Considering Dam Passage for Spring Chinook Salmon Populations in the Upper Willamette Within an Adaptive Management Framework

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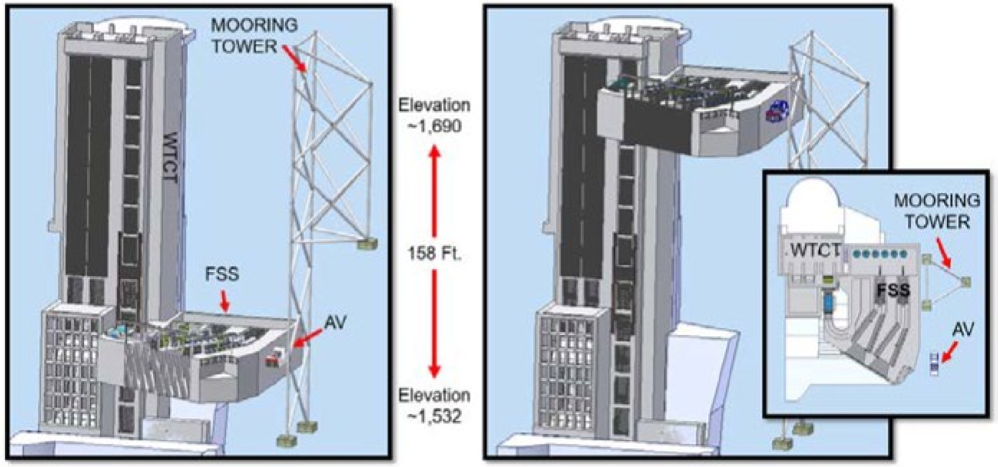
Some dam passage options evaluated

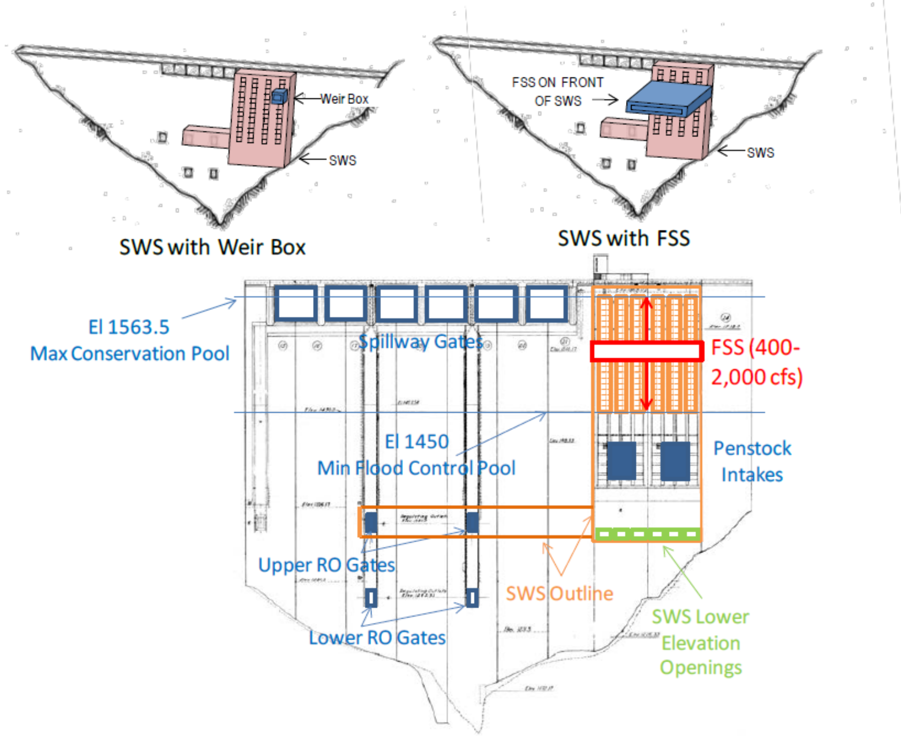
- **Improvements to dam passage have been required to facilitate recovery of spring Chinook salmon populations in the Upper Willamette**
- **Structural vs. operational passage**
  - **Floating Screen Structure (FSS)**
  - **Floating Surface Collector (FSC)**
  - **Spring spill /Spring drawdown/ Fall drawdown**
- **Question: How might spring Chinook salmon population abundance be affected by different downstream passage options?**



Life Cycle Models (LCMs)

