>Riverine habitat:</p> <ul style="list-style-type: none"> - undertake or contribute to salmon habitat improvement projects focussing resources on priorities. Link with local Environment Agency staff. 	<p>Underway</p> <p>Ongoing</p>	<p>Exploitation in home waters:</p> <ul style="list-style-type: none"> - Examples of such schemes can be found on the Rivers Wye, Usk, Tywi, Tamar, Exe, Dart, Teign, Test, Itchen, Hants Avon and Frome <p>Riverine habitat:</p> <ul style="list-style-type: none"> - This approach has spread to more rivers in recent years and is proving very successful. Examples include the Wye & Usk, Pembrokeshire, Ribble, West Country, and Tyne Rivers Trusts – there are many more. <p>Exploitation in home waters:</p> <ul style="list-style-type: none"> - Catch and Release nationally has declined from 56% to 54% (provisionally) in 2007, although is as high as 100% on some rivers. More needs to be done – particularly on those rivers that have been identified as "At Risk".
<p>Anglers</p>	<p>Exploitation in home waters</p> <ul style="list-style-type: none"> - increase levels of catch and release on under-performing rivers - comply with mandatory measures if voluntary measures are either inappropriate or insufficient. - maintain levels of catch and release elsewhere. 	<p>Urgent</p> <p>Urgent</p> <p>Ongoing</p>	<p>Exploitation in home waters:</p> <ul style="list-style-type: none"> - Catch and Release nationally has declined from 56% to 54% (provisionally) in 2007, although is as high as 100% on some rivers. More needs to be done – particularly on those rivers that have been identified as "At Risk".
<p>Netsmen</p>	<p>Exploitation in home waters:</p> <ul style="list-style-type: none"> - comply with mandatory measures if voluntary measures are either inappropriate or insufficient. 	<p>Ongoing</p>	<p>Exploitation in home waters:</p> <ul style="list-style-type: none"> - This is ongoing

DECISION STRUCTURE

Developing fishing controls for salmon fisheries in England & Wales



Notes to accompany Decision Structure

Initial stage - stock assessment

The stock assessment elements of the initial stage of the decision structure (red boxes) are undertaken centrally. Staff in the areas will only be involved in terms of providing information to support the development of derogated or interim targets where their use has been agreed (see Appendix II Salmon Management in the WFD Cycle).

Assessing compliance with the management objective

- The management objective is for spawning escapement (in terms of egg deposition) to exceed the Conservation Limit (or the interim or derogated target where appropriate) for four years out of five.
- Compliance assessments are based on a Bayesian analysis which is used to estimate the probability that spawning escapement (in terms of egg deposition) will exceed the Conservation Limit (or the interim or derogated target where appropriate) for 80% of the time by a specified target date.

Second stage – initial screening for potential options

Within the second stage of the Decision Structure (blue boxes) both socio-economic concerns and stakeholder support are considered for those rivers that have a <50% probability of failing the management objective. By affording these two factors a higher level of importance the 'do-nothing' option remains a valid outcome for these rivers.

This stage can be seen as a screening stage for these rivers, for example effectively ruling out those management options that would not be supported by stakeholders.

For all other rivers (i.e. those where there is >50% probability of failing the management objective) the decision structure does not provide the option of ruling out potential management controls in this way. In these cases all options must be carried through to the next (evaluation) stage.

Third stage – option evaluation

The third main stage (purple boxes) sets out and evaluates those options that could be employed to realise the required changes in exploitation. Considerations that will constrain or direct the thinking at this stage are effectively identified according to which vertical branch of the structure has been followed.

Final stage – selection and implementation

The final stage of the Decision Structure (green boxes) represents the final selection and implementation stage.

ANNEX 3 – NASCO’s request for scientific advice from ICES in 2008

1. With respect to Atlantic salmon in the North Atlantic Area:

- 1.1 provide an overview of salmon catches and landings, including unreported catches by country and catch and release, and production of farmed and ranched Atlantic salmon in 2007;
- 1.2 report on significant new or emerging threats to, or opportunities for, salmon conservation and management;
- 1.3 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 ¹;
- 1.4 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.); ²
- 1.5 compile information on the marine migration and dispersal of escaped farmed salmon with particular emphasis on movements between countries; ³
- 1.6 provide a compilation of tag releases by country in 2007 and advise on progress with compiling historical tag recovery data from oceanic areas ⁴;
- 1.7 identify relevant data deficiencies, monitoring needs and research requirements; ⁵.

