SPRING - Strengthening Pollinator Recovery through Indicators and monitoring

Final Report
2024

THE REPORT SHOULD BE CITED AS FOLLOWS
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Contents

Executive Summary

The SPRING project supports the development of an EU Pollinator Monitoring Scheme. It comprises tasks on evaluating the potential of pollinator Citizen Science, development of butterfly monitoring schemes across the EU, piloting pan traps and transects methods for sampling pollinating insects in the field, evaluating the potential of malaise traps and light traps for sampling wider insect biodiversity and moths respectively.

A provisional network of Butterfly Monitoring Schemes across the EU was completed during this project. This includes support for schemes in Lithuania, Greece, Romania, Latvia, Denmark and Slovakia - mainly on the basis of trained volunteer observers, provision of identification guides and support for coordinators in each Member State. An update to the European Grassland Butterfly indicator was completed and shows a linear decline of 32% in the EU-27 and 36% in Europe from 1990-2020. All Butterfly Monitoring Schemes in Europe were supported by this project through provision of guidance and promotional material, including workshops to share experience and best practices between schemes. Technical tools to support butterfly monitoring communities (website and the ButterflyCount mobile application) were enhanced in response to user feedback, e.g. updates to species lists, improved reports and data downloads and translations. The tools support 36 Butterfly Monitoring Schemes in 30 countries - including 27 EU Member States - and has resulted in 9122 active butterfly transects (i.e. walked in the last two years) for the European continent. In total, around 10,000 volunteers have participated in the eBMS network, providing valuable butterfly monitoring data during all the monitoring years. We updated the Grassland Butterfly Index which was published by as an EEA SEBI 027 indicator, as well as in the EU Biodiversity Strategy Dashboard on the Knowledge Centre for Biodiversity website and Eurostat's 2024 SDG report.

We undertook an audit of methods for pollinator monitoring with Citizen Science. We assessed numerous pollinator Citizen Science projects (from searches of websites and academic papers, and public elicitation) and assessed variation in their methodologies using multivariate statistics. Overall, 75% of pollinator Citizen Science projects focussed on recording pollinators (e.g. butterfly monitoring), 20% focussed on interactions (e.g. focal flower counts like FIT Counts) and 5% focussed on pollination (e.g. level of seed set for insect pollinated plants). We developed a public survey gaining 321 responses from experts in pollinators and/or Citizen Science in 35 European countries about factors and barriers supporting Citizen Science. We found that the support for Citizen Science (based on assessment of the overall rating of pollinator Citizen Science, factors supporting Citizen Science, and barriers) was strongly related to affluence (as measured by Gross National Income). Based on our analysis and experience during the SPRING project we recommend regionally specific ways to support pollinator Citizen Science in different countries.

We developed training materials through a didactical framework, in support of capacity building for pollinator species identification and field sampling. We ran 27 courses during 2022 and 2023, covering all regions of the EU, aimed at participants with a basic or intermediate level of expertise. Courses were adapted to local conditions by translating materials as required. Over 250 participants attended, and the courses received high marks (>90%) through formal evaluation. In collaboration with leading taxonomic experts in bee and hoverfly identification, and in collaboration with the ORBIT and TAXOFLY projects, we ran 17 courses in advanced identification skills for pollinating insects. Over 120 people attended the courses. We developed a large body of material to support capacity building for an EU Pollinator Monitoring Scheme and designed an approach to the development of knowledge and capacity towards a pollinator monitoring scheme for the EU. A Pollinator Academy website was developed to consolidate all training and capacity building material developed during this project.

We piloted pollinator monitoring methods to inform the design of an EU Pollinator Monitoring Scheme. Based on recommendations of the STING expert group (Potts et al. 2021) we tested pan trap and transect sampling across the EU, surveying 231 sites in 15 countries and over 1100 separate days in the field. Over all surveys we collected data on 527 bee, 224 butterfly and 197 hoverfly taxa. At the level of individual field sampling occasion, there was considerable variability in the diversity and abundance of pollinating insects. This represents variability between sites, differences over time (across the season and between years) and differences between bioclimatic regions of the EU. For bees and hoverflies from pan traps, the overall average diversity was 7 to 10 species and 2 to 3 species respectively. The average number of individual insects was 30 bees and 8 hoverflies. Guidance was made available to support surveys and included specifications for building and spraying pan traps, survey protocols for all methods (pan traps, transects, flower and habitat assessments), field recording forms and guidance of entering data via an online data entry system. Data from field surveys was made available to the STING project and experts.

To evaluate the potential of pan traps for pollinator monitoring, we reviewed the impact of floral resources on sampling efficiency. We developed a conceptual framework for the relationship between pollinator abundance and local floral resource, and how this could affect the abundance of sampled insects in scenarios of competition between flowering plants and pan traps. We collated available data to model these relationships, including 14 studies across Europe. After filtering we analysed 11 datasets for pan traps (covering Spain, Greece, UK and The Netherlands) and 4 for transects (covering Romania, The Netherlands, Serbia and the UK). For both pan traps and transects, wild bee abundance initially increased with increasing flower density, peaked and then decreased. The relationship between flower density and abundance of wild bees from transects peaked at high flower densities (e.g. for mass flowing crops), whereas for pan traps the peak was at markedly lower flower densities. This suggests a strong dilution effect for pan traps due to competition between pan traps and flowers. We therefore recommend that the EU Pollinator Monitoring Scheme should focus on transects as the primary sampling method.

We piloted additional sampling methods for pollinating insects: light trapping for moths and malaise trapping for wider insect biodiversity. Moth sampling was tested at 253 locations in five countries (Germany, Hungary, Netherlands, Spain, Sweden) using a cost-effective and portable light trap. A manual and field protocol were produced to support the wider adoption of this sampling method. The ButterflyCount mobile application was extended to capture data from moth traps, including the use of AI image classifiers to support species identification by non-experts. Results from the pilot were encouraging for the abundance and diversity of moths sampled and the practical feasibility of applying the sampling approach across EU Member States.

We developed standardised guidance for the use of Malaise traps and metabarcoding to support pollinator monitoring, and tested Malaise traps in 20 locations (13, 5 and 2 sites in Germany, Hungary and Greece respectively) alongside pan traps. Total insect richness was an order of magnitude lower in pan traps compared to Malaise traps, with ~10-20 taxa and ~400-600 average richness respectively. However, for pollinator richness the two methods were similar, although some species were unique to one or other sampling method. Malaise traps have potential to wider the taxonomic scope of insect sampling within a monitoring scheme, and are recommended as a method to complement but not replace pan traps or transects.

The results of the SPRING project have been communicated to a range of audiences through in-person and online events, including a final conference held in January 2024. Project outputs such as field sampling protocols, training materials, datasets and recommendations have been shared with the Science and Technology for Pollinating Insects (STING) expert group.

The Nature Restoration Regulation requires capacity building and methodological piloting to enable Member States to implement effective monitoring schemes for pollinating insects. The SPRING project has made a major contribution to developing Citizen Science best practice (for butterflies and other pollinators), building capacity through extensive training materials, piloting a range of field methods such as transects, pan traps, light traps and malaise traps that sample all the main groups of pollinating insects (bees, butterflies, hoverflies, moths). The results of the SPRING project have been communicated widely to Member State stakeholders and have contributed directly to the work of the STING expert group reports.

0 Introduction and overall aims of the project

The general objective of the project was to strengthen taxonomic capacity in EU Member States with regard to pollinating insects, and support preparation for the implementation of the **EU Pollinator Monitoring Scheme** including building on the ABLE project on Citizen Science Citizen Science butterfly monitoring.

The EU Pollinator Monitoring Scheme (EU-PoMs) was proposed by the Science and Technology for pollinating Insects (STING) expert group (Potts et al. 2021) and comprises:

- Minimum Viable Scheme ('the MVS') - part of the Core Scheme
  - Pillar 1: Wild bees, butterflies and hoverflies (transect module)
  - Pillar 2: Wild bees and hoverflies (pan traps module)
- Complementary modules – part of the Core Scheme
  - Pillar 3: Rare & threatened species module
  - Pillar 4: Moths module (light traps)
- Additional modules
  - Pillar 5: Pollination services
  - Pillar 6: Flower visitors
  - Pillar 7: Wider insect biodiversity module (Malaise traps)

SPRING did devise and execute a series of tasks in line with the EU-PoMS proposal and as a major contribution to the EU Pollinators Initiative, which addresses the declines in pollinating insects[1] and helps reverse them in line with the targets in the EU Biodiversity Strategy (BDS) 2030[2].

SPRING links to complementary initiatives within the EU Pollinators Initiative, specifically:

- Science and Technology for pollinating Insects (STING);
- Taxonomic tools for an EU Pollinator Monitoring Scheme (Taxo-Fly, ORBIT);
- Horizon Europe research projects, including those under the biodiversity partnership;
- Assessment of taxonomic expertise in Europe – "European Red List" of Taxonomists
- European Red List of Bees, Butterflies, Hoverflies and Moths.

Our consortium for this proposal was integrated within all these activities, with experts contributing across all these projects. We worked with the Commission to co-operate and integrate work across projects, to maximise the potential to add value for mutual benefit and to collectively deliver the aspirations of the EU Pollinator Initiative, the EU BDS 2030 and the EU Green Deal.

The institution in charge of the overall management and coordination was the Helmholtz Centre for Environmental Research - UFZ, Germany. Professor Josef Settele, who is heading SPRING, is a global expert in biodiversity research and science-society-policy interactions. Professor Settele has successfully coordinated several large international research projects (e.g. ALARM within EU-FP6 with 68 partner organisations of 35 countries).

This final report details the work plan for the whole duration of the service contract. The SPRING project was **led and coordinated by UFZ**, and included **18 partners** as sub-contractors (see

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1531489288529&uri=CELEX:52018DC0395

[2] EU https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX:52020DC0380

Annex) and involved a wider group of experts across the EU. SPRING comprised the following 5 main tasks and 8 sub-tasks with an overall budget of €5m. The chapter numbers of the present report correspond to these tasks and subtasks, as do the chapter numbers of the Annex (indicated with an “A” before the number).

- ■ Task 1: Expansion of eBMS and Citizen Science networks on pollinators.
- ☐ 1.1 Expand European Butterfly Monitoring Scheme
- ☐ 1.2 Build up Citizen Science networks on pollinators

- ■ Task 2: Taxonomic capacity building.
- ☐ 2.1 Organise basic taxonomic training
- ☐ 2.2 Organise advanced taxonomic training

- ■ Task 3: Piloting a Minimum Viable Scheme (MVS) in EU.
- ☐ 3.1 Support pilots in EU Member States
- ☐ 3.2 Support the refinement of the MVS methodology

- ■ Task 4: Testing complementary and additional modules.
- ☐ 4.1 Testing the moths module
- ☐ 4.2 Testing the wider insect biodiversity module

- ■ Task 5: Communication

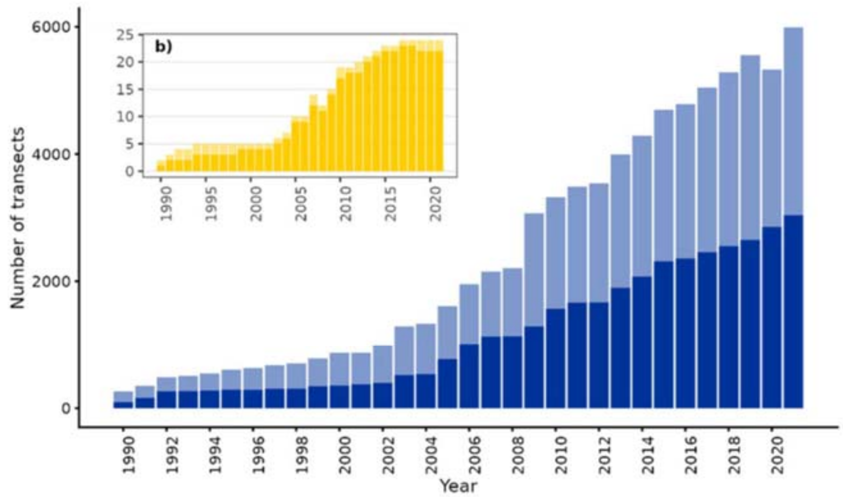
Specific information on the governance of SPRING and the subcontractors involved can be found in Annex Chapter A0.

1 Expansion of eBMS and CS networks on pollinators

1.1 Expand the European Butterfly Monitoring Scheme (eBMS)

1.1.1 Background

Following the completion of the ABLE ("Assessing ButterfLies in Europe") Parliamentary Pilot Project in 2021, the eBMS (European Butterfly Monitoring Schemes) network covered 36 Butterfly Monitoring Schemes in 30 countries - including 21 EU Member States (see Figures 1.1 & 1.2). Figure 1.1a shows the growth in the number of transects monitored each year since 1990 to nearly 6000 transects in 2021. These transects are walked frequently by volunteers through the butterfly season and the identity and abundance of butterfly species are recorded in the eBMS central database, covering a great part of the continent.



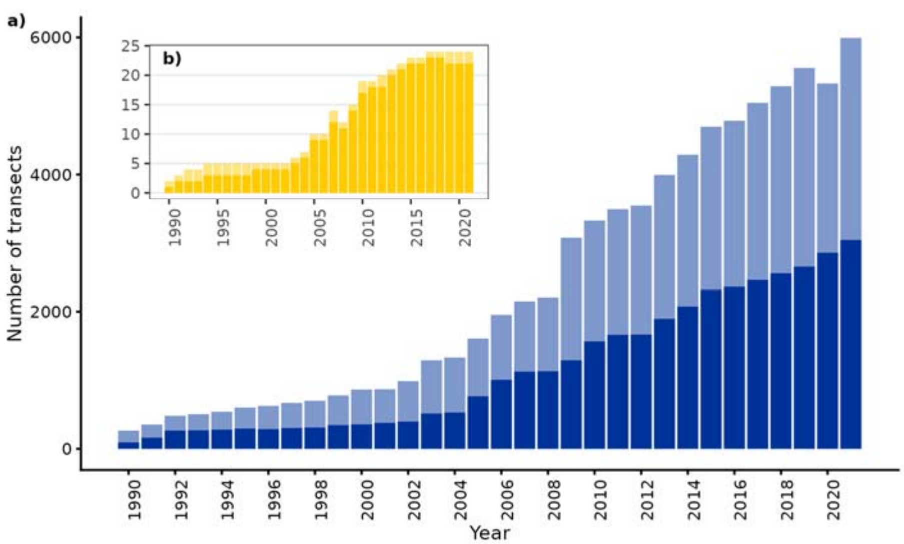


Figure 1.1. Number of transects (main figure = a) and number of Butterfly Monitoring Schemes (inset = b) in Europe. Solid bars are numbers in EU Countries; pale bars include non-EU countries in Europe

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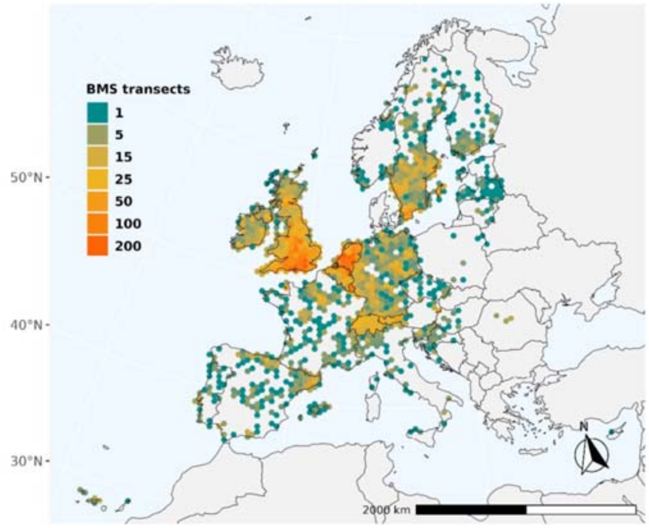

Figure 1.2. Map of the density of Butterfly Monitoring Scheme transects per 50km grid square, collated in the eBMS database v5.0.

The SPRING Parliamentary Preparatory Action Project aimed to complete the network across the EU, covering the missing 6 countries and providing more support on the East of Europe.

1.1.2 Work under the SPRING project

Butterfly Conservation Europe and partners have continued to expand the eBMS and the number of Butterfly Monitoring Schemes (BMS) established in Europe, **completing, by the end of 2023, the network of the 27 EU Member States with a running BMS** (Fig. 1.3).

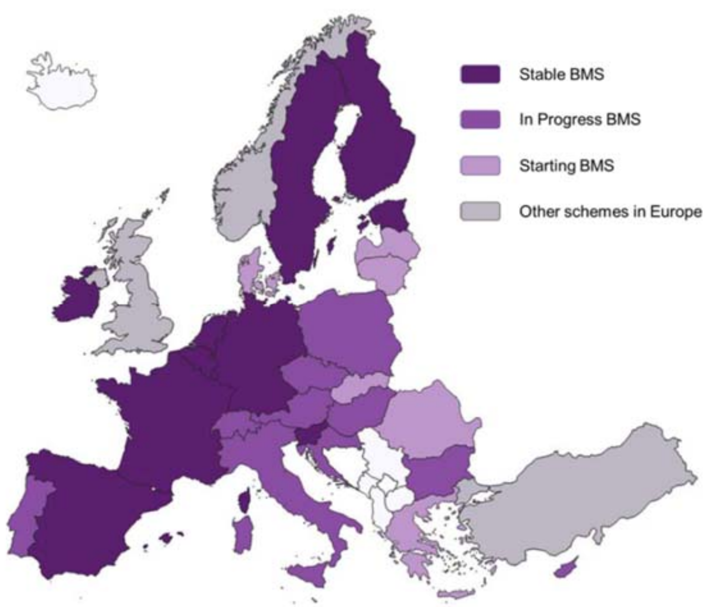

Figure 1.3. Status of the Butterfly Monitoring Schemes in Europe, purple colors for EU countries and different development by color intensity.

The project has succeeded in setting up BMS in the six remaining EU countries - Lithuania, Greece, Romania, Latvia, Denmark and Slovakia - mainly on the basis of trained volunteer observers and reporters through identifying and supporting new 6 coordinators in these Member States.

These countries are now part of the eBMS system, collecting butterfly monitoring data through the online recording facility, using the butterfly-monitoring.net website and the updated Butterfly Count App, which was initially developed in the ABLE project. These tools facilitate easy data sharing, direct from the field to the European database, managed by the SPRING project partner's expert Centre for Ecology and Hydrology. Both new records and previously collected data (e.g. from Greece) have been uploaded to the database, extending the coverage of butterfly abundance to include transects in all EU Member States.

The SPRING project established six new BMS. Further support was provided to the 10 BMS set up in the ABLE project, including recruitment of volunteers and set up of new butterfly transects in these countries. In addition, to the approximately 6000 transects walked in existing schemes in 2021, partners have added around **300 new transects (=sites) and recorded butterfly abundances** during the SPRING project into the eBMS online platform (website; www.butterfly-monitoring.net) (Fig. 1.4). Existing BMS and new schemes set up during SPRING had created new transects and recorded them every year providing valuable monitoring data and consolidating the schemes.

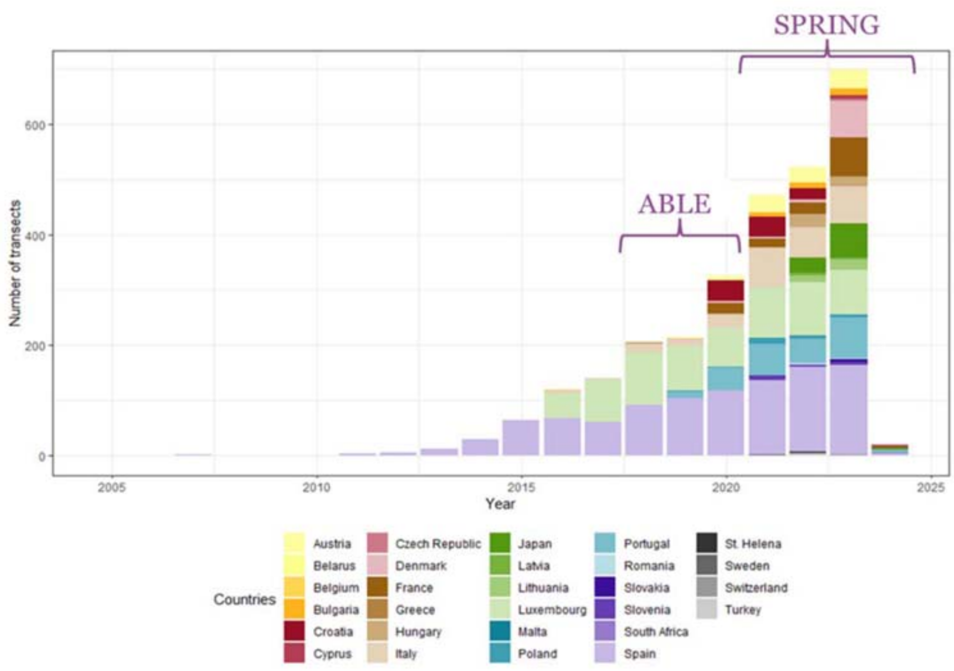

Figure 1.4. Number of active transects on eBMS website through the years and the length of the two European projects: ABLE and SPRING.

We have **provided materials** (butterfly nets, flyers, buttons) and new training resources to help with species identification. We have produced 13 new targeted field guides for EU countries or regions, in national or regional languages covering the species most likely to be seen there. We have also worked with Task 2 to include butterfly information in the online Pollinator Academy.

We have provided coordinators with translation tools and information materials (see Annex A5.1 for links and download options for materials). The eBMS website, the app and other materials have been translated into 22 languages, including regional and national languages of the EU. The eBMS website (butterfly-monitoring.net) and mobile application (ButterflyCount) have been improved in functionality (e.g. refined data capture) and content (e.g. improved inclusion of local names, translated content) throughout the project in response to feedback from Butterfly Monitoring Scheme coordinators and users.

Partners, with support of the EU coordinator, have run 22 workshops and seminars, both online and face-to-face. These have been organised to promote butterfly monitoring, disseminate knowledge and consolidate the networks of butterfly volunteers which are essential for long-term monitoring. Regular meetings and training events have been run with coordinators to increase their skills in outreach to volunteers, data management, translation, use of eBMS system, calculation of trends and reports to Member States.

We carried out a major update of the **European Grassland Butterfly Indicator**, with the addition of two years (2019 and 2020) of monitoring data from Butterfly Monitoring Schemes across Europe (Fig. 1.5). The Indicator is the combined population trend of 17 selected grassland species monitored across Europe and calculated from population trends estimated for the whole European region or restricted to the 27 EU Member States. The indicator spans years between 1990 and 2020. The indicator and species trends have been reviewed by the 25 contributory monitoring schemes (from 23 countries). The indicator accounts for increases in monitoring locations and uneven coverage across Europe (van Swaay et al. 2022[3]).

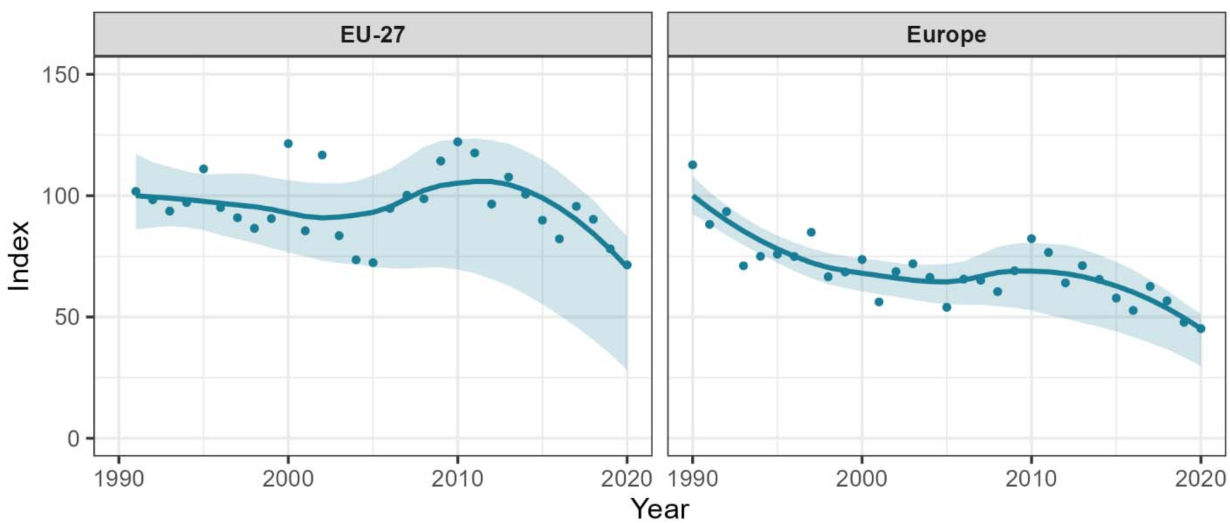

Figure 1.5. European Grassland Butterfly Indicator 1999 - 2020 for EU-27 and Europe. Shaded areas represent 95% confidence intervals.

[3] Van Swaay, C.A.M., Dennis, E.B., Schmucki, R., Sevilleja, C.G., Arnberg, H., Åström, S., Balalaikins, M., Barea-Azcón, J.M. , Bonelli, S., Botham, M., Cancela, J.P., Collins, S., De Flores, M., Dapporto, L., Dopagne, C., Dziekanska, I., Escobés, R., Faltynek Fric, Z., Fernández-García, J.M., Fontaine, B., Glogovčan, P., Gracianteparaluceta, A., Harpke, A., Harrower, C., Heliölä, J., Houard, X., Judge, M., Kolev, Z., Komac, B., Kühn, E., Kuussaari, M., Lang, A., Lysaght, L., Maes, D., McGowan,D., Mestdagh, X., Middlebrook, I., Monasterio, Y., Monteiro, E., Munguira, M.L., Musche, M., Olivares, F.J., Õunap, E., Ozden, O., Pavlíčko, A., Pendl, M., Pettersson, L.B., Rákosy, L., Roth, T., Rüdisser, J., Šašić, M., Scalercio, S., Settele, J., , Sielezniew, M., Sobczyk-Moran, G., Stefanescu, C., Švitra, G., Szabadfalvi, A., Tiitsaar, A., Titeux, N., Tzirkalli, E., Ubach, A., Verovnik, R., Vray, S., Warren, M.S., Wynhoff, I., & Roy, D.B. (2022). European Grassland Butterfly Indicator 1990-2020 Technical report. Butterfly Conservation Europe & SPRING/eBMS (www.butterfly-monitoring.net) & Vlinderstichting report VS2022.039.

The eBMS team has been coordinating with colleagues from other SPRING tasks and taxa, in particular at SPRING meetings, as well as liaising with BMS coordinators from different countries to support the development of EUPoMS involving butterflies and other pollinators.

This task has been developed and delivered in **close cooperation** with Task 1.2 (see chapter 1.2), where eBMS coordinators have shared their experiences of how to increase Citizen Science volunteering, including extending it to cover other wild insect pollinators i.e. bees, hoverflies and moths. We contributed new identification and training materials to colleagues delivering Task 2 (chapter 2). Butterfly Conservation Europe (BCE) and many individual BMS coordinators worked with national and regional leads for Task 3 (chapter 3), trialling the Minimum Viable Scheme (MVS) - walking the transects for butterflies. The integration of eBMS data into the overall pollinator monitoring framework has to be seen and taken forward in STING. We also worked closely with Task 4.1 (chapter 4.1), sharing experience for the development of coordinated, high-quality, cost-effective Citizen Science moth monitoring in Europe, which can be rolled out across the EU.

Specific updates on further activities for the expansion of the European Butterfly Monitoring Scheme can be found in Annex 1.1 (A1.1) and links to downloadable documentation in Annex 5 (A5.1).

1.1.4 Recommendations

- **Ensure integration of eBMS** data in future development of framework for **EU Pollinator Monitoring Scheme (EUPoMS)** to enrich the data available and increase the representativity of butterfly monitoring transects cost effectively across the EU.

- **Secure ongoing support for EU level coordination**, by BCE, of Butterfly Monitoring Schemes to ensure continued reporting of Indicators, repeated application of standardised approaches across all EU Member States, coordinated and cost-effective training, knowledge sharing, high quality data management and data sharing and future development and sustainability of the eBMS network.

- **Grow eBMS schemes further** and support the update of butterfly indicators for the EU Biodiversity Strategy 2023 Dashboard and the EU Sustainable Development Indicators.

- **Member States supporting coordinators of long established BMS schemes in their countries to share their experiences and encourage other Member States** to provide financial support for their BMS. This is vital for those coordinators who are currently volunteers, to enable them to continue to expand the schemes in their country. Schemes need to be on a sustainable pathway, so additional data to underpin indicators can be gathered and results shared in future years.

- **All Member States to make good use of butterfly abundance monitoring results** from the eBMS schemes to help them comply, cost effectively, with a variety of biodiversity reporting requirements under EU and International obligations. These include the EU Nature Restoration Regulation, implementation of the revised EU Pollinators Initiative – A New Deal for Pollinators and evaluation of EU sectoral policies, especially in agriculture, forestry, urban and rural development.

1.2 Building capacity for Citizen Science networks on pollinators

Based on the work undertaken in the SPRING project, two journal papers are at an advanced stage of development at the time of the drafting of the final reporting: (1) a paper on the landscape of Citizen Science; (2) a paper on the barriers and opportunities for pollinator Citizen Science in the EU. These are now near finalisation and the main results are summarized in Annex 1.2.

During the SPRING project, BCE and Dutch Butterfly Conservation have been encouraging the **establishment of moth monitoring sites by volunteers across Europe**. The strategy focuses on different approaches to secure moth monitoring done by volunteers in a long-term in Europe (see Annex A1.2 for more details).

1. Build on the learning and feedback from the moth pilot in Task 4.1 and share it with eBMS coordinators.
2. Support eBMS coordinators to reach out to interested volunteers to set out standardised moth traps, and share LED-traps of moths with them.
3. Produce and translate guidance of the moth LED trap demonstrating how the trap could be assembled by individuals, do the collection of records and submit records to the European platform.
4. Bring together an initial network of expert moth taxonomists who would be willing to act as validators of AI identified photographic images.
5. Translate the App ButterflyCount for moth monitoring into more languages and encourage volunteers to share photos via the App to improve the identification across the EU.
6. Share the experience in the Netherlands of working with farmers and farmer organisations more widely to encourage farmer participation in moth monitoring on more farm sites.
7. Encourage the EU and MSs to recognise the increasing evidence of moths as important pollinators and to provide resources for increasing moth taxonomic expertise, coordination of standardised moth monitoring and use of moth monitoring results in policy evaluation and in their action plans to reverse the declines in pollinators and recovery of the habitats they depend on.

Recommendations for Citizen Science capacity building

Based on a survey of Pollinator Citizen Science approaches, comprising 304 responses from 37 countries, we found that there could be opportunity to explore further the use of Citizen Science in assessing pollination, especially since it links directly to an ecosystem service. We found that although most projects are designed for the ‘general public’, there is opportunity to explore further the use of Citizen Science for specific target audiences, so that they can be tailored to the motivations and needs of these groups.

Overall, the methods audit revealed the huge diversity of methods used in pollinator Citizen Science. While consistent methods rolled out over large scales (e.g. eBMS and FIT Counts) are incredibly valuable, it is valuable to consider the portfolio of methods available for different Citizen Science audiences to meet multiple needs for standardised monitoring, scientific research, public engagement and evaluating impacts of local action.

We found that the support for Citizen Science (based on assessment of the overall rating of pollinator Citizen Science - Fig. A1.11 in Annex), factors supporting , and barriers (Fig. A1.12 in Annex) were strongly related to affluence. Based on our analysis and experience during the SPRING project, we reached the following conclusions for supporting pollinator Citizen Science across Europe:

- Countries are different, so we will need to be **regionally specific** in our aspirations and the way we support pollinator Citizen Science in different countries.
- It is valuable to **continue to invest** in countries with well-established Citizen Science because they can be testbeds for innovation, and deliver of scientific excellence (e.g. attributing causality of trends) via their Citizen Science.
- **Identify 'easy wins'** for expanding pollinator Citizen Science in countries that have attributes making them ready to grow their Citizen Science.
- In countries that do not yet have strong support for Citizen Science, it is valuable to **invest in individuals/communities who are early adopters and enablers.**
- Consider **'designing for the margins'** in places where uptake of current approaches is low. It may be appropriate to consider different methodologies for monitoring with Citizen Science in these places to complement monitoring elsewhere in Europe.

Specifically, for the moth monitoring, it is recommended that the monitoring protocol, which has been successfully tested in several MS during SPRING, is included as a core component of the next phase of the EUPoMS and rolled out across Member States as soon as possible.

To facilitate this, resources are needed to support EU level coordination and help strengthen networking among volunteer and professional experts doing moth monitoring. Especially, to extend expertise in those Member States where there is less taxonomic expertise on moths.
Production of the simple standardised moth traps proven to be effective in the SPRING project should be stepped up and distribution extended further.
To help ensure high quality moth identification across the whole of the EU through AI two actions should be prioritised:

1. the network of expert validators for moth identification should be strengthened and
2. the collation of more photographs of moths from Mediterranean, Eastern and Central European countries should be organised to speed up and enhance the learning of the AI and increase the moth image reference library. The collation of these images and their review would be facilitated by dedicated engagement in these regions.

2 Taxonomic capacity building

Key activities, outputs and recommendations for Task 2.1 and 2.2
A detailed account of the activities within this task can be found in Annex A2, with specific information on the tasks on which the following summary statements are based.

1. SPRING developed an **integrated, international training programme** to increase and mobilise taxonomic knowledge on bees, hoverflies and butterflies. The training curriculum consisted of **5 types of courses** covering all three taxonomic groups and a large range of knowledge levels, and resulted in a total of 44 courses being organized for more than 520 students, most of whom were subsequently deployed in various roles in the SPRING monitoring programme. (**All Subtasks**)
2. The SPRING project proved that it is possible to set up a successful **joint European taxonomic training curriculum**. International cooperation and the exchange of knowledge and specialists proved essential to offer high-quality courses in all regions. Since still not all regions have the expertise to train a new generation of specialists, international cooperation is expected to remain an important part of a capacity building strategy. (**Subtask** 2.2.8, 2.2.10)
3. **Course logistics**. The SPRING courses were planned and organised centrally and in close consultation with the local partners, striking a balance between regional needs and joint standardisation, e.g. in terms of time of year, duration, recruitment, numbers of trainers and trainees, material requirements, et cetera. Based on the experiences from the training programme the course logistics were summarised in a manual, the *Playbook for Organizing Taxonomy Courses for Pollinators,* with universal guidelines, tips and a generic budget overview. The *Playbook*, as well as the SPRING course curriculum and other training resources, are available at the Pollinator Academy website for trainers, following registration.(**Subtask** 2.1.2, 2.1.7, 2.1.8, 2.1.10, 2.2.1-2.2.7)
4. **Alignment with the research approach**. A central mission of the SPRING project was to test different research approaches in practice. Variables included the taxonomic groups covered, the audience group(s) employed, and the requirements imposed on workers; these requirements in turn depended on the research methods and level of taxonomic resolution chosen in the monitoring programme (the MVS). To be able to facilitate this varied approach, the training curriculum, as summarized in the *SPRING course curriculum,* was accordingly varied. Future refinements, and possibly a narrower focus on advanced taxonomy, may be possible once the definitive monitoring approach and level of taxonomic resolution have been decided upon. (**Subtask** 2.1.2, 2.1.10, 2.2.1)
5. **Alignment with regional needs and conditions**. Regional differences in biodiversity, available tools for identification, and logistical preconditions made that the content of individual courses had to be carefully aligned to regional circumstances. The content of the individual courses was determined, tested and fine-tuned in consultation with trainers and local partners. Descriptions of typical course outlines can be found in the *SPRING course curriculum*. Further investments in the development of training materials at a national level would be advisable to close the remaining gap in expertise and resources (also see the Gap Analysis, 2.2.8). (**Subtask** 2.1.2, 2.1.10, 2.2.1)
6. SPRING provided **didactic support** to the specialists who designed and delivered the courses, both preceding the courses and afterwards. Standardised feedback from trainees

and trainers was part of this, and in the second training season (winter 2022-'23), adjustments were made based on previous experiences. Setting clear goals and entry level requirements, together with a good balance between theoretical knowledge transfer and hands-on exercises, were some of the main determinants for a successful course. Not all specialists had a didactic background and guidance in this area was generally welcomed and well used. Didactic support is summarized in *SPRING Tips & tricks for course design* and *SPRING Some important notes on Learning Goals*. In a follow-up programme it is recommended to continue offering didactic support to trainers. (**Subtask** 2.1.3, 2.1.10)

7. SPRING developed a training specifically with **instructions to execute the standardized Minimal Viable Scheme protocol (MVS)** for setting up and managing field sites. It was found that, while an actual field visit provided the best approach, the required knowledge could also be transferred through a webinar or a multilingual e-learning such as was developed for the online Pollinator Academy. An annual refresher helped guarantee the quality of fieldwork and data collected. (**Subtask** 2.1.2, 2.1.4)
8. **Volunteer observers** (citizen scientists) turned out to be highly committed to the project in several national monitoring schemes (this despite the relatively high intensity and complexity of the fieldwork, which in the literature is usually considered a barrier). As professed by the participants, the training courses were an important way of building this level of commitment. The level of knowledge of volunteers was usually considerably lower than that of professionals and thus imposed limitations on the maximum achievable quality of the data collected. Effective deployment of volunteers will have to be tailor-made and will depend on the chosen research objectives and methods. In some cases, a careful mix of professional and volunteer monitoring could be an effective solution. (**Subtask** 2.1.4, 2.2.8)
9. **Gap analysis**. In collaboration with DG Environment, SPRING developed a survey for governments and specialists from the European Member States to get a better overview at the national level of available human capacity, infrastructure, and taxonomic tools for the identification of bees, hoverflies, butterflies and moths. As part of this exercise, SPRING developed a framework for a future European Pollinator Monitoring Scheme, mapping the desired states, infrastructure, and stakeholder community (Fig. 2.2.8.A). Causes beyond the control of the consortium prevented the project from completing of the survey and the associated Gap Analysis during the project. At the time of writing, essential information is still lacking; observations and recommendations on this point are therefore to some extent conditional. (**Subtask** 2.2.8)
10. **Identification tools**. SPRING developed a framework that gives an overview of identification tools that can be used for different levels of knowledge. Such tools are often specific to a country or region and as such not yet available everywhere. For bees and hoverflies, SPRING made available **European identification keys up to genus level for bees and hoverflies**. These keys were designed to be suitable for efficient translation into other European languages, to meet a need felt within the consortium. **Field guides and traditional keys** for identification of bees and hoverflies down to species level are not yet available in all European Member States; this still imposes limitations on the possibilities for training and identification work (for butterflies, however, the necessary identification tools are usually available). The European taxonomic projects **ORBIT** and **TaxoFly**, with which SPRING collaborated, are working on online databases of species factsheets that will partly fill this gap. There is an additional need for identification keys to species level for several genera. (**Subtask** 2.1.4, 2.1.6, 2.1.9, 2.2.2, 2.2.4)
11. For citizen scientists and novice researchers SPRING developed a **regional multi-access key** and a **regional search chart for hoverflies**. These tools were developed in such a way

that they can serve as blueprints for other European regions. For an operational **multi-access key up to genus level for bees**, cooperation was sought with **IDmyBee** (while for butterflies such tools are usually already available). **Search charts for** so-called **morpho groups** (large groups of species, defined by easily recognizable characteristics) were also developed. These enabled inexperienced observers to count pollinators in the field with little knowledge but have the disadvantage that the taxonomic resolution is very low. This approach has some potential to provide important additional data and engage a wider audience, but it is not expected to be part of the recommended standard monitoring programme. (**Subtask** 2.1.4, 2.1.9, 2.2.2)

12. **Innovative tools: image recognition for pollinators**. SPRING set out to further develop the availability and functionality of AI image recognition for pollinators at a European level. In consultation with SPRING, Observation International's app **ObsIdentify** was made available throughout Europe. In an autonomous development, the NIA, the image recognition model developed by Naturalis and working in the background at ObsIdentify, was further expanded and improved geographically through collaboration with new partners. Together with Observation International and Naturalis, the possibility of further increasing the quality of identifications through a geographical filter was explored. An exploratory investigation showed that the approach envisaged by SPRING would yield no substantial gains, but a more advanced solution has since been found for the NIA that will give the desired improvements. A major bottleneck for the training of the NIA at the European level is the availability of reliably identified observations (i.e. photographs), and therefore the number of expert validators volunteering to do such identifications. SPRING supported the expansion of the validator community for pollinators by tapping into its own networks for bees, hoverflies, butterflies and moths, and by providing online training for prospective validators. In addition, existing databases of reliable observations were mapped to facilitate future inclusion in the NIA's image database. Apps such as ObsIdentify and Pl@ntnet, incidentally, are also ready to use tools for identifying flowering plants in the vegetation mapping around pan traps; their use in fieldwork was encouraged. (**Subtask** 2.1.5)
13. SPRING developed **e-learnings** for efficient knowledge transfer, on the one hand to provide low-threshold taxonomic knowledge for a wide audience, and on the other hand to guarantee a universal entry level and reference materials for partakers of taxonomy courses. The e-learnings, which are offered on the Pollinator Academy, give an impression of the possibilities; all kinds of future extensions are possible. While it is clear that in-person training will continue to be indispensable, it is expected that the burden on future trainers could be reduced by the further expansion of e-learnings on selected topics. (**Subtask** 2.1.9, 2.2.4)
14. **International, online exchange of knowledge and tools**. SPRING actively promoted the international exchange of knowledge and tools. This proved to be an underused but promising way to efficiently scale up taxonomic knowledge in Europe (think, for example, of the translatable European keys for the genera of bees and hoverflies). To address the need for a central training and knowledge platform, SPRING launched the **Pollinator Academy** (https://pollinatoracademy.eu/), a website developed with, by and for the taxonomic community. The Pollinator Academy, which showcases how the international exchange of knowledge and tools can be fostered, is not yet a finished product. The active input and involvement of the knowledge community was crucial for its success; to ensure that it grows into a fully functioning platform, it is advisable to give the community co-ownership and control over its further development. (**Subtask** 2.1.9, 2.2.4)

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3 Piloting a Minimum Viable Scheme (MVS)

3.1 Support pilots in EU Member States

List of key stakeholders in Member States for network development (D3.1.7)

Throughout the project we were in contact with key stakeholders in Member States and exchanges took place frequently. The Commission has facilitated contacts with the authorities, but an important factor in their successful engagement will be the extent to which a pilot can be tailored to a particular Member State's needs and capacities. This will only be possible based on the outcomes of the present pilot elaborated within SPRING and further developed within STING.

A list of key stakeholders with whom we have been in exchange is presented in table 3.1.below, but given the manifold interactions it surely is far from complete, but shows in which countries we had higher levels of interactions than in others.

