IFFF
Institute of Forest Entomology,
Forest Pathology and
Forest Protection

Modelling *Ips typographus* Development and Predisposition to Outbreaks in Austria

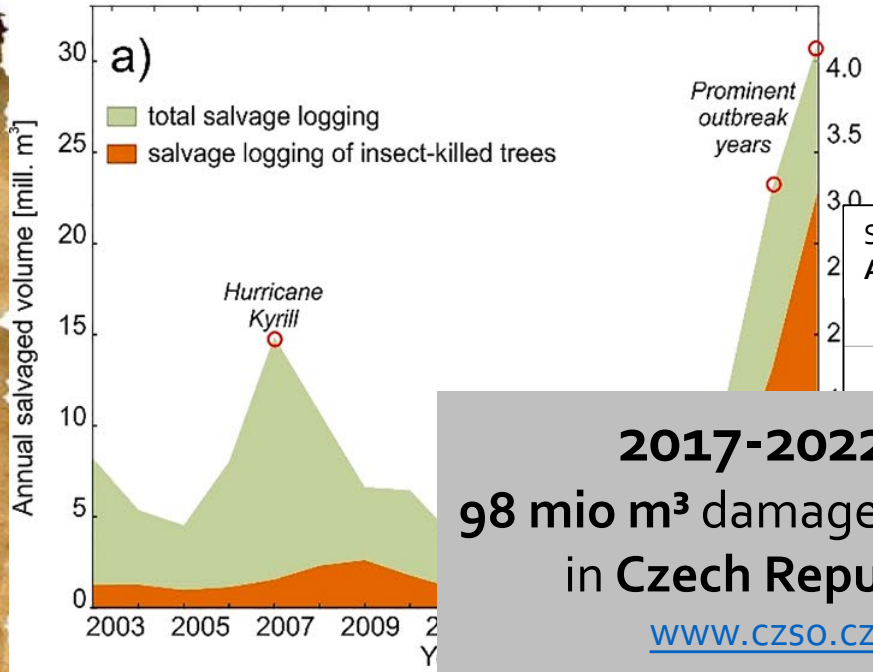
Sigrid Netherer

WANTED

Eurasian spruce bark beetle
Ips typographus

- 1-3 generations + sister broods
- Hibernation in bark or litter
- Reproductive diapause

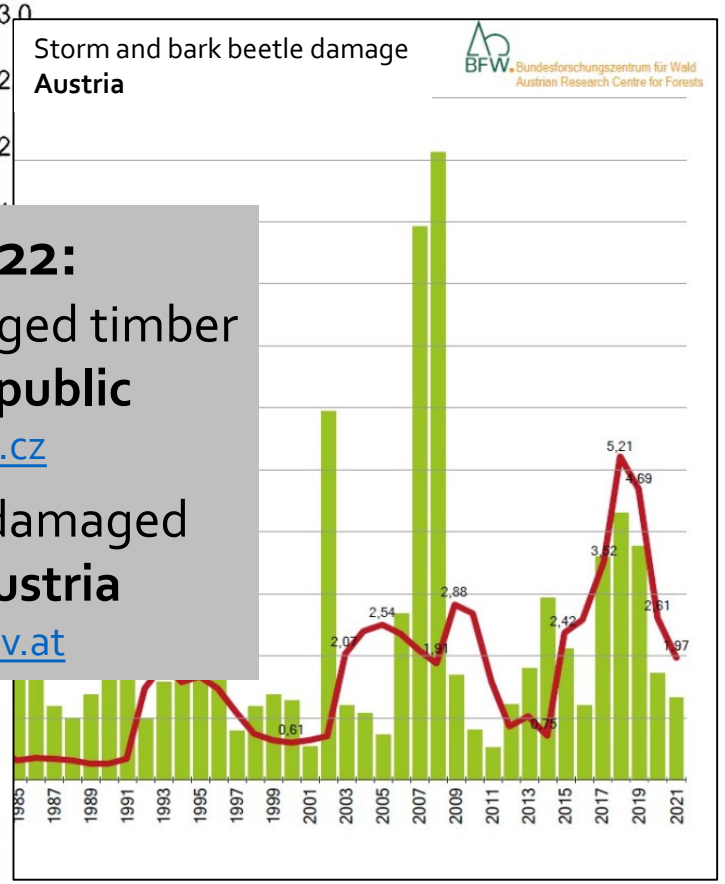
www.stockfreeimages.com



2017-2022:
98 mio m³ damaged timber in **Czech Republic**
www.czso.cz

21.75 mio m³ damaged timber in **Austria**
www.bfw.gv.at

Hlasny et al. (2021)
Forest Ecology and Management



Comprehensive Bark Beetle Monitoring and Risk Assessment important!

RAWLog

Waldfonds
Republik Österreich
Eine Initiative des Bundesministeriums für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft

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Bundesministerium
Landwirtschaft, Regionen und Tourismus

DaFNE

Tools for assessing the disturbance risk of Norway spruce dominated forests:

- **P**redisposition **A**ssessment **S**ystem **(PAS)** (Führer and Nopp 2001; Netherer and Nopp-Mayr 2005)
  Susceptibility of spruce forests to bark beetle infestations, storm and snow damages
- Forest disturbance maps via Sentinel-2 time series (Löw and Koukal 2020)
  Detection of current damaged areas (so-called anomalies)
- Operational sanitation capacities ➔ needs to be developed
  e.g., road density, forest subdivision, machine & personnel availability
- **PHE**nology of **IPS** *typgraphus* **(PHENIPS)** (Baier et al. 2007)
  Development status of the bark beetle
- **T**ranspiration **DEF**icit modul **(TDEF)** (Matthews et al. 2018)
  Acute drought stress of spruce forests

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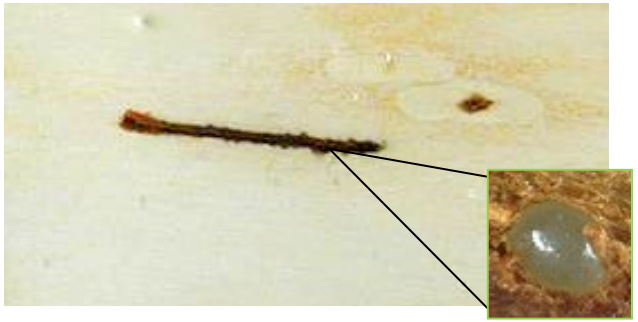

Thermal sums and temperature thresholds for development are well known!

