Evaluation of Proposed Action and Level 1 Action Relative to No Action Alternative Using The Winter-run Life Cycle Model

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QEDα

Overall project goal

The main goal is to build a <u>useful</u> model

G.E.P. Box

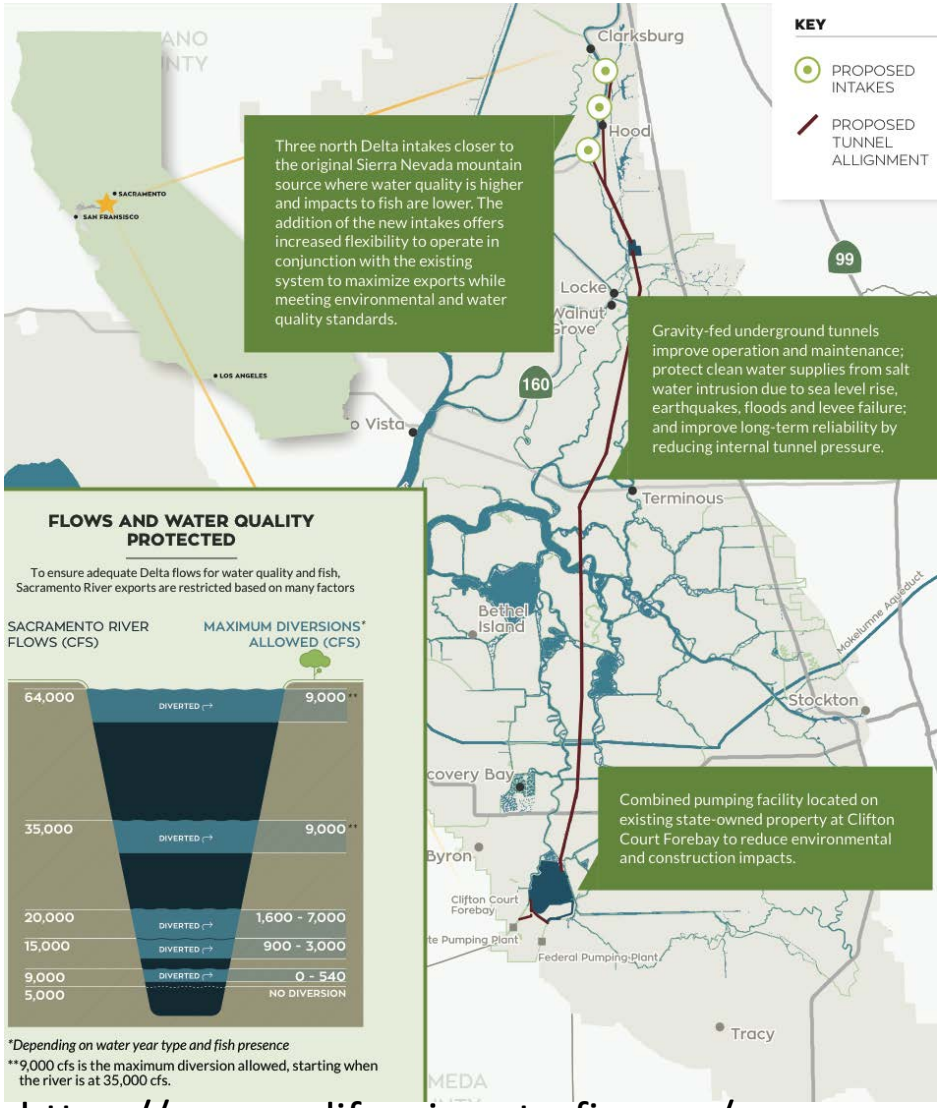
What will make it useful for decision making?

1. Model is sensitive to management needs
   - Temporal and spatial resolution are appropriate
   - Capable of evaluating alternative management actions
2. Model accounts for uncertainty to reflect our understanding of how the system works
3. Model can provide information to make decisions in spite of the existing uncertainty

Useful Life Cycle Model Outputs

1. Specific - can provide specific relationships between population vital rates (e.g., survival or migration) and physical drivers of interest (e.g., flow or temperature)
2. Synoptic - can integrate biological consequences of trade-offs over multiple life-stages or cohorts
    1. Seasonally – e.g., effects of management integrated over different outmigration patterns
    2. Annually – e.g., effects integrated over different water year types

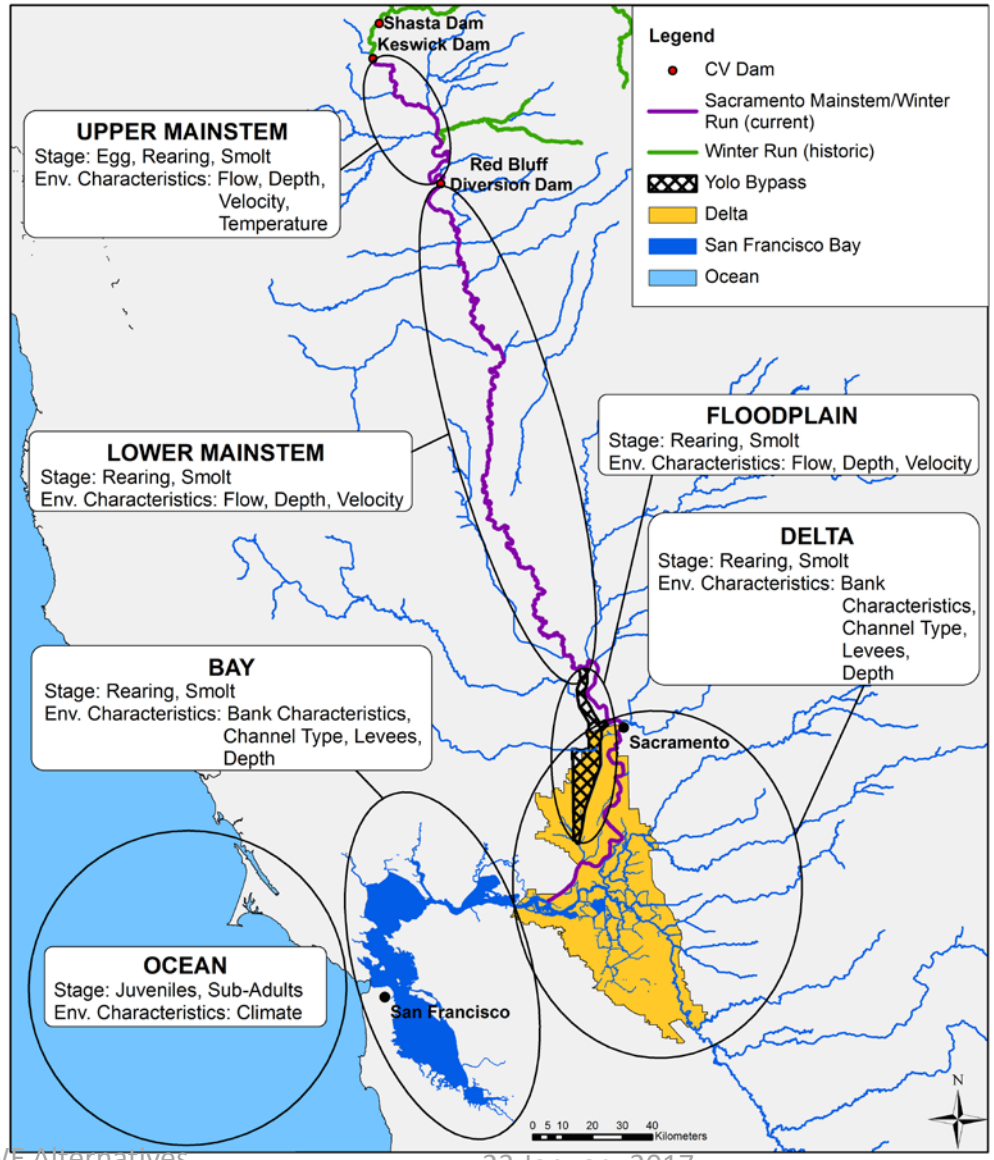
Water Fix



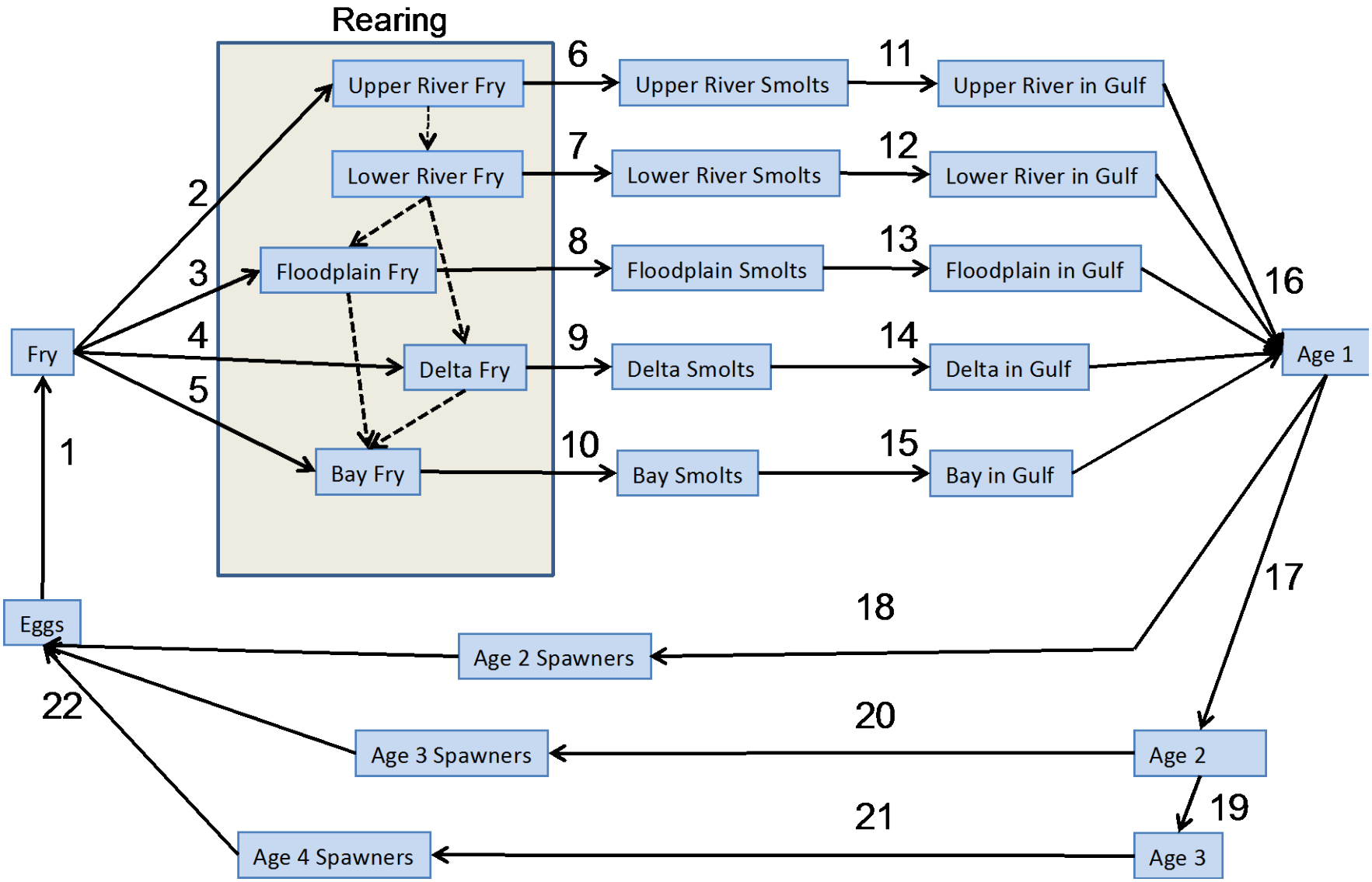
- North Delta Diversions (NDD) to provide water to south Delta pumps
- Exports via NDD and/or south Delta depending on water year type

