Northwest Power and Conservation Council

September 30, 2010

MEMORANDUM

TO: Council Members

FROM: Jim Ruff -- Manager, Mainstem Passage and River Operations

SUBJECT: Presentation by NOAA's Northwest Fisheries Science Center on Preliminary 2010 Reach Survival Data

Background

At the October 14, 2010, Council meeting in Portland, Steven Smith from NOAA's Northwest Fisheries Science Center will present preliminary 2010 reach survival information for juvenile Snake River spring Chinook salmon and steelhead. Dr. Smith will also summarize this year's environmental conditions in the Snake and Columbia rivers, as well as provide preliminary estimates of the proportion of Snake River migrants that were collected and transported from mainstem Snake River hydropower dams in spring of 2010. Comparisons will also be made between the preliminary 2010 reach survivals and previous years' survival rates.

Note this project (#1993-029-00, *Survival Estimates for the Passage of Juvenile Salmonids Through Snake and Columbia River Dams and Reservoirs*) is funded by Bonneville Power Administration as part of the Council's Columbia River Basin Fish and Wildlife Program.

Summary of Results

Estimated survival for Snake River yearling Chinook salmon and steelhead through the hydropower system (Snake River trap to Bonneville tailrace) in 2010 was relatively high compared to recent years. The 2010 estimated hydropower system survival for yearling Chinook was 54.8%, which is higher than the average of 49.3% and higher than the 2009 estimate of 53.1% (Table 1). For steelhead, the 2010 estimated hydropower system survival was 61.7%, which is higher than the average of 40.4% but lower than the 2009 estimate of 67.8% (Table 2).

The higher survival in the last few years for yearling Chinook and steelhead is likely due in part to changes in dam operations during that period. Operations at most dams in 2010 were similar to those in 2009. The adjustable spillway weir (ASW) installed in 2009 at Little Goose Dam was in its second year of operation. The removable spillway weir (RSW) at Lower Monumental Dam and the temporary spillway weirs (TSW) at John Day Dam were in their third year of operation in

2010. Also the new spillway guidance wall at The Dalles Dam, which was partially complete in 2009, was completed in March of 2010.

Snake River flow volume in 2010 was lower than in recent years for most of the migration period. The flow volume and pattern in 2010 were most similar to those of 2004, 2005, and 2007. Mean spill as a percentage of flow was relatively high. Spill percentages in 2010 were much like those in 2007 and 2008 until mid-May, when they decreased with increasing flow. Spill percentages in 2010 were higher than those in 2009 for most of the season. Water temperatures in the Snake River in 2010 fluctuated, with peaks in late April and mid-May, with the fluctuations nearly spanning the range of temperatures experienced at the same times during recent years.

Estimated transportation percentages of yearling Chinook salmon and steelhead from Snake River dams were among the lowest seen from 1995-2009. Our preliminary estimates of the proportion transported of non-tagged wild and hatchery spring-summer Chinook salmon smolts are 38.2% and 22.6%, respectively. For steelhead, the estimates are 36.8% and 34.8% for wild and hatchery smolts, respectively. These estimates represent the proportion of smolts that arrived at Lower Granite Dam that were subsequently transported, either from Lower Granite Dam or from one of the downstream collector dams. The estimates for both hatchery and wild Chinook are lower than those in 2008 and 2009, but not lower than those in 2007. The estimates for both hatchery and wild steelhead are lower than from any year 1995-2009. The differences among years for both Chinook and steelhead are due to differences in collection probabilities at the collector dams and differences in timing of the smolt migrations relative to transportation start dates.

Table 1. Hydropower system survival estimates derived by combining empirical survival estimates from various reaches for Snake River **yearling Chinook** salmon (hatchery and wild combined), 1997–2010. Standard errors in parentheses. Simple arithmetic means across all years are given. Abbreviations: Trap–Snake River Trap; LGR–Lower Granite Dam; MCN–McNary Dam; BON–Bonneville Dam.

Year	Trap–LGR	LGR-MCN	MCN-BON	LGR–BON	Trap–BON
1997	NA	0.653 (0.072)	NA	NA	NA
1998	0.924 (0.011)	0.770 (0.009)	NA	NA	NA
1999	0.940 (0.009)	0.792 (0.006)	0.704 (0.058)	0.557 (0.046)	0.524 (0.043)
2000	0.929 (0.014)	0.760 (0.012)	0.640 (0.122)	0.486 (0.093)	0.452 (0.087)
2001	0.954 (0.015)	0.556 (0.009)	0.501 (0.027)	0.279 (0.016)	0.266 (0.016)
2002	0.953 (0.022)	0.757 (0.009)	0.763 (0.079)	0.578 (0.060)	0.551 (0.059)
2003	0.993 (0.023)	0.731 (0.010)	0.728 (0.030)	0.532 (0.023)	0.528 (0.026)
2004	0.893 (0.009)	0.666 (0.011)	0.594 (0.074)	0.395 (0.050)	0.353 (0.045)
2005	0.919 (0.015)	0.732 (0.009)	0.788 (0.093)	0.577 (0.068)	0.530 (0.063)
2006	0.952 (0.011)	0.764 (0.007)	0.842 (0.021)	0.643 (0.017)	0.612 (0.018)
2007	0.943 (0.028)	0.783 (0.006)	0.763 (0.044)	0.597 (0.035)	0.563 (0.037)
2008	0.992 (0.018)	0.782 (0.011)	0.594 (0.066)	0.465 (0.052)	0.460 (0.052)
2009	0.958 (0.010)	0.787 (0.007)	0.705 (0.031)	0.555 (0.025)	0.531 (0.025)
2010[a]	0.963 (0.041)	0.772 (0.012)	0.738 (0.039)	0.570 (0.031)	0.548 (0.038)
Mean	**0.947 (0.008)**	**0.736 (0.018)**	**0.697 (0.028)**	**0.519 (0.029)**	**0.493 (0.028)**

a. Estimates are preliminary and subject to change.

Table 2. Hydropower system survival estimates derived by combining empirical survival estimates from various reaches for Snake River **steelhead** (hatchery and wild combined), 1997–2010. Standard errors in parentheses. Simple arithmetic means across all years are given. Abbreviations: Trap–Snake River Trap; LGR–Lower Granite Dam; MCN–McNary Dam; BON–Bonneville Dam.

Year	Trap–LGR	LGR-MCN	MCN-BON	LGR–BON	Trap–BON
1997	1.020 (0.023)	0.728 (0.053)	0.651 (0.082)	0.474 (0.069)	0.484 (0.072)
1998	0.924 (0.009)	0.649 (0.013)	0.770 (0.081)	0.500 (0.054)	0.462 (0.050)
1999	0.908 (0.011)	0.688 (0.010)	0.640 (0.024)	0.440 (0.018)	0.400 (0.017)
2000	0.964 (0.013)	0.679 (0.016)	0.580 (0.040)	0.393 (0.034)	0.379 (0.033)
2001	0.911 (0.007)	0.168 (0.006)	0.250 (0.016)	0.042 (0.003)	0.038 (0.003)
2002	0.895 (0.015)	0.536 (0.025)	0.488 (0.090)	0.262 (0.050)	0.234 (0.045)
2003	0.932 (0.015)	0.597 (0.013)	0.518 (0.015)	0.309 (0.011)	0.288 (0.012)
2004	0.948 (0.004)	0.379 (0.023)	NA	NA	NA
2005	0.967 (0.004)	0.593 (0.018)	NA	NA	NA
2006	0.920 (0.013)	0.702 (0.016)	0.648 (0.079)	0.455 (0.056)	0.418 (0.052)
2007	1.016 (0.026)	0.694 (0.020)	0.524 (0.064)	0.364 (0.045)	0.369 (0.047)
2008	0.995 (0.018)	0.716 (0.015)	0.671 (0.034)	0.480 (0.027)	0.478 (0.028)
2009	1.002 (0.011)	0.790 (0.013)	0.856 (0.074)	0.676 (0.059)	0.678 (0.060)
2010[a]	1.013 (0.031)	0.774 (0.021)	0.787 (0.031)	0.609 (0.029)	0.617 (0.035)
Mean	**0.958 (0.012)**	**0.621 (0.045)**	**0.615 (0.047)**	**0.417 (0.048)**	**0.404 (0.049)**

a. Estimates are preliminary and subject to change.

Survival and Travel Time of Migrating Salmonid Smolts in the Snake and Lower Columbia Rivers

Update with Preliminary 2010 Data

Northwest Power and Conservation Council
October 14, 2010

Steven G. Smith steven.g.smith@noaa.gov
Northwest Fisheries Science Center
NOAA Fisheries

Outline

- Survey of migration conditions, juvenile travel time, and, juvenile survival through the hydropower system

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- Percentage transported

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- Avian predation

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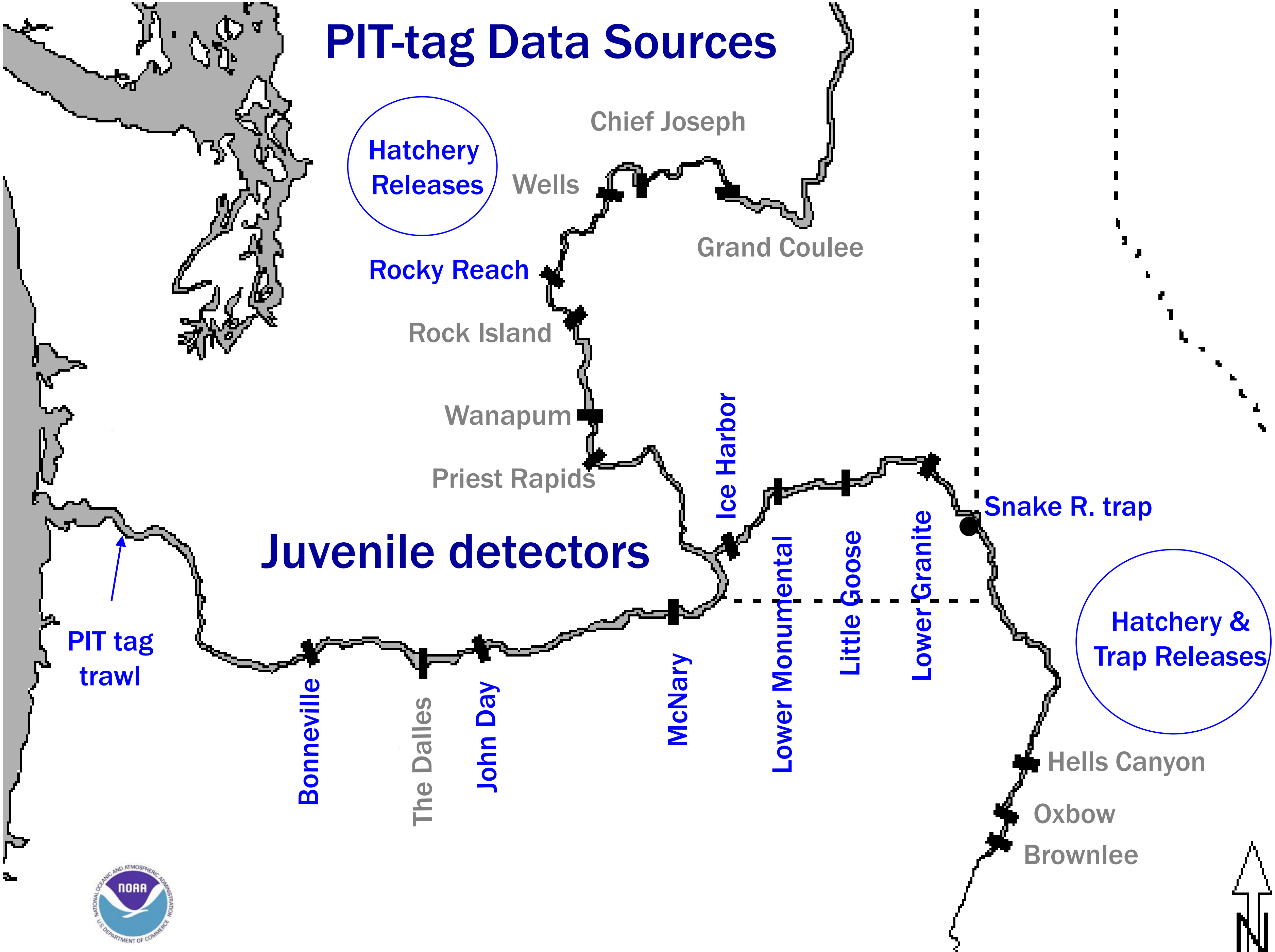
- Survey of migration conditions, juvenile travel time, and, juvenile survival through the hydropower system
- Percentage transported
- Avian predation
- Interplay of factors – what's new and interesting?

- Only those fish left to migrate in-river
- Only juvenile data, not survival to adult

Migration Conditions and Estimated Travel Time and Survival for Spring Migrants

PIT-tag Data Sources



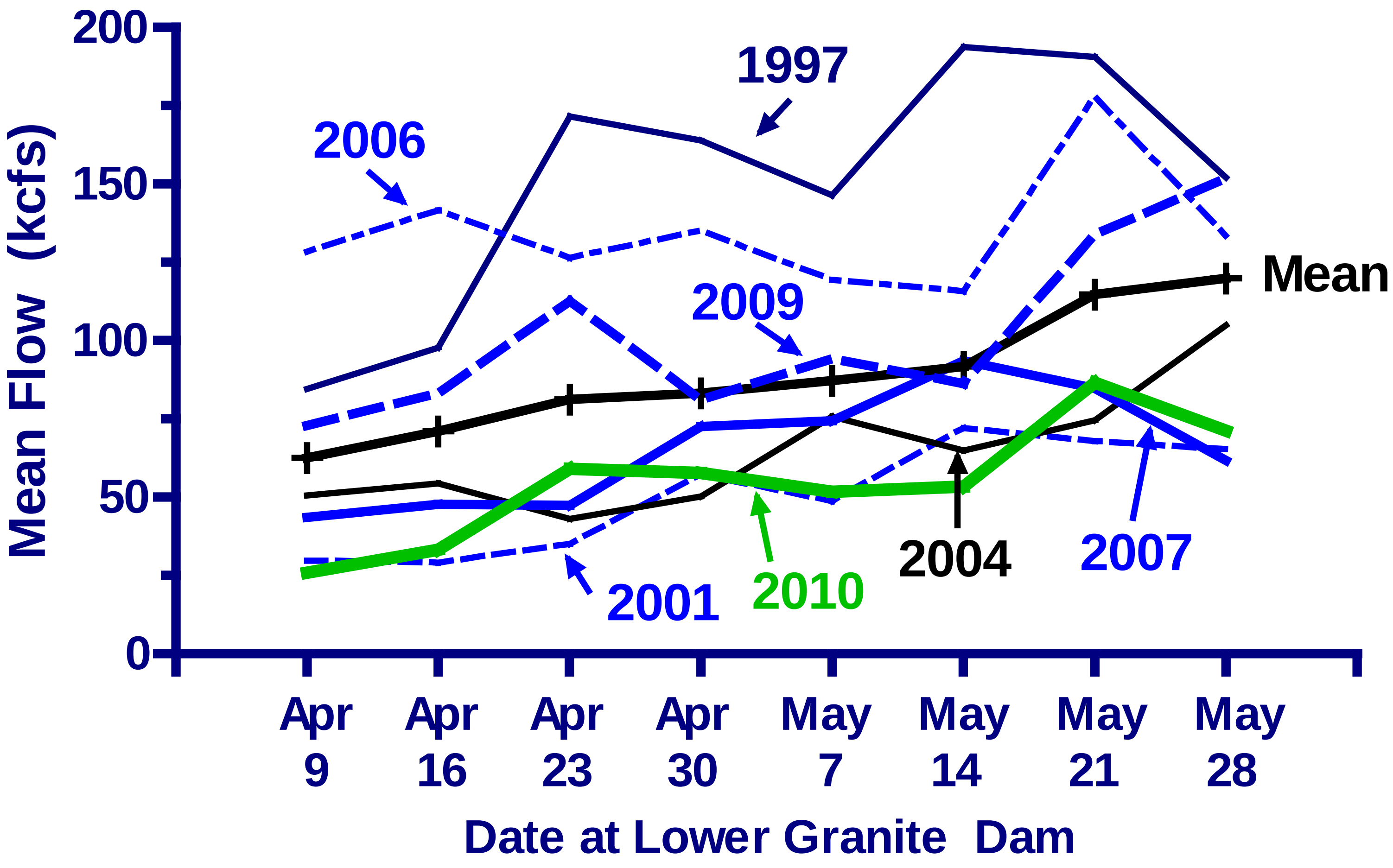
Bird wires at John Day Dam


Avian Predation
Deterrent Array
Avian Lines Have Been
Deployed To Deter Avian
Predation On Juvenile
Salmon, Steelhead, And
Lamprey

