Willamette Instream Flow Project: Integrated tools for the evaluation of alternative flow management strategies

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USGS science for a changing world

Oregon Cooperative Fishery Research Unit — Semper Catostomus

Oregon Fish & Wildlife

Oregon State University™

Context: Willamette Water Allocation

<u>Water allocation</u>:

Agricultural irrigation

Municipal

Fish & Wildlife

Ecosystem needs

BiOp

- Flow targets
- Temperature targets

Managers: What are the best flow management regimes?
What are the tradeoffs?

Science of Willamette Instream Flows Team

SWIFT - team of experts to review and develop science for instream flows

Interdisciplinary Team:

Hydrologists

Geomorphologists

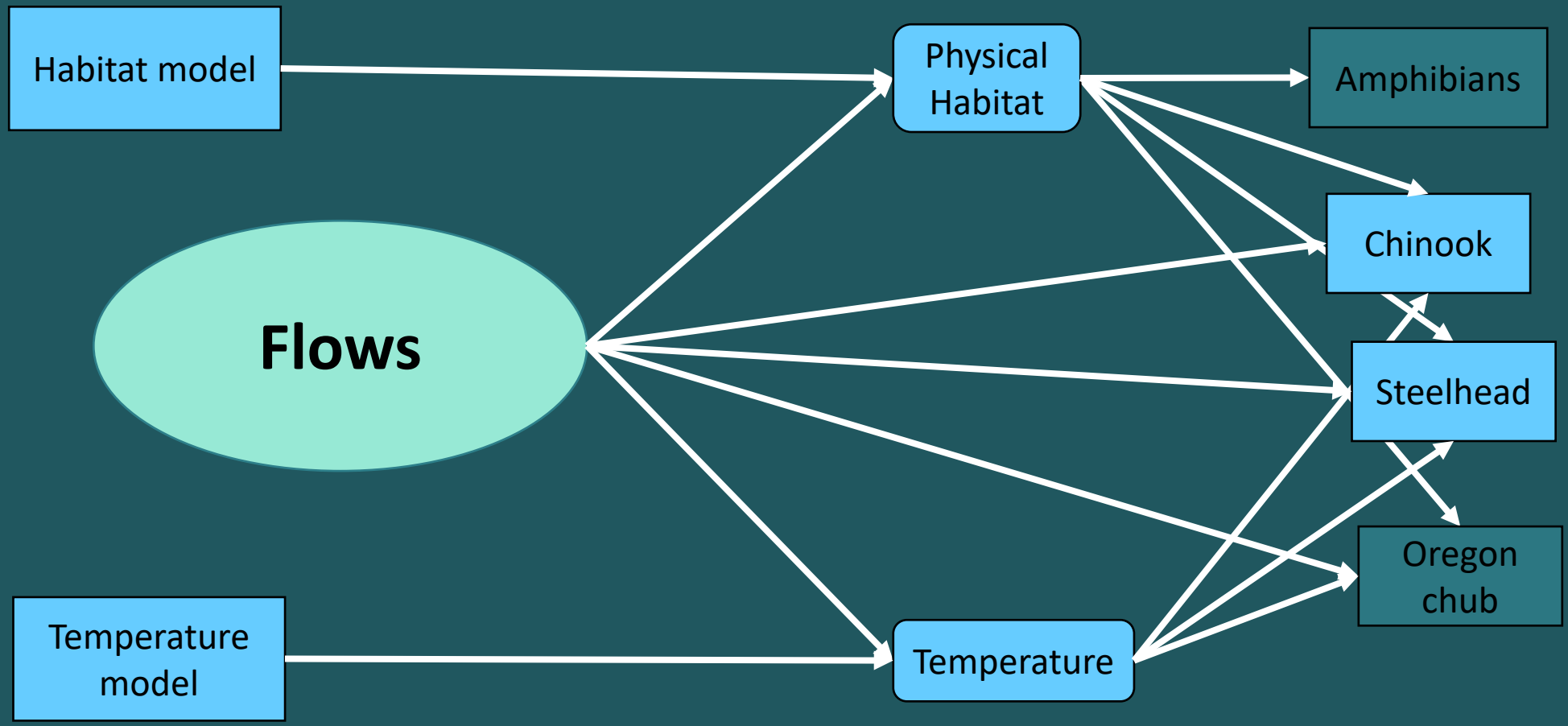
Water quality modelers

Ecologists

Managers

Public Stakeholders

Decision Model Framework

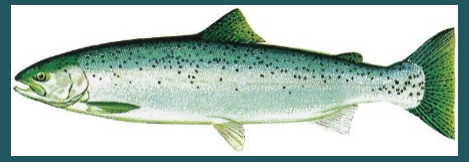


Peterson et al. 2022 *River Research and Applications 38:*293-308

Objectives

