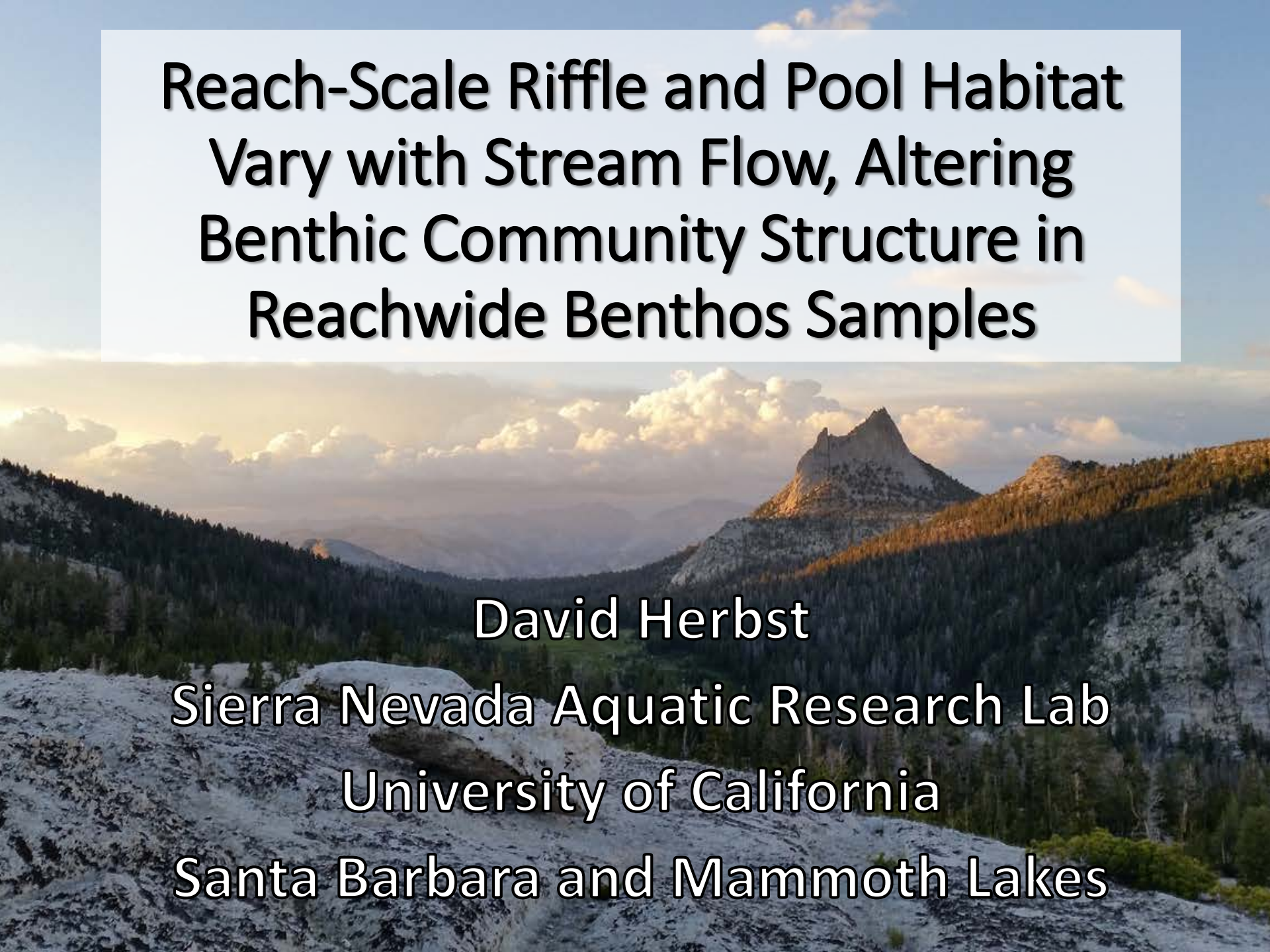
Reach-Scale Riffle and Pool Habitat Vary with Stream Flow, Altering Benthic Community Structure in Reachwide Benthos Samples



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University of California

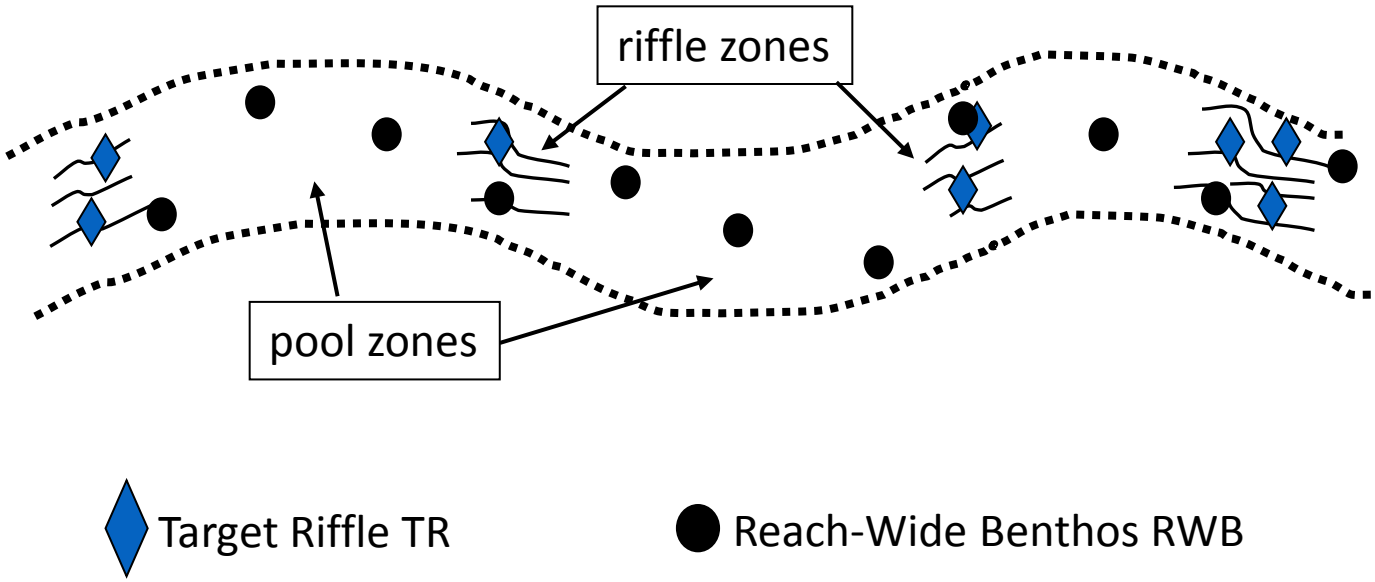
Santa Barbara and Mammoth Lakes

Observations from reference-quality headwater streams in the Sierra Nevada during periods of hydrologic variation including prolonged drought:

1. Monitoring over extensive Sierra stream network contrasting the mixed habitat of reachwide benthos with target riffle sampling data

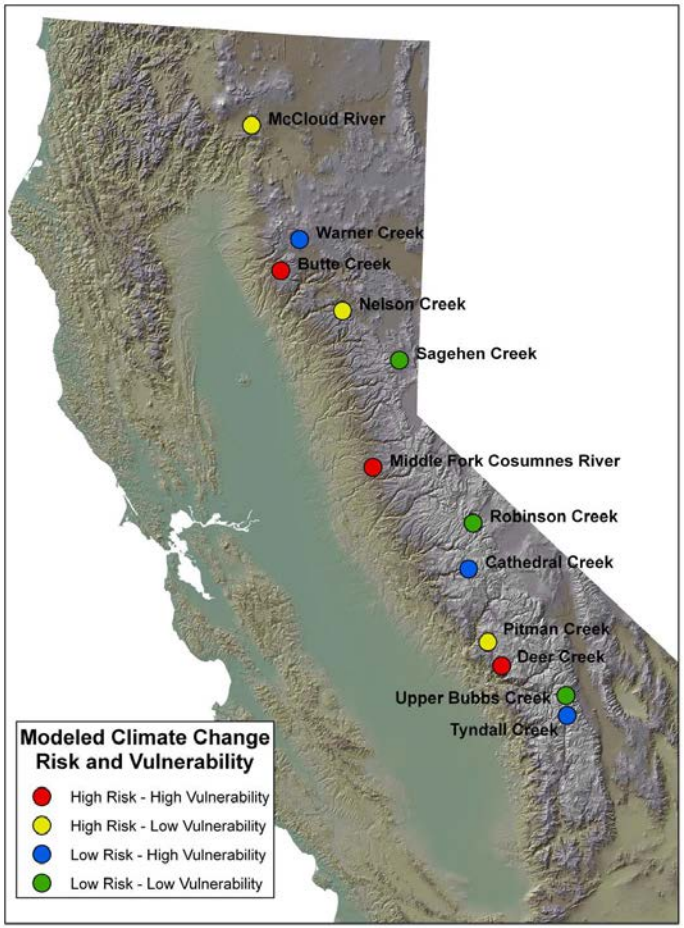
2. Contrasts of riffle and pool habitat and benthic communities in the central Sierra Nevada

