

Quantifying the stabilizing effects of population diversity with the portfolio effect



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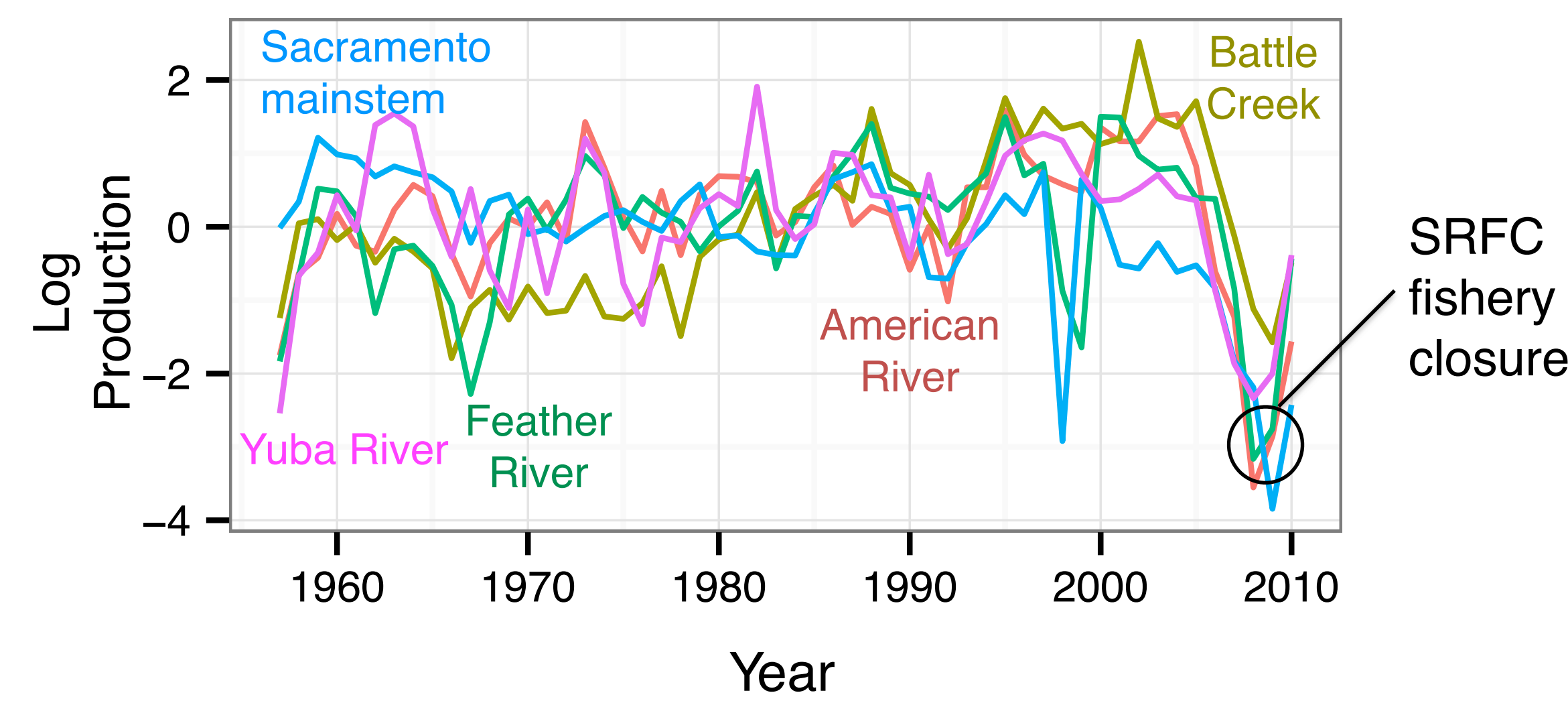


1 The Portfolio Effect and Salmon Populations

- ◆ Biodiversity loss threatens ecosystem integrity by reducing community stability (increasing temporal variability)
- ◆ The portfolio effect is a statistical phenomenon that:
 - ◆ reduces total variability with asset (e.g., population) independence
 - ◆ allows for quantification of diversity effects on aggregate salmon stocks

Application to Sacramento River Fall-run Chinook (SRFC)

