Excerpt from 2009 Report of the ICES Advisory Committee (ACOM)

2.6 NASCO has asked ICES to evaluate the results of studies that estimate the level of prespawning mortality of salmon caught and released by anglers and the implications for stock assessments

ICES reviewed information from a number of countries.

Pre-spawning mortality

Mortality of Atlantic salmon after catch and release (C&R) is highly variable, with temperature often cited as an important factor (Dempson *et al*., 2002; Thorstad *et al*., 2003a; Thorstad *et al*., 2008). C&R angling at low temperatures (below 17–18°C) generally demonstrates lower post release mortalities than C&R at higher temperatures (Table 2.6.1, Figure 2.6.1). There is, however, a lack of studies on the survival after C&R at higher temperatures from release until to spawning and there are no studies on its relationship with survival to repeat spawning. Most of the studies that report mortality rates after C&R have used skilled anglers or artificially hooked already captive fish. This may lead to lower mortality than would be expected if less experienced anglers caught fish. Efforts have been made in a number of countries to inform anglers about good C&R practice through, for example, free instruction videos and advisory leaflets.

ICES considered that C&R recreational fisheries provide an intermediate management strategy between a full retention fishery and fishery closure for populations that are below target levels. Although not fully explored, its population-level effects could be evaluated using the equilibrium dynamics models used to calculate reference points such as the fishing mortality at maximum sustainable yield (Fmsy) or biomass at maximum sustainable yield (Bmsy). The effects would be conditional on life-history traits such as freshwater productivity, survival at-sea and repeat spawning frequency. C&R fisheries would be expected to result in population sizes that are higher than those in a full retention fishery, but lower than those expected to result from fishery closure (Figure 2.6.2).

Multiple recaptures

In all studies, less than 25 % of fish that had been marked upon release after capture by rod and line were caught a second time, and an even smaller proportion was caught a third time (Table 2.6.2). In most rivers where we have estimates of exploitation rates for salmon caught for the first time, the recapture rates after C&R are lower than the exploitation rate (Table 2.6.2). Thus, using marking of C&R fish to estimate exploitation rates or population size is likely to lead to underestimation of the exploitation rate and overestimation of the true population size. There is a need for further studies of the recapture rate of C&R salmon in rivers where exploitation rates are assessed with other methods in order to quantify the relationship between multiple recaptures and exploitation rate.

Implications for stock assessments

If all C&R salmon are counted as survivors, this will lead to an overestimation of the number of spawners. The reasons for this are twofold: (i) released salmon will suffer increased mortality relative to uncaught salmon and (ii) a proportion of the fish will be caught more than once. At present, the effect of catch on stock assessment is handled differently by different countries. Given the information presented, ICES recognized the need to correct for C&R mortality. However, river-specific conditions at the time of fisheries vary; Table 2.6.1 provides general guidance on appropriate values to apply.

Table 2.6.1 Summary of C & R experiments on Atlantic salmon that provide mortality rates and details of the methods used *(NS – Nova Scotia, NB – New Brunswick, NL – Newfoundland, ON – Ontario)*

