Science Review 2013

GLOBAL
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Research using data accessed through the Global Biodiversity Information Facility

Foreword

When surveying the growing number of papers making use of GBIF-mobilized data, one thing that is striking is the breadth of geographic, temporal, and taxonomic scale these studies cover. GBIF-mobilized data is relevant to surveying county-level populations of velvet ants in Oklahoma, to predicting the impact of climate change on the distribution of invasive species, and to determining the extent to which humanity has made innovative uses of the biosphere as measured by the biodiversity of patent applications.

All of these applications rely on both the quality and quantity of the data that are available to biodiversity researchers. Within the wider scientific community the theme of data citation is gaining wider prominence, both as a means to give credit to those who create and curate data, and to track the provenance of data as they are used (and re-used). Many of the papers listed in this report come with Digital Object Identifiers (DOIs) that uniquely identify each publication, which facilitates tracking the use of each paper (for example through citations by other publications, or other venues such as online discussions and social media). Initiatives to encourage 'data papers' in online journals, such as those produced by Pensoft Publishers (see p41), are associating DOIs with data, so that data no longer are the poor cousins of standard research papers. One thing I look forward to is seeing DOIs attached directly to GBIF-mobilized data, so that we can begin to track the use of the data with greater fidelity, providing valuable feedback to those who have seen the value of GBIF and have contributed to GBIF's effort to enable free and open access to biodiversity data.

ROD PAGE
Chair, GBIF Science Committee

A NOTE ON THIS REVIEW

All of the research articles included in the main sections of this review from page 2 to page 39 assert some use of data accessed via GBIF. They were identified through GBIF Secretariat's ongoing programme to monitor scientific literature and tag papers according to use, discussion and mention of GBIF. This archive is freely available at http://www.mendeley.com/groups/1068301/gbif-public-library/. Examples of data use are also highlighted on the GBIF portal at http://www.gbif.org/newsroom/uses.

The categories used for this review are designed to help navigate the major subject areas covered by GBIF-assisted research. Some papers will inevitably cover multiple areas, however, making the classifications and the distinctions appear arbitrary in places. The countries assigned to authors are based on the location of the institutions given in the author information. The free-text descriptions given to some papers in each category are for illustration only — they do not imply greater importance being attached to those papers than to others cited in the review. In this year's review, funding information is also included for the highlighted papers.

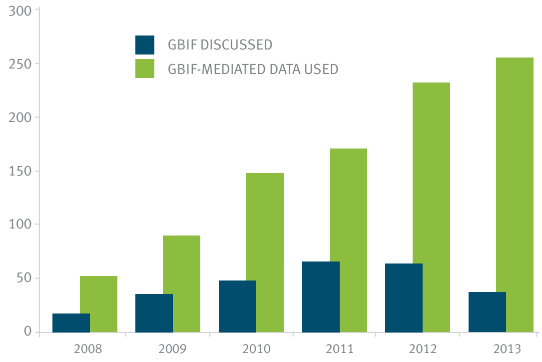

FIGURE 1. A SUMMARY OF GBIF CITATION IN PEER-REVIEWED PUBLICATIONS, 2008-2013.

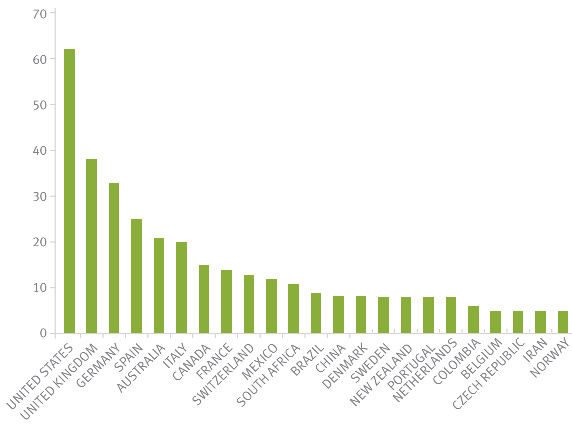

FIGURE 2. NUMBER OF SCIENTIFIC PUBLICATIONS IN 2013 CITING USE OF GBIF-MEDIATED DATA, RANKED BY COUNTRY ACCORDING TO AFFILIATION OF AUTHOR. TOP 23 COUNTRIES SHOWN.

