A Study To Compare Return Rates of Snake River Fall Chinook Salmon Under Alternative Transport and Dam Operational Strategies

Anadromous Fish Evaluation Program
Annual Review
December 11, 2014

Steve Smith steven.g.smith@noaa.gov
Tiffani Marsh, Billy Connor
NOAA Fisheries and USFWS IFRO

Background

- 2001-2004 Studies
  - Tagged at Lyons Ferry and Released Upstream of LGR (2001-2003)
  - Tagged at LGR and Barged or Released in Tailrace (2004)

  - Conventional Design and Analysis

    Estimation of Number of In-River Fish Undetected (C0)

Background

- 2001-2004 Studies

  - Tagged at Lyons Ferry and Released Upstream of LGR (2001-2003)
  - Tagged at LGR and Barged or Released in Tailrace (2004)

  - Conventional Design and Analysis

    Estimation of Number of In-River Fish Undetected (C0)

  - Yearling-Ocean-Entry Life History Tactic

    Don’t complete migration as subyearlings

    Some migrate while bypass systems are dewatered

    Some migrate following spring

Background

- 2001-2004 Studies

  - Tagged at Lyons Ferry and Released Upstream of LGR (2001-2003)
  - Tagged at LGR and Barged or Released in Tailrace (2004)

  - Conventional Design and Analysis

    Estimation of Number of In-River Fish Undetected (C0)

  - Yearling-Ocean-Entry Life History Tactic

    Don’t complete migration as subyearlings

    Some migrate while bypass systems are dewatered

    Some migrate following spring

  - Conventional Methods Biased Because Survival Estimate Is Compromised

New Study Design
“TWS vs. BWS”

TWS = “Transport With Spill” Strategy

BWS = “Bypass With Spill” Strategy

TWS vs BWS Study Design

Figure 3. NOAA Proposal (December 2004 Revision)

Identical Treatment Until Release

Single pool of PIT-tagged hatchery fish (n = 175,568)

Group TWI: Designated for transport (50.0%)

Group BWI: Designated for in-river (50.0 %)

At all collector dams: Transport every Group TWI fish collected; return to river every Group BWI fish collected

Primary Analysis
- **Return Rate Group TWI**
- **Return Rate Group BWI**
- **Compare Return Rates**

Secondary Analysis
- **Return rate transport LGR-LGR**
- **Return rate inriver LGR-LGR**
- **"Conventional" T:B**

TWS vs BWS Study Design

Figure 3. NOAA Proposal (December 2004 Revision)

Use Separation By Code to Apply Experimental Treatment

Single pool of PIT-tagged hatchery fish (n = 175,568)

Group TWI: Designated for transport (50.0%)

Group BWI: Designated for in-river (50.0 %)

At all collector dams: Transport every Group TWI fish collected; return to river every Group BWI fish collected

Primary Analysis
- **Return Rate Group TWI**
- **Return Rate Group BWI**
- **Compare Return Rates**

Secondary Analysis
- **Return rate transport LGR-LGR**
- **Return rate inriver LGR-LGR**
- **"Conventional" T:B**

TWS vs BWS Study Design

Figure 3. NOAA Proposal (December 2004 Revision)

Single pool of PIT-tagged hatchery fish (n = 175,568)

Group TWI: Designated for transport (50.0%)

Group BWI: Designated for in-river (50.0 %)

At all collector dams: Transport every Group TWI fish collected; return to river every Group BWI fish collected

TWS:BWS Ratio

Primary Analysis
- **Return Rate Group TWI**
- **Return Rate Group BWI**
- **Compare Return Rates**

Secondary Analysis
- **Return rate transport LGR-LGR**
- **Return rate inriver LGR-LGR**
- **"Conventional" T:B**

TWS vs BWS Study Design

Figure 3. NOAA Proposal (December 2004 Revision)

Single pool of PIT-tagged hatchery fish (n = 175,568)

Group TWI: Designated for transport (50.0%)

Group BWI: Designated for in-river (50.0 %)

At all collector dams: Transport every Group TWI fish collected; return to river every Group BWI fish collected

Primary Analysis
- **Return Rate Group TWI**
- **Return Rate Group BWI**
- **Compare Return Rates**

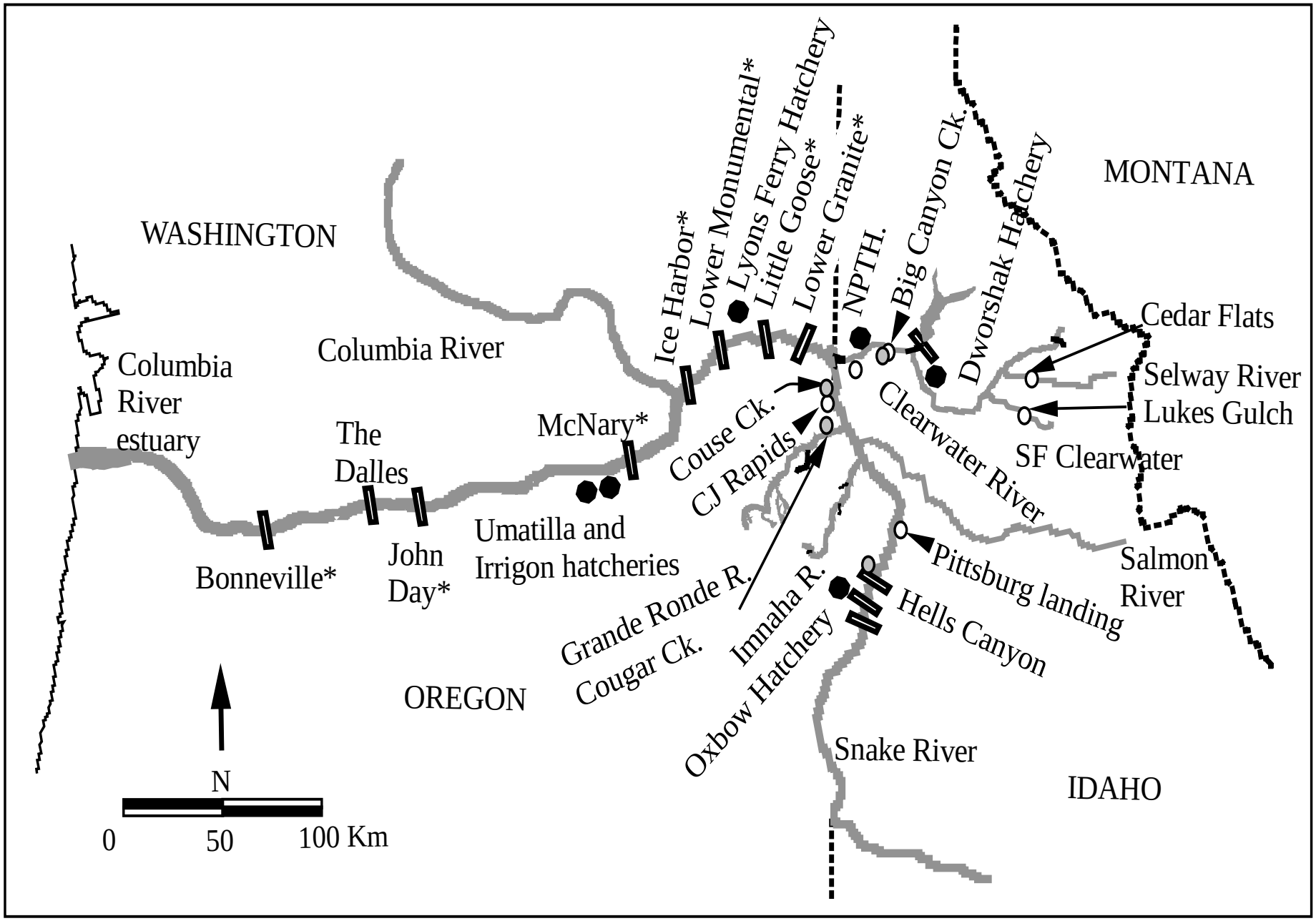
Secondary Analysis
- **Return rate transport LGR-LGR**
- **Return rate inriver LGR-LGR**
- **"Conventional" T:B**

Types of Fall Chinook Salmon

- Natural
  - Not enough of them to conduct a transportation evaluation
- Hatchery Surrogates for Natural Fish
  - Lyons Ferry fish specially reared at Irrigon and Dworshak NFH etc. (for study only)
- Hatchery Production Subyearlings
- Hatchery Production Yearlings
  - Lyons Ferry production rearing

Releases Using TWS:BWS Design

- 2005: Surrogate Subyearlings in Snake and Clearwater
  - Problems with rearing – used to develop and test analytical methods
- 2006, 2008-2010: Surrogates, Production Subyearlings and Yearlings
  - Adult returns complete, results shown today (2009 and 2010 preliminary)
- 2011, 2012: Surrogates, Production Subyearlings and Yearlings
  - Adult returns and analyses to be completed
- (Fish Not Available For Study in 2007)


WASHINGTON
MONTANA
OREGON
IDAHO
Columbia River
Columbia River estuary
Bonneville*
The Dalles
John Day*
McNary*
Umatilla and Irrigon hatcheries
Ice Harbor*
Lower Monumental*
Lyons Ferry Hatchery
Little Goose*
Lower Granite*
NPTH.
Big Canyon Ck.
Dworshak Hatchery
Cedar Flats
Selway River
Lukes Gulch
SF Clearwater
Clearwater River
Couse Ck.
CJ Rapids
Grande Ronde R.
Cougar Ck.
Imnaha R.
Oxbow Hatchery
Hells Canyon
Pittsburg landing
Salmon River
Snake River
N
0
50
100 Km

