Appendix S1

Ecosphere

Juvenile life history diversity is associated with lifetime individual heterogeneity in a migratory fish

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Table S1: Estimates of survival across years by occasion, juvenile life history, natal stream, and fish age. The three juvenile life history pathways are fish that emigrated from their natal stream as subyearlings in summer (*Sum.0*) or fall (*Fal.0*), or as yearlings in spring (*Spr.1*). *DSR* represents both downstream-rearing life histories (summer and fall subyearlings) on occasions when they were assumed to be the same. *LHP* = life history pathway, *Lcl* = lower 95% confidence limit and *ucl* = upper 95% confidence limit.

Interval	LHP	Stream	Age	Median	lcl	ucl
1	Sum.0	Chiwawa	2	0.241	0.163	0.344
1	Sum.0	Nason	2	0.166	0.121	0.222
1	Sum.0	White	2	0.118	0.052	0.245
1	Fal.0	Chiwawa	2	0.401	0.268	0.552
1	Fal.0	Nason	2	0.336	0.254	0.430
1	Fal.0	White	2	0.152	0.096	0.232
1	Spr.1	Chiwawa	2	0.889	0.728	0.959
1	Spr.1	Nason	2	0.853	0.642	0.951
1	Spr.1	White	2	0.547	0.301	0.778
2	DSR	Chiwawa	2	0.347	0.230	0.481
2	DSR	Nason	2	0.388	0.295	0.487
2	DSR	White	2	0.419	0.316	0.531
2	Spr.1	Chiwawa	2	0.434	0.365	0.503
2	Spr.1	Nason	2	0.396	0.316	0.479

Interval	LHP	Stream	Age	Median	lcl	ucl
2	Spr.1	White	2	0.351	0.222	0.506
3	DSR	Chiwawa	2	0.709	0.538	0.832
3	DSR	Nason	2	0.708	0.536	0.833
3	DSR	White	2	0.708	0.536	0.833
3	Spr.1	Chiwawa	2	0.708	0.536	0.834
3	Spr.1	Nason	2	0.708	0.536	0.834
3	Spr.1	White	2	0.708	0.537	0.833
4	DSR	Chiwawa	-	0.027	0.021	0.037
4	DSR	Nason	-	0.028	0.019	0.042
4	DSR	White	-	0.027	0.012	0.060
4	Spr.1	Chiwawa	-	0.013	0.010	0.018
4	Spr.1	Nason	-	0.015	0.010	0.023
4	Spr.1	White	-	0.018	0.008	0.038
5	All	All	3	0.849	0.816	0.876
5	All	All	4	0.849	0.816	0.876
5	All	All	5	0.849	0.816	0.876
6	All	All	3	0.877	0.846	0.904
6	All	All	4	0.878	0.847	0.904
6	All	All	5	0.877	0.845	0.904

Table S2: Estimates of proportions of fish returning at ages three through five across years by juvenile life history pathway, natal stream, and fish age. *DSR* = downstream-rearing life history pathways (summer and fall subyearling emigrants) and *Spr.1* = natal-reach-rearing life history pathway. *LHP* = life history pathway, *Lcl* = lower 95% confidence limit and *ucl* = upper 95% confidence limit.

LHP	Age	Median	lcl	ucl
DSR	3	0.123	0.075	0.192
DSR	4	0.750	0.680	0.803
DSR	5	0.126	0.078	0.193
Spr.1	3	0.065	0.035	0.117
Spr.1	4	0.739	0.660	0.801
Spr.1	5	0.195	0.131	0.277

Table S3: Estimates of detection probabilities across years by occasion, juvenile life history, natal stream, and life history pathway. The three juvenile life history pathways are fish that emigrated from their natal stream as subyearlings in summer (*Sum.0*) or fall (*Fal.0*), or as yearlings in spring (*Spr.1*). *DSR* represents both downstream-rearing life histories (summer and fall). *LHP* = life history pathway, *Lcl* = lower 95% confidence limit and *ucl* = upper 95% confidence limit.

Occasion	LHP	Stream	Age	Median	lcl	ucl
2	Sum.0	Chiwawa	2	0.005	0.003	0.011
2	Sum.0	Nason	2	0.006	0.002	0.015
2	Sum.0	White	2	0.011	0.004	0.032
2	Fal.0	Chiwawa	2	0.008	0.005	0.013
2	Fal.0	Nason	2	0.008	0.005	0.013
2	Fal.0	White	2	0.007	0.003	0.014
2	Spr.1	Chiwawa	2	0.012	0.008	0.016
2	Spr.1	Nason	2	0.010	0.006	0.016
2	Spr.1	White	2	0.005	0.001	0.016
3	DSR	Chiwawa	2	0.257	0.222	0.294
3	DSR	Nason	2	0.256	0.221	0.294
3	DSR	White	2	0.254	0.217	0.294
3	Spr.1	Chiwawa	2	0.252	0.220	0.287
3	Spr.1	Nason	2	0.252	0.219	0.288

