



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

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September 13, 2010

MEMORANDUM FOR: F/NWR5 - Bruce Suzumoto
FROM: F/NWC3 - John W. Ferguson
SUBJECT: Preliminary survival estimates for passage during the spring migration of juvenile salmonids through Snake and Columbia River reservoirs and dams, 2010

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 2010 spring outmigration. We also provide preliminary estimates of the proportion of Snake River smolts that were transported from Snake River dams in 2010. 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 2010, NOAA Fisheries PIT tagged approximately 16,170 river-run hatchery steelhead, 11,990 wild steelhead, and 17,000 wild yearling Chinook salmon for release into the tailrace of Lower Granite Dam. From studies funded by the USACE, we used about 122,360 hatchery yearling Chinook salmon PIT tagged by NOAA Fisheries at Lower Granite Dam for evaluation of "extra" or "latent" mortality related to passage through Snake River dams.

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 2010 was 64.1%.

Estimated survival for Snake River yearling Chinook salmon (hatchery and wild combined) in 2010 was above the average (1993-2010) in almost every reach (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 2010 was 77.2% (95% CI: 74.8, 79.6%). Mean estimated survival in 2010 from McNary Dam tailrace to Bonneville Dam tailrace was 73.8% (95% CI: 66.2, 81.4%). Mean estimated survival for yearling Chinook salmon from Lower Granite Dam tailrace to Bonneville Dam tailrace in 2010 was 57.0% (95% CI: 50.8, 63.1%). Estimated survival for the Lower Granite project (head of reservoir to tailrace) was 96.3%, 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 2010 was 54.8% (95% CI: 47.4, 62.2%).

For Snake River steelhead (hatchery and wild combined), mean estimated survival in 2010 was above the average (1993-2010) 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 2010 was 77.4% (95% CI: 73.3, 81.5%). Mean estimated survival in 2010 from McNary Dam tailrace to Bonneville Dam tailrace was 78.7% (95% CI: 72.6, 84.8%). Mean estimated survival from Lower Granite Dam tailrace to Bonneville Dam tailrace was 60.9% (95% CI: 55.2, 66.6%). Estimated survival for the Lower Granite project (head of reservoir to tailrace) was 100% (actual model calculation was 101.3%), 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 2010 was 61.7% (95% CI: 54.8, 68.6%).

For PIT-tagged hatchery yearling Chinook salmon originating from the upper Columbia River in 2010, estimated survival from McNary Dam tailrace to Bonneville Dam tailrace was 75.1% (95% CI: 67.7, 83.4%; see Table 6).

For PIT-tagged hatchery steelhead originating from the upper Columbia River in 2010, estimated survival from McNary Dam tailrace to Bonneville Dam tailrace was 62.6% (95% CI: 56.5, 69.4%; 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 2010 of Snake River sockeye salmon (hatchery and wild combined) from the tailrace of Lower Granite Dam to the tailrace of Bonneville Dam was 54.4% (95% CI: 41.3%, 71.7%; Table 7). Estimated survival in 2010 of Columbia River sockeye salmon (hatchery and wild combined) from the tailrace of Rock Island Dam to the tailrace of Bonneville Dam was 48.8% (95% CI: 31.4%, 75.8%; Table 7).

Our preliminary estimates of the proportion transported of non-tagged wild and hatchery spring-summer Chinook salmon smolts are 38.2% and 22.6%, respectively. For steelhead, the estimates are 36.8% and 34.8% 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. The estimates for both hatchery and wild Chinook are lower than those in 2008 and 2009, but not lower than those in 2007. The estimates for both hatchery and wild steelhead are lower than from any year 1995-2009. The differences among years for both Chinook and steelhead are due to differences in collection probabilities at the collector dams and differences in timing of the smolt migrations relative to transportation start dates.

Discussion

Estimated survival for Snake River yearling Chinook salmon and steelhead through the hydropower system (Snake River trap to Bonneville tailrace) in 2010 was relatively high compared to recent years. The 2010 estimated hydropower system survival for yearling Chinook was 54.8%, which is higher than the average of 49.3% and higher than the 2009 estimate of 53.1% (Table 4), although there was no statistical evidence that hydropower system survival in 2009 and 2010 were different ($P = 0.71$). For steelhead, the 2010 estimated hydropower system survival was 61.7%, which is higher than the average of 40.4% but lower than the 2009 estimate of 67.8% (Table 5). There was no statistical evidence that hydropower system survival for steelhead was different between 2009 and 2010 ($P = 0.38$).

The higher survival in the last few years for yearling Chinook and steelhead is likely due in part to changes in dam operations during that period. Operations at most dams in 2010 were similar to those in 2009. The adjustable spillway weir (ASW) installed in 2009 at Little Goose Dam was in its second year of operation. The

removable spillway weir (RSW) at Lower Monumental Dam and the temporary spillway weirs (TSW) at John Day Dam were in their third year of operation in 2010. Also the new spillway guidance wall at The Dalles Dam, which was partially complete in 2009, was completed in March of 2010.

Snake River flow volume in 2010 was low compared to that of recent years for most of the migration period (Figure 4). The flow volume and pattern in 2010 were most like those of 2004, 2005, and 2007. Although mean spill volume at the Snake River dams in 2010 was low to average when compared to recent years, mean spill as a percentage of flow was relatively high (Figure 5). Spill percentages in 2010 were much like those in 2007 and 2008 until mid-May, when they decreased with increasing flow. Spill percentages in 2010 were higher than those in 2009 for most of the season. Water temperatures in the Snake River in 2010 fluctuated, with peaks in late April and mid-May, with the fluctuations nearly spanning the range of temperatures experienced at the same times during recent years (Figure 6).

Estimated survival from Lower Granite Dam to McNary Dam for daily groups of yearling Chinook showed an overall gradual decline through the season, with a dip occurring for groups released from Lower Granite between about 25 April and 5 May (Figure 7). Estimated survival from Lower Granite Dam to McNary Dam for daily groups of steelhead showed a dip occurring in a similar period as that for Chinook, but was higher for fish released in early mid-to-late May than for those released in April (Figure 8). There are multiple possible explanations for these observed patterns, and more extensive analysis is required to uncover possible relationships.

