Lemming dynamics in the north American Arctic:

A litterature overview

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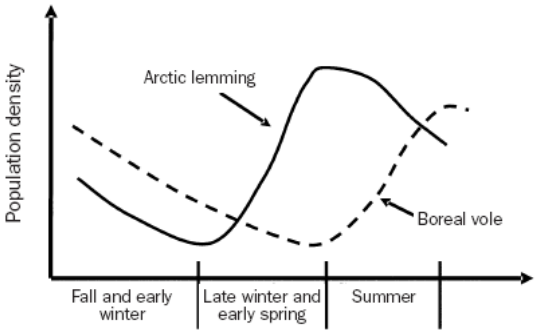
Lemming cycles

- Most lemming populations are cyclic
- Population cycles have important ecological consequences for the functioning of tundra ecosystems
- Climate change is likely to alter cyclic dynamics in tundra species
  - Winter climate is particularly important

- Seasonal dynamics
  - Lemming cycles
  - Vole cycles
- Ecosystem impacts differ
  - For plants
  - For predators



(Ims and Fuglei, 2005, Bioscience)

Lemming data from the North American Arctic

- Cyclic?
- Period?
- Densities / trapping indices?
- Seasonal dynamics
  - Winter reproduction
  - Dynamics over the summer
- Spatial synchrony?

Photo: A. Angerbjörn

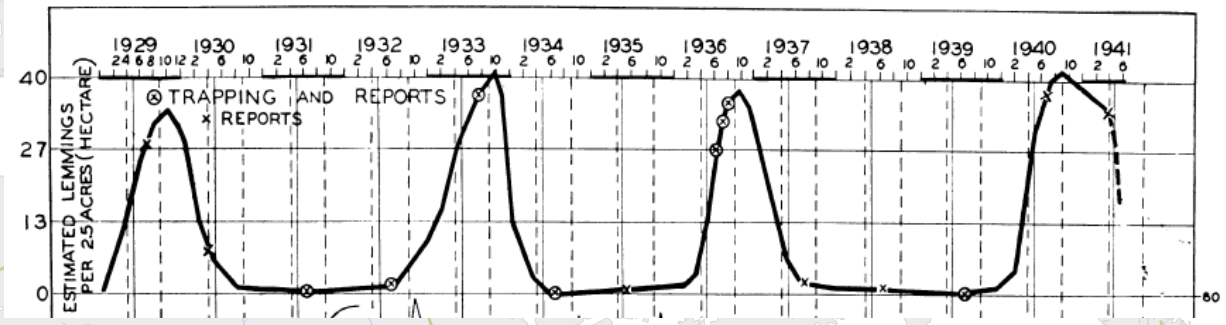
Churchill, Manitoba

Photo: A. Sokolov

- Trapping of collared lemmings since 1930
- Different people, different methods

Churchill, Manitoba

Shelford 1943, Ecology



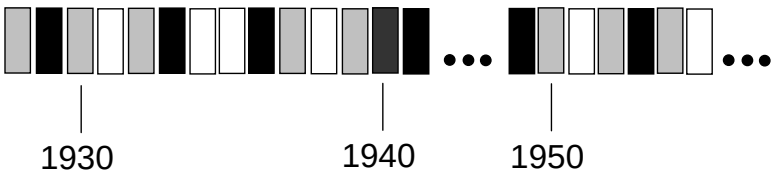
This curve is a rough expression of experience with the lemming rather than an accurate year to year determination by sampling, but based primarily on trapping.

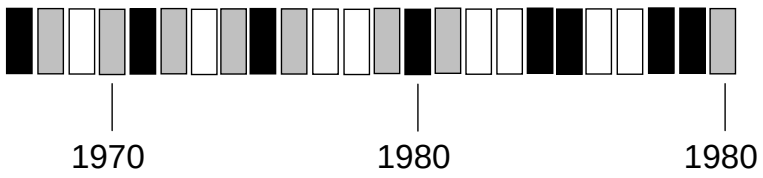
The winter conditions preceding summers in which the population was built up were characterized by heavy snowfall and high winter temperatures at Churchill.

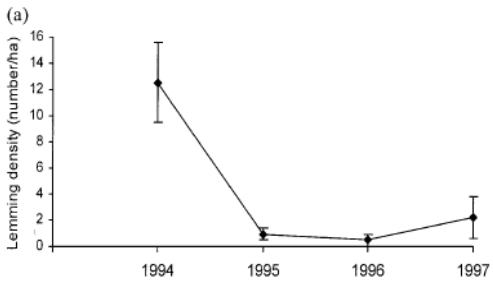
Churchill, Manitoba

- Scott 1993, Arctic

  (based mainly on Shelford 1943, Smith and Foster 1957, Scott and Hansell 1989)