Chinook

Steelhead



A DISCONNECT

Chinook

Adult Returning
Spawning
Subyearlings migrate
Yearlings migrate

Brood year t

Brood year t-1

Steelhead

Adult Returning
Spawning
Smolts migrate

Brood year t

Brood year t-1, 2, 3

Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Solution: Sub-models

Number adults
H_2o storage available

Passage, holding, spawning (t)

No. Swim-up Chi
Redds
+
Age 1 Steelhead

Adult Chi. equivalents
+
Sthd. smolts surviving
To WF

Emergence, growth, survival, movement (BY t-1)
Movement and survival

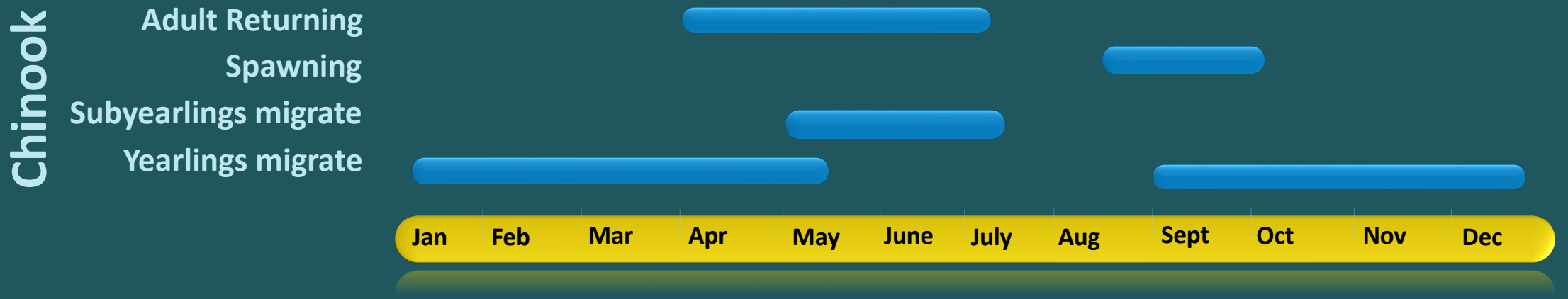
H_2o storage available
#Redds t-1
Degree days
Subyearlings t-1
+
Steelhead smolts

Chinook Streamflow Models

Chinook

- Weekly time step
- Simulated 6 size classes of juveniles:

  <60 mm, 60-75 mm, 75-90mm, 90-105, 105-120, >120
- Begins Last week Feb with adults returning
- Adult submodel user specified run size, % hatchery
- Juvenile submodel user specified redds, subyearlings t-1
- Calibrated monitoring data



