



The potential for vector borne infections in the Nordic area now and in the future

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The potential for vector borne infections in the Nordic area now and in the future

René Bødker
&
Ana Carolina Cuellar
Nalmul Haider

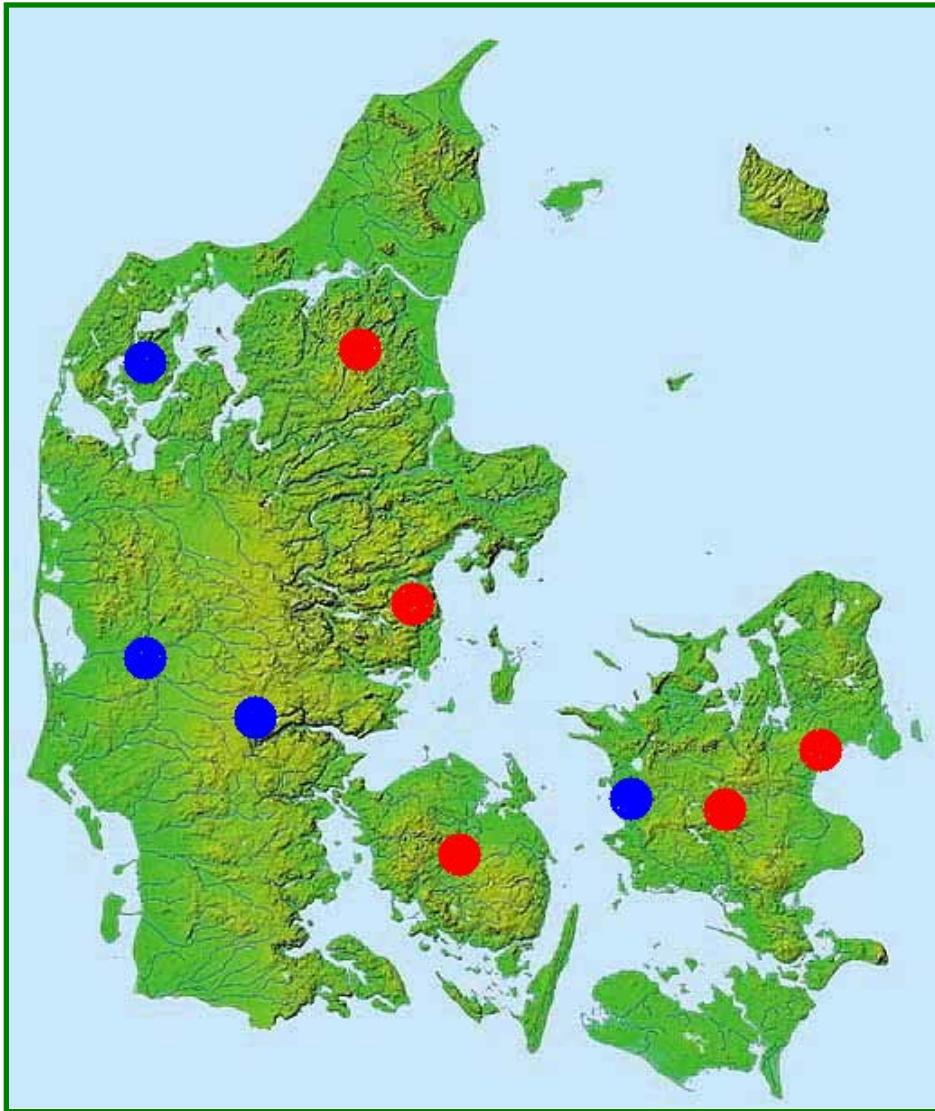
DTU
National Veterinary Institute



Workshop on mosquitoes and
biting midges
Trondheim 13-14 June 2016



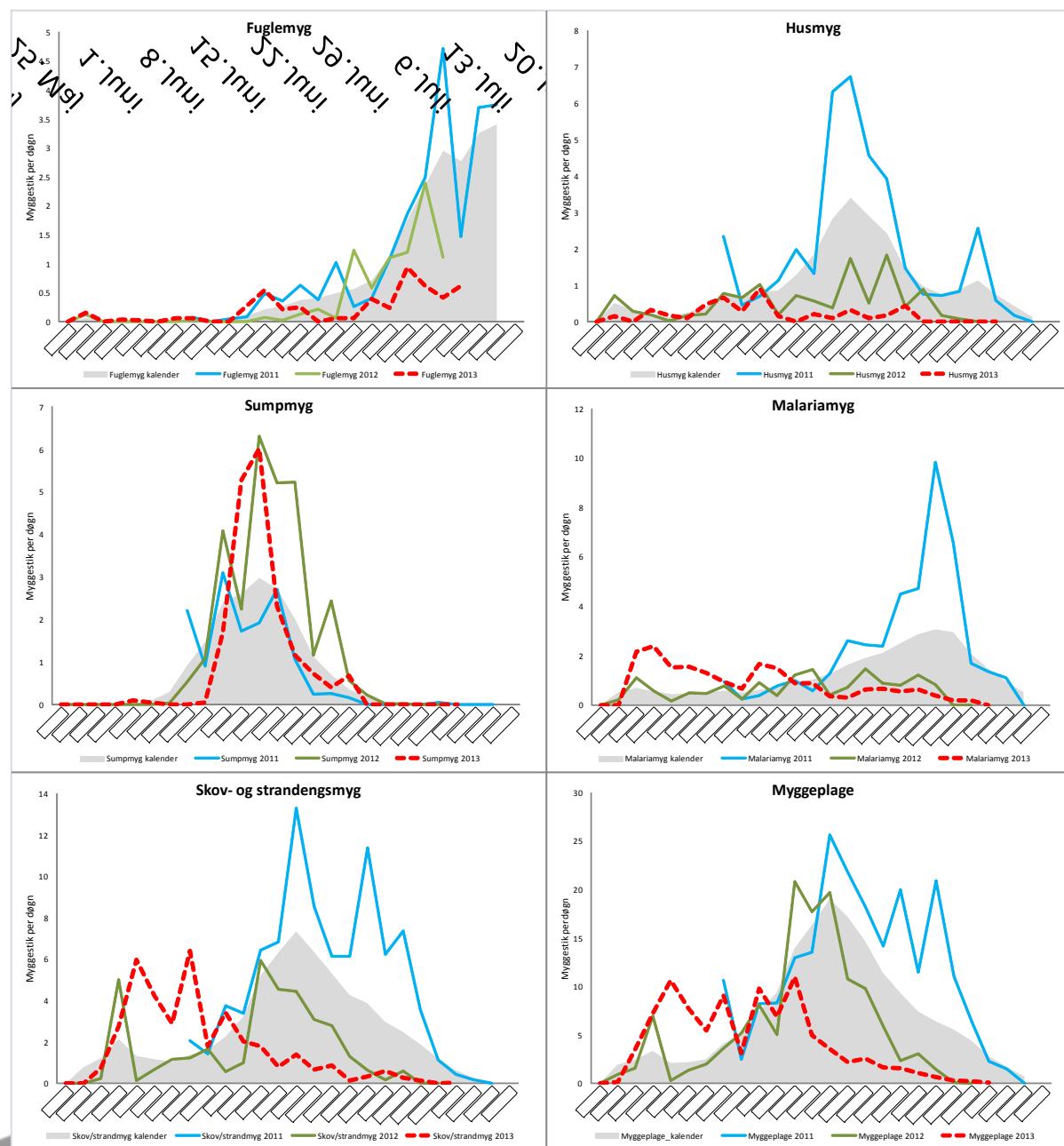
www.myggetal.dk



Weekly vector data are freely available on the internet

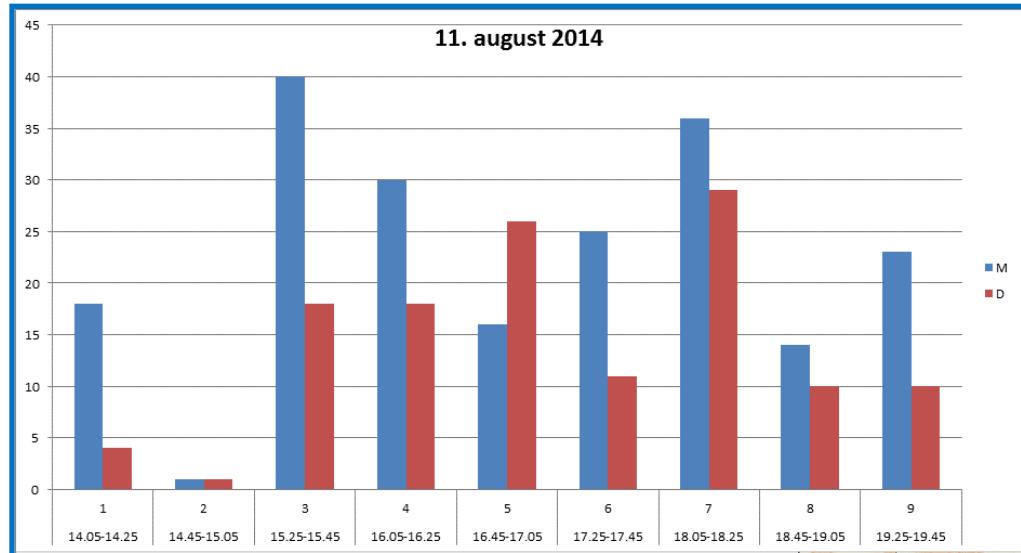


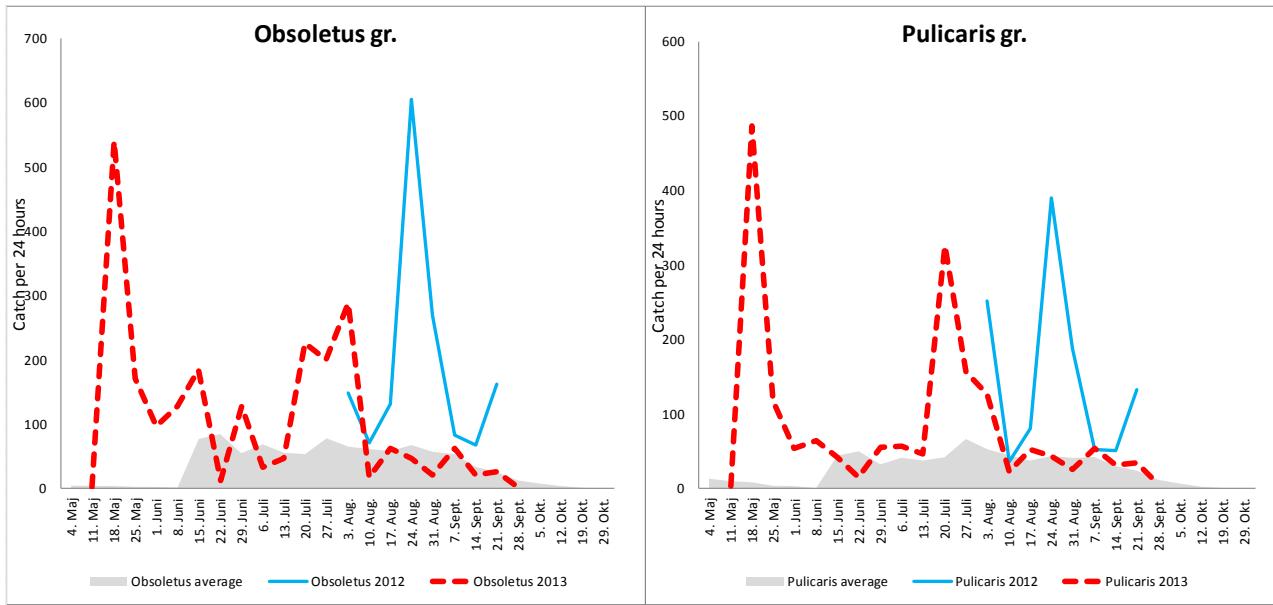
Weekly surveillance:
Mosquitoes at 5 sites
Biting midges at 4 sites
Supplemented by
additional surveys



Exotic mosquitoes

Culex modestus





Presence/Absence (probability of presence)

