Northwest Power and Conservation Council



June 28, 2006

# MEMORANDUM

**TO:** Council Members

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

**SUBJECT:** NOAA Fisheries Service presentation on Snake River juvenile Chinook salmon and steelhead survival, adult return rates in a life-cycle context, and research needed to address uncertainties

At the July 12 Council meeting, John Williams, Steve Smith and Bill Muir from the Fish Ecology Division of NOAA's Northwest Fisheries Science Center will present some of the major findings and updates covered in the NOAA Technical Memorandum of February 2005 entitled, "Effects of the Federal Columbia River Power System on Salmonid Populations." In particular, they will present recent research information on the survival and travel times of juvenile Snake River Chinook salmon and steelhead, particularly as it relates to varying spill and flow conditions.

They will also discuss the importance of evaluating adult return rates based on juvenile migration histories. I have also asked the NOAA researchers to discuss the research needed to address some critical uncertainties.

See the attached abstract for more information.

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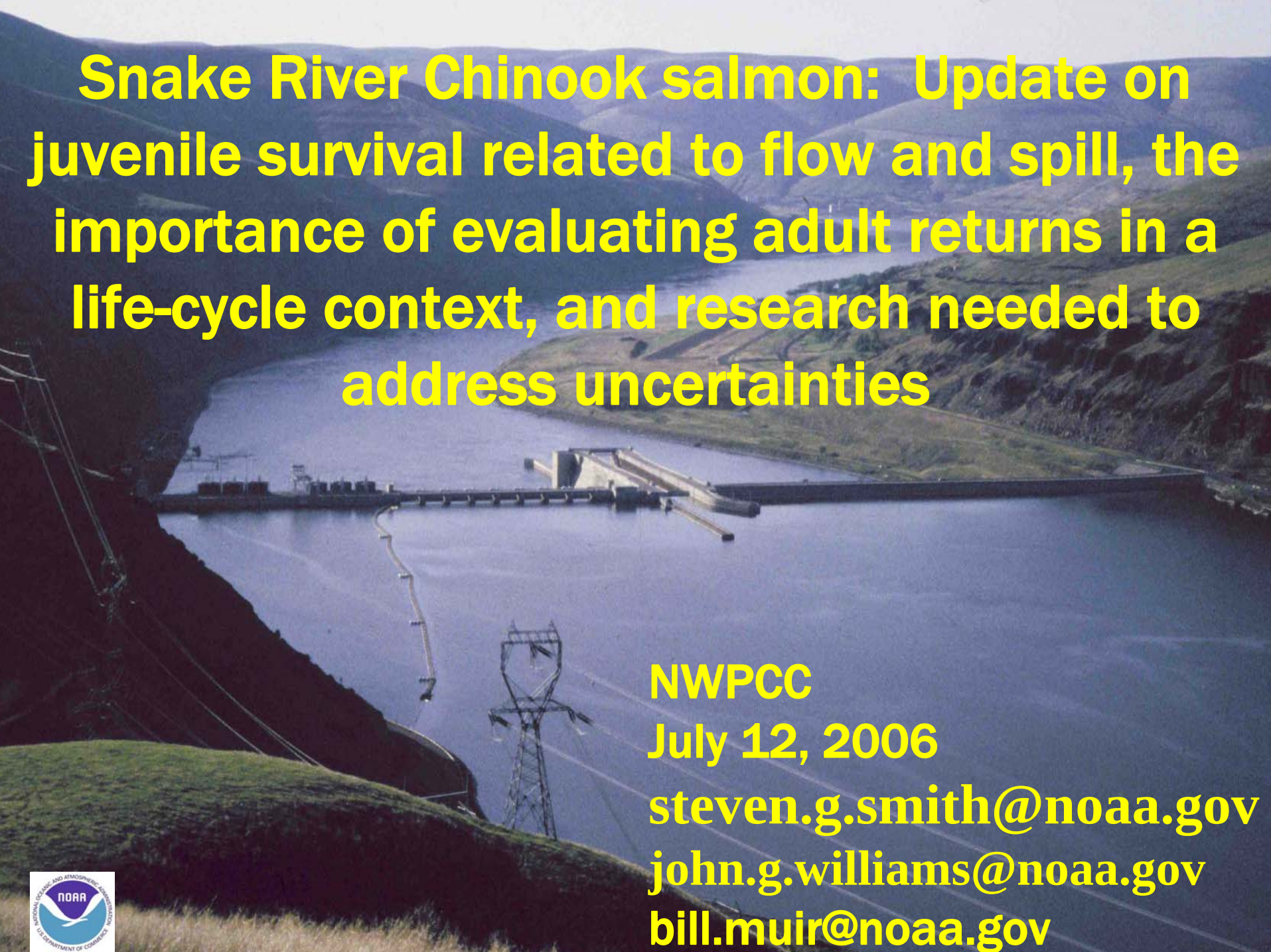
Abstract

**Snake River Chinook salmon: Update on juvenile survival related to flow and spill, the importance of evaluating adult returns in a life-cycle context, and research needed to address uncertainties**

John G. Williams, Steven G. Smith, and William D. Muir
NOAA's National Marine Fisheries Service
Northwest Fisheries Science Center, Seattle

We will present major findings and updates (excluding issues of transportation) covered in the "Effects of the Federal Columbia River Power System on Salmonid Populations", U.S. Dept. of Commerce, NOAA Technical Memorandum, NMFS-NWFSC-63 – February 2005. We will first focus on survival and travel time of Snake River juvenile yearling and subyearling Chinook salmon and steelhead, particularly as it relates to conditions of spill and flow, with information presented to contrast differences among recent years, including results from the high flow, high spill 2006 spring outmigration. We will then discuss the importance of evaluating adult returns based on juvenile migration histories, and in particular, adult return rates based on the population as a whole compared to PIT-tagged fish used to evaluate different experimental treatments. Finally, we will discuss research needed to address uncertainties.



# Snake River Chinook salmon: Update on juvenile survival related to flow and spill, the importance of evaluating adult returns in a life-cycle context, and research needed to address uncertainties


NWPCC
July 12, 2006
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# Outline

- Juvenile survival and travel time through the hydropower system

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- Influence of flow, spill, and other factors

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- Influence of flow, spill, and other factors
- Can we increase survival further?

# Outline

- SARs for Snake River spring-summer Chinook

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- Difference in SARs between PIT-tagged and untagged fish

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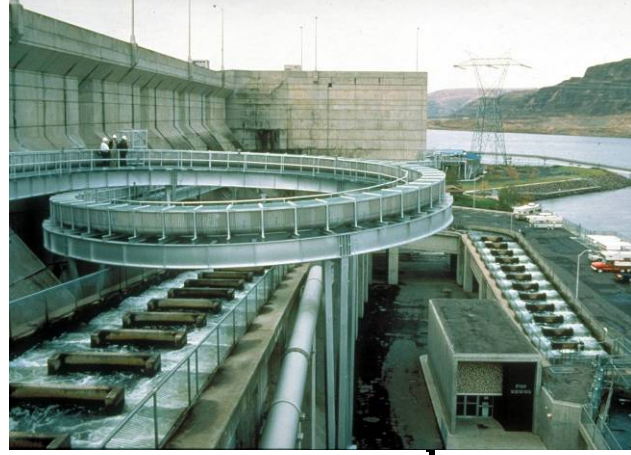
- Difference in SARs between PIT-tagged and untagged fish
- Relationship between hydropower survival and SARs
- Effects of ocean entry timing on SARs
- Research needs/uncertainties