Steelhead Modeling

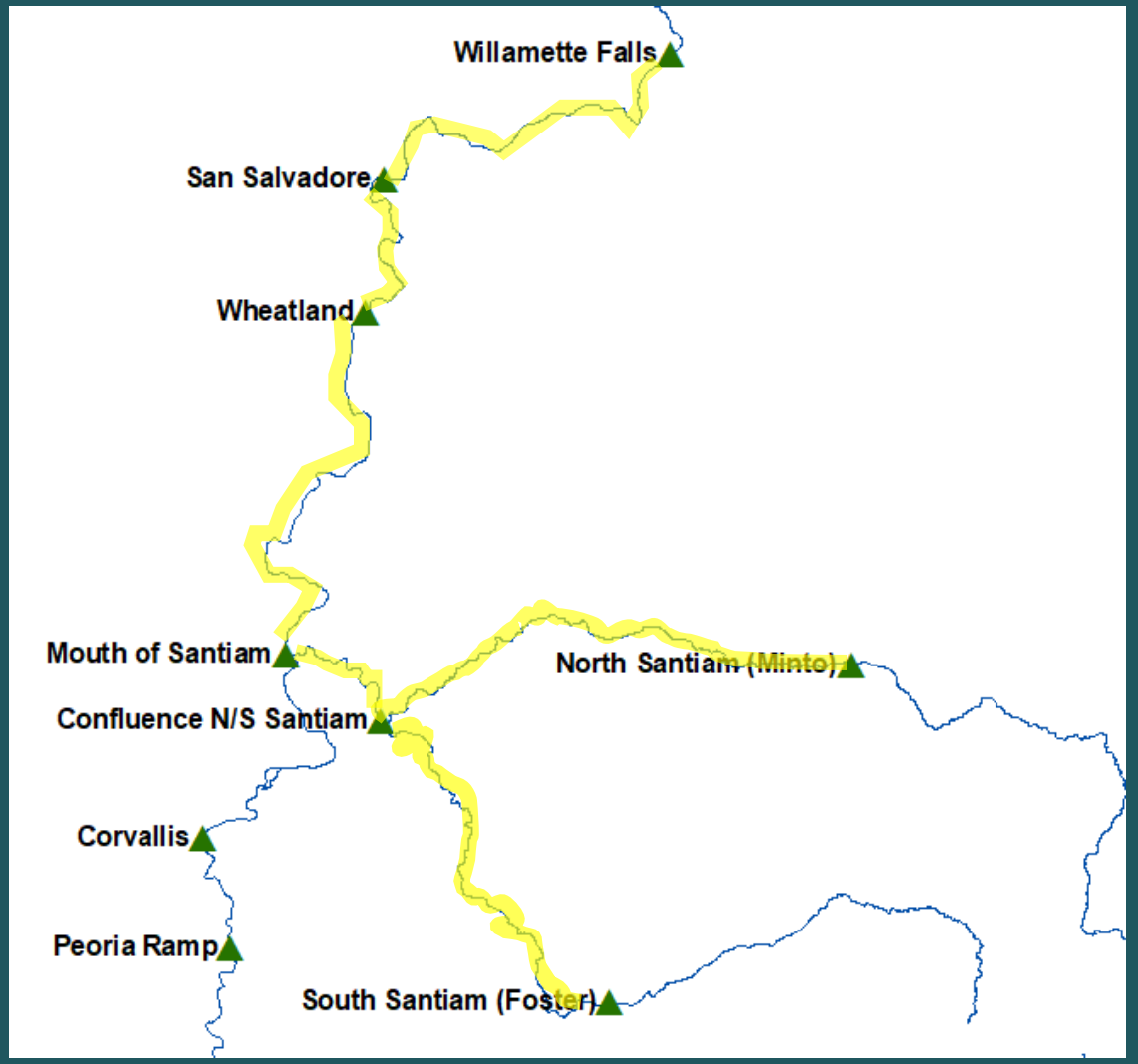
Weekly time step

<u>Two models</u>: Smolt outmigrant
Adult to Age 1

North & South Santiam only
(ignores spawning and rearing in tributaries)

Only includes anadromous LH forms
(residents ignored)

<u>Adult to age 1 assumptions:</u>
STHD spawn with STDH
STHD get all available spawning habitat
Juvenile STHD not compete with residents



