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November 1, 2005

MEMORANDUM FOR: F/NWR5 - Chris Toole
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, 2005

This memorandum summarizes estimated survival of PIT-tagged juvenile salmonids passing through Snake and Columbia River reservoirs and dams during the 2005 migration. Very few additional detections of yearling Chinook salmon and steelhead will occur, so these survival estimates are essentially final. Our completed detailed analyses and report for spring migrants will be available in December, 2005.

Summary of Research

For survival studies funded by BPA in 2005, NOAA Fisheries PIT tagged nearly 18,000 river-run hatchery steelhead, over 5,000 wild steelhead, and about 6,700 wild yearling Chinook salmon for release in the tailrace of Lower Granite Dam. From studies funded by the USACE, we used about 479,000 steelhead PIT tagged at hatcheries for release at various sites in the Upper Columbia River for evaluation of transportation at McNary Dam. Survival estimates provided in this memorandum are based on data from those fish PIT tagged by or for the Fish Ecology Division, as described above, as well as from fish PIT tagged by others for other purposes within the Columbia River Basin.

Survival in 2005 for yearling Chinook salmon from Snake River Basin hatcheries to Lower Granite Dam tailrace were similar to past years for most hatcheries (Table 1). The mean survival of 68% for index groups (release groups that most represent production releases from hatcheries that we've tracked from multiple years—Dworshak, Kooskia, Lookingglass/Imnaha Weir, Rapid River, and McCall/Knox Bridge) was slightly less than the 70% average for the previous 5 years, 2000-2004.

Estimated survival for Snake River yearling Chinook salmon (hatchery and wild combined) in 2005 was lower in some reaches than the average in recent years, and higher than average in

other reaches (Table 2, Figures 1 and 2). In particular, mean estimated survival from Lower Monumental Dam to McNary Dam was the highest of the last 5 years. Mean estimated survival for yearling Chinook salmon from Lower Granite Dam tailrace to McNary Dam tailrace was 73.2%, the second highest in the last five years. Mean estimated survival for yearling Chinook salmon from Lower Granite Dam tailrace to Bonneville Dam tailrace was 52.6% in 2005, slightly lower than in 2002 and 2003; considerably higher than in 2004; and nearly twice that in 2001.

For Snake River steelhead (hatchery and wild combined), estimated survival in 2005 was also lower through some reaches than the average in recent years and higher in others (Table 3, Figures 1 and 2). Also as for yearling Chinook salmon, mean estimated survival for steelhead from Lower Monumental Dam to McNary Dam was the highest of the last 5 years. However, for steelhead, the estimated survival for this reach in 2005 remained below the average of the 1995 through 2000 estimates (Figures 1 and 2).

Because of low detection rates of PIT-tagged steelhead at Bonneville Dam, caused by operation of the new corner collector at the Second Powerhouse, we were unable to estimate survival through the final reach, John Day Dam tailrace to Bonneville Dam tailrace. Consequently, we have no estimate of steelhead survival through the combined reach from Lower Granite Dam tailrace to Bonneville Dam tailrace in 2005. From Lower Granite Dam tailrace to McNary Dam tailrace, estimated steelhead survival (59.4%) was nearly equal to the five-year high observed in 2003 (59.7%). In the farthest downstream reach for which we could estimate survival for steelhead in 2005, from McNary Dam tailrace to John Day Dam tailrace, estimated survival was intermediate between the lower estimates in 2001 and 2004 and the higher ones in 2002 and 2003.

For PIT-tagged yearling Chinook salmon originating from the upper Columbia River in 2005, data were not sufficient to estimate survival from McNary Dam tailrace to Bonneville Dam tailrace. Estimated survival from McNary Dam tailrace to John Day Dam tailrace was 80.1%; higher than in 2004, but lower than in 2002 and 2003 (Table 4). The estimate for the same reach for yearling Chinook salmon originating in the Snake River Basin was almost identical (79.1%).

For PIT-tagged steelhead originating from the upper Columbia River in 2005, estimated survival from McNary Dam tailrace to Bonneville Dam tailrace was 53.3%; higher than in 2004, but lower than in 2003 (Table 5). Estimated survival for steelhead migrating from McNary Dam tailrace to John Day Dam tailrace was higher for migrants from the upper Columbia River (74.9%) than for those from the Snake River (62.3%). For fish released from upper Columbia River hatcheries, we cannot estimate survival in reaches within the hydropower system above 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.

