Analysis of Soil pH Levels and Organics in Cedar Bonnet Island

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Abstract:

Soil pH and percent carbon are soil parameters that influence the function and health of soils. Soil pH can affect the growth of microorganisms, and percent carbon is a metric of life in soils. This study analysed these variables at 12 different sites on Edwin B. Forsythe National Wildlife Refuge, Cedar Bonnet Island Division (EBFR-CBI), with three different samples from each site. Soil pH was measured with a 1:2 ratio (soil to water). Percent carbon was measured by using the loss on ignition (LOI) method using a subsample of approximately 10 grams of dry soil from each site. A linear regression and ANOVA were used to determine any relationship between percent carbon and soil pH, and if there was a difference in the pH levels amongst the sites, respectively. There was no significant relationship between or among either. There may be more variables that were not tested in this study.

Introduction:

Soil: the ground under our feet. It is fascinating how many factors can change the composition and properties of soil. Whether it is habituating to plant, or letting it die, pH affects soils, nutrients, minerals, and growth ("Soil Quality Physical Indicator" 2011, Bickelhaupt 2024). Soil pH is an indication of the acidity or alkalinity of soil, measured in pH. Soil pH can also influence plant growth by affecting microorganisms and bacteria. Most plants prefer neutral soil pH. Soil pH can be affected by rainfall, nitrogen fertilizers, and plant growth ("Soil pH" 2024, Ferguson 2021). Barnegat Bay, the bay where EBFR-CBI is, has coarse-loamy soil with a pH of around 7.1-7.4 ("SHiP" 2022, Soil Data Explorer 2023).

Another interesting factor of soil is the percent carbon. Carbon can be trapped in the soil as decaying plant matter or excretion from animals. Percent carbon is the amount of carbon burned away from a soil sample. (Ferdush 2021, "The Science of Soil Carbon" 2021). This carbon has many effects on the soil, biological, chemical, and physical properties (like water retention) (Rice 2023, Rawls 2003). Soil carbon is a snapshot of the biological life of the soil, while pH has an effect on the microorganism life of said soil. It is hypothesized that this

relationship will be connected. Taking a look at these variables and their impacts on each other can give a deeper understanding of the soil of EBFR-CBI.

Methodology:

Study Sites:

Students from the MATES research class collected 36 soil samples from 12 sites at the Edwin B. Forsythe National Wildlife Refuge, Cedar Bonnet Island Division (EBFR-CBI), from April 24 to May 4, 2026.

Sample Collection:

Soil samples were collected from twelve sites along FWR-CBI **(Figure 1)**. GPS coordinates were recorded at each site using a Garmin Etrex 10. Soil samples were collected with a 30 cm soil corer and collected in a labeled plastic bag for lab testing. Sites were sampled two times, April 28 (Sample A) and May 1, 2026 (Samples B and C)(n = 36).



Figure 1: Soil Sample Sites at EBFR-CBI from April 24 - May 1, 2026?

pH Analysis:

- In a 100 ml graduated cylinder, 30 ml of water is added to 15 ml of soil (2:1ratio) before being mixed four times, and the pH is measured using an OAKTON Benchtop pH Meter **(Figure 2)**.

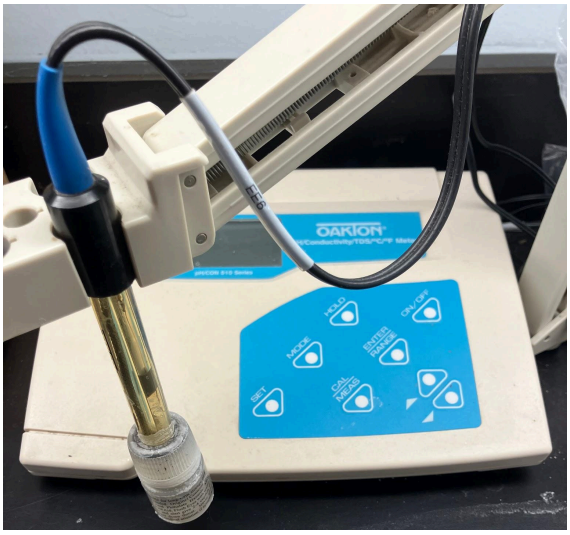


Figure 2: OAKTON Benchtop pH Meter

Organics Analysis:

- Percent Carbon was determined using the loss on ignition (LOI)method.
    - A mixture of samples A, B, and C for each site was combined in a crucible for a single data point.
        - The mixture was burned in a Muffle Furnace **(Figure 3)** for 24 hours at 450 C, and the crucibles were weighed empty and full before having the soil weight subtracted.
        - The burned weight is subtracted from the pre-burn weight to find the amount of carbon in a sample.
        - Percent Carbon is determined by dividing the carbon by the pre-burn soil mass.



Figure 3: Muffler Furnace

- Soil Moisture (%) was determined with the OHAUS MB23 **(Figure 4)**.
    - According to the Moisture Analyzers procedure ("MB23 / MB25 Moisture Analyzer", 2018). A special sample was taken from the field so as not to cause

soil moisture to evaporate prior to testing. Samples were collected in sealed bottles, and immediately, 10 grams of the sample was used to determine moisture.



Figure 4: OHAUS MB23

Statistical analysis:

- Single Variable Linear Regression was performed to analyze the data and determine if there is a significant correlation between percent carbon and soil moisture (%) as well as mean soil pH and percent carbon.
- An ANOVA Single Factor Test was performed to find a statistically significant difference among the pH levels at different sites, each site with three pH levels for the three samples collected.
- All tests were run with an alpha value of 0.05 or a 95% confidence level to determine significance

Results:

Soil pH values ranged from 5.11 to 7.42, mean pH ranged from 5.65 to 6.63, percent carbon ranged from 1.99 to 5.53, and moisture (%) ranged from 6.0 to 25.5. **(Tables 1 and 2).** No correlation was found between percent carbon and soil moisture (%) or mean soil pH and percent carbon. To that end, the ANOVA found no significant difference among the pH levels for each site ($F = 1.55$, $p = 0.1800$).

Table 1: Soil pH from all sites throughout the EBFR-CBI from April 24 - May 1, 2026.

Soil pH:	1	2	3	4	5	6	7	8	9	10	11	12
A	6.12	6.4	6.21	6.26	5.73	5.84	6.1	5.11	6.83	7.42	5.87	6.11
B	6.48	6.51	6.44	6.37	7.05	5.17	5.5	5.92	6.44	5.77	6.04	6.33
C	7.17	6.92	7.12	6.64	5.61	6.36	6.16	5.92	6.33	6.69	6.34	6.54

Table 2: Soil parameters determined (Carbon %, Moisture %, and mean pH) at the MATES laboratory for samples taken at the EBFR-CBI

Regression Data:	1	2	3	4	5	6	7	8	9	10	11	12
Percent Carbon	2.54	1.99	2.69	2.39	2.28	3.88	3.74	3.77	5.53	3.01	3.63	3.92
Moisture (%)	6.0	10.6	10.4	8.8	6.0	12.7	16.7	10.7	5.5	9.6	6.3	25.5
Mean pH	6.59	6.61	6.59	6.42	6.13	5.79	5.92	5.65	6.53	6.63	6.08	6.33