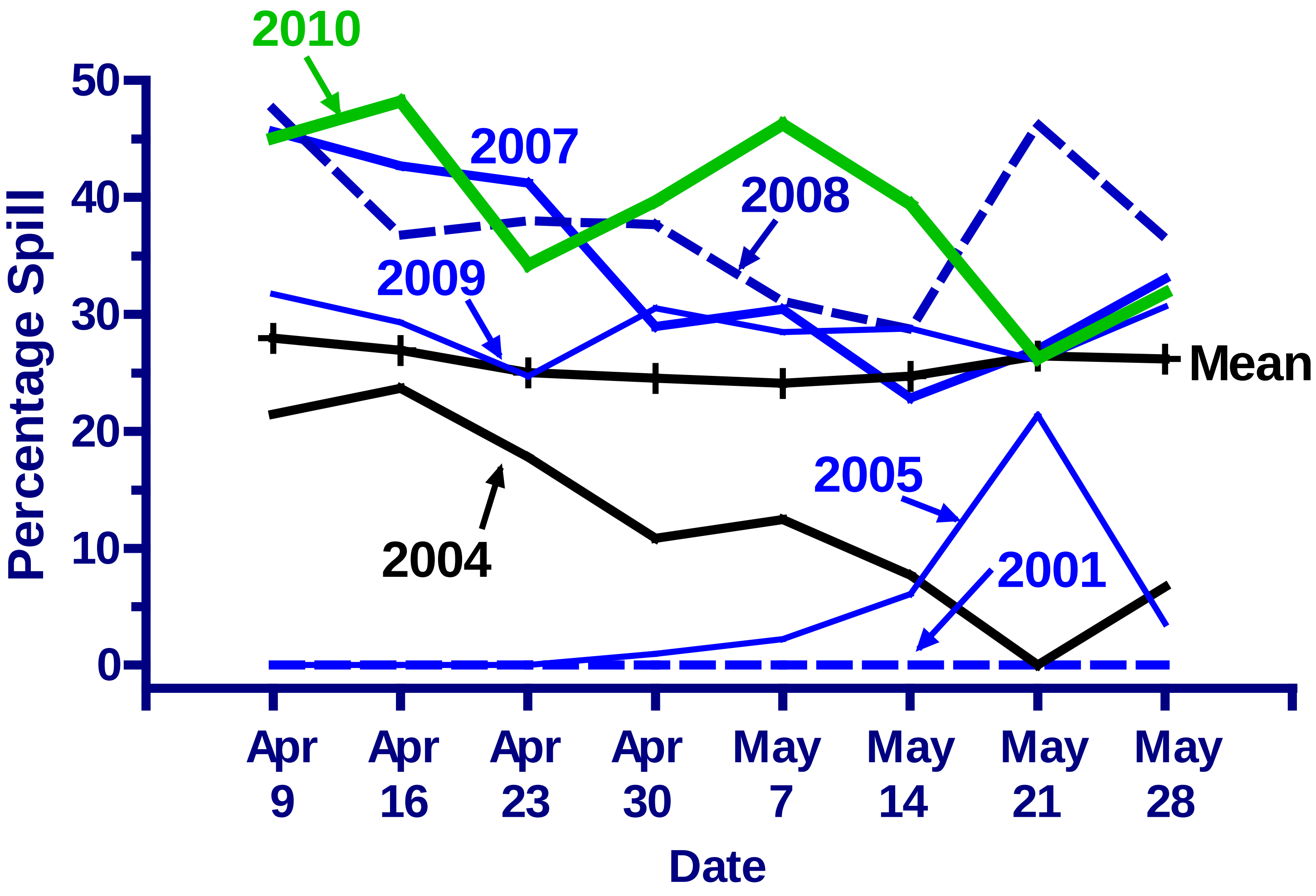
Spillway wall at The Dalles Dam

Surface collector at Little Goose Dam

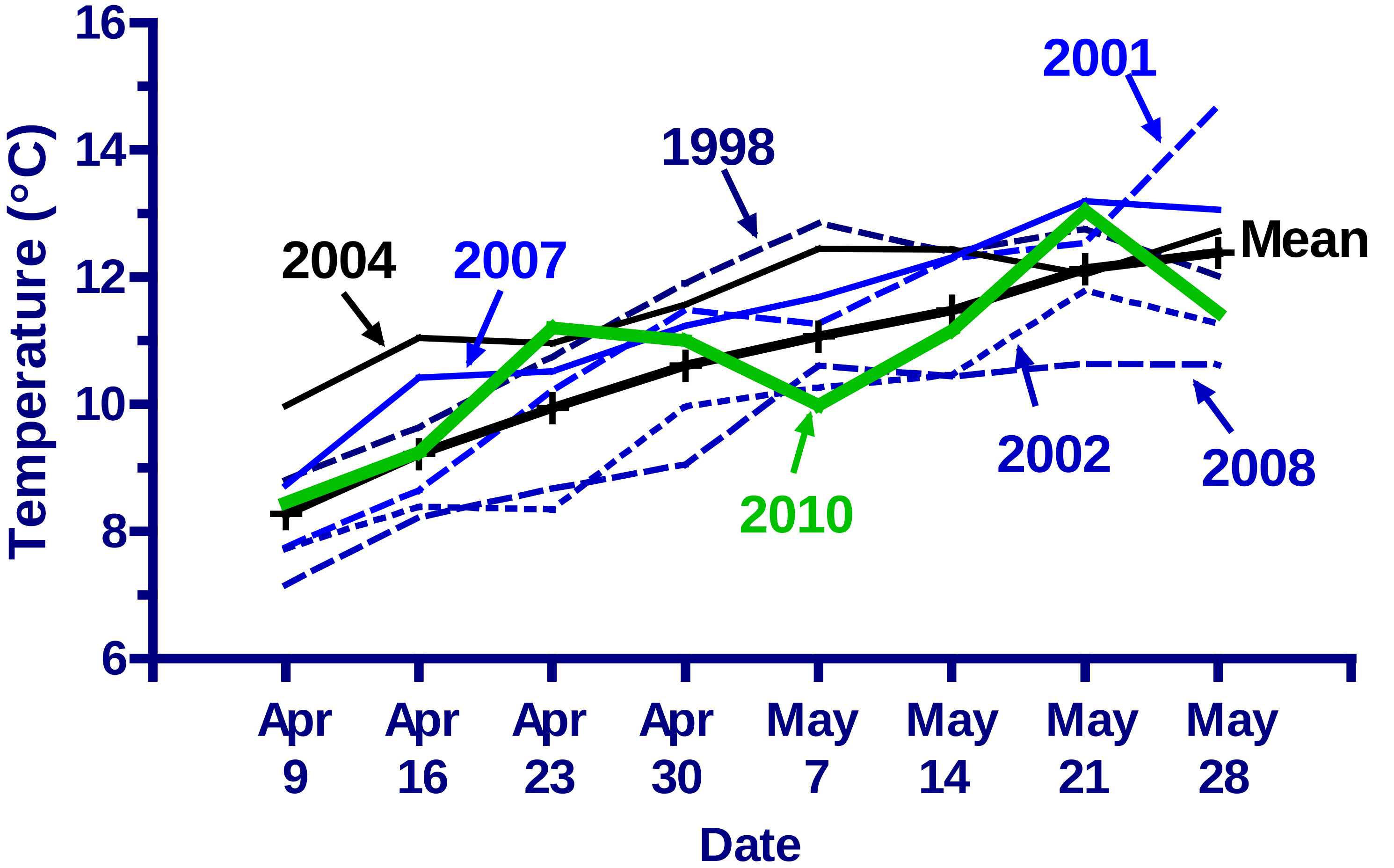
Weekly Mean Flow (kcfs)
Lower Granite Dam 1997-2010



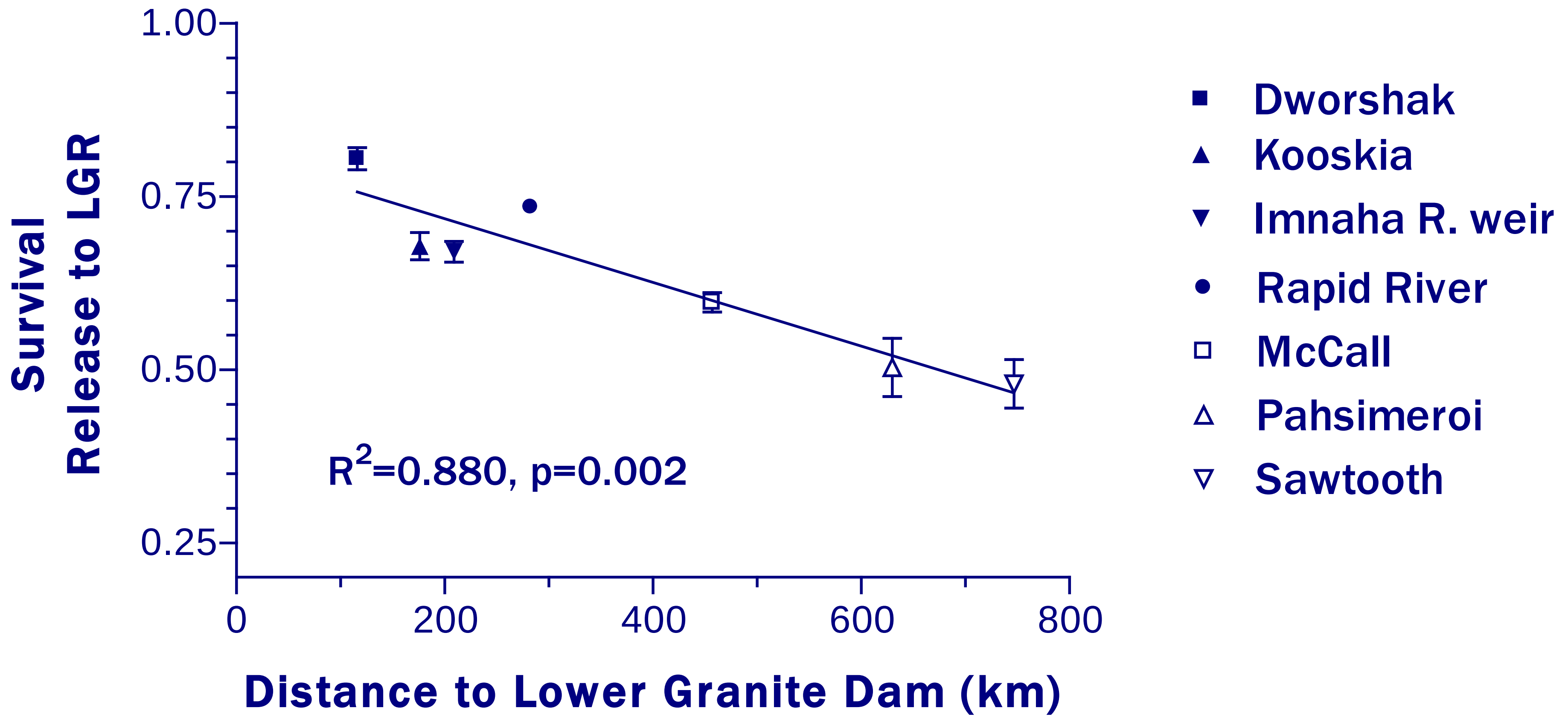
Weekly Mean %Spilled
LGR, LGS, LMN 1997-2010



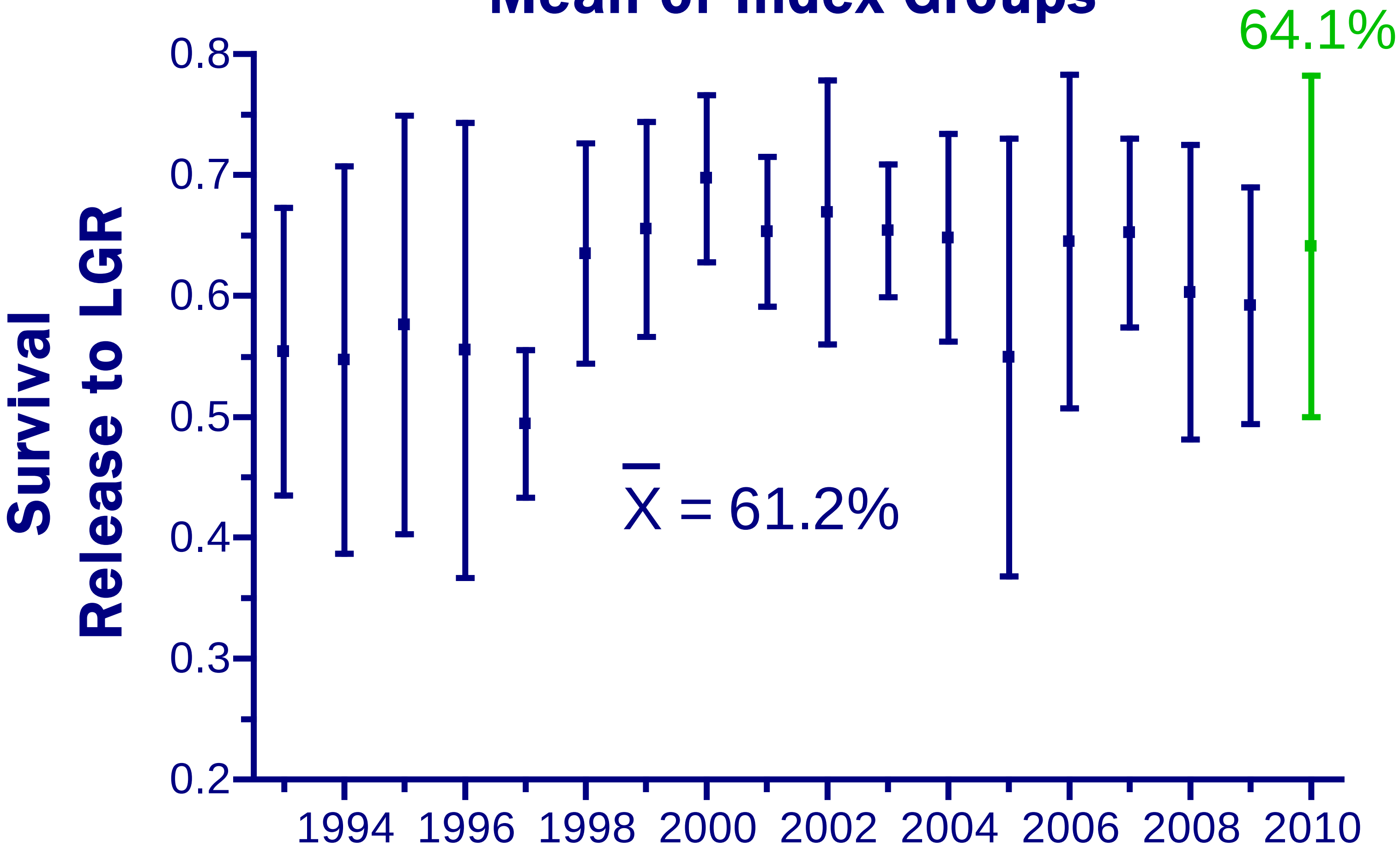
Weekly Mean Temperature
Little Goose Dam 1997-2010



