Seasonal Floodplain-Tidal Slough Complex Could Support Improved Life History Diversity

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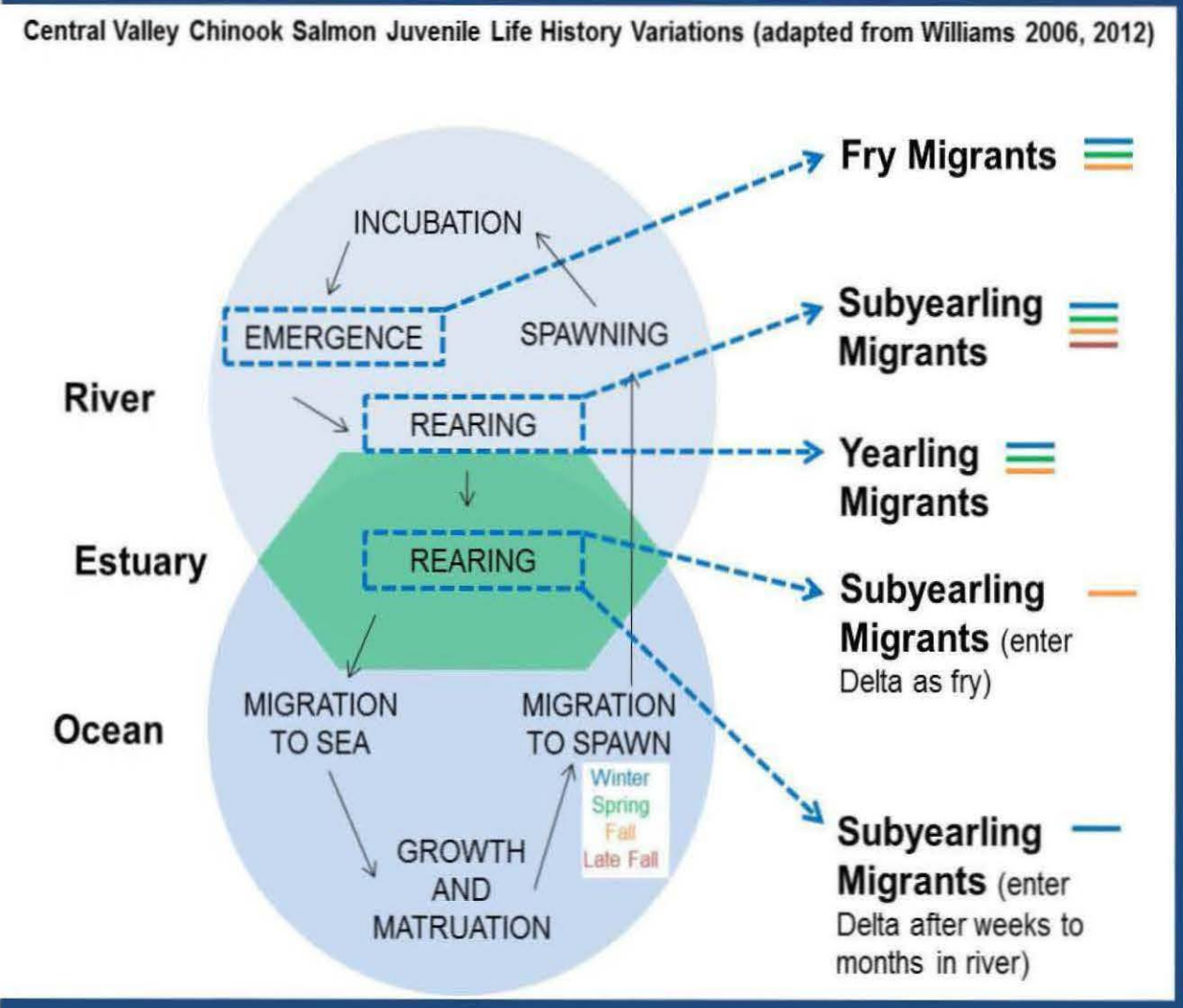
NOAA National Marine Fisheries Service

California
Central Valley

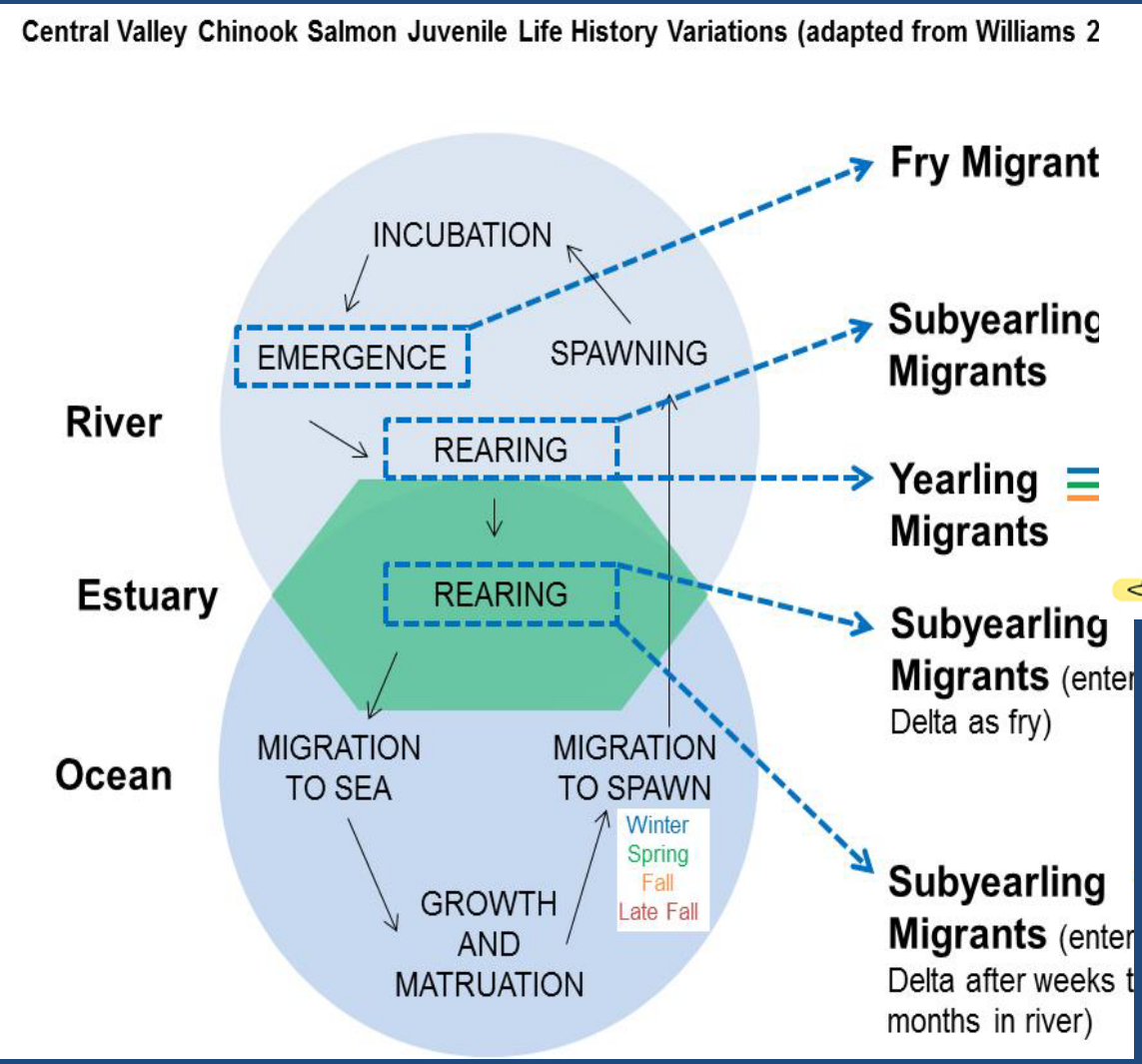
Juvenile Chinook
salmon

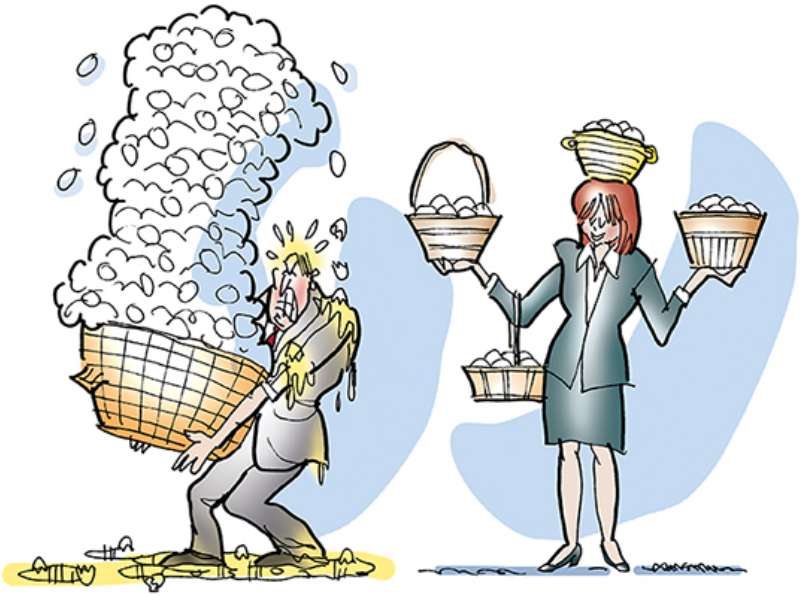
Oncorhynchus
tshawytscha

Life history diversity important for salmon conservation



Life history diversity important for salmon conservation





↑ Spatial Variation in Habitat Use = ↓ Inter-Annual Variation in Juvenile Production

