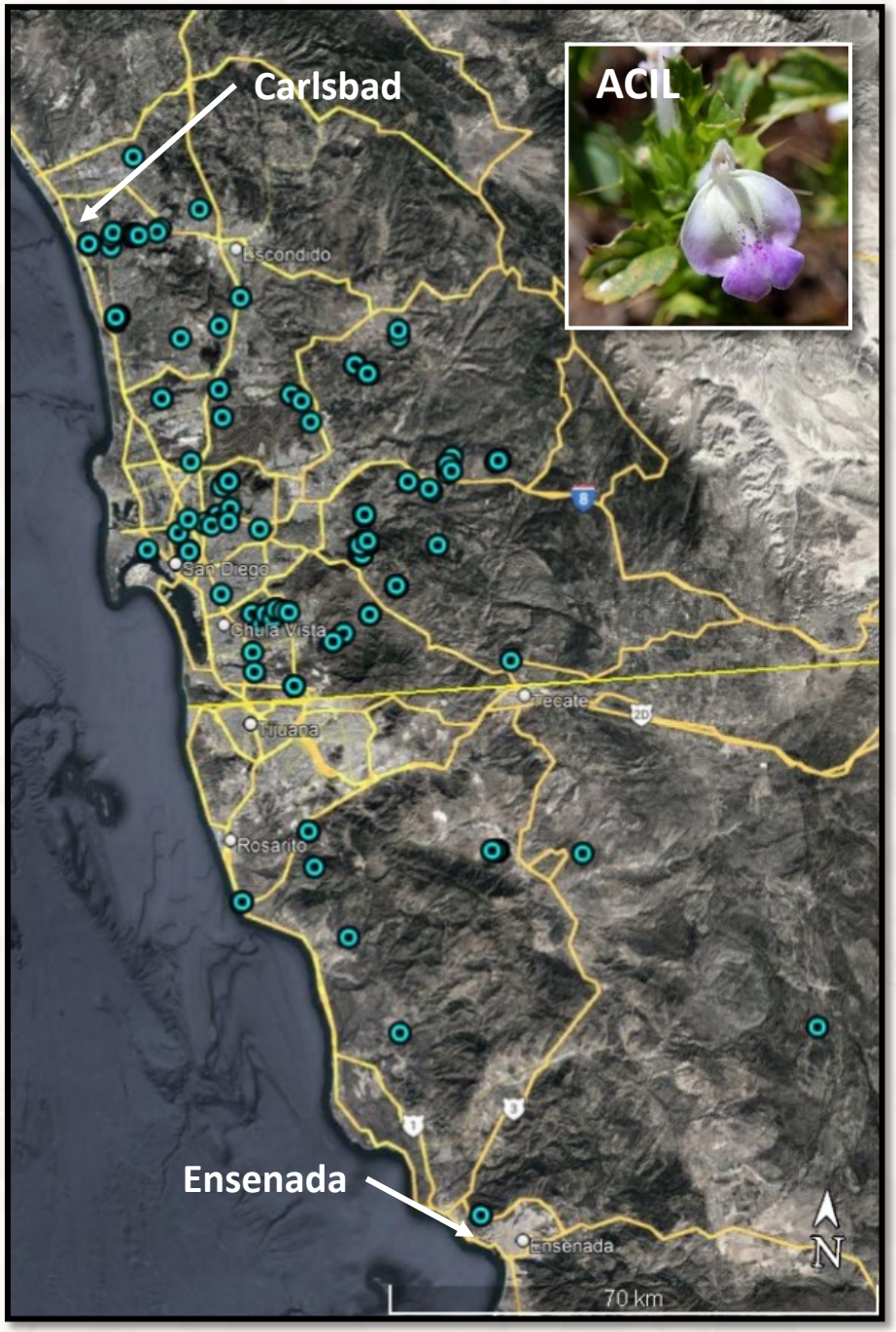
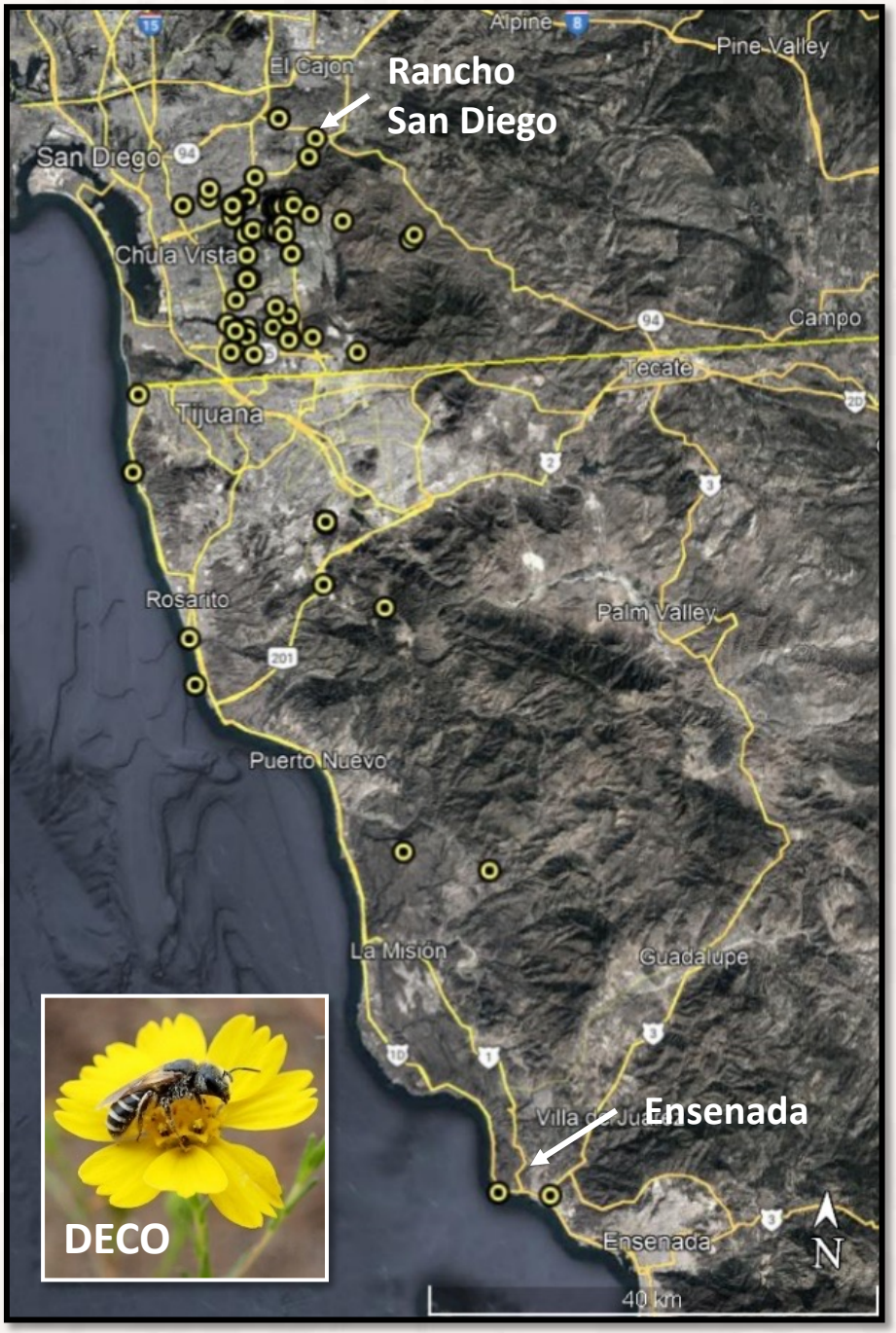
Soil Ecology of two endangered edaphic endemic plants:

Acanthomintha ilicifolia and Deinandra conjugens

Spring Strahm, Patricia Gordon-Reedy and Jessie Vinje


Carlsbad
ACIL
Escondido
San Diego
Chula Vista
Tecate
Tijuana
Rosarito
Ensenada
Ensenada
70 km
N


Alpine
Pine Valley
El Cajon
Rancho
San Diego
San Diego
Chula Vista
Campo
Tecate
Tijuana
Rosarito
Palm Valley
Puerto Nuevo
La Misión
Guadalupe
DECO
Ensenada
Ensenada
40 km
N

Clay Soils

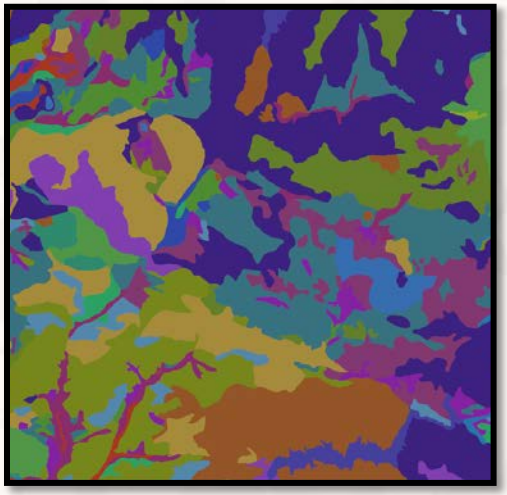
- Alkaline (“basic”)
  - High **pH** and CEC
  - Retains nutrients: Ca^{2+}, Mg^{2+}, K^{+} & Na^{+}
  - Binds others
- Retains water
- Other stuff:
  - Expansive
  - Hard

Management Options

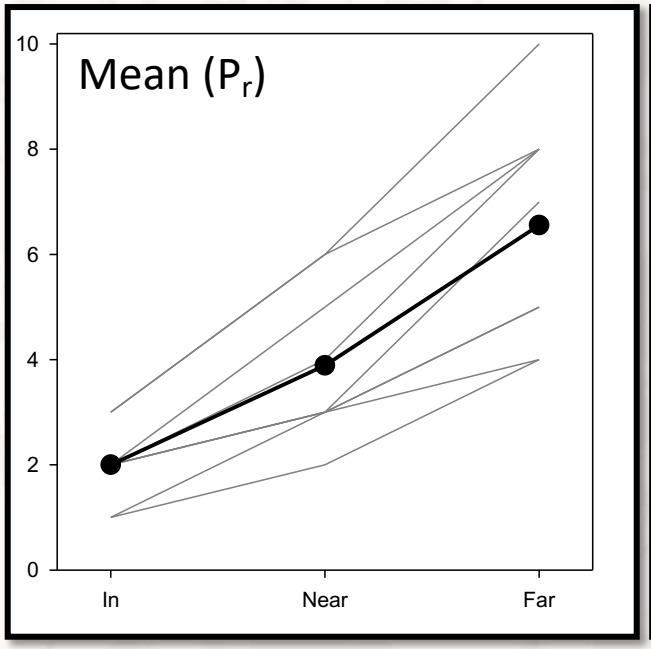
- Preserve & enhance extant occurrences
- Locate suitable but unoccupied sites
  - Enhance, translocate
- **What is suitable**?

