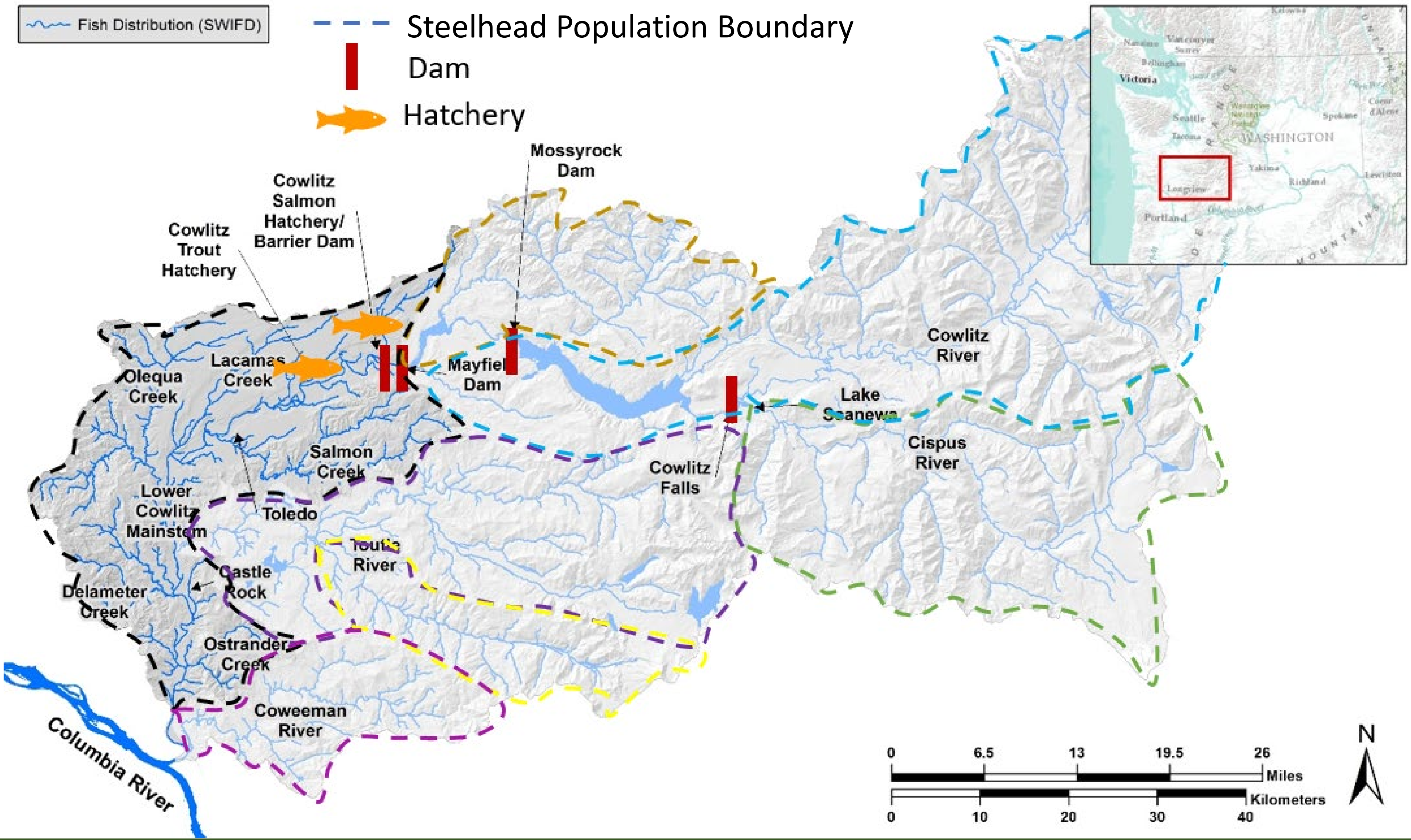
Cowlitz Hatchery Steelhead Transition Plan & Early Winter Run Timing