Table 3.1. List of key stakeholder organisations in Member States for network development

Member State	Key stakeholder Organisation
Austria	Environmental Protection Agency Vienna (Stadt Wien – Umweltschutz)
Austria	Natural History Museum, Vienna
Austria	Institut für Ökologie der Universität, Innsbruck
Austria	Umweltbundesamt
Belgium	Instituut voor Natuur- en Bosonderzoek (INBO)
Belgium	Royal Belgian Institute of Natural Sciences · Direction of Natural Environment
Bulgaria	Bulgarian Butterfly Monitoring Scheme
Bulgaria	National Museum of Natural History, Bulgarian Academy of Sciences
Bulgaria	Ministry of Environment and Water
Bulgaria	Institute of Biodiversity and Ecosystem Research – Bulgarian Academy of Sciences
Croatia	Ministry of Economy and Sustainable Development
Croatia	Croatian Natural History Museum
Czech Republic	Unit of International Conventions, Ministry of the Environment, Praha
Czech Republic	Faculty of Environmental Sciences, Czech University of Life Sciences, Praha
Czech Republic	Biology Centre AS CR, Ceske Budejovice
Denmark	Social-Ecological Systems Simulation Centre (SESS), Aarhus University
Finland	SYKE – Finnish Environment Institute
France	Institut d'Ecologie et des Sciences de l'Environnement, Paris
Germany	Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz, Bonn
Germany	Bundesamt für Naturschutz, Federal Agency of Nature Conservation
Germany	National Monitoring Centre for Biodiversity, Leipzig
Germany	Leipzig summt! – NGO
Germany	Landesamt für Umwelt Landwirtschaft und Geologie" (LfULG) in Saxony
Germany	Senckenberg – Leibniz Institution for Biodiversity and Earth System Research

Member State	Key stakeholder Organisation
Germany	Thünen Institute of Biodiversity, Braunschweig
Greece	Natural Environment and Climate Change Agency (NECCA), Ministry of Environment & Energy
Hungary	Butterfly monitoring Hungary, Hungarian Lepidoptera Society
Hungary	Ministry of Agriculture
Ireland	National Biodiversity Data Centre, Carriganore
Italy	CREA Consiglio per la ricerca in agricoltura e l'economia agraria
Italy	University of Turin
Latvia	Nature Conservation Agency of Latvia, Sigulda
Lithuania	STATE SERVICE FOR PROTECTED AREAS, Ministry of Environment
Lithuania	Nature Research Centre
Luxembourg	Wild pollinator monitoring programme Luxembourg, Luxembourg Institute of Science and Technology (LIST)
Malta	Environment and Resources Authority, ERA
Poland	Jagiellonian University, Kraków
Poland	Ministry of Climate and Environment
Portugal	Department of Life Sciences, University of Coimbra
Romania	Biodiversity Directorate, Ministry of Environment, Waters and Forests
Slovakia	Institute of Zoology, Slovak Academy of Sciences
Slovakia	Slovenská poľnohospodárska univerzita – SPU Nitra
Slovakia	Member of European Parliament
Slovakia	Koppert Biological Systems, R&D
Slovenia	Ministry of Environment and Spatial Planning, Nature Conservation Division, Ljubljana
Slovenia	University of Ljubljana
Slovenia	National Institute of Biology
Slovenia	Slovenian Forestry Institute
Slovenia	Sustainable Agriculture Division, Ministry of Agriculture, Forestry and Food, Ljubljana
Slovenia	SloBees – Pollinator Conservation Society of Slovenia, Škofja Loka
Spain	Grupo Tragsa – State-owned holding company Sociedad Estatal de Participaciones Industriales (SEPI). Madrid
Spain	CREAF (public research center dedicated to terrestrial ecology and territorial analysis)
Sweden	Lund University

Final field protocol manual available

The field protocol for the MVS was revised ahead of the 2023 field season, following feedback from experts within the pollinator community and based on experience of field pilots in 2022. There were two field protocols tested during 2023, depending on the capacity of regional partners and priorities to test elements of the survey design. The key difference between the two field protocols are the number and location of pan traps (e.g. 10 in 2022 vs 5 in 2023) and the taxonomic resolution of transect walks – counts for individual species for all groups (butterflies, bees, hoverflies; 2023 season) or counts for morphological groups for bees and hoverflies, with butterflies recorded to species level (2022 season).

The documents are available online (Minimum Viable Scheme protocols | Pollinator Monitoring (pollinator-monitoring.net)[4] and include:

- Pan trap specification and protocol for spraying with UV paint
- MVS survey protocol for pan traps, transects, flower and habitat assessments
- Guidance for the online data entry system
- Recording forms for pan traps (including flower and habitat assessments) and transects

This has enabled all field teams to undertake the survey and process specimens. Feedback on the manual was generally positive.

Online data entry system to support MVS

The online data system has been further developed and tested for efficient entry and reporting of data from the MVS. An online issue[5] tracker has been used to capture feedback on bugs and requests for additional functionality. The main enhancement in the latest reporting period has been extended functionality for transect data input to enable data to be entered for all protocols (e.g. including species level data from bees and hoverflies). Functionality has also been enhanced for data export – for individual recorders, regional co-ordinators and to enable data analysis.

MVS field data collected throughout the project

Overall, 231 sites were sampled (field data collection for both pan traps and transects) in 2022 and 2023 with over 1100 days in the field (Fig. 3.1).

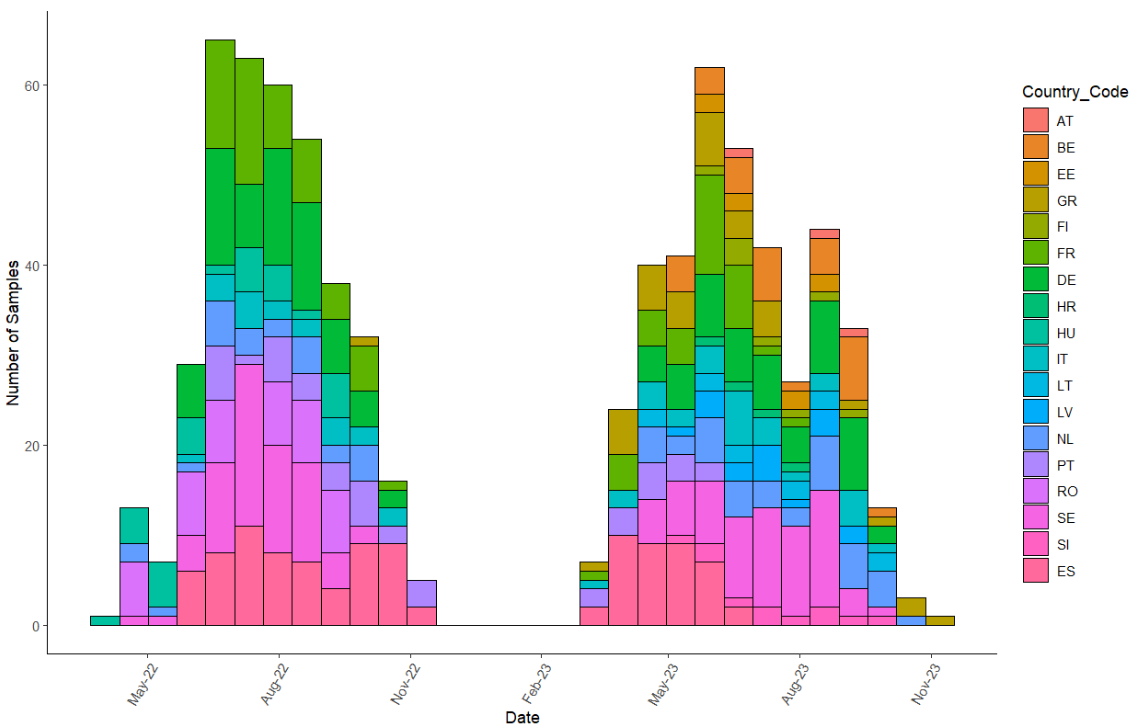

Figure 3.1. Samples (days of visits to field sites) by country over time.

[4] https://pollinator-monitoring.net/mvs-protocols
[5] https://github.com/BiologicalRecordsCentre/SPRING/issues

In terms of diversity of pollinators samples, over the whole network, 527 bee species, 224 butterflies and 197 hoverflies were recorded. Over 75,000 species occurrence records were collected (butterflies, bees, hoverflies, plants). Pan traps recorded higher overall diversity of pollinators (bees – Figure 3.2; hoverflies – Figure 3.3, although the sampling effort was higher for this method compared to transects.

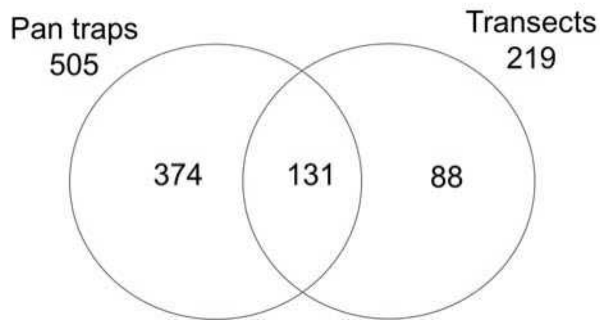

Figure 3.2. Venn diagram of bee species recorded via pan trap or transect sampling, or both.

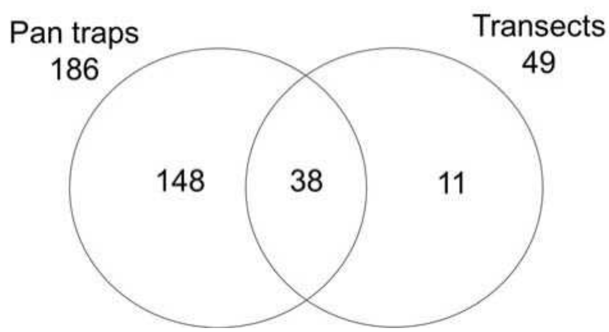

Figure 3.3. Venn diagram of hoverfly species recorded via pan trap or transect sampling, or both.

At the level of sampling events (e.g. visits to a site on a particular day), there is considerable variation in the diversity and abundance of pollinating insects. This includes variation between MVS sites, differences over time (across the season and between years) and overall differences between countries (EU Member States). The sampling protocols (e.g. length of transects, duration that pan traps were in the field) were standardised as far as possible to reduce variability. Mean abundance and species richness by taxon group (bee, hoverflies, butterflies) and country are given in the following summary tables (Table 3.2, Table 3.3).

Table 3.2a. Summary of bee data from pan trap samples. Including number of samples, average number of individuals(abundance) and average number of species (diversity) caught in (non-empty) pantraps by country.The data is organised by sampling occasion (all the non-empty pantraps deployed in the same site at the same date are pooled together).

Country_Code	Mean_Abundance	SD_Abundance	Mean_Diversity	SD_Diversity	Number of Samples
AT	14.66667	18.47521	4.666667	2.886751	3
BE	12.66667	11.61549	5.8	4.459782	30
EE	11.5	6.88684	6.875	3.522884	8
GR	18.44118	19.79163	4.088235	2.261236	34
FI	22.75	27.74244	8.375	7.366672	8
FR	19.14458	26.00663	7.831325	6.096419	83
DE	34.54867	72.29244	8.345133	6.796493	113
HR	21.25	2.629956	8	3.162278	4
HU	160.2	311.3633	15.76667	10.70831	30
IT	29.76596	35.26127	9.06383	6.19047	47
LT	24.58333	18.71537	10	5.410428	12
LV	22.3125	16.98124	10.875	6.417424	16
NL	23.56667	24.60079	6	3.746185	60
PT	21.19048	47.73925	5.523809	4.109704	42
RO	29.56098	38.70856	9.707317	5.230889	41
SE	9.75	15.44459	3.882812	3.485902	128
SI	18.81818	14.81093	9	4.449719	11
ES	27.12621	35.81042	9.145631	5.787762	103

Table 3.2b. Summary of hoverfly data from pan trap samples. Columns described as above.

Country_Code	Mean_Abundance	SD_Abundance	Mean_Diversity	SD_Diversity	Number of samples
AT	0	0	0	0	3
BE	6.566667	12.62369	2.7	2.743645	30
EE	3.125	5.356905	1.625	2.559994	8
GR	7.529412	32.6842	1.058823	1.229466	34
FI	23.875	29.28889	4.875	3.440826	8
FR	6.795181	18.6232	2.168675	2.788562	83
DE	6.982301	21.13265	1.902655	3.082104	113
HR	6.5	6.454972	2.75	3.095696	4
HU	3.3	5.754459	1.666667	1.582955	30
IT	0	0	0	0	47
LT	13.66667	22.31727	5.166667	4.041452	12

LV	8.25	10.49127	3.125	2.30579	16
NL	19.73333	43.62975	3.25	3.833947	60
PT	3.738095	4.768083	1.833333	1.480222	42
RO	7.121951	7.413485	3.463415	2.766745	41
SE	3.71875	5.252577	1.953125	1.939475	128
ES	5.990291	17.19011	1.466019	2.181992	103

Table 3.3a. Overview of the butterflies data from transects. Including number of samples, average number of individuals(abundance) and average number of species (diversity) recorded per transect by country.

Country_Code	Mean_Ab	SD_Ab	Mean_SPPR	SD_SPPR	Samples
AT	13.94	13.508	3.22	1.76462	50
BE	9.75	6.06218	3.41667	1.56428	12
BG	41.4524	37.4974	5.59524	4.26591	42
EE	9.16667	9.17424	4	2.75681	6
EL	20	28.6673	3.48485	2.76271	33
FI	15.6	18.2565	3.8	2.48998	5
FR	42.2235	52.6499	7.84706	4.43875	85
GE	36.93	50.4169	4.95	3.04304	100
HR	40.25	50.1489	6.25	4.272	4
HU	30.9649	39.2041	6.70175	5.0567	57
IT	23.6579	23.1392	5.02632	3.48345	38
MT	14.6	13.5908	4.6	2.17051	10
NL	13.94	13.508	3.22	1.76462	50
RO	37.4444	34.5745	9.44444	6.32656	36
PT	16.5833	15.0663	4.02778	2.70962	36
SE	12.2542	18.1975	3.32203	2.89969	118
SP	24.1966	35.6598	6.25641	6.21338	117

Summary

The SPRING pilots have gained huge experience in the whole process of monitoring pollinating insects. The resulting data has been supplied to the STING expert group to support sampling design options informed by power analysis. During SPRING pilots, data has been collected to assess the potential costs of an EU Pollinator Monitoring Scheme. The SPRING project team is hugely grateful to the substantial contribution of volunteers to field sampling.

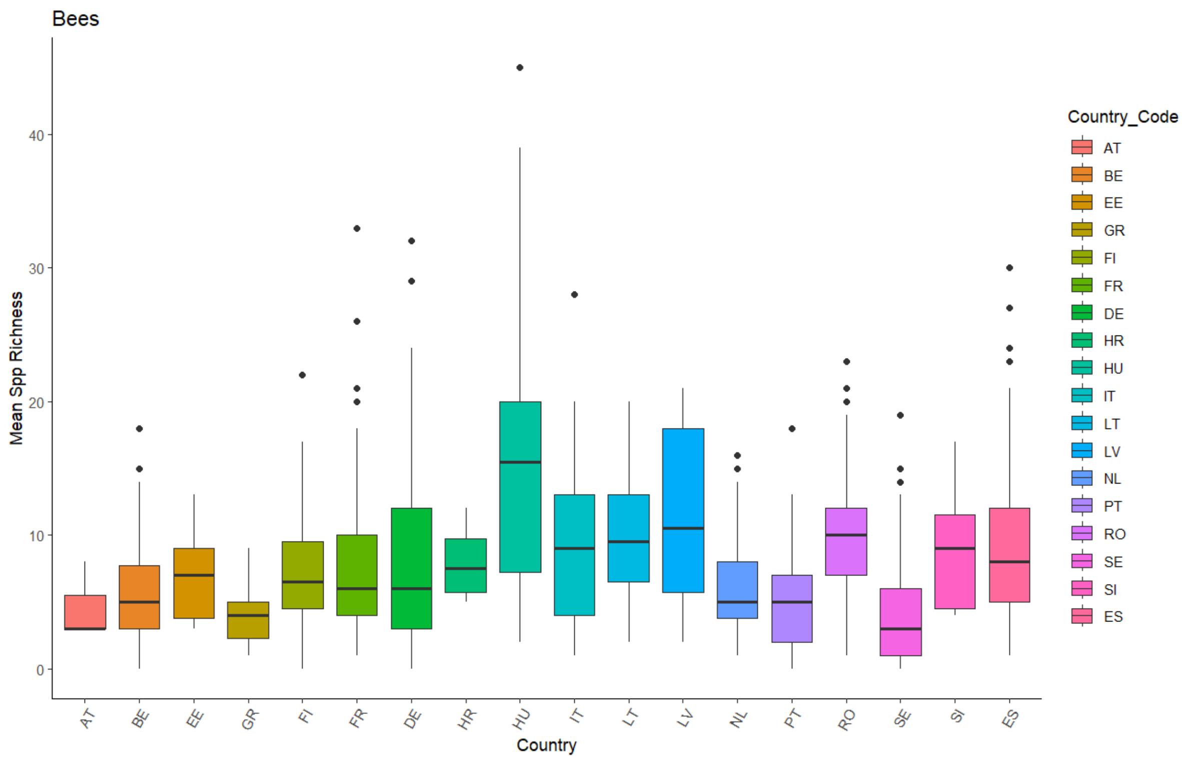

Figure 3.4. Species richness of bees per sampling occasion for pan traps (summed over all pan traps deployed per site).

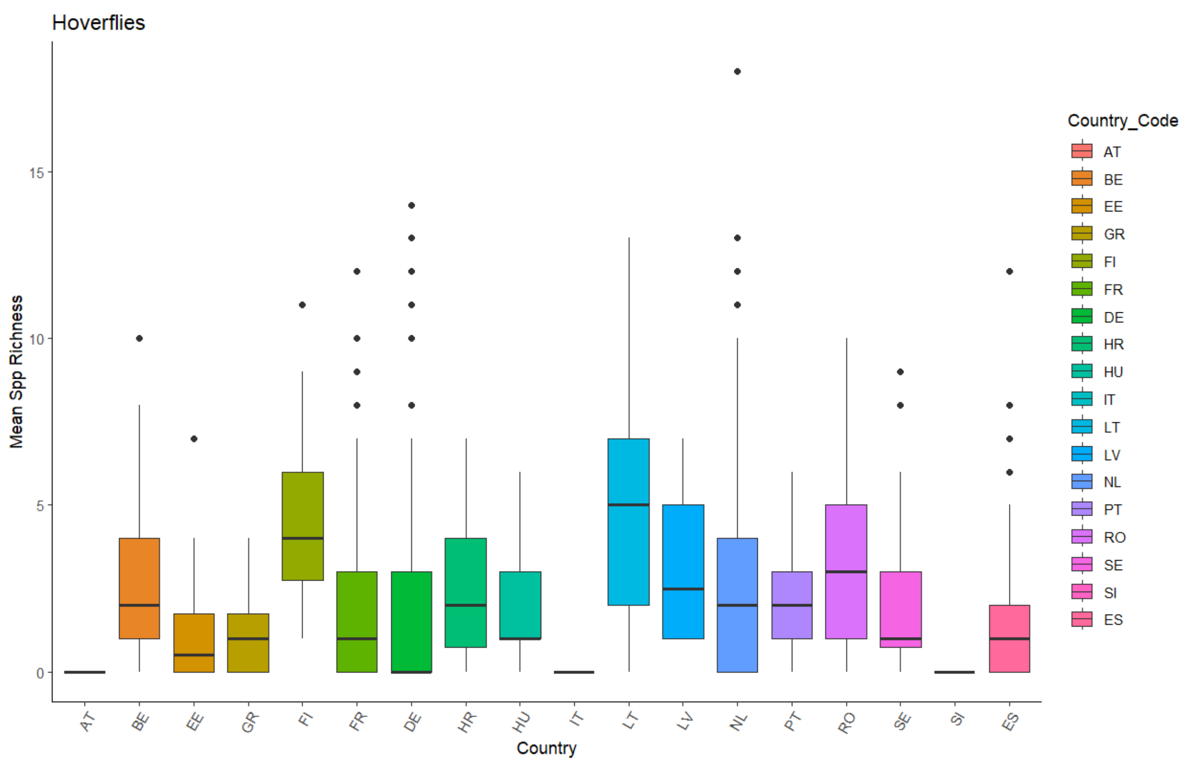

Figure 3.5. Species richness of hoverflies per sampling occasion for pan traps.

3.2 Refinement of MVS methods

The assessment of how floral resources in landscapes affect pollinator abundance (as measured by transect counts or pan traps) is well finalised (and publication is in progress). Relevant data sources for analyses have been identified and meta-data for dataset selection have been collected and analysed. A theory-based analytical approach has been identified and a time plan has been developed.

Floral resource availability is expected to potentially impact the assessment of pollinators and in particular their abundance from pan traps due to different mechanisms of attraction and 'dilution' of pollinators, dependent on the abundance and diversity of flower resources within the vicinity of pan traps and in the broader landscape. Increased understanding of these mechanisms will be achieved by analysing a comprehensive dataset on pollinator richness and abundance collected by pan traps and transect walks along gradients in local and landscape-level flower resource availability. Due to longer processing times of the SPRING samples, we started with already available datasets and complemented them by SPRING data once identification was completed. We (Reading, UKCEH, UFZ) contacted relevant data holders and, together with them, we developed a theory-based analytical approach (Fig. 3.6) during an online workshop (16th February 2022). The concept has been presented and discussed at the SPRING meeting in Barcelona (5th – 7th October 2022).

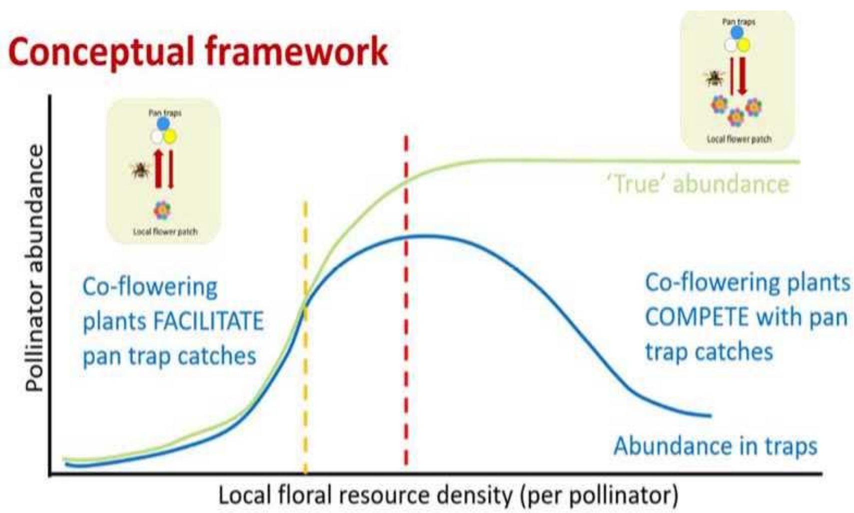

Figure 3.6. Conceptual framework to assess impacts of flower resource density on assessments of pollinator abundance sampled with pan traps. Yellow dashed line, flower densities below which sampled pollinator abundance might be expected to follow patterns of 'true' abundance. Red dashed line, flower densities beyond which sampled pollinator abundance can be expected to significantly deviate from 'true' pollinator abundances, due to a 'dilution' effect.

This conceptual framework assumes a sigmoidal response of 'true' pollinator abundance with increasing flower densities (green line in Fig. 3.6). Co-flowering plants at low densities are expected to facilitate pan trap catches, while high densities of co-flowering plants are expected to compete with pan traps. This leads to an initial match between 'true' abundances and assessments with pan traps, while at a certain point estimates from pan traps diverge from the expected 'true' pollinator abundances (blue line in Fig. 3.6).

Based on meta-data, we identified 27 candidate studies covering eight European countries, about 1000 sites with more than 26,000 spatio-temporal replicates providing data based on pan traps and transect walks. On this basis, we originally planned to identify and quantify the potential impact of local and landscape-level flower resource densities on local pollinator abundance estimates and provide a framework to correct for such impacts and to inform the development of standardised assessments of local floral resources for inclusion in the MVS.

Workshop on relationship between flower density and pollinator numbers

Continuous interactions with project partners (i.e. several mini workshops) have been performed throughout 2023, leading to the assembly of relevant data from pollinator studies across Europe as a basis for the data synthesis.

In the end we (UFZ, Reading, UKCEH) collated relevant published and unpublished data across Europe from 14 studies using pan traps, transects or both. These datasets included SPRING data from the Netherlands and Sweden. After an initial screening, 11 datasets remained for pan traps (covering Spain, Greece, UK, and The Netherlands) and 4 for transects (covering Romania, The Netherlands, Serbia, and UK; Table 3.2). Exclusion criteria were i) flower resources were provided in terms of percentage cover instead of density (flower unit per m²), and ii) low pollinator abundance and in particular low variation across the samples (excluding among others SPRING data from The Netherlands and Sweden), leading to an exclusion of 13 studies from the 27 candidate studies. Since not all studies had information on the three focal groups of EU PoMS MVS, we focused on wild bees for means of consistency and since transect walks are often preferred over pan traps for butterflies and hover flies.

To allow for a direct comparison across the different studies, pollinator and flower data were harmonised and adjusted for sampling effort. Spatial replicates of pan traps or transects were aggregated across the focal study site. Temporal replicates (sampling rounds) were not aggregated but considered as a separate data point. All studies had separate flower surveys for each sampling round. To account for differences in the number of pan traps and their operating time, we calculated wild bee abundance per set of traps and day. For transects, we used wild bee abundance per observation time (minutes). Flower densities are based on flower units, i.e. the number of flowers that can be reached without flying. Flower densities were either already provided as such or have been calculated based on the number of flower units and the size of the respective sampling plot.

Analysis

Since average wild bee abundance differed considerably between locations in central/western Europe (median = 3 specimens) and southern Europe (median = 91 specimens) for pan trap data, we split the dataset into two, a southern (Spain and Greece) and a central/western part (UK and The Netherlands). The distributions of the transect data were similar for southern and central/western locations (southern, Greece and Romania: median = 0.3 specimens; central/western, UK and the Netherlands: median = 0.4 specimens) which did not require a split for the identification and visualisation of the relationship with flower density. For the central/western pan trap dataset, we had 534 individual data points. The southern pan trap dataset comprised 346 data points, and the transect dataset had 659 data points (median abundance = 0.35 specimens).To assess the relationships between wild bee abundance and flower density for pan traps and transects and to compare them with the expectations from our conceptual framework, we used local polynomial regression fitting (loess). This is a nonparametric technique for smoothing scattered data points, which is highly suitable to identify the shape of complex relationships. We identified the significance of the smoothed shape of the relationship against a null hypothesis of no relationship using a permutation test based on mean squared error (5000 permutations).

Table 3.2. Data sources and summary statistics
N, number of data points per study; Pan S, pan trap southern Europe; Pan C, pan traps central/western Europe

Study	Country	Method	N	Abundance mean (sd)	Flower mean (sd)
ALMOND[u]	Spain	Pan S	11	12.01 (12.32)	164.59
BIOPAIS[1]	Spain	Pan S	2	5.99 (3.63)	10.24 (5.92)
Landpolnet2[u]	Spain	Pan S	8	15.21 (8.22)	40.09 (61.06)
Landpolnet1[2]	Spain	Pan S	6	16.68 (10.92)	25.79 (34.25)
POLLOLE[3]	Spain	Pan S	2	5.64 (3.28)	0.19 (0.13)
Serapis[u]	Greece	Pan S	4	9.74 (8.32)	186.99
BHL[u]	Netherlands	Pan C	15	5.62 (6.22)	49.13 (79.15)
IPI_Crops[u]	UK	Pan C	8	4.41 (7.21)	714.4
UKPoMS[u]	UK	Pan C	29	6.68 (8.07)	11.24 (22.71)
BHL[u]	Netherlands	Trans	35	0.76 (0.87)	72.71
IPI_Crops[u]	UK	Trans	8	0.77 (0.98)	647.41
Serapis[u]	Greece	Trans	4	0.91 (0.48)	186.99
Transylvania[4]	Romania	Trans	18	0.31 (0.31)	100.91

Sources: [1]Hevia V, Bosch J, Azcárate FM, Fernández E, Rodrigo A, Barril-Graells H, González JA (2016) Bee diversity and abundance in a livestock drove road and its impact on pollination and seed set in adjacent sunflower fields. Agriculture Ecosystems & Environment 232: 336-344. Data: https://doi.org/10.1016/j.agee.2016.08.021. [2]Torné-Noguera A, Rodrigo A, Arnan X, Osorio S, Barril-Graells H, da Rocha-Filho LC, Bosch J (2014) Determinants of Spatial Distribution in a Bee Community: Nesting Resources, Flower Resources, and Body Size. Plos One 9: e97255. [3]Hevia V, Carmona CP, Azcárate FM, Heredia R, González JA (2021) Role of floral strips and semi-natural habitats as enhancers of wild bee functional diversity in intensive agricultural landscapes. Agriculture, Ecosystems & Environment 319: 107544. [4]Kovács-Hostyánszki A, Földesi R, Mózes E, Szirák Á, Fischer J, Hanspach J, Báldi A (2016) Conservation of Pollinators in Traditional Agricultural Landscapes – New Challenges in Transylvania (Romania) Posed by EU Accession and Recommendations for Future Research. Plos One 11: e0151650. Data: https://datadryad.org/stash/dataset/doi:10.5061/dryad.5dk66. [u]Unpublished data

Results

The loess smoothing was significant for all three cases (p-value pan traps central/west = 0.003; p-value pan traps south = 0.043; p-value transects < 0.001). The overlap in the ranges of covered gradients in flower density across the different studies was high for all three datasets, ensuring that the identified patterns are not driven by a single study (Fig. 3.7a,b,c). For both pan trap datasets and transect dataset, wild bee abundance initially increased with increasing flower density, peaked at a certain point and decreased again thereafter. However, a considerable difference in the shape of the relationship and the flower densities at which the curves peaked was evident (Fig. 3.7d). The curves for both pan trap datasets were remarkably similar, except for an overall higher abundance level in southern Europe. For pan traps, wild bee abundance increased strongly with increasing flower density, deviating from an expected sigmoidal shape, and quickly reached its peak at a very low flower density of about 3 flower units per m². With

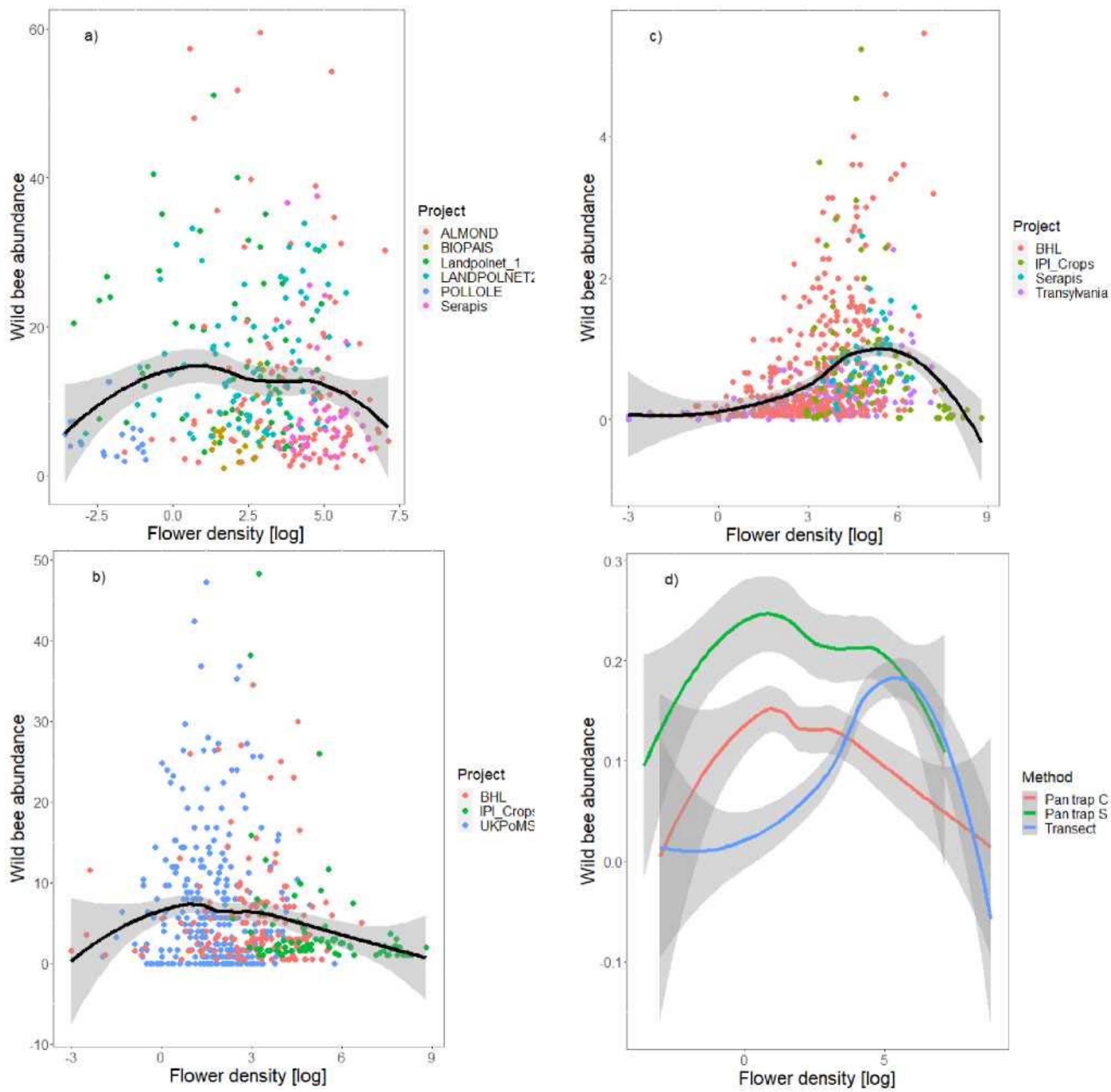

Figure 3.7. Relationship between wild bee abundance and flower density. Black line represents smoothing by a polynomial regression fitting (loess) for pan trap data from southern Europe (a), pan trap data from central/western Europe (b), transect data across Europe (c), and all three overlaid (d). Shaded grey areas are 95% confidence intervals. Different studies (Project) are colour coded. Flower density is displayed on the logarithmic scale (peak of Pan trap C and S is at about 3 flower units per m², peak of Transect is at about 230 flower units per m²). Wild bee abundance in d) has been rescaled per Method to let the entire values range between 0 and 1 (by dividing the abundance values by the respective maximum value).

further increasing flower density, abundance decreased, reached a plateau, and strongly decreased further on. In contrast to that, the shape of the response curve of wild bee abundance to increasing flower density, as assessed from transect data, followed the expected sigmoidal curve with an initial shallow relationship which got increasingly stronger at higher flower densities. Also, in contrast to pan traps, wild bee abundance from transects reached a peak at a very high level of flower density of about 230 floral units per m². Beyond that, abundance decreased again.

Discussion

Our results show a clear difference in the assessed relationship of wild bee abundance and flower density between monitoring methods based on pan traps or transect walks. Since this relationship for transect walks followed our expectation of a sigmoidal shape, transects seem to reliably reflect wild bee responses to changes in flower density across a large range. Transect walks thus highly qualify for the EUPoMS MVS and other monitoring schemes. Only at very high flower densities this method comes to its limits. However, such high densities (above 230 flower units per m²) represent a minority in our datasets (data points above the blue line in Fig. 3.8) and are usually found in mass flowering crops or fruit orchards, but can occur also in Mediterranean areas. Whether the very flat relationship in cases of very low flower densities is caused by insufficient detection or reflects 'true' abundance conditions still needs to be identified or at least be considered in subsequent trend analysis, e.g. via including detection probabilities.

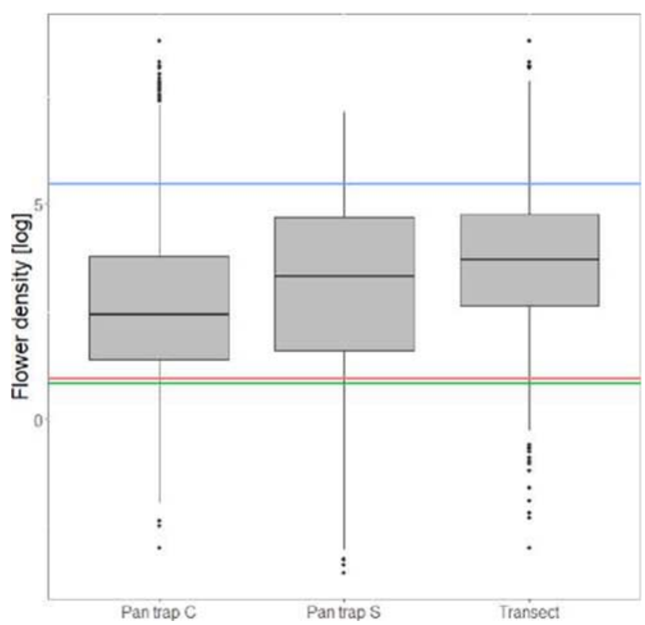

Figure 3.8. Boxplot of flower density per method. Coloured horizontal lines indicate the wild bee abundance peaks in Fig. 3.7. Green, Pan trap S; orange, Pan trap C, blue, Transect.

The consistency between the response curves based on pan traps from southern and central/western Europe indicates some general patterns. Response curves for pan traps deviated considerably from our expectations of 'true' pollinator abundance should behave, but confirmed our expectations according to attraction and dilution effects. The consistently strong increase of wild bee abundance from very low to low flower densities and the deviation from an expected sigmoidal curve might indicate strong attraction of wild bees, e.g. from the surrounding or those just nesting at this location. This might lead to an actual overestimation of local pollinator abundances and consequently to an overly optimistic indication of success for limited management activities under such conditions. More worrying is the observed decline in wild bee abundance at flower densities higher than 3 flower units per m². This effect is likely caused by increased competition for attraction of pollinators by high flower densities. This means that abundance data based on pan traps are, if at all, only reliable for a minority of landscapes with low flower density (data points below the orange and green line in Fig. 3.8), while restoration activities that increase flower densities could be wrongly indicated to generate a decrease of pollinator abundance.

Based on the evident discrepancies between transect and pan trap methods, indicating strong effects of pollinator attraction and dilution on abundance estimates from pan traps, we strongly advocate that the EUPoMS MVS and other pollinator monitoring schemes should focus on transect walks rather than using pan traps to ensure a reliable detection of pollinator trends.

We recommend that the MVS of EUPoMS should focus on transect walks rather than on pan traps.

Acknowledgements

Data on pollinator abundances and flower densities have kindly provided by Neus Rodriguez Gasol (ALMOND), Violeta Hevia (BIOPAIS), Sergio Osorio Cañadas (Landpolnet2), Jordi Bosch (Landpolnet1), Jorge J. Ortega-Marcois (POLLOLE), Theodora Petanidou (Serapis), Joan Diaz Calafat and David Kleijn (BHL), Michael Garratt (IPI_Crops), Claire Carvell (UKPoMS), Anikó Kovács-Hostyánszki (Transylvania)

4 Testing complementary and additional modules

4.1 Testing the moth module

Moth field trials

Fieldwork has been done on 253 locations (see sites on Figure 4.1). In Sweden, Hungary and the Netherlands extra datapoints have been added over the 125 which were originally planned. In total 3006 nights traps were set out in the SPRING project (1586 in 2022, 1420 in 2023 when the season was shorter because of reporting and analysing). Work has been performed according to the protocols described in the Annex in Chapter A4.1.

Figure 4.1. Map with sampling locations for moth monitoring in 2022 and 2023 in the SPRING project.

Moth overall results

In total 69426 moths of 1506 species were reported, a mean of 23.1 moths per trap per night (median 9 moths per trap per night). Most species were macro-moths and many are likely to provide an important role in pollination. Most species were counted in a trap in Spain (Alzinar de Sant Martí 1): 275 moth species. This site also had the highest number of species in one night: on 2 October 2022 a total of 62 species were counted. The highest abundance of moths in one night were counted on Martinkai-legelő, Trap_4 in Hungary on 30 June 2022 with 502 moths in one trap.

In 2022 most moths could be trapped in Spain with a mean of more than 80 moths per trap per night (Figure 4.2). The lowest numbers were counted in the Netherlands, in spite the traps being placed in one of the best and darkest areas for moths in the country.
Most of 2023 Spain again had the highest number of moths per trap, however in August (between weeks 30 and 35) Hungary took over. Except for Spain, where numbers were comparable, mean number of moths in the investigated traps were higher in 2023 than in 2022.

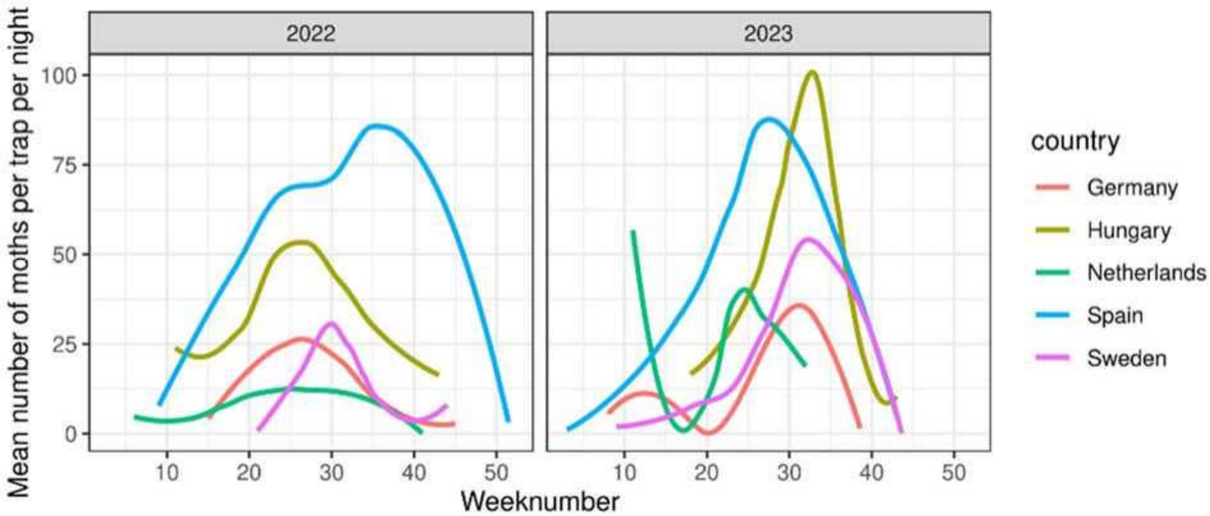

Figure 4.2. Mean number of moths per trap per night per country in 2022 and 2023.

Similarities between traps

For each cluster of five traps the percentage of the total number of species per trap is close to 50% for most of the countries and habitats (Figure 4.3). Only in traps in urban areas is this percentage clearly higher, indicating a more homogeneous moth fauna in cities and villages.

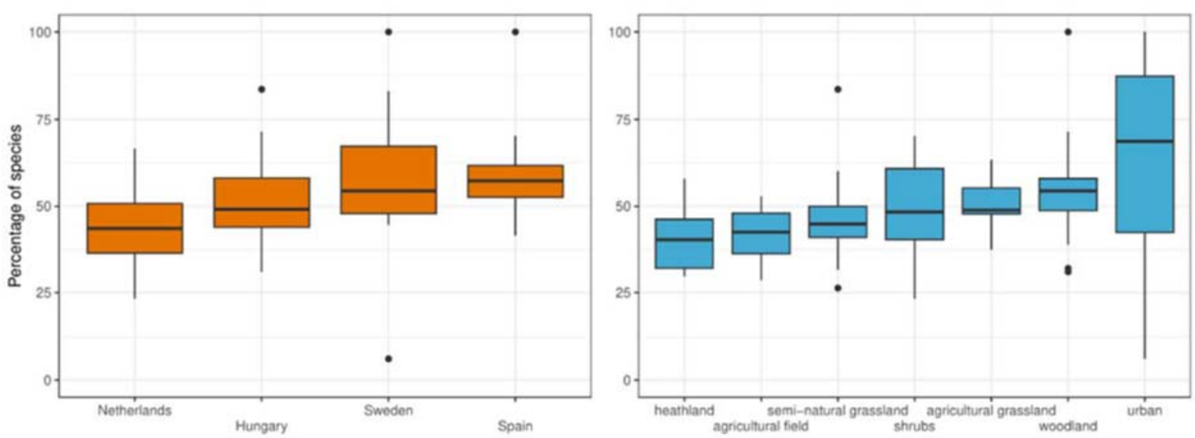

Figure 4.3. For each country (left, orange) and habitat (right, blue) the distribution of the percentage of the species of a cluster per trap is given.