(Annila 1969; Wermelinger and Seifert 1998; Baier et al., 2007)

PHENIPS

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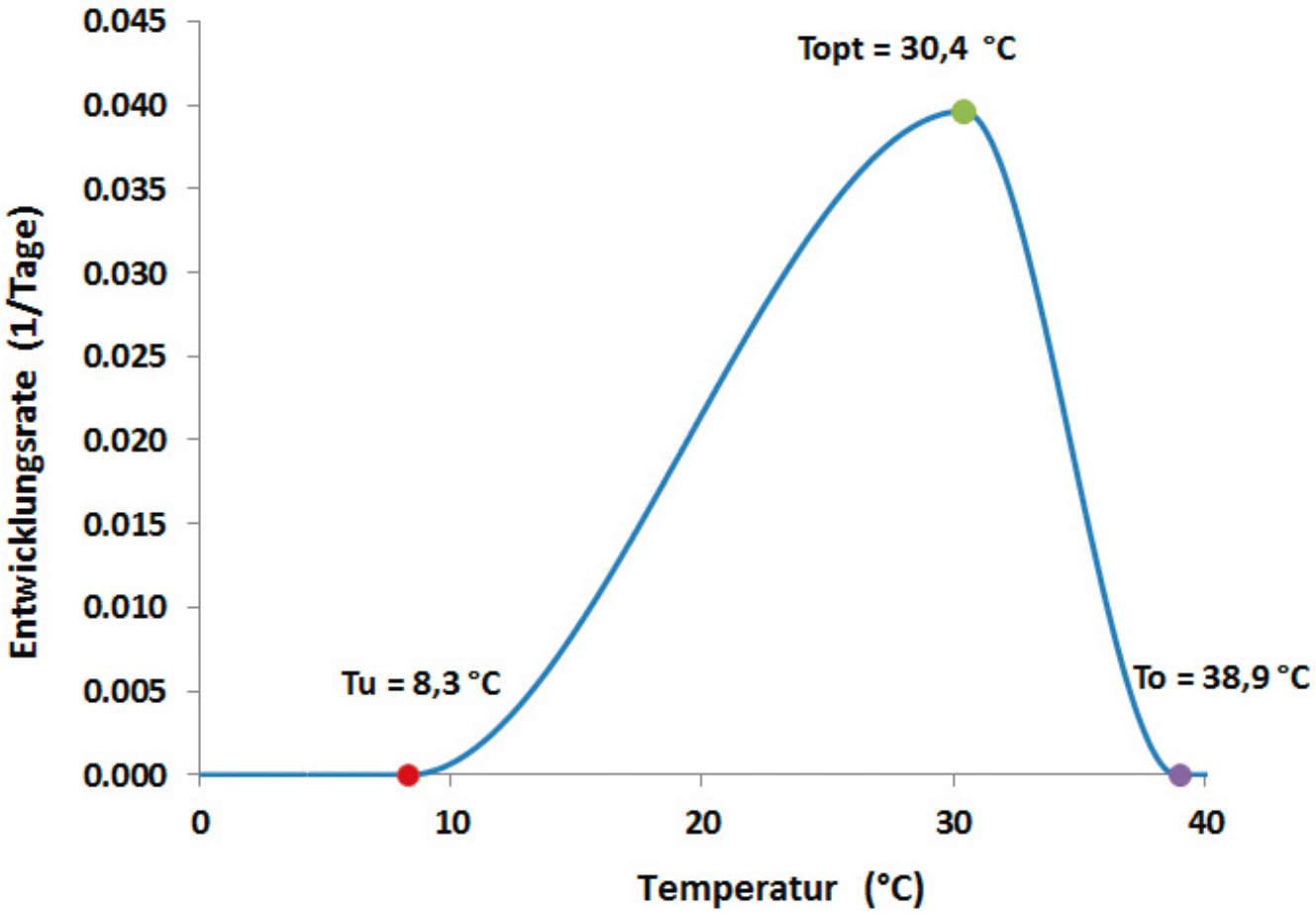

Baier et al., 2007; 2021

Thermal Thresholds

Spring flight/Onset of attack:

- **Tmax ≥ 16.5°C**
- Tsum ≥ 60 degree days > 8.3°C
- Tsum ≥ 140 degree days > 8.3°C

Brood development:

- **Development Zero (Tu) = 8.3°C**
- **Tsum > 8.3°C egg to adult stage = 557 degree days**
- Start of sister brood at > 50% generation development
- Induction of Diapause at day-lenght of < 14.5 hours
- Broods can successfully overwinter at > 60% generation development

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Bark beetle development at a specific site

