Welcome to Butterfly Conservation's 9th International Symposium

Welcome to Wyboston Lakes Conference Centre, Bedfordshire, UK and our 9th International Symposium entitled 'Conserving Lepidoptera in a Changing World'. We felt that this title reflected the perilous and changing state of our Lepidoptera faced with the twin threats of the biodiversity and climate crises.

This is a new venue for us and the first time we have held our Symposium in a specialist conference centre rather than a university. We would welcome feedback on the success or otherwise of this development.

This year's Symposium occurs after five years rather than the usual four, due to the global pandemic, but despite this the event continues to grow with an increase from 79 to 104 accepted talks. We are delighted that the global reach of the conference has been maintained with speakers from 23 countries, although unfortunately the global south and tropics remain underrepresented. We are extremely grateful to all of you for submitting such a fantastic set of presentations.

Our first Symposium was held at Keele University 30 years ago, before moths were a major part of Butterfly Conservation (UK)'s work, indeed there was only one talk (and two posters) on moths during that first Symposium. Five years ago, that had increased to 20 but we are delighted that the growth and interest in moth research and conservation continues to grow with 35 of the 109 talks being on moths or Lepidoptera in general.

Much of the work being presented at the Symposium is concerned with the status of and conservation action needed for rare and restricted species and our first keynote speaker, Nick Haddad from Michigan State University will draw on many lessons learned in the USA.

The interface between science and policy is often underrepresented at scientific conferences, but this vitally important work is addressed by Josef Settle from the Helmholtz Centre for Environmental Research (UFZ) in Leipzig. Josef is not just a leading Lepidoptera researcher but has also worked globally on many policy fora, of which the focus of his talk here, the 'Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)' is one such.

Our third keynote speaker, Toke Thomas Høye from Aarhus University in Denmark discusses the future of global butterfly and moth monitoring and the role of new technologies such as computer vision and deep learning. The rapid advances in this technology combined with the development of new statistical tools for the analysis of citizen science data is reflected in two conference sessions on this important area of research.

Since 2002, Butterfly Conservation (UK) symposia have had a strong climate change component which continues with two sessions. However, we are also focusing on another driver of change on Lepidoptera, with a special session on the impacts of artificial light at night and are very pleased to welcome our fourth keynote speaker, Eva Knop, from the University of Zürich, Switzerland to discuss her current research on this important topic. This research is vital in helping to guide the adaptive approaches we will need to take in the coming decades.

Finally, we are delighted to welcome Blanca Huertas of the Natural History Museum in London, whose keynote will draw attention to the current situation with Lepidoptera conservation and research in the tropics and the opportunities that new technologies offer.

Other sessions focus on the varied and fascinating research on the large blues (*Phengaris* spp.), habitat conservation and conservation in agricultural landscapes and will undoubtedly provide some crucial insights into how we can conserve Lepidoptera in our rapidly changing world.

Don’t forget to tell the world about the Symposium during the next few days, through social media with the hashtag #BCsymposium, but do respect the wishes of those speakers who mention during their presentations that their as yet unpublished results should not be shared.

We would like to take this opportunity to thank David Roy of the UK Centre for Ecology & Hydrology, who suggested and organised the ‘Applying New Technology’ session.

We would also like to thank the administrative co-ordinators who will continue to work over the coming days to ensure that this event runs smoothly, Denise Bell, Charlotte Davidson, Amélie Bouvet, Sandra Muldoon, Sasha Stagg and Russel Hobson. Last but not least, thanks to Darren Castle who is providing technical support and ensuring all presentations are collected and present in each theatre.

Yours with good wishes for a great Symposium and we hope to see you all again in 2027.

Nigel Bourn
Chief Scientist
Butterfly Conservation (UK)

Richard Fox
Head of Science
Butterfly Conservation (UK)

Rob Wilson
Museo Nacional de Ciencias Naturales, Madrid, Spain.

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Thursday 13th April

Symposium / Accommodation Registration and Dinner	
15:00 onwards	Registration for accommodation Woodlands Hotel reception area, Wyboston Conference Centre
16:00 – 19:00	Symposium registration Woodland Hotel by reception area
18:30 – 20:30	Dinner Olive Restaurant
17:00 – midnight	Bar open

Programme: Friday 14th April

7:00 – 9:00	**Breakfast** Olive Restaurant, Woodlands Event Centre	
8:00	**Symposium registration** Woodland Hotel by reception area	
Room	**Rosewood 1**	
8:50	Welcome Julie Williams, Chief Executive, Butterfly Conservation	
9:00	**Keynote lecture** The paths of decline and prospects for recovery of the rarest butterflies *Nick Haddad*	
Room	**Rosewood 1**	**Ebony**
Session	**Species Conservation 1** Chair: Caroline Bulman (Abstracts pages 16 - 17)	**Climate Change 1** Chair: Dirk Maes (Abstracts pages 18 - 20)
9:30	Landscape-scale dynamics of a threatened species respond to local scale conservation management *Rachel Jones*	How does the temporal manifestation of life history events and hostplants impact Lepidopteran phenology in the UK? *Emily Hickinbotham*
9:45	Conservation from theory to practice: the case of *Zerynthia polyxena* threatened by Turin-Lyon megaproject *Irene Piccini*	The conservation value of isolated rear-edge populations of a cold adapted butterfly, *Erebia aethiops*, in Britain *Rosa Ménendez*
10:00	'Gardening' in sand dunes: The last hope for the Tree Grayling in the Netherlands *Albert Vliegenthart*	Butterfly community responses to warming vary across four Mediterranean mountain ranges *Guim Ursul*
10:15	Reintroduction to prevent the extinction of wet ecotype of *Coenonympha oedippus* in Slovenia *Tatjana Čelik*	The influence of climatic extremes on mountain butterfly distributions *Robert Wilson*
10:30	Tools and best practices to inform species status assessments *Geena Hill*	Seasonal fluctuations and climate change effects on Noctuidae assemblage in Askot Wildlife Sanctuary, Uttarakhand: a high-altitude mountain ecosystem of Western Himalayas *Uttaran Bandyopadhyay*
10:45	**Coffee / Tea** Room: Cedar Lounge	

Room	Rosewood 1	Ebony
Session	**Climate Change 2** Chair: Rob Wilson (Abstracts pages 21 - 24)	**Engaging Diverse Communities** Chair: Megan Lowe (Abstracts pages 25 - 27)
11:15	Macro moths' assemblage from the Indian Trans Himalayan region, Lahaul valley: a way towards identifying the potential indicator species for monitoring climate change *Shabnam Kumari*	A trial of automated feedback via personalised data stories in a butterfly citizen science project *Simon Rolph*
11:30	Effects of recent climate change on butterfly beta and functional diversity in the central Iberian Peninsula *Hugo Alejandro Álvarez*	The Mothwall Project: Shedding Light on Moth Biodiversity *Joe Bowden*
11:45	Thinking about hydroregulation and water-balance stress in butterflies under rapidly changing environments *Hans van Dyck*	Engaging the younger generation *Ingeborg Vanes*
12:00	From Africa to the Alps: distribution drivers of the alien species *Cacyreus marshalli* in an alpine protected area *Federica Paradiso*	The potential of timed area counts for monitoring butterfly populations across Europe *David Roy*
12:15	History of an invasion: spatio-temporal dynamics and niche comparison of the butterfly *Cacyreus marshalli* among native and non-native range *Francesca Martelli*	Conserving lowland peatlands in central Scotland by volunteer action *Polly Philpott*
12:30	Climate change and coastal erosion drive changes in populations of Sandhill Rustic *Luperina nickerlii* in Britain and Ireland *Adrian Spalding*	BIMAG – Farmer Insect Monitoring Agricultural Areas *Jeroen van der Brugge*
12:45	Alpine butterflies are getting smaller and brighter: Adaptions to rapidly warming temperatures in the German Alps *Janika Kerner*	An Artist Talk. Moth Navigation, Imposters and Other Experiences *Finlay Taylor*
13:00	**Lunch** Room: Olive Restaurant, Woodlands Event Centre	

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Intergovernmental and other science-policy processes and their relevance for the conservation of insects

Josef Settle</td></tr>
<tr><td>Room</td><td>Rosewood 1</td><td>Ebony</td></tr>
<tr><td>Session</td><td>Phengaris (Maculinea) Research
Chair: Simona Bonelli
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Chair: Emily Dennis
(Abstracts pages 34 - 38)</td></tr>
<tr><td>14:30</td><td>Alcon Blues – habitat factors determining the persistence of an endangered butterfly in the Netherlands
Michiel Wallis De Vries</td><td>Estimating trends of butterflies and moths – statistical challenges and opportunities
Emily Dennis</td></tr>
<tr><td>14:45</td><td>The last of the Maculineans: the rapid decline of Phengaris alcon in Flanders (northern Belgium)
Dirk Maes</td><td>Accounting for varying spatial scales and phenology in the production of UK butterfly abundance estimates
James Clark</td></tr>
<tr><td>15:00</td><td>Crossing borders for the conservation of the Dusky Large Blue (Maculinea nausithous)
Irma Wynhoff</td><td>Using yearly butterfly monitoring data to analyse incidentally monitored areas
Gerdien Bos-Groendijk</td></tr>
<tr><td>15:15</td><td>Adaptation to its host ants by the protected myrmecophilous butterfly Maculinea teleius at a reintroduction site: Analysis of vibroacoustic signals
Luca Pietro Casacci</td><td>Calculating annual population numbers – a comparison between TRIM and rbms
Martin Poot</td></tr>
<tr><td>15:30</td><td>The microbiome of Maculinea butterflies
Francesca Barbero</td><td>A new model for fast analysis of large occupancy data sets
Byron Morgan</td></tr>
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Room: Cedar Lounge</td></tr>
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Room	Rosewood 1	Ebony
Session	***Phengaris* (*Maculinea*) Research (continued)** Chair: Irma Wynhoff	**Methodological Advances in Monitoring and Statistics (continued)** Chair: Emily Dennis
16:15	*Maculinea teleius* butterfly caterpillars of a reintroduced population adapt their cuticular hydrocarbon profile to that of *Myrmica* host ants *Magdalena Witek*	Adaptive citizen science: Spatially targeting recording effort by volunteers to improve biodiversity monitoring *Michael Pocock*
16:30	Population viability and genetic rescue considerations based on cuticular hydrocarbon profiles in *Phengaris alcon* *Gerard Oostermeijer*	The role of habitat indicators in studying butterfly communities *Andreu Ubach*
16:45	Changes in morphology and genetic structure in two populations of *Phengaris* (=*Maculinea*) *teleius* 30 years after separation *Daniel Sanchez-Garcia*	The effectiveness of Pollard walks for assessing local species composition *Bas Oteman*
17:00	Do genetic diversity, inbreeding and impaired gene flow affect the viability Dutch populations of *Phengaris alcon*? *Sheila Luijten*	Standardised moth monitoring in Europe *Chris van Swaay*
17:15		Monitoring spatiotemporal patterns in the genetic diversity of the Meadow Brown *Matt Greenwell*
18:00	**Poster Session 1** Room: Rosewood 3 (Abstracts pages 75 - 85)	
18:30 – 20:30	**Dinner** Room: Olive Restaurant	

Programme: Saturday 15th April

7:00 – 9:00	**Breakfast** Olive Restaurant, Woodlands Event Centre	
8:00	**Symposium registration** Woodland Hotel by reception area	
Room	**Rosewood 1**	
9:00	***Keynote lecture*** A computer vision for globally standardised butterfly and moth monitoring *Toke Thomas Høye*	
Room	**Rosewood 1**	**Ebony**
Session	**Applying New Technology** Chair: David Roy (Abstracts pages 40 - 42)	**Species Conservation 2** Chair: Dan Hoare (Abstracts pages 43 - 48)
9:30	Building an Autonomous Insect Monitoring System *Simon Teagle*	Towards a European Red List of larger moths *Jurriën van Deijk*
9:45	Machine learning tools for automated moth monitoring *David Rolnick*	Conserving Madeira's Threatened Endemic Butterflies *Martin Wiemers*
10:00	Field trials with automated moth monitoring in three different habitats of Denmark *Kim Bjerge*	*Euphydryas aurinia* in the UK: A review of status and conservation recovery *Caroline Bulman*
10:15	A non-invasive method to investigate movement patterns and dispersal barriers in butterflies - the marsh fritillary (*Euphydryas aurinia*) as an example *Emil Grøn Jensen*	Using photo-identification to estimate mobility, lifespan, and population size of the reintroduced Chequered Skipper *Carterocephalus palaemon* in England *Jamie Wildman*
10:30	Camera surveillance exposes moth pollination of red clover *Jamie Alison*	Delayed effect of host ant abundance on the populations of *Phengaris* butterflies *Piotr Nowicki*

Room	Rosewood 1	Ebony
Session	**Applying new technology (continued)** Chair: David Roy	**Species Conservation 2 (continued)** Chair: Dan Hoare
11.15	Analysis of automated monitoring data of insects: suggestions for seeing the forest for the trees *Marc Mazerolle*	Species recovery for three of Scotland's rarest micro-moths *Tom Prescott*
11.30	Future challenges for automated monitoring of moths *Tom August*	Multifaceted measures are needed in conservation of butterflies in Japan: Efforts to solve fundamental problems *Yasuhiro Nakamura*
Session	**Biodiversity and Protected area conservation** Chair: Martina Sasic (Abstracts pages 49 - 51)	**Species Conservation 2 (continued)** Chair: Dan Hoare
11:45	The effectiveness of Natura 2000 network in preventing habitat loss and population declines of endangered species in urban area *Joanna Kajzer-Bonk*	Two decades of monitoring and conservation of the Marsh fritillary (*Euphydryas aurinia*) in the Czech Republic *Vaclav John*
12:00	Mapping Important Lepidoptera Areas (ILA's) *Juan Gallego-Zamorano*	Impacts on *Aricia artaxerxes* from climate change policy in Scotland *Dave Hill*
12:15	Microreserves, a tool for the conservation of threatened butterflies in Catalonia *Guillem Mas Cornet*	Optimising the reintroduction of a specialist peatland butterfly *Coenonympha tullia* onto peatland restoration sites *Andrew Osbourne*
12:30	Inconsistent results from trait-based analyses of moth trends point to complex drivers of change *George Tordoff*	Has intensive forest management doubled the metapopulation size of one of the most endangered butterfly species in Europe? *Marcin Sielezniew*
12:45	Do butterfly distributions support the concept of the Western Palaearctic as a meaningful zoogeographical region for use in species conservation prioritisation? *Martin Davies*	Assessing the Reintroduction of Chequered Skippers into England through Genetic Approaches *Georgina Halford*
13:00	**Lunch** Room: Olive Restaurant, Woodlands Event Centre	

Room	Rosewood 1	
14:00	***Keynote lecture*** Pollinators and their interactions with plants in an increasingly illuminated world *Eva Knop*	
Room	**Rosewood 1**	**Ebony**
Session	**Light pollution impacts** Chair: Richard Fox (Abstracts pages 53 - 56)	**Habitat Conservation** Chair: Christine Haaland (Abstracts pages 57 - 62)
14:30	Street lighting has detrimental impacts on the mass, but not abundance, of nocturnally feeding butterfly caterpillars *Michael Pocock*	Butterfly and Moth Conservation: results from a global synopsis of evidence *Andrew Bladon*
14:45	Impact of streetlights on moth communities under low and high light pollution at night: a citizen science approach in Belgian gardens *Evert Van de Schoot*	The biodiversity of a conifer-dominated forest at different stages of transformation towards Irregular High Forest *Patrick Cook*
15:00	Visual impacts of artificial lighting on nocturnal moths: from perception to background selection *Emmanuelle Briolat*	Landscape composition explains butterfly use of clear-cuts in contrasting forest-farmland mosaics *Lars B Petterson*
15:15	Dim light pollution prevents diapause induction in urban and rural Latticed heath (*Chiasmia clathrata*) moths *Thomas Merckx*	Lepidopteran Response at a Large, High-Diversity Restoration Intended to Restore Connectivity and Expand Habitat *John Shuey*
15:30	Adaptation to nocturnal light in *Yponomeuta cagnagellus* *Roy Van Grunsven*	Butterflies in the city: Habitat suitability and connectivity for urban woodland butterflies *Bradley Neal*
15:45	**Coffee / Tea** Room: Cedar Lounge	
Room	**Rosewood 1**	**Ebony**
Session	**Light pollution impacts (continued)** Chair: Richard Fox	**Habitat Conservation (continued)** Chair: Christine Haaland
16:15	Contrasting effects of wavelength and light intensity on flight-to-light behaviour of moths *Ishbel Hayes*	Landscape-scale impacts of conservation management on Lepidoptera: testing agri-environment scheme gradients at two spatial scales *Jo Staley*

16:30	Artificial light as a driver and detector of moth declines *Avalon Owens*	How do ecological traits affect the responses of Lepidoptera to agri-environment scheme management? *Marc Botham*
Session	**Micro-climate studies** Chair: Thomas Merckx (Abstracts pages 63 - 64)	**Habitat Conservation (continued)** Chair: Christine Haaland
16:45	Seasonal change in oviposition micro-habitat preferences of the High Brown Fritillary butterfly (*Fabriciana adippe*). *Julie Simons*	Kleurkeur – From idea to a certification scheme in practice *Manon Wieringa*
17:00	Cool as a caterpillar: Differences in thermoregulatory ability between life stages of British butterflies *Esme Ashe-Jepson*	Adding shades of grey in a black and white landscape: resource-based habitat quality influences population dynamics in the bog fritillary *Nicholas Schtickzelle*
17:15	Feeling the heat: can microclimate and behaviour buffer butterflies against climate change? *Marcus Rhodes*	Nature-inclusive practices- The interdisciplinary approach to biodiversity restoration in different areas in the Netherlands *Nora Thierry*
17:30	Oviposition choice in Lepidoptera: microclimate matters, but why? *Simon Braem*	Lepidoptera reintroduction in England: to reintroduce or not to reintroduce? *Simon Curson*
18:00	**Poster Session 2 and Wine Reception** Room: Rosewood 3 Butterfly Conservation's European Butterflies Group (EBG) invites symposium attendees to join them for a glass of wine in Rosewood 3 and Cedar Lounge area (Abstracts pages 75 - 85)	
19:30	**Gala Dinner** Room: Rosewood 1	

Programme: Sunday 16th April

7:00 – 9:00	**Breakfast** Room: Olive Restaurant, Woodlands Event Centre	
8:00	**Symposium registration** Room: Woodland Hotel by reception area	
Room	**Rosewood 1**	
9:00	***Keynote lecture*** Back to basics: Challenges to Lepidoptera conservation in the tropics *Blanca Huertas*	
Room	**Rosewood 1**	**Rosewood 3**
Session	**How widespread are declines in Lepidoptera?** Chair: Rosa Menéndez (Abstracts pages 66 - 68)	**Lepidoptera conservation and Agriculture** Chair: Michiel Wallis De Vries (Abstracts pages 69 - 71)
9:30	Harnessing community science initiatives to assess trends in butterfly biodiversity *Maxim Larrivee*	Underestimated threats for butterflies *Simona Bonelli*
9:45	The State of the UK's Butterflies *Richard Fox*	The Barberry Carpet moth: Past, Present, and Future. *William Millard*
10:00	Rural abandonment and climate change threaten south European Mountain butterflies Amparo Mora *Cabello de Alba*	Understanding the effects of atmospheric nitrogen deposition on butterflies in the UK *Hannah Risser*
10:15	Changes in butterfly species composition in grasslands in a study area in Southern Sweden between 1997 and 2019 *Christine Haaland*	Butterfly responses to a broad range of foodplant nitrogen levels *Will Langdon*
10:30	A new Red List of European Butterflies *Martin Warren*	Marvellous moths! Pollen deposition rate of bramble is greater at night than day *Max Anderson*
10:45	**Coffee / Tea** Room: Cedar Lounge	

Room	Rosewood 1
Session	**Final Plenary Session** Chair: Julie Williams (Abstracts pages 72 - 74)
11:15	Direct and indirect climate stressors of montane butterflies *Chris Halsch*
11:30	From Coast to Coast: Comprehensive U.S. At-Risk Butterfly Conservation and Recovery Efforts *Jaret Daniels*
11:45	Breaking down barriers to inclusion in butterfly recording *Megan Lowe*
12:00	From volunteer counts to European wide protection of butterflies: eBMS - European Butterfly Monitoring Scheme *Christina Sevilleja*
12:15	The re-introduction of the Chequered Skipper to England and a briefing on today's field visit to the site *Nigel Bourn and Susannah O'Riordan*
12:30	Closing Address *Nigel Bourn and Julie Williams*
12:40	**Lunch** Room: Olive Restaurant, Woodlands Event Centre
13:30-18:00	**Field Trip**
13:30	Coach departing for field trip
14:30 - 16:30	Field trip to Fineshade Wood
16:30	Coach returns to Wyboston, via train station (arriving approx. 17:30)
18:00	Arriving at Wyboston Conference Centre

Abstracts: Friday 14th April 2023 (AM)

Keynote Lecture (Rosewood 1)

The paths of decline and prospects for recovery of the rarest butterflies

Professor Nick Haddad
Kellogg Biological Station, Department of Integrative Biology, Michigan State University, USA.

Butterflies are in decline. My lab has worked with data from the US state of Ohio, where transects are spread across the state and have been surveyed weekly during the growing season for over 20 years. We have found that butterfly abundances in Ohio have decreased by 2% per year. A third of butterfly species are declining in abundance, including species that are common and rare. Remarkably, the rate of decline in Ohio is matched by rates in other regional, decades long surveys of butterflies including in the UK, Netherlands, Spain, and Catalonia. Against this backdrop, a number of butterflies are threatened with extinction. The total population of each these species across their ranges numbers in the thousands, or even the hundreds. The species and subspecies live in a variety of habitats and regions, and have various life history traits. Drawing on my experience studying six of these rare butterflies in the US, including experiments to test population demographic responses to large restoration treatments, I will discuss some general principles that can guide recovery. First, an understanding of the subtle details of butterfly natural history, details that are often elusive, must underpin any restoration effort. Second, natural disturbance, or interventions to simulate natural disturbance, are critical. Introducing disturbance to maintain healthy ecological systems for rare butterflies introduces the uncomfortable reality that loss of some individual butterflies in degrading habitat during disturbance is needed to save a population. Third, resilient conservation must consider metapopulations, maintaining population sources to replenish populations in other areas after disturbance. Durable partnerships between scientists, landowners, conservationists, and agencies are required to see butterfly restoration through to recovery.

