





Milder winters in Northern Scandinavia may contribute to larger outbreaks of hemorrhagic fever virus.

Climate Change and Impact on Zoonotic and Parasitic Diseases in the North.

September 23-24, Danish Polar Centre
Copenhagen, Denmark

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Umeå, Sweden



Climate change and zoonotic diseases

Zoonotic infectious diseases

- Most commonly transmitted to humans either directly from animals (e.g. rodents) or by vectors (e.g. mosquitoes and ticks)
- Bacterial, viral and parasitic infections, each with its specific characteristics, reservoir host and mode of transmission.
- Several are recognized as emerging diseases and pose a serious threat to human public health.

Climate change effects

- The geographic distribution and thereby the population at risk may change
- The transmission of these diseases may increase due temperature, humidity and precipitation.



Humans - Hantavirus infections are world wide
No specific treatment or safe and effective vaccine are available.

Hemorrhagic fever with renal syndrome (HFRS)

- >150,000 cases/year and thousands die every year, >50% of cases in China

Puumala – Europe

Dobrava - Europe

Hantaan – Asia

Seoul – Asia (Worldwide)

Hantavirus cardiopulmonary syndrome (HCPS).

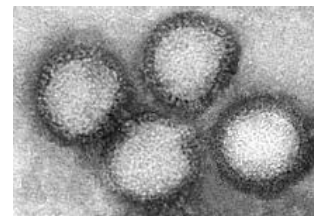
- 250 registered patients/year in South- and North America
- > 40% mortality

Andes – S America

Sin Nombre – N America

Hemorrhagic fever with renal syndrome (HFRS)

- Transmitted from rodents to humans – zoonosis
- Humans inhale infectious aerosols produced from rodent saliva, excreta, urine.



- In Sweden: Puumala virus (PUUV)
- PUUV host is the bank vole (*Myodes glareolus*).



- Incubation 2-6 weeks → Nephropathia epidemica (NE)



From Olsson et al Emerg Infect Dis 2003



Nephropathia epidemica (NE)

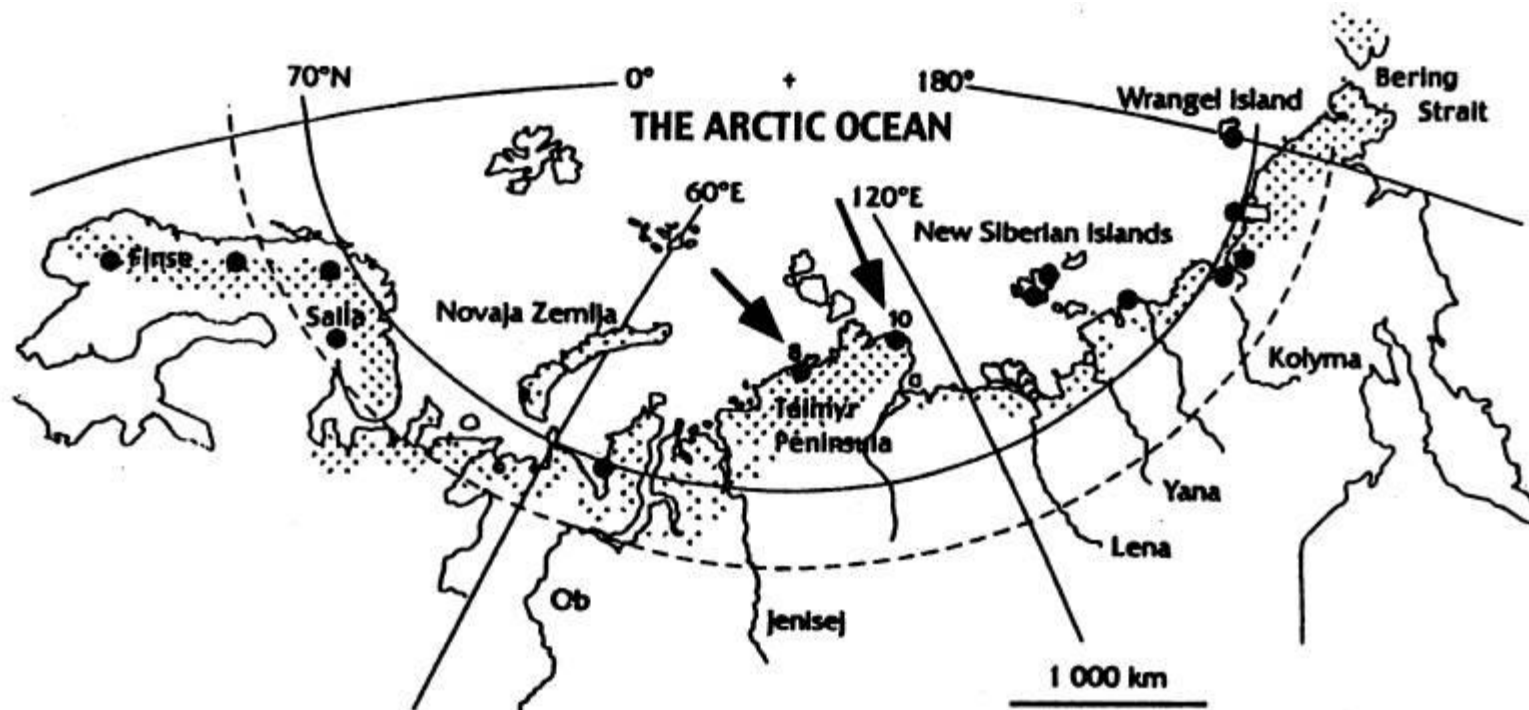
- Symptoms:
 - Acute fever, fatigue, headache, nausea, vomiting, myalgia, abdominal- and backpain, and visual disturbances.
 - The majority has signs of renal failure.
 - One third of the patients has haemorrhagic manifestations and 30%–50% has respiratory tract symptoms
- In Sweden 150-2200 registered cases of NE per year
- ~30% of diagnosed cases are hospitalized
- Fatality rate in humans <0.5%.