Presenter:
Thomas Buehrens

Cowlitz Basin

- 7 winter steelhead populations
- 4 dams
- 2 hatcheries
    - 4 steelhead programs funded by Tacoma Power



Cowlitz Steelhead History

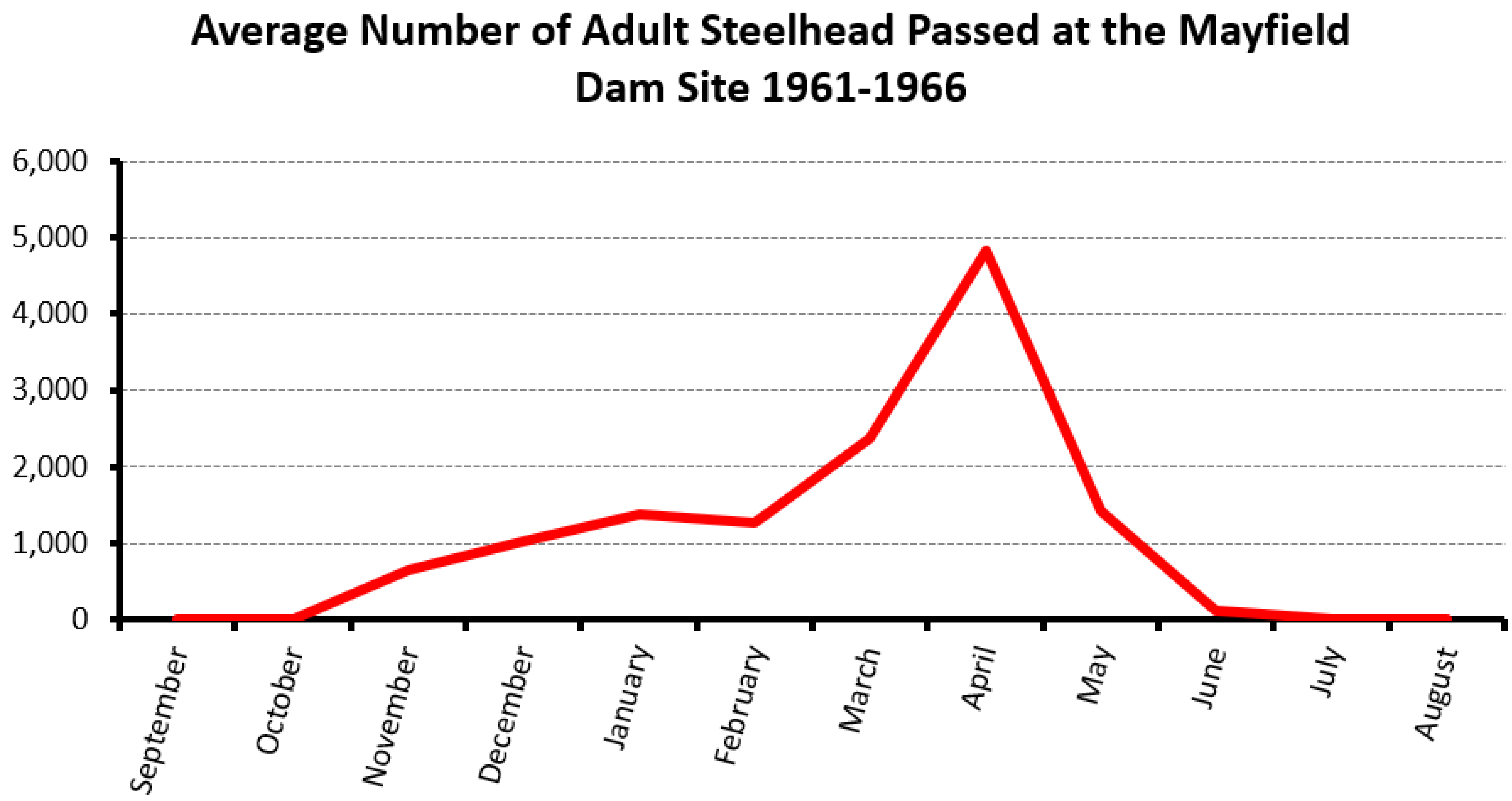
- Historically (pre-dam), one of the largest (maybe the largest) wild winter steelhead population(s) in Washington; phenomenal fishery
- 3 dams built starting in 1960’s, biggest hatchery complex in W. WA built as mitigation
- Hatcheries for W and S steelhead have in recent decades provided (one of?) the largest hatchery steelhead fisheries in WA
- Current hatchery steelhead programs
  - Segregated Summer (derived from Skamania stock)
  - Integrated Late Winter Lower Basin
  - Integrated Winter (Tilton)
  - Integrated Winter (Upper Cowlitz and Cispus)
  - ~~Segregated Early Winter (derived from Chambers Creek stock in Puget Sound)~~

