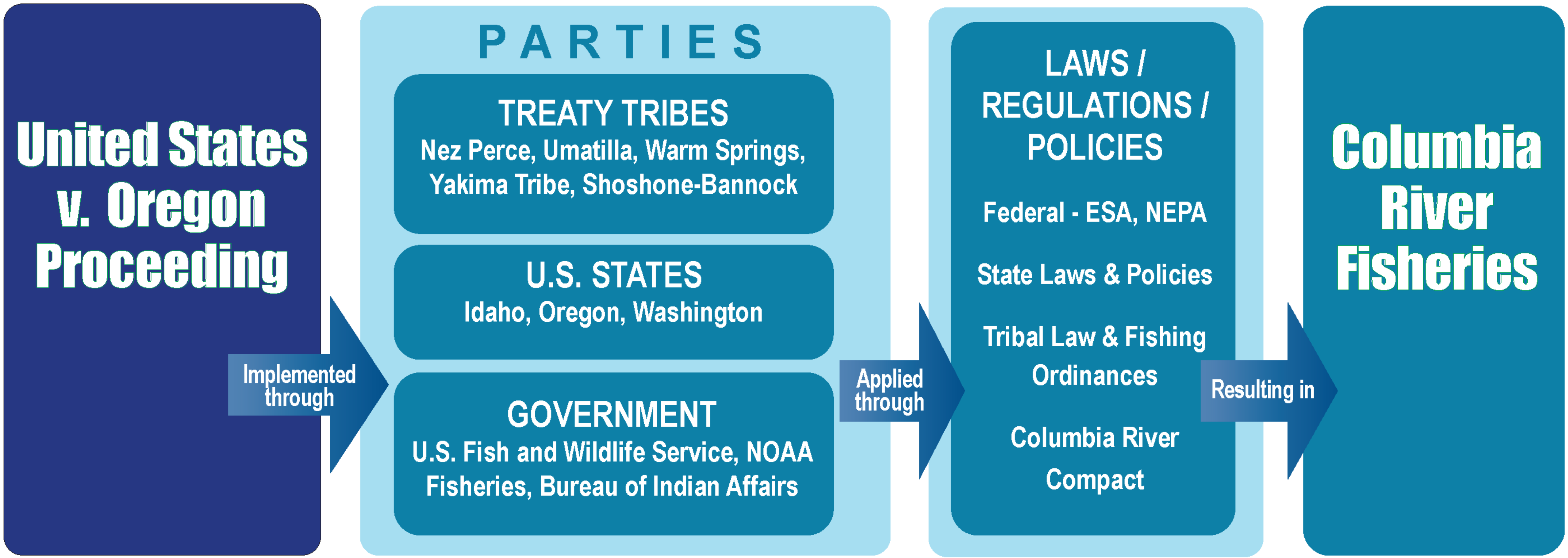
Developed for the exhibit *River of Memory: The Everlasting Columbia 2006-2008* by the King County GIS Center. ©2006 Wenatchee Valley Museum & Cultural Center, Wenatchee, Washington.

Challenges To Managing Mainstem Columbia River Fisheries

- Mixed-Stock, Multi-Species Salmonid Fisheries
- Multiple sovereign co-managers
  - States of Oregon, Washington, Idaho
  - Federal Government
  - Treaty Tribes
  - Non-Treaty Tribes
- In-Season Fisheries/Harvest Management
- Limited resources

U.S. v. Oregon Management Agreement



Columbia River managed under U.S. v. OR Management Agreements

- Two main objectives:

Columbia River managed under U.S. v. OR Management Agreements

- Two main objectives:

- Implements harvest policies that the parties have agreed should govern the amount of harvest

Columbia River managed under U.S. v. OR Management Agreements

- Two main objectives:

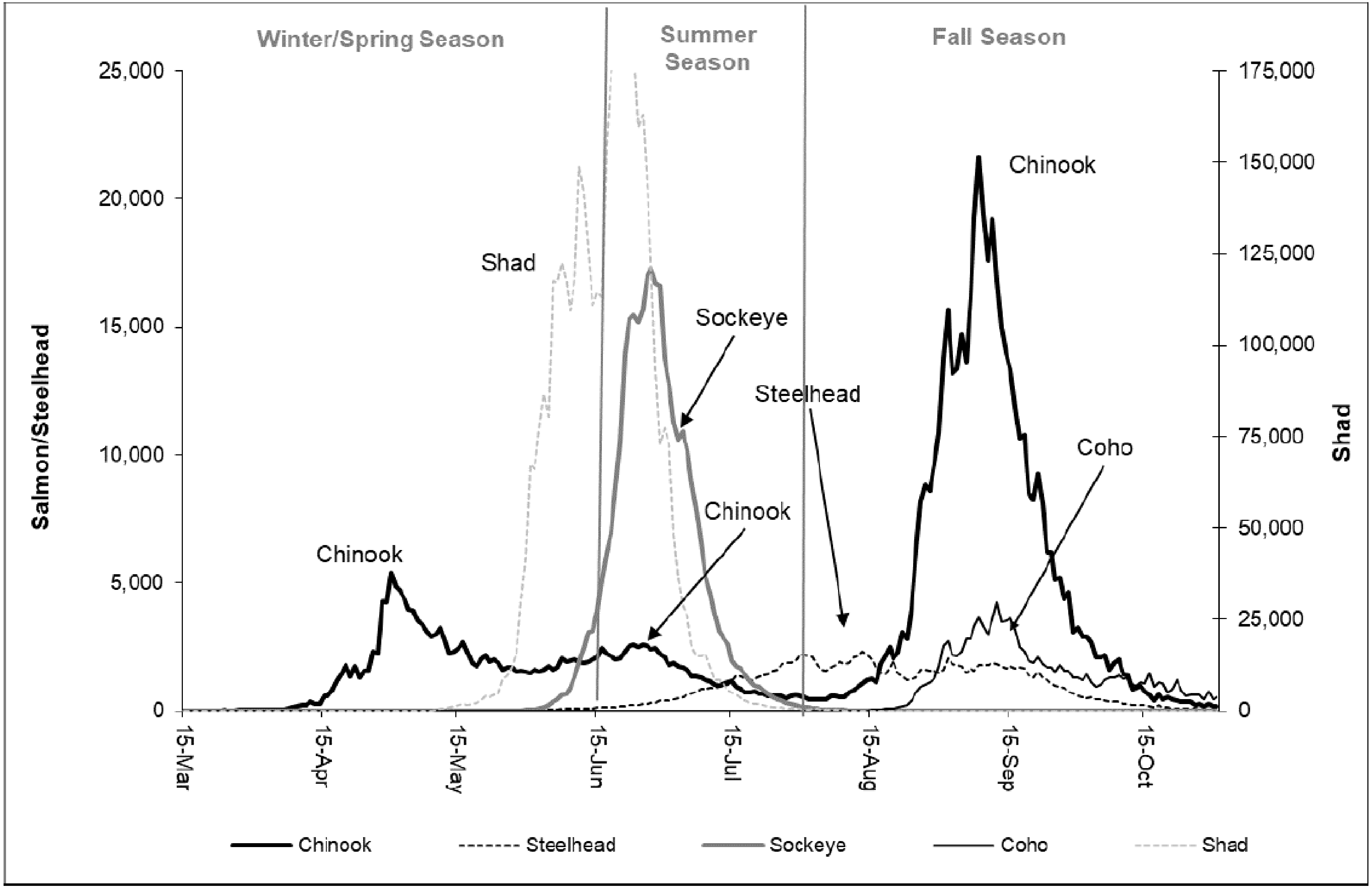
- Implements harvest policies that the parties have agreed should govern the amount of harvest

