Progress of the citizen science project

PUKI – Pflanze • Umwelt • Klima • Interaktion

Arabidopsis thaliana

Cardamine hirsuta

Capsella bursa-pastoris

PUKI
Pflanze · Umwelt · Klima
INTERAKTION

Progress

1: Publications

2: Communication tools and successes achieved by PUKI

3: Participation by citizen scientists with PUKI in 2024 and 2025

Future activities

4: Possible future analyses of data

5: Possible improvements to data flow and analyses

Progress number 1

Publication 1

Title: A citizen science research project for secondary schools on urban ecology and plant genetics

Authors: Bruno Andreas Walther, Leonard Jakob Klamann, Sarah Victoria Weirauch, Petra Bauer

Progress number 1

First, I combined the bachelor theses of our students Leonard Klamann and Sarah Weirauch into one manuscript focused on presenting our research around *Arabidopsis thaliana* as an interesting school project which can be done wholly or in parts in secondary schools.

Progress number 1

Three parts to the publication:

1. Explaining the field work of sampling *A. thaliana* in Düsseldorf and the resulting genetic analyses, demonstrating that some of this work could be replicated in schools.

2. Presenting a detailed protocol of how to teach some basic laboratory techniques such as genotyping, PCR, gel electrophoresis and sequencing in schools.

3. Presenting a lot of basic background knowledge on ecological genetics which can be taught easily in schools.

Progress number 1

Flowchart of publication

Identification and measurement of plant
- Identification of plant species with *Flora Incognita* app
- Take measurements of plant
- Enter data into app

Phenotyping of plants
- Enter data about plant phenology and habitat into app

Taking samples
- Take samples of leaves, seeds and soil
- Dry or freeze samples to preserve them for later analysis

Laboratory analyses
- Extraction of gDNA
- DNA amplification
- Gel electrophoresis
- Sequencing
- Sequence analysis

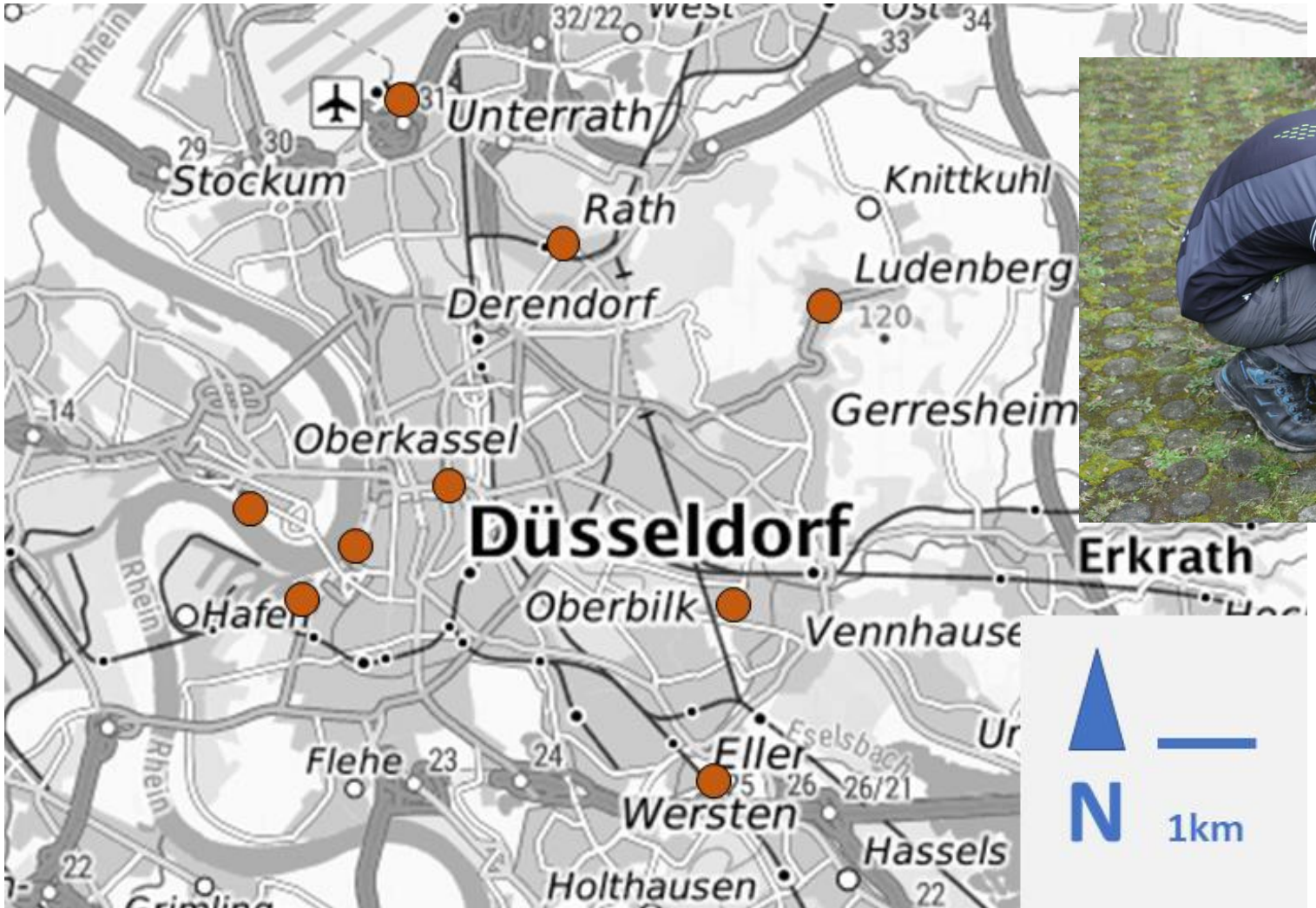
Purification of gDNA
- Purification using the MinElute Gel extraction kit
- Repeated cleaning and centrifugation

