

Characterization of Atlantic Salmon Reproduction in the Upper Susquehanna River

Mark Cornwell*

ABSTRACT

Atlantic Salmon (*Salmo salar*) redds were examined in the upper Susquehanna River during November of 1992 and 1993 at Cooperstown, NY. In 1993, ten redds were composed of 10% boulder, 12% cobble, 52% pebble, 18% gravel and 8% sand. Five redds in 1992 had a composition of 42% cobble, 36% gravel and 10% sand. Fish were sampled with a fine mesh drift net to provide ages, lengths, weights and sex. All fish captured were 4+ years. The estimated spawning period was between 4 and 25 November.

INTRODUCTION

Landlocked Atlantic Salmon were stocked in Otsego Lake annually from 1982-1992 by the New York State Department of Environmental Conservation (Sanford 1993, Foster 1993). In 1988 and 1989 salmon parr were collected in tributary streams of Otsego lake (Hayes 1990). Further, in 1989 spawning activity was observed in Leatherstocking and Lawyers Creek and in the upper Susquehanna river (Foster 1989).

The reproduction of the Atlantic Salmon has been studied by the SUNY Cobleskill Fisheries and Aquaculture program in 1992 and 1993. The objective of this study was to characterize salmon and their redds and to note any changes from earlier studies (Foster 1989).

MATERIALS AND METHODS

Sample Site

The Susquehanna river flows out of Otsego Lake in the town of Cooperstown, NY (42°40'N lat. and 70°00'W long) with an eventual terminus in the Chesapeake Bay. Surface water from the lake provides most of the river flow at the dam site. Studies were conducted at the dam site and the bridge crossing on Susquehanna St., Cooperstown, NY.

*Robert C. MacWatters Internship in the Aquatic Sciences, Summer of 1993.
Department of Fisheries and Wildlife, SUNY Cobleskill, Cobleskill, N.Y.

Fish Collection

Fish were observed from the river bank so specific fish could be identified with their redds. A blocking net was used at the dam to entrap the fish between the dam and the lower river. A fine mesh gill net was drifted through the pool. Fish were collected, placed in totes and anesthetized. Length, weights and scales were taken on each fish. Age was determined by scale examination under a microfische reader.

Redd Analysis

Redds were observed as light areas on the stream bottom at pool-riffle interfaces. Substrate particle size in the 1993 redds was determined using the Modified Wentworth scale (Neilson and Johnson 1984). At each redd a shovelful of substratum was taken to be analyzed. Boulders (<256mm), cobbles (64mm-256mm), pebbles (16mm-64mm), gravel (2mm-16mm), and coarse sand (1mm-2mm) were separated. Each particle size total was weighed and divided by the total weight of sample to determine % composition of the particle type in the redd. Redd substrate size in 1992 was measured as small cobble (64-128mm), gravel-pebble (2-64mm) and sand (.062-2mm).

Temperature and water velocity data were collected on each study day in late afternoon to early evening. Temperature was measured with a hand held thermometer in the water column over each redd. Current velocity was measured with a gurley meter at the center of redds.

RESULTS

Characteristics of Spawning Fish

All four salmon captured in 1993 were 4+ years of age with an average total length of 534mm (Table 1). Similarly, the Atlantic salmon captured in 1992 were 4+ years of age. However, on average the spawning fish were slightly smaller at 495 mm (average weight 1539gm).

Table 1
Salmon Captured with finemesh drift nets, Susquehenna River
20 November 1992 and 5 November 1993

| '92 SEX | '92 AGE | '92 LENGTH | '93 SEX | '93 AGE | '93 LENGTH |
|---------|---------|------------|---------|---------|------------|
| M | 4+ | 443 mm | M | 4+ | 590 mm |
| M | 4+ | 640 | M | 4+ | 589 |
| M | 4+ | 403 | M | 4+ | 376 |
| - | - | - | F | 4+ | 584 |
| AVE | 4+ | 495 | - | 4+ | 535 |

Characteristics of the Spawning Season

In 1993 Atlantic salmon were observed spawning in the upper Susquehanna river from 4 - 25 November. The 1992 spawning season ranged from approximately 6 - 27 November. The season lasted about three weeks each year.

Water Quality Parameters

Water quality measurements in 1992 were taken at each site. Dissolved oxygen (11.5mg/L), conductivity (280 Joules/k/cal.) and pH (range 7.3 - 7.7) were at levels suitable for the Salmon. Temperature was cool at 5.3 - 5.5°C

Redd Location

Most of the redds observed were located on the downstream side of pools at the pool-riffle interface. However, in a few locations, particularly in 1992 there were redds located on gravel bars in runs.

Males on nests generally fled into the upstream pools when disturbed, although this depended to a certain degree on the direction of the disturbance. Females generally approached redds from downstream pools, swimming across the riffles to approach the redd.