- **Segregated**: uses only hatchery fish for broodstock
- **Integrated**: uses a mix of wild and hatchery fish for broodstock

- Hatchery reform
  - End of early winter (Chambers stock) steelhead program (discontinue use of stocks from out outside the region/ESU)
  - ***Need for new Fishery and Hatchery Management Plan (NOAA permit) with transition plan to identify future directions for programs; goal of enhancing <u>fisheries</u> and <u>conservation</u> objectives***

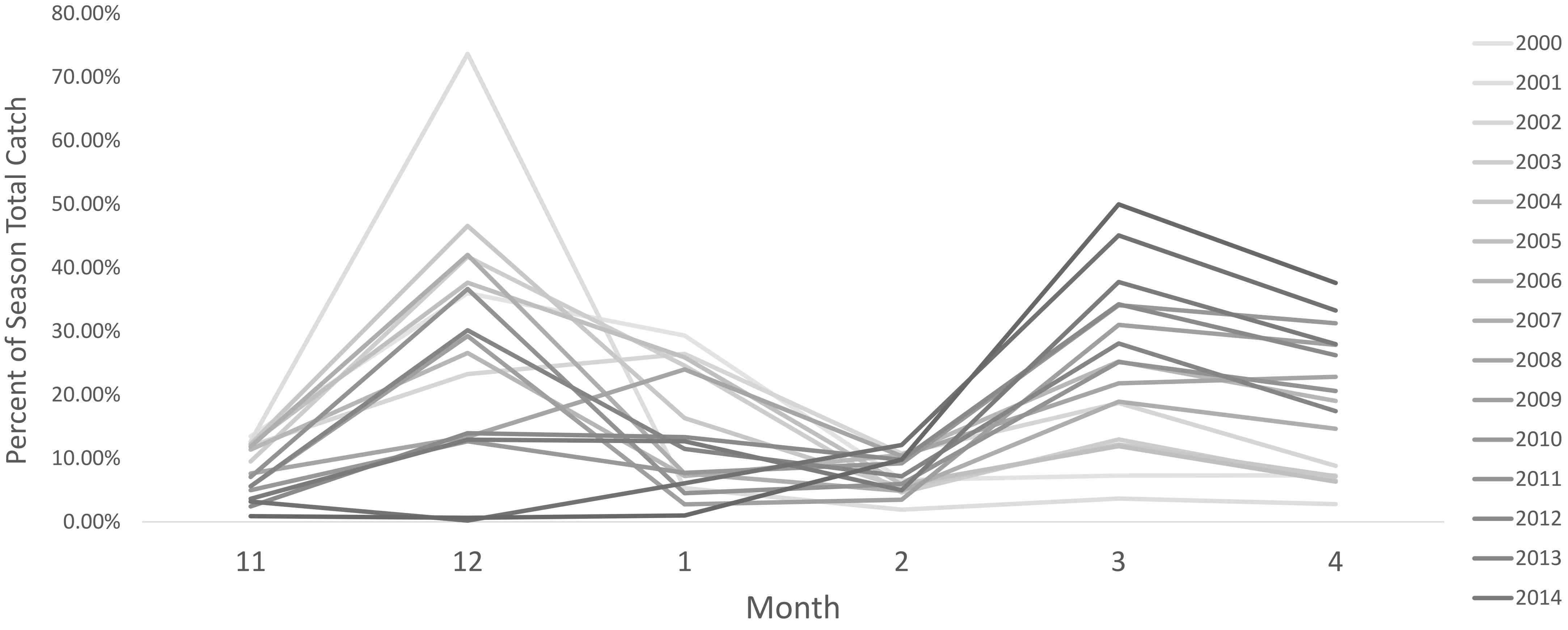
Historical Cowlitz Wild Winter Steelhead Run Timing

