



# Development of bark beetles and bark beetle monitoring

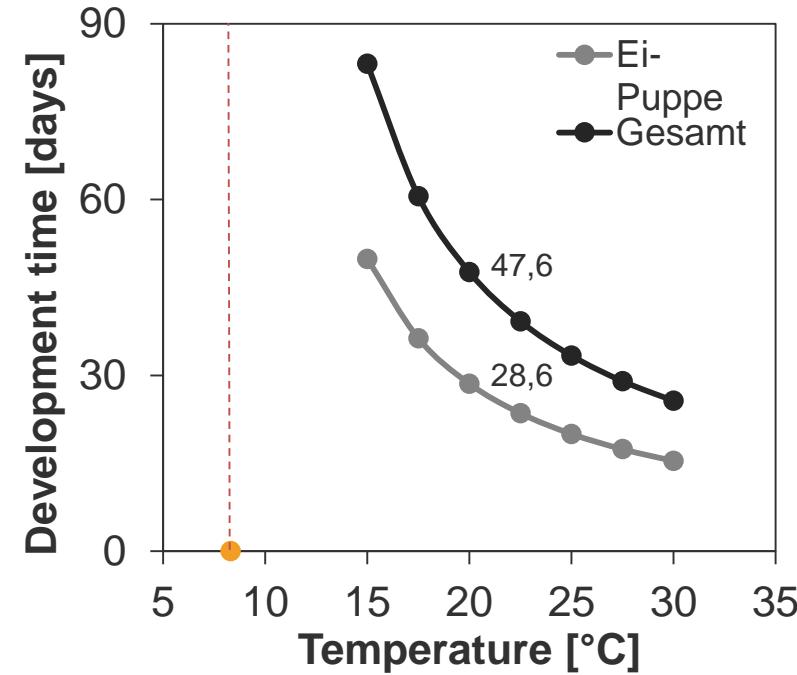
Gottfried Steyrer, Gernot Hoch  
Institut für Waldschutz