Estimated percentages of yearling Chinook salmon and steelhead transported from Snake River dams were among the lowest seen from 1995-2009. 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. For yearling Chinook in 2010, estimated percentages entering the bypass systems at Lower Granite Dam, Little Goose Dam, and Lower Monumental Dam were 26%, 26%, and 8% for wild, and 16%, 12%, and 2% for hatchery, respectively. The transport percentage was lower for hatchery than for wild Chinook salmon because of the difference in percentages entering bypass systems. For steelhead in 2010, the estimated percentages entering the bypass systems at Lower Granite, Little Goose, and Lower Monumental were 23%, 22%, and 6% for wild, and 20%, 23%, and 6% for hatchery, respectively. These bypass percentages are among the lowest estimated from 1995-2009 for both yearling Chinook and steelhead.

Transportation began on 23 April at Lower Granite Dam, 1 May at Little Goose Dam, and 3 May at Lower Monumental Dam. These start dates were earlier than those in 2009 (1 May at Lower Granite, 5 May at Little Goose, and 8 May at Lower Monumental). The very first arrivals of yearling Chinook and steelhead smolts at Lower Granite Dam in 2010 occurred later than in 2007-2009 (Figure 9). When transportation began at Lower Granite on 23 April, only about 2% of the yearling Chinook and 1% of the steelhead had already passed the dam. However, the cumulative passage distribution for Chinook climbed rapidly and approximately 50% of the run had passed Lower Granite through 3 May. The steelhead run was a little more protracted; 50% of the run had passed through 11 May. Despite the earlier transportation start dates and relatively later run passage timing in 2010 than in 2009, the higher spill percentages and consequent lower collection rates resulted in lower percentages of fish transported.

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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), 2008 through 2010.

Hatchery	2008		2009		2010 ^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	0.737 (0.011)	0.534 (0.016)	0.696 (0.007)	0.544 (0.010)	0.898 (0.017)	0.780 (0.014)
Kooskia	0.631 (0.015)	0.509 (0.052)	0.633 (0.012)	0.456 (0.017)	0.744 (0.030)	0.624 (0.022)
Lookingglass (Catherine Cr.)	0.455 (0.008)	0.379 (0.028)	0.371 (0.006)	0.298 (0.012)	0.447 (0.020)	0.369 (0.015)
Lookingglass (Grande Ronde)	0.416 (0.016)	0.352 (0.050)	0.444 (0.022)	0.295 (0.036)	0.422 (0.029)	0.356 (0.034)
Lookingglass (Imnaha River)	0.694 (0.008)	0.518 (0.022)	0.699 (0.009)	0.555 (0.017)	0.680 (0.025)	0.563 (0.017)
Lookingglass (Lostine River)	0.600 (0.012)	0.480 (0.036)	0.585 (0.010)	0.474 (0.024)	0.512 (0.022)	0.395 (0.024)
McCall (Johnson Cr.)	0.330 (0.030)	0.317 (0.052)	0.309 (0.019)	0.326 (0.072)	0.322 (0.018)	0.230 (0.022)
McCall (Knox Bridge)	0.578 (0.007)	0.403 (0.013)	0.513 (0.005)	0.414 (0.008)	0.566 (0.014)	0.462 (0.010)
Rapid River	0.801 (0.004)	0.593 (0.012)	0.728 (0.005)	0.631 (0.010)	0.786 (0.019)	0.666 (0.012)
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Winthrop	---	0.574 (0.074)	---	0.372 (0.043)	---	0.634 (0.069)
Leavenworth	---	0.567 (0.022)	---	0.478 (0.020)	---	0.653 (0.028)

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), 1993–2010. 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 ^a	0.963 (0.041)	0.963 (0.011)	0.975 (0.019)	0.851 (0.018)	0.922	0.947 (0.021)	0.780 (0.039)	0.883
Mean	0.939 (0.010)	0.928 (0.009)	0.914 (0.011)	0.856 (0.015)	0.925	0.877 (0.023)	0.791 (0.036)	0.887

a. Estimates are preliminary and subject to change.

Table 3. Annual weighted means of survival probability estimates for **steelhead** (hatchery and wild combined), 1993–2010. 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 ^a	1.013 (0.031)	0.965 (0.028)	0.983 (0.043)	0.881 (0.030)	0.939	0.953 (0.053)	0.822 (0.038)	0.907
Mean	0.951 (0.009)	0.915 (0.012)	0.900 (0.015)	0.752 (0.038)	0.862	0.797 (0.057)	0.747 (0.035)	0.862

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), 1997–2010. 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 ^a	0.963 (0.041)	0.772 (0.012)	0.738 (0.039)	0.570 (0.031)	0.548 (0.038)
Mean	0.947 (0.008)	0.736 (0.018)	0.697 (0.028)	0.519 (0.029)	0.493 (0.028)

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), 1997–2010. 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 ^a	1.013 (0.031)	0.774 (0.021)	0.787 (0.031)	0.609 (0.029)	0.617 (0.035)
Mean	0.958 (0.012)	0.621 (0.045)	0.615 (0.047)	0.417 (0.048)	0.404 (0.049)

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, 1999–2010. 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 ^a	0.655 (0.014)	0.933 (0.041)	0.804 (0.050)	0.751 (0.040)	0.512 (0.016)	0.996 (0.054)	0.628 (0.038)	0.626 (0.033)
Mean	0.553 (0.017)	0.893 (0.033)	0.843 (0.052)	0.767 (0.035)	0.439 (0.016)	0.879 (0.036)	0.835 (0.059)	0.724 (0.039)

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, 1996–2010. 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. Caution is warranted if using those estimates for inference. 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 ^a	0.723 (0.039)	0.752 (0.098)	0.544 (0.077)	0.778 (0.063)	0.627 (0.152)	0.488 (0.111)
Mean	0.598 (0.048)	0.542 (0.099)	0.388 (0.069)	0.640 (0.035)	0.788 (0.122)	0.520 (0.083)

a. Estimates are preliminary and subject to change.