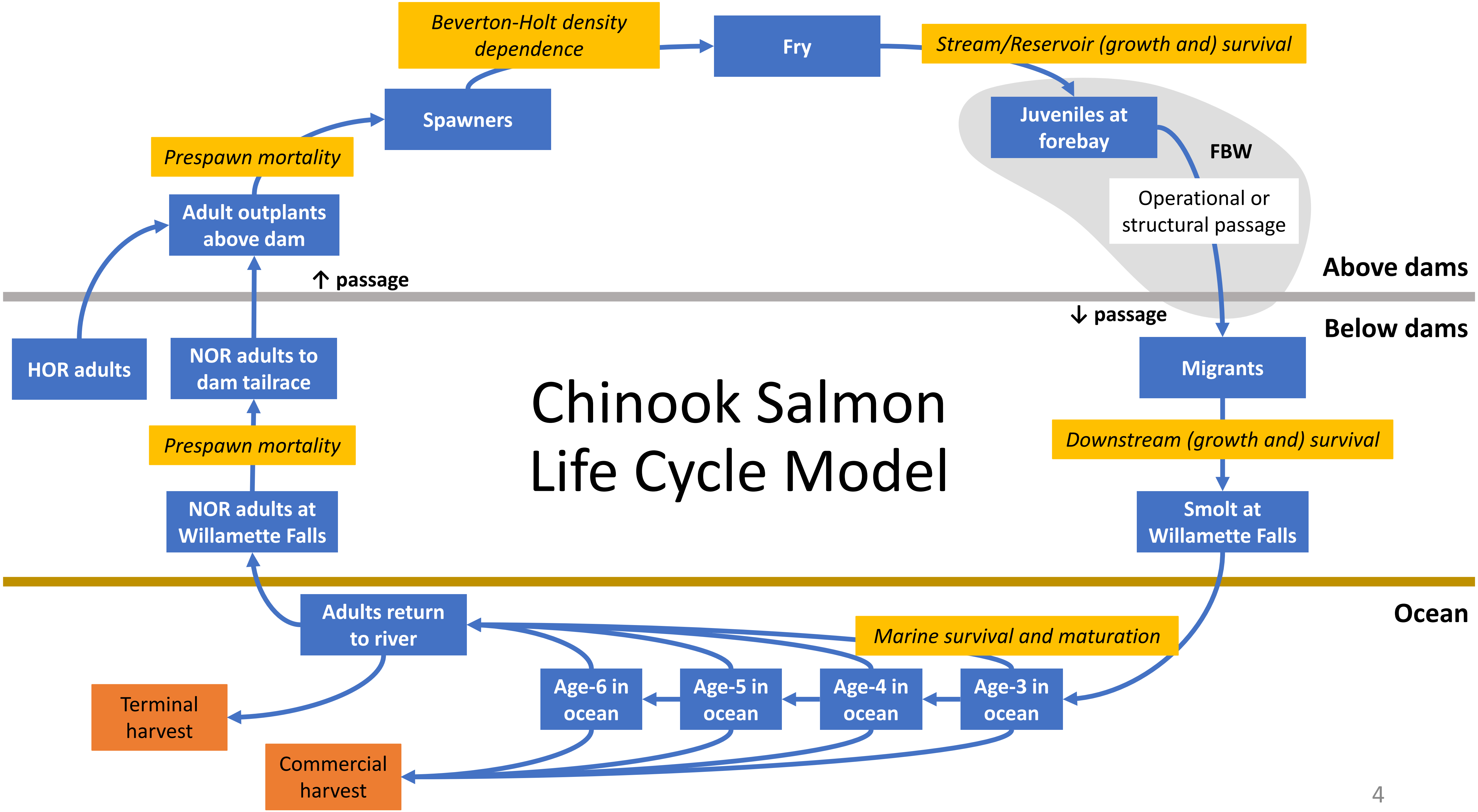
- **Predict time series of population abundance, accounting for life stage processes**
  - **Can project population outcomes from different dam passage options**
  - **Provide a transparent basis to evaluate how well different policy options meet objectives**
- **Credibility established by**
  - **Developing components using empirically based studies**
  - **Fitting the LCM to available time series data / diagnostics**
  - **Accounting for uncertainties through probability distributions / sensitivity tests**
    - **Underrepresented uncertainties: mistakes in identifying the "best" passage option**
- **Consideration of adaptive management options instead could lead to**
  - **Improved understanding**
  - **More confidence about the effectiveness of dam passage options**
  - **Implementation of effective dam passage options**
  - **Adaptive management options can be evaluated using LCMs**

Detroit Dam – Selective Withdrawal Structure (SWS) with Weir Box and Floating Screen Structure (FSS)



COP (2015)

Chinook Salmon Life Cycle Model



Data sources for model components

Sources	Estimated components
Dam tailrace counts of adult salmon	Marine survival rates, spawner abundance
PIT tag studies in each sub-basin	Downstream survival, marine survival
Screw trap and radio-telemetry studies	Juvenile movement, growth, PIT detection efficiencies
Reservoir studies of juvenile salmon	Reservoir survival rates and movement
Spawner carcass surveys	PSM, spawner age composition, fecundity
COP (2015)* Parameter workshops	LCM structure and parameter values
CTC and ODFW Reports	Harvest rates, marine survival rates
Egg-fry survival studies	Egg-fry survival rates
USGS Gauge Hydrological Records/ RES-SIM	Flow and temperature data, PIT detection efficiencies

*US Corps of Engineers Portland District. 2015. Willamette Valley Projects Configuration/Operation Plan (COP). Phase II Report

Juvenile migration pathways

- **Six juvenile migrant types modelled:**
  1. **Spring Subyearling (Fry = mover)**
  2. **Fall Subyearling (Reservoir-rearing = mover)**
  3. **Fall Subyearling (Stream-rearing = stayer)**
  4. **Spring Yearling (Reservoir Summer/Winter = mover)**
  5. **Spring Yearling (Reservoir Winter = stayer)**
  6. **Spring Yearling (Stream-rearing = stayer)**
- **Contribution of each influenced by dam passage options**
- **Six juvenile migrant groups tracked through to adult returns**

Mover – juvenile that leaves natal stream before its first summer
Stayer – juvenile that stays in natal stream until first autumn or later

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NRC Research Press

ARTICLE

Juvenile life-history diversity and population stability of spring Chinook salmon in the Willamette River basin, Oregon

