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MEMORANDUM FOR: F/NWR5 - Bruce Suzumoto

FROM: F/NWC3 - Richard W. Zabel *Richard W. Zabel*

SUBJECT: Preliminary survival estimates for passage during the spring migration of juvenile salmonids through Snake and Columbia River reservoirs and dams, 2012

This memorandum summarizes conditions in the Snake and Columbia Rivers and preliminary estimates of survival of PIT-tagged juvenile salmonids passing through reservoirs and dams during the 2012 spring outmigration. We also provide preliminary estimates of the proportion of Snake River smolts that were transported from Snake River dams in 2012. Our complete detailed analyses and report for the spring migration will be available by the end of the year. As in past years, changes in the database between the time of our annual summer memo and the publication of our final report may result in differences of up to 3 or 4% in estimated survival values.

Summary of Research

For survival studies funded by BPA in 2012, NOAA Fisheries PIT tagged approximately 20,120 river-run hatchery steelhead, 20,120 wild steelhead, and 16,750 wild yearling Chinook salmon for release into the tailrace of Lower Granite Dam.

Survival estimates provided in this memorandum are derived from PIT-tag data from fish PIT tagged by or for NOAA Fisheries, as described above, along with fish PIT tagged by others within the Columbia River Basin.

For yearling Chinook salmon from Snake River Basin hatcheries, estimated survival to Lower Granite Dam tailrace has been



relatively stable since 1998 (Figure 1, Table 1). Mean estimated survival was a composite of production releases from hatcheries Dworshak, Kooskia, Lookingglass/Imnaha Weir, Rapid River, McCall/Knox Bridge, Pahsimeroi, and Sawtooth and has ranged between 54.9 and 69.7% since 1998. Mean estimated survival to Lower Granite Dam tailrace for the index hatchery release groups in 2012 was 63.2%.

Estimated survival for Snake River yearling Chinook salmon (hatchery and wild combined) in 2012 was above average (1993-2012) in most reaches (Tables 2 and 4, Figures 2 and 3). Mean estimated survival for yearling Chinook salmon from Lower Granite Dam tailrace to McNary Dam tailrace in 2012 was 79.5% (95% CI: 76.4, 82.6%). Mean estimated survival in 2012 from McNary Dam tailrace to Bonneville Dam tailrace was 80.7% (95% CI: 70.7, 90.7%). Mean estimated survival for yearling Chinook salmon from Lower Granite Dam tailrace to Bonneville Dam tailrace in 2012 was 64.2% (95% CI: 55.8, 72.5%). Estimated survival for the Lower Granite project (head of reservoir to tailrace) was 92.8%, based on fish PIT tagged at and released from the Snake River trap. The combined yearling Chinook salmon survival estimate from the trap to the Bonneville Dam tailrace in 2012 was 59.6% (95% CI: 51.7, 67.4%).

For Snake River steelhead (hatchery and wild combined), mean estimated survival in 2012 was above the average (1993-2012) in every reach (Tables 3 and 5, Figures 2 and 3). Mean estimated survival for steelhead from Lower Granite Dam tailrace to McNary Dam tailrace in 2012 was 69.8% (95% CI: 65.9, 73.7%). Mean estimated survival in 2012 from McNary Dam tailrace to Bonneville Dam tailrace was 85.6% (95% CI: 47.2, 100.0%). Mean estimated survival from Lower Granite Dam tailrace to Bonneville Dam tailrace was 59.7% (95% CI: 32.7, 86.8%). Estimated survival for the Lower Granite project (head of reservoir to tailrace) was 100.0%, based on fish PIT tagged at and released from the Snake River trap. The combined steelhead survival estimate from the trap to the Bonneville Dam tailrace in 2012 was 59.8% (95% CI: 32.6, 87.1%).

For PIT-tagged hatchery yearling Chinook salmon originating from the upper Columbia River in 2012, estimated survival from McNary Dam tailrace to Bonneville Dam tailrace was 84.1% (95% CI: 69.8, 100.0%; see Table 6).

For PIT-tagged hatchery steelhead originating from the upper Columbia River in 2012, estimated survival from McNary Dam



tailrace to Bonneville Dam tailrace was 100.0% (95% CI: 66.9, 100.0%; Table 6). For fish released from upper Columbia River hatcheries, we cannot estimate survival in reaches upstream from McNary Dam (other than the overall reach from release to McNary Dam tailrace) because of limited PIT-tag detection capabilities at Mid-Columbia River PUD dams.

Estimated survival in 2012 of Snake River sockeye salmon (hatchery and wild combined) from the tailrace of Lower Granite Dam to the tailrace of Bonneville Dam was 47.2% (95% CI: 36.5%, 70.0%; Table 7). Estimated survival in 2012 of Columbia River sockeye salmon (hatchery and wild combined) from the tailrace of Rock Island Dam to the tailrace of Bonneville Dam was 79.4% (95% CI: 32.9%, 100.0%; Table 7).

Our preliminary estimates of the proportion transported of non-tagged wild and hatchery spring-summer Chinook salmon smolts are 22.7% and 24.7%, respectively. For steelhead, the estimates are 28.4% and 26.7% for wild and hatchery smolts, respectively. These estimates represent the proportion of smolts that arrived at Lower Granite Dam that were subsequently transported, either from Lower Granite Dam or from one of the downstream collector dams.

Discussion

For Snake River yearling Chinook salmon in 2012, the estimated survival through the hydropower system (Snake River trap to Bonneville tailrace) of 59.6% was the second highest we've observed in the 1999-2012 time series (higher only in 2006), and greater than the 2011 estimate of 48.8% ($P = 0.07$; Table 4). Compared to long-term averages, estimated survival for yearling Chinook salmon in 2012 was 5.5% higher between Lower Granite Dam and McNary Dams, and 10.3% higher between McNary and Bonneville Dams.

For steelhead in 2012, estimated survival through the hydropower system was 59.8%, which is the third highest in the times series (behind 2008 and 2009), greater than the long-term average of 43.1%, and nearly identical to the 2011 estimate of 59.2% ($P = 0.96$; Table 5).



The pattern through time of flow volume in the Snake River in 2012 was unique among the last 8 migration seasons, in that the highest peak in flow occurred in late April rather than in May, and in fact the flow throughout May was no higher than in early April (Figure 4). The overall average of daily average flow volume was higher in 2012 than in the long-term series, but no other year's flow pattern had those characteristics. Snake River flow fluctuated around 100 kcfs for the first three weeks of April and, increased quickly to the season peak of 178 kcfs on April 27, decreased over the next week back to around 100 kcfs. Mean spill volume at the Snake River dams in 2012 was nearly equal the 2006-2011 average for the first three weeks of April and then jumped to a very high peak during the spike in flow volume (Figure 5). In terms of percentage of flow that was spilled, the first three weeks of April 2012 were below the average of recent years, jumped to near 50% during the spike in flow, and then returned to near-to-below average for the month of May (Figure 5). Water temperatures in the Snake River in 2012 were near average for most of the season (Figure 4). Water temperature increased relative to average during the spike in flow.