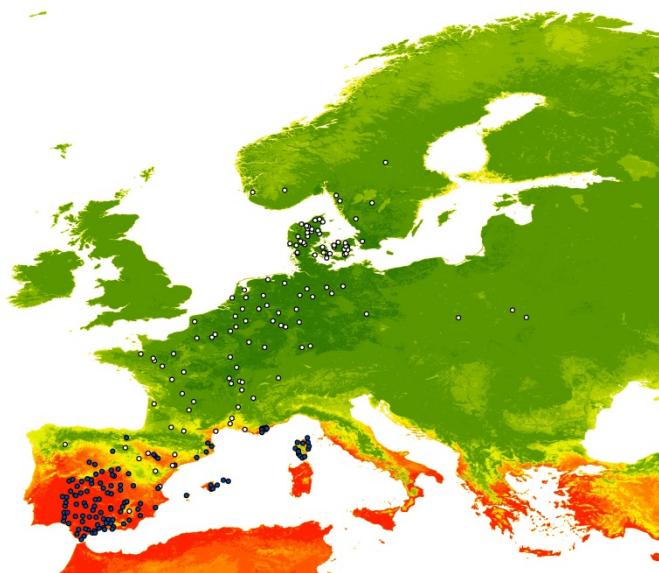
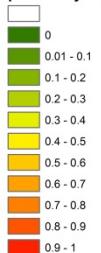
C. imicola

Culicoides imicola

Presence-Absence

- 1 (Presence)
- 0 (Absence)

probability of presence



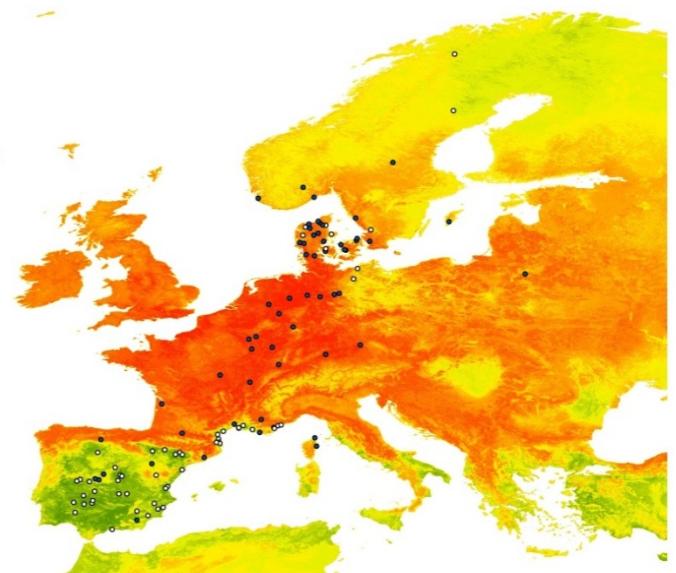
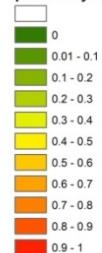
C. obsoletus

Culicoides obsoletus

Presence-Absence

- 1 (Presence)
- 0 (Absence)

probability of presence



Vector mapping in VectorNet (EFSA and ECDC)



In 2015: Norway, UK,
Greenland and
Finland.

In 2016: Latvia,
Poland, Ukraine and
further down



Parameterisation of insect model

Drivers:

Environment

Model parameters:

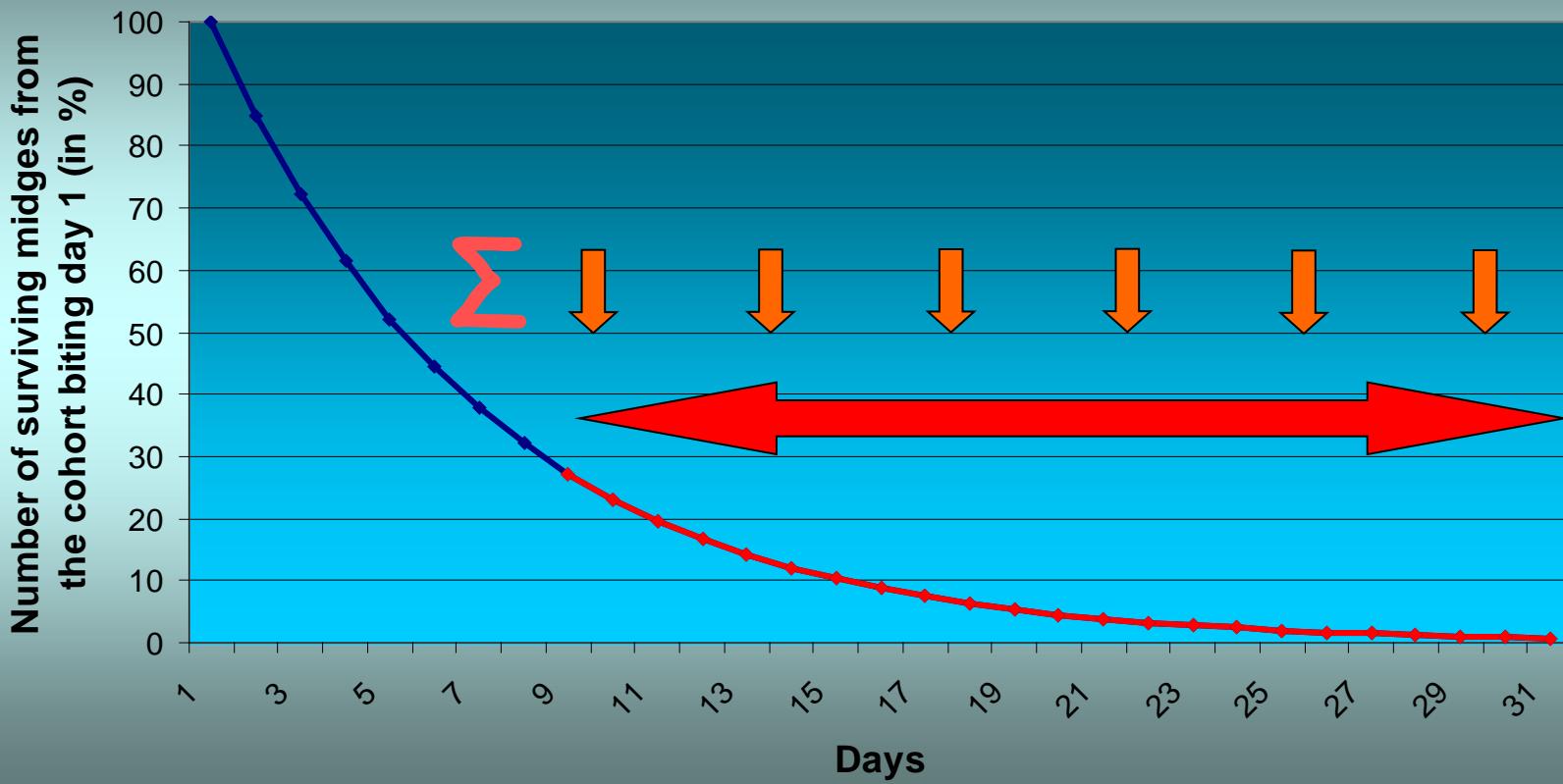
Temperature

Disease specific

- { Number of insect vectors
- { How often the vector bites
- { How long it takes for the virus to develop in the vectors
- { The vectors daily survival rate (how long they live)
- { How long a host is infectious to the vectors
- { The probability of transmission from an infectious host to a vector
- { The probability of transmission from an infectious vector to a host

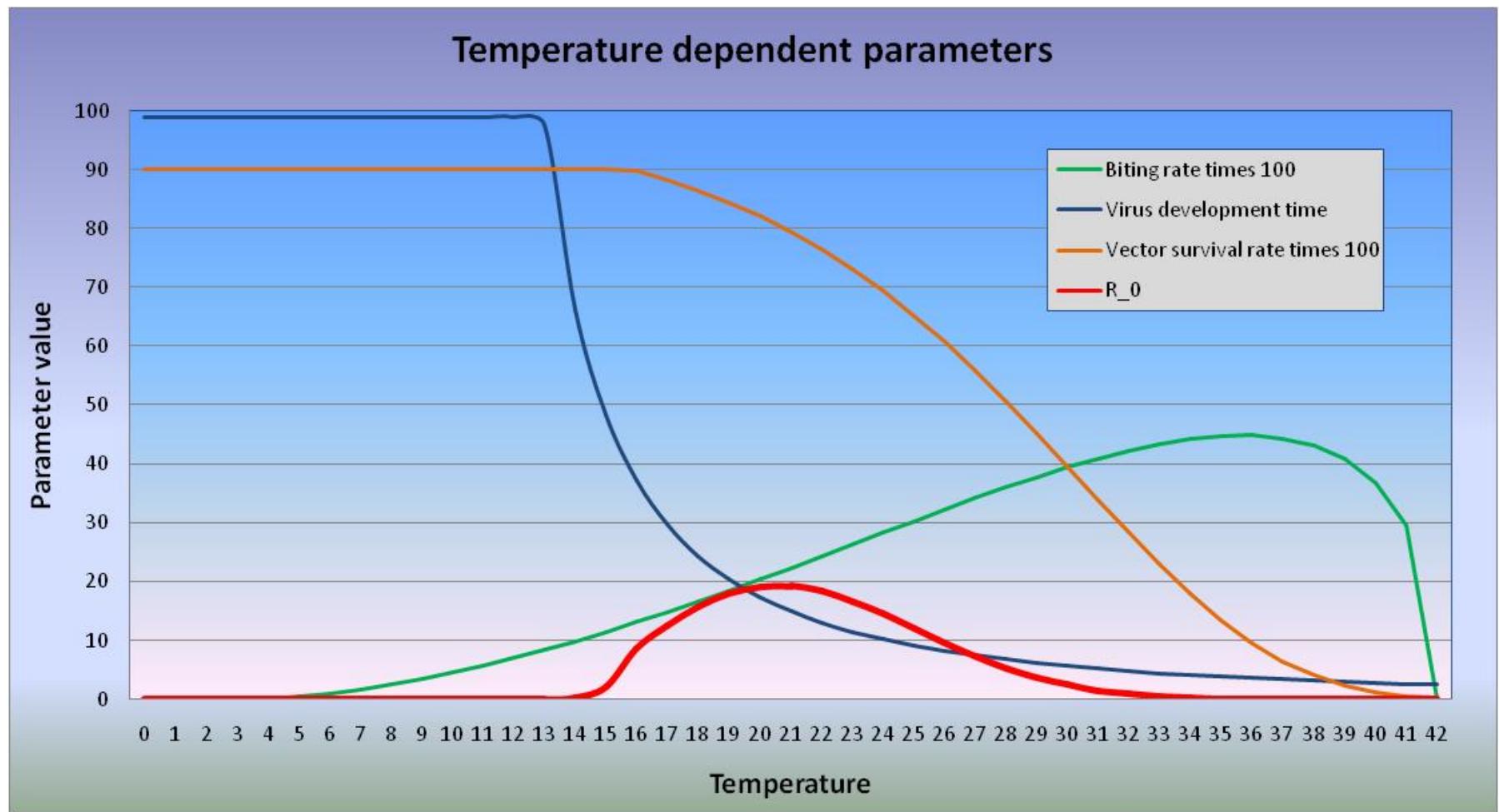
Basic transmission parameters

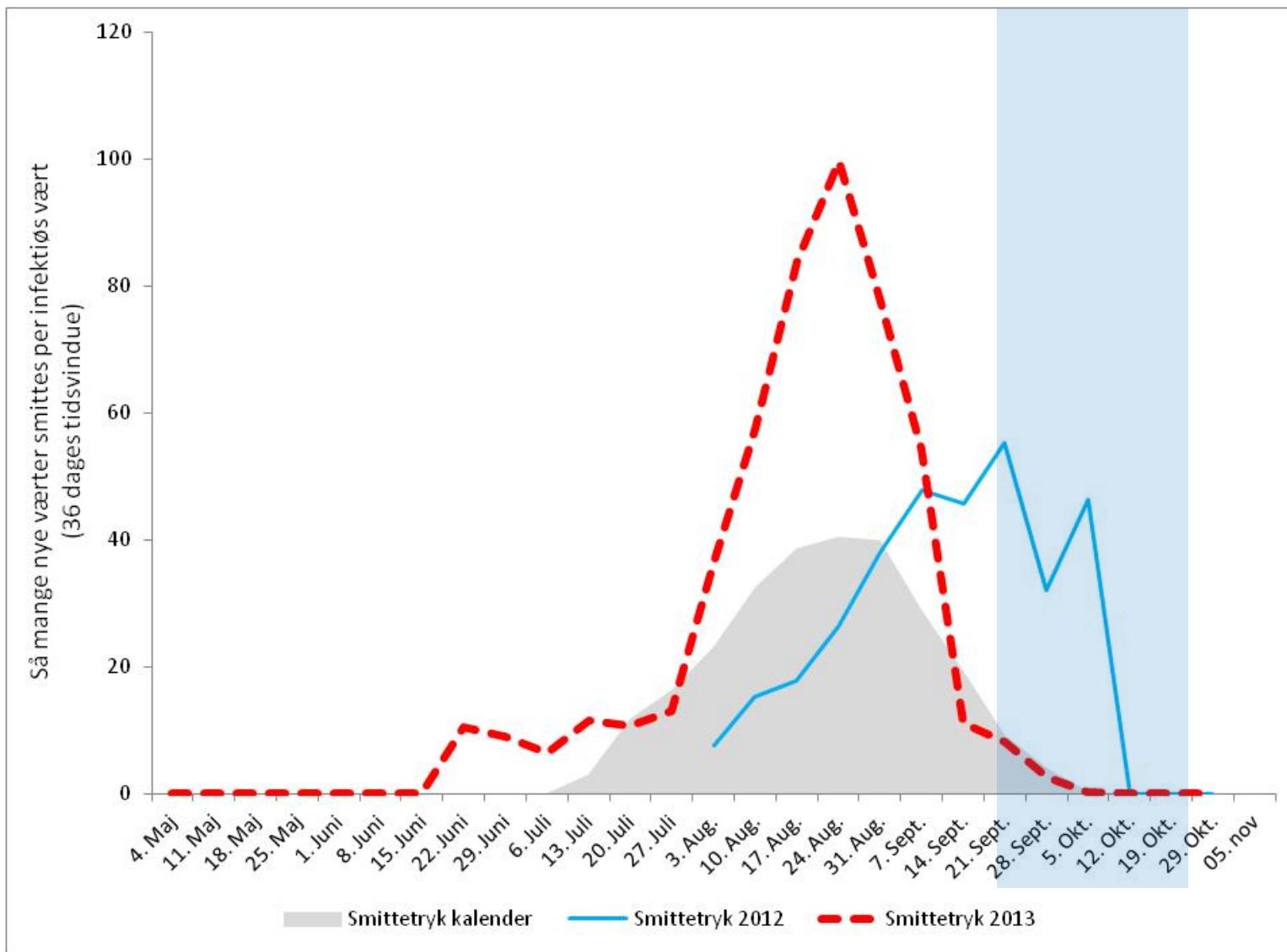
Cohort of culicoides biting a host day 1