R. Kirk Schroeder, Luke D. Whitman, Brian Cannon, and Paul Olmsted

Abstract: Migratory and rearing pathways of juvenile spring Chinook salmon (*Oncorhynchus tshawytscha*) were documented in the Willamette River basin to identify life histories and estimate their contribution to smolt production and population stability. We identified six primary life histories that included two phenotypes for early migratory tactics: fry that migrated up to 140–200 km shortly after emergence (movers) and fish that reared for 8–16 months in natal areas (stayers). Peak emigration of juvenile salmon from the Willamette River was in June–July (subyearling smolts), March–May (yearling smolts), and November–December (considered as "autumn smolts"). Alternative migratory behaviors of juvenile salmon were associated with extensive use of diverse habitats that eventually encompassed up to 400 rkm of the basin, including tributaries in natal areas and large rivers. Juvenile salmon that reared in natal reaches and migrated as yearlings were the most prevalent life history and had the lowest temporal variability. However, the total productivity of the basin was increased by the contribution of fish with dispersive life histories, which represented over 50% of the total smolt production. Life-history diversity reduced the variability in the total smolt population by 35% over the weighted mean of individual life histories, providing evidence of a considerable portfolio effect through the asynchronous contributions of life histories. Protecting and restoring a diverse suite of connected habitats in the Willamette River basin will promote the development and expression of juvenile life histories, thereby providing stability and resilience to native salmon populations.

Reservoir survival

- **Few studies on in-reservoir survival**
  - **Rely on COP (2015) for most of the reservoirs**
- **Lookout Point Reservoir (Kock et al. 2019)**
  - **Estimated monthly survival rates for different juvenile migrant types (April-October)**
- **Need more studies in the main reservoirs**
  - **Dam passage measures may result in differing outcomes for parasites and predators**

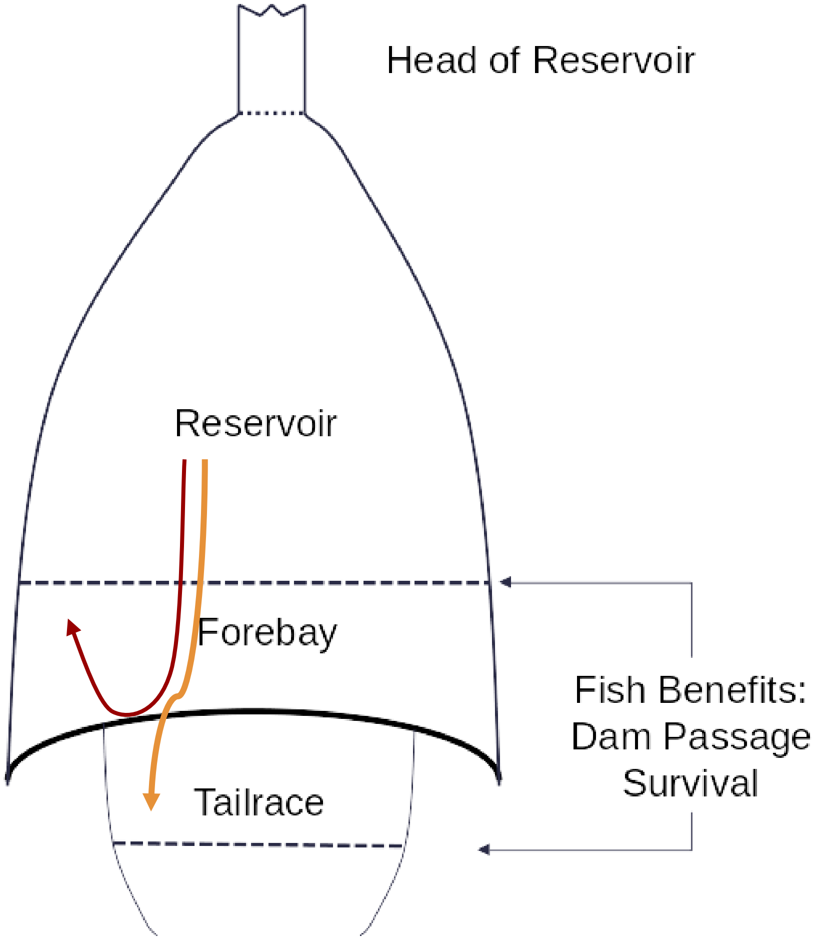
Evaluation of Chinook Salmon (*Oncorhynchus tshawytscha*) Fry Survival in Lookout Point Reservoir, Western Oregon, 2017

By Tobias J. Kock, Russell W. Perry, Gabriel S. Hansen, Philip V. Haner, Adam C. Pope, John M. Plumb, Karen M. Cogliati, and Amy C. Hansen

Corps' Fish Benefits Workbook: Key outputs

Daily estimates rolled into annual estimates of two key parameters: DPS and DPE

- **Dam passage survival (DPS):**
  - **Informs average annual survival of juveniles that approach and attempt to pass dams**
  - **Differentiated by different operation and fish passage specifications, water year type**
- **Dam passage efficiency (DPE):**
  - **Informs proportion of the annual population that remains in the forebay**
  - **Fish not passing subject to in-reservoir mortality and later passage**