# Why talking about bark beetles?

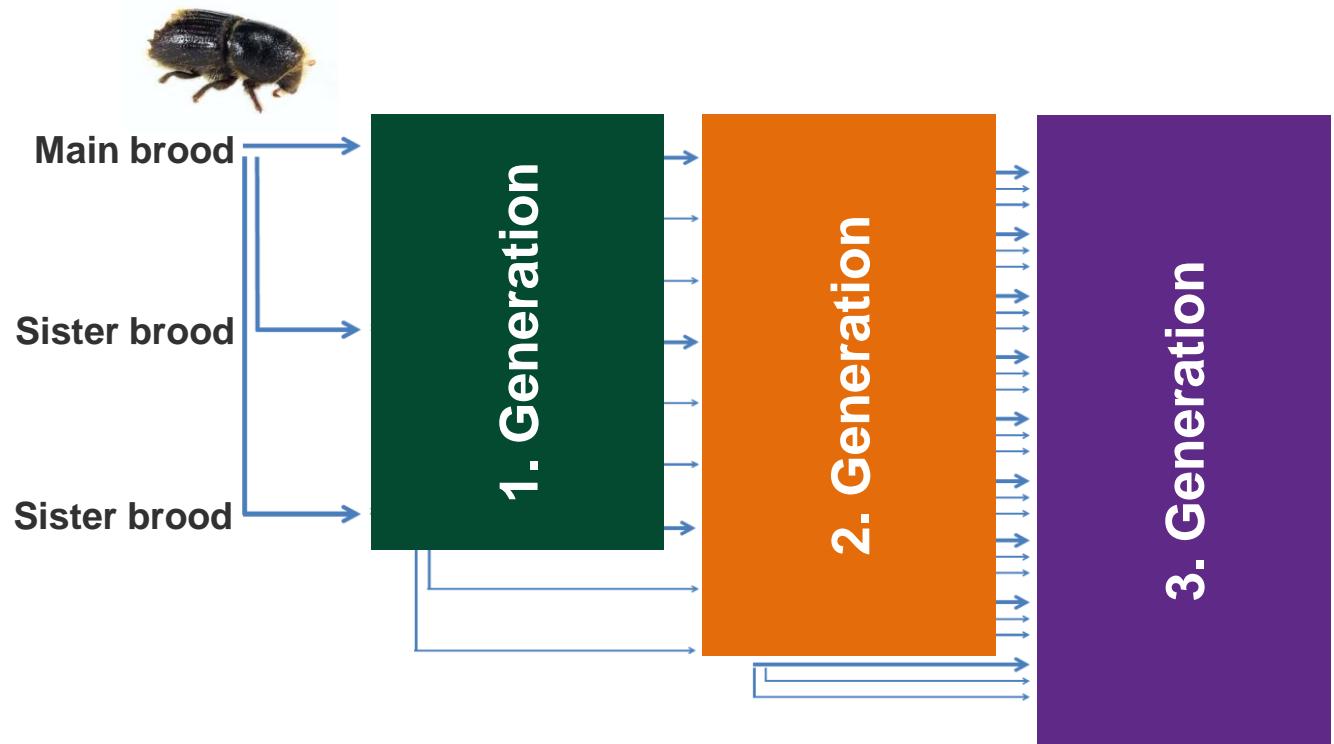


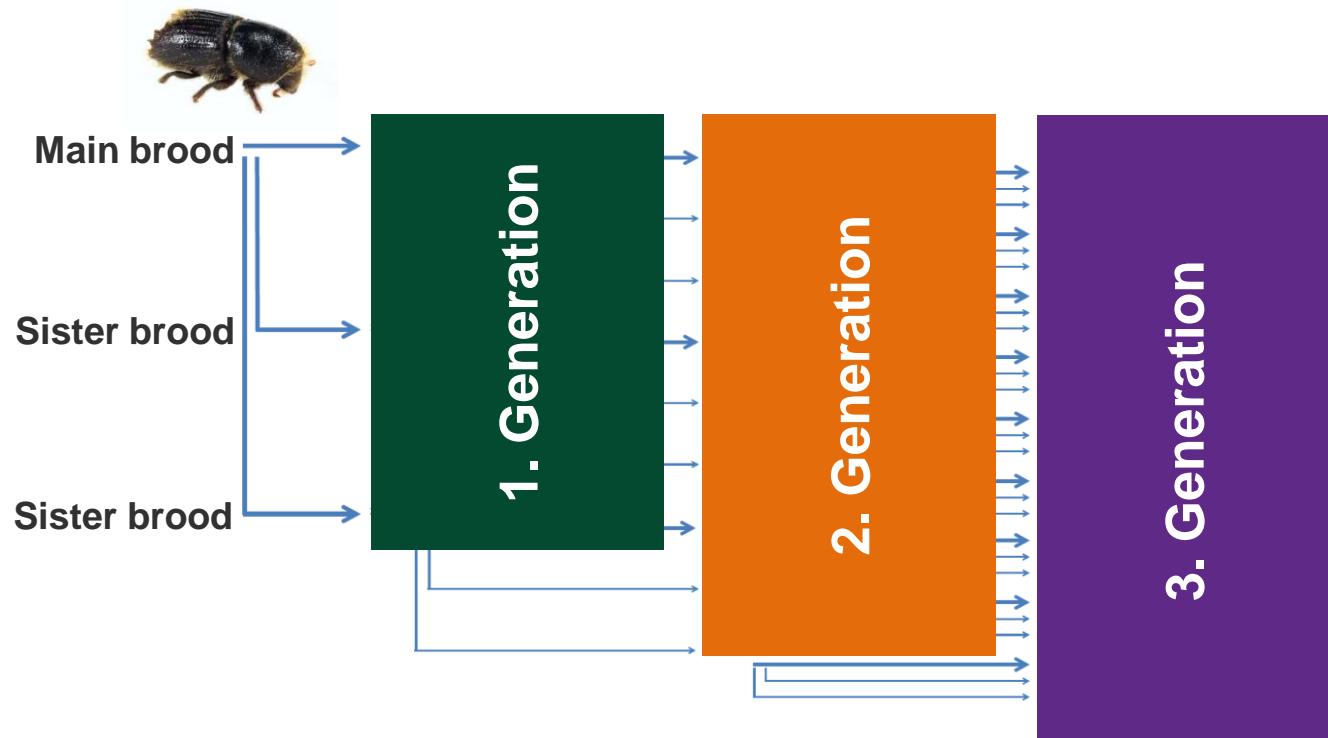
# Development of bark beetles

- 
- About 130 bark beetle species in Austria
  - Basically **secondary pests**
  - BUT:  
in case of mass outbreaks primary infestation!
  - esp. *Ips typographus*
  - **Development is temperature dependent**



(nach Wermelinger & Seifert 1998, Baier et al. 2007)





(Assumption: 50 surviving  
offspring per female)

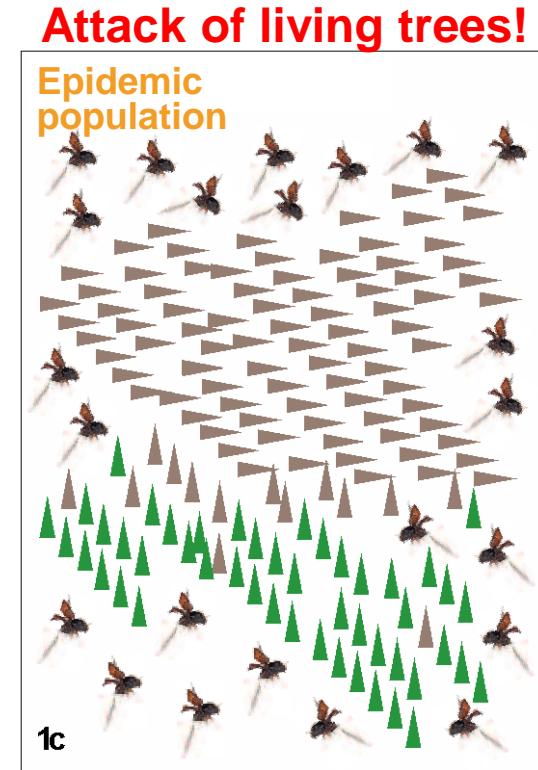
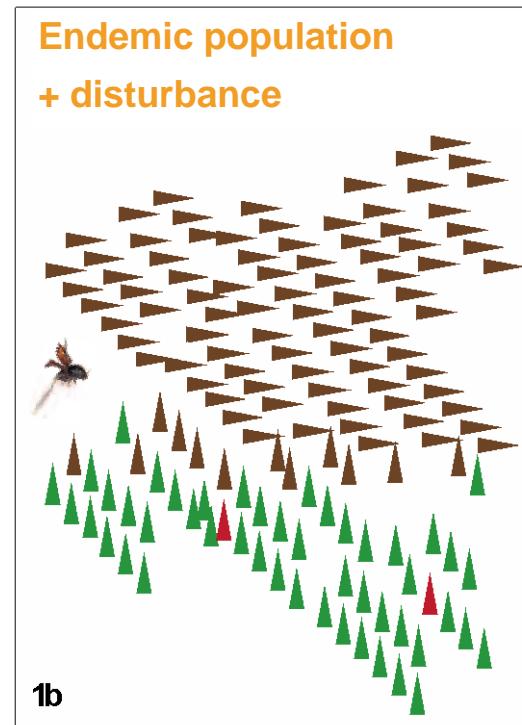
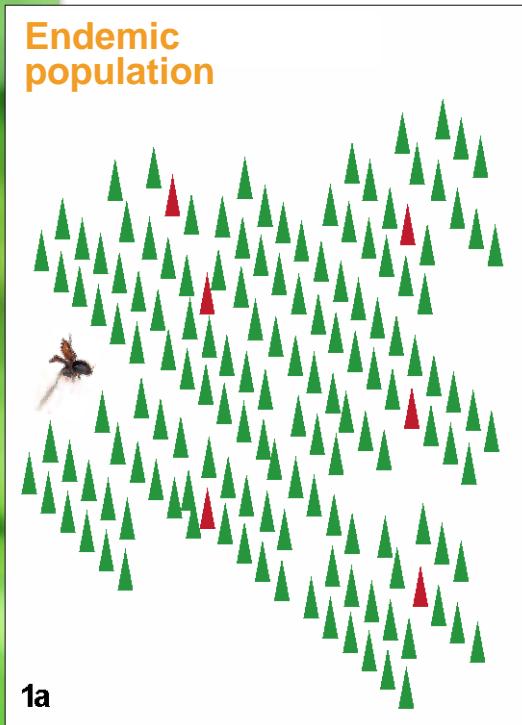
**Reproduction potential of  
one hibernating female**

50

1250

31.250

# Emergence of mass outbreaks



Grafik: Kohl & Schopf (aus Hoch et al. 2019)