RWB vs TR sampling differences: mixed vs stratified sampling



Sentinel Stream Monitoring Network for Sierra Nevada: Monitoring of climate change effects in streams selected to represent a range of climate risk and natural resistance from 2010-2016

Average to Wet Hydrology and Prolonged Drought



12 catchments
24 streams total
(tributary site nested in each catchment)

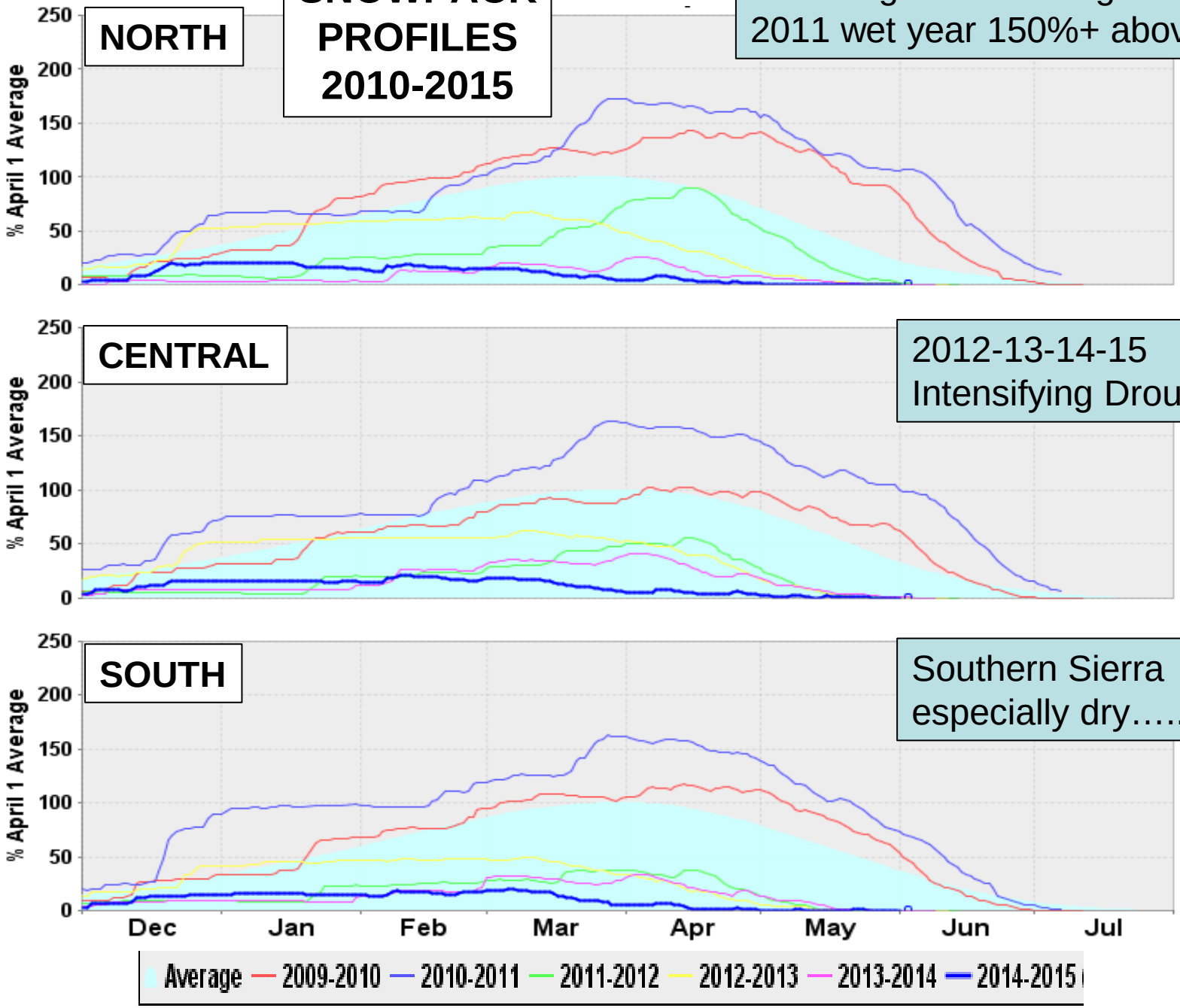
17 in 7 National Forests
7 in 3 National Parks

Highlight observations of:

- **Habitat area and hydrology**
- **Contrasts of RWB to TR**

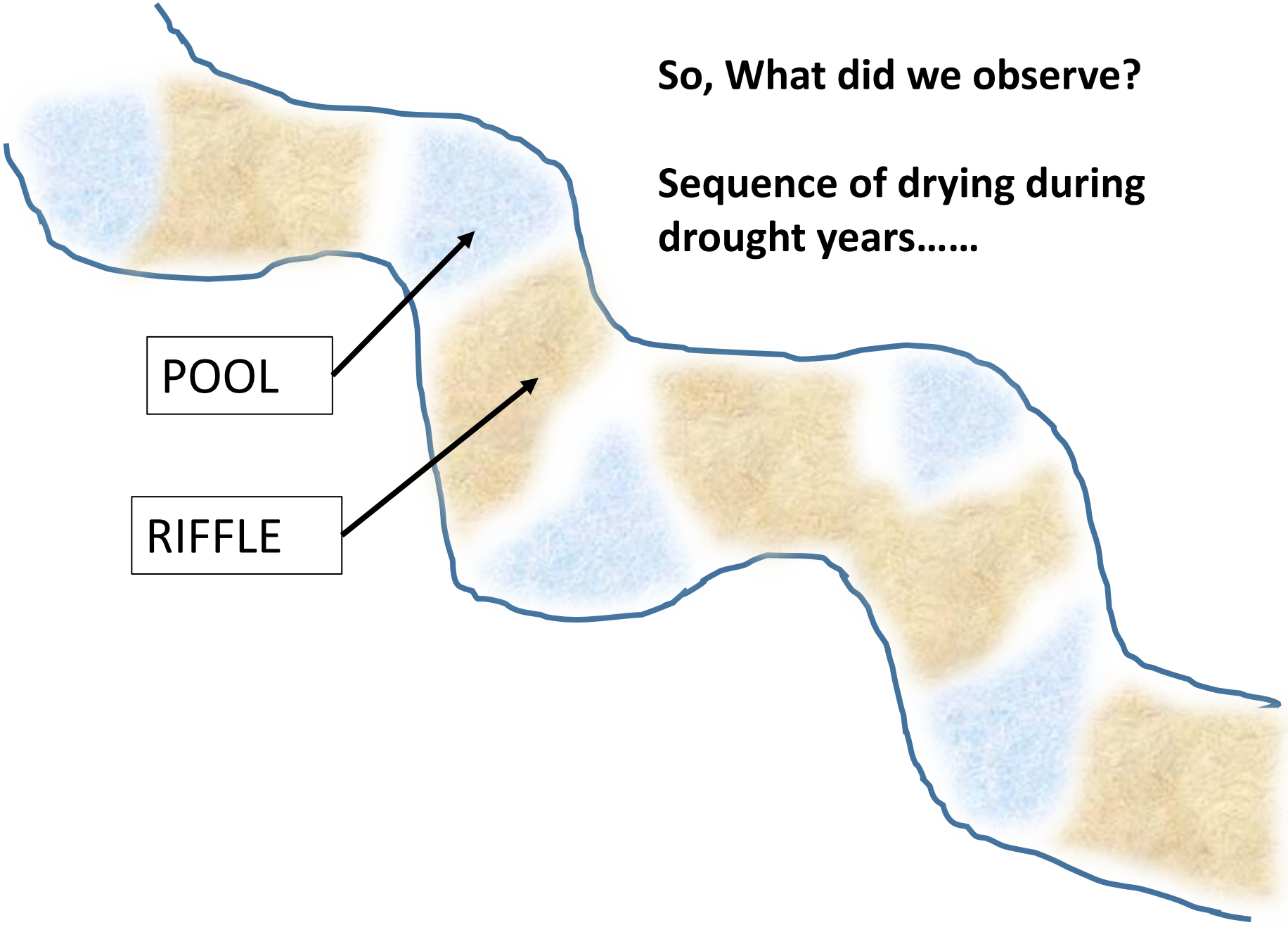
SNOWPACK PROFILES 2010-2015

2010 avg to above avg
2011 wet year 150%+ above avg



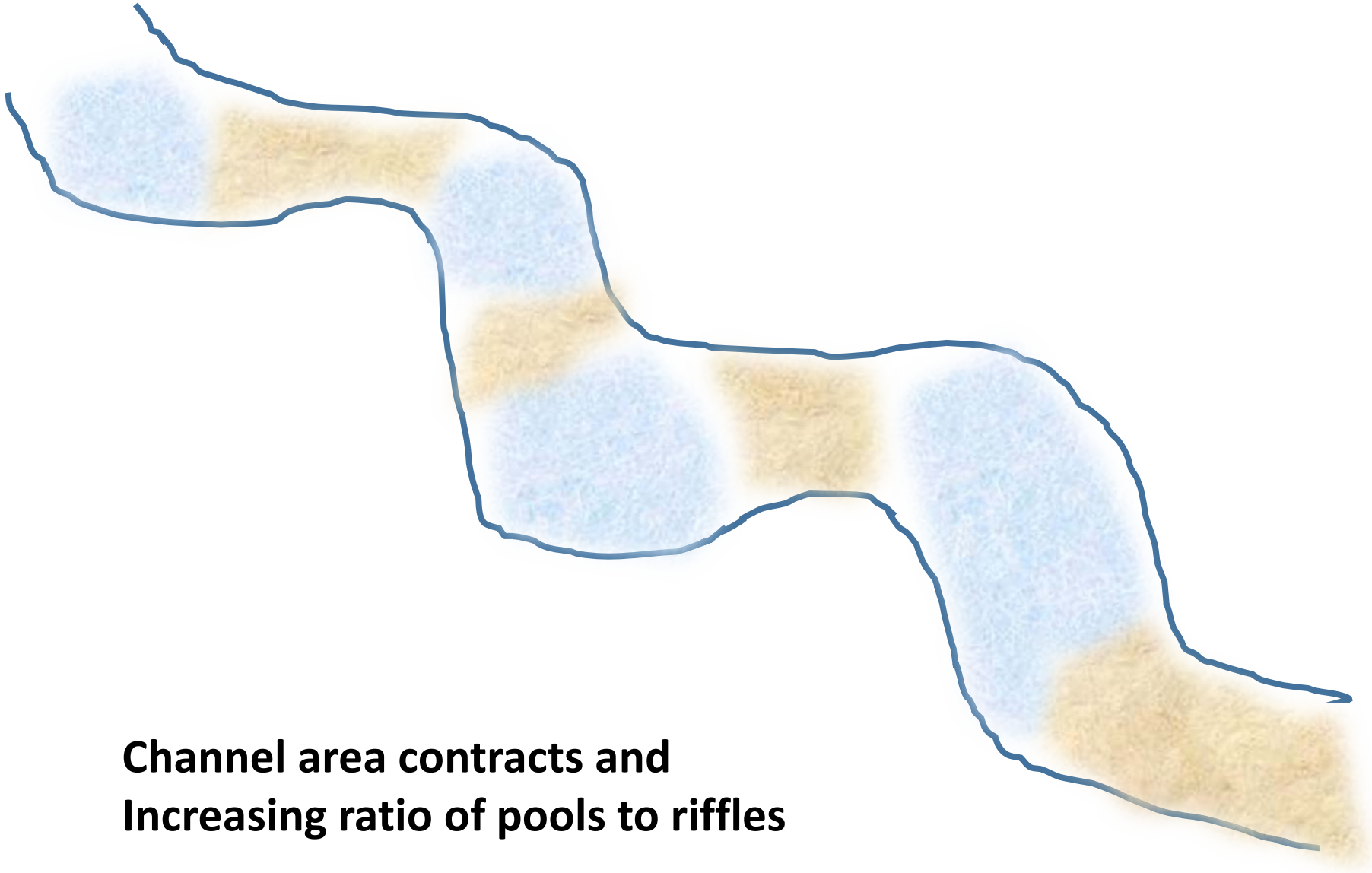
2012-13-14-15
Intensifying Drought

Southern Sierra
especially dry…..

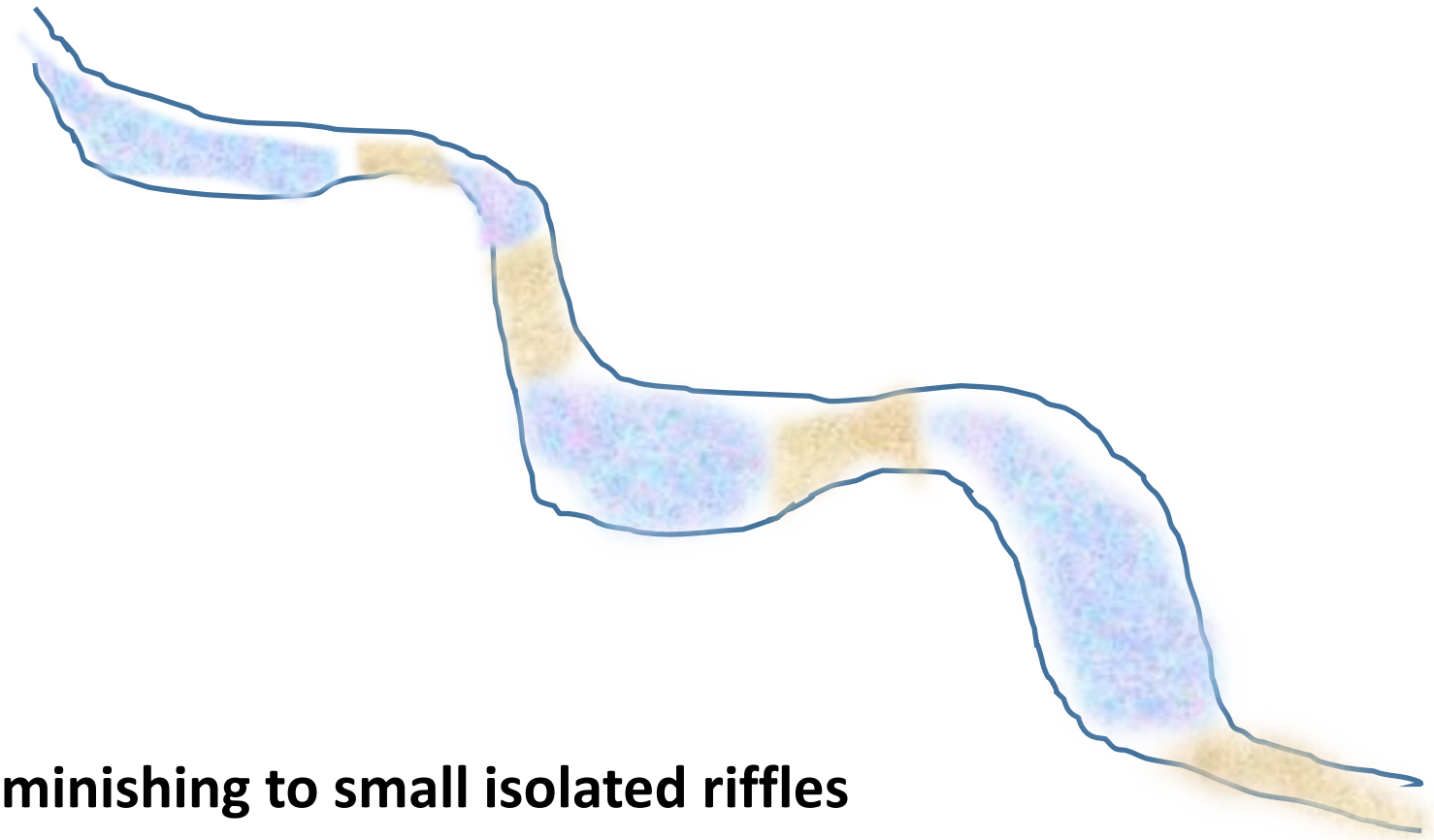


So, What did we observe?

