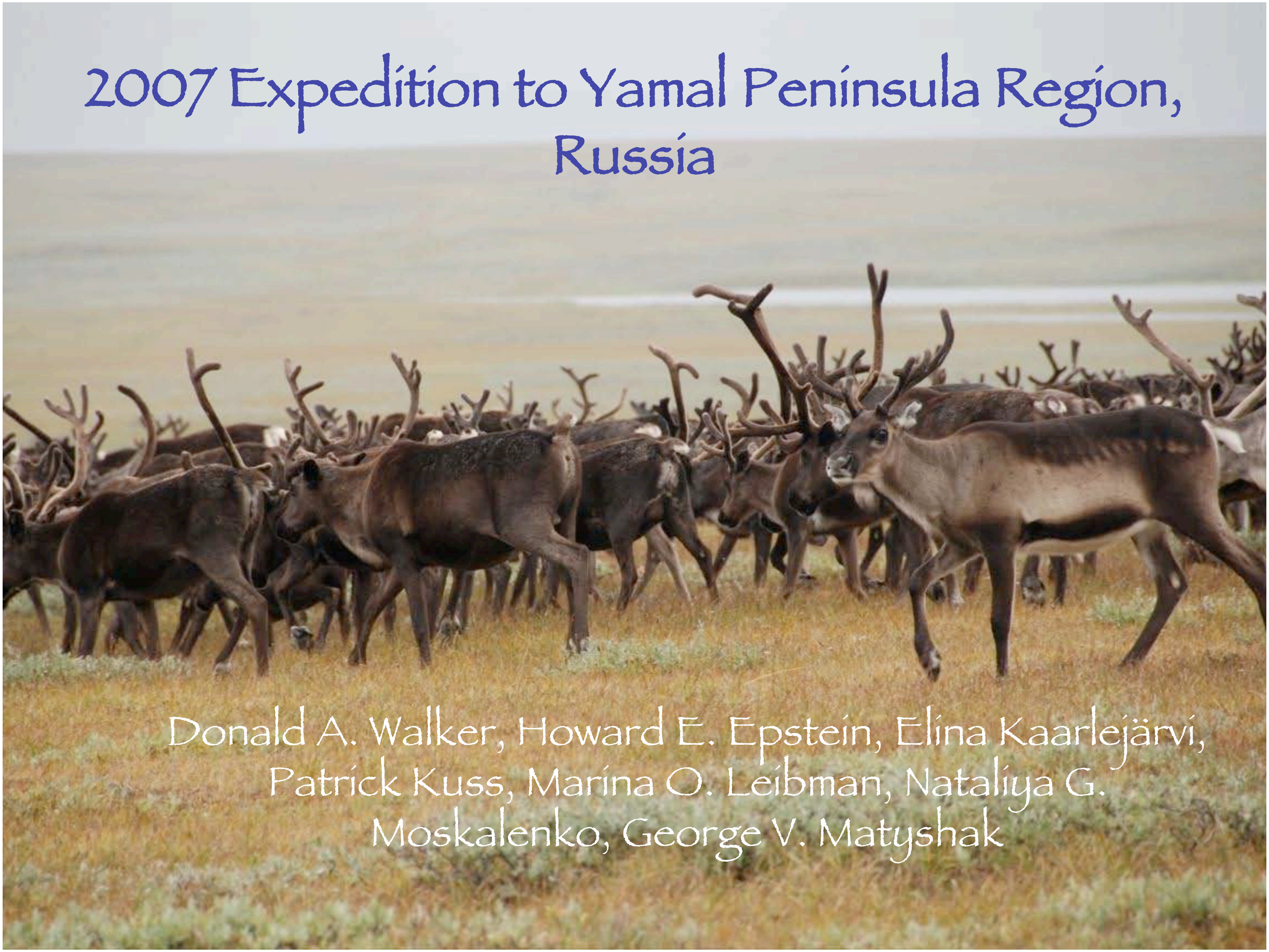
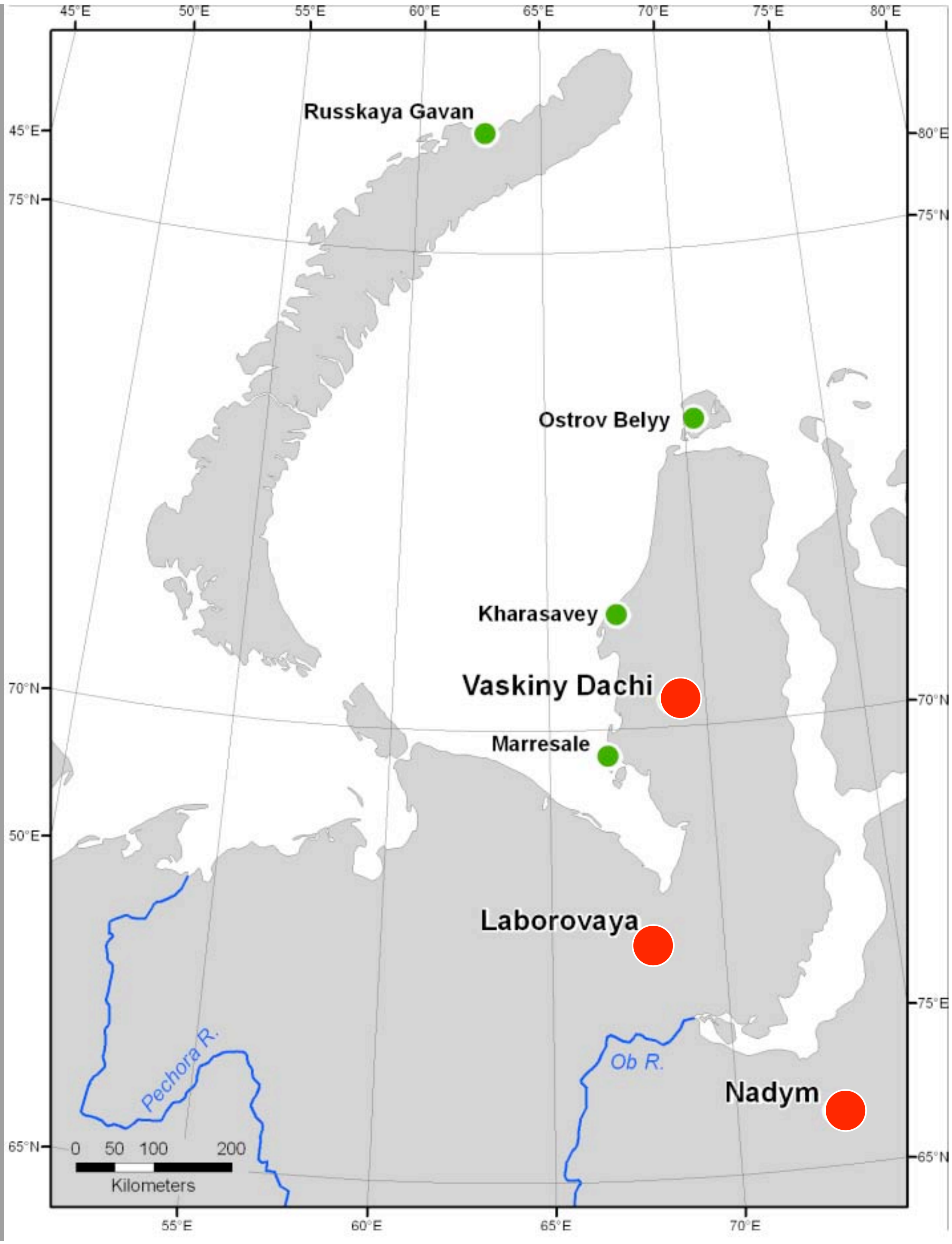


