

Out of State, but Not Out of Mind: Hydro-system Operations and Fish



Jay Hesse
Nez Perce Tribe

Each Dam Unique

Reservoir Length (24 -76 miles)

Physical Design and Bathymetry

Number of Spillways

Number of Spillway Weirs

Number of Turbines

Power Capacity

Number of Fish Ladders

Number of Fish Ladder Entrances

Juvenile Bypass (7)

Juvenile Transportation (3)

Juvenile Fish Guidance Efficiency





Key Hydro Impacts to Fish

Prolonged Juvenile Travel Time

Increased In-river Mortality

Cumulative Stress (Delayed Mortality)

Delayed Adult Passage

Increased Predation Risk

Degraded Water Quality

What Can We Manage?

Water flow - flow (seasonal and daily) and reservoir volume (MOP, drawdown, breach)

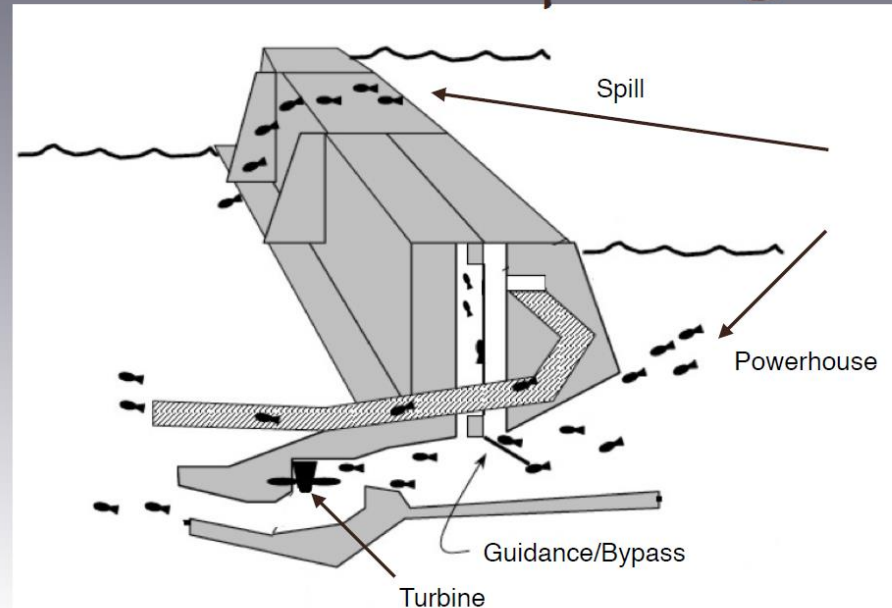
Passage route - transport; spill, spillway weirs, turbine intake screens, powerhouse surface passage

Predator risk - lethal removals, physical obstruction, behavioral change

Water quality - temperature and total dissolved gas



Powerhouse passage



Key Data Sources



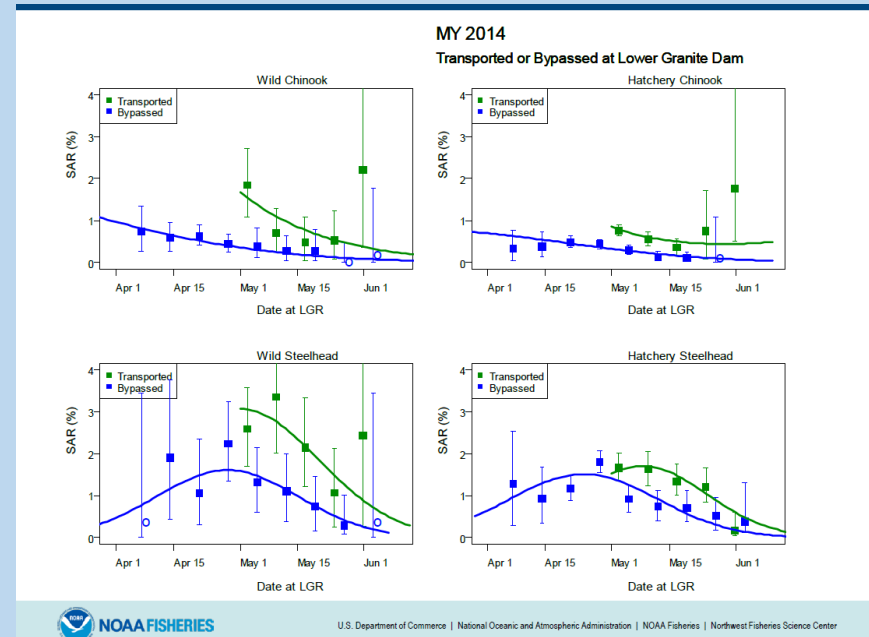
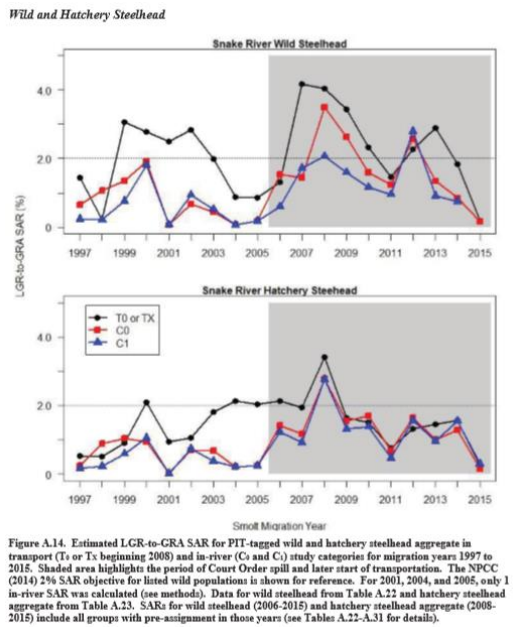
Fish Passage Center Comparative Survival Study -
<http://www.fpc.org/documents/CSS.html>

NOAA Science Center -
<https://www.nwfsc.noaa.gov/publications/scipubs/index.cfm>;
https://www.nwfsc.noaa.gov/assets/26/9359_02262018_135356_Widener.et.al.2018-Spring-Survival-2017.pdf

Generalities

In-river Survival:

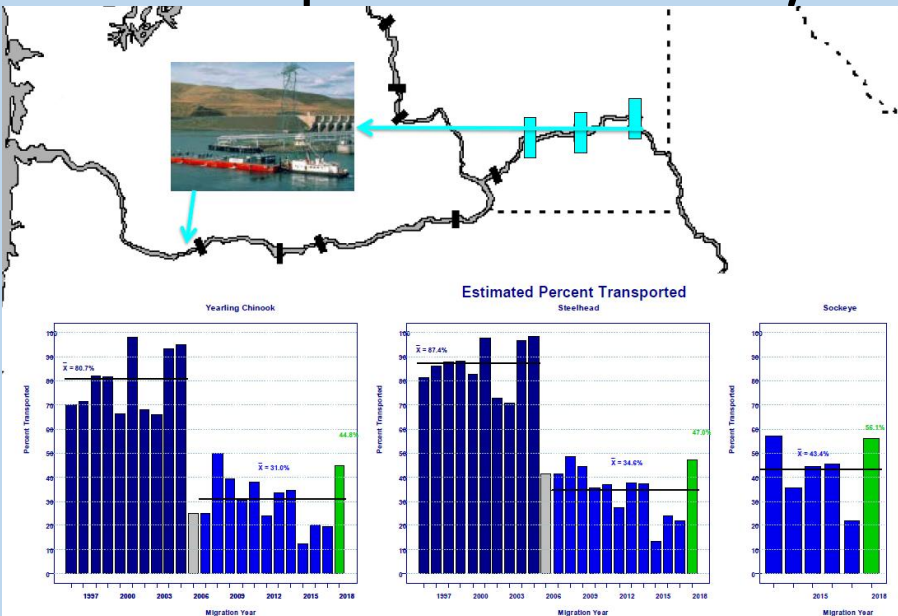
- Spillway > Juvenile Bypass > Turbine
- Increasing number of bypass or turbine experiences (PITPH) decreases SARs
- Faster travel time yields higher survival
- SARs higher earlier and decline as outmigration season progresses



Generalities (cont.)