Occasion	LHP	Stream	Age	Median	lcl	ucl
3	Spr.1	White	2	0.253	0.217	0.293
4	DSR	Chiwawa	2	0.126	0.094	0.166
4	DSR	Nason	2	0.126	0.092	0.169
4	DSR	White	2	0.112	0.069	0.176
4	Spr.1	Chiwawa	2	0.108	0.082	0.141
4	Spr.1	Nason	2	0.129	0.093	0.173
4	Spr.1	White	2	0.119	0.076	0.180
5	All	All	3	0.931	0.790	0.980
5	All	All	4	0.995	0.976	0.999
5	All	All	5	0.954	0.895	0.981
6	All	All	3	0.984	0.967	0.992
6	All	All	4	0.984	0.967	0.992
6	All	All	5	0.984	0.967	0.992

Table S4: Standard deviations of Gaussian hyper-distributions of random effects of year on survival by occasion and juvenile life history pathway (LHP). The three juvenile life history pathways are fish that emigrated from their natal stream as subyearlings in summer (*Sum.0*) or fall (*Fal.0*), or as yearlings in spring (*Spr.1*). *DSR* represents both downstream-rearing life histories (summer and fall). *LHP* = life history pathway, *Lcl* = lower 95% confidence limit and *ucl* = upper 95% confidence limit.

Interval	LHP	Median	lcl	ucl
1	All	0.074	0.010	0.521
1	Fal.0	0.138	0.049	0.398
1	Spr.1	0.079	0.009	0.691
1	Sum.0	0.136	0.037	0.485
2	All	0.234	0.125	0.436
2	Spr.1	0.079	0.013	0.479
2	DSR	0.072	0.011	0.458
3	All	0.022	0.002	0.238
3	Spr.1	0.021	0.002	0.230
3	DSR	0.022	0.002	0.230
4	All	0.203	0.073	0.558
4	Spr.1	0.153	0.024	1.065
4	DSR	0.099	0.013	0.702
5	All	0.024	0.002	0.260

Interval	LHP	Median	lcl	ucl
6	All	0.024	0.002	0.274

Table S5: Standard deviations of Gaussian hyper-distributions of random effects of year on detection probabilities by occasion and juvenile life history strategy (LH). The three juvenile life history pathways are fish that emigrated from their natal stream as subyearlings in summer (*Sum.0*) or fall (*Fal.0*), or as yearlings in spring (*Spr.1*). *DSR* represents both downstream-rearing life histories (summer and fall). *LHP* = life history pathway, *Lcl* = lower 95% confidence limit and *ucl* = upper 95% confidence limit.

Occasion	LHP	Median	lcl	ucl
2	All	0.392	0.217	0.717
2	Fal.0	0.240	0.083	0.693
2	Spr.1	0.190	0.043	0.875
2	Sum.0	0.640	0.290	1.478
3	All	0.259	0.159	0.420
3	Spr.1	0.080	0.016	0.398
3	DSR	0.145	0.058	0.361
4	All	0.298	0.157	0.558
4	Spr.1	0.116	0.024	0.526
4	DSR	0.202	0.086	0.469
5	All	0.024	0.002	0.267
6	All	0.023	0.002	0.274

Table S6: Standard deviations and correlation of random effects of year on age proportions of returning adults. The proportions were modeled with a multinomial logit link, where age 4 was the reference age. *Lcl* = lower 95% confidence limit and *ucl* = upper 95% confidence limit.

Age	Median	lcl	ucl
3	0.5	0.218	1.174
5	0.542	0.299	0.98
Corr	-0.624	-0.931	0.705

Fig. S1: Effects of environmental covariates on survival by occasion (column) and juvenile life history pathway (color). The three juvenile life history pathways are fish that emigrated from their natal stream as subyearlings in summer (*Sum.0*) or fall (*Fal.0*), or as yearlings in spring (*Spr.1*). *DSR* represents both downstream-rearing life histories (summer and fall subyearlings). *CUI.spr* = coastal upwelling index during spring, *SST.sum* = sea surface temperature off the Washington coast during summer, and *SST.win* = sea surface temperature in an arc of the northeast Pacific Ocean defined by Johnstone and Mantua (2014) during the winter prior to when juveniles enter the marine environment. Points represent mean estimates and lines span 95% confidence intervals.