- Incorporates hatchery programs and associated production levels in the Columbia Basin that support harvest and are also important to the conservation of salmon and steelhead populations above Bonneville Dam

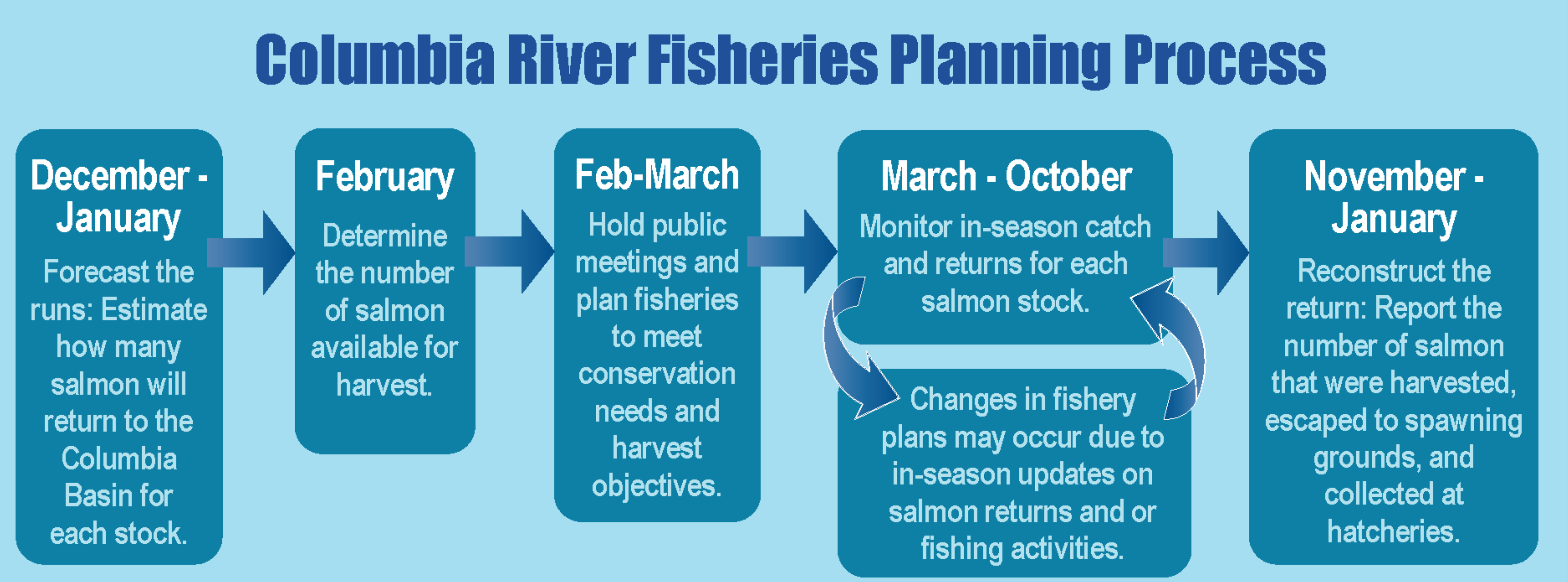
Non-target/ Target Species

	ESA-Listed	Not Listed
Chinook	Snake River Fall	Upper Columbia River Summer/Fall
	Snake River Spring/Summer	Middle Columbia River Spring
	Upper Columbia River Spring	Deschutes River Summer/Fall
	Lower Columbia River	
	Upper Willamette River	
Steelhead	Snake River Basin	Southwest Washington
	Upper Columbia River	
	Lower Columbia River	
	Middle Columbia River	
	Upper Willamette River	
Sockeye	Snake River Sockeye	Okanogan River
		Lake Wenatchee
Chum	Columbia River	
Coho	Lower Columbia River	Upper Columbia River