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

- 2.1 describe the key events of the 2007 fisheries; ⁶
- 2.2 provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved;
- 2.3 review and report on the development of age-specific stock conservation limits, where possible based upon individual river stocks;
- 2.4 describe the status of the stocks and provide annual catch options or alternative management advice for 2009-2011, if possible based on forecasts of PFA for northern and southern stocks, with an assessment of risks relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding; ⁷
- 2.5 further develop methods to forecast PFA for northern and southern stocks with measures of uncertainty.

3. With respect to Atlantic salmon in the North American Commission area:

- 3.1 describe the key events of the 2007 fisheries (including the fishery at St Pierre and Miquelon);⁶
- 3.2 report on the biological characteristics (size, age, origin) of the catch in coastal fisheries and potential impacts on non-local salmon stocks;
- 3.3 provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved;
- 3.4 update age-specific stock conservation limits based on new information as available;

In the event that NASCO informs ICES that the framework (FWI) indicates that re-assessment is required:*

- 3.5 describe the status of the stocks and provide annual catch options or alternative management advice for 2008-2011 with an assessment of risks relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding;⁷

4. With respect to Atlantic salmon in the West Greenland Commission area:

- 4.1 describe the key events of the 2007 fisheries;⁶
- 4.2 provide any new information on the extent to which the objectives of any significant management measures introduced in recent years have been achieved;

In the event that NASCO informs ICES that the framework (FWI) indicates that re-assessment is required:*

- 4.3 describe the status of stocks and provide annual catch options or alternative management advice for 2008-2010 with an assessment of risk relative to the objective of exceeding stock conservation limits and advise on the implications of these options for stock rebuilding.^{7,8}

Notes:

- 1. *With regard to question 1.3, there is interest in determining if declines in marine survival coincide with changes in the biological characteristics of juveniles in fresh water or are modifying characteristics of adult fish (size at age, age at maturity, condition, sex ratio, growth rates, etc.) and with environmental changes. In the event that an annual measure is agreed for the West Greenland fishery, this question should be considered a lower priority than the other questions.*
- 2. *With regard to question 1.4, there is interest in determining the extent to which marine survival regimes are driven by factors in estuarine, nearshore, or offshore environments. To the extent possible, this assessment should focus on discrete stock complexes corre-*

sponding to NASCO management objectives. Characterizing these losses could provide regional and stock-specific context for ongoing research and upcoming research initiatives such as SALSEA.

3. *A number of implementation plans presented by NASCO Parties raised concern about the occurrence in their marine fisheries and rivers of farmed salmon originating in other countries.*
 4. *With regard to question 1.6 the data on tag recovery information should be compiled according to the format developed by the ICES Workshop on the Development and Use of Historical Salmon Tagging Information from Oceanic areas.*
 5. *NASCO's International Atlantic Salmon Research Board's inventory of on-going research relating to salmon mortality in the sea will be provided to ICES to assist it in this task.*
 6. *In the responses to questions 2.1, 3.1 and 4.1 ICES is asked to provide details of catch, gear, effort, composition and origin of the catch and rates of exploitation. For homewater fisheries, the information provided should indicate the location of the catch in the following categories: in-river; estuarine; and coastal. Any new information on non-catch fishing mortality, of the salmon gear used, and on the by-catch of other species in salmon gear, and on the by-catch of salmon in any existing and new fisheries for other species is also requested.*
 7. *In response to questions 2.4, 3.5 and 4.3 provide a detailed explanation and critical examination of any changes to the models used to provide catch advice.*
 8. *In response to question 4.3, ICES is requested to provide a brief summary of the status of North American and North-East Atlantic salmon stocks. The detailed information on the status of these stocks should be provided in response to questions 2.4 and 3.5.*
- * **The aim should be for NASCO to inform ICES by 31 January of the outcome of utilising the FWI.**

ANNEX 4 – Description of fishing methods (nets and fixed engines) used for taking salmon and migratory trout in England and Wales

A wide variety of nets and fixed engines are used to take salmon and sea trout. The term fixed engine is an ancient one used as a general descriptor of stationary fishing gears. The following are generalised descriptions of the gear used in England and Wales (for further details see Russell *et al.*, 1995); in practice there is considerable regional variation in the precise mode of operation of specific gears and in the dimensions and mesh sizes of the nets. These characteristics have generally evolved to suit local conditions and are regulated by local byelaws.

GILLING NETS:

Drift net A drift net consists of a sheet of netting which hangs from a floated head rope to a weighted foot rope and is designed to drift with the current or tide. Regional names include: hang, whammel, sling and tuck nets.

Coracle net These nets are only used in parts of Wales. Short lengths of trammel net are suspended between two coracles (small boats), which then drift downstream with the net strung across the current.