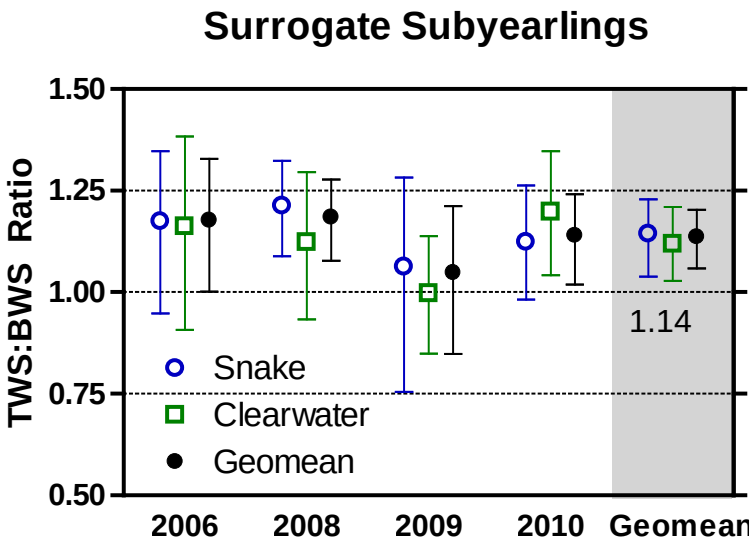
Surrogate Subyearlings

		Clearwater				Snake		
		Released	# in Bypass	% Return		Released	# in Bypass	% Return
2006	**TWS**	48,260	1,717	0.28		113,774	25,511	0.21
	BWS	48,263	1,804	0.24		113,798	25,247	0.18
2008	**TWS**	52,221	3,498	0.41		100,011	20,579	0.69
	BWS	52,230	3,510	0.36		100,038	20,270	0.57
2009	**TWS**	45,006	1,448	0.54		118,871	14,739	0.09
	BWS	45,010	1,408	0.54		117,351	14,385	0.08
2010	**TWS**	57,006	4,282	0.61		97,744	11,685	0.40
	BWS	57,010	4,018	0.51		96,247	11,661	0.35

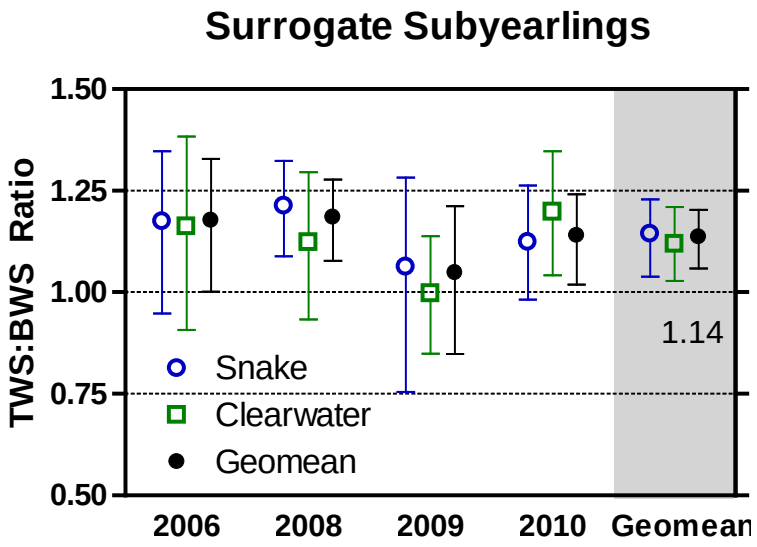
Production Subyearlings

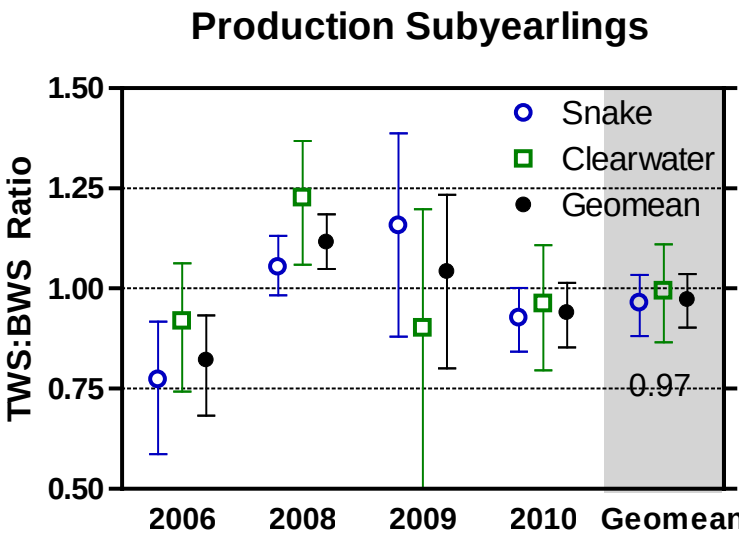
		Clearwater				Snake		
		Released	# in Bypass	% Return		Released	# in Bypass	% Return
2006	**TWS**	37,920	19,429	0.72		62,824	25,880	0.24
	BWS	20,420	10,431	0.79		33,830	14,046	0.31
2008	**TWS**	25,464	7,142	1.45		88,312	31,051	1.31
	BWS	30,007	8,630	1.18		103,247	36,598	1.24
2009	**TWS**	19,155	6,509	0.19		64,128	22,727	0.19
	BWS	21,942	7,439	0.21		74,140	26,149	0.16
2010	**TWS**	28,956	10,592	0.63		82,062	31,754	0.80
	BWS	39,665	13,682	0.66		96,005	37,340	0.86

Overall TWS:BWS Ratio (Entire Groups)



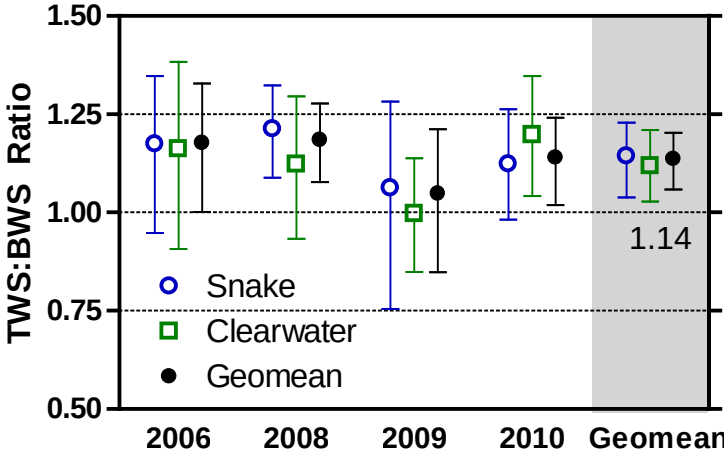
Overall TWS:BWS Ratio (Entire Groups)



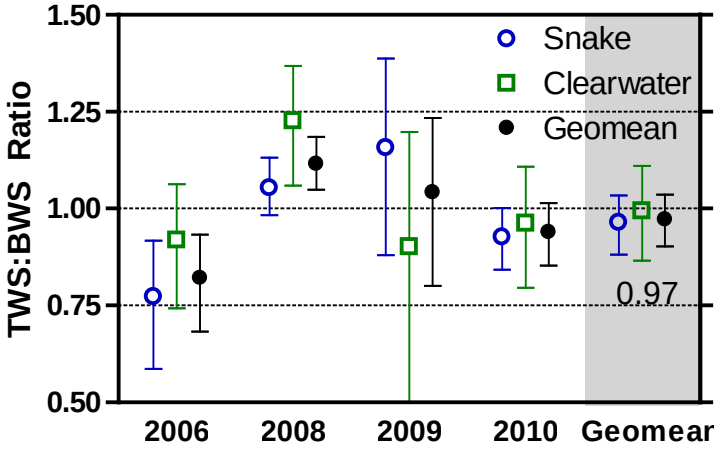


Overall TWS:BWS Ratio (Entire Groups)

