



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 fpcestaff@fpc.org

MEMORANDUM

TO: Stuart Ellis (CRITFC)

Michele DeHart

FROM: Michele DeHart

DATE: September 6, 2012

RE: Adult Sockeye survival in the Bonneville to McNary Dam Reach

In response to your request and comments, the FPC staff has conducted analyses of survival for PIT-tagged adult sockeye salmon from the Snake and Upper Columbia (UCOL) River Basins to determine whether the adult reach survival estimates from Bonneville Dam (BON) to McNary Dam (MCN) were different between the two stocks. To address the request, we have reviewed the adult PIT-tag data that were available for 2010, 2011, and 2012 returns. To address concerns that sockeye may migrate through the locks at dams, we estimated PIT-tagged adult sockeye survival (BON-MCN) using methodology that takes into account any fish that may have passed either BON or MCN dams undetected, but were detected at upstream adult detection sites.

We have also looked at other population characteristics that could be gleaned from the PIT-tag data, including: 1) the migration timing of PIT-tagged adults at BON and the travel time between BON and MCN, 2) the proportion of returning PIT-tagged Snake River sockeye adults that were transported as juveniles and whether the adult survival estimates (BON-MCN) for Snake River sockeye adults were different between those that migrated in-river versus those that were transported as juveniles, and 3) the ladder usage of PIT-tagged UCOL and Snake River sockeye adults at BON and MCN. Below is a brief summary of our findings, followed by a more detailed discussion of the analyses and results.

- Using a methodology that accounts for PIT-tagged sockeye adults that were undetected at BON and/or MCN, but were detected upstream of MCN, allowed for a more precise estimate of adult survival through the BON to MCN reach.

- There were no significant differences in adult reach (BON-MCN) survival estimates between PIT-tagged Snake River sockeye adults and UCOL sockeye adults from the 2010, 2011, and 2012 PIT-tag returns.
- PIT-tagged sockeye adults from the UCOL generally arrive at BON earlier (up to several days) than those from the Snake River.
- Travel times (BON-MCN) of PIT-tagged Snake River, UCOL, and BONAFF sockeye adults are very similar.
- Few PIT-tags were available for Snake River sockeye adults that were transported as juveniles. However, there was no difference in adult survival estimates (BON-MCN) for PIT-tagged Snake River sockeye that migrated in-river versus those that were transported as juveniles.
- For the 2012 return, ladder usage at BON was relatively equal for PIT-tagged Snake River and UCOL sockeye adults, with the vast majority of adults being detected in the Washington shore and Bradford Island ladders and very few being detected in the Cascade Island ladder.
- For the 2012 return, ladder usage at MCN was not equal between PIT-tagged sockeye adults from the Snake River, UCOL, and BONAFF. Snake River sockeye were detected on the Oregon side more frequently (76% of time), whereas UCOL and BONAFF used both ladders evenly.
- Based on the capture histories that were generated for the survival analyses, there appears to be evidence that some PIT-tagged sockeye adults are passing projects undetected, possibly due to passage through the navigation locks.

Methods:

Adult Survival (BON-MCN)

FPC staff estimated adult reach survivals (BON-MCN) for PIT-tagged adult sockeye that were detected at any of the adult PIT-tag detection facilities on the Columbia and Snake rivers. Separate reach survival estimates were done for three different groups, Snake River sockeye adults, Upper Columbia sockeye adults, and adult sockeye that were captured, tagged, and released at the Bonneville Adult Fish Facility (BONAFF) over three separate return years (2010, 2011, and 2012). Returns of PIT-tagged sockeye adults in 2012 were through August 10, 2012.

For Snake River sockeye we used all returning adults that were PIT-tagged and released as juveniles above Lower Granite Dam. For Upper Columbia sockeye, we used all returning adults that were PIT-tagged and released as juveniles at or above the Rock Island Dam bypass facility. Sockeye adults that were captured, PIT-tagged, and released at the BONAFF were considered a separate group, since they could potentially be a mix of Snake and Upper Columbia stocks.

Single-release mark-recapture survival estimates were generated using Cormack-Jolly-Seber (CJS) methodology as described by Burnham et al. (1987) with the MARK program. For each group, capture histories were developed based on where the PIT-tagged adult was detected, including adult detections above MCN. Detections upstream of MCN can occur at Priest Rapids Dam, Rock Island Dam, and/or Wells Dam for UCOL sockeye adults and Ice Harbor Dam and/or Lower Granite Dam for Snake River sockeye adults. Including detections above MCN in the capture histories address the potential for a PIT-tagged sockeye adult to pass a hydroproject

undetected (e.g., through the locks), as the survival estimate will account for these undetected fish that were later detected up-stream.