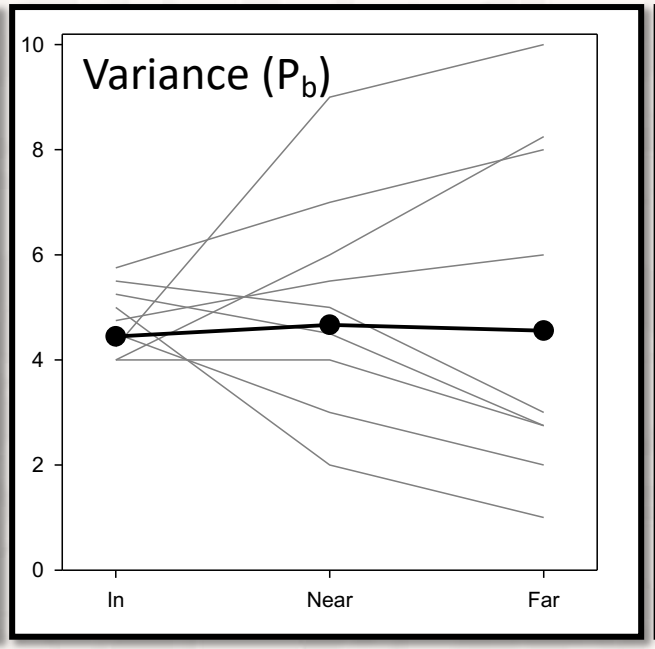
Challenges

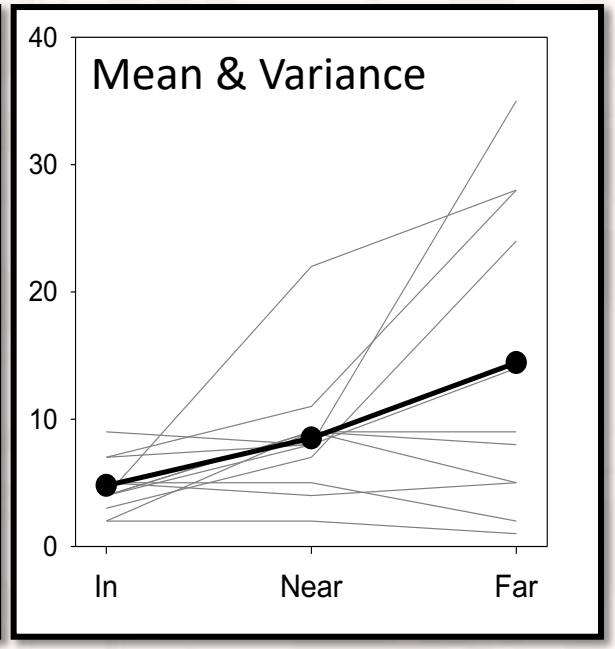
- Limited number of occurrences
- Soil variables are interrelated
- Soils are patchy (noisy data)
- Need to compare against “typical” soil
- Averages are insufficient



