

Monitoring salmon and steelhead: metrics, models, and management scenario evaluations

Presenter: Steve Haeseker



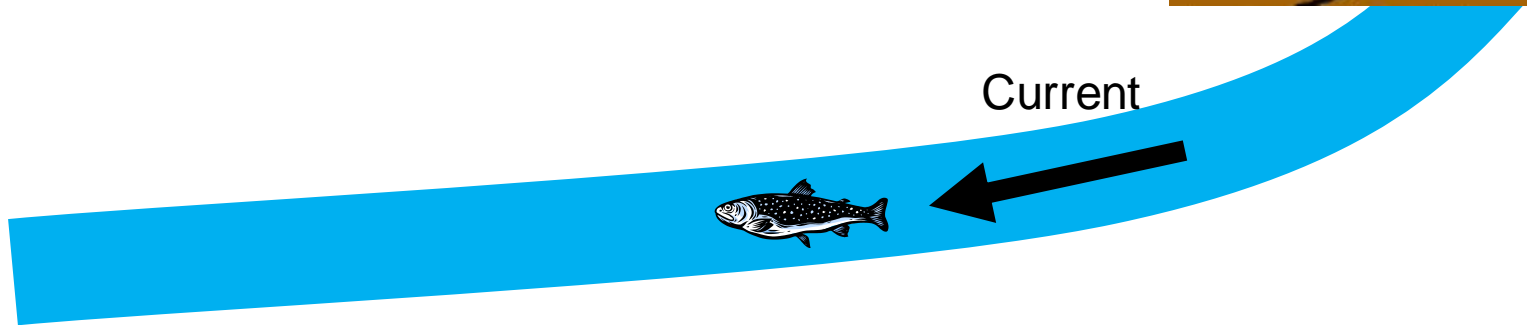
Question: Do smolts generally face upstream or downstream as they migrate to sea?



Current



Ocean



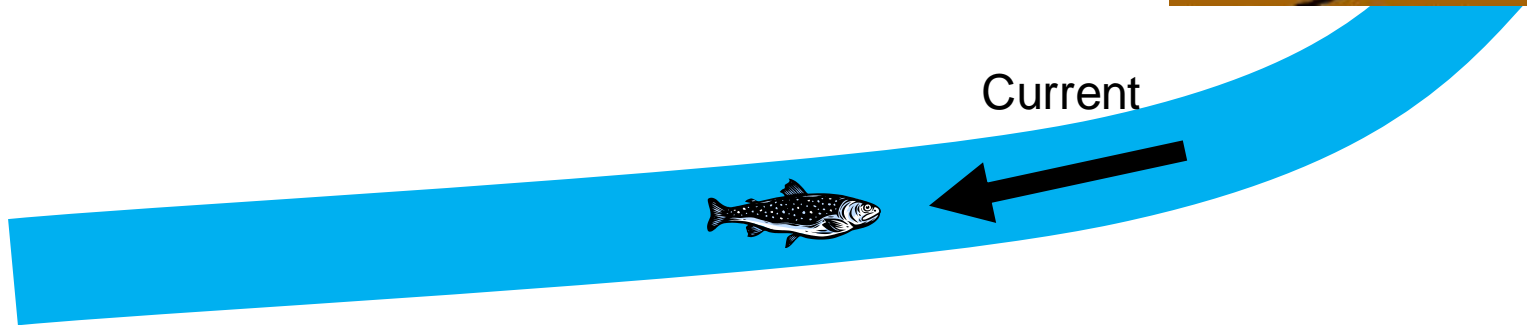
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Current



Ocean

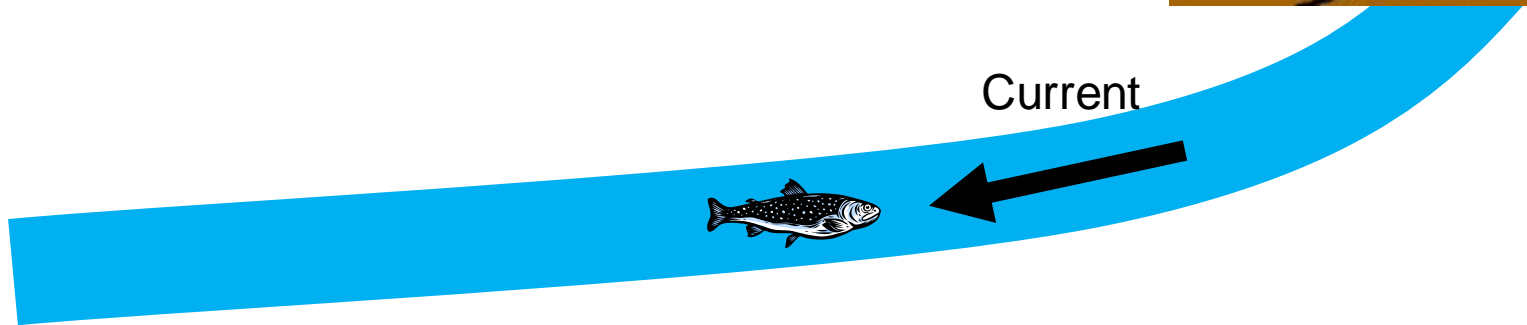


Question: Do smolts generally face upstream or downstream as they migrate to sea?

Answer: upstream



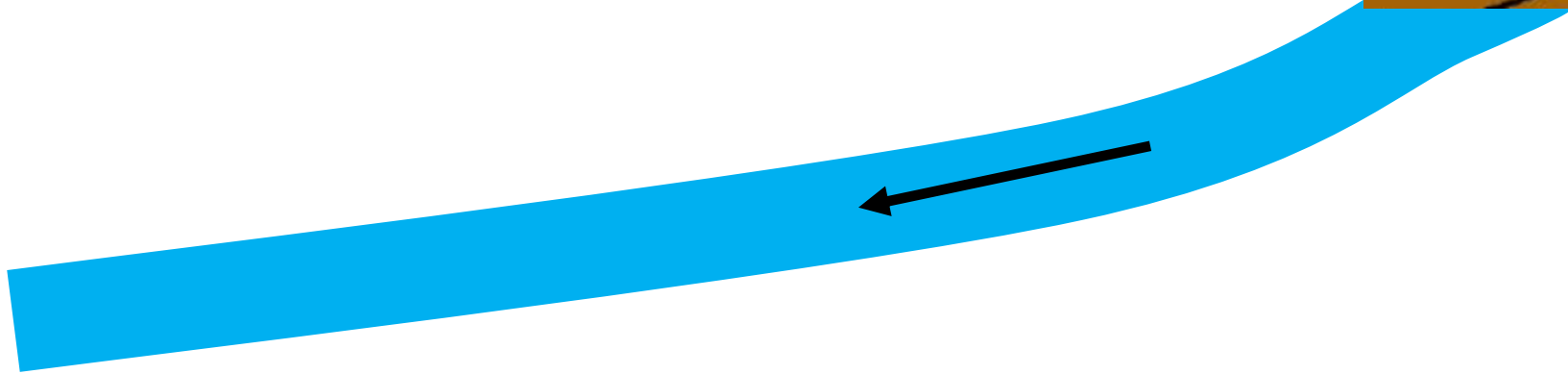
Current



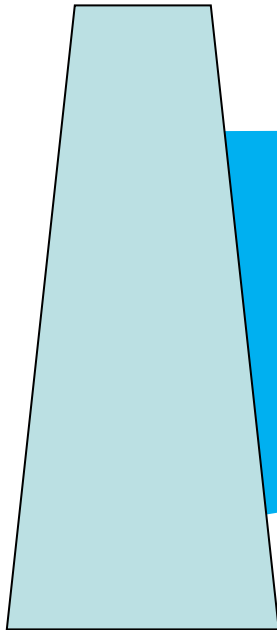
Ocean

How do reservoirs affect the currents that fish rely on?

Current velocity = 7 miles/hour



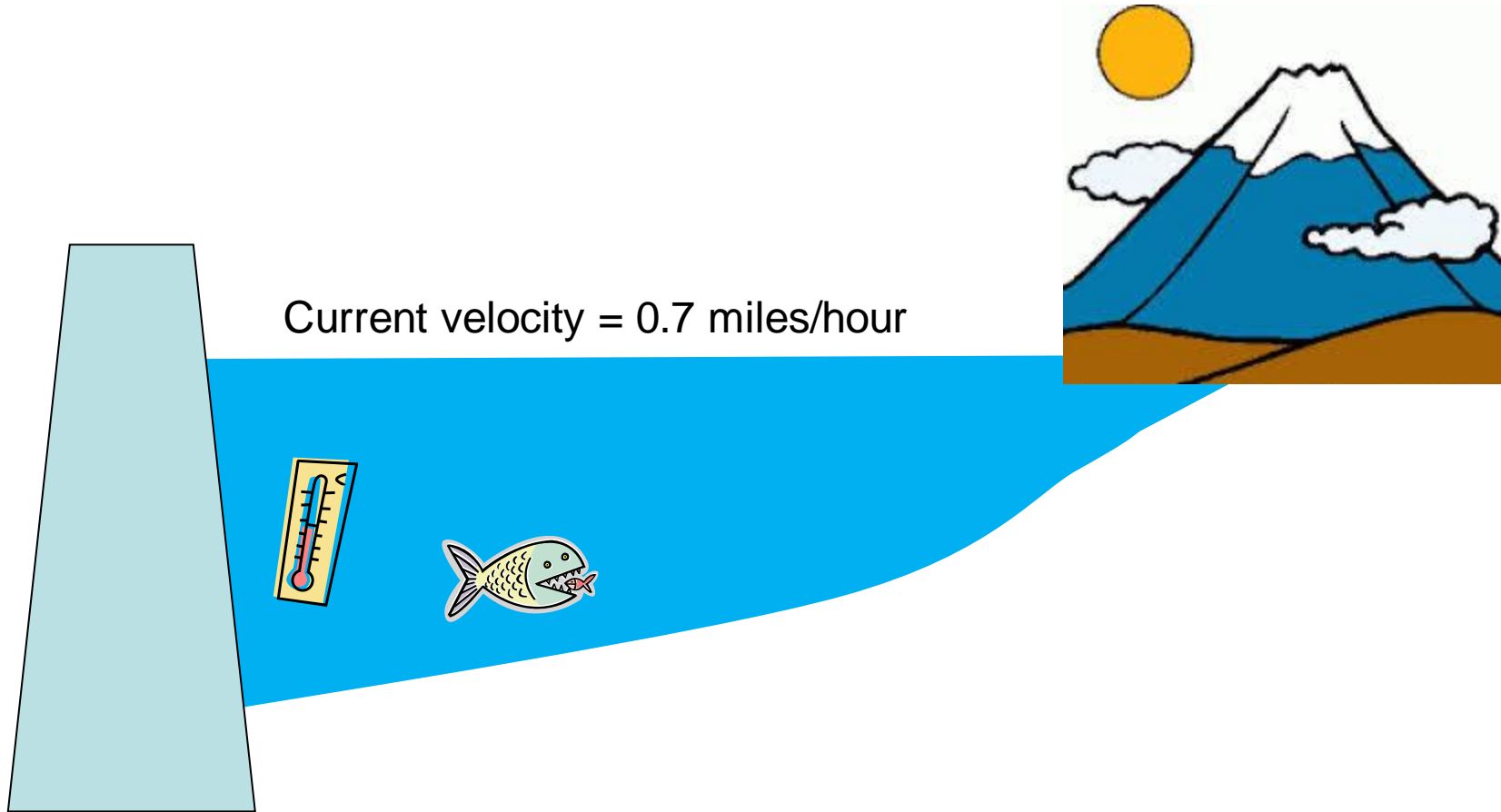
How do reservoirs affect the currents that fish rely on?



Current velocity = 0.7 miles/hour

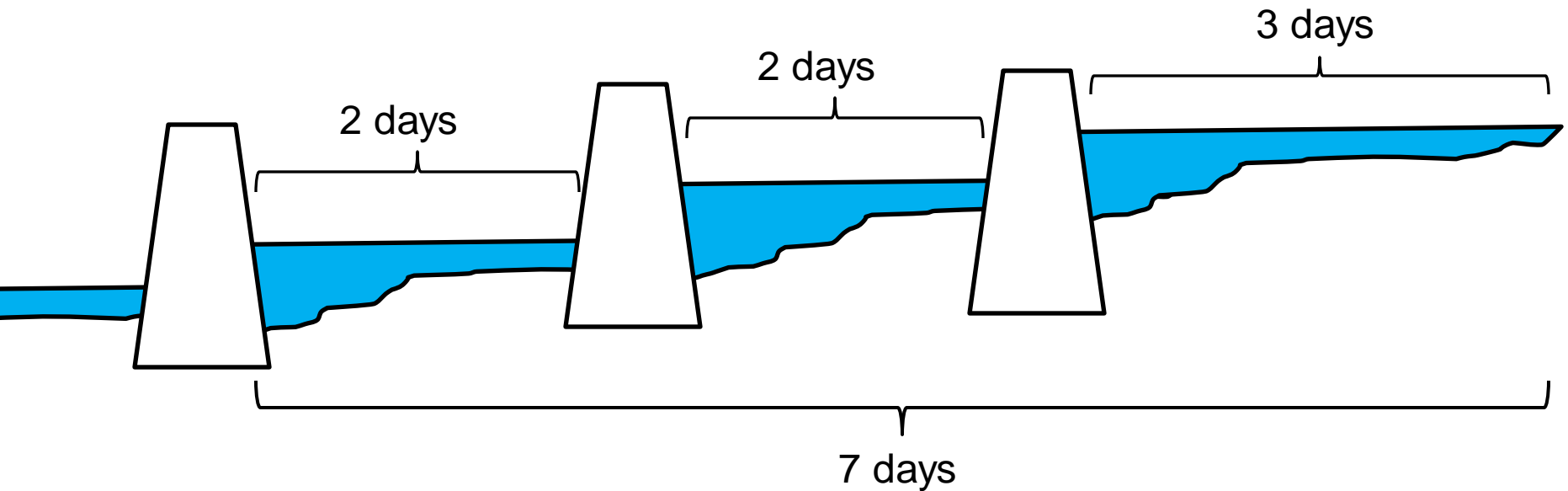


How do reservoirs affect the currents that fish rely on?