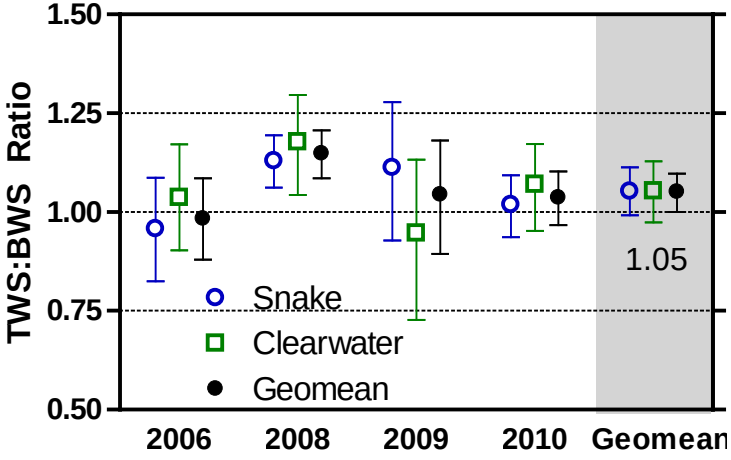
Surrogate Subyearlings



Production Subyearlings

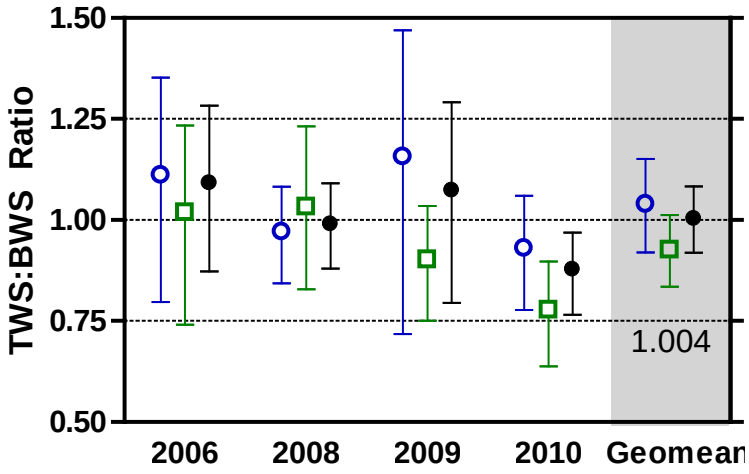


Surrogate + Production Subyearlings

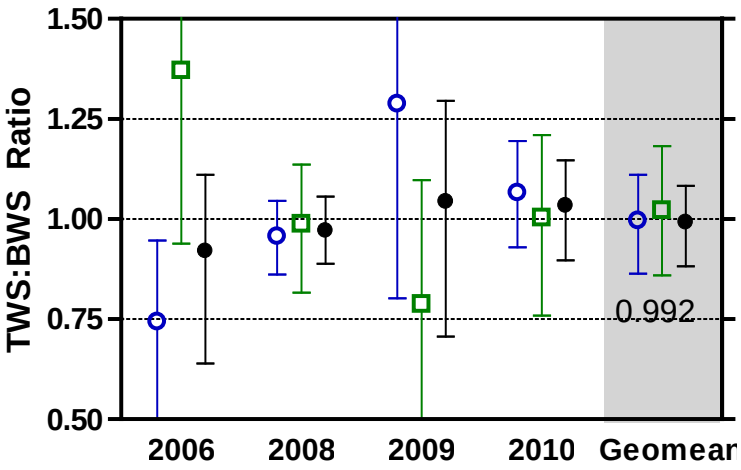


Ratio For Fish Never In A Bypass System
(Ratio Expected To Be 1.0)

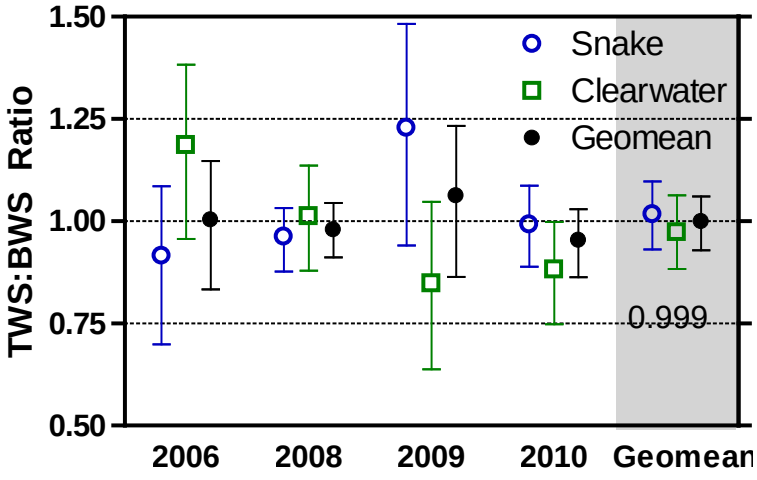
Surrogate Subyearlings



Production Subyearlings

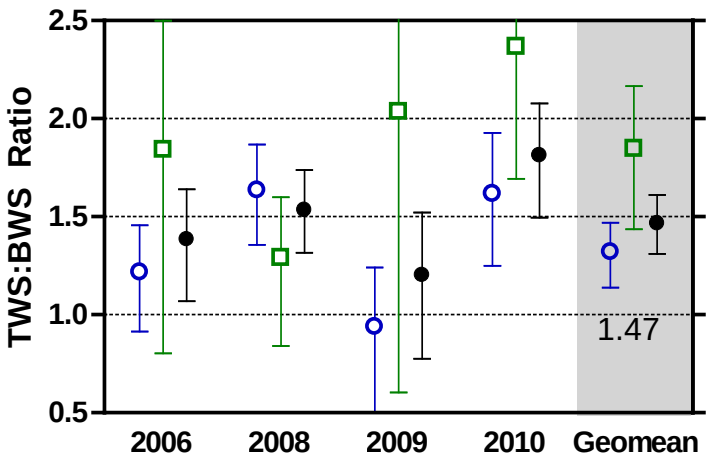


Surrogate + Production Subyearlings

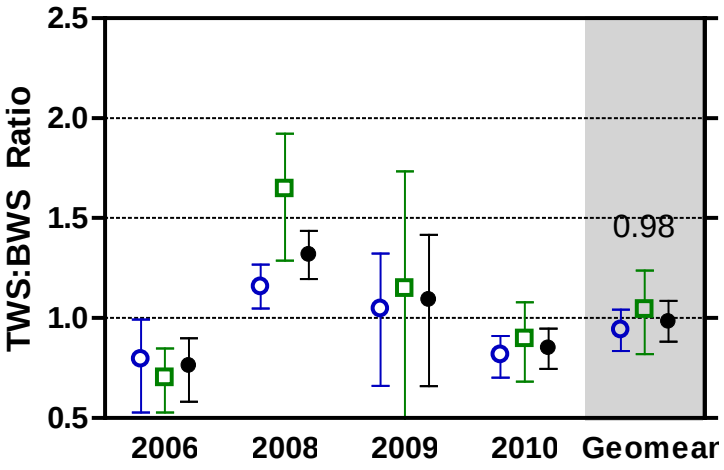


Ratio For Fish In At Least One Bypass System

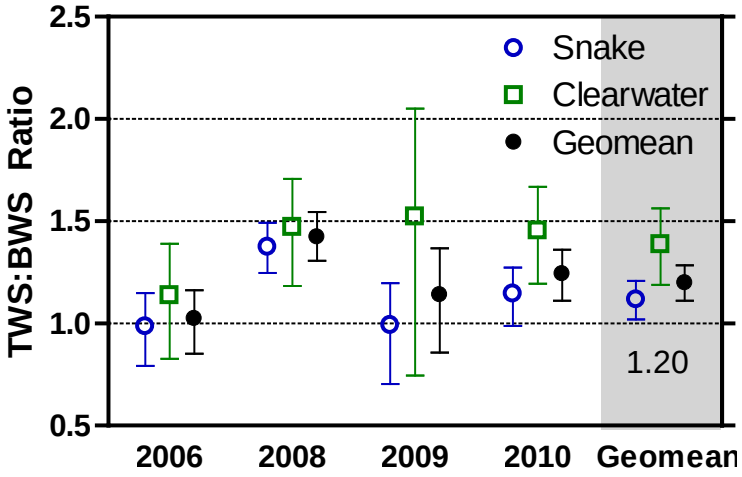
Surrogate Subyearlings



Production Subyearlings



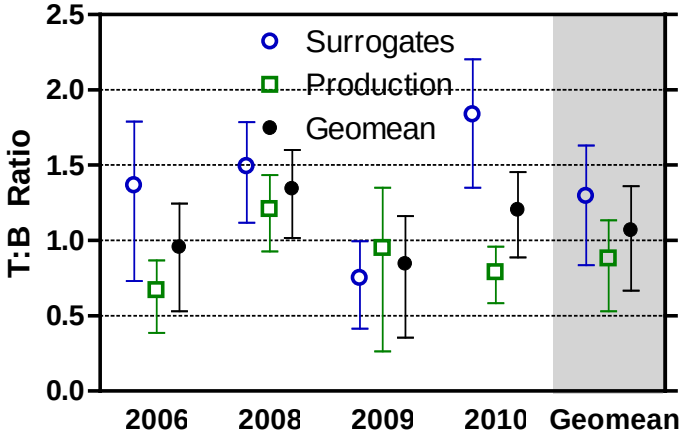
Surrogate + Production Subyearlings



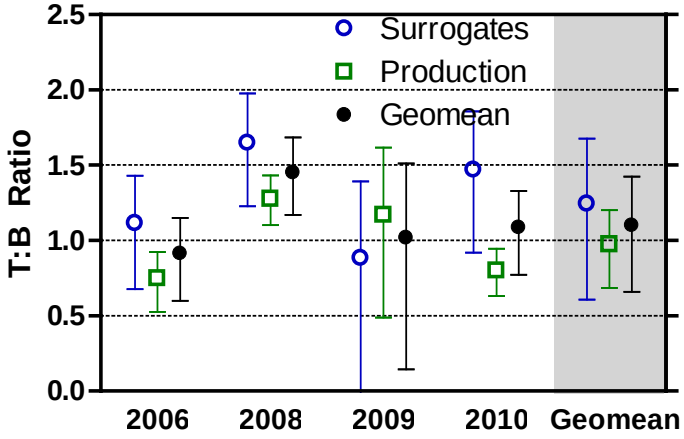
Detailed Analysis for Fish That Entered Bypass Systems

- Seasonal T:B analysis for each collector dam
  - Ignore TWS/BWS designations, use fish actually transported (T) and actually bypassed (B)
- But first, let's look at data pooled across the whole year

