Operation Wallacea Science Report 2025

Krka National Park, Croatia

Krka River gorge © J Murray (2024)

This report has been compiled by Jenna Murray on behalf of all contributing scientists and the support team. The project is the result of the close collaboration between Operation Wallacea (herein 'OpWall') and BIOTA Group Ltd (herein 'Biota').

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1 ABBREVIATIONS & DEFINITIONS

IUCN* International Union for the Conservation of Nature; *https://www.iucn.org/*

OpWall Operation Wallacea, UK; *http://www.opwall.com/*

* For details on how the IUCN Red List categorisation works in relation to the categories listed below, please see *https://iucn-csg.org/red-list-categories/*.

- Extinct (**EX**)
- Extinct in the wild (**EW**)
- Critically endangered (**CR**)
- Endangered (**EN**)
- Vulnerable (**VU**)
- Near threatened (**NT**)
- Least concern (**LC**)
- Data deficient (**DD**)
- Not evaluated (**NE**)

2 THE 2025 TEAM

Sincere thanks go to everyone involved in the project including staff and volunteers from Biota and OpWall, without whom we could not continue to collect our long-term dataset to support ongoing efforts. The names of each person in the 2025 science and support teams are listed below. Equally, thank you to the school students and teachers, and research assistants who contributed time and energy towards the 2025 field season.

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- Warre Van Caenegem, Morgan Hughes, Shannan Poyner and Mark Roper (Chiropterology)
- Grace Corcoran, Angus Jennings and Josh Sains (Entomology)
- Eva Kneip, Jenna Murray, Duncan Pandya and Kathryn Vance (Mammology)
- Elena Račevska (Lecturer and survey support)

2.6 LinkedIn group

The science teams from this and previous years can be found on: *https://bit.ly/krka-linkedin*.

3 INTRODUCTION & BACKGROUND

3.1 Aims and scope

This report summarises the data gathered by staff and students from OpWall's science team based at the Krka National Park Research Station in Puljane, Croatia during the summer of 2025. The project is run with OpWall's in-country partner BIOTA Group Ltd. With systematic surveys of the area having started in 2019, 2025 marked the project's sixth active field season (with the 2020 season having been cancelled due to the global pandemic). The year 2021 did not include a full complement of staff and students during international COVID recovery. The approach to some taxa (e.g., *Chiroptera*) have been altered to better suit the region's terrain and landscape characteristics[1]. The project is based on annual surveys across the habitats in and around the Krka National Park, Šibensko-Kninska, Croatia, which lies within the Krka I Okolni Plato Natura 2000 site (Figure 1). Surveys took place over eight weeks from early-June to early-August.

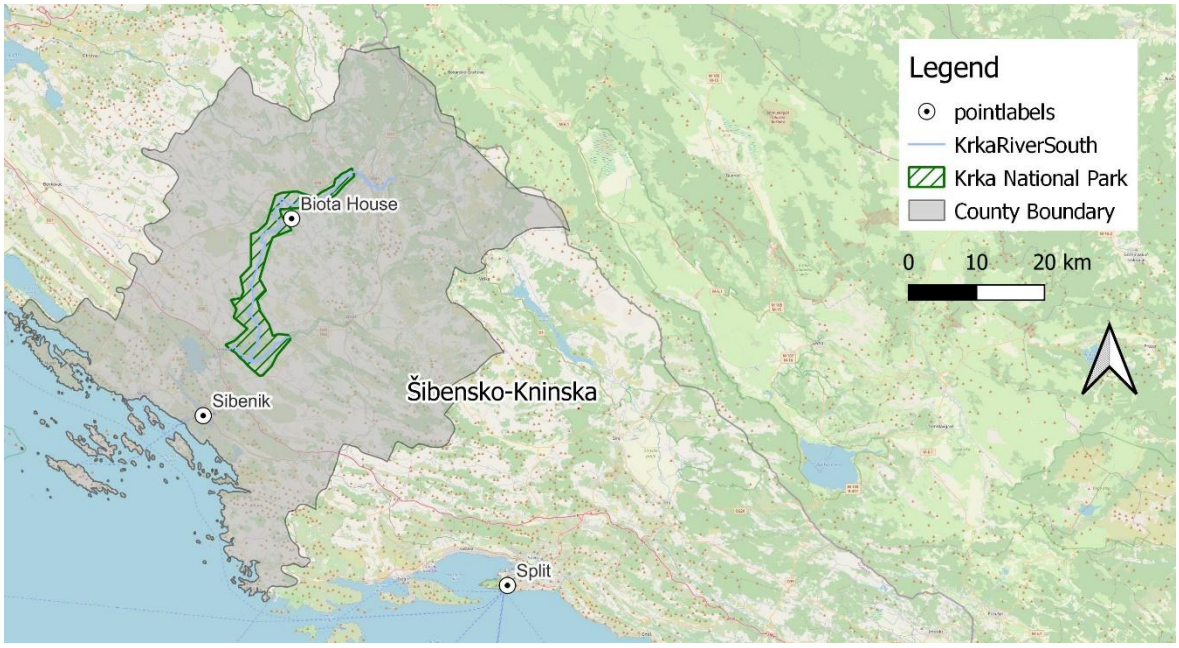

Figure 1: Map of Biota house location in Šibensko-Kninska, Croatia. Basemap © OpenStreetMap (2023)

Our ongoing aim is to monitor changes in the flora and fauna in the study area, with initial seasons providing baseline data and species assemblage assessments, and later seasons performing comparative analysis and monitoring changes in the populations of those taxa. By establishing and delivering a range of long-term monitoring schemes for habitats, herpetofauna, avifauna, mammals (including bats), and invertebrates, we have now laid the groundwork for future monitoring and

[1] *Haelewaters, D., Hughes, M., Barão-Nóbrega, J.A.L., Slater, K., and Martin, T.E. (2024) Standard deviation: standardized bat monitoring techniques work better in some ecosystems. PlosOne*

conservation, informing practical conservation actions both locally and regionally. We facilitate research in addition to the core monitoring, from dissertation projects to collaborations with universities from all over Europe, and it is our intention to expand and build upon this facility. This report gives an overview of the 2025 situation in terms of biodiversity and methods, with suggestions for modifications for the 2026 season considering survey efficacy, biosecurity and environmental impact. Data from previous years are shown for comparison where appropriate.

3.2 Wider context for 2025

The aims of the 2025 season were to further refine methods and protocols for our study taxa, facilitate ongoing research projects and begin to collate data and produce publications as per the publication plan for Krka National Park.