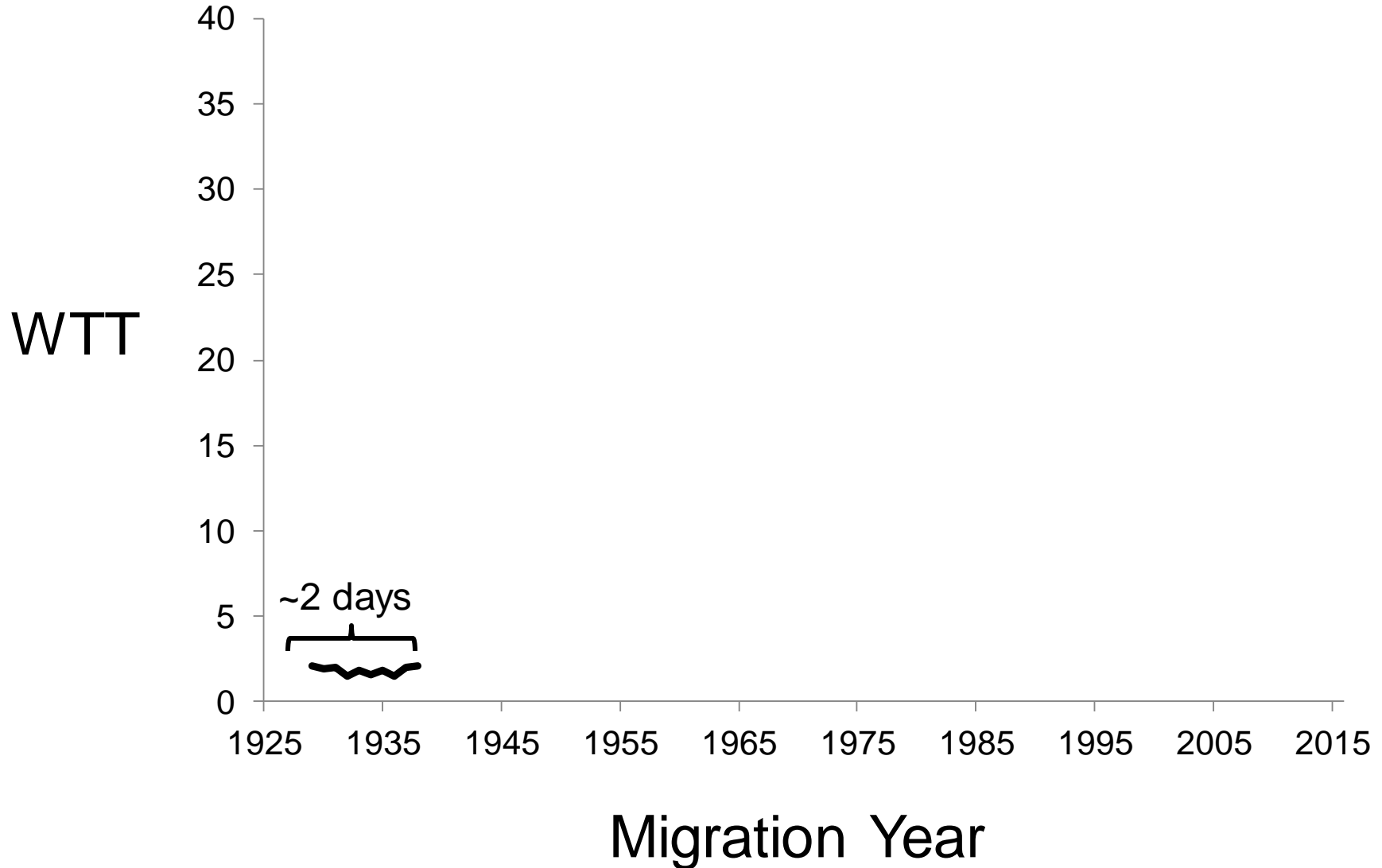


Water Transit Time (WTT)

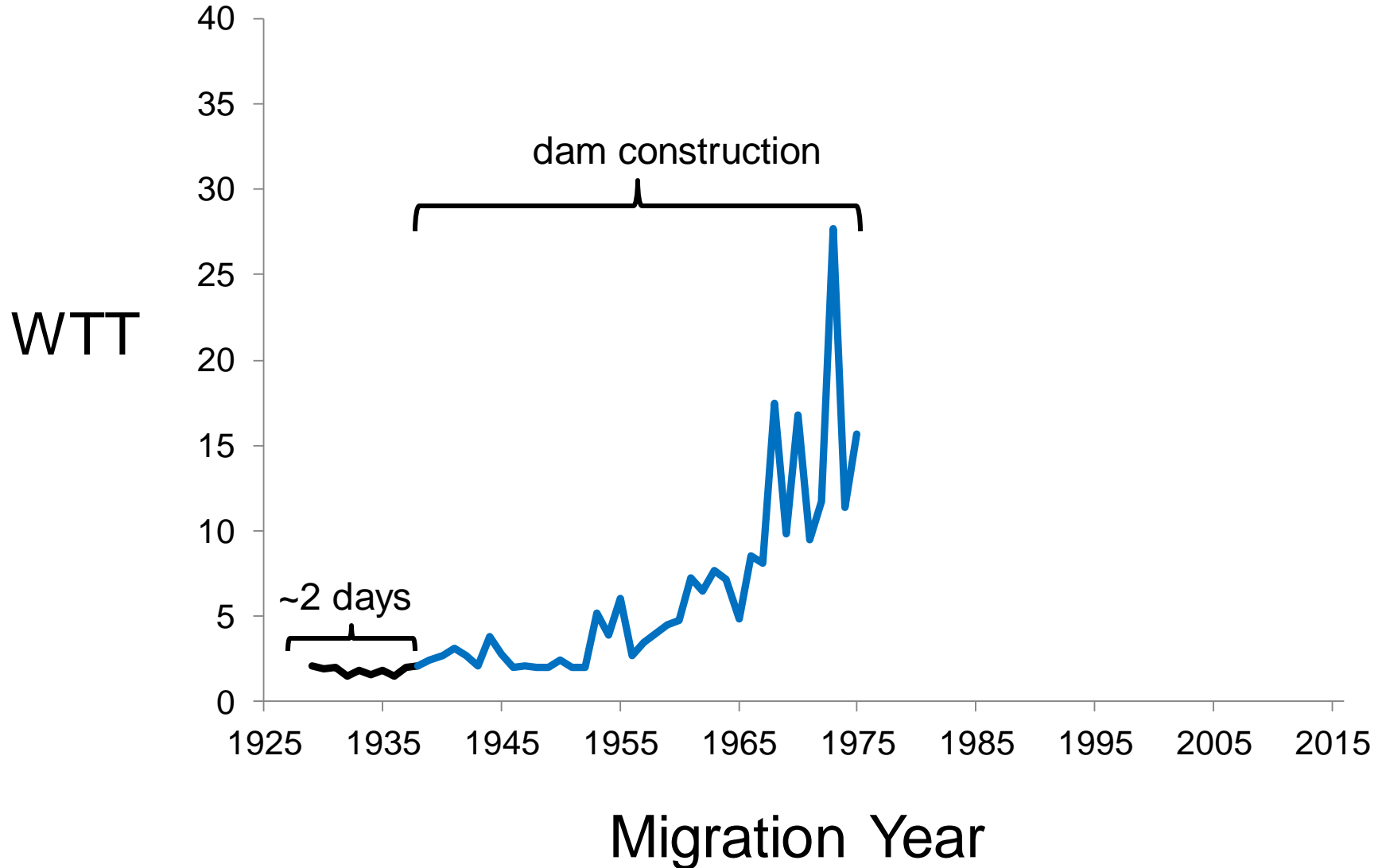
Estimate of the number of days required for average water particle to transit a reservoir (volume/flow)



