Effects of petroleum development on reindeer herding in Northwest Siberia: Combining scientific and traditional knowledge

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ARCTIC CENTRE

Tundra ecosystems are often considered vulnerable or 'fragile' in the face of large-scale petroleum development, in part because even relatively small-scale, low-intensity impacts can accumulate in space and time.

- Scaling up to include human residents, combined arctic social-ecological systems are believed similarly susceptible to industrial impacts, as well as climate change
- In contrast to North America, virtually all terrestrial and aquatic components of Yamal oil and gas fields are seasonally exploited by migratory herders, hunters, fishers and domesticated reindeer (*Rangifer tarandus*)
- The amount of area directly disturbed in Russia is typically greater than in North America, in some cases by an order of magnitude

Taken from the cover of "Gazprom: Emerging Europe Oil and Gas". Shareholders' prospectus issued by Deutsche Morgan Grenfell (London), December 1997

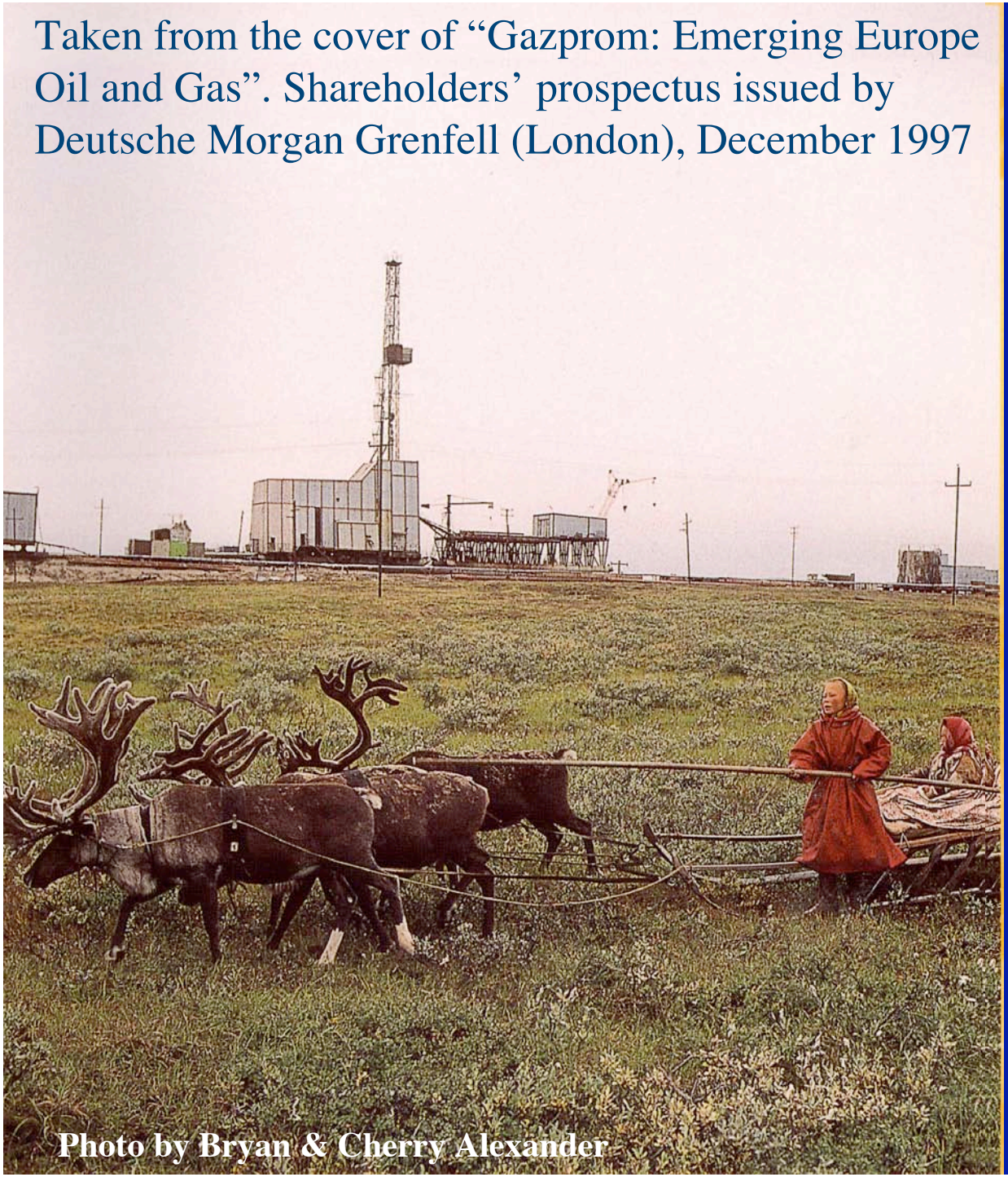
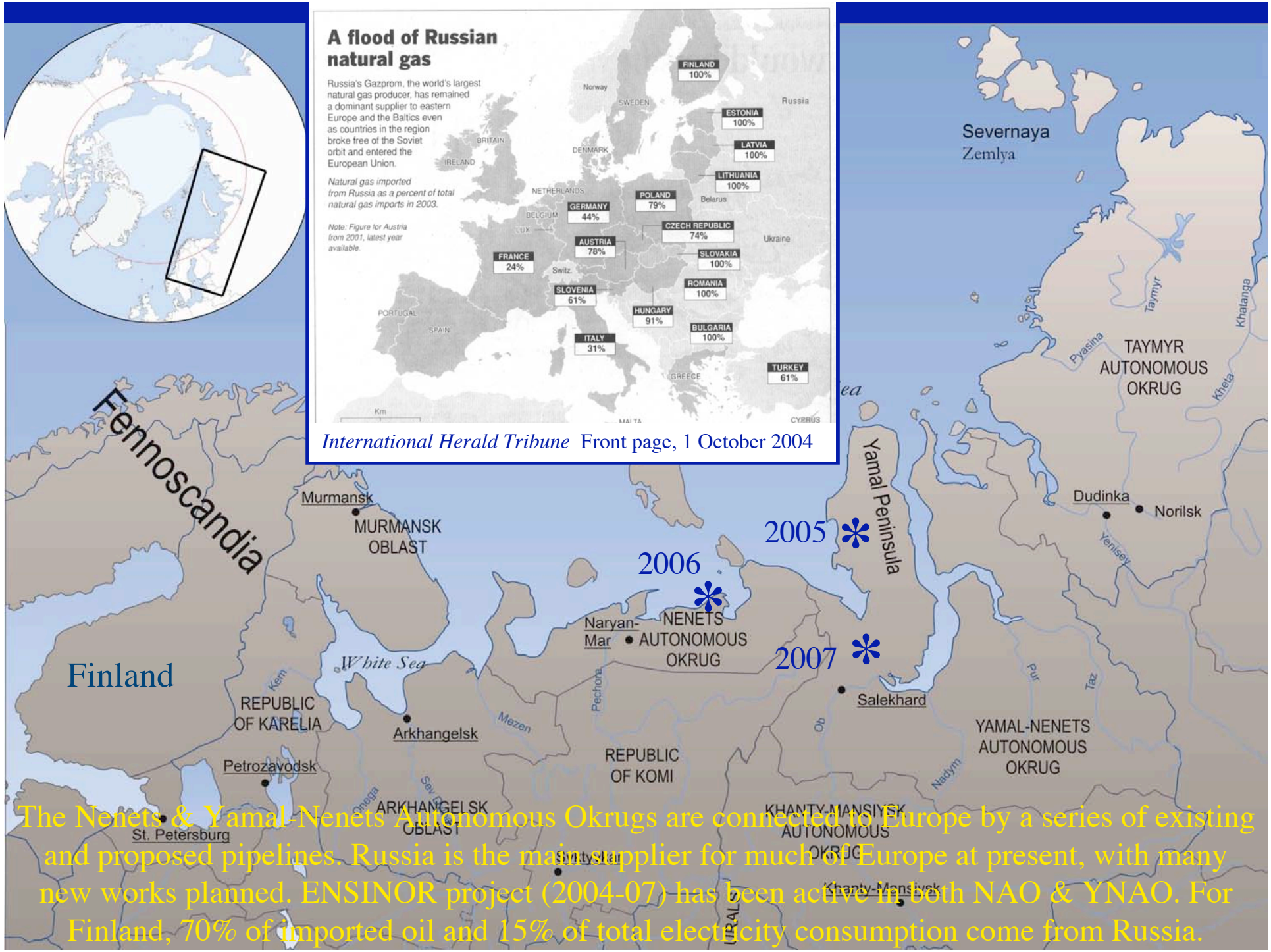


