RECONSTRUCTION OF MARINE SURVIVAL IN WINTER STEELHEAD IN THE ABOVE DAM SOUTH SANTIAM SUB-BASIN

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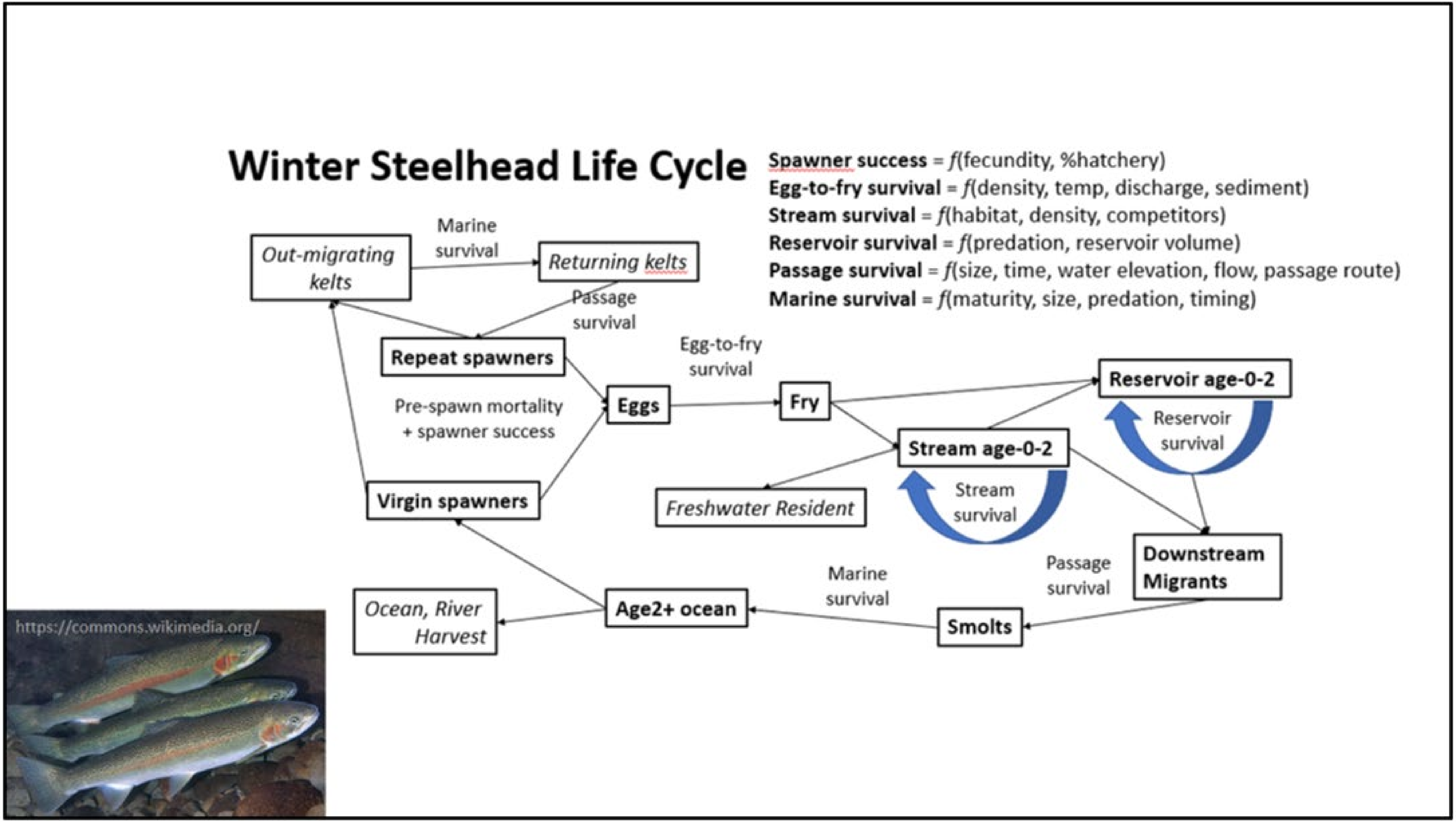
Winter Steelhead Life Cycle
Spawner success = f(fecundity, %hatchery)
Egg-to-fry survival = f(density, temp, discharge, sediment)
Stream survival = f(habitat, density, competitors)
Reservoir survival = f(predation, reservoir volume)
Passage survival = f(size, time, water elevation, flow, passage route)
Marine survival = f(maturity, size, predation, timing)
Out-migrating kelts
Marine survival
Returning kelts
Passage survival
Repeat spawners
Egg-to-fry survival
Pre-spawn mortality + spawner success
Eggs
Fry
Reservoir age-0-2
Reservoir survival
Stream age-0-2
Stream survival
Virgin spawners
Freshwater Resident
Downstream Migrants
Passage survival
Marine survival
Ocean, River Harvest
Age2+ ocean
Smolts
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South Santiam River

