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Restocking soil carbon: Soil organic matter fractions in restored sand and gravel pits

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It is increasingly recognized that not all soil organic carbon (SOC) is created, or more importantly, stored equally, with different size-fractions affecting nutrient cycling, soil stability, and long-term organic matter turnover. While SOC storage has been studied in many natural soil systems and extensively in agricultural soils, these dynamics have been largely overlooked in other managed ecosystems. This study presents SOC storage in abandoned sand and gravel pits restored to functioning grasslands in temperate southern Ontario, Canada, to investigate whether ecosystem restoration practices are effective at creating typical SOC partitioning. Composite soil samples were collected from five restored sand and quarry pits varying in time since restoration (4 to 19 years) and parent material (sand, till, gravel), plus an unrestored gravel pit abandoned for at least 30 years. At each site, soils were collected at 0-5 and 5-10 cm depths, with some sites containing 10-15-and 15-20-cm depth fractions. Soils were separated using standard sonification and wet sieving methods into free-particulate organic matter (fPOM), occluded POM (oPOM), coarse silt, and mineral associated-OM (MAOM) fractions and analyzed in triplicate for carbon and nitrogen percentages, and 13-C and 15-N isotopic ratios. Four of the five restored sites were very coarse, with 86-97 % sand or coarser material. In contrast, the fifth restored and the unrestored site contained 74 to 84 % coarse material. Bulk soil C ranged between 0.5 and 5 % and soil N between 0.04 and 0.6 % across the study sites and depths. The fPOM fractions contained the most C and N proportionally (~40 and 2.5 %, respectively), and surprisingly, the oPOM fraction consistently contained the greatest mass of OC and N. There were wide ranges in 13-C and 15-N signatures between sites, depths, and fractions, with no clear trends in time since restoration or mineral size fractions. These results suggest a great range in SOC storage and turnover between ecosystem restoration projects, which may make generalizations of restoration as a means to increase the terrestrial carbon pool difficult.