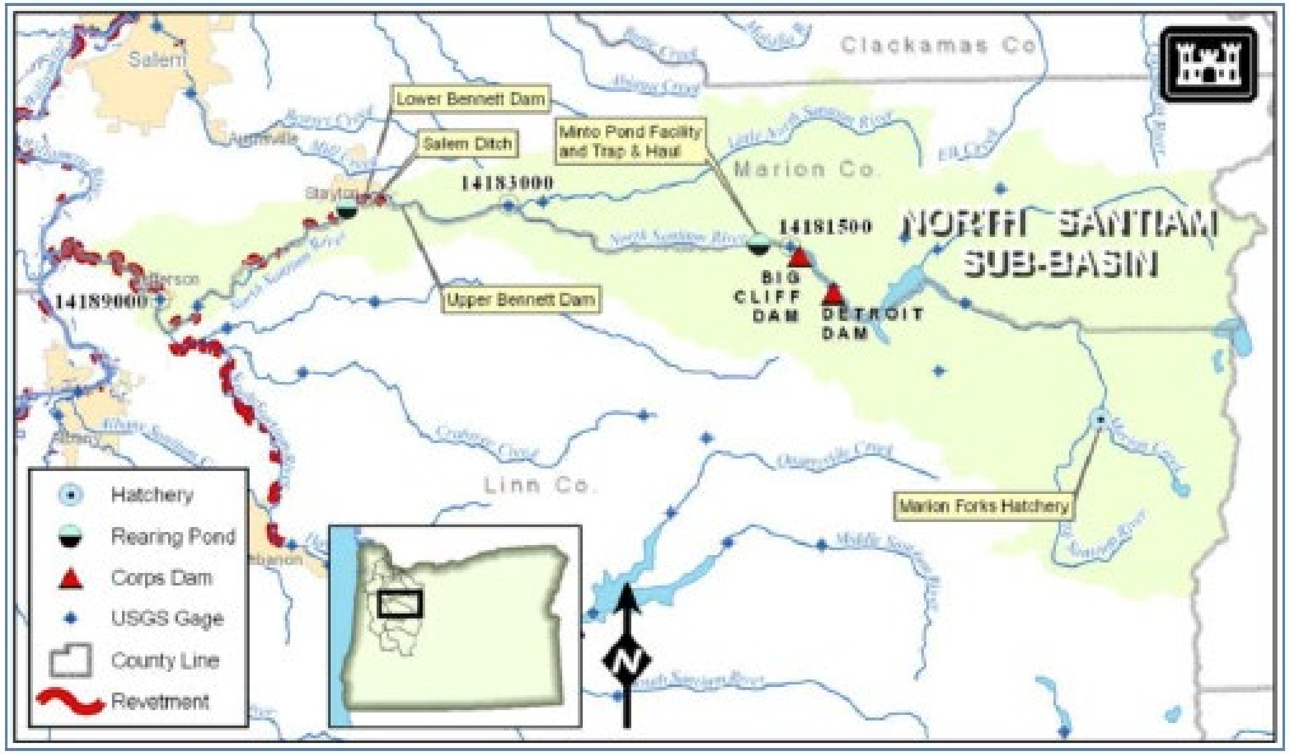


USACE Portland (2012)

Focus on simulation results for Detroit Dam in the North Santiam Sub-basin

- **Three cases simulated:**

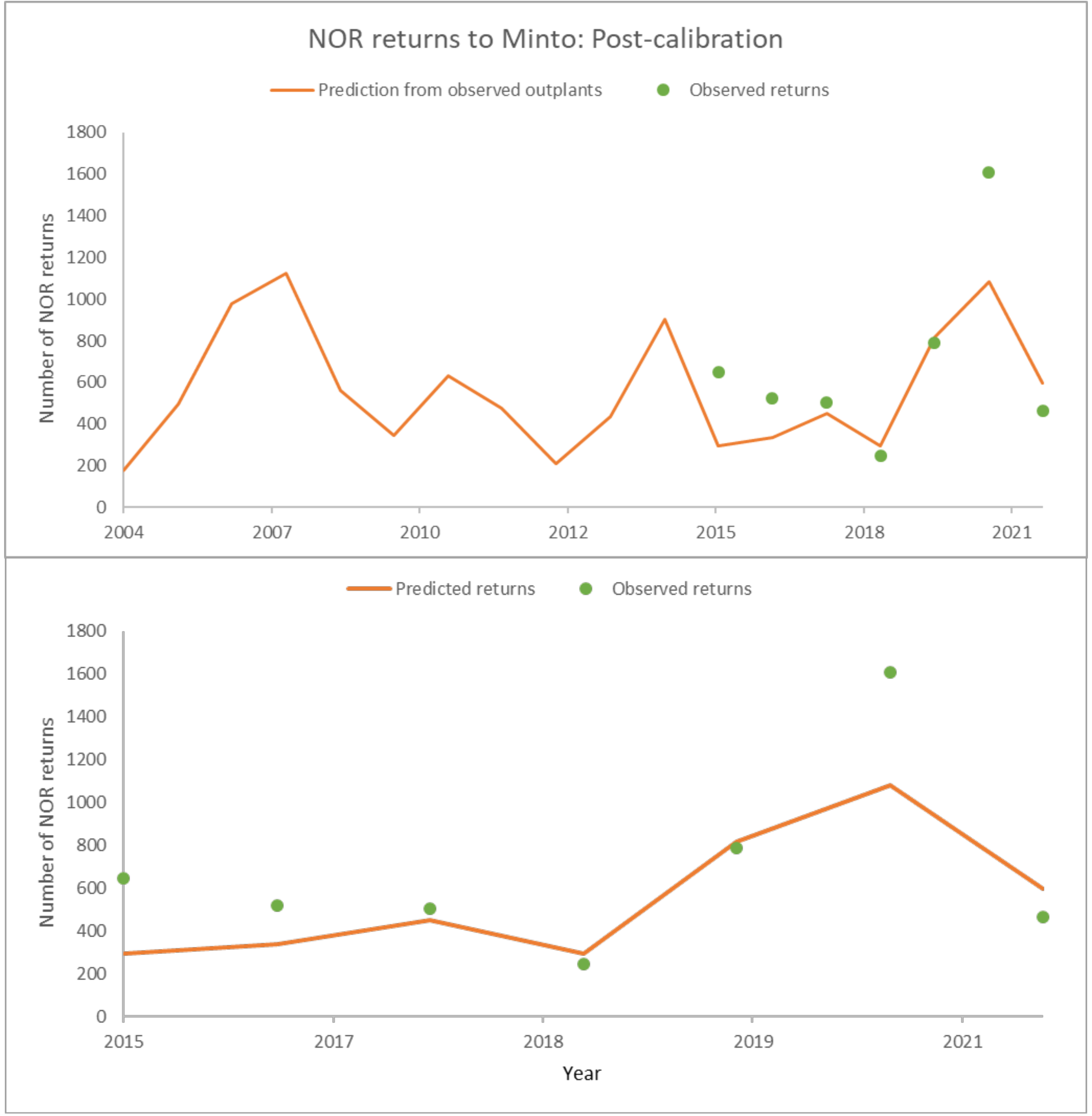
1. **Current conditions**
   - **No new dam passage for juveniles**
2. **Floating Screen Structure (FSS)**
3. **Spring and autumn drawdowns**