Transportation:

- Increasing benefit through spring season
- Greater benefit for hatchery production than wild
- Greater benefit for steelhead than Chinook
- Decreasing benefit with increasing in-river survival
- Transported fish stray at higher rate than in-river fish

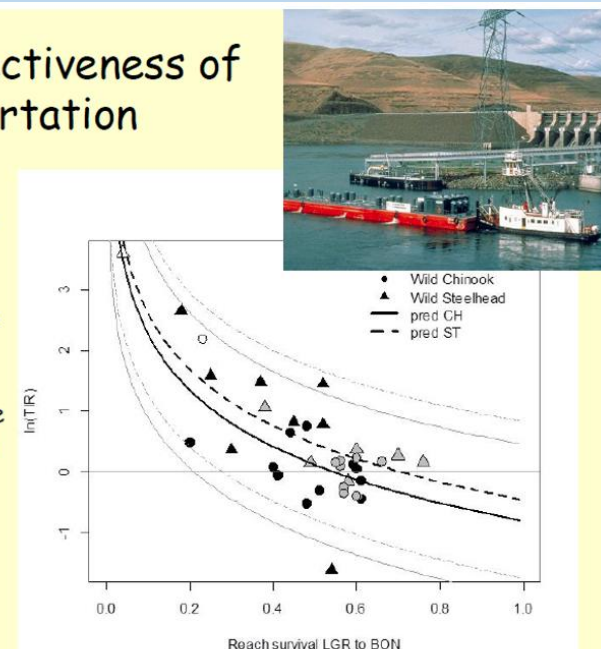


Relative Effectiveness of Transportation

Ratio of Transport SARs to In-river SAR (TIR) decreases with improved in-river conditions and juvenile survival

At $S_R \sim 0.6-0.7$, relative "benefit" of transport becomes "detriment"

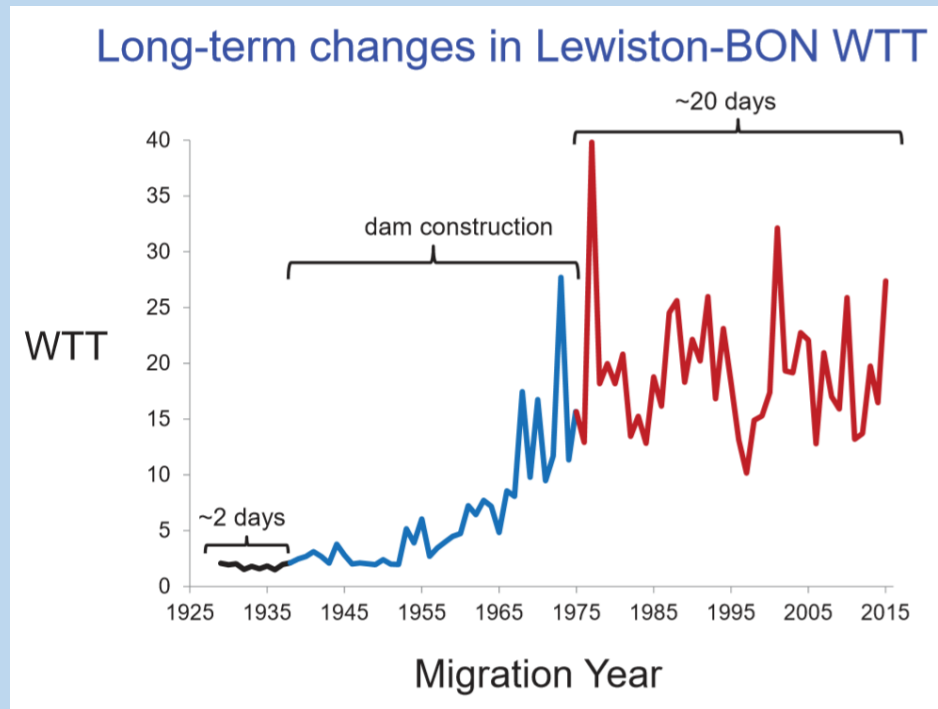
Potential to further improve in-river conditions and S_R



Generalities (cont.)

Flow:

- Higher flow decreases travel time
- Higher spill percentage decreases travel time
- Availability of spillway weirs decreases travel time

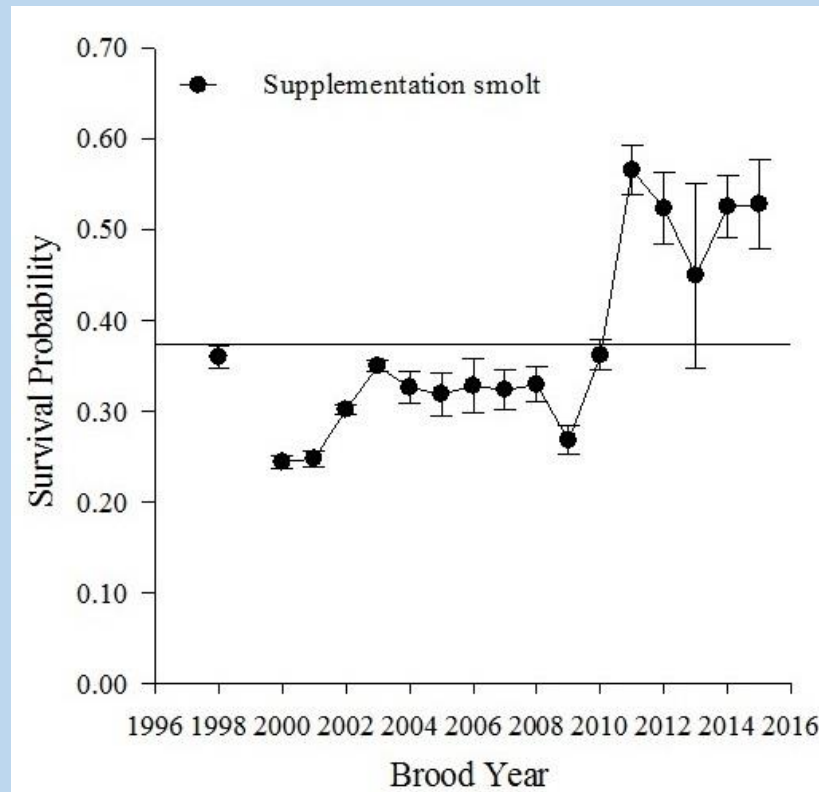


Generalities (cont.)

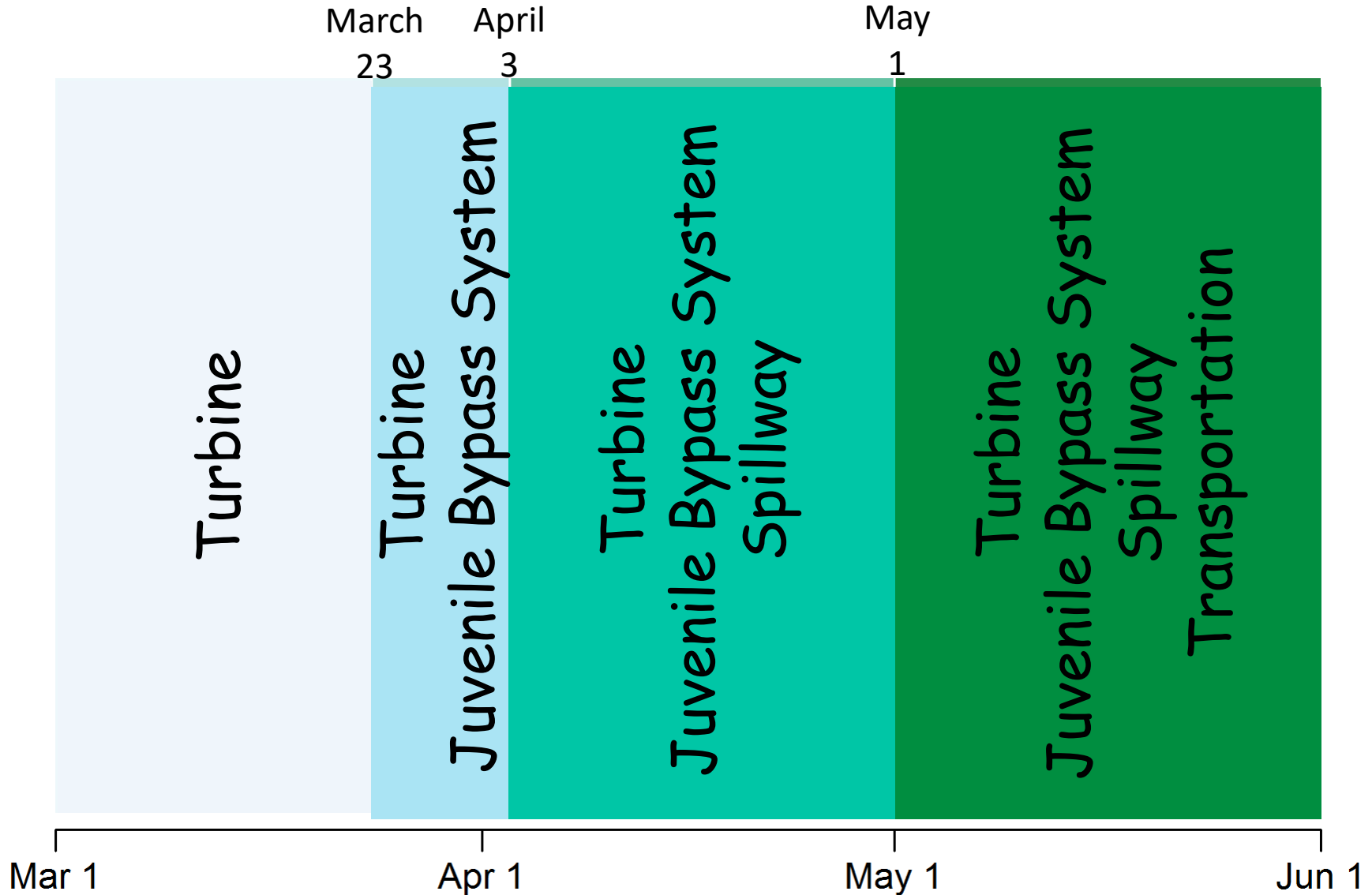


Hatchery Releases:

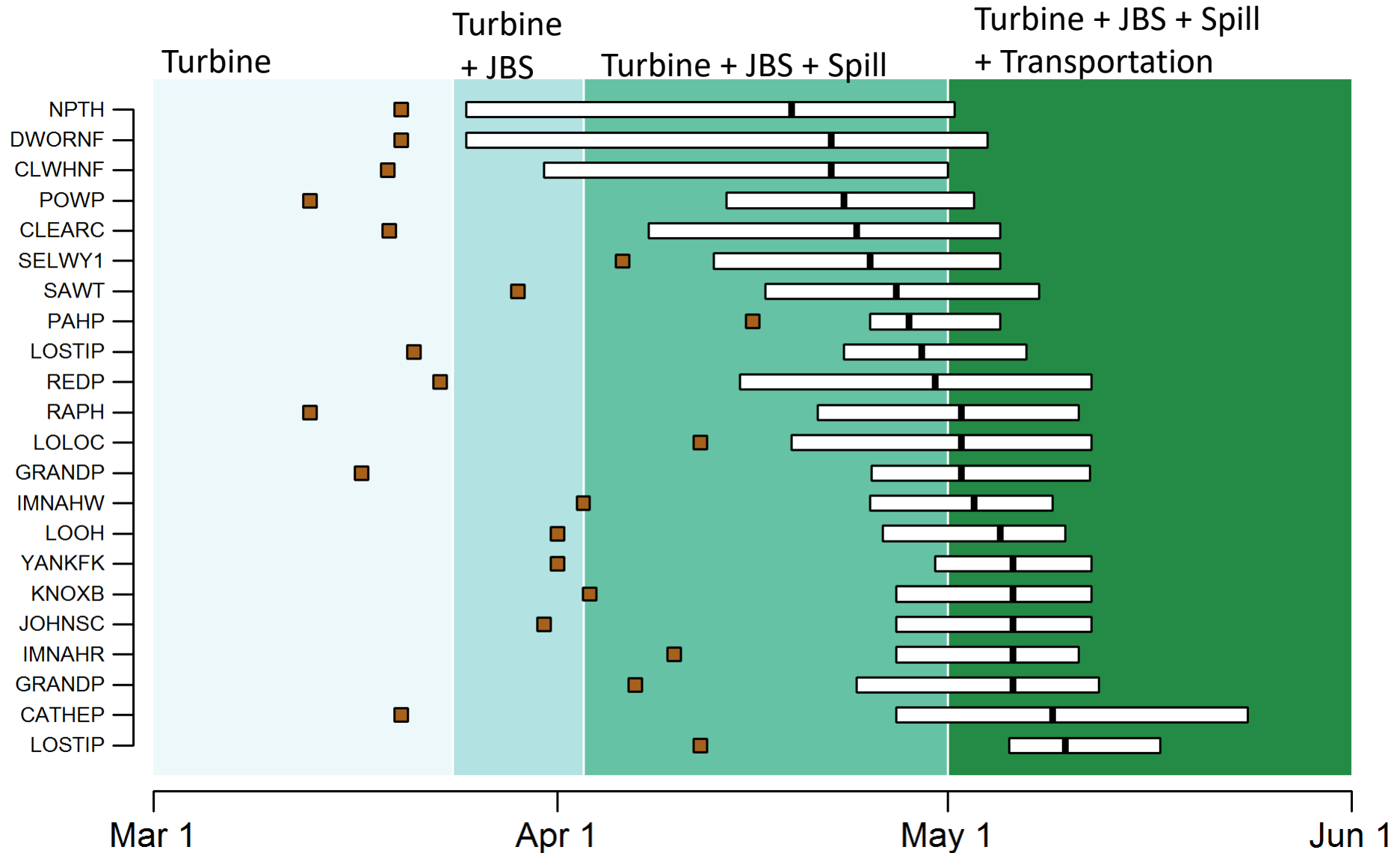
- Later release increases survival to Lower Granite Dam
- Later release decreases travel time



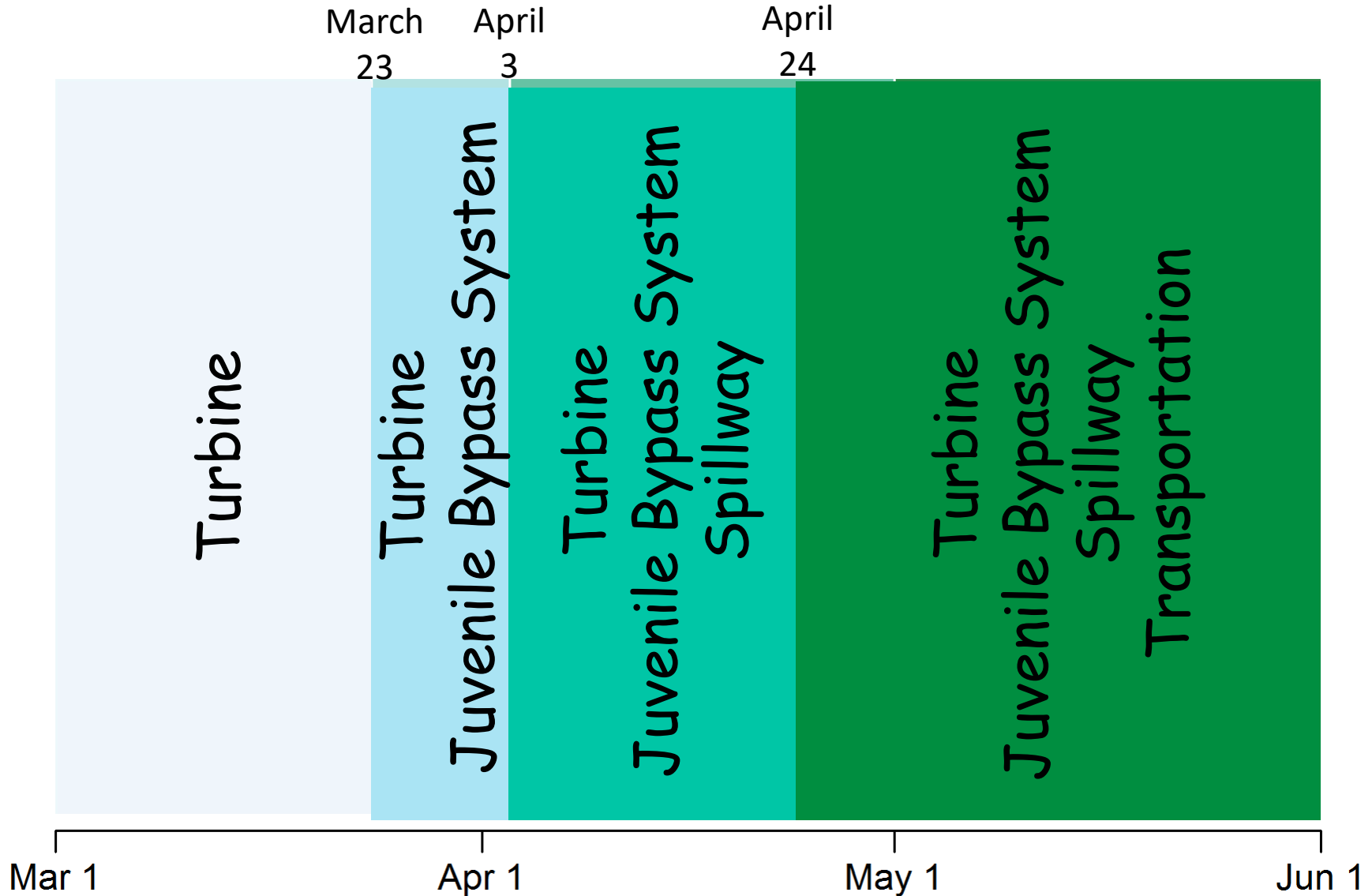
Juvenile Spring Passage Routes Lower Granite Dam (2008 - 2017)