Bonneville Dam Passage Timing



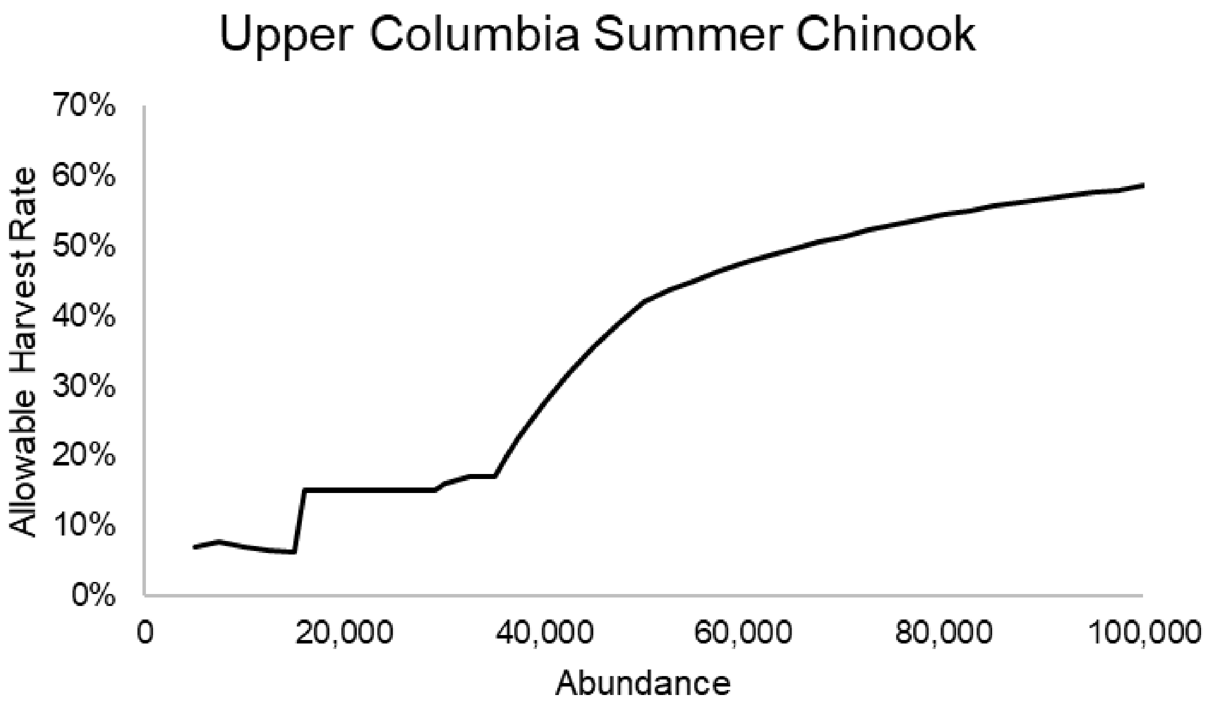
Planning process

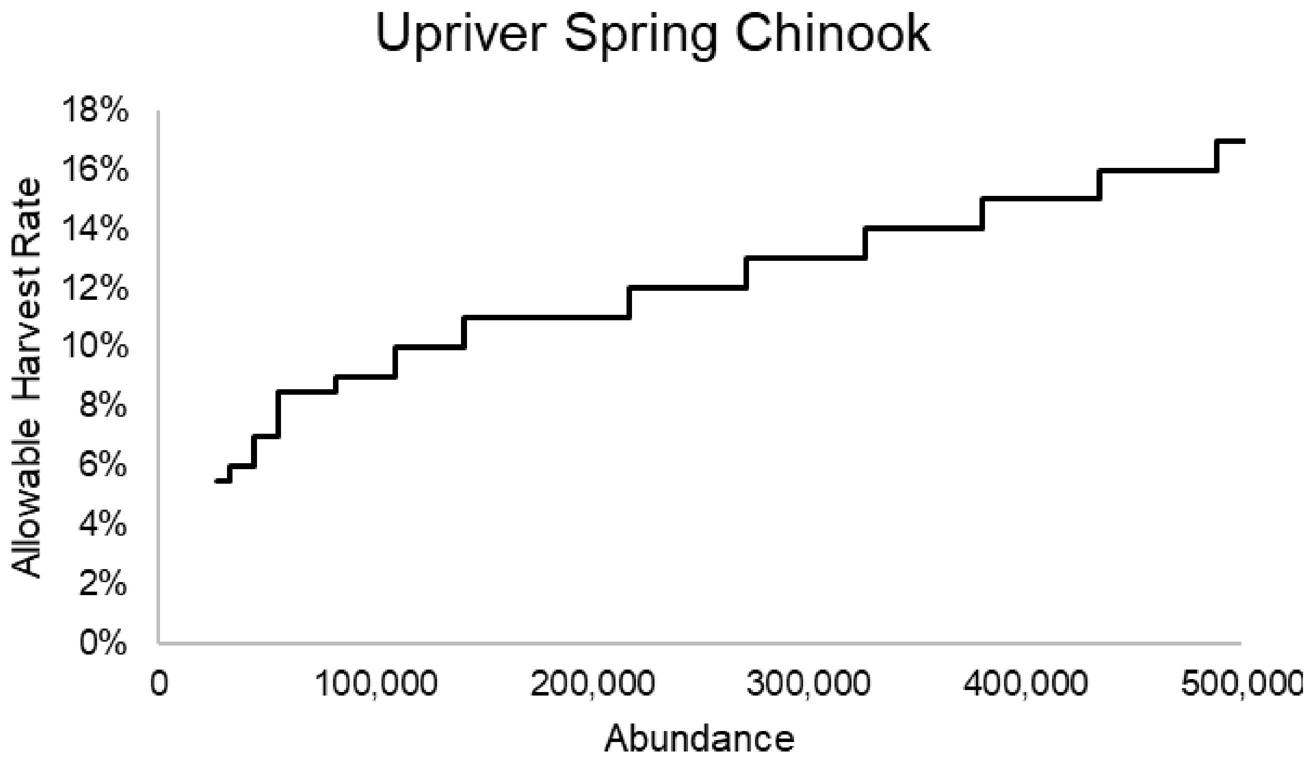


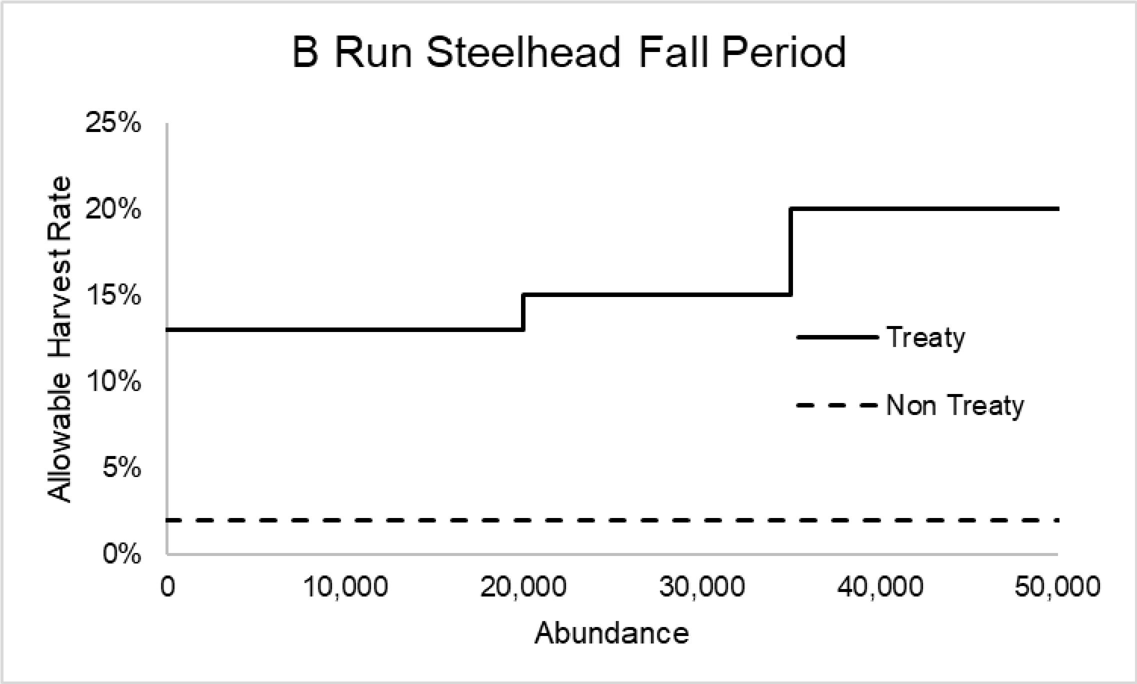
Management Strategies

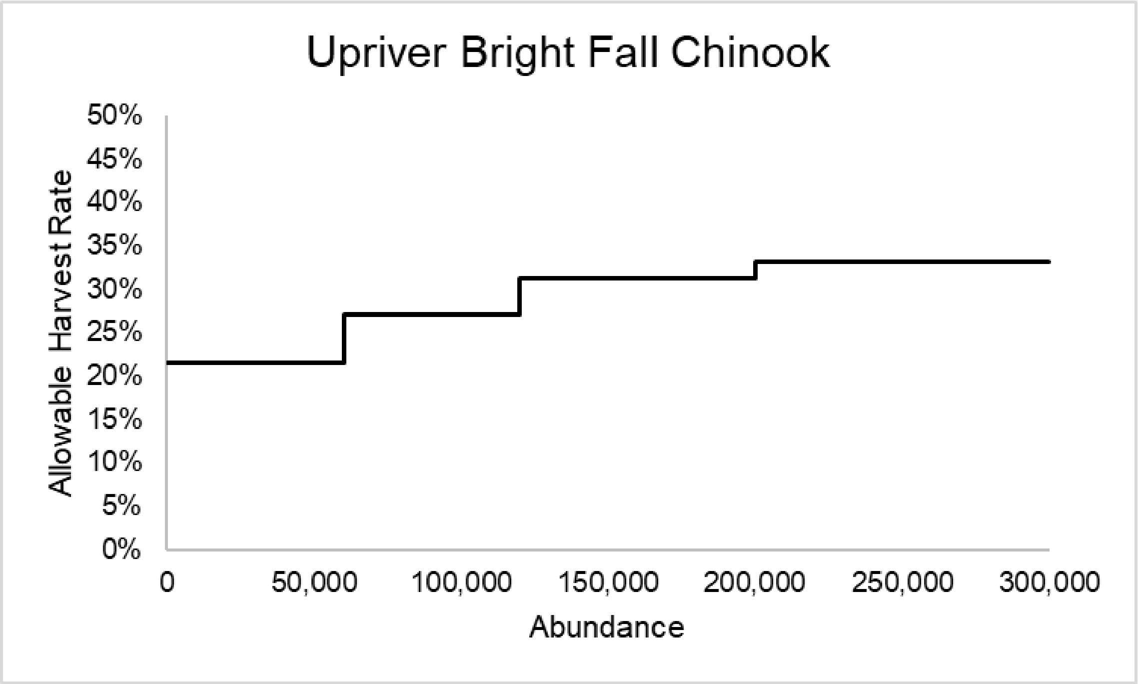
- Surrogate stocks
- Escapement Objectives
- Abundance Based Management
