ANTHROPOLOGICAL AND ENVIRONMENTAL FACTORS IMPACTING CLIMATE CHANGE MITIGATION THROUGH CARBON SEQUESTRATION: AN EVALUATION OF ELEVATION, VEGETATION, FIRE, AND LAND USE

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Introduction

The presence of organic carbon in soil is a direct indicator of the soil's ability to sequester carbon dioxide (CO2) from the atmosphere. In this study, we collected samples from five different locations, along an elevational gradient along Sonoma Mountain, from woodland, grassland, and wetland areas, in order to determine which factors (vegetation, elevation, land use, or fire) have the greatest influence on soil C stocks (Fig.1). The samples were processed by two different complimentary methods to establish C content: Loss on Ignition (LOI) and Total Organic Carbon (TOC).

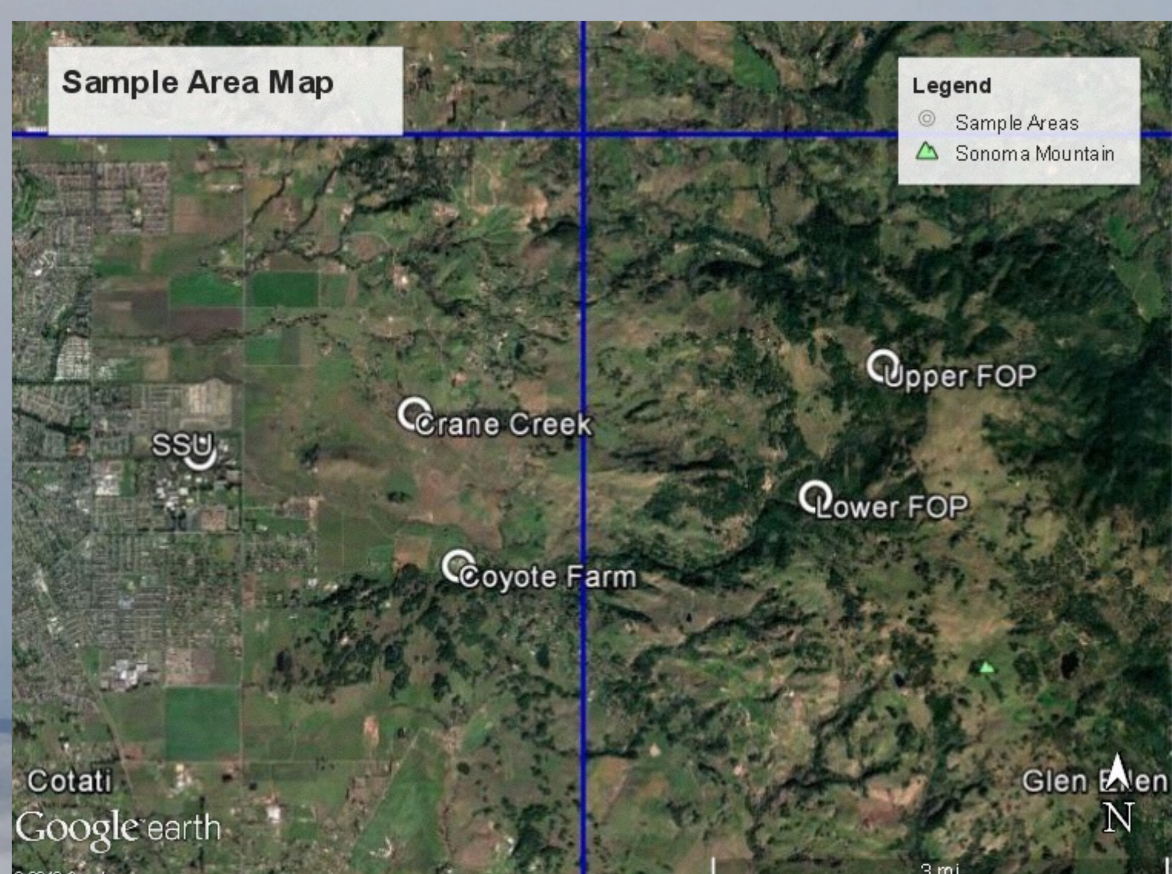

Figure 1: Sample Area Map

	Grassland	Woodland	Wetland	Pond
Sonoma State			x	
Crane Creek	x	x		
Coyote Farm	x	x		
Lower FOP	x	x	x	x
Upper FOP	x	x		x

Figure 2: Sample locations vegetation zones

Background

co2 (a greenhouse gas) naturally occurs in our atmosphere, and is used by plants, through photosynthesis, to produce O2 and the energy they need to grow. Anthropogenic activities have resulted in an increase in co2, and while vegetation is an important carbon (C) sink, current biomass is insufficient to absorb the excess.