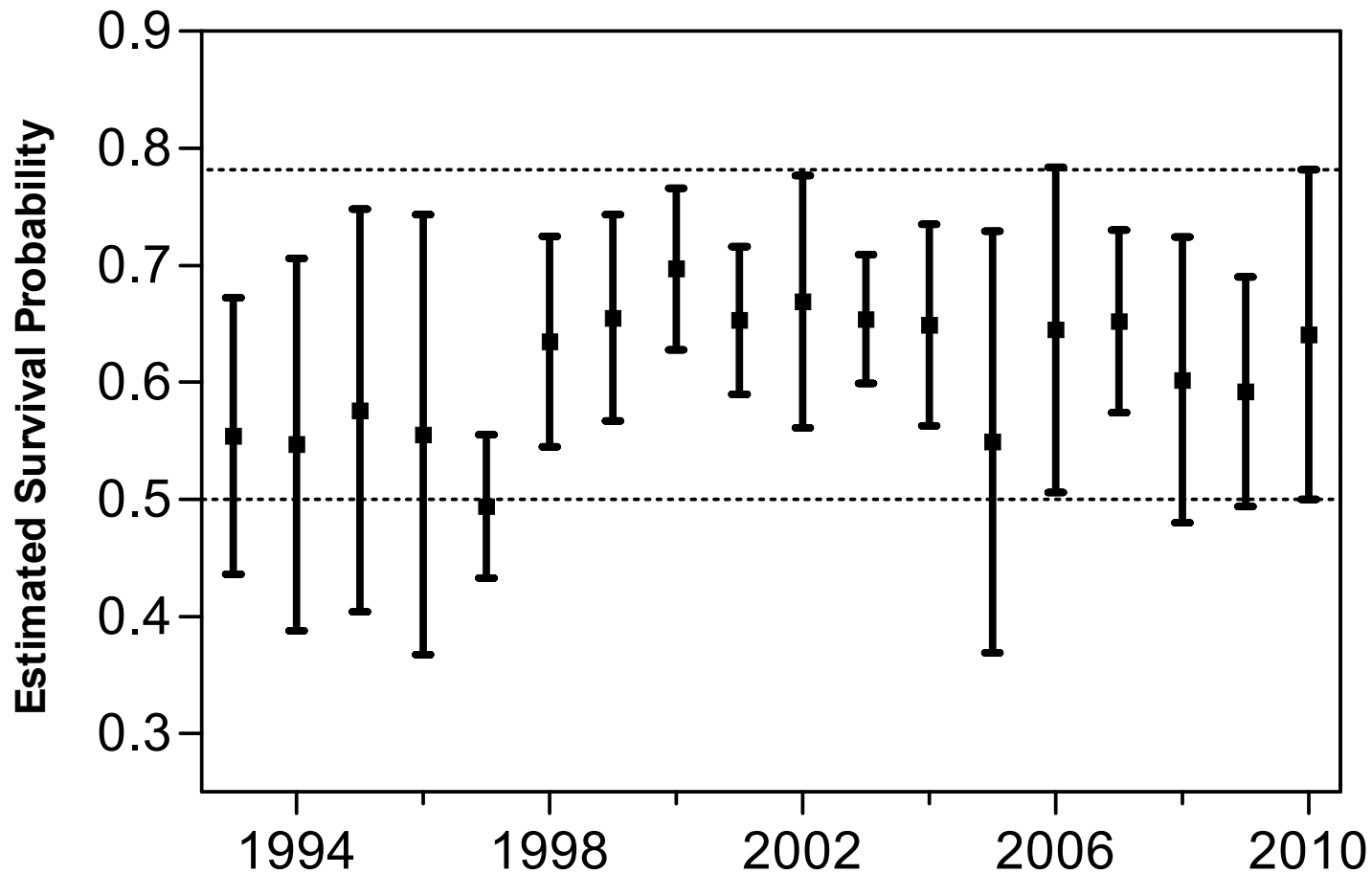


Figure 1. Annual average survival estimates from release to Lower Granite Dam for PIT-tagged yearling Chinook salmon released from Snake River Basin hatcheries, 1993-2010. Hatcheries used for average (index groups) are those with PIT-tag releases through a long series of years. Vertical bars represent 95% confidence intervals. Horizontal dashed lines are the 2010 confidence interval endpoints and are shown for comparison to other years.