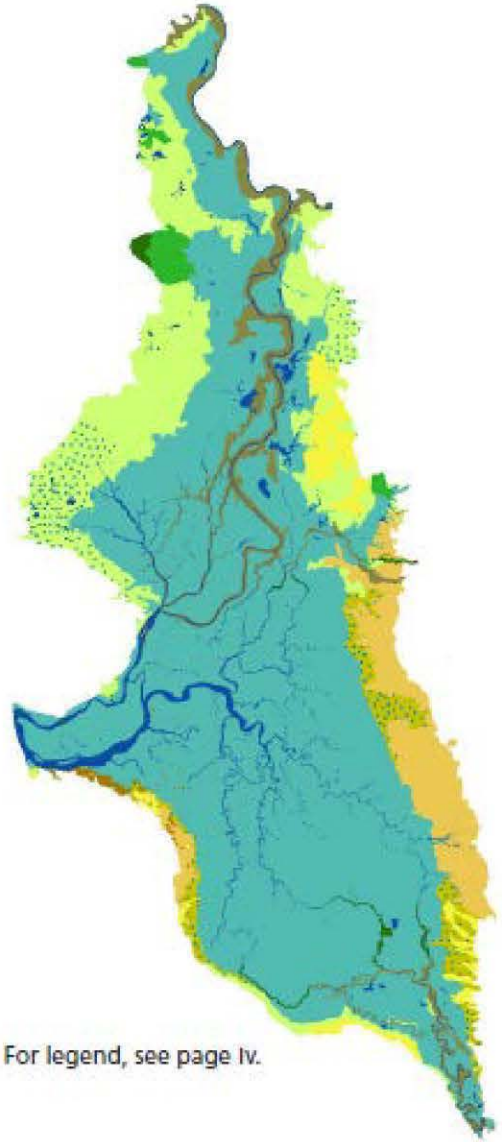
Thorson et al. 2014

Proxy for Life History Diversity

Coefficient of Variation in juvenile Chinook size

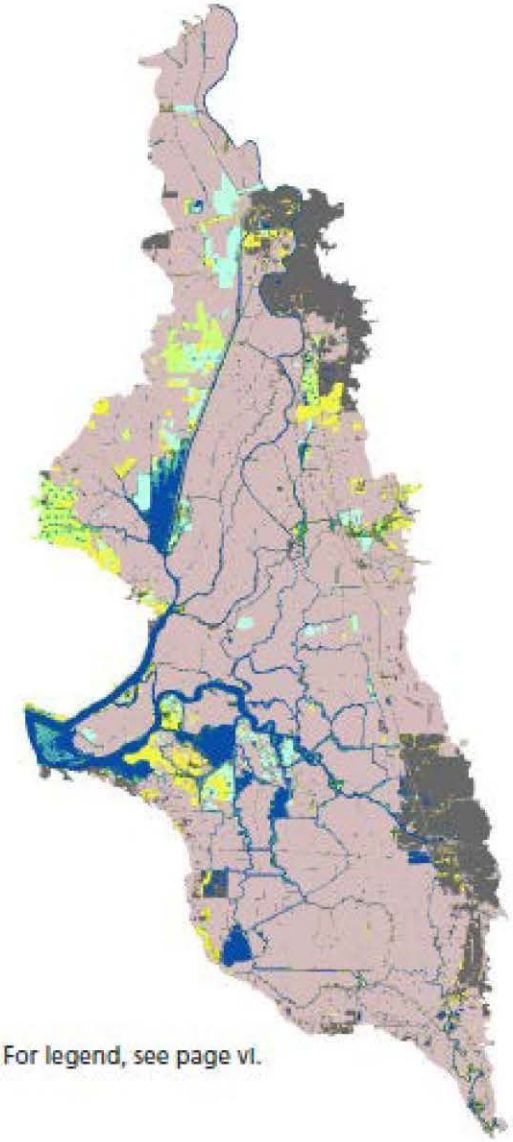
$$\mathbf{CV} = \frac{\sigma}{\mu}$$

A HISTORICAL HABITAT TYPES

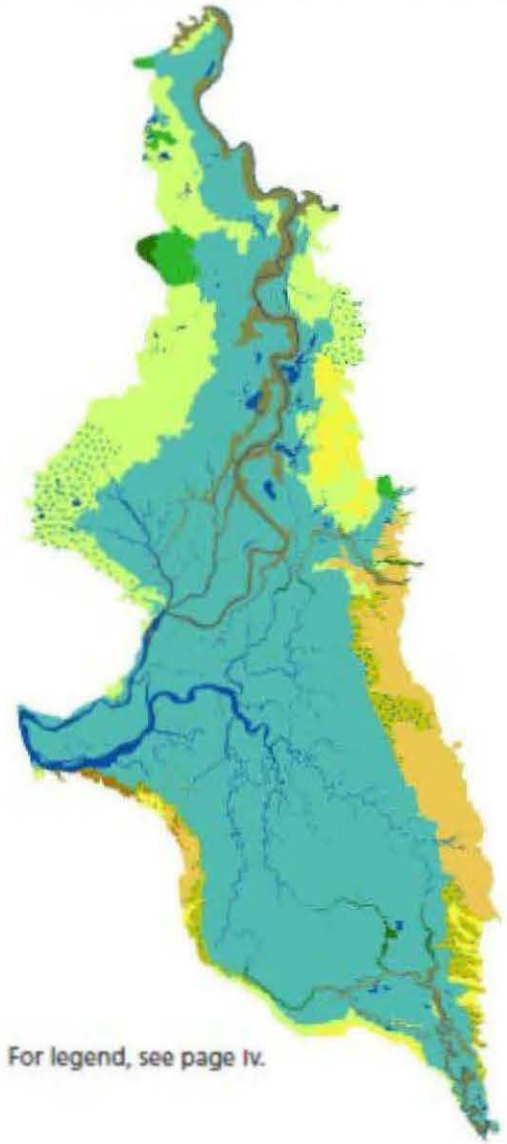


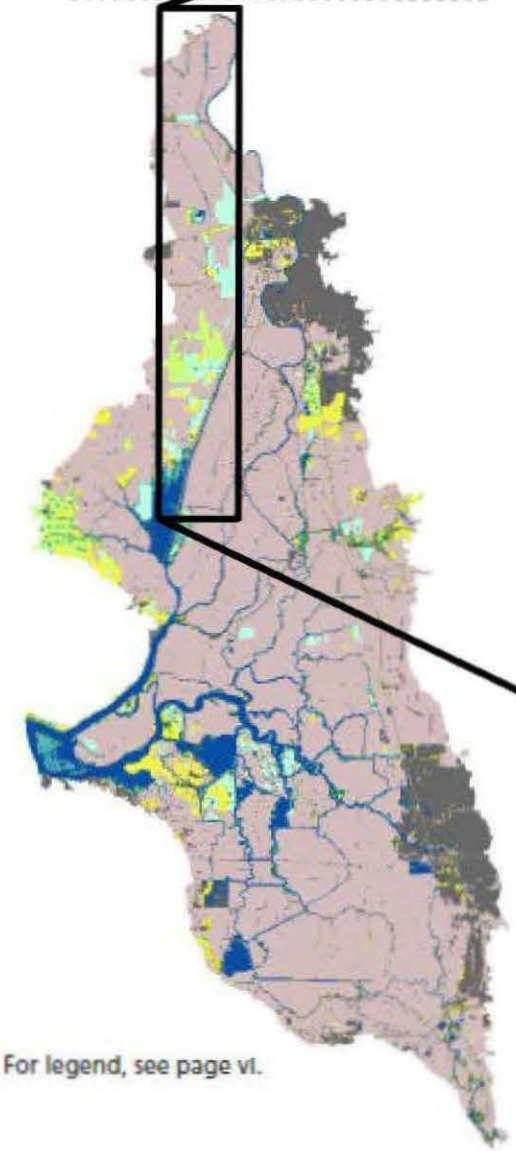
For legend, see page Iv.

B MODERN HABITAT TYPES



For legend, see page vI.


A HISTORICAL HABITAT TYPES
For legend, see page iv.


B MODERN HABITAT TYPES
For legend, see page vi.


Yolo Bypass
(1998 flood extent)

SFEI 2015

1. **What habitat features or processes promote diversity in the YB?**

2. **How does the Yolo Bypass compare to Alternative habitats?**

Flooded Yolo Bypass 2016-03-14

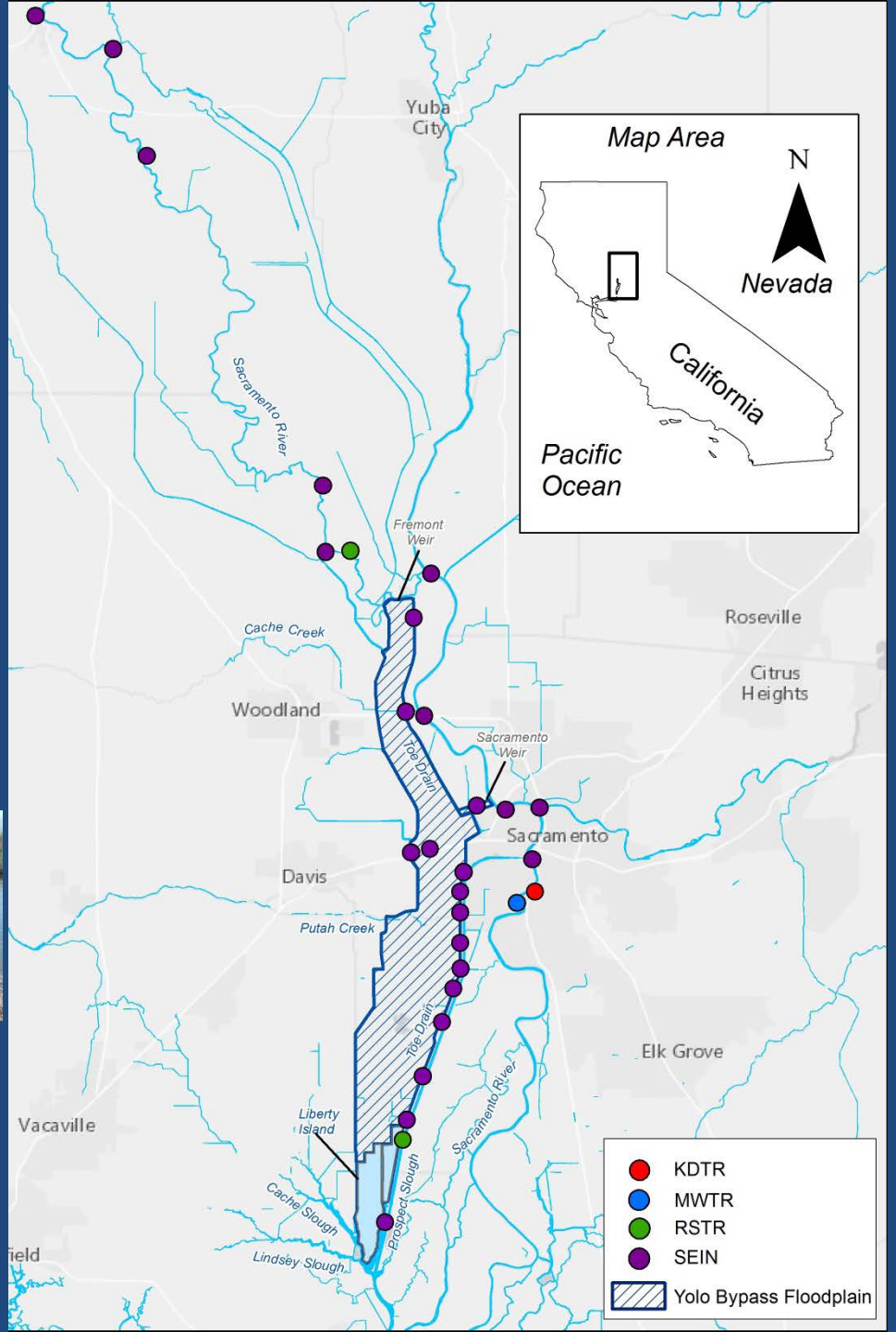
Flooded Sacramento River 2011-03-26

1998-2014 December - June

CA Department of Fish and Wildlife
US Fish and Wildlife Service

Department of Water Resources

US Fish and Wildlife Service



What habitat features or processes promote diversity in the YB? Generalized Least Squares model (GLS)

=

+ Environmental
  - Inundation
  - Discharge
  - Water temperature
  - Season
+ Sacramento River population
  - In river hatchery releases
  - Natural spawner escapement
+ Sampling methods
  - BSEIN volume
  - RSTR hours
  - Time
  - Sample size

