FISH PASSAGE CENTER

1827 NE 44th Ave., Suite 240, Portland, OR 97213
Phone: (503) 230-4099 Fax: (503) 230-7559
http://www.fpc.org/
e-mail us at fpcstaff@fpc.org

MEMORANDUM

TO: Russ Kiefer, IDFG

FROM: FPC Staff

DATE: April 21, 2008

RE: Size differences in transported fish due to size selectivity of smaller fish by juvenile bypass/collection system

At the March 18, 2008 FPAC meeting NOAA Fisheries Staff discussed the transportation data. At the meeting NOAA Fisheries stated that they believe that the collection/bypass system have a fish size bias, collecting smaller fish than those that pass in-river. NOAA believes that since smaller fish survive at a lower rate than larger fish, the TIR ratios may be biased low. Furthermore, NOAA stated that while they agree with the FPC that the overall size differences are very small (about 2-3mm), they believe these differences can affect the survival to adulthood. In response to your request we examined the evidence and analysis regarding the NOAA hypothesis We also reviewed earlier analysis which addressed the potential for size bias. Our review and analysis is described in detail in the following discussion. Our conclusion from our review and analysis is:

- The available data, evidence and our analysis does not support the conclusion suggesting that there is a difference in the size of bypassed or transported (i.e. detected at LGR) juvenile wild Chinook.
- The available data does not suggest that small size differences among transported juvenile fish affects their adult return rate.

The FPC has previously developed analyses (CSS 2006 annual report, chapter 9) evaluating the potential for a sample bias due to juvenile fish size and selectivity of bypass system. These

preliminary analyses presented here, in response to your data request, consider additional juvenile information as well as an evaluation of adult survival as a function of juvenile size.

- The lack of a clear relation was evident in the comparisons between sizes at marking for fish that were detected at LGR (LGR detects) which can be used to represent the run at large that were transported as juveniles vs. fish that were not detected at LGR (non-detects) that can be used to represent those juveniles that migrated in-river. Comparisons between LGR non-detects vs. transported from the group of fish that returned as adults also showed no evidence of size difference, although the sample size for the adults that were known to be transported from Lower Granite Dam as juveniles was low. We also compared bypassed fish and LGR non-detects from fish that returned as adults because of the low sample size of returned adults from transported fish. Our expectation was that if the bypass system was size biased, this would also be evident in the size distribution of the bypassed fish. Again, we did not find clear evidence to support the hypothesis that there is negative size selectivity in the bypass/collection system.

Recent analyses suggest the existence of a negative relationship between smolt size and detection probabilities for certain groups of PIT tagged fish at Little Goose (LGS) and Lower Monumental (LMN) dams (Williams et al. 2005; Zabel et al. 2005). This implies that the bypass systems on Federal Columbia River Power System (FCRPS) are negatively size selective for salmon smolts. It should be noted that these publications focused on fish that were measured, marked and released after their entry into the bypass system at LGR; this precludes any analysis of passage at LGR.

The majority of transported fish are transported from LGR (CSS 2006 annual report, Appendix E, Table 1). Therefore, in order to evaluate the transportation program, it makes sense to evaluate the potential size differences at this location. Analyses in this memo and CSS reports utilize data for fish that are marked above LGR and enter the LGR bypass system similar to the run at large.

A size difference at LGR and other dams was also addressed in the CSS 2006 annual report. Chapter 9 of this report used both a mark-recapture model building exercise and a direct comparison of lengths. The data set included PIT tagged fish from the Snake River and Clearwater River traps. To limit the confounding effects of changing hydrosystem operations on detection probabilities, the data set was restricted from 11 April - 10 May within each of the years 1998-2006.

The model selection exercise resulted in “no clear indication of a strong relationship between individual size and detection probability at LGR, or any site downstream” for wild Chinook in each year where testing was possible (1999, 2000, 2002, and 2005-2006; CSS 2006 annual report, chapter 9). In that same chapter, when using t-tests to compare fish detected at LGR versus fish not detected at LGR for each of the years 1998-2006, there was a significant difference in size at marking only for 1998 and 1999; the magnitude of these differences were equal to or less than 2 mm.

The additional analyses in this memo compare wild Chinook length at marking for fish with a LGR detection versus those without a LGR detection in the years 1998-2006. The data set included fish marked at sites relatively close to LGR (Snake River trap, Salmon River trap, Grande Ronde River, Clearwater River trap and Imnaha River trap). Because this was not a mark-recapture exercise, we did not include a temporal restriction in the data. These two modifications from chapter 9 of the 2006 CSS annual report increased the size of the sample and facilitated the analysis of returning adults.

In this analysis only fish that were detected at some site after LGR (e.g. LGS, trawl, or as an adult) were included in order to assess whether they were previously detected at Lower Granite Dam The size at marking was determined and compared for all fish detected at LGR versus all fish not detected at LGR. The second part of the analysis reduced the dataset to only those juveniles that returned as adults. Here we compared fish that were transported versus non-detected fish.