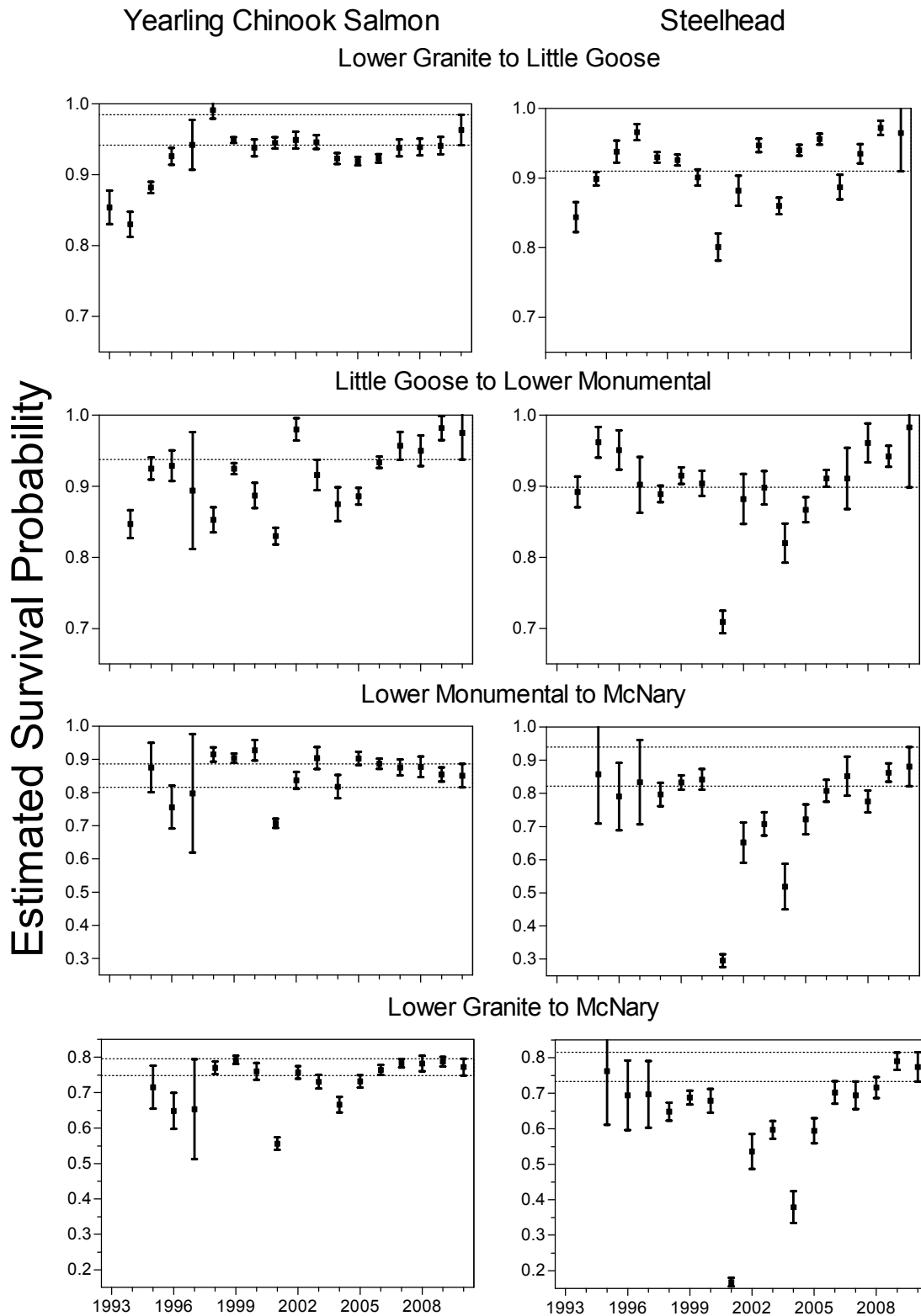


Figure 2. Annual average survival estimates for PIT-tagged yearling Chinook salmon and steelhead, hatchery and wild fish combined. Vertical bars represent 95% confidence intervals. Horizontal dashed lines are 95% confidence interval endpoints for 2010 estimates.

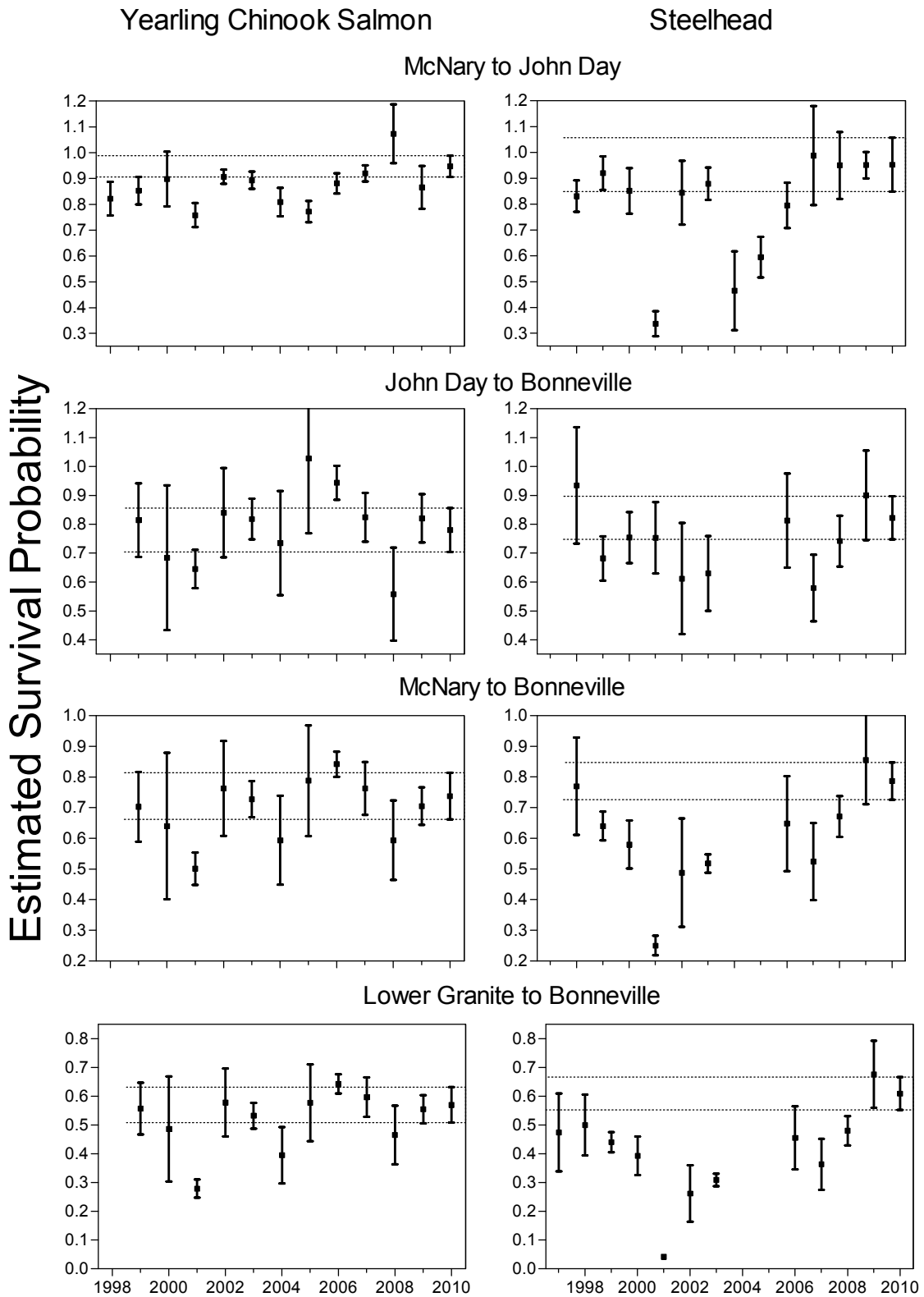


Figure 3. Annual average survival estimates for PIT-tagged yearling Chinook salmon and steelhead, hatchery and wild fish combined. Vertical bars represent 95% confidence intervals. Horizontal dashed lines are 95% confidence interval endpoints for 2010 estimates.

