Lower Columbia River Dam Fish Ladder Passage Times, 2003

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As per your request, we have assembled passage times at Lower Columbia River fish ladders. Ladder passage times are defined from the point fish last leave the transition pool until their last record at the top of the ladder at the exit to the forebay.

Ladder passage times ranged between 2 to 4 hours for most fish (Figures 1-3). Median and mean passage times during 2003 were similar to those observed in previous years (Peery, 2003). We found a higher degree of variability in steelhead passage times in the north ladder at John Day Dam (coefficient of variation CV = 459) as there were several steelhead with longer travel times (10-700 hrs). Less variability was observed in other ladders (CV ranged from 58 at The Dalles north ladder to167 at McNary north ladder) Variability in ladder passage times at all fish ladders were less for spring, summer, and fall Chinook salmon.

Ladder passage times formed a binomial distribution with the deviation from normality being greater for those fish with longer passage times (Figures 4-6). Longer passage times were the result of some fish spending extended periods of time (> 7 hrs) in the upper portion of the fish ladder. Since these fish with longer passage times did not exhibit different behavior (e.g., falling back through the fish ladder or over the dam and re-ascending the ladder) passage times for all individuals at each ladder were pooled for analysis. Each ladder passage time in the binomial distribution was $\log_{10}$ transformed resulting in a nearly normal distribution. A multisample median test (Zar 1999) was performed to test for differences in the grand median. Median test tabulates the number of passage times above and below the grand median for each ladder. The significance is then analyzed by chi-square. We found a significant difference in median passage times for all groups (Table 1). Tukey-type multiple comparisons were used to test for differences in passage times among fish ladders. Confidence intervals were calculated for each population median and multiple comparisons were made based on populations with overlapping confidence intervals (Table 2).

Table 1. Results of multisample median tests.

Species	Chi-square value	Degrees Freedom	p-value
Spring – summer Chinook	159.0	5	< 0.0001
Fall Chinook	59.3	5	< 0.0001
Steelhead	59.8	5	< 0.0001

Table 2. Tukey-type multiple comparisons where overlapping 95 % confidence interval indicate population medians that are statistically similar.

Species	Ladder	Median (hrs)	95% Median Confidence Interval (hrs)	Significance
Spring-summer Chinook				
	TD East	2.31	2.19 – 2.46	B
	TD North	2.01	1.91 - 2.14	A
	JD South	2.95	2.81 – 3.10	C
	JD North	3.11	2.91 – 3.36	C
	MN South	2.54	2.43 – 2.70	B
	MN North	2.93	2.83 – 3.09	C
Fall Chinook				
	TD East	2.39	2.30 – 2.49	A
	TD North	1.77	1.67 – 4.69	A
	JD South	2.96	2.88 – 3.16	B
	JD North	3.08	2.73 – 3.39	B
	MN South	2.88	2.78 – 3.09	B
	MN North	2.87	2.43 – 3.06	A
Steelhead				
	TD East	2.16	2.07 – 2.28	A
	TD North	1.96	1.60 – 2.27	A
	JD South	2.47	2.35 – 2.63	B
	JD North	2.92	2.72 – 3.33	C
	MN South	2.36	2.25 – 2.51	A B
	MN North	2.10	1.85 – 2.36	A