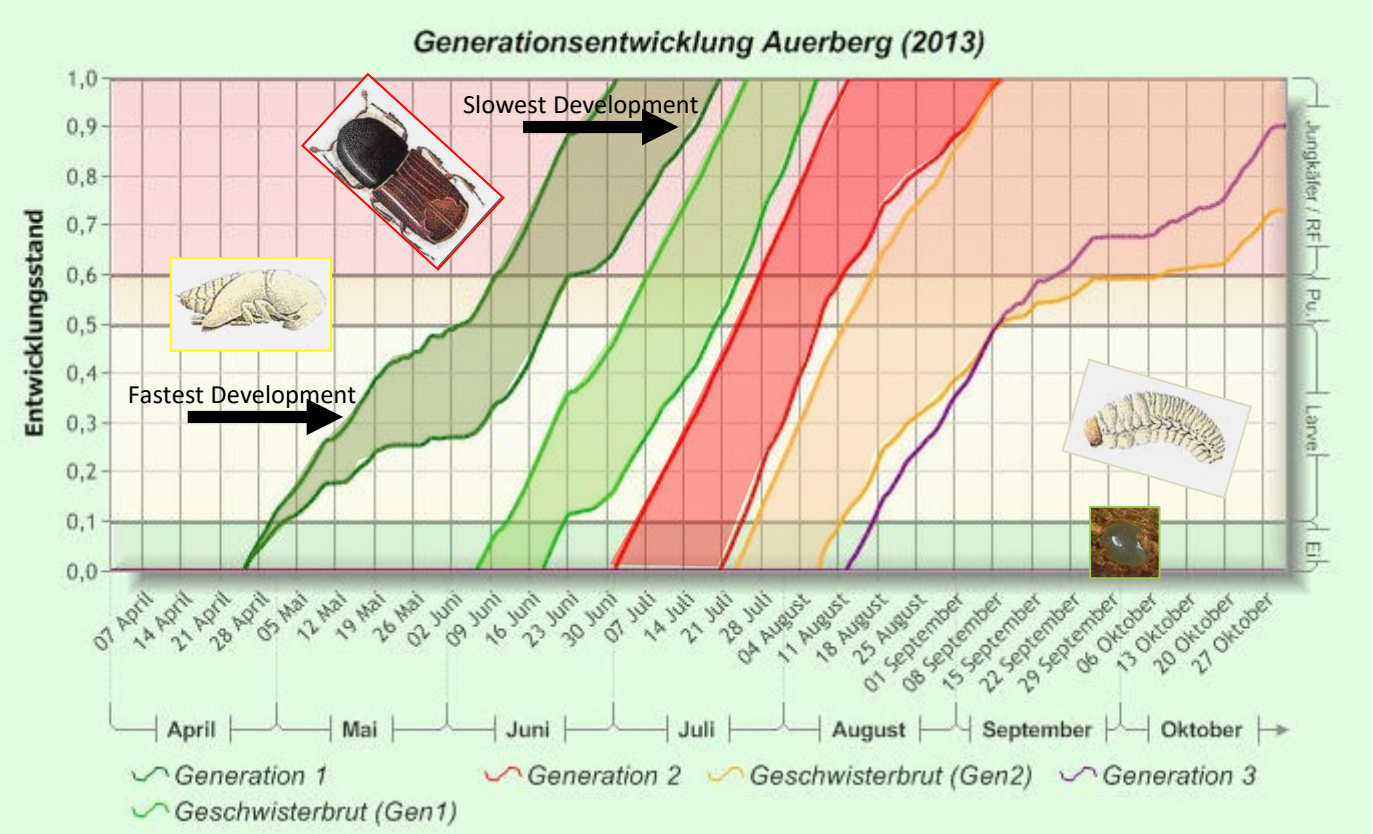
1. Generation

1. Sister Brood

2. Generation

2. Sister Brood

3. Generation



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PHENIPS Online | IFFF-RiskAnalyses (boku.ac.at)

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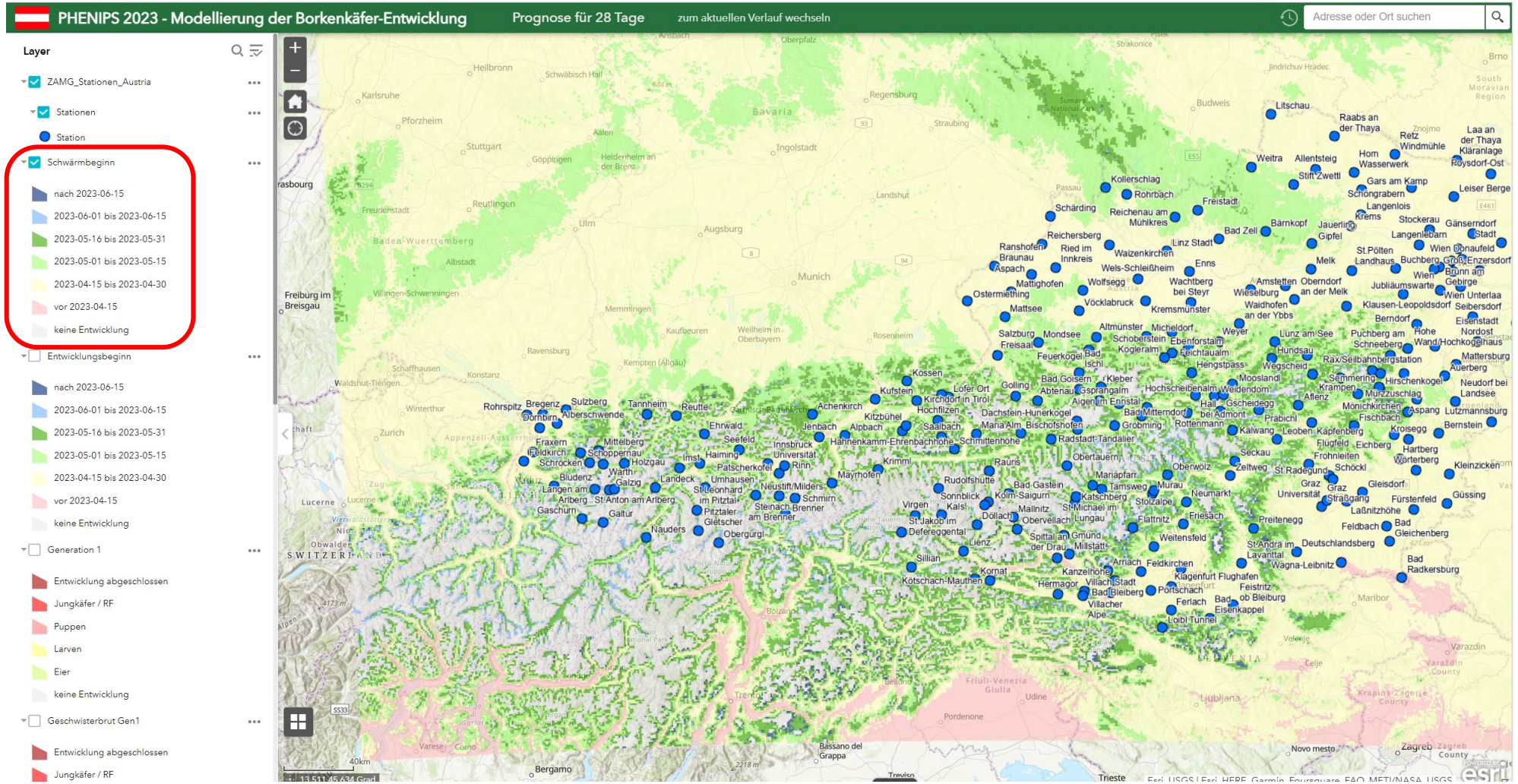
Bark beetle development for entire Austria

INCA weather data (Integrated Nowcasting through Comprehensive Analysis) provided by GeoSphere Austria, 1x1 km grid