Dendrograms (Fig. 4.3.a) are another way of looking at similarities between the moth fauna of the traps. They show that the moth fauna of traps in one habitat resemble each other, and are clearly different from traps in other habitats or other clusters in the same habitat.

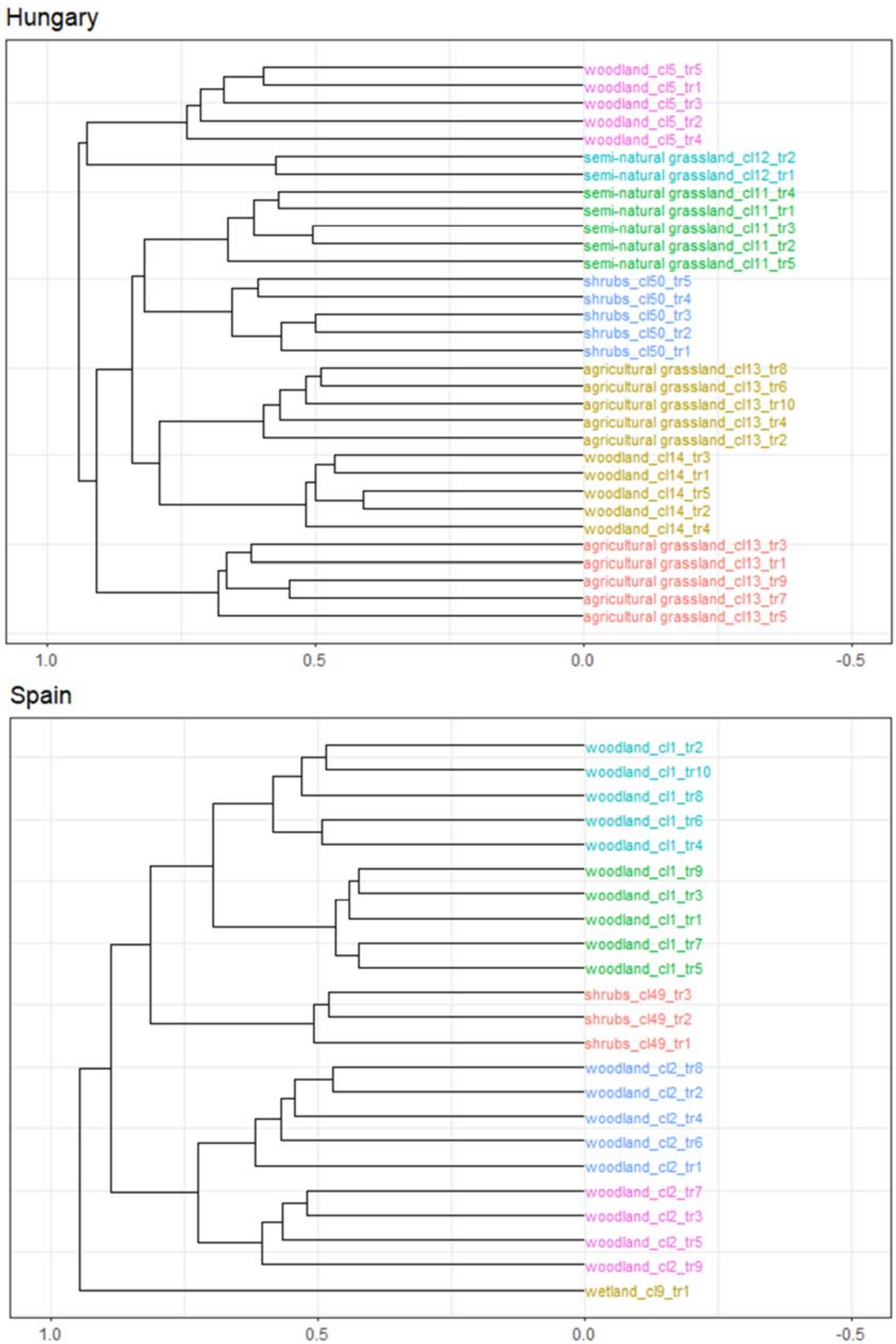

Figure 1.3a: Dendrogram showing the similarities between the traps in Hungary and Spain.

Feasibility of moth monitoring for estimation of European trends

There is increasing evidence for the importance of moths for pollination (Alison et al., 2022; Anderson et al., 2023; Walton et al., 2020). Also, for agriculture, pollination by moths seems to be at least as important as diurnal pollination (e.g. for strawberries: Fijen et al., 2023). Moths are well suitable for monitoring as proven by existing successful monitoring schemes in eight European countries (Belgium (Flanders), Estonia, Finland, Ireland, Hungary, the Netherlands, Portugal and United Kingdom). This is facilitated by the development of automatic identification methods based on Artificial Intelligence. At present, these methods enable correct identification of 95% of moths in North-Western Europe, which enables monitoring by others than experts, for example by volunteers or farmers.

As part of the SPRING project, successful moth monitoring was conducted in five European countries, which led to minor adjustments to the existing well-established, standardized, monitoring protocols used in the Netherlands. Minor adjustments included securing the trap under strong winds and adding a roof to prevent rain entering the trap. These adjustments ensure that established field methods are also feasible in other European countries. This standardised monitoring protocol relies on traps that attract moths with LED lights. Although not all species are caught, most species can be. What is important, though, is that trends across years can be established because of the ease of identification and the standardization of the effort and frequency of the monitoring. Photos of the moths can also be stored for later verification.

To determine the required monitoring effort to get reliable five-year trend estimates of macro moths (the main group sampled by the light traps), model-based power analyses were conducted for different combinations of number of traps and visits per trap per year (with each visit consisting of one night). The effect size was estimated from the data from the Dutch moth monitoring scheme. Figure 4.4 shows the power for different combinations of number of traps and number of visits per trap. For a power of ~80% one could use 40 led traps that are visited six times a year (i.e. set on six occasions and not left permanently on sites). As can be seen in Figure 4.4, other combinations are also possible, for example 25 traps visited ten times a year.

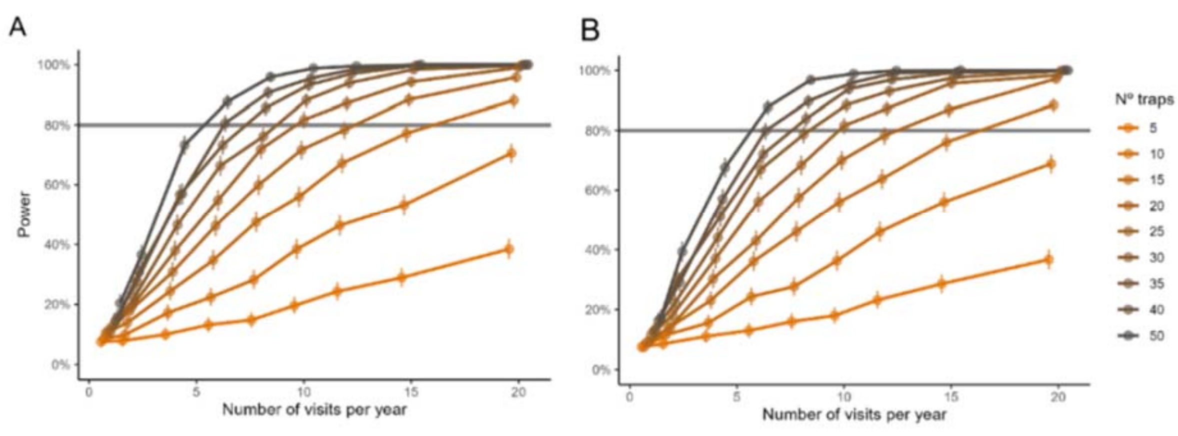

Figure 4.4. Power for different combinations of visits per trap and number of traps (different coloured lines) for all observations of macro moths in **all habitats** in the Dutch moth monitoring scheme. The horizontal grey line indicates a threshold of 80%. (A) Power analysis results for a generalized linear mixed model with year as an ordered factor and polynomial contrasts. (B) Same as (A) but with year as factor with repeated contrasts.

In the SPRING project, data is acquired from traps in spatially close clusters in different countries (for this purpose analysed: Hungary, Sweden, Spain, the Netherlands). This data set shows that there is little overlap in macro moth counts (total number of macro moths) between these spatially close traps.

Species composition showed little commonality between traps that are spatially close (Figure 4.4). The species composition is determined much more by the habitat than by the neighbouring traps. Hence placing several traps on a single sampling site seems a good strategy to place the required number of traps without a drastic increase in sampling effort.

Given the smaller number of moths present in intensive agricultural areas in the Netherlands and their importance for pollination in these areas (Fijen et al., 2023), power analyses were also conducted only on agricultural monitoring sites (Figure 4.5). We found that a solely agricultural landscape will require a slightly higher sampling effort, but differences are minimal.

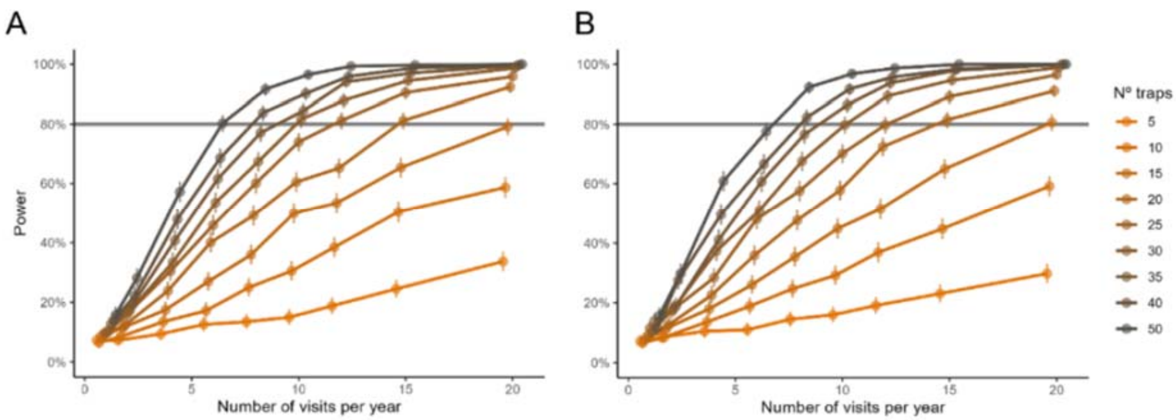

Figure 4.5. Power for different combinations of visits per trap and number of traps (different lines) for observations of macro moths **in agricultural areas** in the Dutch moth monitoring scheme. The horizontal grey line indicates a threshold of 80%. (A) Power analysis results for a generalized linear mixed model with year as an ordered factor and polynomial contrasts. (B) Same as (A) but with year as factor with repeated contrasts.

It is important to stress that for placing and emptying the traps, no moth-identification skills are needed. Simply taking photos of all moths inside the trap, and identifying them either via AI or later via an expert, makes it possible for every interested farmer, warden or nature lover to participate in the monitoring of moths, making this one of the monitoring methods which can be relatively easily deployed with the help of volunteers. This can help reducing the costs for moth monitoring.

Well-established and standardized protocols for the monitoring of moths are used already in eight European countries. These existing protocols, together with the, here determined, required monitoring effort to estimate reliable trends of macro moths, realize a feasible method for monitoring of these taxa of pollinators across the European Union. This can be done in habitats rich in pollinators but will also be sufficient for trends estimates in areas with lower insect densities like intensively used agricultural areas as in North-Western Europe. Because of the relative ease of identifying moths and clear protocols for monitoring, monitoring moths in more European countries will provide reliable trends as indicator for changes in pollinators in Europe. In the Netherlands establishing a monitoring system that allows us to detect a significant change over five years requires **40 traps** deployed once a month in the season (six times per year). However, as the Netherlands has a volunteer-based moth monitoring scheme running many more sites already, extra costs would be minimal.

Reported (and solved) problems

All five participating countries each received 30 identical traps, to be placed in five clusters of five traps each, and five traps as spare. The following issues occurred:

- High number of moths per trap. Especially in Hungary and Spain, the number of moths per trap per night can exceed 200 moths. In such cases emptying the trap and photographing and identifying all moths takes so much time, that it proved to be impossible to properly deal with all five traps per cluster. Moths get very active when the trap gets too hot and many either fly away or get killed. In 2023, the number of traps per night was therefore reduced to three in these countries. In most of Central and Southern Europe that is probably the maximum number of traps which can be managed.
- Species complexes. Some species of moths can only be identified by differences in genitalia or DNA. In such cases, a positive identification in the field or later by photo is not possible. Species complexes have been created in the database and app, so the moths can be entered at least on that level. A relatively low proportion of moths is not identifiable to species.
- Moths too active after hot nights. Especially at low altitudes in the Mediterranean, the temperature can still be over 30°C at sunrise. In such cases, it is almost impossible to identify all moths, as many fly away when opening the top. Some tests have been done by applying cooling elements, but it seems better not to use the traps when high sunrise temperatures are expected. In the mountains and at higher latitudes this was never a problem.
- Adjustments to traps. The traps are very light, which makes it easy to carry them into the field, but the disadvantage is that they can be blown away easily in windy conditions. Two practical solutions have been tested: placing a stone in the trap works most of the time, however it is better to install a small roof over the traps and fix it with rope. That also prevents rain from getting into the trap. On the Dutch sites, a comparison was made between traps with and without a roof. Every nigh a random part of the traps would get a roof (each night a different selection). A test with a mixed negative binomial GLM revealed a significant difference between traps with and without a roof (with roof: 15.8±1.96 individuals, without roof 10.2±1.2 individuals, $p<0.001$). So placing a roof gives significantly more moths than without, protects against rain, and makes it easier to fix the trap in windy nights. This is generally good in W and N Europe, where moth numbers are relatively low and rainy and windy nights occur regularly, however in hot parts of Europe it is better not to use the roof, as it would further enlarge the high number of moths on hot nights in these regions. However, it is important that the trap is always the same: night with and without a roof should not be mixed.
- Software problems. The focus in software was directed to the ButterflyCount app. In general, this worked well and problems were solved quickly. Some recorders preferred to enter their data via the website, which was basic and without identification help from AI. Extra attention for the website is needed in future to support participants who prefer to use this approach to enter their data.
- The app sometimes did not seem to distinguish between the ObsIdentify classifier being down or hard to reach (server problems and/or bad mobile internet connection/coverage) as both conditions classified a lot of easily identified moths as "Unidentified".
- All light-based moth traps experienced reduced trapping efficiency when other light sources interfered with them. Such other sources can be streetlights, full moon (Jonason et al., 2014), and most importantly, the bright summer nights at high latitudes. In Sweden, light trapping is increasingly difficult from about 60°N; at the northernmost site at 66°N, LED traps could only be used until May 20 and from August 1 onwards. One way of reducing the problem is to

increase the light from the LED traps and trials have been done in the Netherlands and Sweden. Another possibility is to complement LED traps with similarly designed sugar bait traps (Pettersson & Franzén 2008, Pettersson 2020). We suggest both options be investigated, and their effects quantified over a range of latitudes.

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Alison, J., Alexander, J.M., Diaz Zeugin, N., Dupont, Y.L., Iseli, E., Mann, H.M.R., & Høye, T.T. (2022). Moths complement bumblebee pollination of red clover: a case for day-and-night insect surveillance. *Biology Letters, 18*, 20220187. https://doi.org/10.1098/rsbl.2022.0187; Anderson, M., Rotheray, E.L., & Mathews, F. (2023). Marvellous moths! pollen deposition rate of bramble (*Rubus futicosus* L. agg.) is greater at night than day. *PLoS ONE, 18*(3), e0281810. https://doi.org/10.1371/journal.pone.0281810; Fijen, T.P.M., Roovers, A., van Deijk, J., & van Grunsven, R.H.A. (2023). Nocturnal pollination is equally important as, and complementary to, diurnal pollination for strawberry fruit production. *Agriculture, Ecosystems & Environment, 350,* 108475. https://doi.org/10.1016/j.agee.2023.108475; Jonason, D., Franzen, M. & Ranius, T. (2014). Surveying moths using light traps: effects of weather and time of year. Plos One 9, e92453; Pettersson, L. B. & Franzén, M. (2008). Comparing wine-based and beer-based baits for moth trapping: a field experiment. Entomol. Tidskr. 129, 129–134; Pettersson, R. M. (2020). Fällor med bete för insekter i midnattssolens glans. Skörvnöpparn 12, 41–43; Walton, R.E., Sayer, C.D., Bennion, H., & Axmacher, J.C. (2020). Nocturnal pollinators strongly contribute to pollen transport of wild flowers in an agricultural landscape. *Biology Letters, 16*(5), 20190877. https://doi.org/10.1098/rsbl.2019.0877

4.2 Testing the wider insect biodiversity module

The pollinating insect community of the EU includes many other taxonomic groups besides bees, hoverflies, butterflies and moths. These include ants, beetles, wasps, and non-hoverfly flies. Given ongoing losses of insect biodiversity, it is important to understand which insects are in decline and how they are continuing to change through time, which in turn requires broad insect sampling and monitoring programs.
A possible solution is to incorporate other sampling methods that can expand the taxonomic scope of the MVS, but these methods must not substantially augment the effort already required for the collection of pan trap and transect data. One such method could be Malaise traps, which are small netted tents that can trap any passing flying insect. Malaise traps are a passive sampling method, so the only time investment is their initial construction at the start of the year and then sample bottles can be collected, reset, and sent for analysis once every two weeks. Passive in this respect means that insects are not attracted by colours like in pan traps.

To determine what unique information might be gained by including Malaise traps in the SPRING MVS, we compared insect richness at each co-located site where insects were observed and determined via MVS methods and collected by Malaise traps with follow-up identification of insect species via metabarcoding. We did so for 13 sites in Germany and 5 sites in Hungary sampled during 2022, and 2 sites in Greece sampled during 2023 (Fig. 4.6). We compared: (1) the total number of insect taxa found using both methods, and (2) the total number of insect pollinators (specifically bees, butterflies, and hoverflies).

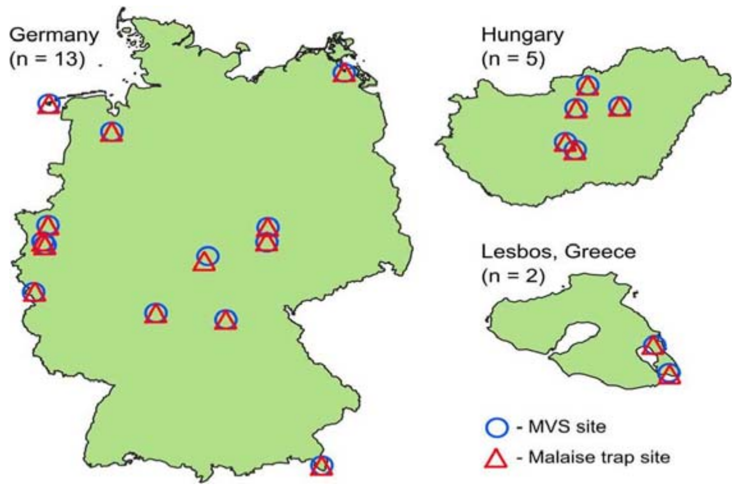

Figure 4.6. Minimum Viable Scheme (MVS) and matching Malaise trap locations in Germany, Hungary, and Greece.

The SPRING project also provided a pilot of Malaise traps as a possible option to complement the Core scheme. An updated protocol for Malaise trapping can be found in the Annex in chapter A4.2.

Methods

Townes-type Malaise traps were set up in a site proximate to each MVS site, typically a few hundred meters away. Traps were generally exposed for 14 days, emptied, and then reset, although shorter and longer exposure periods (ranging from 11–35 days) were occasionally necessary, owing to logistical constraints. Traps were primarily placed in open areas (typically agricultural fields or grasslands), adjacent to forest edges or hedgerows, or within forest clearings. All captured insects were preserved in 80% denatured ethanol (1% methyl ethyl ketone) and transported to the lab to determine wet biomass (following methods in Welti et al. 2022), and later on species identity via metabarcoding (following methods in Buchner et al. 2023). Insect DNA sequences of mitochondrial cytochrome oxidase I were assigned to Operational Taxonomic Units (OTUs) based on a 97% similarity threshold.

To compare methods, we quantified the total number of unique insect taxa identified at each site by pan traps, transect walks, and Malaise traps. For pan traps and transect walks, we counted all unique taxon names collected at each site and sampling date, including each bee, butterfly, and hoverfly morphological group (e.g., a *Bombus* species and a 'ginger bumblebee' were considered separate taxa). For Malaise traps, we considered only taxa caught during the two-week period that overlapped the period when the pan trap and transect walk data was collected. Thus, we do not present the wealth of data generated throughout the Malaise trap sampling season. Not all insect OTUs captured during these periods could be assigned to species names because of incomplete reference data or conflicting matches in the databases. Therefore, species richness was estimated using two different taxa lists. The first list included only OTUs that could be unambiguously matched to a barcode with a species name. We refer to richness quantified using this list as 'species-level' richness. The second taxa list included all species-level identifications, and OTUs that could only be resolved to genus or family level. Despite their coarser resolution, these identifications can still be used to estimate the likely species richness of each insect family (detailed further in Buchner et al. 2023), which we refer to as 'OTU-based' richness.
In addition to total richness, we also compared pollinator richness (i.e., bees, butterflies, and hoverflies only) for each site and sampling date determined using each method, given that the

pan traps and transect walks are designed to target the pollinator community whereas Malaise traps are more general. For this comparison, we combined the data from the pan traps and transect walks into a single taxa list to produce a full MVS perspective of pollinator richness, which we then compared to the Malaise trap data. We also determined which species names were unique to Malaise traps, which are those that are not also present in the MVS taxa list from the same sites and sampling periods. We did this to ascertain whether Malaise traps, which are not targeted towards pollinators, were providing any unique information about the pollinator community that was not provided by the MVS methods.

Results

Total insect richness

Across the 20 co-located sites, which encompassed 75 sampling dates, total insect richness in the MVS methods was around one order of magnitude lower than in Malaise traps (Fig. 4.7). Specifically, pan traps captured an average of 12.3 ± 9.2 total insect taxa (mean ± SD), and transect walks captured 6.4 ± 4.2 taxa. In contrast, the average species-level richness for Malaise traps was 428.6 ± 255.9 and OTU-based richness was 664.3 ± 390.6.

Pollinator richness

Pollinator richness was similar among methods, but tended to be higher in the MVS scheme (Fig. 4.8). MVS methods together captured an average of 18.7 ± 11.2 different pollinators, whereas Malaise traps captured an average of 13.7 ± 11.7 different species-level pollinators and 14.9 ± 12.7 different OTU-based pollinators. However, on average 11.7 ± 10.3 species-level identifications were unique to Malaise traps, meaning that about 85% of these taxa were either not present in the MVS taxa list or were identified to a higher taxonomic level.

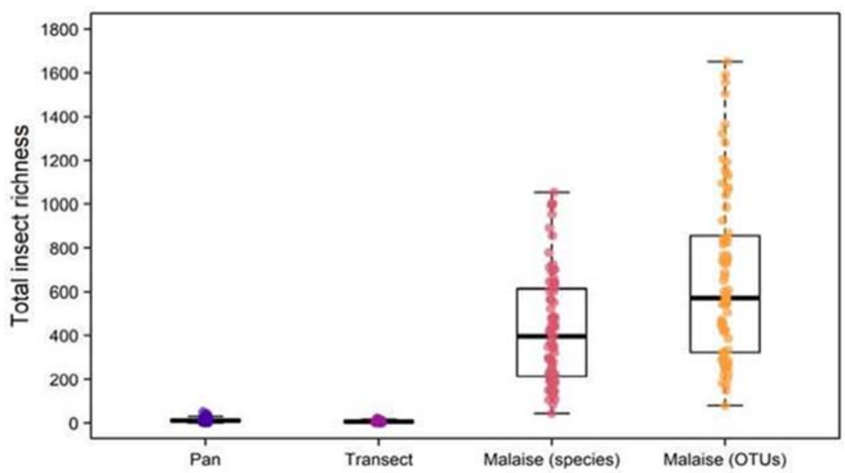

Figure 4.7. Total insect richness for pan traps (dark purple), transect walks (light purple), species-level identifications from Malaise traps (pink), and OTU-based richness (orange).

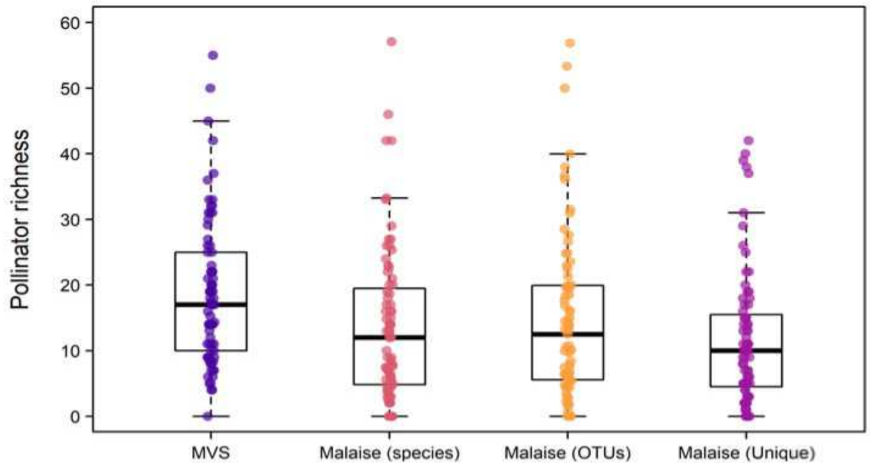

Figure 4.8. Pollinator richness from pan traps and transect walks combined ('MVS'; dark purple), from Malaise trap species-level identifications ('species'; pink), from Malaise trap OTUs ('OTUs'; orange), and the number of species-level identifications that were unique to Malaise traps ('Unique'; light purple)

Regarding specific pollinator groups, the higher number of pollinators caught by MVS methods was primarily driven by the higher number of bees (Fig. 4.9 a), with an average of 11.8 ± 9.2 bee taxa in MVS versus 4.2 ± 5.6 bees identified to species-level in Malaise traps. In contrast, the number of butterflies and hoverflies was more similar among methods, with Malaise traps sometimes capturing more of both (Fig. 4.9 b, c).

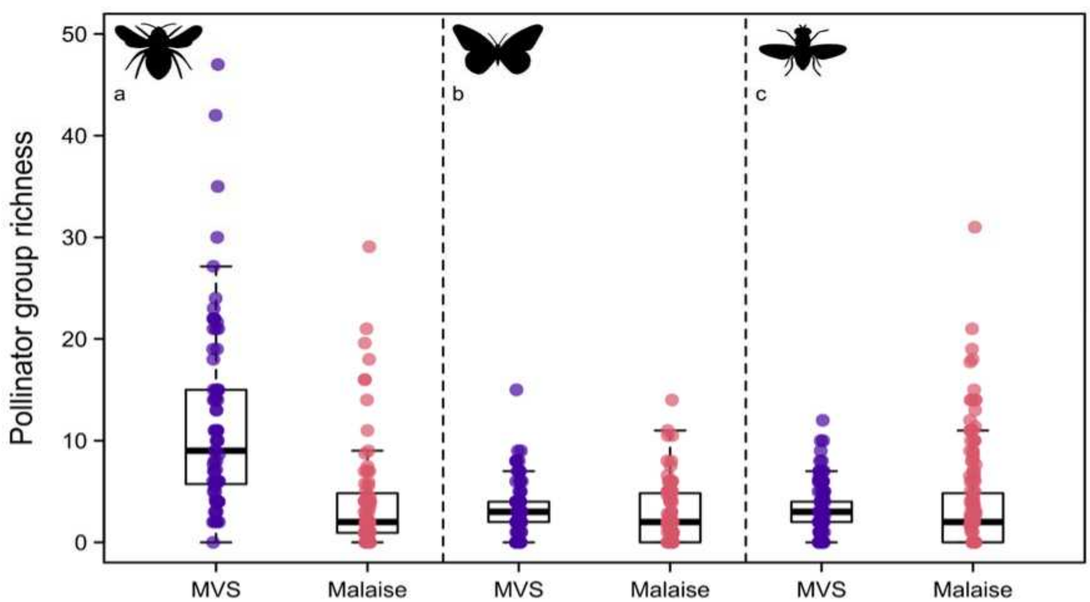

Figure 4.9. Richness of (a) bees, (b) butterflies, and (c) hoverflies captured by a combination of pan traps and transect walks ('MVS'; purple) versus species-level identifications in Malaise traps ('species'; pink).

A comparative list of features of MVS methods (pan traps, transect walks) and Malaise traps is compiled in Table 4.1. The green colour indicates the strength of a method with respect to a certain aspect. Note that the level of personal skills is always a source of human bias when it comes to identifying insects (especially during transect walks).

Discussion

Our results demonstrate the benefits of Malaise traps for capturing a large number of insects that are otherwise not trapped by current MVS methods. This finding makes sense given that pan traps and transect walks target bees, butterflies, and hoverflies, which comprise only 14 insect families out of hundreds that can be found in Malaise traps (Buchner et al. 2023, Chimeno et al. 2023). Genetic methods can also identify a variety of taxa that are difficult to distinguish morphologically, or are not yet know to science (Li and Wiens 2022, Buchner et al. 2023), further augmenting the number of identified insects. Incorporating Malaise traps and metabarcoding into SPRING's MVS protocol will therefore dramatically expand the scope of monitoring to a much broader portion of the insect community for a low investment of both time and additional cost.

While MVS methods outperformed Malaise traps in sampling the pollinator community, particularly bees, our results show that Malaise traps can still provide unique information about pollinators. Specifically, the majority of the species names of bees, butterflies, and hoverflies from Malaise traps were not present in the associated pan trap or transect walk taxa lists. This difference may arise owing to differences in levels of identification, such as a single morphological group identified in a transect walk that was identified to the species-level via genetic methods in Malaise Traps. The difference is expected to be even higher in the Mediterranean, as e.g. wild bee diversity is much higher there and thus more difficult to be recorded by traditional methods. Furthermore, Malaise traps are passive samplers that are continually sampling, whereas pan traps and transect walk samples are only collected on a single day (see Table 4.1), meaning that certain pollinators may be missed by MVS methods but caught in Malaise traps. Consequently, although Malaise traps collect fewer pollinators, the information they do provide is often unique and potentially otherwise unavailable, or difficult to obtain, from MVS methods combined with morphological identification.

Table 4.1. Comparison of Malaise traps, pan traps and transect walks

	Malaise traps	**Pan traps (MVS)**	**Transect (MVS)**
Target group	All flying insects (bulk samples)	Pollinators	Pollinators
Species abundance	Not yet possible	yes (but likely unreliable due to local flower density effect)	yes
Exposure time	DE: Apri-Oct ***≈5000 h***, not weather dependent	DE: monthly (Apr- Sept) □ 6 x 6 h = ***36 h***	DE: monthly (Apr- Sept) 6 x (10 x 50 m] ***≈12 h***
Taxonomic skills	none	high (human bias)	high (human bias)
Data quality	high (species ID)	human bias	human bias // morphospecies!
Sample	specimen homogenized	specimen preserved	specimen alive
Costs	about 80 € / sample (metabarcoding)	> 50 € / h (expert determination □ lab)	> 50 € / h (expert determination □ field, lab)
Upscaling (increasing n)	feasible	limited (expert availability)	limited (expert availability)

Limitations

Malaise traps offer a promising perspective for a broader portion of the insect community, but they are not without their limitations. Currently, Malaise trap community information is limited to presence/absence because genetic methods cannot provide accurate information on relative abundance, although research to address this issue is ongoing (e.g., Sickel et al. 2023). Consequently, species losses will only be registered in Malaise trap data when the species is extirpated. Additionally, metabarcoding processing requires the destruction of the sample: thus, while DNA can be stored for future research, the specimens cannot be re-examined nor vouchered. However, if one divides each sample e.g. into two halves, where only one half is analysed genetically, the other half yields voucher specimens for future analyses.

Recommendations

These limitations mean that, although Malaise traps can collect a wide variety of insects, they are best used in combination with other methods (e.g., pan traps and transect walks) that provide relative abundance information and that preserve specimens for future use. Given that the EU PoMS specifically requires species abundance data, it means that currently Malaise traps are not able to provide this for the EU PoMS Core scheme.

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5 Communications

Besides the press release for the start of SPRING in March 2022 (Fig. 5.1), we did not focus on general press work and rather supported work with the aim to get the attention of the public and especially our potential core community (experts, volunteers, decision makers, etc.) in order to get them involved into SPRING.

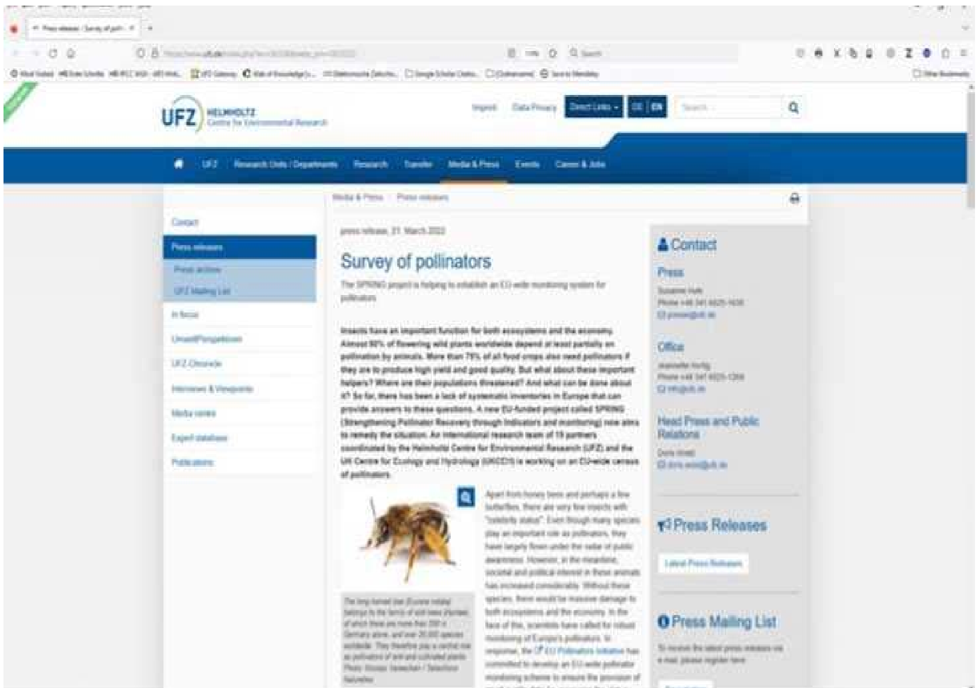
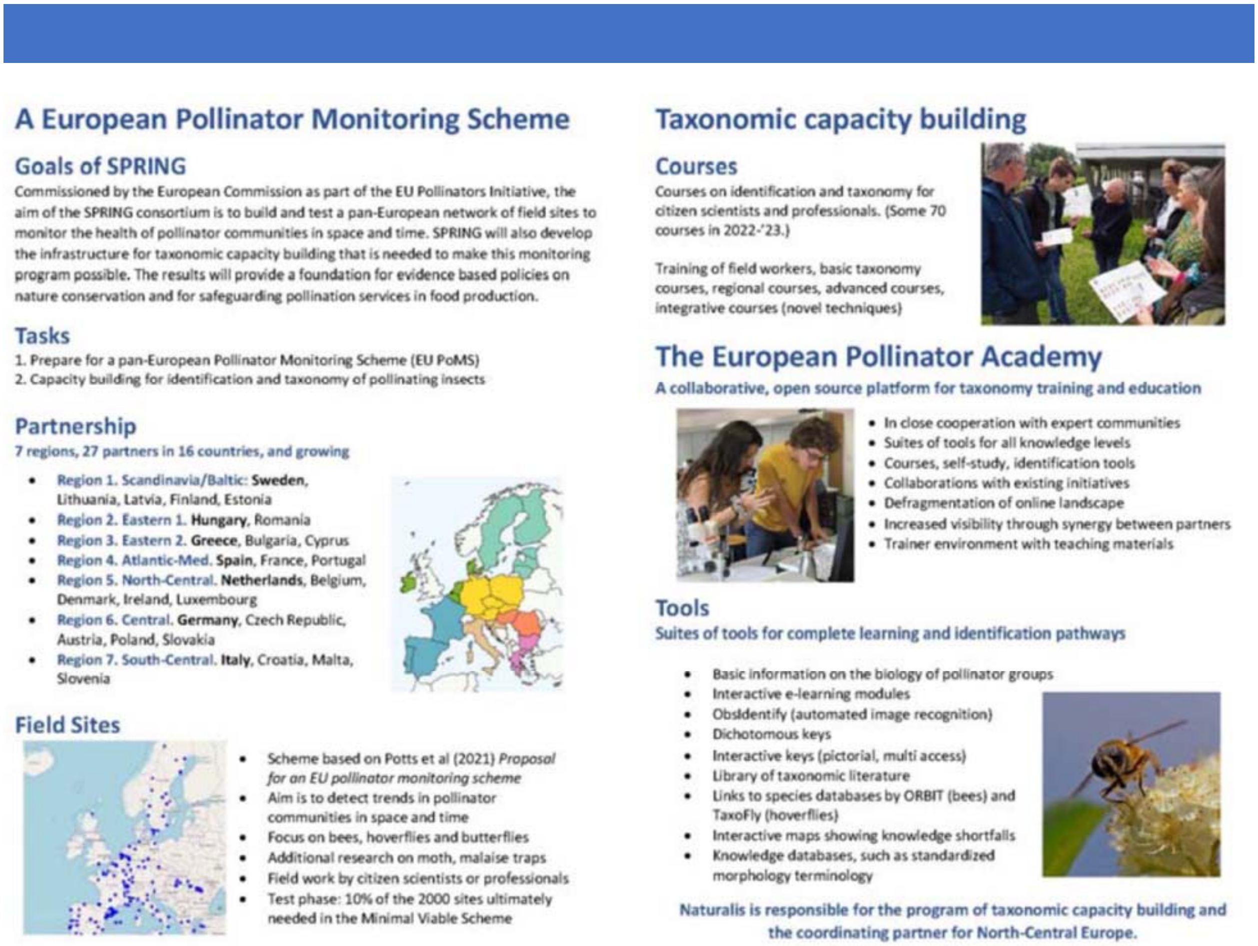


Figure 5.1. Press release for the start of SPRING in March 2022 (screenshot)

We contributed to communication and reporting activities especially through the creation of web pages (www.spring-pollination.eu; https://www.naturalis.nl/en/science/spring-strengthening-pollinator-recovery-through-indicators-and-monitoring), a SPRING flyer which was distributed at conferences (Fig. 5.2), annual newsletters about Task 2 activities (Figs. 5.3. 5.4; also shared with EU partners), preparing and facilitating the conference and workshops during the annual SPRING meetings in October 2022 in Barcelona and October 2023 in Bologna, participation in webinars and conferences (such as 11th International Symposium on Syrphidae in 2022 and the Seminar for the European Butterfly Monitoring Scheme (eBMS) in 2022). Target audiences of the Newsletters during field seasons of 2022 and 2023 were both the SPRING partners, fieldworkers, and other interested parties about the progress and advertise the Pollinator Academy (Figs 5.3 & 5.4).



A European Pollinator Monitoring Scheme

Goals of SPRING

Commissioned by the European Commission as part of the EU Pollinators Initiative, the aim of the SPRING consortium is to build and test a pan-European network of field sites to monitor the health of pollinator communities in space and time. SPRING will also develop the infrastructure for taxonomic capacity building that is needed to make this monitoring program possible. The results will provide a foundation for evidence based policies on nature conservation and for safeguarding pollination services in food production.

Tasks

1. Prepare for a pan-European Pollinator Monitoring Scheme (EU PoMS)
2. Capacity building for identification and taxonomy of pollinating insects

Partnership

7 regions, 27 partners in 16 countries, and growing

- Region 1. Scandinavia/Baltic: **Sweden**, Lithuania, Latvia, Finland, Estonia
- Region 2. Eastern 1. **Hungary**, Romania
- Region 3. Eastern 2. **Greece**, Bulgaria, Cyprus
- Region 4. Atlantic-Med. **Spain**, France, Portugal
- Region 5. North-Central. **Netherlands**, Belgium, Denmark, Ireland, Luxembourg
- Region 6. Central. **Germany**, Czech Republic, Austria, Poland, Slovakia
- Region 7. South-Central. **Italy**, Croatia, Malta, Slovenia

Field Sites

- Scheme based on Potts et al (2021) *Proposal for an EU pollinator monitoring scheme*
- Aim is to detect trends in pollinator communities in space and time
- Focus on bees, hoverflies and butterflies
- Additional research on moth, malaise traps
- Field work by citizen scientists or professionals
- Test phase: 10% of the 2000 sites ultimately needed in the Minimal Viable Scheme

Taxonomic capacity building

Courses

Courses on identification and taxonomy for citizen scientists and professionals. (Some 70 courses in 2022-'23.)

Training of field workers, basic taxonomy courses, regional courses, advanced courses, integrative courses (novel techniques)

The European Pollinator Academy

A collaborative, open source platform for taxonomy training and education

- In close cooperation with expert communities
- Suites of tools for all knowledge levels
- Courses, self-study, identification tools
- Collaborations with existing initiatives
- Defragmentation of online landscape
- Increased visibility through synergy between partners
- Trainer environment with teaching materials

Tools

Suites of tools for complete learning and identification pathways

- Basic information on the biology of pollinator groups
- Interactive e-learning modules
- Obsldentify (automated image recognition)
- Dichotomous keys
- Interactive keys (pictorial, multi access)
- Library of taxonomic literature
- Links to species databases by ORBIT (bees) and TaxoFly (hoverflies)
- Interactive maps showing knowledge shortfalls
- Knowledge databases, such as standardized morphology terminology

Naturalis is responsible for the program of taxonomic capacity building and the coordinating partner for North-Central Europe.

Figure 5.2. Page from the SPRING flyer prepared in 2022.

Figure 5.3. Newsletter by Task 2, July 2022.

Figure 5.4. Newsletter by Task 2, August 2023.

A detailed account of the SPRING documentation and training materials is presented in Annex A5, which includes links for the download of files.

In “A5.1 Task 1 Documentation” you find the communication material developed by Task 1 (Butterflies and Citizen Science activities; see chapter 1) of the SPRING consortium. There you find an overview of the folder structure and links to download the files.
In “A5.2 Task 2 Documentation” and “A5.3 Task 3 Documentation/data base” the principles are the same. A5.3 gives links to the original data which are stored as Excel files.

As an example we here (Box 5.1) present the overview of training materials available at the Pollinator Academy
The specific files are listed in the Annex under A5.2 “Task 2 Documentation” including information on the folder structure and download options.