2007 Expedition to Yamal Peninsula Region, Russia

Donald A. Walker, Howard E. Epstein, Elina Kaarlejärvi, Patrick Kuss, Marina O. Leibman, Nataliya G. Moskalenko, George V. Matyshak

Locations

- Nadym
- Laborovaya
- Vaskiny Dachi



Members of the Expedition

Nadym

Laborovaya and Vaskiny Dachi

Logistics

Laborovaya

Vaskiny Dachi

Field camp at Laborovaya

Nadym

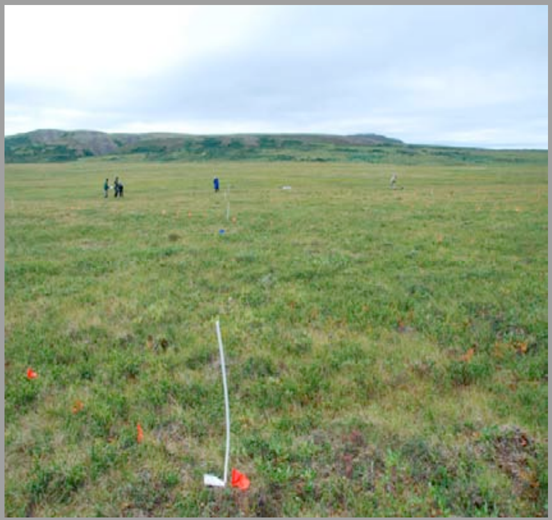
ND-1, forest site

ND-2, CALM grid

Forest and hummock tundra (northern boreal forest)

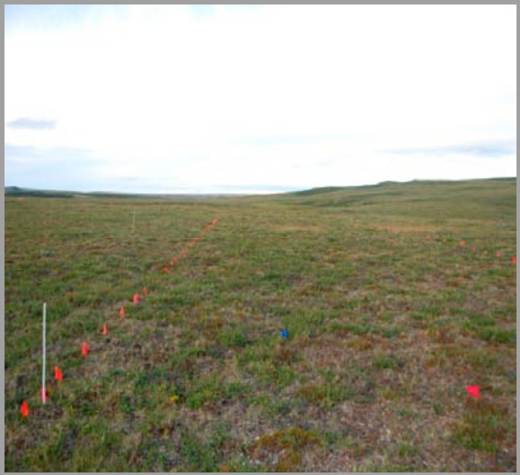
- Nadym-1, sandy fluvial terrace, 20-40 kya
- Nadym-2, sandy fluvial terrace, deep organic, 60-80 kya
- Both sites lichen-rich due to lack of recent reindeer grazing
- Both sites are sandy

Laborovaya



LA-1, clayey site

Southern tundra (subzone E)
- Heavily grazed by reindeer
- Mesic tundra with layey vs. sandy substrate

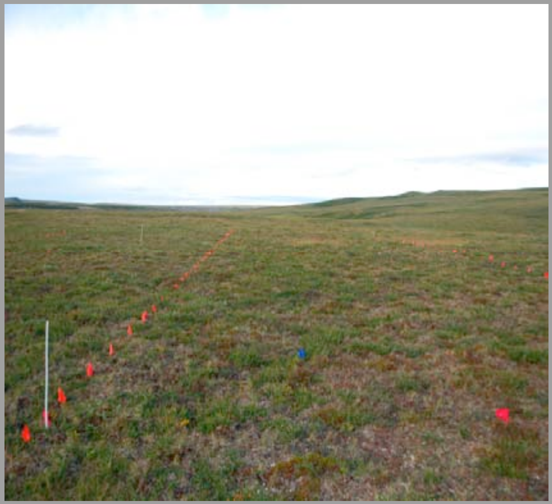


LA-2, sandy site

Vaskiny Dachi

VD-1, Terrace IV

VD-2, Terrace III



VD-3, Terrace II

Typical tundra (subzone D)

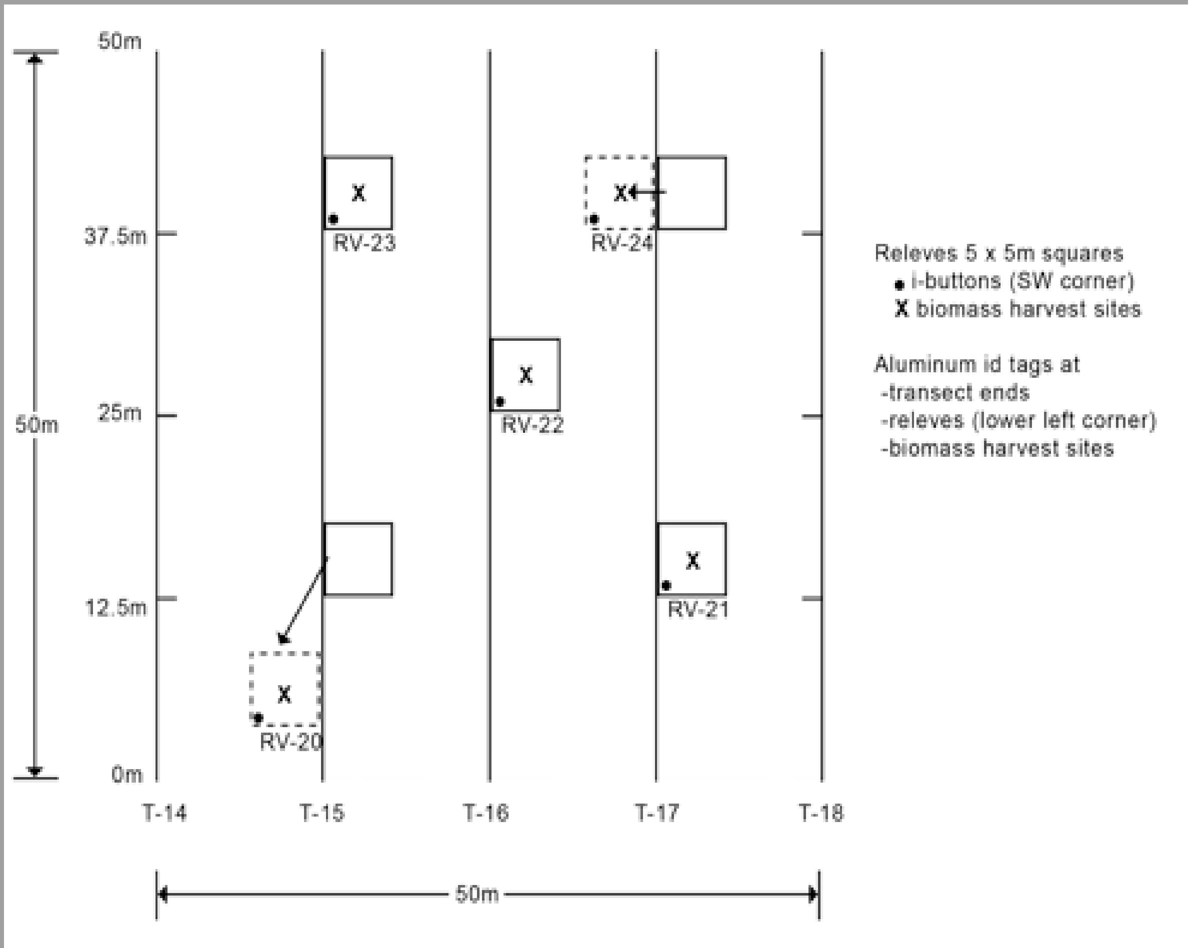
- Terrace IV - clayey marine plain, 130-117 kya
- Terrace III - mixed clay and sand fluvial marine terrace, 75-25 kya
- Terrace II - sandy fluvial terrace, 25-10 kya
- Heavily grazed by reindeer

Vaskiny Dachi

- Unique permafrost conditions
- Landslide successional sequences
- Willows on old landslides

