NOAA FISHERIES

Northwest Fisheries Science Center

Smolt Survival and Travel Time & Transportation Analyses

Update with 2021 Data

USACE Anadromous Fish Evaluation Program

Annual Review 2021

January 11, 2022

Steven G. Smith
steven.g.smith@noaa.gov

Outline – Smolt Survival

- Migration conditions, travel time and survival of PIT-tagged smolts through the hydropower system in 2021

  - Preliminary Results Memo: October 7, 2021 – no bird recovery data
  - Today – bird recovery data from estuary included
  - Draft report to BPA in prep
    – potential to include mid-river bird recovery data

    - Only those fish left to migrate in-river

    - Only juvenile data, not survival to adult

2021 Spring Conditions

- Flow well below average throughout season
- Water temperature above average most of season
- Record high spill percentage
- Moderate dissolved gas,
  probably because of low flow

2021 Spring Migration

- Travel times
  - Slightly shorter than in other recent low-flow years
- Less than 10% transported
- Very low numbers passed dams via juvenile bypass systems
  - Low PIT-tag detection probabilities (data quality diminished)
  - Low numbers collected for transportation

2021 Spring Survival Estimates

- Snake River Yearling Chinook: Near average
- Snake River Steelhead: Below average
- Columbia River Yearling Chinook and Steelhead:
  - Below average both to McNary Dam, and in lower Columbia
- McNary-to-Bonneville below average for multiple stocks
- Generally imprecise because of low detection rates
  - some >100%, likely for same reason

PIT-tag Data Sources

Hatchery Releases

Chief Joseph

Wells

Grand Coulee

Rocky Reach

Rock Island

Wanapum

Priest Rapids

Ice Harbor

Snake R. trap

Lower Granite

Little Goose

Lower Monumental

McNary

John Day

The Dalles

Bonneville

Juvenile detectors

PIT-trawl
Bird colonies
Pile dike
PIT barge

Hatchery & Trap Releases

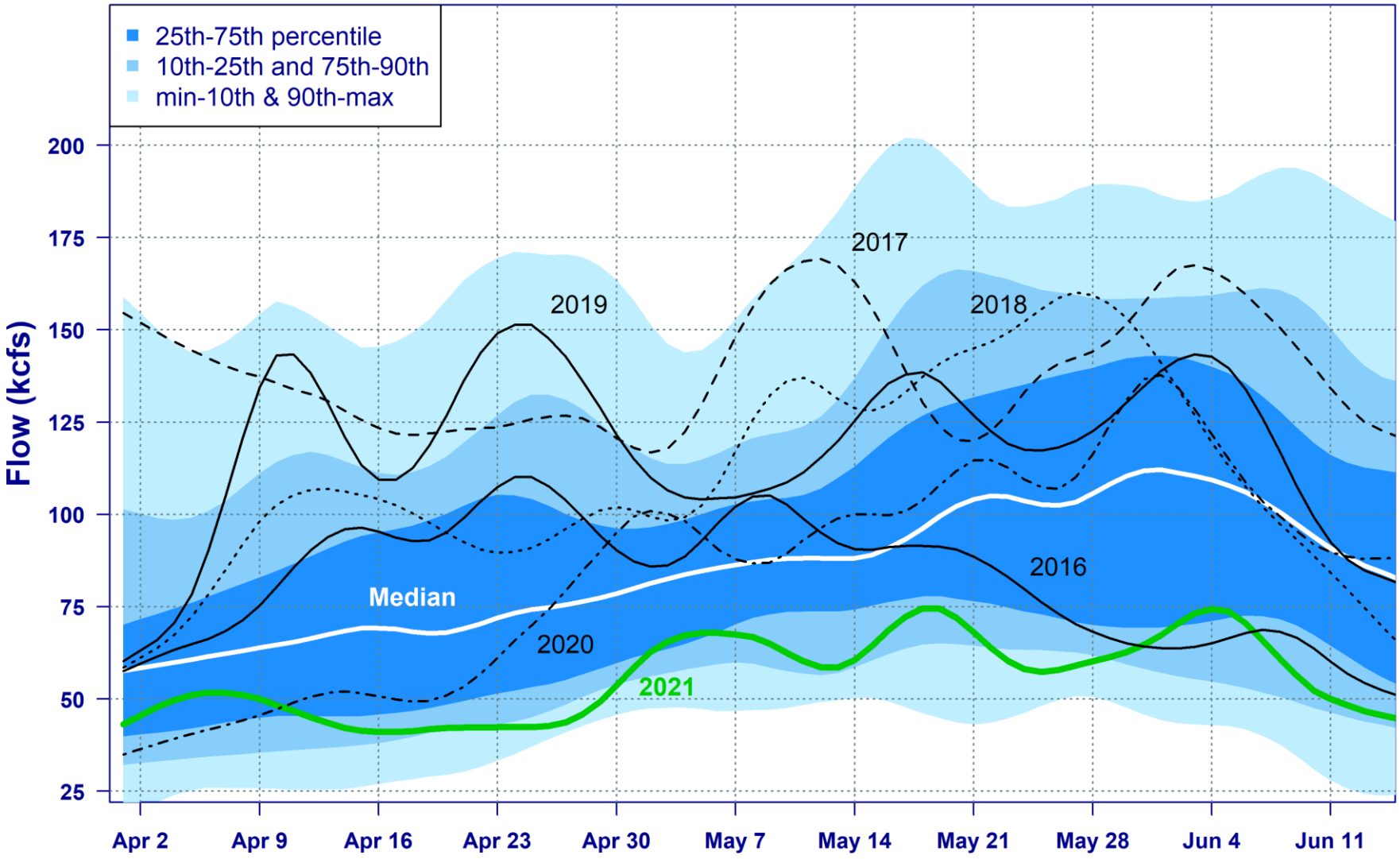
Hells Canyon

Oxbow

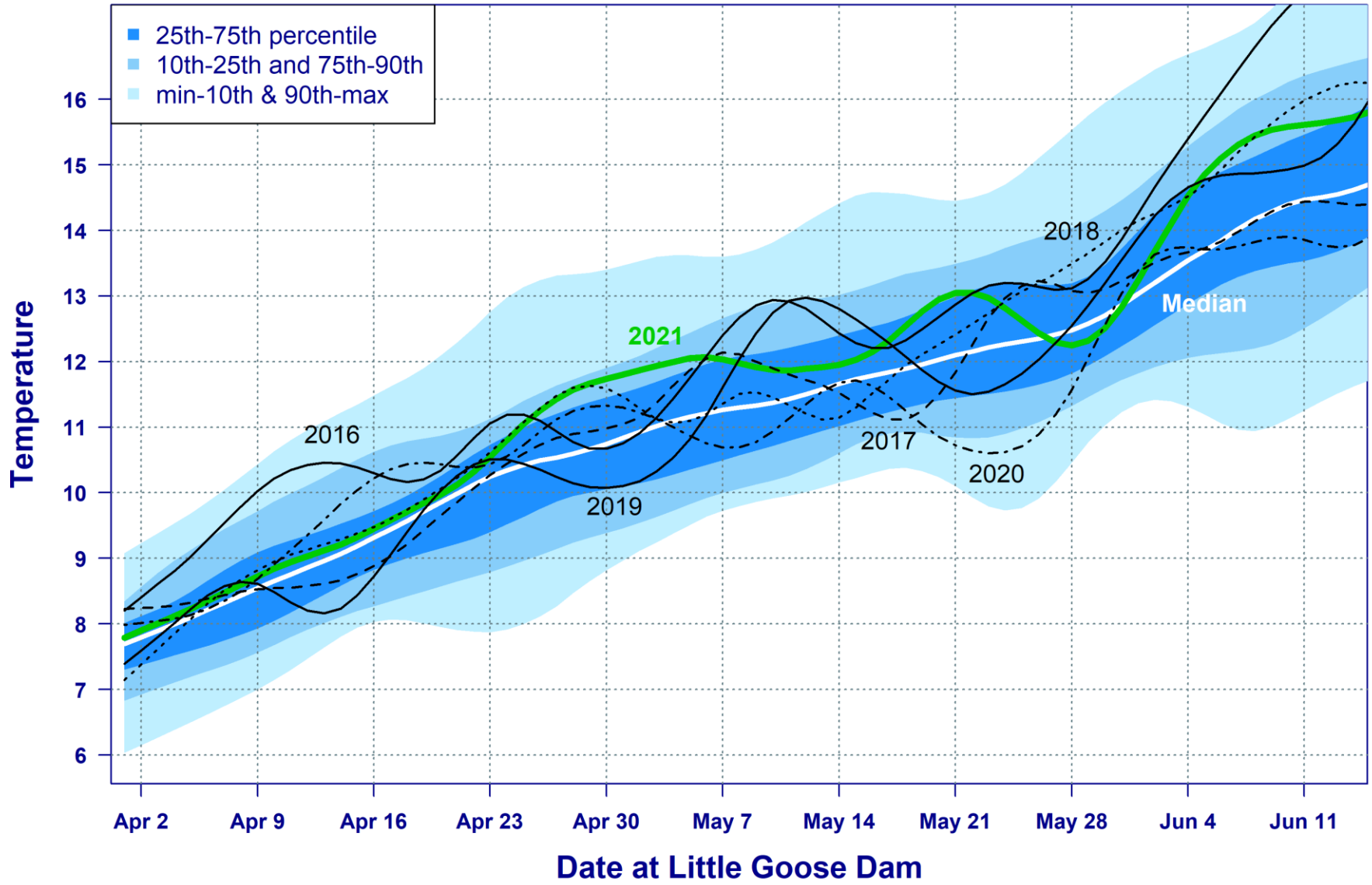
Brownlee

N

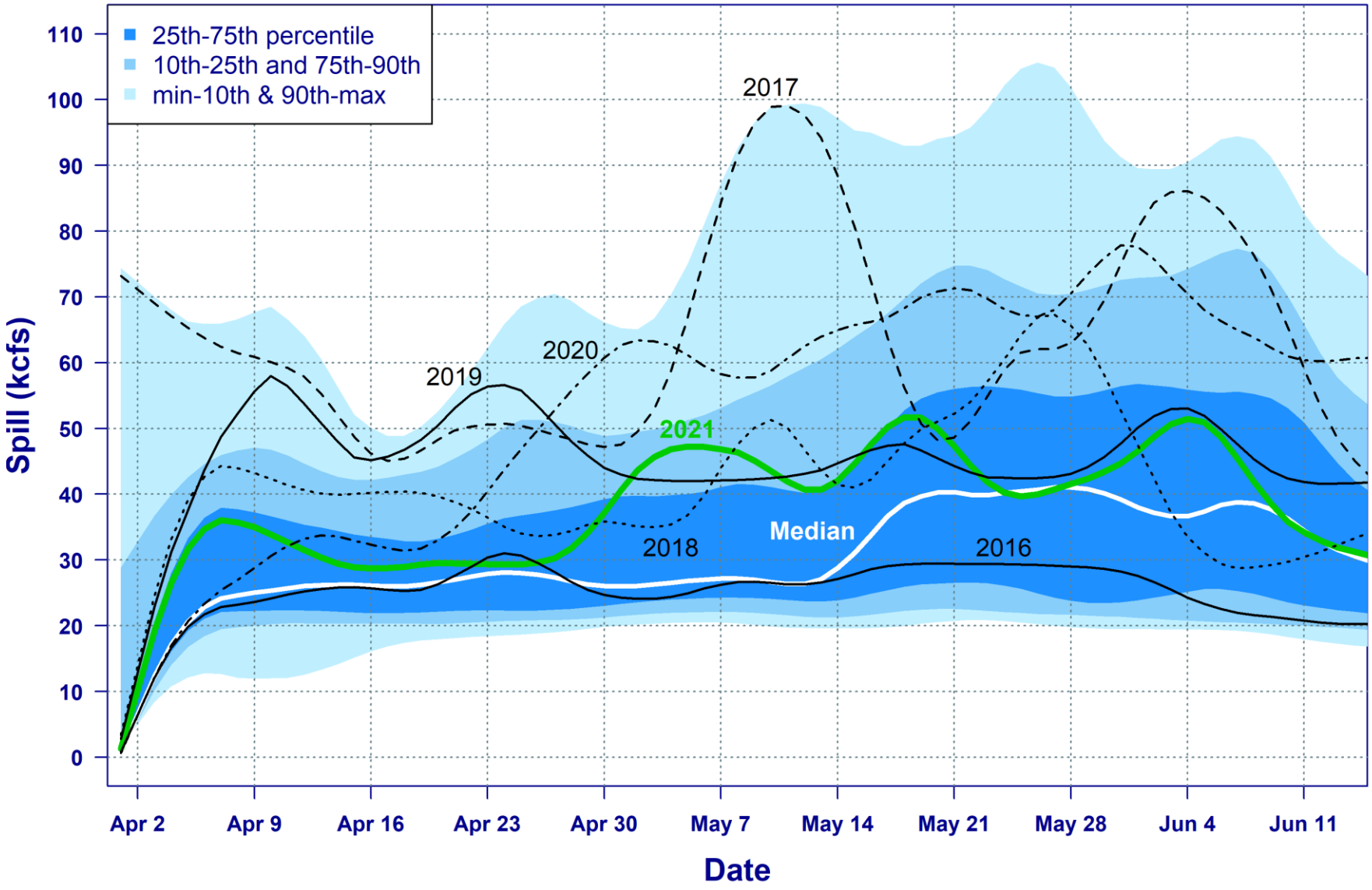
Daily Flow (kcfs) 1989-2021
Little Goose Dam



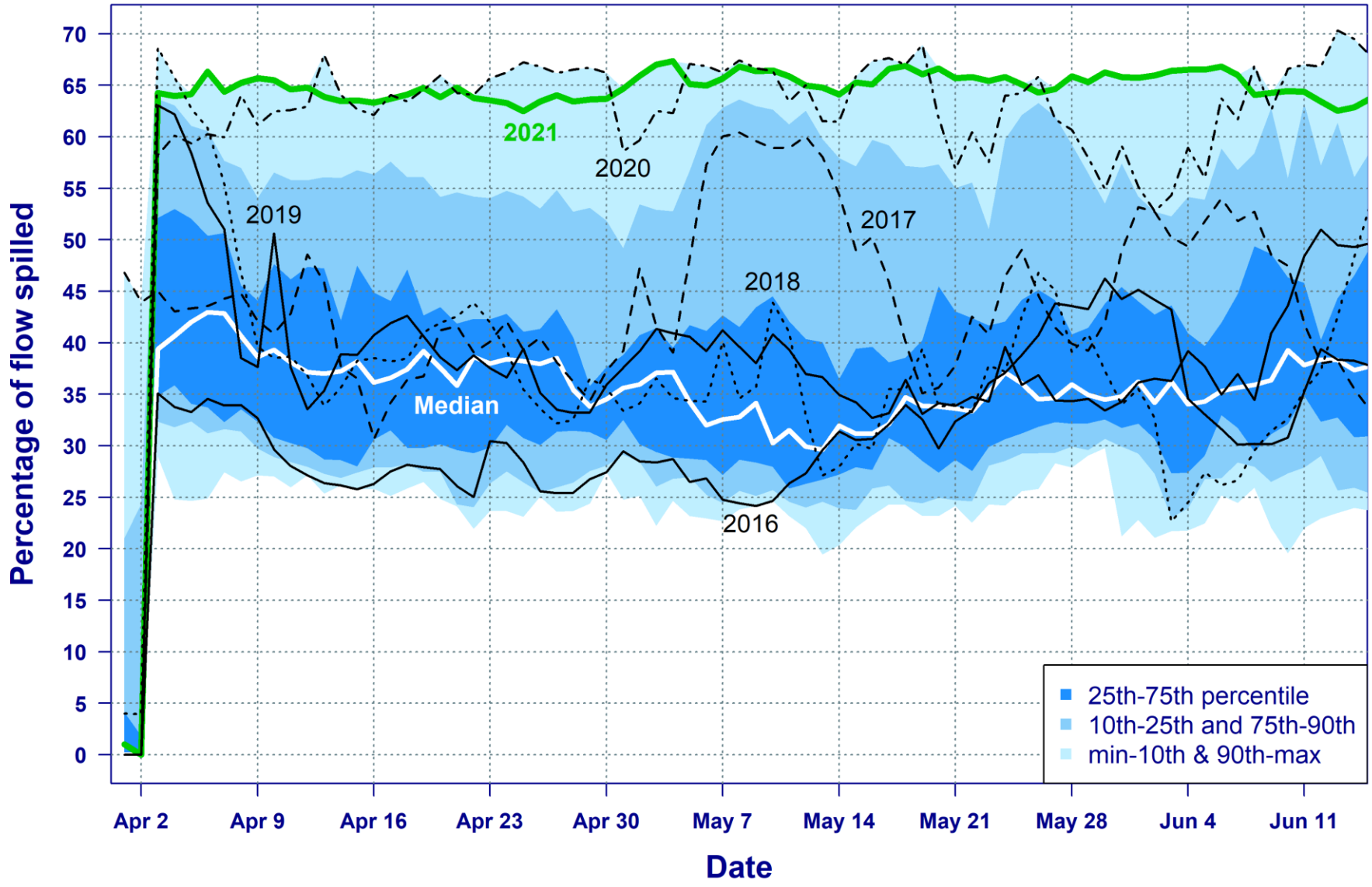
Daily Temperature 1990-2021
Little Goose Dam



