Ecosystem Properties along a Latitudinal Gradient of the Yamal Region, Russia

Howard E. Epstein[1], Donald A. Walker, Patrick Kuss, Elina Kaarlejävi, George Matyshak

[1]Department of Environmental Sciences, University of Virginia, Charlottesville, VA 22904-4123

INTRODUCTION

An understanding of land-atmosphere and biogeochemical cycling in any system is predicated by knowledge of the spatial distribution of vegetation and soil properties, and the capacity for elements to move among the various system components, including plants, soils, and atmosphere. In many regions of the Siberian arctic tundra, this baseline information on vegetation and soils in a spatial context does not exist in any systematic fashion. As part of a U.S. NASA/NEESPI Land Cover Land Use Change project, we analyzed in detail the vegetation and soil properties of three tundra locations along a latitudinal gradient in forest-tundra and arctic tundra in the Yamal Region of Siberia east of the Ural Mountains.

METHODS

Our locations were situated near Nadym (65° 18′ N), Laborovaya (67° 41′ N), and Bovanenkova (Vaskiny Dachi – 70° 17′). At a minimum of two sites per location, using 50m x 50m grids, we systematically sampled leaf area index (LAI), Normalized Difference Vegetation Index (NDVI), species composition, vegetation biomass, foliar nutrient concentrations, and soil characteristics.

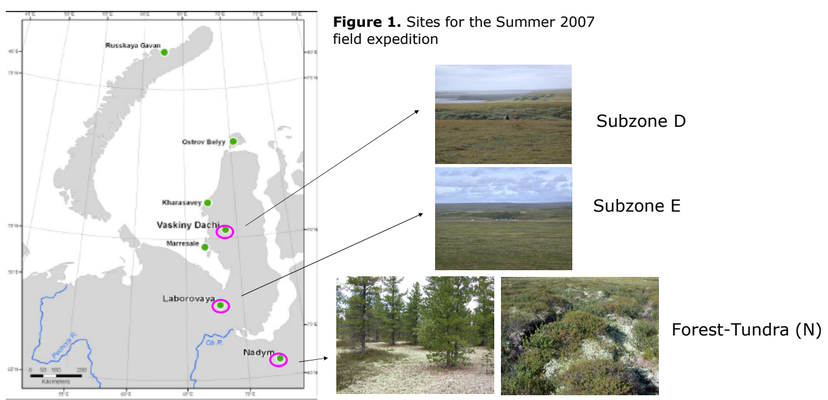


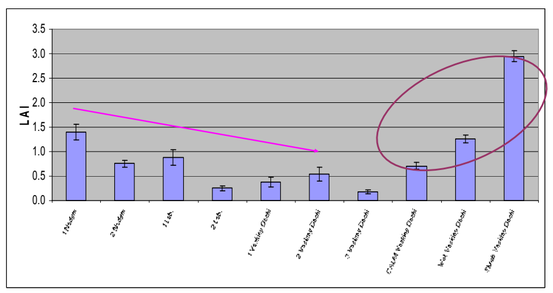
Figure 1. Sites for the Summer 2007 field expedition

Subzone D

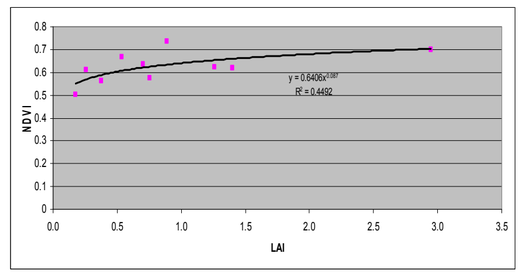
Subzone E

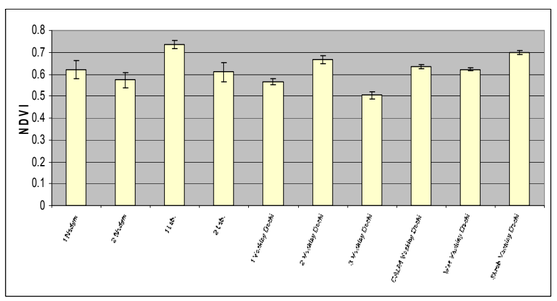
Forest-Tundra (N)

RESULTS – Vegetation Indices

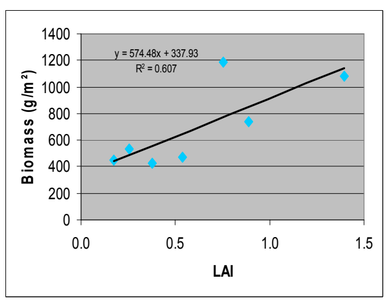


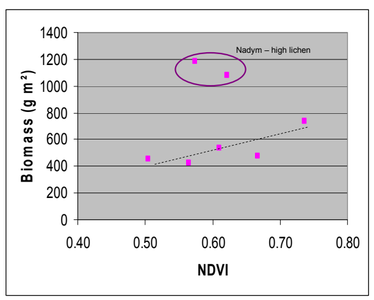
LAI declines with latitude; high spatial heterogeneity