Best predicted size and timing of juvenile Chinook in the YB

=

+ Environmental

Inundation Duration

Variation in Water temperature

Season

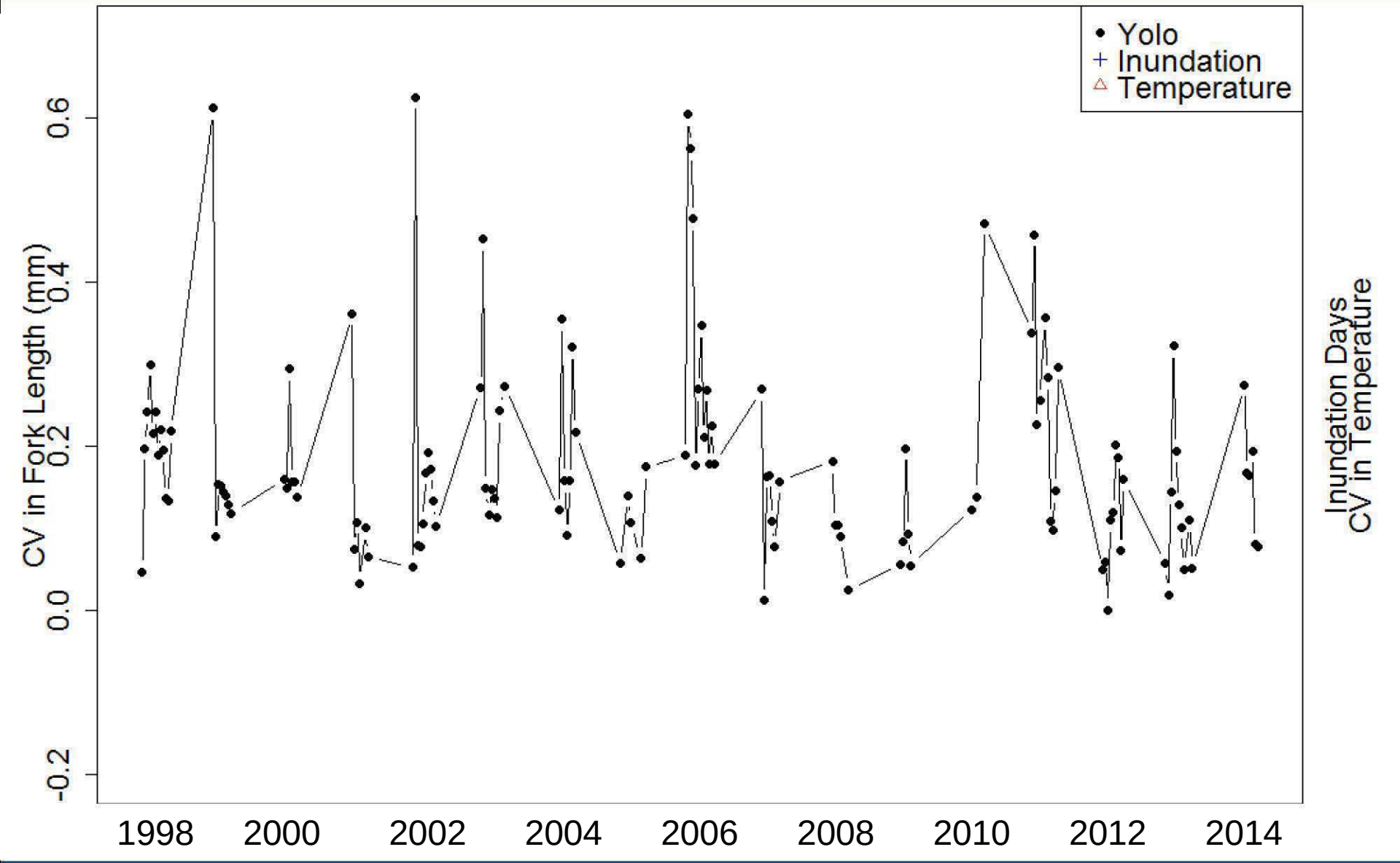
+

+ Sampling methods

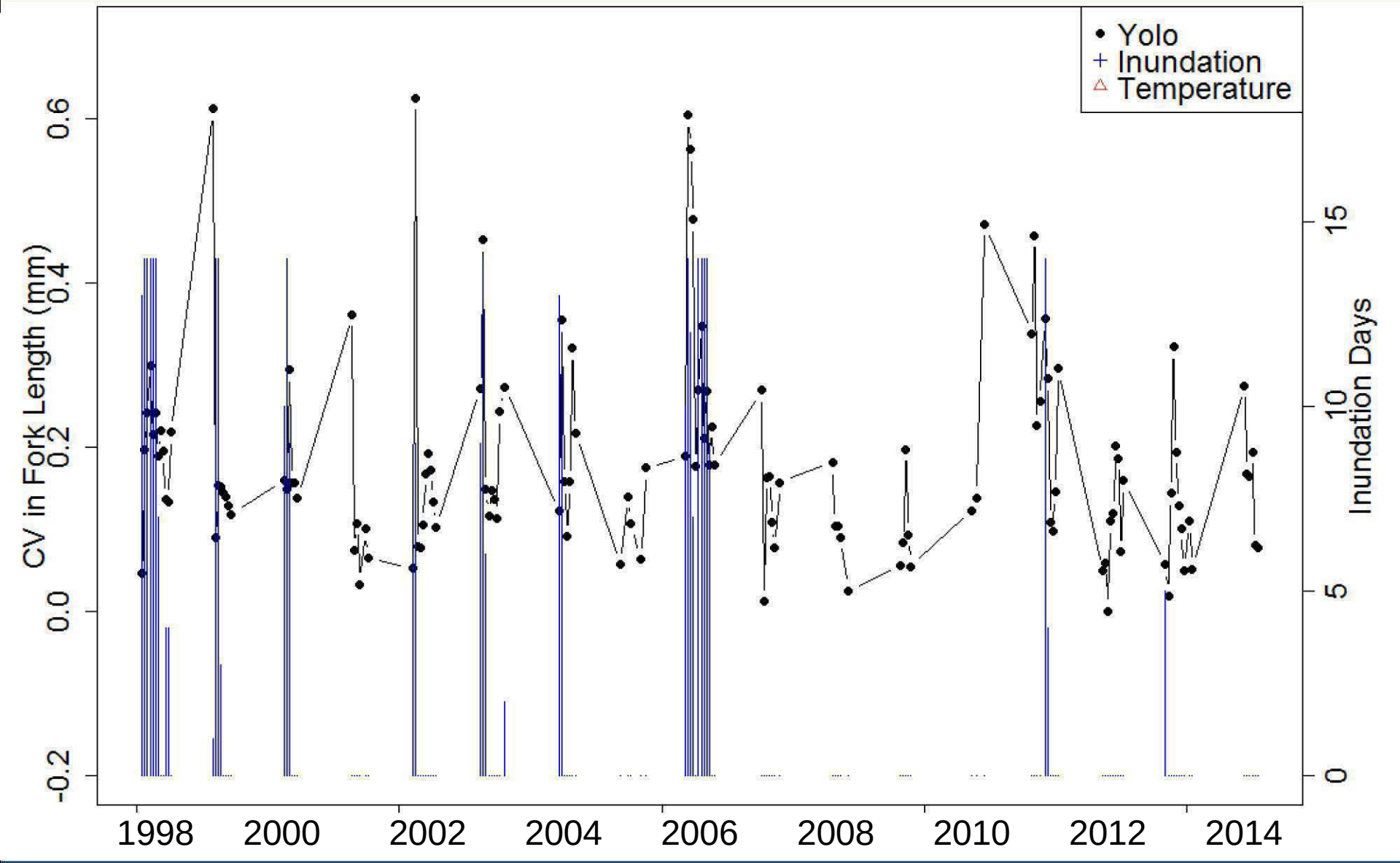
BSEIN volume

RSTR hours