Roth, 2002, Oecologia:
Densities of collared lemmings
Live-trapping on 3 grids in lichen-heath tundra

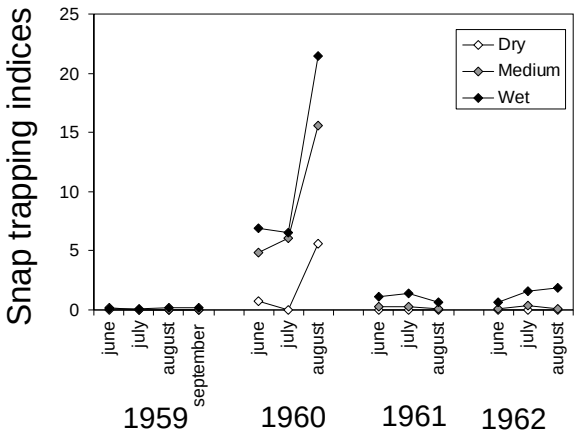
Period: on average 4 years
Shape: variable, gradual increase and decrease common
No information on seasonal dynamics

The lemming cycle at Baker Lake

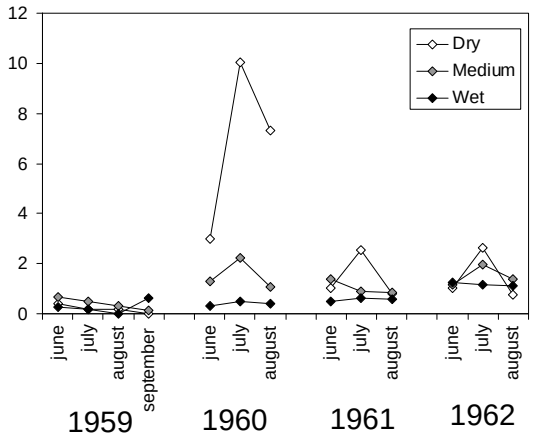
- Krebs 1964
- 4 years of field work: 1959-1962 (May to September)
- Main study area of 3 square miles, additional sampling
- Detailed (semi-complete) description of a single lemming cycle (*Lemmus trimucronatus* and *Dicrostonyx groenlandicus*)
  - Numbers and densities estimated with different methods
  - Timing of breeding, nb of embryos
  - Body weight, weight at maturity
  - Survival for adults and juveniles
  - Movement distances (life trapping)

The lemming cycle at Baker Lake

Lemmus trimucronatus



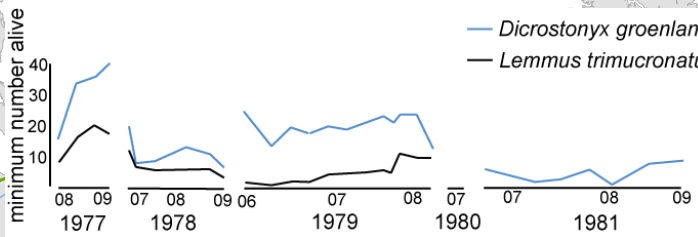
Dicrostonyx groenlandicus



- Lengthened summer breeding season and winter breeding during the increase year
- Higher weights in the peak year
- More wounds on skins from june in the peak year (aggressive behaviour)

Igloolik island

- Rogers and Lewis, 1986, Can. J. of Zoology
- Negus and Berger, 1998, Can. J. of Zoology



Live trapping with 90 traps on about 500x500m

scarce	scarce	considerabe increase	even higher
1981	1982	1983	1984

Long cycle?

Increase during summer in 1983, possibly in 1977

High Arctic: Devon island

- Fuller et al. 1975, Can. J. of Zoology:
- High-arctic lemmings: *Dicrostonyx goenlandicus.* II. Demography

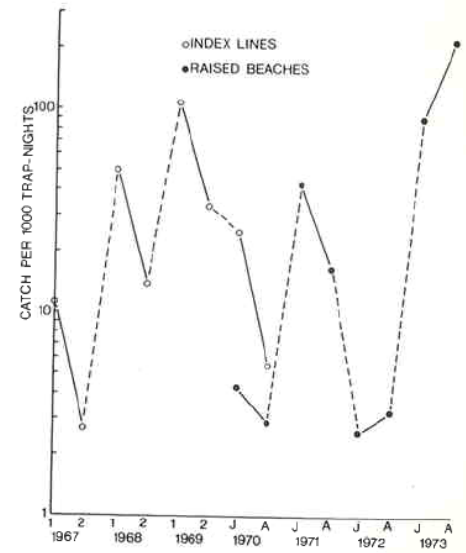


FIG. 2. Catches per unit effort on index lines and all trapping on raised beaches during seven summers. The numbers 1 and 2 in years 1967–1969 represent times of first and second trappings of index lines as shown in Fig. 2. Points plotted for raised beaches are monthly mean catches for July (J) and August (A).