3.3 What is Operation Wallacea?[2]

Operation Wallacea (OpWall) is a conservation research organisation that is funded by, and relies on, teams of volunteers (school students, teachers, and university students) who join expeditions for the opportunity to work on real-world research programmes alongside academic researchers and expert surveyors. Most science programmes abroad that deliver research outcomes are funded on a short-term basis by grants with typically tightly restricted aims. Long-term projects covering large scales that can incorporate more than one ecosystem are rare. By adopting a volunteer-funded model, OpWall does not suffer from those restrictions and can draw upon researchers from a wide range of different disciplines and academic institutions and create long-term research projects. Importantly, this also provides extensive training and networking opportunities for the next generation of researchers. Those researchers and academics also separate OpWall from other volunteer organisations, allowing a truly research-orientated project.

3.4 Research projects and planning

Within the general infrastructure of the Biota-OpWall Krka Project, multiple distinct research projects are in progress and/or planning or awaiting additional years of data. Examples of these independent research projects are provided below. We invite the reader to get in touch regarding new project ideas that the Biota-OpWall Krka Project may be able to facilitate/host.

[2] Taken from *https://www.opwall.com/about-opwall/*

3.4.1 *In progress*

- Atlas projects: Data collection and production of atlases and checklists for the NE KNP area for herptiles and bats. *Project lead: Dr Thomas Martin, OpWall*
- Hermann's tortoise: Various projects (dissertations, etc.) have focused on Hermann's tortoise (*Testudo hermanni*) over the past few years. These have included movement and morphometric data. These projects continue as this is a key flagship species for the park. *Project lead: Dušan Jelić, Biota Group Ltd.*
- Cat snakes: Long-term monitoring of cat snake (*Telescopus fallax*) populations in the park is an ongoing project and is carried out on an ad-hoc basis, with all encountered individuals being brought to the camp for morphometric measurements and individuation through ventral scale marking. *Project lead: Dušan Jelić, Biota Group Ltd.*
- Bat Ectoparasites: Behavioural ecology and tritrophic traits of bats as hosts for bat flies (*Nycteribiidae*) which are, in turn, hosts for microfungi (*Laboulbeniales*). *Project leads: Dr Danny Haelewaters, University of Ghent, Belgium and Dr Morgan Hughes, Czech Academy of Sciences, Ceske Budějovice, Czechia.*
- Bat DNA Sampling: Non-invasive oral swabbing of bat species within Krka National Park to support a future checklist publication. The project particularly focuses on cryptic genera such as *Myotis*. *Project lead: Dr Morgan Hughes, Czech Academy of Sciences, Ceske Budějovice, Czechia.*
- Lure Spinner Trial: The Krka bat team is working with Apodemus, Ltd. to conduct a trial on the efficacy of lures and spinners in capturing bats at constant effort sites.

3.4.2 *In planning*

- Atlas Projects: Data collection and production of atlases and checklists for the NE KNP area for butterflies and birds. *Project lead: Dr Thomas Martin, OpWall*

3.4.3 *Longer-term (as dataset grows)*

- Community ecology trends through time: This project will look at community ecology, incorporating traits and spatial analysis. *Project leads: Drs Joseph Bailey and Hannah White, Anglia Ruskin University, Cambridge, UK*

4 FUTURE DIRECTIONS, POLICIES & GUIDANCE FOR 2025

4.1 Survey protocols and site selection

Staff MUST:

- Ensure that survey protocols are read before surveys commence at the start of each field season and that any questions are discussed with science team prior to the start of fieldwork.
- Ensure that survey protocols are updated throughout the field season, but protocols for standardised surveys should NOT be changed without discussion and justification as data must be consistent year-on-year.
- Anything undertaken that deviates from the survey protocols MUST be clearly documented in Epi-Collect5 notes or in discussion with one of the science leaders.
- Any new transects or Constant Effort Sites (CES) MUST be recorded as new sites, and no existing sites should ever be over-written (e.g., if Site 4 is no longer suitable and a new site is established nearby, this would become Site 9, where 9 is the next available site number).

4.2 Permits

Permits are required for certain activities that involve the capture and handling of protected or notable species (bat trapping) or where invasive techniques (e.g., bird ringing or collection of entomological specimens) take place. These permits, when required, are held by Biota staff with OpWall scientists listed as appropriate. Where survey works are carried out under such a permit, this is made clear to the students and teachers, and particular emphasis is placed on the ethical and welfare considerations, level of training, and expertise.

4.3 Photography, videography, social media

We want to encourage everyone to fully engage with the science we are doing, including the use of media and social media. However, we need to abide by OpWall's strict social media policy, and this should be made clear to those leading and attending surveys during orientation. Survey leaders should ensure volunteers and teachers are aware of the potential dangers of sharing photographs or videos that may misrepresent what we are doing or how we are doing it. For example, a single photo or video clip of handling a snake, removing a bird from a net, or taking a DNA sample from a bat, can easily make it appear the animal is in distress, even though we abide by strict ethical standards, are fully licensed, minimise stress as much as possible, and always have the animal's wellbeing at the centre of what we do.

This should be clearly communicated, and activity leaders can and should tell people to stop filming or taking photos when they feel the need to and/or state that all photos/videos should be checked by the survey leader before being shared (including video edits). The same applies for experiences that may appear more dangerous than they are in a photo or video (e.g., cave visits).

If a school wants to make a video, we encourage this, but they should tell us that is what they are doing, get permission from survey leaders (i.e., explicitly confirm that the survey leader is happy to be filmed/photographed), and should share the transcript and footage with us before it is released to ensure it abides by OpWall's policies and so that we can feedback and correct factual errors and misrepresentations. As part of this, we should also discuss with teachers the importance of accurately communicating science and ethics, including but is not limited to, the type of language used, which should be factual and scientific.

4.4 Biosecurity, Zoonosis & Environmental damage

4.4.1 Use of DEET

All survey leaders need to remind students that DEET damages the environment, so if their insect repellent contains DEET, they must refrain from touching any animal, entering freshwater or wet vegetation, or spraying it in any environment. Students should also be advised (and reminded thereafter) NOT to spray DEET in indoor communal areas (which is essentially all indoor areas), especially near food, and also in groups of people outdoors. It can especially have a negative impact on people with a respiratory condition, especially when combined with the dust and heat.

4.4.2 SARS CoV2 Protocols - IUCN

All bat handling surveys will be undertaken in accordance with protocols outlined by IUCN as compiled by their Bat Specialist Working Group, comprising the latest guidelines for Field Hygiene for Researchers (*IUCN SSC BSG GUIDELINES FOR FIELD HYGIENE_2024*).

