

## **EuroAPPA Meeting Notes**

**2024-11-05 (third meeting)**

### **Participants**

Cala, Jorrit, Claus, Jeff, Nicolas, Noa, Jeroen

agenda

1. data management status quo
2. (proposed by Jorrit) outcome of code review of DOPI

Question: Who is in charge of data management for Butterfly?

Jeroen: WP9.1 - Laura Drivdal (University of Bergen) is the Data Management lead. Mid-term data plan delivery delivered in Month 9 - intermediate / final Data Management Plan (DPM) Deliverables 9.1 (M6) + mid-term (M24) + final DMP (M48).

skilled and paid work and schools to unpaid domestic work. This again produces social inequality and the probability of lifelong and generation-crossing poverty.

Both traditional and changing gender roles also play a part in humans' capacity to assume historical agency and pollinator stewardship. Many activities that threaten pollinator survival have had a strong male dominance, like industrial agriculture, physical infrastructure construction and urbanisation, while areas that can provide positive contributions in pollinator conservation and restoration are areas where women and men equally participate, like family gardening, neighbourhood caring and community leadership. However, traditional gender roles have also provided men and women, as well as generations, with different knowledge, skills and resources (both property and monetary) to assume the positions and work involved in landscape and pollinator restoration. To foster sustainable practices of agency, slow hope and practical hands-on work, more men and women of all ages need the skills, knowledge, resources and attitudes necessary to take up the required work, for instance in clearing out invasive species, making decisions over land use and restoring monoculture areas to multispecies spaces. Research is needed on these issues, and on what are the necessary and the critical elements to make people of all genders and generations in a local community able to assume historical agency in sustainable pollinator restoration initiatives. We will apply gender perspectives in all WPs. In the BUTTERFLY LL case studies, from urban gardening, agriculture, subsistence farming and coastal heath restoration, among others, and in the comprehensive analyses in WP6, we will provide this gender-knowledgeable research and build tools to enhance and share these capacities.

### 1.2.6. Open science practices and data management

Open science practices are integral to ensuring our research is of the highest quality and responsive to evolving needs and constraints. Open Science in BUTTERFLY is tightly linked to its commitments to good ethical conduct and Responsible Research and Innovation. BUTTERFLY is committed to open data management practices, to be monitored and implemented in WP9 (Task 9.3) which involves the [Open Data UiB library team](#) that is dedicated to assisting researchers with adhering to FAIR (Findable, Accessible, Interoperable and Re-usable) principles.

BUTTERFLY will ensure that all participants adhere to FAIR practices. As part of our Open science and data management implementation plan, we will use the [European Open Science Cloud \(EOSC\)](#), a multi-disciplinary virtual environment which enables the storage, sharing, processing and reuse of digital research outputs following FAIR practices. EOSC will support the long-term legacy of BUTTERFLY-initiated research, through the preservation of unpublished project knowledge and data. This includes the data from the large-scale surveys on consumers' perception and willingness to pay for preserving the pollinators and pollination services (6 countries, 1000 to 1500 respondents per country) and the results from the Delphi surveys. BUTTERFLY's EuroAPPA portal will provide open access to all ecological data gathered in WP1. For BUTTERFLY's source code of software for the APIs and R packages (WP1) GitHub will be used as a repository for the archival of source code related to digital deliverables. We will also make use of platforms in consortium partners' home countries where de-identified social science data can be archived (e.g. the Norwegian Agency for Shared Services in Education and Research) to ensure transparency and reproducibility of our social science and humanities research in WP2, 4, 6 and 7.

All ecological data sets that BUTTERFLY will assemble, such as the plant-pollinator network information garnered from the literature review and field campaigns undertaken as part of WP1, will be archived on at least two open-access repositories, including the EOSC and another platform that specialises in biodiversity data. All ecological data sets archived by BUTTERFLY will adhere to the Darwin Core standard vocabulary (Wiczorek et al 2012) with a thorough description of the data generation process and its spatial, temporal, taxonomic, and thematic extent also adhering to current metadata standards, such as the Ecological Metadata Language standard. This ensures that the primary data sources are archived so that they are retrievable long after the project is completed (regardless of the status of EuroAPPA or its constituent databases), adhere to relevant standards to improve interoperability, and are visible to biodiversity data indexing services. In addition, we will improve the visibility of these datasets through the publication of the data through the Global Biodiversity Information Facility (GBIF) and the use of EuroAPPA as a web portal for all ecological deliverables, which will be integrated into the EU Pollinator Hub as well. Similarly, sequence data and their associated annotations generated from the genetic analysis conducted as part of task 1.2.2 will be deposited on an openly accessible sequence database (such as GenBank).

