



FISH PASSAGE CENTER

847 NE 19th Avenue, #250, Portland, OR 97232

Phone: (503) 833-3900 Fax: (503) 232-1259

www.fpc.org/

e-mail us at fpcstaff@fpc.org

MEMORANDUM

TO: Tucker Jones, ODFW

FROM: Michele DeHart

DATE: October 19, 2017

SUBJECT: Juvenile survival for Snake River sockeye

In response to your request, The Fish Passage Center (FPC) is providing estimates of juvenile survival for hatchery raised Snake River sockeye salmon for migration years 2009 to 2017. Additionally, we have included spring environmental conditions for years 2009-2017, and estimates of smolt-to-adult returns (SARs) for migration years 2009 to 2015. Our key results and conclusions based on the analysis of 2017 juvenile survival and historic survival rates and SARs are as follows:

- Snake River sockeye hatchery production has shifted to Springfield Hatchery since 2015, with production from Sawtooth and Oxbow hatcheries phasing out over the last couple of years. 2017 was the first year in which Springfield Hatchery raised sockeye comprised 100% of Snake River sockeye hatchery production.
- Springfield Hatchery sockeye releases in 2015, 2016, and 2017 have experienced several fish health problems that have affected juvenile survival. In 2016 and 2017, survival estimates were among the lowest on record, despite relatively favorable environmental conditions.
- The 2017 survival from release to Lower Granite Dam for Springfield Hatchery reared sockeye was 0.16. This 2017 estimate is the second lowest among the years we have estimates for hatchery Snake River sockeye (2009-2017).
- The 2017 survival from Lower Granite Dam to Bonneville Dam for Springfield Hatchery reared sockeye was 0.23. Over the nine years of available data, the LGR-BON survivals for Springfield releases in 2015, 2016, and 2017 are among the lowest.

- Survival from release to below Bonneville Dam for Springfield Hatchery reared sockeye was 3.7%, lower than all 9 years of available data except 2016's 1.0%.
- Migration year 2015 SAR estimates for Springfield and Sawtooth hatchery sockeye were 0.0% and 0.13%, respectively. As of July 22, 2017, no PIT-tagged Springfield Hatchery adults have been detected.

Methods:

In-River Juvenile Survival

Following the methodology outlined in the Draft 2017 Comparative Survival Study (CSS) Annual Report (McCann et al. 2017), we estimated juvenile survival of hatchery Snake River sockeye from release to Lower Granite Dam (S_1), from Lower Granite Dam to Bonneville Dam (LGR-BON) (S_r), and present the combined estimates for migration year 2017. For context, we also summarize these same estimates for migration years 2009-2016, which are provided in the Draft 2017 CSS Annual Report (McCann et al. 2017).

Environmental Variables

Environmental variables were summarized for the spring migration period spanning early April through the end of June for the years 2009-2017. Total flow at Ice Harbor dam as well as proportional spill levels for the four lower Snake River dams (LGR-LGS-LMN-ICH) are presented in Figure 1. Total flow at Bonneville dam as well as proportional spill levels for the four middle Columbia River dams (MCN-JDA-TDA-BON) are presented in Figure 2. Average spring temperatures (over the same periods) as measured in the tailrace of Lower Granite, McNary, and Bonneville dams are presented in Figure 3.

Lower Granite – Lower Granite (LGR-GRA): Smolt to Adult Return Ratio

Finally, we summarize SAR estimates for migration years 2009-2012 for Oxbow Hatchery (Oregon) reared sockeye, 2009-2015 for Sawtooth Hatchery reared sockeye, and 2015 for Springfield Hatchery reared sockeye. These estimates were provided in the Draft 2017 CSS Annual Report (McCann et al., 2017).

Results:

In-River Survival

S_1 estimates representing survival from release to Lower Granite Dam for hatchery, S_r estimates representing survival from Lower Granite Dam to Bonneville, and combined estimates for in-river survival from release to Bonneville ($S_{rel-BON}$) for hatchery Snake River sockeye from 2009-2017 are provided in Table 1. The 2017 S_1 juvenile survival estimate is 0.16, significantly less than the 2016 estimate of 0.32, and less than every comparable year except one (2010 Sawtooth). The S_r point estimate for 2017 was 0.23, significantly higher than the 2016 estimate but still considerably lower than every estimate available from Sawtooth Hatchery raised sockeye. Combined $S_{rel-BON}$ point estimate for 2017 was 0.04, the second lowest on record after 0.01 observed in 2016.