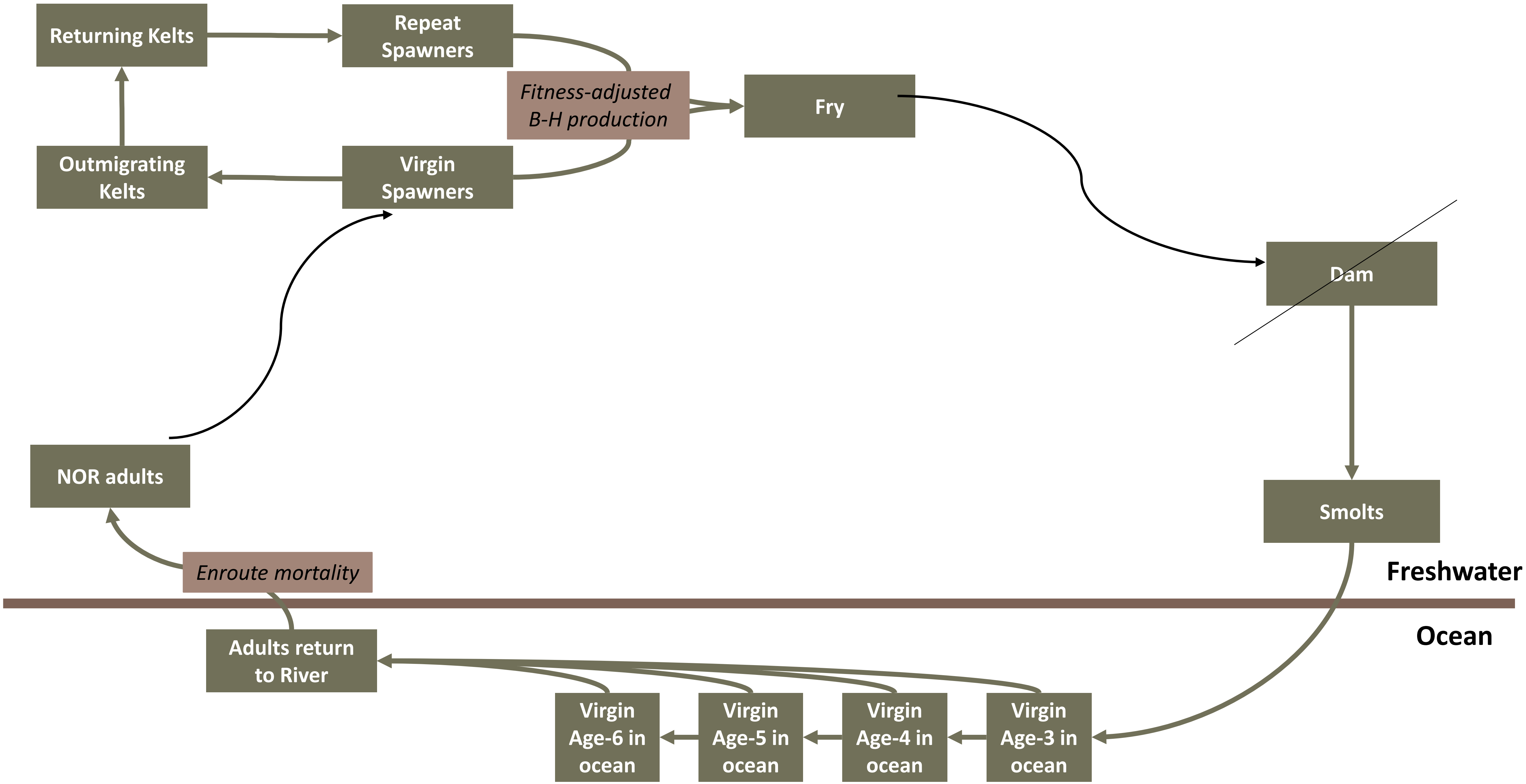
- NO HATCHERY FOR WINTER STEELHEAD
- RESIDENT RAINBOW TROUT
- NO HARVEST OF WINTER STEELHEAD (MORE ON THIS LATER)

Population Dynamics

- BIRTHS
- DEATHS
- IMMIGRATION
- EMIGRATION

We focus principally on survival.

- Dam Passage Survival **Assumed to be constant**
- A constant Survival **estimated in model fitting**
- Early Marine Survival **estimated each year**
- older age marine mortality **assumed to be constant**



Returning Kelts
Repeat Spawners
Fitness-adjusted B-H production
Fry
Outmigrating Kelts
Virgin Spawners
Dam
NOR adults
Smolts
Enroute mortality
Freshwater
Ocean
Adults return to River
Virgin Age-6 in ocean
Virgin Age-5 in ocean
Virgin Age-4 in ocean
Virgin Age-3 in ocean

