

YEAR 0 SCIENCE REVIEW



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FOREWORD



Doug Gurr
Director, NHM



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Executive Chair, AHRC

*Welcome to the DiSSCo UK
Year 0 Science Review.*

This is an exciting moment at the starting point of a bold and visionary project. The UK holds some of the world's largest and most important natural history collections. This collection includes specimens that Darwin collected on the Voyage of the Beagle; fossils unearthed by Mary Anning; samples from the 1872 Challenger expedition – the first ever global exploration of the ocean deeps; meteorites from outer space and diamond dust from the centre of stars over 3 billion years older than the Earth. These collections are our window back into time that allow us to address fundamental questions about the origins of life. They help us understand how life responds to environmental change, how pandemics arise, and about our ability to continue to provide food and energy security for our growing population.

While the knowledge embedded in these collections has been carefully preserved, they have been hard or impossible to access. DiSSCo UK addresses this challenge; this bold 10-year UKRI/AHRC investment in UK science infrastructure will enable the digitisation of the natural history collections across over 100 UK institutions. This will create one of the world's largest digital natural history assets. By digitising and connecting collections that span the entire history of life on Earth, the programme will create a foundational data infrastructure for the UK. One designed from the outset to work with artificial intelligence. This is critical as AI will not only increase the speed and efficiency of digitisation, but will unlock entirely new ways of learning from collections data, linking specimens to environments, risks and futures.

However, data alone does not bring insight. That is why it is so exciting to launch this Year 0 Science Review. Even before the programme formally launches digitisation is already reshaping research and extending the reach of collections far beyond their physical walls. In an era of accelerating environmental change, the ability to draw insight from trusted, long-term records of the natural world is indispensable. DiSSCo UK positions the UK to lead globally in AI-enabled natural science, turning centuries of collected knowledge into a living resource for discovery, policy and innovation. DiSSCo UK is not only a pathfinder for science – it is a sign of how long-awaited large-scale investment in collections research can be unlocked in a digital age to prompt further advances in knowledge, improving our lives in both tangible and as yet unimaginable ways to support a flourishing world.

This review captures the starting point. The ambition that follows is far greater.

Two handwritten signatures in black ink. The signature on the left is 'C. J. Smith' and the signature on the right is 'Doug Gurr'.

INTRODUCTION

The **DiSSCo UK Year 0 Science Review** provides a snapshot of how digitised UK natural science collections are already being used, cited and translated into impact. Ahead of the formal launch of the ten-year programme, it brings together high-level citation metrics with selected research examples to demonstrate how specimen data are underpinning contemporary science across disciplines.

The studies highlighted illustrate the diversity of current use cases. Digitised specimens are being used to model species' responses to climate change, identify future biodiversity and carbon risks, and assess vulnerability in globally significant ecosystems such as peat-forming *Sphagnum* mosses or the impact of collecting mineral rich nodules from the bottom of our oceans. Collections data are also informing food security and biosecurity research, through improved understanding of crop relatives, agricultural pests and invasive species pathways; and supporting human health studies that track disease vectors and environmental drivers of exposure. Other examples combine biological collections with Earth science, palaeontology and geochemistry to investigate planetary processes operating over deep time.

The metrics presented here are drawn primarily from dataset citation tracking via the Global Biodiversity Information Facility (**GBIF**). This is supplemented where possible with UK Earth science examples that sit outside existing biodiversity data infrastructures. These metrics show a steady increase in publications citing UK specimen data, with NHM data being cited at over 40 times the rate of related global biodiversity observations. However, this review also highlights a key limitation: our ability to track usage is uneven. In areas such as Earth science, where no integrated data portal equivalent to GBIF exists, reuse and impact are undoubtedly under-recorded.

Addressing this challenge is a significant opportunity for DiSSCo UK. By providing shared infrastructure, persistent identifiers and consistent data services across both biological and geological collections, the programme has the potential to revolutionise how usage is captured, understood and sustained over time. As digitisation scales and connections between datasets deepen, the reach and relevance of UK collections across research, policy and industry will become increasingly visible.

This Year 0 Review establishes a baseline. It shows what is already being achieved with partial digital coverage and provides a reference point against which the impact of DiSSCo UK can be tracked over time. The sections that follow explore these themes in more detail, illustrating how digitised collections are already informing research and decision-making across the UK and beyond.

Vince Smith, Helen Hardy and Tara Wainwright

DiSSCo UK Coordination Team, Natural History Museum, UK

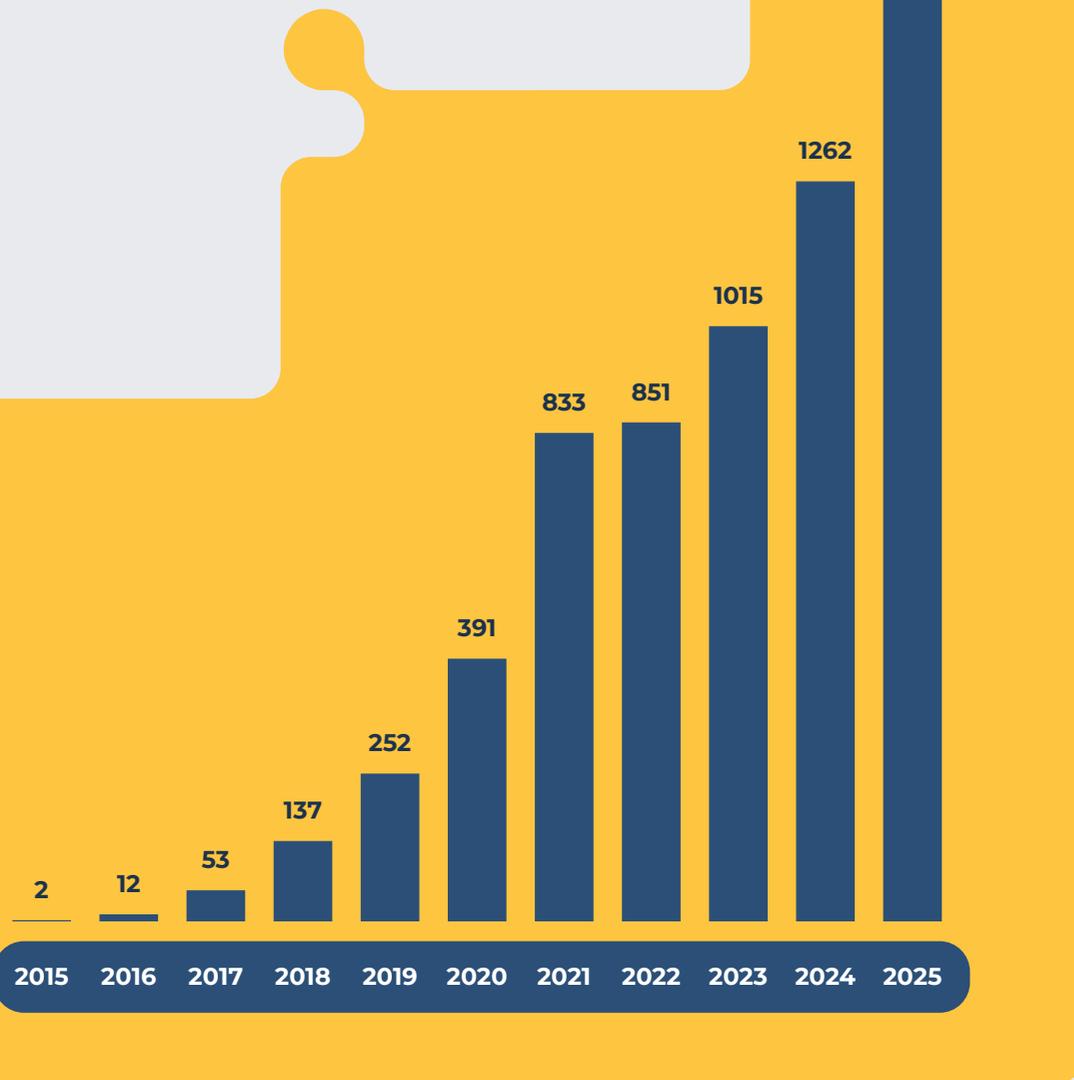
Dmitry Telnov, Max Barclay and Talay Namintraporn in the Natural History Museum's beetle collection.



USAGE CHANGE OVER TIME OF UK DIGITAL COLLECTIONS

The number of publications citing UK natural science collections data over the past decade, showing change in use and impact over time. The 2025 data is an estimate based on a new methodology.

Publications citing UK specimen data are steadily increasing. As more data becomes readily available, the potential for new, innovative research increases, particularly large-scale research that would be unachievable without global data infrastructures.



RESEARCH TOPICS UTILISING UK DIGITAL COLLECTIONS

The number of publications citing UK natural science collections data associated with various research topics created and categorised by GBIF, illustrating how UK data is being used and the scientific diversity of citations. Papers can be described with multiple topics.

The most common research topics from papers using UK data are conservation, ecology, and climate change. Many papers are cross-disciplinary and include multiple themes, and these topics are frequently paired with other research topics.



