FISH PASSAGE CENTER

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MEMORANDUM

TO: Fish Passage Advisory Committee
Fish Passage Center Oversight Board
Ed Sheets, Consulting Services
Robert Lothrop, CRITFC
Bert Bowler, Idaho Rivers United

FROM: Michele DeHart

DATE: October 25, 2005

RE: Preliminary Survival Analysis for Subyearling Chinook originating Above LGR

This memo updates and replaces the memo entitled "Preliminary Survival Analysis for Subyearling Chinook originating Above LGR" dated September 12, 2005. Further updates, including data from other recent years as well as multivariate analysis, will be part of the final analysis that will be included in the FPC annual report. All graphs and the data tables have been updated, including the incorporation of recovery data through October 1, 2005. All trend lines in plots of data are now shown as linear functions, the nature of the final functional relationships may change when our analyses are completed. Further changes include an updated survival estimate for 2002 as well as refinement to the temperature variables used in the analysis. While some changes to the dataset have been made, our conclusions have not changed from the previous memo.

This was a unique year in that spill occurred throughout the summer in the Snake River as part of a court ordered spill for fish passage program. In this analysis the FPC specifically addressed the primary migration characteristic data (juvenile survival and travel time) to determine if an effect of the court ordered summer spill operations could be documented. In order to address this question the travel time and survival of juvenile subyearling Chinook that migrated prior to the initiation of the summer spill program in 2005 was compared to subyearling Chinook survival and travel time from the period after summer spill had been initiated. The 2005 migration was also analyzed compared to past years (2001 to 2004).

Our conclusions based on our preliminary analysis:

- The point estimate for subyearling Chinook survival was the highest recorded in recent years (2001-2005) in the reach from Lower Granite Dam to McNary Dam during the period when spill was occurring in the Snake River.
- And, unlike other recent years where survival either remained low throughout the summer period as in 2001 or declined as in 2002, 2003 and 2004, the 2005 survival increased significantly later in the season.
- This analysis is preliminary. The subyearling migration in the Snake River typically continues through September and into October.
- The preliminary survival estimation is comparable to past years' because the time period of the analysis minimizes the potential of including fish that may over-winter. Over-wintering has been shown to occur mostly in late migrating fall Chinook from the Clearwater River and from groups of "backfill" late hatchery releases. (FPC Memorandum, 5/10/2005, #76-05, www.fpc.org).
- The group 2 fish in 2005 exhibited an extremely fast travel time through the Snake River. The only other year with a travel time estimate as fast was observed for the 2005 migration was group 1 in 2003. The average flow during the time period when the 2003 group 1 migrated was nearly 120 Kcfs, while the average flow in 2005 during the time when group 2 migrated was only 43 Kcfs. This again illustrates the importance of spill in determining the decreased amount of time fish take to migrate through the system when not having to experience the delay associated with passing through a hydroproject.

Methods

Survival and travel time were estimated using PIT-tagged subyearling Chinook of hatchery or wild origin that originated above Lower Granite Dam. Fish released in the Snake River and early releases from the Clearwater River, such as May or June releases from the Big Canyon Creek acclimation facility, were included in the analysis. Late releases of wild Clearwater tagged fish or late season surrogate wild tagged fish from Big Canyon Creek were not included, since these fish exhibit a much later and, therefore, different, migration than the Snake River fish. Consequently, survival and travel time analyses for these later fish will have to be conducted separately, as these fish still continue to pass Lower Granite Dam and other sites.

To estimate travel time and survival, fish detected and returned to the river at Lower Granite Dam were used in the analysis. Survival and travel time for the subyearling Chinook migrants were estimated and analyzed for two distinct time periods in 2005. Separating the migrants into two groups was done to assess survival prior to and after implementation of the court ordered summer spill program. Spill began June 20 at the Lower Snake River projects and July 1 at McNary Dam. For the pre-spill group (group 1) the date range May 20 to June 12 was chosen. Looking at PIT-tag timing at Lower Granite Dam it appeared that May 20 encompassed the beginning of the run, while June 12 was chosen to assure that many of the migrants would pass through at least part of the hydrosystem prior to spill beginning.