https://www.californiawaterfix.com/resources

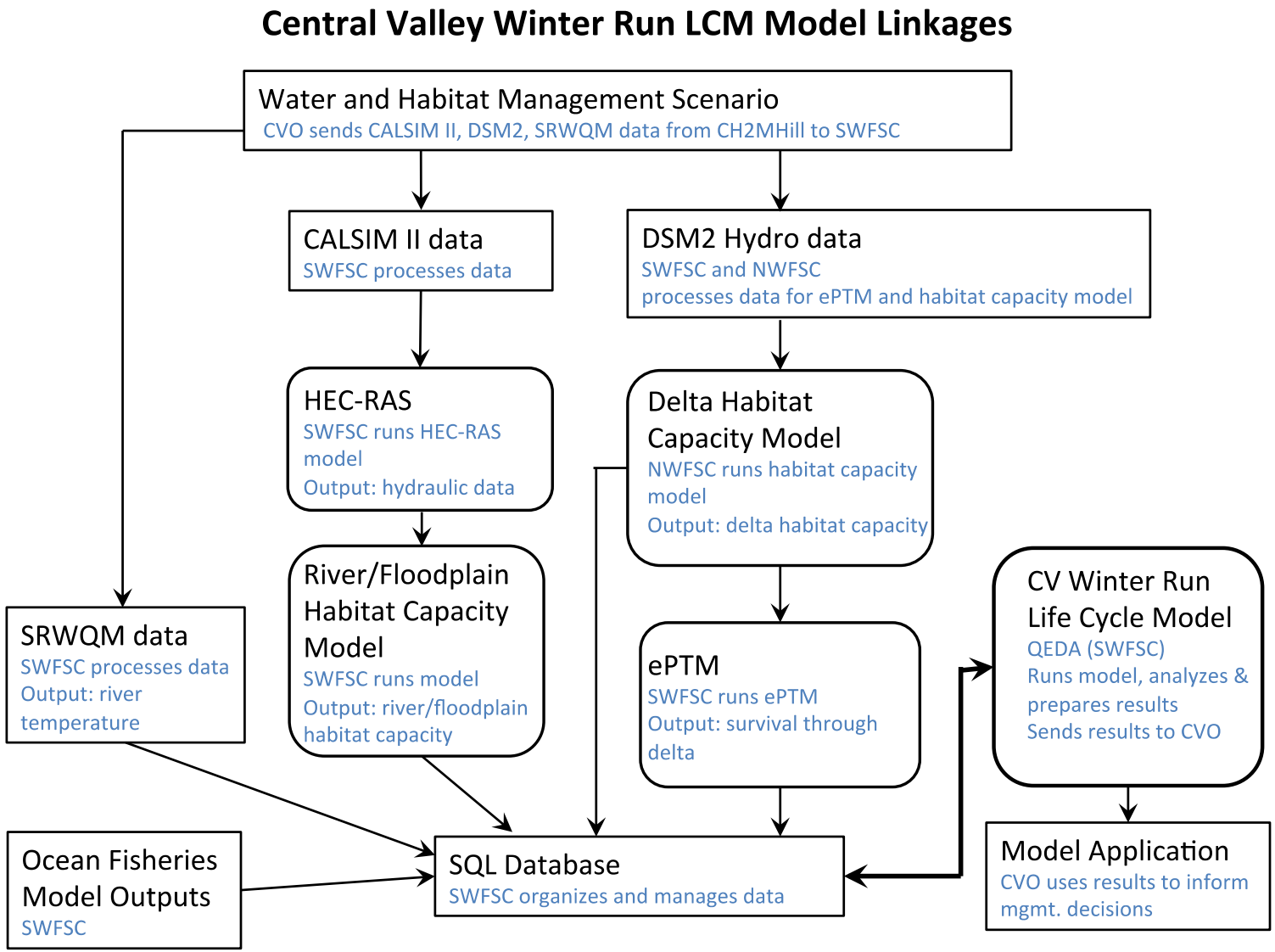
Spatial Structure



WRLCM Diagram



WRLCM Model Linkages



PROPOSED ACTION (PA) VS NO ACTION ALTERNATIVE (NAA)

Scenarios Evaluated

CWF Alternative (PA, NAA) Comparison	Initial Abundance	Hydrology	NDD near - field mortality	Rationale
Scenario 1	10,000	Standard	5%	original scenario run
Scenario 1A	20,000	Standard	5%	explore resiliency of larger population
Scenario 1B	10,000	Revised	5%	test more favorable starting hydrology sequence
Scenario 2	5,000	Revised	5%	explore smaller population under revised hydrology
Scenario 2A	5,000	Revised	0%	explore smaller population, revised hydrology and no near field mortality
Scenario 2B	5,000	Revised	3%	explore smaller population, revised hydrology and 3% near field mortality.

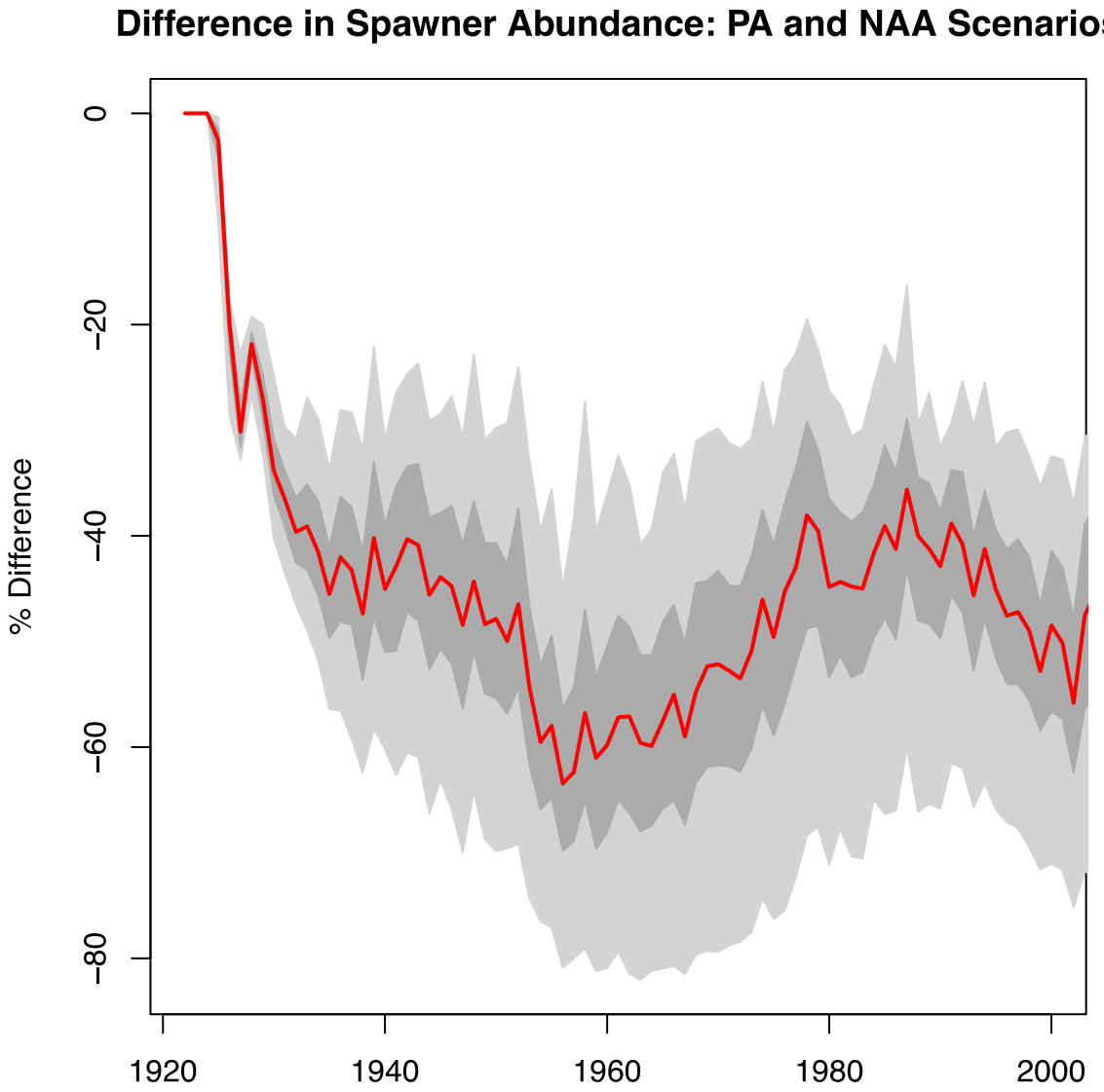
Table 1. Description of modeling scenarios analyzed.

Scenario Results

Cohort Replacement Rate (CRR)

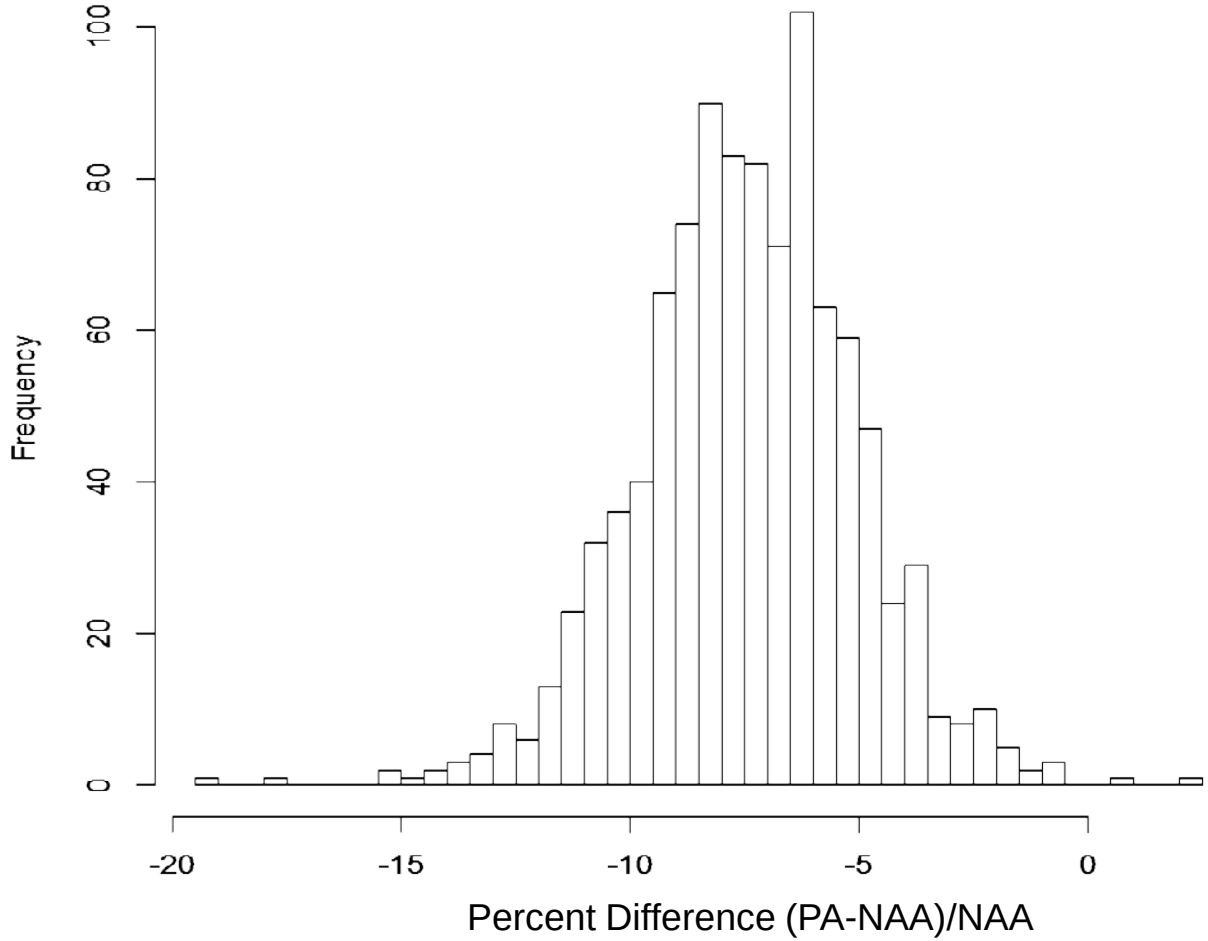
CWF Alternative (PA, NAA) Comparison	Percent Difference in mean CRR (PA-NAA /NAA)	Percent Difference in median CRR (PA-NAA /NAA)	Pr (NAA > PA)
Scenario 1	-8.33%	-8.16%	0.998
Scenario 1A	-8.15%	-7.95%	0.998
Scenario 1B	-8.53%	-8.74%	0.998
Scenario 2	-8.78%	-8.99%	0.998
Scenario 2A	-7.48%	-7.71%	0.998
Scenario 2B	-8.24%	-8.46%	0.998