# Survival and Travel Time for PIT-tagged Spring Migrants



Chief Joseph

Wells

Grand Coulee

Rocky Reach

Rock Island

Wanapum

Priest Rapids

Ice Harbor

Snake R. trap

Estuary recoveries

Lower Monumental

Little Goose

Lower Granite

Bonneville

The Dalles

John Day

McNary

Hells Canyon

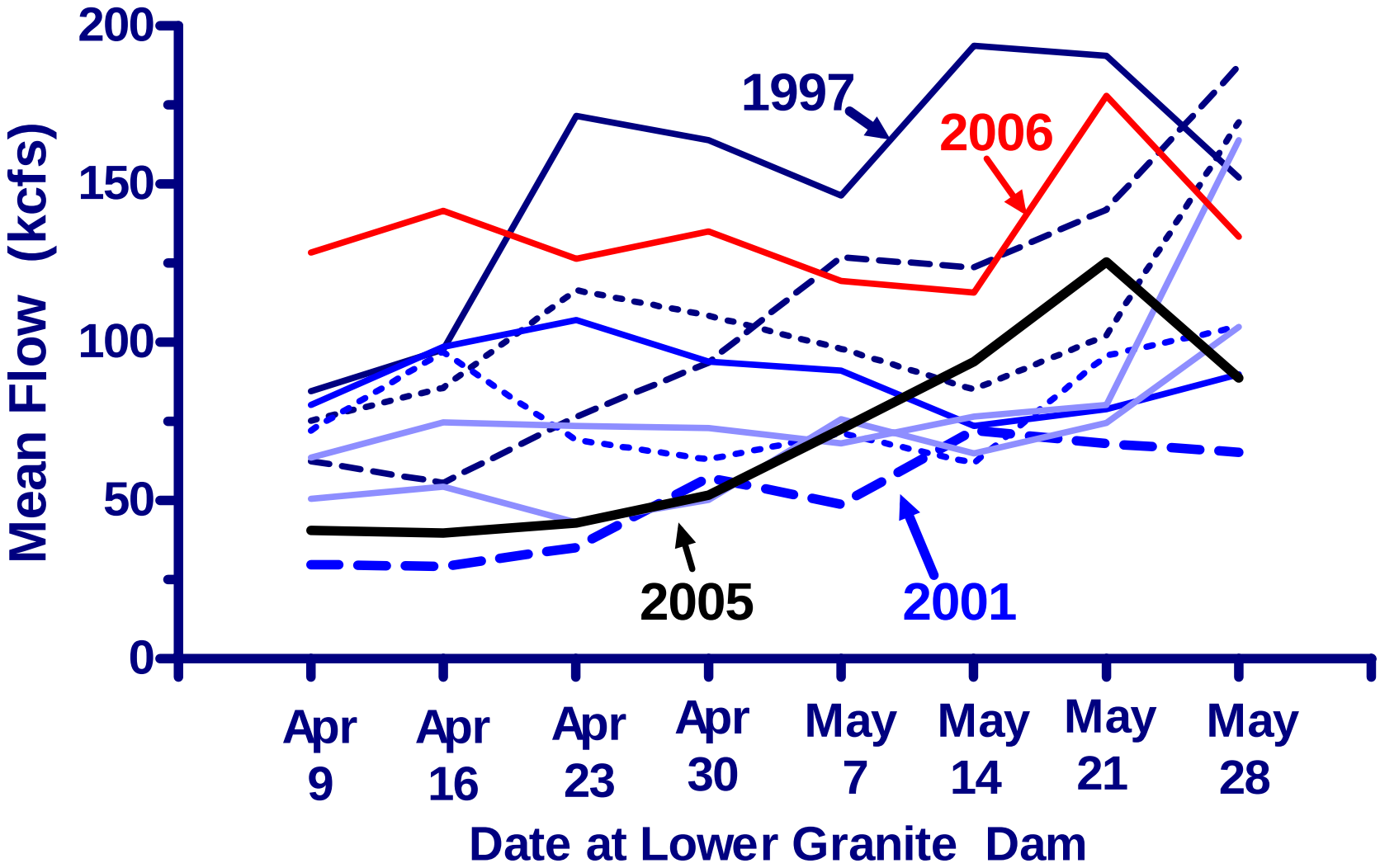
Oxbow

Brownlee

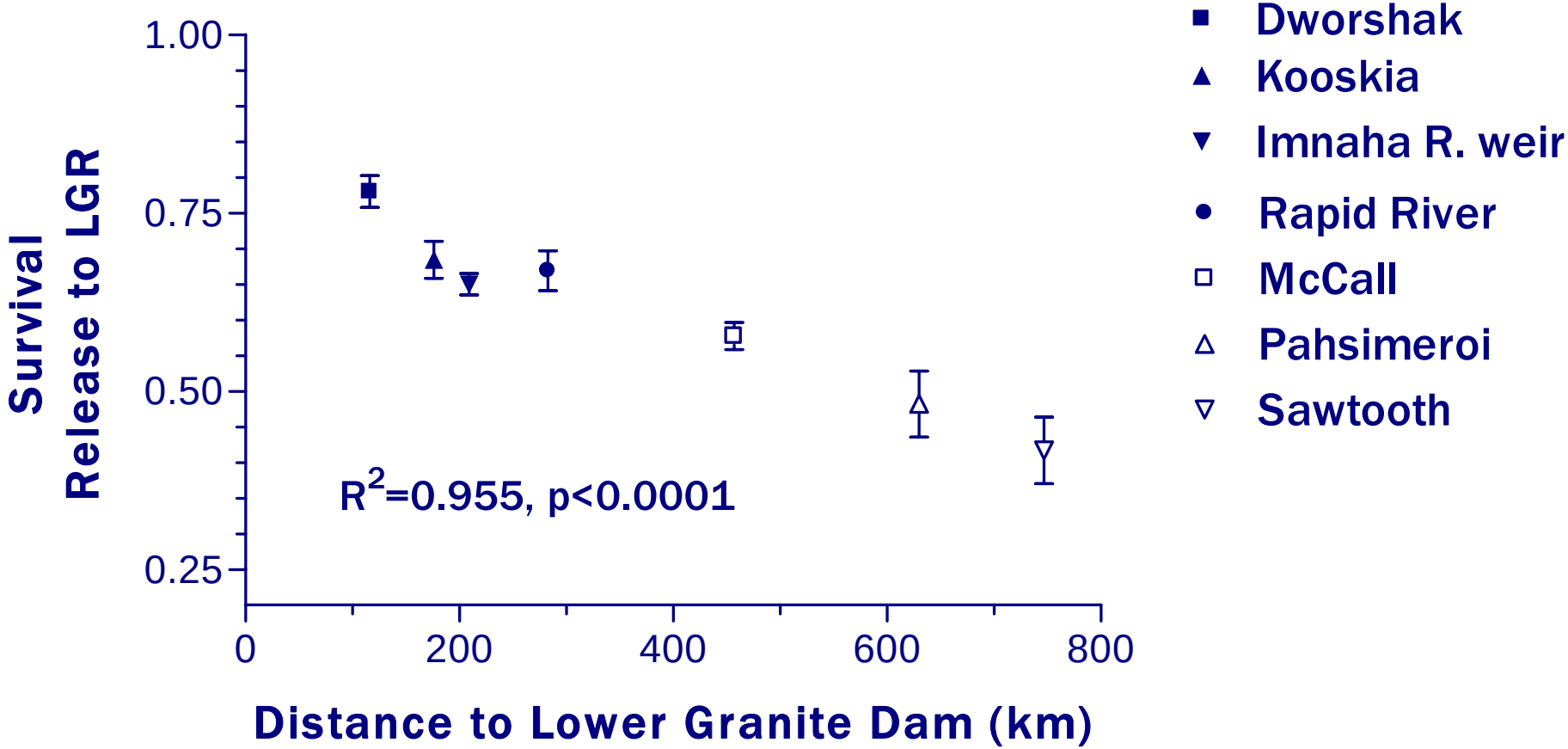
N

# Juvenile detectors

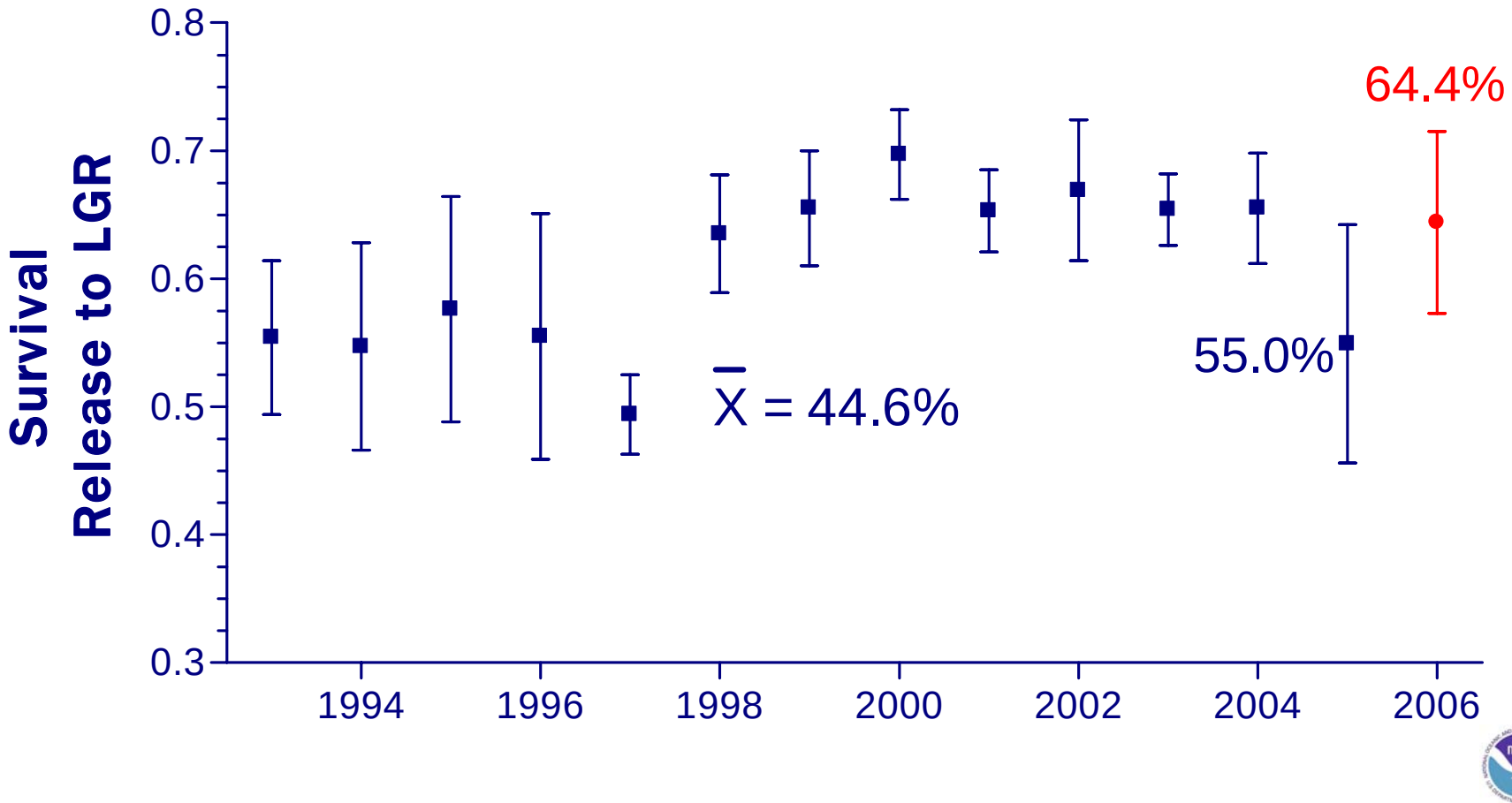
# Weekly Mean Flow (kcfs)
# Lower Granite Dam



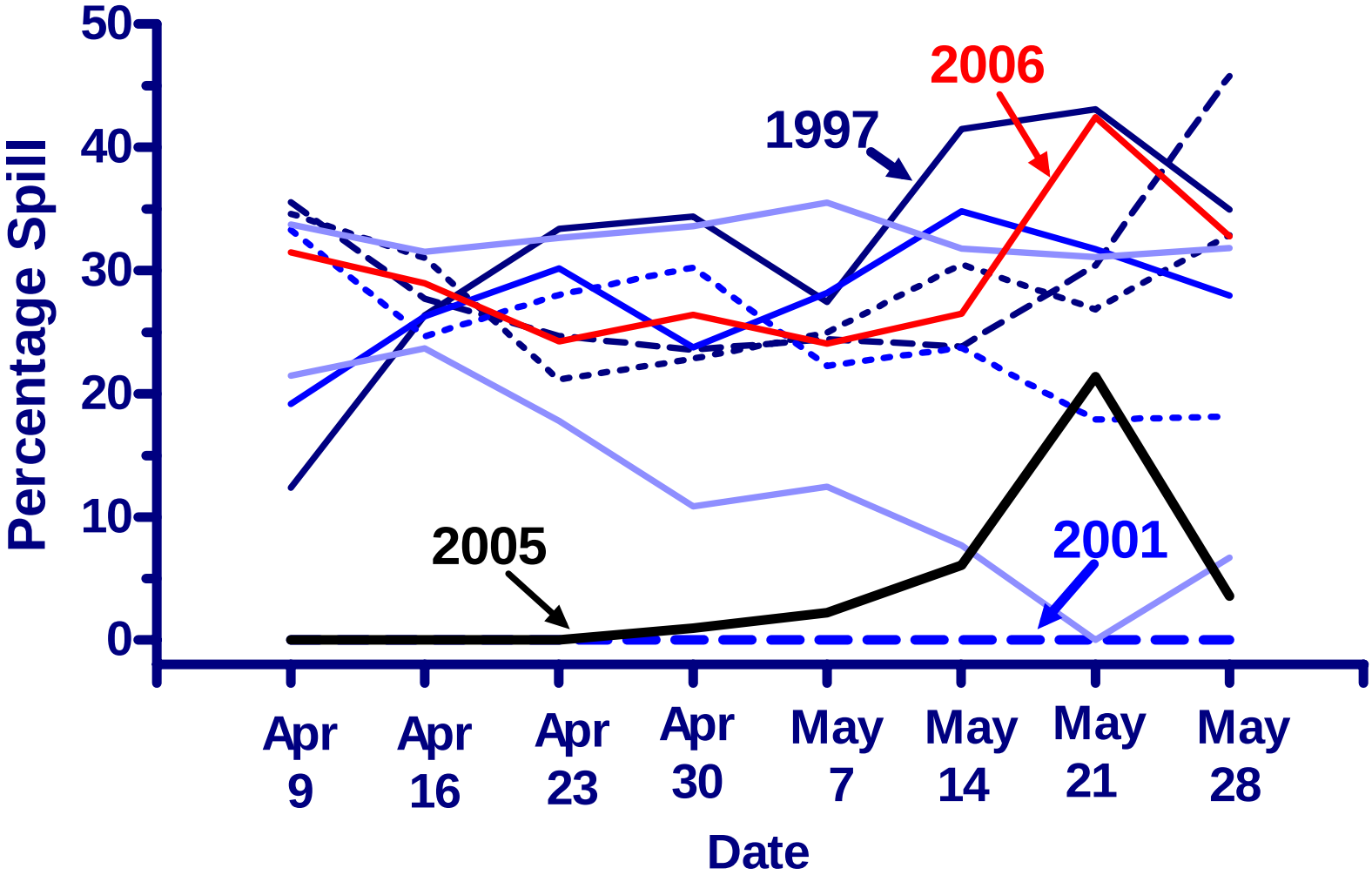
# Hatchery stream type Chinook (1993-2006)



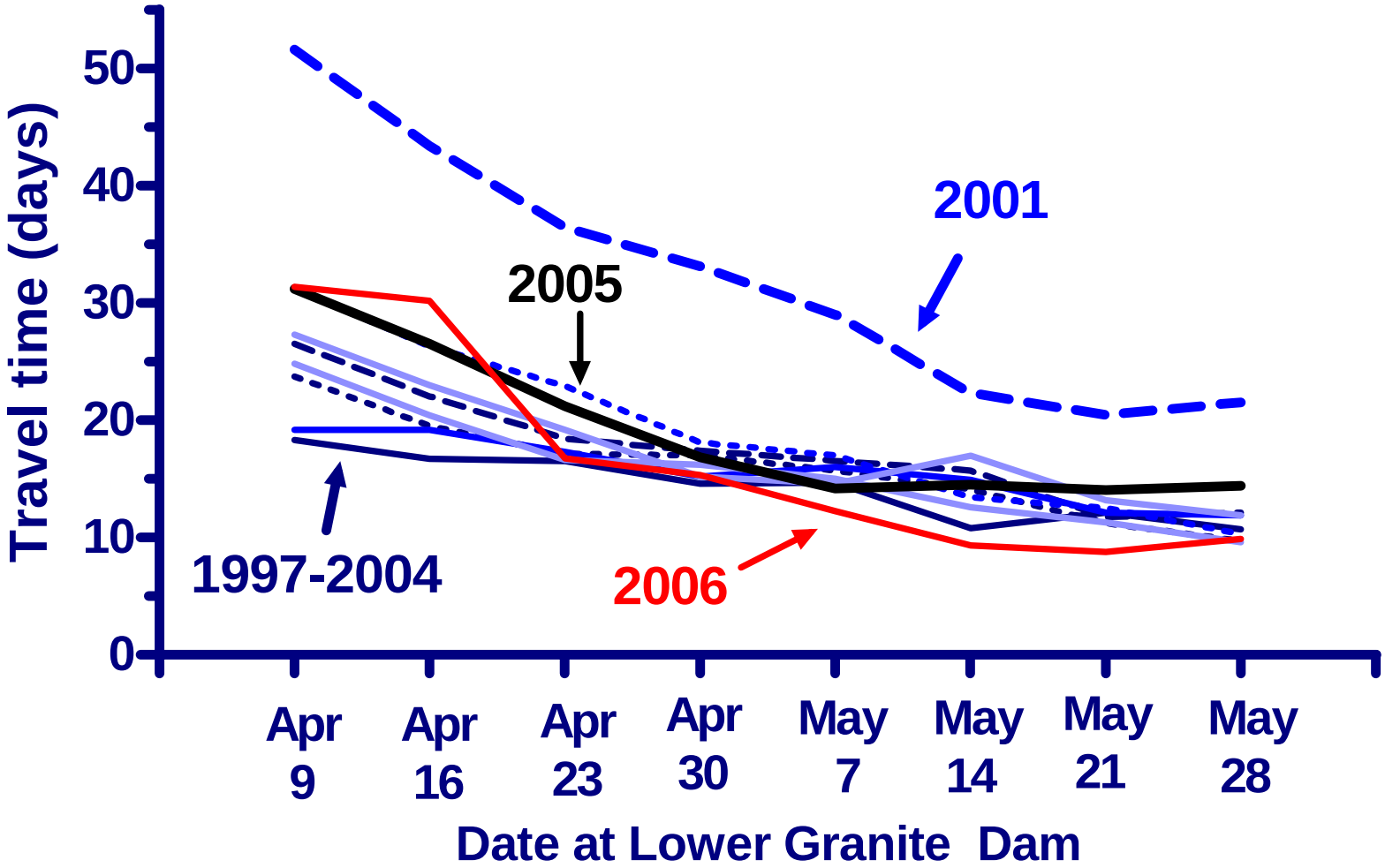
# Stream type Chinook
# All Snake River Basin hatcheries combined



