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The effects of late season angling on gamete viability and early fry survival in Atlantic salmon
by

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#### Abstract

Angled and control male and female Atlantic salmon collected from the headwaters of the Miramichi in the fall of 1992 were spawned at the Miramichi Salmonid Enhancement Centre. No significant differences in gamete viability (measured in terms of egg survival) were found between crosses of control and angled salmon, nor was there evidence of differences in survival to hatch or to first feeding for the resulting fry. These results, combined with adult survival and physiological data indicate that salmon subjected to late season catch-and-release angling can be expected to survive and recover rapidly with no adverse effects on their gametes or progeny.


## RÉSUMÉ

Des saumons de l'Atlantique mâles et femelles capturés par la pêche à la ligne dans le bassin d'amont de la Miramichi à l'automne 1992 ainsi que des individus témoins ont frayé au Centre de mise en valeur des salmonidés de la Miramichi. On n'a décelé aucune différence significative dans la viabilité des gamètes (qui se mesure par la survie des oeufs) entre les croisements des saumons témoins et des saumons capturés à la ligne; il n'y avait non plus aucune différence dans le taux de survie jusqu'à l'éclosion ou la première alimentation des alevins découlant du croisement. Ces résultats, ainsi que les données sur la survie des adultes et les données physiologiques, indiquent que les saumons soumis à une capture (à la ligne) et une remise à l'eau en fin de saison peuvent survivre et récupérer rapidement sans que ceci ait des répercussions négatives sur leurs gamètes ou leur progéniture.

## Introduction

The practice of catch-and-release is being actively promoted in recreational fisheries throughout North America as being a means of protecting and conserving fish populations. A catch-and-release regulation for Atlantic salmon was introduced in Atlantic Canada in 1984. This regulation prohibits the retention of salmon over 63 cm in length in the recreational fisheries of insular Newfoundland, New Brunswick, Prince Edward Island, and Nova Scotia and is viewed as a means of enhancing the reproductive potential of salmon stocks by protecting the large, predominantly female, salmon from harvest.

It is widely recognized that even catch-and-release fisheries affect the biology and production potential of fish stocks. Numerous studies have attempted to quantify the effects of catch-and-release practices. The majority of these have centred on estimating mortality rates, and the effect of environmental parameters, gear types, and angling practices on angling induced stress and mortality (Schill and Griffith, 1986; Dotson, 1982; Marnell and Hunsaker,1970; Wydoski, 1977; Ferguson and Tufts, 1992).

Studies of the effects of catch-and-release angling on Atlantic salmon are limited and have concentrated on determining hooking mortality rates in landlocked (Warner, 1976,1978,1979; Warner and Johnson, 1978) and sea-run salmon (Currie,1985). Little is known about the sublethal effects of catch-and-release angling. One of the potential sub-lethal effects of angling stress is a reduction in reproductive ability. The possibility that caught-and-released salmon, especially those caught late in the season when they are close to spawning, would have reduced gamete viability has been a subject of concern for salmon conservation groups when considering the implications of fall season extensions. This study addresses that concern by comparing the gamete viability from salmon exposed to angling stress late in the season to that of non-angled salmon collected during the same time period.

## Materials and Methods

Salmon for the experiment were collected by seining from the barrier pool operated by the New Brunswick Department of Natural Resources and Energy (NBDNRE) on the North Branch of the Main Southwest Miramichi near Juniper, New Brunswick on October 6, 1992. Water temperature during the experiment was 5-6 $\mathrm{C}^{\circ}$. Control males and females (10 of each) were put directly from the seine into transportation tanks and transported to the Department of Fisheries and Oceans' Miramichi Salmonid Enhancement Centre (SEC) at South Esk, New Brunswick.

Salmon to be used for the "angled" group were placed in $1 \mathrm{~m} \times 0.75 \mathrm{~m} \times 3 \mathrm{~m}$ holding boxes anchored in the river. Angling was simulated by removing salmon ( 10 males and 10 females) from the holding box and imbedding an artificial fly in their lower jaw. The salmon were then
released into the pool where they were played to exhaustion (indicated by loss of equilibrium) on flyfishing gear by experienced anglers. The time that each salmon was played was recorded (Tables $1 \& 2$ ). When exhausted, the flys were removed from the salmon's jaw and the fish were tagged for identification, placed in transportation tanks and transported to the Miramichi SEC.