Salmonid model parameters

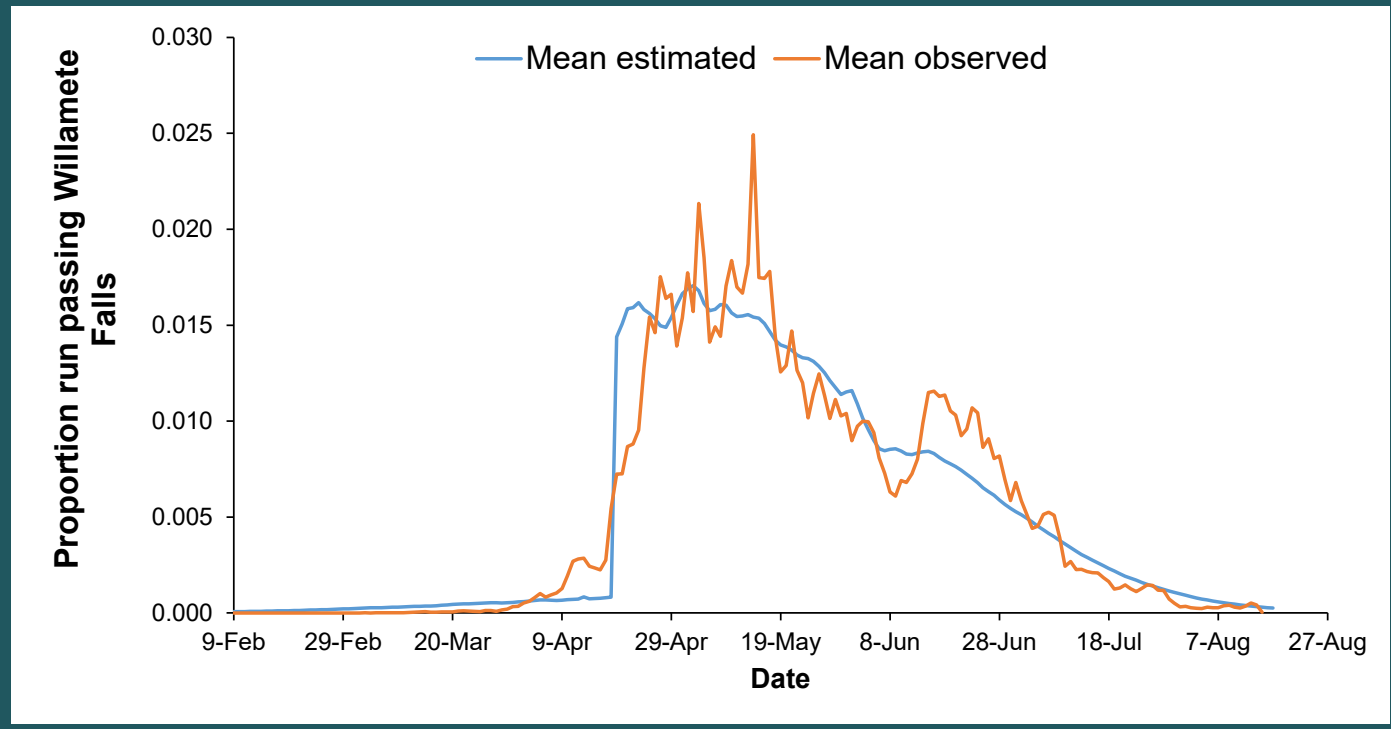
Analysis of existing data
- WF counts
- ODFW surveys
- ODFW tagging

Meta-analyses of published reports
- ODFW, UI

Published studies

Expert judgment

Chinook adult return timing



Evaluating alternative flow regimes

Five alternatives

- Existing
- Higher spring
- Higher summer
- Higher fall
- Willamette Valley Project dam (WVP) minimums

Simulation: years 2000-2018

Observed air temperatures

Regression modeled water temperatures

Output mean:

1) Number emergence redds (adult submodel)
2) Adult equivalents (juvenile submodel)
3) Age 1 steelhead (2 alternative spawning timing)
4) Smolts surviving to Willamette Falls (2 alternative timing)

Rescaled: 0= worst, 1=best

Evaluating alternative flow regimes

Adult Chinook submodel

Run size: 90K

Juvenile Chinook submodel

Number age 1 residents: 10K each tributary

McK MFW SFS NFS

Number redds: 2348, 64, 1088, 840 (lots 2x ave. 2010-2018)