Rodents - Hantavirus

- Persistently infected – no disease
- Specific hantavirus types – specific rodents
- Puumala virus in bank voles in Northern Sweden, Finland, Norway, Russia
- Other hantaviruses in lemmings (Topografov)





Geographic origin of the infected wild lemmings and the geographical distribution of rodents.

(i) *L. lemmus*, *L. sibiricus* western type (found west of the Lena River).

(ii) *L. sibiricus* central type (found between the Lena and Kolyma Rivers).

(iii) *L. sibiricus* eastern type (or *L. trimucronatus*, found east of the Kolyma River).

In addition, Finse, Norway, (origin of the lemming colony), and Salla, Finland (the site of a putative lemming-borne outbreak in 1942), are indicated.

From Vapalahti et al., J Virol. 1999, 73:5586–5592.



Circumpolar Hantaviruses

Human disease

- Finland (Puumala)
- Norway (Puumala)
- Sweden (Puumala)
- Russia (Puumala, Dobrava, Topografov, others)
- Canada (Sin nombre in Manitoba, Alberta)

Antibodies in rodents

- USA (Alaska)
- Other parts of Canada

- Iceland ?
- Greenland ?



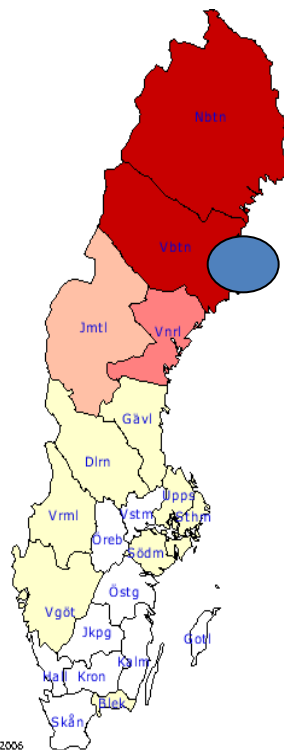
In Sweden: NE caused by Puumala virus is endemic in the four counties in the north of Sweden