Run timing protracted
(neither early nor late)



Recent Fishery Catch

Hatchery winter steelhead catch has evolved: early → bimodal → late



Problem Statement(s)

Fishing opportunity

- End of early winter (Chambers stock) segregated program = severely reduced early winter opportunity
- Low SAR in integrated programs → reduces returns for fishery
- Historical intentional artificial selection for late timing in both segregated and integrated stocks local-origin stocks limits popular early season fishery (Late Nov – February)

Conservation

- Low Smolt-to-Adult-Return (SAR) rate in integrated programs → few fish for supplementation above dams
  - SAR ~1/3 of segregated
- Artificial selection for late timing in integrated stocks may be maladaptive for wild populations
- Current lower river program “integrated in name only”
  - Timing
  - Low proportion of natural origin broodstock in lower river “integrated” program.

Transition Plan Rationale & Objectives (partial list!)

Fishing Opportunity

- Increase early season angling opportunity & maintain opportunity over protracted timeframe (Dec-April)
- Maintain or increase total steelhead available to anglers
- Increase smolt to adult survival in integrated programs

Conservation

- Accelerate supplementation above dams with properly integrated programs
- Increase survival/reduce residualism in integrated programs
- End poor integration in Lower River program
- Meet conservation goals associated with current recovery phase
  - Demographic replacement of wild fish taken for brood in integrated programs
  - <30% mining rate of wild population for integrated programs
  - pHOS (segregated programs) below limits
  - PNI (integrated programs) above targets
  - Short term
    - Assume upper basin pops (above dams) are recolonizing—provide demographic boost
    - Assume lower basin (below dams) is local adaptation—meet pHOS goals
  - Long term
    - Plan that allows 'smooth transition' to local adaptation in upper basin (no major changes needed!)

2 Models To Evaluate Program Alternatives

- Simple demographic model (like All-H-Analyzer, but adapted to Cowlitz) to "do the accounting" to calculate all hatchery metrics and broodstock needs

- Eco-evolutionary* model to evaluate effects of program operations and population, environmental, and fishery characteristics on run timing (and therefore early winter steelhead fishery).

  - This model allowed us to simulate what the effect of selecting the earliest returning adults would be on run timing…"would run timing change and if so, how fast?"

*eco-evolutionary models enable the joint modeling of population dynamic and evolutionary processes (e.g., changes in run timing)