Relatively high rates of descaling of juvenile sockeye passing through Bonneville dam during the week of 8-14 May prompted a decision to decrease flow through Powerhouse 2 and route more flow through Powerhouse 1. On 16 May the turbines in Powerhouse 2 were reduced to half of the 1% efficiency, which resulted in lower flow entering the powerhouse. From 21-23 May the operations at Powerhouse 2 went back to normal, but then returned to operating at less than 1% efficiency from late 23 May until 13 June. The effect of these changes in operation on overall survival through Bonneville dam is not known, but it is known that PIT tag detection probabilities were drastically reduced during that period. The low detection probabilities made for very low precision in survival estimates during that period and made survival estimation to Bonneville impossible for some weekly groups.

Estimated percentages of yearling Chinook salmon and steelhead transported from Snake River dams in 2012 were the lowest seen in twenty years of our estimates 1993-2012. Collection for transportation began on 2 May at Lower Granite Dam, 4 May at Little Goose Dam, and 6 May at Lower Monumental Dam. However, a large spike in smolt passage was associated with the large spike in flow in late April (Figures 6 and 4), resulting in a large percentage of smolts (about 67% of yearling Chinook and 59% of



steelhead) passing Lower Granite Dam before transportation began. Throughout the migration season, high spill percentages, in combination with surface bypass collection at each of the collector dams on the Snake River, resulted in low proportions of fish entering juvenile bypass systems. During the period of general transportation in May, about 60% of smolts that arrived at Lower Granite Dam were transported from a collector dam. These relatively low collection rates and a late start in collection relative to run timing resulted in low proportions transported in 2012.

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Table 1. Mean estimated survival and standard error (s.e.) for yearling **Chinook** salmon released at Snake River Basin and Upper Columbia River hatcheries to Lower Granite Dam tailrace (LGR) and McNary Dam tailrace (MCN), 2010 through 2012.

Hatchery	2010		2011		2012 ^a	
	Survival to LGR (s.e.)	Survival to MCN (s.e.)	Survival to LGR (s.e.)	Survival to MCN (s.e.)	Survival to LGR (s.e.)	Survival to MCN (s.e.)
Dworshak	0.898 (0.017)	0.780 (0.014)	0.722 (0.006)	0.511 (0.010)	0.743 (0.008)	0.642 (0.013)
Kooskia	0.744 (0.030)	0.624 (0.022)	0.729 (0.014)	0.542 (0.029)	0.652 (0.013)	0.409 (0.018)
Lookingglass (Catherine Cr.)	0.447 (0.020)	0.369 (0.015)	0.300 (0.007)	0.228 (0.020)	0.345 (0.007)	0.286 (0.015)
Lookingglass (Grande Ronde)	0.422 (0.029)	0.356 (0.034)	0.434 (0.019)	0.386 (0.097)	0.453 (0.018)	0.350 (0.033)
Lookingglass (Imnaha River)	0.682 (0.025)	0.563 (0.017)	0.572 (0.009)	0.424 (0.025)	0.689 (0.009)	0.568 (0.017)
Lookingglass (Lostine River)	0.447 (0.020)	0.369 (0.015)	0.490 (0.022)	0.409 (0.097)	0.665 (0.017)	0.546 (0.035)
McCall (Johnson Cr.)	0.322 (0.018)	0.230 (0.022)	0.264 (0.015)	0.222 (0.053)	0.357 (0.016)	0.370 (0.049)
McCall (Knox Bridge)	0.566 (0.014)	0.462 (0.010)	0.631 (0.007)	0.469 (0.018)	0.571 (0.006)	0.561 (0.012)
Rapid River	0.786 (0.019)	0.666 (0.012)	0.766 (0.006)	0.533 (0.016)	0.718 (0.014)	0.634 (0.030)
Entiat	---	---	---	0.536 (0.041)	---	0.680 (0.042)
Winthrop	---	0.634 (0.069)	---	0.529 (0.051)	---	0.535 (0.036)
Leavenworth	---	0.653 (0.028)	---	0.432 (0.022)	---	0.589 (0.020)

a. Estimates are preliminary and subject to change.

Table 2. Annual weighted means of survival probability estimates for yearling **Chinook** salmon (hatchery and wild combined), 1993–2012. Standard errors in parentheses. Reaches with asterisks comprise two dams and reservoirs (i.e., two projects); the following column gives the square root (i.e., geometric mean) of the two–project estimate to facilitate comparison with other single–project estimates. Simple arithmetic means across all years are given. Abbreviations: Trap–Snake River Trap; LGR–Lower Granite Dam; LGO–Little Goose Dam; LMO–Lower Monumental Dam; IHR–Ice Harbor Dam; MCN–McNary Dam; JDA–John Day Dam; TDA–The Dalles Dam; BON–Bonneville Dam.

Year	Trap–LGR	LGR–LGO	LGO–LMO	LMO–MCN*	LMO–IHR IHR–MCN	MCN–JDA	JDA–BON*	JDA–TDA TDA–BON
1993	0.828 (0.013)	0.854 (0.012)						
1994	0.935 (0.023)	0.830 (0.009)	0.847 (0.010)					
1995	0.905 (0.010)	0.882 (0.004)	0.925 (0.008)	0.876 (0.038)	0.936			
1996	0.977 (0.025)	0.926 (0.006)	0.929 (0.011)	0.756 (0.033)	0.870			
1997	NA	0.942 (0.018)	0.894 (0.042)	0.798 (0.091)	0.893			
1998	0.925 (0.009)	0.991 (0.006)	0.853 (0.009)	0.915 (0.011)	0.957	0.822 (0.033)		
1999	0.940 (0.009)	0.949 (0.002)	0.925 (0.004)	0.904 (0.007)	0.951	0.853 (0.027)	0.814 (0.065)	0.902
2000	0.929 (0.014)	0.938 (0.006)	0.887 (0.009)	0.928 (0.016)	0.963	0.898 (0.054)	0.684 (0.128)	0.827
2001	0.954 (0.015)	0.945 (0.004)	0.830 (0.006)	0.708 (0.007)	0.841	0.758 (0.024)	0.645 (0.034)	0.803
2002	0.953 (0.022)	0.949 (0.006)	0.980 (0.008)	0.837 (0.013)	0.915	0.907 (0.014)	0.840 (0.079)	0.917
2003	0.993 (0.023)	0.946 (0.005)	0.916 (0.011)	0.904 (0.017)	0.951	0.893 (0.017)	0.818 (0.036)	0.904
2004	0.893 (0.009)	0.923 (0.004)	0.875 (0.012)	0.818 (0.018)	0.904	0.809 (0.028)	0.735 (0.092)	0.857
2005	0.919 (0.015)	0.919 (0.003)	0.886 (0.006)	0.903 (0.010)	0.950	0.772 (0.029)	1.028 (0.132)	1.014
2006	0.952 (0.011)	0.923 (0.003)	0.934 (0.004)	0.887 (0.008)	0.942	0.881 (0.020)	0.944 (0.030)	0.972
2007	0.943 (0.028)	0.938 (0.006)	0.957 (0.010)	0.876 (0.012)	0.936	0.920 (0.016)	0.824 (0.043)	0.908
2008	0.992 (0.018)	0.939 (0.006)	0.950 (0.011)	0.878 (0.016)	0.937	1.073 (0.058)	0.558 (0.082)	0.750
2009	0.958 (0.010)	0.940 (0.006)	0.982 (0.009)	0.855 (0.011)	0.925	0.866 (0.042)	0.821 (0.043)	0.906
2010	0.968 (0.040)	0.962 (0.011)	0.973 (0.019)	0.851 (0.017)	0.922	0.947 (0.021)	0.780 (0.039)	0.883
2011	0.943 (0.009)	0.919 (0.007)	0.966 (0.008)	0.845 (0.012)	0.919	0.893 (0.026)	0.766 (0.080)	0.875
2012 ^a	0.928 (0.012)	0.915 (0.011)	0.940 (0.010)	0.939 (0.013)	0.969	0.918 (0.020)	0.871 (0.056)	0.933
Mean	0.939 (0.009)	0.927 (0.009)	0.918 (0.011)	0.860 (0.015)	0.927	0.881 (0.021)	0.795 (0.034)	0.889