COUNTRIES STUDIED USING UK DIGITISED COLLECTIONS

The number of publications citing UK natural science collections data that study the biodiversity of a specific country. If a country has <25 country-specific research papers, the country is listed under 'Other countries' in the legend.

The scale of the research is often global, reflecting the global origins of the UK's natural science collections, collected across oceans and from every continent. Research encompassing global environments is followed in frequency by research focussed on the US, Brazil, and China, which tracks with the high numbers of researchers in the US and China, and the high biodiversity in Brazil, which hosts an estimated 15–20% of the world's biodiversity.

| | | | | | |
|---|---------------|------|---|--------------------|-----|
|  | Global | 3637 |  | South Africa | 43 |
|  | United States | 211 |  | Indonesia | 39 |
|  | Brazil | 164 |  | Argentina | 37 |
|  | China | 161 |  | Spain | 34 |
|  | Mexico | 161 |  | Russian Federation | 32 |
|  | Canada | 76 |  | Peru | 27 |
|  | Colombia | 54 |  | New Zealand | 26 |
|  | India | 53 |  | Ecuador | 25 |
|  | Australia | 49 |  | Other Countries | 745 |



INTERNATIONAL PROFILE OF RESEARCHERS USING UK COLLECTIONS

The number of authors from each country citing UK natural science collections data. If a country has <150 authors, the country is listed under 'Other countries' in the legend.

Researchers citing UK data are most commonly from the US, China, and the UK.

| | | | | | |
|---|----------------|------|---|-----------------|------|
|  | United States | 1165 |  | France | 256 |
|  | China | 571 |  | Canada | 230 |
|  | United Kingdom | 570 |  | Switzerland | 178 |
|  | Germany | 492 |  | Netherlands | 174 |
|  | Brazil | 462 |  | Italy | 168 |
|  | Spain | 348 |  | South Africa | 163 |
|  | Mexico | 313 |  | Other Countries | 3079 |

CLIMATE CHANGE



Climate change is reshaping the Earth's systems at an unprecedented pace, altering temperatures, ocean chemistry, hydrological cycles and the distribution of life.¹ Understanding these changes and anticipating their future impacts depends on long-term, trusted evidence of how the planet has responded to environmental change in the past.

Natural science collections provide this critical record. Specimens collected over centuries capture biological, chemical and geological signals from before large-scale industrialisation, establishing baselines against which modern change can be measured. When digitised and combined with contemporary observations and climate models, collections data allow scientists to reconstruct past climates, track shifts in species distributions, and test predictions of future change.

The research highlighted in this section demonstrates how digitised collections are already informing climate science; from modelling species' responses to warming and ocean acidification, to revealing the role of key organisms in carbon storage and ecosystem stability. This knowledge supports more effective climate mitigation and adaptation, informing conservation priorities, land and marine management, and policy responses aligned with the UK's Net Zero ambitions.²

¹ <https://www.un.org/en/climatechange/what-is-climate-change>

² <https://www.gov.uk/government/publications/net-zero-strategy>

Image: London currently has a temperate oceanic climate, but due to climate change, it is projected to develop a Mediterranean climate by the middle of the century.

WHEN BRITAIN WAS TROPICAL: WHAT ANCIENT CLIMATES REVEAL ABOUT OUR FUTURE

Fossil pollen helps trace the climate of the past and predicts how global warming could reshape seasonal patterns across the UK.

Palaeoclimate reconstructions are crucial for interpreting current and future climate change. Globally, the mid-Cenozoic era (~33.9–15.97 million years ago) was warmer and wetter than today, but reconstructions of the British Isles from the Oligocene to early Miocene epochs are lacking.

In this study by McCoy et al., palynological records (fossil pollen and spores) and modern floral records from across the British Isles were used to reconstruct palaeoclimate conditions using Climate Reconstruction Software (CREST) models. Köppen-Geiger climate classifications were assigned to the reconstructions, enabling specific climate types associated with different time intervals to be identified.

The models demonstrate that the British Isles experienced significant climatic variability during the mid-Cenozoic era, ranging from temperate to subtropical and tropical climates. While the palaeoclimate was warmer and drier in the Oligocene, the early Miocene was temperate with high precipitation, closely resembling present-day conditions.

These reconstructions enable valuable projections that improve our understanding of how anthropogenic climate change and increased CO₂ could influence regional climates. Under projected warming scenarios, the British Isles will experience wetter summers and warmer winters.



Research

McCoy, J., Gibson, M.E., Hocking, E.P., O'Keefe, J.M.K., Riding, J.B., Roberts, R., Campbell, S., Abbott, G.D. & Pound, M.J. (2024) Temperate to tropical palaeoclimates on the northwest margin of Europe during the middle Cenozoic. *Palaeontologia Electronica*.

<https://doi.org/10.26879/1349>



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Keywords

- British Isles
- Köppen-Geiger
- Middle Cenozoic
- Palaeobotany
- Palaeoclimate

WARMING OCEANS ARE RESHAPING ALGAE ECOSYSTEMS

Climate change is driving shifts in algae distributions, threatening ecosystem stability as refuge points are threatened by human activity.

Rhodoliths, calcareous nodules composed of marine red algae resembling coral, are key structural species that form biodiversity-rich habitats. Their global habitats are increasingly vulnerable to stressors including ocean warming and acidification, and are compounded by the destructive effects of bottom trawling, causing irreversible effects on marine habitats.

In this study, the researchers used species distribution models based on georeferenced observations, digitised specimen records and environmental predictors (e.g., light, temperature, pH) to forecast changes to Rhodolith distribution under two climate scenarios, RCP 2.6 (low emissions) and RCP 8.5 (high emissions). They also created a global bottom trawling intensity index to assess the overlap between trawling activity and present and future Rhodolith distribution.

The models predicted that suitable habitats would shift to northern, deeper waters as ranges contract by 26–44% in shallower and tropical regions while expanding by 19–50% in Arctic and Northern Pacific waters. However, these habitats would be in intensively trawled areas, threatening mass mortalities as organisms are crushed, blocked from light, and unable to photosynthesise.

This study highlights the urgent need to protect the predicted future habitats of Rhodoliths from the irreversible damage of bottom trawling. Without targeted conservation and management, they will face significant risk from the combined pressures of climate change and destructive fishing practices.



Research

Fragkopoulou, E., Serrão, E. A., Horta, P. A., Koerich, G., & Assis, J. (2021) Bottom trawling threatens future climate refugia of Rhodoliths globally. *Frontiers in Marine Science*. 7, 594537.

<https://doi.org/10.3389/fmars.2020.594537>



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Keywords

- Coral reefs
- Coral algae
- Distribution shifts
- Ecosystem structuring species
- Species distributions

RISING TEMPERATURES COULD UNLEASH CENTURIES OF STORED CARBON FROM PEATLAND

Rising temperatures will alter Sphagnum moss distribution, impacting peatland formation and carbon storage.

Peatlands are vital ecosystems in the global carbon cycle, acting as significant carbon sinks by storing nearly 30% of the global soil organic carbon. Central to their function are *Sphagnum* mosses, which engineer peatland environments and facilitate carbon accumulation. However, these mosses are cold-adapted species and therefore particularly vulnerable to warming climates.

In this study, the researchers assessed how climate change could alter the global distribution of *Sphagnum* mosses and the consequential impact on peatlands. Digital specimens, observational records, and environmental factors were used to simulate changes to *Sphagnum* distribution under two climate scenarios, SSP1-2.6 (low emissions) and SSP5-8.5 (high emissions).

Sphagnum mosses are predicted to migrate northward and to higher latitudes in response to climate change, with these shifts occurring under both climate scenarios. Decline in species richness is predicted to affect 23–35% of suitable habitats, with the most influential factors for habitat availability being the temperature of the coldest quarter of the year, precipitation of the driest month, and topsoil calcium carbonate.

As *Sphagnum* richness declines, their role in carbon sequestration could cause southern peatlands to transition from carbon sinks to carbon sources, causing particular concern in regions that have stored carbon for centuries as their degradation could release significant amounts of greenhouse gases. *Sphagnum* mosses are widely found across the UK, so vulnerable peatland areas in low- and mid-latitude regions must be identified and targeted for conservation efforts. Understanding how these vulnerable habitats will change is crucial for predicting future carbon fluxes and the effects on the global carbon cycle.



Research

Ma, X., Xu, H., Cao, Z., Shu, L. & Zhu, R. (2022) Will climate change cause the global peatland to expand or contract? Evidence from the habitat shift pattern of *Sphagnum* mosses. *Global Change Biology*. 28 (21), 6419–6432.

<https://doi.org/10.1111/gcb.16354>



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Keywords

- Carbon sink
- Carbon sequestration
- Climate warming
- Peat moss
- MaxEnt

CLIMATE CHANGE COULD HALF TROPICAL FISH DIVERSITY

Corals play a critical role in maintaining tropical reef fish biodiversity; a loss of corals due to climate change would have catastrophic effects on marine ecosystems.

