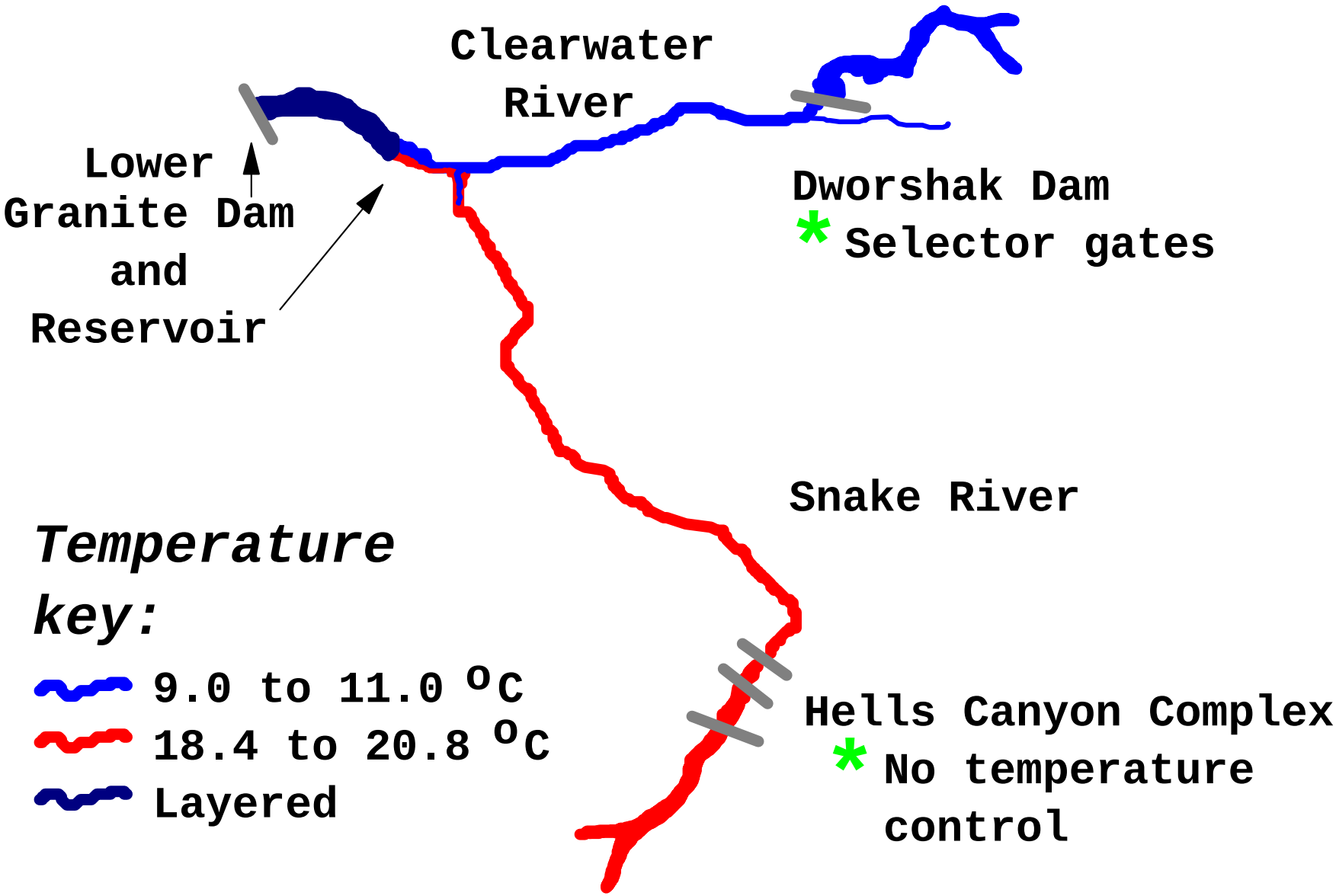
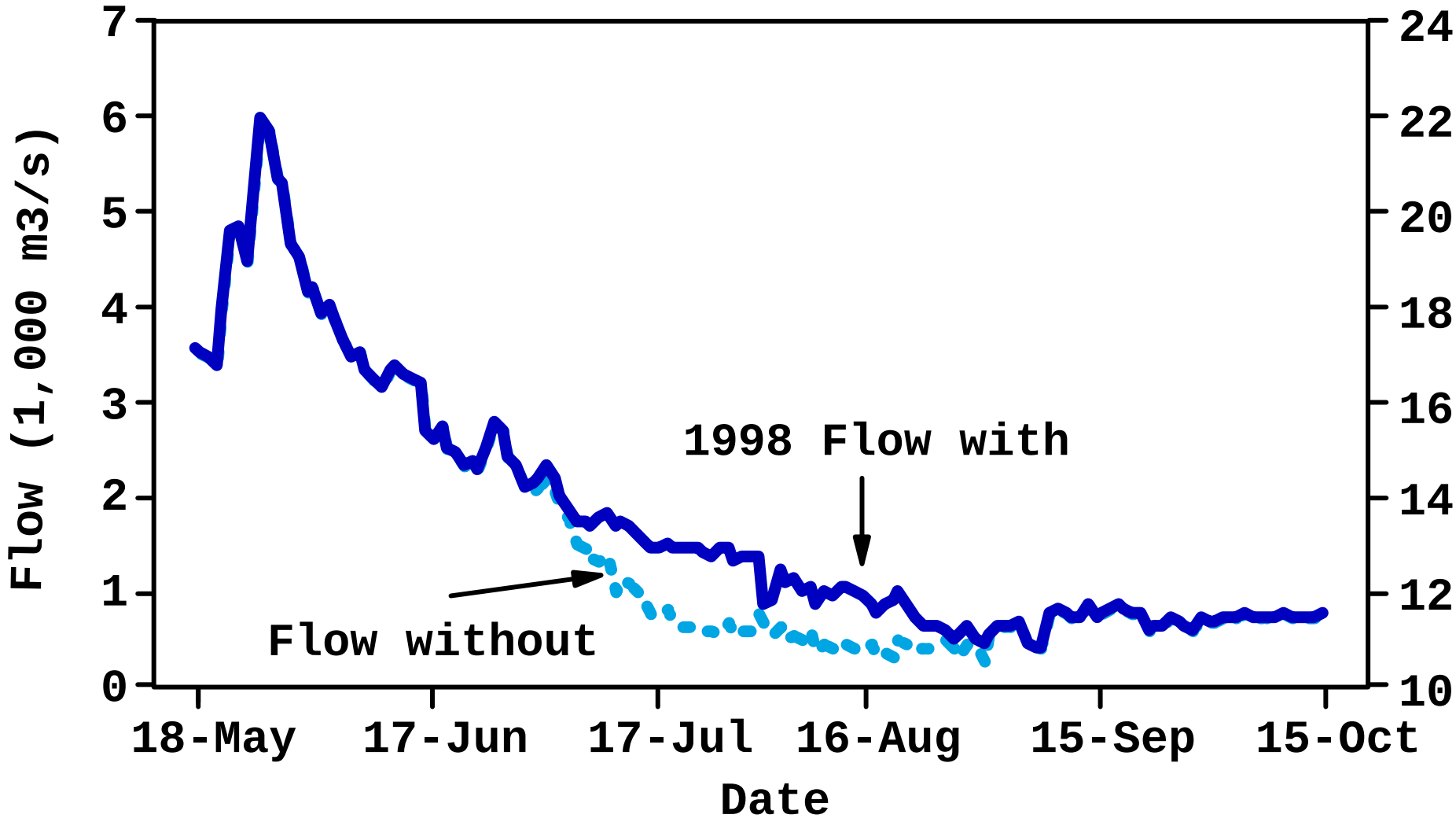
The effects of summer flow augmentation on the migratory behavior and survival of juvenile Snake River fall Chinook salmon

