In response to a CBSM request for the "science-based evidence" that DFO utilized to set the angler catch rates and the catch and release mortality factors used in their 2017 stock assessment document; DFO provided the following information.

Restigouche River and tributaries – angling catch rate of 40% with a C&R mortality rate of 6%

Miramichi system – angling catch rate of 30% with a C&R mortality rate of 3%

Restigouche River assessment

- **Estimates of returns to the Restigouche River are based on angling catches and assumed exploitation rates derived from various sources, including the end of season canoe and dive counts conducted by biologists from the province of New Brunswick and supporting information from the angling fishery in the Matapedia River in recent years.**
- **The history of the assessment follows. The assessment documents are available on the DFO Canadian Science Advisory Secretariat website.**

- **From Randall et al. 1988 (DFO CAFSAC Res Doc 88/ 41).**

salmon) from field surveys. Accepting a spawner/angled fish ratio of 0.70, and a poaching and disease mortality rate of 0.16 implies an angling exploitation rate of > 0.40 for MSW salmon. This relationship can be seen when comparing spawners and returns from Method 2 and Method 1 using different angling exploitation rates (Table 12). As exploitation increases, estimates of spawners from the two Methods converge. Whether or not an angling exploitation rate of > 0.40 is reasonable for Restigouche salmon, however, needs to be confirmed. Exploitation is potentially high because of the characteristics of the river: salmon return early in the season and thus are exposed to anglers during the entire angling season, and the water is clear and many anglers only fish where they can see fish. Nevertheless, an independent estimate of exploitation rate is required for Restigouche salmon.

-

From Randall 1990 (DFO CAFSAC Res Doc 90/2)

Spawning escapement and egg deposition rates as estimated from Method 2 are probably underestimates. The ratio of spawners to angled fish of 0.7 implies an angling exploitation rate of 0.49 which is extremely high. Spawning escapement as estimated from canoe surveys in the Restigouche River also suggest that angling exploitation rates are high (sometimes > 0.5; Table 10). However, canoe surveys may provide estimates of spawners that are negatively biased (Appendix 1; Shardlow et al. 1987), and this would result in estimates of angling exploitation which are too high. In the Miramichi River, exploitation rate by anglers on early run salmon, as estimated from mark-recapture data, averaged 0.34 (Randall et al. 1989b). Exploitation rate by anglers on adult salmon in the Restigouche River is probably at least this high; all Restigouche salmon enter the river early (Peppar 1983) and are thus available to anglers for the entire angling season. Also clear water makes the salmon very visible in the Restigouche and anglers only fish where they can see salmon. Therefore an exploitation rate of 0.3 is probably a reasonable lower limit that can be applied to angling catches in the Restigouche which would give a maximum estimate of returns and spawning escapement (Fig. 6). On the other hand, an exploitation rate of 0.49 is probably an upper limit, which would provide a minimum estimate of spawning escapement. Actual exploitation rate in the Restigouche is probably somewhere between 0.3 and 0.5; obviously exploitation rate needs to be determined accurately if angling catches are going to be continued to be used to estimate salmon abundance in this river. An attempt was made to estimate exploitation rate in 1989 by tagging 1SW salmon at Dalhousie, but the trapping operation was unsuccessful (Appendix 8). Method 2 is used in this assessment to estimate spawning escapement , but this method probably results in underestimates of total egg depositions.

Table 10. Estimated angling exploitation rates (U) in Restigouche River, 1982 to 1989. Number of spawners were estimated from field spawning surveys and returns were estimated assuming a poaching and disease rate of 0.14 for 1SW salmon.

	1SW			
Yr	Angling	Spawners	Returns	u
1982	2,851	1,577	5,149	0.55
1983	896	986	2,188	0.41
1984	1,822	1,374	3,716	0.49
1985	3,517	2,111	6,544	0.54
1986	5,413	5,190	12,329	0.44
1987	5,005	3,930	10,390	0.48
1988	6,776	3,861	12,369	0.55
1989	3,655	4,128	9,050	0.40

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1989	3,655	4,128	9,050	0.40

From Courtenay et al. 1991 (DFO CAFSAC Res Doc 91/13)

Angling exploitation rate is unknown for the Restigouche River, but Randall et al. (1990) argued that it probably lies somewhere between 0.3 and 0.5. Therefore, spawning escapements were calculated for these limits.