# Mean Percentage Spilled
# LGR, LGS, LMN



# Median travel time Stream type Chinook
# Lower Granite to Bonneville (461 km)



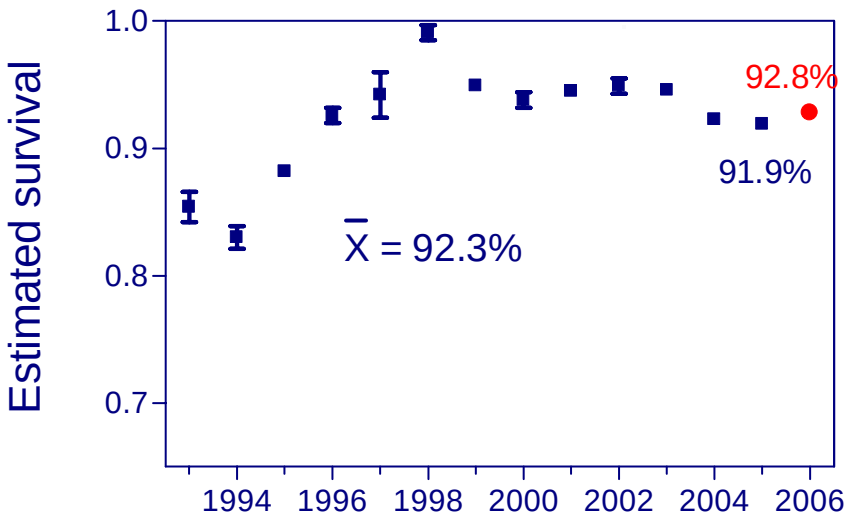
# Most non-tagged fish are transported

In non-spill years – 96 to 99%

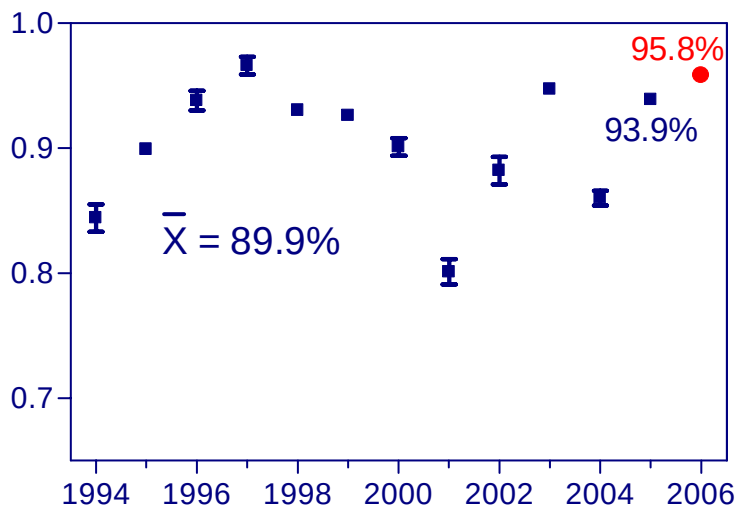
In spill years – 60 to 80%

## Lower Granite to Little Goose

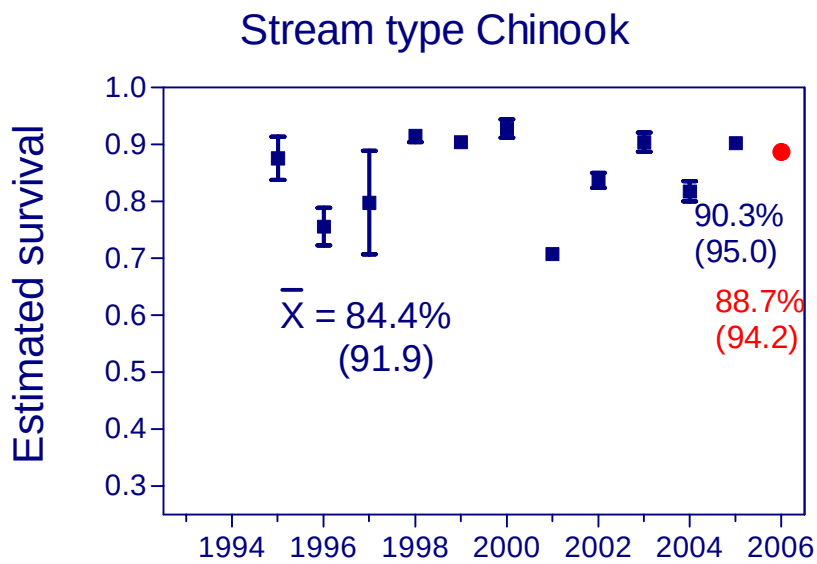
### Stream type Chinook

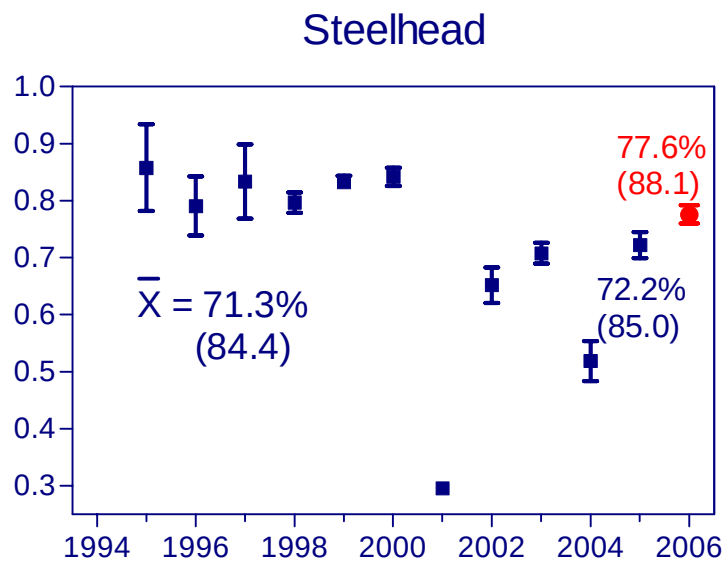



### Steelhead



## Lower Monumental to McNary



Wells

Rocky Reach

Rock Island

Wanapum

Priest Rapids

Crescent Island

Ice Harbor

Lower Monumental

Little Goose

Lower Granite

McNary

Bonneville

The Dalles

John Day

Hells Canyon

Oxbow

Brownlee

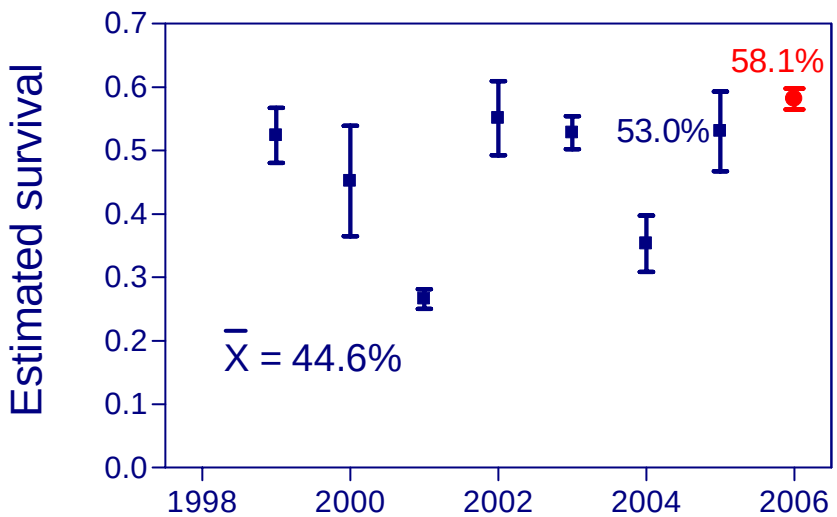
# Lower Monumental-McNary Survival Partitioned in 2006

- Chinook Salmon
  - LMN-MCN 0.887 (0.004)
    - Lower Monumental to Ice Harbor: 0.914 (0.003)
    - Ice Harbor to McNary Dam: 0.964 (0.005)

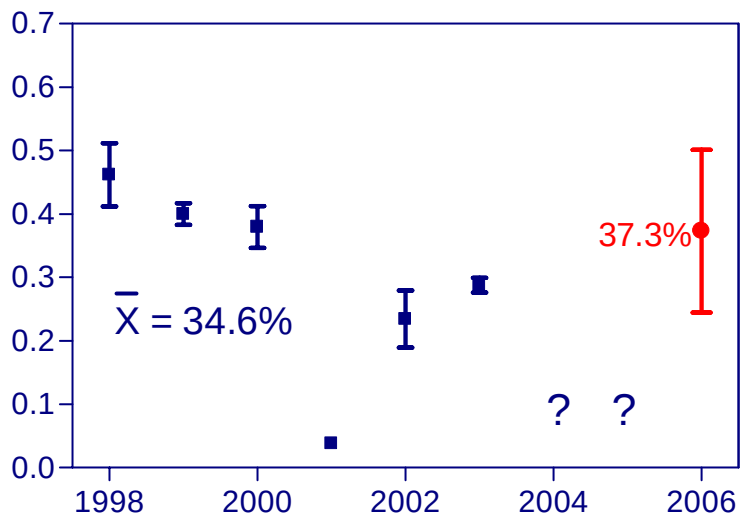
- Steelhead
  - LMN-MCN: 0.776 (0.016)
    - Lower Monumental to Ice Harbor: 0.913 (0.010)
    - Ice Harbor to McNary Dam: 0.863 (0.018)