Flow

Little Goose Dam

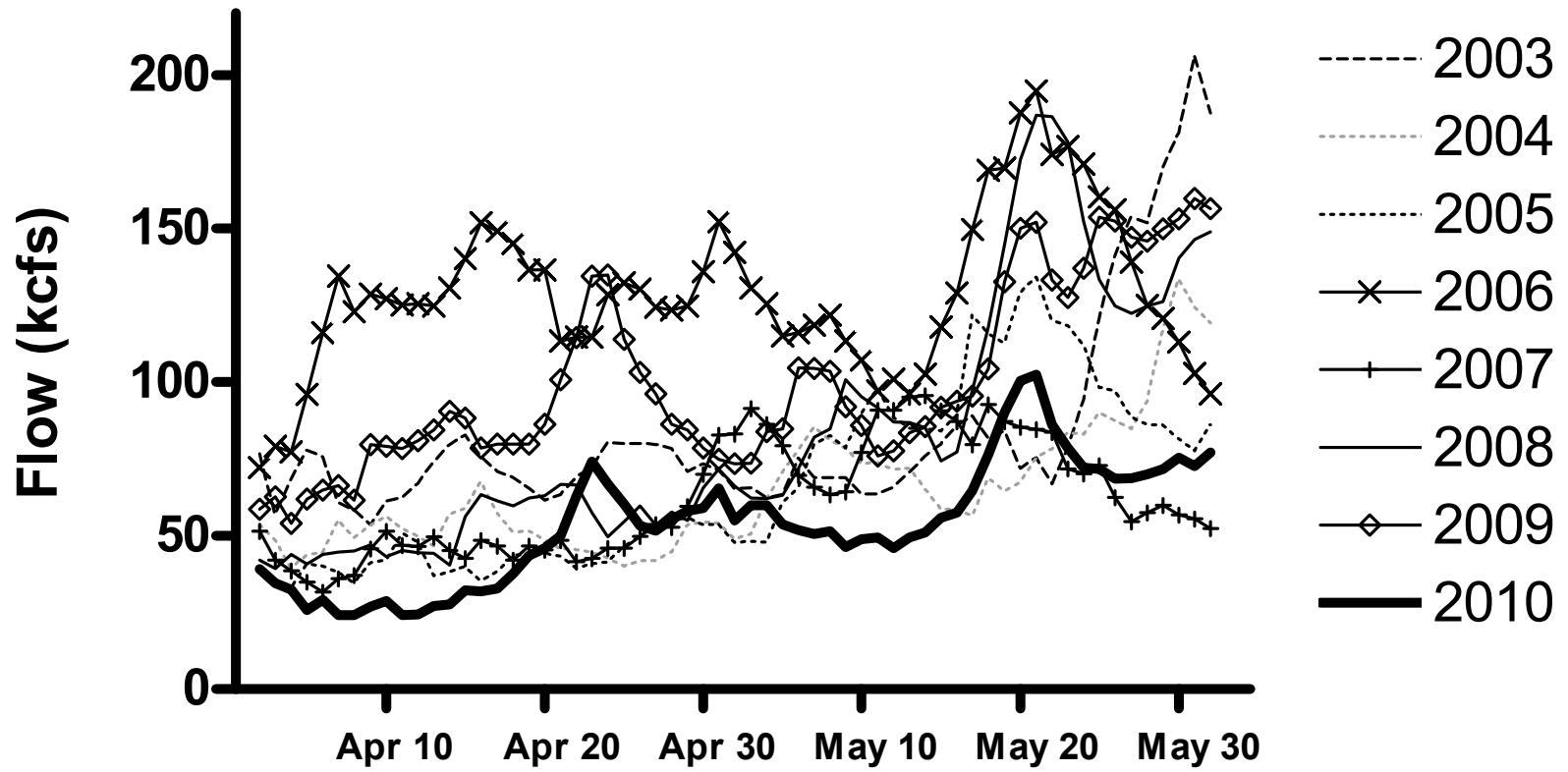


Figure 4. Snake River flow (kcfs) measured at Little Goose Dam during April and May, 2003-2010.