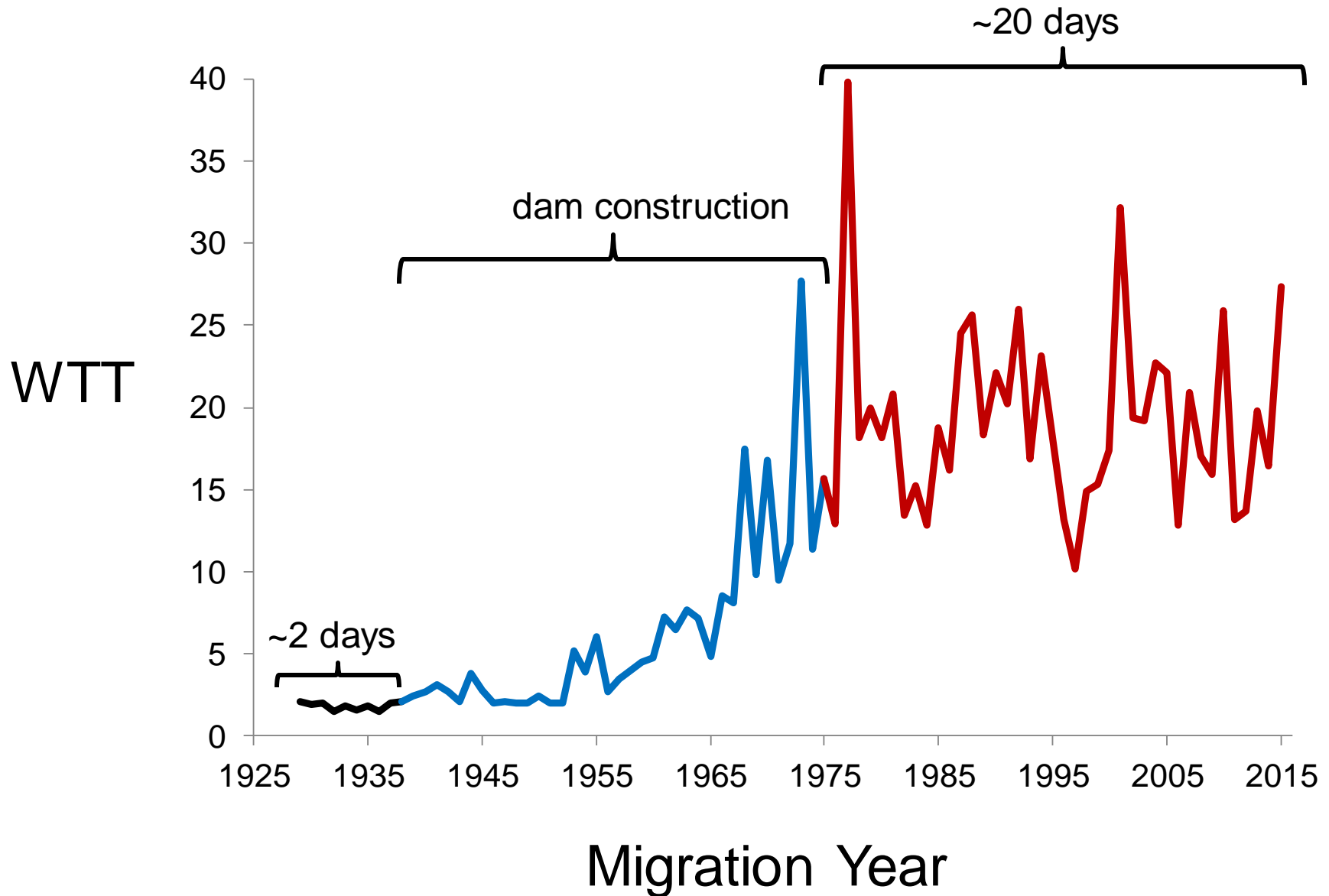
Long-term changes in Lewiston-BON WTT



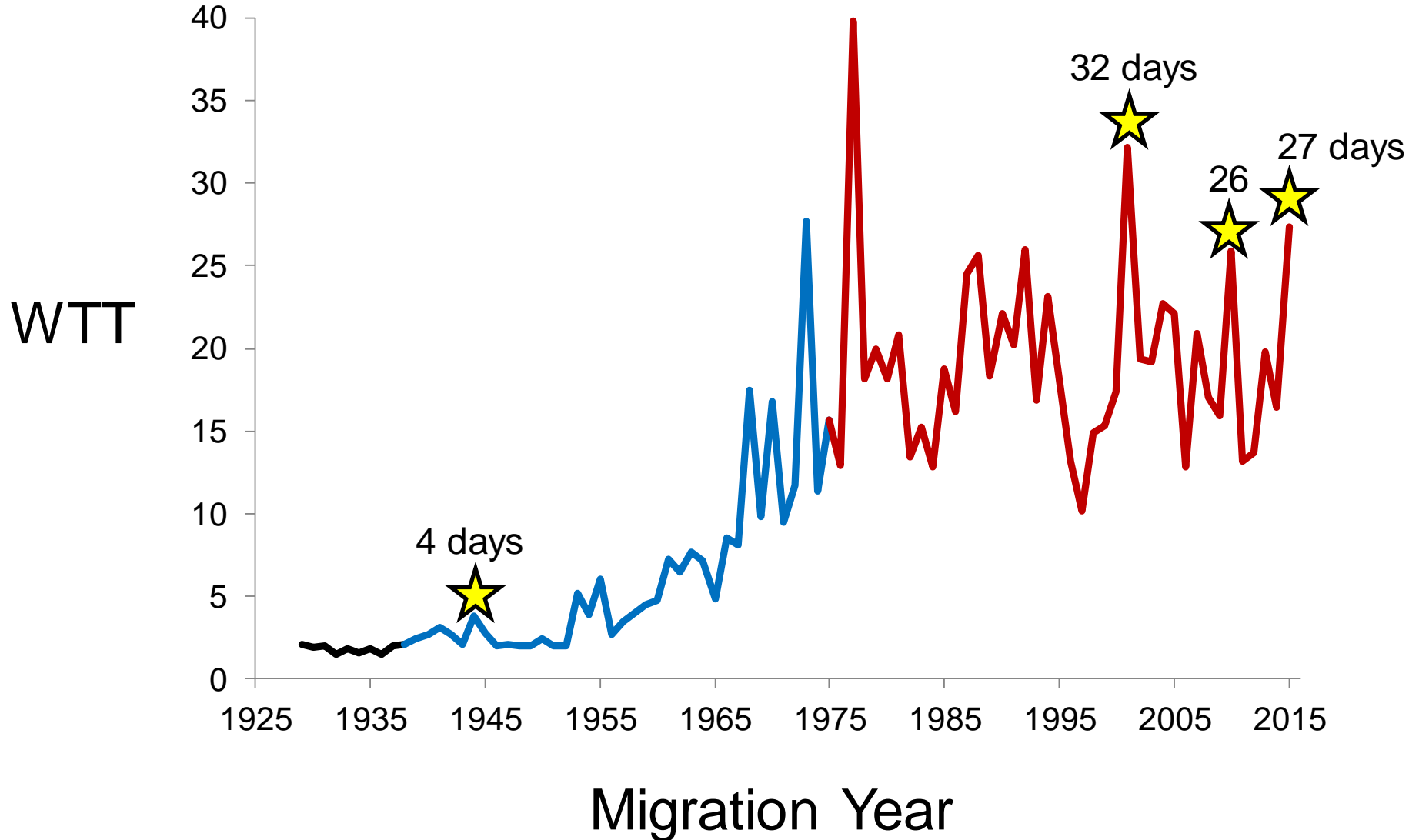
Long-term changes in Lewiston-BON WTT



Long-term changes in Lewiston-BON WTT

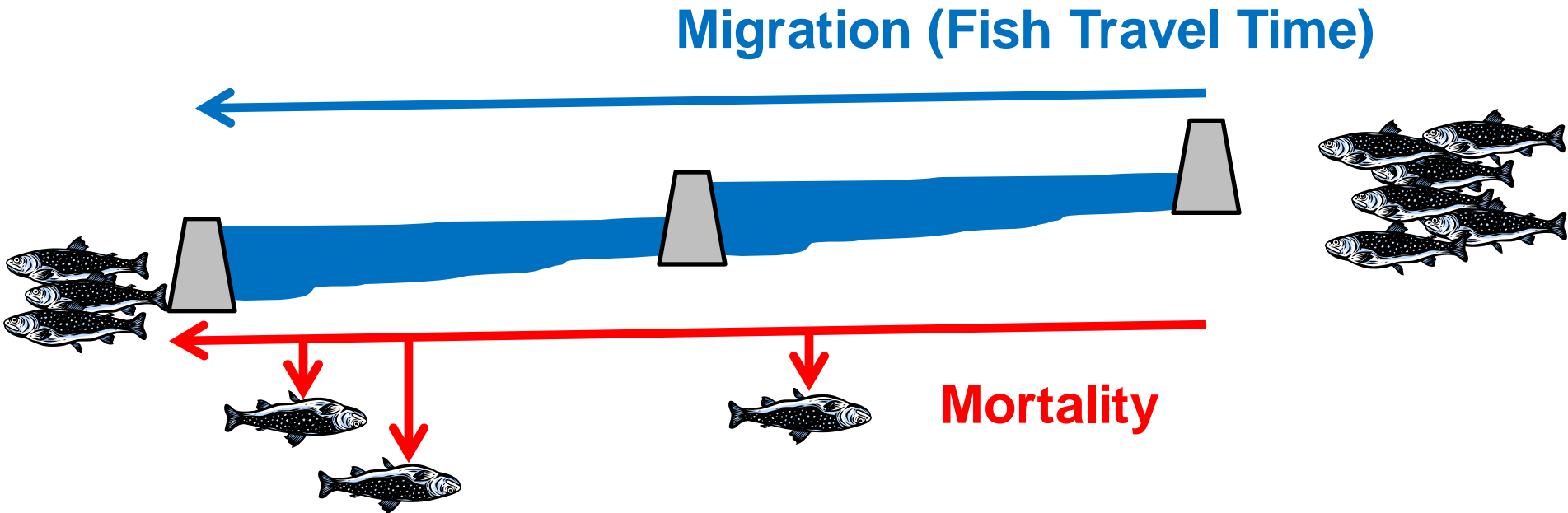


Long-term changes in Lewiston-BON WTT



Juvenile migration

- Two simultaneous processes: **migration** and **mortality**



- **Migration rates** and **mortality rates** affect survival

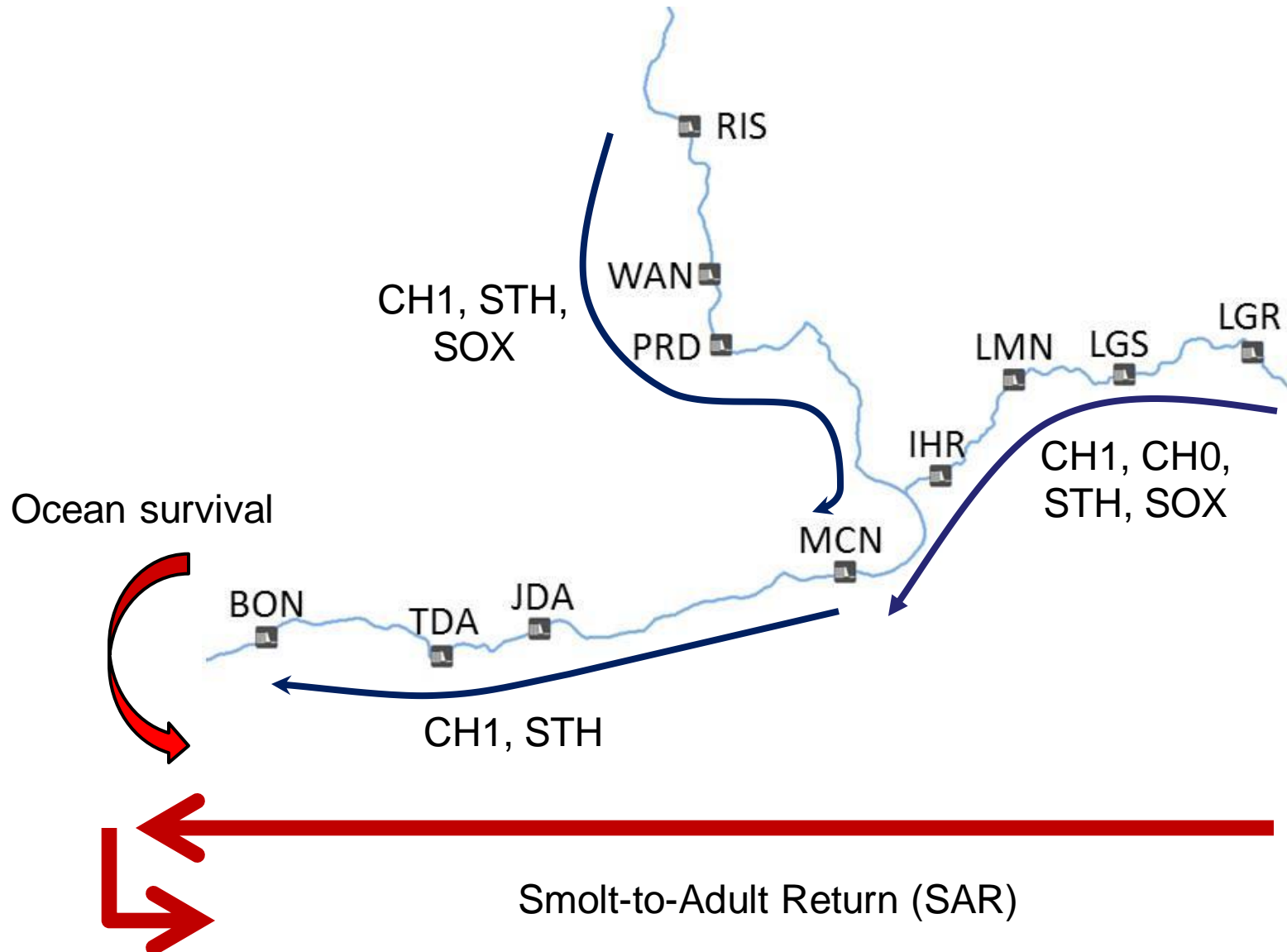
CSS Objectives:

- Measure and monitor juvenile Chinook, steelhead, and sockeye travel time, survival, and SARs (response metrics)
- Develop models that explain variation in response metrics (which factors are most important)
- Apply models to evaluate management scenarios

Five Response Metrics:

- Juvenile fish travel time
- Juvenile survival
- Ocean survival
- Smolt-to-Adult Returns (SARs)
- Transport:In-river Ratios (TIRs)

Monitoring methods:



Monitoring methods (1998-2016):

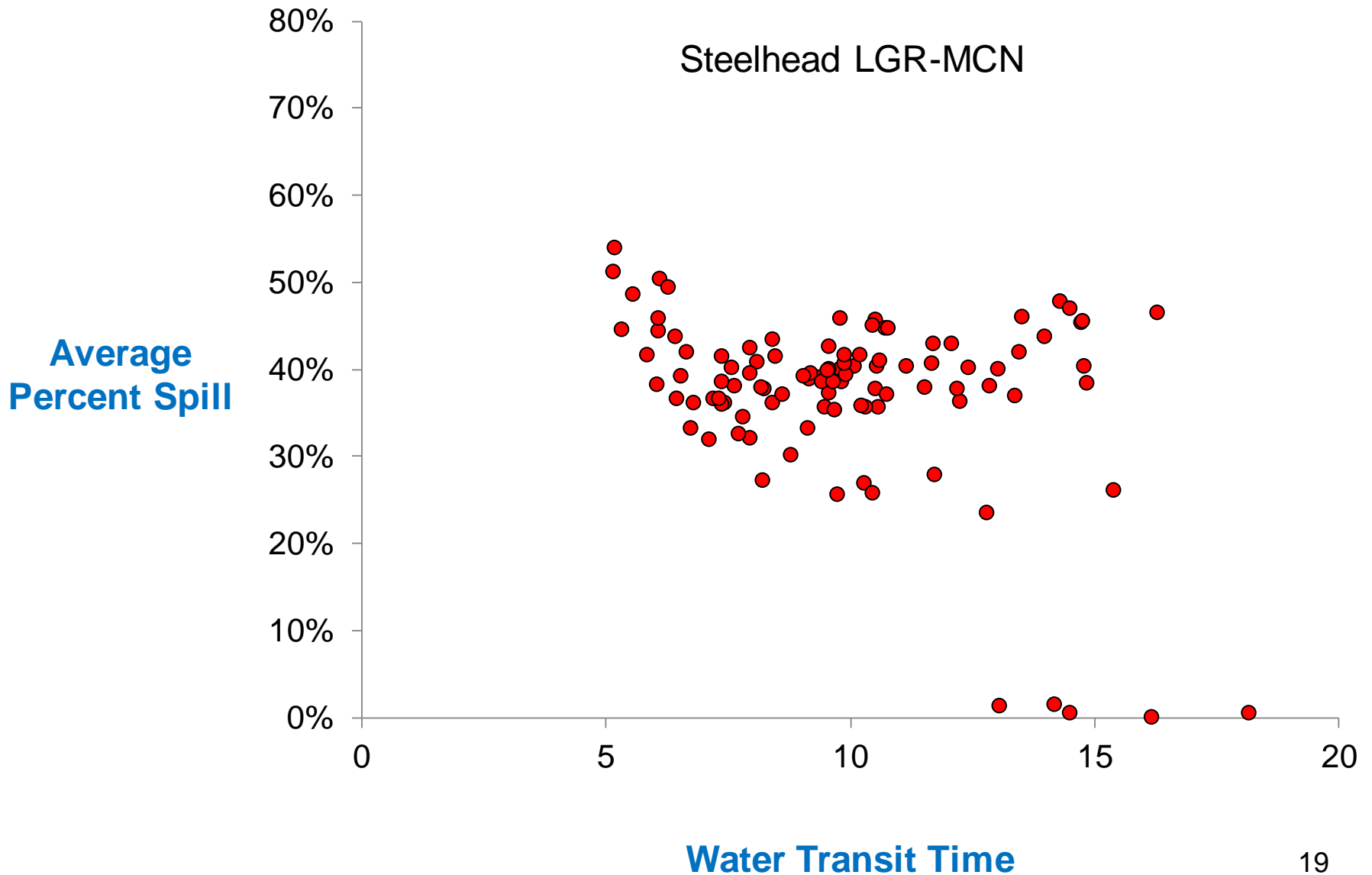
- Weekly/two-week release cohorts of PIT-tagged fish
- Annual estimates or stocks used for some analyses
- Estimated mean fish travel times (FTT), survival probabilities, and SARs

Comprehensive, basin-wide data set (1998-2016):

Reach	Species	Rearing type	Cohorts	Cohort Period
LGR-MCN	steelhead	hatchery and wild	114	1-week
LGR-MCN	yearling Chinook	wild	148	1-week
LGR-MCN	yearling Chinook	hatchery	145	1-week
LGR-MCN	sockeye	hatchery and wild	18	annual
LGR-MCN	subyearling Chinook	hatchery	61	2-week
RIS-MCN	steelhead	hatchery and wild	54	2-week
RIS-MCN	yearling Chinook	hatchery and wild	54	2-week
RIS-MCN	sockeye	hatchery and wild	18	annual
MCN-BON	steelhead	hatchery and wild	107	1-week
MCN-BON	yearling Chinook	hatchery and wild	108	1-week

Full-reach estimates also available (e.g., LGR-BON)

Data collected across range of conditions:



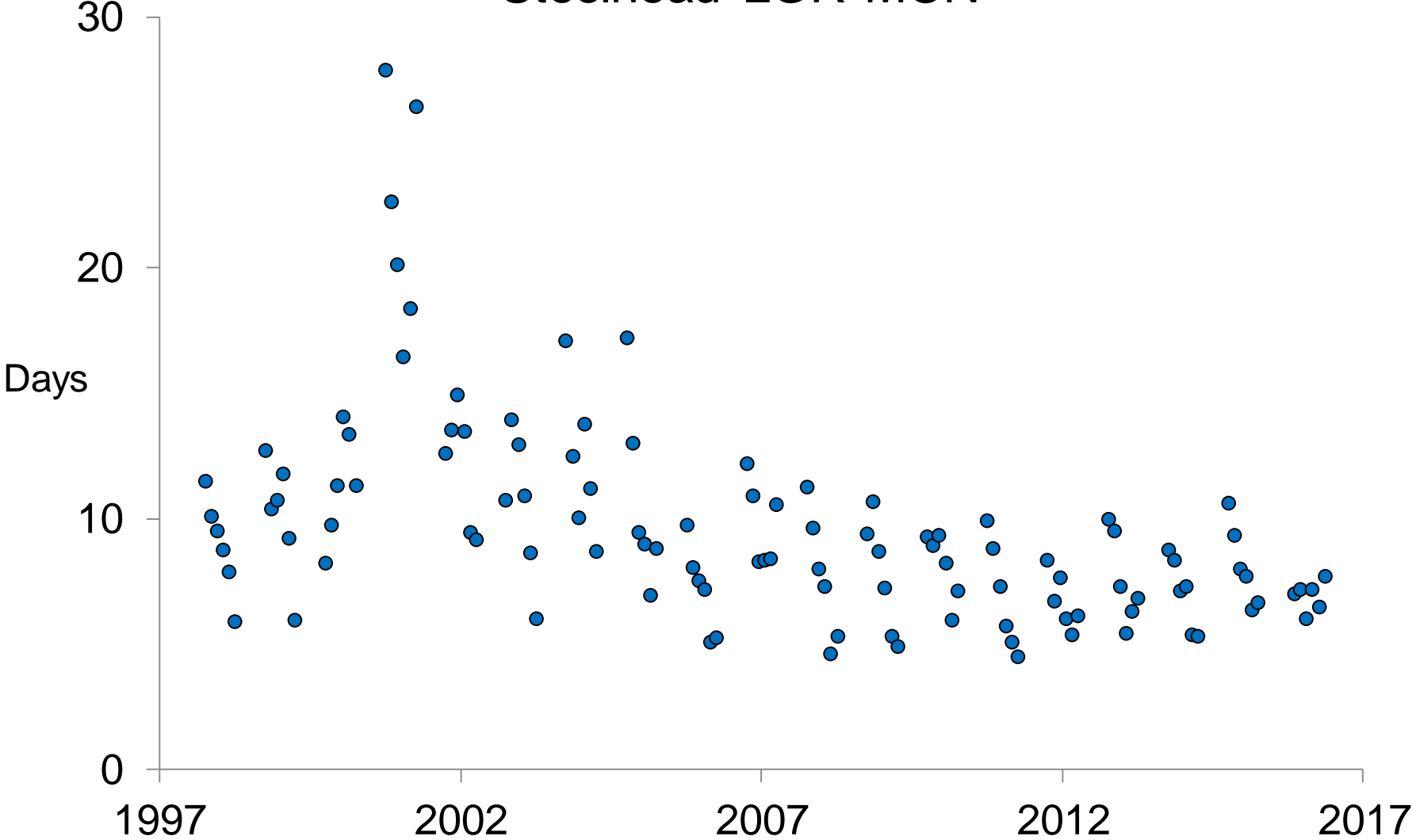
Environmental and Management Factors:

- Seasonality (Julian Day)
- Temperature

- PITPH {
- Average percent spill
 - Surface passage structures (TSW, RSW)
 - Water transit time (WTT, days)
 - PDO, Upwelling, Forage Biomass

