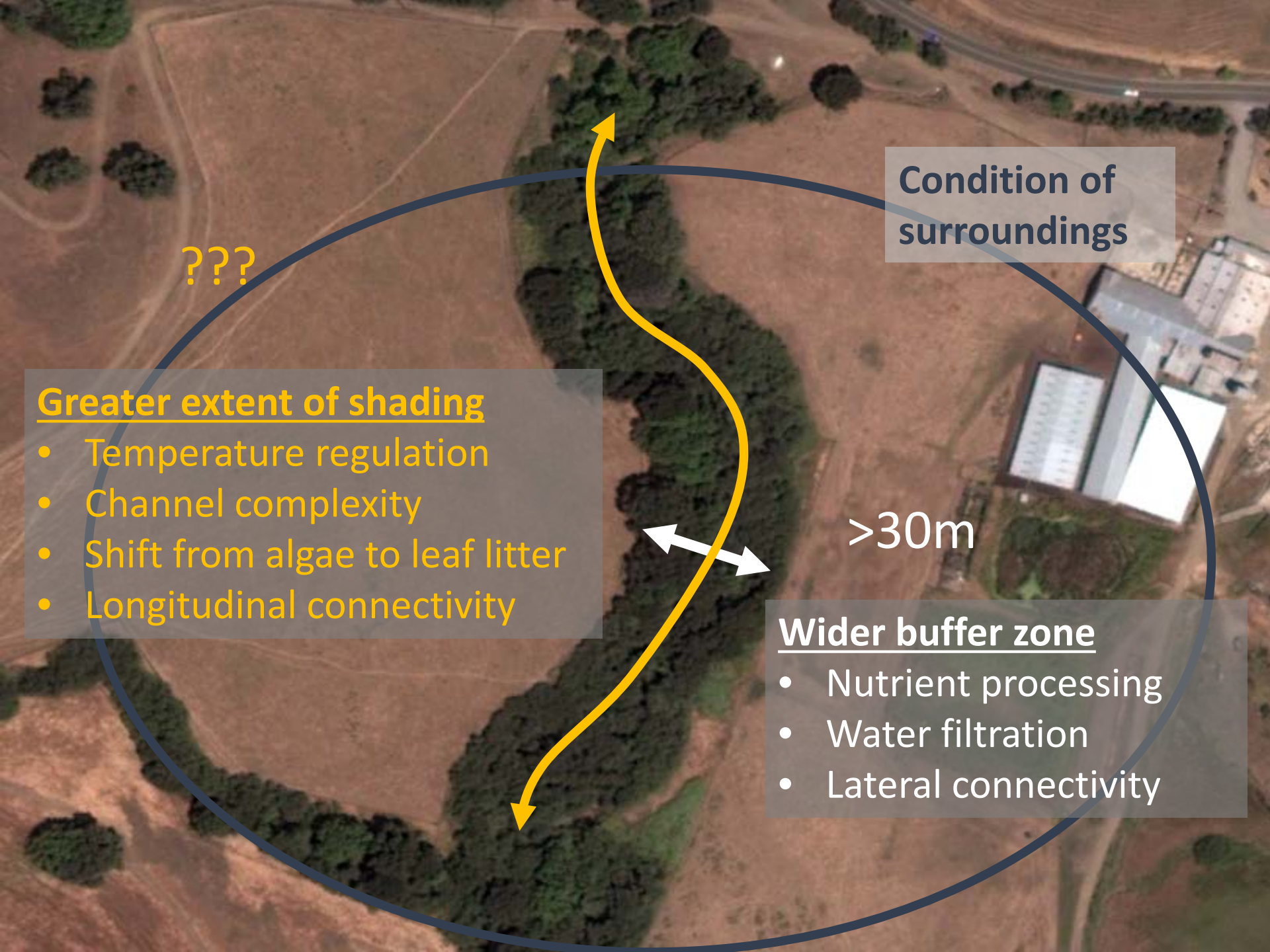
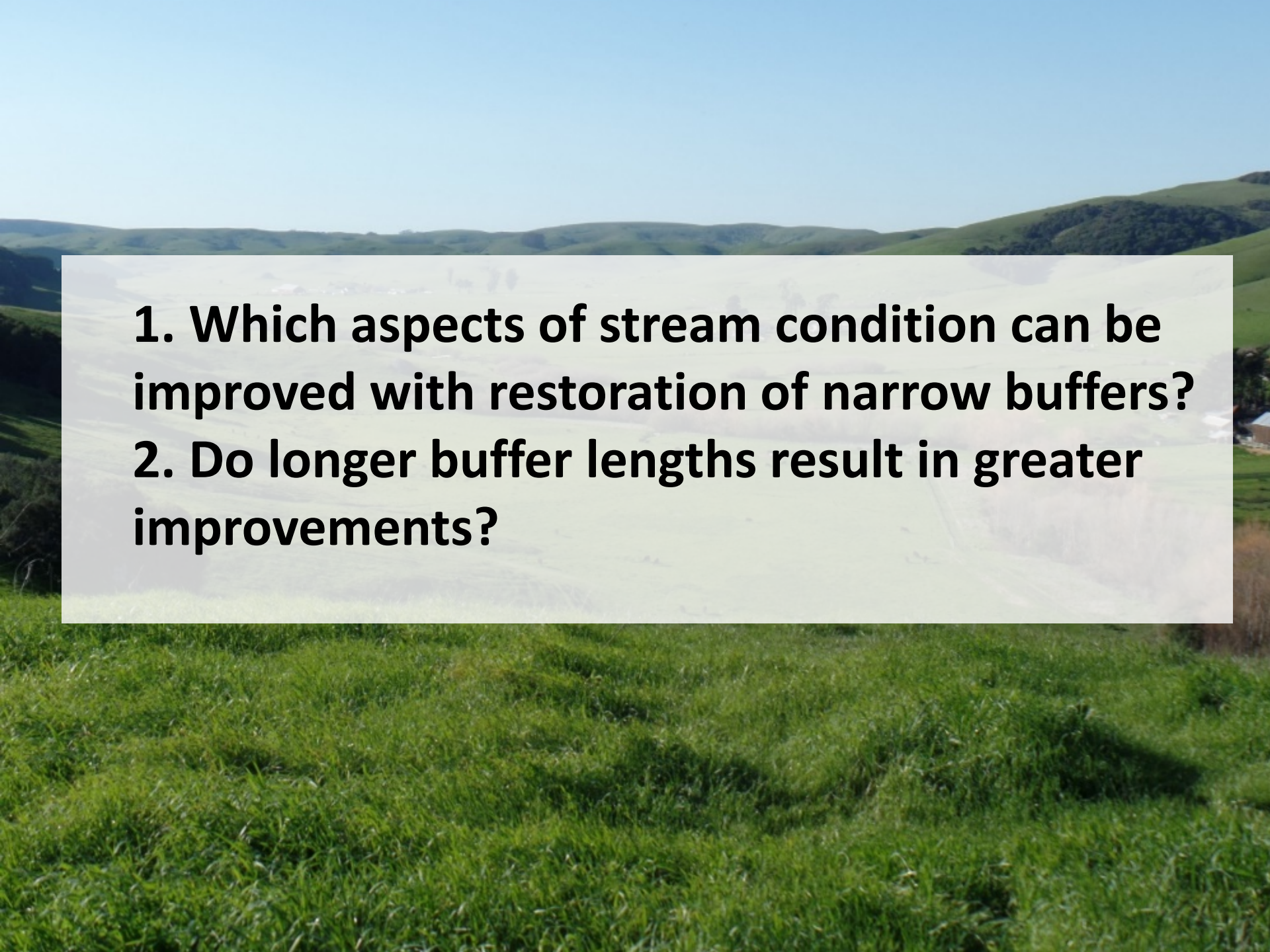
Riparian restoration scale and stream benefits in California rangelands