BUTTERFLY's multi-actor approach invites a diverse set of actors (WP7) to co-create knowledge and solutions, stimulating creativity and trust in the research outputs. BUTTERFLY researchers share new knowledge and data with relevant actors as early in the research process as possible to ensure beneficiaries, particularly the at-risk sectors, benefit from outcomes and learning as it emerges. Beyond BUTTERFLY, the consortium will actively share data and outputs with other initiatives (§1.2.2), including EU-funded projects. We acknowledge that effective knowledge exchange between initiatives can avoid duplicative or unnecessarily competing efforts and instead foster a collaborative culture of effective pollinator restoration research for impact. All scientific publications will be open access and freely available, and we will retain the copyright of all published materials (§1.2.7).

Question: What is the relationship between EuroAPPA and the Data Management plan planning activities?

Noa - First, we need an internal (within BUTTERFLY partners) review of data needs and production. Laura may want to ask the partners (via the WP Leaders or tasks) what data they'd need (use) and deliver (produce), then ask an outsider to review.

Cala - let's add Data Management to the agenda of kick-off meeting in April

Jorrit - Is the Butterfly "Description of Action" Part B planned to be openly accessible?

Jeroen - Currently, not, but this can be revisited as a consortium.

Noa- Suggests to poll this decision to open access "Butterfly Description of Action Part B" in the kickoff meeting agenda.

Jeroen hints at publishing parts of the "Butterfly Description of Action Part B" separately.

Jorrit - could be published in parts, with the promise to publish it all when everyone is ready.

Claus- LL meeting later in December about field protocols and standardized data collection (this can link back to Data Management Plan (DMP))

Noa - Would it be an idea to create an internal data review board (Jorrit: what data would be under review? field data? Any data generated by the project) within BUTTERFLY to help keep track of FAIRness and data quality. The concept of FAIR will be agreed in practice within the group. (Jorrit: I think we need to define what we mean by "FAIR" - I'd prefer being specific e.g., show 2 examples of how your data was reused.)

Jeff: Need to have two time points before the peer review: prior to data collection and at the point of data collation.

Jorrit - He reviewed the DOPI source code and documentation (thanks for sharing).

Code is tightly connected to data, but the data reviewed is incomplete; both need to be analysed together (code + data). DOPI uses stack technologies (PHP + MariaDB + WordPress) - common technologies used by many so it is versatile in terms of the people that eventually would need to deal with the system. Software development practices are old-school - challenges for other developers to work with code (ideally, version control systems (e.g., GitHub or others) would be used, but this seems not to be the case?). Even the code would require some improvement in its FAIRness, documentation, version control, etc.

It should be easy to fix current problems with large databases by avoiding the current path of saving before processing.

Proposes review of data, code and tools.

Proposes to get a common vocabulary and standards for revisions

Jeroen - Tom Breeze (VALOR coordinator) wants to meet in January to discuss data sharing.

Possibility for Tom and the WP leaders relevant to data to meet the discussion group.

#### **IDEAS FROM TODAY TO BE INCLUDED IN BUTTERFLY:**

- **DMP that includes the view of all the partners**
- **Create a Data peer-review board**
- **Agree on a common vocabulary and standards for revisions**
- **Peer-review data, but also code**
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**2024-11-05 (third meeting)**

#### **Participants**

Cala, Jorrit, Jeff, Laura, Nick, Joe

agenda (tentative)

1. introductions
2. first steps for building the platform including the FAIR aspects that Noa mentioned after the last meeting
3. update on DoPI (Nick/Cala)
4. update on GloBI (Jorrit)
5. update on EU Pollinator Hub (Noa)

Cala - question - Do we have clear data management plans for data collection, for example Living Labs? How does this relate to FAIR?

Laura - In BUTTERFLY proposal: plan was to make the plan.

Joe - I am about to teach a course on Open Science/ FAIR data - Findable Accessible Interoperable Reuse - applicable standards - DwC-A - we are writing packages to facilitate R packages to make them "FAIR" . Make sure to "package" data in a way to make them FAIR. <https://github.com/LivingNorway/LivingNorwayR> - Is the package I was referring to. We have a replacement package that is coming out very soon though that allows for packaging datasets using *any* controlled vocabulary and not just Darwin Core though. I'd be really happy to implement the plant-pollinator vocabulary.

Jeff- specific vocabulary for plant-pollinator interactions - good starting point for DoPI

Here it is: <https://ppi.rebipp.org.br/>

The WorldFAIR reports can be downloaded from here:

