Likelihood of establishment in the PRA area (Section 9)

Claire Gent (Defra, UK)

OEPP/EPPO
21 bd Richard Lenoir, Paris,
75011, France
www.eppo.int

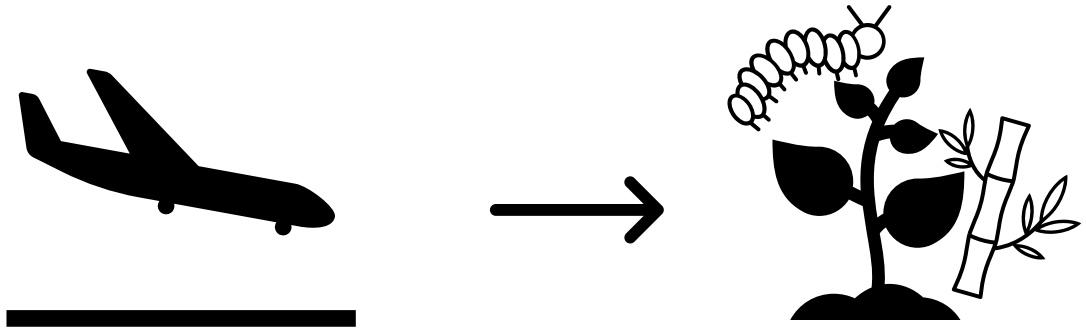


ISPM 5 Definitions

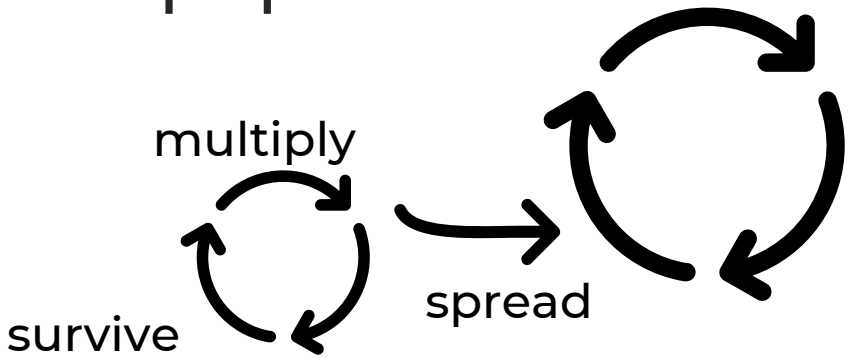
Introduction (of a pest): The **entry** of a pest resulting in its **establishment**

Establishment (of a pest): Perpetuation, for the foreseeable future, of a pest within an **area** after **entry**

Establishment



Likelihood of the perpetuation, for the foreseeable future, of a pest population



ISPM 11 PRA for quarantine pests & EPPO PM 5/5

Some of the factors to consider:

- **availability, quantity & distribution of hosts (or near relatives) or suitable habitat in the PRA area**
- alternate hosts, vectors & ‘essential species’

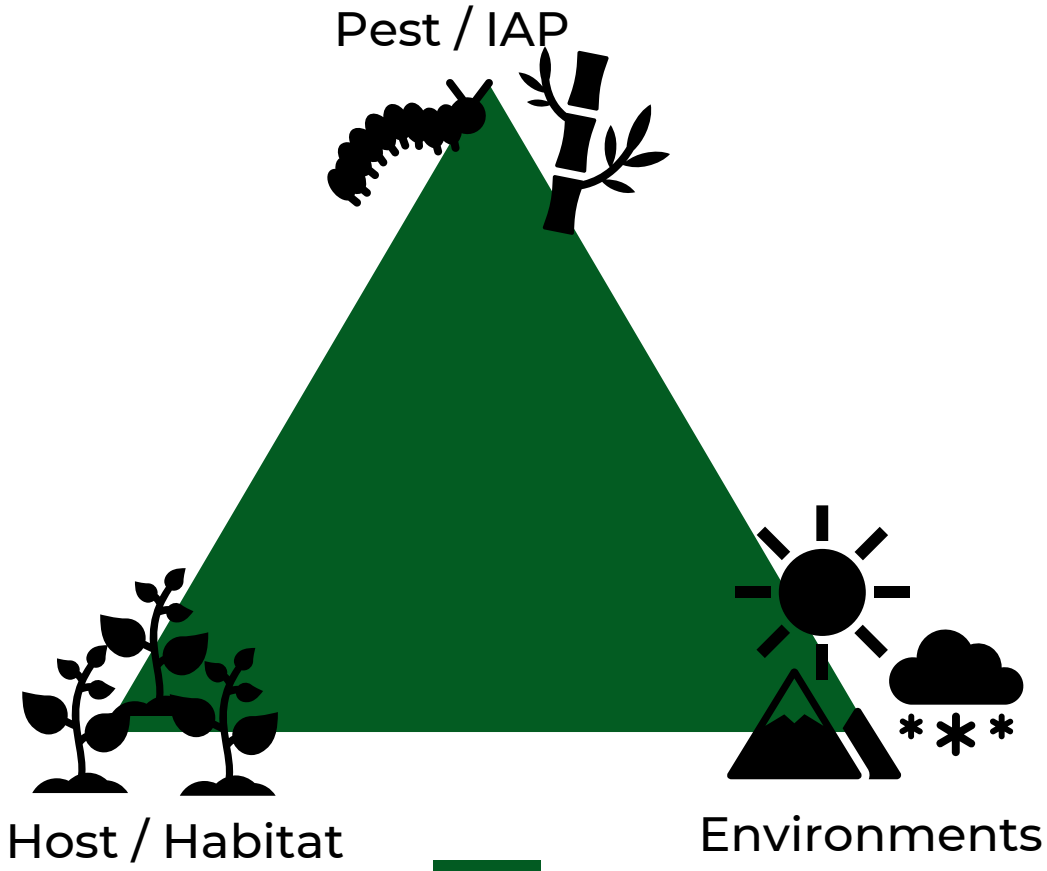
- **climate**
- soil, aquatic environment
- competition & natural enemies
- cultural practices & control measures (‘the managed environment’)

Protected environments

- adaptation potential of the pest
- reproductive strategy & duration of lifecycle/ longevity of IAP
- method of pest survival

Establishment - factors

Adaptability, Longevity, Survival, Reproductive strategy, Mobility



Host availability
Habitat availability
Alternate hosts
Vectors
Essential species

Temperature
Rain / snowfall
Seasonal variation
Day length
Altitude
Soil
Aquatic environment
Competition
Natural enemies
Cultural practices
Control measures

Host plants / unintended habitats

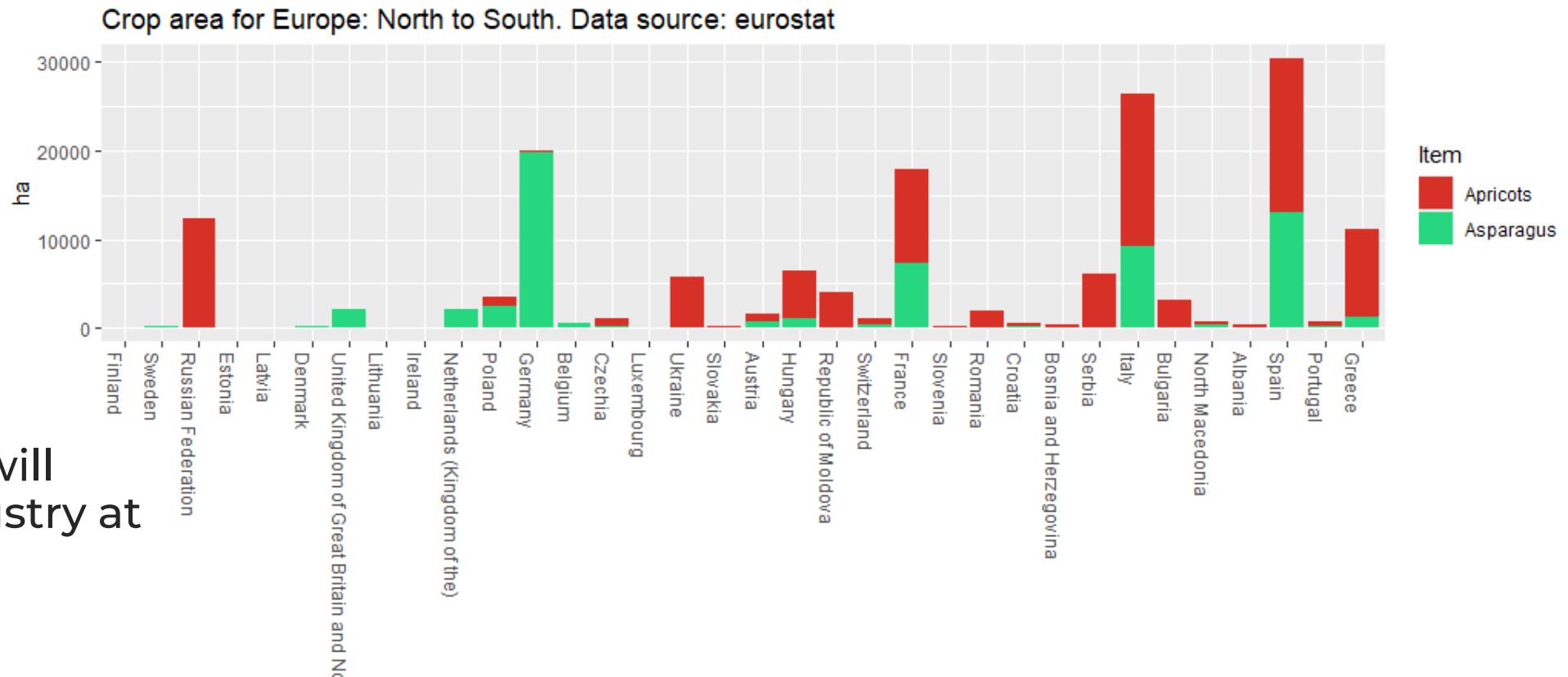
- Refer back to section 7 for **uncertain/doubtful** hosts or habitats to avoid contradicting yourself