Table 1: Estimated in-river survival from release to LGR (S_1), LGR to BON (S_r), and combined release to BON ($S_{rel-BON}$) of PIT-tagged Snake River hatchery sockeye from Sawtooth (2009-2015) and Springfield (2015-2017) hatcheries (with 90% confidence intervals). All reach survival estimates are of combined T and R groups.

Migration Year	S_1		S_r		$S_{rel-BON}$	
	Sawtooth Hatchery	Springfield Hatchery	Sawtooth Hatchery	Springfield Hatchery	Sawtooth Hatchery	Springfield Hatchery
2009	0.47 (0.46-0.48)		0.64 (0.52-0.83)		0.30	
2010	0.15 (0.14-0.16)		0.50 (0.40-0.67)		0.08	
2011	0.73 (0.71-0.74)		0.44 (0.35-0.57)		0.32	
2012	0.59 (0.58-0.60)		0.35 (0.29-0.45)		0.21	
2013	0.55 (0.54-0.56)		0.51 (0.42-0.65)		0.28	
2014	0.53 (0.50-0.56)		0.52 (0.42-0.64)		0.28	
2015	0.48 (0.42-0.56)	0.31 (0.27-0.35)	0.41 (0.34-0.51)	0.22 (0.16-0.36)	0.20	0.07
2016		0.32 (0.29-0.36)		0.03 (0.02-0.04)		0.01
2017		0.16 (0.14-0.18)		0.23 (0.16-0.34)		0.04
Geo Mean	0.46	0.25	0.47	0.11	0.22	0.03

Environmental Variables

As measured at Ice Harbor, the 2017 spring flow volume of 22.2 MAF in 2017 was the highest among the nine years we analyzed, although 2011 was comparable with 22.1 MAF. Average spill during the 2017 migration period was also the highest among the nine years we analyzed across all projects, and higher than average at each individual project. The 2017 spring flow volume at BON was 63.1 MAF, and was slightly less than what was observed in 2011 (63.7 MAF). Average water temperatures in 2017 were within the ranges that have been observed over the past 9 years (Figure 3).

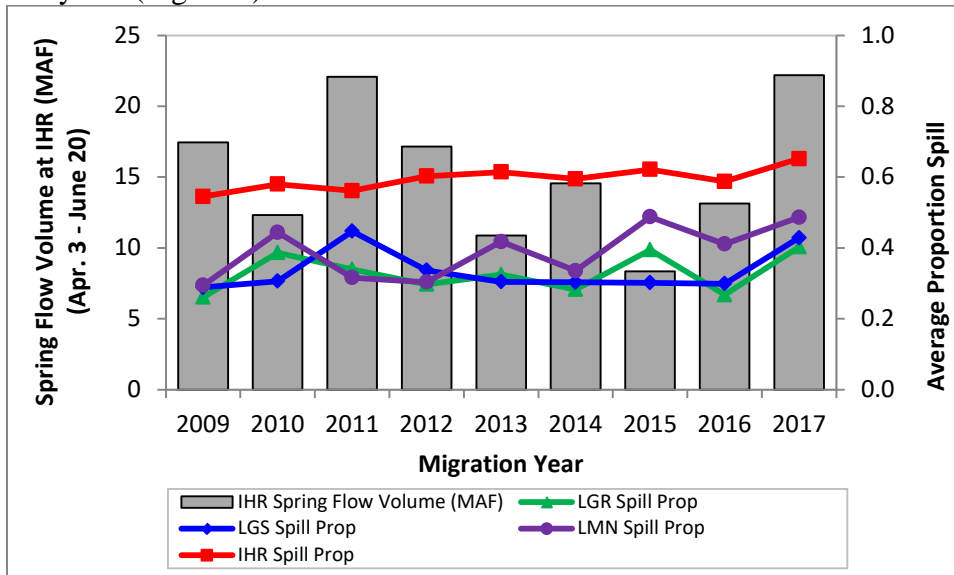


Figure 1: Spring flow volume (April 3-June 20) in the Snake River (at Ice Harbor Dam) and average spill proportion at Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams, 2009-2017.

