IPSWICH RIVER WATERSHED ASSOCIATION

Herring Count

Volunteer Monitoring Program

The Ipswich River Watershed Association (IRWA) is the voice of the Ipswich River. IRWA works to protect nature and make sure there is enough clean water for people, fish and wildlife today and for our children and theirs.

2013 Annual Results Report

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SUMMARY

The Ipswich River Watershed Association has organized one of the longest running annual herring counts in the region, which take place each spring at the fish ladder on the Ipswich Mills Dam in downtown Ipswich. The purpose of the count is to calculate statistically reliable run-size estimates and to determine when and under what conditions river herring use the fish ladder during the spring migration. Volunteers record the number of herring seen during 10 minute counts performed hourly between 7am and 7pm. Environmental conditions that include water temperature, air temperature and cloud cover are also recorded. Run size estimates are calculated and reported to the Massachusetts Division of Marine Fisheries to track herring stocks and inform management of this fishery. Since 1999, the number herring sighted range from 15 in 2010 to 133 in 2008. The corresponding run size estimates calculated for these years are 268 and 2,125. In 2013, 31 herring were counted and the run size estimate was determined to be 294 +/- 171. Run size estimates vary widely from trap data collected from 2006-2009 due to the difficult viewing conditions of this fish ladder. Steps to improve visibility in 2013 are discussed as well as the possibility of using a video camera in future counts to supplement visual counts. For environmental data, peak observations of river herring occur when water temperatures above the Ipswich Mills Dam are between 10 and 20°C and when there is no cloud cover during the day. As indicators of habitat connectivity, the low numbers of returning herring suggest that removing barriers to fish migration and increasing flows are critical steps to restoring the Ipswich River.

ACKNOWLEDGEMENTS

I would like to thank Kate Hone for her outstanding management of the herring count program. I would also like to thank Christine Seibert for her help in preparing background information. Finally, I would like to thank the many volunteers who have participated as herring counters over the years, including Lindsay Williams, the 2013 Golden Fish Award recipient for completing the most counts.

LIST OF ABBREVIATIONS

EEA	Energy and Environmental Affairs
DMF	Division of Marine Fisheries
MBL PIE-LTER	Marine Biological Lab Plum Island Estuary Long-Term Ecological Research
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration

INTRODUCTION

Many groups conduct annual herring counts as a way to monitor the population status of this important fish that is now at historically low levels. River herring is a collective term applied to the closely related Alewife (*Alosa pseudoharengus*) and Blueback Herring (*Alosa aestivalis*) (figure 1). Both species are anadromous, spending most of their lives at sea and migrating to freshwater in the spring to spawn. Both species are native to the Atlantic coast of North America, ranging from Labrador to South Carolina (alewife) and from Nova Scotia to Florida (blueback). Historically these fish were present in most rivers and tributaries along the coast, but mostly due to overharvesting and loss of spawning habitat, many run sizes have declined by as much as 95% (Herring Alliance, 2007).

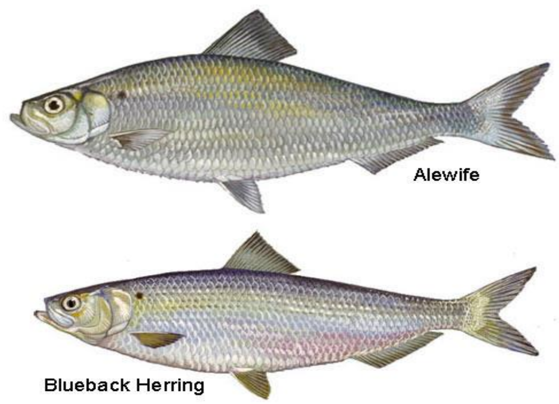


Figure 1. Alewife (*Alosa pseudoharengus*) and Blueback Herring (*Alosa aestivalus*) are collectively known as river herring.

River herring are an important link to the marine and freshwater food webs. By recycling nutrients, they can affect the productivity and water quality of freshwater and estuarine systems (MBL PIE-LTER, 2013, NMFS 2012). They consume plankton and are themselves forage fish for many marine predators and birds.

Historically the Ipswich River, like many coastal rivers, supported a robust population of alewife. Since the early 1800's, a combination of factors has greatly diminished this population. The installation of the Ipswich Mills and Willowdale dams blocked fish passage and early fish ladders proved ineffective. The Ipswich Mills dam now has a relatively new denil fish ladder with wooden baffles that is the most effective type; however, all fishways are inefficient for the passage of most species. The Willowdale dam has an older, mostly unfunctional notched weir-pool fish ladder. The Bostik dam in Middleton has no fish ladder and is impassable (figure 2). There are currently over 70 dam or dam-like structures throughout the Ipswich River watershed with no or little fish passage (figure 3). Furthermore, the transformation of historic alewife spawning lakes and ponds, such as Wenham Lake, into water supply reservoirs (Belding, 1921) and chronic low-flow and no-flow periods caused by water supply withdrawals may impair the herrings' spawning habitat and prevent migration of juvenile and returning populations. For these reasons, the herring population was driven to low numbers and few herring are now observed. Because river herring return to their natal rivers to spawn, their absence is a good indicator of a lack of access to suitable spawning habitat.

Figure 2. From left to right: Ipswich Mills Dam denil fish ladder, Willowdale Dam notched weir-pool fish ladder and Bostik dam with no fish passage.