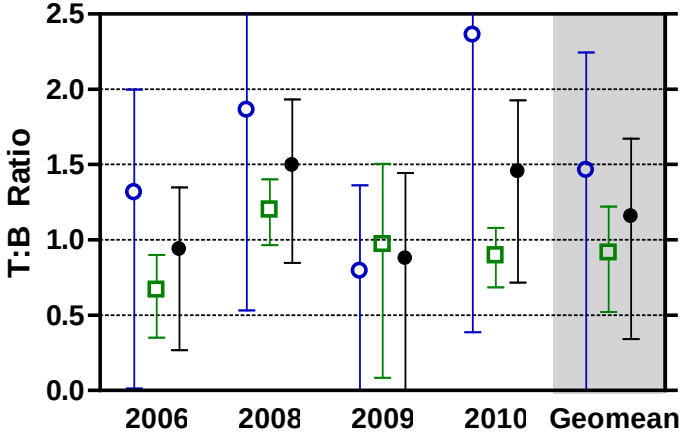
Lower Granite Dam T:B Pooled Annual



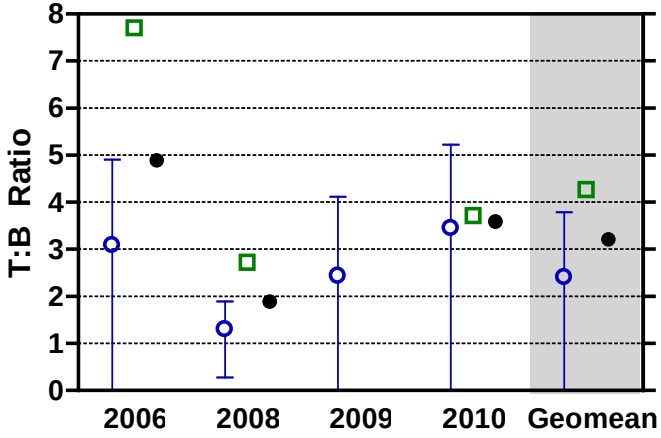
Little Goose Dam T:B Pooled Annual



Lower Monumental Dam T:B Pooled Annual



McNary Dam T:B Pooled Annual



Data

- Daily estimates of smolt-to-adult return rates (SARs)
  - Two groups of smolts for each type/dam/study year:
    - Smolts collected and transported from dam (T)
    - Smolts bypassed at dam and returned to the tailrace (B)
  - Count numbers of PIT-tagged smolts in each group each day (J_i)
  - Count numbers of adults that return 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
    - Experimental group (transported or bypassed at LGR)
    - Date of passage (day of year) (quadratic)
    - Interaction of group with date terms

Descriptive Analysis

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

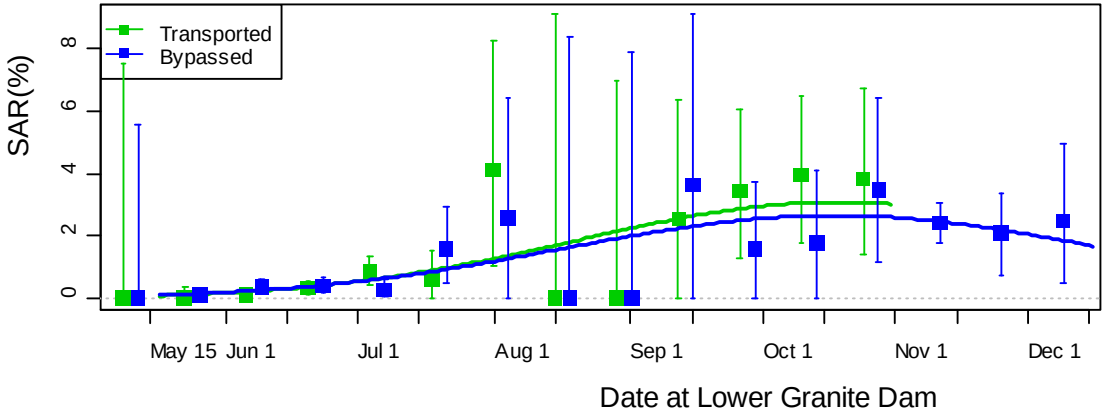
    SAR is (potentially) a function of
    - Experimental group (transported or bypassed at LGR)
    - Date of passage (day of year) (quadratic)
    - Interaction of group with date terms

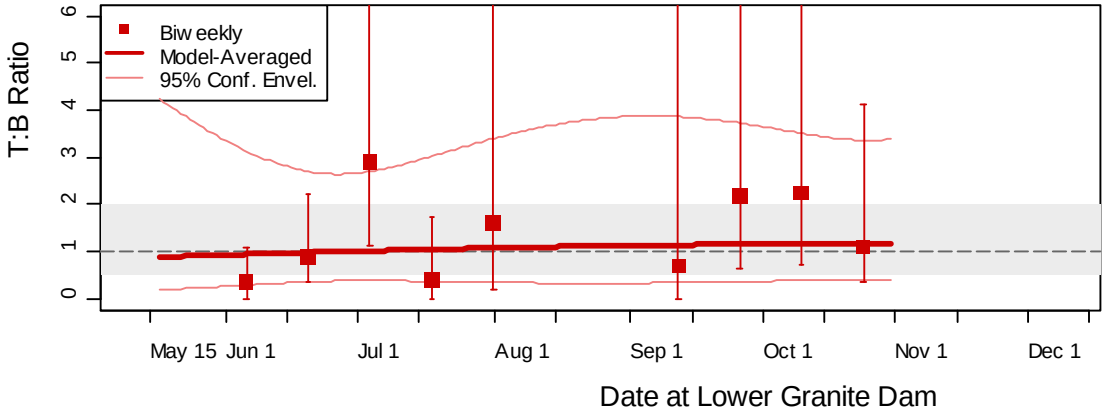
  - Model-average (qAICc) estimated SARs
    - Derive T:B ratio curves and 95% confidence envelopes

2006 Surrogate Subyearlings

Lower Granite Dam

Smolt-to-Adult Return (%)

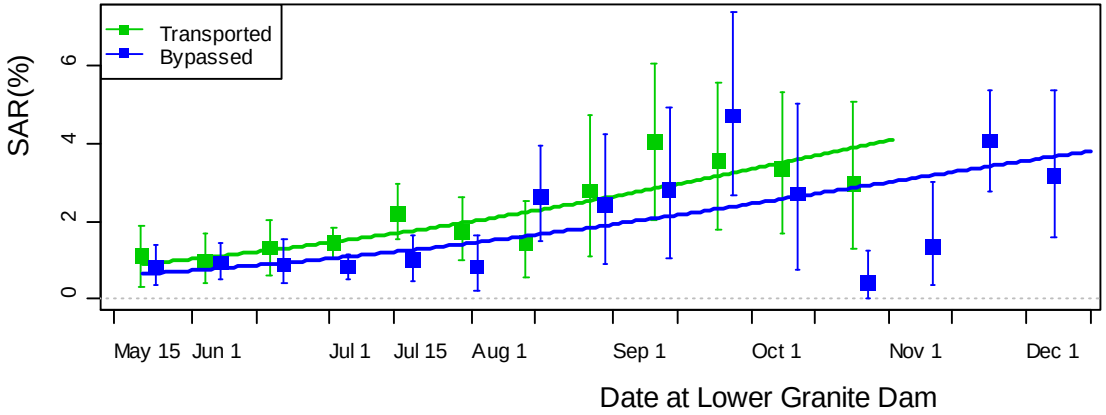


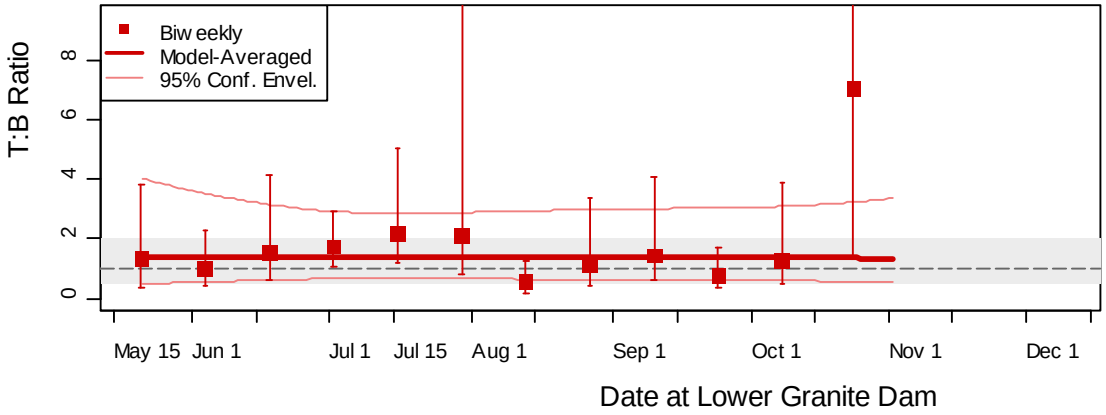


2008 Surrogate Subyearlings

Lower Granite Dam

Smolt-to-Adult Return (%)

