Comparative Survival Study
Chapter 2

In-river travel time, survival, and instantaneous mortality rates of yearling Chinook and steelhead

Methods:

- Two reaches: LGR-MCN (CHW, CHH, STH&W)
  MCN-BON (CHH&W, STH&W)
- Weekly release cohorts of PIT-tagged fish
- Estimated median fish travel time (FTT) and survival rate

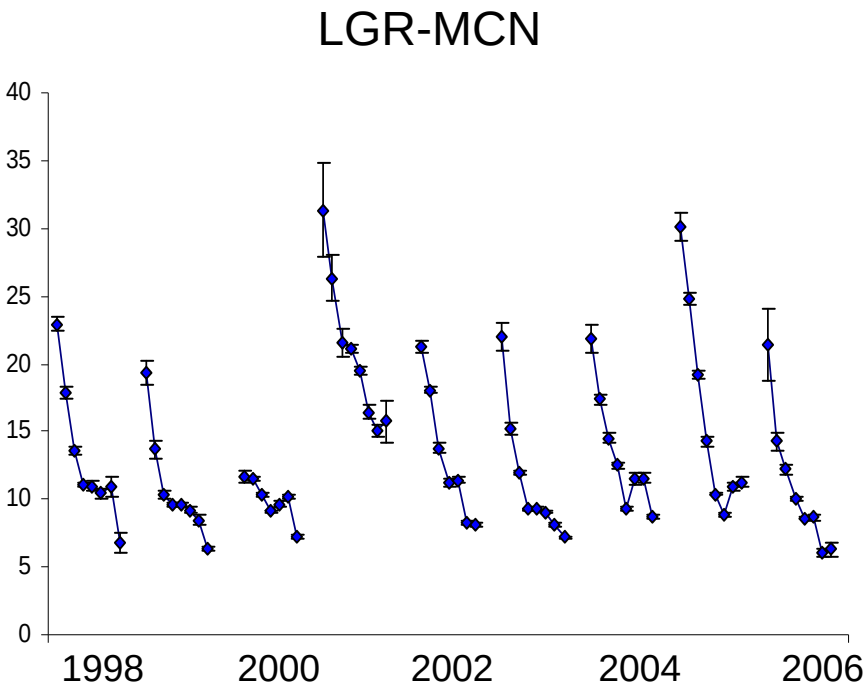
  Instantaneous mortality rate

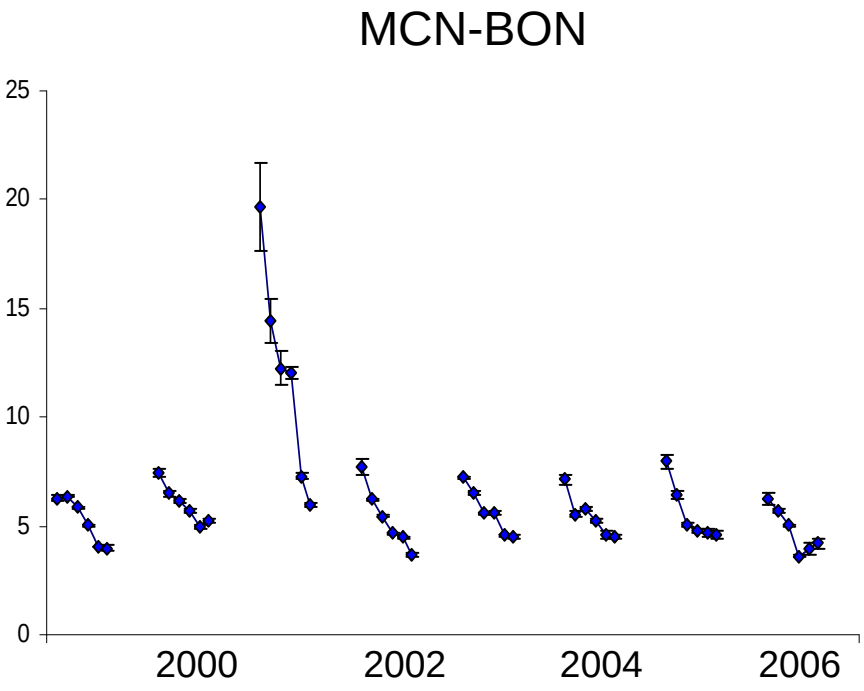
- Evaluated models using AICc and BIC

Environmental and Management Factors:

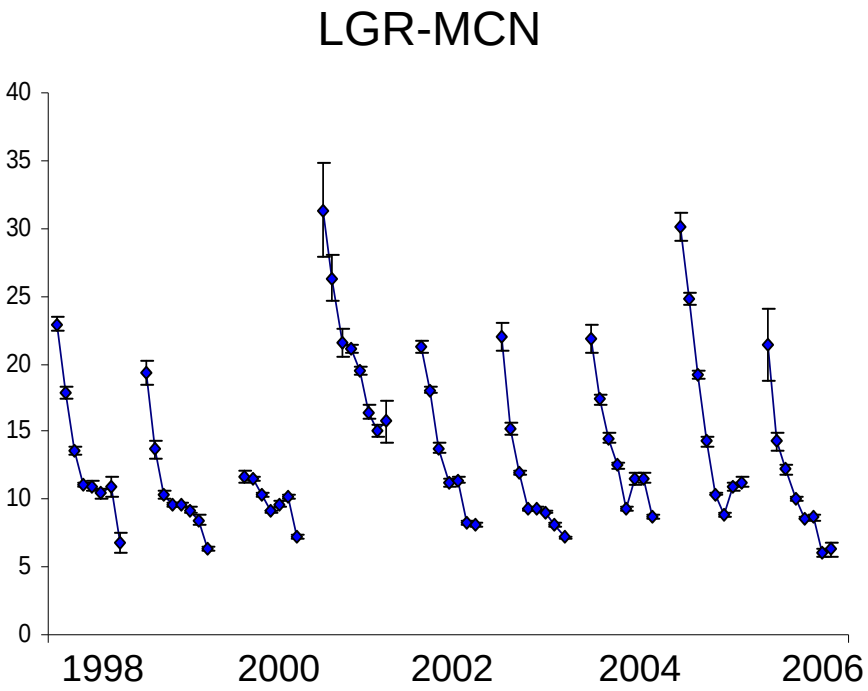
- Temperature
- Turbidity
- Flow (kcfs)
- Flow $^{-1}$
- Water travel time (WTT, days)
- Average percent spill
- Seasonality (Julian Day)

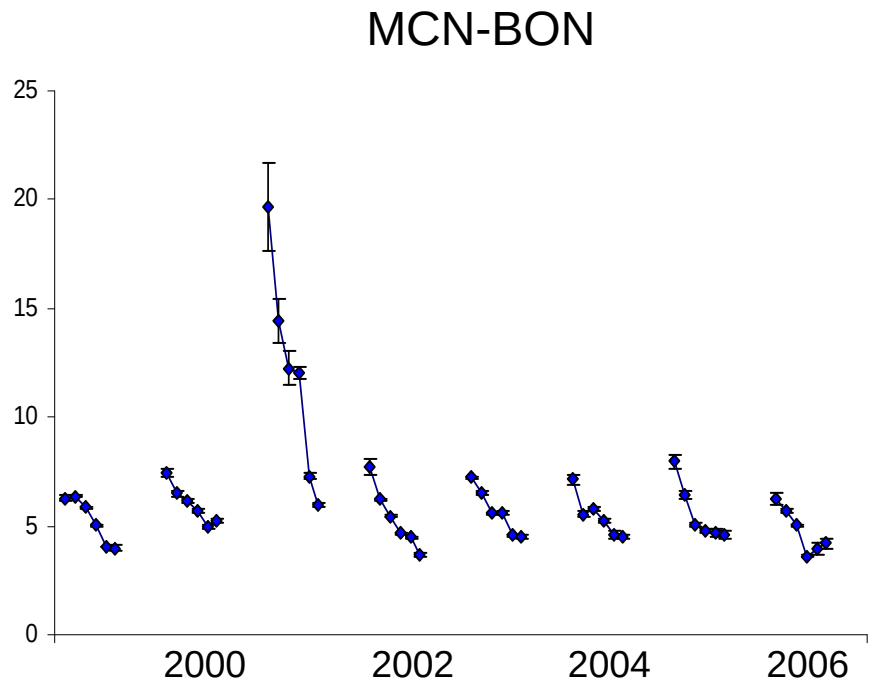
Yearling Chinook median fish travel times





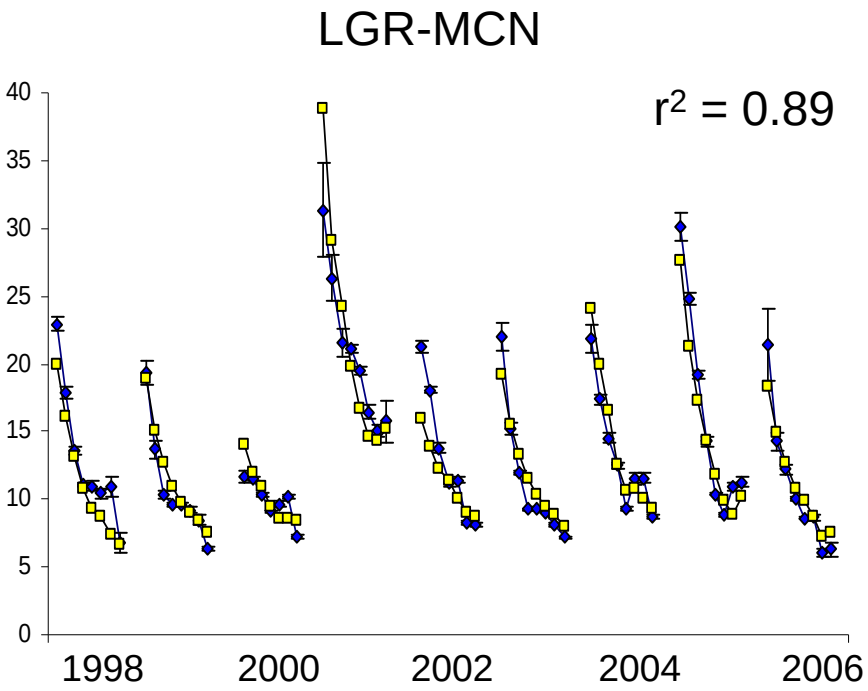
Yearling Chinook median fish travel times

