Briefing to ISAB on transport/spill, 2010

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12 March 2010

Outline

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- 2008 ISAB review

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- 2010 environmental conditions

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- Recent NOAA Transport/spill analysis

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- **Summary**

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- **"Spill-transport operations like those of 2006 and 2007 should be continued long enough to determine how much influence such operational changes have on downriver migration and adult returns"**

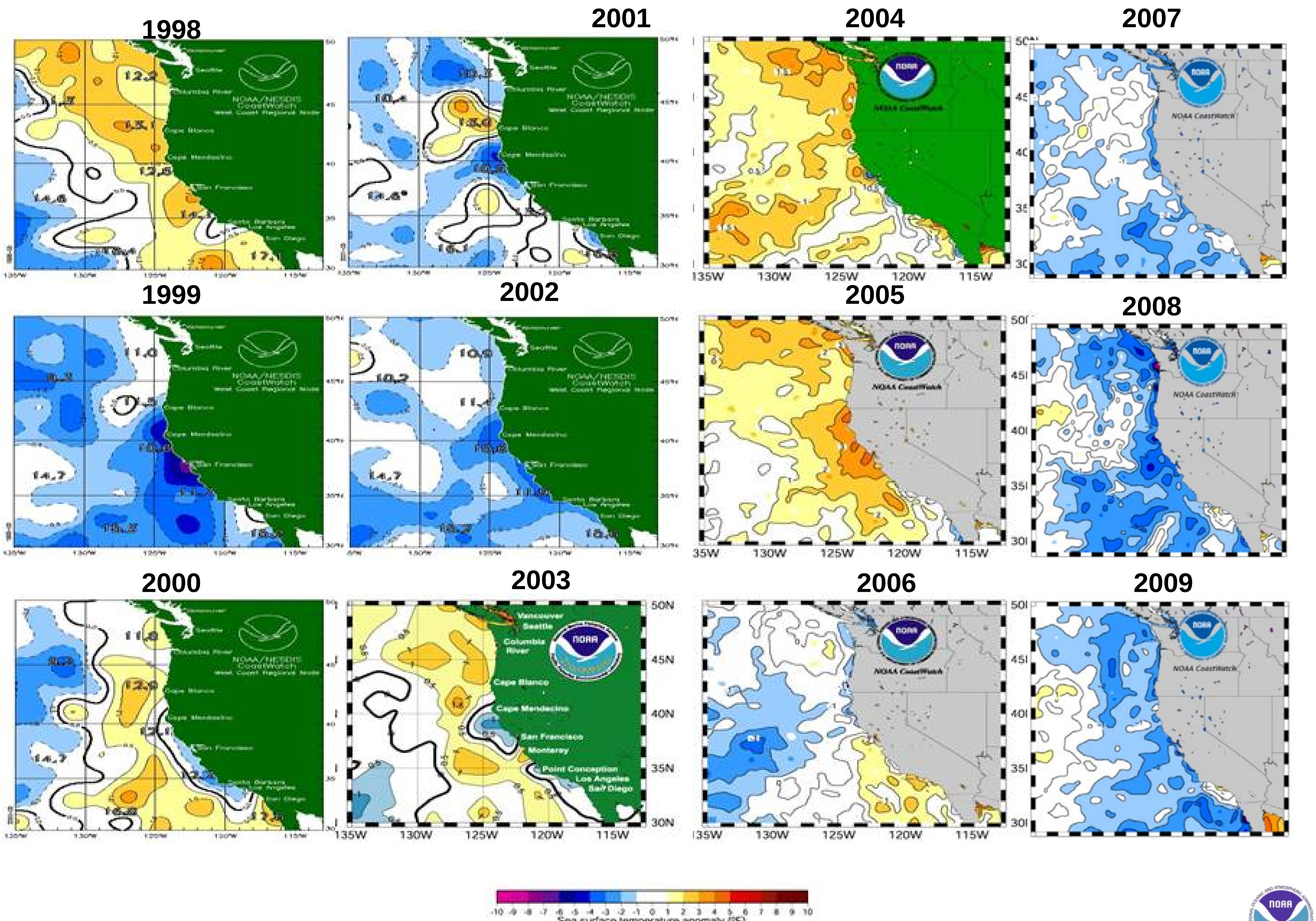
April-September Runoff
(Percent of average)

	2005	2006	2007	2008	2009	2010*
Lower Granite	66	116	*59*	106	108	*56*
Grand Coulee	85	106	*102*	101	80	*75*
The Dalles	74	107	86	101	85	67

* forecast

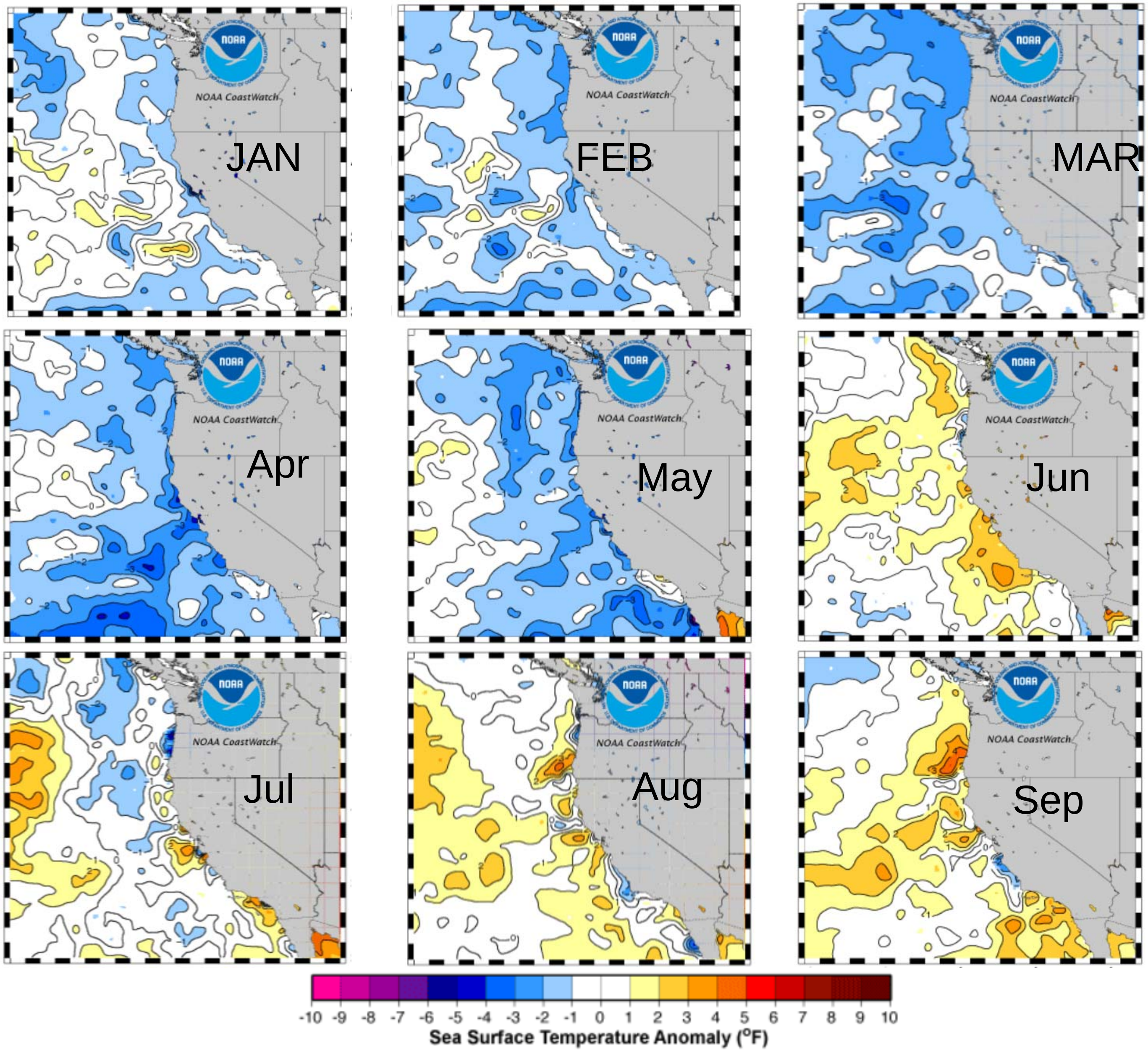
Ocean Conditions

Sea surface temperature anomalies May 1998-2009



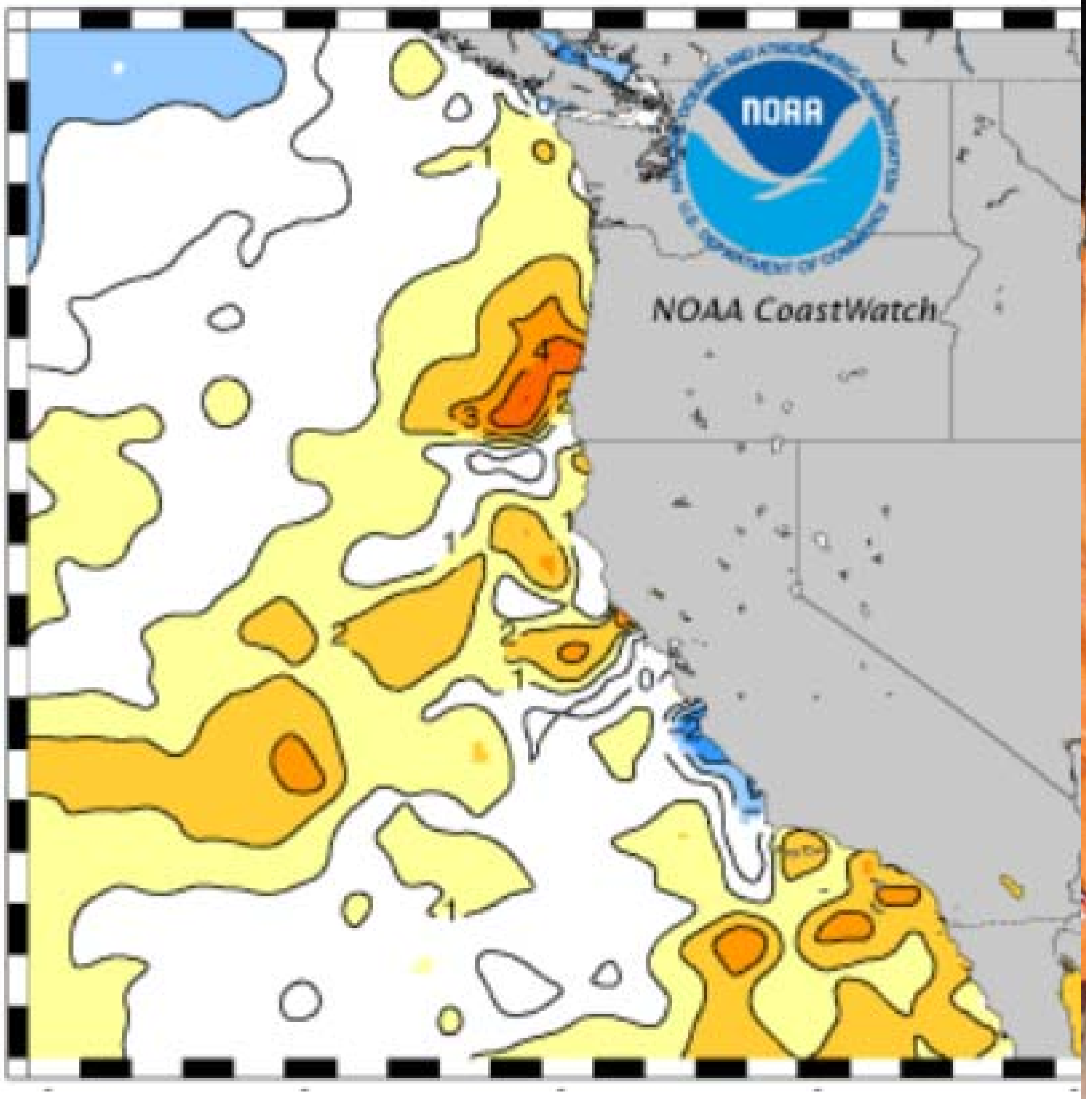
Ocean Conditions

2009 Sea Surface Temperature Anomalies

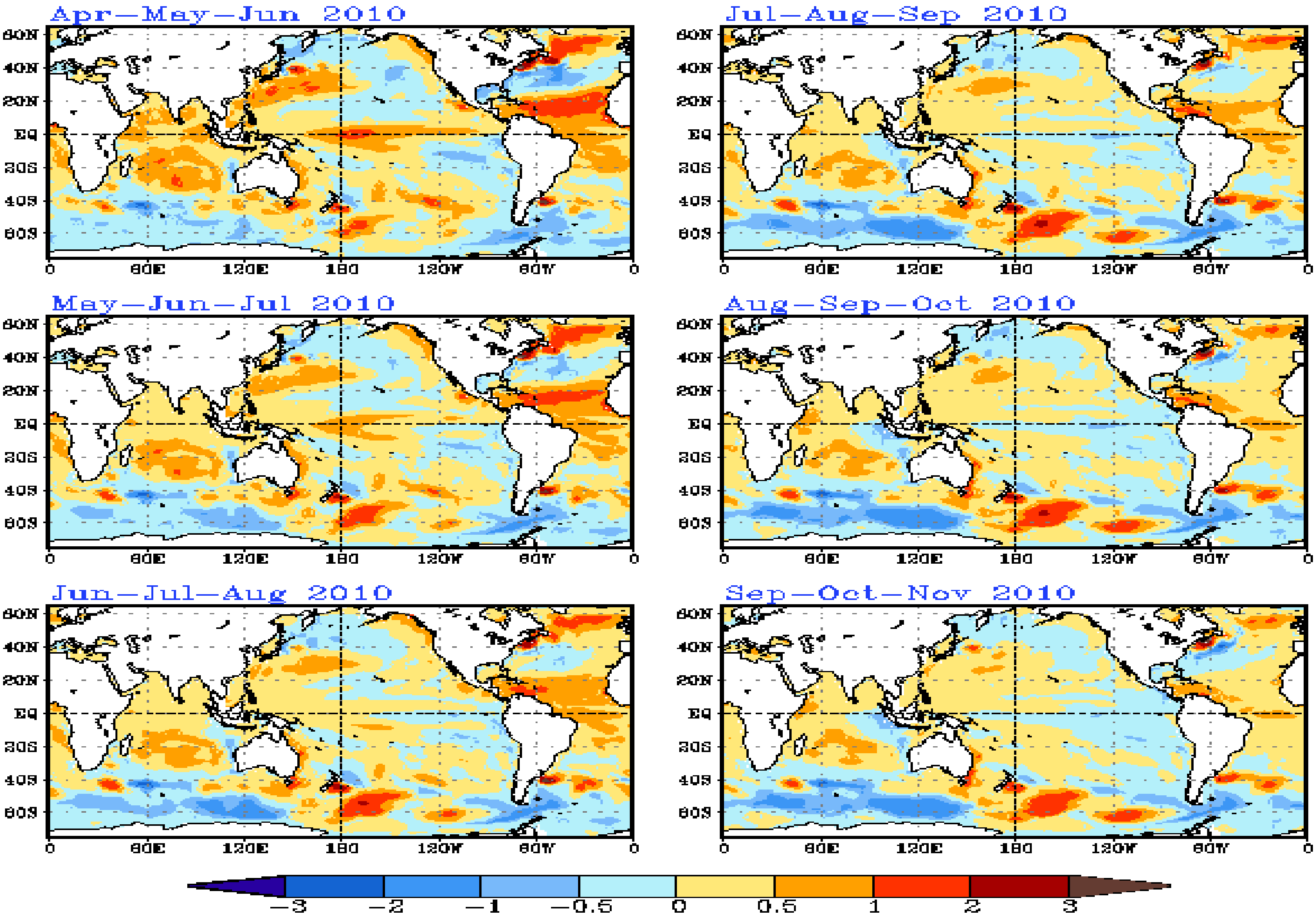


Ocean Conditions

Sept 2009 SST Anomaly



2010 SST forecast



2010 Conditions

- Forecast: 2010 flows will be similar to 2007 in the Snake, but lower than 2007 in the Columbia