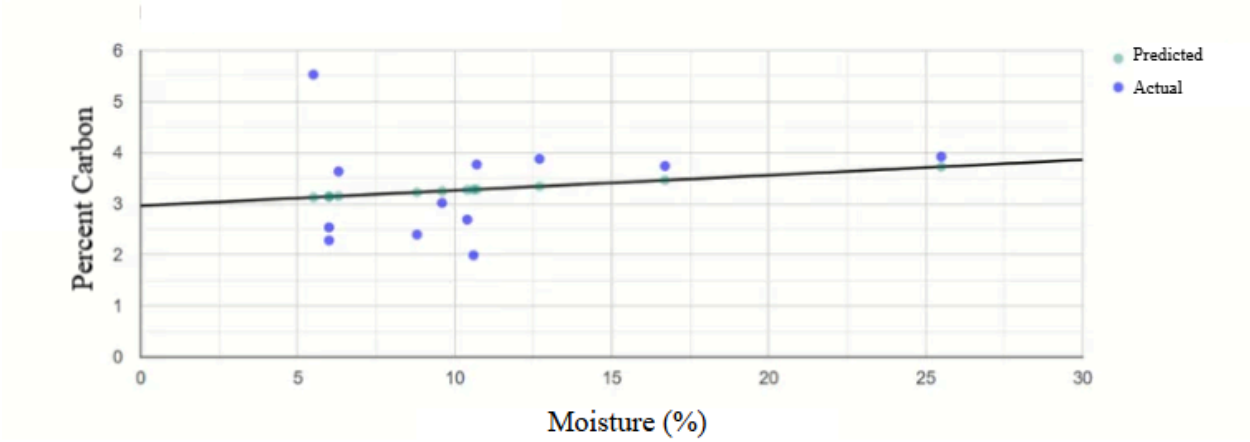


Figure 5: Linear Regression of moisture (%) and percent carbon. (n = 24, April 24,- May 1, 2026) at the 12 sites at the EBFR-CBI.

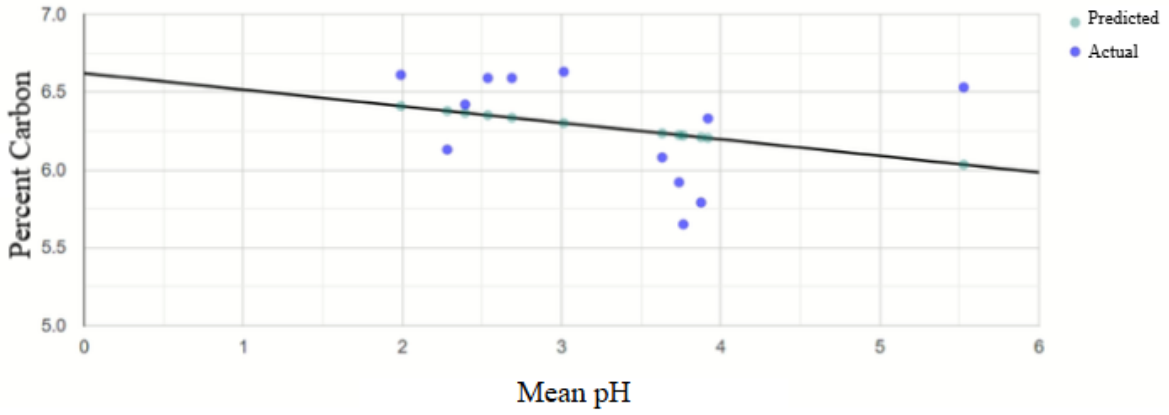


Figure 6: Linear Regression of mean pH and percent carbon. (n = 24, April 24 - May 1, 2026) at the 12 sites at the EBFR-CBI.

Discussion:

It was hypothesized that there would be a significant relationship between soil pH and percent carbon; the Linear Regression says that this relationship is not significant ($p > 0.05$) **(Figures 5 and 6)**. The ANOVA found no significant differences among the pH levels at the sites. Many other variables were not touched in this study, not limited to: conductivity, soil composition, sulfates, iron, etc. There may be another relationship at play here.

Conclusion:

Overall, there was no significant relationship between soil pH and percent carbon, and there was no significant difference in the pH levels of the sites. There are so many soil variables at play that it is hard to pinpoint what could be throwing this relationship off.

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