Box 5.1: Training materials available at the Pollinator Academy

Playbook & Logistics
Checklists, guidelines and templates to help you prepare your training course.
o Playbook
o Course curriculum
o Checklist course preparation
o Template presentation
o Template course outline
o Evaluation form
o About learning objectives
o Tips & tricks for course design

General training materials

About pollinator groups, monitoring skills, the economic importance of pollination and more...

- Welcome to EU PoMS
- Meet the pollinators
- Fieldwork practices
- Going into the field (available in various languages)
- Recognising pollinator groups
- Taxonomy and morphogroups
- Morphogroups – manual for pollinator categories in EU PoMS
- Developing your observation skills
- The ethics of collecting specimens
- Collecting and curating specimens

Handouts, games & quizzes

Handouts per pollinator group and resources to spice up your course.

- Handout - Bees
- Handout – Butterflies
- Handout - Hoverflies
- Handout – Bumblebees
- Quiz – Mimicry (PPT)
- Quiz – Broad pollinator groups (PPT)
- Quick guide to bees (morphogroups)
- Quick guide to bumblebees (morphogroups)
- Quick guide to hoverflies (morphogroups)

Bee training materials

A selection of training materials on bee identification, suitable for a range of skill levels.

- Bees – Recognising bees
- Bees – Recognising bumblebees
- Bees – Ecology & diversity
- Bee morphogroups
- Bee genera identicication
- Pinning bees – instruction video
- Bee anatomy search tool

Hoverfly training materials

A selection of training materials on hoverfly identification, suitable for a range of skill levels.

- Hoverflies – Recognising hoverflies
- Hoverflies – Ecology & diversity
- Hoverflies – morphogroups
- Hoverflies – Regional, distinctive species
- Hoverflies – Wings
- Hoverflies – Distinctive features
- Hoverfly anatomy search tool

Butterfly training materials

A selection of training materials on butterfly identification, suitable for a range of skill levels.

- Butterflies – Recognising groups and species

All of the above documents can be found on:
Pollinator Academy - trainer portal: https://pollinatoracademy.eu/trainer-portal/
Password: Pollinator42

Online microlessons
Link: https://pollinatoracademy.eu/training/microlearnings/
- Bee or hoverfly?
- Wild bee or honeybee?
- Butterfly or moth?
- Bee or wasp?
- Hoverfly or another fly?
- Quiz – Recognising bees and hoverflies
- Quiz – Recognising bees and hoverflies amongst other flies
- Hoverfly body – the basics
- Bee body – the basics
- How do insects get their names?
- The basics of pollinator taxonomy
- Beyond morphological identification
- What makes an insect a good pollinator?
- Female or male butterfly?
- Female or male bee?
- Female or male hoverfly?

Final impressions

Figure 5.5. Group picture of participants of the final presentation of SPRING at the European Commission on the 23rd of January 2024

SPRING final conference

European Commission, Charlemagne building, Rue de la Loi 170, 1040 Bruxelles, room Lord Jenkins.

Tuesday 23rd January 2024, 10am to 4pm.

Registration via: https://events.hifis.net/event/1144/

Programme

9.30-10.00am. Arrival for registration

10:00 – 10.45 am. Welcome

Welcome by Humberto Delgado Rosa, Director, Directorate-General for the Environment, European Commission

Welcome by SPRING coordination. Josef Settele, UFZ

SPRING overview and plan for the day. Josef Settele, UFZ

10.45 – 12:30 Showcase of the SPRING project – Piloting the field sampling: Chair: Josef Settele, UFZ

10:45 – 11:15 Key messages from piloting the Minimum Viable Scheme. David Roy, UKCEH

11:15 – 11:30 Experience from piloting the Minimum Viable Scheme in Spain. Jordi Bosch, UAB

11:30 – 11:45 The role of malaise traps. Mark Frenzel, UFZ

11:45 – 12:00 How to monitor moths within EU PoMS. Irma Wynhoff, Vlinderstichting/BCE

12:00 – 12:15 Comments and Questions

12:15– 13:30 Lunch

13:30 – 15:30 Showcase of the SPRING project – Capacity Building: Chair: David Roy, UKCEH

13:30 – 14:00 Citizen science – butterfly monitoring. Cristina Sevilleja or Sue Collins, BCE/Vlinderst.

14:00 – 14:30 Citizen science – other pollinators. Michael Pocock, UKCEH

14:30 – 15:30 Taxonomic capacity building and resources. Mark van Nieuwstadt and Merel Bozua (both NATURALIS). Regional experiences (Ana Jesovnik, State Institute for Nature Protection, Croatia) and experiences from advanced courses

15:30 – 16:00 Closing remarks
STING project, Simon Potts, UREAD
SPRING project, Josef Settele, UFZ
Final remarks, Martin Hojsik. Member of the European Parliament (MEP)

Figure 5.6. Program of the final presentation of SPRING at the European Commission on the 23rd of January 2024

Annexes of the SPRING Final report

A0 Introduction and overall aims of the project

A0.1 SPRING project management and governance

Project management and organization of the work
The institution in charge of the overall management and coordination is the Helmholtz Centre for Environmental Research - UFZ, Germany. Professor Josef Settele, who is heading SPRING, is a global expert in biodiversity research and science-society-policy interactions.

Decision-making structures and quality control
Core elements of the coordination were a Steering Group (SG) and the Project Office (PO), both headed by the Project Coordinator (Josef Settele, UFZ). The SG (see Table A.1) was responsible for the scientific-technical co-ordination. It made the necessary decisions in coordinating and administering the project. The SG comprised the Coordinator, a member of the coordination team (to be employed at UFZ), and the heads and deputies of the Tasks. The Coordinator reports directly to the EC.

Table A.1: Members of the SPRING Steering Group (SG)

Tasks	Delegate(s) in SPRING SG
Task 1	
Task 1.1	Sue Collins (BCE)
Task 1.2	David Roy (UKCEH)
Task 2	
Task 2.1 & 2.2	Koos Biesmeijer (Naturalis)
Task 3	
Task 3.1	David Roy (UKCEH)
Task 3.2	Josef Settele (UFZ)
Task 4	
Task 4.1	Chris van Swaay (Vlinderstichting)
Task 4.2	Simon Potts (UREAD)
Task 5	
Task 5	Josef Settele (UFZ)

The SPRING project steering group has formally met every 2-4 months and has had regular day-to-day correspondence via email and via a dedicated Microsoft Teams collaborative site. A meeting of all project partners was held via Zoom on 24th June 2021. A second meeting of all project participants was held on 28th January 2022. The January 2022 project meeting was held using the interactive online tool gather.town to allow social interaction between the project team, alongside formal presentations and discussions. Additional meetings were held at the Task and sub-Task level as outlined in the following updates. The first in-person meeting took place in October 2022, hosted by CREAF in Barcelona, the second one in October 2023 in Bologna, hosted by CREA. The final meeting with the Commission took place on the 23rd of January 2024 in Brussels.

Project partner from the very beginning were the following institutions (1: co-ordinator; 2-19 subcontractors):

1. UFZ
2. Naturalis
3. De Vlinderstichting
4. UKCEH
5. Butterfly Conservation Europe
6. Butterfly Conservation - UK
7. Centre for Ecological Research
8. CREA AA
9. Creaf, UAB
10. EIS European Invertebrate Survey
11. University of Helsinki
12. Université Libre de Bruxelles
13. University of Alicante
14. University of Lund
15. University of Mons
16. University of Novi Sad
17. University of Reading
18. University of The Aegean
19. Senckenberg

A1 Expansion of eBMS & CS networks on pollinators

A1.1 Expand the European Butterfly Monitoring Scheme (eBMS)

A1.1.1 Specific updates

Provide training on butterfly identification and transect monitoring

Training on butterfly identification and monitoring methodology has been provided across Europe reaching a large audience, capturing new volunteers and consolidating knowledge for current volunteers. Workshops and seminar have been held in-person this year in several countries: in Cyprus (Akrotiri) bringing people from across the whole island and teaching monitoring for butterflies, moths and dragonflies and the use of the ButterflyCount app; in Italy - several workshops for recruiting more transects and volunteers, one workshop in the Stelvio National Park training rangers and potential volunteers in the protected area; in Bulgaria (Pirin National Park) teaching about butterflies of the area, the importance of monitoring and BMS.

In Lithuania, a training excursion teaching butterflies on the field and use of the app; in Poland workshops in two landscape parks (West and East of Poznań) quite successful with 100 participants; in Spain – first national Spain BMS meeting in-person with people from all around the country, important to consolidate the network.

Recurrent training has been held online to keep a closer relation with volunteers and recorders to solve problems, doubts and create a better network and show the use of the eBMS website and app. These trainings were done in Spain, Lithuania, Italy, Portugal, Slovenia, Latvia, Romania, and Austria.

Figure A1.1 On the left, workshop in Lithuania (June 2022) and right, workshop in Wielkopolskich landscape park Poland.

Provide updated material on butterfly identification and transect monitoring

Training materials continue in preparation in several countries with creation of presentations to teach about butterfly identification, methodology of the transects and 15min counts. In general, eBMS provided that information to coordinator to adapt it and give it on local seminars and workshops. More training videos were produced on the BCE Youtube Channel on the use of the website and app for monitoring. See chapter A5.1 & A5.2.

During this year, three field guides has been completed. One regional field guide for Austria, for the identification of the butterflies of the Lake Neusiedl area, available online pdf in English and in German. One field guide was produced for Malta including all the occurring species and probable migratory species to see on the country; available pdf online in English and Maltese. Some field guides were produced before for some Spanish regions but in 2023 the Field Guide of common species for Spain (including islands) was created with available online version in Spanish and English.

Figure A1.2 Field guides produced in 2022, on the left Austria – Lake Neusiedl area, centre Malta field guide and right Spain Common species.

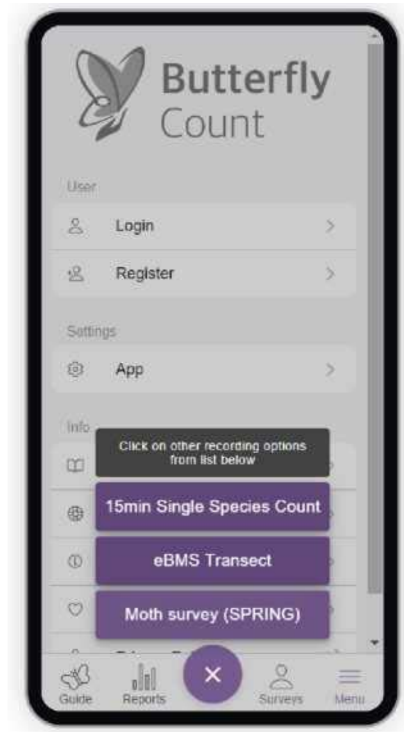
More tailored Field Guides have been developed: Slovenia (mountain species), Denmark, natural parks of Spain, France (three regions), Romania and Bulgaria. Revision and updates of previous field guides are in progress for Cyprus and Italy to improve the material.

National coordinators got support from the project to do their coordination and providing materials for butterfly monitoring, printing field guides (Spain, Lithuania and Poland), buying 52 butterfly nets (Italy, Lithuania, Spain) and creating promotional material like roll-up banners, butterfly eBMS pins, and flyers.

eBMS has been working with task 2 to produce butterfly material for identification in a basic level to be part of the future Pollinator Academy. Material on different modules for butterflies and moths is on preparation and planning which modules will be necessary to new volunteers and people with more knowledge to learn to species level. For available material see Chapter A5.1.

Test the Moth Trap survey with the ButterflyCount app with SPRING and eBMS partners

The ButterflyCount app has incorporated a new function to record the moth abundances collected on the LedTraps tested by the Task 4.1. Partners and several recorders have been testing the app on the field and the website for moth monitoring in 2022, providing improvements that have been included and others will be included. At the moment, it is possible to register moth LedTraps in the app/website, register a visit and enter the moth abundances, recording with scientific names and common names in several languages. The app provides the automatic identification of moths by Artificial Intelligence (AI) generated from Observation.org. The user can take a picture directly on the app while registering a visit and the app provides the identification of the most likely species. If the AI doesn't recognise the species, it will stay as "unknown" and save the picture and abundances for later identification by experts. This automatic identification has been tested and work well mainly in North-Western countries, being quite useful for beginners and encouraging the moth monitoring more frequently.



Incorporate additional languages within the eBMS website and ButterflyCount app

The different tools of eBMS have been improved constantly where translation is fundamental. We incorporated new five languages (Romania, Danish, French, Turkish and Japanese) and continue improving the current languages with new terminology for the new functions and reviewing for a better understood (Slovenian, Spanish, Portuguese, Italian, Bulgarian, German, Swedish, Croatian, Hungarian, Lithuanian, and Polish). All the languages are being done for the website and the ButterflyCount app.

Publish eBMS newsletter

The content of the 2022 newsletter was focused on eBMS progress during 2022, new countries doing monitoring and the fledging schemes improving thanks to SPRING project; provide links to new materials and update the use of the new methodology 15-min counts to encourage its use in Europe. The idea is to publish before the butterfly season to motivate recorders and keep the fundamental feedback.

Re-analyse BMS data to quantify trends for individual species and update EU Butterfly Indicators

The grassland butterfly indicator has had a major updated, with the addition of two years of additional monitoring data from Butterfly Monitoring Schemes across Europe. The Indicator is the combined population trend of 17 selected grassland species monitored across Europe and calculated from population trends estimated for the whole European region or restricted to the 27 EU Member States. The indicator spans years between 1990 and 2020. The indicator and species trends are being reviewed by the 25 contributory monitoring schemes (from 23 countries). See chapter 1.1 for details.

Set up eBMS schemes in remaining Target countries (Greece, Latvia and Slovakia)

The Greece BMS has been set up called ¨Apollo¨, with a stablished coordinator who makes contacts with several volunteers, administration and stakeholders, shares the transect data with eBMS and is on communication with eBMS for further progress. One workshop was done and 13 transects are been monitored in Greece at the moment. Some improvements are being planned on eBMS for allocating Greek volunteers, including translations, managing permissions and access to site for monitoring. We are helping the Greek coordinator on managing data on butterfly monitoring.

For Latvia, there is a BMS coordinator doing some training and coordinating volunteers, specially online for reinforcement of knowledge. Data has been shared with eBMS and translation is in progress. We did some plans for 2023 on going further with the scheme,

Review with coordinators the number of volunteers and transects involved in eBMS schemes

With the latest update of the eBMS database v5 (data shared from all BMS and verified to be part of the central eBMS database by 2021 data), **9122 is the total number of butterfly active transects (i.e. walked in the last two years)** for the European continent.

There are more countries and schemes involved to date, but this data is still being processed for inclusion in the central eBMS database. In total, around **10,000 volunteers** have participated in the eBMS network, providing valuable butterfly monitoring data during all the monitoring years.

Table A.1.1 Total number of transect per Butterfly Monitoring Scheme (BMS) on the eBMS central database

Country/Region	Transects	Country/Region	Transects
Austria -Tirol	209	Italy	89
Austria - Vienna	35	Latvia	35
Belgium - Hander	156	Lithuania	1
Belgium - Wallonia	67	Luxembourg	182
Croatia	36	Netherlands	1438
Cyprus	1	Norway	52
Czech Republic	22	Poland	12
Estonia	9	Portugal	62
Finland	69	Romania	8
France	155	Slovenia	11
Germany	756	Spain	419
Hungary	15	Sweden	1071
Ireland	181		

Incorporate additional languages within the BMS website and ButterflyCount app

To enhance the eBMS tools, website, and app, we are continuously expanding our language options applying translations done in the website Transifex. We have recently added new languages such as Slovak, Greek, Catalan, and Galician. Additionally, we updated the terminology and functions for **18 languages**, including Bulgarian, Croatian, Czech, Danish, Dutch, French, German, Hungarian, Italian, Japanese, Lithuanian, Polish, Portuguese, Romanian, Slovenian, Spanish, Swedish,

The ButterflyCount App has been updated with all languages while countries utilizing the eBMS website for data collection have contributed translations in their respective local languages to the eBMS system.

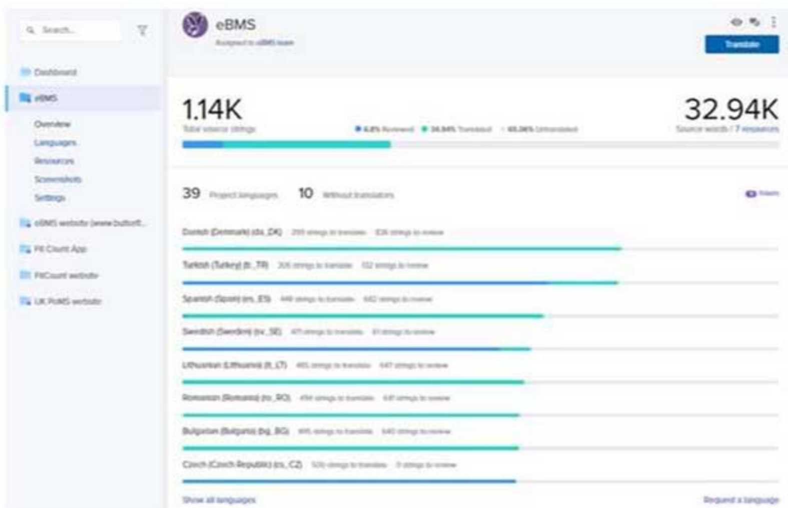


Figure A1.3. Progress of languages translated

Create guidelines for collecting data for moth monitoring on eBMS tools

In collaboration with task 4.1, we have created guidelines for collecting moth data onto the eBMS system. The moth data can be included through the eBMS website and also, through the ButterflyCount App. This App now enables recorders to use an Automatic Identification algorithm to support quick and accurate on moth identification. The Guidelines explains, step-by-step, the whole process, from the registration of the eBMS account, the creation of the different moth trap visits, photograph all the moths present in the morning, and load them for identification and verification.

Provide seminars and workshops on butterfly monitoring in several countries

Training on butterfly identification and monitoring techniques has been disseminated throughout Europe, reaching a significant audience, attracting new volunteers and enhancing the expertise of current volunteers.

In-person workshops and seminars were conducted in several countries during 2023:

- *Cyprus*: few days field trip in Kathika, Cyprus to teach butterfly identification and strengthen the Butterfly Monitoring Scheme (BMS) in the southern region. Another meeting was held in September in North-Cyprus with foreign residents to tally butterflies.
- *Germany:* As part of Task 2, and jointly with the German BMS hosted an online course on butterfly identification in April.

■ In Greece, BCL-Biodiversity Conservation Lab organised a field excursion to Gramos to train volunteers on butterfly monitoring and disseminate the Apollo-Greek BMS.

■ In *Latvia,* one volunteer meeting and several trainings online have been made to reinforce the scheme and get more transect running.

■ In *Italy*, numerous workshops have been conducted from the north to the south. In the National Park Circeo, a workshop was conducted with nature rangers (Carabinieri) to monitor butterflies in protected areas. Another workshop was held in Sicily to develop more transects. A seminar with an agricultural association took place in Turin, and a small BMS workshop was conducted on the WWF Oasis at Lake dell'Angitola.

■ In *Romania*, a few workshops have been held at the Babeș-Bolyai University and in the botanical garden to invite volunteers to join the Romania BMS.

■ *Slovakia*, an online meeting was held in May to introduce the new Slovakia BMS as a starting point to create butterfly transects in the country with the help of the MEP of Slovakia Martin Hojsik.

■ *Spain*: In May, the SOCEME association and eBMS jointly organised multiple online workshops aimed at assisting new and current volunteers in butterfly monitoring. The workshops addressed methodology and provided training on specific butterfly genera to enhance knowledge. Recordings of the workshops are now accessible on SOCEME's YouTube channel.

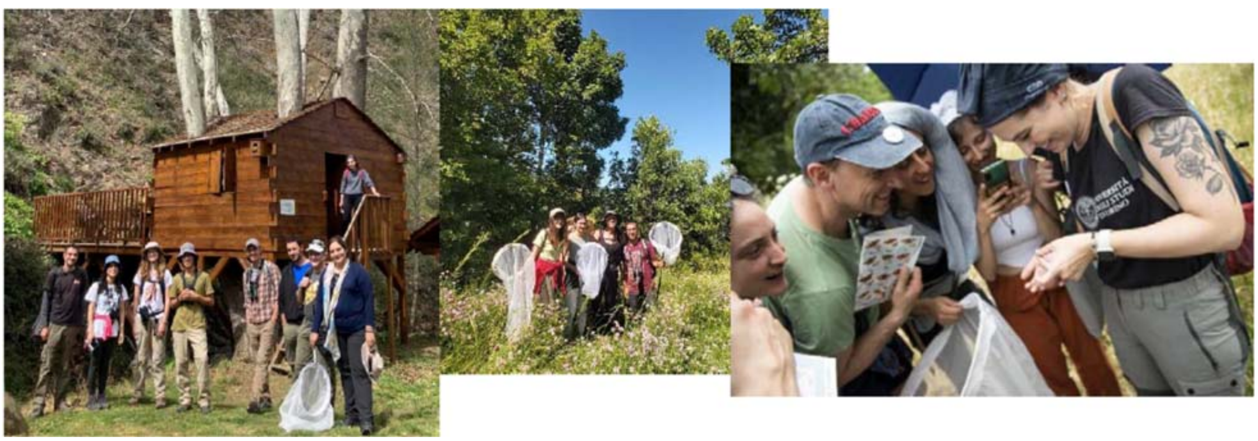


Figure A1.4. Workshops held in 2023:
first, field trip in Cyprus (April); second, Apollo-BMS excursion Greece (July),
third, a butterfly workshop for agriculture in Italy (June).

Annual meetings: bonds of the BMS network

This year, we have emphasized the significance of the Annual Volunteer meetings in consolidating the scheme and sustaining its existing volunteers. These meetings aim to acknowledge volunteer effort, offer feedback, and exchange improvement ideas within the volunteer community.

In 2023, we successfully held fruitful Annual Volunteer Meetings in several diverse countries. In February, we commenced our activities with the III Encontro Censos de Borboletas de Portugal in Avis with participation from over 80 individuals. They delved into discussions about the four-year progress of BMS across 60 transects.

Subsequently, our annual meeting celebrating the 9th year of the Hungarian BMS, transpired in Hungary in July. Volunteers and professionals alike congregated to share their passion for moths and butterflies. Later in autumn, after the butterfly season, additional yearly conferences were held. For instance, in Valsaín, Spain, the II Encuentro Nacional Red de Seguimiento de Mariposas

was attended by 90 participants from diverse regions of Spain who relished a weekend of butterfly discussions.
Subsequently, the recent establishment of Denmark BMS held its Inaugural Annual Meeting, attended by volunteers who participated in this year's monitoring, and the online yearly meet for Lithuania BMS took place, where volunteers enjoyed spending time together and exchanging ideas from the past season.

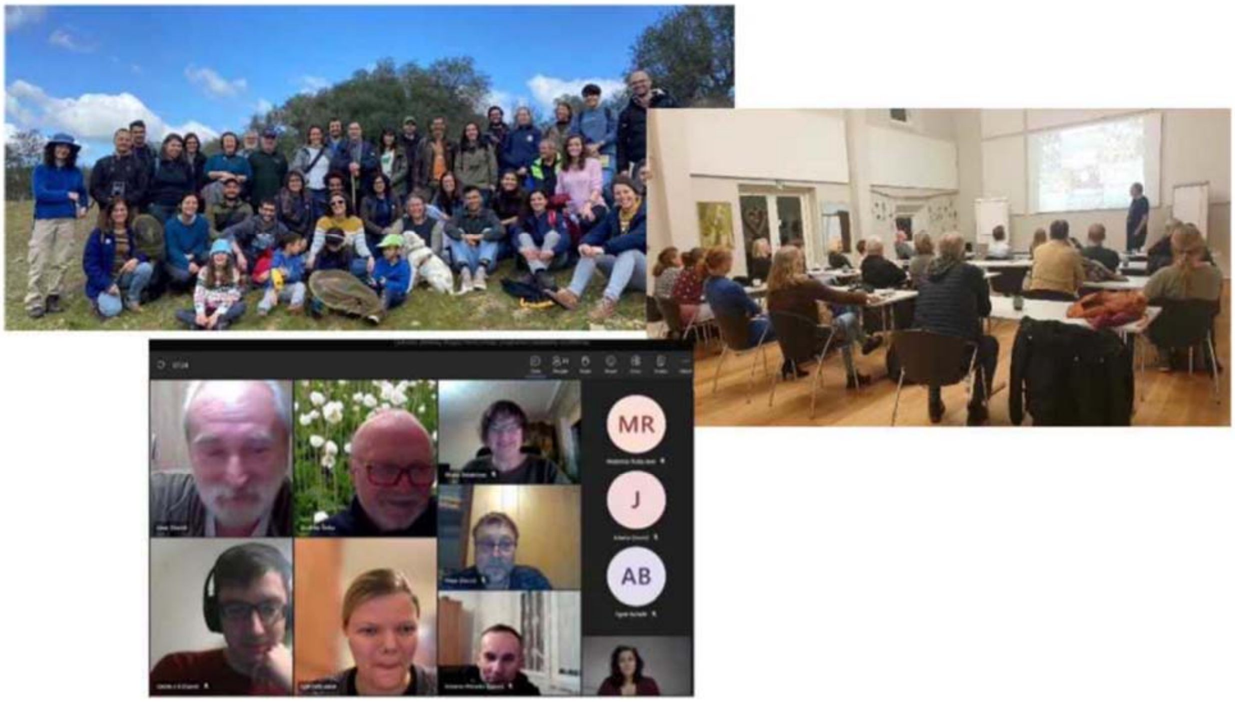


Figure A1.5 Annual meetings: 1^{st} Avis, Portugal; 2^{nd} first meeting Danish BMS, Vejle; 3^{rd} online annual meeting Lithuanian BMS and 4^{th} the 9^{th} meeting Hungarian BMS. There are additional planned in-person meetings in Austria, Slovakia, and Italy in early 2024, before the butterfly season, with the aim of engaging volunteers to maintain the butterfly count.

Figure A1.6 Promotional poster of national meeting in Romania (October 2023)

Provide updated material on butterfly identification and transect monitoring

During 2023, eBMS expanded its efforts to produce additional **tailored field guides** to help in butterfly identification across various countries and regions. A second field guide was specifically developed for the mountainous and challenging species found in Slovenia, which included both Slovenian and English versions. Hard-copy prints of the guide were then distributed amongst volunteers in Slovenia. This type of instructional material is appealing to protected areas. In collaboration with relevant administrations, eBMS created numerous tailored field guides for protected areas. Notably, three field guides in both Spanish and Galician were created for Galician Natural Park in Spain.PN do Monte Aloia, PN Baixa Limia-Serra do Xurés and PN Complexo dunar de Corrubedo e lagoas de Carregal e Viváx.

More Field Guides are in preparation in different countries through the work of BCE and national co-ordinators beyond the SPRING project. We are progressing with the France's tailored guide for the Continental area, Epirus Greek region and common species Field Guides for Romania, Denmark, and Bulgaria. There are also ongoing revisions and updates for the existing field guides in Cyprus and Italy to enhance their material. An updated version in Italian and English is now available for the Padana Plain region

in Italy, featuring more species and better information. For this particular country, updates are currently underway, which involve dividing the islands to ensure better species management and easier monitoring in specific areas. Also, another Field Guide has been produced for the Natural Park Monviso and Val Grande National Park.

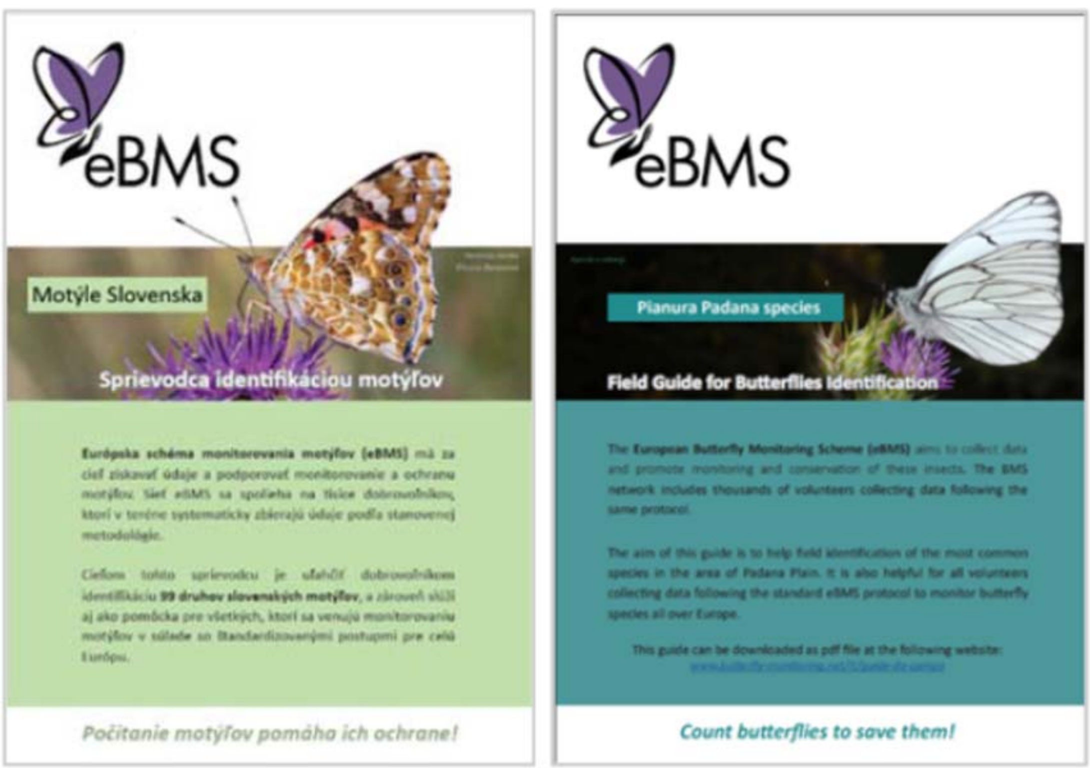


Figure A1.7 Field guides produced in 2023, on the left Slovak FG and on the right, Padana Plain, IT.

As part of the project, national coordinators have received support in coordinating activities (BCE contracts to coordinators) and providing material for butterfly monitoring, including the purchase of 25 butterfly nets (for Slovakia, Austria, and Spain), in addition to the creation of promotional material like butterfly eBMS pins, roll-up banners, and flyers. The countries involved in these activities include Spain, Denmark, Romania, Bulgaria, Hungary, France, Italy, Lithuania, and Slovakia.

To support butterfly identification, eBMS has collaborated with task 2 - Naturalis, to create microlearning resources now accessible on the **Pollinator Academy**. These resources explain how to distinguish between butterflies and moths and identify female and male butterflies, and the body structure of a butterfly (in progress). Additionally, now the Pollinator Academy provides fundamental knowledge about butterflies, resources and useful websites, easily accessible to everyone.

Finish setting up eBMS schemes in remaining Target countries

Establishing a Butterfly Monitoring Scheme (BMS) throughout all EU countries was a demanding undertaking, but the SPRING project successfully accomplished this feat. Currently, the BMS is operational in the six remaining countries. The initial year of the project proved fruitful with the swift incorporation of the Lithuanian BMS. This achievement can be attributed to a dedicated coordinator who promoted the scheme, facilitated meetings and ensured effective communication.

Table A.1.2 Development of target countries in Task 1.1 during SPRING project.

Country	Active transects	Translation	Materials	Starting year
Lithuania	19 transects	Website, app and manuals	Field Guide (FG) and online materials made	2021
Greece	13 transects	Website, app and manuals	Online materials made and FG in progress	2022
Romania	3 transects	Website, app and manuals	Online materials made and FG in progress	2022
Latvia	4 transects	Manuals and app	Online videos	2022
Slovakia	5 transects	Website, app and manuals	Field Guide and online materials made	2023
Denmark	~30 transects	Website, app and manuals	Online materials made and FG in progress	2023

Later, some arrangements were made and Greece, Romania, and Latvia progressed towards the incorporation of butterfly monitoring in their respective countries.
Eventually, in 2023, Slovakia and Denmark established their BMS successfully and in a short time added multiple transects and new volunteers.

BMS coordinators in all EU countries have been generating materials to facilitate effective and repeated monitoring by volunteers and endorsed the scheme and translated the eBMS tools.

Publish eBMS newsletter

eBMS news for 2022 has been compiled and prepared, however the creation of a new eBMS newsletter is delayed. The newsletter on January 2024 with the last updates of the SPRING project results and other news of eBMS has been produced to disseminate among volunteers, eBMS users, coordinators and stakeholders. The content is focused on eBMS progress during 2023, new countries doing monitoring and the fledging schemes improving thanks to SPRING project; provide links to new materials and update the use of the new methodology 15-min counts to encourage its use in Europe, main features and characteristics of ButterflyCount app and the starting of moth monitoring standardise in Europe. The idea is to publish before the butterfly season to motivate recorders and keep the fundamental feedback.

Figure A1.8 Summary results of 15min count method used on the eBMS Newsletter 2024.

A1.2 Building capacity for Citizen Science networks on pollinators

Based on the work undertaken in the first year of the SPRING project, two journal papers have been at an advanced stage of development at the time of the final reporting (Jan 2024): (1) a paper on the landscape of Citizen Science (A1.2.1); (2) a paper on the barriers and opportunities for pollinator Citizen Science in the EU (A1.2.2). These are now near finalisation and the main results are summarized here.

A1.2.1 A global audit of methods for pollinator monitoring with Citizen Science

We assessed the global landscape of pollinator Citizen Science by collating data from 97 pollinator Citizen Science projects (from searches of websites and academic papers, and public elicitation) and assessing variation in their methodologies using multivariate statistics. Overall, 75% of projects focussed on recording pollinators (e.g. butterfly monitoring), 20% focussed on interactions (e.g. focal flower counts like FIT Counts) and 5% focussed on pollination. Unsurprisingly, most project methodologies focus on bees, with some specifically on bumblebees or honeybees, but a substantial portion also focus on butterflies and moths. The majority of projects were open to the general public, and only 10% were focussed on specific groups like bee-keepers, even though specific groups can be highly committed (e.g. providing pollen samples for hives on a weekly basis for laboratory analysis).

Overall, the multivariate analyses indicated that the variation in projects is best explained by the protocol (axis 1: explains 33% of the total variance in methods), with variation from simple projects with submissions anywhere and anyhow, to more complex protocols suitable for systematic monitoring and scientific research. We are undertaking further work to explore how these different types of methods currently relate to the impact of the project (i.e. its scale in terms of number of participants and amount of data, and its scientific and policy impact).

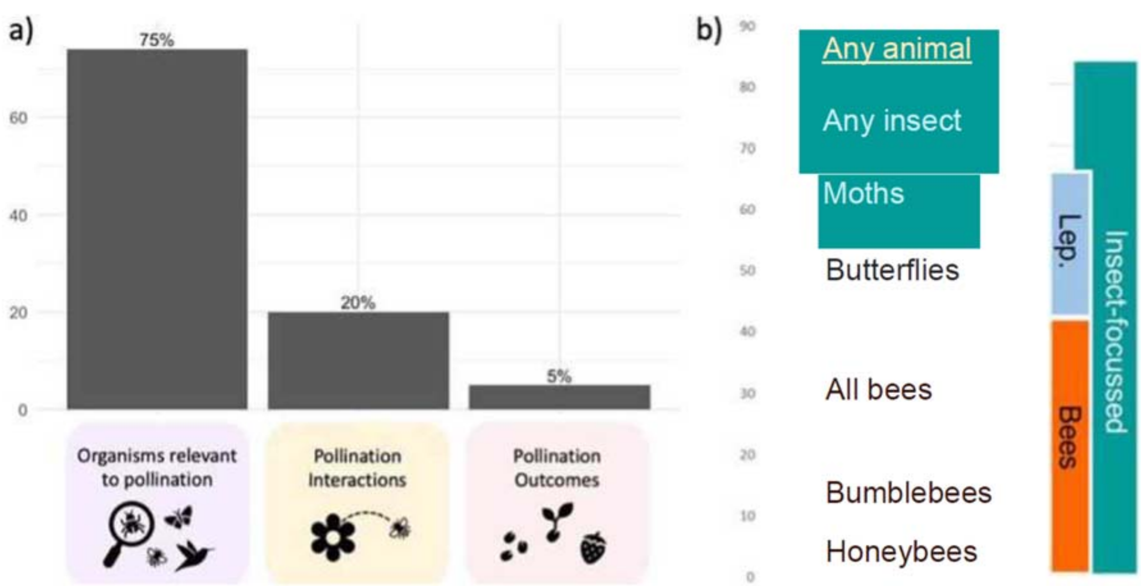


Fig. A1.9 a)The focus of the project: measures of pollination, observations of interactions or observations of species b) The taxa groups focused on in projects.

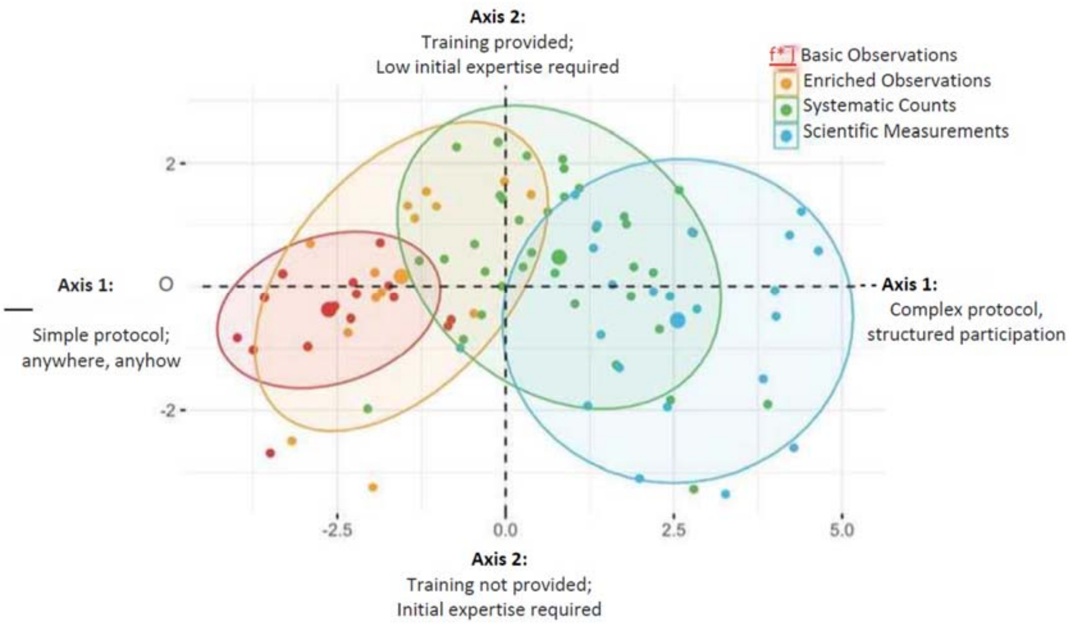


Fig. A1.10 The landscape of pollinator Citizen Science methods according to the two axes that explained the majority of the variation in methods. The axes are described based on how strongly they were correlated to the method attributes used in the analysis.

We found that there could be opportunity to explore further the use of Citizen Science in assessing pollination, especially since it links directly to an ecosystem service. We found that although most projects are designed for the ‘general public’, there is opportunity to explore further the use of Citizen Science for specific target audiences, so that they can be tailored to the motivations and needs of these groups.

Overall, the methods audit revealed the huge diversity of methods used in pollinator Citizen Science. While consistent methods rolled out over large scales (e.g. eBMS and FIT Counts) are incredibly valuable, it is valuable to consider the portfolio of methods available for different Citizen Science audiences to meet multiple needs for standardised monitoring, scientific research, public engagement and evaluating impacts of local action.

A1.2.2 Growing Citizen Science: revealing the factors affecting the state of pollinator Citizen Science across Europe

Within the European Union, there is a strong focus on Citizen Science, as evidenced by its presence in funding schemes such as Horizon 2020 and BiodivERsA. However, despite the shared values in communities across the EU, there are substantial differences in socio-geographic, economic, historical, political and cultural factors across Europe (Halman et al., 2022; Vignoles et al., 2018). There is also variation in Citizen Science activity across Europe as well: there are reported to be more Citizen Science projects, more funding and more support in Central and Western Europe compared to Southern and Eastern Europe (Bio Innovation Service, 2018; Hecker et al., 2018). We collaborative developed a public survey gaining 321 responses from experts in pollinators and/or Citizen Science in 35 European countries about factors and barriers supporting Citizen Science.

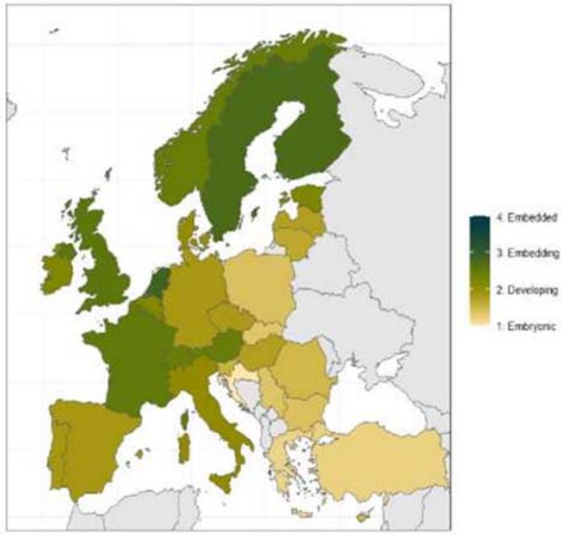


Fig. A1.11 Map of country-level mean rating for ‘overall pollinator Citizen Science’ in European countries. Countries were scored by respondents by choosing a narrative description that best matched their country according to the four levels shown in the key. Values were averaged across all respondents in each country and countries with less than 3 respondents were excluded.

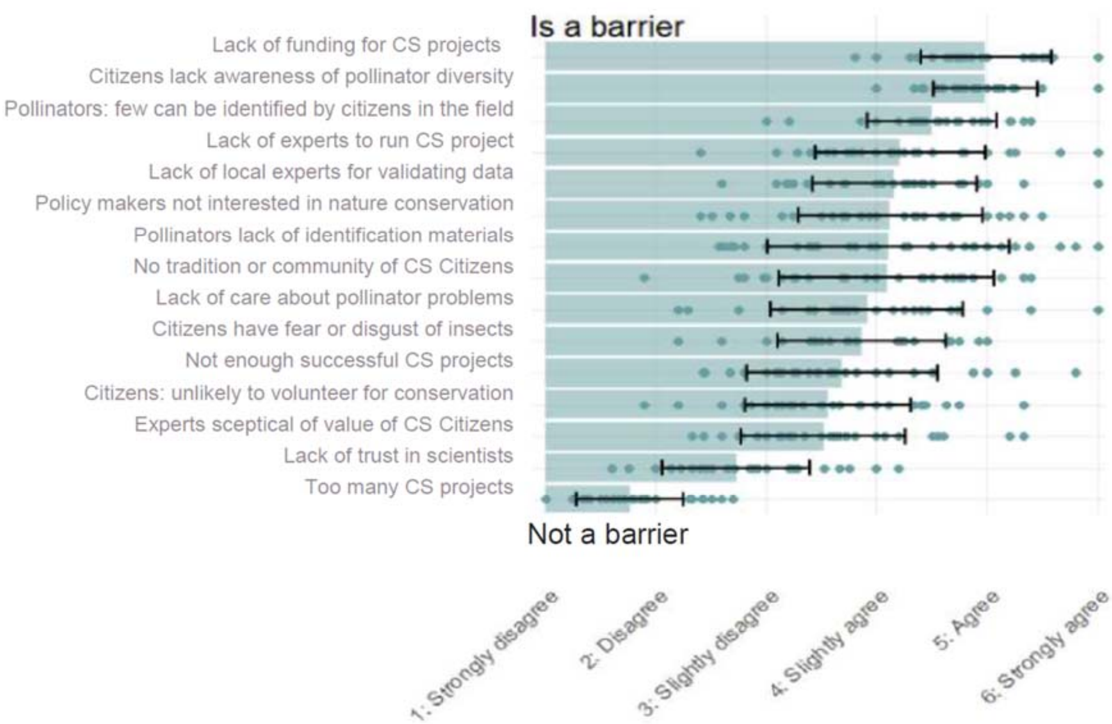


Fig. A1.12 Respondents also scored barriers across countries. The bar shows the mean score across countries, the points are the average score per country, and the error bars represent one standard deviation of the scores. The barriers are ordered from top (is most strongly viewed as a barrier) to bottom (is least strongly viewed as a barrier).