These protocols outline measures (biosecurity and best practice) to reduce the likelihood of transmission of SARS-CoV viruses between bats and researchers. Protocols comprise the following, which will be adopted by project science staff and assistants going forward:

- All bat handlers to be fully vaccinated against both rabies (EBLV) and SARS-C0V-2 with the most up-to-date vaccines.
- Pre-survey check for symptoms of infectious disease (e.g., fever, sore throat, sneezing, coughing, congestion). No one with such symptoms will attend the survey.

- Use of PPE (masks and gloves) by handlers and anyone within 2m of bats (e.g., field assistants/students assisting with data will wear face masks if this applies).
- All tools and equipment will be disinfected prior to survey and between bats where appropriate
- No blowing on bats (use lens-cleaner / blowing tool instead).
- Bats to be kept in clean, individual bags. Bags to be cleaned between use.
- No eating, drinking, etc., in proximity to bats.

When students observe staff wearing masks and gloves, inevitably this results in a discussion regarding not only Covid-19 but also European Bat Lyssavirus (EBLV – Rabies). This should be seen as an opportunity to dispel fear and reinforce our responsibility as OpWall scientists to consider the welfare of individual animals and their populations at all times, and to emphasise that this is of the highest priority to OpWall. Cave work (for bats or otherwise) will abide by the IUCN guidelines for cavers: *map_recommendations_cavers_v2_dec_2021*.

5 METHODS (2025)

5.1 Survey and Sampling Design

There are six transects, which were established in 2019 (Figure 2), and sampling points along each transect are the key locations for many of the surveys. Transects are of variable length and shape and correspond to the principal habitat types occurring in KNP. In 2023, as GPS signal is not reliable on all transects (particularly T4 and T5), 100m markers (Figure 3) were placed along the length of each transect in order to assist the science team in record accuracy.

Figure 2: Location of transects in relation to Biota house and Krka River gorge

Figure 3: Example of 100m markers (in this case, on Transect 1)

5.1.1 Transect Surveys

Surveys for herpetofauna, butterflies and mammals take place along the transects. Surveys for habitats and bird point counts occur at specific sites evenly distributed along the transects. The survey rota was designed in such a way that the transects subject to survey on any given day have not been disturbed by another group prior to the survey. Surveys for each taxonomic group also take place at times aimed at optimising survey success (e.g., herpetofauna transects take place early in the mornings when the target species are likely to be basking and butterfly surveys occurring comparatively later when the temperature has increased and butterflies start to emerge).

5.1.2 Constant Effort Sites

For certain survey types (namely, mist netting for bats and birds), surveys do not take place along standard transects but are sited in areas known to support the target species groups (or in the case of caves, habitats). Ideally, CES will be visited year on year, subject to a standard minimum survey effort, with a view to monitor species richness and abundance over time.

5.1.3 Changes from 2024 season

This season, we reverted back to the five-day survey rota, with caves running every day in the afternoon as opposed to the four-day rota plus cave day which was trialled last season.

Due to their length and proximity, it was decided that transects 2 and 3 would be completed on the same day. This allowed for all six transect to be completed in a singular survey week. This meant that all five replicates could be completed before the season finished allowing for a grace period if any surveys had to be cancelled due to weather.

The bird team was separated into two teams, one for mist netting and the other for point counts with its own dedicated staff team. This allowed for more surveys of each to be conducted throughout the season, thus ensuring five replicates of each transect and site could be completed for both methodologies.

Lastly, the transect rota was altered to ensure whichever transect was being surveyed by mammals that morning had not been walked by any team the day before. This allows for tracks and scat to build up over two days since the last survey without being disturbed by another team, thus increasing the potential for more evidence of mammals to be recorded.

5.2 Summary of 2025 surveys

Table 1: Summary of surveys. See survey protocols for specific times. 'Evening' refers to dusk and first hour or so of darkness; 'night' goes beyond approximately 22:30.

Taxon	Transects: Route	Transects: Intervals	Constant effort sites	Opportunistic
Avifauna		Bird point counts (morning)	Mist netting (morning)	Vantage point surveys at opportunistic sites once surveys completed (morning)
Bats			Mist netting (evening/night)	Roost monitoring at abandoned buildings
Caves			Daily bioblitz surveys (afternoon)	
Habitats		Vegetation structure and cover (afternoon).		Botany surveys if transects complete (afternoon).
Herps	Visual encounter surveys – all herptiles (early morning).			Cat snakes (evening) Herptile lab sessions (measurements, marking etc; daytime) Visual encounter surveys at opportunistic sites once transect replicates complete (morning).
Inverts	Pollard walks butterflies (morning).			Moth trapping (ad hoc, evening)
Mammals	Surveys – tracks and scat (morning)	Camera trapping (constant)		Opportunistic camera trapping Sherman trapping around camp (ad hoc)

6 RESULTS

N.B. See **Appendix 1** for all species lists by year.

6.1 Bats

Bat surveys take the form of either mist netting at constant effort sites, and roost monitoring which includes infra-red monitoring and occasional hand-netting.

6.1.1 Trapping at CES

In 2025, CES surveys took place at Bilušića buk, Brljan-Manojlovac (BM) Trail, Knin Mine, Miljacka Hidroelektrana (HE), Pravoslavni Manastir Krka (the Monastery), Tunnel and Orlić pond. 43 surveys were completed across these sites using wither mist nets or harp traps. A total of 514 bats comprising 17 species were captured at these sites, a large increase from the 115 individuals caught in 2024. The harp traps resulted in 343 captures across 37 surveys, and mist nets 172 captures across 6 surveys. Just as in the 2024 season the most species-rich site was the Monastery again (14 species).

BM trail had the highest abundance of bats with 163 individuals being caught during 7 surveys. However, accounting for the number of surveys per site, Milikacka HE was the most successful location with an average of 42 bats per survey. The most abundant species caught was the long-fingered bat (*Myotis capaccinii*) with 210 captures.

This year many new species were recorded at both the monastery and trail. Blasius's horseshoe bat (*Rhinolophus blasii*), Geoffroy's bat (*Myotis emarginatus*), Kuhl's pipistrelle (*Pipistrellus kuhlii*) and Mediterranean horseshoe bat (*Rhinolophus euryale*) at the monastery. David's myotis (*Myotis davidii*), greater horseshoe bat (*Rhinolophus ferrumequinum*) and Mediterranean horseshoe bat at the trail. The new site for this season, Orlić pond, recorded 35 individuals across six different species. This could potentially be a promising site to continue surveying in future years.

6.1.2 Roost monitoring

The Bechstein's bat (*Myotis bechsteinii)* maternity roost in the attic of the Biota House had returned for the fifth year and roosts of greater horseshoe bat were once again observed in the abandoned school in Puljane.

