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Alewives in Hudson River Tributaries, Two Years of Sampling

Final Report

to

The Hudson River Foundation

by

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ABSTRACT

The river herring observed in Hudson River tributaries in 1998 and 1999 were almost all alewives. We documented alewife runs in 18 tributaries for the first time.

The run in Canterbury Brook was estimated at 1600 alewives and the Moordener Kill at 8600 alewives. Despite being 80 miles apart, the runs were simultaneous in these two tributaries, peaking in mid-May. The run of 1442 alewives in Cocksackie Creek occurred the same week as the previous in 1999. The small run (217) in Lattintown Creek was bimodal which may be related to a dip in tributary water temperature.

Gender ratios were very different among the tributaries examined; Canterbury Brook had 55% females, the Moordener Kill had 23% females, Lattintown Creek had 37%, and Cocksackie Creek had 18.4%.

Females apparently spawned twice each with the first spawning early in the season. Females entering tributaries were mostly second spawners or completely spent. Second spawners made up 65.1% of the Canterbury Brook females and spent fish made up 20.9%. The Moordener Kill run was very different with 44.8% of the females second spawners and 55.2% were completely spent. Lattintown Creek had numbers similar to the Moordener Kill with 46.1% second spawners and 46.2% of the females being spent. Cocksackie Creek had the fewest spawning females (18.2% were second spawners) and the remainder were spent (81.8%).

We estimated that 3.7×10^7 alewife eggs were deposited in Canterbury Brook and about the same (3.9×10^7) were deposited in the Moordener Kill. Egg and larval mortality (comparing deposition to estimates of the drift), however, were very different with Canterbury Brook early life stages having a 61.5% mortality and the ones in the Moordener Kill at 38.5%. Estimates of egg deposition in Lattintown Creek and Cocksackie Creek were also very similar (2.3×10^6 and 2.6×10^6 , respectively) and an order of magnitude lower than the tributaries sampled in 1998. This may be a result of a generally poor alewife year in 1999.

In 1999, our estimates of mortality varied widely from 98.6% in Lattintown Creek to having estimated more eggs and larvae in the drift than were spawned in Cocksackie Creek. We have felt that our estimates of the numbers of adults were conservative and we think that our observations in 1999 confirm that netting adults is inefficient.

Male and female alewives were the same size, and were much smaller than alewives in more northern populations. Only one female alewife attained the age of VIII+, all others were VII+ or younger. Only 8.2% of the alewives aged showed a spawning mark on their scales.

A synthesis of adult alewife behavior is presented. These hypotheses came from our observations and considerable previous work.

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INTRODUCTION

The anadromous fish populations in the Hudson River are widely perceived as significant economic and ecological resources (Schmidt 1996). Considerable research has been done on Hudson River striped bass (*Morone saxatilis*) from its early life stages (Limburg et al. 1997 and references therein) through the contribution of Hudson River adults to the Atlantic coastal stock (Waldman et al. 1997). American shad (*Alosa sapidissima*) adults are monitored by the NYS DEC tagging program and Limburg (1994) reported considerable information on larval and juvenile biology in the Hudson. Juvenile and adult sturgeon (*Acipenser* spp.) are currently being studied by M. Bain, Cornell University. A recent Master's thesis (Rose 1993) looked at larval distribution of rainbow smelt (*Osmerus mordax*) in the Hudson River.

The other two major anadromous species, alewife and blueback herring, perform a significant role in the Hudson estuary. They are forage for a variety of juvenile and adult game fishes (witness the sale of live herring for striped bass bait). The juveniles, by their abundance, are significant zooplankton feeders (Limburg and Strayer 1987). Distribution and abundance of the early life stages of river herring in the Hudson have been summarized (Schmidt et al. 1988) and similar ichthyoplankton data are annually presented in reports to the Hudson River Utilities.

