Macroinvertebrate Response to Biotic and Abiotic Stresses in Freshwater Wetlands of the San Francisco Bay Area

Kevin B. Lunde

Vincent H. Resh

UC Berkeley

Take home messages

1. We should examine wetlands
2. Stream bioassessment methods can be adapted to wetlands
3. Macroinvertebrates are good indicators of endogenous and exogenous factors
4. Land managers and restoration scientists will benefit from having pond indicators

Why Ponds?

- Increasing across past century
- Important connectors across terrestrial landscape
- Common within managed properties

Research Questions

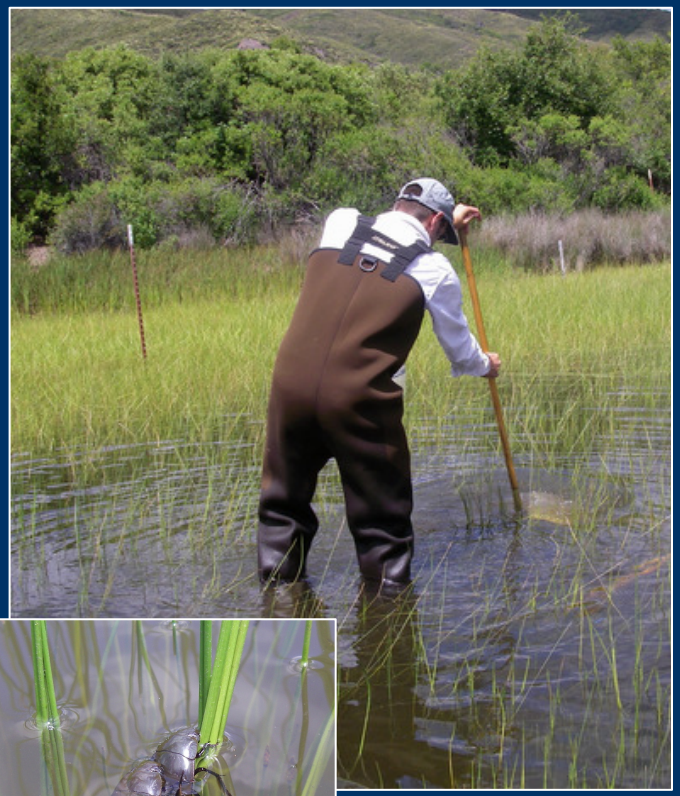
1. What biotic and abiotic factors influence community structure?
2. Can bioassessment metrics be used to evaluate biotic condition?

Site Selection

- 43 sites
  - ✓ Reference (18)
  - ✓ Urban (19)
  - ✓ Test (6)
- 55 sampling events
  - ✓ 2007 (5)
  - ✓ 2008 (11)
  - ✓ 2009 (39)
- 7 ponds re-sampled to examine seasonal and interannual variability

Field Methods

- Sample littoral zone
- (benthic, water column, surface)
- 500 µm dip net
- 20 sweep composite (6m^2)
- Habitat stratified
  - Emergent vegetation
  - Submergent vegetation
  - Surface vegetation
  - Open
- Environmental variables



Environmental Variables

- Water chemistry: turbidity, conductivity, pH
- Vegetation metrics: % submerged, emergent, floating, and absence of vegetation
- Pond: area, depth, % littoral, littoral slope, seasonal or perennial
- Upland habitat: slope, cattle grazing
- Connectivity: distance to other water bodies
- Biota: Mosquitofish, invasive sport fish