Author	**Purpose**	**Method**	**Origin**	**Location**	**Life-stage**	**Telemetry**	**Method**	**Number of fish**	**Study period**	**Mortality rate (%)**	**Water temp**
Tufts *et al*. 1991	Pysiology	Hatchery	Wild	LaHave R, NS	Small		Chased	6	24 hours	0	18
Booth *et al*. 1995	Pysiology	In-river	Wild	Miramichi R, NB	Large		Hooked	20	24 hours	0	6 ± 1
Brobbel *et al*. 1996	Pysiology	In-river	Wild	Miramichi R, NB	Small		Hooked	24	12 hours	0	4 ± 1
Brobbel *et al*. 1996	Pysiology	In-river	Wild	Miramichi R, NB	Small		Hooked	25	12 hours	12	16 ± 1
Wilkie et al. 1996	Pysiology	In-river	Wild	Miramichi R, NB	Small		Hooked	10	12 hours	40	22
Anderson *et al*.1998	Pysiology	Hatchery	Wild	Exploits R, NL	Small		Hooked	5	72 hours	80	20 ± 2
Anderson *et al*.1998	Pysiology	Hatchery	Wild	Exploits R, NL	Small		Hooked	5	72 hours	0	16.5 ± 1
Anderson *et al*.1998	Pysiology	Hatchery	Hatchery	Alma, ON	Small		Hooked	6	72 hours	0	8 ± 1
Wilkie *et al*. 1997	Pysiology	Hatchery	Hatchery	Margaree R, NS	Small		Chased	10	72 hours	0	12
Wilkie *et al*. 1997	Pysiology	Hatchery	Hatchery	Margaree R, NS	Small		Chased	10	72 hours	0	18
Wilkie *et al*. 1997	Pysiology	Hatchery	Hatchery	Margaree R, NS	Small		Chased	10	72 hours	30	23
Dempson *et al*. 2002	Mortality	Natural	Wild	Conne R, NL	Small		Angled	8	14-40 days	0	12.2 ± 1.7
Dempson *et al*. 2002	Mortality	Natural	Wild	Conne R, NL	Small		Angled	20	14-40 days	10	16.1 ± 1.4
Dempson et al. 2002	Mortality	Natural	Wild	Conne R, NL	Small		Angled	21	14-40 days	9.5	19.4 ± 1.3
Thorstad *et al*. 2003	Mortality	Natural	Wild	Alta R, Norway	Small &large	Telemetry	Angled	30	Up to spawning	3	12.2 ± 2.2
Mäkinen *et al*. 2000	Migration	Natural	Wild	R. Teno, Finland	Small	Telemetry	Angled	5	Unknown	0	9.4 ± 1.0
Whoriskey *et al*.	Mortality	Natural	Wild	R. Ponoi, Russia	Small &large	Telemetry	Angled	62	24 hours	2	Not listed
Webb 1998	Mortality	Natural	Wild	R. Dee, Scotland	Small &large	Telemetry	Angled	25	Up to spawning	4	Not listed
Grant 1980	Stocking	Hatchery	Wild	R. Grimsa &Adaldal, Iceland	Large	Telemetry	Angled	30	Up to spawning	4	Not listed
Gowan 2004	Mortality	Natural	Wild	River Eden, Cumbria, UK	Small &large	Telemetry	Angled	208	Up to spawning	7-37	5-18, 11.9 ± 3
Svenning 2007	Migration	Natural	Wild	Målselva, Norway	Small &large	Telemetry	Angled	37	Up to spawning	0	12
Thorstad *et al*. 2007	Mortality	Natural	Wild	Alta R, Norway	Large	Telemetry	Angled	18	Up to spawning	6	12-14
Thorstad *et al*. 2003b	Migration	Natural	Wild	Orkla R, Norway	Small	Telemetry	Angled	34	Up to	0	11.5-

					&large				spawning		15
Davidson et al. 1994	Egg survival	Laboratory	Wild	Miramichi R, NB	Small &large		Hooked	26	Up to spawning	0	5-6
Warner & Johnson	Mortality	Natural	Landlocked	Moosehead lake, Maine	Small		Angled	175	minimum 2 days	22	16.5
Warner 1976	Mortality	Laboratory	Landlocked	Cobb fish cultural station,	Small		Angled	1200	minimum 9 days	3	12.5
Warner 1979	Mortality	Laboratory	Landlocked	Maine	Small		Angled	1221	3-5 days	5	13-15
Tufts et al. 1991	Pysiology	Hatchery	Wild	Casco cultural fish station,	Small		Chased	6	24 hours	0	18
Booth et al. 1995	Pysiology	In-river	Wild	Maine	Large		Hooked	20	24 hours	0	6 ± 1
Brobbel et al. 1996	Pysiology	In-river	Wild	LaHave R, NS	Small		Hooked	24	12 hours	0	4 ± 1
Brobbel et al. 1996	Pysiology	In-river	Wild	Miramichi R, NB	Small		Hooked	25	12 hours	12	16 ± 1
Wilkie et al. 1996	Pysiology	In-river	Wild	Miramichi R, NB	Small		Hooked	10	12 hours	40	22

Table 2.6.2. Information relating to multiple recaptures of salmon after C & R

Location	Study	Method	N	Percent recaptured	Percent recaptured twice	Percent recapture of released a second time	Estimate of exploitation rate in river (%)
Ponoi River, Russia	**Whoriskey *et al.* 2000**	**Floy tags**	**2,520**	**11**	**0.5**		**10-19**
Ponoi River, Russia	**Whoriskey *et al.* 2000**	**Telmetry**	**Unknown**	**7.2**			**10-19**
Alta River, Norway	**Thorstad *et al*. 2003a**	**Ancor T-tags**	**353**	**4**	**0.3**		**50-70**
Aberdeeshire Dee, Scotland	**Webb 1998 and references therein**	**Unknown**	**Unknown**	**5-20**			**Unknown**
Hofsa, Iceland	**Gudbergsson & Einarsson 2009**	**Floy tags or Dart tags**	**592**	**23.5**	**1.7**	**14.3**	**Unknown**
Sela, Iceland	**Gudbergsson & Einarsson 2009**	**Floy tags or Dart tags**	**605**	**24.6**	**2.3**	**22.2**	**75-80**
Grimsa, Iceland	**Gudbergsson & Einarsson 2009**	**Floy tags or Dart tags**	**234**	**17.9**	**0**	**0**	**Unknown**
Haffjardara, Iceland	**Gudbergsson & Einarsson 2009**	**Floy tags or Dart tags**	**379**	**14.8**	**0.3**	**6.7**	**Unknown**