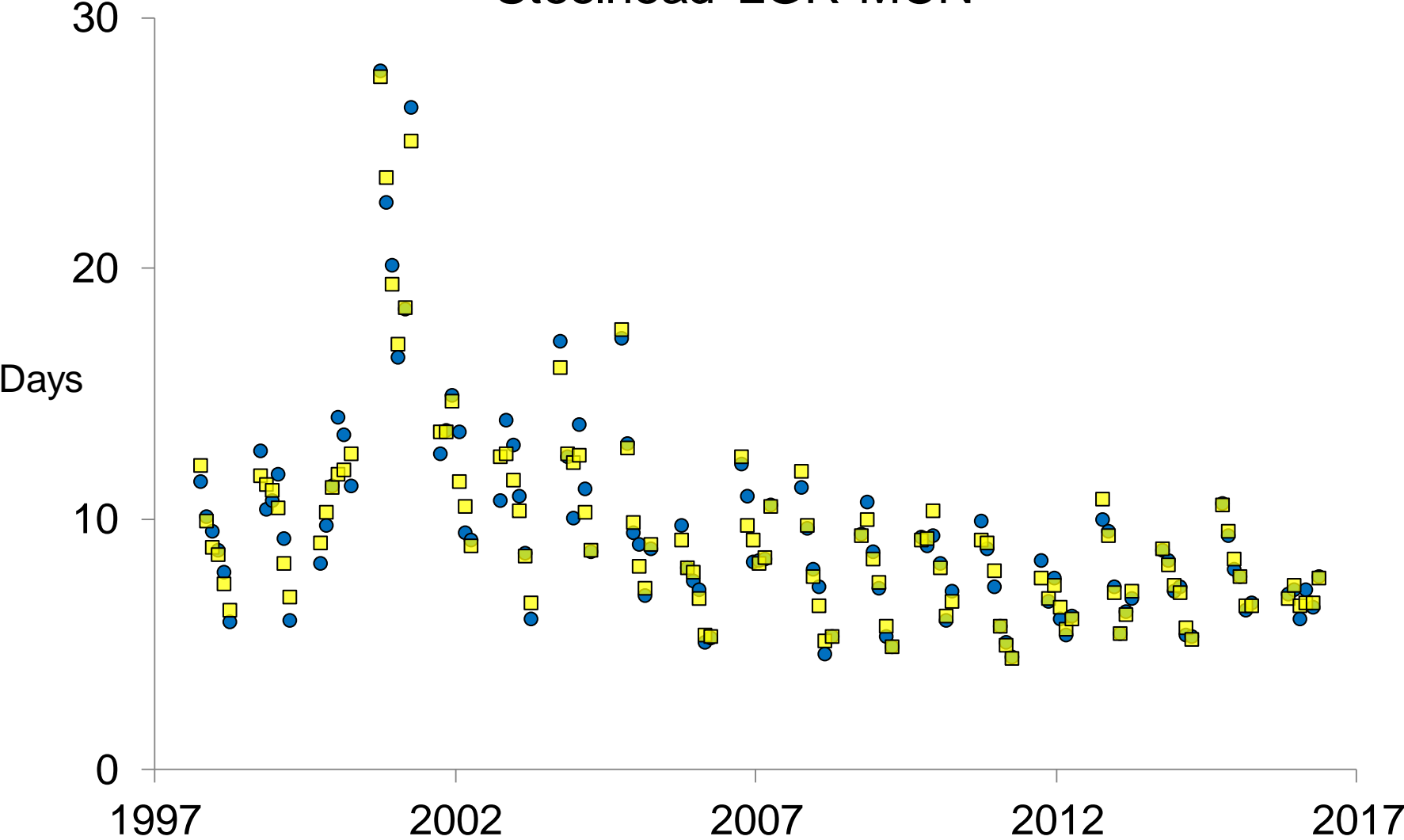
Fish Travel Times

Steelhead LGR-MCN



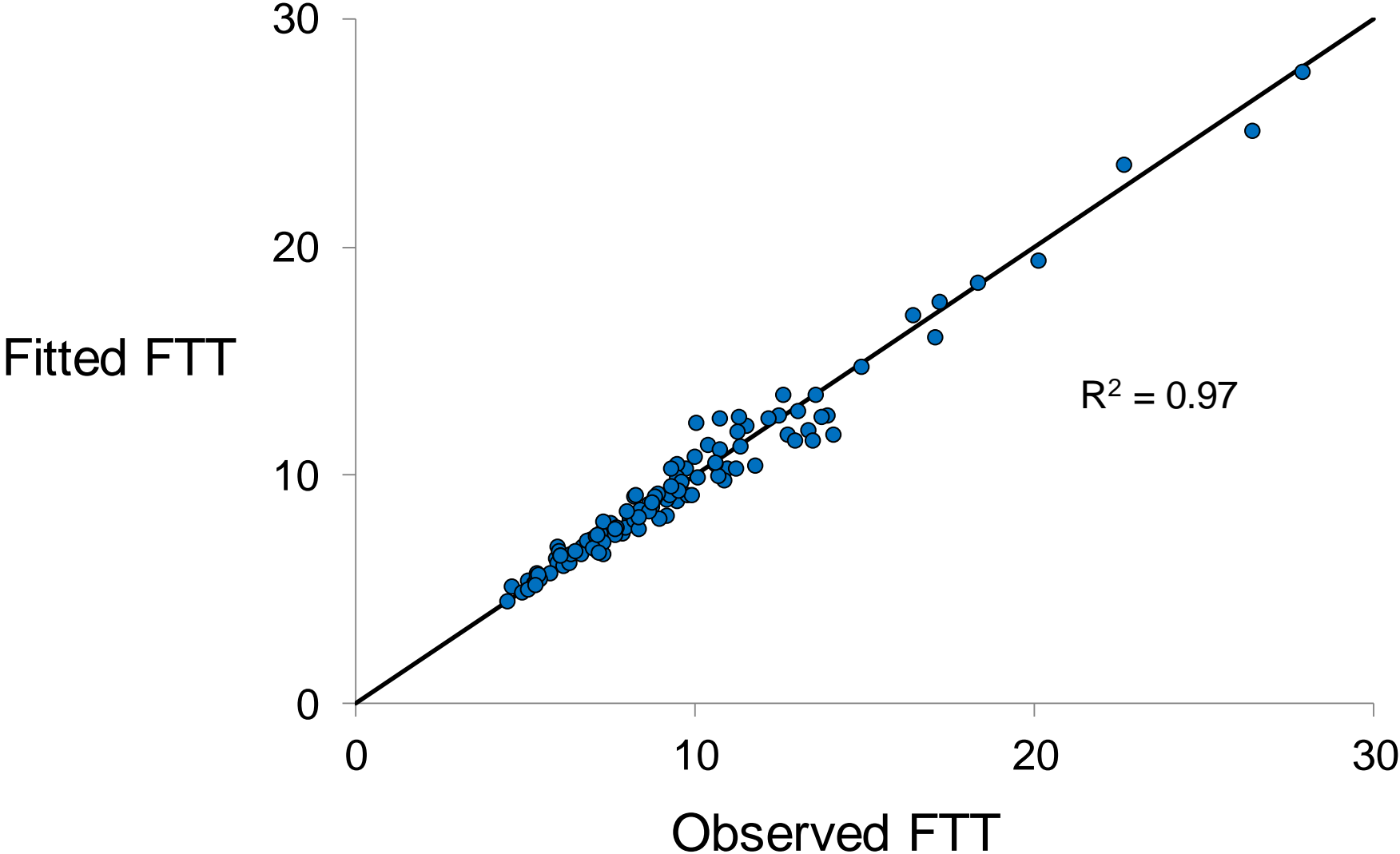
Fish Travel Times

Steelhead LGR-MCN

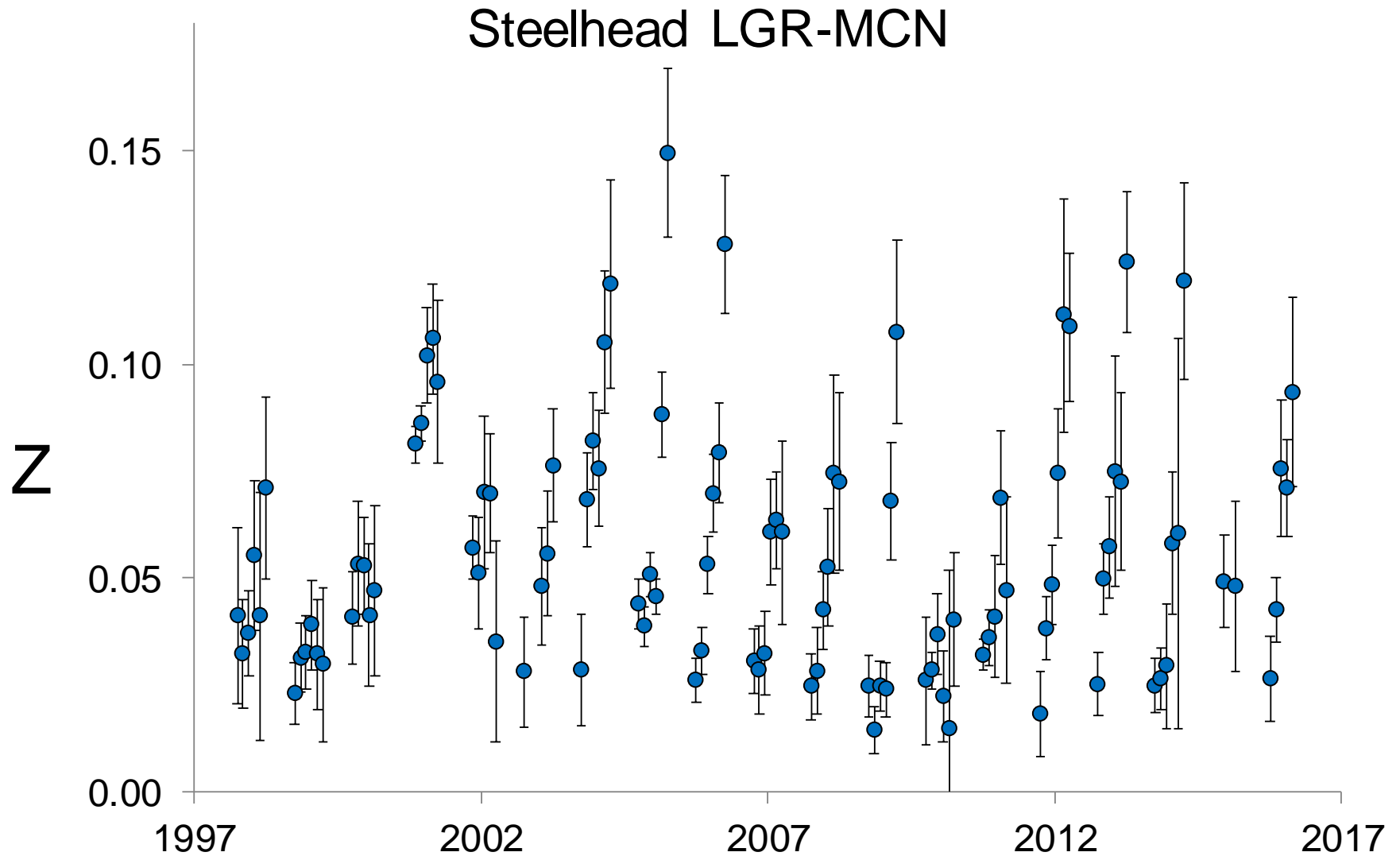


Fish Travel Times

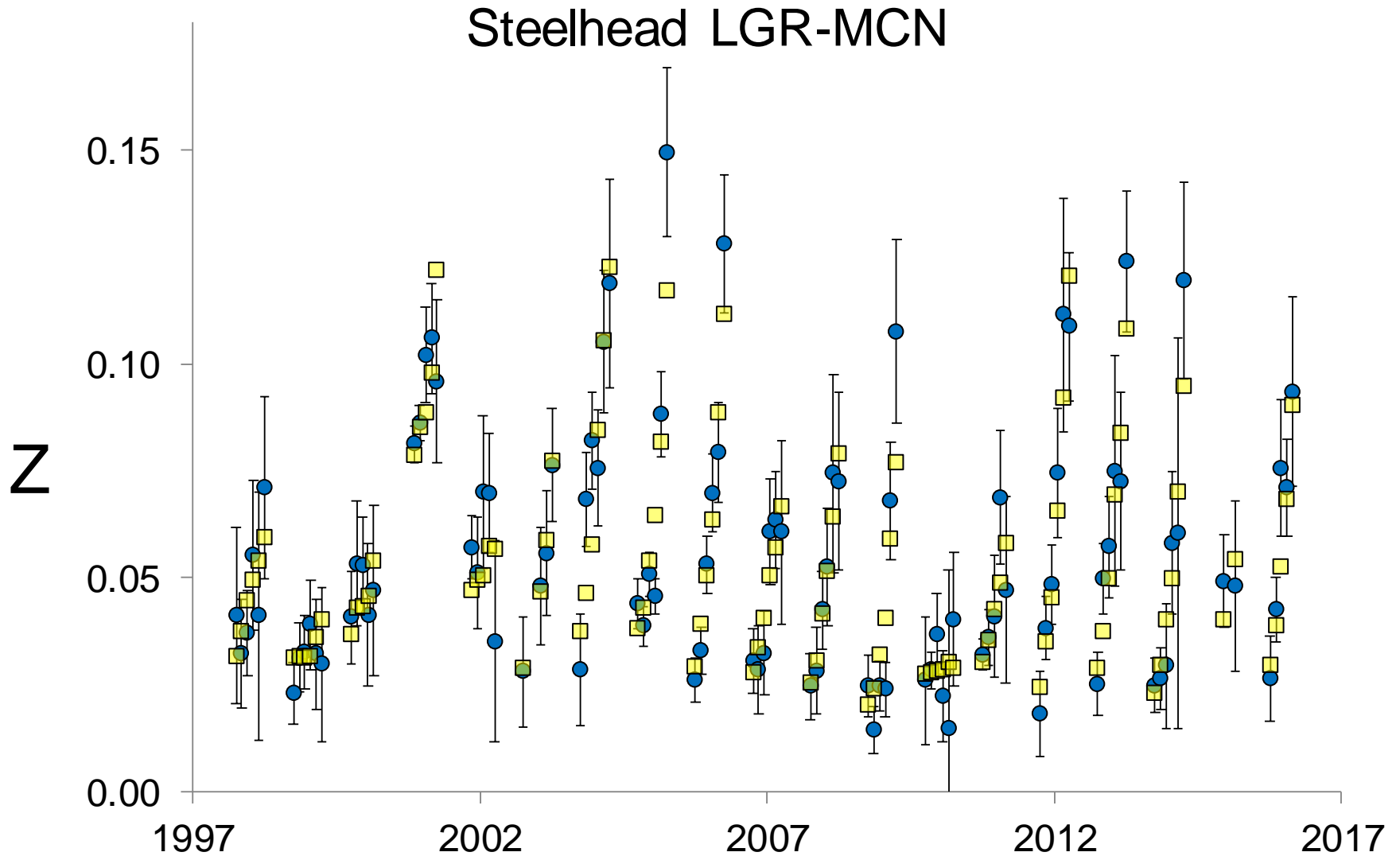
Steelhead LGR-MCN



Instantaneous Mortality Rates

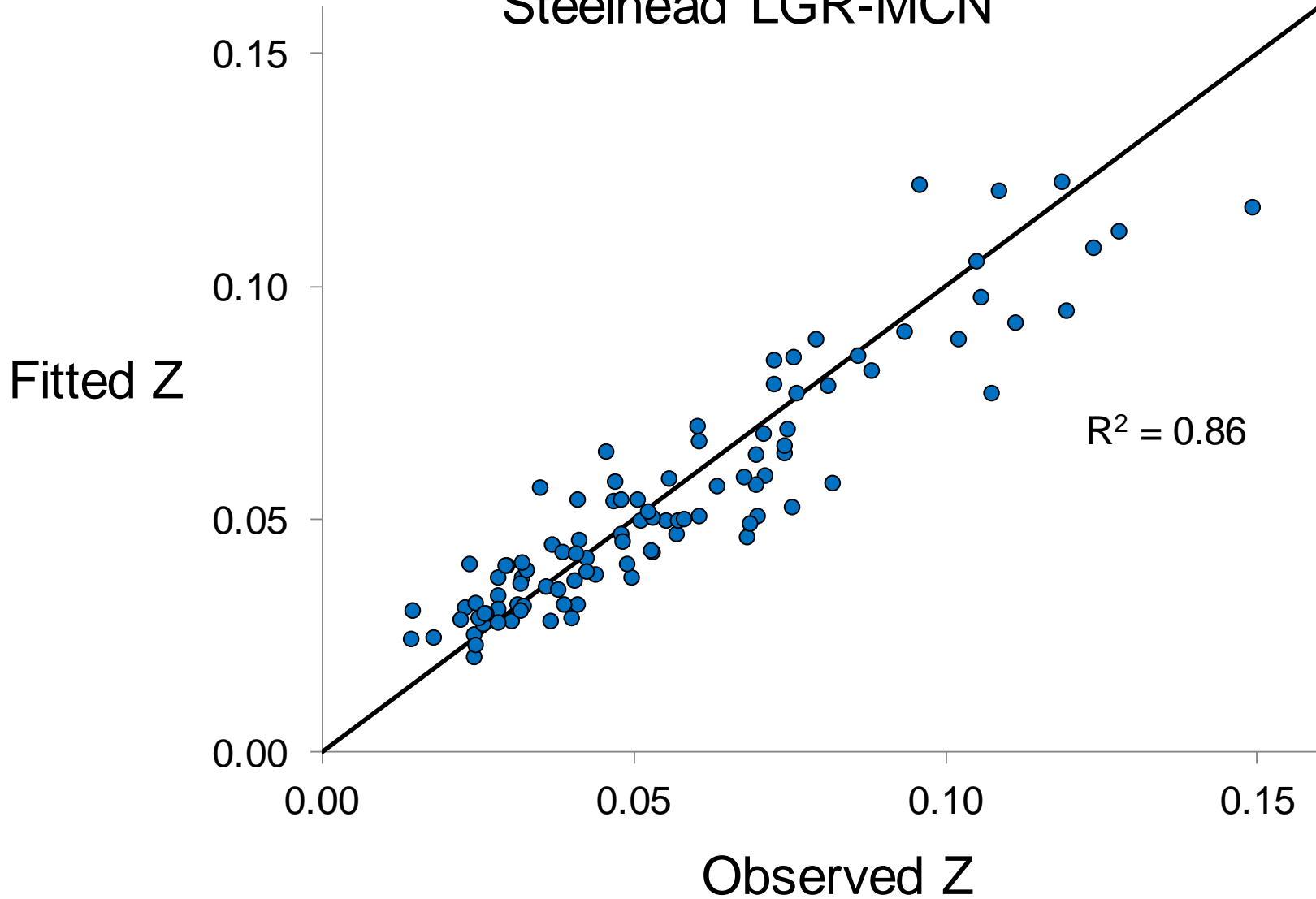


Instantaneous Mortality Rates

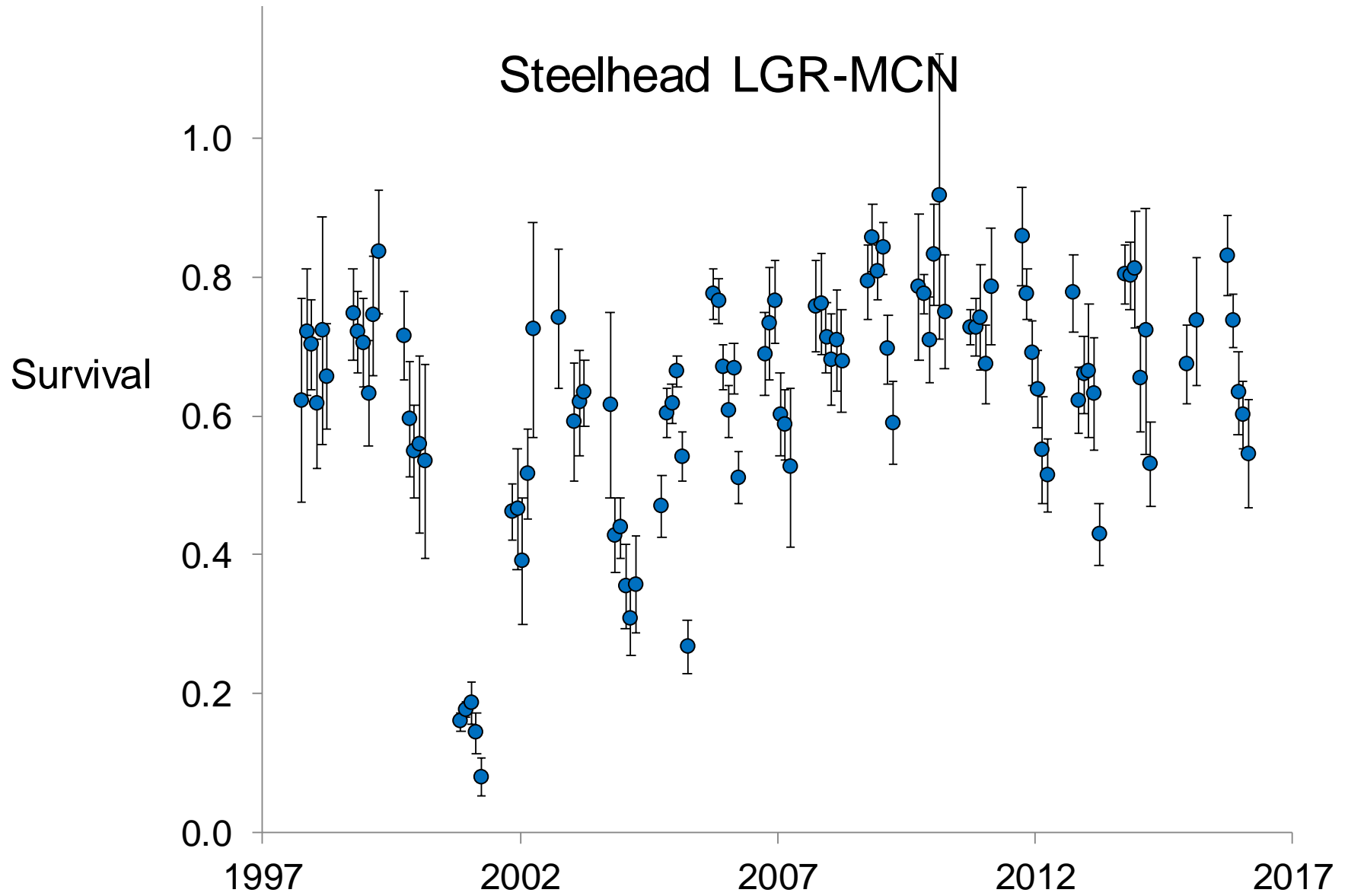


Mortality Rates