On October 19, 1992, the salmon were spawned at the Miramichi SEC. The weights and lengths of each salmon were recorded just prior to spawning (Tables 1-4). The eggs from each female were divided into two roughly equal aliquots. One aliquot was fertilized by a control male and the other was fertilized by an angled male. Each male from both the control and angled groups was used twice; once to fertilize an angled female and once to fertilize a control female. There were 10 groups of eggs (observations) in each cross (treatment).

Egg losses were recorded for each group over the incubation period up until they were loaded into upwelling incubation boxes on April 25, 1993 in preparation for hatching. Initial egg numbers in each group were calculated on February 23, 1993 when the eggs were fully eyed and robust in terms of their ability to withstand handling. A sample of 100 eggs was randomly picked from each egg group. These eggs were placed into a fine mesh net and excess water was allowed to drain. The eggs were then recounted into a 25 ml . graduated cylinder containing a known volume of water. The volume of water displaced by the 100 egg sample was then used to calculate the number of eggs per ml. The total volume of all the eggs in the group was then measured and multiplied by the number of eggs per ml. to give the number of remaining eggs. Egg loss to February 23 was then added to give the initial number of eggs in the group. Percent pre-hatch egg survival for each group (Tables $1 \& 3$ ) was calculated as follows:

## $\%$ Survival $=$ Number of eggs remaining in each group on April $25 \times 100$ <br> Initial number of eggs in each group

These percentages were arc-sine transformed and compared between crosses using a simple one-way ANOVA.

It was not logistically possible to keep each group of fry separate after hatching. However, all the eggs from each cross were loaded into separate incubation boxes and upon hatching the fry from each of the four crosses were held separately and their survival to hatch and first feeding (calculated as a percentage of the total initial number of eggs for each cross) was recorded (Table 5).

## Results and Discussion

Campbell et al. (1992) found that exposing hatchery origin rainbow trout to repeated episodes of acute stress under laboratory conditions during reproductive development resulted in
significantly lower survival rates for the progeny of stressed fish compared to the progeny from unstressed, control fish.

In the present study, there was no significant difference $\left(\mathrm{F}_{3,36}=2.87, \mathrm{P}=0.54\right)$ in fertilization to pre-hatch egg survival between the four crosses (Tables $1,3 \& 5$ ). Mean egg survivals were high and comparable to those of other salmon held at the Miramichi SEC. Furthermore, there was no indication that the progeny of salmon exposed to angling stress exhibited poorer than normal survival through hatching or feed-up (Table 5).

These results are supported by those of a similar experiment conducted at the Miramichi SEC in 1991. The 1991 experiment was basically identical to the present study except that insufficient numbers of salmon were available at the Juniper barrier and therefore salmon collected from the NBDNRE barrier on the Dungarvon River were used for controls. The 1991 egg survivals were found to be more variable than those observed in the present study but did not differ significantly between crosses. The present study was conducted because we felt that our 1991 results may have been genetically "compromised" as a result of using control salmon from the Dungarvon River.

The stress encountered by the angled fish in the experiments was no doubt exacerbated by seining and handling in the holding boxes and subsequent tagging, transportation and manual spawning should therefore be considered a "worse case" scenario. Nevertheless, the results indicate that this late in the season, gametogenesis is far enough advanced that it is unaffected by such stress episodes. Furthermore, salmon exhibit excellent resilience to exposure to such stress at this time of year and in these cold water temperatures (5-6 $\mathrm{C}^{\circ}$ ). No mortalities occurred in the salmon (118 in total) used over the two years' experiments. A series of physiological tests in 1992 which showed that angled salmon have fully recovered from the effects of angling stress in 4-8 hours (Booth et al., 1994). Our results, combined with those of Booth et al. 1994 indicate that salmon subjected to catch-and-release angling in the late fall can be expected to survive and recover rapidly with no adverse effects on their gametes or progeny.

