Missouri River Dams

Larval Walleye Entrainment Investigation II

PPL Montana MoTAC Project 759-13

Prepared by

Tracy Elam
Montana Fish, Wildlife and Parks

Montana Fish, Wildlife & Parks

January 2014

Acknowledgements

McKenzie Leonard and Marilyn Wright collected the samples below Holter Dam, sorted samples at the University of Great Falls laboratory and entered and summarized sample data. Brad Tribby conducted larval fish identification. Chris Hurley collected samples below Canyon Ferry Dam.

Introduction

In 2013 Montana Fish, Wildlife & Parks (MFWP) was awarded $9,308 from PPL Montana MoTAC to investigate entrainment of larval walleye through Canyon Ferry and Holter dams. For the second year in a row MFWP conducted sampling below these two dams to measure larval walleye entrainment through the dams. Both years could be characterized at low flow years where most of the water was passed through the power turbines at each dam. Approximately 80% of the effort to detect larval walleye entrainment was dedicated to Holter Dam. Fish, Wildlife & Parks

Holter Dam Sampling

In 2013 crews netted the Missouri River downstream of Holter Dam in order to capture and estimate the number of larval walleye drifting downstream of Holter Reservoir.

Crews collected larval walleye samples using the similar methods and gear as in 2012 (Grisak et al. 2012) except only daytime sampling was conducted at the Holter site in 2013. They collected samples during the day from the left bank/right bank and upper water column/lower water column. They collected 4 samples per day on 26 days between 10-May and 8-July for a total of 104 samples.

In 2012, the number of larval walleye that drifted over or through Holter Dam over the entire study period was estimated by using the model from Van den Avyle (1993). The formula to calculate the number of larval walleye ($\hat{N}$) drifting past a sampling point was;

$$\hat{N} = \frac{A}{a}\bar{n}$$

where A = the total amount of water that flowed past a sampling point during the study period, a = the amount of water sampled at a sampling point during the study period and $\bar{n}$ = the average number of walleye caught per sample at each site. So, in 2012, 29,448,144,000 cubic feet per second (cfs) of water flowed past the sampling point, 258,085 cfs of water was sampled, and there was an average of 0.05 walleye captured per tow. This produces an estimate of 5,705 larval walleye that drifted past Holter Dam.

Using the data collected in 2013, I attempted to find a different way to estimate larval walleye numbers working under the assumption that walleye drift occurs in a relatively normal distribution (e.g., Mitro and Parrish 1997), that is, the drift period begins with few individuals, reaches a peak, and then the drift subsides as time goes on. For example, Mitro and Parrish (1997) conducted a study on the Poultney River beginning 20-April and captured the first walleye larvae on 3-May. Larval walleye numbers peaked on 9-May and decreased to pre-peak levels by 15-May. This supports the thought that larval walleye drift in a normal distribution and we can calculate an estimate for the modeled distribution. Using this example as a model, the larval drift of walleye can be estimated by calculating the area under a normal curve plotted to the data that was collected. In theory this would be a better representation of how larval walleye are drifting.

To create the modeled distribution I calculated an estimate for each day that walleye were captured using the same equation from Van den Avyle (1993) that was used in 2012 then plotted those numbers on a graph and fit the points with a line. In 2013, walleye were only caught on 3 days, 18-June, 21-June and 2-July and the estimated number of walleye on each day was 5,076, 11,323 and 1,861 (Table 1). In this case I assumed the drift period occurred over a 21 day period (14-June to 5-July). Since walleye were only captured on three days, the beginning of the sampling period (10-May to 14-Jun) is left out of the data set because no walleye were captured and the estimate is zero during that period.

Table 1. Days that crews collected samples in 2013, number of larval walleye captured on each day and the estimate of larval walleye that drifted on each day based on the model from Van den Avyle (1993).

Days sampled	# of larval walleye captured	Estimate
6/14/2013	0	0
6/18/2013	2	5076
6/19/2013	0	0
6/21/2013	5	11323
6/24/2013	0	0
6/26/2013	0	0
6/28/2013	0	0
7/1/2013	0	0
7/2/2013	1	1861
7/5/2013	0	0

Figure 1. Graph of the curve that was fit to the estimated number of larval walleye that drifted in 2013.