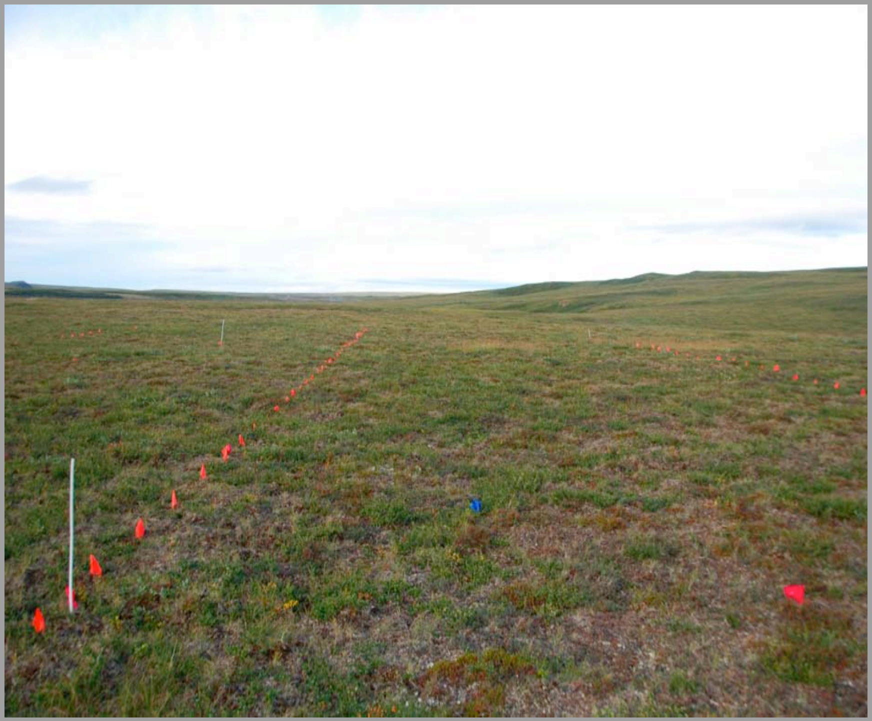
Typical sampling strategy (1)

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



Typical sampling strategy (2)

Plot and transects



Soil pits

Data collected (1)

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

Data collected (2)

Study plots (relevés)

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

Biomass harvest

iButton

Data collected (3)

Soil pits

- 1–2 soil pits at each site
- Descriptions according to US soil taxonomy (G. Matyshak)
- Methane and trace-gas production

Soil samples from each relevé

- Will be analyzed at UAF for physical and chemical properties

Vaskiny Dachi-3

Location:
GPS position: 70 ° 18'01.7"N, 068 ° 50'33.5"E
Elevation: 18 m
Parent material: Aeolian sand over marine sediments?
Classification: Typic Haploturbels, (Podburs in Russia)

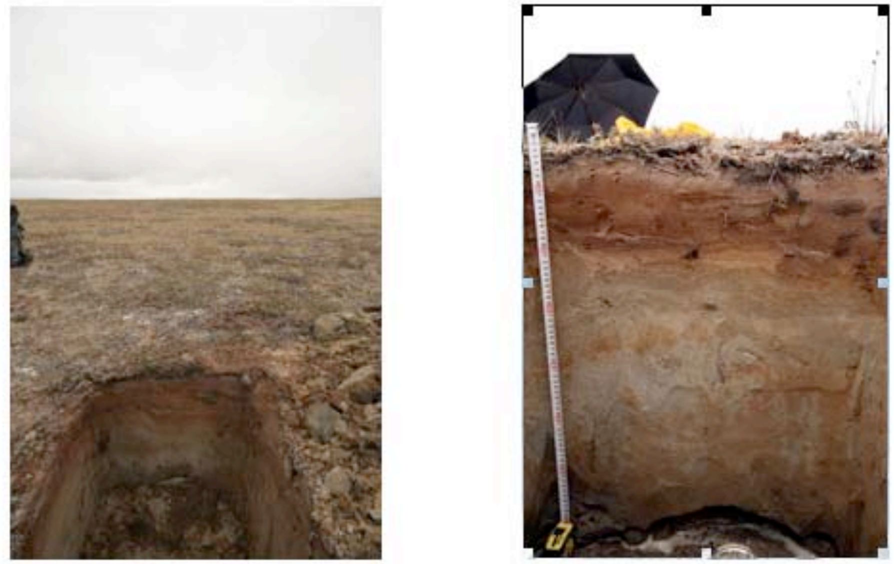


Figure 46. (a) Soil pit at Vaskiny Dachi-3 (pit №12). (b) Closeup of pit wall.

0-0.5 cm; Oi; fibric material (black crast), firm; very abrupt smooth boundary.

0.5-1.5 cm; Ah; dark brown (7.5YR3/3) silty loam, moderate fine subangular blocky structure; very friable, slightly sticky, slightly plastic, common fine and medium roots; abrupt irregular boundary.

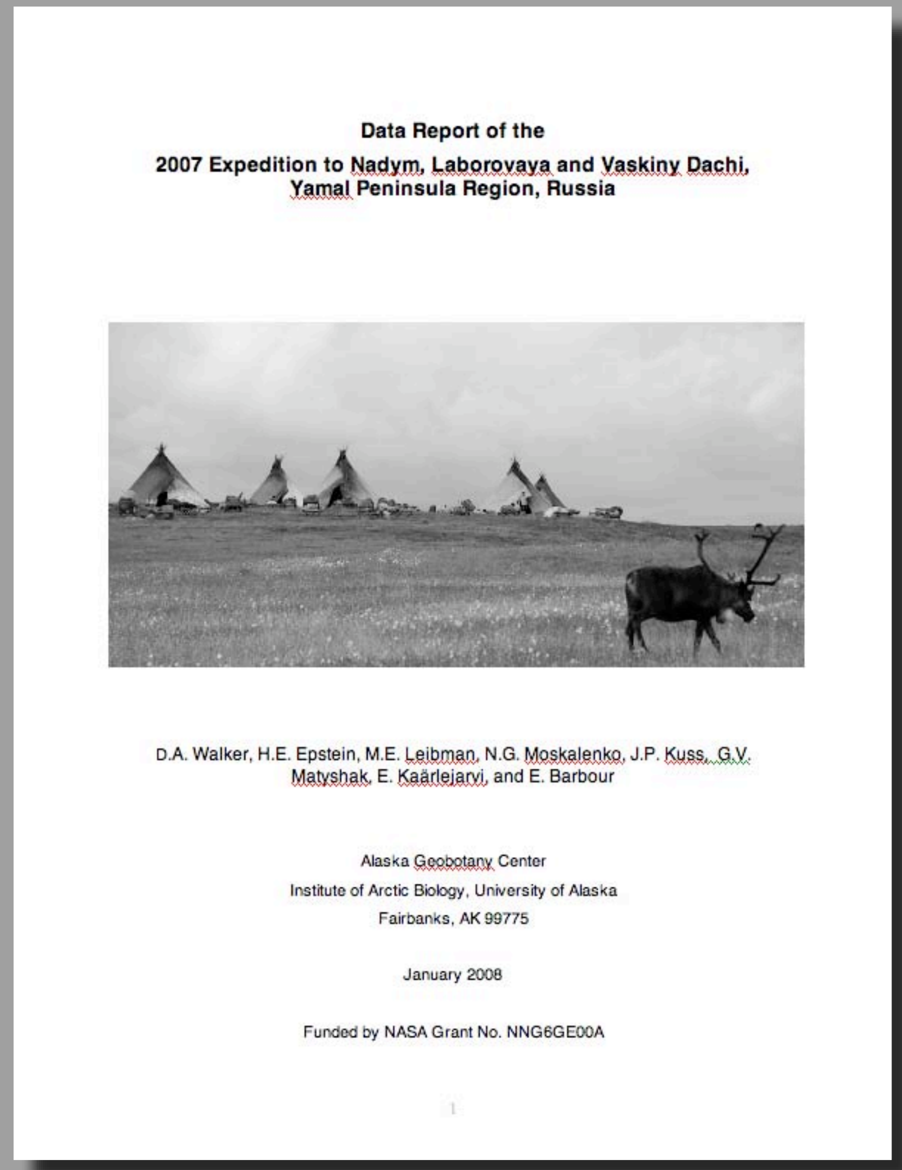
1.5-5 cm; Bw; light brown (7.5YR6/4) sand; weak medium subangular blocky structure; loose, non-sticky, non-plastic, few vertical frozen cracks with brown (7.5YR4/3) of mucky peat of 10 mm to 20 mm few medium roots; gradual irregular boundary.

