



Ecological management of European olive agroforestry:
linking biodiversity conservation, ecosystem services and productivity



WORKSHOP HANDOUT – 10th September 2023

Dear participants, partners, and stakeholders of our projects,

we are looking forward to the final field season of our project ECO-OLIVES!

With this short overview, we would like to inform you about our research activities planned for the autumn season 2023 (September-November) and look forward to staying in touch with you about our activities.

Our optimized study design on 12 olive farms around Monte Pisano includes 16 study trees per farm:

4 controls, 4 bird/bat enclosures and each 4 trees that are systematically pruned in February and April (see our previous reports for details and sketches). This design allows us to study the functions of birds, bats and arthropods in relation to local management, landscape composition and seasonal differences to improve our understanding and ability of combining biodiversity conservation and sustainable olive farming.

Our research activities in the upcoming field season include the following:

1) Local field and harvest data are studied within a landscape context using three approaches:

- (a) detailed assessments of all study trees (see our previous July report for details and first results);
 - (b) habitat monitoring data from the entire study area (all habitat types within 500-meter around each farm);
 - (c) olive harvest data for all study trees (harvest quantity and quality, including data on pest infestation rates).
- For the harvest season 2023, we kindly ask all participating farmers to inform us about the intended harvesting dates as early as possible to support our field work coordination because the combined assessment of harvest and biodiversity data (captures of birds and bats) needs special preparations from our side.

2) Birds and bats are studied using four approaches: (a) Systematic point counts of birds; (b) Systematic monitoring of bat caves and roosts; (c) Acoustic recordings of birds and bats and (d) Scientific capture-release surveys in which we also extract DNA-samples of birds and bats. The combination of these methods allows us to see which species and functions occur in the study area, and to identify the activity and diet composition of insect eating birds and bats that provide pest suppression services and biodiversity conservation values.

3) Predation experiments using artificial caterpillars will not be continued due to low specificity for bird predation marks detected during the spring season 2023 (please see following pages for details).

4) Arthropods (insects and spiders) are recorded with four approaches: (a) repeated visual observations on all study trees; (b) pitfall traps for ground-dwelling arthropods; (c) honey traps for arthropods in the canopy – targeting ants; (d) DNA-analyses of arthropods from canopy-fogging experiments conducted in 2022.

5) With our project “COMPASS” we study the effects of systematic pruning of olive trees on biodiversity, ecosystem services and production. All study trees are being continuously studied in detail to better understand the importance of tree and farm features for their improved, biodiversity-friendly management.

General updates for 2023

With this overview, we provide a short update of our upcoming and continued activities of ECO-OLIVES with special focus on the upcoming and last “complete field assessment” of the whole project. Collecting the described data will be important to conduct a solid statistical analysis of all collected project data (from the spring and autumn seasons 2022 and 2023) and provide you with an overview of the results we found in this project. First insights of the first project results will be shared with you in our yearly project report, as well as in upcoming reports that we will provide to you as soon as the respective analyses are done.

→ We kindly invite you to provide feedback and questions to our project and team in order to help us to continuously improve our work and collaboration with you – please see some specific points below:

Upcoming field work activities



In the upcoming autumn season, we will combine the assessment of harvest data (16 trees per farm) and biodiversity data (birds and bats will be captured with scientific methods), which requires close coordination with the harvest dates of each farm. → We therefore kindly ask all participating farmers, to communicate the prospected harvest date of their farm as soon as possible to us (Virginia Bagnoni) to support the demanding coordination of these large, combined data assessments.

The experimental exclusions of birds and bats (netted trees) will be taken down during the harvest season 2023. The collected nets will be recycled by a company that will produce bottle caps out of the material.

Our COMPASS project will be continued in the years 2024 and 2025, as the effects of systematic tree pruning require a long-time assessment of individual tree- and biodiversity-related responses. We provide first insights on COMPASS-related results on the following pages of this handout.