For the returning PIT-tagged Snake River sockeye adults, we estimated the proportion that were transported as juveniles. In addition, we estimated separate reach survivals (BON-MCN) for those that migrated in-river versus those who were transported as juveniles. Reach survivals were based on the same capture histories above. We did this for all three return years (2010, 2011, and 2012).

Adult Arrival Timing to BON, Adult Travel Times (BON-MCN), and Adult Ladder Usage:

Arrival Timing at BON:

To determine to what degree Snake and UCOL sockeye adults have different arrival timing at BON, we relied on PIT-tag detections at BON. Arrival timing at BON was estimated for return years 2010, 2011, and 2012. We did not estimate arrival timing for BONAFF sockeye adults, as these fish are tagged and released at BON and the timing of releases is based on when enough fish are present for tagging operations and daily quotas and off periods (i.e., weekends) could influence the release timing of these fish.

Adult Travel Times (BON-MCN):

For those PIT-tagged adults that were detected at both BON and MCN, we estimated median fish travel time to determine whether Snake and UCOL sockeye adults have different travel times through the Lower Columbia River. Median fish travel time was also estimated for sockeye adults that were PIT-tagged and released at BONAFF, based on their release date and subsequent detection at MCN.

Adult Ladder Usage:

We summarized ladder usage at BON and MCN for the PIT-tagged sockeye adults from the Snake, UCOL, and BONAFF groups. Ladder usage was based on the first detection for each detected PIT-tagged adult. Adult ladders at BON were broken into three categories, Washington Shore, Cascade Island, or the Bradford Island shore. Ladder usage at BON was not evaluated for BONAFF sockeye adults because all of these adults are collected from the ladder on the Washington shore. Adult ladders at MCN were broken into two categories, Washington Shore or Oregon shore. Ladder usage at MCN was evaluated for all three release groups.

Results:

Adult Survival (BON-MCN)

Snake River, UCOL, and BONAFF sockeye adults:

Adult reach survival (BON-MCN) estimates for the 2010 and 2011 PIT-tagged sockeye returns were similar same for all three groups (Table 1, Figure 1), with no significant differences. For the 2012 PIT-tagged sockeye adult return, the adult reach survival estimate for the UCOL group was higher than that for the Snake River group (Table 1, Figure 1). However, this difference in survival was not significant, as the confidence intervals overlap. The 2012 reach survival estimates for the Snake and UCOL groups were significantly lower than the BONAFF

group (Table 1, Figure 1). Based on upstream detections, it appears that all of the sockeye adults that were PIT-tagged and released from the BONAFF and survived to MCN in 2012 were of UCOL origin, as none of these PIT-tagged fish were detected at IHR or LGR as adults.

Table 1. Adult reach survivals (BON-MCN) for PIT-tagged Snake River, Upper Columbia, and BONAFF sockeye adults returning in 2010, 2011, and 2012

Group	Return Year	Adult Survival BON-MCN	95% Confidence Interval	
			Lower CI	Upper CI
BONAFF	2010	0.81	0.78	0.84
	2011	0.75	0.71	0.78
	2012	0.83	0.81	0.84
SNAKE	2010	0.85	0.74	0.96
	2011	0.68	0.64	0.72
	2012	0.60	0.51	0.68
UCOL	2010	0.81	0.79	0.84
	2011	0.69	0.65	0.72
	2012	0.72	0.68	0.75