Project 199102900

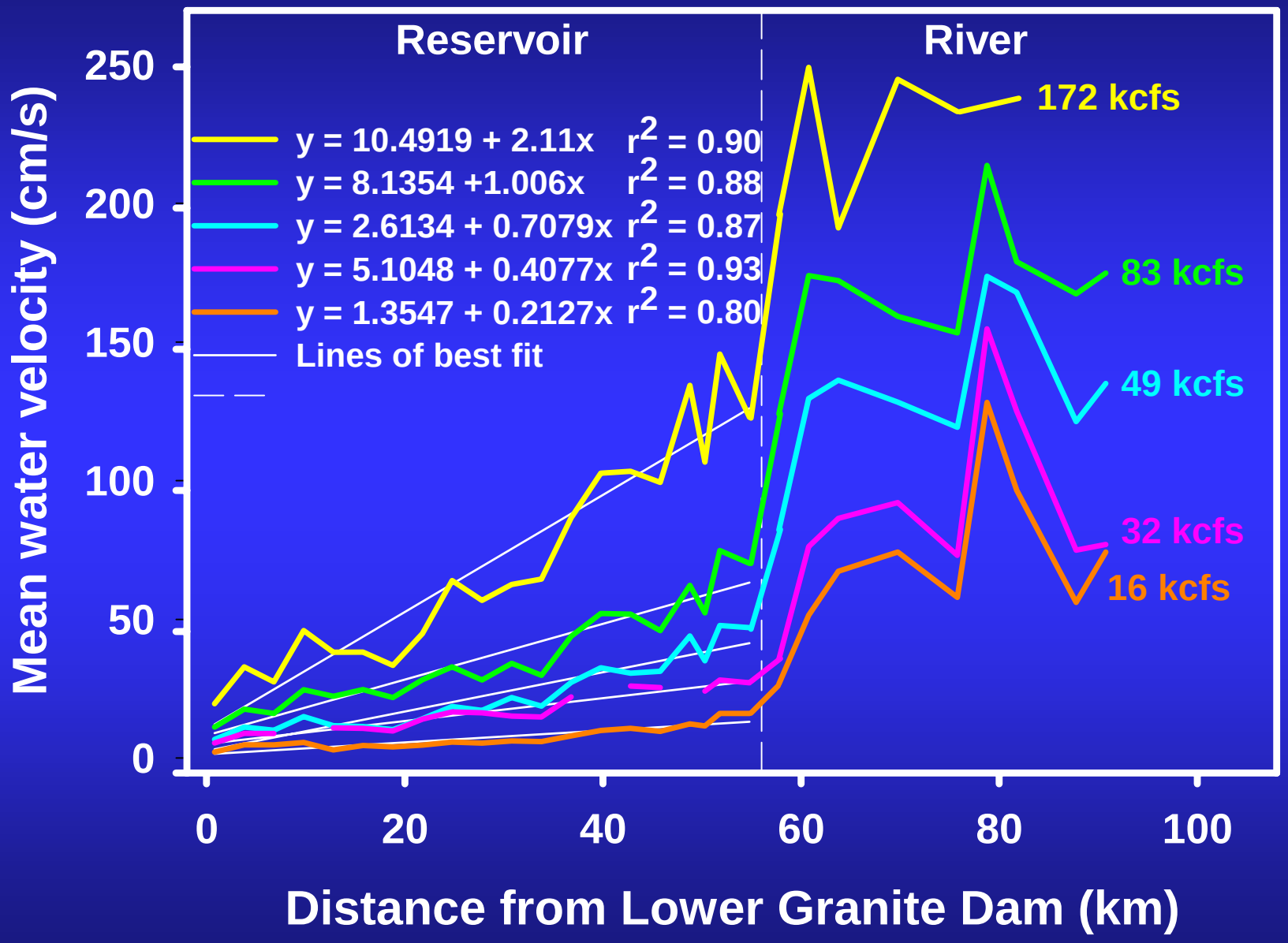

Clearwater River
Lower Granite Dam and Reservoir
Dworshak Dam
* Selector gates
Snake River
Temperature key:
9.0 to 11.0 °C
18.4 to 20.8 °C
Layered
Hells Canyon Complex
* No temperature control

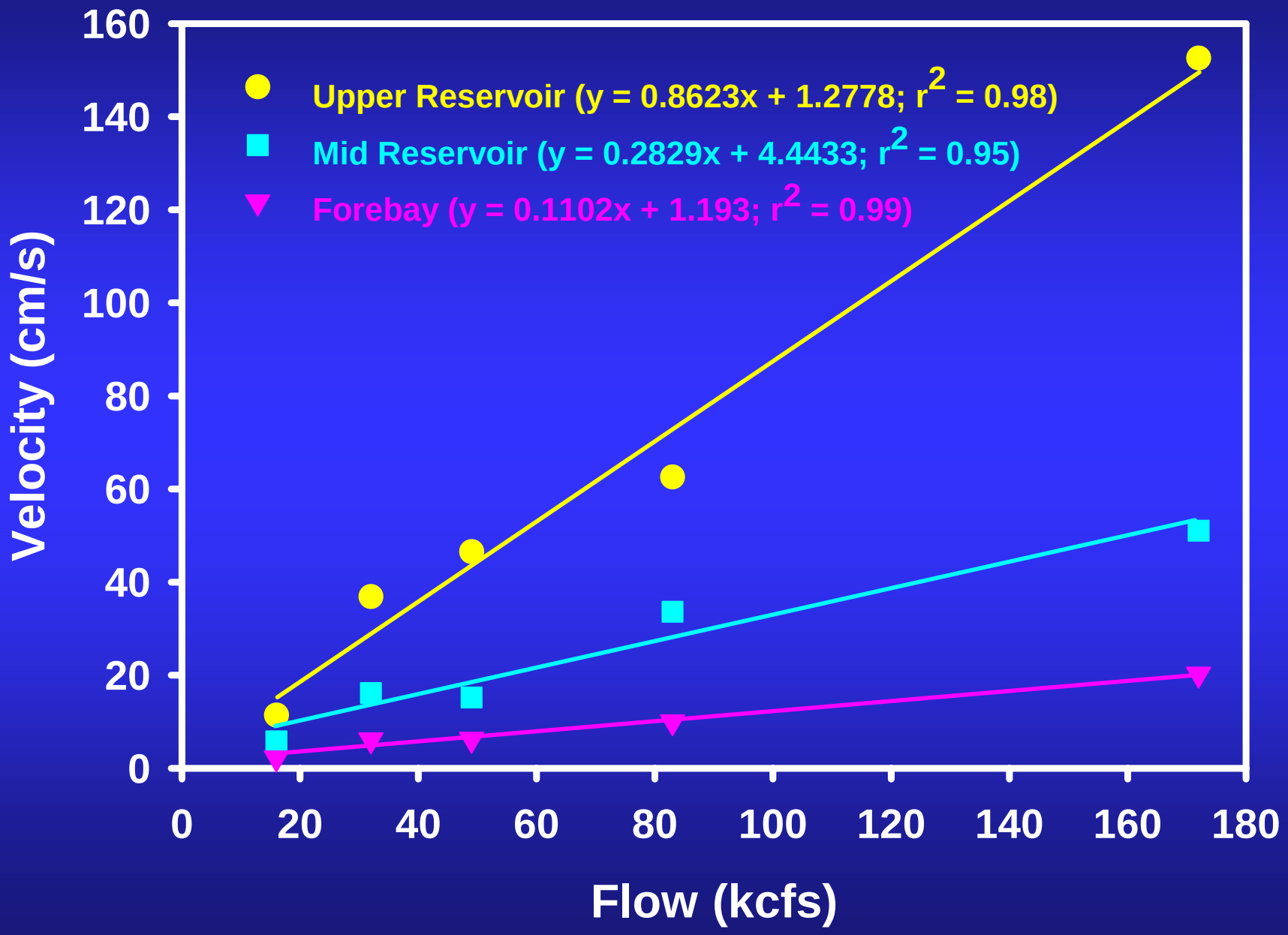
Flow in Lower Granite Reservoir with and without summer flow augmentation