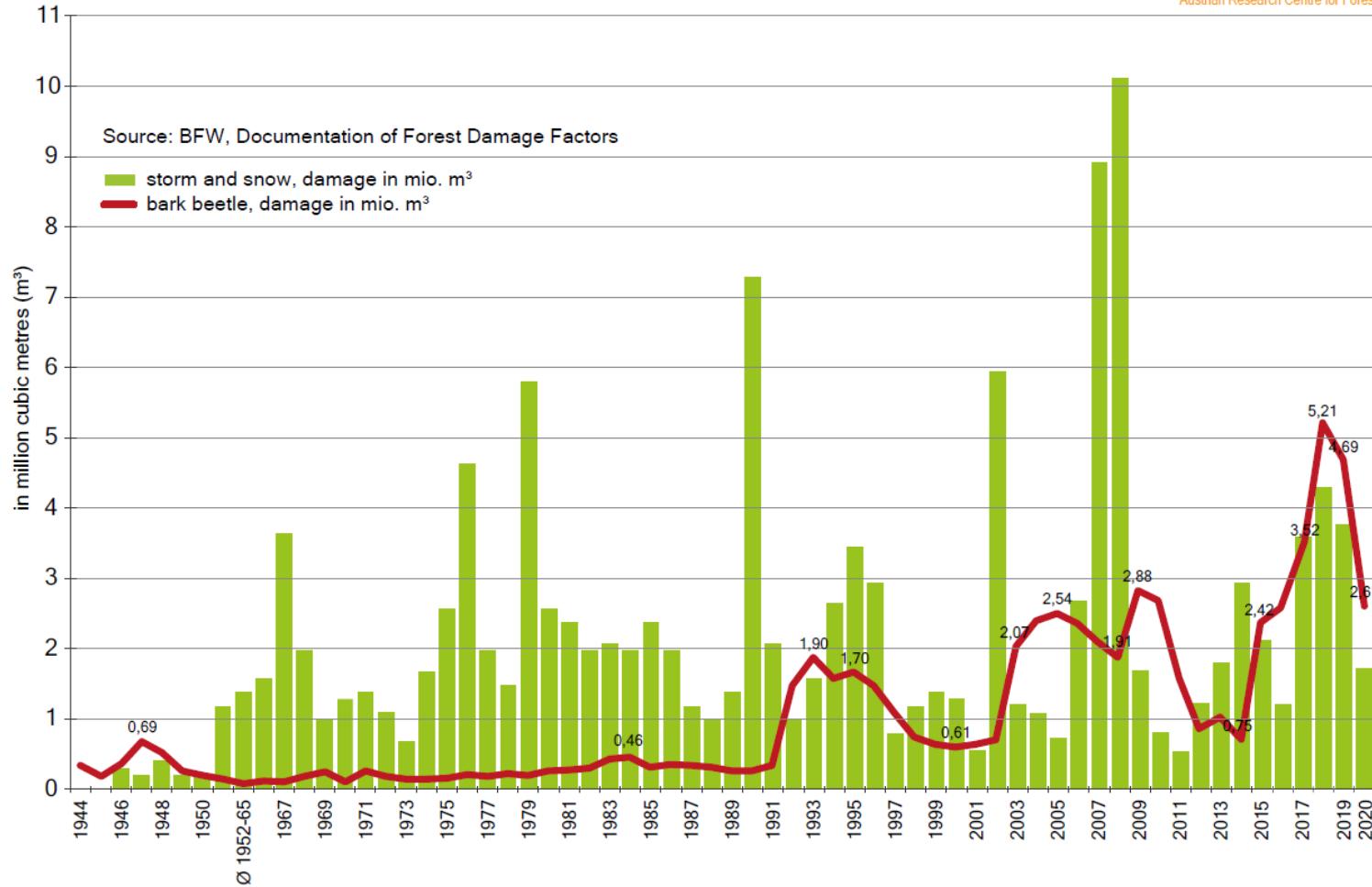
# Monitoring of bark beetles in Austria

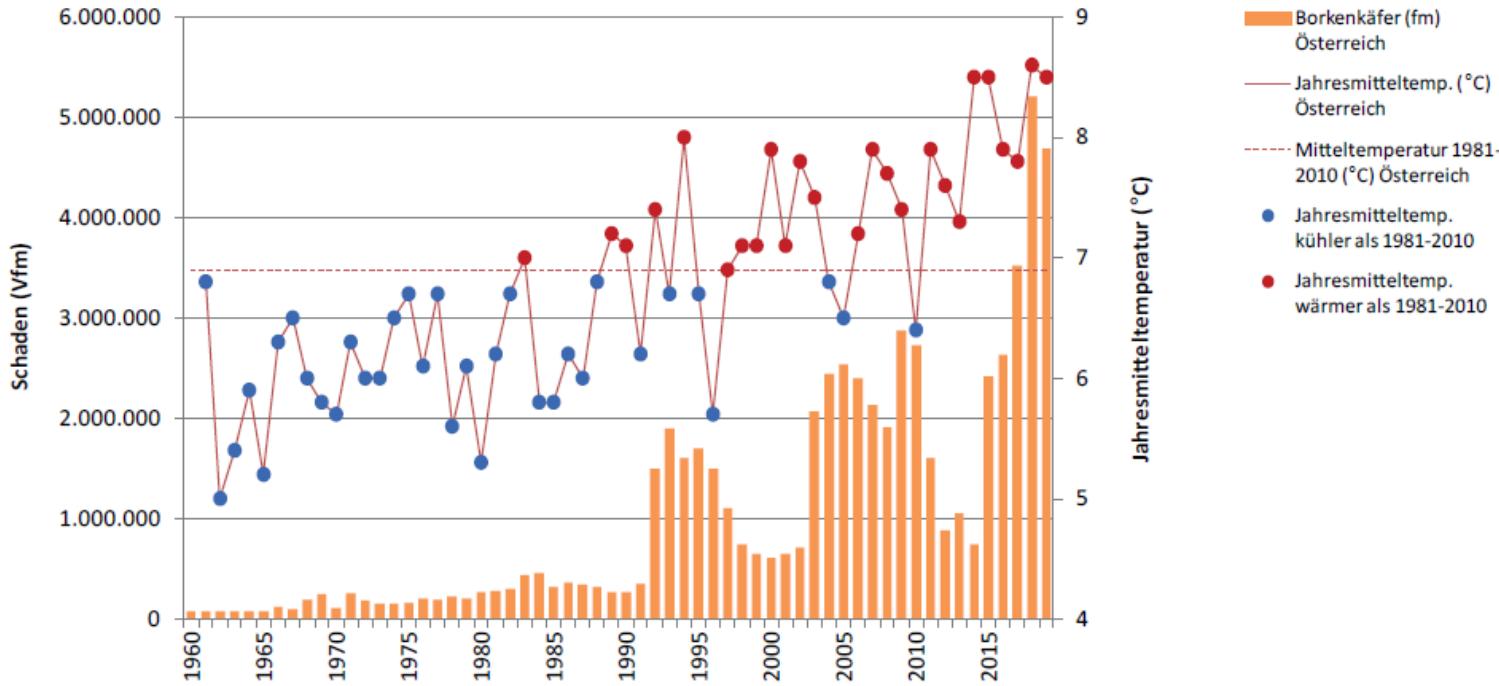
- Dokumentation der Waldschädigungs faktoren (DWF)  
(Documentation of Forest Damage Factors)
- Detection by remote sensing
  - Records of damage by bark beetle
  - Identifying centres of mass outbreaks
- Monitoring by pheromone traps
  - Monitoring of the flight activity
  - Estimation of the swarming intensity
- Model PHENIPS (BOKU, Baier et al. 2007)
  - Modelling the site-specific development of *Ips typographus*

# DWF – Documentation of Forest Damage Factor

- Physiological damage & independent of salvage logging
- Records based on estimates
- Provided by foresters of the district forest authorities (241 EE)
- 67 important damage factors  
(pests, diseases and abiotic damage)
- Includes important bark beetle species,  
such as *Ips typographus* and *Pityogenes chalcographus*