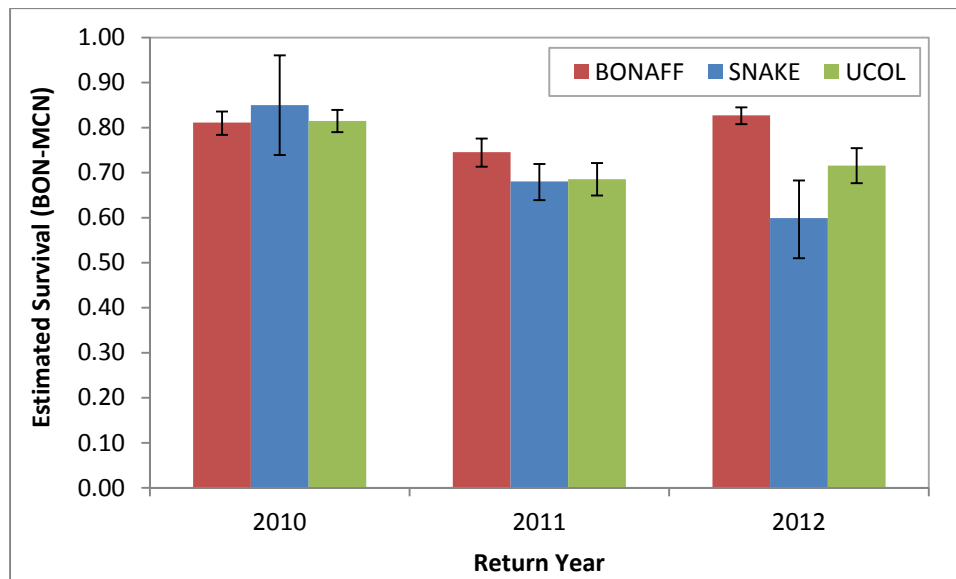


Figure 1. Adult reach survivals (BON-MCN) for PIT-tagged Snake River, Upper Columbia, and BONAFF sockeye adults returning in 2010, 2011, and 2012. Error bars represent 95% confidence intervals.

Arrival Timing to BON:

Table 2 summarizes the estimated 10%, 50%, and 90% arrival dates at Bonneville Dam for PIT-tagged Snake River and Upper Columbia River sockeye adults. These arrival timing data are also presented in Figure 2. In all three years we analyzed, PIT-tagged UCOL adults were seen at BON earlier than those from the Snake River (Figure 2).

Furthermore, not until well past the 90% passage date did the Snake River sockeye adults seem to catch up in their timing to BON. Finally, for return year 2012, there seemed to be a

larger separation in timing for the first half of the sockeye run. For example, the 50% passage date of Snake River sockeye adults was about 8 days later than that for the UCOL adults. This difference in the 2010 and 2011 return years was only 5 days (Table 2).

Table 2. Estimated 10%, 50%, and 90% arrival dates for PIT-tagged Snake River and UCOL sockeye adults detected at BON in 2010, 2011, and 2012.

Return Year	Group	Estimated Arrival Dates		
		10%	50%	90%
2010	Snake	19-Jun	28-Jun	10-Jul
	UCOL	17-Jun	23-Jun	4-Jul
2011	Snake	26-Jun	4-Jul	12-Jul
	UCOL	21-Jun	29-Jun	8-Jul
2012	Snake	23-Jun	3-Jul	12-Jul
	UCOL	17-Jun	25-Jun	6-Jul