Discussion

Following a year of depressed survival for Snake River yearling Chinook salmon in 2004, estimated survival through the entire hydropower system (including Lower Granite Dam reservoir) was higher in 2005, at 48.3%. This was only slightly lower than the average for the years 1995-2004, excluding the low-flow years of 2001 and 2004 (50.1%). For Snake River steelhead, survival remained lower than the 1995-2004 average as far downstream as we could measure it (all but through the last reach), though higher than in 2001 and 2004.

During April 2005, Snake River flows were about half-way between those in the low-flow years of 2001 and 2004 (Figure 3). Flow in 2005 increased rapidly beginning the first week of May. By 8 May average flow was the highest for that date in the last 5 years, and remained the highest of 2001-2005 until 24 May. Spill was not provided in substantial amounts at Snake River collector dams in 2005 until 17 May, and then only for 10 days. Spill occurred throughout the season at Ice Harbor Dam.

Estimated survival for daily groups of yearling Chinook salmon from Lower Granite Dam to McNary Dam was lowest during April, averaging around 63% (Figure 4). It was highest during the first week of May, as flow was increasing, reaching a peak of about 80%. This period of higher survival corresponding with the peak of the passage index. By the time flow reached its peak and spill began in mid-May, the passage index had declined considerably, and survival returned to about 65-70%.

Survival for steelhead remained particularly depressed in the Lower Monumental Dam tailrace to McNary Dam tailrace, as it has been since 2001, likely due to avian predation, primarily by Caspian terns. In 2001, about 21% of the PIT tagged steelhead passing Lower Monumental Dam were later detected on McNary pool bird colonies. Losses of PIT-tagged steelhead to avian predators in this reach were lower in 2002 through 2004, but still substantial. McNary pool bird colonies were just recently surveyed for PIT tags from the 2005 migration and data are not yet available.

With little or no spill provided at Snake River Dams for most juvenile salmonid migrants, detection rates (i.e., collection rates) were sufficiently high that almost all non-tagged smolts were collected and transported. Our preliminary estimates are that 96% of non-tagged spring-summer Chinook salmon smolts and 98.5% of non-tagged steelhead smolts that arrived at Lower Granite Dam were subsequently transported, either from Lower Granite Dam from one of the downstream collector dams. Survival estimates presented here are based on PIT-tagged fish that remained in the river. These fish either passed through turbines

or spillways (very few fish), or were intentionally returned to the river after detection in bypass systems. Therefore, these estimates are applicable only to that minority of non-tagged smolts that remained in river.

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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), 2003 through 2005.

Hatchery	2003		2004		2005	
	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	0.720 (0.008)	0.581 (0.009)	0.821 (0.003)	0.611 (0.015)	0.832 (0.003)	0.661 (0.016)
Kooskia	0.560 (0.043)	0.293 (0.026)	0.769 (0.017)	0.598 (0.065)	0.702 (0.021)	0.405 (0.051)
Lookingglass (Catherine Cr.)	0.347 (0.028)	0.316 (0.009)	0.254 (0.003)	0.204 (0.015)	0.233 (0.003)	0.194 (0.013)
Lookingglass (Grande Ronde)	0.438 (0.046)	0.347 (0.016)	0.514 (0.025)	0.449 (0.130)	0.150 (0.013)	0.096 (0.025) ??
Lookingglass (Imnaha River)	0.715 (0.012)	0.531 (0.015)	0.613 (0.004)	0.449 (0.201)	0.534 (0.004)	0.443 (0.022)
Lookingglass (Lostine River)	0.574 (0.030)	0.405 (0.012)	0.494 (0.004)	0.362 (0.016)	0.403 (0.005)	0.316 (0.018)
McCall (Johnson Cr.)	0.244 (0.009)	0.205 (0.015)	0.278 (0.004)	0.139 (0.018)	0.348 (0.006)	0.219 (0.023)
McCall (Knox Bridge)	0.573 (0.006)	0.488 (0.009)	0.559 (0.002)	0.397 (0.013)	0.603 (0.003)	0.479 (0.013)
Rapid River	0.691 (0.007)	0.534 (0.010)	0.694 (0.003)	0.462 (0.012)	0.735 (0.002)	0.572 (0.014)
Entiat	---	0.655 (0.010)	---	0.569 (0.010)	---	---
Winthrop	---	0.553 (0.014)	---	0.492 (0.022)	---	---
Leavenworth	---	0.637 (0.003)	---	0.493 (0.022)	---	---
Methow	---	0.508 (0.014)	---	0.484 (0.005)	---	---

Table 2.