6.2 Birds

Surveys of avifauna comprise of point counts and mist netting. Bird community composition, biodiversity and abundances were surveyed using point count transect surveys and mist netting at

standardised Constant Effort Sites (CES). Where birds were captured in the hand morphometric and demographic data were collected.

6.2.1 Point counts

This year there was total of 1,131 records of 54 species, with the most commonly recorded species being the common blackbird (*Turdus merula*). This is a slight decrease from 2024 which recorded 1,880 birds across 62 species. This year T1 had the greatest species richness (35 species) and the greatest abundance (384 individuals), whilst T4 had the lowest species richness (20 species) and T2 the lowest abundance (110 individuals).

Six new species have been recorded this year comprising of common pheasant (*Phasianus colchicus*), common redstart (*Phoenicurus phoenicurus*), common reed warbler (*Acrocephalus scirpaceus*), common wood pigeon (*Columba palumbus*), Eurasian goshawk (*Accipiter gentilis*) and spotted flycatcher (*Muscicapa striata*). Additionally, this year recorded the first sighting of the lesser spotted woodpecker (*Dryobates minor*) since 2019.

6.2.2 Mist netting at CES sites

During the mist netting surveys, 357 individuals were caught comprising of 23 species. This is a notable rise from last year's total of 64 individuals; however, this increase may be attributed to the separation of the point count and mist netting teams for this season, which facilitated a greater number of mist netting sessions. The most abundant species caught being the Eastern subalpine warbler (*Curruca cantillans*) with 78 individuals recorded. Overall, site 6 had the greatest species richness (13 species) and abundance (92 individuals), whereas site 1 had the lowest species richness and site 7 the lowest abundance (50 individuals).

Three new species were caught, the common chiffchaff (*Phylloscopus collybita*), common sandpiper (*Actitis hypoleucos*) and middle spotted woodpecker (*Dendrocoptes medius*). Additionally, two olive tree warblers (*Hippolais olivetorum*) were caught, which hadn’t been caught since 2019 (Figure 4).

Figure 4: (Left to right) Common sandpiper, middle spotted woodpecker, olive tree warbler © K Thorpe 2025

6.3 Butterflies and other invertebrates

6.3.1 Butterfly Pollard Walks

Butterfly surveys were conducted using an adapted Pollard walk (Pollard, 1977), following on from the first year of Operation Wallacea researching in Krka National Park in 2019 (see survey protocol).

A total of 3,467 individuals across 58 species were recorded this season. As was observed last year the most commonly recorded species were meadow brown (*Maniola jurtina*) and great banded grayling (*Britensia circe*) with 675 and 655 records, respectively. T3 had the greatest species richness (38 species) and T2 the lowest (15 species). Whereas T6 had the greatest abundance (962 individuals) and agin T2 the lowest (77 individuals).

Four new species were recorded this season, black-veined white (*Aporia crataegi*), gatekeeper (*Pyronia tithonus*), large grizzled skipper (*Pyrgus alveus*) and southern small white (*Pieris mannii*). Additionally, nine ilex hairstreaks (*Satyrium ilicis*) were recorded for the first time since 2019 and a dusky meadow brown (*Hyponephele lycaon*) since 2021.

6.3.2 Other Invertebrates

A species list of other (non-butterfly) invertebrates is provided in the Appendix.

6.4 Caves

Surveys were conducted with students each day to Jazinka cave, located near the start of T4. Surveys were conducted on the two cave cricket species common cave cricket (*Troglophilus cavicola*) and spidery cave cricket (*Dolichopoda araneiformis*), doing population counts of both. Additionally, any incidental sightings of other species were recorded including common toad (*Bufo bufo),* edible dormouse (*Glis glis)* and an unknown horseshoe bat (*Rhinolophidae sp.*).

This season the science team was also granted access to Miljacka II. This was not conducted with students. Two camera traps were placed and captured multiple instances of beech marten (*Martes foina*) and red fox (*Vulpes vulpes*) entering the cave. Thermal imaging of bats inside the cave was conducted and the olm (*Proteus anuinus*) was also recorded for the first time since 2021 when Opwall last had access to the cave.

6.5 Habitats

This season, habitat data was successfully collected from every site along the transects. Data collected includes data such as tree species, understory density, presence of burning on trees, grass height, and canopy openness allowing for a continuous monitoring of the habitat along transects

allowing for comparison against taxon data to determine species distributions based on habitat selection. This year once transect sites had been completed additional surveys were also conducted on bird mist netting sites 1, 3 and 6.

6.6 Herpetofauna

Herpetological surveys are conducted through either transect or opportunistic surveys (the latter comprising all encounters with herpetofauna made outside of designated transects). All surveys this year were conducted using visual encounter methodology, with the capture of focal species.

6.6.1 Encounter surveys (transects and opportunistic)

A total of 231 individuals were recorded across 24 species through a combination of transects and opportunistic surveys. Only 37 individuals of 13 species were recorded on transect, with 198 across 23 species from the opportunistic surveys, thus demonstrating the importance of opportunistic herpetological surveys being conducted allowing for surveys of sites of interest (Table 2).

Table 2: Comparative results of Transect vs Opportunistic surveys for herptiles in 2025

	T1	T3	T4	T5	T6	Transect	Opp	Total
Agile frog		3	1			4	12	16
Balkan green lizard					2	2	16	18
Balkan marsh frog	1					1	12	13
Balkan whip snake	1					1	1	2
Cat snake							12	12
Common toad			1	2		3	21	24
Dahl's whip snake							2	2
Dalmatian algyroides							2	2
Dalmatian wall lizard	3				7	10	16	26
Dice snake				3		3	9	12
Eastern Montepelier's snake							2	2
European green lizard					2	2		2
European legless lizard				2		2	11	13
European pond terrapin							2	2
European tree frog							1	1
Four-lined snake	1					1	2	3
Grass snake		1		2		3	14	17
Hermann's tortoise							33	33
Italian wall lizard							2	2
Leopard snake							6	6
Mediterranean house gecko							3	3
Nose-horned viper	1					1	16	17
Olm							1	1
Smooth Newt							2	2
Total Species	**5**	**2**	**2**	**4**	**3**	**12**	**23**	**24**
Total Records	**7**	**4**	**2**	**9**	**11**	**37**	**198**	**231**

T1 had the greatest species richness (6 species) and T6 the greatest abundance (14 individuals), making a difference from T5 last year. This year T2 didn't record any individuals at all. One novel record for the site was smooth newt (*Lissotriton vulgaris)* (Figure 5).

