Pre and post fire carbon dynamics in a Florida scrub oak

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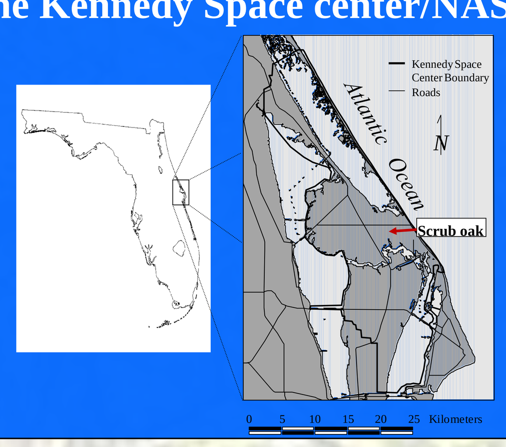
Aug. 2010.

Introduction

Scrub oak is a xeromorphic shrub ecosystem discontinuously distributed in costal and inland Florida (Fig 1). Its structural features are maintained by fire return cycle of 7 to 10 years which maintain biodiversity and cope with the recovery plans of several threatened species; additionally, Florida's subtropical climate is highly variable. It ranges from mild winters, hot dry springs and wet summers on the seasonal basis; annually it fluctuates from very wet to very drought years. However, is the scrub oak a carbon sink under the current prescribed burnt management strategy and climatic variability? The purpose of this research was to follow the carbon dynamics before and after a prescribed fire in a Florida's scrub oak ecosystem, which was also expose to extreme climatic conditions.

Study sites:

Figure 1. Scrub oak location inside the Kennedy Space center/NASA



Selected sites were two coastal scrub oak sites, located inside the Merritt Island National Wild Life Refuge, KSC/NASA, Florida.

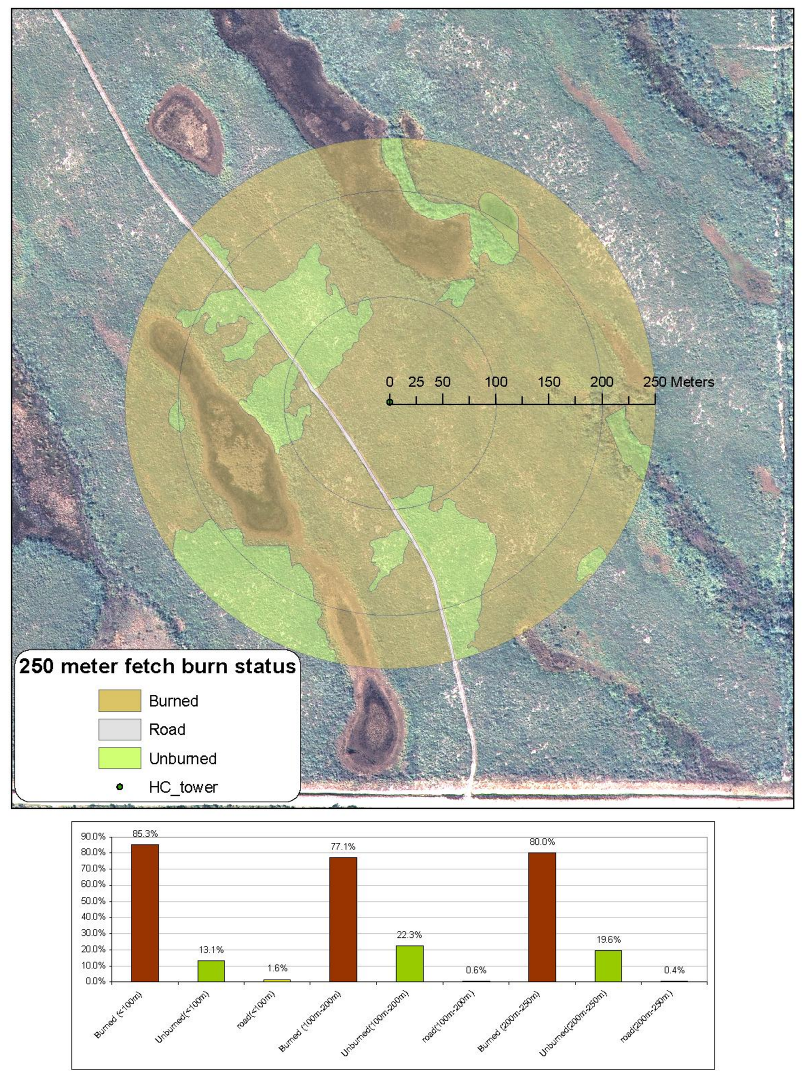
Happy creek (HC)