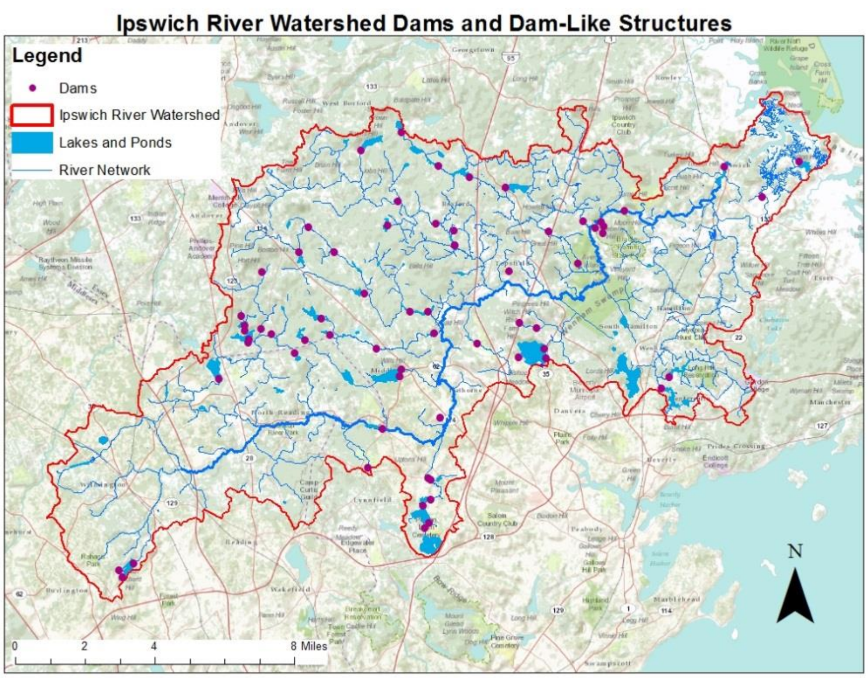


Figure 3. Locations of dams and dam-like structures preventing fish passage in the Ipswich River Watershed

Even though dams have presented a significant obstacle for many years, river herring stocks did not begin to decline precipitously region-wide until the mid-20th century. This coincides with the arrival of foreign trawlers in U.S. coastal waters (Herring Alliance, 2007). Industrial pair trawlers targeting Atlantic herring have further triggered the collapse of many herring runs in Massachusetts since the late 1990's (Nelson, *et al*., 2006) as the result of the unintentional harvest or bycatch of river herring. Bycatch is most strongly impacting river herring populations in southern New England and the mid-Atlantic (Palkovacs, 2013). Because of this collapse, Massachusetts imposed a moratorium on the harvesting or river herring in state waters in 2005 and most recently extended in 2012. This ban was extended to all states in 2013 by the Atlantic States Marine Fisheries Commission unless states can demonstrate a sustainable harvest is possible for a particular run (EEA, 2013).

Efforts to regulate fisheries in federal waters have not been successful. In 2006, river herring were recognized as a species of special concern (NOAA, 2006). A petition by the National Resource Defense Council to list river herring under the endangered species act was rejected by NMFS in 2013 (NOAA, 2013 b). Also rejected by NMFS in 2013 was a proposed amendment to the Atlantic Herring Fisheries Management Plan that would have required 100% observer coverage on industrial trawlers to limit by-catch (NOAA, 2013 a).

If restored, the Ipswich River could provide significant spawning potential for river herring as well as other anadromous fish species such as American shad (Reback, *et al*., 2005). There are currently 278 acres of potential spawning habitat in the watershed comprised of 5 ponds, the Great Wenham Swamp and portions of the main channel of the river with a spawning potential for over 500,000 river herring (Purinton, *et al*, 2003) (figure 4).

Restoration attempts, through restocking have not been successful, however. Early efforts began around 1990 focusing on stocking the river with blueback herring. This species was chosen because of its preference to spawn in flowing water in the main channel of rivers unlike alewife that prefer stiller waters of lakes and ponds, now managed as water supply reservoirs. The restocking occurred by harvesting adult blueback herring (including some alewife) migrating into the Charles River, which has a healthy herring population, and transporting them in specially outfitted trucks to the Ipswich River (figure 5). Over 46,000 river herring were introduced to the Ipswich River from 1990-2007 including; 32,447 blueback from 1990-2003 and 13,670 alewife from 2003-2007. In order to determine the results of restocking efforts, the Massachusetts Division of Marine Fisheries (DMF) maintained a fish trap at the fish ladder on the Ipswich Dam during the spring of 2006-2008. The trap was checked daily and the number and type of river herring and other species utilizing the fish ladder were recorded (table 1). Only modest numbers of herring were counted in the traps, so restocking efforts were discontinued in 2007. Subsequent studies have shown that release location may impact the success of restocking (Mather, *et al*., 2012) and this has been shown by modest gains after restocking herring to small streams and ponds in other north shore rivers (Sartwell, 2013).