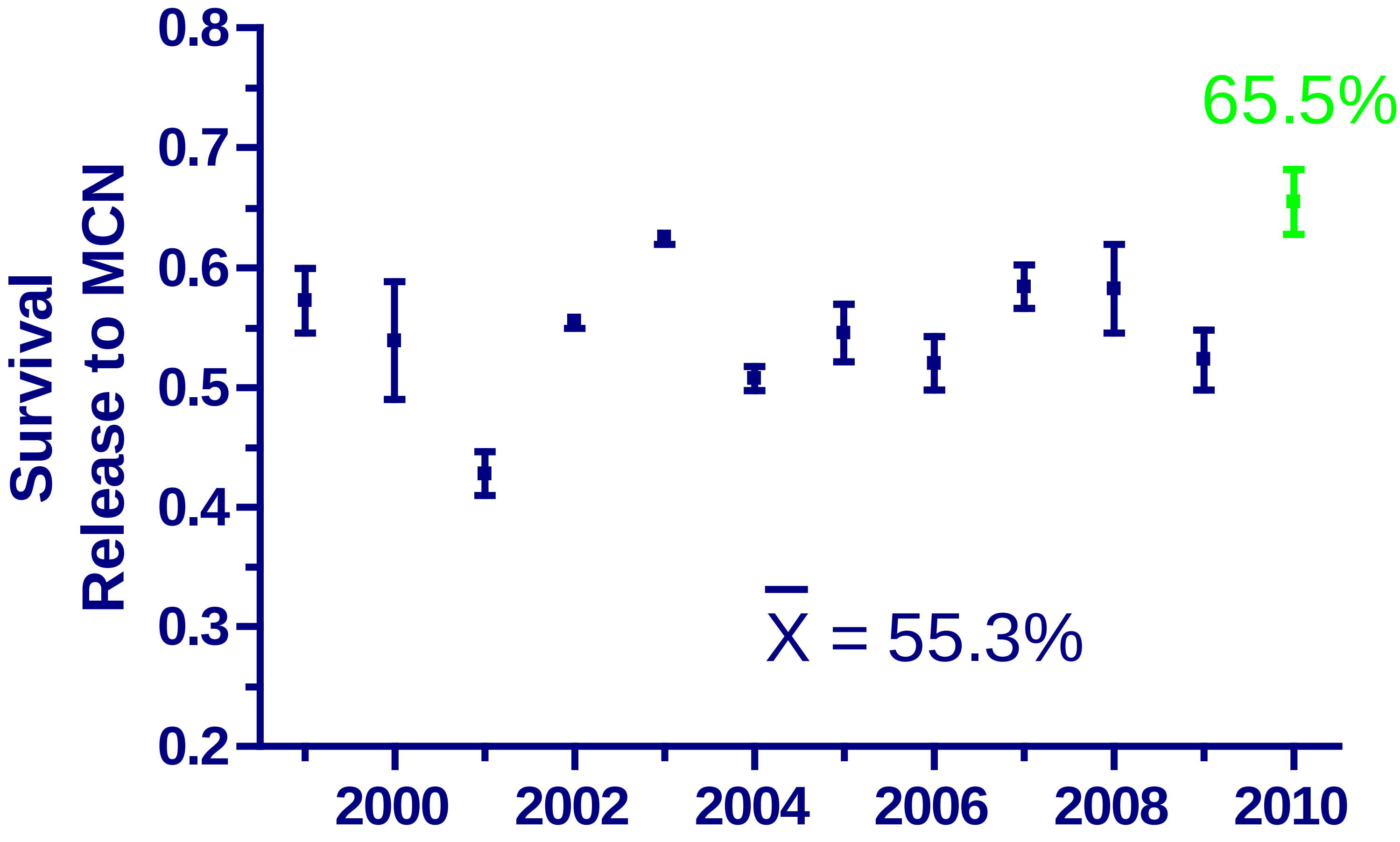
Yearling Chinook (1998-2010)
Snake River Basin Hatcheries



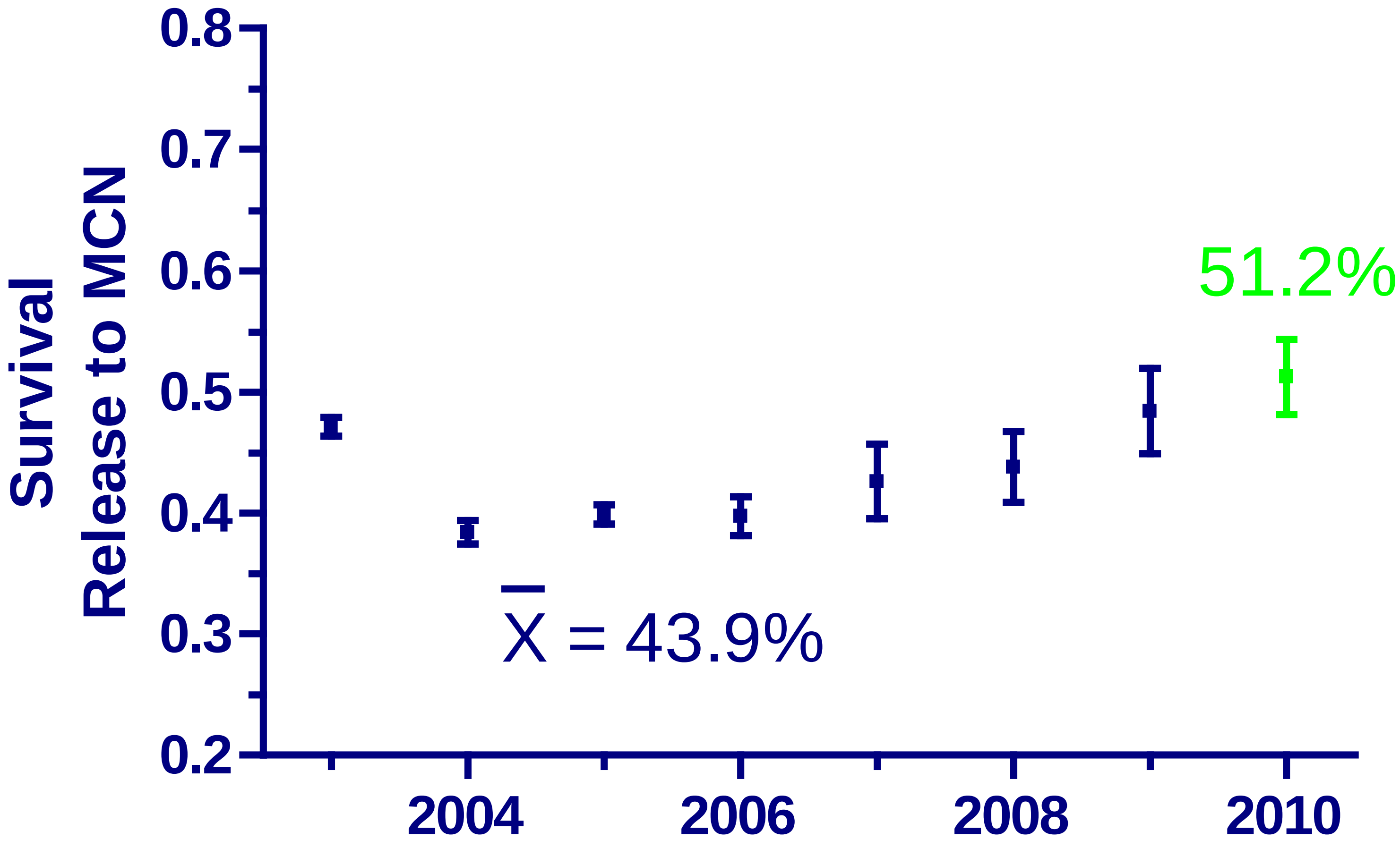
Yearling Chinook
Snake River Basin Hatcheries
Mean of Index Groups



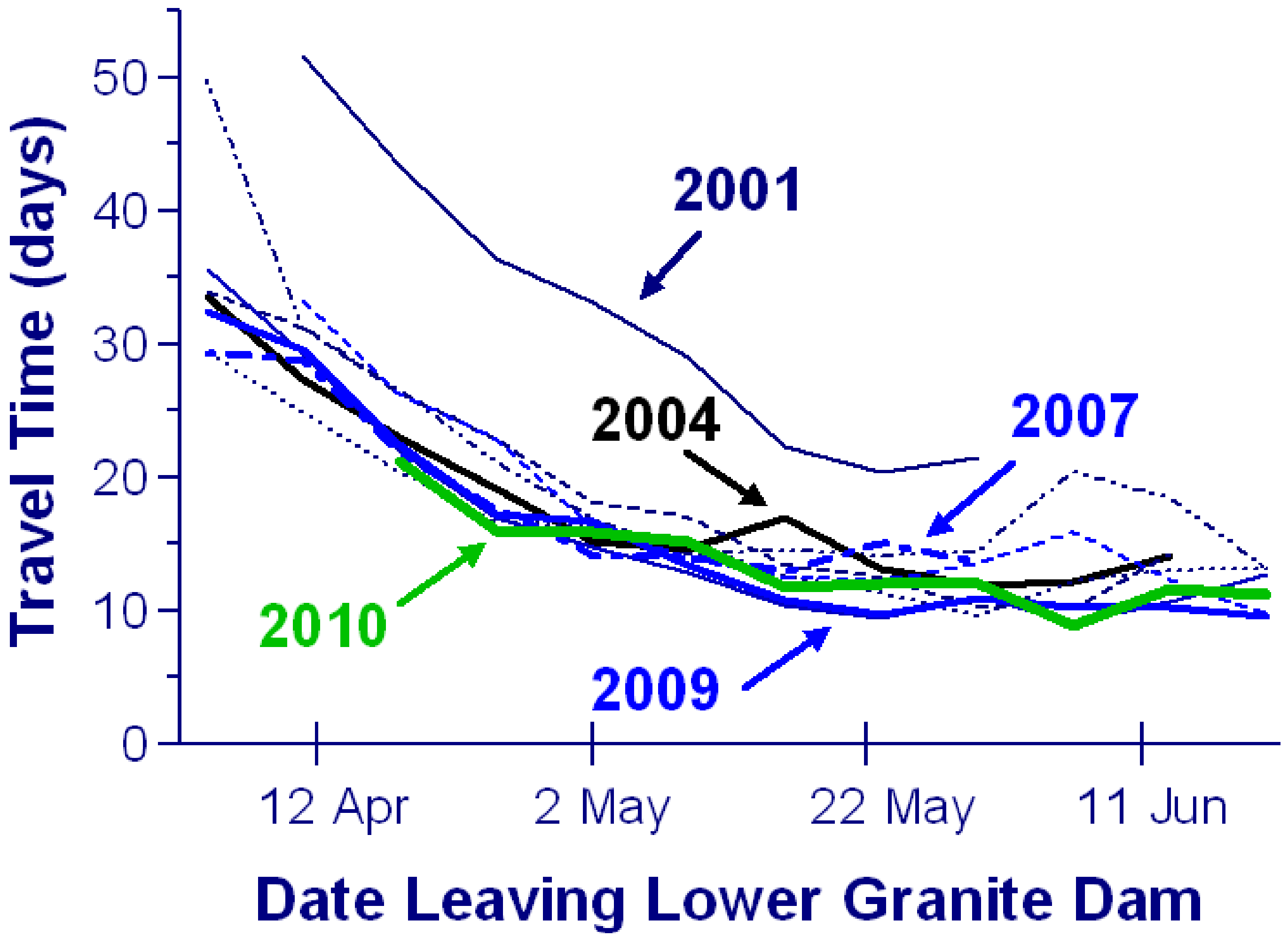
Yearling Chinook
Upper Columbia River Hatcheries



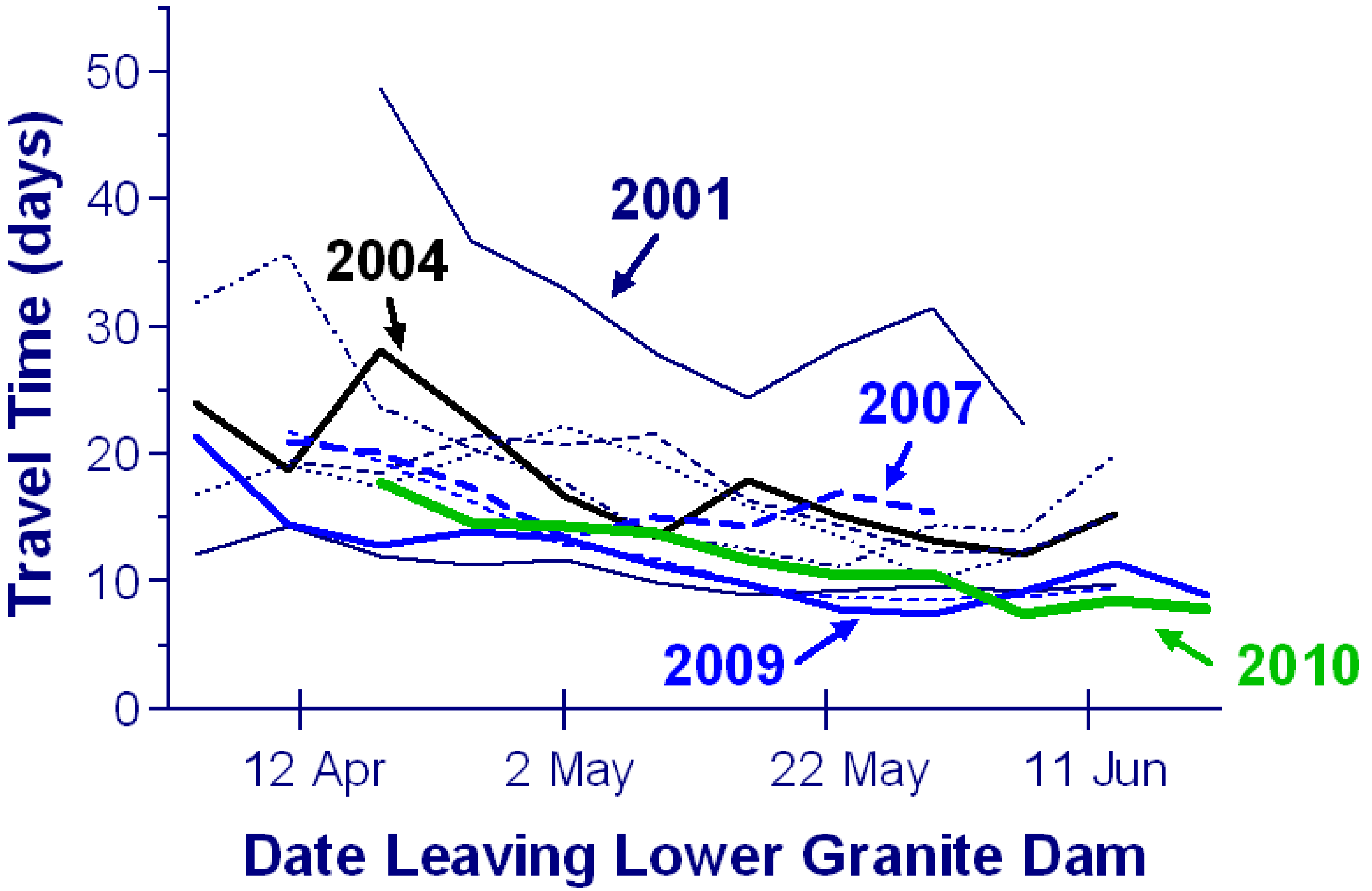
Steelhead
Upper Columbia River Hatcheries