A1.2.3 Develop plans to strengthen citizen and farmer science networks for engagement in volunteer moth monitoring

During the SPRING project, BCE and Dutch Butterfly Conservation have been encouraging the establishment of moth monitoring sites by volunteers across Europe. The strategy focuses on different approaches to secure moth monitoring done by volunteers in a long-term in Europe:

8. Build on the learning and feedback from the moth pilot in Task 4.1 and share it with eBMS coordinators.
9. Support eBMS coordinators to reach out to interested volunteers to set out standardised moth traps, and share LED-traps of moths with them and
10. Produce and translate guidance of the moth LED trap demonstrating how the trap could be assembled by individuals, do the collection of records and submit records to the European platform.
11. Bring together an initial network of expert moth taxonomists who would be willing to act as validators of AI identified photographic images.
12. Translate the App ButterflyCount for moth monitoring into more languages and encourage volunteers to share photos via the App to improve the identification across the EU.
13. Share the experience in the Netherlands of working with farmers and farmer organisations more widely to encourage farmer participation in moth monitoring on more farm sites.
14. Encourage the EU and MSs to recognise the increasing evidence of moths as important pollinators and to provide resources for increasing moth taxonomic expertise, coordination of standardised moth monitoring and use of moth monitoring results in policy evaluation and in their action plans to reverse the declines in pollinators and recovery of the habits they depend on.

During 2023, BCE has been following and developing this strategy through its network and possible partners joining the moth monitoring. In particular, the BCE network has explored the possibility of recruiting possible moth validators among the BCE partner network and lepidoptera experts. To approach this task, BCE has considered its different partners and their current involvement in butterfly and moth monitoring in order to approach the most effective and productive strategy with partners.

Some fruitful results have also been achieved with the establishment of moth monitoring sites in Cyprus, Portugal, Austria, Lithuania, Italy and Spain, which have been recorded by volunteers, in addition to those defined at the pilot site in SPRING (see section on moths below). It is expected that these sites will continue to be monitored in the future.

We have recruited some moth validators from these countries and there are opportunities to recruit more validators in the countries needed to spread volunteer moth monitoring. Improving the AI for Easter and Southern countries will help to involve more volunteers in moth monitoring as it will help and facilitate the identification of a complex group such as moths.

As written in the main document under 1.2, it is recommended that the moth monitoring protocol, which has been successfully tested in several MS during SPRING, is included as a core component of the next phase of the EUPoMS and rolled out across Member States as soon as possible.

To facilitate this, resources are needed to support EU level coordination and help strengthen networking among v0lunteer and professional experts doing moth monitoring. Especially to extend expertise in those Member States where there is less taxonomic expertise on moths.

Production of the simple standardised moth traps proven to be effective in the SPRING project should be stepped up and distribution extended further.

To help ensure high quality moth identification across the whole of the EU through AI two actions should be prioritised:

3. the network of expert validators for moth identification should be strengthened and
4. the collation of more photographs of moths from Mediterranean, Eastern and Central European countries should be organised to speed up and enhance the learning of the AI and increase the moth image reference library. The collation of these images and their review would be facilitated by dedicated engagement in this regions.

A2 Taxonomic capacity building

A2.1 Organise basic taxonomic training

Planning of courses (Task 2.1.2)

All seven European regions **successfully conducted the assigned Basic and Intermediate Taxonomy Courses (BTC, ITC)** in preparation for the field seasons of 2022 and 2023. The basic training program succeeded in its primary aim of training the fieldworkers to carry out the field research as envisioned in the SPRING program. Beyond taxonomy training, it was deemed vital that participants were **trained in the standardized field methods aligned with the Minimal Viable Scheme (MVS).** Training materials, including a manual and an online learning module, were developed accordingly. In preparation of the second field season in 2023, the regions tailored the content of their courses to address the specific needs of the fieldworkers, including those who were new to monitoring and others returning for their second field season.

The coordination of the **course planning was centralized** under the guidance of Task 2 coordinators, ensuring that the various course levels matched the needs of the partners to execute the MVS fieldwork and that the courses fit together well. To establish this **unified European strategy**, monthly online meetings were convened, and a practical framework was established (Figure A2.1.1). These sessions played a vital role in setting course objectives and requirements, assigning external specialists to courses, and evaluating the need to tailor course content to national specifications. Collaborative progress was achieved through the exchange of experiences and materials on a European scale, with online workshops serving as catalysts for joint initiatives and aligning local needs with available resources (refer to Subtask 2.1.4).

SPRING implemented a **standardized survey to gather feedback** from students, trainers, and organizers after each course. The insights gleaned from these assessments were systematically employed to enhance subsequent iterations, ensuring a continuous refinement of the program.

The **distribution of expert trainers** over the different courses was centrally coordinated. Although distributing the international experts across the course program was a complex exercise that required a lot of planning, especially given the large number of courses in the limited windows of time (e.g. outside, or at the very start of the field season), the result was that all courses had an expert teacher with knowledge of local species diversity in front of the group.

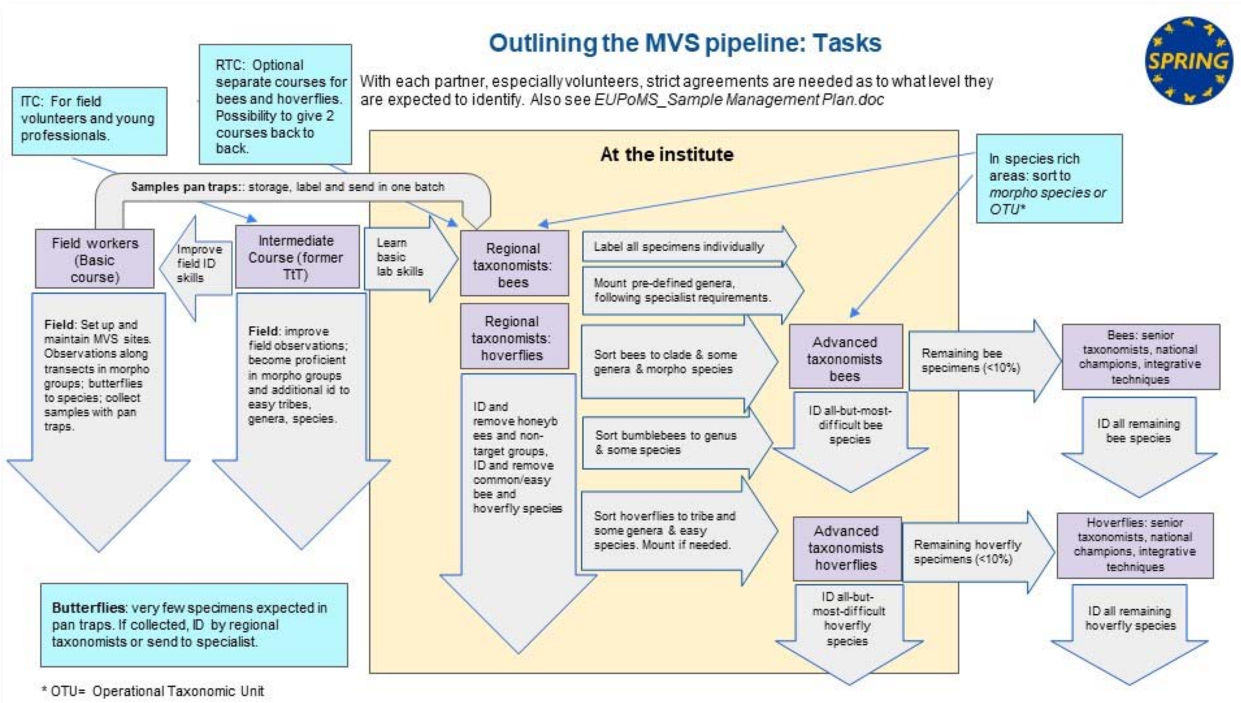


Figure A2.1.1 Aligning the course curriculum with the MVS.

Resources: Experiences and insights were captured in documents that are available for trainers at the Pollinator Academy website: the *SPRING course curriculum, the SPRING Course Outline template, SPRING Course preparation checklist, SPRING Example Evaluation Form* and the *Playbook for Organizing Taxonomy Courses for Pollinators*.

Didactical framework (Task 2.1.3)

A prime objective of the **overall course curriculum** was to achieve an optimal alignment between learning objectives and the requirements for the Minimal Viable Scheme and future pollinator monitoring. Once the overarching **learning pathways** were established (Figure A2.1.2) and consistency across the curriculum was ensured, fundamental **characteristics for each course** were defined (Fig. A2.1.2). Next, course outlines, encompassing critical details such as standardized learning objectives, were outlined for each specific course. These served as reference points for organizers and trainers, offering a structured framework (see, for example, Fig. A2.1.3), while allowing for necessary variations to accommodate regional and taxonomic group differences.

Given that not all organizers and potential trainers had a formal didactic background, the monthly online meetings (see Subtask 2.1.2) were also used to emphasize essential **didactical principles to enhance the effectiveness of the courses**.

In a follow-up programme it is recommended to continue offering didactic support to trainers.

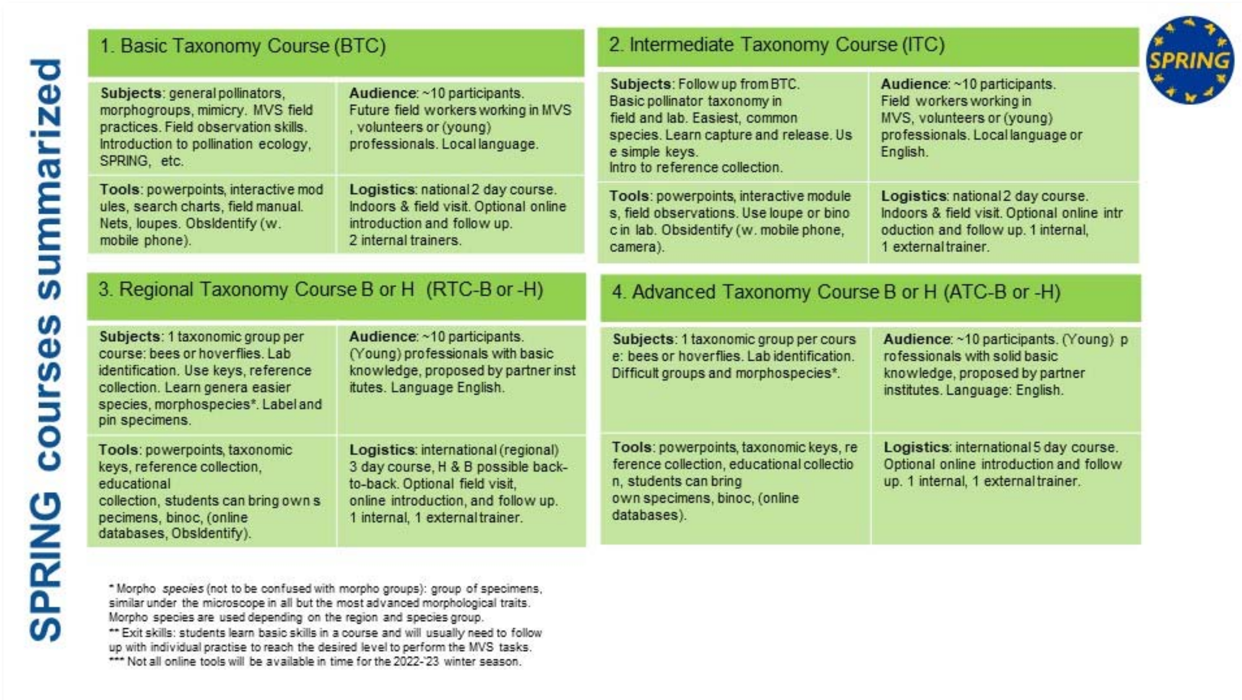


Figure A2.1.2 SPRING taxonomy courses summarised.

Resources: Experiences and insights were captured in documents that are available for trainers at the Pollinator Academy website: *SPRING Some important notes on Learning Goals, SPRING Tips & tricks for course design*, and *SPRING Course preparation checklist*.

Training materials for basic courses (incl. MVS fieldwork protocol) (Task 2.1.4)

An assessment was made of the **tools to match the levels of the different courses** (see Subtask 2.1.6), and the main gaps in availability of identification tools was inventoried. Identification tools were developed accordingly, ranging from field charts for basic morpho groups for the basic courses, to European keys to genera for the advanced courses (Subtask 2.2.2).

The education package for the basic courses that was developed consisted of the following:

- Template for a course outline, detailing learning objectives, time schedule, details on trainers and students, etc cetera
- A set of PowerPoint presentations, covering the subjects to be discussed, and available for translation and regional adaptation
- Identification tools, aimed at users with different knowledge levels
- A *Playbook for organizers of taxonomy courses* (see Subtask 2.2.10)

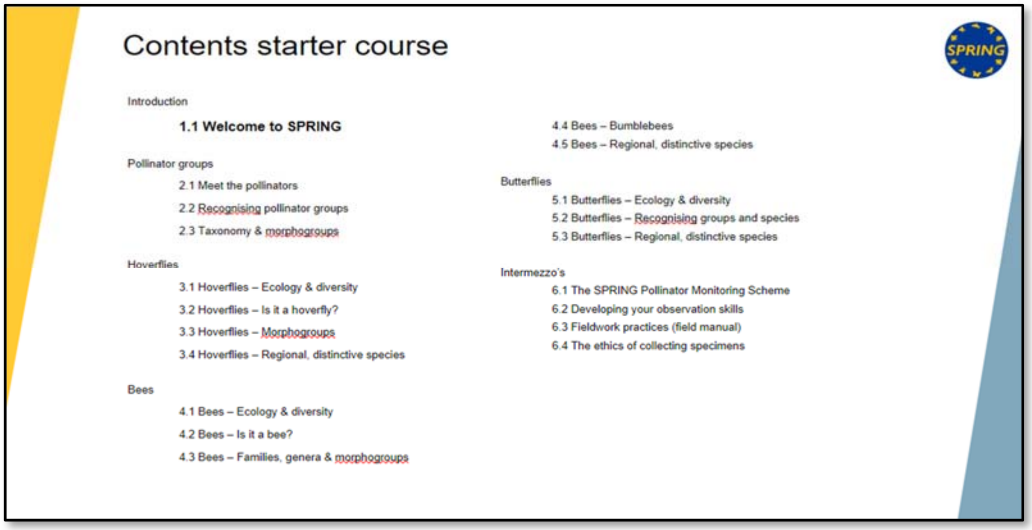


Figure A2.1.3 Overview of the course modules defined for the Basic Taxonomy Courses.

The **course structure and course materials** were developed in collaboration with the regional organizers. In a series of online workshops the partners discussed the goals and course structure, and shared training materials that they already had available, and which were converted into universal materials. As an example, the PowerPoints for the Basic Taxonomy Courses followed the structure as illustrated in Figure A2.3. Each subject is covered by a PowerPoint of approximately 5 to 25 slides.

Resources: All training materials were made available to trainers at the Pollinator Academy (Subtask 2.1.9). A complete list can be found in **Chapter A5.2: Task 2 Documentation,** indicating all the folders with course materials/Playbook & Logistics and Course curriculum & recommendations.

Taxonomic identification tools were developed. For the basic course these encompassed of **Quick Field Charts to morpho groups**, recognizing broad morpho groups (for example Fig. A2.1.4). For the Intermediate Courses, Search Charts were developed to enable field workers to identify a set of indicator species (Fig. A2.1.5). Due to simultaneous development of the course program and identification tools, not all tools were already used in the SPRING courses. Online interactive multi access keys were made available as a stepping stone between basic to advanced courses (see Subtask 2.2.2).

A useful tool for novice observers of pollinators, both for training purposes and for species recognition, is the app ObsIdentify, developed by Observation International. This tool was made available throughout Europe, for example to be used during courses (for details see Subtask 2.1.5).

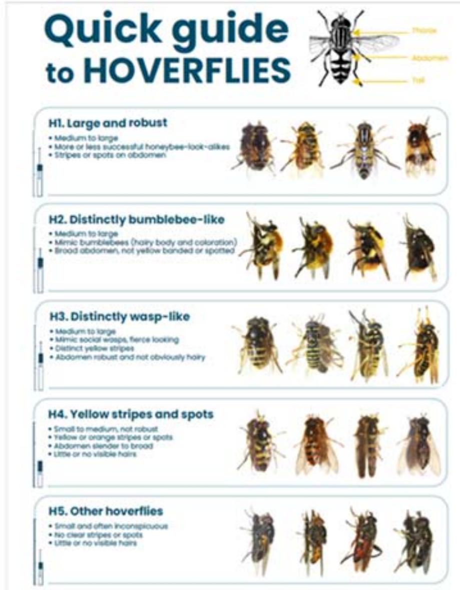


Fig. A2.1.4 Example of a Quick Guide to Morpho Groups.

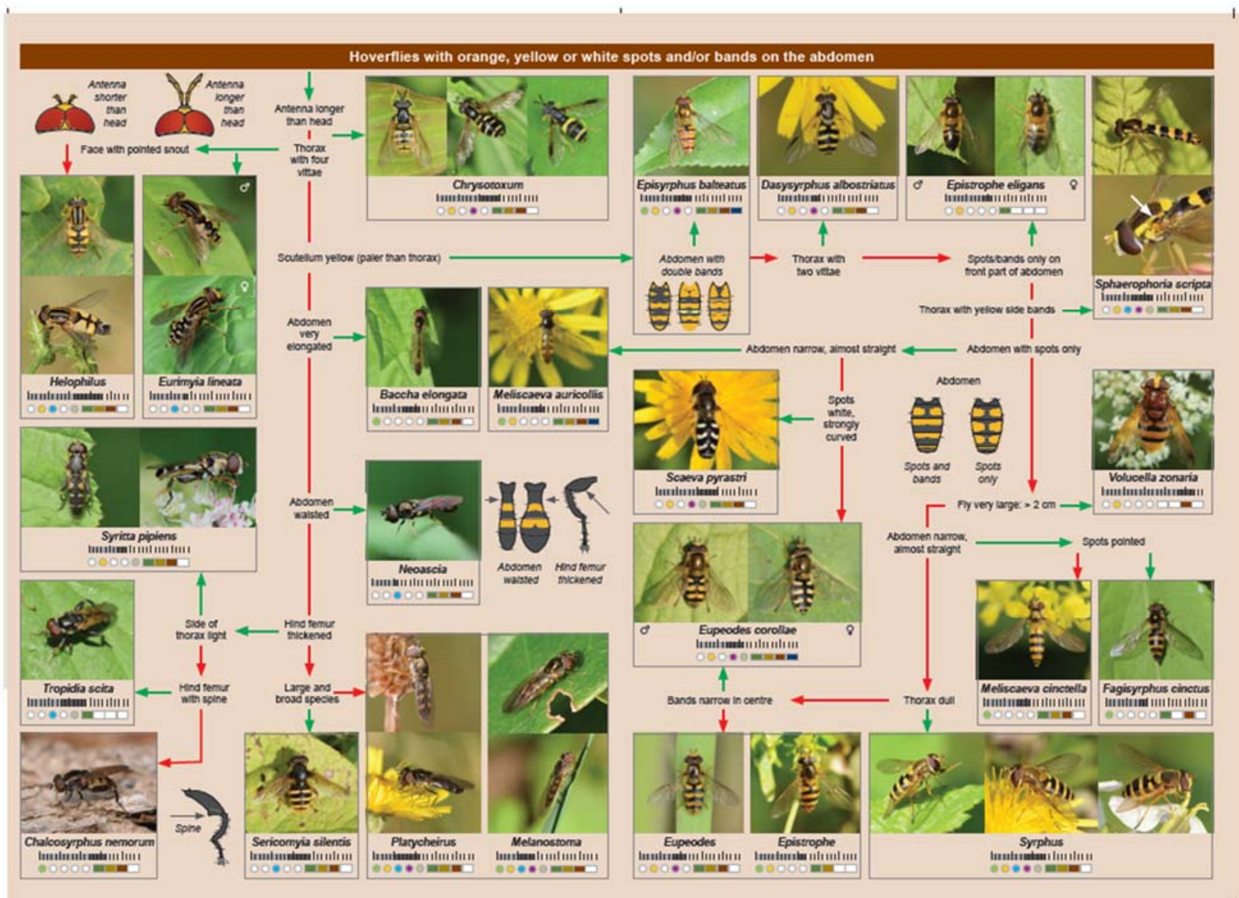


Fig. A2.1.5 Page from Quick Guide to common genera and species of North-western Europe (EIS Kenniscentrum Insecten).

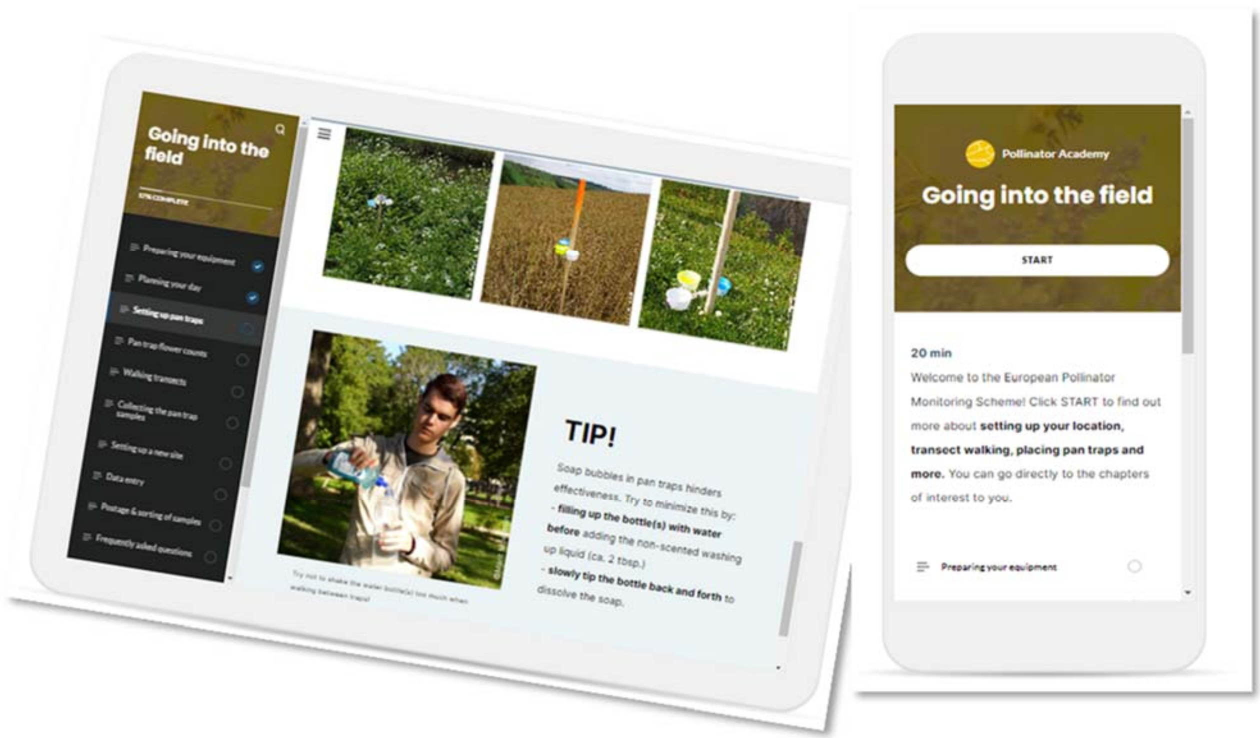


Figure A2.1.6 The online e-learning module, available both on desktop and mobile phone, explaining the MVS fieldwork protocol.

SPRING developed a training specifically with **instructions for the standardized Minimal Viable Scheme protocol (MVS)** for setting up and managing field sites. It was found that, while an actual field visit provided the best approach, the required knowledge could also be transferred through a webinar or a multilingual e-learning such as was developed for the online Pollinator Academy (Fig. A2.1.6). The online module, available at the Pollinator Academy (Subtask 2.1.9) was translated in Italian, Dutch, Hungarian and Greek, and was distributed amongst the SPRING fieldworkers. An annual refresher helped guarantee the quality of fieldwork and data collected. A full list can be found in **Chapter A.5.2 Task 2 Documentation** (/All course materials/General fieldwork course materials).

Observation International: platform and identification tool (Task 2.1.5)

The species **identification tool ObsIdentify**, the associated website Observation.org, and its owner, Waarneming.nl/Observation International, collectively offer a robust and well-developed software ecosystem designed for data collection and biodiversity monitoring tasks. While the platform has a much broader coverage of biodiversity, it provides an efficient tool for identifying and learning about pollinators. The **Nature Identification API (NIA)**, an artificial image recognition software integrated into ObsIdentify and developed by Naturalis, operates in the background.

SPRING identified key areas to improve the functionality for use with pollinators, e.g. to encompass all focal pollinator groups and to aim for comprehensive spatial coverage across Europe. In consultation with SPRING, ObsIdentify was made **available throughout Europe**. Observers can create personal accounts, while group accounts and dedicated project sites are available for initiatives focused on specific regions or taxonomic groups. Additionally, Bioblitzes on pollinators can be organized to generate public interest and channel efforts toward collecting specific observational data.

There were concerns about the **accuracy of the identification software** when expanded from North-western Europe to the entire continent, due to the vast species diversity and spatial variation in pollinator species. Observation International and the Naturalis AI team were tasked with investigating and, if necessary, implementing a solution in the form of a **spatial filter**. An exploratory investigation revealed that the approach envisaged by SPRING would provide only negligible improvement (<0.5%) (*SPRING location filter: Final Report)*. However, a more advanced solution has since been found for the NIA that will give the desired improvements.

Artificial image recognition software such as the NIA relies on large amounts of data for its training. The validation process by human specialists to build a **library of validated images** is a critical bottleneck for fully realizing its potential. Acknowledging this challenge, SPRING undertook efforts to broaden the validator network, specifically targeting specialists for bees, hoverflies, butterflies, and moths across Europe. The coordination of this initiative was led by EIS Kenniscentrum Insecten and Naturalis, with support from the University of Mons, the University of Novi Sad, and Butterfly Conservation Europe (BCE) leveraging their networks (*Coordination of validators for butterflies and moths Final Report* and *Validators for AI Images Final Report*). Notable progress was made in countries such as Malta, Spain, and Portugal. A series of online workshops (and one field workshop in Malta in collaboration with the MAMBO project) was organized to train new validators. The onboarding process involved connecting new validators with mentors for continued guidance.

In a development parallel to SPRING, the **volume of training material for the NIA** was expanded through an initiative by Naturalis that aims to expand the network of biodiversity portals participating in the collaborative effort. These portals both utilize the API and contribute identified images. In 2023, the first expanded version of the NIA was released, resulting in substantial improvements for pollinators. The Naturalis team plans to further expand this collaborative effort in the coming years, and, leveraging its European network, SPRING provided the team with an inventory of European biodiversity portals that could potentially join as partners for upcoming iterations of the NIA.

One of the notable applications for the AI software lies in **moth monitoring**. As part of the SPRING project, Butterfly Conservation Europe (BCE) established and expanded a volunteer initiative for monitoring moths using low-cost LED buckets. Despite the extensive European diversity of moths, which numbers in the thousands of species, the image recognition performs exceptionally well. This allows even volunteers with limited species knowledge to effectively manage an observation point.

Assessment of taxonomic gaps (Task 2.1.6)

A gap assessment was conducted to identify the need of **taxonomic tools for the various levels of expertise** (Fig. A2..17). The availability gaps were documented and identification tools tailored to specific needs were developed. This ranged from field charts designed for basic morpho groups in the basic courses, to comprehensive identification keys for European genera in the advanced courses (see Subtask 2.1.4 and 2.2.2). Tools for the most advanced levels are being developed by the EU projects Orbit and TaxoFly (see Subtask 2.2.2).

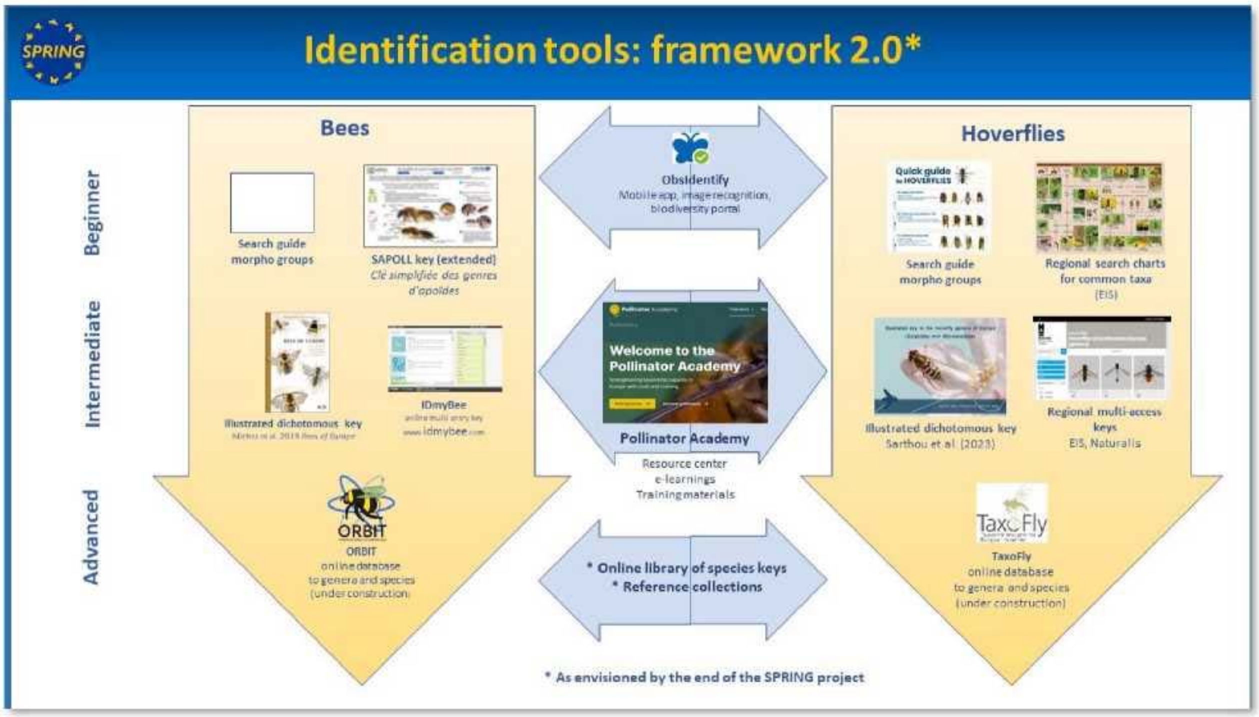


Fig. A2.1.7 Integrated framework of identification tools for European bees and hoverflies across different levels of expertise.

Implementation of Intermediate Taxonomy Courses (Task 2.1.7)

In the original SPRING project proposal, Train the Trainer courses were planned as integral part of the training program. However, during the project's initiation phase it became clear that emphasis needed to shift towards addressing the immediate demand for **additional (second year) training of fieldworkers** and the courses were rebranded as *Intermediate Taxonomy Courses* (and thus followed *after* the Basic Taxonomy Courses). This adjustment aimed to bridge the gap between basic and advanced course levels, recognizing the pressing need for skilled fieldworkers. Task 2 organized **dedicated online workshops for trainers** involved in both basic and advanced courses, for which our didactic specialist visited the training teams. Part of the budget allocated for Train the Trainer courses was redirected to the development of course materials and tools, and in particular to organizing Intermediate Taxonomy Courses (ITC) (Table A2.1.1).

The intermediate level courses aimed to expand the knowledge and experience of the participants that they gained during the first field season. This ensured continuing commitment from volunteers. In some cases volunteers reached a level of skills and commitment where they could contribute to more advanced tasks, such as the initial sorting of pan trap samples and adding data to the SPRING database.

In the course of the training seasons of 2021-2022 and 2022-2023, the organizers from the seven European regions regularly met in online workshops to exchange experiences and ideas, in order to continuously improve the courses.

Based on need and demand, **dedicated train-the-trainer sessions** were conducted by the Task 2 coordinators, both online and face to face (Fig. A2.1.8). This was done both for less experienced trainers (for example for a group in Germany, UFZ), and for highly specialised taxonomists in

Belgium (UMONS). As a result of these sessions we developed more standardised course packages, incorporating lessons learned from previous training sessions, and creating a constant feedback loop leading to more professional courses.

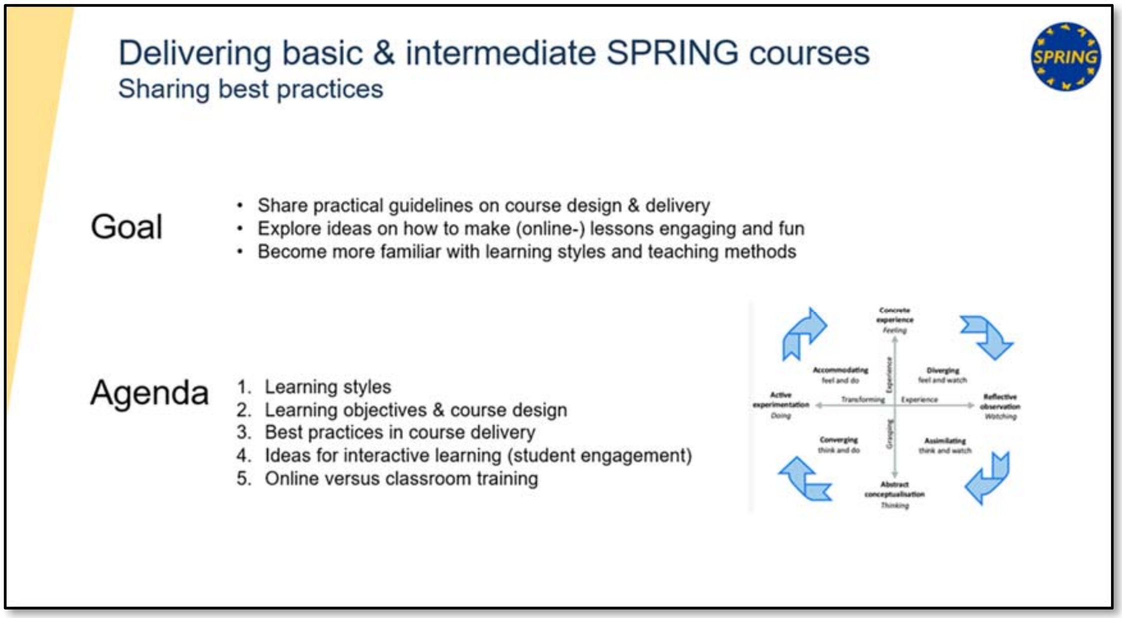


Figure A2.1.8 Goals and agenda for Train the Trainer sessions

In several national monitoring schemes, **volunteer fieldworkers** (e.g. citizen scientists) turned out to be highly committed to the project, despite the relatively high intensity and complexity of the fieldwork, which in the literature is usually considered a barrier. As professed by the participants, the training courses were an important way of building this level of commitment. The level of knowledge of volunteers was usually considerably lower than that of professionals and thus imposed limitations on the maximum achievable quality of the data collected.

Implementation of Basic Taxonomy Courses (Task 2.1.8)

The primary aim of the basic training program was to train the fieldworkers to carry out the field research as envisioned in the MVS program (also see Subtask 2.1.2). All European regions successfully conducted the assigned Basic Taxonomy Courses (BTC) in preparation for the field seasons of 2022 and 2023 (Table A2.1.1). For this purpose the centrally provided training materials were translated and adapted to local requirements by the regional leaders where needed. The Basic Taxonomy Course was evaluated with participating students and received high marks (9+) on average (see Subtask 2.1.10).

After the BTC and even the ITC the following year, the level of knowledge of volunteers was usually considerably lower than that of professionals and thus imposed limitations on the maximum achievable taxonomic resolution observations in the field.

Table A2.1.1 Overview of basic and intermediate courses given in 2022 and 2023. In total more than 350 trainees participated.

Year	Date	Title	Duration (days)	Location	Language	Region	Institute	Parti cipants
2022	25/Apr	BVC - NL	3	Leiden, NL	Dutch	NL	EIS / Naturalis	11
2022	02/May	BVC - France	5	Online + weekend fieldtrip	French	Atlantic-Med.	Creaf, UAB (ES)	12
2022	09/May	BVC - Spain	5	Online + weekend SP	Spanish	Atlantic-Med.	Creaf, UAB (ES)	15
2022	16/May	BVC - Spain	5	Online + field trip SP	Spanish	Atlantic-Med.	Creaf, UAB (ES)	19
2022	19/May	MSV fieldwork	1	Online	German	Central Europe	UFZ	18
2022	23/May	BVC- Portugal	5	Online + field trip PT	Portugees	Atlantic-Med.	U Alicante (ES)	23
2022	28/May	BVC - Greece	2	Mytilene	Greek	South-East	U AEGEAN	8
2022	30/May	MSV fieldwork	1	Online	German	Central Europe	UFZ	15
2022	04/Jul	BVC - Serbia	3	Novi Sad	Serbian	n/a	U Novi Sad (RS)	12
2022	14/Nov	IVC	3	CREAF	English	Atlantic-Med.	Creaf, UAB (ES)	15
2022	21/Nov	IVC	2	Bologna	Italian	Central Med.	CREA (IT)	10
2022	28/Nov	IVC	3	CREAF	English	Atlantic-Med.	Creaf, UAB (ES)	18
2022	05/Dec	IVC	3	Lund	Swedish	n/a	Lund U	18
2022	13/Dec	IVC	3	Aegean	English	South-East	U Aegean (GR)	10
2022	07/Nov	BVC	2	Bologna	Italian	Central Med.	CREA (IT)	26
2023	30/Jan	BVC	2	Bologna	Italian	Central Med.	CREA (IT)	
2023	06/Feb	IVC	2	Bologna	Italian	Central Med.	CREA (IT)	
2023	13/Mar	IVC 1st ed. (only B)	2.5	Germany	German & En	Central Europe	UFZ	8
2023	20/Mar	IVC 2nd (B&H)	4	Germany	German	Central Europe	UFZ	10
2023	10/Apr	BVC	3	Online + field course in Hungary	Hungraian	Pannonian	ÖK (HU)	
2023	22/Apr	BVC	2	Lund university	Swedish	Sweden	Lund U	
2023	24/Apr	BVC	3	Online + field course in Romania	Romanian	Pannonian	ÖK (HU)	
2023	08/May	BVC	2	Norrköping	Swedish	Sweden	Lund U	
2023	15/May	IVC	2.5	Vorden / Netherlands	Dutch	Netherlands	EIS (NL)	12
2023	29/May	IVC	4	Hungary	English	Pannonian	ÖK (HU)	
2023	13/Jun	BVC	2	Arvidsjaur	Swedish	Sweden	Lund U	
2023	19/Jun	IVC	4	Hungary	English	Pannonian	ÖK (HU)	

Online training platform: the European Pollinator Academy (Task 2.1.9)

As the international expert network for SPRING developed, it became ever more apparent how many useful tools were not widely known. The international community could take advantage from this if these tools were made more easily accessible through an efficient sharing mechanism and – in the case of language barriers – by facilitating translations. Advancing this premise became one of the primary goals for Task 2 as part of the capacity building endeavour, and resulted in the **online European Pollinator Academy (www.pollinatoracademy.eu).** Note that the following description of the platform concerns functionalities for both the basic and advanced training programs (e.g. both Task 2.1 and 2.2).

It was agreed with DG Environment that there were important reasons to develop the Pollinator Academy alongside (e.g. outside) the European Pollinator Hive, at least for the time being. These reasons are:

- Need for a dynamic platform that allows for improvements over time
- Flexibility to continue adding different forms of content
- For high quality content, it is indispensable that the taxonomic community have a sense of ownership (e.g. a platform 'for and by specialists')

The plans for a European Pollinator Academy were presented and discussed with stakeholders at the Annual Group Meeting of SPRING and at two conferences for specialists, the 11th International Symposium on Syrphidae from 5-10 September 2022 in Barcelonnette (France) and the Seminar for the European Butterfly Monitoring Scheme (eBMS), 30 Nov-2 Dec 2022 in Laufen (Germany). In consultation with the parties involved the following functionalities and requirements were determined (Fig A2.1.9):

- A European, collaborative, open source platform for training and education
- A knowledge centre, with access to both traditional and innovative resources
- Dedicated pages for bees, hoverflies and butterflies
- An e-learning environment
- A trainer environment
- Multi-linguality
- Involvement of, and linking to, Orbit, TaxoFly, and Butterfly Conservation Europe

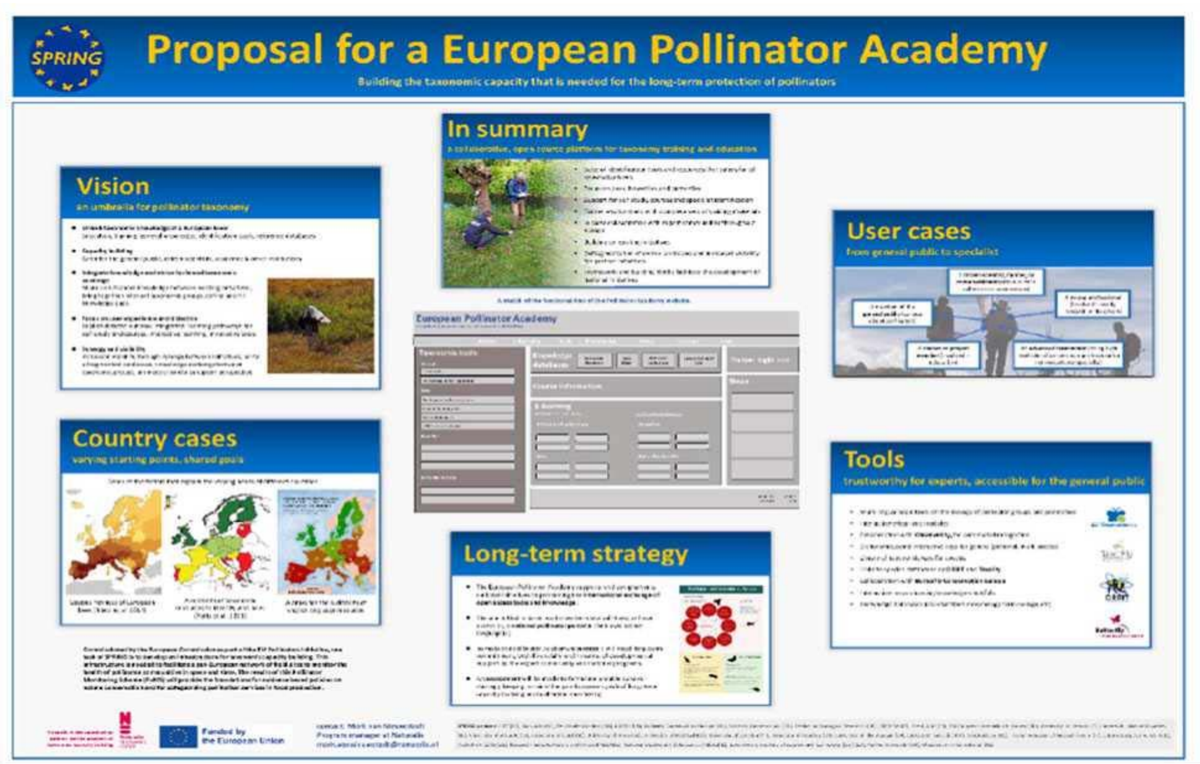


Figure A2.1.9 Proposal for a European Pollinator Academy, as discussed at the SPRING annual group meeting, 28-30 October 2022 in Barcelona.