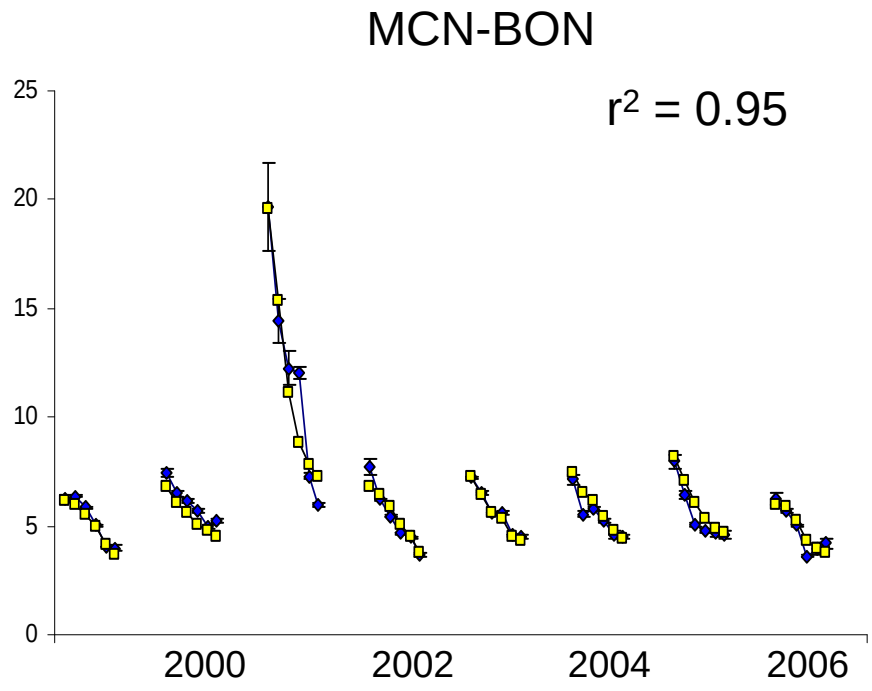




Environmental and management factors: WTT, percent spill, Julian day

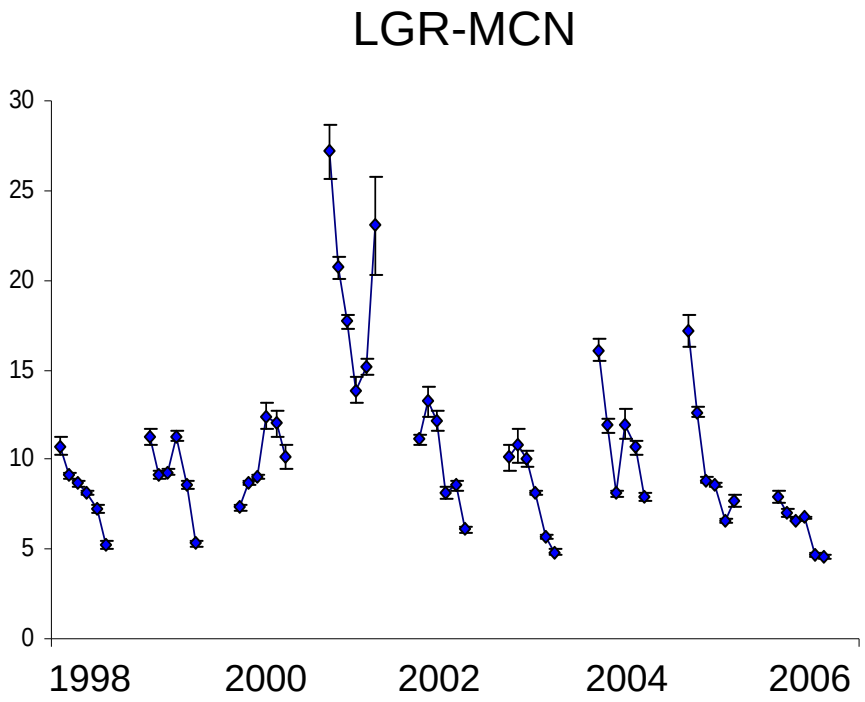
Yearling Chinook median fish travel times

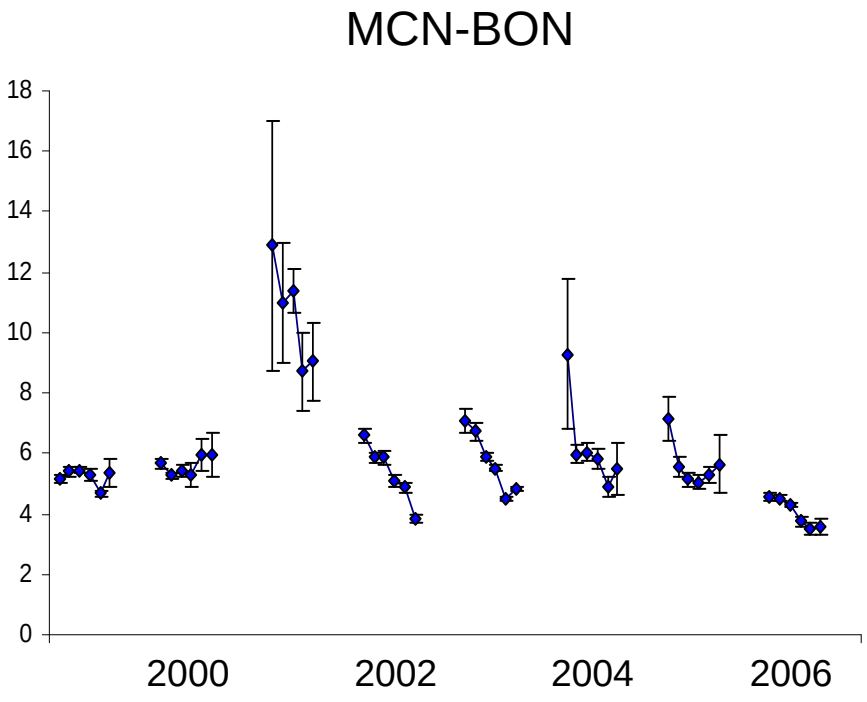




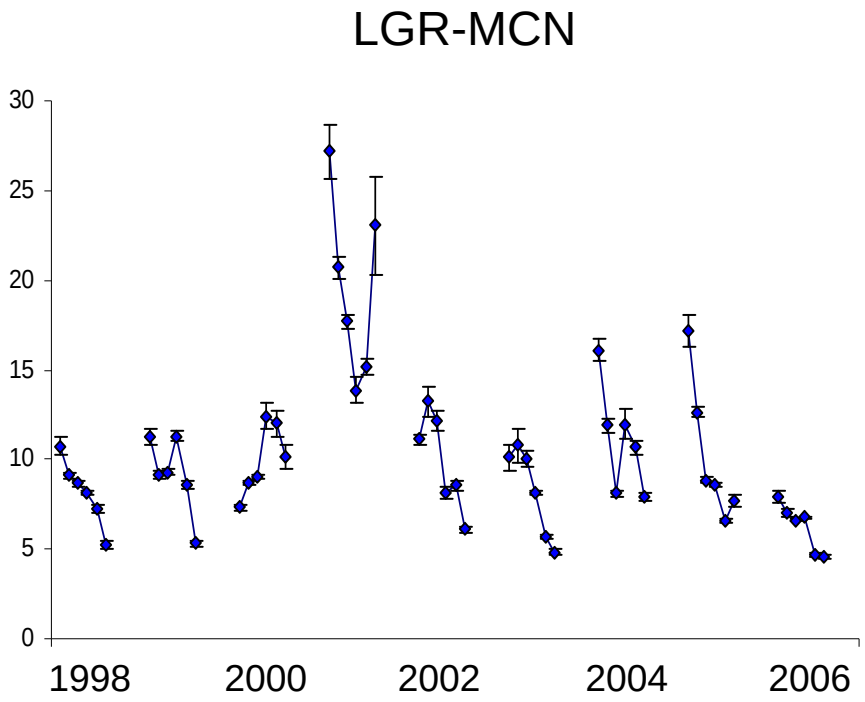
Environmental and management factors: WTT, percent spill, Julian day