Coral reefs are biodiversity hotspots and provide essential habitat for thousands of fish species. While many fish species may be resilient to rising ocean temperatures, corals are far more vulnerable to warming and bleaching events and the loss of coral ecosystems can have far-reaching effects on the fish communities that depend on them.

In this study by Strona et al., a simulation scenario was created in which corals were entirely lost, to estimate the potential impact on fish populations. Global biodiversity was mapped using distribution data for 6964 reef fish species and 119 coral genera and then modelled with fish-coral dependency, accounting for environmental and biogeographic factors such as surface water temperature, salinity, pH, and primary productivity.

A mass extinction of corals would lead to an approximate decline in fish species richness by half, the diversity of fish evolutionary histories (phylogenetic diversity) by one-third, and the diversity of roles in an ecosystem (functional diversity) by one-quarter. While approximately 41% of fish species were predicted to depend on the presence of corals, a reduction in coral cover would be more devastating for fish communities than a reduction in coral diversity.

Coral loss due to climate change could trigger widespread declines in tropical reef fish biodiversity which would not be limited to coral-dependent species but would affect broader reef communities. Conserving and restoring diverse coral communities will therefore prevent mass fish extinctions, the knock-on environmental impacts, and risks to human communities that rely on marine ecosystems.



Research

Strona, G., Lafferty, K.D., Fattorini, S., Beck, P.S.A., Guilhaumon, F., Arrigoni, R., Montano, S., Seveso, D., Galli, P., Planes, S. & Parravicini, V. (2021) Global tropical reef fish richness could decline by around half if corals are lost. *Proc. R. Soc. B*. 288 (1953), 20210274.

<https://doi.org/10.1098/rspb.2021.0274>



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Keywords

- Coral bleaching
- Co-extinctions
- Ocean warming
- Biodiversity hotspots
- Ecological dependency

INVASIVE SPECIES AND BIOSECURITY RISK

Invasive species are non-native species introduced to areas through human activity that threaten local biodiversity. They are a growing driver of biodiversity loss, economic damage and biosecurity risk, with climate change and global trade accelerating their spread and establishment across terrestrial, freshwater and marine environments.³

The UK is home to more than 3,000 invasive species⁴ and natural science collections play a critical role in understanding and managing these. Specimens and associated data provide long-term evidence of species' historical distributions, pathways of introduction and rates of spread, establishing baselines against which recent and future changes can be assessed. When digitised and combined with contemporary observations and environmental data, collections support early detection, risk assessment and predictive modelling of invasive species.

The research highlighted in this section demonstrates how digitised collections data are already being used to track the movement of invasive species, identify high-risk regions and pathways, and inform management and policy responses. As access to collections data increases, their value for biosecurity planning, ecosystem management and climate adaptation will continue to grow.

³ <https://www.nhm.ac.uk/discover/what-are-invasive-species.html>

⁴ <https://www.nonnativespecies.org/non-native-species/information-portal>

Image: Herbarium sheet of invasive plant groundsel bush (*Baccharis halimifolia*), held by the Natural History Museum, London.



UK NATURE AT RISK AS CLIMATE CHANGE COULD INTENSIFY SPREAD OF INVASIVE PLANTS

Invasive plant species are a growing risk to biodiversity and are predicted to harm ecosystem services across the UK and mainland Europe.

Invasive species pose a significant threat to biodiversity and ecosystem function. Climate change is predicted to intensify the impacts of invasive species as suitable habitats change and species distributions are altered.

In this study, four invasive plant species, widely recognised as a concern across the UK and mainland Europe, were identified. The UK researchers used species distributions models, based on digital occurrence records from specimens and biodiversity observations, to predict likely areas of future invasion, and the Invasive Species Effects Assessment Tool (INSEAT) to assess the effects of invasion on 16 ecosystem services, spanning provisioning, regulating, and cultural services.

The most significantly affected ecosystem services predicted to experience harmful consequences from plant invasions were crop production, soil erosion control, and native biodiversity. Climate change is expected to drive a northward and eastward shift in the distribution of the invasive plant species, with the British Isles and Western Europe identified as particularly vulnerable to further invasion.

Invasive plants represent a growing challenge to the maintenance of ecosystem services in the UK, particularly under changing climatic conditions. Proactive and spatially targeted management strategies may mitigate the impacts of invasive species but will require significant investment to prevent and eradicate their establishment. Quantifying the threats to ecosystem services can therefore support effective policy creation that will safeguard nature's contributions to society and human quality of life.



Research

Pérez, G., Vilà, M. & Gallardo, B. (2022) Potential impact of four invasive alien plants on the provision of ecosystem services in Europe under present and future climatic scenarios. *Ecosystem Services*. 56, 101459.

<https://doi.org/10.1016/j.ecoser.2022.101459>



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Keywords

- Climate change
- Non-native species
- Species distributions
- Ecosystem services
- Ecological niche

DECADE OF DORMANCY: LONG LAG PHASES COMPLICATE EARLY DETECTION OF PLANT INVASION

Non-native species can have underestimated impacts as many experience lags that can last decades and even centuries before becoming invasive and harmful to native species.

Lag phases in biological invasions are where non-native plant species remain undetected or minimally spread for extended periods before becoming invasive. They create challenges in predicting future invasions based on current species distributions because the true potential of invasions is obscured.

In this study, over 5,700 herbarium records for 3,505 plant species across 9 regions, including the UK, were assessed for evidence of a lag phase. The researchers developed a model to account for the different phases that can occur in an invasion and sampling biases in collections data. They quantified the prevalence and duration of lag phases, and assessed whether shifts in climate niches contribute to the transition from lag to expansion.

35% of invasion events exhibited a lag phase, with an average duration of 37 years in the UK. Overall, species in the UK had longer lags than in other regions, with 13% of UK species having a lag of over 100 years. The sycamore maple (*Acer pseudoplatanus*) in the UK had the longest lag of all species, taking 320 years to become established, although this record may be influenced by the long history of herbarium collection in the UK.

Species do not consistently experience lags, and most species (58%) experienced a lag only in one region and not others, making it difficult to predict establishment. However, climate niche shifts were observed in 81% of species during the transition from a lag to expansion phase, suggesting that dispersal into new, suitable climates may catalyse the invasive phase.

Lag phases are a substantial and underestimated component of invasion dynamics. The recognition of potential drivers of expansion and lag termination can enable more accurate predictions and more effective management strategies to mitigate future invasions.



Research

Robeck, P., Essl, F., van Kleunen, M., Pyšek, P., Pergl, J., Weigelt, P. & Mesgaran, M.B. (2024) Invading plants remain undetected in a lag phase while they explore suitable climates. *Nature Ecology & Evolution*. 8 (3), 477–488.

<https://doi.org/10.1038/s41559-023-02313-4>



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Keywords

- Lag phase
- Invasive plants
- Climate niches
- Invasion dynamics
- Species distribution

THE CHRISTMAS TREE TRADE BRINGING MORE THAN JOY: HOW EUROPE'S BIOSECURITY IS AT RISK

The human-mediated Christmas tree trade is aiding the dispersal and invasion of a non-native aphid species.

The Nearctic bow-legged fir aphid, *Cinara curvipes*, once native to North America, has rapidly expanded across Europe. Further invasions are expected, intensified by climate change altering habitat suitability and human activity facilitating the spread of non-native species. *C. curvipes* infestations have been found in commercial 'Christmas tree' plantations and human-mediated transport of these trees inadvertently escalates dispersal of the potentially invasive aphid.

In this study, digitised specimen data, over half of which came from UK collections, were used to predict the potential future distribution of *C. curvipes* under four climate scenarios. Potential niches of *C. curvipes* were modelled using machine learning software and combined with laboratory experiments evaluating the life history of the species to assess habitat suitability.

A northward expansion of the species was predicted as *C. curvipes* thrives in cooler climates, with optimal fecundity observed at temperatures between 10–15°C. Under future warming scenarios, Europe and Asia Minor will be particularly vulnerable to invasions. The trade of fir trees, especially during the festive season, is a significant vector for the species' spread, infecting other plants at garden centres and private houses and expanding to natural forests.

This study utilises digitised UK data to predict potential invasions, showcasing the potential for specimen data to assist with early detection and rapid response strategies. The discovery of methods of rapid dispersal and establishment by *C. curvipes* can support mitigation efforts to prevent increased spread, with targeted conservation aimed in regions where fir trees are ecologically or economically significant.



Research

Wieczorek, K., Bugaj-Nawrocka, A., Borowiak-Sobkowiak, B., Endrestøl, A., Ravn, H.P., Solarz, W. & Durak, R. (2025) Adapting to change: exploring the distribution dynamics of the alien and potentially invasive aphid species *Cinara curvipes* (Hemiptera: Aphididae) in the context of global warming. *The European Zoological Journal*. 92 (1), 258–279.

<https://doi.org/10.1080/24750263.2024.2449152>



UK Contributors

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Keywords

- Aphids
- Citizen science
- Demographic parameters
- Mass outbreaks
- "Christmas trees" trade



Herbarium sheet of invasive plant Himalayan balsam (*Impatiens glandulifera*), held by the Natural History Museum, London.

