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A preliminary assessment of the status of the Atlantic salmon (*Salmo salar L.*) stock in Deer Arm Brook, Gros Morne National Park of Canada, Newfoundland

Évaluation préliminaire des stocks de saumon atlantique (*Salmo salar L.*) dans le ruisseau Deer Arm, à Terre-Neuve, en 2000

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Abstract

During the summer of 2000, a fish counting fence was established for the first time on Deer Arm Brook, Newfoundland, in Salmon Fishing Area (SFA) 14A. Almost the entire watershed is located within the boundaries of Gros Morne National Park of Canada. A total of 835 adult anadromous salmon, of which 755 were adult small (< 63 cm fork length) and 80 were large (≥ 63 cm fork length), returned to the river. Data from Deer Arm Brook were not available to determine the values for a number of variables important in the calculation of egg deposition; values were substituted from results on other rivers in SFA 14A to provide a range of potential egg deposition levels. Assuming that substituted values are consistent with Deer Arm Brook, adult runs to the watershed exceeded Department of Fisheries and Oceans conservation requirements.

Résumé

Au cours de l’été 2000, une barrière de dénombrement des poissons a été installée pour la première fois dans le ruisseau Deer Arm (Terre-Neuve), situé dans le secteur de pêche du saumon (SPS) 14A. Le bassin versant se trouve presque entièrement dans le parc national du Gros-Morne. Au total, 835 saumons adultes anadromes sont retournés à la rivière, dont 755 petits (longueur à la fourche < 63 cm) et 80 gros saumons (longueur à la fourche > 63 cm). Comme les données permettant de déterminer les valeurs d’un certain nombre de variables nécessaires au calcul de la ponte n’étaient pas disponibles pour le ruisseau Deer Arm, on y a substitué des données obtenues pour d’autres cours d’eau du SPS 14A pour calculer l’étendue des niveaux de ponte possibles. En supposant que ces données de substitution correspondent à la situation du ruisseau Deer Arm, la remonte de saumons adultes y dépasserait les impératifs de conservation établis par le ministère des Pêches et des Océans.

INTRODUCTION

Deer Arm Brook is a scheduled salmon river in Salmon Fishing Area (SFA) 14A. Its watershed area of 93 km^2 is almost entirely contained within the boundaries of Gros Morne National Park; a very small portion is within the municipality of the Town of Rocky Harbour (Figure 1). Within the National Park, Deer Arm Brook is one of 102 drainage basins identified (W404 - Kerekes and Schwinghamer 1975a, O'Sullivan, 1976) and one of four scheduled salmon rivers. The watershed drops from a maximum elevation of 800m to the East Arm of Bonne Bay in an axial distance of 15.9 km. Many of the watershed's 60 lakes are located at high elevation and are inaccessible to anadromous salmon. Three lakes provide the majority of lacustrine habitat: Eastern Arm Pond, Half Moon Pond, and the fjord-like Ten Mile Pond, a deep (61 m) and ultra-oligotrophic water body (Figure 2).

A fish counting fence was established at the mouth of Deer Arm Brook for the first time in 2000. There is limited historical information on salmon populations in the watershed. The Gros Morne National Park Salmonid Management Plan (Parks Canada, 1990) noted a trend towards a declining catch and catch per unit effort, with a corresponding increase in effort. The recreational fishery in Deer Arm Brook is currently regulated as a Class II River in the Newfoundland Fisheries Regulations but the imminent proclamation of Gros Morne as a National Park will require that Parks Canada develop separate fisheries regulations. Gathering preliminary population estimates on the scheduled salmon rivers within Gros Morne is a first step in this process.

METHODS AND RESULTS

COUNTING FENCE

An adult counting fence was established at the mouth of Deer Arm Brook just below the upper reaches of high tides. It was monitored on a daily basis from June 21 to September 29, 2000. Most of the fence sections had every conduit in place but, to minimize interference for smolt and smaller trout, several sections only had every second conduit in place. A subsample of adults was measured, weighed, and had scales removed for later aging. Monitoring frequency varied depending on the number of salmon moving upstream at a given time.

ADULT RETURNS AND SPAWNING ESCAPEMENT

a) Adult Count and Run Timing

All salmon were counted and most were classified as either adult small or large salmon. Run timing of small salmon was measured as the date that the 25^{th}, 50^{th}, and 75^{th} percentiles of the cumulative count occurred. Water temperature was recorded at the counting fence during every fence check.