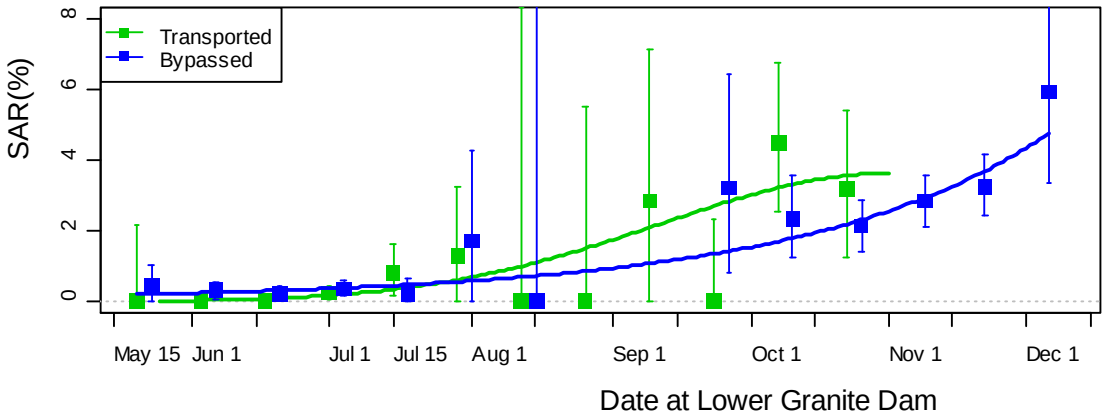


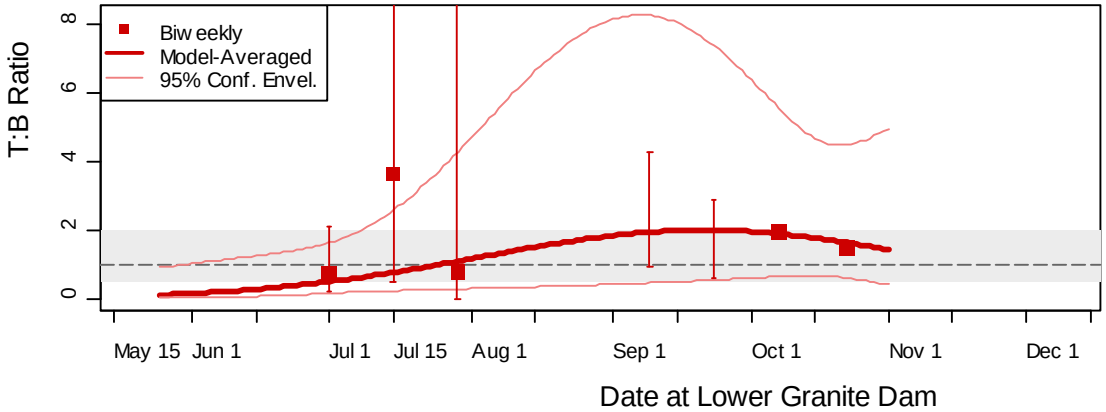


2009 Surrogate Subyearlings

Lower Granite Dam

Smolt-to-Adult Return (%)

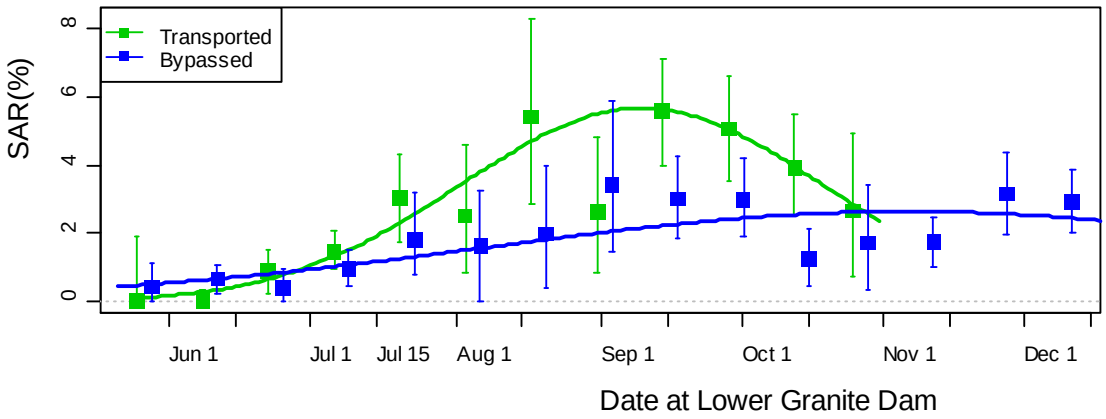


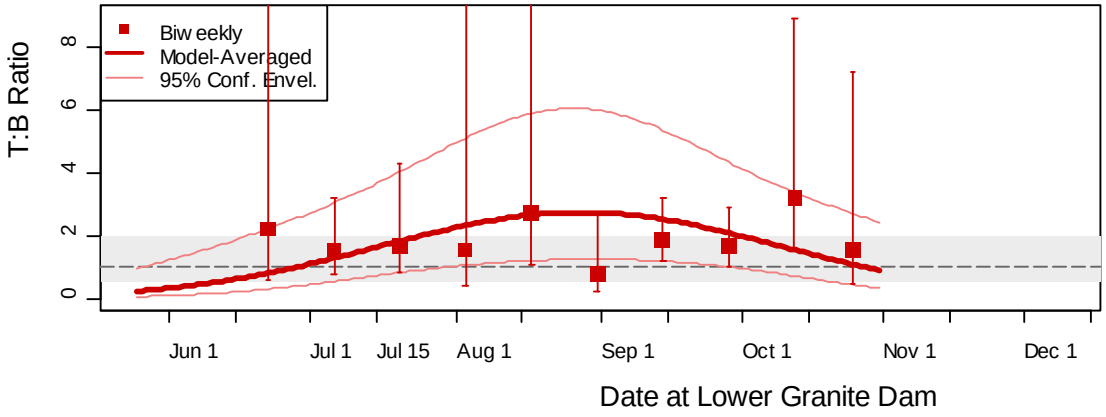


2010 Surrogate Subyearlings

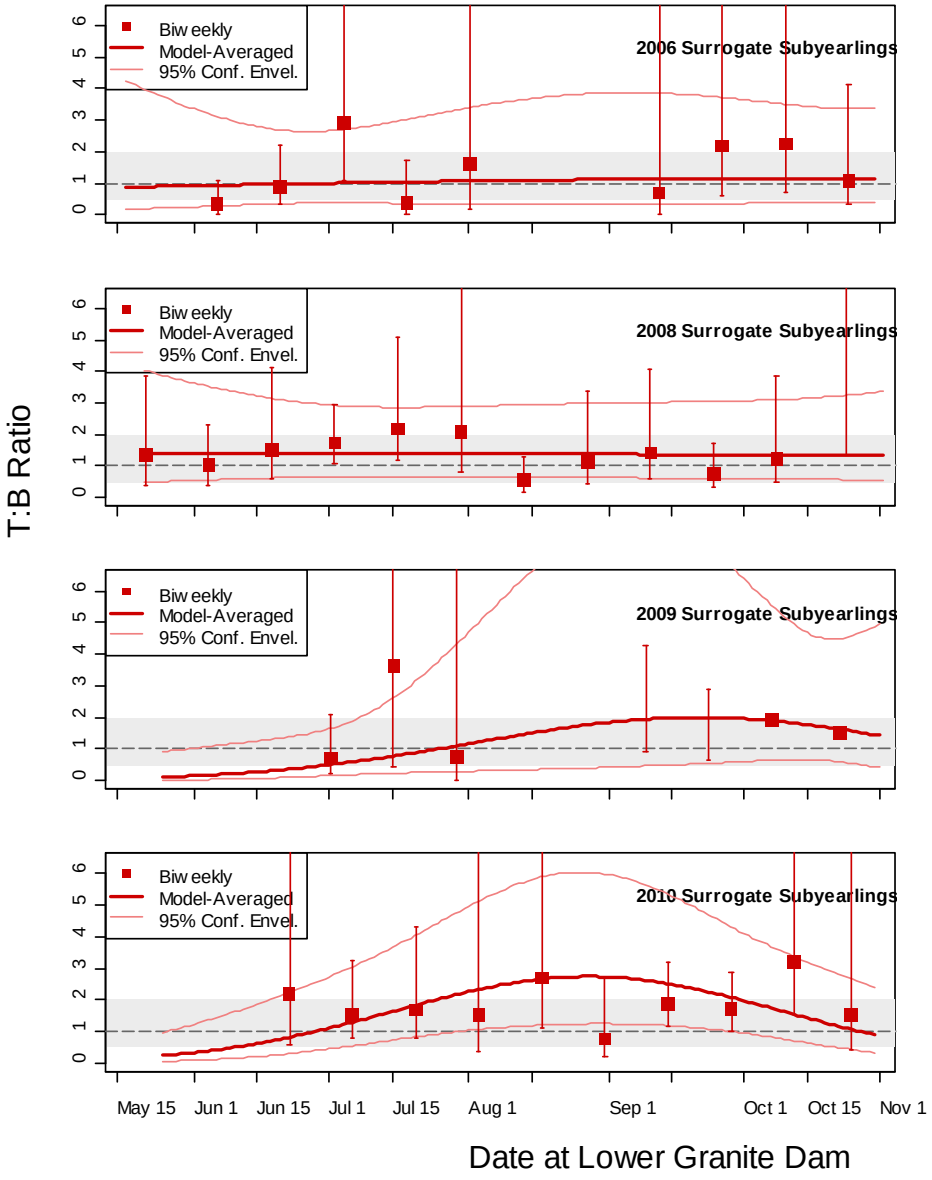
Lower Granite Dam

Smolt-to-Adult Return (%)