Species Conservation 1 (Rosewood 1)

Chair: Caroline Bulman
Butterfly Conservation (UK), Wareham, Dorset, UK.

Landscape-scale dynamics of a threatened species respond to local scale conservation management

Rachel Jones[1,2], Nigel AD Bourn [2], Ilya MD Maclean[1], Robert J Wilson[1,3]
1 Environment & Sustainability Institute, University of Exeter, Penryn Campus, Cornwall TR10 9FE, UK. 2 Butterfly Conservation (UK), Manor Yard, East Lulworth, Dorset, BH20 5QP. 3 Museo Nacional de Ciencias Naturales (MNCN-CSIC), Madrid 28006, Spain.

Landscape-scale approaches are increasingly advocated for species conservation but enlarging the size of patches or increasing their physical connectivity is often impractical. We test how these barriers can be overcome by management of habitat at the local (site-based) level, using the Lulworth Skipper (*Thymelicus acteon*) as an exemplar. Data from four surveys of the UK distribution of *T. acteon* over 40 years were used to test how local habitat influences population density and colonization / extinction dynamics, a metapopulation model was then applied to simulate effects of varying local habitat quality on regional persistence. Population density was closely linked to vegetation height and food plant frequency and simulating effects of coordinated changes to vegetation height and food plant frequency on metapopulation dynamics 40 years into the future would increase patch occupancy above the range observed in the past 40 years (50-80%). In contrast, deterioration of either component below threshold levels leads to metapopulation retraction to core sub-networks of patches, or eventual extirpation. Our results indicate that changes to habitat quality can overcome constraints imposed by habitat patch area and spatial location on relative rates of colonization and local extinction, demonstrating the sensitivity of regional dynamics to targeted in situ management.

Conservation from theory to practice: the case of *Zerynthia polyxena* threatened by Turin-Lyon megaproject

Irene Piccini and Simona Bonelli
Dept Life Sciences and Systems Biology, University of Turin, Italy.

Megaprojects radically change the landscape due to their large-scale investments. Forests and clearings, that support rich invertebrate communities, are often one of the most affected habitats. we present research developed to conserve *Zerynthia polyxena*, an ecotonal protected butterfly species (92/43/CEE), in Susa Valley (NW-Italy) where it was threatened by the expansion of an industrial site, part of the megaproject Turin–Lyon high-speed railway (TAV).

‘Gardening’ in sand dunes: The last hope for the Tree Grayling in the Netherlands

Albert Vliegenthart
Dutch Butterfly Conservation, Wageningen, The Netherlands.
Only one small population of the elusive Tree Grayling (*Hipparchia statilinus*) in The Netherlands is left since 2006. Consequently, studies on behaviour, habitat and ecology were carried out to support the establishment of this isolated population. State Forestry, experts, scientists and voluntary groups have collaborated to maintain the habitat (sand dunes) of the Tree Grayling. Despite all effort, the warm and dry summers of 2018 and 2020 have affected the population dramatically. A species protection plan has been finalised and includes a strategy for conservation measurements and policy on behalf of the Tree Grayling and its main habitat.

Reintroduction to prevent the extinction of wet ecotype of *Coenonympha oedippus* in Slovenia

Tatjana Čelik
ZRC SAZU, Jovan Hadži Institute of Biology, Ljubljana, Slovenia.

Coenonympha oedippus is an endangered European butterfly species listed in the Annexes II and IV of the Habitats Directive. The species has developed two ecotypes (wet and dry) in Slovenia, which differ morphologically, ecologically and genetically. The wet ecotype has experienced a significant decline in its range and abundance over the last 25 years due to habitat destruction and fragmentation caused by intensive agriculture and urbanisation. By 2018, only one population of about 500 individuals survived. As a result, we began developing a species recovery programme that includes ex-situ breeding, reintroduction and supplementation. Our strategic approach in designing and implementing conservation actions followed three documents: the IUCN Guidelines for Reintroductions, the IUCN Guidelines for Ex-situ management and the Improving standards for at-risk butterfly translocations. During the three years (2019–2022) of ex-situ breeding from egg to pupa, we released 398 individuals into the reintroduction area and returned 62 individuals to the source population. Monitoring in 2022 showed that source population had almost doubled in size since the first reinforcement (2020). After the release of 266 pupae (2020: 155, 2021: 111), the reintroduced population was estimated at 71±5 and 133±7 individuals in 2021 and 2022, respectively.

Tools and best practices to inform species status assessments

Geena Hill[1], Jaret C. Daniels[2] and Kristin Rossetti[3]
1 Florida Natural Areas Inventory; 2 University of Florida; 3 Florida Museum of Natural History, USA.

Many butterfly species are declining globally due to various drivers such as climate change, habitat fragmentation, and incompatible land management. Small, isolated populations are most at risk and may experience low genetic variation or decreased connectivity between populations, resulting in inbreeding and further population decline. Several tools may be utilized to assess genetic health of a species as well as to determine suitable habitat. We are working with the U.S. Fish and Wildlife Service to inform species status assessments by combining nondestructive genetic sampling, habitat modeling, land management best practices, and community scientist efforts for butterfly species such as the frosted elfin butterfly (*Callophrys irus*) and the eastern beard grass skipper (*Atrytone arogos*).

Climate Change 1 (Ebony)

Chair Dirk Maes
Research Institute for Nature and Forest (INBO), Brussels, Belgium.

How does the temporal manifestation of life history events and hostplants impact Lepidopteran phenology in the UK

Emily Hickinbotham, Zarah Pattison and Steven Rushton
Newcastle University, UK.

Changes in the global climate have altered the phenology of insects, which in turn has the potential to alter the specific timing crucial for synchrony with their food plants. Understanding the drivers of these changes is important for conservation of species at risk, and will enable us to potentially mitigate future changes. Lepidoptera have been shown to be responsive to climate change, and we have a good understanding of their taxonomy, food plants, and life history traits. In the UK, long-term records on Lepidoptera offer an opportunity to study climate change impacts on a larger scale. Here, we use three phenological variables, along with nine life history traits, taxonomy, food plant phenology and temperature to investigate the main drivers of phenological change in 335 moth species over 52 years. Over half of the species investigated had significantly altered phenology, and while there was no effect of taxonomic relatedness, the life stage a species overwinters as significantly impacted phenological response. Our results illustrate the importance of the previous year on the phenology of the following year, and that long-term data is needed to identify such trends.

The conservation value of isolated rear-edge populations of a cold adapted butterfly, *Erebia aethiops*, in Britain

Rosa Menéndez, Lucy R. Gunson and Michael R. Roberts
Lancaster Environment Centre, Lancaster University, UK.

Genetic diversity is key for species to adapt to environmental changes. Understanding which populations should be prioritised for conservation based on their genetic make-up is becoming increasingly important with a changing climate. Relict isolated populations at the current warmer edge of species ranges may have adaptations to warmer climates but these populations have been less valued for conservation compared to populations at the core of the species range. Here we investigated genetic diversity and differentiation of Scotch argus (*Erebia aethiops*), a cold-adapted butterfly, comparing isolated rear-edge and core populations in Britain, a relict part of the species range.

Butterfly community responses to warming vary across four Mediterranean mountain ranges

Guim Ursul[1], Sara Castro-Cobo[2], Mario Mingarro[1], Juan Pablo Cancela[3], Helena Romo[2] and Robert J. Wilson[1]
1 Museo Nacional de Ciencias Naturales, Madrid, Spain. 2 Universidad Autónoma de Madrid. 3 The Centre for Ecology, Evolution and Environmental Changes (cE3c) Science Faculty, University of Lisbon, Portugal.

Ecological communities change in response to climate change as species shift their geographic distributions, but many communities have not changed as quickly as expected based purely on rates of warming. Time lags could result from delays in extirpations at species' rear range edges ("extinction debt") or in colonizations at leading edges ("colonization credit"), which have contrasting consequences in terms of species richness. We tested changes to butterfly community composition (quantified using CTI, Community Temperature Index) and richness over four replicate mountain climatic gradients in central Spain, differing in climatic conditions and rates of climate change, using field data from 1985-2005 and 2017-2022. Communities changed consistent with an effect of warming, but rates of change and the roles of extinction debt versus colonization credit varied among regions. Results suggest that species which have colonised locations over time were more associated with hotter conditions, in contrast, species which have become locally extinct over time were more associated with colder conditions. Anticipating and managing community responses to warming therefore require understanding of regional climatic gradients and how these influence component species responses.

The influence of climatic extremes on mountain butterfly distributions

Robert Wilson[1], Ursul G.[1], Mingarro M.[1], Gómez-Vadillo M.[1] and Castro-Cobo S.[2]
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Mountains are centres of Lepidoptera diversity and endemism, and represent potential conservation refugia from climate change and other anthropogenic threats. In this context, it is important to test whether an increasing frequency and severity of extreme events associated with climate change could threaten mountain Lepidoptera populations. We modelled changing temperature extremes since the 1980s for two mountain regions of central Spain (the Sistema Central and Sistema Ibérico), showing that exposure depended on the time of year, the habitat type, and the spatial scale of analysis. We show evidence of interannual changes in the phenology, abundance and distribution of butterflies linked to these changing climatic conditions, and of contractions at the lower and upper limits of species' elevation ranges associated with hot and cold extremes respectively. This population turnover at the limits of species ranges results in greater interannual variability in butterfly communities at the lowest and highest elevations. In contrast, intermediate elevations that are sheltered from hot or cold extremes support more stable butterfly populations and communities. The protection of these core mid-elevation populations therefore represents a priority for conservation in a changing climate.

Seasonal fluctuations and climate change effects on Noctuidae assemblage in Askot Wildlife Sanctuary, Uttarakhand: a high-altitude mountain ecosystem of Western Himalayas

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In Indian Himalayas, fluctuations in average monthly temperature and seasonality patterns play key roles in determining moth assemblage patterns, especially for Noctuids, as bulk of the high-altitude moth diversity is represented by them. They are mostly polyphagous and notorious pests to forests and agriculture. Therefore, studies on their seasonal assemblage pattern are important for designing effective habitat and pest management strategies. The present study focuses on the seasonal assemblage pattern of Noctuidae and its relation to different environmental factors at Askot Wildlife Sanctuary in Western Himalaya. Moth abundance was recorded in Pre and Post-monsoon seasons during 2016–2019 by installing light traps along two altitudinal gradients. Site-wise seasonal assemblage patterns were compared using ANOSIM-SIMPER. Effects of environmental variables like Average Monthly Precipitation (AMP), NDVI and Bioclimatic variables (Bio1–12) upon species assemblage were estimated using Canonical Correspondence Analysis (CCA). The Noctuidae assemblage was significantly governed by AMP. For variability in seasonal abundance, the CCA axes were positively influenced by Bio12 (r=0.76), NDVI (r=0.65), Bio1 (r=0.46) and AMP (r=0.26). However, it was most negatively influenced by Altitude (r=-0.43) and Bio4 (r=-0.44). Area occupancy of a few selected species was also calculated in current and future climatic scenarios to assess climate change effects.

Climate Change 2 (Rosewood)

Chair: Rob Wilson
Museo Nacional de Ciencias Naturales, Madrid, Spain.

Macro moths' assemblage from the Indian Trans Himalayan region, Lahaul valley: a way towards identifying the potential indicator species for monitoring climate change

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The trans-Himalayan region lying at the crossroads of the Palaearctic and Oriental realms holds a very unique yet sensitive assemblage of life. The current study has been undertaken in the Lahaul valley which constitutes the trans-Himalayan region of Himachal Pradesh. The relictual forest habitats in this region which are already threatened by climate change are now under immense anthropogenic pressure. The macro moths' assemblage which is well established as an indicator for monitoring ecological and environmental changes at the local as well as landscape levels- has been studied (for the first time) across six major vegetation types along the elevational gradient of 2500–4500 m range following Stratified random sampling study design. The total assemblage of macro moths is consisting of 181 morphospecies among 8 families, dominated by Geometridae (62%) and Noctuidae (27%) which are also having the highest mean altitudinal distribution at around 3300 m in the landscape. Among the six vegetation types, the highest species richness and diversity (Fisher's alpha) has been reported from the deodar dominant vegetation followed by mix and juniper dominant vegetation types. Species with specific altitudinal and vegetational preferences can be used for future monitoring of climate and anthropogenic-driven changes in the landscape.

Effects of recent climate change on butterfly beta and functional diversity in the central Iberian Peninsula

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Mediterranean mountain ranges represent centres of butterfly diversity and endemism in southern Europe. However, rapid warming of high elevations threatens the rare climates on which these unique butterfly communities depend. A loss of habitat-specialist mountain species, and expansion of thermophilous lowland generalists, could reduce beta diversity, leading to biotic homogenisation. We assess recent historical (1985-2005) and current (2017-2022) butterfly diversity in four mountain ranges in central Spain, encompassing elevations of 400-2200 m in the Sistema Central and 1000-2000 m in the Sistema Ibérico. We test 1) how beta and functional diversity are influenced by elevation and by differences among the four mountain ranges; 2) how these patterns have changed over time; and 3) patterns of change in community nestedness, turnover, species loss and functionality. Beta diversity was closely linked to elevation and showed evidence of an uphill shift over time in the Sistema Central. Regional differences were maintained over time, partly because the more species-rich communities of the Sistema Ibérico included species restricted to calcareous geology. The results suggest that ongoing monitoring and protection of communities across a variety of mountain systems is needed to conserve a representative range of Mediterranean butterfly diversity in the face of environmental change.

Thinking about hydroregulation and water-balance stress in butterflies under rapidly changing environments

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The resource-based habitat approach has been a useful concept to recognize, understand, manage and restore functional habitat of butterflies (and other mobile organisms) that have complex relationships with their environment throughout the life cycle. Different larval and adult consumables (e.g. host plants and nectar plants) and utilities (e.g. microclimate) are key ecological resources to define functional habitat of a butterfly at an appropriate spatiotemporal scale within and across different vegetation types. Compared to temperature, the role of humidity has received much less attention and may be underestimated. Water availability is variable and variation in humidity levels is likely to increase further in several regions under climate change. I will summarize relevant knowledge and knowledge gaps on hydroregulation in butterflies based on laboratory and field studies with the Speckled wood (*Pararge aegeria*) and other species. I will present results on humidity measures in the field, lab experiments with drought-stressed host plants and larval reciprocal transplant experiments from humid woodland to dry agricultural environment, and vice versa. I will explore the causes and consequences of water stress throughout the life cycle and will assess its significance for butterfly habitat, survival and behaviour under conditions of human-induced rapid environmental change.

From Africa to the Alps: distribution drivers of the alien species *Cacyreus marshalli* in an alpine protected area

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Cacyreus marshalli is the only alien butterfly in Europe, introduced from southern Africa via the trade of the ornamental Pelargonium plants (*Geraniaceae*) of which it is obligate endophyte. It has recently spread in the Gran Paradiso National Park (GPNP, NW Italian Alps), where it could potentially compete with native geranium-consuming lycaenids. Due to the potential threat of naturalization on indigenous Geranium spp. (sister group of Pelargonium spp.), the Park activated a project in 2017 to assess butterfly and host plant distribution. Using different sampling designs (opportunistic and standardised) and different statistical approaches (GLMM, MaxEnt and N-mixture models) we built up models and to predict future scenarios to understand the impact of climate warming and the effect of possible mitigation strategies. Both approaches showed that *C. marshalli* is associated with its host plant distribution and therefore confined in urban areas. Its expansion is controlled by cold temperatures which, even if the host plant is abundant, constrain the number of eggs. Rising temperatures could lead to an increase in the number of eggs laid, but the halving of Pelargonium spp. populations would mostly mitigate the trend, with a slight countertrend at high elevations.

History of an invasion: spatio-temporal dynamics and niche comparison of the butterfly *Cacyreus marshalli* among native and non-native range

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Alien species introduction is a global phenomenon involving different invasion patterns and is characterized by niche conservatism or shift. We describe the spatial distribution of *Cacyreus marshalli* Butler, [1898] (Lepidoptera: *Lycaenidae*) in its native (southern Africa) and invaded (Europe) ranges. In Europe, *C. marshalli* is widespread in the Mediterranean basin, but absent in northern countries. We first investigated its invasion patterns and their spatio-temporal dynamics in Italy, the most extensively invaded country, identifying three phases and different rates of spread resulting from multiple introductions and human-mediated movements. We then characterized and compared the native and invasive ecological niches of *C. marshalli* with a multivariate approach based on bioclimatic, ecological and human demographic variables. The little overlap between the native and invaded niches (12.6%) indicates a shift in the realized niche of *C. marshalli.* While the expansion potential of *C. marshalli* in Europe remains constrained by the distribution of suitable host plants (Pelargonium spp.), our niche comparison analysis suggests the species has already invaded new ecological and climatic spaces. This includes colder areas than would be suggested by its native distribution in Africa. Our results provide tools to discuss the potential for range expansion of this species and management actions.

Climate change and coastal erosion drive changes in populations of Sandhill Rustic *Luperina nickerlii* in Britain and Ireland

Adrian Spalding
University of Exeter, Exeter, UK.

Populations of *Luperina nickerllii* are coastal in Britain and Ireland where they are represented by four subspecies: *demuthi*, *gueneei*, *knilli* and *leechi*. All four subspecies are potentially threatened by coastal processes and management – storm surges for *gueneei* and *leechi*, sea level rise for *demuthi* and coastal engineering on soft cliffs for *knilli*. British subspecies show adaptations to their coastal environment, including responses to rising sea levels and coastal squeeze; *leechi* populations have shown recent dramatic recovery from storm-effected decline. Conservation strategies are outlined for these subspecies. By contrast, European populations of different subspecies are found well above sea levels, up to 2000m.

Alpine butterflies are getting smaller and brighter: Adaptions to rapidly warming temperatures in the German Alps

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Climate warming forces many species to shift their distributional ranges poleward or uphill in order to track their climatic niches, potentially favoring species with certain life history traits. However, few studies have addressed community-level responses of insects to climate change across elevational gradients. Here, in 2019, we repeated a butterfly monitoring from 2009 on 33 grassland sites along five transects in the National Park Berchtesgaden (Germany). We sampled adult butterflies from May until September and recorded the diversity and abundance of potential host plants. Further, we collected several life history traits of each observed butterfly species from literature. We quantified changes in the elevational distributions of butterflies over time, both at the species and community level and could link those rather to regional global warming than shifts in host plant communities, although we did not find consistent patterns for all species. Further, community changes over time seemed to go hand in hand with changes of certain life history traits, as body size, color lightness and dispersal ability showed clear trends over time. Those were especially pronounced in *Nymphalidae,* while other families responded less distinctly.

Engaging diverse communities (Ebony)

Chair: Megan Lowe
Butterfly Conservation (UK), Wareham, Dorset, UK.

A trial of automated feedback via personalised data stories in a butterfly citizen science project.

Simon Rolph[1], Tom August[1], Cagatay Turkay[2], Rachel Pateman[3], Katty Baird[1], Zoë Randle[4] and Michael Pocock[1]
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2 University of Warwick, 3 Stockholm Environment Institute, 4 Butterfly Conservation (UK).

Citizen science relies on participant engagement for success. Providing feedback improves engagement but is challenging to provide on an individual basis. Data science methods can provide feedback to participants by programmatically generating data-driven personalised visual and textual content known as 'data stories'.
We co-designed and tested data stories about user participation in a project aimed to prompt biological recorders to visit areas where their species records would best improve a model's understanding of species distributions.
We co-designed 5 data stories, each with a personised and non-personalised variant. Participants received weekly emails containing a data story generated from their recent recording activity.
Responses from users showed that personalised variants of data stories were preferred. Users followed links in emails which increased interaction with the project's web application. Evaluative feedback found that data stories show promise as a viable approach to increase engagement and enhance the experience of citizen scientists.

The Mothwall Project: Shedding Light on Moth Biodiversity

Joe Bowden
Natural Resources Canada, Canadian Forest Service.

In this age of rapid climate change and declining biodiversity, how can we begin to document the diversity and distribution of moth species in protected areas across an expansive country like Canada? Building on an idea from a colleague in Denmark some years ago, I decided that the establishment of a series of moth-walls could serve two-fold: 1) to help us document species diversity and distribution across the country and 2) to help us engage the public about the importance of this group of insects by partnering with our National Parks Canada network. After a pilot year in Newfoundland, we established the "Mothwall Project" during summer 2022, which includes establishments at seven National Parks covering Atlantic Canada (four provinces) and represents 4029 km2 of protected area. This project has already yielded two new provincial records, one in Newfoundland and one in Prince Edward Island. Working with Parks interpretive teams provides meaningful engagement with visitors/campers about this under-appreciated insect group.

Engaging the younger generation

Ingeborg Vanes
Dutch Butterfly Conservation, P.O. Box 506, 6700 AM Wageningen, the Netherlands.

Data collected by green volunteers is vitally important to implement conservation strategies. In 2021, Several thousand volunteers have continuously collected data for De Vlinderstichting (Dutch Butterfly Conservation). The largest portion of these green volunteers are 45 years or older. To also engage a younger generation, several methods and tools are being used.Some of these tools have existed for decades. An example for the youngest generation is the cultivation of the large white (*Pieris Brassicae*) in order to use them for education on elementary schools. In the last year, around 3600 parcels with eggs, caterpillars and pupae were sold. Around half of the children in the Netherlands have been able to witness metamorphosis of a butterfly inside their own class at least once during their education. Other tools are relatively new. An example of this last category is a course, organised by a cooperation of 10 green non-profit organisations in the Netherlands. This course is developed for age 16 to 27 and enlarges their knowledge of species. It also familiarises them with green organisations and the vision these organisations have. The tools used for engagement of the younger generation by De Vlinderstichting are wide ranging and continue to expand.

The potential of timed area counts for monitoring butterfly populations across Europe

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Effective biodiversity monitoring is crucial for tackling the biodiversity crisis – more representative trend assessments, identifying major causes of change and to evaluate conservation approaches. All monitoring methods have trade-offs between scientific value versus potential for long-term and large spatial scales applications. Opportunistic recording has a simple approach that reduces barriers to participation, engages large numbers of participants and is primarily used to measure range changes. Standardized Butterfly Monitoring Schemes require more effort but generate rich abundance datasets for biodiversity indicators and many research applications. Despite rapid growth and high value of these two main approaches, assessment of butterflies in Europe has considerable spatial, temporal and taxonomic biases. Through European Butterfly Monitoring Schemes, with support from EU-funded projects (ABLE, SPRING), we have developed a Smartphone application (ButterflyCount) to enable more widespread capture of standardized butterfly abundance data. We review the uptake of the application, focusing on case studies that use 15-minute timed area counts to improve coverage in under-represented habitats (e.g. urban and farmed environments, remote areas) and for under-represented species (e.g. rare and habitat-specialist species). We assess how combination of monitoring approaches can further improve assessment of butterfly populations across the EU, in support of research and conservation.