Spatially Matched Sampling





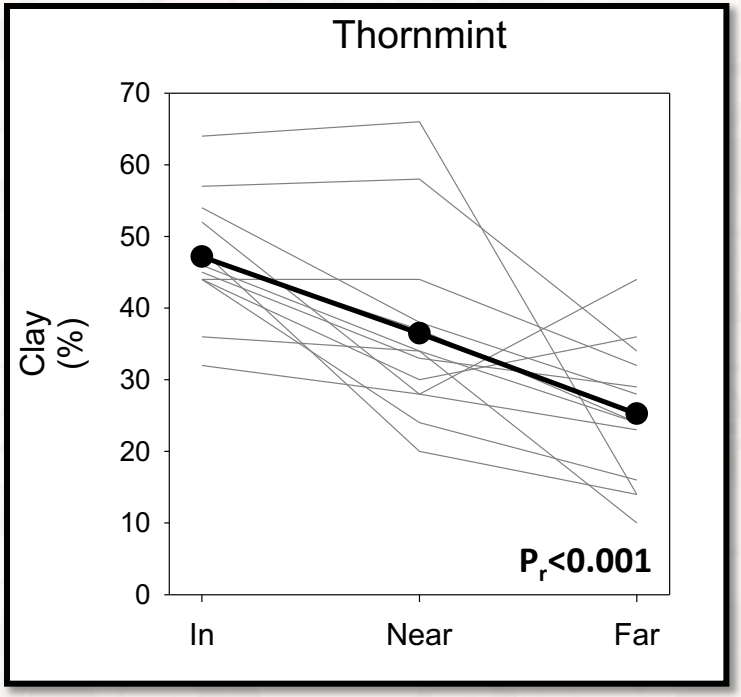


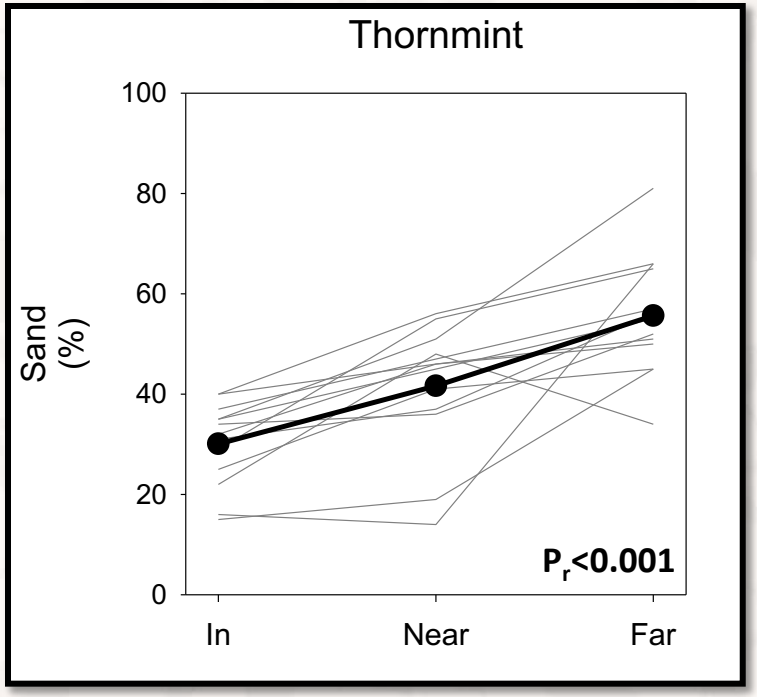
San Diego Thornmint

ACANTHOMINTHA ILICIFOLIA

Texture

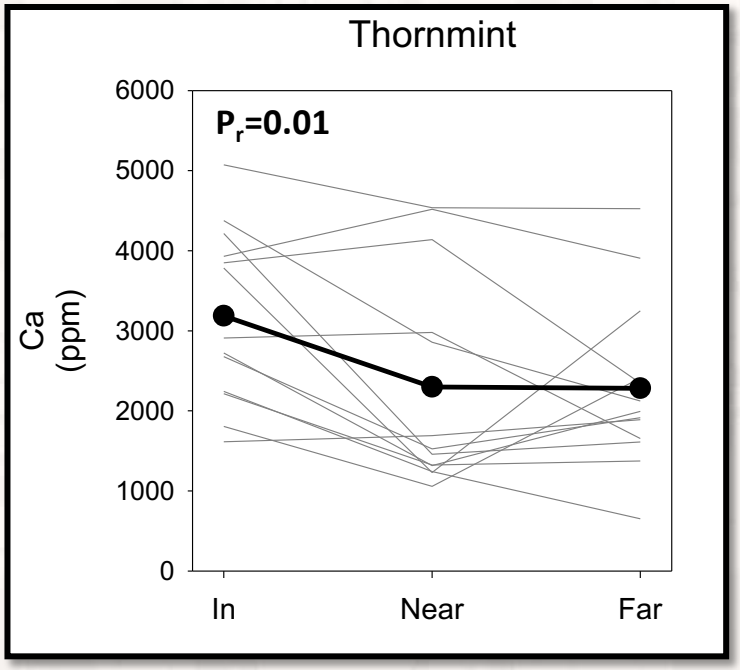
- High clay content

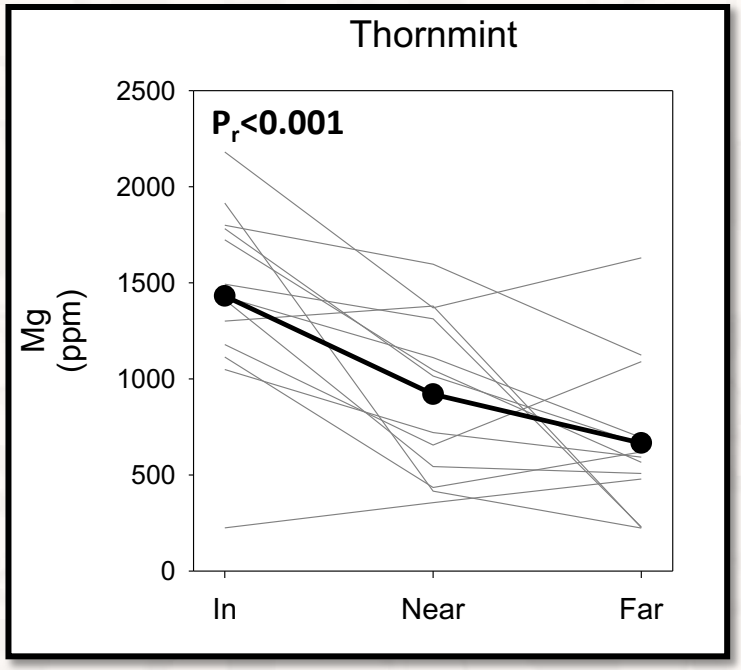




Calcium & Magnesium

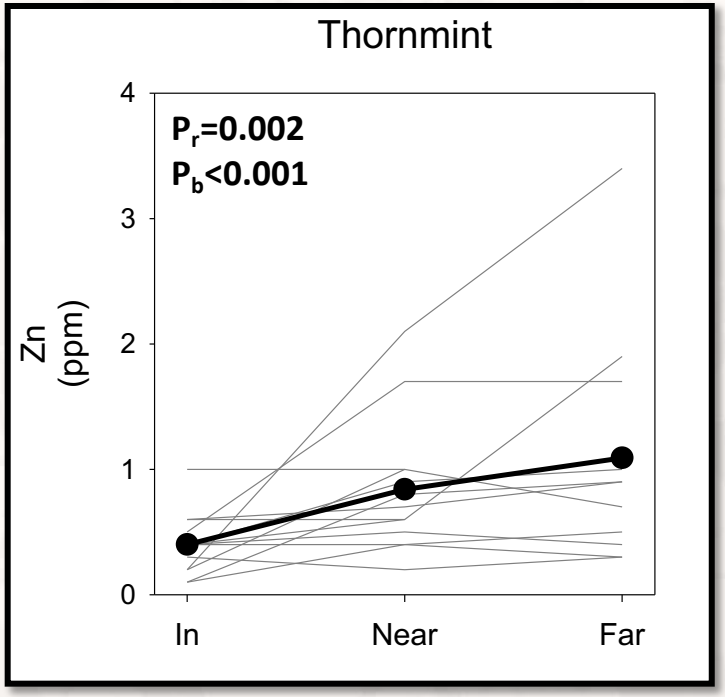
- Soil structure/ porosity/ water retention?

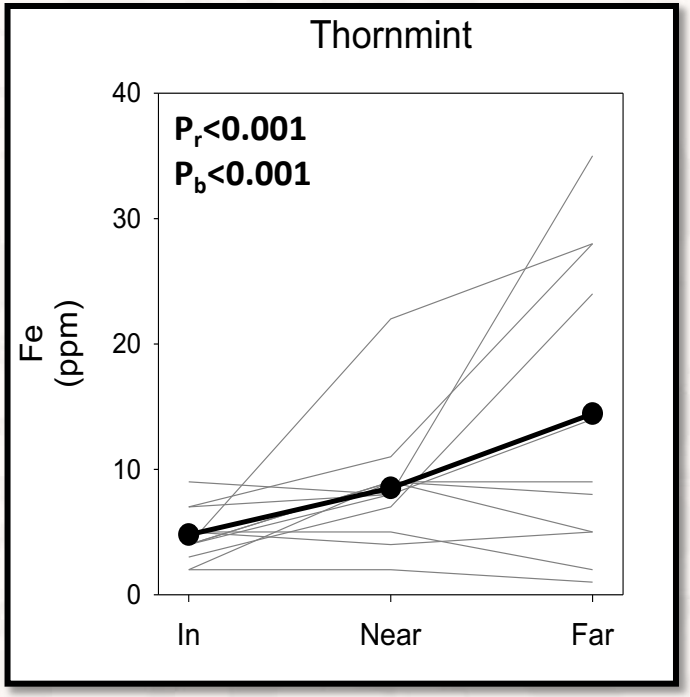




Zinc & Iron

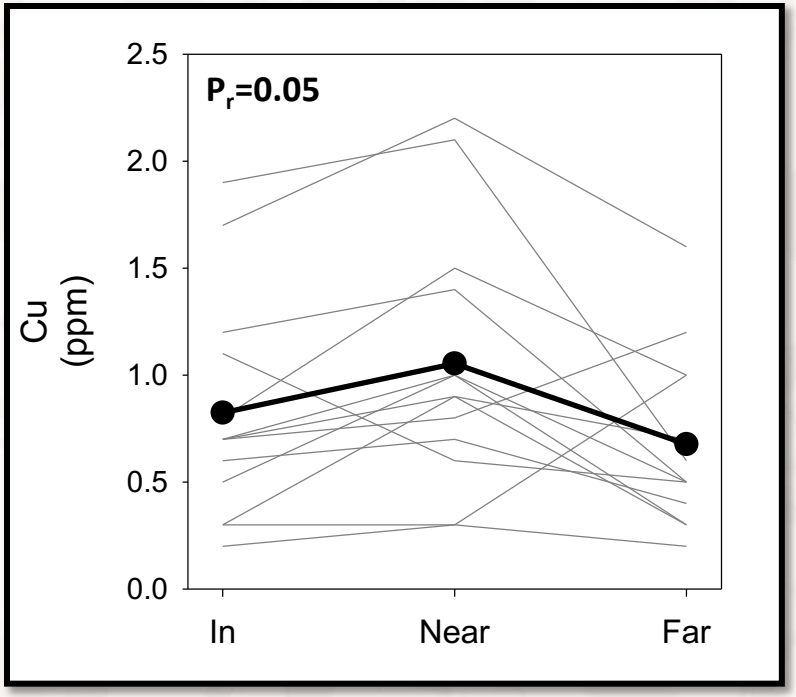
- Avoidance?
- Bound metals?





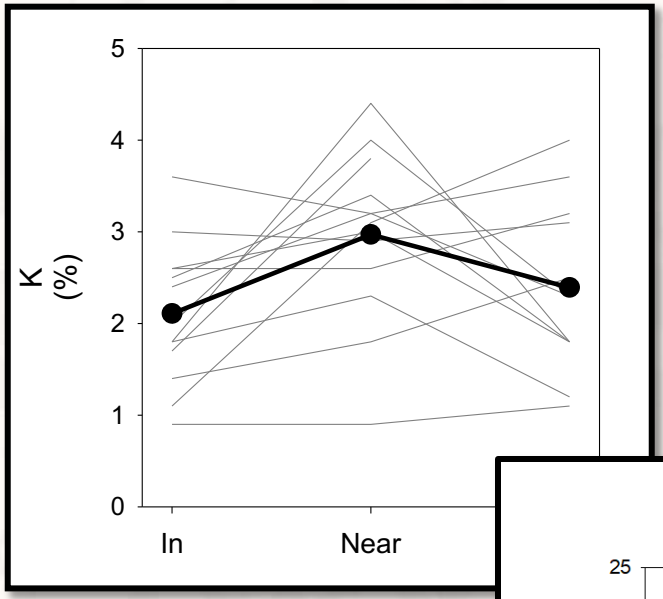
Copper

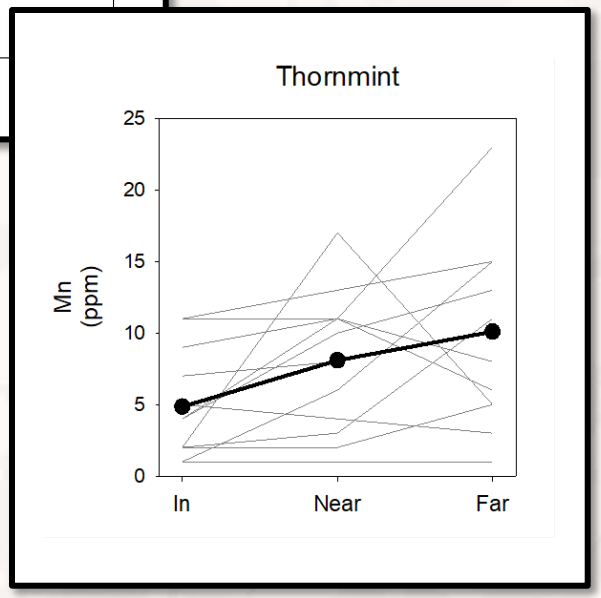
- Noise?
- Refugia?
- Bioaccumulation?
- Gabbroic soils?



Other Items

- Manganese
- pH
- SO^4
- Phosphorus
- Organic matter
- Nitrate
- Sodium
- Boron
- Potassium