5-24 cm; Bwjj; reddish brown (2.5YR4/6, 80%) and light brown (7.5YR6/3, 20%) sand; structureless; very friable, non-sticky, non-plastic, few lenses gray (7.5YR5/1) silty loam; few medium roots; gradual irregular boundary.

24-71 cm; BC; light gray (5YR7/1, 60%) and reddish yellow (5YR7/8, 40%) loamy sand; structureless; loose, non-sticky, non-plastic, water below 71 cm; frozen below 124 cm;

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



Data Report of the

2007 Expedition to Nadym, Laborovaya and Vaskiny Dachi, Yamal Peninsula Region, Russia

D.A. Walker, H.E. Epstein, M.E. Leibman, N.G. Moskalenko, J.P. Kuss, G.V. Matyshak, E. Kaärlejarvi, and E. Barbour

Alaska Geobotany Center

Institute of Arctic Biology, University of Alaska

Fairbanks, AK 99775

January 2008

Funded by NASA Grant No. NNG6GE00A

1

Other data collected but not included in the data report

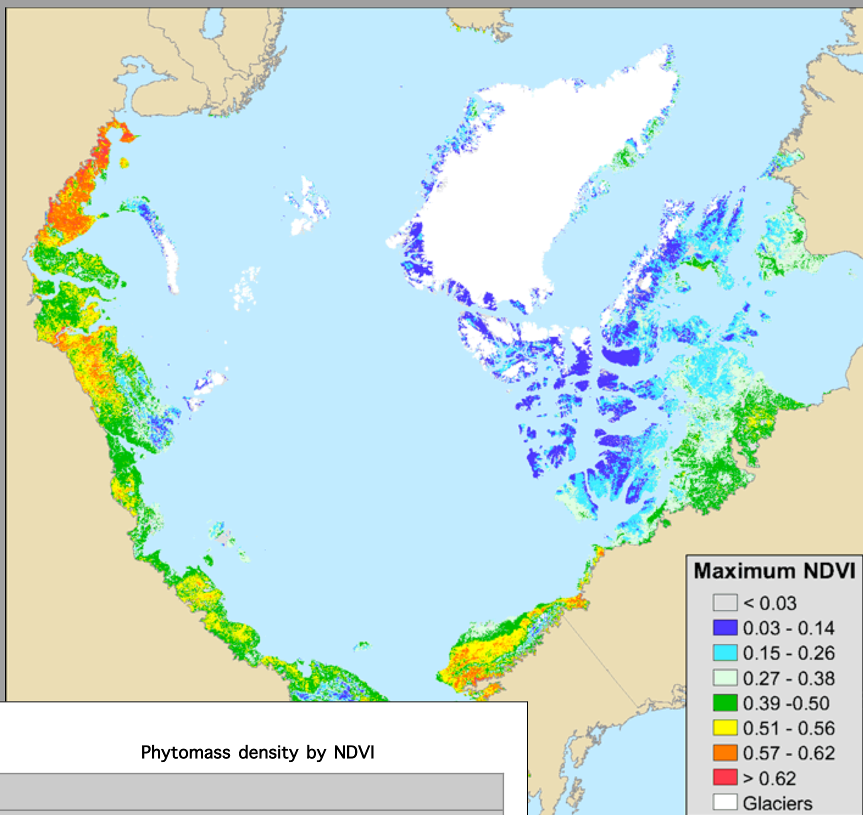
- Permafrost temperature logger information
- CALM data at Nadym and Vaskiny Dachi
- Thesis projects of Gubarkov, Khomutov, Orekhov and others
- Soil chemical and physical analyses

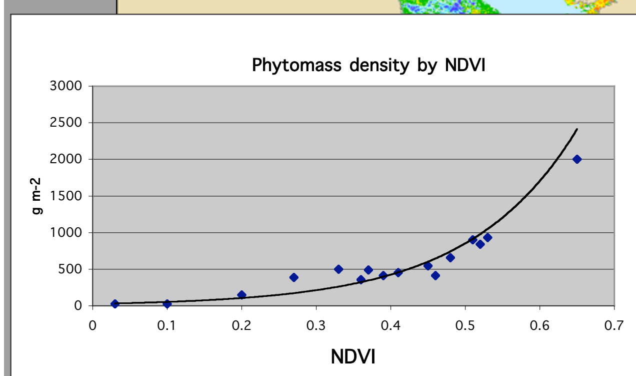
30-m borehole near Nadym CALM grid

Cover/Biomass Report

- The importance of biomass and cover data
- The current problems with tundra biomass and cover data
- The approaches used on the Yamal transect
- Results

The importance of cover and biomass data



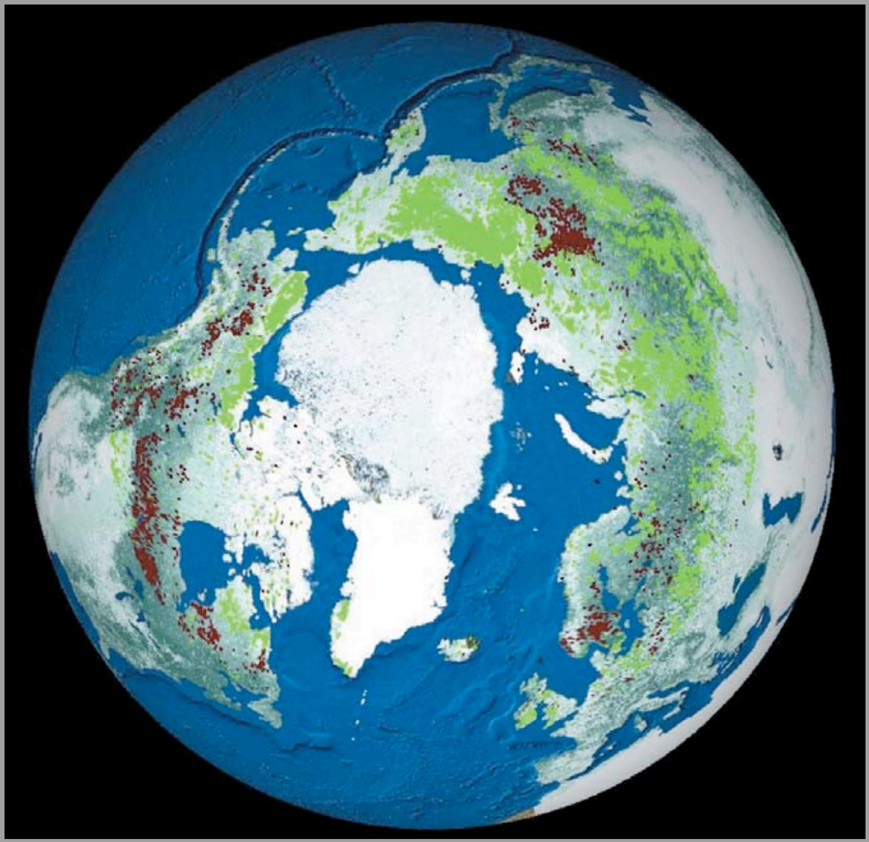


Needed for:

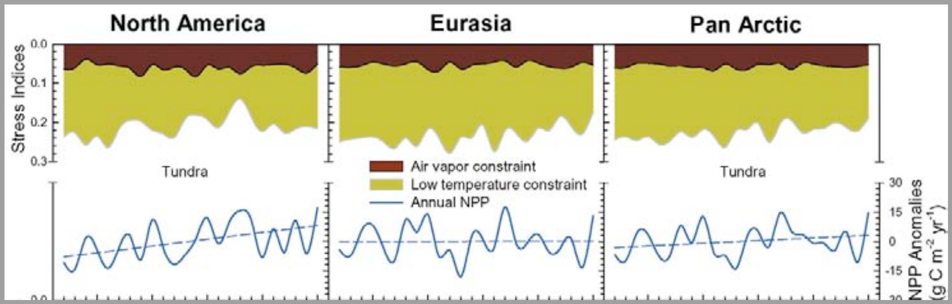
- interpreting space-based spectral data (NDVI),
- developing ecosystem-permafrost relationships (*N*-factor),
- detecting long-term changes to land-cover,
- detecting changes in forage quality.

Walker et al. 2003, JGR, 108 D2 8169.

Numerous studies have shown a general trend of increased NDVI in the Arctic, but…



Bunn et al. 2007, Eos



"Should we believe in the NDVI trend? There are no "ground truth" measurements of photosynthesis at northern high latitudes over the same period, and so the accuracy of the trend cannot be established unambiguously…. It will be a challenge for ecologists to explain how photosynthesis could possibly have increased by approximately 10% from 1981 to 1991." (Inez Fung, 1997)

“What does NDVI really mean in tundra systems… particularly for reindeer and caribou?”

Some areas with low NDVI have high forage quality for reindeer.

Lichen-woodland at Nadym

Bright green areas may be dominated by species such as alder or dwarf-birch, which have abundant toxic secondary plant compounds that protect them from grazing.

Shrub tundra at Laborovaya

Some problems with existing biomass data

- Vegetation type often unknown.
- Soil and site factor information missing.
- Harvest methods not documented.
- Not georeferenced.
- Replication not documented.
- Not linked to NDVI, LAI, or other cover properties of the vegetation.
- Definitions of biomass components unclear.

e.g. Not a clear definition of where the soil surface is or what is dead component of biomass.

"What is above-ground biomass?"

Cover data are even worse…

- Usually cover is estimated.
- Unable to replicate the data.
- Very few good quantitative methods (e.g. point frames).
- Most are very time consuming.

Buckner point-intercept sampler

- Developed for mining reclamation studies.
- Quick, objective, easy to replicate.

Buckner sampler at Nadym

Buckner, D. L. (1985), Point-intercept sampling in revegetation studies: maximizing objectivity and repeatability, edited, pp. 110-113, ESCO Associates, Inc., paper presented at the American Society for Surface Mining and Reclamation meeting, Denver, CO, October 1985.

Biomass standards needed

International CBMP workshop proposed to standardize vegetation sampling procedures.

Yamal methods are fully documented in Appendix D of the data report.

Yamal Biomass procedures
August 2007
Skip Walker, Martha Raynolds

TUNDRA BIOMASS PROCEDURES

TABLE OF CONTENTS

PURPOSE
The goal of biomass sampling of vegetation is to quantify the amount of plant material in a given vegetation type, thus we sample all phytomass from a specified amount of surface area, so the values can be extrapolated over larger areas.

Phytomass is sorted into categories that are relevant to research questions. Phytomass includes three major categories: above-ground live phytomass, above-ground dead phytomass, and below ground phytomass. Phytomass is also commonly sorted by plant functional type, such as deciduous shrub or lichen. Finally, plant functional types can be sorted into plant parts, such as live leaves, dead leaves, stems, reproductive parts.

Most of the difficulties in obtaining good phytomass data come from inconsistencies in the clip harvest methods, and the sorting methods. This document is intended to make these methods as consistent as possible. It is based primarily with some modificatin on the methods used to collect biomass along the North American Arctic Transect (Walker et al. 2007 submitted; Epstein et al. 2007 submitted).

COLLECTING ABOVEGROUND BIOMASS
Equipment needed: Metal frame(s), pegs, serrated knife, clippers, scissors, gallon zip-lock plastic bags, indelible "Sharpie" markers, "write-in-the-rain" paper or Post-its

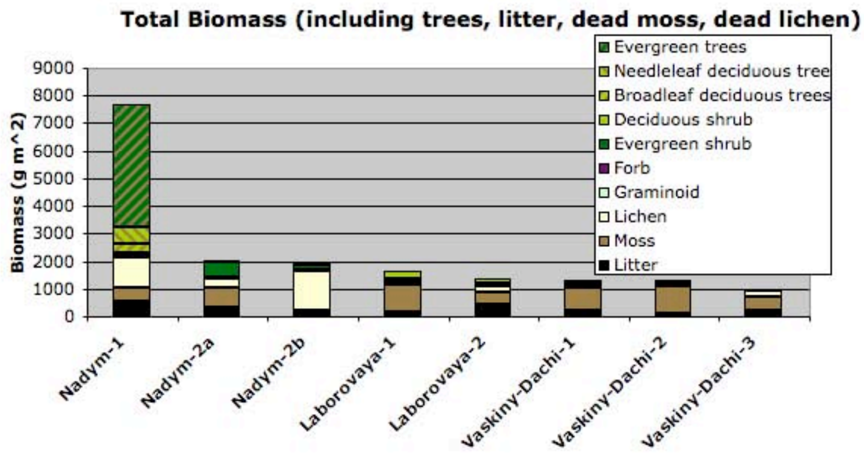
1. **Establish sample grids.** At each location (Nadym, Km-143, Vaskiny Dachi), we will establish 5 10x10-m grids with grid points spaced at 1-m intervals. These will be in replicated homogeneous areas of the zonal vegetation. Within each grid we

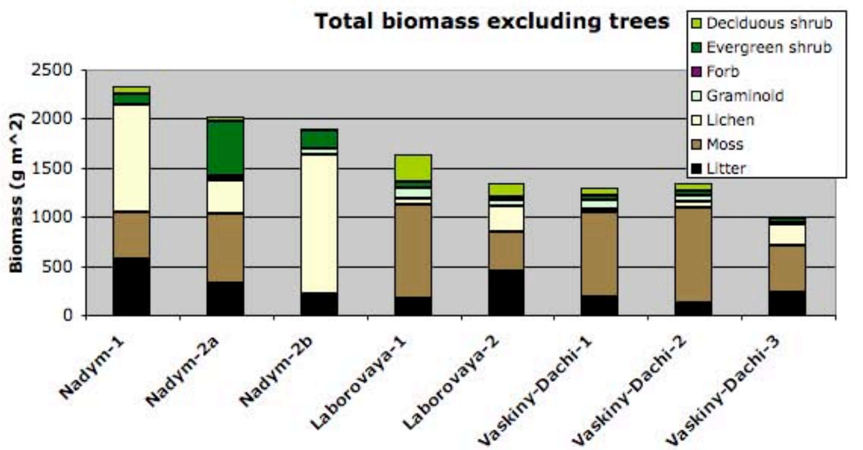
Plant functional types

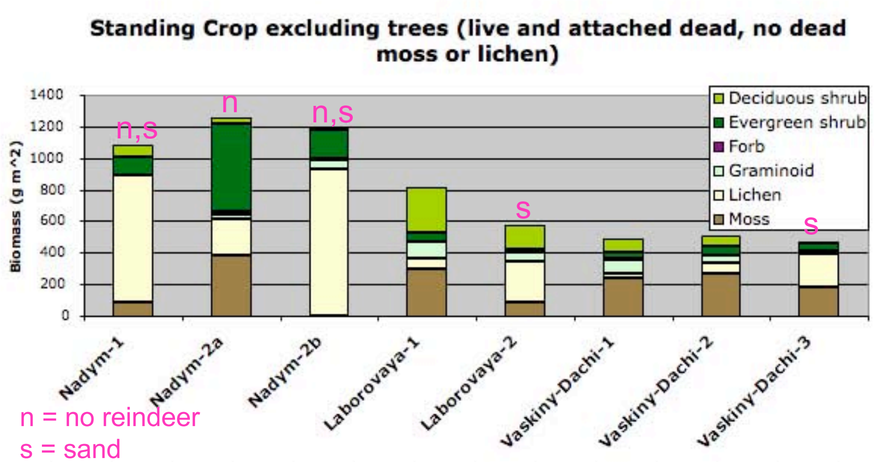
Categories based largely on plant growth forms, used in modeling efforts.

