A Study to Determine Seasonal Effects of Transporting Fish from the Snake River to Optimize a Transportation Strategy

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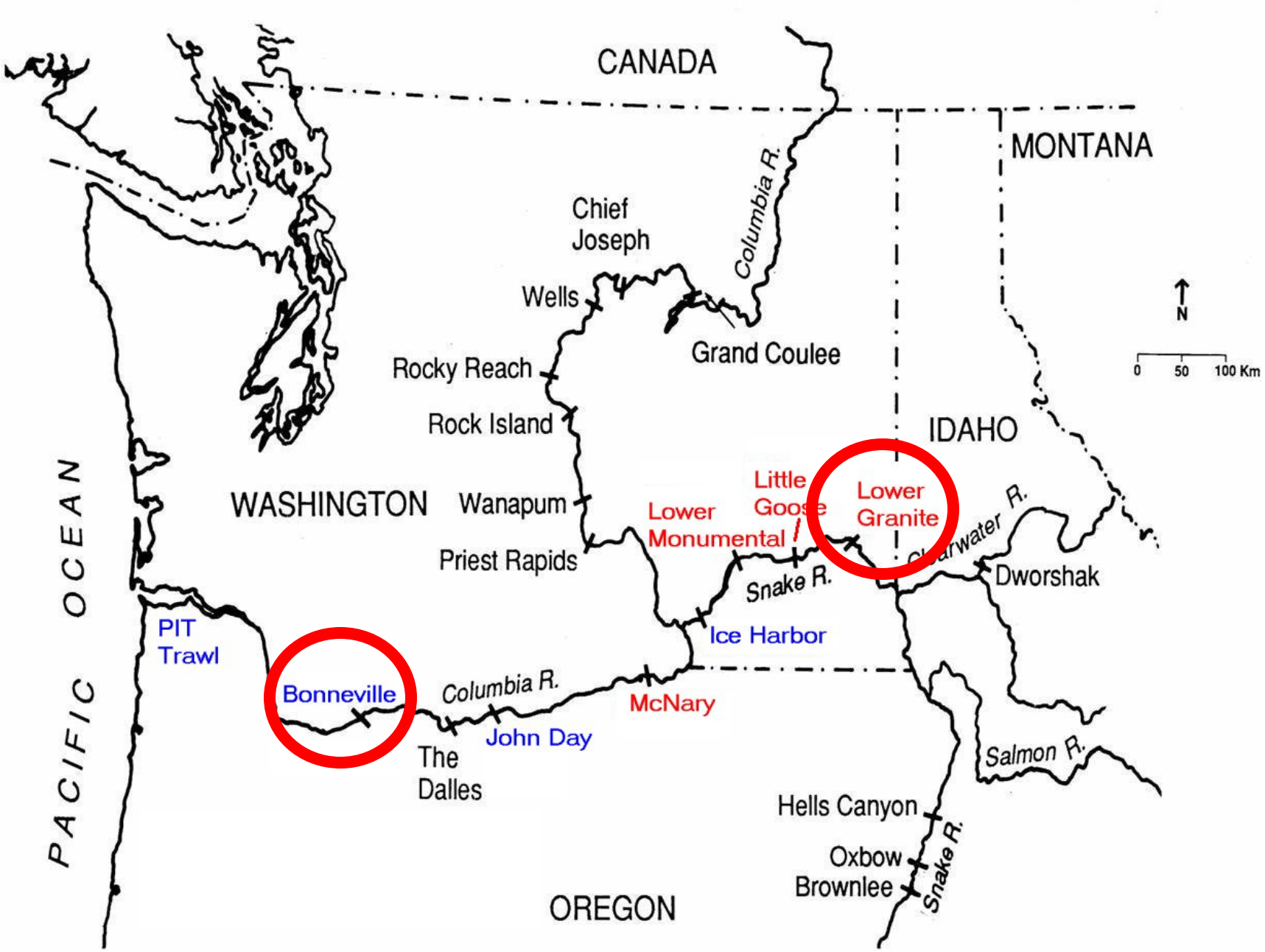
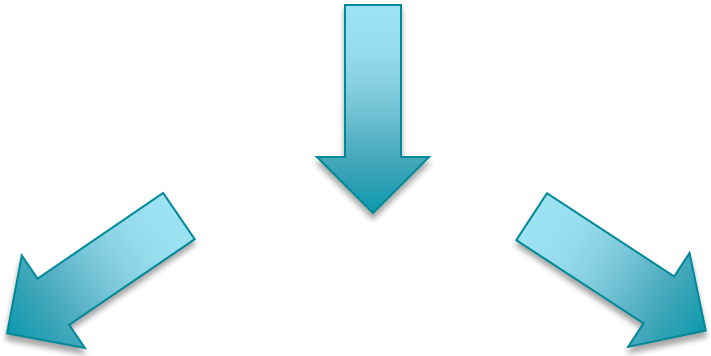

CANADA
MONTANA
IDAHO
WASHINGTON
OREGON
PACIFIC OCEAN
Columbia R.
Chief Joseph
Wells
Grand Coulee
Rocky Reach
Rock Island
Wanapum
Priest Rapids
Little Goose
Lower Granite
Lower Monumental
Snake R.
Clearwater R.
Dworshak
Ice Harbor
McNary
PIT Trawl
Bonneville
Columbia R.
John Day
The Dalles
Salmon R.
Hells Canyon
Oxbow
Brownlee
Snake R.
N
0 50 100 Km

Dam Route Concept



Spillway/Not Detected

Bypass/Detected –
Transport (T) or Bypass (B)

Turbine/Not Detected

What is SAR?