For the post-spill group (group 2) June 17 was chosen as the start date for grouping at Lower Granite Dam, since the PIT-tagged fish would not experience spill until reaching Little Goose Dam. Based on PIT-tag travel time, nearly all fish passing Lower Granite Dam on June 17 would not reach Little Goose Dam until June 20. Minimum travel time was nearly 3 days for the tag groups, while median travel time was 6 days. July 15 was chosen as the end date for the release groups to assure that nearly all fish in the group would pass through the hydrosystem and complete detection and travel time data would be available. It is possible that some of these fish may still be migrant or holding over in reservoirs, but it is likely that the few additional detections on these fish would not greatly change the survival and travel time estimates.

Similar groupings were created for other recent years in order to conduct a comparison among years. For the years 2001 to 2004, the tagged fish were divided into two groups; those detected from May 20 to June 16 were assigned to group 1 and those detected between June 17 to July 15 were assigned to group 2. (Since there were no abrupt operational changes in operations in the season as had occurred in 2005, the groups were not separated by 5 days as had been done for the 2005 migrants).

Average flow, spill and river temperature variables were created based on travel time and a moving 30-day-average to represent downstream passage for each group. For each variable, the daily average measurements were then averaged at each downstream dam based on a moving window, offset by the median travel time for the PIT-tagged group. For example, median travel time from Lower Granite to Little Goose Dam for the early 2005 detection group (5/20 to 6/12) was estimated to be 6 days. The average flow at Little Goose Dam was for this detection group was calculated beginning May 26 through June 24. In a similar manner, average flow, spill, and river temperature for each detection group were calculated at each project downstream to McNary Dam. The data were then averaged over the four projects to produce the overall average values for the total discharge, spill volume, spill percentage, and river temperature variables. Subsequent analyses may be conducted as time permits using water transit time to address the difference in scale of discharge between the two rivers. However, the percentage spill variable is not affected by the discharge difference and spill was the variable of primary interest in this analysis.

Results

Survival

Reach survival estimates are shown in Figure 1 for PIT-tagged subyearling Chinook detected and released at Lower Granite Dam during early summer migration period (group 1) compared to later season (group 2) for the years 2001 through 2005. There are two important trends evident in the survival data. First, the highest point estimate for survival for all years presented is for the late season 2005 (group 2) that migrated during summer spill operations. Second, in the years 2001 through 2004 the differences in survival between groups 1 and 2 was either relatively flat or slightly increasing (2001), or lower for the later group (2002, 2003 and 2004). The differences in the trends among years may be attributable to the amount of spill that occurred in the years during the migration. For example, in 2001, as was the case in 2005, the early group passed during periods of little or no spill at Little Goose and Lower Monumental dams. In 2002, the early group passed Little Goose Dam during a period of spill, whereas it

passed Lower Monumental Dam during a period of virtually no spill. However, in 2003 and 2004, the early summer groups passed through the Snake River during periods of late spring spill. In 2001 survival was low for both early and late season groups, while in 2002, 2003 and 2004 there was a decrease in survival between the group 1 and group 2 migrants. The 2005 estimates show a different trend, with the late group showing a substantially higher survival than the early group. In 2005 there was very little spill during May and early June at Little Goose and Lower Monumental dams as well as relatively low average flows. When the court ordered summer spill began in 2005, spill increased to 70% of daily average flow at Little Goose (subsequently spill was reduced to 40% to address concerns regarding adult passage), while spill at Lower Monumental Dam fluctuated between 40% and 60% of daily average flow. At McNary Dam spill increased from roughly 10% of daily average flow in late June, to roughly 70% July 1. The addition of spill at Little Goose, Lower Monumental and McNary dams appears to have greatly improved survival of the group 2 subyearling Chinook migrants in 2005.

A scatter plot of survival and spill percentage, with second order polynomial trend line (Figure 2), shows that percent spill and survival were highly correlated ($R^2 = 0.71$). A similar plot comparing survival to average total discharge (Figure 3) showed a strong relationship between flow and survival ($R^2 = 0.59$). The late season data point for 2005 appears farthest from the trend line, showing survival much higher than what might be predicted given the low flows alone, another indication of the beneficial effects of summer spill on survival.