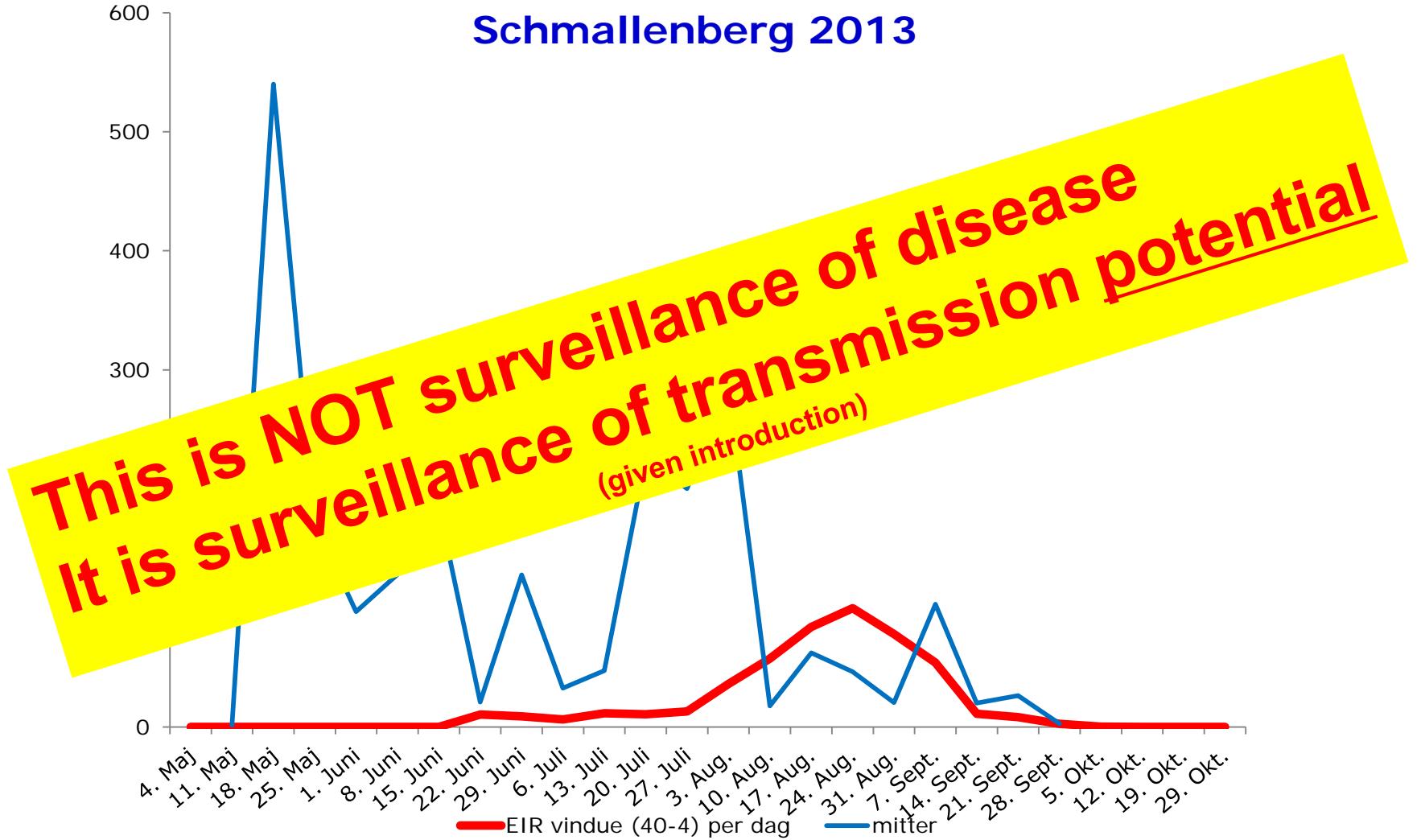
Basic transmission parameters

Temperature dependent parameters

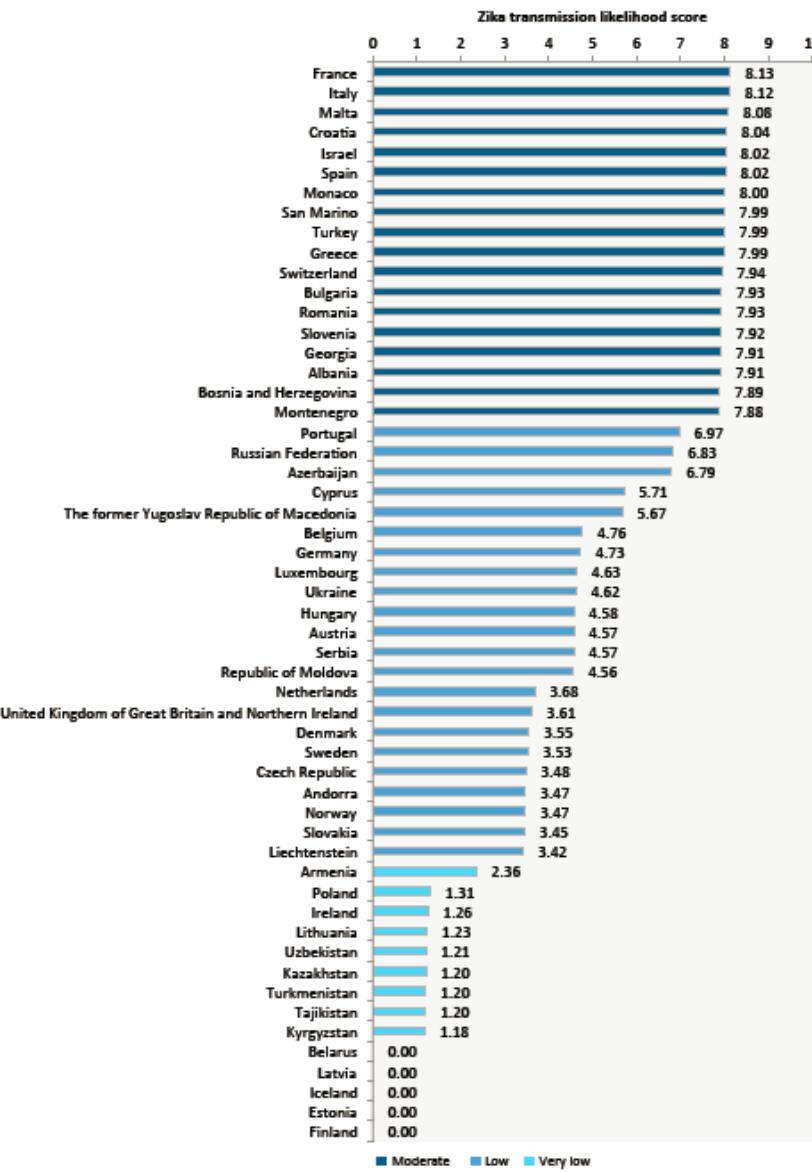




Schmallenberg 2013



Zika virus in Europe 2016



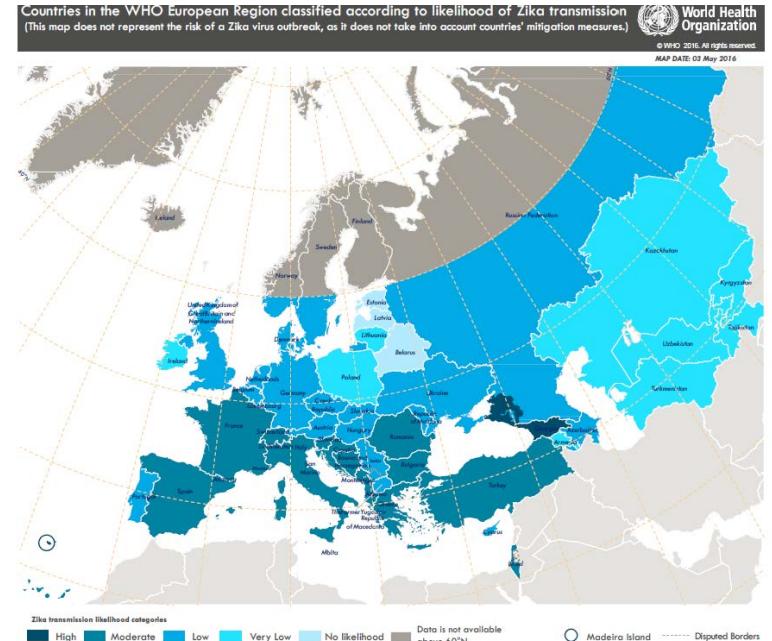
Vector abundance data replaced by teoretic probability for vector presence/absence