# Damage by storm, snow and bark beetle



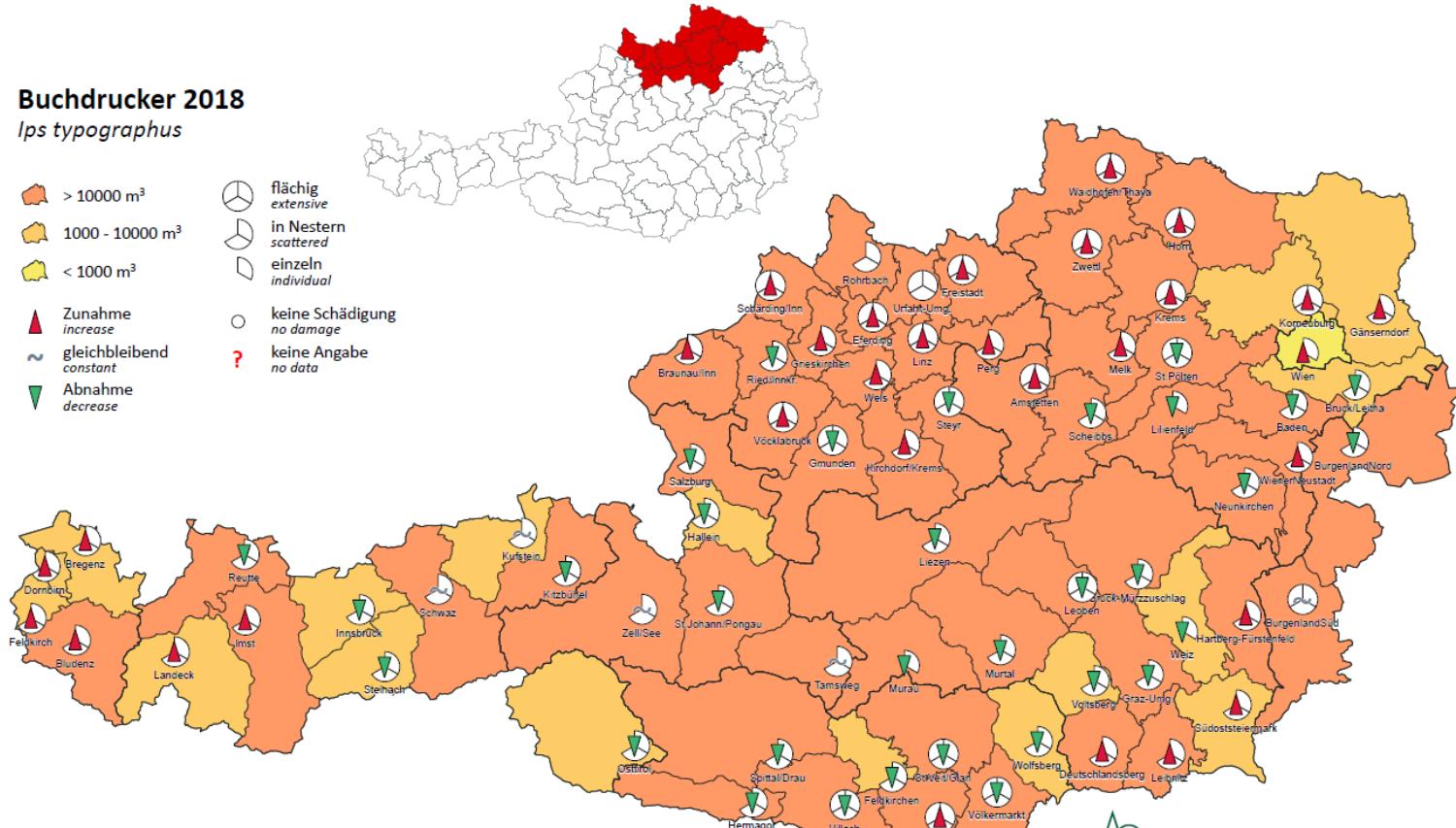


Increasing temperatures and increasing bark beetle damage in Austria  
(Hoch & Steyrer 2020: CCCA Fact Sheet #31)

## Buchdrucker 2018

*Ips typographus*

- > 10000 m<sup>3</sup>
- 1000 - 10000 m<sup>3</sup>
- < 1000 m<sup>3</sup>
- ▲ flächig  
extensive
- △ in Nestern  
scattered
- einzeln  
individual
- ▲ Zunahme  
increase
- ~ gleichbleibend  
constant
- ▼ Abnahme  
decrease
- keine Schädigung  
no damage
- ? keine Angabe  
no data



Dokumentation der Waldschädigungsfaktoren  
Documentation of Forest Damage Factors

Quelle: Mitteilungen der Bezirksforstinspektionen  
Source: Data by forest districts

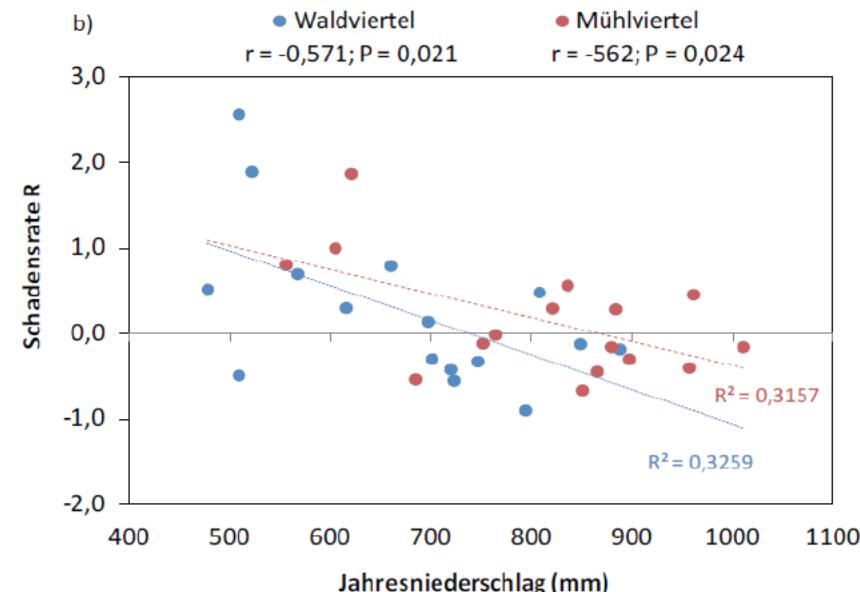
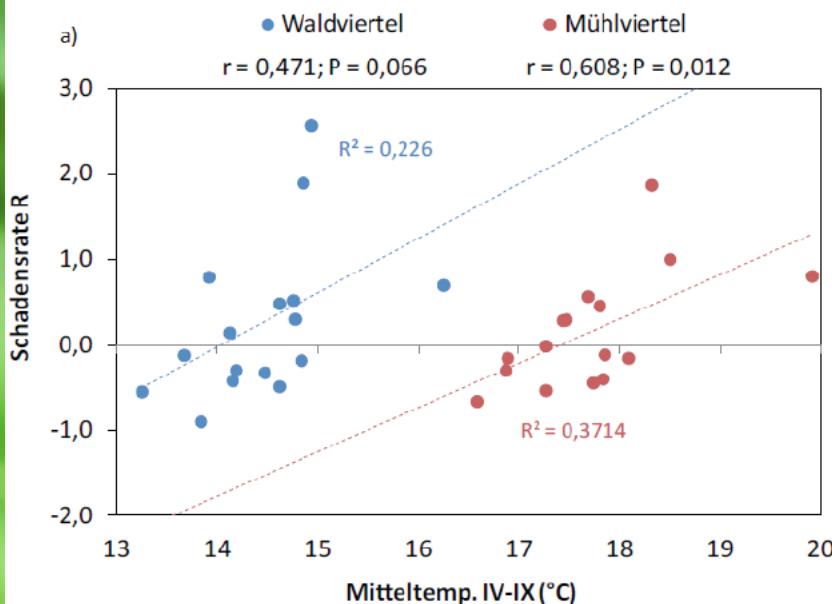
0 20 40 60 80 100 km



Bundesforschungszentrum für Wald  
Institut für Waldschutz  
Austrian Research Centre for Forests  
Department of Forest Protection

# Bark beetle damage and climate

Waldviertel und Mühlviertel, 2002-2017



Damage rate [  $R = \ln(\text{damage}_t / \text{damage}_{t-1})$  ], correlating with annual precipitation sum and summer temperature (source: DWF; ZAMG stations Zwettl and Linz).