Eco-evolutionary Modle

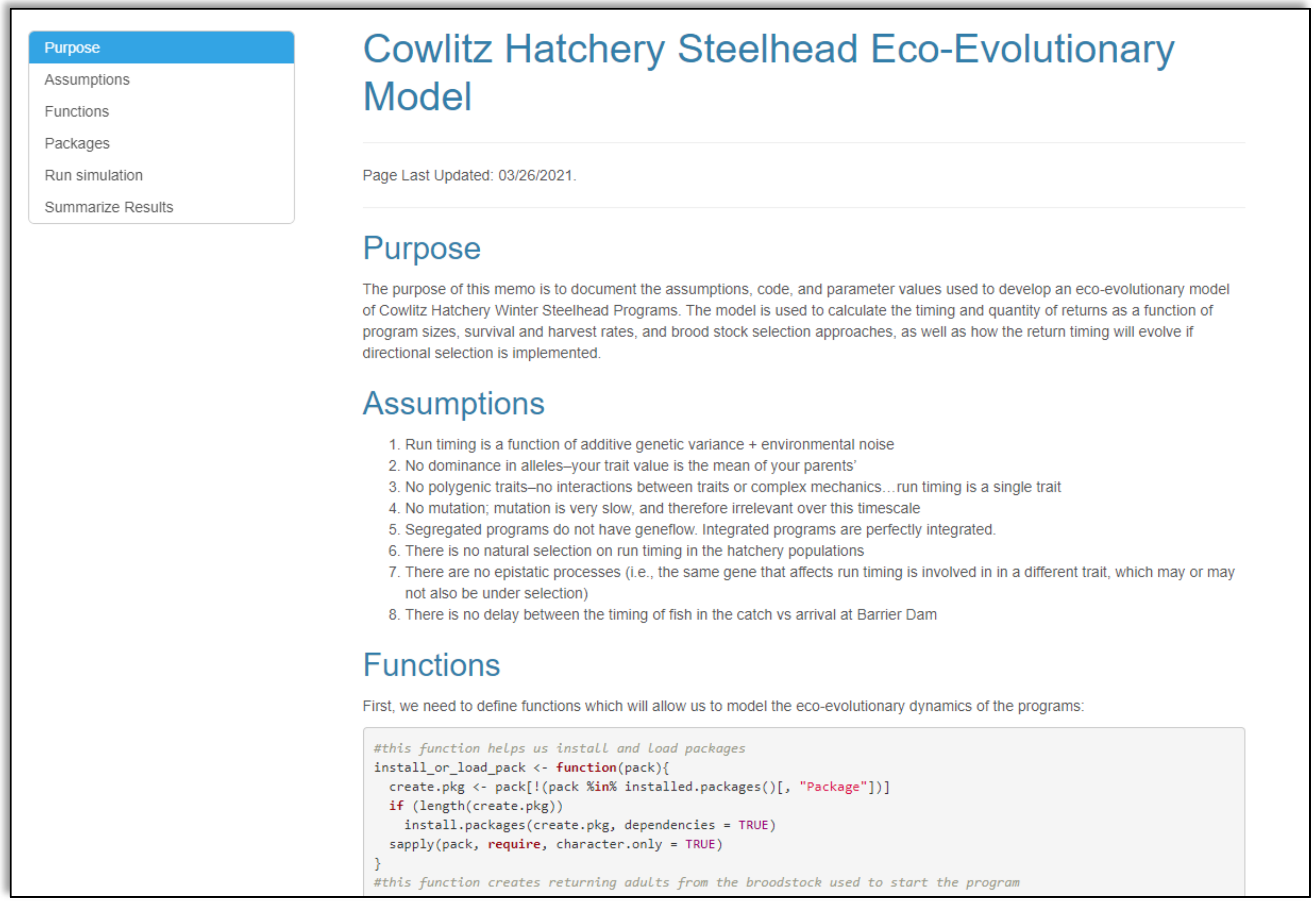
- Transparency:
  - model presented as R markdown file / html webpage
  - Publicly available/sharable code-base

- Clearly documented model inputs, assumptions, and equations

- Standardized formatted graphical and tabular outputs

- Fully automated

- Facilitates improved trust and collaboration



- Purpose
- Assumptions
- Functions
- Packages
- Run simulation
- Summarize Results

Cowlitz Hatchery Steelhead Eco-Evolutionary Model

Page Last Updated: 03/26/2021.

Purpose

The purpose of this memo is to document the assumptions, code, and parameter values used to develop an eco-evolutionary model of Cowlitz Hatchery Winter Steelhead Programs. The model is used to calculate the timing and quantity of returns as a function of program sizes, survival and harvest rates, and brood stock selection approaches, as well as how the return timing will evolve if directional selection is implemented.