River herring do spawn in Hudson River tributaries. Limburg and Schmidt (1990) proposed that watershed development affected the magnitude of river herring runs. Although it is not clearly known which Hudson River tributaries have river herring runs (Schmidt and Cooper 1996), Schmidt et al. (1994) were able to account for all of the alewife eggs produced in the Hudson Estuary by export from sixteen tributaries. The tributaries are, therefore, potentially very important spawning areas for the Hudson River populations.

All of the above information on river herring has come from sampling eggs through juveniles. Little work has been done on the adults of these species in the Hudson River. Lake and Schmidt (1997 and 1998) have made the only (very conservative) population estimates for a herring run in the Hudson that we know of. Quassaic Creek in Newburgh has a run of 4-5000 individuals and this tributary has suboptimal water quality (Stevens et al. 1994) and was not considered a major spawning tributary by Schmidt and Limburg (1989).

The purpose of this project was to turn our attention to the adult river herring as they enter Hudson River tributaries. Clearly, the title of this report has given away one of our observations, that these tributary spawners are mostly alewives. We present observations on size, timing, and gender composition of several runs. We document the presence of alewife runs in several tributaries. We have provided data on age, fecundity, and behavior of spawning alewives in the Hudson River.

METHODS

This study took place in streams tributary to the tidal Hudson River (Fig. 1 and 2) between Westchester County (Saw Mill River at River Mile 18) and Rensselaer County (Poesten Kill at RM 159). River Mile is a Hudson River convention defined as the distance (in miles) north of the Battery at the southern tip of Manhattan. Adult alewives were collected in monofilament gill nets (15.5 m X 1.8 m X 6.4 cm stretch mesh) set in or close to the tidal mouths of various tributaries (Fig. 1 and 2). A second, smaller mesh net (3.2 cm stretch mesh) was often set simultaneously to capture smaller potamodromous fishes, particularly rainbow smelt and spottail shiners.

There were two levels of sampling effort. Two tributaries (Fig. 1), Canterbury Brook in Orange County (RM 58) and the Moordener Kill in Rensselaer County (RM 137.5), were selected to be sampled at least weekly in 1998. Lattintown Creek (Fig. 2) in Ulster County (RM 69) and Coxsackie Creek in Greene County (RM 127) were similarly sampled in 1999. One of the purposes for sampling these streams was to estimate the magnitude of the alewife run. The other tributaries (Fig. 1 and 2) were sampled less frequently, the main purpose being to determine if an alewife run was present in these tributaries and one successful collection of alewives was deemed adequate to establish the presence of a run.

In either case, the percent of the width of the stream that the gill nets blocked was estimated visually, the length of time the net was fished was recorded, and all fishes collected were identified, counted, and measured (total length- TL, to the nearest mm). Catch per unit effort (CPUE) was defined as the number of individuals caught per net hour. In Canterbury Brook and Lattintown Creek, nets were fished both day and night on incoming to high tides. In the Moordener Kill, partially because of other commitments, nets were fished in the evening, after sundown, once a week on the same day, thus we alternately sampled high and low tides. Coxsackie Creek was fished on Monday evenings during drift net sampling (see below) thus alternately sampling high and low tides and also was fished at a daytime high tide each week.

River herring collected in gill nets were all returned to the laboratory. They were identified, measured (TL, nearest mm), weighed (nearest gr), and gender was determined. Ovaries from females were carefully removed and weighed. In 1998, a subset of ovaries were preserved in 50% isopropanol for later fecundity analysis. Scales were removed from all river herring and, later in the study, otoliths were also removed from some specimens to provide an independent check on scale aging. Scales were stored dry in envelopes and otoliths were stored dry in small capped vials.