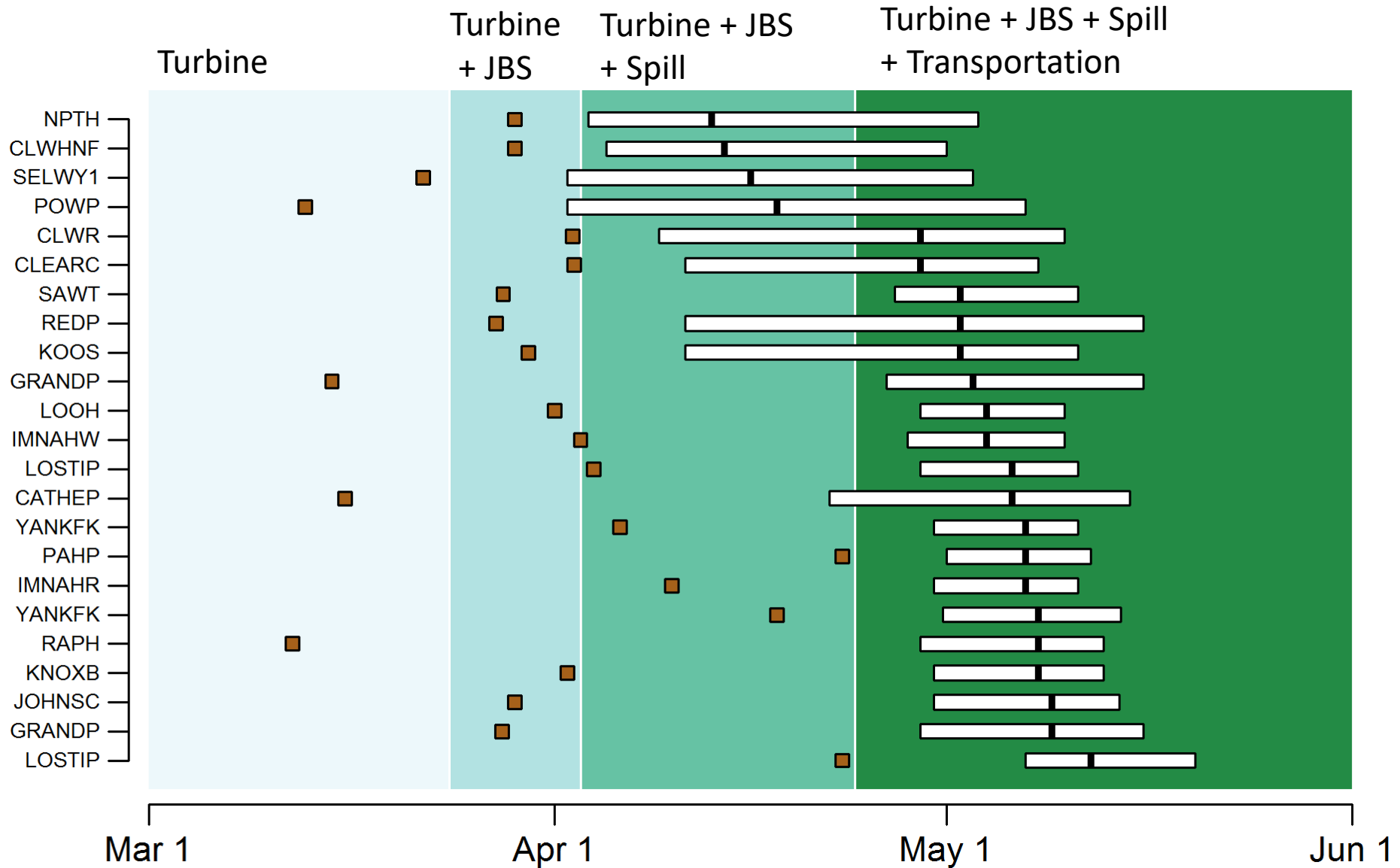
2017 Release and Lower Granite Dam Arrival Timing Hatchery-origin Spring/Summer Chinook Salmon



Juvenile Spring Passage Routes Lower Granite Dam (2018 - 2019)

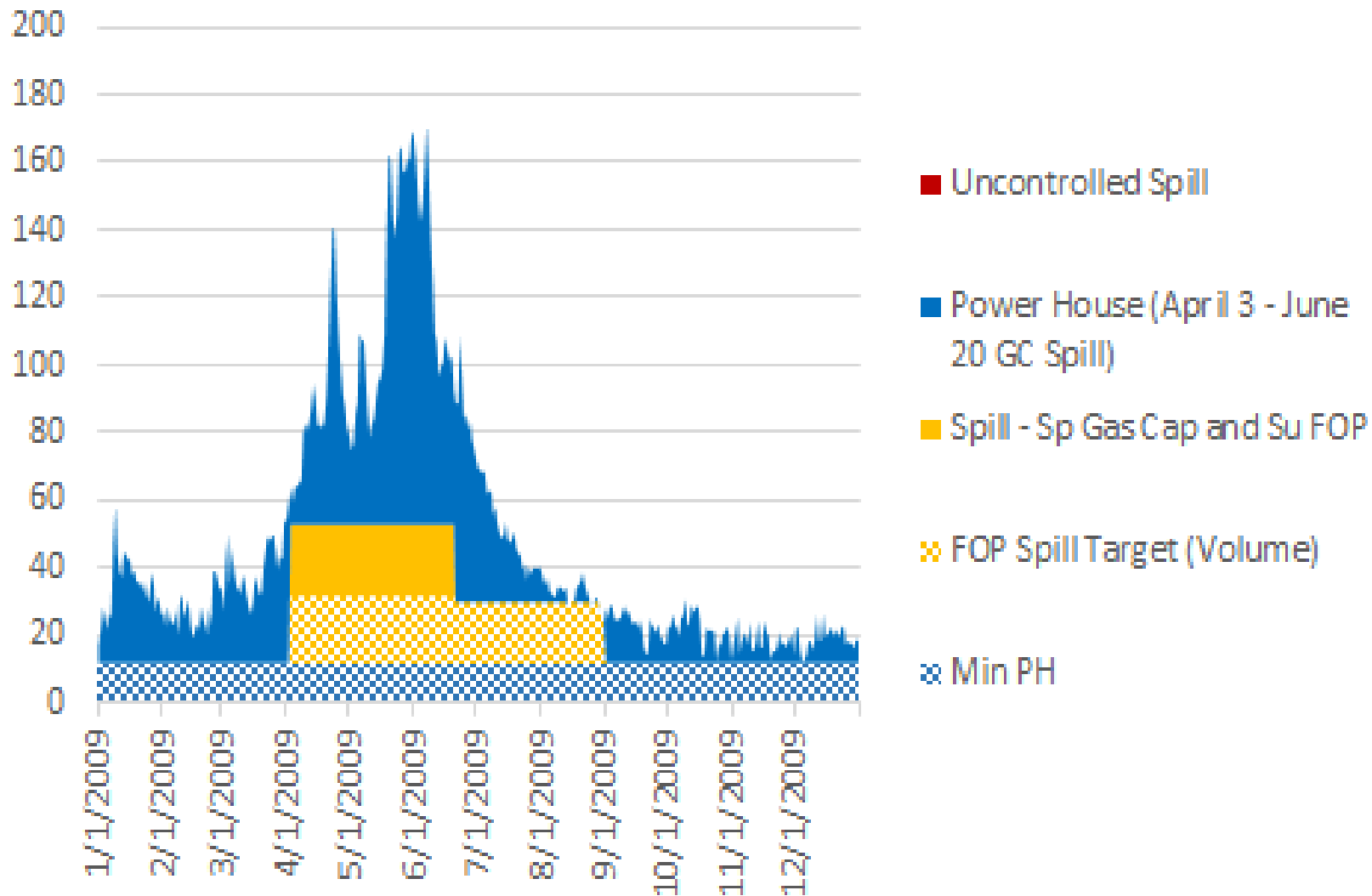


2018 Release and Lower Granite Dam Arrival Timing Hatchery-origin Spring/Summer Chinook Salmon

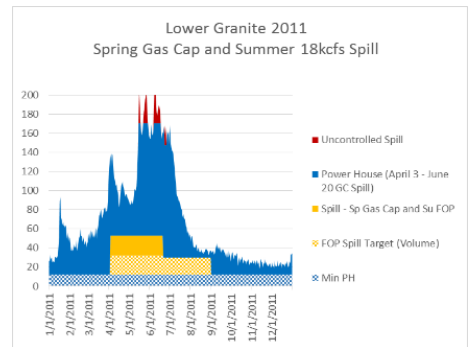
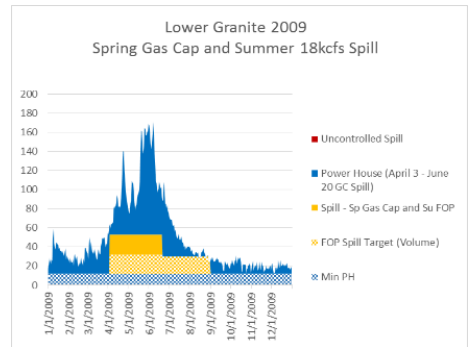
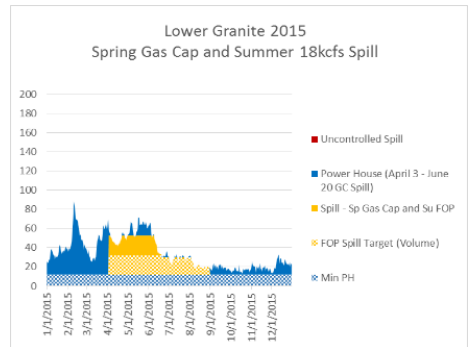


Spill Management Example

(Lower Granite Average Water Year 2009)



2015 (low flow), 2009 (average flow), 2011 (high flow)



Balancing Fish and Power

Longstanding Debate and Litigation



Flexible spill agreement aims to benefit salmon and hydropower, while avoiding litigation

- Parties:
OR/NPT/WA/BPA/COE/BOR
- Support:
States/Tribes/Feds

Agreement "Pillars"

The diagram is shaped like a classical building. It has a blue triangular pediment at the top containing the title 'Agreement "Pillars"'. Below the pediment is a horizontal blue bar. The main body consists of three vertical blue pillars. The left pillar is labeled 'FISH' and contains the text '2019 = 2018' and '2020/21 > 2018'. The middle pillar is labeled 'POWER' and contains '2019/21 => 2018'. The right pillar is labeled 'OPERATIONS' and contains 'Feasible'. Below the pillars is another horizontal blue bar. At the very bottom is a wide blue base containing a list of project goals: 'PITPH, Reach Survival, Travel Time, Revenue, Adaptive Implementation, Navigation, Safety, Structural Integrity'.