## Snake River Trap to Bonneville

### Stream type Chinook

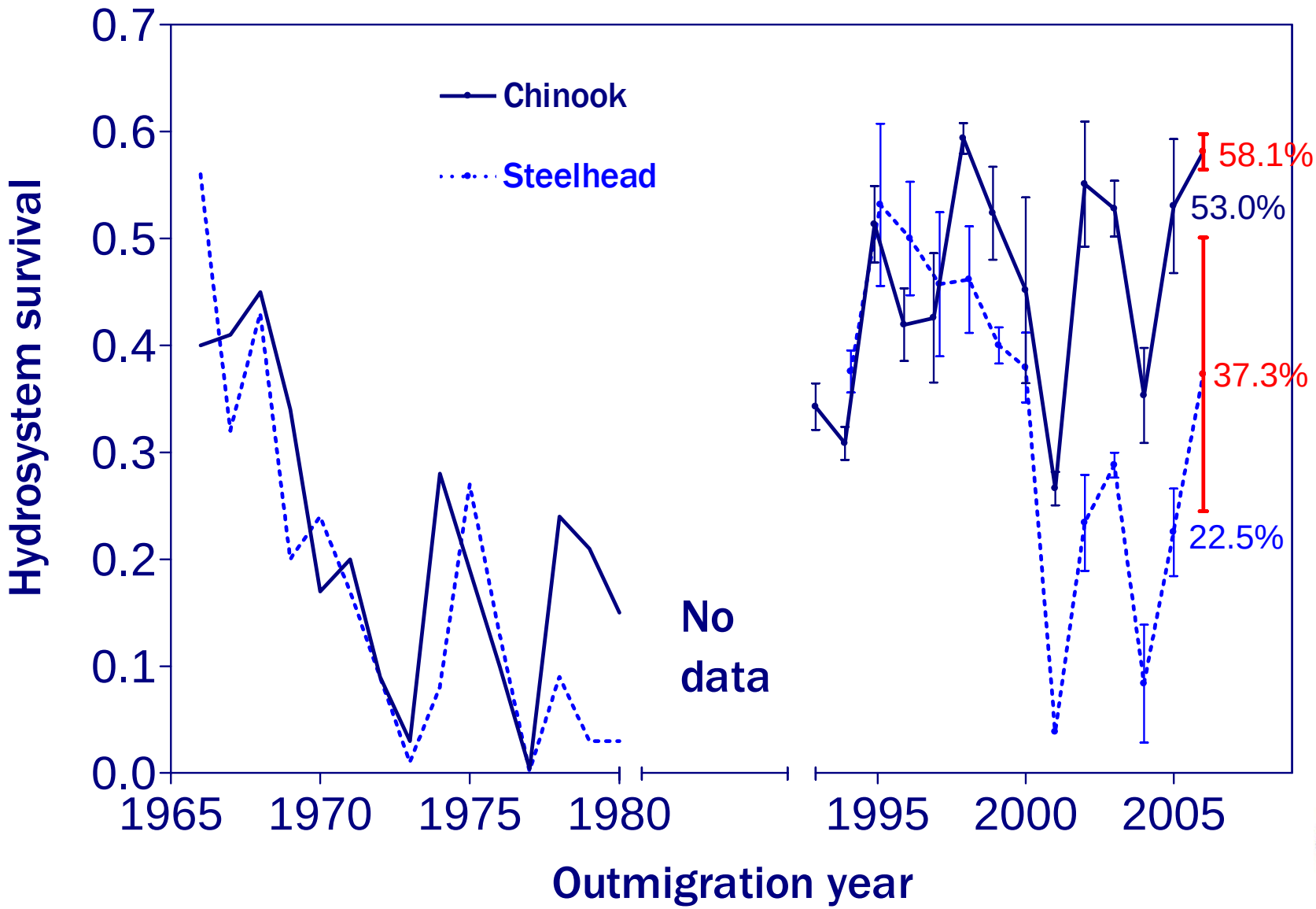



### Steelhead



# Snake River Trap to Bonneville Dam Tailrace

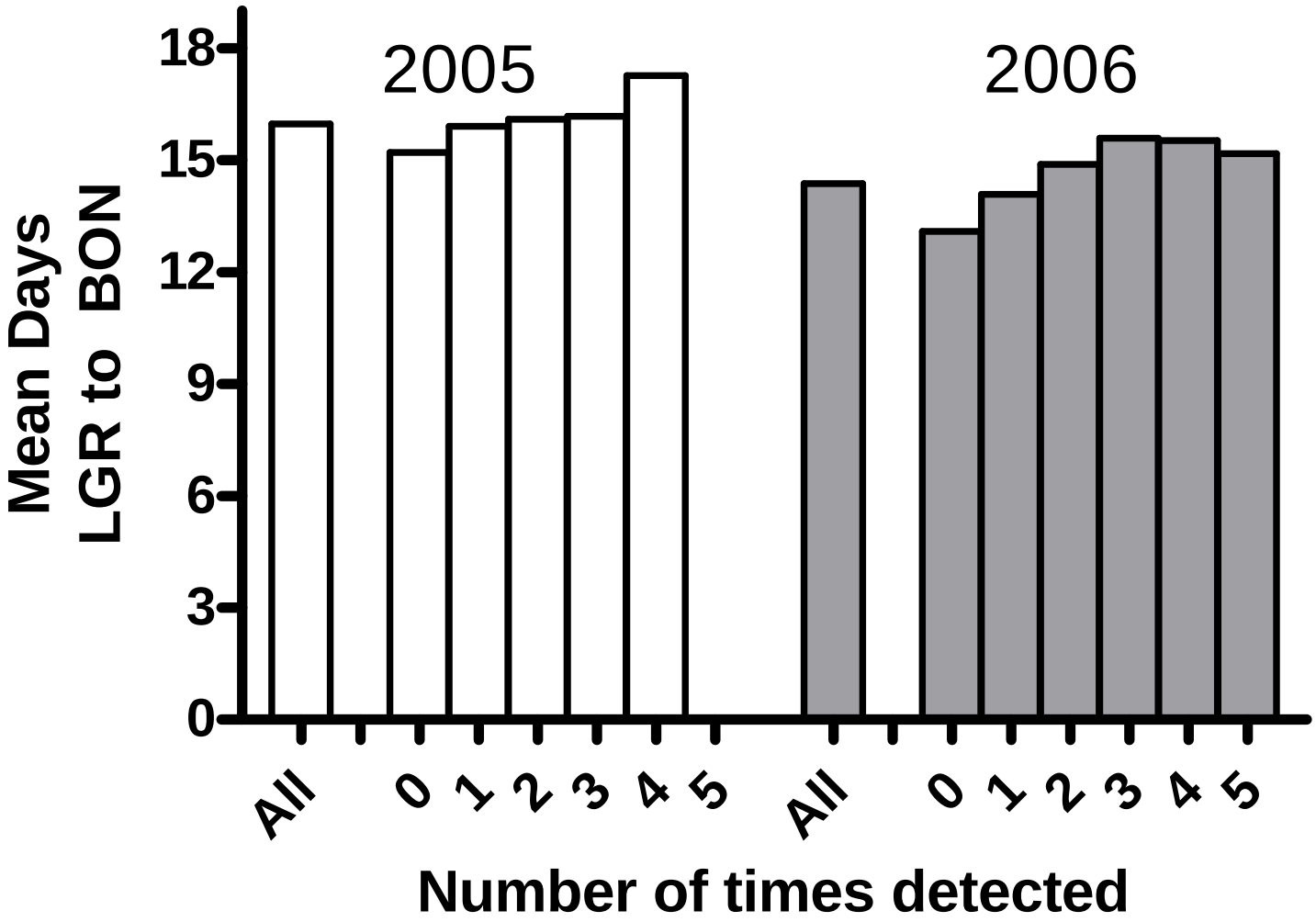
## Per-project expansion in some years



# Flow/Travel Time/Survival etc.

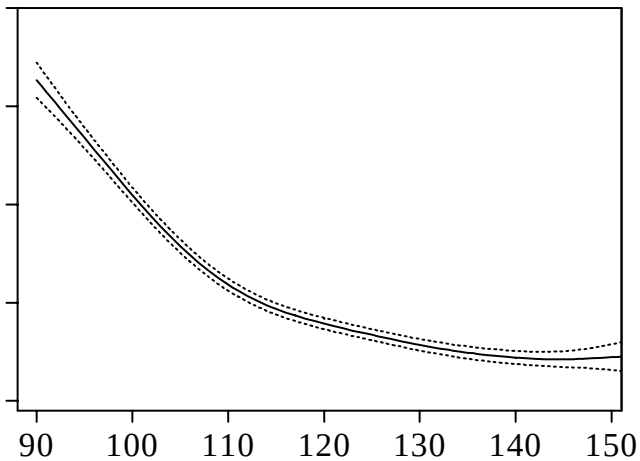
# Likelihood of Improvements

# LGR-BON Travel Time by number of detections

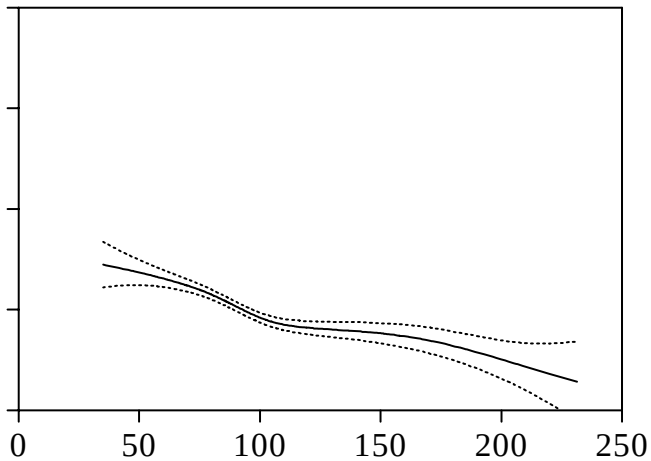


# Stream type Chinook travel time
# Relative influence of date and flow

## Date

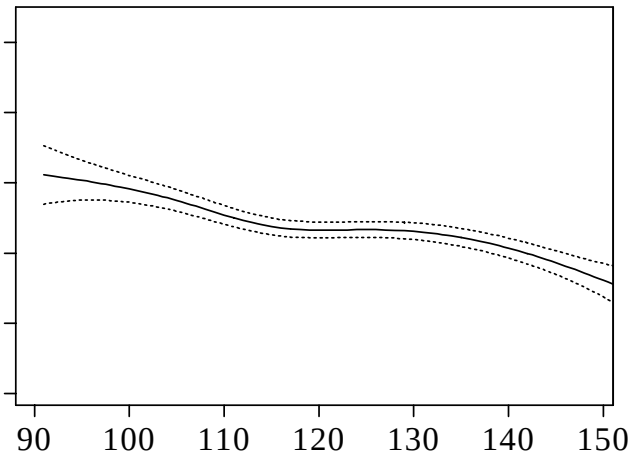



## Flow

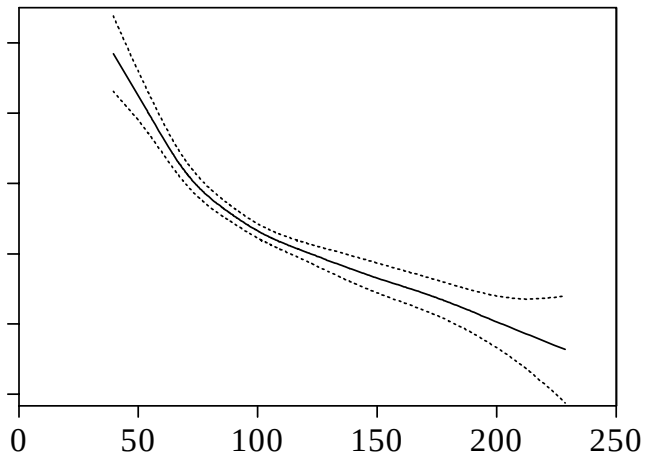


# Steelhead travel time
# Relative influence of date and flow

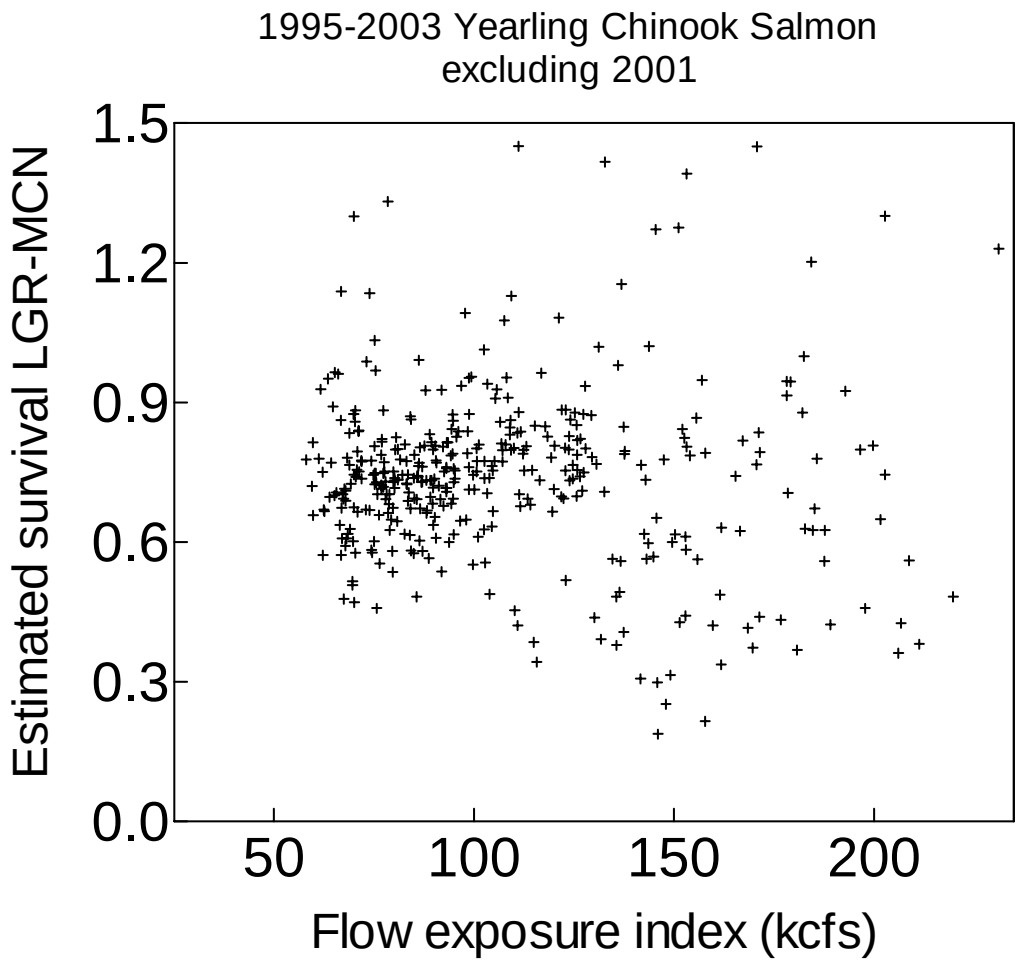
## Date




## Flow



# Stream type Chinook Estimated Survival vs. Flow



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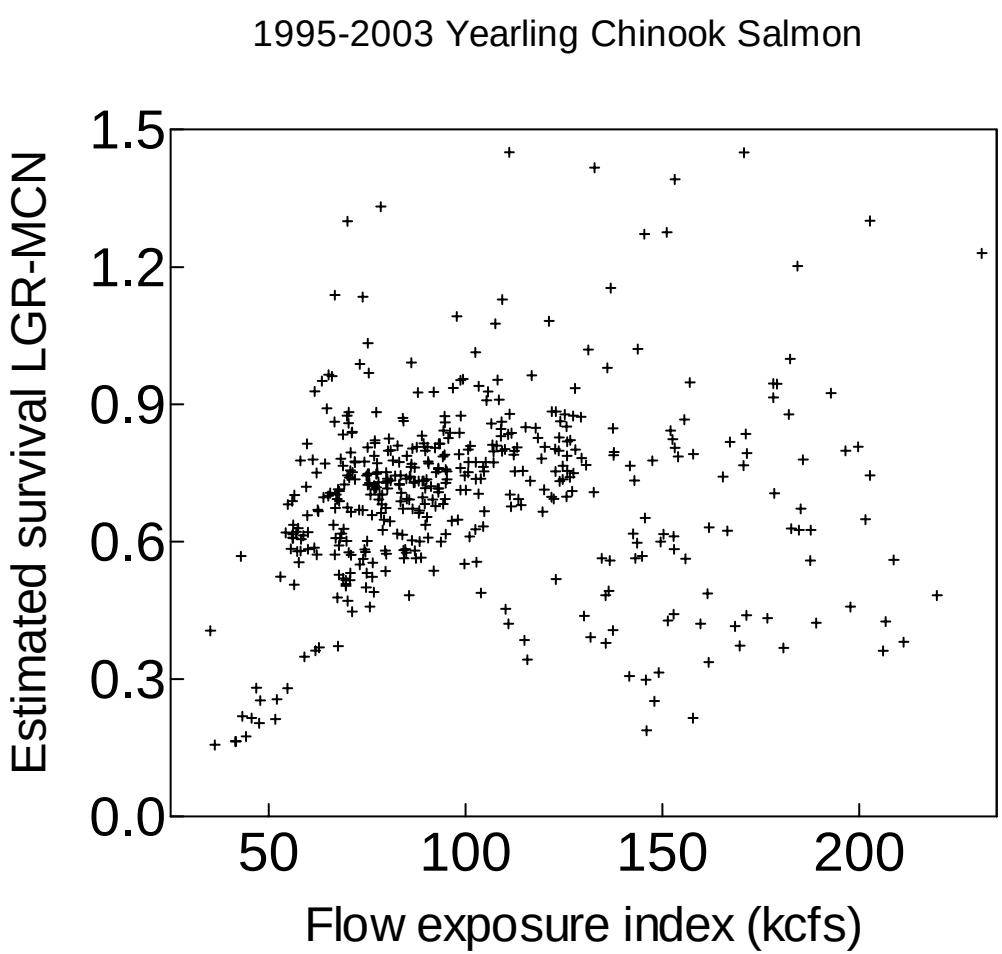