4 year interval between peaks

Summer decline in most years

Karrak Lake

- Samelius et al. 2007, J. of Animal Ecology

Data from 3 snap-trap lines,
25 traps each, 10 days.
Early to mid july.

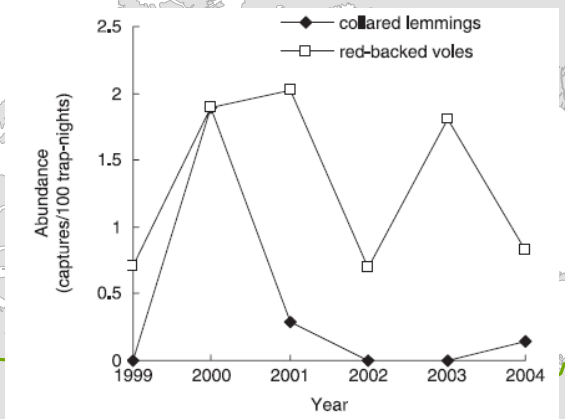


Fig. 2. Small mammal abundance at Karrak Lake in 1999–2004. Brown lemmings were not captured or otherwise encountered at Karrak Lake during this study.

Lemming synchrony in the Canadian Arctic

- 7 sites in the western Arctic and 8 sites in the central Arctic
- Snap trapping in different habitat types
- Total area approximately 100ha at each site
- late june

(Krebs et al. 2002, Can. J. Zool.)

Lemming survey in central NWT

Fig. 3. Lemming and vole population indices for two central Arctic sites, Hope Bay, Nunavut (*a*) and Walker Bay, Nunavut (*b*). Populations of small rodents appeared to be in near-perfect synchrony in this region from 1984 to 2000.

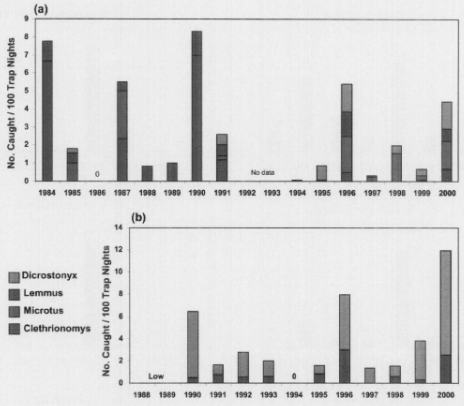
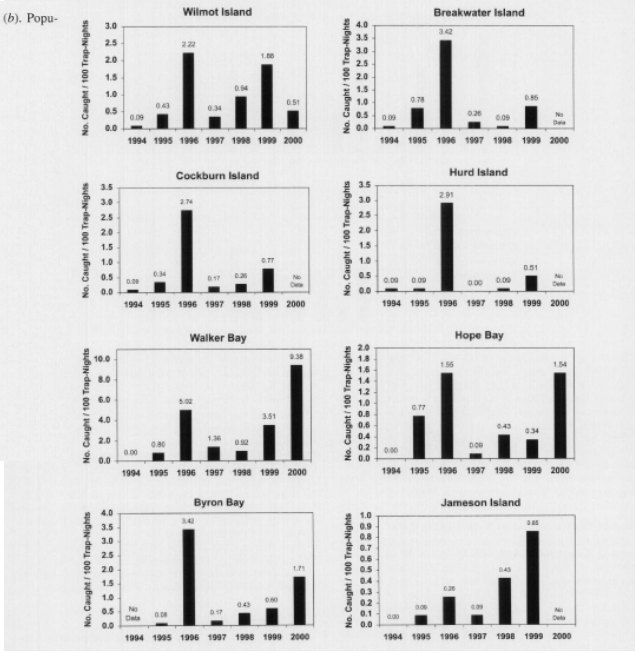


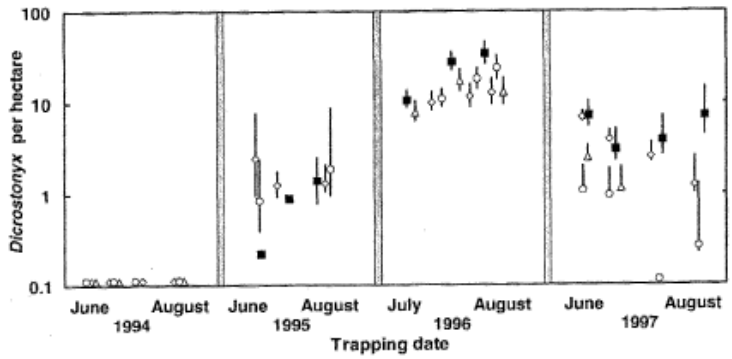
Fig. 4. Collared lemming (*Dicrostonyx groenlandicus*) population indices for six island and two mainland sites in the central Arctic. Except on Jameson Island and Wilmot Island in 1999, lemming populations appeared to be in synchrony in this region from 1994 to 2000.