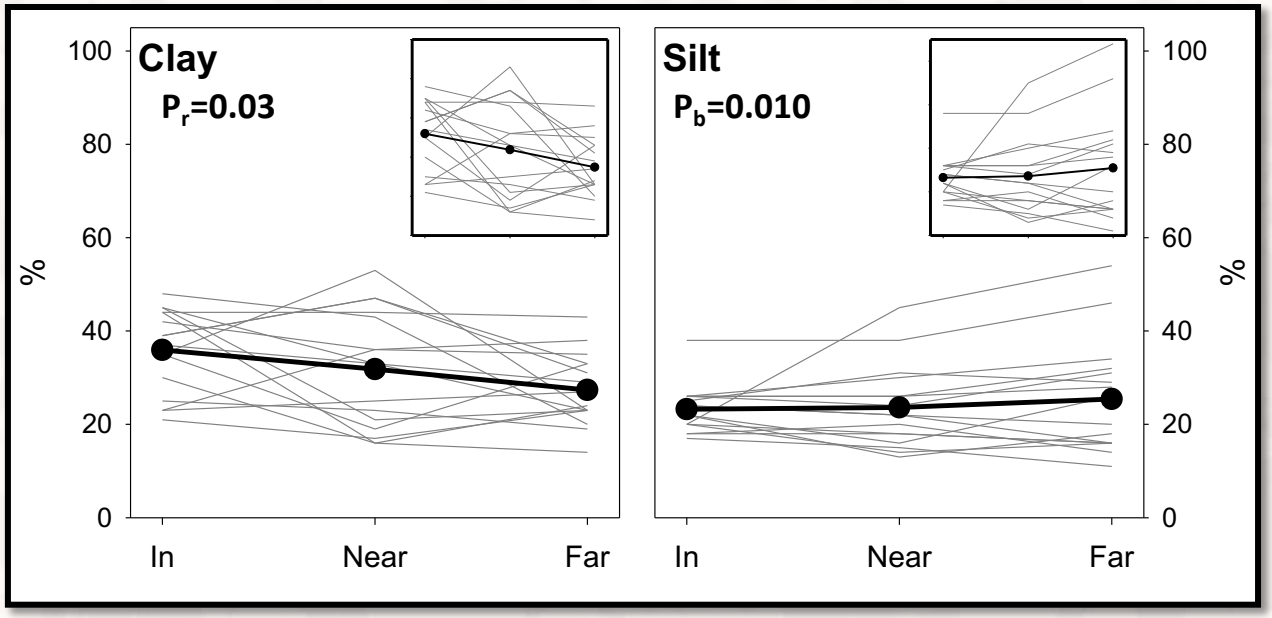


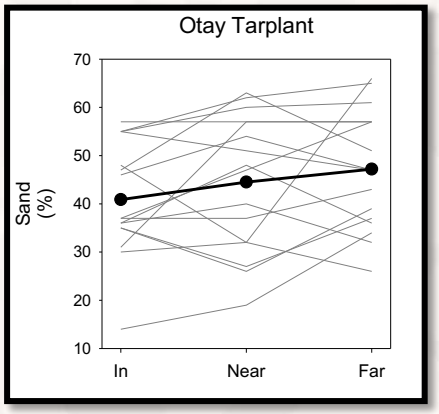
Otay tarplant

DEINANDRA CONJUGENS

Texture

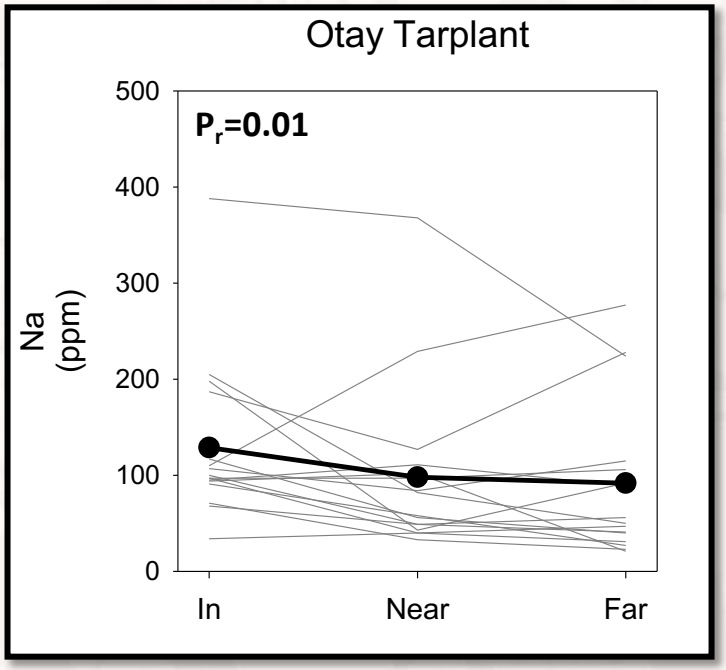
- Clay v. sand ratio?

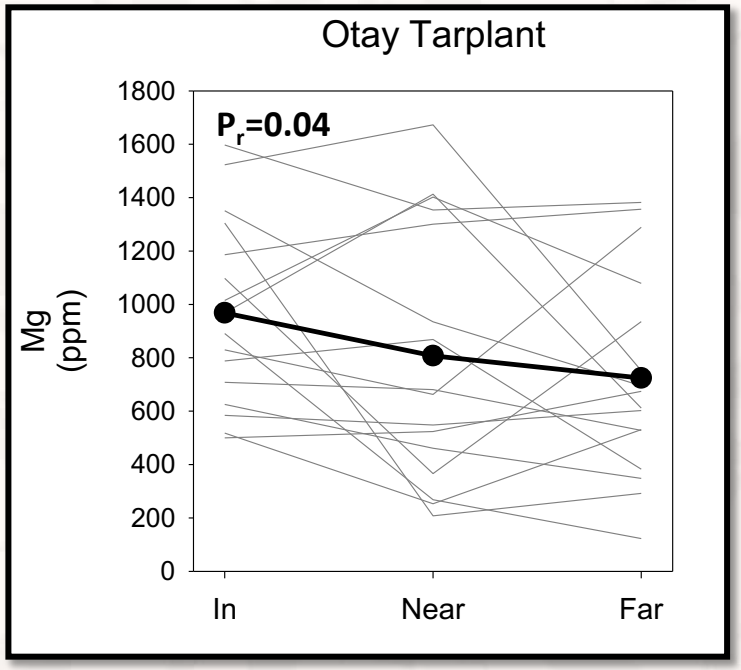




Sodium & Magnesium

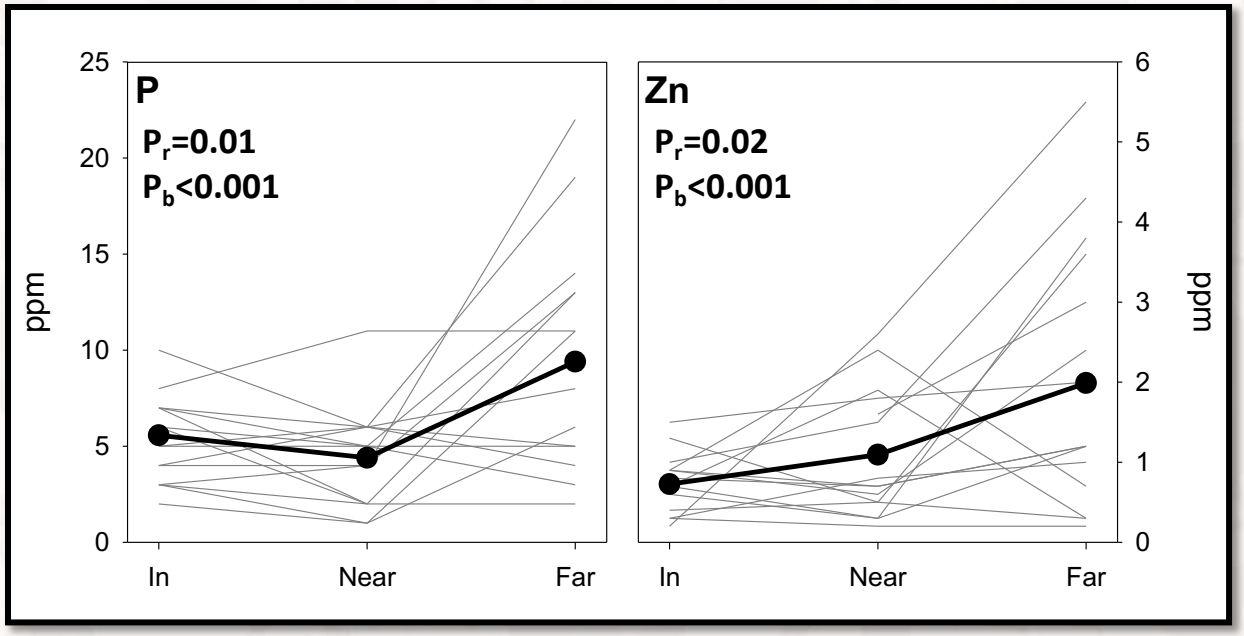
- Soil structure/ porosity/ water retention?
- Friability?





Fertility indicators

- Competition avoidance?



Conclusions

Species	Life History	Soils	Photo
Deinandra conjugens	Late spring annual	Clays *which are locally nutrient poor, within a narrow silt ratio*	
Acanthomintha ilicifolia	Early spring annual	Clays *low in sand, specific soil structure, & low in some metals*	

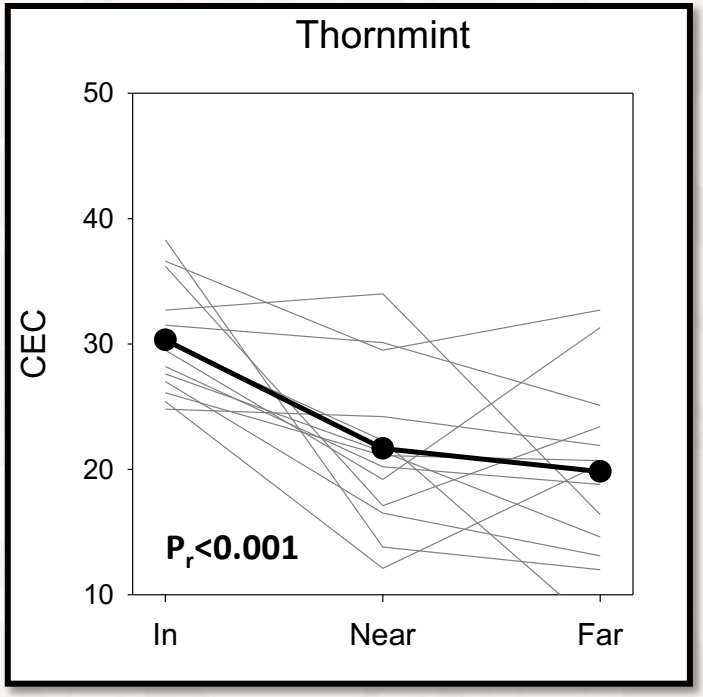
Special Thanks To:

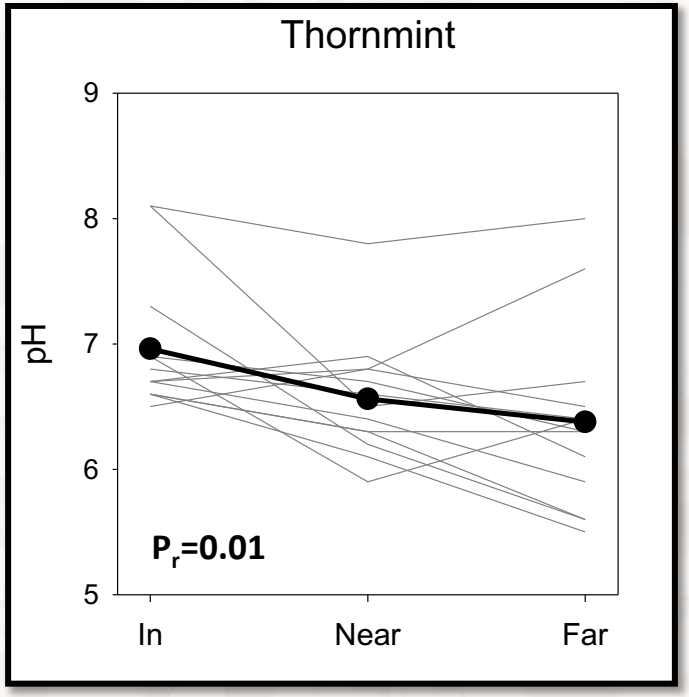
- Patricia Gordon-Reedy, CBI
- Jessie Vinje, CBI
- Dr. David Lipson, SDSU
- Dr. Kris Preston, SDMMP
- California Department of Fish and Wildlife Local Assistance Grant program

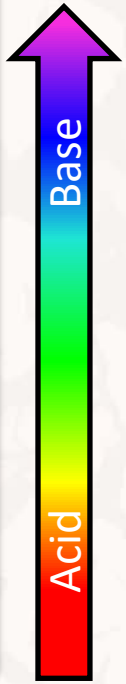
EXTRA SLIDES

CEC and pH

- Texture related
- Nutrient availability?