Photo by Bryan & Cherry Alexander

ENvironmental and Social Impacts of Industrialization in NOrthern Russia (ENSINOR)

- Case study approach
- Three intensive study sites in two federal districts
- Oil in NAO and gas in **YNAO (emphasized today)**
- Climate change in both regions
- Changes in social-ecological systems, including herding
- 20-30+ year time slice
- Local and scientific knowledge (geography, anthropology, biology)
- Partners: herders, Russian scientists, indigenous organizations, industry representatives, and museums



The Nenets & Yamal-Nenets Autonomous Okrugs are connected to Europe by a series of existing and proposed pipelines. Russia is the main supplier for much of Europe at present, with many new works planned. ENSINOR project (2004-07) has been active in both NAO & YNAO. For Finland, 70% of imported oil and 15% of total electricity consumption come from Russia.

The first year of the project was devoted mainly to consultation, permissions, and field reconnaissance. Study areas were jointly selected in cooperation with the different stakeholders, including reindeer herders, during spring/summer 2004.

Dmitri Khorolya, President, Association of World Reindeer Herders (WRH)

A. Azarnov, Minister of Natural Resources

PhD students Timo Kumpula & Anu Pajunen discuss migrations with Roman Okotetto

Dr. Nina Meschtyb discusses migration with Taichi Khudi at Bovanenkovo

Sergei N. Khariuchi, RAIPON

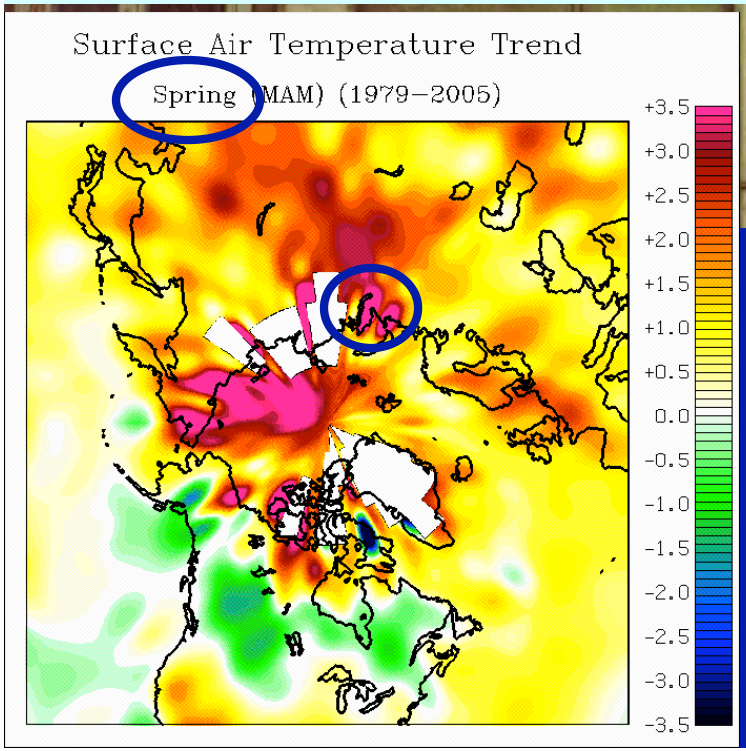
Base camp at km 147 on the Yamal railway/road, July 2007

In summer, natural and social scientists worked together with each other and with reindeer herders as much as possible in both regions. In general, natural scientists worked from a base camp, while social scientists were more mobile to accommodate the movements of herders among their different summer pastures.

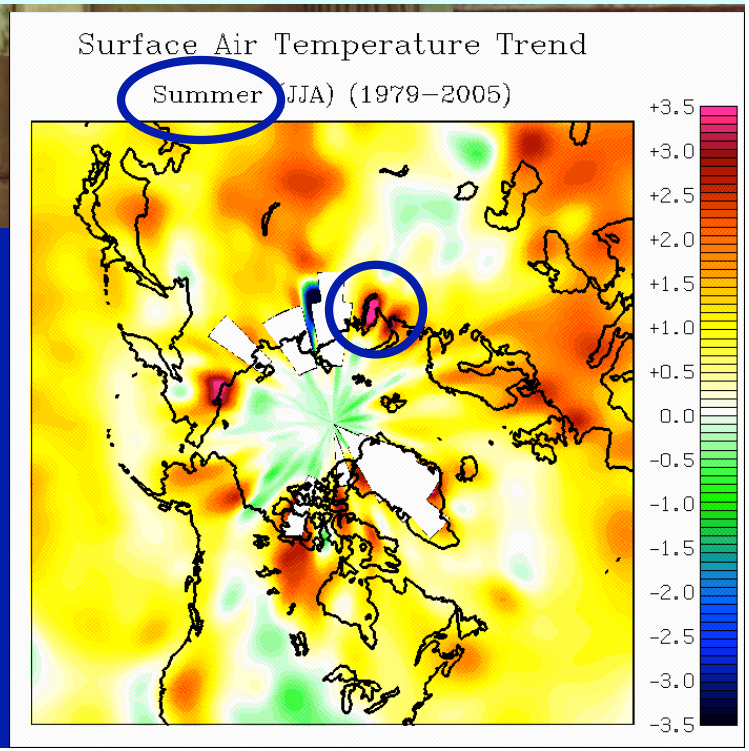
Base camp in Varandei tundra, NAO, July 2006