The website was developed using the following software:

- Silverstripe for the CMS
- Articulate for e-learnings
- Zotero for the library behind the knowledge centre
- DeepL for multi-linguality
- Zenodo as the document repository
- GitHub as the website repository

All training materials developed by SPRING were made available at the Pollinator Academy, either in the public space or in the Trainer Portal, which requires registration but is otherwise open source. The Pollinator Academy is currently being maintained by Naturalis.

The following series of screenshots gives an impression of the functionalities of the Pollinator Academy.

Figure A2.1.10 Screenshot from the Pollinator Academy, showing the homepage and multilingual options.

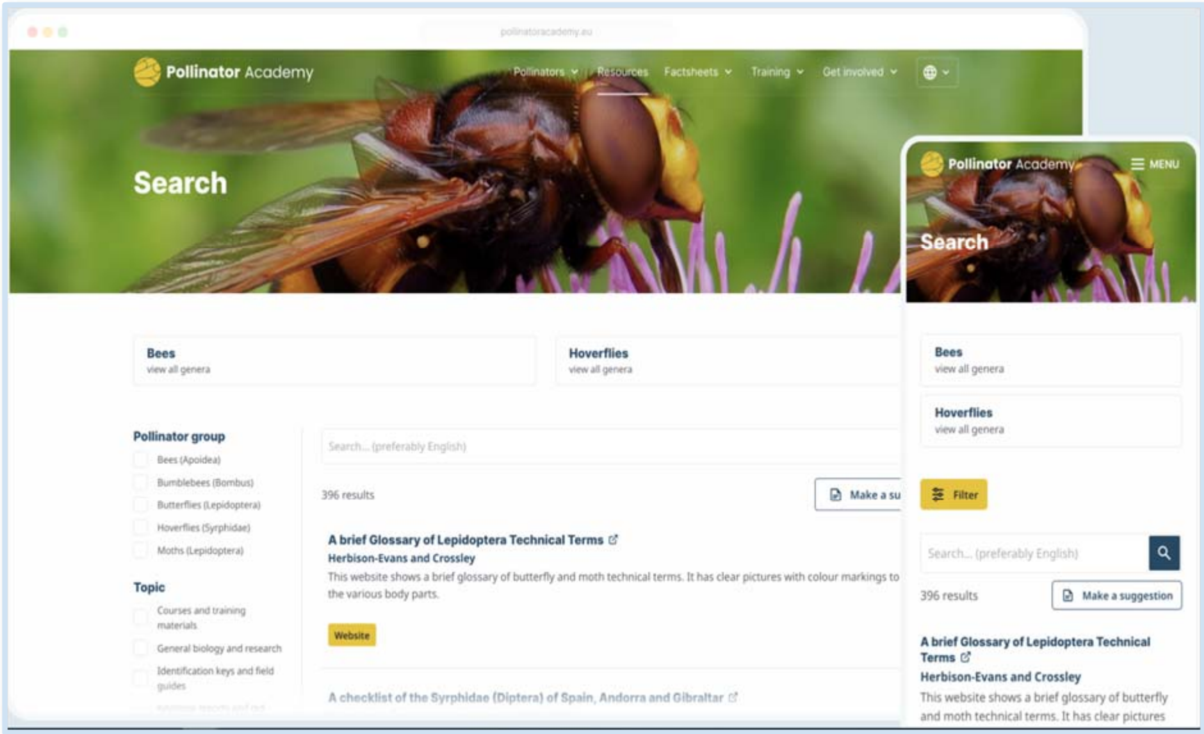


Figure A2.1.11 Screenshot from the Pollinator Academy, showing the Resource Centre and the responsive website.

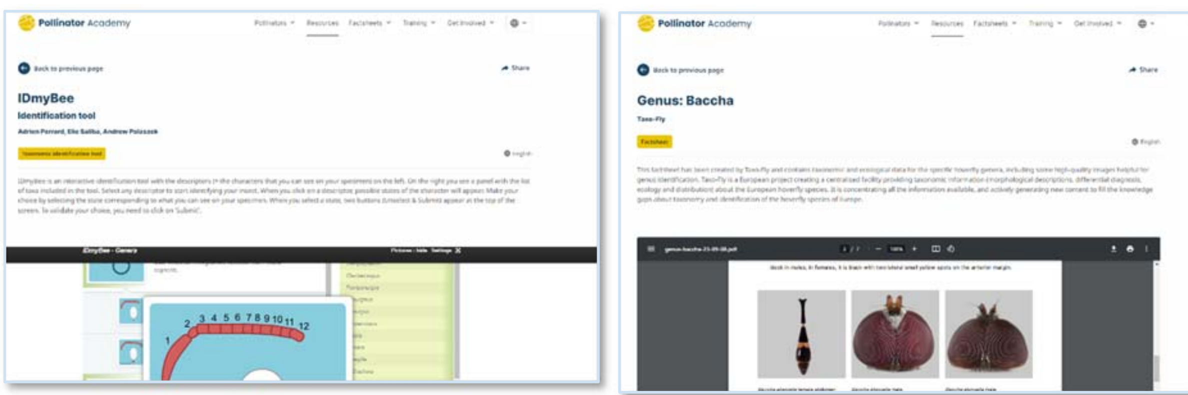


Figure A2.1.12 Screenshot from the Pollinator Academy showing integrated tools and factsheets for the identification of bees and hoverflies, in collaboration with Orbit and TaxoFly.

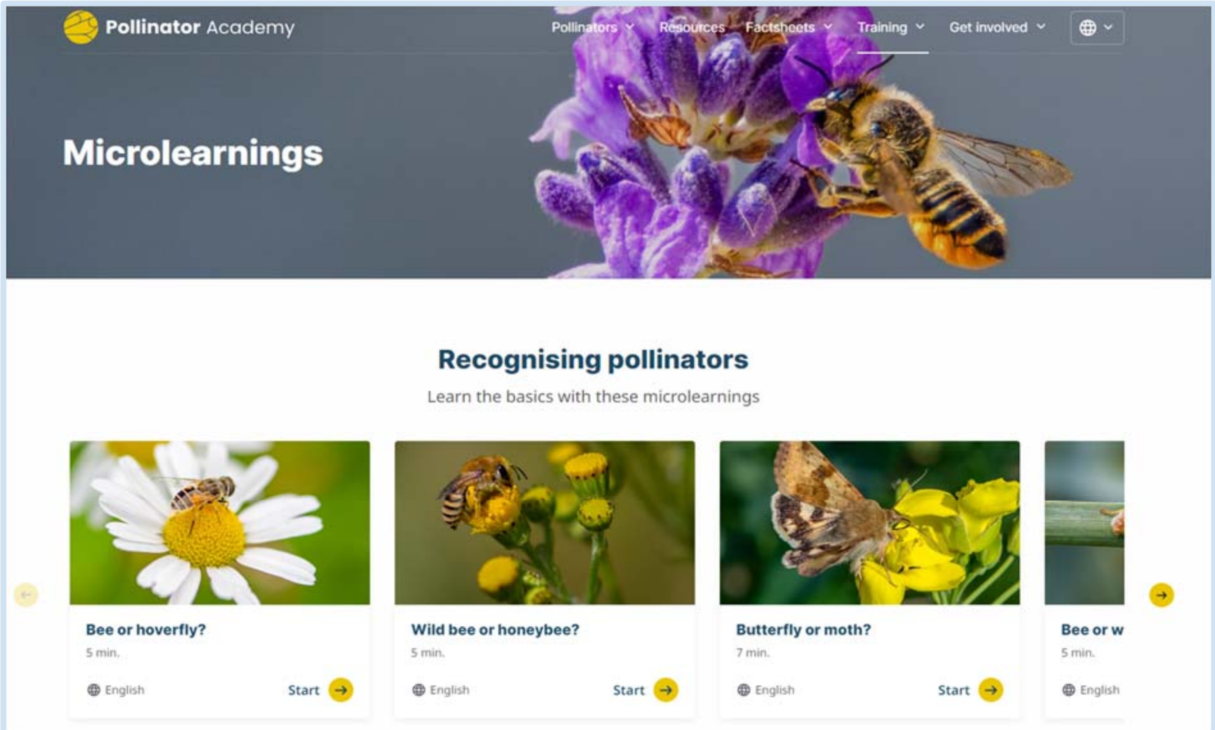


Figure A2.1.13 Screenshot from the Pollinator Academy showing some of the interactive e-learning modules.

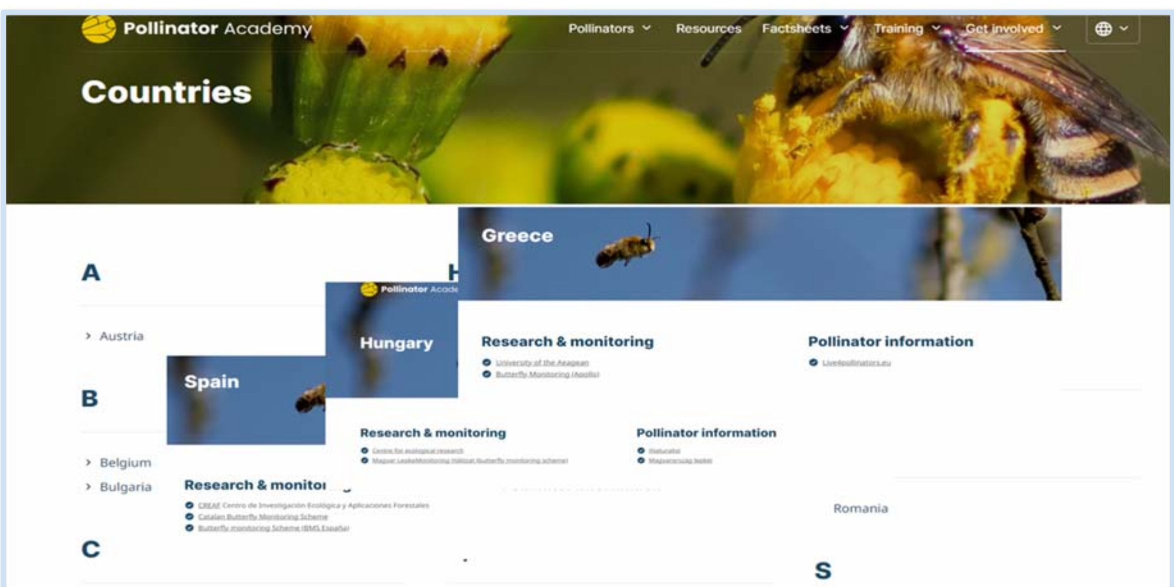


Figure A2.1.14 Screenshot from the Pollinator Academy showing country pages for easy access to regional sources and monitoring schemes.

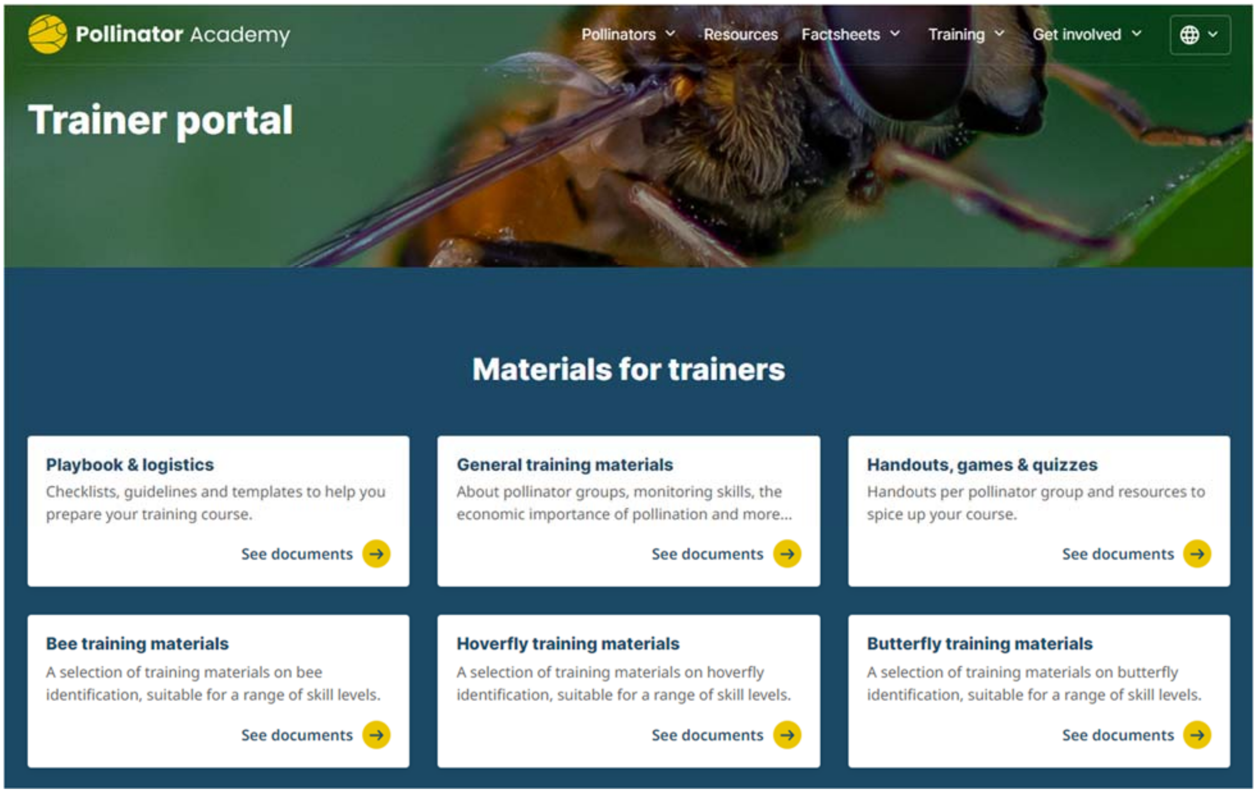


Figure A2.1.15 Screenshot from the Pollinator Academy showing the trainer portal, the place to share course materials.

The Pollinator Academy showcases how the international exchange of knowledge and tools can be fostered. It is not yet a finished product. The active input and involvement of the knowledge community was crucial for its success; to ensure that it grows into a fully functioning platform, it is advisable to give the community co-ownership and control over its further development.

Resources: An overview of the training materials and e-learnings developed by SPRING and available at the Pollinator Academy (some 80 items in total) can be found in the **Chapter A5.2.**

Evaluation of courses and materials (Task 2.1.10)

SPRING implemented a standardized **evaluation process** to collect feedback from students, trainers, and organizers following each course (*SPRING Example Evaluation Form*). The insights derived from these assessments were utilized to improve subsequent iterations, ensuring a continual refinement of the program. Course evaluations, translated as necessary, encouraged participants to share feedback after each session. The results were disseminated and discussed during monthly meetings and communicated through newsletters (refer to Subtask 2.1.11). After the first year of courses, an evaluation of the course curriculum's alignment with fieldwork needs led to an updated scheme outlining how both basic and advanced courses could best meet the requirements of the Minimal Viable Scheme, also incorporating feedback from SPRING partners during the design phase.

The setup of the course program, and the evaluation of courses based on feedback from students, trainers and organizers, was discussed and evaluated in dedicated workshops at the SPRING annual group meetings in Barcelona (October 2022) and Bologna (October 2023).

Figure A2.1.16 Example of evaluation results: the Italian Basic Taxonomy Course, 2022.

Feedback from the course participants was very positive without exception (Fig. A2.1.16). As an example, the evaluation of the Basic Taxonomy Course returned high marks (9+ out of 10) on average. The taxonomy courses had the very practical goal of preparing people for the MVS fieldwork; based on the experiences in the first year it was decided that the learning objectives needed to be further clarified and focused, and the time for interactive, hands-on activities needed to be increased. The other main outcome was the need for basic training materials as online interactive modules. In the second year these were developed in the form of e-learnings at the Pollinator Academy.

A2.2 Advanced taxonomic training

General report

Course design

The Advanced Taxonomy Courses focussed on identification of genera and 'easy' species level identifications (the Regional Courses), and on learning to identify species within specific genera (the Advanced Taxonomy Courses). Typically, an ATC lasted five days, each day focussing on a particular genus and being led by a specialist of that genus (see Box A2.2.1).

Some 40 students followed and ATC for bees and ca. 30 for hoverflies. Given the almost 10-fold difference in species diversity between Northern and Southern countries, students could have very different personal needs and goals. After the course, they were equipped with the basic knowledge and skills to further hone their identification skills on their own, preferably under occasional supervision of a mentor.

The time frame and budget of SPRING did not allow for continuation courses at this level. It is advised that after a year of self-study students are interviewed and the need for additional training is explored.

Training materials

Like for the Basic courses, SPRING built a common European repository through the exchange of training materials between partners that trainers can tap into as a quick access point for the development of course materials. Usually these materials require adjustment to regional needs and circumstances. Additional training materials such as dedicated PowerPoints were developed for the Regional course levels, and are shared in the online repository of the Pollinator Academy.

Identification tools

Taxonomic identification tools ('keys') form one of the backbones of taxonomic training, alongside reference collections and species treatments (e.g. descriptions). Because the suitability of tools depends on the level of expertise, a range of tools was selected to provide for the different knowledge levels that are covered by the SPRING training program (Fig. A2.1.1).

The Advanced courses for Bees and Hoverflies made intensive use of reference collections (physical and in the future also digital) and taxonomic identification keys and descriptions for specific families, genera and species. The Universities of Novi Sad (hoverflies) and Mons (bees) autonomously selected these materials for their European Advanced Courses.

SPRING made available open-access identification keys at genus level for all European wild bees and hoverflies. This was deemed an important step towards building a common taxonomic base for identification throughout Europe. While written in English, they were prepared in such a way that they are ready for easy translation, in order to resolve linguistic impediments that were voiced by our partners. While not formally a deliverable in the SPRING call, several translations have already been prepared, or are under way.

A tool for an intermediate level of expertise are so called multi-access keys, which are online and interactive. Building on existing initiatives, several multi-access keys are now available for bees and hoverflies, although in the case of hoverflies pan-European coverage has not yet been achieved (and indeed, is deemed difficult by some specialists).

Task 2 collaborated closely with the projects Orbit and TaxoFly, since the taxonomic factsheets that these projects are developing are an important resource for training and reference. At the time of writing factsheets at *species* level were not yet publicly available. To help the collaboration

move forward and to accelerate the availability of crucial materials, Task 2 decided to invest in the preparation of factsheets for the European *genera* by Orbit and TaxoFly. Where ready these are made available through dedicated pages at the Pollinator Academy.
To facilitate students to have a common set of minimal skills and knowledge before they enter a course, it was deemed crucial to develop an online curriculum of e-learnings on basic taxonomy topics. This was made the central objective of one of the Integrative Courses; a set of e-learnings showcasing the possibilities of this approach is available at the Pollinator Academy.

Planning and implementation of the Advanced Taxonomy Courses
Without exception, the Regional Taxonomy Courses for Bees and Hoverflies (RTC-B, RTC-H) were organized by the regional SPRING coordinators as planned, as were the Advanced Taxonomy Courses for Bees and Hoverflies at European level (ATC-H, ATC-B), organized by two expert institutes, Department of Biology and Ecology at the University of Novi Sad (Serbia) and Mons University (Belgium). The level of participant satisfaction was already very high after the first round of courses, and the evaluation process lead to what the trainers saw as significant improvements in the following courses, in particular on identifying the objectives, the workload and pacing, and the balance between lectures and practice.

Online access to advanced training materials and identification tools
As reported elsewhere in this report, the Pollinator Academy was designed to be the hub through which resources for taxonomy trainings are being shared. Its Resource Centre brings together both traditional and innovative, interactive tools and resources. As a token of its success, trainers now refer new students to the website as a starting point, instead of having to compile a library of resources. Not all course materials for trainers are finished products (e.g. knowledge and an effort from the trainer is required before they can be used as training materials); therefor there is also a repository for trainers in a protected environment. All interested parties are granted access to this repository.

Planning of courses (Task 2.2.1)

The Regional Taxonomy Courses for Bees and Hoverflies (RTC-B, RTC-H) were planned and carried out by the regional SPRING coordinators according to the predetermined plan. Simultaneously, the Advanced Taxonomy Courses for Bees and Hoverflies at the European level (ATC-B, ATC-H) were organized through collaboration with two expert institutions—the Department of Biology and Ecology at the University of Novi Sad (Serbia) and Mons University (Belgium).
Monthly online meetings were held to establish a unified European strategy. These sessions played a crucial role in establishing course objectives and requirements, assigning external specialists to courses, and assessing the need to adapt the content of the courses to regional requirements.
Acknowledging that some organizers and prospective trainers lacked a didactic background, the online meetings also emphasized essential pedagogical principles. Progress was made through the exchange of experiences and materials on a European scale, with the online workshops acting as catalysts for collaborative endeavours and aligning regional needs with available resources (see Subtask 2.2.2).
SPRING implemented a standardized survey to collect feedback from students, trainers, and organizers after each course. The insights from these assessments were systematically used to enhance subsequent iterations, ensuring an ongoing refinement of the program.

Box A2.2.1: The structure of an Advanced Taxonomy Course

The typical structure for an Advanced Taxonomy Course is as follows: after a general introduction and a brief assessment of the students' individual knowledge and needs, modules follow for individual taxa (e.g. individual genera or groups of genera). Each module is taught by a specialist on the relevant taxon at European level and typically lasts one day – depending to some extend on the complexity of the taxon. The specimens to be identified are provided by the trainers and/or brought along by the students themselves. Each workshop starts with an introduction on the characteristics of the taxon in question and the identification keys available, after which students identify a number of specimens under the guidance of the specialist(s). Throughout the workshop, the experiences are discussed in group sessions. At the end of the course the students have the necessary foundation to further hone their identification skills independently, preferably under the occasional guidance of a mentor. Exactly which taxa and species are the focus of a course is defined on a case by case basis. A course typically lasts 5 days. One specialist per taxon, a specialist assistant, and a coordinator provide a course for 10 to 12 students.

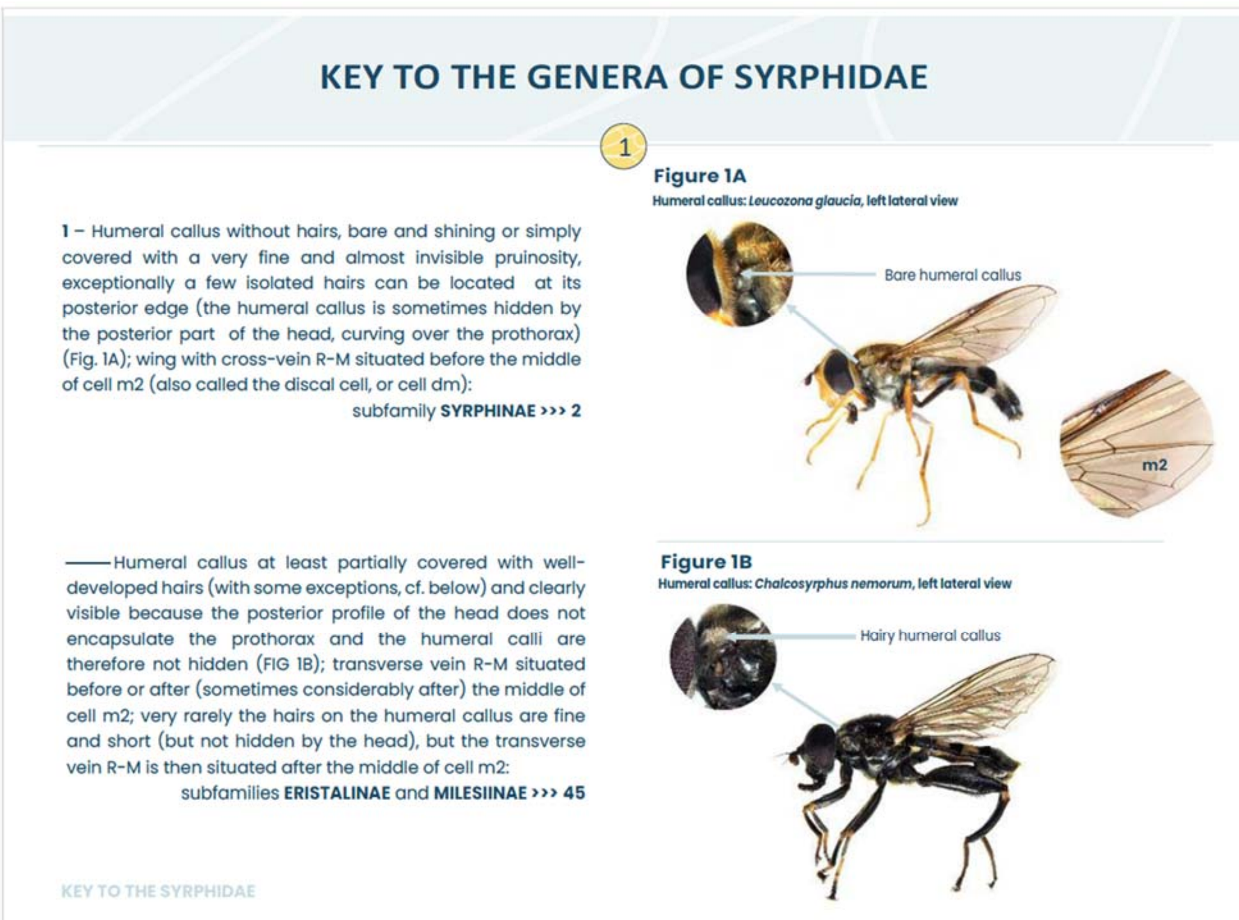
Box A.2.2.2: The structure of a Regional Taxonomy Course

In a typical Regional Taxonomy Course the focus is on learning to identify genera as well as the ‘easier’ species. Depending on the needs the course focusses on identifications in the lab and/or in the field. After a general introduction and a brief assessment of the students' individual knowledge and needs, students learn to use identification keys to genus level, and/or a national key to species level. The specimens to be identified are pre-selected by the trainers. Each module is taught by a specialist and typically lasts a day. Workshops focus on specific morphology (such as wing venation) and/or the characteristics of specific genera, and the use of identification keys, after which students identify a number of specimens under the guidance of the specialists. At different moments throughout the course, experiences are discussed in joint sessions. Interspersed can be such topics as the pinning and conservation of specimens. At the end of the course the students know how to use genus keys and/or a national key to species level, they are able to recognize the main genera and species, and they have the necessary foundation to further hone their identification skills independently, preferably under the occasional guidance of a mentor. Exactly which genera and species are the focus of a course, and which keys are being used, is defined on a case by case basis. A course typically lasts 3 to 5 days. Two specialists and a coordinator provide a training for 10 to 12 students.

Due to the highly specialised nature of the training at the advanced level and there being only one specialist group for bees and one for hoverflies involved, there has been less sharing of training materials between partners. Trainers often preferred to use their own materials, and in many instances there are only few specialists who are capable of teaching the taxonomy of specific genera at a European level. In didactical sessions, SPRING encouraged the different partners to define their learning objectives and timetables in course outlines and share these during Train the Trainer workshops and via our central repository.

Training materials for Regional and Advanced Taxonomy Courses (Task 2.2.2)

Identification tools formed the backbone of the Regional and Advanced Taxonomy Courses. A range of such tools was selected, to cover the broad range of knowledge levels that occurs in the training program (Fig. A2.1.1). A crucial resource for the courses at the regional level were reliable identification keys at the genus level for European bees and hoverflies. Two suitable existing genus keys were selected and subsequent further developed. SPRING now offers an open access key for European bee genera by Michez et al. (Fig. A2.2.2) and for European hoverfly genera by Sarthou et al. (Fig. A2.2.1). These keys are also available for translation. The Bee key has already been translated into Serbian, whereas for the Hoverfly key preparations are under way for translations into French, German, Portuguese and Swedish. The great demand for such keys was underscored by the fact that the key for European hoverfly genera was downloaded more than 1100 times in the first two weeks after publication.



KEY TO THE GENERA OF SYRPHIDAE

1

1 – Humeral callus without hairs, bare and shining or simply covered with a very fine and almost invisible pruinosity, exceptionally a few isolated hairs can be located at its posterior edge (the humeral callus is sometimes hidden by the posterior part of the head, curving over the prothorax) (Fig. 1A); wing with cross-vein R-M situated before the middle of cell m2 (also called the discal cell, or cell dm):
subfamily **SYRPHINAE >>> 2**

—— Humeral callus at least partially covered with well-developed hairs (with some exceptions, cf. below) and clearly visible because the posterior profile of the head does not encapsulate the prothorax and the humeral calli are therefore not hidden (FIG 1B); transverse vein R-M situated before or after (sometimes considerably after) the middle of cell m2; very rarely the hairs on the humeral callus are fine and short (but not hidden by the head), but the transverse vein R-M is then situated after the middle of cell m2:
subfamilies **ERISTALINAE** and **MILESIINAE >>> 45**

Figure 1A
Humeral callus: *Leucozona glaucia*, left lateral view

Bare humeral callus

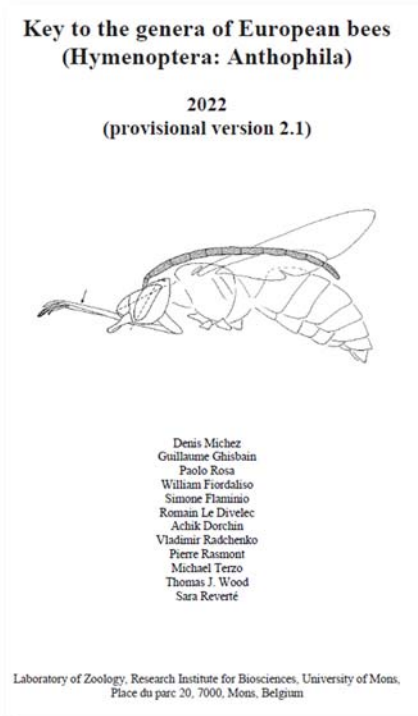
m2

Figure 1B
Humeral callus: *Chalcosyrphus nemorum*, left lateral view

Hairy humeral callus

KEY TO THE SYRPHIDAE

Fig. A2.2.1 Page from Sarthou, Sarthou and Speight (2023) Illustrated key to the hoverfly genera of Europe (Syrphidae and Microdontidae). Version 1.0.1.



Key to the genera of European bees
(Hymenoptera: Anthophila)

2022
(provisional version 2.1)

Denis Michez
Guillaume Ghisbain
Paolo Rosa
William Fiordaliso
Simone Flaminio
Romain Le Divelec
Achik Dorchin
Vladimir Radchenko
Pierre Rasmont
Michael Terzo
Thomas J. Wood
Sara Reverté

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Fig. A2.2.2 Cover of Michez et al. 2022.
Key to the genera of European bees (Hymenoptera: *Anthophila*).

An intermediate-level type of tools are multi-access keys, which are online and interactive. These are suitable for students with a moderate to advanced level of expertise. Leveraging existing initiatives, multi-access keys for hoverflies (Fig. A2.2.3) and bees (Fig. A2.2.4) have been further developed and their accessibility improved through the Pollinator Academy. However, it must be noted that in the case of hoverflies, achieving pan-European coverage using multi-access keys remains a challenge and is considered difficult by some specialists.

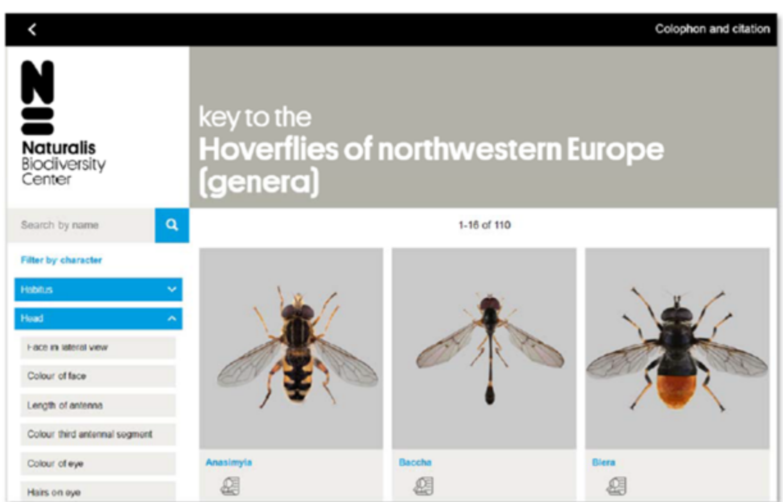


Fig. A2.2.3 Screenshot from the multi access key to hoverfly genera of north-western Europe by EIS, adapted from the multi access key to Dutch hoverflies and with pictures from TaxoFly.

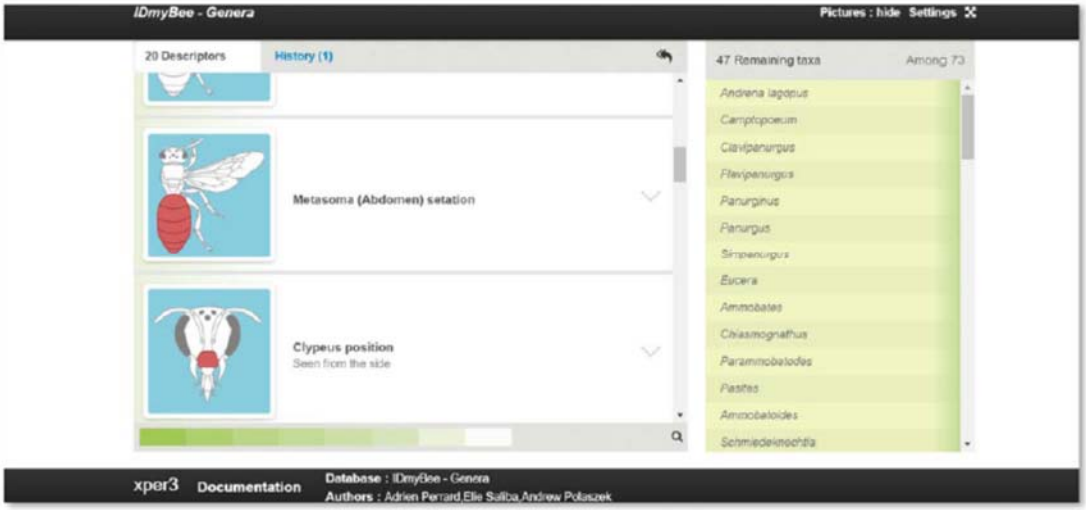


Fig. A2.2.4 Screenshot from IDmyBee, the updated multi-access key for the bee genera of Europe by Adrien Perrard et al

Task 2 established a close collaboration with the projects **Orbit** and **TaxoFly**, recognizing the significance of the taxonomic factsheets they are developing as essential resources for training and reference. Both projects experienced delays, leading to a postponement in the public availability of their *species*-level factsheets. In an effort to foster the collaboration between the projects and accelerate the availability of crucial materials, SPRING invested in the preparation by Orbit and TaxoFly of **factsheets for the European *genera* of bees and hoverflies**. These are accessible through dedicated pages on the Pollinator Academy.

Platform for online training (Task 2.2.4)

As mentioned elsewhere in this report, the Pollinator Academy was established as a hub through which resources for taxonomy trainings are being shared. Its Resource Centre was designed with the goal to bring together both traditional (e.g. paper/pdf) and innovative, interactive tools and resources. As a token of its success, trainers for the Advanced Courses profess that they now routinely refer students to the website as a starting point before a course. Not all course materials for trainers at the portal are finished products; trainers need to internalize and adapt the materials before they can use them in their courses; The trainer repository is therefor only accessible through registration. Note that all partners and interested parties are granted access to the trainer repository.

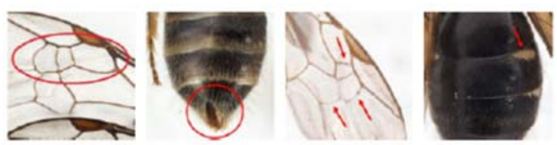
For a complete description of the online platform, refer to Subtask 2.1.9.

Implementation of Advanced Taxonomy courses (Task 2.2.5)

The implementation of the advanced course program was completed according to plan in the course of the Winter seasons of 2022 and 2023. All Advanced Taxonomy Courses for Bees and Hoverflies have been organized (Table A2.2.1).

Table A2.2.1 Overview of Advanced and Regional Taxonomy Courses given in 2022 and 2023. Students exiting an ATC have the knowledge and skills to become proficient identifiers over time (see text).

Year	Date	Title	Duration (days)	Location	Language	Region	Organizer	Participants
2022	**08/Aug**	ATC Bees	5	Mons	English	Europe	UMons (BE)	**8**
2022	**05/Sep**	ATC Bees	5	Mons	English	Europe	UMons (BE)	**8**
2023	**16/Jan**	RTC bees & hoverflies	2	Bologna	Italian	Central Med.	CREA (IT)	**8**
2023	**09/Jan**	ATC Bees	5	Mons	English	Europe	UMons (BE)	**14**
2023	**16/Jan**	ATC Hoverflies	5	Novi Sad	English	Europe	U Novi Sad (RS)	**11**
2023	**23/Jan**	ATC Bees	5	Mons	English	Europe	UMons (BE)	**10**
2023	**30/Jan**	RTC bees & hoverflies	6	Mytilene	Greek	South-East	U Aegean (GR)	**9**
2023	**23/Jan**	ITC Hoverflies	5	Novi Sad	English	Europe	U Novi Sad (RS)	**14**
2023	**02/Feb**	RTC bees	4	Barcelona	English	Atlantic-Med.	Creaf, UAB (ES)	**19**
2023	**10/Jan**	RTC hoverflies	4	Alicante	English	Atlantic-Me.	Creaf, UAB (ES)	**15**
2023	**13/Feb**	ATC Hoverflies	5	Novi Sad	English	Europe	U Novi Sad (RS)	**11**
2023	**20/Feb**	RTC bees	5	Germany	English	Central Europe	UFZ	**12**
2023	**27/Feb**	RTC hoverflies	4	Hungary	English	Pannonian	ÖK (HU)	
2023	**13/Mar**	ATC Hoverflies	5	Novi Sad	English	Europe	U Novi Sad (RS)	**15**
2023	**20/Mar**	RTC bees	4	Hungary	English	Pannonian	ÖK (HU)	**20**
2023	**27/Mar**	RTC hoverflies	5	Germany	English	Central Europe	UFZ	
2023	**06/Nov**	RTC bees & hoverflies	2	Bologna	Italian	Central med.	CREA (IT)	


(a) *Lasioglossum albocinctum* Male
(b) *Lasioglossum lineare* Female
(c) *Lasioglossum glabriusculum* Male
(d) *Lasioglossum interruptum* Female

General comments on identification to species level

Wing venation, head shape, legs, scutum, propodeum, tibial spurs of hind legs, and first abdominal tergites carry identification criteria. The legs and wings need to be slightly spread out to reveal these characters. Male identification requires the antennae to be made clearly visible. It also requires sternites and genitalia extraction.

Morphologically similar genera, and how to distinguish them

- ***Lasioglossum - Halictus & Thrincohalictus***
  Lasioglossum species have submarginal crossvein 3 and recurrent vein 2 less visible than submarginal crossvein 1. Hairs bands on the abdomen are at the basal part of the segments. *Halictus & Thrincohalictus* species have submarginal crossvein 3 and recurrent vein 2 of similar strength than submarginal crossvein 1. Hairs bands on the abdomen are at the apex of the segments (not always clearly visible in Seladonia and Vestitohalictus).

- ***Lasioglossum - Ceylalictus & Nomioides***
  Lasioglossum species have a marginal cell pointed. Females have a furrow on T5. *Ceylalictus & Nomioides* species are very small with a marginal cell rounded to truncated. Females have no furrow on T5.

Fig. A2.2.5 A page from a genus factsheet for *Lasioglossum*, prepared by Orbit for the Pollinator Academy.

All SPRING partner institutes were invited to nominate candidates for the courses, while the courses were advertised in the larger taxonomy community as well. Attendees for the Advanced Taxonomy Courses on Bees or Hoverflies were selected on the basis of their pre-existing knowledge, experience and potential future contribution to a pollinator monitoring program. They had varied nationalities and the courses were therefore conducted in English. Online sessions were organized, either as an introduction to prepare for the face-to-face part of the course (e.g. helping to understand the learning needs and mutual expectations between trainers and participants) or as informative sessions, covering parts of the training that did not require face to face interaction. The team learned that online preparatory workshops and self-study are important ways to ensure that all students meet the minimal requirements for knowledge and skills when they enter the course (also see Subtask 2.2.6). This can increase the effectiveness of the actual courses considerably.
The students leaving the Advanced Taxonomy Courses (40 students for bees and ca. 30 for hoverflies) have the necessary basic knowledge and skills to become trustworthy identifiers, but, depending on their exit level, the taxonomic group and the geographic region they're working on, they will usually have to spend considerable time honing their skills to become truly proficient.

SPRING Costing for Taxonomy Courses (Task 2.2.5)

An estimate of the cost of taxonomy courses was made, based on experiences collected during the project and best available information. An inventory was made of the main cost items for the international Advanced Taxonomy that need to be taken into account, on the basis of which a conservative estimate of the true costs was made.
Although cost data were drawn from experience in developing and running taxonomy courses, because they depend on a number of factors, the true cost of a course can vary considerably. Variable items include, for example, salary costs, inflation, numbers of trainers and participants per course, suitability of existing training facilities, and required preparations (both logistical and subject-related, and including taxonomic collections for study and reference). These in turn depend on the local situation, including the complexity of the taxonomic group being taught and the availability of the required expertise. To account for these factors and for quality standards, calculations were made for a minimum budget (the *Basic version*, Table A2.2.2 & A2.2.4), as well as a *'Gold standard'* (Table A2.2.3 & A2.2.5) to provide a range of plausible cost values. The Gold standard is recommended by the consortium and is expected to produce the best-skilled taxonomists, which over time is likely to result in cost reductions when running a monitoring scheme.
The investments in a course, e.g. for the development of expertise, course design and teaching materials, are substantial. A well-planned repetition of courses can therefore yield significant cost savings. This is also reflected in the calculations, by distinguishing between first-time course development (Table A2.2.3 & A2.2.3) and repeated courses (Table A2.2.4 & A2.2.5). A 'first-time course' can either refer to an institute or group of trainers giving a course for the first time, and/or a training that takes up assemblages of species that have not been taught before, for example in a new region. A specific cost item is the building and maintenance of a taxonomic study collection. (A *study collection* consists of unidentified specimens that students learn to identify during the course; it can have a substantial turn-over rate due to intensive handling. A *reference collection* contains identified specimens that serve as comparative material). A separate calculation estimates the cost of a study collection, again with a lower and upper limit (Table A2.2.6). Separate calculations were made for one-time development of a study collection and for maintenance after each course, assuming a 10% turn-over of specimens due to handling.
Given the considerable costs to set up a course for the first time and the upfront costs of building a training collection, an integrated course program could be part of a long-term vision that would optimize the cost-effectiveness of a monitoring programme and research infrastructure.