FOOD SECURITY



Access to enough nutritious food is essential to life and health, but climate change, pollution, water shortages, crop pests, environmental degradation and overconsumption all impact the security of future global food sources and pose significant threats to the ability to sustainably meet long-term demand.⁵ The United Nations has estimated that global food production would need to increase by 70% by 2050 to feed a population of 9.7 billion.⁶

In the UK, policies such as the Environmental Land Management scheme,⁷ Countryside Stewardship,⁸ and Biodiversity Net Gain⁹ plans, aim to shift farming to more sustainable practices to protect and restore the natural environment through strategic and innovative land management.

Scientific research contributes to improving food production, innovating agricultural practices, and developing more resilient crops. Natural science collections are an important resource for this research as they can inform breeding efforts, reveal genetic traits for crop resilience, and help monitor changes to ecosystem health.

⁵ <https://www.metoffice.gov.uk/research/climate/climate-impacts/food-security/impacts-on-food-security>

⁶ <https://news.un.org/en/story/2013/12/456912>

⁷ <https://www.gov.uk/government/collections/future-of-farming-in-england>

⁸ <https://www.gov.uk/government/collections/countryside-stewardship-get-funding-to-protect-and-improve-the-land-you-manage>

⁹ <https://www.gov.uk/guidance/understanding-biodiversity-net-gain>

Image: Improving the availability of herbarium specimens through digitisation can contribute towards the conservation of cereal crop gene pools.

FROM SPECIMEN TO STRATEGY: USING DIGITISED CROPS TO PROTECT FUTURE FOOD SYSTEMS

Protecting wild species closely related to cereal crops will safeguard valuable traits and facilitate future crop resilience and food security.

Cereal crops, a primary food source for humans and livestock, have undergone extensive domestication over the past 10,000 years, leading to a reduction in genetic diversity. Without variation in the genes of these crops, they are less resilient against extreme events such as climate change, drought, pests and disease. Valuable traits from closely related wild species (crop wild relatives) can be utilised as a conservation resource, but only if these species are protected.

In this study, the researchers identified crop wild relatives that can help conserve the cereal crops barley, oat, rye, and wheat. Georeferenced herbarium data for 90 related taxa determined areas of high species richness to form a complementary conservation network that was compared with existing protected areas.

Ten reserve locations could protect over 80% of the taxa, with the highest-priority site containing 31 species. Most proposed reserves overlap with existing protected areas, so conservation efforts should combine protecting the natural habitats of crop wild relatives with the utilisation of resources such as museums, botanical gardens, and seed banks.

Assessing the potential conservation value and threat status of the species not covered by the ten reserve locations is particularly important as they could contain useful traits at risk of loss. Improving the availability of herbarium specimens through digitisation can therefore contribute to critical conservation assessments and fill in gaps in the data.



Research

Phillips, J., Whitehouse, K. & Maxted, N. (2019) An in situ approach to the conservation of temperate cereal crop wild relatives in the Mediterranean Basin and Asian centre of diversity. *Plant Genetic Resources*. 17 (2), 185–195.

<https://doi.org/10.1017/S1479262118000588>



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Keywords

- Fertile Crescent
- GIS
- Crop wild relatives
- Plant genetic resources
- Protected areas

WARMING SEAS COULD REDRAW THE MAP FOR UK CLAM FARMING

Changing distributions of a crucial aquacultural species could cause economic declines in key regions, but opportunities for the UK where habitat suitability increases.

The Manila clam, *Ruditapes philippinarum*, is a commercially valuable species that inhabits shallow estuaries. The species is native to Eastern Asia and was introduced to the UK in the 1970s for aquaculture where it has since become naturalised. *R. philippinarum* is vulnerable to prolonged increases in temperature and salinity, leading to population declines.

In this study, UK researchers used species distribution models to predict future distributions of *R. philippinarum* under the extreme climate scenario RCP 8.5. Future suitable habitats were modelled based on specimen and biodiversity records from GBIF and projected mean sea surface temperature and sea surface salinity data for the year 2100.

Habitat suitability is expected to shift northward, with opportunities for aquaculture expansion in Northern Europe, Alaska, and parts of Southeast Asia, while current markets such as the Mediterranean and China becoming less suitable. These changes are primarily driven by increases to sea surface temperature beyond the species' tolerance threshold, and salinity fluctuations that induce physiological stress.

Climate change poses substantial risks to the sustainability of *R. philippinarum* aquaculture, impacting regional economies and biodiversity. In regions where suitability is predicted to decrease, habitat conservation and mitigation strategies may help to safeguard production. However, in the UK, suitability is expected to increase, particularly along northern coastlines, providing an opportunity for strategic investment in clam farming and improving food security and economic development. The integration of climate resilience into aquaculture planning can therefore preserve the long-term viability of valuable marine species.



Research

Johnson, A.S., Bridges, A.E.H. & Knights, A.M. (2025) Predicting the future distribution of a commercially important clam (*Ruditapes philippinarum*) in a changing climate. *Estuarine, Coastal and Shelf Science*. 320, 109307.

<https://doi.org/10.1016/j.ecss.2025.109307>



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Keywords

- Aquaculture
- Biogeography
- Climate resilience
- Sustainability
- Estuaries

LOSING SEEDS OF RESILIENCE: RAPESEED CROP SECURITY AT RISK

There is urgent need to conserve the genetic diversity of rapeseed and its wild relatives in the face of climate change and agricultural pressures.

Rapeseed is a vital crop for edible oil, livestock feed, industrial products and biofuel, but its productivity is increasingly threatened by environmental changes and pest infestations. Improvements to rapeseed varieties will utilise the broader rapeseed gene pool to include species with valuable resistance traits. However, these related species may also be at risk, and unless well represented in gene banks, important traits could be lost.

In this study, the researchers conducted a comprehensive gap analysis of rapeseed genetic resources conserved in European gene banks, assessing the representation of species from the primary, secondary, and tertiary gene pools. Species distribution models using digitised herbarium data and bioclimatic variables predicted the changes to the natural distribution of these species under two climate scenarios, RCP 2.6 (low emissions) and RCP 8.5 (high emissions).

Significant underrepresentation was discovered in many rapeseed-related species in European gene banks, particularly in regions where these species naturally occur. Worryingly, some of the species listed as endangered or near threatened have few specimens. Climate change is predicted to cause declines in rapeseed variety ranges, with decreases up to 89.4% under the most severe climate scenarios, potentially exacerbating conservation gaps.

Targeted collection efforts are urgently needed to preserve the biodiversity of the rapeseed gene pool. Weise et al. have proposed a list of priority species for future collection to support long-term conservation and breeding initiatives. Digitising existing specimens will also improve awareness of what species are underrepresented and need targeted collection.



Research

Weise, S., Hoekstra, R., Kutschan, K.J., Oppermann, M., van Treuren, R. & Lohwasser, U. (2023) Analysis of gaps in rapeseed (*Brassica napus*) collections in European genebanks. *Frontiers in Plant Science*. 14.

<https://doi.org/10.3389/fpls.2023.1244467>



UK Contributors

- NHM
- Kew
- RBGE
- BAS



Keywords

- Gap analysis
- Niche modelling
- Plant genetic resources
- Rapeseed
- Crop productivity

Rapeseed plant (*Brassica napus*) from the Natural History Museum collection.



HUMAN HEALTH



Human health is increasingly shaped by environmental change. Climate change, land-use change and biodiversity loss are altering interactions between people, animals and environments, increasing the risk of emerging diseases and placing new pressures on public health systems.¹⁰

Natural science collections play a critical role in understanding these risks, particularly for zoonotic diseases. Specimens documenting wildlife hosts, disease vectors and pathogens preserve long-term records of historical distributions, prevalence, and environmental associations, often predating modern surveillance systems. When digitised and combined with contemporary epidemiological, climatic and environmental data, collections enable researchers to investigate disease ecology, transmission pathways and changing risk profiles.

The research highlighted in this section demonstrates how digitised collections data are already contributing to zoonotic disease research, from tracking shifts in vector distributions to identifying environmental drivers of spillover risk. By strengthening the evidence base for surveillance, natural science collections support an integrated health approach that will improve detection and prevention, creating a more resilient public health preparedness in the UK and beyond.

¹⁰ <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>

Image: The mosquito *Aedes aegypti* is the primary vector for Zika virus. Understanding its geographic spread can help researchers understand human health risk.

BUZZING TOWARDS TROUBLE: MOSQUITO RANGE SHIFTS PUT BILLIONS AT RISK FROM ZIKA VIRUS

Spatial modelling of the vector Aedes aegypti estimates almost half of the world's population could be at risk of Zika virus in the future, requiring mitigation measures to prevent increased transmission.

In recent years there has been rapid spread of Zika virus (ZIKV), a virus transmitted primarily by the mosquito *Aedes aegypti*. It is associated with severe health outcomes, particularly microcephaly in infants born to infected mothers. Given the widespread distribution of *A. aegypti* and its adaptation to urban environments, there is high risk for human exposure which had previously not been spatially calculated.

