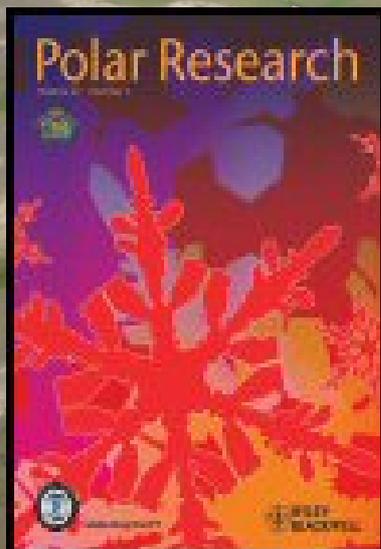


# TOWARDS A SYSTEM ANALYSIS OF YAMAL TUNDRAS

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Eight years ago we have proclaimed rather an obvious idea that ecosystem complexity has to be taken into account while studying tundra ecosystems. The most appropriate approach to do this is using a system analysis with simulation modeling serving as its main tool.



## Reindeer in tundra ecosystems: the challenges of understanding system complexity

Feodor V. Kryazhinskiy & Alexey N. Doroshov



The richness of tundra ecosystems is limited, with relatively few key biotic components determining the general pattern of the dynamics of these systems. Nonetheless, one of reindeer systems, which are among tundra ecosystems, should take into account interactions within the whole complex of key components. Among the most important are the small herbivore species. For example, during peak densities, lemmings may reduce above-ground plant biomass by 20–30%. At the same time, rapid turnover of nutrients in the form of significant amounts of excrement, phytochemicals and strong plant biomass increase in some particular tundra plant groups. It is concluded that three kinds of studies are essential for the sustainable management of Russia's grazing lands: 1) comparative studies of productivity, biological diversity and structure of plant communities under the different pressures, created by the main groups of herbivorous animals (reindeer and small rodents), as well as under varying levels of industrial development; 2) studies of the direct and indirect effects of herbivorous mammals on biological turnover and energy flow within the system; 3) studies of the role of industrial communities on the structure of tundra ecosystems.

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It is widely recognized that the richness of tundra ecosystems is limited, resulting in few interactions among various processes. This feature is a product of 1) low productivity of the dominant plant communities, and 2) the simple structure (small, long-lived species composition, higher than average, stable life span) of tundra communities (Bridges et al. 1995). These characteristics are related to thermal instability of arctic tundra, the relatively short period of existence of these ecosystems and specific climatic conditions. As a consequence, a relatively few key biotic components determine the general pattern of biological turnover and, consequently, the whole dynamics of tundra ecosystems.

Productive and sustainable use of reindeer systems, which are in their natural state, requires, should we ignore the effects caused by other components of tundra ecosystems in addition to reindeer. Moreover, interactions within the whole complex of key components of tundra ecosystems are essential for the long-term, sustained production of reindeer products. Among

these components, the most important for the "negative" cover are small herbivorous rodents, Lemmings species (*Dicrostonyx* sp. and *Lemmus* sp.) play the leading role within this group (Thompson 1981; Titkova 1990; Pechenkin 2000; Chirpovskiy & Pechenkin 2002; Titkova 2003).

In this paper we take a brief look at this group to demonstrate the importance of existing relations between its natural components with complex networks of interactions. First, they were included on the Yamal Peninsula. We attempt to show the practical and theoretical importance of a complex approach to studying tundra ecosystems.