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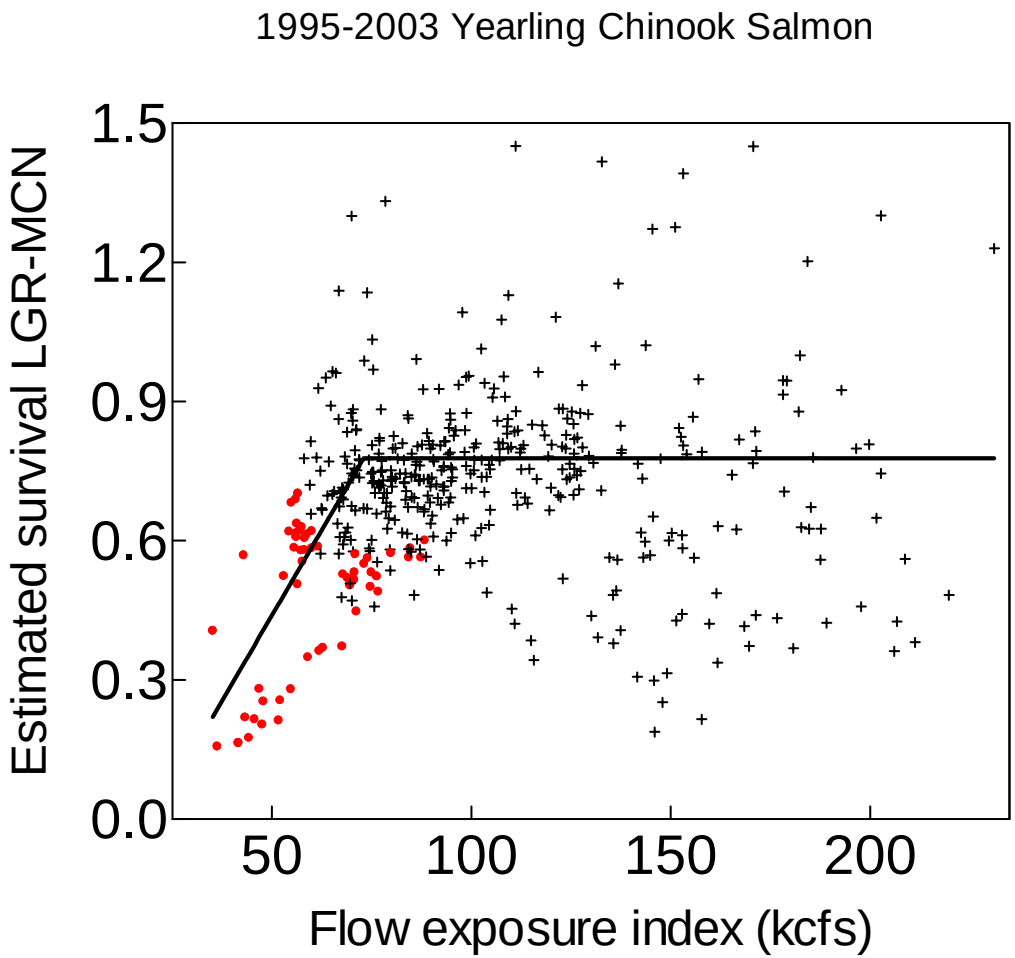
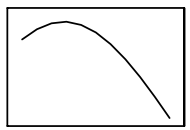
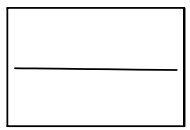
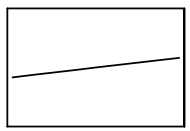


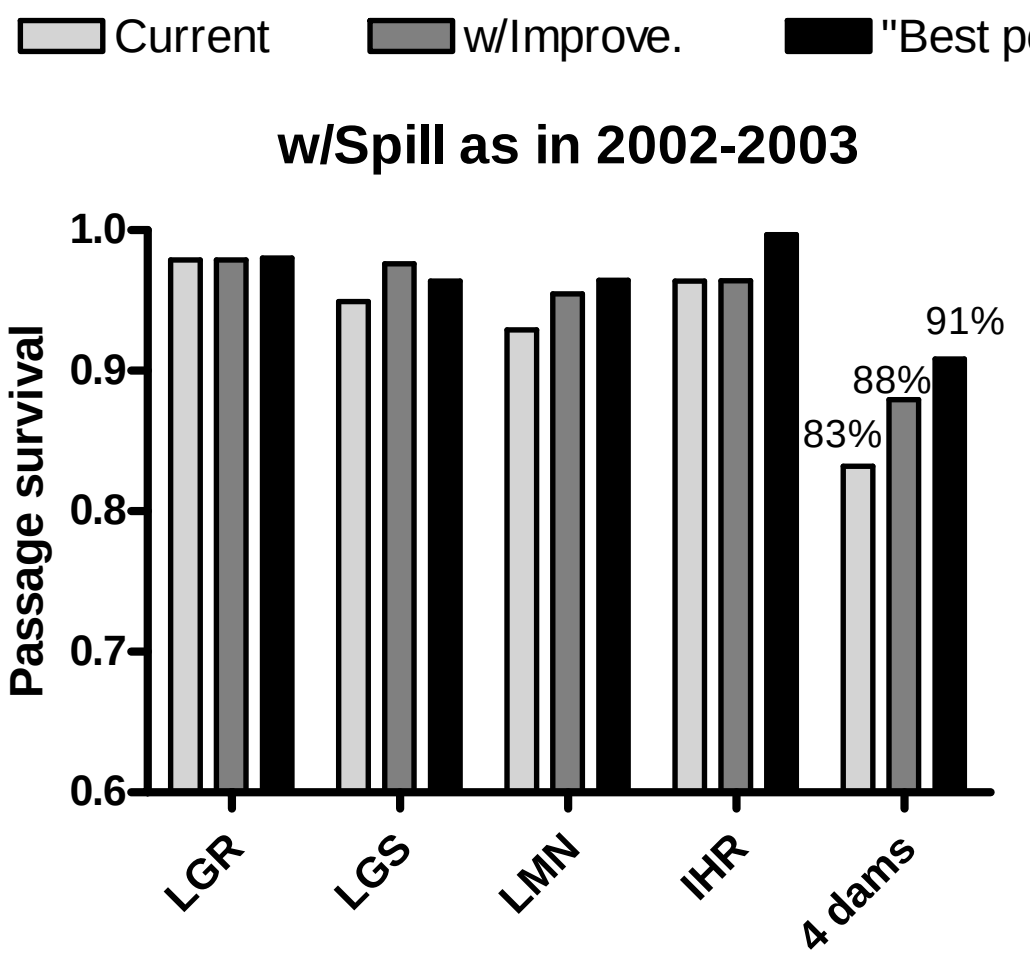
# Analysis of Survival Data for COMPASS Model

- Reach estimates adjusted for dam survival ➔ model reservoir survival only
- Multivariate ➔ flow effect adjusted for temperature and travel time
- Multiple reservoirs ➔ length of reservoir is a predictor

# Analysis of Survival Data for COMPASS Model

- Stream type Chinook Salmon
  LGR-LMN and LMN-MCN
  - Reservoir length 
  - Temperature 
  - Travel Time 
  - Flow 

# Dam Passage Improvements?



# Snake River fall Chinook

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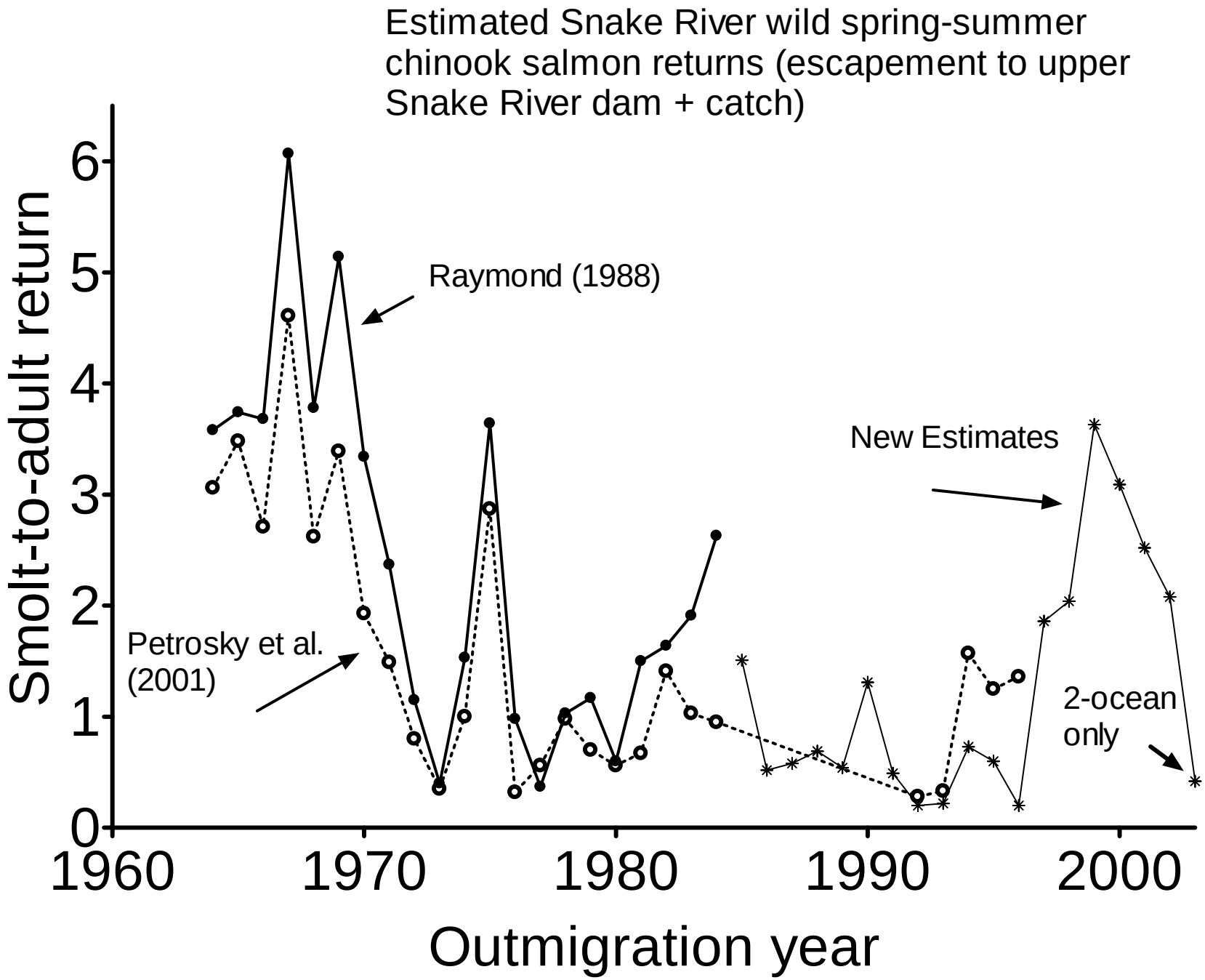
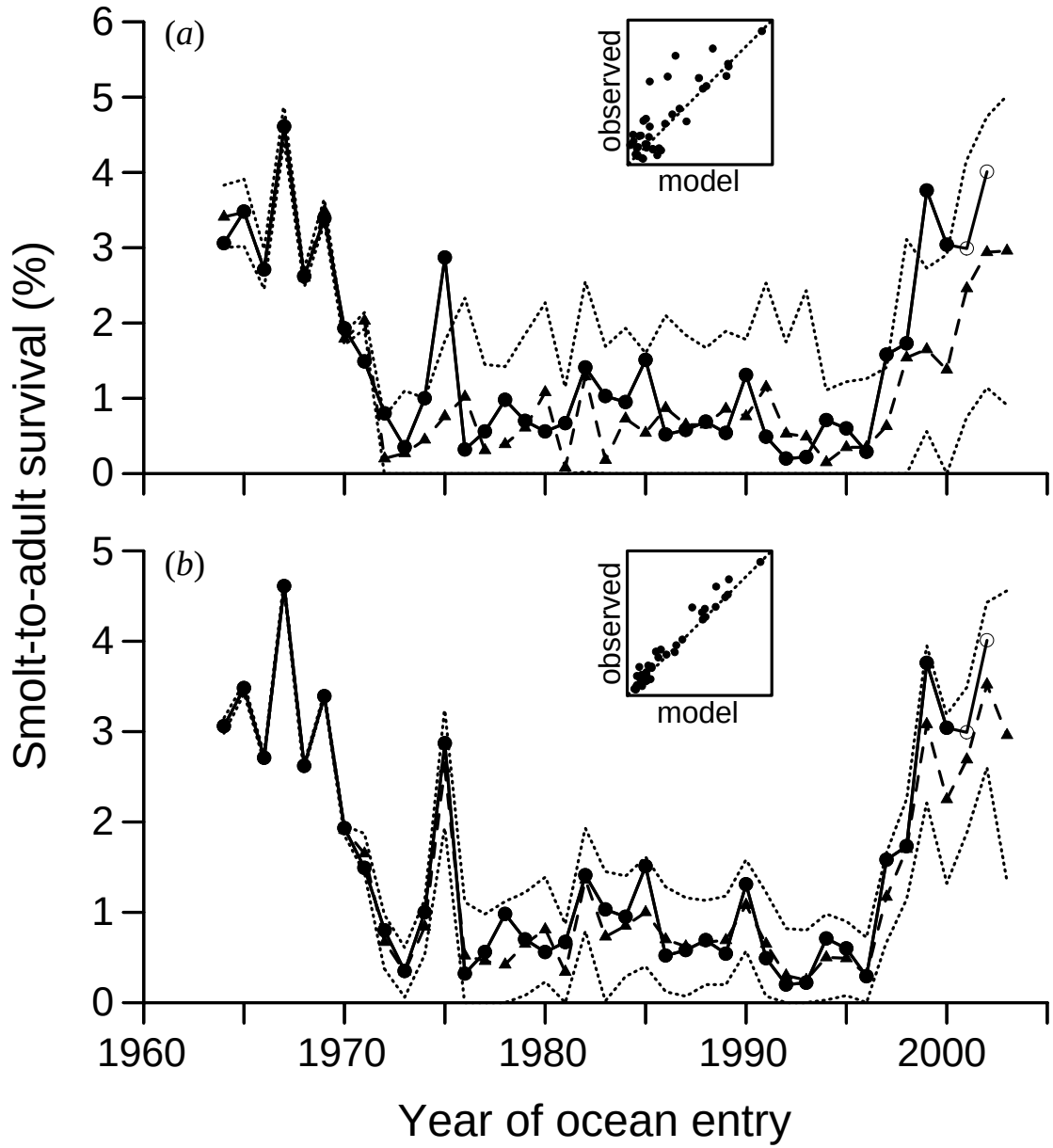
# Snake River fall Chinook