Upcoming questionnaires



Based on the interviews in 2023 (see our yearly report 2022 – left graph), we are currently developing an advanced questionnaire that will not only be conducted within our network of ECO-OLIVES, but also in our international networks.

→ We are keen for your feedback on this – specifically, on the following two points:

1) What are your main open questions on sustainable olive farm management?

(For example, for improved management of farms, trees and biodiversity and factors/questions that should be better understood for this combined management)

2) What is needed for an improved, sustainable olive farm management?

(For example, which specific structures, offerings and approaches are needed on the levels of olive farming research, practice, and policy?)

Upcoming partnerships

In cooperation with our international partners and networks (please see our July report for an overview), we are currently developing applications for extended funding and continuation of our projects. → We welcome any feedback and ideas you might have for a possible expansion and continuation of our work in the study area – please feel free to get in touch with us about it!

Bird assessments

For birds, we considerably expanded our data set this year – especially by adding scientific bird banding approaches. On each project farm, we used the scientific methods and tools to capture, mark and measure different bird species and thus gain vital life history data from the bird community in our study area (for example, to study the variation of different physical parameters and take fecal samples to study their diet, with focus on the contributions of insect eating species to pest suppression services).

Our first insights from these capture-release surveys of birds show:

- **Species diversity:** We captured-released 223 individual birds from 26 different species in April/May 2023. We had 13 re-captures. These data, in combination with our data from point count surveys and DNA analyses of birds and arthropods indicate a high potential of our study area for combining biodiversity conservation and the management of ecosystem services that they provide.
- **Fecal samples:** A total of 187 fecal samples were collected in April/May 2023 – providing valuable information on the bird’s diet and occurrence of ecosystem services in the study area.

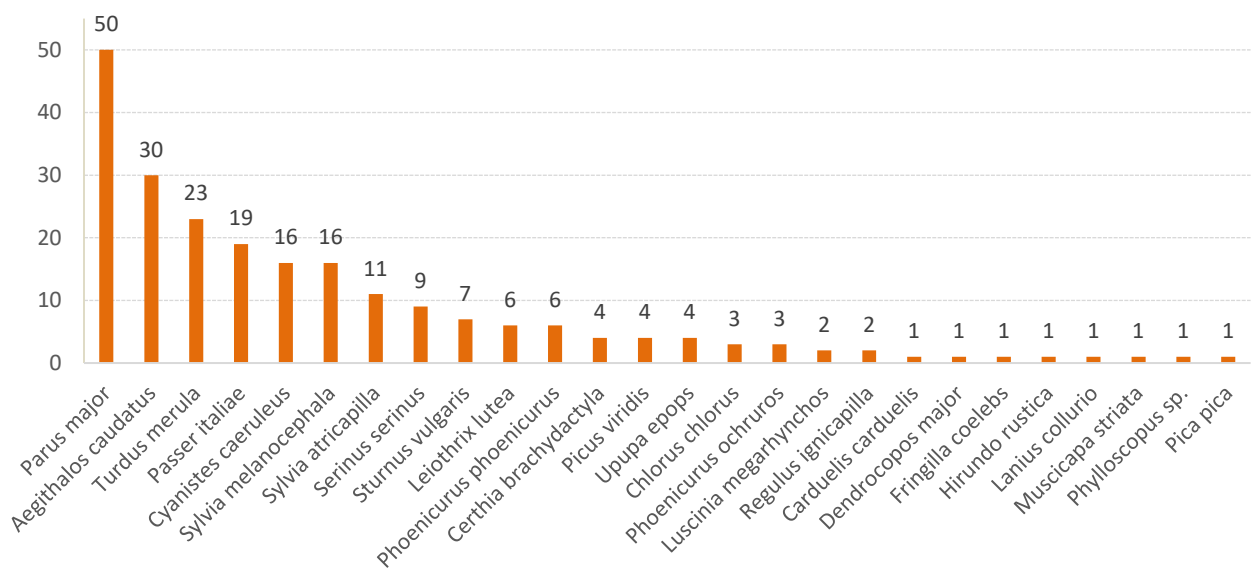


Figure 1: Bird species abundance in capture-release surveys of spring 2023

Mainly insect-eating bird species as the Great Tit, Long-tailed Tit and Eurasian Blackbird are the most abundant species observed by this approach. Scientific /Latin species names are given here – please see our yearly report 2022 for a key to their common names and diet categories.