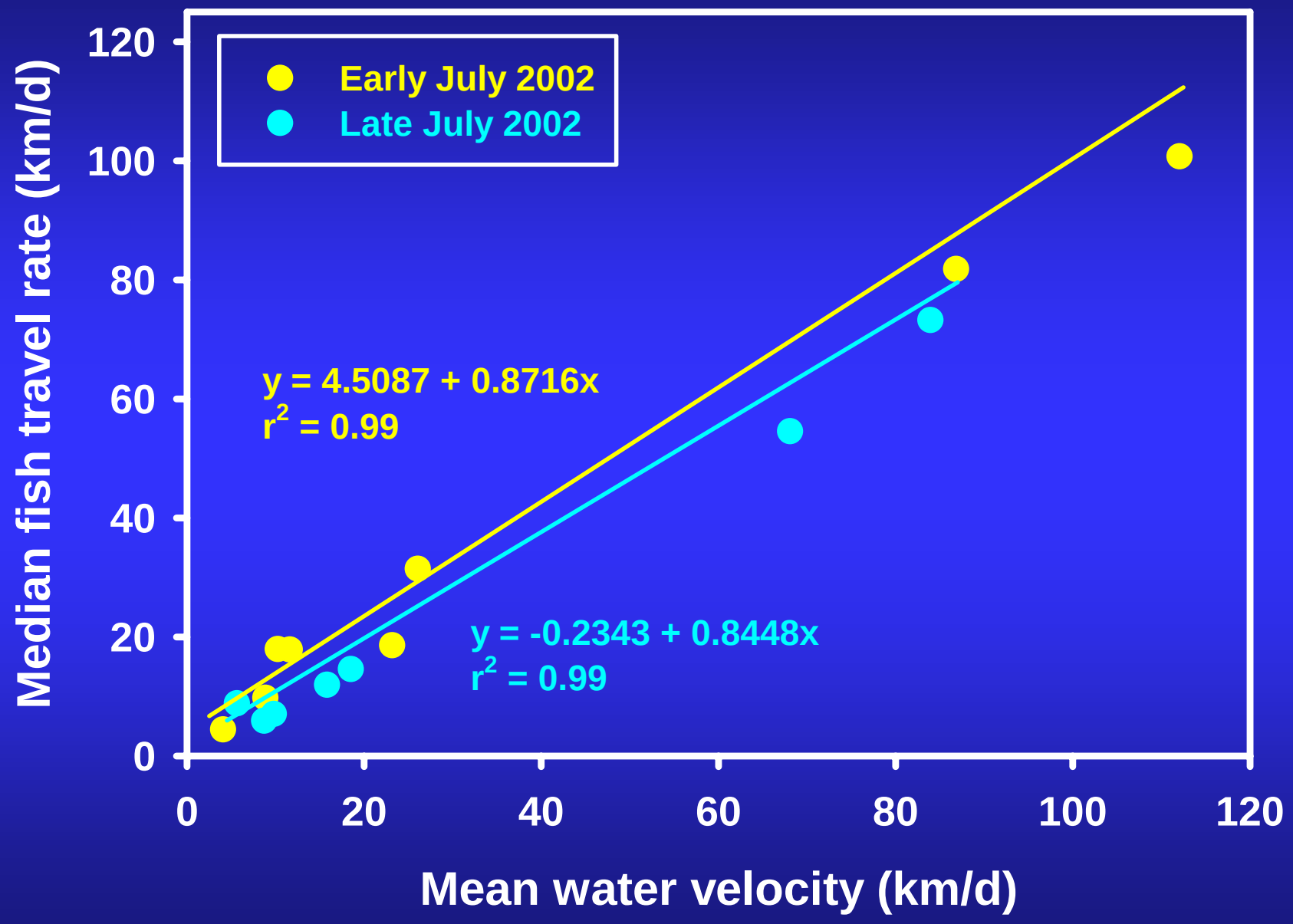


Objective:

Understand the relations between flow, water velocity, and juvenile fall Chinook salmon rates of travel in riverine and impounded habitat.


Reservoir
River
y = 10.4919 + 2.11x r2 = 0.90
y = 8.1354 +1.006x r2 = 0.88
y = 2.6134 + 0.7079x r2 = 0.87
y = 5.1048 + 0.4077x r2 = 0.93
y = 1.3547 + 0.2127x r2 = 0.80
Lines of best fit
172 kcfs
83 kcfs
49 kcfs
32 kcfs
16 kcfs
Mean water velocity (cm/s)
0
50
100
150
200
250
0
20
40
60
80
100
Distance from Lower Granite Dam (km)