Travel Time

A plot of survival and travel time shows that the highest survivals occurred during the periods with the shortest travel times (Figure 4). The only other year with a travel time estimate as fast as was observed for the 2005 migration was group 1 in 2003. The average flow during the time period when the 2003 group 1 migrated was nearly 120 Kcfs, while the average flow in 2005 during the time when group 2 migrated was only 43 Kcfs. This again indicates the importance of spill in determining the decreased amount of time fish take to migrate through the system when not having to experience the delay associated with passing through a hydroproject.

Temperature

A preliminary analysis was conducted relative to temperature for the different groups among years. Temperature was not predicted to have major influence on the survival of the groups in this analysis because of the time period of passage at Lower Granite Dam (prior to July 15). However, a bivariate regression was developed to determine if the survival estimates were influenced by temperature in the same way as they were influenced by the flow and spill variables. Figure 5 shows the relation between the temperature variable and the survival estimates. As can be seen from the graph, little of the variation in survival for the groups of fish used in this analysis can be explained by the temperature variable.

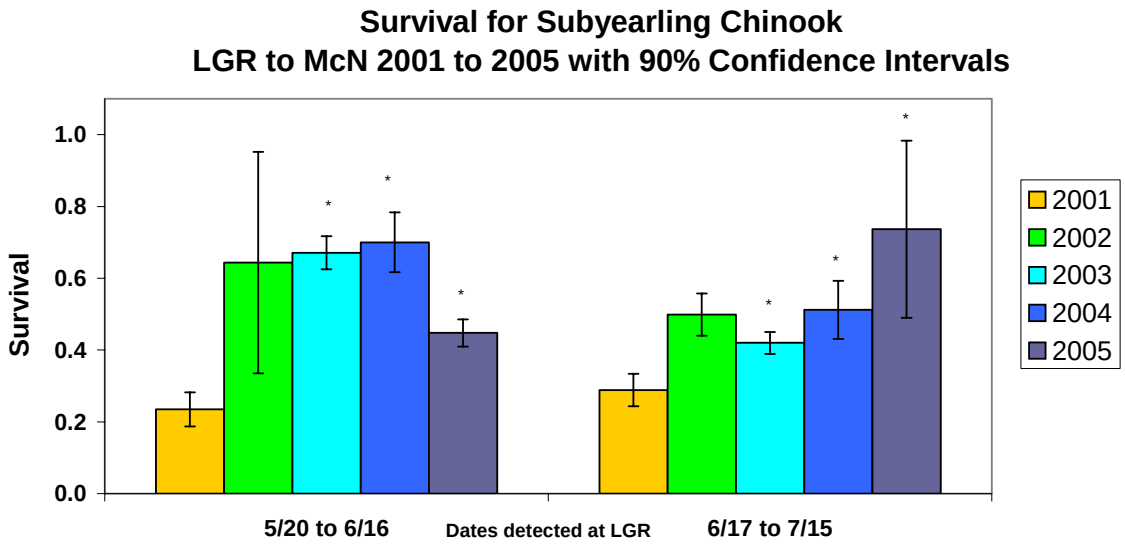

Figure 1. Survival of subyearling Chinook from Lower Granite Dam to McNary Dam by detection period for the years 2001 through 2005. Note that 2005 group 1 end date is actually June 12. The (*) denotes non-overlapping confidence intervals between groups 1 and 2 in those years.