The data for the years 1998-2004 are shown in Figures 1-7. In each figure, Panel A and B display a histogram of 1mm length bins for the LGR not detected and for LGR detected fish, respectively. In most cases, the number of fish passing LGR with a detection is higher than the number of fish passing without a detection (except 2001 which was a year with low flows and little spill). In each case, the distribution of lengths for the LGR detected group matches well with the distribution for the fish not detected at LGR.. When comparing the median of length for juvenile detected fish vs. the non-detected fish, the median length for detected fish is higher than the non-detected fish in 5 cases (1998, 1999, 2000, 2002, and 2003) and the same in two cases (2001 and 2004). These results do not support the hypothesis that there is a negatively size biased selection at LGR for wild Chinook. Additionally, the magnitude of the size differences was very small (1-2 mm where LGR detected fish were larger than non detected fish). The effect of this small shift in size on overall survival to adults is unknown.

This exercise also examined if there was a difference in smolt size during LGR passage for the adults that returned. In panel C of Figures 1-7 only fish that returned as adults to LGR are included. The size at marking as smolts for these fish are compared in the categories not detected at LGR (but not transported below LGR; grey bars) and transported at LGR (dark bars). First, it should be noted that few fish marked at under 70mm have returned. However, few fish are marked at under 70mm (see panels A & B in each figure) and given the small percentages of returning fish, this may be an effect of small sample sizes for smaller fish. When comparing the distributions of size at marking for the twp groups of returned adults, there is no clear pattern across years. There is not a pattern of a size selective bypass at LGR in the adult data; however, the sample size for transported fish is small.

Because of the low sample size for transported fish that returned as adults (for CSS marked wild Chinook) we also considered bypassed fish that returned as adults. Our expectation was that a size bias in the bypass system may be evident in the non-transported but bypassed fish that returned as adults (with no transportation below LGR). The comparisons between this group of fish and the LGR non-detects did not show evidence of a negative size bias in the bypass system (Figure 8). The median length for the LGR bypass group was lower than the no LGR detect

group in three years and higher in three years (2001 is not shown because of the low numbers of returned adults).

The comparisons shown here and the CSS 2006 annual report did not result in evidence of a negative size bias in the bypass system at LGR. Although, most of the transportation takes place at LGR, future work may extend these analyses and compare different groups of fish (i.e. LGR marked fish in regards to a bias in the LGR bypass system) or include other approaches.

References

Berggren, T., Franzoni, H., Basham, L., Wilson, P., Schaller, H., Petrosky, C., et al. 2006. Comparative Survival Study (CSS) of PIT tagged spring/summer Chinook and summer steelhead. . Fish Passage Center.

Williams, J. G., Smith, S. G., Zabel, R. W., Muir, W. D., Scheuerell, M. D., Sandford, B. P., et al. 2005. Effects of the federal Columbia River power system on salmonid populations. U.S. Department of Commerce, NOAA Tech memo. NMFS-NWFSC-63, 150 p.

Zabel, R. W., Wagner, T., Congleton, J. L., Smith, S. G., & Williams, J. G. 2005. Survival and selection of migrating salmon from capture-recapture models with individual traits. Ecological Applications, 15(4), 1427-1439.

Figure 1. 1998 Wild spring Chinook size at marking (x-axis) for detections at LGR (A), no detections at LGR(B), and LGR detections/no detections for only returned adults (C).