Sweden

- 2-24 NE patients / 100,000 inhabitants / year

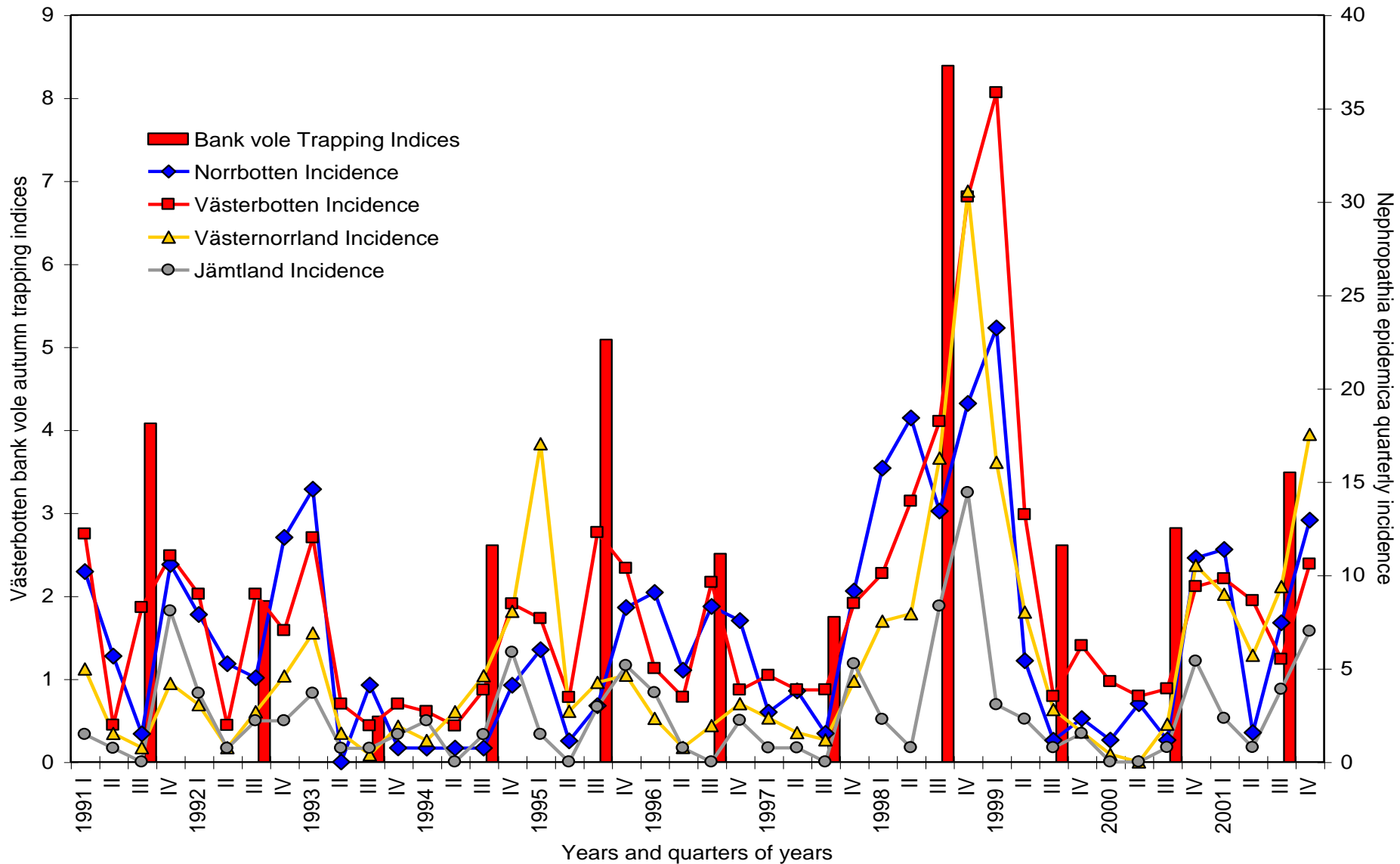
Västerbotten County (Umeå University Hospital)

- 18-313 NE patients / 100,000 inhabitants / year



Bank vole cycles and NE disease incidence

(Olsson et al 2002)