Bronwen Stanford
Erika Zavaleta
University of California, Santa Cruz

Riparian tree restoration

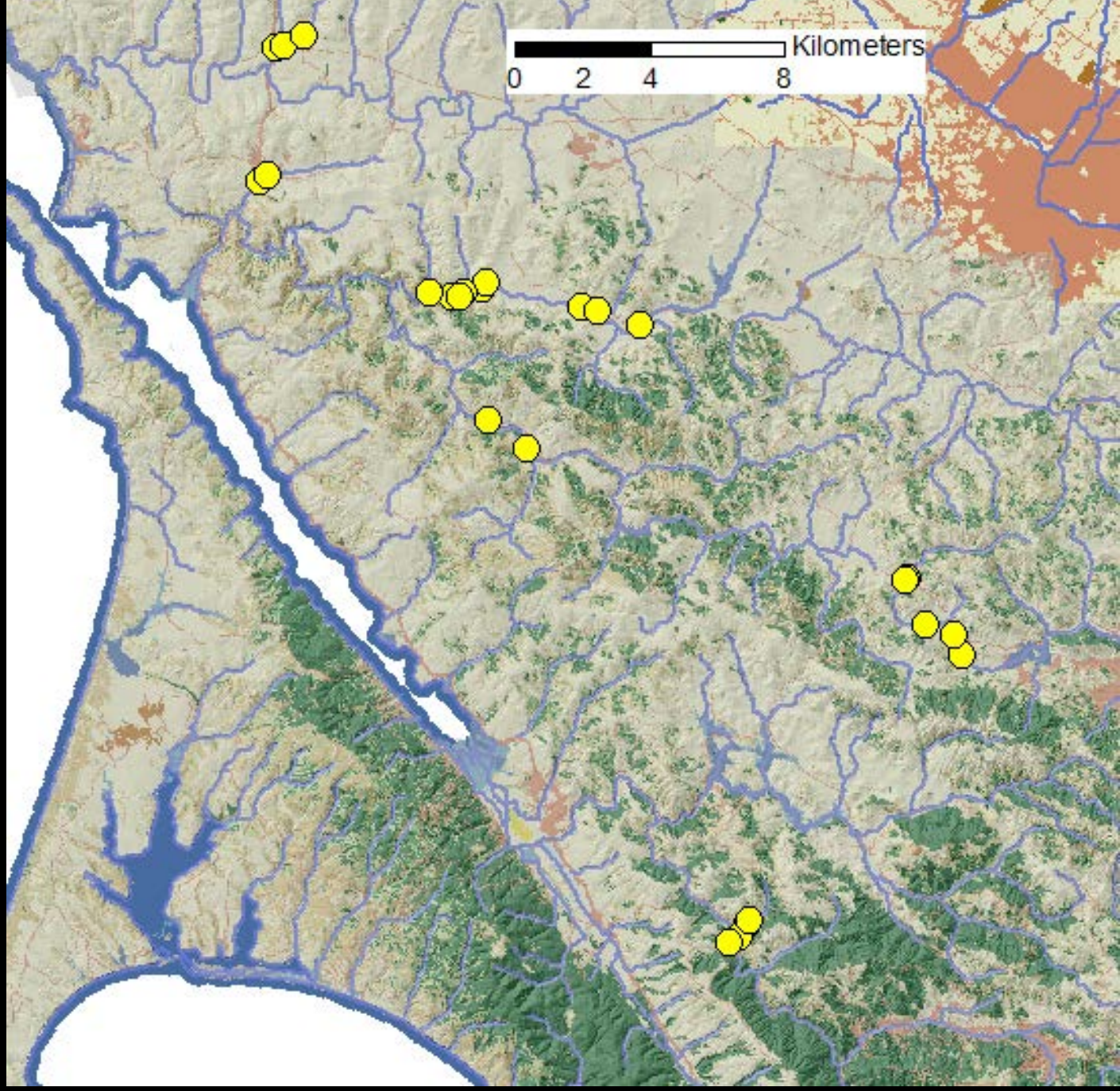
- Widely used in agricultural systems
- Potential to restore ecological function
  - Biogeochemical processing
  - Habitat provision
  - Connectivity


Condition of surroundings
???
Greater extent of shading
• Temperature regulation
• Channel complexity
• Shift from algae to leaf litter
• Longitudinal connectivity
>30m
Wider buffer zone
• Nutrient processing
• Water filtration
• Lateral connectivity

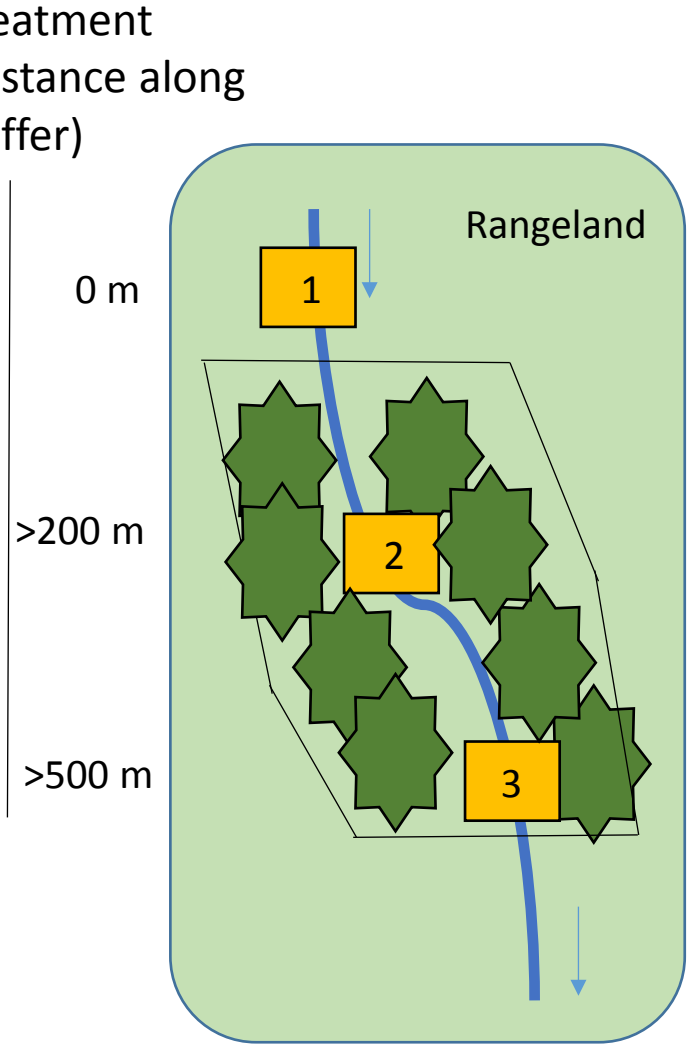


1. Which aspects of stream condition can be improved with restoration of narrow buffers?
2. Do longer buffer lengths result in greater improvements?

- Consistent land use: rangelands
- 2nd-4th order streams
- Restoration completed >7 years ago



NLCD 2011



- Abiotic
  - Channel form
  - Substrate size (D50)
  - Dissolved solids (specific conductivity)
  - Water temperature
- Biotic
  - Aquatic vegetation (% cover)
  - Organic debris and wood
  - Benthic macroinvertebrates
    - Density ↓
    - Richness ↑
    - Percent sensitive ↑ -California Aquatic Bioassessment Laboratory Network

- 25 sites nested in 8 streams
- Primary predictor variable is buffer length – upstream linear length with riparian trees

Upstream of buffer

Within buffer

Upstream of buffer

Within buffer

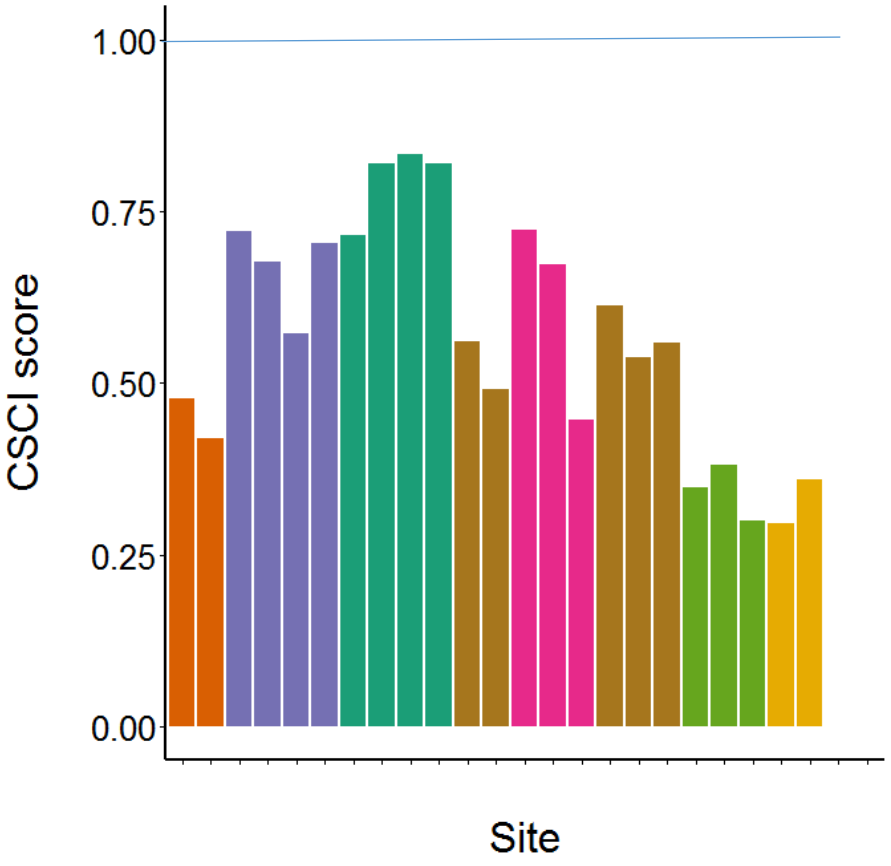
Response of in-stream conditions to

Watershed condition (hydrology, land cover)