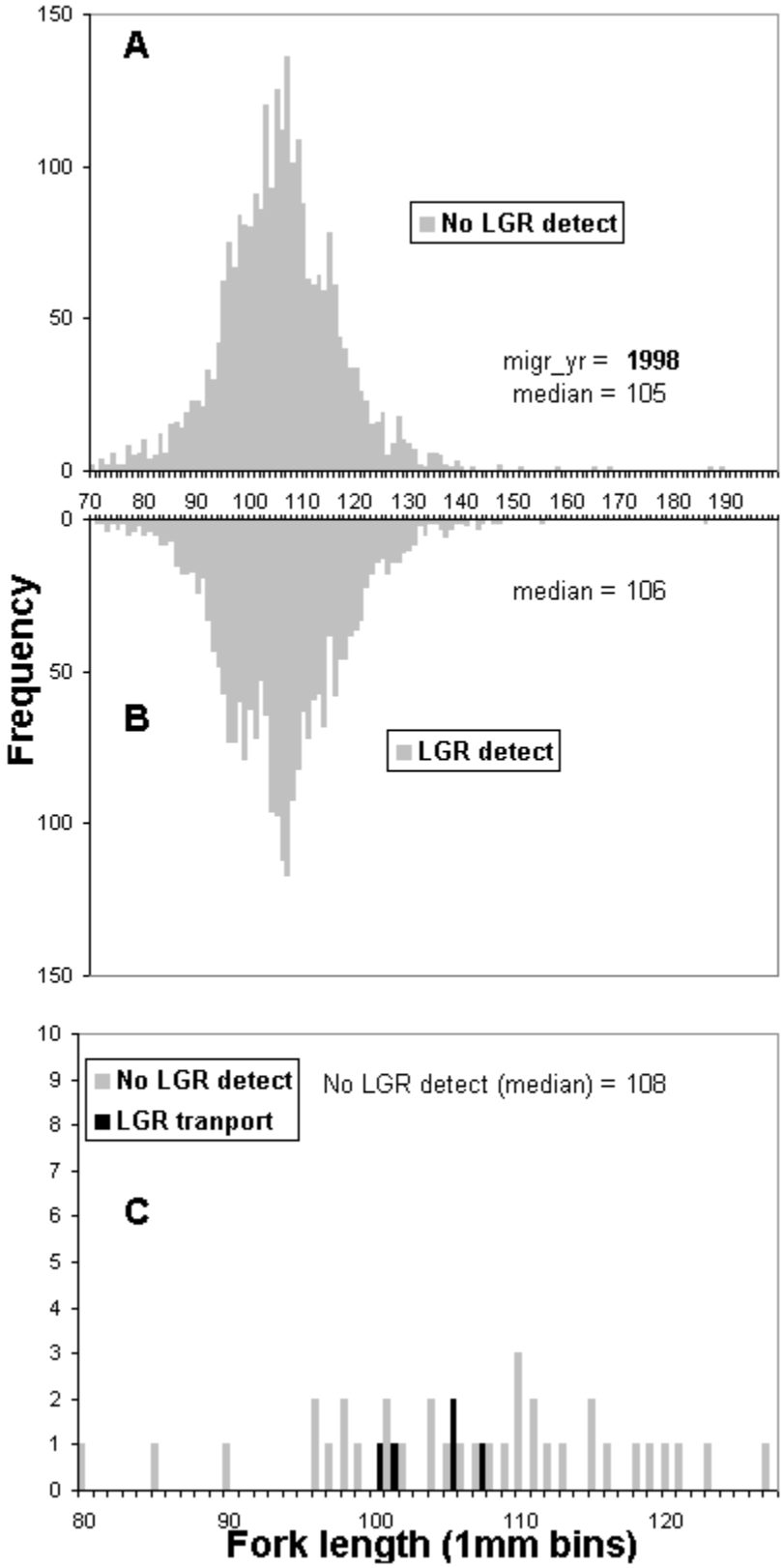

Figure 2. 1999 Wild spring Chinook size at marking (x-axis) for detections at LGR (A), no detections at LGR(B), and LGR detections/no detections for only returned adults (C).