Smolt-to-Adult Return %

A major component of the salmonid life-cycle.

SAR Ratio

- Consider transported, bypassed migrant, and never-bypassed migrant groups
  - Question: Once fish are in the bypass system on a particular day, is it better to transport them or return them to the river?
  - T (SAR):B (SAR) > 1.0 indicates that among LGR-detected fish, those transported returned at a higher rate than those bypassed
  - Alternative standards for other questions consider never-detected group as well – not discussed here

How and Why Do SARs and SAR Ratios Vary Within Migration Seasons?

- Data – Caveats
- "Descriptive" Models – Estimated smooth curves describing SARs for transported (T) and bypassed (B) fish through time
  - Derived curves for T:B ratios
- Results – A Few Detailed, Mostly Summary

Caveats

- Analyses are:
  - Mostly based on available (adventitious) data
  - Restricted by dates of adventitious data
  - Descriptive of patterns in SARs through time within seasons
  - Based on in-river migrants that were bypassed
  - Subject to confounding of mortality and straying
  - Limited by small numbers of adult returns for some years

- Analyses are not:
  - Based on planned, designed experiments
  - Able to shed much light on transport early in the season, 2006-2012
  - Prescriptive for transport on particular dates or under particular conditions
  - Based on non-bypassed in-river migrants fish (C0), because date of passage must be known
  - Able to determine effects of transport on straying

Data

- Daily estimates of smolt-to-adult return rates (SARs)
  - Four groups of smolts for each species/rear-type/MY:
    - Smolts collected and transported from LGR and smolts bypassed there and returned to the tailrace
    - Smolts tagged upstream from LGR or at LGR
  - Count numbers of PIT-tagged smolts at LGR in each group each day (J_i)
  - Count numbers of adults that return to LGR from each daily smolt group (A_i)
  - Estimated SAR for day *i*: $\hat{SAR}_i = A_i / J_i$

Descriptive Analysis

- Models describe patterns through time:
  - Fit a suite of Poisson log-linear regression models

    SAR is (potentially) a function of
    - Migration group (transported or bypassed at LGR)
    - Tagging location (upstream of LGR or at LGR)
    - Date of LGR passage (day of year)
    - Two-way and three-way interactions of above

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  - Model-average (qAICc) estimated SARs
    - Derive T:B ratio curves and 95% confidence envelopes

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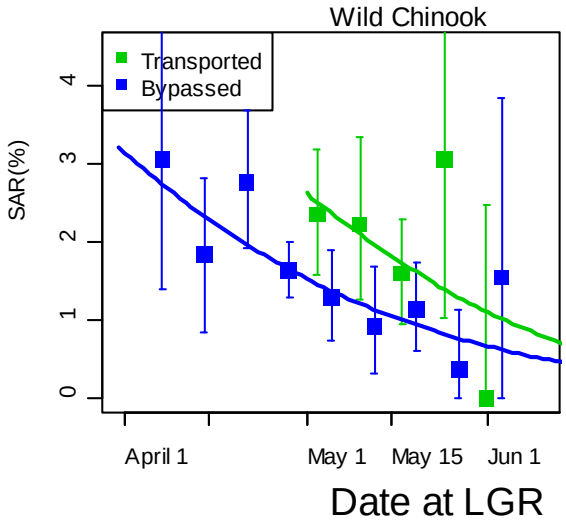
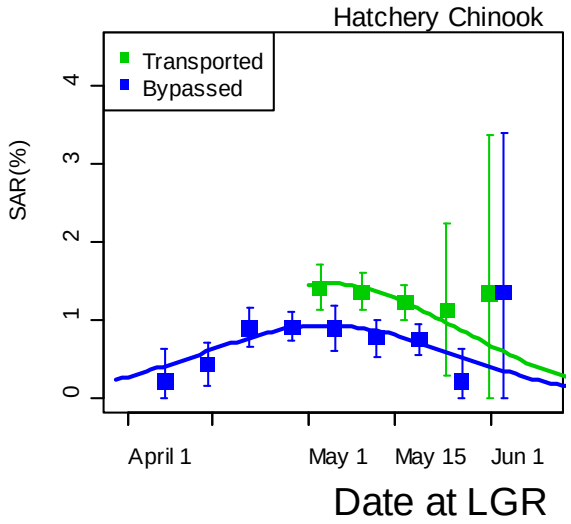
  - Assess model-averaged T:B