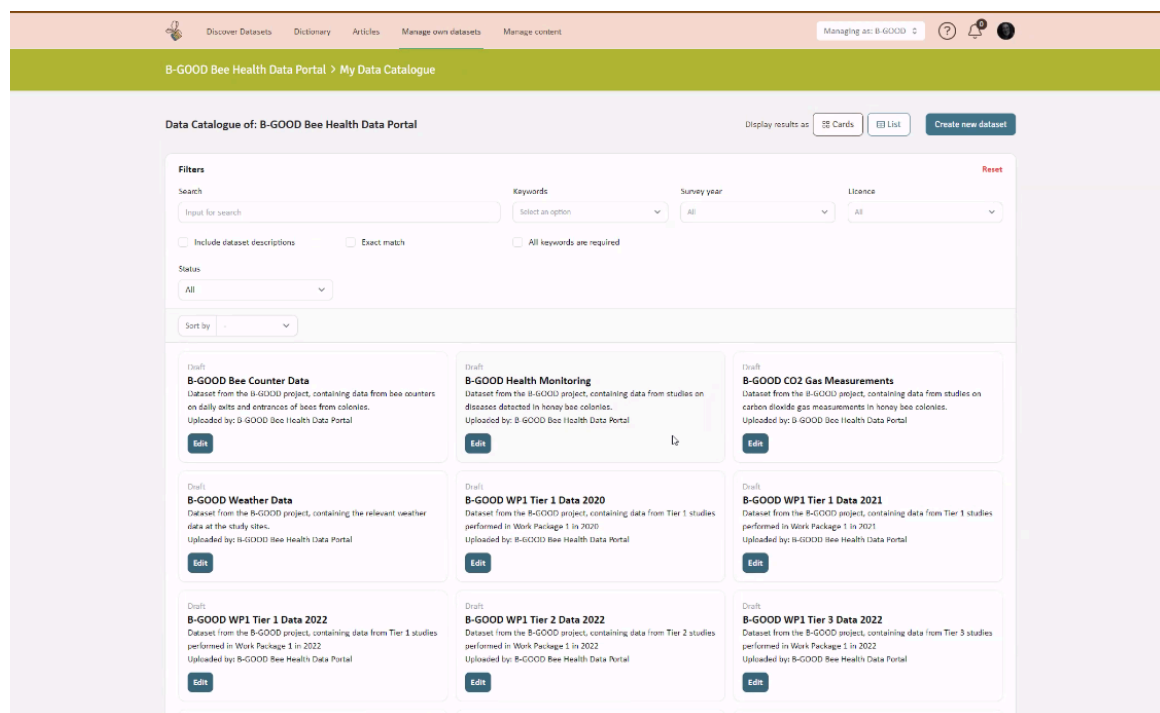
<https://worldfair-project.eu/agricultural-biodiversity/>

Jorrit - in my view, the most important part of FAIR is the last letter "R" - data review where data review is a first demonstration of data reuse, that should be done by someone who did not collect the data. I suggest data reviews from day 1

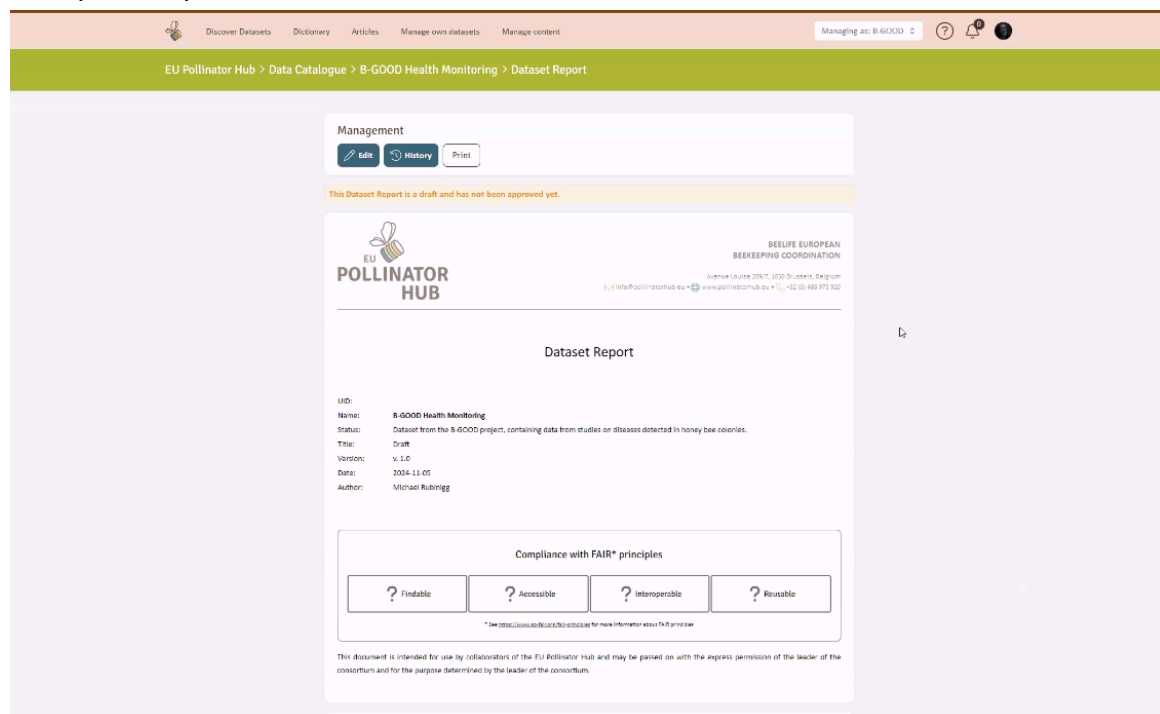
Noa - I think the best would be to have a two entries to the FAIR principles: 1. train and request the partners about FAIR principles and how to build up databases and 2. peer review the datasets going out the be published in to FAIR principles.