a. Estimates are preliminary and subject to change.

Table 3. Annual weighted means of survival probability estimates for **steelhead** (hatchery and wild combined), 1993–2012. Standard errors in parentheses. Reaches with asterisks comprise two dams and reservoirs (i.e., two projects); the following column gives the square root (i.e., geometric mean) of the two–project estimate to facilitate comparison with other single–project estimates. Simple arithmetic means across all years are given. Abbreviations: Trap–Snake River Trap; LGR–Lower Granite Dam; LGO–Little Goose Dam; LMO–Lower Monumental Dam; IHR–Ice Harbor Dam; MCN–McNary Dam; JDA–John Day Dam; TDA–The Dalles Dam; BON–Bonneville Dam.

Year	Trap–LGR	LGR–LGO	LGO–LMO	LMO–MCN*	LMO–IHR IHR–MCN	MCN–JDA	JDA–BON*	JDA–TDA TDA–BON
1993	0.905 (0.006)							
1994	NA	0.844 (0.011)	0.892 (0.011)					
1995	0.945 (0.008)	0.899 (0.005)	0.962 (0.011)	0.858 (0.076)	0.926			
1996	0.951 (0.015)	0.938 (0.008)	0.951 (0.014)	0.791 (0.052)	0.889			
1997	0.964 (0.015)	0.966 (0.006)	0.902 (0.020)	0.834 (0.065)	0.913			
1998	0.924 (0.009)	0.930 (0.004)	0.889 (0.006)	0.797 (0.018)	0.893	0.831 (0.031)	0.935 (0.103)	0.967
1999	0.908 (0.011)	0.926 (0.004)	0.915 (0.006)	0.833 (0.011)	0.913	0.920 (0.033)	0.682 (0.039)	0.826
2000	0.964 (0.013)	0.901 (0.006)	0.904 (0.009)	0.842 (0.016)	0.918	0.851 (0.045)	0.754 (0.045)	0.868
2001	0.911 (0.007)	0.801 (0.010)	0.709 (0.008)	0.296 (0.010)	0.544	0.337 (0.025)	0.753 (0.063)	0.868
2002	0.895 (0.015)	0.882 (0.011)	0.882 (0.018)	0.652 (0.031)	0.807	0.844 (0.063)	0.612 (0.098)	0.782
2003	0.932 (0.015)	0.947 (0.005)	0.898 (0.012)	0.708 (0.018)	0.841	0.879 (0.032)	0.630 (0.066)	0.794
2004	0.948 (0.004)	0.860 (0.006)	0.820 (0.014)	0.519 (0.035)	0.720	0.465 (0.078)	NA	NA
2005	0.967 (0.004)	0.940 (0.004)	0.867 (0.009)	0.722 (0.023)	0.850	0.595 (0.040)	NA	NA
2006	0.920 (0.013)	0.956 (0.004)	0.911 (0.006)	0.808 (0.017)	0.899	0.795 (0.045)	0.813 (0.083)	0.902
2007	1.016 (0.026)	0.887 (0.009)	0.911 (0.022)	0.852 (0.030)	0.923	0.988 (0.098)	0.579 (0.059)	0.761
2008	0.995 (0.018)	0.935 (0.007)	0.961 (0.014)	0.776 (0.017)	0.881	0.950 (0.066)	0.742 (0.045)	0.861
2009	1.002 (0.011)	0.972 (0.005)	0.942 (0.008)	0.863 (0.014)	0.929	0.951 (0.026)	0.900 (0.079)	0.949
2010	1.017 (0.030)	0.965 (0.028)	0.984 (0.044)	0.876 (0.032)	0.936	0.931 (0.051)	0.840 (0.038)	0.917
2011	0.986 (0.017)	0.955 (0.004)	0.948 (0.010)	0.772 (0.014)	0.879	0.960 (0.043)	0.858 (0.051)	0.926
2012 ^a	1.001 (0.026)	0.958 (0.006)	0.914 (0.011)	0.811 (0.022)	0.901	0.814 (0.048)	1.021 (0.148)	1.010
Mean	0.955 (0.009)	0.919 (0.011)	0.903 (0.014)	0.756 (0.034)	0.865	0.807 (0.050)	0.778 (0.037)	0.879

a. Estimates are preliminary and subject to change.

Table 4. Hydropower system survival estimates derived by combining empirical survival estimates from various reaches for Snake River yearling **Chinook** salmon (hatchery and wild combined), 1997–2012. Standard errors in parentheses. Simple arithmetic means across all years are given. Abbreviations: Trap–Snake River Trap; LGR–Lower Granite Dam; MCN–McNary Dam; BON–Bonneville Dam.

Year	Trap–LGR	LGR–MCN	MCN–BON	LGR–BON	Trap–BON
1997	NA	0.653 (0.072)	NA	NA	NA
1998	0.924 (0.011)	0.770 (0.009)	NA	NA	NA
1999	0.940 (0.009)	0.792 (0.006)	0.704 (0.058)	0.557 (0.046)	0.524 (0.043)
2000	0.929 (0.014)	0.760 (0.012)	0.640 (0.122)	0.486 (0.093)	0.452 (0.087)
2001	0.954 (0.015)	0.556 (0.009)	0.501 (0.027)	0.279 (0.016)	0.266 (0.016)
2002	0.953 (0.022)	0.757 (0.009)	0.763 (0.079)	0.578 (0.060)	0.551 (0.059)
2003	0.993 (0.023)	0.731 (0.010)	0.728 (0.030)	0.532 (0.023)	0.528 (0.026)
2004	0.893 (0.009)	0.666 (0.011)	0.594 (0.074)	0.395 (0.050)	0.353 (0.045)
2005	0.919 (0.015)	0.732 (0.009)	0.788 (0.093)	0.577 (0.068)	0.530 (0.063)
2006	0.952 (0.011)	0.764 (0.007)	0.842 (0.021)	0.643 (0.017)	0.612 (0.018)
2007	0.943 (0.028)	0.783 (0.006)	0.763 (0.044)	0.597 (0.035)	0.563 (0.037)
2008	0.992 (0.018)	0.782 (0.011)	0.594 (0.066)	0.465 (0.052)	0.460 (0.052)
2009	0.958 (0.010)	0.787 (0.007)	0.705 (0.031)	0.555 (0.025)	0.531 (0.025)
2010	0.968 (0.040)	0.772 (0.012)	0.738 (0.039)	0.569 (0.032)	0.551 (0.038)
2011	0.943 (0.009)	0.746 (0.010)	0.687 (0.065)	0.513 (0.049)	0.483 (0.046)
2012 ^a	0.928 (0.012)	0.795 (0.016)	0.807 (0.051)	0.642 (0.043)	0.596 (0.040)
Mean	0.946 (0.007)	0.740 (0.016)	0.704 (0.025)	0.528 (0.026)	0.500 (0.025)