COP (2015)

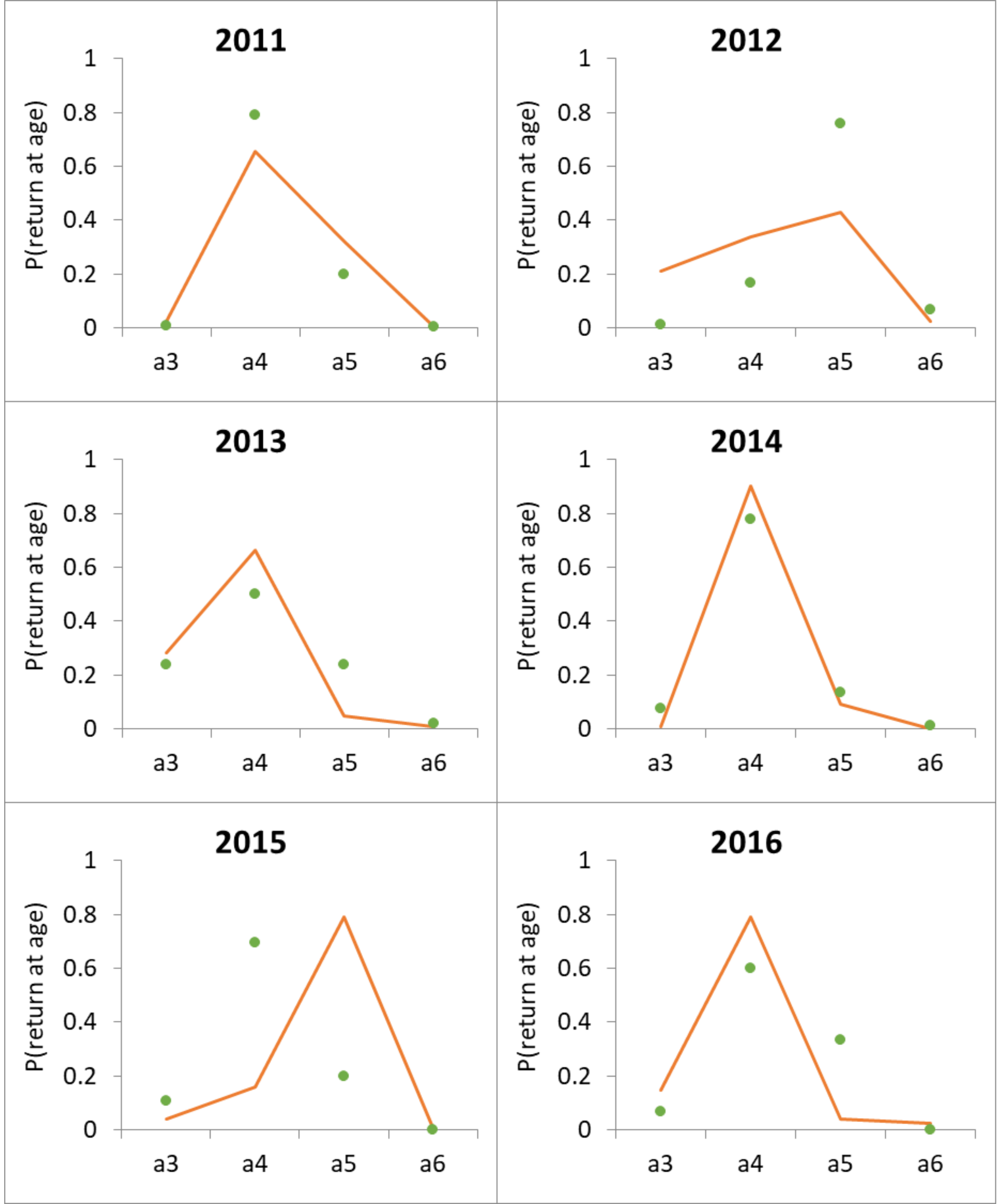
Model calibration: Fitting LCM to abundance and age composition data

- **Freed up**
  - **1st year at sea survival rate**
  - **Proportion maturing at age**
- **Fitted LCM model to**
  - **Natural origin adult counts at Big Cliff tailrace**
  - **Age composition of spawners above Detroit Dam**
- **Ensures that LCM can predict the time series of historical data**