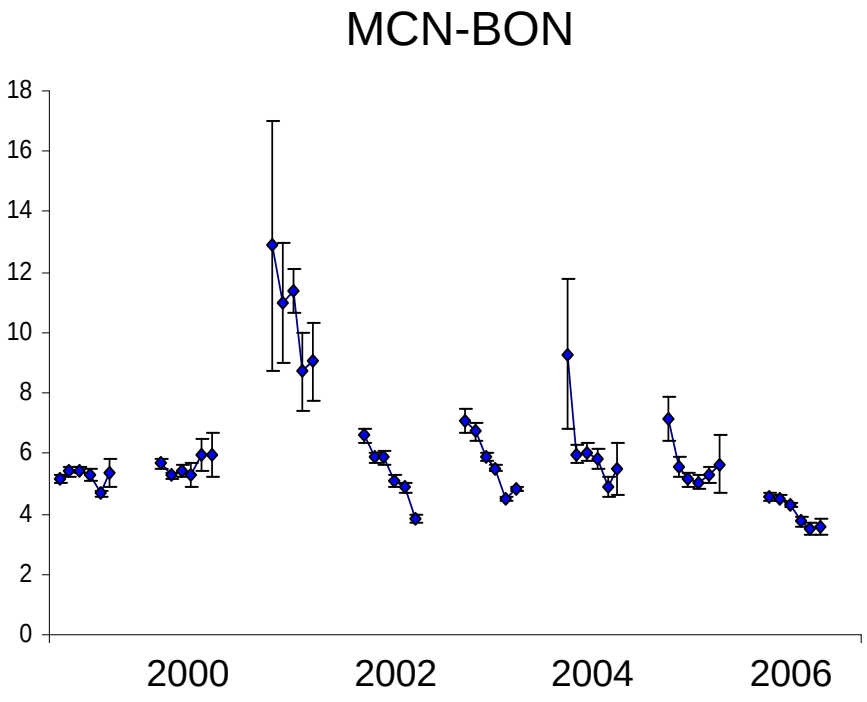
Steelhead median fish travel times





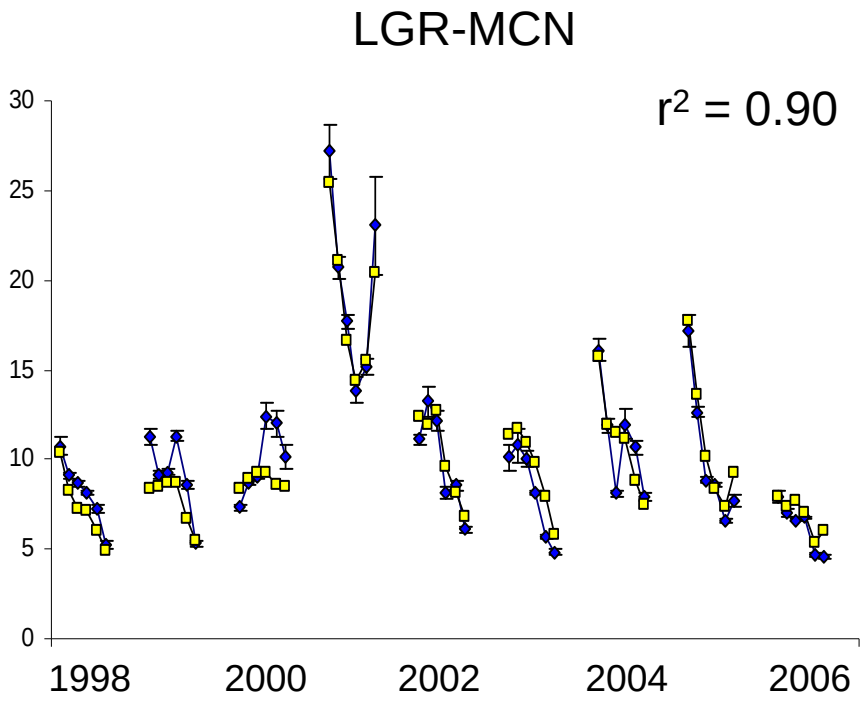
Steelhead median fish travel times

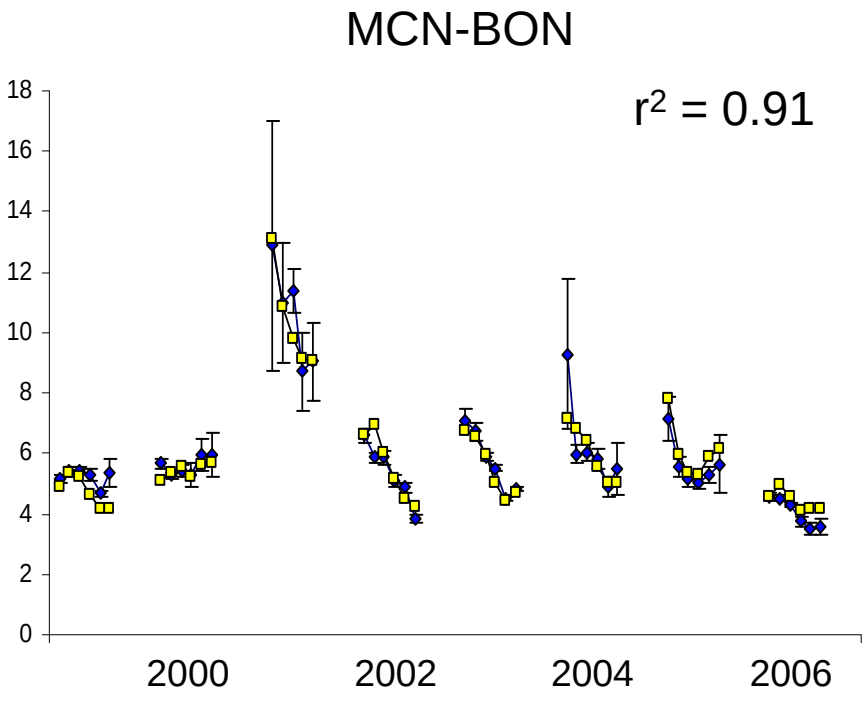




Environmental and management factors: WTT, percent spill, Julian day

Steelhead median fish travel times

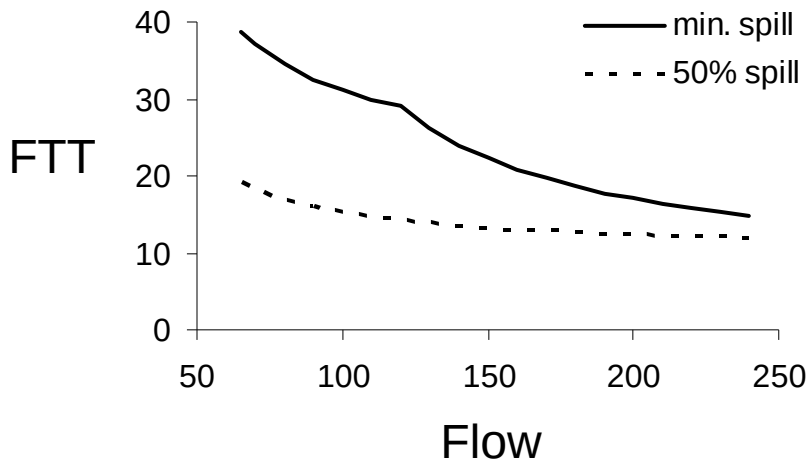




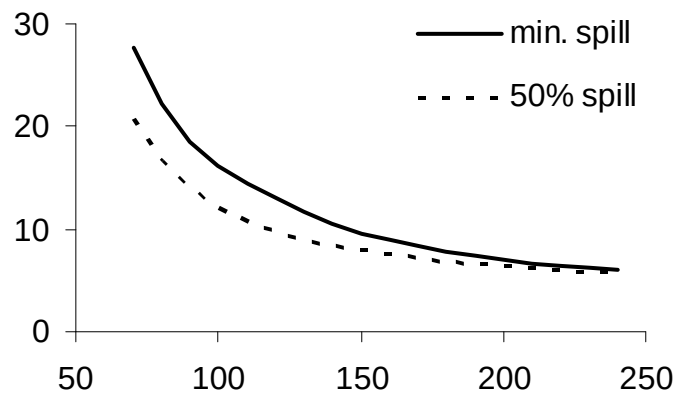
Environmental and management factors: WTT, percent spill, Julian day

LGR-MCN

Chinook

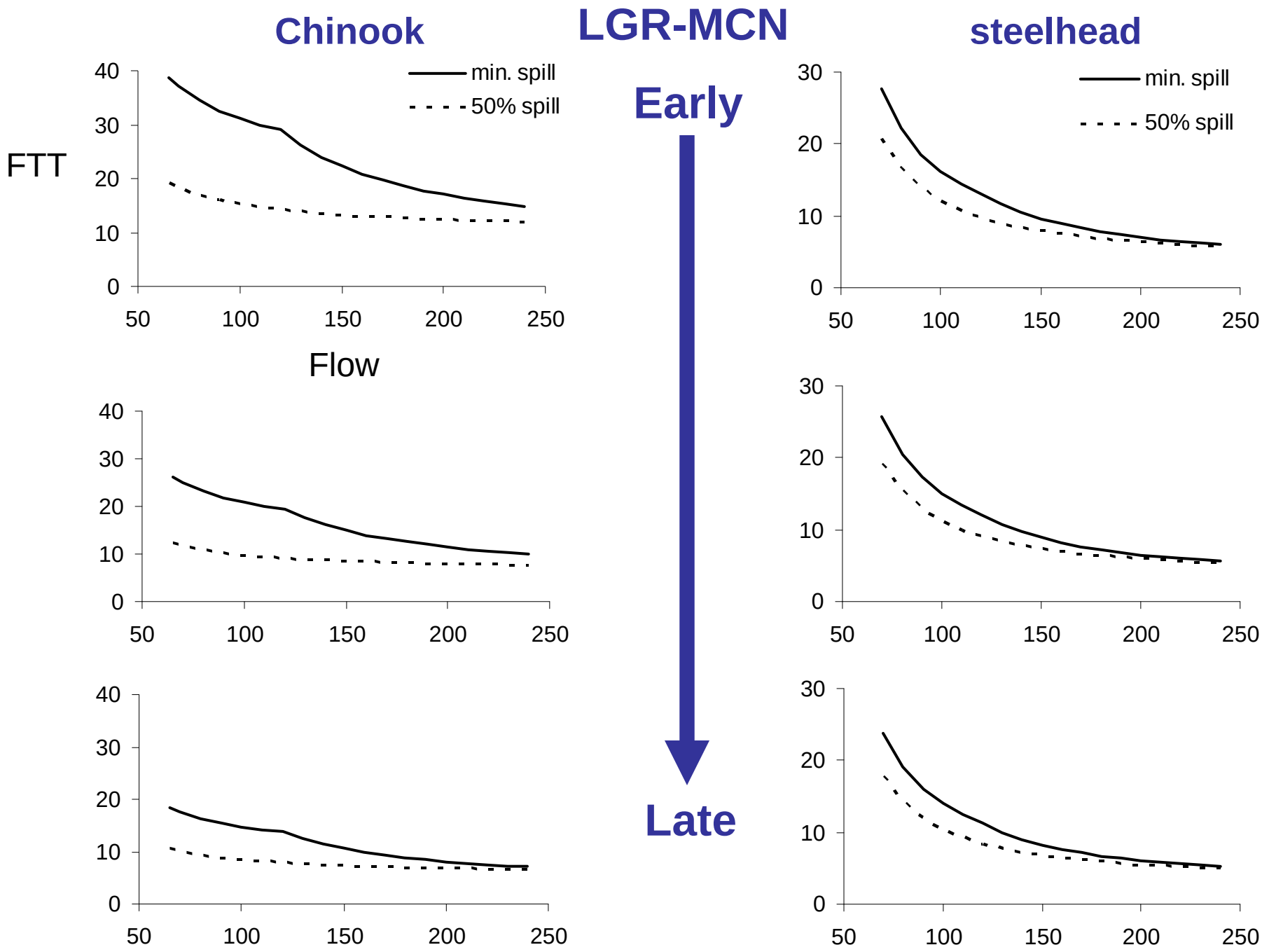


steelhead

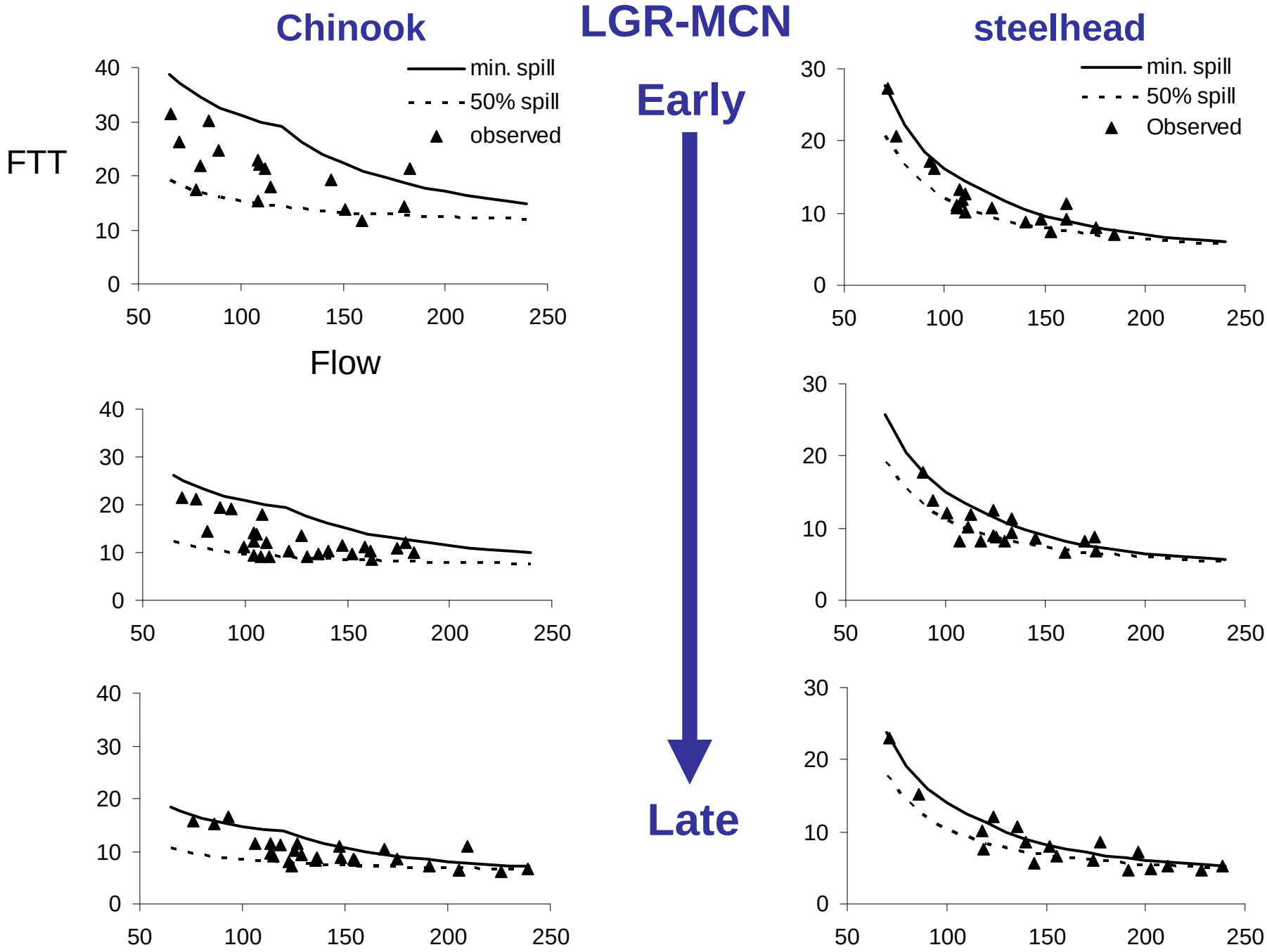


Early

Late


LGR-MCN
Chinook
steelhead
Early
Late
FTT
Flow
min. spill
50% spill
0
10
20
30
40
50
100
150
200
250