FISH

2019 = 2018
2020/21 > 2018

POWER

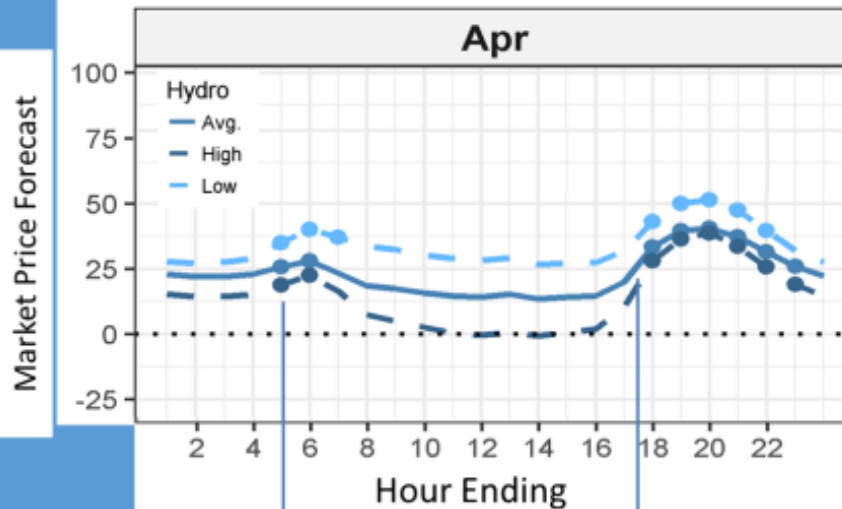
2019/21 => 2018

OPERATIONS

Feasible

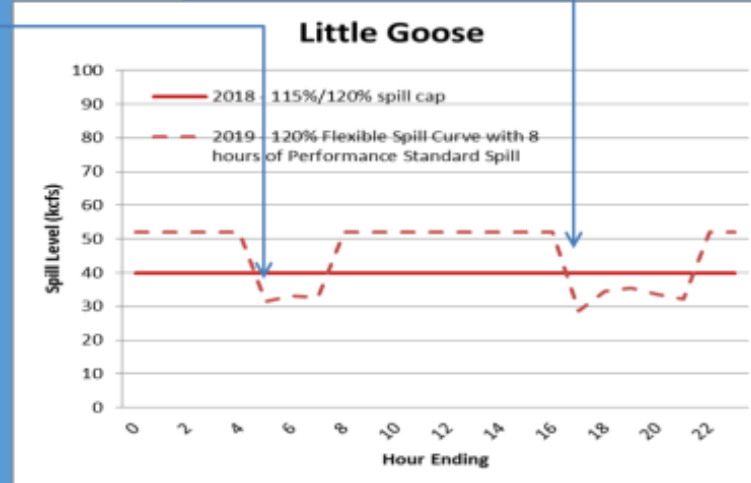
**PITPH, Reach Survival, Travel Time, Revenue, Adaptive Implementation,
Navigation, Safety, Structural Integrity**

"Flex"ible Spill and Power Concepts



Hypothetical
April Market
Shape*

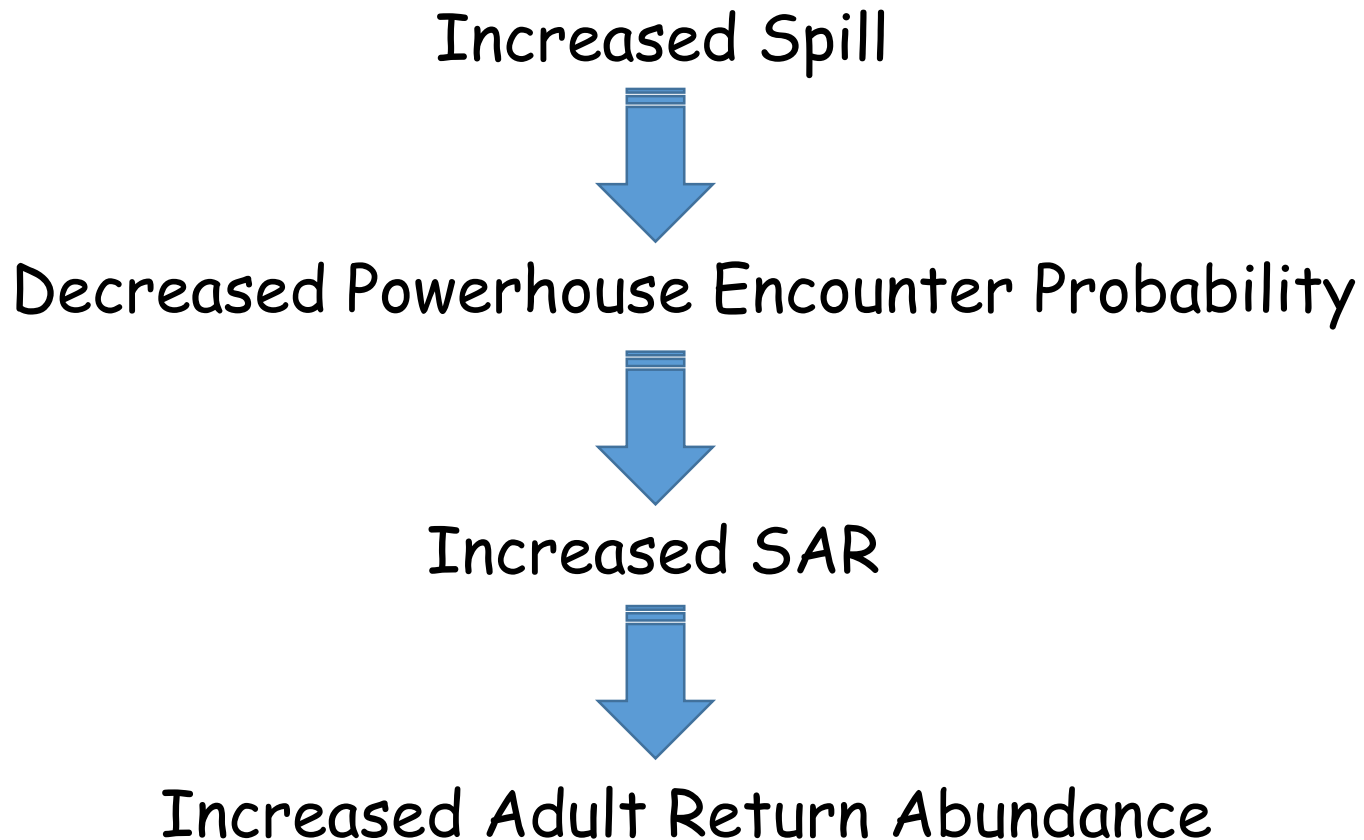
Hypothetical Spill
Shape Comparison
between 2018 Spill
Injunction and 2019
flex operation



*based on modeled data, not actual estimates

- Increase spill when hydropower demand and value is lower
- Reduce spill when hydropower demand and value is higher

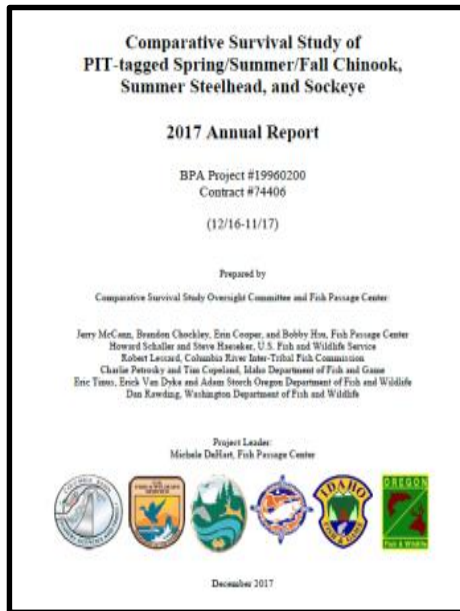
Spill Operations Agreement Fish Benefit Logic Path