As soil is the largest terrestrial C sink, it is important for us to understand what factors influence how efficiently an ecosystem can mitigate climate change (Ontl 2012). By understanding these factors, we can make land management decisions that could increase carbon sequestration in soils.

Materials & Methods

Field Methods

- An average of six samples were taken at each sample site, in five elevation zones.
- Sample sites were selected cover a large area while meeting the slope requirement of 0.
- Soil from the surface to 10cm below was dug up with a trowel, measured with a ruler, and placed into a plastic bag.
- Vegetation was documented and GPS Coordinates were taken at each location.

Figure 3: Soil sample prior to measurement.
Figure 4: Samples being placed in 950°C oven.

Lab Methods: LOI

- Procedure followed Heiri et al., 2001
- Sediment was placed into a small pre-weighed crucible and soil weight determined (~3g,)
- Samples were placed into an oven heated to 105°C for 24 hours to drive off soil moisture (DW105°).
- Samples were then cooled and re-weighed (DW 550) and placed into a furnace at 550°C for two hours, to burn off organic material.

% Organics=((DW105°-DW550°)/DW105°)*100

Lab Methods: TOC

- Sediment (~3g) was weighed and placed into beakers with dispersant made with 10% Sodium Hexametaphosphate ((NaPO3)6)
- Samples were sieved through a 200 micron mesh to remove large organic and inorganic material.
- 5ml of a 10% Hydrochloric Acid (HCl) was added to the sample to remove any calcium carbonate present.
- Samples were centrifuged, acidic liquid was decanted, and DI water was added to restore to a neutral pH.
- Samples were then dried at 60°C, ground with a mortar and pestle, and then shipped off to Paleoenvironmental Change Research Group's lab a Wilmington.
- Here, the samples were placed into small tin capsules and placed into a Costech 4010 Elemental Analyzer interfaced with a Thermo Delta V Plus stable isotope mass spectrometer to measure %C (Lane et. al 2017).

Results

- Linear regression shows that there was a strong association between both LOI and TOC (R2= .84 and P-value<0.01) (Fig. 5).

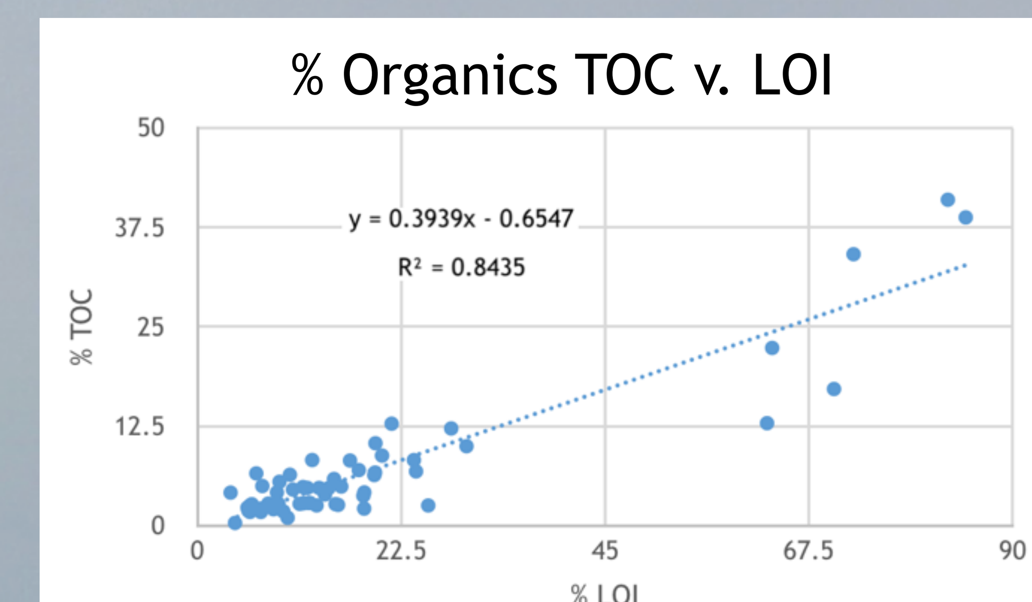

Figure 5: % Organics TOC and LOI

- Both LOI and TOC data show that woodland soils have greater C content than grassland (Fig. 6).
- There was no relationship between elevation and C stocks in woodland samples, however, soil C in grassland areas increased with elevation (Fig. 6).
- Coyote Farm showed higher soil C than expected, likely the result of minimal topographic variation (Fig. 6).