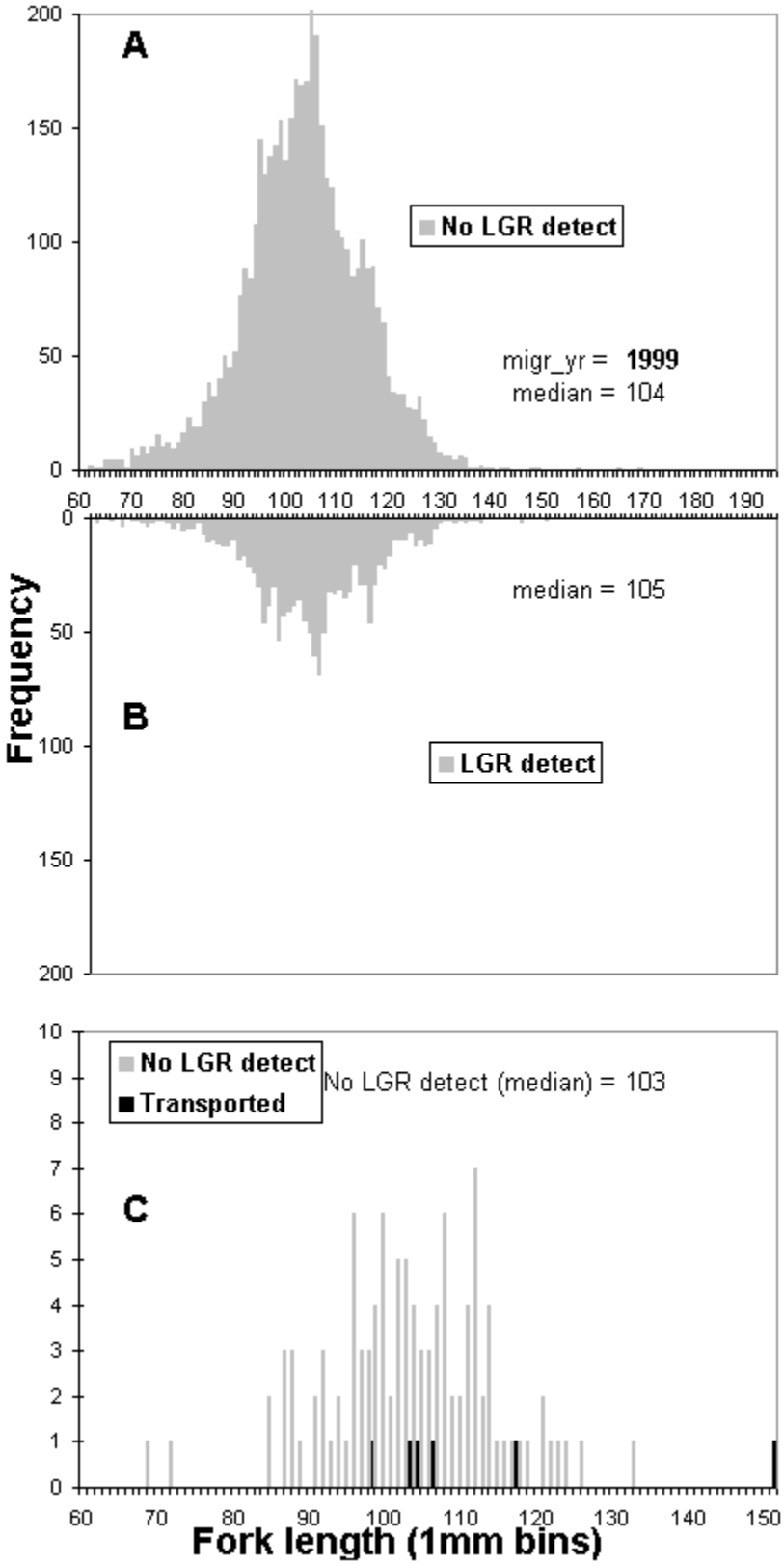

Figure 3. 2000 Wild spring Chinook size at marking (x-axis) for detections at LGR (A), no detections at LGR(B), and LGR detections/no detections for only returned adults (C).

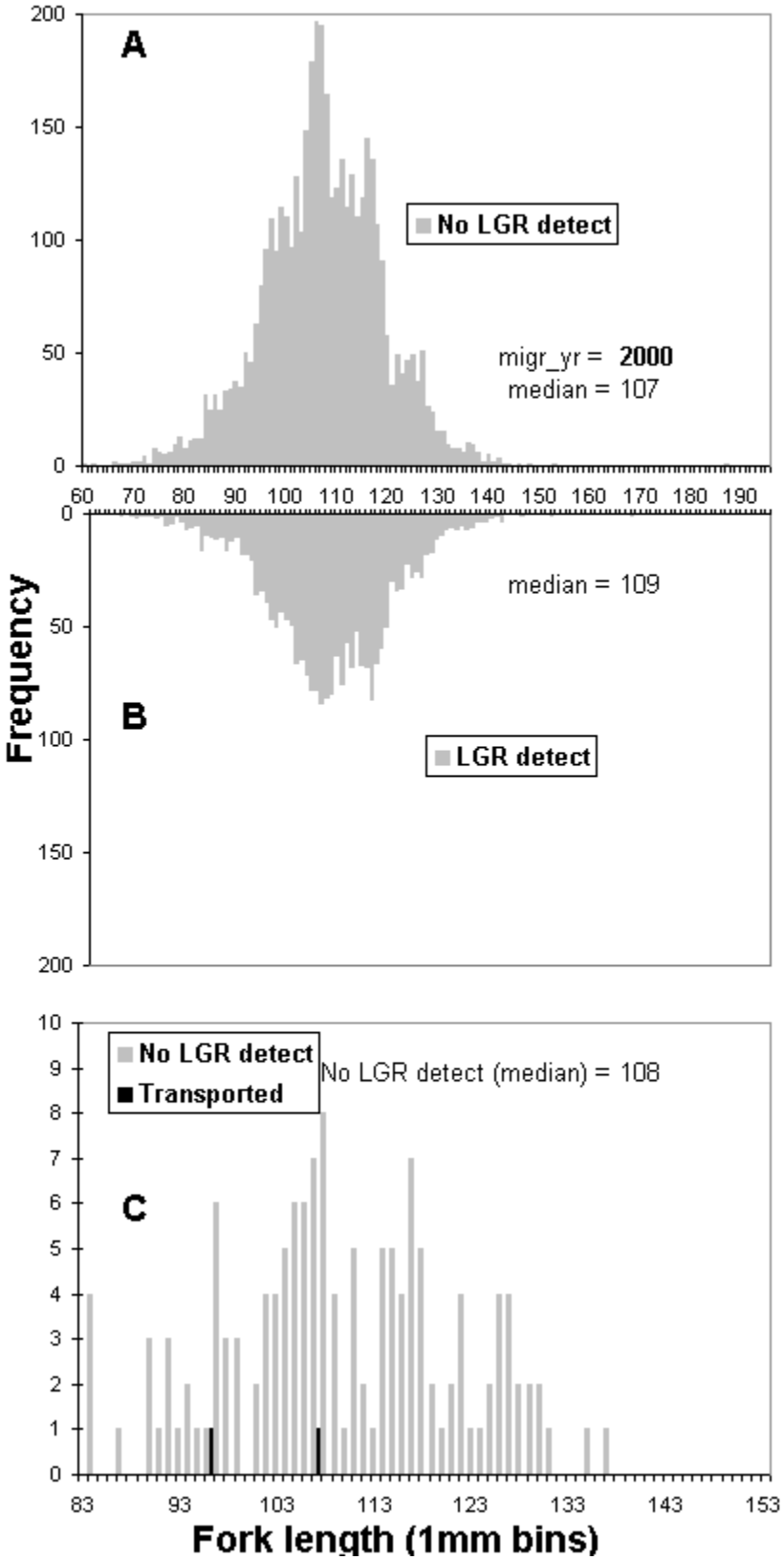

Figure 4. 2001 Wild spring Chinook size at marking (x-axis) for detections at LGR (A), no detections at LGR(B), and LGR detections/no detections for only returned adults