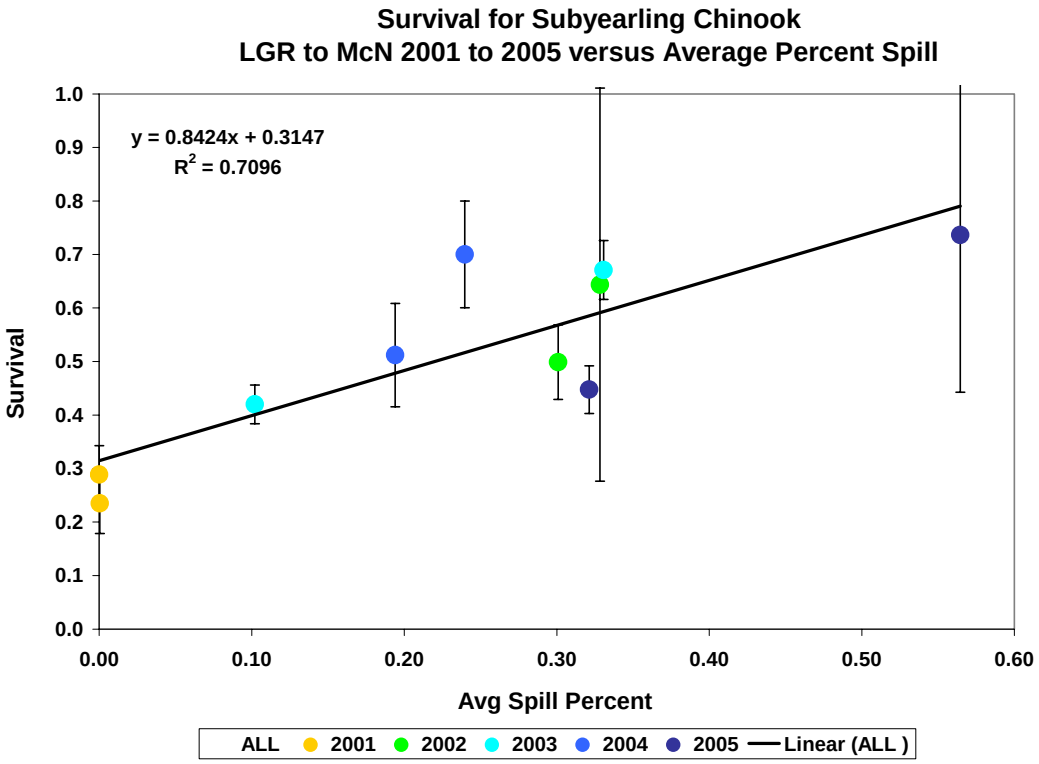

Figure 2. Relationship between Survival and Average Spill Percentage at Little Goose, Lower Monumental, Ice Harbor and McNary dams.

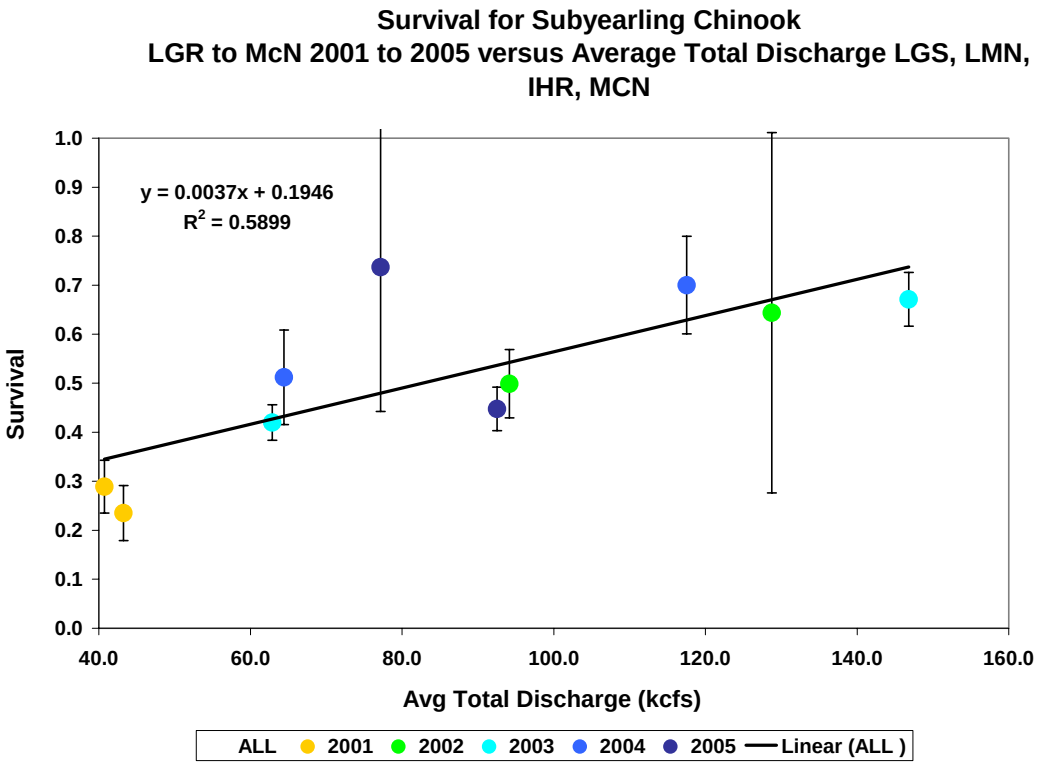

Figure 3. Survival versus Average Discharge at Little Goose, Lower Monumental, Ice Harbor and McNary dams for the years 2001 to 2005.