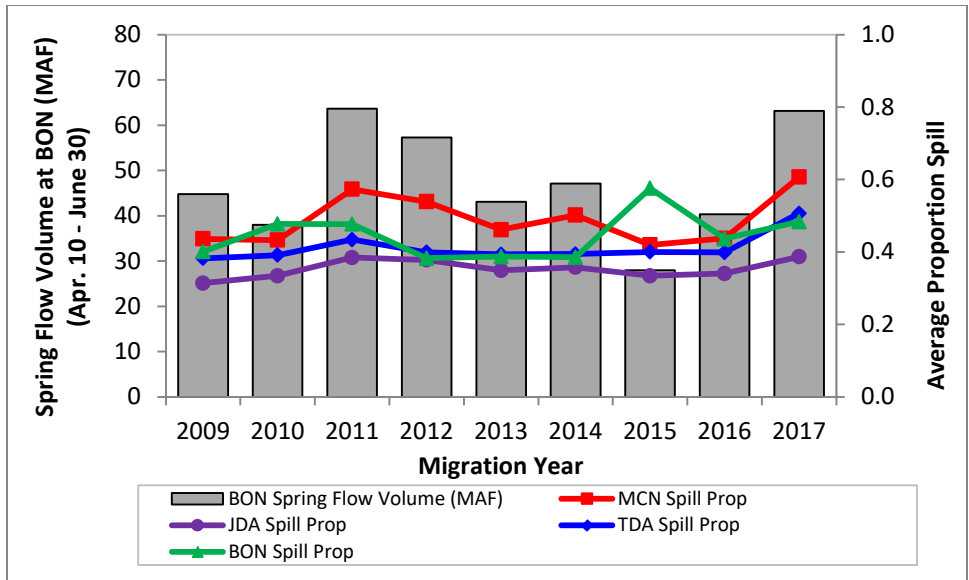


Figure 2: Spring flow volume (April 10-June 30) in the Middle Columbia (at Bonneville Dam) and average spill proportion at McNary, John Day, The Dalles, and Bonneville dams, 2009-2017.

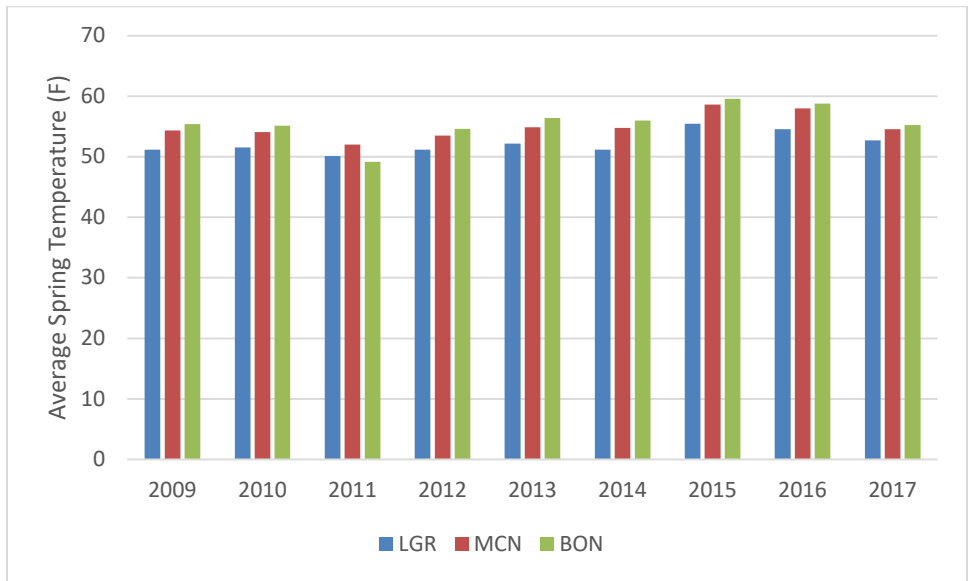


Figure 3: Average spring temperature at the tailrace at Lower Granite (Apr 3-June 20), McNary (Apr 10-June 30), and Bonneville (Apr 10-June 30) dams