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Invasive alien species

Invasive alien species and their impacts continued to be a dominant theme in the research using GBIF as a source of data in 2013. Datasets published through the GBIF network provide records of the distribution of such species in both the habitats where they originally evolved and the regions where, once introduced (whether accidentally or intentionally), they have subsequently spread. Access to these data enables researchers to assess the risk of species invasions under present and future climate conditions, and to understand better the mechanisms behind the spread and establishment of invasive species. Research included in this section offers guidance to policy makers on prioritizing action to reduce the impact of one of the major threats to biodiversity.

Some examples

BULRUSH (*TYPHA LATIFOLIA*) IN LAPPEENRANTA, FINLAND. BY PETRITAP. CC-BY-SA-3.0, VIA WIKIMEDIA COMMONS.

CLIMATE CHANGE AND INVASION RISKS

Bellard, C., Thuiller, W., Leroy, B., Genovesi, P., Bakkenes, M. *et al*. (2013). Will climate change promote future invasions? *Global Change Biology*, 1–9. doi:10.1111/gcb.12344
Author countries: France, Italy, Netherlands
Research funding: Centre National de la Recherche Scientifique, Agence Nationale de la Recherche (France); 7th Framework Project for Research (European Union)

Xu, Z., Feng, Z., Yang, J., Zheng, J., & Zhang, F. (2013). Nowhere to invade: *Rumex crispus* and *Typha latifolia* projected to disappear under future climate scenarios. *PLoS ONE*, 8(7), e70728. doi:10.1371/journal.pone.0070728
Author country: China
Research funding: National Natural Science Foundation, University of Xinjiang, Ministry of Education (China)

These two studies looked at the impacts of climate change on the potential distribution of alien species now causing problems to biodiversity and ecosystems. While new ‘invasion hotspots’ are likely to emerge in some regions, other invasive species will lose out as environments become less suitable for their survival.

Bellard *et al*. used models to project future suitable areas for 100 of the world’s worst invasive species, as defined by the International Union for the Conservation of Nature (IUCN). Occurrence data for 87 of the species were obtained through GBIF and other sources, and GBIF was the sole source of data for six of the species.

The research concluded that based on future climate and land-use changes, the risk of invasion was likely to increase by 2100 in a number of temperate regions including northern and eastern Europe, eastern North America, southern Australia and New Zealand. Many tropical regions, on the other hand, are likely to become less suitable for invasive species as conditions become more extreme. The picture also varies across species groups, with ranges of invasive amphibians and birds likely to shrink, while those of aquatic and terrestrial invertebrates are projected to expand substantially in most cases.

In the second study, Xu *et al*. looked at possible climate change impacts on two highly invasive species: the curled dock (*Rumex crispus*), native to Europe, north Africa and West Asia, but now present in all continents; and *Typha latifolia*, a wetland herbaceous plant native to North America but now widespread in Europe and present in many other regions.

The researchers used more than 97,000 occurrence records of these two species, accessed via GBIF, to project suitable habitats under various climate scenarios for 2050. They found that under most scenarios, both species would lose their entire global habitat, and in one scenario they would lose more than 90 per cent of their current potential range. The study attributes the loss of range to warmer and wetter conditions in the coldest season, while noting uncertainty around the ability of invasive species to adapt to these changing conditions.

EASTERN GREY SQUIRREL (*SCIURUS CAROLINENSIS*) IN FLORIDA. BY BIRDPHOTOS.COM. CC-BY-3.0 VIA WIKIMEDIA COMMONS.