Sequencing
- Sequencing was performed by Eurofins Genomics
- Downloading of raw data from the Eurofins website

Sequence analysis
- Sequence analysis performed using ApE software
- Standardised methods for sequence analysis result in corrected, “clean” DNA sequences

Progress number 1

1. Explaining the field work of sampling *A. thaliana* in Düsseldorf



Progress number 1

Typical urban habitats in Düsseldorf, easily accessible to school children

Progress number 1

Heinrich Heine Universität Düsseldorf

trr_341 plant ecological genetics

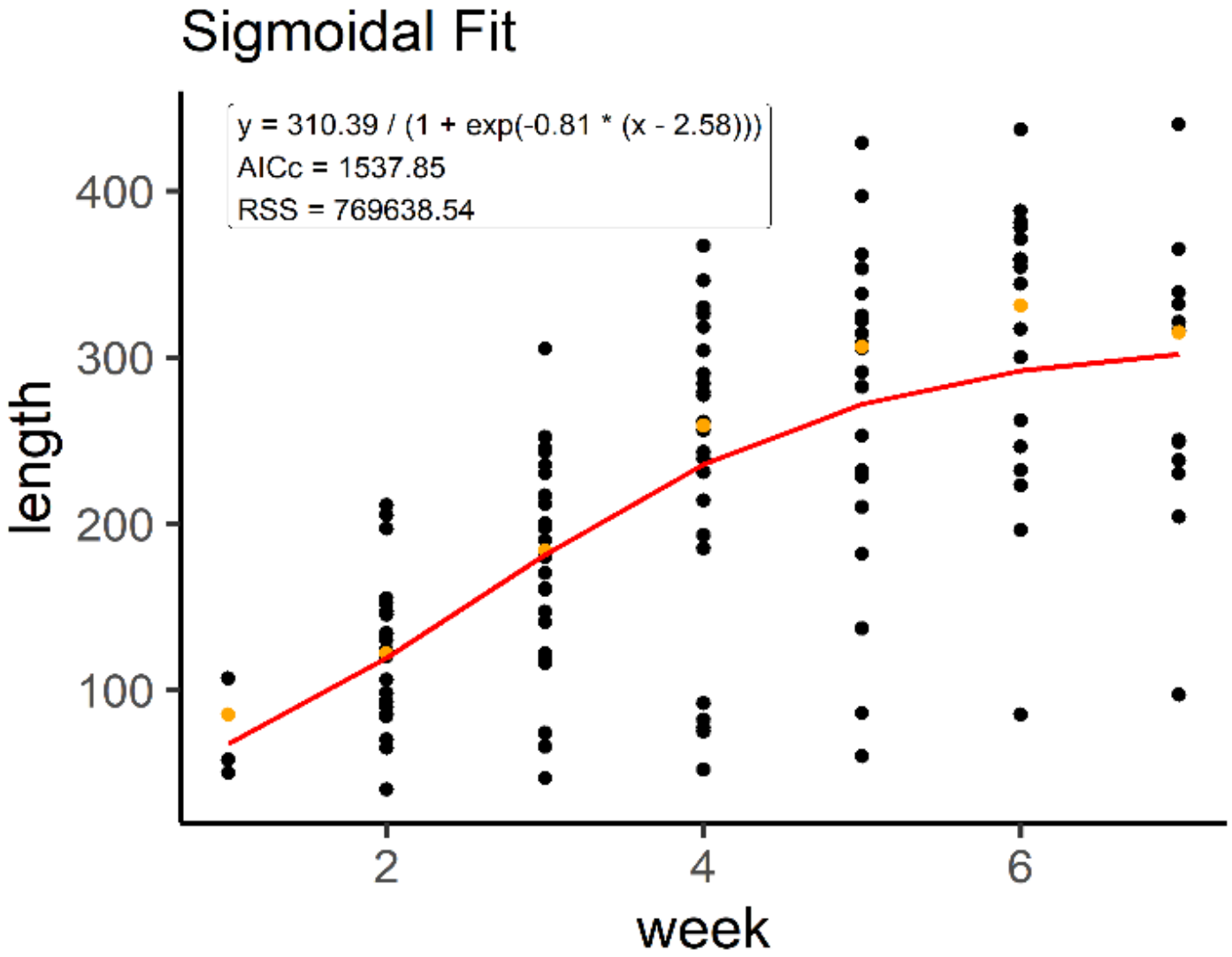
Easy measurements, which we also use for the PUKI citizen science project

- Length of longest shoot (or stem)
- Number of siliques
- Length of rosette leaves
- Etc.