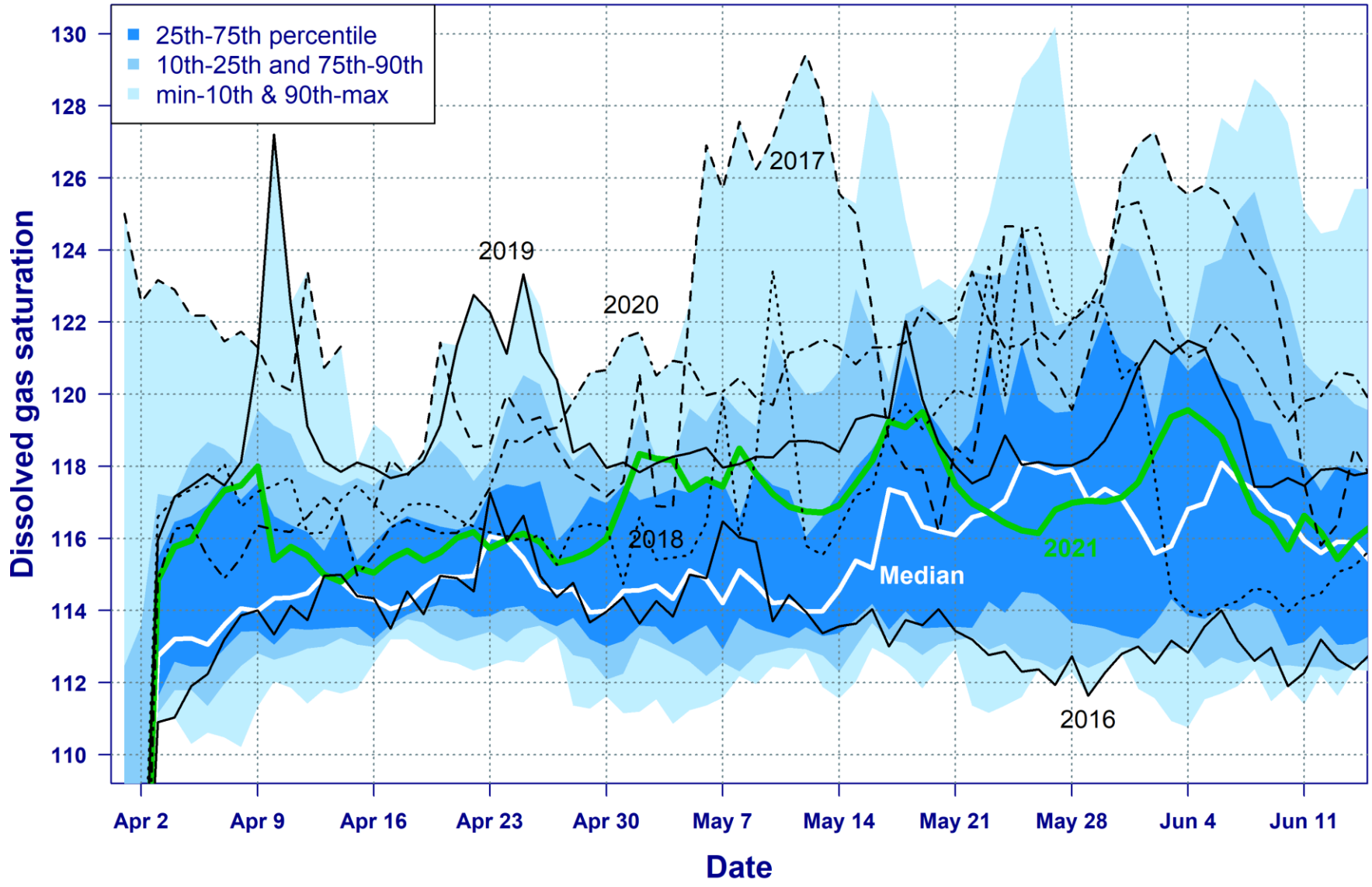
Daily Spill (kcfs) 2006-2021
Mean LGR, LGS, LMN

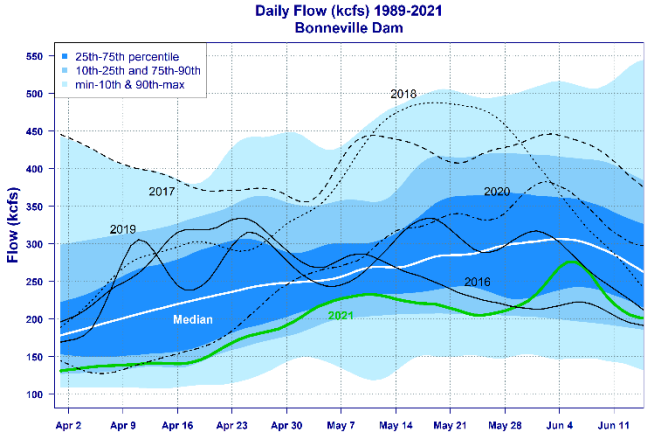


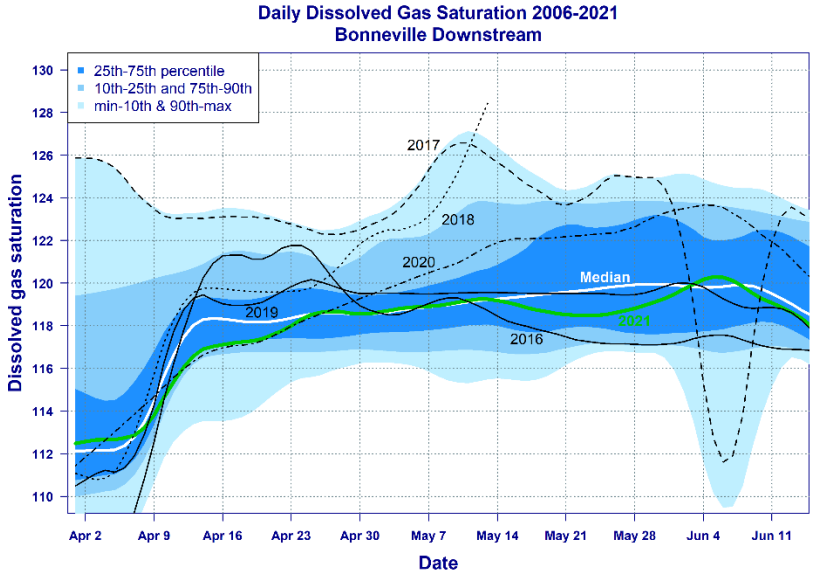
Daily %Spill 2006-2021
Mean LGR, LGS, LMN

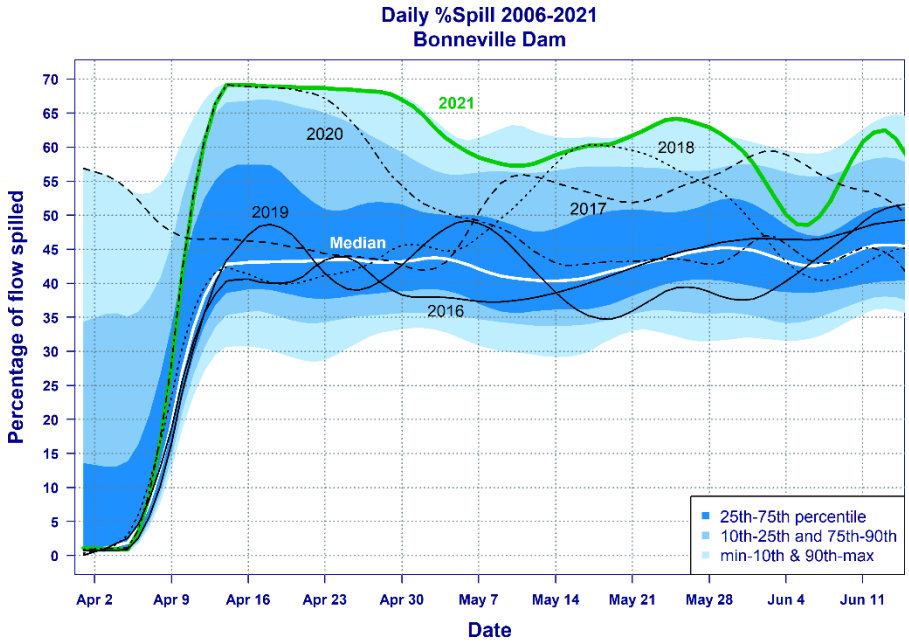


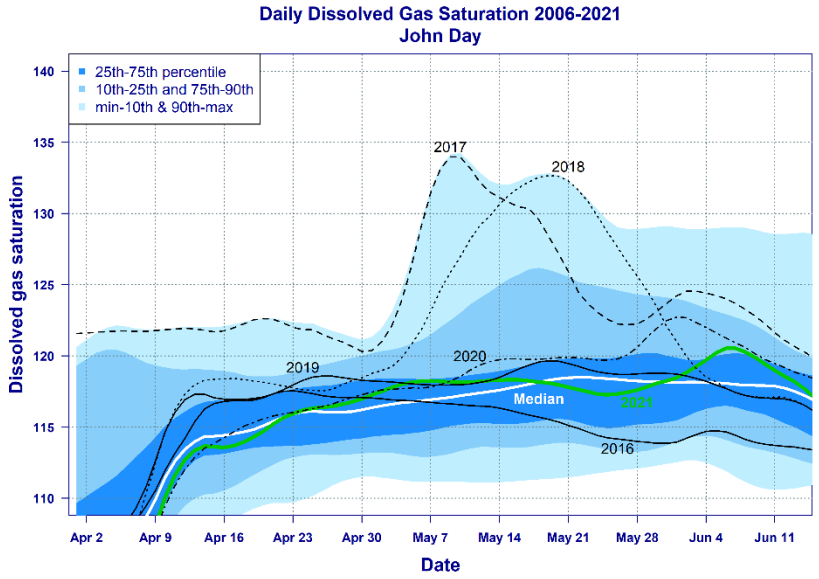
Daily Dissolved Gas Saturation 2006-2021
Mean LGR, LGS, LMN

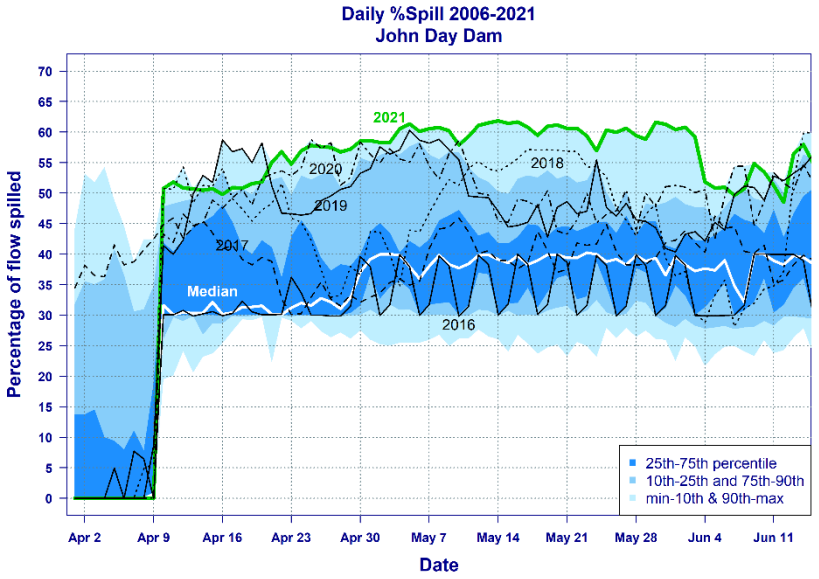


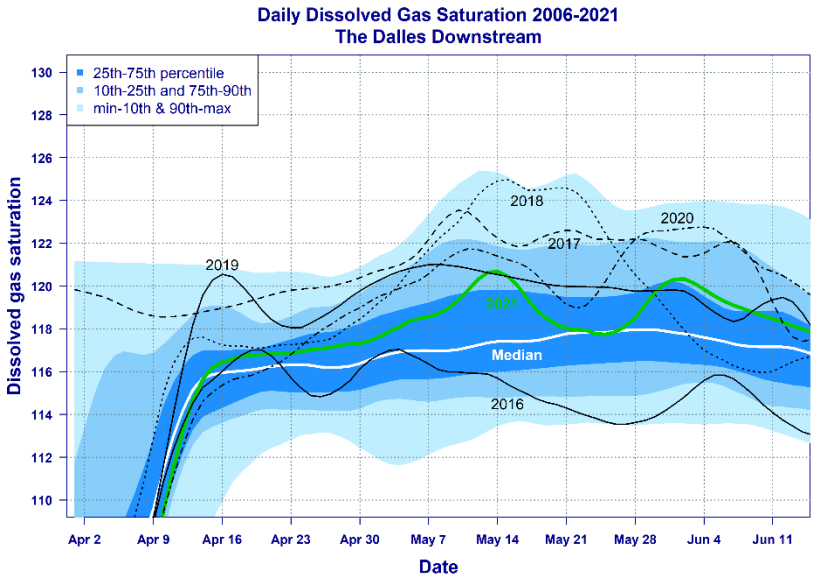

Daily Flow (kcfs) 1989-2021
Bonneville Dam
25th-75th percentile
10th-25th and 75th-90th
min-10th & 90th-max
Flow (kcfs)
2018
2017
2020
2019
2016
Median
2021
Apr 2
Apr 9
Apr 16
Apr 23
Apr 30
May 7
May 14
May 21
May 28
Jun 4
Jun 11

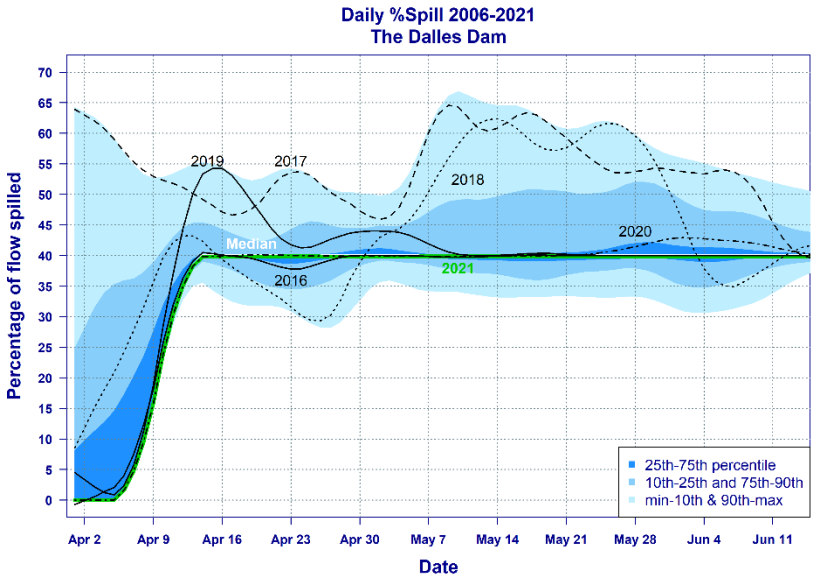

Daily Dissolved Gas Saturation 2006-2021
Bonneville Downstream
25th-75th percentile
10th-25th and 75th-90th
min-10th & 90th-max
Dissolved gas saturation
2017
2018
2020
Median
2019
2016
2021
Apr 2
Apr 9
Apr 16
Apr 23
Apr 30
May 7
May 14
May 21
May 28
Jun 4
Jun 11
Date


Daily %Spill 2006-2021
Bonneville Dam
Percentage of flow spilled
2021
2020
2018
2019
2017
Median
2016
25th-75th percentile
10th-25th and 75th-90th
min-10th & 90th-max
Apr 2
Apr 9
Apr 16
Apr 23
Apr 30
May 7
May 14
May 21
May 28
Jun 4
Jun 11
Date

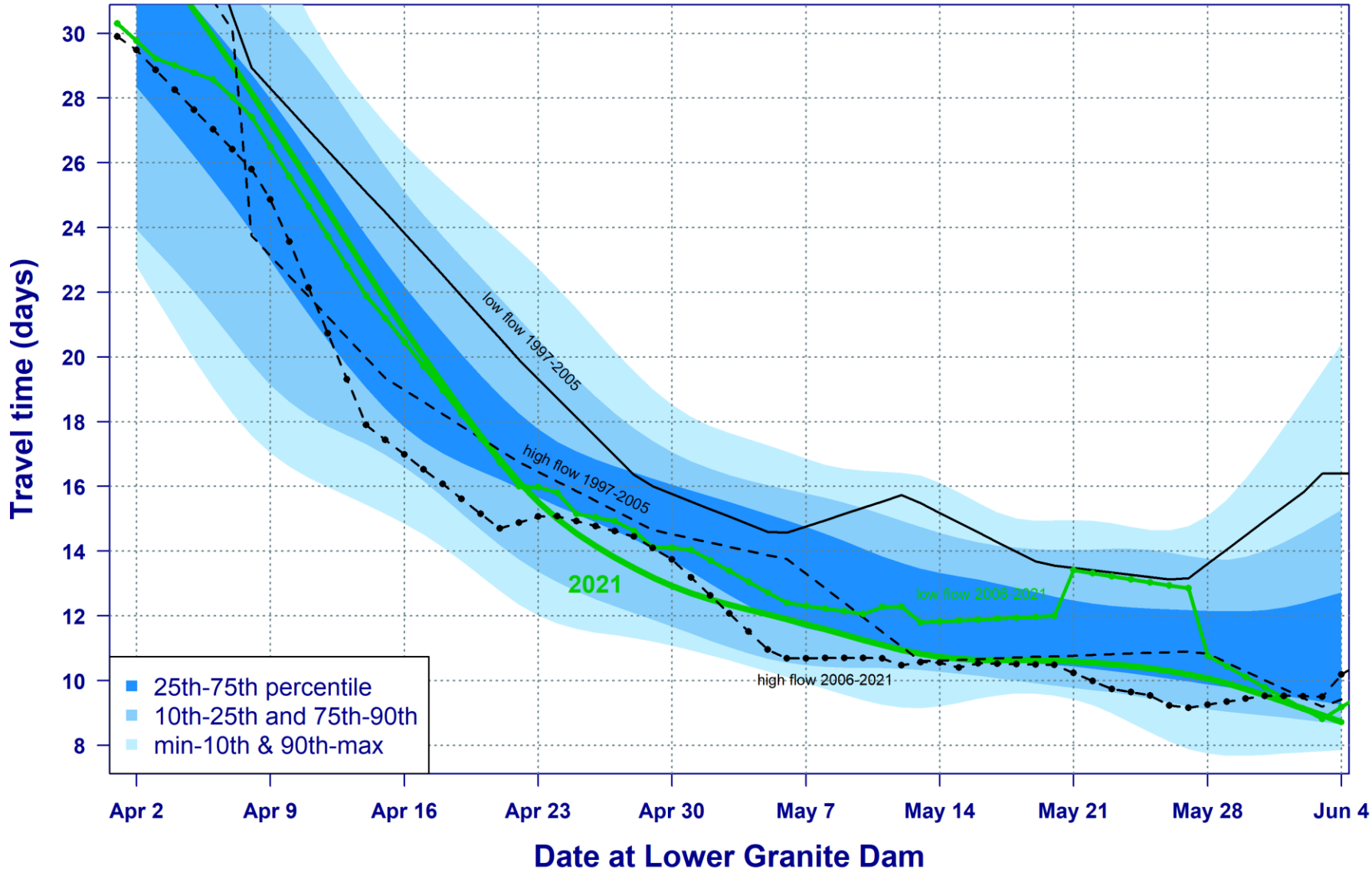

Daily Dissolved Gas Saturation 2006-2021
John Day
25th-75th percentile
10th-25th and 75th-90th
min-10th & 90th-max
Dissolved gas saturation
Date
2017
2018
2019
2020
Median
2021
2016