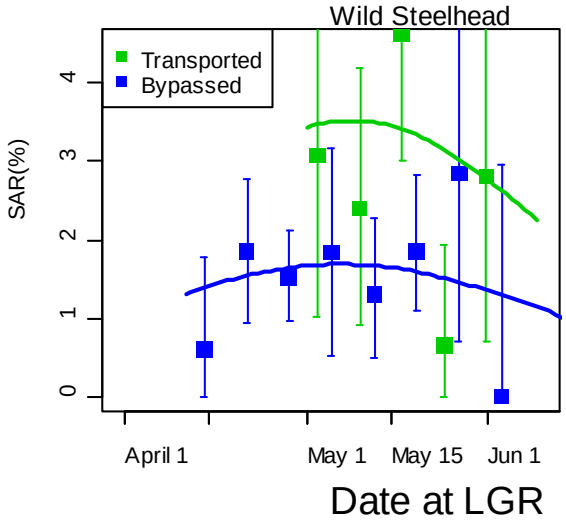
Results

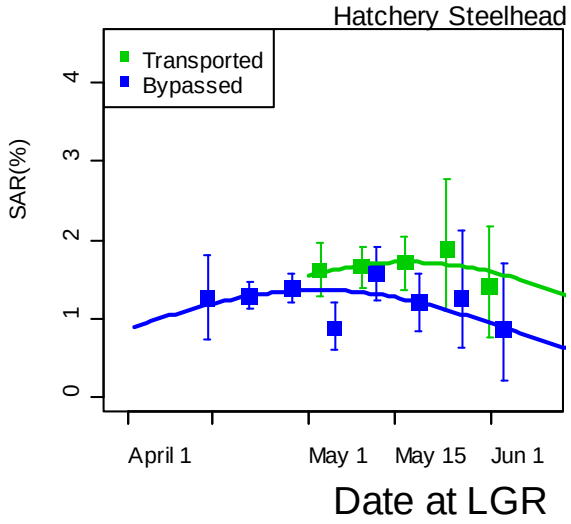
MY 2009 - Tagged Upstream of Lower

Transported or Bypassed at Lower Granite Dam









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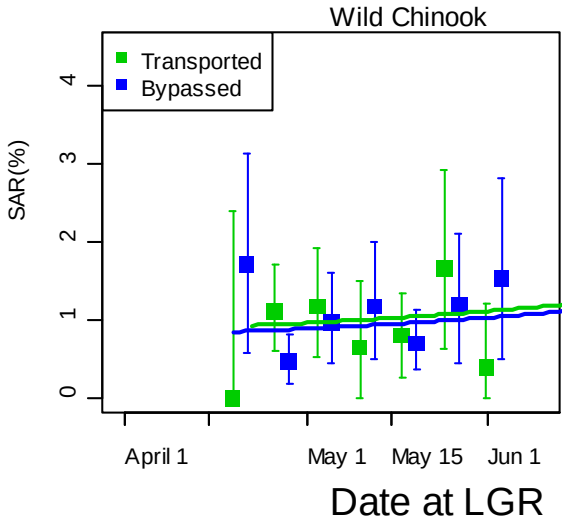
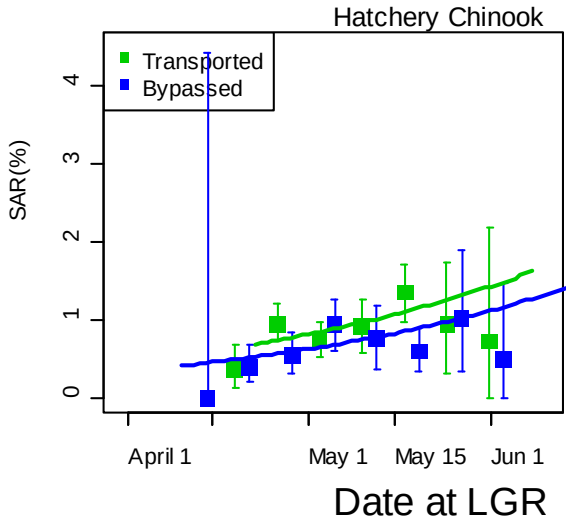
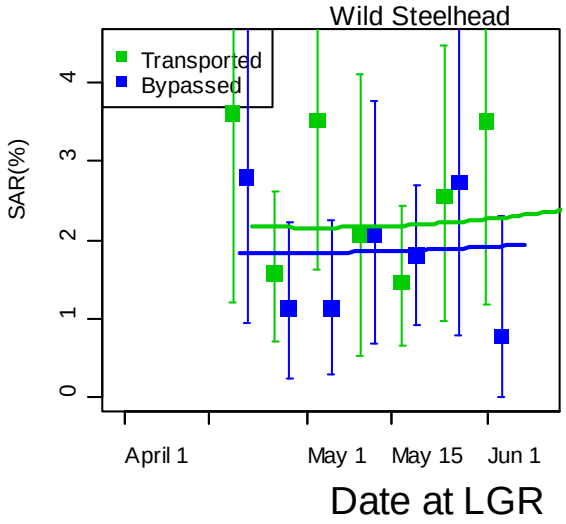
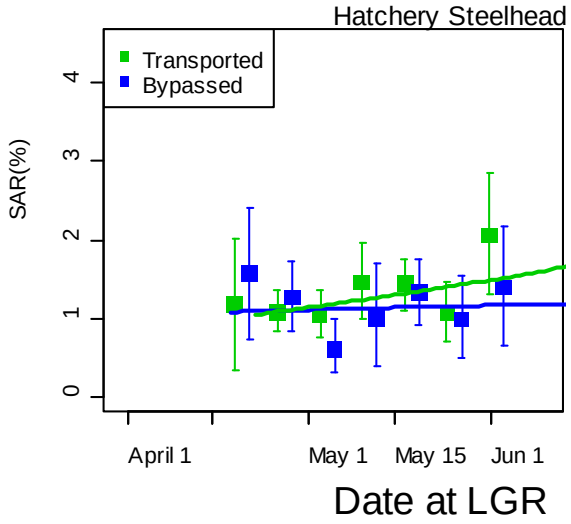