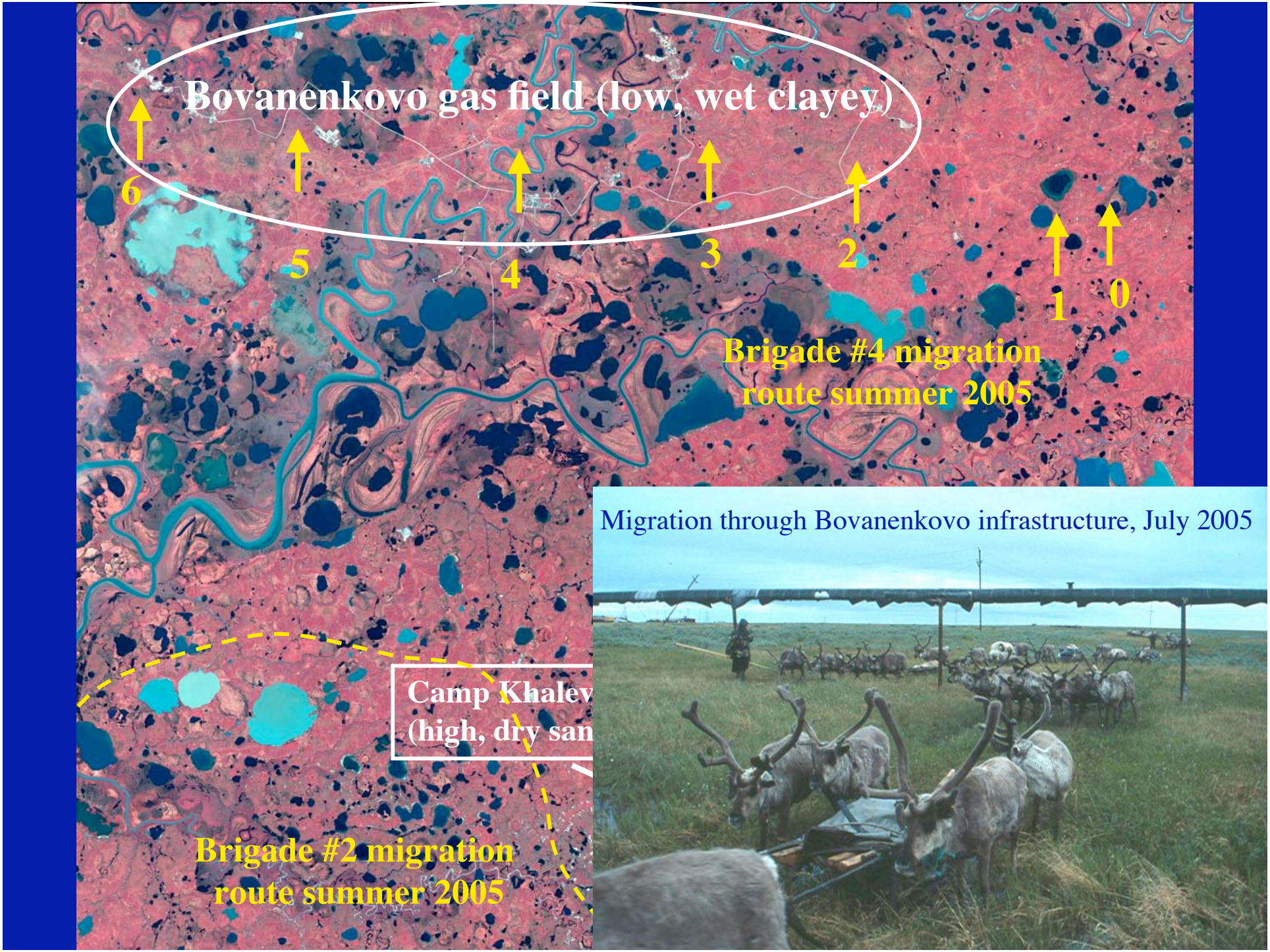
Base camp near Bovanenkovo, YNAO, July 2005

The ENSINOR project was designed to consider primarily oil & gas activities because these were what herders themselves cited as the most important factors affecting them. However, spring and summer air temperatures in NAO and YNAO have warmed over the past 25 to 30 years some 1.0 to >3.0°C. This has major implications for both oil & gas infrastructure and the future of reindeer herding since it means that people and reindeer are potentially exposed to multiple stressors.



"Building the road to your future". Billboard in Obskaya, Yamal Region





Migration through Bovanenkovo infrastructure, July 2005

Participant observation means that certain questions can be addressed in real time as the relevant issues arise

Florian Stammler makes oral notes near Bovanenkovo

Anna Degteva and Anu Pajunen, March 2007

Dr. Nina Meschtyb migrated with Brigade 2

The social scientists in the project worked with a combination of private and state herding enterprises, as well as with oil & gas workers, to understand the different perspectives.

Piotr Khudi and Jochen Dietel at reindeer corral near km 160

Herders migrate through active oil & gas fields. Mutual trust and extensive participant observation are required to address local perceptions and observations of environmental change. A multidisciplinary approach is necessary because the relative importance of environmental versus social drivers can change drastically within and among different management units and over time.

Interviews w/Nazar Taleev et al. in Varandei tundra, July 2006

Interviews with N. Khudi et al, Bovanenkovo gas field, 7/2005

Neighbouring brigades or groups of private herders moving through the same general territory are often only a few kilometers apart. Yet they can be facing very different potential futures based on development plans, which themselves can change with little or no warning. In addition to state-of-the-art science, fully understand this unfolding picture requires meaningful and open engagement with the responsible companies and regional administrations.

Within and near oil & gas fields reindeer herders daily encounter a wide range of environmental impacts.

Abandoned drill rigs are strewn with trash (e.g. rusted metal, broken glass) and often toxic drill muds.

Debris left on Varandei tundra, NAO, July 2006

Sand quarry near Obskaya, Yamal

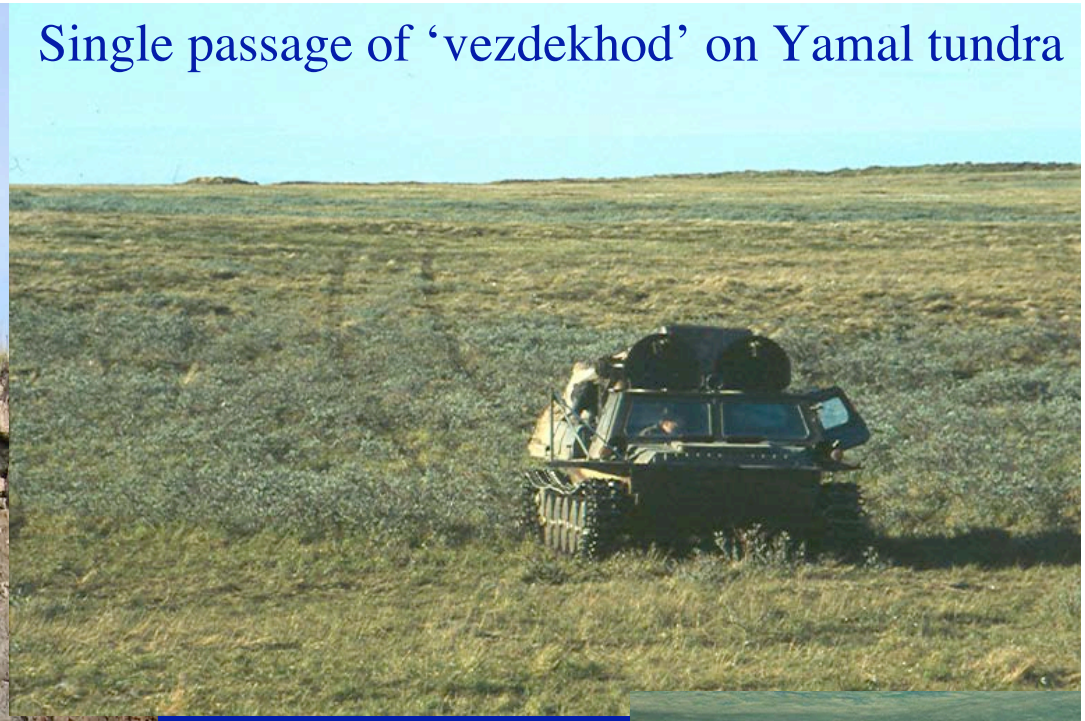
Truck traffic near Loborovaya, Yamal Peninsula

Among the negative effects of development, there can be direct impacts on the plant-soil cover over substantial areas. Sand and gravel quarries, for example, sometimes cover several hectares.

There can also be indirect impacts, including rapid transformation of the hydrological, chemical and nutrient regimes in otherwise intact vegetation. Here, alkaline dust affects moist acidic tundra along roads in Northwest Siberia. Road dust with pH ≈8.0 can travel hundreds of meters. Roads also have the potential to improve access for poachers.