Mean Spill LGR, LGO, LMN

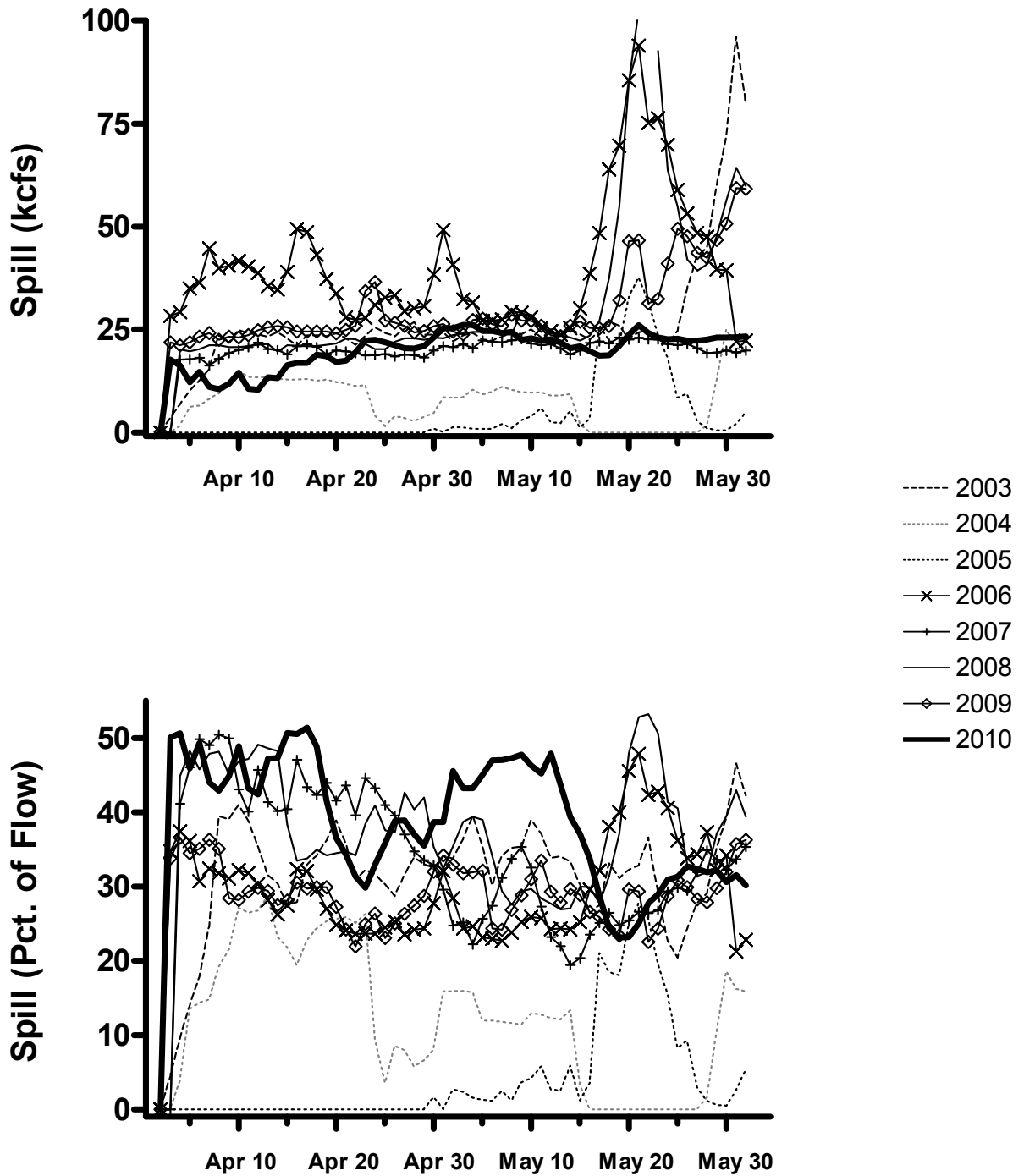


Figure 5. Mean spill (top=kcfs; bottom=percentage of total flow) at Snake River dams during April and May, 2003-2010

Temperature

Little Goose Dam

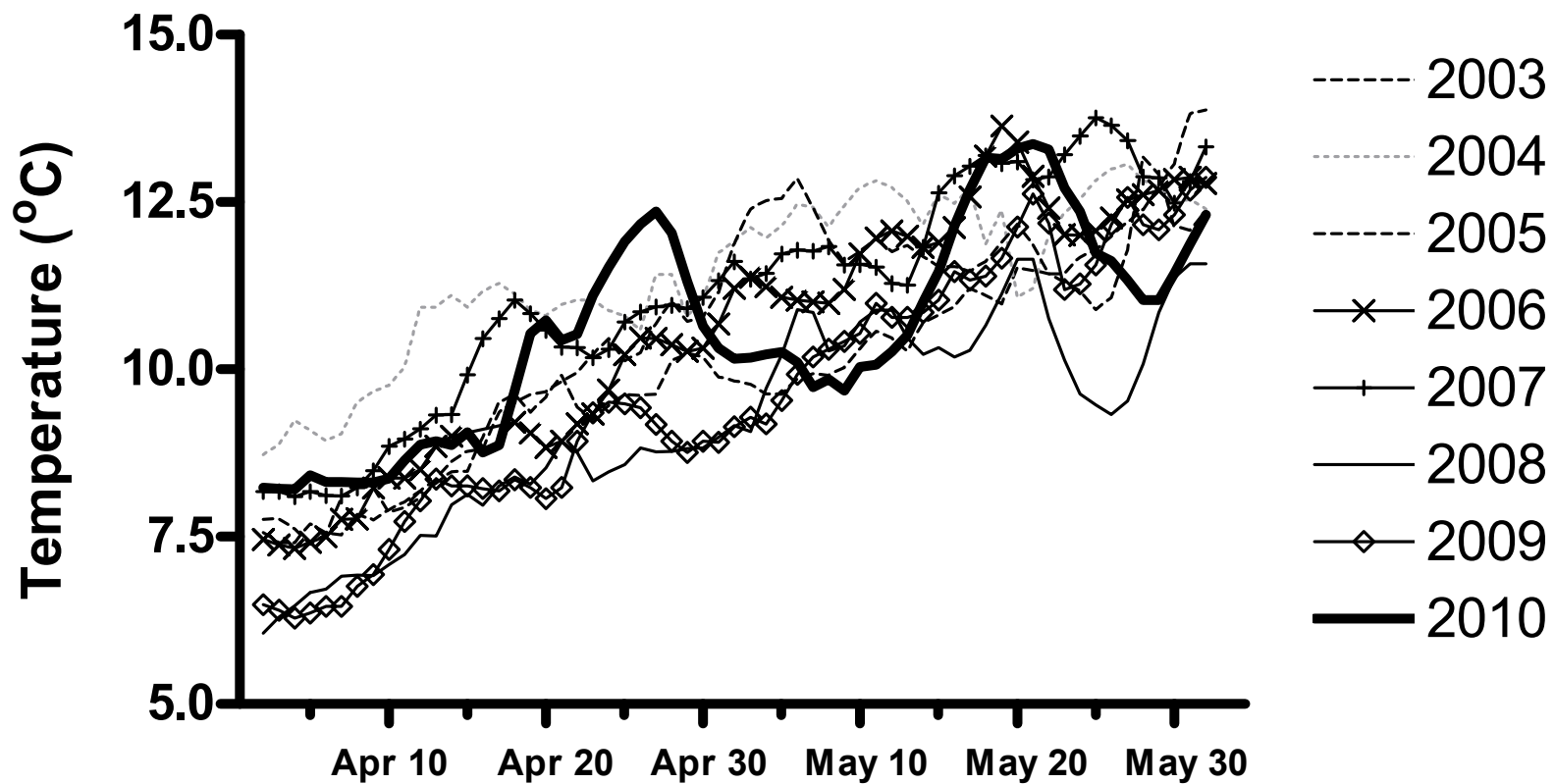


Figure 6. Snake River water temperature (°C) measured at Little Goose Dam during April and May, 2003-2010.