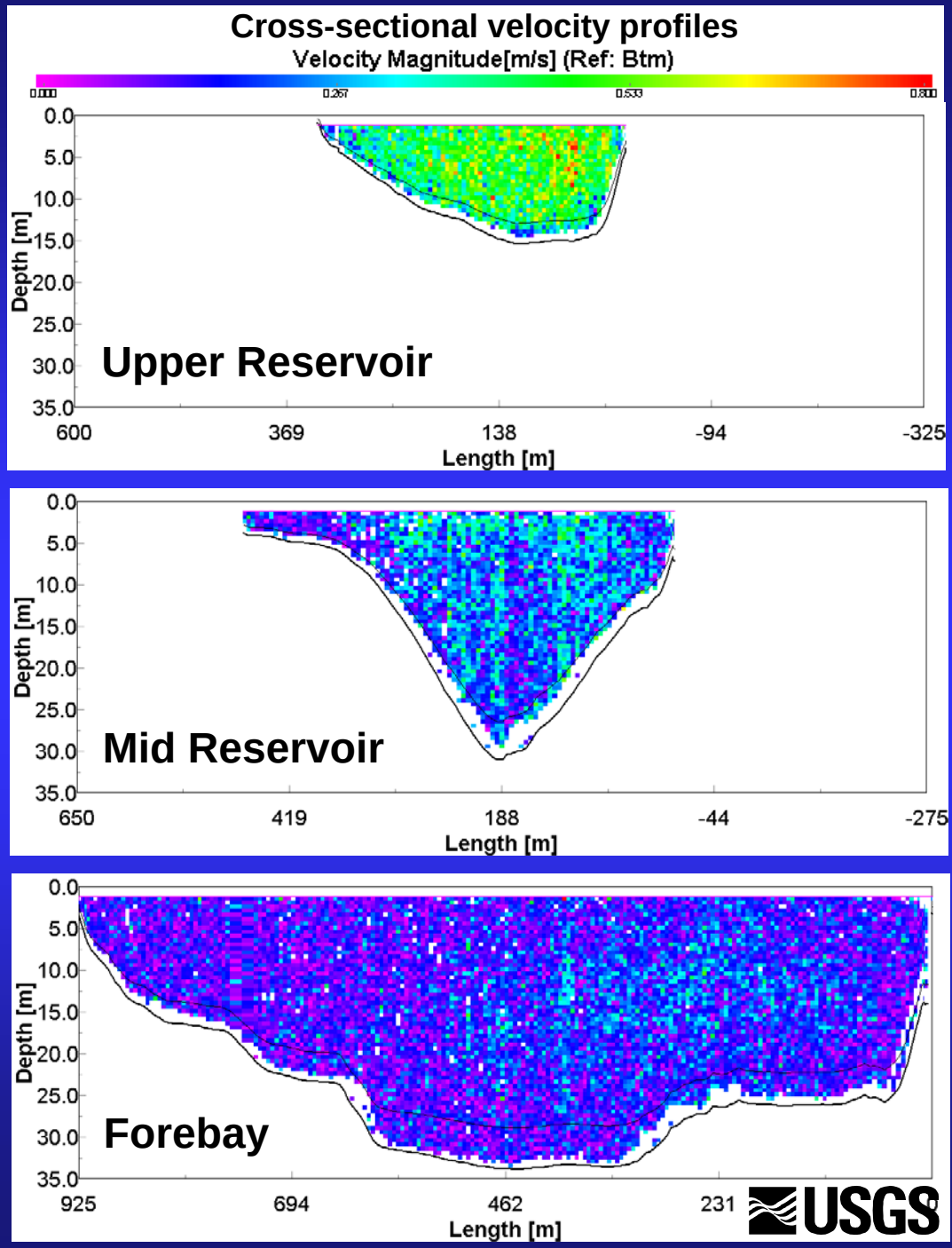

Upper Reservoir (y = 0.8623x + 1.2778; r2 = 0.98)
Mid Reservoir (y = 0.2829x + 4.4433; r2 = 0.95)
Forebay (y = 0.1102x + 1.193; r2 = 0.99)
Velocity (cm/s)
Flow (kcfs)
0
20
40
60
80
100
120
140
160
180


Early July 2002
Late July 2002
y = 4.5087 + 0.8716x
r2 = 0.99
y = -0.2343 + 0.8448x
r2 = 0.99
Median fish travel rate (km/d)
Mean water velocity (km/d)
0
20
40
60
80
100
120

Effects of flow on rate of travel

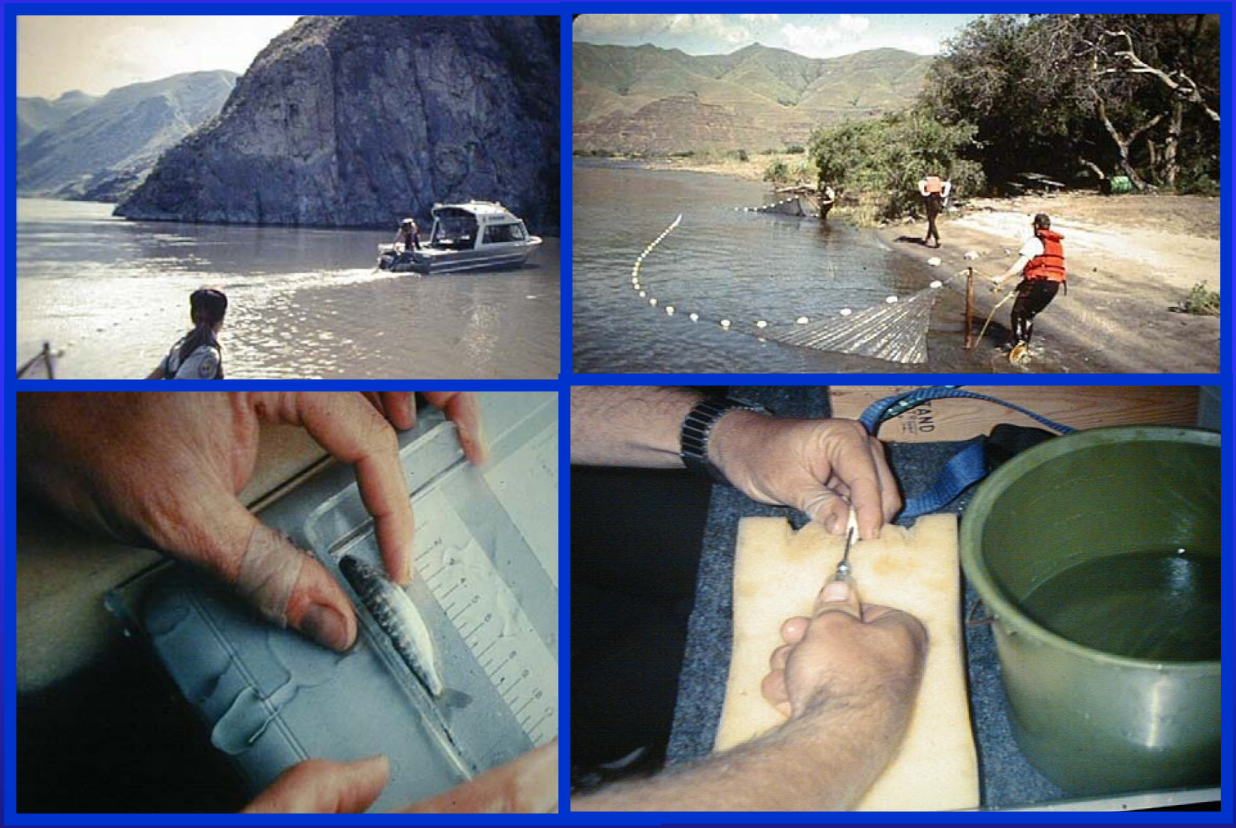
Flow (kcfs)	Rate (km/d)
30*	21.2
44**	30.8
46.4***	32.4
30	10.0
44	13.1
46.4	13.7
30	3.3
44	4.5
46.4	4.8

* Hypothetical base flow
** Base flow + 14 kcfs from Dworshak
*** Base flow + 14 kcfs + 2.4 kcfs from Brownlee



Objective:

Understand the effects of flow and temperature on juvenile fall Chinook salmon survival.