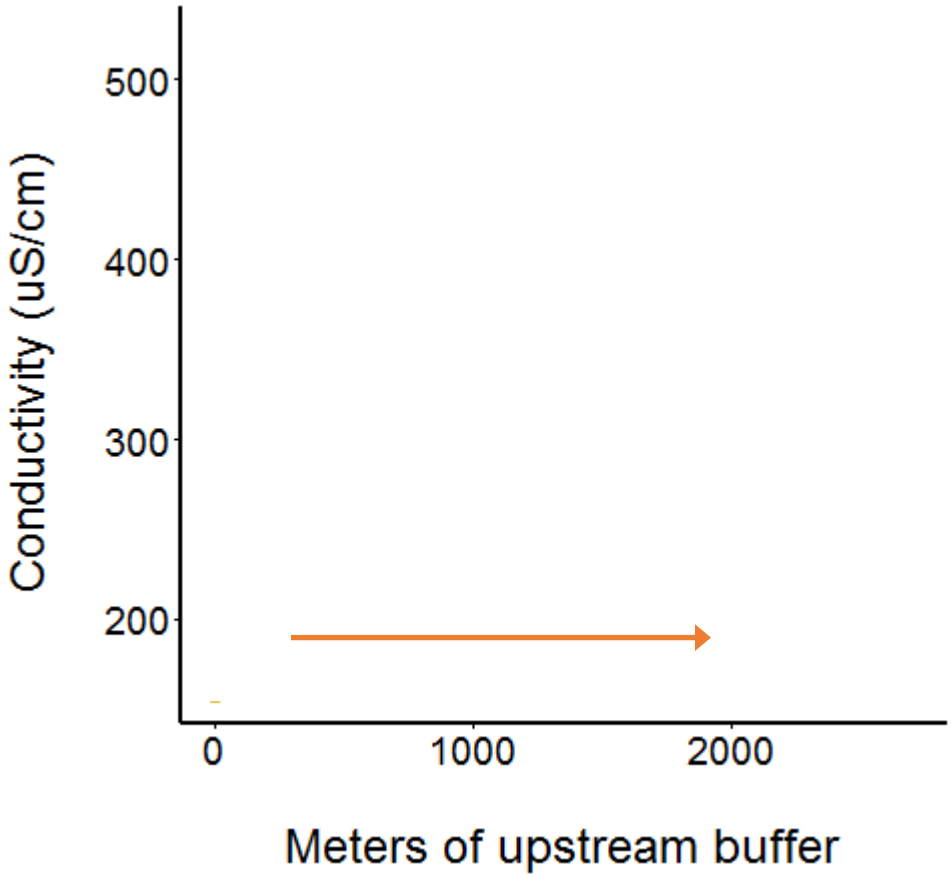
Riparian buffer length

Riparian buffer presence

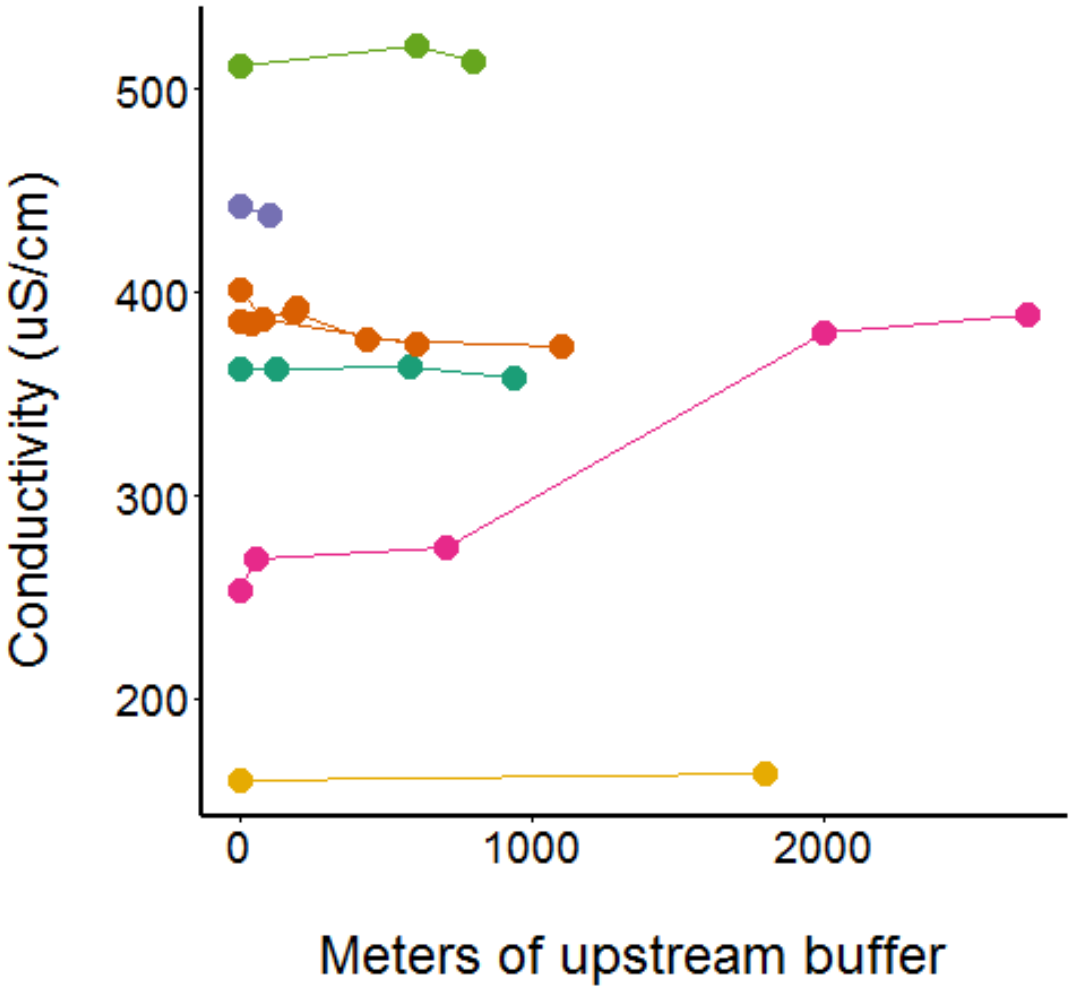
Stream condition variable but below reference