$(Ca^{2+} + Mg^{2+} + K^{+} + Na^{+})$

Summary

- High clay
  - CEC, pH, Ca, Mg likely linked
  - Fe, Zn, bound in the clay
  - Water retention
- Further study:
  - Physical properties: Structure, Density, Friability
  - Experiments: pH, clay, and chemical properties

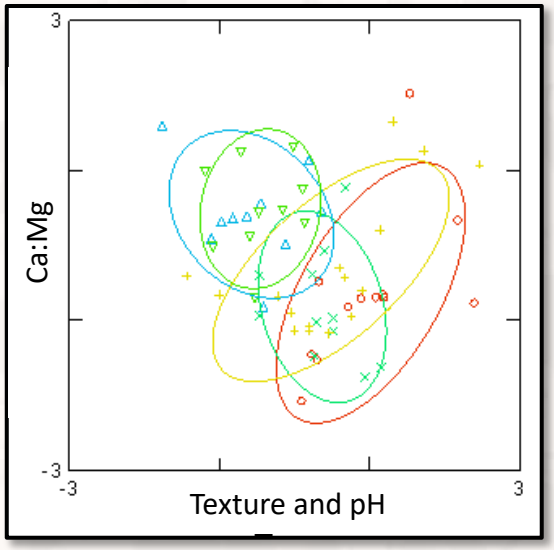
Summary

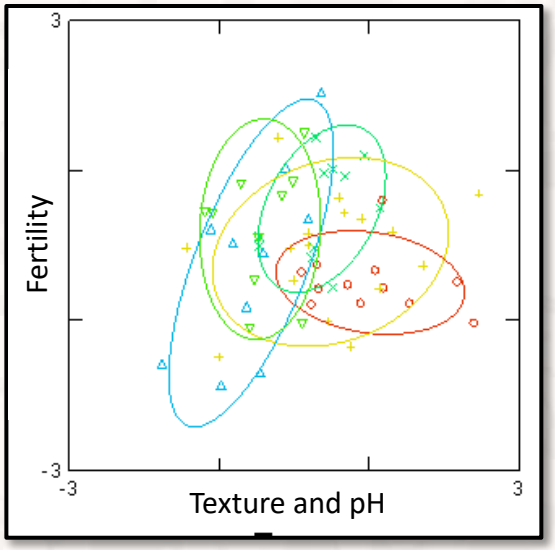
- “Intermediate clay”
  - Lower clay, higher sand than other clay species
  - Silt may be important
- Tolerates low fertility relative to landscape
  - Competition avoidance?
- Further study
  - Salinity tolerant or need for expanding clay?
  - Fertility experiment

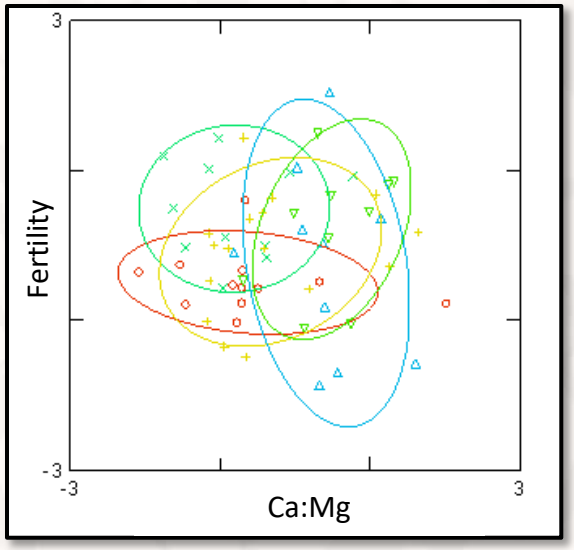
Principle Components Analys

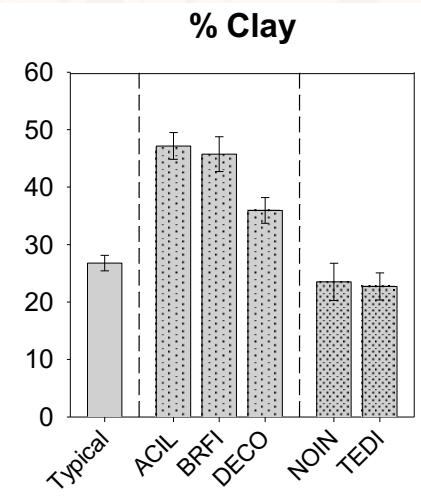
- Texture and pH
- Ca:Mg
- Fertility

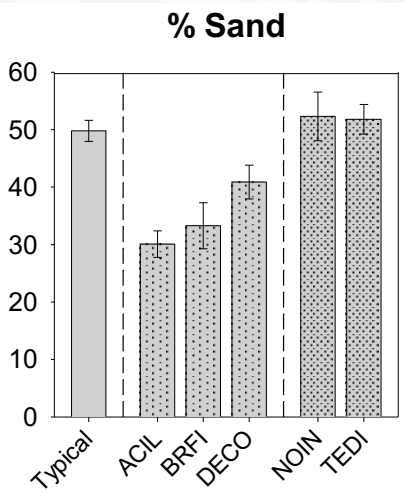
Factor	Texture & pH	Ca & Mg Balance	Fertility
B	0.608	0.471	0.178
Ca:Mg	-0.205	0.919	-0.007
Ca	0.774	0.488	0.191
Ca%	-0.011	0.931	-0.062
CEC	0.895	0.076	0.247
NO_3	0.096	0.086	0.493
OM%	-0.052	0.118	0.649
PH	0.671	0.492	-0.217
SAND	-0.666	0.081	-0.303
SILT	-0.073	-0.079	0.402
SO_4	-0.044	0.109	0.58
SOLSALT	0.03	0.371	0.412
Zn	-0.561	0.045	0.607

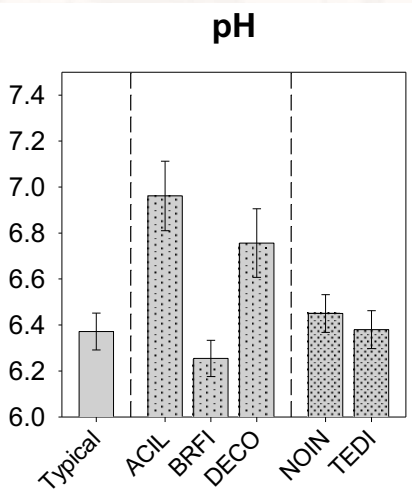


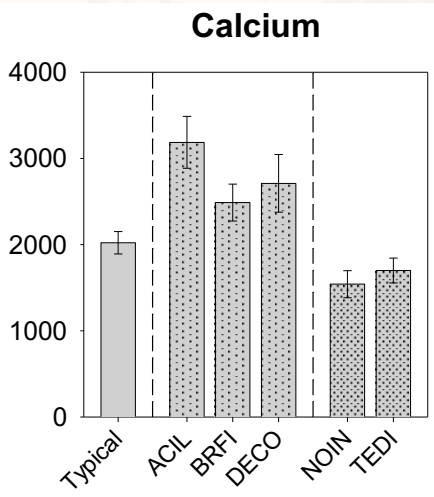


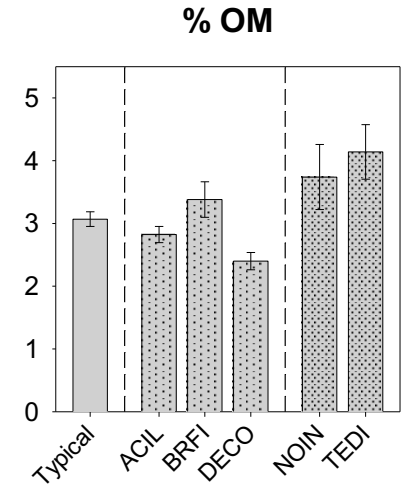


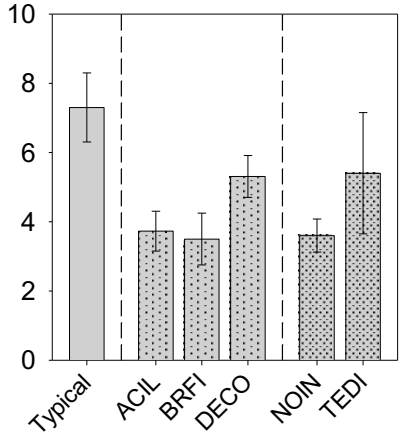

% Clay
60
50
40
30
20
10
0
Typical
ACIL
BRFI
DECO
NOIN
TEDI

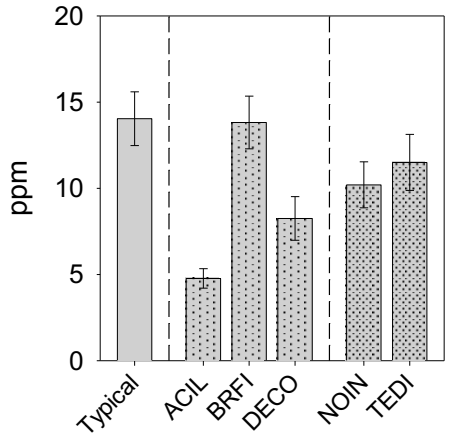

% Sand
60
50
40
30
20
10
0
Typical
ACIL
BRFI
DECO
NOIN
TEDI

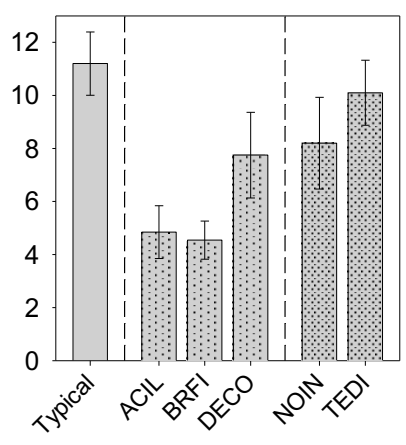

pH
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
Typical
ACIL
BRFI
DECO
NOIN
TEDI