Mean estimated survival and standard error (s.e.) through various reaches of the Snake and Columbia River hydropower system for yearling Chinook salmon originating in the Snake River, 2001 through 2005. Hatchery and wild fish combined.

Reach	2001	2002	2003	2004	2005
LGR-LGO	0.945 (0.004)	0.949 (0.006)	0.946 (0.005)	0.923 (0.004)	0.919 (0.004)
LGO-LMO	0.830 (0.006)	0.980 (0.008)	0.916 (0.011)	0.875 (0.012)	0.879 (0.006)
LMO-MCN	0.708 (0.007)	0.837 (0.013)	0.905 (0.017)	0.818 (0.018)	0.909 (0.013)
MCN-JD	0.758 (0.024)	0.907 (0.014)	0.893 (0.017)	0.809 (0.028)	0.791 (0.019)
JD-BON	0.645 (0.034)	0.840 (0.079)	0.818 (0.036)	0.735 (0.092)	0.922 (0.075)
LGR-MCN	0.556 (0.009)	0.757 (0.009)	0.731 (0.010)	0.666 (0.011)	0.732 (0.011)
MCN-BON	0.501 (0.027)	0.763 (0.079)	0.728 (0.030)	0.594 (0.074)	0.719 (0.046)
LGR-BON	0.279 (0.016)	0.578 (0.060)	0.532 (0.023)	0.395 (0.050)	0.526 (0.035)

Table 3.

Mean estimated survival and standard error (s.e.) through various reaches of the Snake and Columbia River hydropower system steelhead originating in the Snake River, 2001 through 2005. Hatchery and wild fish combined.

Reach	2001	2002	2003	2004	2005
LGR-LGO	0.801 (0.010)	0.882 (0.011)	0.947 (0.005)	0.860 (0.006)	0.939 (0.004)
LGO-LMO	0.709 (0.008)	0.882 (0.018)	0.898 (0.012)	0.820 (0.014)	0.868 (0.009)
LMO-MCN	0.296 (0.010)	0.652 (0.031)	0.708 (0.018)	0.519 (0.035)	0.722 (0.023)
MCN-JD	0.337 (0.025)	0.844 (0.063)	0.879 (0.032)	0.465 (0.078)	0.623 (0.034)
JD-BON	0.753 (0.063)	0.612 (0.098)	0.630 (0.066)	-----	-----
LGR-MCN	0.168 (0.006)	0.536 (0.025)	0.597 (0.013)	0.379 (0.023)	0.594 (0.018)
MCN-BON	0.250 (0.016)	0.488 (0.090)	0.518 (0.015)	-----	-----
LGR-BON	0.042 (0.003)	0.262 (0.050)	0.309 (0.011)	-----	-----

Table 4. Mean estimated survival and standard error (s.e.) through reaches of the lower Columbia River hydropower system for yearling Chinook salmon originating in the upper Columbia River, 2002 through 2005. Hatchery fish only (no wild fish tagged).

Reach	2002	2003	2004	2005
Release-MCN	0.540 (0.020) ^a	0.579 (0.029) ^b	0.511 (0.022) ^c	NA
MCN-JD	0.856 (0.012)	0.902 (0.025)	0.741 (0.038)	0.801 (0.056)
JD-BON	0.867 (0.079)	0.848 (0.091)	0.840 (0.111)	NA
MCN-BON	0.745 (0.069)	0.767 (0.069)	0.622 (0.063)	NA

- a. mean of estimates for fish released at Entiat, Winthrop, and Leavenworth hatcheries
- b. mean of estimates for fish released at Entiat and Winthrop hatcheries, and fish from Methow hatchery released in Twisp and Chewuch acclimation ponds.
- c. mean of estimates for fish released at Entiat, Winthrop, Leavenworth, and Methow hatcheries, and fish from Methow hatchery released in Chewuch acclimation pond.

Table 5. Mean estimated survival and standard error (s.e.) through reaches of the lower Columbia River hydropower system for steelhead originating in the upper Columbia River, 2003 through 2005. Hatchery fish only (no wild fish tagged).