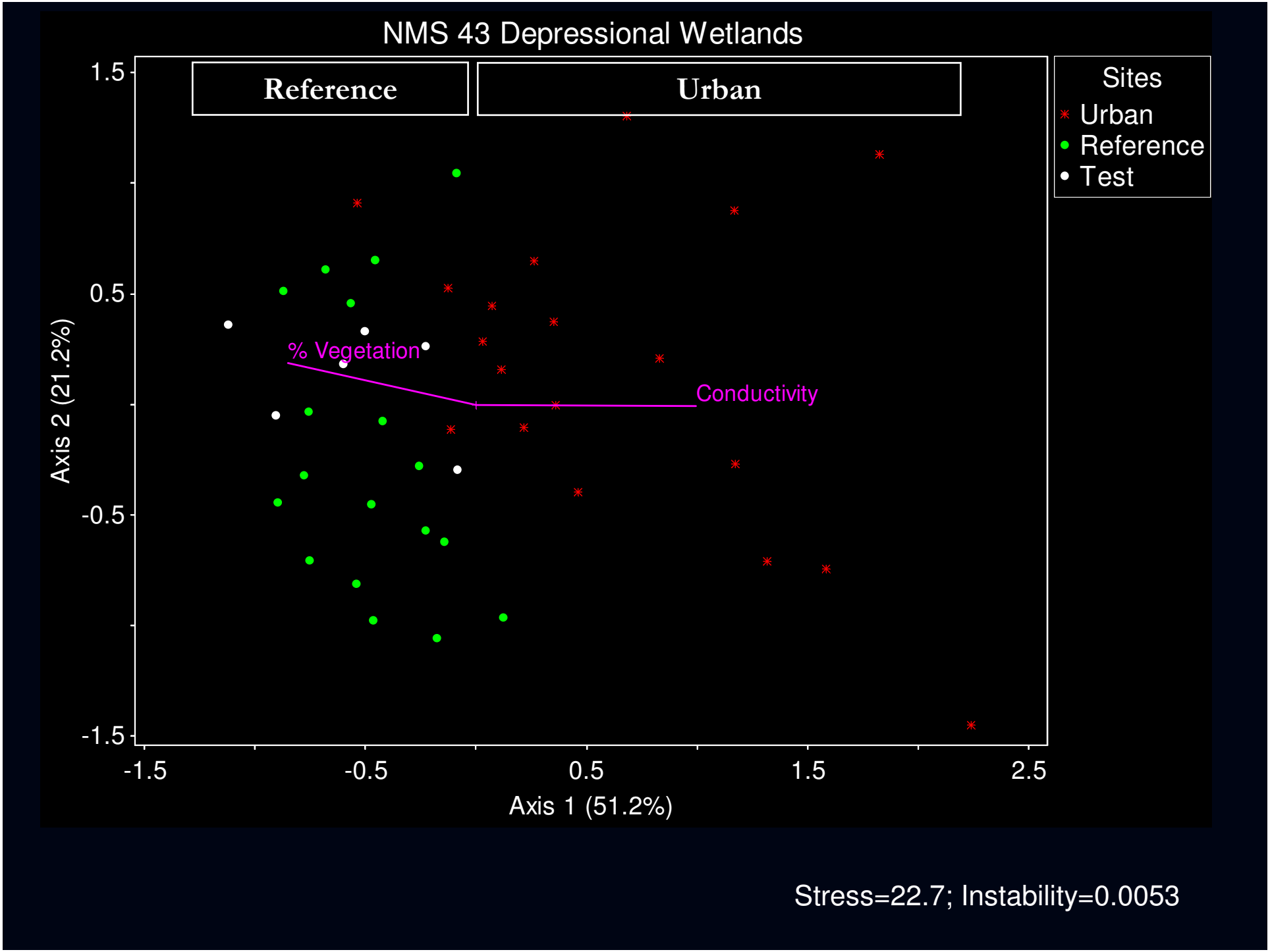
Laboratory Methods

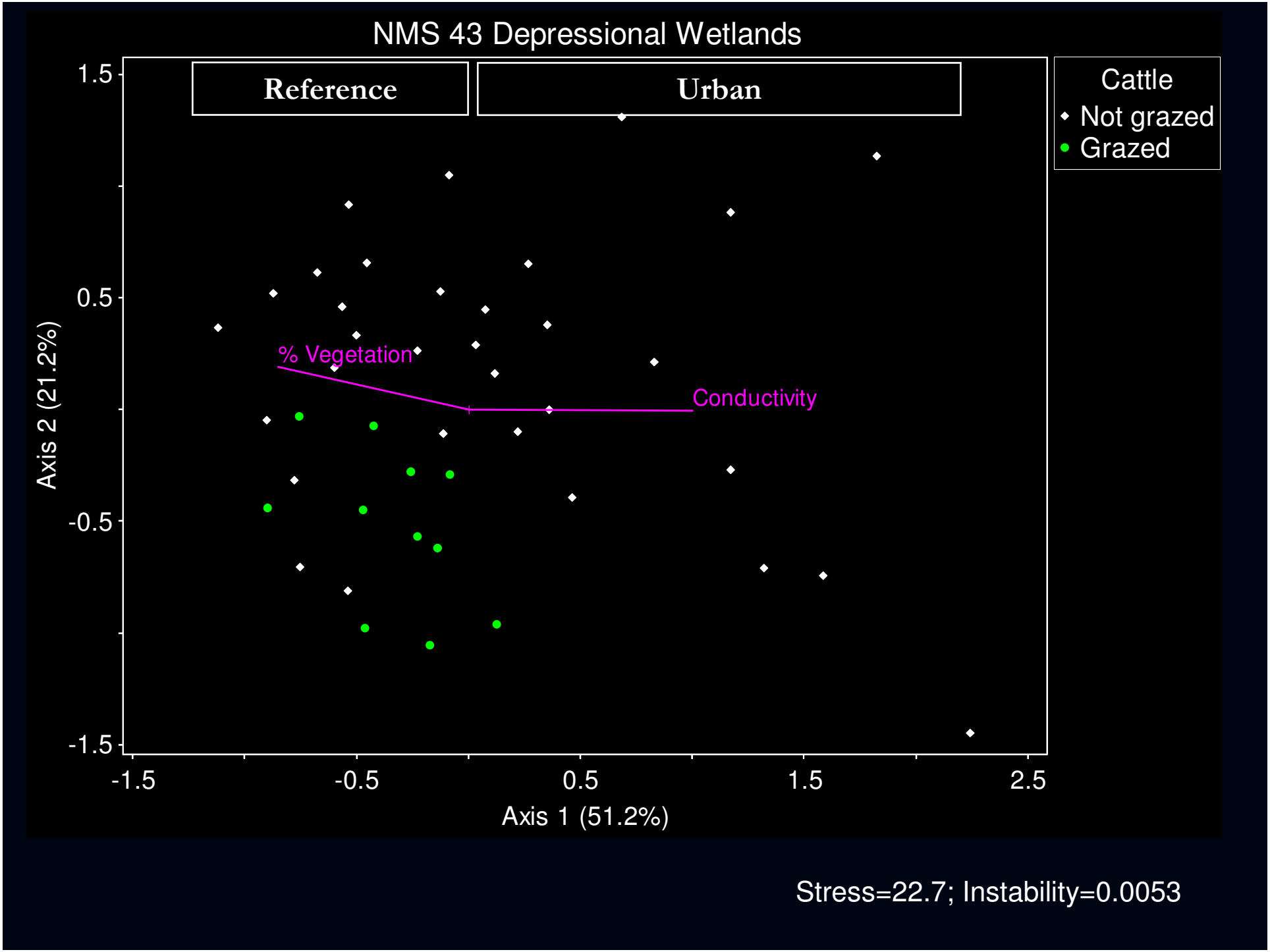
- Fixed count to 500 aquatic organisms
- Composite subsampled (x=9%; range 1 - 35%)
- Identification to genus (EcoAnalysts)

Macroinvertebrate Results

- 123 unique taxa
- Non-insects prevalent and abundant
- Taxa Richness:
  - Median = 19 (7 - 36)
- Extrapolated Abundance:
  - 3386 individuals/m^2 (285 - 25,000/m^2)