Historical Records

McCann 2021

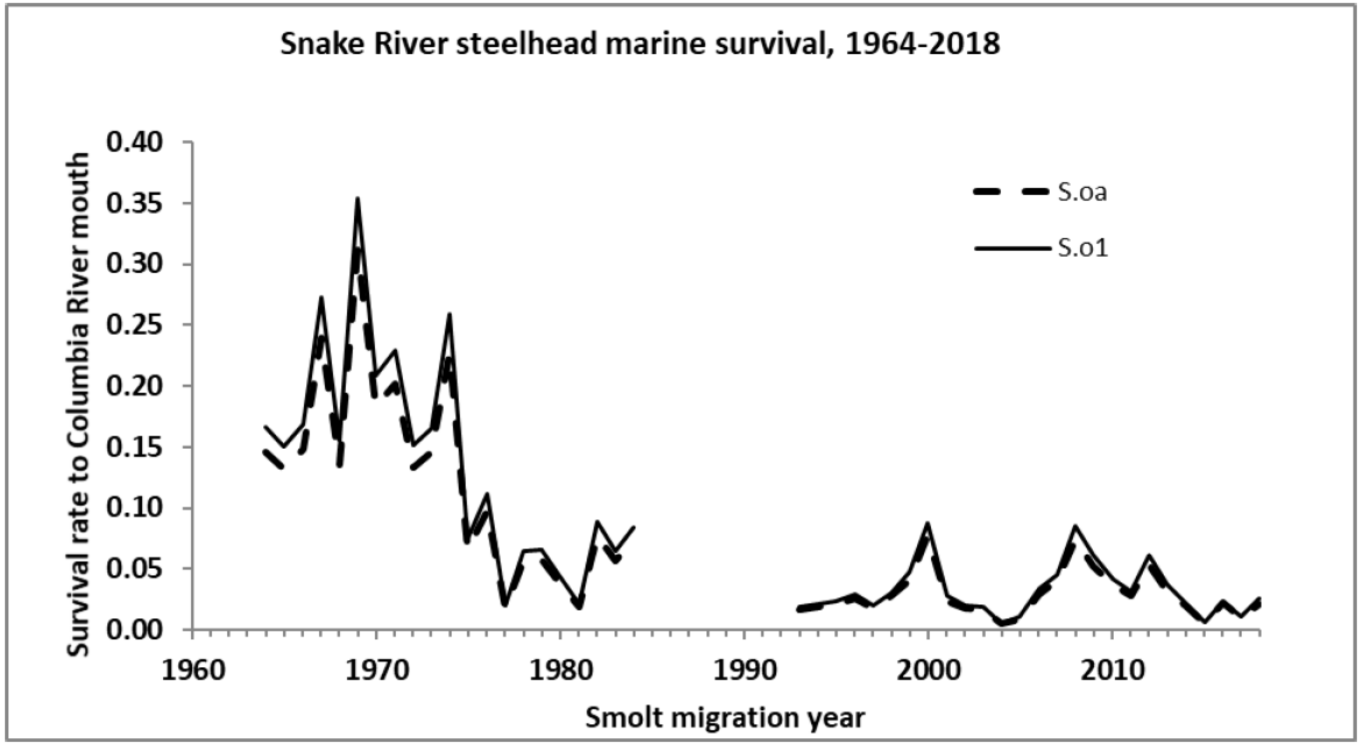