(Hoch & Steyrer 2020: CCCA Fact Sheet #31)

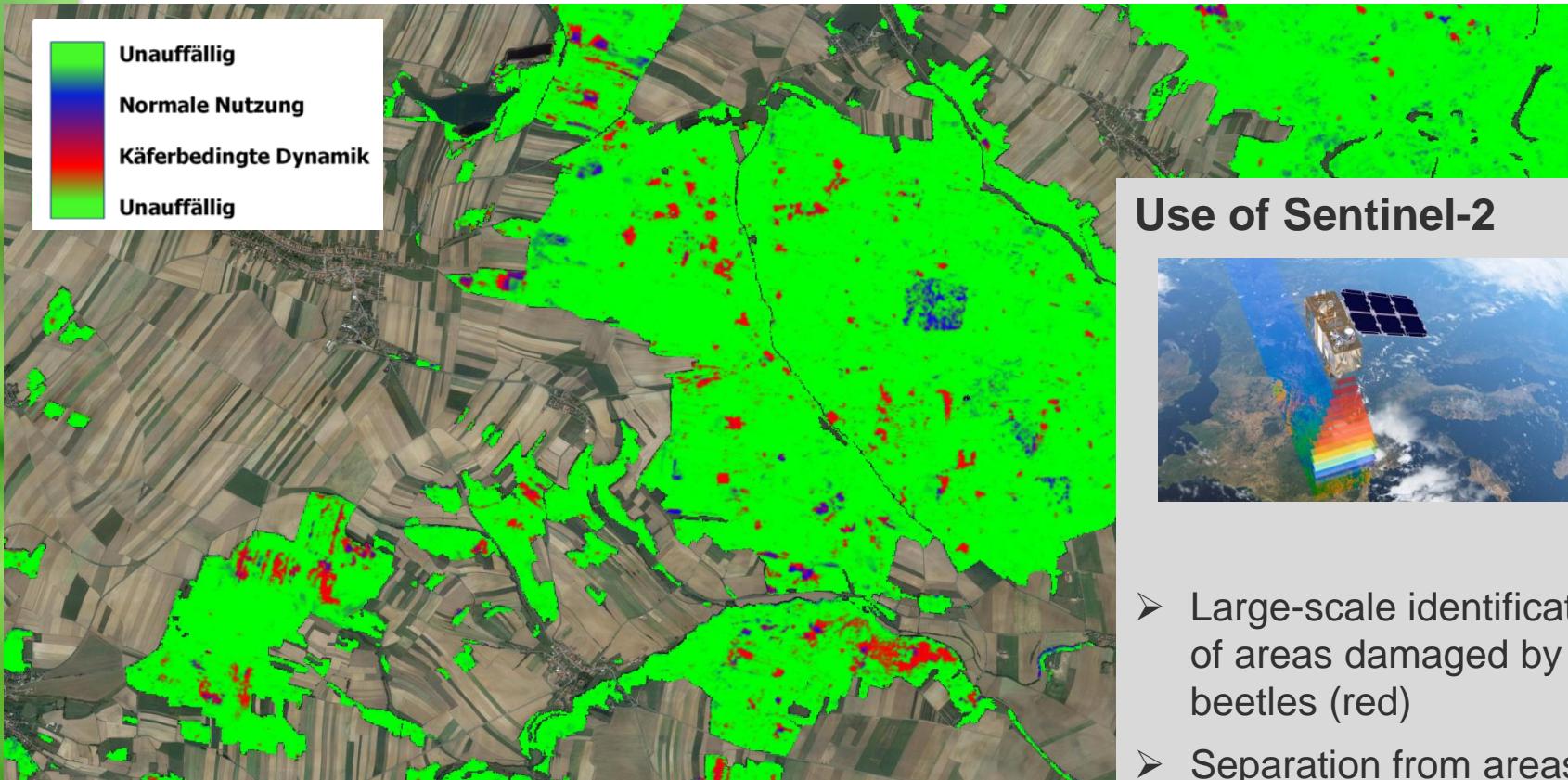
# Bark beetle mass outbreak - climate



- Very extensive damaged areas in the Northeast of Austria
- without classic dynamics = not driven by (major) disturbances
- **New dynamics:**  
driven by **extreme drought** and **high temperatures / heat**
- Pre-damage of the host tree (predisposition)
- Effect on host tree defence

