Chapter Two

Overview of the 2006 Flood Event

Introduction

This Chapter summarizes the water management operations as they unfolded, and the flood event that occurred in May and June 2006. In general, the observed April to August water supply or 2006 seasonal runoff volume was 6.628 MAF, or 106% of normal. However, the shape of the runoff was unusual due to several factors. Record temperatures in the basin in mid-May resulted in very rapid snowmelt and a peak in inflow of 77,000 cfs during the third week of May. In addition, rainfall during the second half of May and the first part of June was above normal in the Kootenai Basin. The observed runoff volume from May 16 through June 30 was 4 MAF - more than 60% of the observed April through August inflow.

In evaluating an event such as what occurred in 2006, comparing the peak runoff volume to the total runoff volume is useful. When comparing the Libby historical peak-to-volume relationship for the period of record of 1929-1999, the observed peak inflow of 77,000 cfs is considered high. In about 67% of the years in the period of record, peak runoff volume in a 6 MAF water year ranges from 48,000 cfs to 68,000 cfs. In addition to the record warm temperatures, rainfall during the second half of May was above normal in the Kootenai Basin and contributed to the high inflows to Libby Dam.

May was followed by record rainfall in June of up to 266% of normal in the drainage to Libby Dam. Significant thunderstorm activity resulted in high inflows with a peak inflow of 62,000 cfs on June 18. River stage at Bonners Ferry peaked at elevation 1766.6 feet on June 18th. By the third week in June, both inflows and river stages at Bonners Ferry began to recede.

More detailed information on water management operations, water supply forecasts, stream flow forecasts, hydrology for 2006 is provided in Appendices K, M, and W.

I. Summary of Libby Dam Water Management Operations in 2006

The following summary describes what the Corps took into consideration, the decision points, and resulting dam and reservoir operations as events unfolded in 2006. A detailed chronology of 2006 water management operations is provided in Appendix K.

A. Summary of January-March Operations

January through March is considered the drawdown period, when Libby Dam is drafted to certain reservoir elevations to provide for flood control storage. The end-of-month elevations are calculated based on a water supply forecast (WSF). During January

through March, Libby Dam was operated to achieve system flood control objectives, including following VARQ Drawdown Guidance, and the end-of month upper flood control elevations.

During this period, ESA consultation was underway with the USFWS, culminating in the issuance of the 2006 Biological Opinion on February 18, 2006. In January 2006, the Corps met with regional entities, the USFWS, BPA, the Kootenai Tribe of Idaho, Salish-Kootenai Tribe, and the States of Montana and Idaho, to develop a scientifically sound plan to test flows for sturgeon. The 2006 USFWS BiOp included an RPA that recommended completing the Kootenai River Ecosystem Function Restoration Flow Plan Implementation Protocol (Protocol) prior to initiation of sturgeon operations.

Consistent with the flood control procedures, the Libby Dam elevation was 2404.2 feet at the end of March. Based on the WSF issued in March, the calculated end of March upper flood control limit was elevation 2404.1 feet.

B. Summary of April Operations

Libby Dam outflows remained at approximately 4,000 cfs with the expectation that the drawdown period would transition into the refill period sometime in April or early May. The VARQ Refill Guidance, issued by the Northwestern Division office on April 19, and later on April 28, identified project releases of approximately 16.4 kcfs starting April 20. In making a decision to maintain project releases at 4 kcfs, the Corps' Northwestern Division, Columbia Basin Water Management Reservoir Control Center (RCC) considered the following information:

- The April final WSF issued on April 6 was 6.076 MAF - 97.2% of normal.

- The RCC prepared system analyses of potential operations to assess Columbia Basin System water management operations. The RCC used the Ensemble Streamflow Predictor (ESP)[1] inflow for the entire Columbia Basin and converted the inflow into a monthly time-step inflow, which is applied in the HYSSR[2] model. This tool is used in the TMT forum to test the system's ability to meet a variety of objectives, including streamflow objectives, spill quantity, and reservoir refill consistent with the actions and objectives addressed in the NOAA Fisheries

[1] Ensemble Streamflow Prediction (ESP) forecasts prepared by the River Forecast Center are used by RCC as an additional WSF indicator and are used as tool in decision-making for Libby operations. ESP forecasts are developed once each week for the entire Columbia River Basin. The forecast begins with a 10-day single trace deterministic streamflow forecast that includes expected precipitation and temperature on the current snow states and soil moisture content. Beginning on day eleven, 44 historic temperature and precipitation sequences are used to develop 44 potential inflow sequences for the basin. These 44 hydrographs may be averaged to develop a WSF, and individual water sequences may be singled out for use as a potential operational hydrograph for use in decision-making.