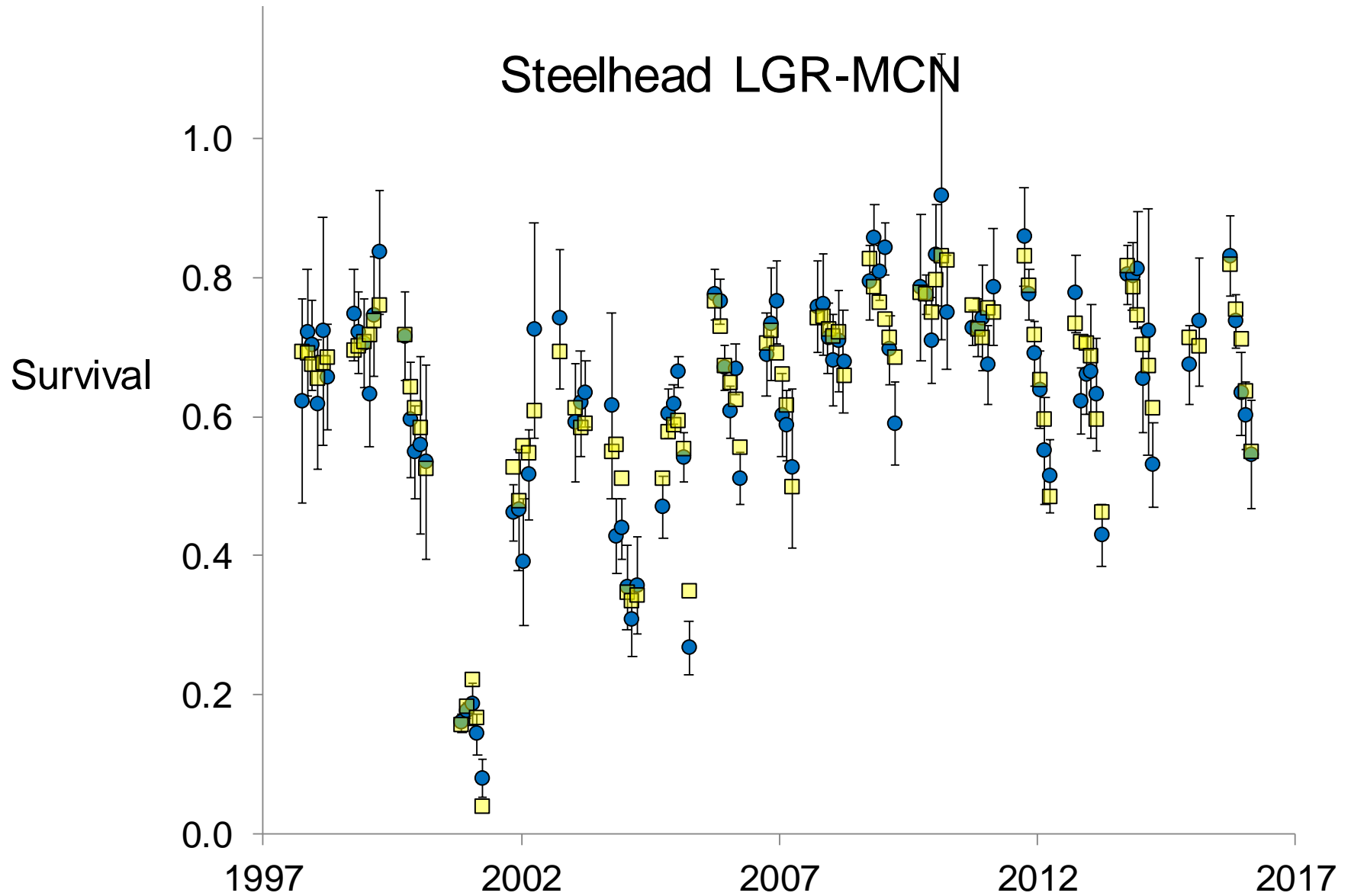
Steelhead LGR-MCN



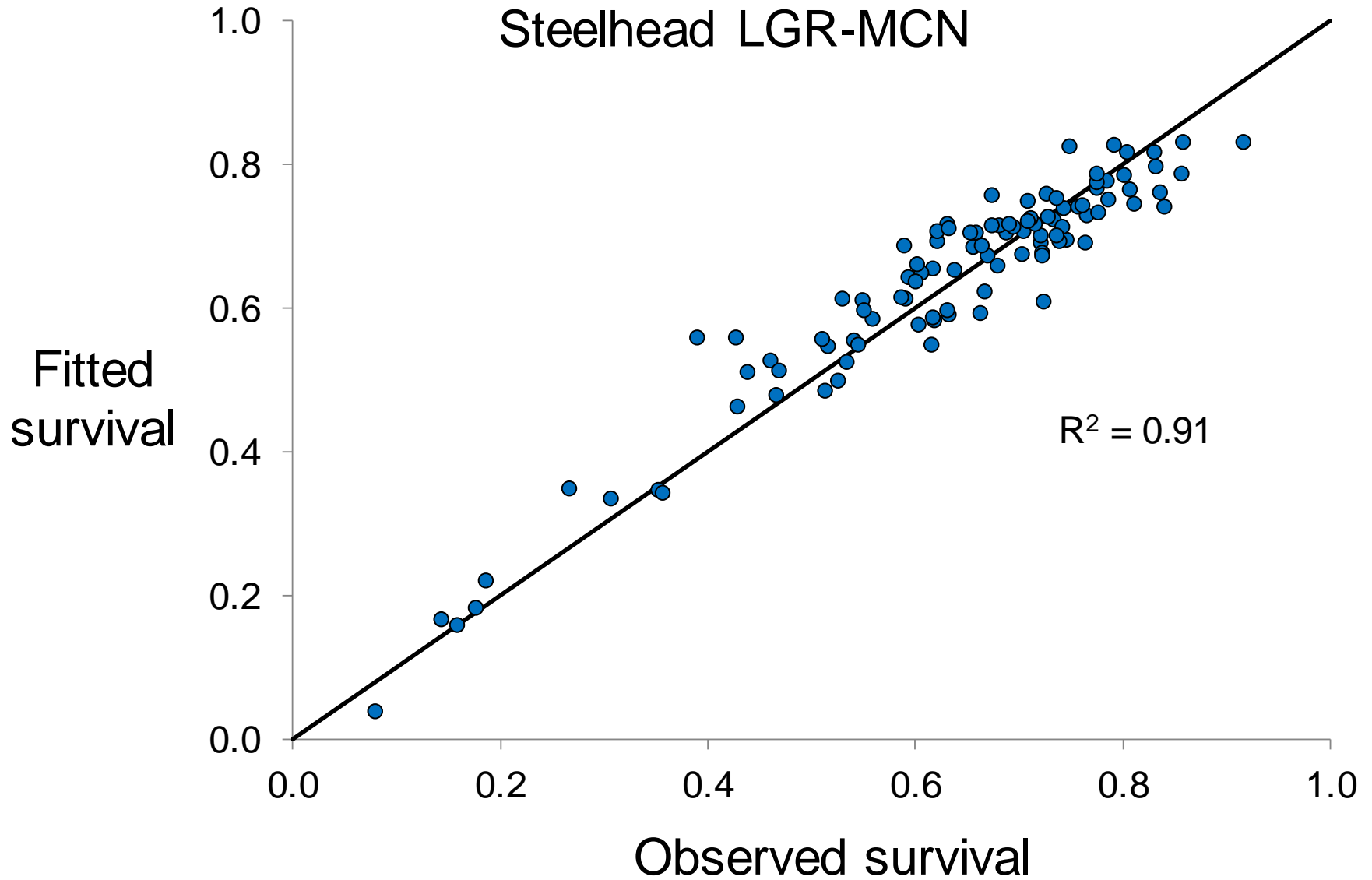
Survival



Survival

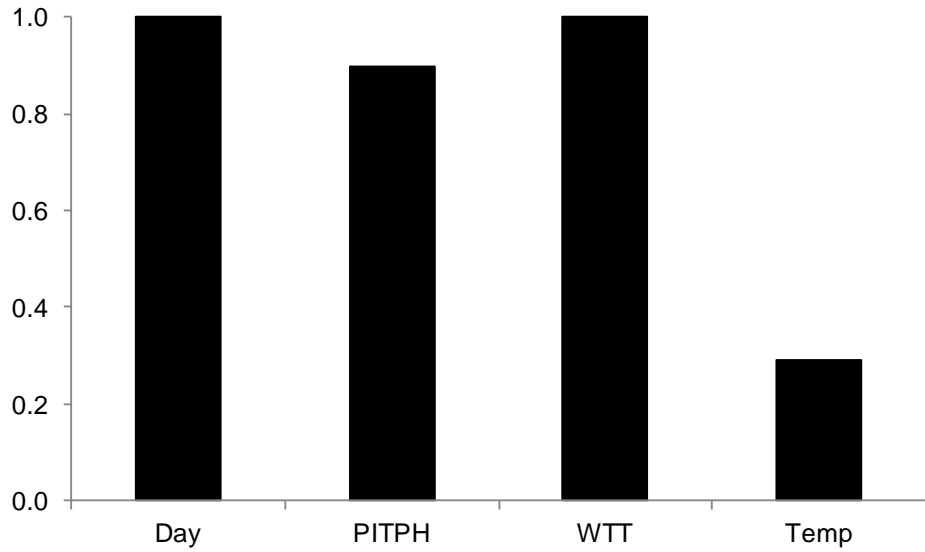


Survival



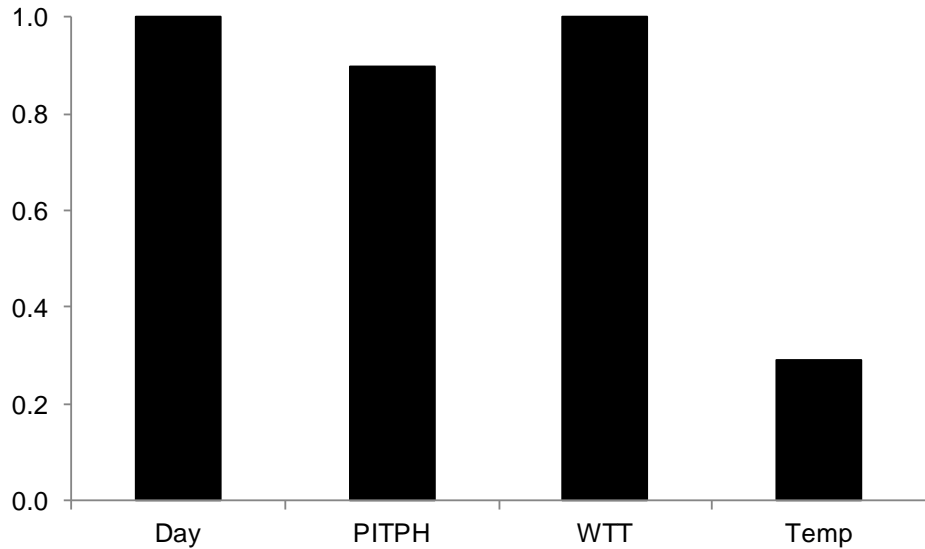
Relative Variable Importance (steelhead)

Fish Travel Time

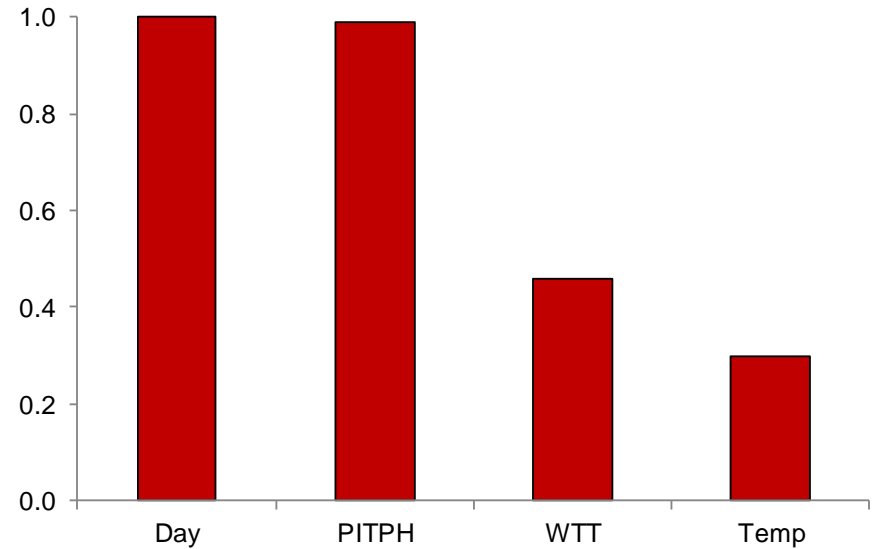


Relative Variable Importance (steelhead)

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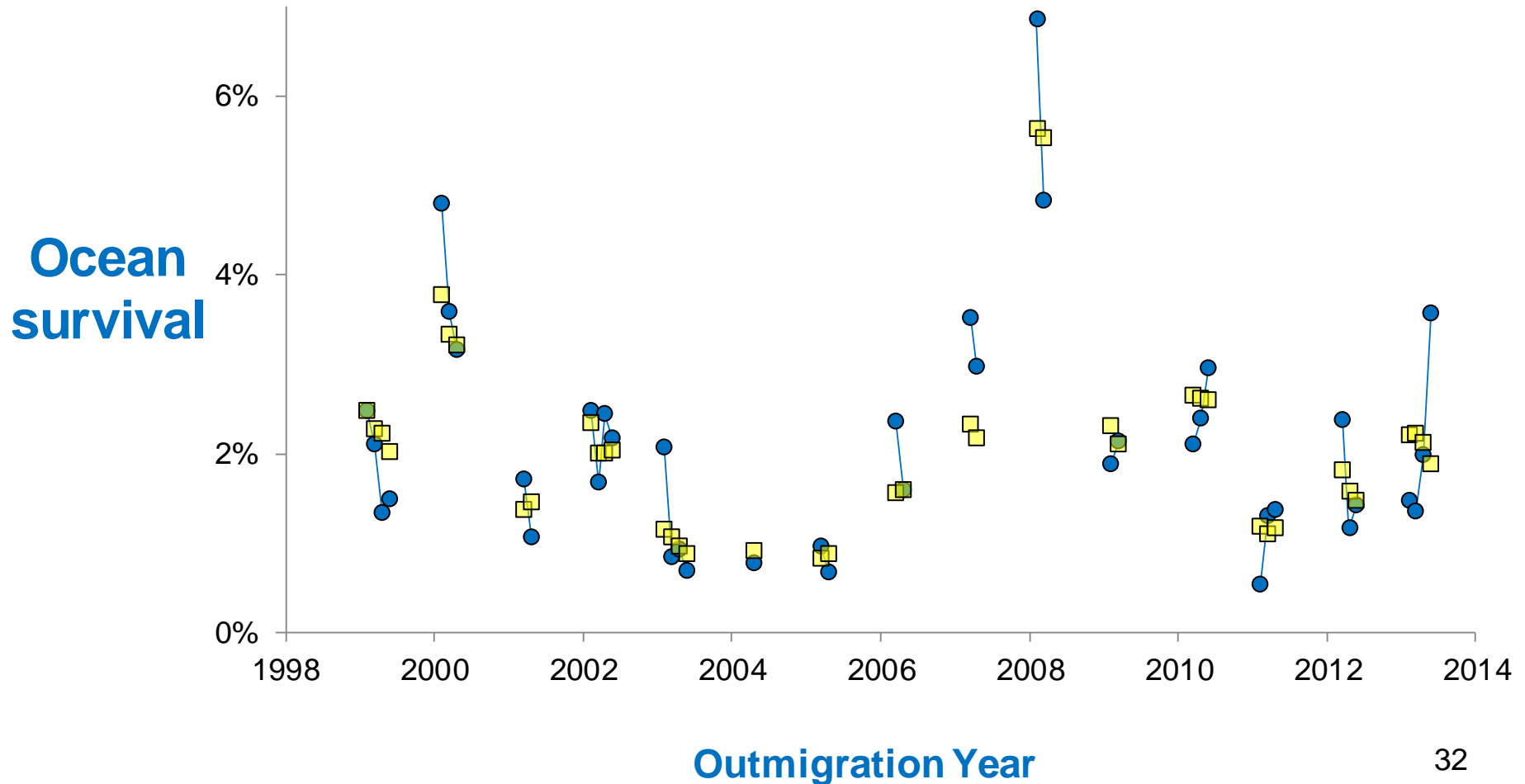


