Multifaceted Criteria used in Determining Acceptance of Survival Compliance Studies at Federally Operated Dams in the Columbia/Snake River

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Objective

Describe the various criteria used to assure:

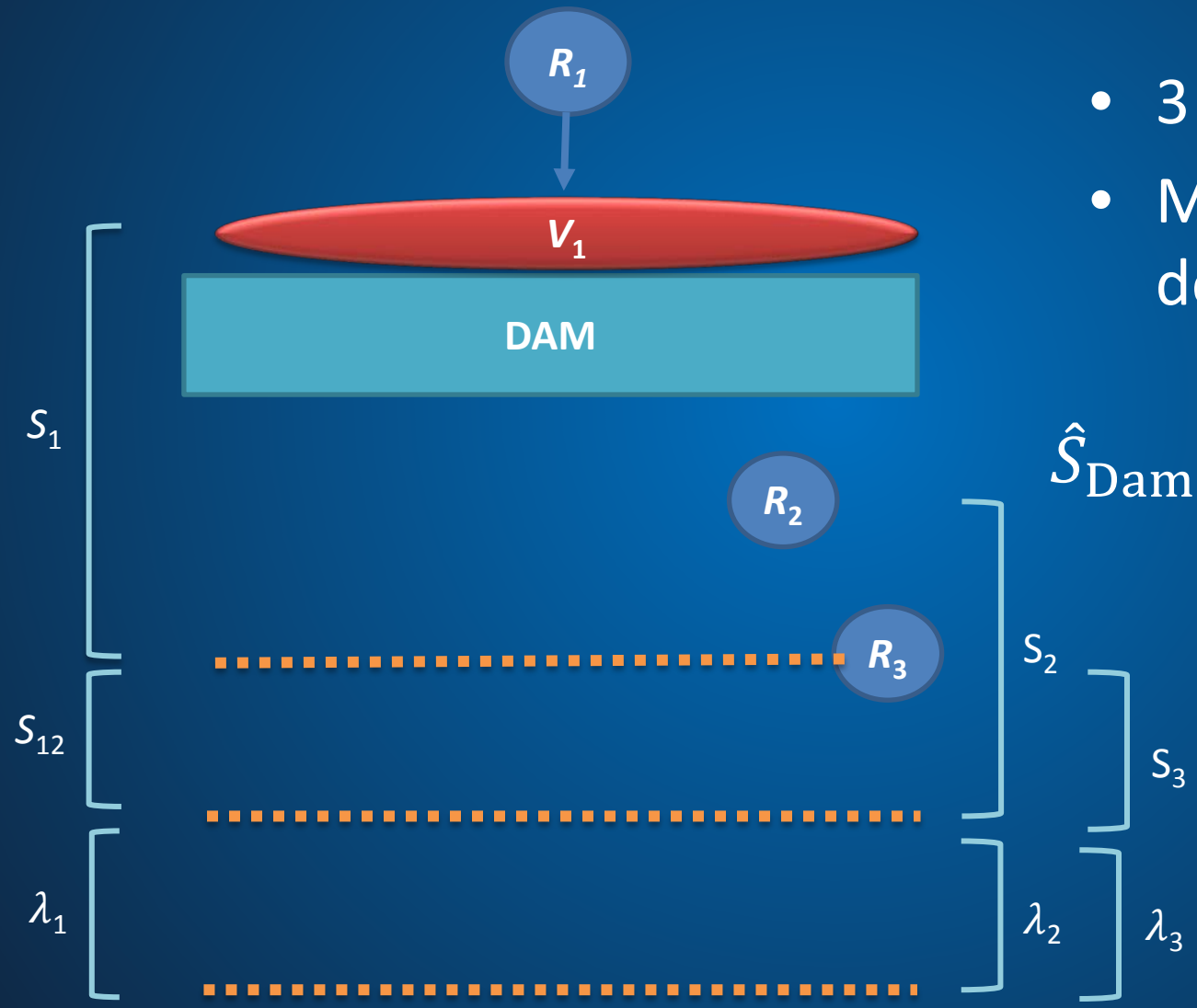
- Accuracy
- Precision
- Representativeness
- Robustness

of acoustic-tagged juvenile salmonid studies in the FCRPS.