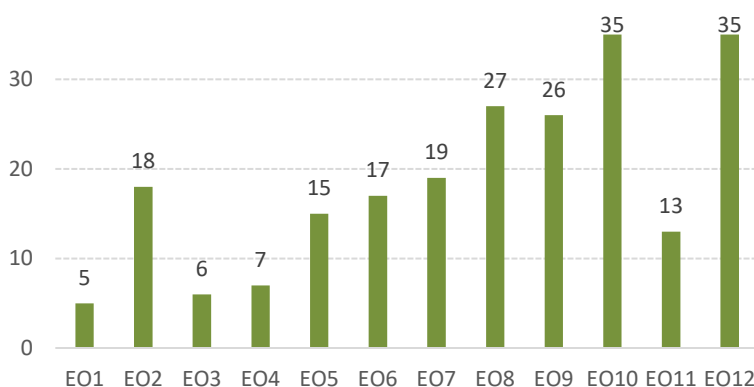


Figure 2: Bird abundances (per farm) in capture-release surveys of spring 2023

We expect to find more migratory bird species in autumn 2023.

Artificial prey experiments:

In spring 2023, we exposed standard-sized, artificial caterpillars (made of plasticine; each 30 x 5 mm) to mimic natural prey of birds and arthropods and quantify predation pressure on our project farms. This approach is providing interesting insights on pest suppression potentials of different agricultural systems.

During each experimental survey in spring 2023, we placed six artificial caterpillars on stems and branches of eight trees per project farm (including both control trees and COMPASS trees). 3-4 days later, we identified and counted all predation marks. We observed the following distribution of feeding marks: Bird feeding marks were observed on only 3% of the exposed artificial caterpillars, while most of them showed no signs of feeding marks (68%), or feeding marks of ants (24%), or other animals (5%).

Due to these results of the experiment, which was designed to study bird feeding marks in more detail, we decided to not continue it in the upcoming field seasons and to focus on other, more insightful approaches in our project. However, we will consider to continue the approach in upcoming studies of ants.

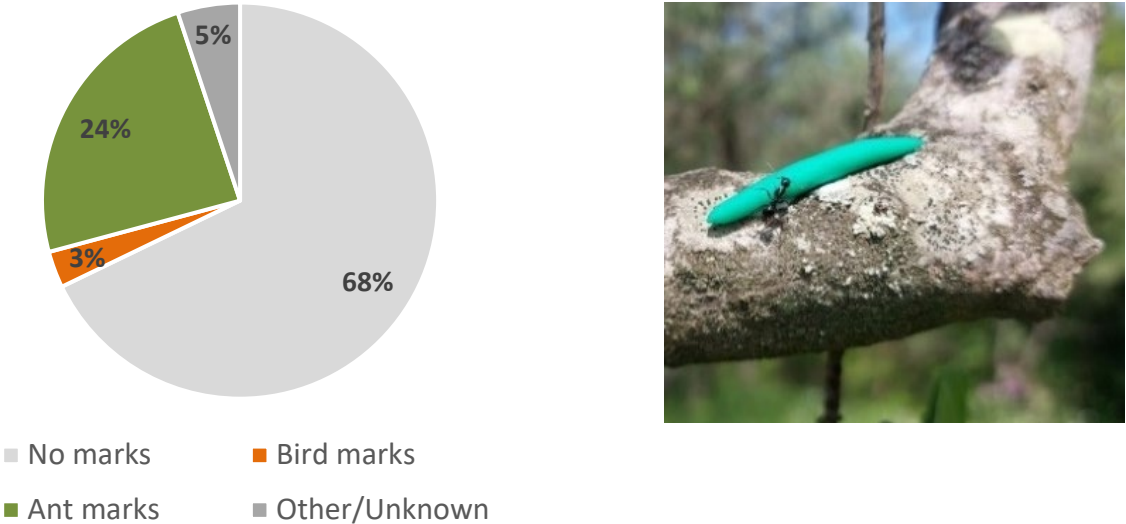


Figure 3: Proportion of observed predation marks, unknown marks and “empty caterpillars” (no marks)