Assumptions

1. Run timing is a function of additive genetic variance + environmental noise
2. No dominance in alleles–your trait value is the mean of your parents'
3. No polygenic traits–no interactions between traits or complex mechanics…run timing is a single trait
4. No mutation; mutation is very slow, and therefore irrelevant over this timescale
5. Segregated programs do not have geneflow. Integrated programs are perfectly integrated.
6. There is no natural selection on run timing in the hatchery populations
7. There are no epistatic processes (i.e., the same gene that affects run timing is involved in in a different trait, which may or may not also be under selection)
8. There is no delay between the timing of fish in the catch vs arrival at Barrier Dam

Functions

First, we need to define functions which will allow us to model the eco-evolutionary dynamics of the programs:

```
#this function helps us install and load packages
install_or_load_pack <- function(pack){
  create.pkg <- pack[!(pack %in% installed.packages()[, "Package"])]
  if (length(create.pkg))
    install.packages(create.pkg, dependencies = TRUE)
  sapply(pack, require, character.only = TRUE)
}
#this function creates returning adults from the broodstock used to start the program
```

Transition Plan Proposal

Fishery and Hatchery Management Plan (FHMP) Transition Planning Process

- Identified several alternatives, used models to compare alternatives in terms of performance with respect to fishing opportunity & conservation objectives

- Overview of all proposed changes beyond the scope of today's presentation

- Changes proposed that I will focus on today:
  - Switch of lower river integrated program to segregated (no longer "poorly" integrated)
  - Select only earliest returning hatchery broodstock for lower river program to advance run timing for 3 generations
  - No net change to total smolt release but double upper basin integrated programs and reduce lower basin program to offset upper basin increases

Results: Run Timing and Abundance

- Timing improved
- Median and 25th percentile return dates move forward by >30 days over 3 generations
- Dec. catch 48 → 380
- Total adult returns within 90-100% of existing depending on integrated SAR

