

Sustainable Rivers Program

Kaskaskia River
Environmental Pool Management -
Assessment



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Above: Emergent vegetation promoted by Environmental Pool Management (USACE photo).

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1 Introduction

The Kaskaskia River Basin encompasses parts or all of 22 counties in Illinois, with 30 main tributaries and 5,840 mi² of drainage (Figure 1). It is a major tributary of the Mississippi River, with headwaters just west of Champaign, Illinois and flows southwesterly across the state for approximately 325 miles to its confluence with the Mississippi River about eight miles north of Chester, Illinois at river mile 117. Two reservoirs, Lake Shelbyville and Carlyle Lake, and one lock and dam, Jerry F. Costello Lock and Dam (Jerry Costello L&D) were constructed and are operated by the Corps.

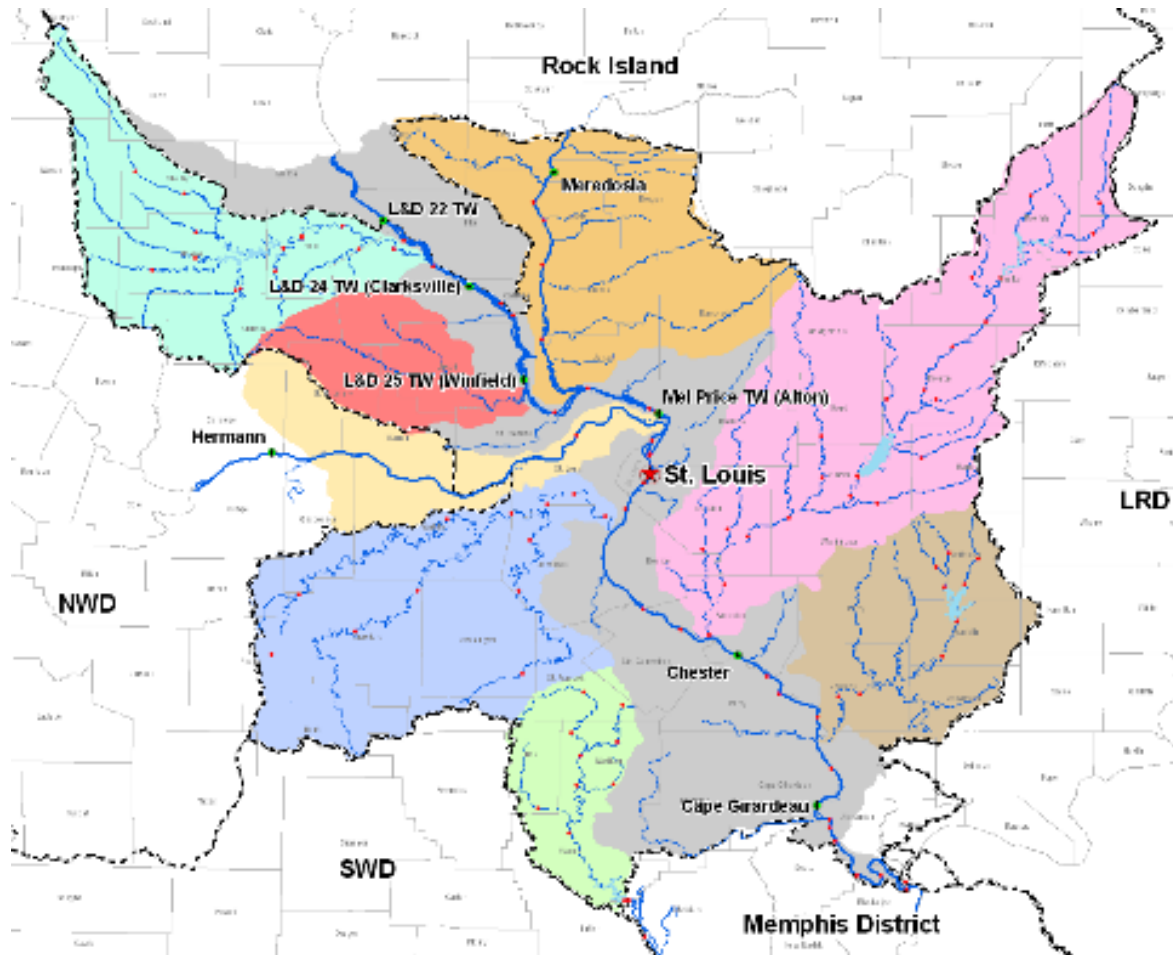


Figure 1. Watershed map of St. Louis District. The Kaskaskia River Basin is the pink area.

In this report pool levels are referenced as a stage. Below is conversion of stages into elevations based on North American Vertical Datum of 1988 (NAVD 88):

Carlyle Lake pool stage minus 0.38 ft = elevation (NAVD 88)

Lake Shelbyville pool stage minus 0.30 ft = elevation (NAVD 88)

Jerry Costello L&D pool stage minus 0.50 ft = elevation (NAVD 88)

Lake Shelbyville was completed in 1970 and is approximately 11,100 water surface acres in size. Normal lake levels during the summer, as denoted in Figure 2, are held at a stage of 599.7 feet. The upstream portions, where the Kaskaskia River and West Okaw River flow into the lake, contain areas that would be the most likely to benefit from a drawdown during the growing season. Carlyle Lake was completed in 1967 and is approximately 62,420 water surface acres in size. Normal lake levels during the summer are held at a stage of 445.0 feet. The upstream portions, where the Kaskaskia River flow into the lake, contain areas most likely to be exposed by and benefit from a drawdown during the growing season. Importantly, the current Water Control Plan allows for a variance of up to a half foot on the guide curve elevation. This variance precludes the need for a deviation.

Downstream of Carlyle Lake, Jerry Costello L&D provides a nine-foot navigation channel for approximately 36 miles from the confluence of the Mississippi River to Fayetteville, IL. Within this stretch the navigation channel was straightened during construction, resulting in the creation of a large number of remnant oxbows and additional shoreline that could be exposed with water level management to grow vegetation. The maximum regulated pool above the Jerry Costello L&D is at a stage of 368.8 feet.