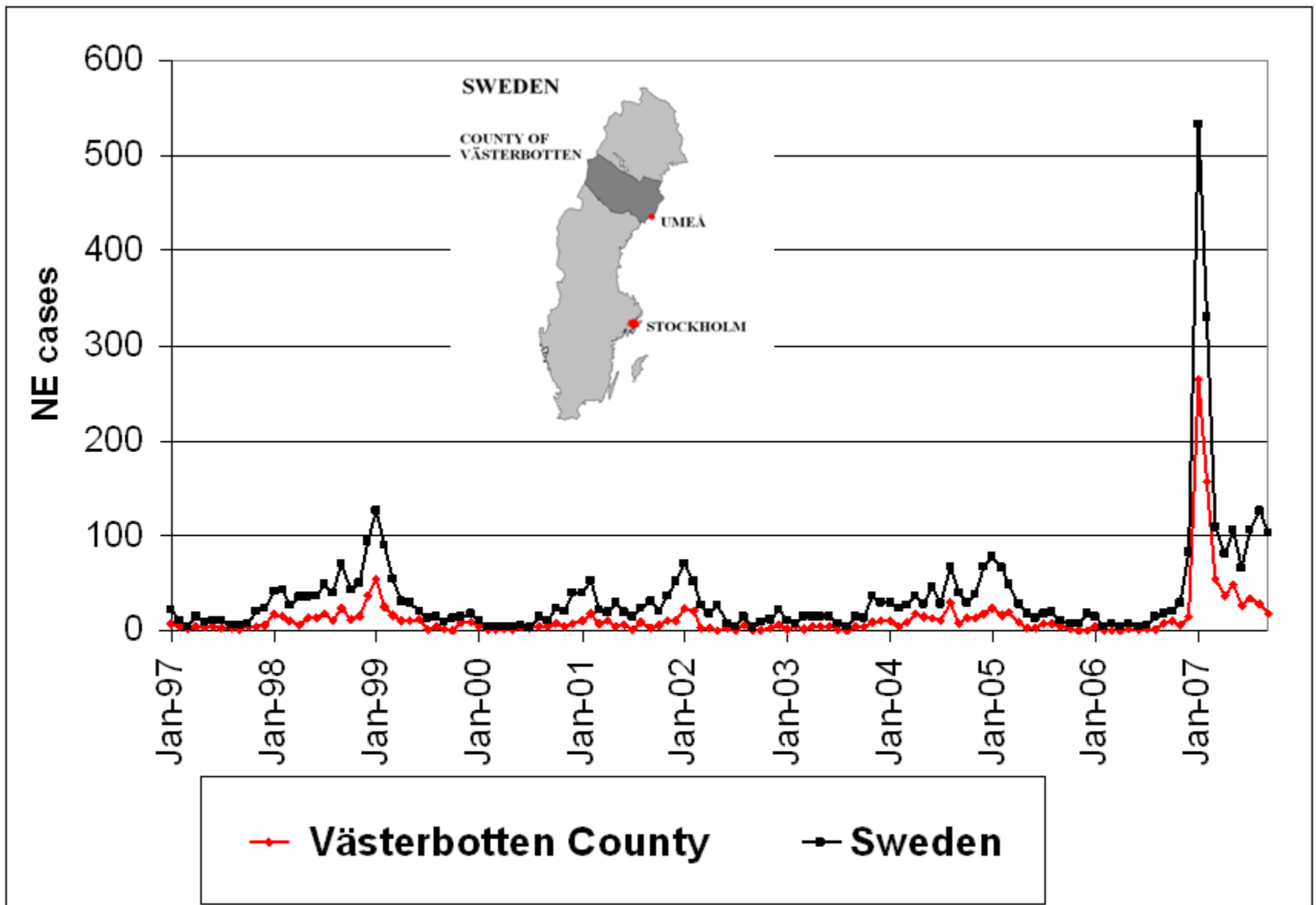
DISPATCHES

Outbreak of Puumala Virus Infection, Sweden

Lisa Pettersson,* Jens Boman,*† Per Juto,*
Magnus Evander,* and Clas Ahlm*

- Sudden and unexpected, large outbreak.
- January-March 2007; 972 cases were recorded in Sweden and 474 cases in Västerbotten County.
- Many sick individuals, public awareness and concern
- In Umeå alone - 250 diagnosed patients in 2 months, 75 hospitalized.
- Heavy burden on health care and society.

- The 2007 incidence was 313/100,000 in Västerbotten County.
- Two known lethal cases were recorded.



L Pettersson, J Boman, P Juto, M Evander, C Ahlm.
Outbreak of Puumala Virus Infection, Sweden. Emerg Inf
 Dis, 14(5):808-10



Puumala virus outbreak 2007

Possible reasons:

- a peak in the bank vole population during autumn 2006– similar to previous NE peaks.

Yes, but the number of NE cases should have been much lower

- an epizootic amongst the bank voles.