2008 BiOp

- Stipulates survival standards for outmigrating juvenile salmonids
- Dam Passage survival = survival from dam face to tailrace mixing zone (≈1-2 km downstream)
- Triple release of acoustic-tagged smolts used to isolate survival to zone of inference

Virtual/Paired-Release Design



- 3 release groups
- Minimum of 3 detection arrays

$$\hat{S}_{\text{Dam}} = \frac{\hat{S}_1}{\left(\frac{\hat{S}_2}{\hat{S}_3}\right)} = \frac{\hat{S}_1 \hat{S}_3}{\hat{S}_2}$$

Study Requirements

1. Three fish stocks

	Survival Standard
Spring migrants: Yearling Chinook salmon	≥96%
Steelhead	≥96%
Summer migrants: Subyearling Chinook salmon	≥93%

2. Precision

Standard error ($\hat{S}_{\mathrm{Dam}}$) ≤ 1.5%

Study Requirements

3. Replication
   - 2 years per fish stock
   - Successful trials must be consecutive

   Minimum testing
   - 8 dams × 3 stocks × 2 reps = 48 trials

   To date
   - 29 trials at 6 dams
   - >109,000 acoustic-tagged fish

Study Requirements

4. Model validity
   A. Tagger effects
      - Balanced effort across releases
      - Comparison of reach survivals and cumulative survivals across taggers

   B. No delayed-handling or tag-burden effects
      - Test whether downstream survival affected by release distance upstream