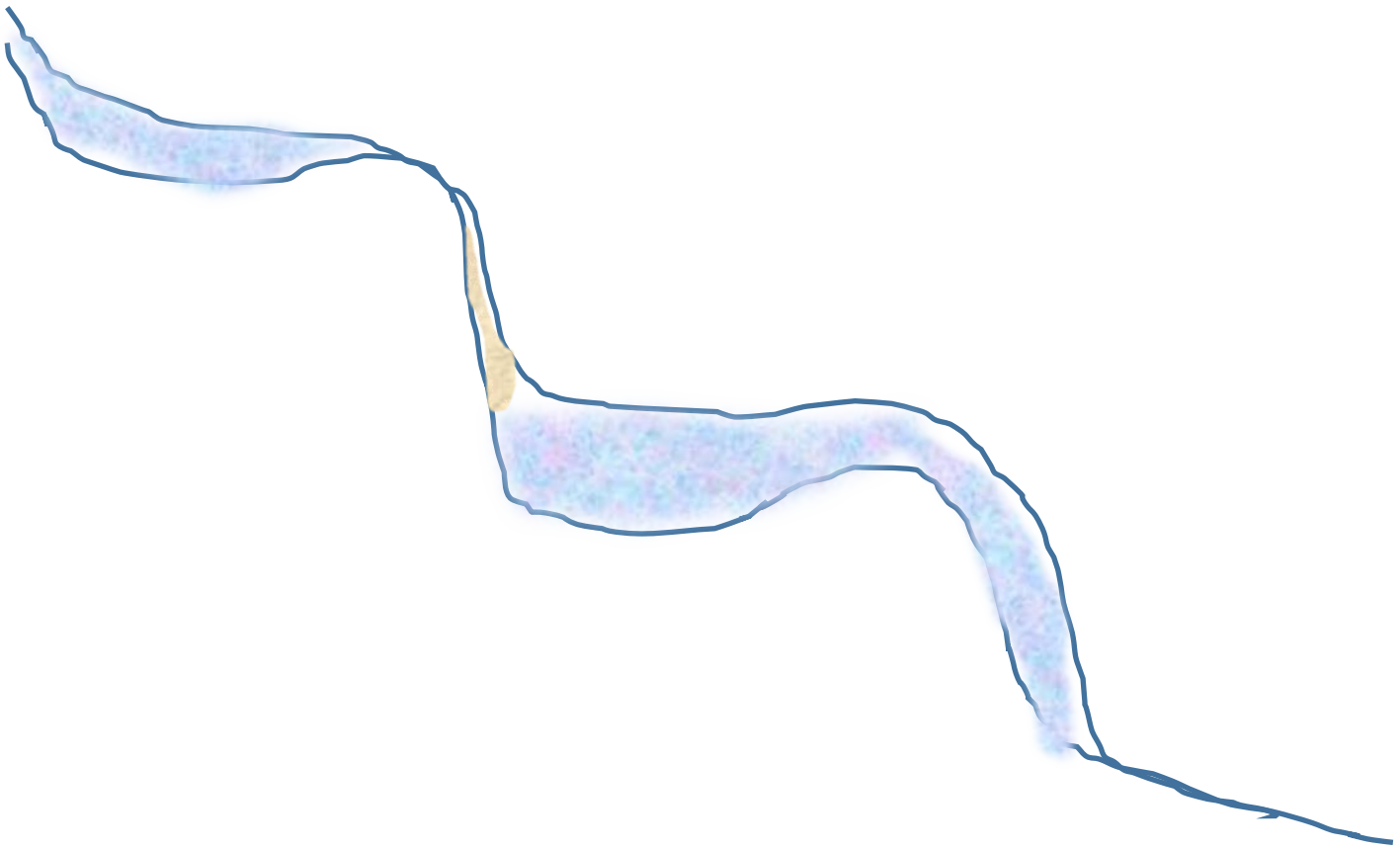
Sequence of drying during drought years……