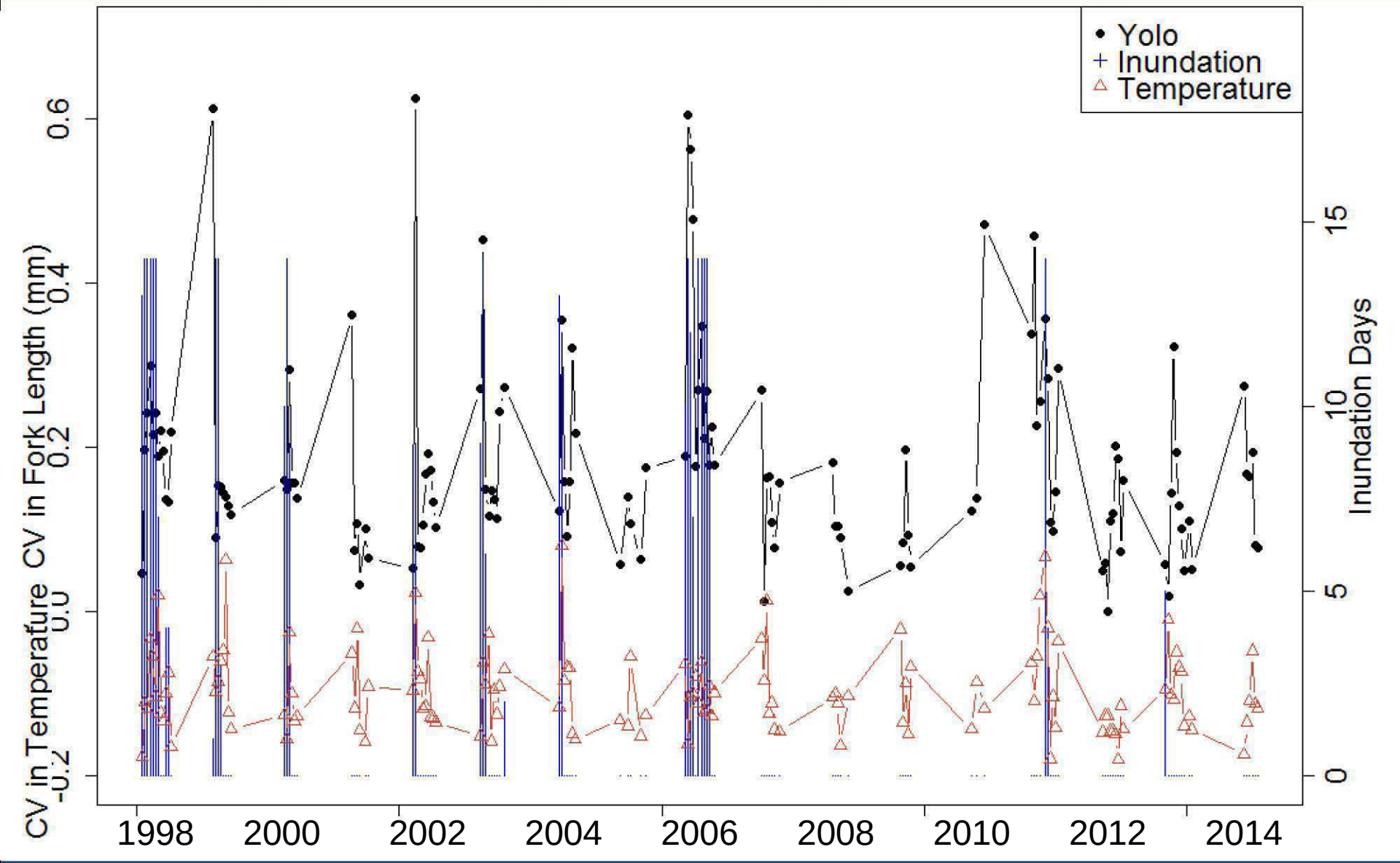
CV in fork length varies over time



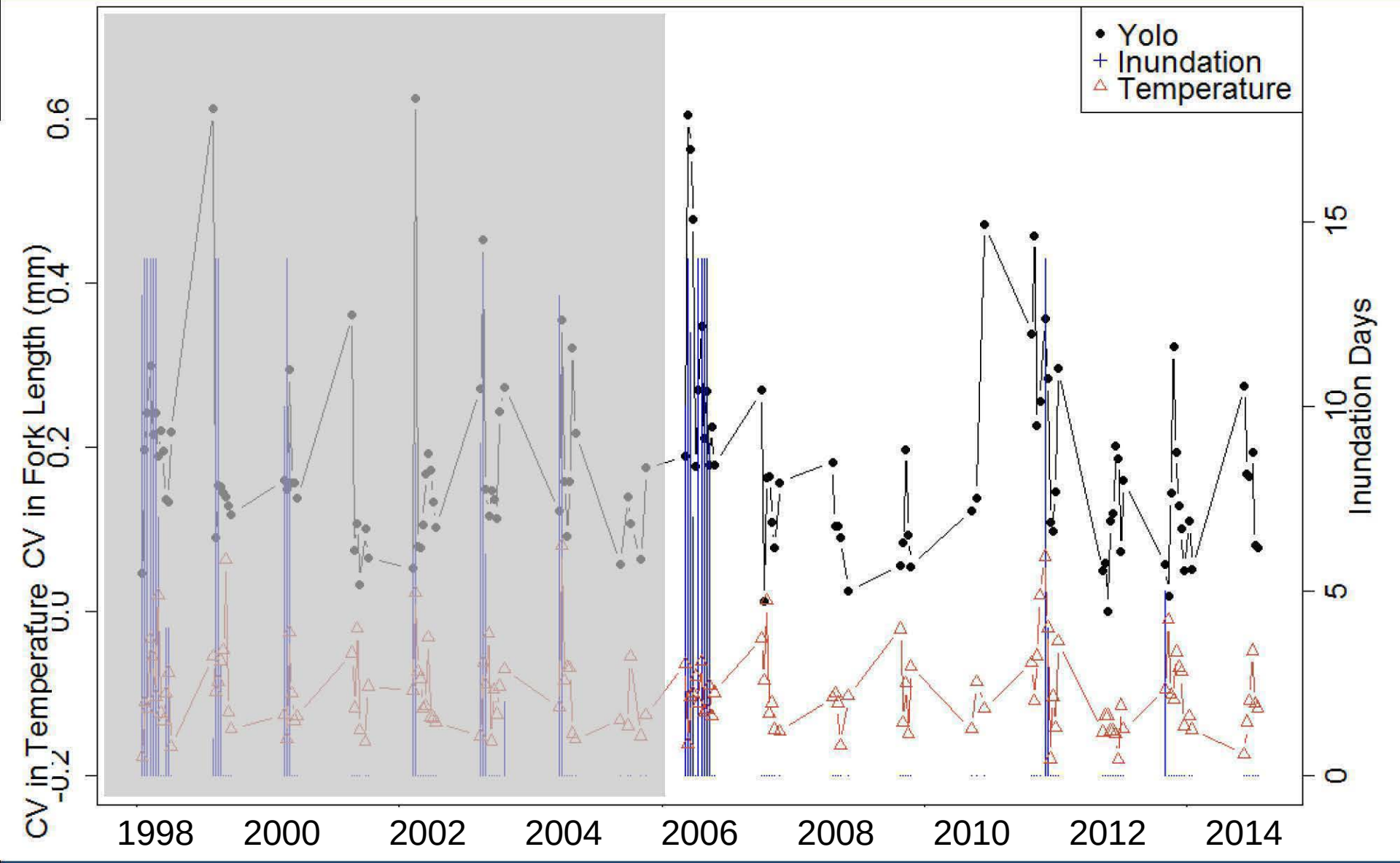
Inundation Days: significant and positive



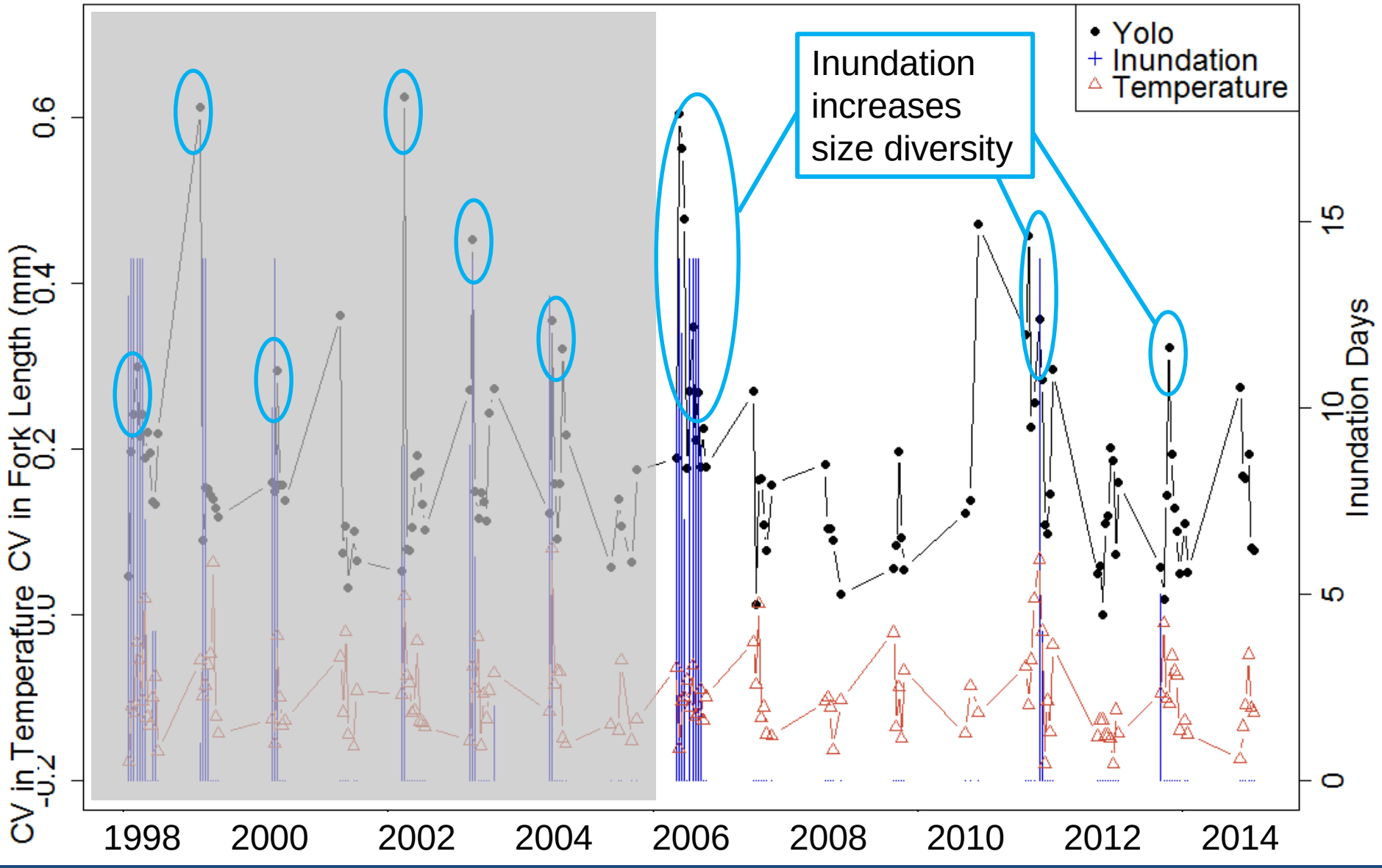
Variation in Water Temperature: floodplain drainage and productivity?