- Harvest Control Rules
  - Tiered
  - Fixed Rate
- Incidental Mortality
- Protections for ESA species at low abundance

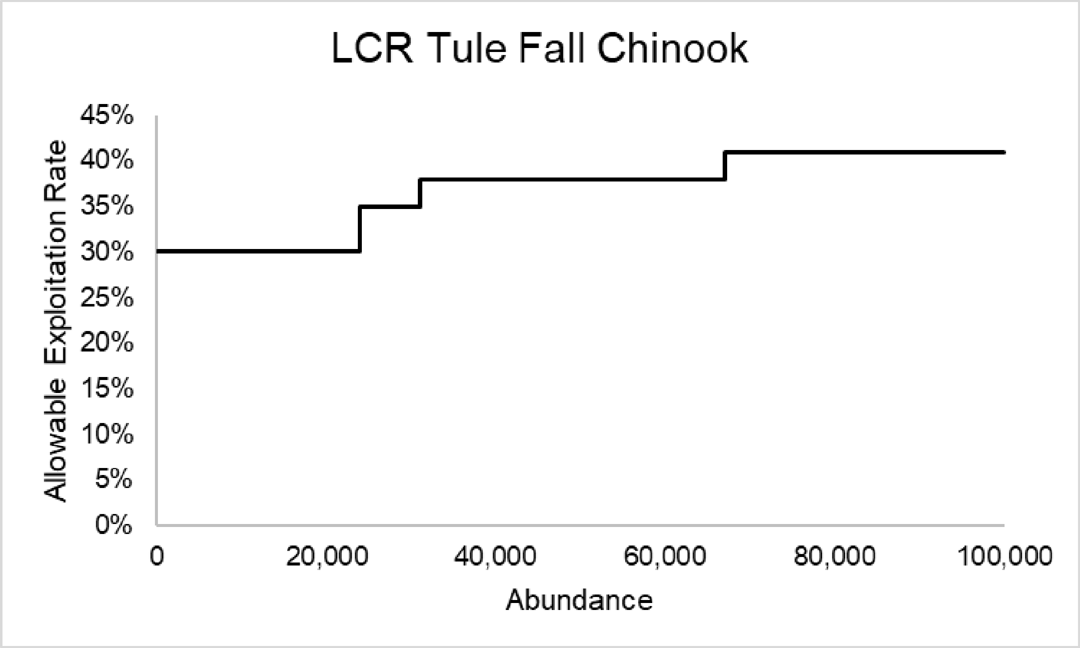
Harvest Control Rules






B Run Steelhead Fall Period
Allowable Harvest Rate
25%
20%
15%
10%
5%
0%
0
10,000
20,000
30,000
40,000
50,000
Abundance
Treaty
Non Treaty