   C. Random and blind assignment of fish to release groups

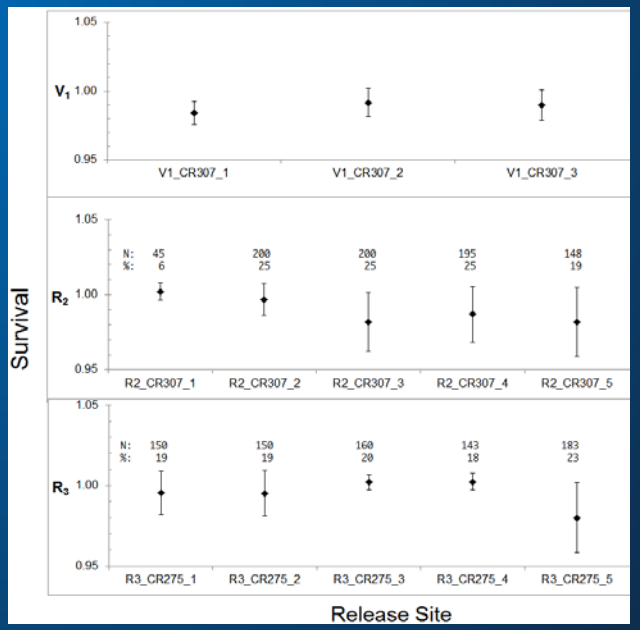
Study Requirements

4. Model Validity (continued)

D. Representative release locations and time

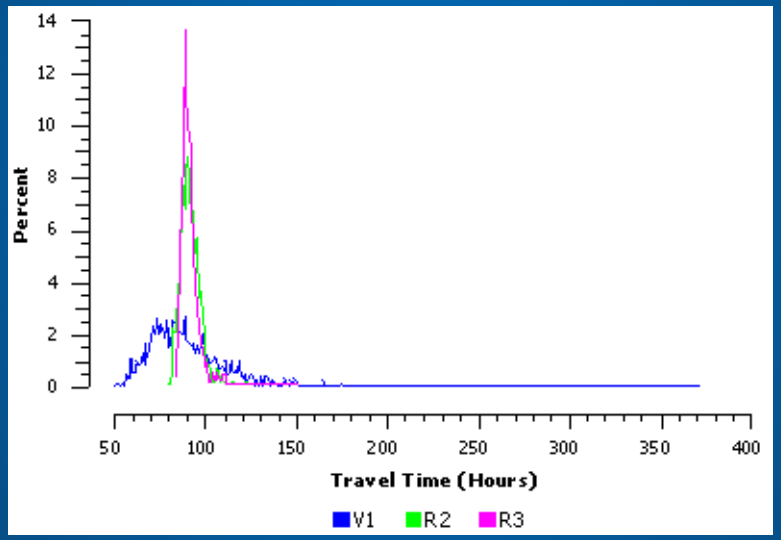
- Alternative Day/Night release times
- Multiple releases across river at each location
  - Test for mortality "hot spots"

Example: Survival by release position of subyearling Chinook salmon released for the Dalles Dam study, 2012



Study Requirements

4. Model Validity (continued)
   E. Downstream mixing of release groups

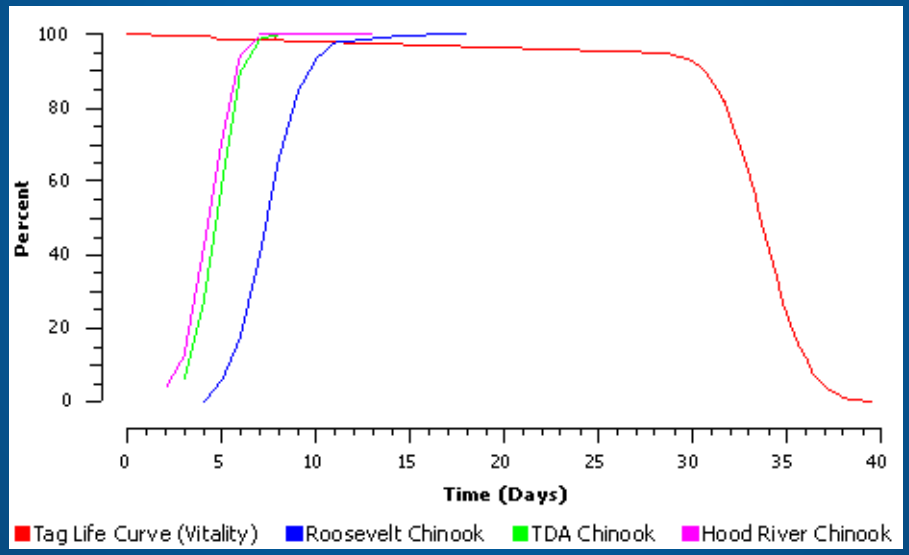


Example: Mixing plot of yearling Chinook salmon, The Dalles Dam, rkm 234, in 2010

Study Requirements

4. Model Validity (continued)

   F. Tag-life-corrected survival estimates



Example: Arrival distributions vs. tag-life curve of yearling Chinook salmon, The Dalles Dam, 2010

Study Requirements

4. Model Validity (continued)

   G. No false-positive detections of dead tagged fish
      - Dead tagged fish releases to assure tailwater array far enough downstream
      - Bias correction if problem

Study Requirements

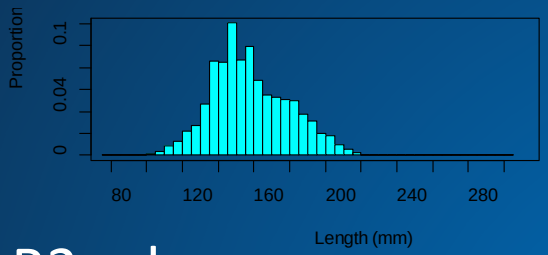
5. Representative Conditions (continued)
   A. Fish source
      - Run-of-river fish from subject dam
   B. Fish condition
      - No previously tagged fish (range 2-5%)
      - No moribund fish or fish with progressive infection, open wound to body, or skeletal deformities (range 3-15%)

