Smolt Survival and Travel Time & Transportation Analyses

Update with 2019 Data

NOAA FISHERIES

Northwest Fisheries Science Center

Technical Management Team

2019 Year-End Review

December 11, 2019

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Outline

- Migration conditions, travel time and survival of PIT-tagged smolts through the hydropower system in 2019
  - September 19 Memo; Draft report to BPA in prep
    - Only those fish left to migrate in-river
    - Only juvenile data, not survival to adult

2019 Spring Conditions

- Flow > average throughout season
  - Spikes in April
- High spill percentage; above average 2006-18
- Water temperature fluctuated; near average overall
- Travel times longer than in other recent high-flow years, especially for Chinook
- Early migration -- 37% transported

2019 Spring Survival Estimates

- Chinook: below average in Snake R,
  above average in lower Columbia R
  (41% Snake trap to Bonneville)

- Steelhead: ~average in Snake R, below average in lower Columbia R (not precise)
  (41% Snake trap to Bonneville)

- Sockeye: 43% Lower Granite to Bonneville; near average

PIT-tag Data Sources

Hatchery Releases

Chief Joseph

Wells

Grand Coulee

Rocky Reach

Rock Island

Wanapum

Priest Rapids

Ice Harbor

Lower Monumental

Little Goose

Lower Granite

Snake R. trap

Juvenile detectors

PIT tag trawl

Bonneville

The Dalles

John Day

McNary

Hatchery & Trap Releases

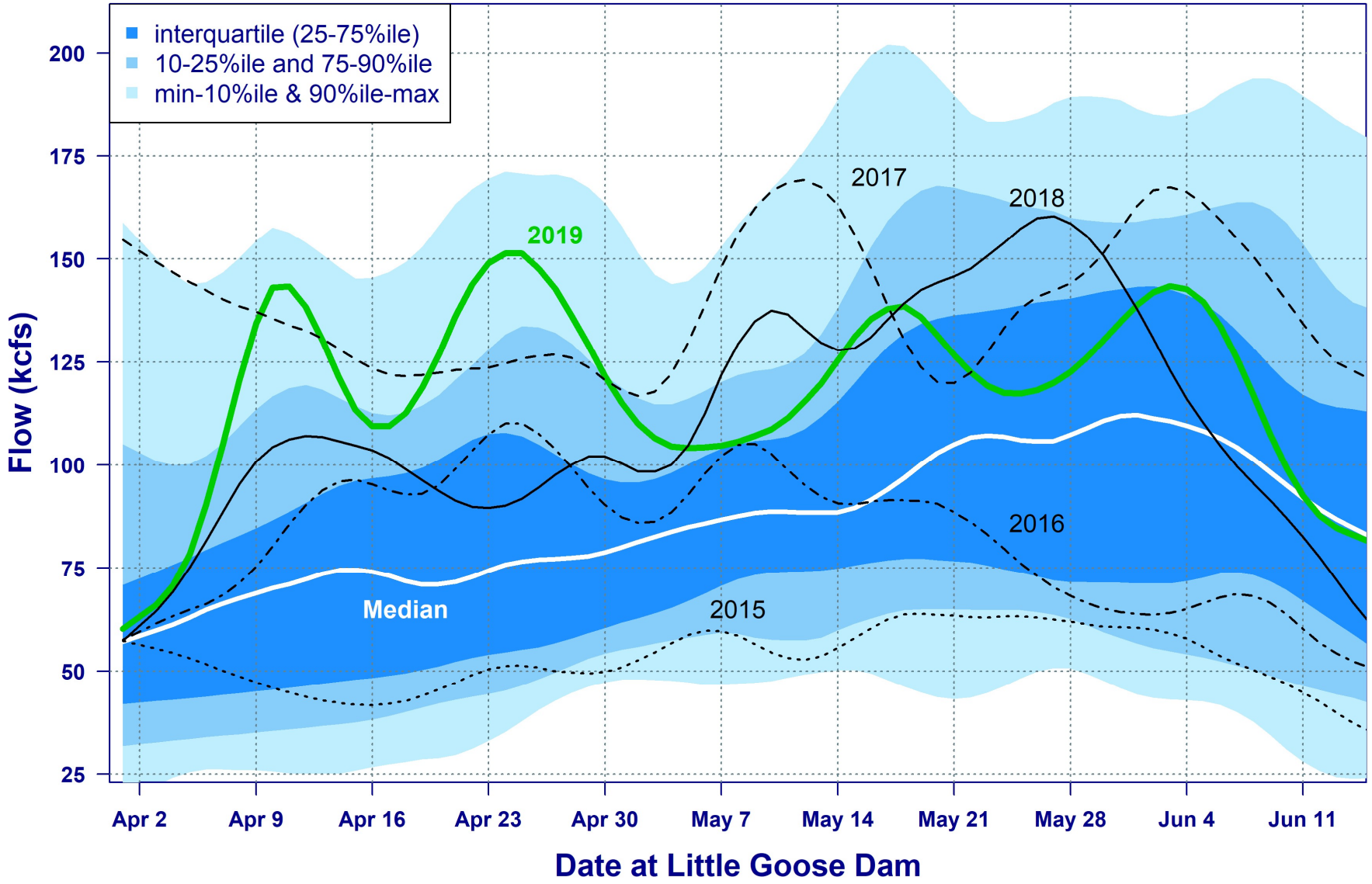
Hells Canyon

Oxbow

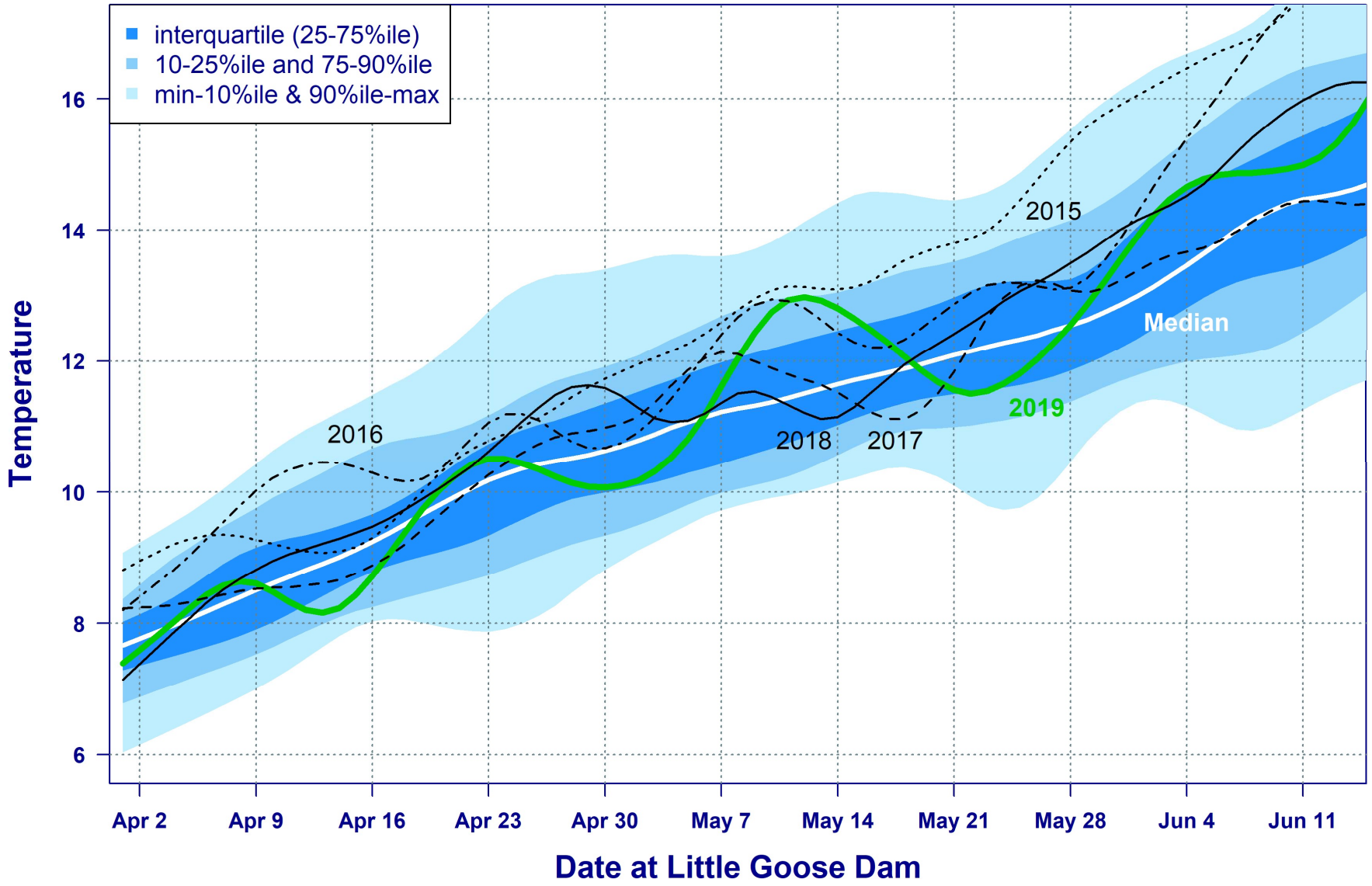
Brownlee

N

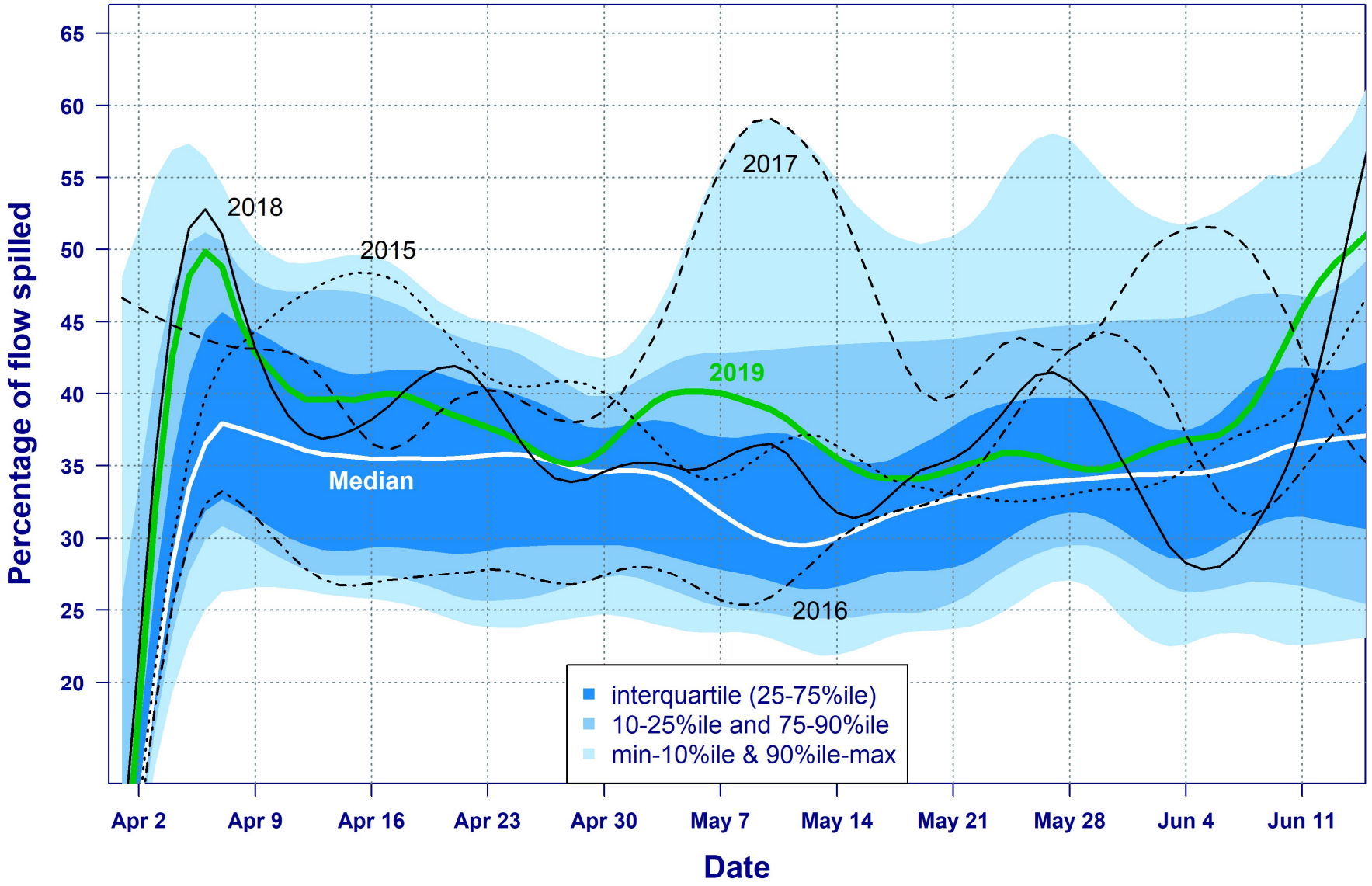
Daily Flow (kcfs) 1989-2019
Little Goose Dam



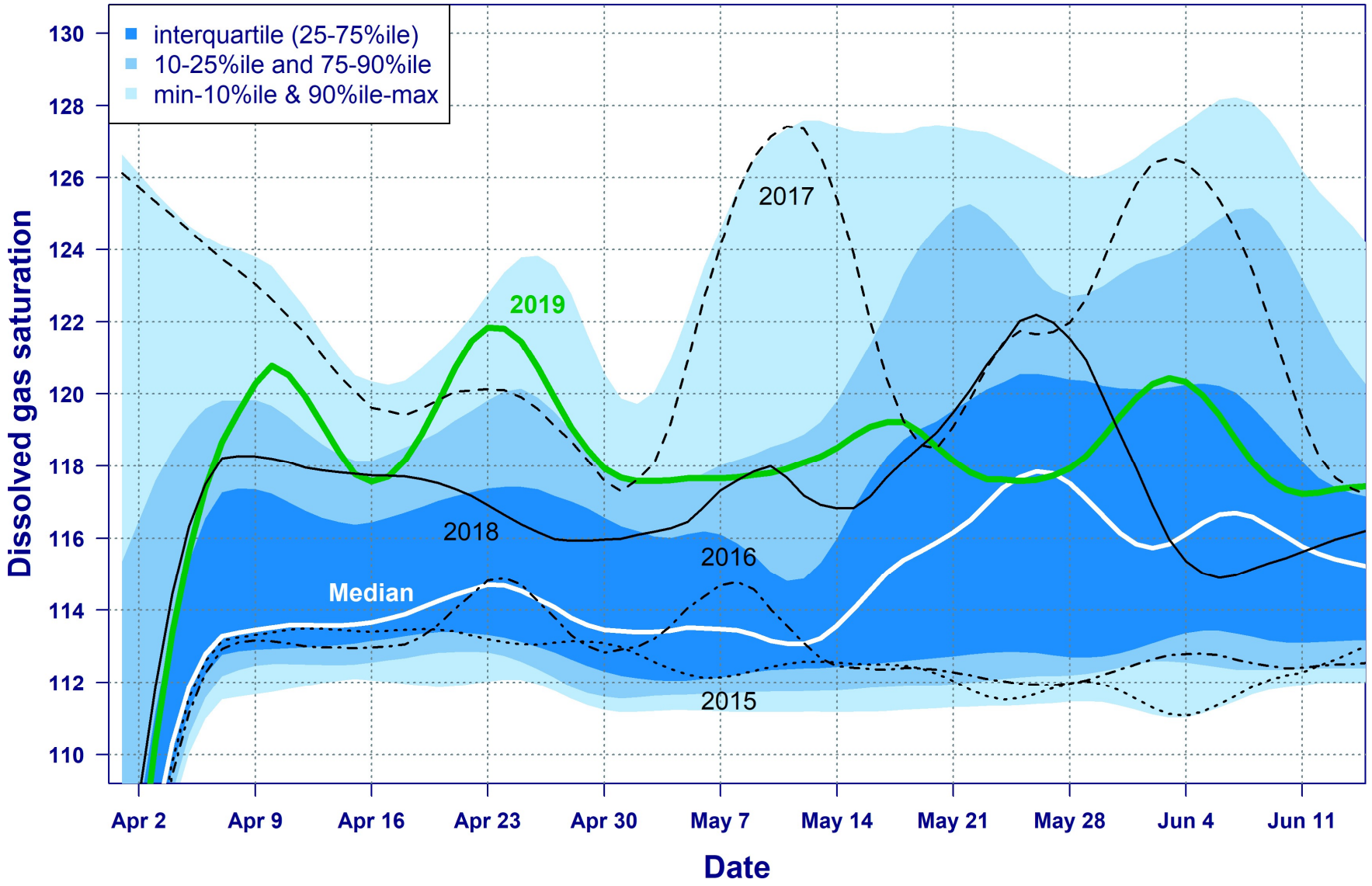
Daily Temperature 1990-2019
Little Goose Dam



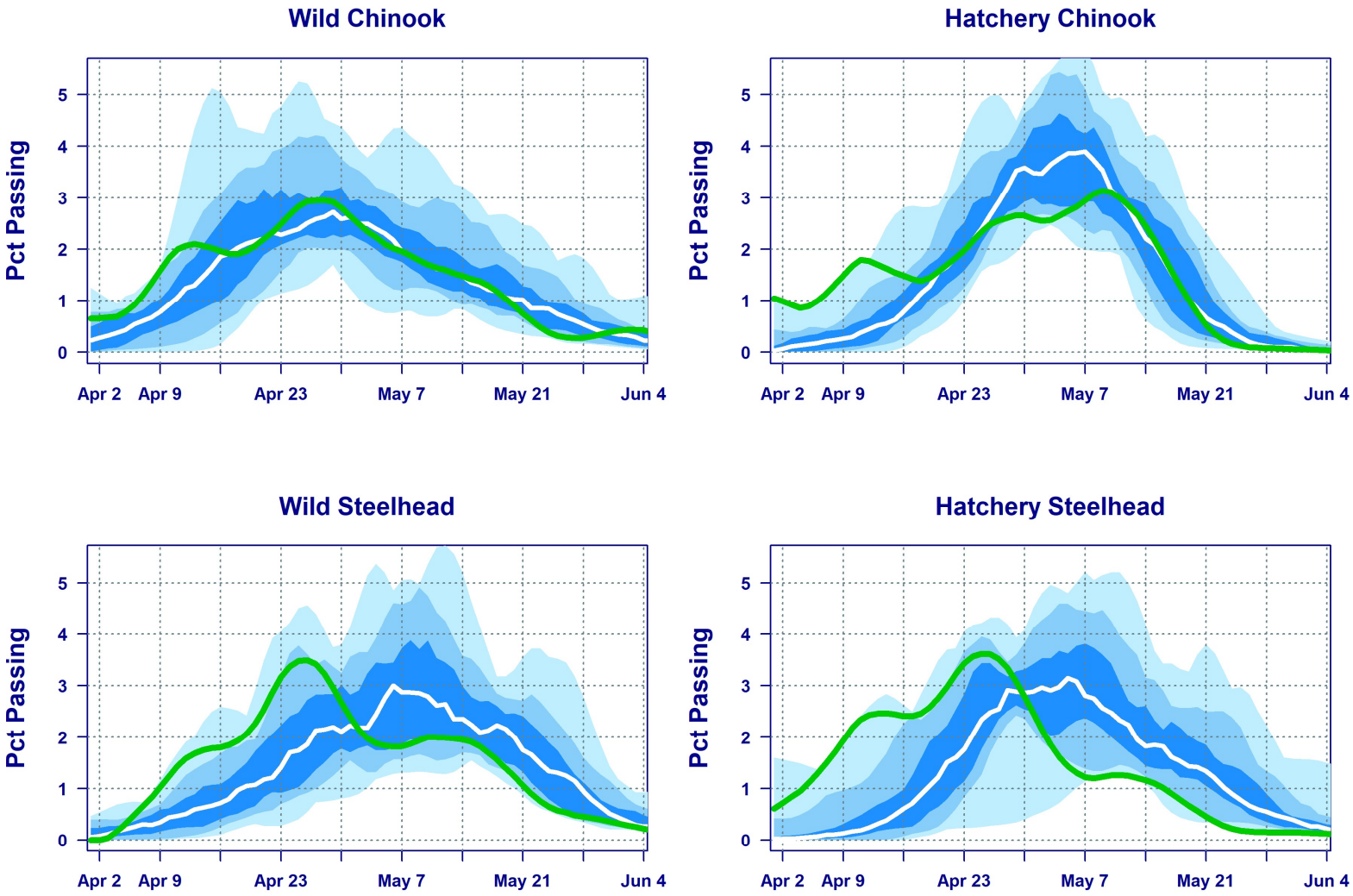
Daily %Spill 2006-2019
Mean LGR, LGS, LMN