Synchrony and cycles in the central Arctic
Unclear pattern in the western Arctic

Walker Bay

- Wilson et al. 1999, Oikos
- Detailed Capture-Mark-Recapture study, live trapping on 4 grids
- Predation exclosure experiment



1994: on 1 *Lemmus* and 1 *Dicrostonyx* caught

Pearce Point: non-cyclic lemmings

- Krebs et al. 1995, Oecologia
- Reid et al. 1997, Ecological monographs
- live trapping on 3 grids, 18-25 ha

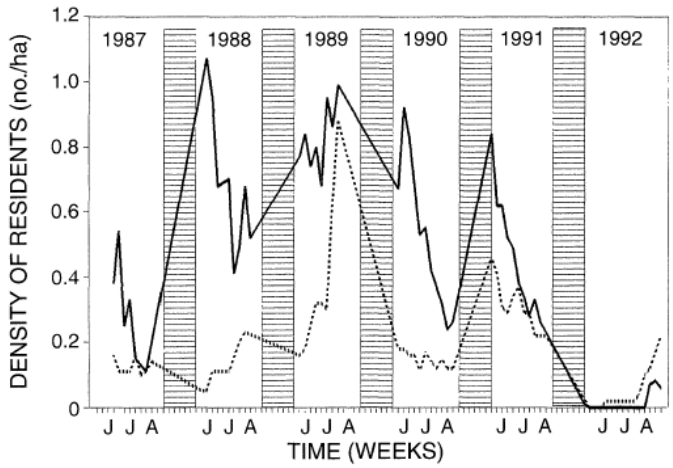
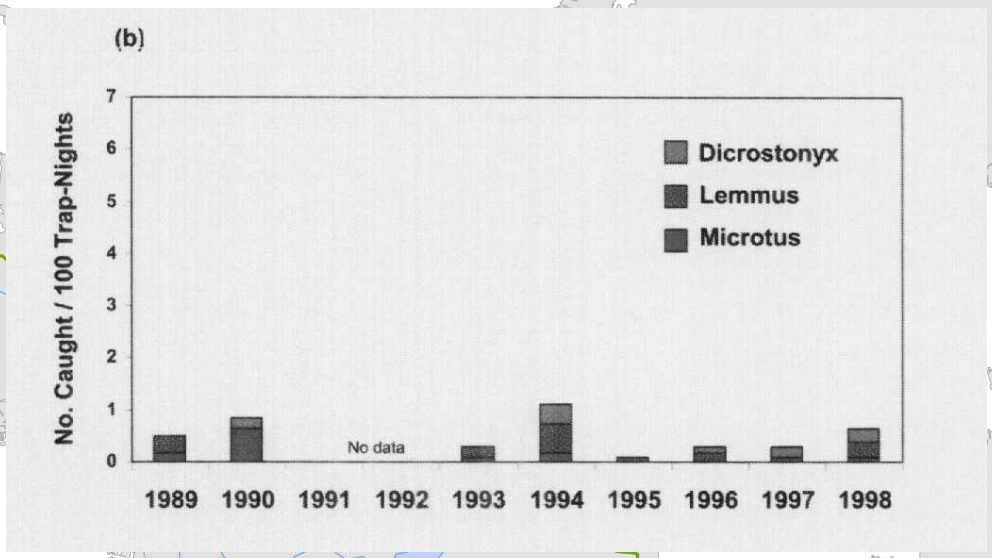


FIG. 1. Mean Jolly–Seber density estimates (no./ha) of resident collared lemmings (solid line) and tundra voles (broken line) on the three study grids in six summers of study. Striped bars represent winter, during which densities are interpolated.