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- **Proportion collected and transported**

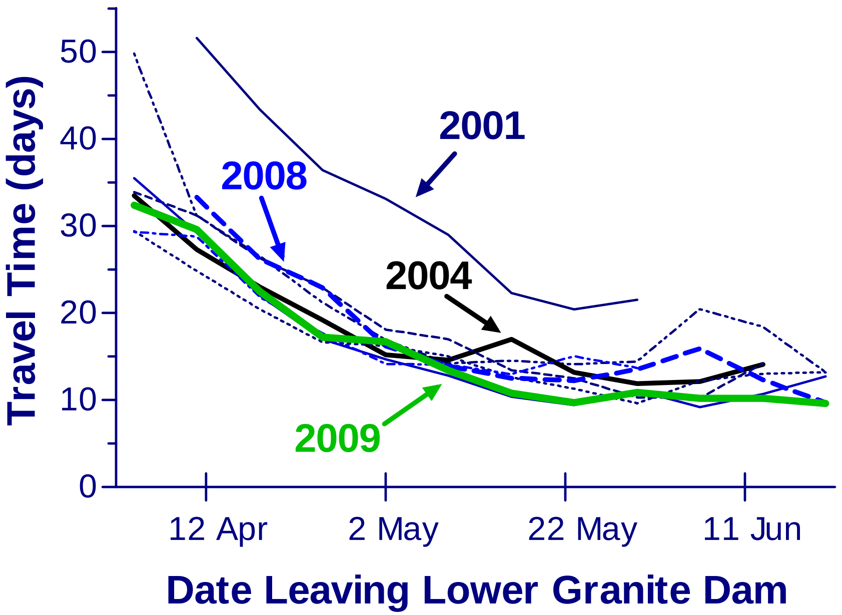
< in low flow years (< water through the powerhouse)

Transport/spill analysis

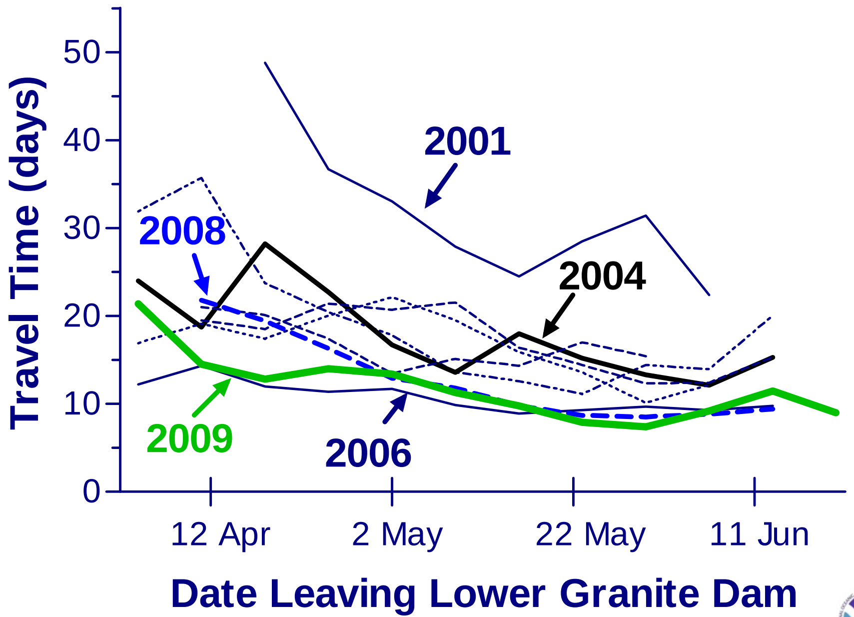
Transport/spill analysis

- Structural and operational changes have reduced travel time through the system

Stream-type Chinook Median Travel Time Lower Granite to Bonneville (461 km)



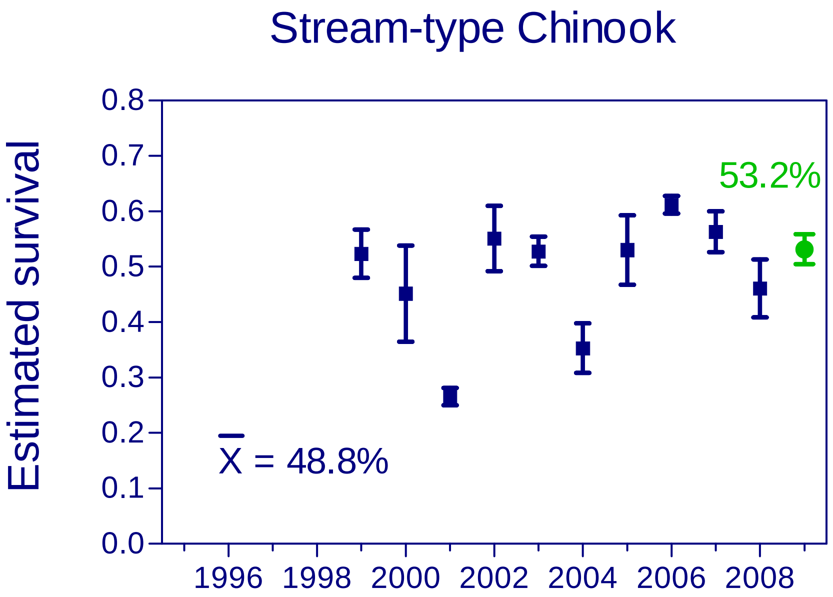
Steelhead Median Travel Time Lower Granite to Bonneville (461 km)

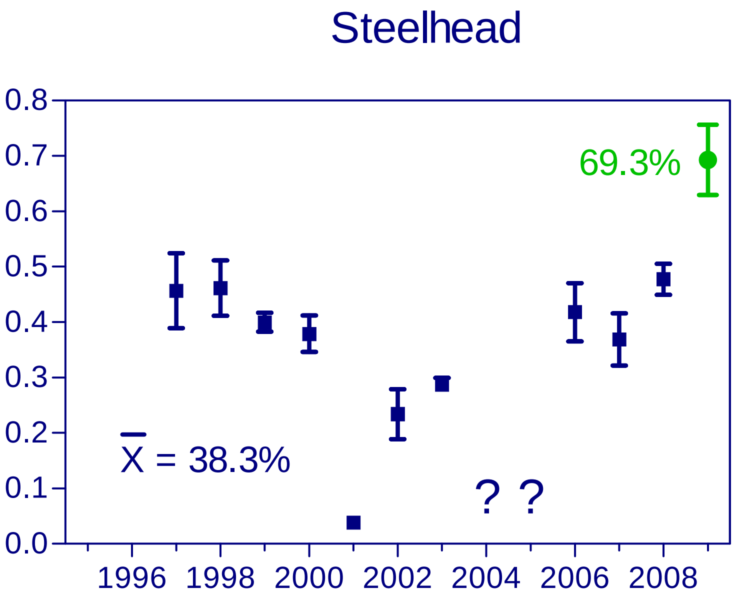


Transport/spill analysis

- Structural and operational changes have improved survival through the system

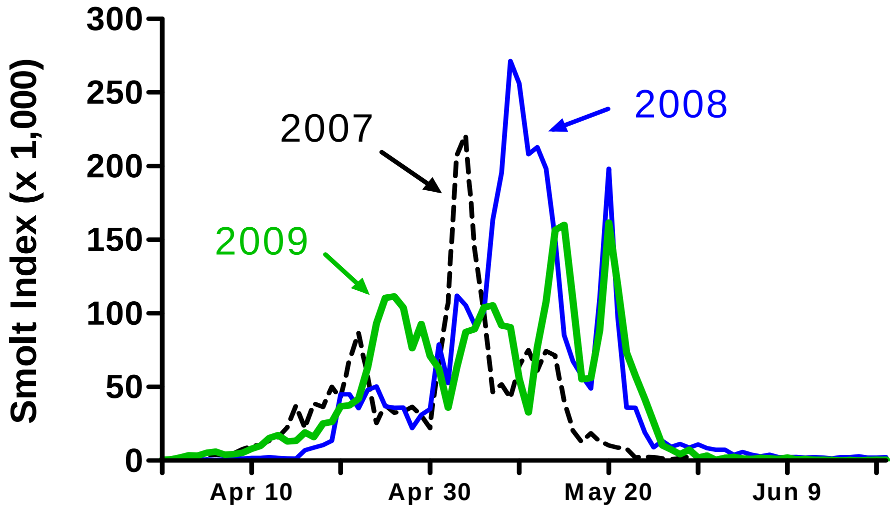
Snake River Trap to Bonneville



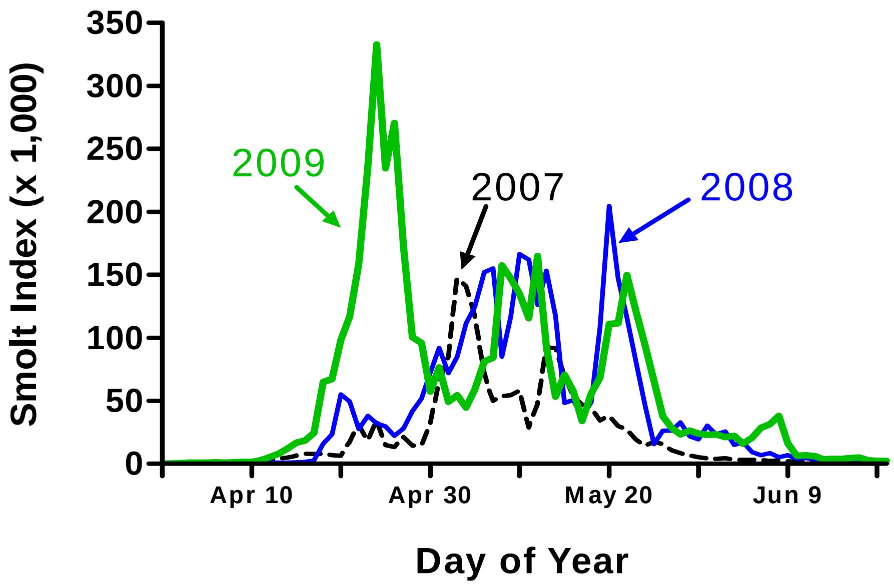


Lower Granite Dam

Yearling Chinook

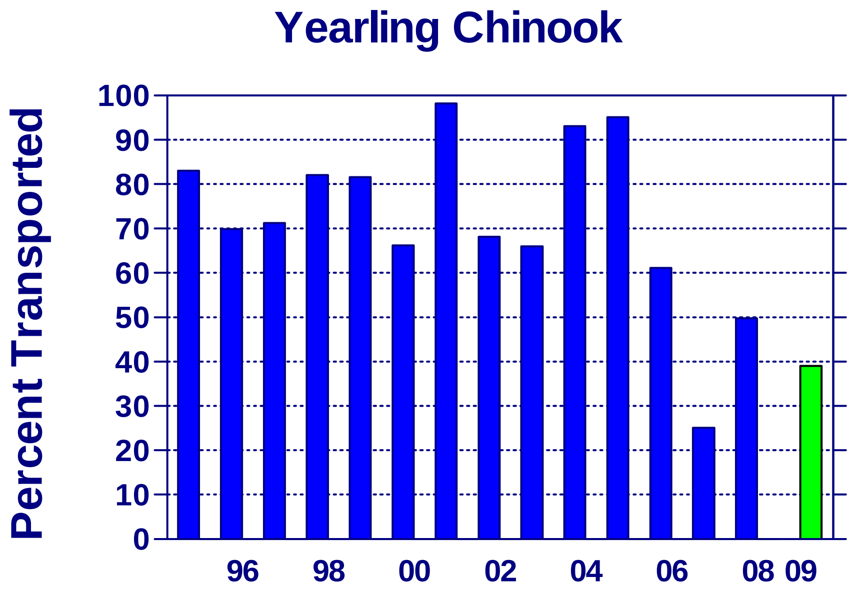


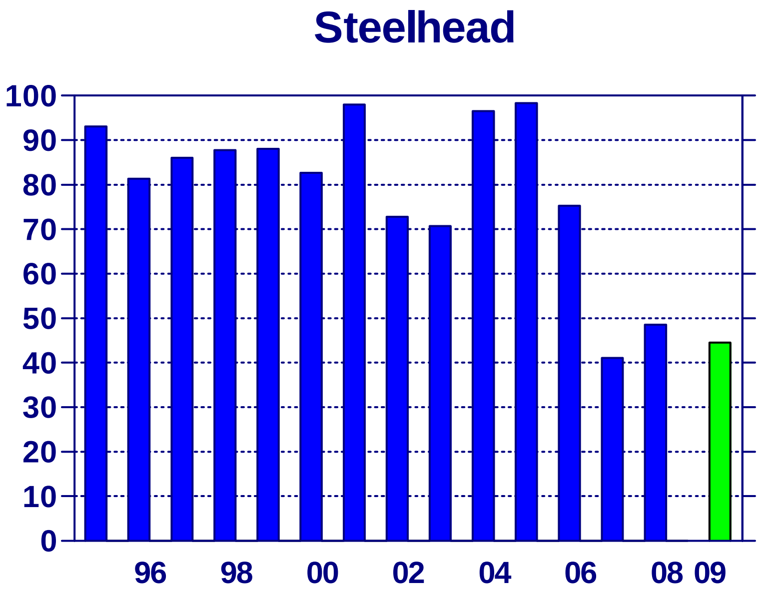
Steelhead



Fewer smolts have been transported in recent years

Percent Transported to Below Bonneville





Analyses of Seasonal Patterns in Smolt-to-Adult Return Rates (SARs)

- Have changes in operations, juvenile survival, travel time resulted in changes in SARs?