Fitting LCM to age composition data

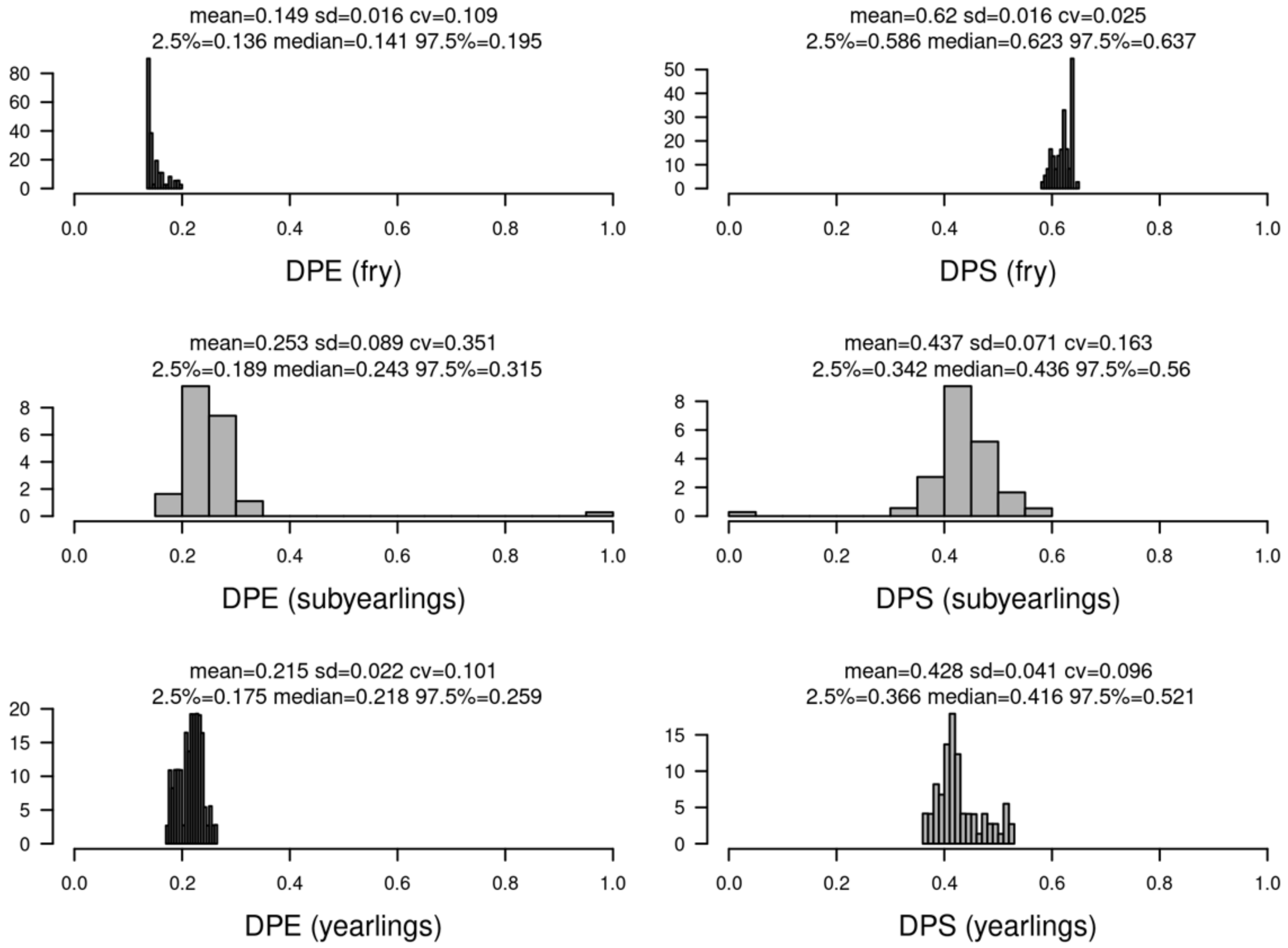
- **Estimated annual deviates in 1st year at sea natural mortality**
- **Annual deviates were bootstrapped from the pool of deviates obtained**



Detroit Dam: Passage Efficiency and Survival

- **FBW outputs for the Detroit Dam on DPE and DPS**
- **Hydrological records from historic years bootstrapped**