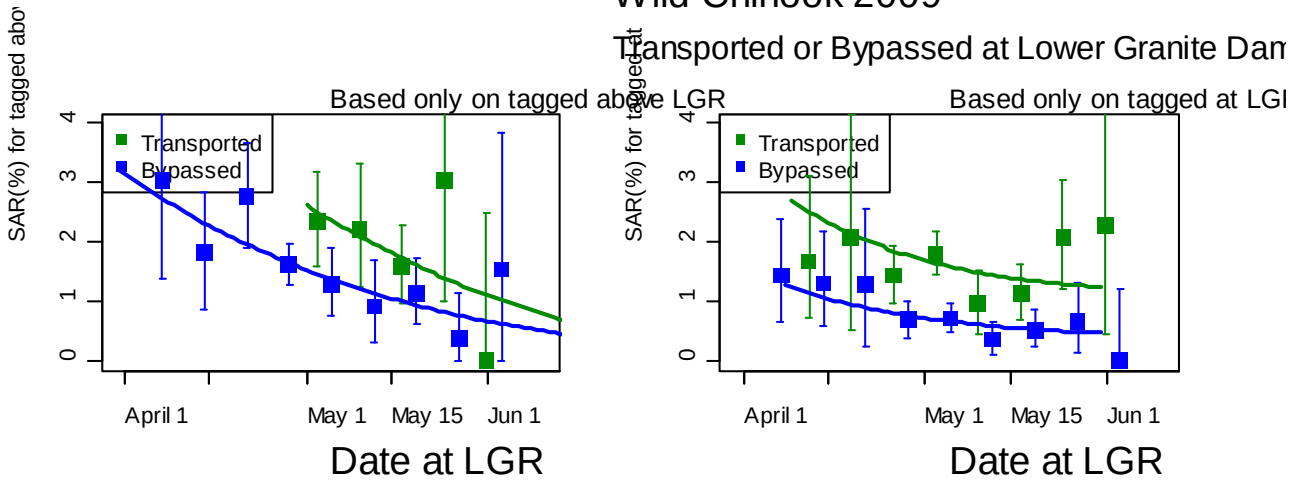


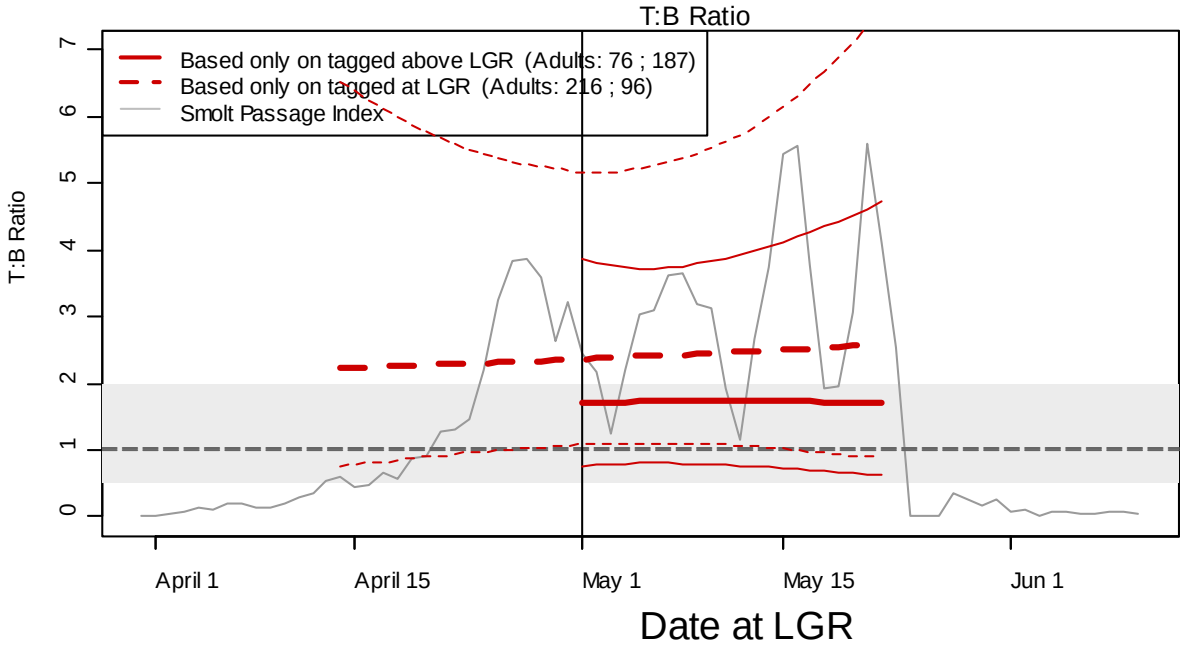




Wild Chinook 2009

Transported or Bypassed at Lower Granite Dam