Habitat RSF probability scenarios 1-3

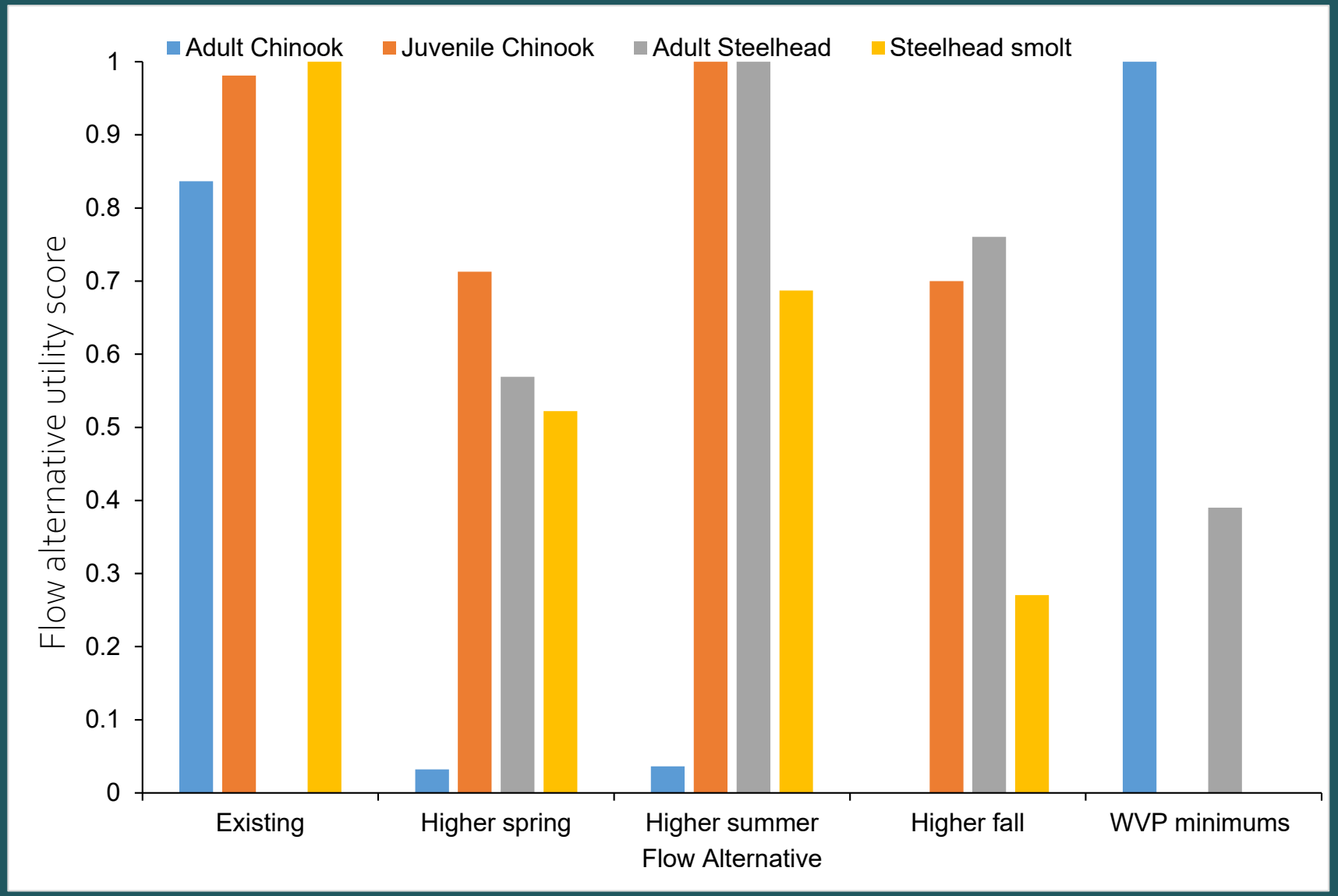
Steelhead Adult to age 1

Run size: 20K each tributary

Steelhead smolts

100K each tributary