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- Caveats for analyses to date

Caveats

- Analyses are:
  - Mostly based on available (adventitious) data

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  - Based on incomplete adult return data for recent migration years

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Data

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

Models for SAR Data

- For four groups of a species/rear-type/migration year:
  - Fit family of statistical regression models (Poisson log-linear regression) with SAR (potentially) a function of:
    - Migration group (transported or in-river migrant)
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    - Date of passage (day of year)
    - Two-way and three-way interactions of above
  - Derive AIC-weighted model-averaged estimates:
    - SAR by day for transported fish
    - SAR by day for in-river migrant fish
    - T:M ratios by day
    - Confidence envelopes

Standards of Comparison for T:M

- Assess daily model-averaged T:M ratio estimates relative to two different standards:

- Standard of 1.0
- Estimated T:M greater than 1.0 indicates that among LGR detected fish, those transported returned at a higher rate than those bypassed

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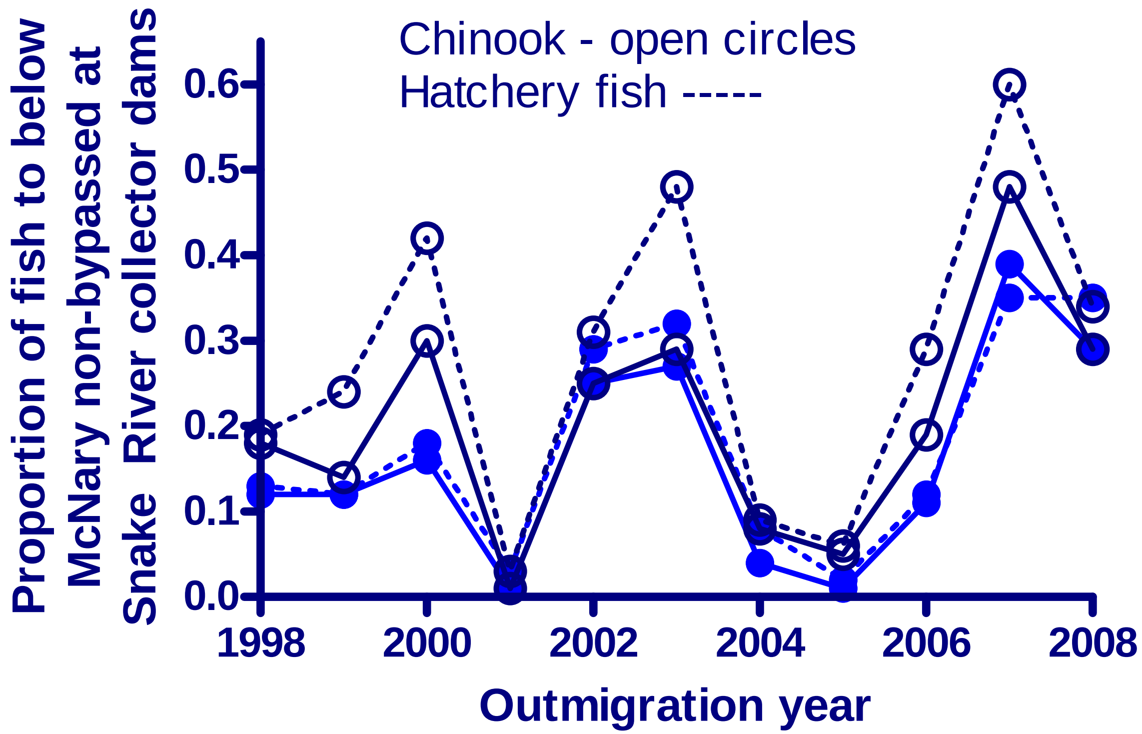
- Statistical "significance" assessed using confidence envelope

Alternative T:M Standard

- Value depends on
  - Ratio of annual SARs for non-bypassed and bypassed in-river migrants
  - Proportion of smolts non-bypassed



Alternative T:M Standard

- Value depends on
  - Ratio of SARs for non-bypassed and bypassed in-river migrants
  - Proportion of smolts non-bypassed
  - (SARC0/SARC1 x % NB + 1 x % C1)

  - For Transport from LGR compared to bypassed in-river migrants:

	WCH	HCH	WST	HST
1998-2005	**1.03**	**1.11**	**1.07**	**1.22**
2006	**1.02**	**1.08**	**1.03**	**1.10**
2007	**1.04**	**1.16**	**1.11**	**1.28**
2008	**1.02**	**1.09**	**1.08**	**1.28**

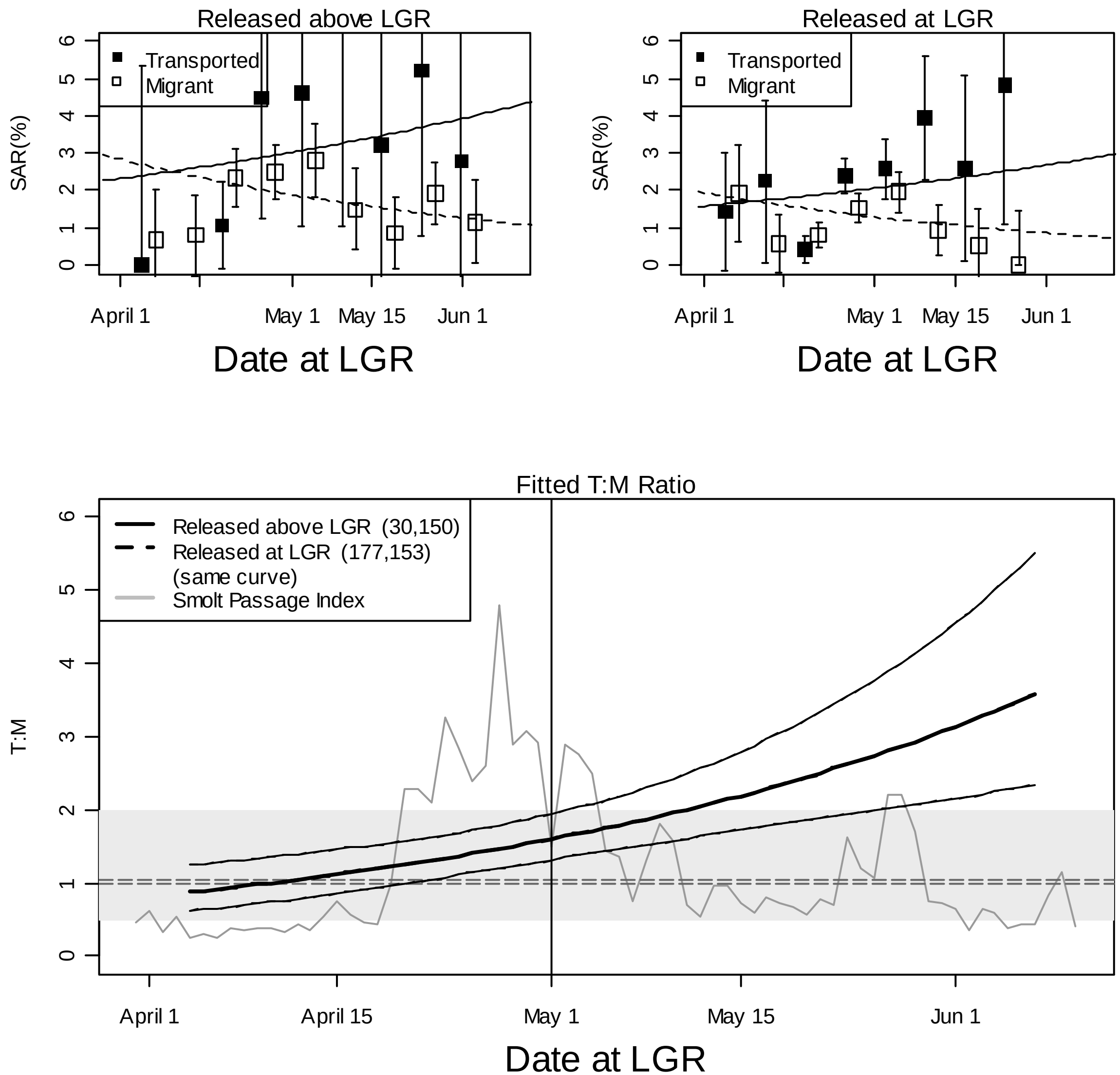
  - For transport from LGO compared to bypassed in-river migrants:

	WCH	HCH	WST	HST
1998-2005	**1.14**	**1.27**	**1.21**	**1.16**
2006	**1.08**	**1.19**	**1.08**	**1.07**
2007	**1.22**	**1.39**	**1.31**	**1.20**
2008	**1.13**	**1.22**	**1.23**	**1.20**

SAR and T:M Modeling Results

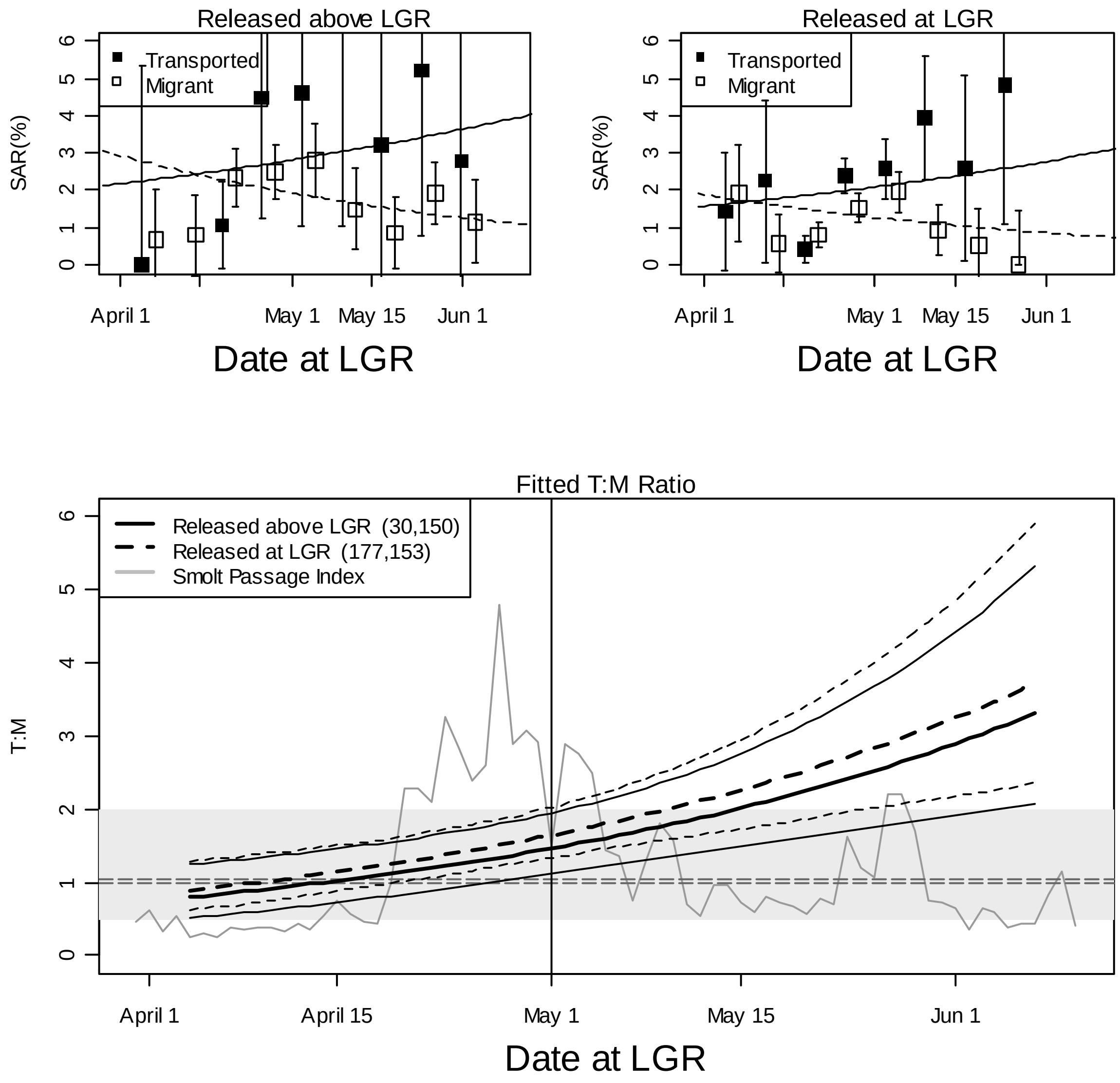
Wild Chinook 1999

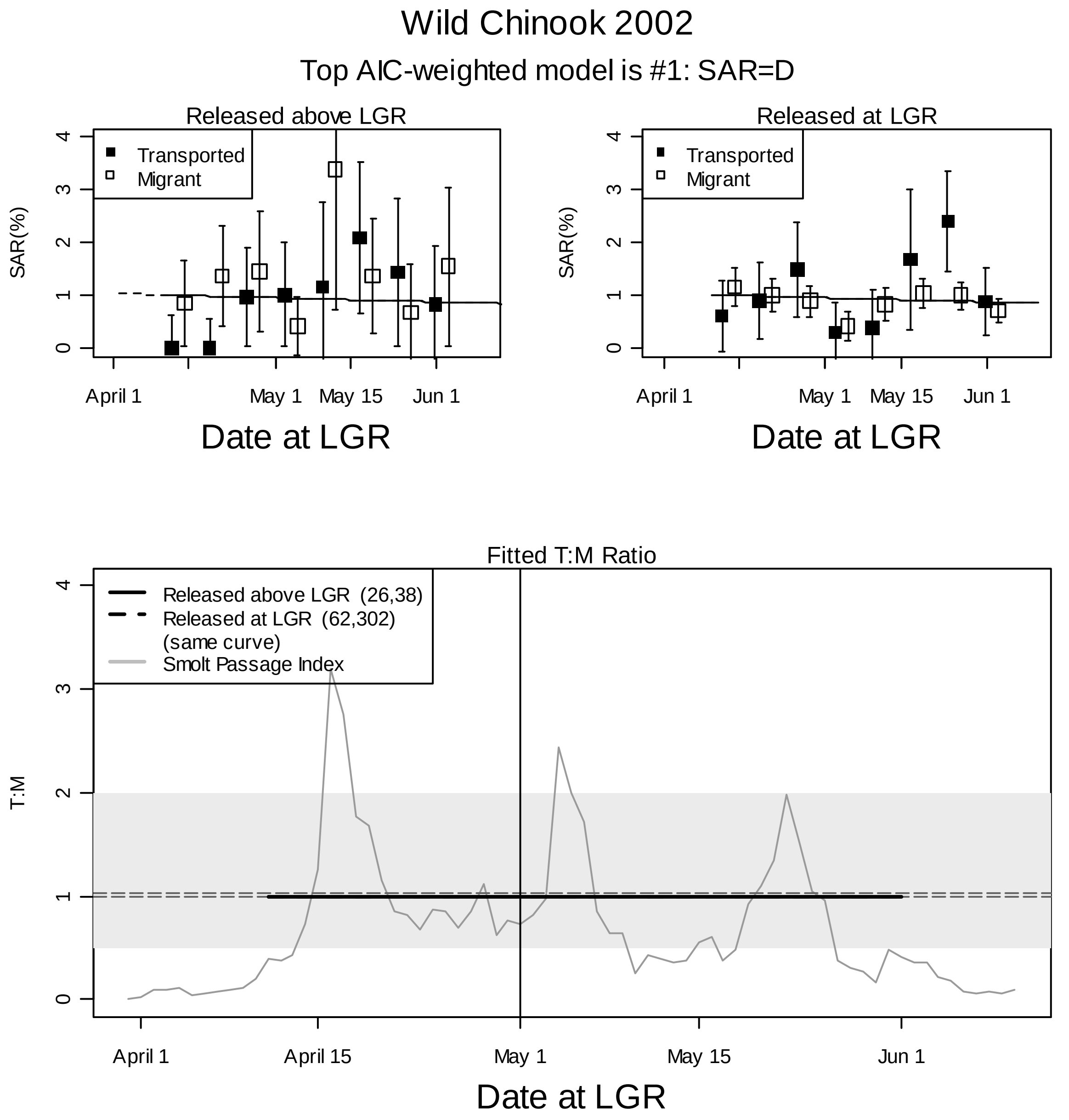
Top AIC-weighted model is #12: SAR=D + L + T + D*T