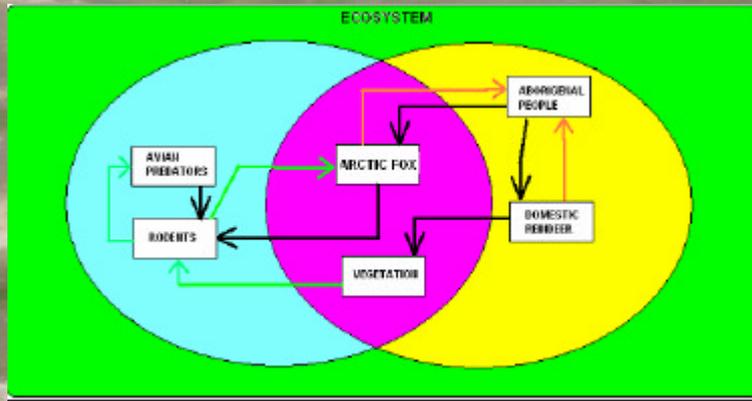
**The modern state of reindeer pastures in Russia from the viewpoint of an ecologist**

Reindeer herding, a traditional activity in Russia's northern regions, is one of the most important factors affecting the state of vegetation cover

Kryazhinskiy & Doroshov 2008, Polar Research 17(4), 107–119

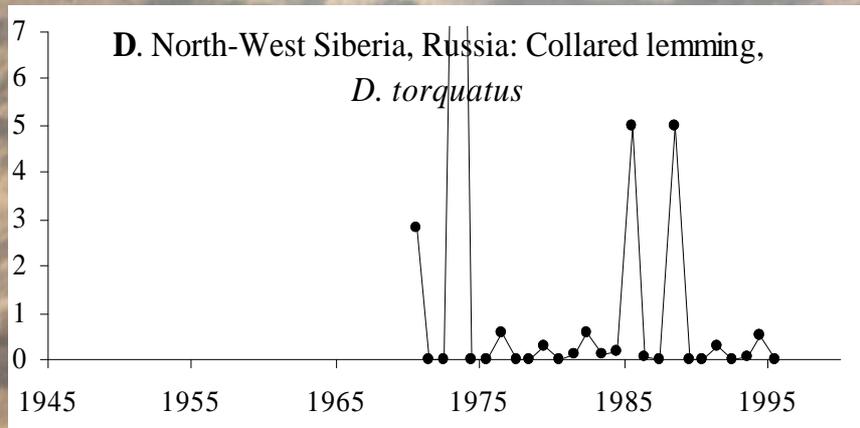
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## SIMPLIFIED SCHEME OF A TUNDRA ECOSYSTEM