Percent difference in spawner abundance Scenario 2A

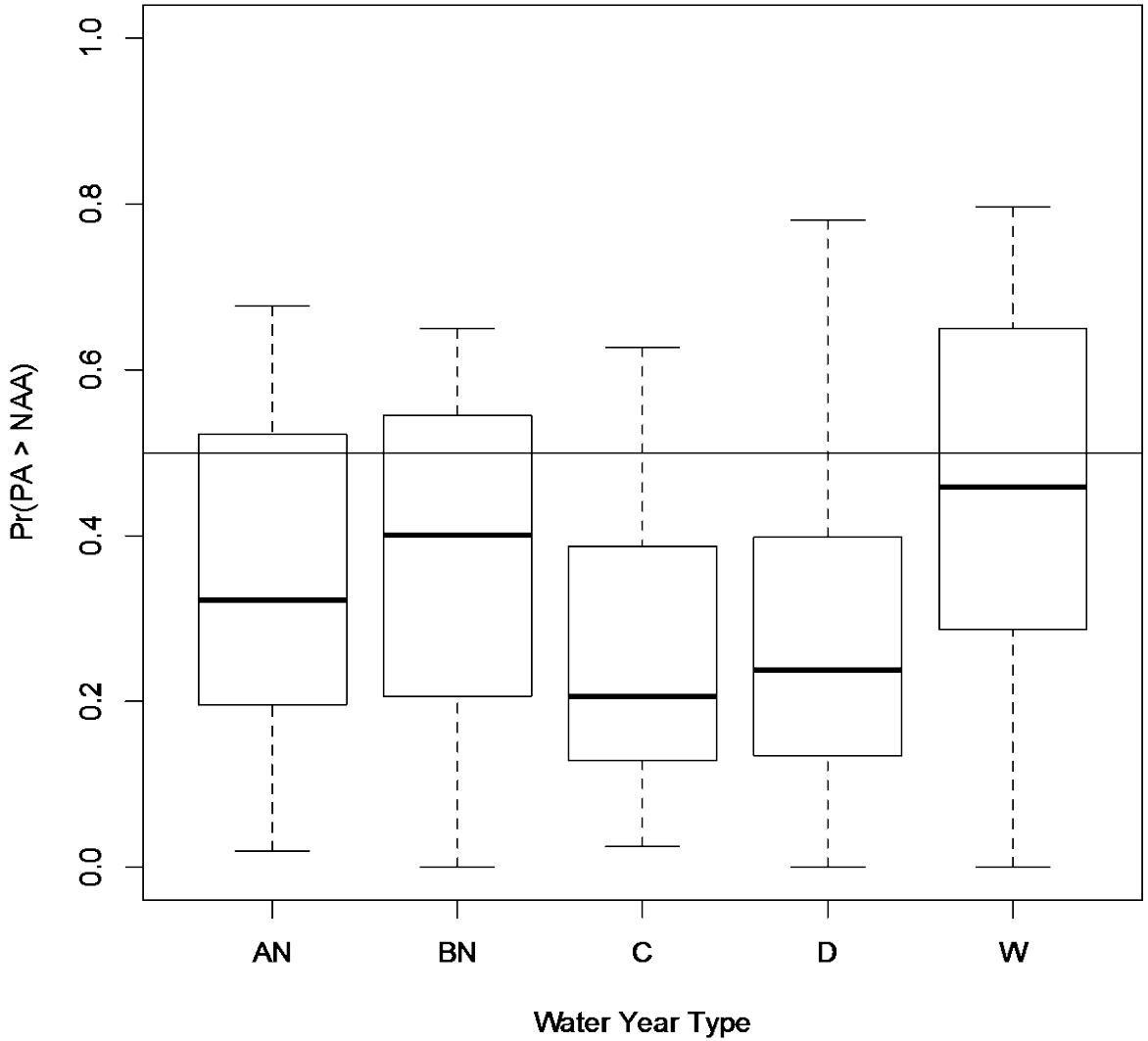


Percent difference in CRR

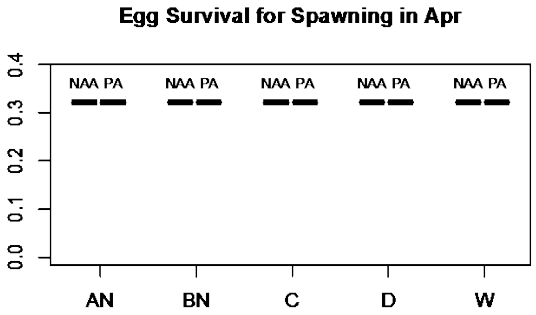
Scenario 2A

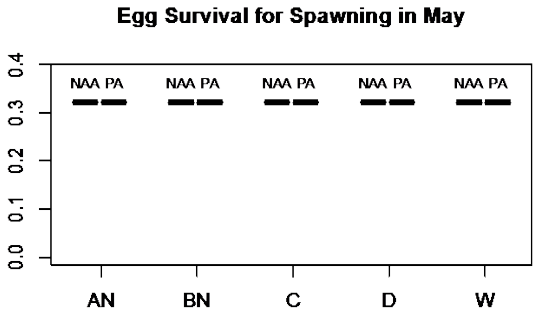


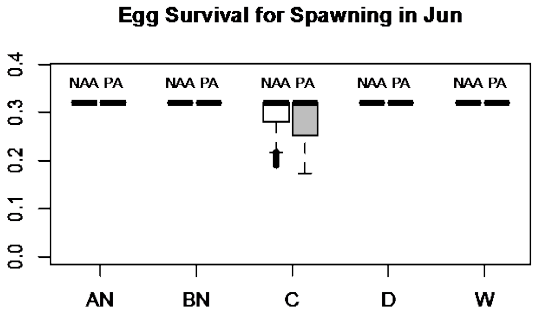
Probability of higher CRR under PA relative to NAA by WYT (Scenario 2A)