Wild Chinook 1999

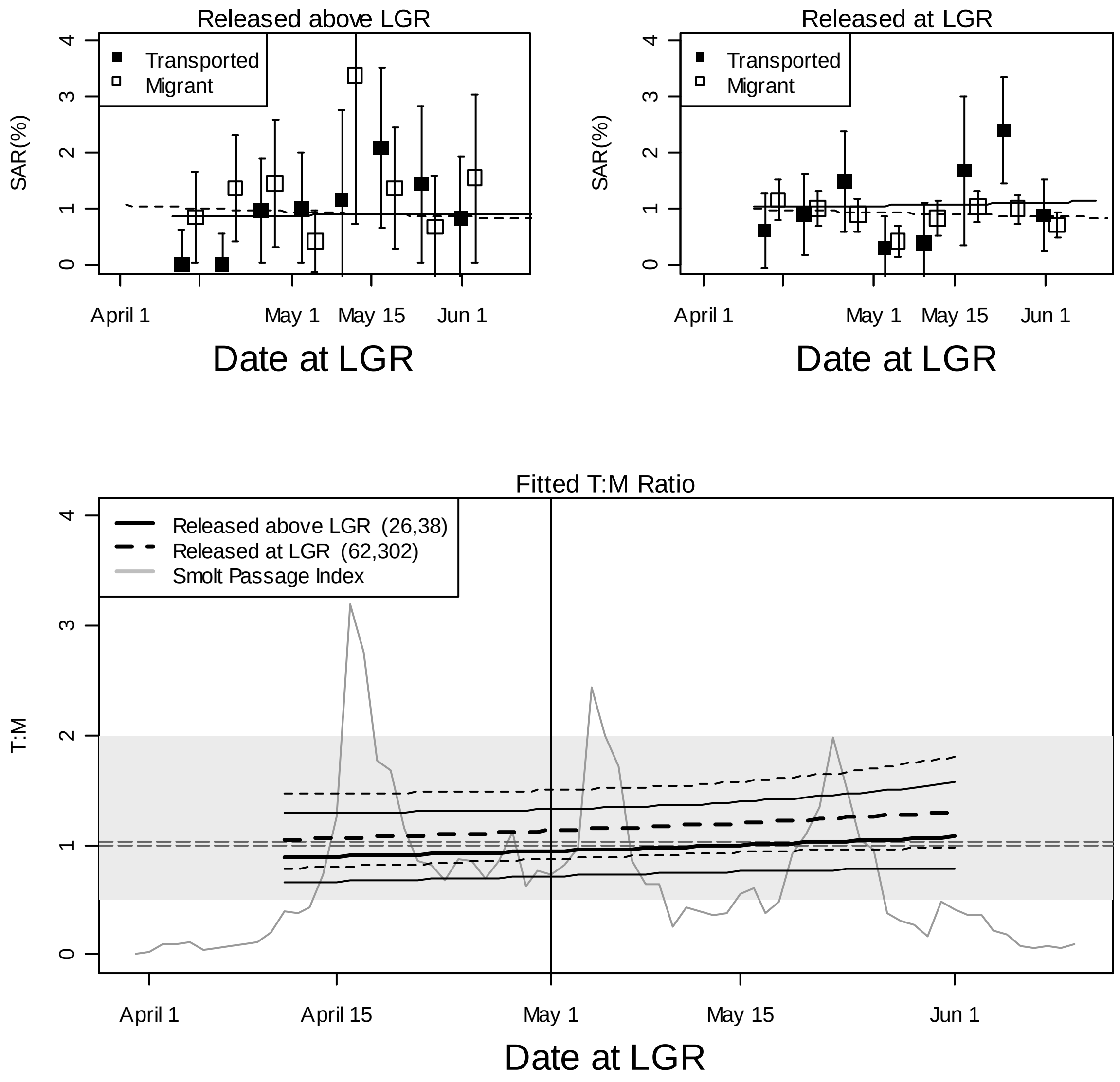
Model-Averaged

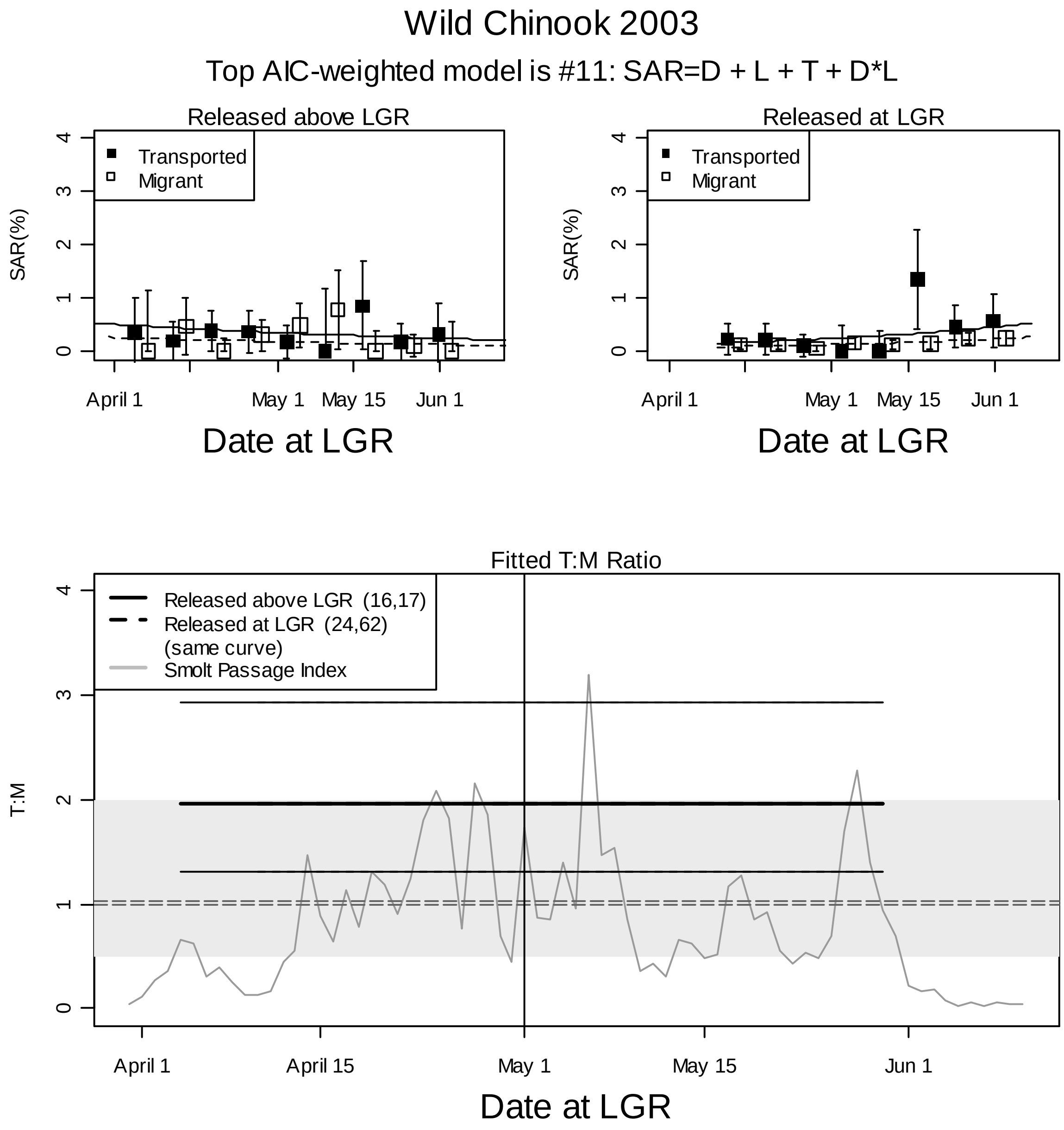



Wild Chinook 2002
Top AIC-weighted model is #1: SAR=D
Released above LGR
Transported
Migrant
SAR(%)
0
1
2
3
4
April 1
May 1
May 15
Jun 1
Date at LGR
Released at LGR
Transported
Migrant
SAR(%)
April 1
May 1
May 15
Jun 1
Date at LGR
Fitted T:M Ratio
Released above LGR (26,38)
Released at LGR (62,302)
(same curve)
Smolt Passage Index
T:M
April 1
April 15
May 1
May 15
Jun 1
Date at LGR

Wild Chinook 2002

Model-Averaged

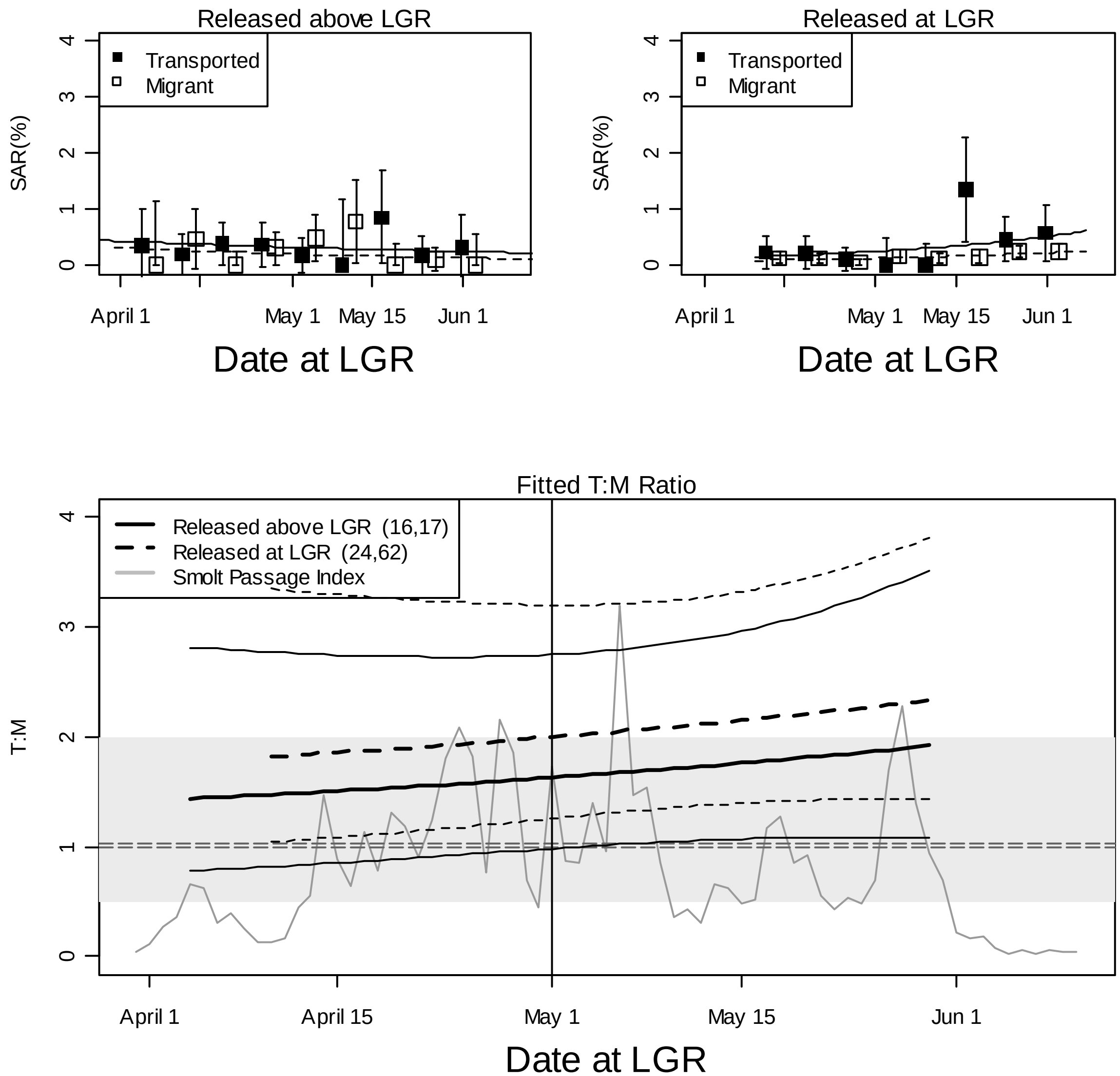




Wild Chinook 2003
Top AIC-weighted model is #11: SAR=D + L + T + D*L
Released above LGR
Released at LGR
Transported
Migrant
SAR(%)
0
1
2
3
4
April 1
May 1
May 15
Jun 1
Date at LGR
Fitted T:M Ratio
Released above LGR (16,17)
Released at LGR (24,62)
(same curve)
Smolt Passage Index
T:M
April 15