In this study, the future distribution of *A. aegypti* was modelled using WorldClim bioclimatic variables and occurrence records based on digitised natural science specimens and field observations. This data was integrated with global population density data to estimate transmission risk categories across populations.

The most suitable habitats for *A. aegypti* are in tropical and subtropical regions with high temperatures, low annual temperature variation, and high precipitation. Around 3.27 billion people, ~40% of the global population, live in areas with some level of ZIKV transmission risk, with 2.26 billion residing in zones of high or very high risk.

This paper is an example of data from natural science specimens being used in conjunction with human data to create a valuable tool that can aid international efforts identifying and protecting at risk populations. Many countries previously not associated with ZIKV transmission may be vulnerable due to changing environmental conditions and rising population densities, and targeted surveillance and public health interventions can minimise the increased risk of transmission, especially in resource-limited regions.



Research

Alaniz, A.J., Bacigalupo, A. & Cattan, P.E. (2017) Spatial quantification of the world population potentially exposed to Zika virus. *International Journal of Epidemiology*. 46 (3), 966–975.

<https://doi.org/10.1093/ije/dyw366>



UK Contributors

- NHM



Keywords

- Mosquito
- ZIKV
- Vector niche modelling
- Vectorial transmission
- Viral contagion risk

MAPPING MPOX RISK: UK IDENTIFIED AS HIGH-RISK REGION FOR FUTURE OUTBREAKS

An assessment of the MPXV zoonotic niche and genome identifies the UK as one of the highest risk regions for future outbreaks.

A global surge in Mpox infections, caused by the monkeypox virus (MPXV), led to outbreaks in 104 non-endemic countries in the 2020s. Novel transmission dynamics are linked to the rapid international spread, and there is an urgent need to map zoonotic and anthropogenic transmission pathways to mitigate future outbreaks.

In this study, the likelihood of MPXV spreading between humans, and from animals to humans, was calculated. Travel statistics, data from science collections and species observations on the distribution and ecological preferences of four rodent species, identified as hosts for MPXV, predicted regions that the virus is likely to spread to.

The zoonotic niche of MPXV was strongly associated with the distribution of specific rodent species and climatic factors such as precipitation and temperature. Zoonotic transmission was observed globally in 40.56% of recorded cases, and in some regions such as Central Africa, up to 70.3%, highlighting the importance of access to zoological specimens to understand historical and potential future niches of host species.

Two groups of MPXV were identified, with the UK having a high imported risk of the most transmissible group linked to greater fatality rates. International connectivity and increasing travel from regions with recent outbreaks or consistently high infection rates makes the UK vulnerable to elevated levels of human-to-human transmission. These early predictions can alert the government to ensure sufficient monitoring is in place and public health strategies are strengthened to prevent a future epidemic.



Research

Sun, Y.-Q., Chen, J.-J., Liu, M.-C., Zhang, Y.-Y., Wang, T., Che, T.-L., Li, T.-T., Liu, Y.-N., Teng, A.-Y., Wu, B.-Z., Hong, X.-G., Xu, Q., Lv, C.-L., Jiang, B.-G., Liu, W. & Fang, L.-Q. (2023) Mapping global zoonotic niche and interregional transmission risk of monkeypox: a retrospective observational study. *Globalization and Health*. 19 (1), 58.

<https://doi.org/10.1186/s12992-023-00959-0>



UK Contributors

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- World Museum Liverpool
- Cambridge University



Keywords

- Machine learning
- Mpox
- Transmission risk
- Zoonotic niche
- Epidemic prevention

SNAILS ON THE MOVE: CLIMATE CHANGE COULD WIDEN SCHISTOSOMIASIS RISK ZONES

Warming temperatures will alter the distribution of an intermediate host species and impact schistosomiasis transmission, putting new populations at risk.

The freshwater snail, *Bulinus truncatus*, serves as an intermediate host for the disease-causing parasitic worm *Schistosoma haematobium*. The tropical disease, schistosomiasis, affects 150 million people and is predominantly found in Africa but with increasing outbreaks in new regions. Climate change is expected to impact the distribution of the disease by altering the suitable habitats available to the host and vector species.

In this study, occurrence records including collections data of the host *B. truncatus*, were modelled alongside bioclimatic data to predict future suitable habitats of the species. The estimated distributions were combined with life-history data to calculate growth rates and assess regions with high survival and reproductive potential.

B. truncatus was found to be highly tolerant to a range of temperatures and has the greatest population growth at 26.6°C. Projections suggest a net increase in suitable habitat of *B. truncatus* by up to 17% by the end of the century, particularly in Southern Europe, Central Africa, and the Middle East. These shifts in host distribution are likely to influence the transmission dynamics of urogenital schistosomiasis, leading to new disease hotspots that reflect the optimal temperature of the host species.

Climate change could significantly reshape the distribution of *B. truncatus*, thereby altering the landscape of schistosomiasis transmission in Africa and Europe and putting new populations at risk. A major challenge to this research, emphasised by the authors, was the lack of ecological snail data that could create reliable models. The Natural History Museum, UK, was a major contributor to the *B. truncatus* dataset; access to further data that may currently be unused in undigitised UK collections will improve the robustness of similar models and overall accuracy of scientific research.



Research

Van Der Deure, T., Maes, T., Huyse, T. & Stensgaard, A. (2024) Climate change could fuel urinary schistosomiasis transmission in Africa and Europe. *Global Change Biology*. 30 (8), e17434.

<https://doi.org/10.1111/gcb.17434>



UK Contributors

- NHM



Keywords

- Climate change
- Schistosomiasis
- Vector-borne disease
- Species distribution modelling
- Thermal niche



Schistosome snail, Natural History Museum.

BIODIVERSITY CHANGE



Biodiversity is changing rapidly, with shifts in species distributions and abundance occurring across the UK and globally. Understanding the scale, direction, and drivers of these changes, and distinguishing long-term trends from short-term variability, requires robust, comparable evidence collected over extended time periods.

Natural science collections provide the essential foundation for measuring biodiversity change. Specimens and associated data establish baselines for species' historical distributions, traits and ecological associations, enabling consistent comparison across decades or centuries. When digitised and combined with contemporary monitoring and environmental data, collections support the detection of trends, range shifts, and ecological responses to environmental pressures.

The research highlighted in this section demonstrates how digitised collections data are already being used to quantify biodiversity change, from documenting contractions and expansions in species ranges to revealing changes in community composition and ecological interactions. By strengthening the evidence base for biodiversity monitoring, conservation prioritisation and restoration, natural science collections support effective implementation of UK biodiversity policy and contribute to national and international frameworks for tracking and reversing biodiversity loss.

Image: UK and Irish butterflies are increasingly at risk as environmental change disrupts the synchrony between key life stages and the seasonal availability of their host plants.

TIMING MISMATCHES UNDER CLIMATE CHANGE THREATEN UK BUTTERFLIES

Climate change risks disrupting the synchrony between key butterfly life stages and the productivity of their plant hosts, limiting population growth.

The brown argus butterfly, *Aricia agestis*, is undergoing rapid distributional shifts in the UK by exploiting new plant hosts. Climate change affects the timing of seasonal life cycles and could cause a mismatch between the production of larvae and food availability. In this way, climate change may shape species' distributions by disrupting established relationships and interactions between species.

In this study, changes to the brown argus butterfly's range were calculated by analysing observational and specimen data every year between 1970 to 2018. These changes were combined with records for ancestral and novel host plants and climatic variables such as temperature and rainfall to estimate variations in life cycles and population growth and identify the drivers of these patterns.

The geographical range of the brown argus butterfly has spread northward and is driven by synchronisation with host plants. Delayed egg-laying and larval emergence improves synchrony with novel host plants and correlates with higher productivity, facilitating rapid range expansion into areas dominated by novel hosts. However, brown argus emergence is advancing as temperatures rise, potentially leading to increased asynchrony and reducing population survival.

Timing mismatches between plant and butterfly life cycles is shaping population patterns and species distributions. As exhibited in this research, museum collections contribute baseline data which, when paired with contemporary records, can detect ecological shifts over time. Climate change will drive further asynchrony and understanding dependencies between species is essential for predicting responses to change and informing conservation strategies.



Research

Stewart, J.E., Maclean, I.M.D., Botham, M., Dennis, E.B., Bridle, J. & Wilson, R.J. (2024) Phenological variation in biotic interactions shapes population dynamics and distribution in a range-shifting insect herbivore. *Proceedings of the Royal Society B: Biological Sciences*. 291 (2036), 20240529.

<https://doi.org/10.1098/rspb.2024.0529>



UK Contributors

- NHM



Keywords

- Climate change
- Phenology
- Population dynamics
- Range shift
- Trophic mismatch

MADAGASCAR'S PLANTS ARE LEFT WITHOUT SEED HELPERS

Megafaunal extinction and ongoing frugivore decline threatens the seed dispersal and subsequent survival of Madagascar's endemic plant species.