- If pest has many hosts or habitats, you might need to decide **which ones to focus** on
  - Which host/group of hosts/habitats have the **widest distribution?**
  - Which host/group of hosts/habitats are the **most suited to pest/IAP establishment?**

Host plants / unintended habitats: Sources

EPPO PM 5/5 has a list of suggested sources

- Some provide only raw data which might need converting to graphs or maps – e.g. Eurostat and FAO stat



- Best source of data will depend on host industry at risk / habitat at risk

Host plants / unintended habitats: Sources



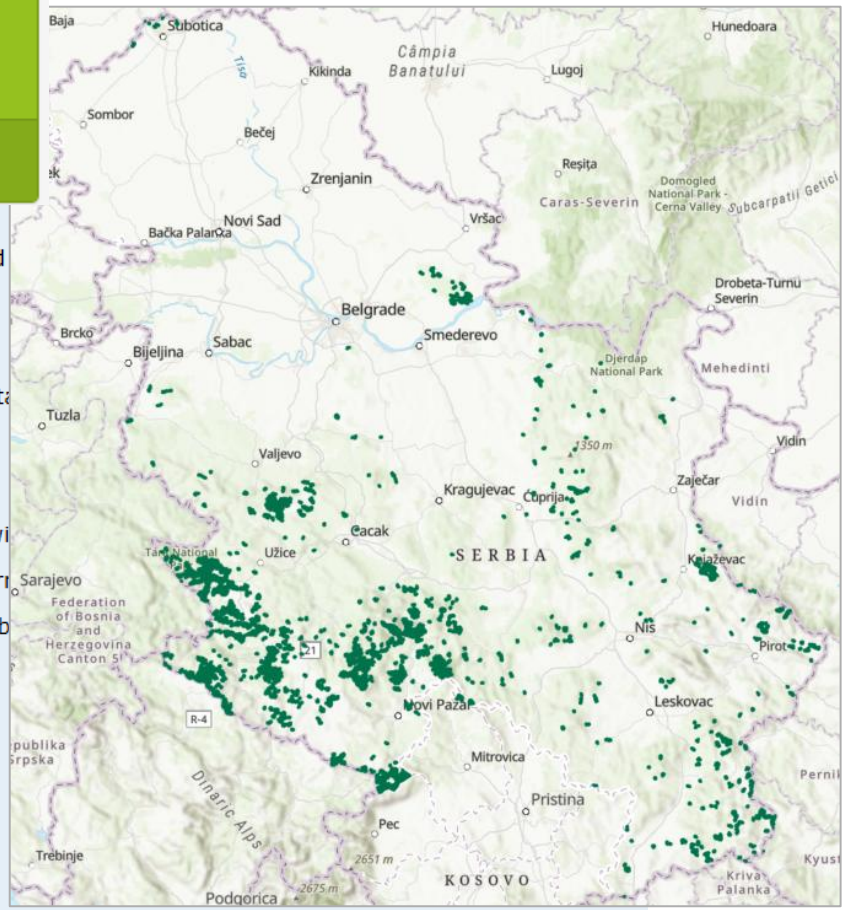
https://sdi.eea.europa.eu/catalogue/srv/eng/catalog.search#/home

Host plants / unintended habitats: Sources

Land cover

567

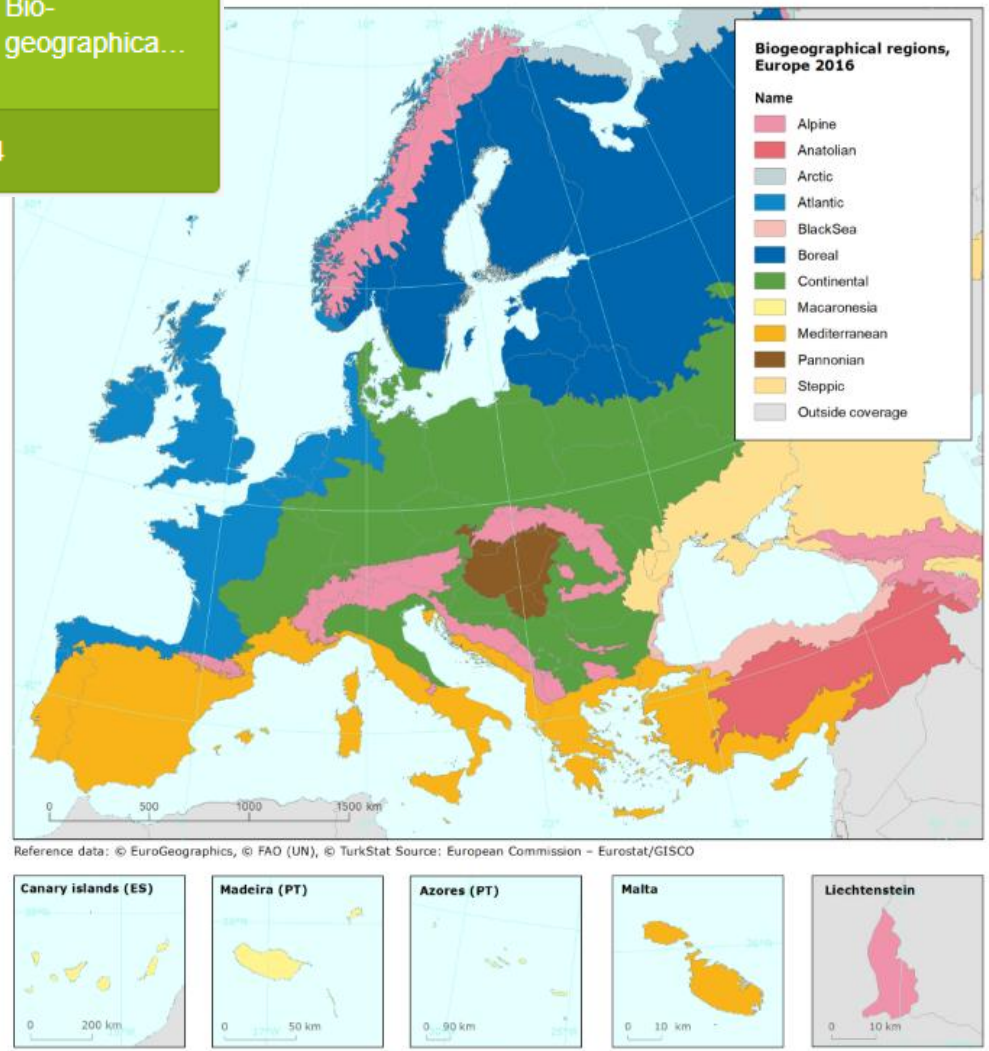
211: Non-irrigated arable land
212: Permanently irrigated land
213: Rice fields
221: Vineyards
222: Fruit trees and berry planta
223: Olive groves
231: Pastures
241: Annual crops associated wi
242: Complex cultivation patterr
243: Land principally occupied b
244: Agro-forestry areas
311: Broad-leaved forest
312: Coniferous forest
313: Mixed forest
321: Natural grasslands
322: Moors and heathland
323: Sclerophyllous vegetation
324: Transitional woodland-shrub



Coniferous forest in Serbia

Bio-geographica...

14



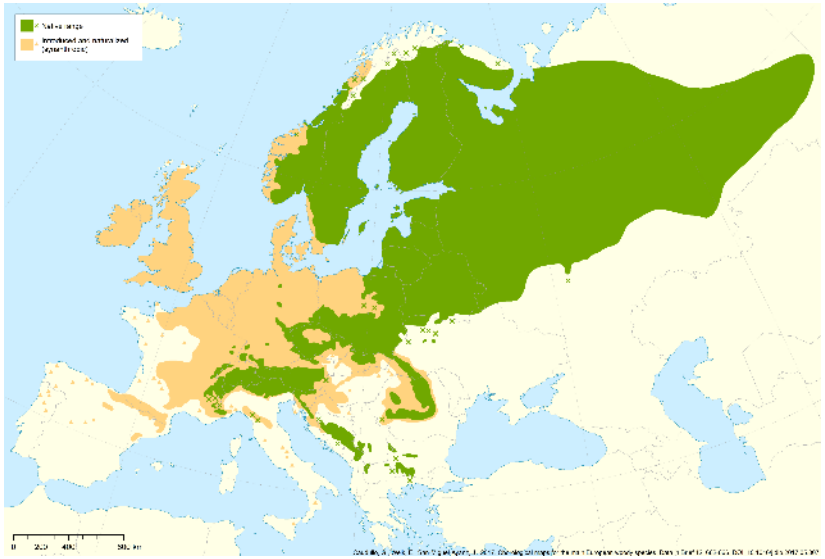
Host plants / unintended habitats: Sources

Know your data: what is it showing, what is it not showing?