Daily %Spill 2006-2021
John Day Dam
Percentage of flow spilled
Date
2021
2020
2018
2019
2017
Median
2016
25th-75th percentile
10th-25th and 75th-90th
min-10th & 90th-max

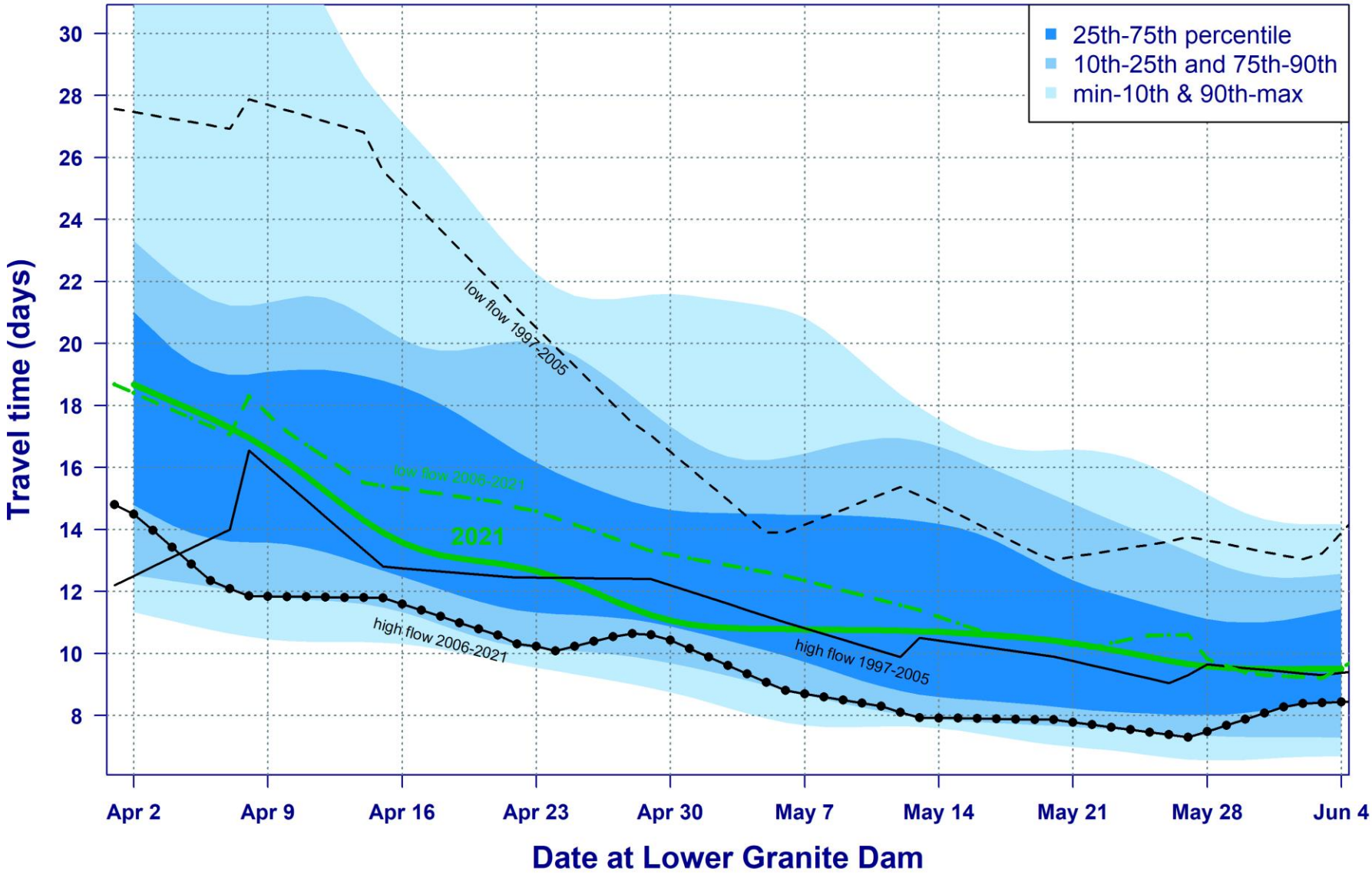

Daily Dissolved Gas Saturation 2006-2021
The Dalles Downstream
25th-75th percentile
10th-25th and 75th-90th
min-10th & 90th-max
Dissolved gas saturation
Date
2018
2020
2019
2017
2021
Median
2016


Daily %Spill 2006-2021
The Dalles Dam
Percentage of flow spilled
Date
2019
2017
2018
2020
Median
2021
2016
25th-75th percentile
10th-25th and 75th-90th
min-10th & 90th-max

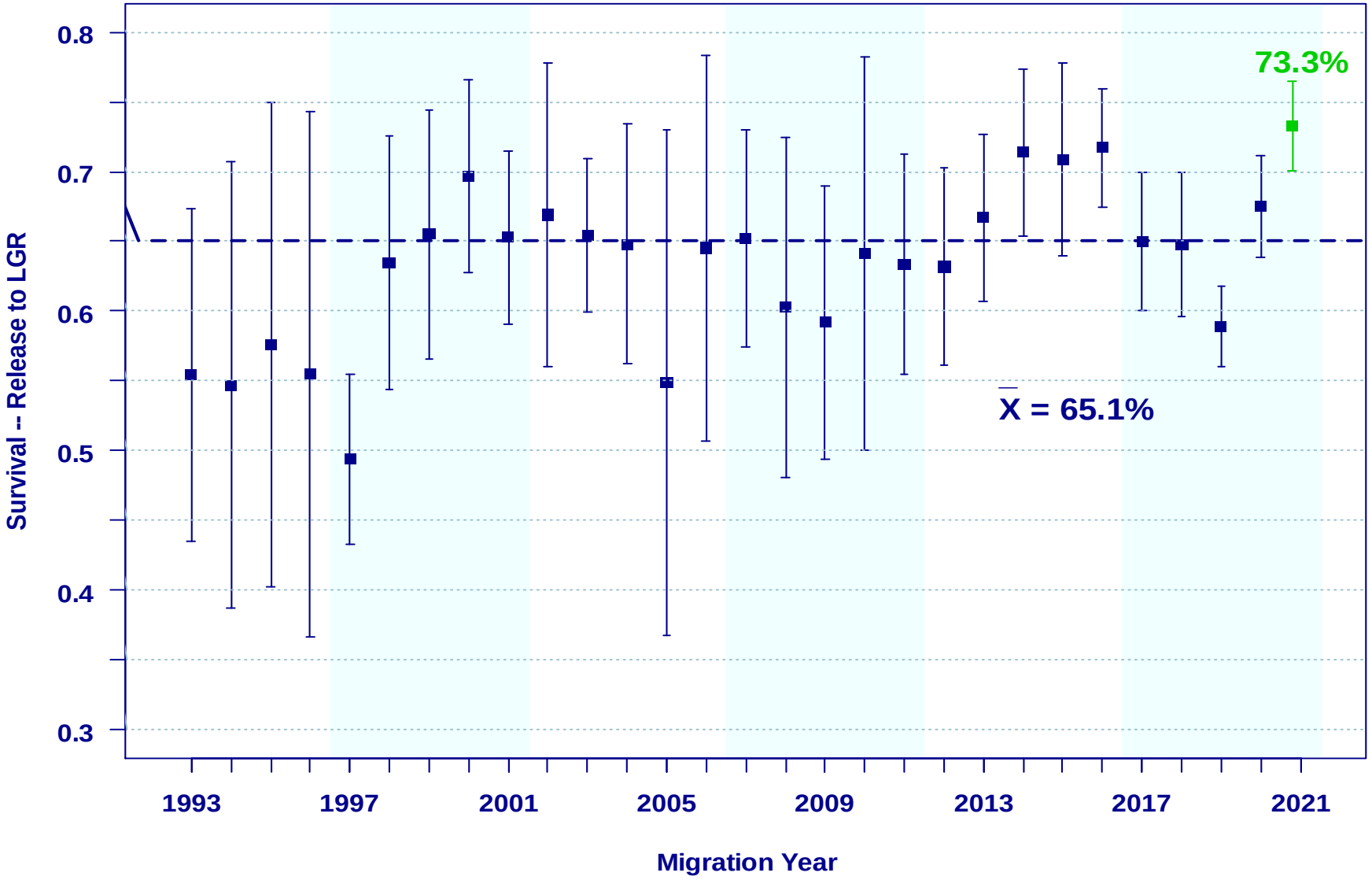
Chinook Travel Time 1997-2021 (exc. 2001)
Lower Granite to Bonneville (461 km)

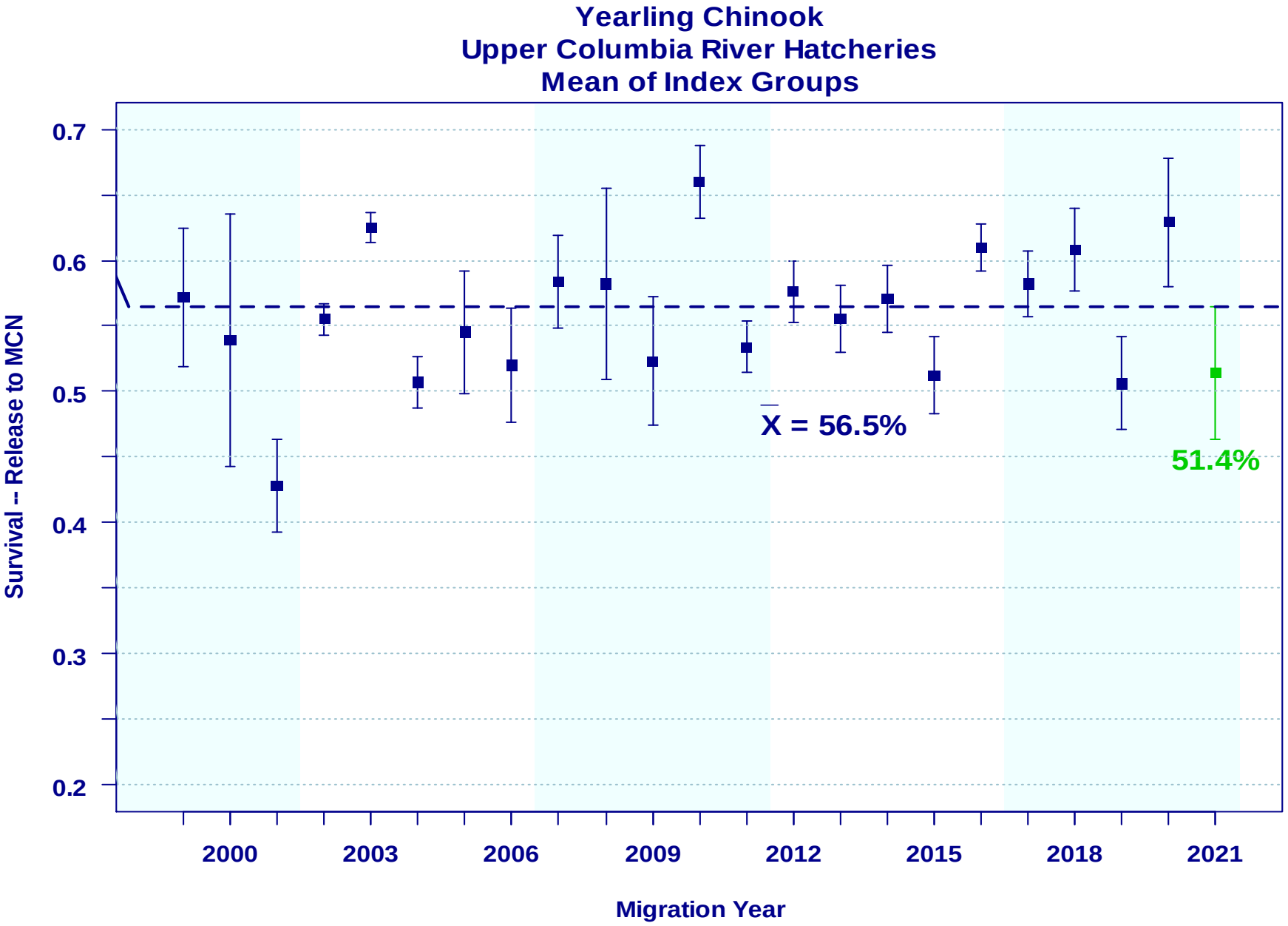


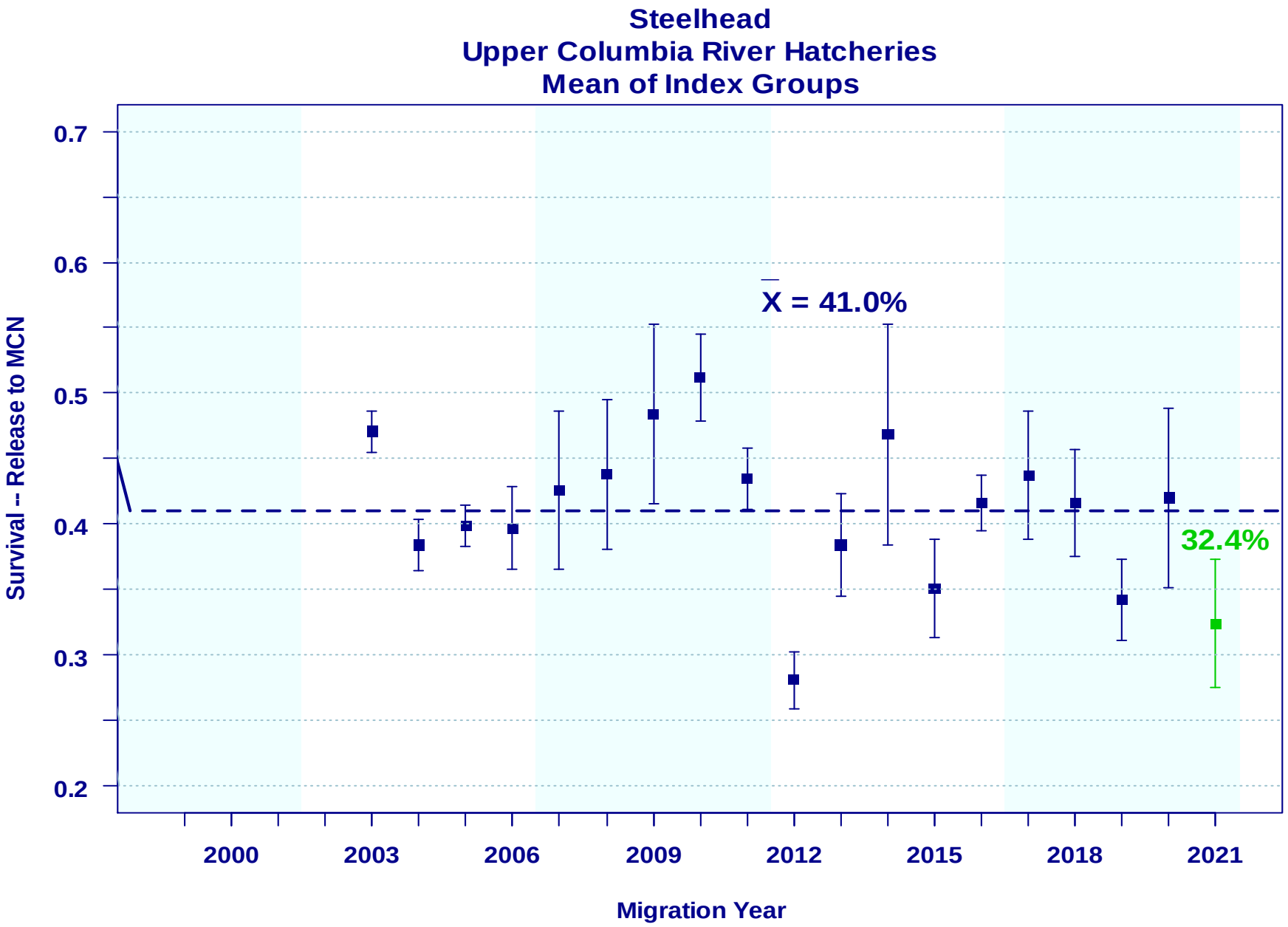
Steelhead Travel Time 1997-2021 (exc. 2001)
Lower Granite to Bonneville (461 km)