Progress number 1

Results

Growth over time



Progress number 1

2. Presenting a detailed protocol of how to teach some basic laboratory techniques in schools

Images of the steps required for the extraction of the gDNA

Progress number 1

This presentation of laboratory techniques cannot usually be taught by teachers without additional help. Rather, the idea is that scientists work *together* with teachers to present these techniques directly to the students.

Like Leonard did at the KölnerKinderUniversität and the HHU's 'Night of Science' in 2024.

Progress number 1

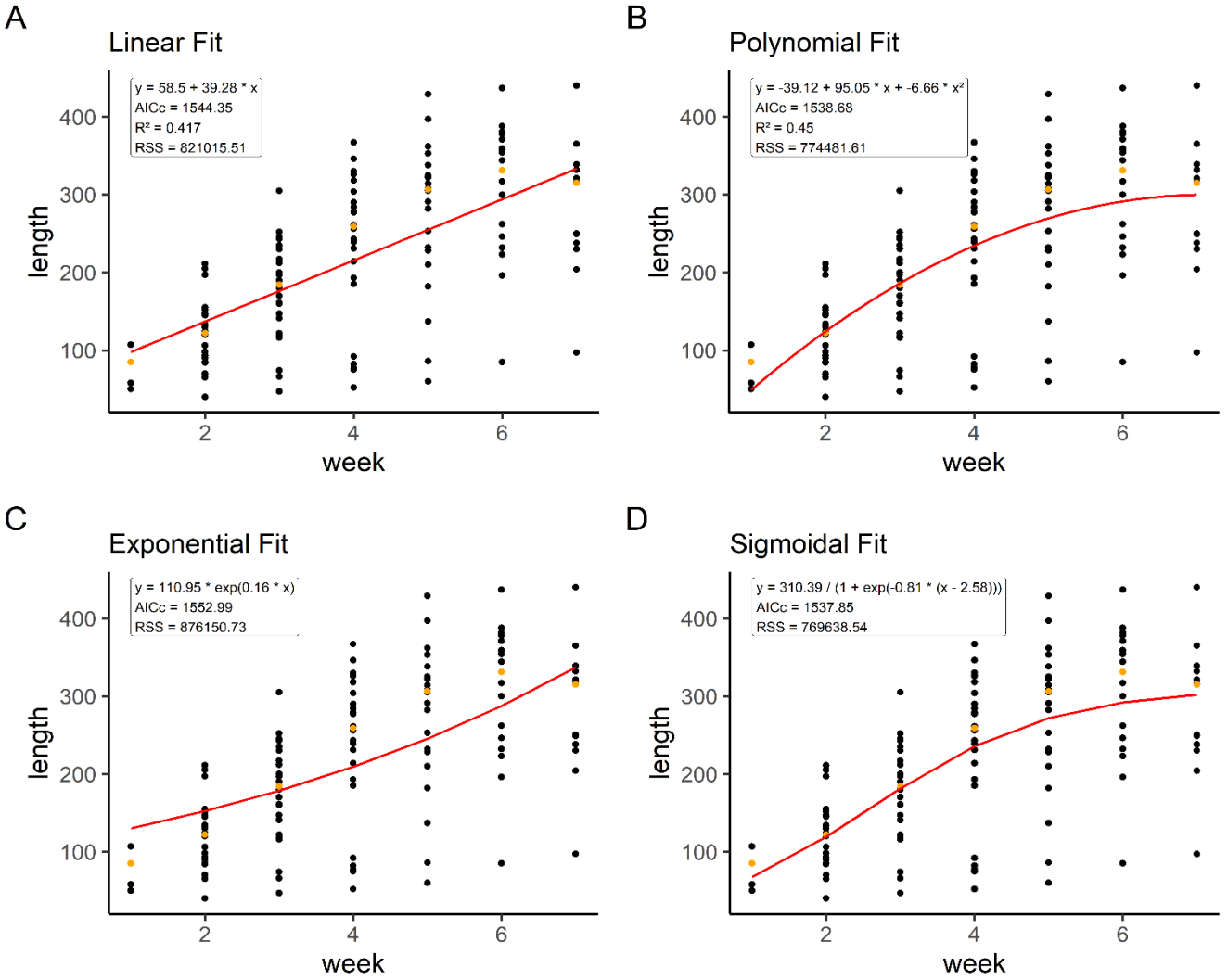
3. Presenting a lot of basic background knowledge

Background module 1: Background knowledge about the biology, ecology and genetics of the thale cress
Background module 2: Why do plants scientists work with the thale cress?
Background module 3: How does the thale cress deal with environmental challenges in ecological settings?
Background module 4: Understanding and exploring correlations ("correlation is not causation")
Background module 5: Comparing two groups
Background module 6: What model explains my data best?