a. Estimates are preliminary and subject to change.

Table 5. Hydropower system survival estimates derived by combining empirical survival estimates from various reaches for Snake River **steelhead** (hatchery and wild combined), 1997–2012. Standard errors in parentheses. Simple arithmetic means across all years are given. Abbreviations: Trap–Snake River Trap; LGR–Lower Granite Dam; MCN–McNary Dam; BON–Bonneville Dam.

Year	Trap–LGR	LGR-MCN	MCN-BON	LGR–BON	Trap–BON
1997	1.020 (0.023)	0.728 (0.053)	0.651 (0.082)	0.474 (0.069)	0.484 (0.072)
1998	0.924 (0.009)	0.649 (0.013)	0.770 (0.081)	0.500 (0.054)	0.462 (0.050)
1999	0.908 (0.011)	0.688 (0.010)	0.640 (0.024)	0.440 (0.018)	0.400 (0.017)
2000	0.964 (0.013)	0.679 (0.016)	0.580 (0.040)	0.393 (0.034)	0.379 (0.033)
2001	0.911 (0.007)	0.168 (0.006)	0.250 (0.016)	0.042 (0.003)	0.038 (0.003)
2002	0.895 (0.015)	0.536 (0.025)	0.488 (0.090)	0.262 (0.050)	0.234 (0.045)
2003	0.932 (0.015)	0.597 (0.013)	0.518 (0.015)	0.309 (0.011)	0.288 (0.012)
2004	0.948 (0.004)	0.379 (0.023)	NA	NA	NA
2005	0.967 (0.004)	0.593 (0.018)	NA	NA	NA
2006	0.920 (0.013)	0.702 (0.016)	0.648 (0.079)	0.455 (0.056)	0.418 (0.052)
2007	1.016 (0.026)	0.694 (0.020)	0.524 (0.064)	0.364 (0.045)	0.369 (0.047)
2008	0.995 (0.018)	0.716 (0.015)	0.671 (0.034)	0.480 (0.027)	0.478 (0.028)
2009	1.002 (0.011)	0.790 (0.013)	0.856 (0.074)	0.676 (0.059)	0.678 (0.060)
2010	1.017 (0.030)	0.770 (0.020)	0.789 (0.027)	0.608 (0.026)	0.618 (0.032)
2011	0.986 (0.017)	0.693 (0.013)	0.866 (0.038)	0.600 (0.029)	0.592 (0.030)
2012 ^a	1.001 (0.026)	0.698 (0.020)	0.856 (0.196)	0.597 (0.138)	0.598 (0.139)
Mean	0.963 (0.011)	0.630 (0.039)	0.651 (0.046)	0.443 (0.044)	0.431 (0.046)

a. Estimates are preliminary and subject to change.

Table 6. Estimated survival and standard error (s.e.) through reaches of the lower Columbia River hydropower system for hatchery yearling **Chinook** salmon and **steelhead** originating in the upper Columbia River, 1999–2012. Abbreviations: Rel–Release site; MCN–McNary Dam; JDA–John Day Dam; BON–Bonneville Dam.

Year	Yearling Chinook Salmon				Steelhead			
	Rel–MCN	MCN–JDA	JDA–BON	MCN–BON	Rel–MCN	MCN–JDA	JDA–BON	MCN–BON
1999	0.572 (0.014)	0.896 (0.044)	0.795 (0.129)	0.712 (0.113)				
2000	0.539 (0.025)	0.781 (0.094)	NA	NA				
2001	0.428 (0.009)	0.881 (0.062)	NA	NA				
2002	0.555 (0.003)	0.870 (0.011)	0.940 (0.048)	0.817 (0.041)				
2003	0.625 (0.003)	0.900 (0.008)	0.977 (0.035)	0.879 (0.031)	0.471 (0.004)	0.997 (0.012)	0.874 (0.036)	0.871 (0.036)
2004	0.507 (0.005)	0.812 (0.019)	0.761 (0.049)	0.618 (0.038)	0.384 (0.005)	0.794 (0.021)	1.037 (0.112)	0.823 (0.088)
2005	0.545 (0.012)	0.751 (0.042)	NA	NA	0.399 (0.004)	0.815 (0.017)	0.827 (0.071)	0.674 (0.057)
2006	0.520 (0.011)	0.954 (0.051)	0.914 (0.211)	0.871 (0.198)	0.397 (0.008)	0.797 (0.026)	0.920 (0.169)	0.733 (0.134)
2007	0.584 (0.009)	0.895 (0.028)	0.816 (0.091)	0.730 (0.080)	0.426 (0.016)	0.944 (0.064)	0.622 (0.068)	0.587 (0.059)
2008	0.582 (0.019)	1.200 (0.085)	0.522 (0.114)	0.626 (0.133)	0.438 (0.015)	NA	NA	NA
2009	0.523 (0.013)	0.847 (0.044)	1.056 (0.143)	0.895 (0.116)	0.484 (0.018)	0.809 (0.048)	0.935 (0.133)	0.756 (0.105)
2010	0.660 (0.014)	0.924 (0.040)	0.796 (0.046)	0.735 (0.037)	0.512 (0.017)	0.996 (0.054)	0.628 (0.038)	0.626 (0.033)
2011	0.534 (0.010)	1.042 (0.047)	0.612 (0.077)	0.637 (0.077)	0.435 (0.012)	1.201 (0.064)	0.542 (0.101)	0.651 (0.119)
2012 ^a	0.478 (0.007)	0.854 (0.026)	0.985 (0.097)	0.841 (0.080)	0.282 (0.014)	0.801 (0.060)	1.251 (0.262)	1.002 (0.209)
Mean	0.546 (0.016)	0.900 (0.030)	0.834 (0.049)	0.760 (0.032)	0.423 (0.020)	0.906 (0.047)	0.848 (0.075)	0.747 (0.044)

a. Estimates are preliminary and subject to change.