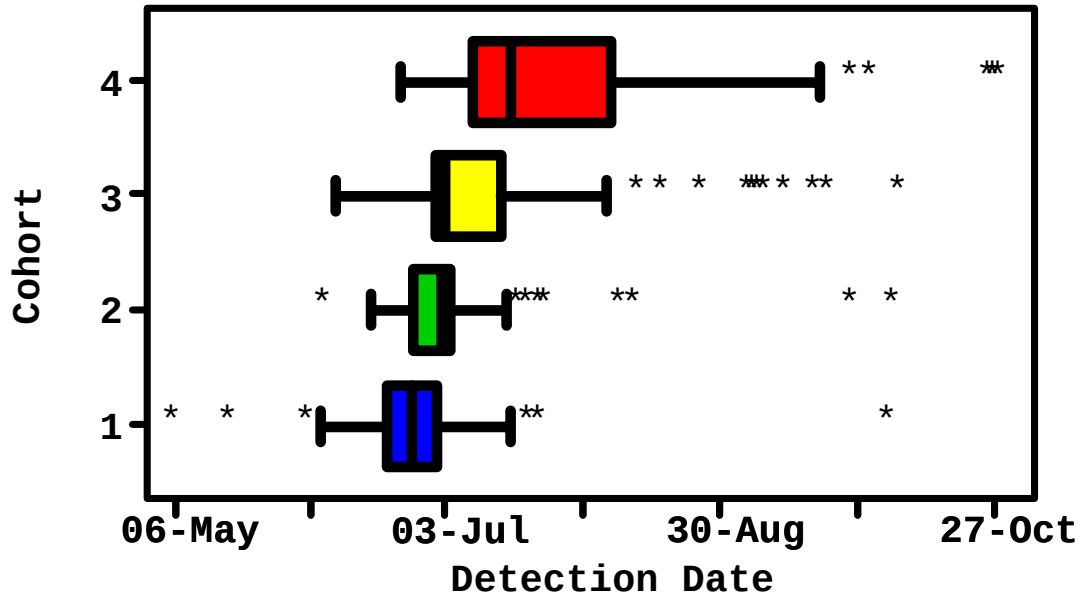


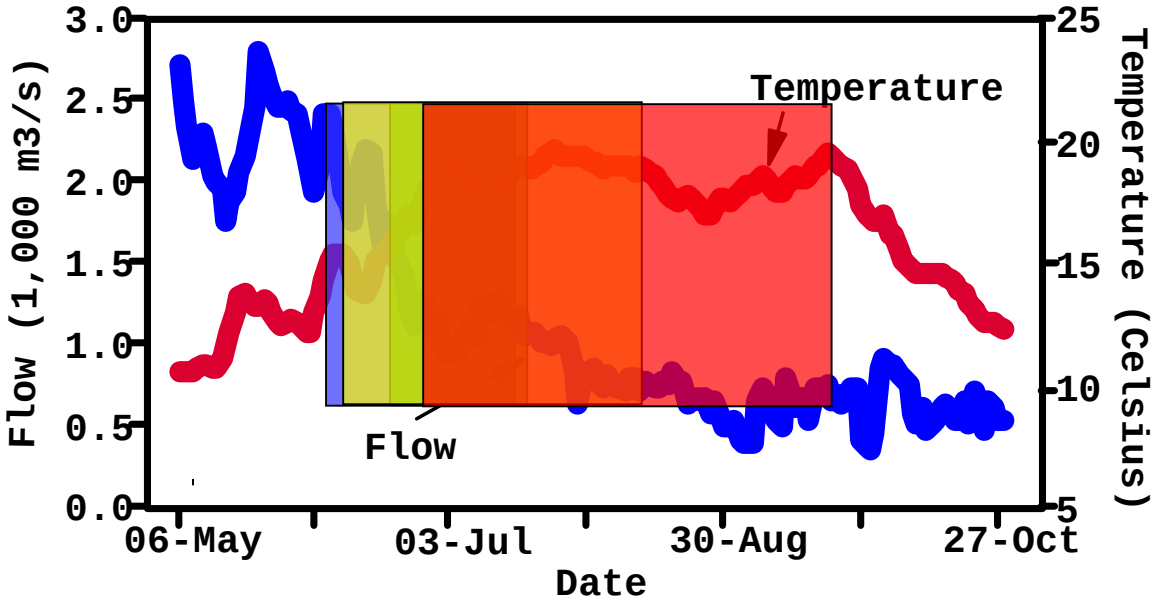
— Used CJS methods to estimate survival to the tailrace of Lower Granite Dam for groups of fish called “cohorts”