In Canterbury Brook, the Moordener Kill, Lattintown Creek, and Coxsackie Creek, we also, at least weekly, sampled the drift for early life stages of fishes. These samples were collected after sundown. Three standard rectangular drift nets (0.135 m² opening, 330 μ m mesh) were deployed at regular intervals across the stream. Nets were fished for about 20 minutes (time was recorded) and were then retrieved and the contents transferred into jars and preserved in the field with about 4% formalin. While nets were fishing, we measured water temperature (hand held thermometer), velocity of water in the mouth of each net (Swoffer current meter), and took a depth and velocity transect over the width of the stream to estimate discharge. In the laboratory, fish eggs and larvae were sorted out of the samples, identified as

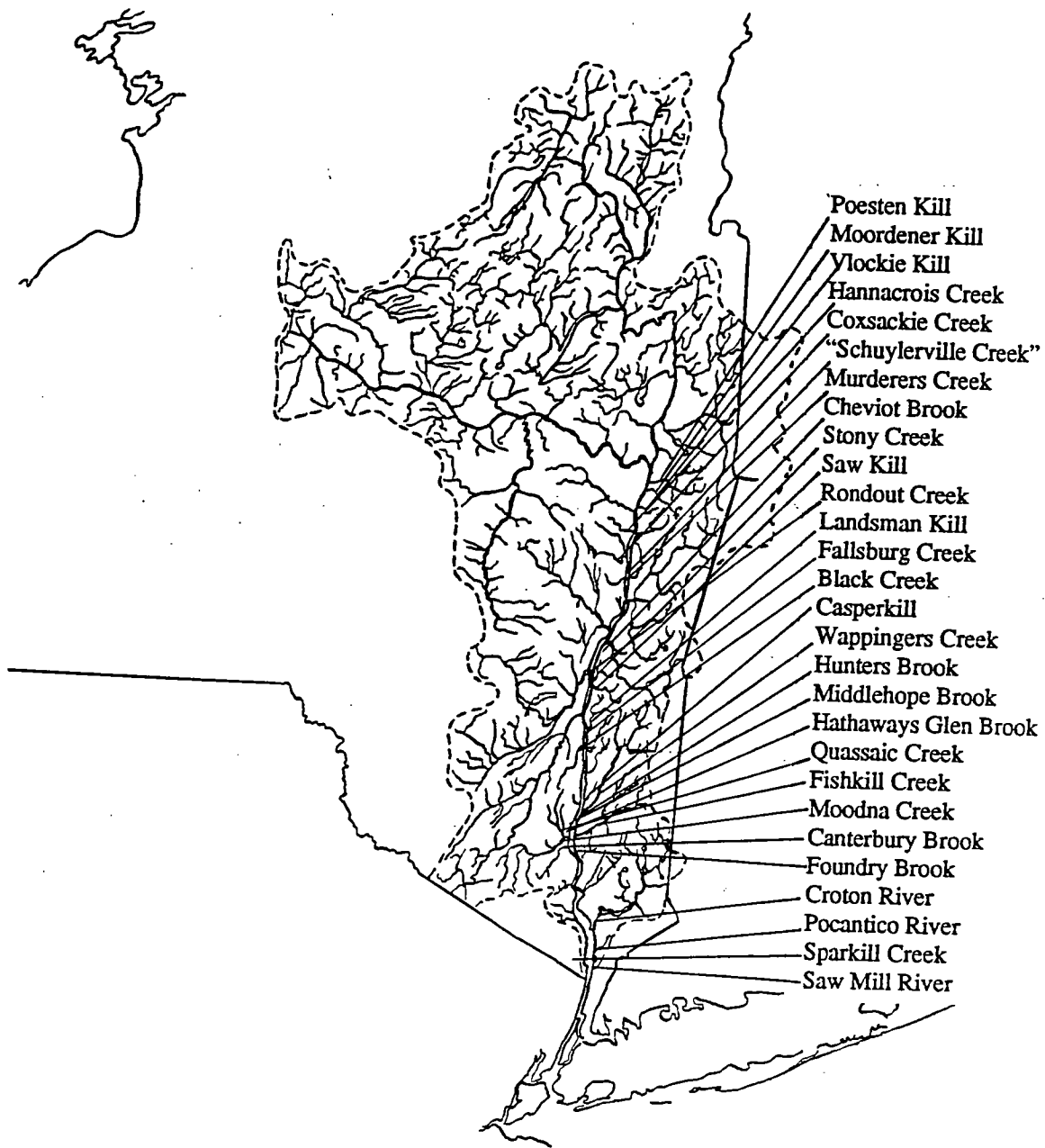


Figure 1. Map of the Hudson River estuary showing locations of tributaries sampled for river herring in 1998.