- ◆ Low spawner returns in 2007 and 2008 led to closure of the Sacramento River Fall-run Chinook (SRFC) salmon fishery during 2008-2009



- ◆ Recent studies argue that homogenization has synchronized SRFC population dynamics, increasing temporal variability and decreasing stock persistence^{1,2}
- ◆ Management with the portfolio effect requires quantifying the variability-reducing benefits of diversity for aggregate stocks

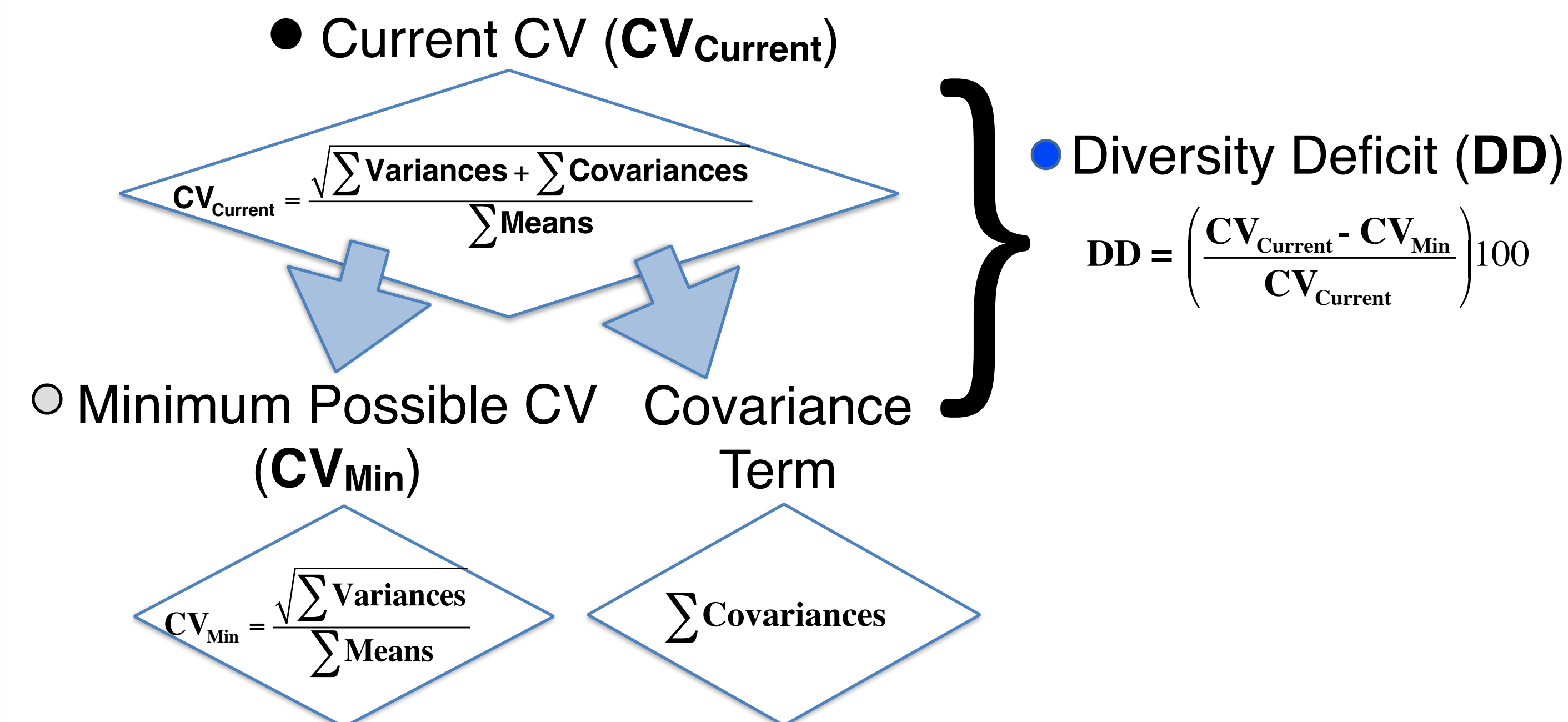
Managing the SRFC with the portfolio effect