Conserving lowland peatlands in central Scotland by volunteer action

Polly Philpott and David Hill
Butterfly Conservation (UK).

Coenonympha tullia (Large Heath), a peatland specialist, was once widespread on Britain's lowland raised bogs. However, centuries of drainage for agricultural and forestry has resulted in a much reduced lowland distribution with remaining colonies typically isolated and at risk from further habitat degradation. In Scotland, the butterfly is now known from less than 20% of remaining lowland bogs. In 2014 Butterfly Conservation formed a new project with the aim of improving the fortunes of Scottish lowland bogs through volunteer action. Dubbed the 'Bog Squad' and supported by a project officer, local volunteers have worked to remove invasive scrub, including non-native *Picea sitchensis* and *Rhododendron ponticum*, as well as installing ditch-blocking dams.

BIMAG – Farmer Insect Monitoring Agricultural Areas

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Hallman et al. (2017) described a 76% decline in flying insect biomass between 1990 and 2017. Kleijn et al. (2018) noticed that few data were available in the Netherlands on the abundance of insects in agricultural areas. For this reason the Netherlands Agricultural and Horticultural Association, BoerenNatuur (Dutch national organization representing all farmer collectives) and Dutch Butterfly Conservation started in 2019 a monitoring program of moths and butterflies in agricultural areas: Farmer Insect Monitoring Agricultural Areas (BIMAG). The choice for butterflies and moths was based on the existence of monitoring networks for butterflies (since 1990) and moths (since 2013). Also recent developments with automatic species identification and LedTraps made moth monitoring applicable for farmers. In total 115 farmers participated in the BIMAG-project between 2019-2022. They monitored macro-moths and butterflies on their farms to start long-term data series and to determine the effect of nature enhancing measures by comparing their barnyard, an intensive managed parcel of land and a plot in a nature enhancing measure. Up to date, they collected sightings of 39.653 individuals belonging to 480 macro-moth species and 13.302 individuals belonging to 32 butterfly species. Comparing the different locations we also found the effect of the management actions taken.

An Artist Talk. Moth Navigation, Imposters and Other Experiences

Finlay Taylor
Royal College of Art, London.

I propose sharing experimental contemporary art practice that draws from knowledge of specific species and habitats of Lepidoptera. Sharing recent drawings, artist books and prints, highlighting the importance of the arts in making accessible knowledge and stimulating questions about the natural world. As well as giving another voice to the plight of the natural world. The importance of looking and observing is a shared practice of naturalists and artists, here the shifts in approach that contemporary art brings will be emphasised.

Abstracts: Friday 14th April 2023 (PM)

Keynote Lecture (Rosewood 1)

Intergovernmental and other science-policy processes and their relevance for the conservation of insects

Josef Settle
Dept. of Conservation Biology & Social-Ecological Systems Helmholtz Centre for Environmental Research (UFZ), Leipzig, Germany.

After a brief introduction to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), this talk presents the Platforms main aspects related to insects specifically, but also to the wider biodiversity and ecosystem services with a focus on the role of and impacts on insects. This is first based on the key results of the pollination assessment which was completed in 2016, where the focus is on trends of pollinators, the reasons for mostly negative trends and in particular the options to counteract those trends. The second part of the presentation will then focus on the Global Assessment of IPBES and some elements of recent IPCC reports.

Phengaris (*Maculinea*) research (Rosewood 1)

Chair: Simona Bonelli

Department of Life Sciences and Systems Biology, University of Turin, Italy.

Alcon Blues – habitat factors determining the persistence of an endangered butterfly in the Netherlands

Michiel Wallis De Vries[1], Bokelaar, J.[1], Limpens, J.[2], Luijten, S.H.[3], Oostermeijer, J.G.B.[3], Van Stipdonk, A.[1] and Wynhoff, I.[1]

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In the Netherlands, the Alcon blue (*Phengaris alcon*) is an endangered and characteristic species of wet heathlands and fen meadows. Its populations have declined by more than 80% over the last 30 years. The declines appear to be driven by a combination of habitat loss and deteriorating habitat quality under the impact of nitrogen deposition, climatic extremes and inadequate management. During 2020-2022 we have investigated 65 sites covering all extant populations as well as recently extinct populations and some restoration areas. Here, we determined habitat suitability at both landscape and local scales. Suitability at landscape scale was quantified as a function of habitat area, soil moisture and topographical heterogeneity. At local scale, habitat suitability was assessed by hostplant abundance and quality, host ant abundance, vegetation structure, botanical composition and soil chemistry. Habitat information at both scales was used to explain population persistence. On the basis of these results, we propose a decision system that can be used to assess not only overall habitat suitability, but also the potential of restoration areas for reintroduction.

The last of the Maculineans: the rapid decline of *Phengaris alcon* in Flanders (northern Belgium)

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Highly anthropogenic regions are affected by rapid biodiversity changes including significant insect diversity losses. In Flanders (northern Belgium), Europe's worst case scenario regarding biodiversity loss, butterflies of oligotrophic biotopes are among the most rapidly declining species. Wet heathlands, for example, suffer from extreme climate events (e.g. desiccation due to droughts, but also flooding during flight periods), eutrophication due to nitrogen deposition and extreme habitat fragmentation. The myrmecophilous Alcon Blue *Phengaris alcon* is a typical species of wet heathlands in Flanders and is a regional species of conservation concern. Previous genetic research revealed that the seven remaining populations (out of the ca. 30 documented populations) are now strongly isolated with exchange of individuals of maximally 3 km between populations. Long-term monitoring of the Alcon Blue populations in Flanders show an alarming decline of tens of thousands of eggs to only a couple of dozens during the last few years. The extremely dry recent years were not only detrimental for the single host plant *Gentiana pneumonanthe*, but also may have caused a shift or even the local extinction of suitable host ants. Despite intensive species-specific management measures, Flanders risks to lose one of its wet heathlands flagship species.

Crossing borders for the conservation of the Dusky Large Blue (*Maculinea nausithous*)

Irma Wynhoff[1], E Remke[2], M Scherpenisse[3], CG Sevilleja[1], A Terstegge[4], P Verbeek[3] and J Boeren[5]
Dutch Butterfly Conservation1, Wageningen, the Netherlands. 2 Onderzoekcentrum B-ware BV, Nijmegen, the Netherlands. 3 Natuurbalans-Limes Divergens BV, Nijmegen, Netherlands. 4 Biological Station Haus Wildenrath e.V. Wegberg, Germany. 5 Province of Limburg, Cluster Nature and Water, the Netherlands.

Until the 1960s, the Dusky Large Blue (Maculinea nausithous) was a common species in the German-Dutch Rur Valley. The butterfly is dependent on both the host plant Great Burnet (Sanguisorba officinalis) and the red ant (Myrmica rubra). In the ants' nest, the caterpillars feed on the ants' brood. Around 1970, the species disappeared from the Netherlands, but in the German Rurauen, a few small populations survived, colonising a road verge in NL in 2001. The great burnet is found in the Rur valley in several different vegetation types, of which the species-rich Arrhenaterion grassland is most important. This type is now limited to road verges and stream banks. The red ant is restricted to forest edges. The butterfly is an important target species for nature conservation in Europe, listed in the Habitat Directive. To ensure long-term conservation of the species, a large, transboundary meta-population is needed, connecting German and Dutch habitats. A Dutch-German INTERREG project has improved cross-border cooperation between water boards, districts, municipalities, provinces, farmers and nature conservation organisations. First the impact of agriculture to the soil was determined, then a plan is drawn up to develop a network of habitat patches and corridors in both countries.

Adaptation to its host ants by the protected myrmecophilous butterfly Ma*culinea teleius* at a reintroduction site: Analysis of vibroacoustic signals

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Maculinea teleius is among the world's rarest butterflies. This species spends most of its immature life inside *Myrmica* ant nests, feeding on ant brood. To live as an undetected social parasite in the nest, it subverts the ants' chemical and vibroacoustic communication. In 1990, *M. teleius* was reintroduced to the Netherlands after going extinct in 1976. Eighty-six individuals were moved from a Polish population to the Moerputten nature reserve.
We recorded the vibroacoustic signals emitted by *M. teleius* pre-adoption caterpillars and different castes of the host ant *Myrmica scabrinodis* from the Polish source and the Dutch reintroduction sites. The host ant signals of the two populations only resemble each other for peak frequency values. In the source system, the parasite signals match those of the host queens, and interestingly, the signals of the Dutch caterpillars have diverged from those of the source population for some frequency and intensity components. Even if differences in the vibroacoustic pattern between the parasite and the host queens at the reintroduction site are still present, the results of playback experiments indicate that after 30 generations the signals of the reintroduced *M. teleius* larvae can enhance benevolent behaviours in the Dutch host workers.

The microbiome of *Maculinea* butterflies

Francesca Barbero[1], Stefanini Irene[1], Witek Magdalena[2], Sánchez-García Daniel[2], Doan Karolina[2], Hais Arthur[1] and Casacci Luca Pietro[1]
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Microbial communities are crucial to the functioning and health of large organisms. Nevertheless, the knowledge about microbial diversity and variation across butterflies' life stages is scant. We investigated the microbiota of rare and threatened species, such as *Maculinea* butterflies, to gain a deeper understanding of these symbioses and pave a new, promising pathway for their long-term conservation. *Maculinea* larvae experience massive environmental and dietary changes, quickly shifting from phytophagous to carnivorous behaviour when they parasitise *Myrmica* ant colonies. This unique life style provides an exceptional model for studying the microbial community, its variations during butterfly development and its potential source (plants, soil, ants).
We characterised and compared the microbiomes of pre-adoption and fully grown *Maculinea* larvae, foodplants, and *Myrmica* hosts using a 16S rRNA-targeted NGS approach. Despite the bacterial communities of pre-adoption and fully grown *Maculinea* larvae showing peculiar characteristics, the latter shared relevant features with the microbiomes of *Myrmica* hosts (both adults and brood). Overall, the information gathered in this study suggests that some bacteria might be involved in fostering the ant-butterfly interaction.
Describing microbial assemblages is the first pivotal step, but surveys aiming at dissecting the function of diverse microorganisms will revolutionise our understanding of complex symbioses.

Maculinea teleius butterfly caterpillars of a reintroduced population adapt their cuticular hydrocarbon profile to that of *Myrmica* host ants

Magdalena Witek[1], Daniel Sánchez Garcia[1], Luca Pietro Casacci[2], Irma Wynhoff[3], Joanna Kajzer-Bonk[4] and Patrizia d'Ettorre[5]

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In 1990, the myrmecophilous butterfly *Maculinea* (=*Phengaris*) *teleius* was successfully reintroduced in the Netherlands. Eighty-six individuals originating from a Polish population were translocated to the Moerputten reserve. A difference of almost 30 butterfly generations between the original Polish and the reintroduced Dutch population offers a unique opportunity to study local adaptations of *M. teleius* butterflies to their host ants. We investigated changes in the profile of cuticular hydrocarbons (CHCs), as chemical mimicry is known to facilitate *Maculinea* butterflies' integration into *Myrmica* host ant colonies. We collected data in both the reintroduced and the source population and analyzed CHC profiles of pre- and post-adopted butterfly caterpillars as well as *Myrmica* ants present in the studied populations. We found that the CHC profile of butterfly caterpillars differs between the source and the reintroduced population. In both populations, the CHC profile of *M. teleius* caterpillars is the most similar to CHC profile of *Myrmica scabrinodis*, which is the most abundant *Myrmica* host species. *M. teleius* from the reintroduced population appears to be more chemically similar to its local *M. scabrinodis* host. These results suggest an ongoing co-evolution process between *M. teleius* and its *Myrmica* host ants.

Population viability and genetic rescue considerations based on cuticular hydrocarbon profiles in *Phengaris alcon*

Gerard Oostermeijer[1, 2,] Luijten, S.H.[1], Seip, L.A.[1], Hancock, D.[1, 2], Groot, A.T.[2], WallisDeVries M.F.[3] and Wynhoff, I.[3].

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Despite a recovery plan between 2002 and 2007, *Phengaris alcon* still declines rapidly in The Netherlands. Most attention focused on habitat quality and host plant populations, whereas genetic diversity and changes in the ant community have not been investigated. Hypothetically, small population sizes and isolation have led to genetic erosion and inbreeding, which would make genetic rescue a potential management option. Variation in caterpillar and host ant cuticular hydrocarbon profiles among populations and regions may however increase the risk of outbreeding depression if individuals with deviant profiles are introduced. We sampled *Myrmica* workers and *P. alcon* caterpillars from a range of populations and regions and compared their CHC profiles. We found that caterpillar CHC profiles were highly similar to *M. ruginodis*, and less to *M. rubra*, whereas *M. scabrinodis* had a very different profile. There was small but significant variation in CHC profiles among populations and regions, so that genetic rescue plans (of *Phengaris* spp. in general) need to take this into account. In addition, our results suggest that the observed decline of *M. ruginodis* and increase of *M. scabrinodis* at many sites is possibly a key explanation for the ongoing decline of the butterfly.

Changes in morphology and genetic structure in two populations of *Phengaris* (=*Maculinea*) *teleius* 30 years after separation

Daniel Sánchez-García[1], Casacci, L.P.[2], Wynhoff, I.[3], Kajzer-Bonk, J.[4], Sztencel-Jabłonka, A.[1], Nowicki, P.[5] and Witek, M.[1]
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The butterfly *Phengaris* (=*Maculinea*) *teleius* is a social parasite of *Myrmica* ants. The species became extinct in the Netherlands, but a successful reintroduction was performed by translocating eighty-six butterflies from the source population in Poland to Moerputten nature reserve in 1990. The aim of our research was to study putative changes in the morphology of the butterflies coming from the reintroduced and source population, wing morphometrics (also including the specimens from the source population from 1990) and genetic structure for over almost 30 years of separation. Our results show that current Polish butterflies are significantly larger than Dutch ones. They also have a bigger wing size than those from the Netherlands and the source Polish population from 1990. Also, all three populations present differences in wing shape and morphological disparity. Moreover, both source and reintroduced populations of *P. teleius* show different levels of genetic variation, with lower variation and a distinct genetic structure in the reintroduced population. These changes in body characteristics may be explained by changes in habitat, which could have affected dispersal capabilities, thermoregulation performance, species fitness or conditions of caterpillar development.

Do genetic diversity, inbreeding and impaired gene flow affect the viability Dutch populations of *Phengaris alcon*?

Sheila Luijten[1], Oostermeijer, J.G.B.[1], Seip, L.A.[1], WallisDeVries M.F.[2] and Wynhoff, I.[2]
(1) Stichting Science4Nature, Amsterdam, the Netherlands. (2) Dutch Butterfly Conservation, Wageningen, the Netherlands.

Despite a recovery plan that was conducted between 2002 and 2007, the Alcon blue (*Phengaris alcon*) still declines rapidly in The Netherlands. Most attention has focused on habitat quality and host plant populations, whereas genetic diversity and changes in the ant community were not yet investigated. We hypothesize that small population sizes and isolation have led to genetic erosion and inbreeding, which would make genetic rescue a possible management option. Using 10 microsatellite markers, we studied genetic diversity of 12 remaining populations in different regions. We found that with a few exceptions, genetic diversity was generally still quite high. The least diverse populations went extinct, and the other went through a bottleneck. All populations were strongly genetically differentiated, suggesting low gene flow, though less differentiation was observed between subpopulations within larger nature reserves. Despite isolation and often small population sizes, inbreeding coefficients were generally not significant, suggesting that *P. alcon* may somehow avoid inbreeding. For each population also information on sex ratios and butterfly size was gathered. We will discuss the options of genetic rescue given the potential problems with translocation of *Phengaris* species arising from geographical variation in caterpillar and host ant CHC profiles (see other presentation).

Methodological advances in monitoring and statistics (Ebony)

Chair: Emily Dennis
Butterfly Conservation (UK)

Estimating trends of butterflies and moths – statistical challenges and opportunities

Emily Dennis
Butterfly Conservation (UK), Wareham, Dorset, UK.

Robust measures of change are vital for providing reliable evidence of global insect decline. In the UK, extensive, long-running data sets on species' abundance and distribution are available for both butterflies and macro-moths. But the path from raw data to functional outputs, such as individual species' trends and multi-species indicators, is not straightforward, with rapidly evolving statistical approaches and challenges presented by non-standardised sampling.

Accounting for varying spatial scales and phenology in the production of UK butterfly abundance estimates

James Clark[1] Emily B. Dennis[2], Byron J.T. Morgan[1] and Rachel S. McCrea[3]
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Long-term citizen-science count data allows for the estimation of butterfly abundance in the UK. However, currently population trends are assessed only at the national scale, and it has been shown that there is spatial variation in flight periods within a species across the UK. We show how the current framework to produce abundance estimates, the generalised abundance index (GAI), developed by Dennis et al. 2016 (Biometrics), can be adapted to account for spatial variation in flight periods. We demonstrate the efficacy of varying spatial scales in producing robust estimates of abundance. The use of this model should allow for more strategic planning and land management across regions of the UK, and, at a smaller scale, for site managers at protected sites across the UK. We hope that this work will aid conservation of UK butterflies as well as be used in a wider context for similar citizen-science datasets across Europe to understand and mitigate declines in butterflies.

Using yearly butterfly monitoring data to analyse incidentally monitored areas

Gerdien Bos-Groendijk Van Swaay, C.A.M. and Van Grunsven R.H.A.
Dutch Butterfly Conservation, Wageningen, the Netherlands.

In the Netherlands, all nature areas (open landscape types like grasslands, meadows and dunes) have to be monitored for butterflies once in six years. This method provides information about the spatial occurrence of species in the area, but not about trends of species in relation to management of the natura area or measures that have taken place. However, combining the data of this six-year-cycle monitoring with data from yearly counted transects in the surroundings of the monitored areas can provide species trends. We developed a method to use the butterfly transect data from the Dutch Monitoring Scheme to correct for species flight curves and fluctuations between the years in the data of the incidentally monitored areas. This method makes it possible to compare the local trend of the area with the regional trend. Thus effects of large-scale influences like climate change can be distinguished from local effects like conservation measures.

Calculating annual population numbers – a comparison between TRIM and rbms

Martin Poot[1] Chris van Swaay[2], Jurriën van Deijk[2], Wim Plantenga[1] and Patrick Bogaart[1]
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TRIM is a program developed for analyzing ecological data with many missing values, e.g. monitoring data. When TRIM was developed as an trend analysis tool, it was only capable to analyze count data with an annual resolution. Parallel to TRIM, the software package UIndex was developed, specifically to analyze monthly water bird counts. Inspired by UIndex, the R version of TRIM was extended to analyze data with a higher temporal resolution than year as well. In this presentation we will demonstrate 'the UIndex approach' of rtrim to butterfly and moth data, and compare the outputs with the now widely used R package rbms and a linear approach to arrive at annual abundance figures. Using the temporal resolution of a week, we find that rtrim copes much better with variable counting coverages on the plot level. In the two alternative approaches data is lost because part of the iterations do not arrive at a stable solution or are left out of the analysis beforehand. These missing values have to be imputed in the subsequent trend analysis. The use of rtrim seems a very efficient tool because the analysis can be done at once, thereby using all data available.

A new model for fast analysis of large occupancy data sets

Byron Morgan[1], Alex Diana[1], Emily Dennis[2] and Eleni Matechou[1]
1 School of Mathematics, Statistics and Actuarial Science, University of Kent, Canterbury, Kent, UK.
2 Butterfly Conservation (UK), Wareham, Dorset, UK.

In recent years, the study of species' occurrence has benefitted from the increased availability of large-scale citizen-science data. These data provide opportunities to measure species' changes in occurrence through the use of occupancy models. Such opportunistic datasets can be substantially large, numbering hundreds of thousands of sites, and hence present a computational challenge. The new model of Diana et al (2020, Biometrics) results in fast Bayesian inference, and incorporates spatio-temporal random effects. We illustrate the performance of the model for data on two UK butterfly species: Ringlet, *Aphantopus hyperantus*, and Duke of Burgundy, *Hamearis lucina*, using records from the Butterflies for the New Millennium database, producing occupancy indices spanning 45 years. The model is available in an R package, FastOccupancy, available at https://github.com/alexdiana1992/FastOccupancy (Diana, 2022). Computational times on a laptop were approximately 19 hours. Our new modelling framework can be applied to a wide range of taxa, providing measures of variation in species' occurrence, to assess biodiversity change and guide conservation.

Adaptive citizen science: Spatially targeting recording effort by volunteers to improve biodiversity monitoring

Michael Pocock[1], Simon Rolph[1], Rich Burkmar[2], Thomas Mondain-Monval[2], Susan Jarvis[2], Rachel Pateman[3], Alison Dyke[3], Jennifer Rao-Williams[3], Cagatay Turkay[4], Greg McInerny[4], Zoe Randle[5], Richard Fox[5], Emma Wright[6], Advaith Siddharthan[7], Simon Pickles[8], Ben Town[9], Katty Baird[1] and Tom August[1]
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Volunteer-collected ('citizen science') data are a vital source of information for biodiversity monitoring from local to international scales, especially the 'unstructured' records collected by people from when and where they choose. However, the raw data are unevenly distributed, so modelling is required to create comprehensive, fine-scale biodiversity maps. This means that although each record is valuable, records are not equally valuable: we don't need simply more records, we need more informative records. In the DECIDE Project we have combined adaptive sampling with citizen science to move towards more optimal recording of Lepidoptera. We have run spatial biodiversity models with 18 million records from 117,000 volunteers for over 800 species of butterfly and macro-moth. We have identified targets for future recording (areas of highest uncertainty) and produced digital tools, co-developed with recorders, to provide bespoke behavioural 'nudges' for recorders, based on our research to understand motivations for recording. Crucially, our simulations showed that even a small amount of recording via adaptive sampling will disproportionately benefit the model outputs. This vision for 'precision citizen science' has mutual benefits to volunteers and to the value of the data, and it could be applied more widely across Lepidopteran science and monitoring.