Redds were positioned in the River so that the distance from the shores was maximized. At the dam site most redds were observed in areas far from the banks. Two 1993 redds closest to the stream bank were located near a gravel bar in a run at the end of the pool.

Two redds at the bridge site in 1993 were located close to each bank (<1.5 m). All other redds were observed in the center of the river.

Redd Characteristics

Of the seven redds studied in 1993, three had fish on them and four were inactive (Table 2). In comparison, two redds sampled at this location in 1992 had higher water velocity (4.5m/s versus 1.1 m/s) and were deeper (.85m versus .39 m). Further, the substrate composition in 1992 was made up of less of the preferred material (40% pebble-gravel) and more sand (15%) and cobble (45%).

Table 2
Atlantic Salmon Redd Characteristics, Dam 1993

| REDD # | % BOULD | % COBBLE | % PEBBLE | % GRAVEL | % SAND | DEPTH M | VEL. ft/s |
|--------|---------|----------|----------|----------|--------|---------|-----------|
| 1 | - | 19 | 71 | 9 | 1 | .37 | .9 |
| 2 | - | - | 58 | 26 | 16 | .39 | .8 |
| 3 | - | 10 | 35 | 38 | 17 | .32 | 1.0 |
| 4 | - | - | 60 | 26 | 14 | .35 | .8 |
| 5 | 45 | - | 32 | 17 | 5 | .32 | 1.7 |
| 6 | - | 30 | 70 | - | - | .53 | 1.5 |
| 7 | 28 | 26 | 40 | 3 | 2 | .46 | 1.2 |
| AVE. | 10 | 12 | 52 | 18 | 8 | .39 | 1.1 |

Seven redds were observed at the Susquehanna Street study site in 1993. Data from three active redds are noted in Table 3. Salmon nesting at the Susquehanna Street site in 1992 were in deeper water (mean depth .87 m) and their redds were composed of more small cobble (40%) and sand (27%) and less pebble-gravel (33%) than in 1993.

Table 3
Atlantic Salmon Redd Characteristics, Susquahanna St. 1993

| REDD # | DEPTH M | % BOULD | % COBBLE | % PEBBLE | % GRAVEL | % SAND |
|--------|---------|---------|----------|----------|----------|--------|
| 1 | .32 | - | - | 80 | 18 | 2 |
| 2 | .37 | - | 24 | 35 | 37 | 4 |
| 3 | .35 | - | 14 | 74 | 11 | .2 |
| AVE | .35 | - | 11 | 66 | 21 | 2 |

DISCUSSION

Many aspects of Atlantic salmon reproduction were consistent over the years studied. For example, spawning occurred at 6-7°C, slightly below the 10°C spawning temperature observed by Alabaster (1990). Further, the spawning season ranged over the same time period, the first three weeks of November. Redds were located in the same preferred areas (Kondolf 1990), on the downstream side of pools at the pool-riffle interface.

However, there were some differences. Under high water conditions found in 1992 Atlantic salmon redds seemed to have suboptimal levels of pebbles and gravel (Gustafson, 1991), in comparison to 1993. Further, while all Atlantic salmon spawning in the upper Susquehanna in 1992 and 1993 were 4+ years of age, in 1989 only 50% were 4+ with the rest being 3+ years (Foster 1989).

Water in the Susquehanna comes from the surface waters of Otsego Lake and thus reaches warm temperatures in the summer. Thermal refuges do occur in the river where the water temperature does not exceed 74°F (Sanford pers comm.), since the Susquehanna does support a small rainbow trout population. Further, there have been reports of anglers seeing Atlantic Salmon in the river (Homburger pers. comm.). However, since most Atlantic Salmon do not die after spawning (Shearer, 1992 and Netboy, 1968) and no fish older than 4+ years have been captured in the river, it is doubtful that adult salmon are able to survive the summer in the river.

It is thus unlikely that the fish observed on the Susquehanna redds were the product of natural spawning in the river. Atlantic salmon produced from the Susquehanna redds would have to find thermal refuges to survive four summers. During this time they would be extremely vulnerable to predation and angling. (At the time of the survey several salmon were found speared at the bridge site, demonstrating the vulnerability of salmon in the river).

Thus, it would appear that the Atlantic salmon spawning in the Susquehanna river originated from fish initially stocked into Otsego Lake. Once the fish are in the river, neither they nor their offspring have any means of getting back over the dam into the lake. Therefore once salmon become entrapped in the river, they are doomed to die of lethal temperatures.

ACKNOWLEDGEMENTS

SUNY Cobleskill's Fisheries Biology class helped collect the data used in this report. Dr. John Foster supervised this study and edited this manuscript. DEC's Kay Sanford and Joe Homburger at the Biological Field Station helped provide insight as to the Salmon population potential in the river.

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