Table 7. Estimated survival and standard error (s.e.) for **sockeye** salmon (hatchery and wild combined) from Lower Granite Dam tailrace to Bonneville Dam tailrace for fish originating in the Snake River, and from Rock Island Dam tailrace to Bonneville Dam tailrace for fish originating in the upper Columbia River, 1996–2012. Note that this table represents all available data on sockeye, and so estimates are provided regardless of the size of their associated standard errors. The estimates to Bonneville tailrace are of questionable quality in several cases due to small release sizes and low detection probabilities. Abbreviations: LGR–Lower Granite Dam; MCN–McNary Dam; BON–Bonneville Dam; RIS–Rock Island Dam.

Year	Snake River Sockeye			Upper Columbia River Sockeye		
	LGR-MCN	MCN-BON	LGR-BON	RIS-MCN	MCN-BON	RIS-BON
1996	0.283 (0.184)	NA	NA	NA	NA	NA
1997	NA	NA	NA	0.397 (0.119)	NA	NA
1998	0.689 (0.157)	0.142 (0.099)	0.177 (0.090)	0.624 (0.058)	1.655 (1.617)	1.033 (1.003)
1999	0.655 (0.083)	0.841 (0.584)	0.548 (0.363)	0.559 (0.029)	0.683 (0.177)	0.382 (0.097)
2000	0.679 (0.110)	0.206 (0.110)	0.161 (0.080)	0.487 (0.114)	0.894 (0.867)	0.435 (0.410)
2001	0.205 (0.063)	0.105 (0.050)	0.022 (0.005)	0.657 (0.117)	NA	NA
2002	0.524 (0.062)	0.684 (0.432)	0.342 (0.212)	0.531 (0.044)	0.286 (0.110)	0.152 (0.057)
2003	0.669 (0.054)	0.551 (0.144)	0.405 (0.098)	NA	NA	NA
2004	0.741 (0.254)	NA	NA	0.648 (0.114)	1.246 (1.218)	0.808 (0.777)
2005	0.388 (0.078)	NA	NA	0.720 (0.140)	0.226 (0.209)	0.163 (0.147)
2006	0.630 (0.083)	1.113 (0.652)	0.820 (0.454)	0.793 (0.062)	0.767 (0.243)	0.608 (0.187)
2007	0.679 (0.066)	0.259 (0.084)	0.272 (0.073)	0.625 (0.046)	0.642 (0.296)	0.401 (0.183)
2008	0.763 (0.103)	0.544 (0.262)	0.404 (0.179)	0.644 (0.094)	0.679 (0.363)	0.437 (0.225)
2009	0.749 (0.032)	0.765 (0.101)	0.573 (0.073)	0.853 (0.076)	0.958 (0.405)	0.817 (0.338)
2010	0.723 (0.039)	0.752 (0.098)	0.544 (0.077)	0.778 (0.063)	0.627 (0.152)	0.488 (0.111)
2011	0.659 (0.033)	NA	NA	0.742 (0.088)	0.691 (0.676)	0.513 (0.498)
2012 ^a	0.762 (0.032)	0.619 (0.084)	0.472 (0.062)	0.945 (0.085)	0.840 (0.405)	0.794 (0.376)
Mean	0.612 (0.043)	0.548 (0.090)	0.395 (0.063)	0.667 (0.037)	0.784 (0.103)	0.541 (0.073)

a. Estimates are preliminary and subject to change.

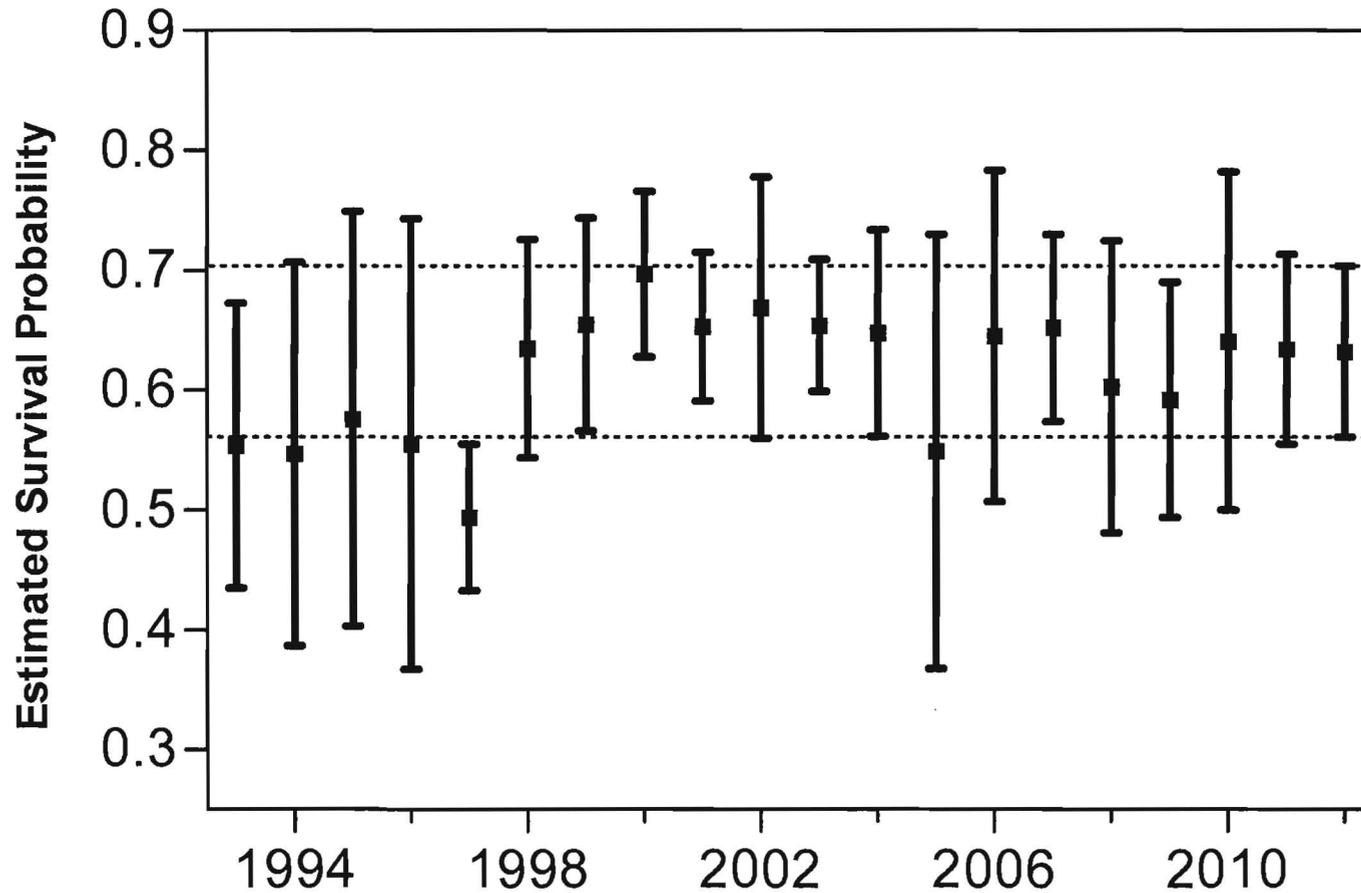


Figure 1. Annual average survival estimates from release to Lower Granite Dam for PIT-tagged yearling **Chinook** salmon released from Snake River Basin hatcheries, 1993-2012. Hatcheries used for average (index groups) are those with PIT-tag releases through a long series of years. Vertical bars represent 95% confidence intervals. Horizontal dashed lines are the 2012 confidence interval endpoints and are shown for comparison to other years.