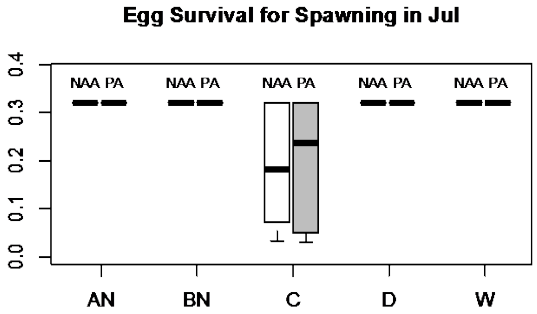


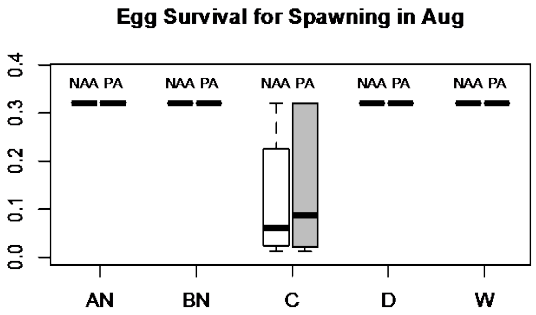
NAA and PA egg to fry survival



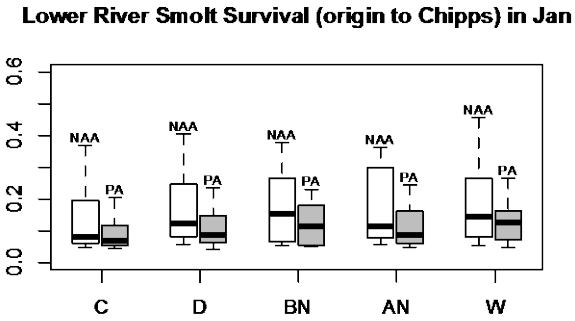


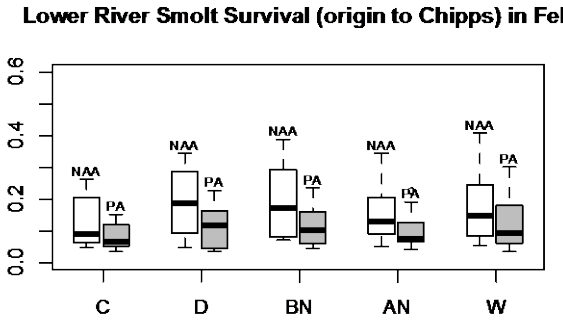


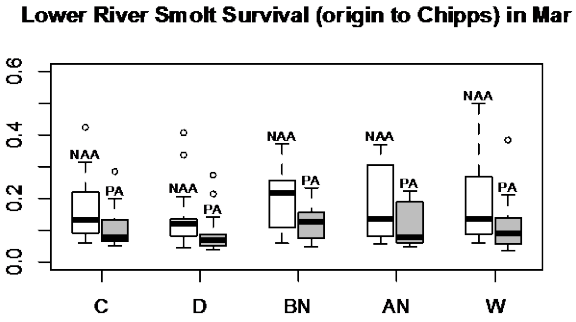


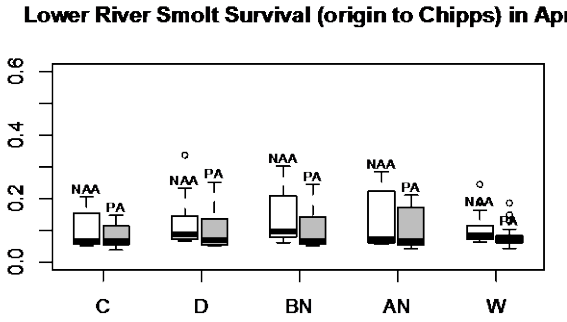


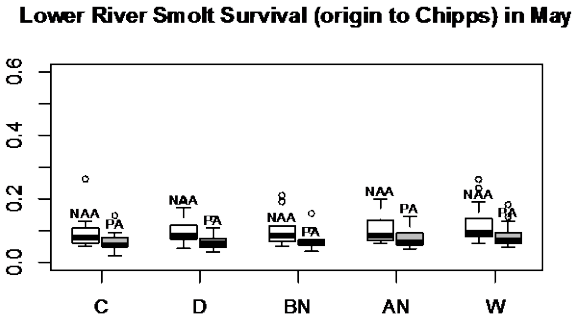
NAA and PA Lower River smolt survival



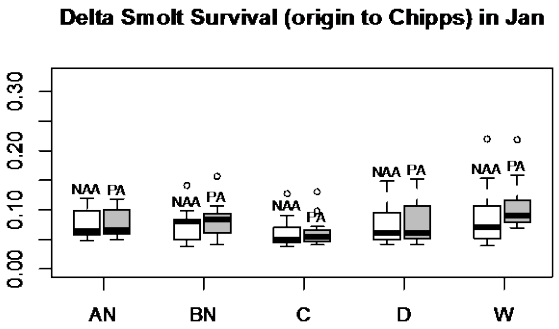


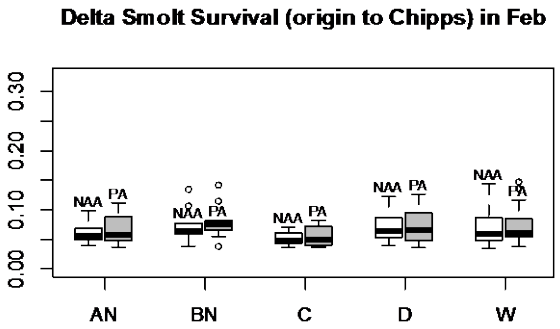


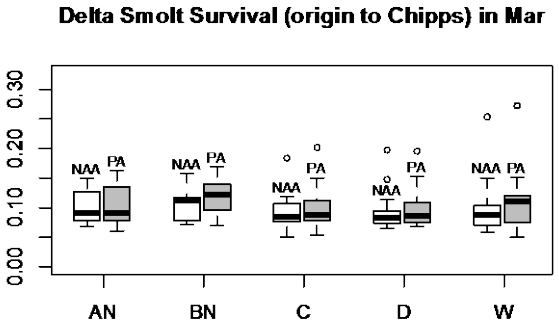


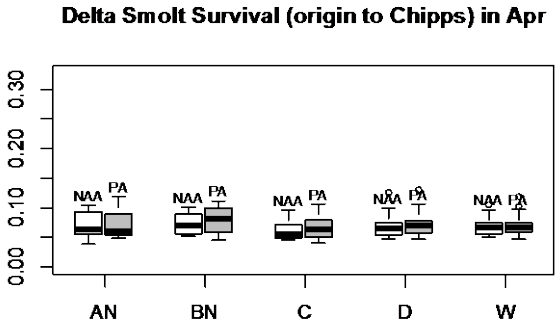


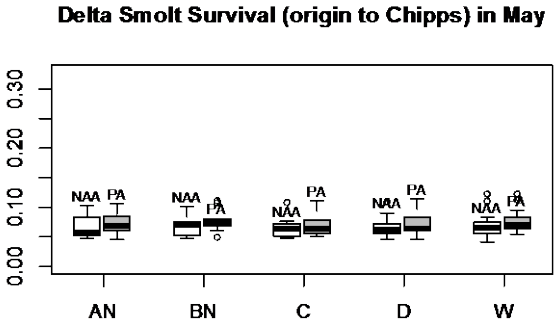
NAA and PA Delta smolt survival



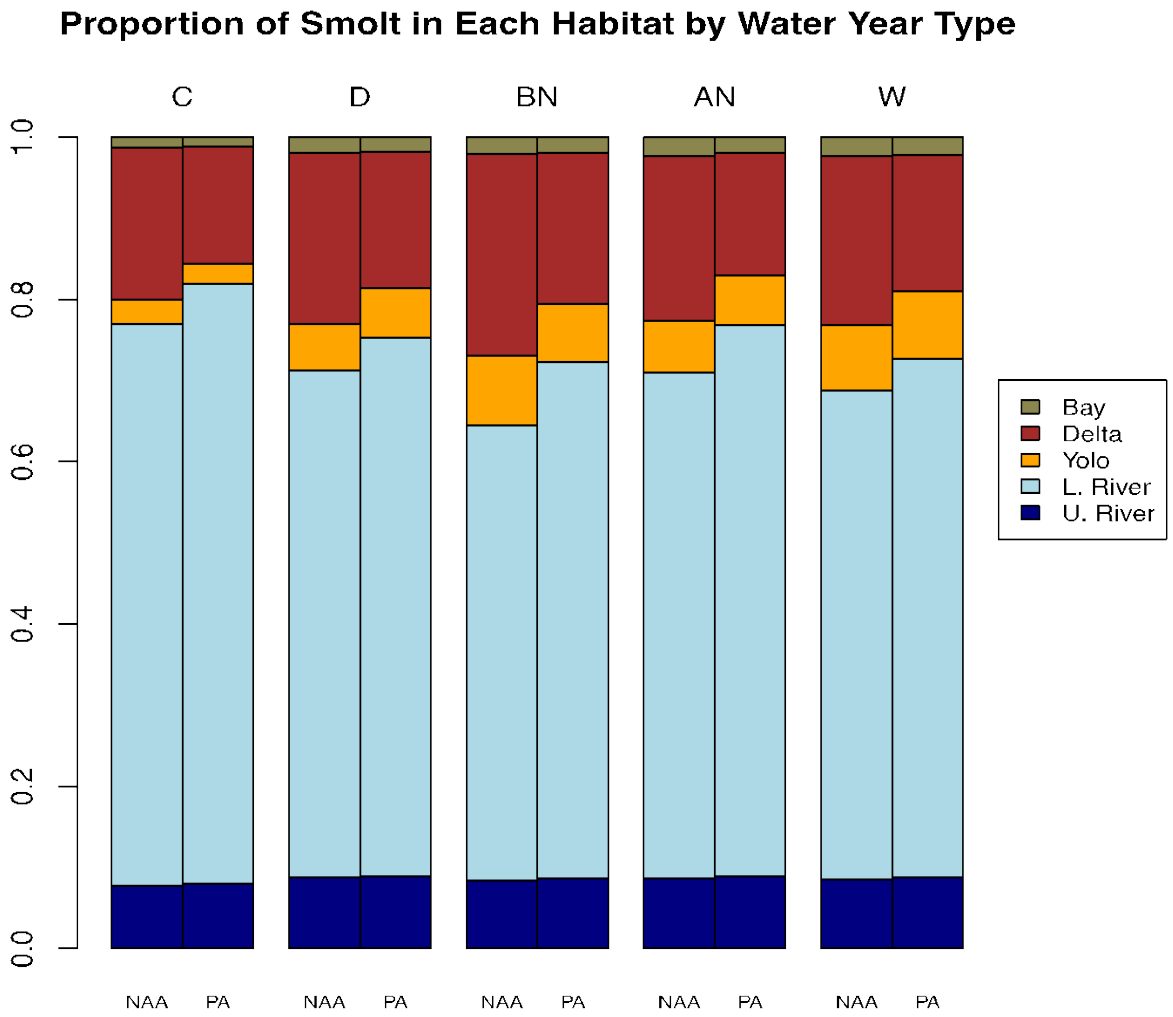






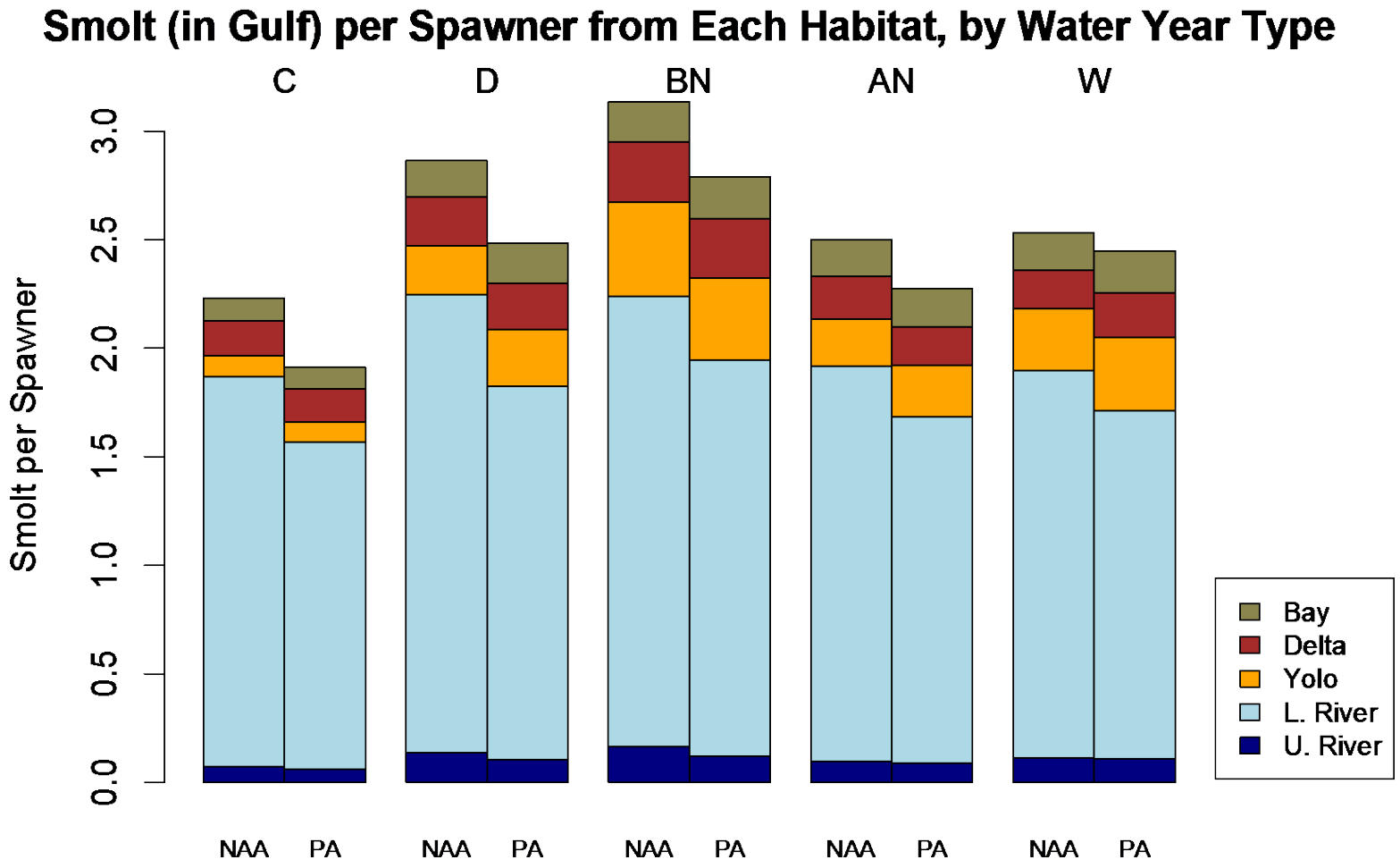


Smolt origination
Scenario 2A



Productivity

Scenario 2A



LEVEL 1 (L1) VS NO ACTION ALTERNATIVE (NAA)

Scenarios Evaluated for L1

Same as PA vs NAA

CWF Alternative (PA, NAA) Comparison	Initial Abundance	Hydrology	NDD near - field mortality	Rationale
Scenario 1	10,000	Standard	5%	original scenario run
Scenario 1A	20,000	Standard	5%	explore resiliency of larger population
Scenario 1B	10,000	Revised	5%	test more favorable starting hydrology sequence
Scenario 2	5,000	Revised	5%	explore smaller population under revised hydrology
Scenario 2A	5,000	Revised	0%	explore smaller population, revised hydrology and no near field mortality
Scenario 2B	5,000	Revised	3%	explore smaller population, revised hydrology and 3% near field mortality.

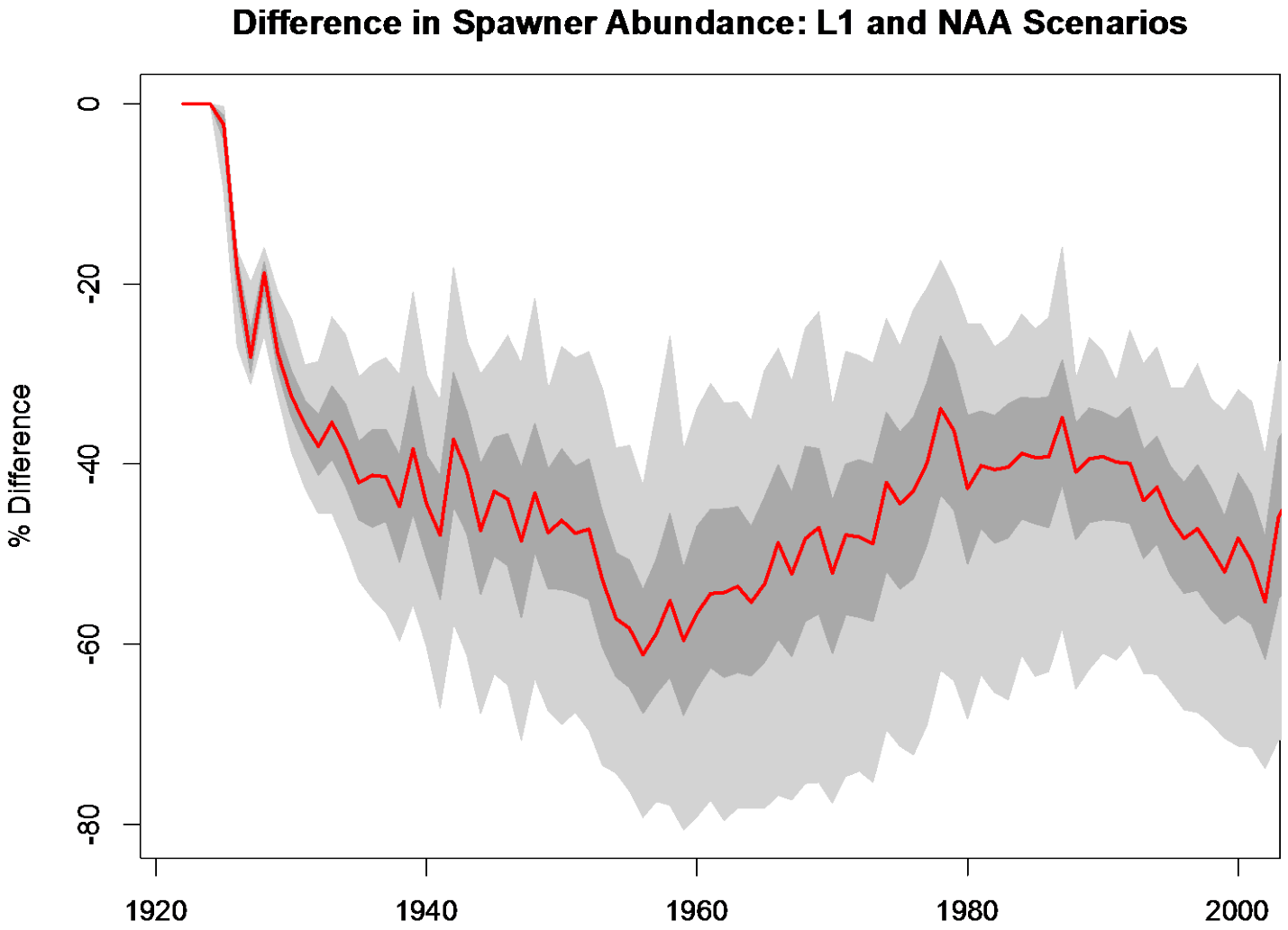
Table 1. Description of modeling scenarios analyzed.

Scenario Results

Cohort Replacement Rate (CRR)

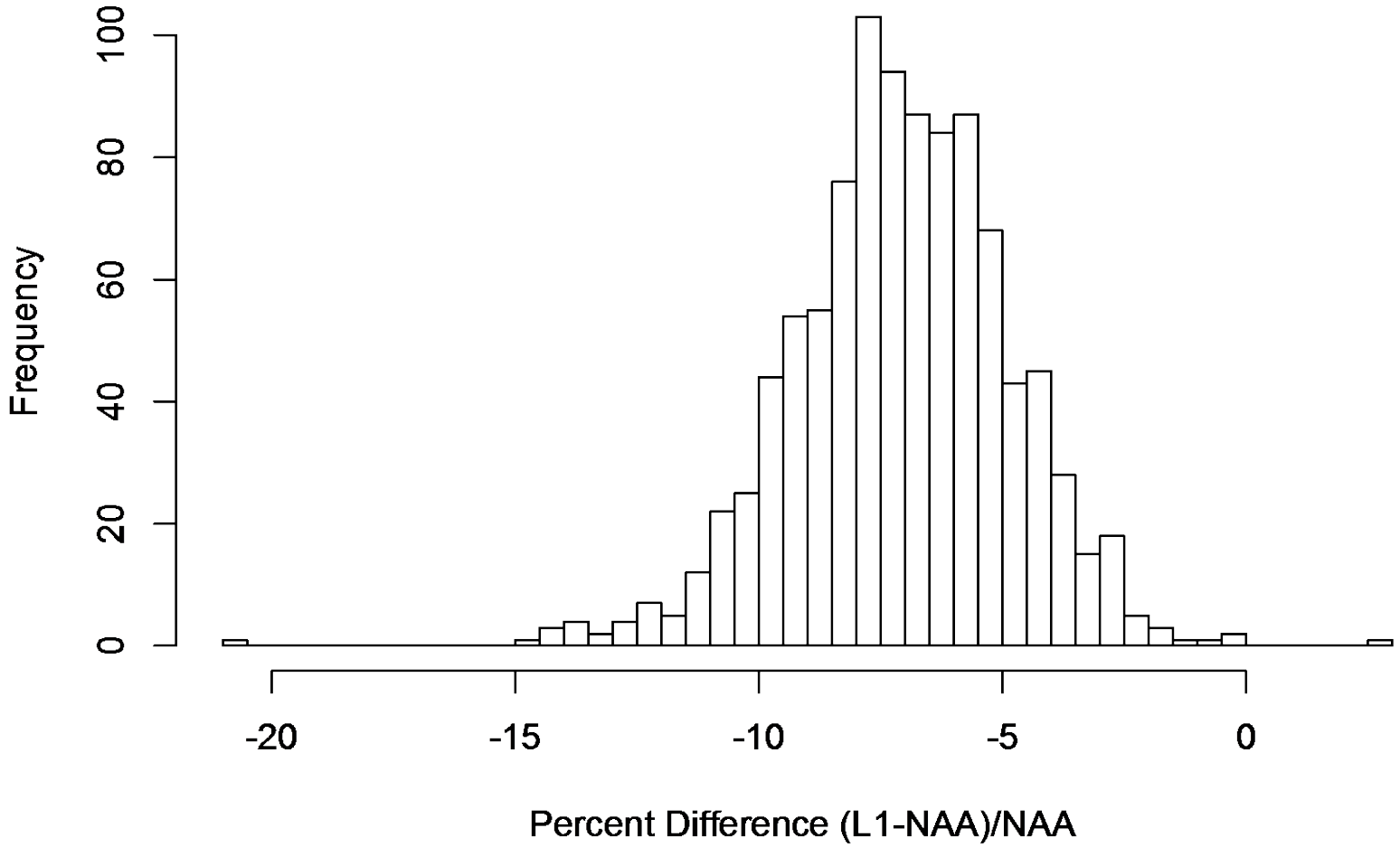
CWF Alternative (L1, NAA) Comparison	Percent Difference in mean CRR (L1-NAA /NAA)	Percent Difference in median CRR (L1-NAA /NAA)	Pr (NAA > L1)
Scenario 1	-8.03%	-7.91%	0.996
Scenario 1A	-7.85%	-7.69%	0.997
Scenario 1B	-8.19%	-8.22%	0.998
Scenario 2	-8.42%	-8.49%	0.999
Scenario 2A	-7.13%	-7.31%	0.999
Scenario 2B	-7.89%	-7.96%	0.999