Channel area contracts and
Increasing ratio of pools to riffles

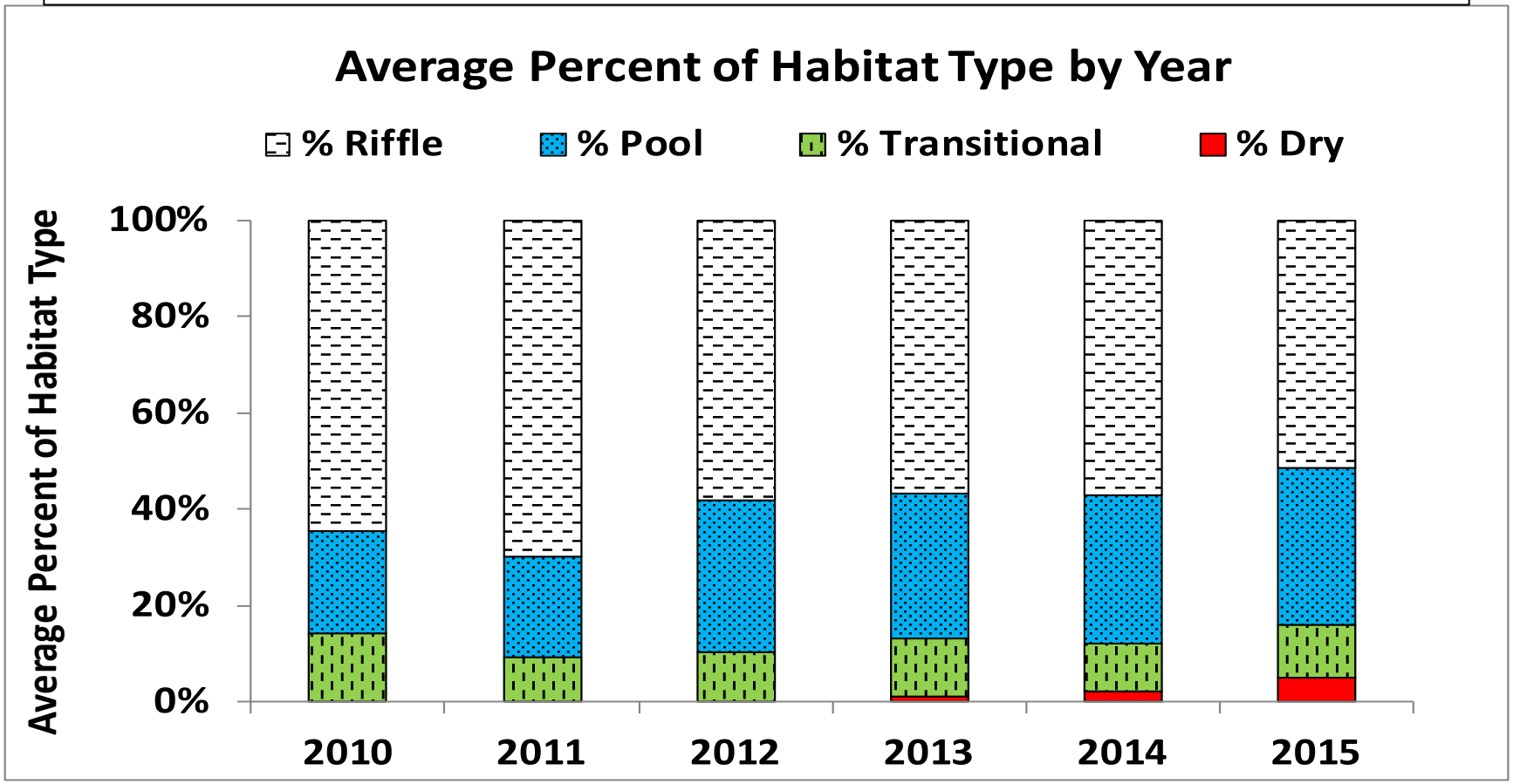


Diminishing to small isolated riffles



And at an extreme to intermittent pools

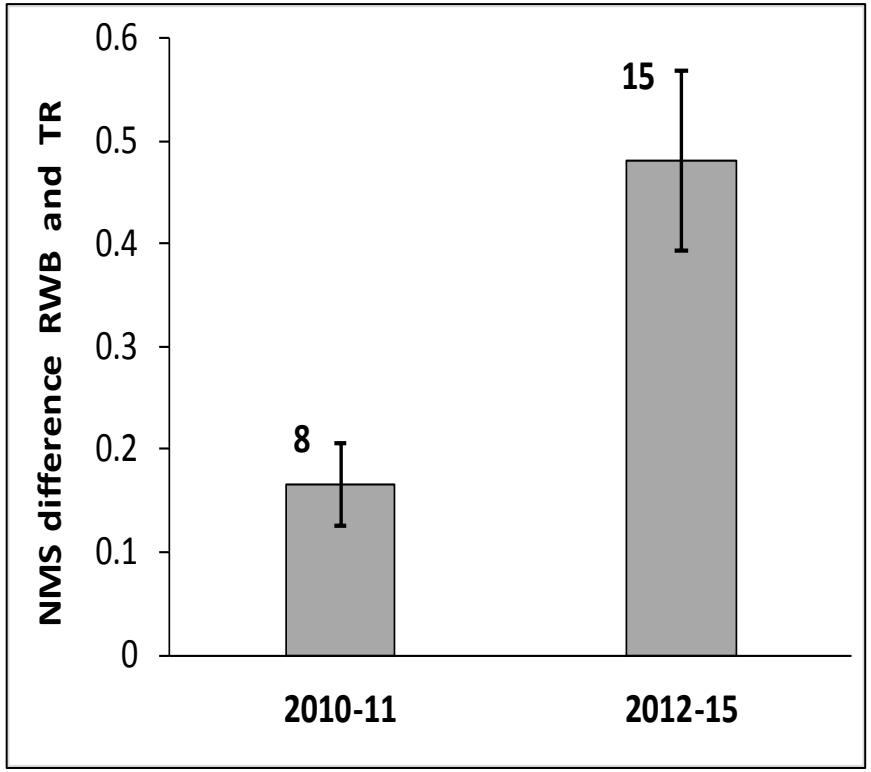
Inter-annual Differences:
Pool areas increase at the expense of riffles during drought compared to avg-wet years and some sections go dry…
>3:1 ratio riffle:pool to <2:1 ratio riffle:pool

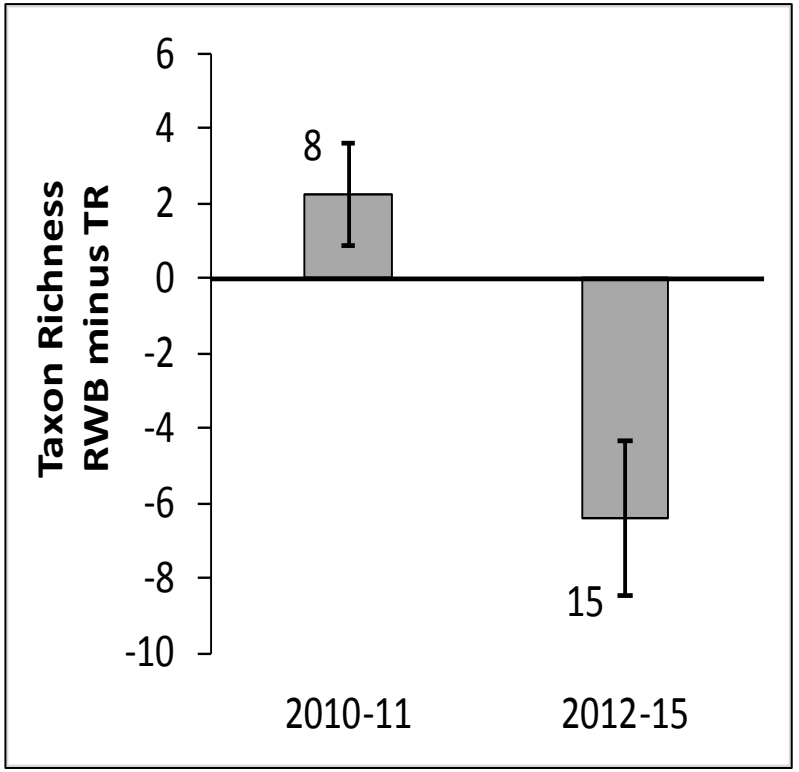


Seasonal changes in riffle/pool can also occur from runoff to base flow periods

Do RWB samples in sentinel streams differ more in community structure from TR as flows recede during drought? (2012-15 flows <20% of 2010-11)

- NMS scores diverge between RWB—TR during drought, and…
- Taxon richness lost in RWB compared to TR during drought

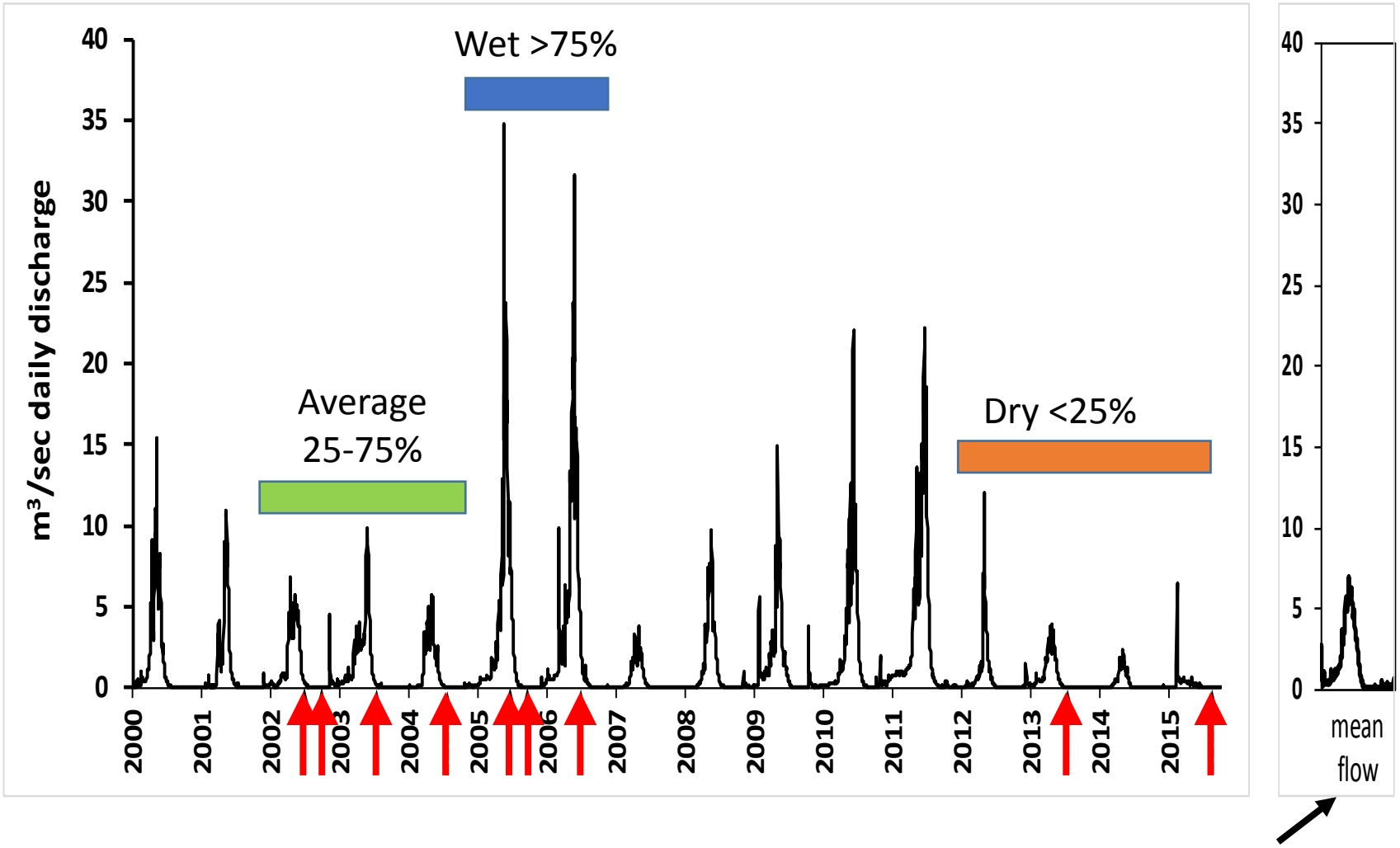




Kings River Experimental Watershed

- **Elevations 7000-8000’**
- **12 stream sites sampled between 2002 and 2015**
- **Riffles and Pools sampled separately**
- **All reference-quality headwater streams**
- **Forest management treatments underway**