A total of 835 salmon were captured at the Deer Arm counting fence. Dates for the run timing of small salmon were July 11 (25^{th} percentile), July 17 (50^{th} percentile), and July 25 (75^{th} percentile) (Figure 3).

b) Adult Returns

The total return to the river (TRR) of adult small and large salmon was based on the count at the fish fence as minimal angling occurred downstream of the fence. No adjustments were made for any other mortality above or below the counting fence.

Of the 835 salmon, 742 were adult small, 79 were large, and 14 were not classified (Figure 4). Numbers of small and large salmon were adjusted based on their proportions to account for the unclassified individuals. The adjusted totals (TRR) are 755 adult small and 80 large.

c) Spawning Escapement

Spawning escapement of small and large salmon to Deer Arm Brook was calculated separately by subtracting an estimate of retained catches from the total return. Recent creel data are not available for Deer Arm Brook. DFO catch data from 1999, estimated from license stub returns, were used to approximate retained catches. No data are available for hook and release mortality on Deer Arm Brook so it was assumed that 10% of released salmon died. No adjustments were made for any other unrecorded mortality above or below the counting facilities.

SE = TRR – RET - HRM

Where:

TRR = total return of small or large salmon
RET = 1999 DFO estimate of retained catches
HRM = hook-and-release mortality

HRM = REL x 0.1

Where:

REL = 1999 DFO estimate of the number of salmon released

For Deer Arm Brook in 1999, DFO estimates that 47 adult small salmon were retained and 24 were released. Ten large salmon were released. Using these values as estimates for the 2000 catch:

SE (small) = 755 – 47 – 3 = 705
SE (large) = 80 – 0 – 1 = 79

CONSERVATION REQUIREMENTS AND POTENTIAL EGG DEPOSITIONS

a) Conservation Requirements

Conservation requirements were calculated in terms of eggs, based on 2.4 eggs/m^2 for fluvial habitat (Elson, 1975) and 368 eggs/ha for lacustrine habitat (O'Connell et al., MS 1991). Fluvial habitat estimates included surface area of all riffle habitat in Deer Arm Brook and Ten Mile Brook (calculated by Hickey 1983). Lacustrine habitat was calculated as the surface area (ha) of Eastern Arm Pond, Half Moon Pond, and the surface area of all water 10 m deep or less in Ten Mile Pond (Kerekes and Schwinghamer 1975b, Anonymous 1996).

CR = (fluvial area x 2.4) + (lacustrine area x 368)

Conservation requirements were estimated to be:

CR = [(105,103 + 9,948) x 2.4] + [(235+33+(205 x 0.146)) x 368] = 385,786 eggs

b) Potential Egg Deposition

Fecundity for small and large salmon was calculated as:

F = RF x MW

Where:

RF = relative fecundity (#eggs/kg)
MW = mean weight of all fish

A relative fecundity of 1,783 eggs/kg of body weight for small and large salmon was estimated from an average of 3,388 (N=264) eggs per female for Western Arm Brook in 1979-80 (Chadwick et al., 1986) based on a mean weight of

1.90 kg. I have assumed that there is no weight difference between male and female adult small or large salmon.

Mean weight of adult small salmon was 2.076 kg and that of large salmon was 4.144 kg, giving:

F(small) = 1,783 x 2.076 = 3701.5
F(large) = 1,783 x 4.144 = 7335.3

Potential egg deposition (ED) by small and large salmon was estimated as:

ED = SE x PF x F

Where:
SE = spawning escapement
PF = proportion female
F = fecundity

It is unknown what proportion of the Deer Arm Brook population is female. As an approximation, ranges of values from other rivers in SFA 14A were included as the proportion female (PF). For both small and large salmon, the range was selected as the highest and lowest percentage females among Lomond River, Torrent River, and Western Arm Brook, calculated from long-term means (Mullins and Caines 2000). For small salmon, the proportion female ranged from 0.578 to 0.827. For large salmon, the proportion female ranged from 0.638 to 0.857.

ED(small, low proportion female) = 705 x 0.578 x 3701.5 = 1,508,324 eggs

ED(small, high proportion female) = 705 x 0.827 x 3701.5 = 2,158,104 eggs

ED(large, low proportion female) = 79 x 0.638 x 7335.3 = 369,714 eggs

ED(large, high proportion female) = 79 x 0.857 x 7335.3 = 496,622 eggs

This gave a high and low estimate of potential egg deposition.