In the EU Pollinator Hub we create machine generated reviews as well as human reviews.

Talking about EU Pollinator Hub integrating with B-Good Bee Health Monitoring.



example of report -



Cala- from DoPi's perspective, it would be a good investment of time to get LL leaders to agree early on about data collection formats, for internal sharing and for integration into open access repositories. Noa is part of the Data Management team.

Jorrit: status of GloBI <> EU Pollinator Hubs -

<https://github.com/globalbioticinteractions/globalbioticinteractions/issues/991>

Jorrit - showed an example of a review of Jeff's Apocynaceae paper:

<https://depot.globalbioticinteractions.org/reviews/globalbioticinteractions/pollinators-of-apocynaceae-database/>

also one for DoPI: <https://depot.globalbioticinteractions.org/reviews/globalbioticinteractions/dopi/>

Nick- DoPI update: new small funding grant from Eva Crane bee charity will fund Nick (for new data analysis) and web developer to update import and export so DoPI can handle the large datasets expected from BUTTERFLY (and hopefully PropPollSoil).

Jorrit offers to take a look at DoPI's code

Cala mentioned SafeGUARD and how their work is similar to DoPI

<https://github.com/globalbioticinteractions/globalbioticinteractions/issues/989>

Joe - will propose WP1 in-person meeting right before or after kick-off meeting in April (Jorrit will not be attending in person due to anniversary and other engagement).

DoPI<>GloBI - <https://github.com/globalbioticinteractions/dopi/> with make.sh being the script that grabs data and turns it into interactions.tsv .


All agree to do recurring monthly meetings first Tuesdays of each month at same time (2pm UK).

## **2024-08-28 (second meeting)**

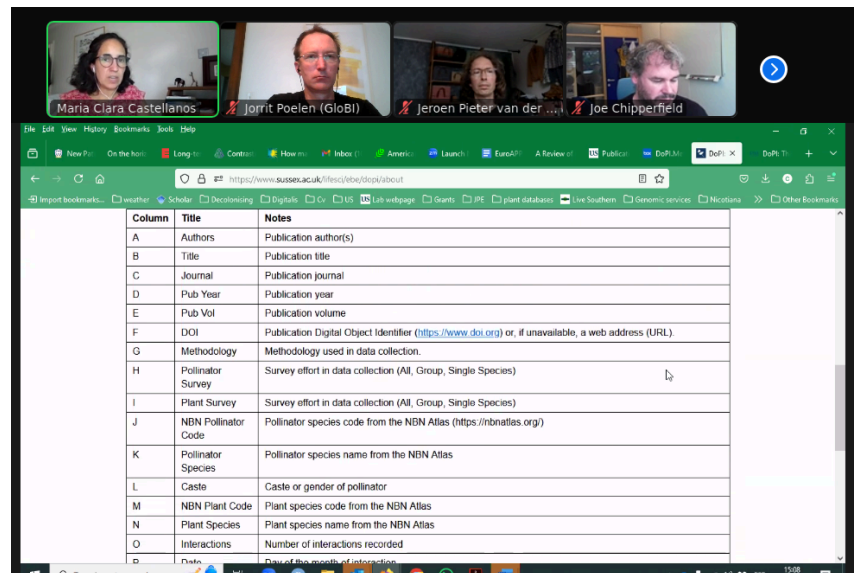
### **Participants**

Cala, Jorrit, Jeff, Noa, Jeroen, Claus, Joe

### **Notes**

- Jorrit - presentation of [GloBI](#) functionalities and how to use it in BUTTERFLY + vision for EuroAPPA
  -  BallroomA\_Tuesday\_1700\_Poelen (reused from 2017) as presented at Poelen, J., 2017. Global Biotic Interactions: A Catalyst for Integrating Existing Interaction Datasets, Connecting Data Curators and Developing Data Exchange Methods. Proceedings of TDWG, 1, p.e20214. Available at: <https://doi.org/10.3897/tdwgproceedings.1.20214>.