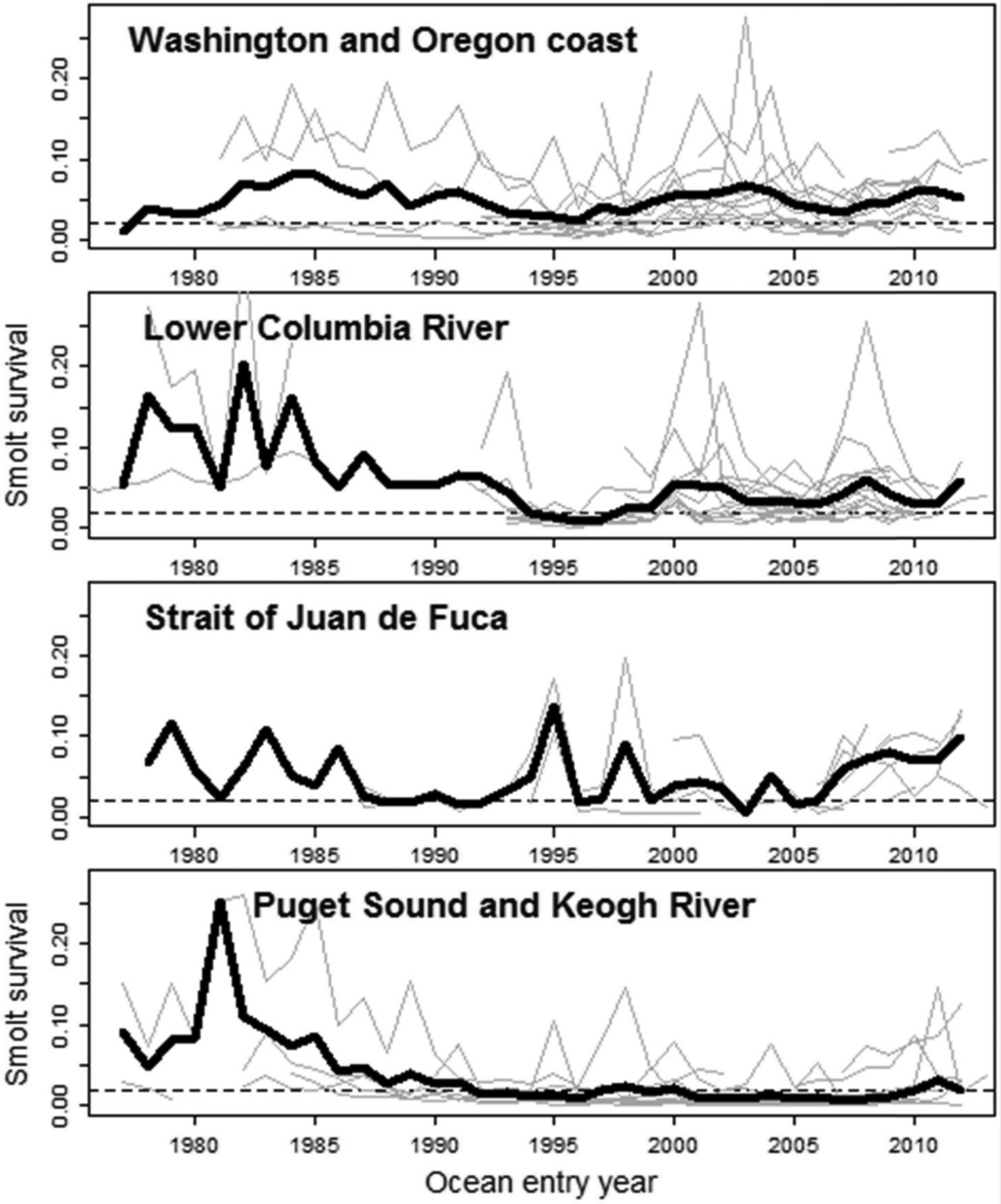


