Bristol Mills 2015 Alewife Count

Project Background

In 2015, local and state organizations worked together for a third year to collect information about the native run of alewives in the Pemaquid River at Bristol Mills. With the help of numerous dedicated volunteers from the community, the Pemaquid Watershed Association, Maine Coastal Program, Department of Marine Resources, and the Town of Bristol helped implement a standardized protocol for counting the number of alewives that successfully pass over the Bristol Mills fishway.

The annual alewife count provides data describing the number of alewives reaching spawning habitat in the Pemaquid Watershed, which is critical to assessing the health of the run. The count also shows how changes in water flow and temporary modifications to the fishway can influence the number of alewives passing upstream.

The data collected by volunteers in 2013 and 2014 showed that the number of adult alewives passing through the fishway at Bristol Mills on their spawning run was much lower than expected, and the run far smaller than what the habitat can support. Observations at the dam and a tagging study demonstrated that the fishway was not providing adequate passage. The monitoring results and fishway observations prompted the town to seek a Maine Coastal Program grant to develop engineering designs for fishway improvements. The designs were completed by Wright-Pierce Engineering and project partners in spring of 2015, and the town has already began fundraising for the project by reserving $20,000 of the town's 2015 budget for the construction of the new fishway. The town is also pursuing an assessment of the Bristol Mills Dam for stability and safety.

In 2015, we installed an electronic fish counter at the top of the fishway. This counter operated continuously and helped us assess the accuracy of the volunteer count, which is a sub sample count (i.e. it is conducted for a half hour period, up to four times each day). The volunteer visual count method is simple, cost effective, and can be reliable. Estimates derived from visual count data may differ from the true run size, based on the timing and duration of relative "surges" of fish passing over the dam. Knowing how well the visual count estimates the actual number of fish passing is critical for management of the alewife run and can be achieved by comparing the volunteer count results with results obtained from a continuously running electronic counter. The side-by-side comparison of the two count methods at Bristol Mills is one of two in the state. It is part of a pilot project to test the effectiveness of both methods as volunteer counts are expanded to more locations in Maine.

Alewife restoration is a high priority due to large-scale population declines that started with the period of major dam building in the 1800s. Each spring adult alewives initiate a migration that starts in the open ocean and brings them to Maine's freshwater spawning grounds. After breeding in lakes, ponds and other still waters, alewives head back to the marine environment. Newly hatched fish spend up to several months in their freshwater nurseries before heading to the ocean. After three or four years, they return to their natal waters and repeat the cycle. Dams and roads that block fish passage interrupt the cycle. Maine's rivers and streams once supported numerous alewife runs, but today there are fewer runs, and most are still much smaller than they were before 1800. Dams and road crossings that block or impair alewife passage are still a major problem and limit the runs from reaching their full potential.

Alewives migrating to and from their spawning grounds in the freshwater are a source of food all along the way to predators like marine fish, eagles, osprey, herons, mink, otters, and freshwater gamefish. Alewives are also an important seasonal bait source for Maine's lobster fishery and some communities have successfully turned the once-common spectacle of alewives in the tens of thousands, and the wildlife they attract, into a family-friendly revenue generating event.

Alewife Run Monitoring Results

Sampling Design

The alewife count used a standardized protocol based on a visual sub-sampling method to estimate the total run size. Each day of the survey, volunteers conducted 30-minute counts of alewives passing over the dam. During the 2013 survey, a 30-minute count was performed three times a day during three four-hour time blocks performed from 7 am to 7 pm. In 2014 and 2015, four counts were performed each day, each during one of four three-hour blocks from 7 am to 7 pm. During counts, volunteers recorded the number of alewives passing over the top of the fish ladder as well as other environmental parameters.

Results

<u>Volunteer Count Trends</u>

In 2015, counts were conducted May 15 to June 19. The daily average number of alewives counted ranged from 0 (on multiple dates) to 208 (on June 12). The highest count in one 30-minute period was 577 alewives on June 12 during the evening count.

The majority of the run occurred during two periods of movement: the first from May 26-June 5, and the second from June 13-June 15. These two periods of higher fish passage are later than the peak periods we saw in 2013 and 2014 (Figure 1). This may be a factor of lower flows in early May in 2015, which could cause difficulties for alewife passage over natural obstacles in streams. Also, colder river and ocean temperatures later in May 2015 may have interfered with large-scale migration patterns.

The two peaks in the run that we have seen every year may be due to multiple factors including adjustments to the fishway and weir/leader, run timing, river discharge (flow), fishway performance under different flows, and other factors.