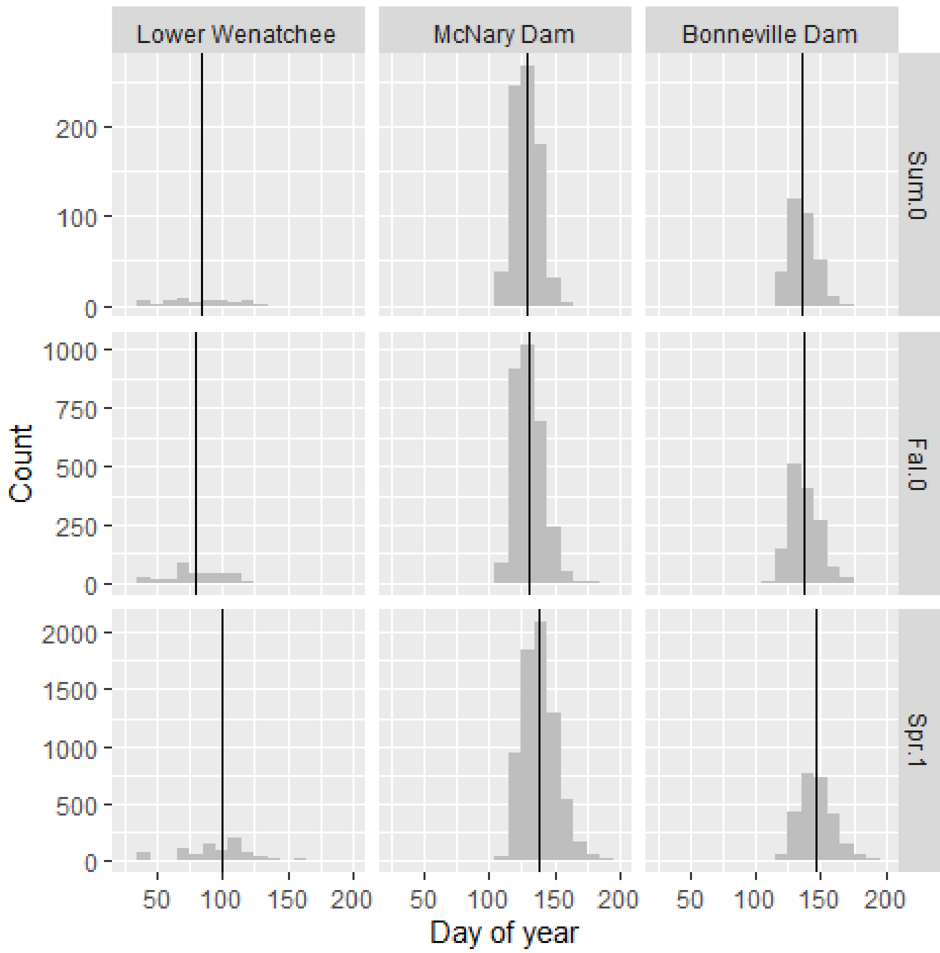

Fig. S2: Day of year of detections at three sites (columns) by juvenile life history pathways (rows). Fish from all study years and natal streams are represented. Vertical lines indicate median detection days. Summer (*Sum.0*) and fall (*Fal.0*) subyearling emigrants (downstream-rearing fish) had very similar detection timing to each other. Downstream-rearing fish were detected 19 days earlier than yearling (*Spr.1*) emigrants (natal-reach-rearing fish) in the Lower Wenatchee River trap, 9 days earlier at McNary Dam, and 10 days earlier at Bonneville Dam on average.