[2] HYSSR is a monthly time-step model that is used for system hydropower modeling and can be used as a tool to test outcomes of other system operations. ESP HYSSR differs from other uses of HYSSR in that ESP HYSSR uses unique calculated inflow as developed using ESP rather than using observed historic inflow sequences. As the ESP inflow is updated, ESP HYSSR can be updated.

and USFWS BiOps. ESP HYSSR[2] was prepared 10 times from April through June. The first of three ESP HYSSR runs were presented to TMT on April 4, and the additional seven runs were used for internal decision-making. The ESP HYSSR model used by RCC for potential operational outcomes and risk associated with shaping the flows identified in the VARQ Refill Guidance, showed in the 44 historic years modeled that Libby Reservoir filled about three quarters of the years studied, and the average outflow from Libby Dam in May and June was less than 20,000 cfs. The output showed little risk of spill at Libby Dam.

- Corps policy decision-makers were continuing discussions with the USFWS, BPA, the states of Montana and Idaho, the Kootenai Tribe of Idaho, and the Salish-Kootenai Tribe on the operational strategy for Libby Dam pursuant to the 2006 USFWS BiOp and RPA. The Protocol for the implementation of flow for sturgeon was completed on April 14, 2006, providing information for regional policy makers to make a recommendation for 2006 sturgeon operations. However, a decision on adoption of the 2006 USFWS BiOp and specifically the 2006 operations for sturgeon was pending additional analysis. Options under consideration for the 2006 operational year[3] included "full powerhouse plus 10,000 cfs" and "stacked flow." If the powerhouse plus 10,000 cfs spill option was adopted, the timing of these releases would be later in the spring to meet the desired temperature attribute. Delaying the Libby VARQ Refill Guidance outflows in April would facilitate meeting this higher flow objective, which would likely occur in early to mid-June. With the stacked flow operation, Libby Dam would release full powerhouse flows coincident with the local freshet from below Libby Dam to Bonners Ferry to provide the desired depth and water temperature attributes for sturgeon spawning near Bonners Ferry - likely in mid-May.

- Beginning in late April, the Columbia River was operated for system flood control as a result of high flows in the lower Snake River. For system flood control purposes, Grand Coulee Dam was operating to draft to its end-of-April flood control elevation, while releasing flow to maintain 359 kcfs in the lower Columbia River, as measured at The Dalles, each day. During this period, the outflow rate from Grand Coulee Dam was monitored. The Corps decided that additional inflow from upstream projects, including Libby, was not advisable as this would require Grand Coulee to release more water and at a higher rate of discharge than desired to maintain flows at or below 359 kcfs at The Dalles, and achieve the Grand Coulee end-of-April system flood control elevation. (Modified through the deviation approved on April 17. See App. K)

- The calculated end of April flood control upper limit for the Libby Dam reservoir was elevation 2417 feet. As the end of month elevation was expected to be at a lower elevation, releasing minimum outflows did not appear to pose a risk to local

[3] Based on the April final WSF, at this time in April, this was a Tier 3 year with approximately 1.028 MAF of water designated for sturgeon flows as described in the 2006 USFWS BiOp.

flood control. The actual end of April reservoir elevation was 2413.2 feet - 3.8 feet below the end of April flood control elevation.

In making decisions about Libby Dam releases in April, the Corps considered all of the factors noted above and concluded, at the time, that the risk to flood damage reduction was low.

C. Summary of May Operations

In May, RCC continually assessed current conditions and information as well as the risk to achieving key objectives, in particular, providing for local and system flood damage reduction, flow operations to achieve the desired habitat attributes for sturgeon, and refilling the Libby reservoir by the end of June or early July. Using the ESP whisker plots for Libby Dam and the ESP HYSSR system analysis, developed and presented to TMT on May 3, demonstrated that Libby reservoir might not refill by the end of June or early July. The RCC determined that continuing a minimum outflow operation was appropriate to meet all the operating objectives for Libby Dam, and the risk to local flood control continued to be low pending resolution on the 2006 sturgeon operations.