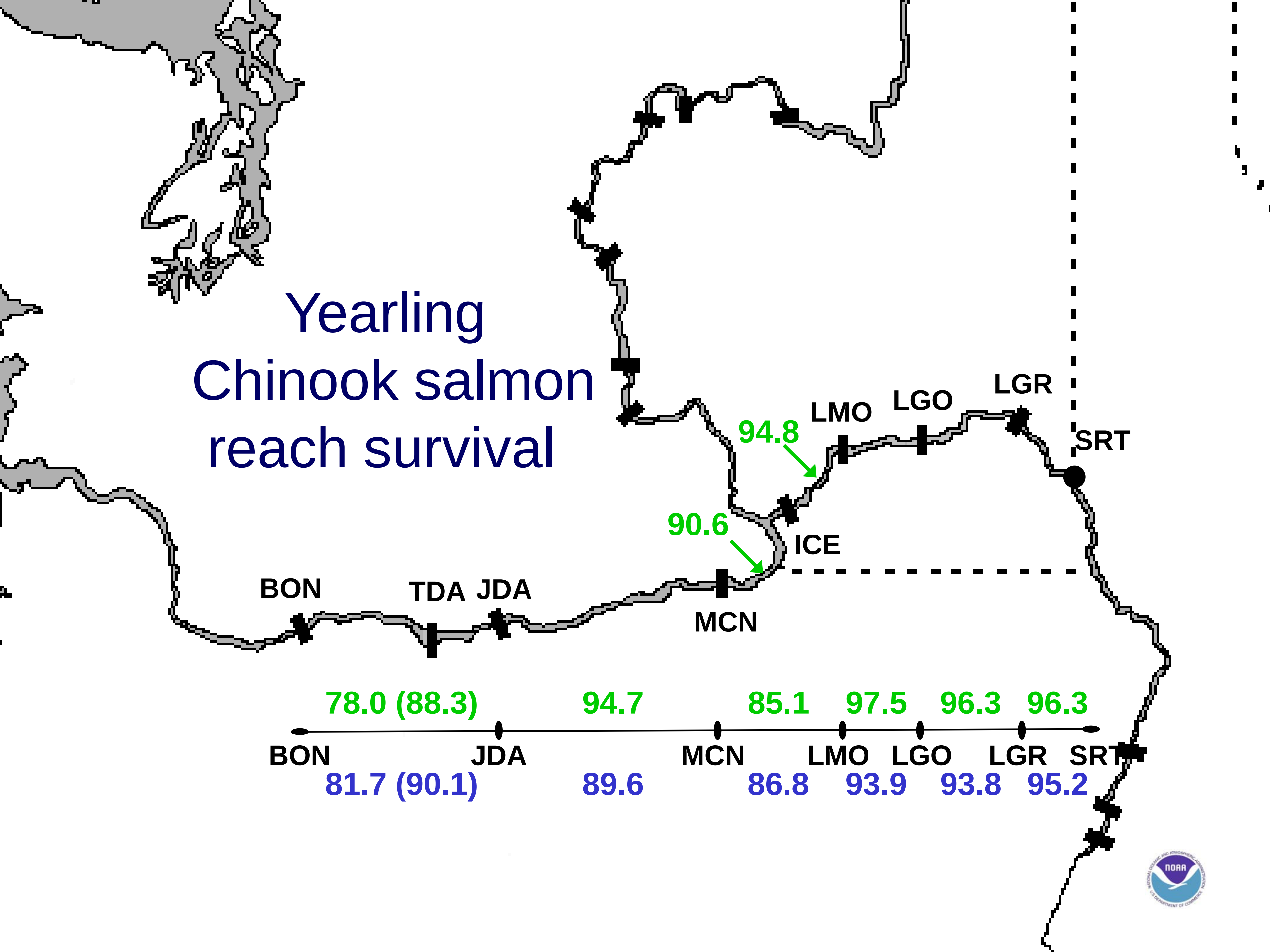


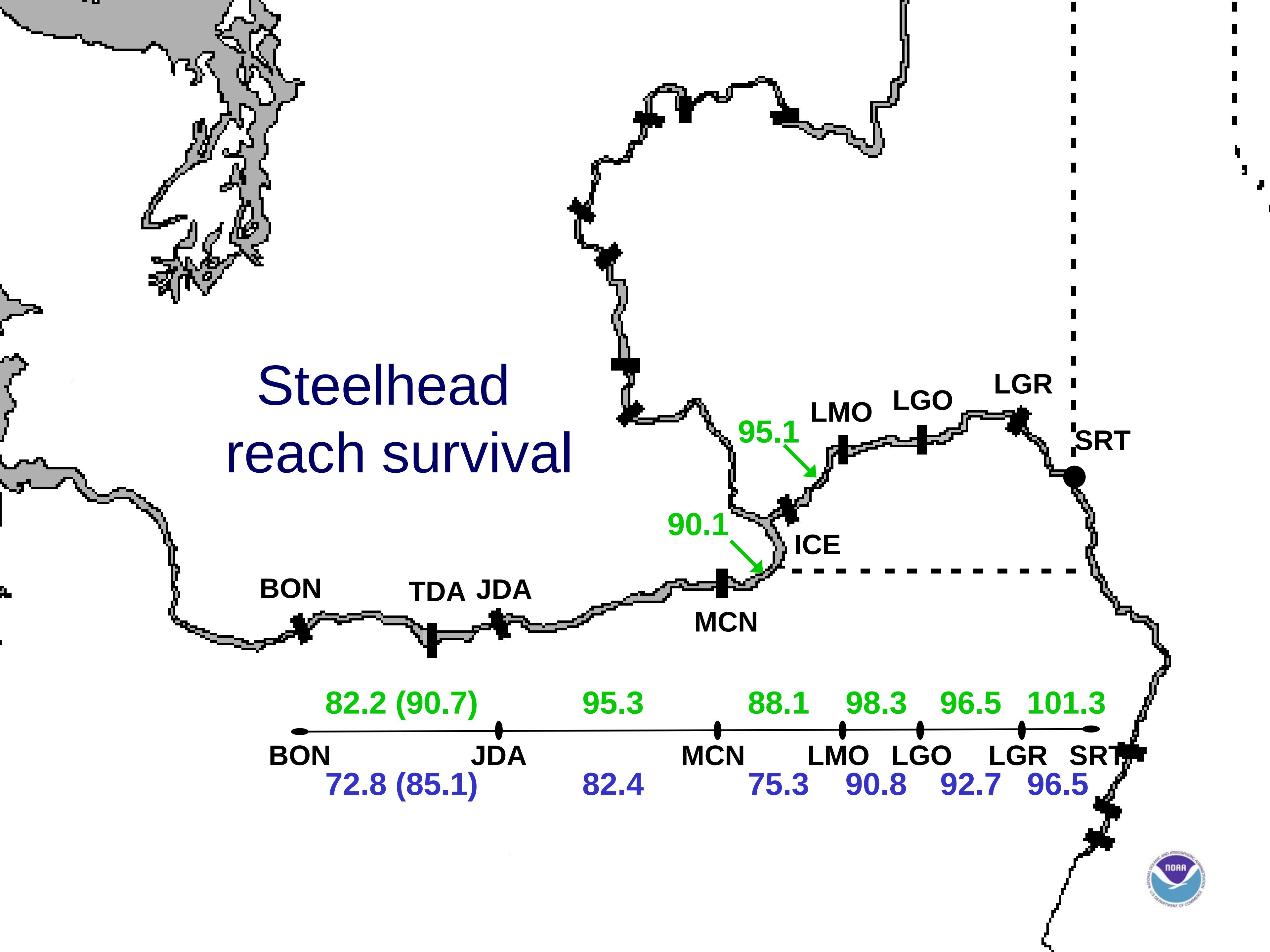
Yearling Chinook Median Travel Time Lower Granite to Bonneville (461 km)

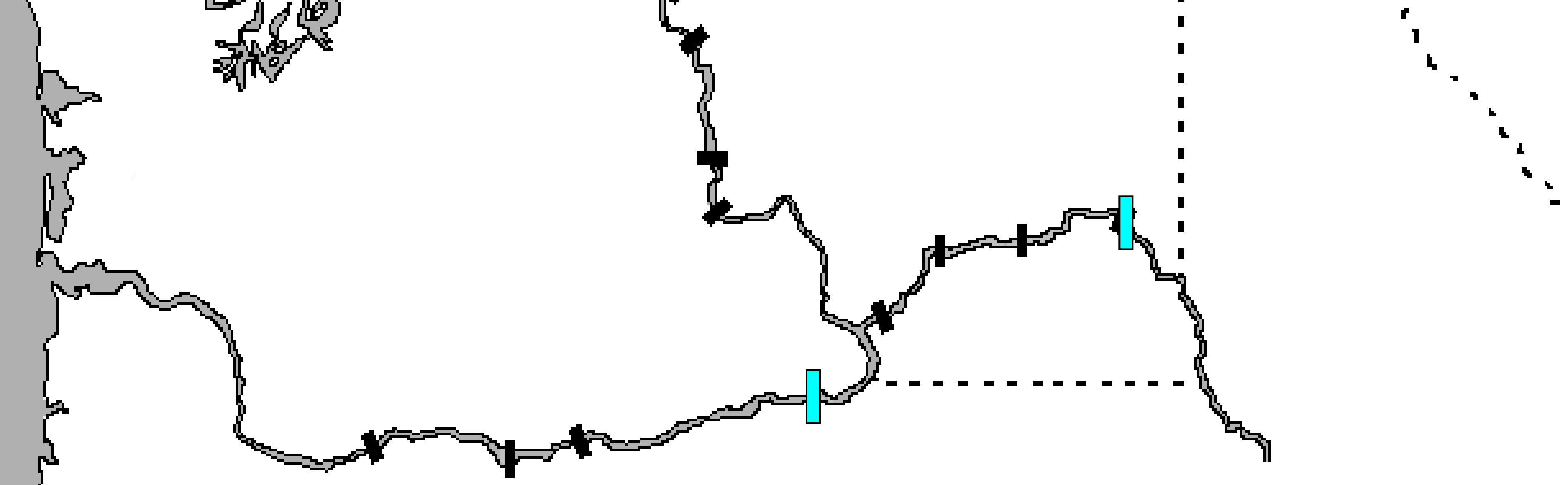


Steelhead Median Travel Time
Lower Granite to Bonneville (461 km)



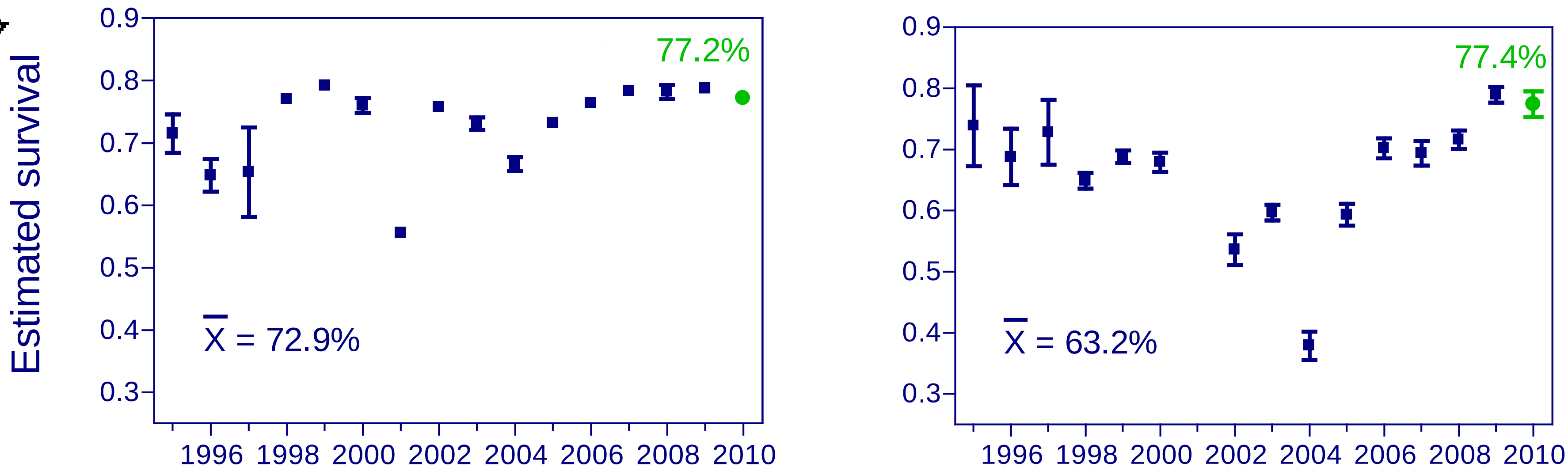

Yearling
Chinook salmon
reach survival
94.8
90.6
LMO
LGO
LGR
SRT
ICE
BON
TDA
JDA
MCN
78.0 (88.3)
94.7
85.1
97.5
96.3
96.3
BON
JDA
MCN
LMO
LGO
LGR
SRT
81.7 (90.1)
89.6
86.8
93.9
93.8
95.2