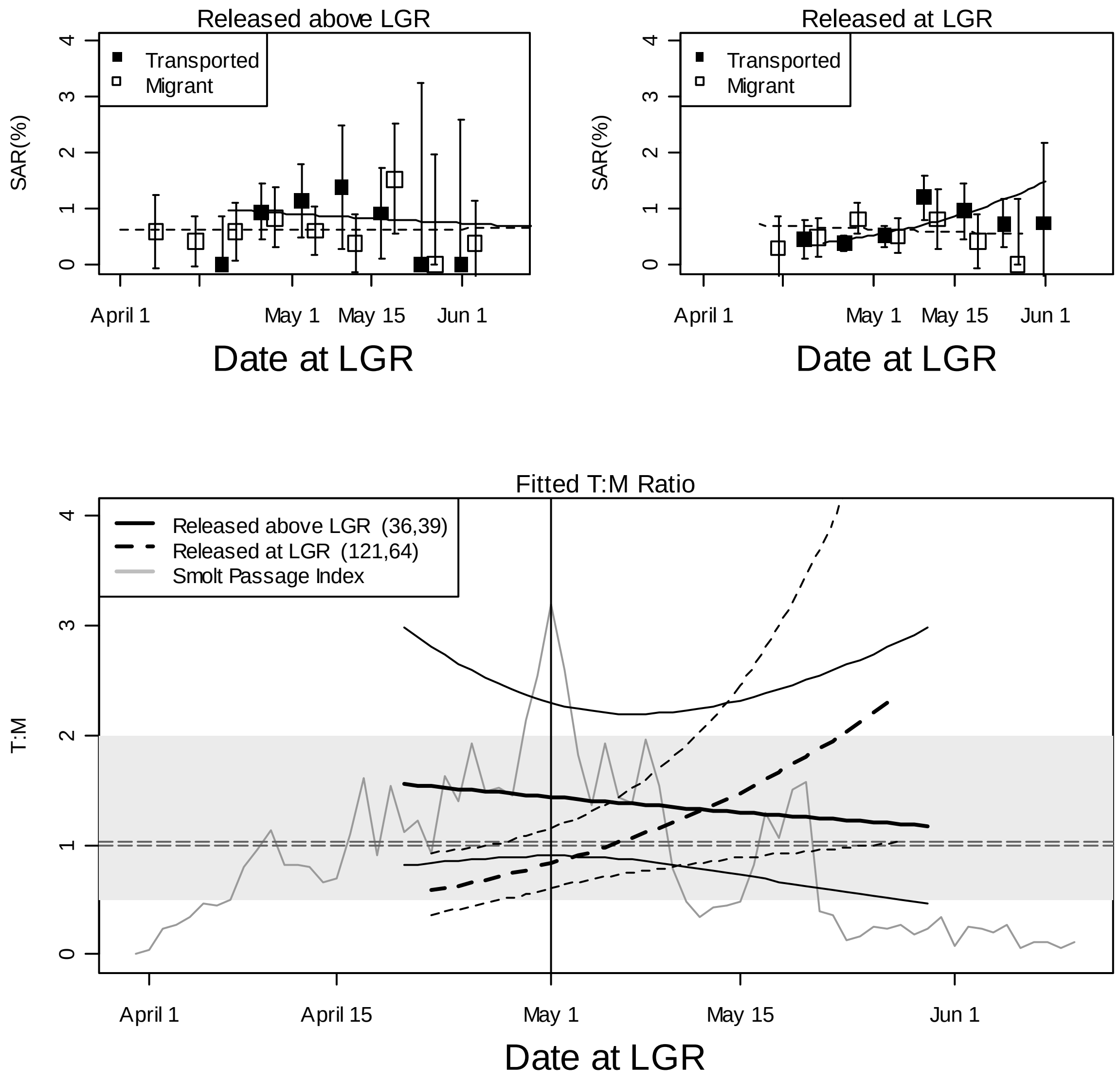
Wild Chinook 2003

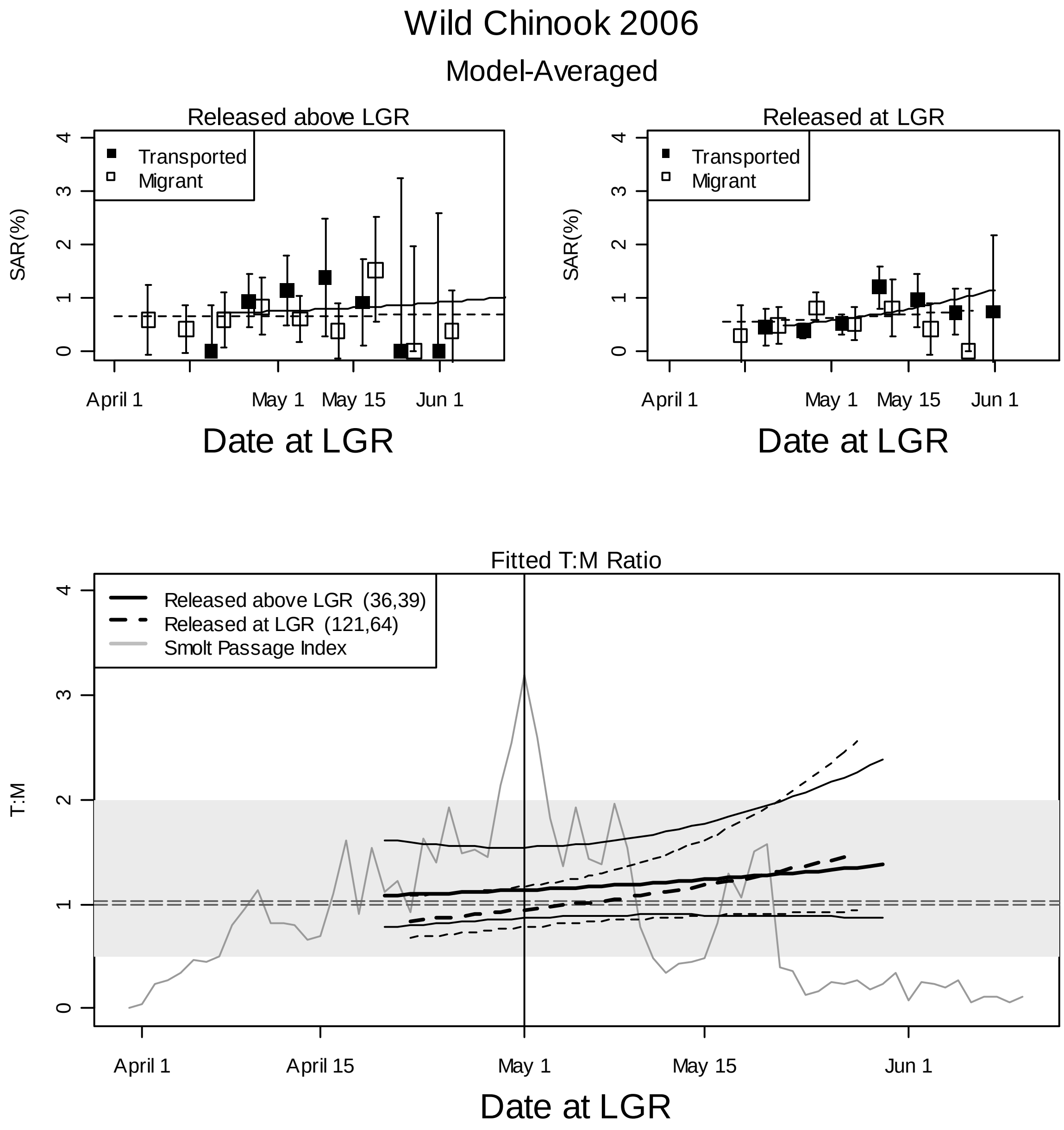
Model-Averaged



Wild Chinook 2006

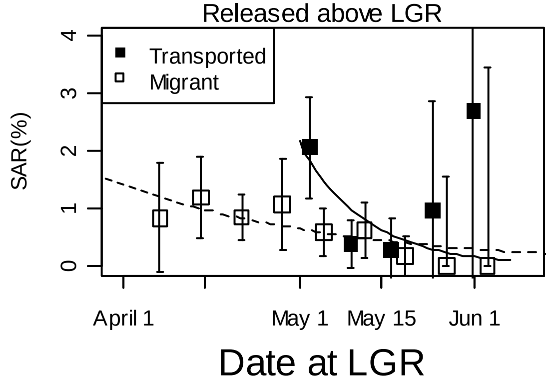
Top AIC-weighted model is #18: SAR=D + L + T + D*L + D*T + L*T + D*L*T

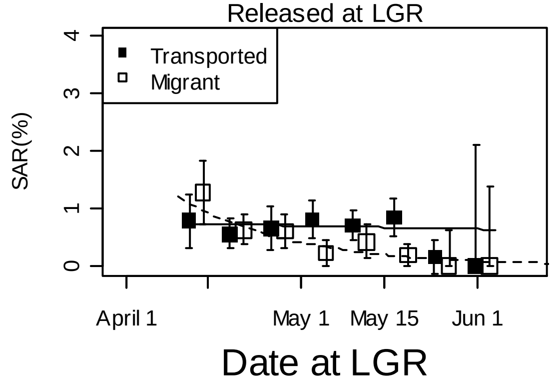


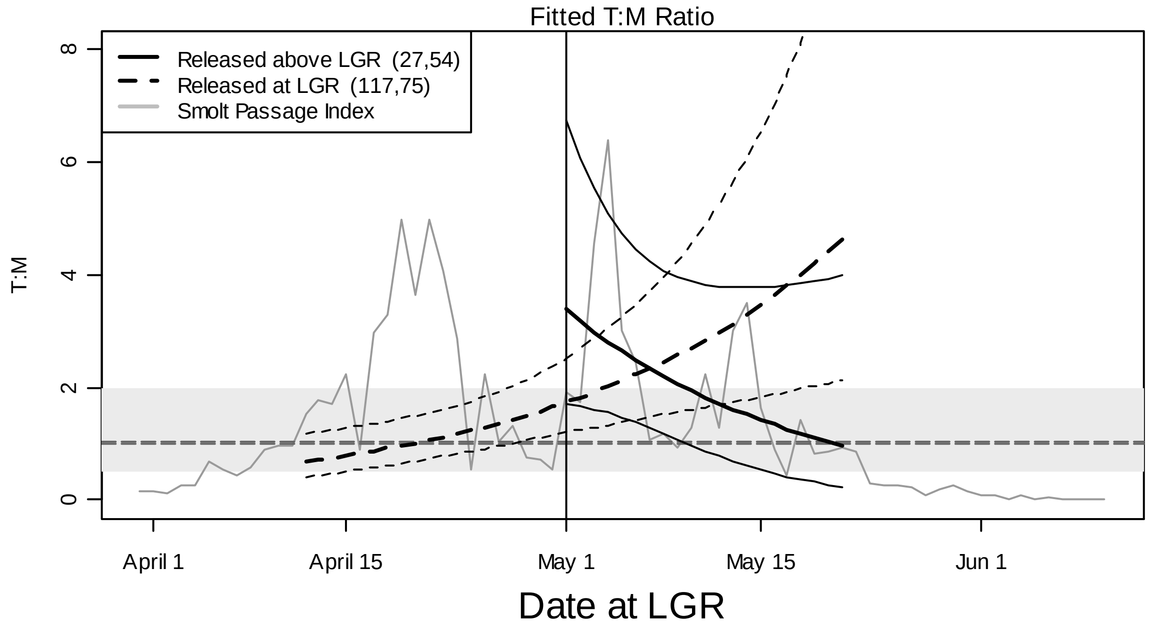

Wild Chinook 2006
Model-Averaged
Released above LGR
Released at LGR
Transported
Migrant
SAR(%)
0
1
2
3
4
April 1
May 1
May 15
Jun 1
Date at LGR
Fitted T:M Ratio
Released above LGR (36,39)
Released at LGR (121,64)
Smolt Passage Index
T:M
April 15