Spring Flight 2023



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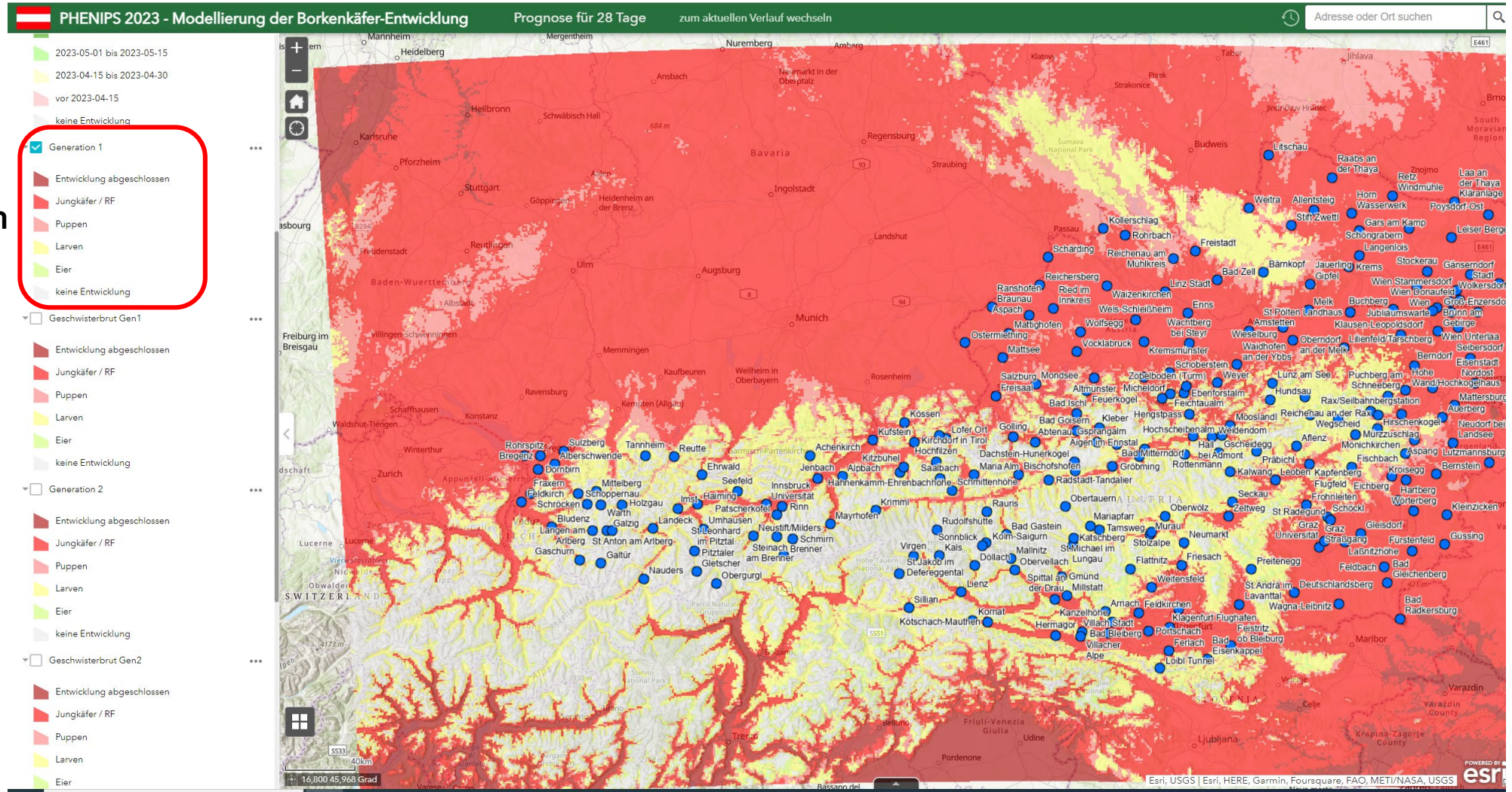
First Generation 19 June 23



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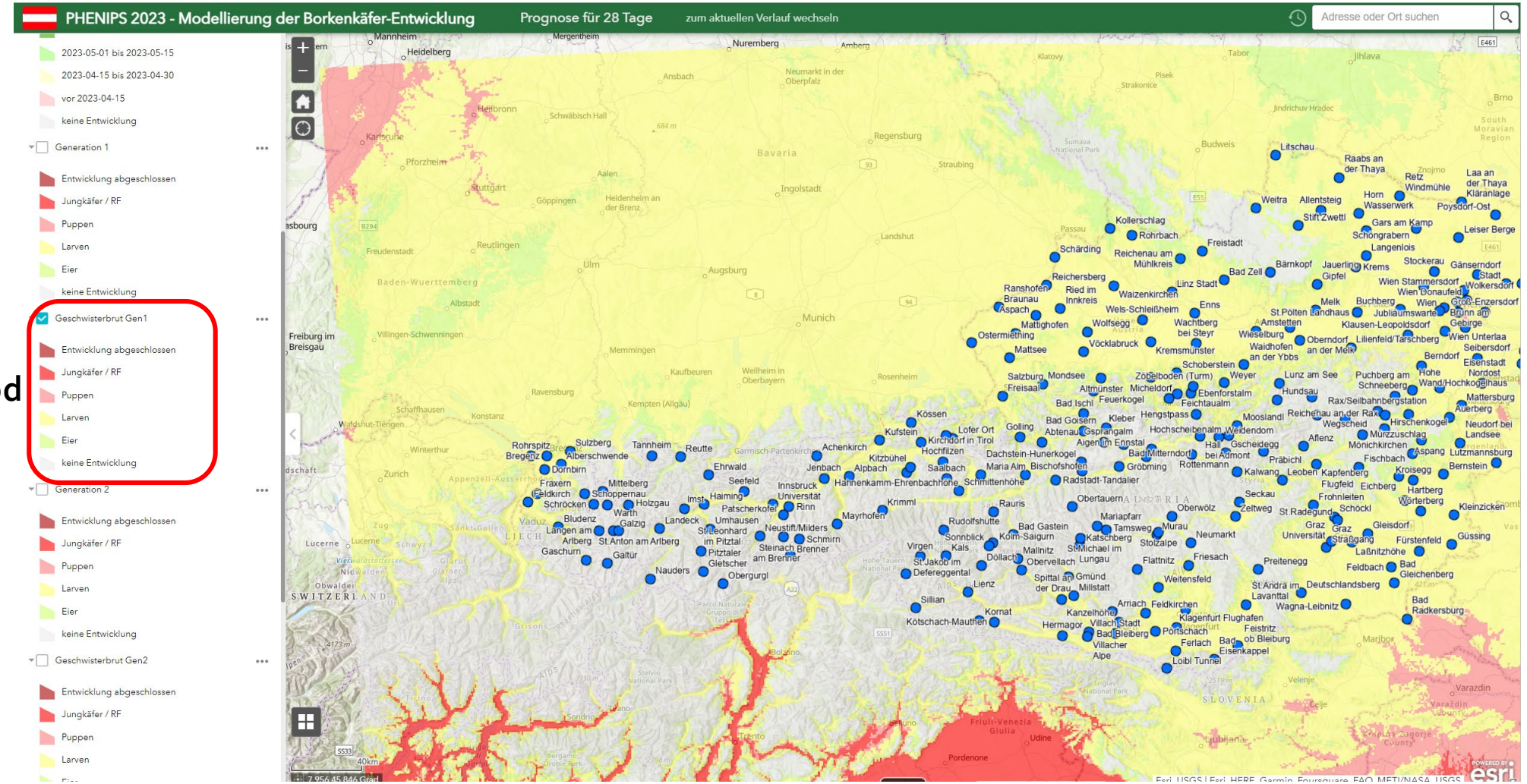
Bark beetle development for entire Austria

INCA weather data (Integrated Nowcasting through Comprehensive Analysis) provided by GeoSphere Austria, 1x1 km grid

First Sisterbrood 19 June 23



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Landwirtschaft, Regionen
und Tourismus

PHENIPS+ DaFNE

PHENIPS plus – Projektteam

Projektkoordinator
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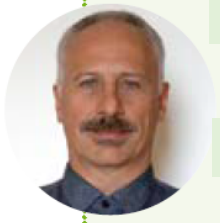

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Head of Department of Forest Protection, BFW

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BFW.