ED(small + large, low prop. female) = 1,508,324 + 369,714 = 1,878,038 eggs

ED(small + large, high prop. female) = 2,158,104 + 496,622 = 2,654,726 eggs

The percentage of the conservation egg deposition requirement (CR) achieved was calculated according to the formula:

% Eggs Achieved = ED(small + large) / CR

% Eggs Achieved (low proportion female) = 1,878,038 / 385,786 = 487%

% Eggs Achieved (high proportion female) = 2,654,726 / 385,786 = 688%

Given the number of small and large salmon entering Deer Arm Brook, the conservation requirements of the river were exceeded by a factor of between 4.8 and 6.9.

DISCUSSION

The salmon stock on Deer Arm Brook exceeded conservation requirements in 2000. This is consistent with the trend for three other rivers monitored in SFA 14A, Lomond River, Torrent River, and Western Arm Brook (Mullins and Caines, 2000).

A number of assumptions were made in the calculations, all of which suggest that results must be interpreted with caution. First, not all potential salmon habitat was included in the determination of conservation requirements. Other smaller ponds and streams, that likely support salmon parr, have not been measured. Second, fish losses are likely underestimated. Numbers of retained fish and estimates of hook and release angling come from license stub return information in 1999 and not from detailed creel census during 2000. Poaching is reported to occur in Deer Arm Brook and Ten Mile Brook but there is no quantification of it. Third, fecundity estimates are based on data from a different river system; they assume that females and males share the same size distribution, and it is assumed that the proportion of female fish is consistent with that reported in nearby salmon rivers. A number of other cautions regarding parameter estimates are discussed by O'Connell and Dempson (1995).

Caution must also be applied to the management of this system as part of a National Park. As Gros Morne works toward developing a comprehensive Aquatic Ecosystem Management Plan, it is important that management targets ensure the long-term viability of Atlantic salmon populations.

ACKNOWLEGEMENTS

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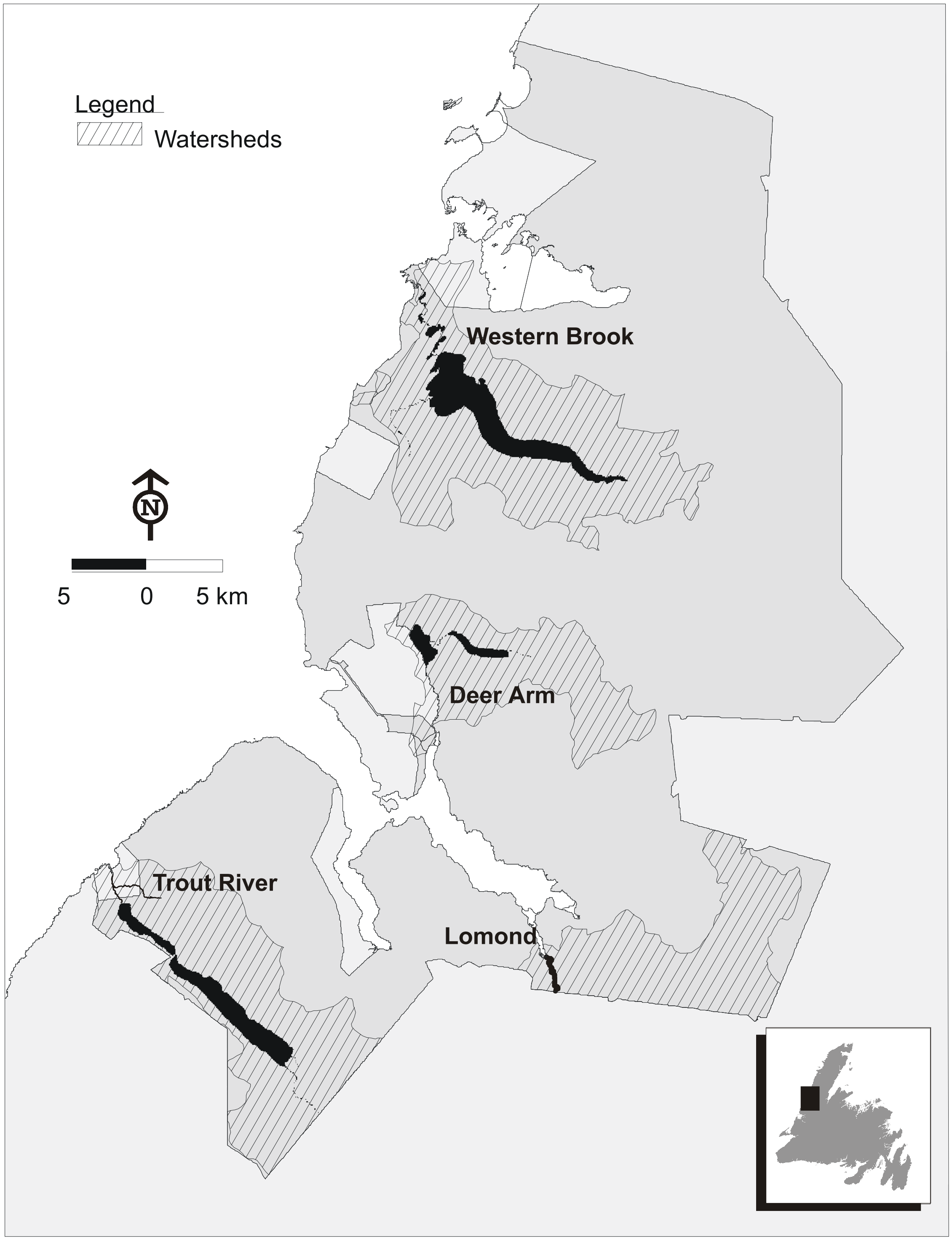