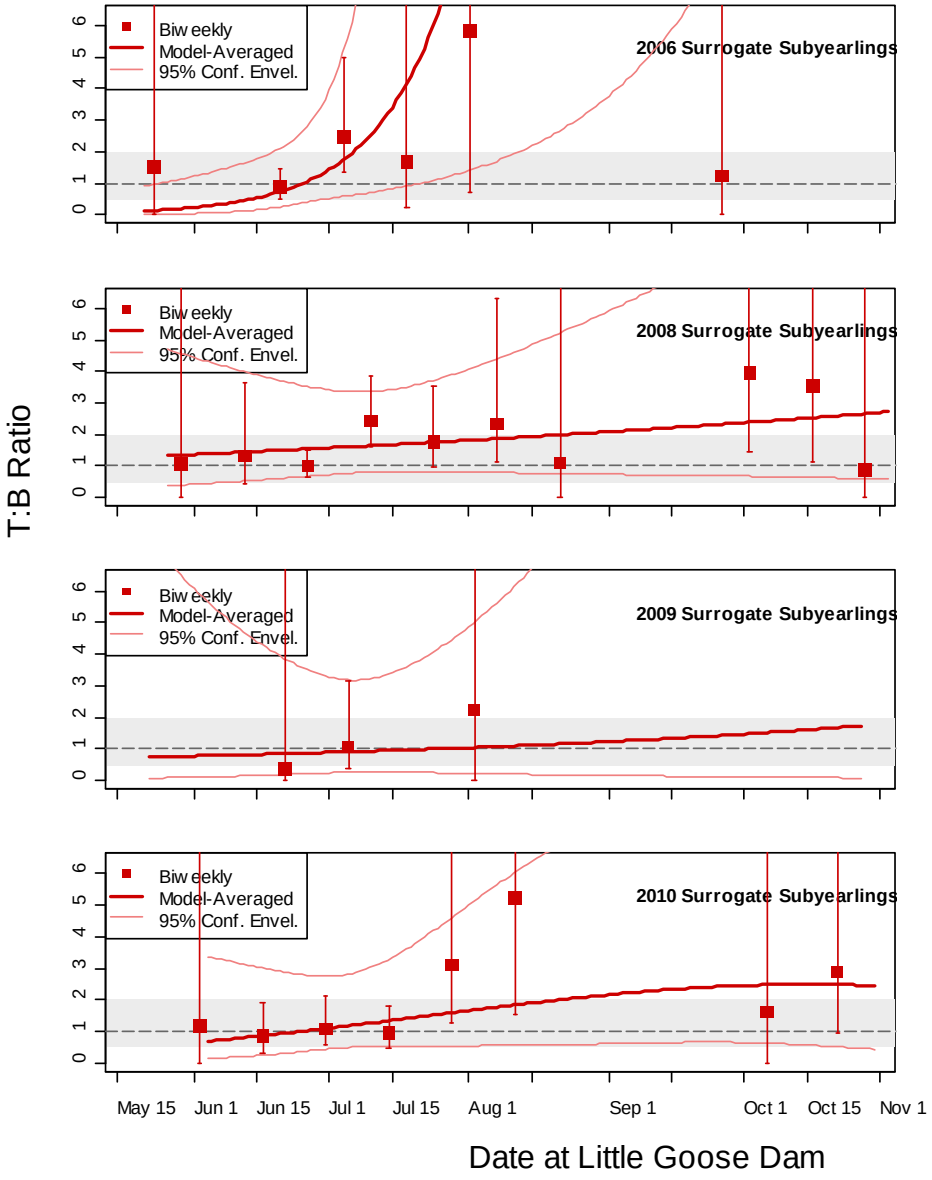




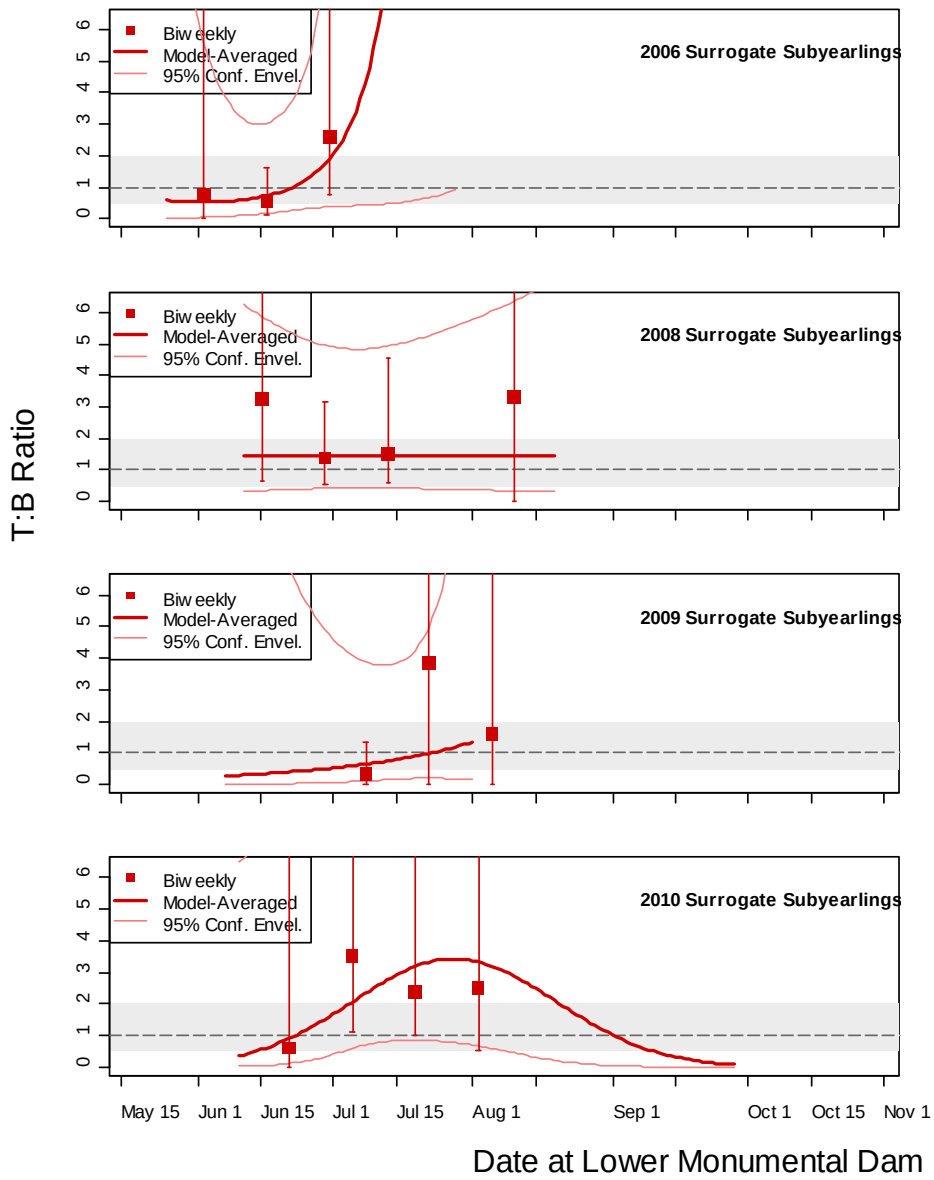
T:B Ratio by Date at Lower Granit



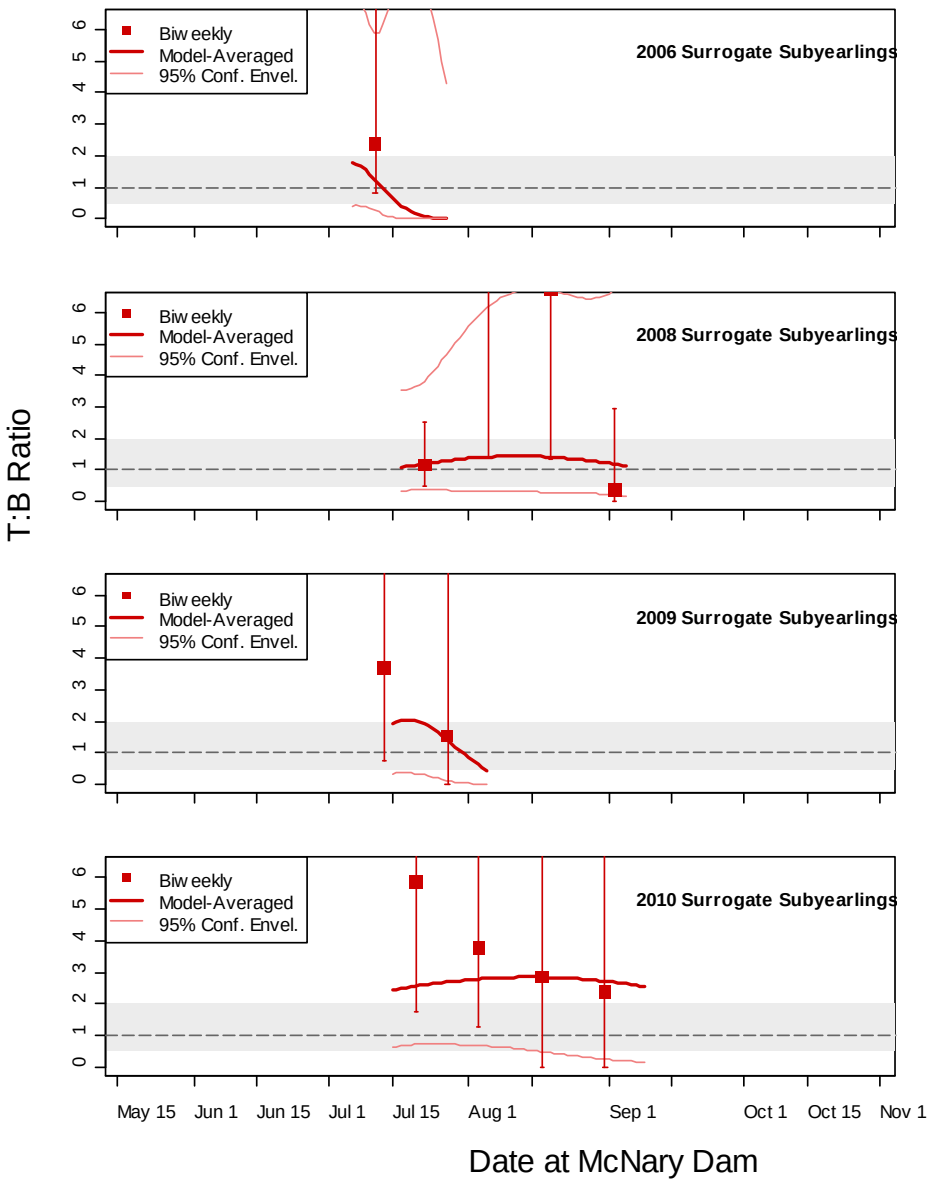
T:B Ratio by Date at Little Goose



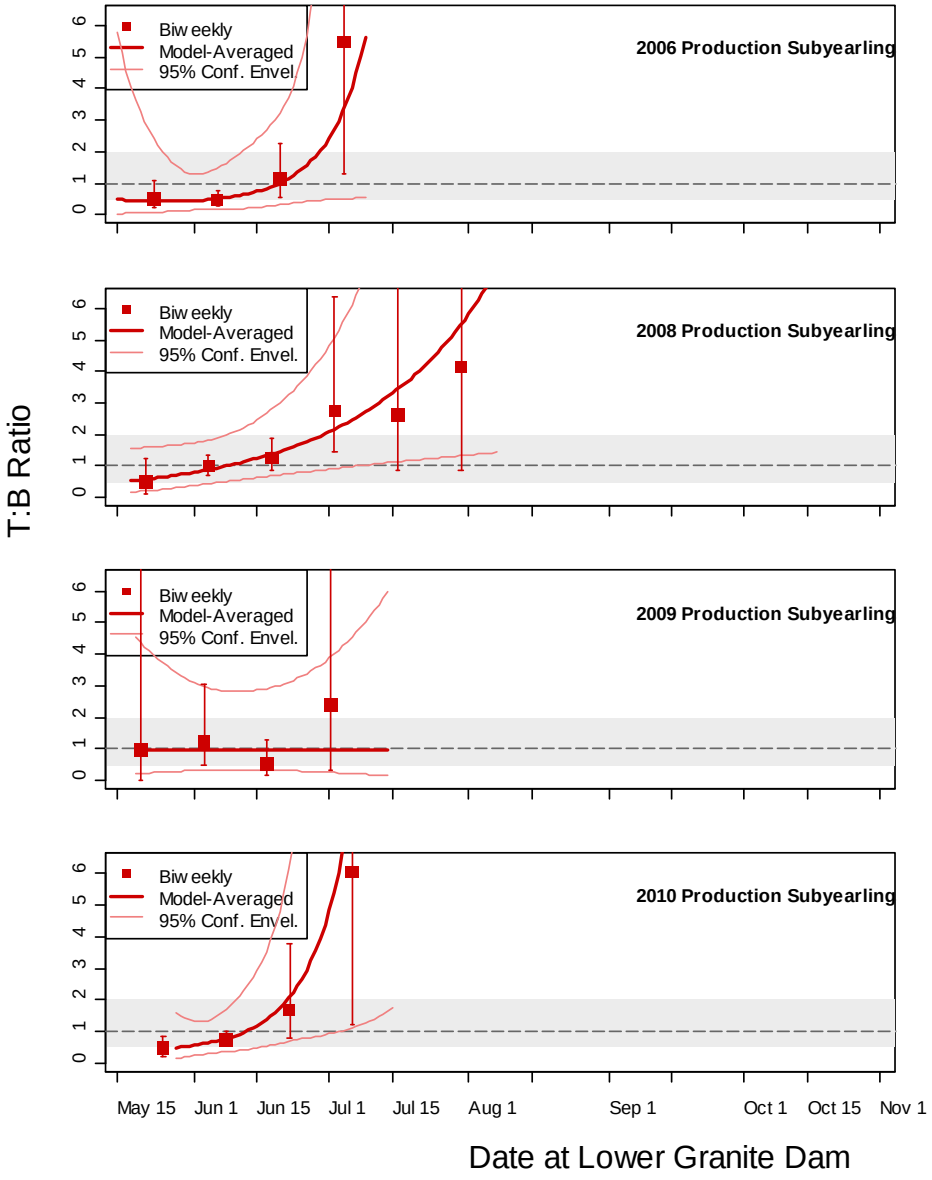
T:B Ratio by Date at Lower Monu



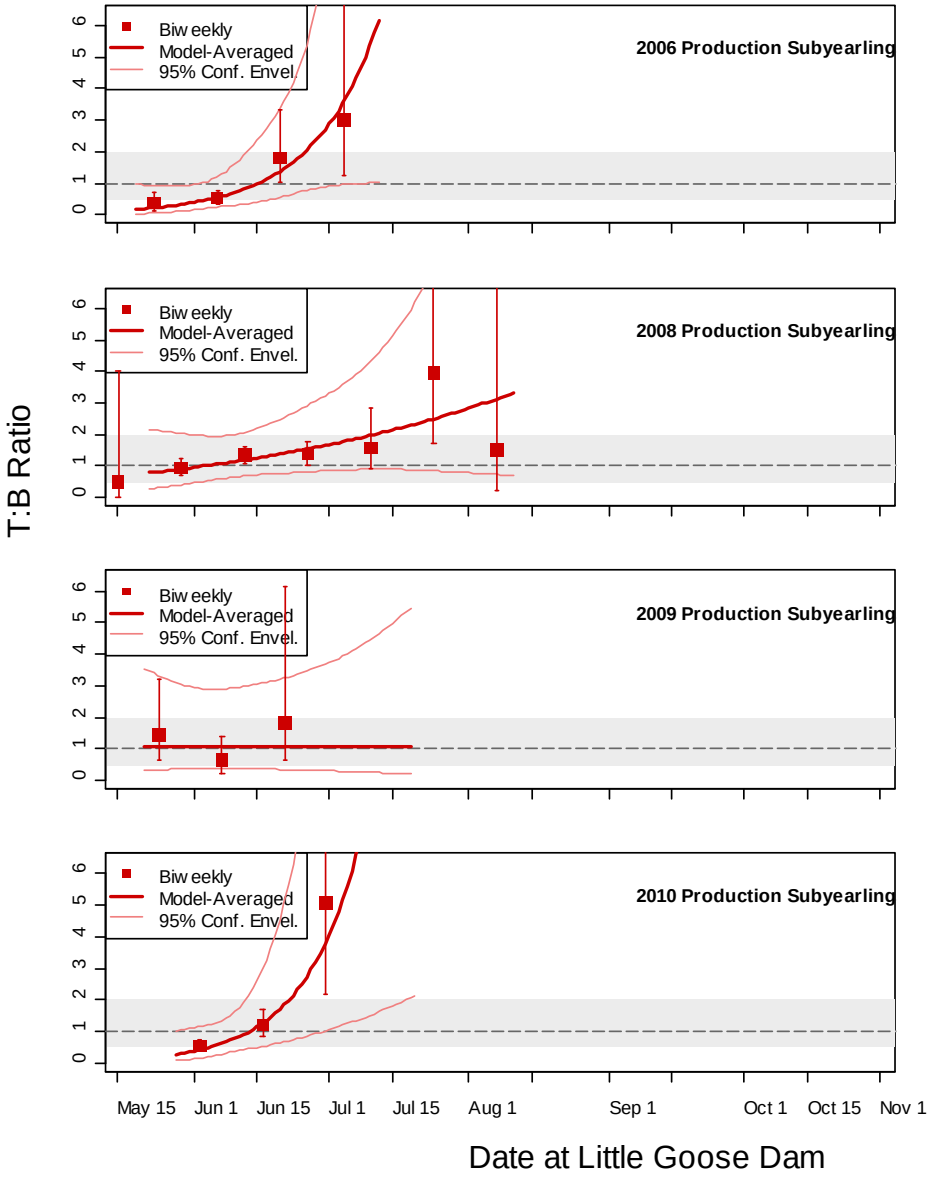
T:B Ratio by Date at McNary Dam



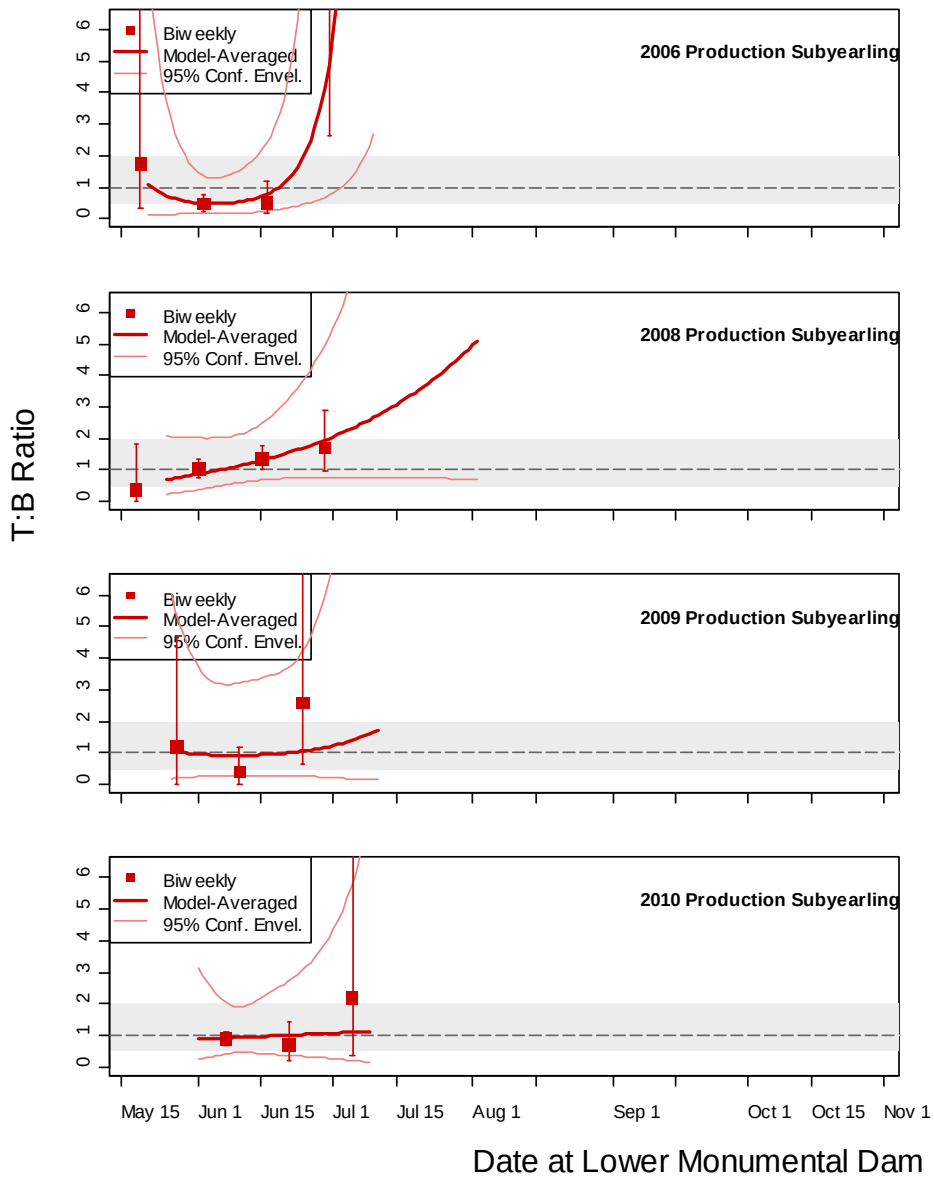
T:B Ratio by Date at Lower Granit



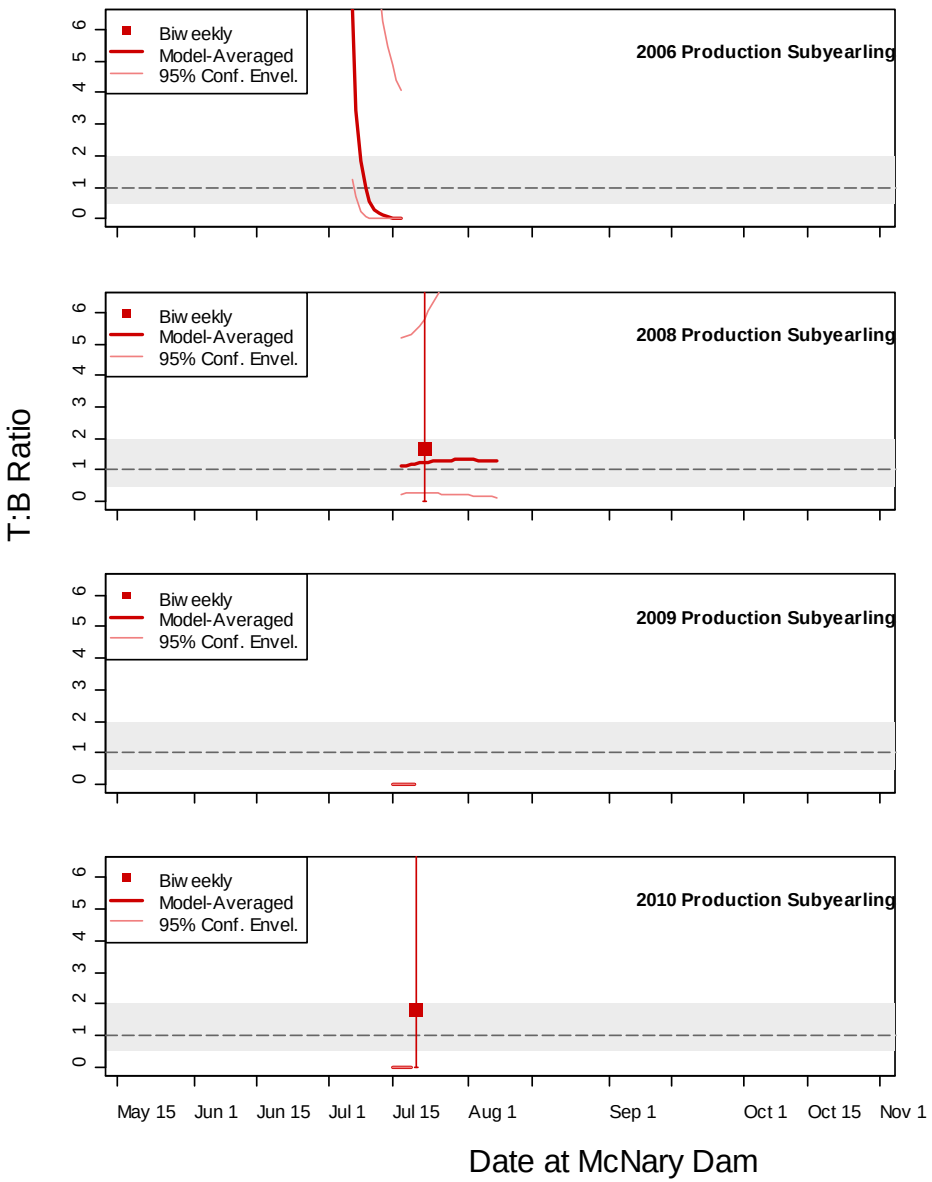