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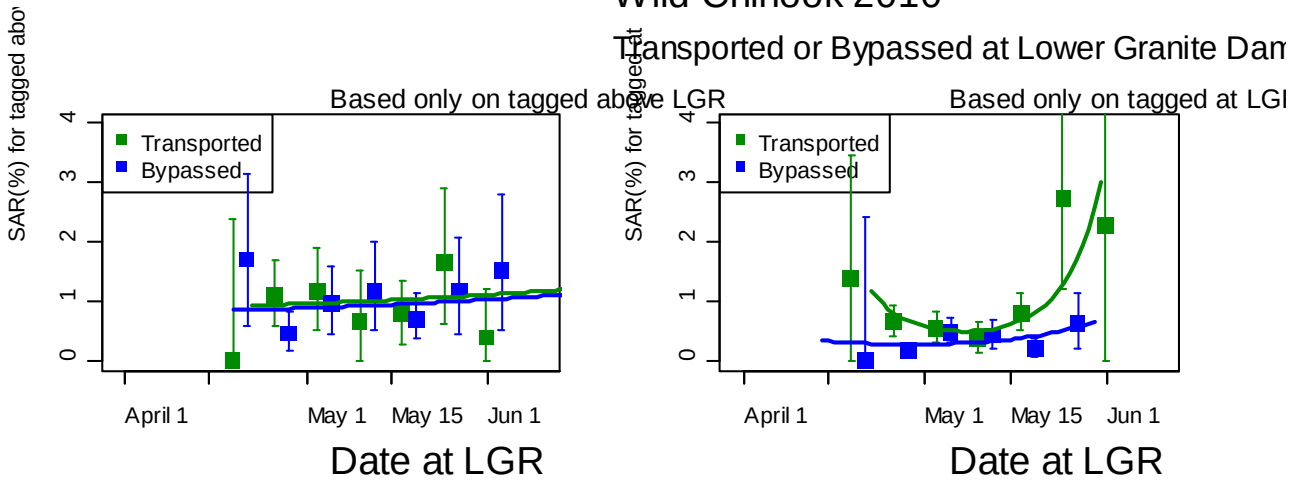
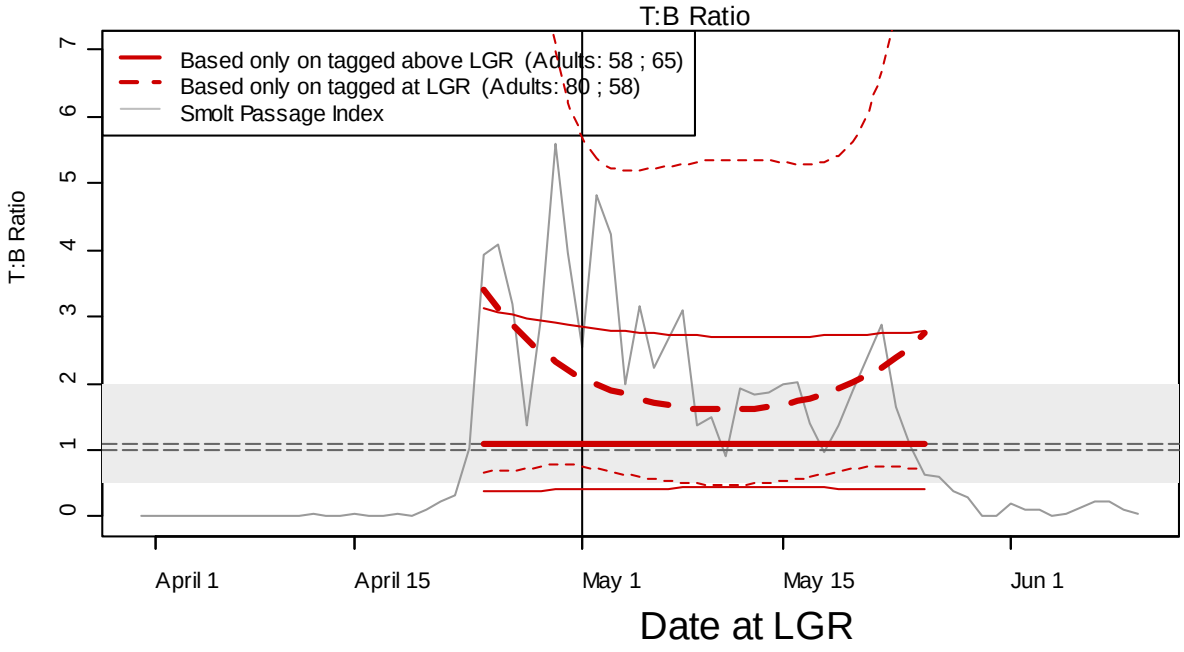
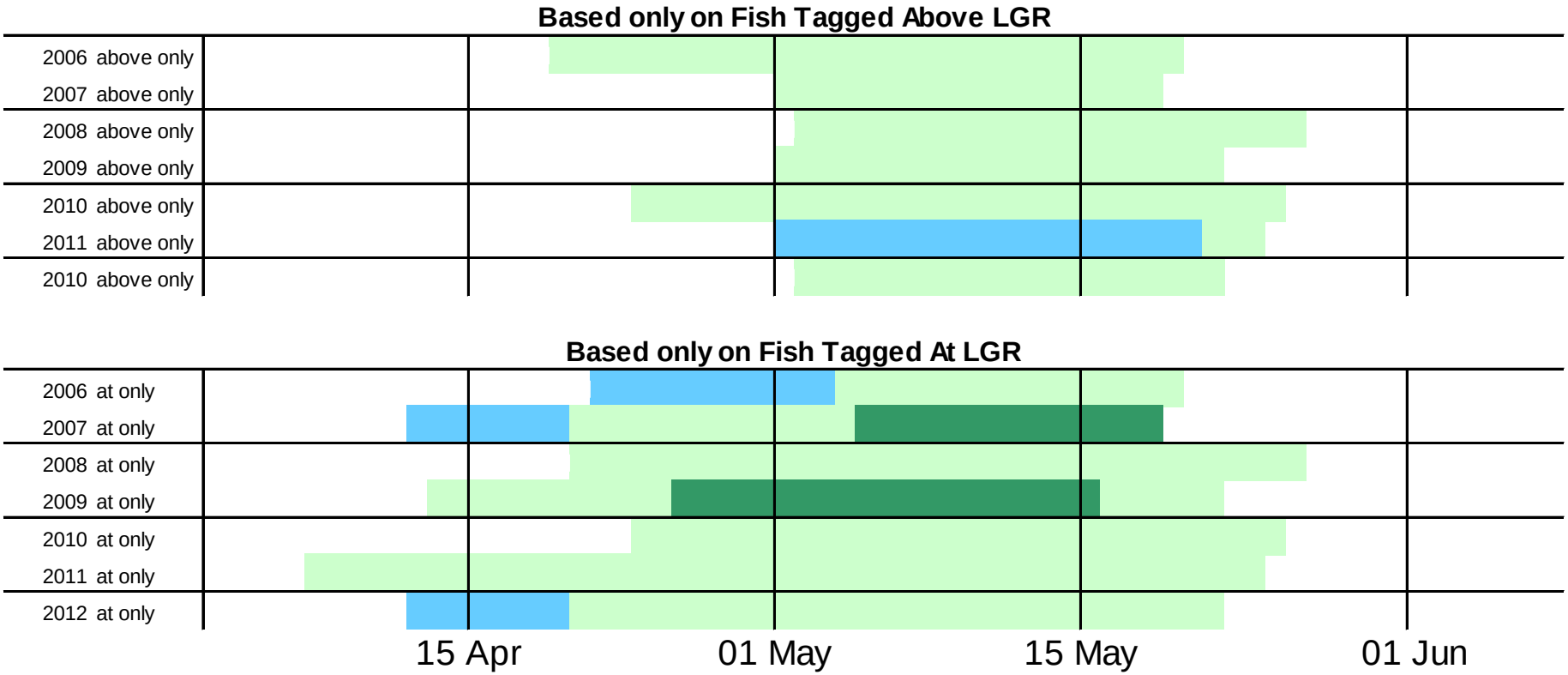