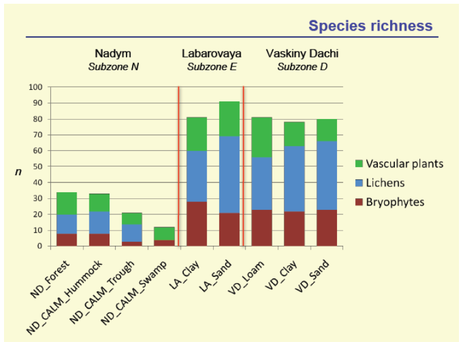


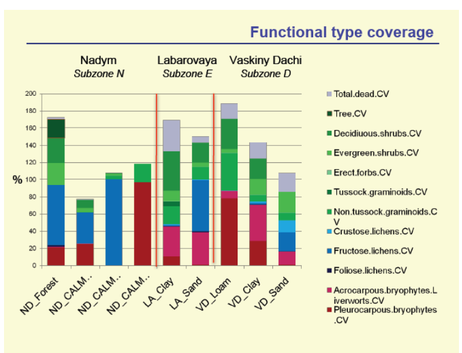
NDVI relatively constant with latitude; minimal spatial heterogeneity

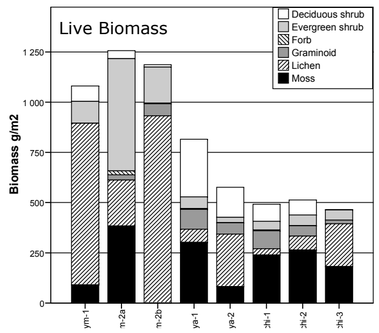


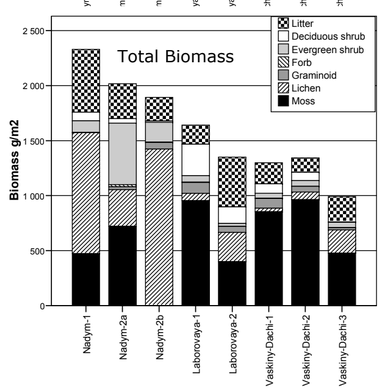


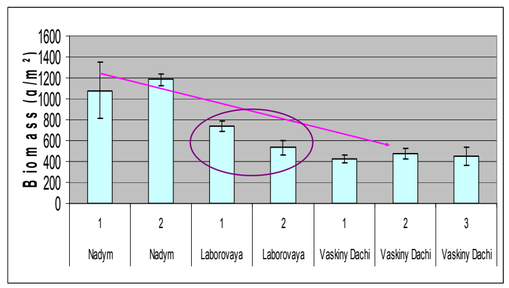
RESULTS – Plant Community Composition and Biomass



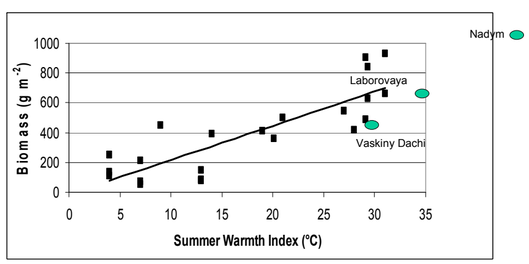






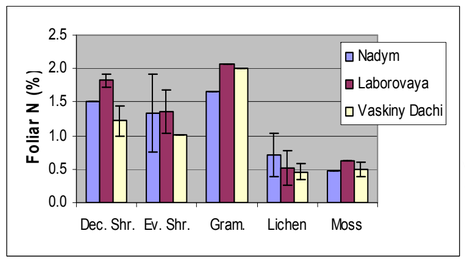


Biomass declines with latitude; high spatial heterogeneity



Yamal sites have greater Summer Warmth Index and lower biomass than comparable North American sites.

RESULTS – Plant and Soil Nutrients



	%Sand	%Clay	%C	%N
Nadym-Forest	48.8	10.88	3.39	0.09
Nadym-Tundra	90.4	2.80	0.56	0.01
Laborovaya-Loam	18.0	22.68	1.72	0.06
Laborovaya-Sand	93.6	2.80	0.59	0.01
Vaskiny Dachi - Loam	33.3	8.52	1.83	0.06
Vaskiny Dachi - Sand	92.8	2.56	1.31	0.04

CONCLUSIONS

Vegetation biomass declined with latitude, whereas species richness increased between Nadym and the two more northern tundra sites. The LAI of vascular plants declined from an average of 1.08 m^2 m^{-2} at Nadym to 0.36 at Vaskiny Dachi along the 5° latitudinal transect. Average NDVI values of the tundra vegetation did not decline with latitude and were 0.60 for Nadym, 0.67 for Laborovaya and 0.58 for Vaskiny Dachi. This is likely due to the contribution of non-vascular, understory vegetation to the NDVI signal. Related, average foliar nitrogen concentrations were greatest at Laborovaya, the site with the highest NDVI. Soil nutrient concentrations were markedly greater in loamy compared to sandy soils. A key result is that, even along this transect of approximately 500 km, the heterogeneity of vegetation properties within a location can be greater than that over the entire transect. This heterogeneity needs to be considered in estimations of biogeochemical cycling in the Yamal region. Our research plan is to continue sampling further north to encompass a broader arctic transect.