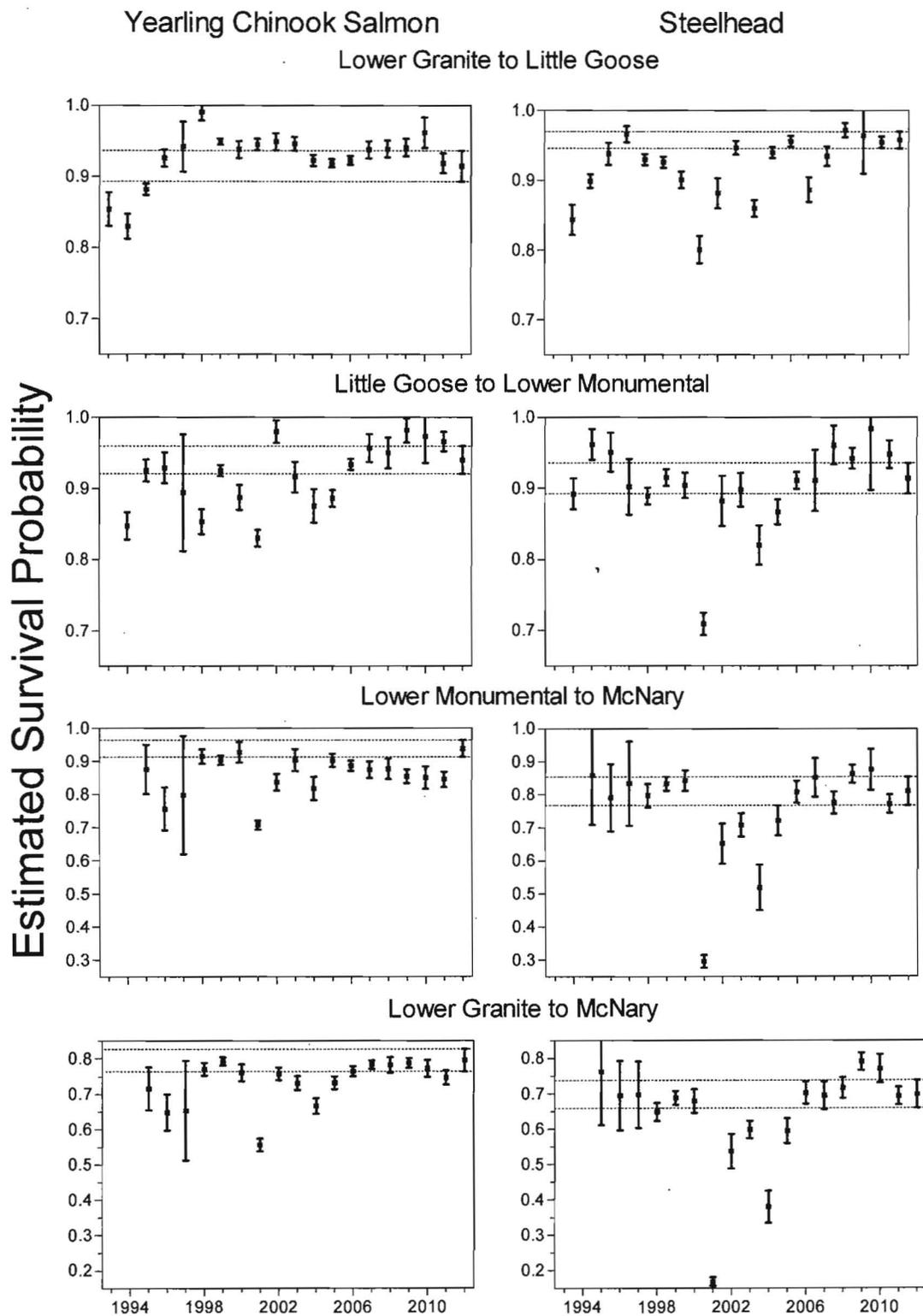


Figure 2. Annual average survival estimates for PIT-tagged yearling **Chinook** salmon and **steelhead**, hatchery and wild fish combined. Vertical bars represent 95% confidence intervals. Horizontal dashed lines are 95% confidence interval endpoints for 2012 estimates.