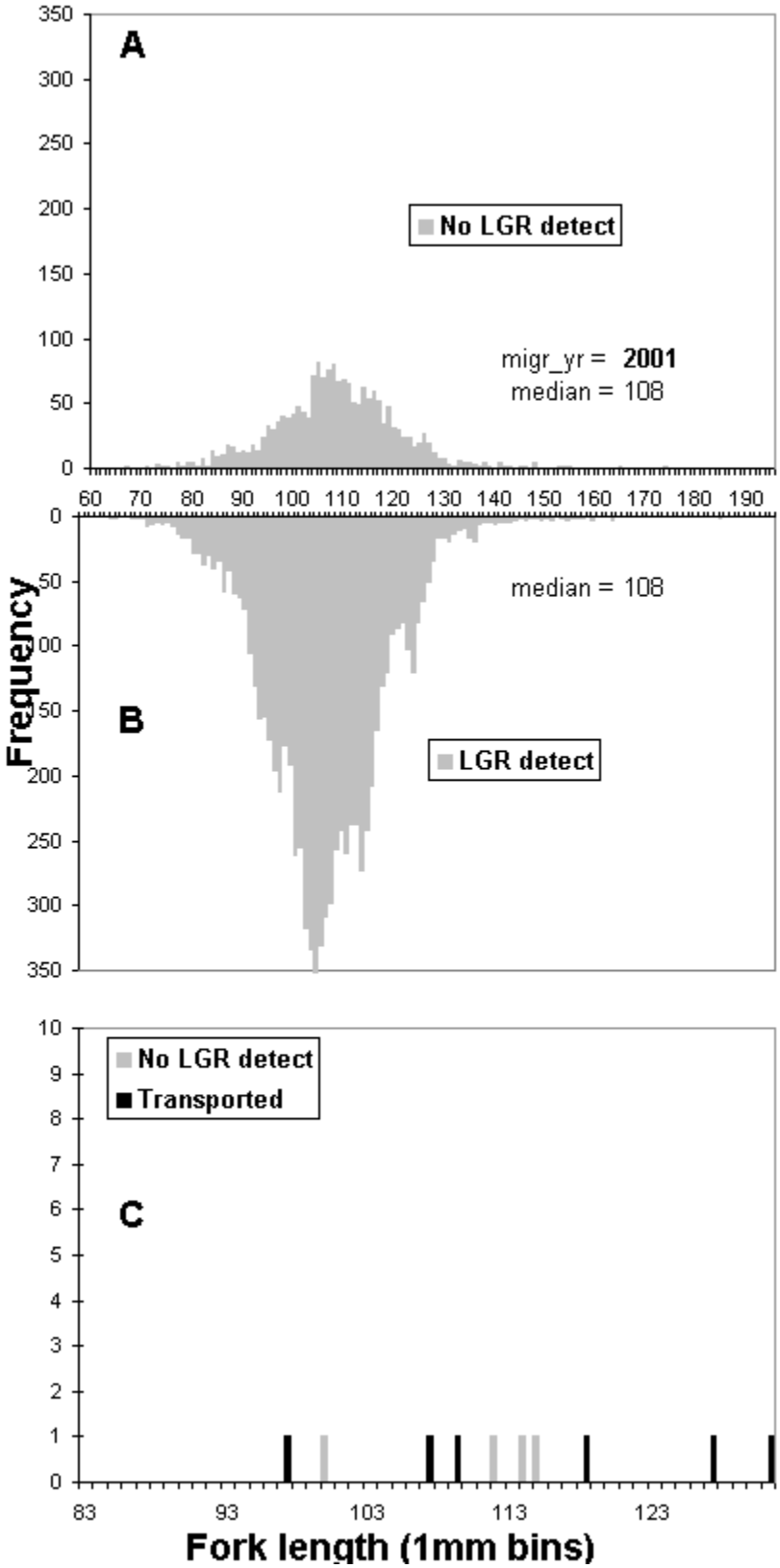

Figure 5. 2002 Wild spring Chinook size at marking (x-axis) for detections at LGR (A), no detections at LGR(B), and LGR detections/no detections for only returned adults (C).