Figure 1: Watersheds of the four scheduled salmon rivers in Gros Morne National Park of Canada. Only portions of the watershed within the National Park boundaries are shown.

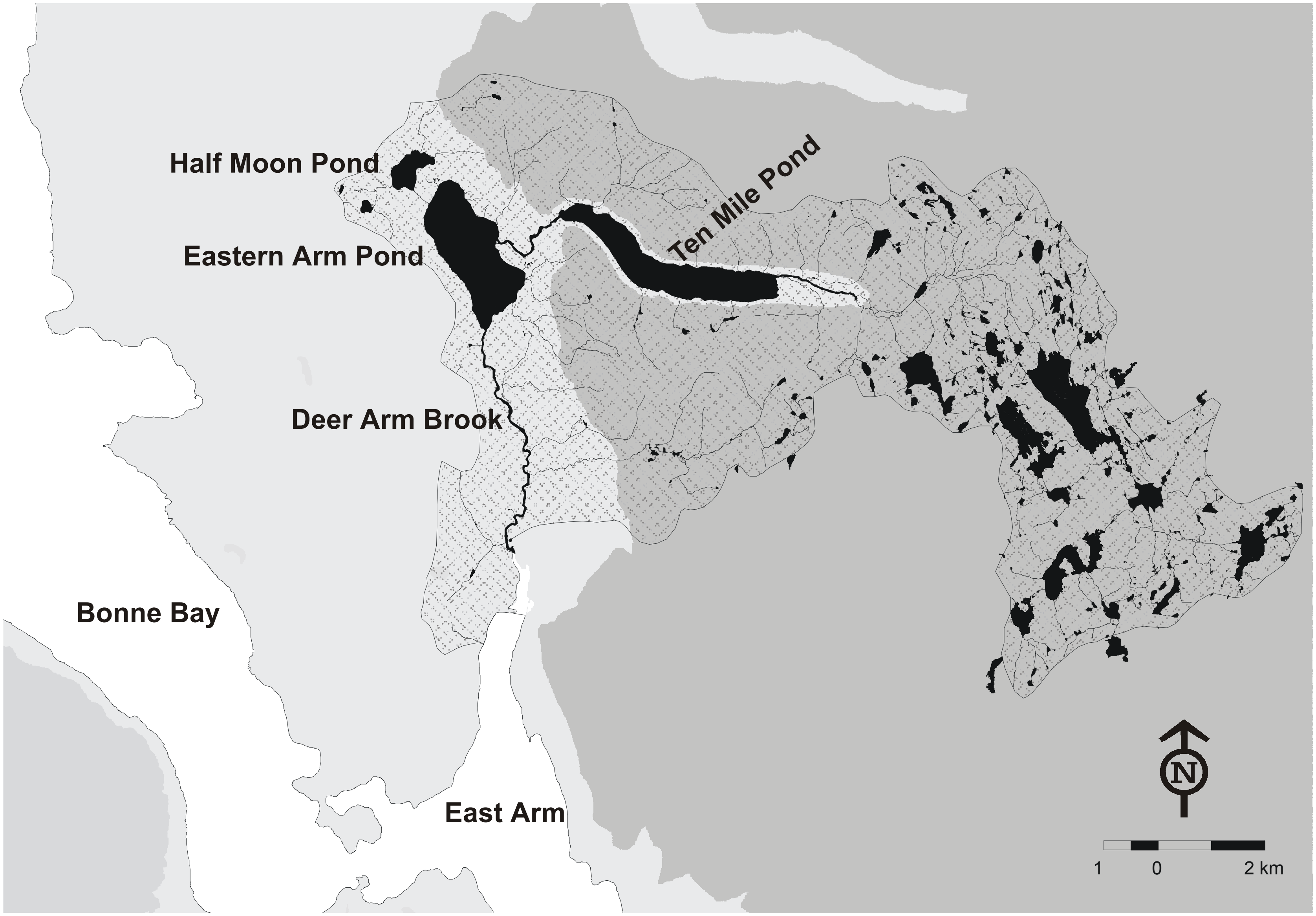

Figure 2: Deer Arm Brook watershed, Gros Morne National Park of Canada. Dark grey shading indicates elevations greater