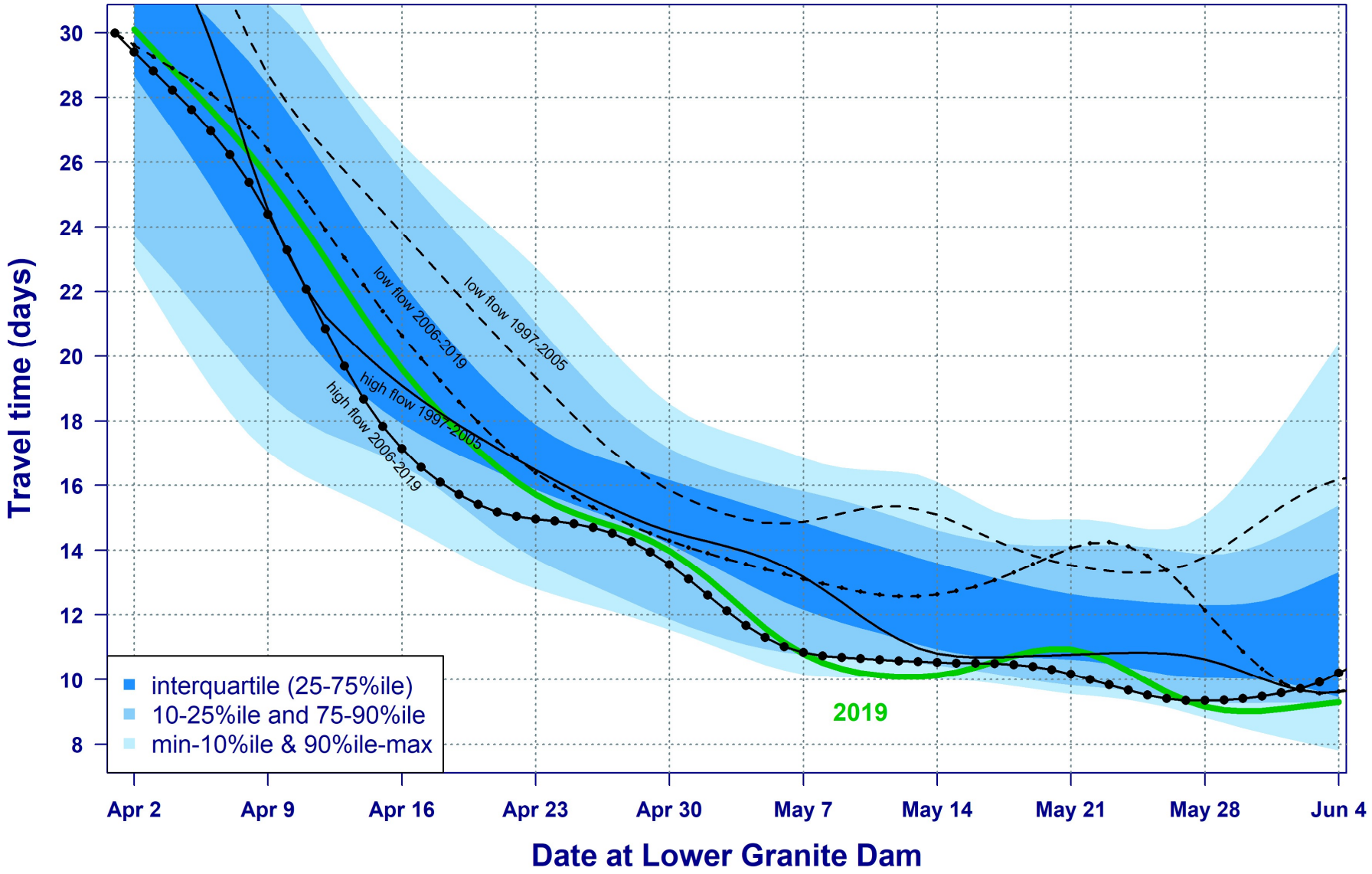
Daily Dissolved Gas Saturation 2006-2019
Mean LGR, LGS, LMN



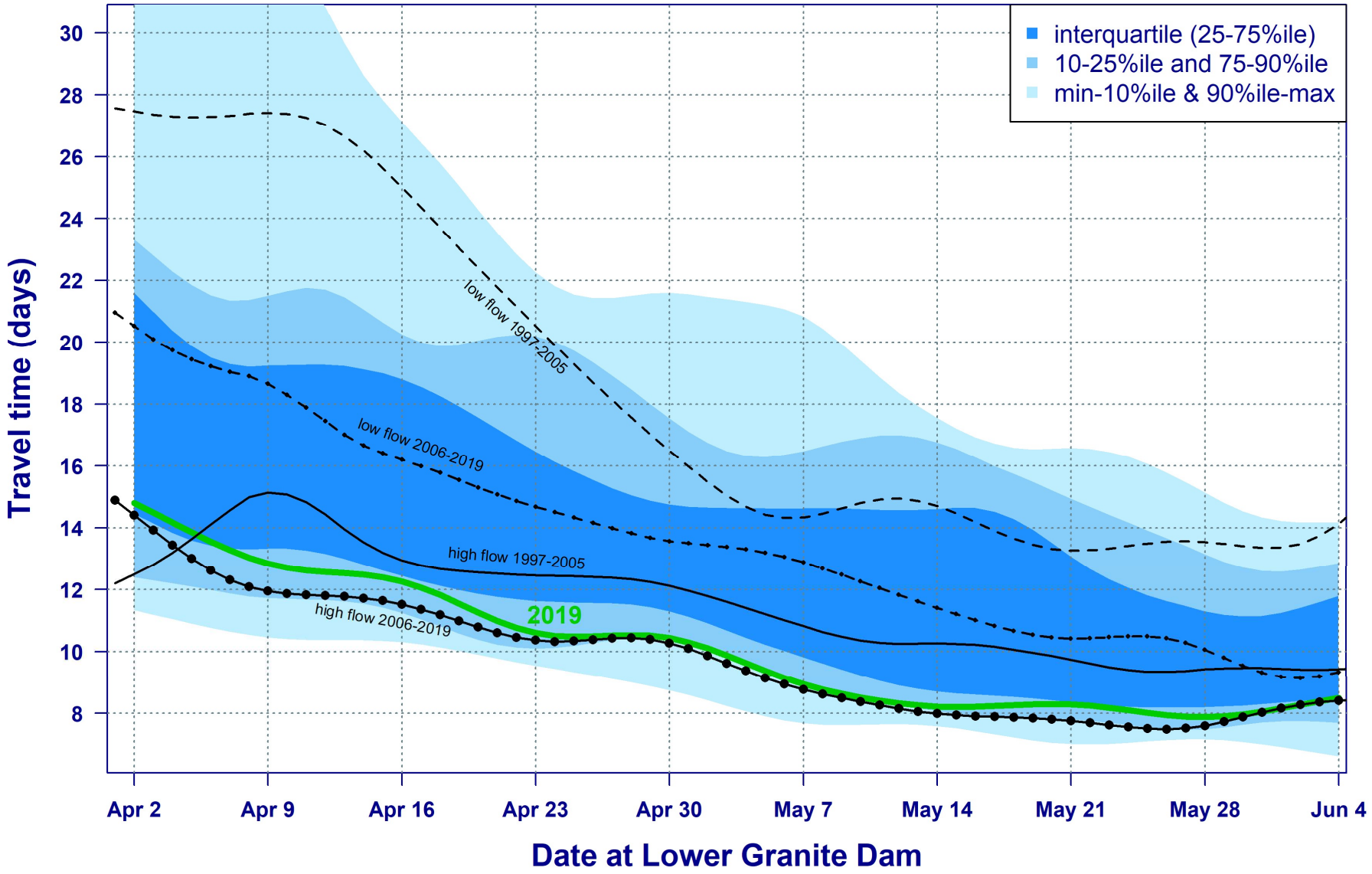
Passage Timing at Lower Granite Dam



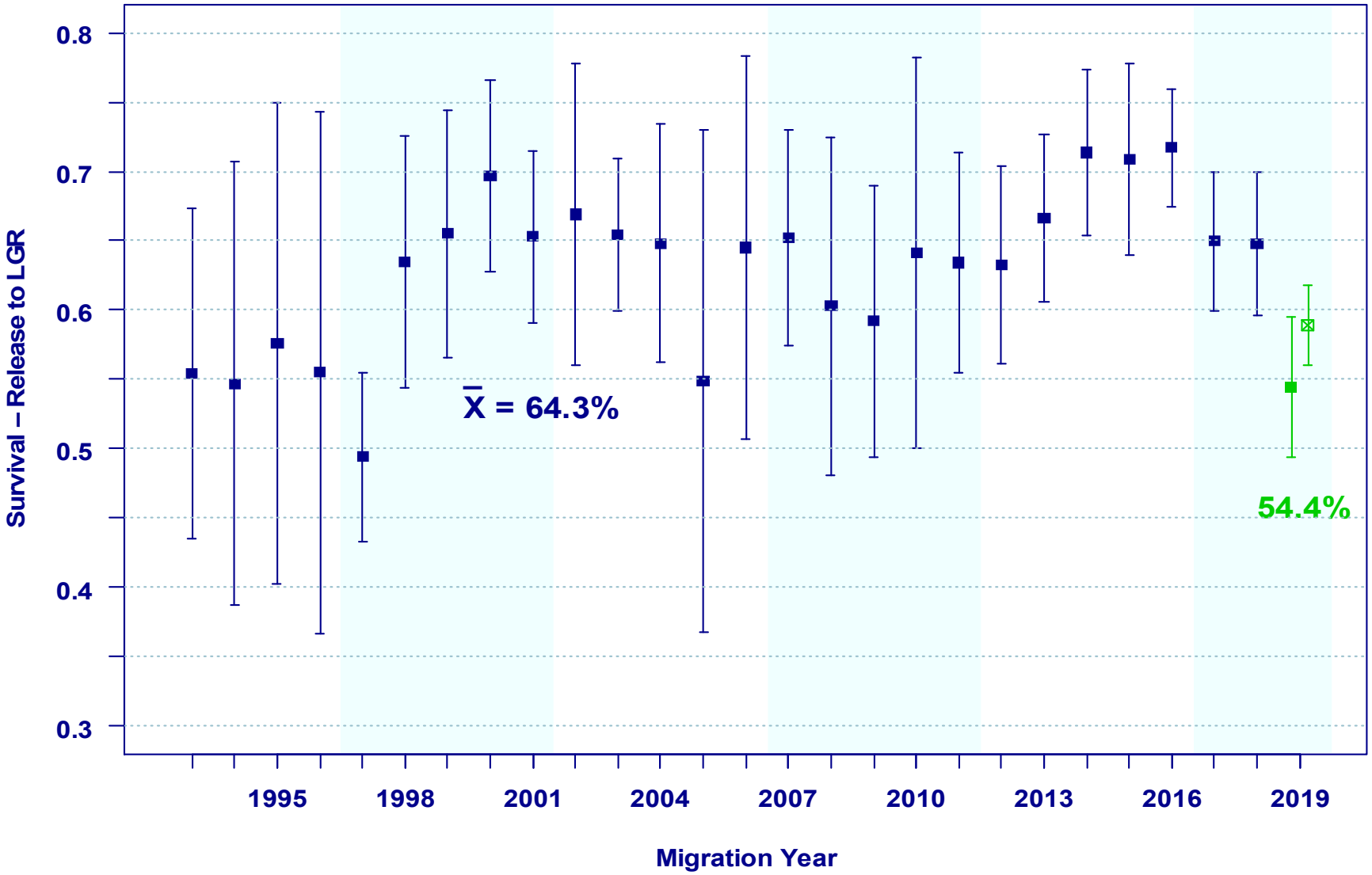
Chinook Travel Time 1997-2019 (exc. 2001)
Lower Granite to Bonneville (461 km)

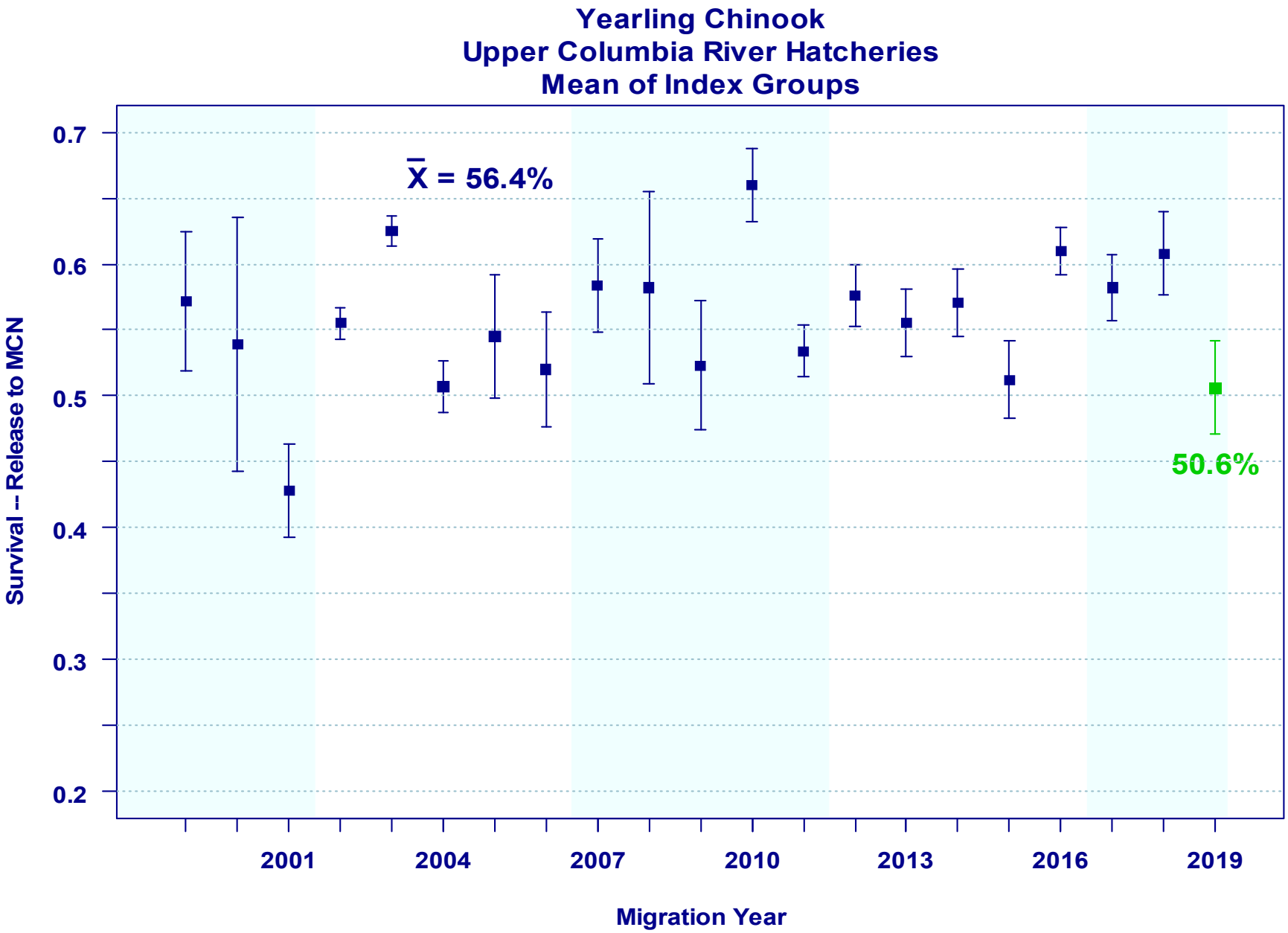


Steelhead Travel Time 1997-2019 (exc. 2001)
Lower Granite to Bonneville (461 km)