Study Requirements

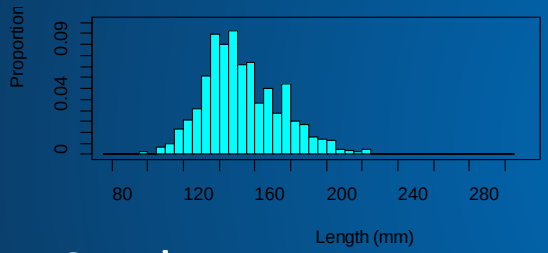
5. Representative Conditions
   C. Fish size distribution compared across release groups and to fish monitoring program (FPC)
      - *Example*: Length distributions at The Dalles Dam, 2012

Yearling Chinook Salmon

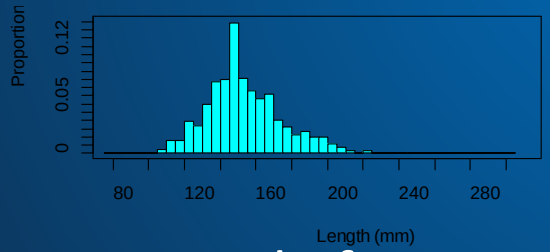
- V1 releases



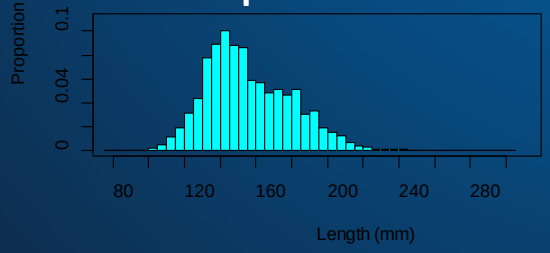
- R2 releases



- R3 releases

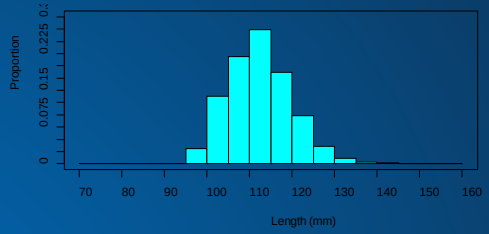


- FPC sample from JDA

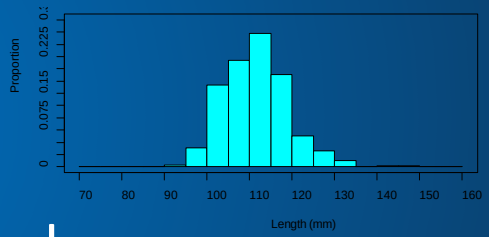


Subyearling Chinook salmon

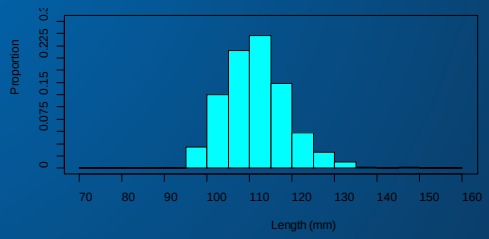
- V1 releases



- R2 releases



- R3 releases



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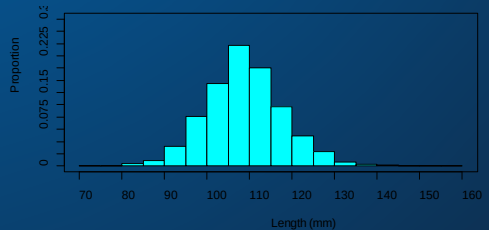


Study Requirements

5. Representative Conditions (continued)

D. Migration timing

- Trials performed during middle of outmigration
- *Example*: Percentage of outmigration covered by compliance studies at The Dalles Dam, 2010-2012