Very low densities, decline in most summers

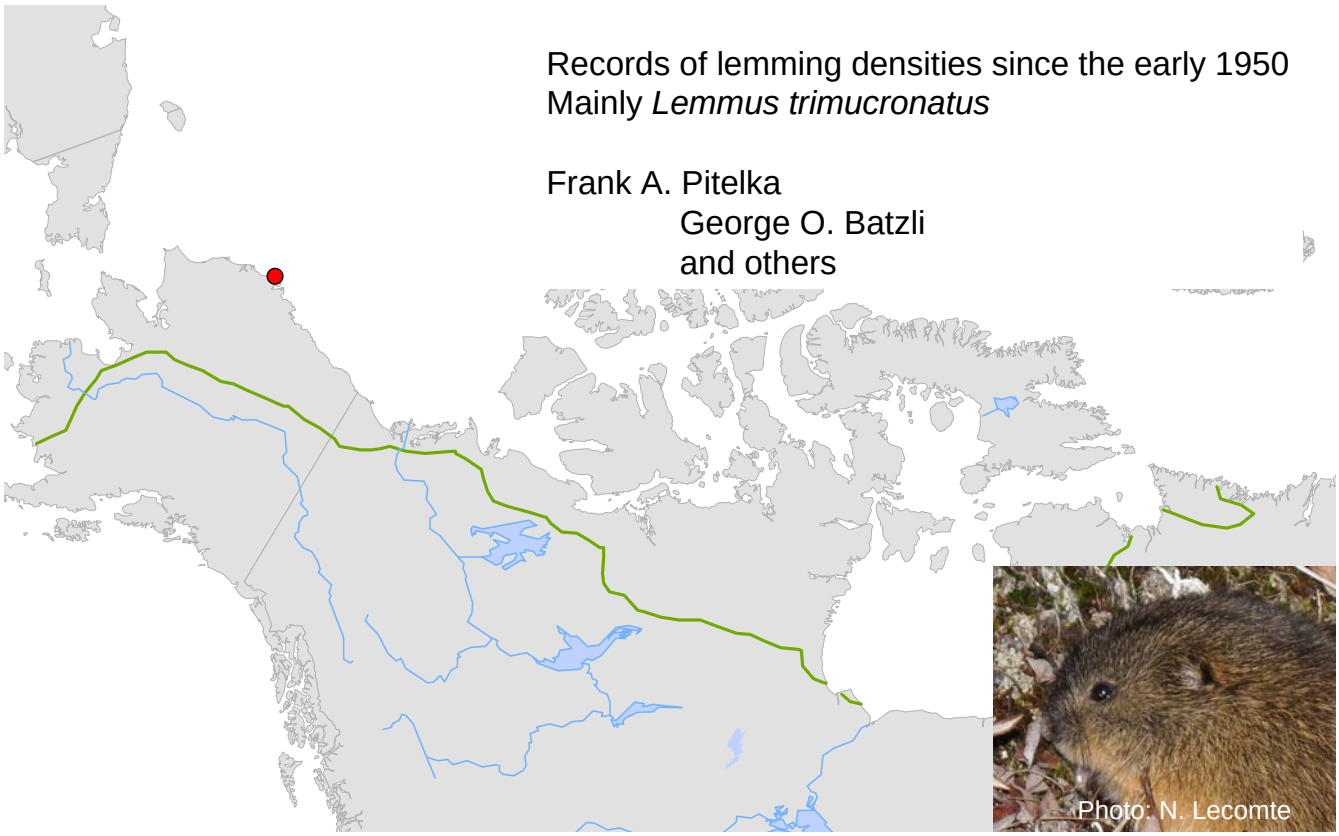
Population growth in some winters

Shingle Point, Yukon



Low densities in all years

Barrow, Alaska



Records of lemming densities since the early 1950
Mainly *Lemmus trimucronatus*

Frank A. Pitelka
George O. Batzli
and others

Barrow, Alaska

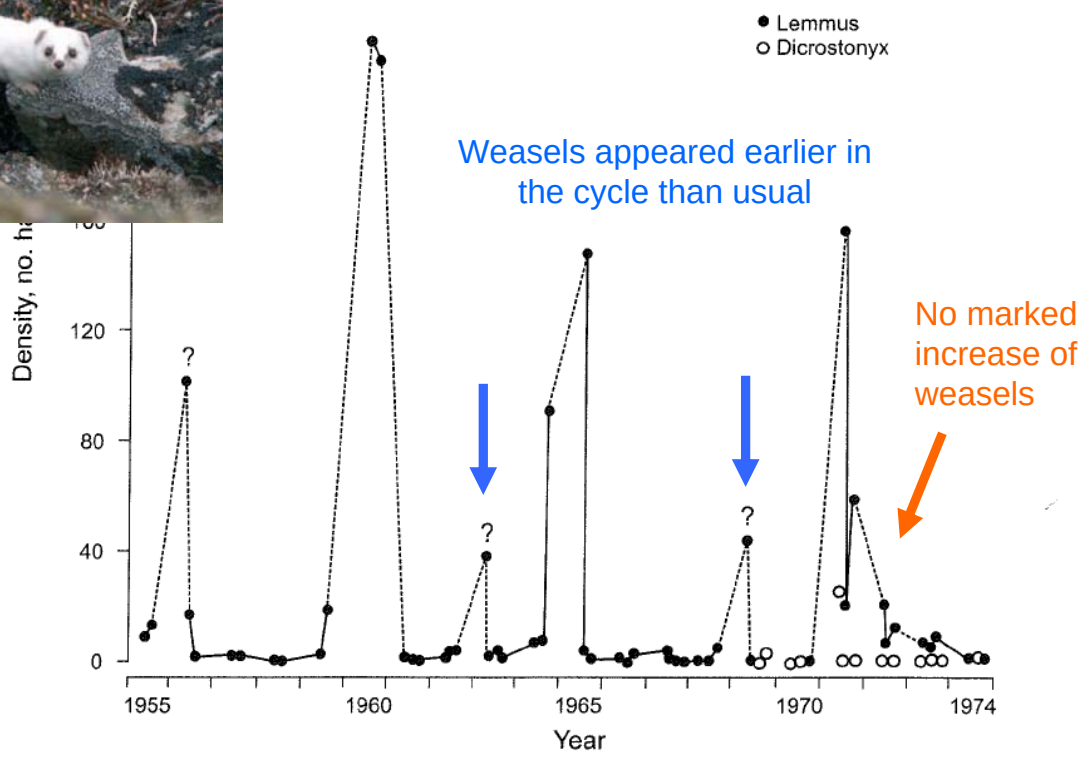


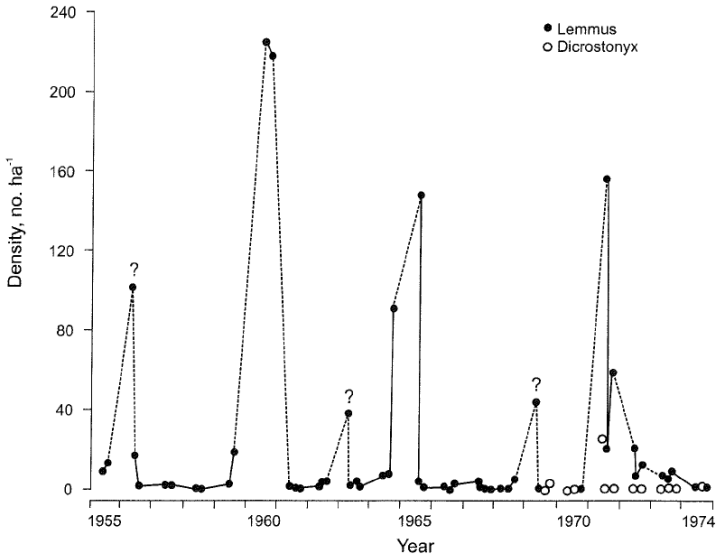
Fig. 2. Overall estimates of densities of lemmings in a variety of habitats based upon catches from trap lines. Mark and recapture estimates from live trapping were used to transform snap-trap indices to densities (Batzli 1981). Dashed lines represent changes in density during winter, and question marks indicate estimates of likely densities reached sometime before snowmelt based upon signs of winter nests and grazing. From Batzli *et al.* (1980).

(Pitelka and Batzli 2007, Acta theriol.)