LGR-MCN


Chinook
steelhead
Early
Late
FTT
Flow
min. spill
50% spill
observed
Observed
0
10
20
30
40
50
100
150
200
250

Instantaneous mortality

Exponential law of population decline:

$$\frac{N_t}{N_0} = S = e^{-Z \cdot t}$$

Rearranging:

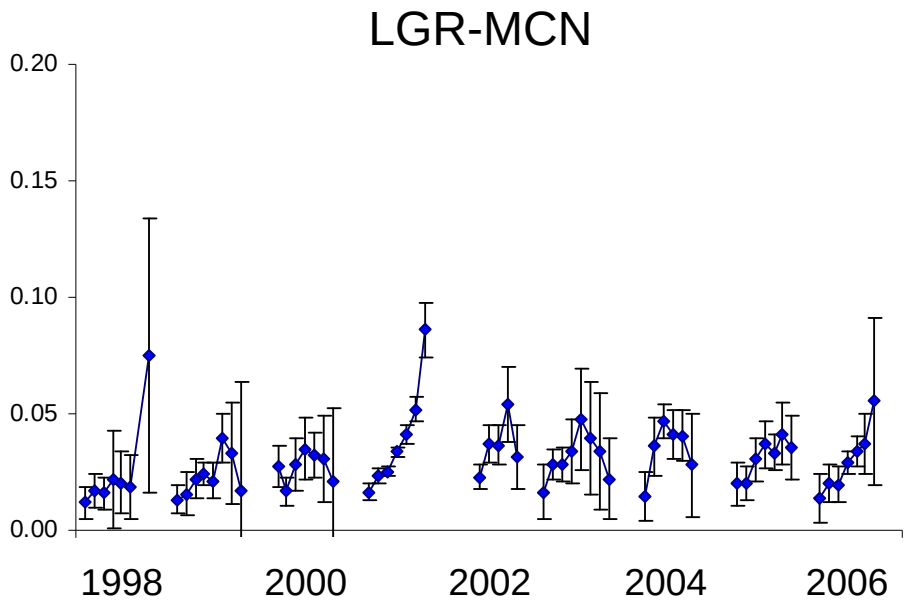
$$Z = \frac{-\log_e(S)}{t}$$

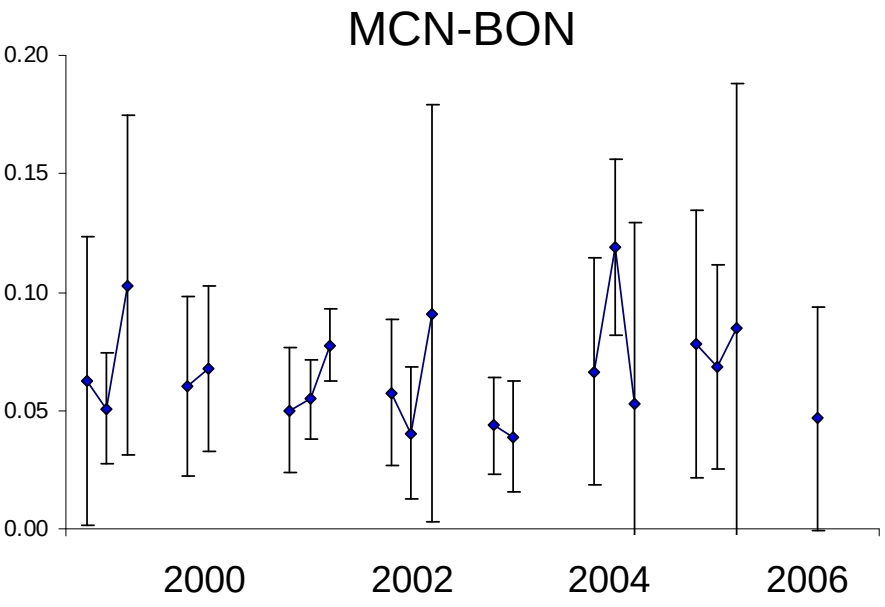
ML estimate of Z: $\hat{Z} = \frac{-\log_e(\hat{S})}{t}$

In this application:

$$\hat{Z}_{LGR-MCN} = \frac{-\log_e(\hat{S}_{LGR-MCN})}{F\hat{T}T_{LGR-MCN}}$$

Yearling Chinook instantaneous mortality rates (Z)





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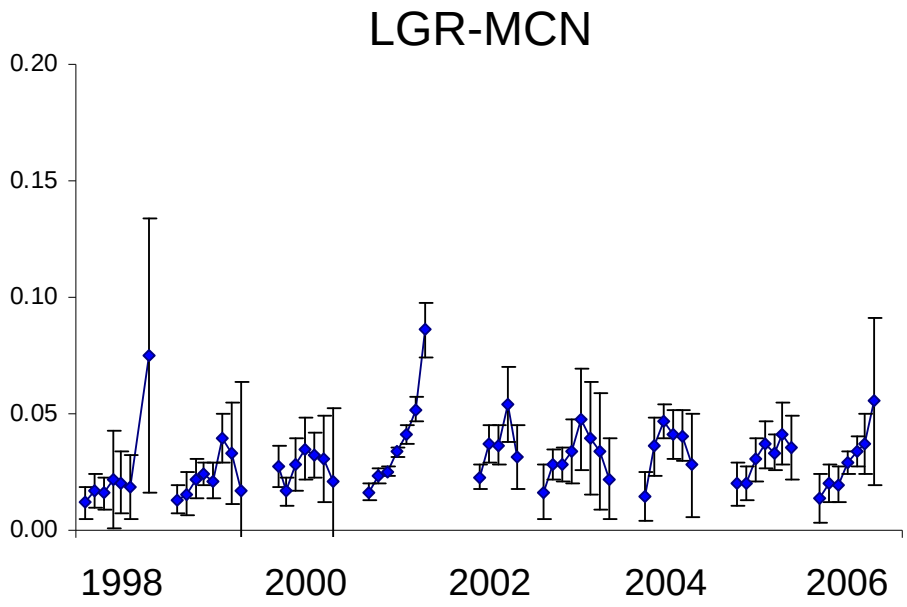
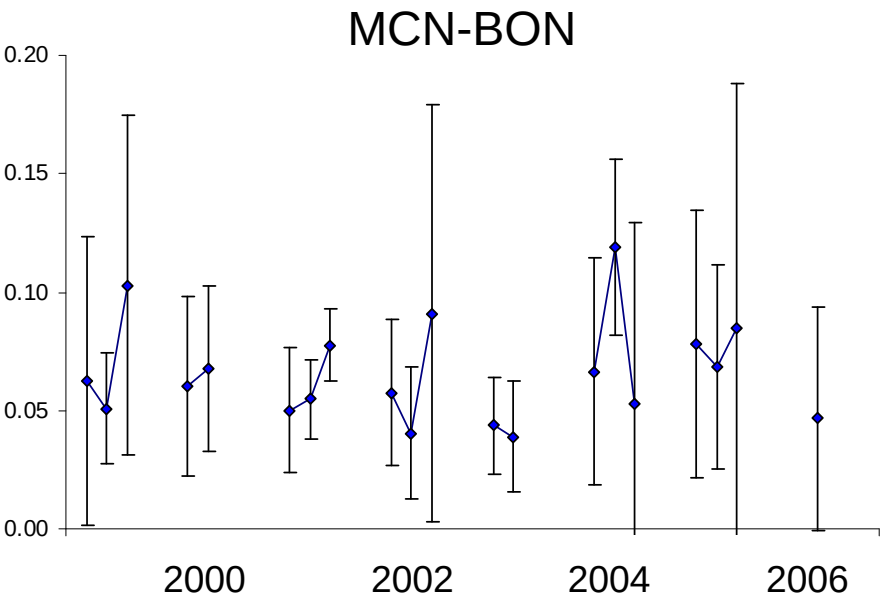


Factors: WTT, Julian Day



Factors: Julian Day

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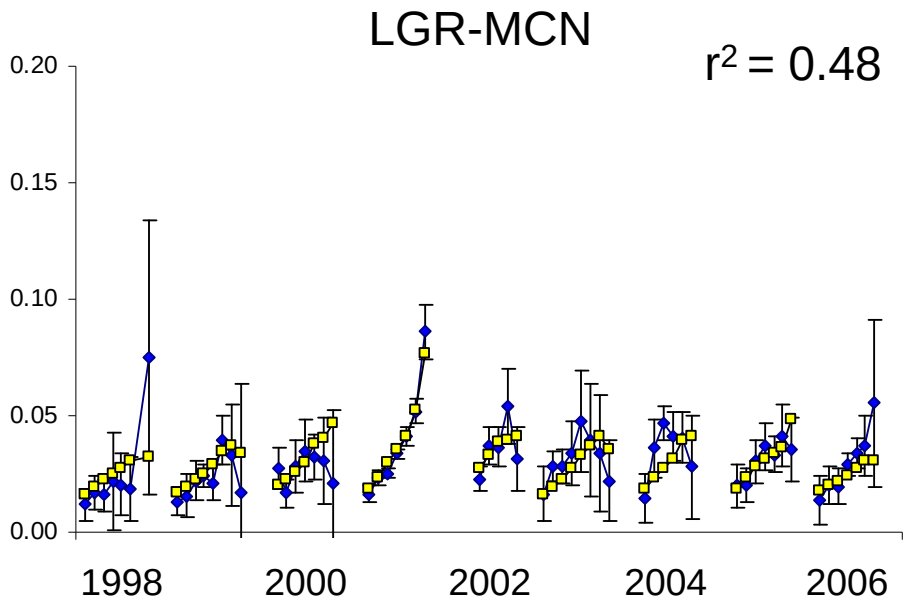
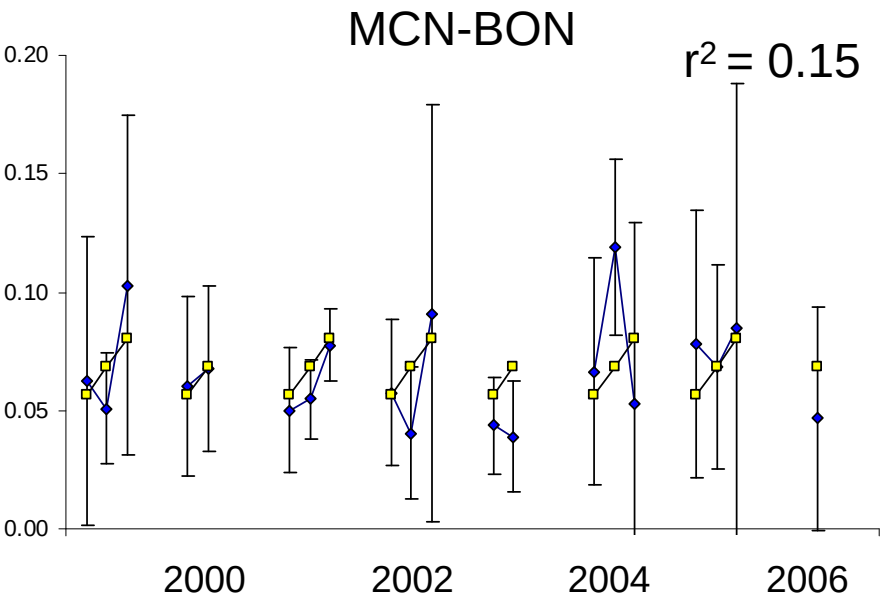
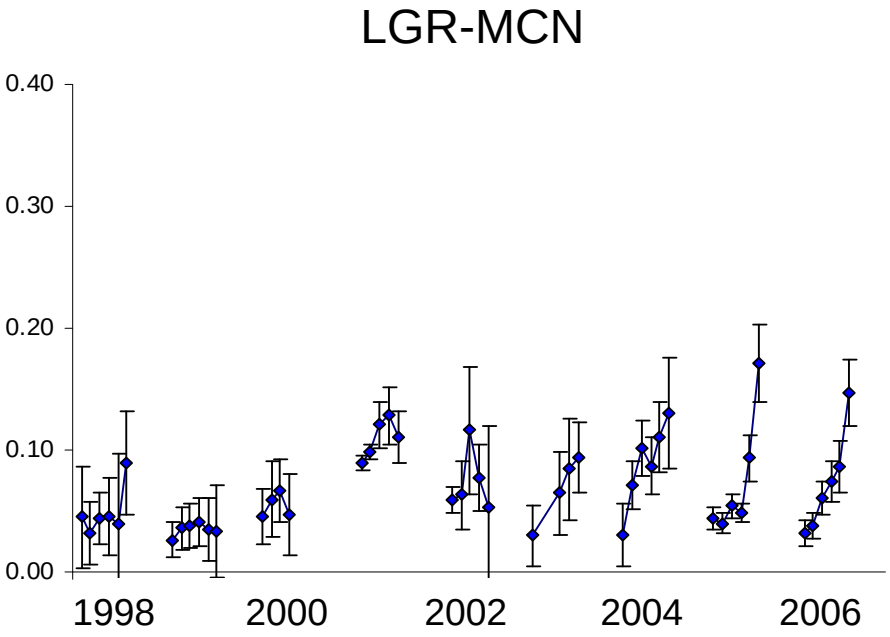