Lower Granite – Lower Granite (LGR-GRA): Smolt to Adult Return Ratio

SAR estimates varied by year and hatchery group between migration years 2009-2015. However, as of July 22, 2017, no PIT-tagged Springfield hatchery raised adult sockeye from the 2015 out-migration have been detected. In contrast, estimated SAR for Sawtooth hatchery reared fish in migration year 2015 was 0.13%, which is slightly lower than the 6-year average, but within the range of estimates for 2009-2015. Oxbow hatchery lacked a sufficiently large PIT-tag release group to estimate SAR for 2015, although SAR estimates ranged from 0.39-2.26% within migration years 2009-2012.

Table 3: Overall LGR-GRA SARs for Snake River Hatchery Sockeye, 2009-2015 (SAWT=Sawtooth Hatchery, OXBH=Oxbow Hatchery, Oregon, SPRF=Springfield Hatchery)

Hatchery Juvenile migration year	Smolts arriving LGR	% SAR estimate	Non-parametric CI	
			90%LL	90%UL
SAWT-2009	17,224	1.15	1.02	1.29
SAWT-2010 ^B	----	---	---	---
SAWT-2011	26,238	0.1	0.06	0.13
SAWT-2012	21,420	0.12	0.08	0.15
SAWT-2013	19,224	0.15	0.11	0.2
SAWT-2014	18,444	0.46	0.38	0.54
SAWT-2015 ^C	16,841	0.13	0.09	0.18
<i>Geometric mean</i>		0.22	0.61	
<i>OXBH-2009</i>	2,214	2.03	1.52	2.56
<i>OXBH-2010^B</i>	---	---	---	---
<i>OXBH-2011</i>	5,442	0.39	0.25	0.54
<i>OXBH-2012</i>	4,857	2.26	1.81	2.75
<i>Geometric mean</i>		1.21	2.46	
<i>SPRF-2015^C</i>	10,572	0	0	0

^A Estimated population of tagged study fish alive to LGR tailrace (includes fish detected at the dam and those estimated to pass undetected) using Group T tags.

^B All PIT tagged sockeye were routed in-river. There were very few incidentally transported PIT-tagged fish for both groups,

therefore, estimate of overall SAR (LGR-to-GRA and LGR-to-BOA) was not possible.

^C Incomplete, 2-salt returns through July 22, 2017.

Discussion:

When interpreting the data from 2015-2017, it is important to note that there have been significant changes in the production of Snake River sockeye, beginning in migration year 2015. As noted above, survival of Snake River sockeye was lowest in 2016 and 2017, and relatively low in 2015, despite generally favorable environmental conditions (Figure 1-3). Prior to 2015, hatchery sockeye were reared at Sawtooth Hatchery and Oxbow Hatchery (Oregon) and released at or near Redfish Lake. In addition to Sawtooth and Oxbow reared fish, Springfield Hatchery began releasing hatchery sockeye at Redfish Lake in 2015. In 2016, releases of Sawtooth Hatchery reared sockeye were terminated and in 2017 releases of Oxbow Hatchery reared sockeye were also terminated. This meant that hatchery sockeye releases in 2016 were of Oxbow and Springfield reared fish and releases in 2017 were of Springfield reared fish only. Springfield Hatchery sockeye releases in 2015, 2016, and 2017 have experienced several fish health problems that have affected juvenile survival (McCann et al. 2017). Most notably, initial survival in 2017 from release at Redfish Lake to Lower Granite Dam (S_1) was 0.16, with subsequent in-river survival to Bonneville (S_r) of 0.23. While the low release to Lower Granite survival (S_1) that was observed in 2017 is comparable to what was observed in 2010 for Sawtooth reared fish ($S_1=0.15$), the subsequent LGR-BON survival estimate (S_r) for this Sawtooth group was considerably higher ($S_r=0.50$) than what was observed in Springfield reared fish in 2017. Therefore, the total in-river survival estimate for this Sawtooth group in 2010 was still considerably higher than what was observed for Springfield reared fish in migration years 2016 and 2017.

Literature Cited:

Fish Passage Center. 2017. Fish Passage Center 2016 Annual Report. BPA Contract #199403300. August 2017.

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