Barrow, Alaska

1946: peak
1949: peak population in late winter which collapsed in spring

Period: 5-6 years (peaks reaching the summer)



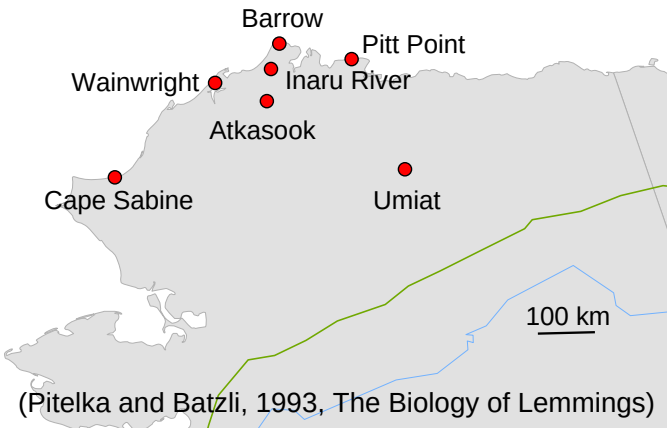
(Pitelka and Batzli 2007, Acta theriol.)

year	lemmings	snowy owls	pomarine skuas
1975	moderate	breeding	breeding
1976	high	breeding	breeding
1977	low		
1978	low	low	breeding
1979	low		
1980	low		
1991	present	0.47	breeding
1992	low		
1993	peak	0.11	breeding
1994	low		
1995	peak	0.31	breeding
1996	Decreasing	0.11	breeding
1997	low		
1998	low		
1999	peak	0.16	breeding
2000	Decreasing		

(Krebs et al. 2002 after D. Holt Quakenbrush et al. 2004. Arctic)

Alaska

- *Lemmus sibiricus* does not fluctuate in synchrony in Alaska
- No synchrony among species
- Strong cycles at the coast
- Declining towards inland
  - More micotines
  - Other predators



(Pitelka and Batzli, 1993, The Biology of Lemmings)