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Validation is ongoing!

Phloem temperatures

Trap logs

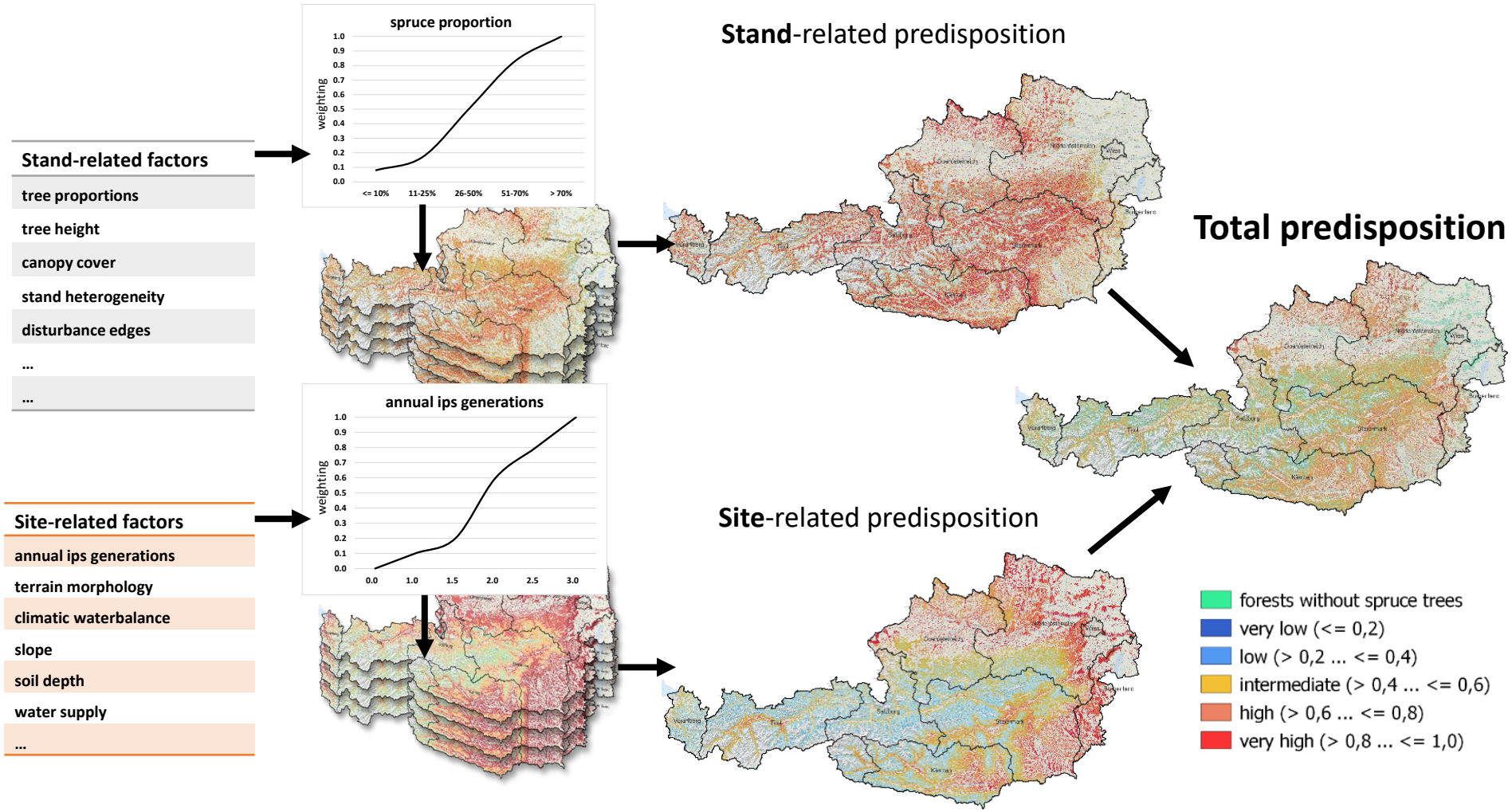
Pheromone traps

PAS - *Ips typographus*

Predisposition Assessment Systems (PAS)

- knowledge-based additive expert models
- open model systems
- available for various disturbance agents
- already applied in Austria, Germany, Sweden and Switzerland

Führer and Nopp 2001; Netherer and Nopp-Mayr 2005; Seidl et al. 2022; Temperli et al. 2020; Nordqvist et al. 2023



PAS - *Ips typographus*

RAWLog project:

- *Ips typographus*, Storm, Snow
- **10**-m-resolution
- first time for **all Austria**
- Incorporation of **novel remote sensing** rather than terrestrial data
  e.g. proportions of tree species, detection of forest disturbance areas via Sentinel-2 time series
- **Dynamization** through an annual system update
  updated 10-year average of climatic factors
  regular update of
- **Automatization** of data preparation and calculation processes

Till Hallas
PhD student

RAWLog

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BFW.

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Team:

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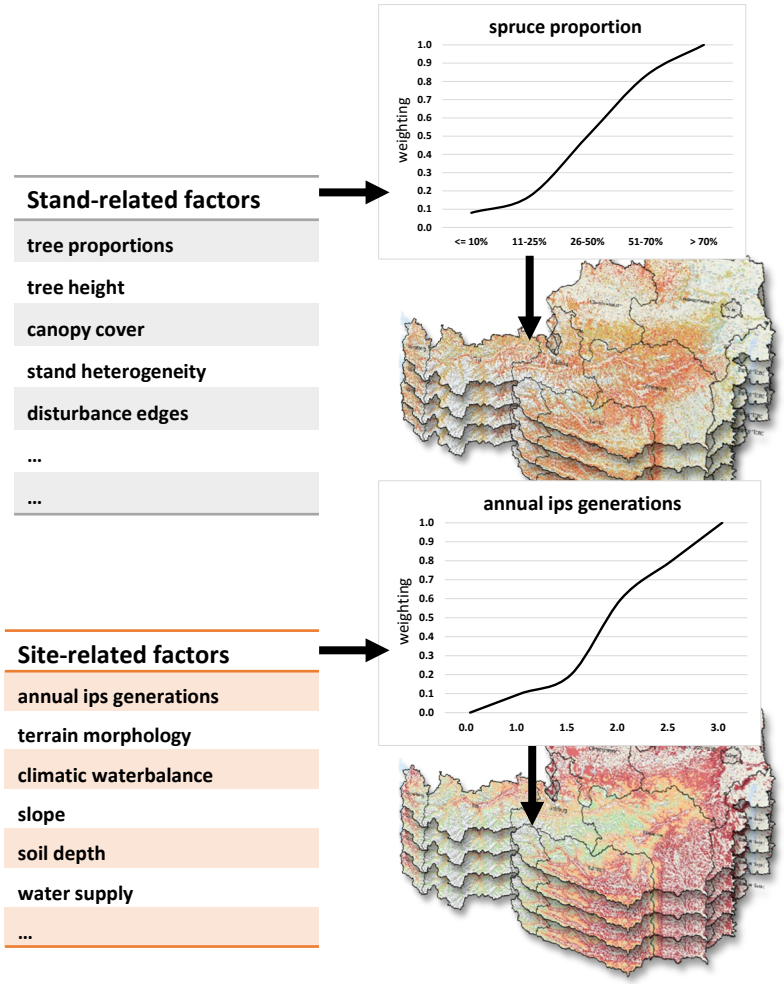
BFW-Forest Ecology: Michael Englisch, David Keßler
BFW-Forest Technology: Nikolaus Nemestothy, Christoph Huber

PAS - *Ips typographus*



Important factors:

Stand level

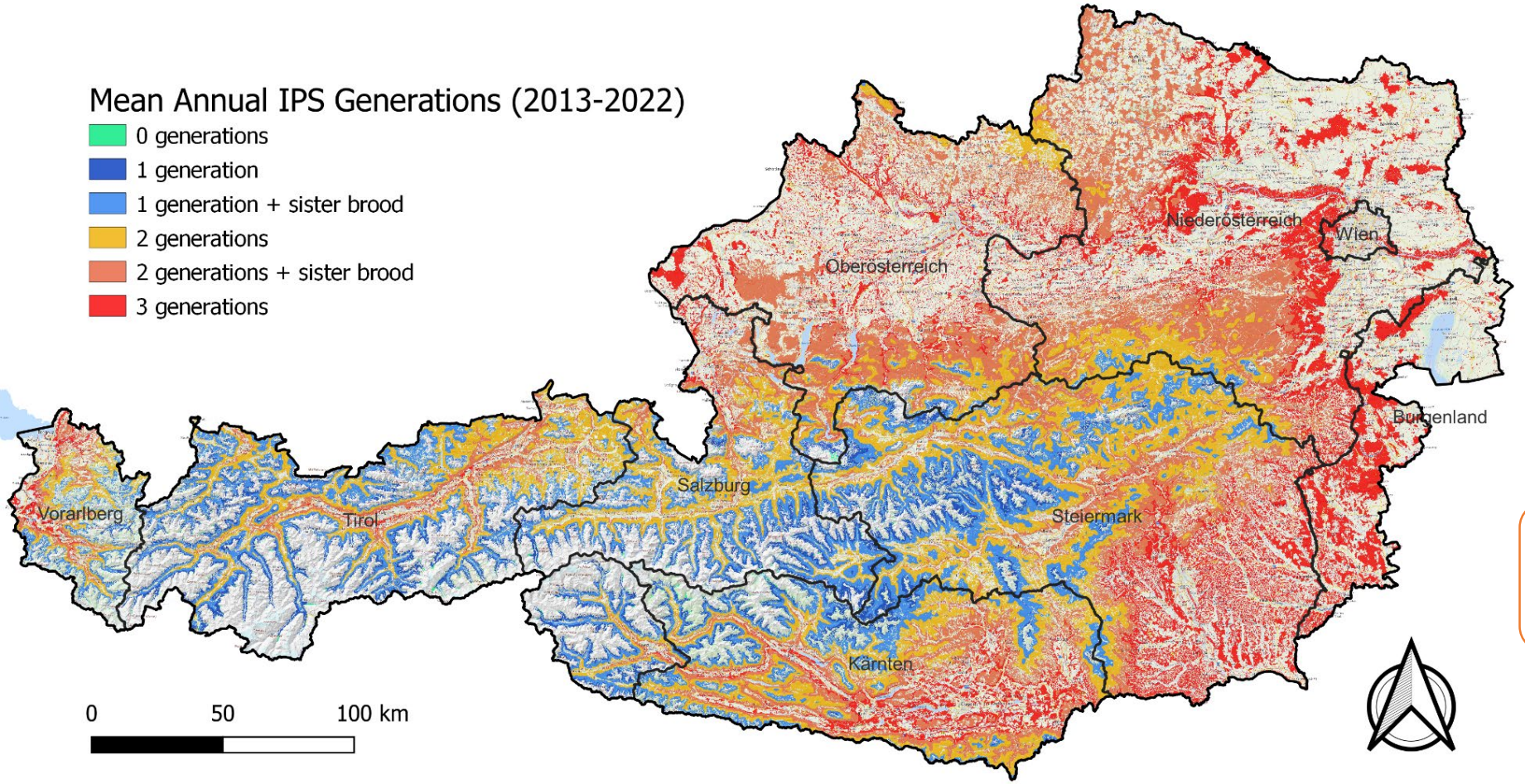
- Tree species proportions (spruce, pine, conifers, deciduous etc.)
- Tree height (instead of stand age)
- Tree height distribution (stand heterogeneity)
- Fragmentation/stand edge
- ....

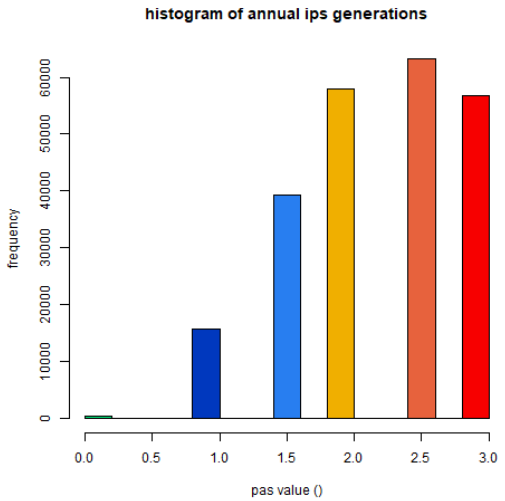
Site level

- Temperature (Ips generations)
- Climatic water balance (Apr-Oct)
- Road distance and density
- Main wind direction (derived from daily wind data)
- Wind speed (based on monthly 90%-percentile of hourly data)
- Frequency of wet snow events
- ...