Distribution maps European forest trees e.g. *Picea abies* (Norway spruce)



https://www.euforgen.org/species



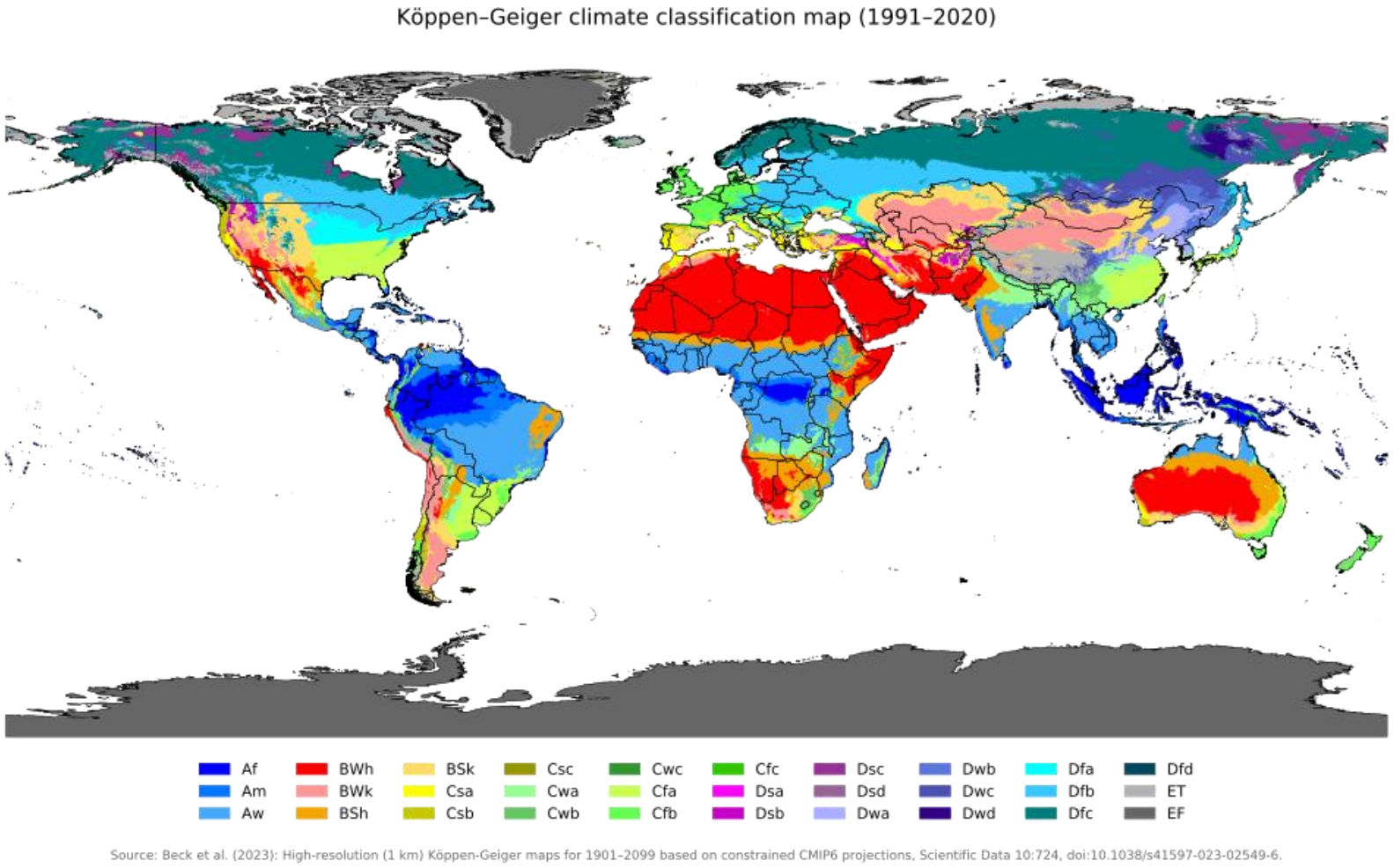
https://figshare.com/collections/Chorological_maps_and_data_for_the_main_European_woody_species/2918528

Climate suitability: common factors

Climate factor	Example organism affected
Winter temperature	Plant distribution is limited by cold hardiness
Summer temperature	Invertebrate generations per year
Rainfall	Often critical for plant survival
Humidity & leaf wetness	Often critical for pathogen lifecycles
Soil & substrate temperatures	Invertebrates that spend part of their lifecycle below ground
Soil & substrate moisture	Critical for plants

after Eyre *et al.* 2012

Climate suitability: climate types



Lots of K-G resources online:

https://en.wikipedia.org/

https://koeppen-geiger.vu-wien.ac.at/present.htm

https://www.gloh2o.org/koppen/

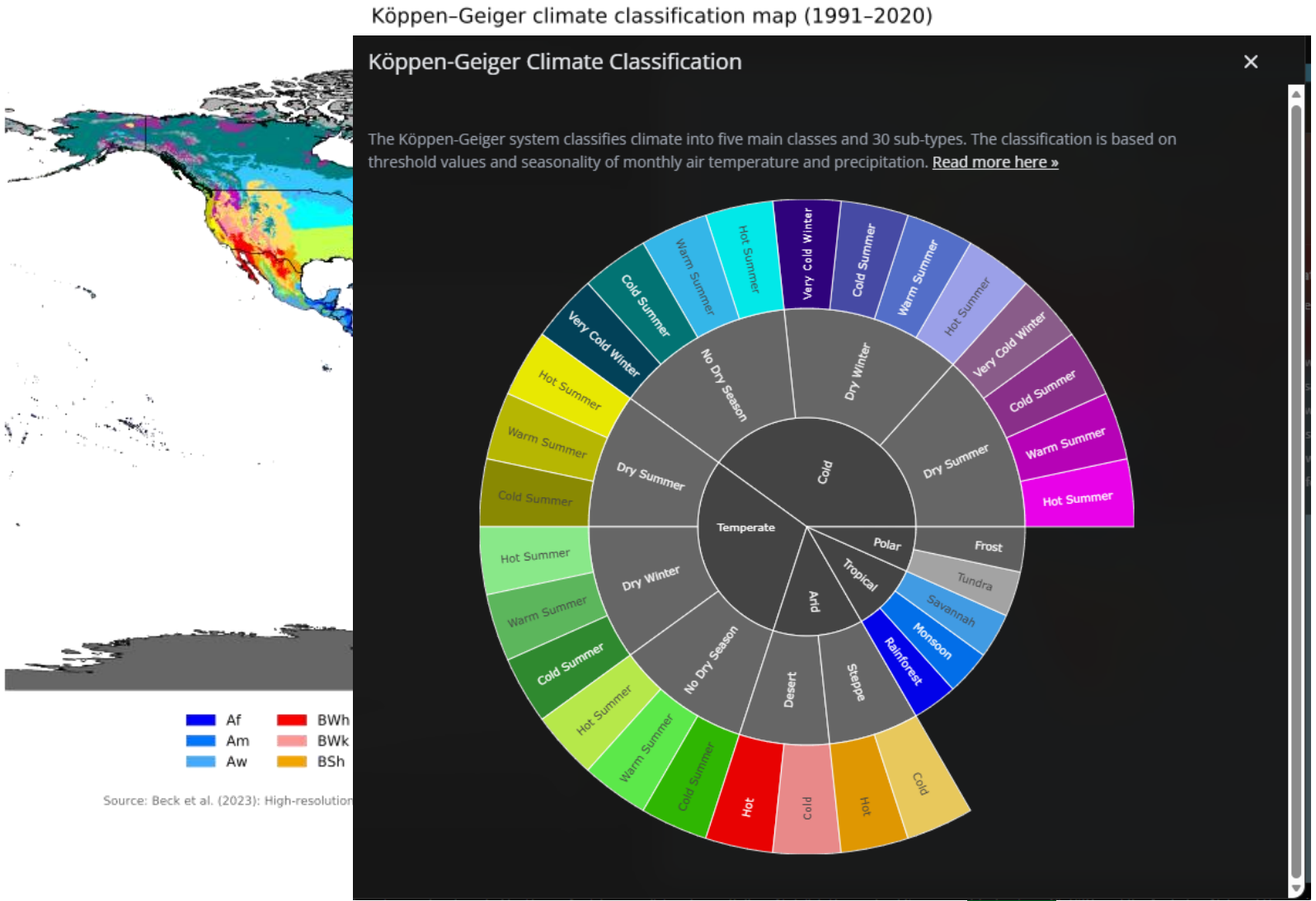
https://koppen.earth/

...and in literature

MacLeod & Korycinska (2019)

Beck *et al.* (2023)

Climate suitability: climate types



Lots of K-G resources online:

https://en.wikipedia.org/

https://koeppen-geiger.vu-wien.ac.at/present.htm

https://www.gloh2o.org/koppen/

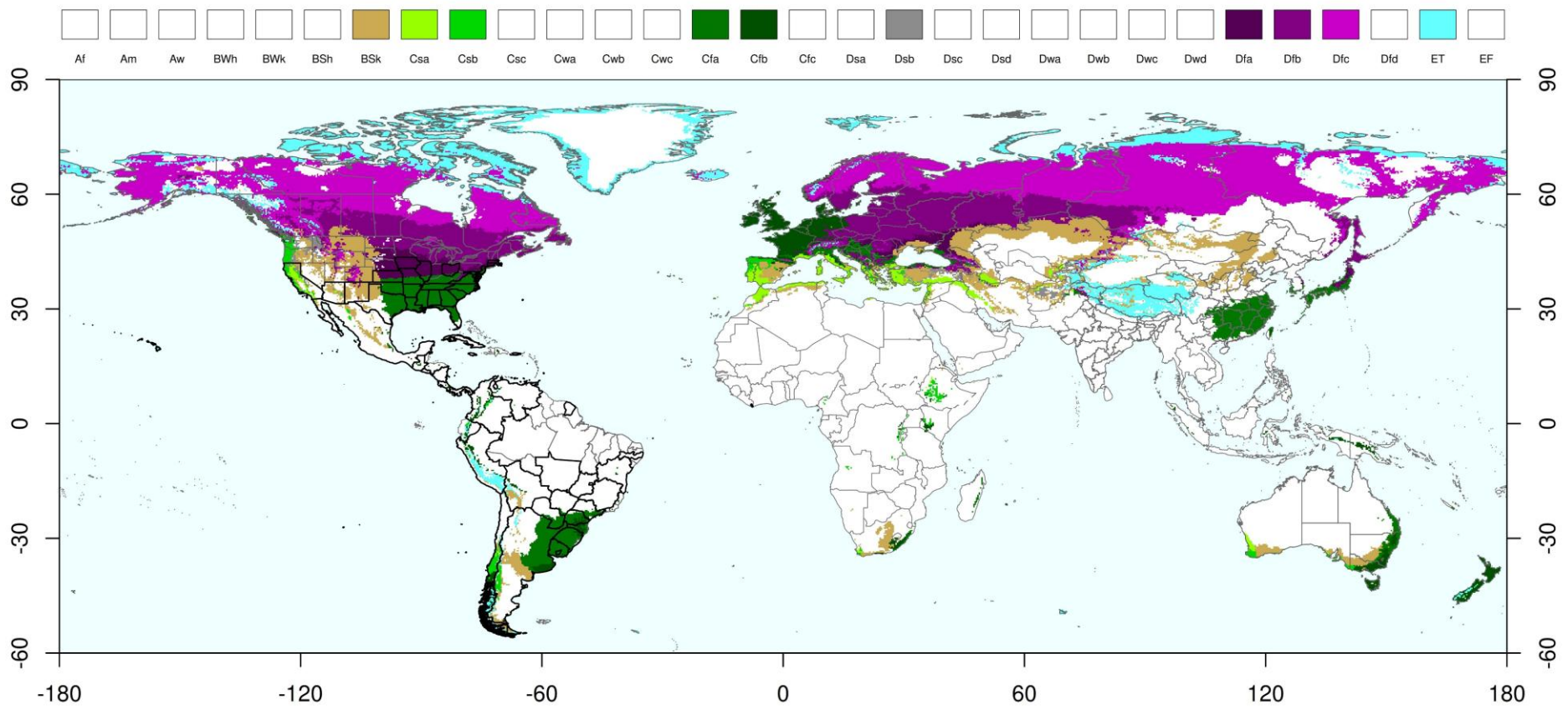
https://koppen.earth/

...and in literature

MacLeod & Korycinska (2019)

Beck *et al.* (2023)

Climate suitability: climate types



EU Köppen-Geiger climates for *Elasmopalpus lignosellus*

Based on the Köppen-Geiger climate classification by Beck et al. (2023). Period 1991-2020.