# Detection by remote sensing (ÖWI)

➤ Institut für Waldinventur, BFW



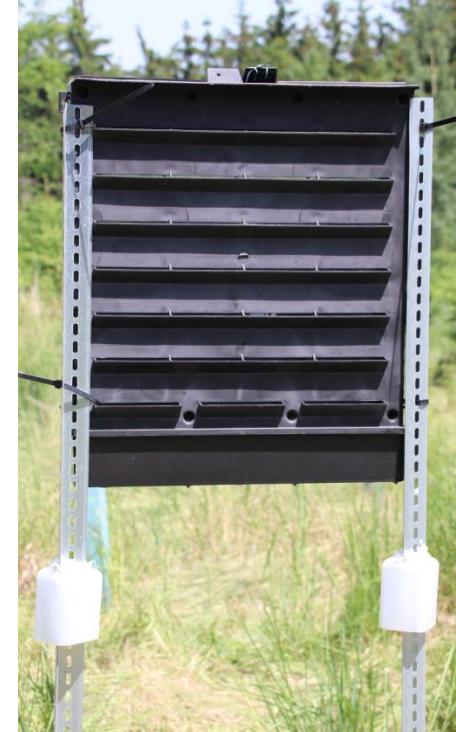
Use of Sentinel-2



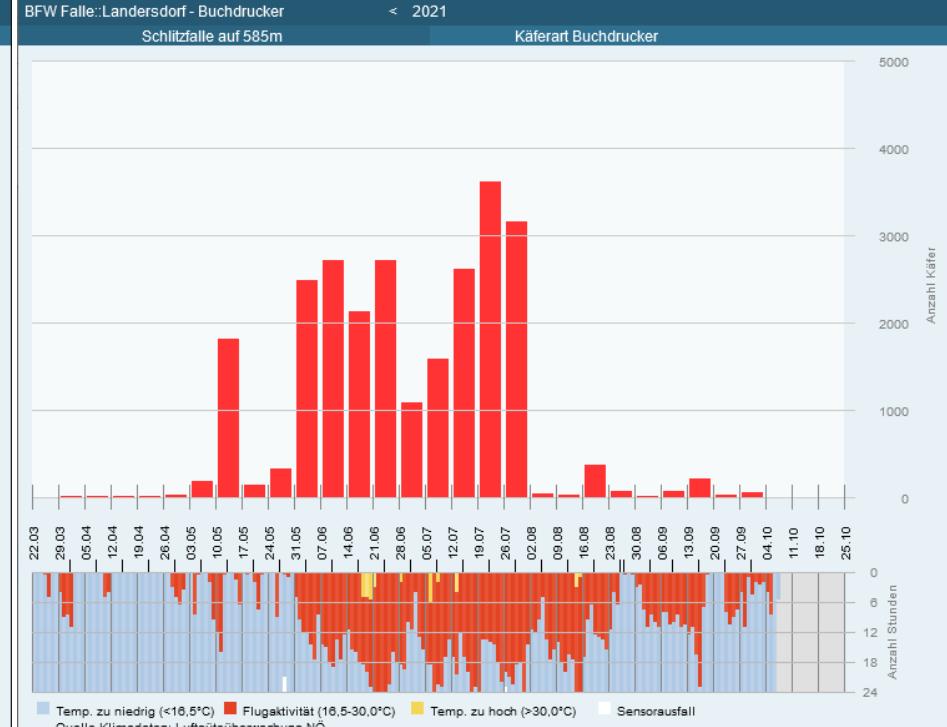
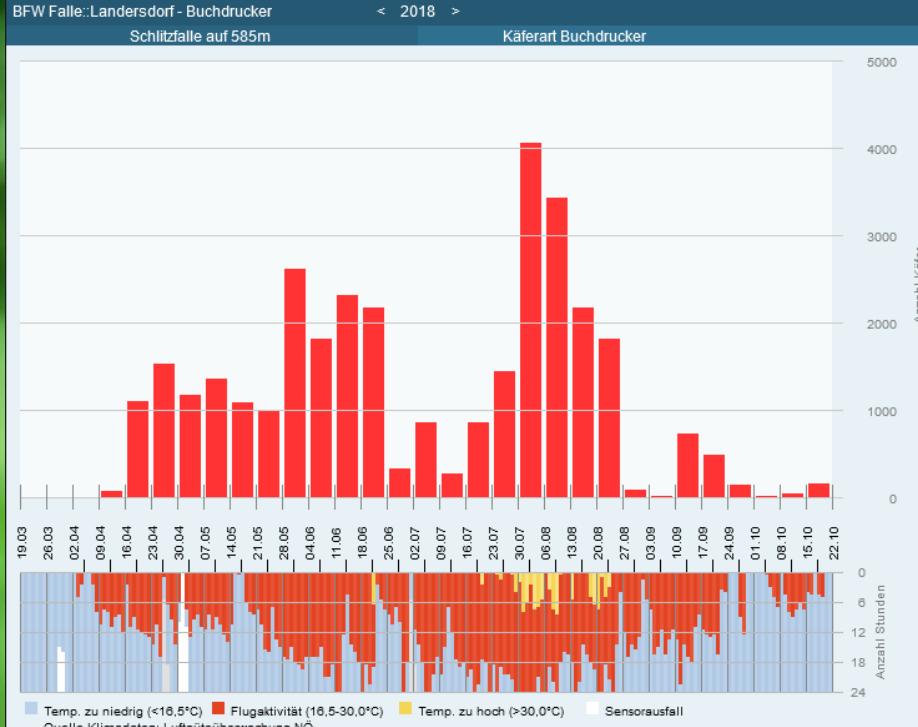
- Large-scale identification of areas damaged by bark beetles (red)
- Separation from areas with normal growth

# Monitoring by pheromone traps

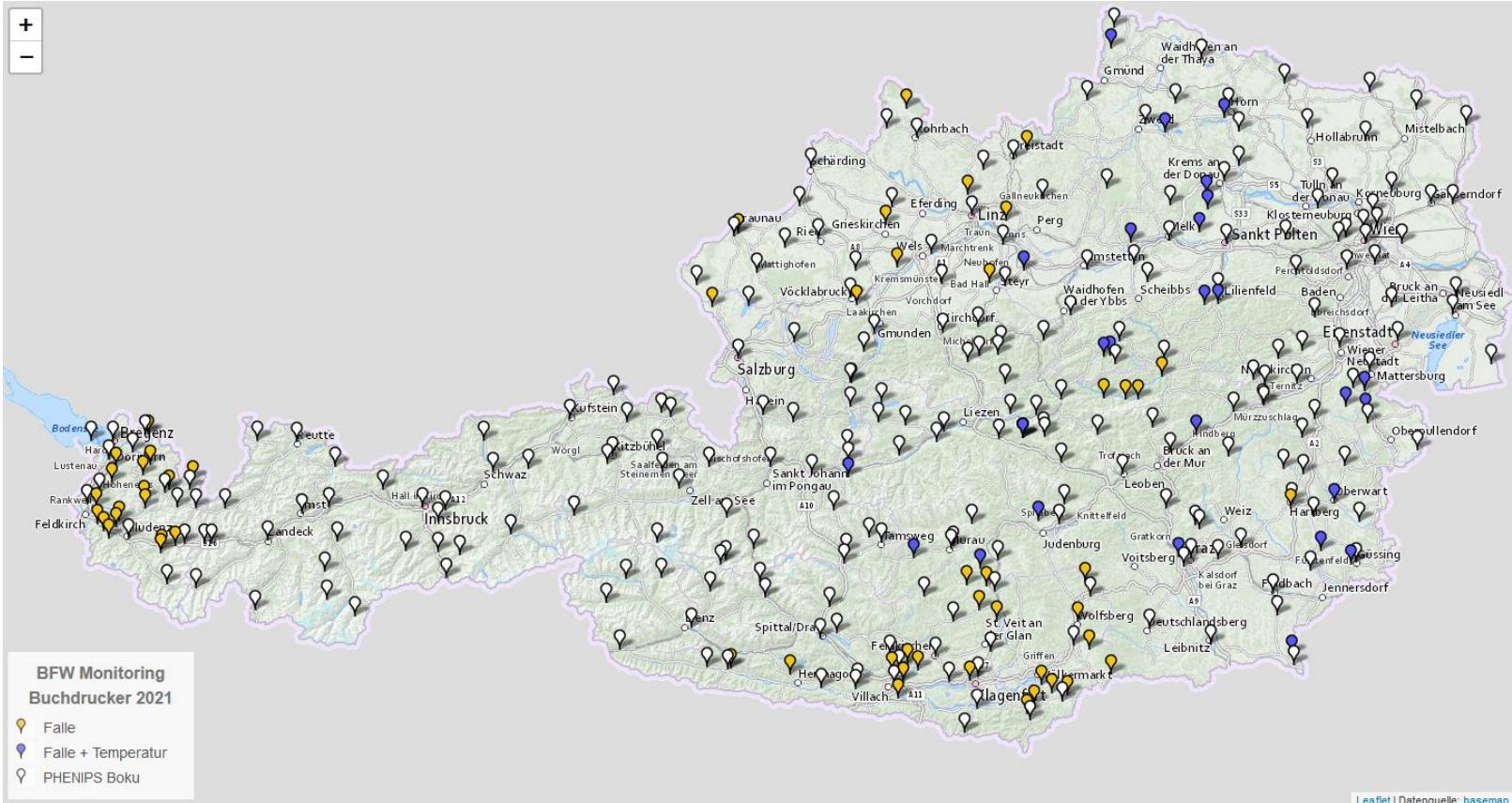
- Monitoring of the flight activity & Estimation of the swarming intensity
- Lure baited traps as monitoring tool
- Lure = aggregation pheromone (+ kairomone)
- Different types of traps
- Monitoring programmes:  
operational, regional or supra-regional
- In Austria: national  
bark beetle trap monitoring,  
BFW (in cooperation with LFD und LK)



BFW Webseite  
Borkenkäfermonitoring  
[www.borkenkaefer.at](http://www.borkenkaefer.at)



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BFW Monitoring  
Buchdrucker 2021