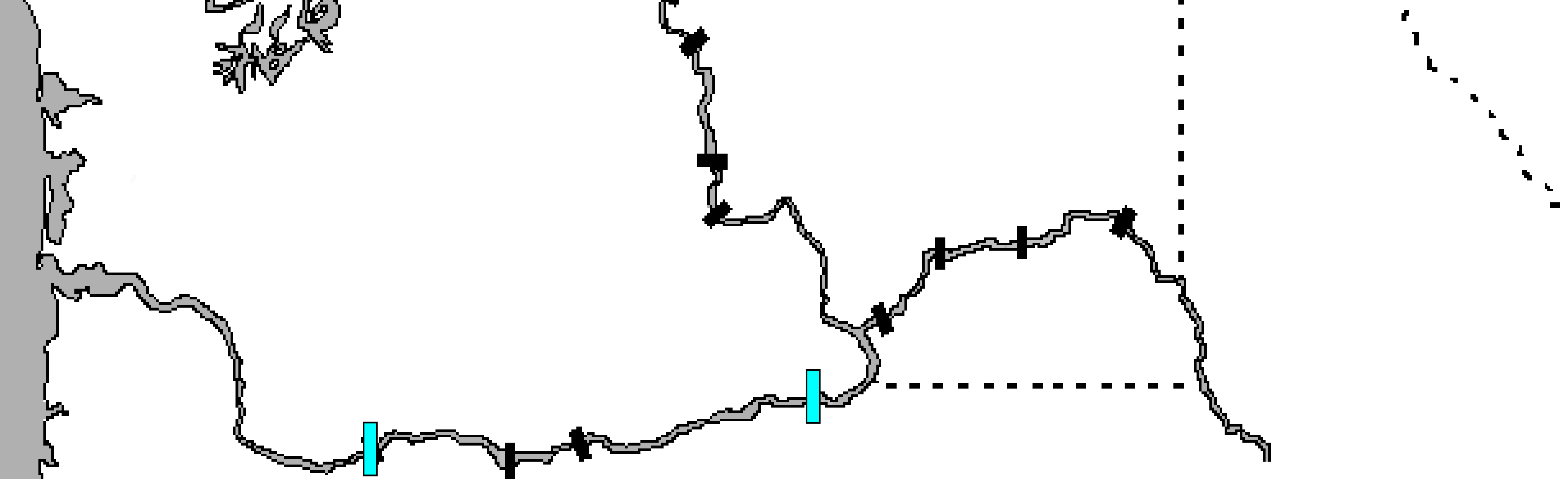

Steelhead
reach survival
LGR
LGO
LMO
SRT
95.1
90.1
ICE
BON
TDA
JDA
MCN
82.2 (90.7)
95.3
88.1
98.3
96.5
101.3
BON
JDA
MCN
LMO
LGO
LGR
SRT
72.8 (85.1)
82.4
75.3
90.8
92.7
96.5



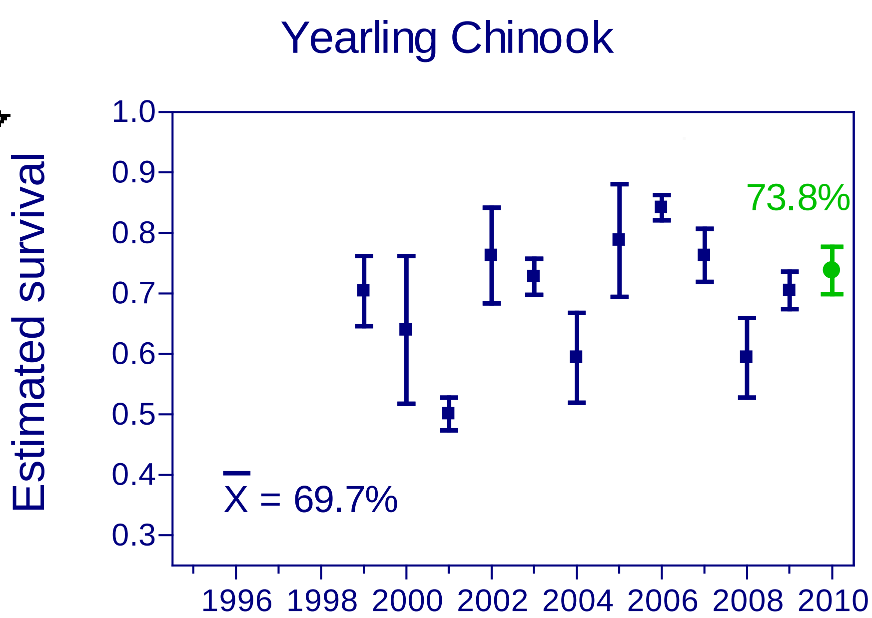
Lower Granite to McNary

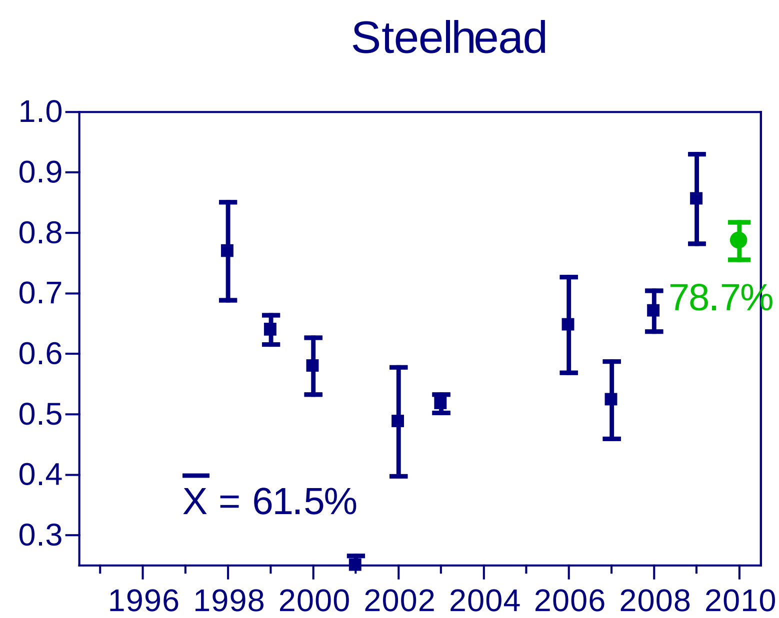
Yearling Chinook | Steelhead

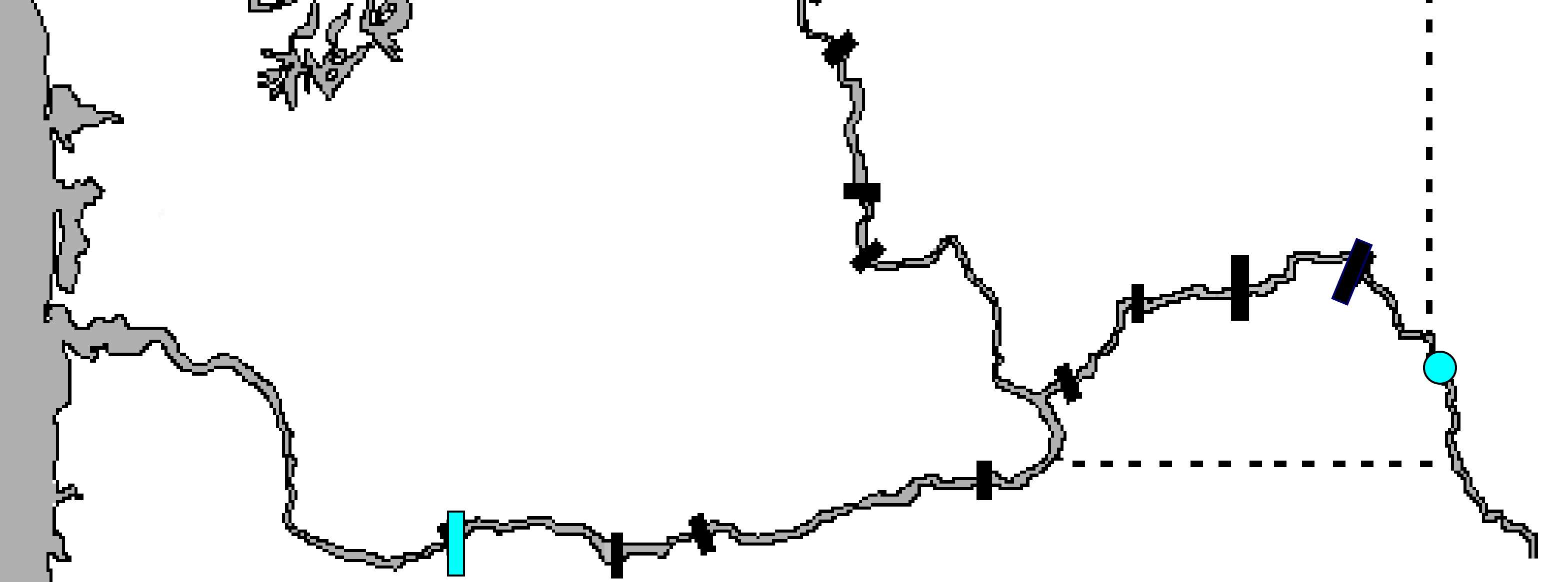




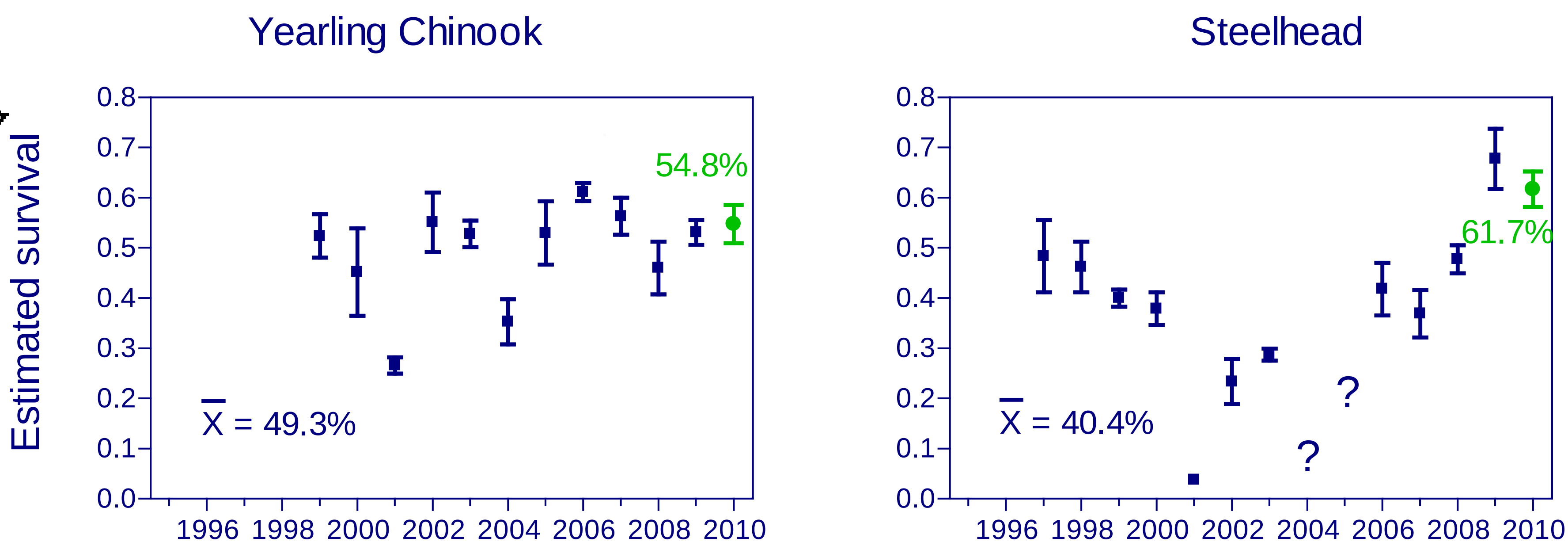
McNary to Bonneville
Fish from Snake River