medians significantly different at p = 0.05 indicated by different letters
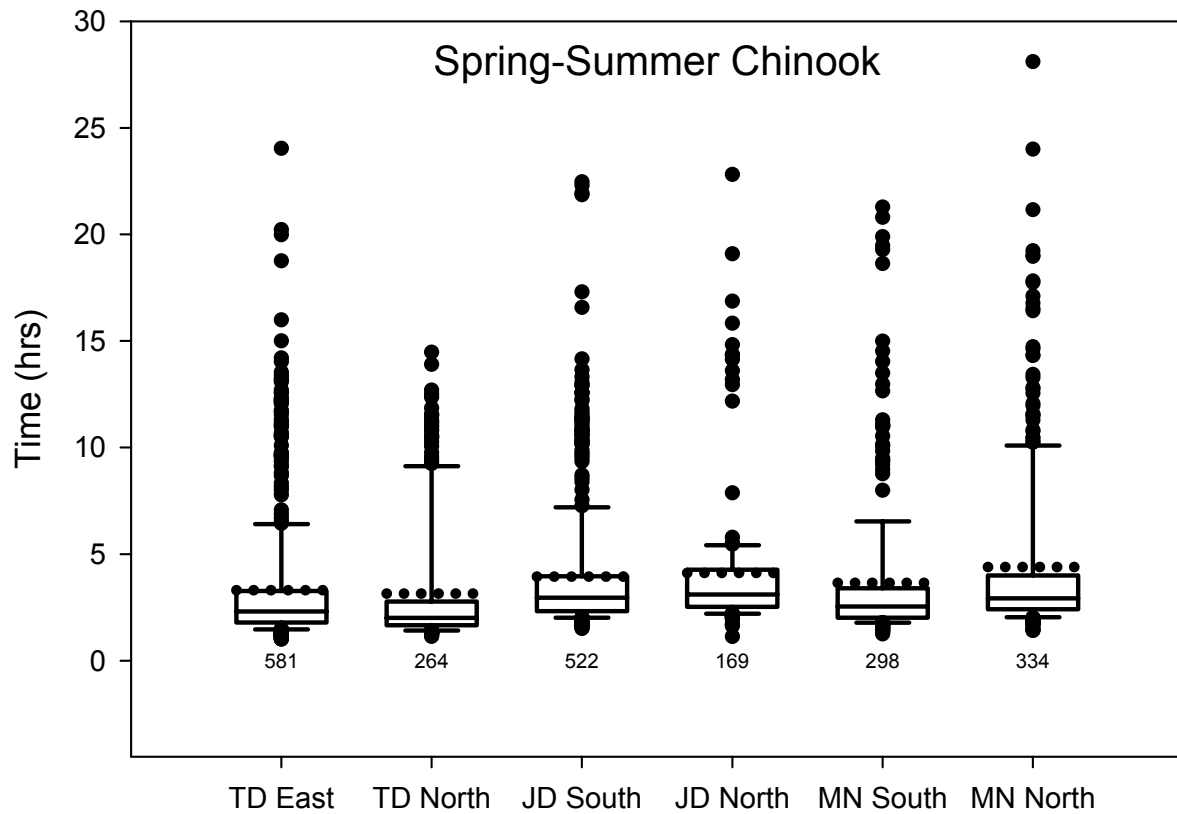
Figure 1. Mean (dotted line), median (solid line), quartile, 10th, 25th, 75th, and 90th percentiles ladder passage times for adult spring-summer Chinook salmon at The Dalles (TD), John Day (JD), and McNary (MN) dams. Symbols (circles) above