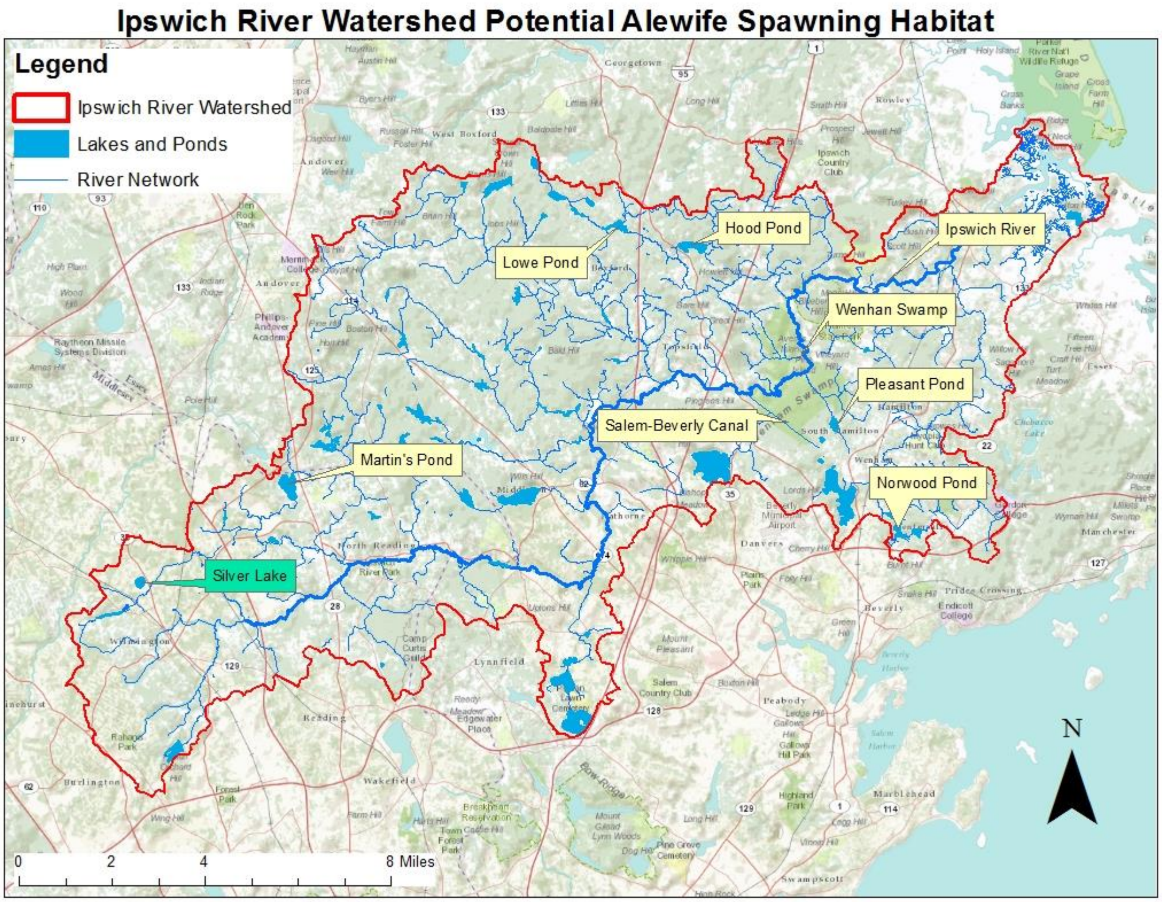


Figure 4. Lakes and ponds in the Ipswich River Watershed identified as potential spawning habitat for alewives in Purinton, *et al*. (2003) (beige). Silver Lake (green) is another potential site not included in this earlier report.

Figure 5. Restocking the Ipswich River with river herring at Salem Road in Topsfield. This took place from 1990-2007.

Division of Marine Fisheries Fish Trap Results				
Species	**2006**	**2007**	**2008**	**2009**
River Herring	377 Alewife*	153 Alewife 5 Blueback	130 Alewife 1 Blueback	187 Alewife 1 Blueback
Sea lamprey	347	1199	1021	254
American shad	4	1		
Other	24 American Eel 4 Brown Trout 15 Yellow Perch 2 Largemouth Bass 2 Golden Shiner 1 Pickerel 22 Bullhead 7 Bluegill	2 American Eel 8 Brown Trout 29 Yellow Perch 11 Largemouth Bass 3 Golden Shiner 5 Pickerel 1 Bullhead 22 Sunfish	2 American Eel 42 White Sucker 1 Creek Chubsucker 20 Yellow Perch 6 Largemouth Bass 23 Golden Shiner 1 Pickerel 3 Bullhead 18 Sunfish 4 Bluegill 22 Pumpkinseed	3 White Sucker 22 Yellow Perch 25 Largemouth Bass 11 Shiner 11 Trout 1 Pickerel 40 Brown Bullhead 1 Bluegill 17 Pumpkinseed

*Counting stopped early in 2006 due to the May floods.

Table 1. Fish trap data collected at the Ipswich Mills dam fish ladder from 2006-2008 by the Mass. Division of Marine Fisheries.

The Ipswich River herring count began in 1999 to monitor restocking efforts while recording when and under what conditions river herring are migrating into the Ipswich River. Although restocking was discontinued, we are continuing to monitor herring to calculate statistically reliable run-size estimates as well as track environmental conditions. This report describes the counting procedure, analysis methods and results for 2013 and previous years. Run sizes estimates are presented as well as the occurrence of herring relative to environmental factors such as water temperature and cloud cover. The timing of the run during the day is also analyzed. Results are discussed in light of the factors that have reduced numbers of herring and steps being taken to better manage the Ipswich Mills dam fish ladder and possible restoration plans for the Willowdale fish ladder. The need for continued monitoring including the use of a video camera to capture the infrequent and sporadic timing and variety of species comprising the run is also discussed.

METHODS

During the season, trained volunteers counted returning herring during ten minute shifts between 7am-7pm. Volunteers can sign up ahead of time or drop in. the sign up schedule is placed at the fish ladder so drop-in counters know what time slots need to be filled. During each shift, volunteers watch the fish ladder for upcoming fish and record however many they see. Herring are only counted if they cross the counting board, heading upstream (figures 6 and 7). A data entry form is used to record the volunteer's name, date and time prior to beginning a count (figure 8). Also recorded are air temperature, water temperature, cloud cover and other species seen. The forms are collected by IRWA for analysis.