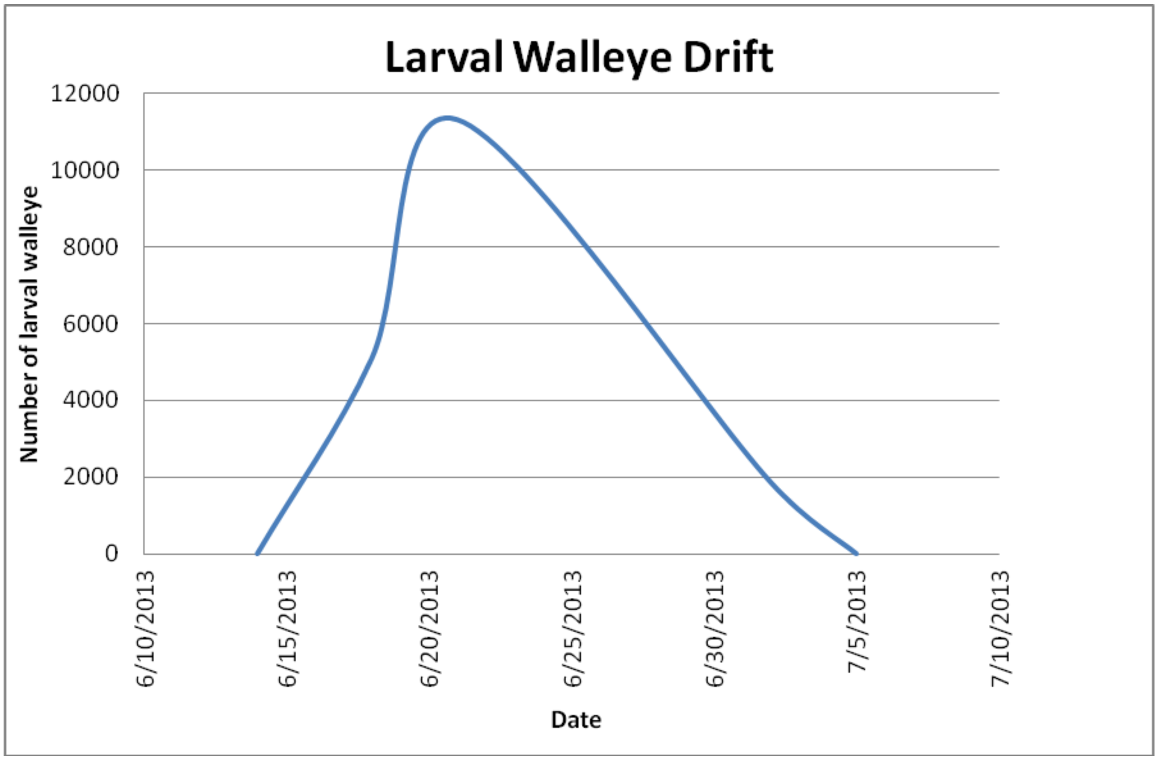


Table 2. Values from the graph in Figure 1 that were used to calculate the area under the modeled distribution to estimate the number of larval walleye that drifted over the sample period in 2013.

Date and # of Days (x)	Number of larval walleye (y)
6/14/2013 $x_0 = 0$	$y_0 = 0$
6/18/2013 $x_1 = 4$	$y_1 = 5076$
6/21/2013 $x_2 = 7$	$y_2 = 11323$
7/2/2013 $x_3 = 18$	$y_3 = 1861$
7/5/2013 $x_4 = 21$	$y_4 = 0$

Using the trapezoidal rule the area under the curve can now be calculated to estimate the number of larval walleye that drifted during the 21 day period. The equation for the trapezoidal rule is;

$$\int_{x_0}^{x_4} f(x)dx \approx (x_1 - x_0) * \{\frac{y_0 + y_1}{2}\}$$

where the x axis is the number of days in the sampling period and y is the estimated number of larval walleye that drifted during the sampling period.