Lake Shelbyville and Carlyle Lake are authorized and operate for flood risk management, recreation, navigation, water quality, fish and wildlife conservation and water supply. Jerry Costello L&D is authorized and operates for navigation, recreation, and fish and wildlife conservation.

In 2020, the St. Louis District evaluated daily release and water surface elevations at pool above Jerry Costello L&D, Carlyle Lake, and Lake Shelbyville to determine feasibility of implementing Environmental Pool Management (EPM) at each location. Additionally, a review of the past 21 years was conducted to evaluate the likelihood of success above Jerry Costello L&D. This report summarizes those assessments.

1.1 EPM Operations

The general goal for Lake Shelbyville, Carlyle Lake, and Jerry Costello L&D is to improve surrounding habitat by drawing pool elevations down 0.5 to 2.0 ft during the growing season (May through September). While the general goal is the same at each project, hydrologic and hydraulic constraints vary for each project, which affects the ability to accomplish the desired drawdown at the different pools. The best period for Lake Shelbyville and Carlyle Lake has been determined to be later in the season (July and August).

1.1.1 Lake Shelbyville

Lake Shelbyville is a headwater flood risk management reservoir with 1,054 mi² of unregulated drainage upstream. Lake Shelbyville primary purpose is to reduce flooding downstream with control points at Cowden, Ramsey, and Vandalia. The drainage area between Lake Shelbyville and Vandalia is unregulated and covers 886 mi². The constraints of inflow coming into the lake from upstream and regulating for downstream local flows coming into the Kaskaskia River between Lake Shelbyville and Vandalia, drive reservoir pool stages. To accomplish a half foot drawdown during the growing season, relatively low inflows and low local flows downstream are needed for the months of April through September so that reservoir pool stages can be maintained at or near seasonal guide curve and accomplish the desired drawdown. Drier than normal to drought like conditions are the ideal conditions to accomplish the desired drawdown regulation during the growing season.

1.1.2 Carlyle Lake

Carlyle Lake is a flood risk management reservoir located approximately in the center of the Kaskaskia River watershed with a total drainage area of 2,717 mi², 1,054 mi² upstream of Lake Shelbyville and 1,663 mi² between Lake Shelbyville and Carlyle Lake. In addition to the upstream drainage area, Carlyle regulates for downstream local flows to Venedy Station, which has a local drainage area of 1,676 mi² below Carlyle Dam. Though the Upper Kaskaskia River watershed is regulated by Lake Shelbyville, any volume of water that enters Lake Shelbyville must be released over time. As a result, large events that result in sustained releases from Lake Shelbyville and also result in sustained elevated inflows to Carlyle Lake, thereby increasing the chances that local rainfall events between Lake Shelbyville and Carlyle Lake will further elevate inflows resulting in increased Carlyle Lake pool stages. In addition to the upstream constraints driving inflows influencing lake stages, release constraints in regulating to reduce flooding downstream also influence lake stages.

1.1.3 Jerry F. Costello Lock and Dam

Jerry Costello L&D is a navigation lock and dam located 0.7 mi upstream of the outlet of the Kaskaskia River basin. There is a total of 5,840 mi² of drainage area. 2,717 mi² are upstream of Carlyle Dam and 3,123 mi² of largely unregulated drainage area are located downstream of Carlyle Lake. Jerry Costello L&D is a hinge point operated run of the river lock and dam project and pool stages are driven by inflow to meet hinge point operating limits and influenced by backwater from the Mississippi River during high flow events. Figure 2 illustrates how Jerry Costello L&D is operated with varying river conditions.

Accomplishing EPM at Jerry Costello L&D requires high enough inflows (>1,500 cfs) to sustain sufficient navigation depths while accomplishing a half foot drawdown and inflows cannot be too high (<10,000 cfs) to maintain hinge point stage low enough to attain the desired drawdown benefits. Additionally, the Mississippi River must remain low enough not to cause open river conditions due to backwater. Ideal conditions for regulating Jerry Costello L&D for EPM involves relatively low Mississippi River stages/flows and sustained inflows above 1,500 cfs either from timely events downstream of Carlyle Lake or events that cause sustained elevated outflows from Lake Shelbyville and/or Carlyle Lake.

2 Methods

Flow and pool stages for 2000-2020 were compiled and analyzed at each of the Kaskaskia projects to determine how successful the effort to achieve environmental pool at those projects could be. Of the three projects, the primary focus was on Jerry Costello L&D. Pool levels at Jerry Costello L&D are largely determined by releases from Shelbyville and Carlyle, but backwater from the Mississippi also has an influence. High releases from Shelbyville and Carlyle during large rain events can cause the stage at Red Bud, hinge point location for Jerry Costello L&D, to rise and thereby require lock gates openings to be increased to pass water and keep Red Bud within its limits. Exposed shorelines are inundated if flows exceed 10,000 cfs. High stage levels on the Mississippi River, downstream of Jerry Costello L&D, can have a back water effect up the Kaskaskia River which can raise levels above 368.8 feet and halt any drawdown attempts. These limitations factor into whether management for environmental pool conditions can be attained in the Jerry Costello L&D pool. As for Carlyle Lake and Lake Shelbyville, their limitations include reservoir inflows as well as outflow constraints related to channel capacities of the Kaskaskia River below the dams, which affects how quickly the pools can be drawn down.