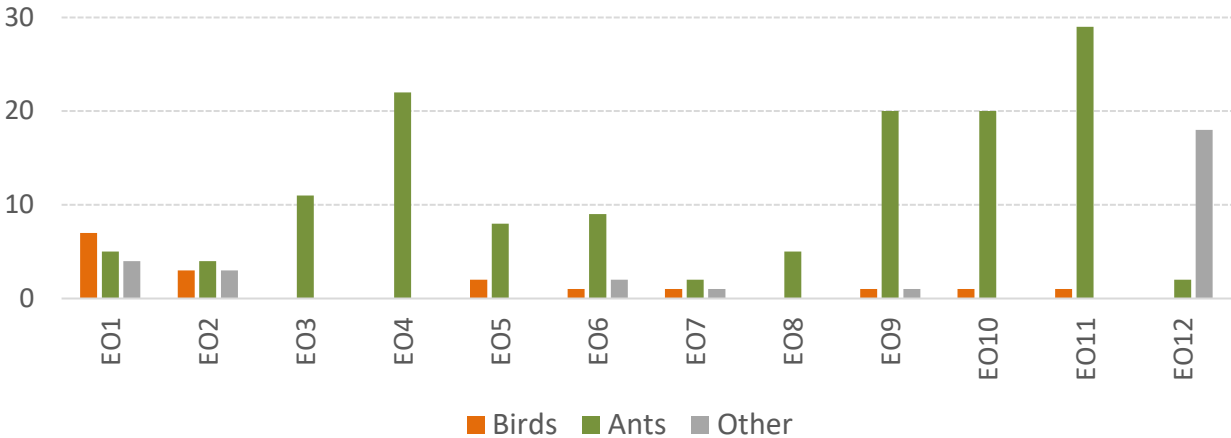


Figure 4: Counts of bird marks, ant marks and other/unknown marks per olive grove

Bat assessments

In spring 2023, bat sounds were recorded twice for three consecutive nights (one hour before and after sunset – see yearly report 2022 for details and common species names). Our recordings produce very large data files that require long time for processing. Here, we provide insights from the first two recording nights per farm in 2023 (including recordings of 16 different bat species and a total of 1622 bat passes). Our data provide important information on the feeding activity and social behavior of bats (both can be identified by their distinctive patterns in the data files). In the upcoming season, we will add habitat surveys and scientific capture-release studies for bats (similar to capture-release studies of birds, using specific equipment).