Calcium
4000
3000
2000
1000
0
Typical
ACIL
BRFI
DECO
NOIN
TEDI


% OM
5
4
3
2
1
0
Typical
ACIL
BRFI
DECO
NOIN
TEDI


Phosphorus
10
8
6
4
2
0
Typical
ACIL
BRFI
DECO
NOIN
TEDI

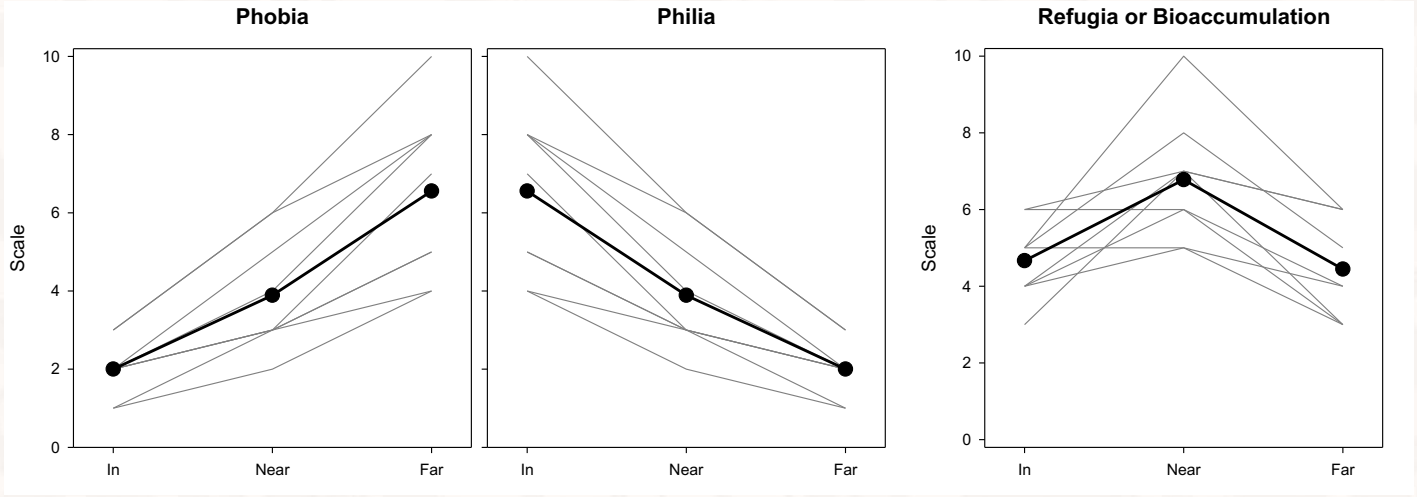

Iron
ppm
20
15
10
5
0
Typical
ACIL
BRFI
DECO
NOIN
TEDI

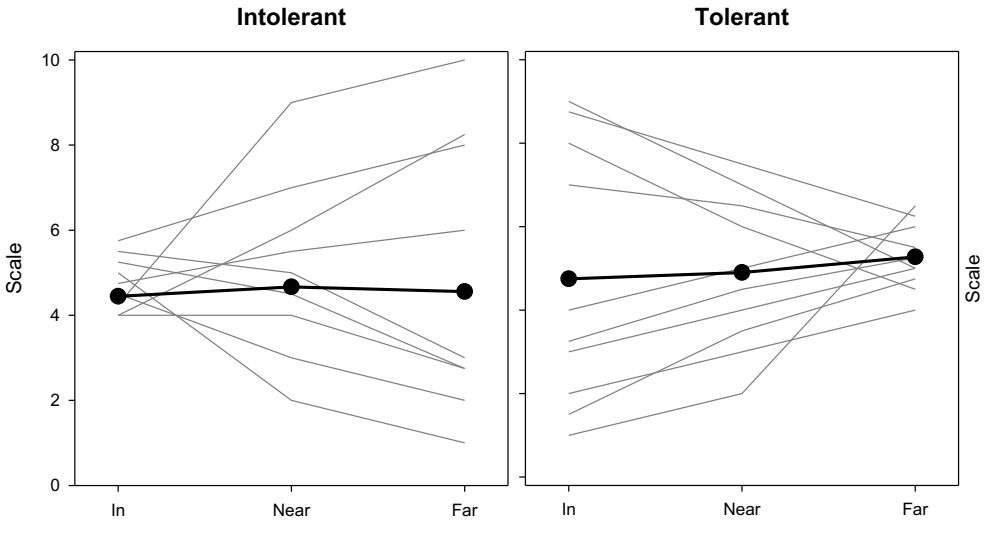

Manganese
12
10
8
6
4
2
0
Typical
ACIL
BRFI
DECO
NOIN
TEDI

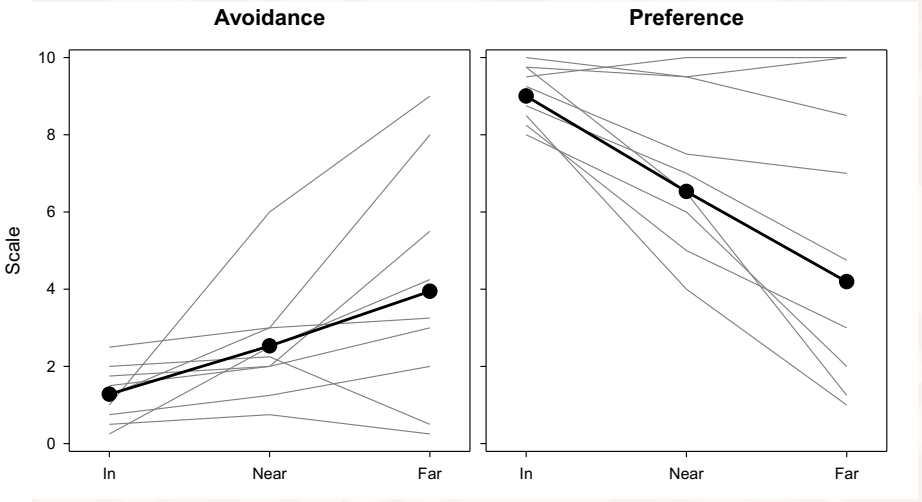
Next Steps

- Retest extreme outliers
- Greenhouse experiments
- Reciprocal transplants, common garden studies
- Leaf tissue assays
- Follow up on all borderline variables
- Compare microclimates

Patterns of Association



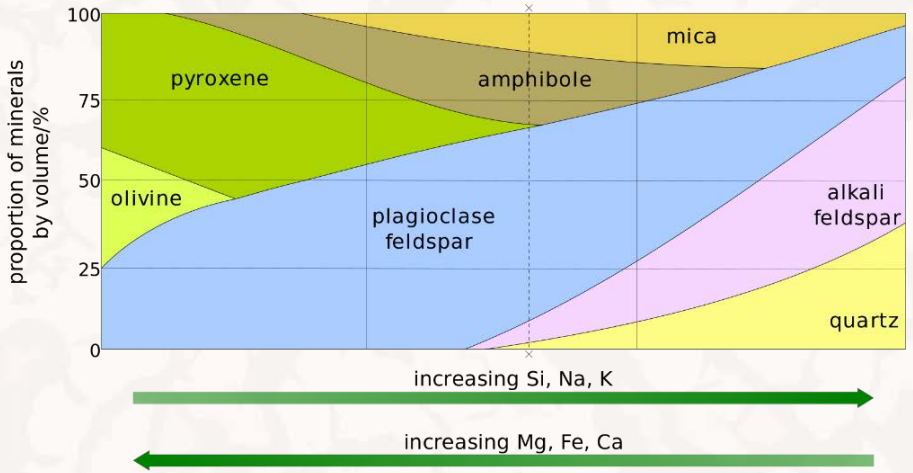




Gabbro Soils

- Alkaline (“basic”)
  - higher CEC, higher pH
- Mafic: Mg and Fe enriched
  - Variable in composition
  - Mg, Fe, Ca, Al, Na

	MAFIC	INTERMEDIATE	FELSIC
extrusive	basalt	andesite	rhyolite
intrusive	gabbro	diorite	granite