Thawing ice-rich permafrost at Bovanenkovo

Single passage of ‘vezdekhod’ on Yamal tundra

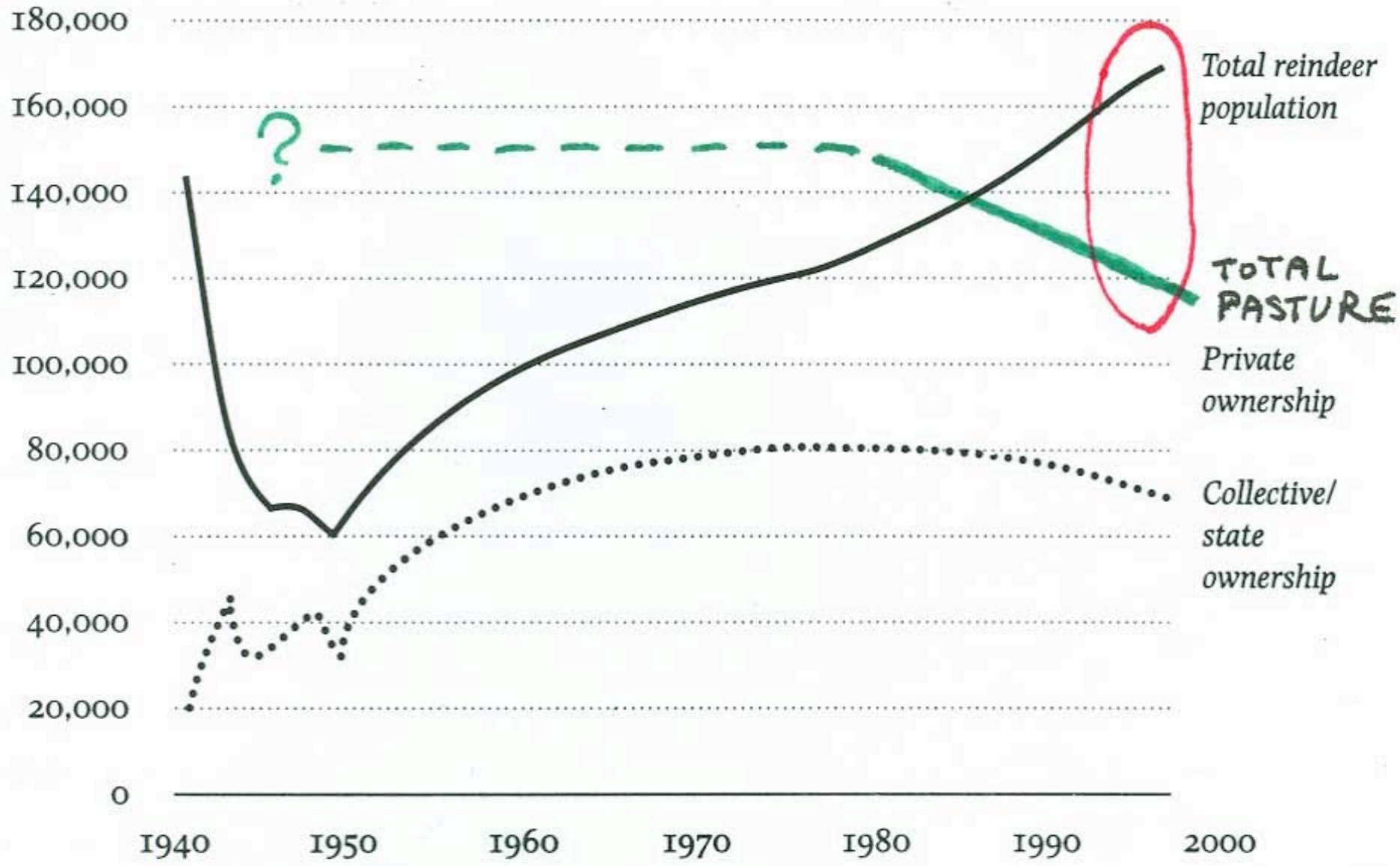


Visible changes in land cover over time can result from a combination of anthropogenic and natural processes. Examples include off-road vehicle traffic and thermal erosion of ice-rich permafrost.

Drying soil samples

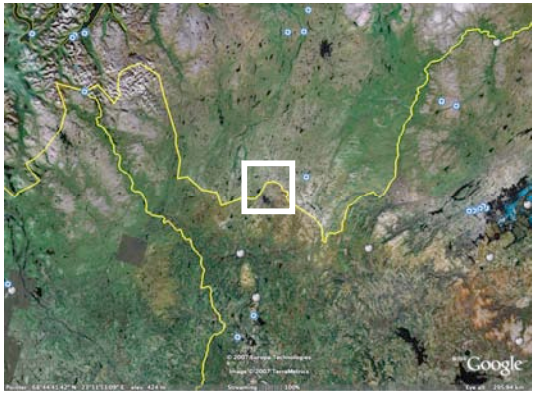
PhD student Anu Pajunen & assistant Elina Kaarlejärvi

In addition to thorough ground truthing and classification of the land cover types visible in the satellite imagery, detailed measurements were made of the vegetation (composition, cover, biomass, nutrients) and soils in different natural and anthropogenic habitats within summer pastures near Bovanenkovo and mainly vegetation along the railway/road corridor on southern Yamal (eg km 147).



Source: This graph is constructed from data in Tables 5.1 and 5.2

Figure 5.1. Reindeer population and ownership (1941–1994)