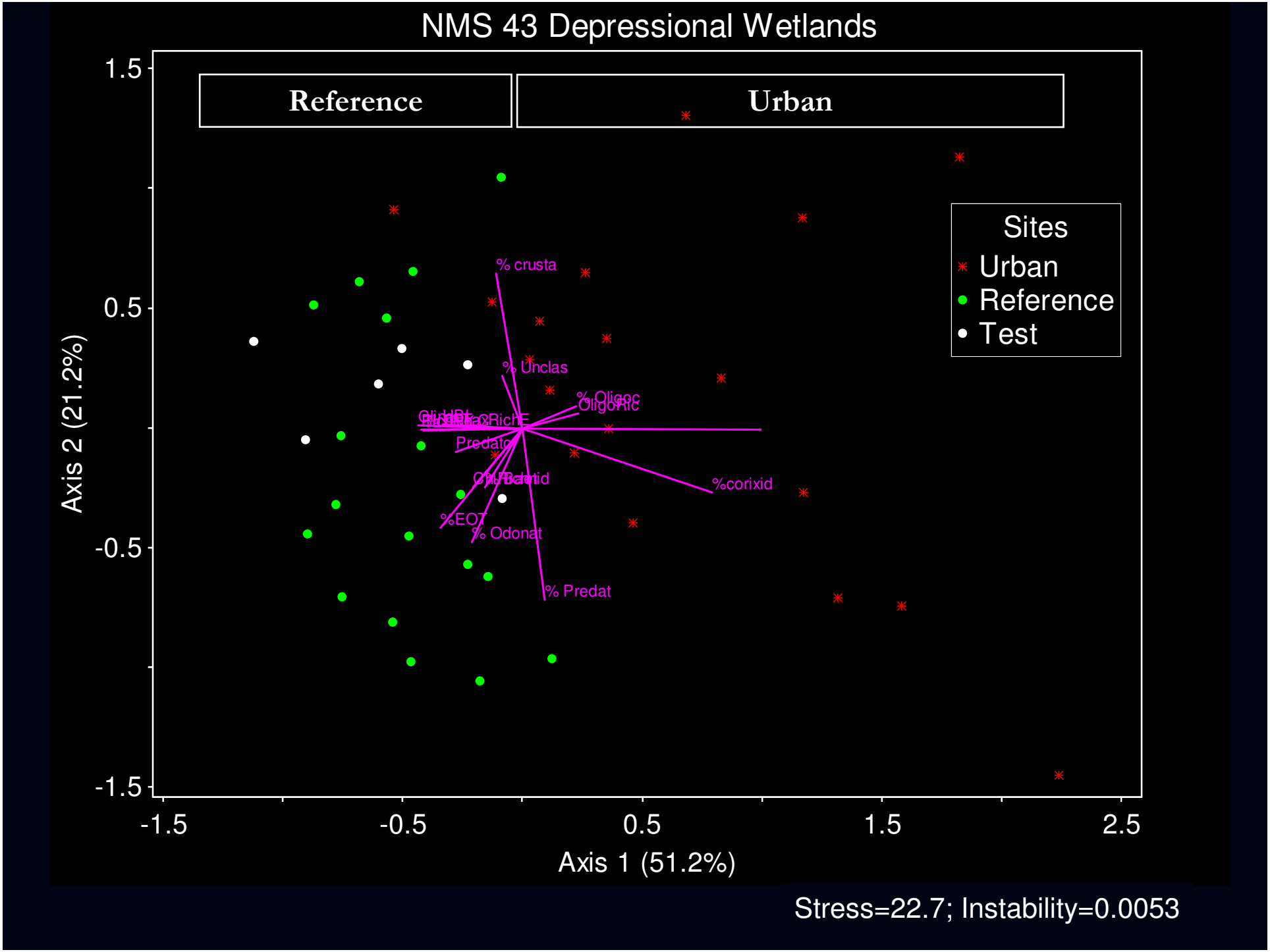
		% Occurrence
Crustacea	*Simocephalus*	91%
Insecta	Chironominae	81%
Crustacea	Cyprididae	74%
Insecta	Orthocladiinae	72%
Gastropoda	*Physa*	70%
Insecta	Tanypodinae	65%
Annelida	Tubificidae	53%
Insecta	*Callibaetis*	53%


NMS 43 Depressional Wetlands
Reference
Urban
Sites
Urban
Reference
Test
% Vegetation
Conductivity
Axis 2 (21.2%)
Axis 1 (51.2%)
1.5
0.5
-0.5
-1.5
-1.5
-0.5
0.5
1.5
2.5
Stress=22.7; Instability=0.0053


NMS 43 Depressional Wetlands
Reference
Urban
Cattle
Not grazed
Grazed
% Vegetation
Conductivity
Axis 2 (21.2%)
Axis 1 (51.2%)
1.5
0.5
-0.5
-1.5
-1.5
-0.5
0.5
1.5
2.5
Stress=22.7; Instability=0.0053