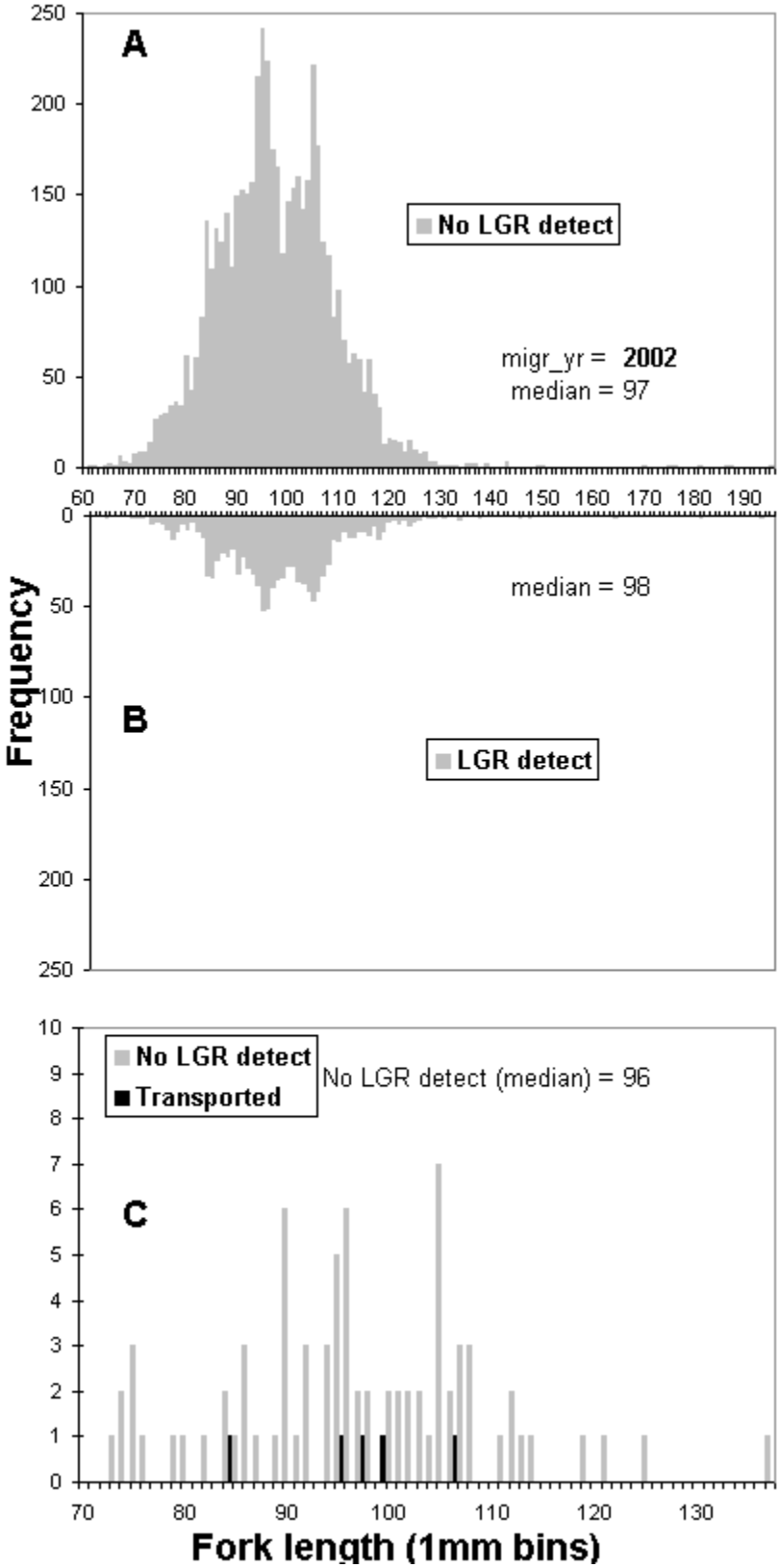

Figure 6. 2003 Wild spring Chinook size at marking (x-axis) for detections at LGR (A), no detections at LGR(B), and LGR detections/no detections for only returned adults (C).