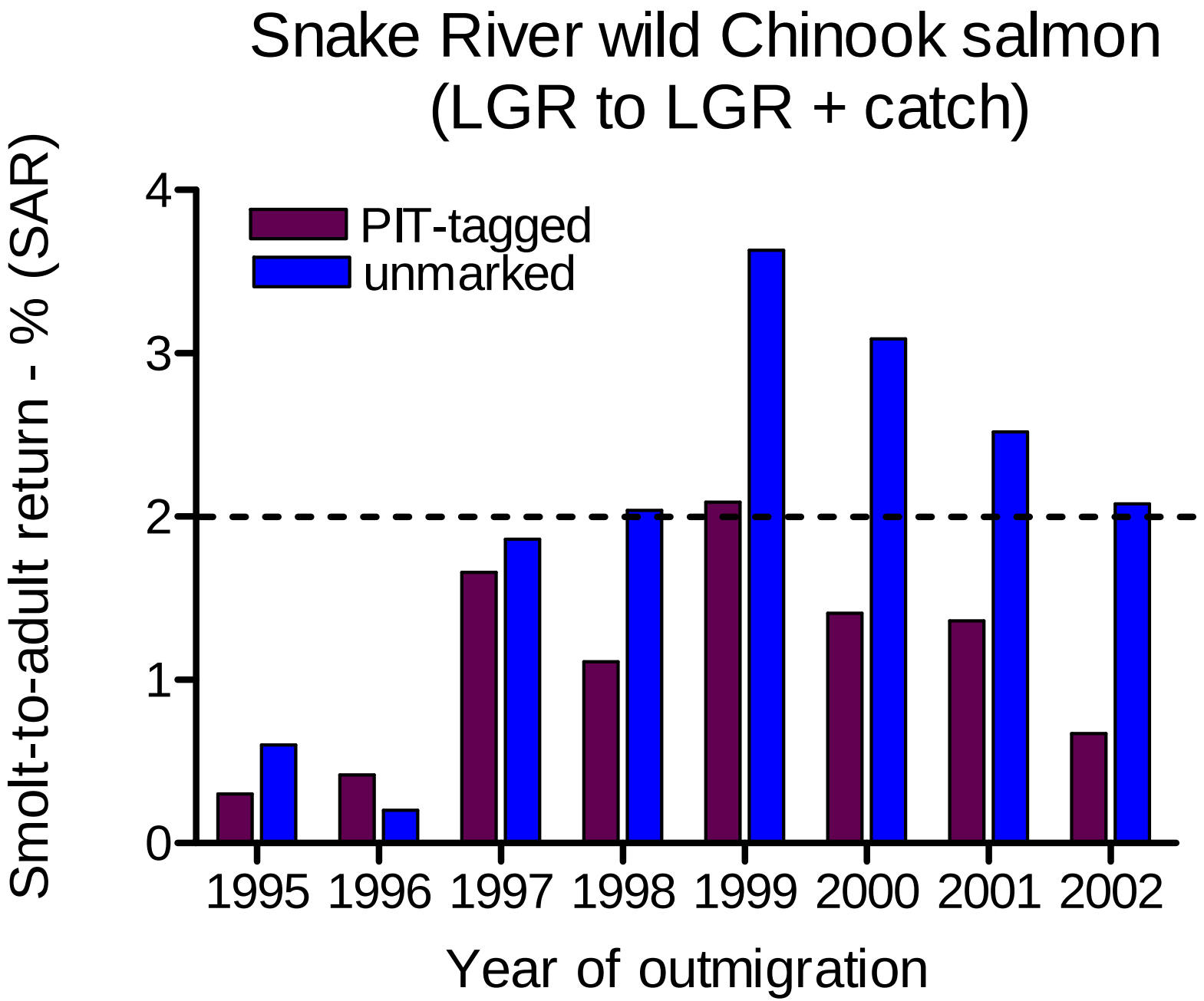
- Most survival data represent conditions that no longer exist
- We have little empirical data downstream of McNary Dam
- Because 50% or greater of the adult returns come from reservoir-type juveniles, we need  adult returns to sort things out

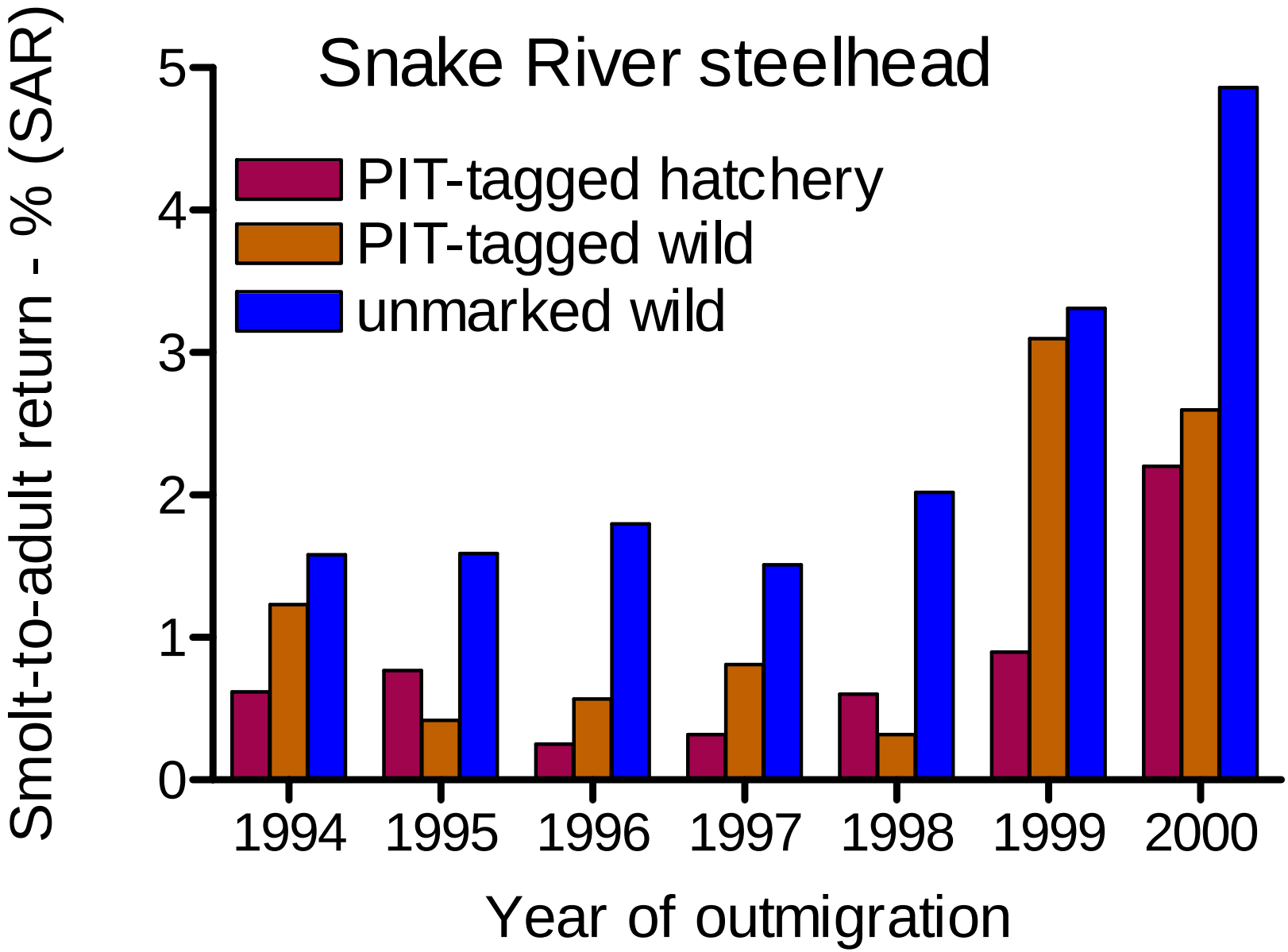
# Smolt-to-Adult Return (SAR) for Spring Migrants


Estimated Snake River wild spring-summer chinook salmon returns (escapement to upper Snake River dam + catch)
Smolt-to-adult return
0
1
2
3
4
5
6
1960
1970
1980
1990
2000
Outmigration year
Raymond (1988)
Petrosky et al. (2001)
New Estimates
2-ocean only

Scheuerell & Williams, Figure 3

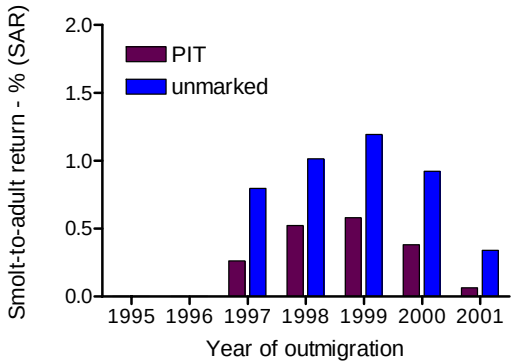



Snake River wild Chinook salmon
(LGR to LGR + catch)
Smolt-to-adult return - % (SAR)
PIT-tagged
unmarked
0
1
2
3
4
1995
1996
1997
1998
1999
2000
2001
2002
Year of outmigration

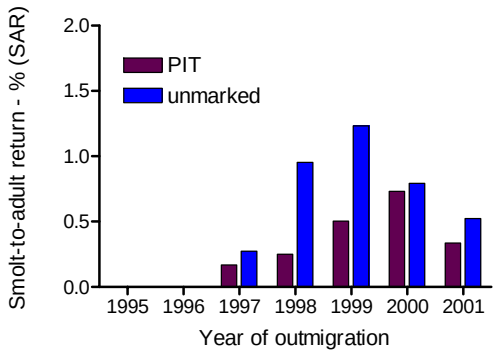

Snake River steelhead
PIT-tagged hatchery
PIT-tagged wild
unmarked wild
Smolt-to-adult return - % (SAR)
0
1
2
3
4
5
1994
1995
1996
1997
1998
1999
2000
Year of outmigration

Hatchery to hatchery SARs - no adjustment for smolt survival to LGR or adult harvest downstream of LGR- Data after 2005 CSS report