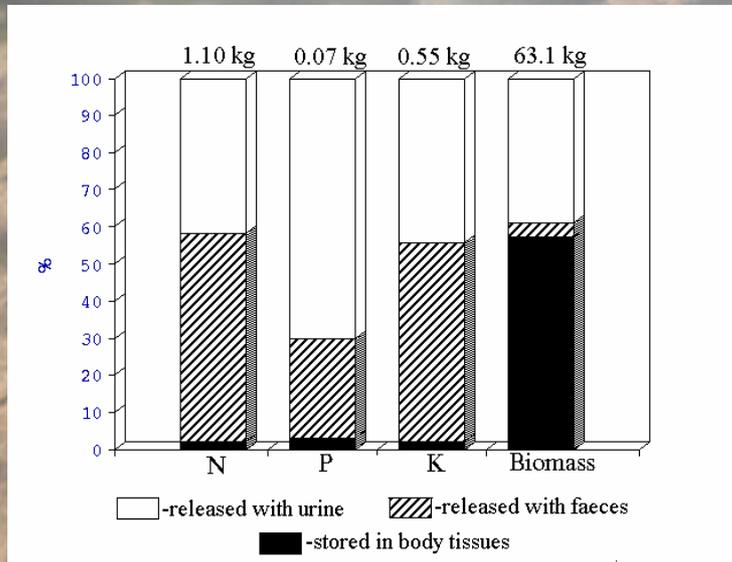


A CONTEMPORARY ECOSYSTEM CONSISTS OF TWO OVERLAPPING AND INTERACTING SUBSYSTEMS: BIOCECENOSIS AND ANTHROPOCENOSIS

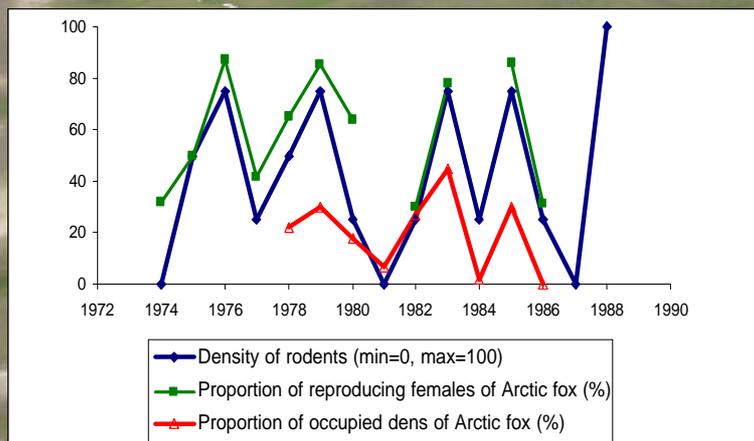
THE HIGHEST OUTBREAK OF LEMMINGS DENSITY WAS OBSERVED AT THE YAMAL IN 1973  
(Data of Balahonov et al., 1973 taken from Stenseth, 2000)



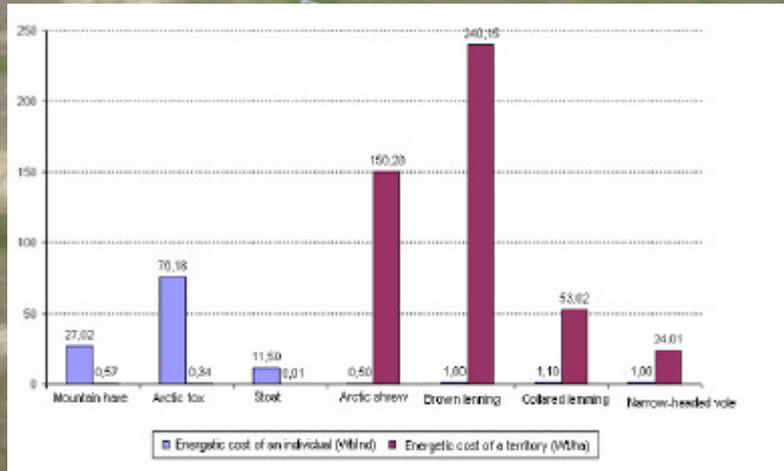
The role of small rodents in ecosystem turnover  
(Kryazhimskiy & Danilov, 2000)



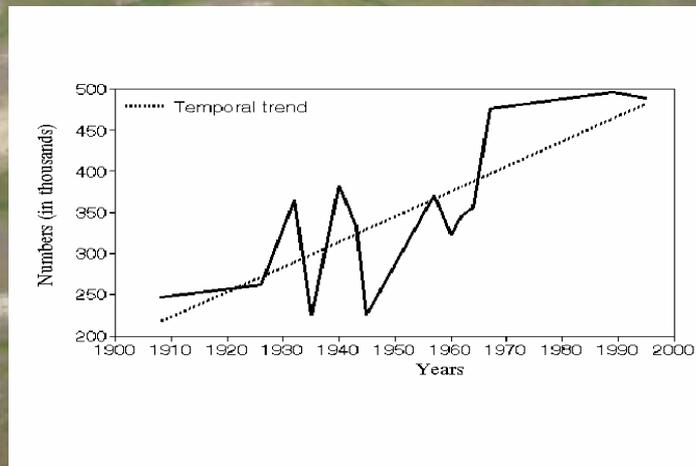
Dependence of reproduction of Arctic fox on rodents density