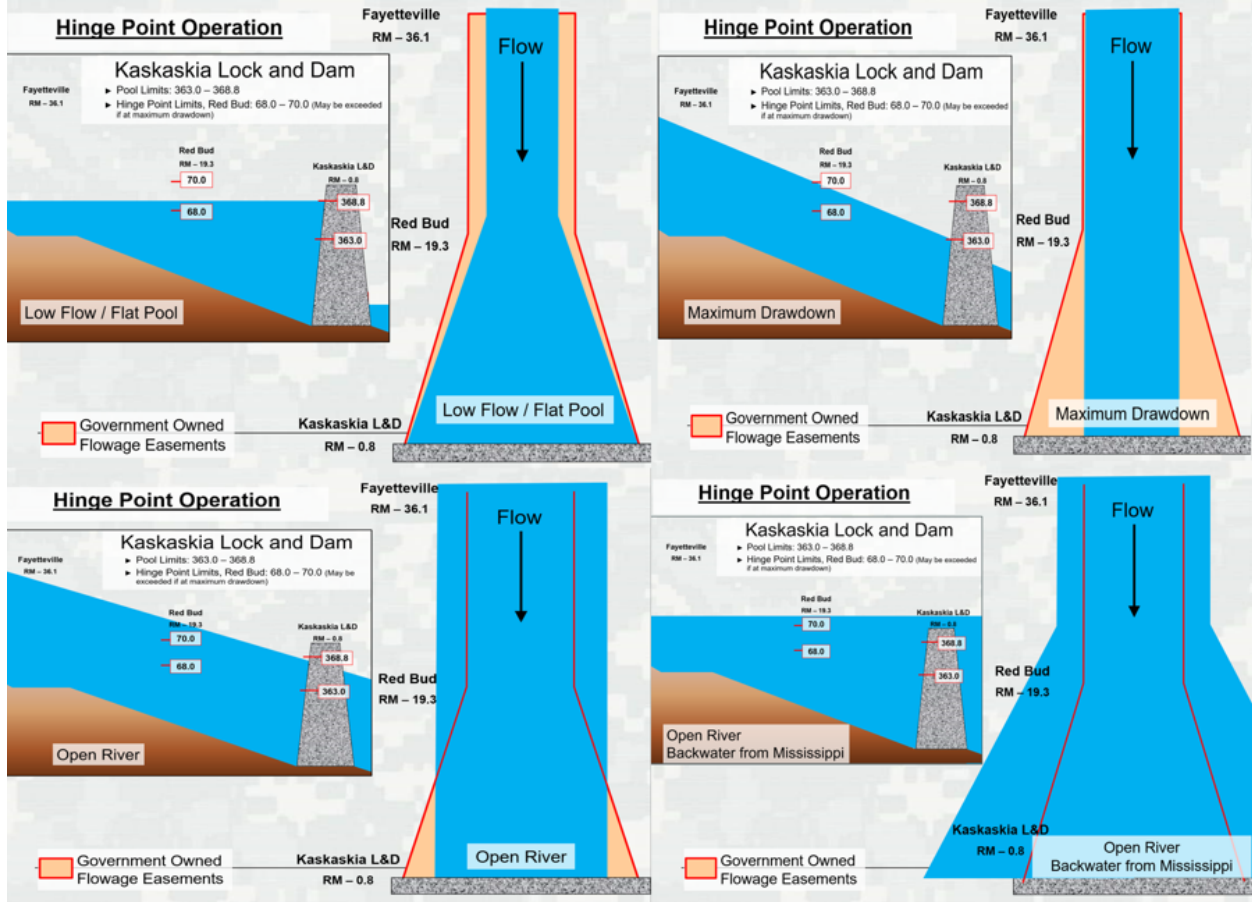


Figure 2. Jerry F. Costello Lock and Dam illustrative operating limits.

3 Results/Discussion

The 2020 season at Lake Shelbyville began with ideal conditions to support EPM operations. Initial inflows were managed to begin slowly evacuating water towards a half foot below the seasonal guide curve (April), however, an untimely inflow event (May) caused pool stages to rise to levels that made attaining a half foot drawdown not possible. Figure 3 shows the 2020 pool stage hydrograph and the zone rules and targets from the water control plan. Similarly, conditions at Carlyle Lake were initially promising for an EPM drawdown at the beginning of the growing season (April). However, untimely late June and July inflow events resulted in elevated lake stages and a drawdown was not able to be accomplished. A drawdown of at least 30 days is needed to allow sediment to consolidate, seeds to germinate, and emergent or aquatic vegetation to grow large enough to withstand gradual (~1 inch per day) water level increases. As a result, a minimum of 30 days was used to evaluate potential drawdown success. Figure 4 shows the 2020 pool stage hydrograph and the zone rules and targets from the water control plan.

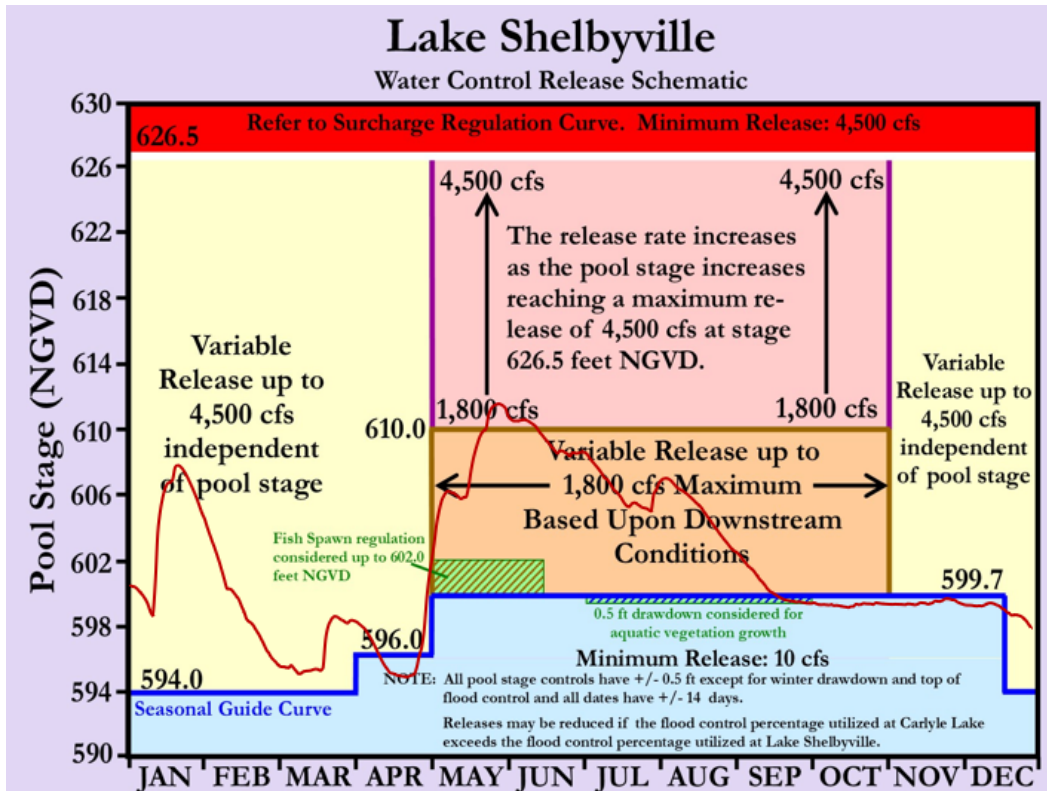


Figure 3. Lake Shelbyville water control plan release schematic and 2020 pool stage hydrograph.