Figure 5: Smooth newt © E Gilbert 2025

6.7 Mammals

Mammal surveys include recording sightings and evidence of species along transects and incidentals off transect. Additionally, camera traps were deployed both on and off transect to record species presence and behaviour.

6.7.1 Mammal observations on transects

In total of 392 records across 17 species was recorded, with 148 of these across 11 species being recorded on transects. As observed in 2024 T1 again had the greatest species richness (8) and T2 the lowest (5). However, despite still having the lowest species richness T2 had a significant increase from only recording one species in 2024. Again, T1 had the greatest abundance of records, however this year T5 also matched with 23 records in total, and T2 again had the lowest with 5 records. Wild boar (*Sus scrofa*) was the most recorded species (35 records), with many wallowing pits and rubs containing hair being found on transect (Figure 6), which had not been recorded in previously.

Figure 6: Wild boar wallowing pit and rub containing hair © K Vance, E Kneip 2025

6.7.2 Mammal incidental observations

244 records across 17 species were recorded off transect, an increase from 14 species in 2024. Species that were only recorded from incidental records and not on transect were wood mouse (*Apodemus sylvaticus*), Western broad-toothed field mouse (*Apodemus epimelas*), white-toothed pygmy shrew (*Suncus etruscus*) recorded through Sherman trapping. Edible dormouse (*Glis glis*) and golden jackal (*Canis aureus moreotica)* also only through incidental records, the latter being difficult to ID evidence for due to a difficultly in differentiating scat and tracks from domestic dogs (*Canis lupus familiaris*). Two interesting records this season were the finding of a roadkill golden jackal, allowing us to bring back to base and collect multiple morphometric photos and measurements of a rarely observed species by Opwall (Figure 7) and the first recorded sighting of a least weasel (x), which had only previously had scat recorded in 2019.

Figure 7: (Left to right) Golden jackal full body, front left paw displaying fusing of second and third digital pads, jackal dentition © J Murray 2025

6.7.3 Camera trapping

Replicating last year, 24 cameras were placed with the same number distribution across transects and in opportunistic sites of interest off transect. In total, 10 species were observed across 535 positive triggers, a decrease from the 12 species across 825 trigger last season. A possibility of this decrease could be attributed to less active days in the field or potentially a decrease in mammal presence throughout the survey site. Comparatively, beech marten (*Martes foina*) was the most observed species with 143 triggers, a notable increase from only 41 the previous year. Multiple species had a significant decrease in triggers including red fox (*Vulpes vulpes*) (from 148 in 2024 to 81 in 2025), roe deer (*Capreolus capreolus*) (122 to 93) and brown hare (*Lepus europaeus*) (87 to 8).

This season marked quite a change in distributions, with previously successful transects and specific camera locations being significantly less successful when compared to previous seasons. In 2024 T6 and T1 resulted in the most triggers with 226 and 121 triggers respectively, however this year these transects had a significant drop in triggers with only 57 and 11 being recorded across four cameras each. Instead, T5 and T4 were the most successful transects with the highest detections rates of 2.0 and 1.88. Detection rate being (total positive triggers/total days recording)/number of cameras on transect, thus accounting for any camera failures and differing camera numbers on transect. T2 was the least successful with a detection rate of 0.18.

7 ADDITIONAL ACTIVITIES

7.1 Additional Lectures and Workshops

In addition to the core taxon lecture series which run every day (Bats, birds, herps, mammals and inverts), we provided a range of supplementary lectures and workshops. A selection of these were provided to RAs in their second week on site as a replacement to the core lectures they had their first week. Others were used to fill gaps in the schedule or if people need a survey alternative.

7.1.1 Second week RA lectures/workshops

- Survey design: For the third year, we delivered a lecture on the key principles of biological recording, survey design, bias and data interpretation using the bat lure trail as a case study.
- Data tools: Lecture demonstrating the use of R and QGIS in research projects using the lure trial as a case study.
- LinkedIn and CV workshop: Demonstrating the use of LinkedIn as an important networking tool and working through students profiles and CVs and advising on improvements and enhancements.
- Careers workshop: Each staff member detailed their academic and work history. This allowed students to learn of vastly different potential careers paths they can pursue, be it pursuing degrees or primarily through work experience. It also gave them the opportunity to ask questions about working in the conservation field.

7.1.2 Guest Lectures

We continued to deliver weekly guest lectures. Staff members produced talks on particular areas of research they had conducted or a topic of interest. Lectures included frog research in Ecuador, habitat analysis in Ireland, the importance of natural history notes, mammal tracking in Canada and the creation of a bat monitoring company in New Zealand. This allowed students to gain insight into practical applications of research all over the world in the conservation field.

7.1.3 Additional workshops

- Debate workshop: Groups of students are given conservation topics of debate and split into ‘for’ and ‘against’. Groups are given 15 minutes to research their topic and compile an argument, before nominating a spokesperson to debate their point for 3 minutes, after which the opposing team has 1 minute to respond. Roles were then reversed. Examples of topics covered include ecotourism is beneficial to the environment, wolves should be

reintroduced into Scotland, extinct species should be brought be back and flagship species take away funding from less charismatic species.

- Invertebrate BioBlitz: Students were separated into teams and given nets and pots to capture and identify as many invertebrates as they could in the allotted time gaining points on how specific they could get their identifications (i.e. to family, genus or species level) and how many different orders of invertebrates they could find.
- Amphibian parental care: A lecture and quiz detailing the many different case studies of breeding and caring for young in amphibians.
- Mammal calls quiz: A quiz containing sound clips of different native animal calls.
- Mist net workshop: Teaching students how to put up a mist net for the capture of bats and birds and racing to do so.
- Sherman Trapping: Preparing and placing Shermans traps around camp in the evening and collecting in the morning with the intention of capturing different small mammal species for analysis in camp.

8 FUTURE DIRECTIONS

8.1 Transects Rota for 2025

Separating the bird team, combing T2 and T3 and providing a rest day before mammals were all very successful this year, and should be continued in future seasons (Figure 8).

	Fri	Sat	Sun	Mon	Tue
T1	*Mammals*	*Birds*	*Butterflies*	*Herps*	
T2 & T3		*Mammals*	*Birds*	*Butterflies*	*Herps*
T4	*Herps*		*Mammals*	*Birds*	*Butterflies*
T5	*Butterflies*	*Herps*		*Mammals*	*Birds*
T6	*Birds*	*Butterflies*	*Herps*		*Mammals*

Figure 8: Suggested transect rota for 2026.

8.2 Caves

Returning to the five-day survey rota and running a cave survey every day in the afternoon worked well for the weeks rota, however as the only cave we could survey in was Jazinka this raises concern of heavy footfall in a singular cave which could impact species presence. It should be recommended that if completing five cave surveys each week other caves should be identified for suitable surveys for the coming seasons to reduce this footfall.