No data available

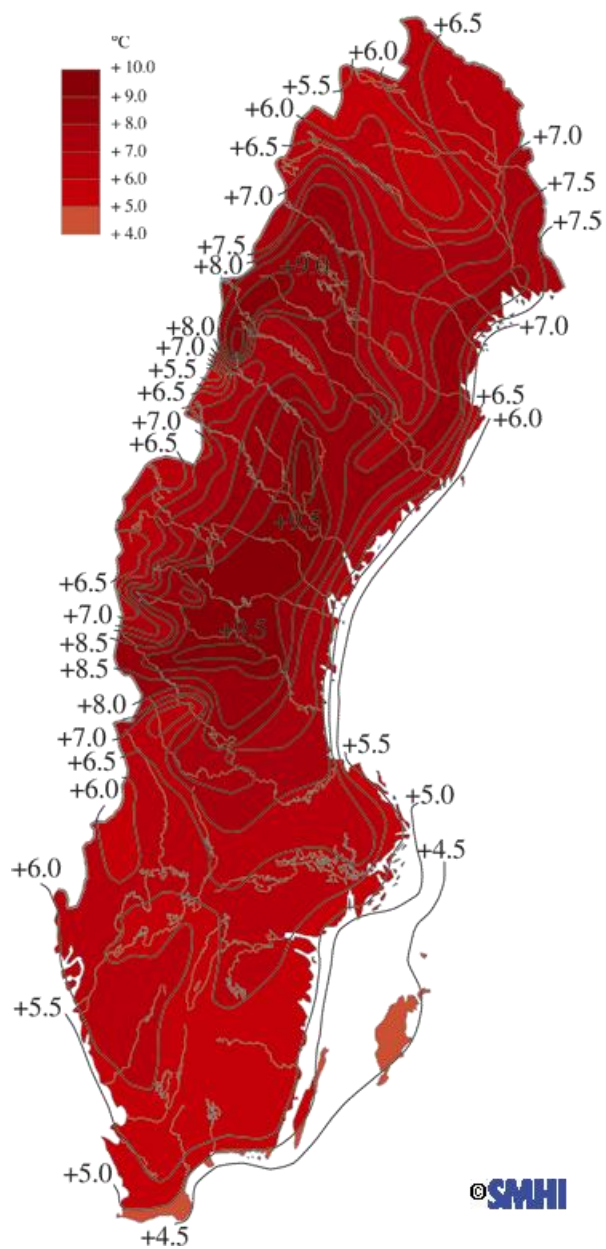
- a mild winter with less snow and more ice.

Yes



Puumala virus outbreak

- More voles were sighted indoors
- No snow-cover in early winter
- Instead - Rain and ice



Deviation of the average temperature from normal (in °C). December 2006

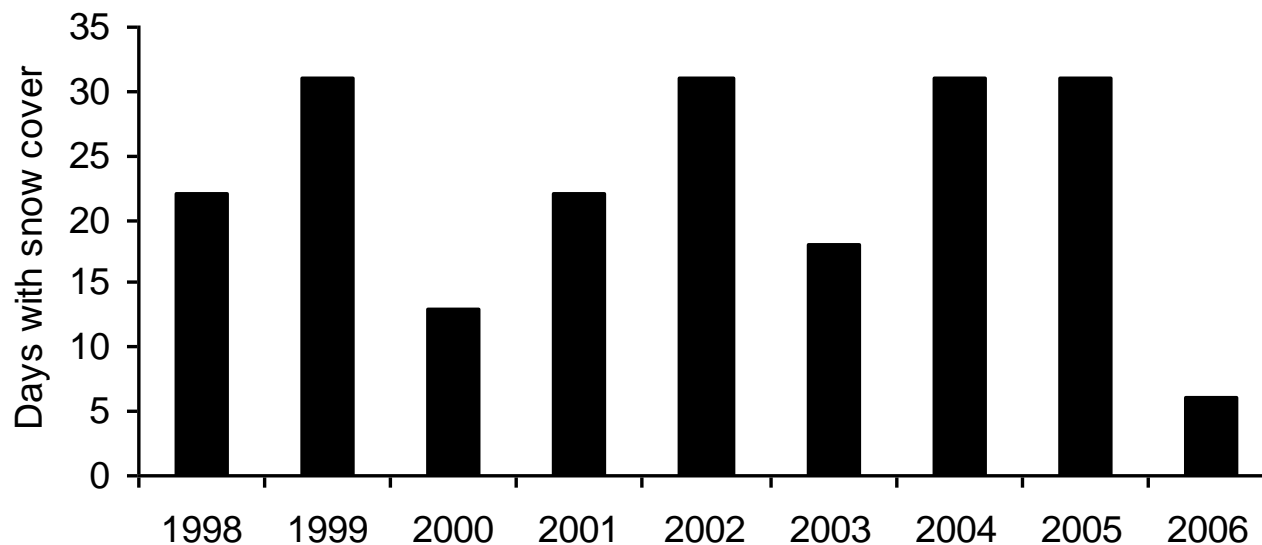
A new record

Old records were from 1929, 1934 and 1972.