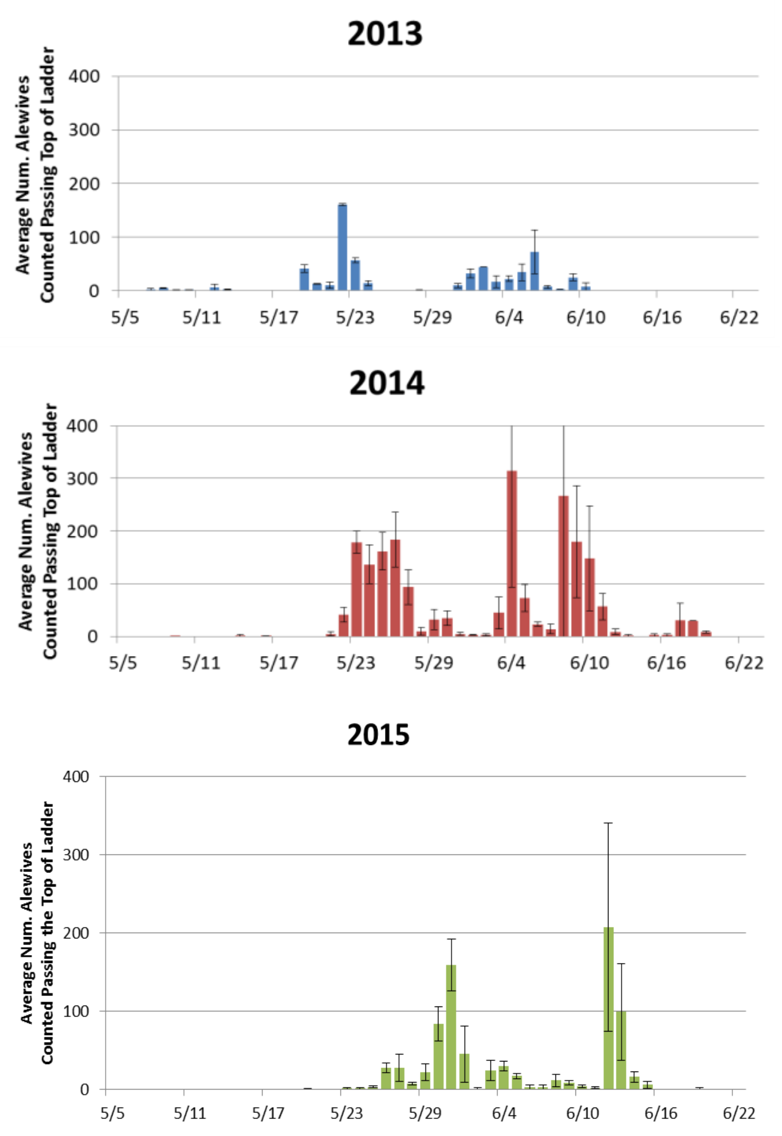


Figure 1. The average daily volunteer counts for 2013, 2014, and 2015. Error bars represent daily standard error (±1SE).

<u>Water Temperature and Depth</u>

In 2015 we collected water depth and temperature data at a fixed station immediately upstream of the dam during each fish count. We found that more alewives were counted when water temperatures were over 14ºC and when water depths reached 26-28 inches at the top of the fishway (Figures 2 and 3). During 2014, we found higher counts when the water was about the same level, at 26-29 inches.

The relationship between temperature and alewife movements has been documented for many other sites in Maine. Water depth in the impoundment behind the dam is a function of discharge in the watershed and to a lesser extent, management of flashboards in the dam. With more water in the impoundment, velocity and turbulence in the fishway can increase. At some point those increases are likely to exceed the fishway's design limitations, resulting in fewer fish observed passing.

Estimated Total Run from the Volunteer Counts

The data were extrapolated to estimate a total run size for the year using methods described by G. Nelson in *A Guide to Statistical Sampling for the Estimation of River Herring Run Size Using Visual Counts* (MADMF TR-25, 2006). ***Please note that the 2013 and 2014 run estimates have been revised based on a change in statistical methods to more accurately extrapolate the volunteer counts.*** The estimated counts for 2013 and 2014 are higher than previously estimated, but there is a wider margin of error. The estimates below were determined using a one-way stratified sampling design.