APPENDIX 1: FAUNA SPECIES LISTS BY YEAR

Species lists below include records to species or species aggregate level. Those records of animals identified to family or genus level only have been omitted for the purpose of species listing.

Avifauna

Table 3: Bird species recorded during point counts in KNP by OpWall/Biota staff, by year (2018-2025)

Species	2018	2019	2021	2022	2023	2024	2025	Total
Barn swallow	5	4	24	14	26	136	29	238
Black woodpecker						2		2
Blue rock thrush				1				1
Cetti's warbler		4	2	7	20	22	16	71
Cirl bunting	33	3	15	12	18	43	50	174
Common blackbird	51	37	78	116	188	269	159	898
Common buzzard	2		9	7	5	19	3	45
Common chiffchaff		2		1	7	7	12	29
Common cuckoo		2		1	6		36	45
Common firecrest						6		6
Common kestrel	1		6	5	2	6	4	24
Common kingfisher			5	4	2	5	6	22
Common linnet				3		13	1	17
Common moorhen	3		4					7
Common nightingale	41	23	3	12	23	24	29	155
Common pheasant							3	3
Common redstart							1	1
Common reed warbler							1	1
Common sandpiper			3			3		6
Common starling	2			3			3	8
Common swift			1	2	4	20	1	28
Common whitethroat				1				1
Common wood-pigeon							1	1
Corn bunting				1	8		1	10
Dunnock			1					1
Eastern black-eared wheatear						3		3
Eastern olivaceous warbler		1	2					3
Eastern orphean warbler		2		1	4	3	1	11
Eastern subalpine warbler	22	7	15	16	19	30	1	110
Eurasian blackcap	32	15	64	103	112	332	152	810
Eurasian blue Tit			22	15	27	88	46	198
Eurasian bullfinch						2		2
Eurasian chaffinch	2	9	23	4	69	62	38	207
Eurasian collared dove			8	1		7	8	24
Eurasian golden oriole	7	37	44	49	55	257	133	582
Eurasian goshawk							3	3
Eurasian hobby			1					1
Eurasian hoopoe		1			14	1	12	28

Eurasian jay	3	6	18	11	20	79	20	157
Eurasian magpie				1				1
Eurasian nuthatch	1		9					10
Eurasian scops owl	2							2
Eurasian sparrowhawk			2		1			3
Eurasian treecreeper			1	1	3	6		11
Eurasian wren						3		3
European bee-eater						3		3
European goldfinch			5		1			6
European green woodpecker		2	2			2		6
European greenfinch	1		1		3	10	4	19
European honey buzzard	1		1					2
European nightjar	3		1	7	4		1	16
European pied flycatcher						1		1
European robin	1			2		3	5	11
European serin	2		1					3
European turtle dove	6	12	23	45	37	51	42	216
Garden warbler		1	2	1	2			6
Glossy ibis				1				1
Great cormorant	1					1	7	9
Great reed warbler	7		3		3	24	12	49
Great spotted woodpecker	1	1	2	1	2	5	3	15
Great tit	4	4	20	8	32	138	100	306
Green sandpiper						3		3
Grey heron			1	5	1	1	5	13
Grey wagtail			1	1	1		19	22
Grey-headed woodpecker						2		2
Hawfinch	1	1	4	4	16	35	28	89
Hooded crow	3		1			5	1	10
House sparrow		1	3	3	2	2	2	13
Icterine warbler						2		2
Larus sp						1		1
Lesser grey shrike						1		1
Lesser kestrel					2			2
Lesser spotted woodpecker	1						2	3
Lesser whitethroat			5		1			6
Little grebe	3		4					7
Long-tailed tit				4	5	47	39	95
Mallard	2		11	7	2	10	7	39
Middle spotted woodpecker					1	7	6	14
Northern raven						1		1
Pallid swift					1	3		4
Purple heron					1			1
Red-backed shrike	1	4		2	2	11	12	32
Rock dove/feral pigeon						2		2
Rock partridge				1		2		3
Sand martin						1		1
Sardinian warbler			1				1	2
Short-toed snake eagle				1	3			4

Sombre tit			4	5	4	27		40
Song thrush						1	1	2
Spotted flycatcher							9	9
Tawny pipit			9	1	8	14	4	36
Tree pipit		1						1
Western house martin	6		10	5	1	4	12	38
Western yellow wagtail						1		1
White wagtail	1							1
Willow warbler						5		5
Woodchat shrike				2	4		3	9
Woodlark		5	7	23	10	6	1	52
Yellow-legged gull	1	1	7	2	18	1	2	32
Total Species	**34**	**26**	**49**	**48**	**49**	**63**	**54**	**99**
Total Records	**253**	**186**	**489**	**523**	**800**	**1881**	**1098**	**5230**

Table 4: Bird species recorded during mist netting in KNP by OpWall/Biota staff, by year (2018-2025)

Species	2018	2019	2021	2022	2023	2024	2025	Total
Barn swallow	24			7		1		32
Blackbird	9	45	9	77	37	22	71	270
Blackcap	46	23	2	43	21	2	44	181
Black-headed bunting	4							4
Blue tit		1	4	10	5		8	28
Cetti's warbler		3		35	2	1	3	44
Cirl bunting	25	2		39	12	3	39	120
Collared flycatcher		1						1
Common chaffinch	2			3	1		1	7
Common chiffchaff							7	7
Common cuckoo				1				1
Common greenfinch	10			4	3			17
Common house-martin	3			3				6
Common kingfisher				17		1		18
Common nightingale	11	7		4	4	3	8	37
Common reed warbler		1						1
Common sandpiper							1	1
Corn bunting	5			1				6
Crested lark	4							4
Eastern orphean warbler	9	1	1	2	6	2	9	30
Eastern subalpine warbler	43	34	9	36	32	10	81	245
Eurasian green woodpecker				1				1
Eurasian nuthatch			1					1
Eurasian treecreeper					1			1
Eurasian wryneck	6							6
European bee-eater	26				2			28
European goldfinch	3	1						4
European nightjar		1			5	1		7
European robin		1						1
Garden warbler			1		1			2