CO_2 research site

Carbon exchange was measured simultaneously at the two scrub oak sites (HC & CO_2 site), using the eddy covariance approach. Measurements were taken two years before fire (2004 – Feb 2006), and after fire through Nov 2007.

Dominant species: ***Quercus myrtifolia, Q. geminata, Q. chapmanii, and Serenoa repens.***

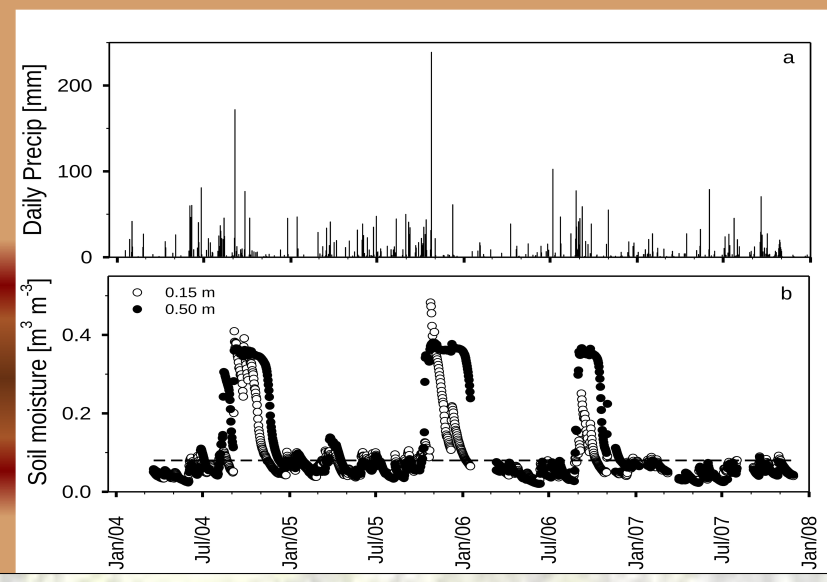
Mean canopy ht = 1.5 m



Happy creek (HC) was control burned in February 2006. More than 80% of the 250 m fetch was burnt during the controlled fire.

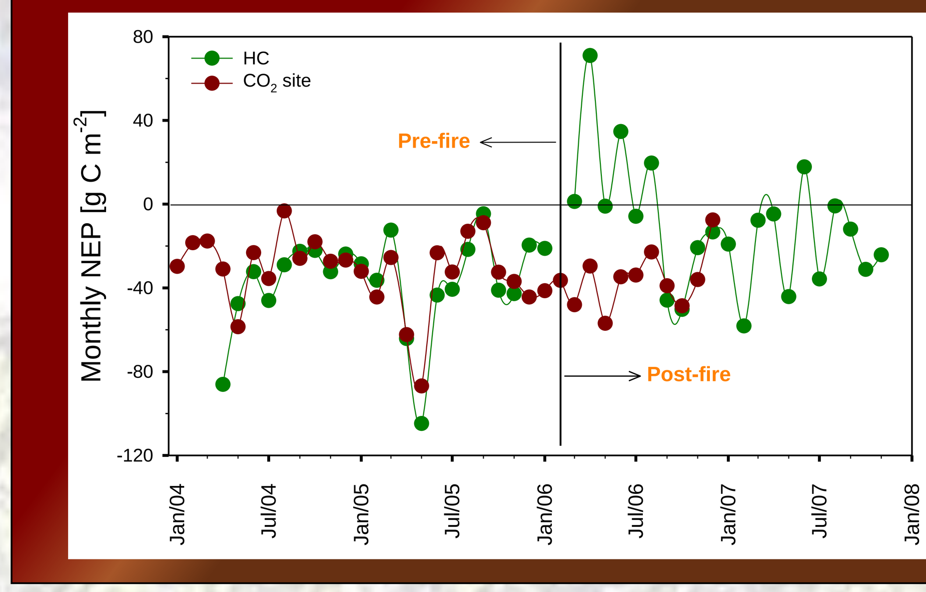
Results: (note: -NEP = C gain by the ecosystem.)