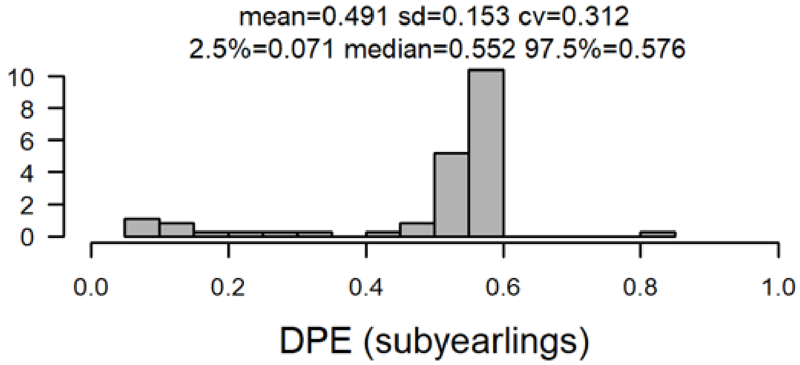
No change in Dam passage

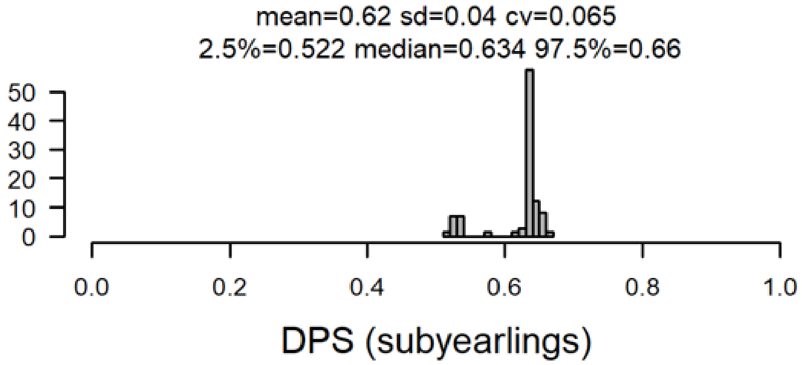


Detroit Dam: Passage Efficiency and Survival

No change in dam passage

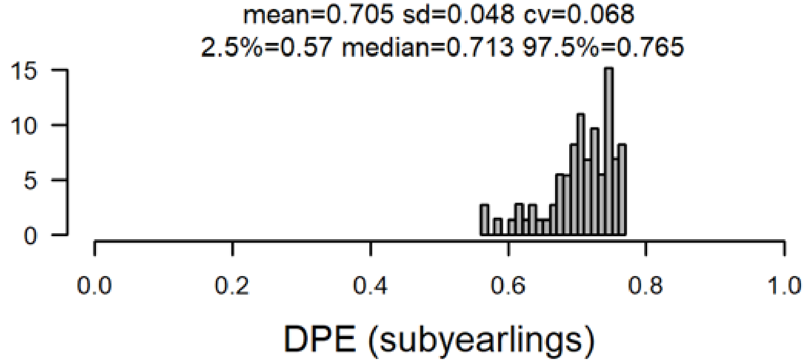
- Outplanting of HOR adults

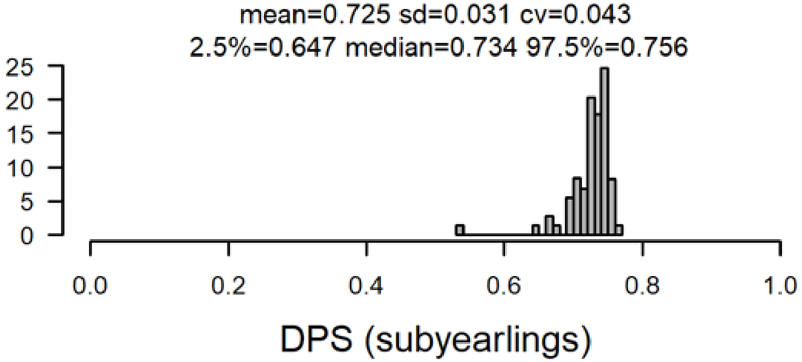




Spring and autumn drawdowns

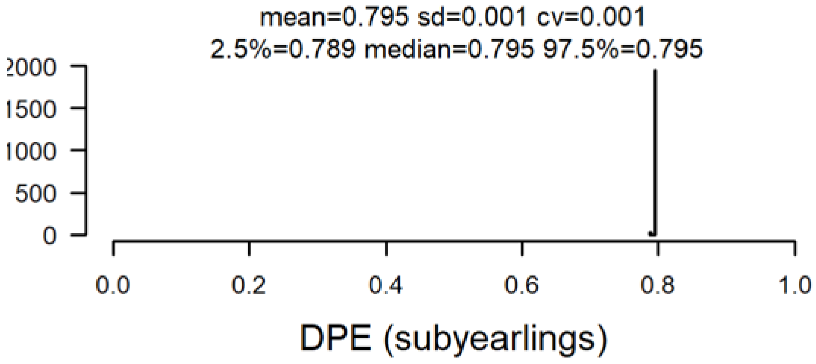
- Outplanting of NOR adults
- DPE*DPS = 1.5x No change

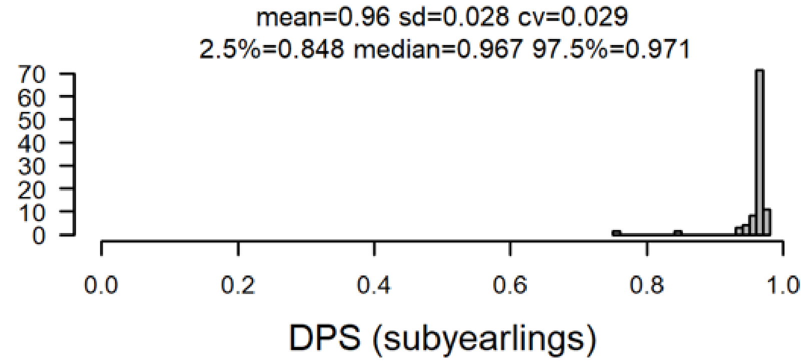




Floating Screen Structure

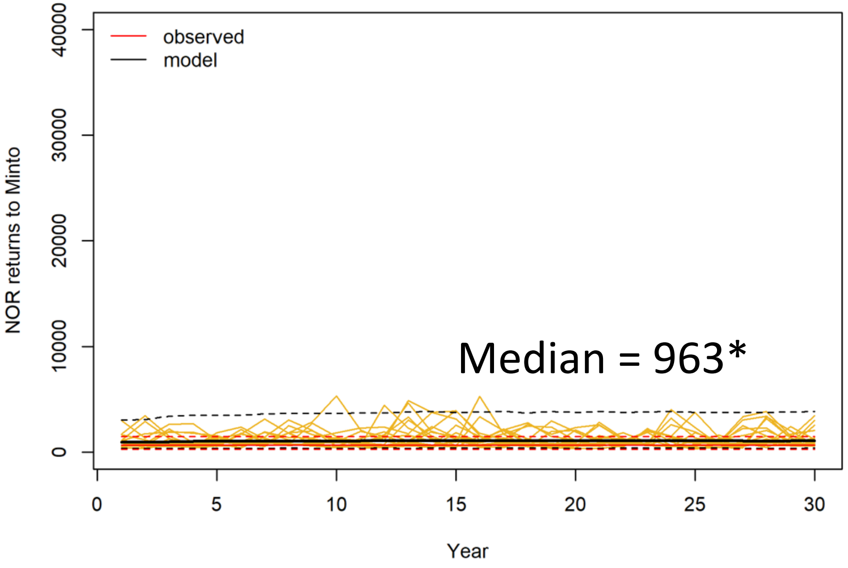
- Outplanting of NOR adults
- DPE*DPS = 2.2x No change
- DPE*DPS = 1.5x Spills