No difference between 2015 and 2016 data

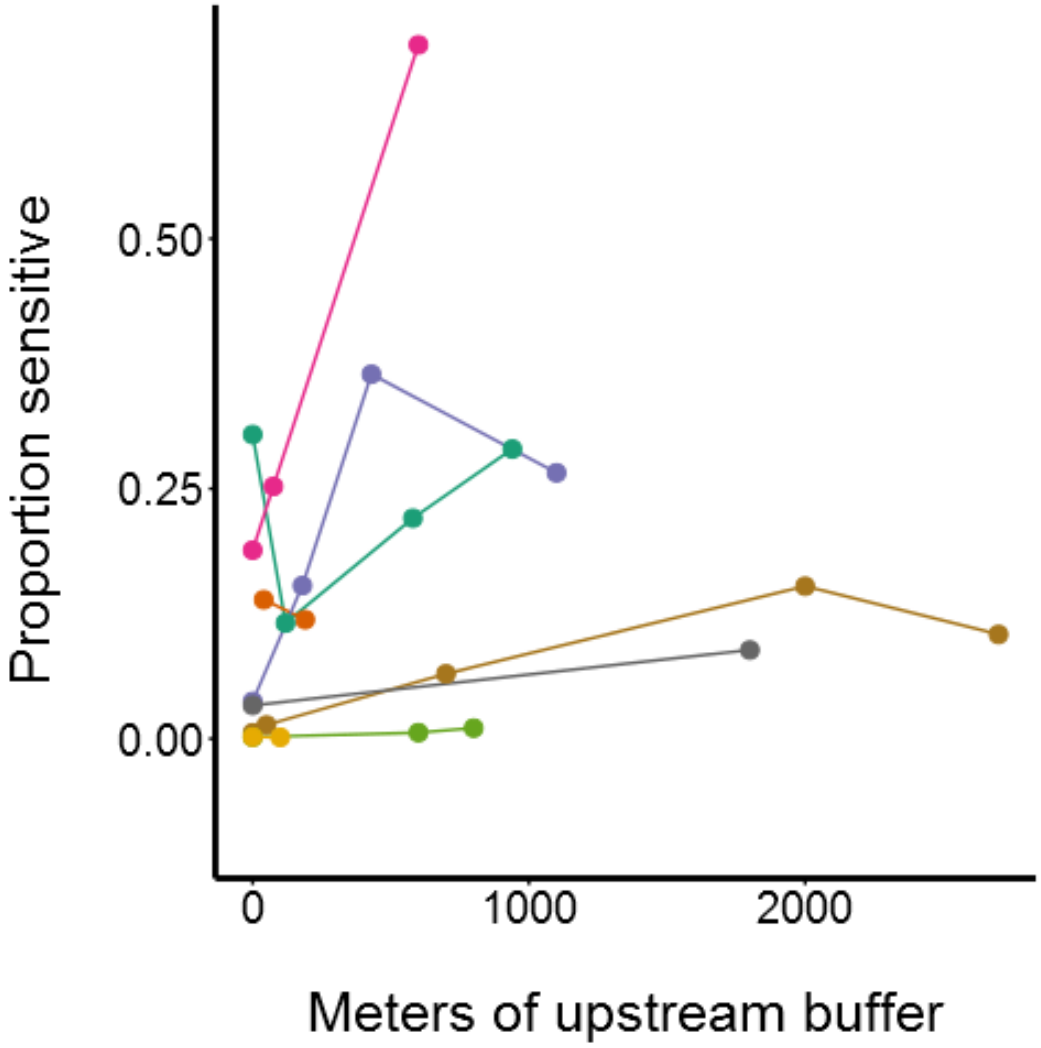

Conductivity (uS/cm)
500
400
300
200
0
1000
2000
Meters of upstream buffer

Watershed scale controls water quality



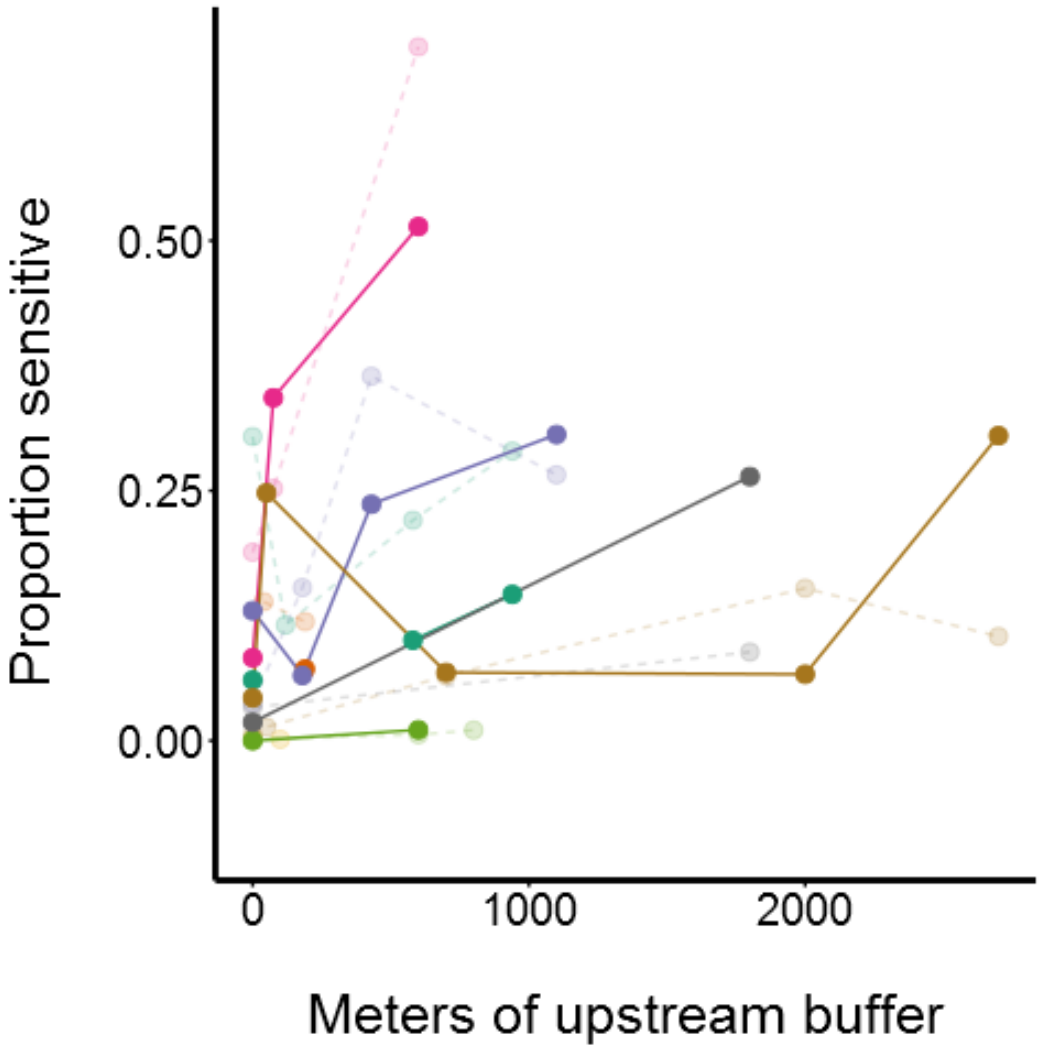
2015 and 2016

Buffer length increases % sensitive taxa



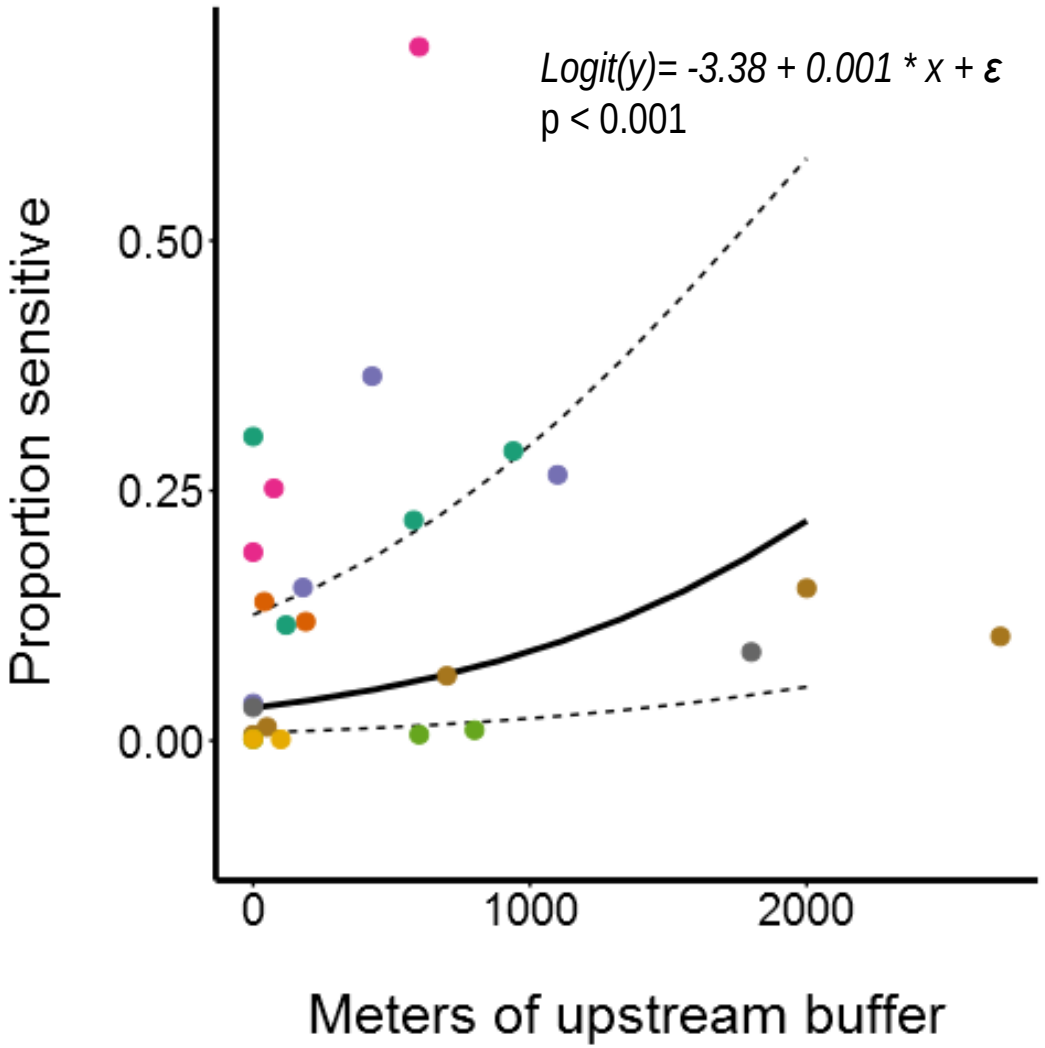
Sensitive = tolerance level 0 - 2 out of 10, CAMLnet 2003