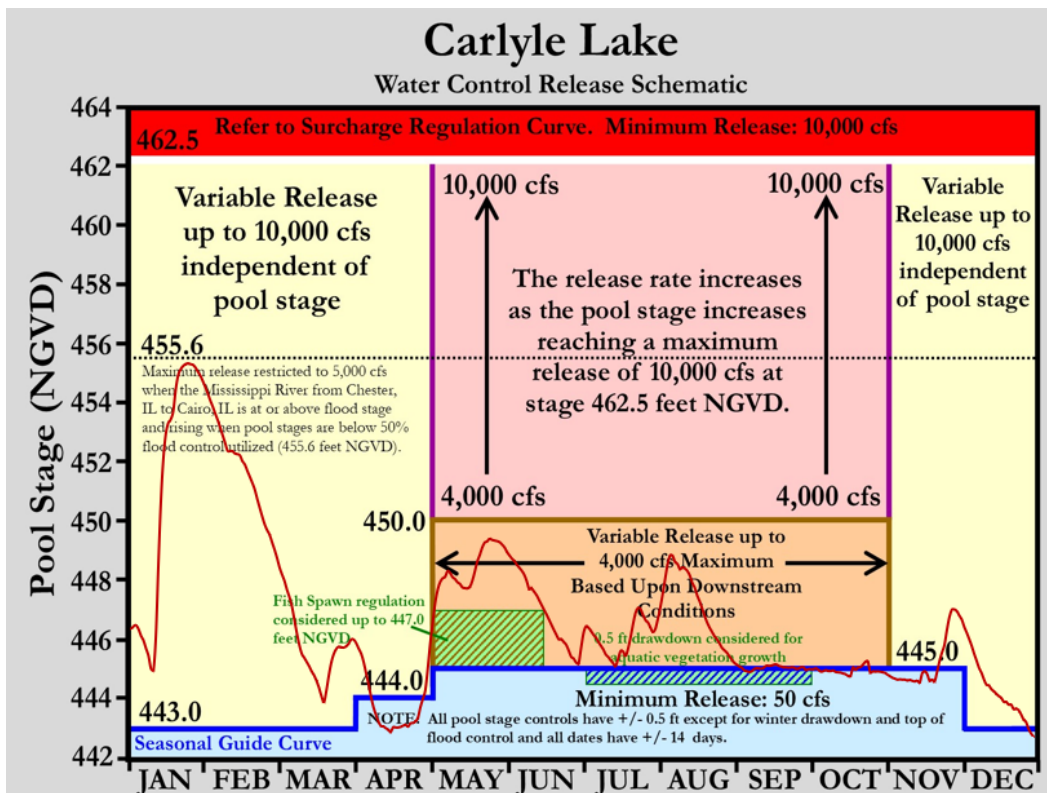


Figure 4. Carlyle Lake water control plan release schematic and 2020 pool stage hydrograph.

Table 1. Summary of 21-year assessment of EPM potential at Jerry F. Costello L&D.

Year	Start Date	End Date	Consecutive days of drawdown	Average Inflow 1May-31 August	Successful (Y/N) (Y = 30+ days)
2000	7/6	8/31	57	7,052	Y
2001	no drawdown - drought		0	1,061	N
2002	6/22	8/31	71	3,743	Y
2003	5/17	8/31	107	2,895	Y
2004	7/3	8/31	60	1,685	Y
2005	no drawdown - drought		0	381	N
2006	no drawdown - drought		0	1,323	N
2007	no drawdown - drought		0	332	N
2008	8/8	8/31	24	4,011	N
2009	7/2	8/31	81	4,881	Y
2010	no drawdown - backwater		0	2,887	N
2011	no drawdown - backwater		0	3,197	N
2012	no drawdown - drought		0	962	N
2013	7/15	8/31	48	4,571	Y
2014	7/24	8/31	39	1,864	Y
2015	5/1	5/27	27	5,065	N
2016	6/7	8/31	86	3,449	Y
2017	7/8	8/31	55	1,688	Y
2018	7/17	8/31	48	2,424	Y
2019	no drawdown - backwater		0	9,443	N
2020	7/8	8/31	55	4,739	Y

EPM drawdowns at Jerry Costello L&D showed a success rate of 52% for the 2000-2020 period. Additionally, results show a correlation between inflow rates and whether EPM was possible (Table 1). Years with higher inflow averages tended to be less successful at maintaining environmental pool than drier years. However, the years of 2010, 2011 and 2019 demonstrate that success depends on more than just Kaskaskia River flows. In those years the Mississippi River was high, and backwater effects (high flows on the Mississippi leading to high water levels on the Kaskaskia River) precluded a drawdown for even 1 day. 2001, 2005, 2006, 2007 and 2012 show days of drawdown as “0” as drought conditions existed and EPM at the project would not have been attempted.

Lake Shelbyville and Carlyle Lake had similar results regarding probability of success. Table 2 shows the model results for the two projects along with results for Jerry Costello L&D (from Table 1).

The project success rate for Lake Shelbyville and Carlyle Lake were 43% and 29%, respectively. The model evaluation was interesting because the lakes did better in dry years and the navigation project did better in wet years. The likelihood of success that at least one project in the basin achieves EPM in any given year was estimated to be 81% (Table 2).