Wild Chinook 2007

Top AIC-weighted model is #18: SAR=D + L + T + D*L + D*T + L*T + D*L*T

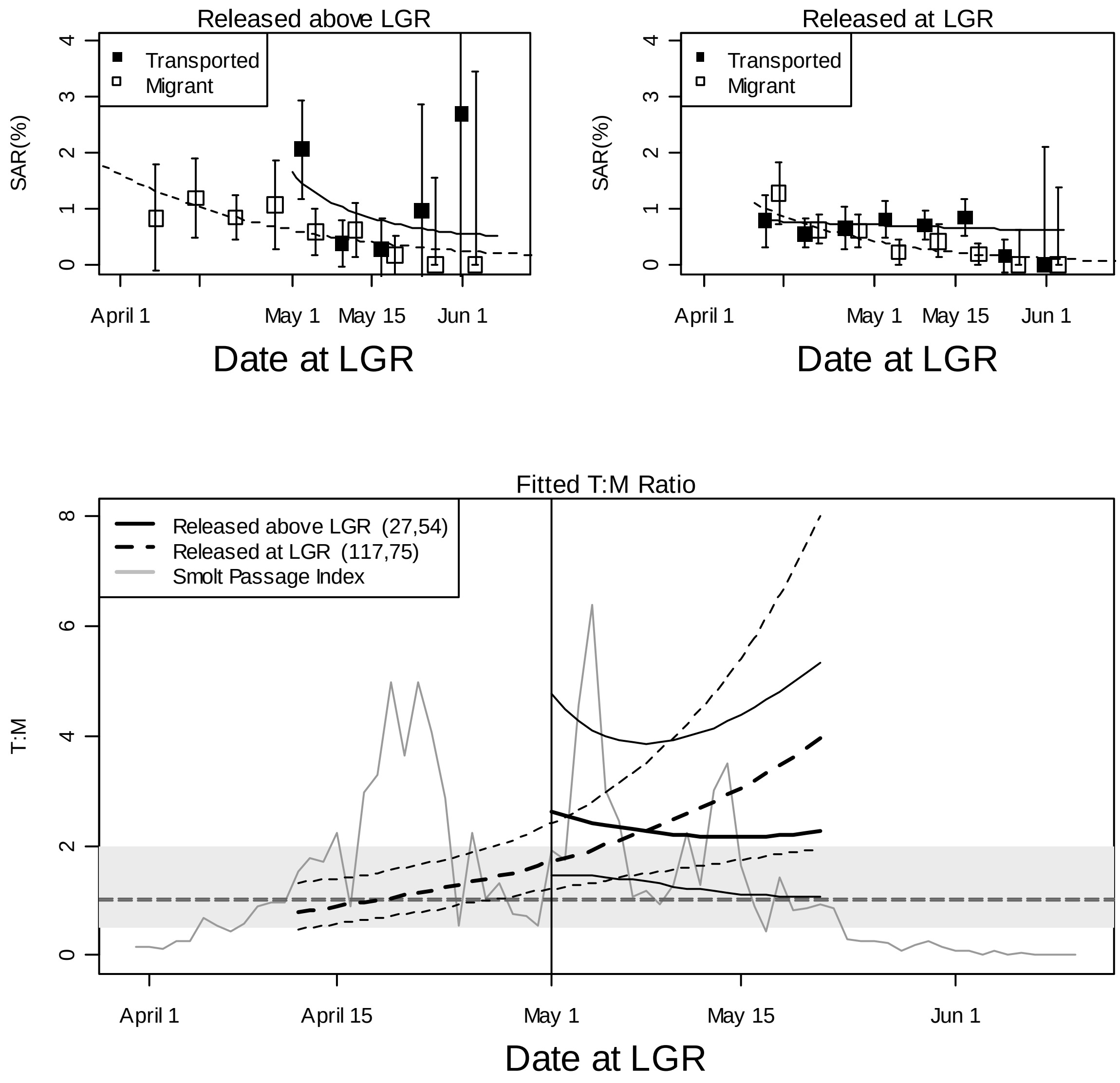


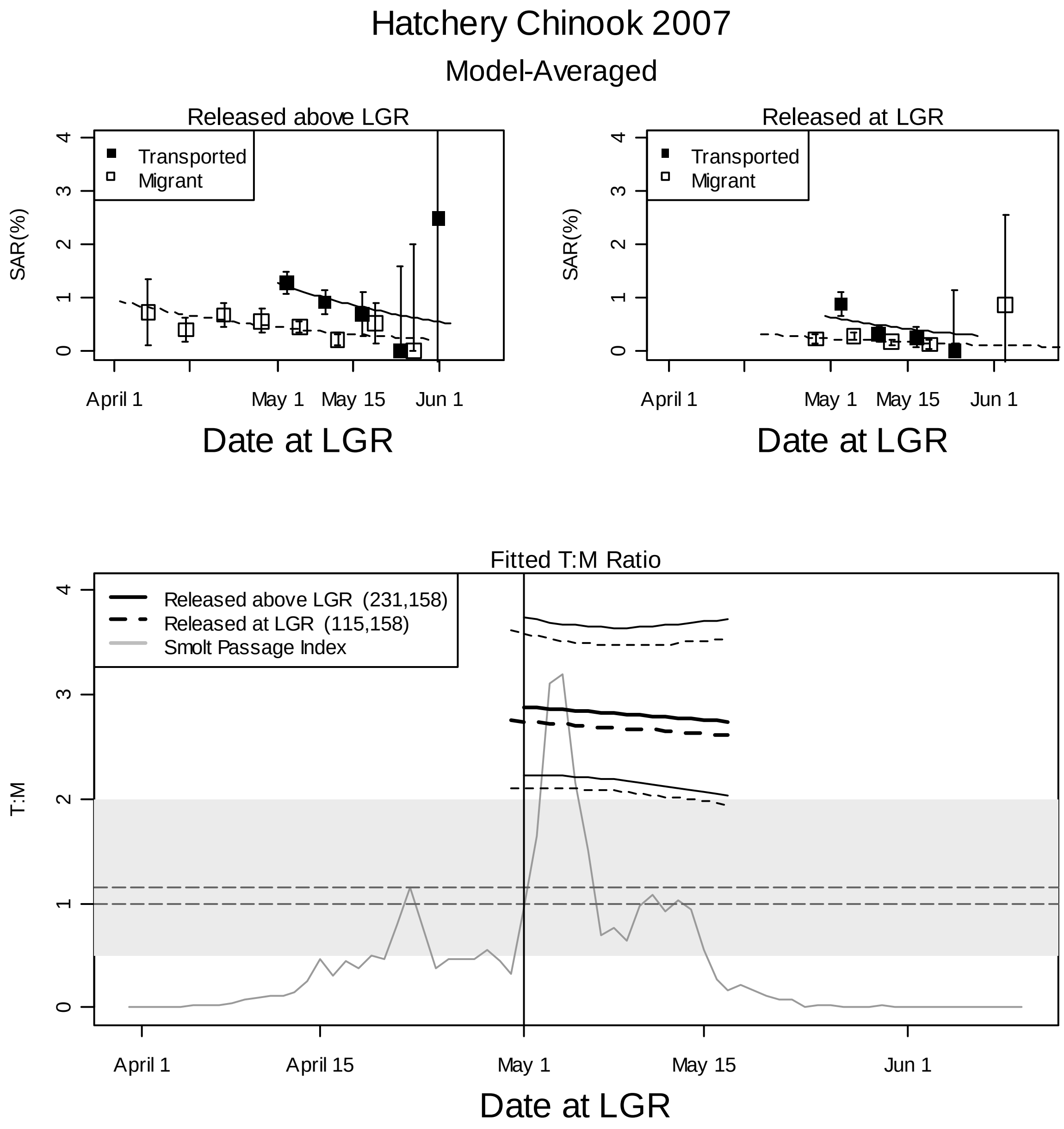




Wild Chinook 2007

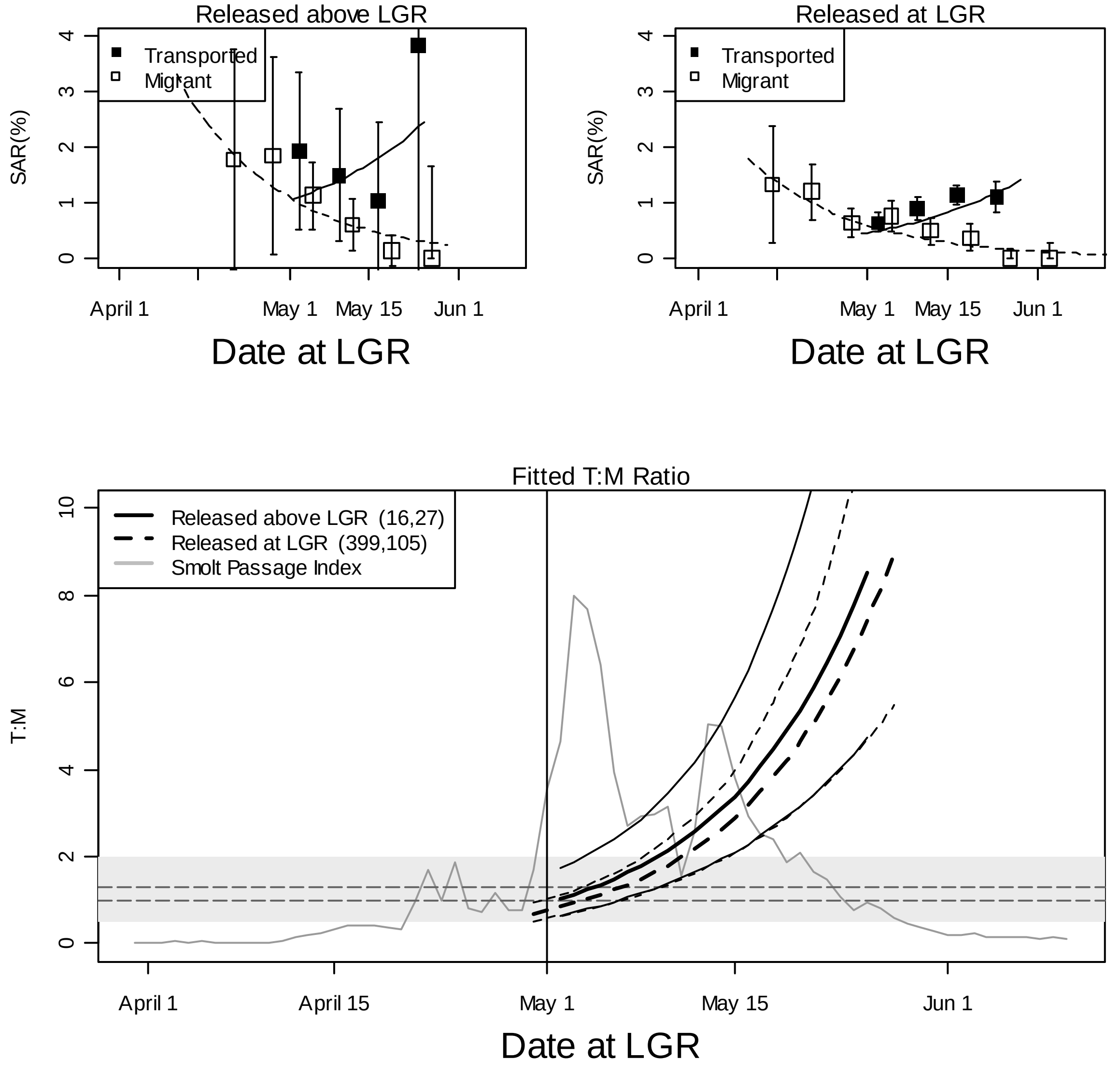
Model-Averaged




Hatchery Chinook 2007
Model-Averaged
Released above LGR
Transported
Migrant
SAR(%)
Date at LGR
April 1
May 1
May 15
Jun 1
Released at LGR
Fitted T:M Ratio
Released above LGR (231,158)
Released at LGR (115,158)
Smolt Passage Index
T:M
April 15

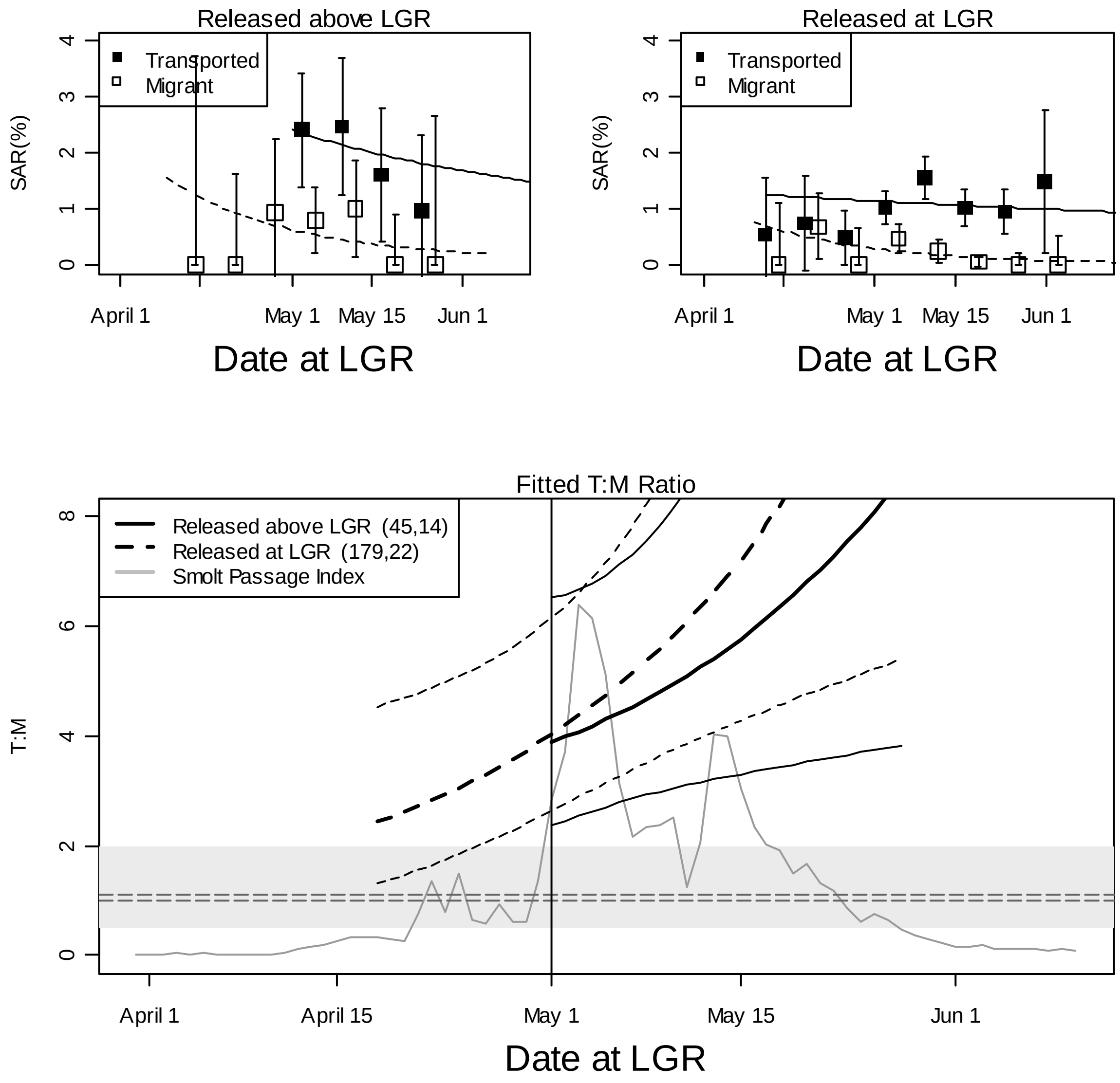
Hatchery Steelhead 2007

Model-Averaged

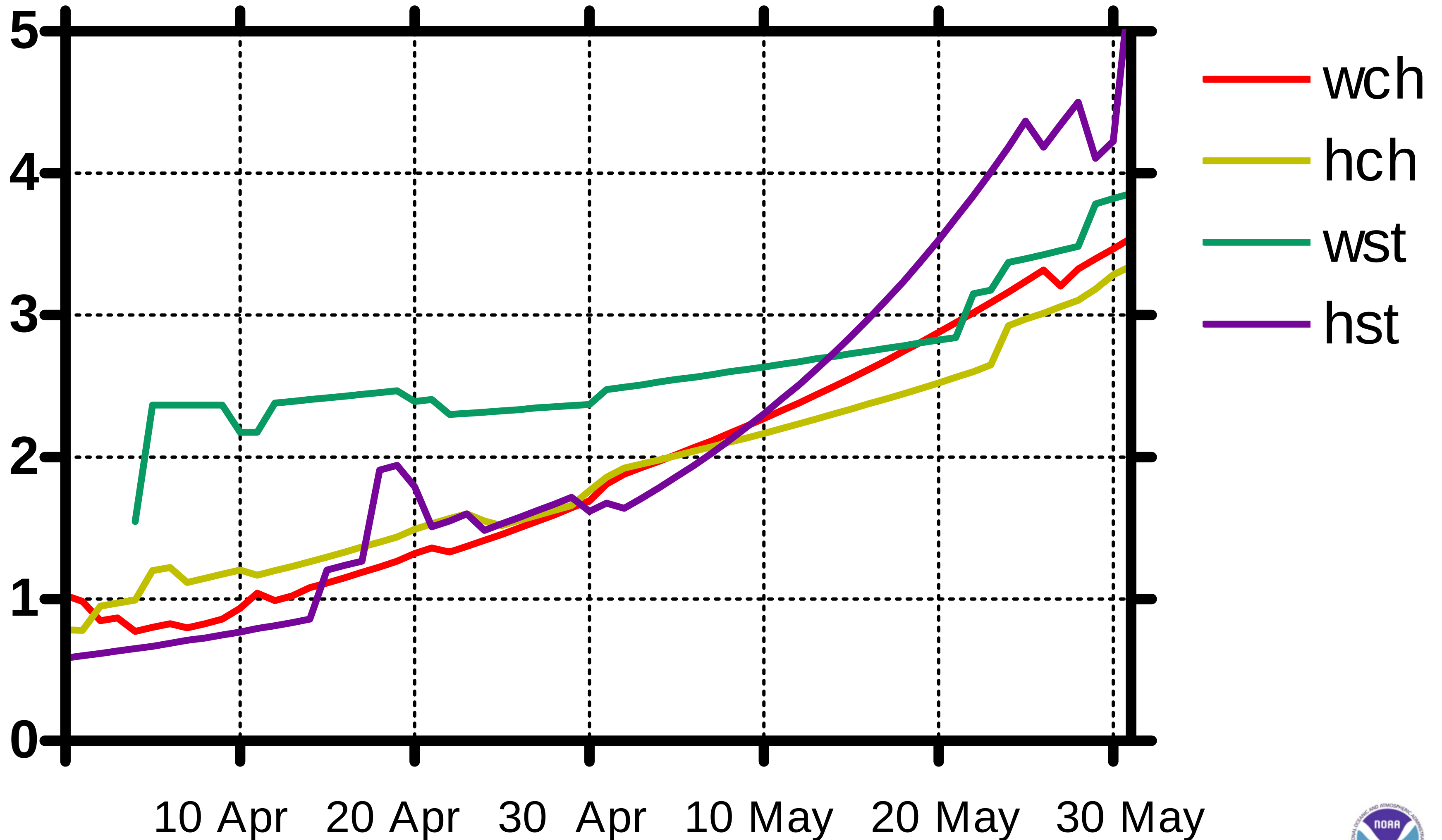


Wild Steelhead 2007

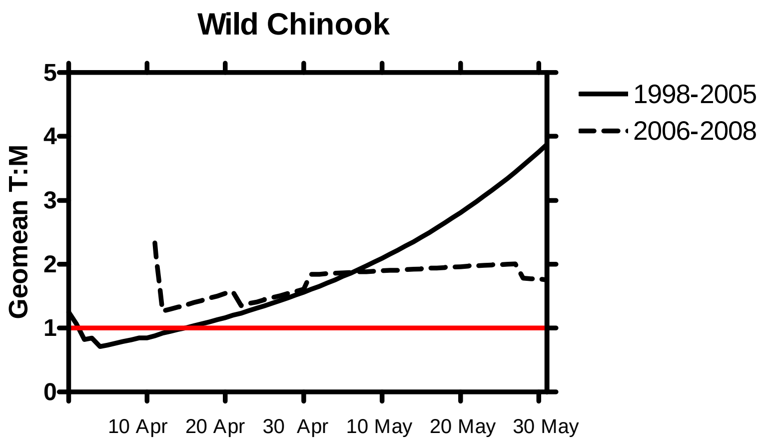
Model-Averaged

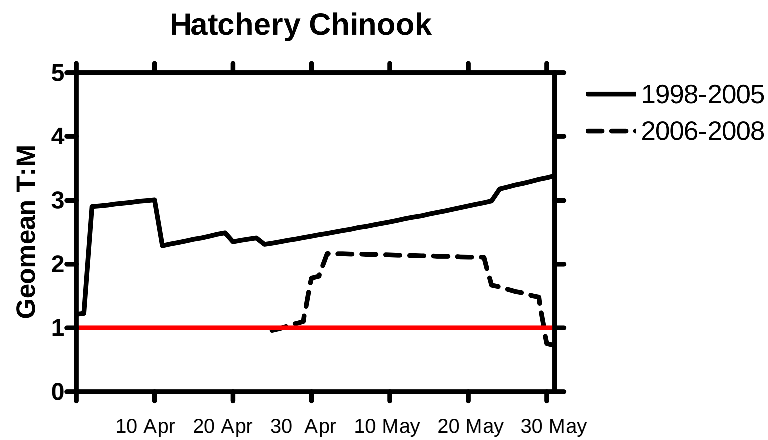


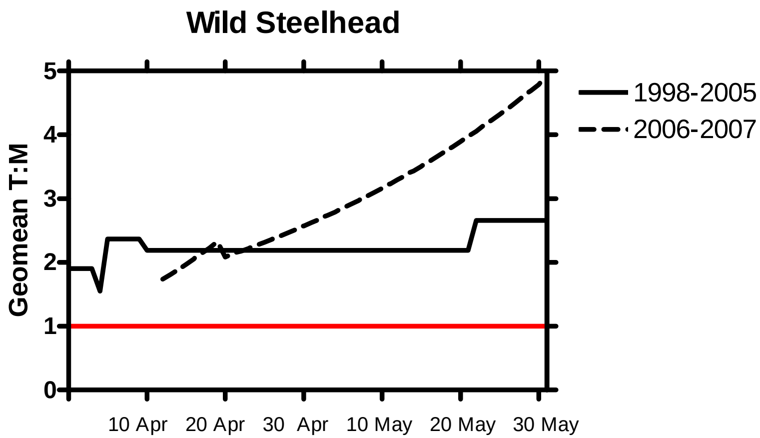
Geometric Mean Estimated T:M
All Years (Top AIC Models)

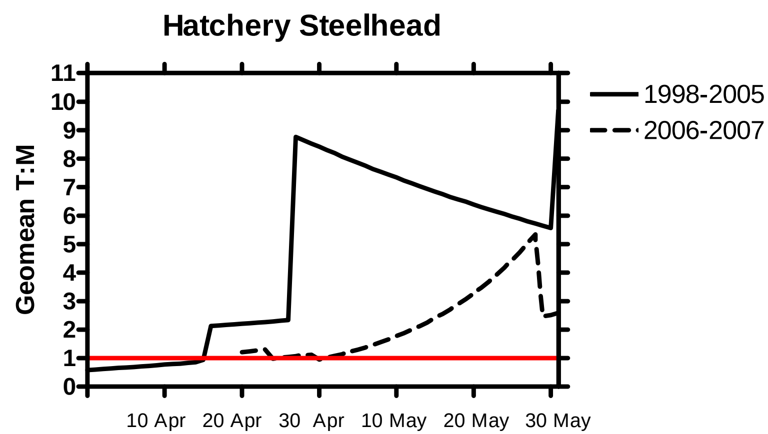


Geometric Means of Estimated T:M
(Preliminary Analysis)









Adults Returning

- Total number of adults returning depends on:
  - Number of smolts arriving at LGR
  - Proportion transported
  - SAR for transported smolts
  - SAR for inriver migrant smolts