The only transmission parameter is vector competence

No native mosquitoes included

No temperature

= a score (likelihood of transmission) with two decimals



Predicting risk by surveillance of risk factors

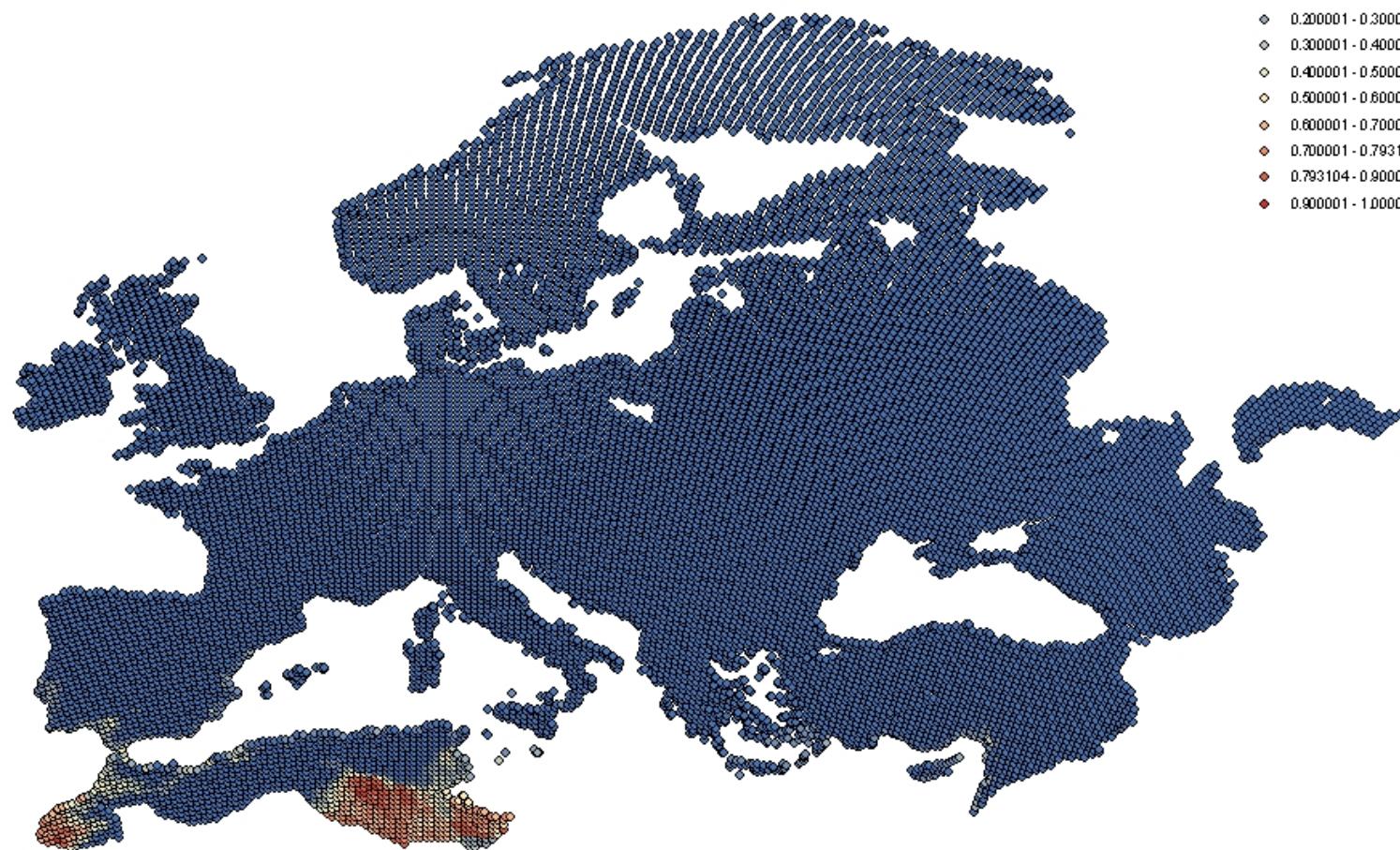
HTII

January

Number of month with $R_0 > 0$ in 25 years

prop_risk

- ◆ 0.00000 - 0.100000
- ◆ 0.10001 - 0.200000
- ◆ 0.20001 - 0.300000
- ◆ 0.30001 - 0.400000
- ◆ 0.40001 - 0.500000
- ◆ 0.50001 - 0.600000
- ◆ 0.60001 - 0.700000
- ◆ 0.70001 - 0.793103
- ◆ 0.793104 - 0.900000
- ◆ 0.900001 - 1.000000



Predicting risk by surveillance of risk factors

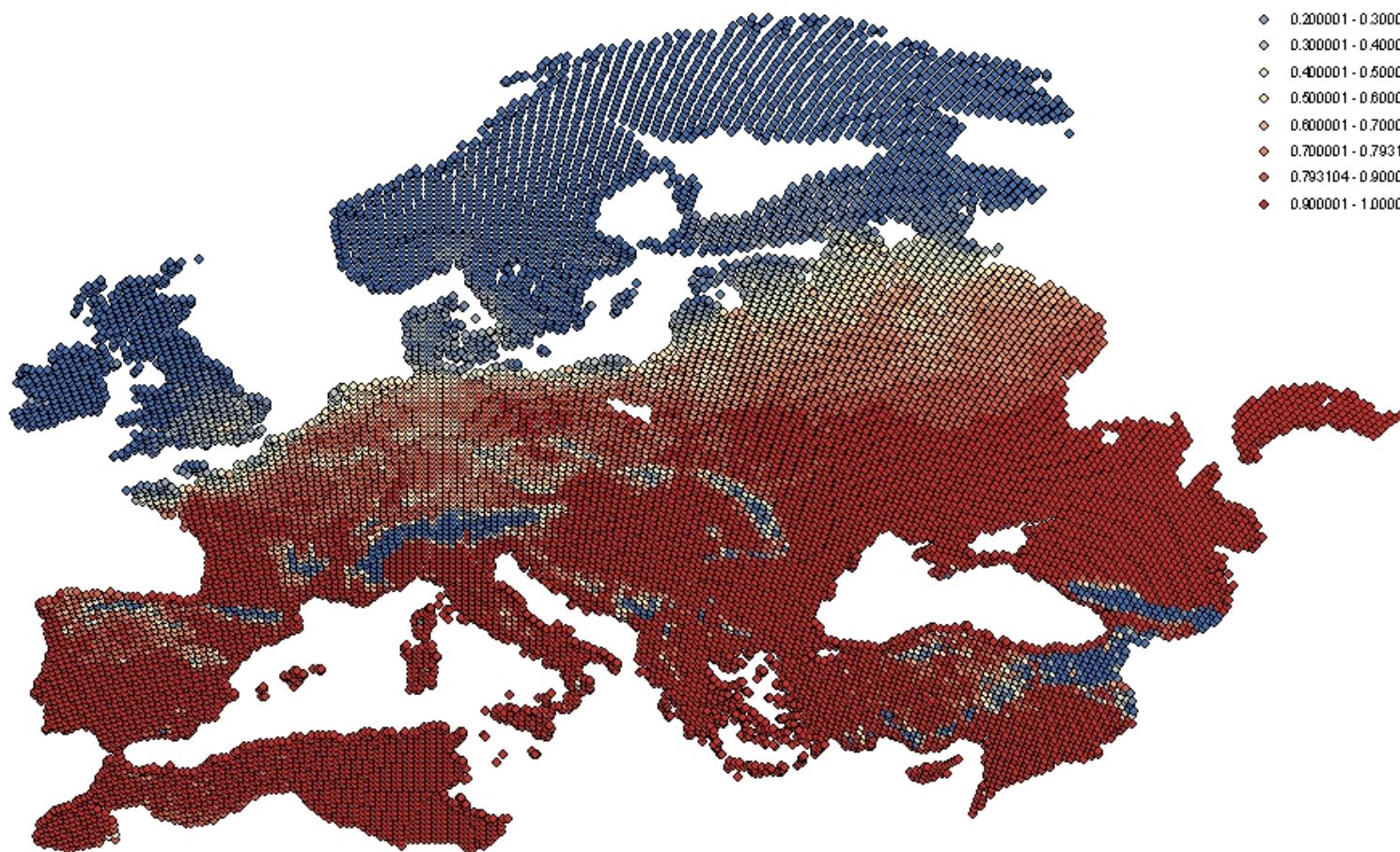
HTII

April

Number of month with $R_0 > 0$ in 25 years

prop_risk

- ◆ 0.00000 - 0.100000
- ◆ 0.10001 - 0.200000
- ◆ 0.20001 - 0.300000
- ◆ 0.30001 - 0.400000
- ◆ 0.40001 - 0.500000
- ◆ 0.50001 - 0.600000
- ◆ 0.60001 - 0.700000
- ◆ 0.70001 - 0.793103
- ◆ 0.793104 - 0.900000
- ◆ 0.900001 - 1.000000



Predicting risk by surveillance of risk factors

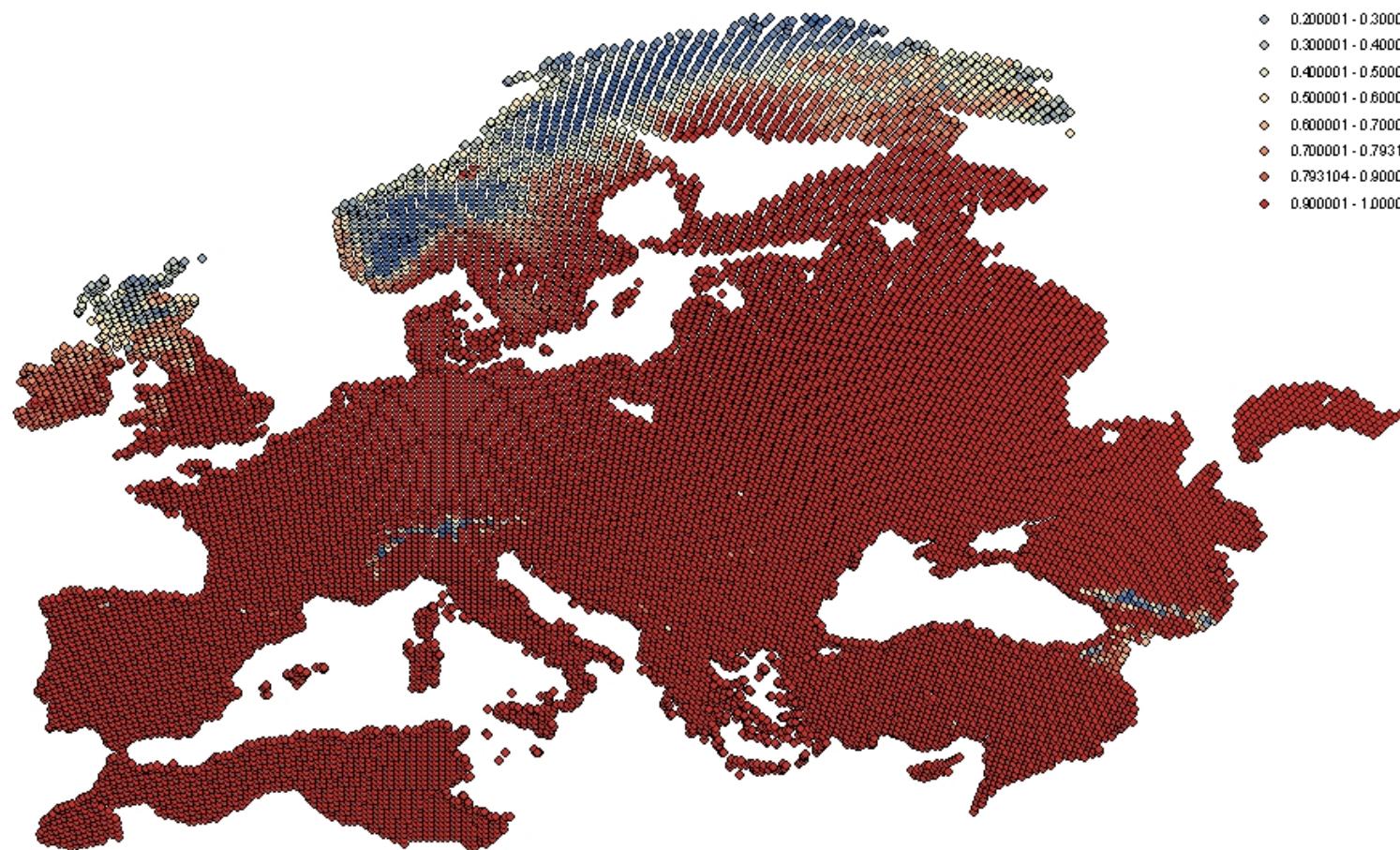
HTII

July

Number of month with $R_0 > 0$ in 25 years

prop_risk

- ◆ 0.00000 - 0.100000
- ◆ 0.100001 - 0.200000
- ◆ 0.200001 - 0.300000
- ◆ 0.300001 - 0.400000
- ◆ 0.400001 - 0.500000
- ◆ 0.500001 - 0.600000
- ◆ 0.600001 - 0.700000
- ◆ 0.700001 - 0.793103
- ◆ 0.793104 - 0.900000
- ◆ 0.900001 - 1.000000