Progress number 1

Background module 6: What model explains my data best?

AICc indicates that sigmoidal fit model best explains the data!



Progress number 1

Publication 2

Title: Citizen scientists help with investigating plant adaptations: A simple sampling protocol yields first results for five common plant species

Authors: Bruno Andreas Walther, Vera Hesen, Leonard Jakob Klamann, Agnes Christine Rzepka, Anja Linstädter, Patrick Mäder, Petra Bauer … perhaps others

Progress number 1

Heinrich Heine Universität Düsseldorf

trr_341 plant ecological genetics

First, I describe in great detail the development of the sampling strategy for the PUKI citizen science project and the PUKI-data-entry-function within the *Flora Incognita* app which resulted from it.

Second, I present the first results from the first two years of data collection accomplished by the citizen scientists.

Overall approach of the citizen science project PUKI

Goals
- Engagement
- Preparation
- Research data collection
- Analysis
- Dissemination

Mission
'Our mission is to promote interest in wild plants and work with citizens to explore the fascinating adaptations of plants to urban environments and climate change.'

Vision
'Our vision is a committed community of people working together to research the adaptations of wild plants in order to promote nature conservation and support a more conscious design of the environment on our own doorstep.'

Team composition
- Professional scientists
- Engaged citizens
- Early career researchers
- Scientific coordinator

Research strategy
The PUKI project will expand as a collaborative citizen science platform within the TRR framework, advancing ecological genetics through public participation in research across Germany. The strategy focuses on deepening scientific integration, enhancing educational outreach, and refining data management and communication systems. Through co-creative development, interdisciplinary collaboration, and adaptive engagement methods, PUKI aims to address novel ecological research questions while sustaining broad citizen involvement.

Target groups
- **Citizens** (botanical amateur groups, gardening clubs and plant enthusiasts, museums, environmental NGOs, users of *Flora Incognita*)
- **Biology students and researchers** (at the universities participating in the TRR)
- **Schools, children, teachers** (nearby schools, local children invited to participatory events and field excursions)

For additional information

www.puki.hhu.de

PUKI
Pflanze · Umwelt · Klima
INTERAKTION

Progress number 1

1. The plant species must occur in almost all of Germany.
2. The plant species must be common in many different habitats (including many urban habitats).
3. In Germany, the plant species is not threatened or protected by law.
4. The plant species must belong to the family Brassicaceae.
5. The plant species must be used as a model species in our current research group (the TRR 341).

Progress number 1

Arabidopsis thaliana *Cardamine hirsuta* *Capsella bursa-pastoris* *Diplotaxis tenuifolia* *Brassica rapa*

Most difficult!

Progress number 1

Heinrich Heine Universität Düsseldorf
trr_341 plant ecological genetics

Sampling methodology:

1. Easy to understand: We needed easy-to-understand instructions which could be accessed through *Flora Incognita*, through the PUKI-website, or through printed instructions.

2. Easy to do: We agreed to keep the necessary equipment to a minimum:

- mobile phone
- ruler
- tea spoon
- collecting bags

Progress number 1

Sampling methodology:

3. Quick to do: Sampling of an individual plant should take a max. 15-20 minutes.

4. Reliably to do: Any data taken by the citizens needed to be reliable enough for scientific analysis. For instance, we are very confident that citizen scientists can reliably measure distances with a ruler, count individual pods, or identify different colours. Likewise, they can pick a pod and leaf from a plant and place them into a bag. The only somewhat difficult task, the species ID, is accomplished by *Flora Incognita*.

Progress number 1

Laboratory methods:

The usual *'cookbook'* for TRR

- Extraction of gDNA
- DNA amplification
- Gel electrophoresis
- Sequencing
- Sequence analysis

Progress number 1

Heinrich Heine Universität Düsseldorf

trr_341 plant ecological genetics

Additional methods:

1. Soil analyses:
- **ICP-MS elemental analysis**
- **Soil colour analysis**
- **pH, soil electrical conductivity (Anja Linstädter's group)**
- **NO3 and NH4 (Anja Linstädter's group)**
- **Particle size analysis (Anja Linstädter's group)**