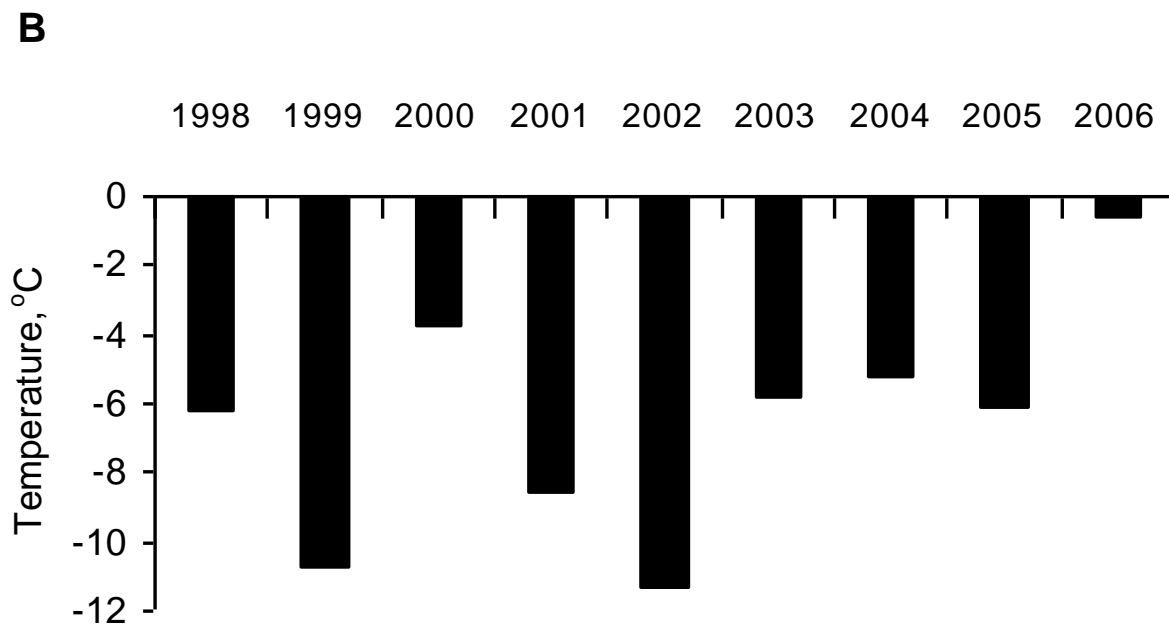


Days with snow cover in December (Västerbotten coastal area)

A



Average temperature in December (Västerbotten coastal area)



Climate effect on bank voles

- In Fennoscandia during winter small rodents spend most of their time in the subnivean space, between the snow cover and the ground.



2006-2007

- No protection under the snow from predators
- No food under the snow
- No shelter from cold weather under the snow