- **evergreen shrub**
  - stem
  - live foliar
  - attached dead foliar
  - reproductive
- **deciduous shrub**
  - stem
  - live foliar
  - attached dead foliar
  - reproductive
- **graminoid**
  - live
  - attached dead
- **forb**
- **equisetum**
- **bryophyte** (mosses & liverworts)
  - live
  - dead
- **lichen**
  - live
  - dead
- **algae**
- **litter** (all unattached dead plant parts)
- **soil and roots** (belowground)

Biomass along the Yamal transect

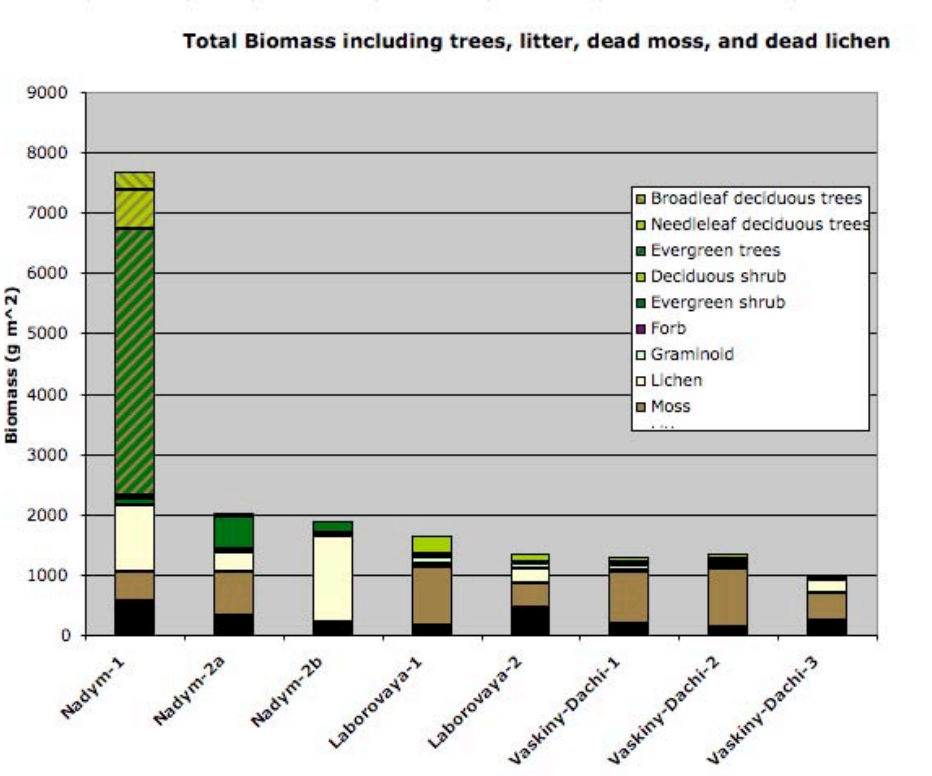


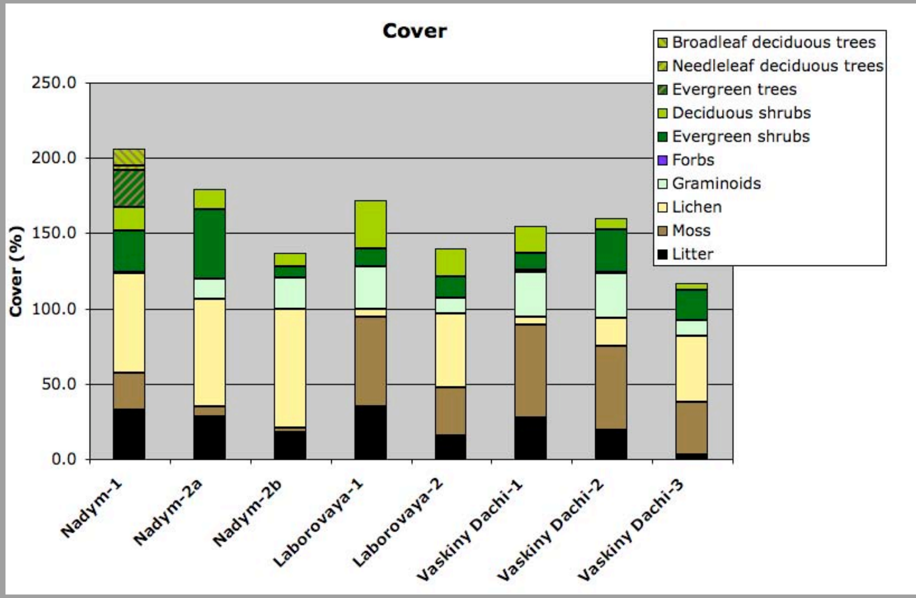


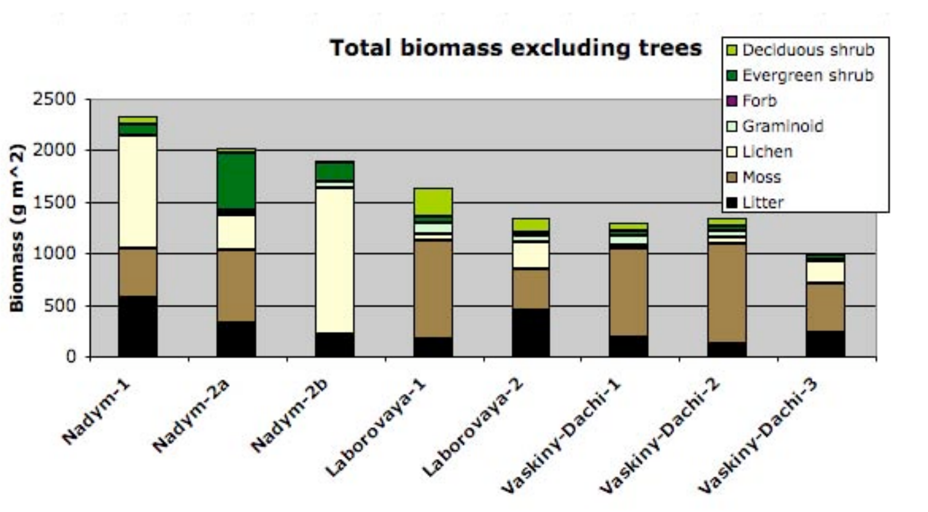


- Climate trend for tundra and understory and tundra vegetation: 2000–2300 g m^{-2} at Nadym to about 1000–1300 g m^{-2} at Vaskiny Dachi.
- Total biomass determined by allometric equations (Zianis 2005), adds another 4,121 g m^{-2} ± 851 g m^{-2} to Nadym forest site.
- Sandy soils have 250–350 g m^{-2} 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 of biomass and cover data