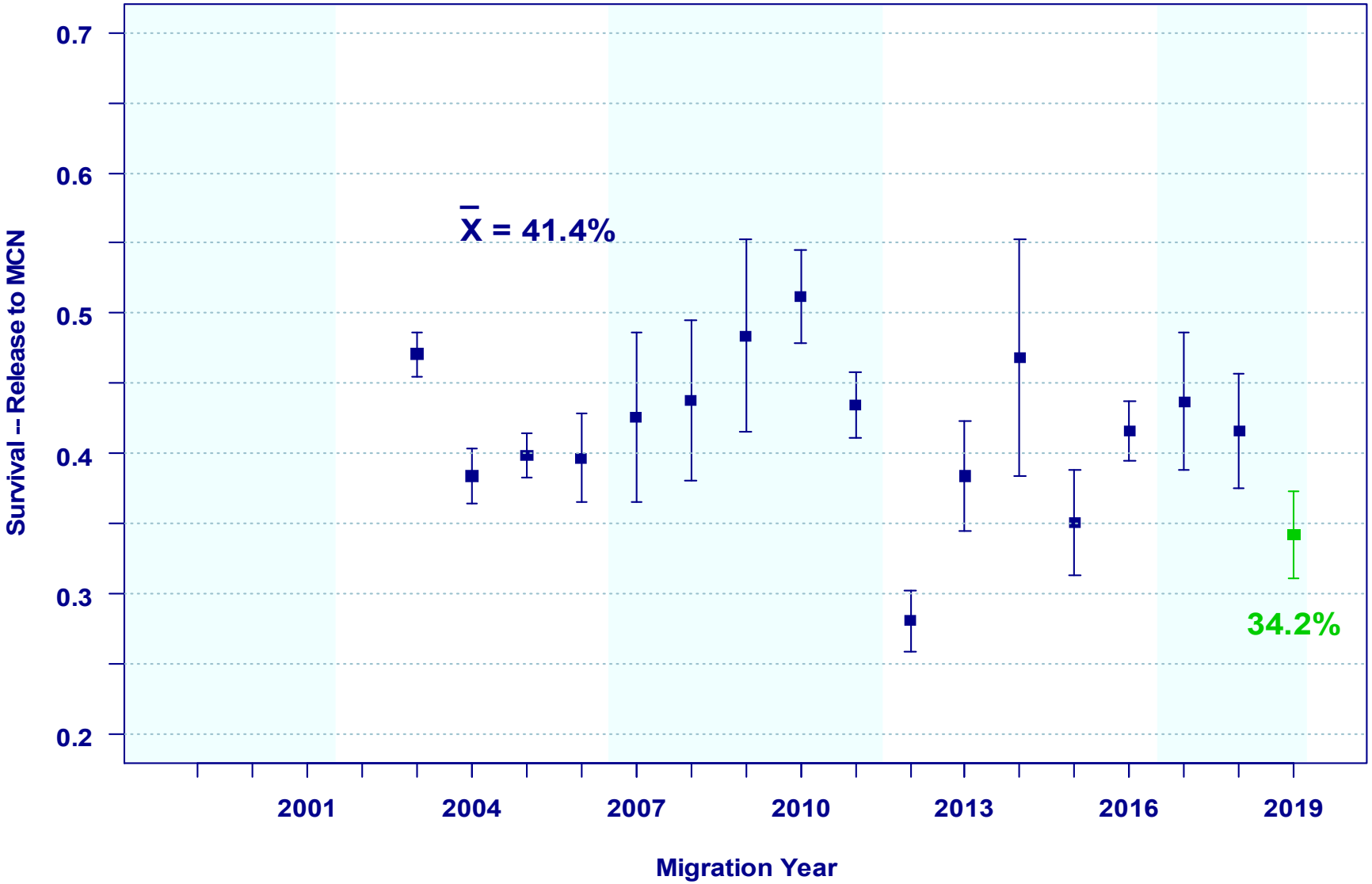


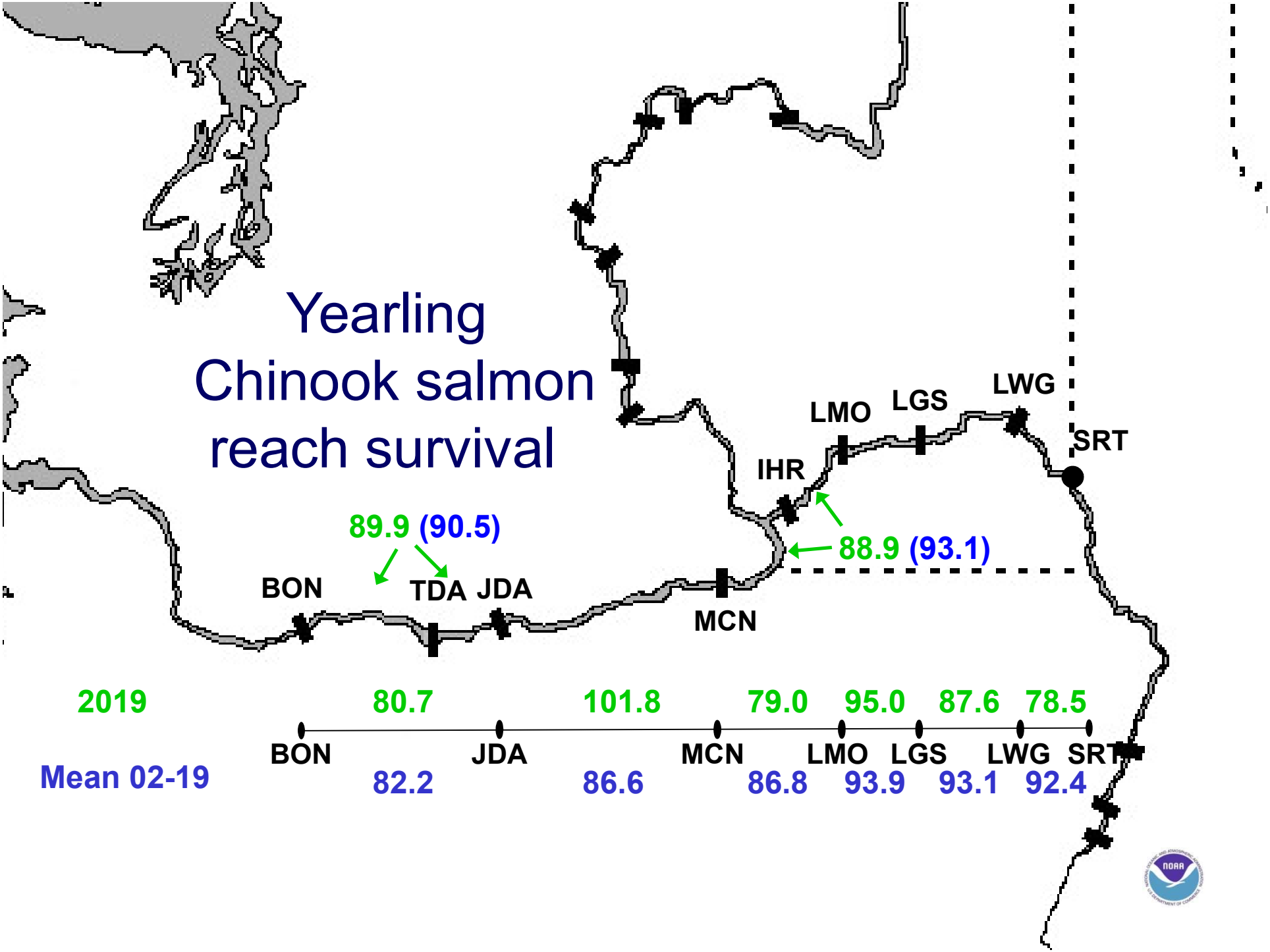
Yearling Chinook
Snake River Basin Hatcheries
Mean of Index Groups

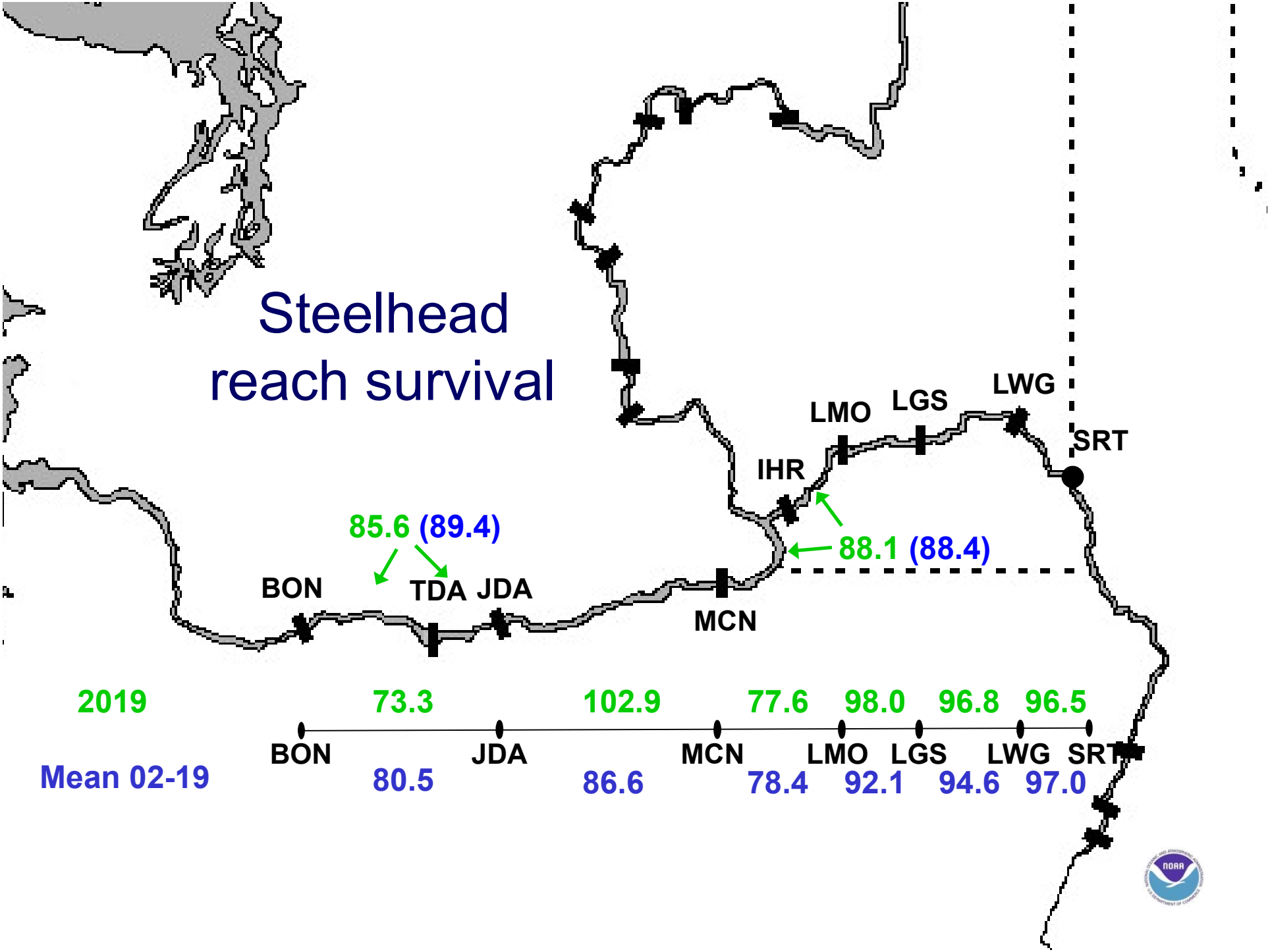


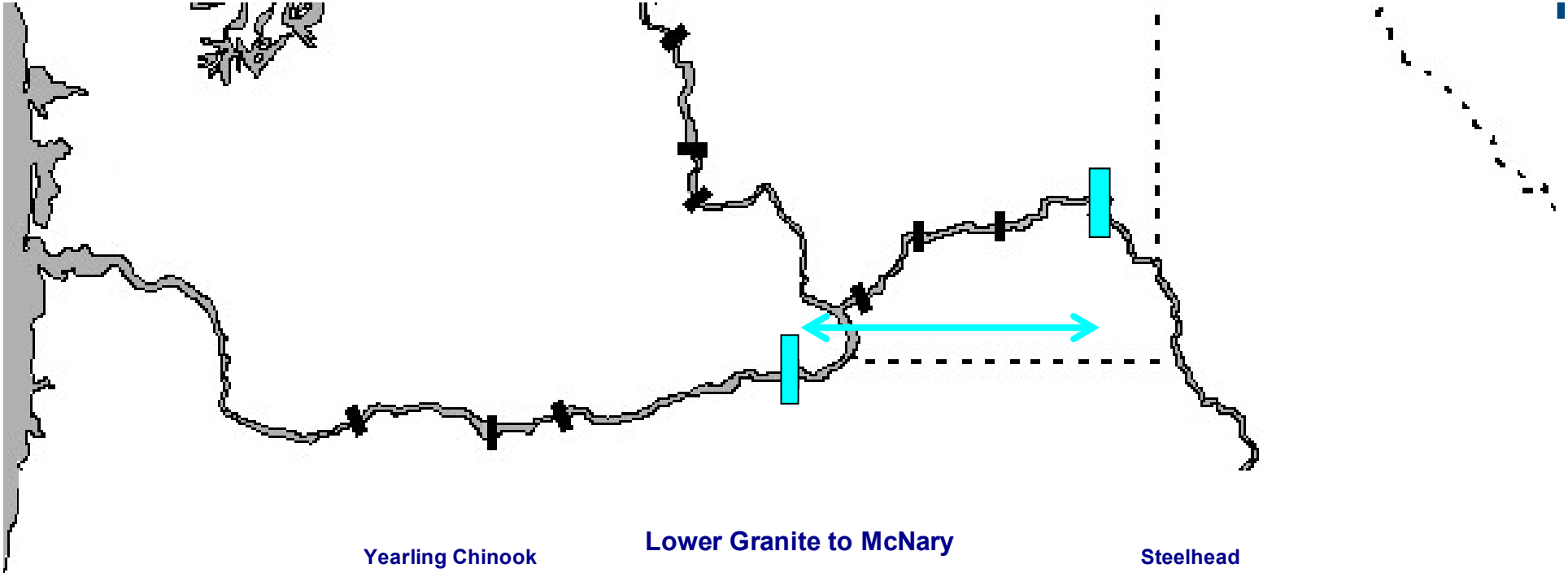

Yearling Chinook
Upper Columbia River Hatcheries
Mean of Index Groups
$\bar{X}$ = 56.4%
50.6%
Survival -- Release to MCN
0.7
0.6
0.5
0.4
0.3
0.2
2001
2004
2007
2010
2013
2016
2019
Migration Year

Steelhead
Upper Columbia River Hatcheries
Mean of Index Groups



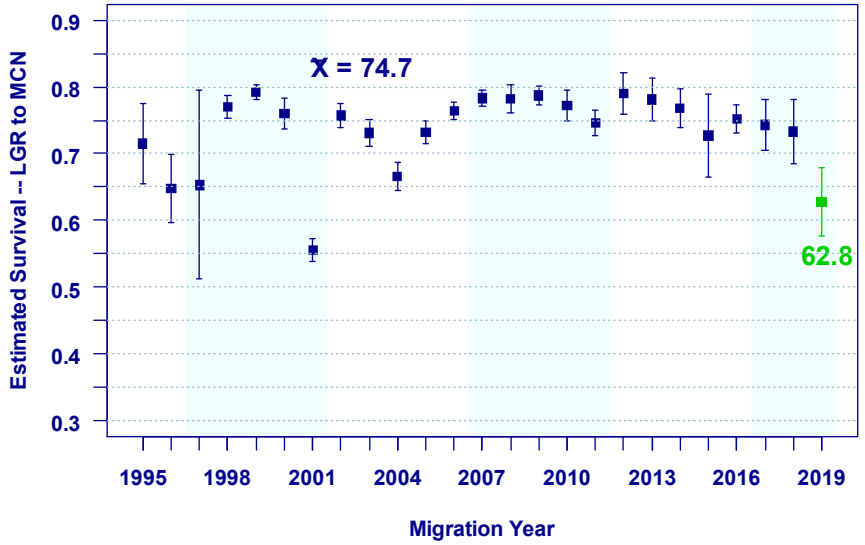

Yearling
Chinook salmon
reach survival
LWG
LGS
LMO
SRT
IHR
89.9 (90.5)
88.9 (93.1)
BON
TDA
JDA
MCN
2019
80.7
101.8
79.0
95.0
87.6
78.5
BON
JDA
MCN
LMO
LGS
LWG
SRT
Mean 02-19
82.2
86.6
86.8
93.9
93.1
92.4


Steelhead
reach survival
LWG
LGS
LMO
SRT
IHR
85.6 (89.4)
88.1 (88.4)
BON
TDA
JDA
MCN
2019
73.3
102.9
77.6
98.0
96.8
96.5
BON
JDA
MCN
LMO
LGS
LWG
SRT
Mean 02-19
80.5
86.6
78.4
92.1
94.6
97.0