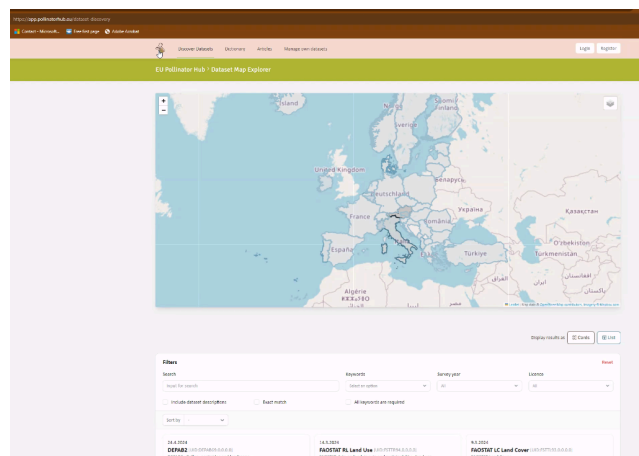
- Review paper created by bots in GloBI
  - <https://depot.globalbioticinteractions.org/reviews/Extended-Bee-Network/bee-interaction-database/>
  - Q. from Joe: Is there any scope in GloBI's current data model for placing estimates of the strength of the relationship? So that "eats" in this example could be qualified (sort of like "sometimes eats", "rarely eats").
  - A. from Jorrit: not easy, better to keep the original data linked to GloBI.
  - A. from Jeff: It's challenging because the strength of interactions can vary a lot in space and time.
  - Q. from Noa: Is this a manual or automatic review? A. from Jorrit: Automated, but "nudged" by a human.
- Cala - presentation of [DoPI](#) functionalities and how to use it in BUTTERFLY + vision for EuroAPPA
    - hired a bunch of students to process datasets of scientific quality data.
    - every single data point has been entered manually with to DoPI schema specifically designed for pollination interactions



Column	Title	Notes
A	Authors	Publication author(s)
B	Title	Publication title
C	Journal	Publication journal
D	Pub Year	Publication year
E	Pub Vol	Publication volume
F	DOI	Publication Digital Object Identifier ( <a href="https://www.doi.org">https://www.doi.org</a> ) or, if unavailable, a web address (URL).
G	Methodology	Methodology used in data collection.
H	Pollinator Survey	Survey effort in data collection (All, Group, Single Species)
I	Plant Survey	Survey effort in data collection (All, Group, Single Species)
J	NBN Pollinator Code	Pollinator species code from the NBN Atlas ( <a href="https://nbnatlas.org/">https://nbnatlas.org/</a> )
K	Pollinator Species	Pollinator species name from the NBN Atlas
L	Caste	Caste or gender of pollinator
M	NBN Plant Code	Plant species code from the NBN Atlas
N	Plant Species	Plant species name from the NBN Atlas
O	Interactions	Number of interactions recorded
P	Day of the month of interaction	

- every taxonomic name is linked to a name identifier, so that information can be looked up on a separate website
- strength of interactions ~ quality of the datapoint (visit vs. flower visitation vs pollen seen on insect etc) expressed in various levels 1-5.
- data in spreadsheets and databases
- uses "simple" web technologies - <https://en.wikipedia.org/wiki/MySQL> with a web interface
- workflow spreadsheets -> mysql -> web interface
- possible for folks to submit their data for inclusion in DoPI

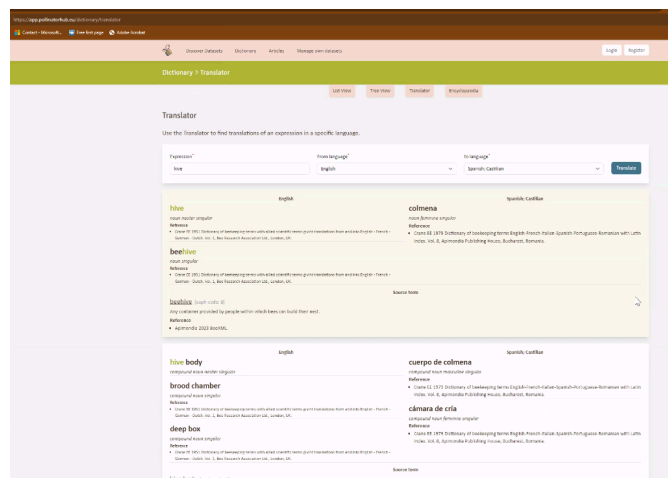
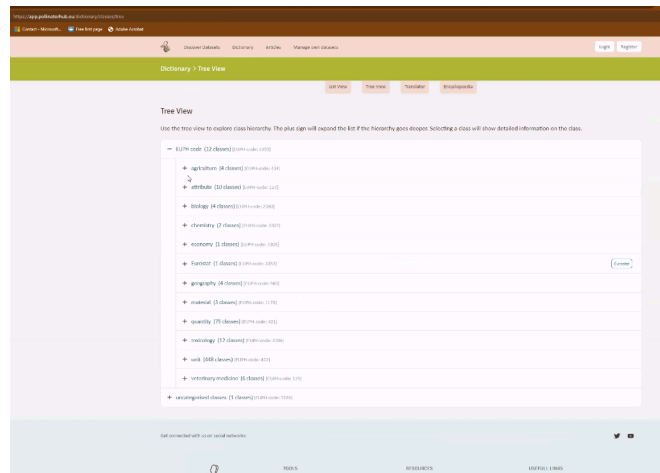
- Balfour, N.J., Castellanos M.C., Goulson, D., Philippides, A. & Johnson, C. (2022) DoPI: The Database of Pollinator Interactions. Ecology, e3801. <https://doi.org/10.1002/ecy.3801>
- working with "computer engineer" to help improve DoPI
- Jorrit Asks: where do you keep the original data - Cala Answer: Sussex hosts DoPI websites as well as the original spreadsheets.
- Noa - how do you manage to make the DoPI data FAIR - what is your protocol for including data in DoPI? How do you assess the datasets for their FAIR-ness? - Cala Answer: Most datasets are published and openly available. We tried to include each datapoint published in a scientific dataset.
  - Noa - how to best reuse tables / datasets in publications - some additional metadata is sometimes needed to fully understand the data? - Cala: we categorized the "quality" of the pollination interaction (see above).
- Claus - every time I move data, I often introduce errors or mistakes.
- Jorrit - There is a need to keep track of all the processing we do from data in datasets when we reuse them for other things.
- Noa - presentation of [EU Pollinator Hub](https://pollinatorhub.eu/) functionalities and how to use it in BUTTERFLY + vision for EuroAPPA (10 minutes)
  - Presentation page: <https://pollinatorhub.eu/>
  - Data Platform: <https://app.pollinatorhub.eu/>
  - BeeXML Standard for data sharing: <https://beexml.org/>
  - Notes:
    - Pollinator Hub is an infrastructure that aims to bring datasets together - scope: integrating any data related to pollinators, pollination, bees and beekeepers.