Golden oriole		1			1	1		3
Great reed warbler	1	3		20	1	1	7	33
Great spotted woodpecker	2	1						3
Great tit	13	3	14	16	9	1	47	103
Grey wagtail		1		2		4	13	20
Hawfinch	1			4	4		5	14
Hoopoe	1					1	1	3
House sparrow	26			1			3	30
Icterine warbler	3					2		5
Lesser spotted woodpecker				1				1
Linnet	3	1						4
Long-tailed tit			3		2	1	7	13
Melodious warbler	2							2
Middle-spotted woodpecker							1	1
Olive-tree warbler		1					2	3
Red-backed shrike	5	3	1	1	8	3	1	22
Rock dove				2				2
Scops owl	1							1
Sedge warbler	1			5		1		7
Serin	6			2	4			12
Sombre tit		1	2	2	10	2	19	36
Spanish sparrow	10							10
Tawny pipit	1							1
Tree sparrow	4							4
Turtle dove	1			1			2	4
White wagtail	1							1
Whitethroat	3							3
Wood warbler	1		1	1	2	2		7
Woodchat shrike	3				3	1		7
Total Species	**37**	**22**	**12**	**29**	**24**	**22**	**23**	**59**
Total Records	**319**	**136**	**48**	**341**	**176**	**66**	**380**	**1446**

** Mist netting not undertaken in 2020*

Herpetofauna

Table 5: Herptile species recorded in KNP by OpWall/Biota staff, by year (2018-2025)

Species	2018	2019	2021	2022	2023	2024	2025	Total
Aesculapian snake		1						1
Agile frog	26	6			9	20	16	77
Balkan green lizard	18	28	5	4	11	27	18	111
Balkan marsh frog	35	1	4	1	6	4	13	64
Balkan whip snake	3	6	2	3	1	10	2	27
Cat snake		11		3	11	46	12	83
Common toad	15	16	12	2	7	25	24	101
Dahl's whip snake		3			3	3	2	11
Dalmatian algyroides		13	3				2	18
Dalmatian wall lizard	11	62	18	4	27	27	26	175
Dice snake	11	1	2	1	4	1	12	32
Eastern Montepelier's snake		29		4	4	4	2	43
European green lizard		2				2	2	6
European green toad	1	1				2		4
European legless lizard	3	2		1	5	6	13	30
European pond terrapin	4	3	1	1		2	2	13
European tree frog	1	2			1	1	1	6
Four-lined snake		5	2	1	1	6	3	18
Grass snake	6	1	4		3	11	17	42
Hermann's tortoise	4	72	4	9	3	50	33	175
Italian wall lizard	91	2	4	2	1	14	2	116
Leopard snake		1		2	1	4	6	14
Mediterranean house gecko		4				11	3	18
Nose-horned viper		7			8	13	17	45
Olm							1	1
Slow worm						2		2
Smooth Newt							2	2
Total Species	**14**	**24**	**12**	**14**	**18**	**23**	**24**	**27**
Total Records	**229**	**279**	**61**	**38**	**106**	**291**	**231**	**1235**

Mammalia

Table 6: Mammal species (transects and incidentals) recorded by OpWall/Biota staff, by year (2018-2025)

Species	2018	2019	2022	2023	2024	2025	Total
Badger		9		66	33	32	140
Beech marten	4	87		30	14	31	166
Bi-coloured shrew					1		1
Brown hare	1	12		39	20	20	92
Brown rat				1	1	1	3
Edible dormouse				1	11	6	18
European wildcat		2		11	21	22	56
Golden jackal	1			1	2	3	7
Grey wolf	4	2		1	2	4	13
Least weasel		3				3	6
Northern white-breasted hedgehog	3	2		42	37	35	119
Polecat		1					1
Pygmy white toothed shrew				1		2	3
Red fox	2	1		80	78	36	197
Red squirrel					1	6	7
Roe deer	1	8		45	34	39	127
Western broad-toothed field mouse					4	1	5
Wild boar	1	5		3	10	46	65
Wood mouse	2		5	2		11	20
Total Species	**9**	**11**	**1**	**14**	**15**	**17**	**19**
Total Records	**19**	**132**	**5**	**323**	**269**	**298**	**1046**

**Transects not completed in 2020 - 2022*

Table 7: Mammal species recorded by camera trapping in KNP by OpWall/Biota staff, by year (2018 - 2025)

Species	2018	2022	2023	2024	2025	Total
A mouse	6	3	4	147	8	168
A rat				8	8	16
Badger	21	23	18	80	72	214
Beech marten	1	20	23	41	137	222
Brown hare	32	1	74	87	8	202
Edible dormouse		4		53		57
European wildcat	2	6	8	19	18	53
Golden jackal		22	3	23	6	54
Northern white-breasted hedgehog			2	15	3	20
Red fox	8	36	63	148	79	334
Red Squirrel		2		6	1	9
Roe deer	11	26	17	122	93	269
Wild boar	15	8	14	47	49	133
Total Species	**8**	**11**	**10**	**13**	**12**	**13**
Total Records	**96**	**151**	**226**	**796**	**482**	**1751**

**Camera trapping not conducted in 2019 and 2021*

Chiroptera

Table 8: Bat species recorded (all methods) in KNP by OpWall/Biota staff, by year (2018-2025)

Species	2018	2019	2021	2022	2023	2024	2025	Total
Balkan long-eared bat					2	3	8	13
Bechstein's bat	1		17	4	11	6	8	47
Blasius's horseshoe bat				1			20	21
Common pipistrelle					3	1		4
Daubenton's bat		9		2				11
David's Myotis	4			1	2	1	48	56
Geoffroy's bat			3	8	12	7	88	118
Greater horseshoe bat	5		5	12	4	6	28	60
Greater mouse-eared bat	2			4	3	1	2	12
Kuhl's pipistrelle	16		19	9	2	3	20	69
Leisler's bat	1							1
Lesser horseshoe bat	2		8	10	5	8	18	51
Lesser mouse-eared bat	3		1		2		5	11
Long-fingered bat	2	17	3	60	31	82	210	405
Mediterranean horseshoe bat	1		3	5	1	6	21	37
Natterer's bat	4	1	8	6		3	7	29
Noctule bat	9			21	5		5	40
Savi's pipistrelle	1		2		1		10	14
Schreiber's bent-winged bat			1	2	1	1	1	6
Serotine bat	2		3	6		1		12
Soprano pipistrelle	2			1	1		25	29
Steppe whiskered bat						2		2
Rhhyp							4	4
Whiskered bat	1			4	3	3	4	15
Total Species	**16**	**3**	**12**	**17**	**17**	**16**	**19**	**24**
Total Records	**56**	**27**	**73**	**156**	**89**	**134**	**532**	**1067**

Lepidoptera

Table 9: Lepidoptera species recorded in KNP by OpWall/Biota staff, by year (2019-2025)