Buffer length increases % sensitive taxa



Sensitive = tolerance level 0 - 2 out of 10, CAMLnet 2003

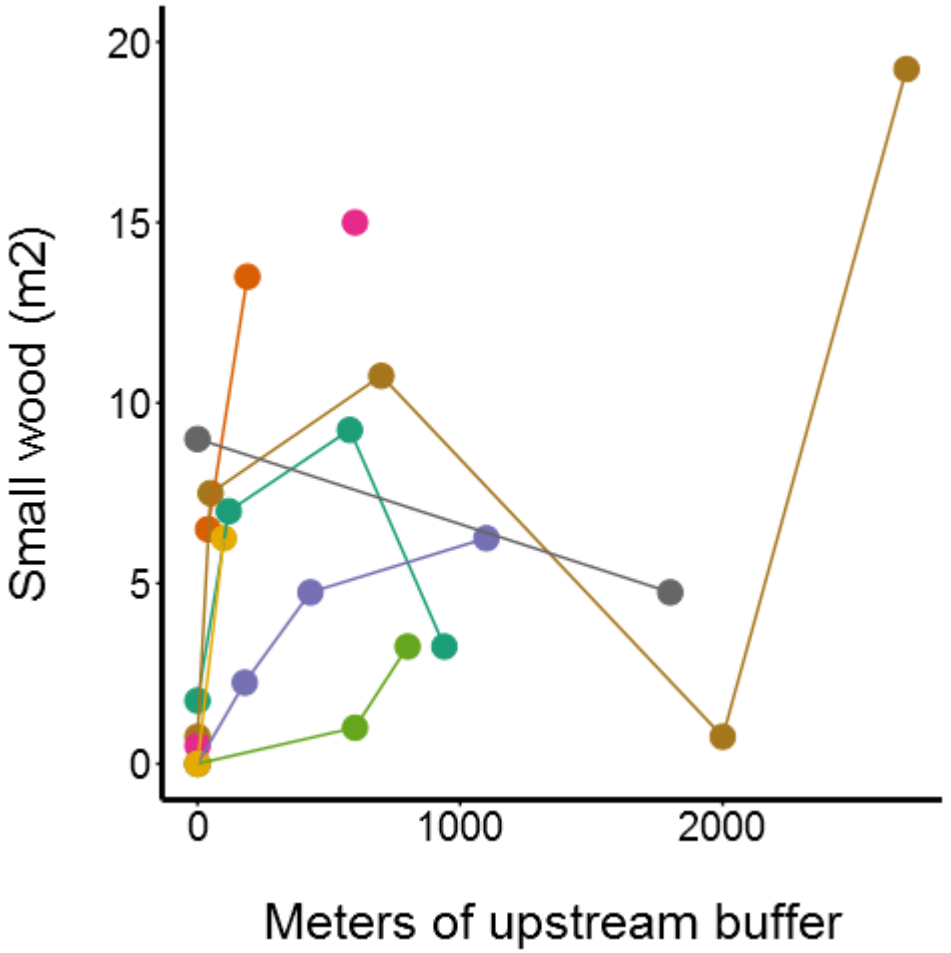
Buffer length increases % sensitive taxa



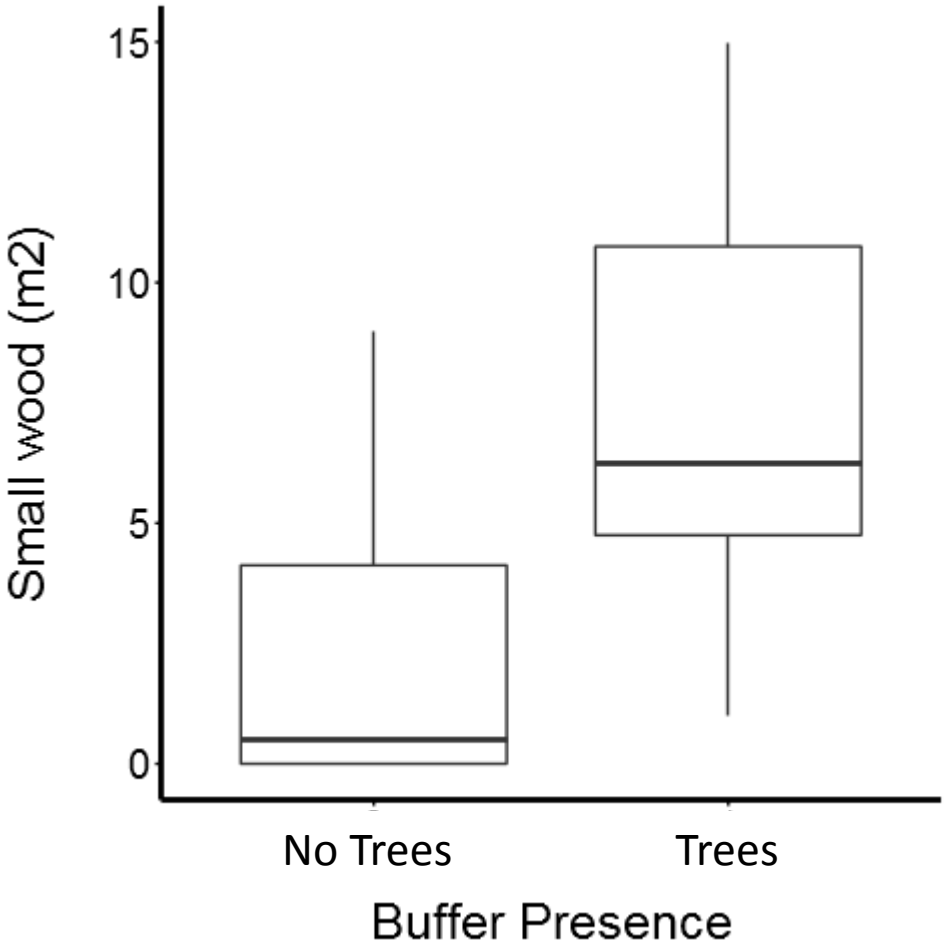
Sensitive = tolerance level 0 - 2 out of 10, CAMLnet 2003