The ESP graph shown in Figure 4 below was prepared on May 1. The first ten days included the 10-day temperature and precipitation forecast for sites throughout the Columbia Basin. Figure 4 shows the forecasts that were prepared for the Kootenai Basin. This forecast tool includes 44 historic temperature and precipitation sequences overlaid on the snow and soil moisture conditions expected on May 11. Note that the actual peak inflow of 77,000 cfs that occurred in May was not included in this forecast.[4]

[4] Also, note that a major event represented in Figure 4 was a thunderstorm event that occurred around June 25th (1969) with an ESP produced inflow peak as high as 88,000 cfs. This 88,000 cfs peak inflow is not meant to simulate the inflow that was experienced in 1969. This demonstrates that if a thunderstorm event occurred in 2006 with similar magnitude and intensity as occurred in 1969, there may be potential for inflow of 88,000 cfs in late June. The 1969 weather sequence that simulated a late June inflow of 88,000 cfs also simulated an April through August inflow volume of 7.1 MAF, the third highest volume of the 44 years simulated. In the ESP graph shown, the maximum outflow shown for each day is not necessarily from the same historic weather sequence. The daily maximum flow may be from one year's historic weather sequence one day and from another year's historic weather sequence the next day. There is not necessarily any day-to-day continuity in the maximum, or minimum flows, although there can be (a large event can cause the largest flows to occur on several consecutive days).

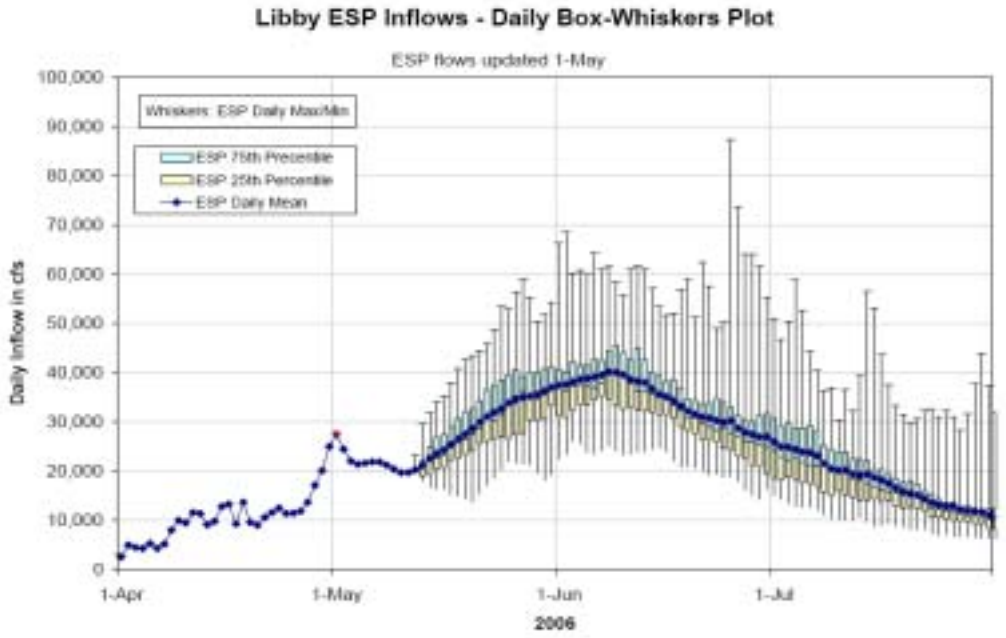

Figure 4.

In a letter dated May 4, 2006, the Corps proposed a stacked flow operation for 2006 in coordination with USFWS and other regional state and tribal biologists. The USFWS concurred that the proposed operation was consistent with the 2006 BiOp in a letter dated May 5, 2006. The plan was to provide 25,000 cfs for up to two weeks with the objective of timing the start of these releases to coincide with a peak in local run-off freshet below Libby Dam. The Corps also stated that it would not intentionally exceed elevation 1764 feet at Bonners Ferry. The Corps signed a Record of Consultation and Statement of Decision (ROCASOD) on May 8, 2006 advising the USFWS of the Corps' intent to operate Libby Dam in accordance with the USFWS 2006 Biological Opinion.