PAS - *Ips typographus*

Predisposing factor temperature





- calculated with PHENIPS
- many red areas are not covered by spruce

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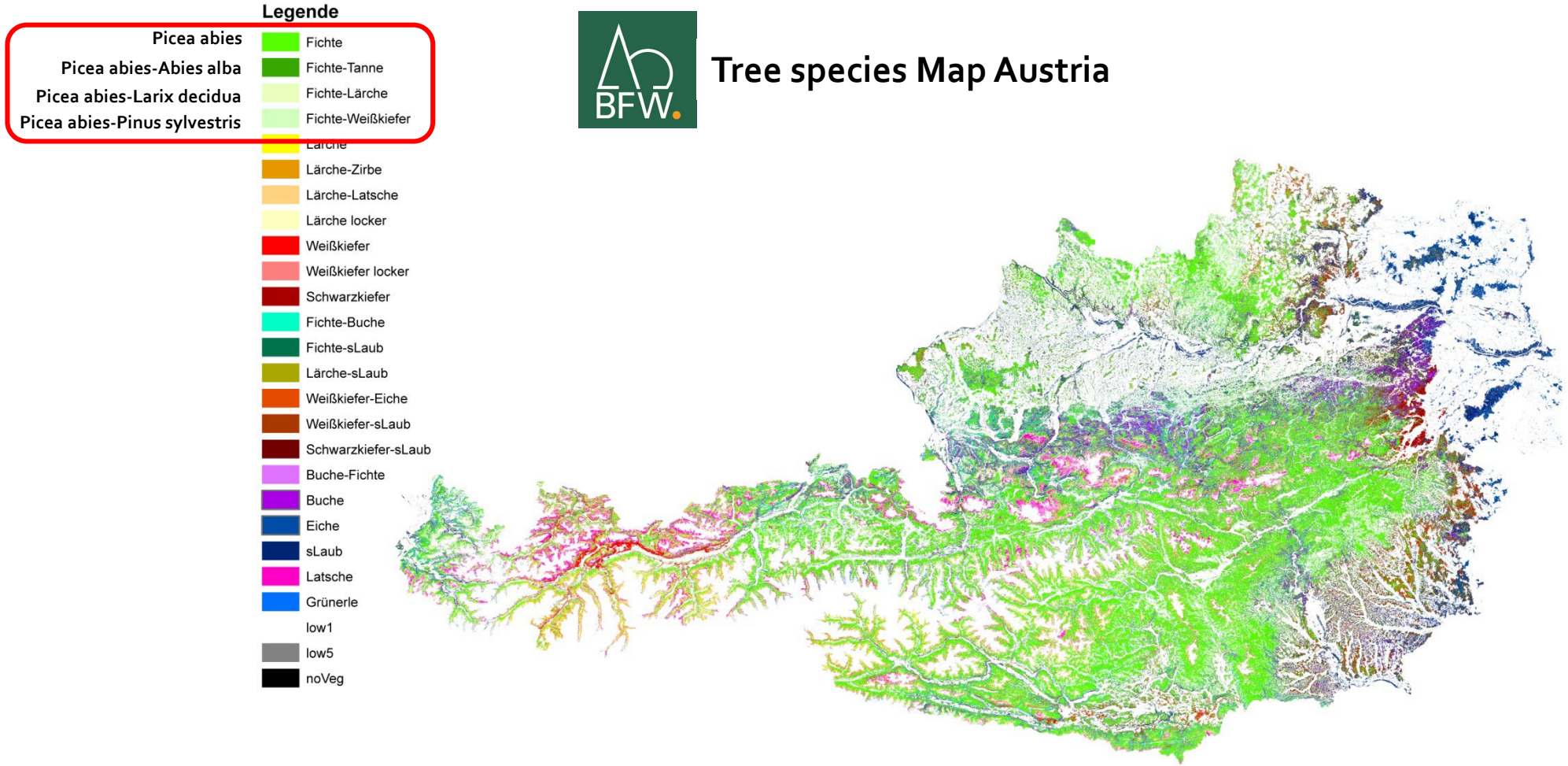
Predisposing factor Norway spruce



PAS - *Ips typographus*

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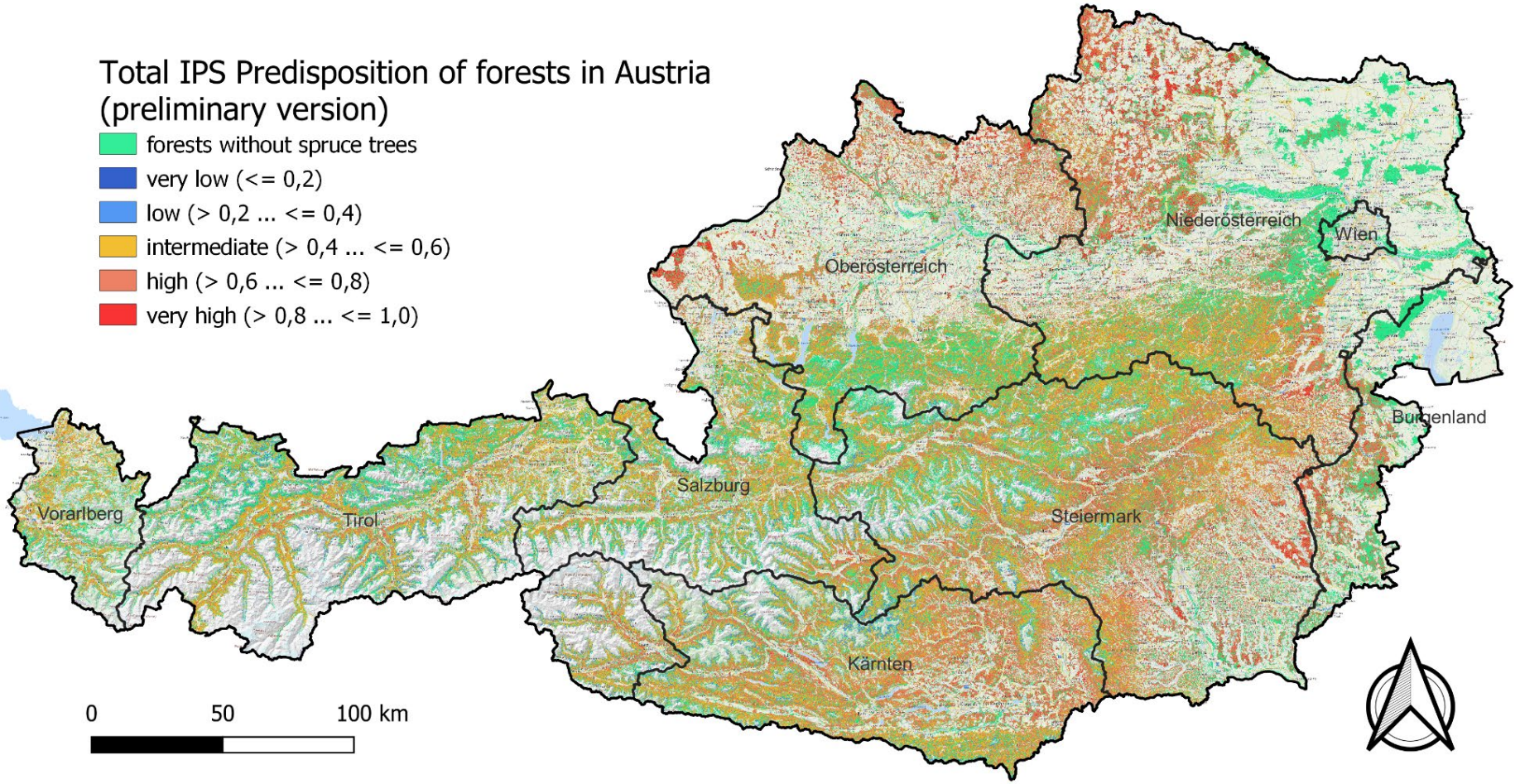
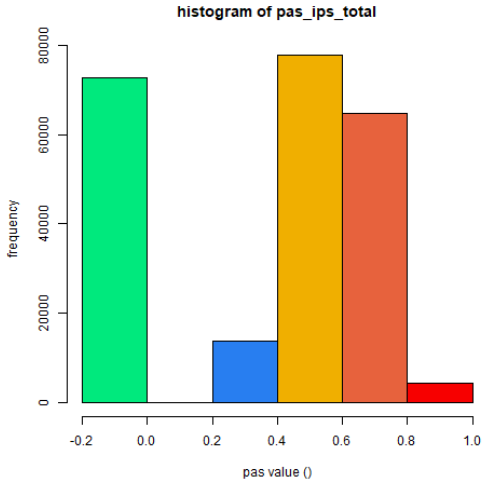
Preliminary results