Upriver Bright Fall Chinook
Allowable Harvest Rate
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0
50,000
100,000
150,000
200,000
250,000
300,000
Abundance


LCR Tule Fall Chinook
Allowable Exploitation Rate
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0
20,000
40,000
60,000
80,000
100,000
Abundance

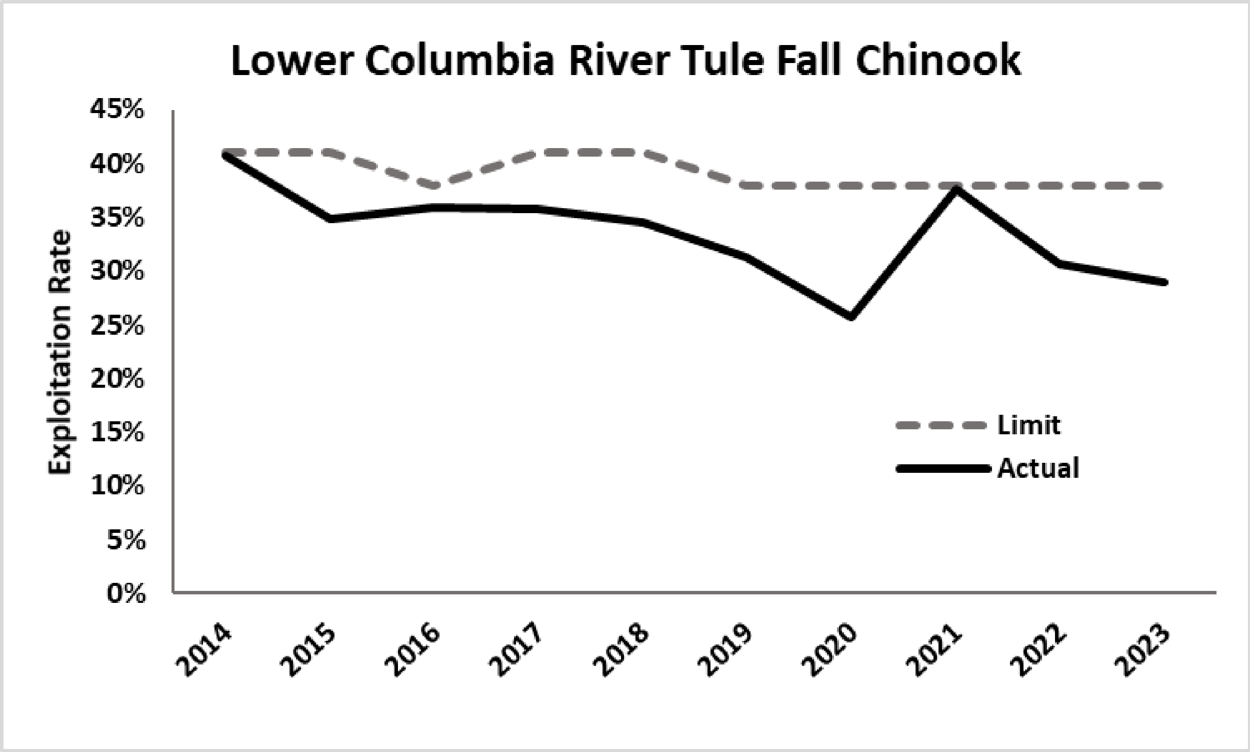
Preseason Planning

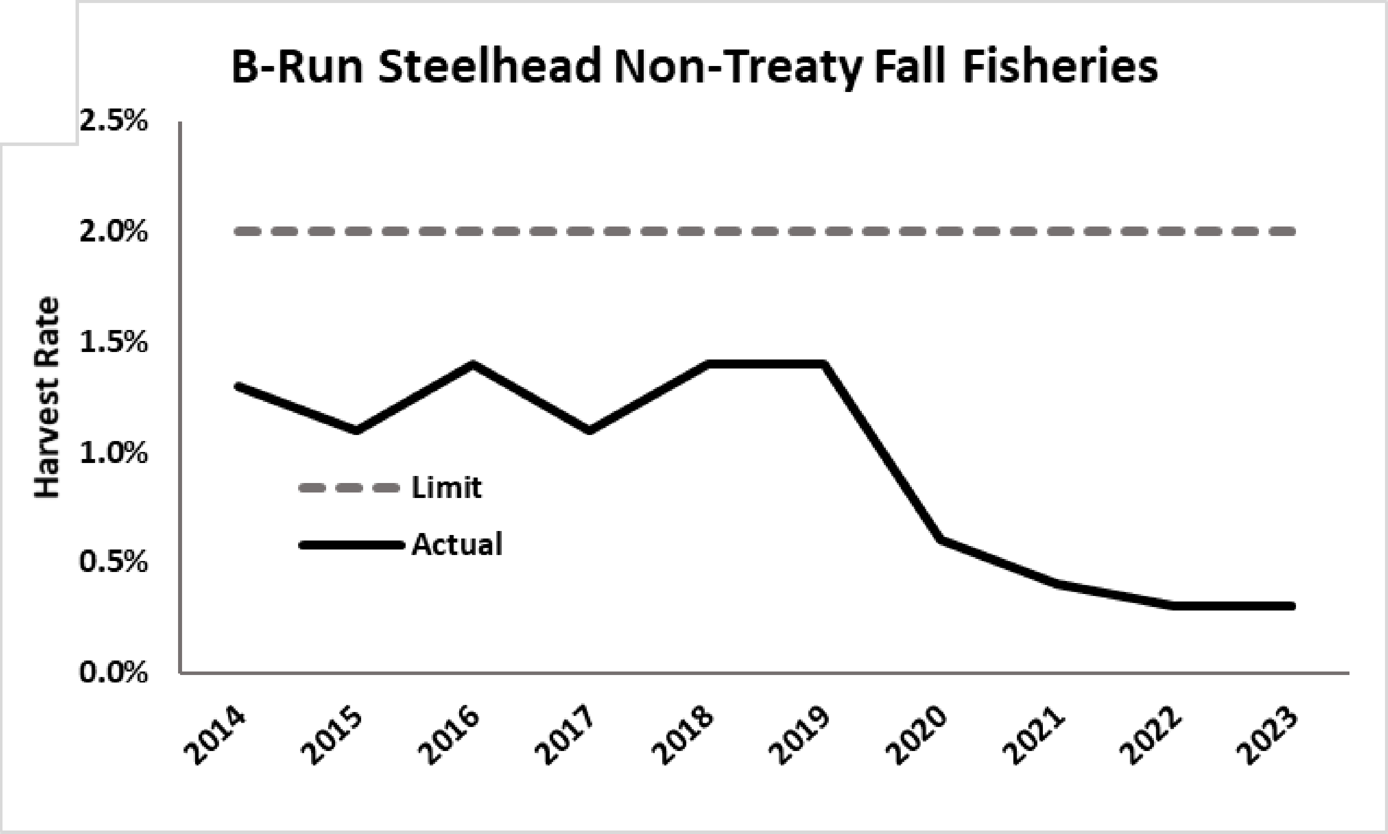
- Catch limits based on harvest rates or escapement goals for managed stock groups
- Retention or size limits
- Selective fisheries
  - Mark-selective (MSF) – release fish with fins intact
  - Time, area, gear selective
    - Season structure (time/area)
    - Gear type (e.g. net mesh size)
- In-season monitoring – CWT, PIT, Genetic