Conclusions

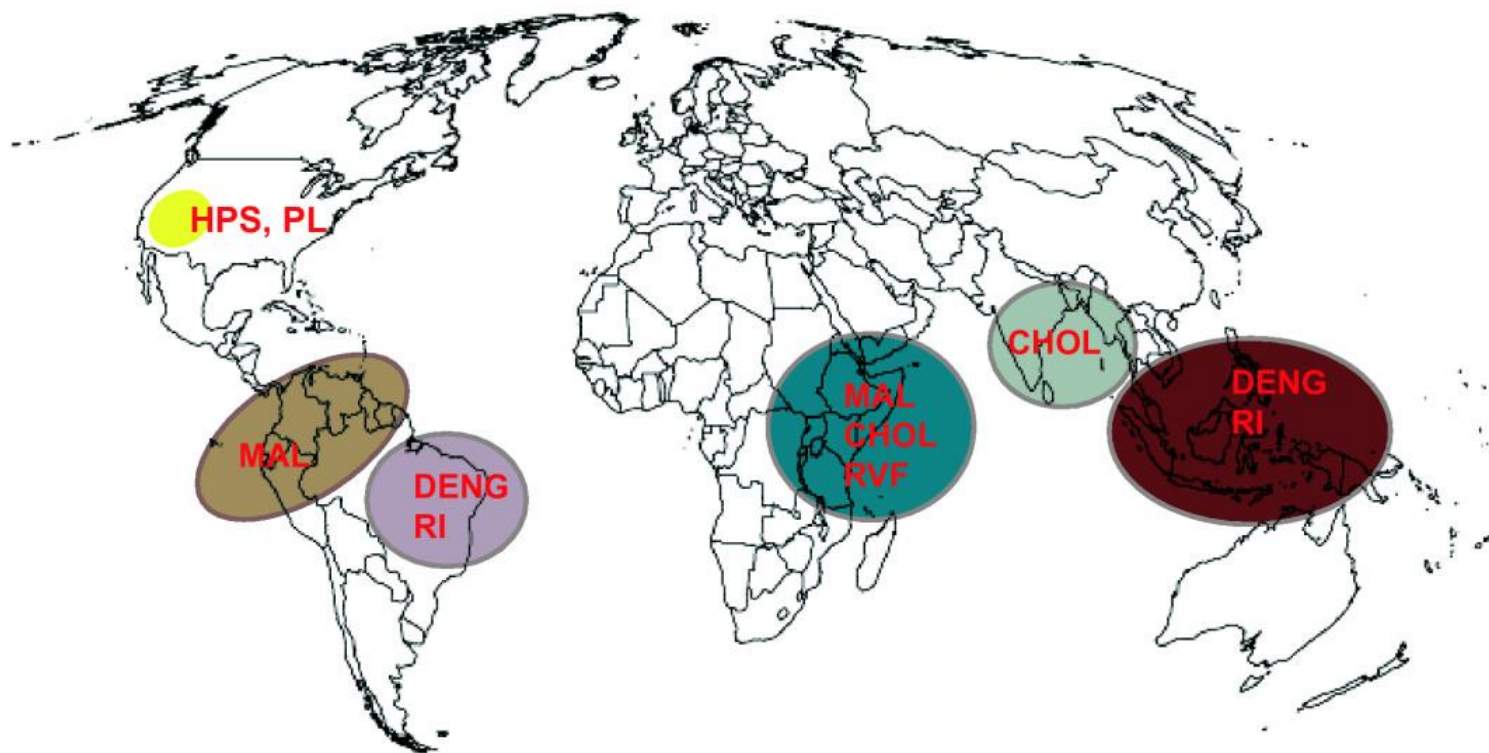
- A combination of a mild climate at the beginning of winter, loss of protective snow cover and high rodent reservoir numbers likely caused the sudden and dramatic increase of NE cases in the winter 2006/2007 in northern Sweden.
- Rodent-borne hantaviruses should be regarded as an increasing threat to health in the North since future climate change scenarios predict higher temperatures.



For the future

- Preparedness for epidemics of hantavirus
- Preparedness for other viral zoonotic diseases e.g. mosquito-borne
- Based on rodent/vector surveillance, virus detection and climate studies
- Improved knowledge of pathogenesis and natural history

Hotspots of potential elevated risk for disease outbreaks under El Niño conditions: 2006 – 2007.



DENG Dengue Fever
 RI Respiratory Illness
 CHOL Cholera
 MAL Malaria
 RVF Rift Valley Fever
 HPS Hanta Virus Pulmonary Syndrome
 PL Plague