The role of habitat indicators in studying butterfly communities

Andreu Ubach and Constantí Stefanescu
Granollers Natural Sciences Museum, Spain.

BMS projects need powerful tools to evaluate how landscape changes affect butterfly populations and, through the dynamics of butterfly assemblages, to diagnose the status of natural areas and the effectiveness of managing policies. The Catalan BMS has developed two indices which use butterfly counts at the section level and relate them to the vegetation composition of the transects. CORINE habitat types are recorded on each transect every 6 years, to provide a detailed history of local landscape changes. A species specialization index (SSI) informs of the species' preferences for a list of aggregated habitat types, while the so-called open-closed index (TAO) measures the preference of butterflies along a gradient from closed forest to open grassland. These two indices are used and combined to select a set of species that become part of the grassland and forest indicators. They can also be aggregated at the community level to analyse how landscape changes affect butterfly assemblages at the local scale. In our region in NW Spain, it has become very evident in the last three decades a tendency of butterfly communities to be dominated by closed-loving and generalist species to the detriment of grassland specialists, which face strong declines and local extinctions.

The effectiveness of Pollard walks for assessing local species composition

Bas Oteman
Dutch Butterfly Conservation, Wageningen, the Netherlands.

For many insect species establishing local species composition is difficult. There are many techniques available to study species composition, their suitability differs strongly between insect groups and regions. Insight in the sensitivity of the different methods to changes is species composition is very valuable. The Pollard walk is a method often used to determine local species abundance, we assessed the suitability of this method for establishing local species composition. The Pollard walk is relatively simple and can be used for several insect groups. Hence, in regions where insect monitoring does not have priority, this type of data might be the only type that is available or can reasonability be collected. Insight into the sensitivity of Pollard walk data to changing species composition might allow us to provide local species composition estimates. In the Netherlands there is a long running monitoring system based on Pollard walks, and there is a tradition of reporting opportunistic observations. A list of local species was compiled using the opportunistic observations and compared with the Pollard walk data. We focus on species that recently colonized a region, and examined how quickly this change in species composition was reflected by the Pollard walk data in the region.

Standardised moth monitoring in Europe

Chris van Swaay and Van Deijk, J.R.
Dutch Butterfly Conservation, Wageningen, the Netherlands.

Moths are a far more species rich group than butterflies, and are in decline. Thereby they play an import role for ecosystem services like pollination and an important food source for higher trophic levels, which makes it even more important to monitor them. Although national moth monitoring actually started earlier than butterfly monitoring, it is only recently that it is picking up at a larger scale. The introduction of AI based image recognition now makes it possible for anyone to join moth monitoring, even without previous knowledge of the species. All that is needed is a trap and a smartphone. Traps can now be equipped with LEDs powered by a powerbank, which is relatively cheap, portable, and can be placed anywhere. In the EU-funded project SPRING, which studies methods to monitor pollinators, the practical use of such LED-traps is investigated in five European countries. The traps work well in most of Central Europe, but in some nights the number of moths can be over 200, making it difficult to photograph and count them all in the early morning. In Sweden nights are short and in June don't get dark enough, resulting in poor attraction to the trap. Here stronger lights will be needed.

Monitoring spatiotemporal patterns in the genetic diversity of the Meadow Brown

Matt Greenwell[1], Marc S. Botham[2], Michael W. Bruford[3], John C. Day[2], Melanie Gibbs[2], Toke T. Høye[4], Dirk Maes[5,6], Ian Middlebrook[7], Martin Musche[8], , Lars B. Pettersson[9] David B. Roy[2], Josef Settele[8], Constanti Stefanescu[10], Tiit Teder[11,12,] Nia E. Thomas[3], Kevin Watts[13] and Tom H. Oliver[1]
1 University of Reading, UK. 2 UKCEH. 3 Cardiff University, UK. 4 Aarhus University, Denmark. 5 Research Institute for Nature and Forest (INBO), Belgium. 6 Radboud University. 7 Butterfly Conservation UK. 8 Helmholtz Centre for Environmental Research, Leipzig, Germany. 9 Lund University, Sweden. 10 Natural Sciences Museum of Granollers, Spain. 11 University of Tartu, Estonia. 12 Czech University of Life Sciences. 13 Forest Research, Alice Holt, Farnham, Surry, UK.

Genetic diversity underpins all aspects of life. Populations with low levels of genetic diversity are more at risk of collapse due to a number of factors including an inability to adapt to changes in habitat and climate. In an era of unprecedented environmental change, ensuring populations of wild species maintain their genetic diversity is a key conservation priority. Despite this being recognised by international organisations such as the Convention on Biological Diversity, attempts at monitoring or improving the genetic diversity of populations have been minimal, with very few cases of genetic monitoring occurring outside of domesticated or socioeconomically important species. Here I present the results of the first eight years of a genetic monitoring scheme for the Meadow Brown butterfly (*Maniola jurtina*). Butterflies are ideal for such schemes as they are good indicator species for other insects, but also because there are excellent population monitoring data available (e.g. UKBMS), allowing us to compare whether changes in abundance are reflected in changes in genetic diversity or vice versa. Using data from the monitoring scheme I will also present the results of a large-scale spatial analysis into the genetic diversity and population structuring of the Meadow Brown across Europe.

Abstracts: Saturday 15th April 2023 (AM)

Keynote Lecture (Rosewood 1)

A computer vision for globally standardised butterfly and moth monitoring.

Toke Thomas Høye
Department of Ecoscience, Aarhus University, Denmark.

Advances in computer vision and deep learning provide potential new solutions to the challenge of understanding ecological responses to environmental change such as the potentially global insect decline. Cameras can effectively, continuously, and non-invasively perform entomological observations throughout diurnal and seasonal cycles. When trained on these data, deep learning models can provide estimates of insect abundance, biomass, and diversity. Further, deep learning models can quantify variation in phenotypic traits, behaviour, and interactions. Emerging prototypes of new insect cameras hold the potential to complement existing approaches and generate automated and globally standardised data on butterflies and moths. However, to reach this transformative goal, international collaboration and coordination on a range of outstanding challenges is critical. Such challenges include defining minimal requirements and standards for hardware design, recording software, metadata collection, machine learning models, analyses pipelines, and the integration with existing monitoring programs. I will also present current steps towards global collaboration on these challenges and highlight future research avenues to facilitate the transition of these technologies from the current level of demonstration to broad scale application in global butterfly and moth monitoring.

Applying new technology (Rosewood 1)

Chair: David Roy
UK Centre for Ecology and Hydrology, Wallingford, UK.

Building an Autonomous Insect Monitoring System

Simon Teagle
UK Centre for Ecology and Hydrology, Wallingford, UK.

In this presentation we will explore the key things to consider when building an autonomous insect monitoring system, how it works, how it's tested for real world deployment, what are its strengths and limitations? We will look at the difference between an autonomous system compared to traditional methods. We will also compare various design options and hardware characteristics, including how best to manage the data capture and how to power the unit in the field.

Machine learning tools for automated moth monitoring

David Rolnick Aditya Jain, Michael Bunsen, Fagner Cunha, Deva Sou, and the rest of the AMI team
McGill University, Montreal, Canada & Mila Quebec AI Institute, Montreal, Canada.

In this talk, we will discuss machine learning tools used in the Automated Monitoring of Insects (AMI) platform, a camera trap system for attracting and identifying moths. Our machine learning algorithms pinpoint insects in camera trap images, track them as they move across the sheet, classify them as moth/non-moth, and identify each individual to species where possible. We will describe how these algorithms work and how to use the AMI software to accelerate fieldwork and focus on particular species of interest in camera trap data.

Field trials with automated moth monitoring in three different habitats of Denmark

Kim Bjerge[1], Nathan Pinoy[2], Henrik Karstoft[1] and Toke Thomas Høye[2]
1 Department of Electrical and Computer Engineering, Aarhus University, Finlandsgade 22, 8200 Aarhus N, Denmark. 2 Department of Ecoscience and Arctic Research Centre, Aarhus University, C.F. Møllers Allé 8, 8000 Aarhus C, Denmark.

Traditionally moth monitoring is done with light traps, where the moths are attracted to a light source. These traditional methods are very time consuming and challenging to scale in time and space. However, there is a need to make more efforts in getting data more efficiently to evaluate spatial, temporal and taxonomic aspects of moth population trends. Automated monitoring using cameras is a new approach that enables study of insects in greater spatial and temporal dimension. In this work we have recorded images of insects and moths from three different locations in Denmark in the season 2022 with habitats of nature covering bog, heather and forest in a summer period of four months. Time-lapse and motion based images were recorded during night with four traps on each location with a total of 12 Automated Moth Traps (The Aarhus AMT). The images were analysed with a deep learning pipeline to identify the moths and count the number of observed species. We have collected experience with the new automated method in relation to effort and challenges of recording image data. Finally we have analysed the observed occurrence of moths in relation to habitats and weather conditions during the monitoring period.

A non-invasive method to investigate movement patterns and dispersal barriers in butterflies - the marsh fritillary (*Euphydryas aurinia*) as an example

Emil Grøn[1], Jensen Morten Frederiksen[1], Trine Bilde[2] and Toke Thomas Høye[1]
1 Department of Ecoscience, Aarhus University, Denmark. 2 Department of Biology, Aarhus University, Denmark.

The ability to recognize individuals from artificial tags, such as bird rings, has enabled great insights into the movement ecology and demography of species. The possibility to use natural distinct morphological traits to identify individuals represent a non-invasive capture-mark-recapture (CMR) procedure. Many butterfly species have individually distinct wing patterns, but so far, no attempts have been made to recognize individuals in flying insects. Through a digital photographic identification analysis, performed in I3S Pattern+, we investigated dispersal barriers and movement patterns of the marsh fritillary (*Euphydras aurinia*) at four different locations in Northern Jutland, Denmark. We found that I3S Pattern+ works for well for individual identification of the marsh fritillary. From individual recognition and localisation, we were able to estimate populations sizes, survival rates and movement patterns in the study sites. We also found that the low dispersal capabilities of the species in a Danish landscape does not seem to be due to physical barriers such as roads or small forests, but the distance among habitat patches strongly reduce population connectivity. These findings point to the crucial necessity of large continuous habitats for the marsh fritillary, but also showcases the future potential of this non-invasive CMR method.

Camera surveillance exposes moth pollination of red clover

Jamie Alison, Jake M. Alexander, Nathan Diaz Zeugin, Yoko L. Dupont, Evelin Iseli, Hjalte M. R. Mann and Toke T. Høye
Department of Ecoscience, Aarhus University, Denmark.

Recent decades have seen a surge in awareness about insect pollinator declines. Bees receive the most attention – but most flower visiting species are lesser-known, non-bee insects. Nocturnal flower visitors, e.g. moths, are especially difficult to observe and largely ignored in pollination studies. Clearly, achieving balanced monitoring of all pollinator taxa represents a major scientific challenge. Automated monitoring with remote cameras shows great promise to address data-deficiencies in entomology and pollination ecology. We demonstrate this in a case study where time-lapse cameras provide season-wide, day-and-night pollinator surveillance of *Trifolium pratense* (L.; red clover). Aiming to characterise visitation of this important wildflower and forage crop, we reveal the first evidence to suggest that moths act as pollinators, and impact seed set, much like bumblebees. This is a remarkable finding; moths have received no recognition throughout a century of *T. pratense* pollinator research. Our favoured explanation is not that moth visits are negligible, but that nocturnal visitors have been systematically overlooked.

Analysis of automated monitoring data of insects: suggestions for seeing the forest for the trees

Marc Mazerolle[1] and Marc Bélisle[2]
1 Université Laval, QC, Canada. 2 Université de Sherbrooke, QC, Canada

Recent technological advances in automated detection and recognition of insects offer new possibilities in terms of monitoring, but these are not without challenges in terms of data analysis. Notably, automated recording stations can produce large amounts of data, depending on the sampling frequency and period. Yet this data profusion is no panacea. Despite efforts to standardize protocols, the ability to detect species will remain dependent on many variables including weather, time of day, light source, habitat, and species. These variations in detection probability induce bias in certain estimators commonly used to analyze insect data such as generalized linear (mixed) models. To overcome these issues, we advocate the simultaneous estimation of both ecological (state or vital rate) and observation processes. Using examples adapted from automated recording stations developed for moths, we illustrate different designs that produce data amenable to such analyses. We also show that minor changes in protocol can be used to test hypotheses on phenology, behavior, abundance, and species richness. These examples may help define guidelines at the start of projects to optimize field sampling designs and efforts, increasing the value of data to test hypotheses on the long term.

Future challenges for automated monitoring of moths

Tom August, David Roy, Reto Schmucki and Alba Gomez-Segura.
UK Centre for Ecology and Hydrology, Wallingford, UK.

Automated monitoring systems for moths are being developed at pace, and we are beginning to see larger scale demonstration projects that are showing their ability to provide large volumes of images. Despite the progress made, there are still challenges to overcome to realise the potential of these systems at a global scale, and alongside traditional recording. Drawing on experience deploying systems in Argentina and Panama we will discuss the challenges that these systems face when deployed in remote areas. In these regions of the world the moth communities are typically less well characterised, and poorly documented with open image libraries needed for training AI. To maximise the benefit of any new technology, we must consider how it can be used in conjunction with existing data, methods, and recorders. Existing moth-monitoring schemes are well established in a number of countries. We will discuss opportunities to bring together traditional methods and data and new technologies to the benefit of both communities.

Species Conservation 2 (Ebony)

Chair: Dan Hoare
Butterfly Conservation (UK), Wareham, Dorset, UK.

Towards a European Red List of larger moths

Jurriën van Deijk[1], Mark Parsons[2], Phil Sterling[2], Sam Ellis[2,] and Chris van Swaay[1]
1 Dutch Butterfly Conservation, Wageningen, Netherlands. 2 Butterfly Conservation (UK), Wareham, Dorset, UK.

Declines in moths have been identified, and in some cases quantified, in various European countries. For example in Hungary (Valtonen et al. 2017), Finland (Antäo et al. 2020) and Great Britain (Bell et al 2020). But moths remain relatively poorly studied in some parts of Europe, specifically in Southern and Eastern Europe, where both the data and the community of experts are more scattered. Producing a European Red List of Moths will therefore not only help identifying conservation priorities for this taxon, it could further raise the profile and encourage the recording of this fascinating group of insects. Within this project we will identify the main threats to them and make recommendations for further research and conservation action needed in Europe. It will help identify priority sites for conservation with moths acting as 'umbrella' species for other threatened taxonomic groups. As well as adding weight to existing priority sites for conservation as these species can occur alongside other threatened taxa. During this presentation an insight will be given about the current state of this Red List and some preliminary results, which would not be possible without the help and support of a wide range of experts across Europe.

Conserving Madeira's Threatened Endemic Butterflies

Martin Wiemers[1] Sam Ellis[2,3], Cristina G. Sevilleja[2,4], Chris van Swaay[2,4], Irma Wynhoff[2,4], Emanuela Cosma[4], Juan Gallego-Zamorano[4] and Sérgio Teixeira[5]
1 Senckenberg Research Institute, Müncheberg, Germany. 2 Butterfly Conservation Europe. 3 Butterfly Conservation (UK). 4 Dutch Butterfly Conservation. 5 Madeira Fauna & Flora.

Nearly 60% of Europe's threatened butterfly species are endemics, including six which are confined to the Macaronesian Islands. We used the ButterflyCount app 15-minute Counts to undertake surveys across the primary laurel forests and other habitats of Madeira Island for the three most endangered endemics: *Pieris wollastoni*, *Gonepteryx maderensis* and *Pararge xiphia*. We built Species Distribution Models to identify other potentially suitable locations for future survey and established a Madeira Butterfly Monitoring Scheme to enable abundance trends to be assessed in the future. A programme of public events and volunteer training recruited local conservation agency staff and civil society to the monitoring scheme. *P. xiphia* was found to be the most widespread target species and in the laurel forests, remains more abundant than the invasive *P. aegeria*. *G. maderensis* was much scarcer and confined to primary laurel forests, with just eight population centres for the butterfly identified. Our survey confirmed that *P. wollastoni* is probably extinct (last recorded in 1986), the first European butterfly to do so. We liaised with local conservation partners to produce species action plans which aim to improve the conservation status of the two remaining endangered butterflies.

Euphydryas aurinia (Marsh Fritillary) in the UK: A review of status and conservation recovery

Caroline Bulman, Jones, R.E., Cook, P., Plackett, J., Wainwright, D., Middlebrook, I. and Bourn, N.A.D.
Butterfly Conservation (UK), Wareham, Dorset, UK.

A status review of *Euphydryas aurinia* was completed in 2018 across the UK. Data was collected on occupancy, population size, patch boundaries and habitat. Providing a snapshot of the status of the species and characteristics of extinct/extant sites; aid the targeting of conservation initiatives and measure effectiveness. The change in population status was analysed over a 23-year period. In 1994 Warren identified 432 colonies in the UK, with 228 of these located in England. During the 1990s the species underwent a 66% decline in England and only 108 populations were identified in 2001. Extinction and decline were related to loss of habitat caused by agricultural improvement, over-grazing or abandonment. By 2018 the decline rate had decreased, one-third of sites were consistently occupied but high turnover was detected with 44% of occupied sites being new colonisations or discoveries. The review demonstrates that the number of sites in active management has increased due to improving habitat quality and connectivity, through agricultural support schemes and targeted landscape-scale projects. Butterfly Conservation and partners have been actively working across the UK distribution of the species, we highlight different approaches to nature recovery across landscapes and delivery of bespoke work to reverse the downward trends.

Using photo-identification to estimate mobility, lifespan, and population size of the reintroduced Chequered Skipper *Carterocephalus palaemon* in England

Jamie Wildman[1,2], Jeff Ollerton[1], Nigel A.D. Bourn[2], Susannah O'Riordan[2], Duncan McCollin[1].
1 University of Northampton, Northampton NN1 5PH, UK. 2 Butterfly Conservation (UK), Wareham, Dorset, UK.

In 2018, Butterfly Conservation reintroduced the Chequered Skipper *Carterocephalus palaemon* to Fineshade Wood in Northamptonshire after the species' extirpation from England in 1977. The sensitive nature of the reintroduction, vulnerability of the founder population, and importance of butterfly welfare required a non-invasive alternative to mark-release-recapture (MRR) to annually estimate *C. palaemon* mobility, lifespan, and population size at Fineshade Wood. The upperside wing markings of *C. palaemon* were found to be unique to each butterfly, therefore a photo-identification technique known as photographic mark-recapture (PMR) – often used in Cetology – was selected. *C. palaemon* photographs taken during timed count sampling and casual encounters 'captured' and 'recaptured' individual butterflies across three flight periods. In some cases, individuals were recaptured multiple times and found to have moved distances that belie the species' sedentary reputation. We demonstrate that wild butterflies with unique wing markings can be tracked using PMR in conjunction with geospatial data, emphasising both the power of volunteer effort and potential of the technique for monitoring butterfly populations.

Delayed effect of host ant abundance on the populations of *Phengaris* butterflies

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The availability of specific host ants is the main factor limiting populations of flagship *Phengaris* butterflies, and thus often a target of monitoring programmes. Nevertheless, the way in which host ant abundance impacts the butterfly dynamics may not necessarily be straightforward. We investigated the delay in the response of *Phengaris* populations, annually surveyed with intensive mark-recapture, to host ant nest densities within their habitat patches around Přelouč, Czech Republic. While local population sizes of both *P. teleius* and *P. nausithous* fluctuated strongly between years, they showed no apparent correlations with the nest densities of their primary hosts, *Myrmica scabrinodis* and *M. rubra* respectively, in the same season. However, the population sizes of *P. teleius* were clearly affected by past densities of *Myrmica* hosts, especially those recorded two years before, and less so a year before. In *P. nausithous* the patterns were roughly similar, but less evident, presumably due to better dispersal of this species, which makes population sizes less dependent on local dynamics. Our findings potentially explain why habitat restoration activities do not immediately lead to *Phengaris* population increases. They also caution against using snapshot estimates of host ant abundance as proxies of habitat quality for *Phengaris* butterflies.

Species recovery for three of Scotland’s rarest micro-moths

Tom Prescott, David Hill and Patrick Cook
Butterfly Conservation (UK), Wareham, Dorset, UK.

Silver Shade *Eana argentana*, Tiree Twist *Periclepsis cinctana* and Inverness Twitcher *Choreutis diana* are three extremely rare and threatened micro-moths which are all only known in the UK from single, very small and remote locations in Scotland. However, little is known about their habitat preferences and life history here or on the continent, or their current Scottish status. They are therefore in a precarious position on the edge of survival and high priority species in Butterfly Conservation’s Strategy. But how do you implement conservation action on such small, obscure and almost unknown species? In 2019 Butterfly Conservation staff successfully led targeted surveys on all three species. At least five *Periclepsis cinctana* were seen on the wing on Tiree after an absence of seventeen years, whilst *Eana argentana* was re-found at Glen Tilt with twenty recorded, the last being a single moth seen in 2014. Whilst searches for *Choreutis diana* in Glen Affric found 42 ‘occupied’ trees and the first adults to be reported for 24 years. Further advances have been made post-Covid including establishing monitoring of *Choreutis diana* and building all important good relations with the owners of each site and thus nudging each a little along their recovery curves.

Multifaceted measures are needed in conservation of butterflies in Japan: Efforts to solve fundamental problems

Yasuhiro Nakamura
Japan Butterfly Conservation Society (JBCS)

The decline of butterflies in Japan is serious and a quarter of butterfly species are listed on the Red List. JBCS has focused on the conservation of endangered butterflies over 15 years. We have over 20 projects for endangered butterflies by ourselves, and our members set up local conservation bodies for endangered butterflies. In this way, although many endangered species conservation projects are underway, the factors that have led to the decline are wide-ranging and difficult-to-solve; such as abandonment of management, climate change, and an increase in deer populations. For example, the habitat of the *Melitaea scotosia* is a wet grassland, but due to the loss of coppice management that has been practiced until 1960s, changes in water quality and a decrease in the amount of water have made it difficult to maintain the suitable condition of grassland. Therefore, it is necessary to cut down the surrounding woodland widely. For this reason, linking other environmental problems with butterfly conservation and promoting multifaceted approaches through partnerships with other organizations are important. The use of biomass and organic agriculture are easy to work on, and we are currently starting to work on these.