than 200 m, much of which is inaccessible to anadromous Atlantic salmon.

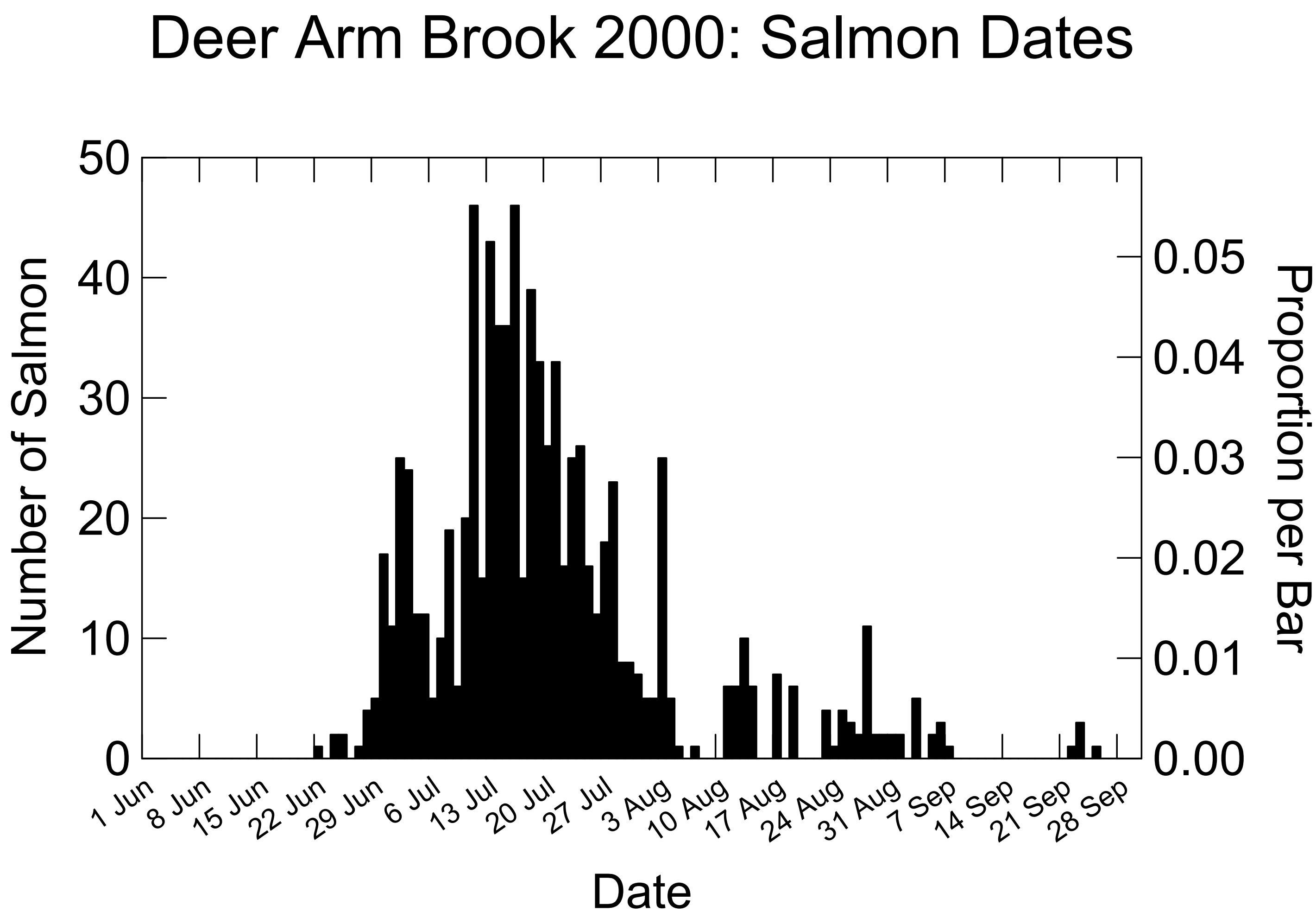

Figure 3: Histogram showing the timing of upstream movement by anadromous Atlantic salmon in Deer Arm Brook. Dates for the run timing were July 11 (25th percentile), July 17 (50th percentile), and July 25 (75th percentile).