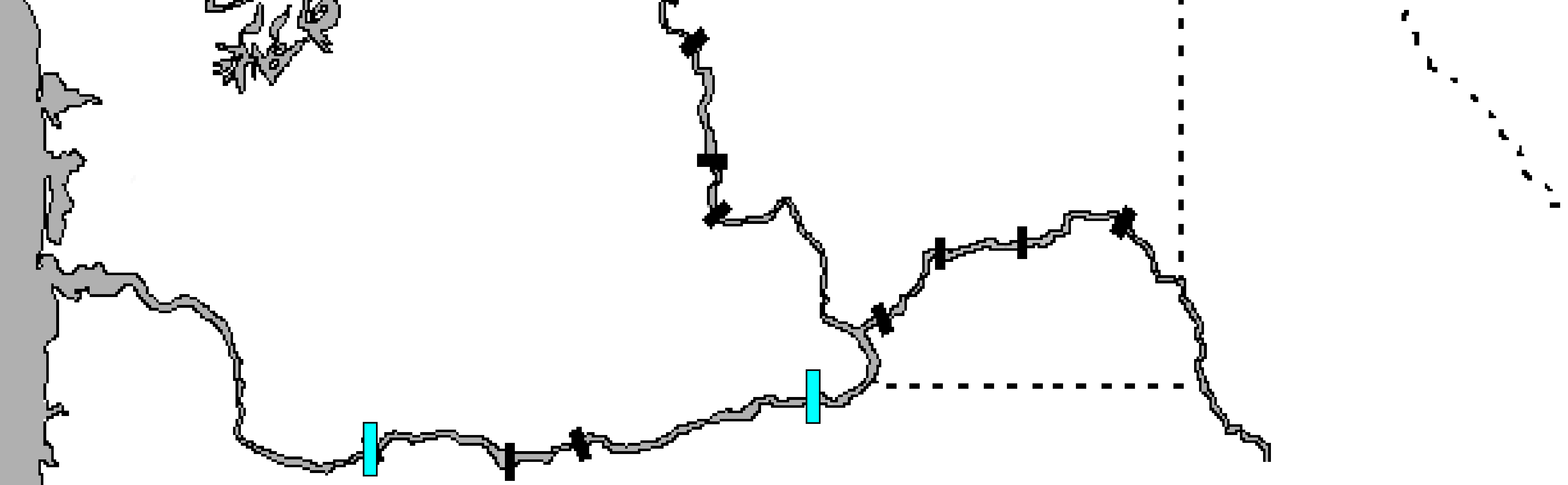




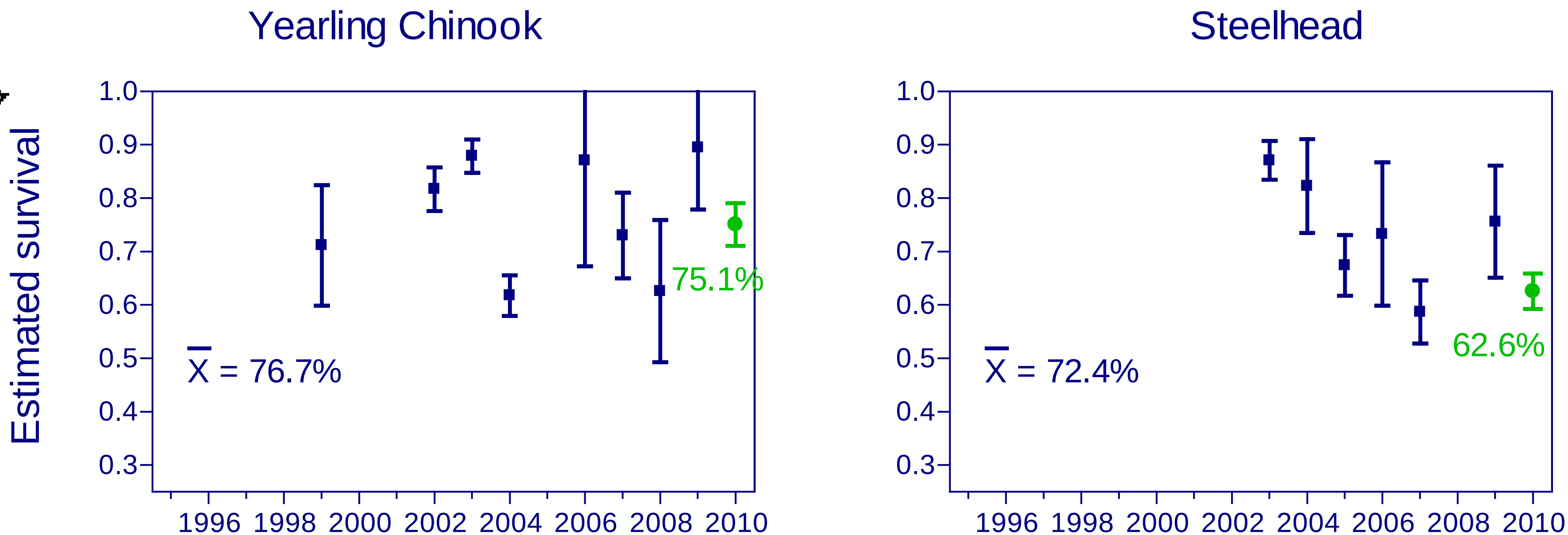


Snake River Trap to Bonneville



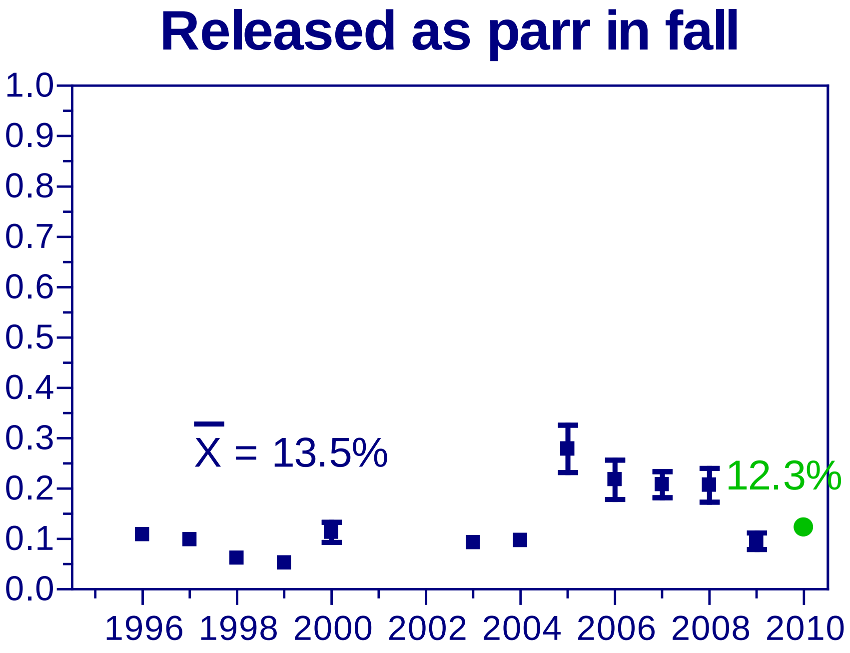


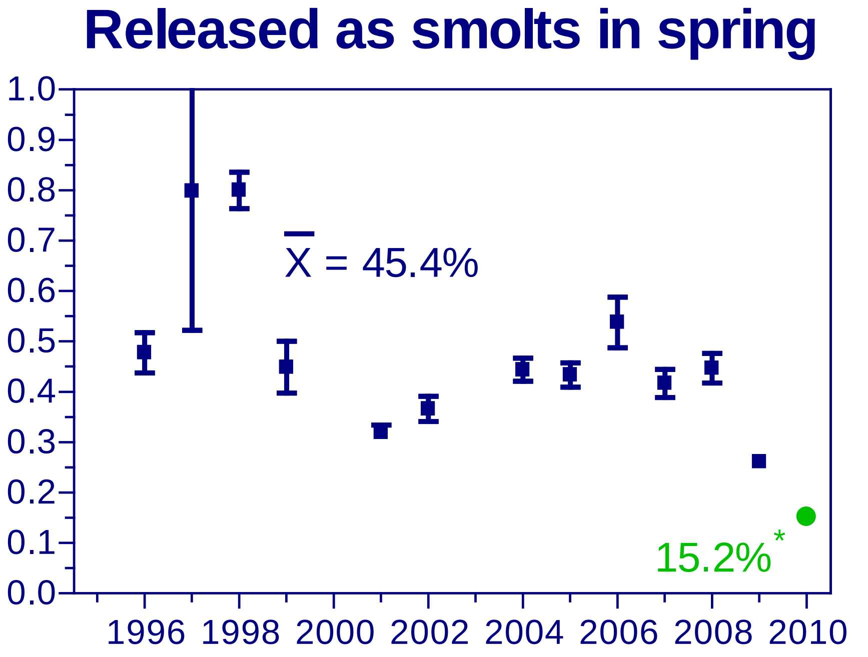
McNary to Bonneville
Fish from Upper Columbia



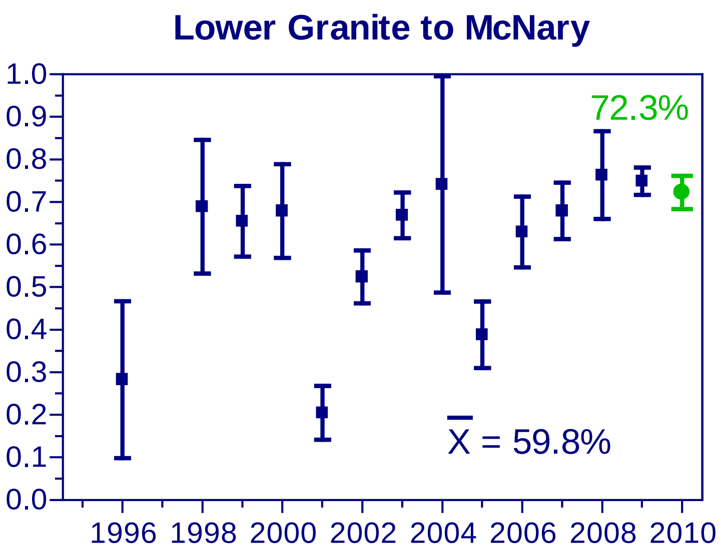
Sockeye Survival

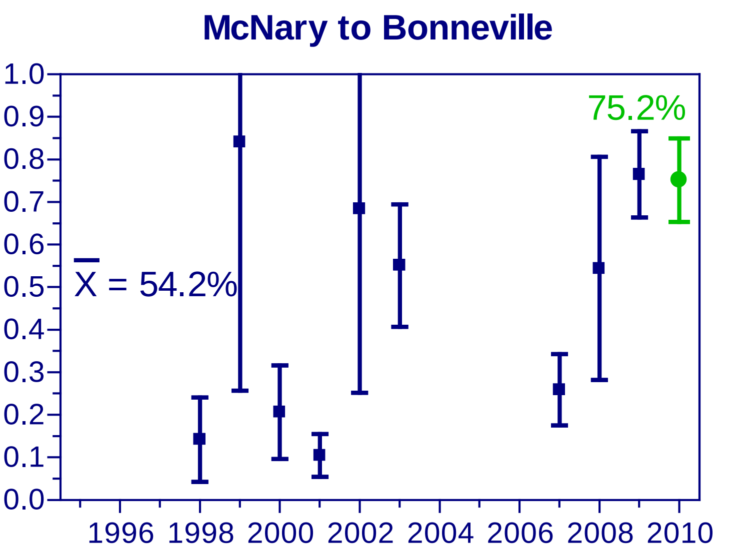
Snake River Sockeye
Redfish Lake to Lower Granite

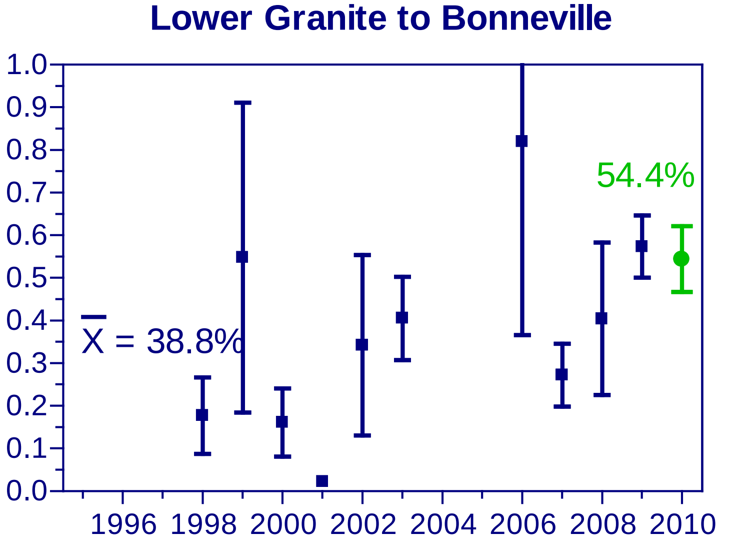




Snake River Sockeye
Smolts Migrating in Spring



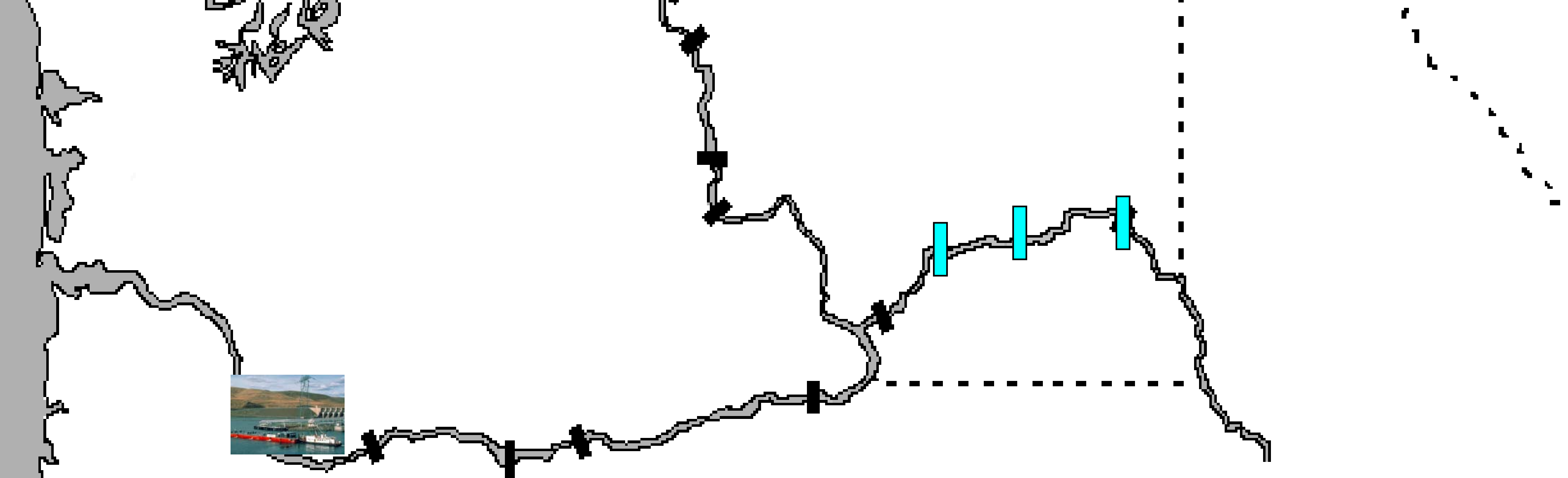




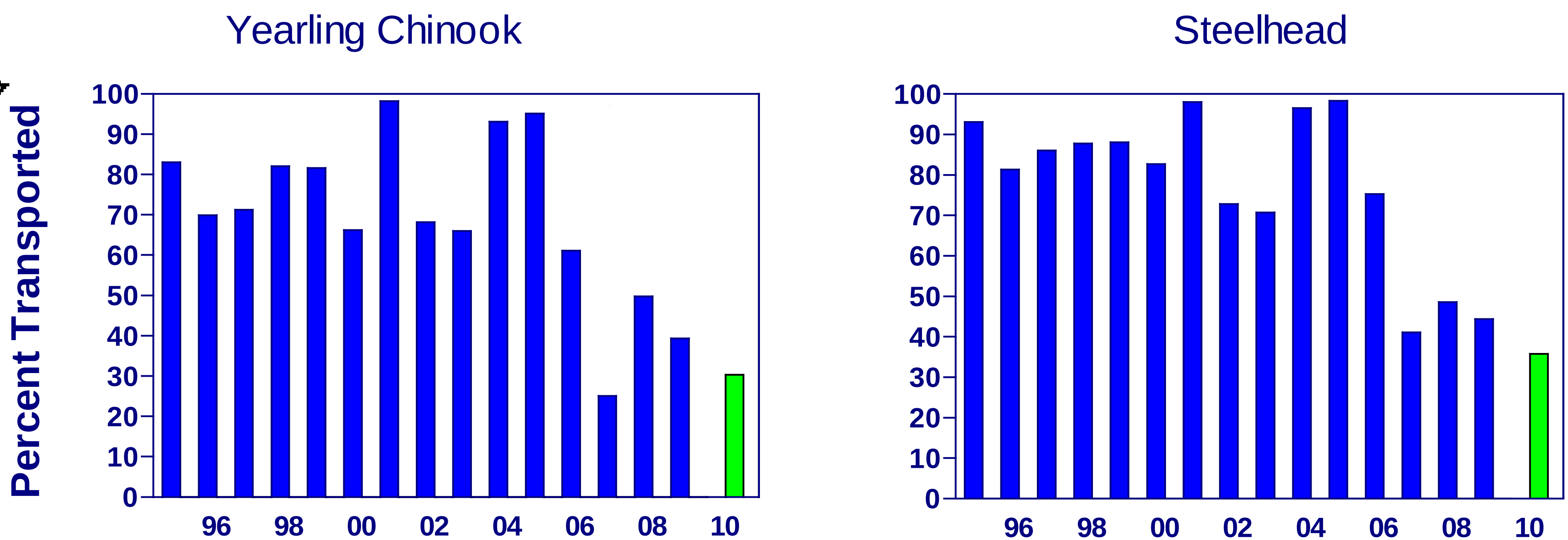
Spill, Transport, In-River Population Size, Predation and Smolt Survival