The data are entered in a Microsoft Excel spreadsheet to calculate a run size estimate. A template is used to work with a run size estimator program provided by DMF that is based on the work of Nelson (2006) which uses visual count data collected at ten minute intervals to calculate a run size estimate. From 1999-2007, volunteers performed counts in two successive five-minute intervals according to Rideout (1979). Beginning in 2008, IRWA adopted the single ten minute count protocol. In a volunteer river herring summary by DMF (2005), the newer method is described to generate reliable results with 6-9 counts per day unlike the previous method which requires 13. The recommendations consist of having 3 ten-minute counts during three daily periods (7-11am, 11am-3pm and 3-7pm) from April 1st to mid-June. In 2013, volunteers performed an average of 6.9 counts per day, making the method using ten minute intervals better suited to our counting effort. In previous years where the data may have been entered as 5 minute intervals, the time and count values were combined so the new method could be applied to every year. The DMF program will then accept user input to generate a statistically sound run-size estimate.

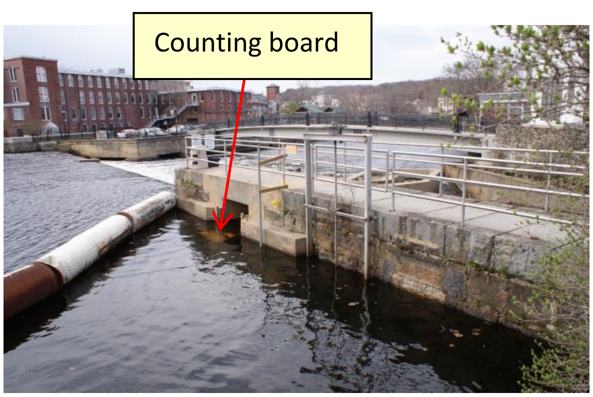
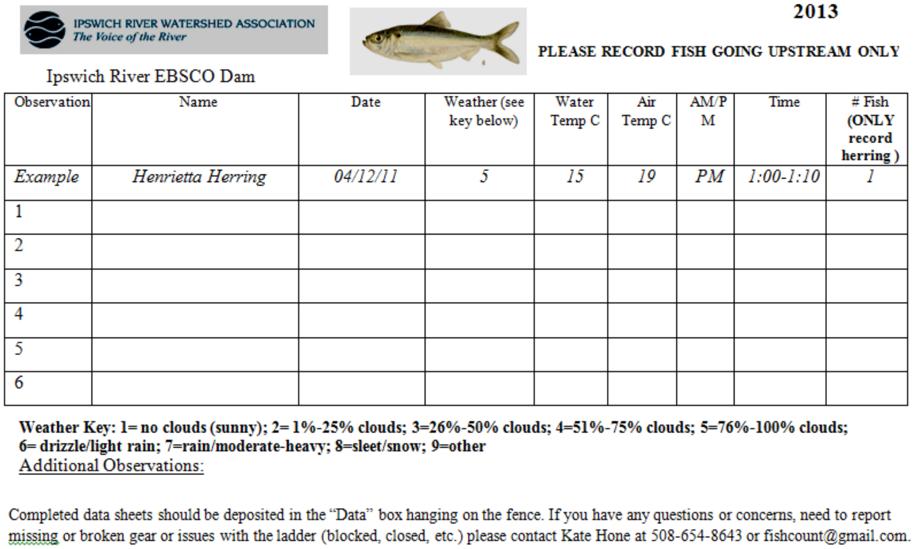


Figure 6. Counting location at the top of the fish ladder on the Ipswich Mills Dam. Note the location of the counting board in relation to the fish ladder visible in the background.

Figure 7. View of the counting board from the perspective of a fish counter standing on the walkway.



IPSWICH RIVER WATERSHED ASSOCIATION
The Voice of the River

2013

PLEASE RECORD FISH GOING UPSTREAM ONLY

Ipswich River EBSCO Dam

Observation	Name	Date	Weather (see key below)	Water Temp C	Air Temp C	AM/PM	Time	# Fish **(ONLY record herring)**
Example	*Henrietta Herring*	*04/12/11*	*5*	*15*	*19*	*PM*	*1:00-1:10*	*1*
1								
2								
3								
4								
5								
6								

Weather Key: 1= no clouds (sunny); 2= 1%-25% clouds; 3=26%-50% clouds; 4=51%-75% clouds; 5=76%-100% clouds; 6= drizzle/light rain; 7=rain/moderate-heavy; 8=sleet/snow; 9=other
Additional Observations:

Completed data sheets should be deposited in the "Data" box hanging on the fence. If you have any questions or concerns, need to report missing or broken gear or issues with the ladder (blocked, closed, etc.) please contact Kate Hone at 508-654-8643 or fishcount@gmail.com.