In-season Updating

- Expected run to Bonneville updated first
- Catch plus release mortality in lower river fisheries added to get river mouth run size
- Actual catches plus any additional expected catches derived from harvest models
- Run sizes normally updated weekly
- Fisheries catch by stock in-season based on CWT analysis for fall chinook

Harvest Rates – Limit vs. Actual





Current approach to forecasting

Response = run reconstruction output

- Example: Upriver spring Chinook =
  Jan 1 – June 15 Bonneville counts + harvest < Bonneville
- Generally by age

Predictors

- Pre-season
  - Previous years’ abundance
    - Age composition
- In-season
  - Dam counts
  - River flow

We use sibling regression and multi-year averages

- Dynamic linear models

$$
\begin{cases}
\log(y_{a,t}) = \alpha_t + \log(y_{a-1,t-1})\beta_t + v_t, & v_t \sim \mathcal{N}(0, V_t) \\
\alpha_t = \alpha_{t-1} + w_{\alpha,t}, & w_{\alpha,t} \sim \mathcal{N}(0, W_{\alpha,t}) \\
\beta_t = \beta_{t-1} + w_{\beta,t}, & w_{\beta,t} \sim \mathcal{N}(0, W_{\beta,t})
\end{cases}
$$

- Model averaging

During the season we update our forecasts based on dam counts and average run timing in previous years.

$$\text{Bonneville return} = \frac{\text{Bonneville return through day } d}{\text{Ave. prop. complete through day } d}$$

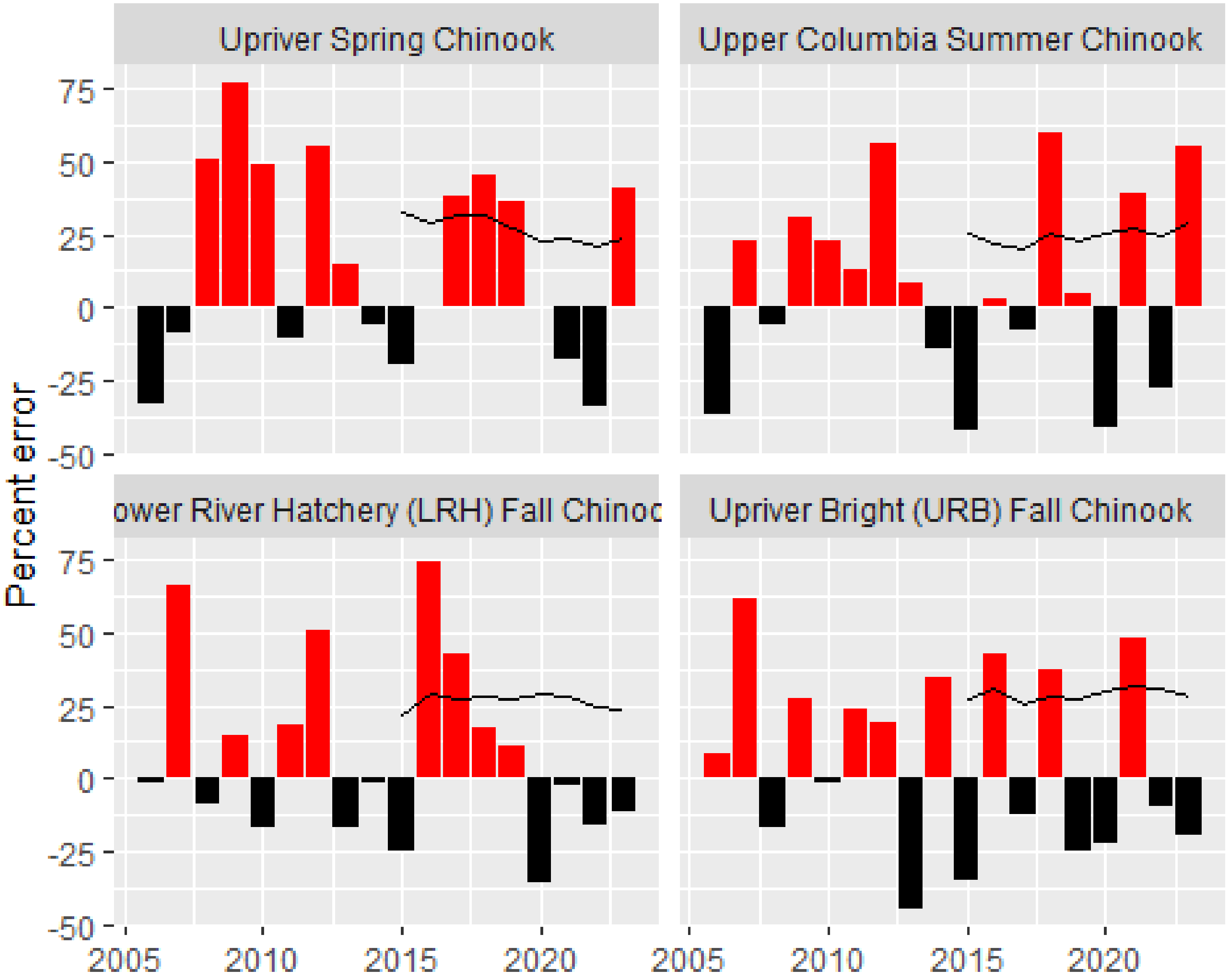
We also integrate pre-season and in-season predictors to update forecasts

- Integrated model with likelihoods for
  - pre-season sibling regression
  - in-season dam counts and run timing
- Linear models with jacks and dam counts as predictors

How good do they do?