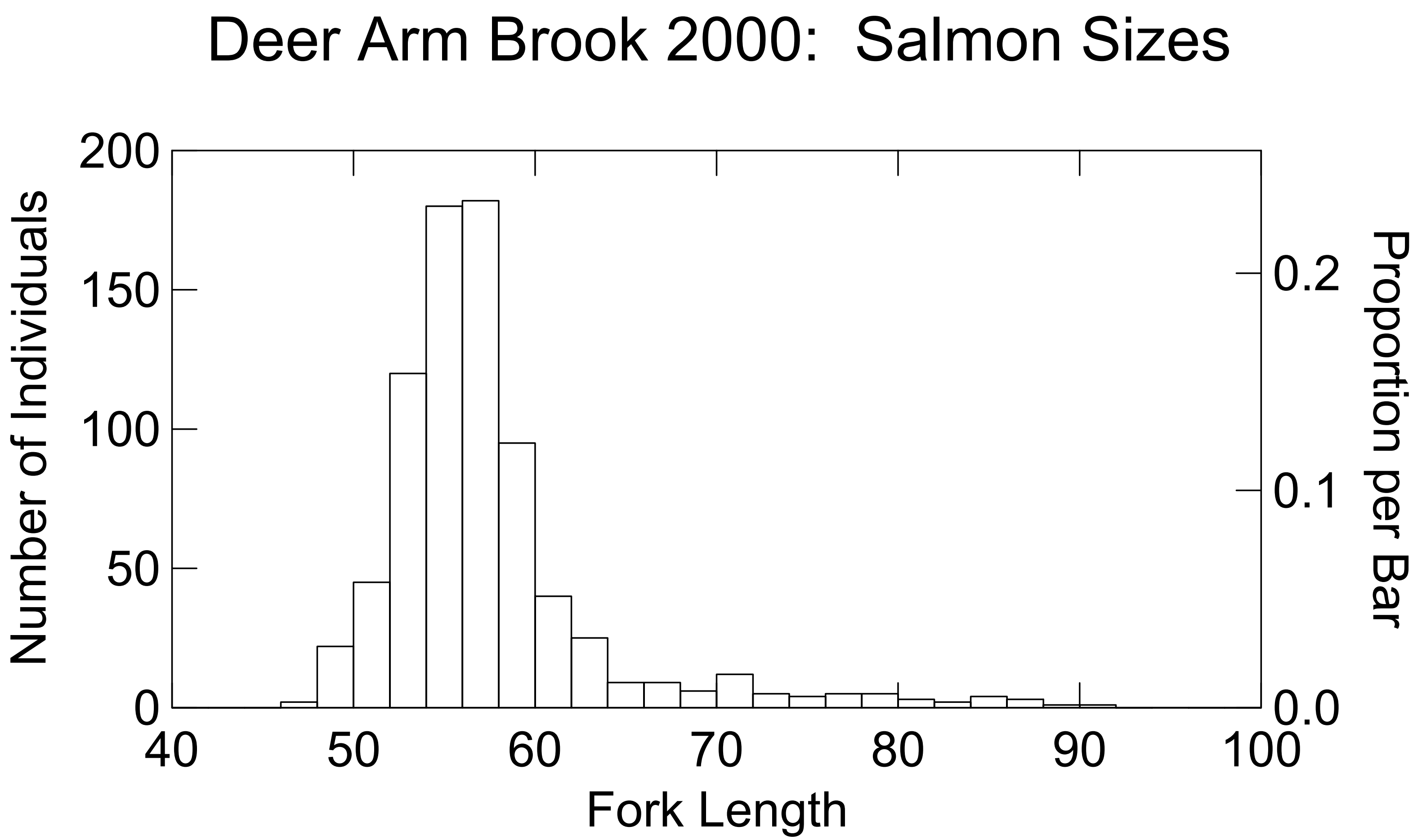

Figure 4: Size distribution of anadromous Atlantic salmon captured at the counting fence in Deer Arm Brook, 2000.