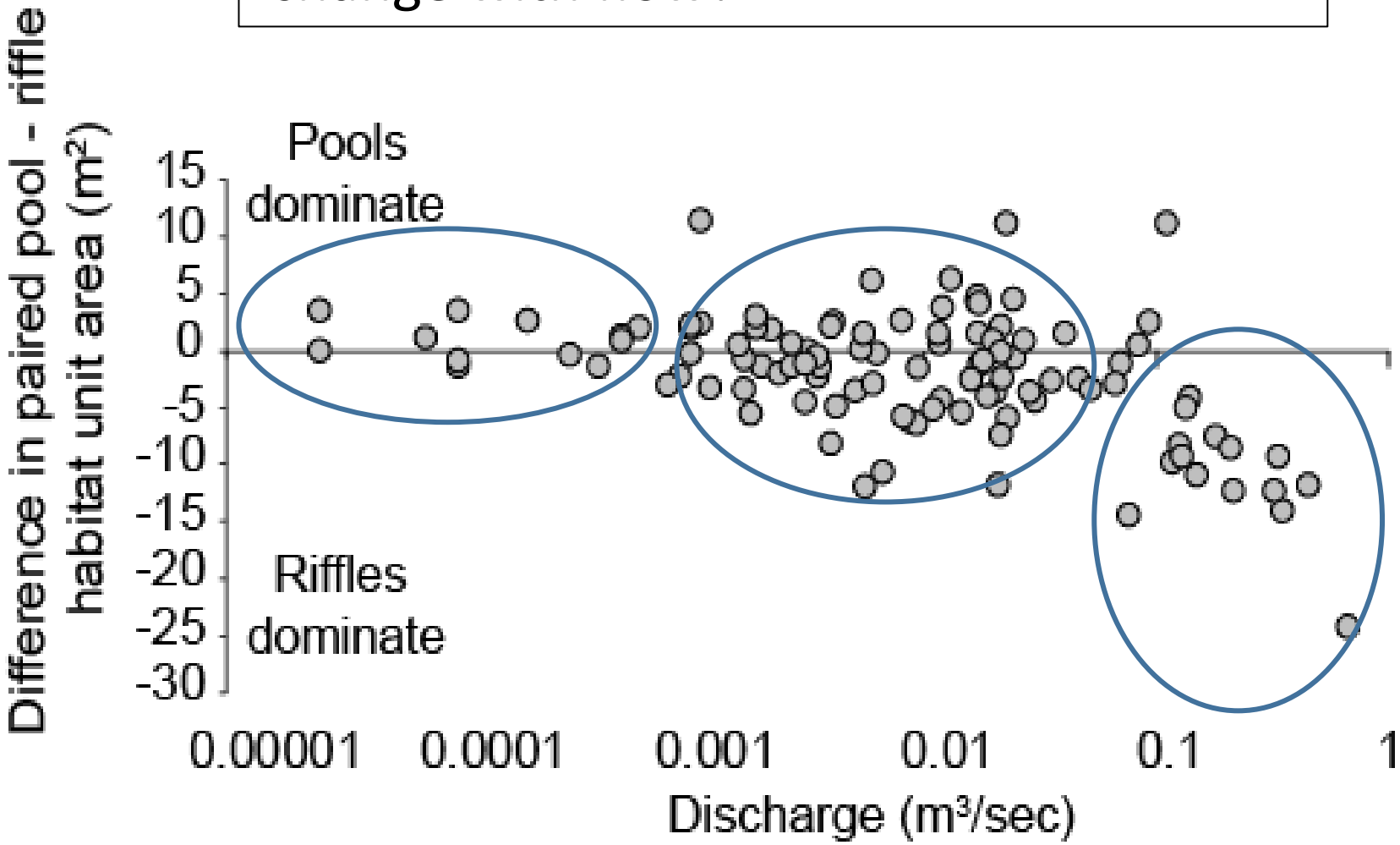
Discharge data from nearby Pitman Creek



Sampling over a range of hydrologic conditions

Mean historic flow (baseline 1975-2000)

How does habitat area in stream reaches change with flow?