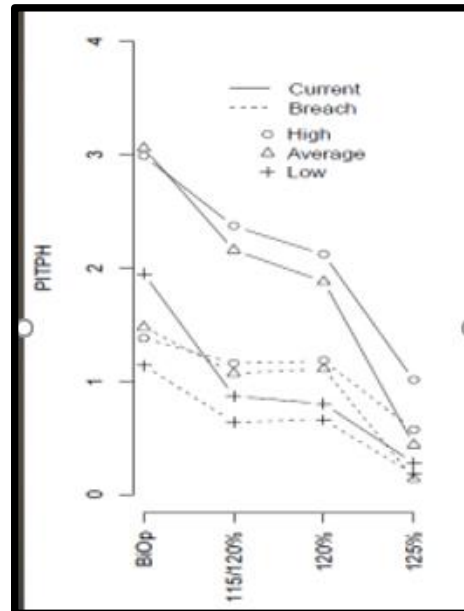
Fish Benefit Modeling

CSS-based PITPH Index

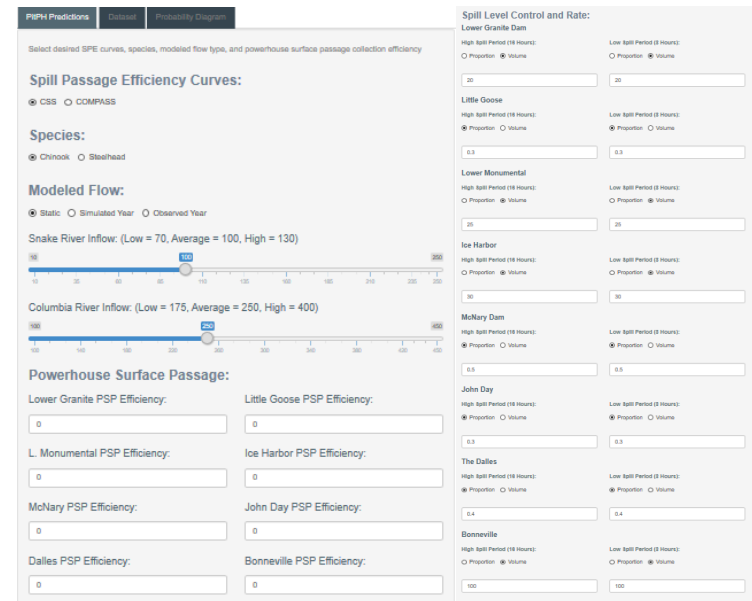
<https://nptfisheries.shinyapps.io/pitph2/>



**NPCC Program Project
Empirically-based**



**Spill Operations have Mechanistic
Linkage to PITPH**



**Web-accessible Open Access
Dynamic Scenario Capability (i.e. Flex)**

Increased Spill = Decreased Powerhouse Encounter Probability

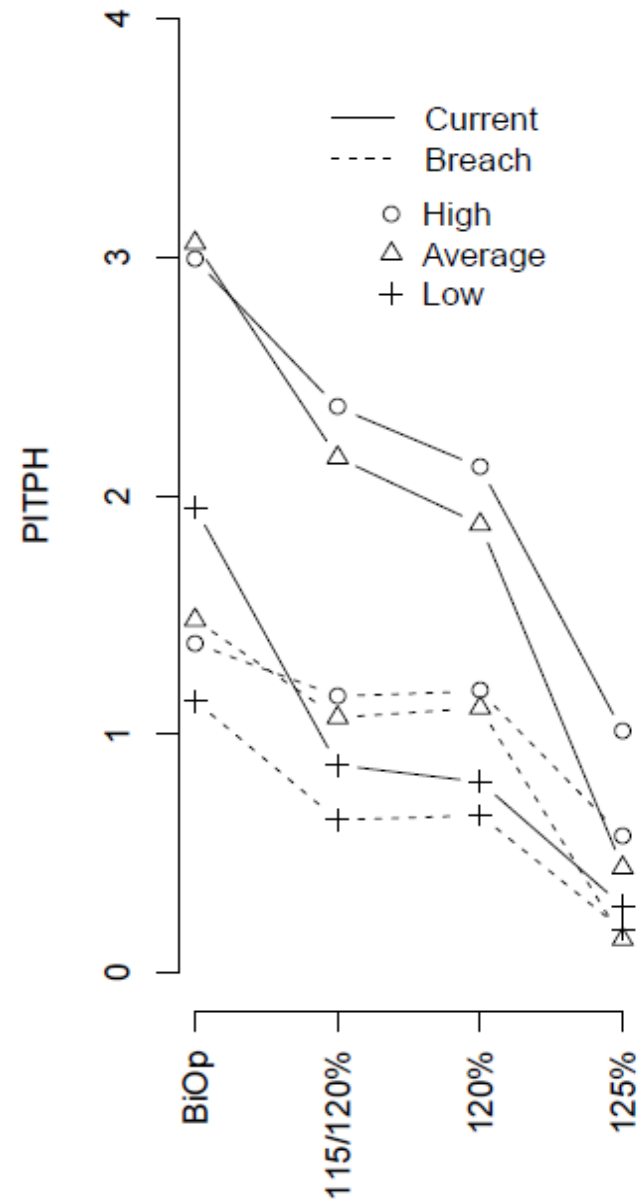
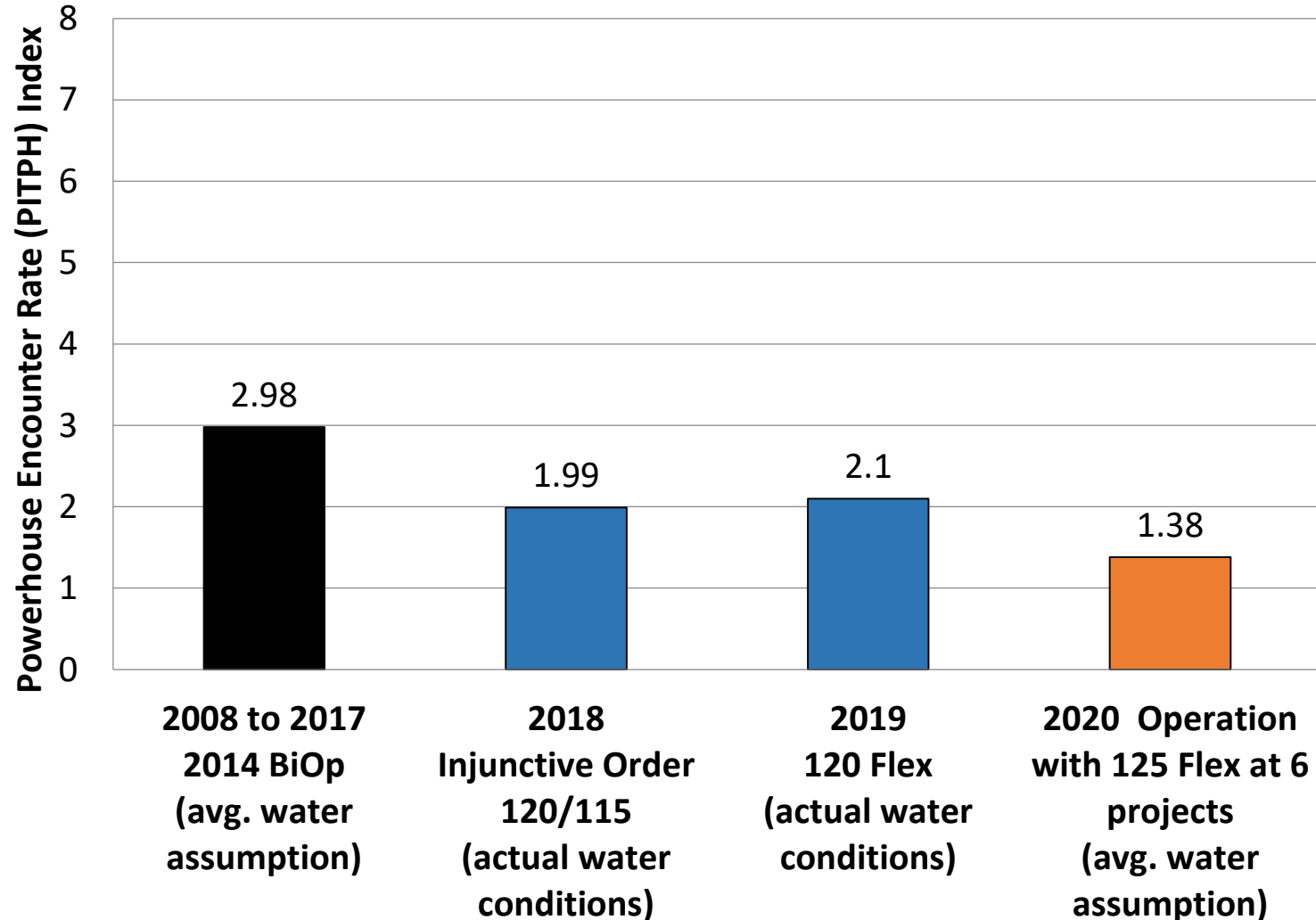


Figure 2.2: PITPH (left) and WTT (right) values for breached and non-breached scenarios.