Figure 2. Daily precipitation & soil moisture from Jan 04 to Dec 07 at HC. Dashed line is the field capacity at 0.08 $m^3\ m^{-3}$



Mean annual precipitation (P) equals1340 mm. Precipitation was seasonal (Fig 2a). Annual P was at average before fire (1334mm and 1505mm in 2004 & 2005, respectively). However, drought conditions prevailed after fire with a deficit in precipitation of 371 and 447 mm for 2006 and 2007, respectively. Soil moisture followed precipitation patterns (Fig 2b). Soils were below the field capacity from March to the end of August 06 and most of 07.

Figure 4. Monthly NEP for HC before and after fire, and for the CO_2 site from Jan 2004 to Dec 2006.



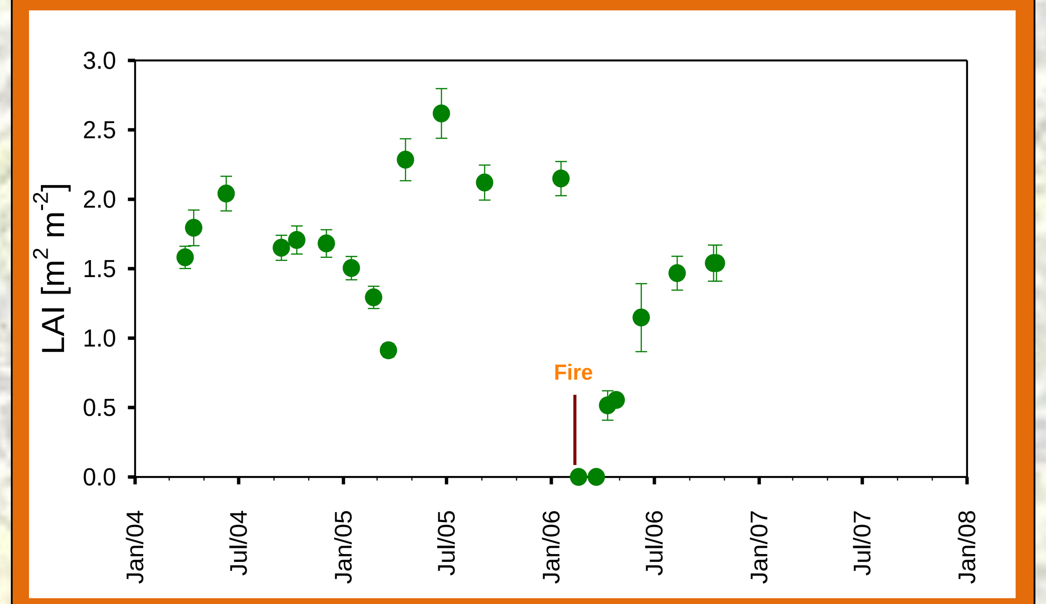
Seasonal NEP was similar at both sites before fire, with maximum C uptake during the spring (Fig 4). NEP was reduced at the CO_2 site during the spring 2006, probably due to the water deficit. **Fire released 316 g C m^{-2} at HC (table 1)**, and extra 119 g C m^{-2} were released through August however, HC became a carbon sink similar in magnitude to the CO_2 site by September and remained as a carbon sink through the end of the measurements.

Table1.Carbon content (g Cm^{-2}) in aboveground biomass during pre and post fire conditions, and carbon release during the fire at HC.