Percent difference in Spawner Abundance Scenario 2A

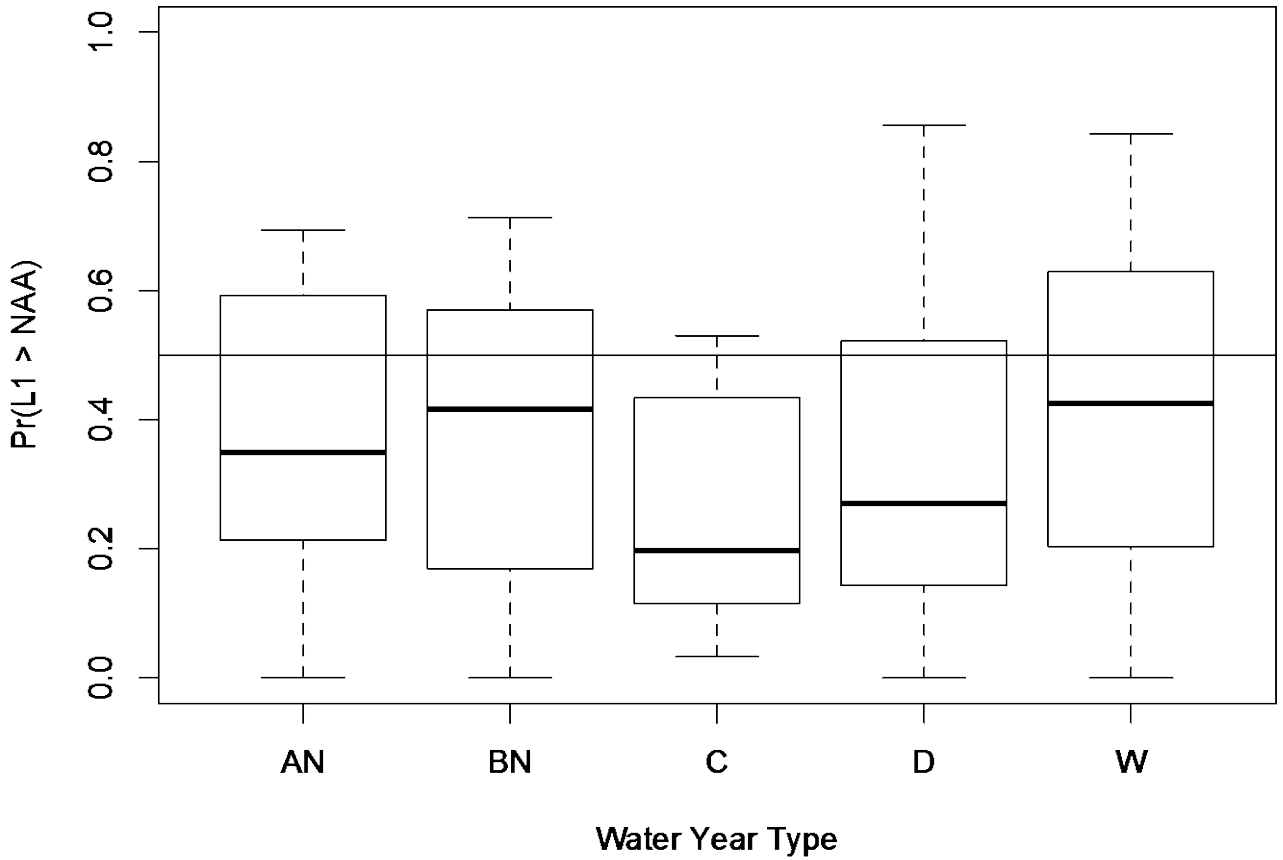


Percent difference in CRR

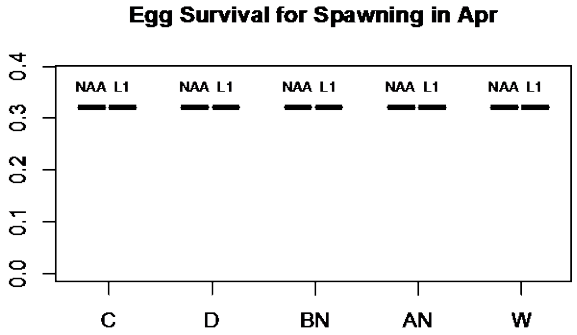
Scenario 2A

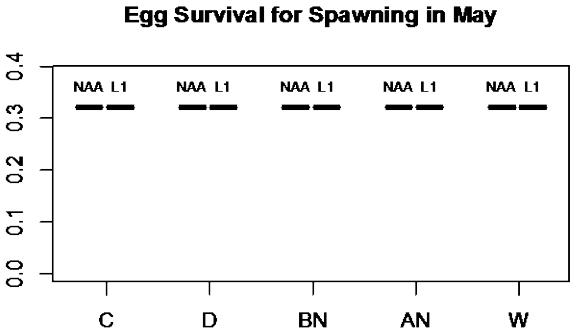


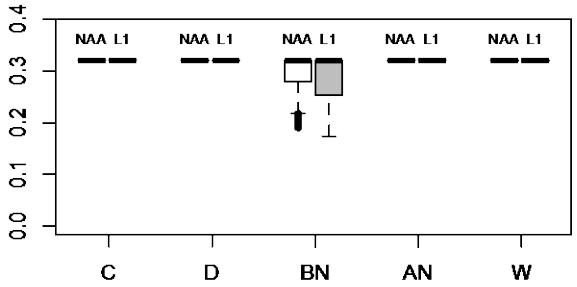
Probability of higher CRR under L1 relative to NAA by WYT (Scenario 2A)