— Four cohorts per year

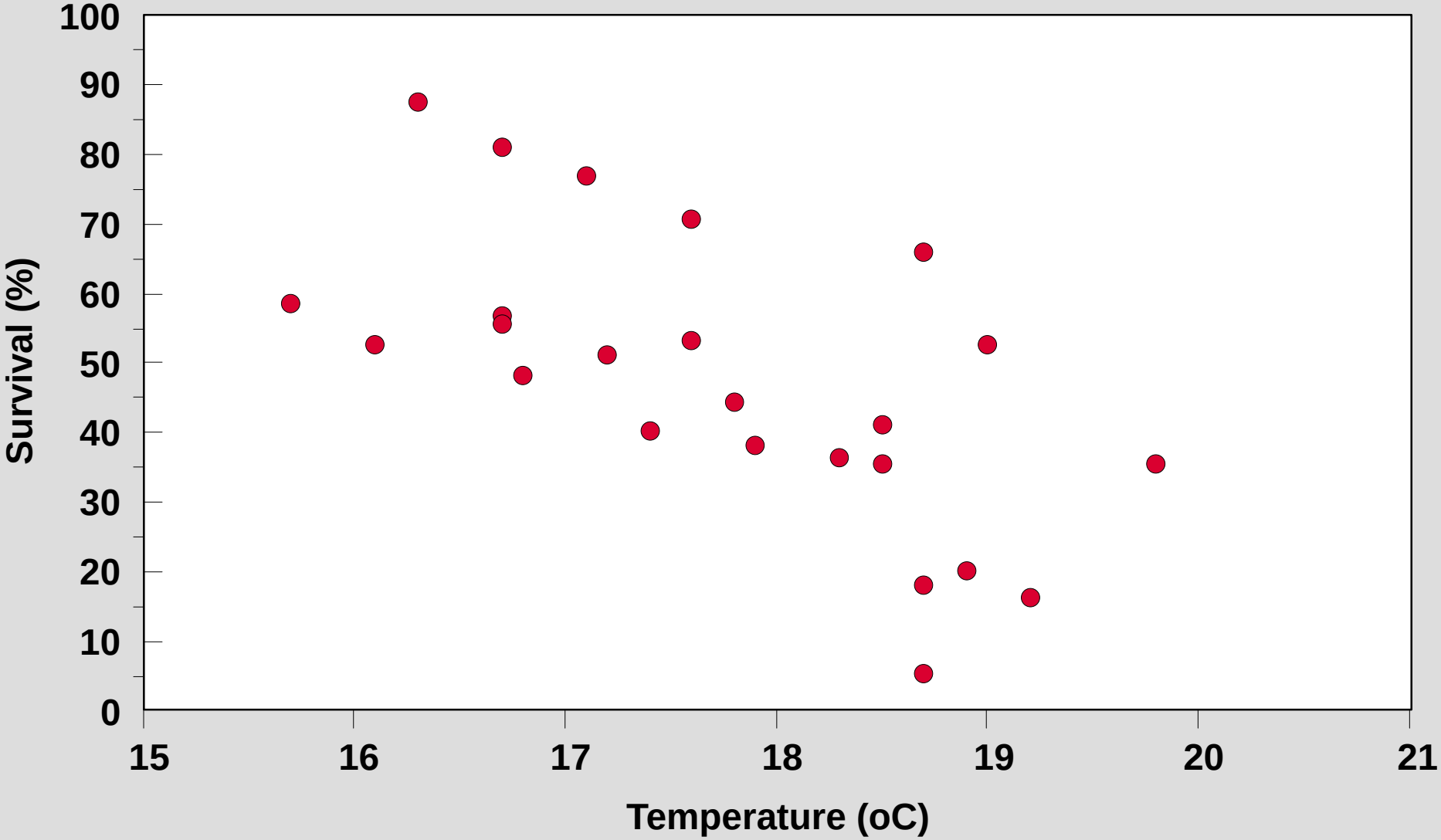
— Years 1998 to 2003

Migration timing flow and temperature in Lower Granite Reservoir

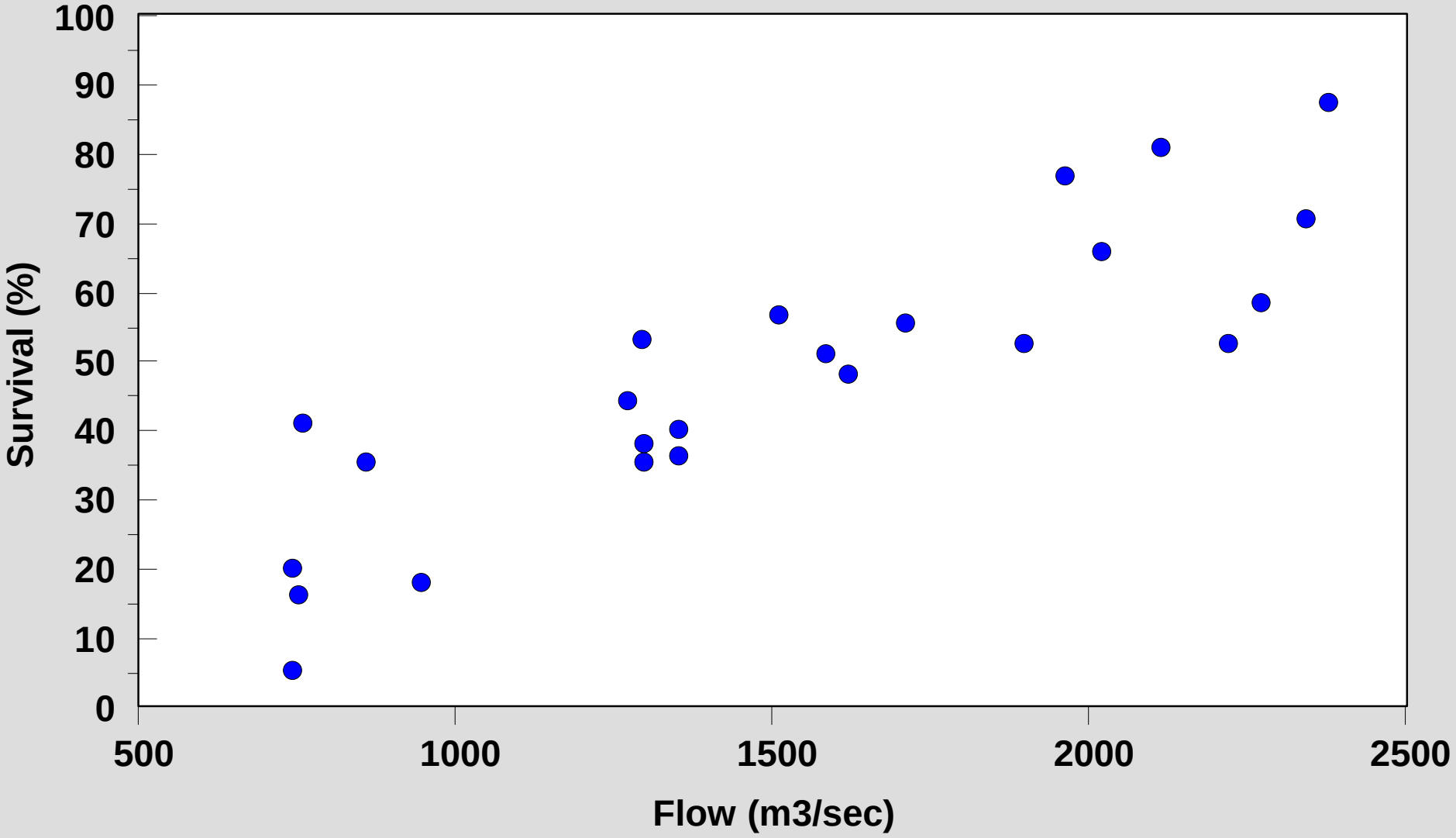




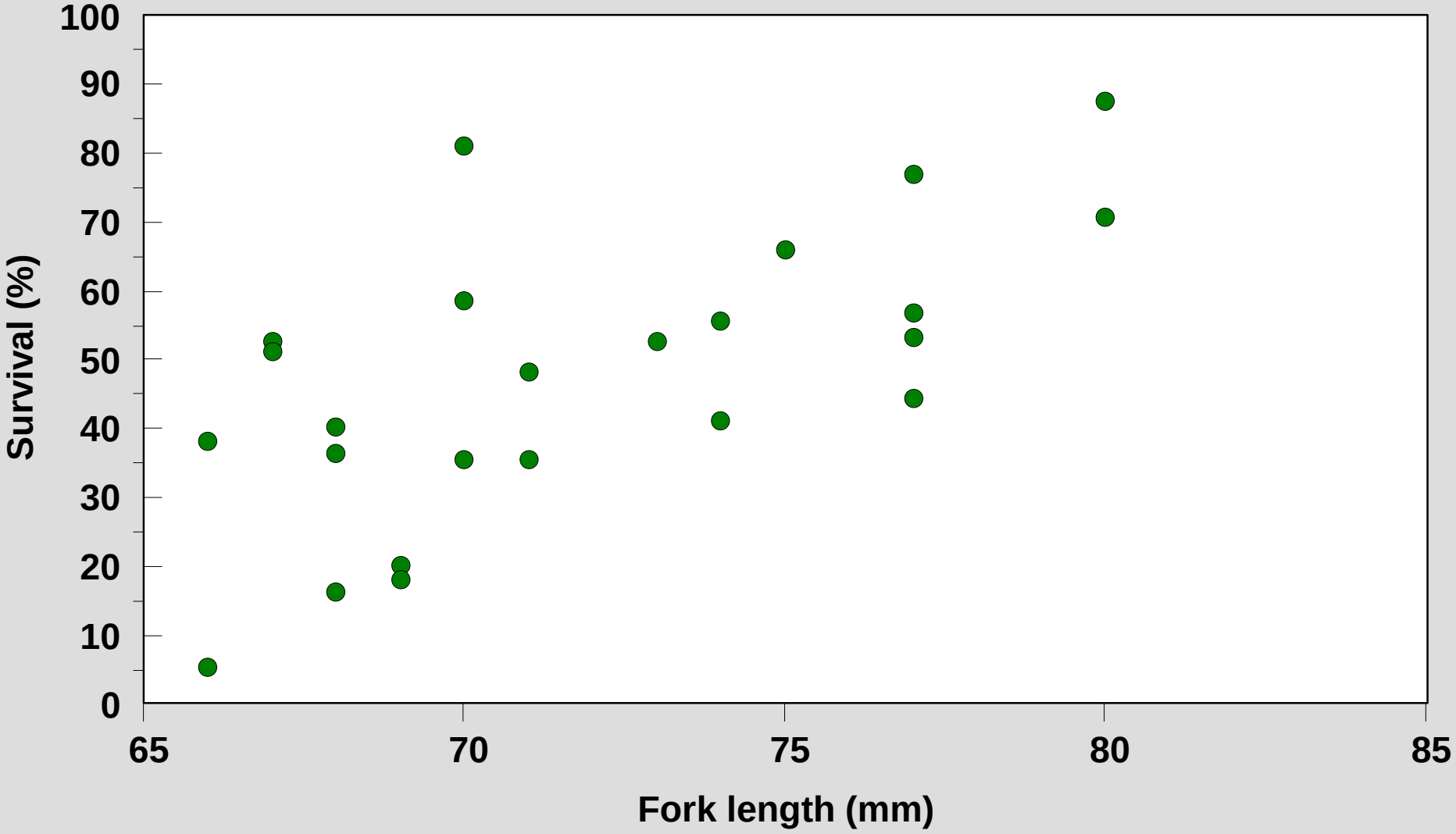
Survival and temperature (1998-2003)



Survival and flow (1998-2003)