- Specific locations with coordinates
- Observations at the Country or State level

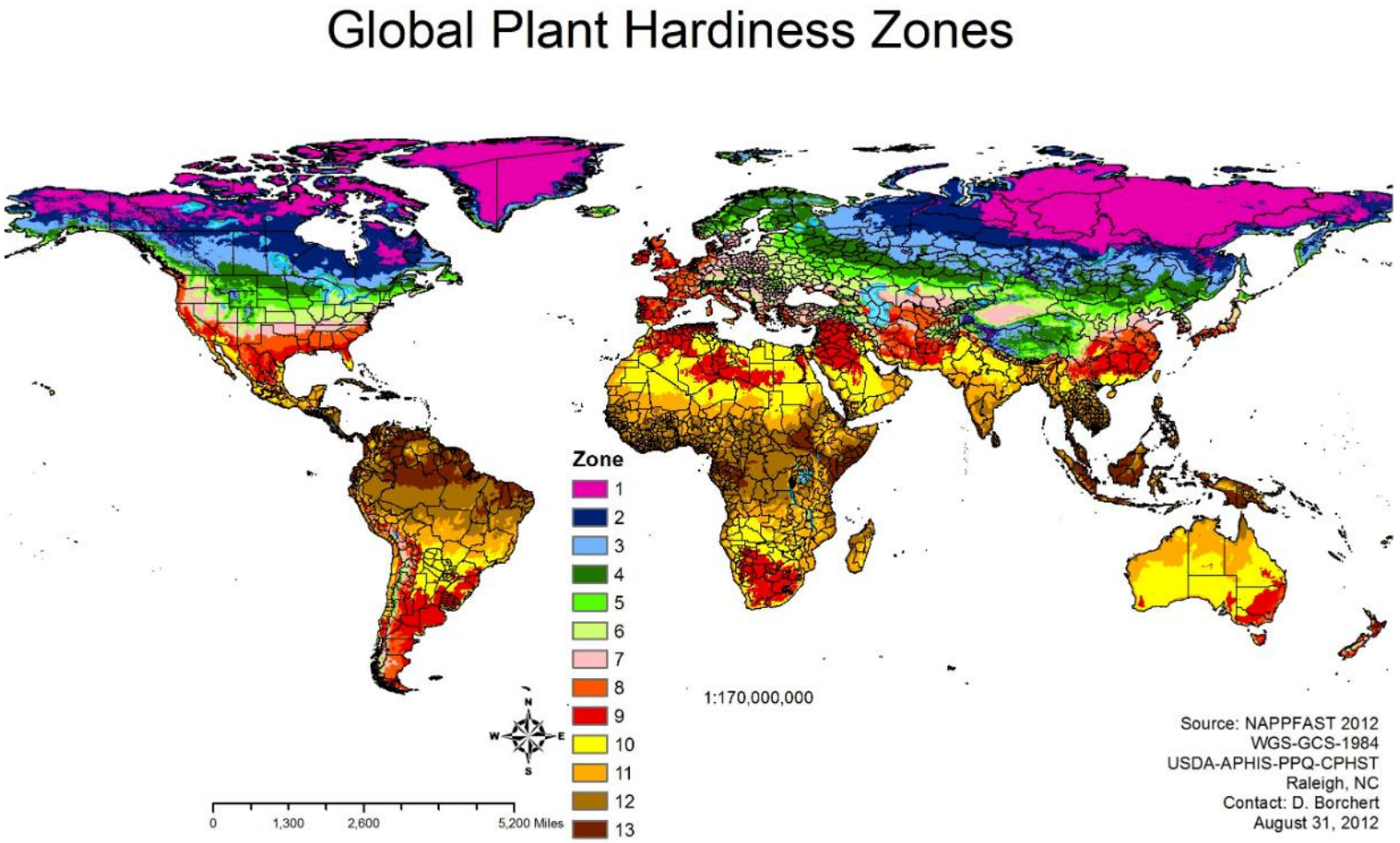
Pest distribution based on EPPO Global Database

Administrative boundaries: ©FAO-UN, ©EuroGeographics

Cartography: EFSA 07/10/2026. Created using the EFSA ScanCLIM v02 tool

This map does not imply the expression of any opinion whatsoever on the part of EPPO concerning the legal status of any country, territory city or area of its authorities, or concerning the delimitation of its frontiers or boundaries

Climate suitability: hardiness zones (for plants)



Climate suitability: hardiness zones (for plants)

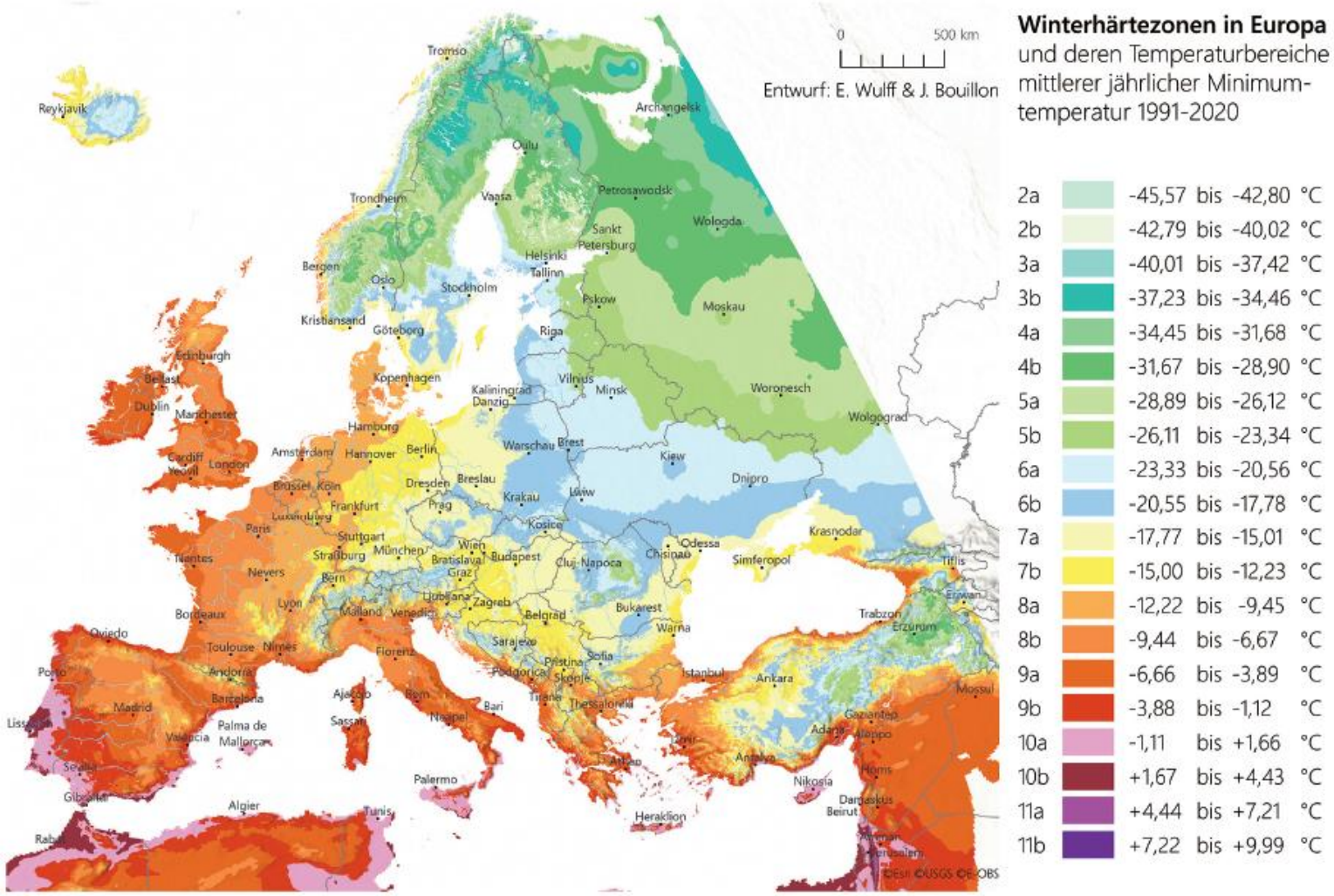
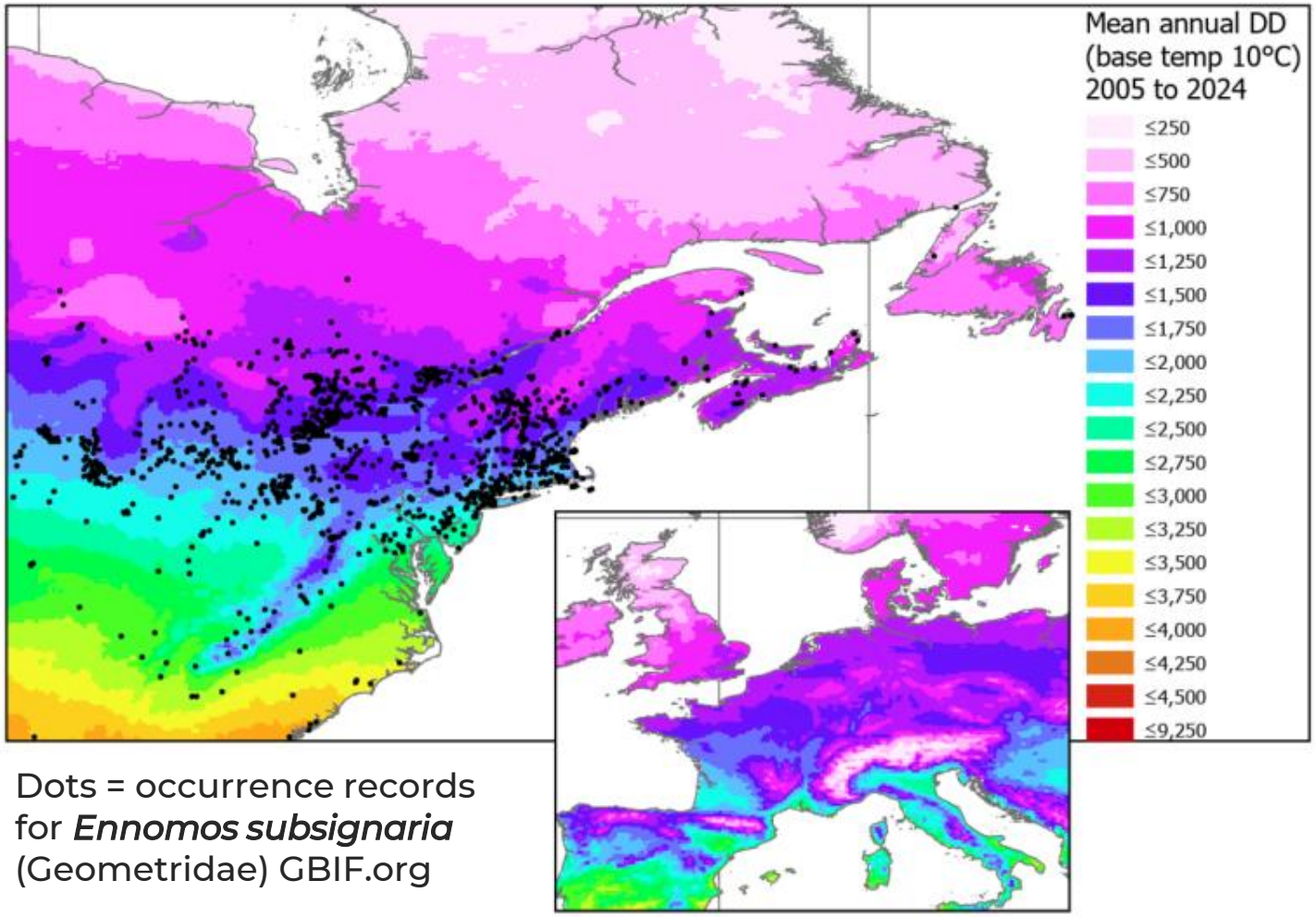