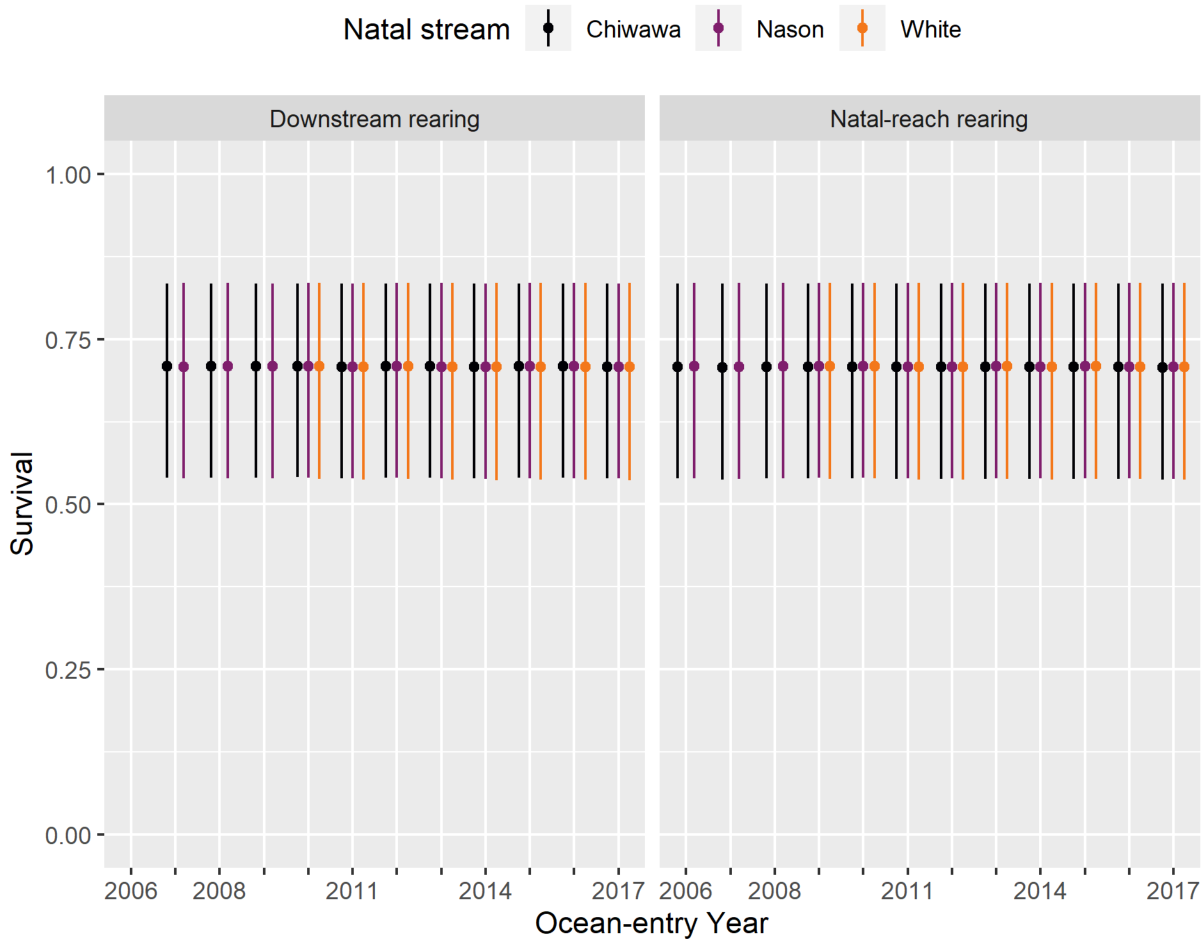

Fig. S3: Annual survival estimates between McNary Dam and Bonneville Dam by natal stream (color) and juvenile life history pathway (column): Points represent median estimates and lines span 95% confidence intervals. As with all effects, the lack of year-to-year variability does not imply that survival is constant, but rather that this model and data did not provide evidence of year-varying survival rates.

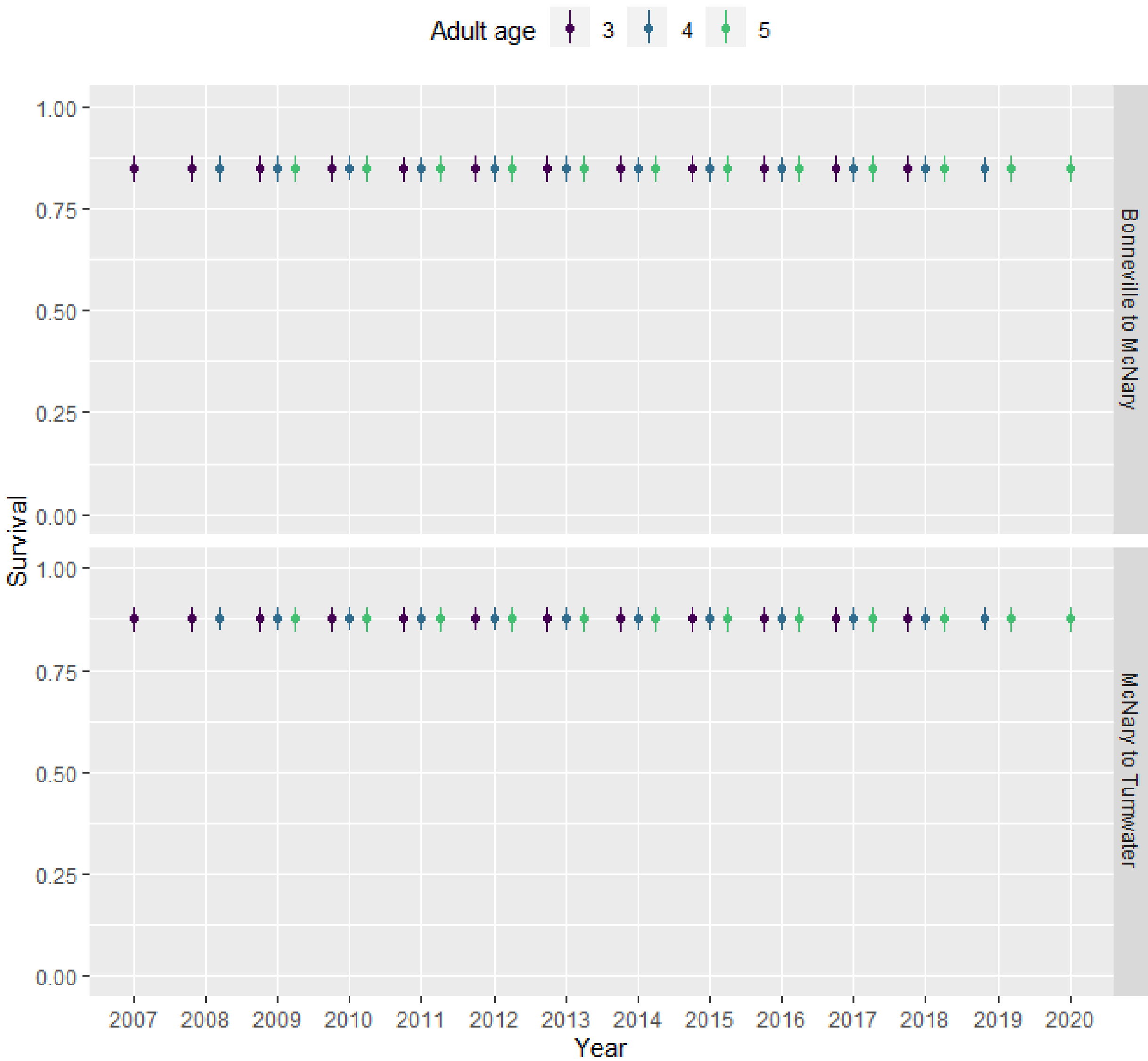

Fig. S4: Annual survival estimates for upstream migrating adult Chinook salmon between Bonneville Dam and McNary Dam (top row) and McNary Dam and Tumwater Dam (bottom row), where color represents adult age. Points represent median estimates and lines span 95% confidence intervals.