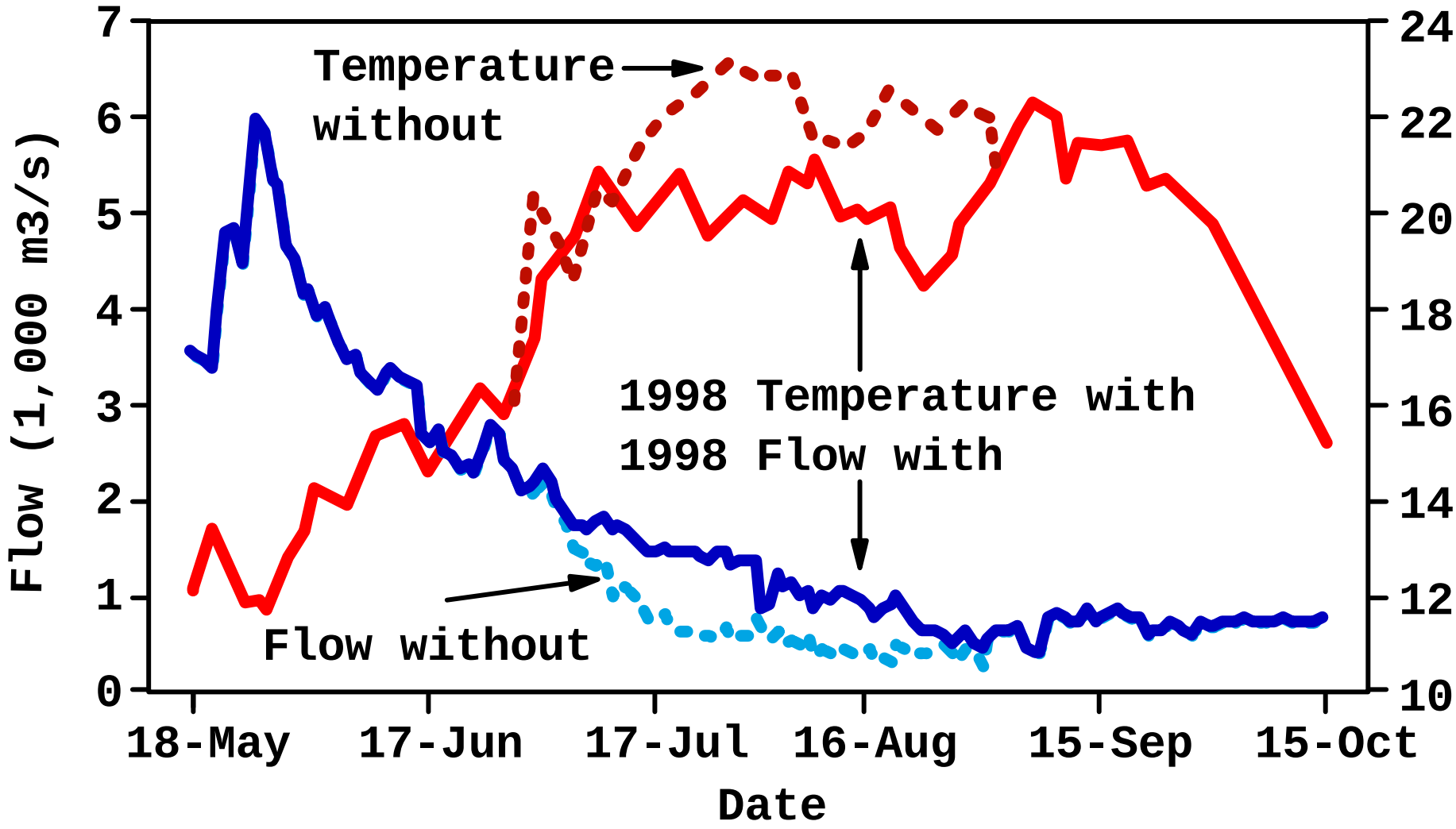
Survival and fork length (1998-2003)

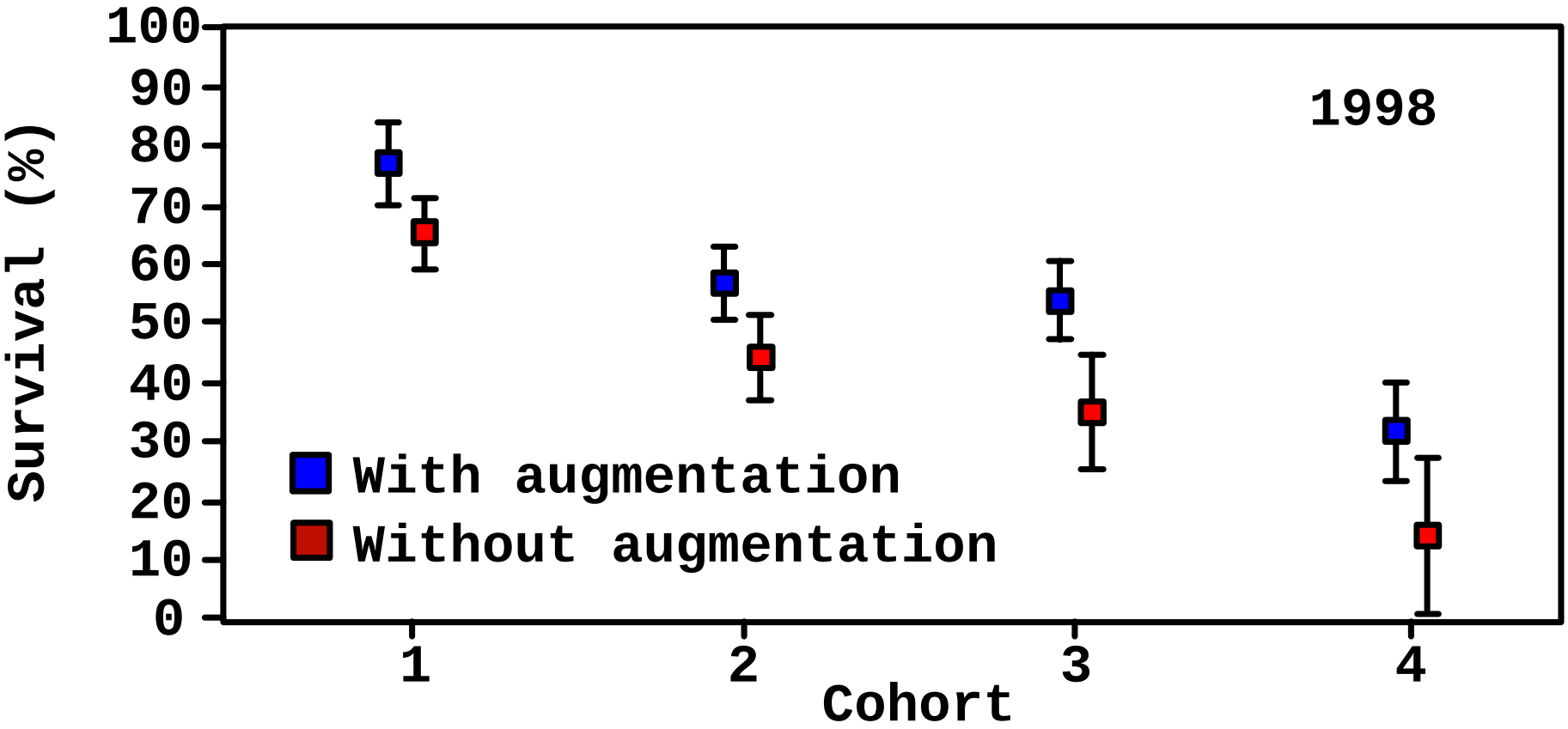


The Best Model for Predicting Survival (N = 26 Cohorts)

Factor	Coefficient	P (B = 0)	R2	P
Constant	99.812	0.0105	0.87	< 0.0001
Temperature	-11.630	0.0001		
Temperature*Flow	0.093	0.0008		
Temperature*FL	0.001	0.0001		