Environmental Drivers: multi-effect model

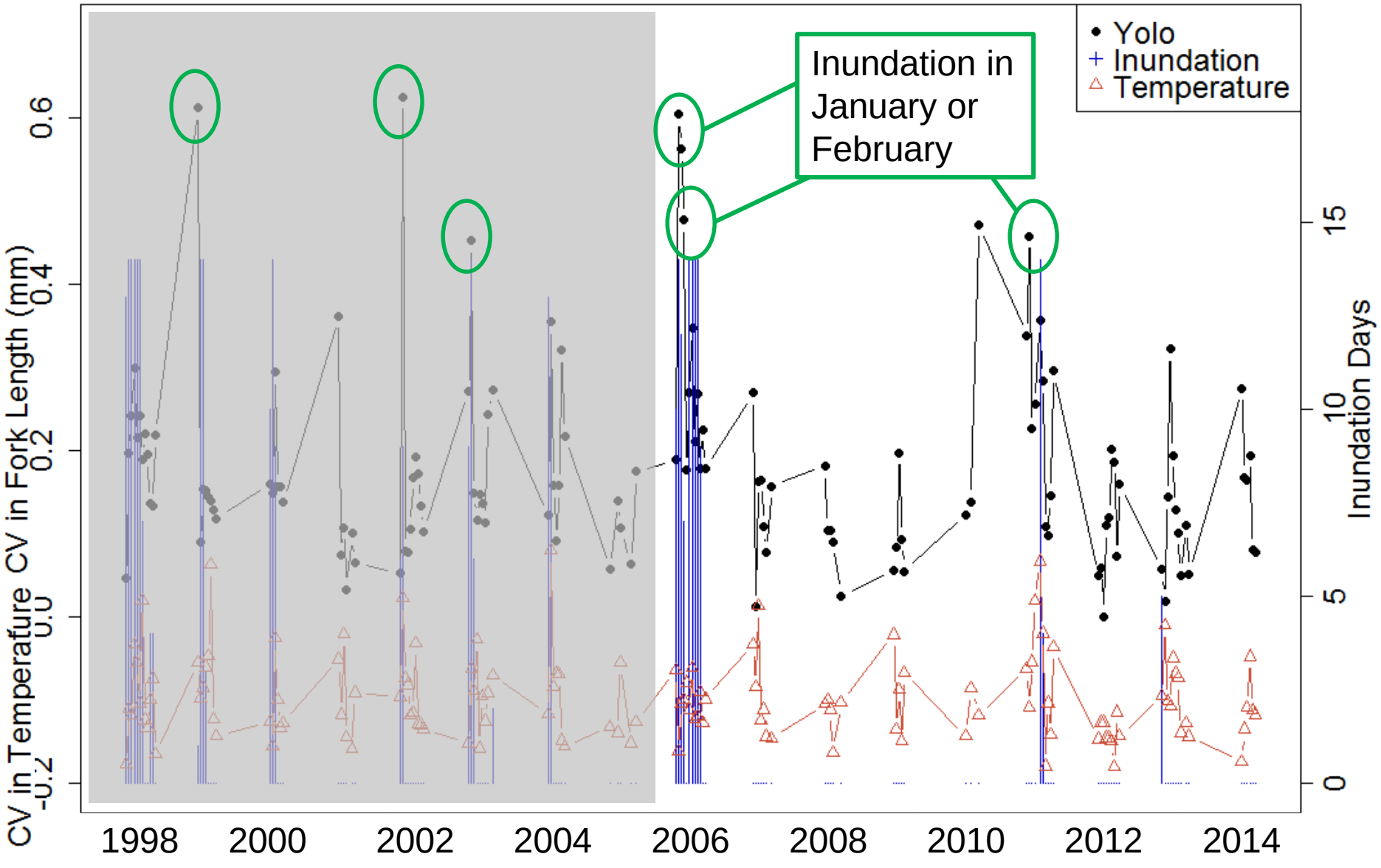


Inundation Duration: significant and positive



Season: significant and negative

= earlier in the year CV in juvenile salmon size was greater



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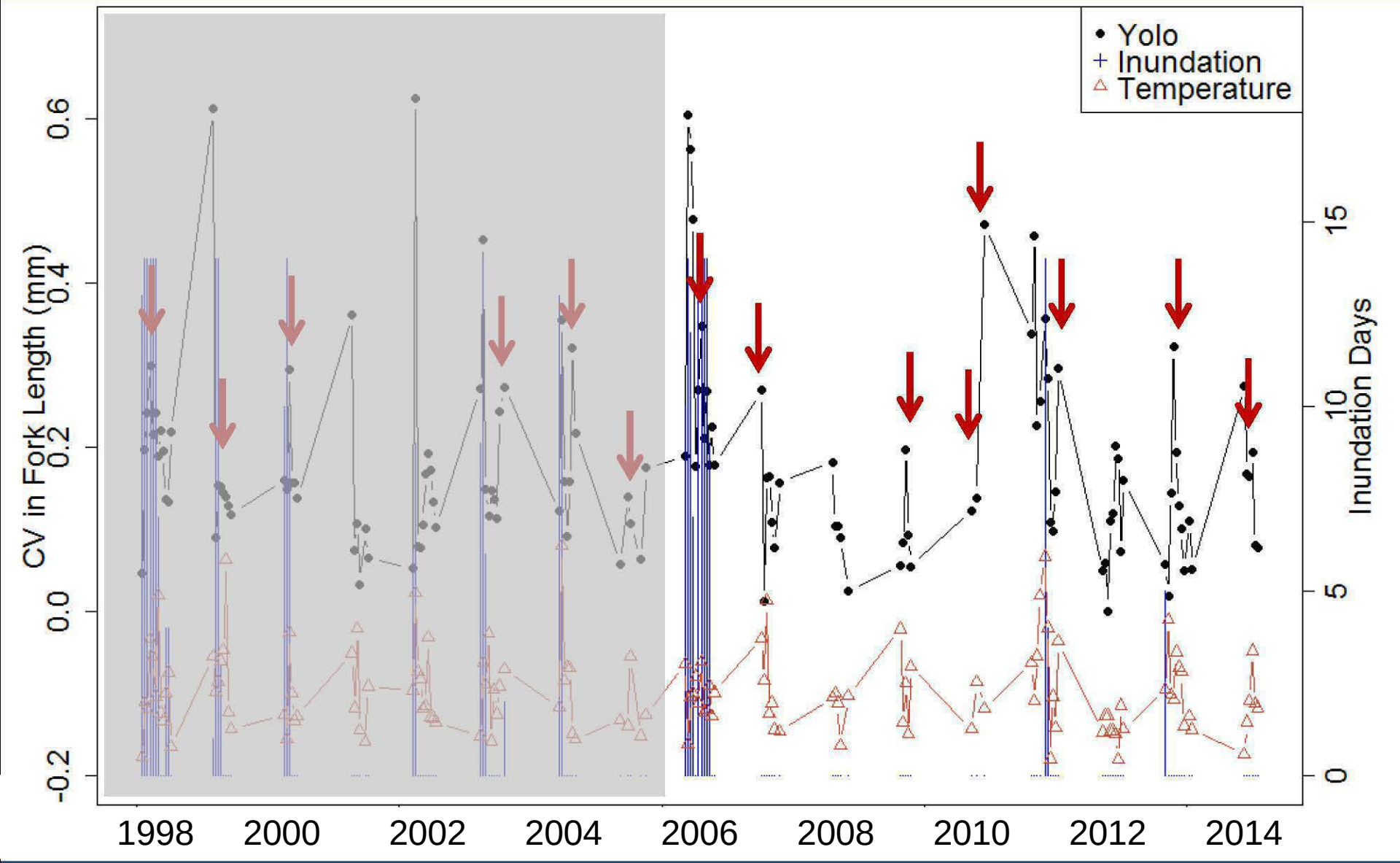


Habitat features or processes promote diversity in the YB

Inundation Duration

- Growth benefits (flood pulse concept)
- Increased connectivity
- Expansion and diversification of rearing habitat

Variation in Temperature

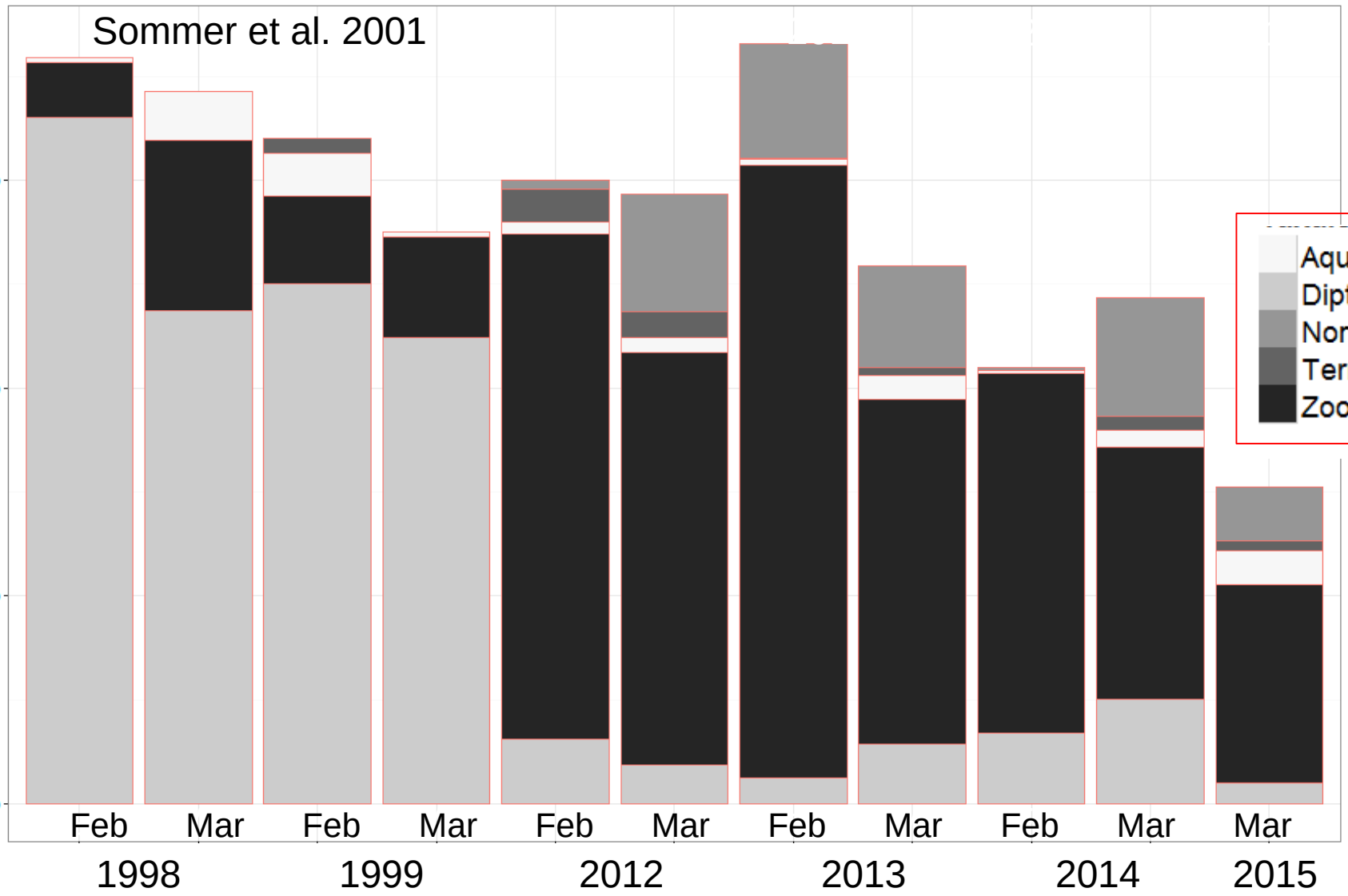
- Indicator for hydrologic complexity
- Capturing environmental variables related to productivity (spring warming and a flood pulse)

Season

- Describing a period in late winter important to migration timing or run variation
- Increased connectivity