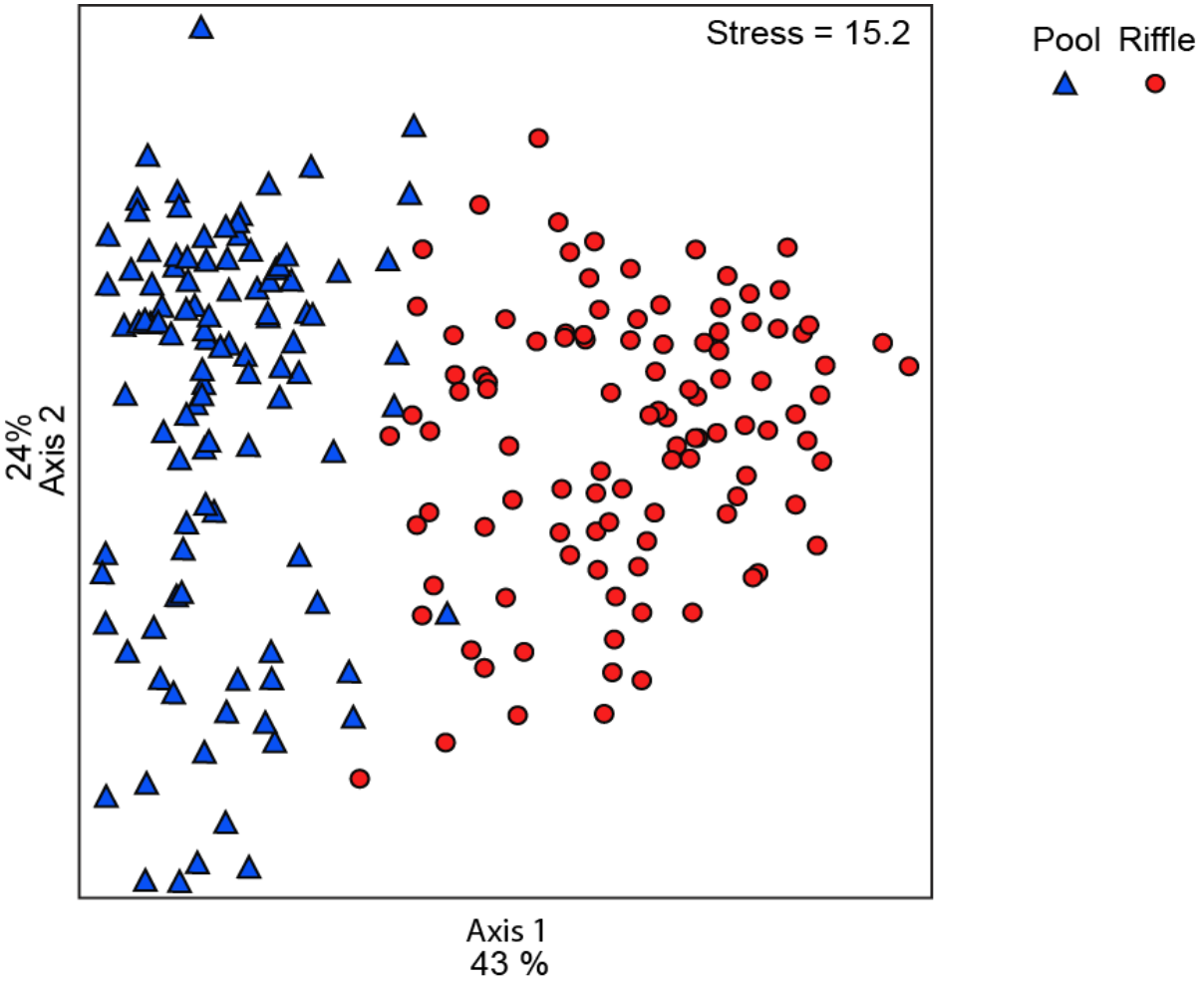


Pool and Riffle communities distinctly different in NMS ordination

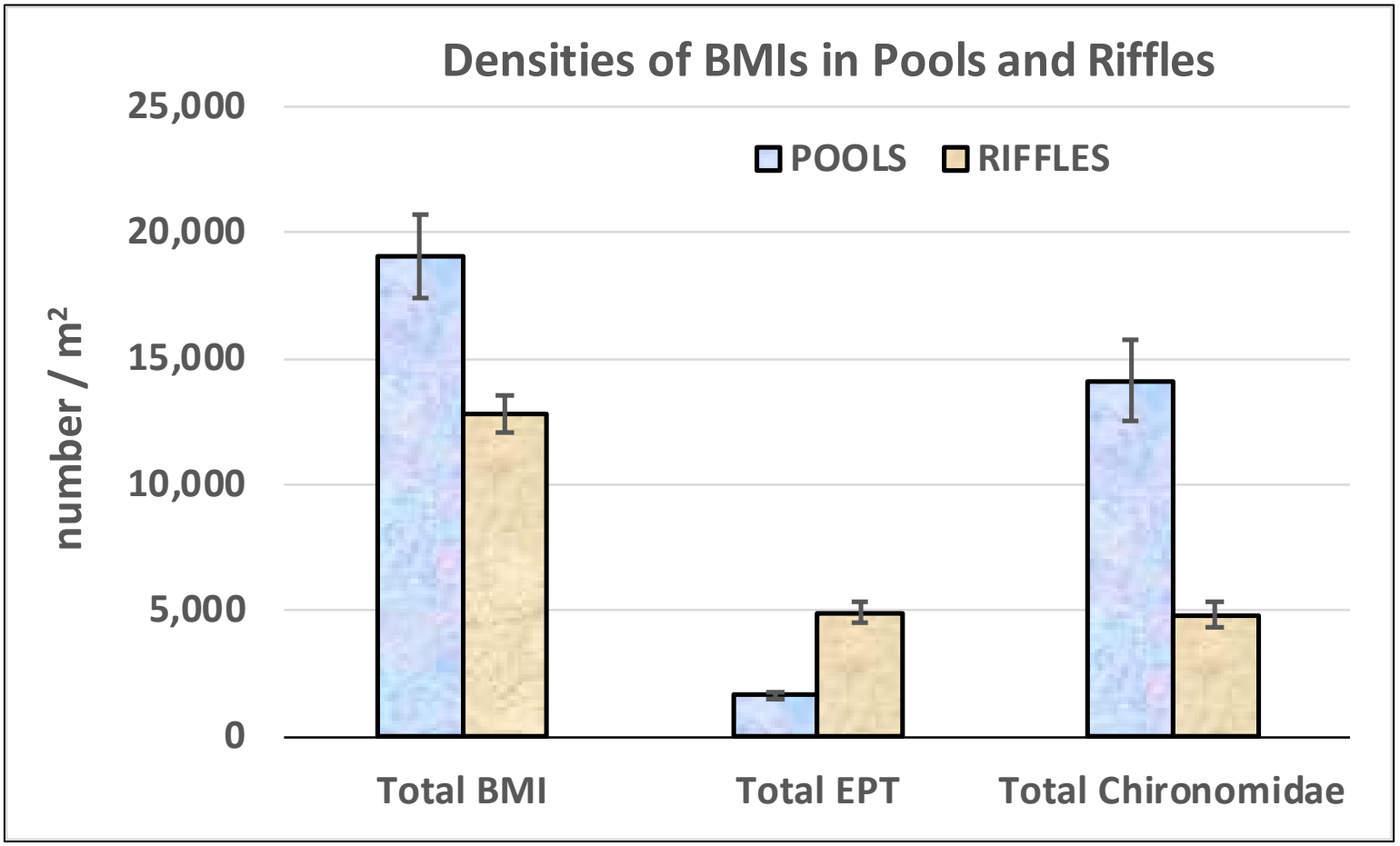
Kings River Headwater streams

Pools vs Riffles

2002-2006 2013, 2015

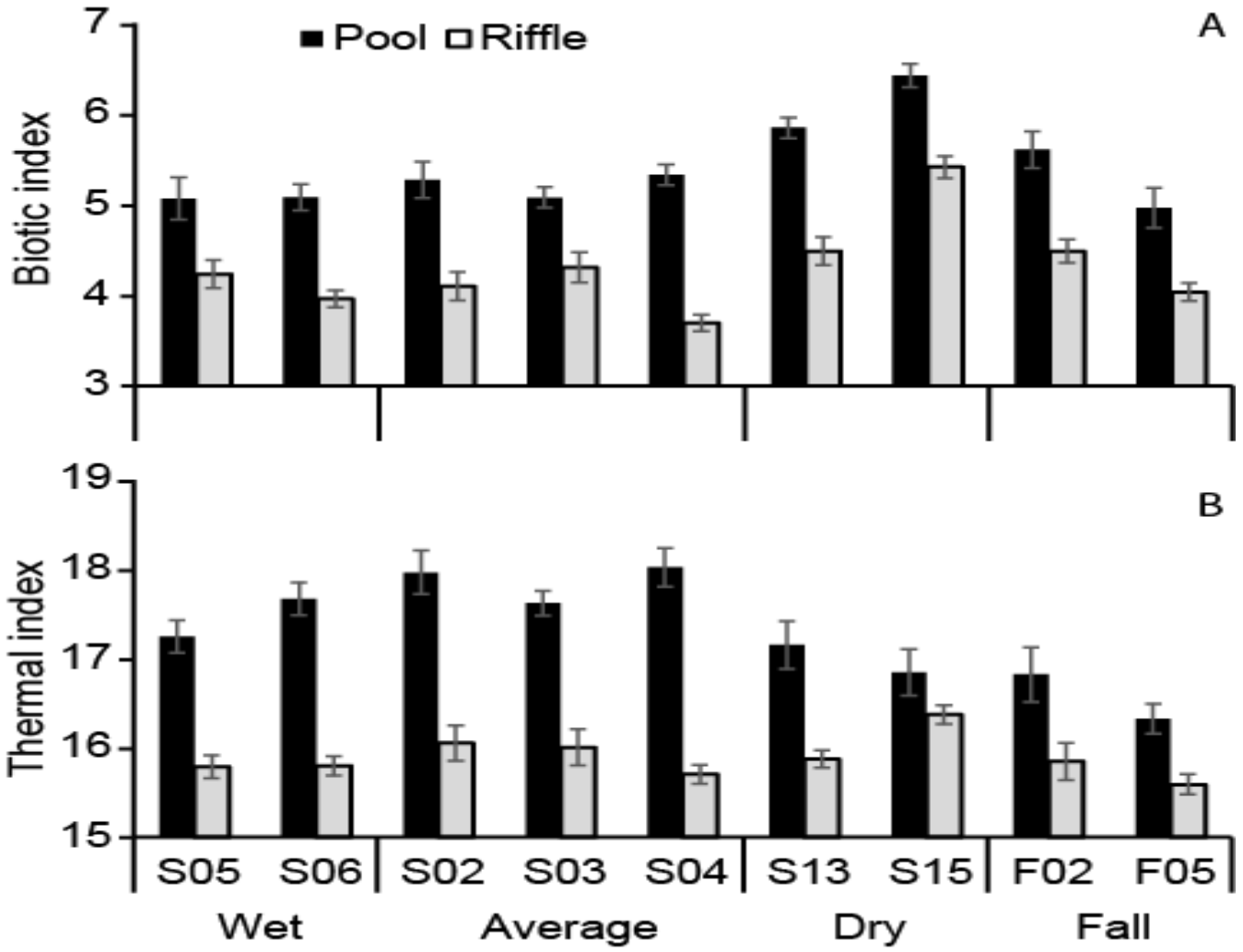


Kings River study shows BMI taxa densities differ between riffles and pools



Larger, long-lived, sensitive EPT dominate in riffles; few in pools
Smaller, more tolerant midges prevail in pools; dominate in declining flows

Traits related to tolerance also varied between riffles and pools across a variety of hydrologic conditions and seasons



How have differences been accounted for in bioassessment analysis?
From CA perennial stream assessment 2000-2007: Use of a "fudge factor" because RWB samples underscore condition….