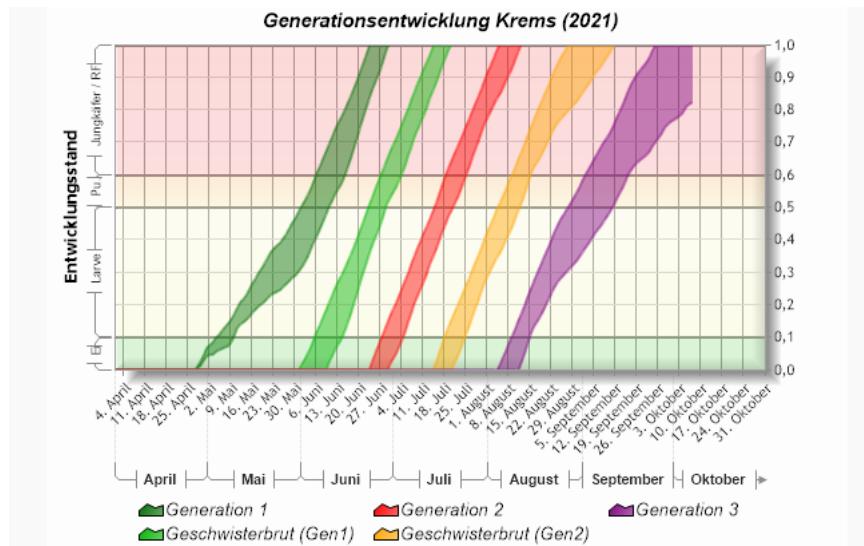
- 📍 Falle
- 📍 Falle + Temperatur
- 📍 PHENIPS Boku

Leaflet | Datenquelle: basemap.a

**BFW Webseite**  
**Borkenkäfermonitoring**  
**[www.borkenkaefer.at](http://www.borkenkaefer.at)**

# Model PHENIPS

- Phenology model of *Ips typographus* (BOKU), Baier et al. 2007
- Air temperature, solar radiation, topography
- swarming activities, rates of brood development and incidence of sister broods and filial generations
- Site model:

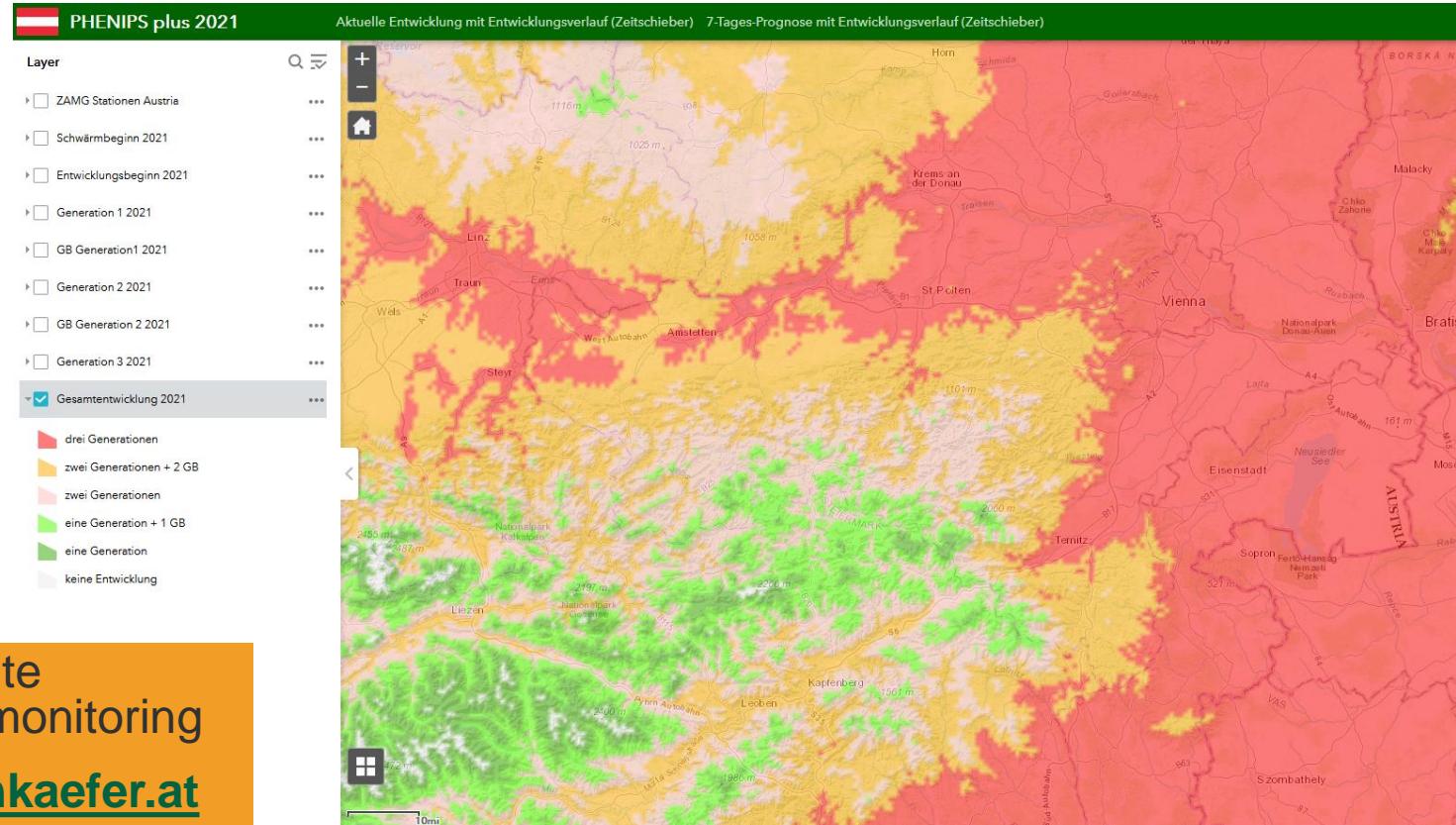


Bark beetle development  
(Model PHENIPS, Univ. BOKU)  
at the monitoring site Krems

BFW Webseite  
Borkenkäfermonitoring  
[www.borkenkaefer.at](http://www.borkenkaefer.at)

# Model PHENIPS plus

➤ Further Development to areal model (bas. INCA-Modell; ZAMG)



BFW Webseite  
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# Biology of *Ips typographus*