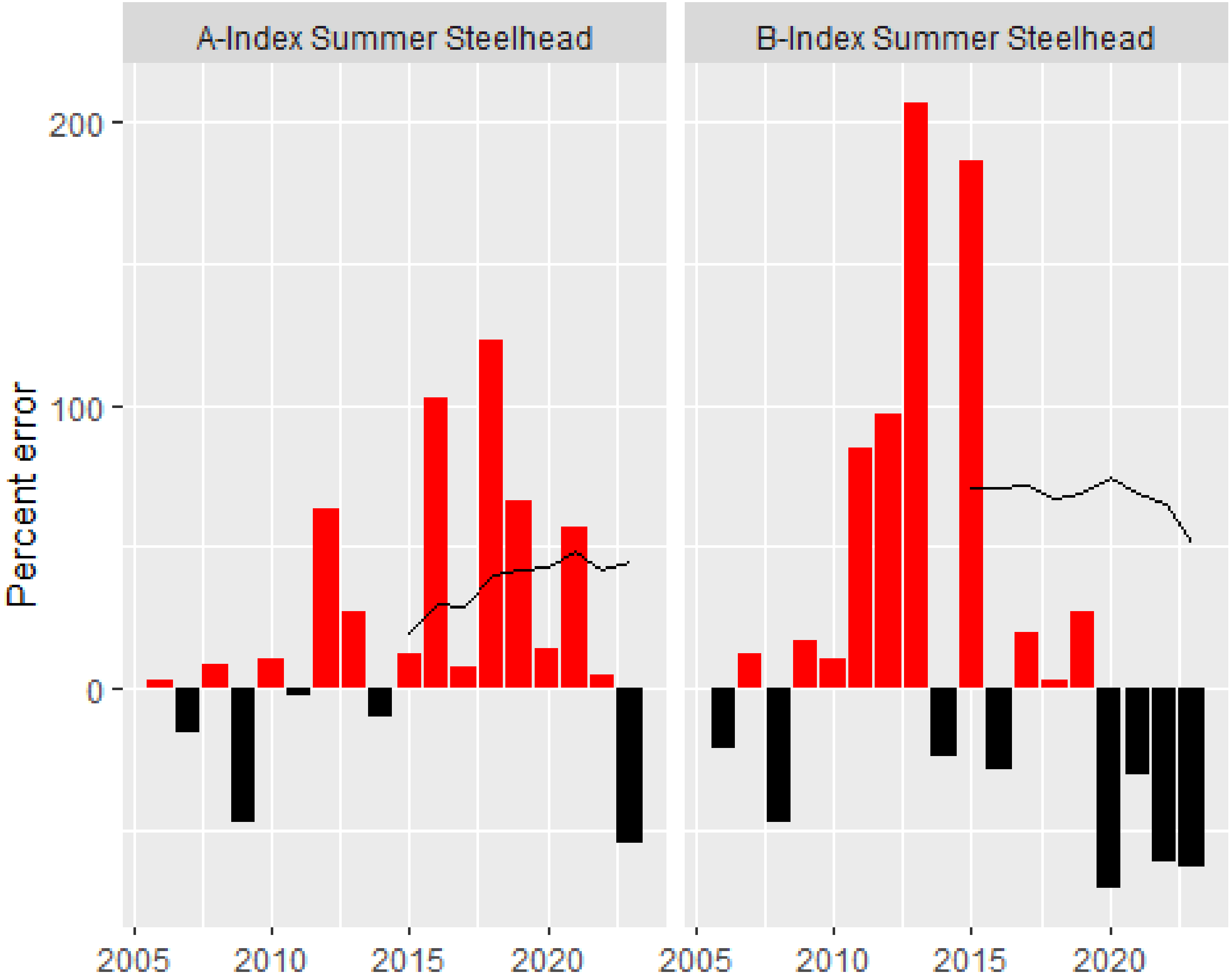
Chinook preseason MAPE 25–30%

Black line is the 10-year average absolute prediction error (MAPE)