Survival, Flow, Passage Index Yearling Chinook 2010

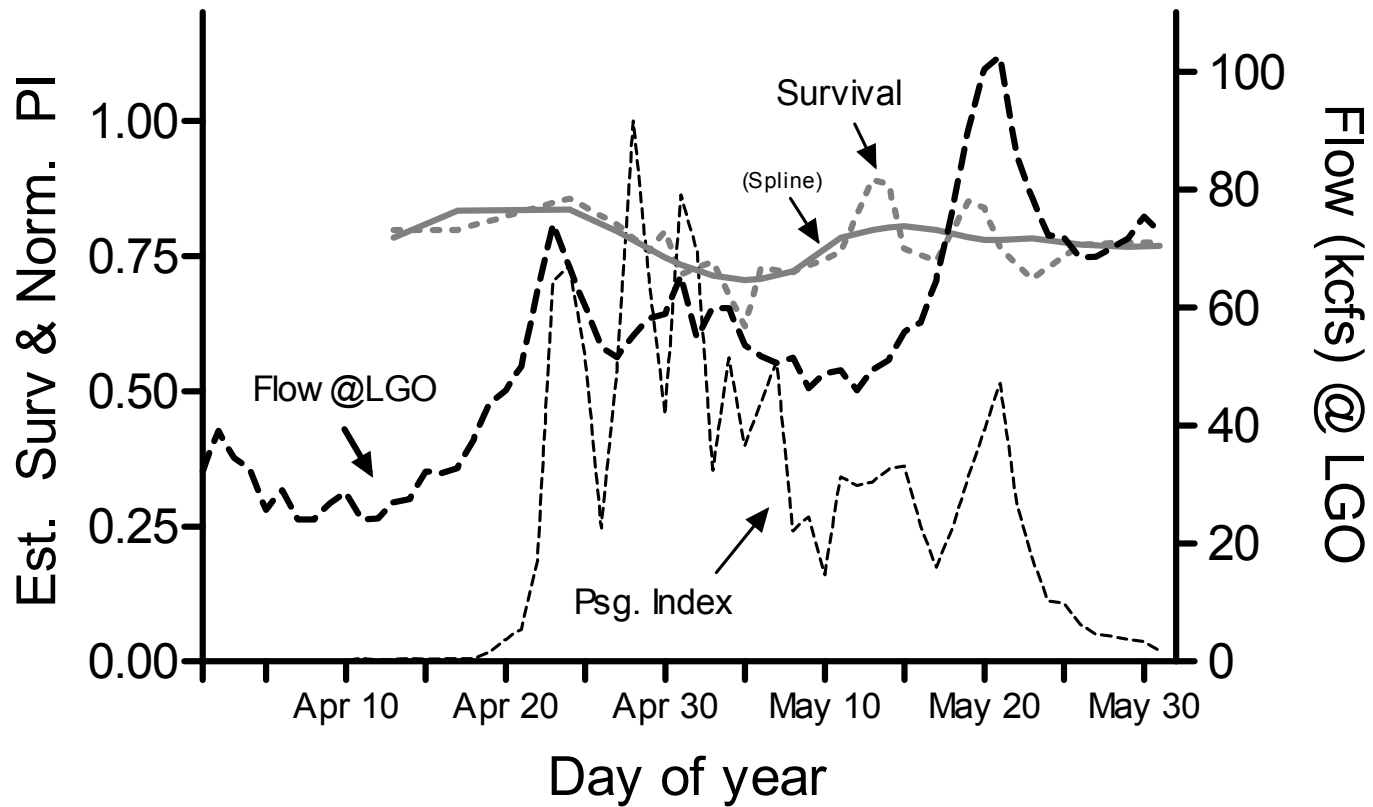


Figure 7. Estimated survival probability for yearling Chinook salmon from Lower Granite Dam to McNary Dam, flow volume at Little Goose Dam, and passage index at Lower Granite Dam (normalized: peak day = 1.0) by day of year, 2010. A curve showing a spline smooth of estimated survival is included.