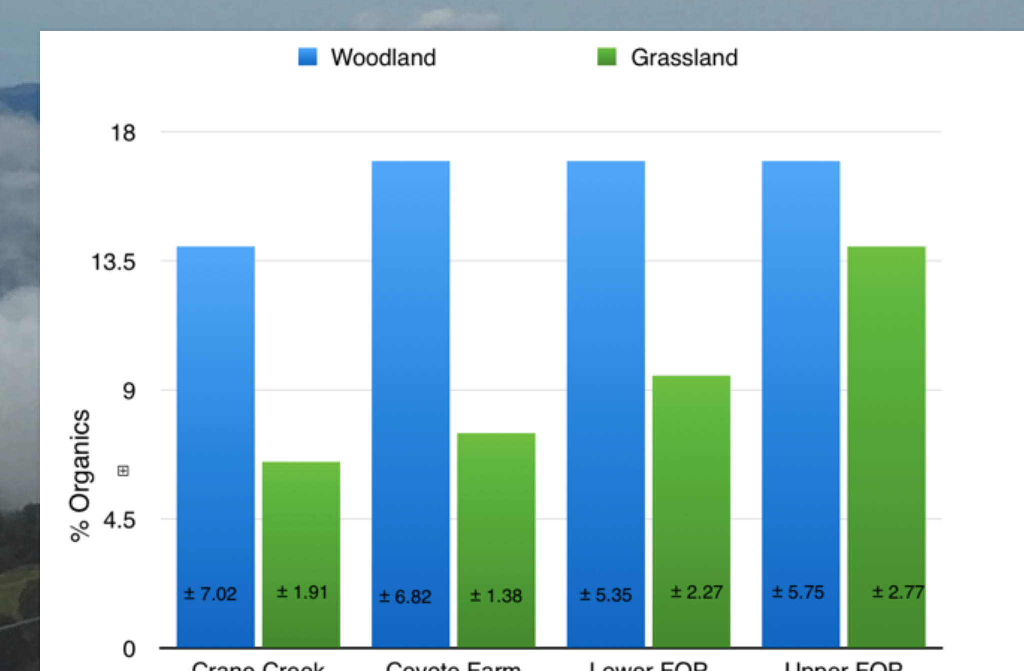

Figure 6. LOI data measured by average of ~six samples taken from each grassland and woodland, in each location.

- Fire impacted soils at Crane Creek regional park did not have lower soil C in either woodland or grassland soils (Fig 7).

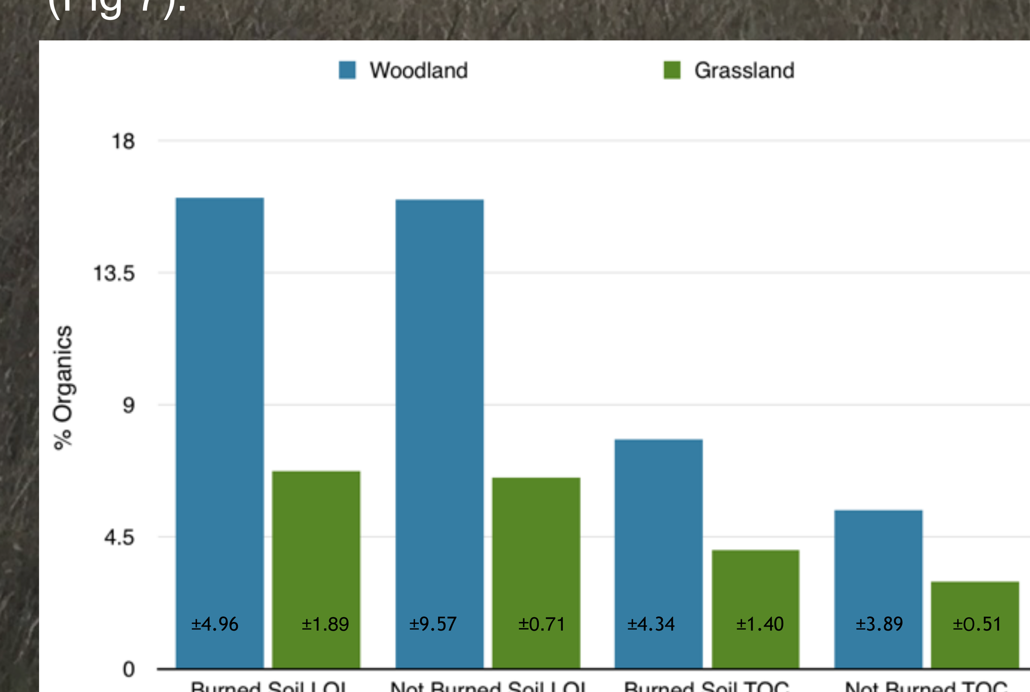

Figure 7: Comparison of % Organics (LOI and TOC) of fire impacted soils vs. unaffected soils.