and below boxes indicate values greater than the 90th percentile or less than the 10th percentile. Sample sized are indicated under the plots.
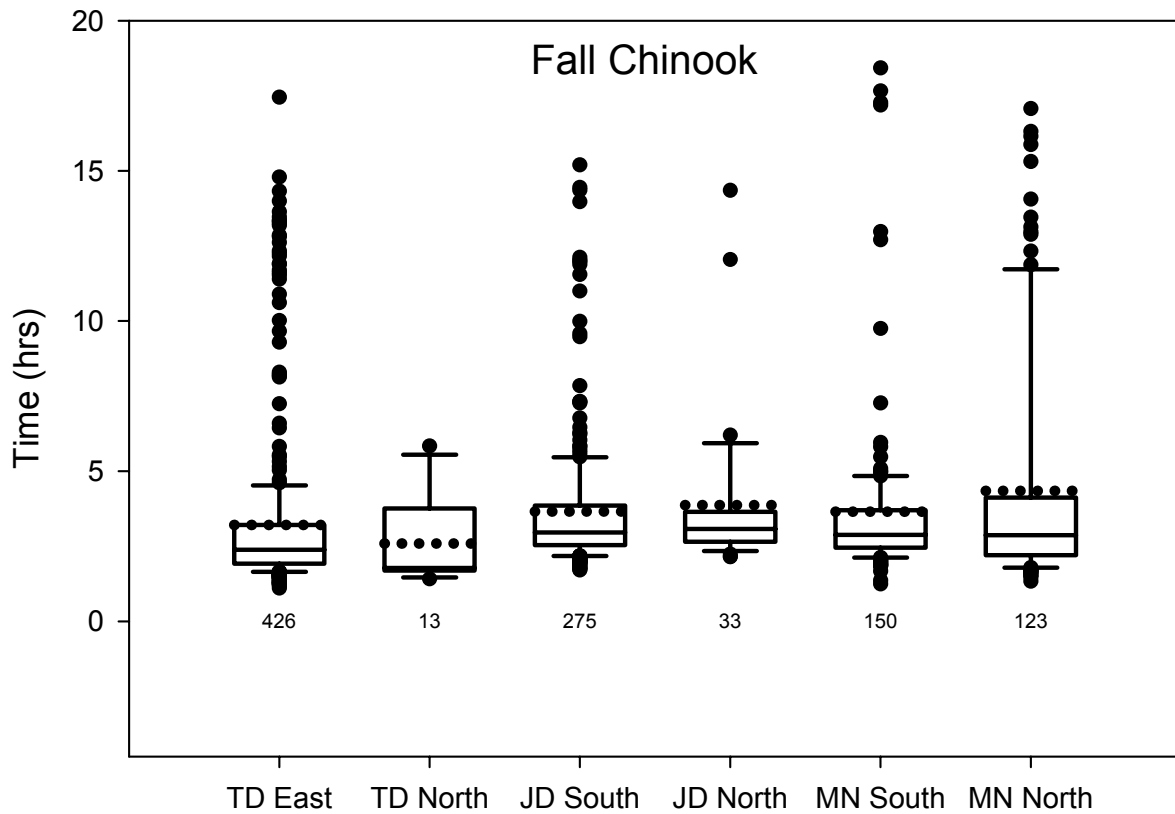
Figure 2. Mean (dotted line), median (solid line), quartile (bars) 10th, 25th, 75th, and 90th percentiles ladder passage times for adult fall Chinook salmon at The