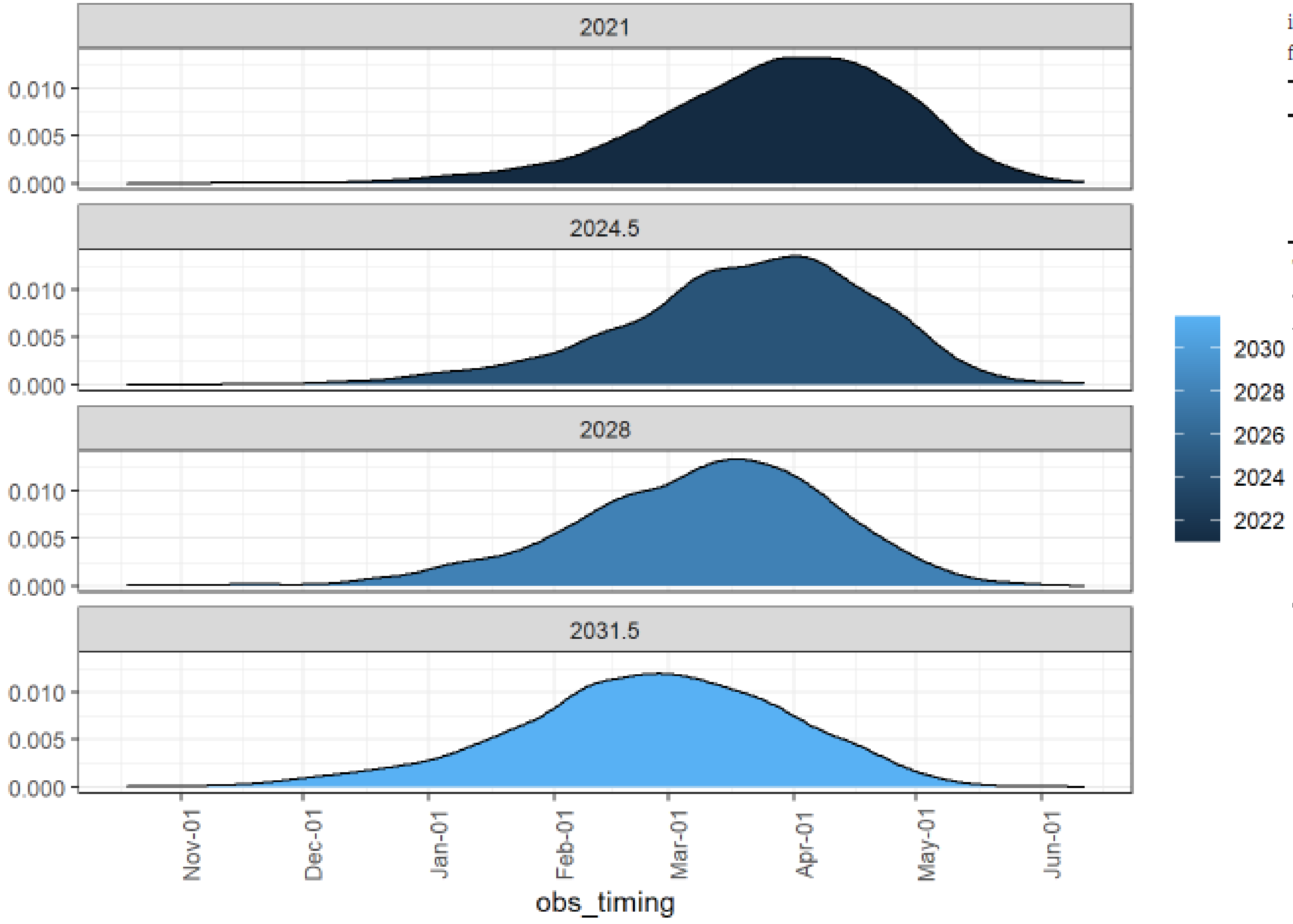


Figure 1: Return timing of the aggregate of Cowlitz winter steelhead programs

Table 1. Return timing quantiles by day of year, where 1 is Jan 1st, -31 is Dec 1st of the previous year, and so forth.

year	0.025	0.25	0.5	0.75	0.975
2021	18	68	89	108	137
2024	6	60	81	100	129
2028	1	48	70	89	121
2032	-19	34	56	78	114

Table 2. Percent of returns/catch by month.

month	2021	2024.5	2028	2031.5
January	4.3	6.5	10.0	15.3
February	12.7	15.3	23.7	31.8
March	33.8	38.1	39.8	32.1
April	36.7	32.0	21.2	13.2
May	11.6	6.2	3.0	1.0
June	0.2	0.3	0.1	0.1
October	NA	NA	0.1	0.1
November	0.1	0.2	0.3	0.9
December	0.7	1.4	1.9	5.4

Table 3. Catch by month.

month	2021	2024.5	2028	2031.5
January	300	460	704	1080
February	892	1080	1668	2244
March	2380	2688	2804	2264
April	2584	2256	1492	932
May	820	436	208	72
June	16	20	4	4
October	NA	NA	8	8
November	8	12	24	64
December	48	96	136	380

Results: Conservation Objectives

"Normal" SAR scenario

- Able to meet ALL conservation goals
  - Upper Basin
    - pHOS <30%
    - pNOB >50%
    - Mining <30%
    - Demographic replacement? Yes
  - Lower Basin
    - pHOS <10%

"Low SAR/low smolt dam passage survival" scenario

- **Not** able to meet **ALL** conservation goals
  - Upper Basin
    - pHOS <30%
    - Mining <30%
    - Demographic replacement? Yes
    - ~~pNOB >50%~~
  - Lower Basin
    - pHOS <10%

Next Steps

- ~~Finalize proposal with Tacoma Power~~
- ~~Solicit public comment~~
- Submit transition plan to FERC
- Submit updated HGMPs for submission to NOAA

Questions?

Collaborators:

WDFW: Bryce Glaser, Sam Gibbons, Brian Gale, John Serl, Josua Holowatz, Todd Hillson, Todd Seamons

Tacoma Power: Phil Sandstrom, Matt Bleich, Tim Hoffnagle