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Alewives in Hudson River Tributaries

Final Report

to

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by

Robert E. Schmidt and Thomas R. Lake
Hudsonia Limited
Bard College, Annandale, NY 12504

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Hudsonia Bard College Annandale, N.Y. 12504 914-758-1881

ABSTRACT

The river herring observed in Hudson River tributaries in 1998 were almost all alewives. We documented alewife runs in seven 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. Gender ratios were very different with Canterbury Brook having 55% females and the Moordener Kill only 23% females.

Females apparently spawned twice each with the first spawning early in the season. Females entering tributaries wre 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.

We estimated that $3.7X10^7$ alewife eggs were deposited in Canterbury Brook and about the same ($3.9X10^7$) 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%.

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.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

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) 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). 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. One of the purposes for sampling these two streams was to estimate the magnitude of the alewife run. The other tributaries (Fig. 1) 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 to the nearest mm). Catch per unit effort (CPUE) was defined as the number of alewives caught per net hour. In Canterbury Brook, 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.

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. 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 and the Moordener Kill, we also, at least weekly, sampled the drift for fish early life stages. These samples were collected after sundown. Three standard rectangular drift nets (0.135 m^2 opening, 330 μm mesh) were deployed at regular intervals across the stream. Nets were fished for about 20 minutes (time was recorded) and were then retreived 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 (Swoffor current meter), and took a depth and velocity transect over the width of the stream to measure discharge. In the laboratory, fish eggs and larvae were sorted out of the samples, identified as far as was practical, and counted.

The magnitude of the alewife runs were 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,