Figure 8. Data sheet for the annual Ipswich River herring count

After copying the data from the Excel template into a Microsoft Access table in the analysis program, the first step requires design entry parameters to be input by the user. These include: Design (one or two-way), Day Length (constant), Count Interval (min.), Day Length (hrs.), Number of Periods (2 or 3 for two-way analysis only), Start Time and End Time for each period (entered as 24hr. time). The choice of one or two-way analysis depends on the number of mean counts for each of the three daily periods with a requirement for at least 2. One-way analysis is used for between 2 and 4 mean counts, two-way with 2 periods for between 4 and 6 mean counts and two-way with 3 periods for over 6 mean counts. In 2013, there were 2.3 mean counts per period, but rather than use the one-way analysis, we used a two-way analysis with 2 periods based on mean counts of 3.6 and 3.3 per 0700-1300 and 1300-1900 periods respectively. The parameters used for the 2013 analysis are recorded in Table 2. A similar method was used to estimate run sizes for previous years using this model.

Survey Design Parameter	**Input value**
Count Interval (min.)	10
Day Length (hrs.)	12
Number of Periods	2
Start Time-End Time (Periods 1, 2)	07:00am-13:00, 13:00-19:00

Table 2: Survey Design input parameters for 2013 run size analysis.

Count frequency and environmental data were analyzed to characterize the timing of the run. The frequency of counts performed and the number of herring counted were compared for each day of the 2013 season. Numbers of herring observed during each hour of the day were compared for 2013 and all available years combined. The number of herring observed for each of the cloud cover types and at different water temperature values were also compared.

RESULTS

The 2013 herring count took place from April 1 to June 1. Forty two volunteers performed a total of 413 individual counts while recording 31 herring using the fish ladder. The first herring was sighted on April 11th and the most sightings occurred on April 30th. The last herring was observed on May 5th.

The run size estimate was calculated using the method described previously with annual results summarized in Table 2 and figure 9. In 2013, there were 6.9 mean counts per day and 2.3 mean counts for each of the three periods. Using the 2-way analysis with 3.5 mean counts for two periods, the total run-size estimate was calculated at 294+/- 171.

A profile of the daily count is compiled to show the distribution of when counts are taking place relative to when and how many herring are sighted (figure 10). This gives a good indication of how well the counting effort captured the periods when herring were most active.

The count profile was analyzed by hour of the day to compare 2013 and all years combined. (Figure 11). This was done to see how this may change during the counting timeframe. Numbers of herring appear to peak around 4-5 pm. In 1999, 2000 and 2001, counts extended beyond 7:00 pm (19:00 hrs.).

Environmental data were also recorded by volunteers during each counting shift. Water temperature, air temperature and cloud cover (weather code) are recorded to track under what conditions herring are seen. When water temperature is matched with 2013 count totals, herring did not appear until the water temperature reached 12.0°C and peaked at 16°C (figure 12). This result is consistent with previous years where over 95% of herring have been observed while water temperatures are between 10 and 22°C. The maximum number herring observed for all years combined, peak at a water temperature of 18°C. Plotting herring counted by cloud cover shows that the majority of herring were observed when there was no cloud cover or sunny (figure 13).

Year	Herring Counted	Number of Counts	Days of Count	Mean Counts/Day	Run Size Estimate	DMF Trap Results (Alewife)
1999	53	248	47	5.3	949	
2000	35	282	38	7.4	440	
2001	77	211	64	3.3	1255	
2002	73	209	70	3.0	2726	
2003	41	270	73	3.7	668	
2004	55	397	63	6.3	381	
2005	88	503	54	9.3	691	
2006	57	270	38	7.1	677	377
2007	15	312	62	5.0	213	158
2008	133	384	75	5.1	2125	131
2009	117	309	60	5.2	1603	254
2010	15	259	58	4.5	268	
2011	48	421	72	5.8	663	
2012	55	365	70	5.2	756	
2013	31	413	60	6.9	294	

Table 2: Annual Ipswich River herring count data 1999, 2013. DMF (Division of Marine Fisheries) trap results are actual counts obtained at the fish ladder from a trap maintained daily.