Evaluation alternative flows



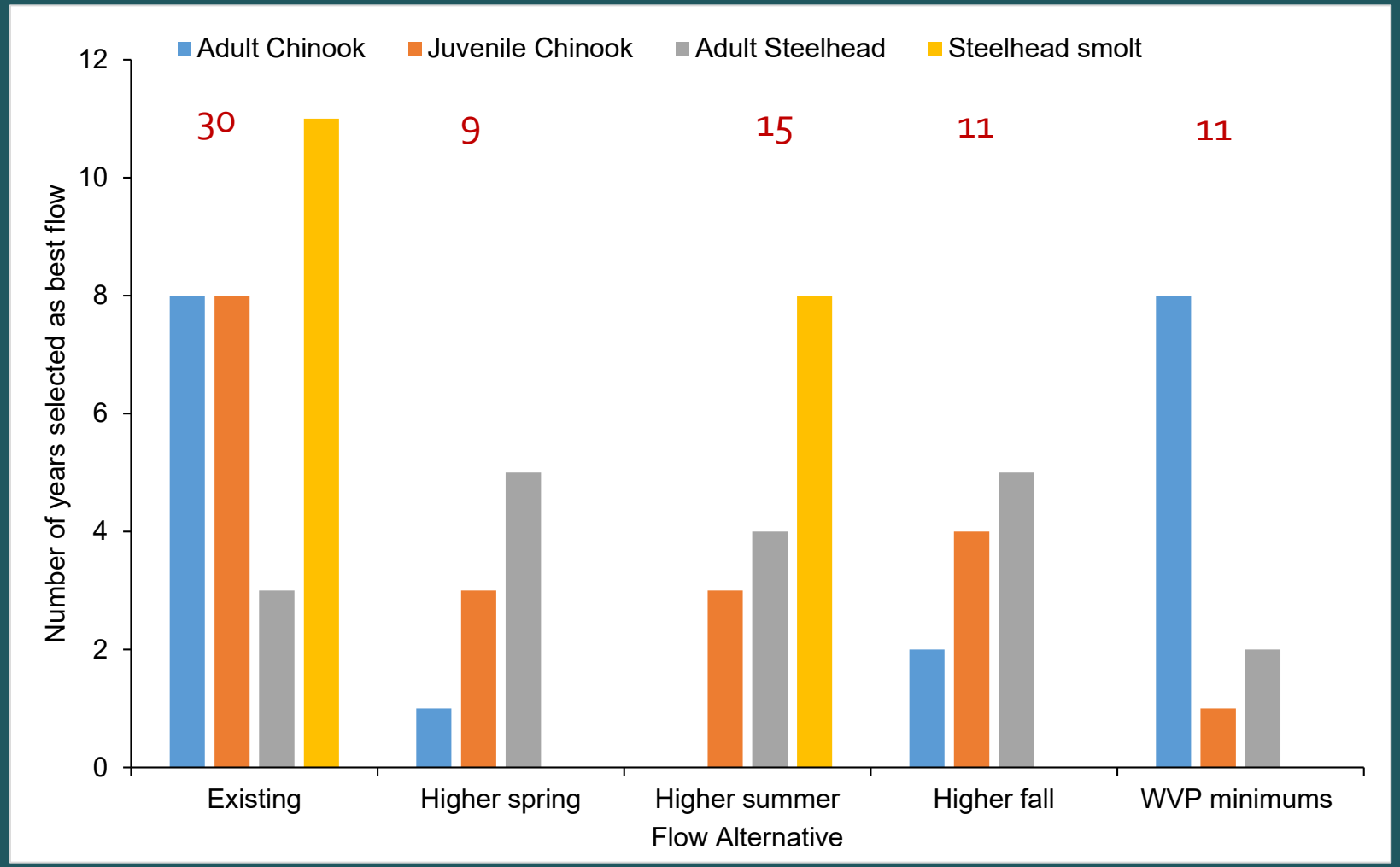
Best

Worst

Provisional: subject to revision

Evaluation alternative flows

Count the numbers of years and