Survival, Flow, Passage Index Steelhead 2010

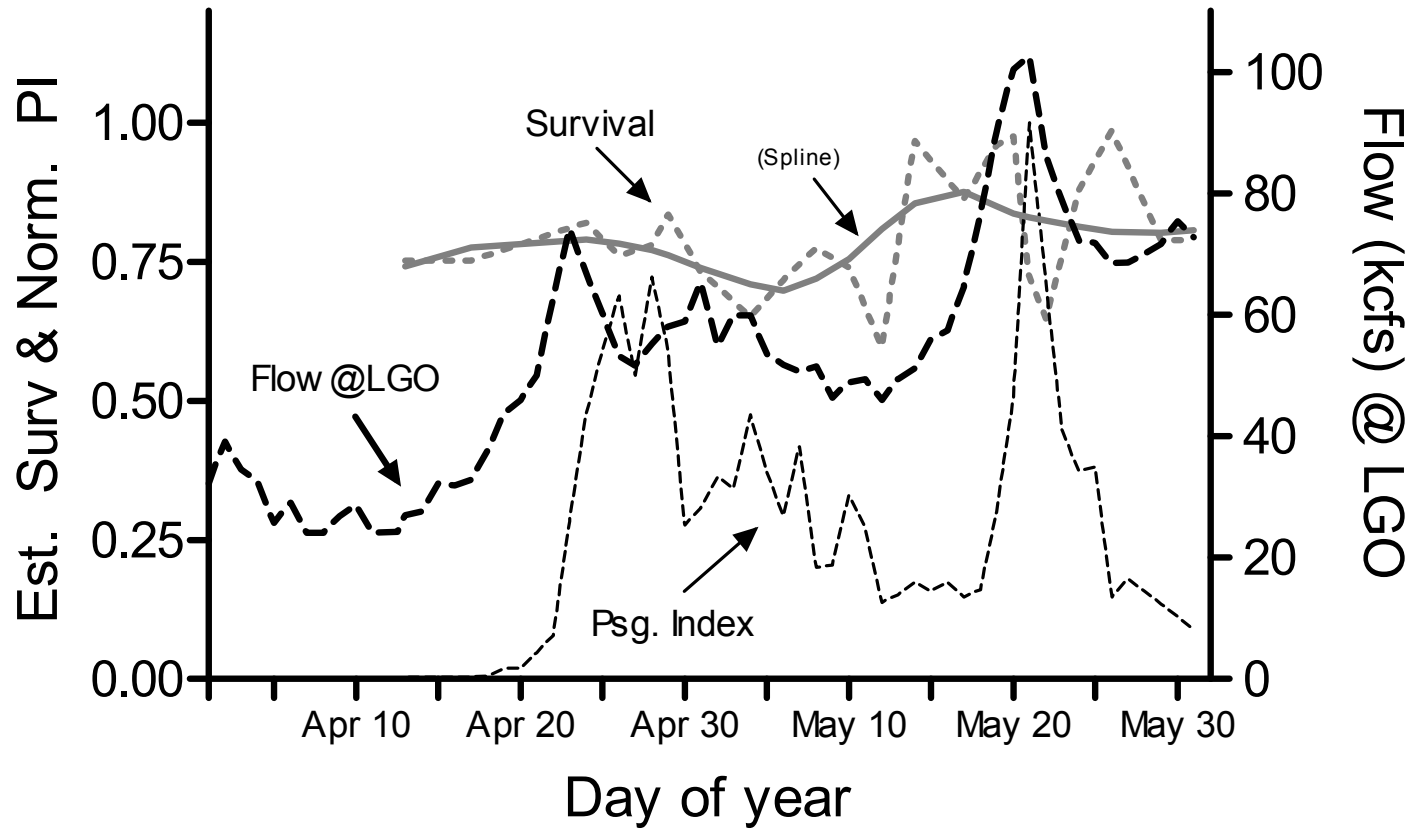
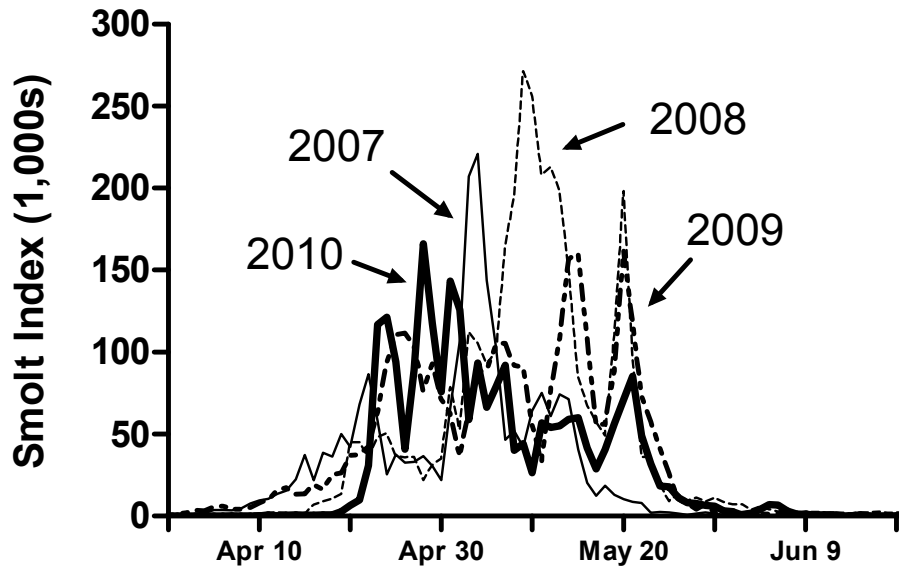


Figure 8. Estimated survival probability for steelhead from Lower Granite Dam to McNary Dam, flow volume at Little Goose Dam, and passage index at Lower Granite Dam (normalized: peak day = 1.0) by day of year, 2010. A curve showing a spline smooth of estimated survival is included.

Smolt Passage at Lower Granite Dam

Yearling Chinook



Steelhead

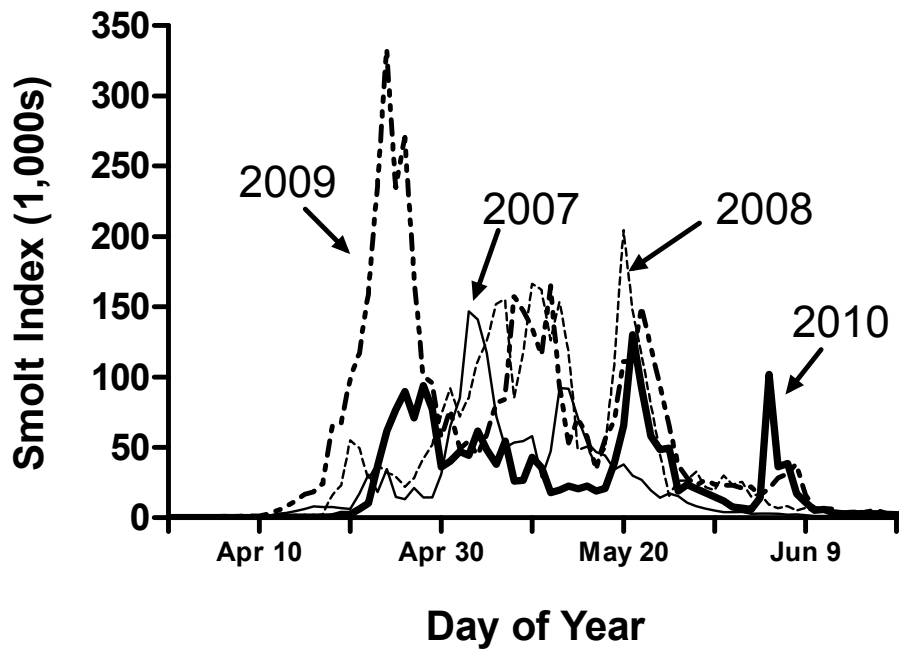


Figure 9. Smolt index in thousands at Lower Granite Dam 2007-2010 for hatchery and wild combined yearling Chinook and steelhead.