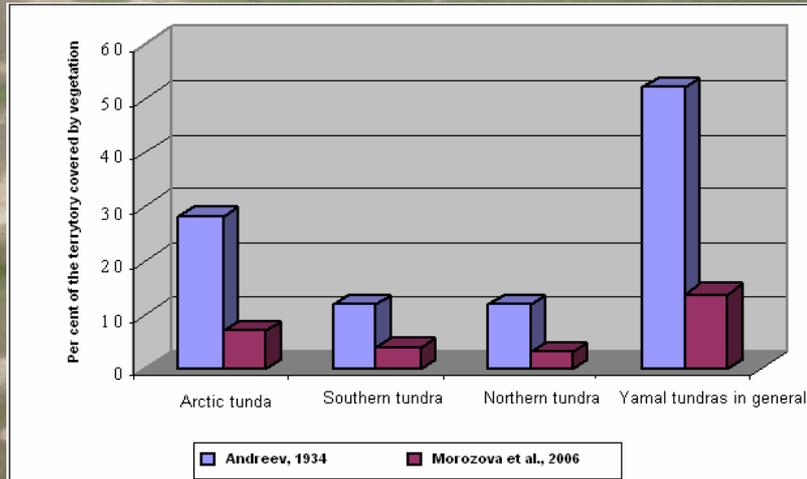
EVALUATION OF “ ENERGETICAL COST” INDICATED THAT SMALL MAMMALS (PER A PIECE OF TERRITORY) MUCH MORE “ VALUABLE” THAN BIG ANIMALS (INCLUDING THEIR PREDATORS).



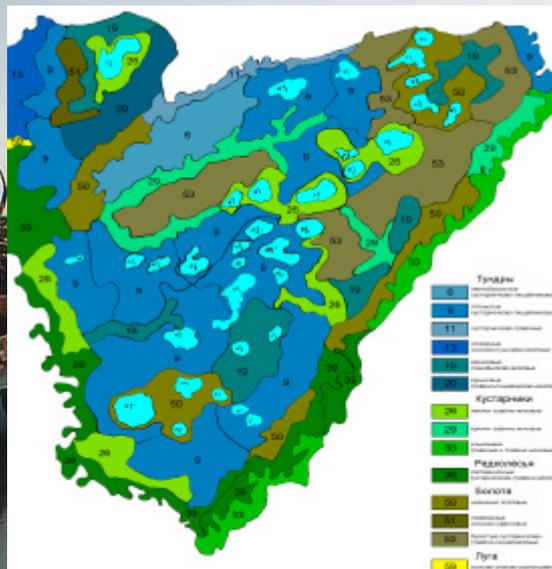
IN THE COURSE OF XX CENTURY NUMBERS OF DOMESTIC REINDEER CONSTANTLY INCREASED IN THE YAMAL PENNINCULA



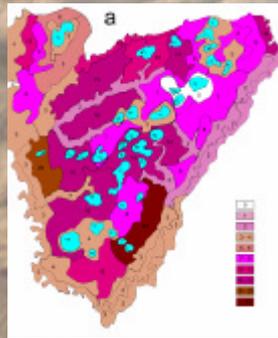
**PARTICIPATION OF LICHENS IN VEGETATION COVER HAS BEEN REDUCED IN THE PAST 30 YEARS**



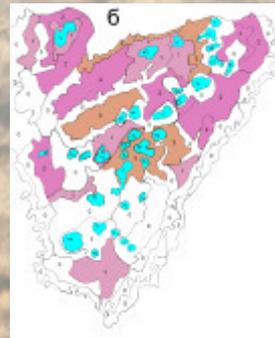
**GEOBOTANICAL MAP OF THE KEY PLOT FOR MONITORING THE STATE OF VEGETATIVE COVER IN THE MIDDLE YAMAL**



IN THE RECENT 10 YEARS THE  
CAPABILITY OF TUNDRA TO  
FORAGE REINDEER BECAME  
SIGNIFICANTLY LOWER



1985



1995

THANK YOU FOR YOUR  
ATTENTION