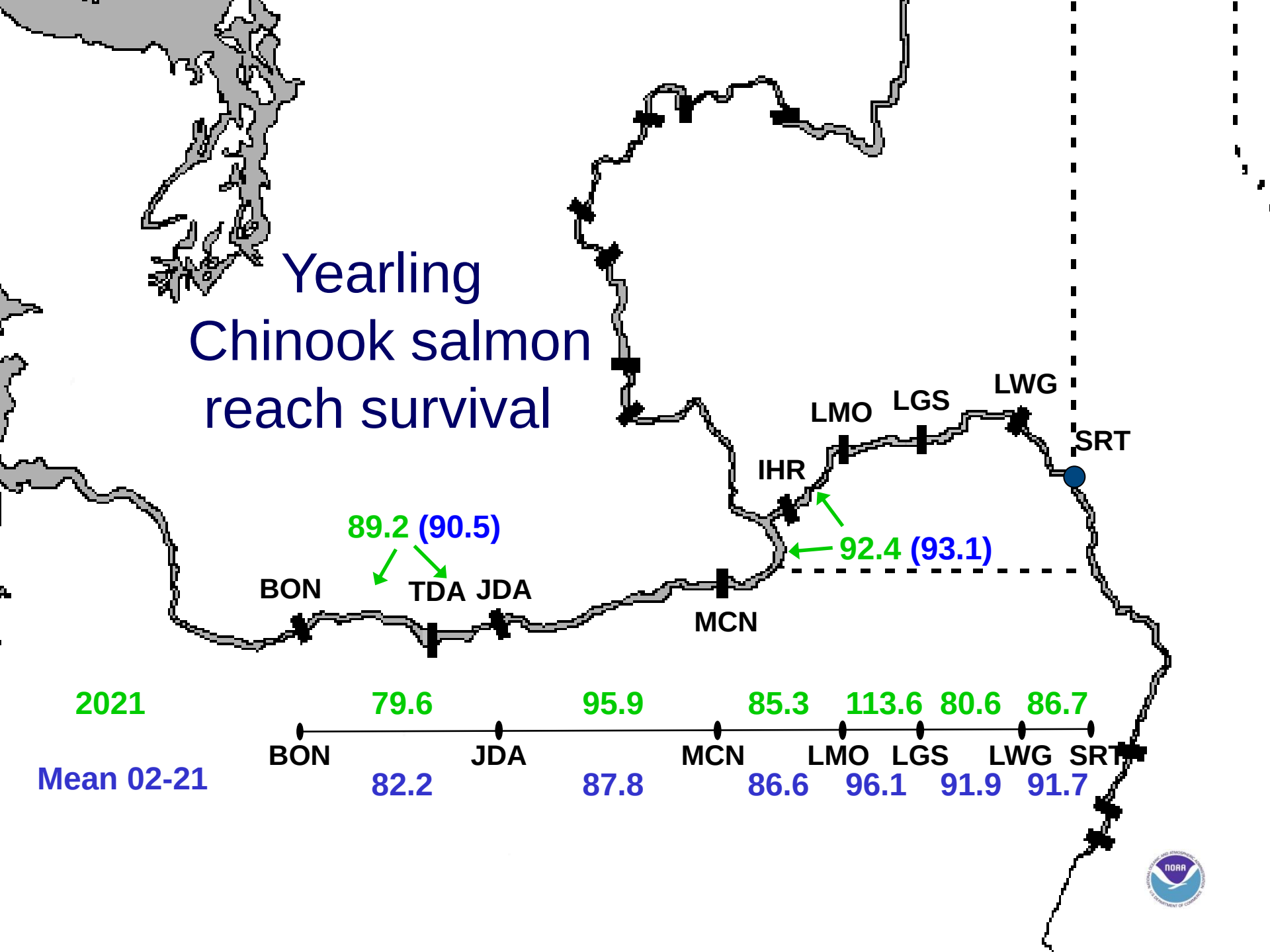


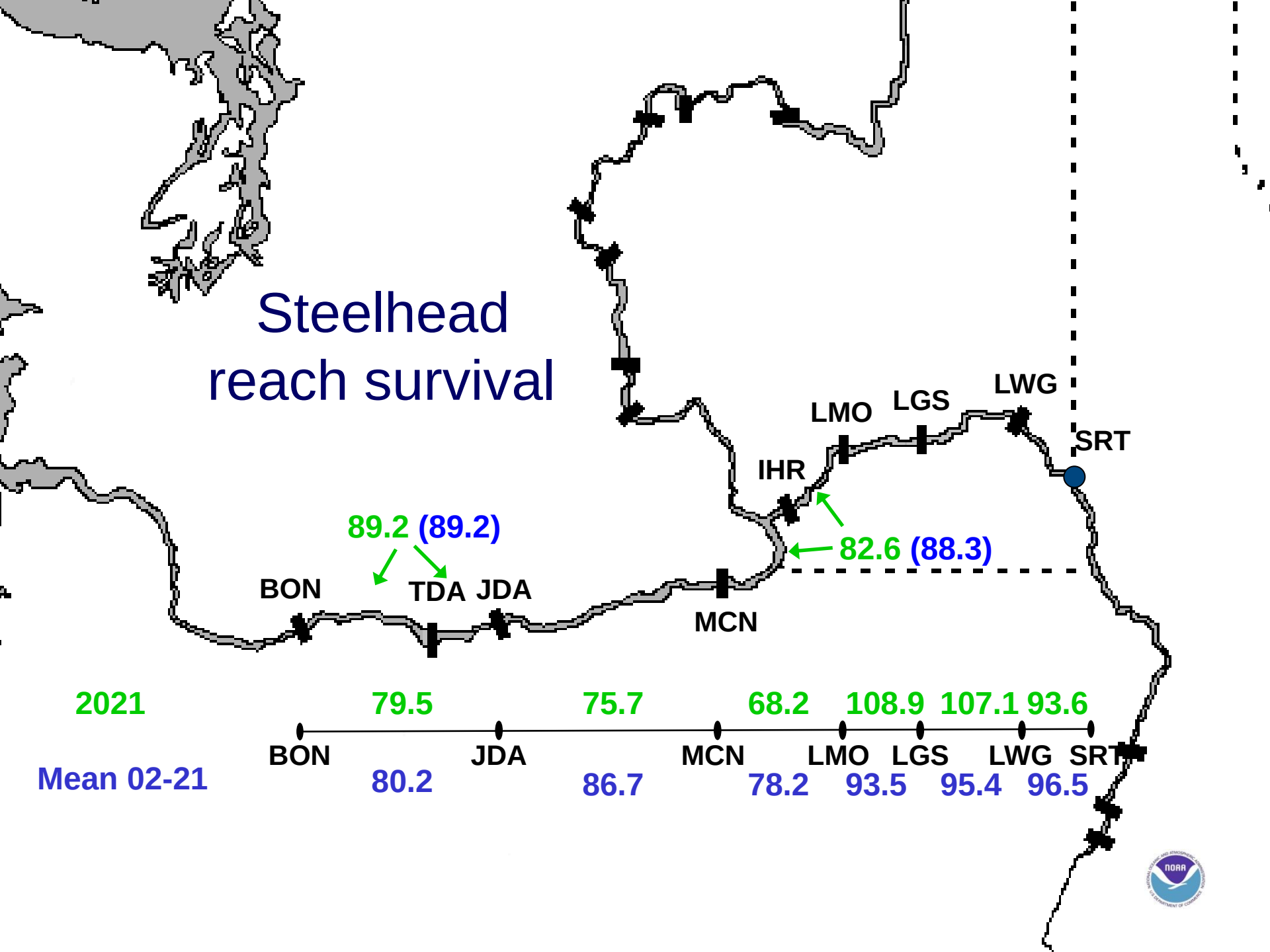
Yearling Chinook
Snake River Basin Hatcheries
Mean of Index Groups




Yearling Chinook
Upper Columbia River Hatcheries
Mean of Index Groups
Survival -- Release to MCN
0.7
0.6
0.5
0.4
0.3
0.2
X = 56.5%
51.4%
2000
2003
2006
2009
2012
2015
2018
2021
Migration Year

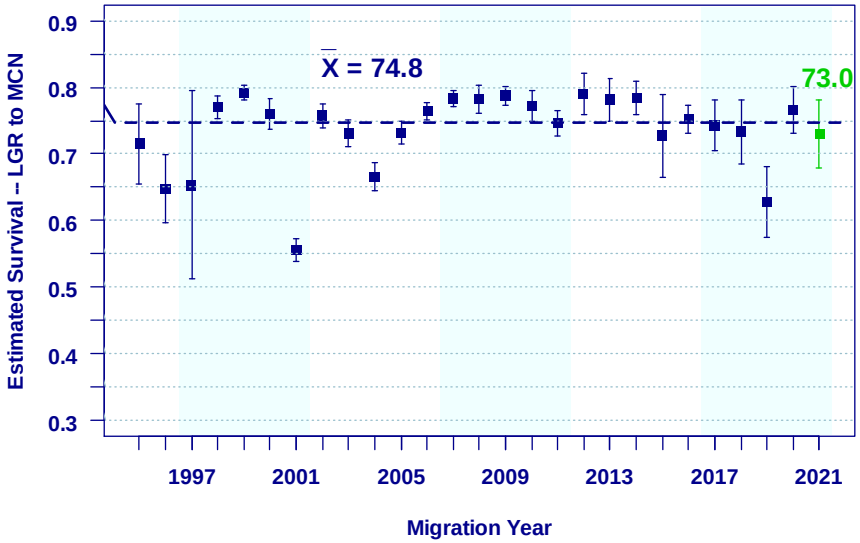

Steelhead
Upper Columbia River Hatcheries
Mean of Index Groups
Survival -- Release to MCN
0.7
0.6
0.5
0.4
0.3
0.2
X̄ = 41.0%
32.4%
2000
2003
2006
2009
2012
2015
2018
2021
Migration Year


Yearling
Chinook salmon
reach survival
LWG
LMO
LGS
SRT
IHR
89.2 (90.5)
92.4 (93.1)
BON
TDA
JDA
MCN
2021
79.6
95.9
85.3
113.6
80.6
86.7
BON
JDA
MCN
LMO
LGS
LWG
SRT
Mean 02-21
82.2
87.8
86.6
96.1
91.9
91.7

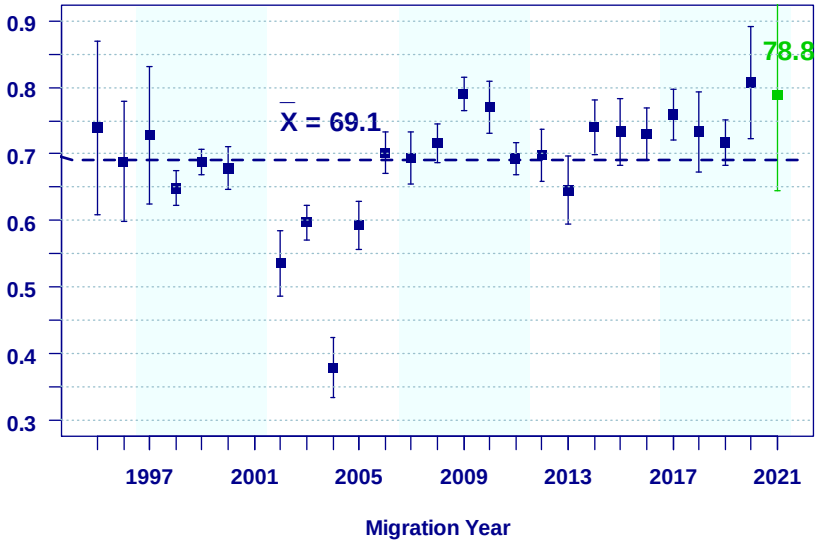

Steelhead
reach survival
LWG
LGS
LMO
SRT
IHR
89.2 (89.2)
82.6 (88.3)
BON
TDA
JDA
MCN
2021
79.5
75.7
68.2
108.9
107.1
93.6
BON
JDA
MCN
LMO
LGS
LWG
SRT
Mean 02-21
80.2
86.7
78.2
93.5
95.4
96.5