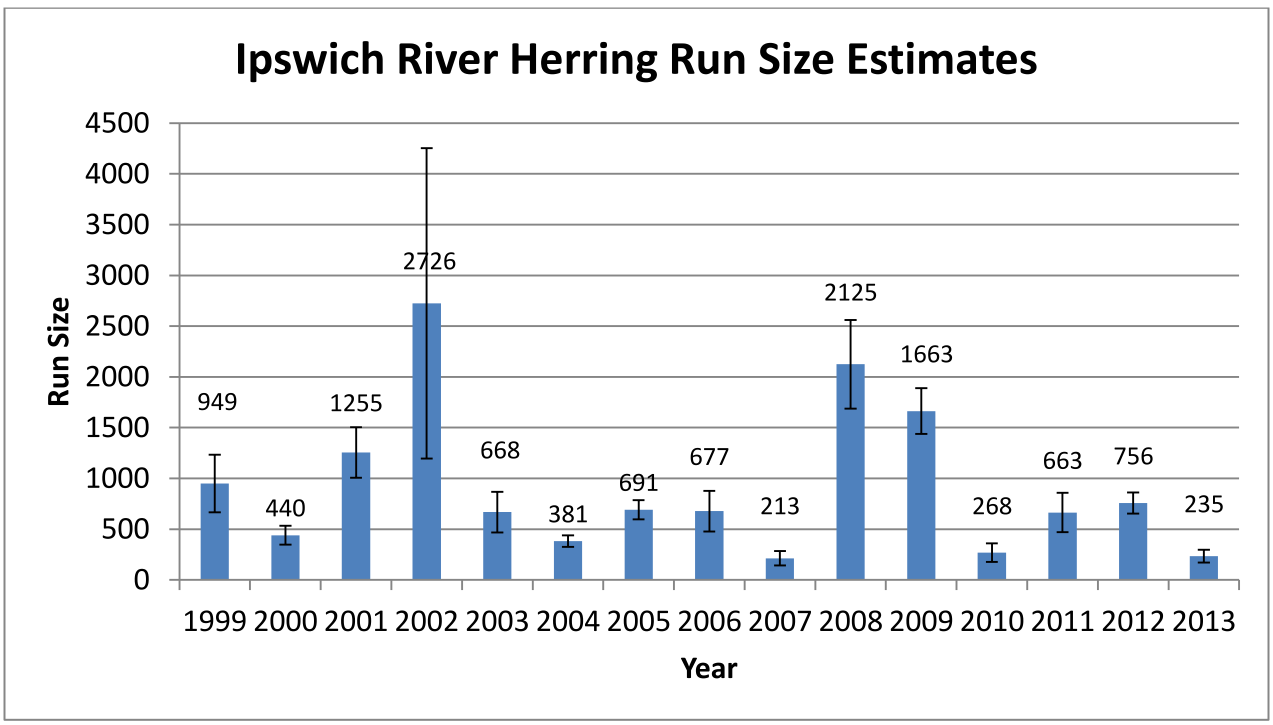


Figure 9. Annual run-size estimates for Ipswich River herring counts, 1999-2013.

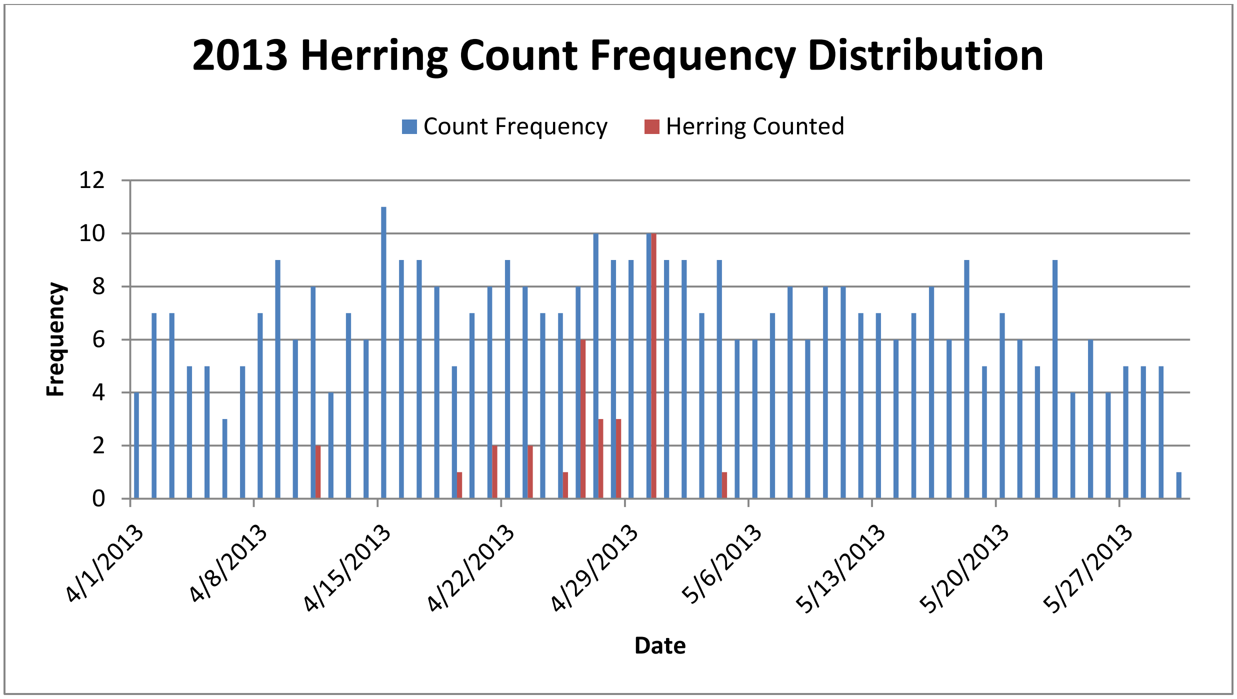


Figure 10. Frequency of daily counts and herring totals for 2013.