Wild Chinook Salmon - Lower Granite Dam

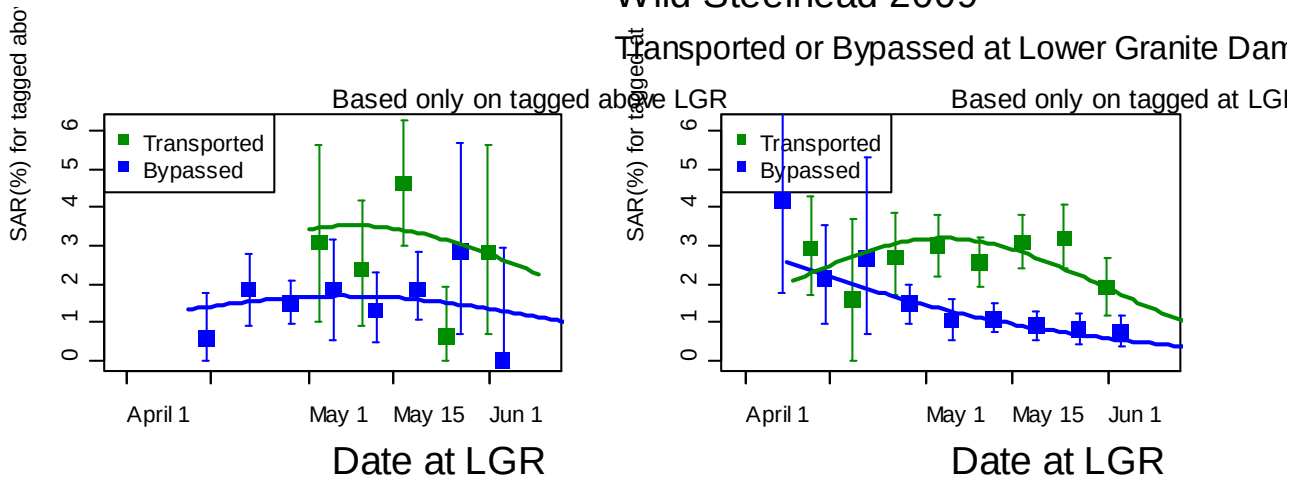
Summary of Model-Averaged T:B Values (Descriptive)