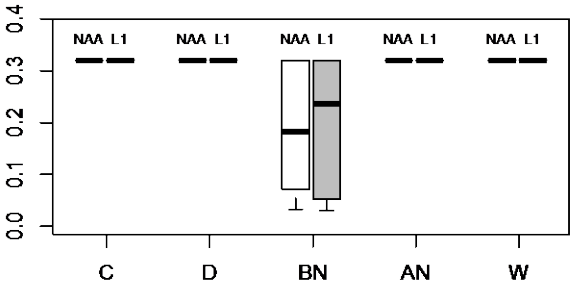


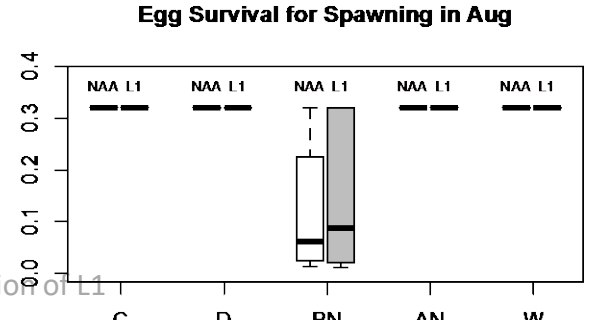
NAA and L1 egg to fry survival



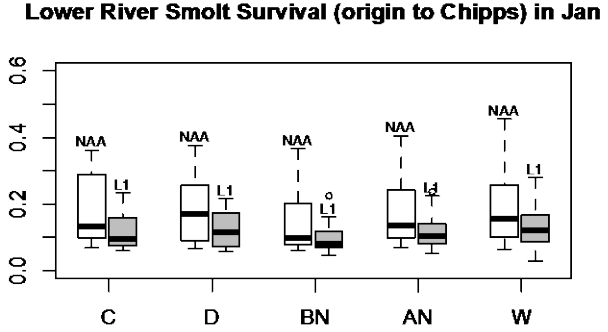


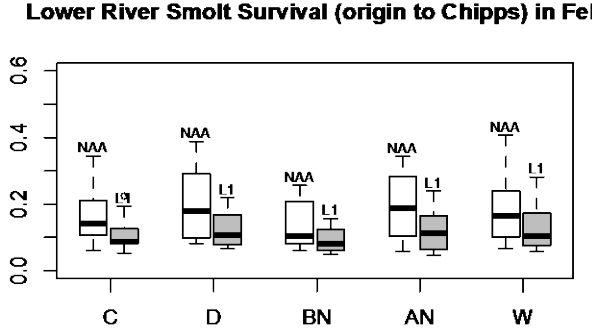


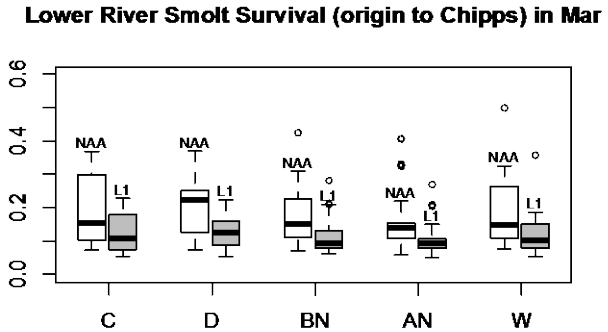


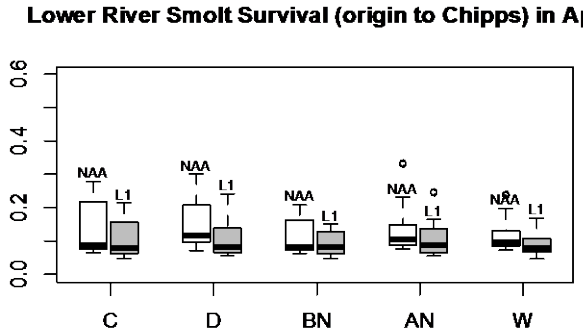


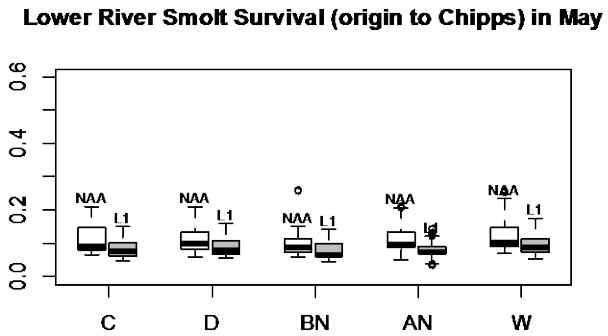
NAA and L1 Lower River smolt survival



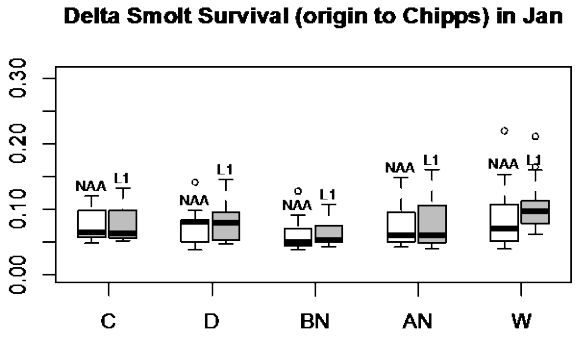


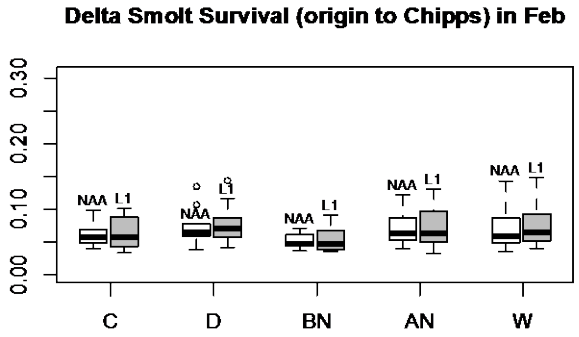


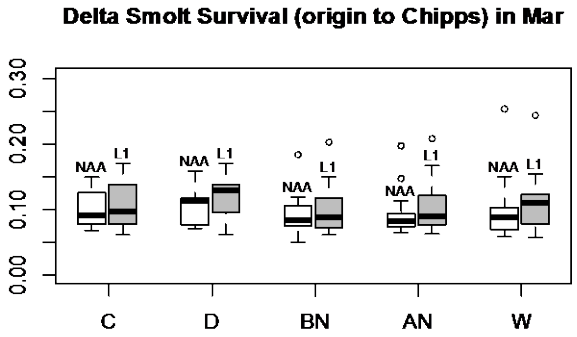


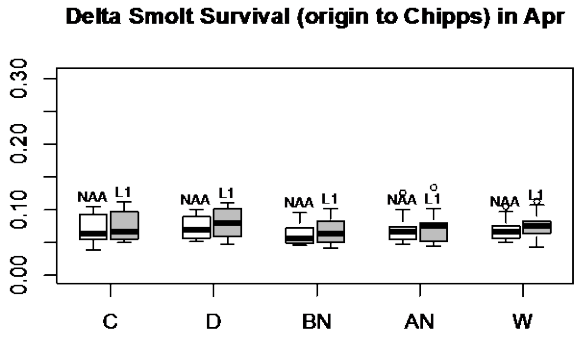


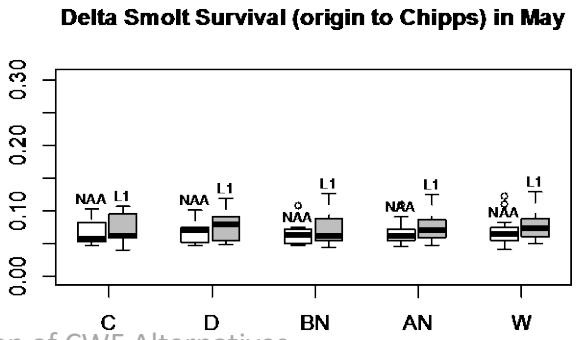
NAA and L1 Delta smolt survival





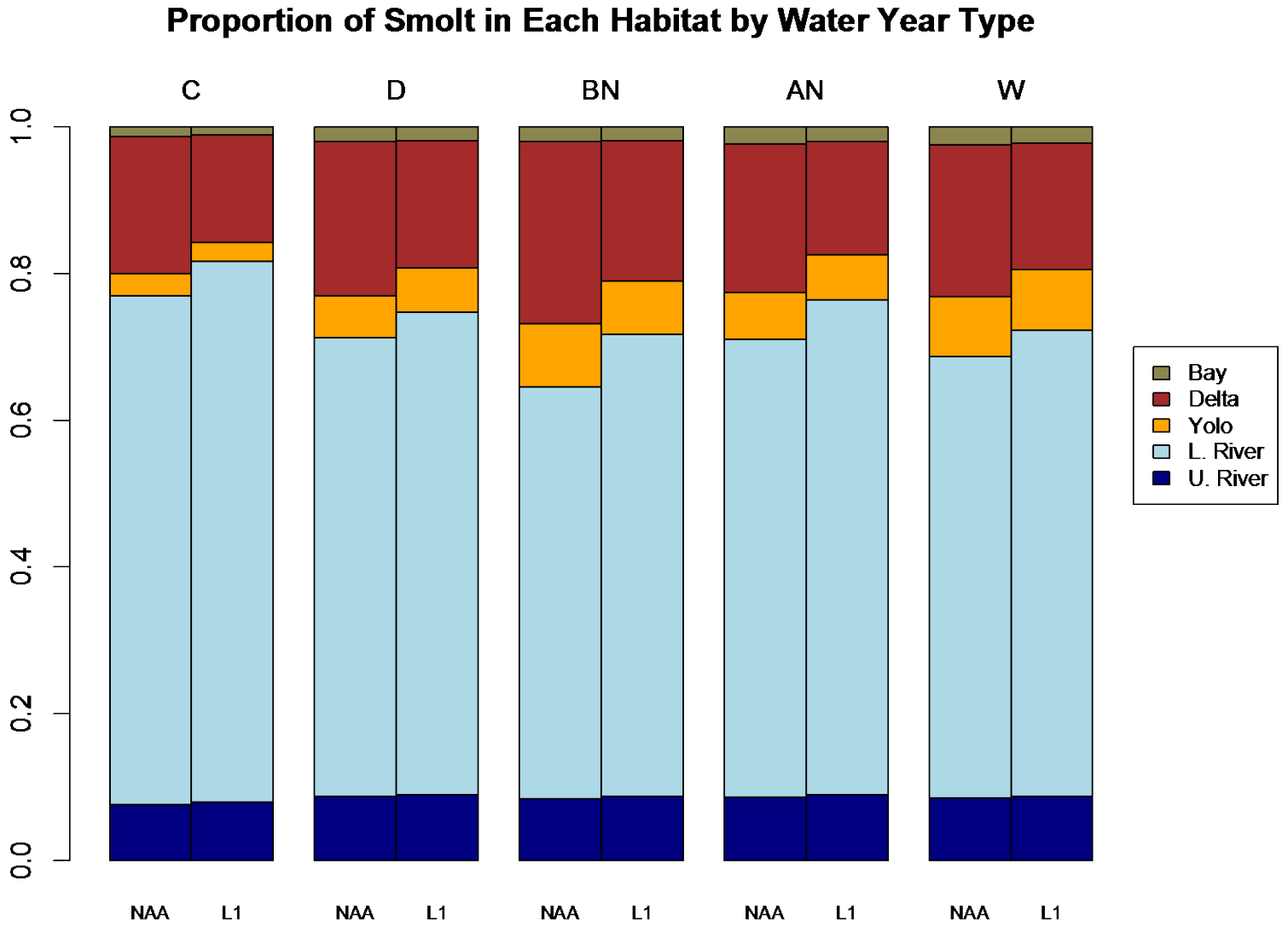






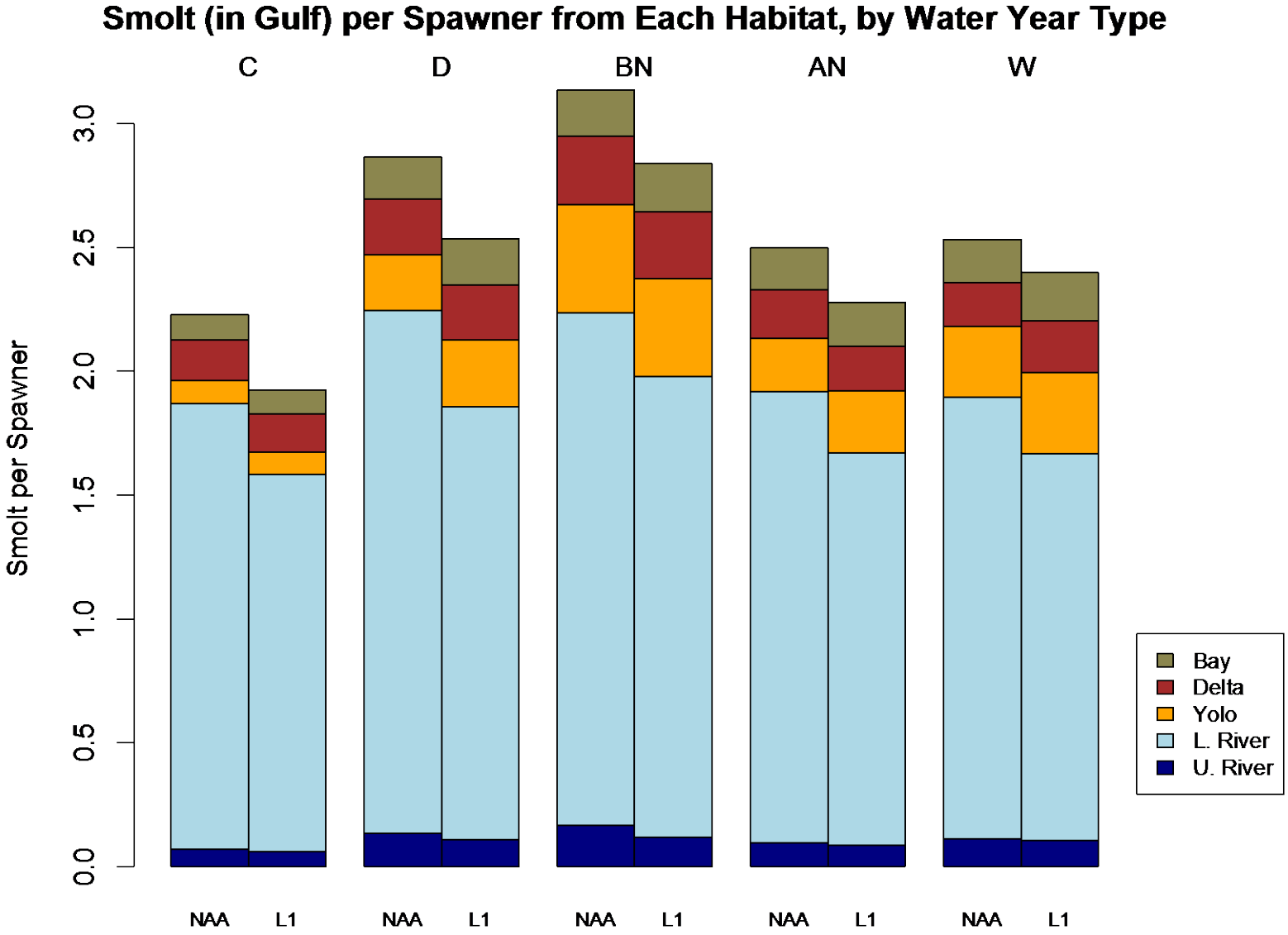
Smolt origination

L1 vs NAA, Scenario 2A



Productivity

L1 vs NAA, Scenario 2A

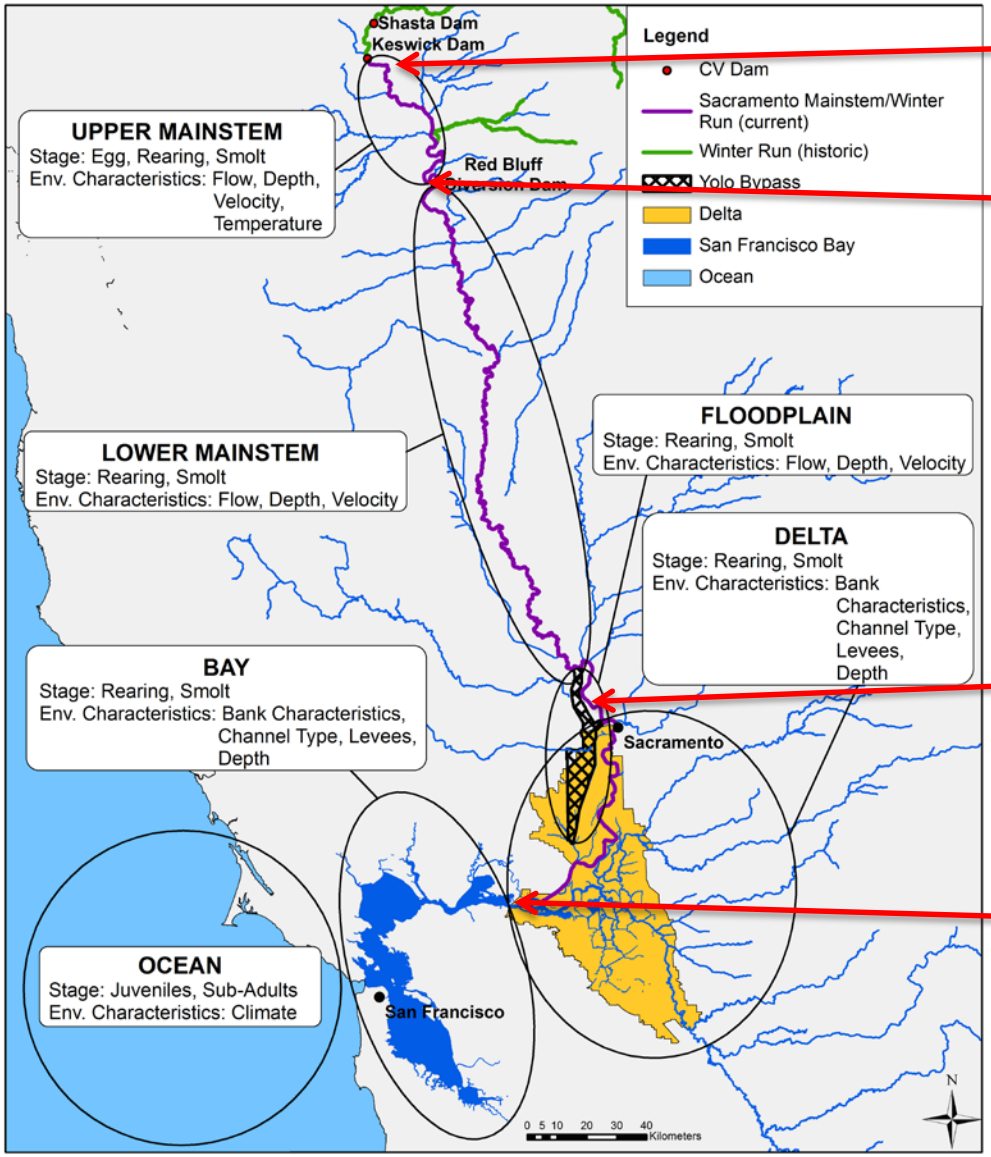


Questions?