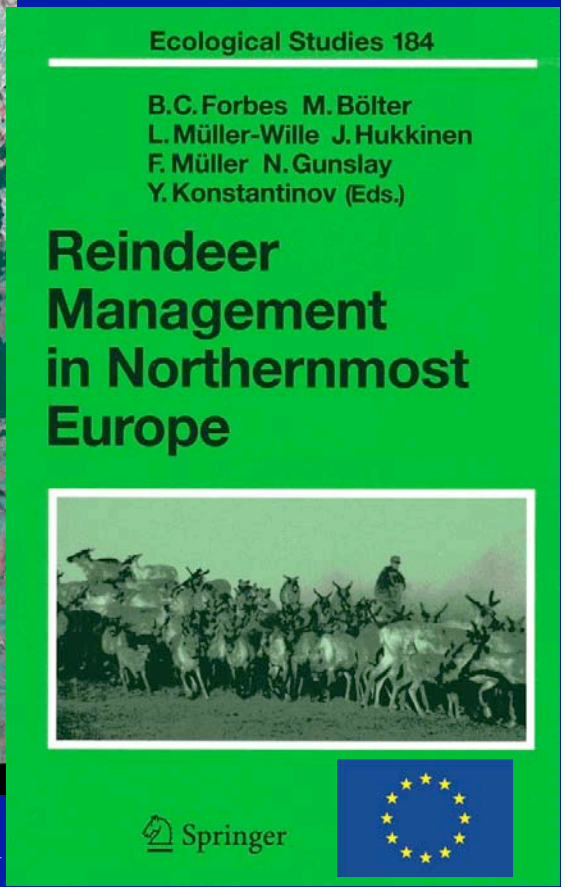


Norway

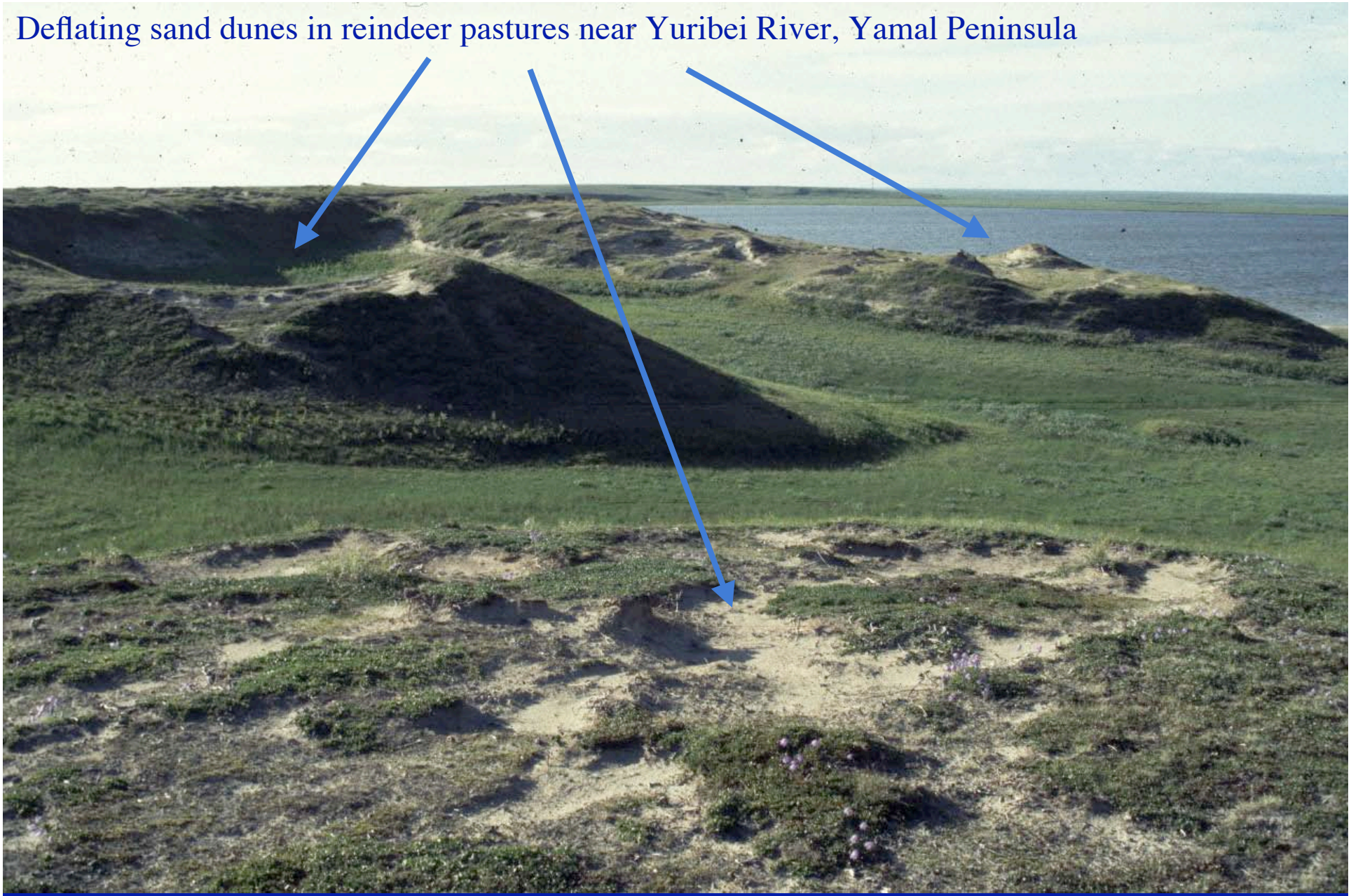
Finland

IKONOS satellite image, 4 m res., 11 x 11 km, 2001

In terms of extensive land use, in northernmost Fennoscandia and northern Russia reindeer can have profound impacts on ecosystem parameters such as vegetation cover, surface albedo, productivity, soil infiltration and decomposition rates. Visible is the absence of fruticose lichens due to long-term trampling/grazing.

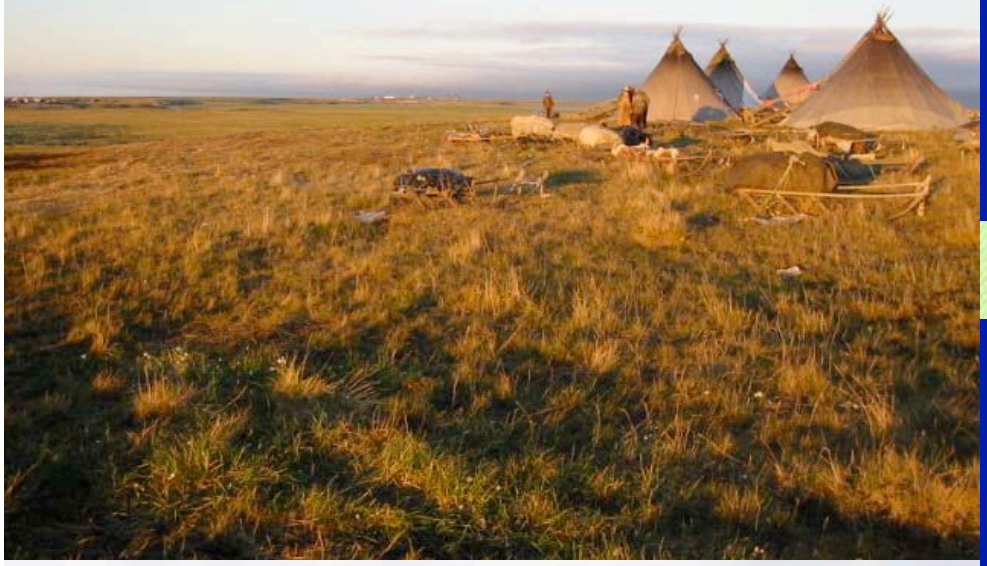


Deflating sand dunes in reindeer pastures near Yuribei River, Yamal Peninsula



In YNAO & NAO, net losses of pastures to the petroleum industry in the last 20-30 yrs mean animals use progressively smaller parcels of land. Degradation on well-drained sites with fine sands and loess has been called ‘overgrazing’ by Russian geobotanists.

Nenets brigade camps with grassy steppe-like vegetation near Bovanenkovo, Yamal Peninsula



Active campsite dominated by *Alopecurus alpinus*

Certainly the mires and riparian habitats of the region can handle heavy pasturing loads. However, some Russian scientists have argued that the sustained pressure of combined grazing and trampling is capable of turning dwarf-shrub heath to graminoid-dominated steppe tundra over extensive areas (e.g. Vilchek, Zimov, etc).

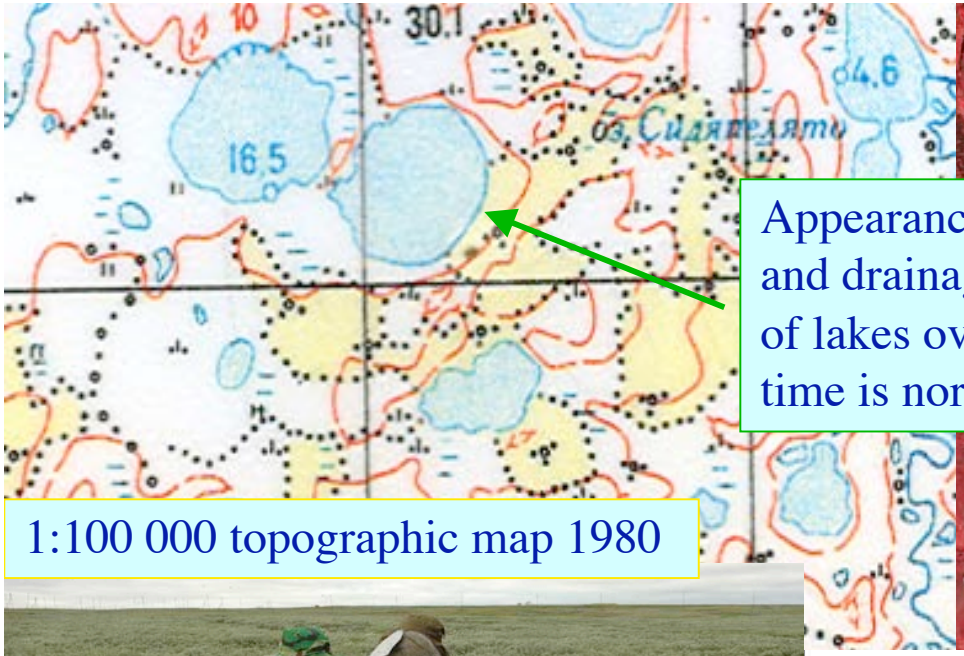
ОЛЕНЬИ ПАСТБИЩА

Skip raised the issue of what plants the reindeer are eating or, rather, not eating. Animals on the move between camps are limited to what is available along the route, mainly graminoids and *Salix* spp. In summer, free ranging animals have more choice. But I have not seen them eating *Betula* or *Alnus* in peak season.