Reach	2002	2003	2004	2005
Release-MCN	NA	0.475 (0.020) ^a	0.383 (0.018) ^b	0.449 (0.080) ^b
MCN-JD	NA	0.954 (0.047)	0.786 (0.059)	0.749 (0.047)
JD-BON	NA	0.786 (0.119)	0.623 (0.168)	0.755 (0.167)
MCN-BON	NA	0.695 (0.108)	0.496 (0.124)	0.533 (0.119)

- a. mean of estimates for fish from Chelan, East Bank, Entiat, Leavenworth, Methow, Wells, and Winthrop hatcheries released on various dates at numerous release sites.
- b. mean of estimates for fish from Chelan, East Bank, Ringold, Wells, and Winthrop hatcheries released at various locations.

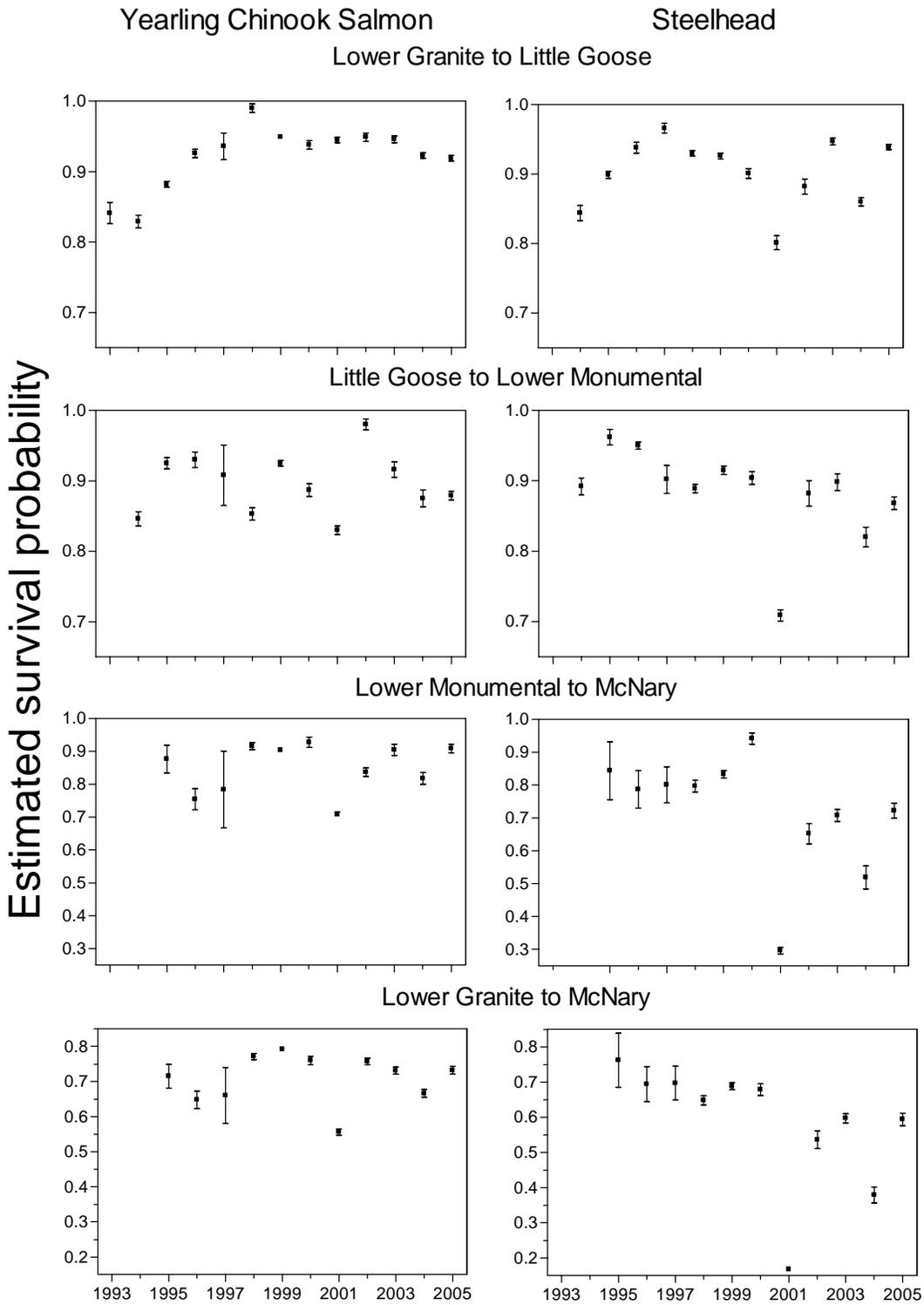


Figure 1. Annual average survival estimates for PIT-tagged yearling Chinook salmon and steelhead, hatchery and wild fish combined. Vertical bars represent plus/minus one standard error.