Development is  
temperature dependent

*Thermal sum*  $K_{gesamt} = 557 \text{ TG}$

$ENP = 8,3 \text{ }^{\circ}\text{C}$

bei const.  $20 \text{ }^{\circ}\text{C}$  :  $TG/d = 11,7$

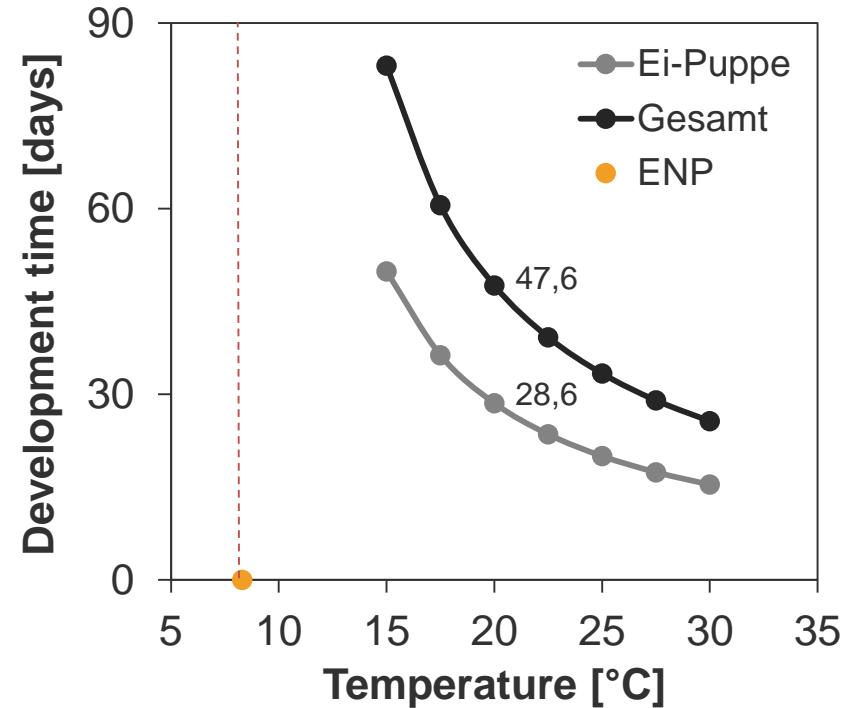
time:  $557 / 11,7 = 47,6 \text{ d}$

$$TG = \frac{T_{max} + T_{min}}{2} - ENP$$

TG ... degree-days

T ... temperature

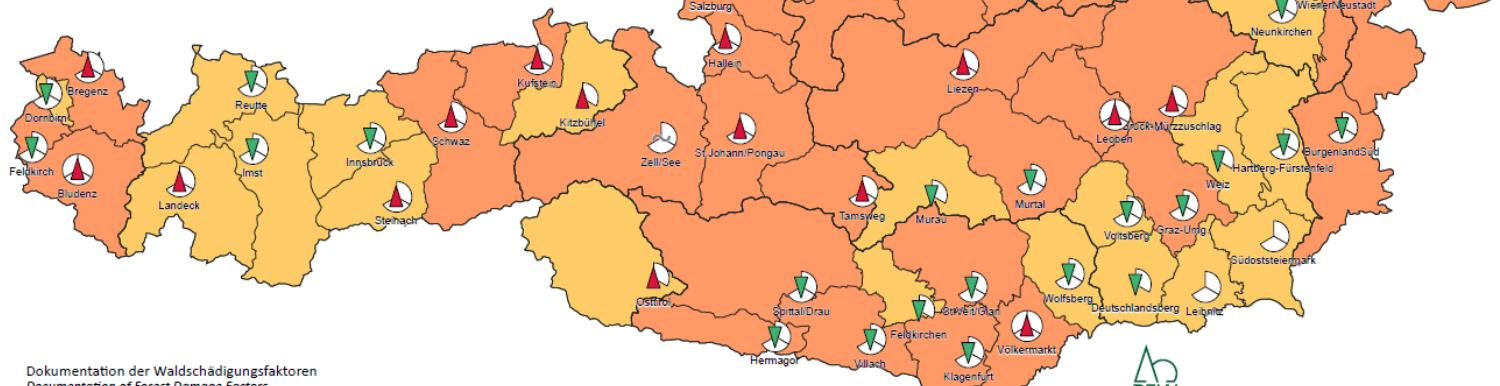
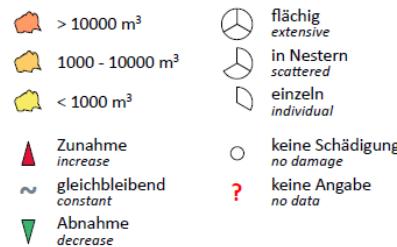
ENP ... Development threshold



(nach Wermelinger & Seifert 1998, Baier et al. 2007)

## Buchdrucker 2020

*Ips typographus*



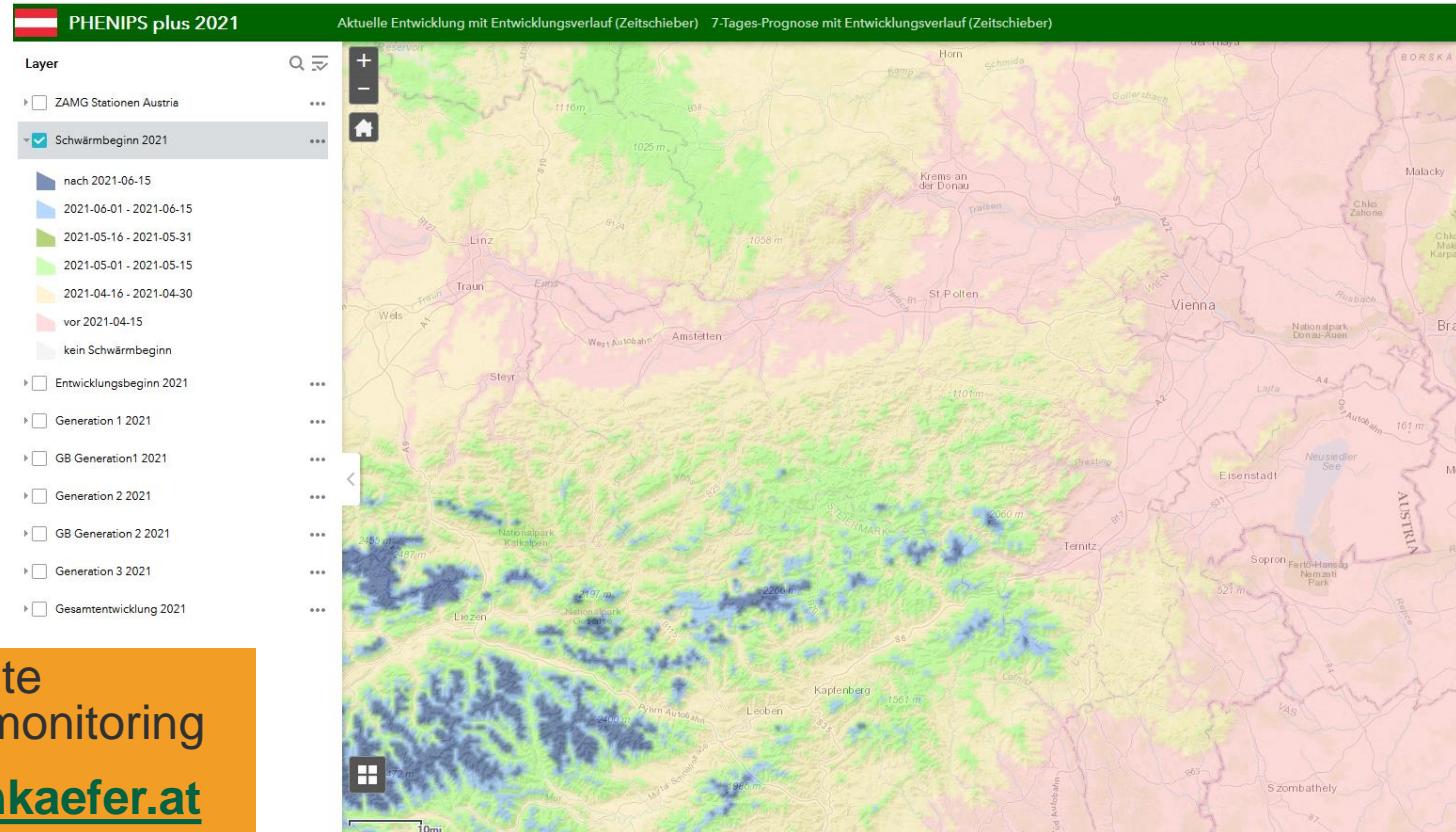
Dokumentation der Waldschädigungsfaktoren  
Documentation of Forest Damage Factors

Quelle: Mitteilungen der Bezirksforstinspektionen  
Source: Data by forest districts

0 20 40 60 80 100 km

# Modell PHENIPS plus

➤ Erweiterung auf Flächenmodell (bas. INCA-Modell; ZAMG)



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