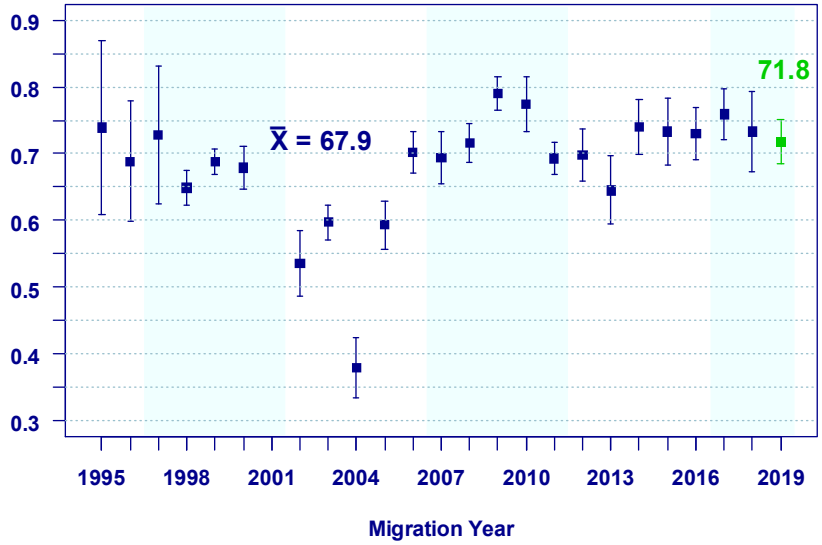


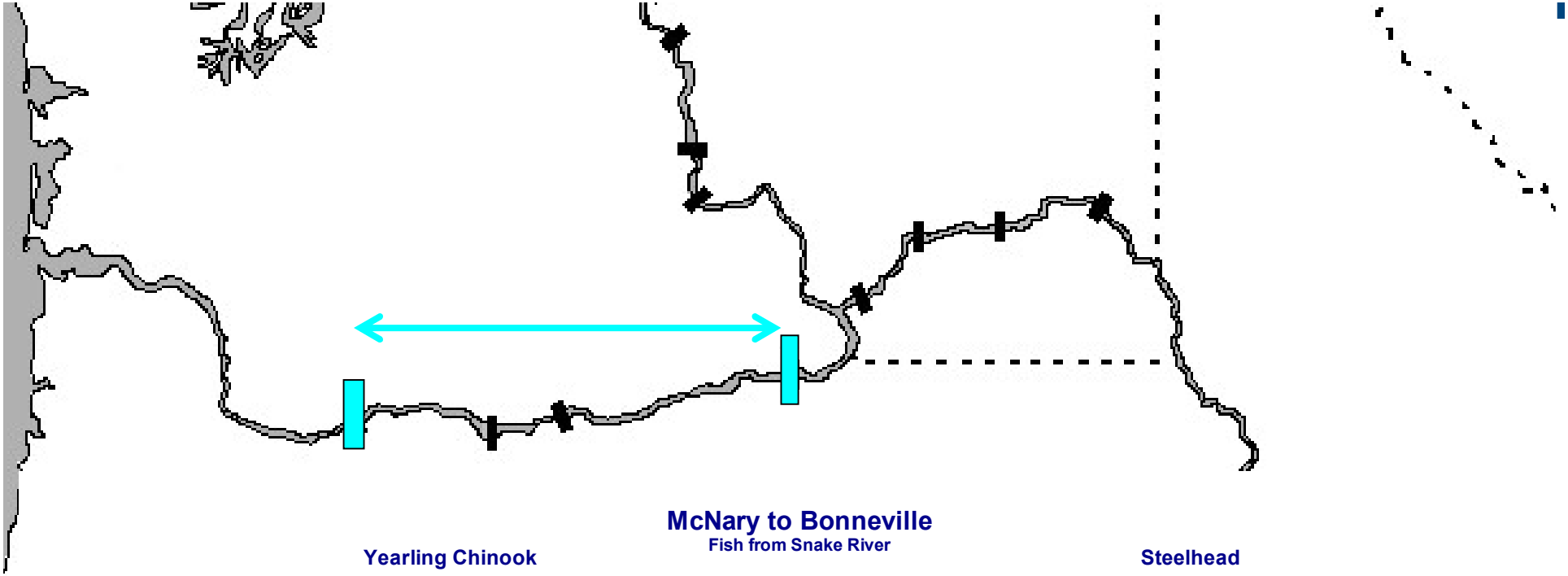
Lower Granite to McNary

Yearling Chinook



Steelhead

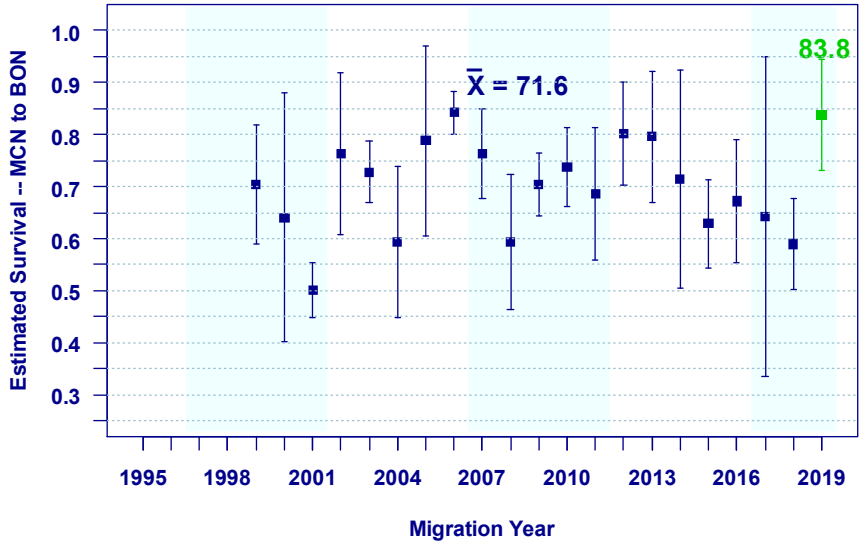




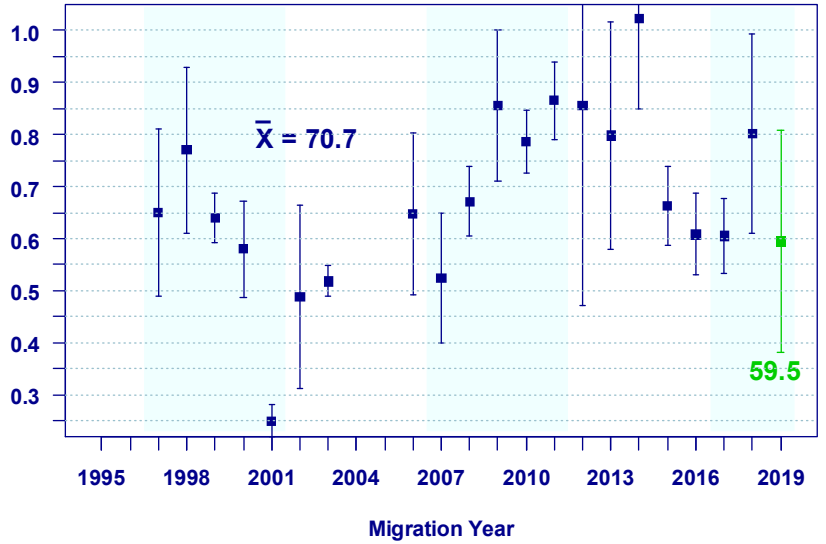
McNary to Bonneville

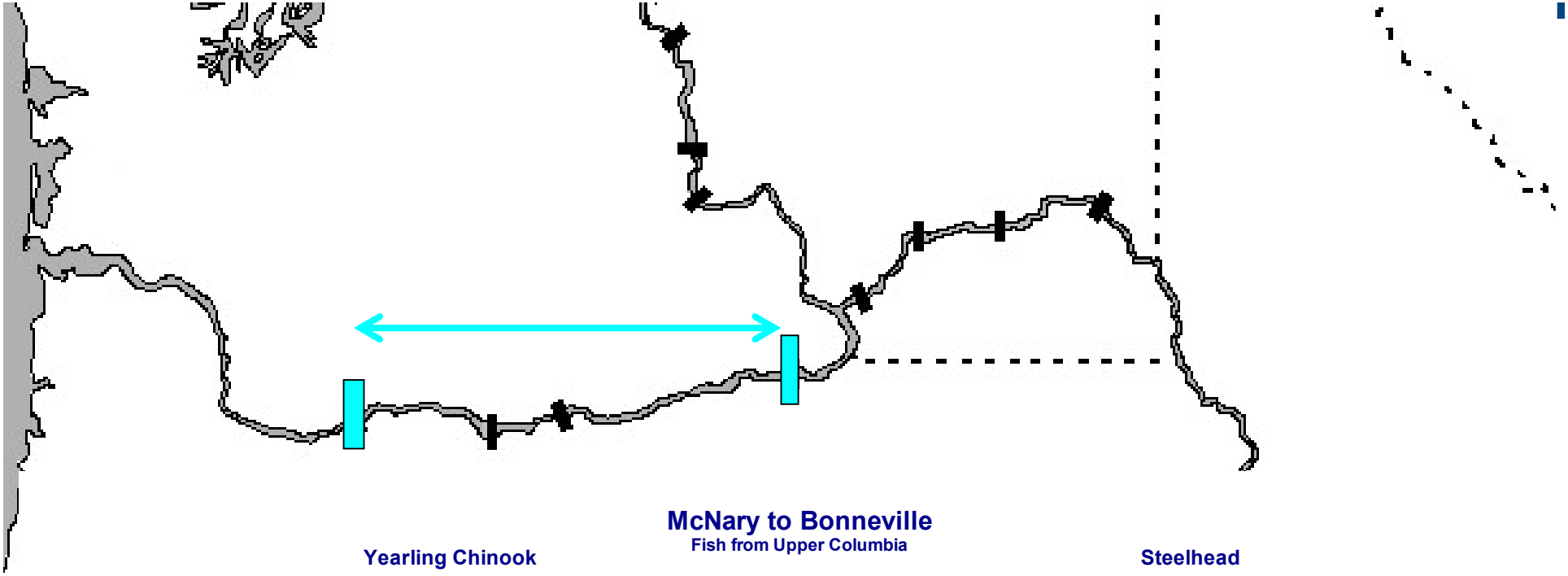
Fish from Snake River

Yearling Chinook



Steelhead

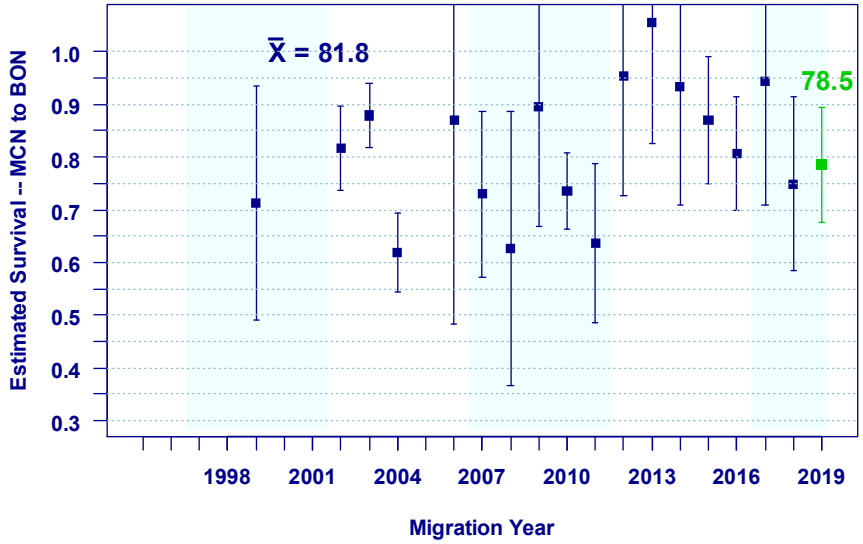




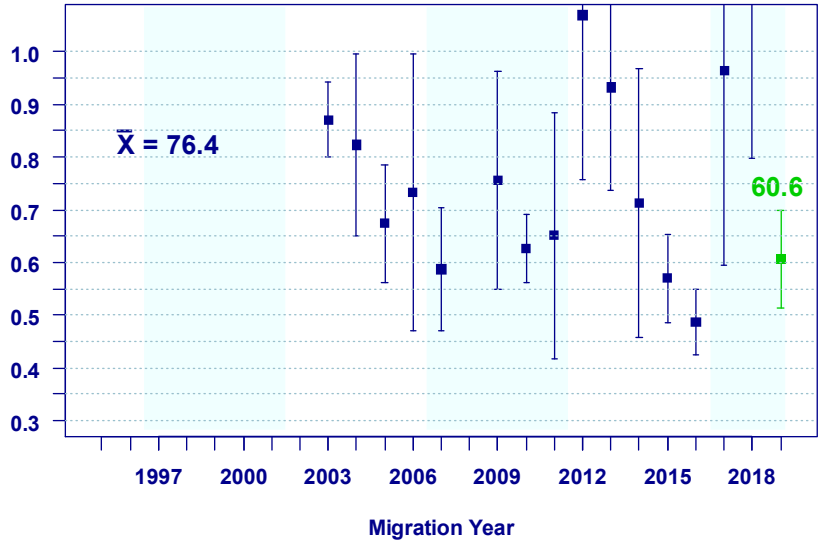
McNary to Bonneville

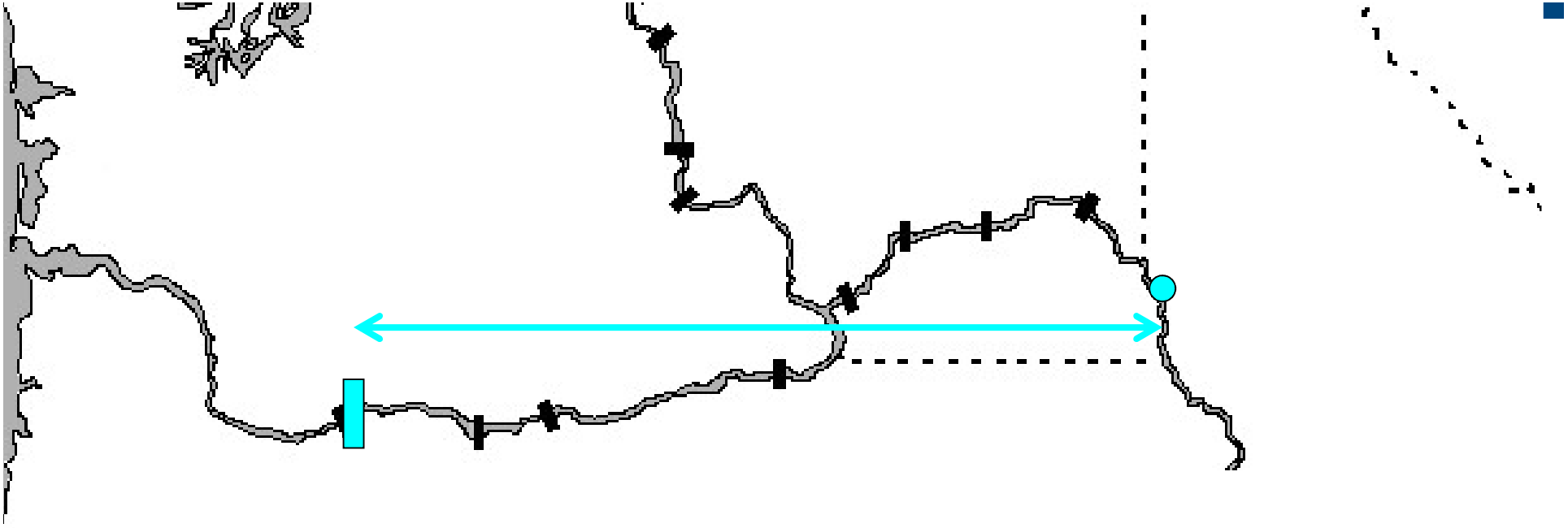
Fish from Upper Columbia

Yearling Chinook



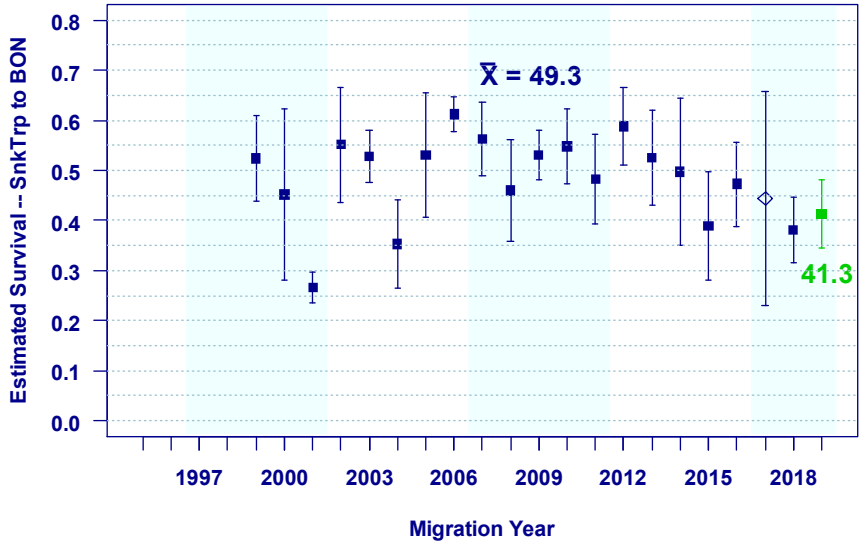
Steelhead



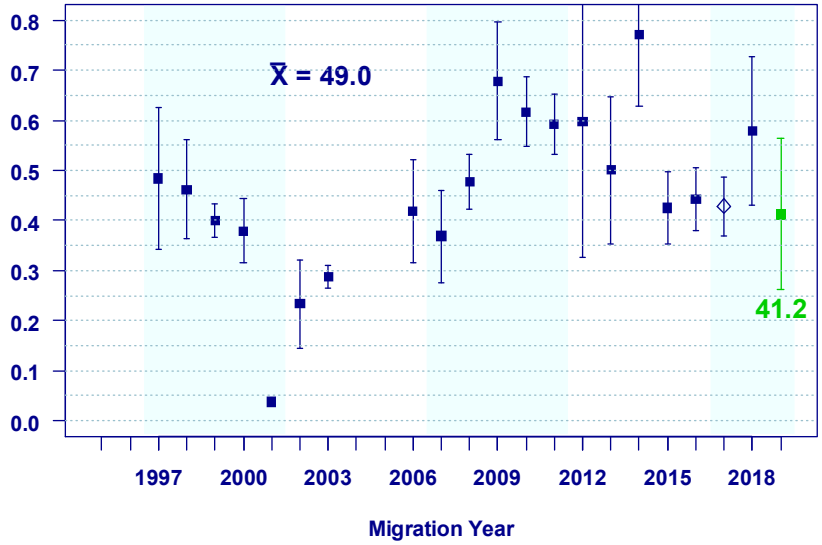


Snake River Trap to Bonneville

Yearling Chinook

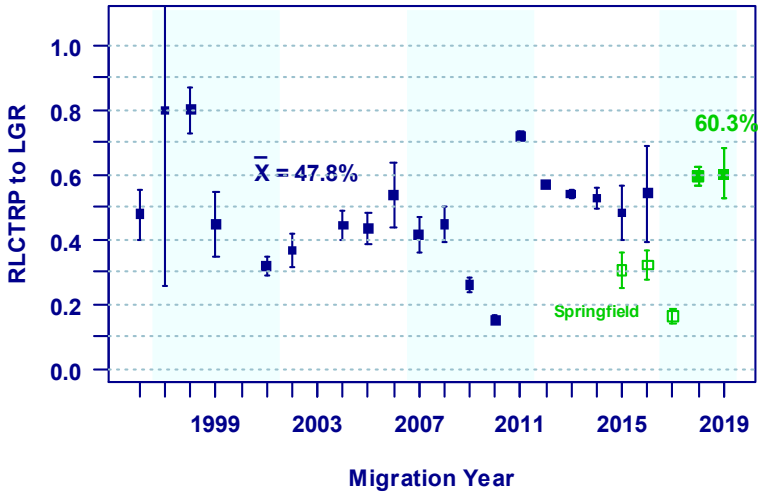


Steelhead

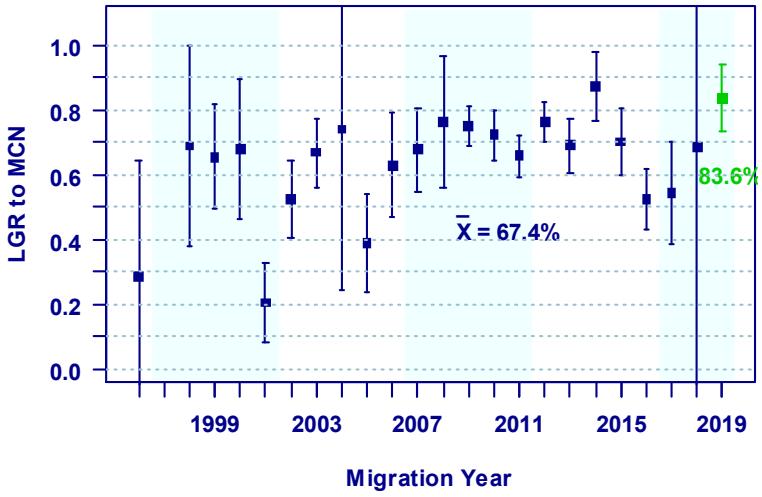


Snake River Sockeye: Estimated Survival

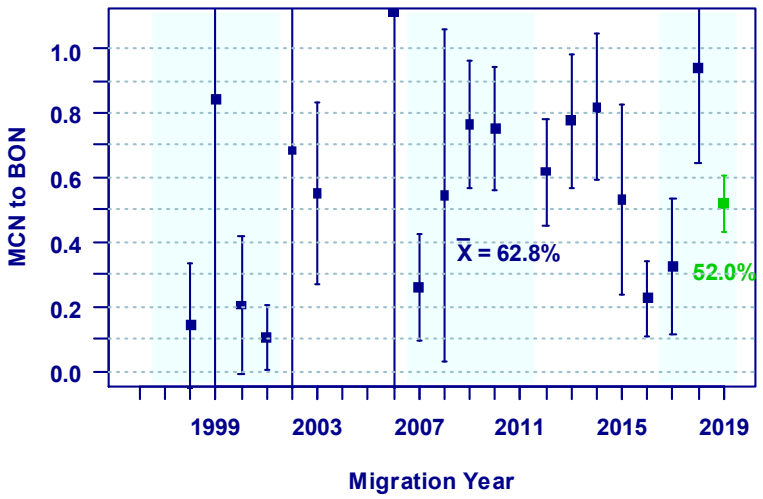
Redfish Lake Trap to Lower Granite



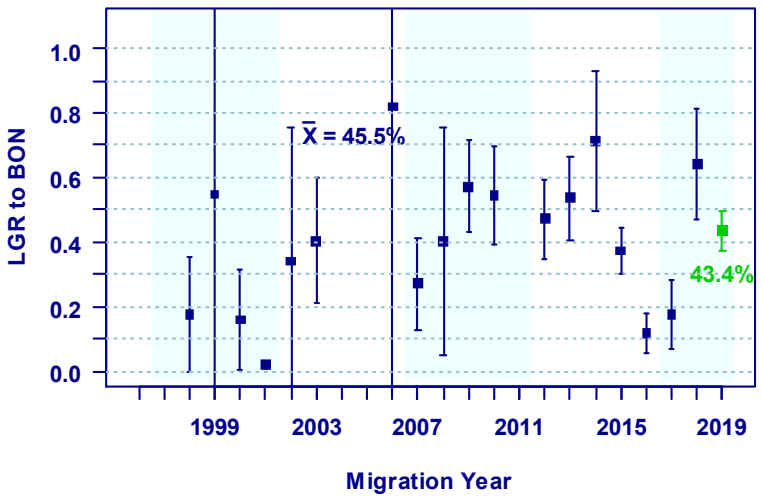
Lower Granite to McNary



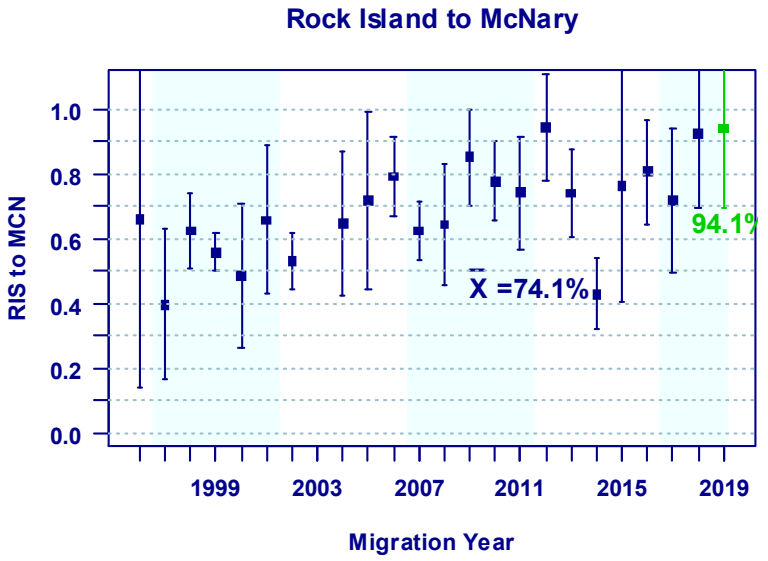
McNary to Bonneville

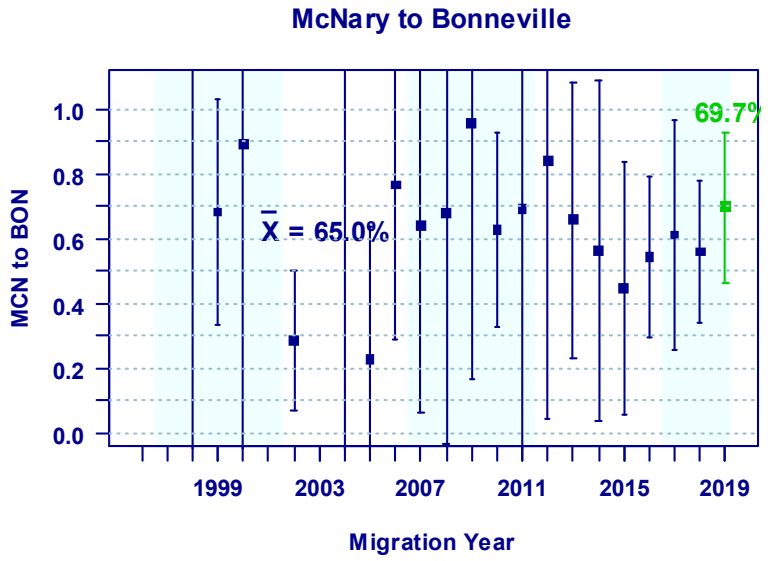


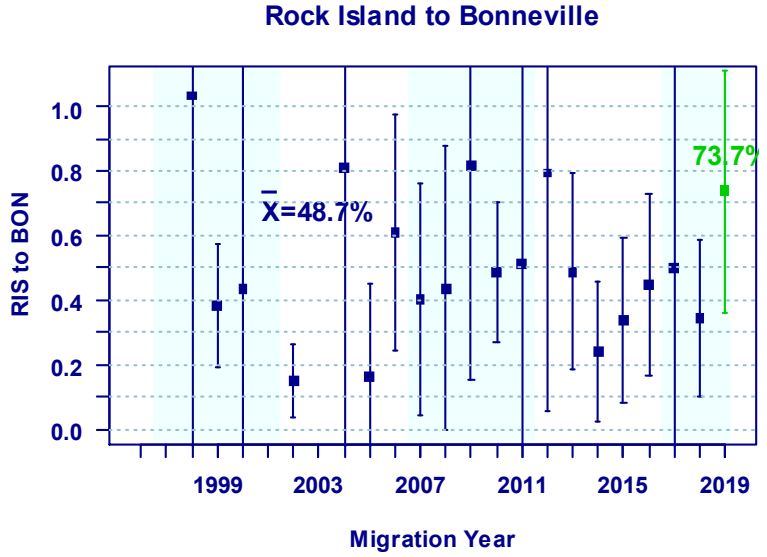
Lower Granite to Bonneville

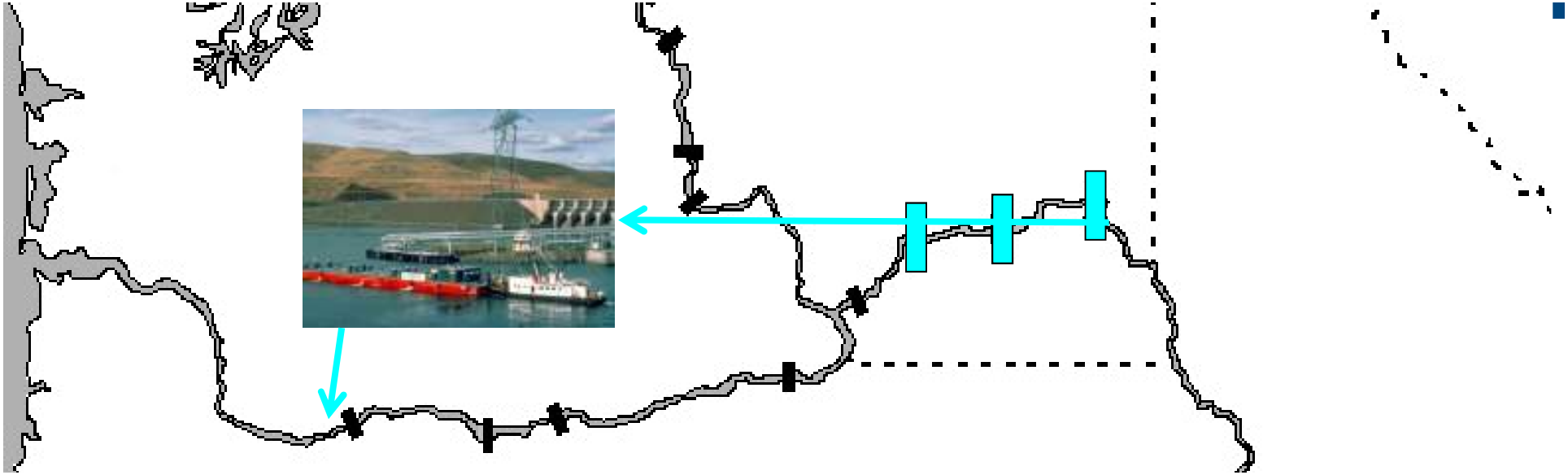


Columbia River Sockeye: Estimated Survival

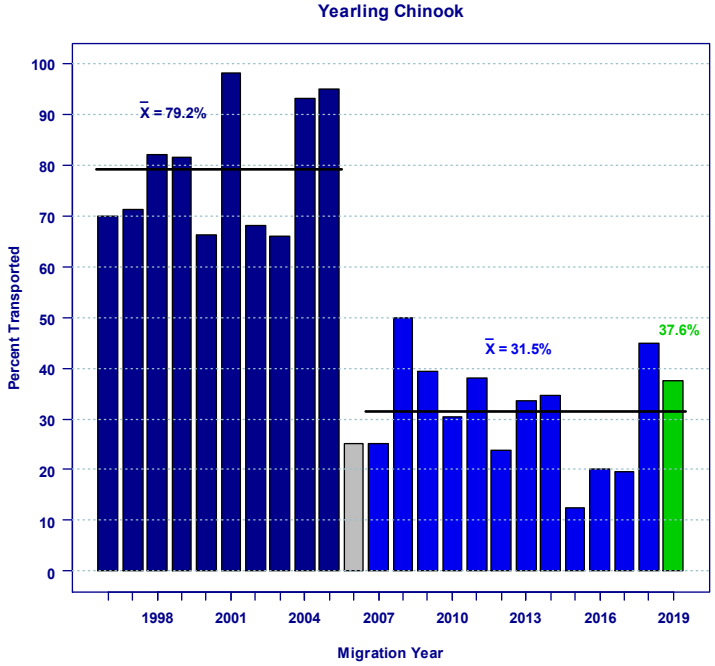


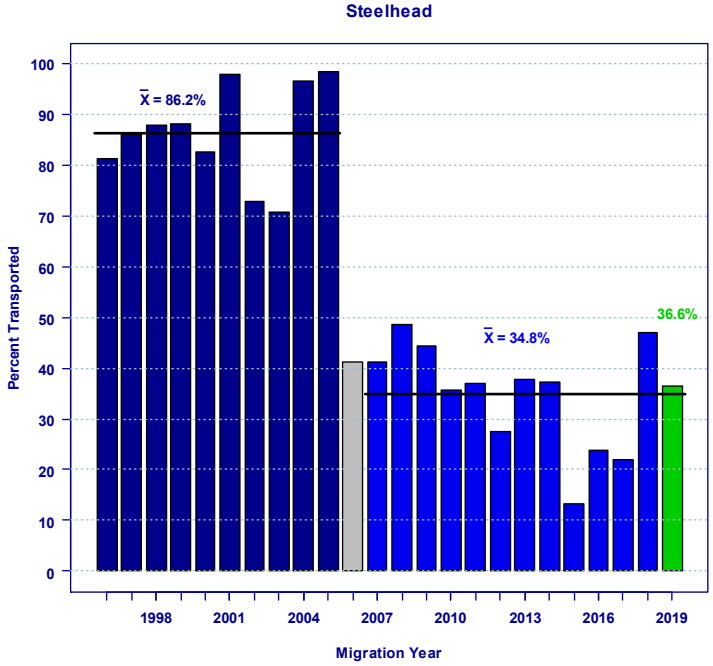


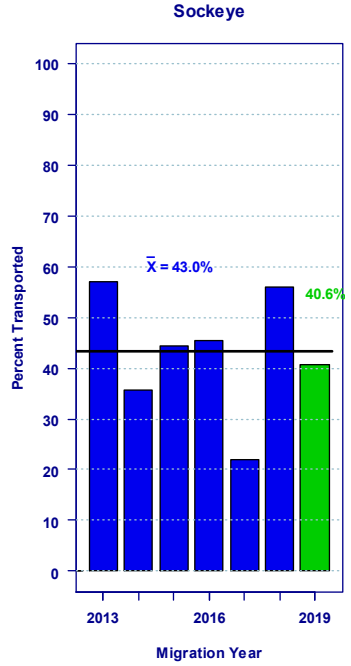




Estimated Percent Transported







Acknowledgments

- Bonneville Power Administration