Growth benefits and productivity: IRI analysis

Flooding | **Drought**



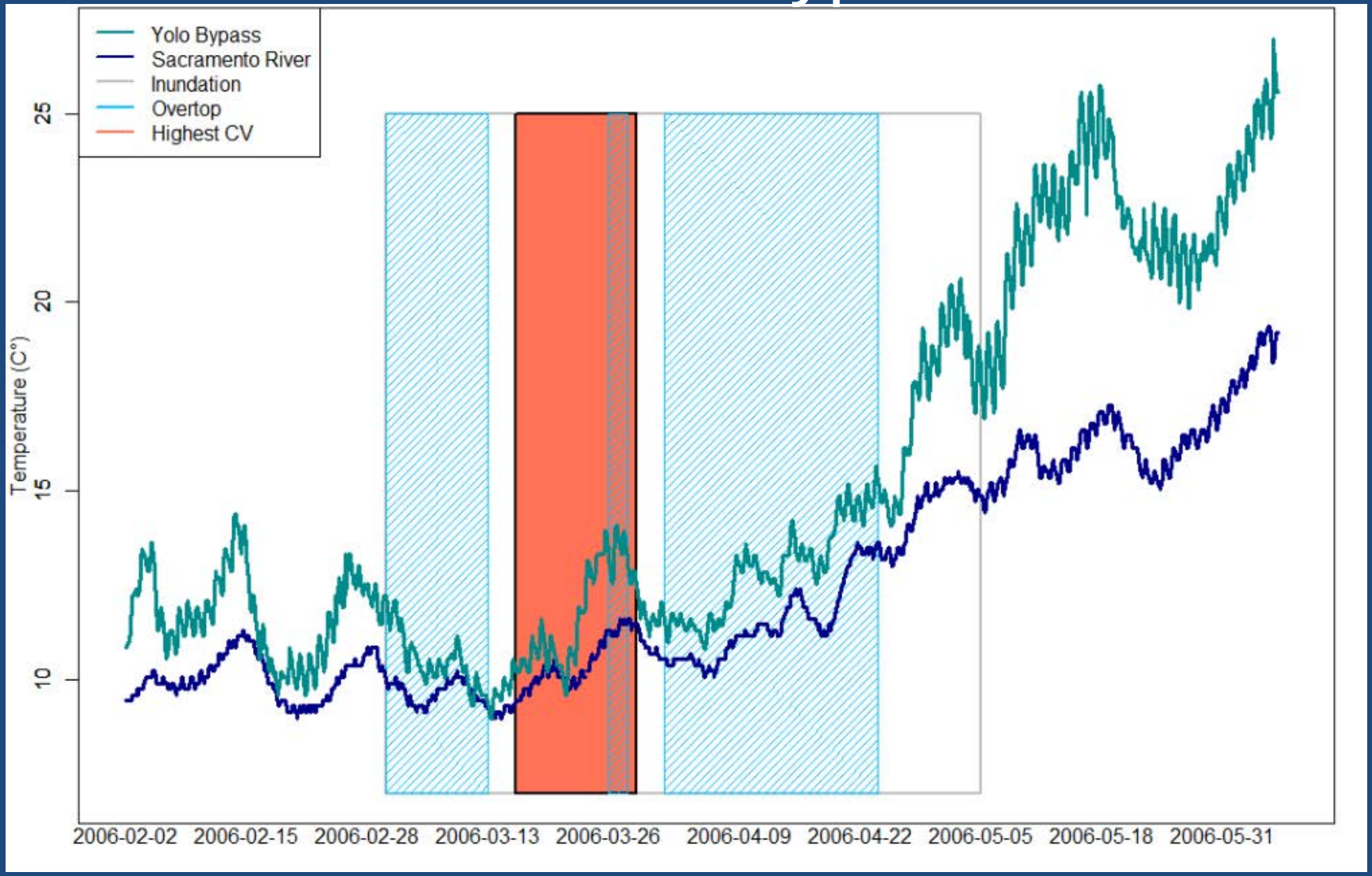
1. **What habitat features or processes promote diversity in the YB?**

2. **How does the Yolo Bypass compare to Alternative habitats?**

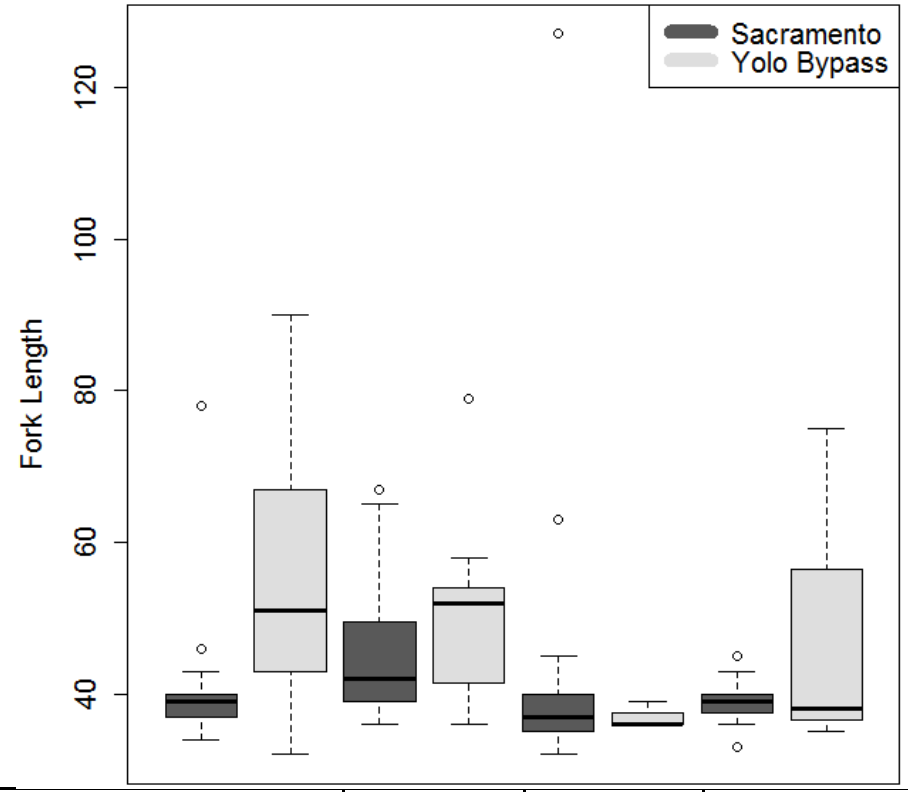
Flooded Yolo Bypass 2016-03-14

Flooded Sacramento River 2011-03-26

Simplified Sacramento River lacks thermal heterogeneity when compared to the Yolo Bypass



Increased connectivity provides alternate routes in the North SFE

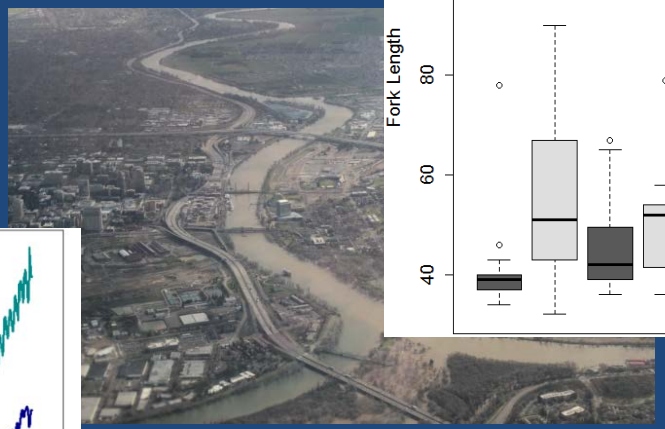


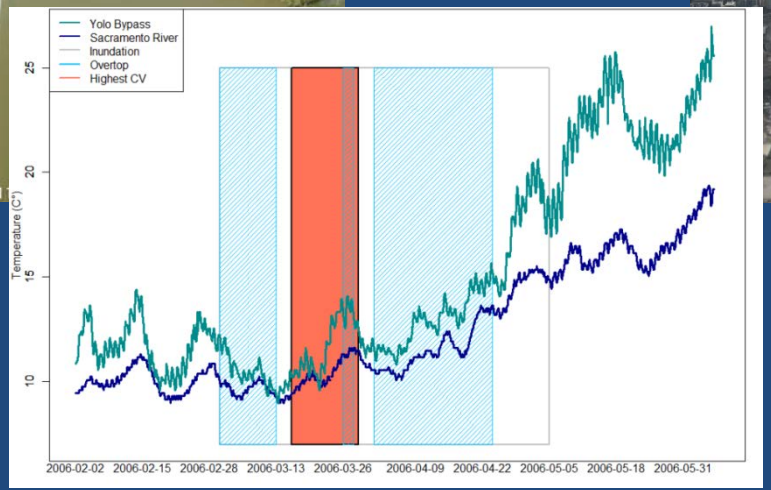
		1998	2000	2002	2003
Inundation	Date Range	1/16-4/15	2/14-3/17	1/4-1/18	12/31-1/28
	# of Days	90	33	15	29
CV in Temperature	Date Range	4/9-4/22	3/9-3/22	1/10-1/23	2/6-2/19
	Yolo Bypass	0.1704	0.1356	0.1733	0.1345
	Sacramento R.	0.0960	-	0.1137	0.0806
Weir Overtop	Date Range 1st	1/16-3/10	2/14-3/17	1/4-1/10	12/31-1/5
	Date Range 2nd	3/24-4/11	-	-	1/16-1/19

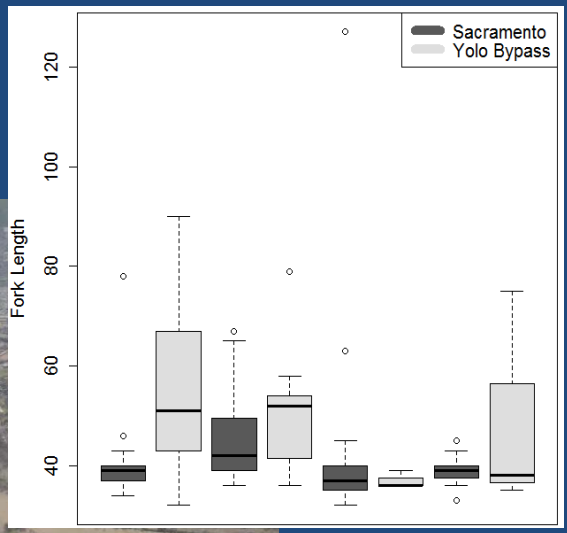
1. What habitat features or processes promote diversity in the YB?

2. How does the Yolo Bypass compare to Alternative habitats?

Flooded Yolo Bypass 2016-03-14







Acknowledgements

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IEP and DWR for funding

CA Department of Fish and Wildlife

US Fish and Wildlife Service

Field personnel on the Yolo Bypass project: Gina Benigno, Louise Conrad, Jared Frantzich, Bill Harrell, Naoaki Ikemiyagi, Matt Nobriga, Kevin Reece, and Nick Van Ark.





Questions?

Goertler, P. A. L., T. Sommer, W. Satterwaite and B. Schreier. (In Review)

Evidence that a seasonal floodplain-tidal slough complex supports time-specific size variation for juvenile Chinook salmon, with implications for life history diversity.