Questions

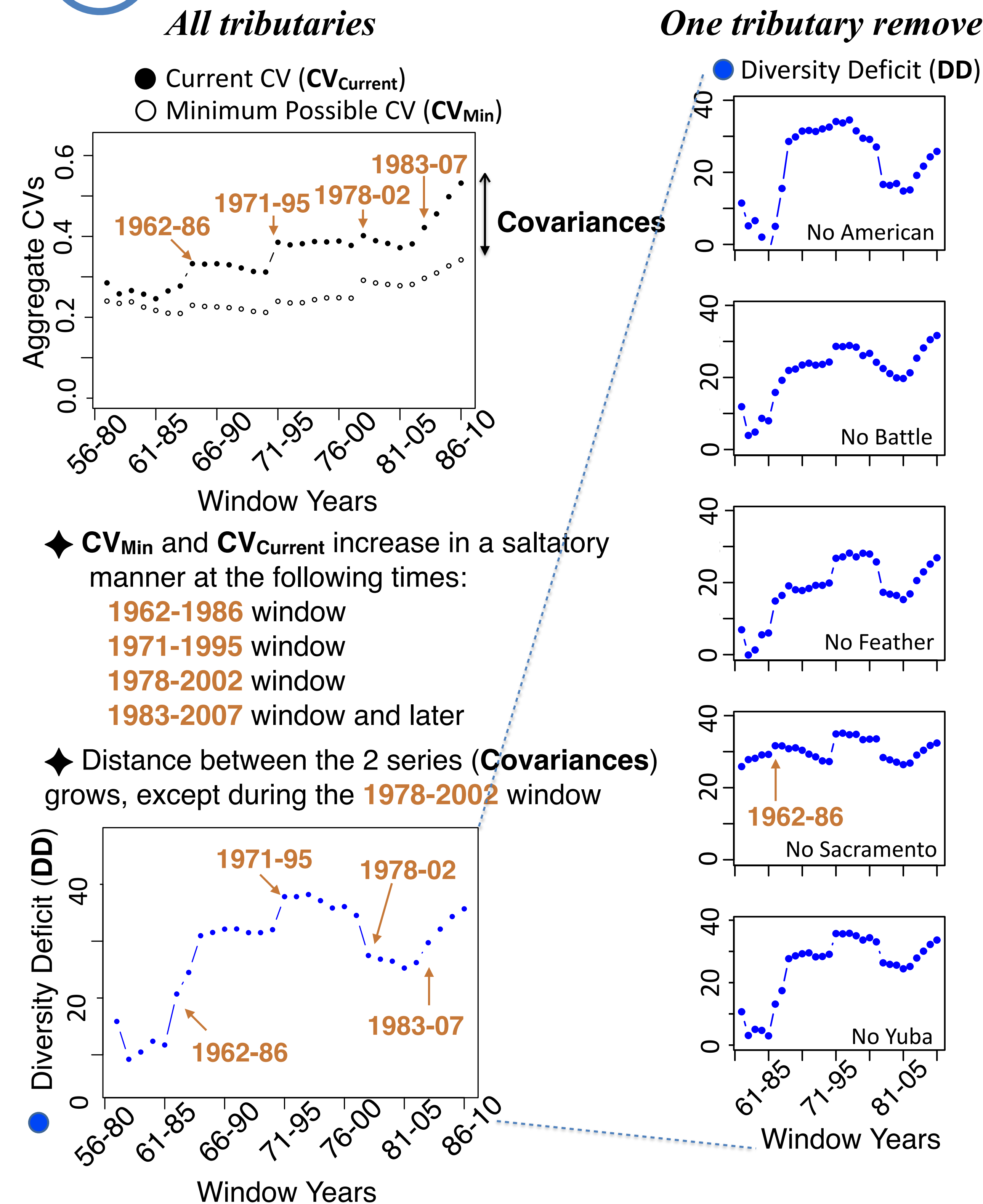
- ◆ How much could population diversity have reduced the SRFC's variability?
- ◆ What were the sources of changes in population diversity for the stock?
- ◆ Could maximum diversity have prevented the fishery's closure?