- PTAGIS – Pacific States Marine Fisheries Commission
- DART – University of Washington Columbia Basin Research
- NOAA Colleagues: Jim Faulkner, Dan Widener
- Legions of Agencies, Coordinators, Taggers, ETC.


Questions

Smolt Transportation Seasonal Analyses

Yearling Chinook & Steelhead

Migration Years 2015-2017

- Updated with adult returns through Dec 5, 2019
- Added smolt migration year 2017
- Data from LGR, LGS, and LMN

Estimating Patterns of SAR vs. Date

- Need a “time-stamp” – date of passage/detection

- These analyses use fish that entered JBS at LWG, LGS, or LMN
  - tagged upstream of LWG or at LWG
  - either transported (T) or bypassed (B or “C1”)
  - can adjust “standards” based on observed C0 > C1
  - e.g.:

    if (C1/C0 = 1.1) then (T/C1 > 1.1) implies (T/C0 > 1)

Snake River Conditions

Migration Year	Flow	Spill%	Temperature	Dissolved gas
2015	Very low	High (30-50%)	Very warm	Below average (112-113%)
2016	Above average (flat)	Average (~30%)	Warm	Average (112-115%)
2017	Very high	Very high (40-50%)	Average	Very high (118-126%

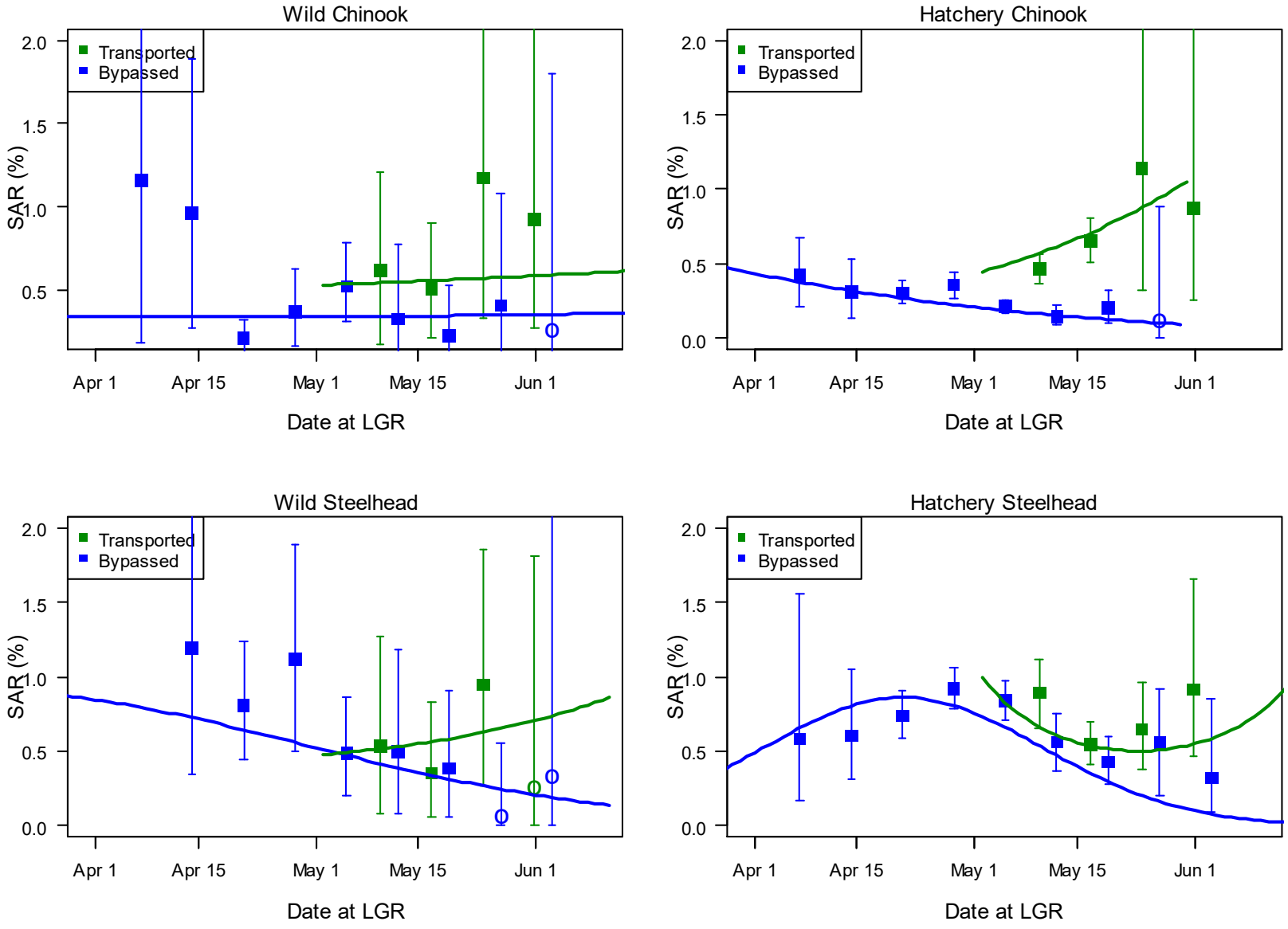
2015 Results

- Wild Chinook:
  - SAR ~ 1.0% for Transported (May) from LGR and LGS
  - Very low SAR for Bypassed fish, nearing 0 for May
    - April: 11 / 4402 => 0.25% May: 0 / 1971 => 0.02%
  - Very high T:B ratios (May) from LGR and LGS
  - Low numbers of smolts from LMN, no T or B adults
- Wild Steelhead:
  - Small numbers of smolts, very small numbers of adults
  - No evidence of T:B>1