When these numbers are entered into the equation to estimate the area under the modeled distribution (the plotted curve) we calculated 110,054 larval walleye that drifted past the sampling point over the 21 day sampling period (Table 3).

Table 3. Total estimate of larval walleye that drifted over the sample period in 2013 based on the calculations of the area under the modeled distribution.

Date and # of Days	Estimated number of larval walleye/day	Estimated number of larval walleye for sample period
6/14/2013- 0	0	
6/18/2013- 4	5076	10152
6/21/2013- 7	11323	24598.5
7/2/2013- 18	1861	72512
7/5/2013- 21	0	2791.5
Total estimate		110054

In 2013, from 10-May to 8-July, 26 days were sampled for a total of 104 samples. Over the entire sampling period only about 0.01% of the total amount of water that flowed past the sampling point was sampled. On days that samples were collected, between 2% and 6% of the river flow was sampled. On days that larval walleye were captured, about 5% of the river flow was sampled. With such a small area being sampled, it is likely that days where zero larval walleye were collected do not actually mean there were zero walleye drifting. Instead we must take into account the possibility of low probability of detection and assume larval walleye were still drifting past the sampling point even if none were captured as represented by the modeled normal distribution (Figure 1).

If the equation from Van den Avyle (1993) is used to estimate the population over the entire study period, 10-May to 8-July, as was done in 2012, a very different estimate of the number of larval walleye that drifted past the sampling point is produced. The total amount of water that flowed past the sampling point over this span of time was 17,740,512,000 cfs. The total amount of water that was sampled was 655,353 cfs. The average number of larval walleye per sample was 0.08 per tow. When these numbers are entered into the equation I estimate 2,103 larval walleye drifted past the sampling point. I think this number is probably skewed low by all of the days where no walleye were captured. Again, we should not assume that the capture of 0 larval walleye represents 0 larval walleye drift.

I believe the method using a modeled distribution is probably a better way to estimate the number of larval walleye that drifted through Holter Dam, but with so few captures (8), it is hard to say that one of the two estimates is accurate. It is probably best to use both estimates as a range of the total number of walleyes drifting. So, when both methods are use, we can say that there were between 2,103 and 110,054 larval walleye that drifted past Holter Dam in 2013.

By revisiting the data from 2012 at the Holter site, using the same process I used for 2013, the two different estimate types can be used to find a range of the number of larval walleye that drifted past Holter Dam. We now have to look at the 2012 data with the same assumptions we used with the 2013 data. In 2012, from 10-May to 9-July, 20 days were sampled for a total of 80 samples. Over the entire sampling period about 0.001% of the total amount of water that flowed past the sampling point was sampled. On days that samples were collected, between 1% and 4% of the river flow was sampled. On days that larval walleye were captured, about 2% of the river flow was sampled. Again, we should not assume that the capture of 0 larval walleye represents 0 larval walleye drift.