T:B Ratio by Date at Little Goose



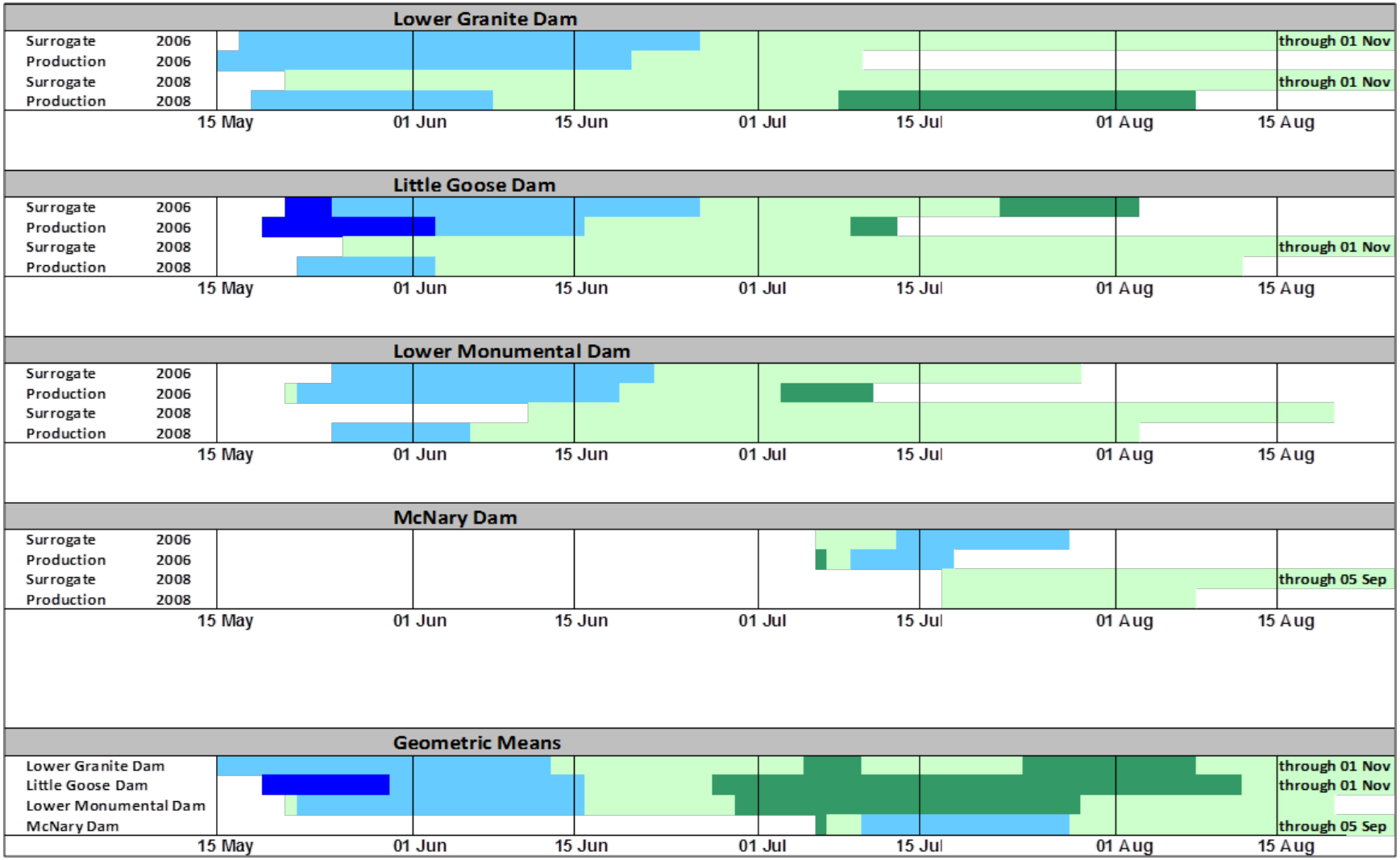
T:B Ratio by Date at Lower Monu



T:B Ratio by Date at McNary Dam



Summary of estimated T:B relative to standard T:B=1.0



Summary

- Higher return rates for bypassed fish until mid-June
- Higher return rates for transported fish after mid-June

Summary

- Higher return rates for bypassed fish until mid-June
- Higher return rates for transported fish after mid-June
- Pooling annual data, averaging across years and subyearling types, transported SAR was higher than bypassed at all dams:
  - 7% higher at Lower Granite
  - 10% higher at Little Goose
  - 16% higher at Lower Monumental
  - 220% higher at McNary

Next Steps For This Project

- Add Data for Release Years 2011-2012
- Analyze Age of Ocean Entry (Scale Analysis) and Age at Return
- Analyze with and without jacks
- Analyze rates of yearling-ocean-entry life history tactic
- Analyze groups released late in summer

Questions?