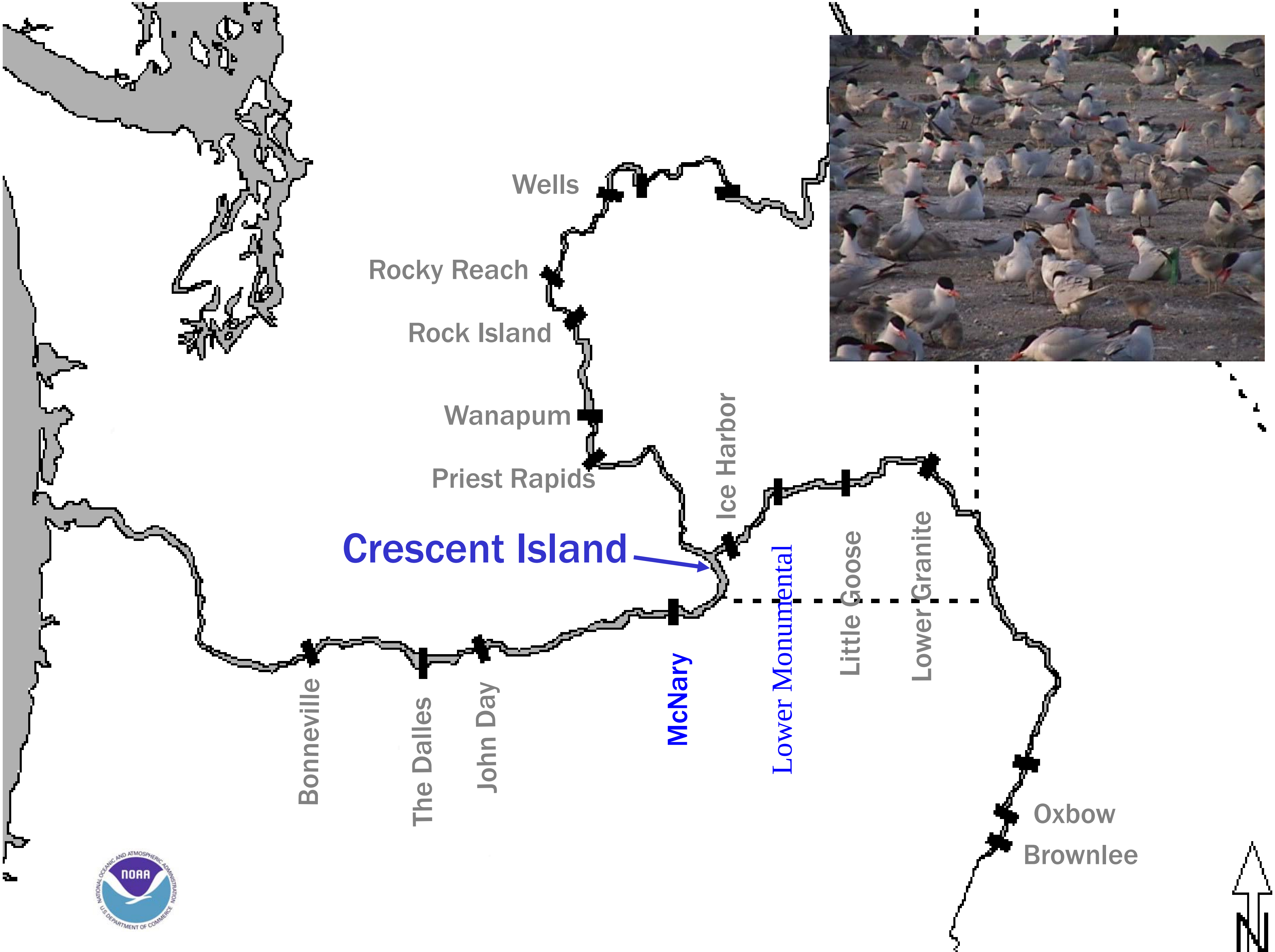
Preliminary estimates of transport % for 2010 based on PIT-tag data:

- **38% wild Chinook**
- **23% hatchery Chinook**
- **37% wild steelhead**
- **35% hatchery steelhead**



Percent Transported to Below Bonneville

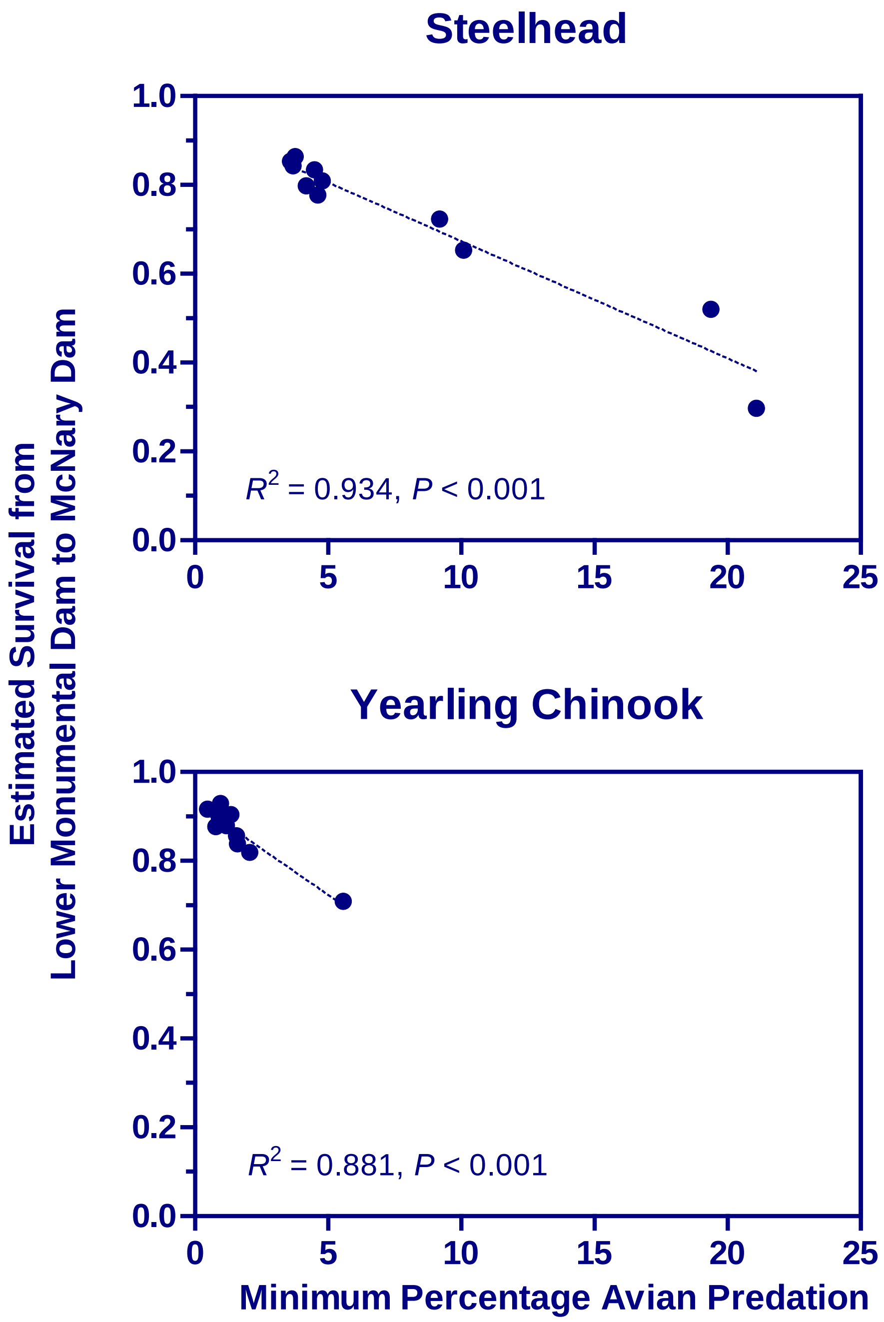


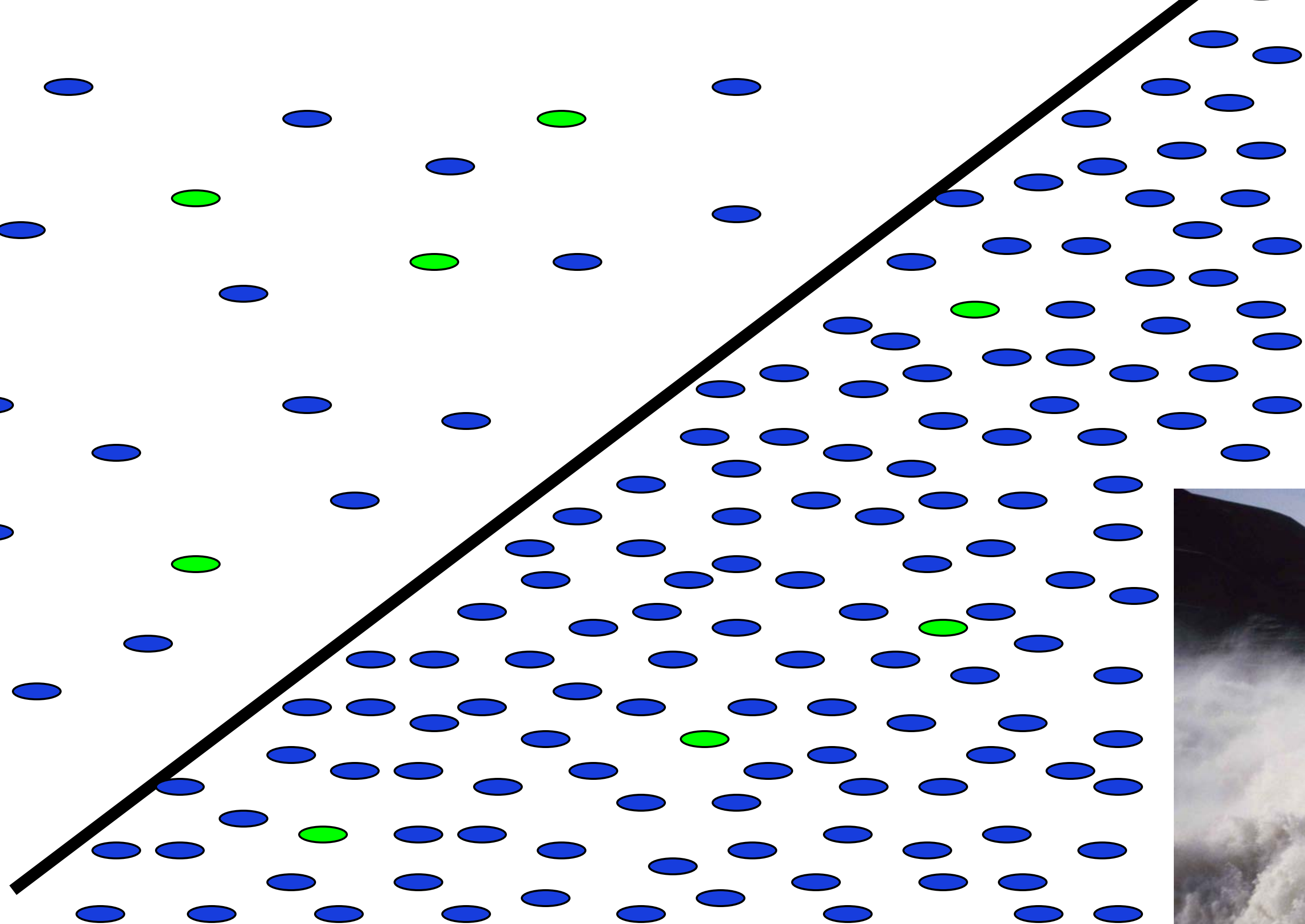

Wells
Rocky Reach
Rock Island
Wanapum
Priest Rapids
Crescent Island
Ice Harbor
Bonneville
The Dalles
John Day
McNary
Lower Monumental
Little Goose
Lower Granite
Oxbow
Brownlee
N

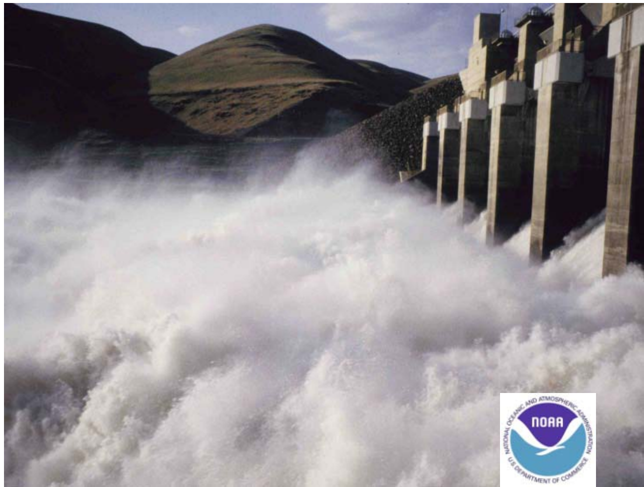
Minimum Estimate of Steelhead Mortality from Avian Predation

- Percentage of PIT-tagged steelhead detected at LMN eventually recovered on nesting colonies

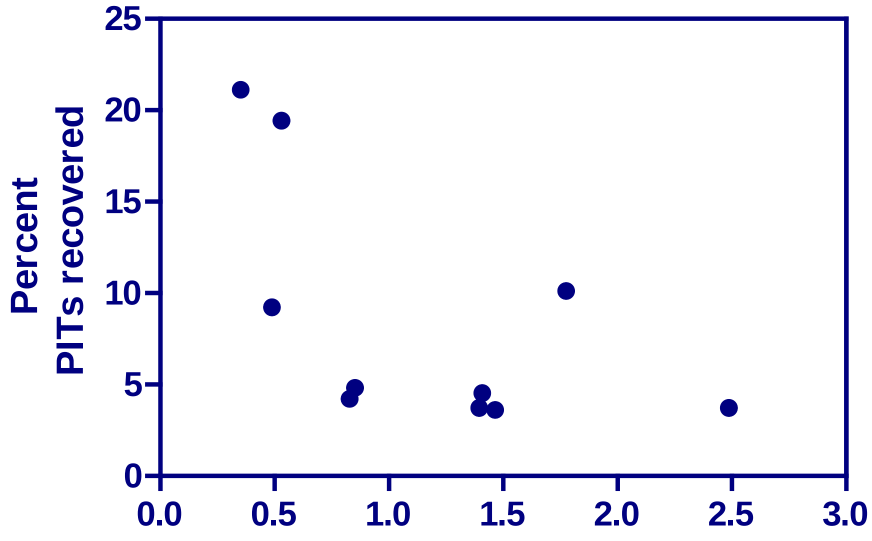
1998	4%	2004	19%
1999	5%	2005	9%
2000	4%	2006	5%
2001	21%	2007	4%
2002	10%	2008	5%
2003	4%	2009	4%


Steelhead
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
R2 = 0.934, P < 0.001
Yearling Chinook
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
R2 = 0.881, P < 0.001
Estimated Survival from
Lower Monumental Dam to McNary Dam
Minimum Percentage Avian Predation

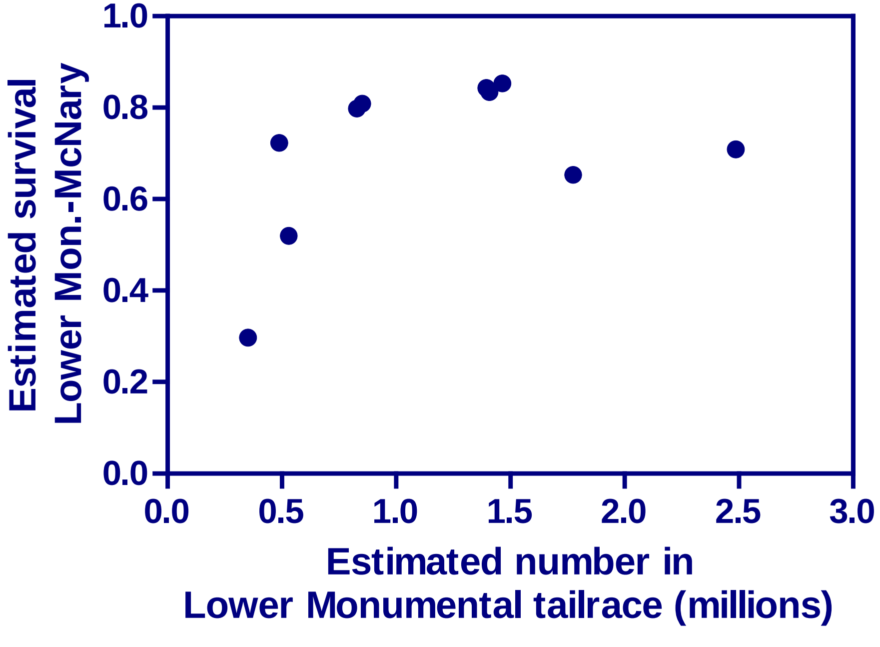

Maximum transport
Transport with spill



Steelhead



Percent
PITs recovered
25
20
15
10
5
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0