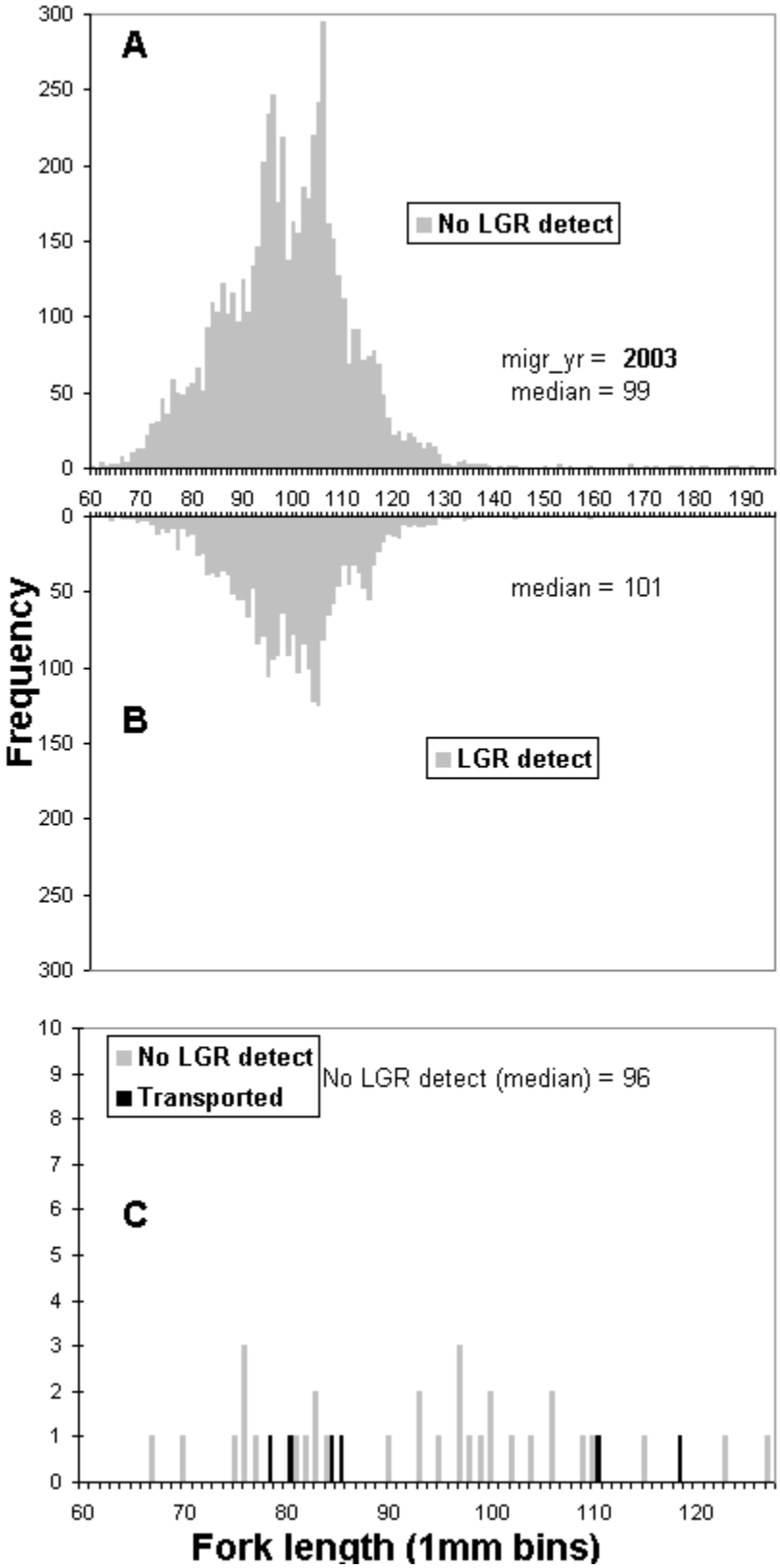

Figure 7. 2004 Wild spring Chinook size at marking (x-axis) for detections at LGR (A), no detections at LGR(B), and LGR detections/no detections for only returned adults (C).