tributaries where alternative was best



Best

Worst

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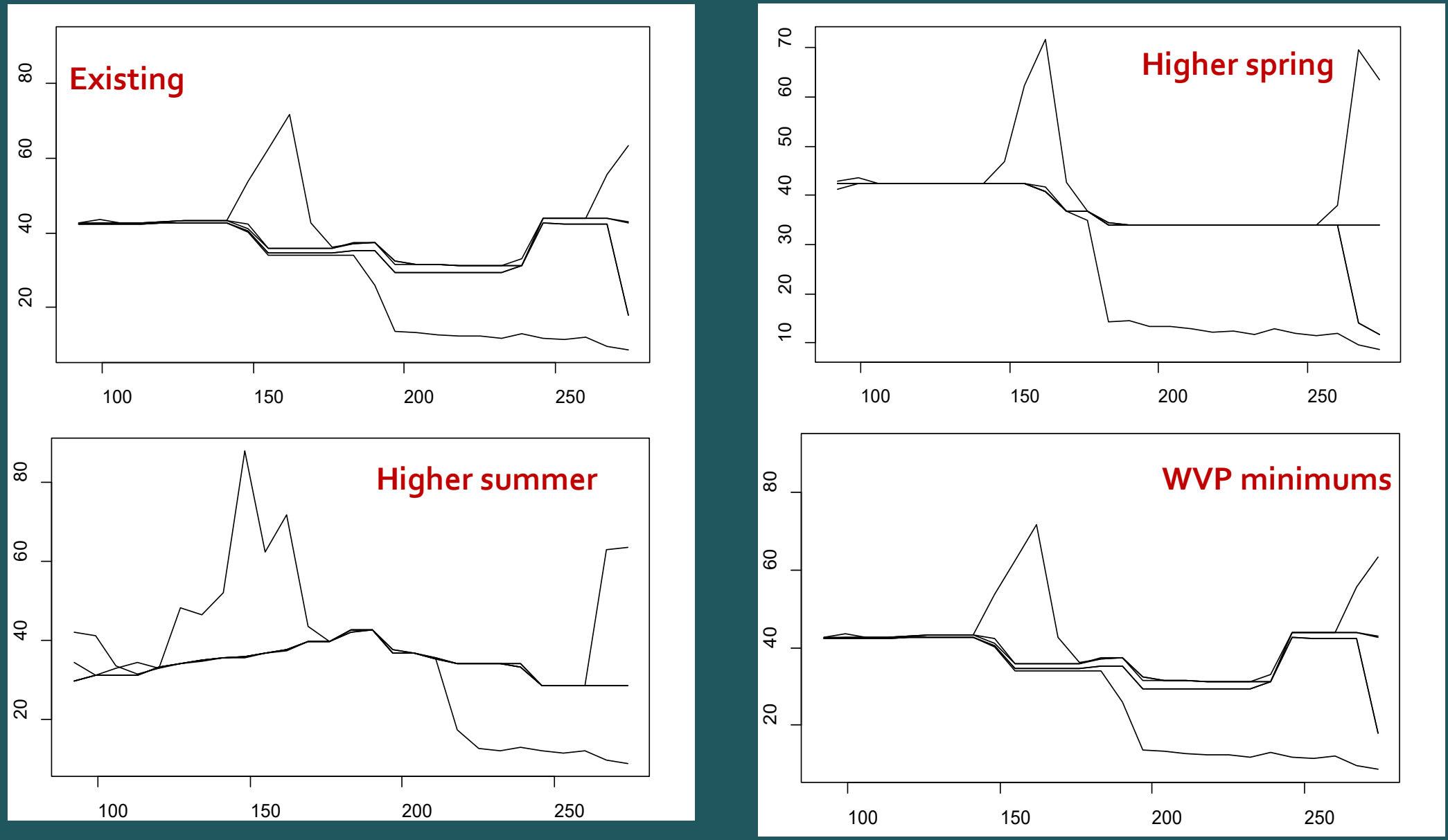
Partial controllability