Estimated survival
Lower Mon.-McNary
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Estimated number in
Lower Monumental tailrace (millions)

Conclusions

- Low survival in low-spill (high-transport) years in part simply because of fewer fish in river

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  - In-river survival would have been higher under same conditions if non-tagged bypass fish had been returned to the river instead of transported

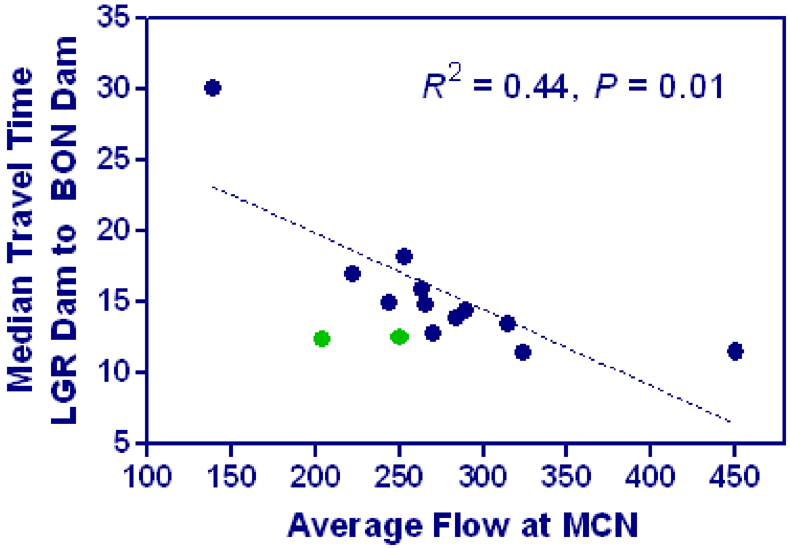
Conclusions

- Low survival in low-spill (high-transport) years in part simply because of fewer fish in river
  - In-river survival would have been higher under same conditions if non-tagged bypass fish had been returned to the river instead of transported
- Converse is also true: one effect of increasing spill is increasing number in river/reducing individual vulnerability to predation, indirectly contributing to higher survival

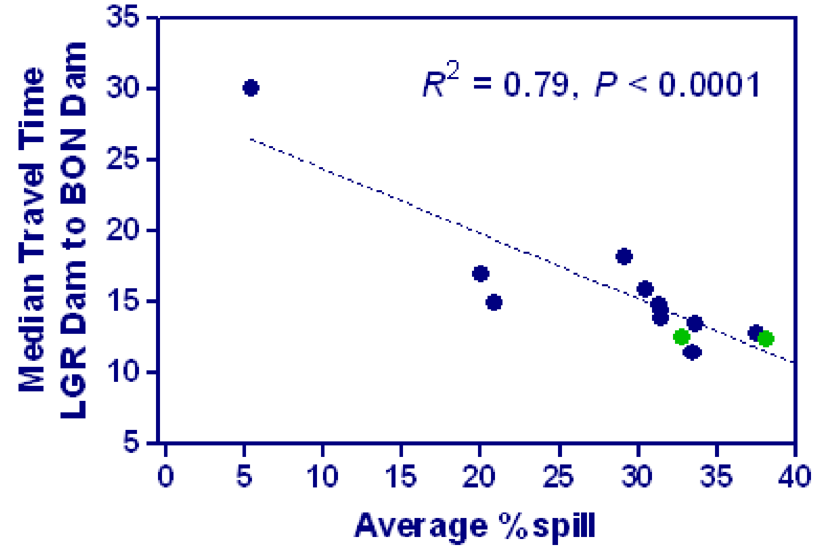
So why has survival increased for steelhead in last two years?

Steelhead Travel Time LGR to BON

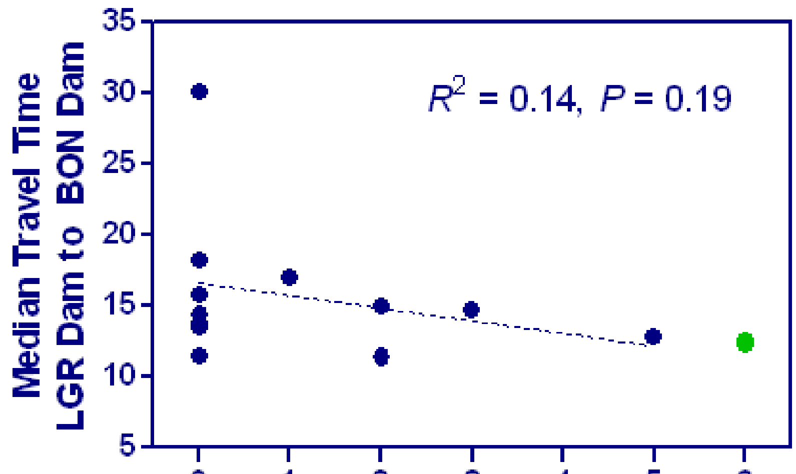
Travel Time vs. Flow



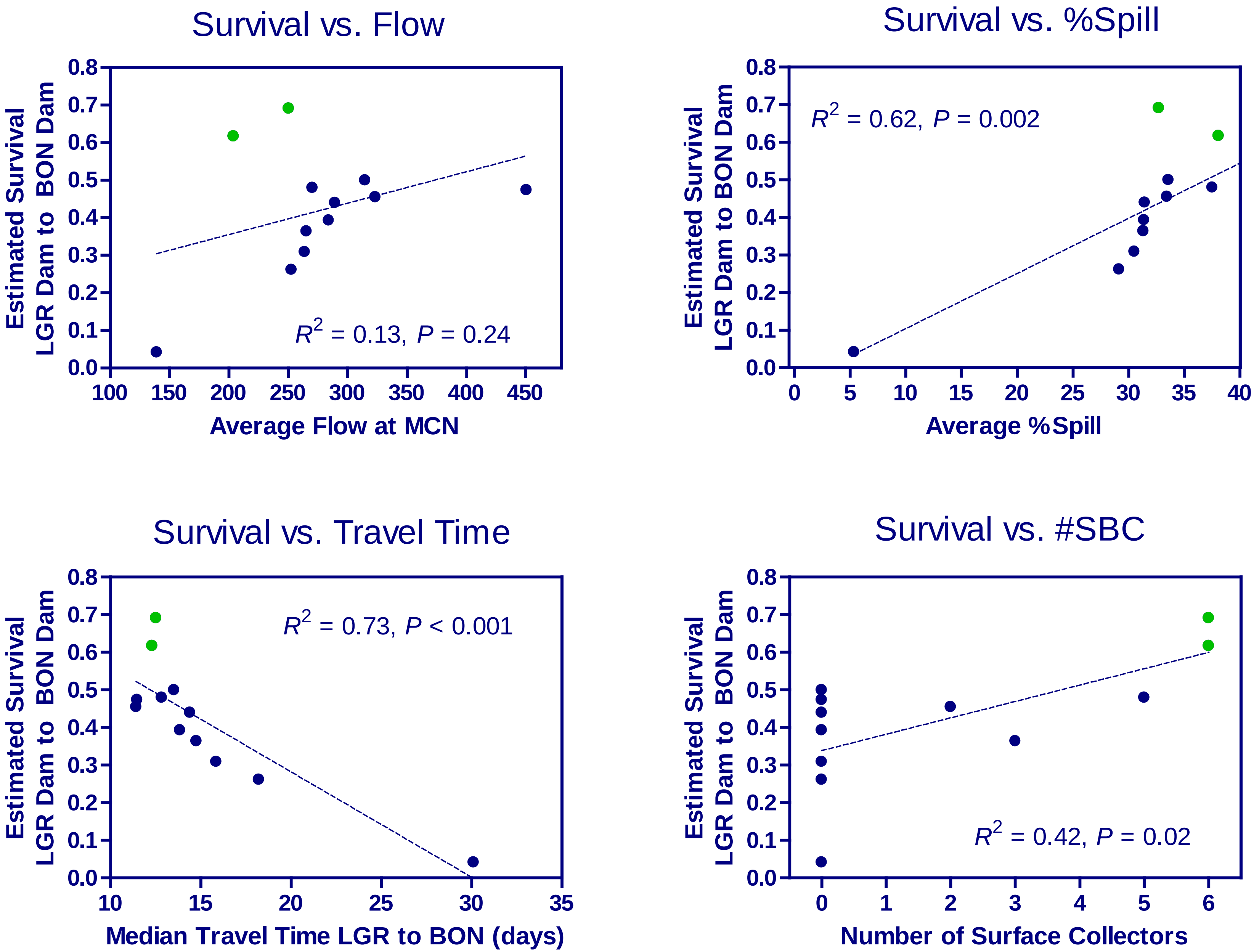
Travel Time vs. %Spill



Travel Time vs. #SBC



Steelhead Survival LGR to BON

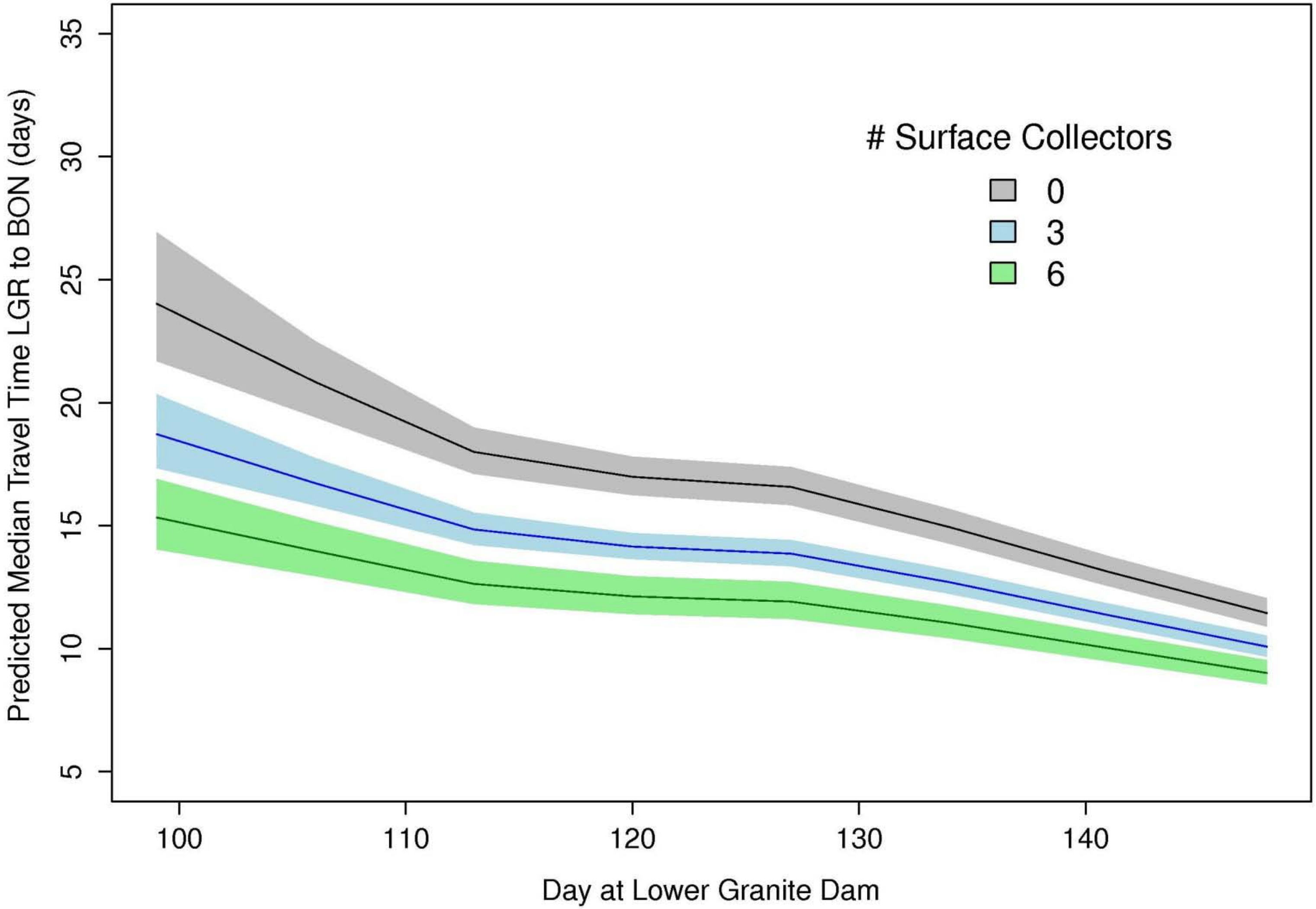


Effect of Number of Dams with Surface Collectors on Migration Rate

Steelhead

Adjusting for day of release, flow, and spill%, each additional surface collector was associated with an increase in median migration rate from Lower Granite to Bonneville of 1.7 km/day.

Steelhead Predicted Median Travel Time by Number of Dams with Surface Collectors



Effect of Number of Dams with Surface Collectors on Migration Rate

Steelhead

Adjusting for day of release, flow, and spill%, each additional surface collector was associated with an increase in median migration rate from Lower Granite to Bonneville of 1.7 km/day.

Yearling Chinook

Adjusting for day of release, flow, and spill%, each additional surface collector was associated with an increase in median migration rate from Lower Granite to Bonneville of 0.4 km/day.

Effect of Number of Dams with Surface Collectors on Survival

Steelhead

Adjusting for day of release, flow, and spill%, each additional surface collector was associated with an increase in estimated mean survival from Lower Granite to McNary of 1.85%.

Effect of Number of Dams with Surface Collectors on Survival

Steelhead

Adjusting for day of release, flow, and spill%, each additional surface collector was associated with an increase in estimated mean survival from Lower Granite to McNary of 1.85%.

Yearling Chinook

Adjusting for day of release, flow, and spill%, each additional surface collector was associated with an increase in estimated mean survival from Lower Granite to McNary of 1.01%.

Conclusions

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- Likely contributing factors include relatively high spill rates and increased migration rate, promoted by additional surface passage structures
- Reduced steelhead residualization?

Final Conclusions

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  - increased number of in-river migrants
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  - not necessarily increased smolt-to-adult survival for the population

- Transported fish have:
  - 1.5-day travel time from LGR to BON
  - Near 100% survival from Lower Granite to Bonneville

    (but more post-Bonneville mortality than in-river)

Final Conclusions

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  - Improvements in in-river survival would have to exceed the transport benefit to increase survival to adulthood


Questions