Similar responses
- Density (inverse)
- *Temperature (inverse)*

Buffer presence increases in-stream wood



Buffer presence increases in-stream wood



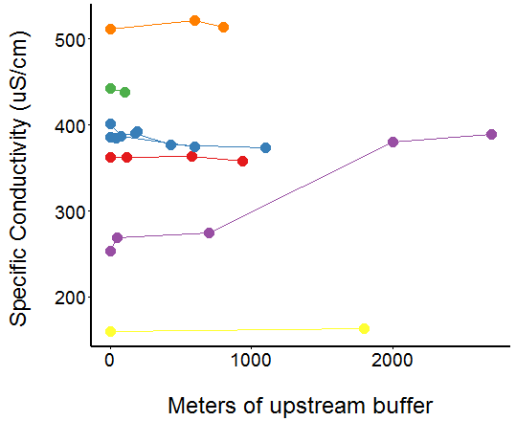
Paired t-test
$p < 0.04$

Similar responses
- *% cover macrophyte (inverse)*

1. Response controlled by watershed-scale

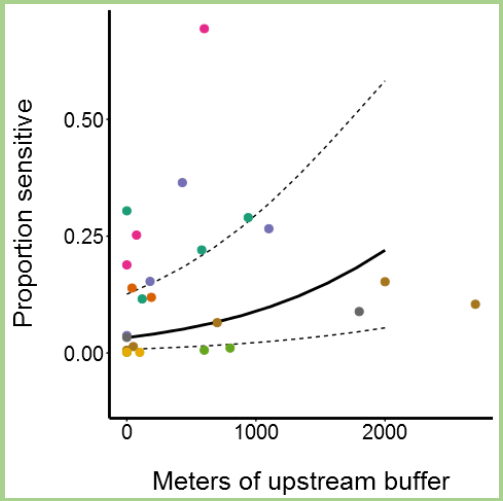
(controls including land use, geology)

Conductivity
Channel form



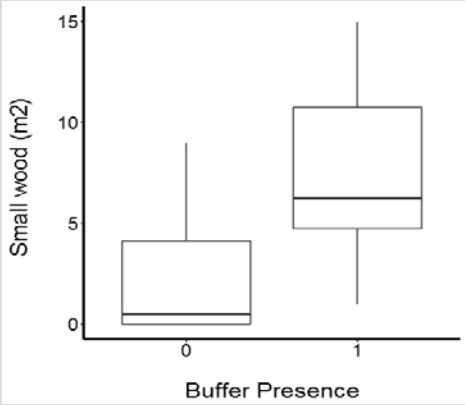
2. Buffer length

Proportion sensitive insect families
Insect abundance
Temperature



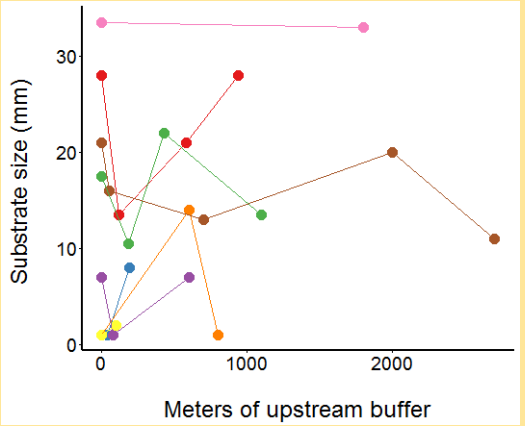
3. Buffer presence

Wood
Aquatic vegetation



4. Patterns vary by site

Substrate size
Insect family richness



Conclusions

- BUFFERS MATTER – even narrow, short buffers
- Longer buffers (>500m) can be better than shorter
- Recovery is constrained by watershed condition
- Patterns robust across contrasting rainfall years

Thanks to
David Herbst
Karen Holl
Liam Zarri
Jessica Beatty
UCSC interns

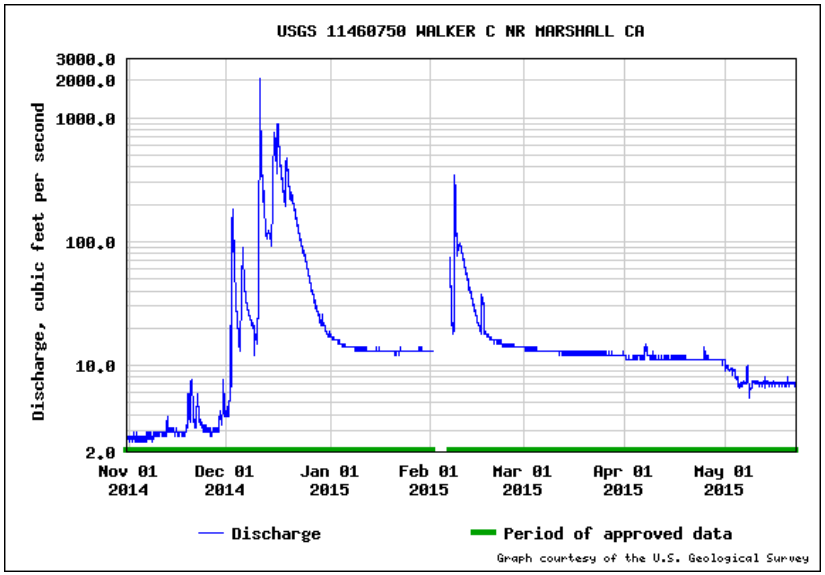
UNIVERSITY OF CALIFORNIA
SANTA CRUZ

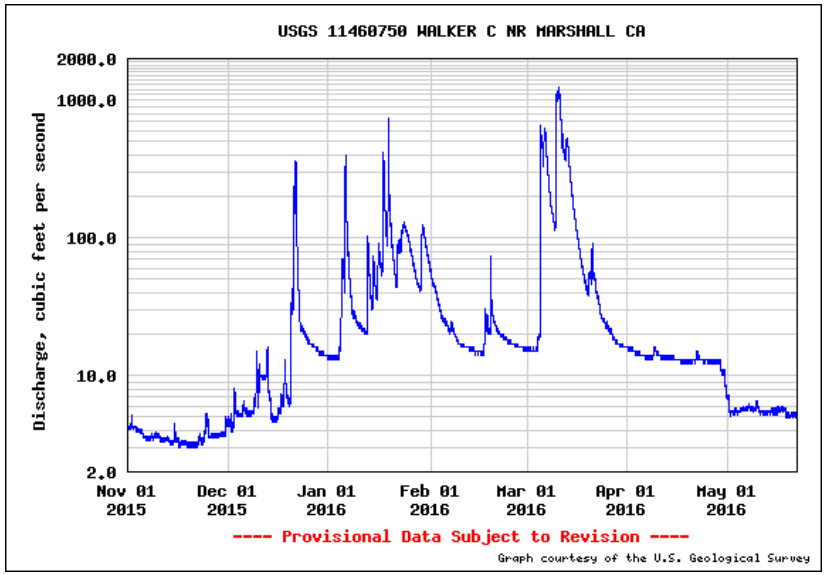
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