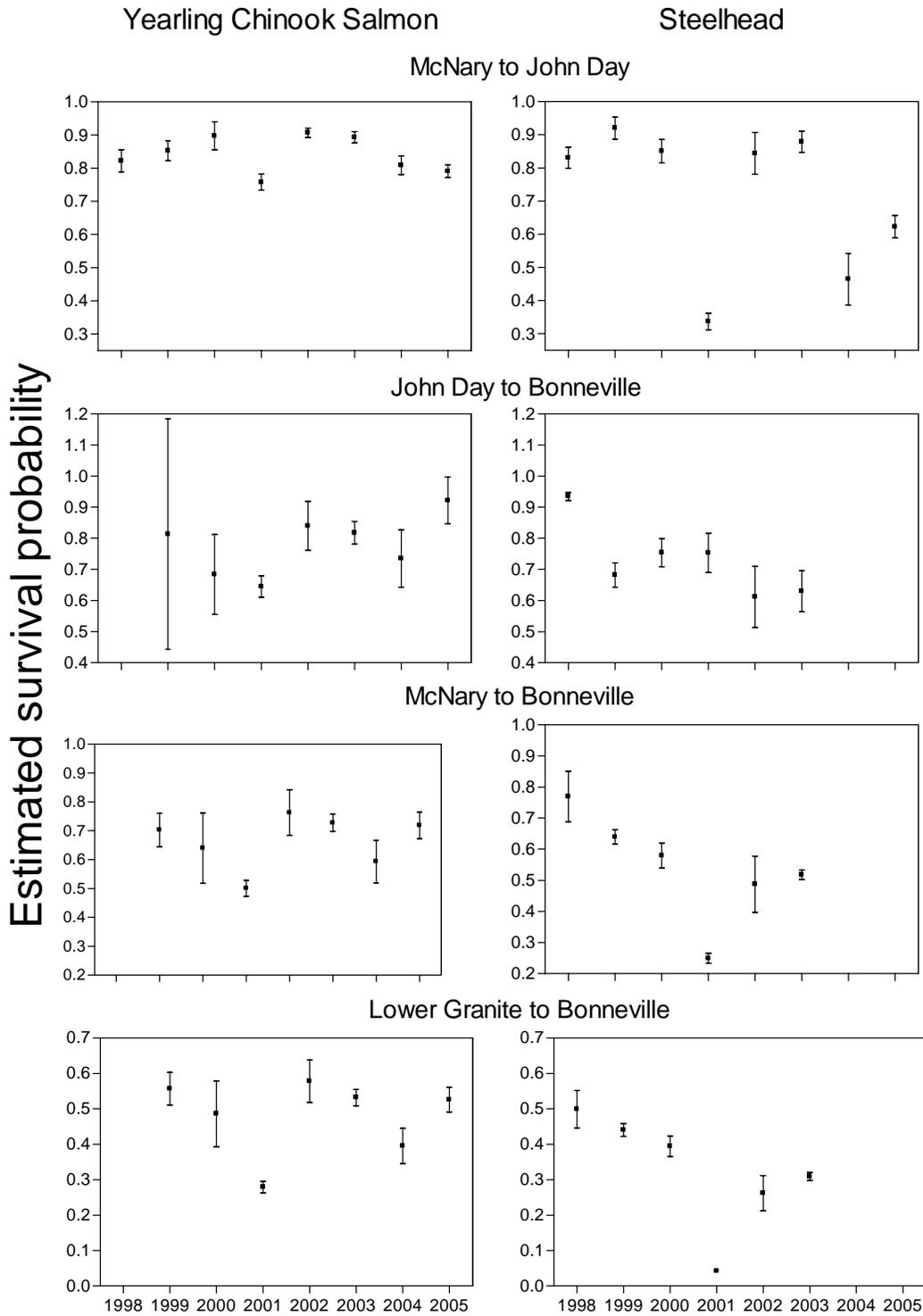


Figure 2. Annual average survival estimates for PIT-tagged yearling Chinook salmon and steelhead, hatchery and wild fish combined. Vertical bars represent plus/minus one standard error.