The more extensive reviews of assessment methods began with Locke et al in 1994 (DFO Res Doc 95/122). Comparisons were made to angling catch and exploitation rate assumptions, mark and recapture with estuary trapnets and fall spawner counts. Based on fall spawner counts, estimated escapement was closest to angling catch of large salmon and exploitation rates of 0.5 in some years and 0.3 in other years, i.e. within the range 0.3 to 0.5..

7 - Assessment results

7.1 - Status of stock (all methods)

	Large spawners	Small spawners
Target (71.4 million eggs):	12,200	2,600
Evidence for 'target met':		
Mark-recapture estimate	16,218	17,061
95% confidence limits	(12,438-25,839)	(12,331-29,101)
Evidence for 'target not met':		
Angling exploitation estimate		
ER=0.3	11,955	11,264
ER=0.5	6,650	4,811
Canoe-based spawner counts	6,871	4,390
Diver spawner counts	5,693	4,493
with DNRE adjustment	6,105	4,720

There is information from the Matapedia River regarding exploitation rates for retained fish only in the Province of Quebec reports. Exploitation rates (retained) for large salmon are generally in the range of 24% to 46% whereas exploitation rates on grilse are higher, ranging between 43% and 81%. If catch and release values are included, the catch rates (catch / returns) for grilse and salmon combined (catch and release not separated by size group) for the period 2012 – 2016 is 58

Sommaire de l'exploitation sportive de 1984 à 2017 de la rivière Matapédia

Optimal: 10,415

Zone salmonicole Q1 No. rivière: 01150000 *Seuils de conservation (million d'oeufs)* **Démographique: 3,123**

	Captures sportives							*Taux (%) Exploitation*					*Montaison*			*Reproducteurs*			
Année	*Mad.*	*Réd.*	*Total*	*Remise à l'eau*	*Jours-pêche*	*Succès (Cap./j-p.)*	*Succès ajusté*	*Mad.*	*Réd.*	*Total*	*Retrait*	*Prélè-vement*	*Mad.*	*Réd.*	*Total*	*Mad.*	*Réd.*	*Total*	*Oeufs déposés (million)*
2004	1 124	727	1 851	397	8 235	0,22	0,27	50	28	38	0	1 851	2248	2610	4858	1124	1877	3001	12,74
2005	578	810	1 388	281	8 500	0,16	0,20	43	32	35	0	1 388	1348	2569	3917	770	1759	2529	10,55
2006	1 009	566	1 575	376	8 317	0,19	0,23	51	28	39	0	1 575	1960	2042	4002	951	1476	2427	9,39
2007	435	709	1 144	259	7 614	0,15	0,18	56	37	42	0	1 144	773	1937	2710	338	1228	1566	7,18
2008	1 082	456	1 538	325	7 986	0,19	0,23	53	24	39	1	1 539	2042	1863	3905	960	1406	2366	8,73
2009	542	656	1 198	284	7 376	0,16	0,20	52	28	36	0	1 198	1048	2323	3371	506	1667	2173	9,18
2010	709	730	1 439	421	7 780	0,18	0,24	69	37	48	0	1 439	1034	1949	2983	325	1219	1544	7,18
2011	785	1 106	1 891	462	9 096	0,21	0,26	52	35	41	0	1 891	1506	3155	4661	721	2049	2770	12,77
2012	376	512	888	154	7 519	0,12	0,14	59	25	33	0	888	636	2031	2667	260	1519	1779	9,01
2013	417	952	1 369	234	8 179	0,17	0,20	62	46	50	0	1 369	669	2063	2732	252	1111	1363	6,56
2014	370	448	818	368	8 725	0,09	0,14	70	30	41	0	818	525	1479	2004	155	1031	1186	6,97
2015	717	541	1 258	370	8 413	0,15	0,19	76	44	57	26	1 284	947	1242	2189	230	677	907	4,89
2016	393	0	393	787	6 698	0,06	0,18	68	0	20	55	448	574	1367	1941	176	1317	1493	10,31
2017	358	213	571	631	7 507	0,08	0,16	81	12	25	44	615	440	1830	2270	74	1581	1655	12,35
2012 -2016	455	491	945	383	7 907	0,12	0,17	68	30	41	16	961	670	1636	2307	215	1131	1346	7,55

Remarque : Les données d'abondance représentent des valeurs minimales et conservatrices. En effet, les inventaires de reproducteurs ne sont pas effectués sur l'ensemble des sections accessibles au saumon sur la rivière. En 2005, 2012, 2016 et 2017, le nombre de reproducteurs est basé sur l'inventaire de mi-saison. En 2000, 2007, 2011 et 2013, les inventaires de reproducteurs ont été réalisés dans des conditions difficiles d'observation. En 2001 et 2004, les montaisons ont été estimées à partir du taux d'exploitation. Les données ne tiennent pas compte de celles de la rivière Causapscal. La pêche d'alimentation est exclue des calculs (voir tableau 3 pour le détail des pêches).