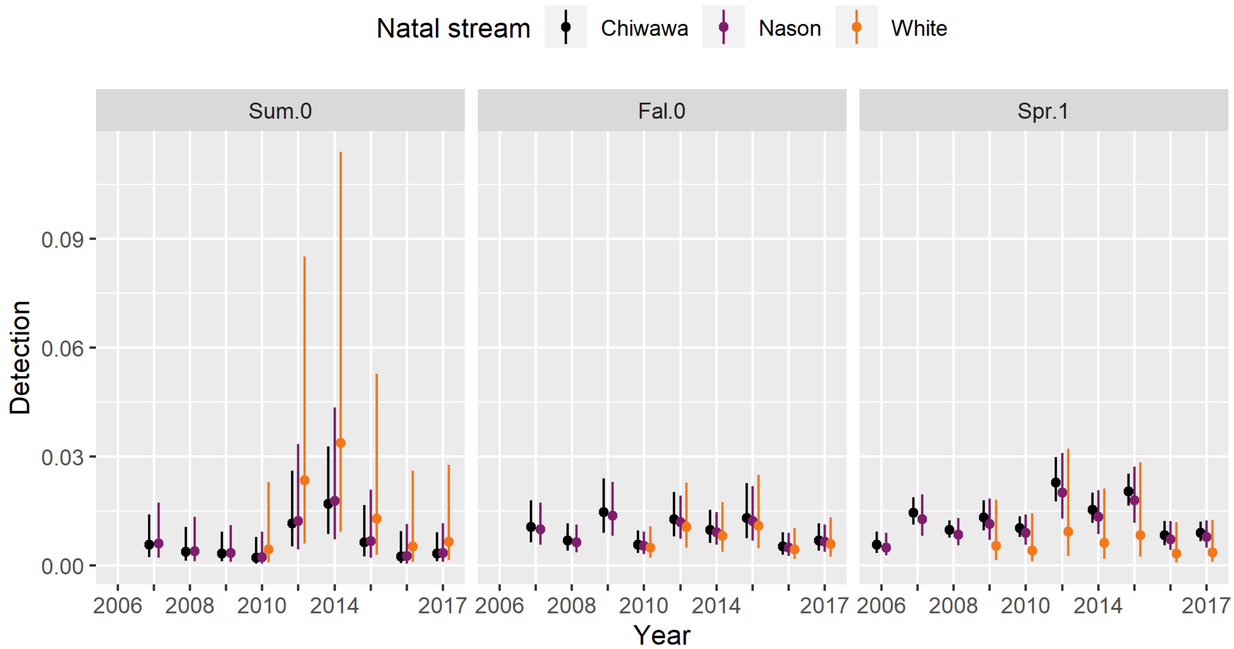

Fig. S5: Annual detection probability estimates for downstream-migrating juvenile Chinook salmon at the lower Wenatchee River screw trap by natal stream (colors) and juvenile life history strategy (columns). The three juvenile life history pathways are fish that emigrated from their natal stream as subyearlings in summer (*Sum.0*) or fall (*Fal.0*), or as yearlings in spring (*Spr.1*). Points represent median estimates and lines span 95% confidence intervals.