Table 2. Evaluation of EPM potential at Jerry Costello L&D, Lake Shelbyville, and Carlyle Lake.

Year	Jerry Costello L&D success (Y/N)	Lake Shelbyville success (Y/N)	Carlyle Lake success (Y/N)	EPM success at 1 or more locations
2000	Y	N	N	Y
2001	N	Y	N	Y
2002	Y	N	Y	Y
2003	Y	Y	N	Y
2004	Y	Y	N	Y
2005	N	Y	Y	Y
2006	N	Y	Y	Y
2007	N	Y	Y	Y
2008	N	N	N	N
2009	Y	N	N	Y
2010	N	N	N	N
2011	N	Y	Y	Y
2012	N	Y	N	Y
2013	Y	N	N	Y
2014	Y	N	N	Y
2015	N	N	N	N
2016	Y	N	N	Y
2017	Y	Y	Y	Y
2018	Y	N	N	Y
2019	N	N	N	N
2020	Y	N	N	Y

4 Conclusion

Environmental pool management is a viable water control technique at all three projects that can be achieved with the existing Water Control Manual. It can provide additional habitat at each project for no additional cost. The half foot variance in the existing Water Control Manuals allows for EPM, however future updates to the manuals will specifically call out EPM so that it will be institutionalized. Generally drier years are more likely to produce success at Lake Shelbyville and Carlyle Lake. Wetter years tend to facilitate success at Jerry Costello L&D.

5 Postscript

Based on the assessment described in this report, EPM was attempted for Kaskaskia River reservoirs in 2021 and 2022. EPM at Jerry Costello L&D was successful in 2021 and 2022. EPM at Carlyle Lake was successful in 2021. EPM was successful at Lake Shelbyville in 2022. 2023 was a severe drought year and EPM was not attempted so that, if needed, the water could be used for the Middle Mississippi River.

Appendix A: Model results examples

Plots A1-A6 show years with and without EPM potential at Lake Shelbyville, Carlyle Lake, and Jerry F. Costello Lock and Dam. Plots illustrate how historical years were assessed and summarized in Table 2.



Figure A1. In 2007, conditions resulted in an approximately 150-day drawdown between early May and late September at Lake Shelbyville. 2007 was noted as successful for EPM potential at Lake Shelbyville in Table 2.

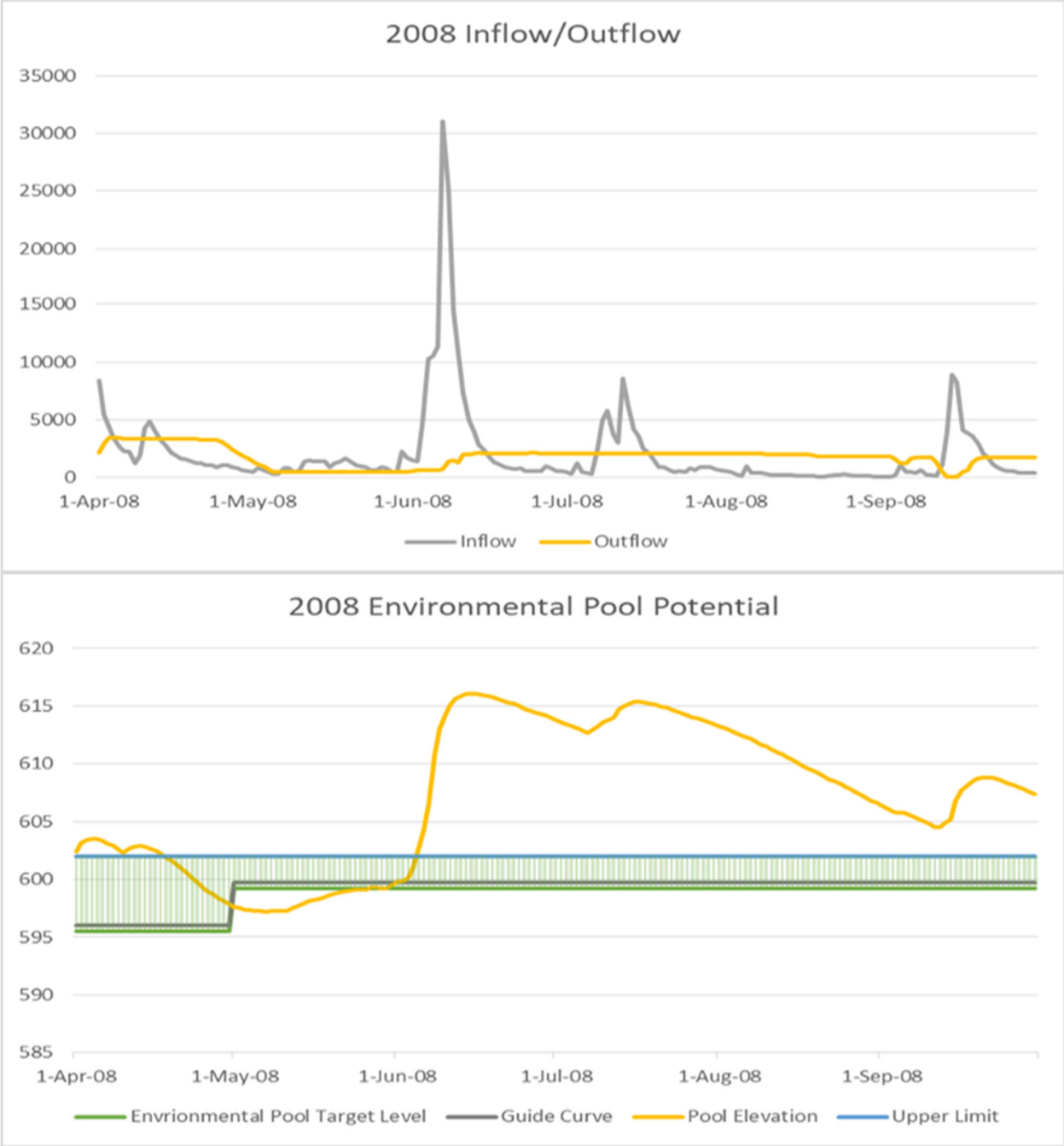


Figure A2. In 2008, a short drawdown occurred in May at Lake Shelbyville, but it would not have been possible to maintain a drawdown later into the growing season due to several large rain events which increased the reservoir water elevation. 2008 was noted as unsuccessful for EPM potential at Lake Shelbyville in Table 2.

