

Application of space-based technologies and models to address land-cover/land-use change problems on the Yamal Peninsula, Russia:

2007 field studies along the Yamal bioclimate gradient



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Abstract:

The Yamal Peninsula in northern Russia has undergone extensive changes during the past 20 years due to gas and oil development, grazing and trampling by reindeer herds, and changes in climate. We are using a combination of ground-based studies, remote-sensing studies, and studies of land-use activities to help develop vegetation-change models. In 2007-2008 we are establishing a latitudinal transect of six locations in the Yamal Peninsula region. Here we present a summary of ground-based measurements of vegetation, soil, permafrost, active-layer, and spectral reflectance at three sites visited in Aug 2007: Nadym (northern boreal forest), Laborovaya (southern tundra), and Vaskiny Dachi (typical tundra). Biomass varies from about 1800-2300 g m⁻² for tundra and forest understory at Nadym to about 1000-1300 g m⁻² at Vaskiny Dachi. Areas with sandy soils have 250-350 g m⁻² less biomass than comparable

clayey sites, with less mosses and graminoids, and much more lichen biomass than nearby areas with more clayey soils. Lichen biomass was especially large in the ungrazed areas near Nadym – over 1000 g m⁻² in two areas studied at Nadym compared to less than 250 g m⁻² in areas where reindeer grazing has occurred annually. Ground-based measurements of NDVI and optically-measured LAI showed little correspondence to the biomass data, demonstrating the difficulty of linking ground-based measurements of NDVI and LAI to biomass data at the plot level. However, space-based measurements of NDVI along the climate gradient in both North America and Eurasia show clear latitudinal trends that correspond to the biomass data. The baseline of information established along the Yamal transect could be extremely useful for monitoring long-term changes in plant biomass, permafrost temperatures, and active layer depths as temperatures warm in the region.

Greening of the Arctic An IPY Initiative

Acknowledgments:

Funding: NASA Grant No. NNG6E00A and NSF Grant No. ARC-0531180. Many Russian colleagues helped with the logistics, field work, and science. Marina Leibman and Nataliya Moskalenko were especially critical to the planning and execution of the expedition. They and their colleagues at the Earth Cryosphere Institute in Tyumen and Moscow made this undertaking possible. Presented at 2008 NASA Carbon Cycle and Ecosystems Joint Science Workshop, April 28-May 2, 2008, University of Maryland.

Locations and study sites:



ND-1, forest site



ND-2, CALM grid



Laborovaya Camp



LA-1, clayey site



LA-2, sandy site

Forest and hummock tundra (northern boreal forest)

- Nadym-1, sandy fluvial terrace, 20-40 kya
- Nadym-2, sandy fluvial terrace, deep organic, 60-80 kya
- Both sites lichen-rich due to lack of recent reindeer grazing
- Both sites are sandy

Southern tundra (subzone E)

- Heavily grazed by reindeer
- Mesic tundra with clayey vs. sandy substrate

Vaskiny Dachi



VD-1, Terrace IV



VD-2, Terrace III



VD-3, Terrace II

Typical tundra (subzone D)

- Terrace IV - clayey marine plain, 130-117 kya
- Terrace III - mixed clay and sand fluvial marine terrace, 75-25 kya
- Terrace II - sandy fluvial terrace, 25-10 kya
- All sites heavily grazed by reindeer

Logistics:



Truck: Labytangi-Laborovaya



Helicopter: Laborovaya-Vaskiny Dachi and return to Labytangi.

Members of the expedition:



Nadym: Back row: Patrick Kuss, Nataliya Moskalenko, Elina Karlejärvi, Howie Epstein, Alexander Nikitin, Olga Opokina, Evgeny Elanchev, Vladimir Romanovsky, Front row: Pavel Orekhov, Olga Ponomoreva, George Matyshak. Not shown: Skip Walker.