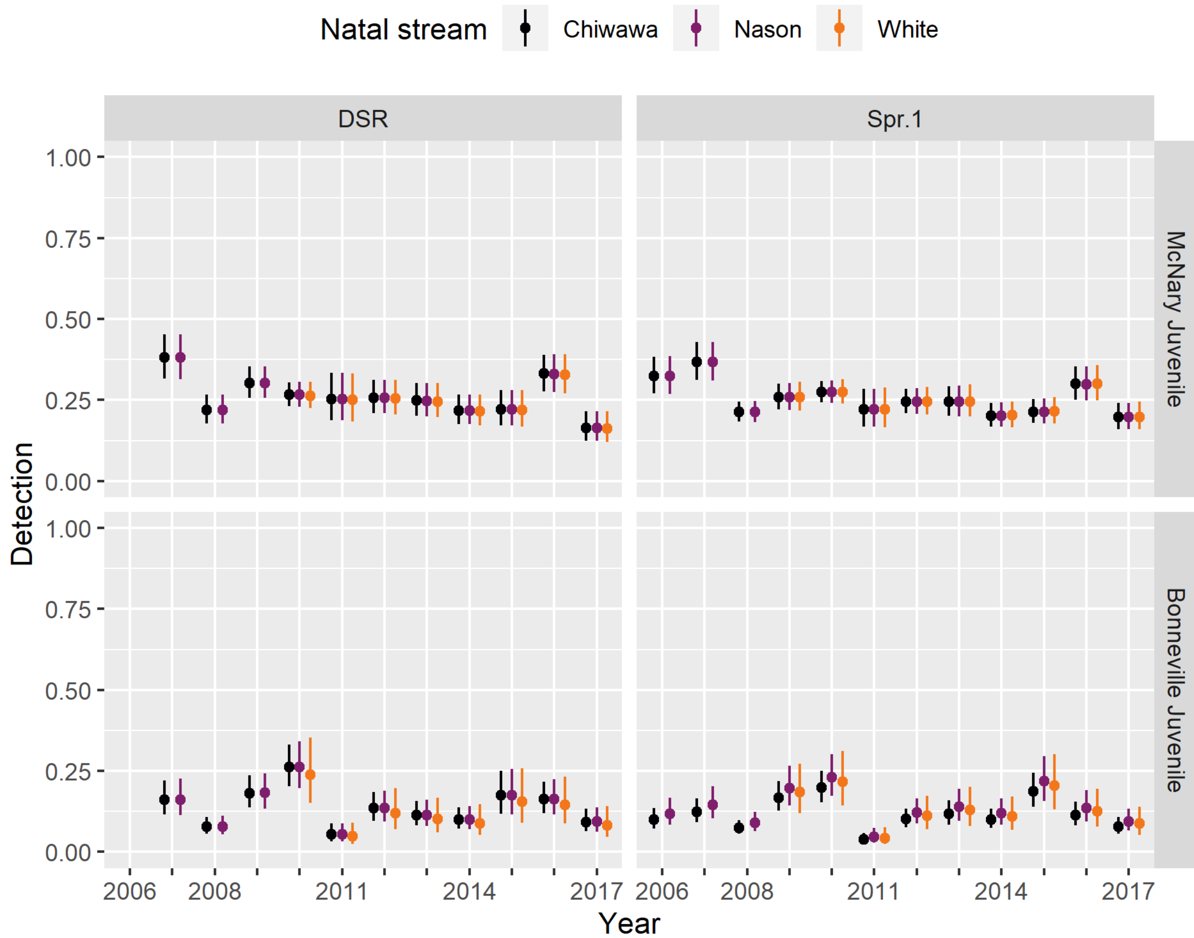

Fig. S6: Annual detection probability estimates for downstream-migrating juvenile Chinook salmon at McNary Dam (top row) and Bonneville Dam (bottom row) by natal stream (colors) and juvenile life history pathway: *DSR* = downstream-rearing life histories (summer and fall subyearling emigrants) and *Spr.1* = natal-reach-rearing life history (spring yearling emigrants). Points represent median estimates and lines span 95% confidence intervals.

