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Soil Decomposition Processes Affect Forage Quality in a Grazing System for Geese

Plant communities of the coastal Yukon-Kuskokwim Delta in western Alaska are susceptible to increased frequency of storm-driven floods with increasing storm energy and rising sea levels. Changes in quality and availability of forage plants would alter the annual productivity and recruitment of more than 400,000 geese. Fundamental to an understanding of nutrient fluxes through this grazing food web is information regarding the dynamics of soil decomposition processes by soil microbes. This study concentrates on four communities dominated by the graminoids *Puccinellia phryganodes*, *Carex subspathacea*, *C. mackenziei*, and *Triglochin palustris*, all of which are important forage species for geese.

Soil Cores Were Incubated in the Laboratory

We sampled soils from the four plant communities at three positions across a 30-km coastal-to-inland transect in preparation for experimental manipulation of floodwater salinities. Plant samples were collected immediately adjacent to soil core sample points. Soils were incubated at 15°C for 30 days in the laboratory to determine rates of nitrogen mineralization (nitrogen available for uptake by plants) and bulk soil respiration (a measure of microbial activity.) Available nitrogen (as NH_4 and NO_3 ions) was extracted from subsamples before and after incubation using 2M KCl. Extracts were analyzed on a continuous flow Lachat Autoanalyzer. Respiration was measured as rates of CO_2 evolution across 10 day intervals. Carbon dioxide concentration was determined using a Shimadzu gas chromatograph. Percent forage nitrogen was measured by standard micro-Kjeldahl methods. The full factorial model (plant community, landscape position, and sample depth) was analyzed by ANOVA.

Soil Respiration and Nitrogen Mineralization Varied Significantly

Soil water content seems to be an important determinant of respiration rates, but saline soils have reduced activity even with high water content (Figure). Soil respiration rates were significantly influenced by plant community type ($P < 0.0001$), landscape position ($P = 0.0002$), and sample depth ($P < 0.0001$), with significant two-way interaction of factors. Soil water content, oxidation-reduction potential, and pH were also highly variable between communities and landscapes, but only soil water content was found to significantly correlate with soil respiration rates. When water content was entered into the model as a covariate, significant variation in respiration was only attributed to soil depth ($P < 0.0001$), and the depth interactions with community type ($P = 0.0114$) and landscape position ($P = 0.0062$). Soil water salinity was negatively correlated with soil respiration rate ($r = -0.3241$, $P = 0.0235$).

Nitrogen mineralization rates also varied significantly for all factors and their two-way interactions. Mineralization was correlated with soil moisture ($r = 0.4841$, $P = 0.0005$) and soil respiration ($r = 0.5862$, $P < 0.0001$), and showed a weak negative correlation with soil salinity ($r = -0.2521$, $P = 0.0973$). Microbial immobilization of nitrogen was common under *Carex subspathacea* communities (Figure).

Forage Quality Showed Landscape and Species-Specific Differences

Nitrogen content in forage tended to increase from coast to inland for *Puccinellia phryganodes* and decrease for *Carex*

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subspathacea, while the other two species showed a rather flat response (Figure). Forage nitrogen was not correlated with soil respiration and mineralization rates. Responses of soil and plant nutrient processes to simulated storm surge flooding will provide information valuable in assessing potential ecosystem effects of rising sea level.

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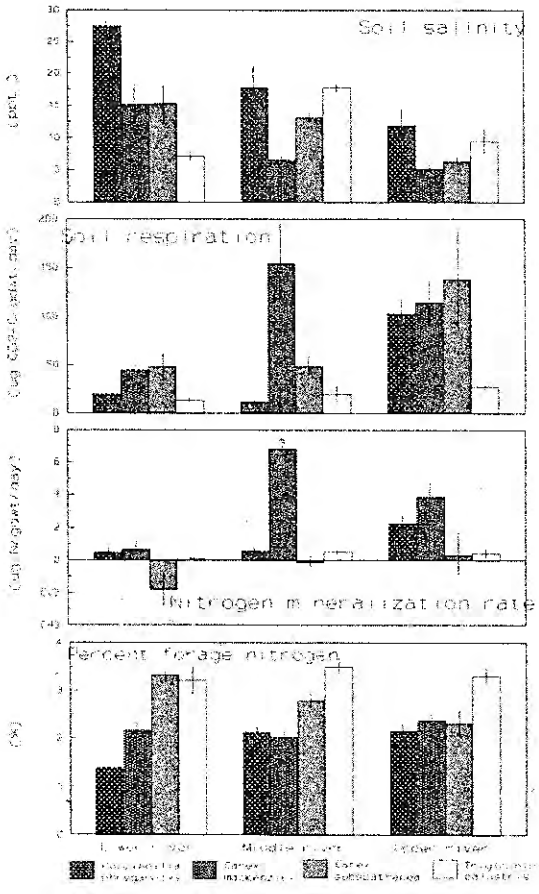

Figure. Plant community and landscape level variation in soil salinity, respiration rate, nitrogen mineralization rate, and forage nitrogen (n = 8 in each column).