Two decades of monitoring and conservation of the Marsh fritillary (*Euphydryas aurinia*) in the Czech Republic

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Two decades ago, only a handful Marsh Fritillary colonies, all situated in the westernmost part of the country, were known in the Czech Republic. Annual monitoring of all sites by larval webs counts, active searches for hitherto unknown localities, and efforts to secure legal protection and appropriate vegetation management, began in 2001. Until present, 98 colonies had been discovered; mark recapture and genetic studies distinguished three metapopulation units. Within the sites, the larval webs counts fluctuate with a 10-years period, asynchronously among colonies. PCR-detection of infestation rates by Hymenoptera and Diptera parasitoids suggest that the fluctuations are driven by parasitoids. Only two thirds of the colonies are inhabited at present. Some of the vacant colonies are due to transient extinctions inherent to metapopulation systems, some were inevitably lost due to insufficient conservation. Despite the losses, the annual larval webs totals remain stable across the country. This stability despite sites losses is explicable by meticulous vegetation management, applied for the largest, centrally situated sites. Management-attributable vegetation changes, such as increase of grasses, suggest that limiting the effort for a few selected sites may not secure the metapopulations in a long term, calling for landscape-level conservation efforts.

Impacts on *Aricia artaxerxes* from climate change policy in Scotland

Dave Hill[1], Tom Prescott[1], Frances Winder[1], and Barry Prater[2]
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In Scotland there are ambitious government targets to increase woodland cover in order to combat climate change. Woodland creation subsidies combined with further incentives for landowners through carbon offsetting schemes are leading to negative impacts on *Aricia artaxerxes* (Northern Brown Argus) through habitat loss and fragmentation. The Scottish Borders area is a prime target for new woodlands, but is also a national stronghold for the *Aricia artaxerxes*, a declining species of flower-rich calcareous grasslands. Butterfly Conservation volunteers have been systematically surveying and assessing *Aricia artaxerxes* in the Scottish Borders since 2016. A total of 158 sites have been identified with 91% of these surveyed to date. Around half of all sites are identified as being under threat with the impacts of afforestation and a lack of grazing leading to scrub and bracken infestation the main issues. To combat these pressures, Butterfly Conservation has proactively supplied mapping data to organisations involved in woodland development screening to achieve earlier interventions. Furthermore, through the Borderlands Inclusive Growth Deal, we are developing a nine-year project in partnership with the local authority which aims to pilot ecologically sustainable land management of species-rich grassland via a local agri-environment scheme, using *Aricia artaxerxes* as a flagship.

Optimising the reintroduction of a specialist peatland butterfly *Coenonympha tullia* onto peatland restoration sites

Andrew Osbourne, Sarah Griffiths, Simon Caporn, and Emma Coulthard
Manchester Metropolitan University, UK.

Peatland restoration has gained prominence because of its importance in climate change mitigation, reducing greenhouse gasses emissions and providing a net carbon sink. The large heath butterfly *Coenonympha tullia*, a peatland specialist, is threatened because of habitat destruction; the butterfly has become a flagship species for peatland ecosystem restoration within Chat Moss, Greater Manchester, U.K. A species reintroduction programme is currently underway on a peatland restoration site.

Has intensive forest management doubled the metapopulation size of one of the most endangered butterfly species in Europe?

Marcin Sielezniew[1,2], Cezary Bystrowski[3], Krzysztof Deoniziak[1], Izabela Dziekańska[1,2] , Jacek Hilszczański[3], Tomasz Jaworski[3] and Piotr Nowicki[4]

1 Faculty of Biology, University of Bialystok, Bialystok, Poland. 2 Association for Butterfly Conservation, Warsaw, Poland. 3 Forest Research Institute, Sękocin Stary, Poland. 4 Institute of Environmental Sciences, Jagiellonian University, Kraków, Poland.

Danube Clouded Yellow *Colias myrmidone* has suffered a dramatic decline in Europe. In Poland, the last metapopulation inhabits the Knyszyn Forest but the occurrence of the butterfly is restricted to eastern parts of this large woodland complex. All the recently created habitats exist on former agricultural lands, i.e., mostly extensive pastures that were afforested in the mid-20th century. The regional occurrence of larval food plant (*Chamaecytisus ruthenicus*) is nowadays limited to these forest stands. Logging enables its flourishing, and clearings are colonized by the butterfly. Intensive mark-release-recapture studies performed in 2022 showed that, both the occupied area and number of individuals in the summer generation doubled compared to 2017 as a result of creation of new clear-cuts, which also improved connectivity among habitat patches. However, forestry-related practices aimed at rapid growth and dense replanting of forest trees result in a fast disappearance of the habitat. In contrast, patches spared for natural succession may be suitable for more than 10 years. In 2021 we started a project funded by the Polish State Forests aimed at ecological research, as well as elaboration and implementation of conservation measures to ensure the long term sustainability of the large *C. myrmidone* metapopopulation

Assessing the Reintroduction of Chequered Skipper into England through Genetic Approaches

Georgina Halford[1,2,] Jenny Hodgson[1], Ilik Saccheri[1], Nigel Bourn[2], Caroline Bulman[2], Dirk Maes[3]

1 University of Liverpool, UK. 2 Butterfly Conservation (UK). 3 Research Institute for Nature and Forest, Belgium.

Butterfly Conservation began the scheme to reintroduce Chequered Skippers (*Carterocephalus palaemon*) to England, with a translocation of individuals from Belgium to parts of the Rockingham forest area of Northamptonshire in 2018. Since, work has continued to ensure the reintroduced population can survive in the long term. Here, I use whole genome sequencing of wing-clips from individuals from the source populations and the newly established English population to assess the health of the individuals in terms of their population genetics. I compare the genetic diversity contained in the reintroduced population to that of the source population, giving an indication of how much of the genetic diversity has been maintained post translocation. Furthermore, I look at any potential signatures of inbreeding within the new population and for indications on the genetic lineages of the reintroduced population through genetic admixture mapping.

Biodiversity and Protected area conservation (Rosewood 1)

Chair: Martina Sasic
Croatian Natural History Museum, Zagreb, Croatia.

The effectiveness of Natura 2000 network in preventing habitat loss and population declines of endangered species in urban area

Joanna Kajzer-Bonk and Piotr Nowicki
Institute of Environmental Sciences, Faculty of Biology, Jagiellonian University, Gronostajowa 7, 30-387 Kraków, Poland.

We verified the hypothesis that protected sites mitigate habitat and biodiversity loss in urban areas under strong anthropogenic pressure. The study has been conducted across 20 years in the metapopulations of three focal species of *Phengaris* (*Maculinea*) butterflies. We revealed a twofold decrease in the number of habitat patches. Total area of habitats decreased by 21% for *P. alcon*, and by 13% for *P. teleius* and *P. nausithous*. Before the establishment of the Natura 2000 sites, the negative trends in patch numbers and their area were similar regardless of the location (inside vs. outside the present Natura 2000 sites), whereas afterwards the negative trends prevailed outside Natura 2000, except for *P. alcon* for which the habitat loss also continued within Natura 2000. For all three studied species, local population declines were detected outside Natura 2000 sites after their establishment. We conclude that the legal protection of species alone does not guarantee their persistence in urban setting, whereas protected sites may ensure effective conservation and the stability of populations. As meadow habitats provide a whole range of ecosystem services, we emphasize the urgent need to develop a network of protected habitats in urbanized areas.

Mapping Important Lepidoptera Areas (ILA’s)

Juan Gallego-Zamorano, Anna Herlings, Jurriën van Deijk and Chris van Swaay
Dutch Butterfly Conservation, Wageningen, the Netherlands.

Lepidoptera, i.e., butterflies and moths, are considered key for the well-functioning of ecosystems and therefore used as bioindicators of the state of nature. For their conservation, it is essential to select and prioritize areas where efforts should be concentrated to preserve their populations and avoid their decline. Here we define Important Lepidoptera Areas (ILA’s) as places of international significance for the conservation of lepidoptera which should be large enough to safeguard a viable population of a species, but at the same time, should be small enough to be conserved in their entirety. To identify ILA’s, Butterfly Conservation Europe and partners developed a set of robust and standardized criteria based on observational data, which might be applied to any region in the world. As a showcase, we will present how these criteria are applied to the Netherland’s lepidoptera community as well as how to easily map ILA’s using open-source data. Finally, we will present a newly developed interactive web-tool to search and get information about ILA’s online.

Microreserves, a tool for the conservation of threatened butterflies in Catalonia

Guillem Mas Cornet and Irene Figueroa
Paisatges Vius Association, Barcelona, Catalonia, Spain.

Microreserves de papallones is an initiative of the NGO Paisatges Vius which aims to define and implement a strategy for the conservation of threatened butterflies in Catalonia, an autonomous community located in the northeast of the Iberian Peninsula. 46 of the 203 species of butterflies in Catalonia are threatened, but the project only focuses on the 25 (9 as endangered and 16 as vulnerable) that are threatened by factors that can be realistically and effectively addressed through the protection of spaces and active management. The main work is the establishment of a network of micro-reserves through the coordinated involvement of private owners, conservationist entities, research groups and administrations. Since 2021, up to 6 micro-reserves have been already created. They are focused in species such as *Phengaris alcon*, *Phengaris arion*, *Brenthis ecathe*, *Aricia morronensis* and *Erebia epystigne*. Surveys aimed at specific species are also carried out since in some cases the problem is precisely the lack of information at population and trend level. The basis of the project will be presented at the symposium: which are the target species, how the surveys to find hotspots are organized, how the micro-reserves are established, how they are managed and how they are monitored.

Inconsistent results from trait-based analyses of moth trends point to complex drivers of change

George Tordoff[1], Emily B. Dennis[1,2], Richard Fox[1], Patrick M. Cook[1], Tony M. Davis[1], Dan Blumgart[3] and Nigel A. D. Bourn[1]
1 Butterfly Conservation (UK), Manor Yard, Wareham, Dorset BH20 5QP, UK. 2 School of Mathematics, Statistics and Actuarial Science, University of Kent, Canterbury CT2 7FS, UK. 3 Rothamsted Research Institute, Harpenden AL5 2JQ, UK.

Trait-based approaches are advocated for their ability to predict population declines in data-deficient taxa and regions. Several reviews have, however, highlighted inconsistent results between studies. Traits studies of moths are commonplace and support this pattern of inconsistency, albeit with largely consistent results for traits relating to dietary and habitat breadth. We use the most comprehensive moth trends available, those for British macro-moths, to test the utility of traits approaches using a multi-model inference approach. We found strong associations for several traits; woodland moths and those feeding on grasses and lichens/algae are faring well; declines were associated with univoltinism, narrow diet breadth, nocturnal flight, overwintering as an egg, moorland habitat preference, and feeding on forbs. Abundance and distribution trends produced different outcomes, with no trait having significant associations for both measures of change. Our findings corroborate previous studies for certain traits, but for others they provide further evidence that traits analyses can yield inconclusive or contradictory results. We suggest that these inconsistencies are rooted in the complex drivers of population change. Overall, our study adds to evidence that unequivocal relationships between traits and population changes are lacking for most parameters, limiting the usefulness of trait-based approaches in predicting species declines.

Do butterfly distributions support the concept of the Western Palaearctic as a meaningful zoogeographical region for use in species conservation prioritisation?

Martin Davies
Parides Ecological and Training Consultancy, UK.

European conservationists often refer to the Western Palaearctic as a key zoogeographical reference point in considering faunal diversity and species populations and to guide prioritisation of conservation initiatives. The Palaearctic zoogeographical realm (or ecozone) has long been recognised to have a high degree of biological distinctiveness compared to the Afro-Tropical realm to the South-west and the Oriental realm to the South-east. At the same time, some species in the Palaearctic have a circumpolar Holarctic distribution. What is less clear is the extent of faunistic evidence supporting the division of the Palaearctic realm into identifiable Western and Eastern parts. Based on a wide review of published sources, this study examines the species diversity and patterns of endemism of Palaearctic butterflies, from Western Europe across the full breadth of Eurasia to eastern Russia and China. It asks to what extent the distributions of individual species collectively support the idea of there being identifiable Western Palaearctic and Eastern Palaearctic butterfly faunas and, if so, where would be the most appropriate dividing line between them. Such conclusions could have important implications for approaches taken in future conservation prioritisation processes such as Red Data Book assessments and identification of key areas for conservation.

Abstracts: Saturday 15th April 2023 (PM)

Keynote Lecture (Rosewood 1)

Pollinators and their interactions with plants in an increasingly illuminated world

Eva Knop
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The artificially illuminated area at night has rapidly increased over the past decades, so that to date a growing proportion of the world's ecosystem are exposed to light at night. It is increasingly recognized that artificial light at night can have detrimental effects on species occurrence, reproduction, and survival by influencing physiological and behavioral processes. I will thus give an overview on how night-active organisms are affected by artificial light at night with a focus on plants and insects. This also includes the characteristics of the most important light sources and the sensitivity of organisms to them. For example, due to its energy-efficiency the wide-spread high pressure sodium streetlamps are increasingly replaced by LED streetlamps, which usually emit much more blue light that is known to be most problematic for insects. I will then zoom in and focus on how night-active pollinators and their interactions with plants, in particular plant-moth interactions, are affected by artificial light at night. I will show that nocturnal plant-pollinator interactions close to streetlamps are disrupted, which can be linked to a reduction of the reproductive output of plants. Finally, I will focus on indirect effects and consequences of artificial light at night on plant-pollinator interactions and elucidate underlying mechanism. For example, a change of interactions due to artificial light at night might not be limited to the illuminated area. Also, there is increasing evidence that it also affects plant-pollinator interactions during daytime and that various mechanisms cause these indirect effects.

Light pollution impacts (Rosewood 1&2)

Chair: Richard Fox
Butterfly Conservation (UK), Wareham, Dorset, UK

Street lighting has detrimental impacts on the mass, but not abundance, of nocturnally feeding butterfly caterpillars

Michael Pocock[1], Douglas Boyes[1,2], Marc Botham[1], Darren Evans[2] and Richard Fox[3]
1. UKCEH Wallingford.UK. 2. University of Newcastle 3. Butterfly Conservation, UK.

This research is presented in memory of Douglas Boyes who tragically died in 2021.

There has been much recent concern about the impact of artificial light at night on Lepidoptera, but much of the research has focussed on the adult stages of nocturnal moths even though artificial light can affect moths across their life cycle. Indeed, our recent research showed that lighting was associated with local substantial (33-47%) reductions of moth caterpillar abundance. However, butterflies also have nocturnal larvae: if their larvae are affected in the same way as moths, this suggests that street lighting could be contributing to butterfly declines. We undertook matched-pairs sampling, conducting nocturnal sweep-netting in the spring (March to June) to sample butterfly as well as moth larvae. We found that there was a negative effect on moth larvae, confirming previous results, but no effect of lighting on butterflies. From this we suggest that the effects on moth larvae abundance are due to the behaviour of egg-laying females rather than impacts on the larval life stage. However, butterfly caterpillars were smaller under streetlights, suggesting that their feeding was affected, which could impact on their future individual fitness.

Impact of streetlights on moth communities under low and high light pollution at night: a citizen science approach in Belgian gardens

Evert Van de Schoot[1] Renate Wesselingh[2] Hans Van Dyck[1]
1 Behavioural Ecology & Conservation Group, Earth & Life Institute, UCLouvain, Louvain-la-Neuve, Belgium. 2 Plant Evolutionary Ecology, Earth & Life Institute, UCLouvain, Louvain-la-Neuve, Belgium.

There is mounting evidence for strong alterations in moth communities, including many species and population declines. Multiple drivers have been put forward as causes, but recently, light pollution caused by artificial light at night (ALAN) receives growing scientific attention. ALAN has been shown to affect biological cycles, feeding and pollination behaviour, but it can also disturb organisms by attracting or repelling them. We study the impact of ALAN on moths across their life cycle combining both field studies in gardens (i.e., community-level responses) and controlled laboratory experiments (i.e., intra-specific responses). For the laboratory experiments, we reared first and second-generation caterpillars of the Garden Tiger moth (*Arctia caja*) under dark night and ALAN-conditions with a split-brood design. We monitored several life-history traits like caterpillar growth and survival. In this talk we will mainly focus on our first results of a field study in gardens. With the help of twenty-four volunteers, we sampled moth communities in gardens with either high or low skyglow levels and presence or absence of street lighting to obtain a full factorial design. Besides the effects on species diversity, also changes in species traits within these communities are investigated considering multiple environmental factors.

Visual impacts of artificial lighting on nocturnal moths: from perception to background selection

Emmanuelle Briolat[1], Jolyon Troscianko[1], Matthew Craggs[1], Jonathan Bennie[2] and Kevin Gaston[3]
1 Centre for Ecology & Conservation, University of Exeter, Penryn, TR10 9FE, UK. 2 Centre for Geography and Environmental Science, University of Exeter, Penryn, TR10 9FE, UK. 3 Environment and Sustainability Institute, University of Exeter, Penryn, TR10 9FE, UK.

Artificial light at night alters many properties of the light environment that nocturnal Lepidoptera have evolved to live in, from the timing and structure of light to its intensity, colour and polarisation. These differences are likely to disrupt any behaviours and interactions that involve vision, including moths' ability to find and handle flowers, intra-specific communication, and antipredator defences. At the end of the night, moths have been shown to preferentially select resting backgrounds which more closely match their wing patterns, at least in terms of brightness, reducing detection risk from predators. Yet artificial lighting is expected to interfere with this ability, raising predation risk in the daytime, as well as making moths more visible to any visually-guided predators active at night. By modelling the perception of a well-studied species with extraordinary nocturnal colour vision, the elephant hawkmoth (*Deilephila elpenor*), we found that the impact of light pollution depends on the type and intensity of artificial lights considered, with some light types completely blocking colour vision. Meanwhile, preliminary experiments with a broader range of species suggest that moths may indeed choose backgrounds providing poorer camouflage under those same light types, hinting at real-world impacts of different lighting technologies.

Dim light pollution prevents diapause induction in urban and rural Latticed heath (*Chiasmia clathrata*) moths

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Light pollution is increasingly affecting biodiversity and may also disrupt seasonal adaptations. Even dim light at night (dLAN), such as skyglow—which can spread far beyond urban areas—, can interfere with using photoperiod as a seasonal cue. We tested how dLAN impacts diapause induction and whether urban evolution counteracts it, by using common-garden experiments with a common, widespread geometrid moth (the Latticed heath, *Chiasmia chlathrata*). We raised offspring from urban and rural populations from North- and Mid-European countries in treatments with and without dLAN. The dim light treatment strongly increased direct development overall—with no evidence for urban adaptation to it—but distinctly more so in Mid- than in North-European populations. Because proper diapause induction is critical for surviving winter, these results indicate that dim but widespread light pollution may have detrimental effects on insect populations, especially so at mid-latitudes, and may hence explain part of the ongoing, large-scale insect declines globally.

Adaptation to nocturnal light in *Yponomeuta cagnagellus*

Roy Van Grunsven[1] Cieraad, E.[2,3]. van der Sman F.[2] and Zwart N.[2]
1 Dutch Butterfly Conservation, Wageningen, The Netherlands. 2 Institute of Environmental Sciences, Leiden University, Leiden, The Netherlands. 3 Research & Innovation, Nelson Marlborough Institute of Technology, Nelson, New Zealand.

Moths evolved under dark nights with only moon- and starlight. During the last century there has been an enormous increase in artificial light at night (ALAN) and many moth populations are now exposed to illuminated nights. We know that artificial light affects many aspects of physiology and behaviour, and impacts moth populations. ALAN is a novel phenomenon on an evolutionary scale but as it is widespread and has a significant impact, strong selection is expected. There is very little known about adaptation of moths to ALAN. We tested whether feeding and calling behaviour of *Yponomeuta cagnagellus* differed between populations from dark and illuminated sites by collecting caterpillars from locations with and without illumination, rearing them in the lab and exposing adults to different nocturnal light levels. We looked at the difference in feeding and calling behaviour between populations from dark and illuminated sites and the direct impact of experimental illumination on these behaviours. We did find differences in behaviour between populations from dark and illuminated sites but no difference in the sensitivity to ALAN.

Contrasting effects of wavelength and light intensity on flight-to-light behaviour of moths

Ishbel Hayes[1], Jonathan Bennie[1], Kevin Gaston[1] and James Bell[2].
1 University of Exeter, Penryn Campus, Penryn, Cornwall, TR10 9FE, UK. 2 Rothamsted Research, Harpenden, AL5 2JQ. UK.

Differences in the breadth and peaks of wavelengths emitted by a light source have a significant effect on their attractiveness to moths. Light bulbs dominated by shorter wavelengths are associated with higher moth abundance, often attributed to moth spectral sensitivity peaks at this end of the visual spectrum. However, when comparing the attractancy of different types of bulb, behavioural differences caused by variation in emission spectra are often confounded by intensity and bulb design. This study used mark-recapture experiments to compare the flight-to-light behaviour towards UV (396nm), blue (460nm), green (520nm) and red (630nm) LEDs with a standardised photon flux. Unlike previous studies which compare attractancy based solely on outcome here behaviour upon release and recapture were observed. These additional data highlighted the impacts of wavelength and intensity on take-off behaviour and allowed for behaviour-mediated differences in trap efficiency to be compared between wavelengths. Understanding the factors impacting insect attraction to light can guide spectral tuning of future lighting technologies to reduce the negative impacts of flight-to-light behaviour. A new light-pollution map utilising high resolution night-time imagery from the Luojia1-01 satellite has been collated which could provide novel insights into the relationship between moth population declines and artificial light.

Artificial light as a driver and detector of moth declines

Avalon C. S. Owens
The Rowland Institute at Harvard, Cambridge, MA, USA.

Recent reports of precipitous declines in the abundance of insects across diverse habitats have alarmed researchers, policymakers, and the public alike. The eerie absence of moths to be seen swirling under streetlights, trapped in car headlights, or plastered against lit windows raises concerns that habitat loss, pesticide use, and climate change are upending the foundations of global food webs. But what if the moths are still there… just not at the lights? Over the past century, exponential growth in anthropogenic light pollution should not only have diluted moths among a greater number of light sources but also actively selected against flight-to-light behavior. Moths that fly to light often die, while those that survive lose vital opportunities to forage and reproduce; in some habitats, this evolutionary pressure has already had hundreds of generations in which to act. Here I leverage multiple sources of long-term moth survey data to investigate changes in the effectiveness of entomological light traps relative to other trap types. Light trap survey data are a primary line of evidence for moth declines. If light traps have been compromised by the coextensive intensification of artificial light at night, our understanding of Lepidoptera conservation must be reexamined.