Dalles (TD), John Day (JD), and McNary (MN) dams. Symbols (circles) above and below boxes indicate values greater than the 90th percentile or less than the 10th percentile. Sample sized are indicated under the plots.
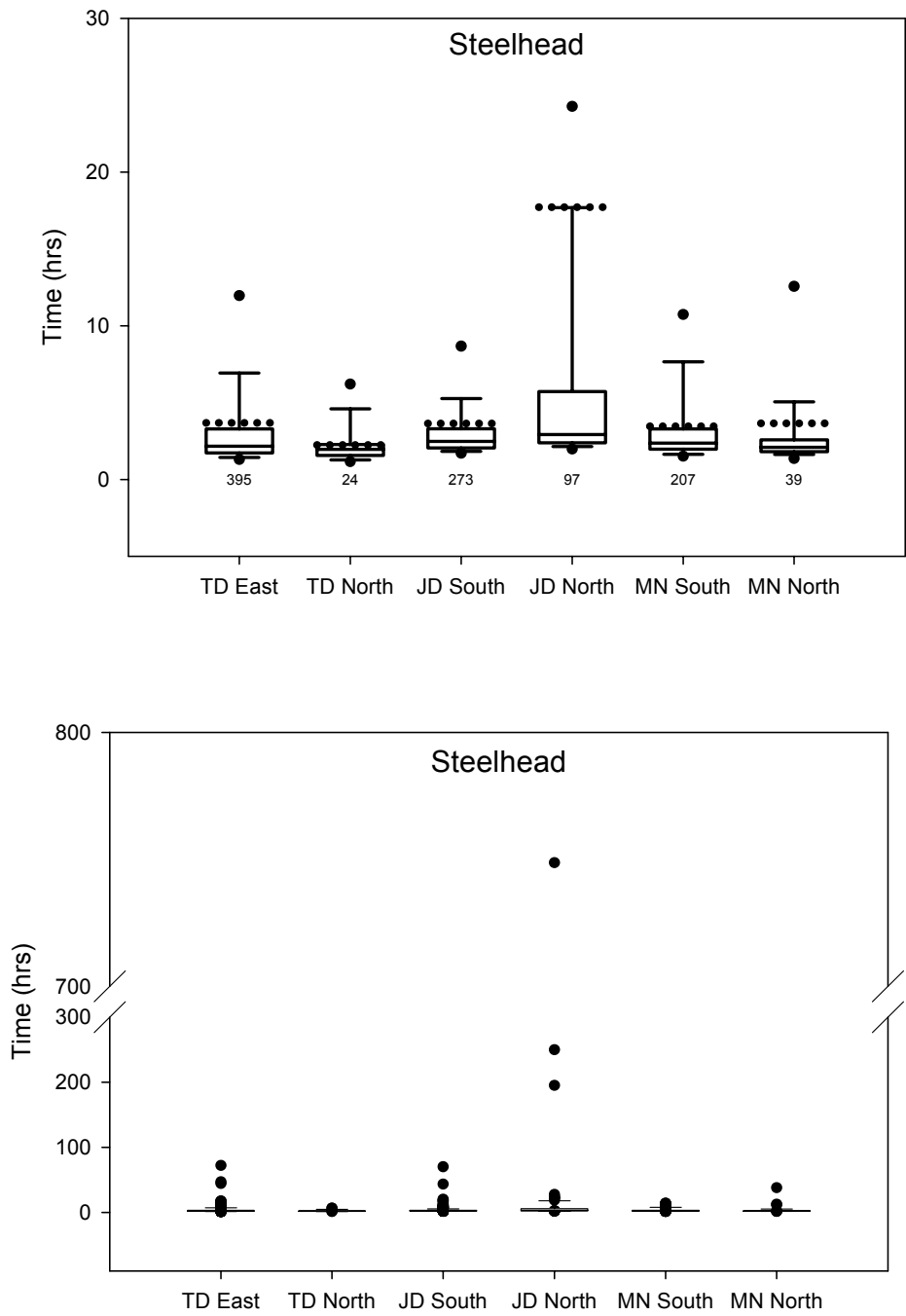
Figure 3. Mean (dotted line), median (solid line), quartile (bars) 10th, 25th, 75th, 90th, and 5th