Madagascar, a biodiversity hotspot with exceptionally high numbers of species exclusive to the island, has experienced a significant loss of large-bodied, frugivorous animals since the Holocene. These extinctions have disrupted ecological mutualisms, particularly seed dispersal systems, leaving many plant species without effective dispersers.

In this study, anachronistic species, where the seed is too large to be dispersed by a living, native frugivore, were identified. The researchers modelled the seed and fruit dimensions of endozoochorous (animal-dispersed) species with the body mass of extant and extinct lemur species to determine flora too large to be ingested. Combined with mapped digitised specimen and biodiversity data, plant species were identified that lacked co-occurring frugivorous lemurs and therefore suffer from complete or local extinction of their dispersers.

Many species were found to produce seeds or fruits too large for any extant frugivore to ingest, suggesting evolutionary adaptations to now-extinct megafauna. Of the 3018 animal-dispersed plant species analysed, two have experienced complete extinction of potential dispersers, rendering them anachronistic. Additionally, 747 species have two or less co-occurring dispersers and 489 of these are suffering from local extinction of potential dispersers due to deforestation, habitat fragmentation, and hunting restricting the ranges of surviving lemurs.

This paper offers new insights into the long-term effects of declining biodiversity and species loss by demonstrating that dysfunctional seed dispersal is a widespread threat to Madagascar's flora. Conservation strategies, such as species reintroductions, ecological corridors, and seed conservation, can help to restore ecological function and protect the highest risk species identified in this study.



Research

Albert-Daviaud, A., Buerki, S., Onjalalaina, G.E., Perillo, S., Rabarjaona, R., Razafindratsima, O.H., Sato, H., Valenta, K., Wright, P.C. & Stuppy, W. (2020) The ghost fruits of Madagascar: Identifying dysfunctional seed dispersal in Madagascar's endemic flora. *Biological Conservation*. 242, 108438.

<https://doi.org/10.1016/j.biocon.2020.108438>



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Keywords

- Anachronism
- Conservation
- Lemur
- Madagascar
- Seed dispersal

THE EXTINCTION OF PALM SPECIES THREATENS ECOSYSTEMS AND THE ECONOMY

Hundreds of palm species threatened with extinction lack functional or evolutionary alternatives, potentially causing scientific, industrial, and welfare deficiencies.

Current conservation assessments, notably the IUCN Red List, are geographically and taxonomically biased, partially because of data deficiencies, and only cover a fraction of vascular plant species. There is an urgent need to accelerate extinction risk assessments for vascular plants, particularly palms (Arecaceae). Despite their ecological and socio-economic importance, palms have not been comprehensively assessed at the global scale in recent decades.

In this study, 48 machine learning models incorporating occurrence records and ecological, geographic, and anthropogenic predictors were assessed. The most balanced and accurate model was selected to predict extinction risk for 1,381 unassessed palm species. Integrating these predictions with 508 recent extinction assessments created a risk overview for approximately 75% of known palm species and identified priority conservation regions.

Over half of palm species are threatened, 455 of which are evolutionarily distinct, 447 of which are functionally distinct, and 185 of which have documented human uses. While 91% of threatened human-used species had potential substitutes, 16 species lacked any alternatives, and 30 regions had at least one threatened used species without a substitute, indicating low resilience in certain areas.

This research evidences the extinction threat to hundreds of palm species which would have significant implications on ecosystems and human well-being. The integration of machine learning predictions with evolutionary, functional, and ethnobotanic data provides a comprehensive, unbiased view of extinction rates. This methodology can be applied to other plant groups to support global biodiversity, reduce Red List biases, and help meet international conservation goals.



Research

Bellot, S., Lu, Y., Antonelli, A., Baker, W.J., Dransfield, J., Forest, F., Kissling, W.D., Leitch, I.J., Nic Lughadha, E., Ondo, I., Pironon, S., Walker, B.E., Cámara-Leret, R. & Bachman, S.P. (2022) The likely extinction of hundreds of palm species threatens their contributions to people and ecosystems. *Nature Ecology & Evolution*. 6 (11), 1710–1722.

<https://doi.org/10.1038/s41559-022-01858-0>



UK Contributors

- NHM



Keywords

- IUCN Red List
- Machine learning
- Vascular plants
- Palms
- Extinction risks



Areca palm illustration (*Areca catechu*) from the Natural History Museum collection.

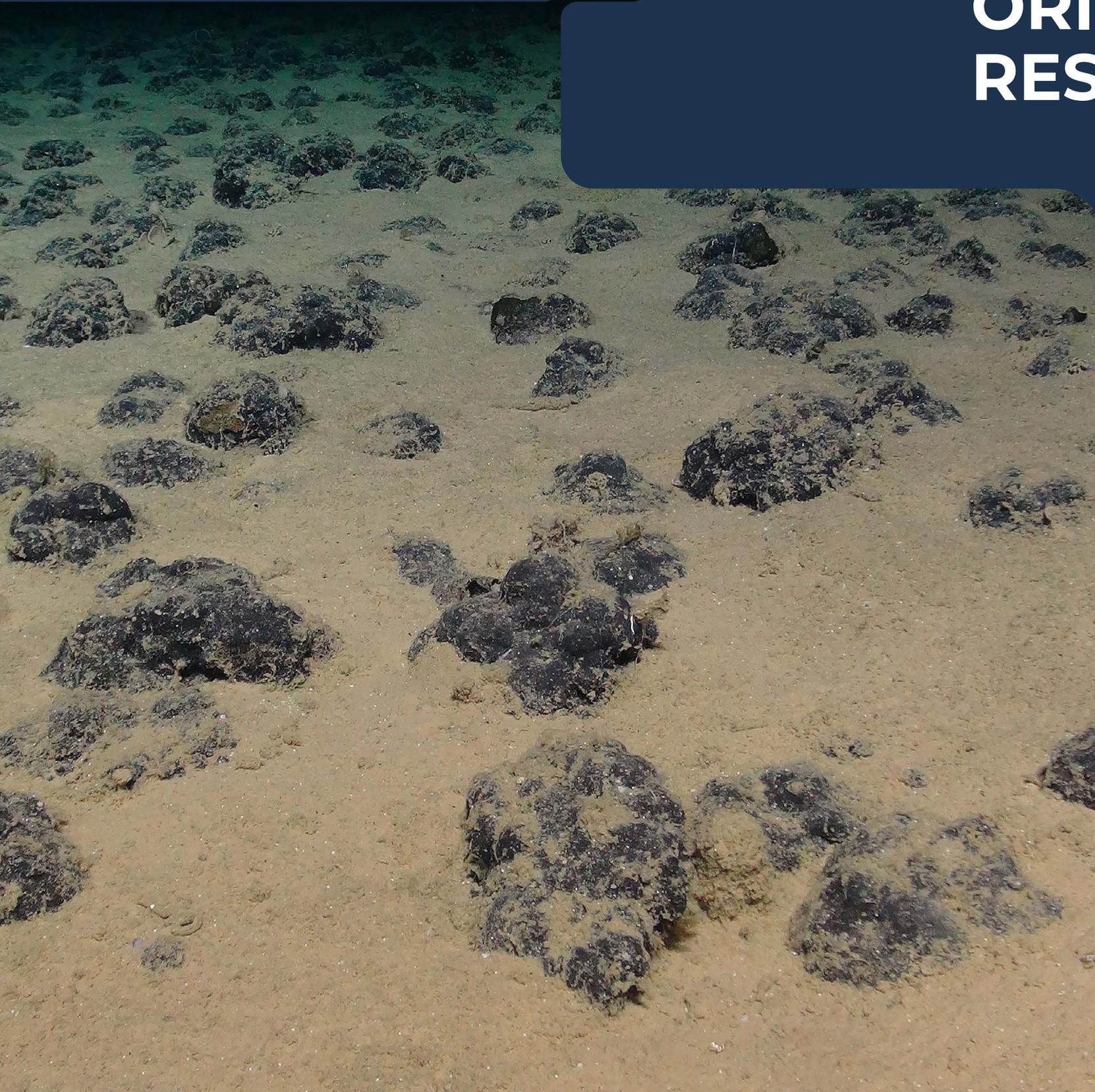
PLANETARY ORIGINS AND RESOURCES

Earth and planetary systems are shaped by geological processes that control the formation of landscapes, natural resources and environments on Earth and beyond. Understanding how these systems operate, respond to disturbance and drive environmental change is essential for managing resources, assessing environmental risk and supporting sustainable decision-making.

Geological collections provide a critical evidence base for this understanding. Rock, mineral, fossil and meteorite specimens preserve records of Earth and planetary processes across deep time, from tectonics, volcanism and sedimentation to geochemical cycling and planetary formation. When digitised and combined with geospatial, geochemical and environmental data, collections enable researchers to reconstruct past environments, understand the formation and distribution of resources, and investigate analogues for processes occurring in extreme settings, including the deep ocean and extraterrestrial environments.

The research highlighted in this section demonstrates how digitised geological collections are already supporting applied Earth and planetary science, from informing sustainable resource management and assessing the environmental impacts of extraction to advancing understanding of planetary materials through meteorite studies. By providing long-term context and physical evidence, geological collections strengthen the evidence base for resource security, environmental resilience and Earth system science in a changing world.