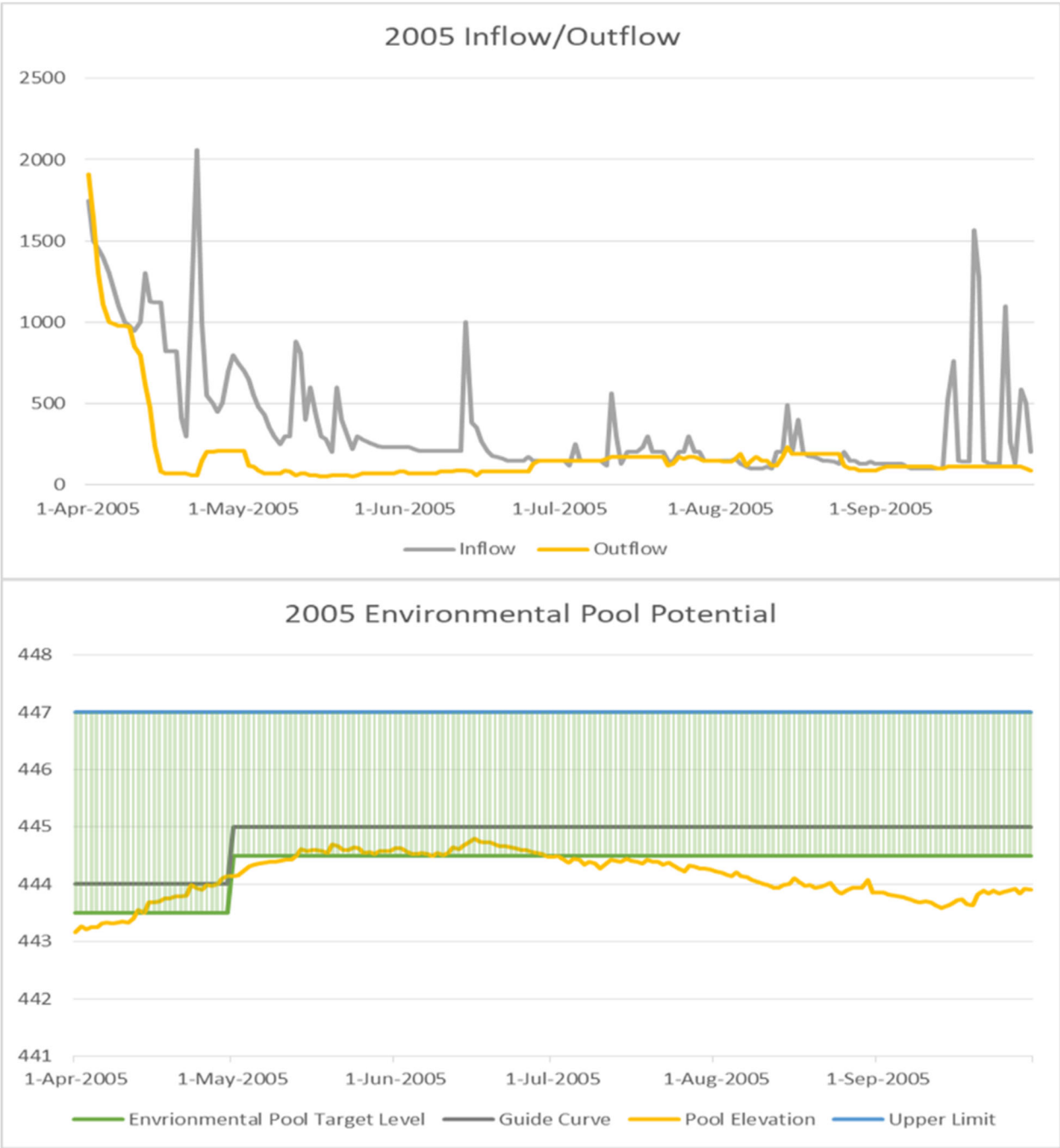


Figure A3. In 2005, conditions would have supported an approximately 150-day drawdown between early May and late September at Carlyle Lake. 2005 was noted as successful for EPM potential at Carlyle Lake in Table 2.