Lower Granite to McNary

Yearling Chinook



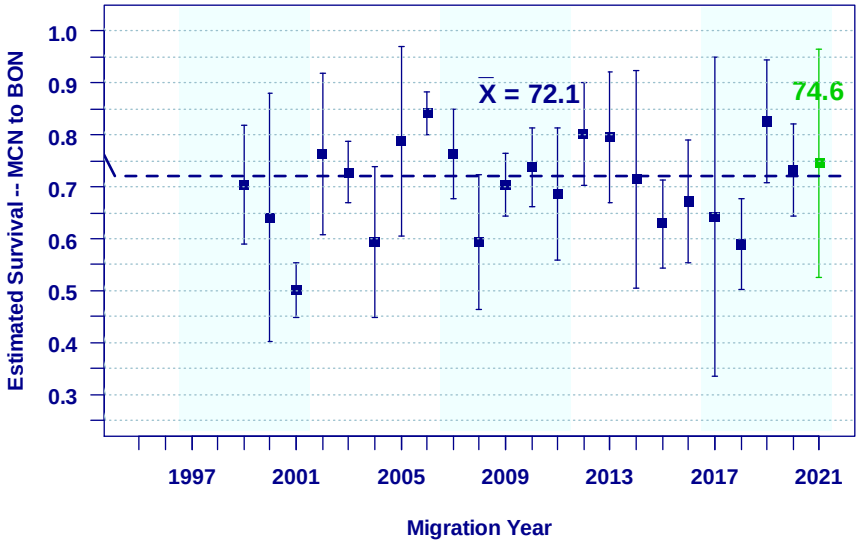
Steelhead



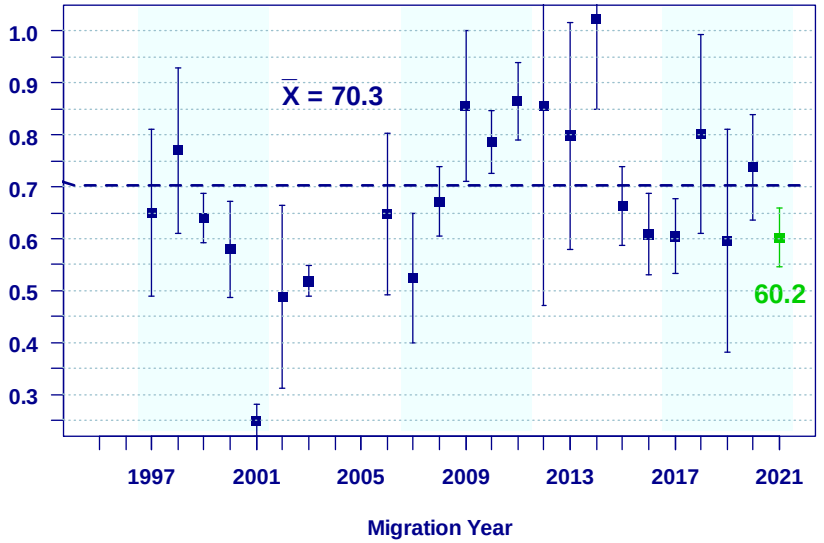
McNary to Bonneville

Fish from Snake River

Yearling Chinook



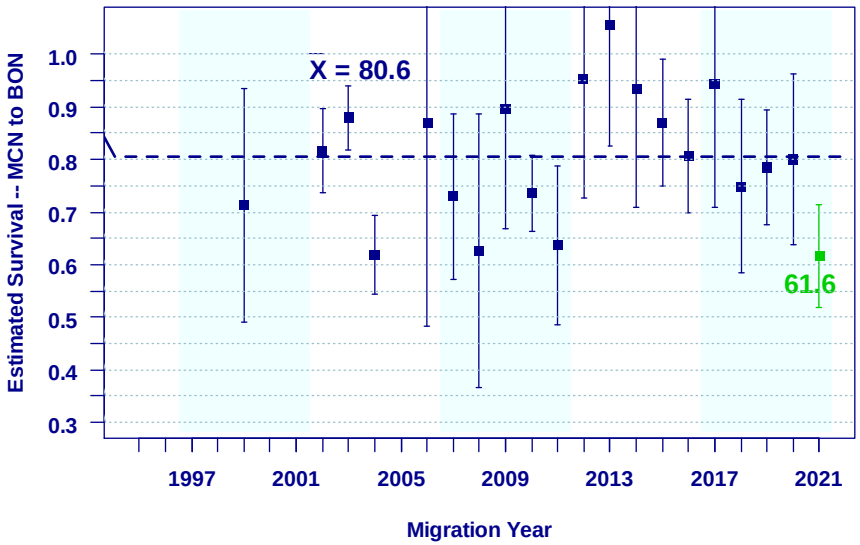
Steelhead



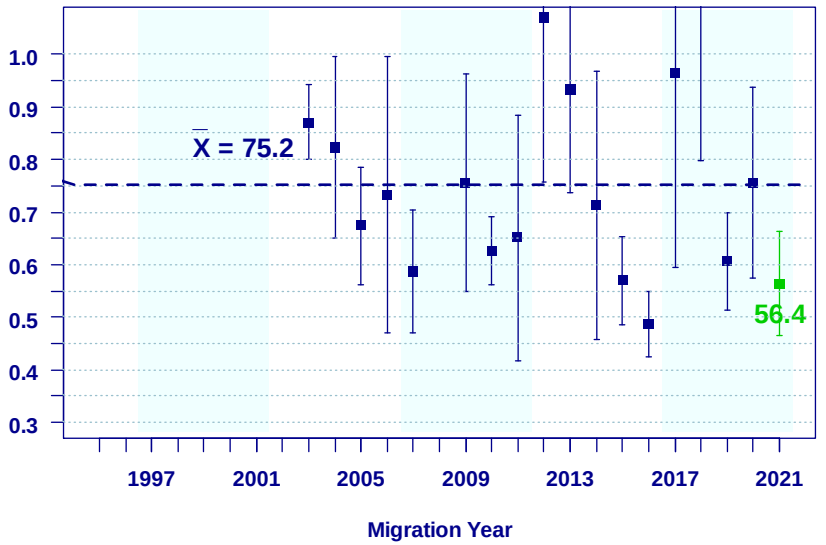
McNary to Bonneville

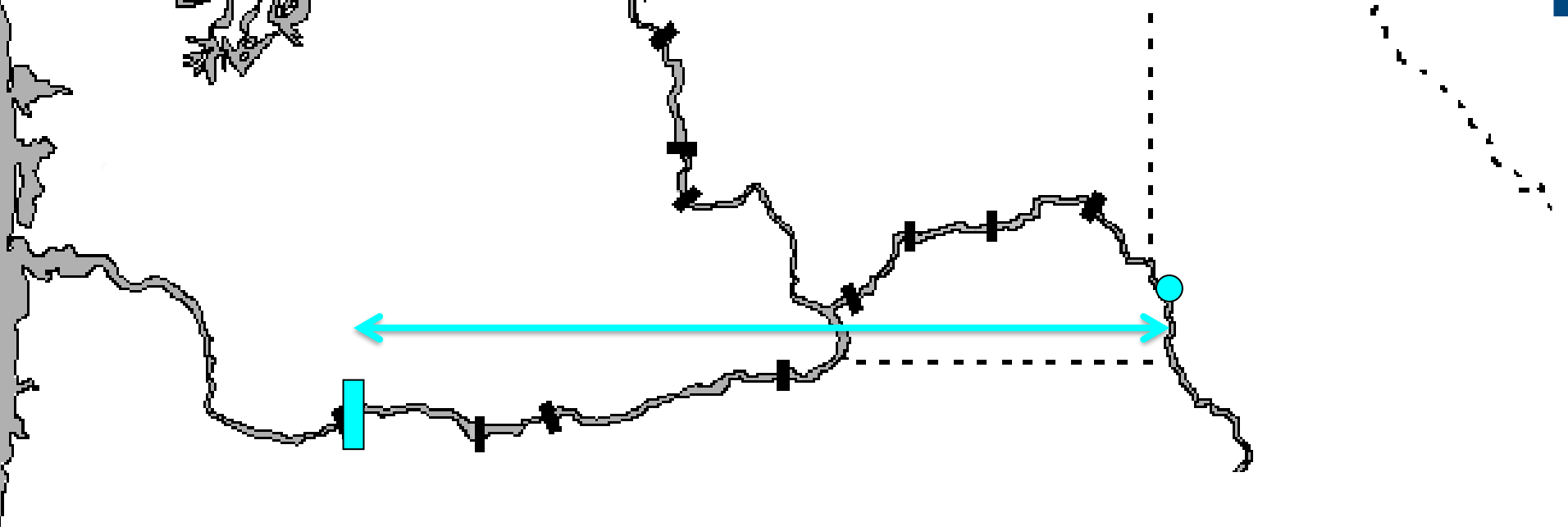
Fish from Upper Columbia

Yearling Chinook



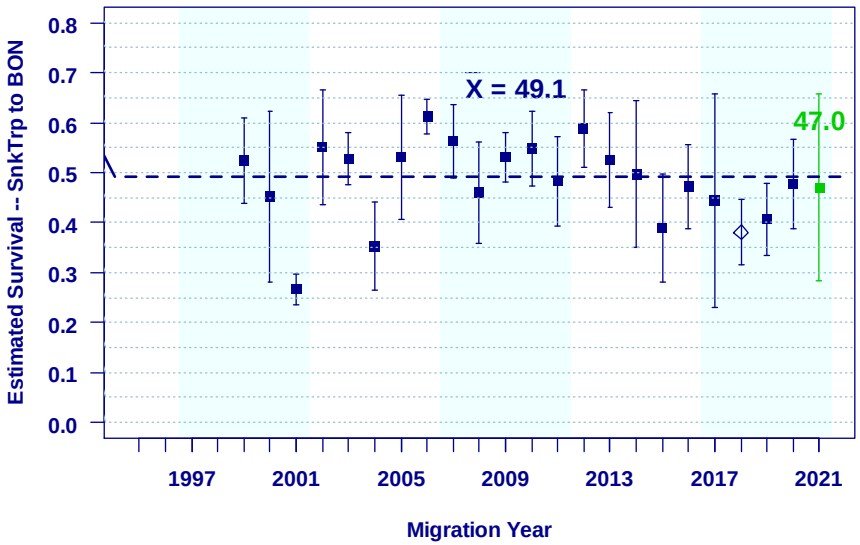
Steelhead



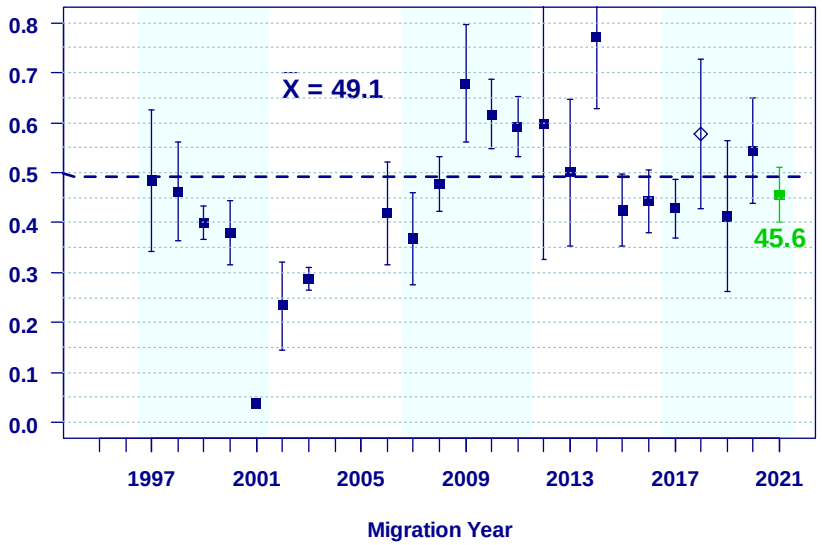


Snake River Trap to Bonneville

Yearling Chinook

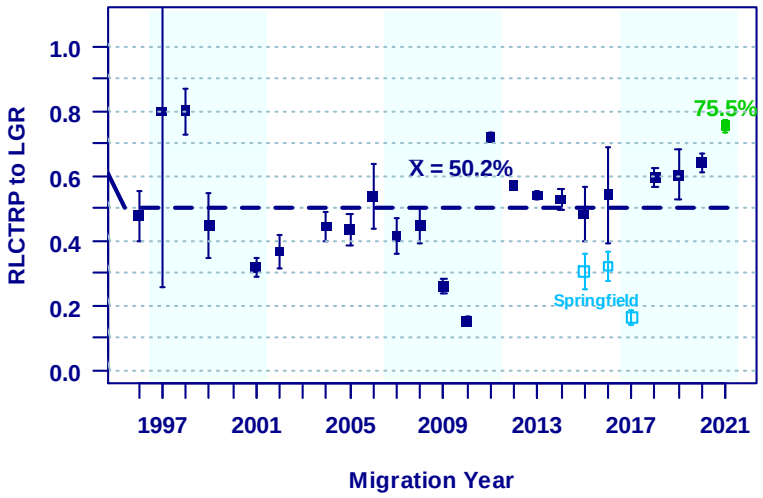


Steelhead

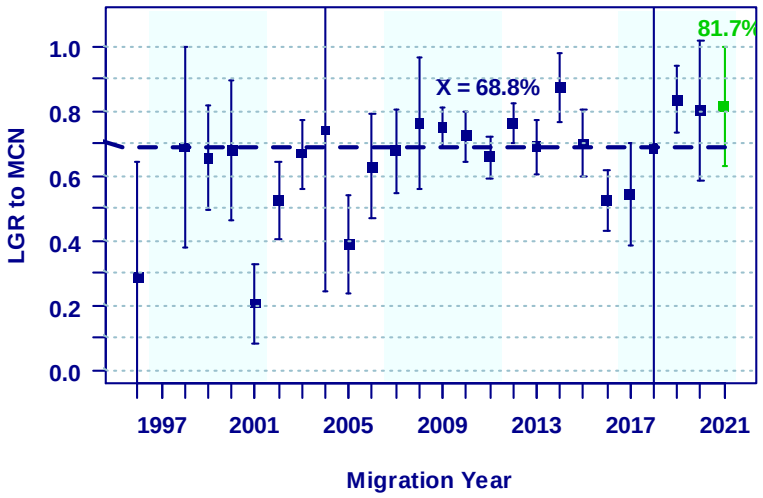


Snake River Sockeye: Estimated Survival

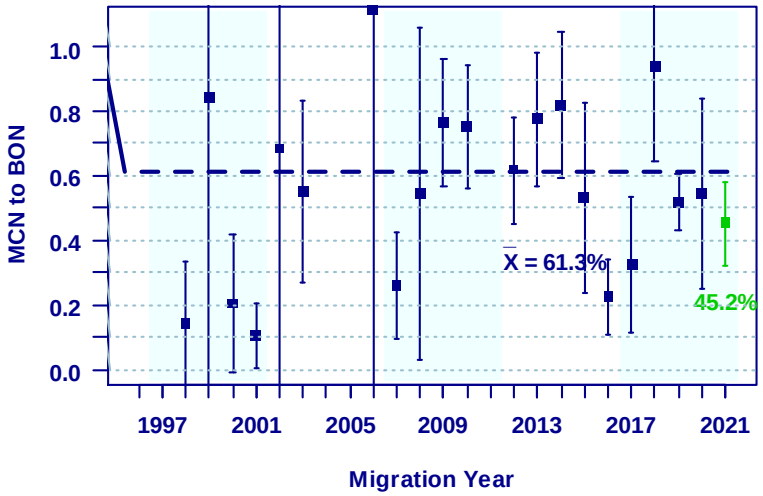
Redfish Lake Trap to Lower Granite



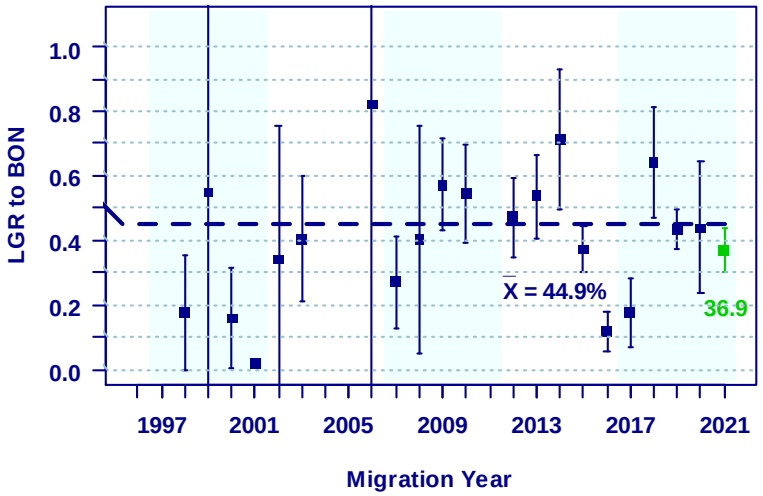
Lower Granite to McNary



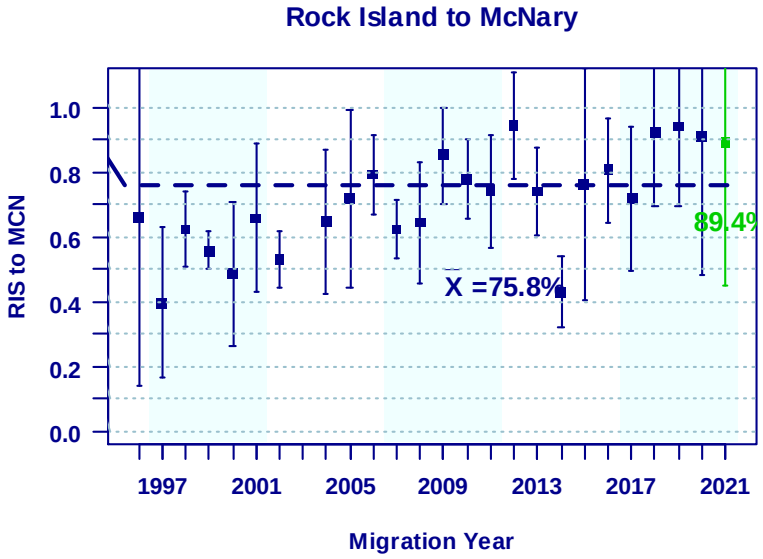
McNary to Bonneville

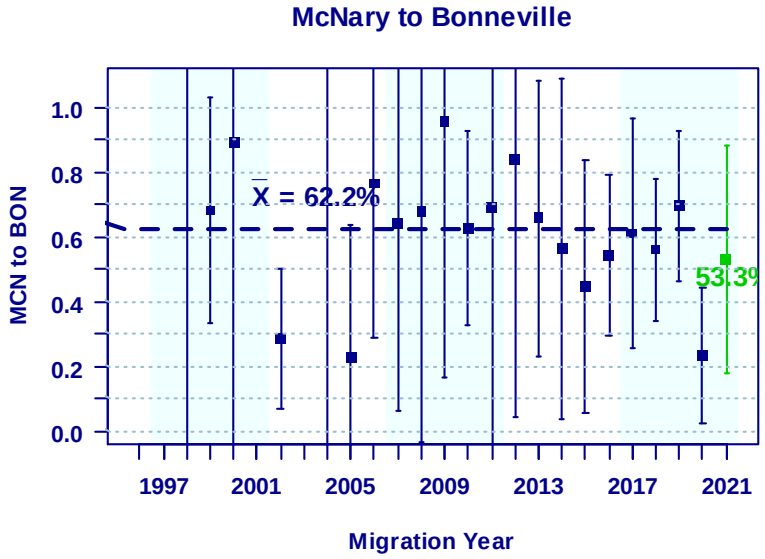


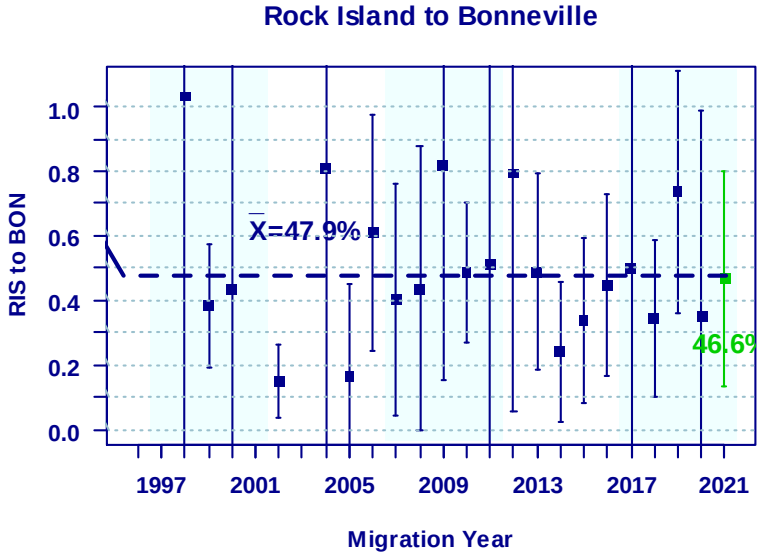
Lower Granite to Bonneville



Columbia River Sockeye: Estimated Survival

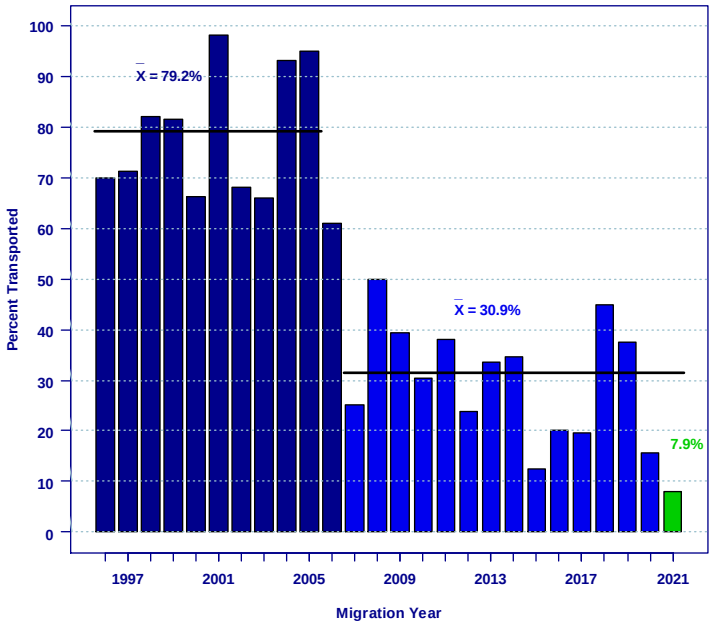




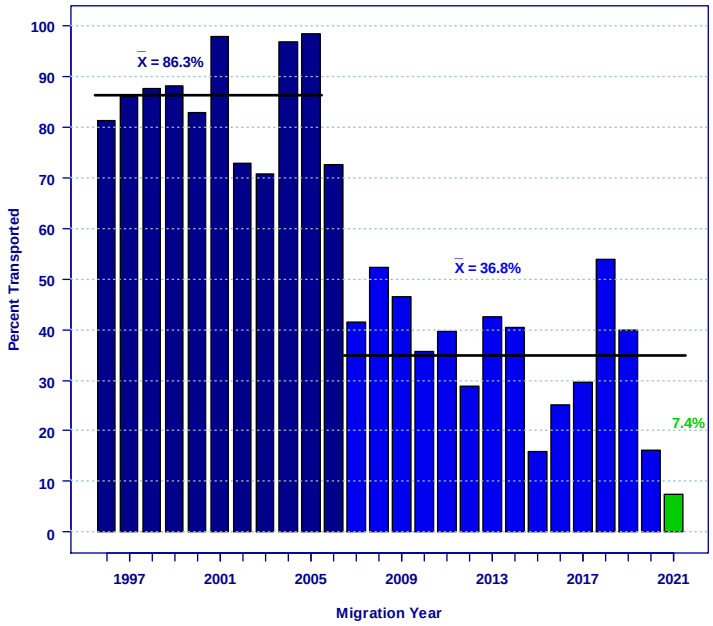


Estimated Percent Transported

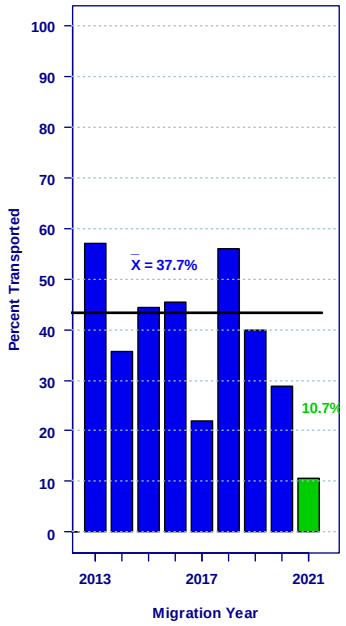
Yearling Chinook



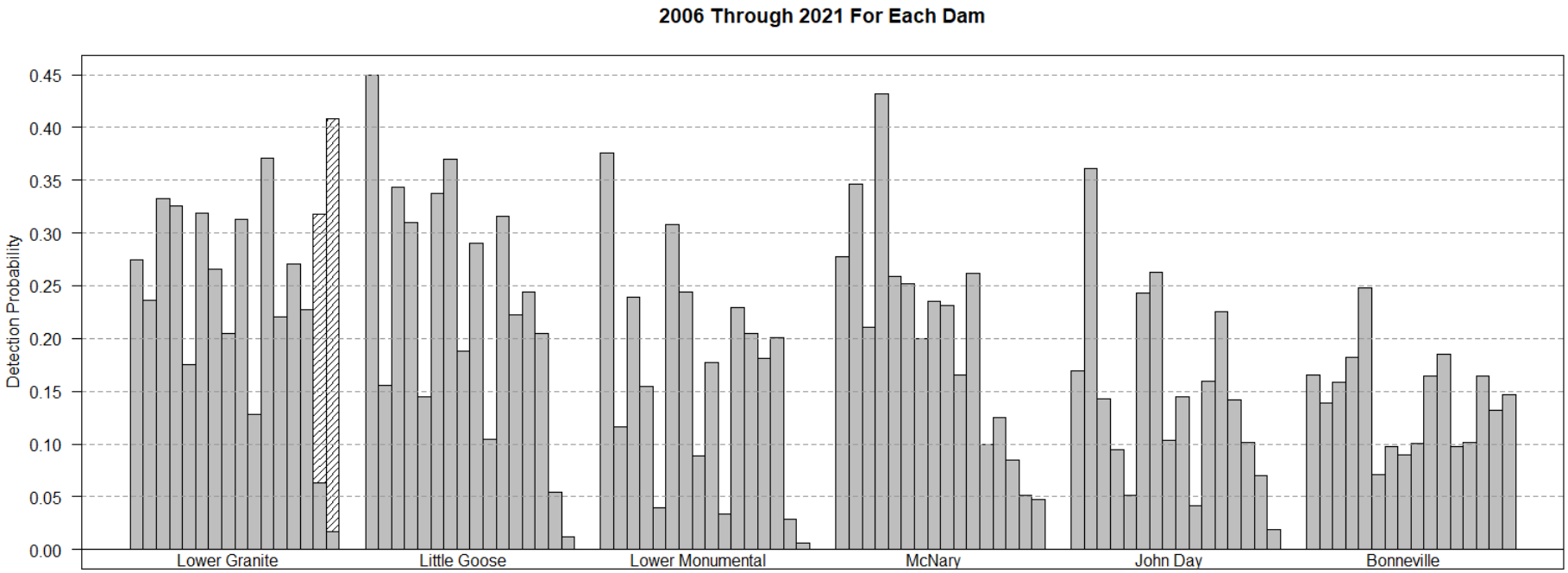
Steelhead



Sockeye



Annual Detection Probabilities
Yearling Chinook



Consequences of (Very) Low PIT-Tag Detection Rates

- Less information means generally lower precision in all estimates
- Measures taken for broad-scale estimates
  - Adjustments for finer scales not possible
- Lost Resolution
  - Subsets of smolts (e.g. wild vs hatchery; LGR spillway-detected vs. bypass-detected)
  - Some one-project reaches extremely imprecise