Figure 4.39 Marine survival for Snake River wild spring/summer Chinook (1964-2019) (top) and wild steelhead (1964–2018) (bottom).

Historical Records

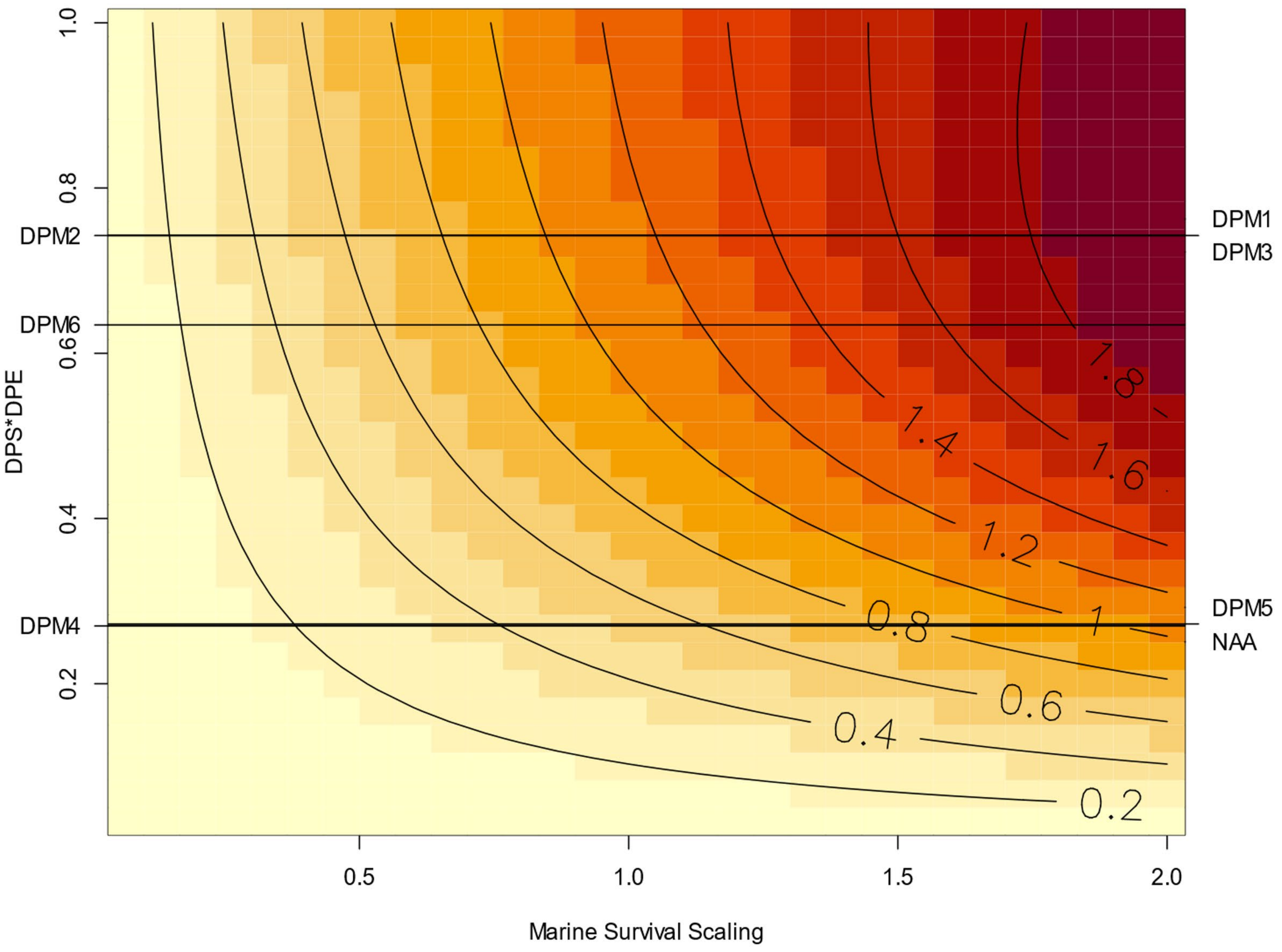
Kendall 2017



Kinds of Mortality we can possibly change

- Dam Passage Mortality
  - DAM OPERATIONS & PASSAGE DEVICES
- Early Marine Survival Mortality
  - PISCIVOROUS BIRD REMOVAL
  - PINNIPED REMOVAL
  - HABITAT MODIFICATIONS
    - *MANAYUNKIA SPECIOSA* (C.SHASTA)
  - POSSIBLE DAM OPERATIONS
    - *MANAYUNKIA SPECIOSA* (C.SHASTA)
- **Enroute mortality of adults**
  - **sea lion removal in lower Columbia river**
- **Kelt mortality**
  - **Kelt reconditioning (e.g., Yakima River)**
  - **dam operations to promote kelt passage survival**