Habitat Conservation (Ebony)

Chair: Christine Haaland
Swedish University of Agricultural Sciences, Sweden.

Butterfly and Moth Conservation: results from a global synopsis of evidence.

Andrew Bladon, Rebecca K. Smith and William J. Sutherland
Department of Zoology, University of Cambridge, UK.

In the last few years, global concern over the decline of insect populations has increased, and efforts to assess trends have intensified. Butterflies and moths represent a diverse and popular insect Order with a long history of ecological study and a vital role in ecosystem function, and have become a flagship for insect conservation. But despite a good understanding of their ecology and natural history, how much do we know about the effectiveness of conservation actions for Lepidoptera? While there is an urgent need for conservation action, it is vital that interventions are effective and evidence-based to ensure the cost-effective allocation of resources and delivery of results. We used the subject-wide evidence synthesis approach developed by Conservation Evidence to compile the global evidence for butterfly and moth conservation into a single synopsis, which is freely available online for practitioners and policymakers. I will present an overview of the synopsis, including an introduction to the Conservation Evidence approach, a description of the availability and quality of evidence for global butterfly and moth conservation, and an analysis of the extent to which patterns and biases in the evidence match or differ from other taxa covered by Conservation Evidence synopses.

The biodiversity of a conifer-dominated forest at different stages of transformation towards Irregular High Forest

Patrick Cook[1] Daniel Alder[2], Lisbeth Hordley[1], Stuart Newson[3].
1 Butterfly Conservation (UK), Manor Yard, East Lulworth, Wareham, Dorset, UK. 2 Independent Ecologist. 3 British Trust for Ornithology, The Nunnery, Thetford, Norfolk, IP24 2PU, UK.

Commercial, conifer dominated forestry is a major land use in the UK and an important sector for the provision of timber. There is a growing interest in alternative forestry techniques in the UK, such as irregular silviculture, and stands can be found at varying stages of transformation towards irregular structures. We examined the response of moths and bats in conifer dominated stands managed under irregular silviculture principles at a site in Southern England. We document the biodiversity found at the site and specifically tested (1) the influence of habitat structure within stands on biodiversity and (2) the response of biodiversity to three irregular forest development stand stages at different stages along the continuum of transformation. There was a surprising level of biodiversity at the site, despite the conifer dominated nature of the stands and plantation origins on grassland. A total of 248 moths (27% of larger moths associated with woodland) and 13 bats (76% of all UK resident species) were recorded. Habitat structural features identified as important for moths and bats included; (1) a canopy with patchy openness, (2) higher canopy cover of broadleaved trees and (3) greater quantities of deadwood.

Landscape composition explains butterfly use of clear-cuts in contrasting forest-farmland mosaics

Lars B Petterson[1], Dafne Ram[1], Åke Lindström[1] and Paul Caplat[2].
1Department of Biology, Biodiversity Unit, Lund University, Ecology Building, SE-223 62 Lund, Sweden. 2 School of Biological Sciences, Queen's University Belfast, UK & Centre for Environmental and Climate Science, Lund University, Sweden.

Land use intensification and habitat loss have led to widespread declines in European butterflies. Whereas habitat quality is crucial for butterflies, the distribution of habitats at the landscape scale also matters. In Sweden, clear-cuts in production forests are ubiquitous. This transient habitat is commonly used by butterflies. We compared butterfly communities in 120 clear-cuts in two Swedish regions. All Swedish farmland indicator species and 75% of the grassland indicator species were observed in clear-cuts. The butterfly communities differed between the regions and were influenced by the amount of clear-cuts and farmland in the surrounding landscape. Many butterfly species were more abundant on clear-cuts the more open habitat there was in the landscape, independently of whether these open habitats were farmland or clear-cuts. Hence, clear-cuts may be functional habitats for some species, and these species do not necessarily see clear-cuts as very different from other open habitats available in the landscape. Given that clear-cuts are only suitable for a few years, butterflies must have good dispersal abilities to be able to find them soon after they appear. The larger question is how important clear-cuts are as full-worthy, albeit temporary, habitat, or if they serve as complementary habitats in the forest-farmland landscape.

Lepidopteran Response at a Large, High-Diversity Restoration Intended to Restore Connectivity and Expand Habitat

John Shuey
The Nature Conservancy, Indiana Field Office, Indiana, USA.

The eastern tallgrass prairie of North America is shattered, largely converted to agriculture. In 1997, we initiated a >3000 ha restoration as a strategy to restore connectivity and expand habitat at a modest 8,500 ha grassland/savanna landscape. We included phytophagous insects as conservation targets and planted the vast majority of the vascular plant species (621 species) known from adjacent natural habitats on the assumption that the majority of regionally imperilled insects are monophagous. High diversity/quality restoration is time consuming, and our last major planting was completed in 2021.

Butterflies in the city: Habitat suitability and connectivity for urban woodland butterflies

Bradley Neal, Phillip Wheeler and Yoseph Araya
The Open University, Milton Keynes, UK.

As urban land use expands, understanding the conservation of biodiversity in urban settings becomes increasingly important. Urban areas contain a wide range of remnant natural, semi-natural and anthropogenic woodlands but the biodiversity of these woodlands is not well studied. We used repeat line transect surveys to investigate the habitat associations of butterflies in ten woodland patches representing a range of sizes and woodland characteristics in the urban habitat matrix of Milton Keynes, UK. We found that urban woodlands supported a significant proportion of the woodland butterfly community in the wider landscape, and that butterfly species richness and abundance was associated with woodland type rather than patch size, with significant differences in biodiversity indices and structural complexity between woodland patches. This has important implications for the management of small urban woodland patches as elements of habitat networks to support urban butterfly populations. Future work will involve using remote sense data to rapidly assess the structural complexity of the Milton Keynes roadside vegetation to help determine its function as a pipeline to aid butterfly movement from patch to patch.

Landscape-scale impacts of conservation management on Lepidoptera: testing agri-environment scheme gradients at two spatial scales

Jo Staley[1], Marc Botham[1], Susan Jarvis[2], John Redhead[1], Morag McCracken[1] and Emily Upcott[1]
1 UK Centre for Ecology and Hydrology, Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB, UK. 2 UK Centre for Ecology and Hydrology, Lancaster Environment Centre, Library Avenue, Bailrigg, Lancaster, LA1 4AP, UK.

Agri-environment schemes (AES) are a significant mechanism to deliver environmental policy within the UK, mainland Europe and elsewhere. We applied a novel, pseudo-experimental design to assess the responses of butterflies and moths to AES interventions at large spatial scales, specifically considering impacts beyond farm or AES agreement boundaries. Survey sites were selected along two contrasting AES gradients at local (1km2) and landscape (3 × 3km) scales, applied to arable, grassland and upland agricultural systems. Butterflies and moths, along with other mobile taxa (pollinating insects, birds and bats), were monitored at 54 sites for four years.
Strong evidence was found for positive relationships with the local and / or landscape AES gradients for butterflies and moths, in terms of whole community responses (total abundance, species richness or diversity). The positive relationships found with the local and landscape gradients indicate that greater AES uptake is associated with greater species richness, diversity or abundance of both butterflies and moths. For example, there were on average 117 (53%) more butterflies at the high vs the low end of the landscape AES gradient. These results are relevant for AES policy, including in the context of the ongoing development and piloting of the Environmental Land Management Schemes.

How do ecological traits affect the responses of Lepidoptera to agri-environment scheme management?

Marc Botham[1], Susan Jarvis[2], John Redhead[1], Morag McCracken[1], Emily Upcott[1] and Jo Staleym[1].
(1) UK Centre for Ecology and Hydrology, Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB, UK. (2) UK Centre for Ecology and Hydrology, Lancaster Environment Centre, Library Avenue, Bailrigg, Lancaster, LA1 4AP, UK.

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Kleurkeur – From idea to a certification scheme in practice

Manon Wieringa, Stip, A., Vliegenthart, A., Veling, K., Molenaar, M. and Van Houten, C.
Dutch Butterfly Conservation, Wageningen, the Netherlands.

Road verges and other common green areas have a huge potential for biodiversity. They function as ecological corridors, living areas for flora and fauna and stepping stones for species. However, oftentimes these functions are not met because of the lack of ecological management. For this reason, habitat functions for species like *Phengaris teleius* becomes endangered. In order to adapt roadside maintenance to the benefit of biodiversity and with that many butterflies and other species, the Dutch Butterfly Conservation started Kleurkeur in 2019. With Kleurkeur a certification scheme for ecological management of roadsides and common green areas was founded that hands out practical measures and ensures ecological sound maintenance. We would like to give an overview of our findings after three years of implementation. What are the bottlenecks and the strong points? What does the future look like? And maybe the most pressing question: what are the most important steps for a successful certification scheme for ecological management?

Adding shades of grey in a black and white landscape: resource-based habitat quality influences population dynamics in the bog fritillary

Nicholas Schtickzelle and Victor Brans
UCLouvain - Earth & Life Institute, Croix du Sud 4, L7.07.04, 1348 Louvain-la-Neuve, Belgium.

The bog fritillary (*Boloria eunomia*) is a specialist butterfly inhabiting wet meadows and peat bogs, originally chosen as a model system to study metapopulation dynamics because, for this species, the landscape can be easily defined by a clearcut but meaningful "habitat vs matrix" dichotomy. It has been intensively studied in Belgium since 1992, becoming a landmark study system for (meta)population dynamics and viability. Here, we show how we refined our understanding of its population dynamics, in its density-dependent and density-independent aspects, by adding levels of details in the quantification of its habitat quality. We replaced the simplified black and white view ("habitat quality is constant, only habitat size and configuration in the matrix matters") by a more detailed "shades of grey" view ("habitat quality varies in space and time according to resource availability"). We present how we synthesized data collected on the species over 30 years to reconstruct spatiotemporal changes in habitat quality, filling data gaps via interpolation, proxy variables or expert assessment, and used this to revisit the estimation of density dependence in population dynamics.

Nature-inclusive practices - The interdisciplinary approach to biodiversity restoration in different areas in the Netherlands

Nora Thierry
Dutch Butterfly Conservation, Wageningen, the Netherlands.

Biodiversity is under severe pressure in the Netherlands. In this densely built-up nation, every square metre already has an end use, leaving very little space for biodiversity outside of the Natura 2000 areas. At present, ecologically valuable areas are fragmented and fauna is trapped within these areas. The Dutch Butterfly Conservation is collaborating with organisations from different disciplines on nature-inclusive approaches to create ecologically valuable landscapes outside of the nature reserves, such as in urban areas, business parks, industrial estates and infrastructure. To ensure the quality of these nature-inclusive interventions, the Dutch Butterfly Conservation has developed guidelines for nature-inclusive practices. An example is a roadmap developed for the sand and gravel mining industry on how to create and maintain habitat for pollinators on their mining sites. This roadmap describes the necessary steps to be taken in order to successfully pursue biodiversity restoration as an integral part of the landscape outside of nature reserves.

Lepidoptera reintroduction in England: to reintroduce or not to reintroduce?

Simon Curson and Tim Bernhard
Chief Scientist Directorate, Natural England, Peterborough, UK.

Conservation translocations are the intentional movement and release of living organism where the primary objective is a conservation benefit. This includes reinforcement or reintroduction within a species' indigenous range with assisted colonisation and ecological replacement outside of the indigenous range.
Conservation through intervention is now common. There should be strong evidence that the threats that caused previous extinctions have been correctly identified and removed or sufficiently reduced. Prior to start planning a translocation, we should consider whether there are less interventionist management options that would be as effective to meet the objective. A translocation should have clearly defined goals, and follow a logical process from initial concept, feasibility, engagement, design and plan, risk assessment, implementation, monitoring, adjustment and evaluation.
In Britain, there have been several Lepidoptera extinctions, including well known cases such as with the Large Copper and Large Blue. In the case of the Large Copper, several attempts have been made to re-establish the species in Britain, all of which have failed. We have now a better understanding of the complexity and scale of its specific habitat requirements and following IUCN guidelines and the Reintroduction Code for England, there is scope to make a re-introduction that has a considerably higher chance of long-term survival. This would involve restoration of habitats at a landscape scale through the East Anglian fenland. Large Copper is an iconic species, which like the Large Blue, would engage the public and stakeholders to support the wider conservation objective of the re-establishment of a large-scale fenland habitat.
However, with predicted changes in landscape and climate, should we be spending time, effort and money on such re-introduction schemes? Or should we accept that some species have disappeared, and others will arrive under their own steam?

Micro-climate studies (Rosewood 1)

Chair: Thomas Merckx
Biology Department, Vrije Universiteit Brussel, 1050 Brussels, Belgium.

Seasonal change in oviposition micro-habitat preferences of the High Brown Fritillary butterfly (*Fabriciana adippe*)

Julie Simons[1], Paul Ashton[1], Anne Oxbrough[1] and Rosa Menendez[2]
1 Dept. of Biology, Edge Hill University, Ormskirk, UK. 2 Lancaster Environment Centre, Lancaster University, UK.

Successful oviposition strategies influence the survival of butterfly populations. The preference-performance hypothesis suggests that females select sites that maximise offspring performance. For species overwintering as an egg, females face additional complexity of choosing a location which will be optimal for the larvae upon hatching the following spring. The UK population of the endangered High Brown Fritillary (*Fabriciana adippe*) survives in just four landscape areas. The spring-emerging larvae require a warm early successional habitat for development. Changes of environmental conditions in these habitats can occur rapidly due to vigorous vegetation re-growth, exacerbated by global warming induced early onset of the growing season. This research investigates the rate of change in micro-habitat variables during the overwintering egg stage and their influence on temperature variation to provide a new understanding of the oviposition preferences of the endangered High Brown Fritillary. Results are discussed in the context of short-term environmental change and implications for successful conservation of a threatened species.

Cool as a caterpillar: Differences in thermoregulatory ability between life stages of British butterflies

Esme Ashe-Jepson[1], Edgar C. Turner[1], Andrew J. Bladon[1], Gwen E. Hitchcock[2] and Rich Knock[2].
1 Department of Zoology, University of Cambridge, UK. 2 Wildlife Trust of Bedfordshire, Cambridgeshire, and Northamptonshire. UK.

Climate change poses a severe threat to ecological communities, the impacts of which have been recorded on many taxa, particularly ectothermic organisms such as insects. The thermal adaptation of a species will play a critical role in population persistence and extinction risk. Butterflies are an ecologically sensitive group, showing marked responses to environmental change. Body temperature is a key determinant for many processes relevant for butterfly fitness, therefore there is strong selective pressure for butterflies to maintain their body temperature within tolerable ranges under variable ambient conditions. However, most studies of butterfly responses to temperature are on adults, making it difficult to predict how thermoregulatory ability, and therefore sensitivity to changing ambient conditions, differs across life stages. Larvae differ morphologically, behaviourally, and ecologically from adults, therefore it is likely that they differ in thermoregulatory ability. In this study, we investigated how larvae and adults from 12 butterfly species across a network of reserves in Bedfordshire responded to fine-scale changes in air temperature. We found significant differences in thermoregulatory ability between life stages, as well as traits that predict the buffering ability of larvae. Our findings have important implications for identifying species at risk under future climate change.

Feeling the heat: can microclimate and behaviour buffer butterflies against climate change?

Marcus Rhodes[1], Richard ffrench-Constant[1], Jonathan Bennie[1], Adrian Spalding[2] and Ilya Maclean[1]
1 University of Exeter, UK. 2 Spalding Associates (Environmental Ltd), UK.

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Oviposition choice in Lepidoptera: microclimate matters, but why?

Simon Braem and Hans Van Dyck
Behavioural Ecology & Conservation Group, Earth & Life Institute, UCLouvain, Louvain-la-Neuve, Belgium.

The way Lepidoptera lay their eggs varies a lot among species. While searching for suitable oviposition sites, butterflies and moths are likely to respond to a range of environmental factors that are assumed to correlate with offspring survival and growth. For many species, microclimate plays a significant role for the selection of a suitable host plant or even a specific part of the host plant. However, we know still little about how common microclimatic preferences really are, and results of published studies are mixed about the circumstances under which expected oviposition preference would affect offspring performance. We will present a preliminary literature survey on microclimatic preference during oviposition site selection, which was conducted during a PhD-project. We present and discuss some of the outstanding questions on this very topic, which open new perspectives on the evolutionary relevance of oviposition site preference and its significance in a species conservation context. In addition to insights from the literature, we will also present and integrate new experimental data on intraspecific variation in oviposition behaviour in the Speckled Wood Butterfly (*Pararge aegeria*). Results demonstrate how *P. aegeria* females of different anthropogenic landscapes deal with microclimatic mosaics for egg laying.

Abstracts: Sunday 16th April 2023 (AM)

Keynote Lecture (Rosewood 1)

Back to basics: Challenges to Lepidoptera conservation in the tropics

Blanca Huertas
Natural History Museum, Cromwell Rd, South Kensington, London SW7 5BD, UK.

The often use of butterflies as flagship organisms for conservation because of their charismatic appearance and appeal to the public, hasn't reached its full potential in areas of the planet with the largest diversity of species recorded. Despite centuries of research in Lepidoptera, information for species distributions and ecological data for most species is almost inexistent, scarce or is not unpublished anywhere. Most species rich' nations from tropical regions are not yet fully documented and the taxonomy in various groups remains unresolved, including examples of potentially endangered species still unnamed. There are also gaps in critical information for decision making such as national checklists, Red List Assessments and studies in endemism. Consequently, butterflies as well other insects are little used for conservation programmes and left out of bioeconomy programmes. Whilst most research funding prioritises innovative research to mitigate threats for humans and the planet (e.g. climate change), core research to fill up gaps in knowledge remains undervalued and underfunded as a result. Likewise, building capacity and communication to wider audiences to preserve, understand and exploit critical information locked away is also often belittled in funding proposals and conservation practise. Although the impediments and gaps that research and conservation programmes face in the tropics, there is hope. In an age when technology has increased accessibility for scientists and citizen scientist alike, I will present some examples that might bring new opportunities for the butterflies and its habitats in the world's richest nations in biodiversity, but also most threatened.

How widespread are declines in Lepidoptera? (Rosewood 1)

Chair: Rosa Menéndez
Lancaster Environment Centre, Lancaster University, UK.

Harnessing community science initiatives to assess trends in butterfly biodiversity

Maxim Larrivée[1], Federico Riva[1,2], KP McFarland[3] and Solis-Sosa, R.[4,5]
1 Montréal Insectarium, Montréal, Quebec, Canada. 2 Department of Ecology and Evolution, Université de Lausanne, Switzerland. 3 Vermont Center of Ecostudies. Vermont, USA. 4 eButterfly, Canada. 5 School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada.

Understanding insect declines has emerged as an essential priority in conservation. Many studies suggest that – at least locally – population trends are plummeting, and thus biodiversity is destined to decline. However, beyond a few exceptional studies, a lack of large-scale and long-term data hinder through assessments of biodiversity change at the large scales at which global conservation initiatives typically act. Community science initiatives have recently emerged as a potential source of data to address these shortcomings. We leverage the observations submitted to eButterfly in the form of checklists (https://www.e-butterfly.org/) by community scientists across North America to assess whether and where butterfly biodiversity has changed in the last decade. Using a randomization approach and tens of thousands of checklists, we evaluate whether butterfly biodiversity has indeed declined across regional and continental scales. To our knowledge, this analysis provides one the first assessment of butterfly biodiversity trends across large extents, fine grains, and at northern latitudes for the most beloved insect taxa in community science.

The State of the UK's Butterflies

Richard Fox[1], Emily B Dennis[1], Karen M Purdy[1], Ian Middlebrook[1], David B Roy[2], David G Noble[3], Marc S Botham[2] and Nigel AD Bourn[1]
1 Butterfly Conservation (UK), Wareham, Dorset, UK. 2 UK Centre for Ecology & Hydrology, Benson Lane, Wallingford, Oxfordshire, OX10 8BB, UK. 3 British Trust for Ornithology, Thetford, Norfolk, UK.

The plight of insects has become a common concern but robust empirical evidence for insect declines remains limited. Although the UK is among the most ecologically degraded countries on earth, it has some of the best insect monitoring data. We present the latest assessment of long-term abundance and distribution trends for UK butterflies derived from countrywide schemes using millions of citizen-science observations. UK butterfly indicators show a reduction of 6% in abundance at monitored sites and a 42% decrease in distribution over the period 1976-2019. Almost twice as many butterfly species have decreased significantly in abundance or distribution, or both, than have increased: 59% have decreased and 32% increased. Habitat specialists show much stronger declines, particularly in distribution, than wider countryside species. For the first time, we also present separate butterfly abundance and distribution trends for all four UK countries; England's butterflies have fared the worst, while Scotland is the only country in which butterflies show a pattern of overall long-term increases. Despite the gloomy overall picture painted by the long-term trends, numerous examples show that, given sufficient resources, targeted species conservation action can turn around the fortunes of threatened butterflies at site, landscape and national levels.

Rural abandonment and climate change threaten south European Mountain butterflies

Amparo Mora Cabello de Alba[1,2] and José Miguel Barea[3,4]
1 Lancaster University, 2 Picos de Europa National Park. 3 Agencia de Medio Ambiente y Agua de Andalucía, Spain. 4 Granada University, Spain.

Severe declines of butterfly populations have been reported in western Europe, but little is known of how populations are doing in southern Europe, though worrying decreasing trends have been documented in Catalonia (NE Spain). Moreover, existing butterfly time series come from densely populated, highly modified and relatively flat regions in Europe, while mountain ranges, much less populated and harbouring high butterfly diversity, are less studied due to the difficulty of setting up long term monitoring in difficult terrain and weather conditions. Here, we analyse trends for butterfly populations in two mountain ranges in southern Europe (Picos de Europa, N Spain and Sierra Nevada, SE Spain). Both areas together hold 60% of all Iberian species and 28% of European species. Population trends in the last decade differed between the two mountain ranges with significant declines in Picos de Europa, but fluctuations in Sierra Nevada, declining initially but with positive trends in recent years. Our results suggest that land use changes (i.e. abandonment) is acting synergistically with climate change, exacerbating their effects on butterfly populations. These mountain regions, though protected as National Parks, are under a great threat. Landscape-scale adaptive measures, continued monitoring, and increasing our scientific knowledge will be essential.