Trammel net Trammel nets are similar to drift nets but are modified by the addition of sheets of larger mesh netting on one or both sides of the net. Such nets are referred to as being 'armoured'. A fish striking a trammel net pushes the small mesh net through one of the large meshes in the adjoining net and is caught in the resultant pocket. Sometimes known locally as tuck nets.

Sling net The sling net is a type of drift net previously used exclusively on the River Clwyd in North Wales. It differs from other drift nets only in so far as the nets are permitted to carry weights (not exceeding 4 kg) at either end, designed to retard the drift. This gear is no longer fished.

Coastal net A loose term used to describe the nets used in the fishery off the East Anglian coast. In practice, various methods of fishing have been employed, including drift nets and beach seine nets (which may take fish by gilling).

SWEEP/ENCIRCLING NETS:

Seine net A seine net (also known as a draft or draw net) consists of a wall of netting with a weighted foot rope and floated head rope. One end is held on the shore while the rest is paid out from a boat to enclose an area of water between two points on the shore. The net is then retrieved and any fish enclosed drawn up onto the shore. Seine nets normally operate within estuaries, although some are also fished off coastal beaches.

Wade net A wade net consists of a short (~30 m) single sheet of netting which is attached to a pole at each end, and is pulled along the foreshore parallel to the beach by two men, one wading and the other on the beach. Nets are 'beached' at regular intervals, or when a fish strikes, in much the same way as a seine net.

FIXED ENGINES:

Basket trap This is a type of fixed engine which has only been used on the River Conwy in North Wales. It consists of a metal basket set between two boulders, which is designed to catch salmon and sea trout which fall back when attempting to ascend a small waterfall.

Compass net These nets are operated from a boat held stationary against the current. A net is hung between two long poles lashed together in a V-shape and held over the side of the boat so that the net streams out underneath the boat. When a fish strikes the net, the poles are pivoted upwards with the aid of counter-balancing weights.

Crib (or Coop) These ancient fixed engines consist of stone buttresses set across a river, the gaps between the buttresses being filled by box-like traps made of either wood or metal with in-scale entrances. The River Eden cribs were built by monks in 1133 A.D., although the Derwent cribs are of more recent construction.

Putchers (and Putts) Putchers are wickerwork or metal conical baskets which, when erected on stages, form putcher ranks (containing up to 800 putchers). This type of fixed engine is peculiar to the Bristol Channel and is dependent upon the high turbidity and large tidal range which occurs in this area. Each putcher has a mouth from 1 to 1.5 m wide, tapering to a narrow point which will prevent fish of moderate size from passing through. A netting leader is often used to guide fish into the putchers. Putts are of similar design to putchers, only larger.

T-net T-nets are fixed engines operated close to the shore, usually in specific berths. They comprise a 'leader', usually about 200 m in length, stretching out from the beach to a 'headpiece', which contains two traps with funnel entrances. Some fish may become enmeshed or entangled in the leader of the net, but the majority are taken, free-swimming, in the traps.

'T or J'-net 'T or J'-nets consist of plain sheets of netting on a floated head rope which hang vertically in the water by means of a weighted foot rope and are set from the shore in the shape of a 'T', 'J' or 'P'. These nets are usually operated as fixed engines, held stationary by means of weights, anchors or stakes, but can also be drifted with weights used to retard the rate of movement. Fish can only be caught in a 'T or 'J' net by becoming enmeshed or entangled in the walls of the net.

HAND-HELD NETS:

Haaf or heave net These one-man-operated nets are operated exclusively in the North West Region. The gear consists of a rectangular net hung from a horizontal wooden beam up to 5.5m wide. A central pole permits the netsmen to stand in the tideway holding the net facing the current with the netting streaming behind him. The net is lifted when a fish strikes the net. It is usual for several netsmen to work together line-abreast.

Lave (or dip) net Lave nets, one regional variety of similar hand-held, one-man-operated nets, consist of a large Y-shaped wooden frame supporting a net, similar in design to an angler's landing net, but measuring up to 2 m across. The netsman actively stalks fish in estuary pools or shallows at low tide.