Clipping of biomass in high shrubs near km 147 on south-easterly slopes (*Alnus fruticosa* and *Betula exilis* with some *Salix lanata*). Three 40 m transects, each with five 100 x 100 cm quadrats. Timo Kumpula took portable ASD spectrometer measurements along these same transects.

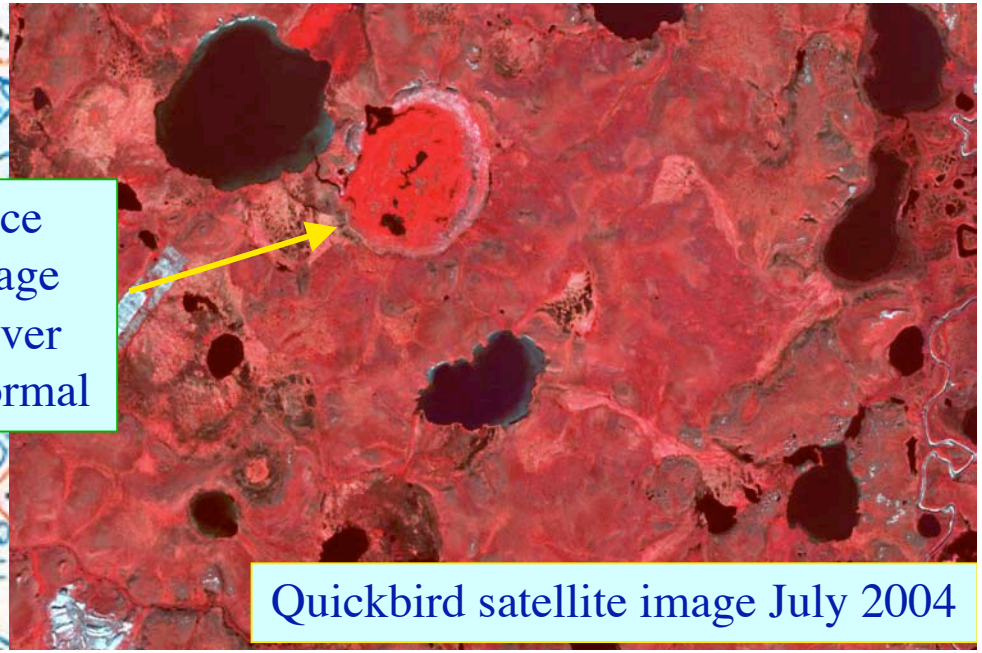
Juha Moilanen & Sara Bystedt clipping leaves

Elina Kaarlejärvi and Sara Bystedt drying biomass at km 147, July 2007



1:100 000 topographic map 1980

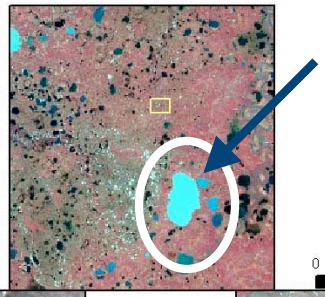
Appearance and drainage of lakes over time is normal



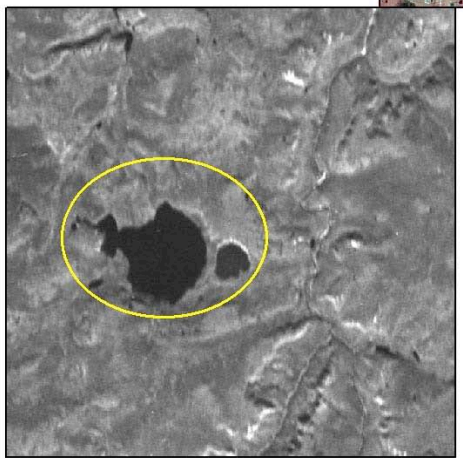
Quickbird satellite image July 2004

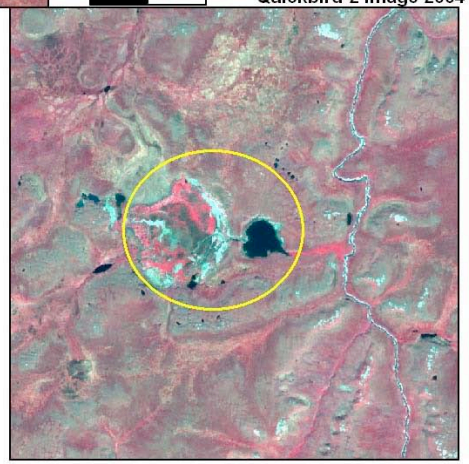
Dr. Nina Meschtyb and researcher Timo Kumpula

One factor that has garnered some attention as a possible response to recent climate warming is the rate of lake drainage in parts of Alaska and in YNAO (seen here).



Lake Khalevto began draining summer 2005





Smith *et al.* examined satellite imagery over a large swath of the West Siberian Basin and calculated the net rate of lake disappearance at 11% since 1973, mainly within the discontinuous permafrost zone. Fish from lakes/rivers constitute an important resource base for Nenets. Working further north on the Yamal Peninsula, reindeer herders have also reported recent drying and drainage of lakes.