In 2013, the run size successfully ascending the Bristol Mills fishway was estimated to be 14,228 (95%CI = ±4,803) alewives. In 2014, 50,343 (95% CI = ±20,424) alewives were estimated to have passed through the top of the ladder. The increase in 2014 may have been due to adjustments to the fishway that improved its performance, such as modifications to the weir-leader, entry pool, water control at the exit, and repair of a non-conforming baffle, but there was also more variability in the counts, resulting in a wider margin of error. In 2015, the total count is estimated to be 19,783 (95% CI = ±8,527). The high margin of error again is a result of the higher variability in daily counts.

The difference between the years may be due to natural fluctuations in the population size or some combination of fishway management and population fluctuations. The lower counts in 2015 compared to 2014 were observed at many alewife runs across the state and the Northeast. The smaller 2015 run may be a natural population fluctuation, may be due to environmental variables that delayed the 2015 runs (colder temperatures and low water flow), or may be due to offshore pressures on the populations (e.g. susceptibility to bycatch).

The accuracy of the volunteer count can be improved by performing 2 counts during each period, instead of one. In 2014 and 2015, four counts were performed each day, each during one of the time blocks 7-10am, 10am-1pm, 1-4pm, and 4-7pm. The accuracy will be improved if two counts are performed each of these blocks, for a total of eight counts per day.

Comparing the Volunteer Count to the Electronic Counter

In 2015, the electronic counter counted 31,688 alewives passing upstream at the top of the fishway. This estimate does not include any counts through the top tubes of the counter as we found that debris going through the top tubes resulted in false counts. The volunteer count estimated a much smaller run 19,783 (95% CI = ±8,527), though the upper 95% confidence interval estimate of the volunteer count (28,310) approaches the electronic counter total.

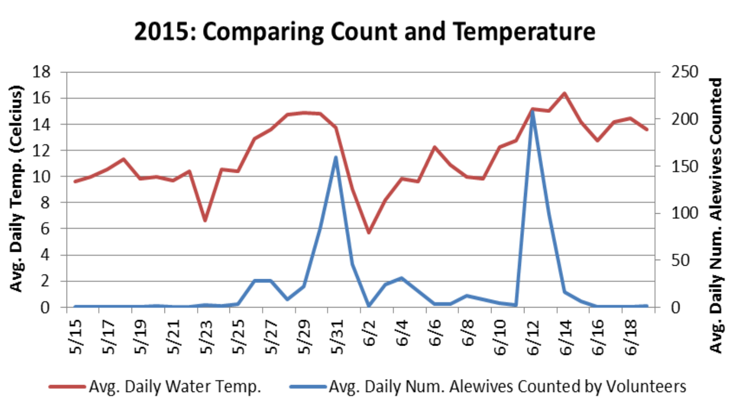


Figure 2. The average daily counts for 2015 compared to the average daily water temperature.

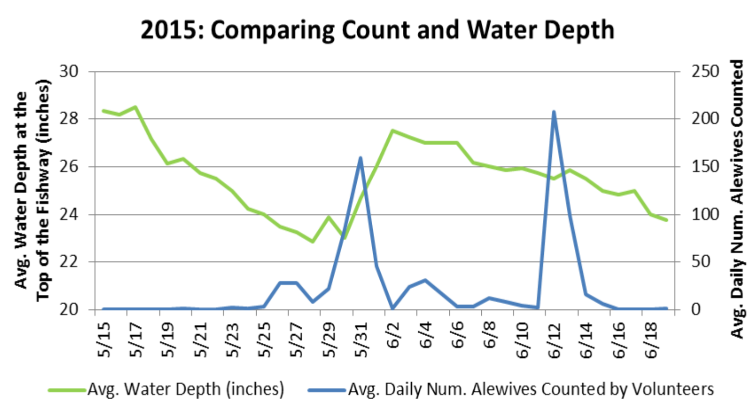


Figure 3. The average daily counts for 2015 compared to the average daily water depth at the top of the fishway.

The difference between the two counters is likely resulted from human error during the count and error associated with the counter. In some cases at other sites, we have found that volunteer counts can underestimate the number of alewives during peak runs periods when large numbers of fish are passing. We have also found volunteer counts to underestimate runs when alewives run at night. In other cases, volunteer counts can overestimate the run when alewives that have already spawned are descending the river at the same time as fish that have not yet spawned are still moving upriver. Electronic counters can also be prone to error. During peak run periods, the counter cannot distinguish between individual fish entering a single counting tube in mass. For example, as many as three fish will enter an individual counting tube together, but if there body lengths overlap, they may be counted as one fish – this will lead to an under-estimate of the true count. Electronic counters can also over-estimate the run if other fish species are frequently going back and forth through the tubes, or if large amounts of debris are going through the tubes in masses large enough to approximate a fish.