Predicting risk by surveillance of risk factors

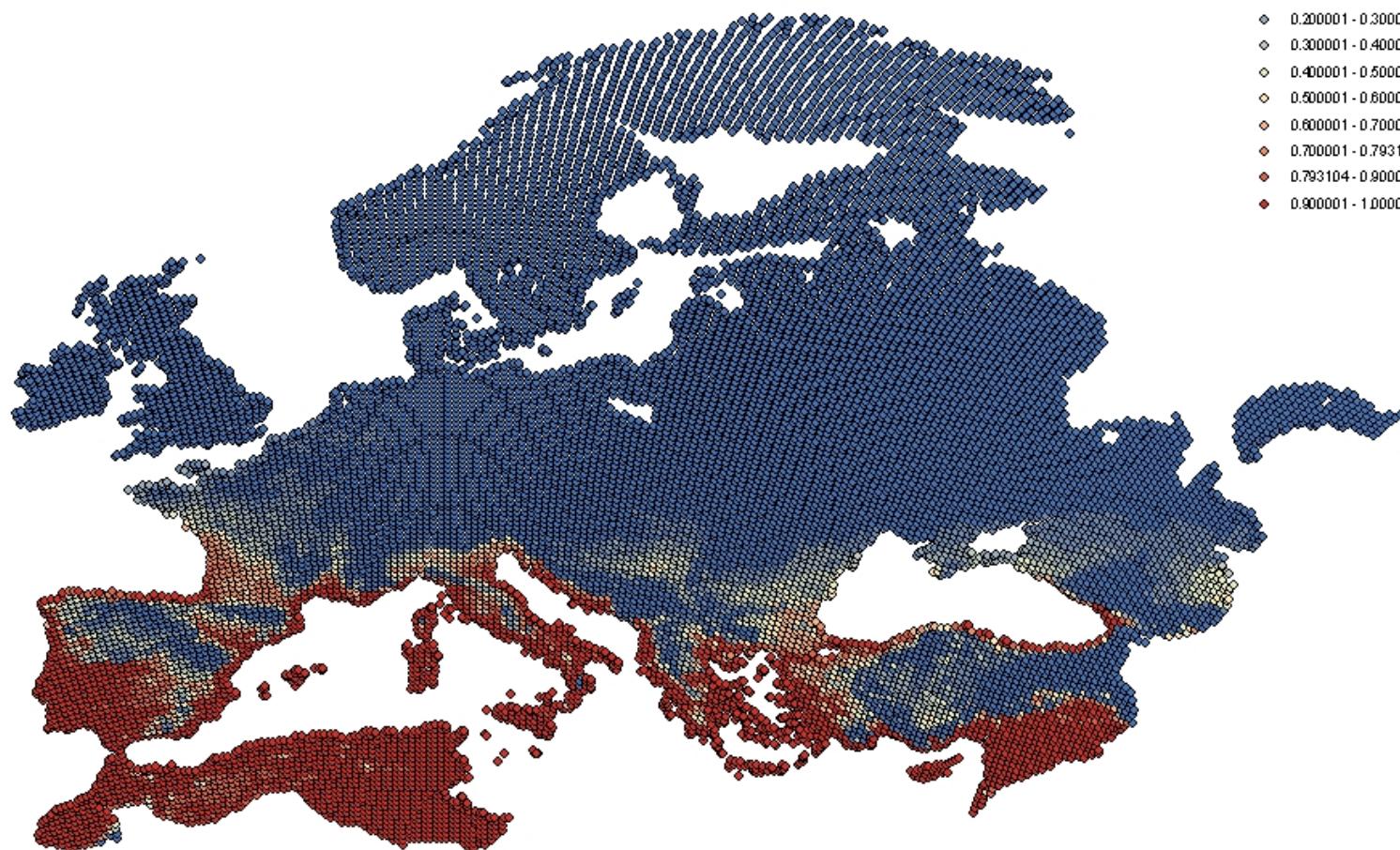
HTII

October

Number of month with $R_0 > 0$ in 25 years

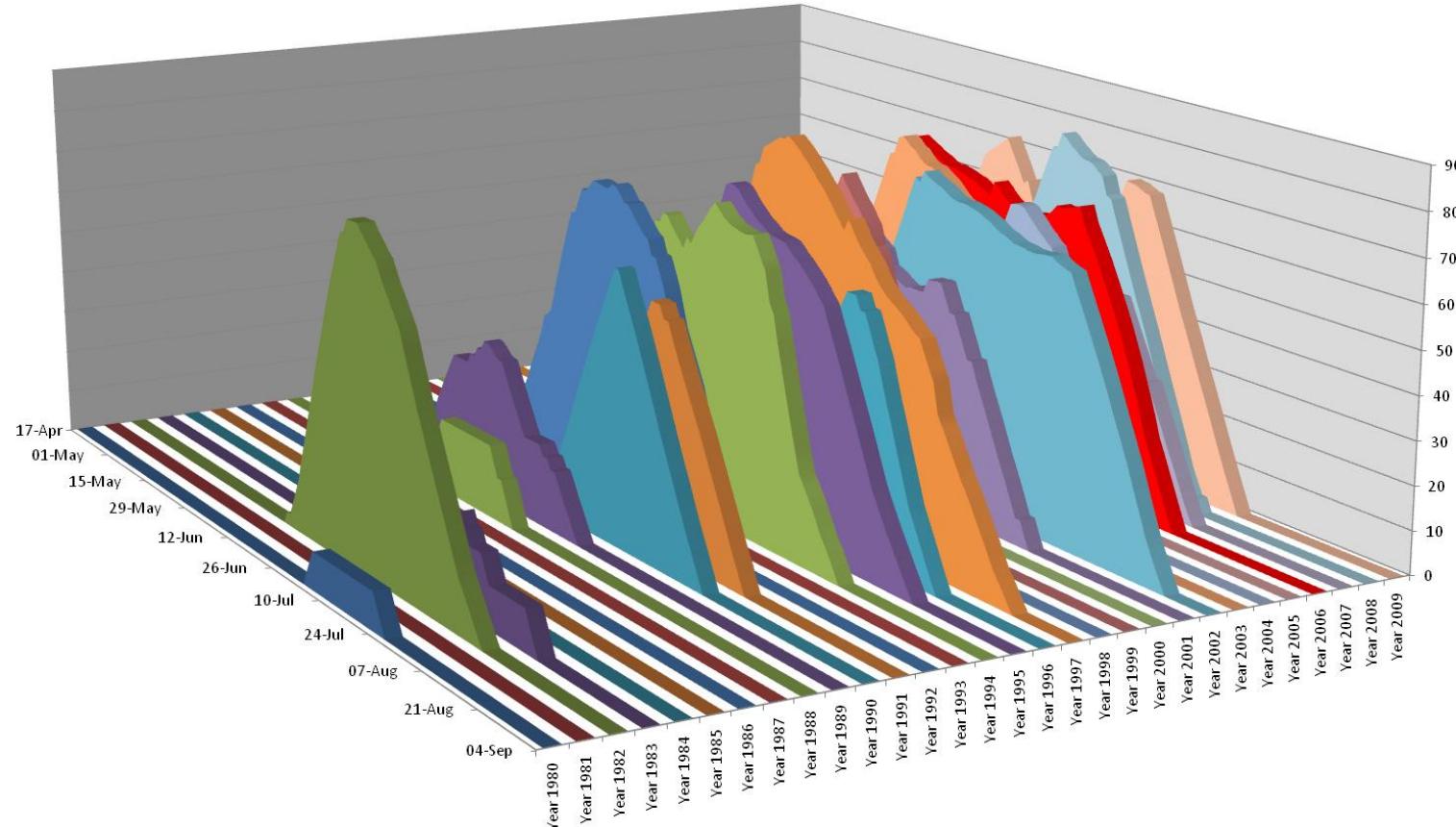
prop_risk

- ◆ 0.00000 - 0.100000
- ◆ 0.100001 - 0.200000
- ◆ 0.200001 - 0.300000
- ◆ 0.300001 - 0.400000
- ◆ 0.400001 - 0.500000
- ◆ 0.500001 - 0.600000
- ◆ 0.600001 - 0.700000
- ◆ 0.700001 - 0.793103
- ◆ 0.793104 - 0.900000
- ◆ 0.900001 - 1.000000