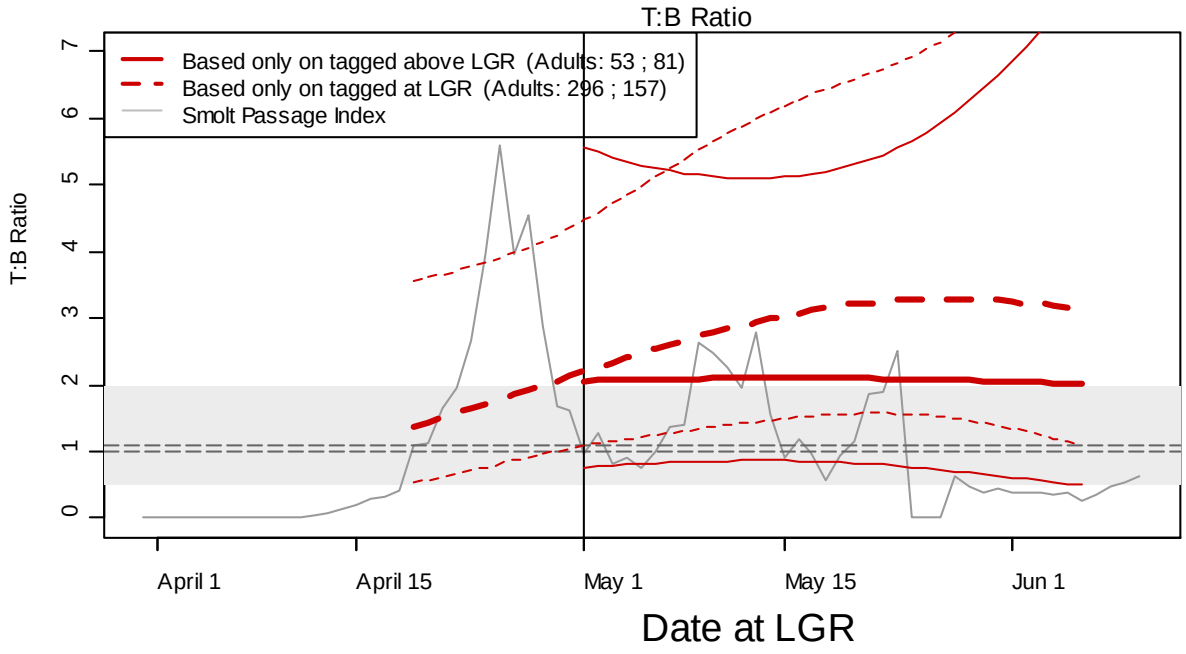
Standard = 1.0 (C1; Bypassed)



Wild Steelhead 2009

Transported or Bypassed at Lower Granite Dam





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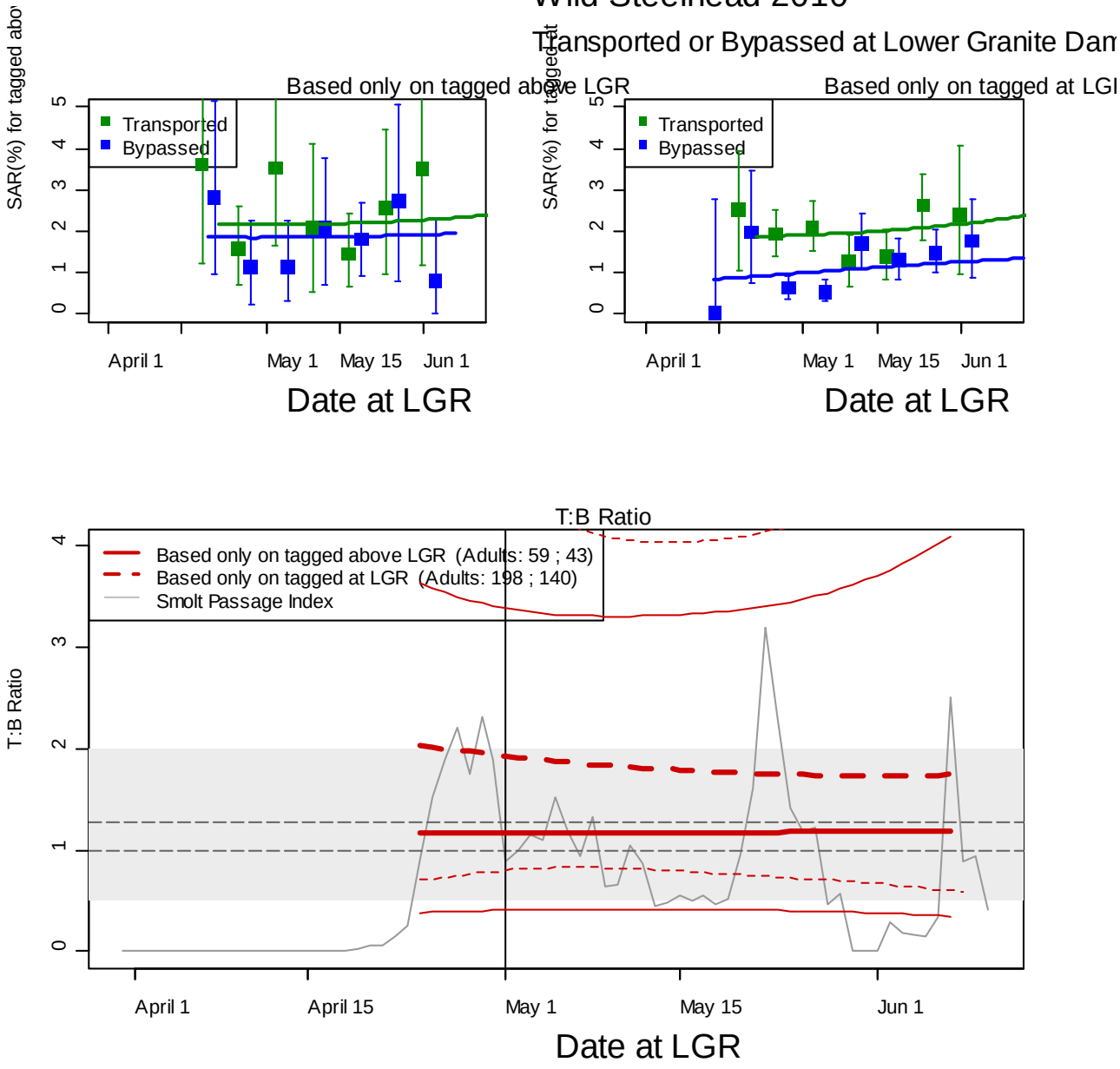