Credit: Steve Culberson

CALIBRATION SLIDES

Indices of Abundance



Escapement

Juvenile abundance

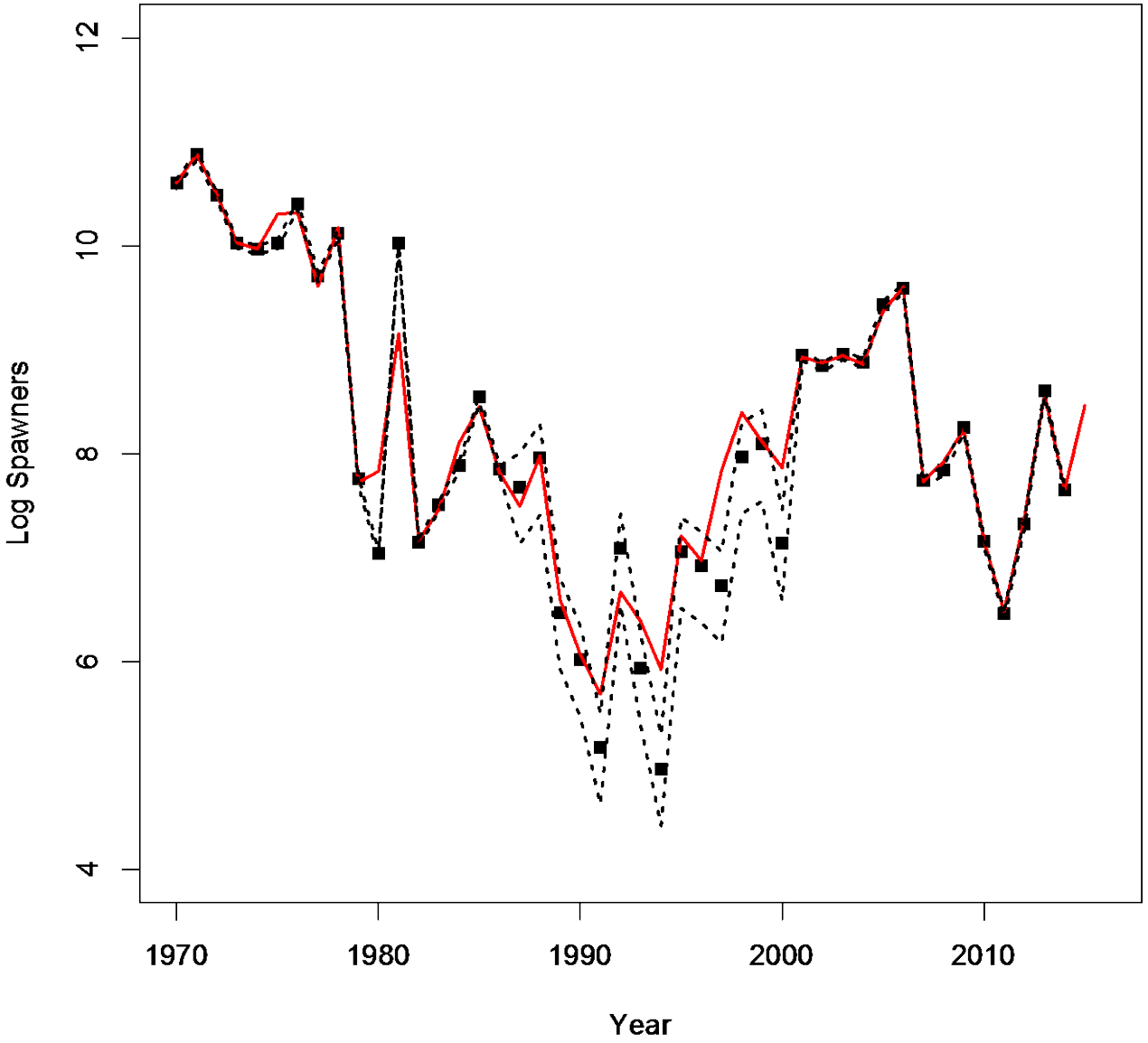
Knights Landing catch

Chipps Island abundance

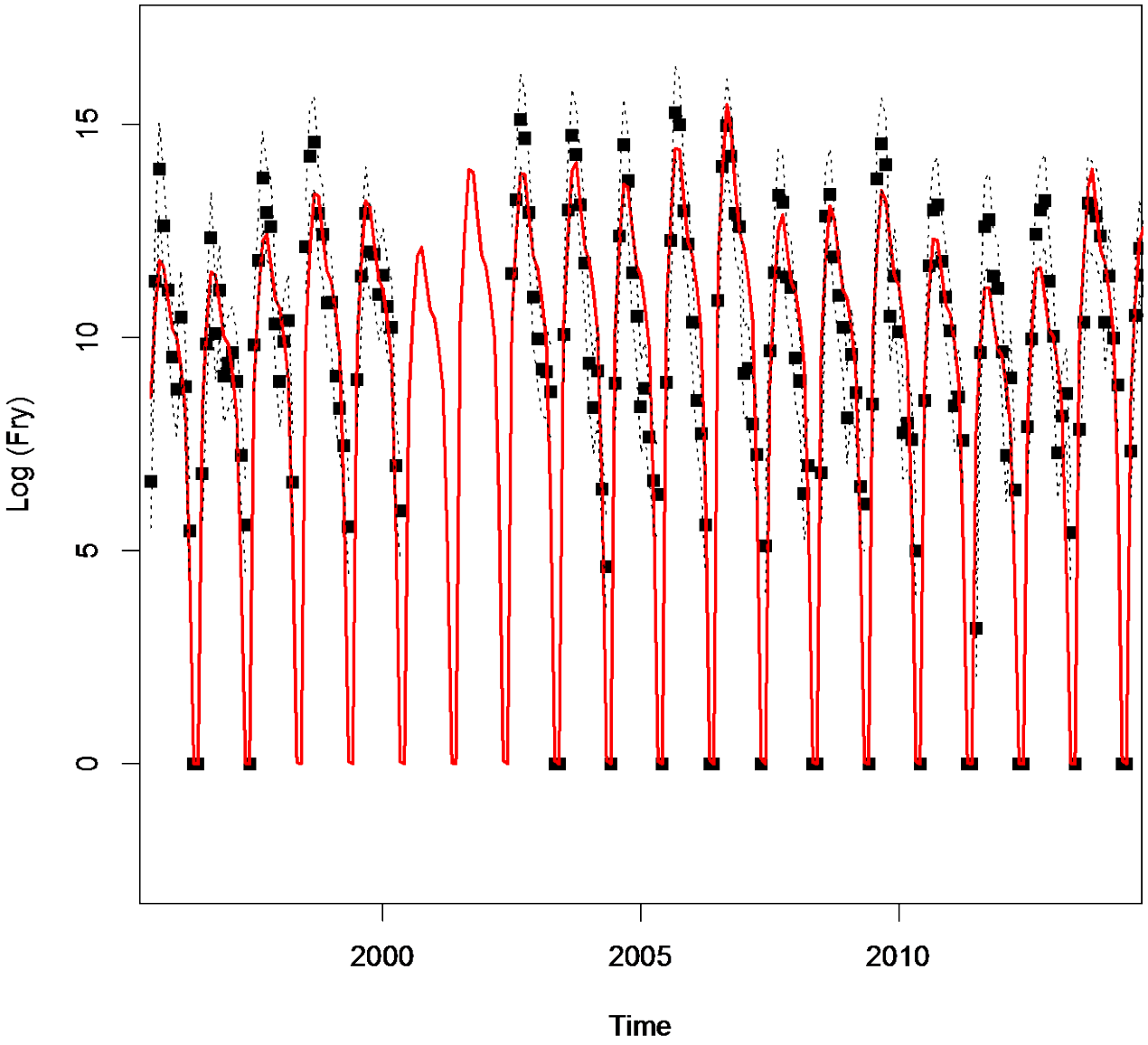
Indices of abundance

Data	Date	Coefficient of Variation	Sampling Distribution	Data time step
Natural Escapement	1970-2014	0.15 (1970-1986) 0.5 (1987-2000) 0.15 (2001-2014)	lognormal	Annual
RBDD monthly juvenile counts	1996-1999, 2002-2014	0.85	lognormal	Monthly
Knights Landing monthly catches	1999 - 2008	NA	multinomial	Monthly
Chipps Island monthly juvenile abundance	2008 - 2011	1.5	lognormal	Monthly