Year	Yearling Chinook salmon	Juvenile Steelhead	Subyearling Chinook salmon*
2010	81.0%	76.4%	80.5%
2011	87.0%	73.1%	N/A
2012	N/A	N/A	66.6%
Average	84.5%	74.8%	73.6%

* Restricted to temperatures <20.5°C

Study Requirements

5. Representative Conditions (continued)
   E. Fish behavior at dams
      - Trial fish within historical range:
        - Spill passage efficiencies
        - Forebay residence times

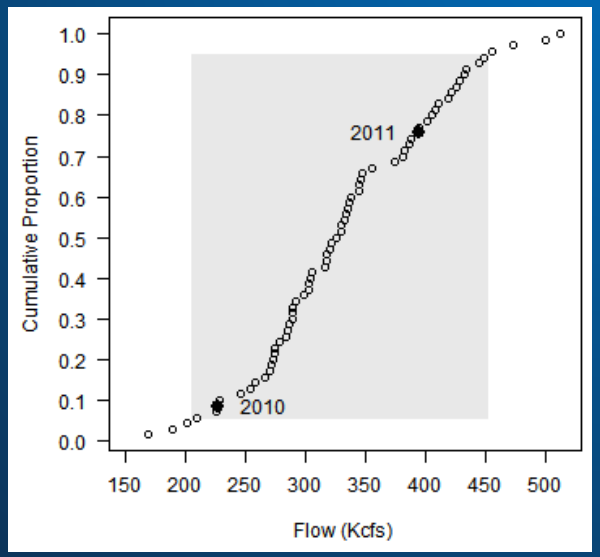
Study Requirements

5. Representative Conditions (continued)

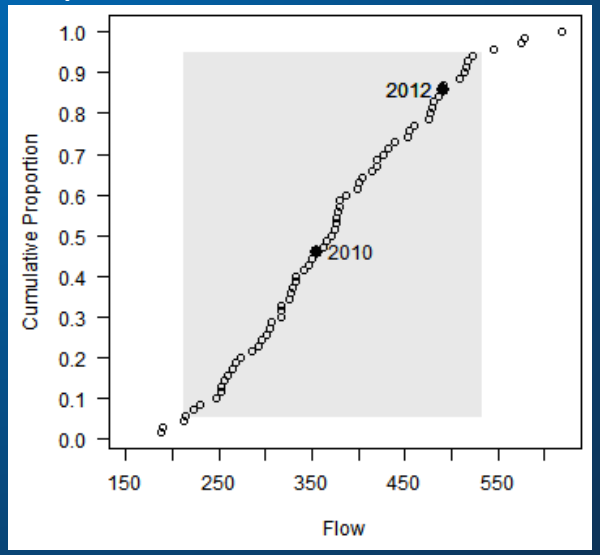
F. Water years

- Trials must be conducted when project discharges are within the middle 90% of most recent 70 years of average flows

Example: The Dalles spring trials



Example: The Dalles summer trials



Study Requirements

6. Consistency with Future Dam Operations

- Trial conditions must be within:

  ±5% of targeted spill percentile

  or

  ±5% kcfs of targeted spill volume

7. Hydraulic Diversity

- Assure trials over a variety of river conditions
  1. Average flows between trials ≥5% different
  2. Hydraulic patterns between trials ≥5% different

Summary

A cursory look at the overall results:

Stock	Survival		Target
	Mean	Range	
Yearling Chinook salmon (9)	0.9699	0.9597 – 0.9868	>0.96
Steelhead (9)	0.9795	0.9534 – 0.9952	>0.96
Subyearling Chinook salmon (11)	0.9466	0.9076 – 0.9789	>0.93
Average standard error	0.0098	0.0021 – 0.0212	<0.015

Summary

- As many as 18 criteria considered in assessing validity, robustness, and representativeness of compliance studies

- 29 trials at 6 dams conducted to date
  - 23 met survival standards
  - 26 met precision requirements
  - 2 to 4 may be voided for excess spill (McNary)

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Questions?