The Climate Science for Ecological Forecasting Symposium

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Introduction

The climate and ecological crises are inextricably linked. Climate change and extreme weather are driving biodiversity losses and destabilising ecosystem function, in turn undermining our ability to reduce carbon emissions and adapt to environmental change. Addressing these global challenges depends on understanding how ecological processes and climate dynamics respond to, and influence, one another.

On the 11th-12th May 2022, the Royal Meteorological Society (RMetS) and British Ecological Society (BES) joined forces to hold the Climate Science for Ecological Forecasting symposium at the Coin Street Conference Centre, London.

The symposium brought together ecologists and climate scientists to share innovation at the climate-ecology interface, to cross-fertilise research agendas, and to identify needs and opportunities for interdisciplinary collaboration. Over 120 delegates from around the world attended the meeting, including academics and practitioners representing both disciplines.

The symposium comprised a series of keynote talks from pioneers at the climate-ecology interface, talks and posters selected through an open call, and interactive workshops.

Keynote talks

Six keynote speakers presented research transforming the climate-ecology interface, highlighted progress in climate science and ecological forecasting to date, and proposed opportunities for integrating these disciplines.

Michael Dietze (Boston University & Ecological Forecasting Initiative) opened the meeting with a call for more iterative, near-term ecological forecasting, as it allows for rapid evaluation and improvement of forecasts, and provides predictions at timescales relevant for decision making (Dietze et al., 2018).

Mark Urban (University of Connecticut & Centre for Biological Risk) compared progress in climate science and climate biology to date (Hannah, 2021), noting that climate biology is 20 years behind in terms of science and policy. Mark highlighted differences between the disciplines (in modelling approaches, problem dimensionality, data availability, culture and funding), and called for international coordination and funding to establish a universal biodiversity forecasting platform (Urban et al., 2022).

Greta Bocedi (University of Aberdeen) followed with an overview of process-based models in ecological forecasting and their ability to capture the mechanisms by which climate change influences biodiversity.

Greta explained that most models include only a subset of these mechanisms and called for greater international coordination to incorporate more.

Niklaus Zimmermann (Swiss Federal Research Institute WSL & ETH Zürich) discussed the challenges in applying climate predictors to ecological forecasts, including the need to produce climate predictions at fine spatial and temporal resolutions, and to generate predictions of biologically meaningful variables. Niklaus introduced Climatologies at High resolution for the Earth's Land Surface Areas (CHELSA; https://chelsa-climate.org/) as a possible solution. He discussed the many sources of uncertainty in biodiversity models and suggested collaborating with climate scientists to address some causes of uncertainty.

Emma Visman (UK Centre for Ecology and Hydrology) spoke of her experience translating climate information into knowledge and action, primarily in the humanitarian sector. Emma emphasised the role of local knowledge in understanding climate impacts and the importance of approaching climate information from the users' perspective to ensure research outputs are actionable.

Ed Hawkins (National Centre for Atmospheric Science, University of Reading) shared the great efforts made in the presentation of climate projections in the latest IPCC report. Specifically, Ed discussed the challenge of presenting uncertainty to decision makers and suggested reframing probabilistic forecasts as a range of plausible scenarios.

Thematic sessions

Presentations (talks and posters) submitted via the open call for abstracts were invited under five themes:

1. **Extreme weather events**
   Ecological forecasts often focus on the impacts of incremental climate change at centennial timescales, but extreme weather events can impact biodiversity in the near-term. This theme aimed to capture forecasting efforts at sub-seasonal to interannual timescales. Presentations examined the impacts of heatwaves, drought and novel climatic conditions on a range of ecosystems (wetlands, freshwater, urban) and ecological processes (species interactions, foraging, health).

2. **Shifting climates shaping ecology**
   Identifying species which will survive or suffer under climate change relies on our understanding of the mechanisms tying biodiversity to climatic conditions. Abstracts submitted under this theme largely used climate projections to drive a system-specific ecological model forward, providing a forecast of some ecological outcome (population dynamics, species distribution, functional diversity) by 2100. Those accepted as talks introduced additional elements, such as genomic data, phenology or coupled modelling frameworks.

3. **Ecological understanding to improve climate prediction and adaptation**
   Atmosphere-biosphere interactions remain a large source of uncertainty in climate projections. This theme showcased instances in which ecological understanding has improved climate prediction. Presentations fell into two categories: those using ecological processes or organism responses as indicators of climate change, and those focused on the role of ecology in carbon cycling and its inclusion in Earth System Models.

4. **From research to operations**

Climate science and weather forecasting routinely inform decision making (e.g. in agriculture, disaster risk management, health, energy and transportation). This theme highlighted instances in which ecological forecasts influence decision making. A clear focal point for operational ecological forecasts is the impact of pests (e.g. locusts and quelea) on crop production.

5. **Biodiversity change scenarios and targets**

   In climate science, uncertainty is represented by a set of plausible emissions scenarios (Relative Concentration Pathways) and a suite of General Circulation Models. Presentations highlighted efforts to develop comparable scenarios for biodiversity (Sala et al., 2000). Examples were largely UK-focused and centred around the future provision of ecosystem services, community composition and resilience.

In total, 87 abstracts were submitted to the open call. The number of abstracts submitted under each theme provides an important insight into the current state-of-play at the climate-ecology interface (Figure 1).

The most popular theme was “shifting climates shaping ecology” (n=36). Contrast this with abstracts submitted under “extreme weather events” (11). This implies, as previously suggested (Dietze et al., 2018), that the dominant focus in ecological forecasting has been on centennial timescales, and that more attention on near-term forecasts could provide novel ecological insights.