Results Cont.

- Soils from artificial wetlands (University Ponds) contained less soil C than comparable (Turtle Pond Wetland (Fig. 8) natural wetlands (Fig. 9).

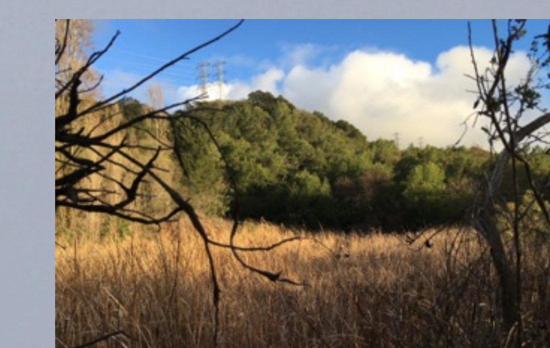

Figure 8: Turtle Pond Wetland

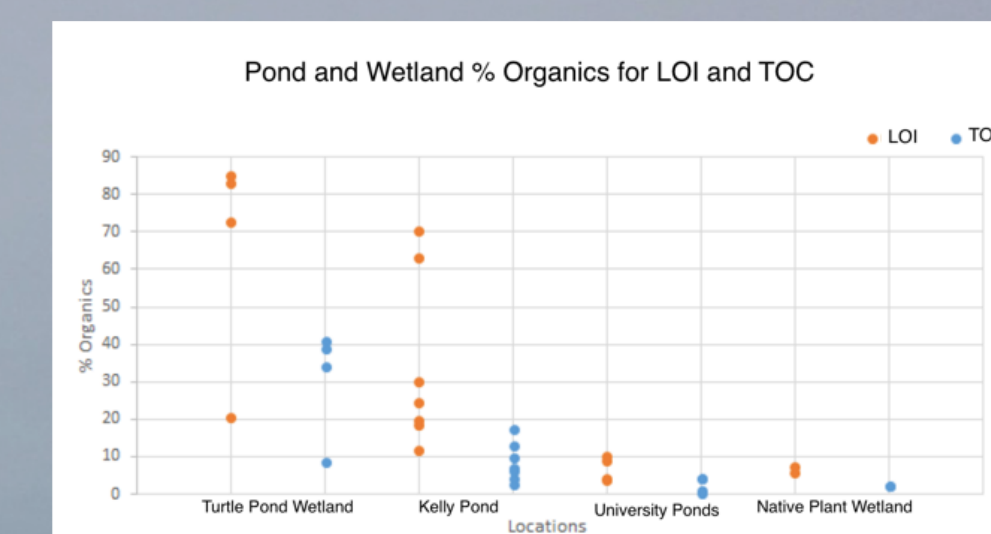

Figure 9: Pond and Wetland % Organics for LOI and TOC

Conclusion

Coyote Farm (CF) grassland and woodland soils contained more C than Crane Creek, despite their similarity in elevation. This could be the result of the discontinuation of large-scale grazing on CF, or the lack of topological variability.

Our data shows that natural wetland and woodland soils both store more C than grassland soils, meaning that natural wetlands and woodlands are extremely important C sinks. We recommend prioritizing wetland restoration and reforestation projects as climate change mitigation efforts.

References

- Oliver Heiri, André F. Lotter, & Gerry Lemcke. 2001 "Loss on ignition as a method for estimating organic and carbonate content in sediments: reproducibility and comparability of results" Journal of Paleolimnology 32, no. 3: 287-99.
- Ontl, T. A. & Schulte, L. A. (2012) Soil Carbon Storage. Nature Education Knowledge 3(10): 35
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Limitations

- Some samples were lost in the TOC process as a result of poor chromatography.
- One Crane Creek grassland sample was lost in the LOI process due to a spill.
- Lower FOP woodland sampling was limited to five samples because of the high concentrations of poison oak.

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