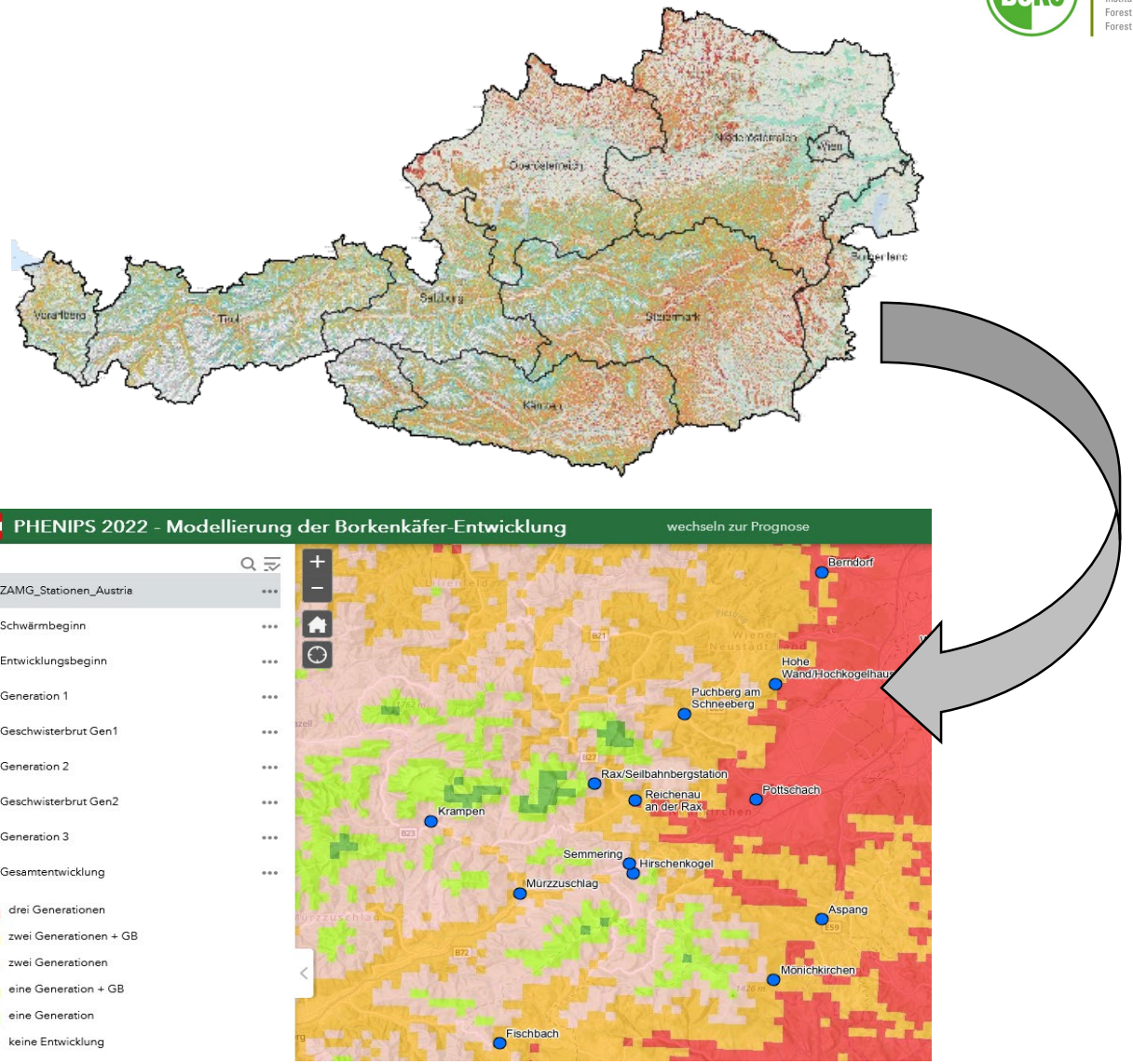




- not all factors are included yet
- snow predisposition is missing
- validation and calibration has just started

Next Steps

- Implementation of **PAS-Layers into PHENIPS** Map-Services
- Evaluation of **operational sanitation capacities**
- Development of a comprehensive **model framework**
  → **Bark beetle early warning system**
- **Calibration and validation** of the system with remote sensing and terrestrial data



Screenshot: [PHENIPS Map-Services 2022]

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Thank you!
Questions Welcome!