PLOS ONE





GLS: Excluded Covariates

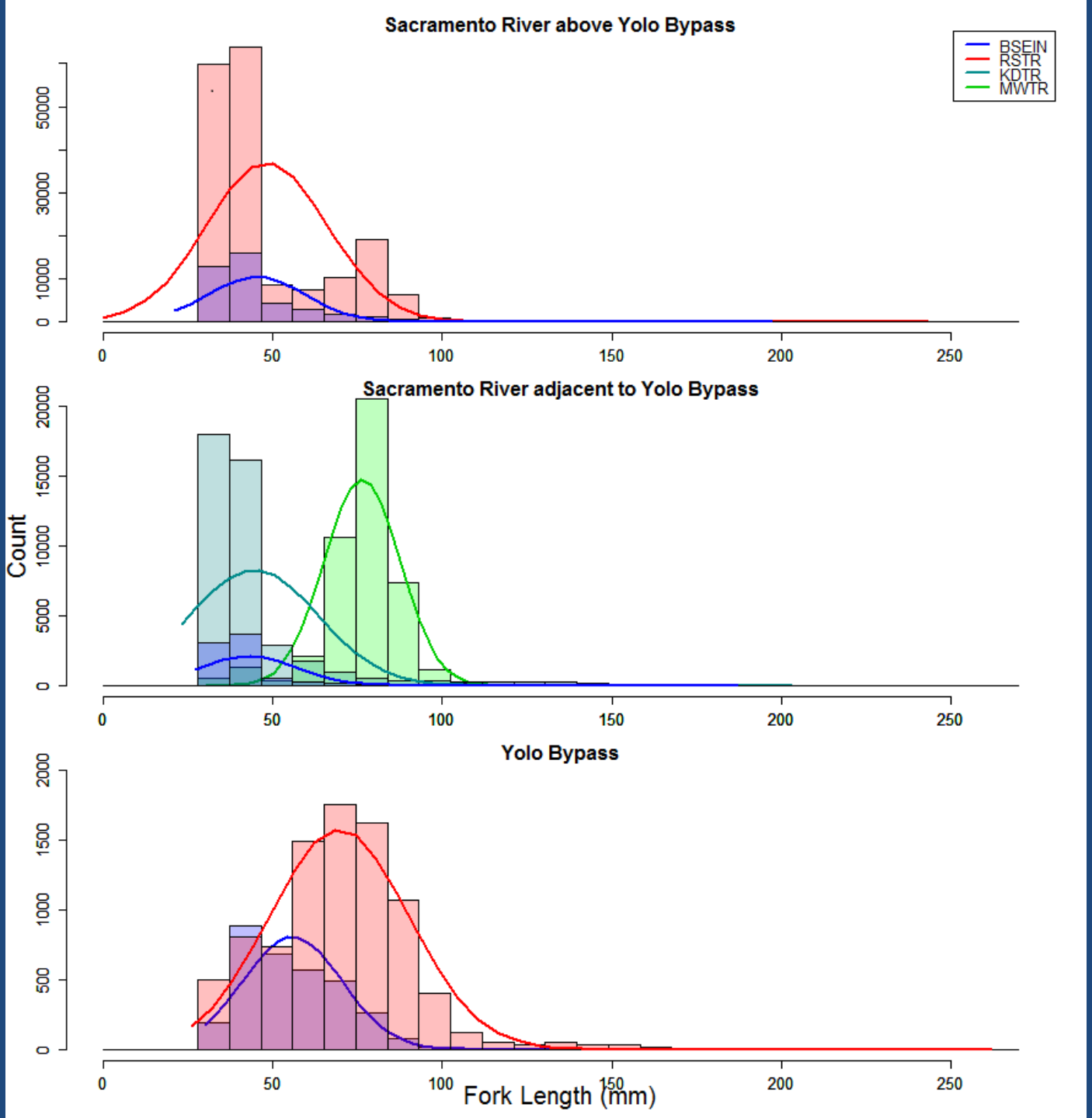
- Inundation acres vs. Inundation days
- Mean discharge vs. variation in discharge
- Mean temperature vs. variation in temperature
- **Upper Sacramento River Chinook**
- **Adjacent Sacramento River Chinook**
- Prey resources

- Inundation
  - **Total inundation days**
  - Mean inundation acres
  - CV in inundation acres
- Temperature
  - Mean temperature
  - **CV in temperature**
- QYolo
  - Mean flow
  - **CV in flow**

Model	AIC
1	-195.3720
2	-191.1926
3	-181.3322

Model	AIC
1	-169.6798
2	-174.3439

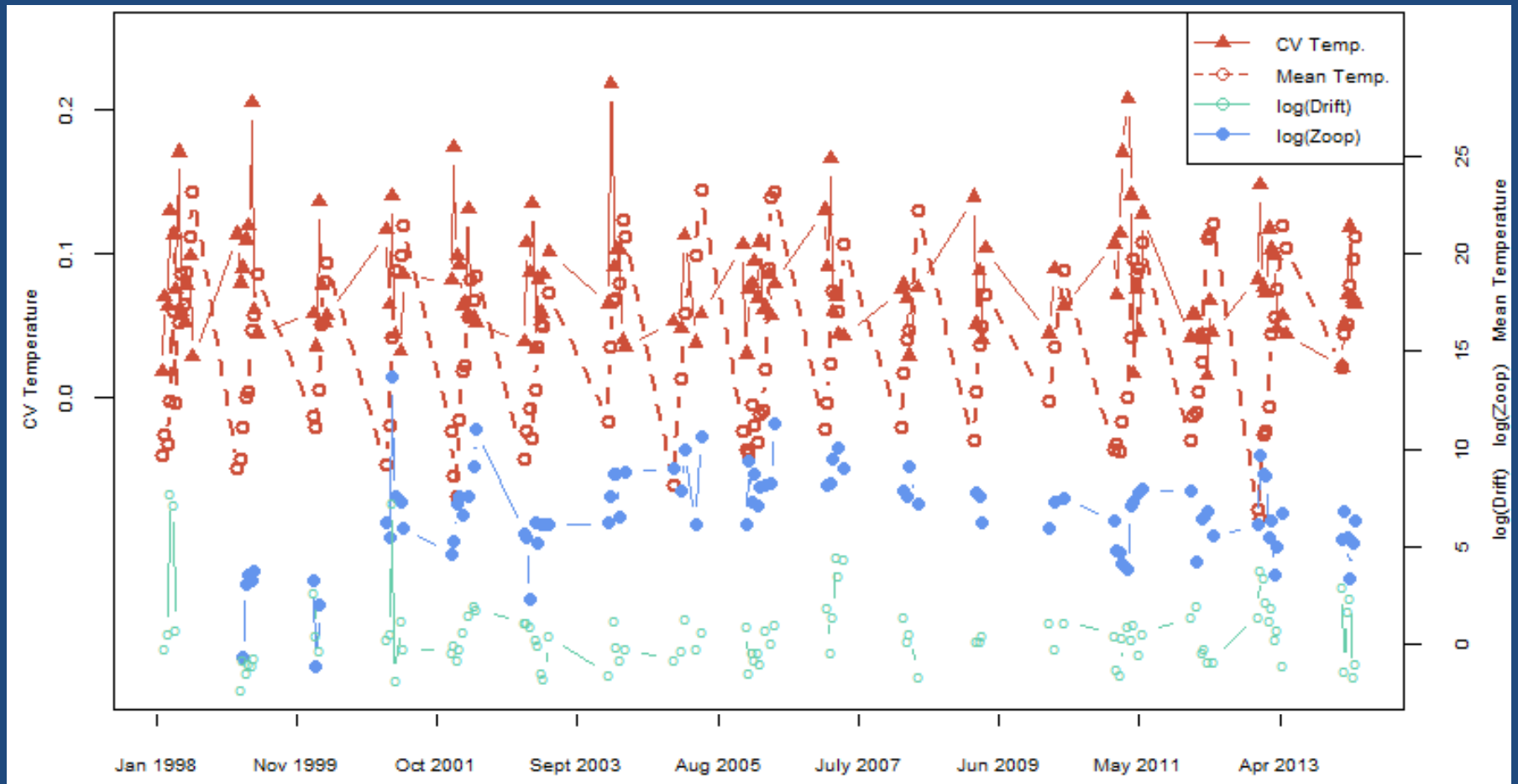
Model	AIC
1	-183.2677
2	-187.9211


Sacramento River above Yolo Bypass
BSEIN
RSTR
KDTR
MWTR
0
10000
30000
50000
0
50
100
150
200
250
Sacramento River adjacent to Yolo Bypass
Count
0
5000
10000
15000
20000
0
50
100
150
200
250
Yolo Bypass
0
500
1000
1500
2000
0
50
100
150
200
250
Fork Length (mm)

- To better interpret the interaction between inundation and temperature we compared datasets with categorical (A) and continuous (B) measures of inundation duration.
- To clarify gear biases we also tested models with only those fish caught in beach seines (C) and the rotary screw trap (D).

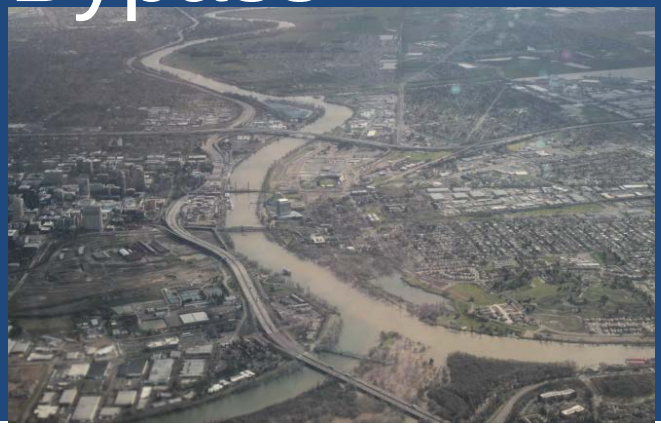
Data	Model	AICc	ΔAICc
A	Inundation Days * CV in Temperature + BSEIN volume + RSTR hours + Season	-221.14	0
A	Inundation Days + CV in Temperature + BSEIN volume + RSTR hours + Season	-218.80	2.3
A	Inundation Days + Season + BSEIN volume + RSTR hours	-218.39	2.75
B	Inundation Days * CV in Temperature + BSEIN volume + RSTR hours + Season	-217.48	3.66
B	Inundation Days + CV in Temperature + BSEIN volume + RSTR hours + Season	-215.22	5.92
B	Inundation Days + Season + BSEIN volume + RSTR hours	-212.6	8.54
A	Inundation Days + CV in Temperature + BSEIN volume + RSTR hours	-212.29	8.85
B	Inundation Days + CV in Temperature + BSEIN volume + RSTR hours	-211.5	9.64
C	Inundation Days + CV in Temperature	-125.54	-
C	Inundation Days + CV in Discharge	-125.45	-
C	Inundation Days + BSEIN volume	-125.39	-
D	Inundation Days + RSTR hours + Season	-174.82	-
D	Inundation Days + CV in Temperature + RSTR hours + Season	-173.74	-
D	Full	-172.90	-

Variation in temperature difficult to interpret: (1) spring months (2) floodplain drainage could be influenced by productivity?