ISOPLETHS OF R/S DETERMINE MARINE SURVIVAL AND DAM PASSAGE SURVIVAL

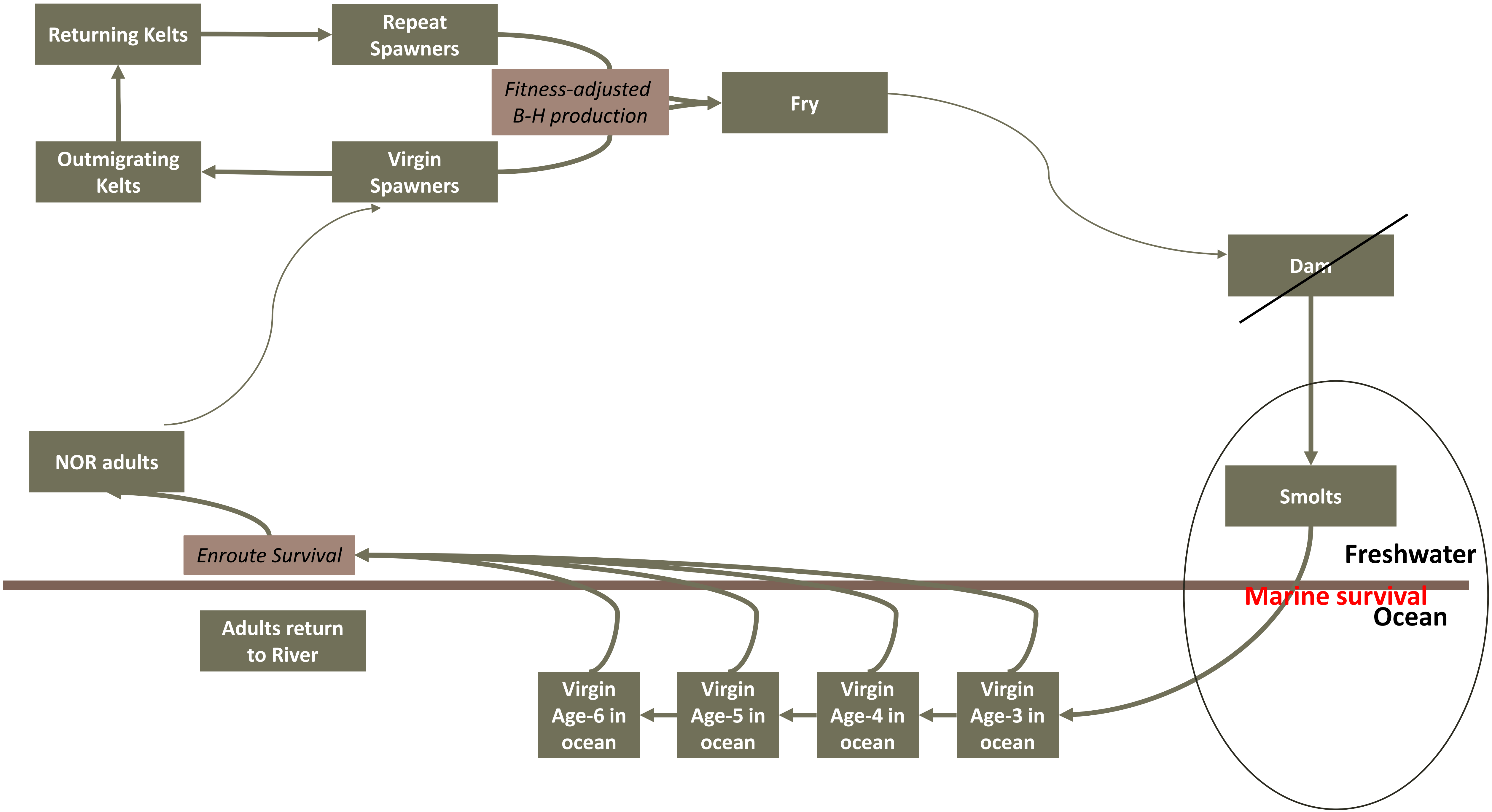


Estimating Marine Survival from Spawner Counts

1. **We lack a time series of age composition data.**
2. **We don't have direct estimates of marine survival for UWR steelhead.**
3. **Spawner counts can be predicted based on a single time changing survival rate holding other variables constant in the model.**