Changes in butterfly species composition in grasslands in a study area in Southern Sweden between 1997 and 2019

Christine Haaland
Swedish University of Agricultural Sciences, Sweden.

In summer 1997, butterflies were recorded in grasslands along transects in a study area located East of Lund (Scania, Sweden). These recordings were repeated in 2019. Land-use in the study area (covering about 1800 ha) was also investigated again as well as certain environmental factors. Overall species number (n=25) was higher in 2019 compared to 1997. In 2019, 10 new species were recorded, while 4 could not be found again (i.e. *Cyaniris semiargus*, *Lycaena hippothoe*, *Brenthis ino*). Species numbers increased or stayed the same in almost all transects. Overall abundances were similar between the years with 2209 individuals recorded in 1997 and 2247 in 2019. Largest increase in individuals showed *Maniola jurtina*, *Coenonympha pamphilus*, *Cynthia cardui* and *Lycaena phleas*. Only minor changes of certain environmental factors were observed, these showed a trend to a slightly less intensive grazing (higher vegetation, higher flower abundance) and abandonment of some grasslands. The study area was already in 1997 characterised by intensive farming dominated by large arable fields, but with some semi-natural grasslands – mostly nature reserves – left. In 2019, trends of further intensification could be identified (merging of fields, 50% decrease of ley), while permanent grasslands remained almost to the full extent.

A new Red List of European Butterflies

Martin Warren[1], Sam Ellis[1], Chris van Swaay[2] and David Allen[3]
1 Butterfly Conservation Europe. 2 Dutch Butterfly Conservation, Wageningen, Netherlands. 3 IUCN, Gland, Switzerland.

The last Red List of European butterflies was produced in 2010, using data from the previous 10 years, so is now quite out of date. The last assessment was also made by combining highly variable trend data from each country, often derived purely from expert opinion. The current Red List takes advantage of two major new datasets. First, the European Butterfly Monitoring Scheme, which gathers data from 22 countries, has generated trends for over 169 species for the period 2009-2018. Second, a large amount of distribution records are now available via GBIF and other portals that can be used to generate distribution trends for the majority of Europe's 474 species. Together these can provide a far more accurate assessment of extinction risk than was previously possible. Many rare species are also covered by bespoke surveys now, and this information was gathered from regional experts. The provisional results will be presented, with examples of species that are newly assessed as threatened, and a few that have been removed from the list. We will also discuss the limitations of the Red Listing process, which looks only at trends over the last 10 years and ignores long term declines.

Lepidoptera conservation and Agriculture (Rosewood 3)

Chair: Michiel Wallis de Vries
Dutch Butterfly Conservation, Wageningen, the Netherlands.

Underestimated threats for butterflies

Simona Bonelli[1], Alfredo Santovito[1], Tiziana Schilirò[2], Marta Gea[2] and Irene Piccini[1].
1 Department of Life Science and Systems Biology, University of Turin, Italy. 2 Department of Public Health and Pediatrics, University of Turin, Italy.

Biodiversity is currently declining worldwide. Several threats have been identified such as habitat loss and climate change. Nevertheless, little information is known on lethal and sub-lethal effects of pesticides and air pollutants on non-target organisms, such as butterfly and other invertebrates. These elements can work in addition or in synergy to other threats or other compound (i.e. fungicides and heavy metals), contributing to the decline of current species and/or local extinction.The aim of our work was to investigate—by micronucleus (MN) assay—the sub lethal, genotoxic effect of the glyphosate-based herbicide and of the particulate matter (PM) on two target butterfly species (*Lycaena dispar* and *Pieris brassicae* respectively). MNi represent chromosome fragments or whole chromosomes that fail to segregate properly during mitosis, appearing as additional nuclei. They are the result of clastogenic or aneugenic damage. This method was never been applied on invertebrate larvae and on Lepidoptera before. Results showed that glyphosate and PM extracts induced significant DNA damage in exposed caterpillars compared to controls. In conclusion, it has proven that glyphosate and PM induce genomic damage at the larval stage that can constitute local threats for survival and vitality of butterfly populations.

The Barberry Carpet moth (*Pareulype berberata*): Past, Present, and Future

William Millard
University of East Anglia, Norwich, Norfolk, UK and The John Innes Centre, Norwich, Norfolk, UK.

The Barberry Carpet moth has been subject to conservation measures in England since 1970. The larvae feed on the foliage of Common Barberry, and adults utilise the plant for shelter during the day. Common Barberry has a scattered distribution in the UK and is not considered to be a native. Common Barberry was historically planted in orchards and gardens for its fruit in England, but research has suggested it was never widespread in the UK[1]. Common Barberry acts as a host for the fungus *Puccinia graminis*, which causes Stem Rust in cereal crops. Research has shown that most varieties of wheat grown in the UK are NOT resistant to stem rust[2]. Outbreaks of Stem Rust are becoming more common in mainland Europe, and may soon become prevalent in the UK. Any future conservation work will need to utilise the evolving evidence base for insect conservation and crop protection. This talk will outline the history of the Barberry Carpet moth in the UK, and will provide insight into its future.

Understanding the effects of atmospheric nitrogen deposition on butterflies in the UK

Hannah Risser[1,2], Carly Stevens[1], Ed Rowe[3], Susan Jarvis[2] and Susan Zappala[4]
1 Lancaster Environment Centre, Lancaster University. 2 UK Centre for Ecology & Hydrology, Lancaster, UK. 3 UK Centre for Ecology & Hydrology, Bangor, UK. 4. Joint Nature Conservation Committee, Peterborough, UK.

Atmospheric nitrogen deposition has been linked with an overall loss of plant species richness and homogenisation of semi-natural habitats both in the UK and elsewhere. We expect that nitrogen-induced changes in plant communities will impact invertebrate species through the loss of reproductive habitat, food plants and suitable microclimatic conditions caused by the shifts in composition of plant communities. Butterflies are often used as indicator species due to their sensitivity to environmental change, our comprehensive understanding of their ecology, and the existence of long-term datasets on their abundance and distribution. We performed a spatio-temporal analysis on data from the UK Butterfly Monitoring Scheme using generalised additive models to understand the complex and often non-linear relationships between butterfly trends and their drivers. We demonstrate that butterflies vary in their relationships with nitrogen deposition and highlight both species-level and trait level differences.

Butterfly responses to a broad range of foodplant nitrogen levels

Will Langdon[1], Owen Lewis[1] and Richard Fox[2]
1 University of Oxford. 2 Butterfly Conservation UK, Wareham, Dorset, UK.

Despite the ever-increasing body of work that suggests European butterfly and moth communities are changing in response to increasing levels of reactive nitrogen in the environment, there is a paucity of experimental work attempting to examine the mechanisms underlying these changes. Alongside micro-climatic cooling and loss of foodplants, some authors suggest that an important driver could be changes to foodplant stoichiometry, but struggle to reconcile the heterogeneous results of experiments testing the responses of herbivores to increasing foodplant nitrogen. These show very variable effects, perhaps reflecting a mix of variation in herbivore nutritional optima, and nitrogen treatments used in experiments (which vary in their distance from these optima). Here we report the results of experiments looking at variation in the responses of several common butterfly species to increasing foodplant nitrogen across a broad range of treatments, hoping for a first step towards reconciling some of the variable results of current experimental work.

Marvellous moths! Pollen deposition rate of bramble is greater at night than day

Max Anderson[1,2], Fiona Mathews[1] and Ellen Rotheray[1]
1 University of Sussex, Brighton, UK. 2 Butterfly Conservation (UK), Wareham, Dorset, UK.

Widespread concerns about declines of wild pollinating insects has attracted considerable research interest. However, this has almost exclusively focussed on bees and other diurnal invertebrate taxa. This study aimed to assess the relative contribution of diurnal and nocturnal insects to the pollination of bramble, which has been identified as a key source of pollen and nectar for diurnal pollinators. The results emphasise the importance of bramble as a resource for pollinating insects, supporting a diverse range of taxa. In light of the threats of changes to grazing management practices and habitat loss faced by pollinating insects, this work highlights the value of low intensity, conservation grazing in facilitating beneficial scrub development and habitat heterogeneity. Crucially, the findings demonstrate for the first time, that approximately one third of all pollen on the stigmas of bramble flowers is deposited at night than in the day, and moths are responsible for the overwhelming majority of flower visits, emphasising the importance of these insects in pollination.

Final Plenary session (Rosewood 1)

Chair: Julie Williams
Butterfly Conservation (UK), Wareham, Dorset, UK.

Direct and indirect climate stressors of montane butterflies

Chris Halsch[1], Arthur Shapiro[1], Adriana Parra[2], Kyle Rodman[3], James Thorne[1] and Matthew Forister[2].
1 University of California, Davis, California, USA. 2 University of Nevada, Reno, Nevada, USA. 3 Ecological Restoration Institute, Northern Arizona University, Flagstaff, Arizona, USA.

Climate change is a driver of declines of butterflies in the Western United States. However, climate change is not one cohesive phenomenon and can be decomposed into a network of direct and indirect pathways resulting from rising temperature, altered precipitation patterns, and increasingly frequent extreme events. Using the longest insect monitoring dataset in North America, remotely sensed data, and high-resolution climate data, we explore hypotheses about the direct and indirect impacts of climate on butterflies in the same year and in the previous year. Specifically, we use Bayesian hierarchical path analysis to quantify the relationships between weather, remote sensed plant variables, and butterflies. We show that changing conditions are having a negative impact on butterflies in relatively pristine montane regions. While we find considerable heterogeneity (among species and sites) in the nature and magnitude of weather impacts, the direct impacts of snow on butterflies are widespread and potentially important for the future of butterflies experiencing more frequent and extreme disruptions to winter snowfall. These results demonstrate the complexity of climate driving butterfly declines in montane regions and the importance of considering lagged effects for predicting population responses.

From Coast to Coast: Comprehensive U.S. At-Risk Butterfly Conservation and Recovery Efforts

Jaret Daniels[1], Geena Hill[2] and Kristin Rossetti[3]
1 University of Florida; 2 Florida Natural Areas Inventory; 3 Florida Museum of Natural History, USA.

A growing body of evidence supports ongoing defaunation of butterflies in North America. The drivers of loss are complex and often attributable to multiple, interacting factors, several of which may be incompletely understood. In the face of this uncertainty, effective at-risk species recovery efforts require a comprehensive toolkit of diverse options to help stabilize, reestablish, and ultimately increase wild populations. As part of a comprehensive decadal effort, we focused on some 42 different declining or federally listed butterfly taxa in the United States. We deployed collaborative recovery planning with diverse stakeholder communities using the Open Standards for the Practice of Conservation to strategically develop, manage, and evaluate tailored initiatives. These involved a broad mix of approaches including habitat and species restoration, basic research, and public education. We present a detailed overview of these efforts, their impact, and the lessons learned.

Breaking down barriers to inclusion in butterfly recording

Megan Lowe, Steve Bolton, Rachael Conway, Ele Johnstone, Kate Merry and Chloe Smith
Butterfly Conservation UK, Wareham, Dorset, UK.

Citizen science, the involvement of members of the public in gathering scientific data, has grown in popularity in the UK and the world in recent years. In addition to the data itself, Butterfly Conservation's recording schemes offer an important opportunity for the charity to engage large numbers of people in recording and our wider work.
Using demographic data gathered through participant surveys, we explore the differences and similarities between audiences who take part in two distinct citizen science schemes: the 'entry level' Big Butterfly Count, and the more advanced UK Butterfly Monitoring Scheme.
Results revealed a broadly similar audience for both schemes, with a narrow sector of UK society reflected in the recording community. We consider the implications of these results, and the potential barriers that prevent wider participation. We provide examples of how we are working to overcome barriers, increase our reach, and better support both current and future butterfly recorders.

From volunteer counts to European wide protection of butterflies: eBMS - European Butterfly Monitoring Scheme

Christina Sevilleja[1,2], Nigel A D Bourn[3], Sue Collins[2], Irma Wynhoff[1,2], Josef Settele[4], Chris van Swaay,[1,2], Martin Warren[2], Reto Schmucki[5] and David B. Roy[5]
1 Dutch Butterfly Conservation, P.O. Box 506, 6700 AM Wageningen, the Netherlands. 2 Butterfly Conservation Europe, P.O. Box 506, 6700 AM Wageningen, Netherlands. 3 Butterfly Conservation, Manor Yard, East Lulworth, Wareham, Dorset, BH20 5QP, UK. 4 Helmholtz Centre for Environmental Research, Theodor-Lieser-Strasse 4, 06120 Halle, Germany. 5 UK Centre for Ecology & Hydrology, Benson Lane, Wallingford, Oxfordshire, OX10 8BB, UK.

The current biodiversity and climate crisis's are seriously impacting insects, but there are still gaps in our knowledge about their trends and threats. Long-term monitoring data are essential to clarify the trends of biodiversity and support evidence-based conservation actions. The European Butterfly Monitoring Scheme (eBMS) coordinates the long-term and standardized monitoring of butterflies across Europe. Thanks to the support of two EU-funded Projects, ABLE and SPRING, the network of volunteers and experts joining eBMS is being developed, supported centrally and growing fast. In this presentation, we will present the current state of eBMS, which currently consists of more than 20 participating countries, with almost 30 Butterfly Monitoring Schemes and more than 10,000 transects, contributing 15 million counts to the database from 1976 to 2020. We will describe future developments and plans for this growing network, focusing on the citizen science aspect. The eBMS network and database are a fundamental resource to help detect environmental changes related to the distribution and abundance of butterflies, which serve as ambassadors for insect biodiversity.

The re-introduction of the Chequered Skipper to England and a briefing on today's field visit to the site.

Nigel Bourn and Susannah O'Riordan
Butterfly Conservation UK, Wareham, Dorset, UK.
We will present a brief overview of the science underpinning the re-introduction of *Carterocephalus palaemon* to England using stock from Belgium, report on the progress of the project, the key lessons learnt and the next steps to ensure its continued presence in England.

Poster abstracts

Poster sessions are between 18:00 and 19:00 on Friday 14th and between 18:00 and 19:30 on Saturday 15th including the Symposium wine reception. Poster presenters are requested to be by their posters during these times to discuss their work.

The butterfly monitoring scheme in Spain: Network status and preliminary results

Amparo Mora Cabello de Alba, Miguel Munguira, Saba González, Fernando Jubete, Ángel Marco, Sergio Montagud, Ignacio Arce, Marisol Redondo, José Miguel Barea, Rocío Zamudio, Cristina Sevilleja, Juan Pablo Cancela, and David Gutiérrez
Sociedad para la Conservación y el Estudio de las Mariposas en España (SOCEME).

Spain is one of the European countries supporting more biodiversity due to its location in the Mediterranean basin, topographical complexity and historical preservation of traditional land uses. Consequently, it is a major priority area for the study and conservation of butterflies. The Spanish Butterfly Monitoring Scheme, part of the European scheme, has shown a steady increase in the number of recording sites since its setting in 2014. Currently, a total of 211 transects are active throughout the entire country (except for Basque Country, Navarra, La Rioja and Catalonia, which have independent schemes). Half of these transects are placed in natural protected areas (Biosphere Reserves, National Parks and others). Here, we present some preliminary data analyses for the 9 first years of monitoring based on more than 8,200 field visits that resulted in more than 600,000 butterfly records and 210 species. We also summarize the ongoing work in terms of monitoring, communication and dissemination of results.

Butterfly species richness, abundance, and diversity in fragmented urban landscapes: implications for conservation and management strategies

Flora Tiley
University of the West of England, UK.

Urbanization causes fragmentation of natural landcover. Butterflies are important pollinators and environmental indicators that are found in these fragmented urban greenspaces. Butterflies are sensitive to urbanization, so more research is needed to understand the interplay of variables that influence butterfly populations across heterogenous urban landscapes. This study assesses the effects of local and landscape factors on butterfly assemblages in urban greenspaces. Butterfly richness and abundance was surveyed in 30 grassland sites (including parks, cemeteries, and nature reserves) in Bristol, UK from July to September 2022. Sites ranged in size, shape, proximity to city centre, management, use, plant diversity, proportion of mown grassland area and disturbance. Land use and land cover at 200m, 500m, 1000m and 2000m from the centre of the transect area was examined to quantify fragmentation. General linear models (GLMs) were employed to relate butterfly abundance, species richness and diversity to local and landscape variables. We recorded 1299 individual butterflies of 21 species. Findings suggest that time of year, temperature, plant species richness and water coverage at a small spatial scale relate to butterfly abundance and species richness. Understanding which variables have the greatest influence on butterflies informs conservation and management practices.

Departure and arrival of butterflies in France: A database-based study about disappearance and discovery of butterfly species in metropolitan French departments

Alexia Monsavoir, Gaëlle Sobczyk-Moran and Xavier Houard
Office pour les insects et leur environnement, France.

The poster presents a work at the scale of the French territory. The national butterfly databases were used to study the appearance or disappearance of each species in each department (which are administrative territorial divisions in France). The study of these statuses has made it possible to note the departments that seem to be most affected by the disappearance of butterflies, and also the species that seem to be disappearing the most suddenly from our territory. It appears that 66% of species have lost at least one department and the departments most affected by the disappearance of species are in the northern half of the country.

Back from the Brink – Limestone's living legacies project

Jan Gilbert, J. Bendle J. & J. Plackett
Butterfly Conservation, Wareham, Dorset, UK.

The Cotswolds is a landscape of national importance due to the unimproved limestone grassland within it. In the 1930s approximately 40% of the Cotswolds was covered by unimproved limestone grassland, but now this covers just 1.5% (Cotswolds AONB factsheet) The project, supported by the National Lottery Heritage Fund, was part of 'Back from the Brink'. This ground-breaking approach to nature conservation brought together seven species conservation organisations alongside Natural England and worked together to save a number of rare and threatened species across England. Much has been lost or declined in quality due to a decline in grazing, lack of management and scrub encroachment. This has resulted in a corresponding decrease in species richness.
www.cotswoldsaonb.org.uk/userfiles/file/Factsheet/FACTSHEET8.pdf

Building a Global Butterfly Index

Holly Mynott[1], Monika Bohm[2], Louise McRae[3], Chris Van Swaay[4], Federico Riva[5] and David Roy[6]

1 Butterfly Conservation, Manor Yard, East Lulworth, Wareham, Dorset BH20 5QP, UK. 2 IUCN SSC Butterfly & Moth Specialist Group, IUCN Species Survival Commission, Rue Mauverney 28, 1196 Gland, Switzerland. 3 Zoological Society of London, Regent's Park, London, England, NW1 4RY, UK. 4 Dutch Butterfly Conservation, Postbus 506, 6700 AM Wageningen, The Netherlands. 5 Institute for Environmental Studies, Vrije Universiteit Amsterdam, NU building, 8th floor, Wing A, De Boelelaan 1111, 1081 HV Amsterdam, The Netherlands. UK Centre for Ecology and Hydrology, Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, OX10 8BB, UK.

There is currently a taxonomic bias in conservation research towards vertebrates, resulting in limited data on trends or status for many insect groups. Where data exist, e.g. Europe and the USA, some large butterfly population declines have been recorded. Without sufficient monitoring elsewhere, we may be unable to recognise population declines and implement the required conservation actions. The Global Butterfly Index is a collaboration project aiming to gather time-series population data from butterfly monitoring schemes around the world to create an indicator of global butterfly population trends. We hope that the results will: The Global Butterfly Index is a collaboration project aiming to gather time-series population data from butterfly monitoring schemes around the world to create an indicator of global butterfly population trends. We hope that the results will: Create a global indicator to detect population changes which is less biased towards Europe and North America, Provide a mechanism to understand drivers of change across all biogeographic regions, and Establish an invertebrate group firmly in the global biodiversity indicator and policy space (including the Living Planet Index), so that the findings will have impact. The Global Butterfly Index project is in its early stages, and we are still looking for information about and data from butterfly monitoring schemes. This map summarises those we are aware of so far.

Could you add any information to this map?

Testing the effectiveness of field margins in preventing spray drift from reaching non-target Lepidopteran larvae

Ivy Ng'iru[1,2], Stephen Short[1], Dave Spurgeon[1], Pete Kille[2], David Buckingham[3] and Melanie Gibbs[1]
1 UK Centre for Ecology & Hydrology, Wallingford, Oxfordshire UK. 2 Cardiff University, UK. 3 The Royal Society for the Protection of Birds, Sandy, Bedfordshire, UK.

Along with habitat loss and climate change, pesticides are a major factor affecting global biological diversity. In Farmlands, field margins play a crucial role of offering habitats to various invertebrates including lepidopteran species. Margins also reduce the exposure of their inhabitants to agricultural chemicals. Often, lab toxicity tests focus only on determining lethal doses, preventing the assessment of sub-lethal doses which could impact fitness-related traits and ultimately have knock-on effects at the population level. In addition to this, various ecological factors coupled with differences in species behavior and micro-habitat use may influence bioavailability and chemical uptake. Consequently, this project aims to develop new methods (e.g., using molecular tools) to assess the effectiveness of field margins in attenuating pesticide spray drift in situ within UK field margins, determine how structural heterogeneity changes their effectiveness, determine the role ecological factors play in influencing sensitivity differences across species as well as provide empirical evidence to support and promote the use of field margins by farmers.

The shifting geography of second brood Small Tortoiseshell (*Aglais urticae*) in the UK

Ian Middlebrook[1], Marc Botham[2] and Richard Fox[1]
1 Butterfly Conservation (UK), Wareham, Dorset, UK. 2 UK Centre for Ecology & Hydrology, Benson Lane, Wallingford, Oxfordshire, OX10 8BB, UK.

There is a traditional perception in the UK that a strong second brood of Small Tortoiseshell (*Aglais urticae*) is more likely to be seen in the warmer southern counties, while first brood adults in northern areas are more likely to enter directly into hibernation. Analysis of data from the UK Butterfly Monitoring Scheme (UKBMS) shows a pattern that begins to contradict this view. Second broods are now being seen less frequently in south-east England, while producing good numbers in northern counties. This changing phenology may be one of the factors behind the significant long-term decline of this species in the UK. This poster illustrates how the geography of the second brood has been changing in the UK over the last 40 years.

The value of museum and other uncollated data in reconstructing the decline of the Chequered Skipper *Carterocephalus palaemon* in England

Jamie P. Wildman[1,2] Jeff Ollerton[1], Nigel A.D. Bourn[2], Tom M. Brereton[2], John L. Moore[3], Duncan McCollin[1]
1 University of Northampton, Northampton NN1 5PH, UK. 2 Butterfly Conservation (UK), Wareham, Dorset, UK. 3 Upper Redgate Farm, Dutlas, Knighton, Powys, LD7 1UE, UK.

