Annual Report: DETERMINING PATTERNS OF PLANT SUCCESSION, ECOSYSTEM SERVICES AND HYDROLOGY AT WILD BASIN WILDERNESS PRESERVE

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INTRODUCTION

Resampling fixed plots and/or transects within plant communities represents one of the strongest methods of change detection of ecosystem structure and function (e.g. Callaghan et al. 2011). While informal qualitative understanding of the vegetation structure has existed for the Wild Basin for some time (Williams 1977, Respes 1987), a formal quantitative assessment of the vegetation structure took place in 2013, with resampling in 2014 and 2015 (Johnson 2015). Within Wild Basin, five distinct vegetation communities were identified. In analyzing the data, we have found that fractional canopy, elevation, slope, litter depth and soil structure best predict plant community structure at Wild Basin. Interestingly, measures of soil moisture have not turned out to be good predictors of structure. From a plant ecological perspective, this represents a paradox. Water is often the most limiting factor for plant growth, particularly in this part of Texas and becomes more important as one moves westward. Thus, the estimates of soil moisture that I have collected should theoretically predict how different combinations of species should grow in different parts of the landscape.

We believe that different types of inter-measurement variability are masking our ability to understand how water availability affects plant growth. Because conditions can change drastically with respect to different years, different time intervals between rain events, different magnitudes of rain events, diurnal differences in soil moisture at single sites, and spatial variability, a comprehensive study of soil moisture is warranted. Additionally, using historic areal photos, we have found that the successional patterns of the Wild Basin landscape have proceeded since the last major disturbance event, the 1961 fire, with some variability across the Wild Basin landscape. Because of this, a more systematic sampling of the

plant community of Wild Basin is warranted, to better estimate plant community structure of Wild Basin in light of our discovery that successional trajectories of communities is also a good predictor of habitat for species of concern such as the Golden Cheeked Warbler. Additionally, by working within the iTree framework for determining community structure, we are able to estimate ecosystem services for Wild Basin.

Our goals this summer were two fold: 1) to perform an extensive soil moisture study to better understand the hydrology of the Wild Basin landscape, and 2) to extend the sampling protocol for plant community structure to the grid-point system established by Belaire and colleagues at Wild Basin (Figure 1), modeling ecosystem services as a function of plant succession patterns since the 1961 fire.



Figure 1. A grid of points across Wild Basin that have been established by Belaire and colleagues for the coordinated study of Wild Basin.

METHODS

Soil Moisture

To determine the water retention capabilities of soils in various secession trajectories at Wild Basin Nature Preserve, five sites were chosen whose vegetation was representative of five major trajectories: new growth forest, new growth covered, new growth exposed, new growth riparian, and old growth forest (Garcia and Johnson, unpublished GIS data). Soil moisture measurements were taken multiple times at each of these sites using a Decagon Devices GS1 and Em5b data recorder. For each measurement, a hole was dug so that it was six inches deep (including leaf litter). The GS1 (attached to the Em5b) was then placed into the hole so that the electrodes were vertically aligned and the top electrode was at least 1.5 inches from the surface. The GS1 was left in the soil for 3 minutes and then removed. Once removed, the electrodes were wiped free of dirt, and the hole was filled back in. Because disruption to the soil could cause variation in water retention abilities, each filled-in hole was marked and subsequent measurements were not taken from the same point. This procedure was then

repeated at varying times after rain events, where rainfall and average temperature were recorded. In order to standardize these data across multiple rain events, hours since rain event (HSRE) was divided by the intensity of the rain event (inches rained). To determine the relationship between the soils' ability to retain moisture and soils' physical composition, we collected soil samples from each of the five soil sample sites referred to above. These samples were then sieved using the Fieldmaster Soil Sampling Sieve Set. This sieve set included the #5 (4000 micron), #10 (2000 micron), #35 (500 micron), #60 (250 micron), #125 (micron), and #230 (63 micron) sieves. For the three largest sieves (#5, #10, and #35) the masses of both leaf litter and rocks retained were recorded separately. At the other three sizes (#60, #125, and #230), the total mass retained was recorded.

Modeling Succession and Ecosystem Services using iTree

This study utilized the iTree Eco modeling program; a software application utilized to quantify forest structures from field data of both complete inventories and randomly located plots at those forests. Carbon uptake of all the trees in the Wild Basin Wilderness Preserve was estimated from this once the field measurements of vegetation characteristics were obtained. These include numbers on total height of the trees present, actual height of their live growth, how much dieback they are experiencing, what percent of their growth profile is missing, and more are all are input into iTree to build the model for the sites in our study. To gather this information, we went to each of the 19 grid points in our study and recorded measurements on all trees located within a 5.7 meter radius. After completing the process of entering in all the vegetation from the sites, we then used this information to then create the model and ran several analyses, including avoided runoff values, carbon sequestered, and carbon storage. These values were then multiplied against community multipliers for open savannah and woodlands. The five trajectories described in soil moisture methods above were grouped to these to categories (Garcia and Johnson, unpublished data) so determine the overall results for the whole preserve.