2016

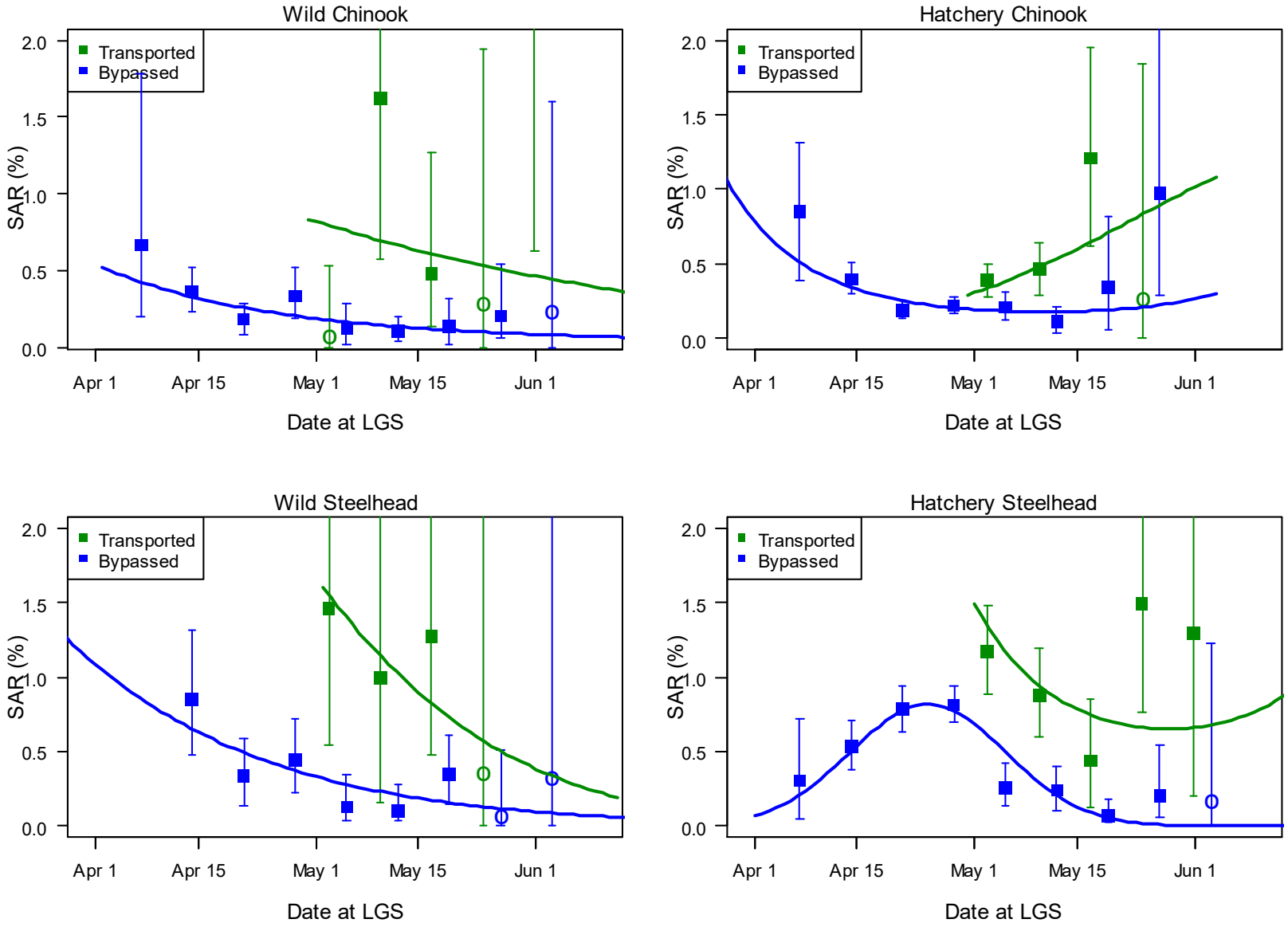
MY 2016

Transported or Bypassed at Lower Granite Dam



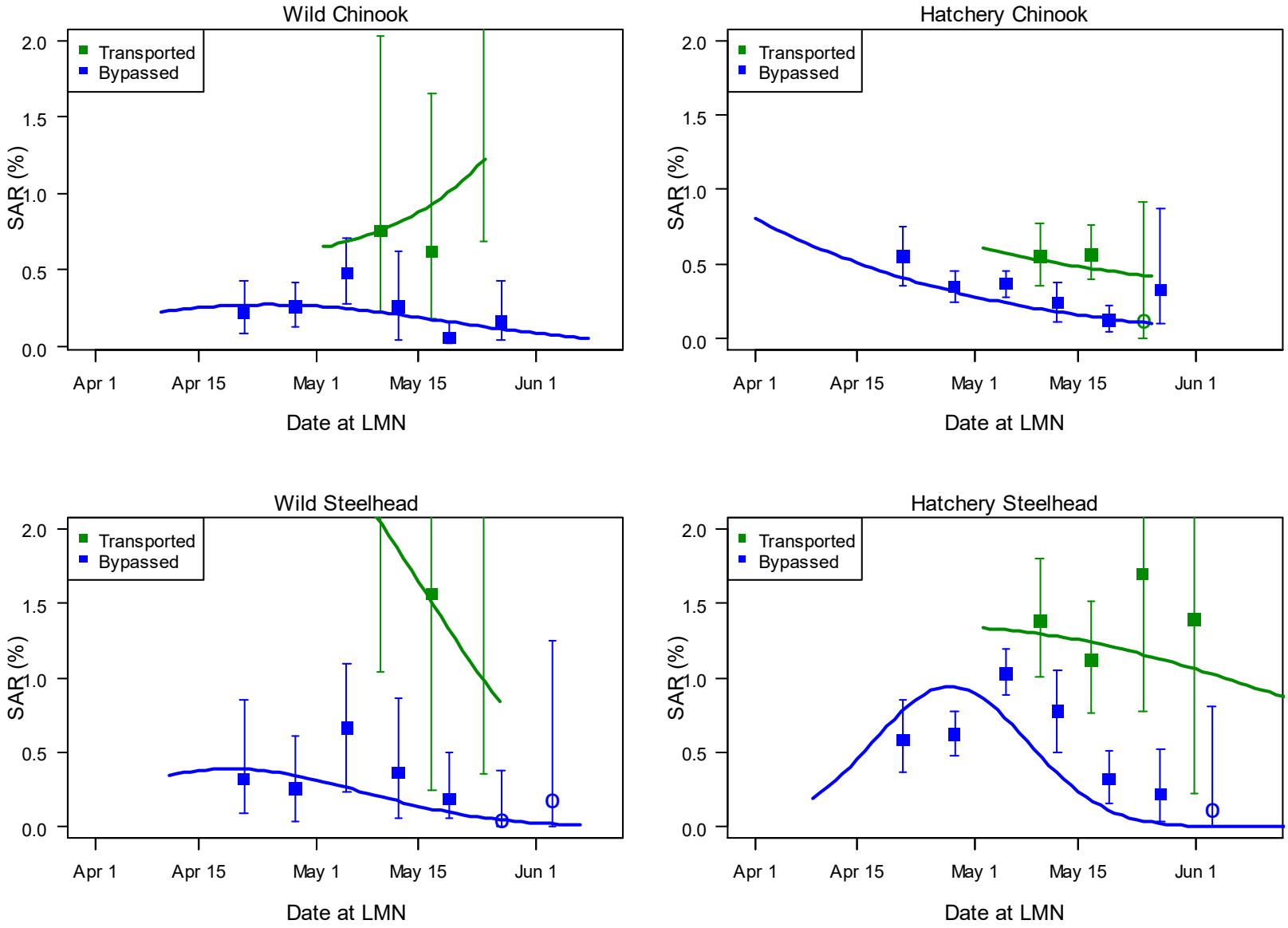
MY 2016

Transported or Bypassed at Little Goose Dam



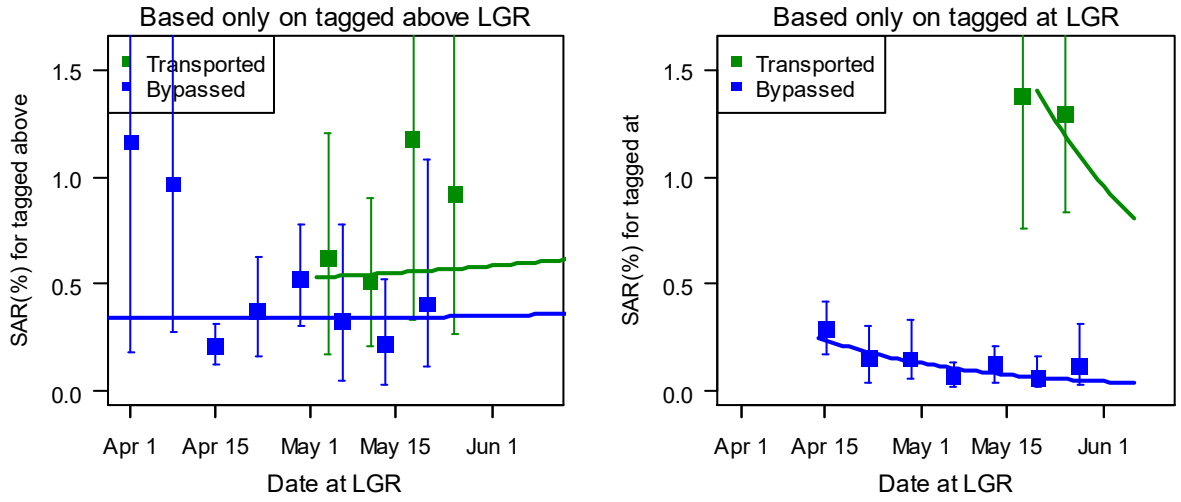
MY 2016

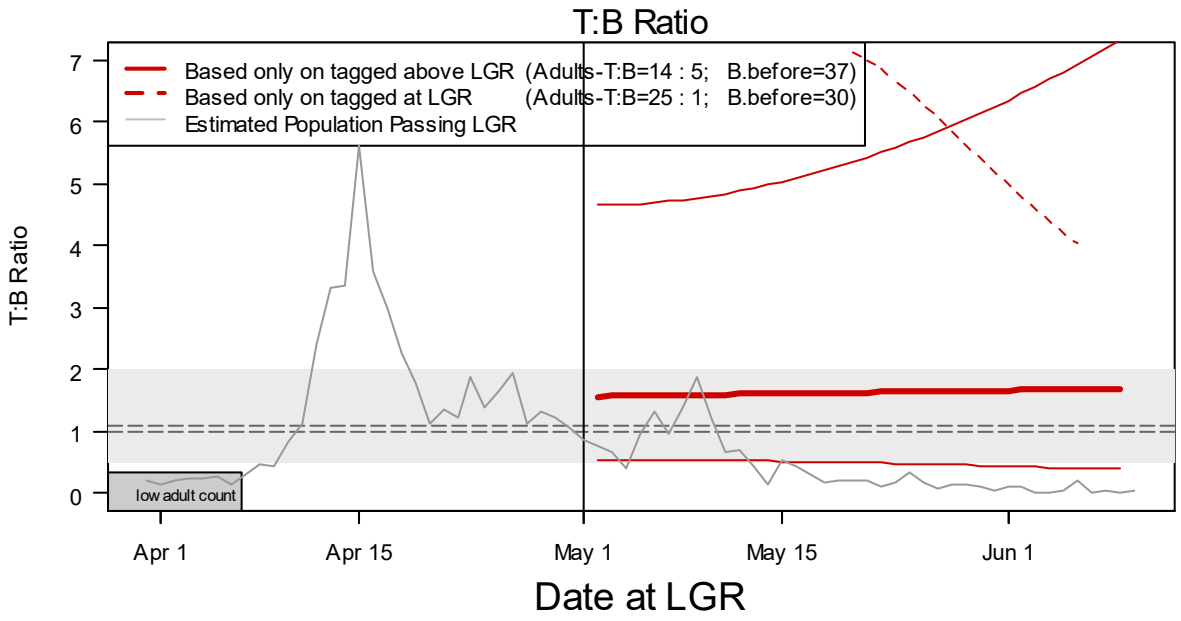
Transported or Bypassed at Lower Monumental Dam



Wild Chinook 2016

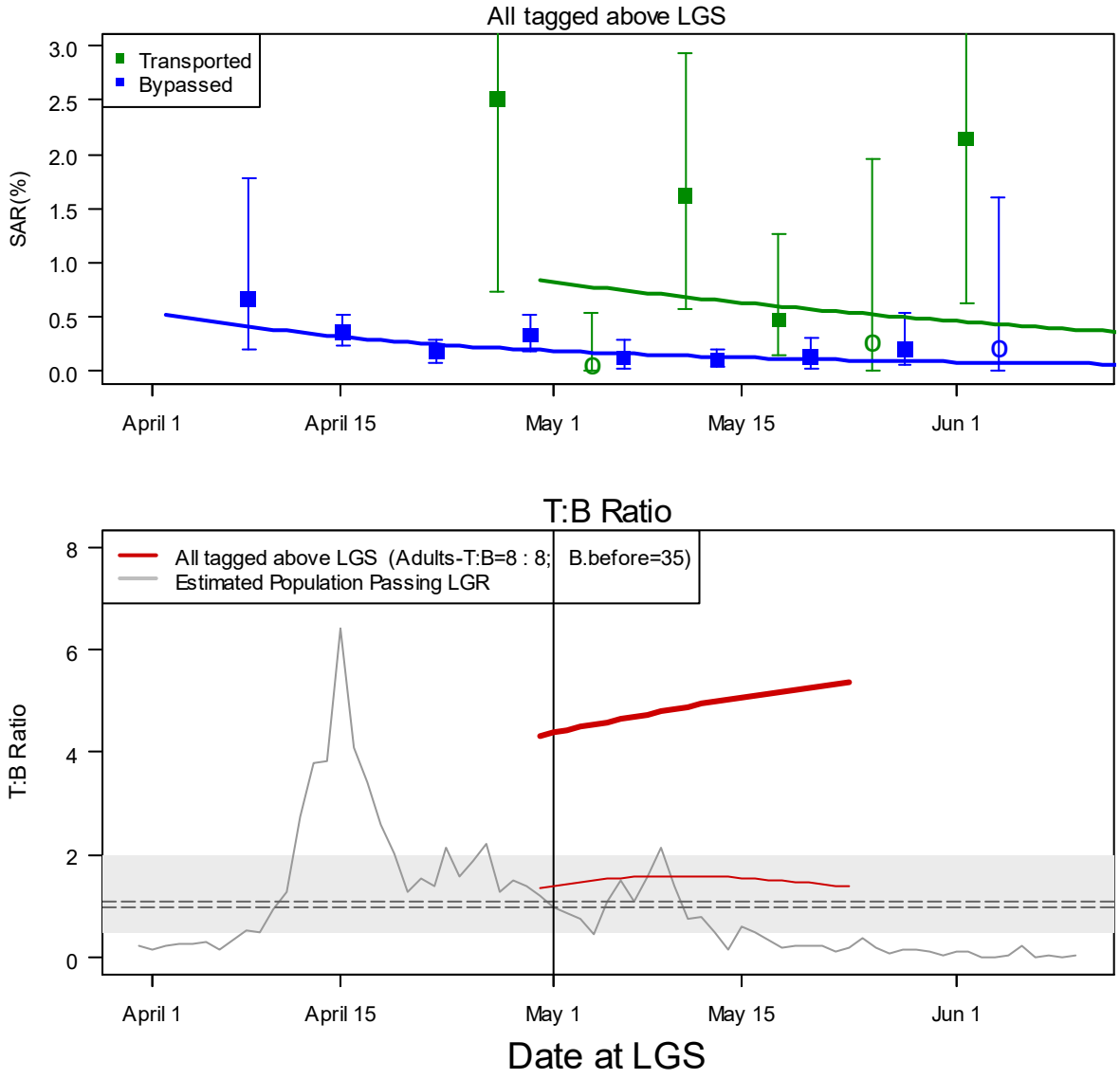
Transported or Bypassed at Lower Granite Dam





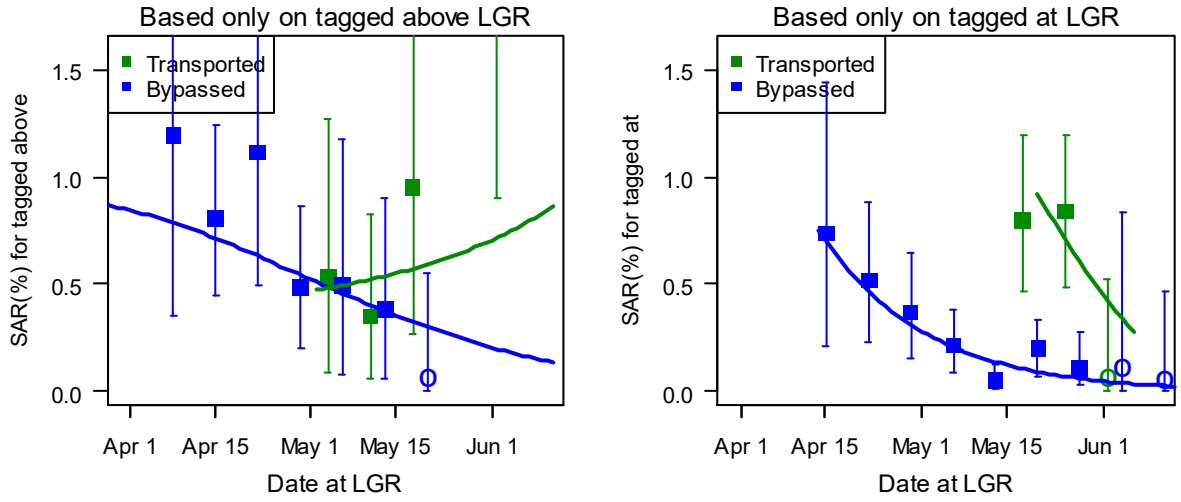
Wild Chinook 2016

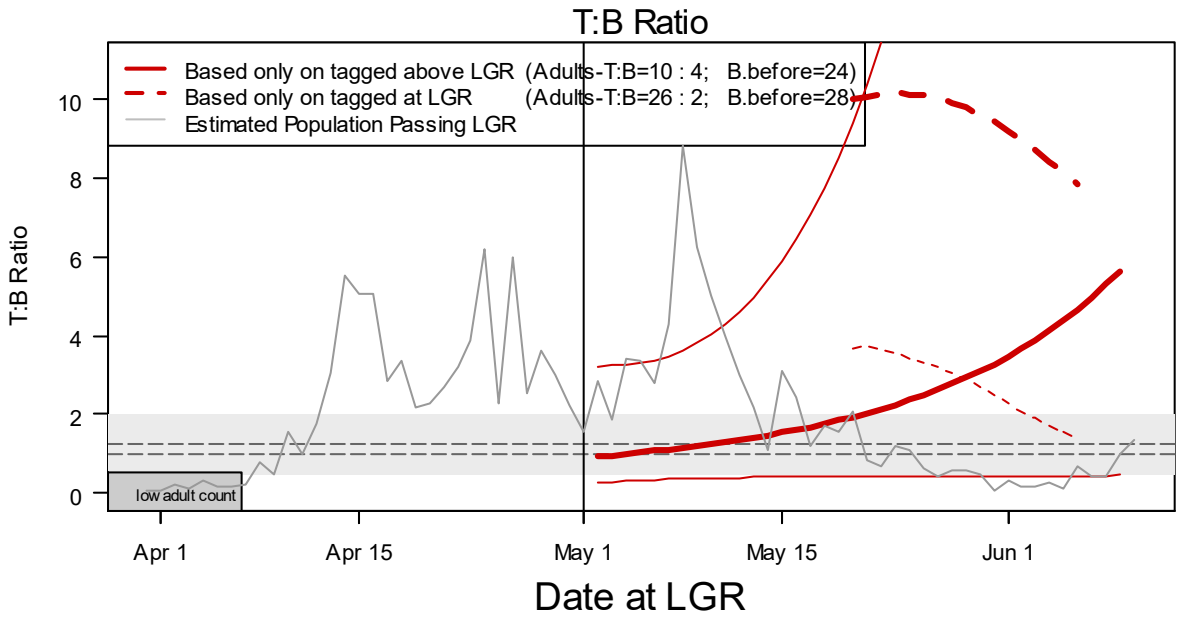
Transported or Bypassed at Little Goose Dam