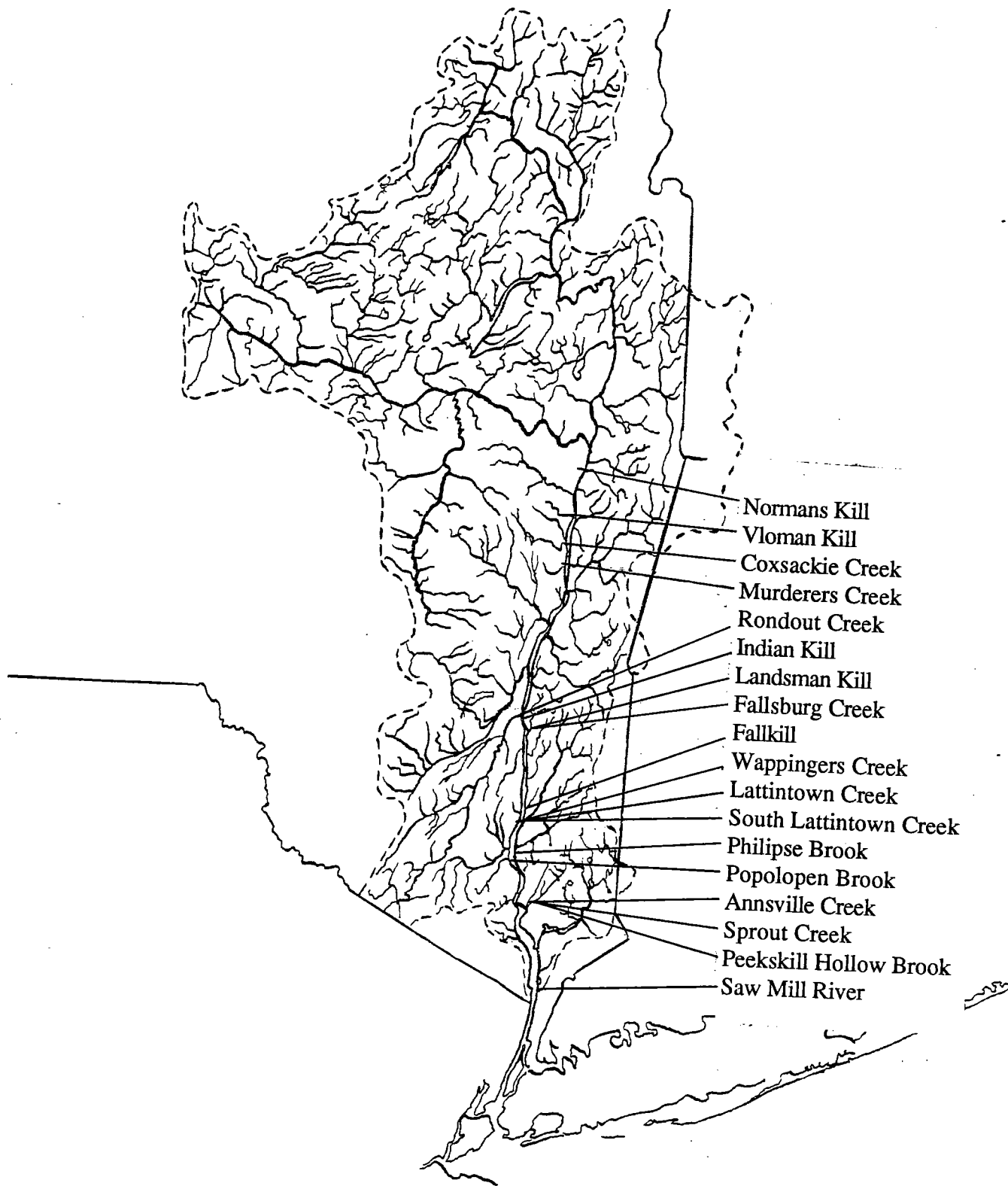


Figure 2. Map of the Hudson River estuary showing locations of tributaries sampled for river herring in 1999.

far as was practical, and counted.