Abb. 7: Neue Winterhärtezonen für Europa für den Zeitraum 1991–2020.

Comparable method with other maps / regions of the world?

Wulff & Bouillon (2024).

Climate suitability: degree days



Dots = occurrence records for ***Ennomos subsignaria*** (Geometridae) GBIF.org

Growing Degree Days originally used in agriculture to predict plant growth stages

$$\mathrm{GDD} = \frac{T_{\max} + T_{\min}}{2} - T_{\mathrm{base}}.$$

(simplest but not best formula)

If base temperature (aka lower developmental threshold) not known, then 5 or 10°C usually used

Map shows mean annual DD calculated using formula from Baker (1980)
Temperature data reanalysed from ERA5-Land
https://cds.climate.copernicus.eu/datasets/reanalysis-era5-land?tab=overview

Climate suitability: Modelling

Lifecycle parameters – base temperature and degree days

ClimMAP

SCAN-Clim | MAP-DD

Degree Day Analysis

Biofix: 01-04

Start year: 2017

Ending year: 2020

Cutoff temperature for organism development:

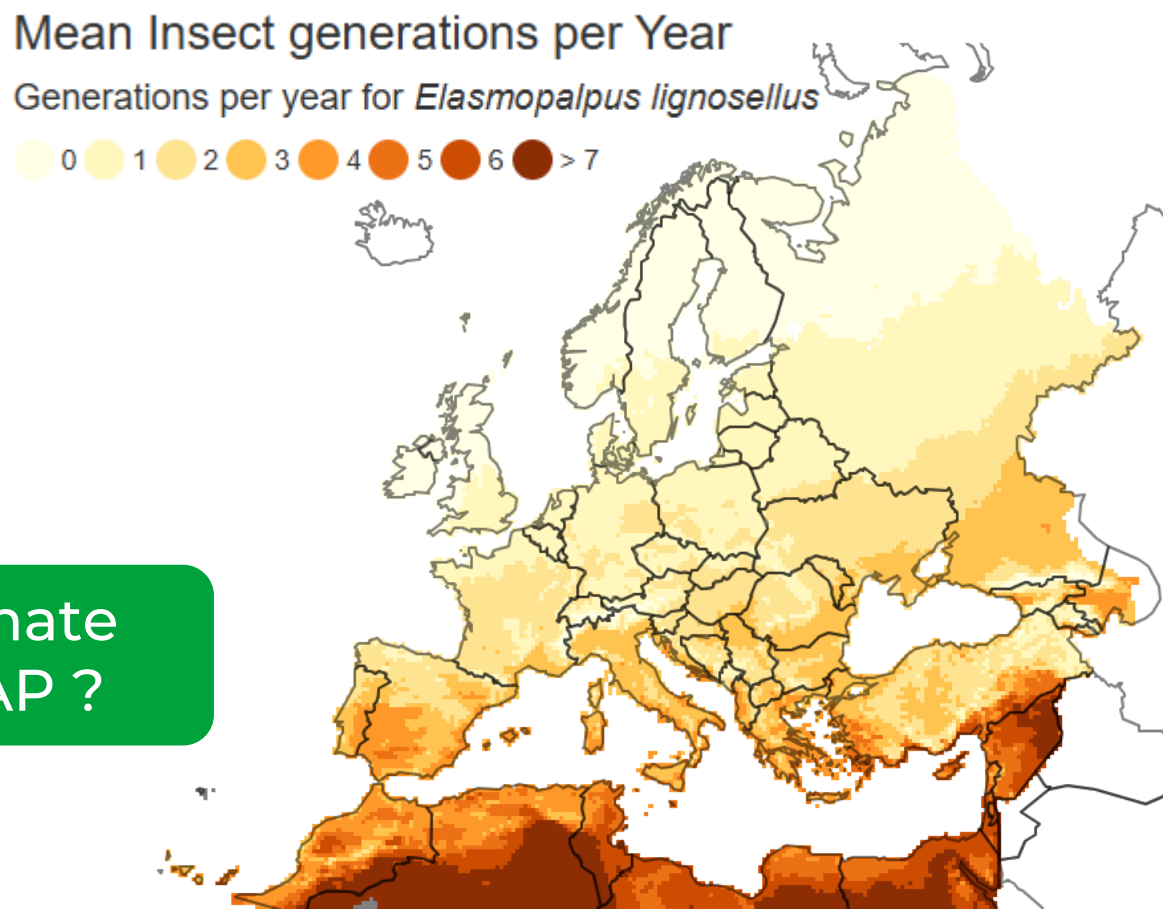
Base temperature for organism development: 14

Insect Generations

☑ Map insect generations

Scientific name of organism: Elasmopalpus lignose

Required degree days per generation: 439



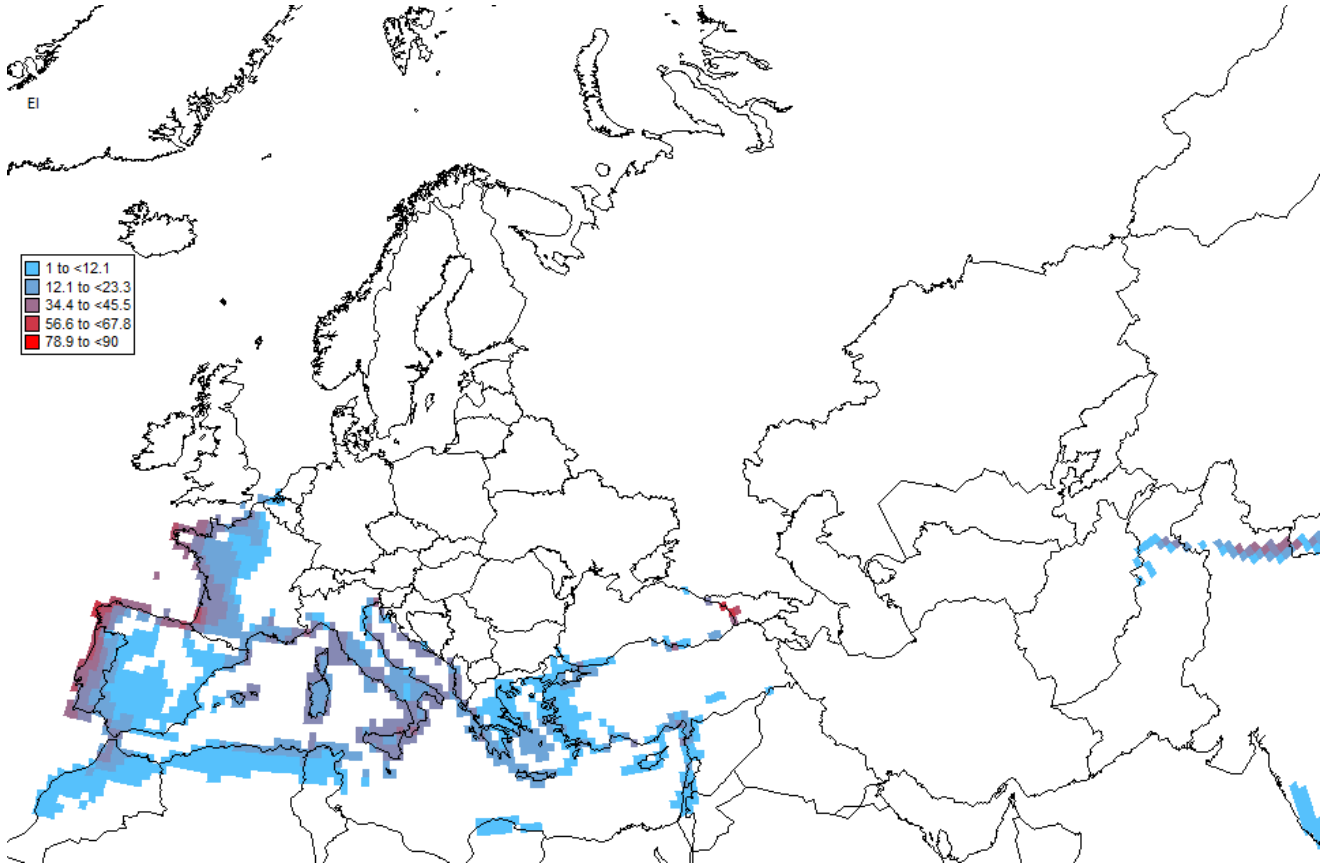
Microclimate of pest/IAP ?