and 95th percentiles (circles) ladder passage times for adult steelhead at The Dalles (TD), John Day (JD), and McNary (MN) dams (top panel). All values are shown in bottom panel.
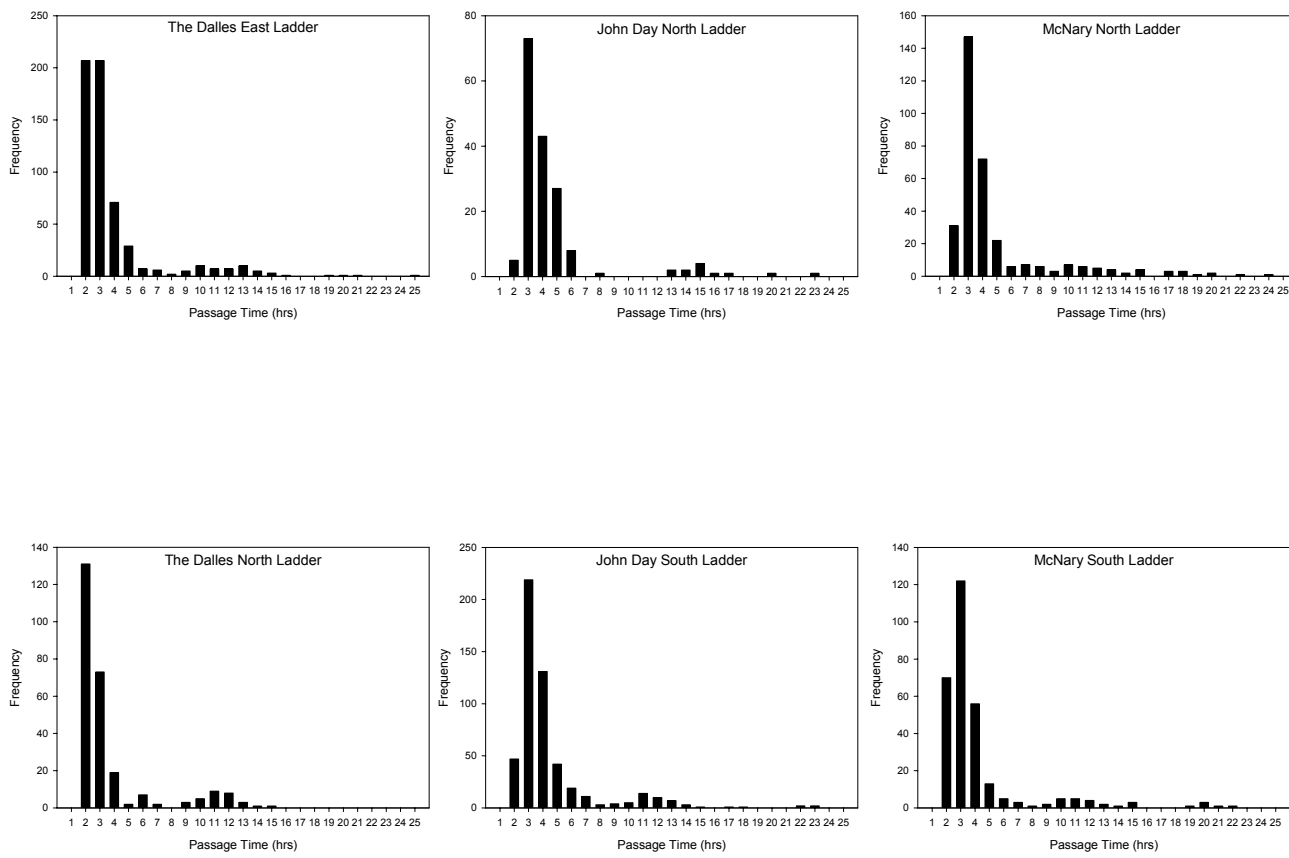
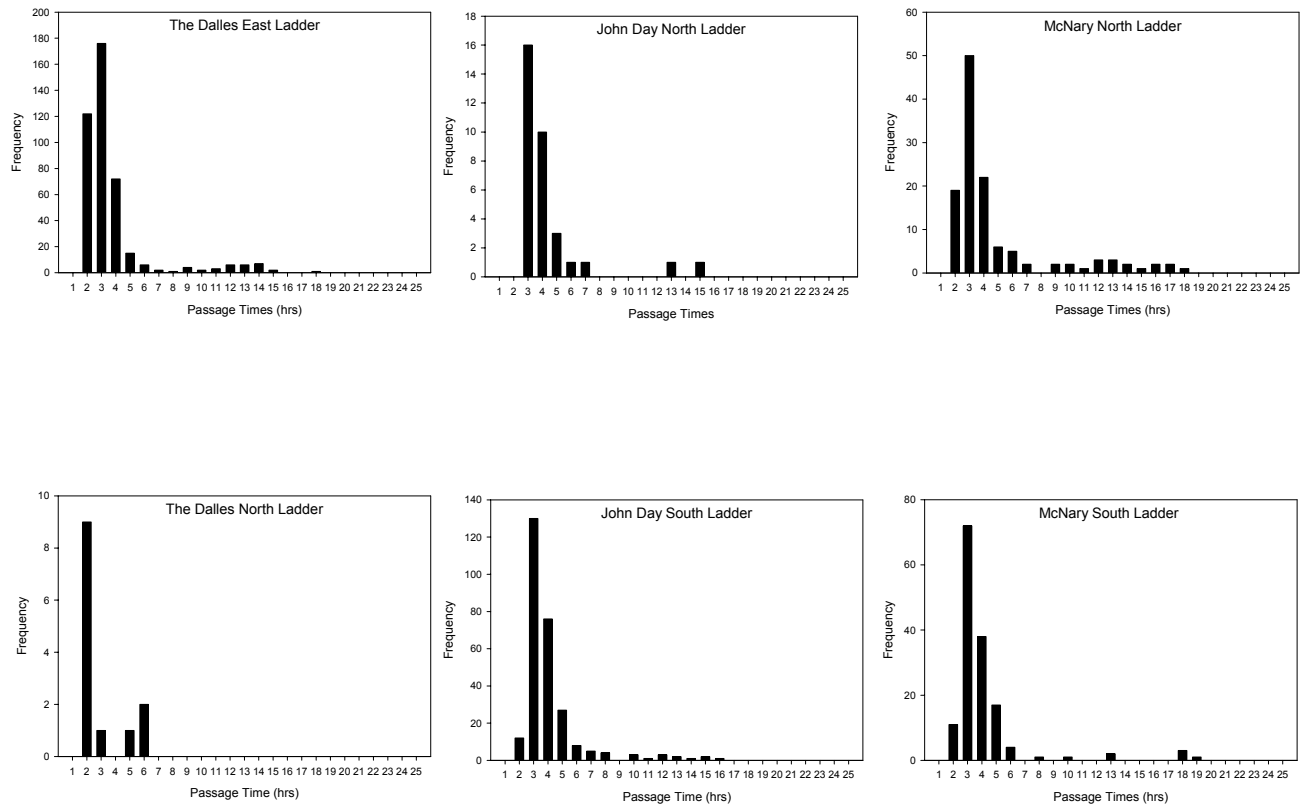Figure 4. Length frequency distributions for spring and summer Chinook ladder passage times.