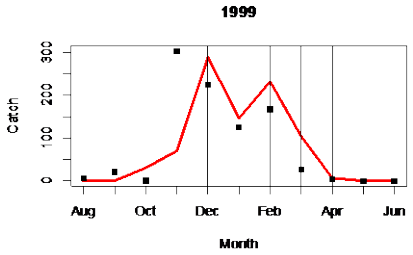
Natural origin log escapement

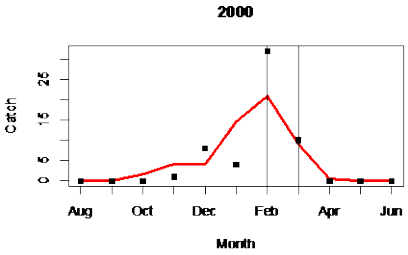


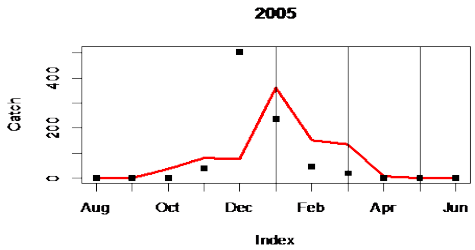
Monthly juvenile log abundance

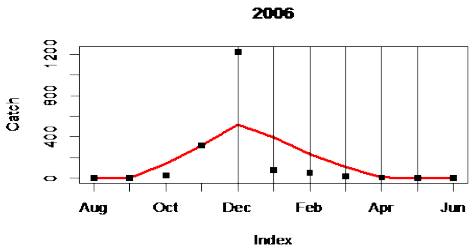


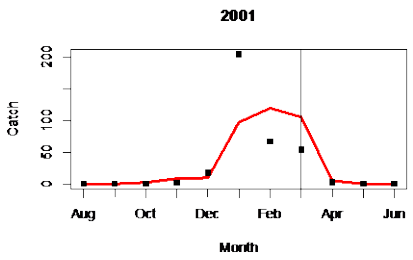
Knights Landing catch

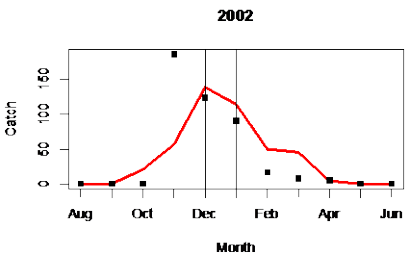


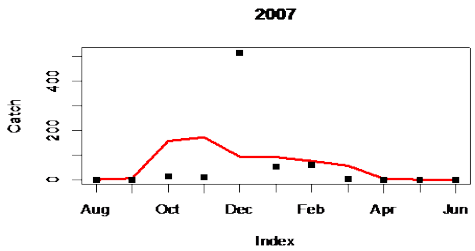


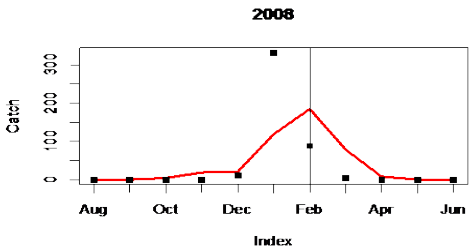


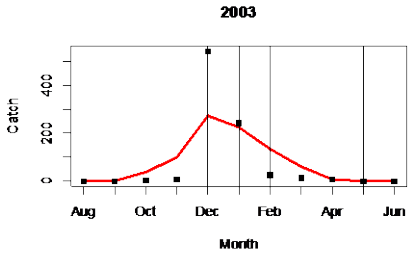


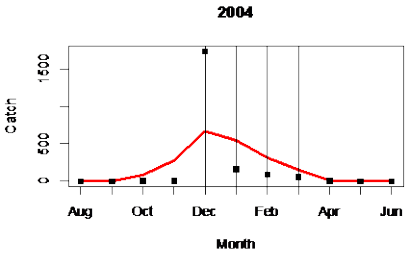




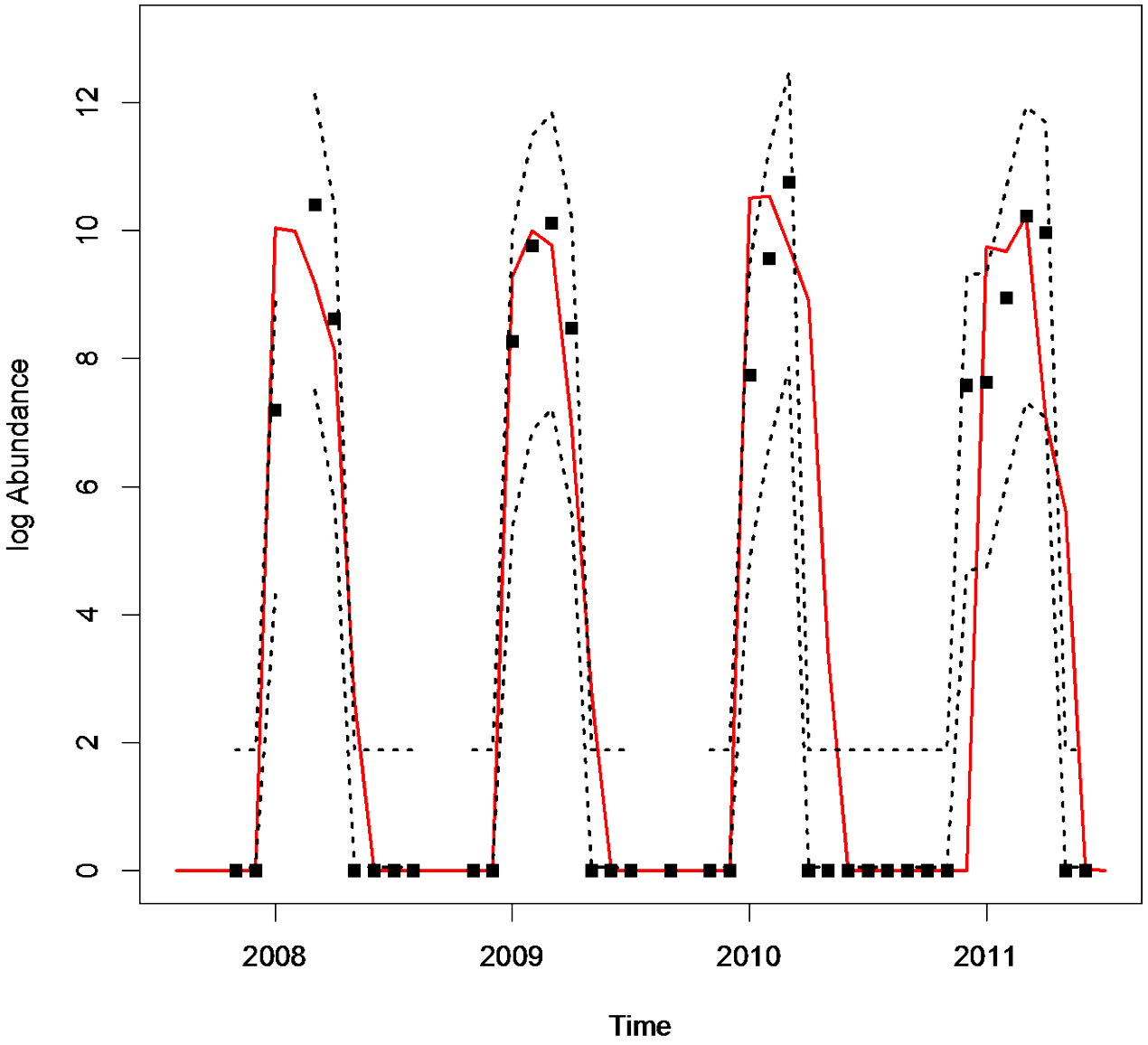








Chipps Island log abundance



Simulations for WaterFix

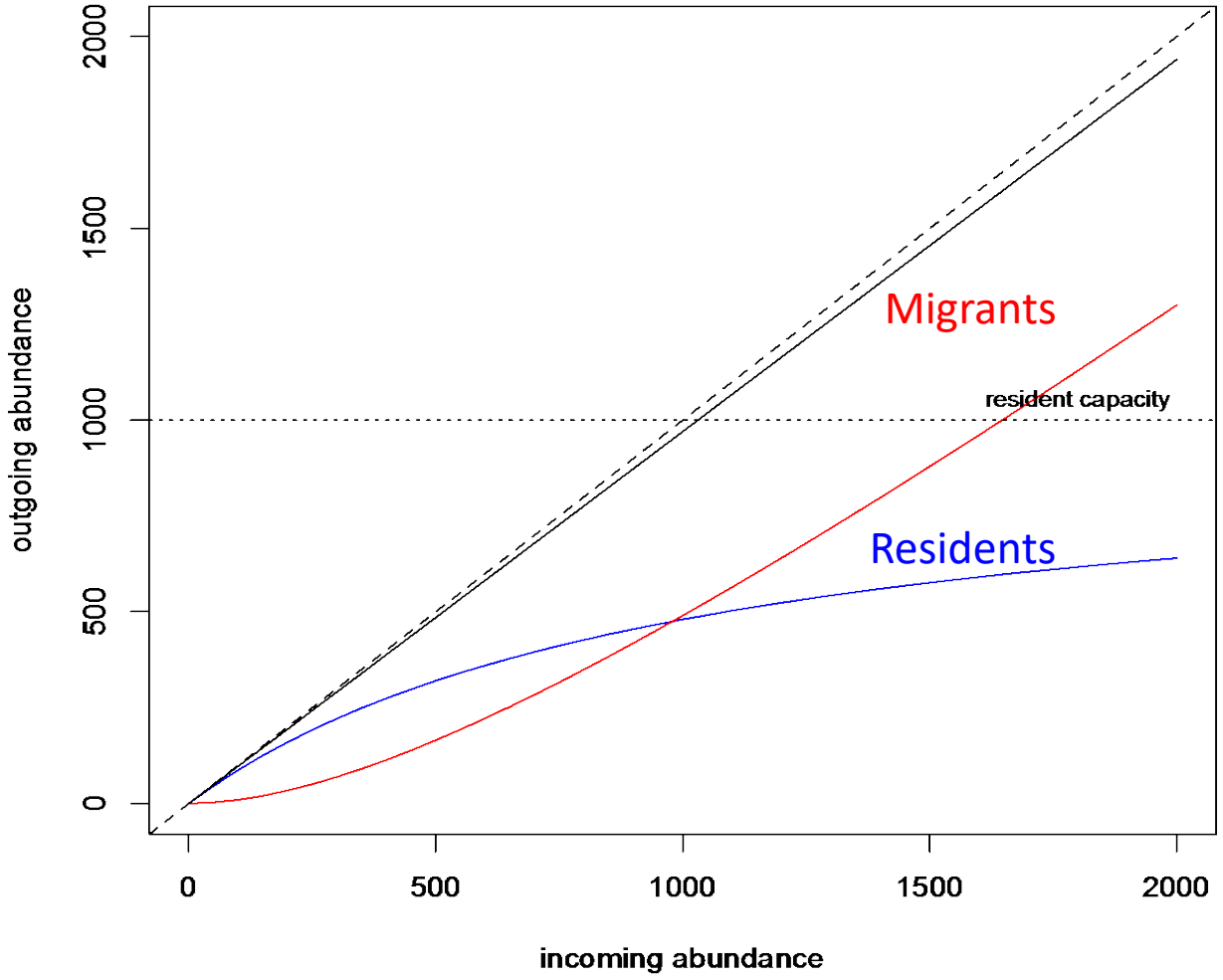
- Incorporated parameter uncertainty in simulations, parameter set k

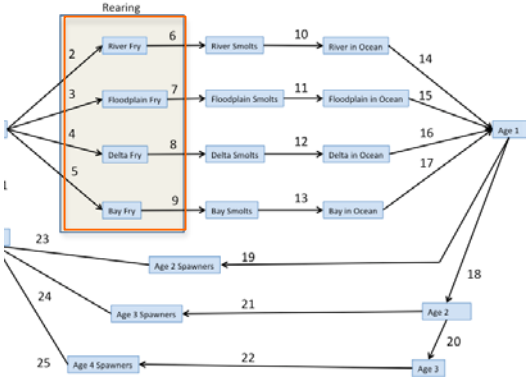
State parameters $$^{k}\theta \sim MVN(\hat{\theta}, \hat{\Sigma})$$

Random Effects $$^{k}\varepsilon_{1:T} \sim N(0, \mathrm{I}\sigma_{\varepsilon}^{2})$$

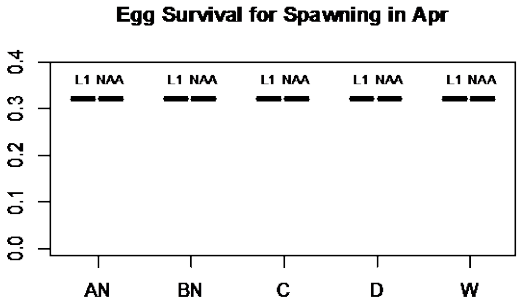
- NOTE: We are not interested in forecasting observations, so do not include measurement error

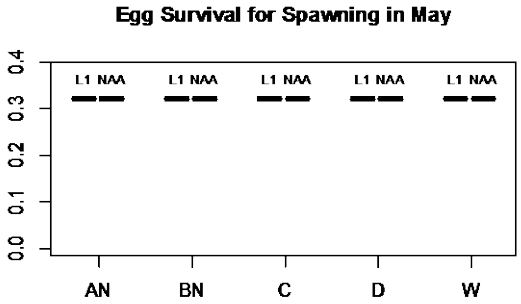
Fry Rearing Movement Function

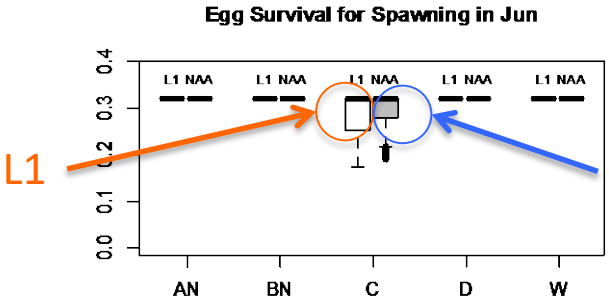


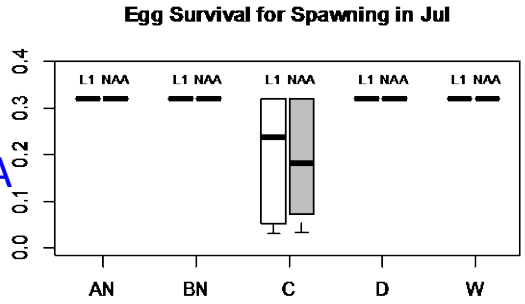


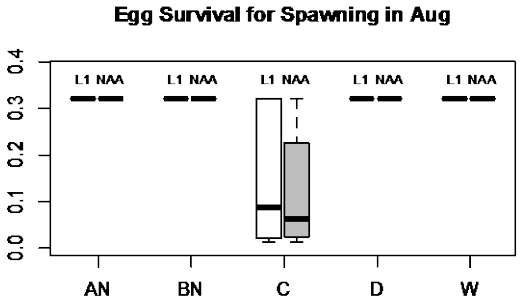
NAA and L1 egg to fry survival



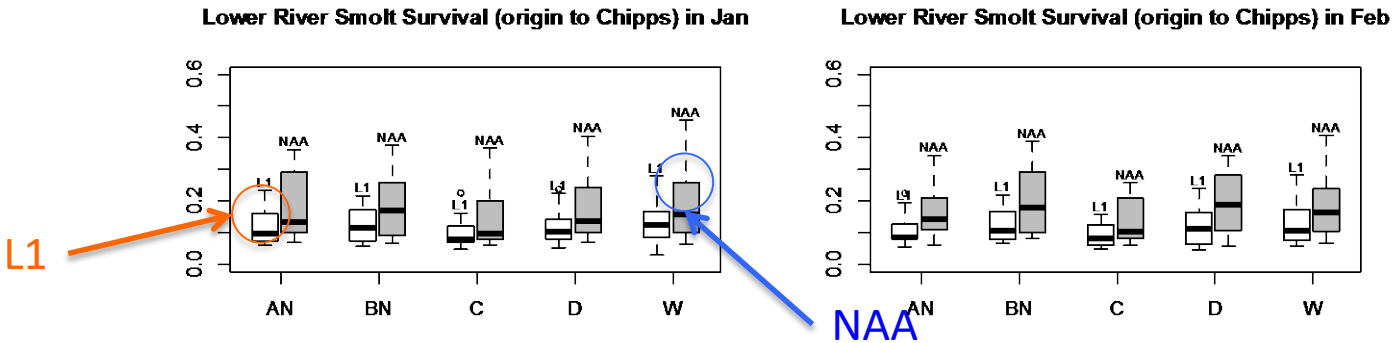


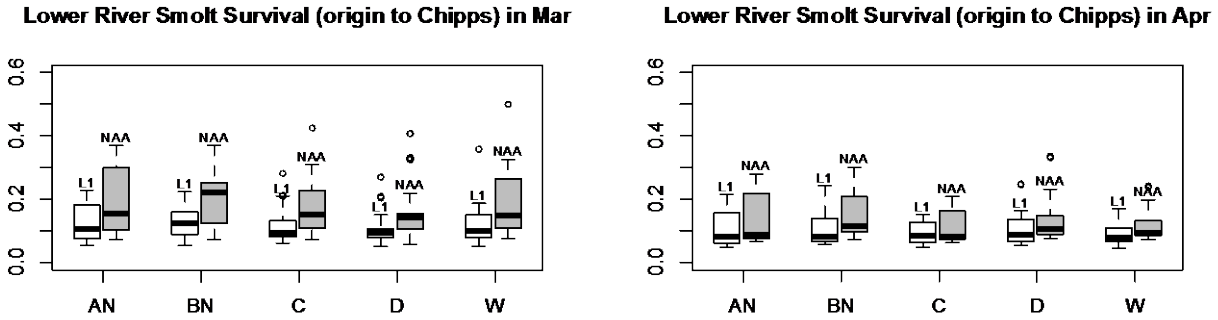


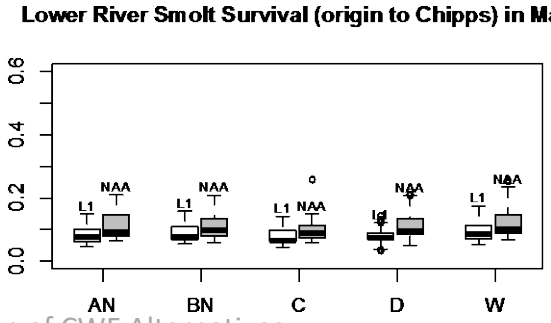




NAA and L1 Lower River smolt survival







NAA and L1 Delta smolt survival