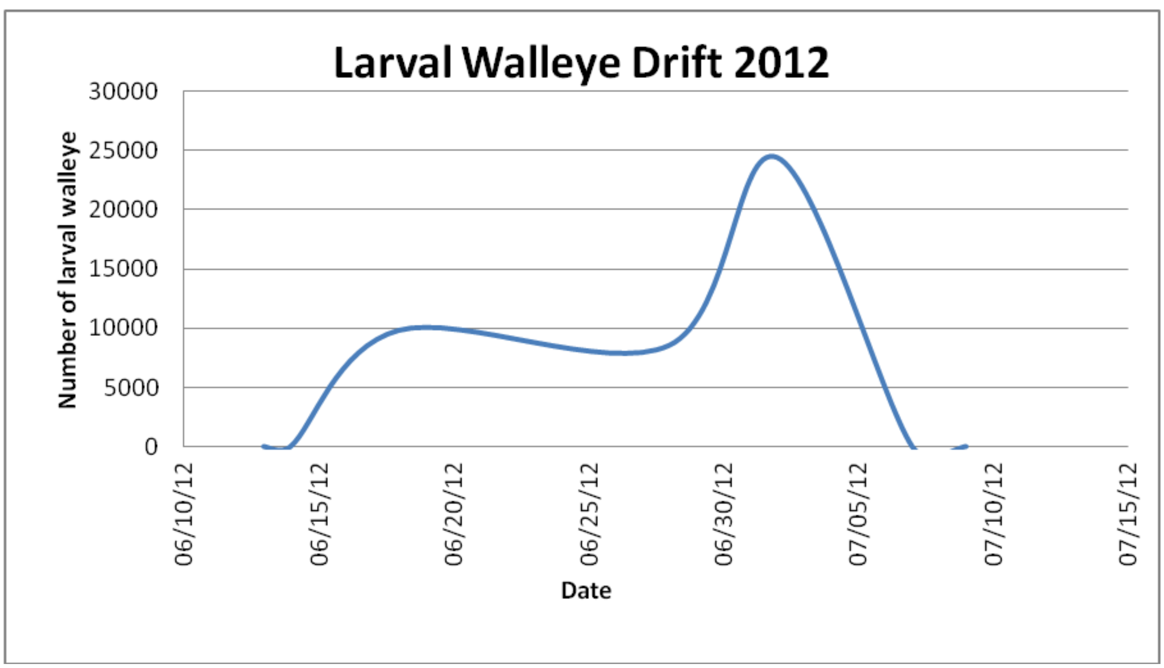
Table 4. Days that crews collected samples in 2012, number of larval walleye captrued on each day and the estimate of larval walleye that drifted on each day based on the model from Van den Avyle (1993).

Days sampled	# fish captured	Estimate
06/14/12	0	0
06/18/12	1	9806
6/21/2012	0	0
6/27/2012	0	0
6/28/2012	1	8526
7/2/2012	2	24405
7/7/2012	0	0

As with the 2013 data I calculated the daily estimate for the three days in which larval walleye were captured (Table 4). The beginning of the sample period (10-May to 14-June) was again left out because no walleye were captured and the estimate is zero during that time period.

The daily estimate data is again plotted on a graph and fit with a line which can be used to estimate the number of larval walleye drifting over a 23 day period (Figure 2).

Figure 2. Graph of the curve that was fit to the estimated number of larval walleye that drifted each day in 2012.



The same process to find the area under the curve is used with the days and estimates that were calculated for the 2012 data. When these numbers are run through the equation we end up with an estimate of 238,146 larval walleye that drifted over the 23 day sampling period. This is much higher than the previous estimate of 5,705, but the two methods can now be combined and produce a range to say that between 5,705 and 238,146 larval walleye drifted past Holter Dam in 2012.

Table 5. Values from the graph in figure 2 that were used to calculate the area under the modeled distribution to estimate the number of larval walleye that drifted over the sample period in 2012.

Date and # of Days (x)	Number of larval walleye (y)
6/14/2012 $x_0 = 0$	$y_0 = 0$
6/18/2012 $x_1 = 4$	$y_1 = 9806$
6/28/2012 $x_2 = 14$	$y_2 = 8526$
7/2/2012 $x_3 = 18$	$y_3 = 24405$
7/7/2012 $x_4 = 23$	$y_4 = 0$

Table 6. Total estimate of larval walleye that drifted over the sample period in 2012 based on the calculations of the area under the modeled distribution.

Date and # of Days	Estimated number of larval walleye/day	Estimated number of larval walleye for sample period
6/14/2012- 0	0	
6/18/2012- 4	9806	19612
6/28/2012- 14	8526	91660
7/2/2012- 18	24405	65862
7/7/2012- 23	0	61012
Total estimate		238146