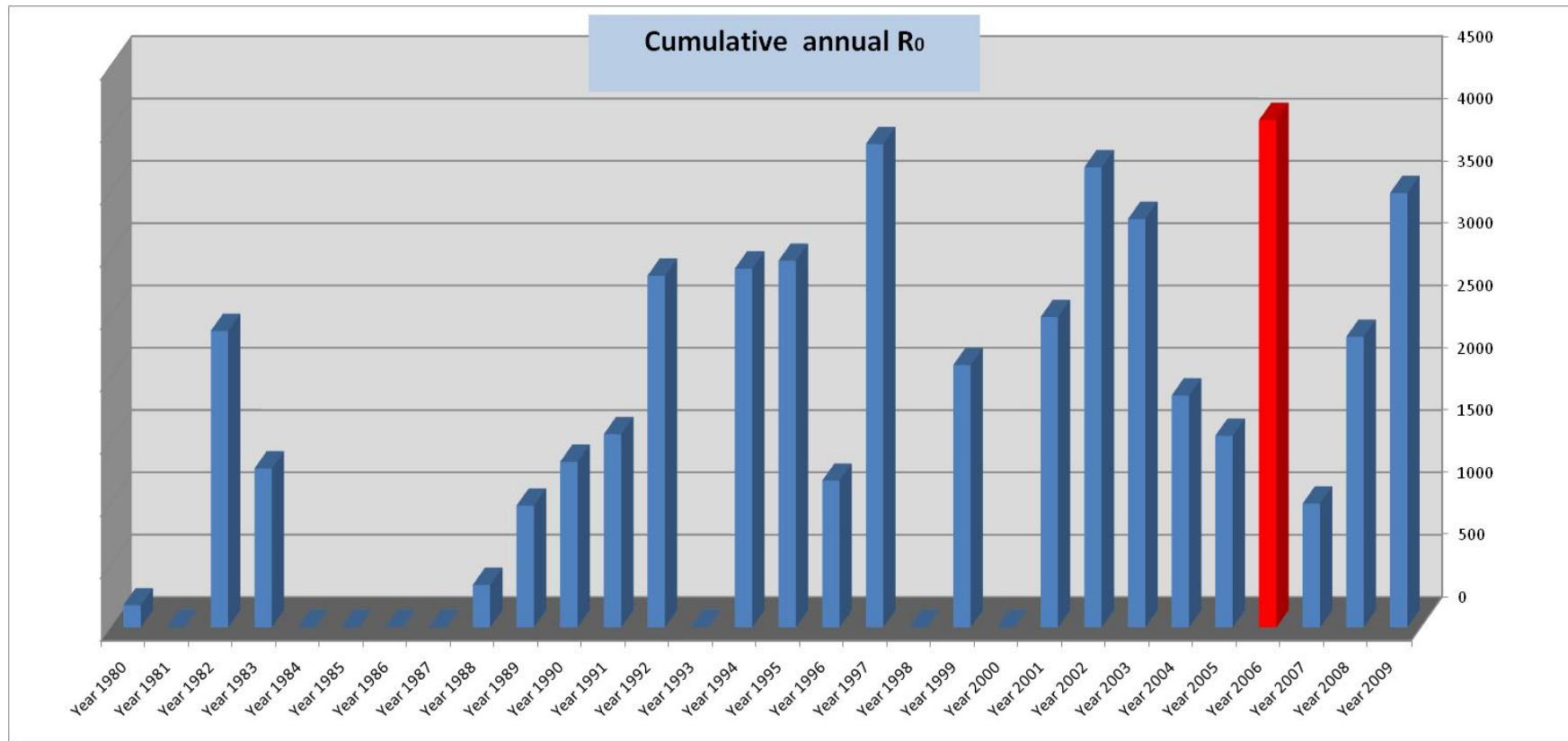


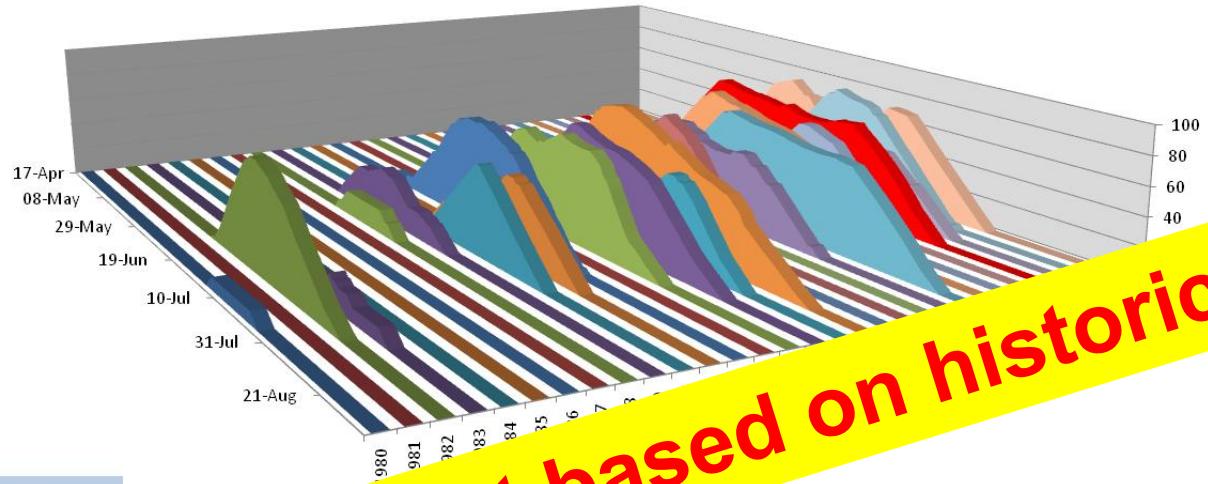
Bluetongue

Daily R_0 calculated for 30 years at one location in Eastern Denmark



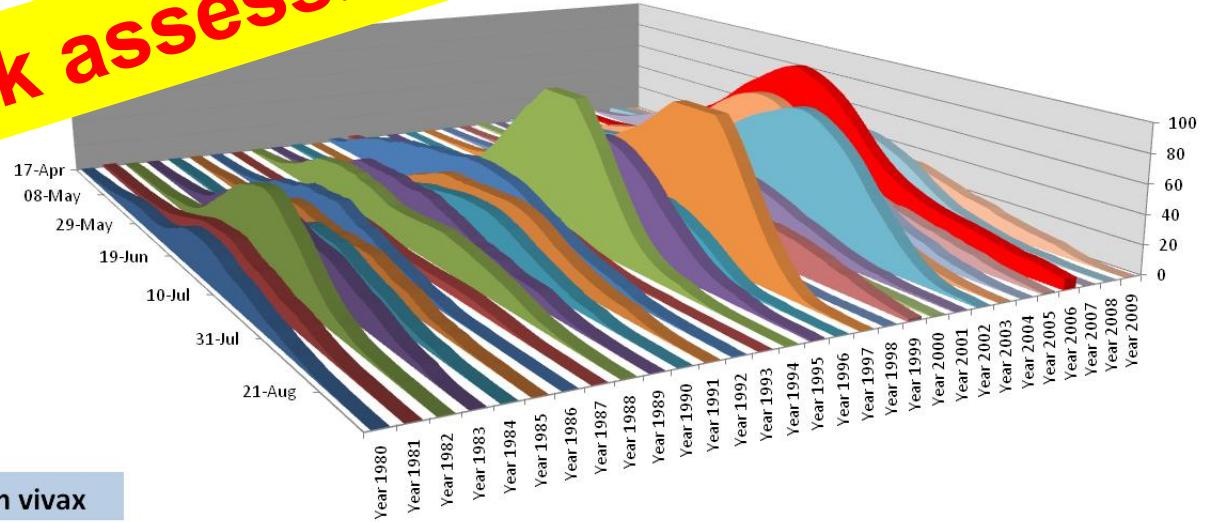
Bluetongue





Bluetongue virus

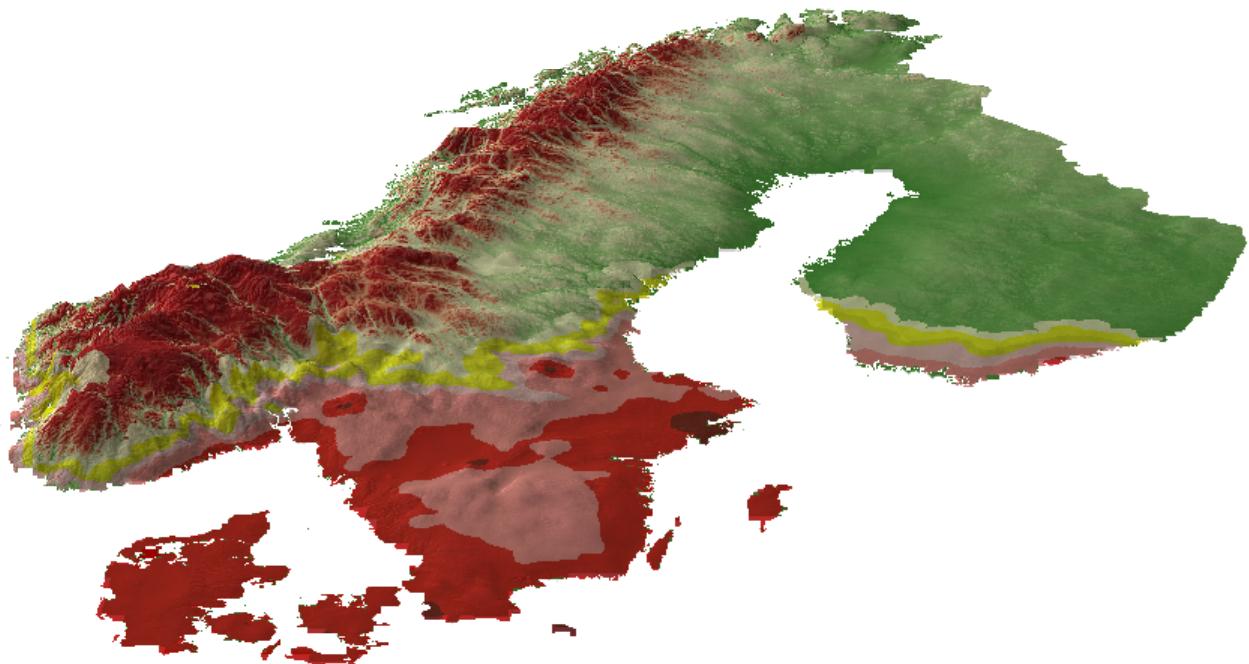
Risk assessment based on historic data



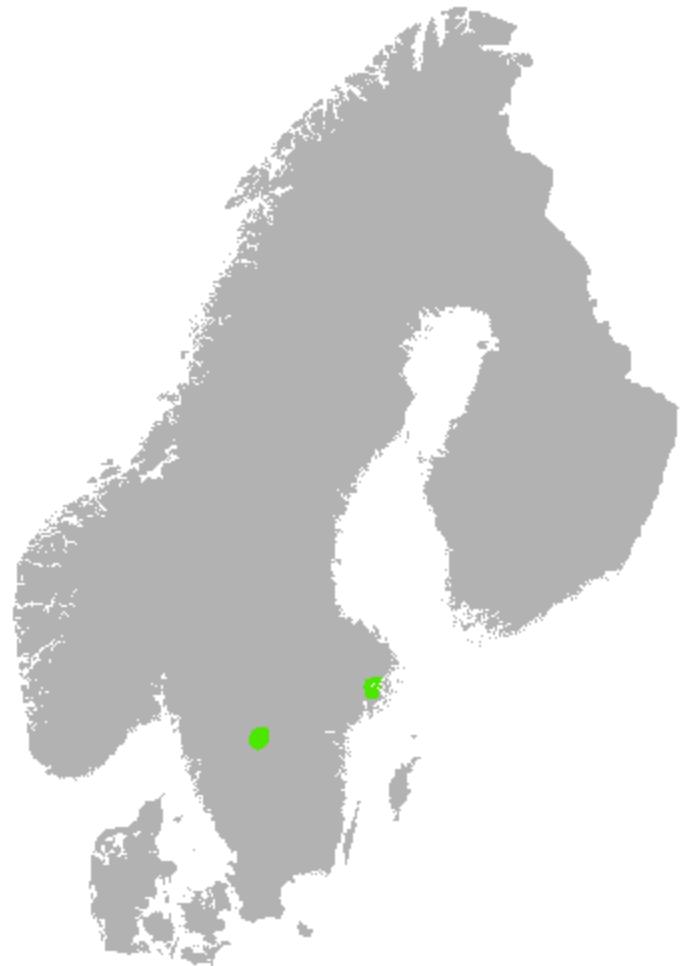
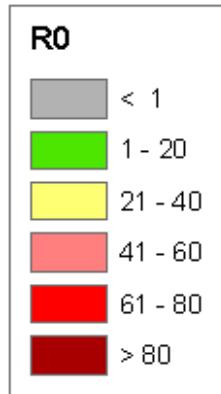
Plasmodium vivax

NordRisk Site Menu

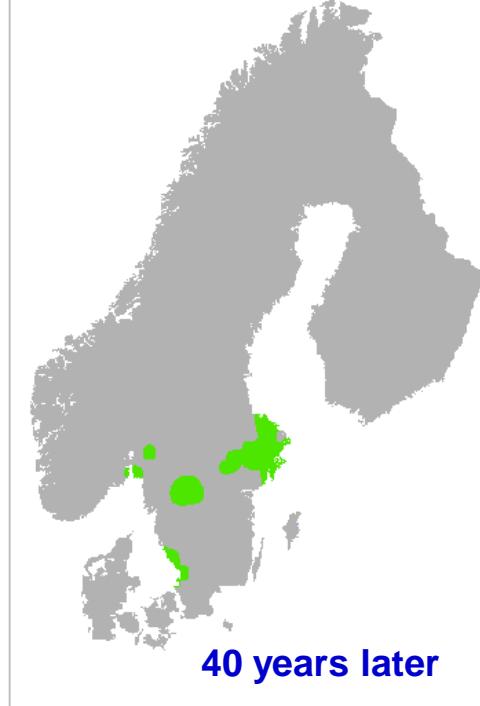
- [Introduction](#)
- [Background](#)
- [+ Diseases](#)
- [+ Vectors](#)
- [+ Climate conditions](#)
- [+ Climate projections](#)
- [+ Topography](#)
- [+ Demography](#)
- [+ Land use](#)
- [+ Husbandry](#)
- [Links](#)
- [+ Contact](#)



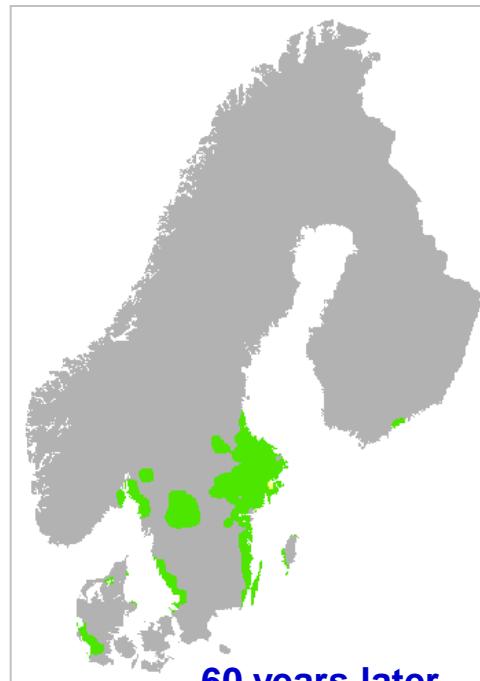
Bluetongue



R_0 05 May 2008

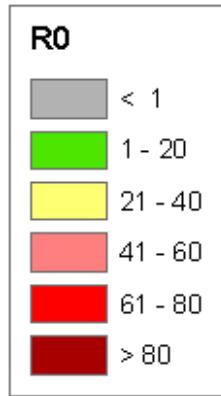


40 years later

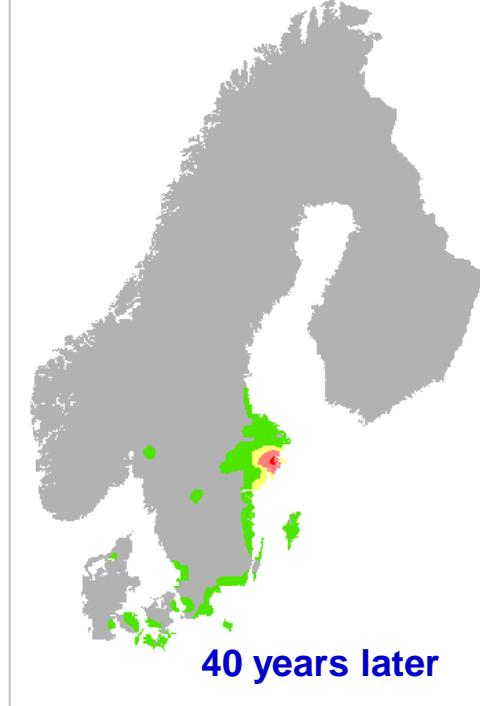


60 years later

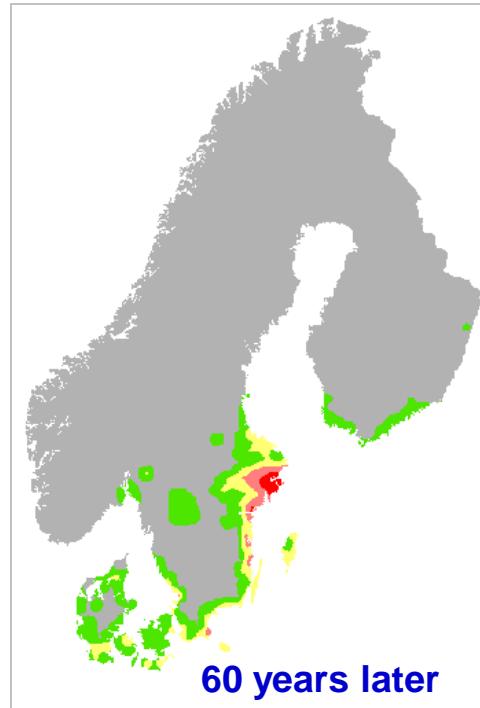
Bluetongue



R_₀ 02 Jun 2008

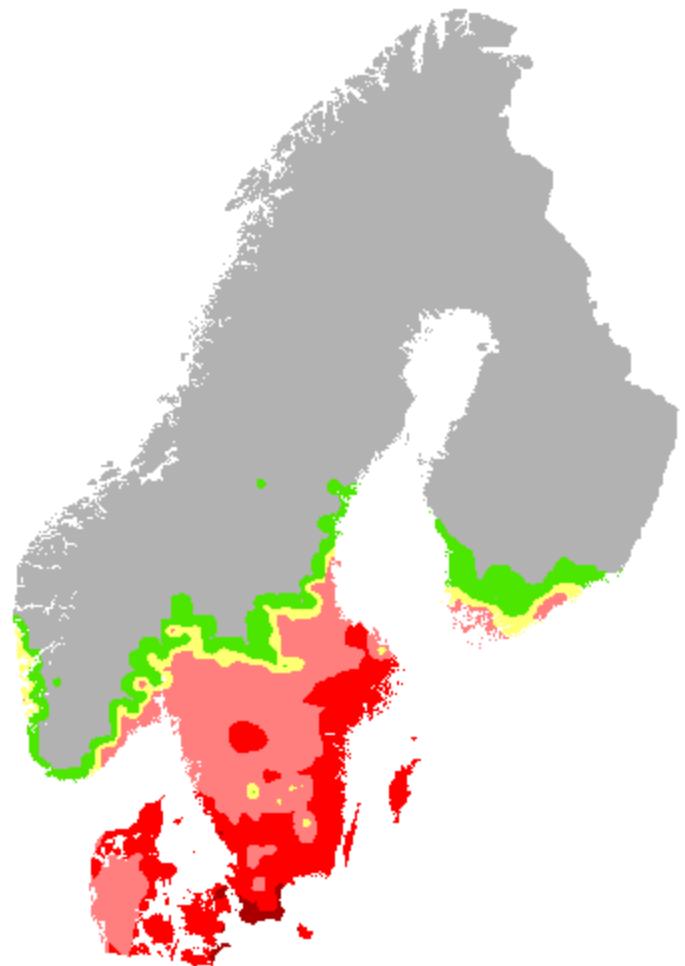
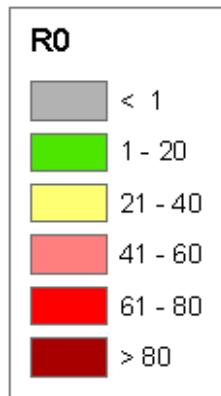