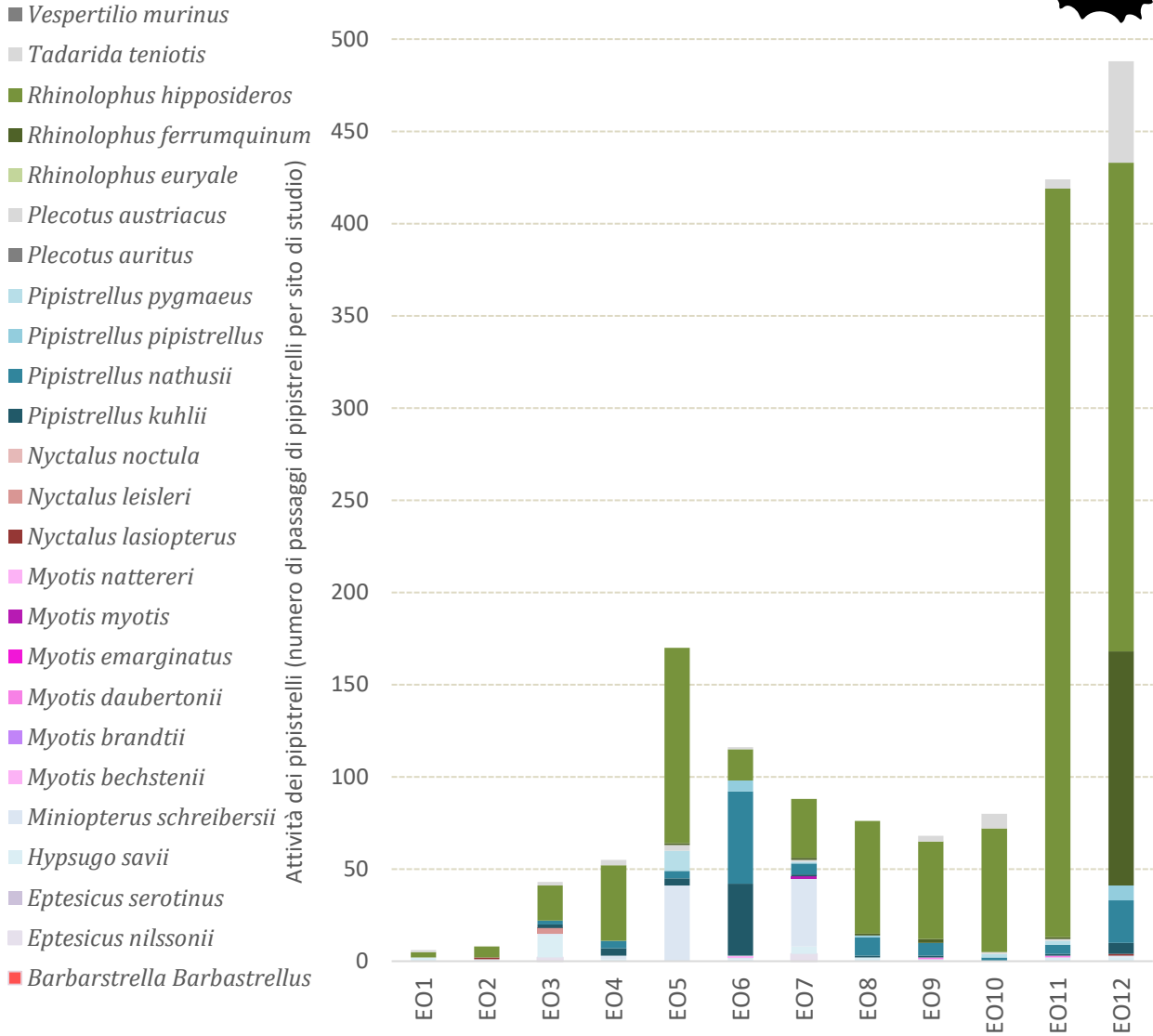


Figure 5: Bat activity (number of bat passes of 16 species) per olive grove in spring 2023

Arthropod assessments

Our surveys of insects and spiders are designed to better understand the arthropod diversity in our project farms, and how this diversity is modified by changing biotic and abiotic factors. With the expansion of our project, we increased the amount of traps and visual observations per farm to include the COMPASS project trees in our data collection. Here, we provide some insights into preliminary results, as the processing of recorded data (sorting of traps and species identification in the laboratory, as well as statistical analyses) is still in progress. Thus, we present some preliminary data from spring 2023 here:

Pitfall traps

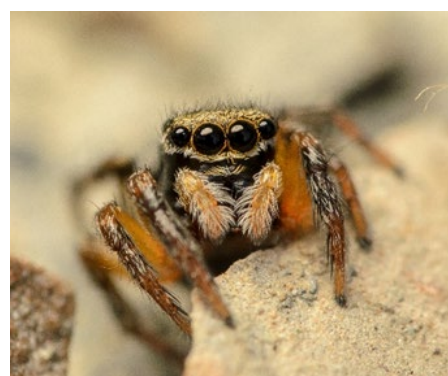
First results from our pitfall trap surveys in spring 2023 (targeting ground-dwelling arthropods) show that 3705 arthropods were recorded by this method. The table below provides an overview of recorded arthropod numbers per farm and taxonomic group (focusing on beetles, ants, spiders, and other arthropods). These data provide important information on the occurrence of predatory arthropods such as ants and spiders that function as meso-predators and thus provide important contributions to natural pest suppression services in addition (and complex interaction) with the services of top-predators such as birds and bats. For example, we found **31 spider species** only in April 2023, 9 of which were not found in our 2022 samplings, increasing the total number of spider species to 115.

The occurrence of biodiversity, related functions and interactions strongly depends on factors such as local plant species richness and abundance, as well as landscape composition and connectivity – as well as (micro-)climatic and soil conditions. With our project, we aim to study all olive groves in an ecosystem context that considers all possible key factors and drivers as co-variables in our analyses.

Site	Beetles	Ants	Spiders	Other
EO1	17	81	20	80
EO2	16	128	17	202
EO3	28	247	45	250
EO4	20	94	26	83
EO5	48	111	26	140
EO6	69	110	42	159
EO7	75	182	57	204
EO8	8	38	40	44
EO9	36	62	43	53
EO10	33	90	26	82
EO11	14	160	37	133
EO12	22	40	35	104
TOTAL	388	1338	415	1564

Table 1: Numbers of arthropod individuals (sorted by taxonomic groups) recorded from pitfall trap surveys in spring 2023 – listed by farm.

The picture below shows *Euophrys innotata*, one of the new recorded spider species recorded from our pitfall traps
© Andrea Piccinini

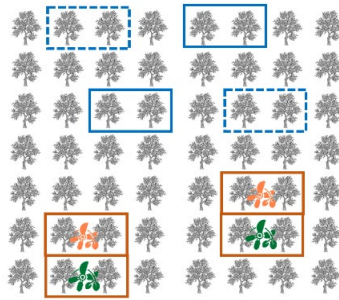
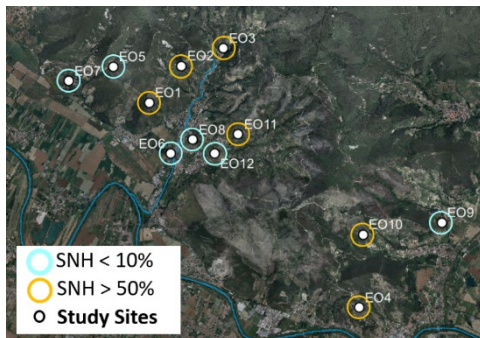


Analyses of Winkler Traps and Honey Traps from this year are still in progress (partly in cooperation with our project partners at the University of Florence). First insights from **Visual Observations** of arthropods are provided in our updates on farm and tree assessments below (in combination with COMPASS data).

Farm & Tree assessments

By studying all our 12 project farms and 192 project trees in detail (see previous report for details), we gain a better understanding of the variability between farms and trees that will be considered in our project. Please note that the data collection, data entry and statistical analyses are still in progress and that the following insights therefore only provide a rough picture and trend of the results to be expected.

Variability of farms and trees



Farm	dbh			height		
	(mean)	(min)	(max)	(mean)	(min)	(max)
EO1	106	62	150	414	310	530
EO2	88	28	126	323	220	400
EO3	93	48	185	385	280	440
EO4	94	53	155	417	360	520
EO5	102	40	200	420	220	590
EO6	58	44	72	406	320	440
EO7	105	34	172	452	380	570
EO8	78	44	102	441	300	580
EO9	80	58	110	431	340	570
EO10	66	28	155	406	230	580
EO11	84	35	170	398	340	500
EO12	52	34	66	396	250	550
Mean	84	42	139	407	296	523