The Corps then coordinated with the USFWS and the biologists on the Sturgeon Recovery Team (SRT) for the recommended start time for the stacked flow operation. RCC monitored the Bonners Ferry water temperatures and local inflows daily to inform the timing for the stacked flow operation and, based on available information, considered increasing the flow above 4 kcfs on May 8 to capture a rise in the local flow. In coordinating a start date, the SRT biologists indicated this was too early for a successful test of the stacked flow operation because water temperatures continued to be below the desired range of 48 – 50 degrees. Their view was that starting on this date would have been an operation to attain depth only, and would not achieve all the desired habitat attributes.

Consequently, the RCC conducted additional analysis and in its assessment of the May 8 ESP forecast, RCC expected another slight rise in flow into Libby and the Bonners Ferry area in mid-May, which would be a viable start time for the stacked flow operation because river temperatures would be slightly warmer. On May 9, RCC participated in the SRT conference call and notified participants that initiating increased releases on May 14 for the stacked flow operation would be the most advantageous operation to achieve the desired habitat attributes for sturgeon. The participants on the call concurred with the timing of the increased outflow. On May 10, the Corps, BPA, and the USFWS held a public meeting in Libby, Montana, describing the stacked flow operation scheduled to begin on May 14.

The Corps presented the information in Figure 5, below, at the public meeting on May 10. This graph was prepared on May 9 and represents expected inflow to Libby reservoir of 5.97 MAF from April through August. This volume is similar to the Corps 6.179 MAF WSF prepared earlier in the month. The River Forecast Center's WSF for May was 6.06 MAF. These WSFs and the calculated inflow to Libby reservoir for this period are similar, indicating a comparable range or level of forecast error. This graph shows a peak inflow to the Libby reservoir of about 38,000 cfs, whereas the observed peak inflow was 77,000 cfs.

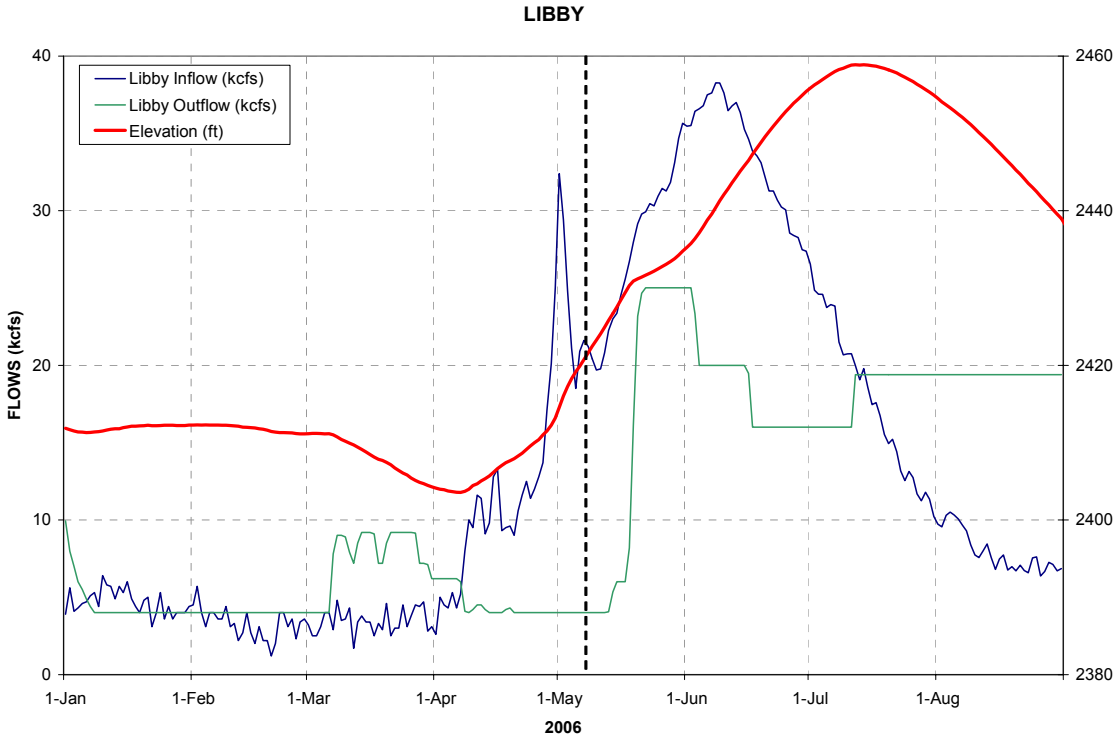

Figure 5.