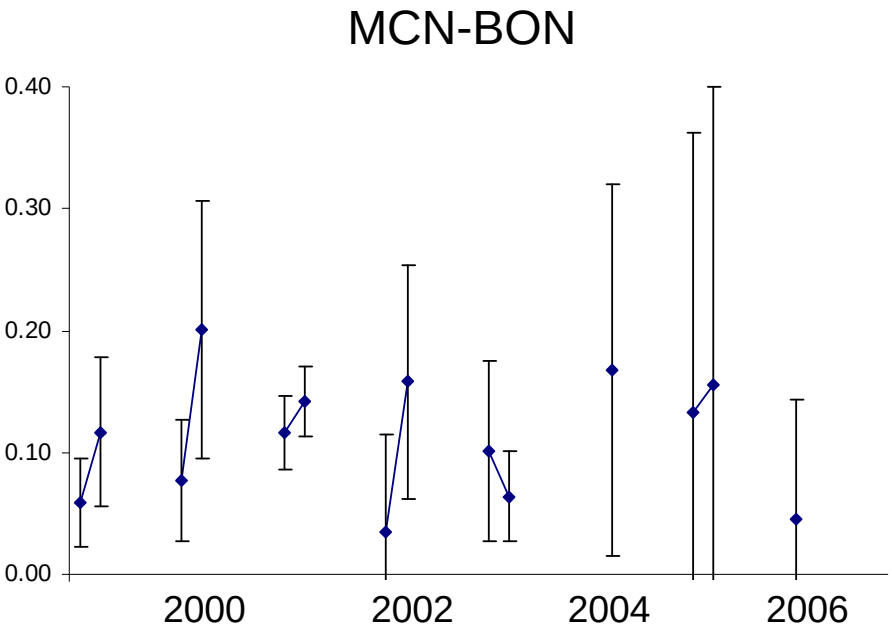


Factors: WTT, Julian day

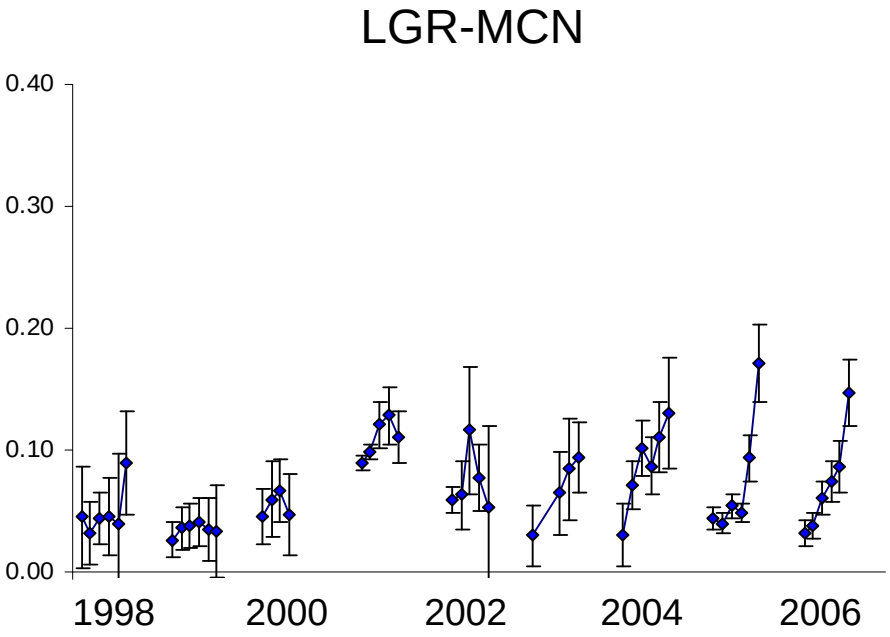
Factors: Julian day

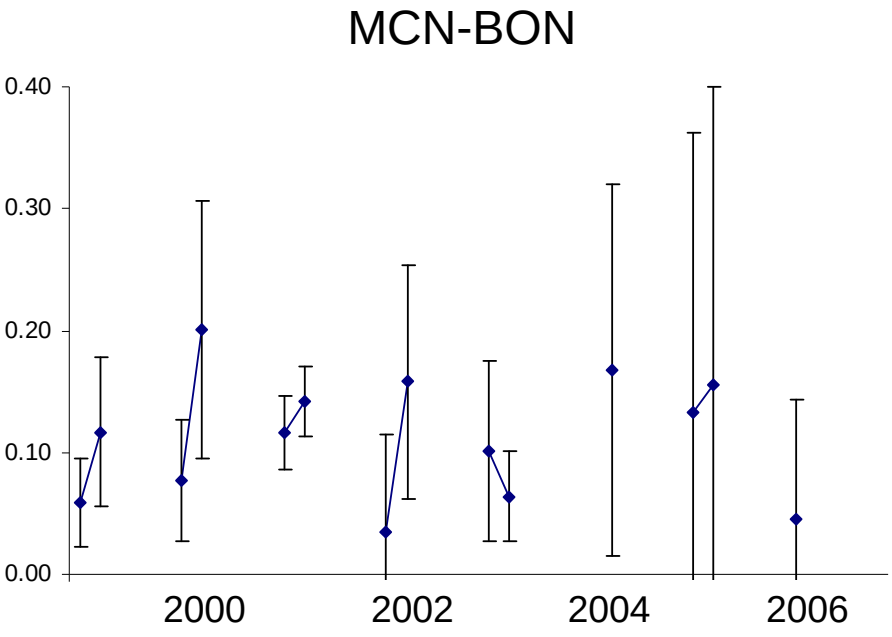
Steelhead instantaneous mortality rates (Z)





Steelhead instantaneous mortality rates (Z)

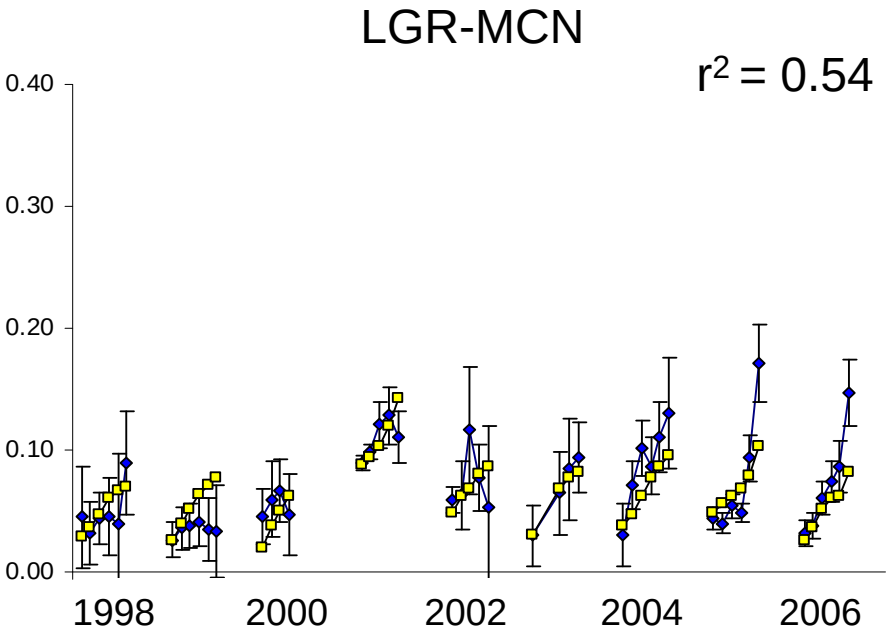


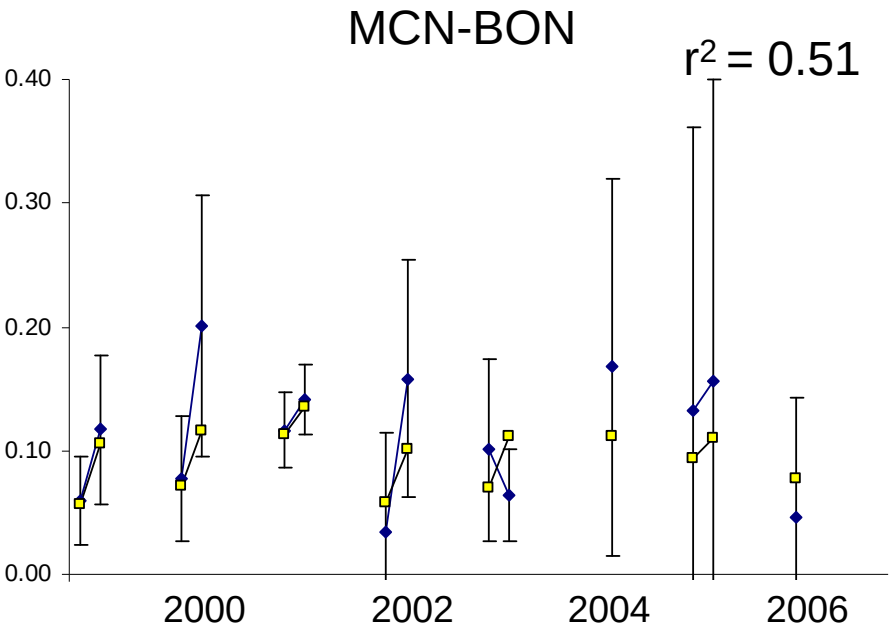


Factors: flow $^{-1}$, Julian day, spill

Factors: temperature

Steelhead instantaneous mortality rates (Z)