RESULTS/DISCUSSION



Figure 2. Gross carbon sequestered per year by community

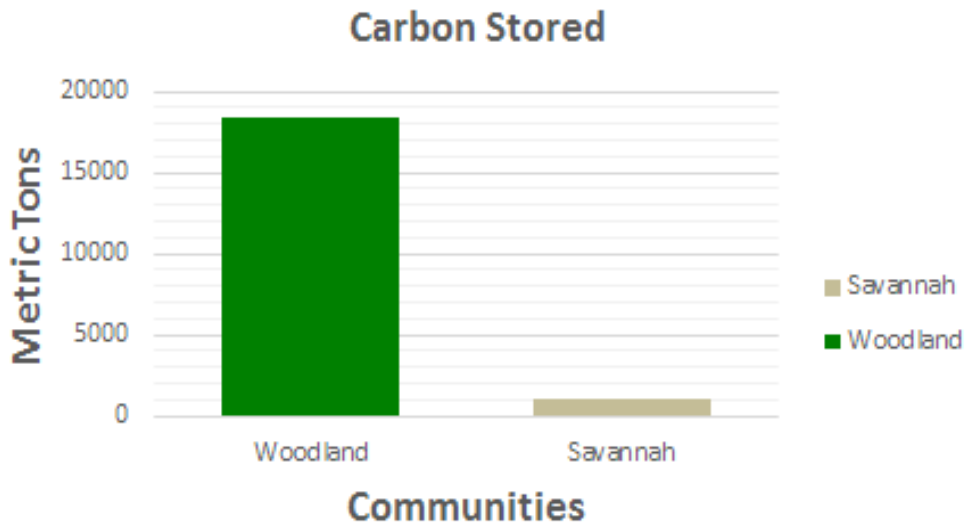


Figure 3 Carbon stored per year by community

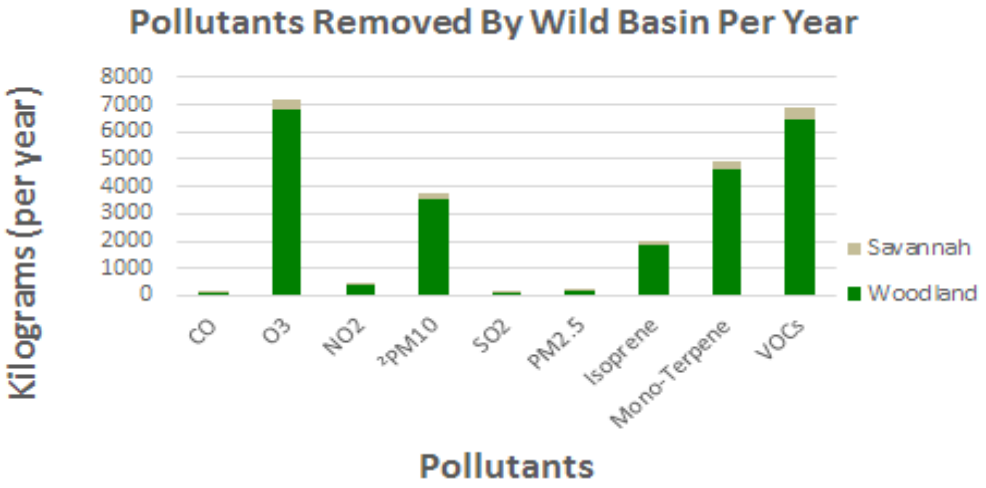


Figure 4 Pollutants removed per year by community

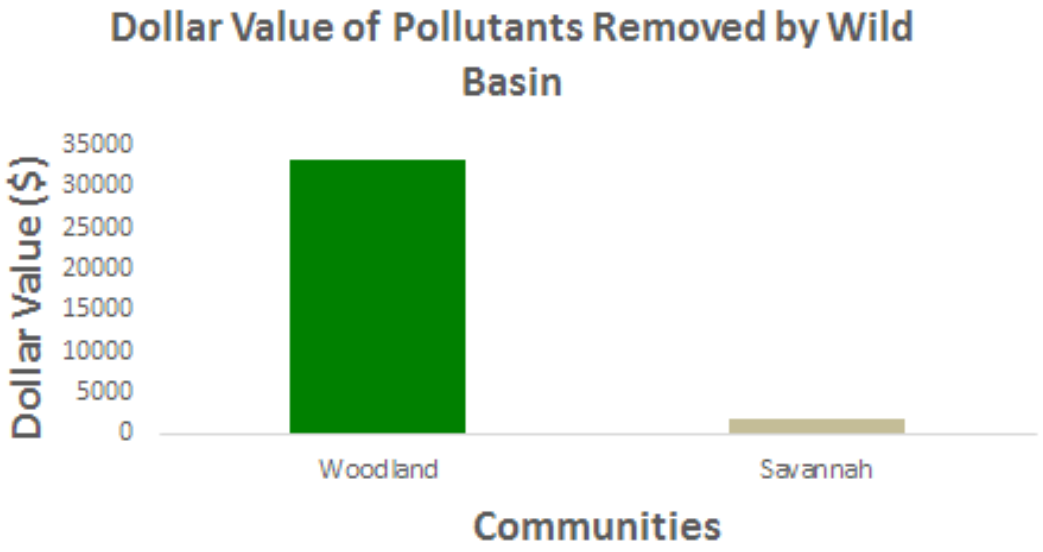


Figure 5 Dollar value of pollutants removed per year by community

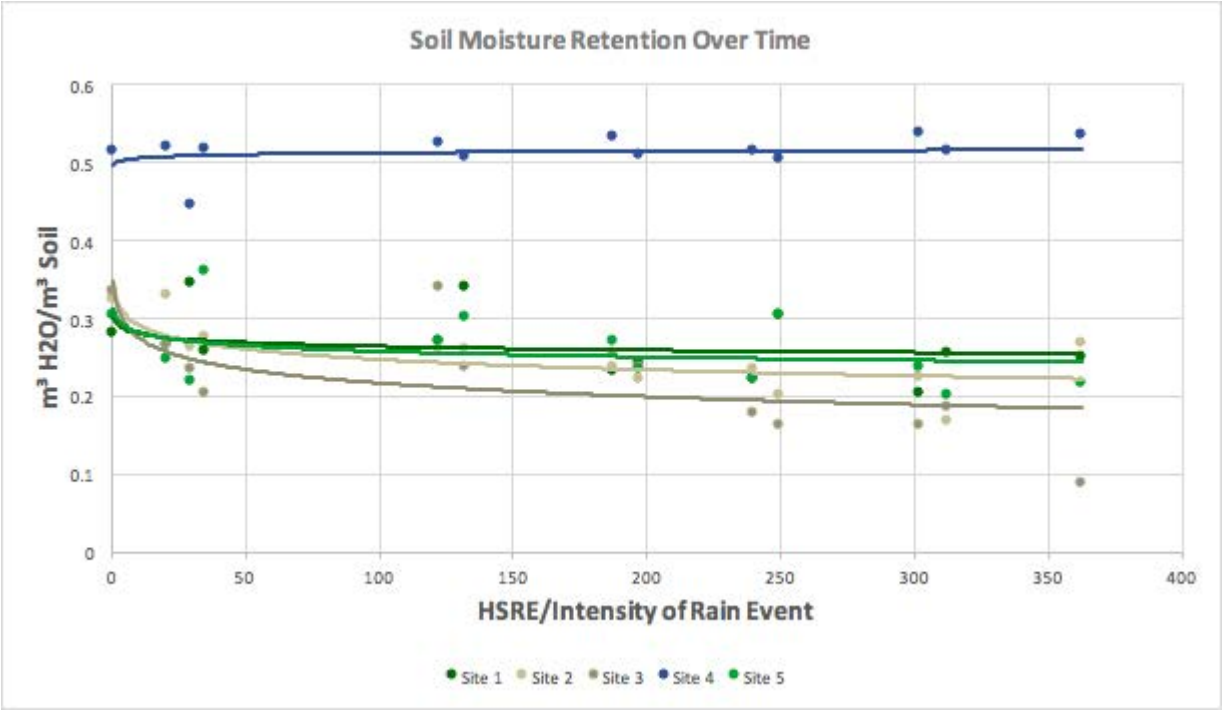


Figure 6 Soil moisture retention over time

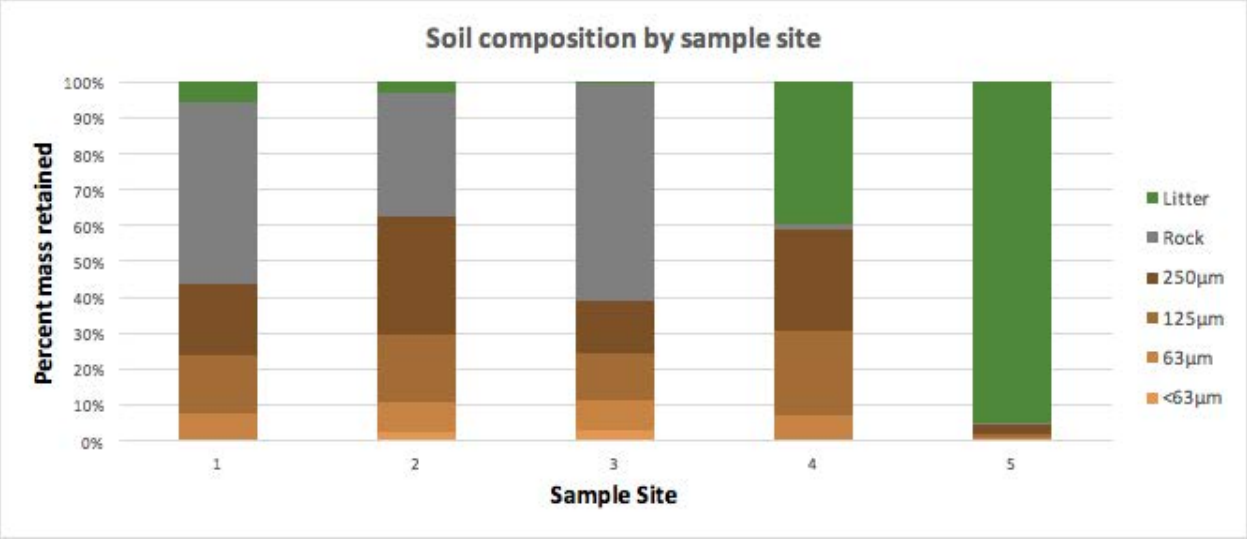


Figure 7 Soil composition by sample site

From the iTree results, we are able to get values for many of the ecosystem services that Wild Basin provides for the Austin community. Wild Basin has the capability to sequester 539.56 metric tons of carbon per year, as well as storing 19,503,596.76 kilograms of carbon per year (Figure 2, 3). It is also apparent that the community type also plays a large role in the ability to provide those services. What we call the woodland community (high Ashe juniper cover) is much more capable of both storing and sequestering carbon, which makes sense as there are more trees available to conduct photosynthesis and take carbon out of the atmosphere.