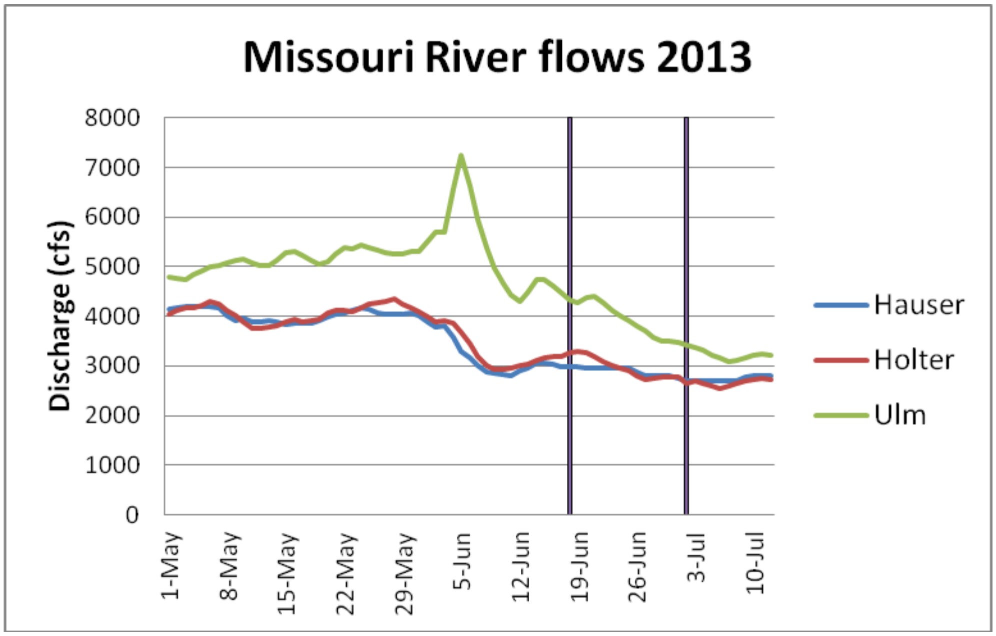
Even though the two types of estimates differ greatly for both years, using both types of estimates and giving a range of the total number of larval walleye that drifted past Holter Dam may be a better way to portray what is happening, as opposed to giving one specific number as the estimate. Since crews were only able to sample approximately 4% of the daily river flow being estimated in 2013 and only about 2% in 2012, combined with the limited number of larval walleye captured (8 in 2013 and 4 in 2012), it stands to reason that estimates are not going to be very accurate. Maybe all that can be said is that larval walleye are drifting past Holter Dam, but the ability to capture and estimate their abundance in such a large river is extremely challenging in inefficient.

Mitro and Parrish (1997) found that walleye larvae drift or possibly actively migrate at night, but they were studying larval walleye moving from a river, where walleye spawned, to a lake to rear. I would assume that the larval walleye captured below Holter Dam would not be actively seeking the river but would have proper rearing habitat in Holter Reservoir itself. The larvae that were collected by Mitro and Parrish were captured 2 to 6 days posthatch and all were yolk-sac larvae. In 2012 below Holter Dam the mean length of walleye larvae captured was 18.2 mm (range 9-23). Looking at a study conducted by Bulkowski and Meade (1983), based on growth rates in a hatchery with water temperature at 19 C, the age of the larvae captured in 2012 below Holter Dam were 1 to 7 weeks old. In 2013 the mean length of walleye larvae captured was 17 mm (range 13-21). The age of walleye larvae captured in 2013 would be approximately 3 to 6 weeks old. I think this information further supports putting a range on the estimate for the number of larval walleye moving past Holter Dam. In lakes, walleye may be dispersed by lake currents, prevailing winds, and wave action. Colby et al. (1979) found that young walleye are capable of regulating their distribution about two weeks after hatching. So, depending on these factors and proximity of walleye spawning areas to Holter Dam, if it is just random drifting and not active migration, it is possible that the number of walleye larvae moving past Holter Dam is fairly low.

It does not appear that discharge plays a big role in when larval walleye are drifting instead there are probably many other factors such as spawning location, spawning date, reservoir current speed and possibly wind direction that contribute to when larval walleye will drift past Holter Dam. In both years of the study, the first larval walleye was detected on 18-June and the last on 2-July. These dates, in both years, occur after the peak of spring flows. In 2012, river flows peaked on 8-June at about 9,000 cfs and the first larval walleye was detected 10 days after peak flow when the river level was about 7,000 cfs. In 2013, there was not a typical peak associated with spring runoff and peak flow occurred on 28-May at about 4,400 cfs and the first larval walleye was detected 21 days later when river flows were about 3,300 cfs. Crews captured twice as many larval walleye in 2013 but river flows were about half of levels from 2012. Capture efficiency was probably higher in 2013 due to the lesser amount of water. Although it is only two years of data, there seems to be a pattern as to when larval walleye are drifting past Holter Dam.