2. Leaf economic spectrum (Anja Linstädter's group)

Progress number 1

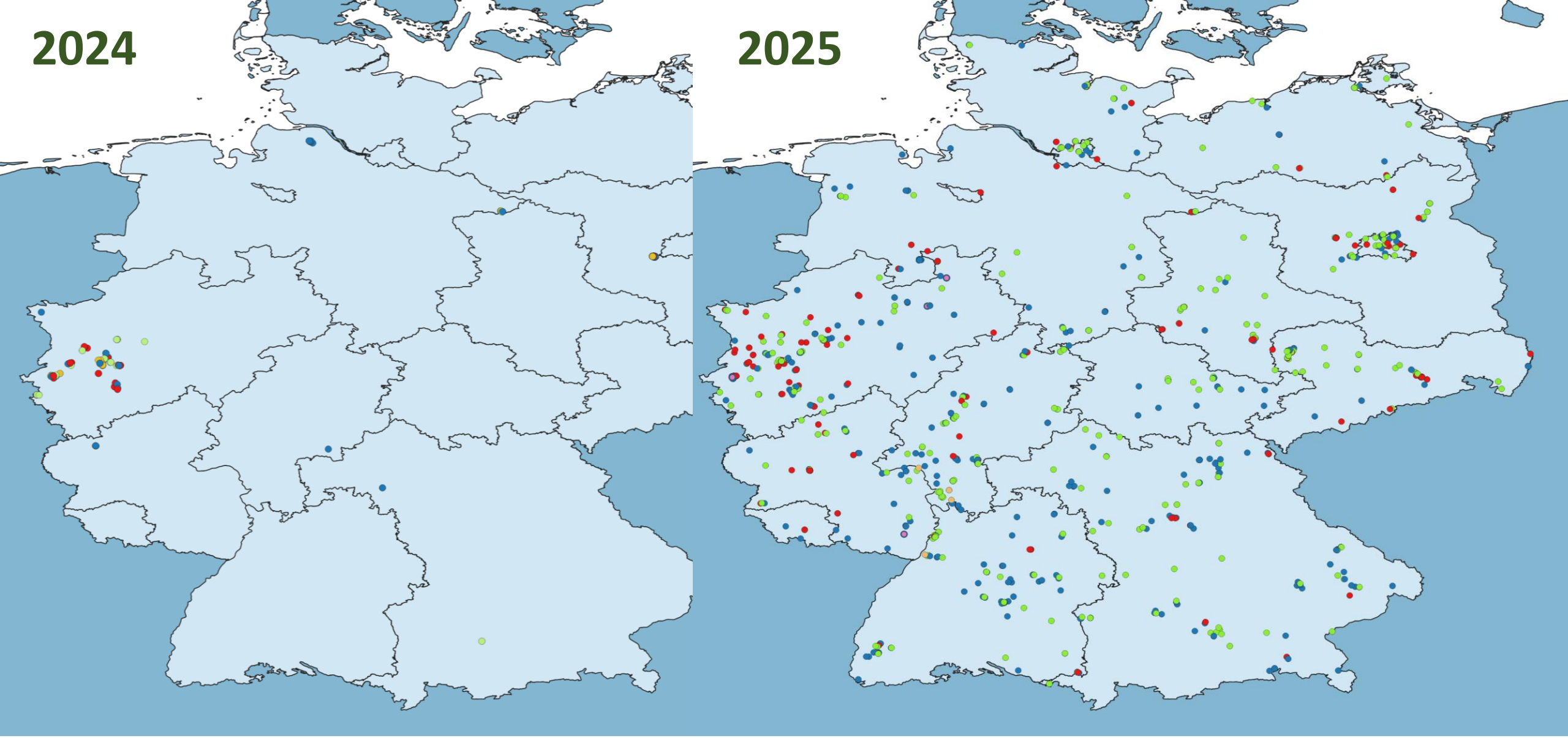
Additional methods:

3. Data cleaning and checking
- Outliers
- Missing values (can sometimes be determined)
- Uncertain species determination
- Determining Ellenberg Indicator Values (EIVs) and Disturbance Indicator Values (DIVs) for neighboring species (lots of misspelling)