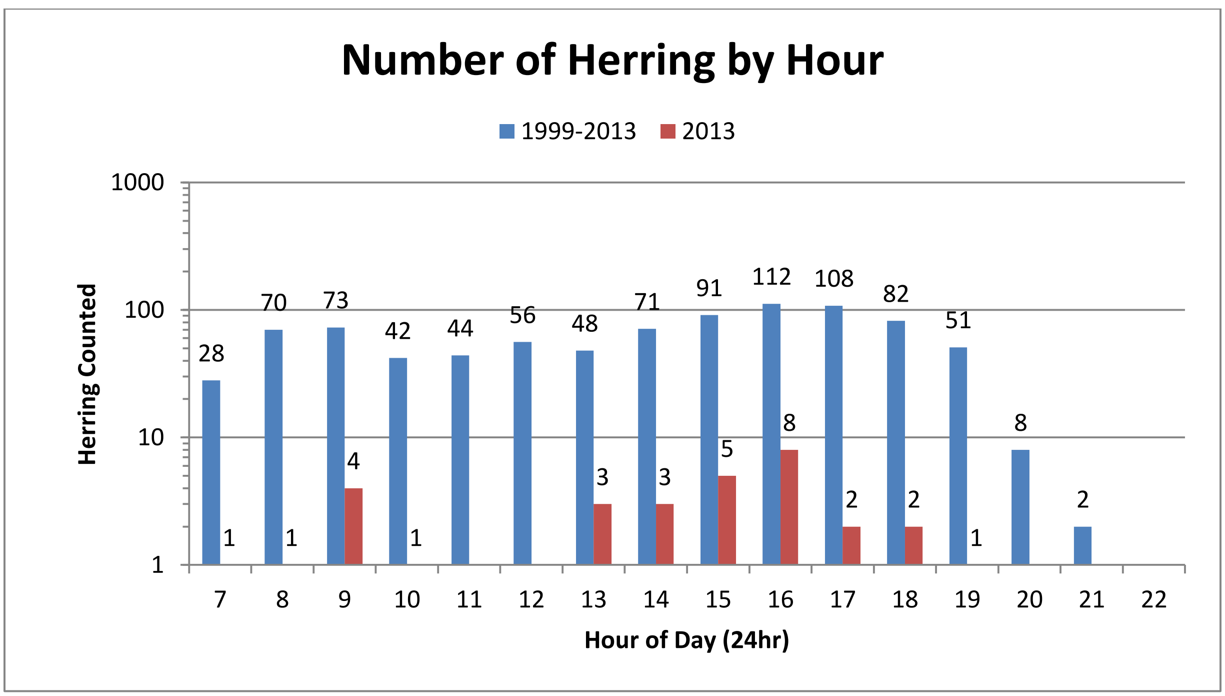


Figure 11. Comparison of hourly distribution of total numbers of herring counted for 2013 and 1999-2013 combined. The total cumulative number of herring counted is 886 and 31 for 2013.

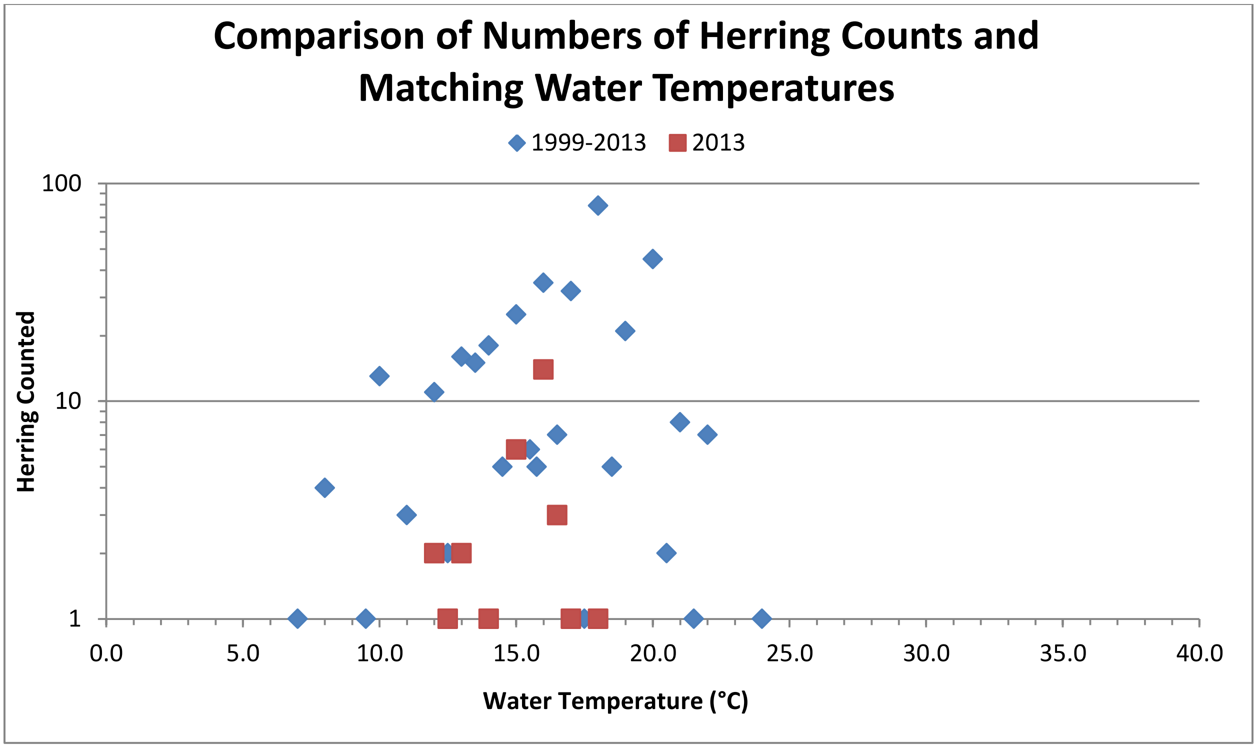


Figure 12. Comparison of total numbers of river herring counted at specific water temperature values. The peak temperature value is 18°C.