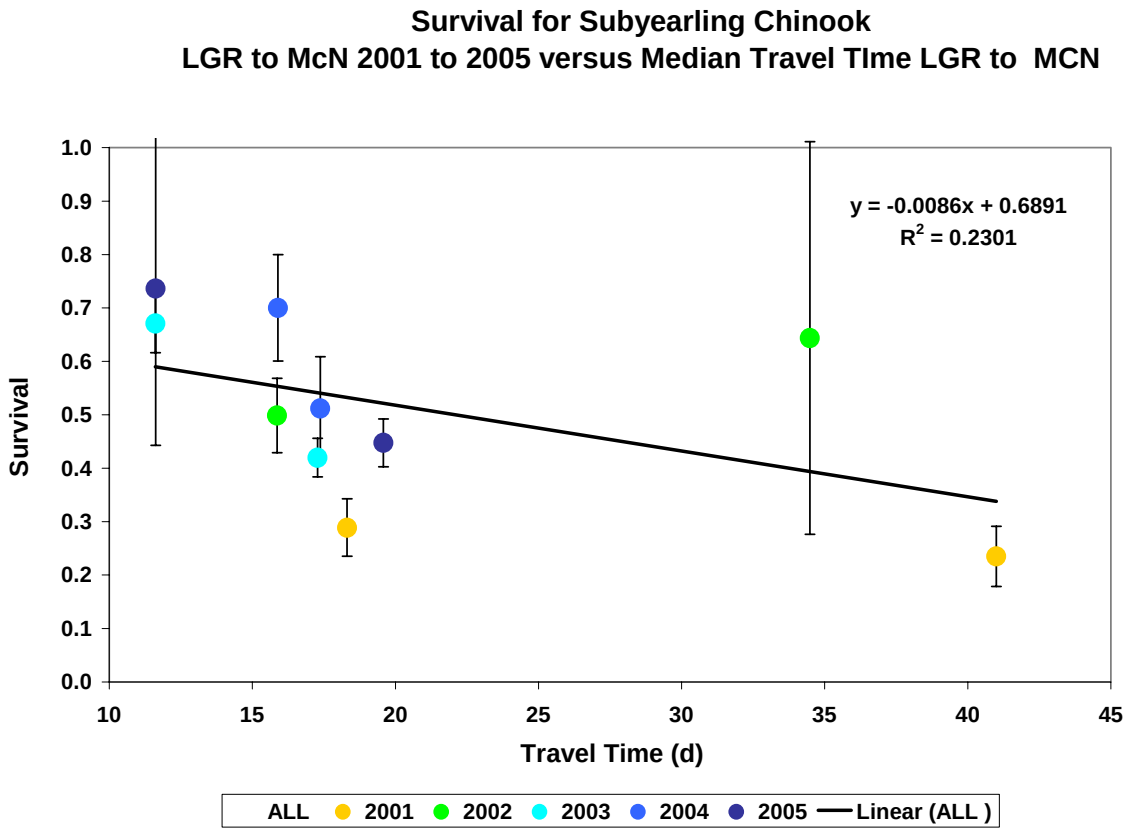

Figure 4. Survival versus Median Travel Time.