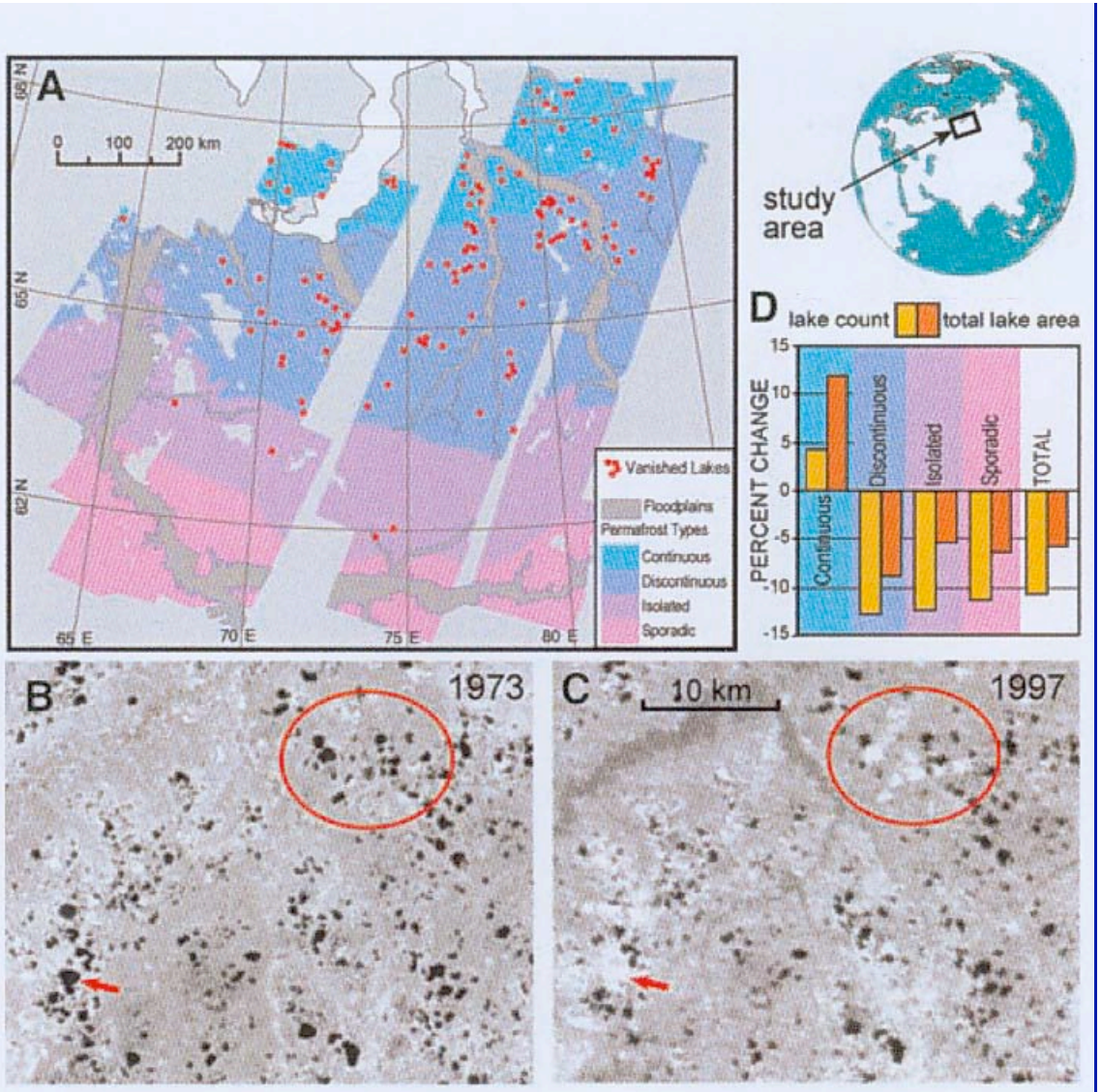


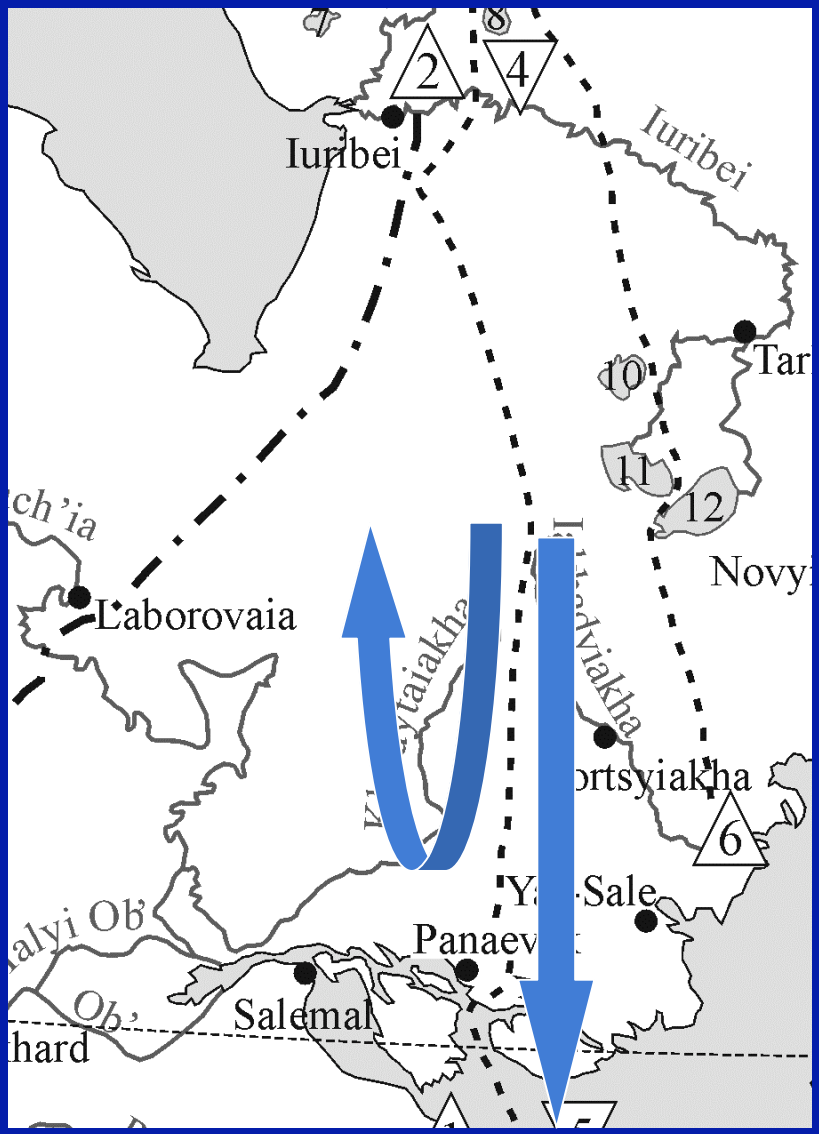
Fig. 1. (A) Locations of Siberian lake inventories, permafrost distribution, and vanished lakes. Total lake abundance and inundation area have declined since 1973 (B), including (C) permanent drainage and revegetation of former lakebeds (the arrow and oval show representative areas). (D) Net increases in lake abundance and area have occurred in continuous permafrost, suggesting an initial but transitory increase in surface ponding.

Smith *et al.* (2005) *Science*

Brigade 4, Yarsalinksi sovkhoz crossing Se-yakha River, Bovanenkovo gas field, July 2005

The timing of break-up on major rivers is critical for the entire region. In summer 2005 the Se-yakha River broke up two weeks ahead of ‘normal’, sending the herds racing to get to the windy summer pastures along the coast of the Kara Sea where insect relief is critical to calf survival.

Response to rapid change/extreme weather - Nov 2006



The relatively free use of space according to herders' own needs is a critical factor at present. However, if too much oil & gas infrastructure encroaches on their migration routes, this adaptive capacity will be greatly reduced.

Climate change

Increasing shrub abundance in the Arctic

The warming of the Alaskan Arctic during the past 150 years[1] has accelerated over the last three decades[2] and is expected to increase vegetation productivity in tundra if shrubs become more abundant[3,4]; indeed, this transition may already be under way according to local plot studies[5] and remote sensing[6]. Here we present evidence for a widespread increase in shrub abundance over more than 320 km^2 of Arctic landscape during the past 50 years, based on a comparison of historic and modern aerial photographs. This expansion will alter the partitioning of energy in summer[7] and the trapping and distribution of snow in winter[8], as well as increasing the amount of carbon stored in a region that is believed to be a net source of carbon dioxide[9].

During oil exploration of the United States Naval Petroleum Reserve no. 4 in northern Alaska in 1948–50, low-altitude oblique photographs of exceptional clarity were taken at thousands of locations between the Brooks Range and the Arctic coast[10]. In July of 1999 and 2000, we took photographs at 66 of the same locations spanning an area 400 km (east to west) by 150 km. We analysed pairs of new and old photographs for changes in the three principal deciduous shrubs, dwarf birch (*Betula nana*), willow (*Salix* sp.) and green alder (*Alnus crispa*), and for changes in treeline white spruce (*Picea glauca*) along the southern edge of the study area.