Climate suitability: Modelling

CLIMEX Compare Locations model parameters used in Kriticos *et al.* (2013)

Index	Parameter	Value[a]
Temperature	DV0 = lower threshold	10 °C
	DV1 = lower optimum temperature	14 °C
	DV2 = upper optimum temperature	25 °C
	DV3 = upper threshold	32 °C
Moisture	SM0 = lower soil moisture threshold	0.24
	SM1 = lower optimum soil moisture	1
	SM2 = upper optimum soil moisture	1.5
	SM3 = upper soil moisture moisture	2
Cold stress	TTCS = temperature threshold	2.5 °C
	THCS = stress accumulation rate	-0.0045 week^{-1}
	DTCS = degree day threshold	17 °C days
	DHCS = stress accumulation rate	-0.0015 week^{-1}
Hot stress	TTHS = temperature threshold	32 °C
	THHS = stress accumulation rate	0.002 week^{-1}
Dry stress	SMDS = soil moisture threshold	0.2
	HDS = stress accumulation rate	-0.012 week^{-1}
Annual Heat Sum	PDD = degree-day threshold[b]	980 °C days

[a]Values without unit are a dimensionless index of a 100 mm single bucket soil moisture profile.
[b]Minimum annual total number of degree-days above DV0 neded for population persistence



Ecoclimatic index for *Austropuccinia psidii* (Basidiomycota) establishment. Most suitable >35

Anastasia Korycinska for EPPO in press

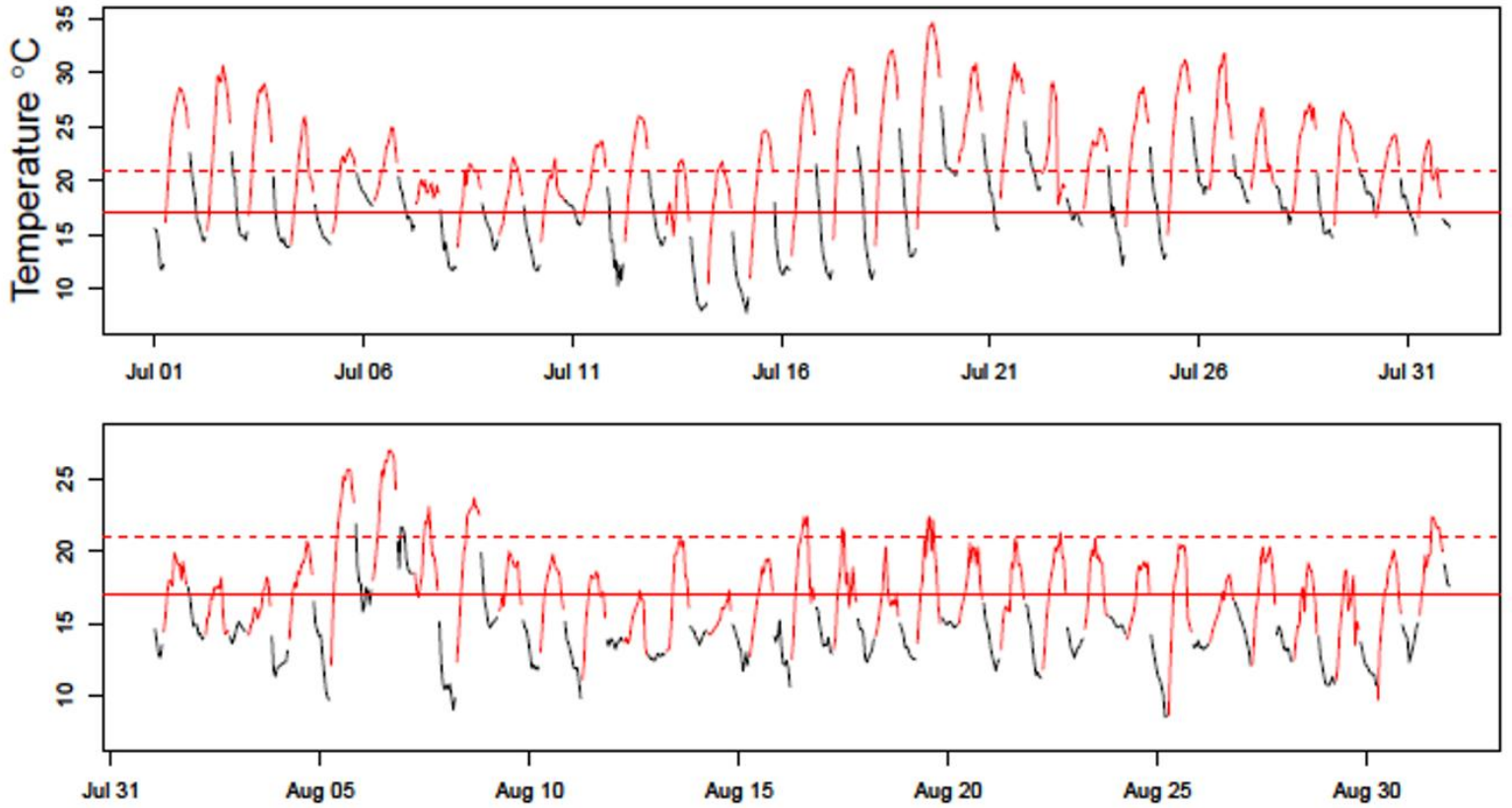
Climate suitability: Modelling

Lifecycle parameters

Elasmopalpus lignosellus
ovipositing minimum temperature is 17°C
+
mating takes place **only at night and only when > 21°C.**
+
adult females live for approximately two weeks

No. of nights where temperatures of ≥ 21°C		
Month	2002 cool year	2006 warm year
April	0	0
May	0	0
June	0	4
July	4	14
August	2	2
September	0	2
October	0	0

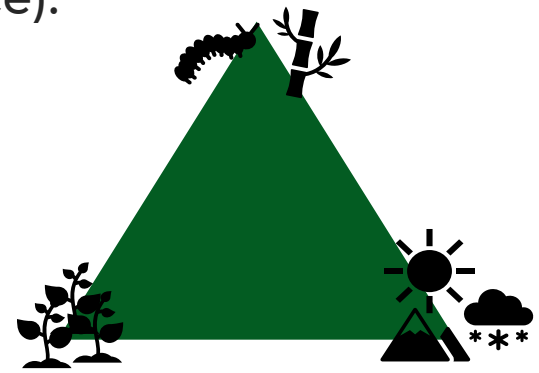
Weather data for Cambridgeshire (Met.Office)



---- minimum temperature for mating (°C)
—— minimum temperature for ovipositing (°C)
hourly temperatures, red = day, black = night.

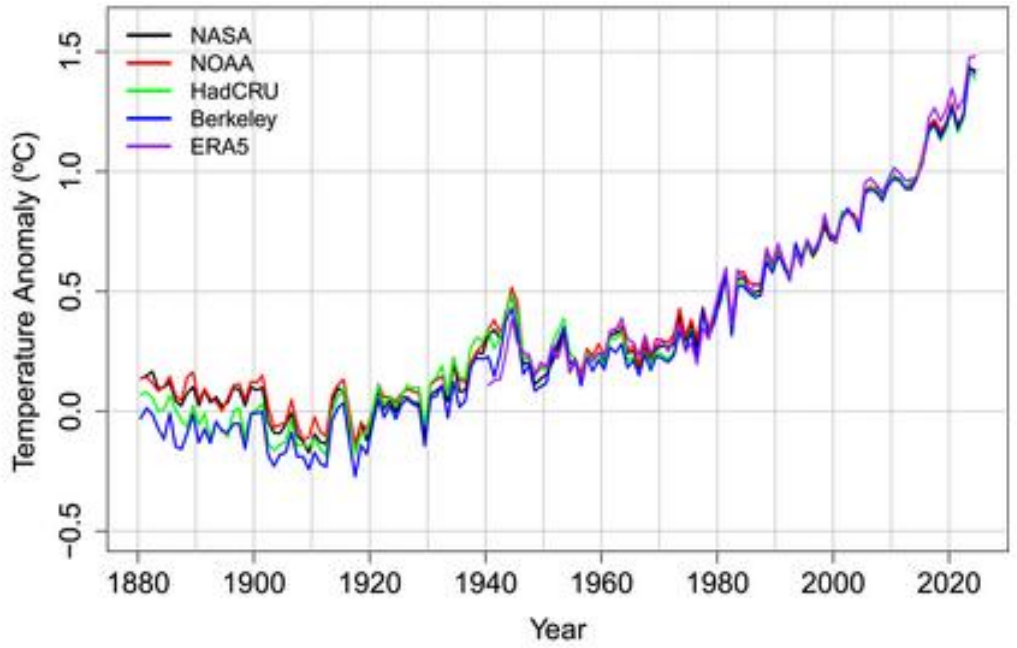
Climate suitability – climate change

We are living in climate change already and the change is accelerating – with faster warming over the last 10+ years than during any previous decade (>98% confidence).