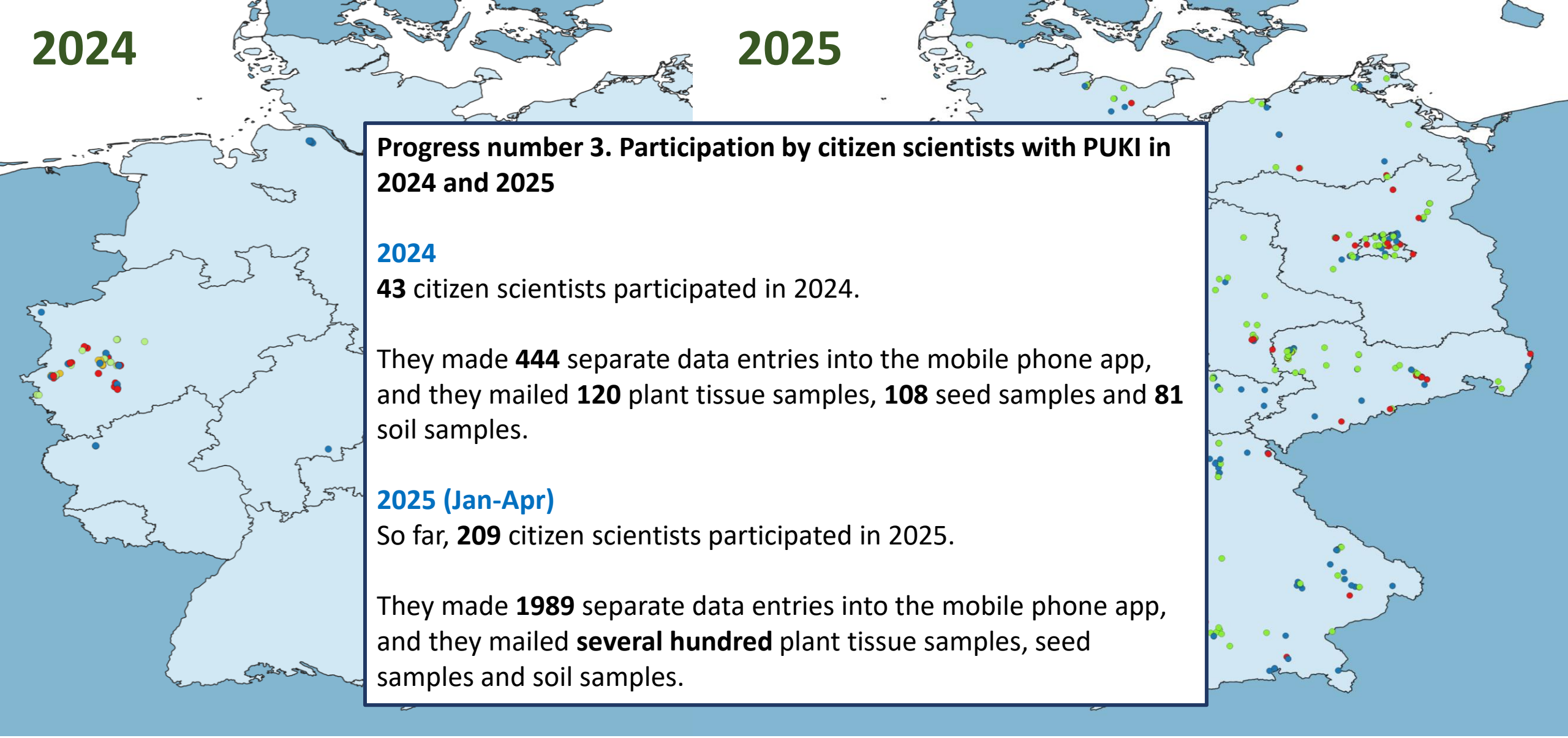
4. GIS mapping

Progress number 2: Summary of communication tools and successes achieved by the citizen science project PUKI (2023-2025)

Category and dates	Type	Summary
Social media		
2 March 2023-present	project website	1 continuously updated website (www.puki.hhu.de)
	social media channels	Bluesky, Facebook, Instagram, Youtube
	Newsletter	2 issues
	blog articles	4 articles
Traditional media		
12 March 2024-present	5 publications	1 newspaper article, 1 journal article, 1 press presentation, 2 press releases
Meetings and excursions		
12 January 2024-present	different formats	13 field excursions, 3 information stands, 2 scientific presentations, 7 talks
Scientific conferences		
October 2024-present	conference poster	2 conference posters



Because of a push-story in *Flora Incognita*, we were lucky to get nationwide coverage and exponential increase in participation!



Progress number 3. Participation by citizen scientists with PUKI in 2024 and 2025

2024

43 citizen scientists participated in 2024.

They made **444** separate data entries into the mobile phone app, and they mailed **120** plant tissue samples, **108** seed samples and **81** soil samples.

2025 (Jan-Apr)

So far, **209** citizen scientists participated in 2025.