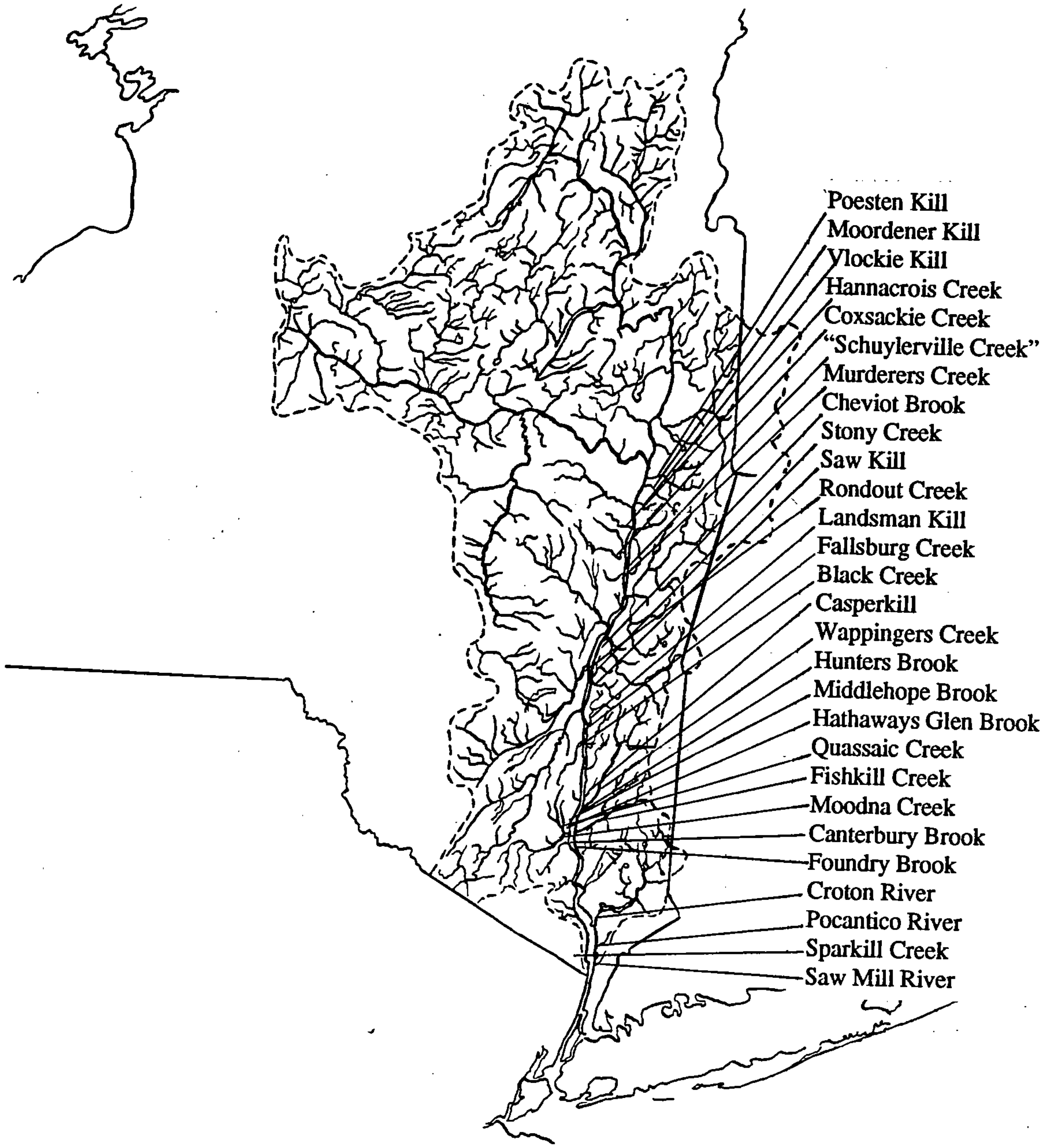

Figure 1. Map of the Hudson River estuary showing locations of tributaries sampled for river herring. Open circles indicate no herring were collected, closed circles indicate the presence of herring runs.

on days we did not sample, could be predicted from the preceeding sample. CPUE was diveded 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 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 by 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 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 29 different tributaries of the Hudson River (Table 1). We collected river herring in 16 of these tributaries. Most of the river herring collected were alewives (*Alosa pseudoharengus*). Rondout Creek and the Poesten Kill had the highest percentage of blueback herring (*Alosa aestivalis*) present (Table 1), but female bluebacks were only seen in Rondout Creek. We conclude that virtually all of the reproducing river herring in Hudson River tributaries are alewives.

Seven of the tributaries sampled were either listed in Schmidt and Cooper (1996) as "herring runs not documented" (Moordener Kill, Cheviot Brook, Hunters Brook, and Middlehope Brook, the latter was listed as "Roseton Brook" in Schmidt and Cooper, 1996) 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 documentd alewife runs in four 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, Murderers Creek, 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 717 individuals of 25 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. Thirteen species were seen in Canterbury Brook whereas only eight were taken in the Moordener Kill. 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.

Timing of the 1998 Alewife Runs

In 1998, there was a period of one or two weeks where alewives were quite abundant in the tributaries with generally low abundance the rest of the spring (Fig. 2). Our catches in Canterbury Brook and the Moordener Kill described a single peak of abundance in mid-May (Fig. 2). Previous studies have shown a bimodal pattern with abundant alewives in late April followed by a (usually smaller) run in mid-May (Lake and Schmidt, 1997 and 1998; Schmidt and Stillman, 1994).

Table 1. List of river herring catches in Hudson River tributaries, 1998. River Mile (RM) is the number of miles north of the Battery in Manhattan. CPUE is the mean catch per net hour in standard gill nets. An asterisk (*) indicates two tributaries that were sampled intensively.

Tributary	RM	# River Herring	% Alewives	CPUE
Saw Mill River	18	0	-	-
Sparkill Creek	24.5	0	-	-
Pocantico River	28	0	-	-
Croton River	34	0	-	-
Foundry Brook	53	0	-	-
*Canterbury Brook	58	200	99.5	1.3
Moodna Creek	58	8	100.0	0.4
Fishkill Creek	60	16	100.0	0.7
Quassaic Creek	60	13	100.0	0.8
Hathaways Glen Brook	63	20	100.0	0.7
Middlehope Brook	65	25	100.0	7.1
Hunters Brook	67.5	6	100.0	0.5
Wappingers Creek	67.5	20	100.0	1.2
Casperkill	69	17	100.0	0.7
Black Creek	85	28	100.0	7.0
Fallsburg Creek	87.5	0	-	-
Landsman Kill	87.5	0	-	-
Rondout Creek	92	37	75.7	2.5
Saw Kill	98	1	100.0	0.7
Stony Creek	99.5	0	-	0
Cheviot Brook	106	9	100.0	1.3
Murderers Creek	118	0	-	-
"Schuylerville Creek"	123	0	-	-
Coxsackie Creek	127	37	100.0	9.2
Hannacrois Creek	132	0	-	-
Vlockie Kill	136	0	-	-
*Moordener Kill	137.5	88	98.9	4.3
Poesten Kill	159	21	80.9	6.5

Table 2. List of species collected in gill nets in tributary mouths in 1998. Numbers are number of individuals collected.