Steelhead preseason MAPE ~50%

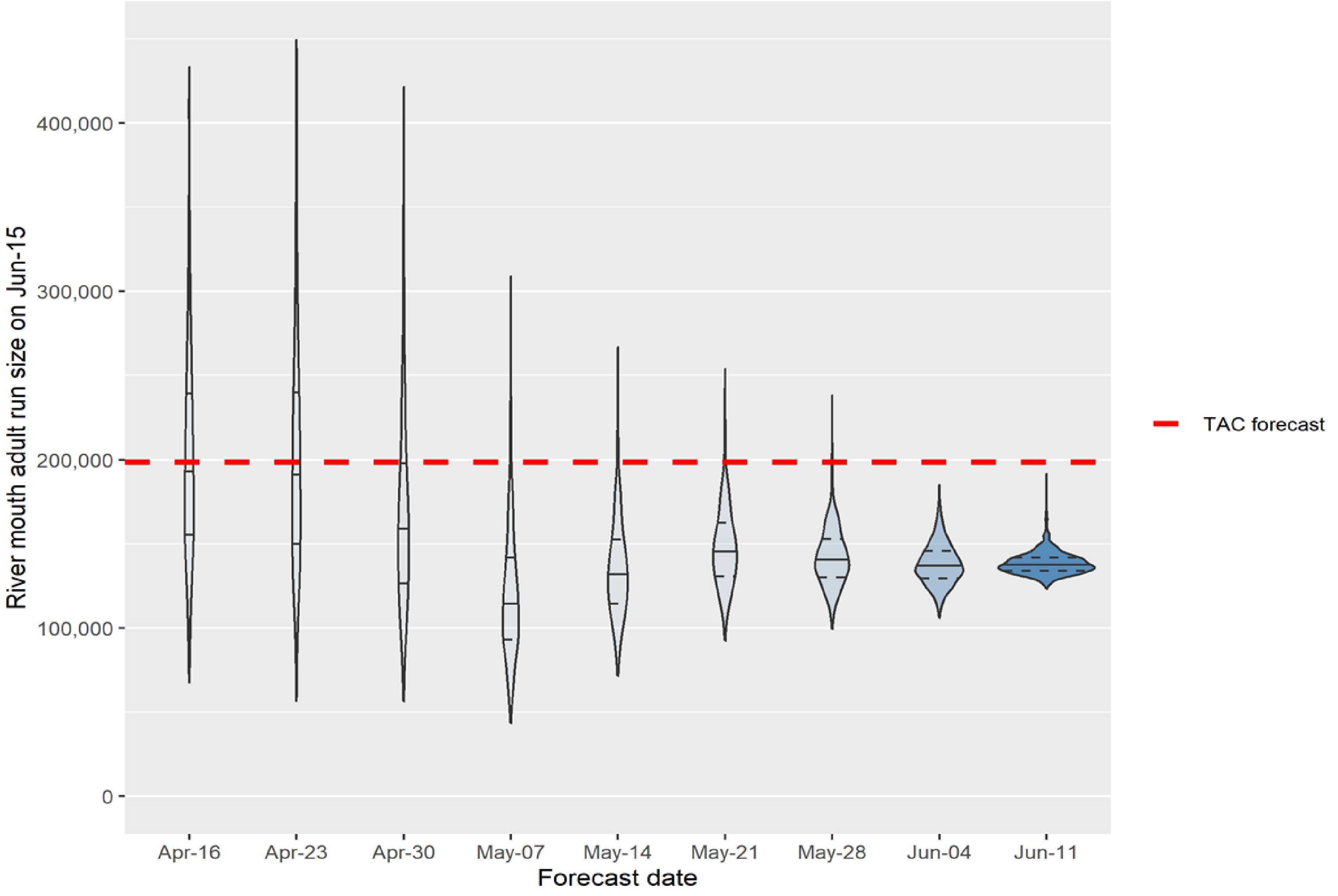
Black line is the 10-year average absolute prediction error (MAPE)



Joint likelihood inseason model

Violin plots of posterior for River-mouth run sizes.

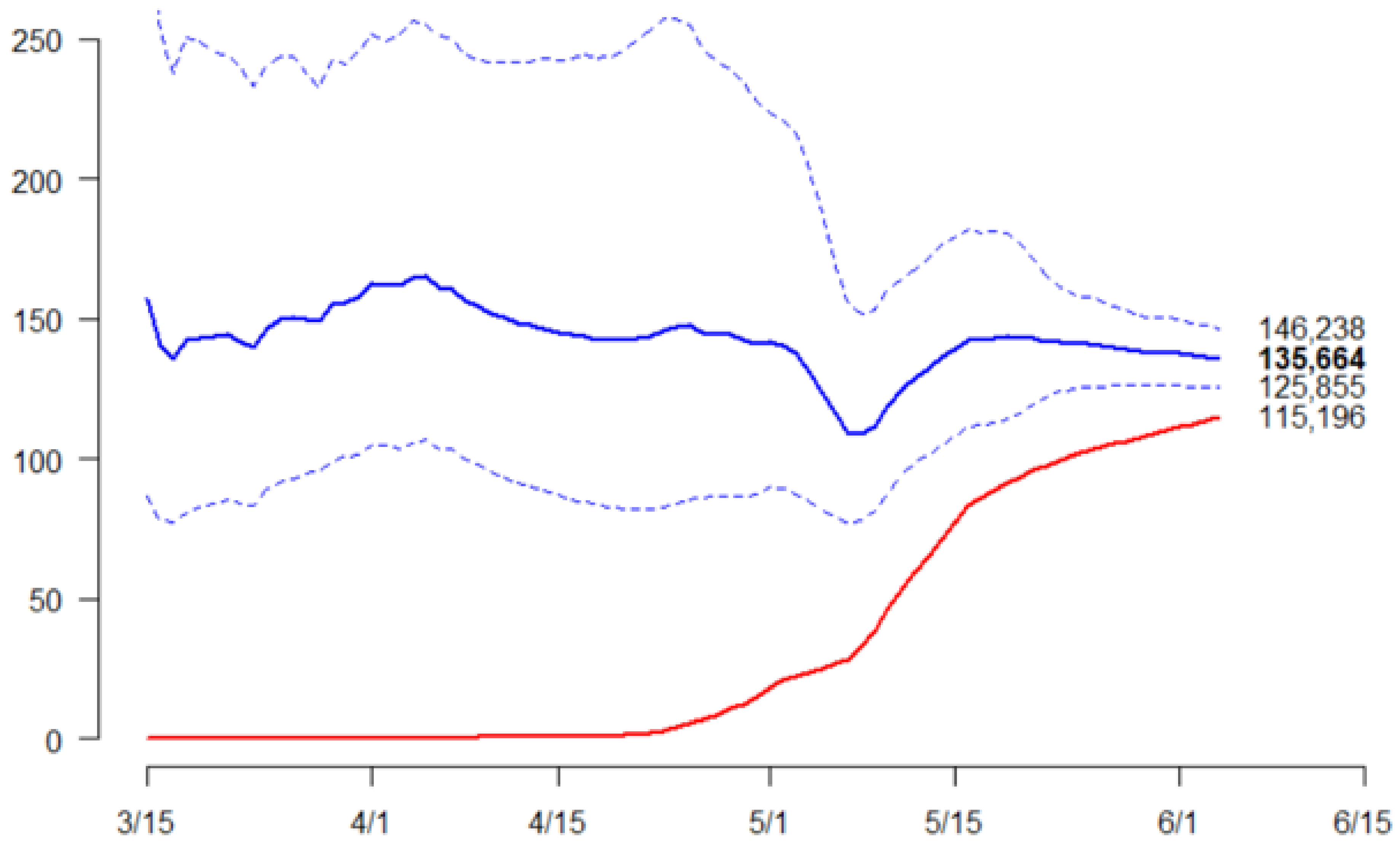
Dashed reference lines are IQR and solid line is median of posterior



In-season linear model

Dashed lines spawn 95% prediction interval.

Solid blue line is expected value. Red line is count to date.



General challenges

- Environmental covariates
    - Matching covariates with habitat use of stock in space and time
        - What do we know about where fish are and when, and what affects their survival

    - How to incorporate?
        - Variable selection, regularization, etc. (optional)