Future sampling should be centered on dates that walleye larvae were captured in past years. The dates were consistent between years and greater effort could lead to more walleye captured and more reliable estimates.

Figure 3. Hydrograph for the Missouri river below Hauser Dam, below Holter Dam and near Ulm for 2013. The two black vertical lines show when larval walleye were capture below Holter Dam.



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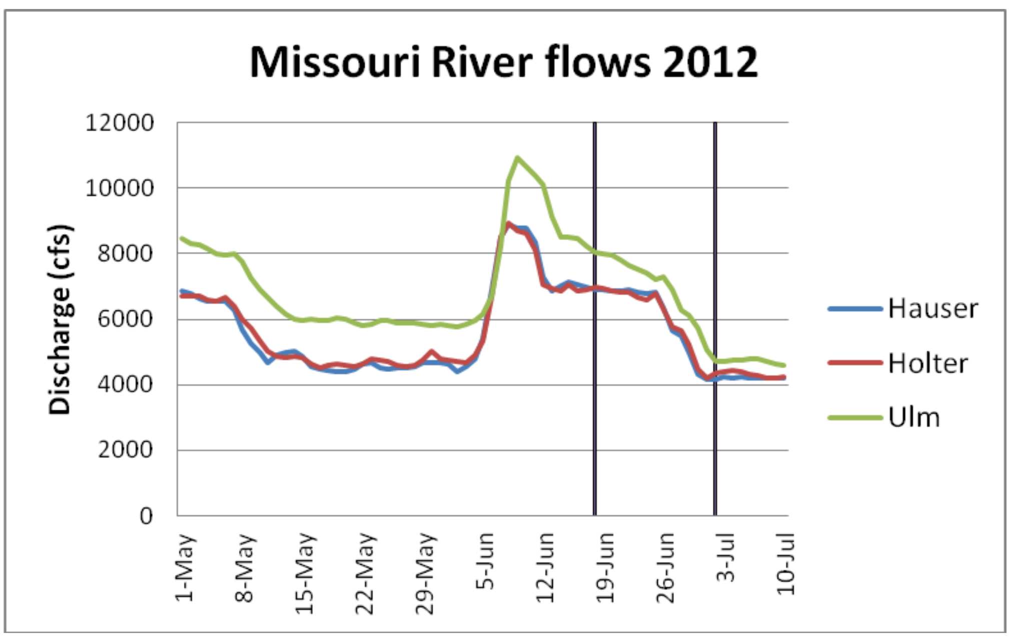

Canyon Ferry Dam sampling

Sampling below Canyon Ferry Dam occurred for 28 days between May 2 and July 8. A total of 112 samples were collected; all but 4 were collected during daylight hours. Only 4 larval fish were collected during this period, all were identified as catostomidae larvae.

During the sample days, all water that flowed past Canyon Ferry Dam was drawn through the power house for generation. Observers did not record any sample days where water flowed through spill gates.

Consistent with 2012, little to no spill over the Canyon Ferry Dam spill gates results in few fish being entrained, or low detection ability. One of the principal reasons for evaluating walleye entrain through Canyon ferry Dam and Holter Dam is the perception that these reservoirs are serving as sources of walleye to downstream sections of Missouri River. Possible impacts of such a condition could be high predation on trout and diminished population levels. The results of the 2012 and 2013 entrainment studies show few fish [walleye] were entrained under the flow conditions experienced during these years . Further, these studies served to dispel public perception of millions of walleye being introduced to the Missouri River from upstream sources. Perhaps further investigations during high flow years would help to understand the influence of high flows on walleye entrainment from these reservoirs.

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