Image: Polymetallic nodules are potato size lumps of rock that contain the manganese, cobalt, nickel and copper that we need to transition to renewable energy, but collecting these from the ocean floor could have untold impacts on biodiversity.



DEEP-SEA MINING IMPACTS AND RECOVERY IN THE CLARION-CLIPPERTON ZONE

UK researchers assessed the persistence and ecological recovery of seabed mining impacts decades after disturbance.

Some areas of the seabed, such as the Clarion-Clipperton Zone in the North Pacific, are hotspots for polymetallic nodule deposits. These are mineral aggregations consisting of valuable metals such as cobalt and nickel. Understanding how the associated ecosystems, often highly diverse and specialised, respond to disturbance from mining is critical for evaluating the environmental risks of future seabed resource extraction.

A UK-led research team analysed geological and biological evidence from the Clarion-Clipperton Zone to investigate the legacy of deep-sea mining tests conducted 44 years earlier. Using analyses of seabed material and corresponding images from the RRS James Cook expeditions, Jones et al. assessed long-term recovery in previously mined sites.

Physical changes to the sediment and altered biological communities persisted decades after the original disturbance, although there was some recolonisation from megafauna and macrofauna in even the most disturbed areas. The impacts to the seabed were caused by the hydraulic lifting of the collector rake, with modern vehicles leaving similar impacts.

Visible effects from deep-sea mining can be expected to last for decades, but some ecological effects could be reduced by minimising the direct impact of the collector. These findings provide essential long-term evidence on the disturbance and recovery of deep-sea environments, informing the management of critical mineral resources.



Research

Jones, D.O.B., Arias, M.B., Van Audenhaege, L., Blackbird, S., Boolukos, C., et al. (2025) Long-term impact and biological recovery in a deep-sea mining track. *Nature*. 642 (8066), 112–118.

<https://doi.org/10.1038/s41586-025-08921-3>



UK Contributors

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Keywords

- Deep-sea mining
- Clarion-Clipperton Zone
- Seabed disturbance
- Ecosystem recovery
- Sediment cores

HISTORIC SEABED COLLECTIONS REVEAL LONG-TERM EARTH SYSTEM CHANGE

Historic deep-sea sediment collections provide a global archive for reconstructing past ocean conditions and understanding long-term Earth system responses to climate change.

Understanding how Earth systems respond to climate change requires long-term records that extend beyond the period of modern observation. Sediments recovered from the deep ocean preserve chemical, physical, and biological signals that record past ocean conditions, climate states, and biogeochemical cycles.

The authors reconstructed the complex curatorial history of the sediment collections gathered by the nineteenth-century HMS Challenger expedition. This is the first complete digital dataset of the collection, assessing the completeness, condition, and provenance of the materials and standardising information across thousands of items.

These legacy geological collections can function as long-term Earth system archives, and by re-examining the historic seabed deposits using modern analytical techniques, researchers can reconstruct past ocean environments, providing critical context for understanding present-day ocean change.

The digital dataset greatly enhances access by enabling researchers worldwide to discover, compare and analyse specimens without handling fragile historical materials. By fully digitising this major ocean collection, the study opens new research opportunities in marine ecology, climate thresholds, and environmental change, transforming nineteenth-century samples into a valuable resource for modern science.



Research

Miller, C.G. & Jouet-Sarkany, M.M.H. (2025) Sir John Murray's H.M.S. Challenger sedimentary deposits collection at the Natural History Museum, London. *Historical Biology*. 1–27.

<https://doi.org/10.1080/08912963.2025.2506185>



UK Contributors

- NHM



Keywords

- Deep-sea sediments
- Earth system change
- Ocean history
- Climate archives
- Challenger Expedition

METEORITE COLLECTIONS UNDERPIN PLANETARY SCIENCE AND SOLAR SYSTEM RESEARCH

Meteorite collections provide essential physical evidence for understanding solar system formation and planetary processes.

Antarctic meteorites constitute over two-thirds of all classified meteorites and are crucial for understanding the formation and evolution of the solar system, preserving materials from space that cannot otherwise be accessed. These materials are extremely sensitive to contamination and degradation, and their scientific value depends on careful recovery, documentation, curation, and preservation.

In this study, MacArthur et al. describe the curation and classification of the first two UK Antarctic expeditions, implementing a rigorous workflow spanning field collection, frozen transport, controlled thawing, and laboratory analysis. Non-destructive digital methods, including measurement of mass and physical properties, high-resolution photography, and 3D scanning and model creation, documented the structure of each meteorite and guided subsampling decisions. Detailed petrographic, geochemical, and isotopic analyses enabled accurate meteorite classification. All data, including curation histories, instrument settings, physical measurements, and digital models, were recorded in a comprehensive digital database to ensure long-term traceability and accessibility.

By digitising the collection, the project extends access beyond the physical specimens, providing essential reference material for interpreting new discoveries and enabling ongoing research into planetary differentiation, impact processes and the chemical evolution of planetary bodies. Digitisation therefore not only safeguards these rare samples but also opens new research opportunities, ensuring that the UK Antarctic meteorite collection remains an accessible and evolving scientific resource for decades to come.



Research

MacArthur, J.L., Joy, K.H., Jones, R.H., Harvey, T.A. & Almeida, N.V. (2024) Curation and classification procedures for the UK Antarctic meteorite collection. *Meteoritics & Planetary Science*. 59 (12), 3215–3228.

<https://doi.org/10.1111/maps.14273>



UK Contributors

- NHM
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Keywords

- Meteorites
- Planetary materials
- Antarctic collections
- Solar system formation
- Planetary science

LEGACY GEOLOGICAL COLLECTIONS SUPPORT CARBON STORAGE ASSESSMENT

Archived geological core collections provide critical evidence for assessing the suitability of potential reservoirs for carbon storage.

Geological carbon storage is a valuable strategy for reducing atmospheric carbon dioxide emissions, but its safe and effective deployment depends on detailed understanding of subsurface rock properties. Access to geological core materials is essential for evaluating the capacity, integrity, and risks of potential reservoirs for carbon storage.

In this study, Payton et al. re-analysed legacy core material using modern digital image analysis techniques to assess reservoir porosity, permeability and grain properties. The digital techniques allowed non-destructive, high-resolution investigation of features that control fluid flow and storage capacity, overcoming many limitations of traditional laboratory methods.

The digital analysis techniques applied to Wilmslow Sandstone Formation samples show substantial connected porosity and permeability ranges, indicating good reservoir suitability, while the Scottish Middle Coal Measures Formation samples exhibit extremely low porosity and connectivity, demonstrating how digital approaches can rapidly screen out poor candidates.

By reusing archived cores rather than commissioning new drilling, geological collections can help to reduce cost and environmental impact while providing robust evidence to support storage assessment. Curated subsurface collections can underpin applied research critical to Net Zero objectives, enabling evidence-based evaluation of carbon storage potential and long-term environmental safety.



Research

Payton, R.L., Chiarella, D. & Kingdon, A. (2023) Using legacy core material to assess subsurface carbon storage reservoir potential. *Geological Society, London, Special Publications*. 527 (1), 387–397.

<https://doi.org/10.1144/SP527-2022-18>



UK Contributors

- BGS



Keywords

- Carbon capture and storage
- Geological cores
- Subsurface resources
- Reservoir characterisation
- Legacy data