Species	Canterbury Brook	Moordener Kill	Other Tributaries
Anguilla rostrata	-	1	2
Alosa mediocris	-	-	1
Dorosoma cepedianum	-	-	4
Cyprinus carpio	1	1	11
Notemigonus crysoleucas	7	2	35
Semotilus corporalis	-	-	1
Catostomus commersoni	37	2	33
Ameiurus catus	17	-	23
A. natalis	1	-	-
A. nebulosus	-	-	10
Esox niger	4	-	1
Oncorhynchus mykiss	-	-	1
Salmo trutta	2	3	1
Fundulus heteroclitus	-	-	8
Ambloplites rupestris	-	1	20
Lepomis auritus	2	-	33
L. gibbosus	13	-	22
L. macrochirus	2	-	13
Micropterus dolomieu	-	-	3
M. salmoides	-	-	3
Pomoxis nigromaculatus	-	-	5
Morone americana	60	113	170
M. saxatilis	6	1	13
Perca flavescens	-	-	24
Stizostedion vitreum	-	-	4
Total	153	124	440

Alewife runs are reported to occur between 12-16°C (Pardue, 1983). Tributary water temperatures (Fig. 3) reached about 12°C at the end of April in 1998 which generally coincided with an increase in catch per unit effort in our two main tributaries. We did, however, see spawning (see the section on drift of eggs and larvae, below) at temperatures below the reported minimum (10.5°C) necessary for spawning (Pardue, 1983).

Despite the fact that Canterbury Brook and the Moordener Kill are about 80 miles apart, the alewife runs in both occurred simultaneously (Fig. 2). This observation is similar to

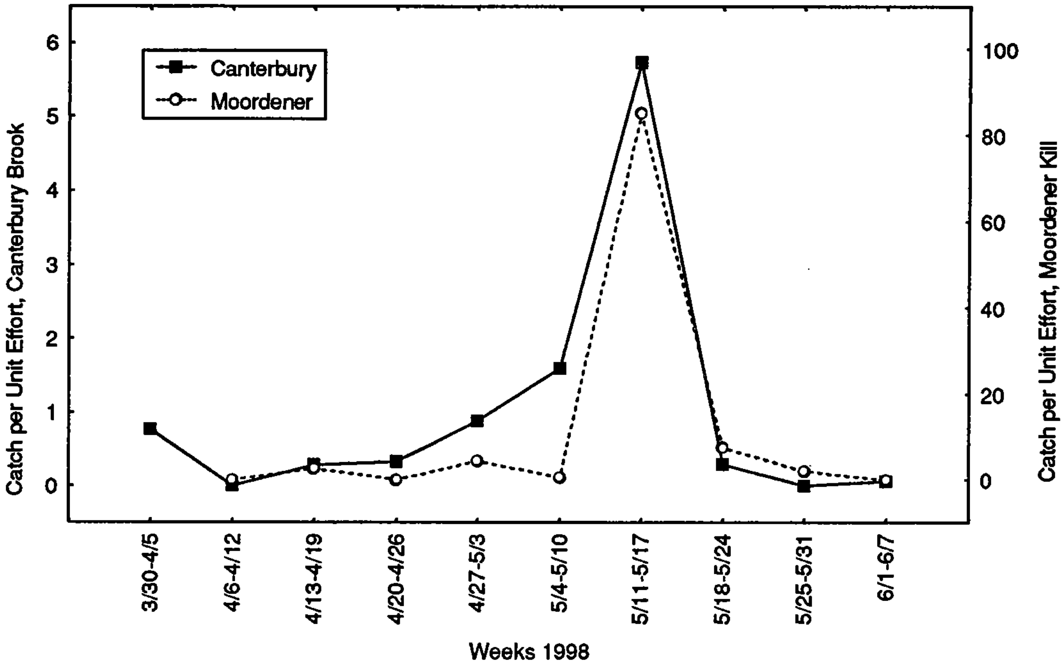

Figure 2. Catch per net hour of alewives in Canterbury Brook (weekly means) and the Moordener Kill in 1998. Note that the scales are different for the two streams.

Limburg and Schmidt (1990) where they reported that alewives appeared in all tributaries at about the same time regardless of the location of the tributary in the estuary. The magnitude of the run in the Moordener Kill was greater than in Canterbury Brook. The catch per net hour in the Moordener Kill was almost always an order of magnitude greater than in Canterbury Brook (Fig. 2).

Sampling for alewives in Canterbury Brook occurred on incoming tides, 17 during the day and 17 at night. Catch per net hour did not differ between day (mean= 1.09 alewives per net hour, range 0-10) and night (0.96, 0-10.1). This observation suggests that alewife runs can be sampled during the day and at night with equivalent results.

Tidal stage does make a large difference in catch rates of alewives, however. Samples in the Moordener Kill on high tides showed greater catches per net hour than samples taken on subsequent low tides (Fig. 4), frequently much greater. This observation suggests that alewives enter tributaries on incoming and high tides and sampling at other times will underrepresent the magnitude of the run.