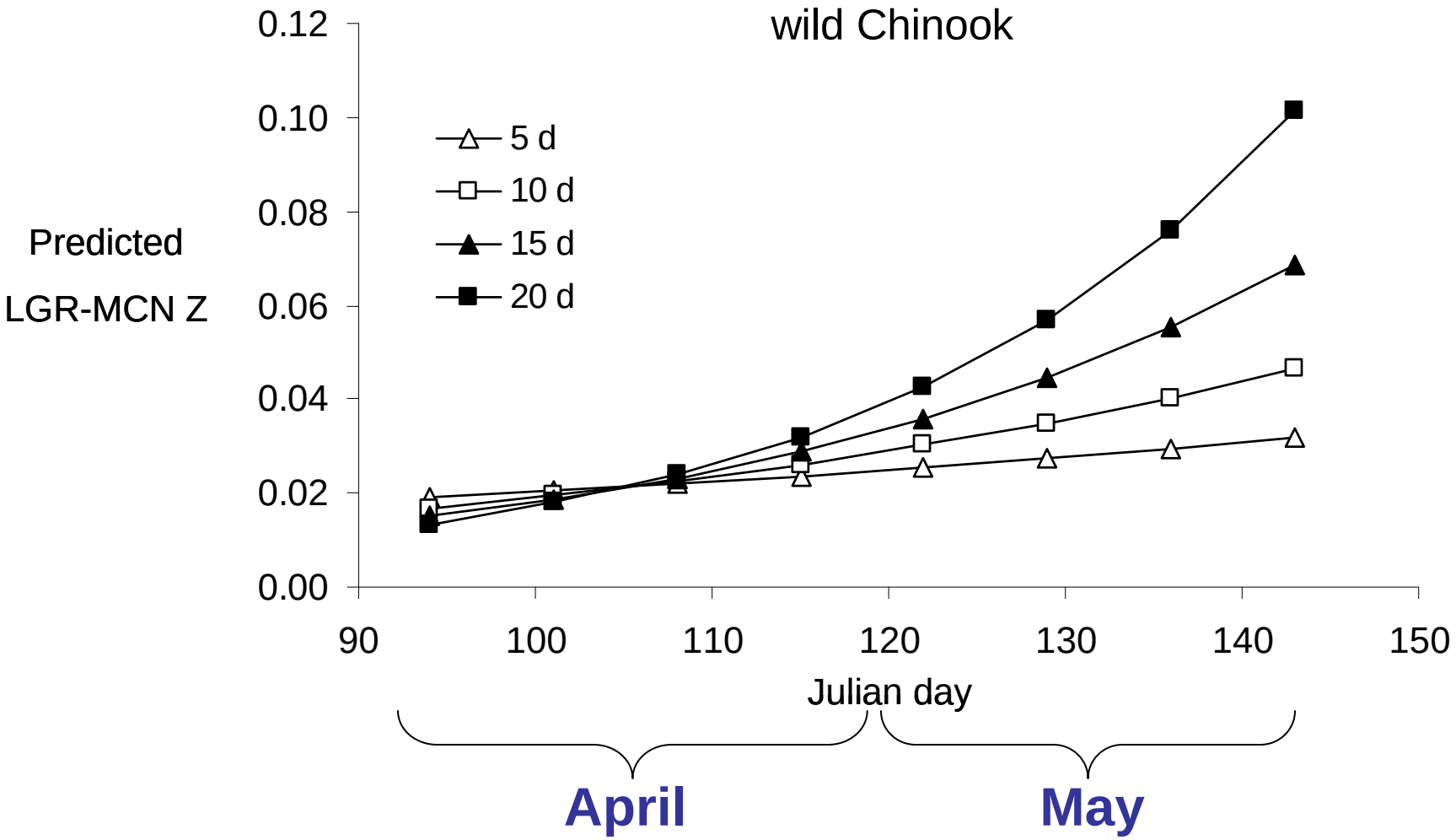
Factors: flow $^{-1}$, Julian day, spill

Factors: temperature

Daily percent mortality by species and reach:

	LGR-MCN		MCN-BON	
	CHW	STH&W	CHH&W	STH&W
Daily percent mortality (mean Z)	3.0%	6.7%	6.4%	10.6%

Predicted relationship for instantaneous mortality



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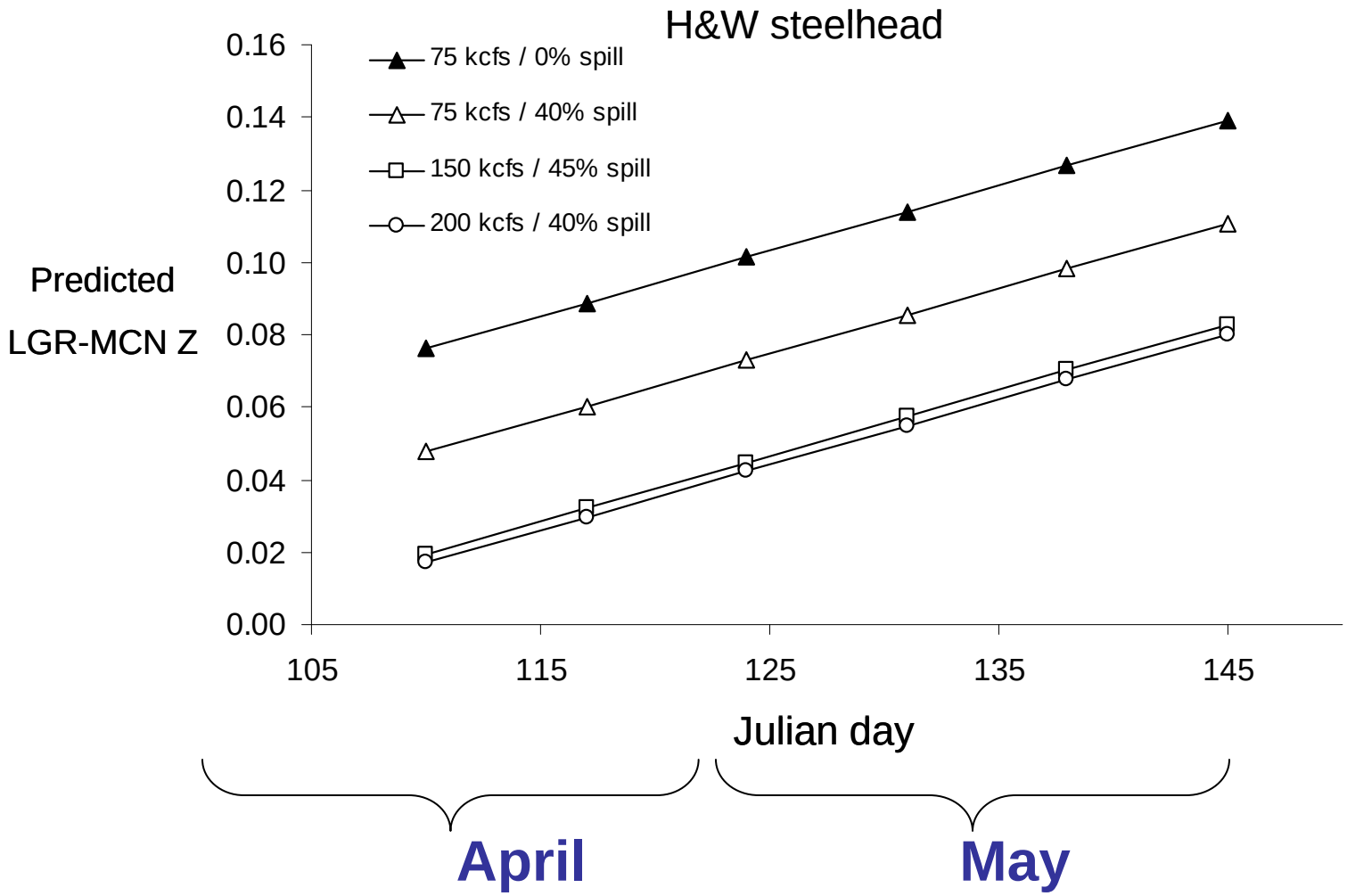


Environmental and management factors consistent across survival approaches

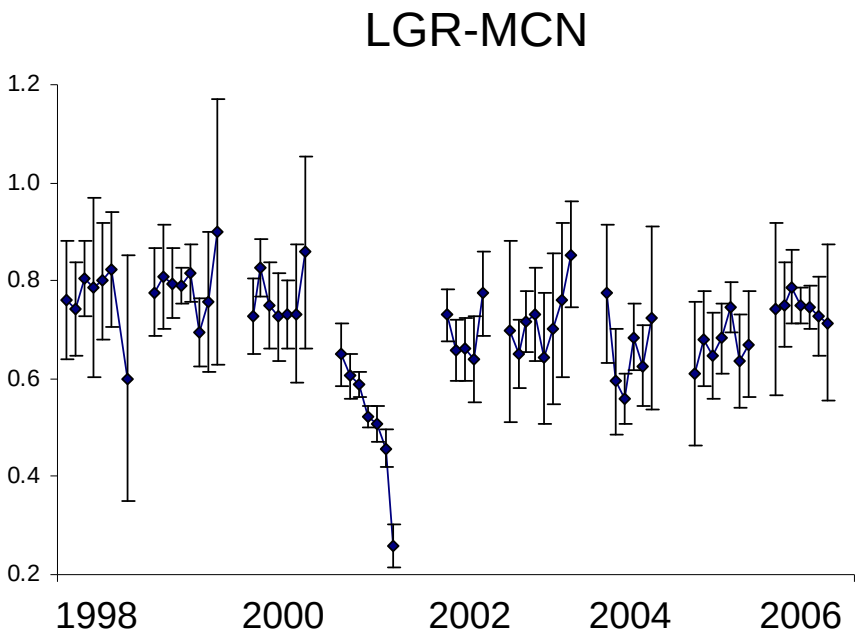
CHW, LGR-MCN

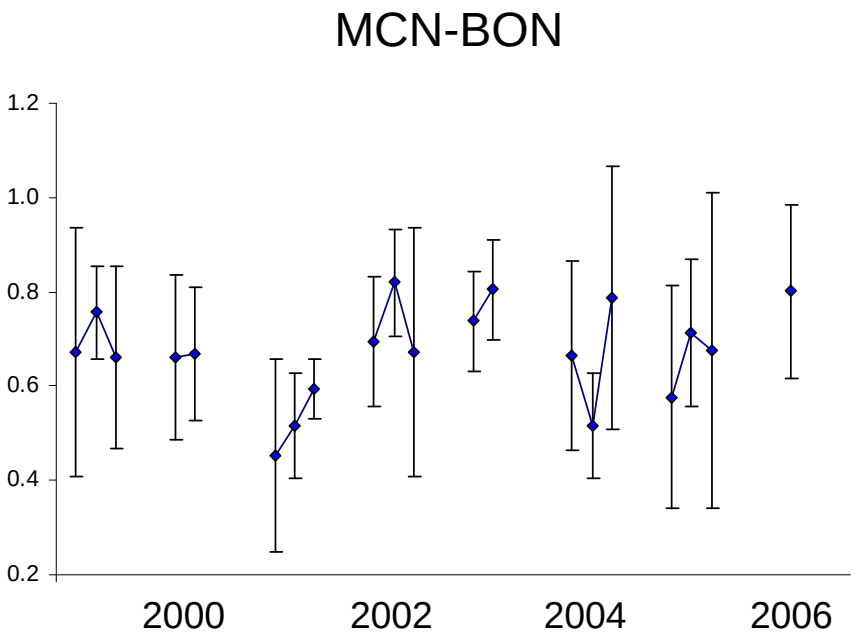
Variable Z	Standard
WTT	WTT
Spill	Spill
Julian day	Julian day