The magnitude of the alewife runs was calculated from the gill net CPUE data. We assumed that a given net intercepted all alewives entering that part of the stream that the net covered for the time a net was fished. We also assumed that the magnitude of the alewife run, on days we did not sample, could be predicted from the preceding sample. CPUE was divided by the percent coverage of the tributary by the net and multiplied by the number of hours (incoming to high tides) of appropriate conditions for migration. These results were then multiplied by the number of unsampled days subsequent to each data point and finally summed.

The magnitude of the export of alewife eggs and larvae was calculated by first finding the density ($\#/m^3$) of alewife eggs and larvae (separately) per drift net using the numbers counted, the water velocity in each net, and the area of the mouth of the net. The average densities of eggs and larvae were then calculated for each sampling night. Average densities were converted to numbers/second by calculating the flow of the stream from the depth and velocity transects and multiplying by the densities.

Total export of eggs was calculated by multiplying the instantaneous transport ($\#/s$) by the number of seconds between a given sample and the next sample. This assumes that egg export is uniform over a 24 h period (Schmidt and Stillman, 1994) and that the amount of eggs exported did not change drastically between samples. Total export of yolk sac larvae was calculated somewhat differently because they tend to drift mostly after sunset (Schmidt and Stillman, 1994) and we adjusted the estimate of drift over 24 h based on those empirical observations. Total export of all life stages was the sum of export of eggs and export of yolk sac larvae.

Fecundity for a given female was estimated from 1998 data by first weighing the preserved ovaries. Three small subsamples were collected from the ovaries and also weighed (nearest 0.001 gr). Eggs were teased from the connective tissue in each subsample and were classified as either large or small (visually). Counts for large and small eggs were kept separately. Counts for each egg size for each subsample were averaged and the total number of large and small eggs per fish were estimated by proportion.

Total number of eggs imported into a tributary was estimated first by determining how many females entered the tributary (total number of alewives times the gender ratio). The females were further classified as first spawning, second spawning, or spent (explained below in results) and the numbers in each category were determined by multiplying the total number of females in a tributary by the observed proportion of females in each category. Finally, the number of large (ripe) eggs per category was multiplied by the estimate of the number of females in each category and summed for a given tributary.

Scales from 1998 fish were removed from envelopes, cleaned gently, and mounted between glass microscope slides. Images were projected on a white wall with a microprojector and annuli and spawning marks were determined following Marcy (1969). Ages were reported as observed, we did not add annuli to compensate for scale erosion. Otoliths were placed in a well slide in water and examined with transmitted light. We did not section or polish the otoliths.

RESULTS

River Herring

We deployed gill nets in 38 different tributaries of the Hudson River (Table 1). We collected river herring in 28 of these tributaries. Most of the river herring collected were alewives (*Alosa pseudoharengus*). Rondout Creek, the Poesten Kill, and the Normans Kill had the highest percentage of blueback herring (*Alosa aestivalis*) present (Table 1), but note that very few herring were seen in the latter tributary. Of the blueback herring we caught in the tributaries, few were females. Blueback herring probably are spawning in the Rondout, Catskill Creek (R. Simmons, Normandeau Inc., *pers. comm.*), and the Poesten Kill, but we suspect that their numbers are small. We conclude that virtually all of the reproducing river herring in Hudson River tributaries in general are alewives.

Fifteen of the tributaries sampled were either listed in Schmidt and Cooper (1996) as "herring runs not documented" (Normans Kill, Moordener Kill, Murderers Creek, Cheviot Brook, Fallkill, Lattintown Creek, South Lattintown Creek, Hunters Brook, and Middlehope Brook [listed as "Roseton Brook" in Schmidt and Cooper, 1996], Popolopen Brook, Sprout Brook, and Annsville Creek) or were not listed at all (Canterbury Brook, Casperkill, and Hathaways Glen Brook, the latter listed as "Unnamed-Newburgh" in Limburg and Schmidt, 1990). Therefore we added three tributaries that have alewife runs to the list of 66 tributaries in Schmidt and Cooper (1996) and we documented alewife runs in fifteen others.