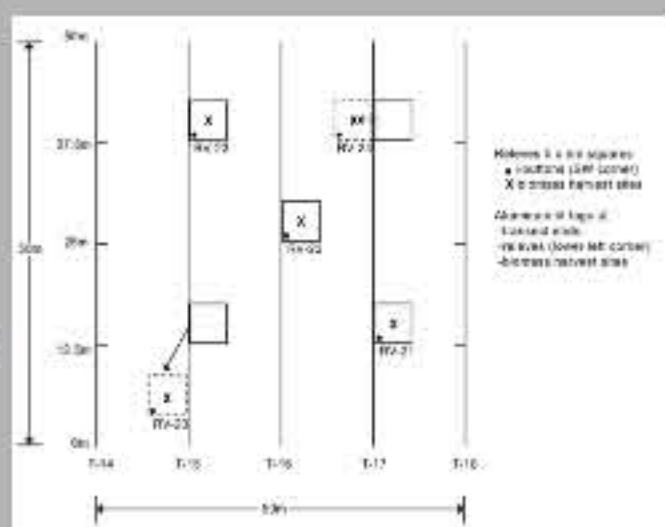


Laborovaya and Vaskiny Dachi: Back row: Elina Karlejärvi, Nataliya Moskalenko, Howie Epstein, Patrick Kuss, Anatoli Gubarkov, Artem Khomutov. Front row: Marina Leibman, George Matyshak, Skip Walker.

Methods:

Sampling strategy

- 5 50-m transects
- 5 10x10-m plots
- 1 soil pit
- Adjustments for homogeneous zonal vegetation



Plot and transects



Soil pits

Transects

- Species cover (Buckner sampler)
- Forest structure, (Point-centered quarter method, density, basal area, biomass)
- Leaf area index (LAI-2000)
- NDVI (PSII)
- Active layer thickness (thaw probe)



Cover (Buckner sampler)



NDVI (PSII)



Active layer

Study plots (relevés)

- Species cover (all species, cover estimates)
- Site descriptions (vegetation structure, photos, geology, thaw depth, etc.)
- LAI and NDVI
- Biomass (harvest, 20 x 50-cm plots)
- iButtons for N-factor determination



Biomass harvest



iButton

Soil pits

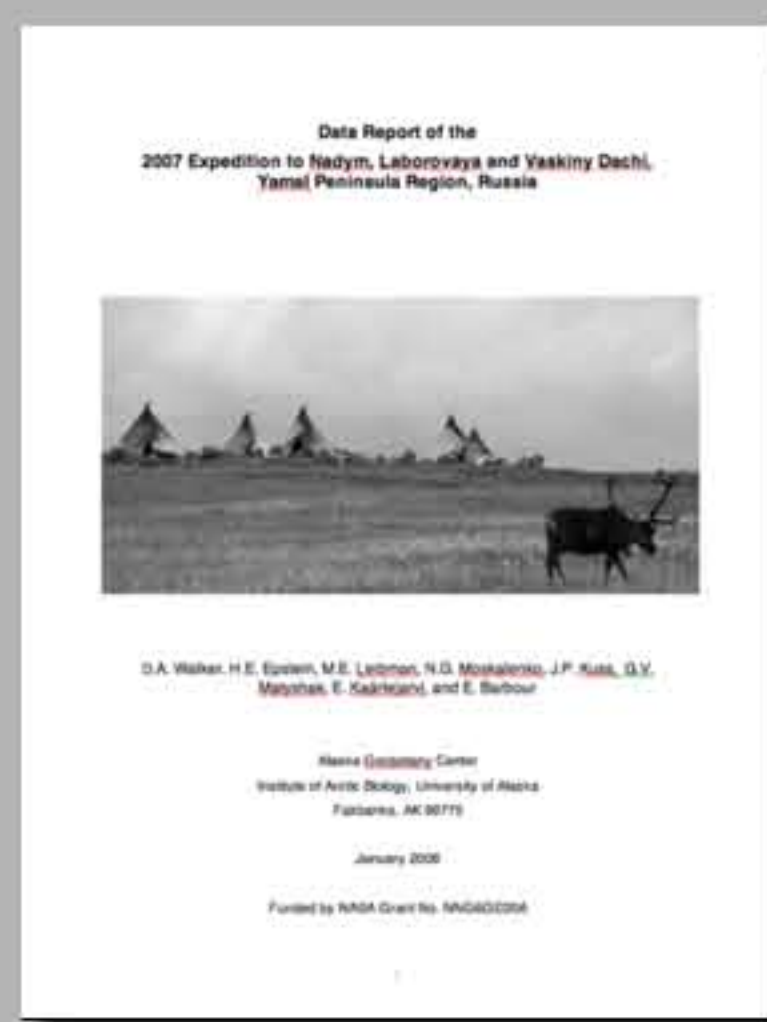
- 1-2 soil pits at each site
- Descriptions according to US soil taxonomy (G. Matyshak)
- Trace-gas production
- Soil samples from each relevé
- Analyzed at UAF for physical and chemical properties