STH&W, LGR-MCN

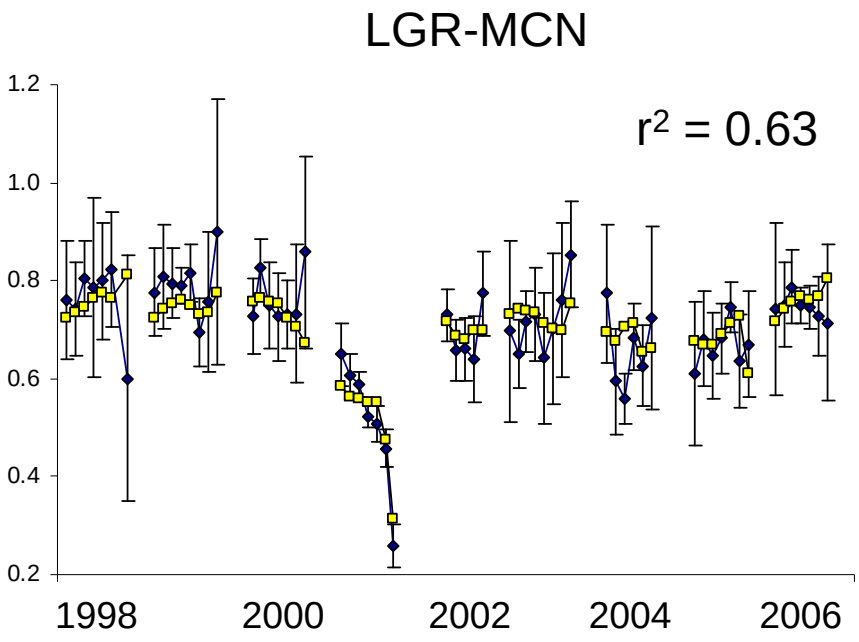
Variable Z	Standard
WTT	
Flow $^{-1}$	Flow $^{-1}$
Spill	Spill
Julian day	Julian day