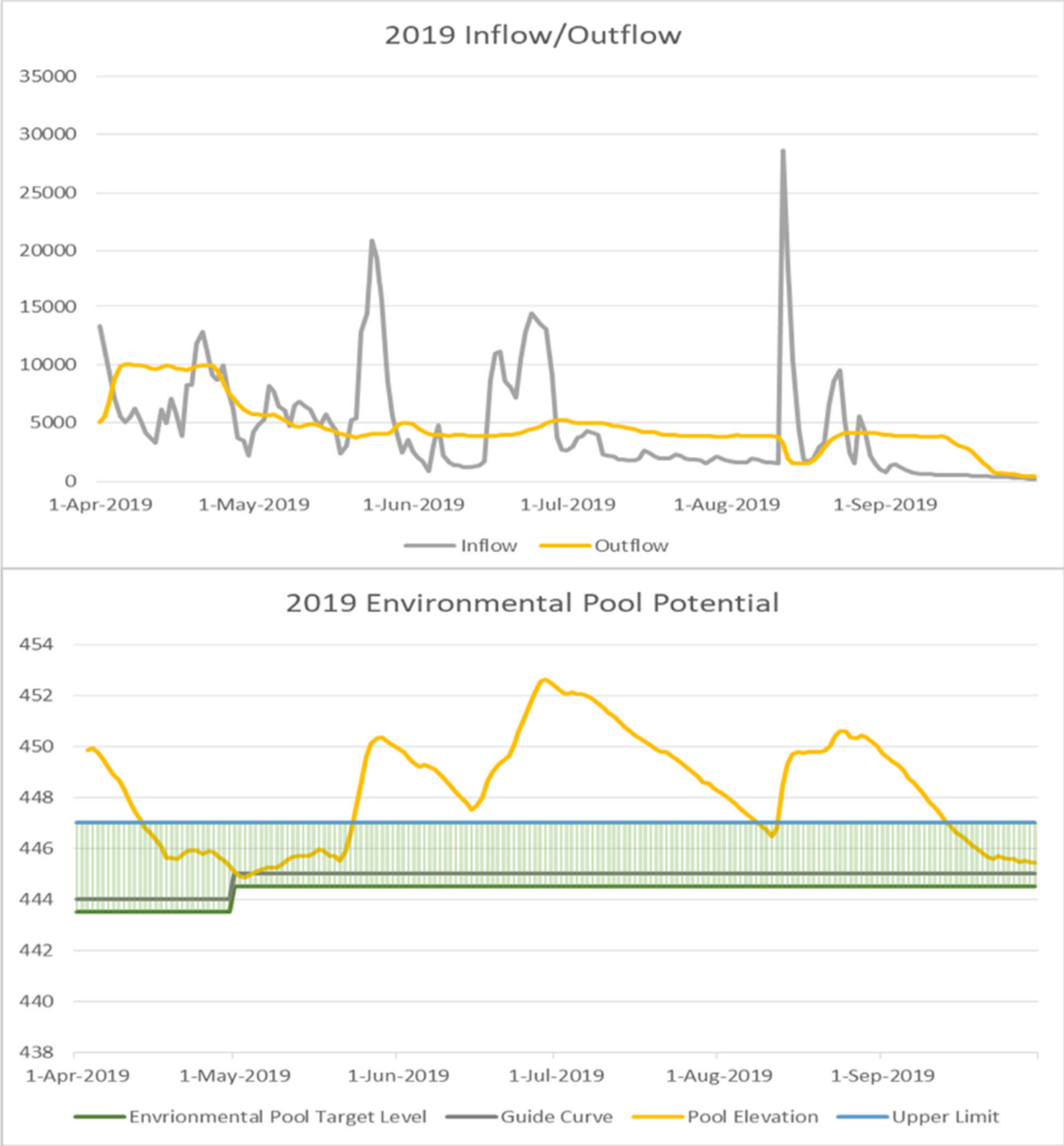


Figure A4. A brief, less than 30-day drawdown in 2019 may have been possible between early May and June 1 at Carlyle Lake. However, several large runoff events pushed the lake to flood elevations for nearly all of the remaining growing season. 2019 was noted as unsuccessful for EPM potential at Carlyle Lake in Table 2.

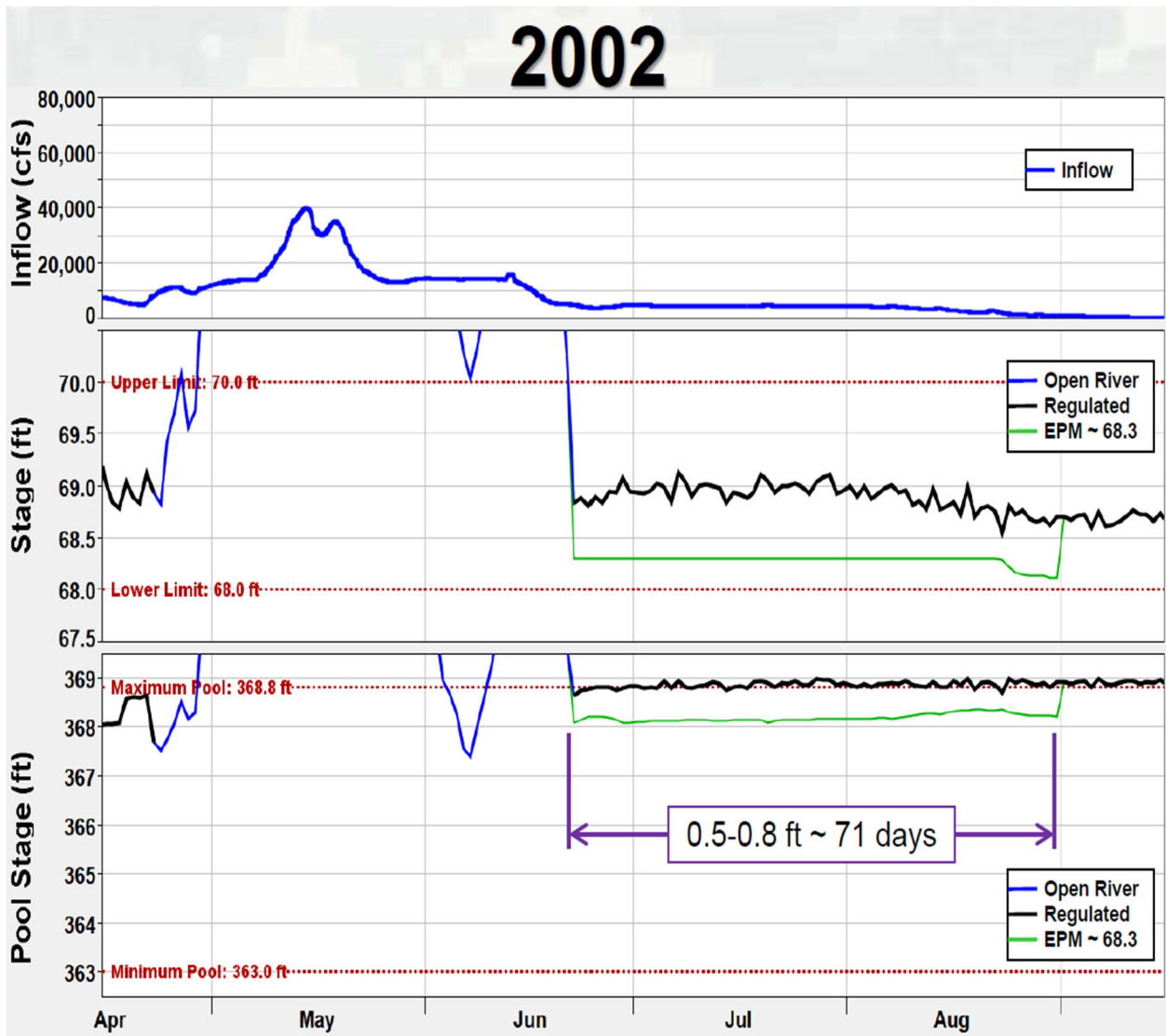


Figure A5. In 2002, conditions would have supported an approximately 71-day drawdown between mid-June and late August at Costello Lock and Dam, 2002. 2002 was noted as successful for EPM potential at Costello Lock and Dam in Table 2.