  - Temporal resolution is degraded; virtual release groups must be pooled over longer periods
  - More difficult to investigate effects of seasonally changing conditions
    - “2021 is basically worthless for the COMPASS model” – J. Faulkner

Consequences of (Very) Low PIT-Tag Detection Rates

- Increased spill is intended to benefit fish, but the current information environment decreases power to understand the actual effect
  - Difficult to demonstrate a benefit
  - Difficult to recognize if harm is being done inadvertently

Acknowledgments

- Bonneville Power Administration
- PTAGIS – Pacific States Marine Fisheries Commission
- Avian Predation Detection Project
  - Real Time Research -- Astoria-Megler Bridge etc.
  - Corps of Engineers Fish Field Units – East Sand Island
- DART – University of Washington Columbia Basin Research
- NOAA Colleagues: Jim Faulkner, Dan Widener
- Legions of Taggers, Coordinators, Agencies, etc.

Smolt Transportation Analyses

Yearling Chinook & Steelhead
Data from Migration Years 2016-2019

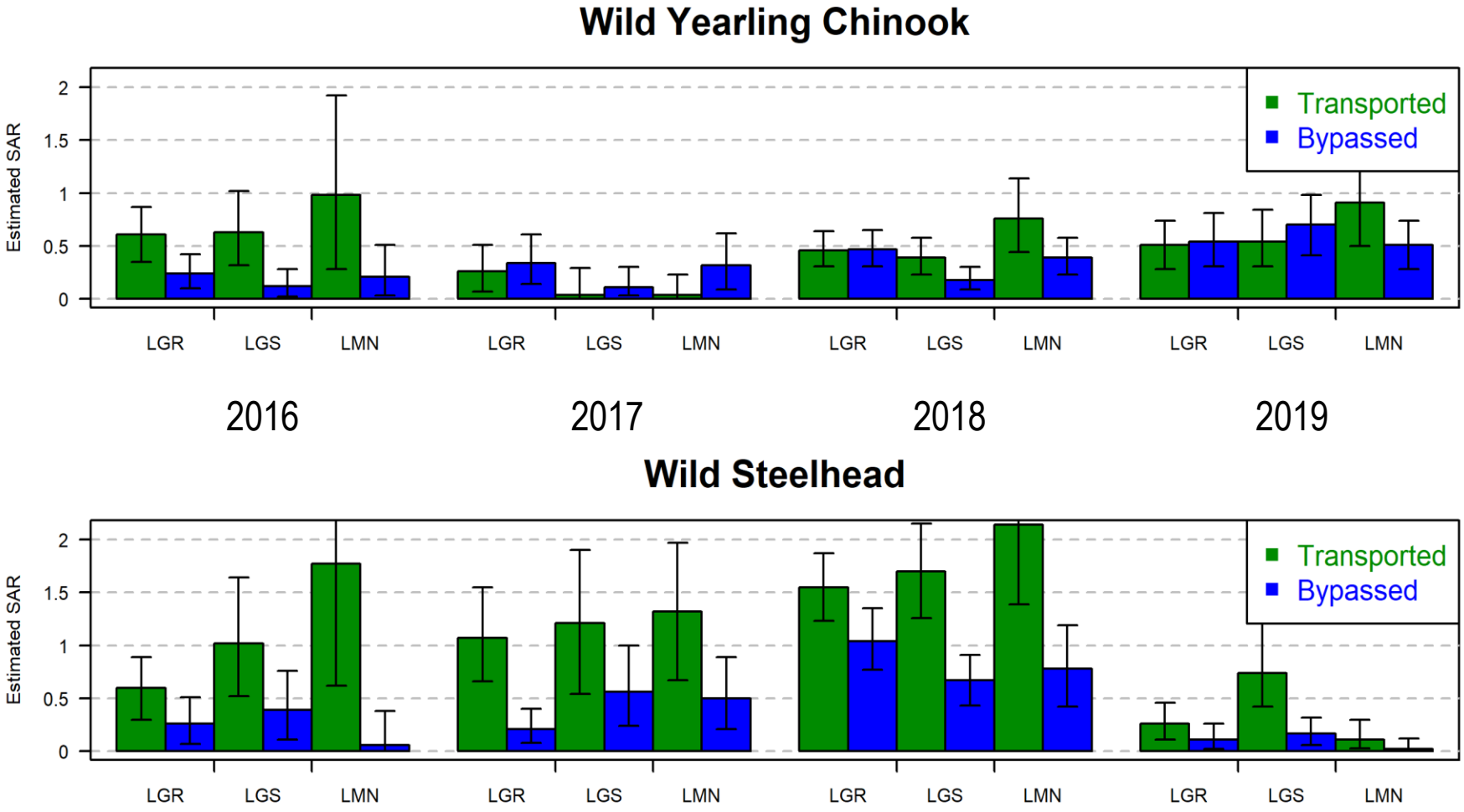
- Updated with adult returns through Dec 31, 2021
- Added smolt migration year 2019
- Data from LGR, LGS, and LMN

Snake River Conditions

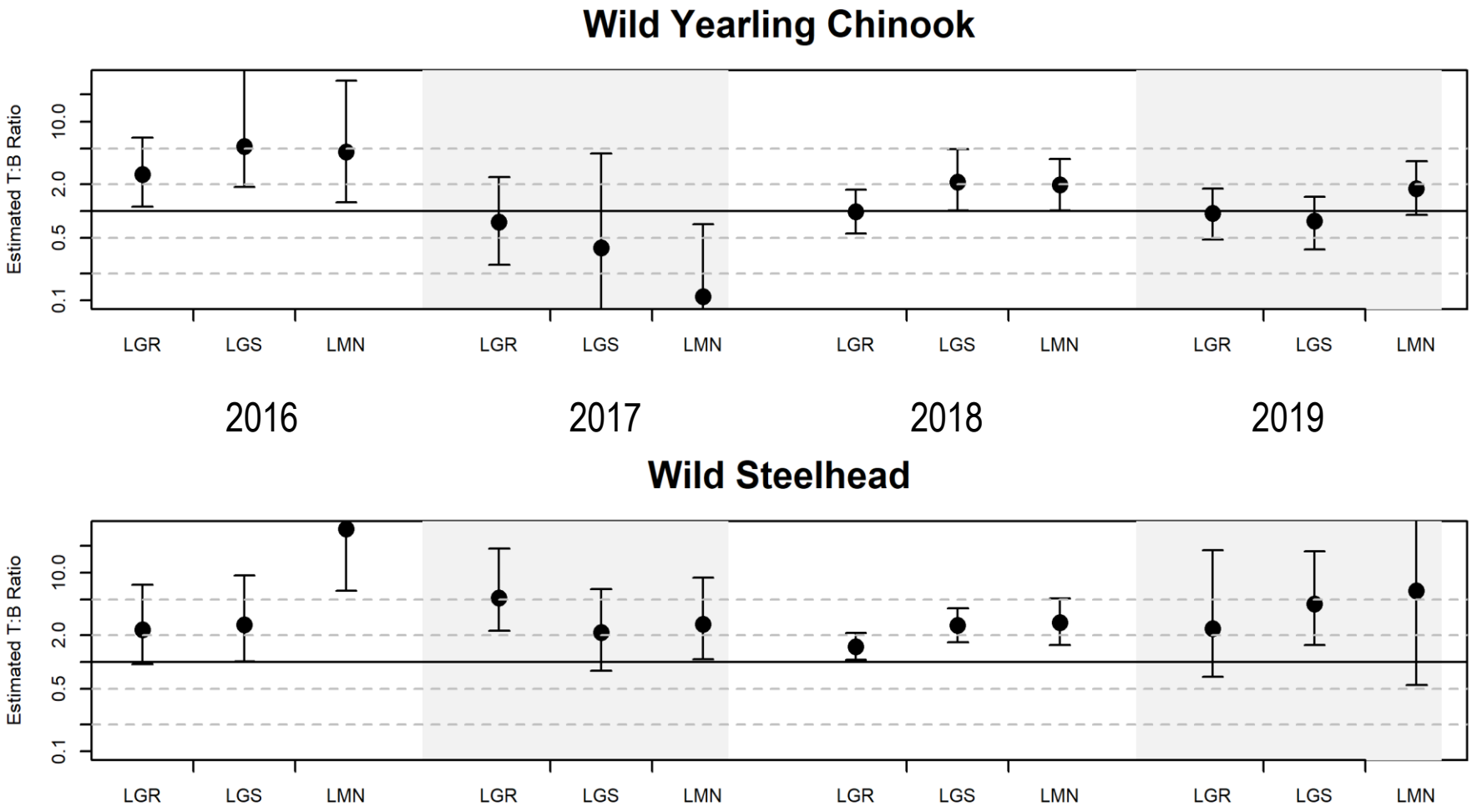
Migration Year	Flow	Spill%	Temperature	Dissolved gas
2016	Above average (flat)	Average (~30%)	Warm	Average (112-115%)
2017	Very high	Very high (40-50%)	Average	Very high (118-126%
2018	High	High (35-55%)	Warm	Above average (116-122%)
2019	High	Above average (35-45%)	Average; fluctuating	Above average (118-120%)

Annual Summaries

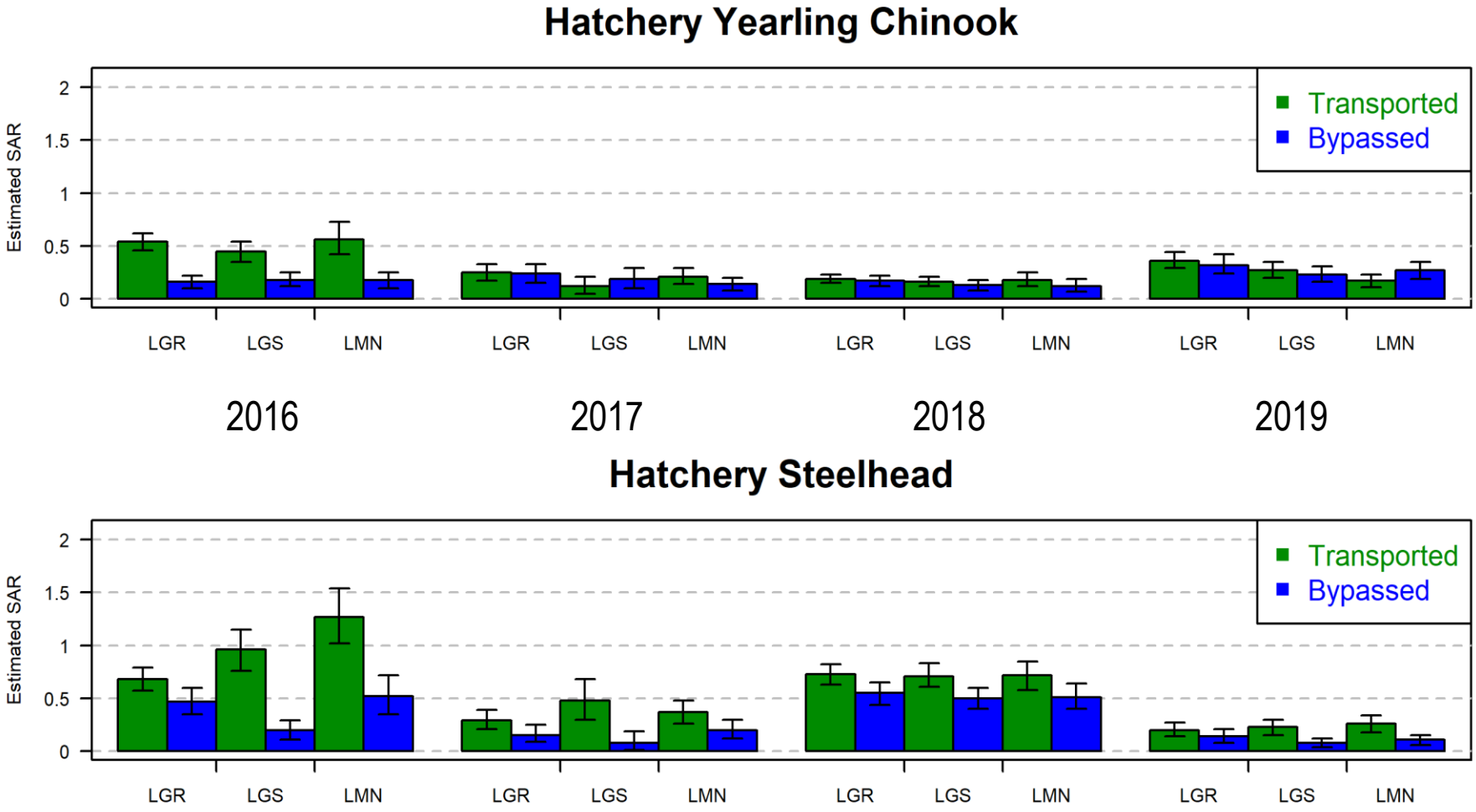
Annual Estimated SARs – Transport Period