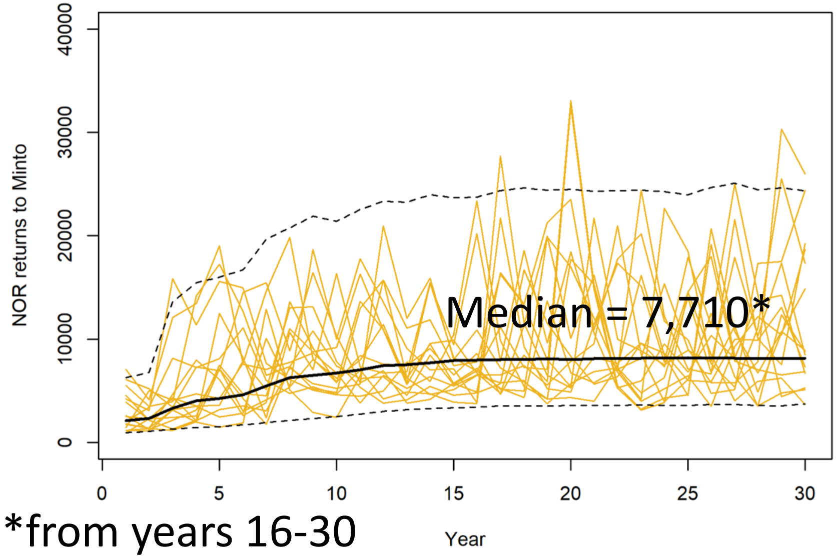


30-year projections of NOR spawners from the LCM for Spring Chinook salmon in the North Santiam River

- **Medians and 95% Confidence Intervals for spawner abundance by year**



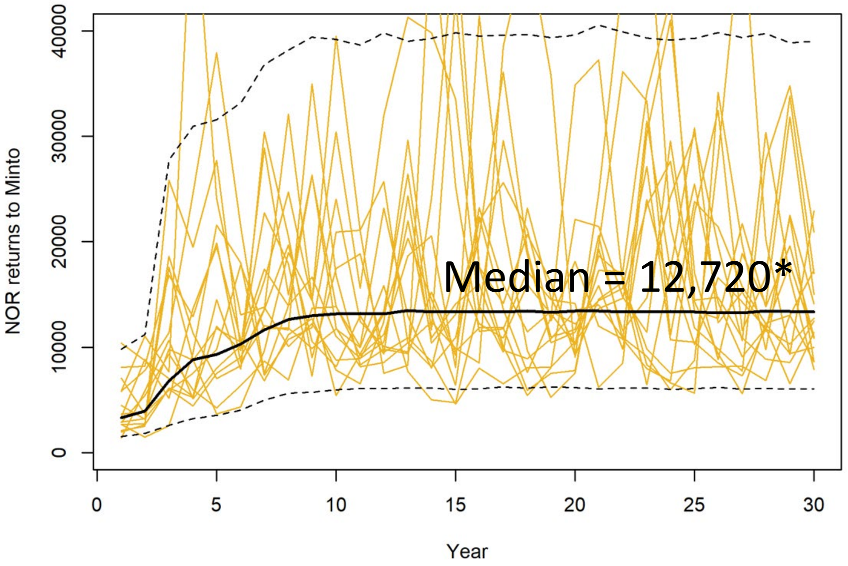
No change in dam passage



*from years 16-30

Spring, autumn drawdowns

- **8x No change**



Floating Screen Structure

- **13x No change**
- **1.65x drawdowns**

Conclusions

- **Median projected spawner abundance on average**
  - **Much higher for the two dam passage options than for the no change option**
  - **Higher for structural than for operational dam passage**
  - **Differences attributable mainly to mean differences in DPE and DPS**
- **Considerable overlap in projected outcomes of spawner abundance between the dam passage options**
  - **Uncertainty over which may perform the best**

Conclusions

- **Uncertainty is underrepresented especially in**
  - **Dam Passage Efficiencies and Dam Passage Survival Rates**
  - **Reservoir survival rates**
- **With additional uncertainties in DPE, DPS and reservoir survival rates**
  - **The range of LCM outcomes for each option will be wider**
  - **It will be even less clear which dam passage option could perform the best**
  - **Risk that a dam passage options will be ranked incorrectly**

Conclusions

- **High uncertainty over the potential effectiveness of different dam passage methods suggests an <u>adaptive management approach</u>:**
  - **Evaluation of the effectiveness of candidate adaptive management plans for informing and achieving long-term conservation objectives**
  - **Implementing dam passage options within a deliberately experimental framework**
  - **Close monitoring of reservoir survival rates, DPE and DPS, NOR return rates**
  - **Contingency plans and decision rules specified**
    - **Measures taken can be deliberately modified or stopped depending on the data obtained**

Acknowledgments

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