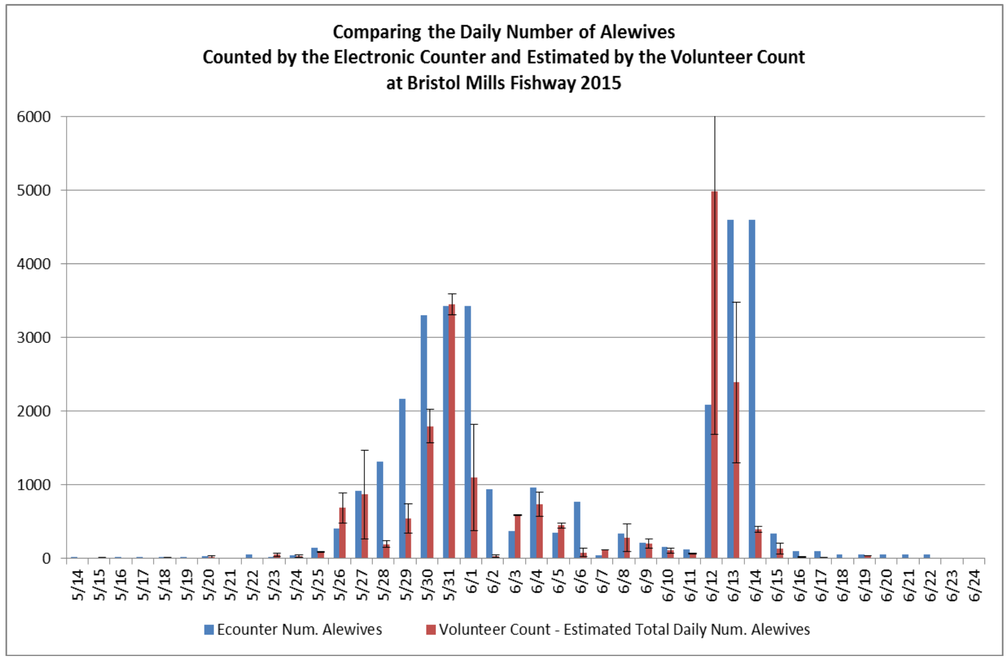


Figure 4. The total daily alewife counts as recorded by the electronic counter and estimated by the volunteer count at Bristol Mills, May-June 2015.

Comparing the total daily counts derived using the electronic counter results and volunteer estimates, we can see that while both methods show the same trends, they usually do not show the same daily counts (Figure 4). On some days, the volunteer count estimated that more fish passed the top of the ladder (8 days), but on other days, the electronic counter recorded more fish (32 days). Especially on days when the run stronger, i.e. there were a lot of alewives passing the top of the ladder, the difference between the two counts was larger, and more often the electronic counter recorded many more fish than the volunteer count estimated. We see this during the peak run periods from May 27 – June 3, and from June 12 – 15.

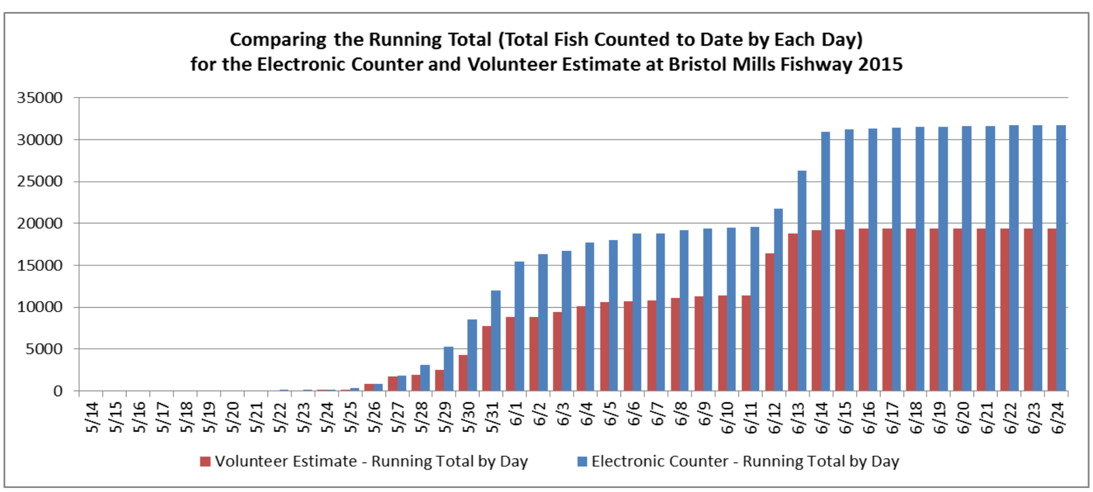


Figure 5. The running count of the total daily alewife counts as recorded by the electronic counter and estimated by the volunteer count at Bristol Mills, May-June 2015.