Flood Control Guidance was issued on May 11, which identified Libby Dam outflows of 19.7 kcfs. Based on the May 8 ESP HYSSR results, which showed Libby reservoir refilled in even fewer years than indicated in the May 3 ESP HYSSR results, RCC's concerns about not meeting the summer refill objective continued. The May 8th ESP forecast for Libby showed inflow of about 25,000 cfs by May 18, and indicated a statistical 75% confidence that inflow would be less than 50,000 cfs through June. As the May final WSF was 98.9% of normal, RCC planned to shape Libby outflows to provide the stacked flow operation in accordance with the objectives of the USFWS BiOp and the refill objectives for summer salmon flow augmentation.

By May 18, inflows to the Libby reservoir were increasing to 63,000 cfs and the stage at Bonners Ferry was slightly above 1762 feet. With the prediction of flows approaching flood stage, reports of increased snow pack melting and runoff in tributaries to the Kootenai River and a verbal request from Boundary County, the Corps deployed an emergency response flood team to make an assessment of the threat of local flooding. Upon arrival, it was evident that there was a potential for flooding, and the team began providing technical to the Bonners Ferry community. On May 19, a flood emergency was declared and the team began providing direct assistance in addition to technical assistance to the Bonners Ferry community.

Early in the event, the flooding threat was localized in nature however, there was one key area that could have resulted in significant damage. Flooding consisted of flooding of low lands, some residential access roads and along the right bank levee down stream of the Highway 95 Bridge in Bonners Ferry. The levee was being severely eroded and complete levee failure was considered to be imminent. A levee breach would have resulted in major flooding of the North Bonners Ferry community, and the resulting flood waters could have cut off access to the City's sewage treatment facility, damaged the above ground sewer line, released raw sewage, and damaged utilities, roads and local homes protected by this levee. During this time, Corps senior management met to discuss the status of the emergency activities and other options to address the flooding issues including reduction of the outflow from Libby Dam for the remainder of the refill season. Outflow was not reduced because the reservoir was too full to capture the expected residual runoff without significantly increasing the risk of spill.

By May 20, the inflow to Libby Reservoir was in excess of 70,000 cfs, which was more than double what was forecast earlier in the week. The reservoir was filling quickly and maintaining higher outflow was recommended to keep space available in the reservoir for the remainder of the runoff season. On May 21, Libby reservoir inflows peaked at 77,000 cfs and the reservoir filled to elevation 2437 feet (22 feet from full).

Inflow to the reservoir for the month of May was 38,660 cfs, 141% of average. Bonners Ferry stage on May 21 was as high as 1763.65 feet. Powerhouse releases of 25,000 cfs, continued through the month of May to slow refill. At the end of May, the Libby reservoir was at elevation 2449.8 feet - 9.2 feet from full.

D. Summary of June Operations

In early June, RCC was monitoring the shape of the inflow runoff to Libby reservoir. Because of the high inflow in May and the snowpack diminishing significantly, the expectation was for less than average inflow to Libby in June, and a recession trend in inflows because the snowpack had diminished.

The ESP information prepared on May 30 (see Figure 6) indicated that some drafting of the Libby reservoir should be feasible June while continuing to release full powerhouse outflow. A small rise in inflow in early June was expected, followed by a recession that would allow for a draft of the reservoir. Because Libby was within 9 feet from full, RCC planned to maintain full powerhouse outflow and draft the reservoir when inflow receded to below 25,000 cfs. RCC continued to monitor the shape of the runoff, recognizing that if the inflow did not recede, or remain in the 30 kcfs range, spill may become necessary.