Instantaneous Mortality Rate



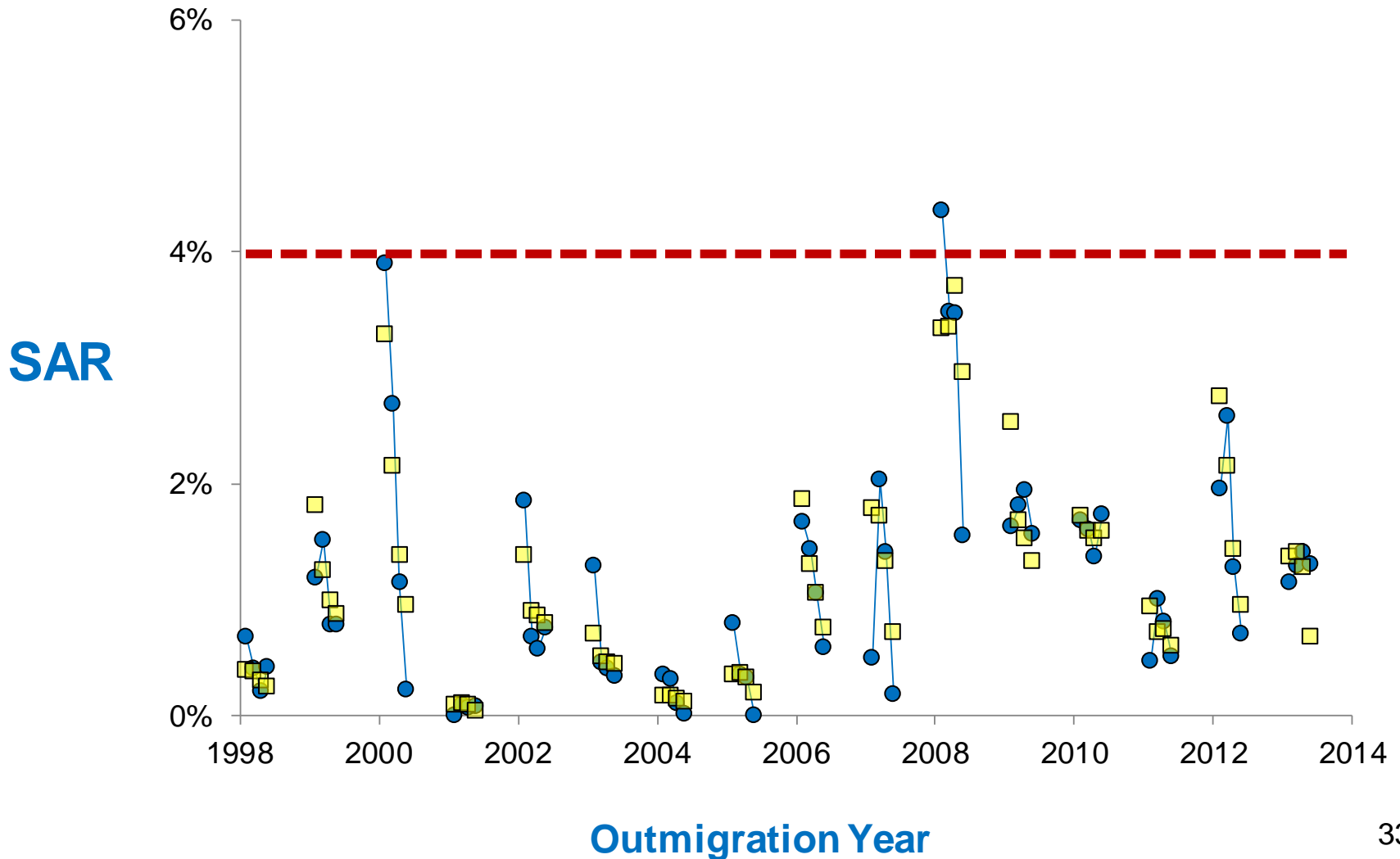
Models of ocean survival (Snake River steelhead)

 Influenced by WTT, PITPH, and ocean factors



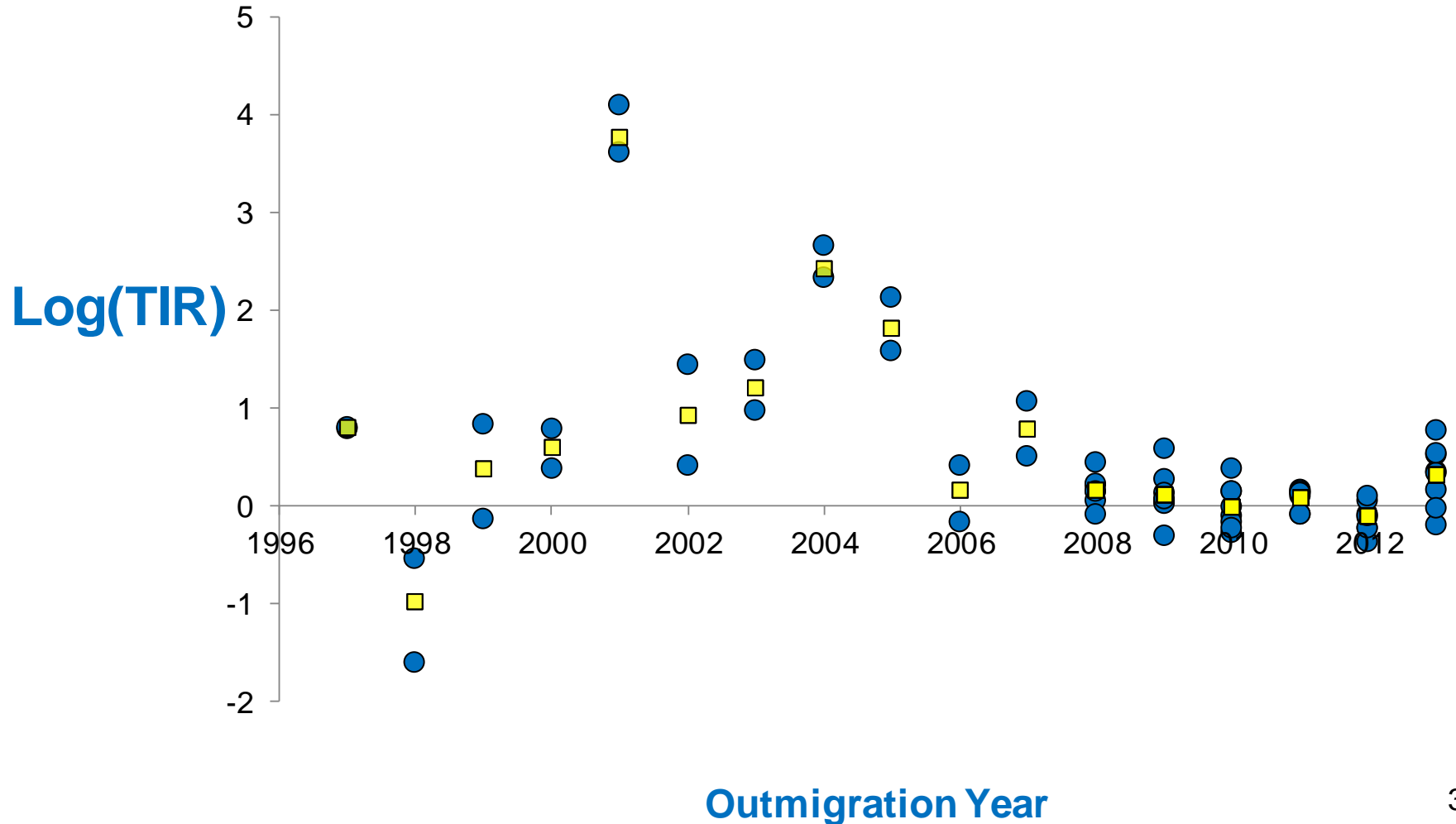
Models of SARs (Snake River steelhead)

 Influenced by WTT, PITPH, and ocean factors



Models of TIRs (Snake River steelhead)

 Influenced by WTT and PITPH



Applying models to evaluate management scenarios

CSS Oversight Committee response to ISAB (2017)

Snake River spring/summer Chinook salmon and steelhead

Four spill management scenarios:

- Current Biological Opinion spill levels

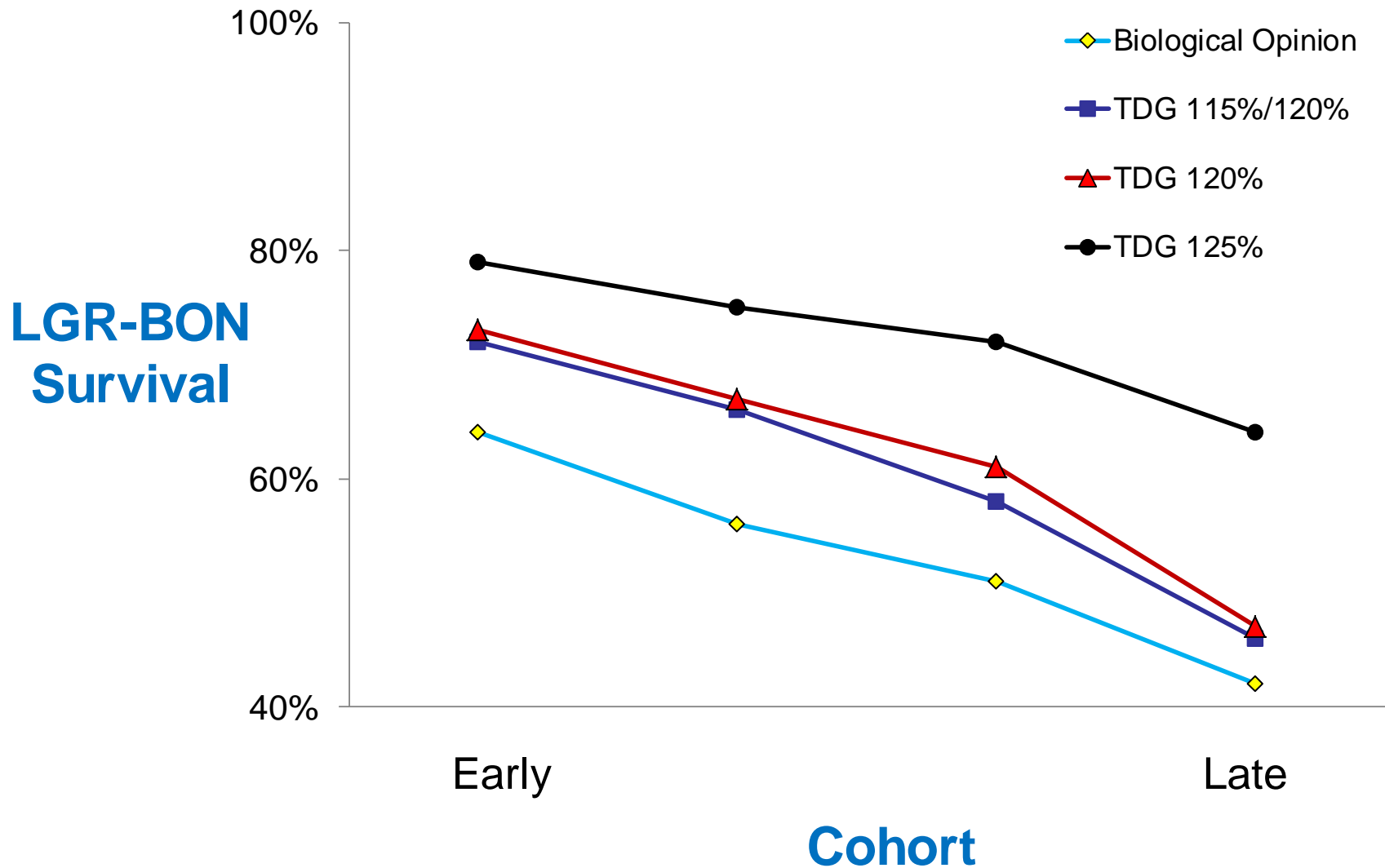
- 115% forebay, 120% tailrace Total Dissolved Gas (TDG)

- 120% tailrace TDG

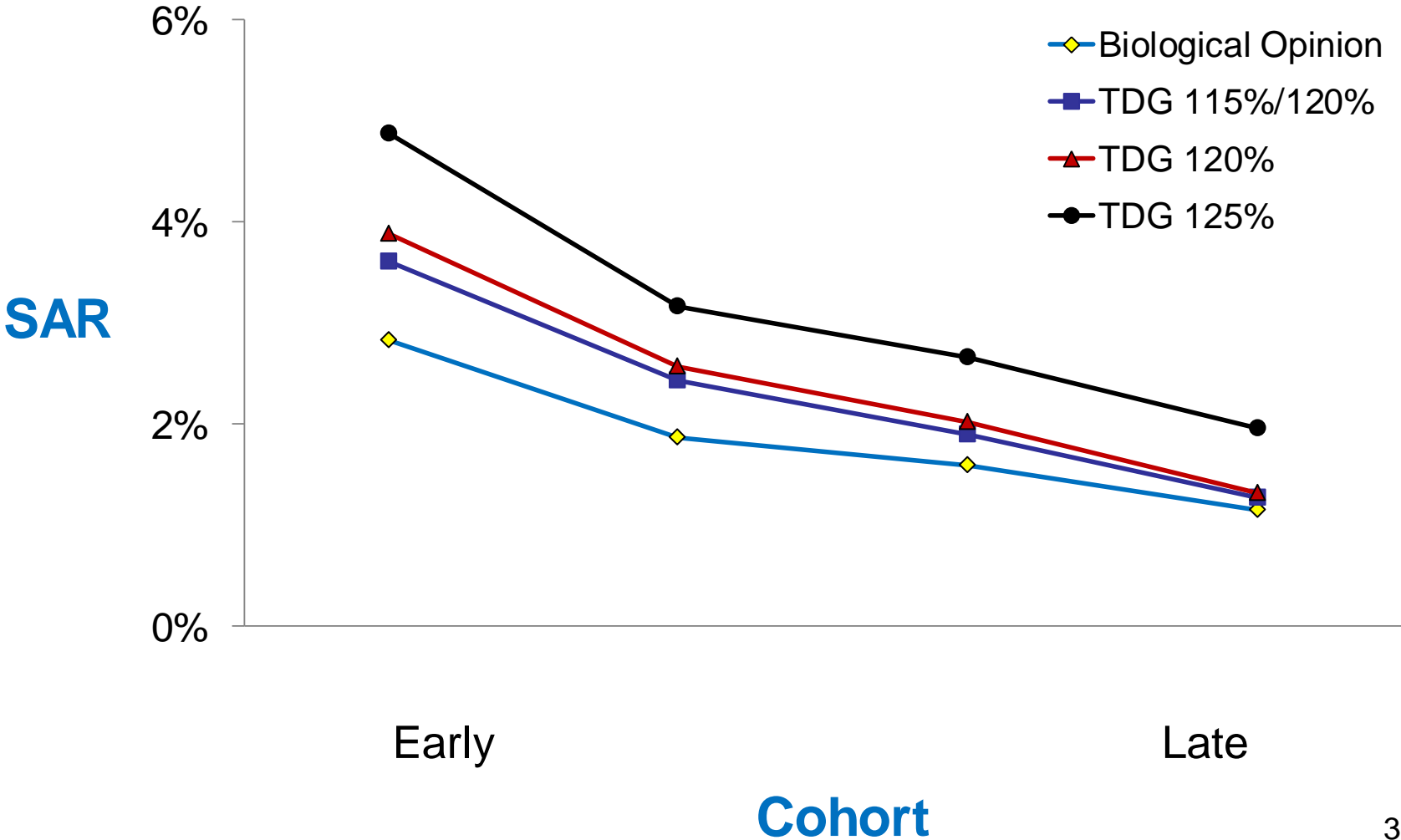
- 125% tailrace TDG

Incorporated variability in flow and ocean conditions

Evaluating spill management scenarios (Snake River steelhead)