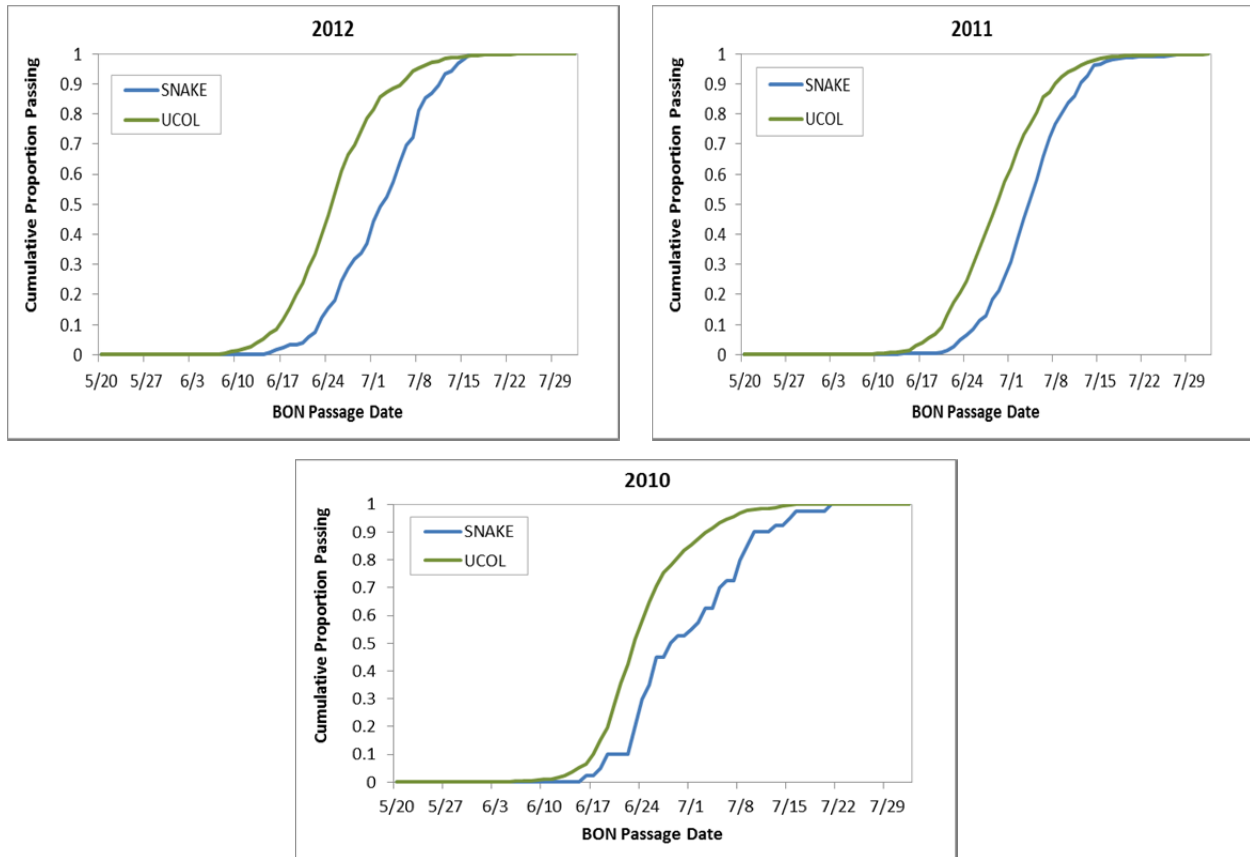


Figure 2. Adult arrival timing for PIT-tagged Snake River and Upper Columbia sockeye adults detected at BON in 2010, 2011, and 2012.

Adult Travel Times (BON-MCN):

There appears to be very little variation in median adult travel times (BON-MCN) between years and groups. Across all three return years (2010-2012), and all three groups

(Snake, UCOL, and BONAFF), the median adult travel time (BON-MCN) only ranged from 6.1 days to 7.0 days (Table 3). Furthermore, within a single return year, there appears to be very little difference (less than one day) in median adult travel times (BON-MCN) between Snake, UCOL, or BONAFF sockeye adults that are detected at both BON and MCN (Table 3).

Table 3. Minimum, maximum, and median travel times (BON-MCN) for PIT-tagged Snake River, UCOL, and BONAFF sockeye adults.

Return Year	Group	Travel Time (days)				
		Minimum	Maximum	Median	Lower CI	Upper CI
2010	BONAFF	4.4	17.1	6.1	6.1	6.2
2011	BONAFF	5.4	21.5	6.8	6.8	6.9
2012	BONAFF	4.8	25.9	6.4	6.3	6.7
2010	SNAKE	4.7	10.3	6.2	5.6	6.8
2011	SNAKE	5.4	26.6	7.0	6.9	7.1
2012	SNAKE	5.1	17.4	6.7	6.4	7.0
2010	UCOL	4.5	17.4	6.2	6.1	6.3
2011	UCOL	4.9	22.9	7.0	6.8	7.0
2012	UCOL	5.0	20.0	6.7	6.5	6.9

Snake River Sockeye Adult Survival – In-River vs. Transported:

For the 2012 return, only about 9% of the PIT-tagged Snake River sockeye adults that were detected at BON were transported as juveniles (Table 4). The low “proportion transported” for return year 2012 is due to a few different factors. First, adult sockeye returning in 2012 would have out-migrated in 2009, 2010, and 2011, with the majority returning after two years in the ocean (i.e., migration year 2010) (Tuomikoski et. al., 2012). In migration year 2010, there was an issue with the pre-assignment of PIT-tagged Snake River sockeye juveniles. During transport operations, approximately 70% of the juveniles that were detected at the transportation sites were to be loaded onto the barge, while the remaining 30% were to be returned to the river. However, this pre-assignment did not get uploaded to PTAGIS in time. As a result, nearly all PIT-tagged Snake River sockeye juveniles in 2012 followed the default operation and were returned to the river. Second, recent analyses (Tuomikoski et. al., 2012) revealed that hatchery sockeye reared at Sawtooth Hatchery rarely return after only one year in the ocean while those reared at Oxbow Hatchery routinely return after only one year. In recent years, the majority of PIT-tagged Snake River sockeye are from the Sawtooth Hatchery release, which means that we would not expect to see the 2011 out-migrants from the Sawtooth Hatchery release group until 2013.