Species	2019	2021	2022	2023	2024	2025	Total
Adonis blue	10		20		298	109	437
Amanda's blue					1	1	2
Anomalous blue			2		1		3
Balkan Marbled White					1	2	3
Berger's clouded yellow		1			4	3	8
Black-veined white						2	2
Blue-spotted hairstreak	6				1	3	10
Brown argus	10	7	41	44	38	33	173
Brown/blue				2			2
Cardinal	1		1	6	11		19
Chalkhill blue	1			4			5
Chapman's blue			3	1		1	5
Cleopatra	1	1			1		3
Clouded yellow	1	2	1	26	4	39	73
Comma	1		1		1	2	5
Common blue	13	9	33	32	40	121	248
Common brimstone	4			11	8	5	28
Dingy skipper	1	1			2	1	5
Dusky meadow brown		1				1	2
Eastern bath white	1						1
Eastern wood white	2	1					3
Escher's blue	3		2	1	2		8
Essex skipper				7		1	8
Gatekeeper						1	1
Grayling	1	16	6	59	13	81	176
Great banded grayling	83	34	60	176	417	675	1445
Green-veined/Balkan green-veined white	44		12		9	10	75
Grizzled skipper				3		2	5
Hermit	9	1	1	15	9	1	36
High brown fritillary					2		2
Holly blue	5	4	34	3	41	8	95
Ilex hairstreak	2					9	11
Iolas blue	1						1
Lang's short-tailed blue		1	1	1	2		5
Large grizzled skipper						2	2
Large skipper	4				1	2	7
Large tortoiseshell				6	3	3	12
Large wall brown	9				2	2	13
Large white	2			58	12	7	79
Little tiger blue	2				2	2	6
Lulworth skipper	11	1	2	2	2	64	82
Mallow skipper	2				5		7
Marbled fritillary	1						1
Marbled white	117	7	60	218	54	255	711

Marbled white (subs leucomelas)		1			2		3
Meadow brown	158	35	133	175	486	655	1642
Meleager's blue			1				1
Mountain small white	10	5	12	2	22	17	68
Nettle tree	4	1	7	2	10	10	34
Niobe fritillary	5		2	2	4	2	15
Oberthür's grizzled skipper	3	1	1		8	1	14
Old-world swallowtail	1			3	2	2	8
Orbed red underwing skipper	2				15	1	18
Oriental marbled skipper	1				1		2
Oriental meadow brown	7		9	10	10	16	52
Painted lady	34		1			1	36
Peacock	2			2			4
Purple hairstreak				1			1
Queen of Spain fritillary				1	1	1	3
Red admiral	1	3	5	2	36	3	50
Scarce swallowtail	32	16	18	30	83	30	209
Short-tailed blue	1	1			4		6
Silver spotted skipper	1						1
Silver-studded blue	2		2	1	1	1	7
Silver-washed fritillary	13	11	58	42	352	264	740
Small blue	8			5	3	29	45
Small copper	4	6	9		5	2	26
Small heath	44	6	4	24	219	63	360
Small skipper	12	1	4	6	9	36	68
Small white	2		12	72	11	15	112
Southern comma	1		1				2
Southern small white						6	6
Southern white admiral	46	27	23	70	92	113	371
Speckled wood	62	8	7	47	118	157	399
Spotted fritillary	51	1		4	423	210	689
Tree grayling	53	21	110	10	221	10	425
Wall brown	12	11	8	41	74	55	201
White-letter hairstreak				4			4
Wood white	6	7	4	3	69	59	148
Woodland/Eastern rock grayling	32	31	259	125	390	151	988
Total Species	**59**	**34**	**40**	**45**	**58**	**58**	**80**
Total Records	**958**	**280**	**970**	**1359**	**3658**	**3358**	**10583**

**Surveys not conducted in 2020*

Other Invertebrates

Table 10: Invertebrate records (not including butterflies) by OpWall/Biota staff in 2025

Araneae
Araneus circe
Argiope lobata
Menemerus semilimbatus
Oxyopes heterophthalmus

Blattodea
Loboptera decipiens

Coleoptera
Hylotrupes bajulus
Lampyris noctiluca
Saperda punctata

Diptera
Dasyrhamphis umbrinus
Philipomyia graeca
Suillia gigantea

Hymenoptera
Dolichoderus quadripunctatus
Megascolia maculata

Isopoda
Armadillidium pallasii

Lepidoptera
Acleris variegana
Acrobasis cf sodalella
Acrobasis dulcella
Aethes smeathmanniana
Agonopterix cf adspersella
Aleimma loeflingiana
Altenia scriptella
Amata phegea
Ancylis obtusana
Apoda limacodes
Aprominta designatella
Archips xylosteana
Argyroderces pyrogrammos
Aristotelia subericinella
Caloptilia fidella
CF Tenaga rhenania
cf Vulcaniella extremella
Chlorissa cloraria/viridata
Clepsis consimilana
Clepsis pallidana
Cnaemidophorus rhododactyla
Cosmia confinis
Dicrognophos sartata
Dicycla oo
Dolicharthria bruguieralis
Dysauxes punctata
Dyscia innocentaria
Dyspessa ulula
Eilema complana
Ematheudes punctellus
Epinotia festivana
Epinotia thapsiana
Eteobalea isabellella
Eublemma parva
Eublemma viridula
Eucrostes indigenata
Eudonia delunella
Eupithecia gemmata
Hedya atropunctana
Heliomata glarearia
Heliothis peltigera
Hemaris croatica
Homoeosoma sinuella
Horisme vitalbata
Hypsopygia costalis
Idaea camparia
Idaea degenaria
Idaea deversaria
Idaea ochrata
Idaea sericeata
Ligdia adustata
Lozotaenia forsterana
Malacosoma castrensis
Meganola togatulalis
Mirificarma eburnella
Nemapogon
Neocochylis millierana
Ochromolopsis ictella/zagulajevi
Odonestis pruni
Palpita vitrealis
Pempelia palumbella
Peribatodes rhomboidaria
Phaiogramma etruscaria
Phalonidia contractana
Phragmatobia fuliginosa
Phycita meliella
Phytometra viridaria
Propiromorpha rhodophana
Pyralis farinalis
Pyralis regalis
Pyrausta aurata
Pyrausta cingulata
Rhodostrophia calabra
Selenia lunularia
Spatalia argentina
Spodoptera exigua
Tortrix viridana
Udea ferrugalis
Xylocampa sp.
Zebeeba falsalis
Zekelita antiqualis

Neuroptera
Libelloides macaronius

Odonata
Cordulegaster bidentata

Orthoptera
Barbitistes yersini
Dolichopoda araneiformis
Gryllomorpha dalmatina
Gryllotalpa spp.
Troglophilus cavicola

Raphidioptera
Dichrostigma flavipes

Total:103