   - **We estimated annual survival rates below the dam and prior to the first full year at sea.**
   - **We also estimate a single survival rate that does not change over time representing the early freshwater survival.**

We focus principally on survival.

- DAM PASSAGE SURVIVAL
- A CONSTANT SURVIVAL
- EARLY MARINE SURVIVAL
- OLDER AGE MARINE SURVIVAL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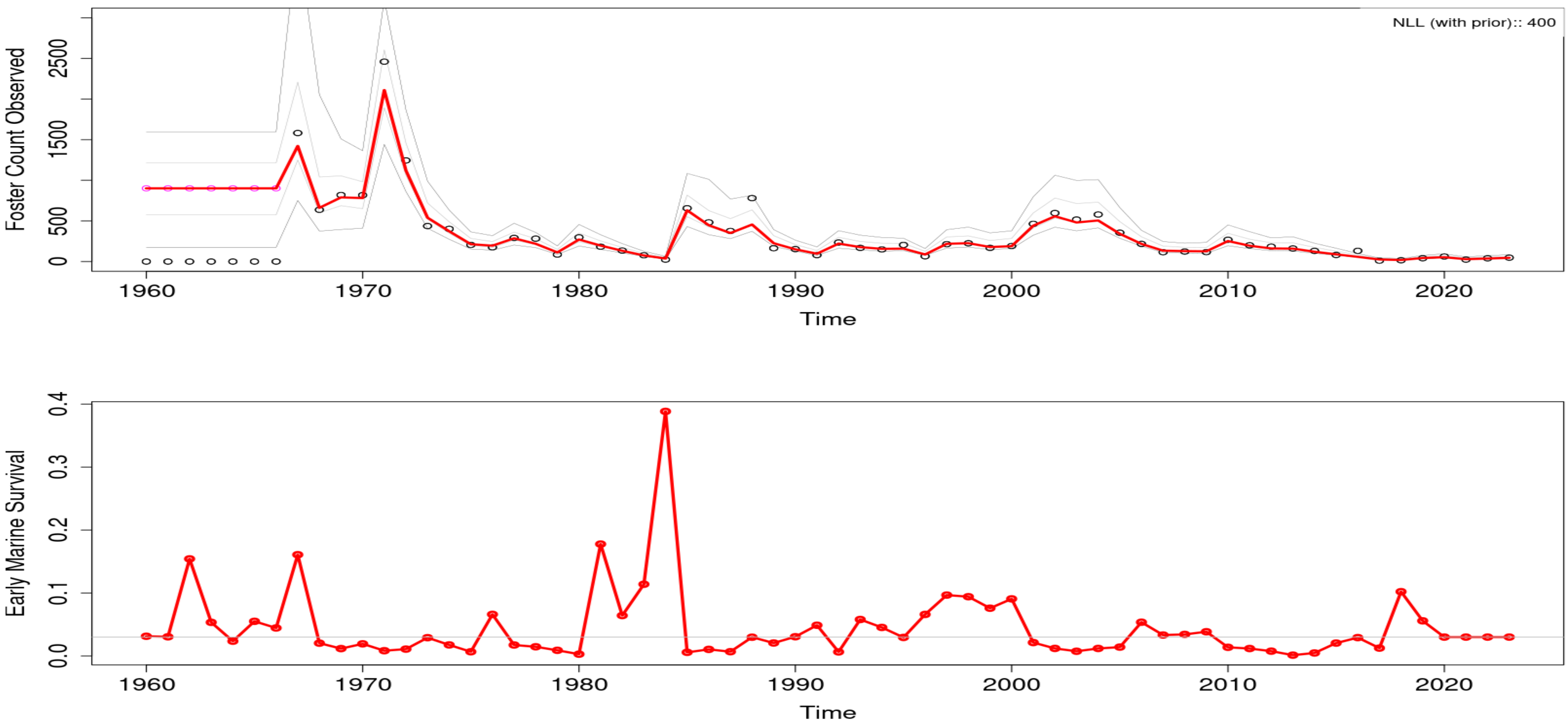
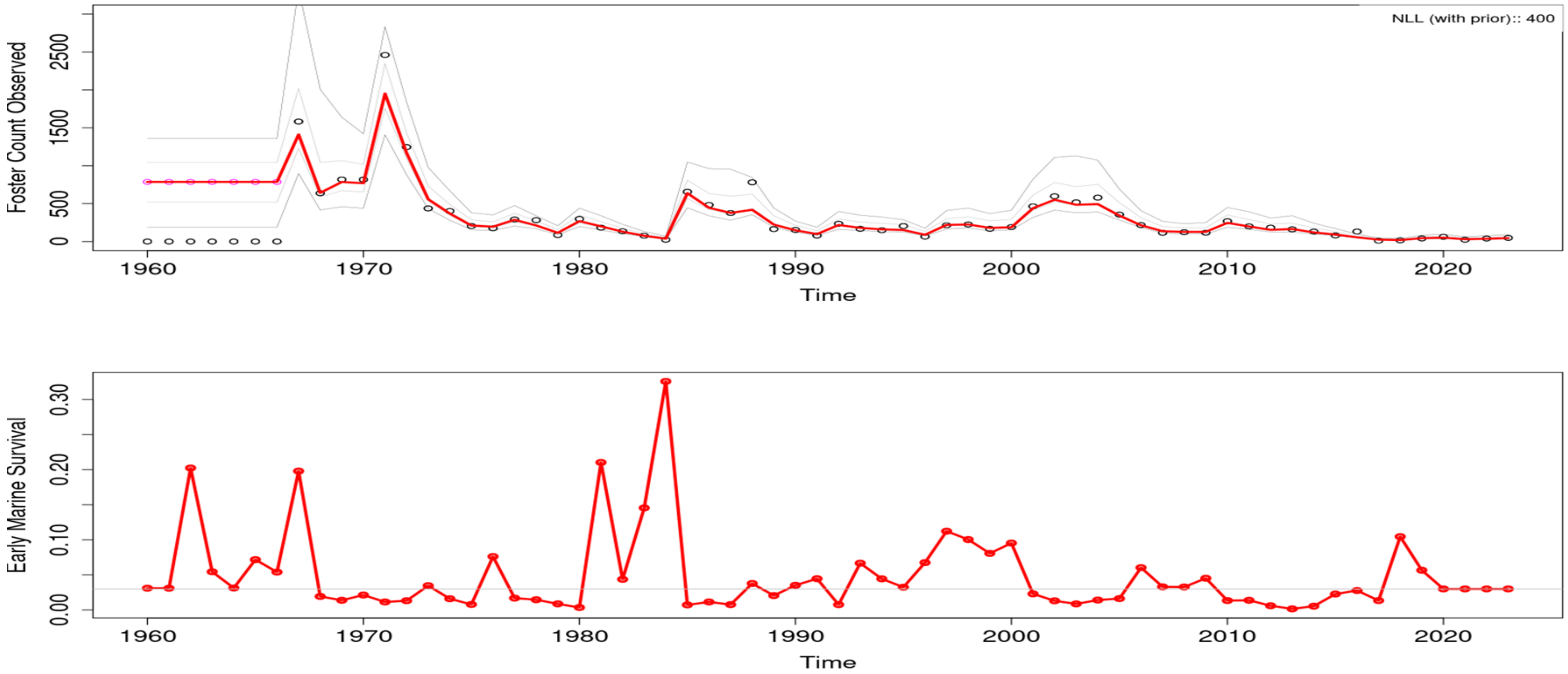
Two Cases