Little Goose Dam

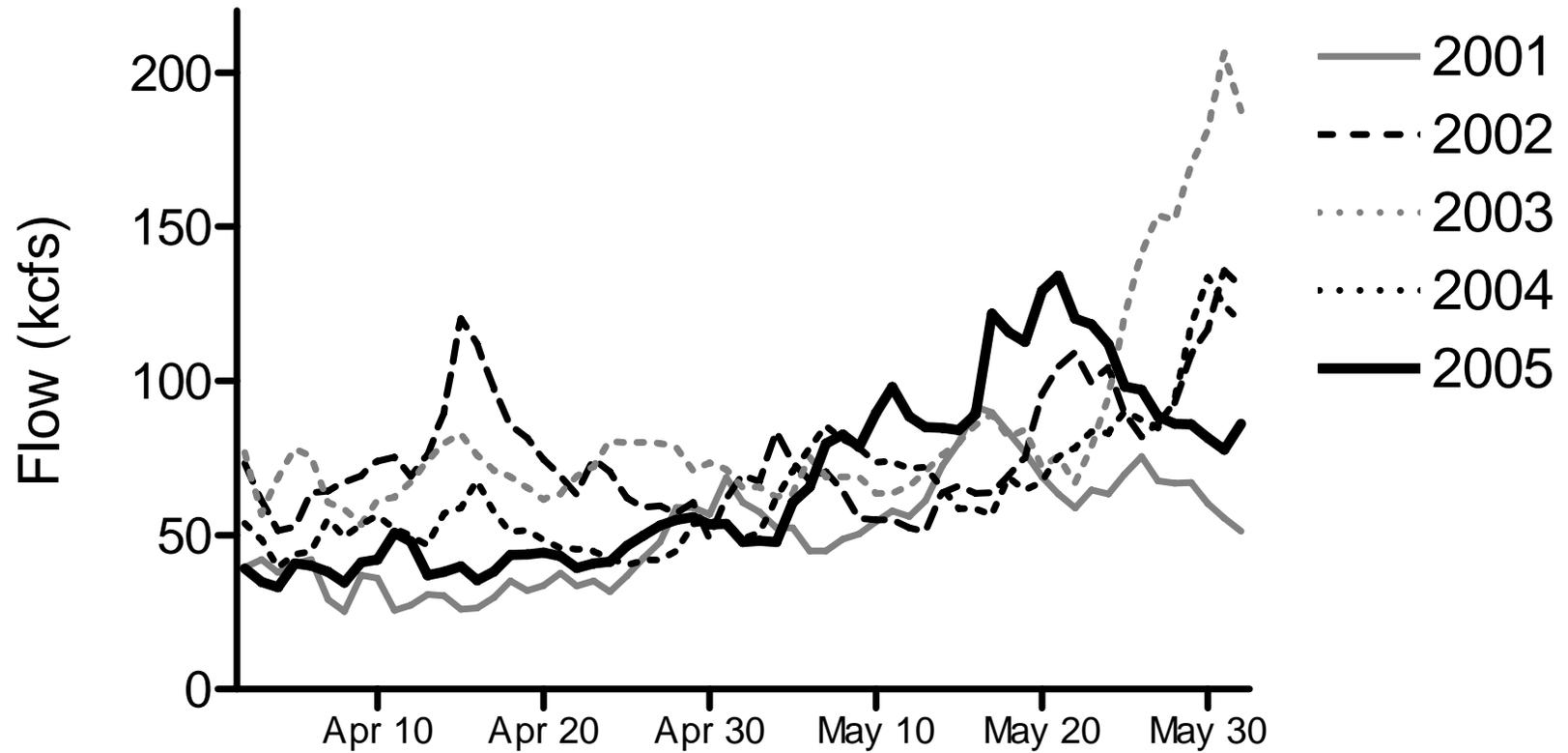


Figure 3. Snake River flow (kcfs) measured at Little Goose Dam during April and May, 2001-2005.