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Table 1: Size, time played, fecundity, and spawning information for angled Atlantic salmon females collected at the New Brunswick Department of Natural Resources and Energy Juniper Barrier Pool on the North Branch of the Main Southwest Miramichi - October 6, 1992

| ID <br> Number | Time Played (min.sec) | Length (cm) | Weight <br> (kg) | Total Number of Eggs | Angled Male |  |  | Control Male |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | Male <br> ID <br> Number | Initial Number of Eggs | $\begin{aligned} & \text { \% } \\ & \text { Survival } \end{aligned}$ | Male <br> ID <br> Number | Number of Eggs | $\begin{aligned} & \% \\ & \text { Survival } \end{aligned}$ |
| AF1.92 | 19.40 | 100.0 | 10.7 | 16,136 | AM1.92 | 8,961 | 98.8 | CM1.92 | 7,175 | 99.1 |
| AF2.92 | 27.30 | 98.0 | 9.9 | 12,635 | AM2.92 | 6,635 | 93.3 | CM2.92 | 6,000 | 95.1 |
| AF3.92 | 6.30 | 79.0 | 4.8 | 6,925 | AM3.92 | 3,628 | 97.7 | CM3.92 | 3,297 | 98.5 |
| AF4.92 | 10.30 | 74.0 | 4.7 | 6,457 | AM4.92 | 3,068 | 98.7 | CM4.92 | 3,389 | 96.4 |
| AF5.92 | 10.03 | 88.0 | 6.4 | 9,583 | AM5.92 | 3,063 | 99.0 | CM5.92 | 6,520 | 98.3 |
| AF6.92 | 12.15 | 81.0 | 4. | 5,062 | AM6.92 | 2,435 | 99.0 | CM6.92 | 2,627 | 98.6 |
| AF7.92 | 9.00 | 81. | 8.8 | 10,880 | AM7.92 | 5,211 | 97.5 | CM7.92 | 5,669 | 98.6 |
| AF8.92 | 9.00 | 77.0 | 4.8 | 6,333 | AM8.92 | 3,323 | 96.1 | CM8.92 | 3,013 | 98.2 |
| AF9.92 | 11.00 | 74.0 | 4.1 | 6,016 | AM9.92 | 2,946 | 98.9 | CM9.92 | 3,077 | 98.6 |
| AF10.92 | 4.00 | 70.0 | 3.6 | 5,279 | AM10.92 | 2,651 | 99.2 | CM10.92 | 2,628 | 99.2 |

Table 2: Size, time played, and spawning information for angled Atlantic salmon males collected at the New Brunswick Department of Natural Resources and Energy Juniper Barrier Pool on the North Branch of the Main Southwest Miramichi - October 6, 1992

Time

| ID <br> Number | Played <br> $($ minsec $)$ | Length <br> $(\mathbf{c m})$ | Weight <br> (kg) | Control <br> Female | Angled <br> Female |
| :--- | :--- | :--- | :--- | :--- | :--- |
| AM1.92 | 8.00 | 84.0 | 5.4 | CF1.92 | AF1.92 |
| AM2.92 | 4.15 | 64.5 | 2.4 | CF2.92 | AF2.92 |
| AM3.92 | 11.00 | 78.0 | 4.2 | CF3.92 | AF3.92 |
| AM4.92 | 7.41 | 88.0 | 5.8 | CF4.92 | AF4.92 |
| AM5.92 | 10.00 | 73.5 | 2.9 | CF5.92 | AF5.92 |
| AM6.92 | 5.45 | 55.0 | 1.5 | CF6.92 | AF6.92 |
| AM7.92 | 17.20 | 86.5 | 5.3 | CF7.92 | AF7.92 |
| AM8.92 | 4.30 | 54.0 | 1.3 | CF8.92 | AF8.92 |
| AM9.92 | 5.00 | 54.5 | 1.3 | CF9.92 | AF9.92 |
| AM10.92 | 6.00 | 58.5 | 1.6 | CF10.92 | AF10.92 |

Table 3: Size, fecundity, egg survival, and spawning information for control Atlantic salmon females collected at the New Brunswick Department of Natural Resources and Energy Juniper Barrier Pool on the North Branch of the Main Southwest Miramichi - October 6, 1992