We are also able to see how much of certain pollutants Wild Basin has the capacity to remove (Figure 4). Overall, Wild Basin has the potential to remove 25,536,755.51 grams of pollutants (including 0_3 and NO_2) in a year. Dollar values were also calculated for the potential amount of pollutants that Wild Basin can remove, and saves the city of Austin that much money in doing so (Figure 5). Overall, Wild Basin can save the city $35,051.96 per year with its pollution removal capabilities. We also notice again the clear trend that the woodland community is much more effective at providing ecosystem services, as it just has much more vegetation at its disposal. One caveat with this analysis is that we didn't actually measure removal of pollutants. The specific degree to which ecosystems do this depends on the degree of pollutants in the environment. These estimates represent the capacity to do so, should conditions be such that this physiologically occurs. Also, our study did not take into account what was consider shrubs, or woody vegetation that was not greater than 2.54 centimeters at breast height. Leaving these measurements out no doubt greatly affects any values we received from i-Tree on pollution removal estimates and the like.

Based on our results for soil moisture retention, we conclude that a soil's ability to retain moisture is characteristic of the community in which it is found. This can be seen in Figure 6, where sites 2 and 3, which we classified as Juniper-Oak Savannah, both show less of an ability to retain moisture over time. In both of these sites, we also observed relatively high amounts of rock, relative to leaf litter (Figure 7). In contrast, sites 1, 4, and 5, all of which were classified as Juniper-Oak Woodland, show relatively

higher moisture retention values (Figure 6). For the most part, these three sites also showed a higher proportion of litter to rock when samples were taken (Figure 7). Site 4, a riparian site, showed the highest moisture retention value, which even appeared to increase as time progressed after the rain event. We have concluded that this occurred because site 4 was our lowest elevation site, and as water from the other areas of the preserve drained down-hill after each rain event, it collected in site 4.

From these data we can conclude that there is a relationship between the amount of organic matter in a soil, and its ability to retain moisture over time, a conclusion that has been shown previously to be true (Rawls 2003; Gupta et. al 1979; Saxton et al, 2006).

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