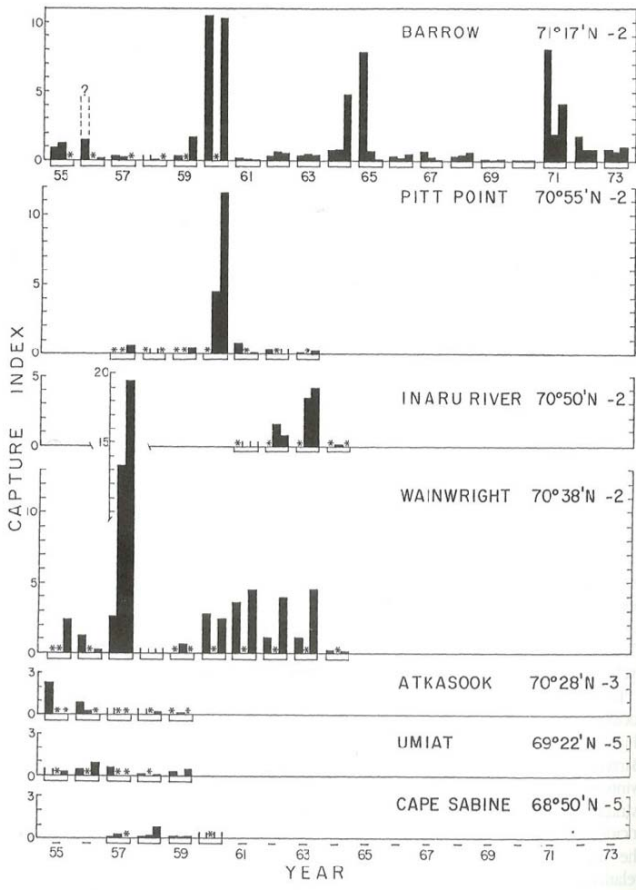
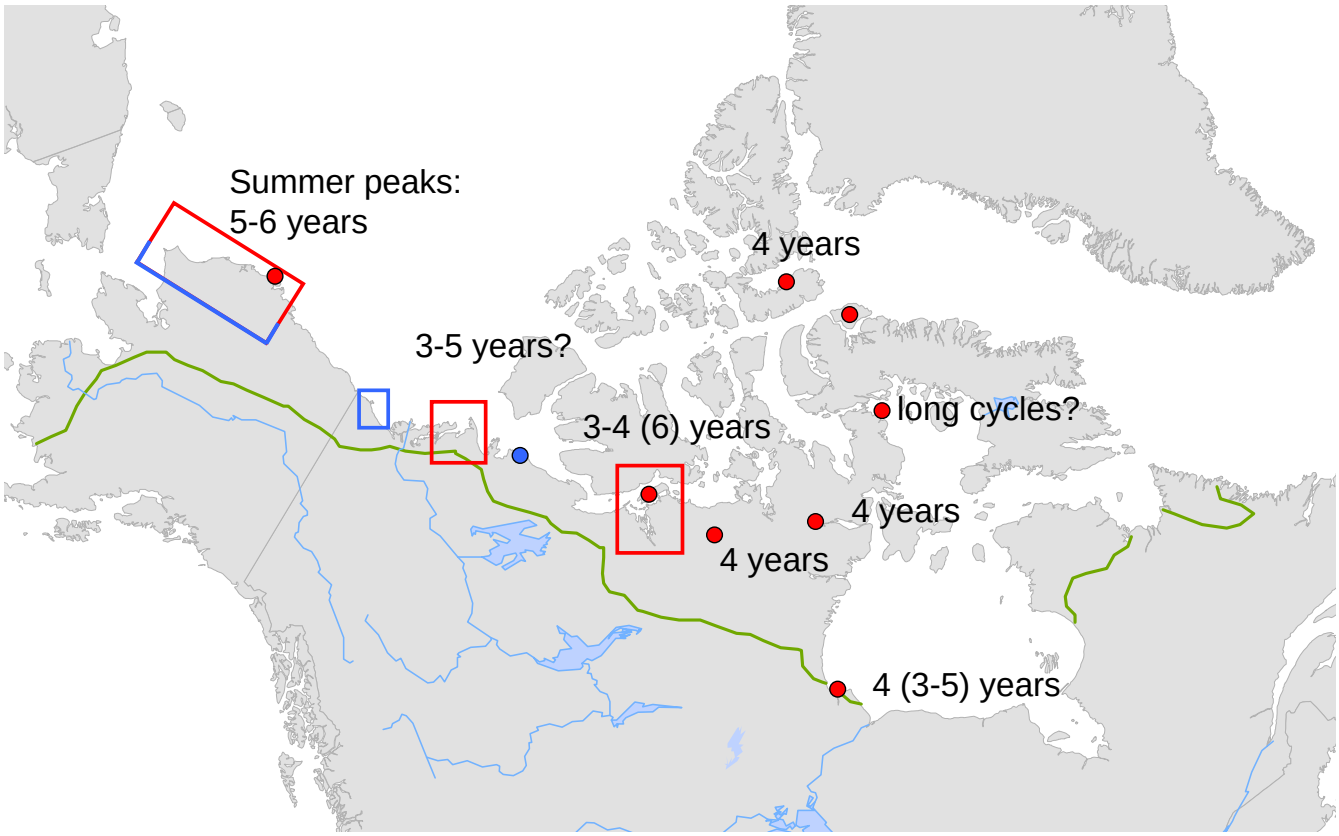
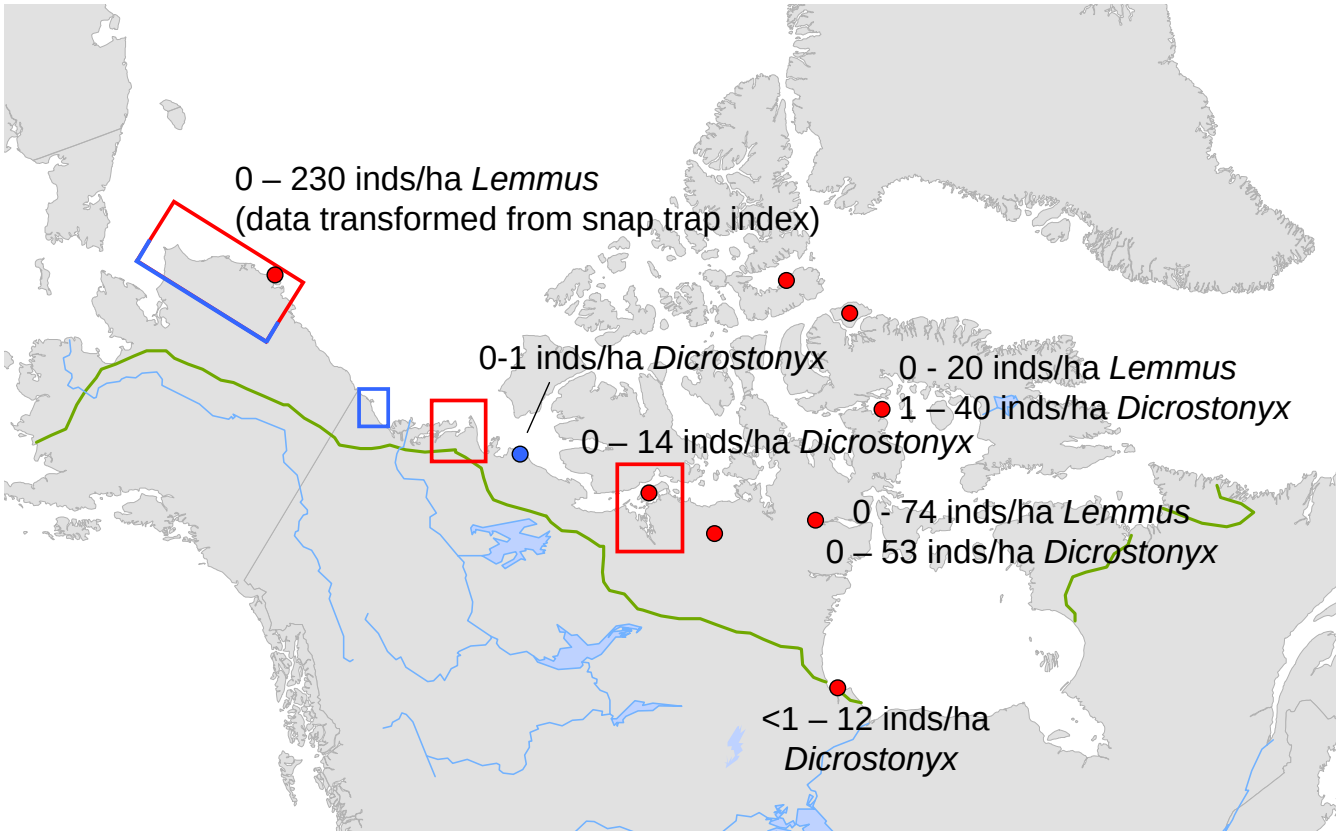


Figure 11 Relative abundance of the brown lemming, *Lemmus sibiricus*, at the seven best sample localities. Figures following latitudes represent the number of coexisting species of microtin rodents. Refer to Fig. 1 for relationship of localities to coast and interior mountain ranges. Captur index represents number of captures per 100 trap nights.

Cyclicity



Densities



Conclusions

- Among the reviewed time series there is no indication for a change in cyclic dynamics
- Some lemming populations in western north America have low densities and are not cyclic
- Seasonal dynamics are variable between and within sites
  - Winter reproduction is usual
  - Summer dynamics are variable, both increase and decrease are observed in the same sites
- Amplitude of population fluctuations are very variable

Thank you!

Photo: A. Angerbjörn

Photo: O. Gilg

Photo: N. Lecomte