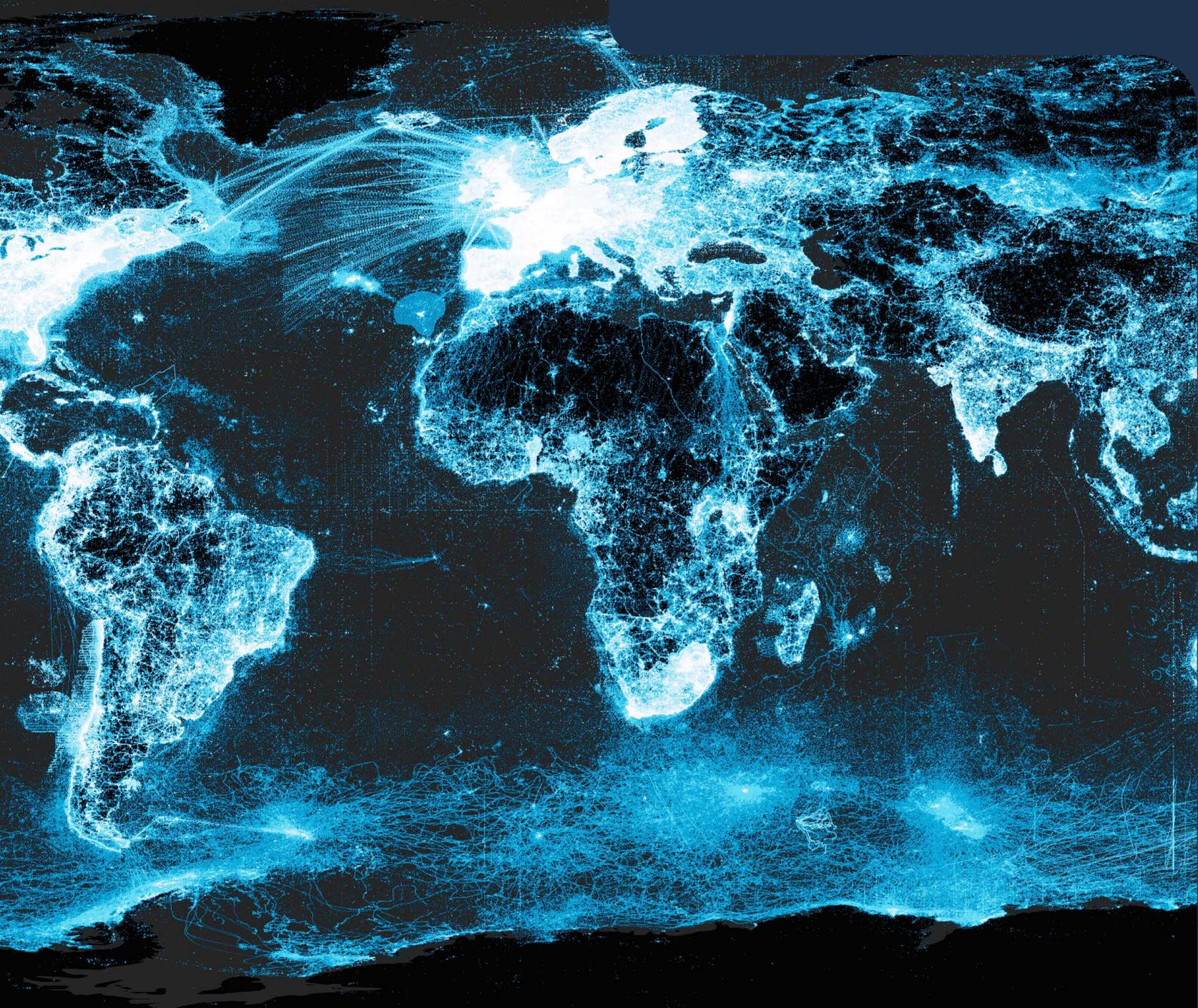
DATA INNOVATION

By transforming dispersed, analogue specimens into connected, machine-readable datasets, digitisation is opening up new research paradigms based on scale, integration and computational analysis rather than isolated observation.

As collections data become accessible across institutions and disciplines, researchers can analyse patterns across millions of specimens, spanning centuries of environmental and biological change. This shift supports new forms of inquiry, including large-scale synthesis, comparative analysis and hypothesis generation, and allows collections data to be integrated with environmental, genomic and observational datasets in ways that were previously impractical. Advances in artificial intelligence and data science are accelerating this transformation. Machine learning enables automated transcription, image-based identification and quality assurance at scale, while AI-driven analytics, knowledge graphs and predictive models support new ways of extracting insight from complex, heterogeneous data.

The examples in this section demonstrate how data innovation is amplifying the value of digitised collections, enabling faster discovery, more reproducible research and wider reuse across science, policy and industry. Together, digitisation and emerging technologies are redefining the role of natural science collections as active, computational infrastructure for 21st-century research.

Image: The Global Biodiversity Information Facility mediates 3.6 billion occurrence records, of which digitised natural history collections make up a small but critical part, as they provide the only historical record of the distribution of most species.



A DYNAMIC VISUALISATION TOOL TO TRANSFORM MINERAL ANALYSIS

A novel heat map visualisation tool innovates how mineral data are understood and analysed, enhancing the discovery of meaningful trends across large evolving datasets.

With open-access mineralogy databases gaining traction, there are new opportunities to uncover data patterns, structures, and anomalies for further scientific exploration. Heat maps are a common methodology for visualising correlations in mineralogy, but up until now, these tools have been limited by static datasets and a lack of domain-specific interactivity.

In this study, Zhang et al. present a novel approach to exploratory data analysis in mineralogy by enhancing a 3D heat map system with live data integration.

The system incorporates a range of data on species, classifications, and localities, including records from UK collections. Data can be visualised based on mineral classes or element groups with customisations that enhance interpretability.

Two use cases illustrate the system's capabilities in identifying both well-known and novel mineralogical patterns. The first explores element co-existence in igneous minerals, revealing patterns of chemical association and incompatibility among mineral classes. The second focuses on rare earth elements, highlighting significant but often excluded or infrequent elemental combinations.

By coupling a live data pipeline with an interactive 3D heat map interface, the authors provide a technically robust and scientifically informed visualisation tool that can support data-intensive research in mineralogy. The system not only facilitates current research but also lays the groundwork for future developments, including applications in other geoscience domains and the integration of additional data such as temporal attributes and mineral formation conditions.



Research

Zhang, J., Que, X., Madhikarmi, B., Hazen, R.M., Ralph, J., Prabhu, A., Morrison, S.M. & Ma, X. (2024) Using a 3D heat map to explore the diverse correlations among elements and mineral species. *Applied Computing and Geosciences*, 21, 100154.

<https://doi.org/10.1016/j.acags.2024.100154>



UK Contributors

- NHM



Keywords

- Exploratory data analysis
- Data science
- Correlation analysis
- Mineral informatics
- Data visualisation

HARNESSING MACHINE LEARNING AND HERBARIUM DATA TO ACCELERATE DISCOVERY OF ANTIMALARIAL DRUGS

Innovative, data-driven methods can efficiently and accurately predict novel plants that can be utilised for antimalarial treatments to combat rising antimicrobial resistance.

Increased resistance in antimalarial drugs has been detected in the two most widely used treatments. Many effective pharmaceutical drugs and antimalarial compounds have been derived from plants, with discovery guided by ethnobotanical knowledge, whereby scientists investigate plants based on their traditional usage. However, this approach is limited in scope and may overlook a vast number of potentially valuable species.

In this study, the UK researchers developed a machine learning framework to predict the potential ability to inhibit or kill malarial parasites in species of three flowering plant families, known for their chemical diversity and traditional medicinal use. Georeferenced specimen and observation records were combined with species traits such as morphology, biochemistry, environmental niches, and medicinal usage. Several machine learning models were evaluated against traditional ethnobotanical selection methods.

Machine learning accurately predicted antimalarial activity and outperformed ethnobotanical approaches. The researchers estimated that approximately 7,677 species across the three families have potential antimalarial activity requiring further investigation. Within these species, over 1,300 were identified to have a low likelihood of exploration through conventional ethnobotanical methods.

This study demonstrates that machine learning can significantly enhance the identification of plant species for potential future antimalarial treatment. Technological innovation, alongside increased digital access to natural science specimens, can complement traditional knowledge and create scalable, data-driven approaches that will accelerate discovery of novel medicinal compounds.



Research

Richard-Bollans, A., Aitken, C., Antonelli, A., Bitencourt, C., Goyder, D., Lucas, E., Ondo, I., Pérez-Escobar, O.A., Pironon, S., Richardson, J.E., Russell, D., Silvestro, D., Wright, C.W. & Howes, M.-J.R. (2023) Machine learning enhances prediction of plants as potential sources of antimalarials. *Frontiers in Plant Science*, 14, 1173328.

<https://doi.org/10.3389/fpls.2023.1173328>



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Keywords

- Antiplasmodials
- Ethnobotany
- Machine learning
- Malaria
- Traditional & indigenous knowledge

FROM LEAVES TO LABELS: MACHINE LEARNING STREAMLINES DATA EXTRACTION OF DIGITISED HERBARIUM SPECIMENS

LeafMachine2 is a new tool that can accelerate botanical research by automatically extracting plant trait data from digitised herbarium images.

While there have been increased efforts and success digitising herbarium collections, the ability to efficiently and accurately extract morphological information from the generated images is still limited. Extraction of morphological traits, such as the number of flowers or length of leaves, is a resource and time intensive task. Technological innovation through machine learning and computer vision tools can automate and accelerate the process to transform botanical research.

In this study, the authors developed LeafMachine2, a suite of machine learning algorithms that work simultaneously to identify, isolate, and extract leaf traits from images of plant specimens. The tool was trained on nearly half a million human annotations from 5,648 herbarium images.

LeafMachine2 can successfully identify and measure different components of digitised plants such as roots, stems, leaves, and flowers, and identify the presence of archival or contained components such as seeds in plastic bags or printed maps. The tool works with high accuracy across a range of flowering plant families, even for complex or low-quality images.

The newly designed tool, LeafMachine2, represents a significant advancement in automated plant trait extraction, offering a scalable, efficient, and adaptable tool for botanical research. The authors advocate for infrastructure improvements that can manage the vast quantities of machine-derived trait data that will be generated in the future and emphasise the importance of standardised digitisation practices, highlighting the benefits of a collaborative nationwide programme where workflows and best practice are shared and monitored.



Research

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- Morphometrics
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The outputs of LeafMachine2, which uses machine learning to extract plant trait data from digitised herbarium sheets.

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