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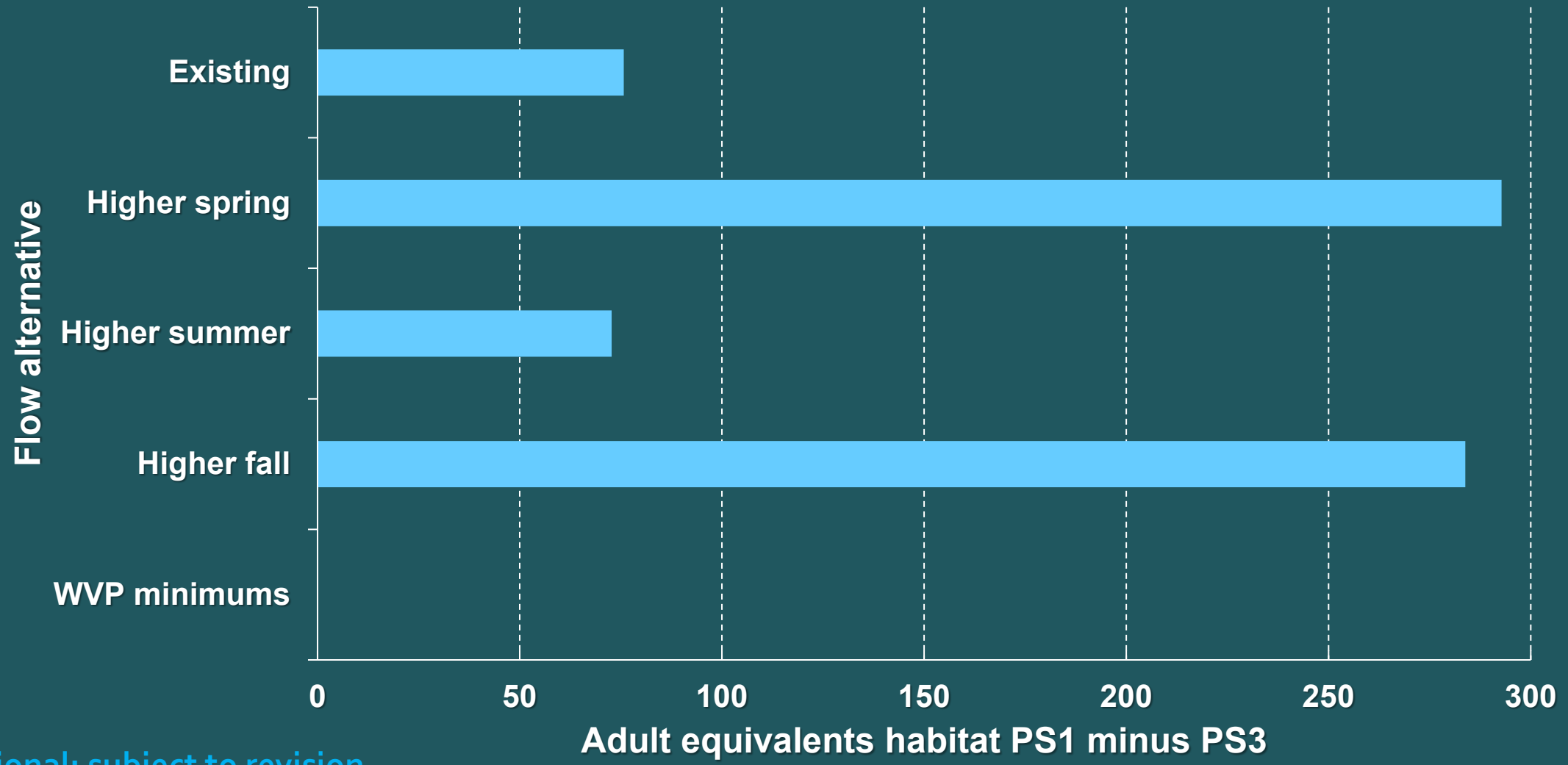
Habitat probability scenarios and estimated adult Chinook equivalents (ACE)

Average ACE ~ 3800



Provisional: subject to revision

Conclusions

We can build flow management decision models with existing data and information plus expert opinion

We can use decision models to identify best flow management strategy and evaluate tradeoffs

Within season management?

Chinook habitat definition differences

Huge gaps in *O. mykiss* knowledge

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