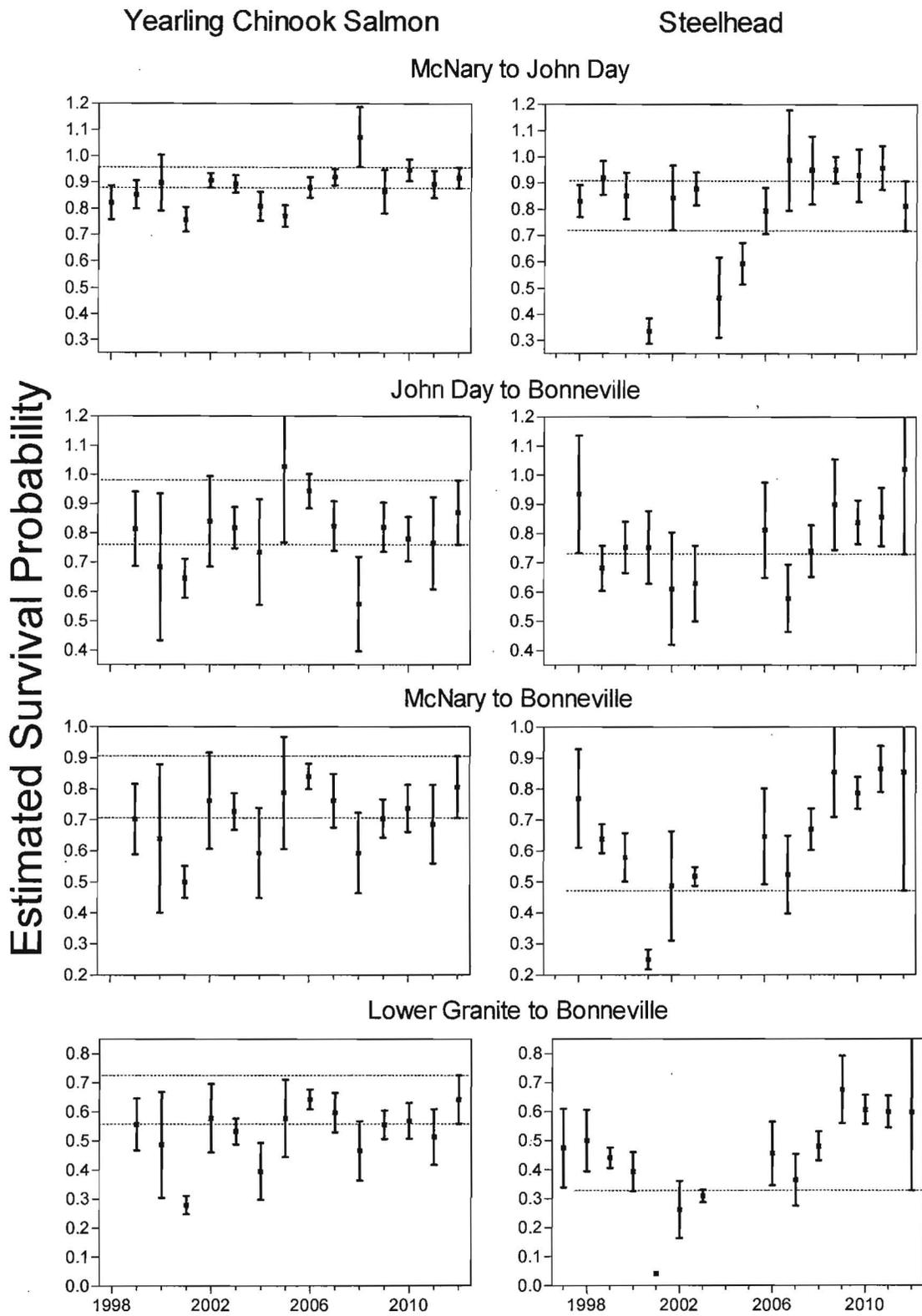


Figure 3. Annual average survival estimates for PIT-tagged yearling **Chinook** salmon and **steelhead**, hatchery and wild fish combined. Vertical bars represent 95% confidence intervals. Horizontal dashed lines are 95% confidence interval endpoints for 2012 estimates.

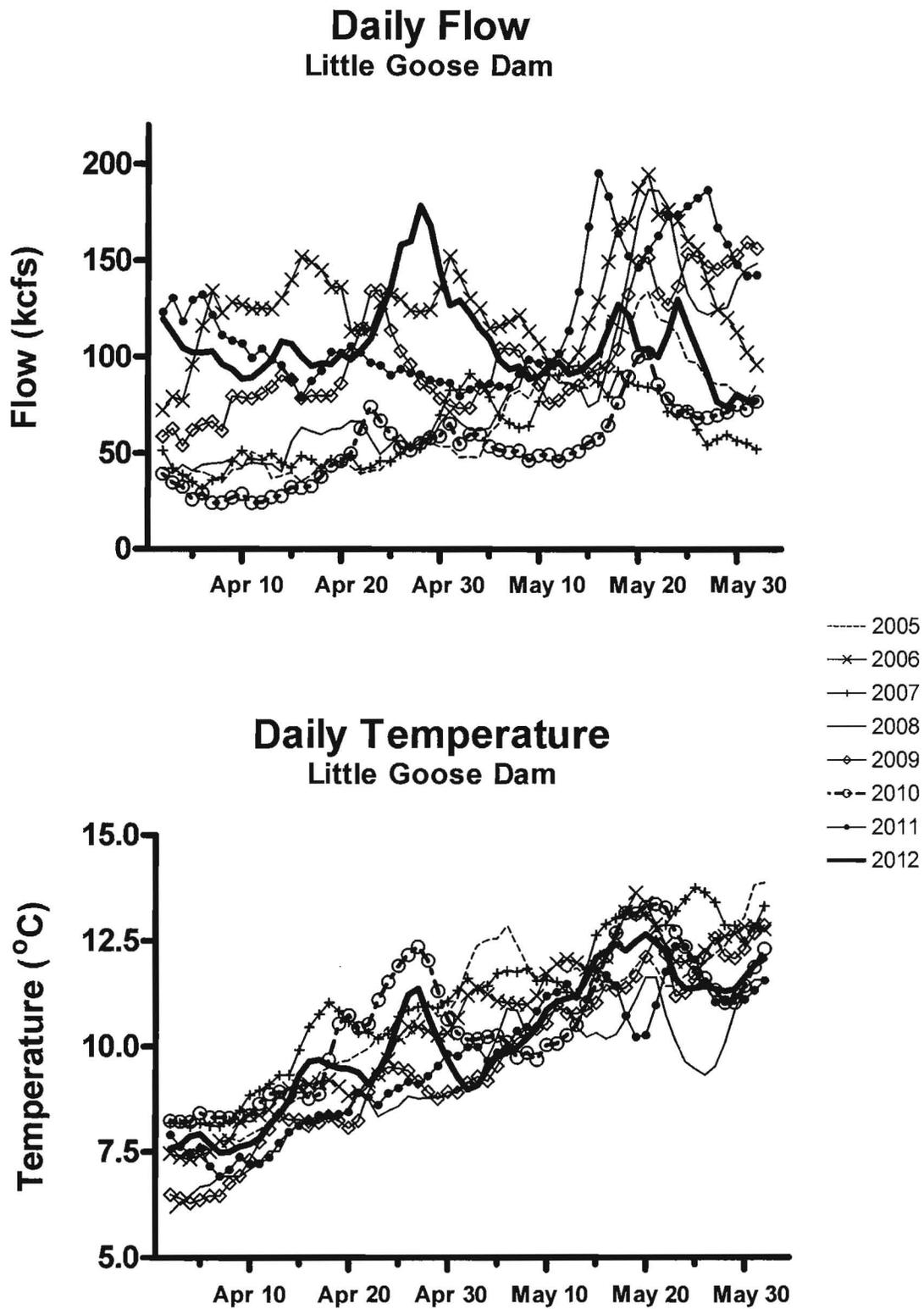


Figure 4. Snake River flow (kcfs; top panel) and water temperature (°C; bottom panel) measured at Little Goose Dam during April and May, 2005-2012.