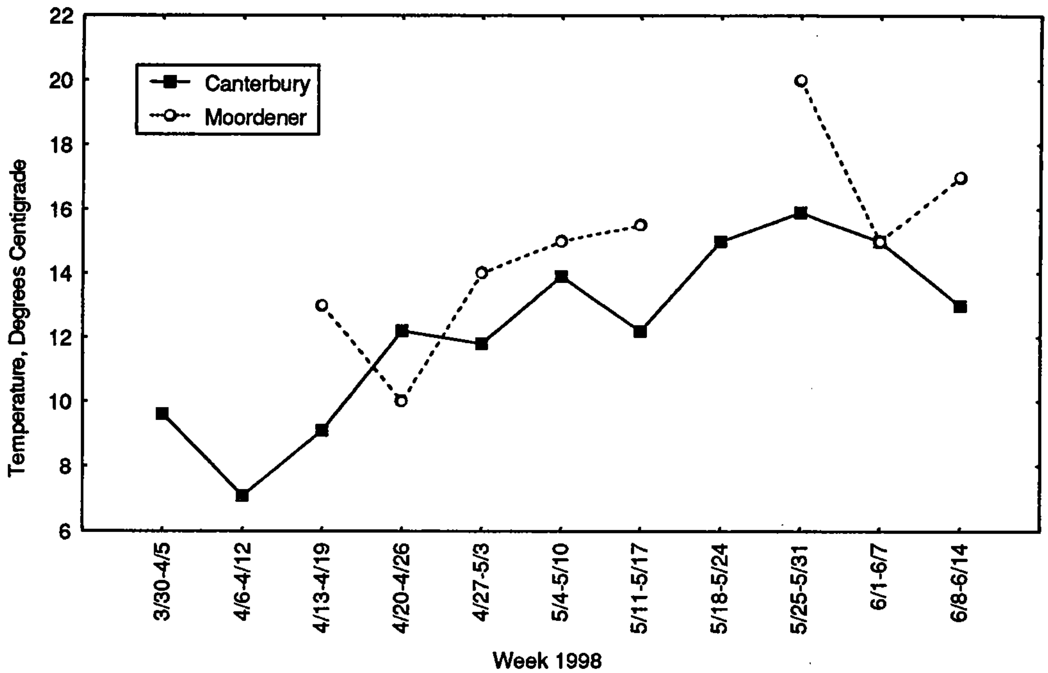

Figure 3. Water temperature in two tributaries during alewife sampling in 1998.

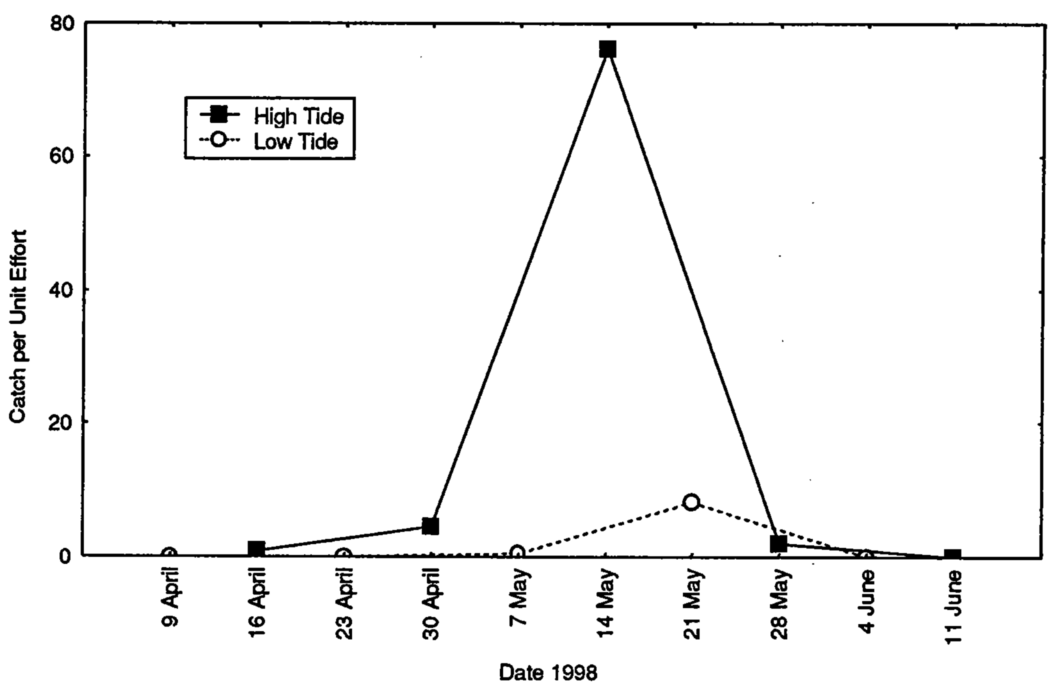

Figure 4. Alewife catch per net hour in the Moordener Kill comparing tidal stages.