Flow and temperature with and without summer flow augmentation





Estimated increases with augmentation

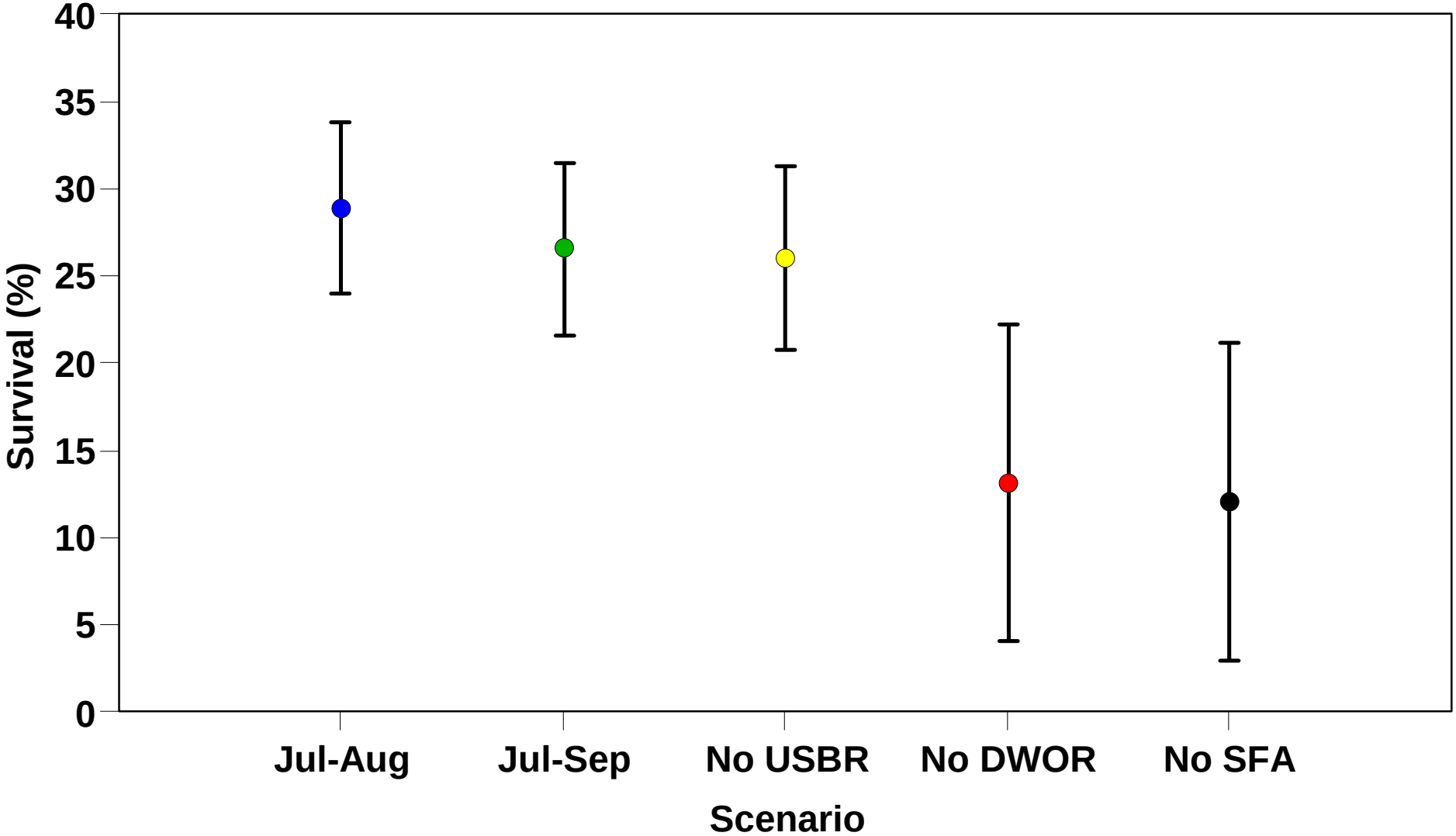
Cohort 1 up 12.4%

Cohort 2 up 13.0%

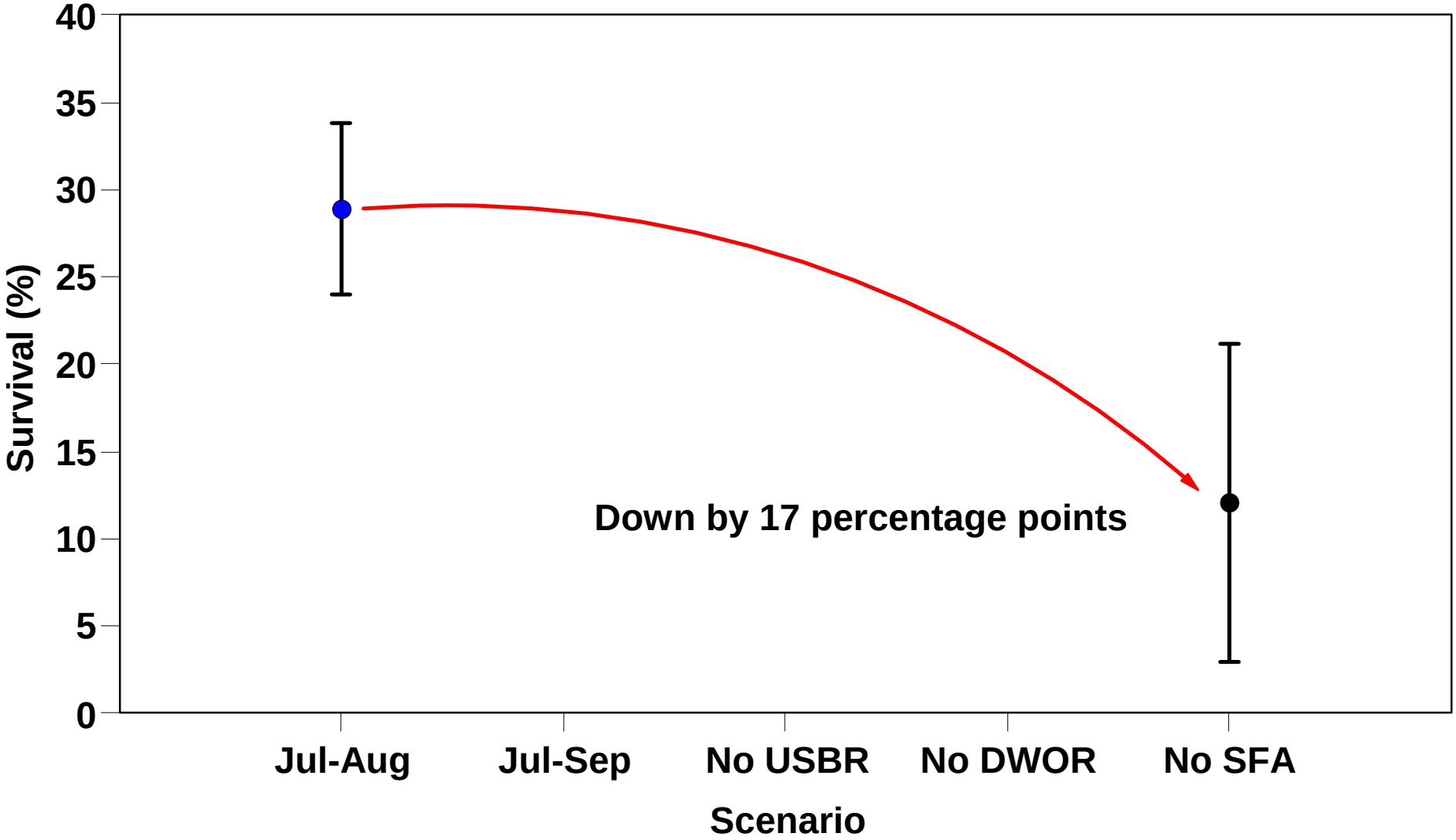
Cohort 3 up 19.2%

Cohort 4 up 19.0%

Estimated changes in survival of cohort 4 in 2002 by scenario



Predicted result of incremental decreases in flow augmentation



Points relevant to the symposium:

1) **Incremental decreases in flow decrease velocity which decreases rate of travel especially in upper reservoir reaches, but to a much lower extent in forebays.**

2) **Incremental decreases in flow (hence velocity) accompanied by incremental increases in temperature likely reduce survival.**