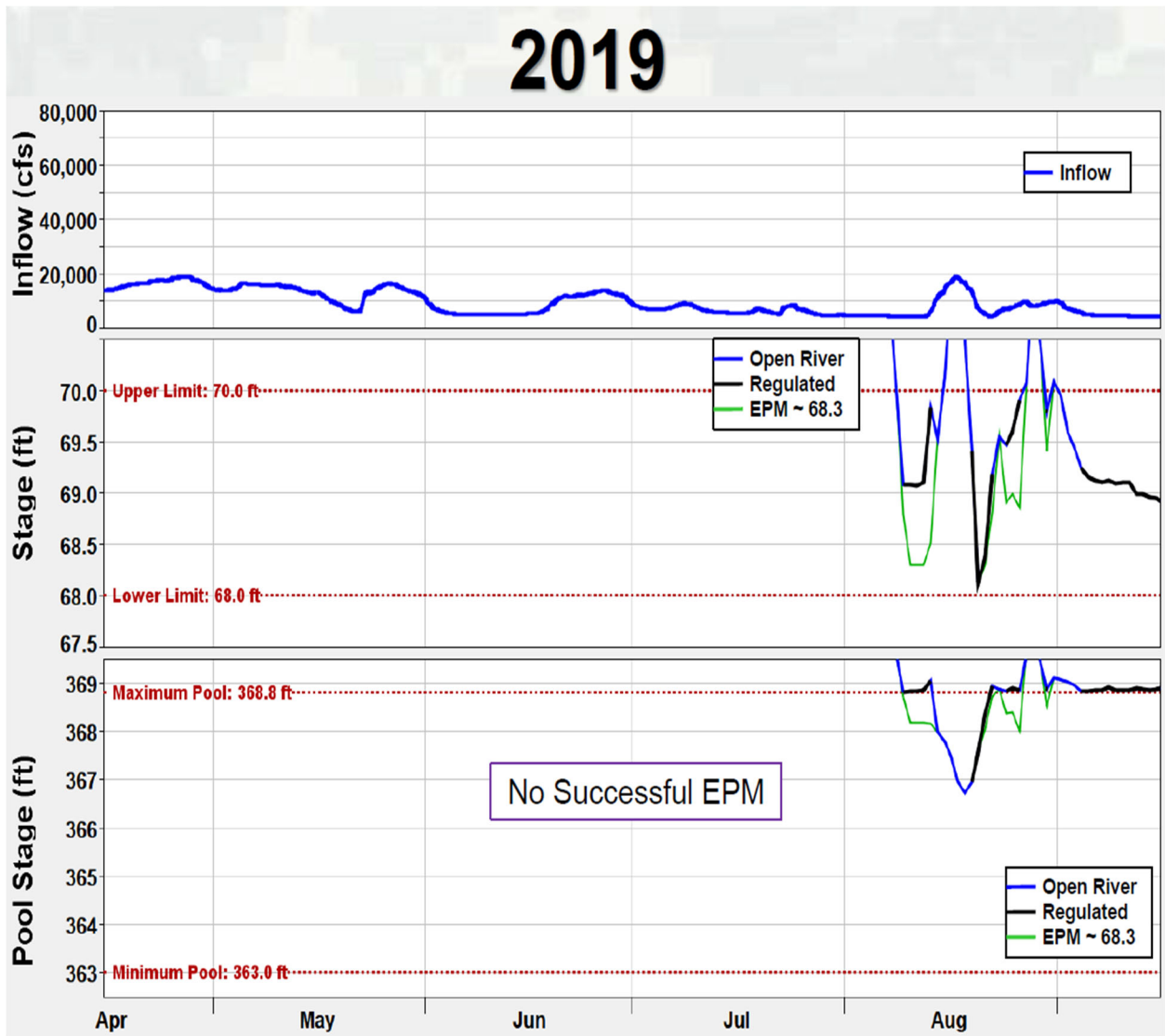


Figure A6. A prolonged backwater effect from high Mississippi River Stages would have prevented a drawdown at Costello Lock and Dam in 2019. 2019 was noted as unsuccessful for EPM at Costello Lock and Dam in Table 2.

Appendix B: Examples of benefits provided by drawdowns

Environmental Pool Management (EPM) is a water management strategy that manages pool elevations to generate environmental benefits. Figures B1-B3 show some of the desired ecological responses to EPM drawdowns, including germination and establishment of wetland plants, provision of bird habitats, and flowering of plants for pollinators.



Figure B1. Early vegetative response to a pool drawdown at Lake Shelbyville. Note the bands of vegetation that germinated at different times based on exposure during the drawdown (left image). If drawdown conditions by early July were maintained for 60+ days, many of these species would have time to flower and produce seed, which would provide forage for waterfowl and replenish the seedbank for future drawdowns (right images). Vegetation also helps stabilize lake banks, which reduces erosion and turbidity (USACE photos).



Figure B2. Mudflat habitat creation during a drawdown at Carlyle Lake. This shallow water and recently exposed mud can provide valuable habitat for shorebirds, herons, and egrets by increasing access to prey items that provide fuel for breeding or migrating (photo by Lane Richter, USACE).



Figure B3. The forbs that respond to and reach maturity during a drawdown can provide valuable pollen and nectar resources for a wide range of pollinators, including an assortment of bees, wasps, flies, and beetles. These same pollinators are responsible for pollinating many of the fruits, vegetables, nuts, and other crops that humans consume (photos by Lane Richter, USACE).