The Chequered Skipper *Carterocephalus palaemon* was extirpated from England in 1977 following a precipitous decline in range and abundance in the 1900s. By searching and collating museum and other sources of data, we deepened understanding of decline to further conservation objectives. A preexisting Butterflies for the New Millennium (BNM) database of UK butterfly species records contained 266 historic English *C. palaemon* records. Labels attached to pinned butterfly specimens held at UK museums and natural history societies added 2,175 new records, whilst private specimen labels accounted for a further 465 records. Museum and private collection labels represented 2,640 (74.7%) of all new records. Entomological diaries and published and unpublished texts provided an additional 894 records. In summary, label data from museums and other sources increased *C. palaemon* records meeting quality control criteria by 1328.6%, infilling English distribution and furthering insight into environmental and anthropogenic drivers of decline at key sites. The quantity of new records collated from historic data suggests similar work could be carried out for other extirpated, declining, or endangered butterfly species to improve knowledge of habitat requirements, historical distribution, identify drivers of decline, and inform reintroductions.

Building Resilience: Restoration of the Miami Blue Butterfly (*Cyclargus thomasi bethunebakeri*) Florida:USA

Kristin Rossetti, Sarah Steele Cabrera, Taylor Hunt, Matthew Standridge, Robin Sarabia, and Jaret Daniels
Florida Museum of Natural History, University of Florida, USA.

The Miami blue (*Cyclargus thomasi bethunebakeri*) is a small, brightly-colored Lycaenid butterfly endemic to Florida, USA. Once common throughout coastal Southern Florida, this butterfly has experienced a catastrophic reduction in distribution and abundance, and has been listed as endangered under the US Endangered Species Act since 2012. The butterfly is currently restricted to a few remaining remote island populations within the Key West and Great White Heron National Wildlife Refuges, making it one of the most critically endangered insects in North America. The Daniels lab, in partnership with relevant stakeholders, has engaged in comprehensive strategic planning, resulting in a multi pronged recovery strategy. Established on-the-ground recovery actions funded by the U.S. Fish and Wildlife Service's Cooperative Recovery Initiative and Disney Conservation Fund include continued monitoring of the extant habitat, range wide genetic population analysis, maintenance of captive breeding populations, study of ant-larval interactions, development of best reintroduction methods, detailed assessment of potential release sites, and comprehensive evaluation of measures of success. Based on the lessons learned, we have an increased understanding of variables and strategies that can help maximize successful wild population establishment and are currently working to re-establish this butterfly at two sites in southern Florida.

Easy portable LED moth trap

J.R. van Deijk, R. Wever, J. Boers, S. van der Heide, I van Deijl and R.H.A. van Grunsven
Dutch Butterfly Conservation, Wageningen, the Netherlands.

Declines in insect abundance are an important topic but data suitable for estimates of abundance trends are often lacking. Standardized monitoring of moths has been done for a long time and several traps, like Robinson and Heath traps, are available, but none of the existing trap types seemed suitable for a large-scale monitoring scheme. A Robinson trap uses a mercury vapour lamp with a high electricity consumption, problematic in remote areas. Heath traps are funnel traps with an actinic light running on a lead acid battery. This trap can be used in remote areas, but the lead acid battery is heavy, and actinics are unreliable when used with a light sensor. Therefore we tested a new trap running on a battery pack with UV-LED's and a light sensor that switches it on at sunset. We compared this LED moth trap to standard Heath traps and tested the effect of 1000 and 2000 running hours on the efficacy of the lamp. We also compared two different types of UV-LED. The novel trap is relatively affordable, light, stackable and has its own power source and catches 2.5 times as many moths as a Heath-trap. This makes large scale standardized moth monitoring feasible.

Breaking down barriers to inclusion in butterfly recording

Megan Lowe
Butterfly Conservation (UK), Wareham, Dorset, UK.

Citizen science, the involvement of members of the public in gathering scientific data, has grown in popularity in the UK and the world in recent years. Yet, the conservation sector in the UK is still far from being fully representative of society. Using data gathered through participant surveys, we explore the differences and similarities between audiences who take part in two distinct citizen science schemes that have different skill and time requirements; Big Butterfly Count, and the UK Butterfly Monitoring Scheme. We consider the challenges and barriers to participation in butterfly conservation and provide examples of how we are diversifying our approach in attempt to break down barriers to inclusion, increase our reach, and better support both current and future butterfly recorders.

The efficiency of emergency conservation methods: a case study of the unique population of the Alcon Blue butterfly in the Białowieża Forest

Izabela Dziekańska[1,2] and Marcin Sielezniew[1,2]
1Faculty of Biology, University of Bialystok, Białystok, Poland. 2 Association for Butterfly Conservation, Warsaw, Poland.

Larvae of the Alcon blue butterfly *Phengaris alcon* initially feed inside the flowerheads of Gentiana plants, but complete their development as social parasites of *Myrmica* ants. We investigated a recently discovered isolated population of the species in the area of the Białowieża Forest using the mark-release-recapture method. The seasonal number of adults was estimated at 1,460 individuals, and their density (850/ha) was the highest among all populations using *G. pneumonanthe* studied so far. Moreover, the rare and specific parasitoid turned out to be three times more numerous than its butterfly host. Complicated ecological requirements make *P. alcon* a very sensitive species, and for the focal population the main threat is related to mowing in the wrong period. In 2020 we performed an unplanned experiment to save caterpillars present in freshly cut plants selected from the hay. We kept gentians bearing eggshells in water, to collect just-emerged larvae ready for adoption. Nearly a thousand caterpillars were transported to the site and put close to the nests of host ants. In the next season we noticed that the majority of them had developed successfully and some of the pupae were even infested by parasitoids, proving that such desperate actions can be effective.

Kleurkeur: A certification scheme for ecological road verge management and other common green areas

Molenaar, M. Wieringa, M., Stip, A., Vliegenthart, A., Veling, K., Van Houten, C.
Dutch Butterfly Conservation, Wageningen, the Netherlands.

Kleurkeur is a certification scheme for ecological roadverge management and other common green areas. It is aimed at embedding ecological thinking and execution in roadside management to ensure the use of these areas as living and foraging place for butterflies and other insects. It is used by green contractors and their clients (e.g. municipalities, provinces) as a guideline for the ecological management of roadverges, dikes, vegetation next to railways, and many other common green areas. From the start in 2019 until 2022 already more than 1800 people are certified and the number of certified contractors is still growing. And slowly we see a movement from the more traditional roadverge management to ecological management. Even mower manufacturers are looking for ways to adapt their products to ecological management and are reaching out. In this poster presentation we give an overview the certification scheme Kleurkeur by explaining the assessment guideline Kleurkeur.

The response of invertebrates to rewilding with large herbivores

Patrick Cook, Alan Law , Zarah Pattison and Nigel J. Willby.
Biological and Environmental Sciences, University of Stirling, Stirling, UK.

Abandonment of marginal agricultural land is accelerating across Europe and alternative land management strategies, such as rewilding, are required for the conservation of biodiversity. Rewilding using large herbivores is becoming increasingly adopted. Large herbivores can have dramatic impacts on their environment, creating novel habitat mosaics. There is limited data concerning long-term rewilding studies, preventing wider adoption and integration into policy. Bamff Estate in Perthshire, Scotland is an example of a rewilding project on previously agricultural land. Castor fiber have been present since 2002 and a low intensity mixed grazing regime, using cattle and pigs as trophic proxies for extinct fauna, was introduced in 2022. Here we present the first year of data from a long-term monitoring and research project. The aims of the project are to document the taxonomic and functional response of plants and terrestrial invertebrates (bees, butterflies, ground beetles, hoverflies, moths and spiders) at a local and landscape scale to the new management regime. Results from year 1 of the study indicate an increase in species richness and abundance for butterflies and hoverflies. Plant-pollinator interactions were also higher in the rewilding area for both butterflies and hoverflies with a greater diversity of plants used in the network.

Butterfly Safari

Peter Gill
Graffeg Publishing, Cardiff, Wales, UK.
A poster promoting the new book Butterfly Safari by Andrew Fusek Peters

Andrew Fusek Peters has spent five years travelling round the UK to document and celebrate British butterflies. In *Butterfly Safari*, he shows butterflies in a new light, capturing close-ups of wing scales and the delicate structure of eggs, eyes and antennae. He has also pioneered never before-seen flight shots and astonishing aerial sequences. Many of these photos have already appeared in the national papers and magazines.

Andrew Fusek Peters is a wildlife and landscape photographer based in Shropshire. He has been on commission for the National Trust for the last eight years on the Long Mynd and Stiperstones nature reserves. His photos are regularly published in magazines and the national papers.

The shifting ecological preferences and UK distribution of the Fiery Clearwing *Pyropteron chrysidiformis* in response to Climate Change

Rebecca Levey, Pestridge, E. Tinsley-Marshall, P. and Davis, T.
Butterfly Conservation (UK), Wareham, Dorset, UK.

In the UK, the Fiery Clearwing *Pyropteron chrysidiformis* is a species of conservation priority that is fully protected under Schedule 5 of the Wildlife and Countryside Act 1981. When monitoring began in 1998, its range was restricted to seven coastal sites in the county of Kent in Southeast England. Twenty-one sites have been discovered and subsequently lost since then, as suitable habitat on the coast has reduced. Threats include coastal development, scrub encroachment and climate change.

Butterfly Conservation had been monitoring the fluctuating Fiery Clearwing populations through egg counts at the coastal habitat sites. When development projects threatened the species' survival, staff additionally advised on mitigation. The Kent's Magnificent Moths Project has recruited volunteers to take on egg surveys at known coastal populations. Over the first two surveying seasons, the project has trained 52 volunteers in egg identification. Project staff are working with site managers to strengthen the remaining colonies and are spending time with landowners who have opportunities to sensitively manage the newly discovered populations.

We present an update on the project's discovery of 18 new breeding sites as the species' distribution and ecological preferences shift, in response to the impacts of climate change.

Population Viability Analyses to study interactions between Environmental Change Drivers in nature

Victor Brans and Nicolas Schtickzelle
UCLouvain, Earth & Life Institute, Croix du Sud 4 L7.07.04, 1348 Louvain-la-Neuve, Belgium.

Biodiversity and ecosystems are greatly impacted by five major Environmental Change Drivers (ECDs): habitat degradation, climate change, pollution, invasive species, and overexploitation. These ECDs have often been studied separately but current studies suggest their interactions (antagonistic or synergistic) could be important, which could lead to different viability situations than expected. Even though crucial, studying interactions between ECDs in nature is difficult, and therefore rarely been done. The "Boloria eunomia in Ardenne" model system could be used to overcome this problem. B. eunomia (the bog fritillary) is a specialist butterfly, declining in Western Europe, impacted by all ECDs but one (overexploitation). Some of their impacts have been studied separately in nature for more than 30 years at UCLouvain. A lot of data is therefore available to test the interactions of ECDs. Using the most complete data sets, (meta)population trajectories can be projected using Population Viability Analysis (PVA) models. When started from the past, they allow to test predictions under different ECDs scenarios against observed data to quantify the impact and interactions of ECDs, and, when started from the present, to predict future situations under different conservation scenarios to design conservation guidelines to protect the species and likely related ones.

Four-spotted Moth *Tyta lutuosa* adapting to man-made habitats in East of England

Sharon Hearle
Butterfly Conservation (UK), Wareham, Dorset, UK.

This scarce and vulnerable species was once widely distributed on farmland and verges in southern England. The larvae feed on Field Bindweed (*Convolvulus arvensis*) found in dry, sandy/chalky thin soils in open, well-drained sites. Survey work between 2010-2022 has identified declines where road verges have become increasingly rank and overgrown; tree and hedge planting has reduced suitable habitat, and field margins are generally unsuitable due to herbicide use or sown grass margins. Current surveys have confirmed abundant *Tyta lutuosa* adults and some larval records on south facing banks of a network of roadside ditches dug by landowners to prevent illegal hare coursing. The new ditches are also rich in arable flora and provide valuable nectar for the adult moths. *Tyta lutuosa* was recorded in 2022 along a 4-mile length of flood relief channel where the upper south facing bank, crumbling soils with abundant field bindweed and regular mowing created ideal conditions. The moth has adapted to new habitat opportunities in Cambridgeshire and Essex. The creation of suitable breeding habitat for *Tyta lutuosa* is vital for its long-term future. We now have further evidence of how to provide this.

The thermal ecology of a montane butterfly, *Erebia epiphron*

Sophie Mowbray[1], Adam McVeigh[2], Steven R. Ewing[3], Andrew J. Bladon[4] and Rosa Menéndez[1]
1 LEC, Lancaster University, 2 Nottingham Trent University, 3 Centre for Conservation Science, RSPB, 4 Conservation Research Institute, University of Cambridge.

Cold adapted species are particularly vulnerable to the effects of climate change. Among UK butterflies, the mountain ringlet, *Erebia epiphron*, is the most specialist cold adapted species, restricted to the mountains of the English Lake District and the Scottish Highlands. The underlying mechanisms constraining the species' UK distribution are currently not fully understood. Here we show that summer temperature is partly responsible for explaining the distribution of the species in the Lake District, at the southern edge of the UK range. We then examined how *E. epiphron* responds to temperature, both in terms of adult behavioural thermoregulation, and oviposition site selection. Behavioural thermoregulation was quantified by measuring the ability of individuals to buffer thoracic temperatures against changes in ambient air temperatures. Differences in buffering ability were observed among populations found at different elevations. Analysis of the temperature of sites selected by females for egg laying provided insights into egg and larvae thermal requirements. Increased understanding of the thermal ecology of *E. epiphron* and other mountain butterflies will allow for more informed management strategies to help cold-adapted species to adapt to future climate change.

Livestock density affects species richness and community composition of butterflies: a nationwide study

Toni Kasiske[1,6], Sebastian Klimek[1], Jens Dauber[1,6], Alexander Harpke[2,3], Elisabeth Kühn[3], Martin Musche[3] and Josef Settele[3,4,5]
1 Thünen-Institute of Biodiversity, Braunschweig, Germany. 2 Department of Community Ecology, Helmholtz Centre for Environmental Research - UFZ, Halle, Germany. 3 Department of Conservation Biology and Social-Ecological Systems, Helmholtz Centre for Environmental Research - UFZ, Halle, Germany. 4 iDiv - German Centre for Integrative Biodiversity Research, Leipzig, Germany. 5 Institute of Biological Sciences, University of the Philippines Los Baños, College, Laguna, Philippines. 6 Biodiversity of Agricultural Landscapes, Institute of Geoecology, Technische Universität Braunschweig, Germany.

Over the past century land-use change and deterioration in habitat quality through agricultural intensification have led to a loss and degradation of grassland habitats in Europe. As a consequence, numerous groups of insects have suffered from these processes. Using nation-wide butterfly data from the German Butterfly Monitoring Scheme, we investigated the effects of three indicators related to land cover and agricultural land-use intensity based on agricultural census data at municipality scale. We found a negative relationship of butterfly species richness to the indicator related to the herbivore livestock density. Further, our results indicate a shift in butterfly communities towards mobile habitat generalists with increasing herbivore stocking rate. Accordingly, our findings highlight the importance of low herbivore livestock densities to halting the loss of grassland butterflies and safeguard biodiversity as well as associated ecosystem services. We here demonstrate that indicators related to grassland management intensity based on livestock distribution data can provide inside into spatial diversity patterns of butterflies at the national scale and we make recommendations for further research needs.

eButterfly: a roadmap towards a global butterflying community

Rodrigo Solis Sosa[1], Maxim Larrivée[1,2,] Kent McFarland[1,3,] Xinbao Zhang[1], Micheal Bunsen[1]
1 eButterfly. 2 Montreal Insectarium. 3 Vermont Center for Ecostudies

eButterfly, an online butterfly community science platform, has grown across North America from a small team in Montreal to an international community with more than half a million records over the last ten years. eButterfly's ever-growing database has been used to evidence large-scale shifts in butterfly phenology, such as the Northern expansion of the Giant Swallowtail (*Papilio cresphontes*) and range expansion of the invasive European common blue (*Polyommatus icarus*) across North America and the relevance of these landscape-level phenomena is only expected to increase with climate change.
On our tenth anniversary, eButterfly aims to expand globally. To do so, several challenges must be overcome regarding Data Quality, Data Availability, and finding the right balance between the platform's Level of Complexity and Appeal to Community Scientists.
In this poster, we want to share with the ESA/CSEE community all the learning points we've had along the way, so other conservation community science initiatives may be created and grow efficiently.
Throughout eButterfly's global expansion, we identified three challenges, 1) Data Quality, 2) Data Availability, and 3) the Appeal Vs Complexity Challenge.
We implemented a Checklist-based system to control for effort to ensure data quality, following Darwin Core Standards with different privacy levels.

Fineshade Wood Field Visit Sunday 16th April

Fineshade Wood (An introduction)

Situated in north Northamptonshire, Fineshade Wood covers 500ha and is the largest surviving remnant of Rockingham Forest. This once-vast ancient broad-leaved forest covered over 200 square miles but is now fragmented, made up of woodland patches dotted through an arable landscape. Fineshade Wood consists of areas of ancient mixed broadleaf woodland and planted conifers, with many ponds, a stream and a disused railway line running through it. Over 2400 species have been recorded at this diverse site, including 4 European Protected Species and over 460 species of vascular plant. It records around 34 butterfly species annually, with occasional sightings of 2 further species, taking the overall tally for the site to 36 species. It is also one of the most important sites for Adder, *Vipera berus*, in the region. The woodland is managed by Forestry England and is a significant attraction in the local area for recreation as well as wildlife.

The reintroduction of Chequered Skipper, *Carterocephalus palaemon*, to Fineshade Wood

Chequered Skipper, *Carterocephalus palaemon*, was declared extinct in England in 1976, the decline largely due to changes in woodland management practices over several decades. Rockingham Forest was the centre of the butterfly's former distribution and offered the best chance for it to thrive again in England. The large woodland sites, situated close together, had the potential to provide the well-connected habitat network that metapopulations of Chequered Skipper would need to survive. By returning Chequered Skipper to England the status of the species in the UK would be strengthened.

Restoring the Chequered Skipper to England was just one action in the National Lottery funded Back from the Brink project, a broad partnership of conservation organisations working together to save 20 species from extinction and benefit over 200 more through 19 projects throughout England. Before the reintroduction could take place, targeted management was undertaken at 16 sites across the landscape to create a network of habitats into which the Chequered Skipper could expand. Work included over 7km ride widening and 23ha of vegetation management. Chequered Skipper were sourced from Belgian due to similarity of habitat and climatic conditions and use of the same larval foodplants (False-brome, *Brachypodium sylvaticum*, and Wood Small-reed, *Calamagrostis epigejos*) as the old English colonies of Chequered Skipper. Dirk Maes from the Research Institute for Nature and Forest led research on modelling habitat features and climate information from seven landscapes across the butterfly's range in northwest Europe to identify the areas which matched the conditions in Rockingham most closely. This, along with information on population sizes from Philippe Goffart from the Département de L'Etude du Milieu Naturel et Agricole, helped identify the most suitable sites to collect from.

Fineshade Wood was chosen as the initial reintroduction site in Rockingham Forest due to being the woodland in most suitable condition. A significant operation had been carried out by Forestry England in 2015, opening up 8km of ride, which was followed up with a programme of ride management and rotational cutting. Between 2018 and 2021 a total of 78 adult Chequered Skipper were released in late May/early June (56 females, 22 males). In spring 2019 an English born Chequered Skipper was sighted for the first time in over 40 years. This initial breeding success has continued with sightings in subsequent years (105 in 2019, 60 in 2020, 64 in 2021 and 146 in 2022) and an increase in the area of habitat in which the butterfly can be found (from 65ha in 2019 to 87ha in 2022).

In 2021 we came to the end of the Back from the Brink collaboration but secured funding from the Government's Green Recovery Challenge Fund for a second phase of work, the Chequered Skippers-Taking Flight project, which ran until March 2023. This enabled further habitat management (4.5km ride widening and 9ha vegetation management) and an additional reintroduction to be carried out.

Fineshade lepidoptera

Whilst now best known for the reintroduction of Chequered Skipper (*Carterocephalus palaemon*), Fineshade also supports locally significant populations of Dingy Skipper (*Erynnis tages),* Grizzled Skipper (*Pyrgus malvae*), Small Heath (*Coenonympha pamphilus*) and Black Hairstreak (*Satyrium pruni*), with regular sightings of White-letter hairstreak (*Satyrium w-album*) and White Admiral (*Limenitis camilla*). Over 850 species of moth have been recorded here, including 16 nationally scarce species, and 3 red data book species: Concolorous (*Photodes extrema*), of which there is a significant population, *Epiblema grandaevana* and *Triaxomasia caprimulgella*. Early April is a quiet time for butterflies at Fineshade, but if the weather is good the following butterfly species might be seen during the Symposium excursion: Brimstone (*Gonepteryx rhamni*), Orange-tip (*Anthocharis cardamines*), Holly Blue (*Celastrina argiolus),* Red Admiral (*Vanessa atalanta*), Small Tortoiseshell (*Aglais urticae*), Peacock (*Aglais io*), Comma (*Polygonia c-album*), and Speckled Wood (*Pararge aegeria*). It may also be possible to look for Chequered Skipper larvae, which should be in their final instar or pupal stage.

Further information available on-line

The paper by Dirk Maes et al. on The potential of species distribution modelling for reintroduction projects: the cast study of the Chequered Skipper in England can be requested through Researchgate or downloaded from https://pureportal.inbo.be/en/publications/the-potential-of-species-distribution-modelling-for-reintroductio

For further information about the work carried out under the Back from the Brink project in Rockingham Forest, the project report is available at https://naturebftb.co.uk/wp-content/uploads/2022/01/IP06-Roots-of-Rockingham-Final-Report-BftB-Website.pdf

Further information on the reintroduction and the Chequered Skippers – Taking Flight project can be found on our website https://butterfly-conservation.org/our-work/conservation-projects/england/chequered-skippers-taking-flight-in-rockingham-forest

A leaflet on the reintroduction of the Chequered Skipper at Fineshade can be found on our website https://butterfly-conservation.org/sites/default/files/2022-05/chequered-skipper-leaflet_1.pdf