SHIFTING NICHES AND THE CHALLENGE FOR INVASIVE SPECIES CONTROL

Di Febbraro, M., Lurz, P. W. W., Genovesi, P., Maiorano, L., Girardello, M. *et al.* (2013). The use of climatic niches in screening procedures for introduced species to evaluate risk of spread: a case with the American eastern grey squirrel. *PLoS ONE*, 8(7), e66559. doi:10.1371/journal.pone.0066559
Author countries: Germany, Italy, United Kingdom
Research funding: None specified

Guo, W.-Y., Lambertini, C., Li, X.-Z., Meyerson, L. A., & Brix, H. (2013). Invasion of Old World *Phragmites australis* in the New World: precipitation and temperature patterns combined with human influences redesign the invasive niche. *Global Change Biology*, 19(11), 3406–22. doi:10.1111/gcb.12295
Author countries: China, Denmark, United States
Research funding: Danish Council for Independent Research, Natural Sciences, S C Van Fonden (Denmark); China Scholarship Council (China); National Science Foundation, University of Rhode Island (United States)

Two 2013 research papers made use of data available through GBIF to investigate how species can shift their ecological ‘niches’ when introduced to alien environments — complicating the task of predicting invasion risks and controlling their spread.

In the first study, a team from Italy, Germany and the United Kingdom looked at the case of the eastern grey squirrel (*Sciurus carolinensis*), originally from North America, which has virtually wiped out the native red squirrel (*Sciurus vulgaris*) in large parts of the British Isles and northern Italy where it spread after being introduced more than a century ago.

Using records on the occurrence of the grey squirrel both in its native and introduced ranges, accessed through GBIF, online collections and field observations, the researchers compared different models to see which best matched the actual spread of the invasive squirrels. It found that when only occurrences from the mammals’ native range were considered, the model underestimated the actual spread of the squirrels into areas of the UK where they have thrived in wetter and colder regions than in their native habitats.

The authors conclude that this supports the hypothesis that the species shifted its climatic niche after it was introduced to new European environments — in other words it has colonized areas very different from those in its native range. They suggest that risk assessment based only on native occurrences is likely to underestimate the areas an alien species might invade — and recommend caution in using such models to construct ‘white lists’ of species assumed to pose a low risk of invasion.

In the second study, a team from China, Denmark and the United States looked at the spread of Old World varieties of the common reed, *Phragmites australis*, in parts of the Americas where it has overrun native reeds in wetland habitats, spreading rapidly in recent decades from the Atlantic coast of the US to many western states and the Gulf of Mexico region.

This study examined records from the native and invasive ranges of the species to detect whether the species had shifted its niche since it was introduced centuries ago. It used 1,890 records accessed through GBIF to compare the predictions of its models with the actual distributions of the reed.

The research concluded that American populations of the common reed occurred in climatic conditions significantly different from those in its native Eurasian ranges. It also suggested that the invasive species had shifted its niche since introduction, apparently adapting to warmer temperatures and higher rainfall, as well as greater human disturbance of habitats, in recent decades.

THE COMMON RAGWEED (*AMBROSIA ARTEMISIIFOLIA*), DORDOGNE, FRANCE. BY PÈRE IGOR. CC-BY-SA-3.0, VIA WIKIMEDIA COMMONS.

PREDICTING SPREAD OF ALLERGENIC INVASIVE PLANTS IN EUROPE

Cunze, S., Leiblein, M. C., & Tackenberg, O. (2013). Range expansion of *Ambrosia artemisiifolia* in Europe is promoted by climate change. *ISRN Ecology*, 2013, 1–9. doi:10.1155/2013/610126
Author country: Germany
Research funding: Hesse Ministry of Higher Education, Deutsche Forschungemeinschaft (Germany)

Follak, S., Dullinger, S., Kleinbauer, I., Moser, D., & Essl, F. (2013). Invasion dynamics of three allergenic invasive Asteraceae (*Ambrosia trifida, Artemisia annua, Iva xanthiifolia*) in central and eastern Europe. *Preslia*, 85, 41–61. http://www.preslia.cz/P131Follak.pdf
Author country: Austria
Research funding: Climate and Energy Fund (Austria)

The common ragweed (*Ambrosia atermisiifolia*) is a plant native to North America, introduced accidentally to southeastern Europe in the 19th century. It has since become widespread in parts of the continent. Typically growing in urban wasteland and overgrown fields, it is a significant human health risk because many people are allergic to its pollen.