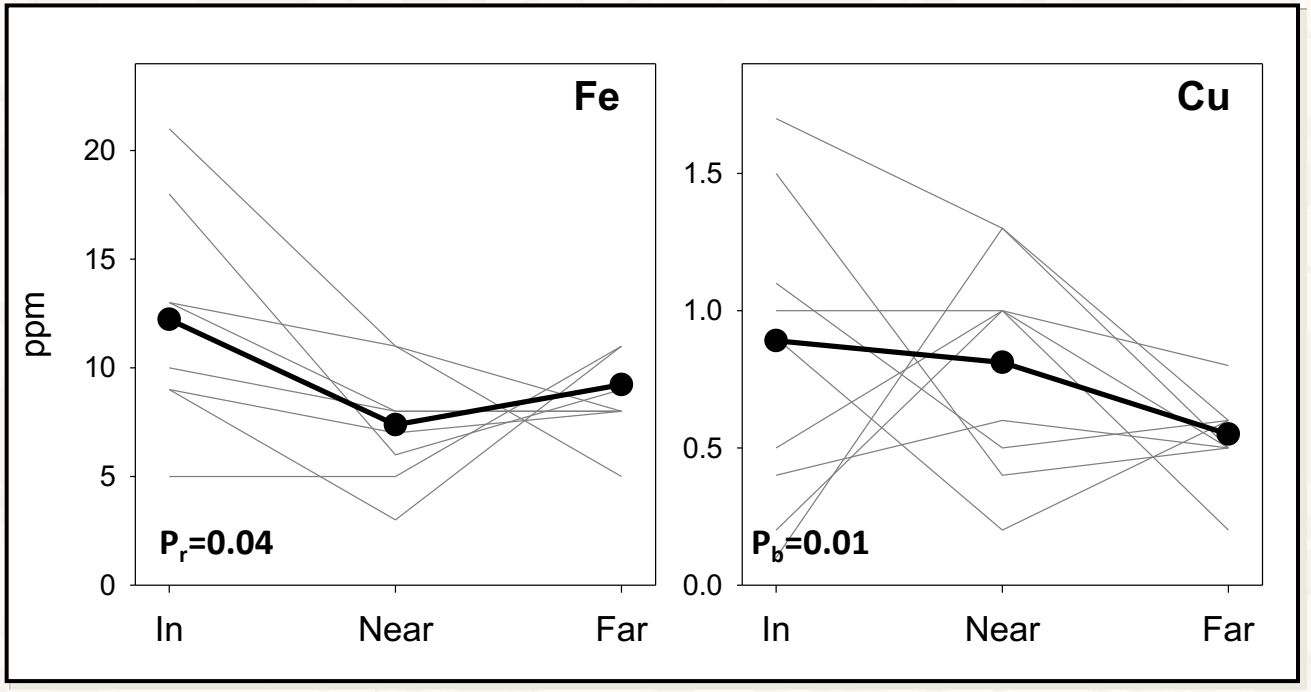


Parry’s Tetracoccus

TETRACOCCUS DIOICUS

Totally Metal

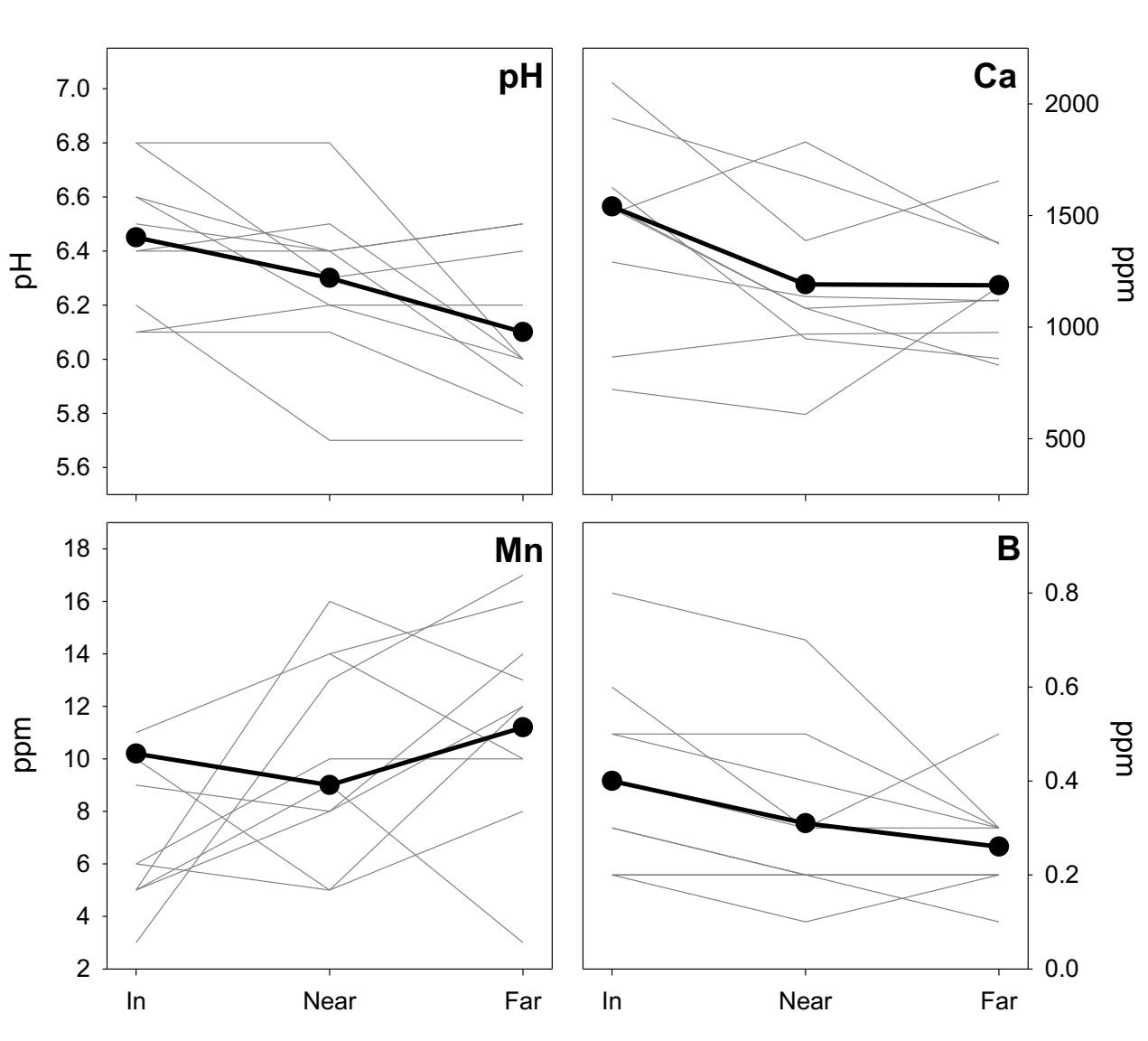
- Tolerates relatively high Fe and Cu
  - (Or other associated metals not measured)
- Does not select for it, competition avoidance



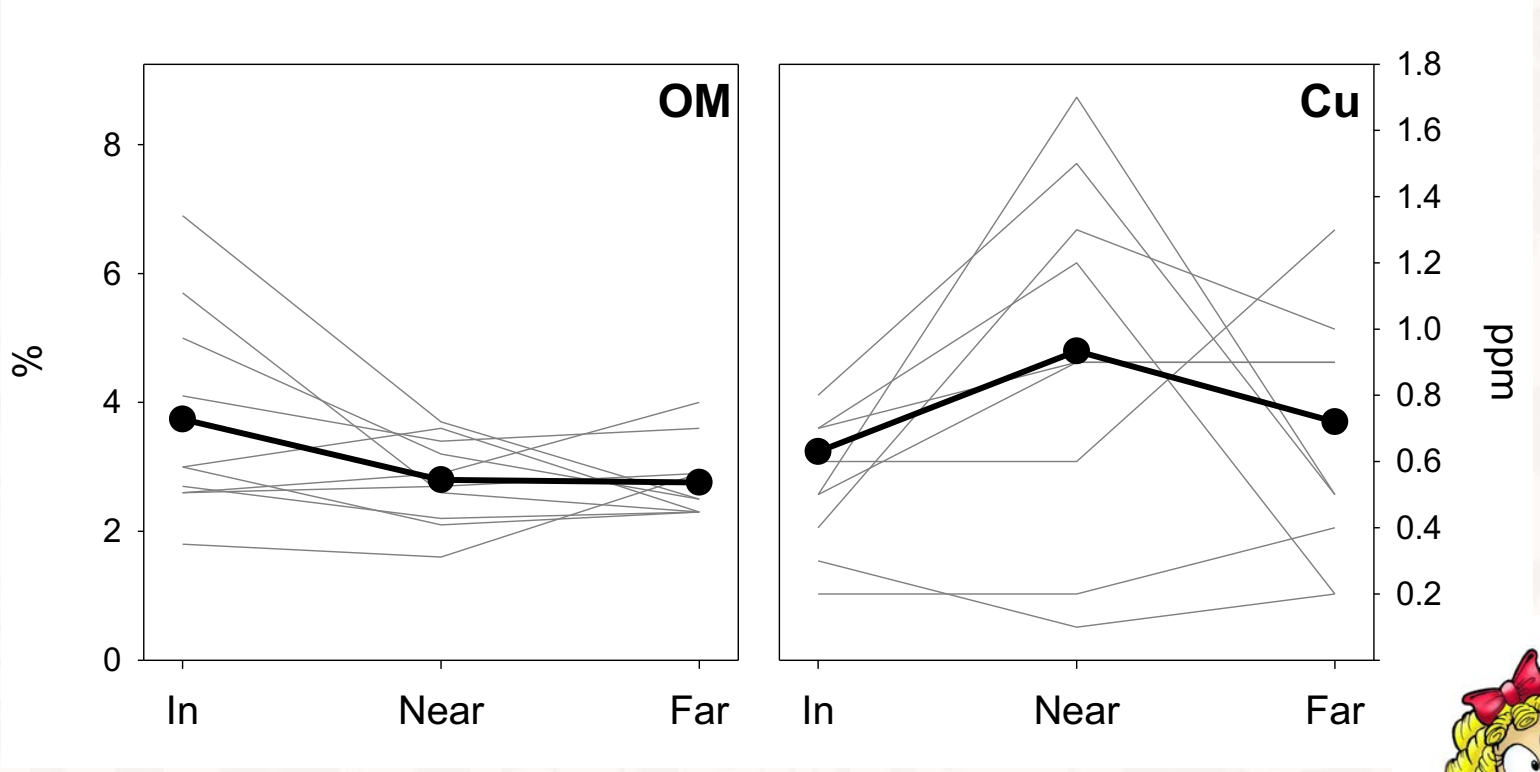
Dehesa Nolina

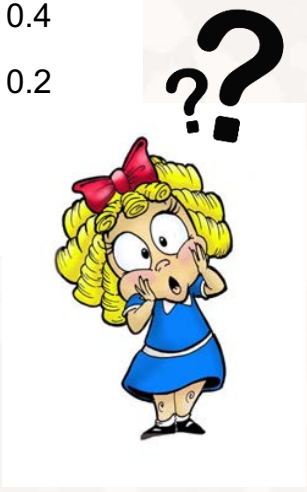
NOLINA INTERRATA

pH


pH
Ca
Mn
B
pH
ppm
ppm
ppm
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
2000
1500
1000
500
18
16
14
12
10
8
6
4
2
0.8
0.6
0.4
0.2
0.0
In
Near
Far
In
Near
Far

