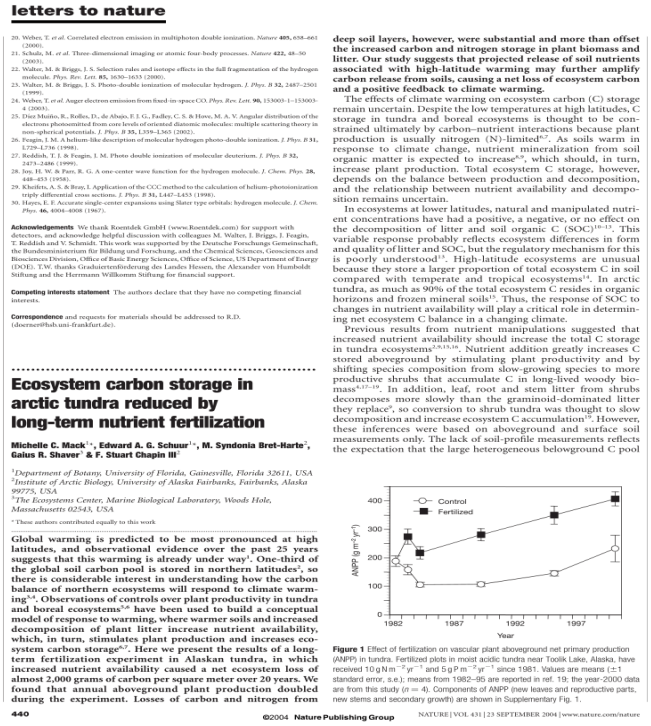
Tundra Ecosystems: A Comparative Analysis



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Ecosystem carbon storage in arctic tundra reduced by long-term nutrient fertilization

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Global warming is predicted to be most pronounced at high latitudes, and observational evidence over the past 25 years suggests that this warming is already under way[1]. One-third of the global soil carbon pool is stored in northern latitudes[2], so there is considerable interest in understanding how the carbon balance of northern ecosystems will respond to climate warming[3,4]. Observations of controls over plant productivity in tundra and boreal ecosystems[5,6] have been used to build a conceptual model of response to warming, where warmer soils and increased decomposition of plant litter increase nutrient availability, which, in turn, stimulates plant production and increases ecosystem carbon storage[6,7]. Here we present the results of a long-term fertilization experiment in Alaskan tundra, in which increased nutrient availability caused a net ecosystem loss of almost 2,000 grams of carbon per square meter over 20 years. We found that annual aboveground plant production doubled during the experiment. Losses of carbon and nitrogen from deep soil layers, however, were substantial and more than offset the increased carbon and nitrogen storage in plant biomass and litter. Our study suggests that projected release of soil nutrients associated with high-latitude warming may further amplify carbon release from soils, causing a net loss of ecosystem carbon and a positive feedback to climate warming.

The effects of climate warming on ecosystem carbon (C) storage remain uncertain. Despite the low temperatures at high latitudes, C storage in tundra and boreal ecosystems is thought to be constrained ultimately by carbon–nutrient interactions because plant production is usually nitrogen (N)-limited[6,7]. As soils warm in response to climate change, nutrient mineralization from soil organic matter is expected to increase[8,9], which should, in turn, increase plant production. Total ecosystem C storage, however, depends on the balance between production and decomposition, and the relationship between nutrient availability and decomposition remains uncertain.

In ecosystems at lower latitudes, natural and manipulated nutrient concentrations have had a positive, a negative, or no effect on the decomposition of litter and soil organic C (SOC)[10–13]. This variable response probably reflects ecosystem differences in form and quality of litter and SOC, but the regulatory mechanism for this is poorly understood[13]. High-latitude ecosystems are unusual because they store a larger proportion of total ecosystem C in soil compared with temperate and tropical ecosystems[14]. In arctic tundra, as much as 90% of the total ecosystem C resides in organic horizons and frozen mineral soils[15]. Thus, the response of SOC to changes in nutrient availability will play a critical role in determining net ecosystem C balance in a changing climate.

Previous results from nutrient manipulations suggested that increased nutrient availability should increase the total C storage in tundra ecosystems[5,9,13,16]. Nutrient addition greatly increases C stored aboveground by stimulating plant productivity and by shifting species composition from slow-growing species to more productive shrubs that accumulate C in long-lived woody biomass[9,17–19]. In addition, leaf, root and stem litter from shrubs decomposes more slowly than the graminoid-dominated litter they replace[9], so conversion to shrub tundra was thought to slow decomposition and increase ecosystem C accumulation[16]. However, these inferences were based on aboveground and surface soil measurements only. The lack of soil-profile measurements reflects the expectation that the large heterogeneous belowground C pool

Figure 1 Effect of fertilization on vascular plant aboveground net primary production (ANPP) in tundra. Fertilized plots in moist acidic tundra near Toolik Lake, Alaska, have received 10 g N m^{-2} yr^{-1} and 5 g P m^{-2} yr^{-1} since 1981. Values are means (±1 standard error, s.e.); means from 1982–95 are reported in ref. 19; the year-2000 data are from this study ($n = 4$). Components of ANPP (new leaves and reproductive parts, new stems and secondary growth) are shown in Supplementary Fig. 1.

This book contains papers resulting from the International Biological Programme studies on the tundra biome and is organized in the following sections: tundra.Product details. Date Published: June ; format: Hardback; isbn: ; length: pages. dimensions: x x 10 mm; weight: kg.Tundra ecosystems: a comparative analysis / edited by L. C. Bliss, O. W. Heal, J. J. Moore. Subjects: Tundra ecology. Physical Description: xxxvi, p.16 Feb - 21 sec - Uploaded by S. Gerica Download Tundra Ecosystems A Comparative Analysis International Biological Programme.Tundra ecosystems: a comparative analysis. Translate with. google-logo. translator. This translation tool is powered by Google. FAO is not responsible for the.Available in the National Library of Australia collection. Format: Book; xxxvi, p.: ill. ; 24 cm.Tundra ecosystems: a comparative analysis (International Biological Programme) at c-homesport.com - ISBN - ISBN c-homesport.com: Tundra Ecosystems: A Comparative Analysis (International Biological Programme Synthesis Series) () and a great selection of.Tundra Ecosystems: A Comparative Analysis and a great selection of similar Used, New and Collectible Books available now at c-homesport.comChanges in arctic and alpine ecosystems affect resources for local . Tundra ecosystems: A comparative analysis, (International.The alpine and polar climatic limit for growth of woody plants is very much dependent on the mean temperatures of the warmest three or four summer months.The tundra biome is the youngest on the planet, having developed its current structure and Tundra ecosystems: A comparative analysis.The Coastal Tundra at Barrow, Alaska. Jerry Brown, Philip C. Miller, Larry L. Tieszen, Fred L. Bunnell. Tundra Ecosystems: A Comparative Analysis. L. C. Bliss.Tundra Ecosystems: A Comparative Analysis (L.C. Bliss, O.W. Heal and. J.J. Moore, Eds.), Cambridge: Cambridge University Press. (Price: $)