Compare also with abstracts submitted to “ecological understanding to improve climate prediction and understanding” (15). “Shifting climates…” and “ecological understanding…” were designed to complement one another, representing instances in which climate science has informed ecological prediction and demonstrating how ecological knowledge improves climate prediction, mitigation and adaptation, respectively. The imbalance of abstracts suggest a large flow of information from climate science to ecology, but a gap in ecology’s efforts to feedback (Bonan & Doney, 2018).

“From research to operations” received the fewest abstracts (9), suggesting that ecological forecasts are rarely translated into operational decision making tools (Payne et al., 2017).

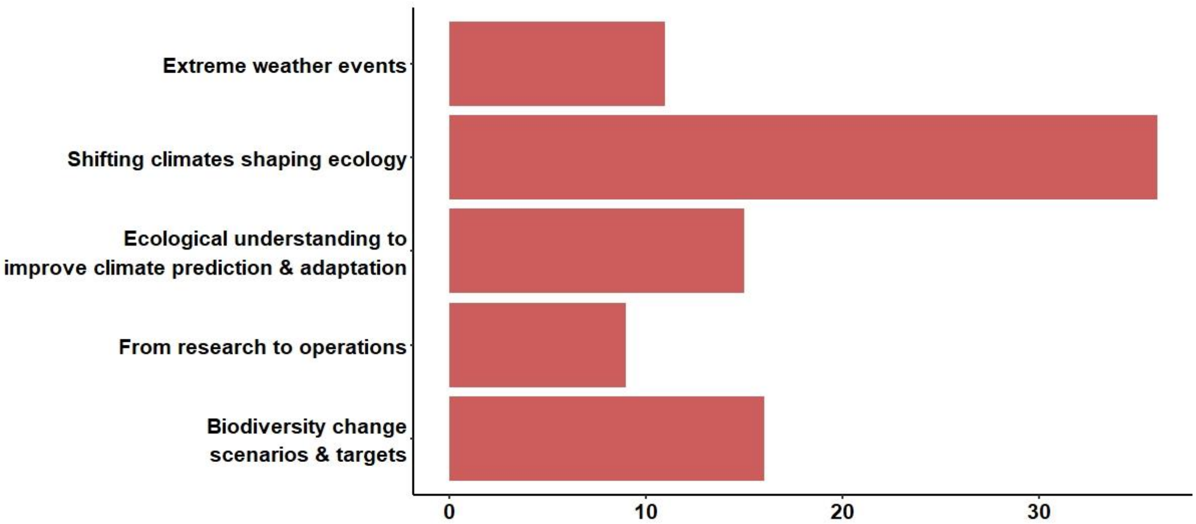

Figure 1. The number of abstracts submitted under each theme. Themes are described in the main text.

Workshops

Four parallel workshops gave delegates the opportunity to network, develop new skills and think creatively:

- **Nature for the National Adaptation Plans**
  (Orly Razgour and Olly Watts, BES Climate Change Special Interest Group)
  The National Adaptation Programme addresses risks identified in the 2022 UK Climate Change Risk Assessment. This workshop explored four risks: species and habitats (N1), terrestrial colonisation (N3), freshwater ecosystems (N11), and landscape character (N18). Discussion focused on vulnerabilities, evidence gaps, climate-smart objectives and practical actions. A summary of discussions (highlighting interacting risks, research gaps and recommendations) was sent to the Department for Environment, Food and Rural Affairs (DEFRA).

- **The now and the future of modelling at the climate-ecology interface**
  (Luke Evans, University of Reading)
  This workshop discussed opportunities for improving modelling at the climate-ecology interface. Delegates identified the following needs: open and accessible repositories for ecological code and data, interdisciplinary climate-ecology training, and diverse collaboration teams that span production (software developers) to implementation (users) as well as ecological and climate scientists.

- **Promoting your research**
  (India Stephenson and Minhyuk Seo, BES)
  This interactive workshop introduced participants to different ways of communicating research, focusing on telling a story to sell a piece of research and writing a press release, with successful examples from the BES and RMetS. Participants practiced their learning by telling compelling stories related to their work and drawing infographics which simplified their research into key messages.

- **Nature-based solutions**
  (Vicky Pope, University College London & *Climate Resilience and Sustainability*)
  Nature-based solutions work with nature to address societal challenges, reducing the impacts of climate change and benefiting human wellbeing and biodiversity. The workshop discussed examples of nature-based solutions and potential barriers. The reintroduction of beavers, for example, benefits flood management, biodiversity and tourism, but causes conflict with landowners and fishermen, possibly resolved through dialogue and careful selection of reintroduction sites. Restoration of peatland, saltmarsh and woodland all combat climate change, but long-term viability under climate scenarios must be considered.

Reflections

Feedback on the symposium was positive, and many felt the symposium fulfilled a need to bring ecologists and climate scientists together. However, climate scientists were outnumbered, despite advertising through RMetS channels. More effort is required to engage climate scientists at the climate-ecology interface and we hope that publishing this report in *Weather* further involves this group.

As we seek to predict and prepare for the future of our planet, the need for ecological forecasting will continue to grow. Conversations had at the symposium provide key considerations as we move forward, specifically, focusing on the impacts of extreme weather, developing demand-led operational forecasts, and increasing the flow of ecological understanding to improve climate prediction and adaptation.

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Author contributions

VLB, LCE and HM led the organisation of scientific content of the meeting. All authors contributed to the conceptualisation, writing and revision of the report.

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