What is needed?	Solution
Quantify how much aggregate CV reduction is possible with maximum diversity	New metric: Diversity Deficit
Represent unequal population contributions to the portfolio effect	Incorporate population-specific means and variances
Retrospectively identify statistical origins (temporal, spatial) of diversity loss	25-yr sliding window analyses One tributary removed analyses
Determine whether maximum diversity could have prevented the fishery's closure	Estimate probability of 2008, 2009 production based on variance associated with maximum population independence

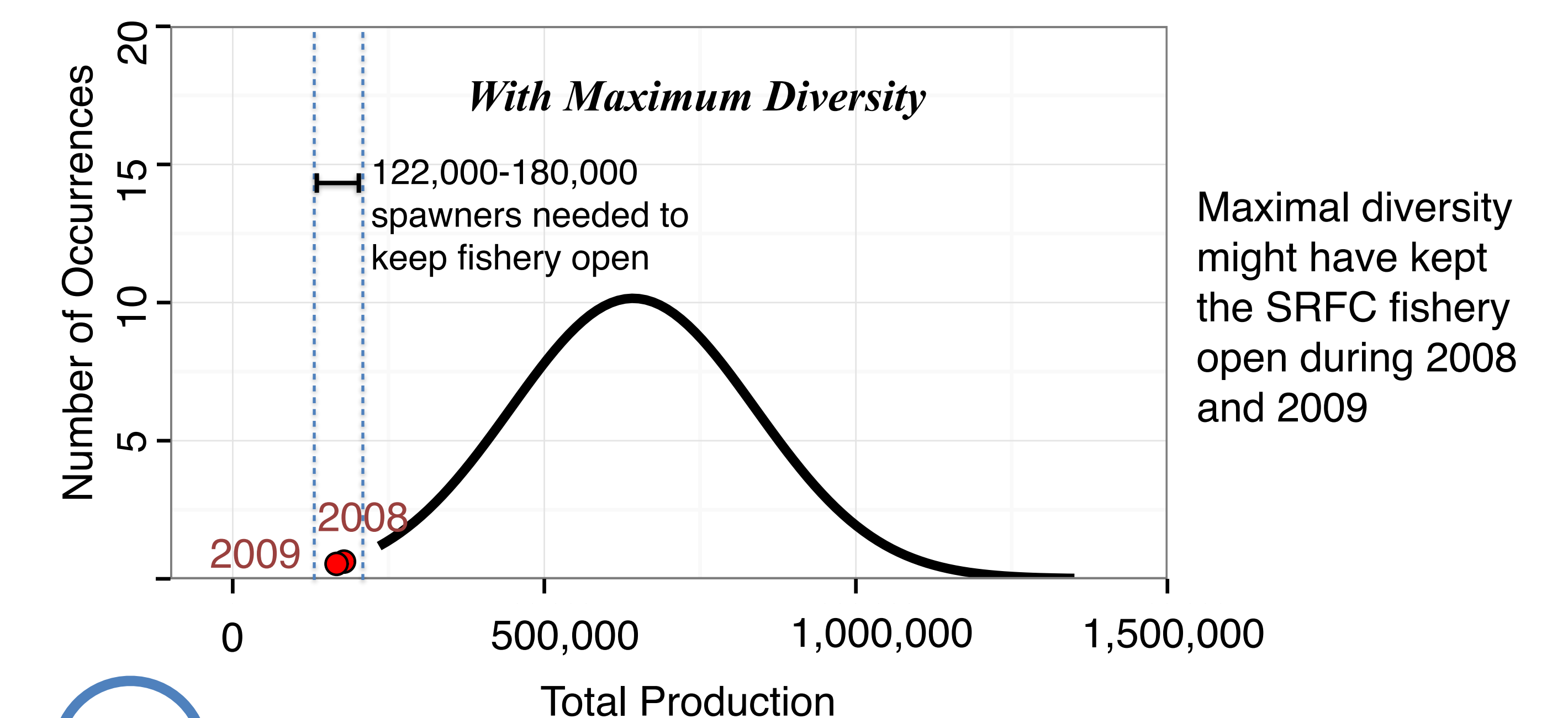
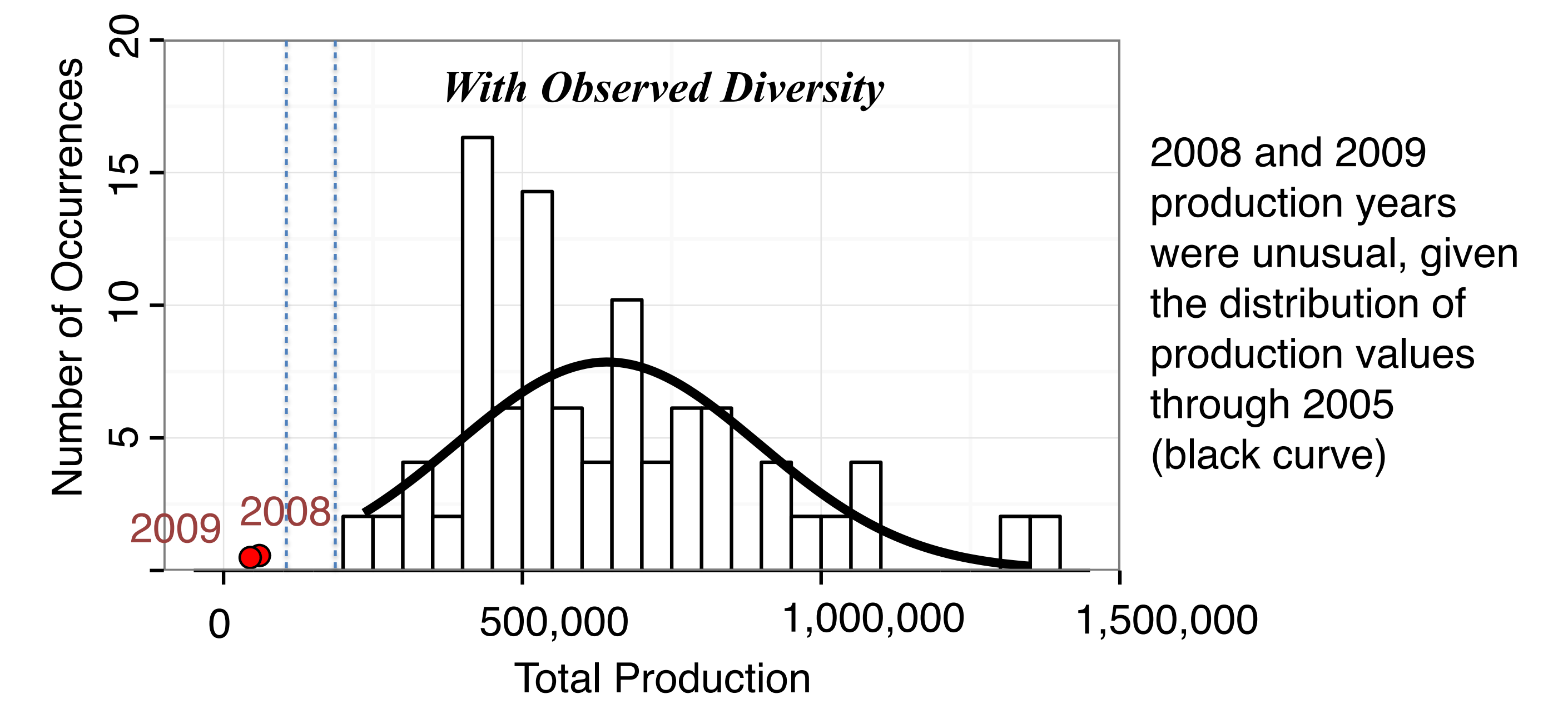
2 Quantifying Population Diversity with the Diversity Deficit



3 Retrospective Analyses of Changing Stability



4 Would the Fishery have Closed Under Maximum Diversity?



5 Conclusions

- ◆ Diversity declined as a saltatory process for the Sacramento River Fall-run Chinook (SRFC), primarily due to early changes in the Sacramento River mainstem population
- ◆ Maximum diversity might have prevented the closure of the SRFC fishery
 - ◆ However, complete independence among populations may not be possible
- ◆ Our new metric, the Diversity Deficit, is broadly useful for any study aimed at understanding how diversity may contribute to variability
- ◆ By calculating how much diversity could reduce variability of the stock over time, we provide the specific conclusions needed for effective policy decisions

References

- Lindley et al. 2009. NOAA-TM-NMFS-SWFSC-447.
- Carlson & Satterthwaite. 2011. *Can. J. Fish. Aquat. Sci.*, 68, 1579-1589.

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