Lentic IBI development

- 37 metrics examined
- 18 selected via ordination


NMS 43 Depressional Wetlands
Reference
Urban
Sites
Urban
Reference
Test
% crusta
% Unclas
% Oligoc
Oligo%
Predato
%corixid
%EOT
% Odonat
% Predat
Axis 2 (21.2%)
Axis 1 (51.2%)
1.5
0.5
-0.5
-1.5
-1.5
-0.5
0.5
1.5
2.5
Stress=22.7; Instability=0.0053

Lentic IBI development

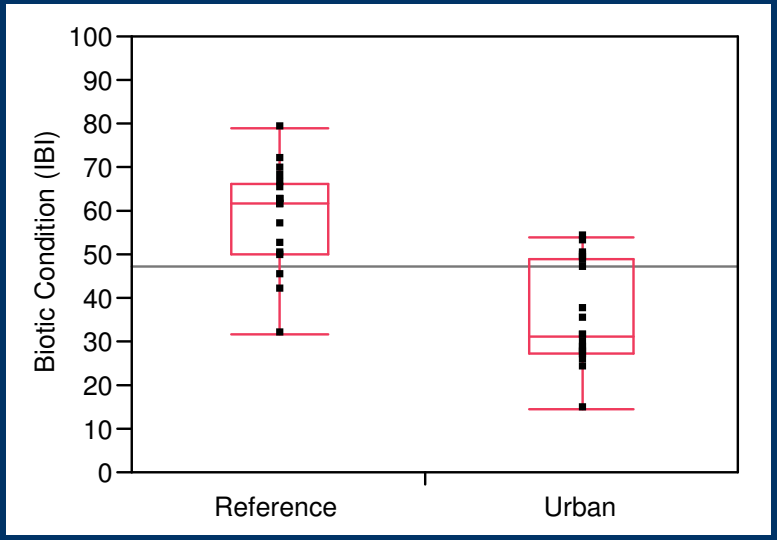
- Range, Redundancy (r<0.7), Discrimination
- Selected 9 final metrics:

% Gastropods	Taxa richness	% Odonata
% Ephemeroptera	Predator richness	Oligochaete richness (neg)
% Amphipods	HBI	% Corixids (neg)

- Scale multimetric index from 0 to 100

IBI Results

- Range 14-79, median 49
- Few very poor sites; no excellent sites
- Discrimination ($p<0.001$)
  - Reference: 58.5
  - Urban: 36.2
- Test IBI against management techniques and natural variables



Management Implications

- Highest IBI scores: more vegetation, lower conductivity, grazed, proximate ponds, (seasonal)
- Artificial ponds have similar condition to natural ponds
- Invasive fish did not lower biotic condition

Management can improve biotic condition

Conclusions

- ✓ Were macroinvertebrates responsive to various stresses?

  Yes!