Miramichi system assessment

- **There are no estimates of angling catches (kept, released) from New Brunswick since 1997. Catch data come from the NB FISHSYS survey. Angling catch data for the Miramichi and SW New Brunswick rivers for the period 1969 to 1994 are summarized in Moore et al. 1995 (DFO Atl. Fish. Res Doc 95/4). This report is available on the Canadian Science Advisory Secretariat website under the publications tab for Research Document.**

- **For small salmon, between 1984 and 1997, the percentage of the total returns of small salmon which were estimated to have been retained in the angling fisheries ranged from a low of 12% in 1995 (but there were extensive river closures that year due to low and warm water) to a high of 63% in 1984, 51% in 1997. The average over those years for retained (only) grilse was 28%. The angling catches for the years 1951 to 1997 are in table 4 of the assessment report by Chaput et al. 1998 (DFO CSAS Res Doc 98/34). This report is available on the Canadian Science Advisory Secretariat website under the publications tab for Research Document.**
- **For large salmon, retention has not been allowed since 1984. Between 1984 and 1997, the percent of the salmon return which was angled (catch / return) has ranged from a low of 10% (in 1995, see above) to a high of 69% in 1989. The average over that period is 38%.**
- **In the absence of angling catch estimates:**
    - **Between 1998 and 2012, DFO assumed that the losses (retained plus catch and release mortality) of grilse in the angling fishery represented 25% of the estimated**

return to the Miramichi (overall and to each branch). Note this is lower than the average rate of retention over the period 1984 to 1997 but because of reductions in season bag limits, this was considered appropriate. This rate was applied to each branch as well.

- Between 1998 and 2012 for large salmon, it was assumed that 30% of the large salmon return was angled and the losses from catch and release were assumed to be 3% of the angled catch (3% of 30% of returns).
- When mandatory catch and release was introduced in 2015 and continued to 2017, the retentions for small and large salmon were zero. It was assumed that 30% of the run of small salmon and large salmon was angled, a catch rate similar to that applied to large salmon since 1998.

Catch and release mortality rates in the angling fishery

A catch and release value for the Restigouche was first referenced by Randall et al 1986 (DFO CAFSAC Res Doc 86/1). A value of 8% catch and release mortality was reported and used for the 1985 assessment.

3. Spawning escapement

For estimating spawning escapement, a total angling catch (PQ landings and NB catch and release) of 6,100 MSW salmon was used (calculated from Method 1 on Page 5). Mortalities attributed to angling stress were calculated as 8% of the estimated caught and released MSW salmon in New Brunswick:

	Catch and release	Mortalities	Proportion
Camp 1	223	12	0.05
Camp 2	150	10	0.07
Camp 3	219	50	0.23
Camp 4	257	20	0.08
Camp 5	277	3	0.01
TOTAL	1,126	95	0.08

This work continued into 1986 when similar accounting for mortalities relative to catch and released fish was reported in Randall et al. 1987 (DFO CAFSAC Res Doc 87/6).

3. Spawning escapement

A total angling catch of 8,800 MSW salmon (Québec landings and estimates of catch and release in New Brunswick, page 5) was used for estimating spawning escapement. Mortality rate attributed to catch-and-release stress was estimated to be 5%:

	Catch and release	Mortalities	Proportion
Camp 1	330	6	0.02
Camp 2	133	22	0.17
Camp 3	197	18	0.09
Camp 4	374	12	0.03
Camp 5	293	12	0.04
Total	1,327	70	0.05

The above estimate of catch-and-release mortality is probably an overestimate for two reasons: (1) a proportion of mortalities reported by camp managers probably died from furunculosis even though symptoms were undetectable; (2) extensive surveillance of the Upsalquitch River in 1986 indicated mortalities attributable to the catch-and-release program were low. Of 33 fish tagged before release, none were subsequently observed dead in pools despite close observations. Within the whole Upsalquitch tributary, 48 MSW salmon mortalities were observed, which is 8% of the number of MSW salmon released by anglers (Table 9). This is the maximum rate that could be attributed to angling stress. However, most of these deaths probably resulted from furunculosis. Twenty-two of 23 mortalities observed within Upsalquitch barrier had symptoms of furunculosis, and all salmon sent to Halifax for autopsy (6) were confirmed to have died from this disease (A. Eaton, DFO, Halifax). Assuming 50% of MSW salmon deaths outside of the barrier resulted from angling stress would indicate a mortality rate of 3%. These observations suggest catch-and-release mortalities were low and a rate of 5% is probably an overestimate. It was interesting to note that of the 33 salmon tagged and released in Upsalquitch River, none were subsequently caught a second time.