From Anyamba *et al.* *International Journal of Health Geographics* 2006 5:60



Now

**Nephropathia epidemica:
Data on voles indicate new,
extensive outbreak**

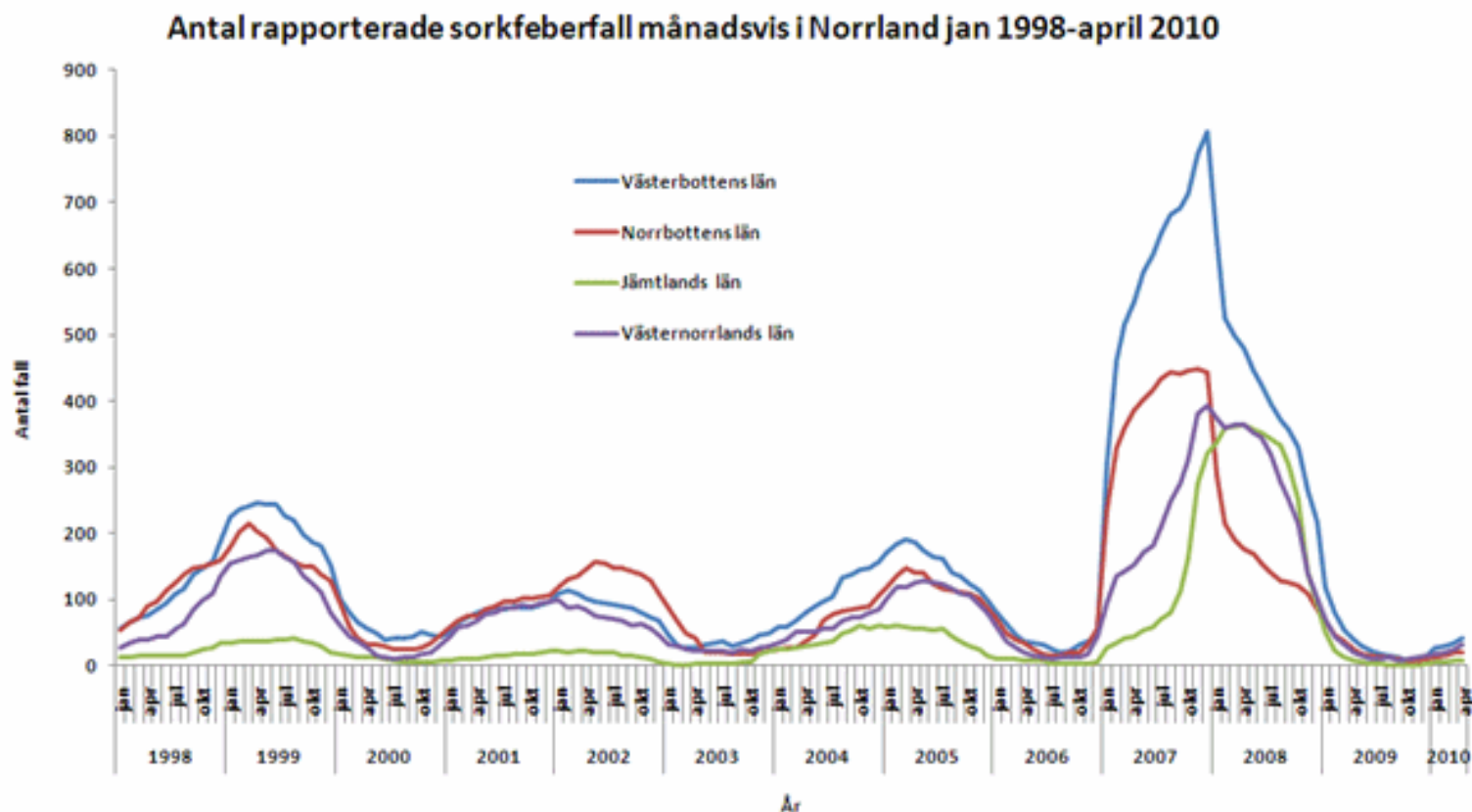
Olsson, Hjertkvist, Ahlm

Evander, Hörnkvist

Läkartidningen 2010

Jul 21-Aug 10;107(29-31):1769-70

Puumala virus cases April 1998-April 2010





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Control, County Council of Västerbotten***

Lena Skedebant, Jens Boman

Family *Bunyaviridae* Genus *Hantavirus*

Segmented negative stranded RNA genome. Envelope with glycoproteins.

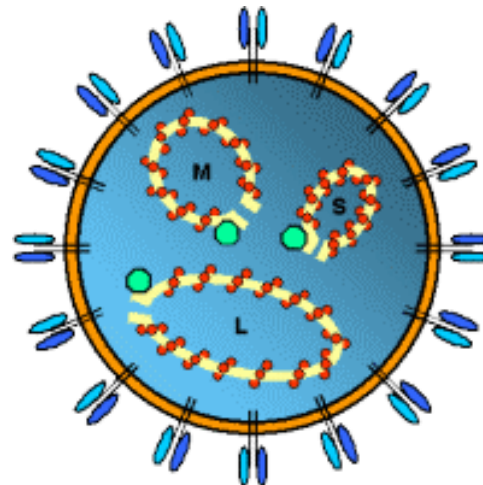


Small (S), Medium (M),
Large (L) RNA segment

● S-segment – nucleocapsid
protein (N)

■ M-segment –
Glycoproteins ($G_N + G_C$)

● L- segment - RNA-
dependent RNA
polymerase



Puumala virus