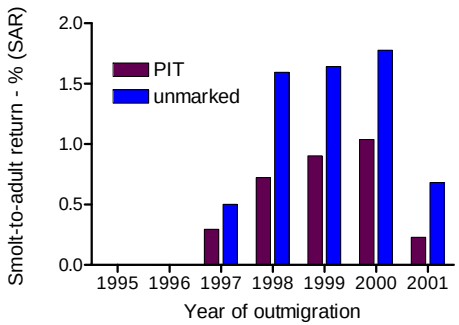
Dworshak Hatchery Chinook salmon *




Rapid River Hatchery Chinook salmon *




McCall Hatchery Chinook salmon *

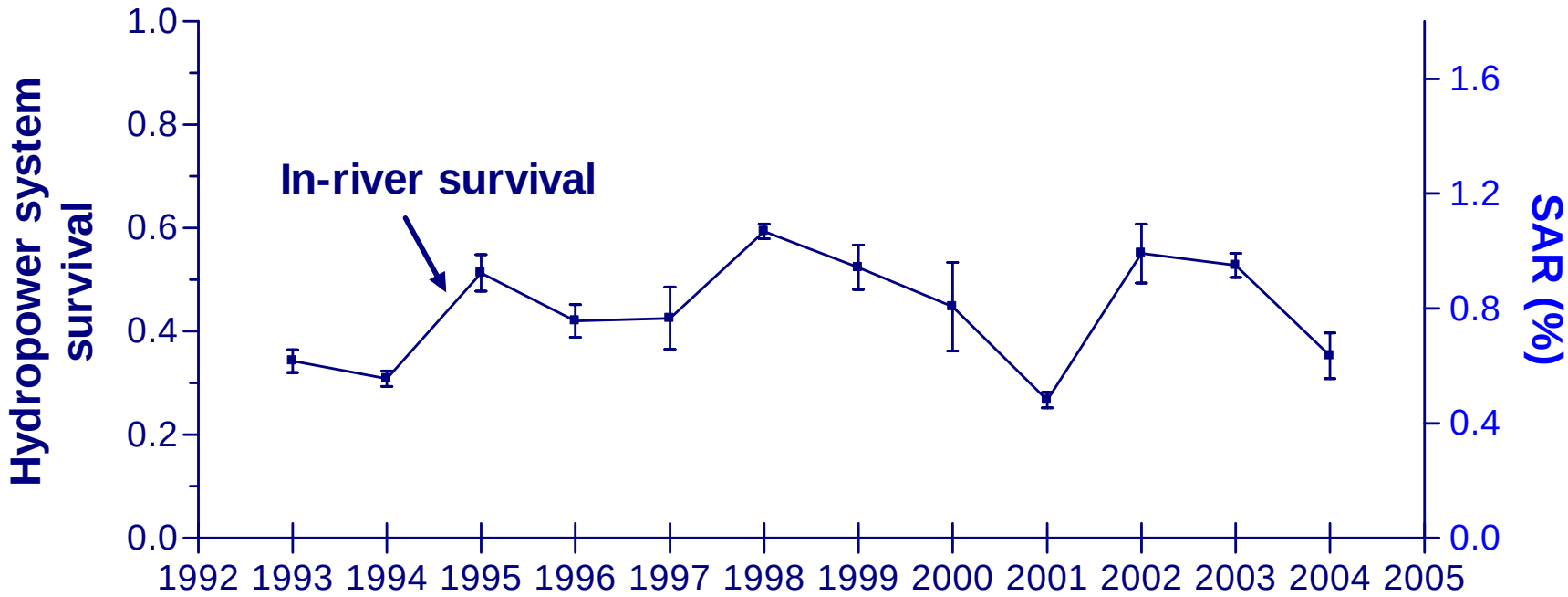



* Includes adjustment for harvest upstream of LGR

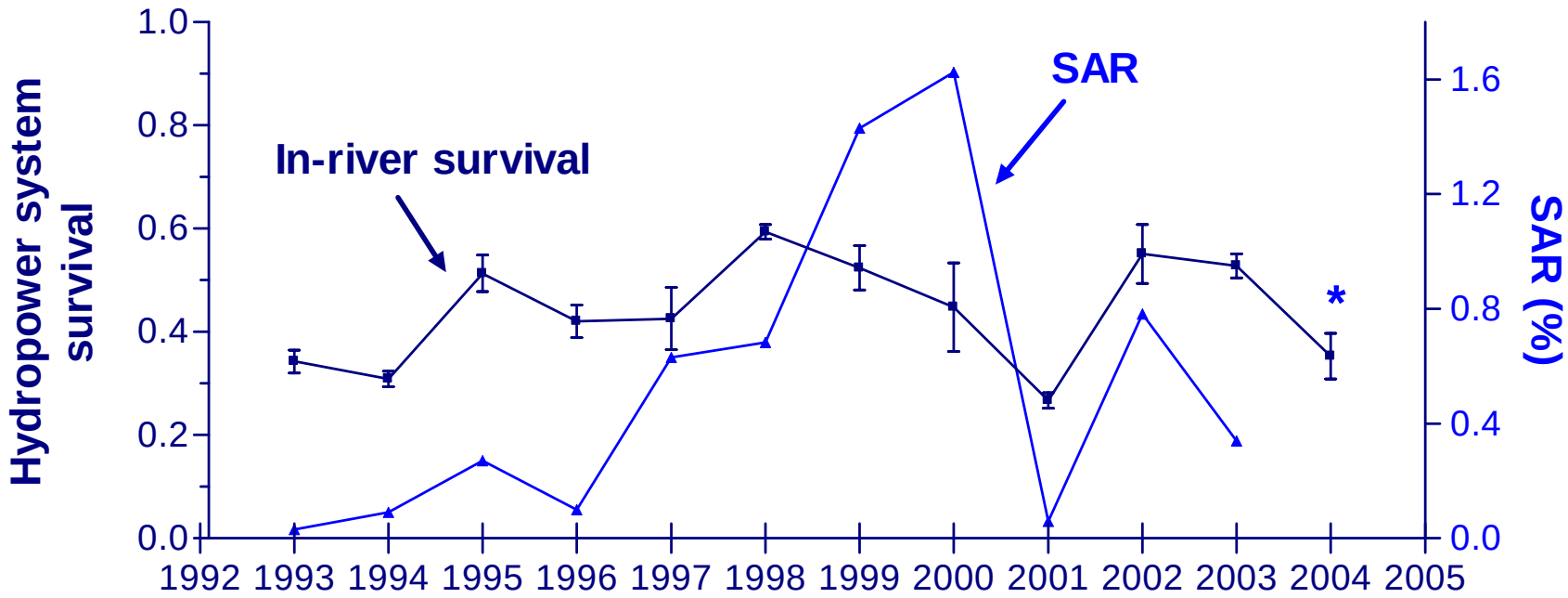
# Potential causes

- Shed or expelled PIT tag
- Tag not read in adult
- Decreased fitness
- Combination of the above