In the first study Cunze *et al.* aimed to predict whether the invasive plant was likely to shift its range in Europe due to climate change. The research generated models using GBIF to identify 2,016 records of the ragweed's occurrence in its native North America, and 2,779 records from its invasive range in Europe – together with past climate records and forecasts for climate change based on various scenarios. It compared the results for current suitable habitats with independent data on the regions where ragweed has been reported.

The study found that when only the European occurrences were used, the model produced implausible results. The authors concluded that this was due to sampling bias among the European records available through GBIF when the models were generated (in 2009).

However, when the GBIF-mediated data from the plant's native range in North America were used to generate the models, there was a much better match with known occurrences in Europe. On this basis, the researchers predicted that climate change would enable the ragweed to thrive in many more parts of Europe, with potential invasions possible over huge areas including northern France, Germany, the Benelux countries, Czech Republic, Poland, the Baltic States, Belarus and wide parts of Russia.

In the second study, Follak *et al.* analysed the history of invasions by three wind-pollinated plant species closely related to common ragweed that are also highly allergenic but have received less attention. Also using data accessed through GBIF among other sources, the study looked at the relative influence of temperature, precipitation, land use and types of habitat — and through this analysis, identified substantial parts of central and eastern Europe at risk from future invasions.

In view of the high cost of the plants' spread in terms of human health (estimated at €110 million per year in Hungary, for example), the authors of both studies urge close monitoring and early control measures to minimize their impacts.

BLOODY RED MYSID (*HEMIMYSIS ANOMALA*). BY S. POTHOVEN, GLERL. CC-BY-NC 2.0, VIA FLICKR.

USING SOCIO-ECONOMIC FACTORS TO TARGET SPECIES INVASIONS

Gallardo, B., & Aldridge, D. C. (2013). The "dirty dozen": socio-economic factors amplify the invasion potential of 12 high-risk aquatic invasive species in Great Britain and Ireland. *Journal of Applied Ecology*, 50(3), 757–766. doi:10.1111/1365-2664.12079
Author country: United Kingdom
Research funding: 7th Framework Programme for Research (European Union)

This study from the Aquatic Zoology Group of Cambridge University set out to identify invasive species that posed the highest risk to aquatic biodiversity in Great Britain and Ireland. Starting with a list of 12 invertebrates, fish and plants known to be 'potential aquatic invaders', the researchers used both environmental and socio-economic factors to establish which areas were at greatest risk of invasion from which species.

To generate models for the study, the researchers obtained data on the global occurrence of all 12 species through GBIF, Fishbase, the United States Geological Survey and the Atlas Flora Europaea. Environmental factors such as climate, altitude and geology were used to determine which areas of Great Britain and Ireland would be most suitable for the invaders to thrive.

An innovation of the study was to integrate socio-economic factors to improve the prediction of invasion risk. For example, population density, a 'human influence index' and the proximity to major ports can predict where activities such as shipping, sport fishing, canal building and the pet trade are most likely to introduce aquatic invaders.

The study concluded that the threat from aquatic invasive species was especially high in southeast England, with five species of special concern: the killer shrimp (*Dikerogammarus villosus*), bloody red mysid (*Hemimysis anomala*), both from the Black Sea/Caspian region; the water primrose (*Ludwigia grandiflora*); and two crayfish species from Central America (*Procambarus clarkii* and *P. fallax*). The authors note that including socio-economic factors can improve prediction of areas at risk of multiple invasions and help target limited resources for prevention and control.