Table A2.2.2 Advanced Taxonomy Course, basic version, first time.

Advanced Taxonomy Course: Basic version, first time							**Total***	**70750**
	Number	Lab days	Days preparation & online training	Rate/ day	Travel	Subsistence/ day	Total / person	Total
Coordinator/Organizer	1	5	15	700	500	150	15250	15250
Trainer(s) per day (first expert)	1	5	16	1000	500	150	22250	22250
Trainer(s) per day (second expert)	1	5	4	1000	500	150	10250	10250
Trainees	10	5	1	0	500	150	1250	12500
Venue		5		1000				5000
Local travel				500				500
Materials*				5000				5000
*** Excluding a taxonomic training collection.**								

Table A2.2.3 Advanced Taxonomy Course, Gold Standard, first time.

Advanced Taxonomy Course: Gold Standard, first time							**Total***	**111500**
	Number	Lab days	Days preparation & online training	Rate/ day	Travel	Subsistence/ day	Total / person	Total
Coordinator/Organizer	1	5	15	700	500	150	15250	15250
Trainer(s) per day (first expert)	1	5	26	1000	500	150	32250	32250
Trainer(s) per day (second expert)	4	5	4	1000	500	150	10250	41000
Trainees	10	5	1	0	500	150	1250	12500
Venue		5		1000				5000
Local travel				500				500
Materials*				5000				5000
*** Excluding a taxonomic training collection.**								

Table A2.2.4 Advanced Taxonomy Course, Basic version, on repetition.

Advanced Taxonomy Course: Basic version, on repetition							**Total***	**60250**
	Number	Lab days	Days preparation & online training	Rate/ day	Travel	Subsistence/ day	Total / person	Total
Coordinator/Organizer	1	5	10	700	500	150	11750	11750
Trainer(s) per day (first expert)	1	5	11	1000	500	150	17250	17250
Trainer(s) per day (second expert)	1	5	4	1000	500	150	10250	10250
Trainees	10	5	1	0	500	150	1250	12500
Venue		5		1000				5000
Local travel				500				500
Materials*				3000				3000
*** Excluding a taxonomic training collection.**								

Table A2.2.5 Advanced Taxonomy Course, Gold Standard, on repetition.

Advanced Taxonomy Course: Gold Standard, on repetition							**Total***	**96000**
	Number	Lab days	Days preparation & online training	Rate/ day	Travel	Subsistence/ day	Total / person	Total
Coordinator/Organizer	1	5	10	700	500	150	11750	11750
Trainer(s) per day (first expert)	1	5	16	1000	500	150	22250	22250
Trainer(s) per day (second expert)	4	5	4	1000	500	150	10250	41000
Trainees	10	5	1	0	500	150	1250	12500
Venue		5		1000				5000
Local travel				500				500
Materials*				3000				3000
*** Excluding a taxonomic training collection.**								

Table A2.2.6 Costs of developing and maintaining a taxonomic study collection for an Advanced Taxonomy Course.

Building a taxonomic training collection for Advanced Taxonomy Courses			
Item	**Lower bound**	**Upper bound**	**Units**
Number of species per 1-day workshop (focus on 1 genus)	25	50	specimens
Number of workshop days per course	5	5	days
Number of students	10	12	persons
Adjustment factor for multiple-person-use of specimens	0,75	0,75	
Number of specimens in training collection	937,5	2250	specimens
Taxonomic preparation time per specimen	0,5	1	hours/specimen
Total taxonomic preparation time	469	2250	hours
Logistics: time for organizing & managing hardware**	16	16	hours
Hardware costs**	1000	1000	euro
TOTAL for *building* a training collection (one-time investment)	**485**	**2266**	**hours**
Day rate	**700**	**700**	euro/day
Cost	**42416**	**198275**	**euro**
Maintenance factor (per-course turn-over rate of 10%)	0,1	0,1	
TOTAL for *maintenance* of training collection (per course)	**47**	**225**	**hours per course**
Day rate	**700**	**700**	day rate
Cost	**4102**	**19688**	**euro**
** Including boxes, pins, labels, storage, etc.			

Implementation of Integrative Taxonomy courses (Tasks 2.2.3 & 2.2.6)

The course on Integrative Taxonomy focussed on online e-learning and the opportunities that this offers to efficiently train large numbers of students. In December 2022 SPRING organized a 4-day training in person for an international group of young taxonomists, in which they learned how to design interactive learning modules. Additional training was given in online workshops; a total of 8 young taxonomists was trained in the development of e-modules. The training focussed not only on software functionalities, but also emphasized didactics, user psychology, and functional design. The group went on to develop around 20 e-learning modules for the Pollinator Academy.

The SPRING consortium perceived the potential benefits for a centralized, online environment that facilitates distance self-learning for course preparation and self-assessment, with a focus on blended learning. The realization that such an innovative online learning environment was needed grew out of experiences from the SPRING training program: it was recognized that effective courses require a standardized level of basic knowledge and skills among students before they

enter a course. Online training modules can help to address students' entry-level skills and knowledge in an efficient way. The provision of a blended learning environment enables students to optimize their preparation. Following an assessment of the needs and requirements for an online learning environment, a dedicated software package was selected (e.g. Articulate - Rise 360 tool).
The young taxonomists trained in the development of e-learnings were assigned the development of e-learnings on taxonomy, which resulted in the creation of around 20 modules that now form the foundation for online training at the Pollinator Academy (Fig. 2.2.6.A). While these modules showcase the potential of the new learning environment, realizing its full potential requires the collaborative development of additional learning modules in partnership with specialist communities.
A second course on Integrative Taxonomy, focussing on genetic techniques, was conducted in January 2023 in Novi Sad.

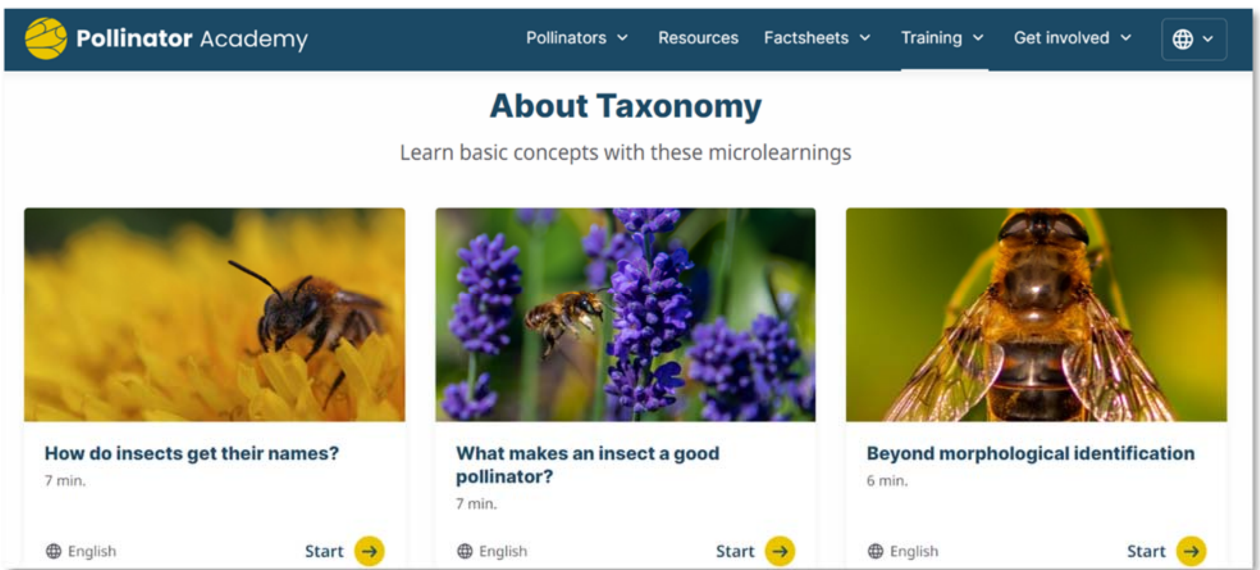


Figure A2.2.6 Example of a webpage at the Pollinator Academy with access to e-learning modules.

Implementation of Regional Advanced Taxonomy courses (Task 2.2.7)

The Regional Advanced Courses focussed on the identification of genera and species that are relatively easy to identify. All regions had organized Regional Taxonomy Courses for Bees or Hoverflies (RTC-B and RTC-H) before the field season of 2023 (Fig. 2.2.5.A). These courses were often given by a team of both local and external (e.g. international) trainers, who visited from other institutes. Although it was logistically challenging to make this happen, it was felt that the resulting pairings enhanced the quality of the courses and the international collaboration between partners. In total over 17 Advanced and Regional Taxonomy Courses on Bees and Hoverflies (RTC-H, RTC-B, ATC-H, ATC-B) have been given. The Regional Courses were often delivered in a mixture of English and the native language. This bi-lingual approach was needed to ensure that the course was adapted to the needs of the students. Technical language sometimes created a barrier and, for efficiency, should be learned prior to a course, for example with e-learnings.

Report on strategy to safeguard identification capability (Task 2.2.8)

The ultimate goal of Task 2 was to prepare capacity building for a future European Pollinator Monitoring Scheme. The aforementioned training materials and activities developed in the SPRING project are expected to significantly enhance the capacity for pollinator identification in all participating countries. However, an integrated and comprehensive strategy is needed to build the taxonomic knowledge and identification capacity that are required to upscale to a full blown European Pollinator Monitoring Scheme.

The strategic assessment centred around surveys to be sent to the representatives of all European Member States in order to chart their current state, future needs, and barriers. The framework for this assessment is ready for implementation, but due to reasons beyond the control of the project, sending out the surveys was stalled and the subtask could not be brought to a conclusion. Given the impeding completion of the SPRING project, responsibility for the delivery and analysis of the surveys was handed over to DG Environment in October 2023 for future continuation. Task 2 also partook in discussions to map out an interim approach until more detailed information on taxonomic capacity building is available. Here we describe the preparatory work that has been done.

The following preparatory steps were taken:

1. Mapping of a framework for EU PoMS
2. Preparatory talks with taxonomic specialists
3. Framework for capacity needs established
4. Surveys for Member States prepared
5. Experts invited to share their personal data with national authorities
6. Online workshop with Member States in preparation for the surveys
7. Responsibility for surveys handed over to DG Environment
8. Talks with STING-2 and CETAF to map out an interim approach

Development of a EU PoMS framework
To better understand the different national and international actors, and the way in which academic and societal partners and goals are interrelated, the EU PoMS framework was drawn up (simplified version: Fig. A2.2.7). The SPRING project is represented in this diagram as a preparatory action, together with the main actors focusing on the development at European level of taxonomic knowledge and fieldwork techniques (Fig. A2.2.8). Experts from the various stakeholders were asked in four workshops (respectively focusing on bees, hoverflies, butterflies and moths) to map out the most important areas of interest for a capacity building strategy.

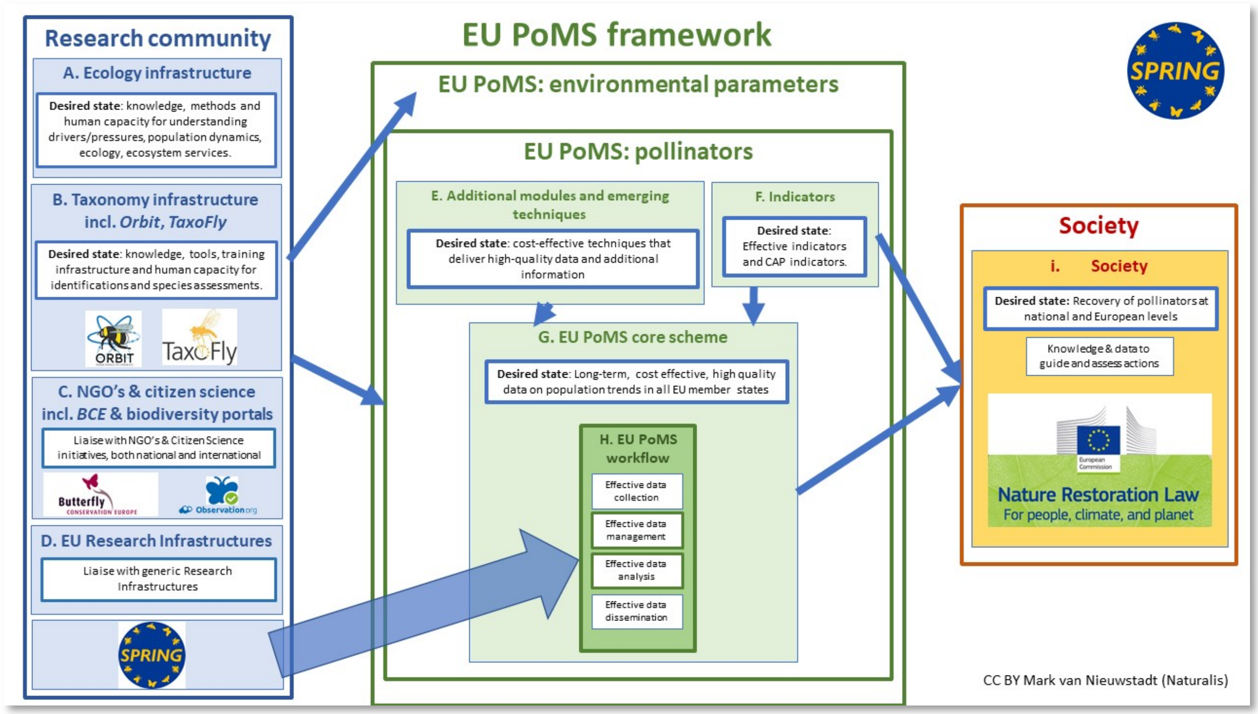


Fig. A2.2.7 Framework of a future European Pollinator Monitoring Scheme, mapping the desired states, infrastructure, and stakeholder community.

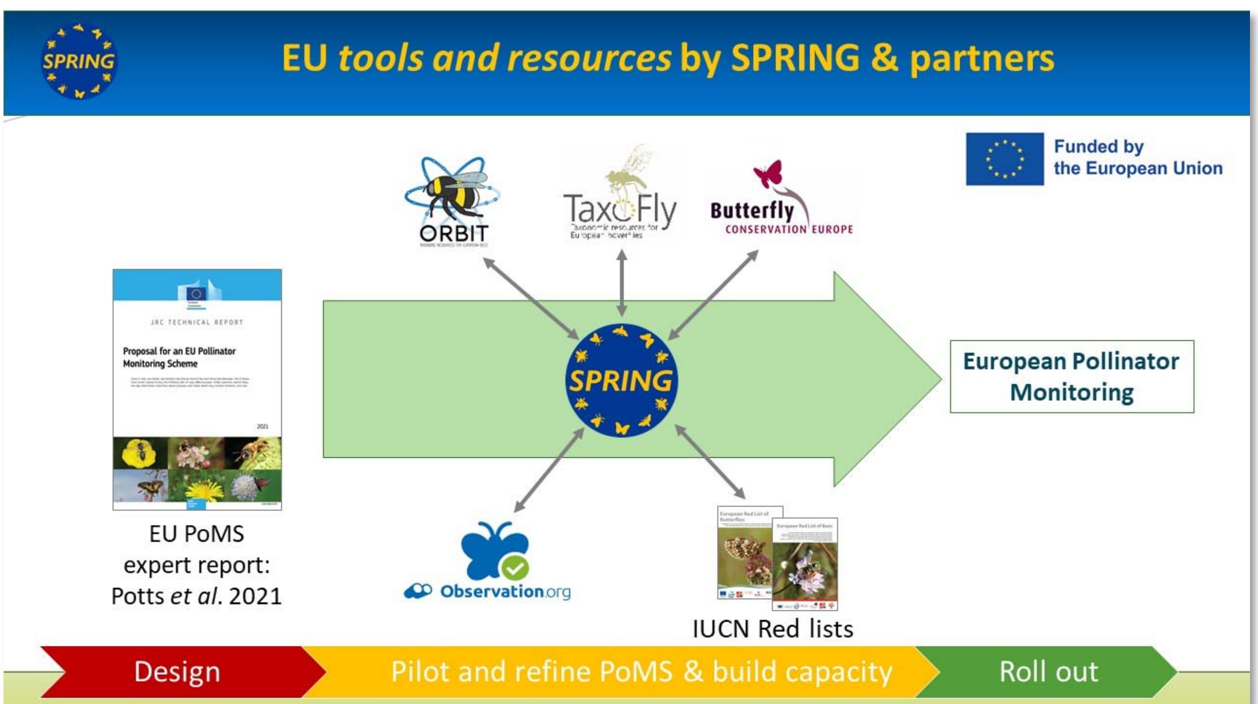


Fig. A2.2.8 Pathway illustrating the role of SPRING and partner projects in preparation for a European Pollinator Monitoring Scheme.

Framework for capacity needs

The development of any biodiversity monitoring scheme involves a number of the same phases. Accordingly, specific expertise and materials are required (Fig.2.2.9). Furthermore, we identified three main pillars of capacity that must be developed to enable a European Pollinator Monitoring Scheme (Fig.2.2.10). These two schemes form the basis for the surveys on the state of affairs in various European Member States with regard to the capacity to monitor pollinators. Furthermore, the surveys were aligned with the knowledge inventory previously conducted by Potts et al. (*Proposal for an EU Pollinator Monitoring Scheme*, 2021, JRC 122225).

Knowledge development for biodiversity monitoring

Step	Tools and activities	Who (human capacity)
1. Which species are there?	National species lists	
2. How to recognize them?	Field guides and other identification tools, both traditional and interactive	
3. Where do they occur?	Atlas or online atlas	
4. Does a species increase or decrease in a specific area? a. Presence/absence (change in occurrence) b. Population trends	a. Atlas; observation database **b. Standardized monitoring through time (PoMS)**	
5. Environmental variables: causes and effects; drivers; mitigation measures		

Fig. A2.2.9 Five steps in development of knowledge and capacity towards a functional biodiversity monitoring scheme.

Three pillars of capacity building for monitoring

1. **Human capacity**
   - Coordinators
   - Trainers & alpha taxonomists
   - Surveyors
   - Identifiers (lab)
2. **Taxonomic tools and resources**
   - ID keys
   - Physical and digital reference collections
3. **Infrastructure for training and support**
   - National and international training program
   - Pollinator Academy
   - Communities for taxonomists (fora) and general public (biodiversity portals)

Figure A2.2.10 Three pillars of capacity building for pollinator monitoring.

Surveys for Member States

Five separate surveys were developed: four to respectively map out the state of affairs for the four main groups of pollinators, i.e. wild bees, hoverflies, butterflies, and moths. A fifth survey focuses on the infrastructure needed to set up a pollinator monitoring network. These surveys pay specific attention to the different approaches that Member States could take in terms of the workforce they deploy for monitoring (Fig.2.2.11). The employability of volunteers or paid employees is related to the minimum quality requirements that will be imposed on the data. It should be emphasized that a volunteer network is not necessarily the cheapest or most efficient solution under all circumstances; however, analysing this is outside the scope of the surveys.

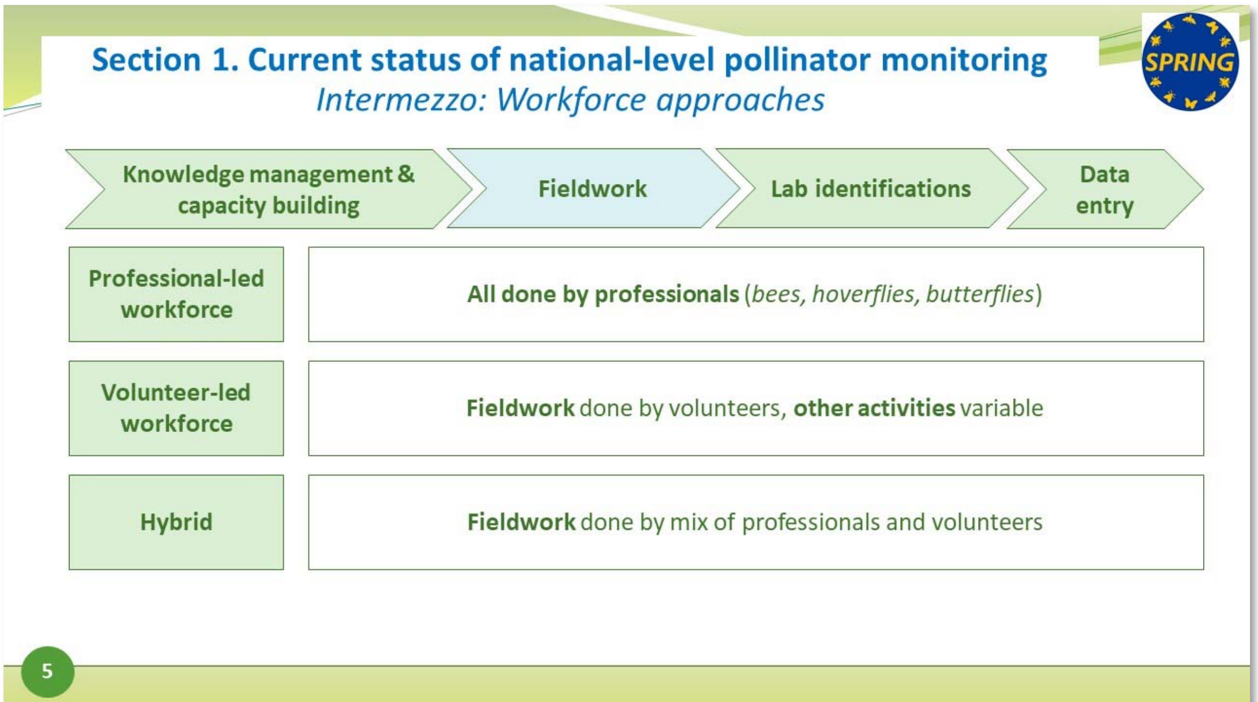


Fig. A2.2.11 Alternative approaches to build a workforce for pollinator monitoring.

Together with DG Environment, an online workshop to explain the surveys to the representatives of the Member States was organized on May 31, 2023. As set forth in the introduction, the surveys are ready to be submitted to the interested parties. Due to reasons beyond the control of the project, sending out the surveys was stalled and the subtask could not be brought to a conclusion. Given the impeding completion of the SPRING project, responsibility for the delivery of the surveys was handed over to DGE in October 2023 for future continuation. Because there was a current need for the further development of taxonomic capacity, Task 2 partook in talks with STING-2 and CETAF about an interim approach.

Report on the annual training programme (Task 2.2.10)

At the annual group meetings in Barcelona and Bologna, workshops were organized to report, share and discuss the course program of the previous year. The results of these workshops were integrated in the planning and outline of the course curriculum and course content (Subtask 2.1.2), and the development of tools (Subtask 2.1.3).

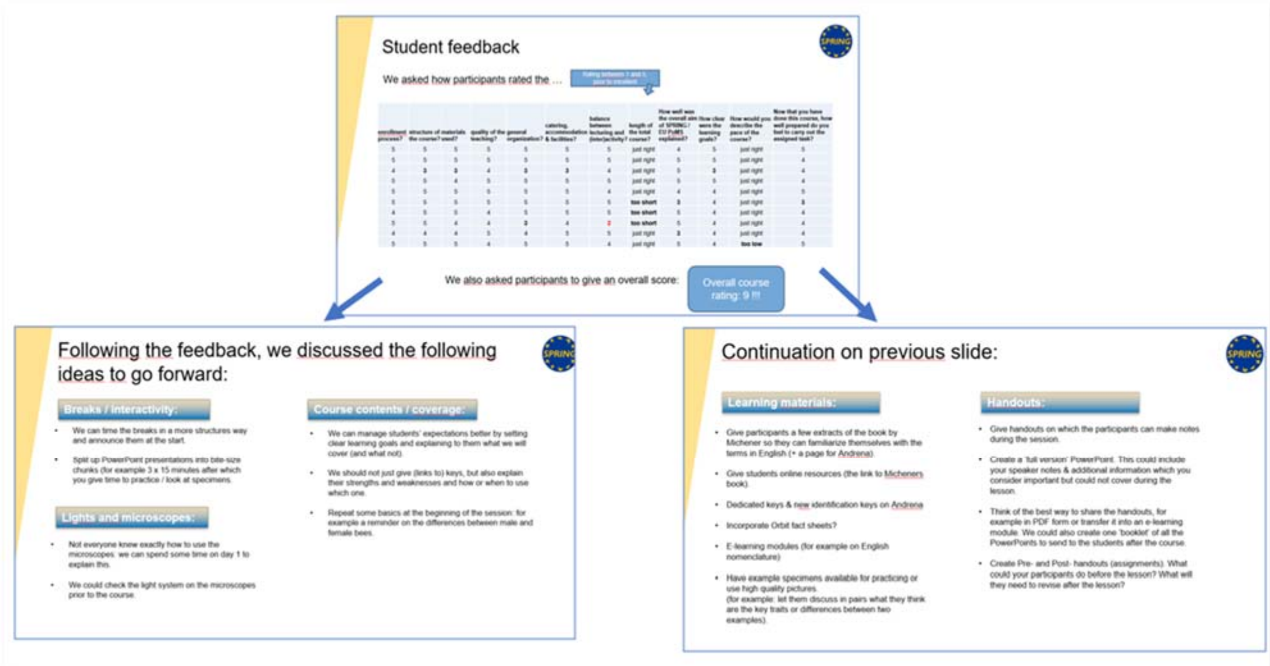


Figure A2.2.12 Example of evaluation resulting in program improvements.

Feedback on the status of the SPRING fieldwork and capacity building was gathered and presented on a poster during the annual SPRING meeting (Fig. 2.2.13). Some takeaways from this survey were:

- Most partners were positive about the impact of the SPRING project, but indicated that they were not yet fully ready for a full monitoring scheme.
- Region Leaders, who were then in their second year of field work, were generally more positive than countries which joined in the second year. The latter often indicated the need for more time to develop their network of field sites and training curriculum. This highlights both the progress made by the original consortium partners and the need for additional support. A multi-annual plan seems to be advisable to develop the monitoring program.
- Involvement of citizen scientists was generally low in Eastern and Central Europe, while in other regions there were many positive experiences, albeit variable between countries.
- The final question, "Are we going to save pollinators this way?" elicited the most negative feedback, indicating a broad acknowledgment of the limitations within the academic sphere of influence and the imperative for societal action to bring about real change.

During the feedback sessions, a need was expressed for guidelines that would consolidate the diverse experiences across Europe related to the organization of the courses. Organizers from various regions aggregated their knowledge and experience into a Playbook designed for organizers and commissioners (see Fig. A2.2.14).

Region	Country	How is the involvement of citizen scientists up to now?	Capacity to ID pollinators that came out of the pan traps?	How engaged are key national authorities?	How ready is your country to monitor pollinators after SPRING?	How successful has the SPRING project been (overall impression)	Are we going to save the pollinators if we continue this way?
1. Scandinavia/ Baltic	Sweden (lead)	Y	Y	Y	Y	Y	O
	Lithuania	Y	O	O	O	Y	O
	Latvia	Y	O	O	O	Y	O
	Finland	O	O	Y	Y	O	N
	Estonia	Y	O	N	O	Y	O
2. Eastern 1	Hungary (lead)	Y	Y/O	Y/O	Y	Y	O
	Romania	N	N	N/O	N	O/N	O
3. Eastern 2	Greece (lead)	O	O	O	N	Y	N
	Bulgaria						
	Cyprus	O	O	Y	N	Y	N
4. Atlantic/ Mediterranean	Spain (lead)	Y	Y	Y	O	O	N
	France	Y	O/N	O	N	O	N
	Portugal	Y	Y	O	O	O	N
5. North-West	Netherlands (lead)	Y	Y	Y	Y	O	N
	Belgium	N	Y	O	Y	Y	N
	Denmark						
	Ireland	Y	O/N	Y	Y	Y	N/O
	Luxembourg	Y	Y/O	Y	Y	Y	O
6. Central	Germany (lead)	N/O	Y	N	N	Y/O	O
	Czech Republic						
	Austria	O	N	N	O	O	N
	Poland						
	Slovakia						
7. South	Italy (lead)	Y/O	Y/O	O/N	N	Y	O/N
	Croatia	N	Y	O	O	Y	O
	Malta	Y	O	Y	Y	Y	O/N
	Slovenia	O	Y	O	O	Y	O
TOTAL							
Yes (positive)		12	8	8	8	14	0
O, O/N, O/Y (Neutral)		7	12	11	8	8	13
No (Negative)		3	2	3	6	0	9
No response*		5	5	5	5	5	5

Figure A2.2.13 Feedback on the state of affairs, collected at the annual SPRING meeting in November 2023. *Nor response: no representative present at the meeting.

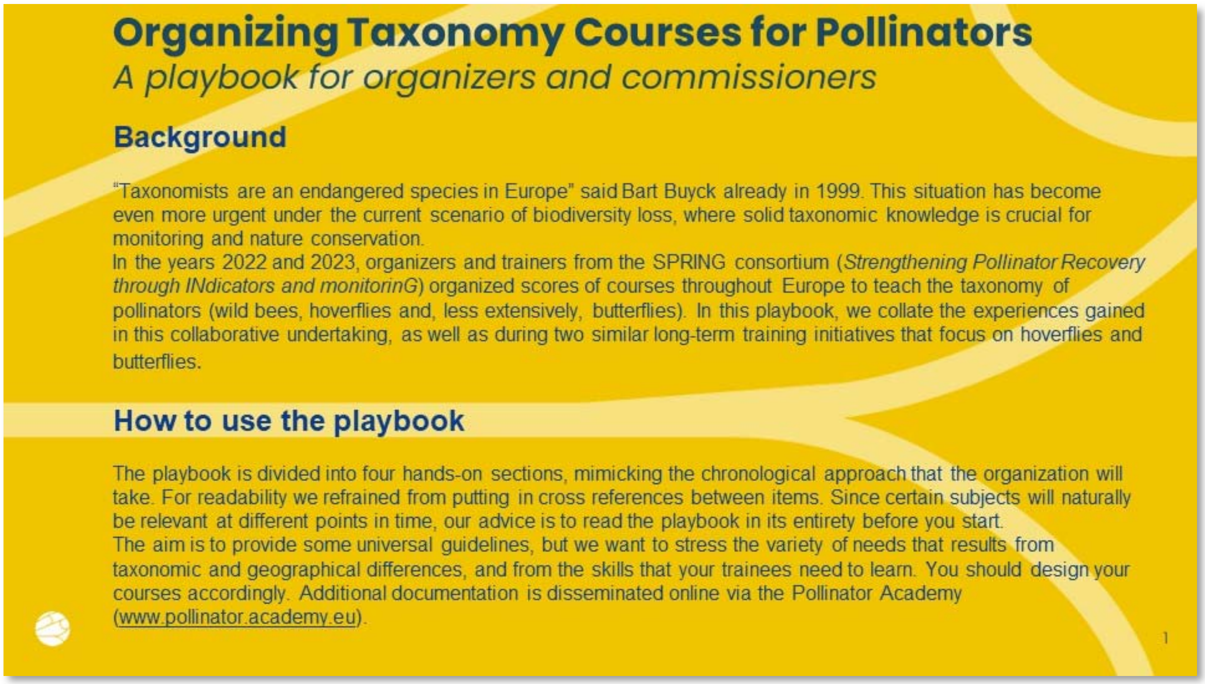


Fig. A2.2.14 Screenshot from the Playbook for organizers of Taxonomy Courses for Pollinators.

The generated course outlines and tools derived from the course curriculum for basic and advanced courses served as the foundation for the Trainer portal at the Pollinator Academy. The trainer portal is accessible for registered users only, because the materials offered there often require expert adaptation to the local needs and conditions (refer to Fig. A2.2.15).

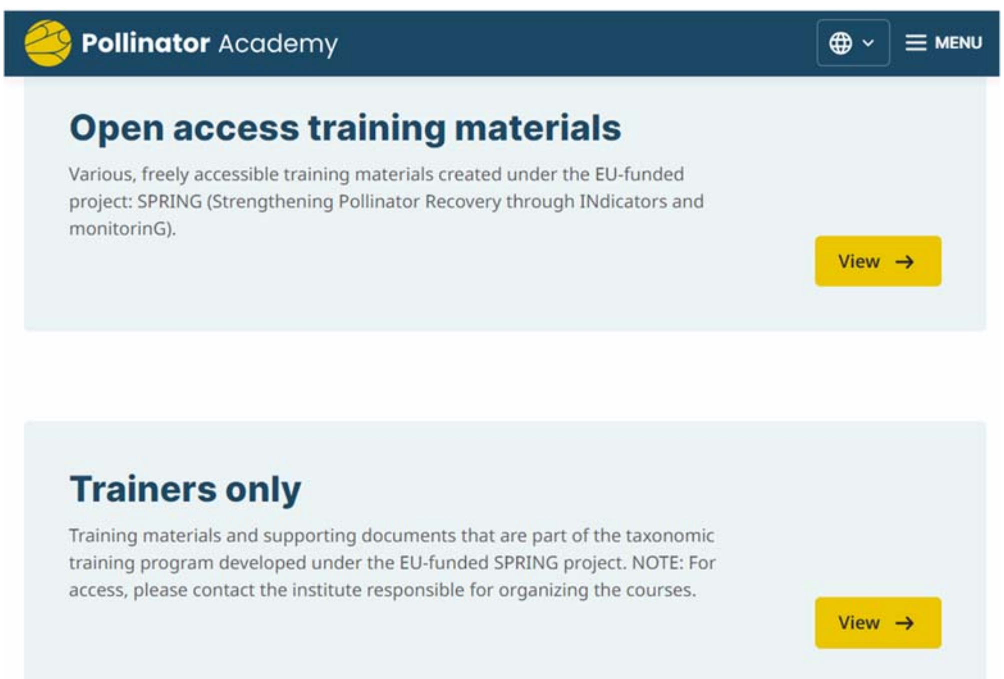


Fig. A2.2.15 Portal to trainer materials at the Pollinator Academy.

A4 Testing complementary and additional modules

A4.1 Testing the moth module

Protocols for Moth Field Trials

Three protocols have been produced:
a) How to build your own LED moth trap[6]. Although for monitoring purposes is not needed to use exactly the same trap on every location (as long as the trap remains the same in time), the LED traps are a relatively cheap and versatile method to trap moths.
b) How to set up and use a LED trap[7]. Also available in Spanish, Italian, German, Dutch and Swedish.
c) How to register moth trap samples on eBMS website
More information can be found on https://butterfly-monitoring.net/bms-methods.

The protocols have been specifically designed to be used by citizen scientists. The ButterflyCount app (see: app stores) is an essential part of this. Not only does it make entering data easy and quick, but it also has a built-in identification via the obsidentify image recognition (an essential part of the survey protocol). At the end of the SPRING project extra attention has been given to the validation of moth photos which have been entered using the ButterflyCount app. These photos can further improve the quality of the image recognition, as this algorithm is trained on a regular basis (usually once a year).

A4.2 Testing the wider insect biodiversity module

Updated protocol for Malaise trapping (SPRING Malaise trap protocol)

Note: for reasons of standardisation, this protocol is based on the LIFEPLAN protocol[8] which again is based on the Global Malaise Program protocol[9]. Some modifications were applied for SPRING.

- Video instructions for IBA volunteers (IBA Insect Biome Atlas; Swedish initiative): https://www.nrm.se/allainsekter/volfilm[10]
- Insect Biome Atlas: http://www.insectbiomeatlas.org[11]

Background of the sampling protocol

It is critical to employ standardised operating procedures for the Malaise trapping. Our coordinated efforts will ensure specimen preservation for genetic analysis and high data quality, allowing the comparison of Malaise trap sites within SPRING.
Note that the samples collected within the SPRING project were based on bulk processing (metabarcoding) of complete samples. We are aware of the drawback of not having insects left

[6] https://butterfly-monitoring.net/sites/default/files/Pdf/moth%20monitorin/Self-made%20your%20LEDmoth%20Trap.pdf
[7] https://butterfly-monitoring.net/sites/default/files/Pdf/moth%20monitorin/Manual%20Ledtraps%20English%20Feb2022%20-%202%20pages.pdf
[8] https://www.helsinki.fi/en/projects/lifeplan/instructions#section-91831
[9] https://biodiversitygenomics.net/resources/bioscan/
[10] https://www.nrm.se/allainsekter/volfilm
[11] https://www.insectbiomeatlas.org/

for morphological approaches, but bulk metabarcoding is necessary for quick processing of the data to be able to compare the results in due time with those generated by the MVS protocol.

Equipment necessary

- Malaise trap kit (net, trap head; assembly instruction sheet)
- about 15-20 sample collection bottles (1000 ml); external and internal labels
- ≥ 95% ethanol for preserving samples. Pure ethanol is quite expensive and not necessary, denaturated ethanol is suitable and much cheaper (denaturation: 1% MEK = methyl ethyl ketone; ethanol denaturated with mercapto ethanol or ethyl acetate is not recommended!)
- Aluminum foil for wrapping the collection bottle

Malaise trap types

- **“ez-Malaise Traps”** (about 400 €)**:** employed in **SE, NL, HU**; This model is manufactured by MegaView Science Co. (Bugdorm, Taiwan). Compared to the commercially available design, few modifications may be useful: Nalgene bottles and barbed tent pegs, removal of the "moth excluder device" (a triangular piece of cloth with small holes, used to keep out bigger insects when focusing on Diptera and Hymenoptera). The support poles at the front and back of the traps may be upgraded to a sturdier material than in the trap kits sold online. To reduce wear by the pole ends on the cloth pockets holding them in place, one can provide pipette rubber bulbs (to be mounted by the trap manager on the ends of the poles before sticking them into the pockets).
- **Krefeld type** (about 440 € without stainless-steel bottle-holder): employed partly in **DE**; this is similar to the ones distributed by Bioform[12] (449 € including collection bottle). Note that the original trap is produced by the Krefeld Entomological Association.
- **LTER-Germany type** (about 100 €): cheap version manufactured in Bangladesh, used for the LTER-D Malaise Trap project[13]. This type is used at about 12 SPRING sites mostly run by institutions already taking part in the LTER-D Malaise trap project.

Figure A4.2.1 Malaise trap LTER-Germany type with terms used throughout the protocol

[12] https://www.bioform.de/shop.php?action=tree&wg=1&pid=706&treeid=5290

[13] https://www.ufz.de/lter-d/index.php?en=46285

Installing traps

When setting up the trap, the following aspects are to be considered:

- Preferred SPRING habitats are connected to agricultural land use like crop fields, pastures or meadows. Traps should not be placed in forests without e.g. clearing.
- Position the trap at a right angle to an insect flight line (preferably in areas with low undergrowth). Typical insect flight lines are along the edges of forest, hedgerow margins etc.
- Direct the trap head towards the equator (Europe: southwards). However, condition 1. (right angle to flight line) has priority!
- The trap head with the bottle holder must be the highest part of the trap (i.e. avoid placing the trap on a downhill slope with the collecting part lowest). This is because the trap design depends on insects moving towards the highest and lightest part of the trap.
- Consider possibilities of wildlife disturbance and/or human vandalism – try to avoid either scenario as much as possible; the trap may be relocated if consistent issues persist after deployment.
- Ensure that all proper specimen collecting permissions are obtained (i.e. from local authorities, property owners, etc.).

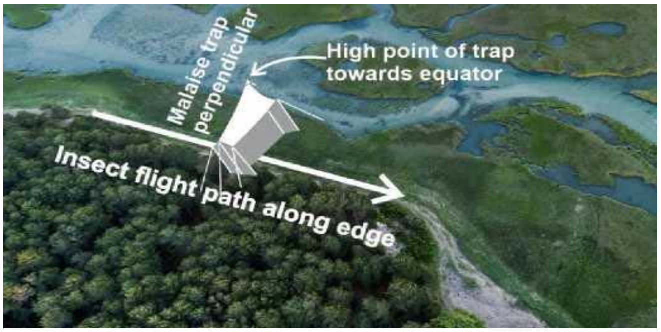


Figure A4.2.2 Positioning of Malaise trap relative to the edge of landscape elements and towards the equator (Europe: southwards) direction if possible

Activation of trap

Collecting bottle

Fill the collection bottle up to 3/5 full with 80 % Ethanol at the time of deployment. Do not substitute with other kinds of alcohol or other preservatives. Wrap the bottle with aluminum foil to protect it from the sun and hide trapped insects from occasional visitors. If during hot periods much ethanol evaporates, increase the amount in the collection bottle next time and lower the amount when temperatures are declining again.

Deployment

- After arriving at your field site, assemble and set up the trap securely (according to the Malaise trap instruction sheet).
- When possible, tie the front and/or back ropes to nearby trees for added support.
- Also, if available, attach the trap poles to a 6- to 8-foot stake or post at its highest points to protect the trap against falling over from high winds, especially if it is placed in an exposed area.
- Attach an **ID label** to the tent pole.
- It may be useful to attach an **information sign** telling occasional visitors what it is about and that you have the permission from the corresponding authority.
- Tightly affix the prepared collection bottle to the bottle holder.
- Begin the collection on a day of the week you can consistently return to for the duration of the sampling period (e.g. check for public holidays)!

Collection & Monitoring

- Collect the catch **exactly each 14 days (use the same day of the week!)** during the insect activity period (correlated with vegetation period; i.e. during non-freezing temperatures).
- **Labelling** needs to include (1) unique ID of the site (country code, location and number, e.g. DE-FBG1), dates of the activity period (use standard date formatting like yyyy-mm-dd, e.g. 2022-04-15 to 2022-04-30), consecutive number of collection events (e.g. 1 for first collection round, 2 for the second etc.). Place one paper label inside and one sticky label outside the bottle.
- One may take a **picture** of the trap at least from the front side aspect of the trap (about 5 m distance) including the surroundings each time you collect a sample! This to provide an overview about the status of the trap and the vegetation around. If you need to cut the vegetation, take a picture afterwards as well.
- In the field protocol sheet specify the **trap condition** (GOOD, AVERAGE, POOR and give a short description for the reasons especially for the POOR rating) at the time of collecting the sample.
- When collecting the sample, wipe the **bottle holder** with a clean duster, to avoid dead insects remaining between weeks. Then screw on the new bottle with ethanol for the next sample.
- Check for **spider nets** inside the tent, especially at the trap head where the tent is connected with the bottle holder.
- Ensure that especially **herbaceous vegetation** is kept at a similar height like at the start of the trapping season (often you will need to cut the vegetation at a perimeter of 3 m during the maximum growth time).
- Visit the trap frequently - if you can! - to monitor for and repair damage, and to avoid sample overflow. In particular, check the trap after strong winds or heavy rain. Be always prepared for replacement or repair of parts when you are visiting the trap.
- **List of items for field work:** smartphone (pictures), rope, trap poles, Malaise net (in case the present one is heavily damaged), bottle holder, adhesive tape for repair, collecting bottle with ethanol, sample labels, field protocol sheet, tools (scissors, screw driver, pencil)

Storage

- When in the field, store the sample in a shaded cooler (if available), shielded from light (this is more important than the cooler).
- When back from the field, place the samples in a cool, dark location. This is critical to preserve the DNA in the samples; improper storage will result in DNA degradation rendering samples unusable for DNA sequencing (e.g. under constant light, heat or variable temperatures).
- Ensure that the entire insect mass is fully submerged in ethanol before storage; add fresh 95 or 100 % ethanol to the sample bottle so that there are about 4 cm of Ethanol above the level of insect mass.

Delivery

- If you need to send the samples to a lab for metabarcoding, consider the official rules for delivering dangerous goods in your country.
- If samples are sent to a different country, check the applicability of the Nagoya protocol regulations!