# Yearling chinook salmon

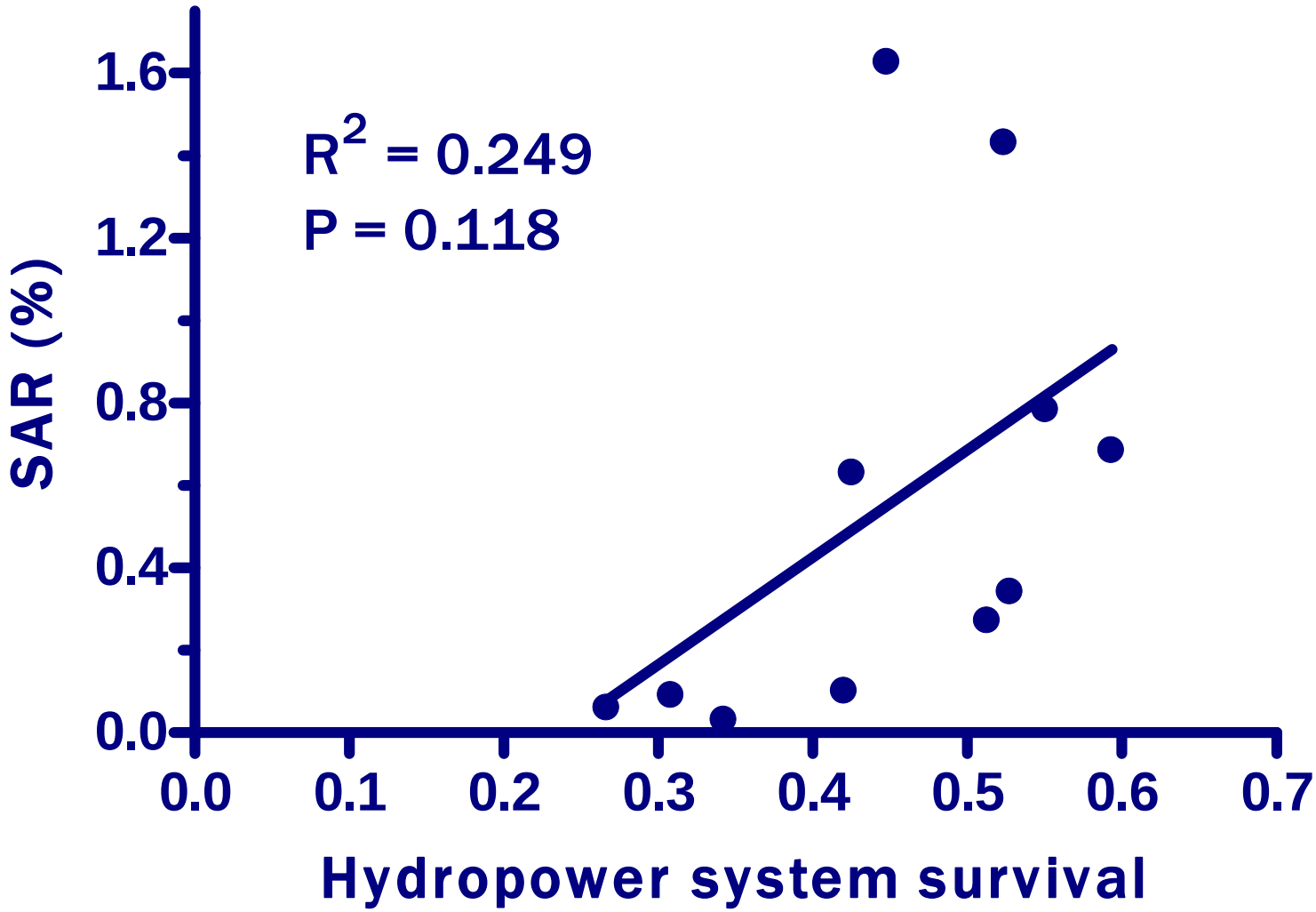


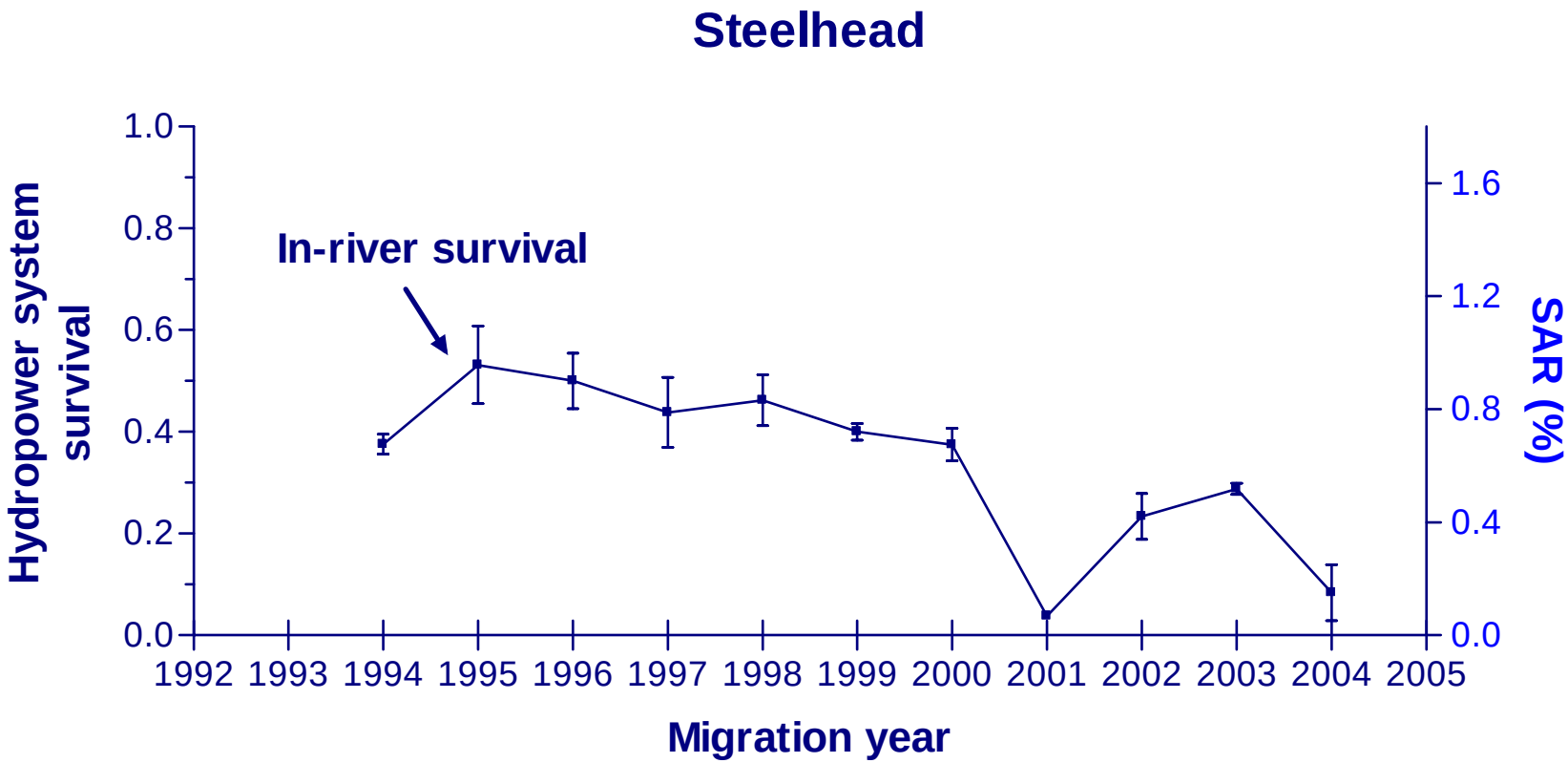
# Yearling chinook salmon

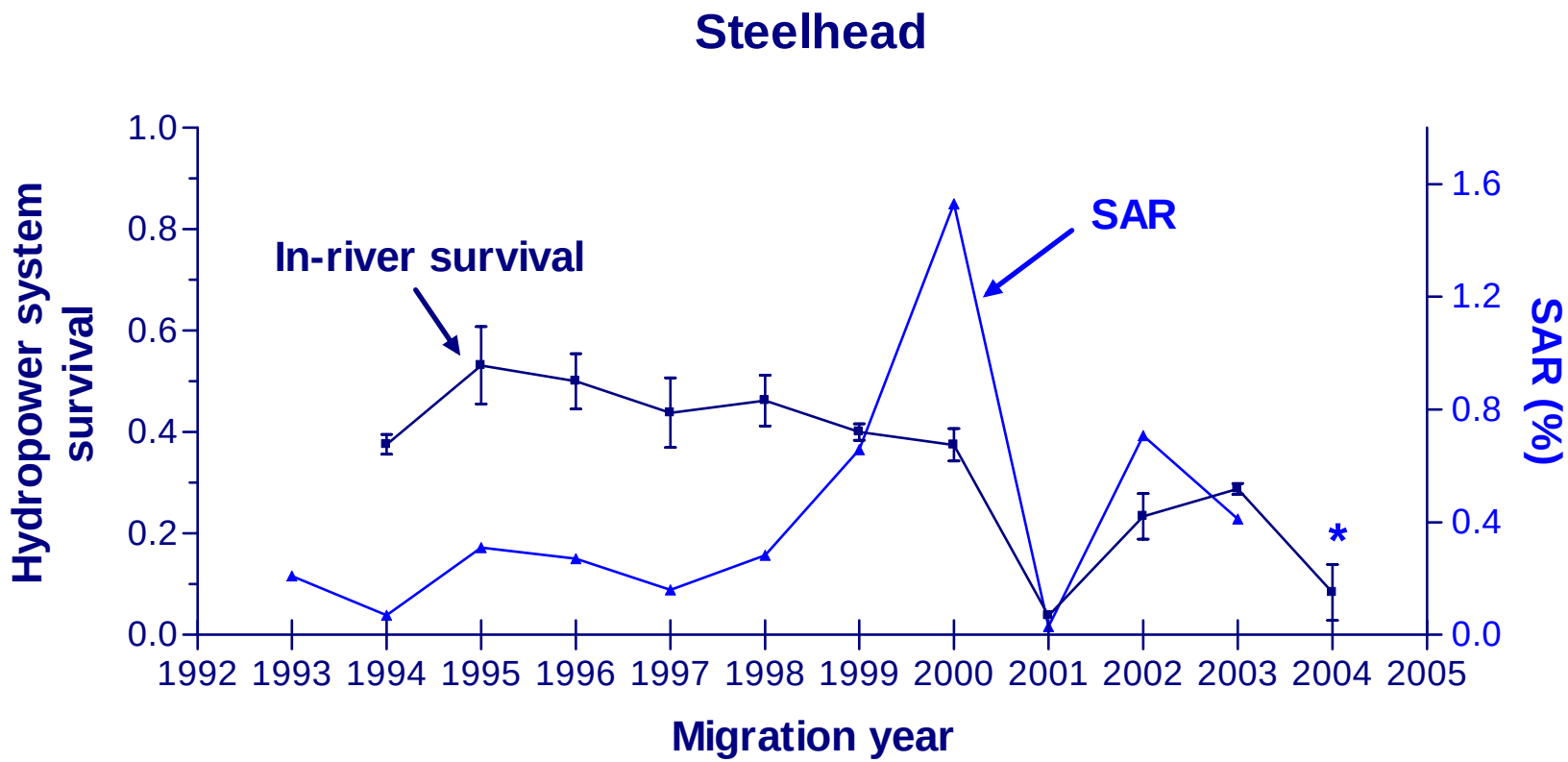



* Incomplete adult returns

# Yearling Chinook

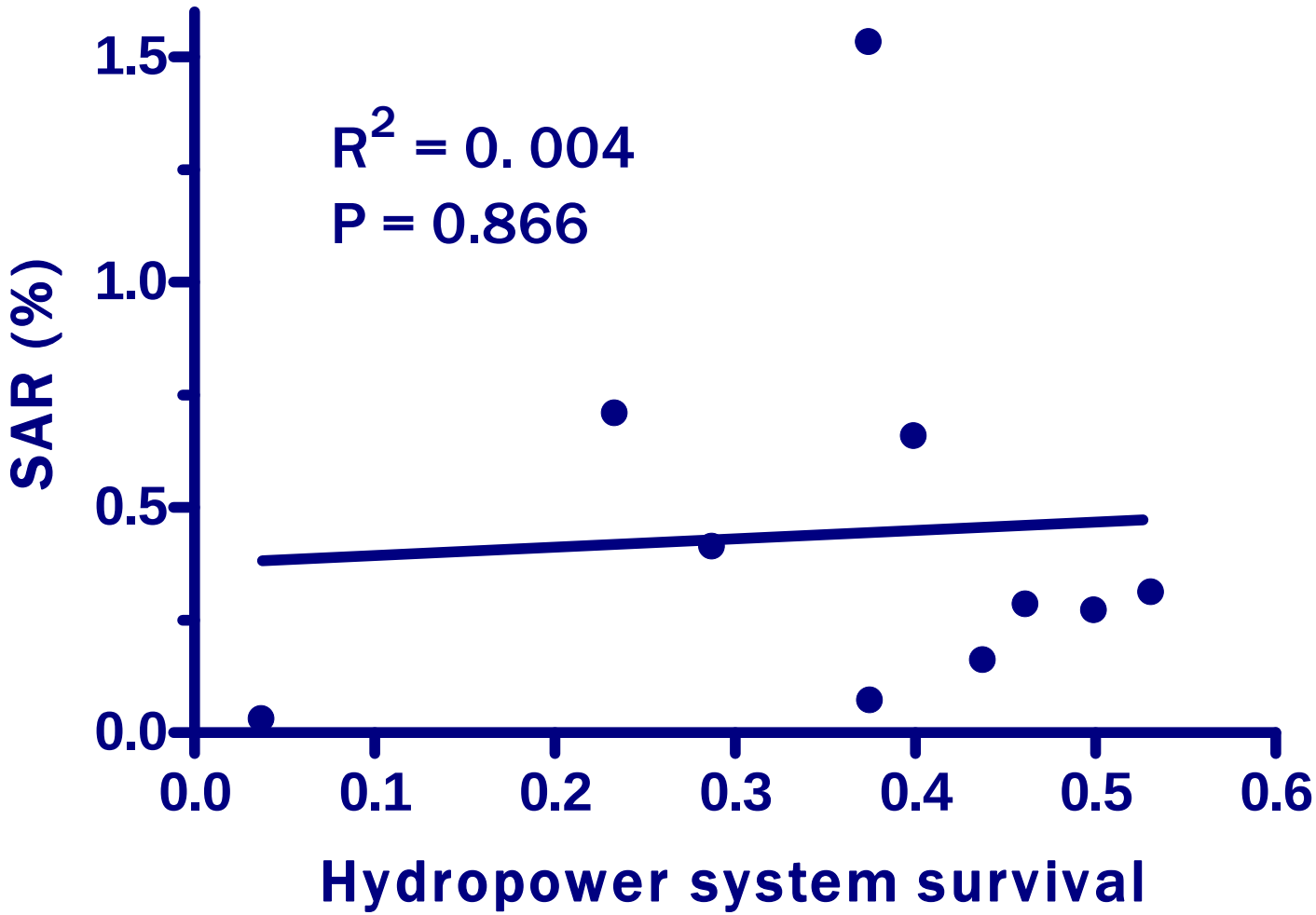



Steelhead
Hydropower system survival
SAR (%)
In-river survival
1.0
0.8
0.6
0.4
0.2
0.0
1.6
1.2
0.8
0.4
0.0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
Migration year

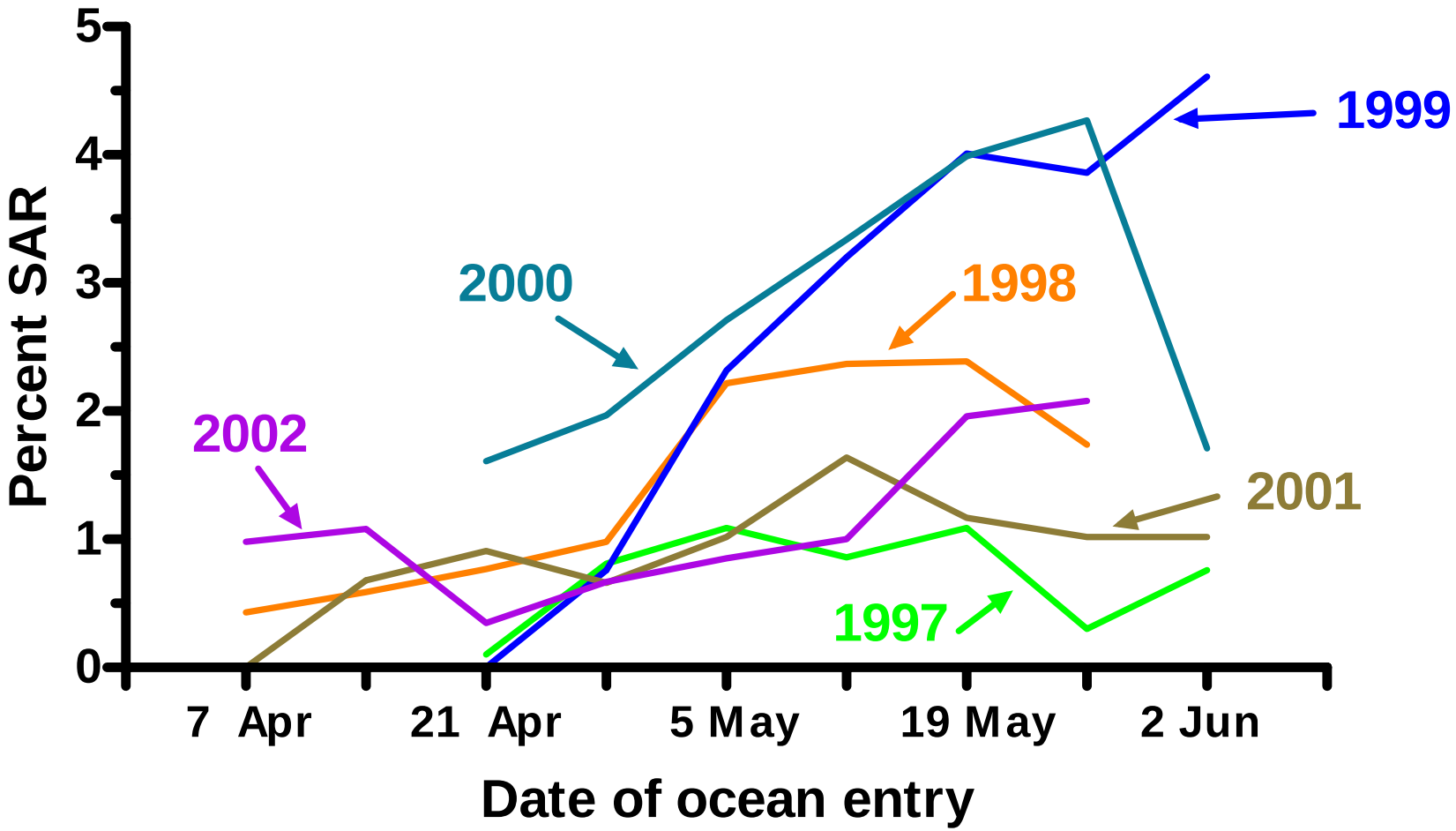


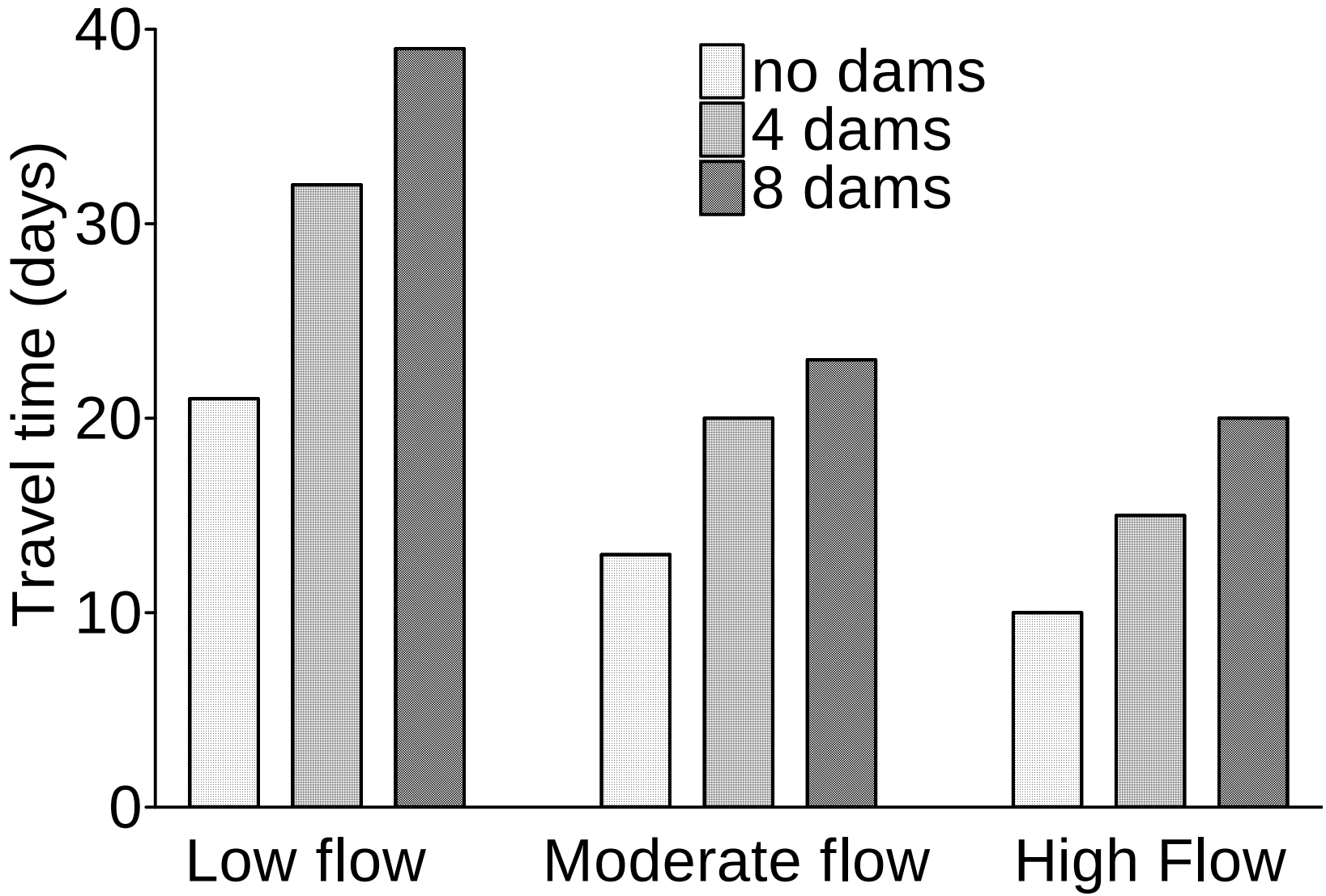

* Adult returns incomplete

# Steelhead


1.5
1.0
0.5
0.0
SAR (%)
$R^2$ = 0. 004
P = 0.866
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Hydropower system survival

# Hatchery Chinook






| | | | |
|---|---|---|---|
| Snake R. | (35-53 kcfs) | (71-106 kcfs) | (106-177 kcfs) |
| Columbia R. | (141-177 kcfs) | (212-318 kcfs) | (353-494 kcfs) |

# How do we reduce travel time?

- Increased flows increase migration rates through the system, but effectiveness is reduced because of reservoirs

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- Migrants tend not to pass through bypass/turbine routes during the day

# How do we reduce travel time?

- Increased flows increase migration rates through the system, but effectiveness is reduced because of reservoirs
- Migrants tend not to pass through bypass/turbine routes during the day
- Migrants will pass through spillways and RSWs during the day

# Research needs/uncertainties

- Continue monitoring travel time and survival with PIT tags

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- Evaluate efforts to decrease travel time through the system

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- Gain a better understanding of latent mortality

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Questions