We can also look at these data in a different way by comparing the running total count between the electronic counter and the volunteer estimates (i.e for each day, how many alewives had passed up to that point). The running totals show that the alewife count from the volunteer estimate and the electronic counter follow the same trend, with a slow start, then an increase in the run starting May 27, and then another increase in the run on June 12 (Figure 5). Where the counts differ is in the amplitude of the increase – the count as recorded by the electronic counter increases more on the days where there was a strong run. On days when there were smaller numbers of fish (June 3 – 12 and June 15 – June 24), the difference between the two methods was less.

The difference between the electronic and visual counts may be due to the frequency of the volunteer counts and how the fish behave at this site. In 2014 and 2015, four counts were performed each day, each during one of the time blocks 7-10am, 10am-1pm, 1-4pm, and 4-7pm. As mentioned earlier in this report, the accuracy of the volunteer count can be improved by performing 2 randomly spaced counts during each period, instead of one, for a total of eight counts per day.

The electronic counter may have also recorded more fish if they were passing when we do not perform visual counts, before 7am or after 7pm. Looking at the daily trends in the visual count, we see that in 2014 and 2015 the average number of fish counted during the early morning (7-8am) and during the evening (5-7pm) was the largest compared to other hours in the day (Figure 6). This may indicate that the fish are running during the early morning and late evening, or during the night when we are not there to count them. In 2013, however, the peak of the run occurred more during mid-day hours. More years of data collection will be helpful to understand if the run is more typically a day run or night run.

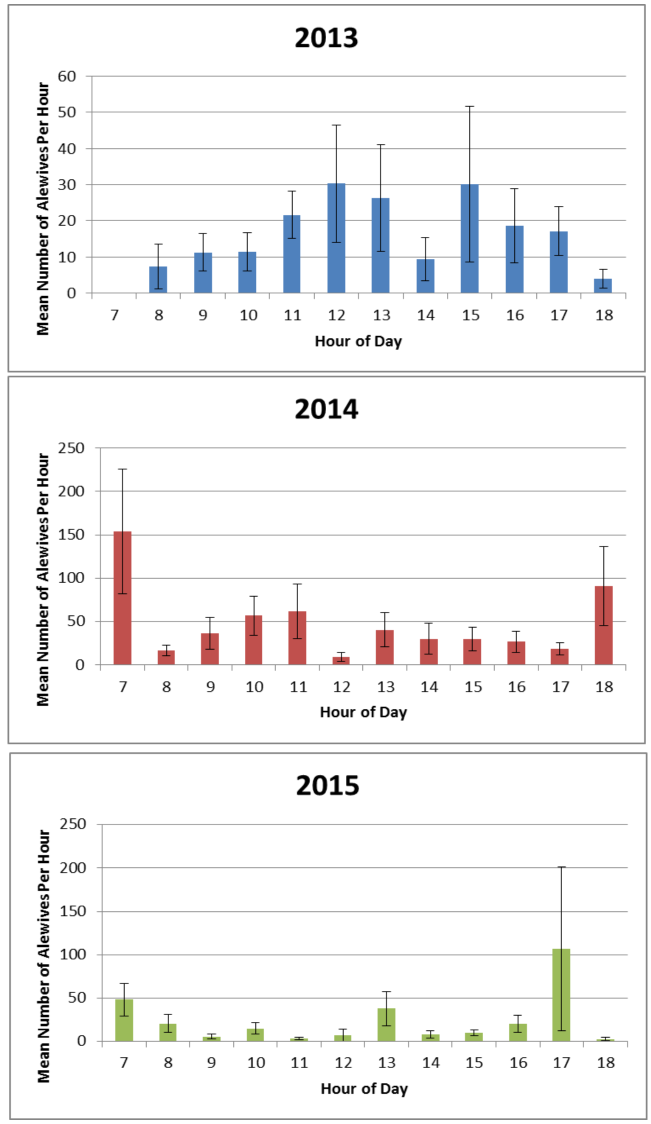


Figure 6. The average number of alewives counted by volunteers in 2013, 2014, and 2015 within each hour of the day.