Results:

Data Report

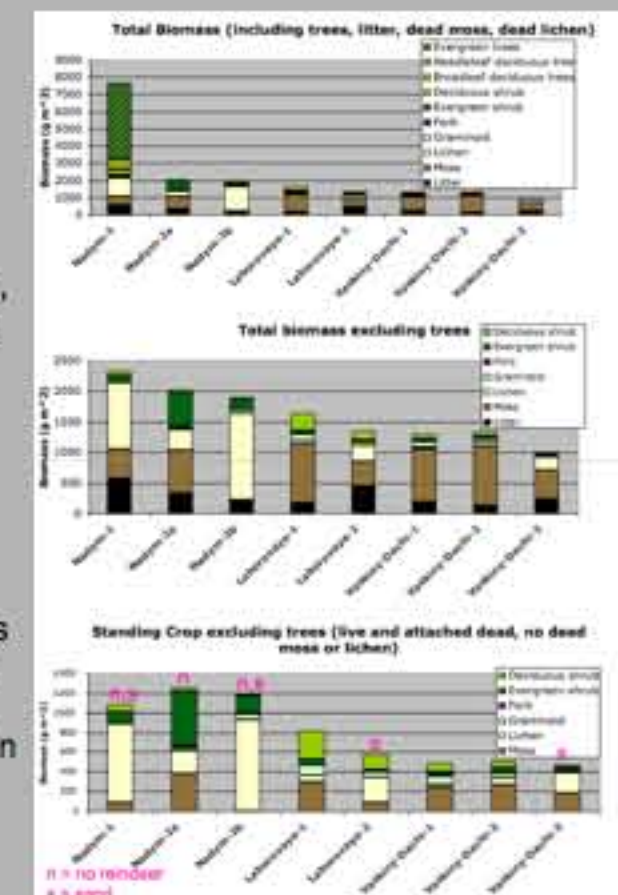
- Background for the project,
- General descriptions of each locality with photographs,
- Maps of the sample sites,
- Summary of sampling methods
- Tabular summaries of data
- Soil descriptions with photos
- Photos of each study plot
- Contact information for participants
- Species lists
- Appendices with methods
- Available in hard copy and on line (pdf)
- Raw data files available from Alaska Geobotany Center



Available at: <http://www.geobotany.uaf.edu/yamal/>

Biomass along the Yamal transect

- Biomass trend along climate gradient: 2000-2300 g m⁻² (understory) at Nadym to about 1000-1300 g m⁻² at Vaskiny Dachi.
- Total biomass determined by allometric equations (Zianis 2005), adds another 4,121 g m⁻² ± 851 g m⁻² to Nadym forest site.
- Sandy soils have 250-350 g m⁻² less biomass than comparable clayey sites, with much more lichen biomass and less mosses and graminoids.
- Lichen biomass was especially large in the ungrazed sandy areas near Nadym – over 1000 g m⁻² in two areas studied at Nadym compared to less than 250 g m⁻² in sandy areas where reindeer grazing has occurred annually.



Comparison with North America Arctic Transect