40 years later

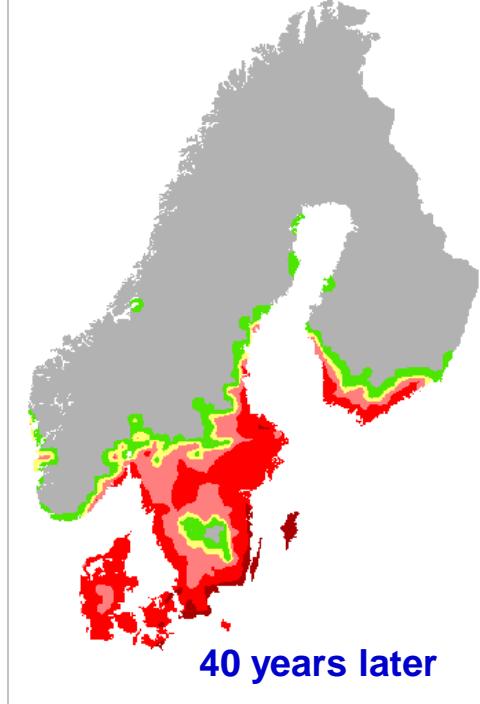


60 years later

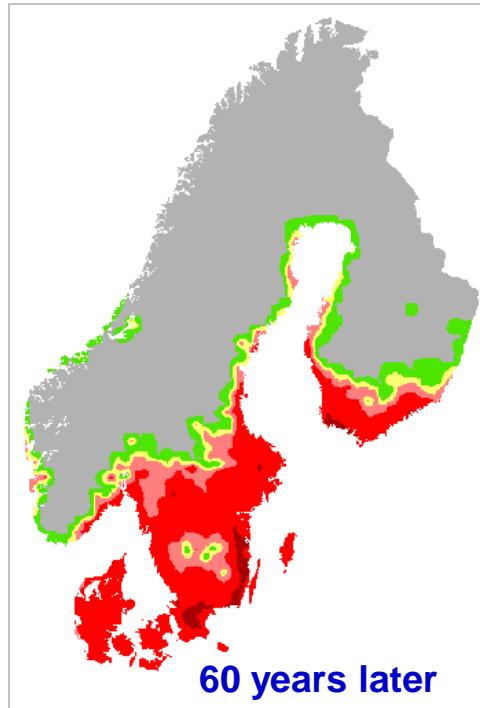
Bluetongue



R_0 30 Jun 2008

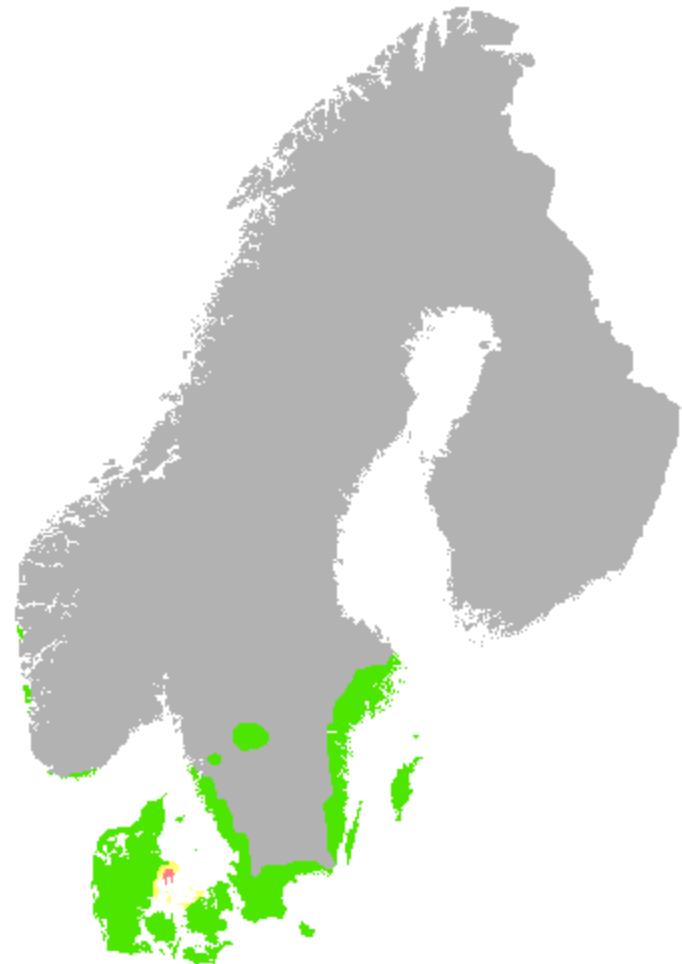
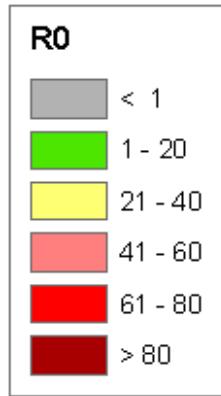


40 years later

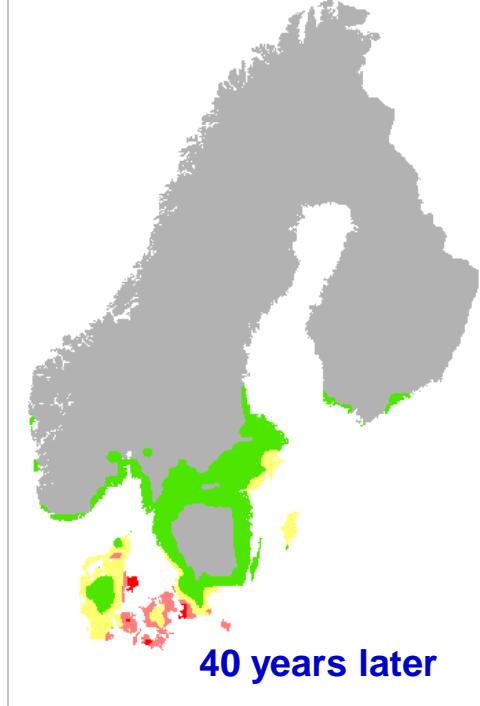


60 years later

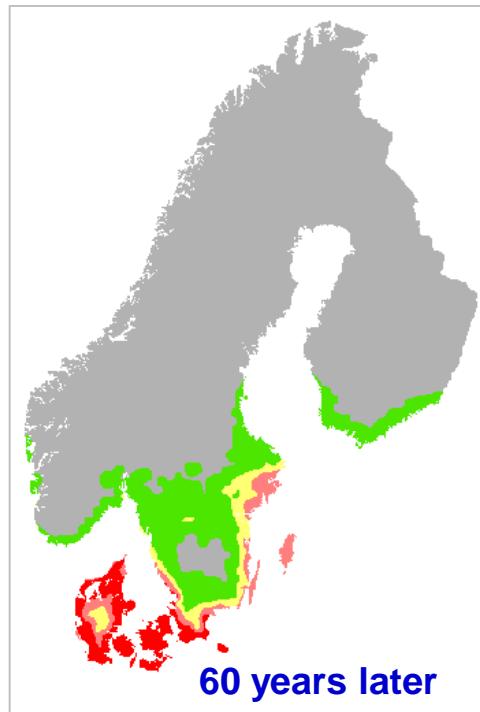
Bluetongue



R₀ 28 Jul 2008

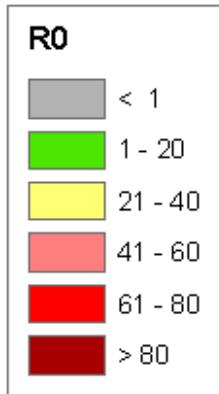


40 years later



60 years later

Bluetongue



R_0 25 Aug 2008



40 years later



60 years later

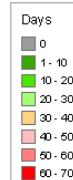
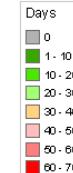
Dirofilaria: Annual number of days with infectious mosquitoes

2008

2038

**Forecasting based on
climate change models**

(we can do this because we use biological models rather than pure statistical models)



Climate change: Mountain slopes as a proxy for climate change



Altitude	Vector density <i>m</i>	$a^2 * p^n / -\ln p$	<i>C</i>	R_0	<i>C</i> (<i>t</i> = t_{300m})	<i>C</i> (<i>m</i> = m_{300m})
300 m	21.1	0.84	11.5	4,206	11.5	11.5
600 m	3.9	0.55	1.1	417	1.8	6.4
800 m	1.7	0.45	0.3	120	0.72	4.7
1000 m	0.3	0.18	0.014	5.2	0.09	1.3
1400 m	0.06	0.09	0.008	3.0	0.04	0.2
1700 m	0.01	0.02	0.00002	0.007	0.004	0.02