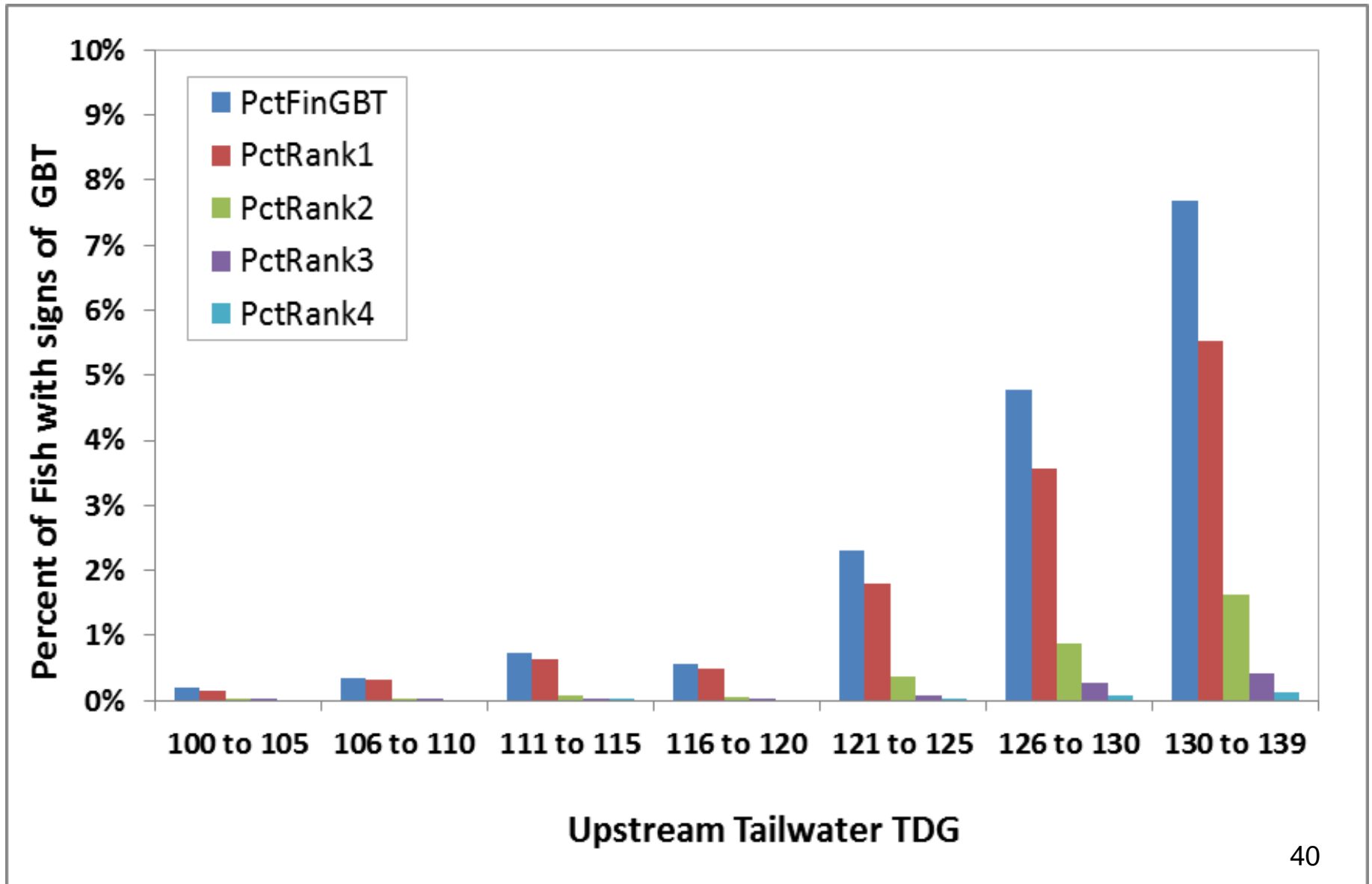
Evaluating spill management scenarios (Snake River steelhead)



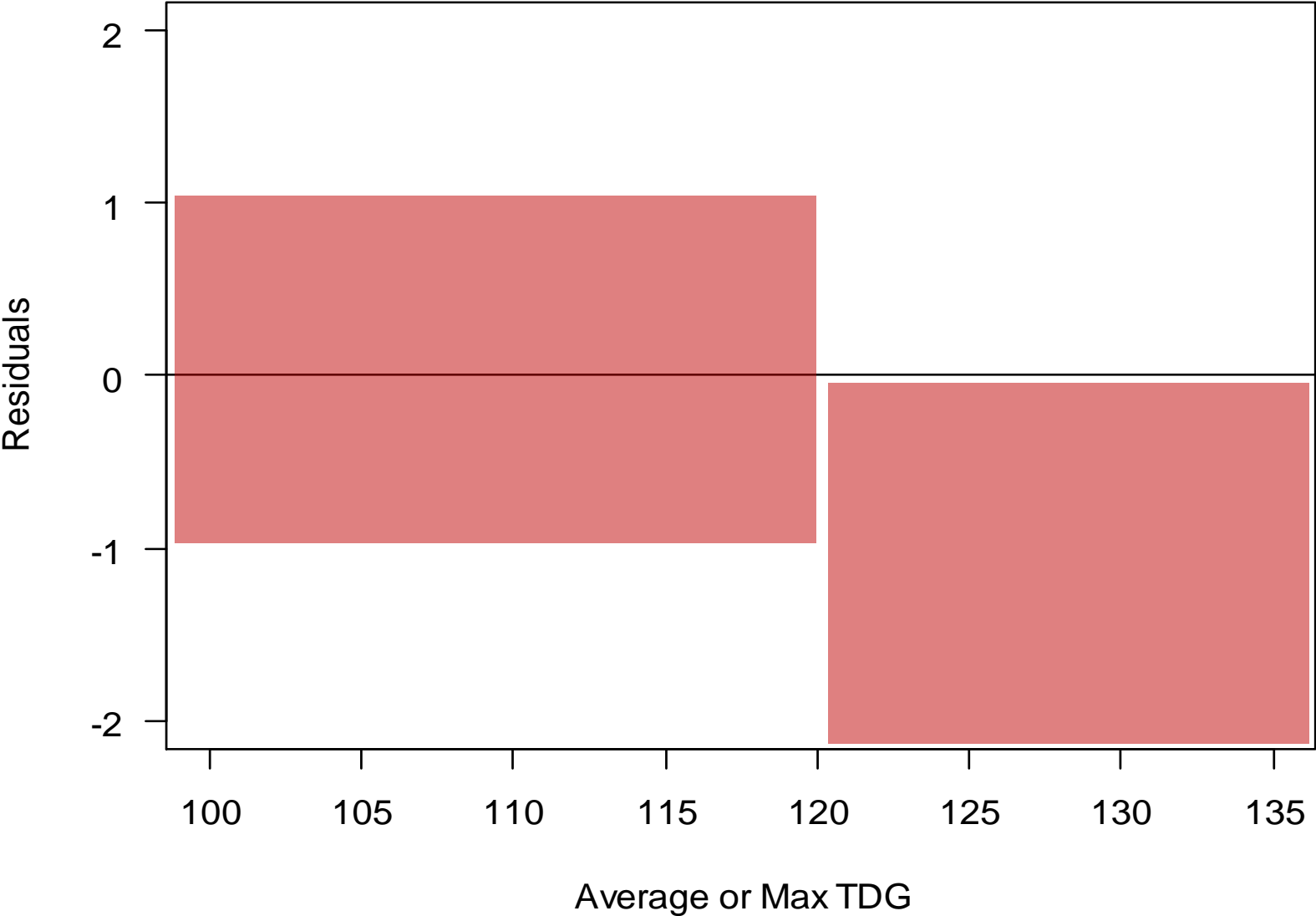
Conclusions

- Assembled comprehensive data set across species and across the basin
- Employed consistent analytical framework
- Combinations of managed (WTT, spill) and environmental (seasonal, temperature, ocean conditions) factors influence response metrics
- Models provide tools for evaluating effects of future management actions

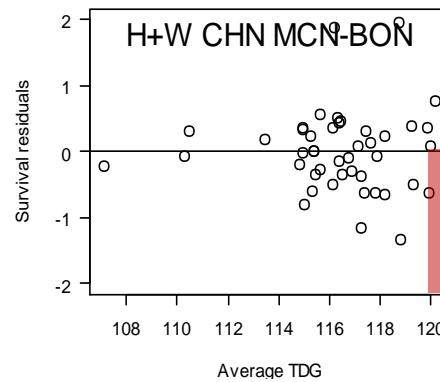
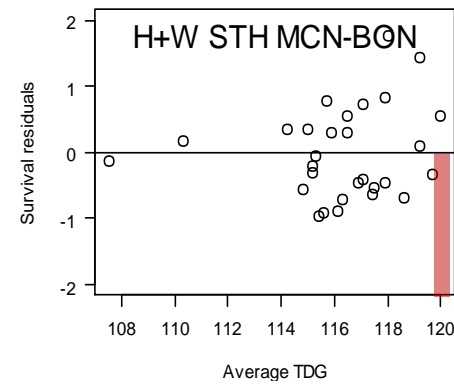
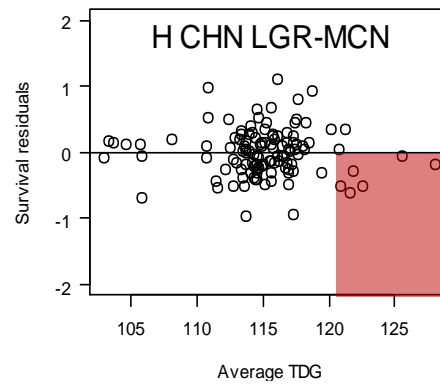
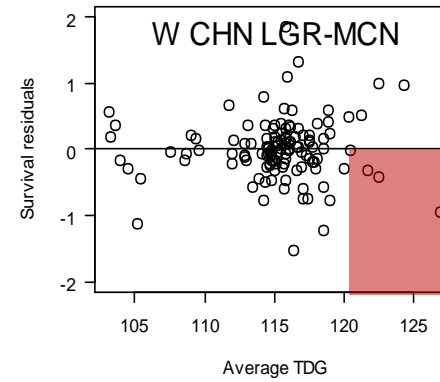
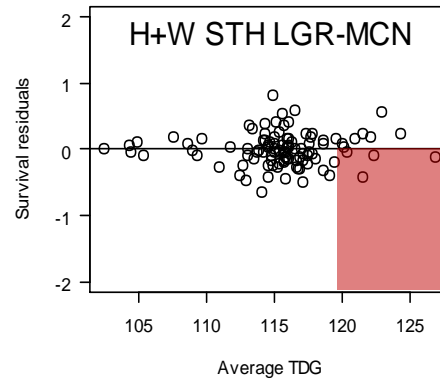
Smolt Monitoring Program Results 1995-2014



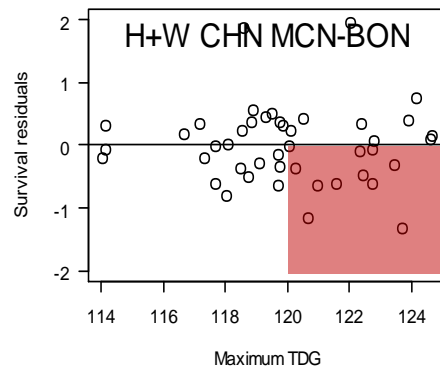
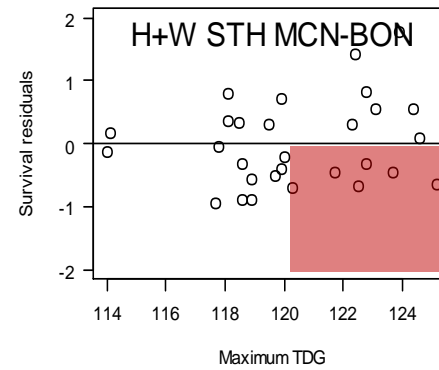
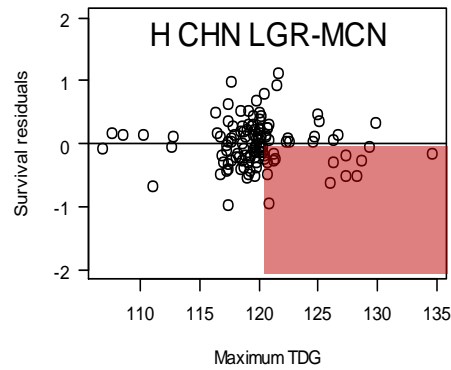
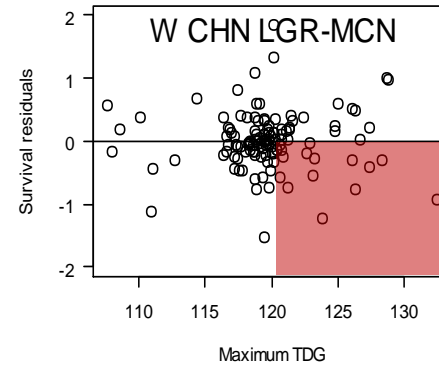
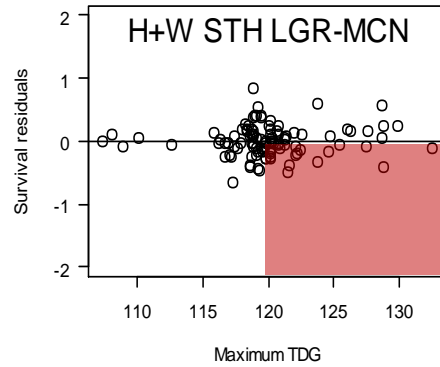
Expected Survival Residuals



Survival Residuals Versus Average TDG



Survival Residuals Versus Maximum TDG



Conclusions

- The majority of observations were collected under TDG levels of less than 120%
- Observations were collected under involuntary spill levels where the TDG levels were above 120% and up to a maximum of 135%
- Residual plots indicated no detrimental effects of high TDG over the range of TDG levels observed 1998-2016