A5 Communications

A5.1 Task 1 Documentation

Communication material developed by Task 1 of the SPRING consortium (to be linked from here to online download page).

Overview in folder structure

Overview of entire folder structure:

001 SPRING pollinator PPA > 001 SPRING project > Reporting > Final reporting > Deliverables >

Name	Date modified	Type
Field guides eBMS	7/9/2024 1:44 PM	File folder
Leaflets eBMS - ButterflyCount app	7/9/2024 10:13 AM	File folder
Task 2 appendices	7/9/2024 10:13 AM	File folder
Task 3 appendices	7/9/2024 10:15 AM	File folder

Overview of files in folder "Field guides eBMS":

ɔollinator PPA > 001 SPRING project > Reporting > Final reporting > Deliverables > Field guides eBMS

Search Field guides e

Name	Date modified	Type	Size
Denmark eBMS Field Guide Danish finalv2	7/5/2024 1:33 PM	Adobe Acrobat D...	12,862 KB
Denmark eBMS Field Guide English finalv2	7/5/2024 1:36 PM	Adobe Acrobat D...	12,894 KB
eBMS Field Guide Austria-Burgerland Helmut -English_cc	7/5/2024 1:37 PM	Adobe Acrobat D...	19,196 KB
eBMS Field Guide Austria-Burgerland Helmut_cc	7/5/2024 1:37 PM	Adobe Acrobat D...	19,568 KB
eBMS Field Guide CommonSpecies_Monviso_black	7/5/2024 1:37 PM	Adobe Acrobat D...	15,346 KB
ebms Field Guide Slovenia 2 English 08022023_final	7/5/2024 1:38 PM	Adobe Acrobat D...	14,949 KB
ebms Field Guide Slovenia 2 Slovenian 02022023_final	7/5/2024 1:38 PM	Adobe Acrobat D...	14,975 KB
EspeciesComunesEspañaFG_eBMS_cc	7/5/2024 1:38 PM	Adobe Acrobat D...	16,637 KB
IT_Mediterranean2023_eBMS FGCommonSpecies_English15012...	7/5/2024 1:38 PM	Adobe Acrobat D...	15,422 KB
IT_Mediterranean2023_eBMS FGCommonSpecies_Italian080420...	7/5/2024 1:38 PM	Adobe Acrobat D...	15,457 KB
leaflet Malta- English final 02032023	7/5/2024 1:39 PM	Adobe Acrobat D...	6,394 KB
leaflet Malta- Maltese 02032023	7/5/2024 1:39 PM	Adobe Acrobat D...	6,410 KB
Lithuania FG ebms -English_cc	7/5/2024 1:39 PM	Adobe Acrobat D...	16,237 KB
Lithuania FG ebms -LT_cc	7/5/2024 1:39 PM	Adobe Acrobat D...	16,167 KB
PadanaPlain2023_eBMSFG__CommonSpecies_finalv4_English	7/5/2024 1:39 PM	Adobe Acrobat D...	15,111 KB
PadanaPlain2023_eBMSFG__CommonSpecies_finalv4_IT	7/5/2024 1:40 PM	Adobe Acrobat D...	15,200 KB
Poland_FG- Polish_cc	7/5/2024 1:40 PM	Adobe Acrobat D...	16,211 KB
Slovak FG eBMS commonSp - Englishv1 final	7/5/2024 1:40 PM	Adobe Acrobat D...	16,348 KB
Slovak FG eBMS commonSp - Slovakv1 final	7/5/2024 1:40 PM	Adobe Acrobat D...	16,294 KB
Spain-CommonSpeciesFG_eBMS English_cc	7/5/2024 1:40 PM	Adobe Acrobat D...	16,217 KB
ValGrandeNP Field Guide CommonSpecies_PNVG2023_final	7/5/2024 1:40 PM	Adobe Acrobat D...	13,714 KB

Overview of files in folder “Leaflets eBMS – ButterflyCount app”:

001 SPRING project > Reporting > Final reporting > Deliverables > Leaflets eBMS - ButterflyCount app

Name	Date modified	Type	Size
ButterflyCount Original leaflet English	7/9/2024 8:09 AM	Adobe Acrobat D...	2,042 KB
eBMS leaflet_final_English	7/9/2024 8:09 AM	Adobe Acrobat D...	7,776 KB
German BMS leaflet_final	7/9/2024 8:09 AM	Adobe Acrobat D...	1,478 KB
German ButterflyCount leaflet	7/9/2024 8:09 AM	Adobe Acrobat D...	1,182 KB
Italian BMS leaflet_final	7/9/2024 8:09 AM	Adobe Acrobat D...	7,939 KB
Italian ButterflyCount	7/9/2024 8:09 AM	Adobe Acrobat D...	7,494 KB
Portuguese ButterflyCount leaflet	7/9/2024 8:09 AM	Adobe Acrobat D...	1,910 KB
Spanish BMS leaflet_final	7/9/2024 8:09 AM	Adobe Acrobat D...	2,527 KB
Spanish ButterflyCount panfleto	7/9/2024 8:09 AM	Adobe Acrobat D...	1,938 KB

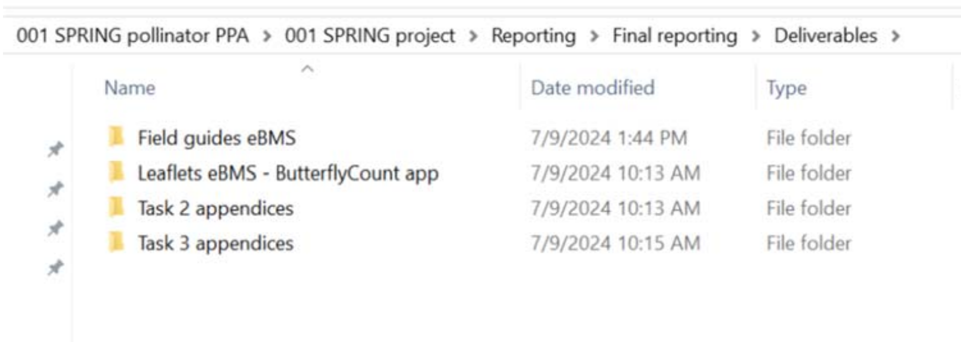
A5.2 Task 2 Documentation

Training materials developed by Task 2 of the SPRING consortium and available at the Pollinator Academy, either entirely publicly accessible, or for trainers only.

SPRING Pollinator Academy overview of documents and their respective folders

Overview in folder structure

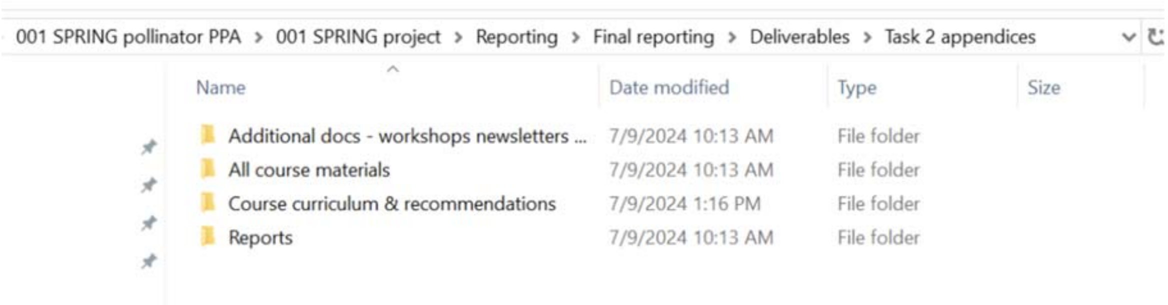
Overview of entire folder structure:



001 SPRING pollinator PPA > 001 SPRING project > Reporting > Final reporting > Deliverables >

Name	Date modified	Type
Field guides eBMS	7/9/2024 1:44 PM	File folder
Leaflets eBMS - ButterflyCount app	7/9/2024 10:13 AM	File folder
Task 2 appendices	7/9/2024 10:13 AM	File folder
Task 3 appendices	7/9/2024 10:15 AM	File folder

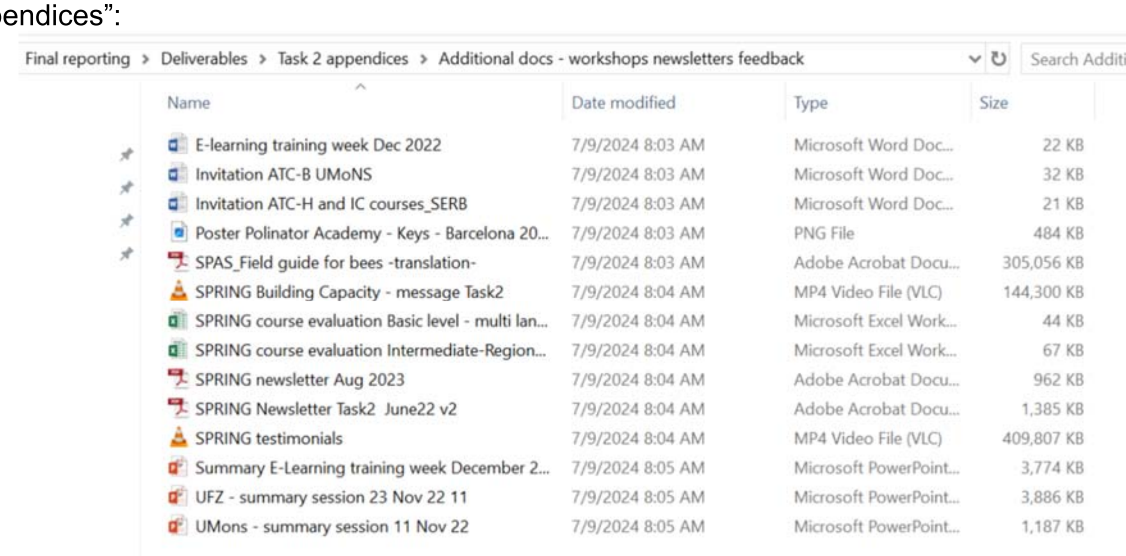
Overview of sub-folder structure in folder "Task 2 appendices"



001 SPRING pollinator PPA > 001 SPRING project > Reporting > Final reporting > Deliverables > Task 2 appendices

Name	Date modified	Type	Size
Additional docs - workshops newsletters ...	7/9/2024 10:13 AM	File folder	
All course materials	7/9/2024 10:13 AM	File folder	
Course curriculum & recommendations	7/9/2024 1:16 PM	File folder	
Reports	7/9/2024 10:13 AM	File folder	

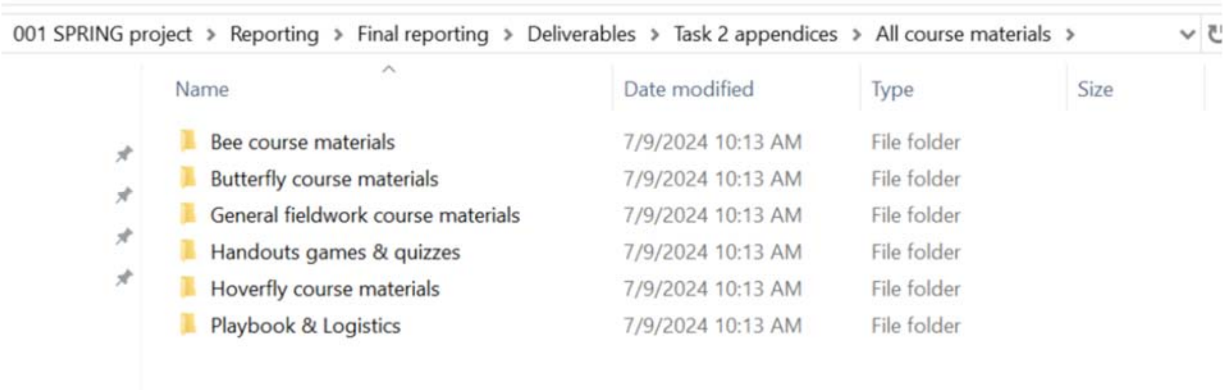
Overview of files in sub-folder "workshops newsletters feedback" within the folder "Task 2 appendices":



Final reporting > Deliverables > Task 2 appendices > Additional docs - workshops newsletters feedback

Name	Date modified	Type	Size
E-learning training week Dec 2022	7/9/2024 8:03 AM	Microsoft Word Doc...	22 KB
Invitation ATC-B UMoNS	7/9/2024 8:03 AM	Microsoft Word Doc...	32 KB
Invitation ATC-H and IC courses_SERB	7/9/2024 8:03 AM	Microsoft Word Doc...	21 KB
Poster Polinator Academy - Keys - Barcelona 20...	7/9/2024 8:03 AM	PNG File	484 KB
SPAS_Field guide for bees -translation-	7/9/2024 8:03 AM	Adobe Acrobat Docu...	305,056 KB
SPRING Building Capacity - message Task2	7/9/2024 8:04 AM	MP4 Video File (VLC)	144,300 KB
SPRING course evaluation Basic level - multi lan...	7/9/2024 8:04 AM	Microsoft Excel Work...	44 KB
SPRING course evaluation Intermediate-Region...	7/9/2024 8:04 AM	Microsoft Excel Work...	67 KB
SPRING newsletter Aug 2023	7/9/2024 8:04 AM	Adobe Acrobat Docu...	962 KB
SPRING Newsletter Task2 June22 v2	7/9/2024 8:04 AM	Adobe Acrobat Docu...	1,385 KB
SPRING testimonials	7/9/2024 8:04 AM	MP4 Video File (VLC)	409,807 KB
Summary E-Learning training week December 2...	7/9/2024 8:05 AM	Microsoft PowerPoint...	3,774 KB
UFZ - summary session 23 Nov 22 11	7/9/2024 8:05 AM	Microsoft PowerPoint...	3,886 KB
UMons - summary session 11 Nov 22	7/9/2024 8:05 AM	Microsoft PowerPoint...	1,187 KB

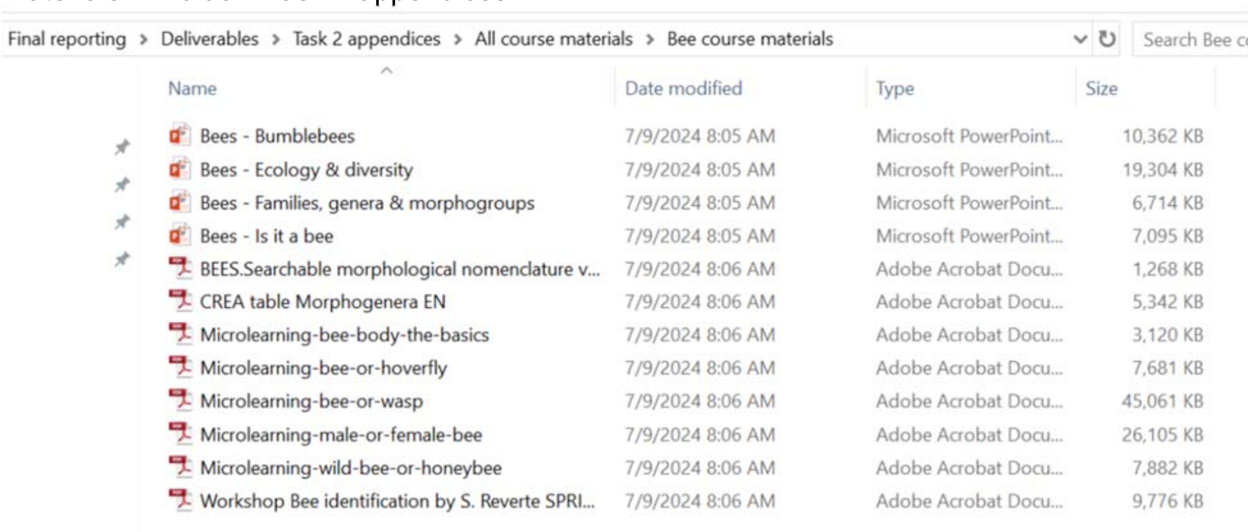
Overview of sub-folder structure in folder “Task 2 appendices” in the sub-folder “All course materials”:



001 SPRING project > Reporting > Final reporting > Deliverables > Task 2 appendices > All course materials >

Name	Date modified	Type	Size
Bee course materials	7/9/2024 10:13 AM	File folder	
Butterfly course materials	7/9/2024 10:13 AM	File folder	
General fieldwork course materials	7/9/2024 10:13 AM	File folder	
Handouts games & quizzes	7/9/2024 10:13 AM	File folder	
Hoverfly course materials	7/9/2024 10:13 AM	File folder	
Playbook & Logistics	7/9/2024 10:13 AM	File folder	

Overview of files in sub-folder “Bee course materials” within in the sub-folder “All course materials” in folder “Task 2 appendices”:

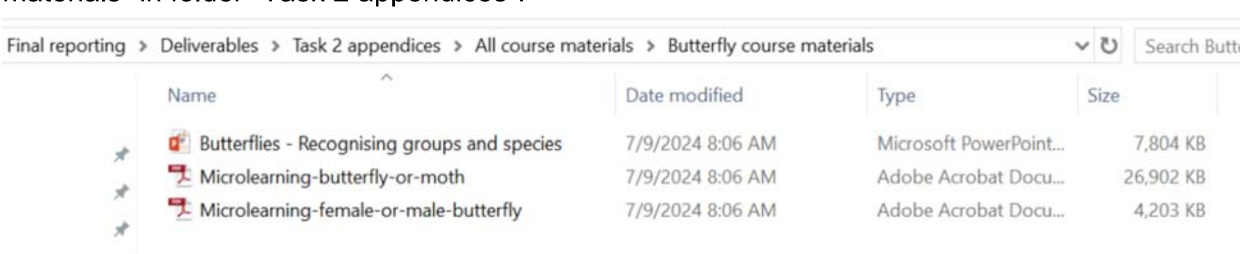


Final reporting > Deliverables > Task 2 appendices > All course materials > Bee course materials

Search Bee cc

Name	Date modified	Type	Size
Bees - Bumblebees	7/9/2024 8:05 AM	Microsoft PowerPoint...	10,362 KB
Bees - Ecology & diversity	7/9/2024 8:05 AM	Microsoft PowerPoint...	19,304 KB
Bees - Families, genera & morphogroups	7/9/2024 8:05 AM	Microsoft PowerPoint...	6,714 KB
Bees - Is it a bee	7/9/2024 8:05 AM	Microsoft PowerPoint...	7,095 KB
BEES.Searchable morphological nomenclature v...	7/9/2024 8:06 AM	Adobe Acrobat Docu...	1,268 KB
CREA table Morphogenera EN	7/9/2024 8:06 AM	Adobe Acrobat Docu...	5,342 KB
Microlearning-bee-body-the-basics	7/9/2024 8:06 AM	Adobe Acrobat Docu...	3,120 KB
Microlearning-bee-or-hoverfly	7/9/2024 8:06 AM	Adobe Acrobat Docu...	7,681 KB
Microlearning-bee-or-wasp	7/9/2024 8:06 AM	Adobe Acrobat Docu...	45,061 KB
Microlearning-male-or-female-bee	7/9/2024 8:06 AM	Adobe Acrobat Docu...	26,105 KB
Microlearning-wild-bee-or-honeybee	7/9/2024 8:06 AM	Adobe Acrobat Docu...	7,882 KB
Workshop Bee identification by S. Reverte SPRI...	7/9/2024 8:06 AM	Adobe Acrobat Docu...	9,776 KB

Overview of files in sub-folder “Butterfly course materials” within in the sub-folder “All course materials” in folder “Task 2 appendices”:



Final reporting > Deliverables > Task 2 appendices > All course materials > Butterfly course materials

Search Butter

Name	Date modified	Type	Size
Butterflies - Recognising groups and species	7/9/2024 8:06 AM	Microsoft PowerPoint...	7,804 KB
Microlearning-butterfly-or-moth	7/9/2024 8:06 AM	Adobe Acrobat Docu...	26,902 KB
Microlearning-female-or-male-butterfly	7/9/2024 8:06 AM	Adobe Acrobat Docu...	4,203 KB

Overview of files in sub-folder “General fieldwork course materials” within in the sub-folder “All course materials” in folder “Task 2 appendices”:

Final reporting > Deliverables > Task 2 appendices > All course materials > General fieldwork course materials

Name	Date modified	Type	Size
Aan-de-slag-met-veldwerk-DUTCH v2023	7/9/2024 8:06 AM	Adobe Acrobat Docu...	26,081 KB
Collecting and curating specimens	7/9/2024 8:06 AM	Microsoft PowerPoint...	4,077 KB
Developing your observation skills	7/9/2024 8:06 AM	Microsoft PowerPoint...	10,122 KB
Fieldwork practices	7/9/2024 8:06 AM	Microsoft PowerPoint...	4,126 KB
Going-into-the-field-ENG v2023	7/9/2024 8:06 AM	Adobe Acrobat Docu...	25,558 KB
Going-into-the-field-GERMAN v2023	7/9/2024 8:06 AM	Adobe Acrobat Docu...	26,459 KB
Lavoro-di-campo-italia-ITALIAN v2023	7/9/2024 8:06 AM	Adobe Acrobat Docu...	27,195 KB
Manual pollinator categories SPRING 2022 v20...	7/9/2024 8:06 AM	Adobe Acrobat Docu...	787 KB
Meet-the-pollinators	7/9/2024 8:06 AM	Microsoft PowerPoint...	4,181 KB
Microlearning-beyond-morphological-identifica...	7/9/2024 8:06 AM	Adobe Acrobat Docu...	2,427 KB
Microlearning-how-do-insects-get-their-names	7/9/2024 8:06 AM	Adobe Acrobat Docu...	4,269 KB
Microlearning-the-basics-of-pollinator-taxonomy	7/9/2024 8:06 AM	Adobe Acrobat Docu...	8,504 KB
Microlearning-what-makes-an-insect-a-good-p...	7/9/2024 8:06 AM	Adobe Acrobat Docu...	18,869 KB
Quick guide to bees - version 2024	7/9/2024 8:06 AM	Adobe Acrobat Docu...	6,018 KB
Quick guide to bumblebees - version 2023	7/9/2024 8:06 AM	Adobe Acrobat Docu...	5,231 KB
Quick guide to hoverflies - version 2023	7/9/2024 8:06 AM	Adobe Acrobat Docu...	4,363 KB
Quick_reference_card_data_entry_SPRING	7/9/2024 8:06 AM	Adobe Acrobat Docu...	726 KB
Recognising pollinator groups	7/9/2024 8:06 AM	Microsoft PowerPoint...	15,450 KB
Taxonomy and morphogroups	7/9/2024 8:06 AM	Microsoft PowerPoint...	1,456 KB
Terepre-fel-magyarorszag-HUNGARIAN v2023	7/9/2024 8:06 AM	Adobe Acrobat Docu...	27,309 KB
The ethics of collecting specimens	7/9/2024 8:06 AM	Microsoft PowerPoint...	1,522 KB
Welcome to the European monitoring scheme	7/9/2024 8:06 AM	Microsoft PowerPoint...	6,468 KB
πηγαίνοντας-στο-πεδίο-ελλάδα-GREEK v2023	7/9/2024 8:06 AM	Adobe Acrobat Docu...	27,476 KB

Overview of files in sub-folder “Handout games & quizzes” within in the sub-folder “All course materials” in folder “Task 2 appendices”:

Final reporting > Deliverables > Task 2 appendices > All course materials > Handouts games & quizzes

Name	Date modified	Type	Size
EIS - 2023 - Quick guide to hoverflies Northwes...	7/9/2024 8:06 AM	Adobe Acrobat Docu...	76,212 KB
Handout - Bees	7/9/2024 8:07 AM	Adobe Acrobat Docu...	1,864 KB
Handout - Bumblebees	7/9/2024 8:07 AM	Adobe Acrobat Docu...	1,697 KB
Handout - Butterflies	7/9/2024 8:07 AM	Adobe Acrobat Docu...	1,725 KB
Handout - Hoverflies	7/9/2024 8:07 AM	Adobe Acrobat Docu...	1,496 KB
Manual pollinator categories SPRING 2022 v20...	7/9/2024 8:07 AM	Adobe Acrobat Docu...	787 KB
Microlearning-practice-bees-hoverflies-among-...	7/9/2024 8:07 AM	Adobe Acrobat Docu...	1,586 KB
Microlearning-practice-recognizing-bees-and-h...	7/9/2024 8:07 AM	Adobe Acrobat Docu...	19,081 KB
Quiz - Broad_pollinator_groups	7/9/2024 8:07 AM	Microsoft PowerPoint...	5,959 KB
Quiz - Mimicry	7/9/2024 8:07 AM	Microsoft PowerPoint...	4,457 KB
Sarthou et al (2023) EU Hoverfly Key [EN]	7/9/2024 8:07 AM	Adobe Acrobat Docu...	4,432 KB

Overview of files in sub-folder “Hoverfly course materials” within in the sub-folder “All course materials” in folder “Task 2 appendices”:

Final reporting > Deliverables > Task 2 appendices > All course materials > Hoverfly course materials | Search Hoverf

Name	Date modified	Type	Size
Hoverflies - Additional slides distinctive features	7/9/2024 8:07 AM	Microsoft PowerPoint...	22,712 KB
Hoverflies - Ecology & diversity	7/9/2024 8:07 AM	Microsoft PowerPoint...	11,820 KB
Hoverflies - Is it a hoverfly	7/9/2024 8:07 AM	Microsoft PowerPoint...	19,064 KB
Hoverflies - Morphogroups	7/9/2024 8:07 AM	Microsoft PowerPoint...	10,146 KB
Hoverflies - Regional, distinctive species	7/9/2024 8:07 AM	Microsoft PowerPoint...	7,525 KB
Hoverflies - Wings	7/9/2024 8:07 AM	Microsoft PowerPoint...	2,143 KB
HOVERFLIES.Searchable morphological nomenc...	7/9/2024 8:07 AM	Adobe Acrobat Docu...	1,032 KB
Hoverfly genera identification 2	7/9/2024 8:07 AM	Adobe Acrobat Docu...	9,478 KB
Microlearning-bee-or-hoverfly	7/9/2024 8:07 AM	Adobe Acrobat Docu...	7,681 KB
Microlearning-hoverfly-body-the-basics	7/9/2024 8:07 AM	Adobe Acrobat Docu...	14,345 KB
Microlearning-hoverfly-or-other-fly	7/9/2024 8:07 AM	Adobe Acrobat Docu...	33,277 KB
Microlearning-male-or-female-hoverfly	7/9/2024 8:07 AM	Adobe Acrobat Docu...	24,517 KB

Overview of files in sub-folder “Playbook & Logistics” within in the sub-folder “All course materials” in folder “Task 2 appendices”:

Final reporting > Deliverables > Task 2 appendices > All course materials > Playbook & Logistics | Search Playb

Name	Date modified	Type	Size
SPRING (2024) Playbook for Organizers 1.0 Fin...	7/9/2024 8:07 AM	Adobe Acrobat Docu...	343 KB
SPRING course curriculum	7/9/2024 8:07 AM	Microsoft Word Doc...	228 KB
SPRING course curriculum	7/9/2024 8:07 AM	Adobe Acrobat Docu...	437 KB
SPRING Course Outline template	7/9/2024 8:07 AM	Microsoft Word Doc...	248 KB
SPRING Course preparation checklist	7/9/2024 8:07 AM	Microsoft Word Doc...	249 KB
SPRING Course presentation template	7/9/2024 8:07 AM	Microsoft PowerPoint...	6,514 KB
SPRING Example Evaluation Form	7/9/2024 8:07 AM	Microsoft Word Doc...	32 KB
SPRING Some important notes on Learning Go...	7/9/2024 8:07 AM	Adobe Acrobat Docu...	171 KB
SPRING Tips & tricks for course design	7/9/2024 8:07 AM	Adobe Acrobat Docu...	587 KB

Overview of files in sub-folder “Course curriculum & recommendations” in folder “Task 2 appendices”:

Final reporting > Deliverables > Task 2 appendices > Course curriculum & recommendations | Search Cou

Name	Date modified	Type	Size
SPRING course curriculum	7/9/2024 8:07 AM	Adobe Acrobat Docu...	437 KB
SPRING Overview training materials	7/9/2024 8:07 AM	Microsoft Word Doc...	26 KB

Overview of files in sub-folder “Reports” within the folder “Task 2 appendices”:

001 SPRING project > Reporting > Final reporting > Deliverables > Task 2 appendices > Reports | Search Repor

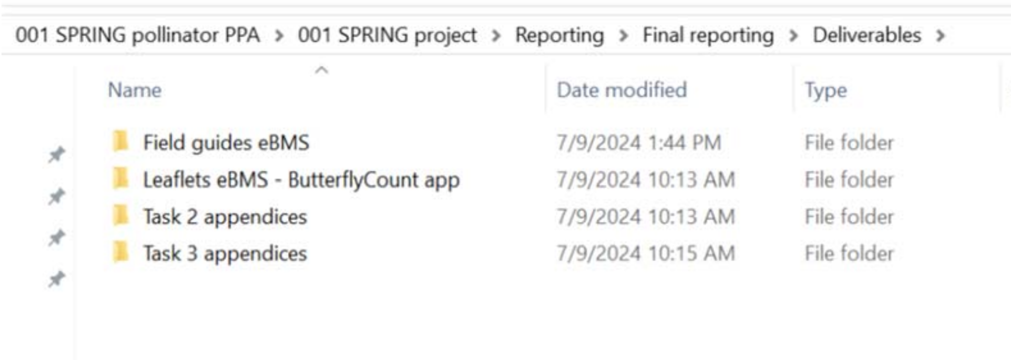
Name	Date modified	Type	Size
Coordination of validators for butterflies and m...	7/9/2024 8:07 AM	Adobe Acrobat Docu...	485 KB
SPRING location filter (final report)	7/9/2024 8:07 AM	Adobe Acrobat Docu...	115 KB
Tools for SPRING - Validators for AI images (Fin...	7/9/2024 8:07 AM	Adobe Acrobat Docu...	127 KB

A5.3 Task 3 Documentation/data base

Documentation of data base developed within Task 3 of the SPRING consortium (to be linked from here to online download page).

Overview in folder structure

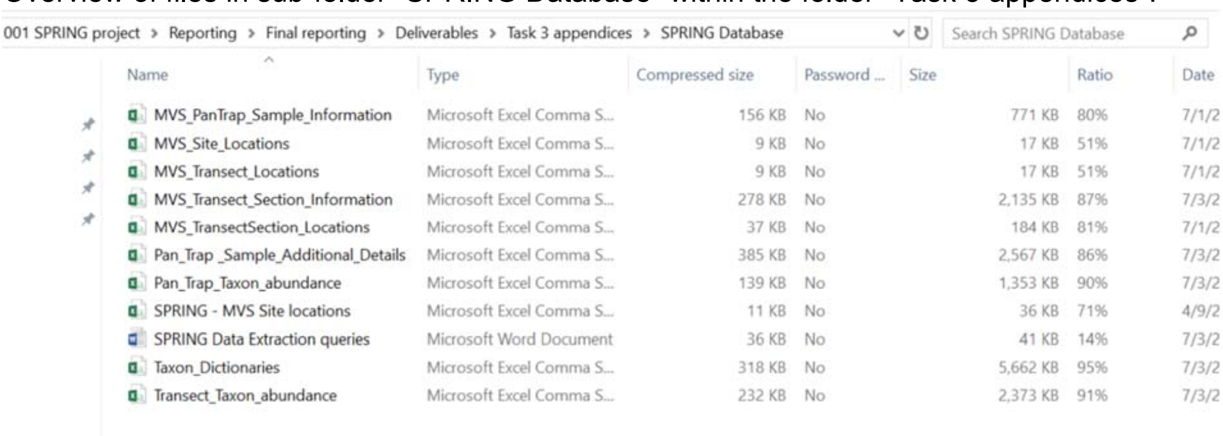
Overview of entire folder structure:



001 SPRING pollinator PPA > 001 SPRING project > Reporting > Final reporting > Deliverables >

Name	Date modified	Type
Field guides eBMS	7/9/2024 1:44 PM	File folder
Leaflets eBMS - ButterflyCount app	7/9/2024 10:13 AM	File folder
Task 2 appendices	7/9/2024 10:13 AM	File folder
Task 3 appendices	7/9/2024 10:15 AM	File folder

Overview of files in sub-folder "SPRING Database" within the folder "Task 3 appendices":



001 SPRING project > Reporting > Final reporting > Deliverables > Task 3 appendices > SPRING Database

Search SPRING Database

Name	Type	Compressed size	Password ...	Size	Ratio	Date
MVS_PanTrap_Sample_Information	Microsoft Excel Comma S...	156 KB	No	771 KB	80%	7/1/2
MVS_Site_Locations	Microsoft Excel Comma S...	9 KB	No	17 KB	51%	7/1/2
MVS_Transect_Locations	Microsoft Excel Comma S...	9 KB	No	17 KB	51%	7/1/2
MVS_Transect_Section_Information	Microsoft Excel Comma S...	278 KB	No	2,135 KB	87%	7/3/2
MVS_TransectSection_Locations	Microsoft Excel Comma S...	37 KB	No	184 KB	81%	7/1/2
Pan_Trap _Sample_Additional_Details	Microsoft Excel Comma S...	385 KB	No	2,567 KB	86%	7/3/2
Pan_Trap_Taxon_abundance	Microsoft Excel Comma S...	139 KB	No	1,353 KB	90%	7/3/2
SPRING - MVS Site locations	Microsoft Excel Comma S...	11 KB	No	36 KB	71%	4/9/2
SPRING Data Extraction queries	Microsoft Word Document	36 KB	No	41 KB	14%	7/3/2
Taxon_Dictionaries	Microsoft Excel Comma S...	318 KB	No	5,662 KB	95%	7/3/2
Transect_Taxon_abundance	Microsoft Excel Comma S...	232 KB	No	2,373 KB	91%	7/3/2

Detailed list of each document – the example of Task 2
(this is an alternative way to list the files – just as an example)

Ref	Document	Folder	Subtask
1	E-learning training week Dec 2022.docx	Additional docs - workshops, newsletters, feedback	2.1.9, 2.2.3
2	Invitation ATC-B UMoNS.docx	Additional docs - workshops, newsletters, feedback	2.2.2
3	Invitation ATC-H and IC courses_SERB.docx	Additional docs - workshops, newsletters, feedback	2.2.2
4	SPRING Building Capacity - message Task2.mp4	Additional docs - workshops, newsletters, feedback	2.1.11, 2.2.10
5	SPRING course evaluation Basic level - multi language.xlsx	Additional docs - workshops, newsletters, feedback	2.1.10
6	SPRING course evaluation Intermediate-Regional-Advanced.xlsx	Additional docs - workshops, newsletters, feedback	2.1.10
7	SPRING newsletter Aug 2023.pdf	Additional docs - workshops, newsletters, feedback	2.1.11
8	SPRING Newsletter Task2 June22 v2.pdf	Additional docs - workshops, newsletters, feedback	2.1.11
9	SPRING testimonials.mp4	Additional docs - workshops, newsletters, feedback	2.1.11
10	Summary E-Learning training week December 2022.pptx	Additional docs - workshops, newsletters, feedback	2.1.4, 2.1.9, 2.2.2, 2.2.4
11	UFZ - summary session 23 Nov 22 11.pptx	Additional docs - workshops, newsletters, feedback	2.1.3, 2.1.10
12	UMons - summary session 11 Nov 22 .pptx	Additional docs - workshops, newsletters, feedback	2.1.3, 2.1.10, 2.2.1
13	Bees - Bumblebees.pptx	All course materials/Bee course materials	2.1.4
14	Bees - Ecology & diversity.pptx	All course materials/Bee course materials	2.1.4, 2.2.2
15	Bees - Families, genera & morphogroups.pptx	All course materials/Bee course materials	2.1.4
16	Bees - Is it a bee.pptx	All course materials/Bee course materials	2.1.4
17	BEES.Searchable morphological nomenclature v03-11-23.pdf	All course materials/Bee course materials	2.2.2
18	CREA table Morphogenera EN.pdf	All course materials/Bee course materials	2.2.2
19	Microlearning-bee-body-the-basics.pdf	All course materials/Bee course materials	2.1.4, 2.1.9
20	Microlearning-bee-or-hoverfly.pdf	All course materials/Bee course materials	2.1.4, 2.1.9
21	Microlearning-bee-or-wasp.pdf	All course materials/Bee course materials	2.1.4, 2.1.9
22	Microlearning-male-or-female-bee.pdf	All course materials/Bee course materials	2.1.4, 2.1.9
23	Microlearning-wild-bee-or-honeybee.pdf	All course materials/Bee course materials	2.1.4, 2.1.9
24	Workshop Bee identification by S. Reverte SPRING 2023.pdf	All course materials/Bee course materials	2.1.4, 2.2.2
25	Butterflies - Recognising groups and species.pptx	All course materials/Butterfly course materials	2.1.4

26	Microlearning-butterfly-or-moth.pdf	All course materials/Butterfly course materials	2.1.4, 2.1.9
27	Microlearning-female-or-male-butterfly.pdf	All course materials/Butterfly course materials	2.1.4, 2.1.9
28	Aan-de-slag-met-veldwerk-DUTCH v2023.pdf	All course materials/General fieldwork course materials	2.1.4
29	Collecting and curating specimens.pptx	All course materials/General fieldwork course materials	2.2.2
30	Developing your observation skills.pptx	All course materials/General fieldwork course materials	2.1.4, 2.2.2
31	Fieldwork practices.pptx	All course materials/General fieldwork course materials	2.1.4
32	Going-into-the-field-ENG v2023.pdf	All course materials/General fieldwork course materials	2.1.4
33	Going-into-the-field-GERMAN v2023.pdf	All course materials/General fieldwork course materials	2.1.4
34	Lavoro-di-campo-italia-ITALIAN v2023.pdf	All course materials/General fieldwork course materials	2.1.4
35	Manual pollinator categories SPRING 2022 v20220321.pdf	All course materials/General fieldwork course materials	2.1.4
36	Meet-the-pollinators.pptx	All course materials/General fieldwork course materials	2.1.4
37	Microlearning-beyond-morphological-identification.pdf	All course materials/General fieldwork course materials	2.1.9
38	Microlearning-how-do-insects-get-their-names.pdf	All course materials/General fieldwork course materials	2.1.9
39	Microlearning-the-basics-of-pollinator-taxonomy.pdf	All course materials/General fieldwork course materials	2.1.9
40	Microlearning-what-makes-an-insect-a-good-pollinator.pdf	All course materials/General fieldwork course materials	2.1.9
41	Quick guide to bees - version 2024.pdf	All course materials/General fieldwork course materials	2.1.4
42	Quick guide to bumblebees - version 2023.pdf	All course materials/General fieldwork course materials	2.1.4
43	Quick guide to hoverflies - version 2023.pdf	All course materials/General fieldwork course materials	2.1.4
44	Quick_reference_card_data_entry_SPRING.pdf	All course materials/General fieldwork course materials	2.1.4
45	Recognising pollinator groups.pptx	All course materials/General fieldwork course materials	2.1.4
46	Taxonomy and morphogroups.pptx	All course materials/General fieldwork course materials	2.1.4
47	Terepre-fel-magyarorszag-HUNGARIAN v2023.pdf	All course materials/General fieldwork course materials	2.1.4
48	The ethics of collecting specimens.pptx	All course materials/General fieldwork course materials	2.1.4, 2.2.2
49	Welcome to the European monitoring scheme.pptx	All course materials/General fieldwork course materials	2.1.4, 2.2.2
50	πηγαίνοντας-στο-πεδίο-ελλάδα-GREEK v2023.pdf	All course materials/General fieldwork course materials	2.1.4, 2.2.2

51	EIS - 2023 - Quick guide to hoverflies Northwest Europe.pdf	All course materials/Handouts games & quizzes	2.1.4
52	Handout - Bees.pdf	All course materials/Handouts games & quizzes	2.1.4
53	Handout - Bumblebees.pdf	All course materials/Handouts games & quizzes	2.1.4
54	Handout - Butterflies.pdf	All course materials/Handouts games & quizzes	2.1.4
55	Handout - Hoverflies.pdf	All course materials/Handouts games & quizzes	2.1.4
56	Manual pollinator categories SPRING 2022 v20220321.pdf	All course materials/Handouts games & quizzes	2.1.4
57	Microlearning-practice-bees-hoverflies-among-other-pollinators.pdf	All course materials/Handouts games & quizzes	2.1.9
58	Microlearning-practice-recognizing-bees-and-hoverflies.pdf	All course materials/Handouts games & quizzes	2.1.9
59	Quiz - Broad_pollinator_groups.pptx	All course materials/Handouts games & quizzes	2.1.4
60	Quiz - Mimicry.pptx	All course materials/Handouts games & quizzes	2.1.4
61	Sarthou et al (2023) EU Hoverfly Key [EN].pdf	All course materials/Handouts games & quizzes	2.2.2
62	Hoverflies - Additional slides distinctive features.pptx	All course materials/Hoverfly course materials	2.1.4
63	Hoverflies - Ecology & diversity.pptx	All course materials/Hoverfly course materials	2.1.4
64	Hoverflies - Is it a hoverfly.pptx	All course materials/Hoverfly course materials	2.1.4
65	Hoverflies - Morphogroups.pptx	All course materials/Hoverfly course materials	2.1.4
66	Hoverflies - Regional, distinctive species.pptx	All course materials/Hoverfly course materials	2.1.4
67	Hoverflies - Wings.pptx	All course materials/Hoverfly course materials	2.1.4, 2.2.2
68	HOVERFLIES.Searchable morphological nomenclature v10-10-23.pdf	All course materials/Hoverfly course materials	2.2.2
69	Hoverfly genera identification 2.pdf	All course materials/Hoverfly course materials	2.1.4, 2.2.2
70	Microlearning-bee-or-hoverfly.pdf	All course materials/Hoverfly course materials	2.1.9
71	Microlearning-hoverfly-body-the-basics.pdf	All course materials/Hoverfly course materials	2.1.9
72	Microlearning-hoverfly-or-other-fly.pdf	All course materials/Hoverfly course materials	2.1.9
73	Microlearning-male-or-female-hoverfly.pdf	All course materials/Hoverfly course materials	2.1.9
74	SPRING course curriculum.docx	All course materials/Playbook & Logistics	2.1.2, 2.2.1
75	SPRING course curriculum.pdf	All course materials/Playbook & Logistics	2.1.2, 2.2.1
76	SPRING Course Outline template.docx	All course materials/Playbook & Logistics	2.1.2, 2.2.1

77	SPRING Course preparation checklist.docx	All course materials/Playbook & Logistics	2.1.2, 2.2.1
78	SPRING Course presentation template.pptx	All course materials/Playbook & Logistics	2.1.2, 2.2.1
79	SPRING Example Evaluation Form.docx	All course materials/Playbook & Logistics	2.1.10, 2.2.1
80	SPRING Some important notes on Learning Goals.pdf	All course materials/Playbook & Logistics	2.1.3
81	SPRING Tips & tricks for course design.pdf	All course materials/Playbook & Logistics	2.1.3
82	SPRING course curriculum.pdf	Course curriculum & recommendations	2.1.2, 2.2.1
83	SPRING Overview training materials.docx	Course curriculum & recommendations	2.1.4, 2.2.2
84	Coordination of validators for butterflies and moths Final Report	Reports	2.1.5
85	SPRING location filter (final report)	Reports	2.1.5
86	Tools for SPRING - Validators for AI images (Final Report)	Reports	2.1.5
87	Playbook for Organizing Taxonomy Courses for Pollinators	All course materials/Playbook & Logistics	2.1.2, 2.2.10