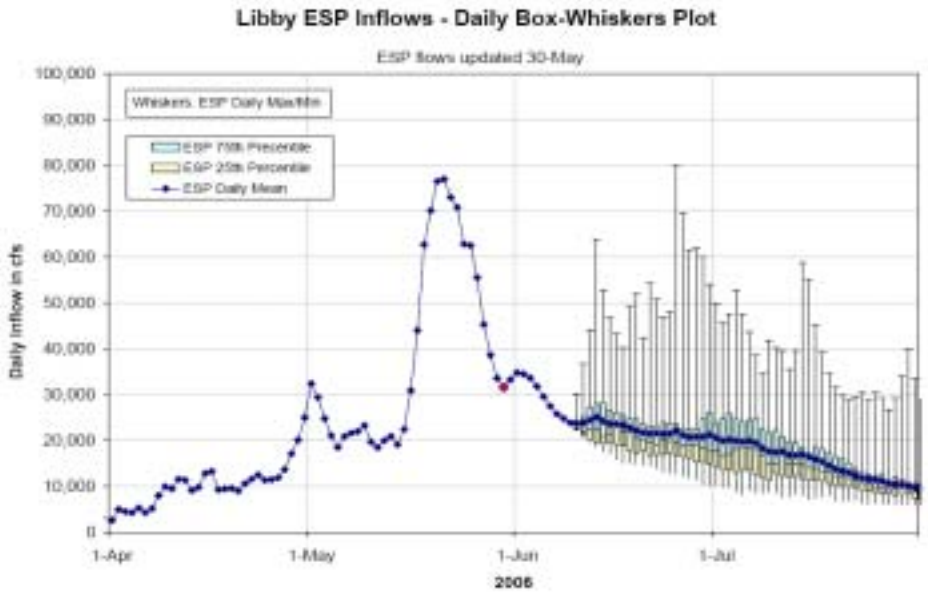

Figure 6.

By June 7, the inflow to Libby reservoir remained in excess of 40 kcfs and the reservoir had filled to above elevation 2454 feet, within five feet from full with about 200 KAF of space available. Discussions began on June 7 with local and state officials about initiating a pre-emptive spill with the objective of slowing refill to maintain adequate storage space in the reservoir. The SRT also indicated that if a pre-emptive spill for flood control was needed, it may also be beneficial to white sturgeon. On June 7, significant

thunderstorm activity resulted in inflows greater than 10 kcfs over levels projected earlier in the day. Consequently, RCC contacted local officials to apprise them of current conditions, and that spill of 8 kcfs would begin on June 8. Because of increases in inflows from those forecasted, spill levels were increased to 14 kcfs and maintained from June 9 through June 16 when spill was again increased to 19 kcfs because of another change in the inflow forecast.

Inflow to the Libby reservoir continued to increase because of thunderstorm activity in the basin upstream of Libby. On June 17, the reservoir was near full, inflow was being monitored hourly, and it was necessary to increase spill to 31,000 cfs for a total outflow from the dam of 55,000 cfs. Libby elevation was above normal full reservoir elevation, or 2459 feet, for approximately 34 hours. The maximum elevation was about 0.13 feet above full. Emergency management actions continued throughout this period. River stage at Bonners Ferry peaked at elevation 1766.6 feet on June 18th. By June 20th, inflows and river stage levels began to recede, and spill levels were reduced slowly to minimize sloughing of levee embankments downstream. Spill ended on June 27th. The observed inflows to Libby Dam in June were 39,612 cfs, 108% of normal.

E. Summary of July and August Operations

- July WSF from RFC was 7.10 MAF, 114% of normal.
- Average July inflow was 14,141 cfs, 69% of average. The first half of July the average inflow was approximately 18 kcfs, and the last half of the month the inflow was about 10 kcfs.
- Salmon flows were initiated in early July after regional discussions.

In July, the outflow from Libby Dam was set at 19,000 cfs to begin the twenty foot draft for summer flow augmentation for salmon. Ultimately the inflow in July was only 69% of average and inflow receded quickly across the month. The strategy through early and mid-July was to try to provide a steady outflow through the summer period for salmon flow augmentation. By late July the outflow was reduced to about 13, 900 cfs as the region agreed to maintain a steady outflow from Libby that would not draft the total twenty feet from the reservoir by the end of August. The observed inflow to Libby Dam in August was also quite low - 68% of average. The reservoir ended August at elevation 2443.26 feet, 15.74 feet from full.