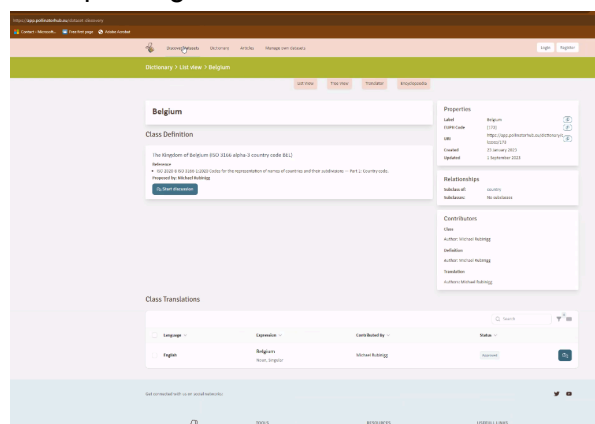
- data is coming from many different sources academics, industry, field experts, and community scientists with very different ways of expressing and collecting the data
- create a dictionary to help standardize data integration and classify specific concerns. This dictionary also helps to translate the terms into different languages (CSV, JSON, XML). The dictionary is a community resource.



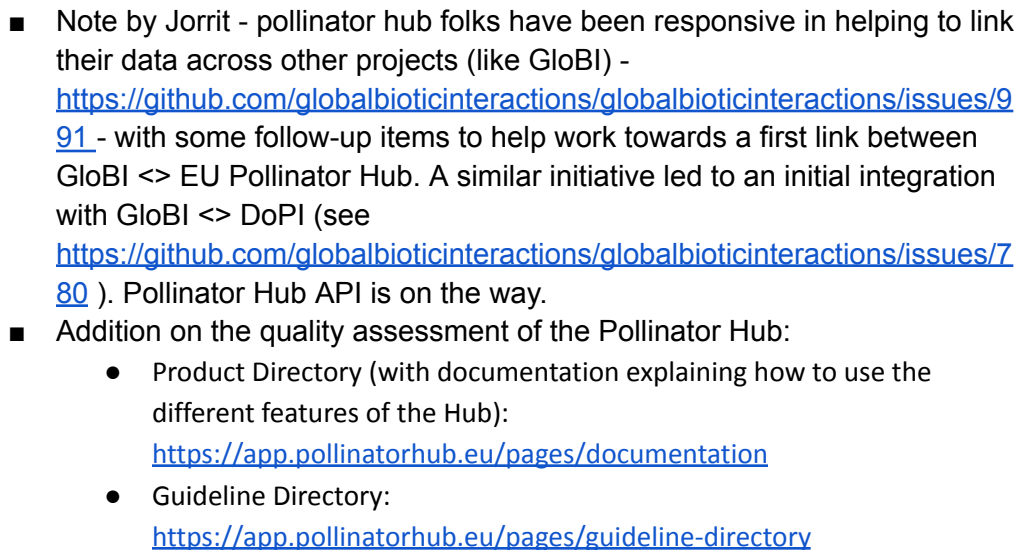
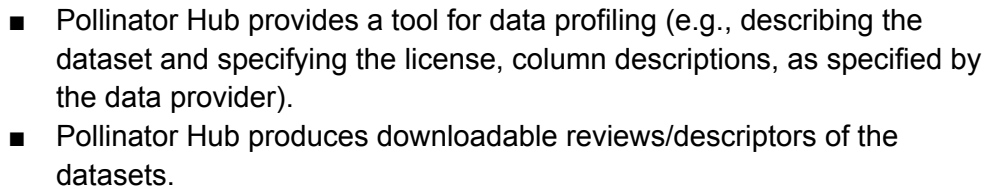
- the Hub is an open-source community tool with collaboration features like working in close teams, discussions etc.