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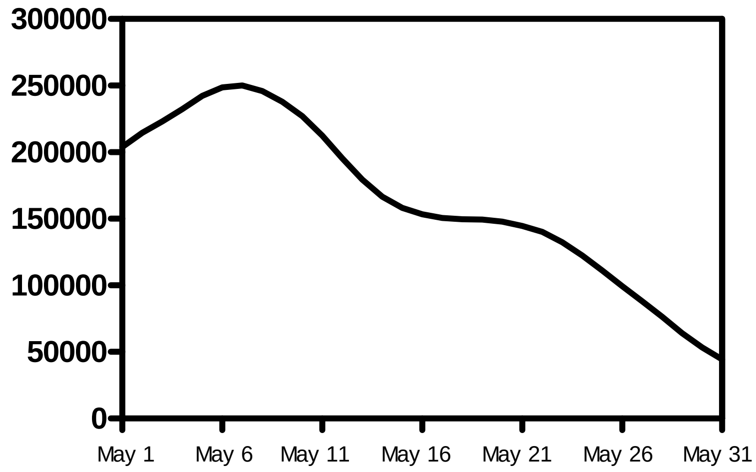
  - Proportion transported depends
    - Proportion in bypass system (% spill)
    - Proportion of those in bypass system that are transported
    - For steelhead:
      - ~ 30% of LGR arrivals with spill (2007)
      - ~ 85% of LGR arrivals without spill

Adults Returning

- Scenarios under discussion are the same in April:
  - Differences in adult returns depend on different management choices for May
  - Smoothed average passage distribution at LGR for steelhead:

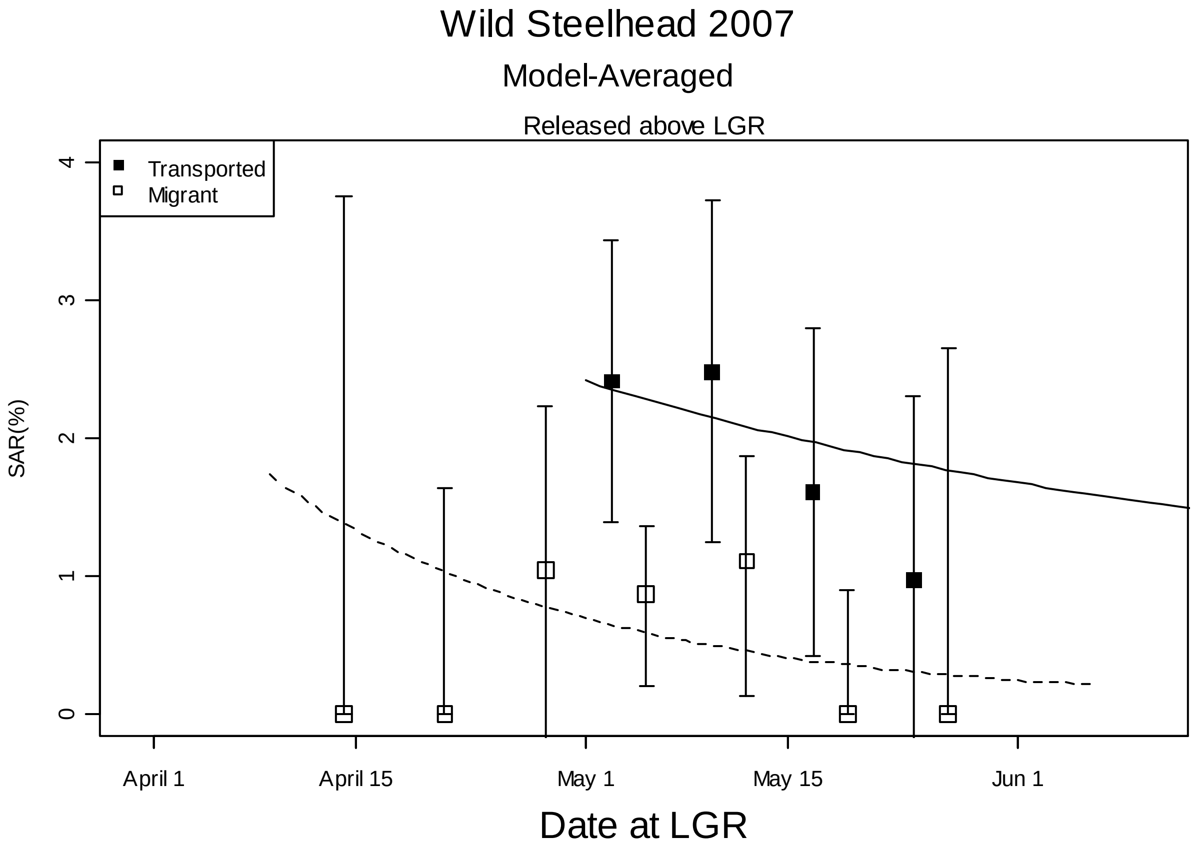
    Hatchery and Wild Combined: 5M in May (7M seasonal total)

    ~ 10% Wild



Adults Returning

- For SARs use model-averaged estimates for Wild Steelhead released above Lower Granite Dam in 2007
  (increasing SARm by 11% for C0:C1 adjustment)



Adults Returning

Overall SARs for May-passing fish based on preceding assumptions:

Percent Transported	Resulting SAR
0%	0.47%
100%	2.08%
30% with spill (2007)	0.92%
85% without spill	1.83%

* SARs for run at large (T and M) likely higher than these based on PITs

* SARs in worse ocean would be lower

Adults Returning

Total adults returning from May-passing fish based on preceding assumptions:

Percent Transported	Total Adults From 5M Steelhead smolts	Adults from 500K Wild steelhead smolts
0%	23,600	2,360
100%	105,500	10,550
30% with spill (2007)	46,600	4,660
85% without spill	92,900	9,920

Questions about

Analyses of Seasonal Patterns in SARs and T:M

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- Transported fish stray > migrant fish (3-5%)
- Transported fish have impaired homing ability
- More transports PIT tagged in recent years (>196k steelhead, >107K spring Chinook, 2006-2008 from alternate release site study)

Straying

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- Substantially more transported steelhead return then steelhead that migrate inriver
- Is transport the problem or do we have too many hatchery steelhead (>9 million)?

Lamprey passage

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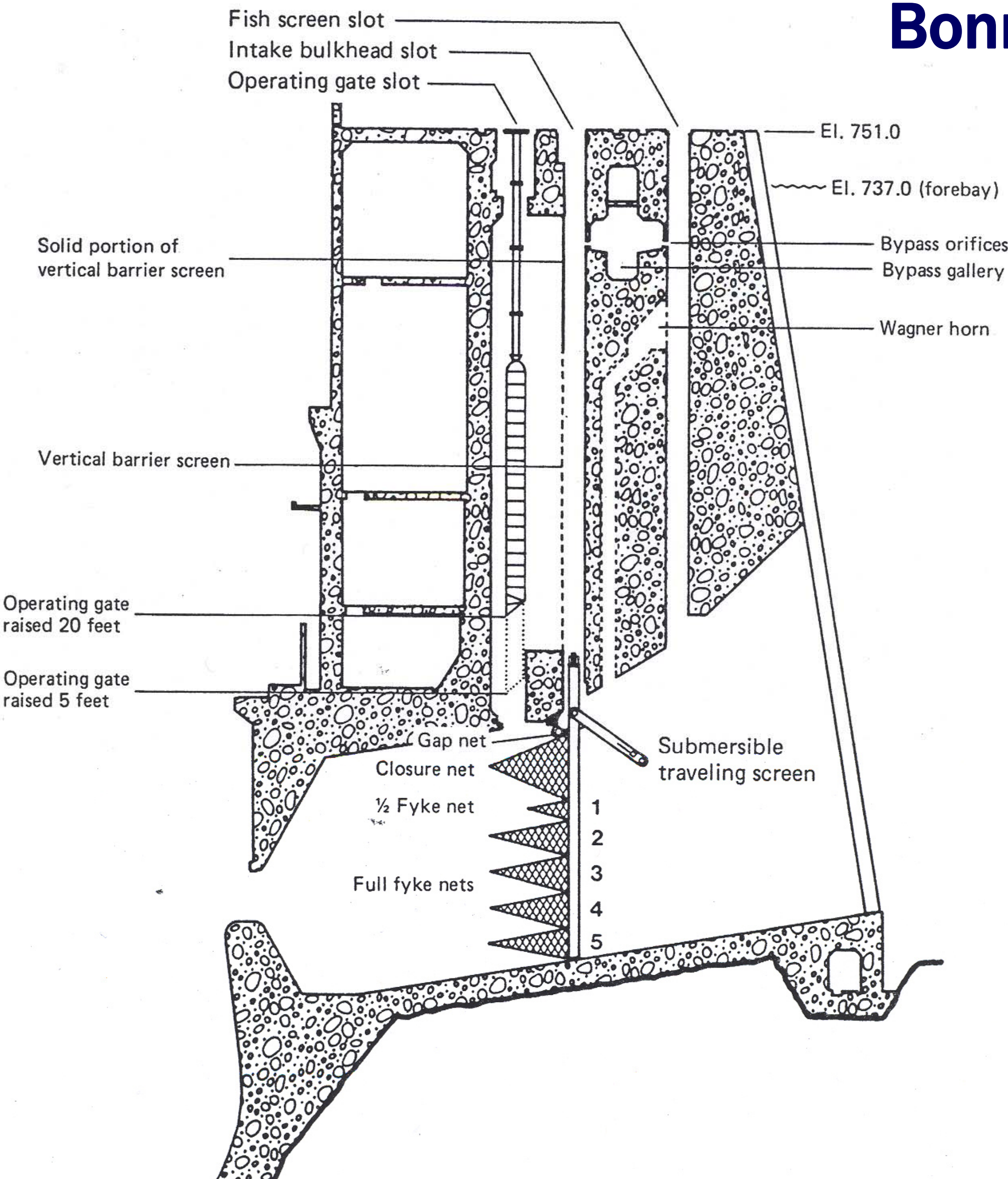
- Weak swimmers, negatively buoyant
- Very little passage data available
- Occasionally found impinged on bar screens

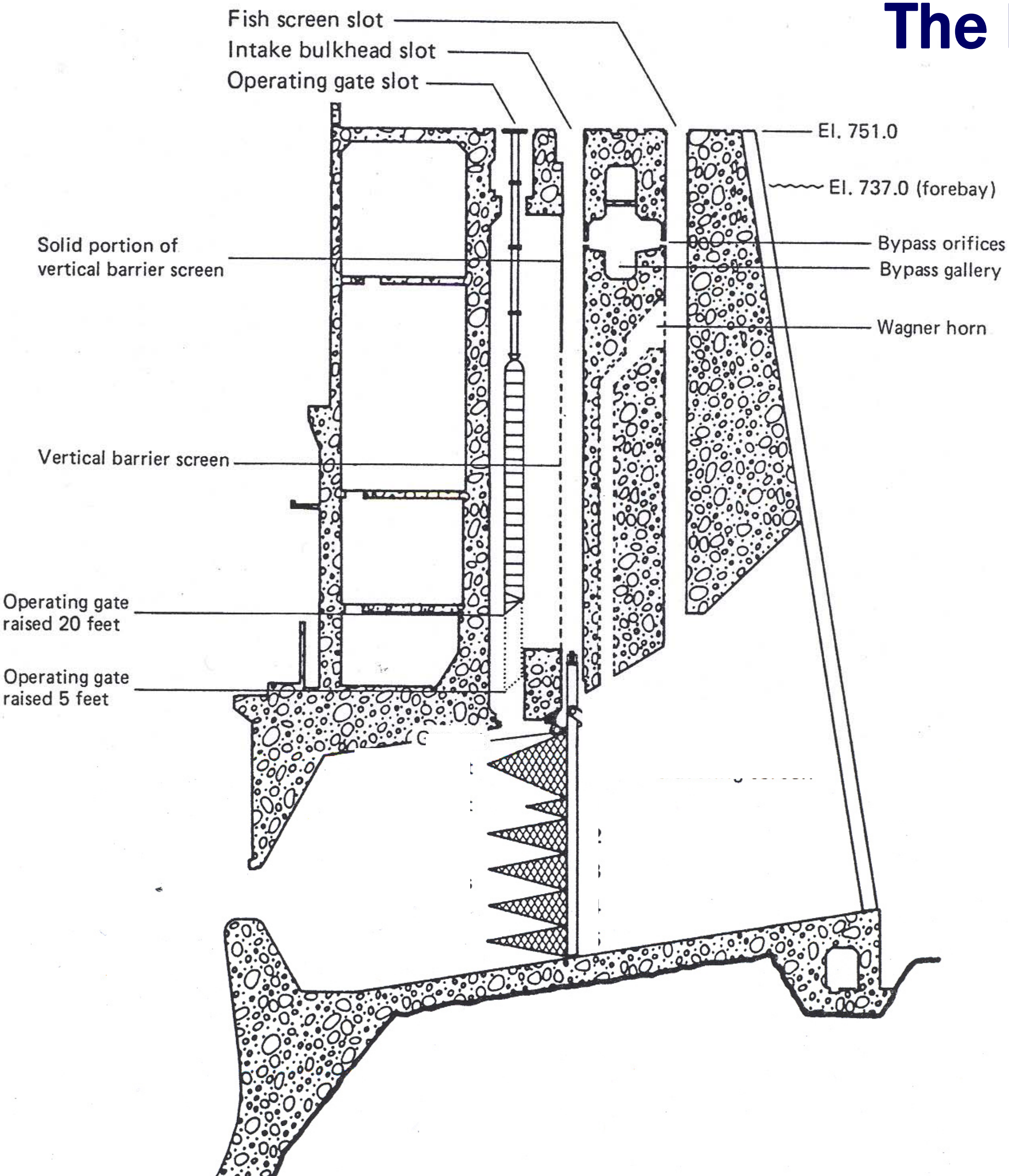
ESBS	STS
LGR	LMO
LGO	ICE
MCN	JD
	BON

Lamprey depth distribution Bonneville Dam, 2002 44 tests



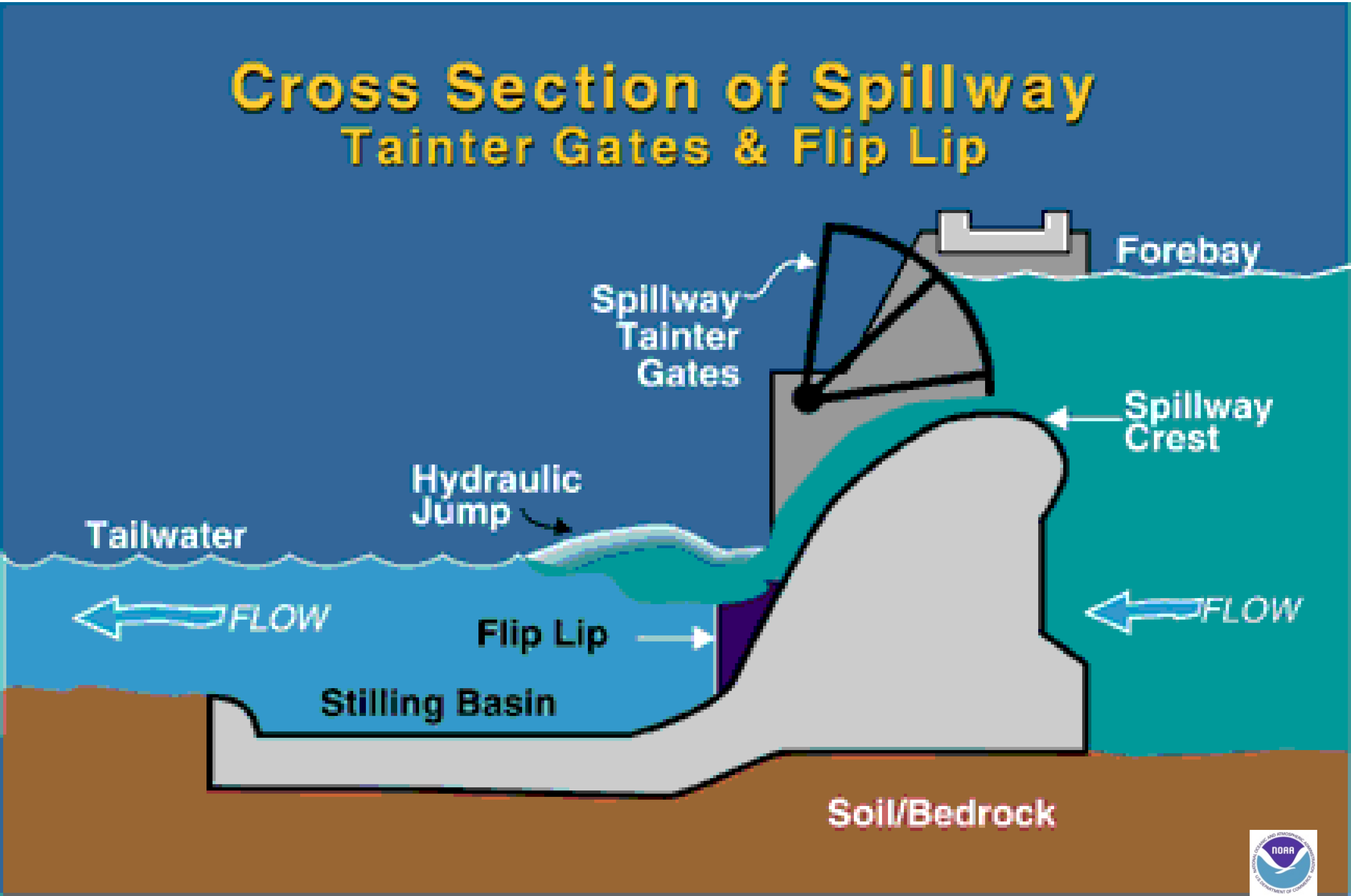
GW	1
GN	8
CN	10
FN-1	15
FN-2	135
FN-3	257
FN-4	165
FN-5	99
Total	690