II. Overall Summary of 2006 Water Management Operations

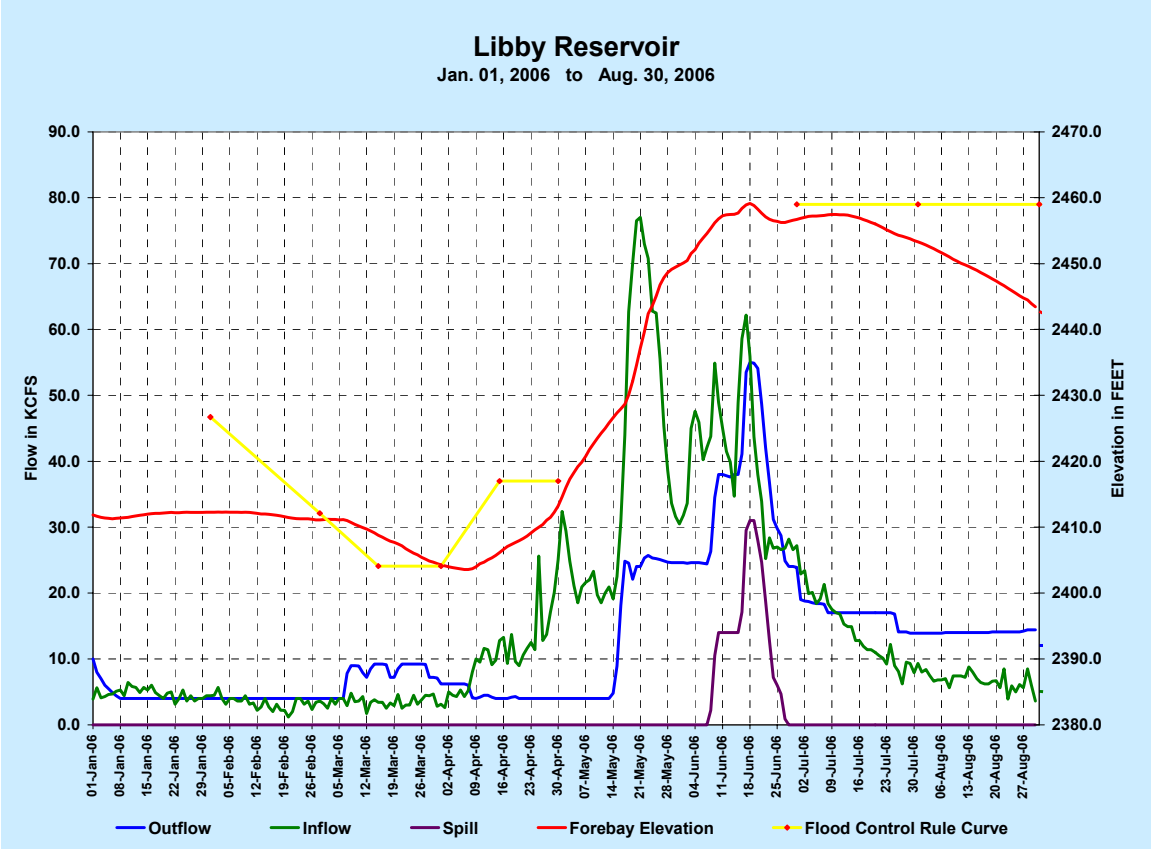

Figure 7.

Figure 7 shows the operation of Libby during the January through August period of 2006. The observed volume runoff for the April through August period was 6.62 MAF, 106% of average, but the shape of the inflow into Libby Dam was concentrated with a peak in mid May followed by another peak in early June. The Figure shows Libby Dam releases at minimum flows from early April through mid-May and then Libby releases were increased to provide for the stacked flow operation. Once releases were increased to full powerhouse outflow in mid-May, high inflows resulted in the reservoir filling to within nine feet of full by the end of May. Figure 7 also demonstrates the secondary peak inflow in mid-June associated with the rain events. This led to the initiation of spill as the reservoir filled resulting in peak outflows of 55 kcfs from Libby Dam on June 18. Spill levels were gradually reduced until spill was ended on June 27. The figure shows the reductions in outflows that continued until salmon flow augmentation started in early July. A steady release of salmon flows in the July through August period resulted in Libby reservoir ending at elevation 2443 feet at the end of August.