Increased Spill = Decreased Powerhouse Encounter Probability

2019 - 2021 Spill Operations Agreement Fish Benefit - PITPH Modeling Estimates



Decreased Powerhouse Encounter Probability = Increased SAR

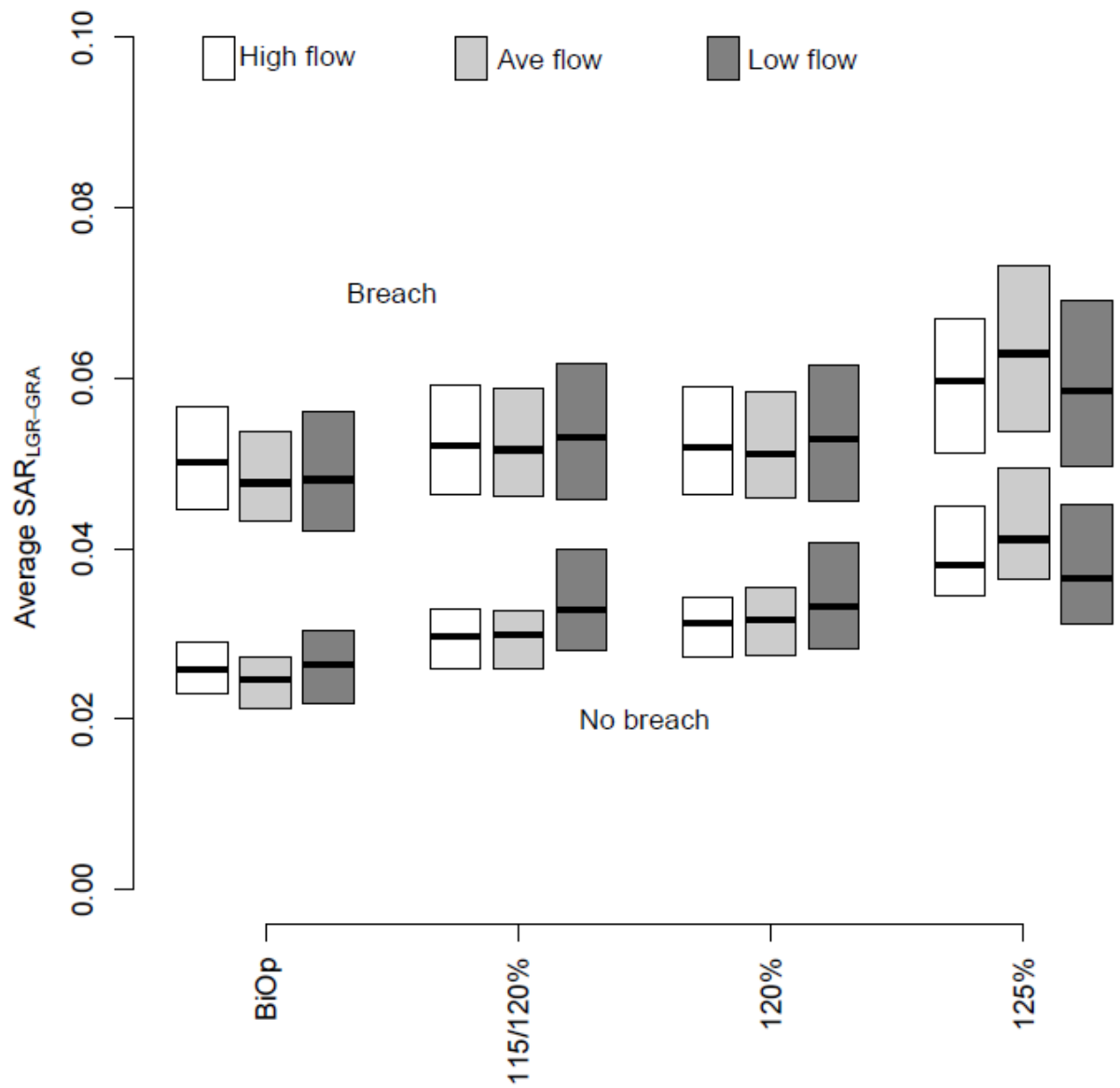
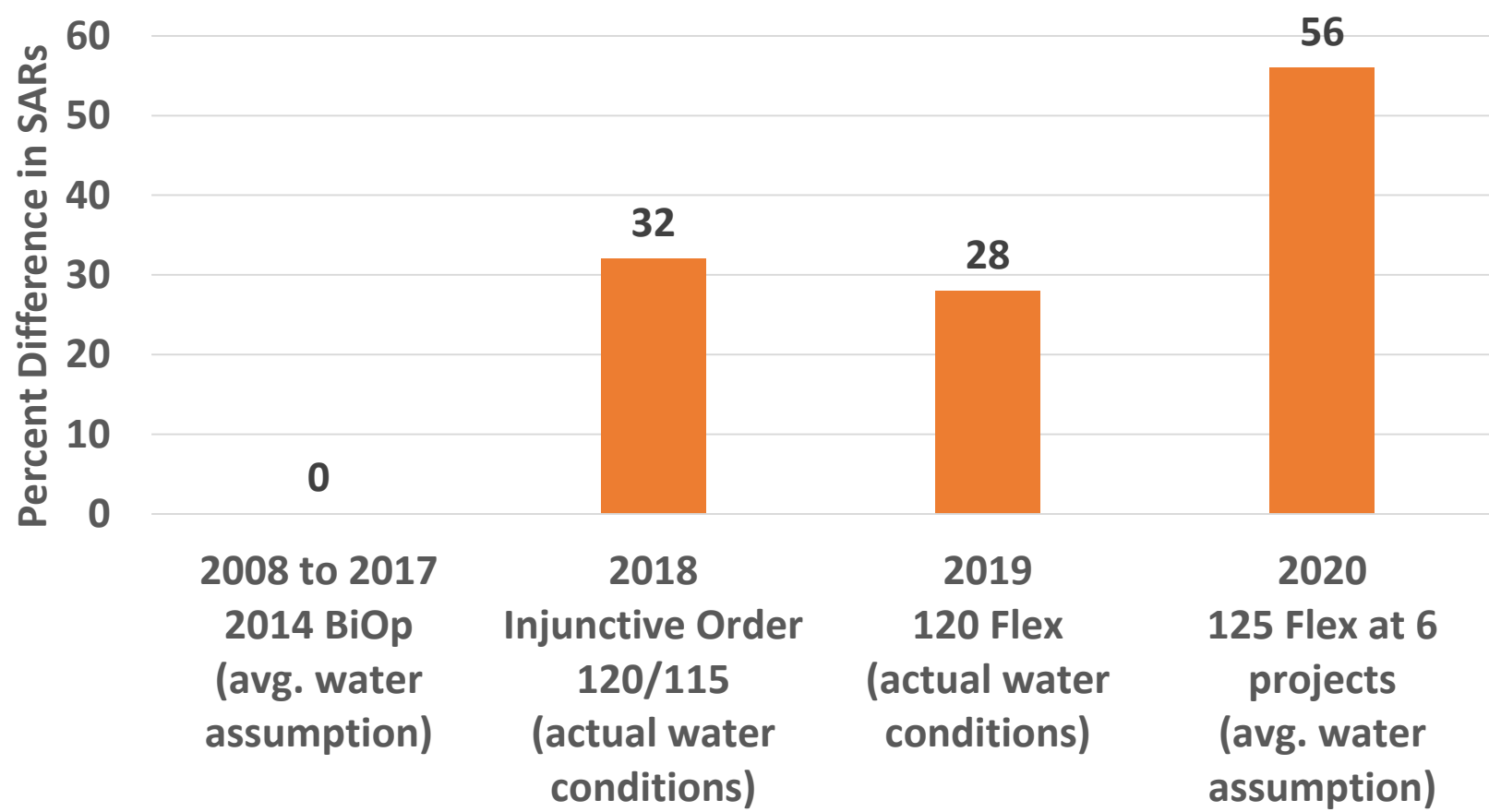


Figure 2.10: Sensitivity analysis of predicted long-term average SAR at LGR between 2036 and 2045 at all combinations of spill levels and flow levels. Each cluster of three bars represent high flow (white boxes), average flow (light grey boxes), and low flow (dark grey boxes). Boxes represent the 25%-75%

Decreased Powerhouse Encounter Probability = Increased SAR

2019 - 2021 Spill Operations Agreement
Fish Benefit (Snake River Chinook) - Modeled SAR
Percent Change Relative to the 2014 BiOp Operation



High Level Summary of Spill Operations

- ▶ 2019 as part of 2019-2021 Spill Agreement
 - ▶ Spring spill levels - 16 hours at 120% TDG spill 2014 BiOp ("Performance Standard Spill") levels for up to 8 total hours per day (two ~ 4 hour periods).
 - ▶ Summer spill levels - performance standard through Aug 30.
- ▶ 2020
 - ▶ 6 projects will spill up to 125% TDG with 8 hours of flexible spill reductions. The Dalles will be at 2017 performance standard spill and John Day will be operated to 120% flexible spill.
 - ▶ Limited Implementation changes from 2019
 - ▶ Summer spill volume will be reduced to minimum spill levels Aug 15-30.