Lamprey depth distribution The Dalles Dam, 1960 14 tests



FN-1	101
FN-2	209
FN-3	311
FN-4	387
FN-5	460
FN-6	211
Total	1,679

Spillway passage?



Less likely to use surface passage structures (Lower Granite RSW)

Lamprey passage

- No injury or mortality data available for juvenile lamprey passing through spillways or turbines

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- Transporting most salmonids would likely increase predation risk for juvenile lamprey passing through turbines

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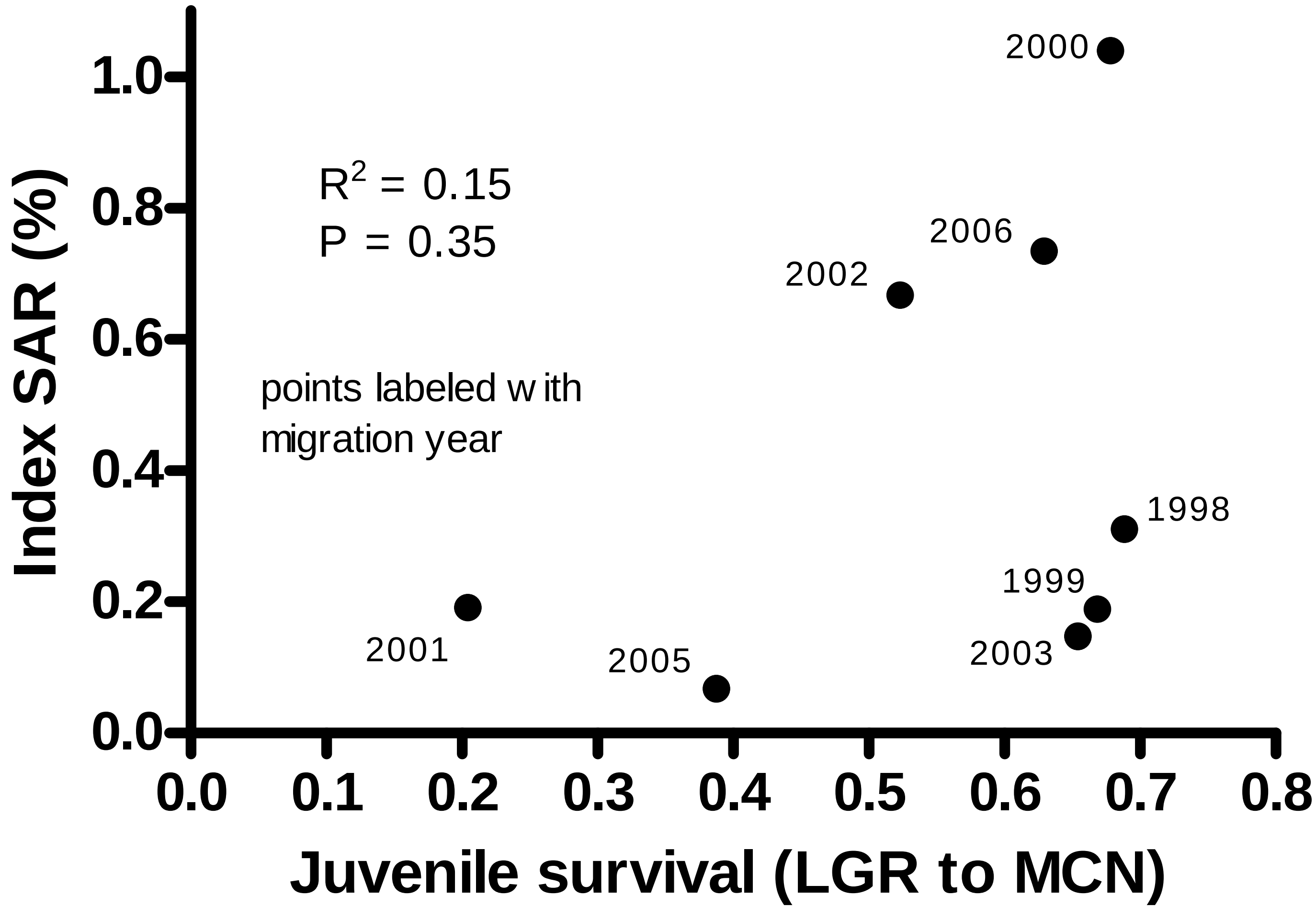
- No data available on sockeye injury rates and mortality for spillway or turbine passage



Comparison of annual Snake River sockeye salmon Index SAR estimates with annual survival estimates of smolts from Lower Granite Dam to McNary Dam, juvenile outmigration years 1998-2006

Percent Snake River transported
vs
Snake River SAR

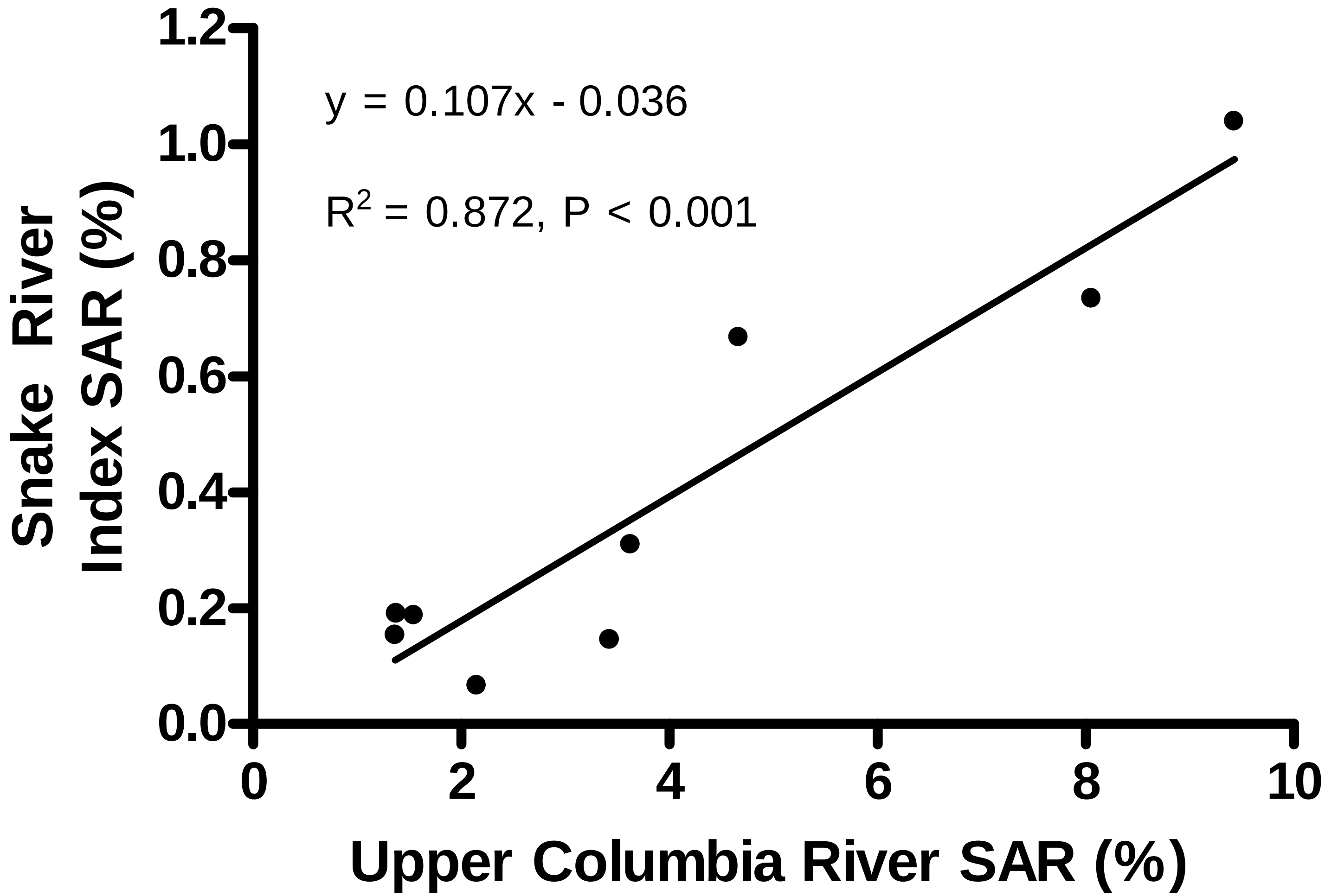
$R^2 = 0.71, P < 0.01$

Percent Snake River transported

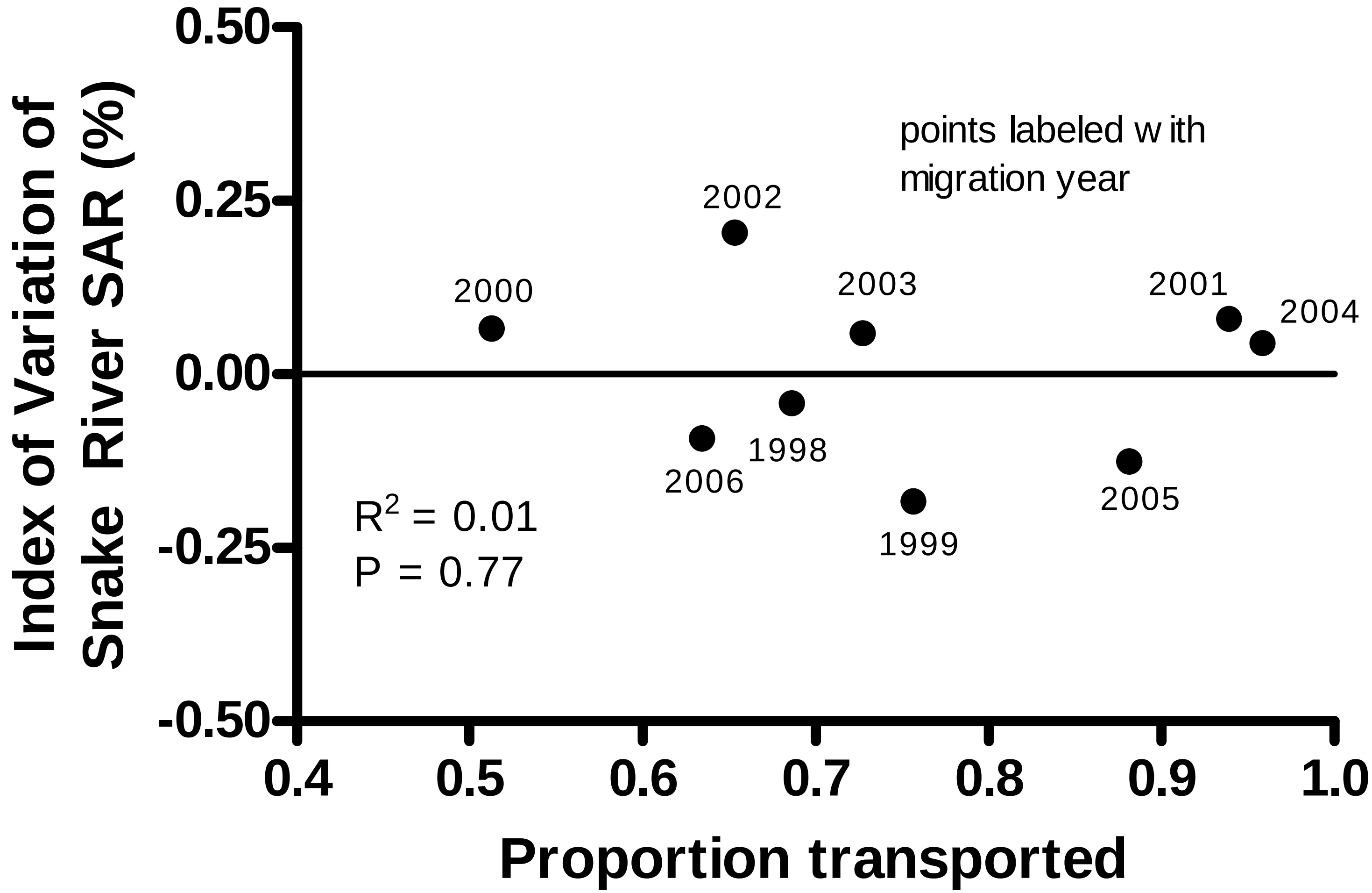
vs

Columbia River SAR

$R^2 = 0.73, P < 0.01$



Comparison of estimated SAR for combined Columbia River sockeye salmon population (smolts at McNary Dam and adults at Bonneville Dam) with Index SAR for Snake River sockeye salmon (smolts and adults at Lower Granite Dam), juvenile outmigration years 1998-2006



Relationship between the proportion of Snake River sockeye salmon juveniles transported and an index of Snake River-specific variation of subsequent Index SARs (residuals of regression of Snake River Index SARs on Columbia River SARs), juvenile outmigration years 1998-2006

New structures

- LMO surface passage (2008)

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- LGO surface passage (2009)
- John Day surface passage (2008)
- John Day tailrace bird wires (2010)
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- Should result in survival improvement

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Summary

- Recent operations have improved performance of migrants and lessened differences in SARs between transports and migrants with a transport benefit occurring later in the season
- However, transport still returns more adults for most stocks, especially later in the migration season, so transporting fewer fish in recent years has resulted in substantially fewer adult fish returning
- Terminating spill in May will greatly reduce survival for fish left in river, but few fish will be affected

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- Low flow conditions in 2010 will likely offset any survival gains made with additional passage structures
- It would be prudent to demonstrate that passage improvements have reduced the late season transport benefit for wild steelhead under moderate to high flow conditions before testing them during low flow/poor ocean conditions