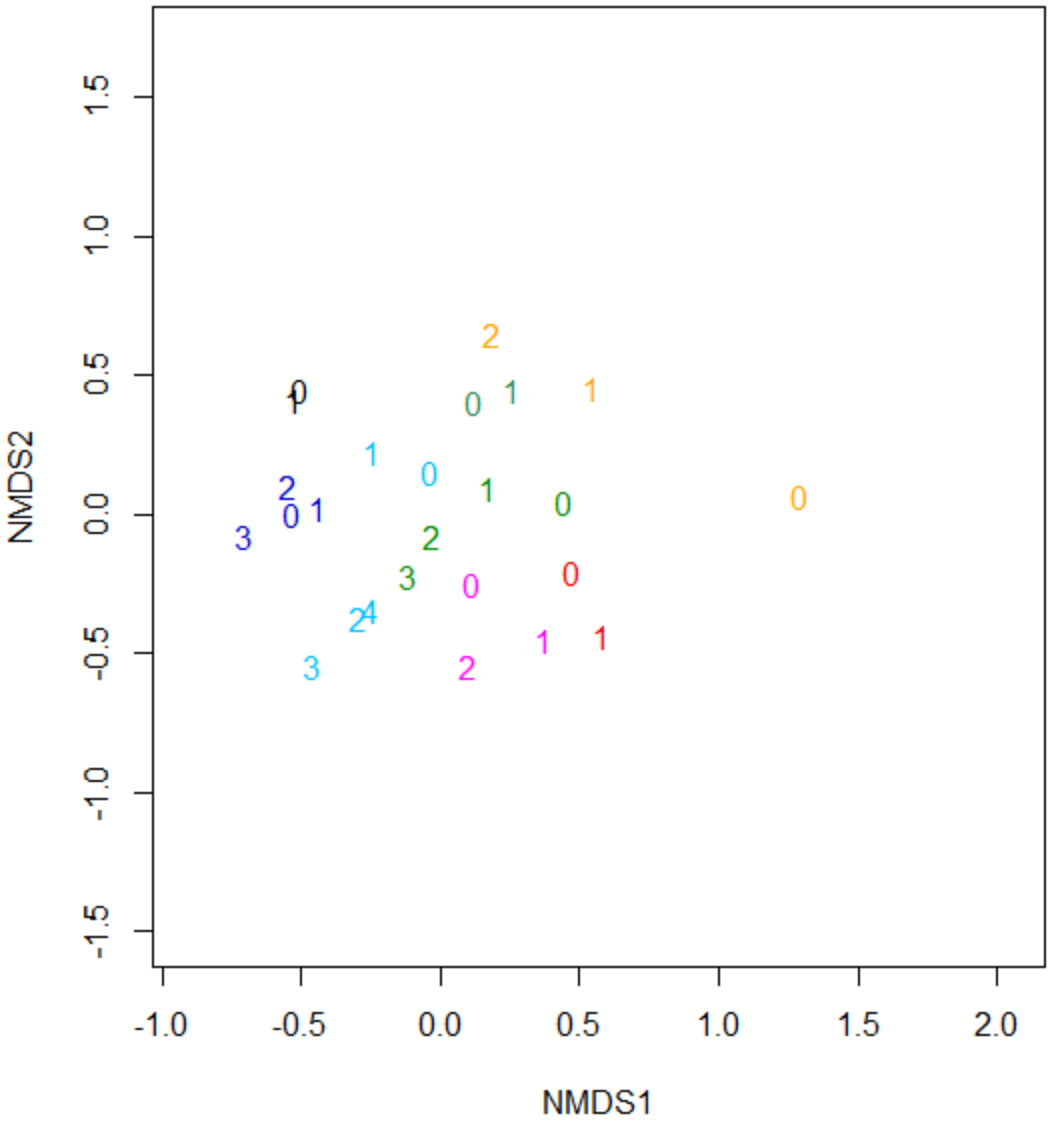
bstanfor@ucsc.edu

Year Two - 2016

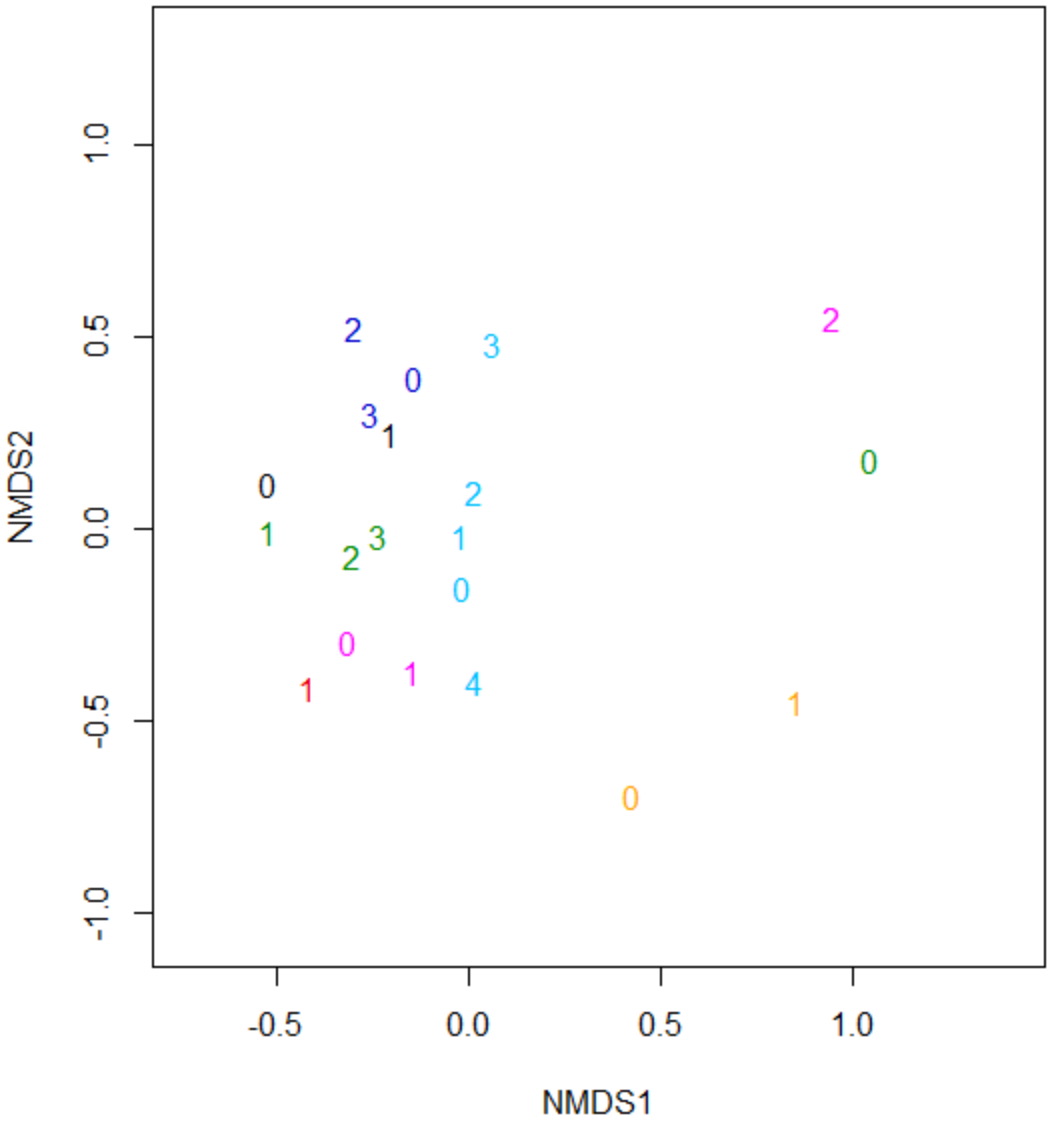
- Confirmation of year one patterns
- Some reversals – stronger relationship of buffer length and richness
- More data to come