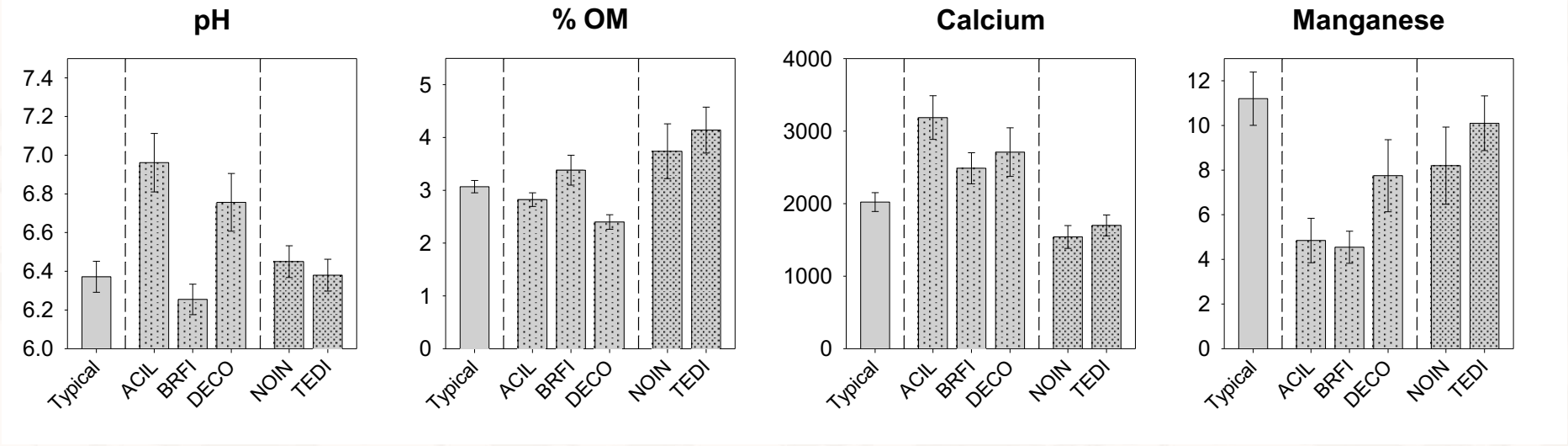
Fertility





Take Aways

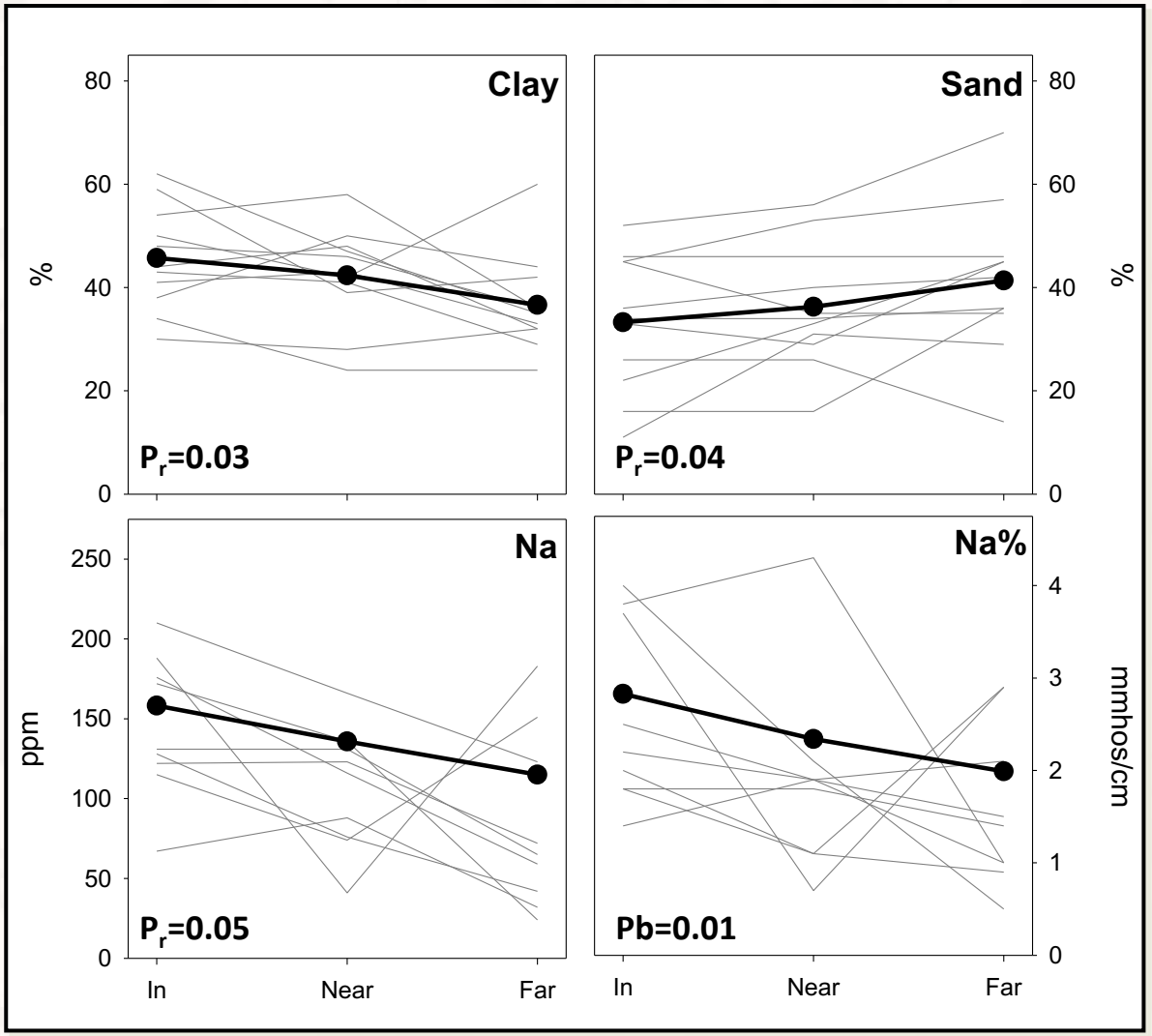
- Effect of gabbro is local
- Gravitating toward more neutral pH?
- Calcium was the strongest predictor
- Contributing to OM pool?



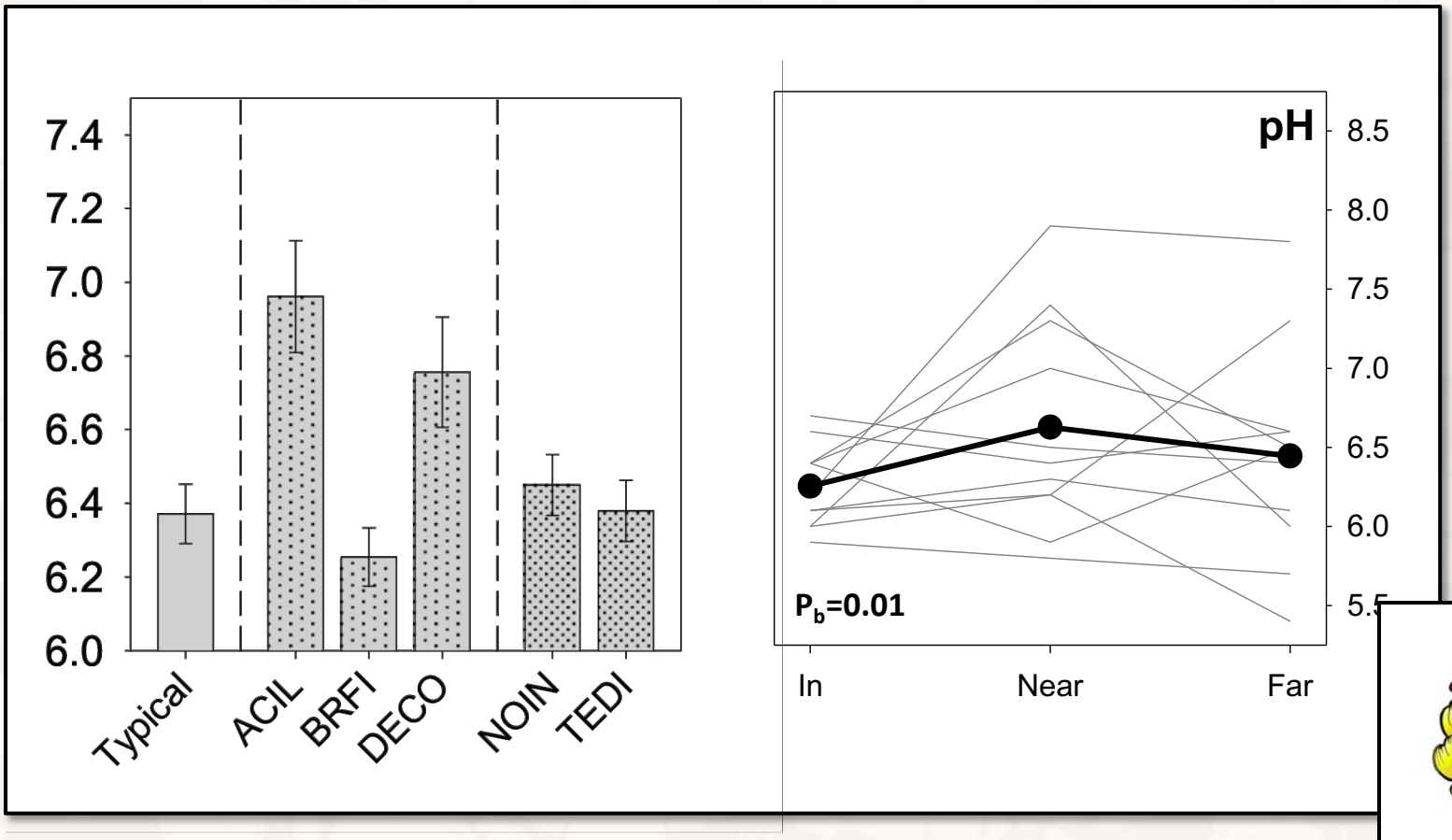
Threadleaf Brodiaea

BRODIAEA FILIFOLIA

Texture and… sodium?



pH


7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
Typical
ACIL
BRFI
DECO
NOIN
TEDI
pH
8.5
8.0
7.5
7.0
6.5
6.0
5.5
P_b=0.01
In
Near
Far

Take Aways

- Prefers (relatively) acidic clays
  - Lower pH relative to other clay species
  - Is this San Diego specific?
- Sodium
  - Swelling clays
  - Clay is cation rich
  - Competitive edge