Survival, Flow, Passage Index

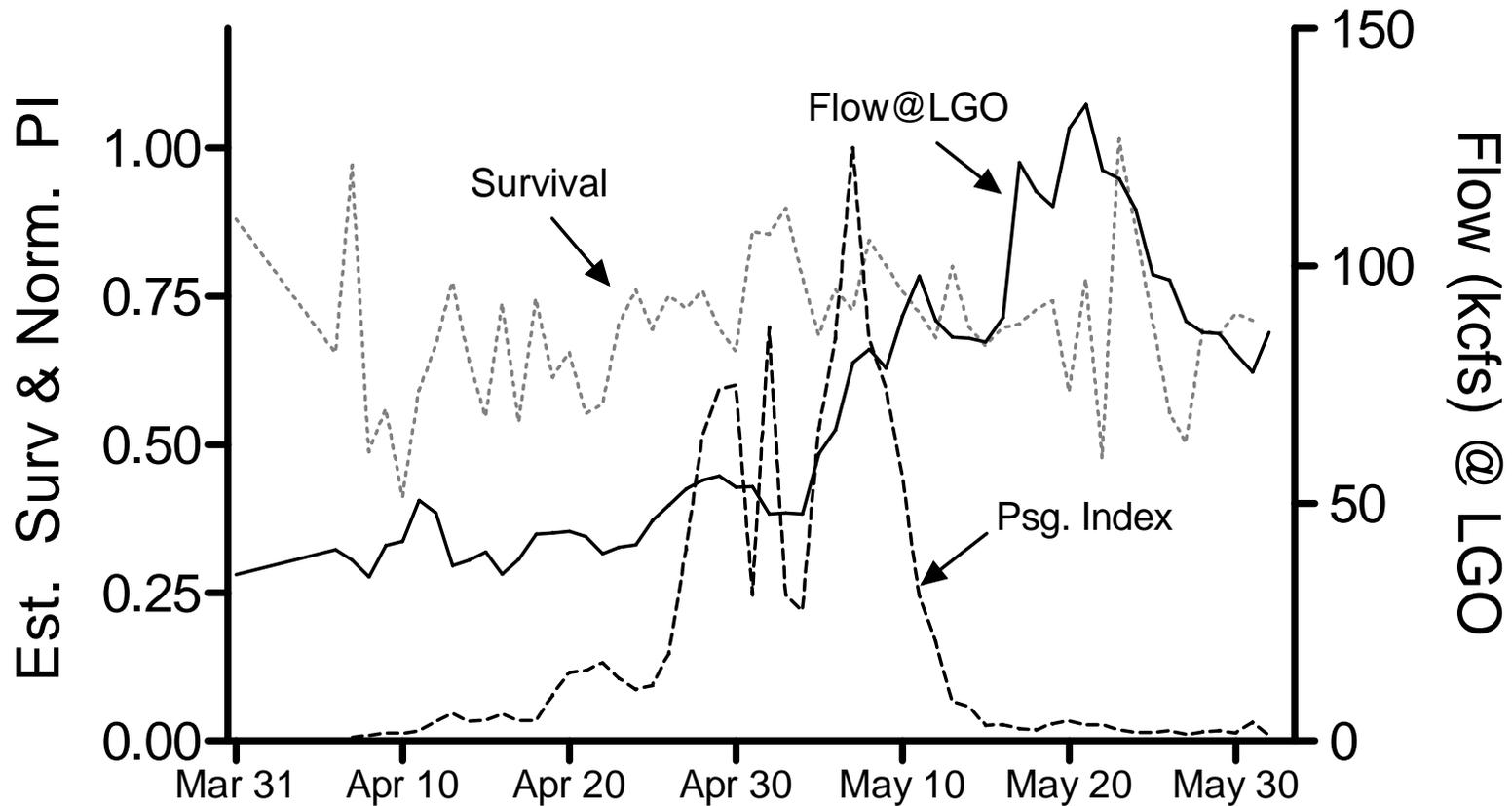


Figure 4. Estimated survival probability for yearling Chinook salmon from Lower Granite Dam to McNary Dam, flow volume at Little Goose Dam, and passage index at Lower Granite Dam (normalized: peak day = 1.0) by day of year, 2005. A curve showing a spline smooth of estimated survival is included.