ANNEX 5

ICES Compilation of microtag, fin clip and external tag releases – 2007 season

Marking season: 2007 Country: UK (England and Wales)											
Marking Agency	Origin	Life Stage	H/W	Stock Origin	Primary Tag or Mark		Number marked	Code or Serial	Secondary Tag or Mark	Release date	Release Location
					External Mark	Adipose Clip					
	Hatchery juvenile			0	151,732		179,103				
	Wild juvenile			0	14,098		28,208				
	Adult			1,937	0		1,937				
Totals				1,937	165,830		209,248				
Marking Agency	Age	Life Stage	H/W	Stock Origin	Primary Tag or Mark	Number marked	Code or Serial	Secondary Tag or Mark	Release date	Release Location	
EA North East	Various	Adult	W	Tyne	Floy tag	340	Various	None	Jun-Dec	Tyne	
EA North East	1+	Parr	H	Tyne	Adipose	5,000		None	20-Mar	Tyne (Kielder Burn)	
EA North East	1+	Smolt	W	Tyne (Kielder Burn)	Adipose	3,158		None	March	Tyne	
EA Thames	Various	Adult	W	Thames	Floy tag	4		None	Various	Thames	
EA Thames	S1	Smolt	H	Shannon	Microtag	9,000		Adipose	06-Mar	Thames (Kennet)	
EA Thames	S1	Smolt	H	Shannon	Microtag	6,000		Adipose	06-Mar	Thames (Kennet)	
EA Thames	S1	Smolt	H	Delphi	Adipose	1,760		None	10-Apr	Thames	
EA Thames	S1	Smolt	H	Delphi	Adipose	1,918		None	11-Apr	Thames	
EA Thames	S1	Smolt	H	Delphi	Adipose	1,947		None	12-Apr	Thames	
EA Thames	S1	Smolt	H	Delphi	Adipose	2,556		None	18-Apr	Thames	
EA Thames	S1	Smolt	H	Delphi	Adipose	2,577		None	21-Apr	Thames	
EA Wales	Various	Adult (kelts)	W	Taff	Floy tag	16		None	Jan	Taff	
EA Wales	Various	Adult	W	Taff	Floy tag	185		None	Various	Taff	
EA Wales	Various	Adult	W	Taff	Floy tag	88		Radio tag	Various	Taff	
EA Wales	S1	Smolt	H	Taff	Adipose	50,150		None	Apr	Taff	
EA Wales	S1	Smolt	H	Taff	Microtag	5,000		Adipose	Apr	Taff (Cardiff Bay cage - estuary)	
EA Wales	1+	Parr	H	Taff	Adipose	17,000	02/01	None	Mar-Apr	Taff	
EA Wales	Various	Adult	W	Dee	Floy tag	1,266	Various	None	Feb-Oct	Dee	
EA Wales	S1	Smolt	H	Dee	Adipose	10,445		None	14-Feb	Dee (Maerdy smolt pond)	
EA Wales	S1	Smolt	H	Dee	Adipose	6,872		None	14-Feb	Dee (Tryweryn trap)	
EA Wales	S1	Smolt	H	Dee	Adipose	16,000		None	7-Mar	Dee (Tryweryn trap)	
EA Wales	1+	Parr	H	Dee	Adipose	3,700		None	4-Apr	Dee (Tryweryn trap)	
EA Wales	0+	Parr	H	Conwy (Lledr)	Adipose	4,415		None	15-Jan	Conwy (Dolwyddelan smolt pond)	
EA Midlands	0+	Parr	H	Tyne	Adipose	16,000		None	4-Oct	Trent (Dove)	
EA South West	0+	Parr	H	Axe	Adipose	11,392		None	20-Sep	Axe smolt pond	
EA North West	2+	Smolt	H	Ribble	Microtag	543	01/42/20	Adipose	10-Feb	Ribble (Hodder/Langdon)	
EA North West	1+	Smolt	H	Ribble	Microtag	3,196	20/42/60	Adipose	Feb-Mar	Ribble (Hodder/Dunsop Pond)	
EA North West	1+	Smolt	H	Lune	Microtag	3,632	20/42/61	Adipose	Mar	Lune	
Cefas/EA Wales	Various	Smolt	W	Dee (Ceiriog)	Microtag	2,184	01/42/88	Adipose	Apr-May	Dee (Ceiriog)	
EA Wales	Various	Smolt	W	Dee	Microtag	1,866	01/42/87	Adipose	Apr-May	Dee (Lower)	
Cefas	Various	Smolt	W	Tamar	Microtag	4,287	01/42/90	Adipose	Apr-May	Tamar	
Cefas	Various	Parr	W	Itchen	Adipose	50		PIT	Sept	Itchen	
Cefas/CEH	Various	Adult	W	Tyne	Floy tag	38	EO169 - EO301	Acoustic tag	Mar-Oct	Tyne	
Cefas/CEH	Various	Parr	W	Frome	Adipose	10,890		PIT	Sept	Frome	
Cefas/CEH	Various	Parr	W	Frome	Microtag	5,773	01/42/89	Adipose	Apr-May	Frome	

Note: Some microtagged smolts on the Dee (Ceiriog) and Frome had previously been PIT tagged as juveniles.