|  |  |  |  |  | Angled Male |  |  |  | Control Male |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ID <br> Number | Time <br> Played (min.sec) | $\begin{aligned} & \text { Length } \\ & (\mathrm{cm}) \end{aligned}$ | $\begin{aligned} & \text { Weight } \\ & \text { (kg) } \end{aligned}$ | Total Number of Egegs | Male <br> ID <br> Number | Initial Number of Egegs | $\begin{aligned} & \text { \% } \\ & \text { Survival } \end{aligned}$ |  | Male <br> ID <br> Number | Number of Eggs | $\begin{gathered} \text { \% } \\ \text { Survival } \end{gathered}$ |
| CF1.92 | 0.00 | 75.0 | 4.2 | 6,976 | AM1.92 | 4,365 | 99.6 | - | CM1.92 | 2,611 | 99.5 |
| CF2.92 | 0.00 | 90.0 | 7.8 | 8,858 | AM2.92 | 5,667 | 96.8 |  | CM2.92 | 3,191 | 96.4 |
| CF3.92 | 0.00 | 70.5 | 3.6 | 6,636 | AM3.92 | 3,471 | 99.6 |  | CM3.92 | 3,165 | 99.3 |
| CF4.92 | 0.00 | 73.5 | 3.9 | 7,006 | AM4.92 | 4,161 | 98.4 |  | CM4.92 | 2,840 | 97.4 |
| CF5.92 | 0.00 | 73.5 | 3.7 | 5,558 | AM5.92 | 2,934 | 96.8 |  | CM5.92 | 2,624 | 94.4 |
| CF6.92 | 0.00 | 75.0 | 4.1 | 6,419 | AM6.92 | 2,841 | 99.2 |  | CM6.92 | 3,578 | 99.0 |
| CF7.92 | 0.00 | 67.0 | 3.0 | 4,786 | AM7.92 | 2,718 | 98.3 |  | CM7.92 | 2,068 | 97.4 |
| CF8.92 | 0.00 | 79.0 | 5.3 | 8,491 | AM8.92 | 4,425 | 98.2 |  | CM8.92 | 4,065 | 90.2 |
| CF9.92 | 0.00 | 73.5 | 3.9 | 7,649 | AM9.92 | 3,752 | 96.7 |  | CM9.92 | 3,897 | 97.2 |
| CF10.92 | 0.00 | 74.0 | 4.2 | 7,095 | AM10.92 | 3,158 | 98.8 |  | CM10.92 | 3,937 | 98.7 |

Table 4: Size and spawning information for control Atlantic salmon females collected at the New Brunswick Department of Natural Resources and Energy Juniper Barrier Pool on the North Branch of the Main Southwest Miramichi - October 6, 1992

| m <br> Number | Time <br> Played <br> (minsec) | Length <br> (cm) | Weight <br> (kg) | Control <br> Female | Angled <br> Female |
| :--- | :--- | :--- | :--- | :--- | :--- |
| CM1.92 | 0.00 | 80.0 | 4.3 | CF1.92 | AF1.92 |
| CM2.92 | 0.00 | 62.5 | 2.3 | CF2.92 | AF2.92 |
| CM3.92 | 0.00 | 88.0 | 6.3 | CF3.92 | AF3.92 |
| CM4.92 | 0.00 | 52.0 | 1.2 | CF4.92 | AF4.92 |
| CM5.92 | 0.00 | 85.5 | 5.4 | CF5.92 | AF5.92 |
| CM6.92 | 0.00 | 86.0 | 5.6 | CF6.92 | AF6.92 |
| CM7.92 | 0.00 | 82.0 | 4.8 | CF7.92 | AF7.92 |
| CM8.92 | 0.00 | 57.5 | 1.5 | CF8.92 | AF8.92 |
| CM9.92 | 0.00 | 53.5 | 1.2 | CF9.92 | AF9.92 |
| CM10.92 | 0.00 | 59.0 | 1.7 | CF10.92 | AF10.92 |

Table 5: Pre-hatch, hatch, and feed-up survival for eggs and fry from angled and control salmon collected at the Juniper Barrier, October 6, 1992.

| Mating Cross | Pre-hatch egg survival (\%) Mean (range) | Survival to Hatch (\%) | Survival to <br> Feed-up(\%) |
| :---: | :---: | :---: | :---: |
| Angled Female x Angled Male | 97.8 (96.1-99.2) | 97.3 | 96.2 |
| Angled Female x Control Male | 98.1 (95.1-99.2) | 97.7 | 96.8 |
| Control Female x Angled Male | 98.7 (96.7-99.6) | 98.4 | 97.1 |
| Control Female x Control Male | 96.9 (90.2-99.5) | 96.4 | 94.7 |