1. **Base Case**
   - **All spawners produce the same number of eggs regardless of age**
   - **All fish survive 100% after their first year in the ocean.**
2. **Age dependent fecundity and less than 100% marine survival after 1st ocean year.**
   - **Older bigger fish make more eggs.**
   - **90% of the fish survive each year in the ocean.**
     - **So a 5 year old fish has 90%*90%=81% survival**
     - **This was applied to repeat spawners too, but there was no additional kelt survival applied.**
       - **A 7-year-old fish that has spawned multiple times has the same survival as a fish that remained in the ocean.**

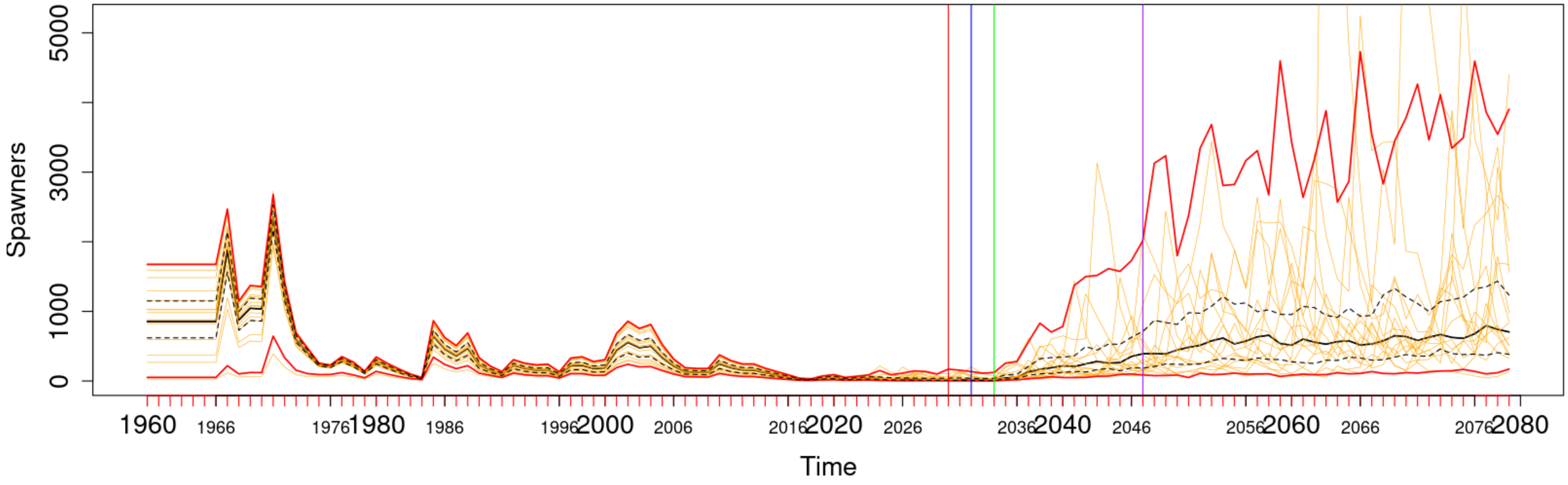
Fit and Marine Survival Base Case



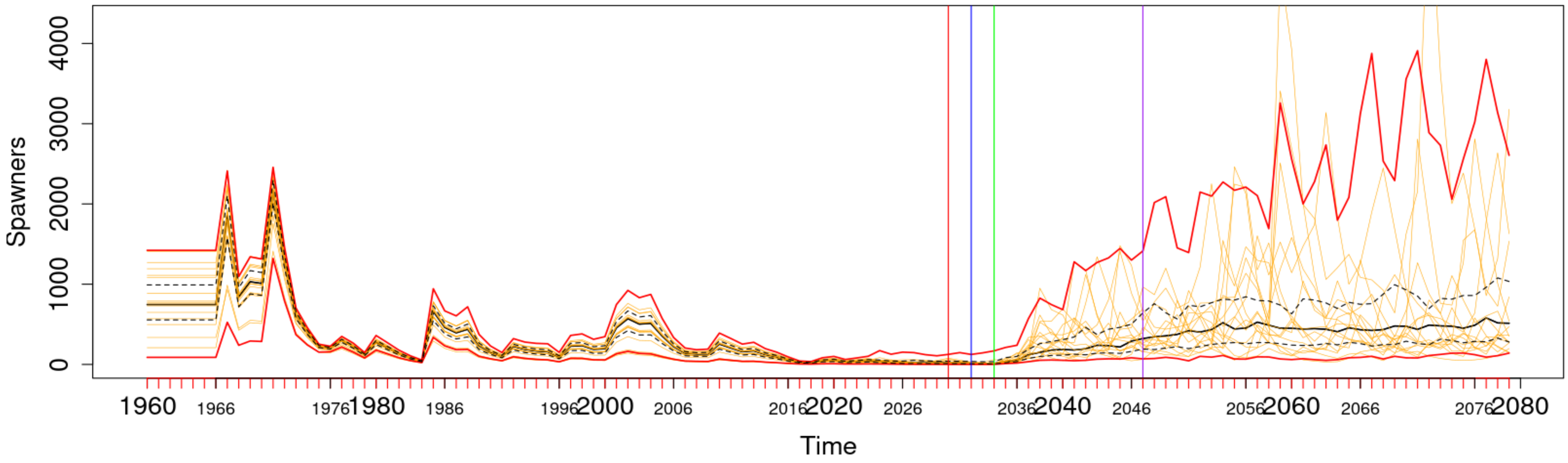
Fit and Marine Survival Age dependent Case



Future looking Simulations Base Case for the winter steelhead in the South Santiam Sub-basin



Future looking Simulations Age Dependent Case



Performance Metrics and parameter estimates

Base	Fresh Surv	Initial	R/S	Geo Mean S
Mean	.047	901.2	1.23	648.4
SE	.006	366.8	.77	463.5
Age Dependent				
Mean	.064	786.4	1.7	495.7
SE	.01	301.7	1.04	317.2

Ongoing work.

- **Better characterize autocorrelation in marine survival and uncertainty in autocorrelation.**
- **Better evaluate how modest structural changes to the model work.**
  - **What happens when fewer kelts die in freshwater through reconditioning or improved passage?**
  - **Sensitivities to priors and assumed values.**
  - **Addition of different ages of smolting and residualization of juvenile winter steelhead**

To Conclude

1. **Models can be useful when they incorporate components of population dynamics relevant to the assessed fish population and are fitted to time series data on abundance.**
2. **There are no trade-offs in the model but between species trade-offs have already been found in the outcomes of dam passage measures.**
   - **Improving survival will always increase abundance, at least until the river is full of fish.**
3. **We don't talk about residency, but if marine survival is really low it could be an important consideration.**