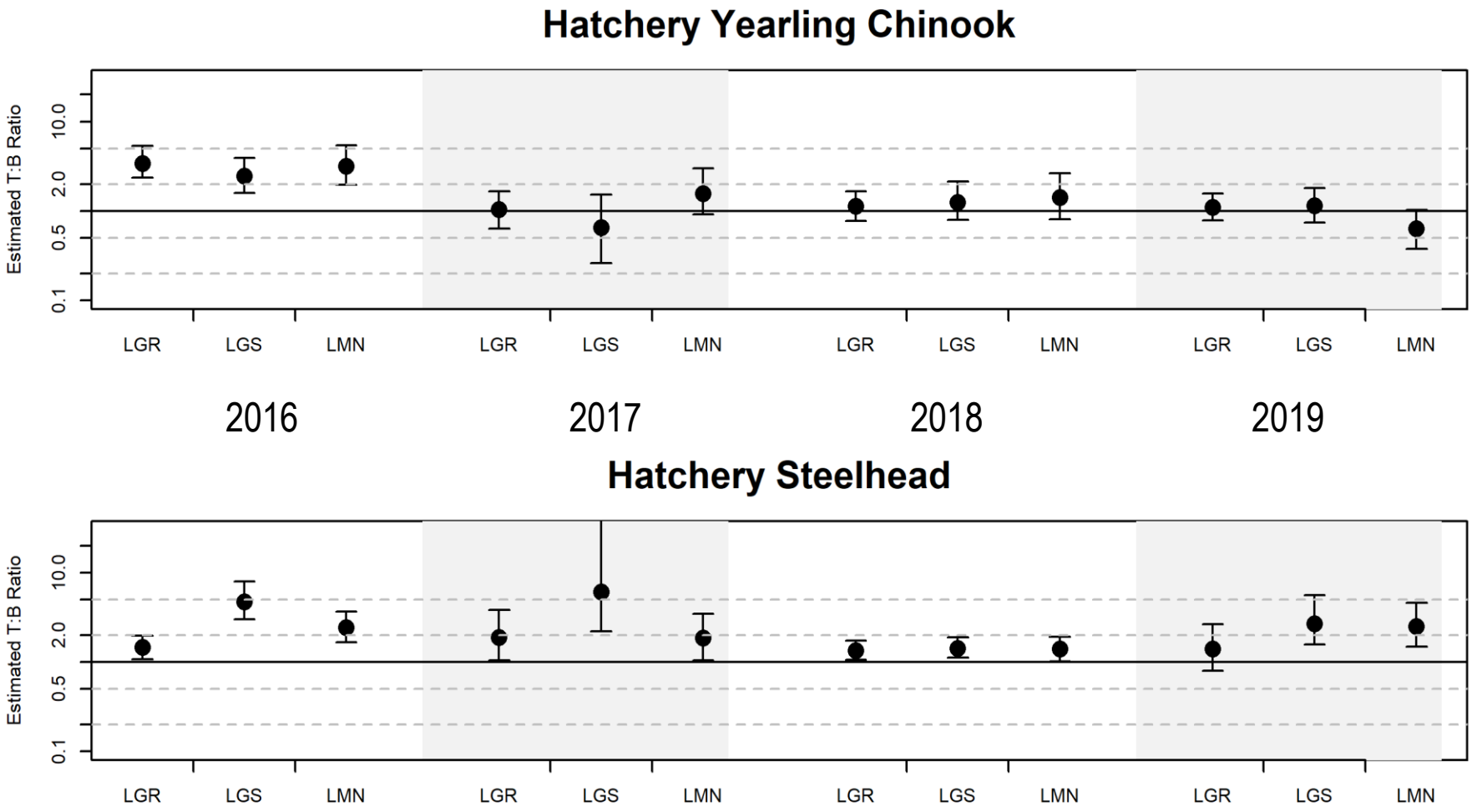
Annual Estimated T:B – Transport Period



Annual Estimated SARs – Transport Period



Annual Estimated T:B – Transport Period



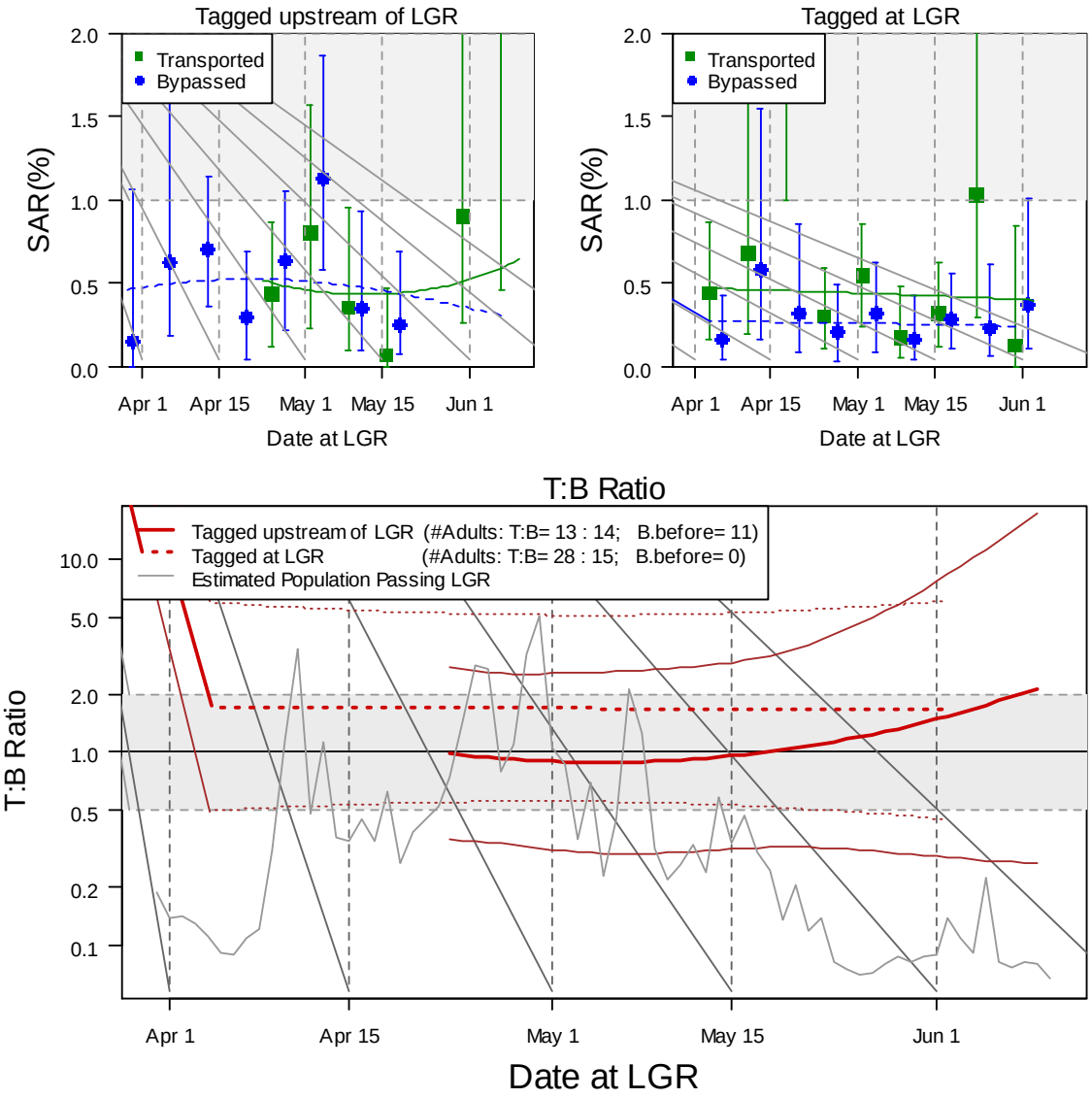
Some Seasonal Stuff

Estimating Patterns of SAR vs. Date

- Need a “time-stamp” – date of passage/detection.
- Annual summaries today, but time-stamp still necessary.
- These analyses use fish that entered JBS at LGR, LGS, or LMN
  - tagged upstream of LGR or at LGR
  - either transported (T) or bypassed (B or “C1”)
  - can adjust “standards” based on observed C0 > C1
  - e.g.: if (C0/C1 = 1.1)
    and (T/C1 > 1.1)
    then (T/C0 > 1)

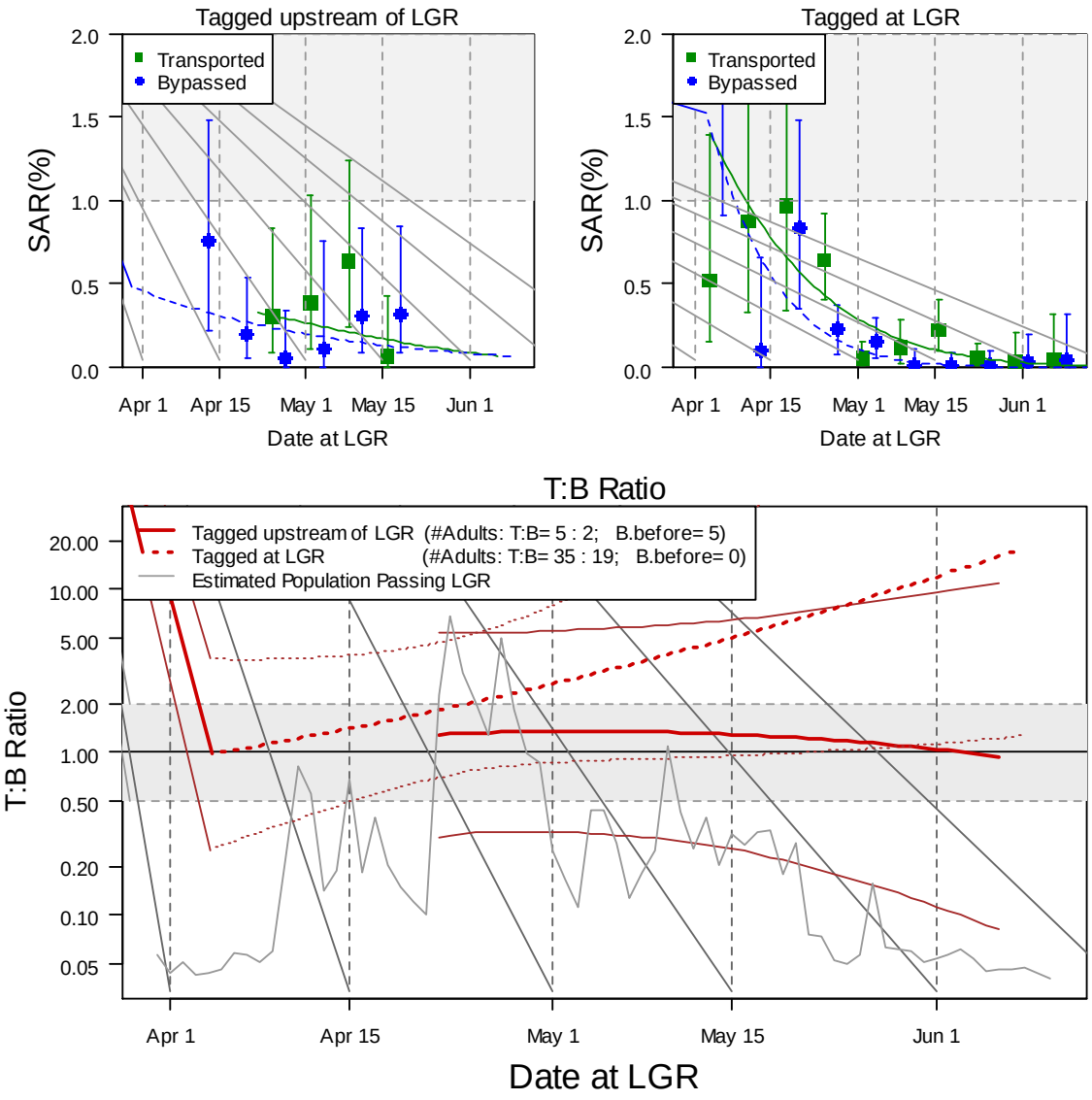
Wild Chinook 2019

Transported or Bypassed at Lower Granite Dam



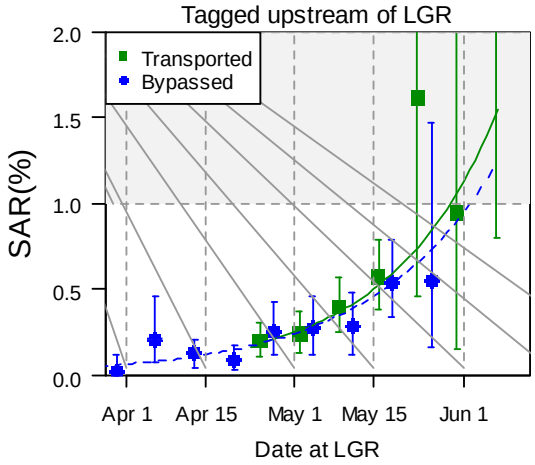
Wild Steelhead 2019

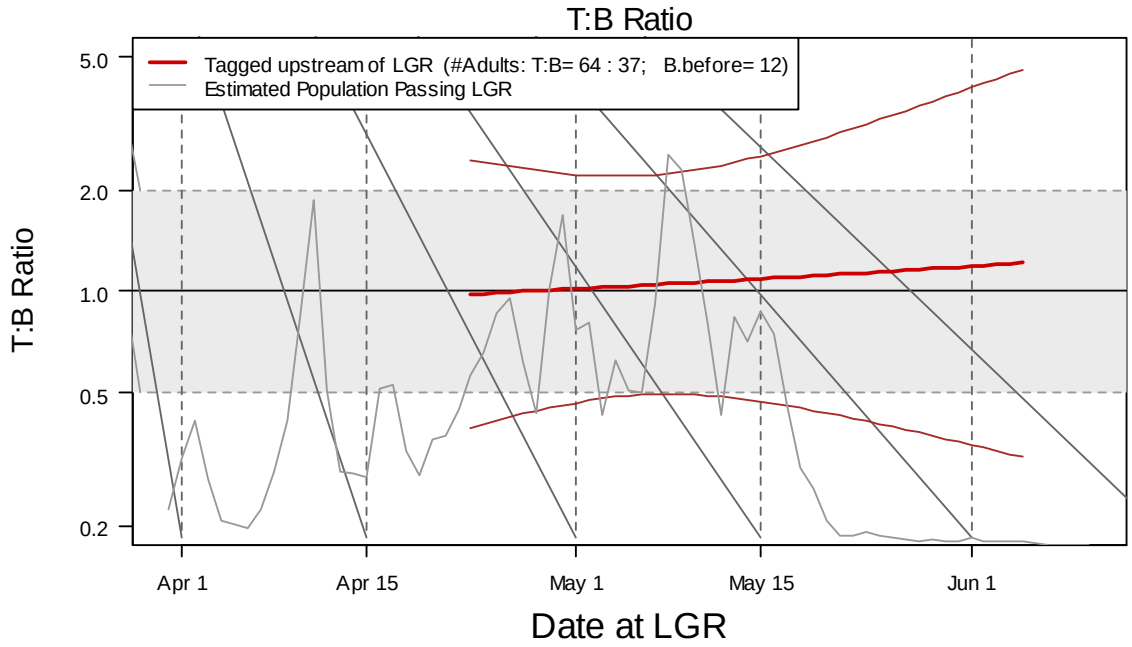
Transported or Bypassed at Lower Granite Dam



Hatchery Chinook 2019

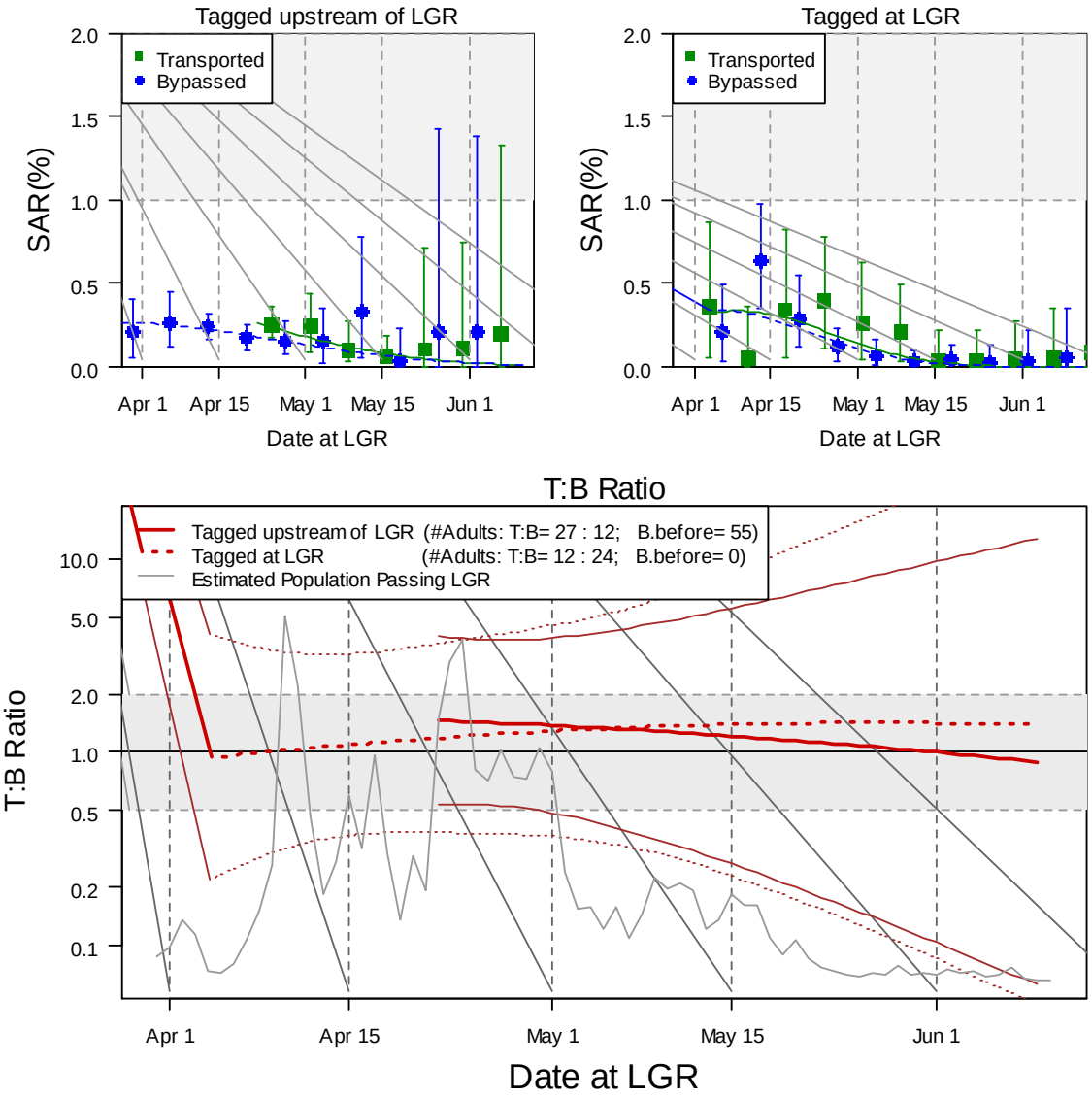
Transported or Bypassed at Lower Granite Dam