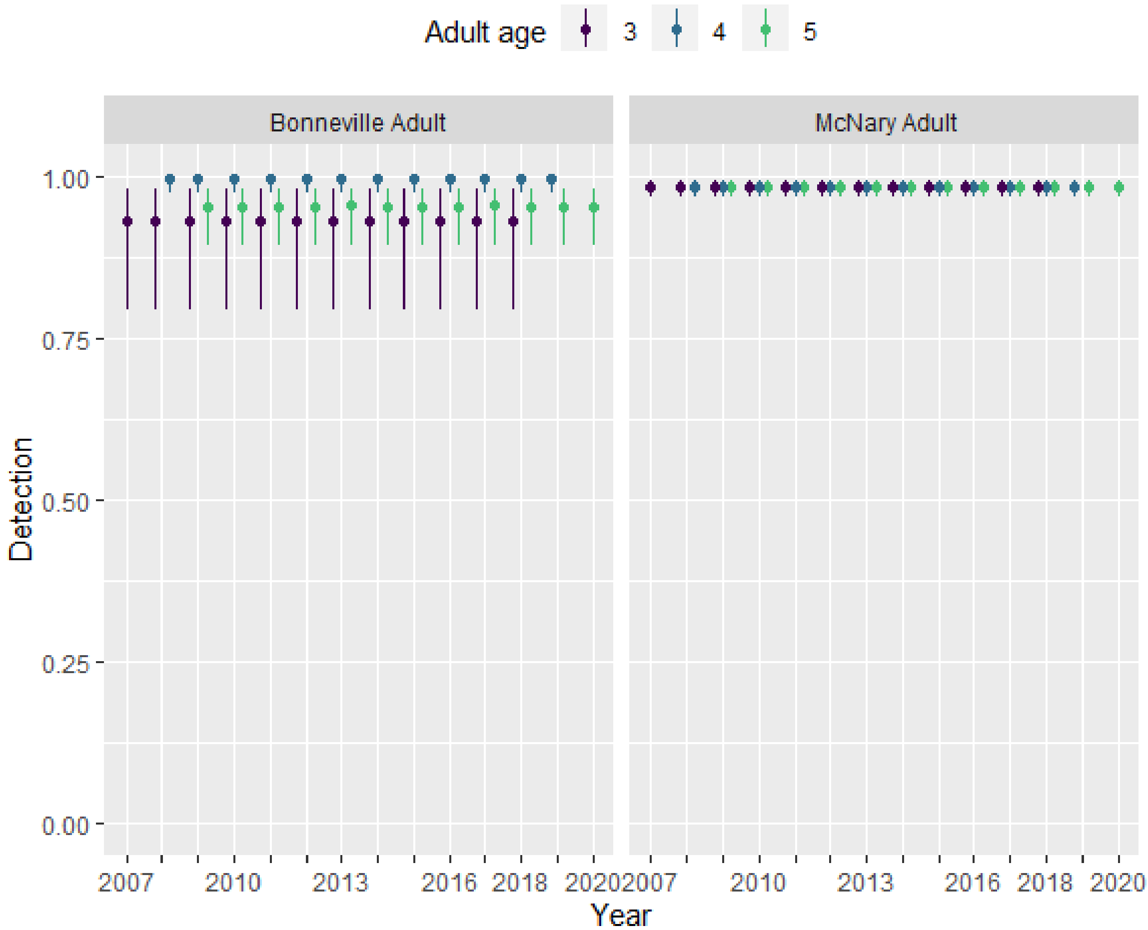

Fig. S7: Annual detection probability estimates for upstream-migrating adult Chinook Salmon at Bonneville Dam (top row) and McNary Dam (bottom row), where color represents adult age. Points represent median estimates and lines span 95% confidence intervals.