Mean Spill

LGR, LGO, LMN

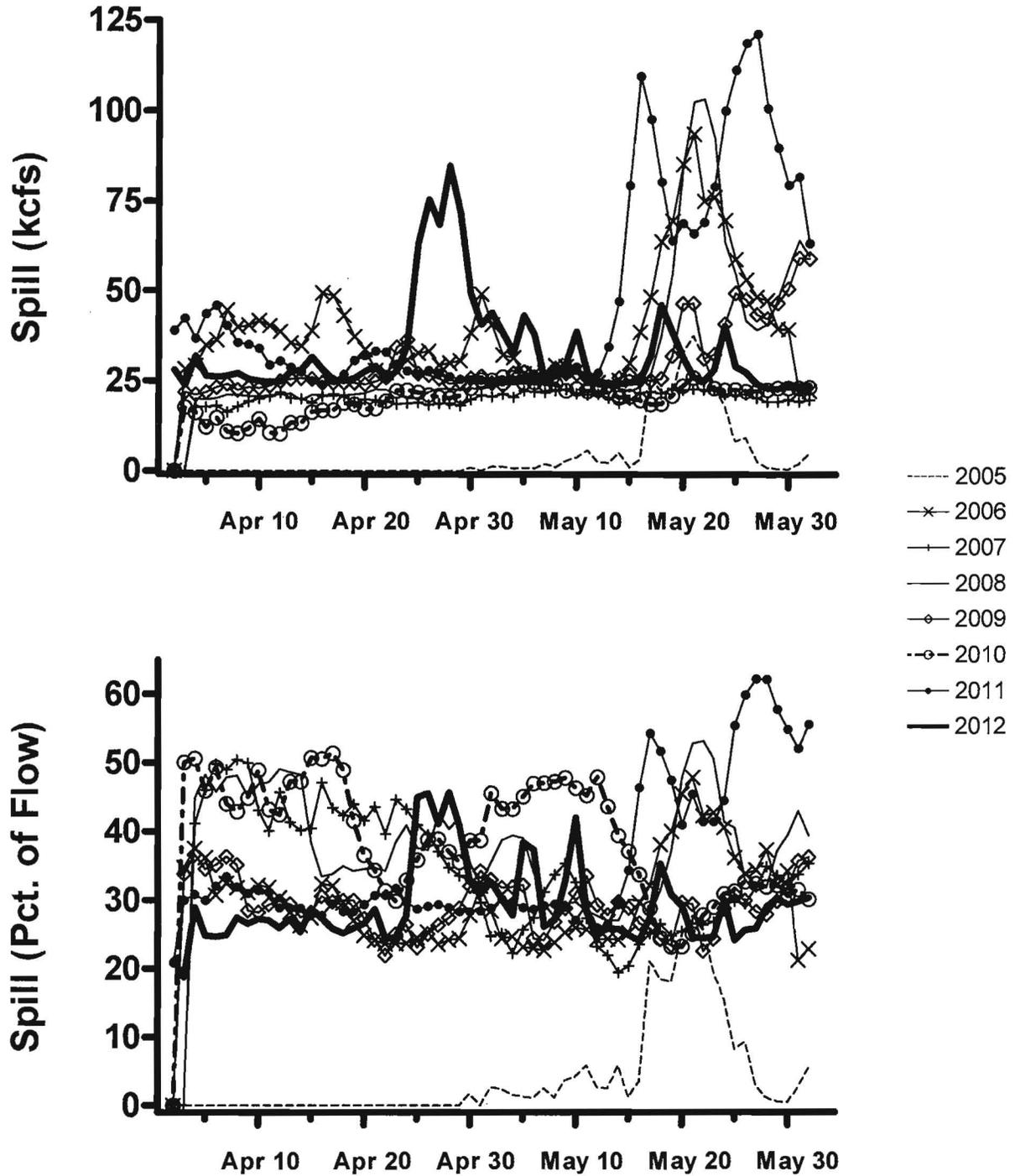
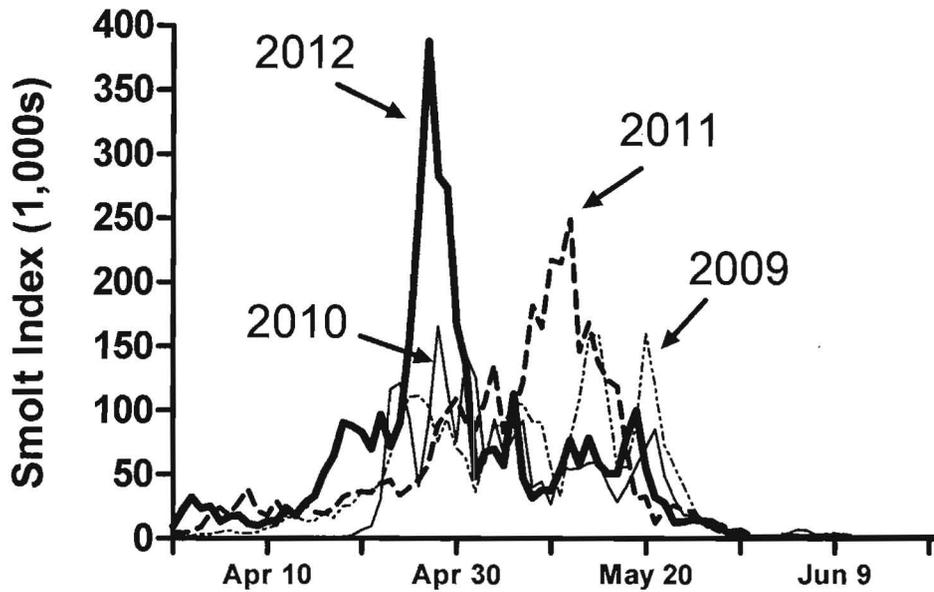


Figure 5. Mean spill (top panel shows kcfs; bottom panel shows percentage of total flow) at Snake River dams during April and May, 2005-2012.

Smolt Passage at Lower Granite Dam

Yearling Chinook



Steelhead

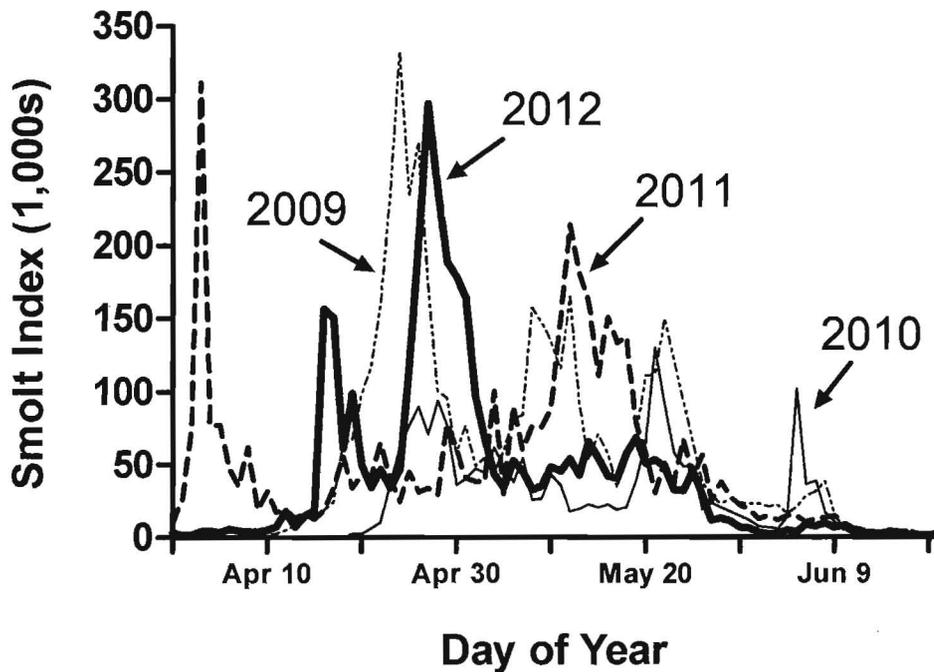


Figure 6. Smolt index in thousands at Lower Granite Dam 2009-2012 for hatchery and wild combined yearling Chinook and steelhead.