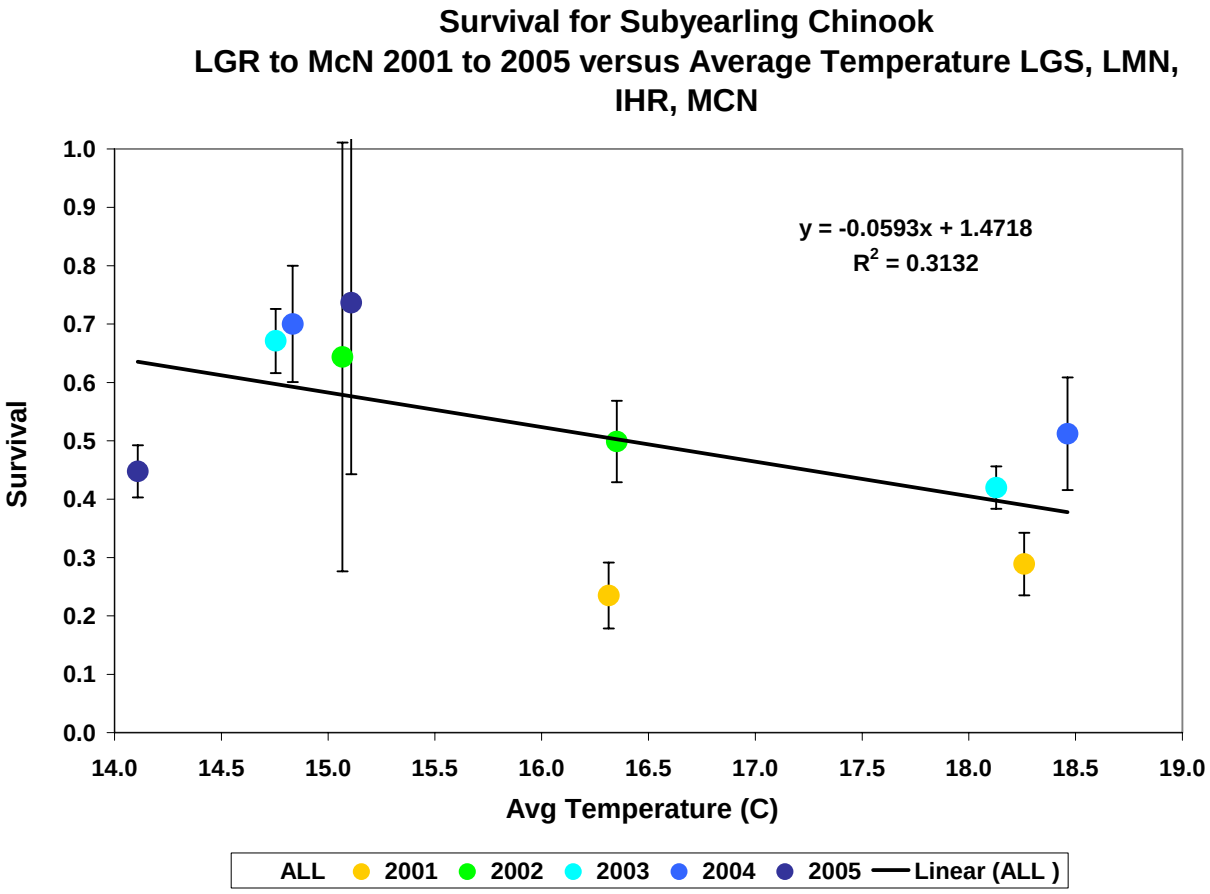

Figure 5. Average Temperature at Lower Granite Dam versus survival.

Appendix A

Table 1. Summary of Survival, Flow, Spill and Temperature data used in analysis for years 2001 to 2005.