Wild Steelhead 2016

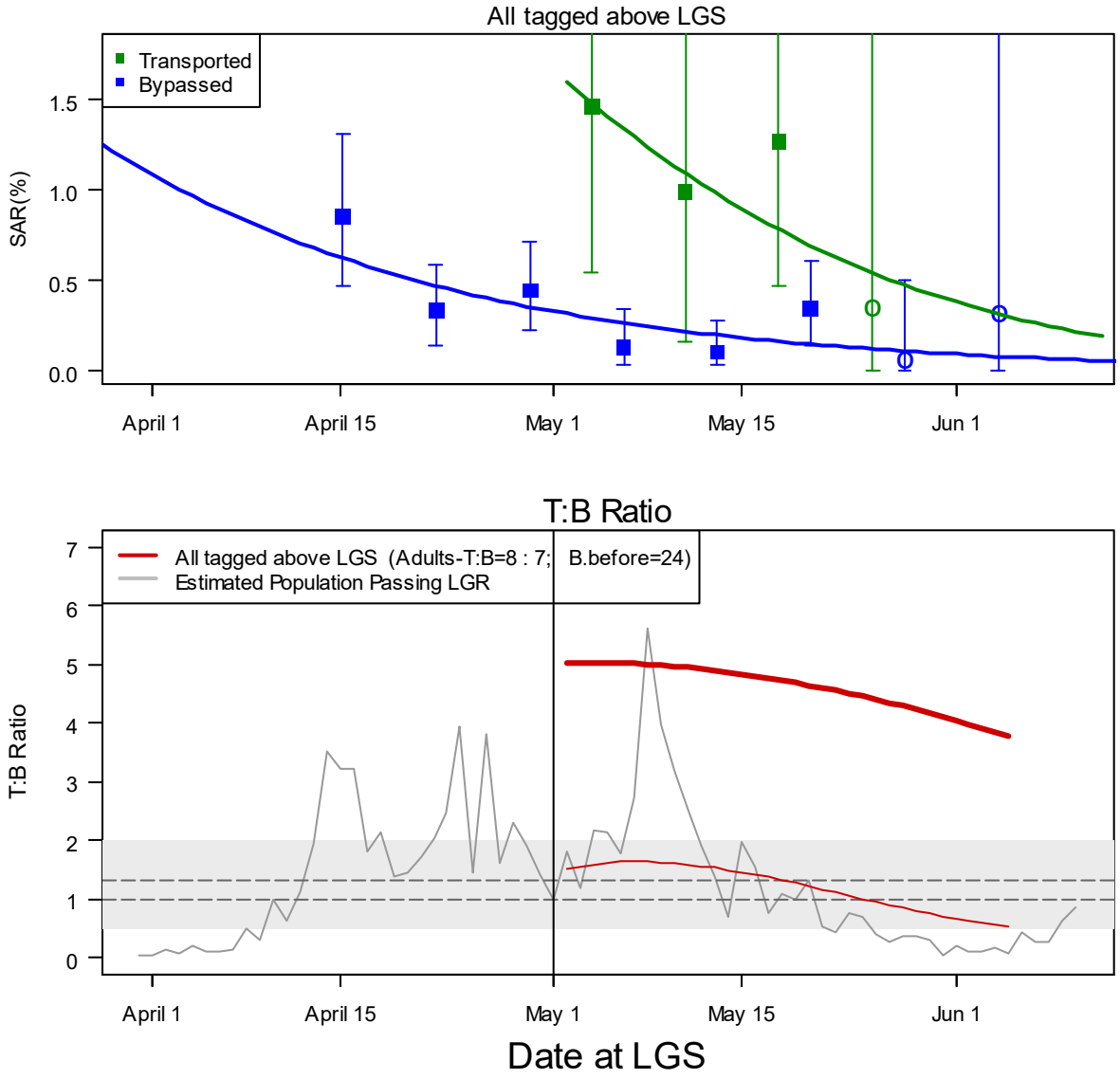
Transported or Bypassed at Lower Granite Dam





Wild Steelhead 2016

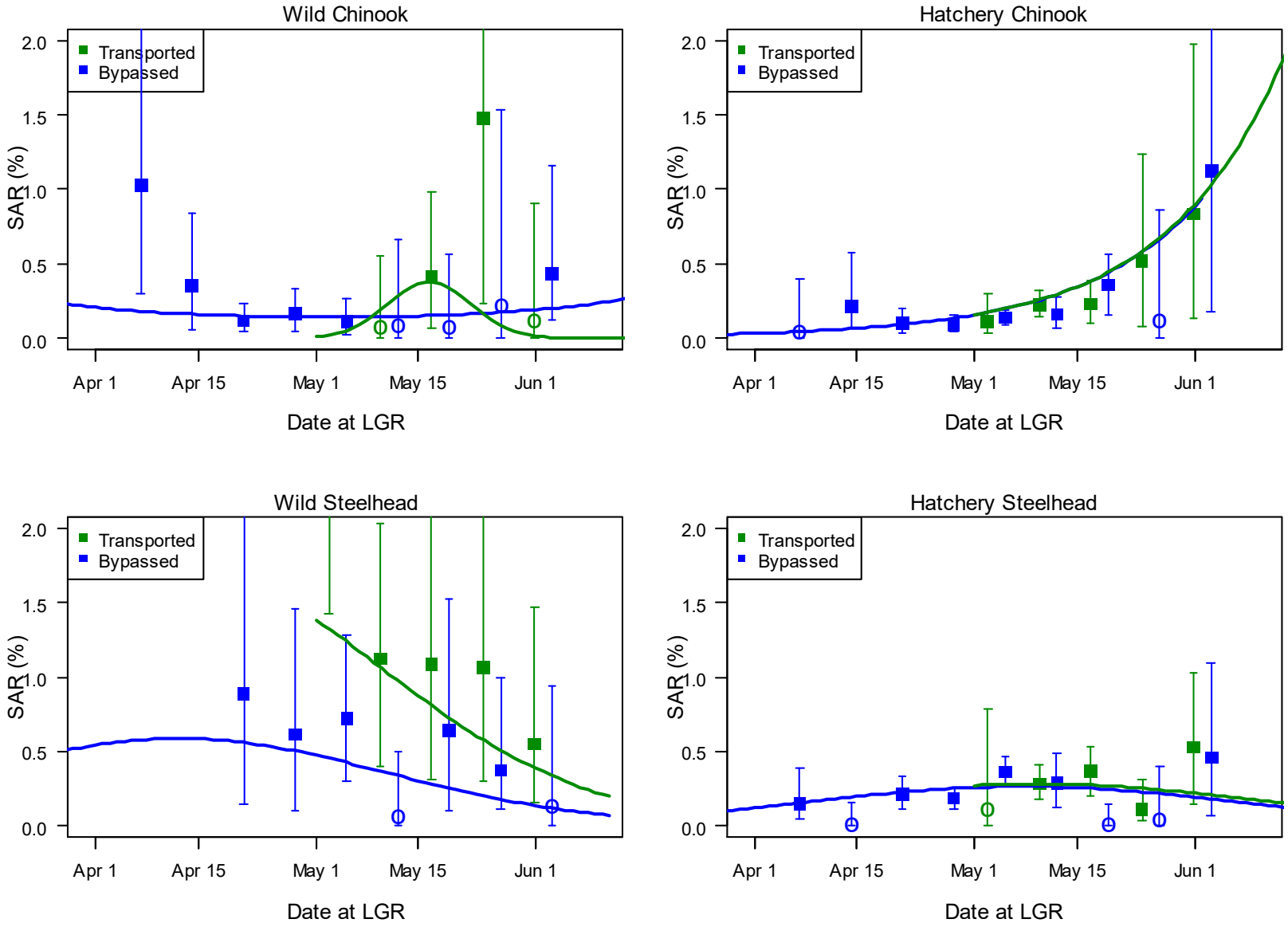
Transported or Bypassed at Little Goose Dam



2017

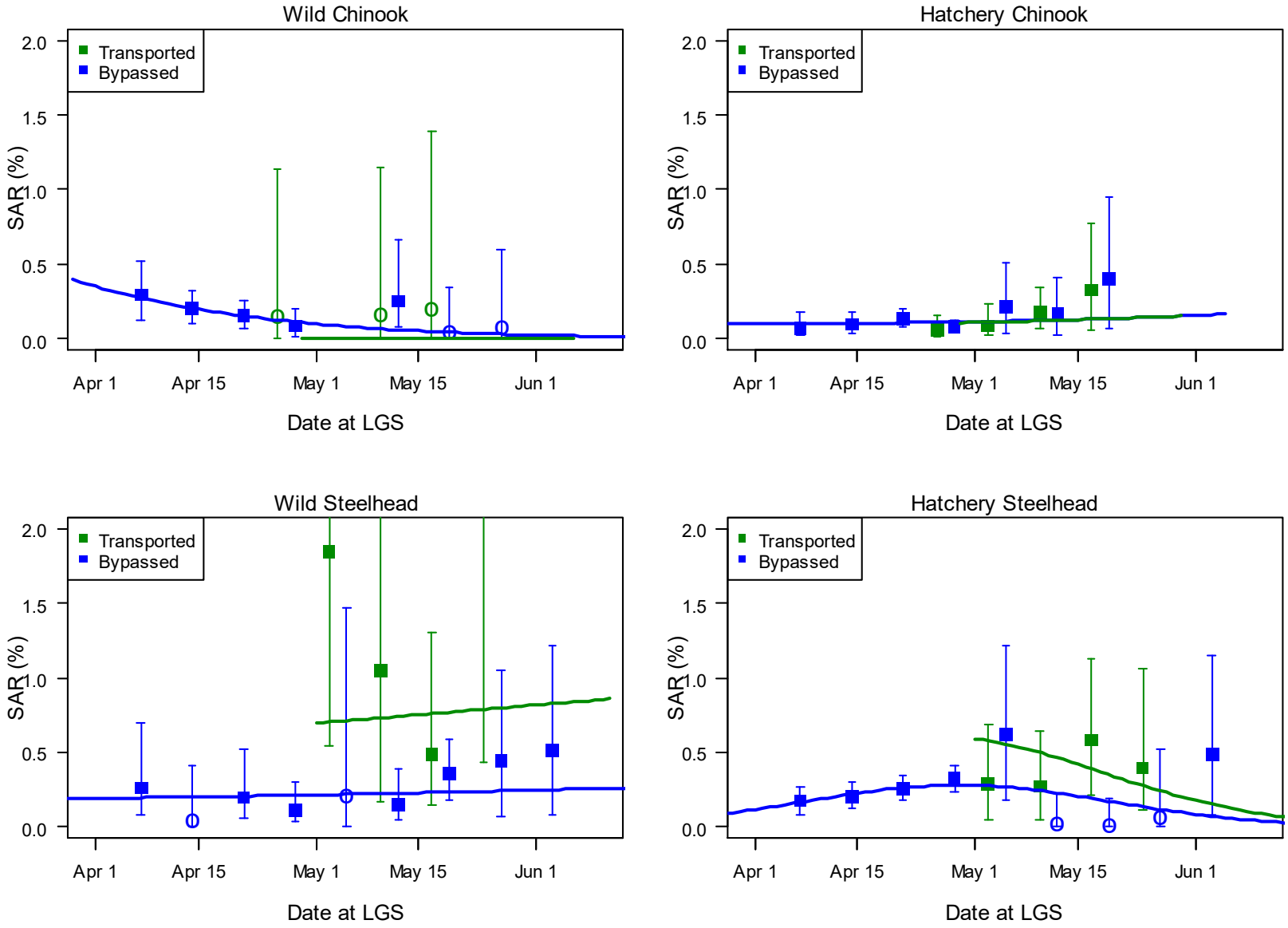
MY 2017

Transported or Bypassed at Lower Granite Dam



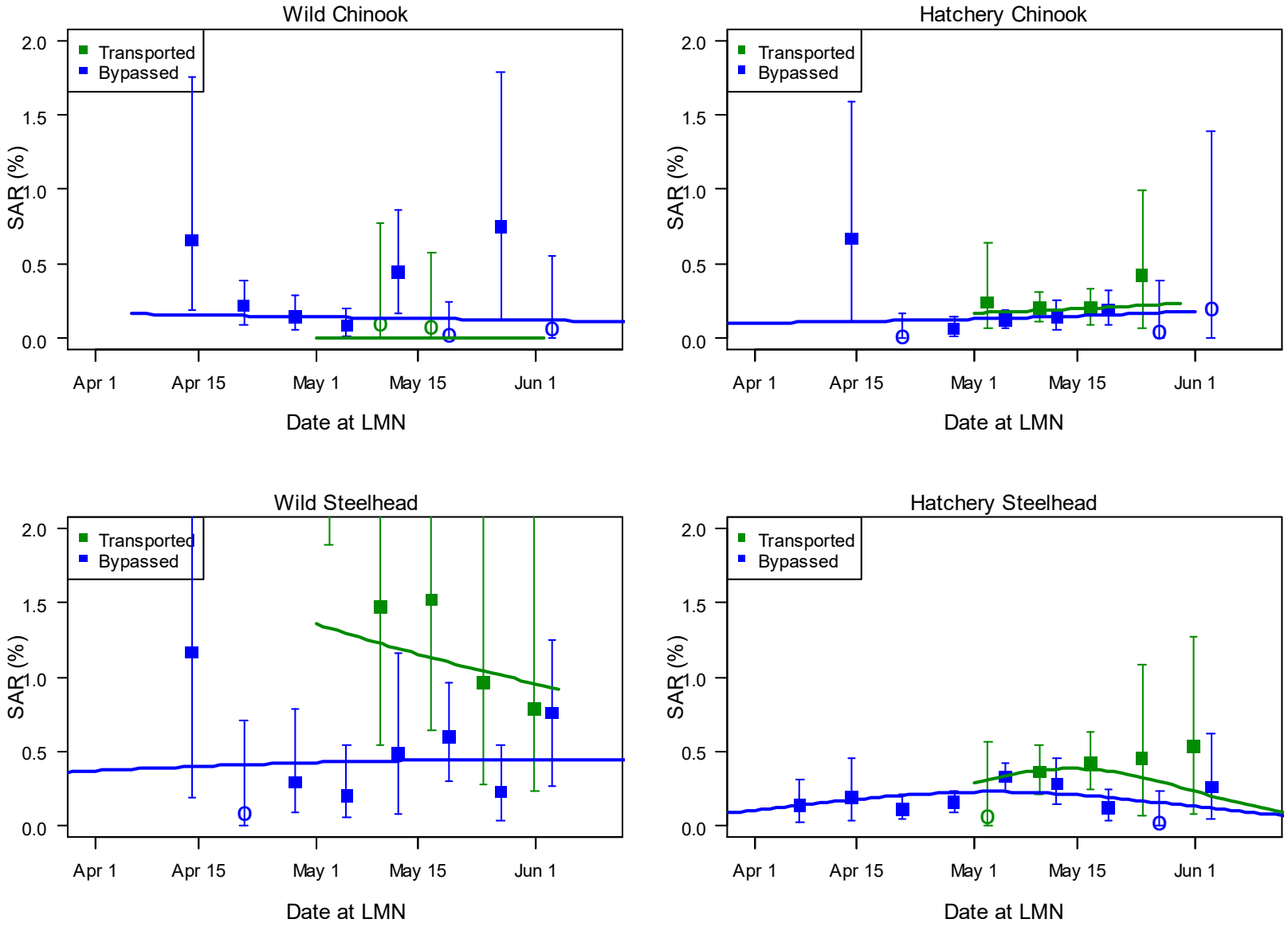
MY 2017

Transported or Bypassed at Little Goose Dam



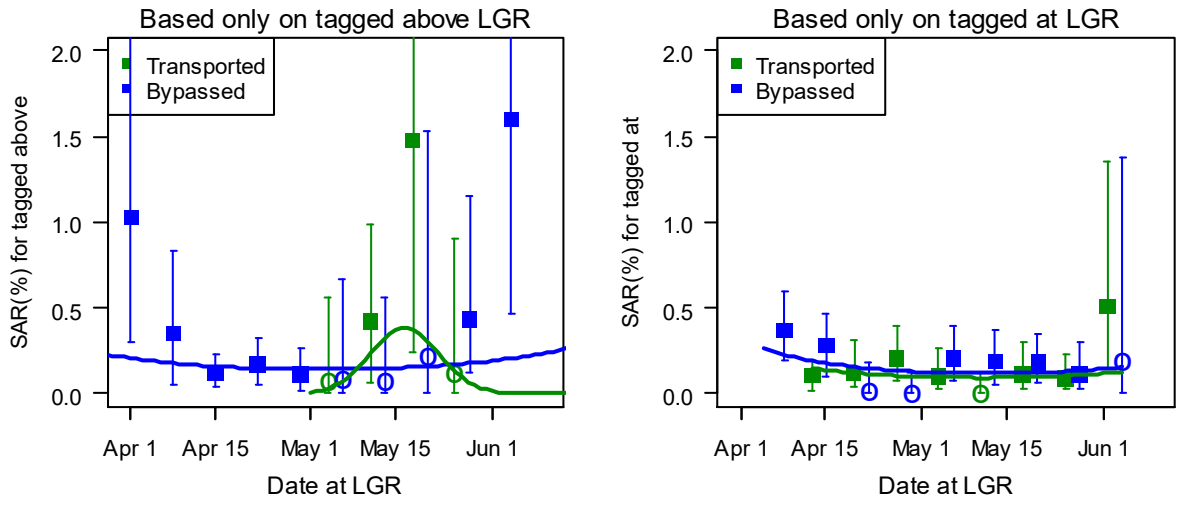
MY 2017

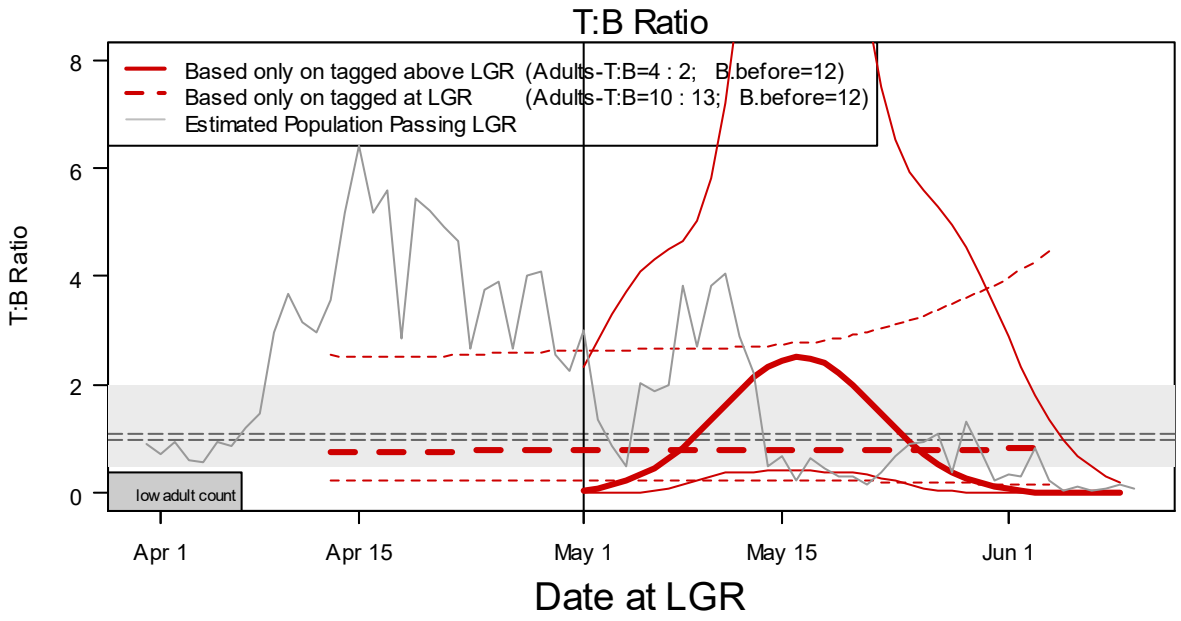
Transported or Bypassed at Lower Monumental Dam