Seven of the tributaries we sampled had no documented alewife runs and we were unable to catch alewives in this study (Foundry Brook, Sparkill Creek, Saw Mill River, Landsman Kill, Fallsburg Creek, Indian Kill, and "Schuylerville Creek"; the latter was not listed in Schmidt and Cooper, 1996). However, since we also failed to catch alewives in some tributaries where we know they exist (Croton River, Vlockie Kill, and Stony Creek), we don't feel that we have ruled out any of the above tributaries for having alewife runs. With a small amount of sampling effort, it is possible to miss a run.

Gill Net By-catch

Although not part of this study, our netting does document presence of other, possibly potamodromous, species in these tributaries (Table 2). Besides river herring, we collected 1653 individuals of 28 species, mostly consisting of important game and forage fishes. The most abundant species in our collections was white perch, well documented as a potamodromous species in the Hudson River (Limburg and Schmidt, 1990; Lake and Schmidt, 1997 and 1998; Schmidt and Stillman, 1994). In fact, more white perch were collected than alewives in the Moordener Kill and Lattintown Creek. A second potamodromous species, white sucker, was seen in greater abundance than alewives in Lattintown Creek. Thirteen species were seen in Canterbury Brook, eight in the Moordener Kill, 17 in Lattintown Creek, and 13 in Cocksackie Creek. Comparing the lists in Table 2, it seems that there are substantial differences in species composition among Hudson River tributaries. These data do add further support to the hypothesis that tributaries are important to a wide variety of fishes, not just the anadromous alewife.

Table 1. List of river herring catches in Hudson River tributaries, 1998-1999. River Mile (RM) is the number of miles north of the Battery in Manhattan. An asterisk (*) indicates tributaries that were sampled intensively.

Tributary		RM	# River Herring	% Alewives	CPUE
Saw Mill River	1998	18	0	-	-
	1999		0	-	-
Sparkill Creek	1998	24.5	0	-	-
Pocantico River	1998	28	0	-	-
Croton River	1998	34	0	-	-
Annsville Creek	1999	43.5	1	100.0	0.1
Peekskill Hollow	1999	43.5	1	100.0	0.2
Sprout Brook	1999	43.5	2	100.0	0.1
Popolopen Brook	1999	46.5	1	100.0	0.1
Philipse Brook	1999	51.5	0	-	-
Foundry Brook	1998	53	0	-	-
*Canterbury Brook	1998	58	200	99.5	1.3
Moodna Creek	1998	58	8	100.0	0.4
Fishkill Creek	1998	60	16	100.0	0.7
Quassaic Creek	1998	60	13	100.0	0.8
Hathaways Glen Brk	1998	63	20	100.0	0.7
Middlehope Brook	1998	65	25	100.0	7.1
Hunters Brook	1998	67.5	6	100.0	0.5
Wappingers Creek	1998	67.5	20	100.0	1.2
	1999		5	100.0	1.0
*Lattintown Creek	1999	68.5	48	100.0	<0.01
S. Lattintown Crk.	1999	68.5	3	100.0	0.1
Casperkill	1998	69	17	100.0	0.7
Fallkill	1999	75.5	11	100.0	4.4
Black Creek	1998	85	28	100.0	7.0
Indian Kill	1999	85	0	-	-
Fallsburg Creek	1998	87.5	0	-	-
	1999		0	-	-
Landsman Kill	1998	87.5	0	-	-
	1999		0	-	-
Rondout Creek	1998	92	37	75.7	2.5
	1999		57	82.4	8.1
Saw Kill	1998	98	1	100.0	0.7
Stony Creek	1998	99.5	0	-	-
Cheviot Brook	1998	106	9	100.0	1.3