- Whenever we see overlapping concepts, an associated descriptor is created in the Pollinator Hub dictionary. These descriptors help to link datasets and their records that use these concepts. Example: below for concept "Belgium"



- Some datasets are open access, and the provider decides how to publish the dataset (open / closed, liscence, etc. ).



- Quality Asset Directory (Including the SOPs, WIs and Methods):  
<https://app.pollinatorhub.eu/pages/sop-directory>
- Criteria Catalogue: <https://app.pollinatorhub.eu/pages/criteria-catalog>

### **Commonalities of the three platforms (and teams behind them):**

We all agree that we care about data sharing and data quality

We all aim to preserve the original data

And be able to review data - this implies comparing datasets and therefore having them in common categories

### **Jeroen:**

Quality of the data has three angles:

- Quality of the data itself
- Assessment of the quality of the data
- Attributes of the data and their quality

For next meeting:

- List of the other components that will need to be in EuroAPPA beyond datasets (eg. code, model results, maps, any other results of the project and beyond) (20 minutes)

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## **EuroAPPA Meeting 2024-07-01 (first meeting)**

### **Notes**

#### **Participants**

Cala, Jorrit, Jeff, Noa, Jeroen, Claus, Joe

#### **Agenda**

- Discuss existing EU hubs on pollinators
- Ideas on how we can approach the one-stop-shop pollinator information hub to suggest to VALOR

#### **Action Items**

(Noa) check on the availability of BeeLife overview of the EU pollinator project

(Jorrit, done) setup EuroAPPA GloBI project page

<https://www.globalbioticinteractions.org/euroappa/> include Butterfly 24 partners. In addition, make a list of related initiatives shared in this meeting. A place where everything is linked.

(Cala) create poll using <https://framadate.org/abc/en/> or similar for the internal BUTTERFLY/EuroAPPA meeting in late August, propose an agenda, etc. Tentative points for the late August meeting Agenda:

- Jorrit - presentation of GloBI functionalities and how to use it in BUTTERFLY + vision for EuroAPPA
- Cala (+Nick) - presentation of DOPI functionalities and how to use it in BUTTERFLY + vision for EuroAPPA
- Noa - presentation of EU Pollinator functionalities and how to use it in BUTTERFLY + vision for EuroAPPA
- Other visions of EuroAPPA?
- List of the other components that will need to be in EuroAPPA beyond datasets (eg. code, model results, maps, any other results of the project and beyond)
- Other points:
  - decide when/if to propose a meeting with VALOR pollinator hub team

(TBD) - organise a meeting to find a way to deal with data sharing among BUTTERFLY members and (potentially) with other non-POLLINATOR projects within the project(s) like VALOR etc - close to project start (December/January).

## Notes

Cala - [SafeHub](#) derived from SafeGuard, involves folks from VALOR. Pensoft is developing the SafeHub infrastructure. Pensoft has received funding from various EU projects to develop. Cala is editor in chief for Journal of Pollination Ecology and was approached by Pensoft with a business proposal and rejected their offer.

Think this got shared in previous emails already but here is the Safeguard web page:

<https://www.safeguard.biozentrum.uni-wuerzburg.de/Project/SafeHub.aspx>

Noa - BeeLife developed the EU Pollinator Hub for the EFSA (European Food Safety Authority). EFSA is the owner but has not committed to long-term maintenance. It aims to bring together all pollinator data that can be used for example pesticide risk assessment. ECHA (European Chemicals Agency) will use the same framework for chemical risk assessment. Used as a repository with data curation.

Pollinator Hub is in contact with SafeHub. Not linked to any specific project, but is used by many.

Simon Potts

Noa - suggested not developing anything new, but reusing existing.

Jorrit - suggests a sustainability model where we use EuroAPPA as an opportunity to provide links to all existing resources and certify that the resources (data, websites, etc) are standardized, movable, reusable and transferable (give them a “sticker” confirming this)

Jeff - let EuroAPPA focus on plant pollinator interactions. Looking at all of this, DOPI and GloBI stand out because they deal with INTERACTIONS, not just "pollinators", and provide important resources for the pollinators, and the pollinators that service the plants.

Joe - three different components - (1) mobilizing existing data (2) collecting raw data (3) processing datasets into model output (data synthesis). Our very specific BUTTERFLY use-case-driven "one-stop shop" (EuroAPPA) should enable the distribution of the data and the model results. We need the functionality and can reuse existing initiatives when needed.

Noa - Questions:

- Do we have any software developers in the team? Jorrit +
- How will we share the data among the 24 partners during the project in a standardised way? (daily data-sharing work) - The EU Pollinator Hub allows this team to work on datasets.
- about modelling - How will we present the outcome of the modelling efforts in a reusable way?