For the 2012 PIT-tagged Snake River sockeye adults, the estimated adult reach survivals (BON-MCN) were 0.60 for those that out-migrated in-river and 0.55 for those that were transported as juveniles (Table 4, Figure 3). The difference in reach survivals between these two groups is not statistically significant, as the confidence intervals overlap.

For the 2011 return, approximately 41% of the returning PIT-tagged Snake River sockeye adult were transported as juveniles (Table 4). The estimated adult reach survivals (BON-MCN) for the 2011 returns were 0.67 for those that migrated in-river and 0.69 for those that were transported as juveniles (Table 4, Figure 3). As with the 2012 return, the adult reach survivals for in-river migrants are not significantly different from those for transported fish. Finally,

approximately 20% of the PIT-tagged Snake River sockeye adults that returned in 2010 were transported as juveniles (Table 4). The estimated adult reach survivals (BON-MCN) for the 2010 returns were 0.84 for those that migrated in-river and 0.88 for those that were transported as juveniles (Table 4, Figure 3). Again, the adult reach survivals for in-river migrants are not significantly different from those for transported fish.

Table 4. Number of PIT-tagged Snake River sockeye adult detections at BON and MCN and estimated adult reach survival (BON-MCN) for return years 2010, 2011, and 2012, based on juvenile out-migration route (i.e., transported or in-river). Numbers in parentheses are 95% confidence intervals.

Return Year	BON Detections		MCN Detections		Estimated Reach Survival (BON-MCN)	
	In-River	Transp.	In-River	Transp.	In-River	Transp.
2012	111	11	64	6	0.60 (0.51-0.69)	0.55 (0.25-0.84)
2011	306	210	198	145	0.67 (0.62-0.72)	0.69 (0.62-0.75)
2010	32	8	27	7	0.84 (0.72-0.97)	0.88 (0.65-1.10)

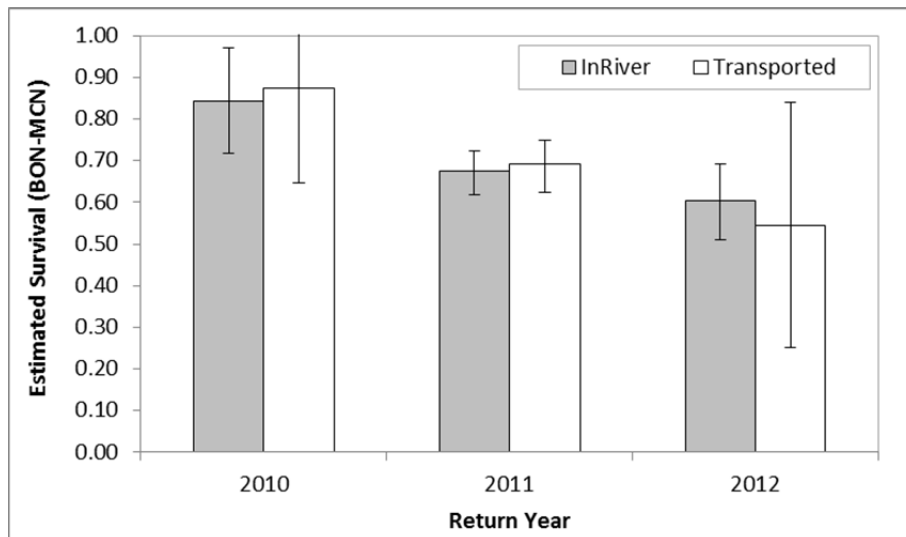


Figure 3. Adult reach survivals (BON-MCN) for PIT-tagged Snake River sockeye adults that out-migrated in-river versus those that were transported as juveniles. Error bars represent 95% confidence intervals.

Adult Arrival Timing to BON, Adult Travel Times (BON-MCN), and Adult Ladder Usage:

Adult Ladder Usage:

Based on first time adult detections at BON, it appears that there was no difference in ladder usage between Snake River sockeye adults and those from the UCOL (Table 5) in 2012. For both groups, the proportion of PIT-tagged adults that were first detected at the Washington Shore ladder ranged from 0.51 to 0.52. This proportion for the Bradford Island ladder ranged from 0.42 (Snake) to 0.46 (UCOL). Finally, very few PIT-tagged adult sockeye were first detected at the Cascade Island ladder (range of 0.02-0.06).