Table 9. Observed mortalities of MSW salmon in Upsalquitch River, 1986.

Area	Mortalities	Furunculosis	Catch and release
Angling camps	11	Unknown	279
Crown reserve	27	Unknown	351
Upsalquitch barrier	10	10	---
TOTAL	48		630

And again reported by Randall et al. in the 1987 assessment (DFO CAFSAC Res Doc 88/41).

Mortalities from stress of catch-and-release of MSW salmon were estimated from observations at five angling camps. Camp managers provided data on the number of MSW salmon caught and released in their stretch of water, and an estimate of the total mortalities they observed that may have resulted from catch-and-release stress (i.e., no physical indication of furunculosis lesions on the fish). These estimates were made in 1985 and 1986 as well.

For estimating spawning escapement in 1987, angling catches of 4,853 MSW salmon and 5,068 1SW salmon were used in Methods 1 and 2 (Table 2). The MSW salmon catch included fish landed in Québec and fish caught and released in New Brunswick. Mortality rate attributed to catch-and-release stress was estimated to be 5% (as in 1986):

	Catch and release	Mortalities	Proportion
Camp 1	149	4	0.03
Camp 2	65	10	0.15
Camp 3	83	12	0.14
Camp 4	339	10	0.03
Camp 5	255	6	0.02
Total	891	42	0.05

And again in 1988, and reported by Randall et al 1989 (DFO CAFSAC Res Doc 89/33).

Mortalities from stress of catch-and-release of MSW salmon were estimated from observations at five angling camps. Camp managers provided data on the number of MSW salmon caught and released in their stretch of water, and an estimate of the total mortalities they observed that may have resulted from catch-and-release stress (i.e., no physical indication of furunculosis lesions on the fish). Similar estimates have been made since 1985.

For methods 1 and 2, spawning escapement in 1988 was estimated using angling catches of 6776 1SW salmon and 5509 MSW salmon (Table 3). MSW salmon catches included 963 salmon harvested in Quebec and 4546 salmon caught and released in New Brunswick. Mortality rate attributed to catch-and-release stress was estimated to be 4%:

	Catch-and-release	Mortalities	Proportion
Camp 1	238	2	0.01
2	118	15	0.13
3	196	12	0.06
4	423	20	0.05
5	229	5	0.02
TOTAL	1204	54	0.04

And again in 1989 and reported in Randall et al 1990 (DFO CAFSAC 90/2).

Observations of mortalities of MSW salmon from five angling camps are summarized below:

	Catch and release	Mortalities	Proportion
Camp 1	153	6	0.04
2	51	10	0.20
3	96	2	0.02
4	350	30	0.09
5	291	20	0.02
Total	941	68	0.07

A mortality rate of 0.07 is higher than the rate used in the 1988 assessment of 0.04 (Randall et al. 1989a). Many wardens and anglers observed that mortality rates within the river were higher than average in the Restigouche River during 1989. Lower than normal water levels during July and August may have contributed to these mortalities (Fig. 2). With furunculosis being so widely distributed throughout the Restigouche system, it is difficult to differentiate between mortalities resulting from this disease or from the stress of catch and release. It is possible that some fish may die after being hooked and released only because they were initially weakened by disease. A mortality rate of 0.07 was used in this assessment, but it is not possible to attribute this rate solely to the stress of catch-and-release.

A mortality rate of 0.07 would indicate 255 MSW salmon died after being released back into the river by anglers during 1989 (0.07 X 3641).

And finally in 1991, Courtenay et al. (DFO CAFSAC 91/13) summarized all the years of monitoring in the Restigouche and concluded:

The mortality rate associated with catch-and-release of MSW salmon was assumed to be 6%. This rate is based on data collected at five angling camps (Figure 1) over the years 1985-1989 (Appendix 1).