In 36 of the 66 repeat photo-pairs, we found distinctive and, in some cases, dramatic increases in the height and diameter

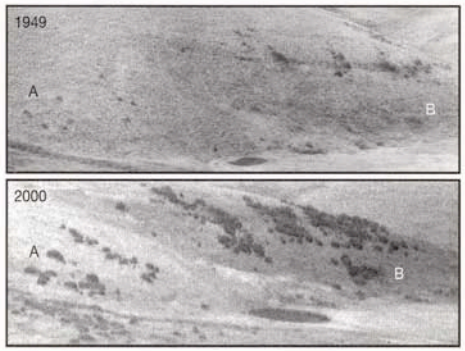


Figure 1 The Ayiyak River (N68° 53′, W152° 31′), showing an increase in the density of shrub patches, the growth of individual shrubs and an expansion of shrubs into areas that were previously shrub-free. A and B denote the same locations in the old and new photographs.

Sturm *et al.* (2001) *Nature*

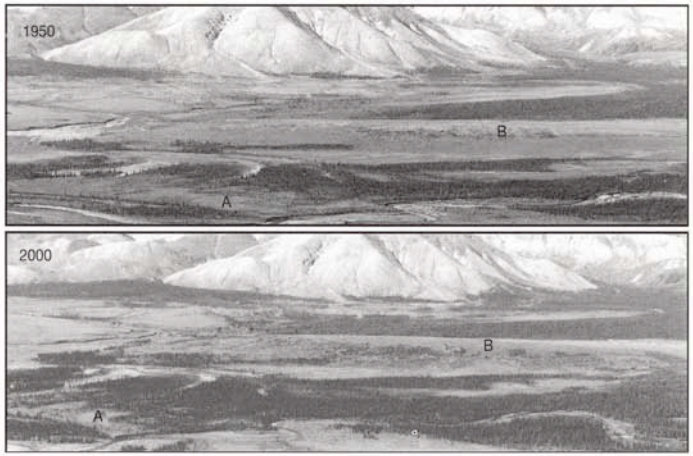
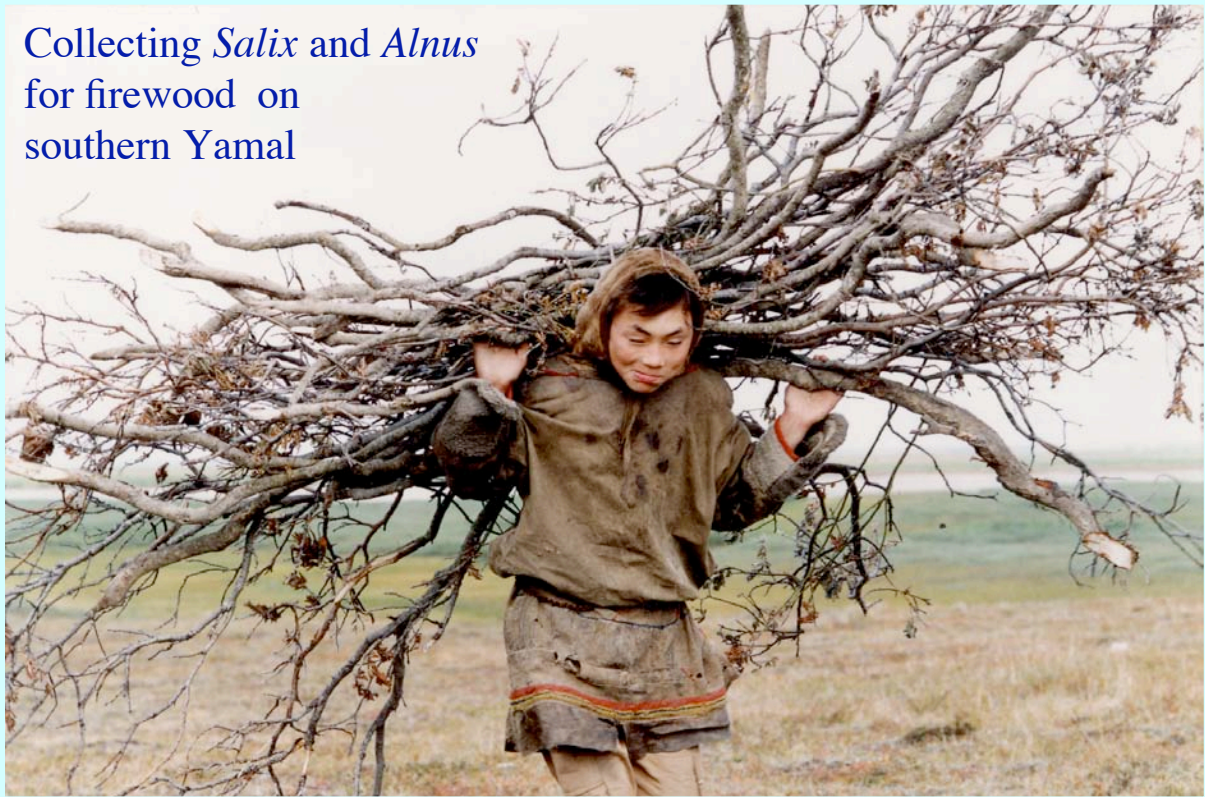
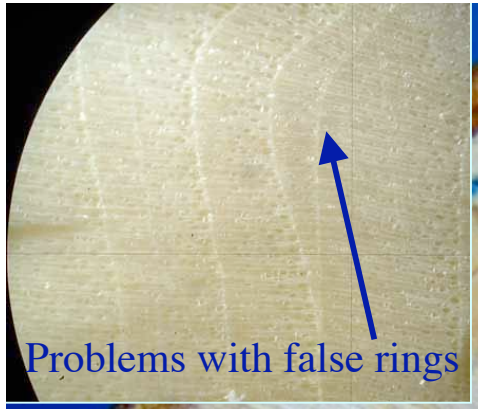


Figure 2 The Kugururok River (N68° 06′, W161° 31′), showing in-filling of spruce stands (A) and increased abundance of shrubs in the middle ground (B); A and B denote the same locations in the old and new photographs.

Another expected response to climate change is an increase in woody plant growth north of treeline. Repeat aerial photography has indicated an increase in shrub abundance for N Alaska. Herders in NAO (BALANCE) and YNAO (ENSINOR) have reported shrub increases. Is it possible to quantify this increase at appropriate scales?

Collecting *Salix* and *Alnus* for firewood on southern Yamal





1 cm

In the absence of repeat airphotos in northern Russia, we are conducting dendrochronological analyses of willow shrubs (*Salix lanata, Alnus fruticosa*) to see if a climate signal is detectable in willow growth over the past 20-30 years. Comparisons of the data from Varandei tundra to summer temperature records from climate stations have shown a strong relationship over a large area. Proxy data to be checked against NDVI.

Profile of *Salix lanata* from Bovanenkovo, March 2006

Conclusions

- The general trend of tundra vegetation change on Yamal under local anthropogenic and zoogenic disturbance is a decrease in shrub cover and an increase in graminoid cover
- Once established, graminoid-dominated states on organic substrates can persist for decades, in some cases for many centuries
- Reindeer can and do exploit graminoid-dominated patches as long as they are free of trash, chemicals, disturbance (e.g. dogs, loud noises)
- A great deal of pasture has been permanently removed for infrastructure (railway, roads, quarries, etc.) yet the development is still in its early phase. Full production is several years in the future
- Herders want to know which areas of pasture will be affected and to have a say in preserving viable migration routes for future generations of tundra nomads (campsites, fishing lakes and streams, sacred sites...)
- Herders have adapted quite well to a range of major socio-economic and ecological changes in recent decades. However, this resilience is not unlimited since it depends in large part on abundant free space

http://www.arcticcentre.org/ensinor