Migr year	LGR Dates	Group	Site	Median Travel Time LGR[a] to	Begin Date for flow Parameter	30d Avg Total Q	30d Avg Total Spill	30d Avg Spill Percent	30d Avg Temp at LGR	LGR to MCN Survival Estimate (95% CI)
2005	5/20 to 6/12	1	lgs	6.1	05/26/05	64.7	5.9	0.12	14.37	0.448 (0.403-0.492)
2005	5/20 to 6/12	1	lmn	10.6	05/30/05	60.0	6.7	0.14	15.29	
2005	5/20 to 6/12	1	ihr	15.1	06/04/05	54.0	33.7	0.63	15.79	
2005	5/20 to 6/12	1	mcn	19.6	06/08/05	191.4	74.9	0.39	16.93	
2005	6/17 to 7/15	2	lgs	5.1	06/22/05	42.6	20.9	0.48	11.40	0.737 (0.443-1.031)
2005	6/17 to 7/15	2	lmn	7.3	06/24/05	40.2	21.0	0.53	16.62	
2005	6/17 to 7/15	2	ihr	9.5	06/26/05	39.0	23.4	0.60	16.99	
2005	6/17 to 7/15	2	mcn	11.6	06/28/05	186.9	120.5	0.64	19.25	
2004	5/20 to 6/16	1	lgs	3.6	05/23/04	89.8	1.6	0.01	13.43	0.700 (0.6-0.8)
2004	5/20 to 6/16	1	lmn	7.7	05/27/04	89.6	3.5	0.03	14.53	
2004	5/20 to 6/16	1	ihr	11.8	05/31/04	80.1	52.2	0.68	14.95	
2004	5/20 to 6/16	1	mcn	15.9	06/04/04	210.6	53.0	0.23	16.42	
2004	6/17 to 7/15	2	lgs	4.7	06/21/04	40.7	0.0	0.00	17.14	0.512 (0.416-0.609)
2004	6/17 to 7/15	2	lmn	8.9	06/25/04	39.5	0.0	0.00	17.69	
2004	6/17 to 7/15	2	ihr	13.2	06/30/04	38.4	29.9	0.78	18.52	
2004	6/17 to 7/15	2	mcn	17.4	07/04/04	139.2	0.0	0.00	20.50	
2003	5/20 to 6/16	1	lgs	3.8	05/23/03	117.4	30.0	0.24	13.67	0.671 (0.616-0.726)
2003	5/20 to 6/16	1	lmn	6.4	05/26/03	113.4	28.7	0.24	14.73	
2003	5/20 to 6/16	1	ihr	9.0	05/29/03	106.0	58.6	0.55	14.97	
2003	5/20 to 6/16	1	mcn	11.6	05/31/03	250.4	79.1	0.29	15.65	
2003	6/17 to 7/15	2	lgs	4.9	06/21/03	39.2	0.0	0.00	16.70	0.420 (0.384-0.456)
2003	6/17 to 7/15	2	lmn	9.1	06/26/03	36.6	0.0	0.00	17.36	
2003	6/17 to 7/15	2	ihr	13.2	06/30/03	33.3	13.5	0.41	18.11	
2003	6/17 to 7/15	2	mcn	17.3	07/04/03	142.3	0.0	0.00	20.34	
2002	5/20 to 6/16	1	lgs	9.2	05/29/02	94.7	21.3	0.21	13.28	0.644 (0.276-1.011)
2002	5/20 to 6/16	1	lmn	17.7	06/06/02	81.4	0.0	0.00	14.09	
2002	5/20 to 6/16	1	ihr	26.1	06/15/02	70.1	51.7	0.75	15.34	
2002	5/20 to 6/16	1	mcn	34.5	06/23/02	268.7	98.5	0.35	17.56	
2002	6/17 to 7/15	2	lgs	5.2	06/22/02	53.9	8.4	0.16	15.10	0.499 (0.429-0.569)
2002	6/17 to 7/15	2	lmn	8.8	06/25/02	49.8	0.0	0.00	15.40	
2002	6/17 to 7/15	2	ihr	12.3	06/29/02	45.2	36.0	0.80	16.24	
2002	6/17 to 7/15	2	mcn	15.9	07/02/02	227.8	62.4	0.25	18.67	
2001	5/20 to 6/16	1	lgs	24.4	06/13/01	29.3	0.0	0.00	15.54	0.235 (0.179-0.291)
2001	5/20 to 6/16	1	lmn	29.9	06/18/01	28.2	0.0	0.00	15.88	
2001	5/20 to 6/16	1	ihr	35.5	06/24/01	26.6	0.0	0.00	16.72	
2001	5/20 to 6/16	1	mcn	41.0	06/29/01	89.0	0.0	0.00	17.11	
2001	6/17 to 7/15	2	lgs	7.3	06/24/01	26.5	0.0	0.00	16.45	0.289 (0.235-0.343)
2001	6/17 to 7/15	2	lmn	10.9	06/27/01	27.9	0.0	0.00	16.41	
2001	6/17 to 7/15	2	ihr	14.6	07/01/01	27.2	0.0	0.00	20.00	
2001	6/17 to 7/15	2	mcn	18.3	07/05/01	81.4	0.0	0.00	20.17	

[a] Travel times to Little Goose and McNary Dam were calculated, while those for LMN and IHR were interpolated between those values.