"Since the O/E models (developed with TRC data) have a slight tendency to underscore RWB samples (Rehn et al. 2007), we added 0.04 to all RWB scores to correct for the bias.."

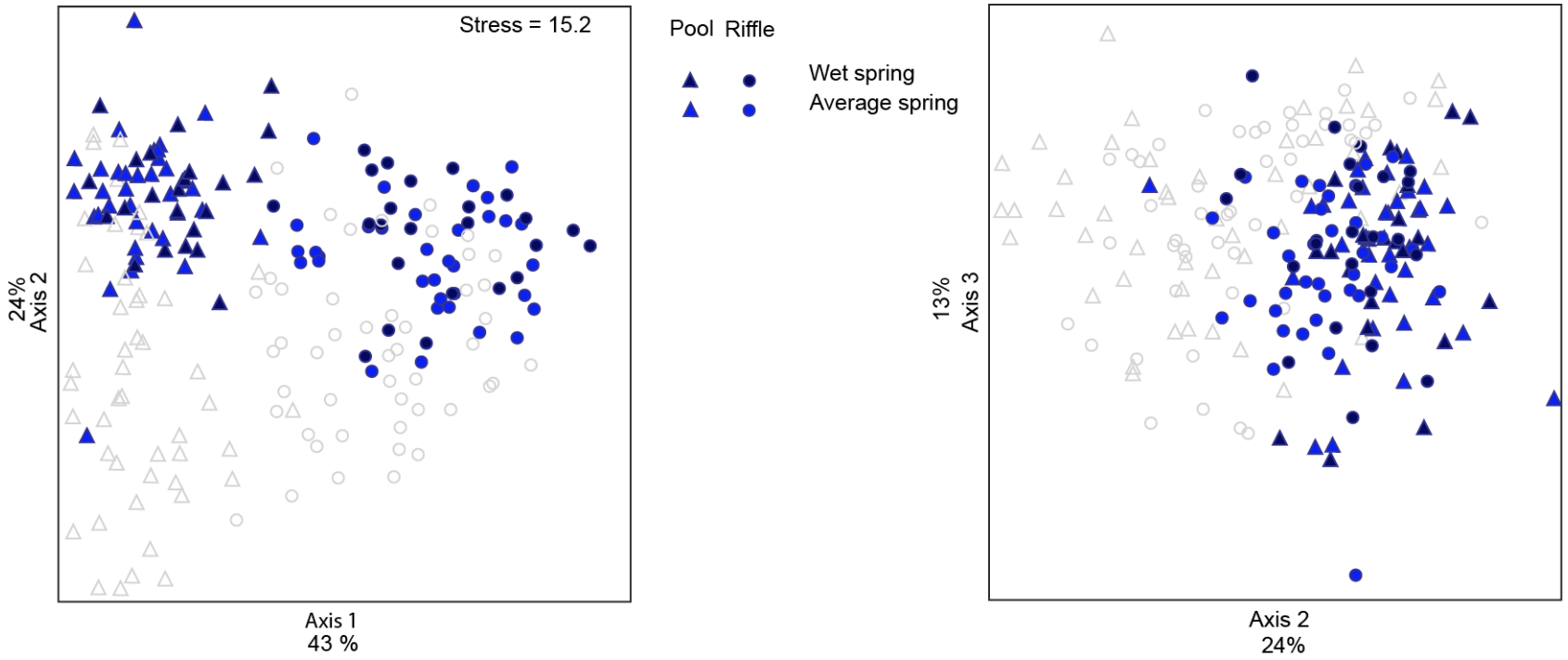
Likely this is owing to more pool taxa comprising the RWB sample type.

- Comparative study of Rehn et al 2007 shows TRC and RWB data are essentially interchangeable - except for "bias at higher elevations, large watersheds, and where streams were most disturbed."
  Again a result of P vs. R area differences?
- Gerth and Herlihy 2006 also found divergence in TR vs RWB as the riffle area of habitat decreased
- Still…probably OK for most assessments using RWB …but recognize there are conditions when bias exists between sites of differing geomorphology, and within sites over time
- Flow regime effects on changing proportions of riffle and pool habitat are an important source of bias

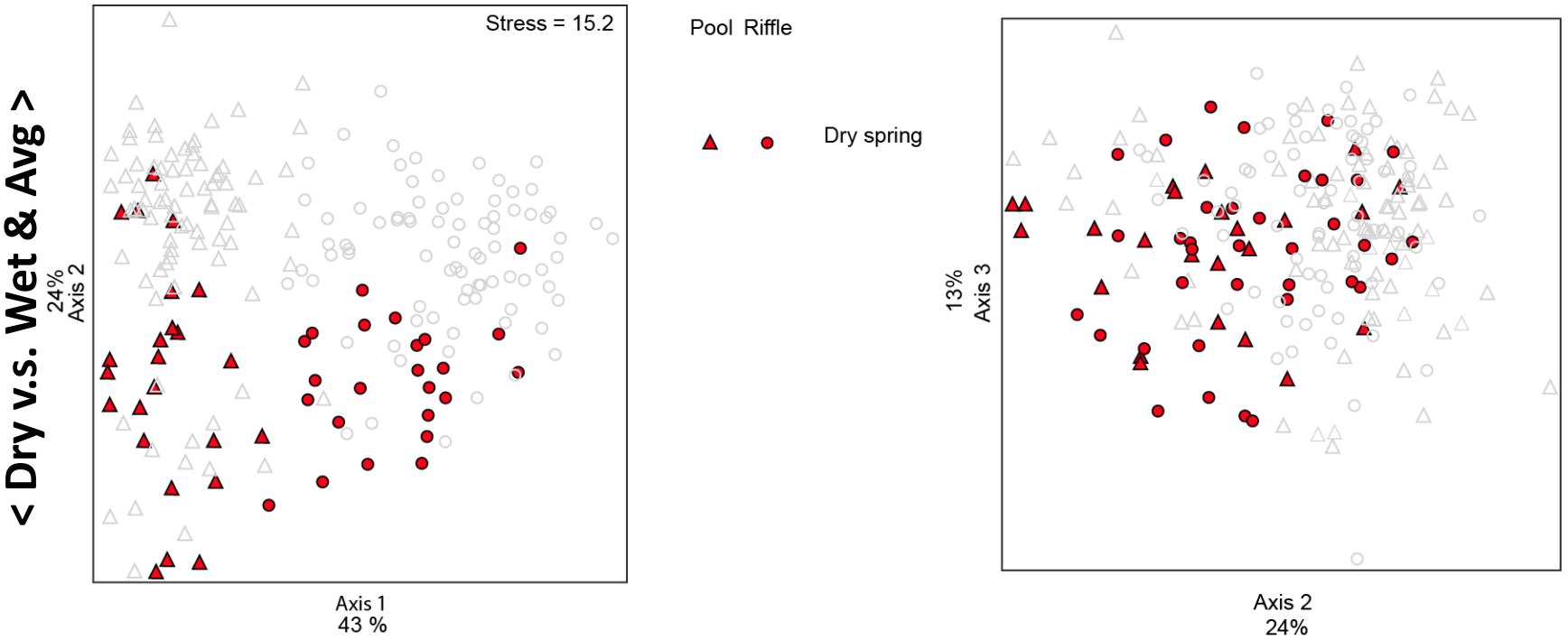
CONCLUSIONS

- Riffles and Pools differ significantly in community structure, density, and trait composition
- As flows decline there is an increased proportion of pools at the expense of riffles
- With more pools in a reach, RWB samples will contain more pools, and hold higher densities of midges and tolerant taxa, but fewer EPT
- RWB samples may be effective at detecting hydrologic change but this may mask other stressors or result in degradation and variability in the condition of reference streams during drought or lower flows
- Flow regime alters geomorphology and distribution of habitat types, changing the biological signal in RWB data

Wet and average years (2002, 2003, 2004, 2005, 2006)



Dry years (2013, 2015)



DROUGHT shifts the stream community to very different species composition