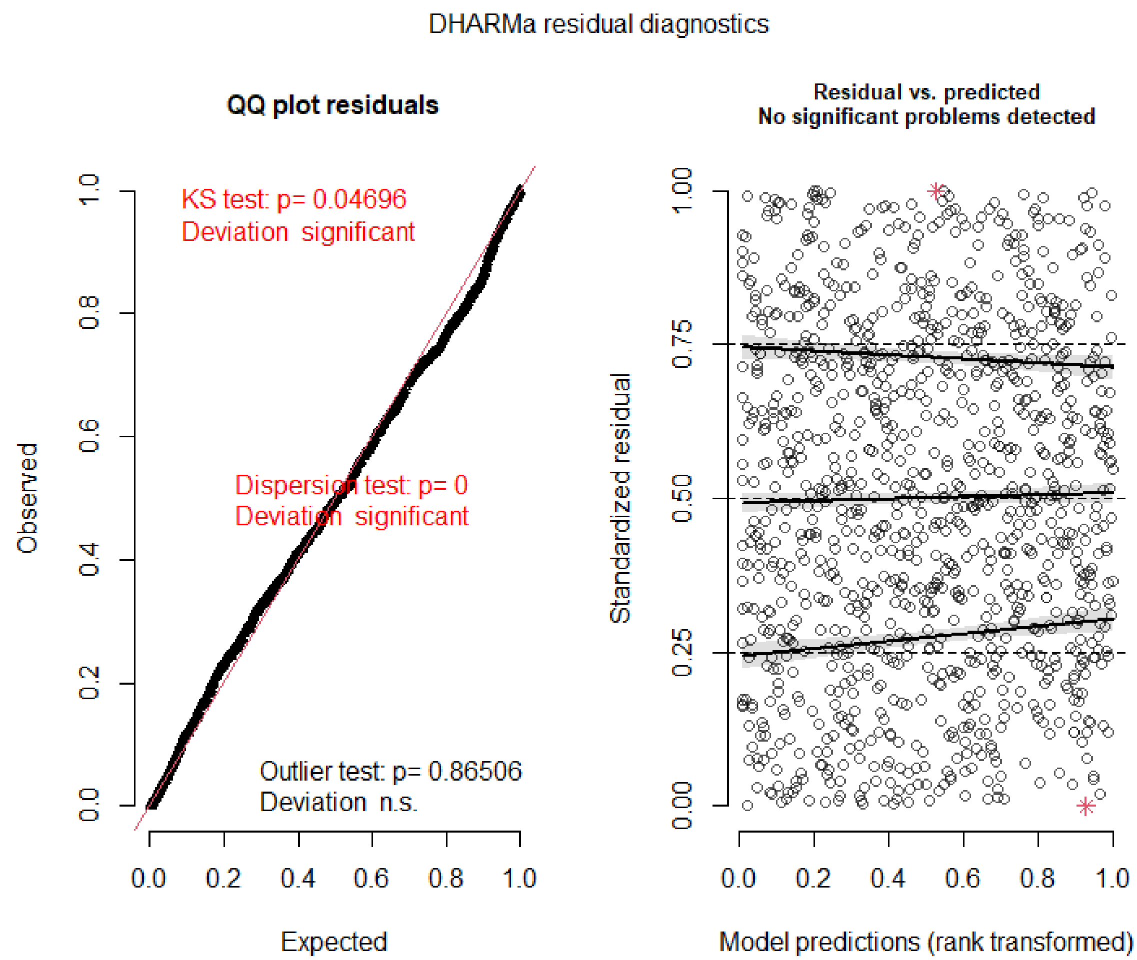

Fig. S8: DHARMa residual diagnostics for simulated quantile residuals conditional on fitted random effects. The left panel shows a Q-Q plot and the right show a plot of residuals versus rank-transformed model predictions. Red asterisks indicate outliers and the thick lines show a quantile regression fit to the residuals, which should follow the dashed horizontal lines if the residuals are uniformly distributed along the y-axis as expected. Both the dispersion and K.S. tests test for deviations from the expected distribution of the residuals, where lower p-values indicate more evidence of deviation from the exception. While both of these tests are significant, the residuals are very close to the 1-to-1 line on the Q-Q plot. Therefore, we assume that the low p-values in the tests is due to the large number of data points (i.e. residuals).

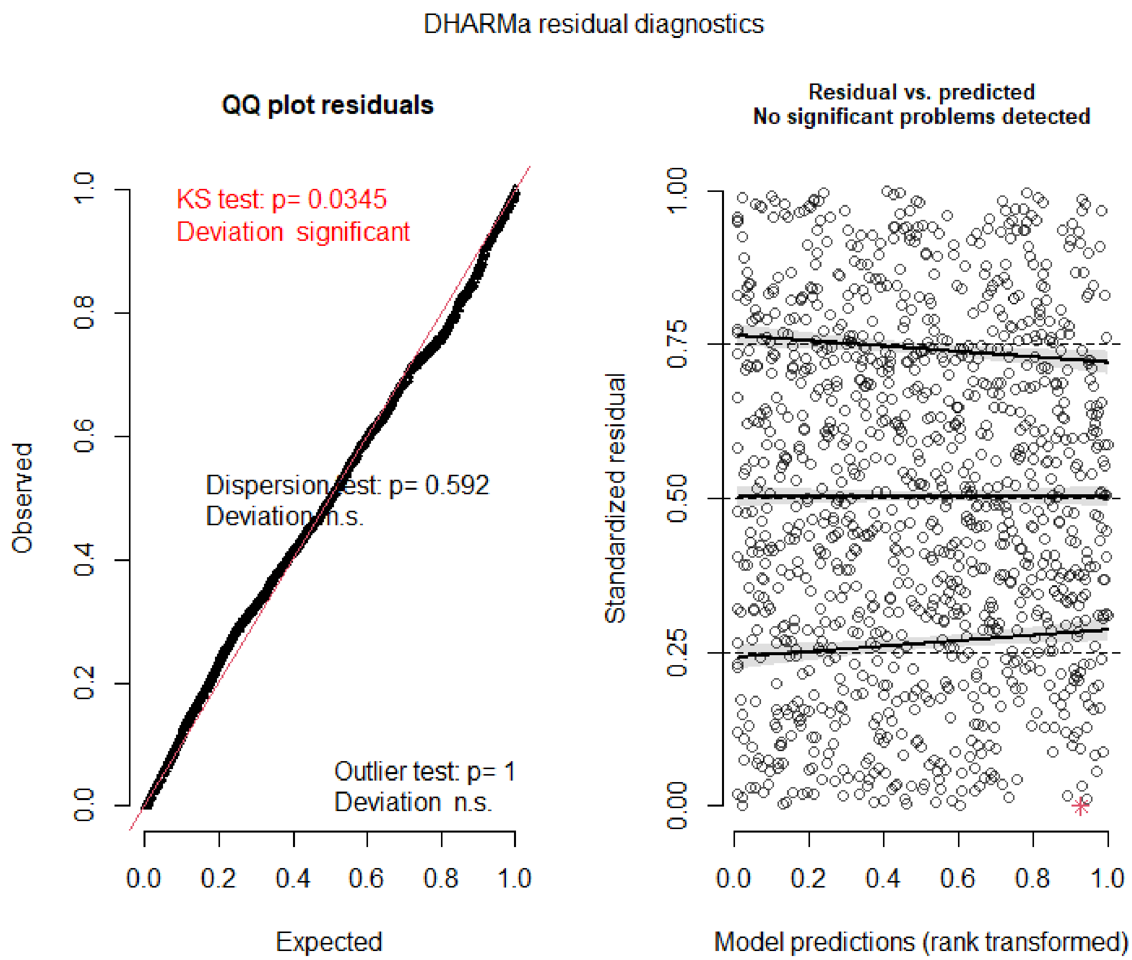

Fig. S9: DHARMa residual diagnostics for standardized quantile residuals marginalized over random effects of year. The left panel shows a Q-Q plot and the right show a plot of residuals versus rank-transformed model predictions. Red asterisks indicate outliers and the thick lines show a quantile regression fit to the residuals, which should follow the dashed horizontal lines if the residuals are uniformly distributed along the y-axis as expected. Both the dispersion and K.S. tests test for deviations from the expected distribution of the residuals, where lower p-values indicate more evidence of deviation from the exception. While the K.S. test is significant, the residuals are very close to the 1-to-1 line on the Q-Q plot. Therefore, we assume that the low p-values in the tests is due to the large number of data points (i.e. residuals).