Figure 6: Study area & sites (left), study tree distribution / farm (center) and tree variability, in cm (right)

For example, through our **detailed farm assessments** and biodiversity data, we observe first trends related to semi-natural habitat (SNH): farms surrounded by more SNH tend to provide higher levels of biodiversity and related effects of natural pest control. Likewise, through **detailed tree assessments**, we gain a better understanding of variability at farm and landscape level: the mean, minimum and maximum of tree diameters and heights (in cm) vary and thus need to be considered together with other tree data in the analyses of biodiversity- and pruning-related effects. The variability of all recorded farm and tree data will be considered into our analyses and combined with landscape composition data, in order to gain the best possible understanding of how the management of olive farms and biodiversity can be combined sustainably.

Effects of systematic tree pruning on biodiversity and ecosystem services

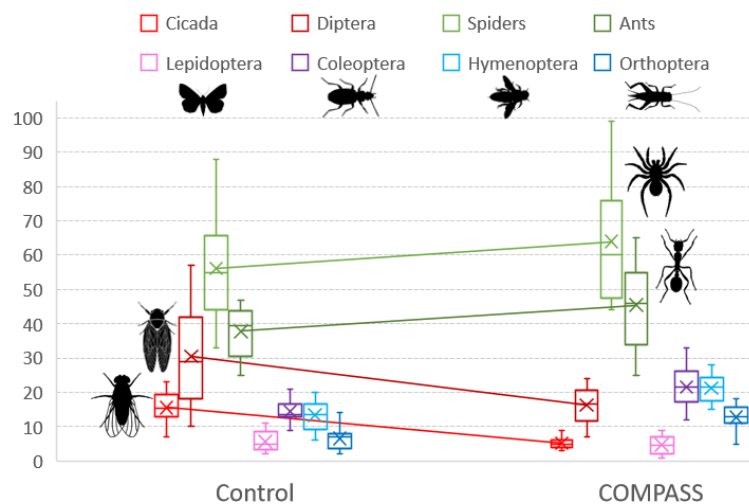
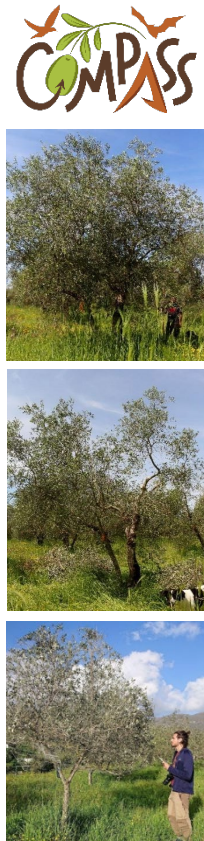


Figure 7: COMPASS pruning effects on arthropod abundance

First analyses show a promising effect of pruning: Comparing mean arthropod numbers between our control trees and pruned COMPASS trees, we see that several predatory, service-providing arthropods tend to increase on the trees (like ants and spiders) while herbivores tend to decline (like Cicada and Diptera, including olive flies).

In summary, we are looking forward to the upcoming field season and further analyses of our data – and to keep exchanging with you on our projects and findings!

Our team of ECO-OLIVES

is very grateful for your interest and support!

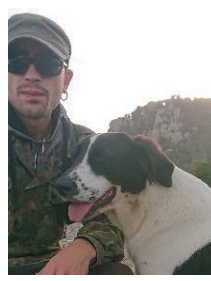
We are especially grateful for the trust and the inspiring, instructive exchange with the olive grove owners who participate in our project and let us do research on their fields. It is especially important to us that you always feel well informed about our project and know that you can contact us at any time with questions, feedback and for joint exchanges.



Bea



Virginia



Tommaso



Rym



Andrea



Luca



Tara



Maurizio



Manuela



Shanti

→ ***In October 2023, we welcome two new members in our team:***

Manuela – who will study the plant community composition on our project farms for her Master thesis; and Shanti – who will help us with the individual harvest data collection of our 192 study trees!

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