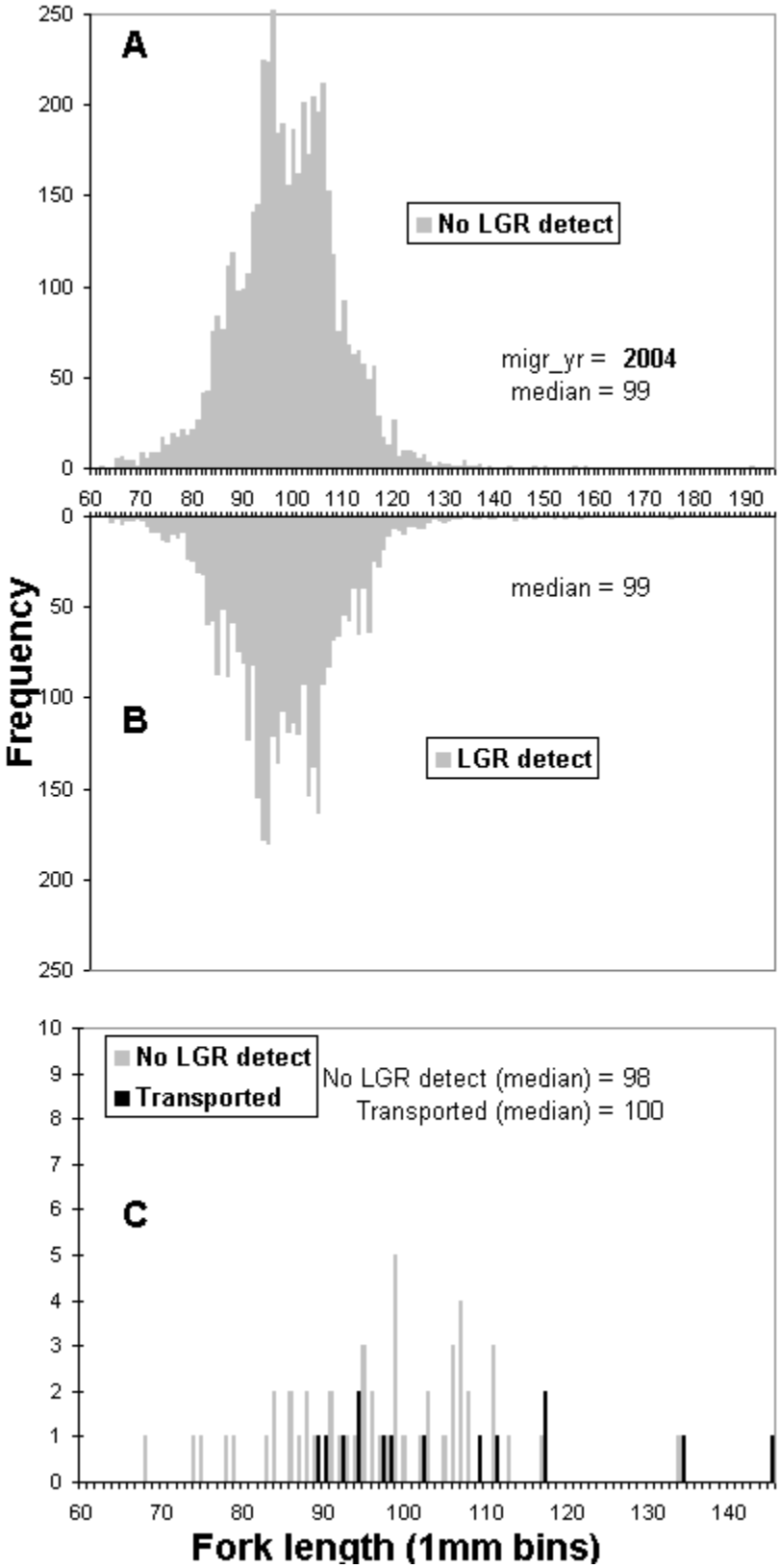
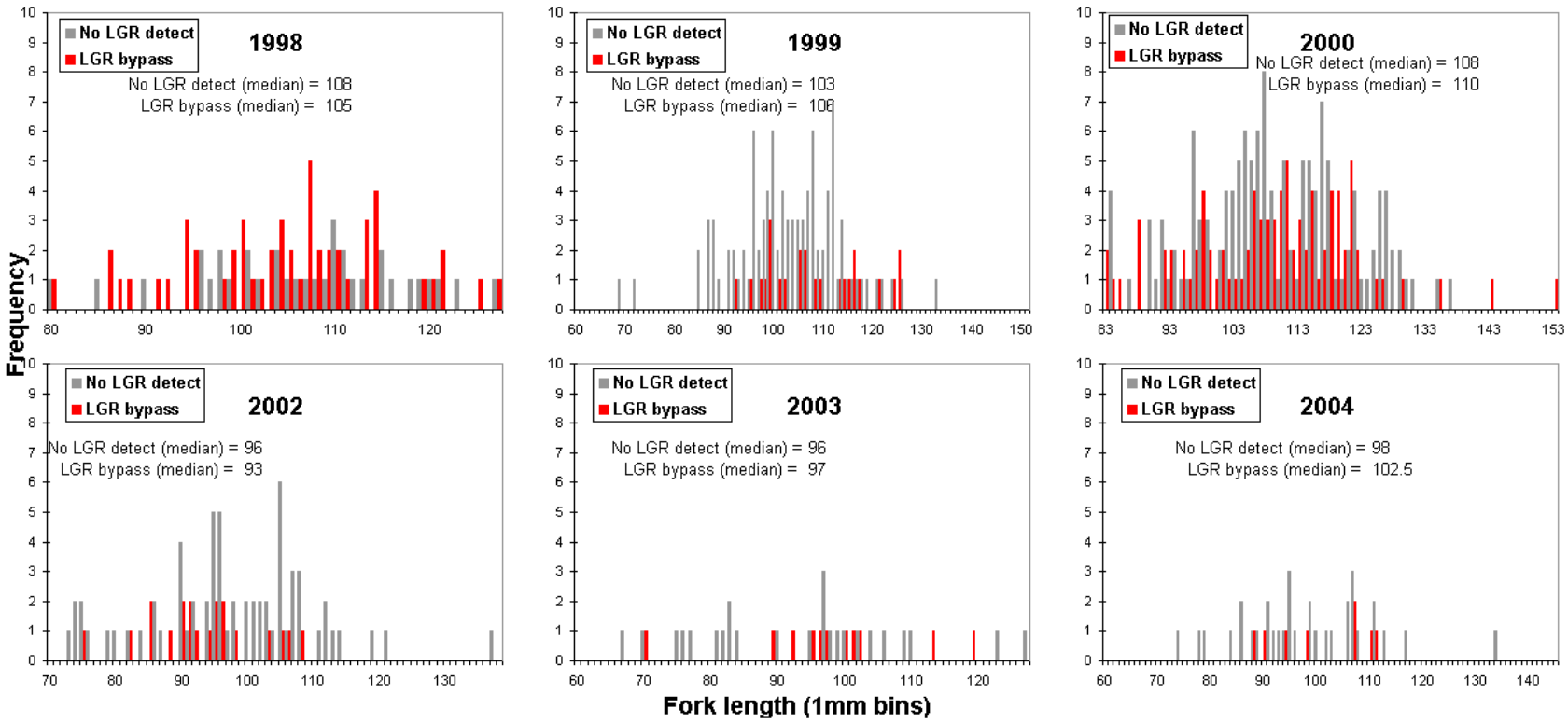
Figure 8. Wild spring Chinook size at marking (x-axis) for detections at LGR (grey bars), and LGR bypassed fish (red bars). Data is shown for years 1998-2004; 2001 is not shown because of the small number of in-river fish.