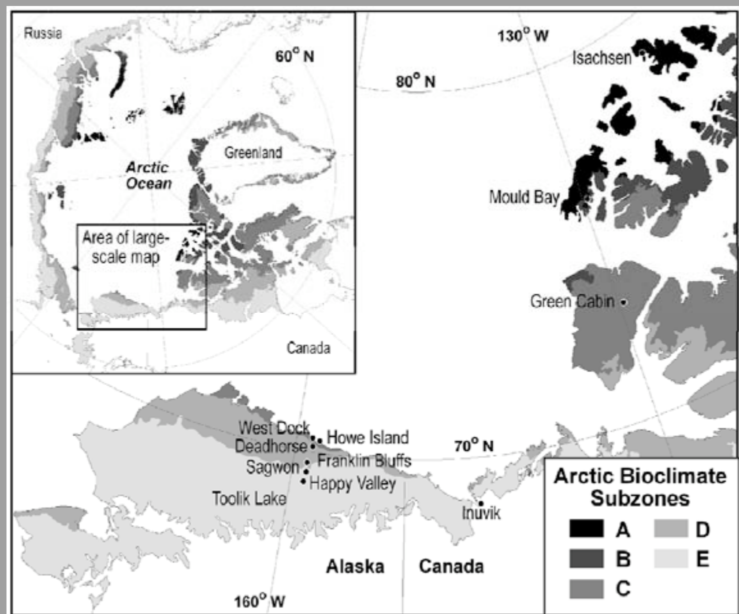


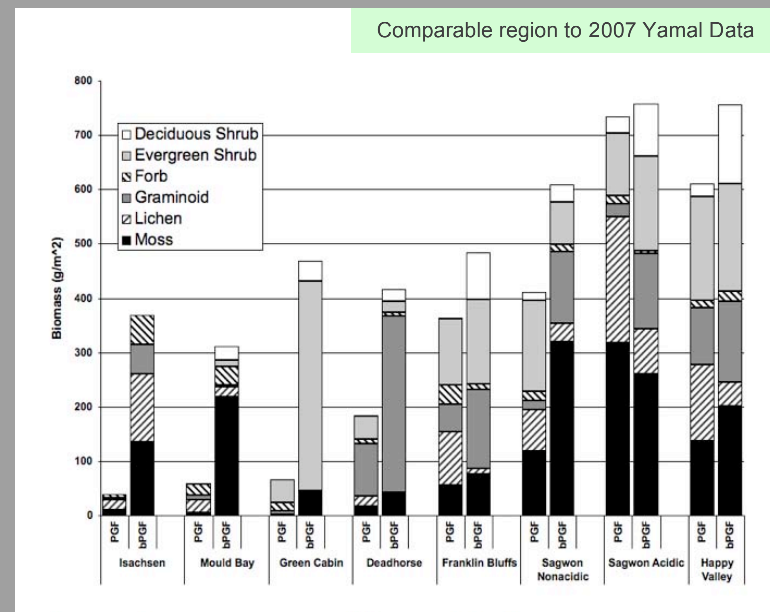




- Less correspondence between the cover data and the climate gradient.
- Cover data do appear to show general correspondence with the trends of the hand-held LAI and NDVI values at the same sites (Epstein et al. talk).

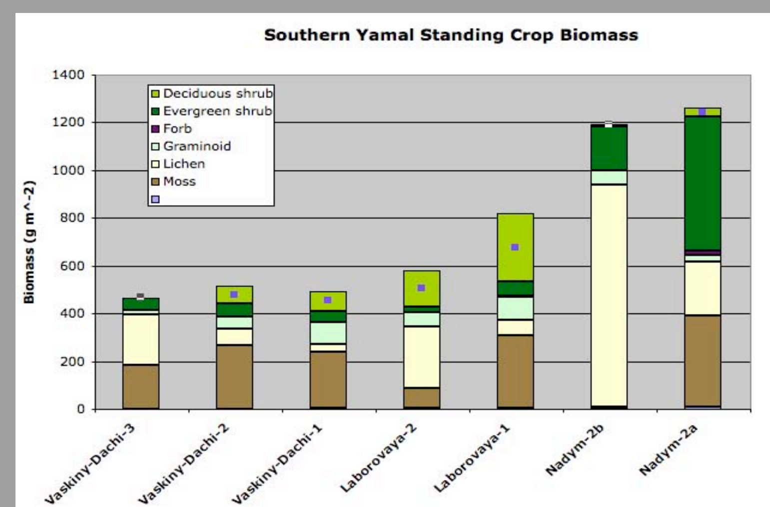
Comparison with North America Arctic Transect





Walker et al. 2008 submitted. *Journal of Geophysical Research - Biogeosciences.*

Standing Crop				
Subzone	North America		Yamal	
Subzone D	Daedhorse	410	Vaskiny Dachi-1	491
	Franklin Bluffs	490	Vaskiny Dachi-2	512
	Sagwon MNT	610	Vaskiny Dachi-3 (sand)	465
Subzone E	Sagon MAT	730	Laborovaya-1	815
	Happy Valley	730	Laborovaya-2 (sand)	575
Boreal Forest			Nadym-2a	1256
			Nadym-2b (sand)	1186



Thermal effects of biomass to permafrost: the *n*-factor

Most biomass determinations do not consider the dead moss as part of the biomass.

Whether it is considered part of the plant biomass or soil, it is the most critical to insulating the permafrost in summer and must be considered in developing meaningful models of permafrost-ecosystem interactions.

"What is biomass?"

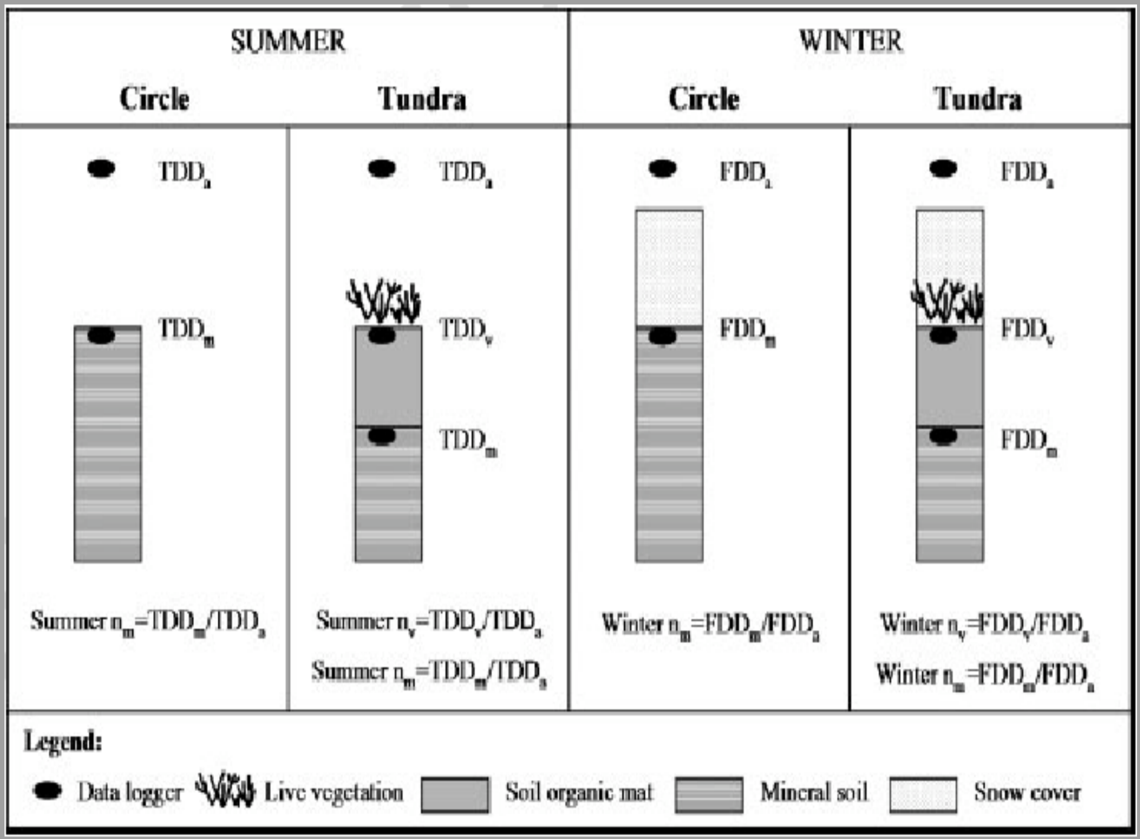
n-Factor:

Ratio of the sum of degree-day temperatures at the soil surface to the sum of degree-day temperatures in the air:

$$n = DDT_{soil} / DDT_{air}$$

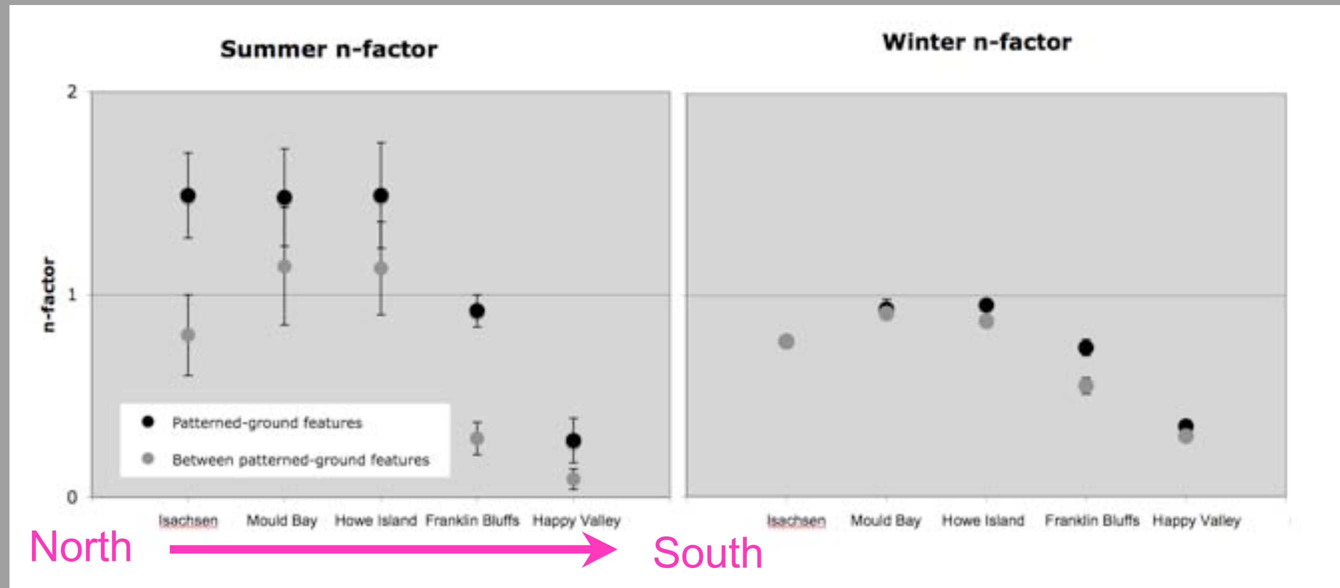
Summer n_s: uses thawing degree days
Winter n_w: uses freezing degree days

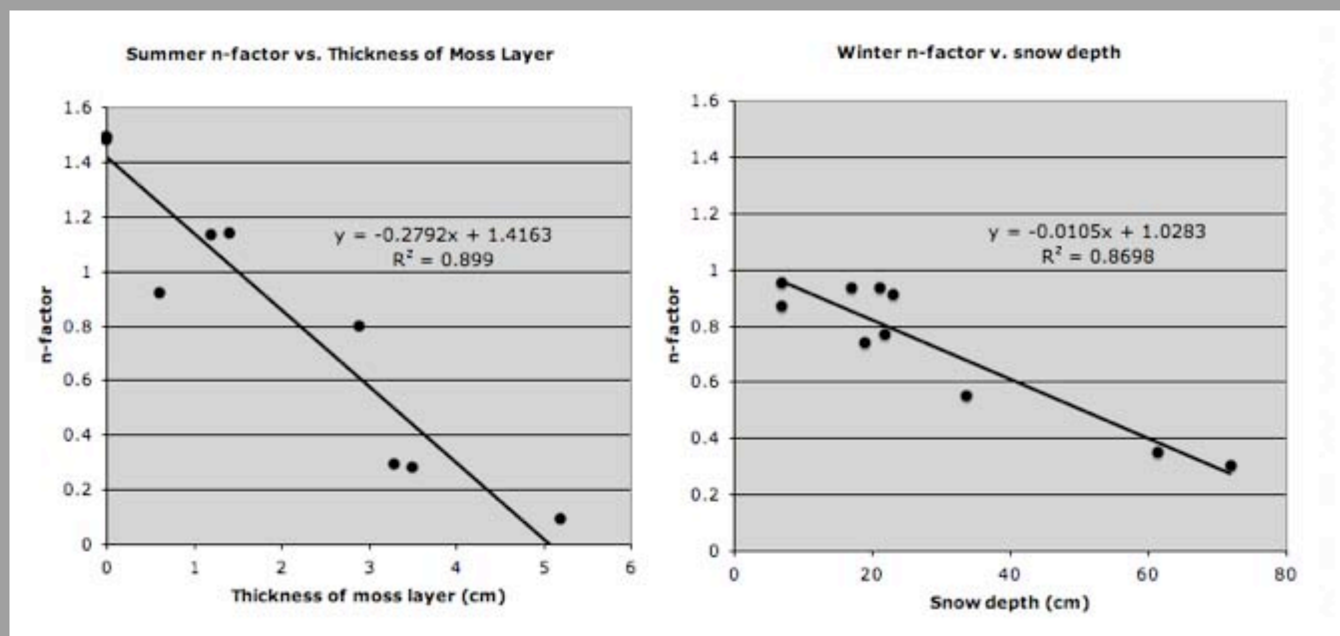
Summer and winter *n*-factor: placement of iButtons



Anja Kade et al., 2006, *Permafrost and Periglacial Processes*

n-factor of tundra and patterned ground features along the North American Transect





Walker et al., 2008 submitted, *JGR - Biogeosciences*

Conclusions

- The baseline of information collected along the Yamal transect is helping us g a more complete understanding of the relationships between vegetation, clima reindeer, permafrost, and key biophysical variables.

- The data will be extremely useful for monitoring long-term changes at the si where data were collected.

- Biomass clearly increases with temperature along the gradient and the valu correspond well with standing crop data from the NAAT.

- There are clear substrate effects on plant functional-type abundance, with sa sites having less total biomass, but more lichens.

- Nadym is effectively an area where reindeer have been excluded for many ye and may be a good area to contrast with the rest of the transect, where reind are ubiquitous.

- International standards of biomass and cover measurements are needed detect change.

Acknowledgements

- We greatly appreciate the efforts of Marina Leibman and Nataliya Moskalenko, at the Earth Cryosphere Institute in Moscow, who were responsible for the logistics for this major undertaking.
- Many people at ECI especially Academician Vladimir Melnikov, Elena Slagoda, Dimitri Drozdov, Olga Ponomareva, Olga Opokina, Anatoly Gubarkov, and Artyom Khomutov, Pavel Orekov helped with the expedition.
- Lev Bogatyrev and Gosha Matyshak helped immensely by providing the space and drying ovens for the biomass studies.
- Evgeny Chuvilin provided space in his cold room for our biomass samples.
- This project was funded by the NASA Land-Cover Land-Use Change project No. NNG6GE00A.