CARBON STORAGE AND TURNOVER IN *SPHAGNUM* PEAT: POTENTIAL RESPONSES TO A GLOBALLY CHANGING CLIMATE

R. K. WIEDER, S. T. STARR, C. J. WILLIAMS

Department of Biology, Villanova University, Villanova, PA 19085, U.S.A.

Boreal and subarctic peatlands in the northern hemisphere are a major source of atmospheric CH_4, yet since the most recent deglaciation have been a major sink for atmospheric CO_2. An estimated 1/3 of the world's soil carbon currently is stored as peat. Conceptually, peat accumulates when net primary production at the surface exceeds organic matter decomposition throughout a peat column over long periods of time. Global climate models are in general agreement that projected climate changes will be greatest in the boreal zone of the northern hemisphere. Both production and decomposition are affected by climatic variables, notably temperature and moisture. Although carbon balance in boreal and subarctic peatlands is likely to respond to changing climate, the expected magnitude and direction of the responses are uncertain. If production is stimulated more so than decomposition, peatlands will become an increasingly greater sink for atmospheric carbon. However, if decomposition is stimulated more so than production, peatlands may become a source of atmospheric carbon, representing a positive feedback on climate change. To gain insight into potential responses of peatlands to climate change, we have characterized rates of organic matter accumulation in peat at boreal and temperate zone sites representing a latitudinal gradient across North America that differ considerably with respect to climate.

Based on ^{210}Pb dating of peat, net rates of organic matter accumulation in peatlands over the past 50–100 years have been remarkably similar across widely differing climatic regimes. However, a canonical discriminant analysis clearly separates sites based on the organic matter quality of the peat (relative abundance of soluble fats, oils, waxes; soluble carbohydrates; soluble phenolics; holocellulose; α-cellulose, hemicellulose; acid-soluble carbohydrates; concentrations of N, P, and S). Statistically significant differences among sites with regard to organic matter quality suggest differences in susceptibility to decomposition. Hence, future carbon balance in peat will be affected not only by projected climate change, but also by these site-specific differences in organic matter quality.

To more directly evaluate carbon turnover in peatlands, we exposed vegetation in the field to $^{14}CO_2$ in a single day's pulse labeling at three sites: Big Run Bog, West Virginia (39 07'N, 79 35'W; mean annual temperature 7.9 °C), Bog Lake Bog, MN (47 32'N, 93 28'W; mean annual temperature 4.0 °C), and Wetland 307 of the Experimental Lakes Area in western Ontario (49 41'N, 93 40'W; mean annual temperature 2.1 °C). At 3, 12, and 24 months after labeling, only 30 %, 30 %, and 1 %, respectively, of the original label was recovered in aboveground vegetation (vascular and nonvascular plants) at Big Run Bog, versus 55 %, 42 %, and 7 %, respectively, at Bog Lake Bog and 71 %, 40 % and 33 %, respectively, at Wetland 307. Thus, turnover of photosynthetically fixed carbon is fastest at our southernmost, warmest site, and slowest at our northernmost, coolest site. In general, net primary production increases with decreasing latitude. At boreal sites, net primary production may be as low as 150 g (dry mass) m^{-2} yr^{-1}, while at Big Run Bog, net primary production has been measured as 1045 g (dry mass) m^{-2} yr^{-1}. The comparatively high rates of net primary production at Bog Run Bog do not result in relatively high rates of organic matter accumulation (based on ^{210}Pb dating), because of the exceptionally rapid turnover of photosynthetically fixed carbon at Big Run Bog (based on ^{14}C labeling) that returns carbon to the atmosphere. Comparisons of present day carbon balance in peatlands located in different climate regimes, assessed by traditional approaches in combination with the application of ^{210}Pb dating, characterization of organic matter quality of peat, and field labeling of vegetation with ^{14}C, can provide insights into potential future responses of carbon balance in peatlands to changing climate.