"In the assessment of risks, Members shall take into account available scientific evidence;…**relevant ecological and environmental conditions**…" WTO- SPS Art 5.

"**risk assessment must look at ascertainable risk, i.e. what is *likely* or *probable*, not what could be *possible*** NAPPO (2011)

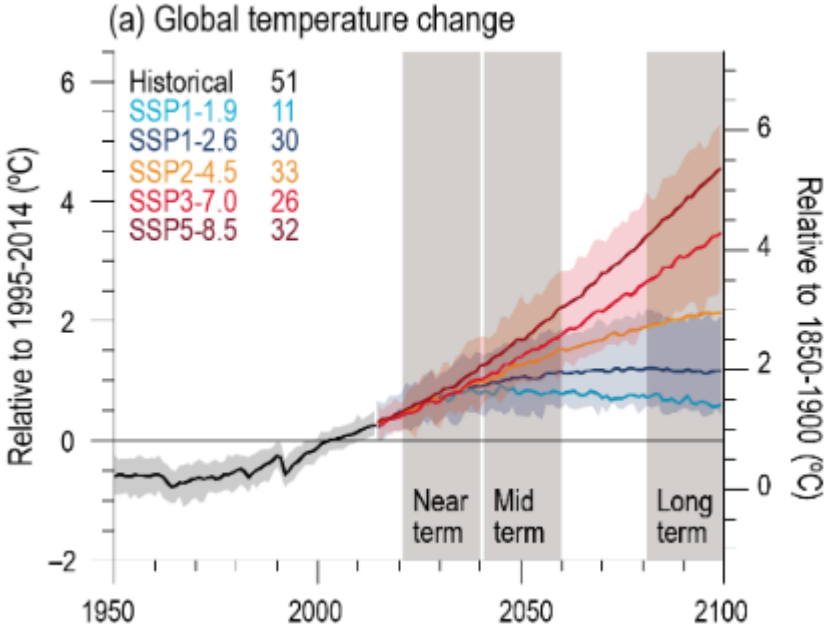


Yearly average global mean surface temperature from five data sources adjusted for El Niño/Southern Oscillation, volcanism, and solar variation. All are aligned so that the average from 1991 to 2020 equals 0.88°C, to approximate warming since pre-industrial.

Foster & Rahmstorf (2026)

Climate suitability – climate change

- Increasing uncertainty in predictions for the long term



Lee *et al.* (2021)

- Horizon time frame should not be too distant
- Other data in the PRA will no longer be relevant (e.g. trade volumes, crops, pest distribution)

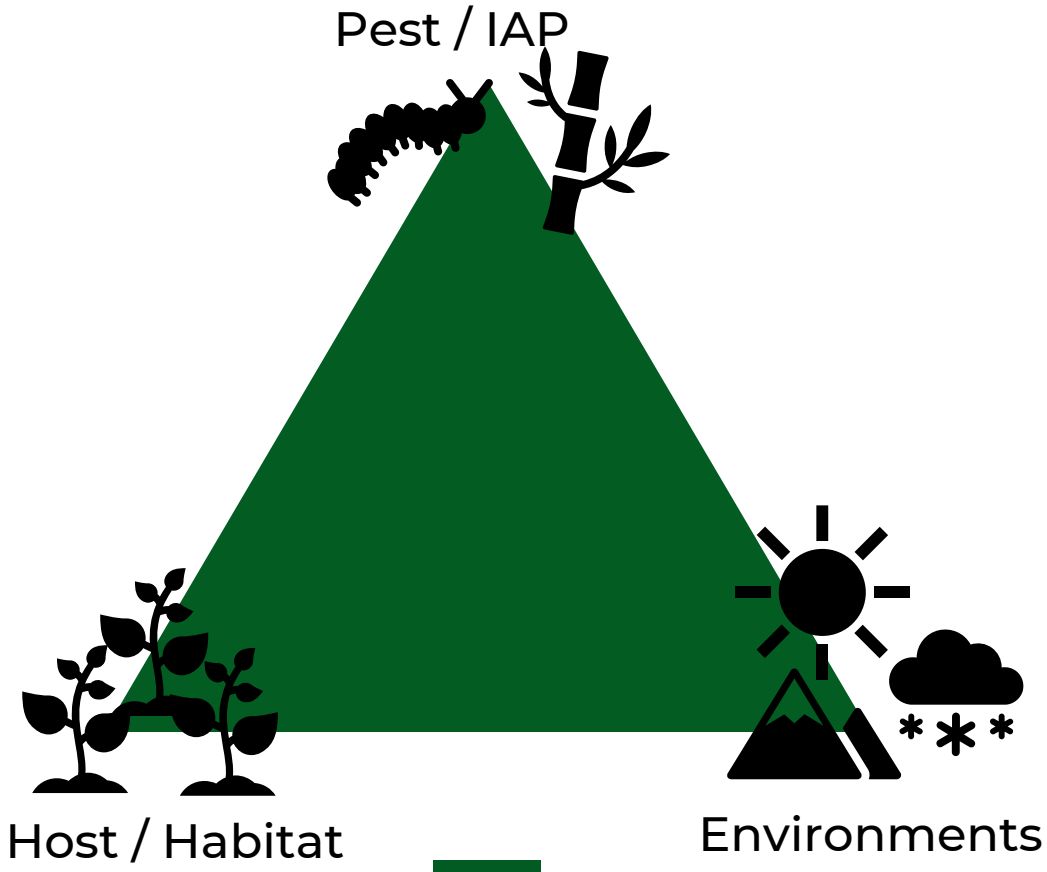
https://koppen.earth/ Beck *et al.* (2023) **2041-2070**

Suggested scenarios:

- SSP1 -2.6 and/or SSP2 -4.5
- SSP3 -7.0

Establishment

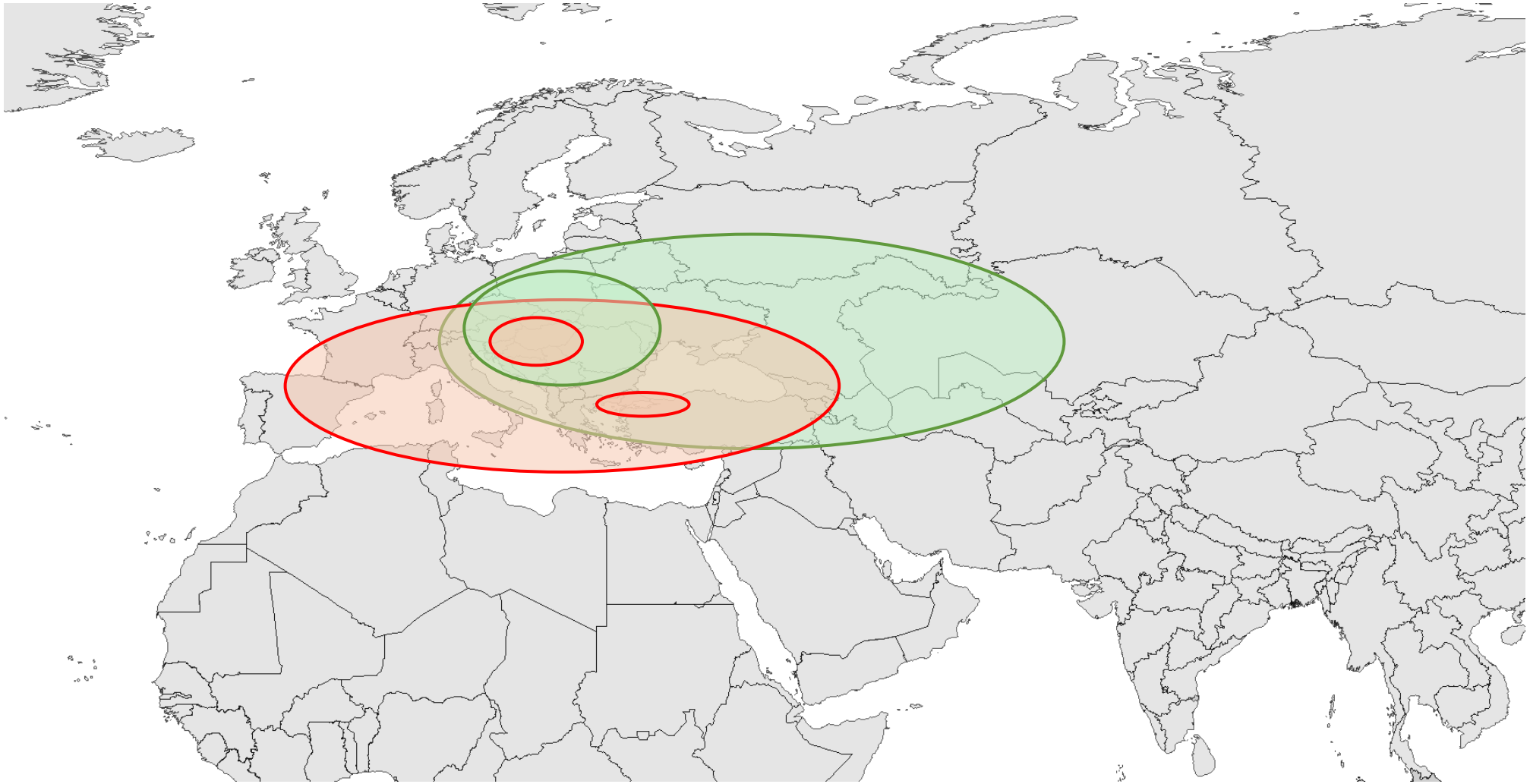
Adaptability, Longevity, Survival, Reproductive strategy, Mobility



Host availability
Habitat availability
Alternate hosts
Vectors
Essential species

Temperature
Rain / snowfall
Seasonal variation
Day length
Altitude
Soil
Aquatic environment
Competition
Natural enemies
Cultural practices
Control measures

Limits & suitability of the area of potential establishmsnet



Likelihood of establishment outdoors

The area of potential establishment may be:

- the whole of the PRA area
- part or parts of the PRA area

It can be defined:

- ecoclimatically
- geographically
- by crop or by production system or by types of ecosystems.