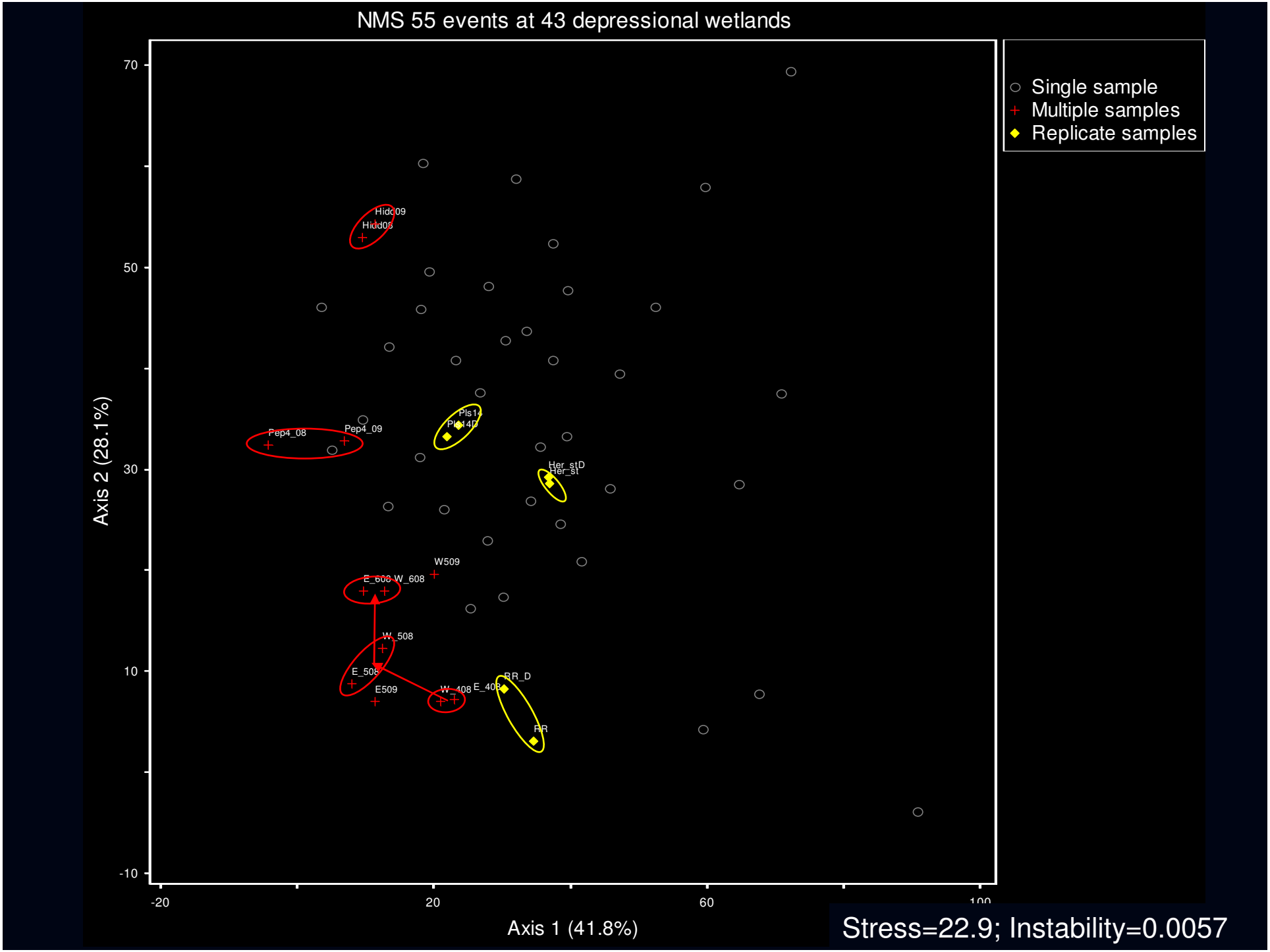
- ✓ Could bioassessment metrics be used to evaluate biotic condition?

  Yes!

Future efforts: add sampling sites and compare results with other wetland indicators (e.g. CRAM)

Acknowledgements

- Funding:
  - Alameda County Clean Water Program: Arleen Feng
  - National Science Foundation GRFP
- Access:
  - East Bay Regional Parks
  - City of Novato, Davis, Oakley, and Alameda County
- Field and Lab support:
  - Sahar Osman, Kevin Yao, Jianni Xin Mohammad Aghaee


NMS 55 events at 43 depressional wetlands
Single sample
Multiple samples
Replicate samples
Axis 2 (28.1%)
Axis 1 (41.8%)
70
50
30
10
-10
-20
20
60
Hidd09
Hidd08
Pep4_08
Pep4_09
Pls14D
Her_stD
Her_st
W509
E_608
W_608
W_508
E509
W_408
E_408
RR_D
RR
Stress=22.9; Instability=0.0057

Coleoptera 195/m^2

Associated with littoral vegetation and pond level vegetation

Hemiptera 2350/m2

Associated with conductivity and shallow ponds

Odonata 353/m2

Associated with low turbidity, pH, and littoral vegetation

Biting Flies

- Biting flies uncommon
  - Culicidae 7/43 10.9/500 34/m2
  - Ceratopogonidae 16/43 6.1/500 96m2
  - No Tabanidae, Muscidae, Simulidae