Wild Chinook 2017

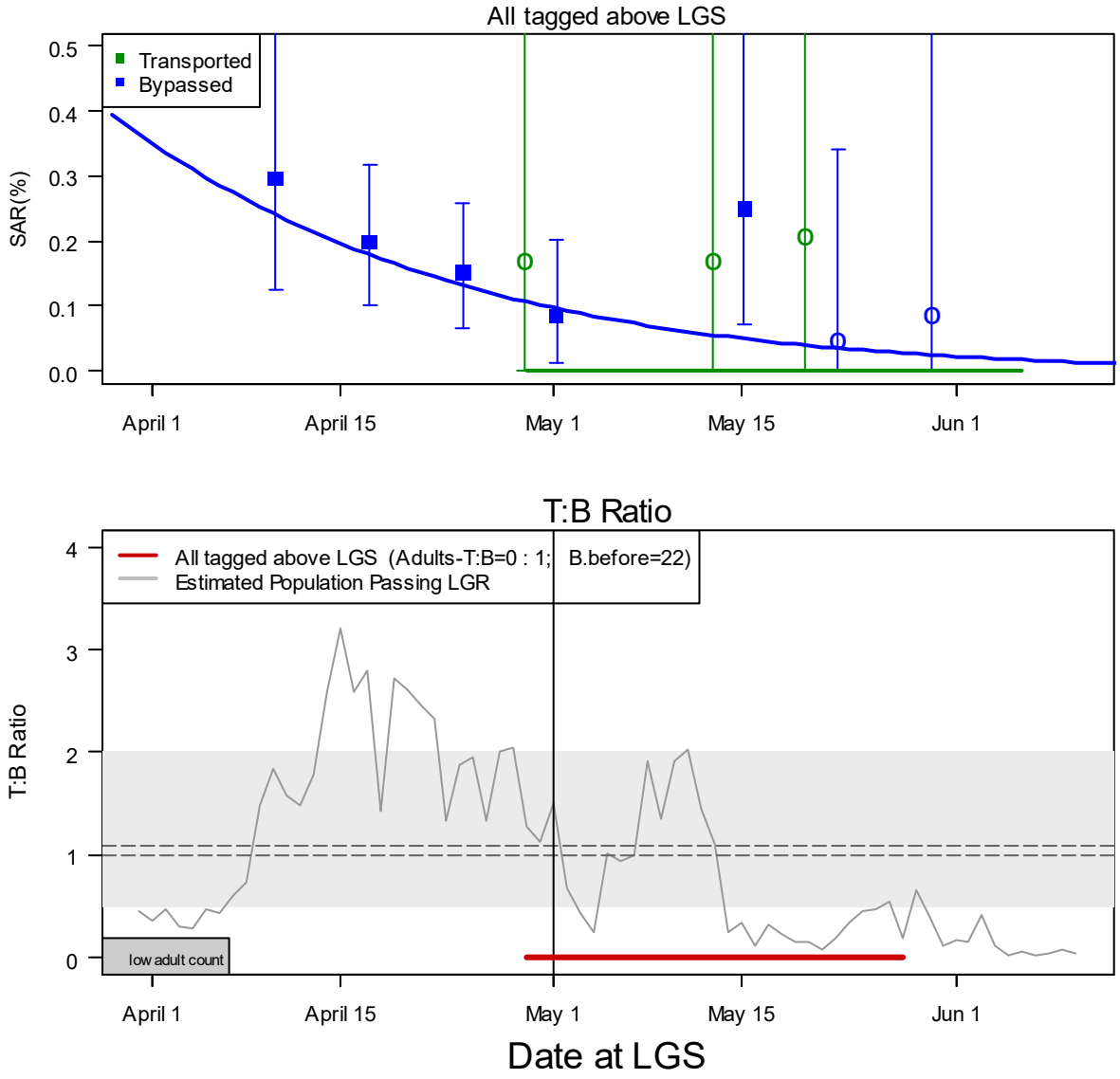
Transported or Bypassed at Lower Granite Dam





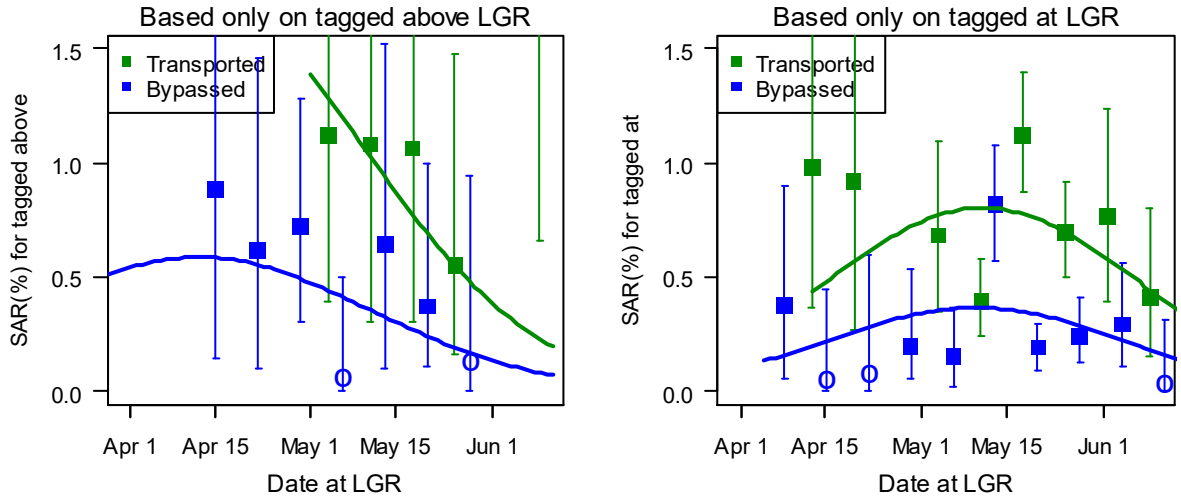
Wild Chinook 2017

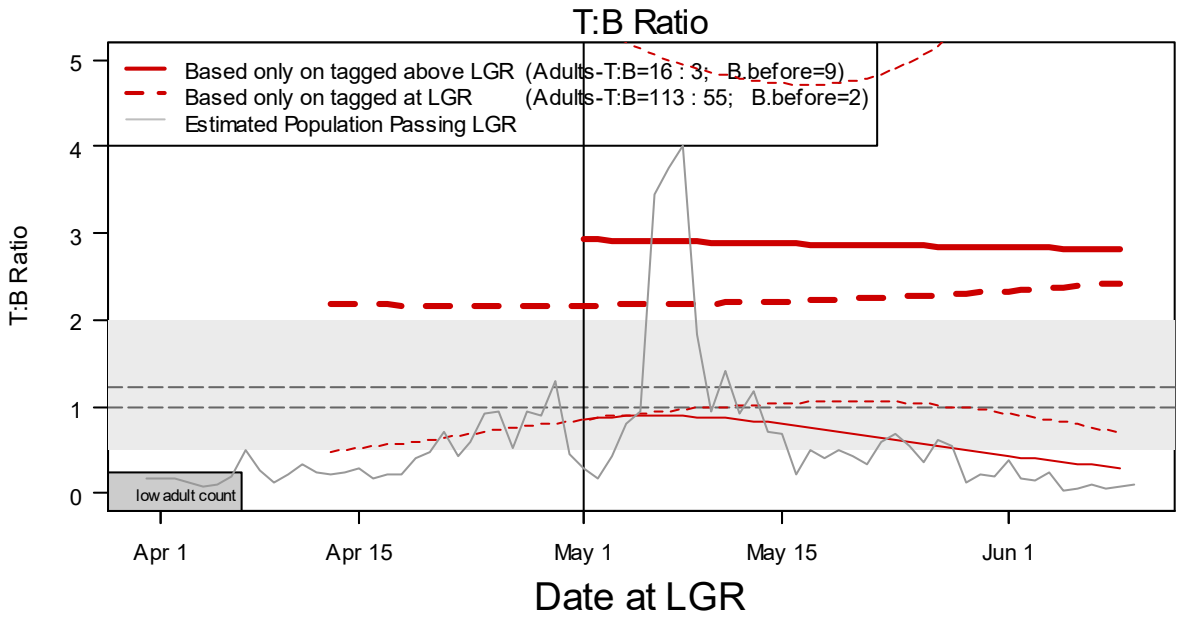
Transported or Bypassed at Little Goose Dam



Wild Steelhead 2017

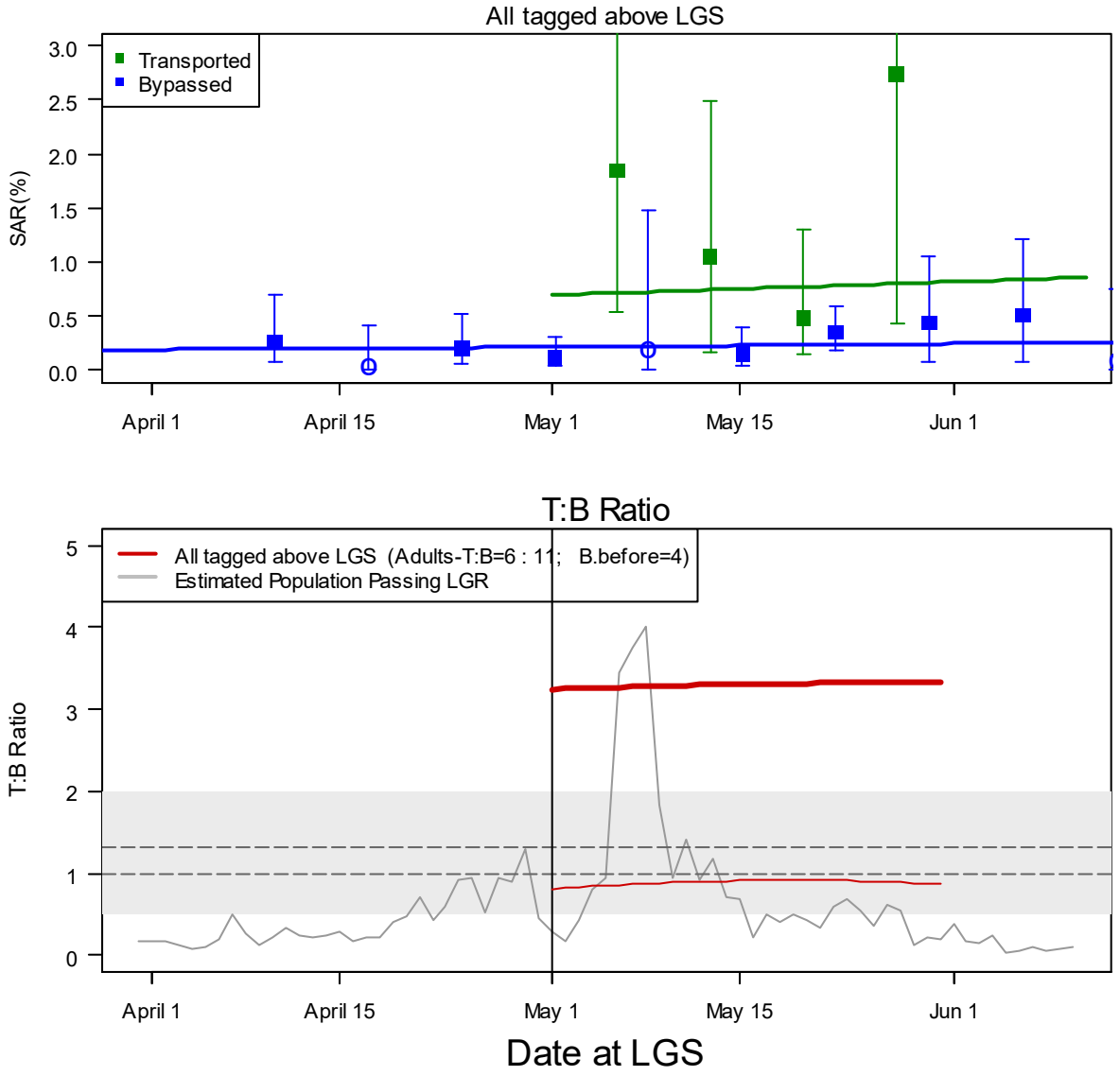
Transported or Bypassed at Lower Granite Dam





Wild Steelhead 2017

Transported or Bypassed at Little Goose Dam



April Research Barges
Fish Tagged at Lower Granite Dam

	Dates	Totals		
		SAR-Transport	SAR-Bypass	T:B Ratio
WILD CHINOOK SALMON				
2014	April 25	0.43 (0.26-0.69)	0.39 (0.20-0.63)	1.09 (0.55-2.47)
2015	April 13, 20	0.36 (0.10-0.71)	0.07 (0.02-0.20)	4.99 (0.97-25.3)
2016	--			
2017	April 13, 20, 27	0.13 (0.07-0.22)	0.12 (0.06-0.19)	1.12 (0.42-3.18)
STEELHEAD				
2014	April 25	2.22 (1.14-4.01)	2.20 (1.22-3.38)	1.01 (0.41-2.42)
2015	April 13, 20	0.11 (0.00-0.74)	0.50 (0.19-0.97)	0.22 (0.00-1.98)
2016	--			
2017	April 13, 20, 27	0.65 (0.18-1.27)	0.08 (0.02-0.28)	8.19 (1.77-41.4)

Annual Summaries

Wild Chinook Salmon
Annual Summary
Fish Tagged Upstream of LGR

	Before Transport Began	During Transportation Period		
	SAR-Bypass (90% CI)	SAR-Transport	SAR-Bypass	T:B Ratio
2015				
LGR	0.30 (0.13-0.50)	1.30 (0.73-2.01)	0.04 (0.00-0.25)	34.4 (6.97-50.3)
LGS	0.21 (0.06-0.41)	1.11 (0.56-1.76)	0.03 (0.00-0.19)	39.6 (8.42-58.7)
LMN	0.29 (0.08-1.02)	0.10 (0.00-0.68)	0.07 (0.00-0.46)	NA (NA-NA)
2016				
LGR	0.35 (0.26-0.44)	0.61 (0.40-0.91)	0.24 (0.10-0.47)	2.57 (1.17-7.26)
LGS	0.31 (0.22-0.41)	0.63 (0.32-1.02)	0.12 (0.02-0.28)	5.30 (1.85-33.3)
LMN	0.38 (0.25-0.54)	0.98 (0.28-1.92)	0.21 (0.03-0.51)	4.59 (1.25-28.8)
2017				
LGR	0.15 (0.09-0.23)	0.27 (0.08-0.53)	0.16 (0.03-0.37)	1.70 (0.46-10.7)
LGS	0.17 (0.11-0.24)	0.06 (0.00-0.37)	0.04 (0.00-0.29)	NA (NA-NA)
LMN	0.15 (0.08-0.23)	0.04 (0.00-0.25)	0.18 (0.03-0.42)	0.21 (0.00-1.30)

Wild Steelhead
Annual Summary
Fish Tagged Upstream of LGR

	Before Transport Began	During Transportation Period		
	SAR-Bypass (90% CI)	SAR-Transport	SAR-Bypass	T:B Ratio
2015				
LGR	0.27 (0.08-0.74)	0.15 (0.05-0.41)	0.20 (0.06-0.53)	0.78 (0.12-4.90)
LGS	0.12 (0.00-0.79)	0.15 (0.04-0.41)	0.17 (0.05-0.46)	0.90 (0.14-5.65)
LMN	0.66 (0.00-4.42)	0.15 (0.00-1.00)	0.18 (0.00-1.19)	NA (NA-NA)
2016				
LGR	0.73 (0.52-0.98	0.60 (0.36-0.95)	0.26 (0.07-0.51)	2.31 (0.95-7.33)
LGS	0.55 (0.36-0.78)	1.02 (0.52-1.64)	0.39 (0.11-0.67)	2.62 (1.01-9.23)
LMN	0.55 (0.28-0.95)	1.77 (0.62-3.21)	0.06 (0.00-0.38)	30.7 (6.26-53.5)
2017				
LGR	0.64 (0.29-0.98)	0.97 (0.61-1.39)	0.22 (0.08-0.42)	4.51 (1.87-17.3)
LGS	0.17 (0.06-0.33)	1.18 (0.42-2.13)	0.65 (0.27-1.14)	1.82 (0.59-5.74)
LMN	0.12 (0.03-0.32)	1.22 (0.69-2.02)	0.53 (0.22-0.93)	2.32 (0.94-6.11)

Summary

- 2015: see above
- 2016: T:B ratio > 2; both species, all 3 dams
- 2017: low T:B ratios for wild Chinook; 2+ for wild steelhead
- Annual and weekly SARs mostly below 1% for both stocks

Summary / Conclusions

- Results tend to be similar for Lower Granite and Little Goose Dams
  - About 75-80% of transported fish

- Lower Monumental: fewer fish transported, less PIT-tag data, lower T:B ratios (often ~ 1.0)

Summary / Conclusions

- Less seasonality in T:B ratios in recent years (lines flatter)
- Higher than average T:B ratios in May 2015 and 2016, but only wild steelhead had high T:B's everywhere in 2017
- More fish migrating in April in recent years
  - Transportation began around April 24 in 2018 and 2019, but fish arrived earlier, especially in 2019

Next for this project

- Further data reduction through multi-year analysis with parameters tied across years and covariates
- Updated data report completed in first half of 2020
- Multi-year synthesis analysis reported next year; report in winter 2020-2021

Questions?

Caveats: SAR regression analyses

- 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 (C1)
  - Subject to confounding of mortality and straying

  - NUMEROUS: 20 years x 4 species/rearing types x 3 dams =240 data sets

- Analyses are not:
  - Based on planned, designed experiments
  - Able to say much about transport in April, 2006-2014
  - Prescriptive for transport on particular dates or particular conditions
  - Based on non-bypassed in-river migrants (C0), because C0 date of passage is unknown
  - Able to determine effects of transport on straying

Zero Adult Counts

"If nothing goes right, is everything all wrong?"

- **Median Unbiased Estimator** of Binomial Probability

10 trials, no successes: MUE = 3.35%

100 trials, no successes: MUE = 0.345%

1000 trials, no successes: MUE = 0.0345%

HOWEVER, sum 3 weeks with 100 trials: 0/300 MUE = 0.115%