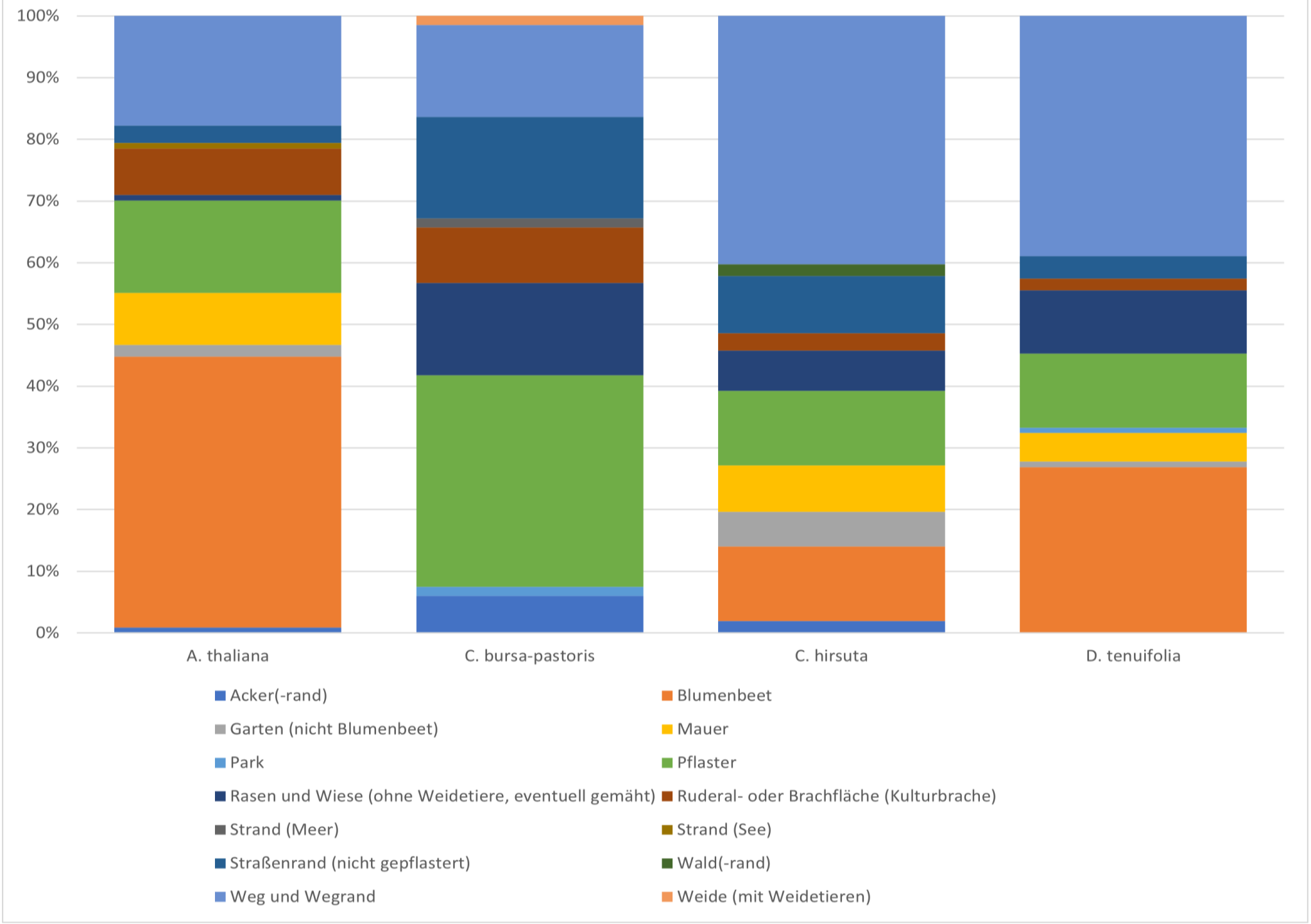
They made **1989** separate data entries into the mobile phone app, and they mailed **several hundred** plant tissue samples, seed samples and soil samples.

Because of a push-story in *Flora Incognita*, we were lucky to get nationwide coverage and exponential increase in participation!

Links die letzten Umschläge, die wir vor einigen Tagen versandten.

Und rechts das Lager für die Blatt-, Schoten- und Erdproben, die fein säuberlich mit den Sammlungsnummern versehen in entsprechenden Tüten und Stehsammlern lagern.

Diese Proben können dann von unseren Studierenden für ihre Bachelor-, Master- oder Doktorarbeiten verwendet werden.


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
A. thaliana
C. bursa-pastoris
C. hirsuta
D. tenuifolia
Acker(-rand)
Blumenbeet
Garten (nicht Blumenbeet)
Mauer
Park
Pflaster
Rasen und Wiese (ohne Weidetiere, eventuell gemäht)
Ruderal- oder Brachfläche (Kulturbrache)
Strand (Meer)
Strand (See)
Straßenrand (nicht gepflastert)
Wald(-rand)
Weg und Wegrand
Weide (mit Weidetieren)

Heinrich Heine Universität Düsseldorf

trr_341 plant ecological genetics

Percentage distribution of the three categories of light incidence (yellow = sunny, light grey = half-shady, dark grey = shady) among the two groupings of habitats. Green habitats are: field (edge), flower bed, garden (not flower bed), lawn and meadow (without grazing animals, possibly mowed), ruderal or fallow land (cultivated fallow land), beach (sea), beach (lake), forest (edge), path and path edge, pasture (with grazing animals); grey habitats are: wall, park, pavement, roadside (unpaved).

Future activities 1

Goal: Possible future analyses of data

There are four kinds of samples/data

- Plant tissue samples
- Seed samples
- Soil samples
- Data from mobile phone app (phenological, habitat and other data)

Future activities 1

Goal: Possible future analyses of data

Many of the planned analyses have already been mentioned above during the presentation of the two planned publications.

Here are further opportunities.

1. So far, only primers for *A. thaliana* have been used. If someone is interested in the German-wide distribution of specific alleles for specific genes within one of the five target species, our sample collection may help. Please talk to us!