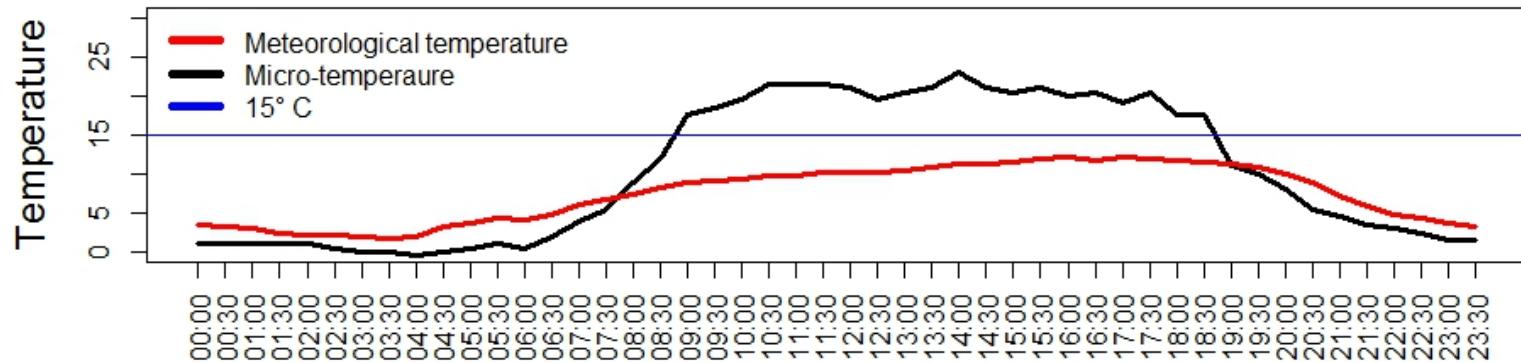


http://www.nordrisk.dk/diro_ani_wait.htm

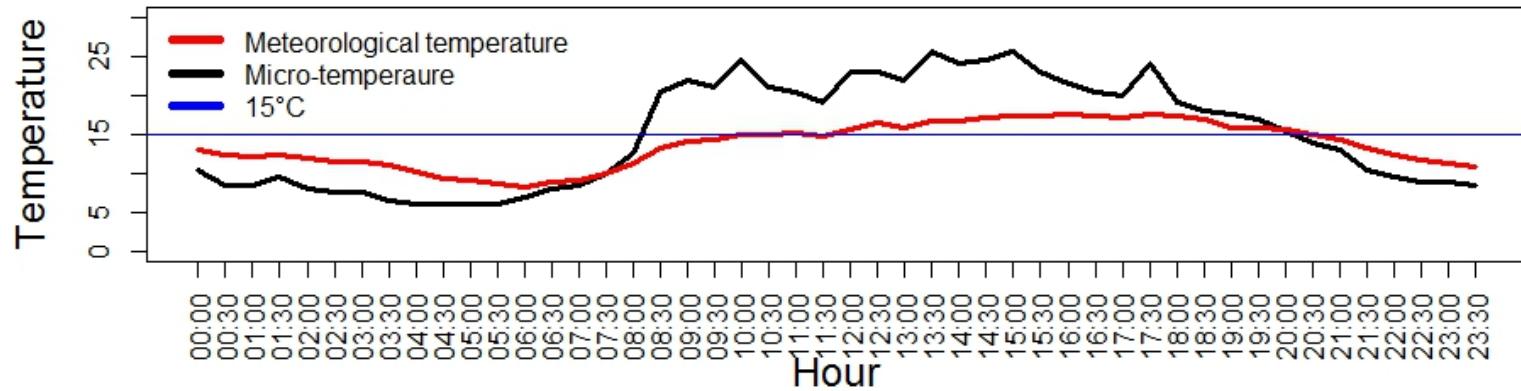


Micro-climate versus meteorological temperature

1st May 2015

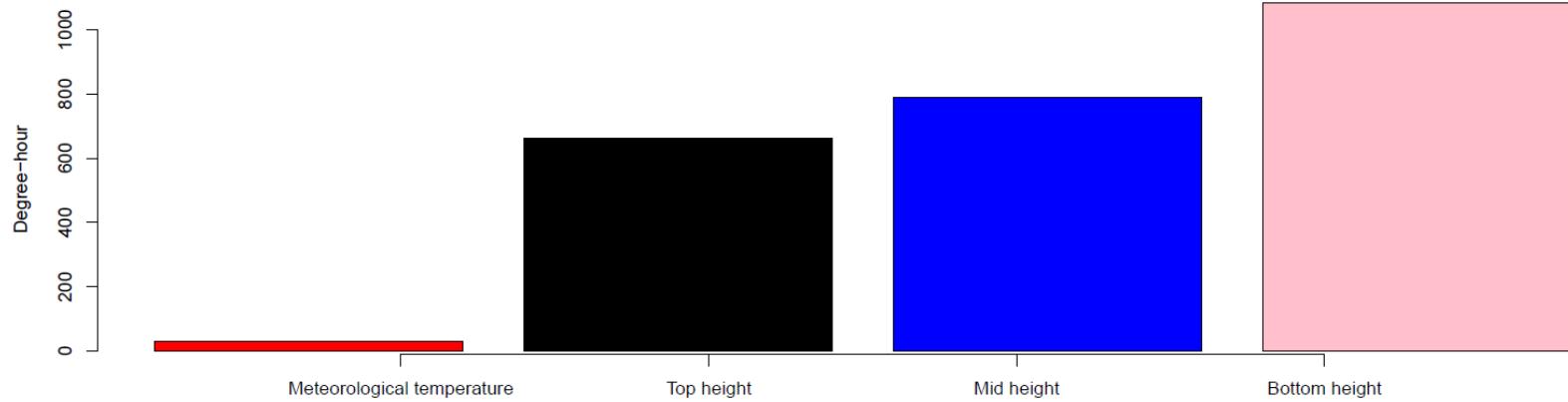


1st August 2015

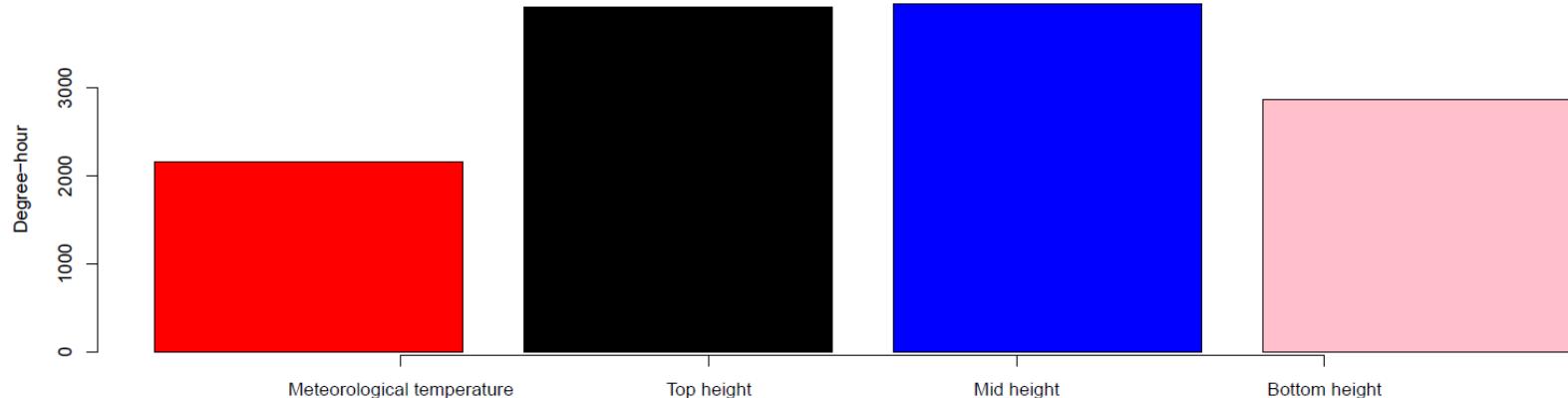


Degree-hours above 15°C

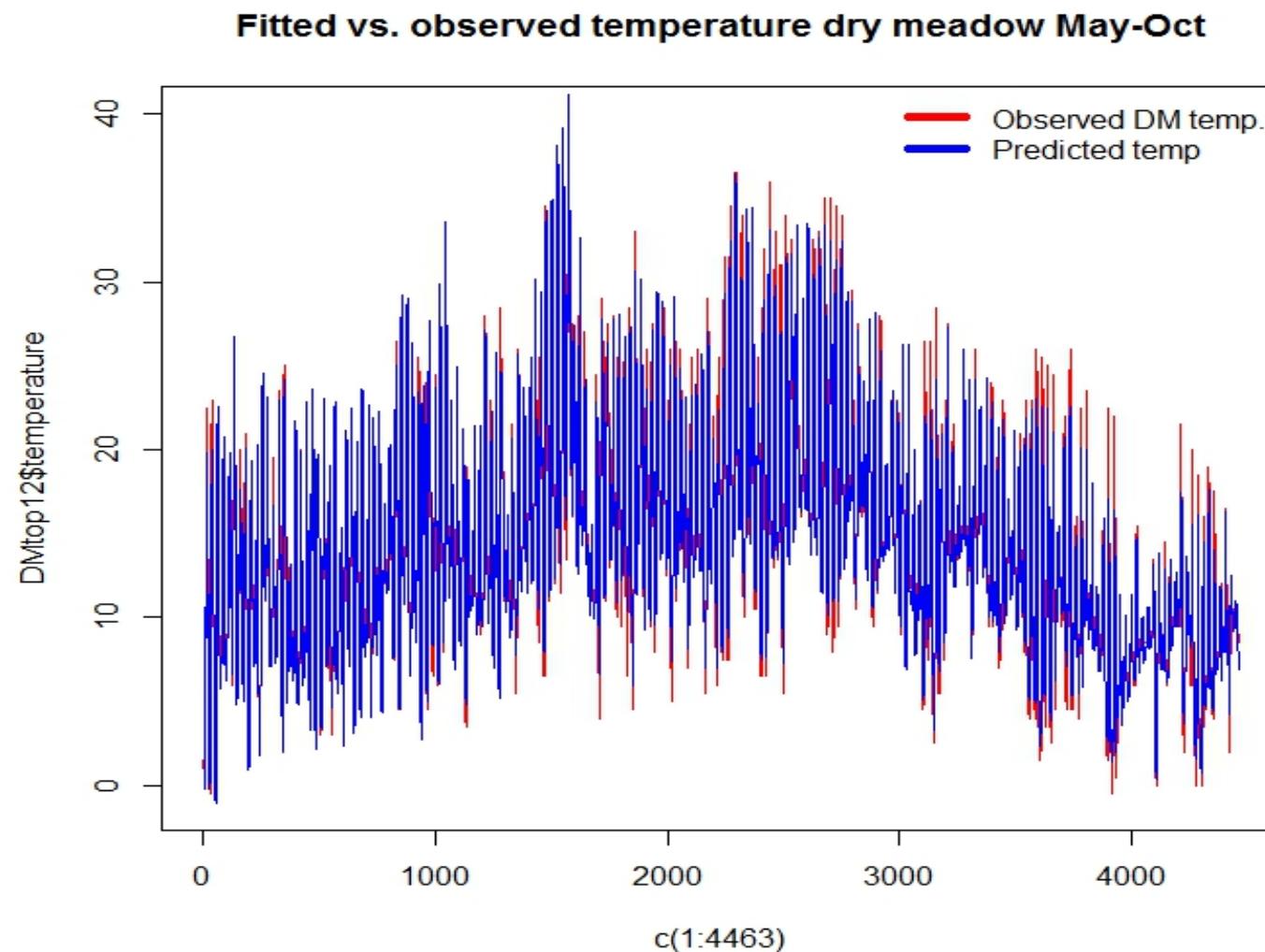
Degree-hours >15° at Dry Meadow , May 2015



Degree-hours >15°C at Dry meadow, August 2015

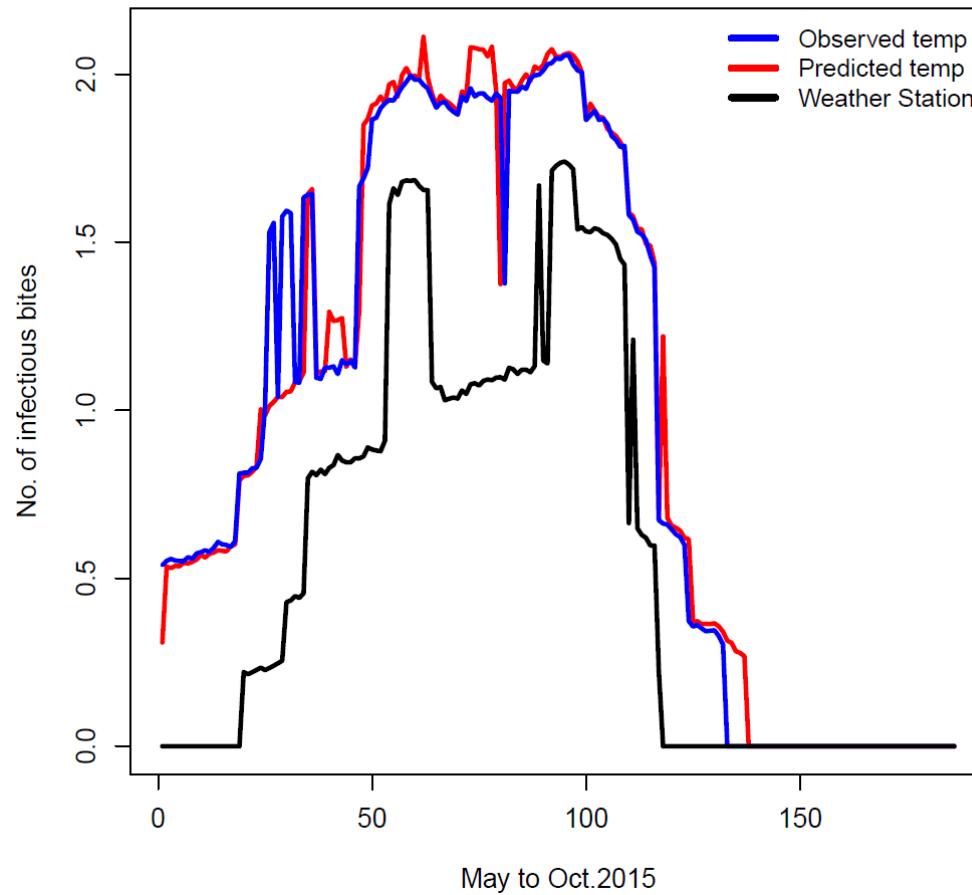


Observed versus predicted microclimate



Infectious bites/culicoides

Total infectious bites by predicted and observed Micro-temp._DM34



Model visualization



- If you want to map vectors or even develop a surveillance system for vectors, then first ask yourself what you will do with the data
- Ask yourself how you will make decisions related to human and veterinary health based on your vector data
- Else you risk ending up just mapping mosquitoes and not vectors
- Keep your focus on the diseases
 - mosquitoes and Culicoides are just input variables

Thank you
for your attention

René Bødker

*You are most welcome to
contact René Bødker*

rebo@vet.dtu.dk

www.myggetal.dk
www.nordrisk.dk