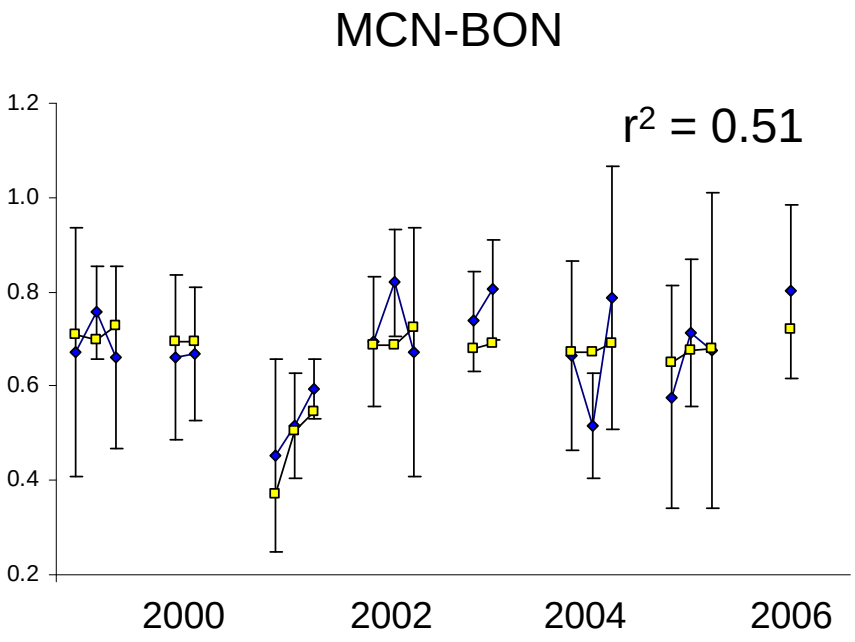
Yearling Chinook survival



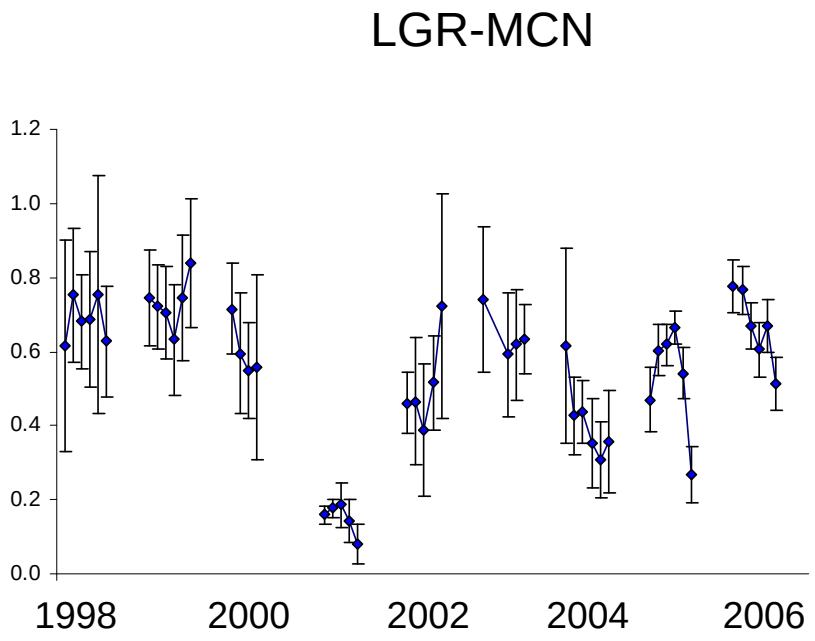


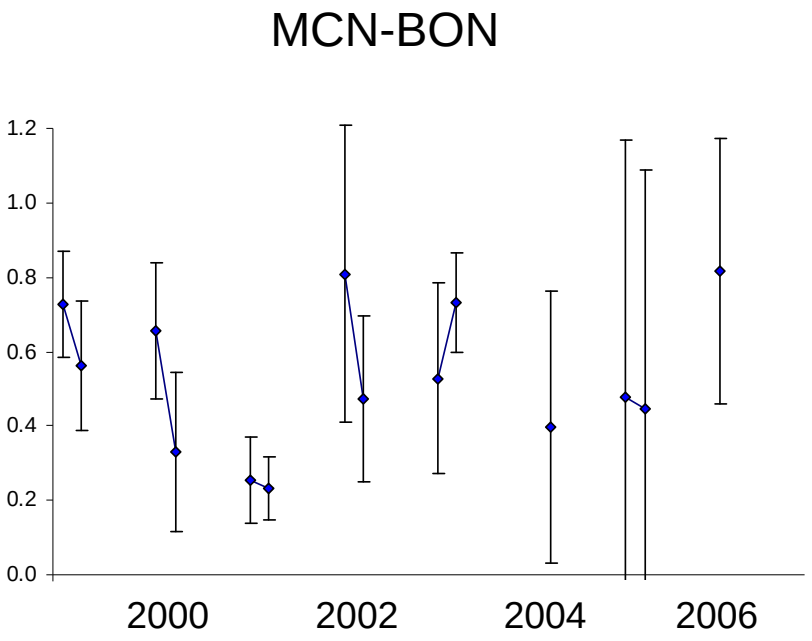
Yearling Chinook survival



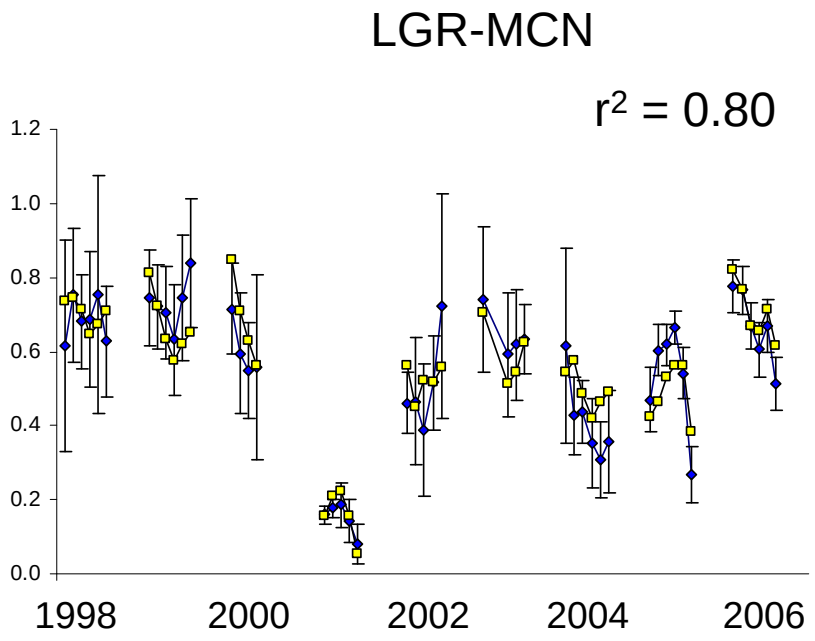


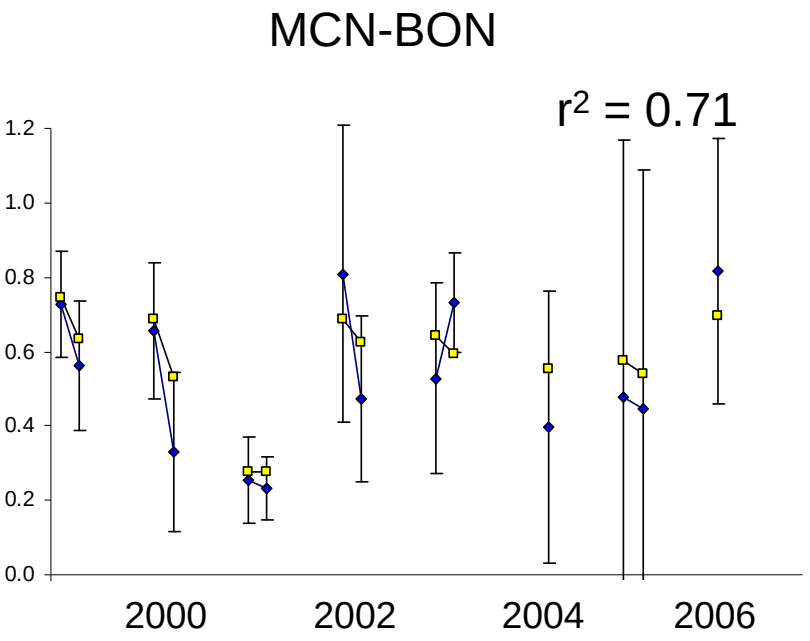
steelhead survival



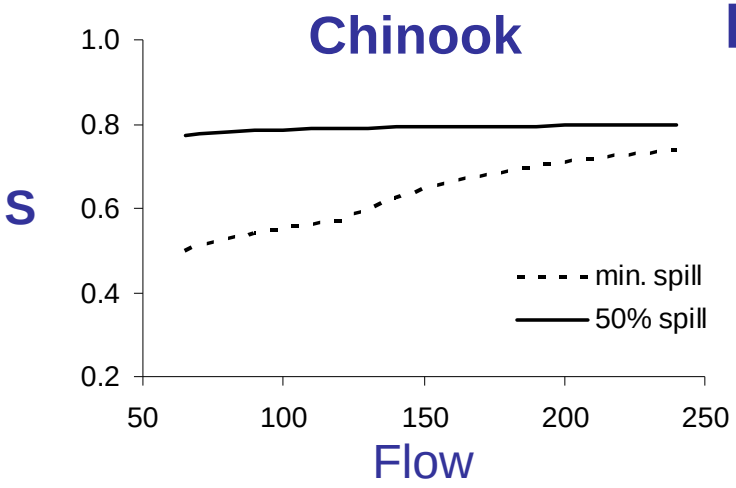


steelhead survival

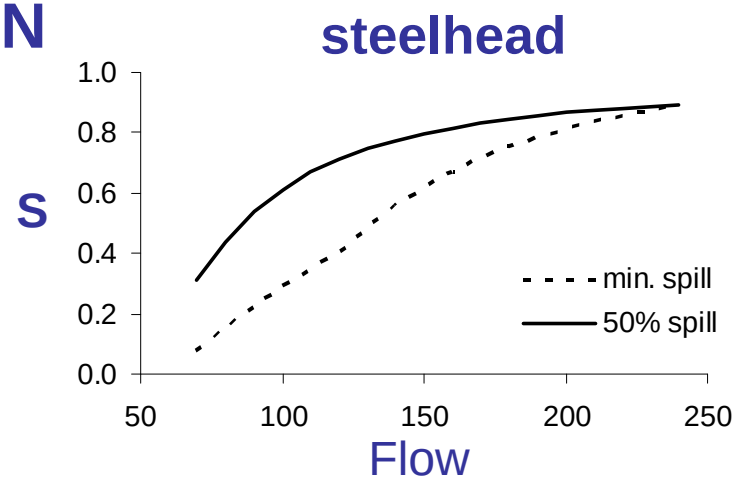




LGR-MCN

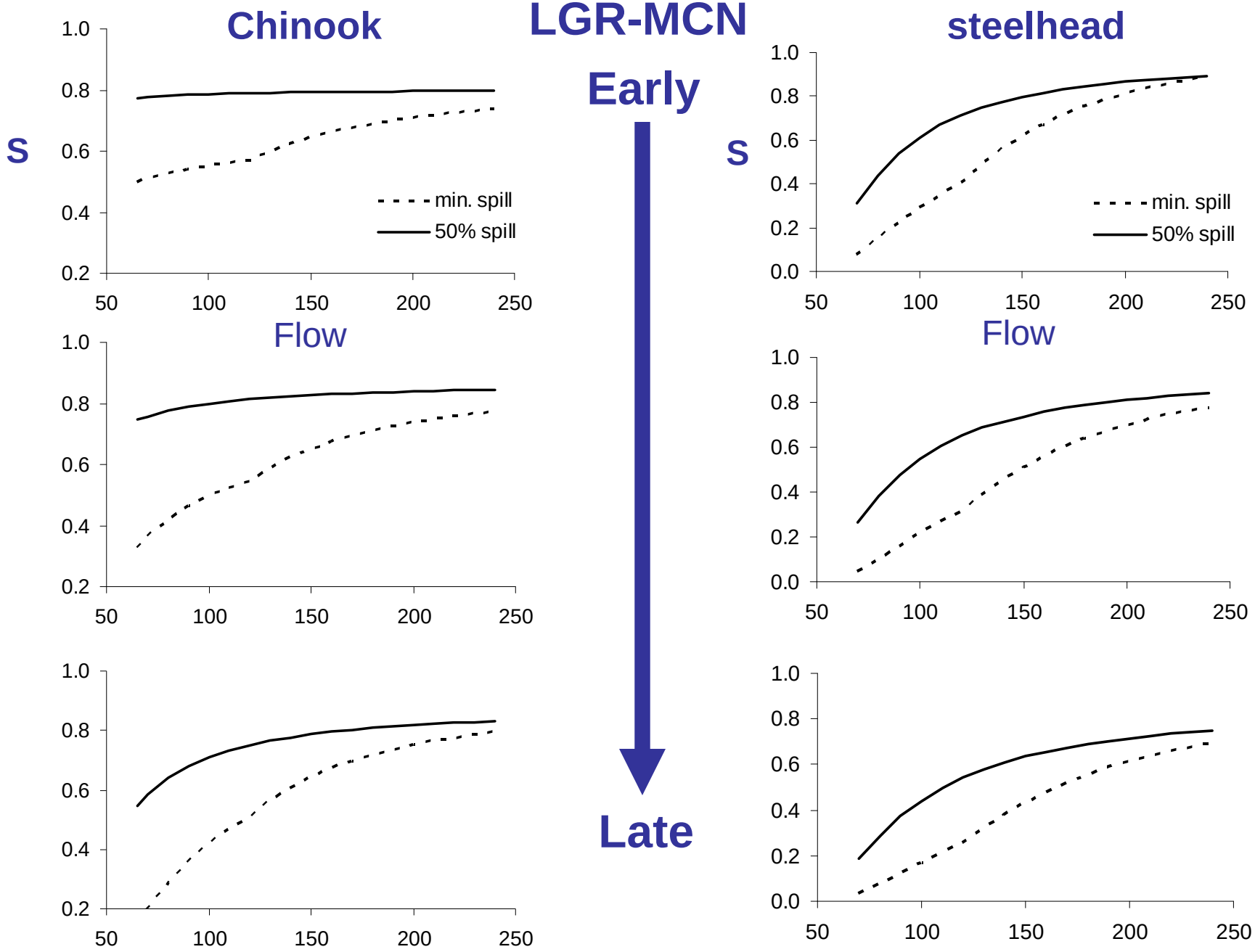


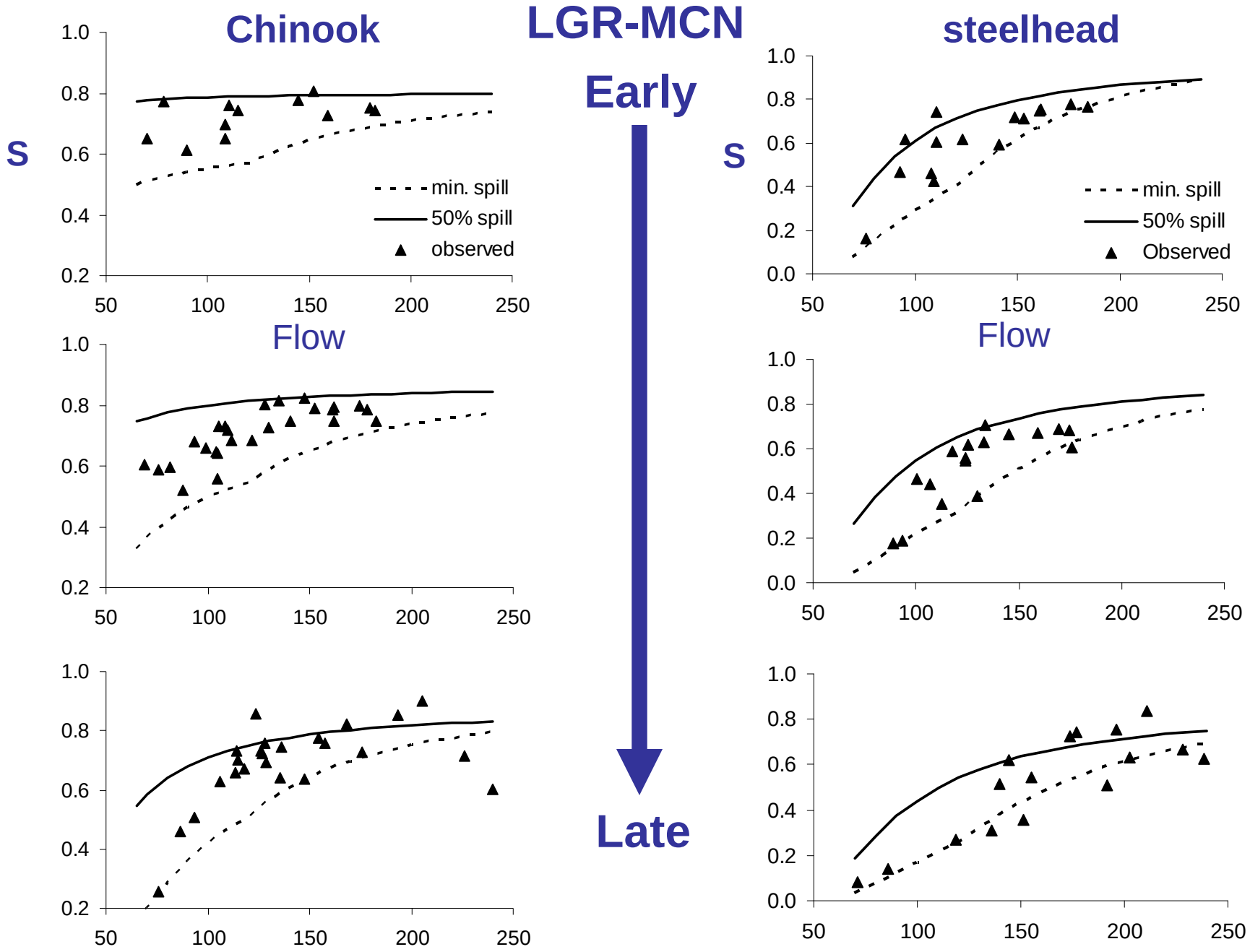
Early



Late

LGR-MCN


Chinook
steelhead
Early
Late
s
s
Flow
Flow
min. spill
50% spill
min. spill
50% spill
1.0
0.8
0.6
0.4
0.2
0.0
50
100
150
200
250


LGR-MCN
Chinook
steelhead
Early
Late
s
s
Flow
Flow
min. spill
50% spill
observed
min. spill
50% spill
Observed
1.0
0.8
0.6
0.4
0.2
0.0
50
100
150
200
250

Conclusions

If spill levels were *increased*:

fish travel times would be *shorter* (both species, both reaches)

instantaneous mortality rates would be *lower* (steelhead, LGR-MCN)

juvenile survival rates would be *higher* (both species, both reaches)

Conclusions

Juvenile travel times, instantaneous mortality rates, and survival rates through the hydrosystem are strongly influenced by managed river conditions including flow, water travel time, and spill levels.

Statistical relationships were developed that can be used to predict the effects of environmental factors and management strategies on migration and survival rates of juvenile yearling Chinook and steelhead.

Analyses indicate that improvements in in-river survival and travel times can be achieved through management actions that reduce water travel time or increase the average percent spilled. The effectiveness of these actions varies over the migration season.