APPENDIX 1 RATE OF MORTALITY ASSOCIATED WITH CATCH AND RELEASE OF MSW SALMON ON THE RESTIGOUCHE RIVE

Since 1984, MSW salmon angled in N.B. waters have been released to contribute to spawning escapeme order to quantify the mortality associated with catch and release, managers at five angling camps mai records from 1985 to 1989 of the number of MSW fish angled and observed dead in their stretch of Carcasses bearing furunculosis lesions were excluded, being assumed to have died from that disease than from the stress of catch and release. These data are as follows:

Year	Camp	Catch and release	Mortalities	M/C	arcsine squareroot M/C ((sin M/
1985	1	223	12	0.0538	13.4133
	2	150	10	0.0667	14.9632
	3	219	50	0.2283	28.5430
	4	257	20	0.0778	16.1984
	5	227	3	0.0132	6.6013
	MEAN	225	19	0.0880	15.9438 (0.0755)
1986	1	330	6	0.0182	7.7494
	2	133	22	0.1654	23.9984
	3	197	18	0.0914	17.5943
	4	374	12	0.0321	10.3188
	5	293	12	0.0410	11.6759
	MEAN	265	14	0.0696	14.2674 (0.0607)
1987	1	149	4	0.0268	9.4302
	2	65	10	0.1538	23.0935
	3	83	12	0.1446	22.3482
	4	339	10	0.0295	9.8897
	5	255	6	0.0235	8.8236
	MEAN	178	8	0.0756	14.7170 (0.0645)
1988	1	238	2	0.0084	5.2597
	2	118	15	0.1271	20.8877
	3	196	12	0.0612	14.3258
	4	423	20	0.0473	12.5589
	5	229	5	0.0218	8.4973
	MEAN	241	11	0.0532	12.3059 (0.0454)
1989	1	153	6	0.0392	11.4218
	2	51	10	0.1961	26.2831
	3	96	2	0.0208	8.2989
	4	350	30	0.0857	17.0239
	5	291	20	0.0687	15.1983
	MEAN	188	14	0.0821	15.6452 (0.0727)
	MEAN OF ANNUAL MEANS			0.0737	14.5759 (0.0633)

Individual camps showed relatively little variation over the five years of the survey. The mortality rates at the camps furthest downstream (2 and 3) were higher than those upstream - probably because mortalities from upstream camps drifted downstream. Five year means (arcsin squareroot transformed) by camp are as follows:

CAMP	1	2	3	4	5	MEAN
Mean	9.4549	21.8452	18.2220	13.1979	10.1593	14.5759
(%)	(2.6985)	(13.8458)	(9.7781)	(5.2128)	(3.1112)	(6.3334)
S.D.	3.1641	4.3060	7.7070	3.2895	3.3503	5.3331
Range	(5-13)	(15-26)	(8-29)	(10-17)	(7-15)	(9-22)

From these data, the decision was made to set the mortality rate associated with catch and release of MSW salmon at 6%. The comparable estimate used in the Miramichi assessment is 3%. Randall et al. (1990) argued that the greater mortality rate in the Restigouche River might be associated with the prevalence of furunculosis, a disease common in the Restigouche River but not the Miramichi River.

A catch and release mortality rate value for the Miramichi River was first referenced in the assessment document of Randall et al. 1986 (DFO CAFSAC Res Doc 86/2). The value of 3% was based on a study conducted at North Pole Stream during 1982 and 1983 and the reference to study is "Currie, B. 1985. North Pole Stream Hook and Release Program. Proceedings of the 1985 Northeast Atlantic Salmon Workshop, Moncton, NB. 1786 p." of which I do not have a copy.

The relevant table from Randall et al. 1986 is below. The 3% rate for the Miramichi has been applied every year to catch and release values for grilse and salmon.

Mortality rate of MSW salmon released by anglers was estimated to be 0.03:

River		Released	Mortality	Proportion
North Pole, Miramichi	1982	44	2	0.05
	1983	19	0	0.00
	TOTAL	63	2	0.03

A more comprehensive summary of how catch and release mortality is considered in Canada and in Europe is provided by ICES in the Working Group report of 2010 (section 2.6). You can find the ICES report on the ICES website in their publications tab, the acronym for the expert group is WGNAS.

As of 2009, it was reported that within Canada, catch and release mortality rates used in assessments ranged from 3% to 10% (Newfoundland).

Few jurisdictions in the northeast Atlantic (Europe) incorporated a catch and release mortality rate for the angling fisheries, the exception was UK (England & Wales) that used a catch and release mortality rate of 20%.