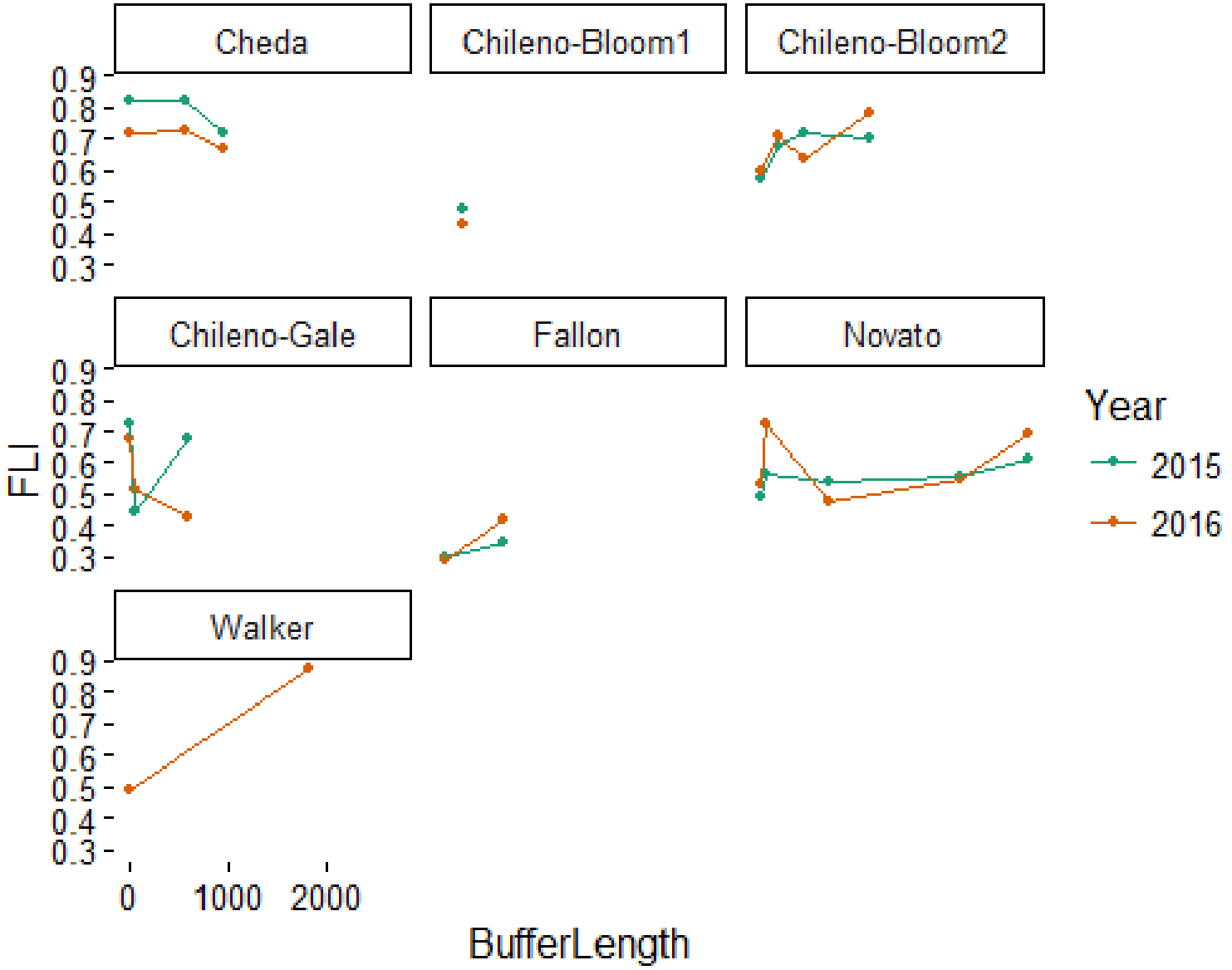




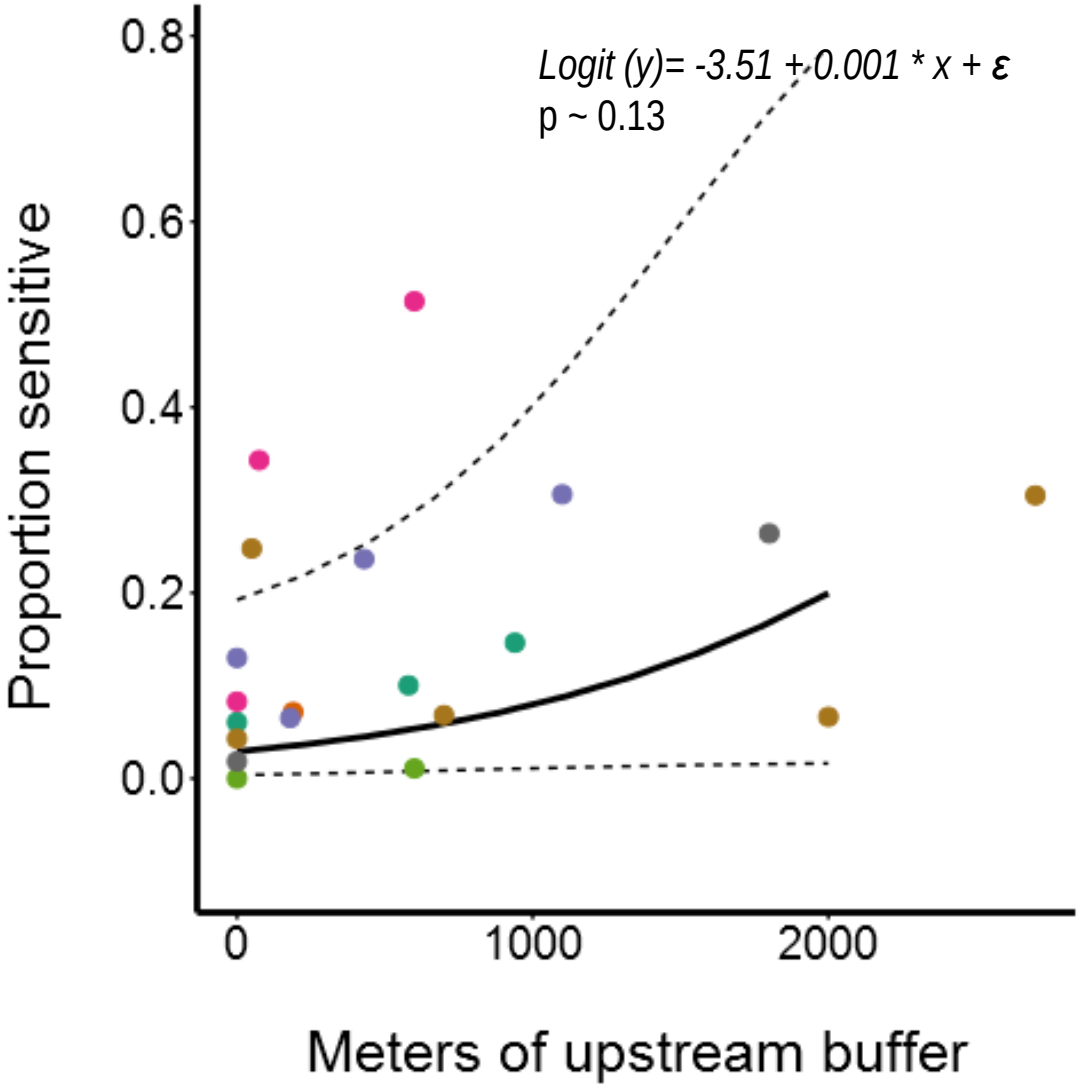

NMDS2
NMDS1
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0

2016



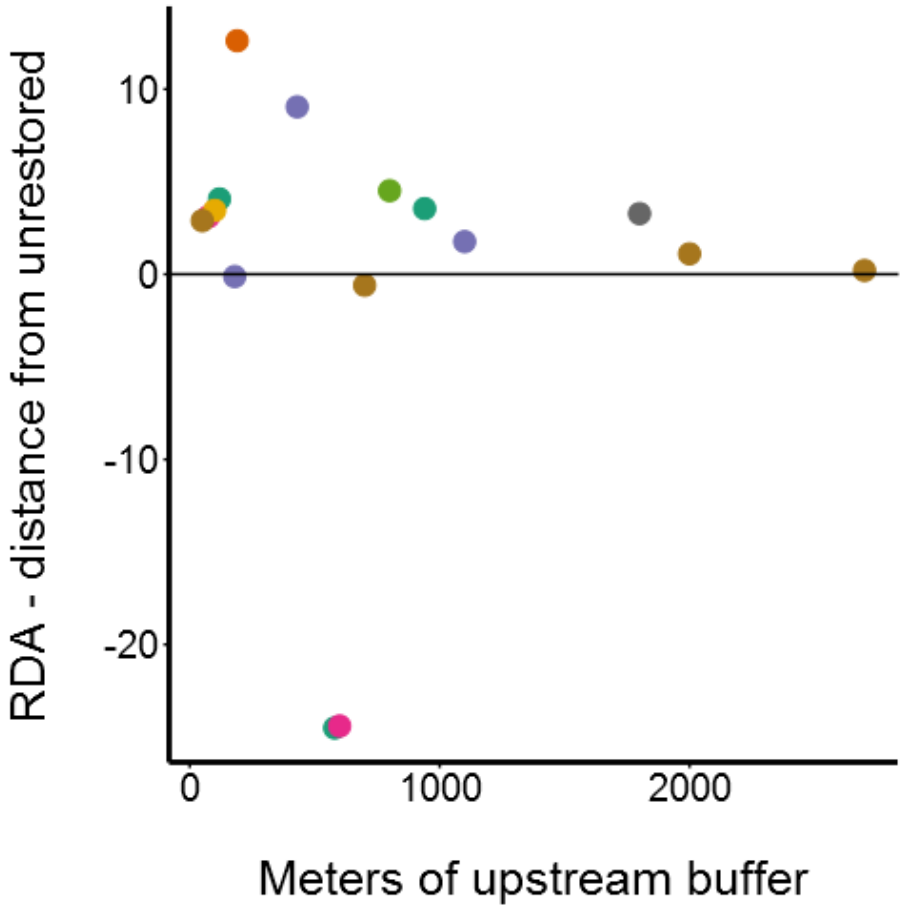

Cheda
Chileno-Bloom1
Chileno-Bloom2
Chileno-Gale
Fallon
Novato
Walker
FLI
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
1000
2000
BufferLength
Year
2015
2016

Buffer length increases % sensitive taxa



2016 data

Sensitive = tolerance level 0 - 2 out of 10, CAMLnet 2003


RDA - distance from unrestored
10
0
-10
-20
0
1000
2000
Meters of upstream buffer

Stream condition variable but below reference