2019 Spring Spill Operation (120 Flex)

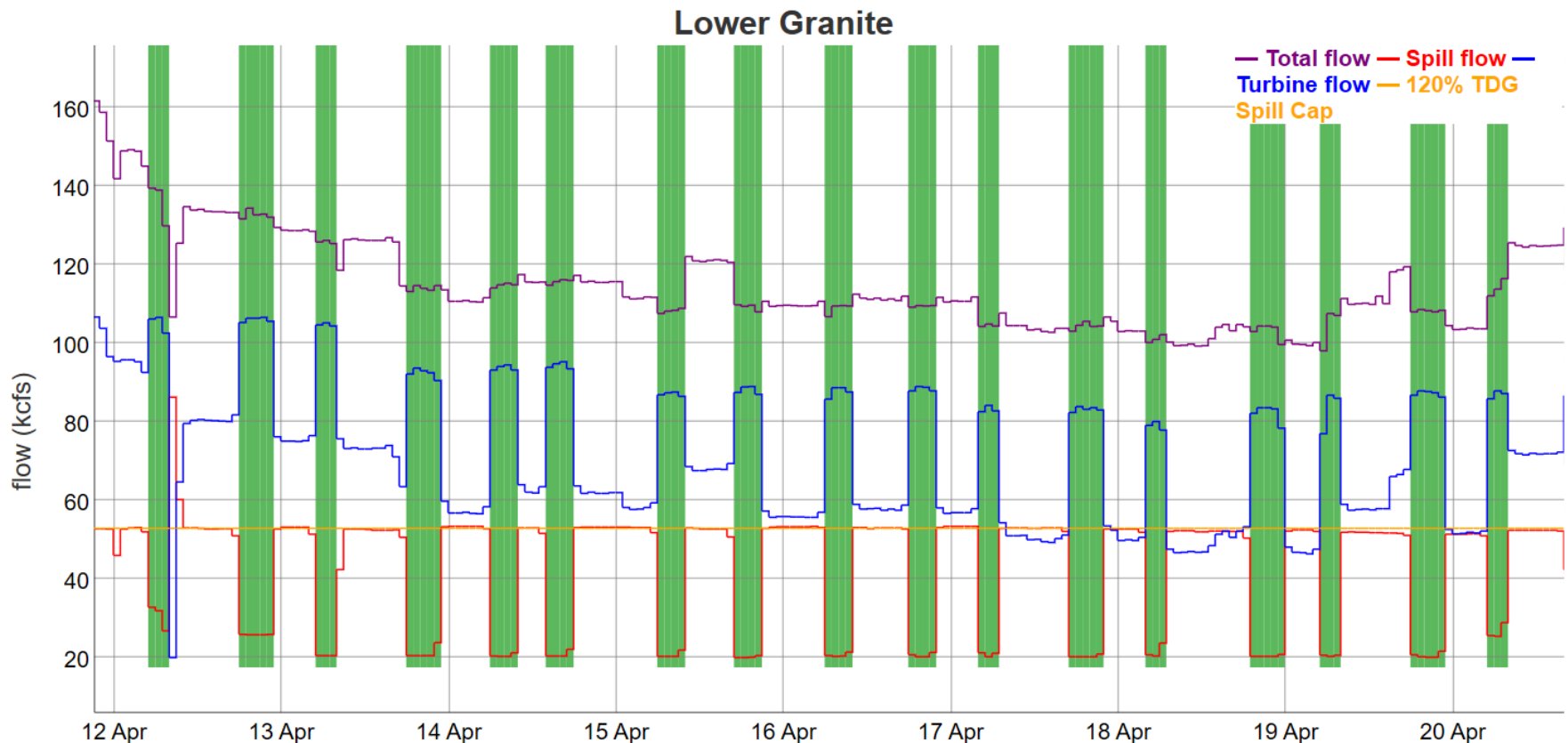
Location	Estimated Mean 120% Total Dissolved Gas Spill Cap (16 hours)	Performance Standard Spill (8 hours)
Lower Granite	45 kcfs	20 kcfs
Little Goose	52 kcfs	30%
Lower Monumental	44 kcfs	30 kcfs (Bulk Spill Pattern)
Ice Harbor	87 kcfs	30%
McNary	180 kcfs	48%
John Day	146 kcfs	32%
The Dalles	135 kcfs	40%
Bonneville	122 kcfs	100 kcfs

2020/21 Spring Spill Operation (125 Flex)

Location	Estimated mean 125% Total Dissolved Gas Spill Cap (16 hours), with alternative operation at JDD and TDA.	Performance Standard Spill (8 hours).
Lower Granite (125 flex)	72 kcfs	20 kcfs
Little Goose (125 flex)	79 kcfs	30%
Lower Monumental (125 flex)	98 kcfs	30 kcfs (bulk spill pattern)
Ice Harbor (125 flex)	119 kcfs	30%
McNary (125 flex)	265 kcfs	48%
John Day (120 flex)	146 kcfs	32%
The Dalles (Performance Standard)	40%	40%
Bonneville (125 flex)	150 kcfs	100 kcfs

2019 Implementation Lower Snake Example (Lower Granite)

Green vertical bars indicate hours with reduced spill exercised as per the 2019 flex spill agreement

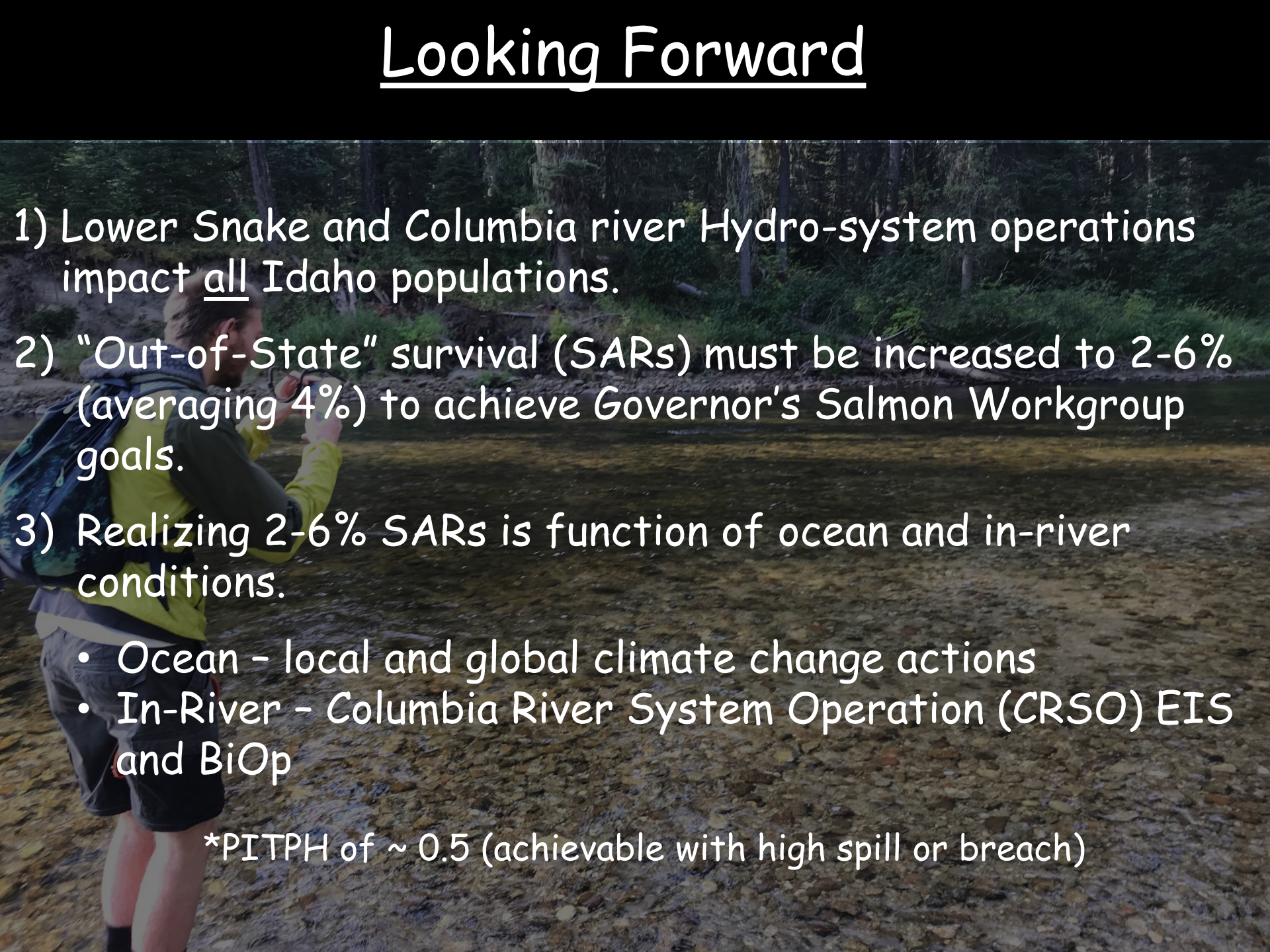


http://pweb.crohms.org/ftppub/water_quality/flexspill/flex_spill_implementation_lag.html

Operations Summary

- Fall/Winter: ~ 6 months of max power production.
- Early Spring: ~ 2-4 weeks of power priority with juvenile bypass exploratory/transition operation to address migratory timing shifts resulting from climate change.
- Spring: ~ 3 months of high spill, balanced with increased power generation on high demand hours (flex spill) during spring.
- Summer: 2 months of integrated fish and power during summer (similar operations since 2006).
- Summer: 2 weeks of power priority with some surface/spillway passage (reduced late summer spill) starting in 2020.
- Transportation: Spring and summer guided by transport:bypass (T:B) research study designs and repeatable results starting in 2020.

Looking Forward

- 
- 1) Lower Snake and Columbia river Hydro-system operations impact all Idaho populations.
 - 2) "Out-of-State" survival (SARs) must be increased to 2-6% (averaging 4%) to achieve Governor's Salmon Workgroup goals.
 - 3) Realizing 2-6% SARs is function of ocean and in-river conditions.
 - Ocean - local and global climate change actions
 - In-River - Columbia River System Operation (CRSO) EIS and BiOp
- *PITPH of ~ 0.5 (achievable with high spill or breach)