Figure 5. Length frequency distributions for fall Chinook ladder passage times.
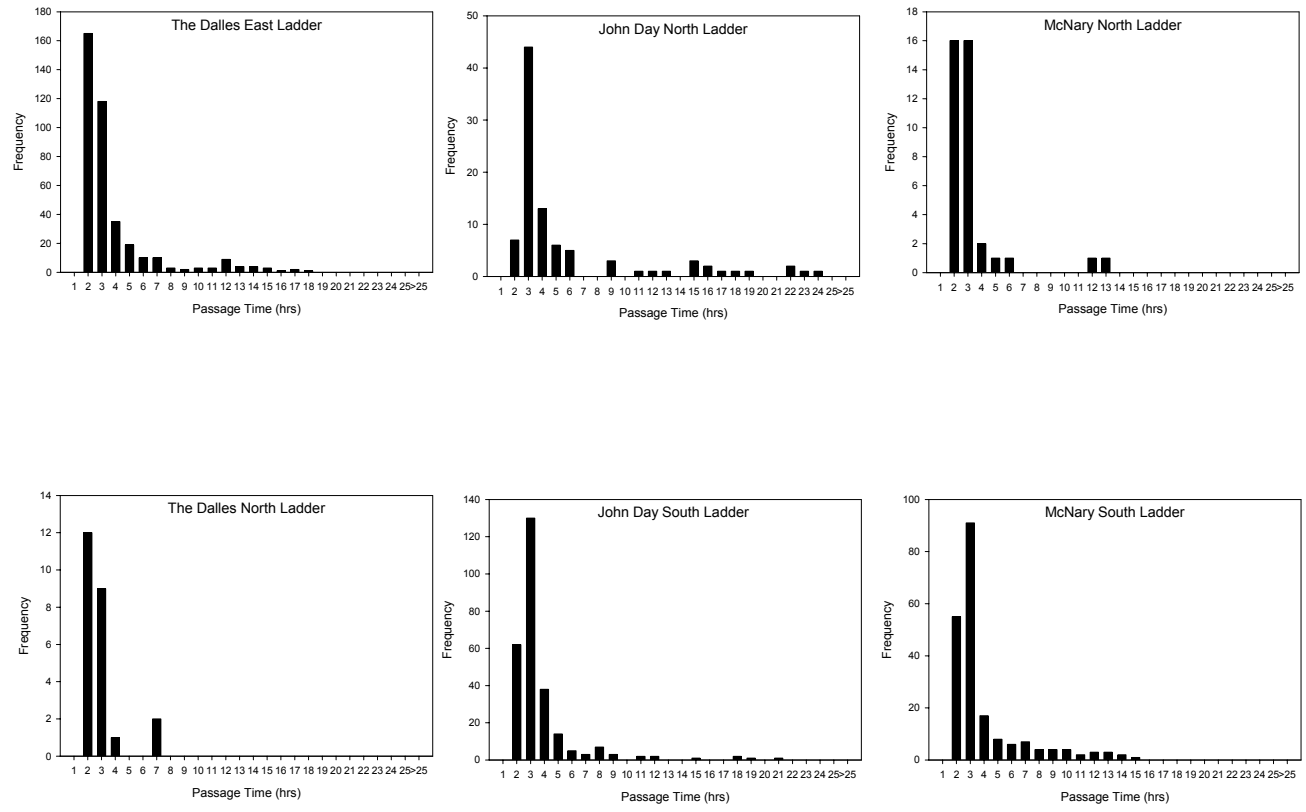
Figure 6. Length frequency distributions for steelhead ladder passage times.

References

Peery, C.A. 2003. Fish ladder passage times. Letter Report to the U.S. Army Corps of Engineers.

Zar, J.H. 1999. Biostatistical Analysis, 4th edition. Prentice-Hall Inc, Upper Saddle River, New Jersey.