Future activities 1

Goal: Possible future analyses of data

2. So far, no plans have been developed what to do with the seeds. That is another study-in-waiting.

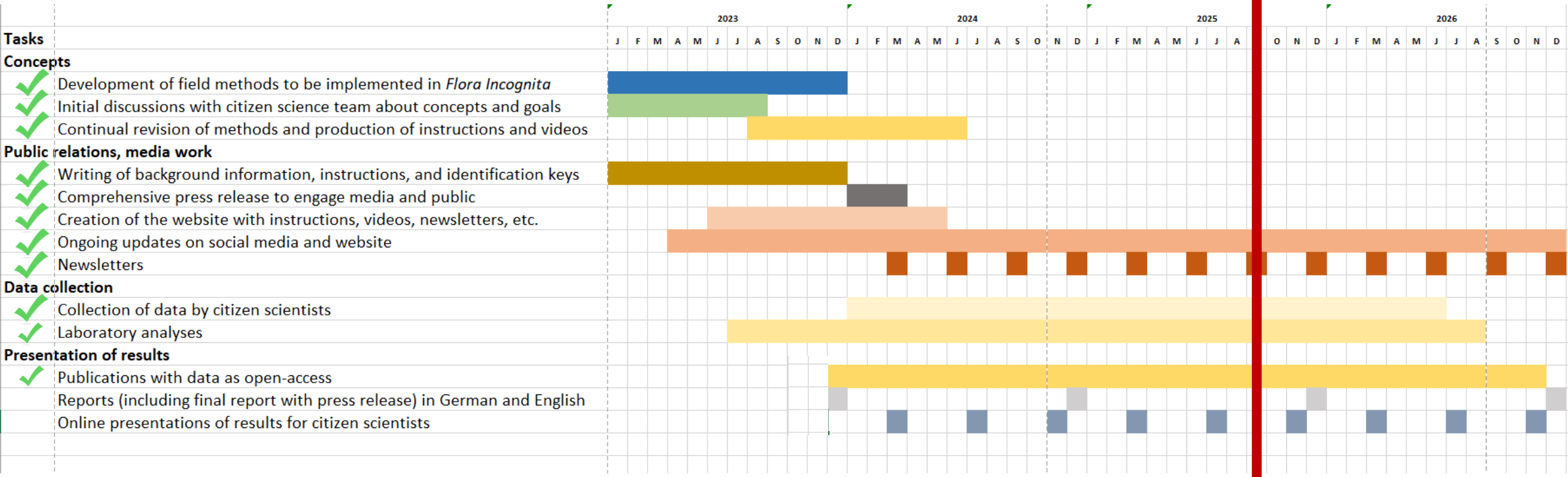
3. Since geographic coordinates are associated with every sampled plant individual, one could do various GIS-based analyses: climate, habitat, soil, niche modelling, etc.

Principle	Definition	Realization within PUKI
1	Citizens participate actively.	Participation Levels: Citizen scientists engaged in 3 of 4 levels – crowdsourcing, distributed intelligence, participatory science; not in extreme citizen science.
2	Citizens collect real scientific data.	Manuscripts: 3 scientific papers in preparation.
3	CS data are of genuine interest for both partners.	Mutual Benefits: Scientists gain insights and publications; citizens benefit through learning (e.g., plant ID, blog, talks), interactions, and fieldwork enjoyment.
4	Citizens contribute at different levels in the scientific process.	Participation Scope: Involved in multiple scientific stages, incl. first 3 participation levels.
5	Citizens receive feedback about the results.	Feedback Channels: Website, blog, newsletter, social media, chat, email, and direct contact.
6	Citizens are made aware of biases and limitations of the study.	Transparency: Biases and limitations addressed in manuscripts
7	CS is made public.	Open Data: All data will be publicly available with publication.
8	The contribution of citizens will be acknowledged in the publication.	Acknowledgment: All citizen contributions will be recognized in publications.
9	CS is evaluated with respect to data output, data quality and impact for participants.	Evaluation: Planned for 2026+.
10	CS respects legal and ethical issues.	Further Info: Detailed at www.puki.hhu.de.

green = **achieved**, orange = **in progress**, blue = **planned**

List of long-term visions and goals for extreme citizen science
1. Better outreach communication in various traditional and social media channels (newspapers, journals, website, blog, videos, social media, etc.)
2. Building citizen science teams with several team members on long-term 100% contracts to ensure consistency, know-how, building of personal relationships between team members and members of the public, etc.
3. Better outreach to schools should be enabled by producing children-specific and age-adapted teaching materials
4. More discussion and workshops with citizens and stakeholders to refine or re-define the goals of the citizen science project, e.g.: Are there types of data of great interest to stakeholders which are not collected yet? Are socio-economic-environmental concerns which are important to stakeholders incorporated into the scientific approach? Can concrete applications to real-world problems be developed directly from the citizen science project?
5. Can our citizen science project work more with museums? Museums attract many people with interests which should be ideal for making the participants in citizen science projects. So how can synergies between citizen science projects and museums be developed? Can workshops and educational materials be developed together?
6. There is a need for more web-based interactive tools: together with web designers and social scientists, chat rooms, questionnaires, quizzes, etc. can be developed which increase both the communication and fun aspect of the citizen science project, but also produce useful data for the scientists.

Timeline for PUKI



Acknowledgements

The co-authors mentioned above plus

Tim Blank
Justine Floret
Poonam Kanwar
Hans-Jörg Mai
Ghinwa Mashhady
Huiyao Zhang
(and some of the above may also become co-authors)

And all the participating citizen scientists!