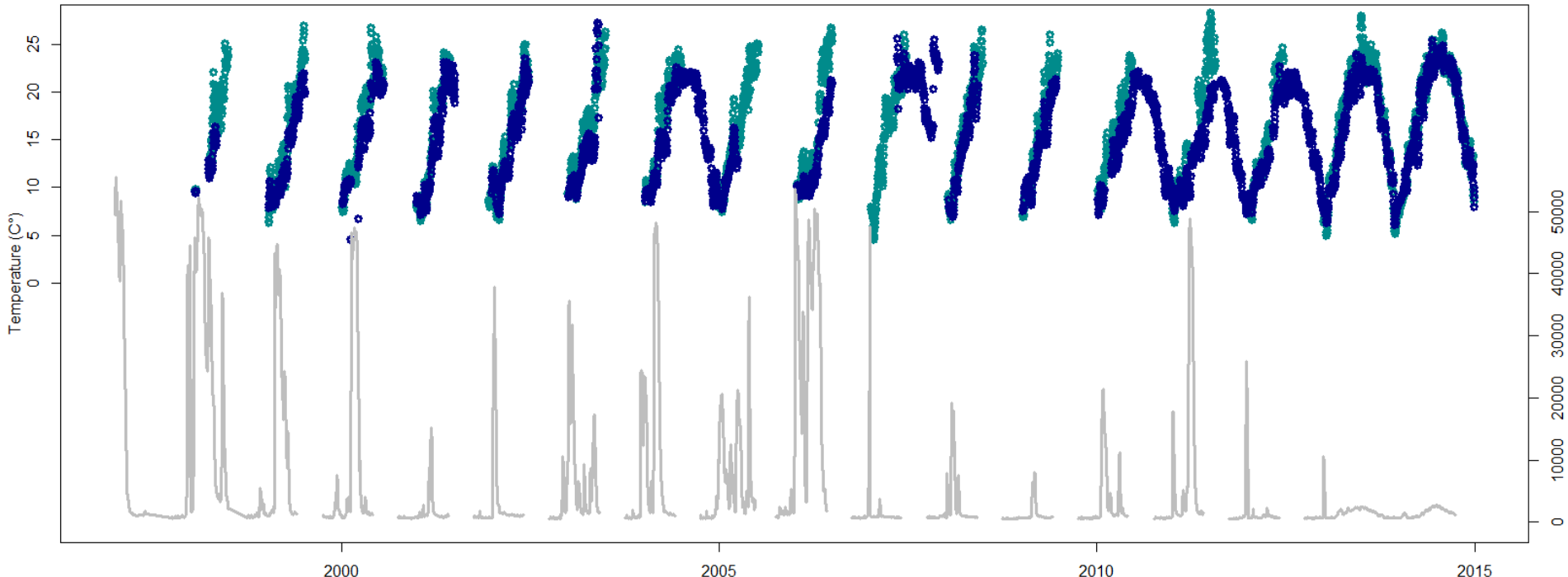


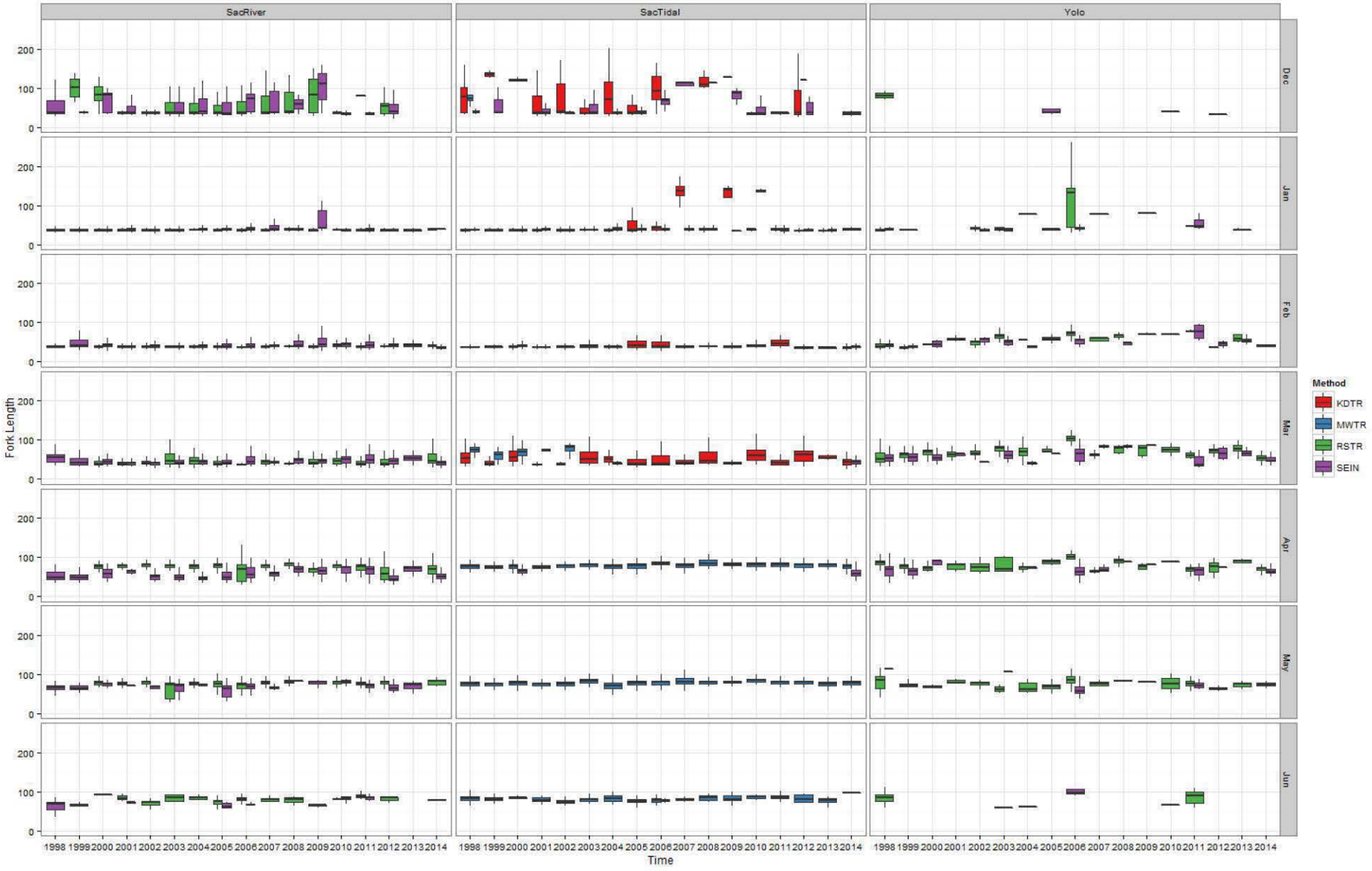
Simplified Sacramento River lacks thermal heterogeneity when compared to the Yolo Bypass

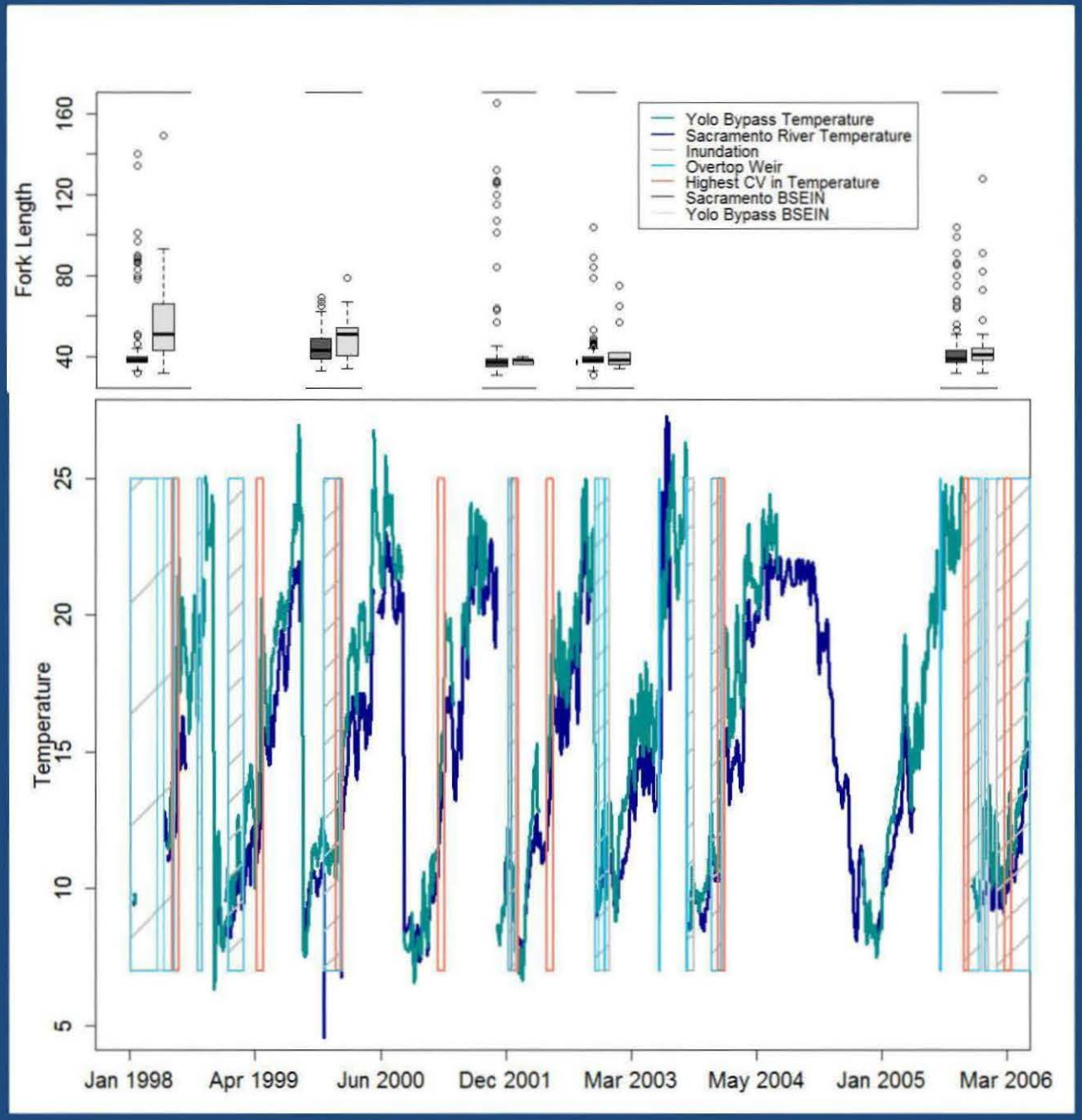
Flooded Yolo Bypass 2016-03-14



Flooded Sacramento River 2011-03-26




SacRiver
SacTidal
Yolo
Dec
Jan
Feb
Mar
Apr
May
Jun
Fork Length
0
100
200
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Time
Method
KDTR
MWTR
RSTR
SEIN


Fork Length
40
80
120
160
Yolo Bypass Temperature
Sacramento River Temperature
Inundation
Overtop Weir
Highest CV in Temperature
Sacramento BSEIN
Yolo Bypass BSEIN
Temperature
5
10
15
20
25
Jan 1998
Apr 1999
Jun 2000
Dec 2001
Mar 2003
May 2004
Jan 2005
Mar 2006

Inundation, temperature, season and **sampling effort** best predicted size and timing of juvenile Chinook in the YB

Model	ΔAICc	weight
Inundation Days + CV in Temperature + BSEIN volume + RSTR hours + Season	0	0.689
Inundation Days+ Season + BSEIN volume + RSTR hours	2.6	0.186
Inundation Days + CV in Temperature + BSEIN volume + RSTR hours	3.7	0.107
Inundation Days + BSEIN volume + RSTR hours	7.7	0.015
Inundation Days + CV in Temperature + CV in Discharge	11	0.003
Inundation Days + CV in Discharge	13.7	0.001

Season: significant and negative

= earlier in the year CV in juvenile salmon size was greater

1.) increased access to floodplain
2.) run-timing variation

Model	ΔAICc	weight
Inundation Days + CV in Temperature + BSEIN volume + RSTR hours + Season	0	0.689
Winter run Escapement	31.6	0
Null	32.1	0
Spring run Escapement	33.9	0
Fall run Escapement	33.9	0
Hatchery Release	34	0
n	34.2	0
Late-fall run Escapement	34.3	0
Hatchery Release + all Escapement	40.1	0