Add a summary / justification for rating and explanation of uncertainty

Rating of the likelihood of establishment outdoors	*Very low* ☐	*Low* ☐	*Moderate* ☐	*High* ☐	*Very high* ☐
Rating of uncertainty			*Low* ☐	*Moderate* ☐	*High* ☐

Likelihood of establishment in protected conditions

Permanent/temporary structures

- Glasshouses
- Foil tunnels
- Shade houses

Management practices

- Temporary structures - seasonality
- Growing media and substrates
- Rotation of stock
- If hosts are only grown under protection – means of spread from structure to structure?
- Suitable habitat for IAP?

Rating of the likelihood of establishment in protected conditions	*Very low* ☐	*Low* ☐	*Moderate* ☐	*High* ☐	*Very high* ☐
Rating of uncertainty			*Low* ☐	*Moderate* ☐	*High* ☐

Add a summary / justification for rating and explanation of uncertainty

Group exercise

Use Köppen–Geiger climate classification to estimate the likelihood of establishment of the pest in the EPPO region - based on current climate

https://koppen.earth/

Groups can also discuss how future climate may impact establishment

Thank you



linkedin.com/company/eppo-oepp/



bsky.app/profile/epponews.bsky.social



www.facebook.com/EPPOsecretariat/

References & Further Reading

Baker, C.R.B. (1980), Some Problems in Using Meteorological Data to Forecast the Timing of Insect Life Cycles1. *EPPO Bulletin*, 10: 83-91. https://doi.org/10.1111/j.1365-2338.1980.tb02628.x

Beck HE, McVicar TR, Vergopolan N, Berg A, Lutsko NJ, Dufour A, Zeng Z, Jiang X, van Dijk AIJM & Miralles DG (2023) High-resolution (1 km) Köppen-Geiger maps for 1901–2099 based on constrained CMIP6 projections. Scientific data 10, 724. https://doi.org/10.1038/s41597-023-02549-6

Eyre, D., Baker, R.H., Brunel, S., Dupin, M., Jarošík, V., Kriticos, D.J., Makowski, D., Pergl, J., Reynaud, P., Robinet, C. and Worner, S. (2012) Rating and mapping the suitability of the climate for pest risk analysis. *EPPO Bulletin*, 42(1), pp.48-55.

Foster, G., & Rahmstorf, S. (2026). Global warming has accelerated significantly. *Geophysical Research Letters*, *53*(5), e2025GL118804.

Lee *et al.* (2021) Future Global Climate: Scenario-Based Projections and Near-Term Information. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte *et al.* (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 553–672, doi: 10.1017/9781009157896.006.

MacLeod & Korycinska (2019) Detailing Köppen-Geiger climate zones at sub-national to continental scale: a resource for pest risk analysis. *Bulletin OEPP/EPPO Bulletin* 49, 73–82. Available from https://doi.org/10.1111/epp.12549.

NAPPO (2011). Discussion Document DD 02: Climate Change and Pest Risk Analysis. https://www.nappo.org/application/files/5415/8341/5783/DD_02_Climate_Change_Discussion_DocumentRev-07-08-12-e.pdf

Wulff, E., & Bouillon, J. (2024). *Erstellung einer neuen Winterhärtezonenkarte für Europa unter Berücksichtigung mesoklimatischer Effekte* (Vol. 109, pp. 81-98).

Further Reading - Climate Change in PRA:

Szyniszewska, A.M., Akrivou, A., Björklund, N., Boberg, J., Bradshaw, C., Damus, M., Gardi, C., Hanea, A., Kriticos, J., Maggini, R. and Musolin, D.L. (2024) Beyond the present: How climate change is relevant to pest risk analysis. *EPPO Bulletin*, **54**, pp.20-37.

Rosace, M.C., Björklund, N., Boberg, J., Bradshaw, C.D., Camac, J., Damus, M., Kompas, T., Li, C., MacLeod, A., Maggini, R. and Rossi, E. (2024) Including climate change in pest risk assessment: Current practices and perspectives for future implementation. *EPPO Bulletin*, **54**, pp.52-72.

Further Reading – Modelling/mapping:

European Food Safety Authority (EFSA) and Maiorano, A. (2022) SCAN-Clim: a tool to support pest climate suitability analysis based on climate classification. *EFSA Journal*, 20(2), p.e07104.

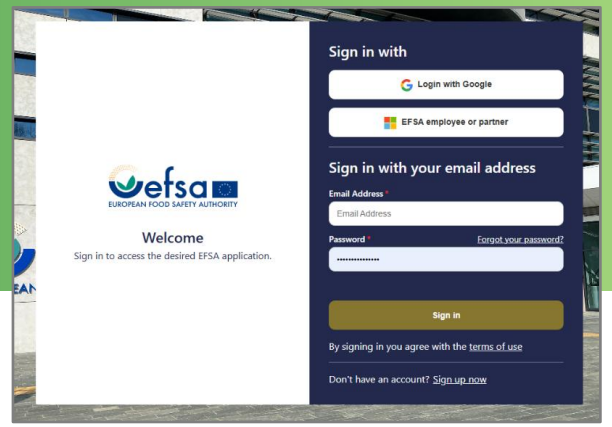
Kriticos, D., Szyniszewska, A., Bradshaw, C., Li, C., Verykouki, E., Yonow, T. and Duffy, C. (2024) Modelling tools for including climate change in pest risk assessments. EPPO Bulletin, 54, pp.38-51.

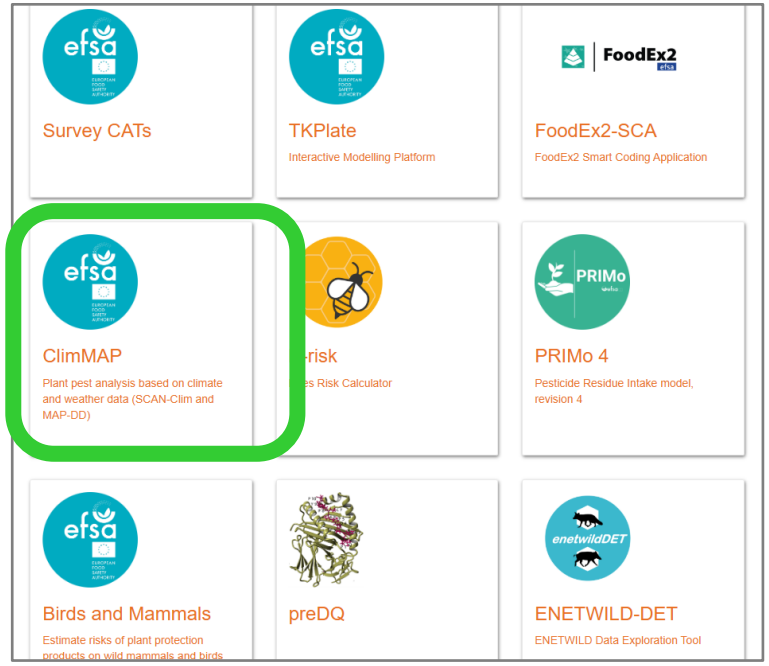
Tool – EFSA's ClimMAP

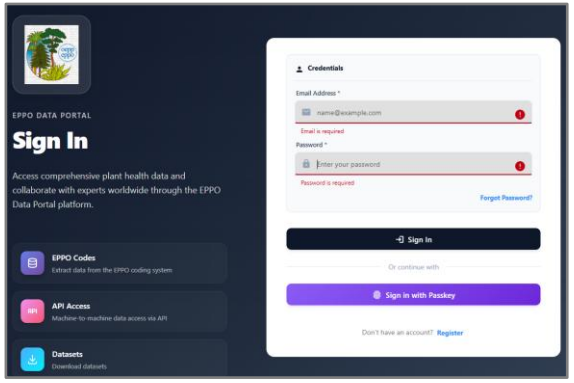
- Create an EFSA account

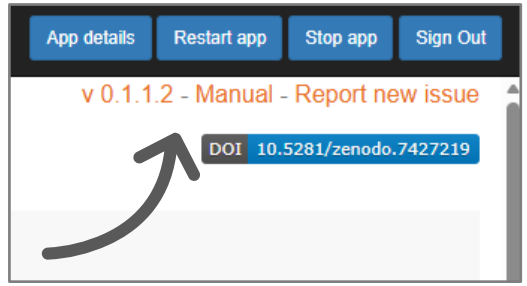
https://login.efsa.europa.eu/efsab2c.onmicrosoft.com/B2C_1_SignIn_v3/oauth2/v2.0/authorize?app=the%20EFSA%20R4EU%20Portal&response_type=code&client_id=be616b14-895a-4257-9e38-b503da802ba3&scope=be616b14-895a-4257-9e38-b503da802ba3%20openid%20email&state=BmUHXpyr2jv00zfPwaY4sAkqTpZkpHCON68LzKwh9nk%3D&redirect_uri=https://r4eu.efsa.europa.eu/login/oauth2/code/shinyproxy&nonce=JLZNJWL3qJPvACN6obv1Fl-l6rEi1FpM8wSQ-LE0nyg

- EFSA R4EU – will be prompted to log in https://r4eu.efsa.europa.eu/
- Also need an EPPO Data Portal account (for API key) https://data.eppo.int/ui/#/auth/login









•Follow manual in top-right-hand- corner