	Standing biomass	Forest floor	Total
Pre fire	750.7	380.6	1131.3
Post fire	198.9	616.4	815.3
C release			316.0

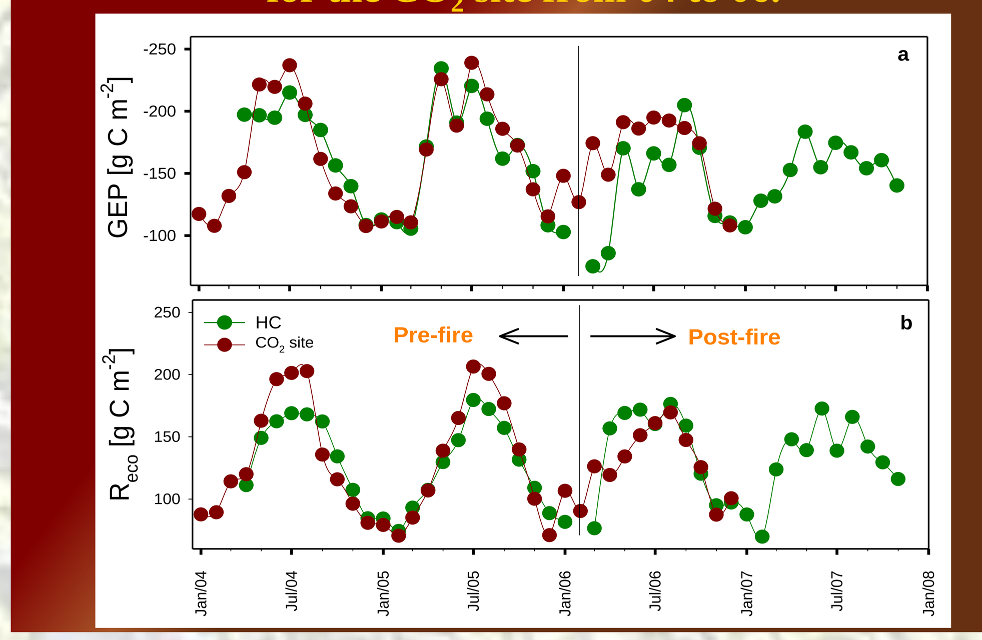
Fire released close to 74% of the carbon content in standing biomass (table 1). The amount of carbon released by this fire event was similar to annual NEP either at HC or at the CO_2 site (table 2).

Figure 3. Seasonal trend of leaf area index (LAI) at HC before and after the fire.



Leaf area index (LAI) was seasonal with maximum values from the end of the spring to fall. Values > 2.5 m^2 m^{-2} were recorded in 2005. LAI recovered quickly after fire and by October reached similar values as in 2004 before the fire.

Figure 5. Monthly gross ecosystem production (GEP) and respiration (R_{eco}) for HC before and after fire, and for the CO_2 site from 04 to 06.



Monthly GEP was similar at both sites before fire (Fig. 5a). GEP was reduced by 60% in Mar 06 due to reductions in LAI during fire, as compared to the CO_2 site however, annual GEP was reduced only 23%. Monthly GEP recovered six months after the fire. Monthly R_{eco} was lower at HC in pre-fire conditions but higher after fire due to increases in soil temperature. R_{eco} drive net carbon exchange during the fire year.

Table 2. Annual NEP (g C m^{-2} yr^{-1}) for each site and year (January – December). NPP_A = above ground net primary production at HC.

Year	CO_2 site	Happy creek	NPP_A
2004	-316	-342	
2005	-443	-460	193
2006	-435	+284	
2007		-240	

Annual NEP was similar at both sites for two years during pre-fire conditions (table 2) . HC was a carbon source during the fire year, it was a carbon sink in similar magnitude as the source during the following year, offsetting the carbon released during the fire and the following months after it, in despite of the severe drought conditions, which certainly may have limited the recovery.

Conclusions:

- Scrub oak is a net carbon sink in the landscape under the current managements strategies and climatic conditions.
- Carbon released during the fire year at the scrub oak ecosystem is offset during the following year even during extreme climatic conditions like severe droughts.
- Aggrading leaf area index is the driver in ecosystem recovery.