We checked the electronic during the evening (after the last count was performed) and in the morning (before the first count was performed) on five days. Comparing the two methods, the number of fish passing during the daytime hours (7am-7pm) was similar (Table 1). On four of the five nights, the counter did detect fish outside of the volunteer count hours, but on two of these nights the counts were not very large compared to the daily counts (June 3 and June 6), and on another night no fish were detected (June 2). During the other two nights, a large number of fish were detected (May 26 and June 4). These few sample dates may or may not be reflective of daily patterns for the rest of the run. None of these dates were peak periods in the run, and fish behavior may change at different points in the run. These few sample dates show that at least during some days, fish were passing the counter during the late evening, night, and early morning periods when volunteers were not counting fish.

		26-May	2-Jun	3-Jun	4-Jun	6-Jun
Daytime Count (7am-7pm)	Volunteer Estimate	686	24	588	732	78
	Electronic Count	402	45	366	901	104
Overnight Count (7pm to 7am)	Volunteer Estimate	0	0	0	0	0
	Electronic Count	912	0	55	345	40

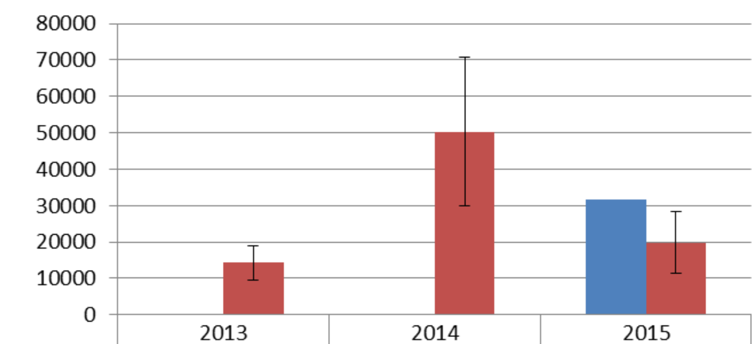
Table 1. Comparing the number of alewives estimated by the volunteer count and recorded by the electronic counter during the day vs. nighttime hours.

Conclusions: 2015 Alewife Count

In 2015, we compared the volunteer count estimate to an electronic counter and found that while the volunteer count is providing an estimate approaching the count recorded by the electronic counter, there is a wide margin of error around the volunteer count that limits our ability to compare between year differences in the run size. We may be able to improve the accuracy of the volunteer count by increasing the number of counts performed each day and by performing counts earlier in the morning and later into the evening.

Since 2013, we have found that the run size is much lower than the potential based on the amount of spawning habitat above the dam. The DMR estimates that the run at Bristol Mills could be over 600,000 alewives, but in 2013, 2014, and 2015, we observed a much smaller run. Comparing the trend among the last three years, we can say we are 95% confident that the 2014 run was larger than the 2013 run by 10,888 alewives (the difference between the two 95% confidence intervals). We can also say we are 95% confident that the 2014 run was 1,609 larger than the 2015 run. We are less certain that there was any real difference between the 2013 and 2015 run. With the current volunteer count method, we are likely only to be able to determine a true difference in the run when it increases/decreases by over 75%. Because the run is relatively small right now, and we are hoping for recovery to over 550,000 fish, the volunteer count is likely adequate for identifying increases of such magnitude.

The volunteer count is an important way to collect these data and is providing us with useful information to assess the current alewife run on the Pemaquid River. We recommend in 2016 for the volunteer effort to be increased so that two counts are performed every counting block, and that the electronic counter be installed again to assess whether increased volunteer count frequency increases the accuracy of the count. To better gauge the daily pattern of the run, the day length for the count could be expanded to start at 5am and end at 9pm, as long as there is adequate light to perform the visual counts.



	2013	2014	2015
Electronic Count			31,688
Volunteer Estimated Count	14,228	50,343	19,783
Lower Volunteer Count 95%CI	9,425	29,919	11,256
Upper Volunteer Count 95%CI	19,031	70,767	28,310

Figure 7. Total run estimates from the volunteer effort and electronic fish counter at Bristol Mills in 2013, 2014, and 2015. Error bars indicate ±95% confidence interval.

Many thanks to all the volunteers who made the count possible!

This report was compiled by the Maine Department of Marine Resources and the Maine Coastal Program, August 10, 2015. Any questions may be directed to Claire Enterline (claire.enterline@maine.gov) and Slade Moore (smoore@bioconserve.net).