Table 5. Ladder usage of PIT-tagged Snake River and UCOL sockeye adults detected at Bonneville Dam in 2012. Ladder usage was based on the first detection for each adult.

Group	Ladder	Total Detected	Proportion
Snake R.	Bradford Island	56	0.46
	Cascade Island	3	0.02
	WA Shore	63	0.52
UCOL	Bradford Island	218	0.42
	Cascade Island	31	0.06
	WA Shore	264	0.51

Based on first time adult detections at MCN, it appears that there was a difference in ladder usage between Snake River sockeye adults and those from the UCOL and BONAFF (Table 6) in 2012. Approximately 76% of the Snake River sockeye adults detected at MCN in 2012 were first detected on the Oregon side, while only 24% were first detected on the Washington side. For UCOL and BONAFF adults, the split between the Washington and Oregon sides was even (Table 6).

Table 6. Ladder usage of PIT-tagged Snake River, UCOL, and BONAFF sockeye adults detected at McNary Dam in 2012. Ladder usage was based on the first detection for each adult.

Group	Ladder	Total Detected	Proportion
Snake R.	Washington	17	0.24
	Oregon	53	0.76
UCOL	Washington	183	0.50
	Oregon	182	0.50
BONAFF	Washington	641	0.49
	Oregon	670	0.51

Discussion:

Based on the analyses conducted for this data request, we found no evidence of significant differences in adult reach survival (BON-MCN) between PIT-tagged sockeye adults from Snake River versus those from the Upper Columbia River. However, for the 2012 return, we did find that the sockeye adults that were captured, PIT-tagged, and released at the Bonneville Adult Fish Facility had significantly higher adult survival (BON-MCN) than both the Snake River and UCOL adults. The cause of this higher survival in 2012 is unclear. Since these fish are captured and tagged as adults at the BONAFF, there may be some inherent selection for adults that are in better condition. Return year 2012 was the only year where we saw a significantly higher adult reach survival for this group.

Based on the capture histories that were generated for the survival analyses, there appears to be evidence that some PIT-tagged sockeye adults are passing projects undetected, possibly due to passage through the navigation locks. For example, a total of 123 PIT-tagged Snake River sockeye adults were used in the survival estimates for the 2012 return. Of these, one was not detected at BON (though later detected at MCN, IHR, and LGR) and four were not detected at

MCN (though later detected at IHR and/or LGR). Furthermore, 516 PIT-tagged UCOL sockeye adults were used in the 2012 survival estimates. Of these, three were undetected at BON (though later detected at MCN, PRD, RIS and/or WEL) and five were undetected at MCN (though later detected at PRD, RIS, and/or WEL). This is an important point because it highlights the limitations of using dam counts or PIT-tag counts to estimate conversion rates between two projects, particularly for sockeye adults. The use of actual detection histories is more advisable, since this methodology accounts for undetected fish when estimating reach survivals.

References:

Burnham, K.P., D. R. Anderson, G.C. White, C. Brownie, and K.H. Pollock. 1987. Design and analysis methods for fish survival experiments based on release-recapture. American Fisheries Society Monograph 5. Bethesda, MD. 437 pp.

Tuomikoski, J., J. McCann, B. Chockley, H. Schaller, S. Haeseker, J. Fryer, C. Petrosky, E. Tinus, T. Dalton, and R. Ehlke. 2012. Comparative survival study (CSS) of PIT-tagged spring/summer/fall Chinook, summer steelhead, and sockeye, DRAFT 2012 Annual Report. Project No. 19960200.

http://www.fpc.org/documents/CSS/2012%20CSS%20Annual%20Report_draft.pdf



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

DATA REQUEST FORM

Request Taken By: Michele Deltart Date: 10-Aug-2012

Data Requested By:

Name: Stuart Ellis (CRITFC) Phone: _____
Address: _____ Fax: _____
Email: _____

Data Requested:

Conversion rates of Snake River sockeye vs.
UCOL or BONAFF sockeye.
Any ideas as apparent differences?
How many of Snake River sockeye adults were
transported?

Data Format: Hardcopy Text Excel
Delivery: Mail Email Fax Phone

Comments:

Data Compiled By: [Signature] Date: 6-Sept-2012

Request # 49