Hatchery Steelhead 2019

Transported or Bypassed at Lower Granite Dam

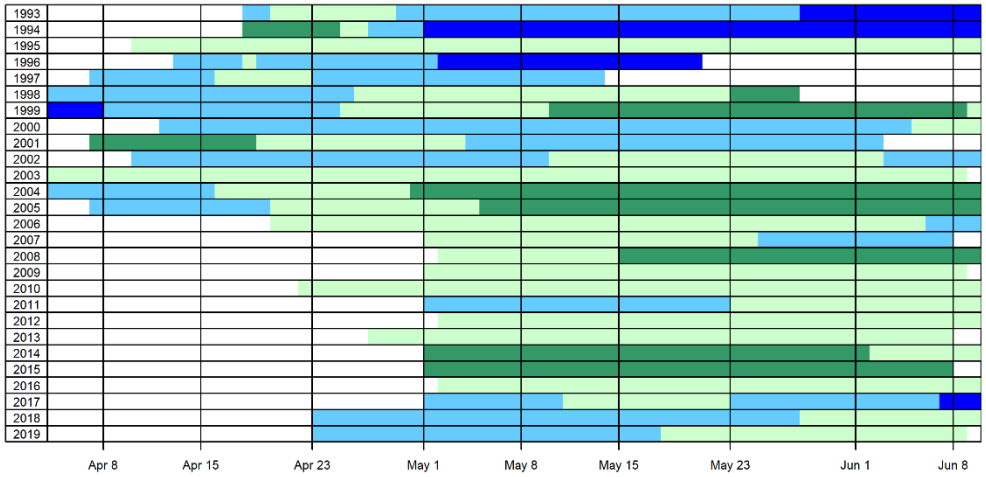


Wild Chinook Salmon - Lower Granite Dam

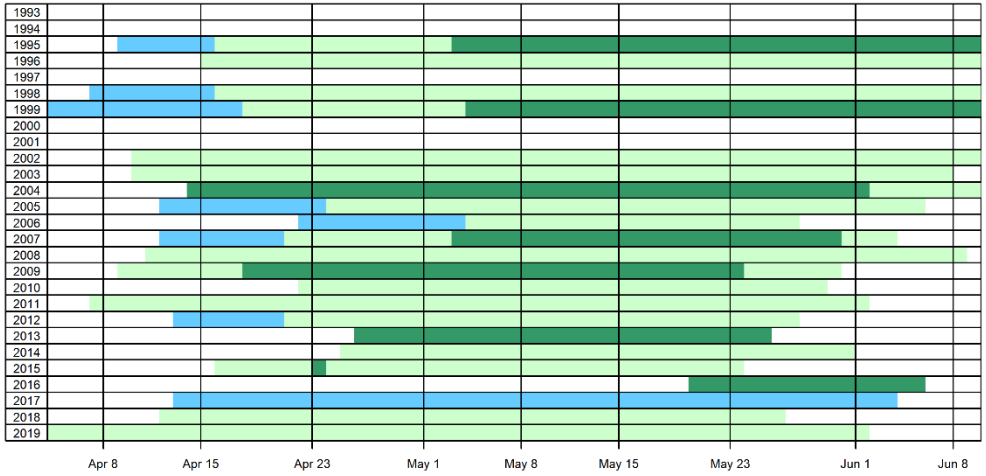
Summary of Model-Averaged T:B Values

Standard = C1 (Bypassed)

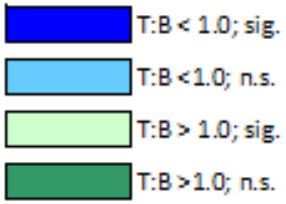
Based only on Fish Tagged Upstream of Lower Granite Dam



Based only on Fish Tagged at Lower Granite Dam



Date at Lower Granite

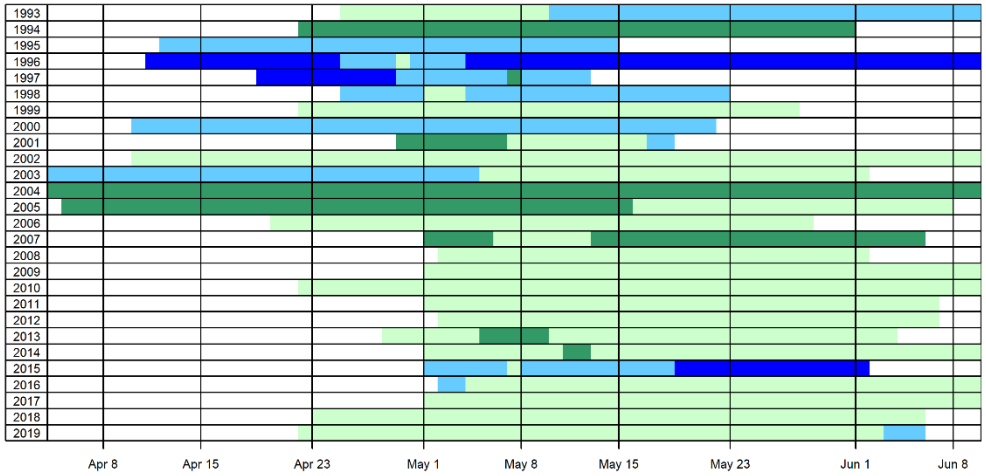


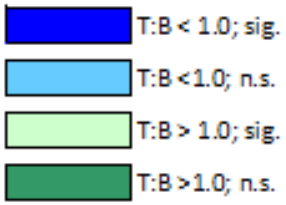
Wild Steelhead - Lower Granite Dam

Summary of Model-Averaged T:B Values

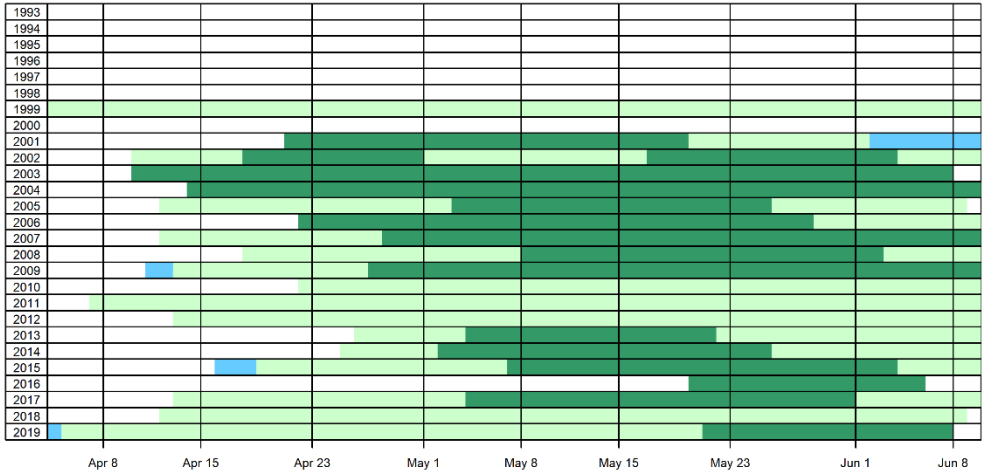
Standard = C1 (Bypassed)

Based only on Fish Tagged Upstream of Lower Granite Dam





Based only on Fish Tagged at Lower Granite Dam



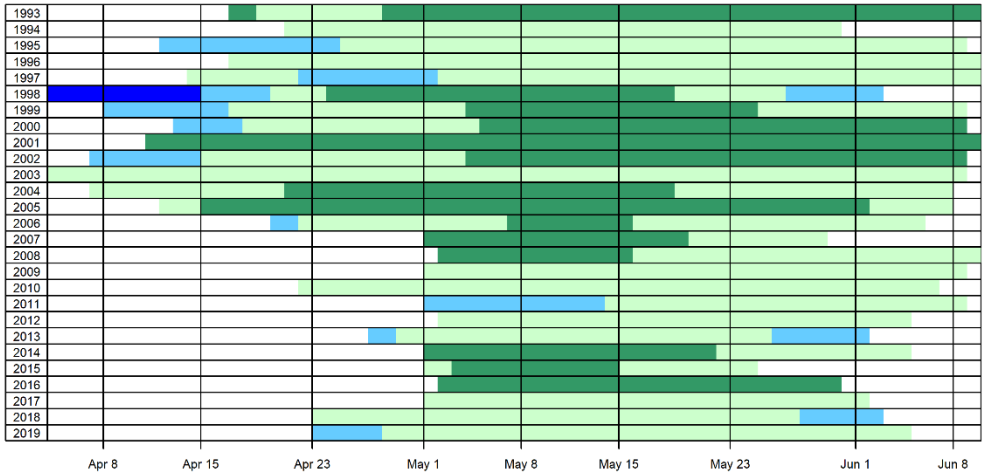
Date at Lower Granite

Hatchery Chinook Salmon - Lower Granite Dam

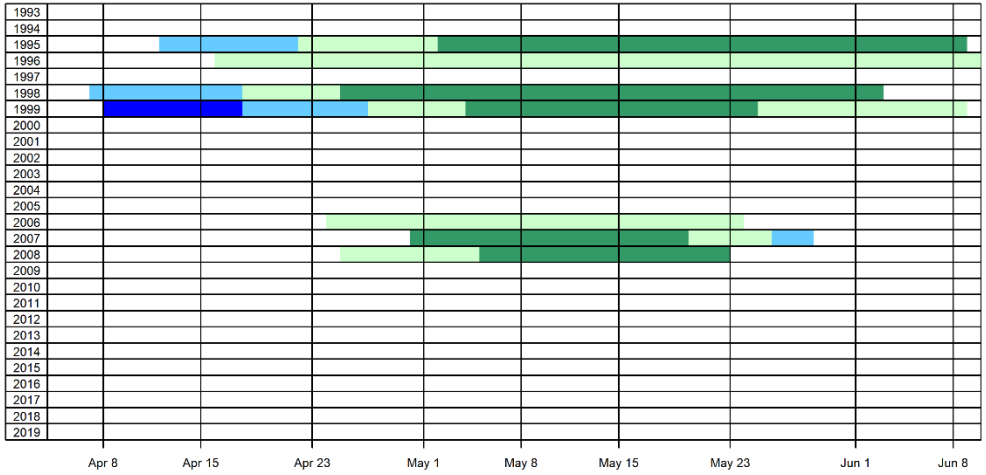
Summary of Model-Averaged T:B Values

Standard = C1 (Bypassed)

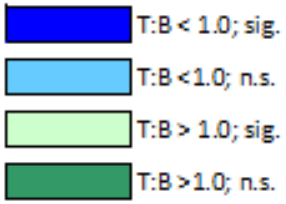
Based only on Fish Tagged Upstream of Lower Granite Dam



Based only on Fish Tagged at Lower Granite Dam



Date at Lower Granite

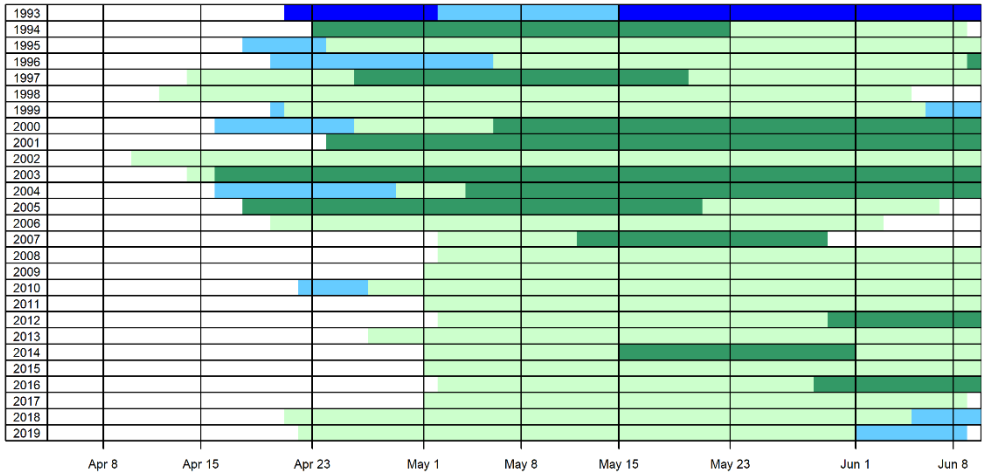


Hatchery Steelhead - Lower Granite Dam

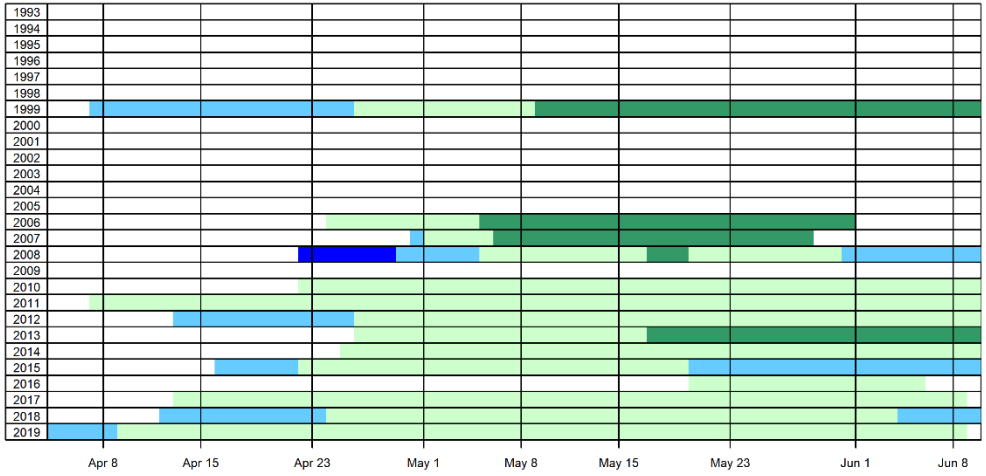
Summary of Model-Averaged T:B Values

Standard = C1 (Bypassed)

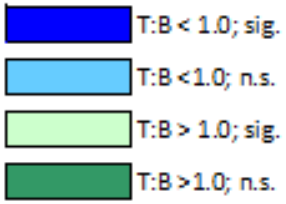
Based only on Fish Tagged Upstream of Lower Granite Dam



Based only on Fish Tagged at Lower Granite Dam



Date at Lower Granite



Test Barges Before Beginning of General Transportation

Research Barges: Fish Tagged at Lower Granite Dam Before Beginning of General Transportation

Wild yearling Chinook salmon

		Transported			Bypassed			
Mig Year	Dates	Smolts	Adults	SAR (90% CI)	Smolts	Adults	SAR (90% CI)	T:B (90% CI)
2017	April 13,20,27	4,683	6	0.13 (0.05-0.22)	5,250	6	0.12 (0.06-0.21)	1.12 (0.42-2.89)
2018	April 12, 19	3,443	21	0.61 (0.41-0.85)	3,295	10	0.31 (0.16-0.52)	1.99 (1.08-4.21)
2019	April 4, 11, 18	1,205	10	0.84 (0.43-1.34)	1,357	3	0.23 (0.09-0.45)	3.61 (1.40-14.4)

Wild Steelhead

		Transported			Bypassed			
Mig Year	Dates	Smolts	Adults	SAR (90% CI)	Smolts	Adults	SAR (90% CI)	T:B (90% CI)
2017	April 13,20,27	644	5	0.80 (0.34-1.42)	1,499	1	0.08 (0.02-0.21)	10.2 (2.33-48.1)
2018	April 12, 19	1,266	21	1.67 (1.12-2.22)	1,111	8	0.74 (0.38-1.19)	2.27 (1.17-5.14)
2019	April 4, 11, 18	1,233	10	0.82 (0.42-1.31)	1,207	10	0.84 (0.43-1.34)	0.98 (0.45-2.15)

Hatchery Steelhead

		Transported			Bypassed			
Mig Year	Dates	Smolts	Adults	SAR (90% CI)	Smolts	Adults	SAR (90% CI)	T:B (90% CI)
2017	April 13,20,27	1,832	3	0.17 (0.06-0.34)	6,906	14	0.21 (0.12-0.31	0.84 (0.23-1.94)
2018	April 12, 19	1,988	4	0.21 (0.06-0.46)	2,997	15	0.51 (0.31-0.74)	0.41 (0.15-0.97)
2019	April 4, 11, 18	1,860	4	0.22 (0.06-0.39)	4,332	16	0.37 (0.23-0.53)	0.60 (0.18-1.29)

Acknowledgments

- U.S. Army Corps of Engineers
- PTAGIS – Pacific States Marine Fisheries Commission
- Legions of Taggers, Coordinators, Agencies, etc.


Questions