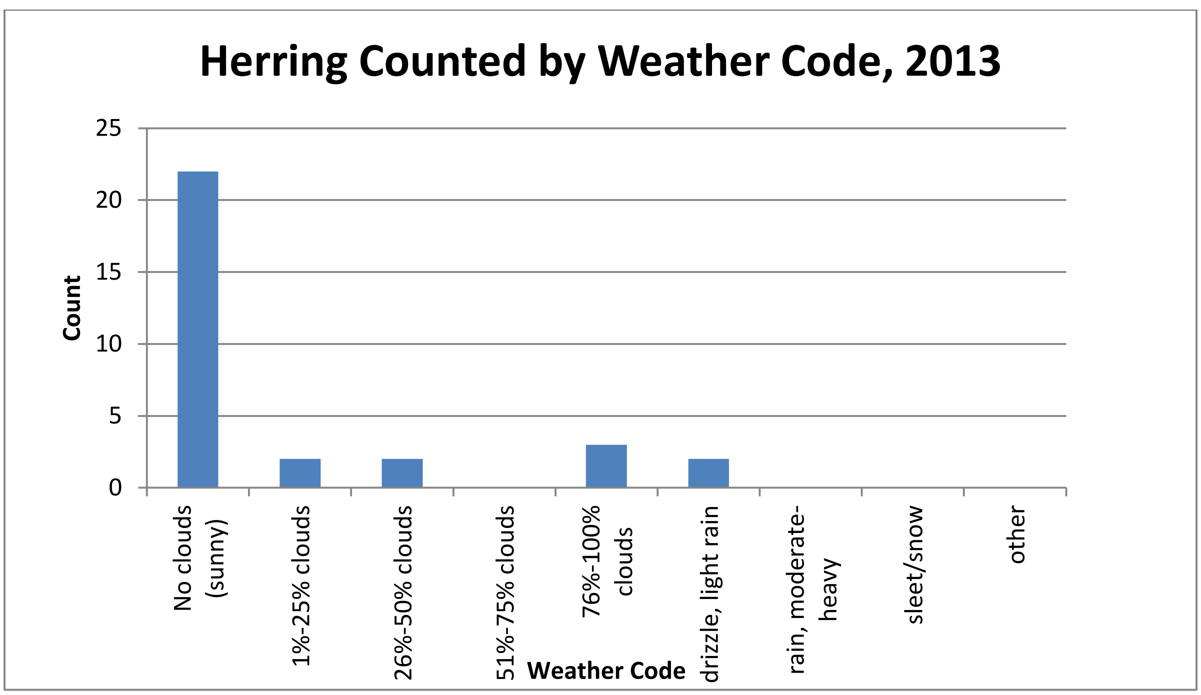


Figure 13. The presence of herring for various cloud cover types during the day.

DISCUSSION

The Ipswich River herring count has been successful from the standpoint of high volunteer participation, strong counting effort and as one of the longest running counts in the region. However, historically low numbers of river herring continue to be recorded despite the introduction of over 40,000 alewife and blueback herring and upgrades to the Ipswich Mills dam fish ladder. Run sizes are healthier in the nearby Parker River indicating that habitat loss remains an obstacle to recovery. The goal of this program is to continue collecting valuable data to calculate run size estimates and monitor environmental conditions of the herring run while raising awareness of the need for continued restoration efforts.

Given the sporadic nature of the Ipswich herring run, it has been difficult to calculate reliable run-size estimates. The new statistical analysis model accommodates varying degrees of counting effort which may not include each hour of the counting day. After calculating run sizes for previous years, a high degree of difference was observed between the visual count estimate and the actual trap data over the 4 year timespan this was collected (table 2). This may be due to the location of the counting board on the downstream side of the dam before 2013. Herring may have circled underneath the platform before exiting the fish ladder leading to fish being counted multiple times. Preliminary findings indicate that moving the counting board in 2013 to the upstream side of the dam where visibility is better and at the point where fish have committed to entering the river may have helped since the run size estimate is within the range of the 2006-2008 trap data. Additional years will be needed to confirm this, assuming no further restoration efforts take place that may otherwise increase numbers of herring beyond the trap data.

In 2013 efforts have been made to better manage the fish ladder and explore the possibility of improved fish passage on the Willowdale dam. An operation and management plan was developed by DMF for the town of Ipswich for how to keep the fish ladder in good working condition. The town cleans debris from the baffles early in the spring for the upriver migration and removes a low flow spillway in the fall for any potential out migration of juveniles should low flows prevent water from going over the main spillway (figure 13). Staff members from the U.S. Fish and Wildlife Service and DMF are also exploring the possibility of installing a steep-pass fish ladder on the Willowdale dam as an alternative to the existing, inefficient notched weir-pool structure.

The goal for 2014 is to install a video camera at the top of the fish ladder. This technology will function similar to the trap maintained by DMF in the past with the advantage of being easier to deploy on a more frequent basis and less intrusive. We suspect herring may migrate in the evening or early morning based on reports of sightings after 7pm when counting has stopped. By using software to record passage events, it is hoped that this will improve the analysis of when herring migrate as well as record other species. This will be used to supplement visual count data as a means to compare accuracy.

There is an opportunity to more closely monitor environmental factors to give a more accurate understanding of when herring are migrating. Water temperature was correlated with the herring run according to the recommendations of NMFS (2012). However, this is the temperature recorded in the impoundment, above the dam, by volunteers. Knowing the ocean surface temperature during each day of the run might also be useful since this may be the initial trigger for herring to migrate up river. Also, correlating the tide cycle with the timing of the run might show if this has any effect of when herring arrive at the fish ladder.

Figure 14. The low flow spillway now remains open in the fall to allow any juvenile herring to exit the river when water often does not go over the main spillway of the dam.

River herring are excellent indicators or habitat connectivity in a watershed. By documenting low numbers or herring returning to the Ipswich River during the spring migration, volunteer counters have contributed greatly to our understanding of the degree of this impairment. This understanding will benefit continued restoration efforts to improve access to suitable spawning habitat. Removal of barriers to migration will not only benefit river herring, but other anadromous and non-migratory fish that need access to different river habitats. Restoring river herring will have benefits for commercial fisheries, wildlife and improvements to water quality.

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Species of Concern NOAA National Marine Fisheries Service River herring (Alewife & Blueback herring)
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