List of Various Initiatives

1. EU Pollinator Hub / EFSA owns it  
<https://github.com/globalbioticinteractions/globalbioticinteractions/issues/991>
2. SafeGuard <https://github.com/globalbioticinteractions/globalbioticinteractions/issues/989>
3. EU Pollinator Information Hive
4. Simon Potts keeps a website links to various initiatives
6. BeeLife keeps track of everything pollinator-related in the EU (Noa to check available)
7. Leon Marshall's project ("Beeconnected: decoding interactions in space and time through predictive ecology") <https://www.nwo.nl/en/projects/viveni222141>
8. B-Good - <https://b-good-project.eu/>
9. PoshBee - <https://poshbee.eu/>
10. EUPoMS - <https://wikis.ec.europa.eu/pages/viewpage.action?pageId=23462107>
11. eBMS - <https://butterfly-monitoring.net/>
12. Nordic Pollinator Project - coordinated by KEMI
13. STEP
14. SUPER-B
15. B-THENET
16. BeSafeBeeHoney
17. iPOL-ERA
18. Better-B
19. ApiGuards -
20. WorldFAIR - <https://worldfair-project.eu/agricultural-biodiversity/>
21. PollinERA - <https://pollinera-horizon.eu/> + WildPosh - <https://wildposh.eu/>
22. VALOR + BUTTERFLY

- 23. Pollinator Academy - <https://pollinatoracademy.eu/>
- 24. COLOSS
- 25. SURPASS - <https://bee-surpass.org/>
- 26. RestPoll - <https://restpoll.eu/>

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from Simon Potts website

- **Safeguard**: Safeguarding European wild pollinators
- **DRUID**: Drivers and Repercussions of UK Insect Declines (NERC)
- **EU-PoMS**: Design of the European Pollinator Monitoring Scheme (EU DG ENV)
- **EuropaBON**: Europa Biodiversity Observation Network: integrating data streams to support policy (EU H2020)
- **PoshBee**: Pan-European Assessment, Monitoring, and Mitigation of Stressors on the Health of Bees (EC H2020)
- **Showcase**: Showcasing synergies between agriculture, biodiversity and ecosystem services to help farmers capitalising on native biodiversity (EU H2020)
- **SMOOPS**: Sustainable Management of Orchard Pollination Services (BBSRC/NERC, Syngenta, Avalon and Worldwide Fruit)
- **SPRING**: Supporting Pollinator Recovery through Indicators and Monitoring (DG ENV)
- **ORBIT**: Developing resources for European bee inventory and taxonomy (DG ENV)
- BBSRC **Waitrose Collaborative Training Partnership** (Reading lead)
- **PMRP** Pollinator Monitoring and Research Partnership (Defra, JNCC, the Welsh Government, Scottish Government and project partners)
- **Tropical**: Translating Research Opportunities to enhance Pollination benefits to economically Important Crops And improve Livelihoods (GCRF)
- **SuperFarm**: Sustainable farming through effective pollination and pest regulation in India (GCRF)
- RestPoll: Restoring Pollinator habitats across European agricultural landscapes based on multi-actor participatory approaches (Horizon EU)
- WildPosh: Pan European assessment, monitoring, and mitigation of chemical stressors on the health of wild pollinators (Horizon EU)
- **MAMBO**: Modern Approaches to the Monitoring of Biodiversity (Horizon EU)

- **STING**: Science and Technology for Pollinating Insect0073
- Nature positive finance (NERC)

#### **Recently completed Projects:**

- **STEP**: Status and Trends of European Pollinators (Coordinator, EU Framework 7)
- **LIBERATION** - Linking farmland biodiversity to ecosystem services for effective ecological intensification (EU FP7)
- **SCALES**: Securing the Conservation of biodiversity across Administrative Levels and spatial, temporal, and Ecological Scales (EU Framework 7)
- **SUPER-B** - Sustainable Pollination in Europe (EU COST Action)
- **NPPMF** - National Pollinator and Pollination Service Monitoring Framework (Defra)
- **Crop pollination**: Sustainable Pollination services for UK Crops (Insect Pollinator Initiative project, RCUK)
- **AgriLand**: Linking agriculture and land use change to pollinator populations (Insect Pollinator Initiative project, RCUK)
- **Urban Pollinators**: Urban Pollinators: their ecology and conservation (Insect Pollinator Initiative project, RCUK)
- Landscape food webs: structure and function (NERC)
- **Closing the gap**: bigger, healthier, and better-connected hedgerows (Green Recovery Challenge Fund)
- **Resilient Pollination**: Modelling Landscapes for Resilient Pollination Services (BBSRC Global Food Security)
- Optimising multifunctional land-use decisions: combining environmental, economic and social models for pollinators (NERC)
- Economic benefits of pollination to global food systems: Evidence and knowledge gaps (NERC)