Wild Steelhead - Lower Granite Dam

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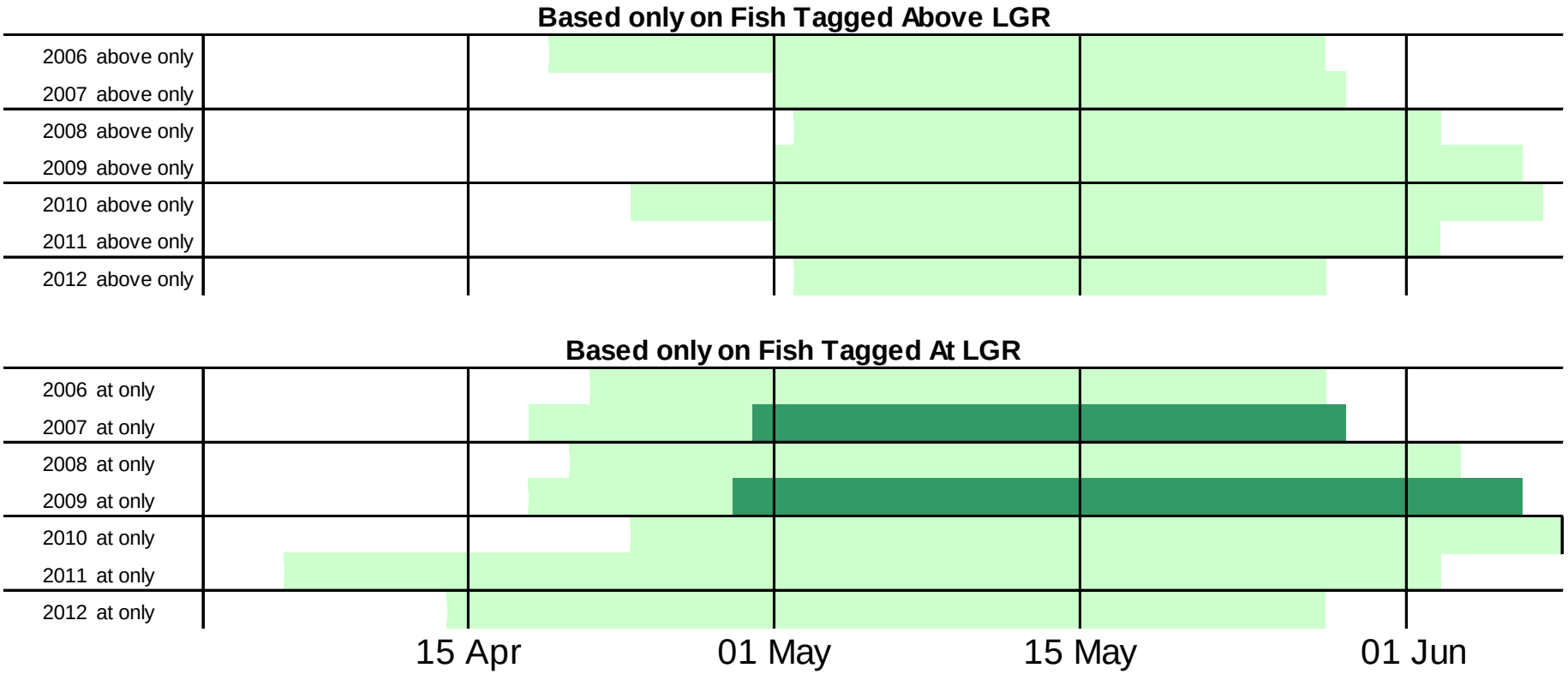

Next Steps

- Do All Analyses for Little Goose Dam and for Lower Monumental Dam, if sufficient data
  - Further evaluate different standards for non-transport comparison (done but not presented here)
- Ultimate goal: Identify factors that can be used to make transport/in-river strategy in real time
  - Collect data on environmental covariates (freshwater, estuary, saltwater) that might affect T:B
  - Statistically evaluate models that *explain* patterns in SAR, not just describe
  - Develop decision criteria

Acknowledgements

- Co-authors, Rich Zabel
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- Agencies and Staff who PIT-tagged these fish
- PTAGIS Database


Questions?