Major Discoveries from the Carbon Study at MOFEP Compartments

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The primary objective of the study was to quantify differences in carbon (C) flux and storage in the mixed oak forests in SE Missouri Ozarks as a function of alternative management, landscape form, and climate. The MOFEP compartments provided the basis for predicting net C exchanges (NCE, equivalent to net ecosystem productivity) at multiple temporal scales (monthly to 100 years). These predictions were extended to a spatial context NCE and C storage using processed Landsat imagery, along with ecological land type phases (ELTP) and digital elevation model (DEM) databases. The major discoveries include:

1) C storages were 182, 170, and 130 Mg C ha^{-1} for the non-harvest (NHM), singletree uneven-age cut (UAM), and clear-cut even-age (EAM) stands, respectively. The proportion of mean C pools were 29% in living tree biomass, 35% in the soil, 22% in woody detritus, 10% in roots, and 4% in forest floor.
2) Harvesting did not affect the species composition, forest floor, and roots, but significantly ($p= 0.05$) changed tree stand density, mineral soil, living tree C, and coarse woody debris (CWD). The harvesting reduced carbon storage in living tree (31% in UAM, 93% in EAM), but harvesting also increased CDW C pools by 50% (UAM), and 176% (EAM). UAM significantly increased mineral C pool by 13%, while EAM only slightly increased (1%) soil C.
3) Landsat images estimated 8.7 million metric tons of aboveground biomass for the studied landscape with an average of 126 Mg C ha^{-1} ranging from 1 to 460 Mg C ha^{-1}.
4) Forty-two percent of the biomass was distributed in elevations 250-300 m, 52% in areas with slopes<10 degrees, and 30% in southeast facing slope. The highest mean biomass (143 Mg C ha^{-1}) with the lowest standard deviation (SD 16 Mg C ha^{-1}) was obtained for the NHM, while smaller means and higher SD were obtained for EAM and UAM forests. No statistical difference was detected among the biomass means of the 3 major ELT types (11, 17, and 18).
5) Soil respiration (SR) rate had an average of 4.14 μmol m^{-2} s^{-2} at MOFEP, which is the major C sources in the ecosystem, and significantly differed by stands and by management ($F=43.23$, $P=0.0012$; $F=10.21$, $P=0.0026$, respectively).
6) The two types of harvesting (UAM and EAM) had different effects on SR, which was not significantly different from the EAM and NHM, but was elevated in the UAM.
7) SR rate was also significantly different by ELTP: mean SR rate at UAM increased compared to NHM in protected ultic back-slopes, protected alfic back-slopes, and alfic bench or shoulder-ridge and decreased in exposed ultic back-slopes and exposed alfic back-slopes.
8) The mass of litter lost after 32 months ranged from 61% in oak litter to 71% in oak-hickory mixed litter. Mass lost of all the litter was not significantly affected by UAM ($P=0.053$), while the litter types were significantly affected decomposition except at 19 months ($P<0.001$). During the 32 months of litter decay, the mass loss of oak-hickory mixed litter was significantly higher (6.6% and 6.8%) than that of oak litter ($P<0.001$) and oak-pine mixed litter ($P<0.003$), respectively.
9) The major tree species (white oak, black oak, scarlet oak, hickory and short leaf pine) was measured at three different age classes, young (<10 years), intermediate (15-25 years), and mature (>80 years) and three canopy levels (upper, middle, and lower). The average photosynthetic rate among all the species at control condition (i.e. 1500 PAR, and 360 μmol/mol ambient CO_2 concentration) was 7.97 and 8.23 μmol m^{-2} s^{-2} for Aci curve and light response curve, respectively.
10) The average maximum photosynthetic rate among all the species was 19.7 (CO_2 response) and 8.46 (light response) μmol m^{-2} s^{-2}. The upper canopy positions typically experienced greater photosynthetic capability compared to the lower canopy positions ($p<0.0001$ to 0.0125). Specific leaf weight was the best predictor of photosynthetic rate among the factors (i.e. SPAD chlorophyll concentration, vapor pressure deficit, temperature, and fraction of PAR intercepted).