Other research relating to invasive species citing use of GBIF-mediated data

Title	Journal	Authors	Author countries	DOI/URL
Effects of climate change, invasive species, and disease on the distribution of native European crayfishes.	Conservation Biology	Capinha, C., Larson, E. R., Tricarico, E., Olden, J. D., & Gherardi, F.	Portugal, United States, Italy	10.1111/cobi.12043
Invasion trajectory of alien trees: the role of introduction pathway and planting history.	Global Change Biology	Donaldson, J. E., Hui, C., Richardson, D. M., Robertson, M. P., Webber, B. L. *et al.*	Australia, South Africa	10.1111/gcb.12486
Next-generation invaders? Hotspots for naturalised sleeper weeds in Australia under future climates.	PLoS ONE	Duursma, D. E., Gallagher, R. V., Roger, E., Hughes, L., Downey, P. O. *et al.*	Australia	10.1371/journal.pone.0084222
Evaluating the combined threat of climate change and biological invasions on endangered species.	Biological Conservation	Gallardo, B., & Aldridge, D. C.	United Kingdom	10.1016/j.biocon.2013.02.001
Invasion ratcheting in the zebra mussel (*Dreissena polymorpha*) and the ability of native and invaded ranges to predict its global distribution.	Journal of Biogeography	Gallardo, B., zu Ermgassen, P. S. E., & Aldridge, D. C.	United Kingdom	10.1111/jbi.12170
Evaluation of online information sources on alien species in Europe: the need of harmonization and integration.	Environmental Management	Gatto, F., Katsanevakis, S., Vandekerkhove, J., Zenetos, A., & Cardoso, A. C.	Greece, Italy	10.1007/s00267-013-0042-8
Montpellier broom (*Genista monspessulana*) and Spanish broom (*Spartium junceum*) in South Africa: An assessment of invasiveness and options for management.	South African Journal of Botany	Geerts, S., Botha, P. W., Visser, V., Richardson, D. M., & Wilson, J. R. U.	South Africa	10.1016/j.sajb.2013.03.019
The absence of fire can cause a lag phase: the invasion dynamics of *Banksia ericifolia* (Proteaceae).	Austral Ecology	Geerts, S., Moodley, D., Gaertner, M., Le Roux, J. J., McGeoch, M. A. *et al.*	South Africa, Australia	10.1111/aec.12035
The ecology, biogeography, history and future of two globally important weeds: *Cardiospermum halicacabum* Linn. and *C. grandiflorum Sw.*	NeoBiota	Gildenhuys, E., Ellis, A. G., Carroll, S. P., & Le Roux, J. J.	South Africa, United States	10.3897/neobiota.19.5279
Epilobium brachycarpum: a fast-spreading neophyte in Germany.	Tuexenia	Gregor, T., Bönsel, D., Starke-Ottich, I., Tackenberg, O., Wittig, R. *et al.*	Germany	http://www.tuexenia.de/fileadmin/website/downloads/Tuexenia33/11Gregor-etal_Tuexenia33.pdf
How far could the alien boatman *Trichocorixa verticalis verticalis* spread? Worldwide estimation of its current and future potential distribution.	PLoS ONE	Guareschi, S., Coccia, C., Sánchez-Fernández, D., Carbonell, J. A., Velasco, J. *et al.*	Spain, Australia	10.1371/journal.pone.0059757
Macroecology meets invasion ecology: performance of Australian acacias and eucalypts around the world revealed by features of their native ranges.	Biological Invasions	Hui, C., Richardson, D. M., Visser, V., & Wilson, J. R. U	South Africa	10.1007/s10530-013-0599-4

Title	Journal	Authors	Author countries	DOI/URL
Applying distribution model projections for an uncertain future: the case of the Pacific oyster in UK waters.	Aquatic Conservation: Marine and Freshwater Ecosystems	Jones, M. C., Dye, S. R., Pinnegar, J. K., Warren, R., & Cheung, W. W. L.	United Kingdom, Canada	10.1002/aqc.2364
How many marine aliens in Europe?	Management of Biological Invasions	Katsanevakis, S., Gatto, F., Zenetos, A., & Cardoso, A. C.	Greece, Italy	10.3391/mbi.2013.4.1.05
The biology of invasive alien plants in Canada. 12. *Pueraria montana var. lobata* (Willd.) Sanjappa & Predeep.	Canadian Journal of Plant Science	Lindgren, C. J., Castro, K. L., Coiner, H. A., Nurse, R. E., & Darbyshire, S. J.	Canada	10.4141/cjps2012-128
Regeneration dynamics of non-native northern red oak (*Quercus rubra L.*) populations as influenced by environmental factors: A case study in managed hardwood forests of southwestern Germany.	Forest Ecology and Management	Major, K. C., Nosko, P., Kuehne, C., Campbell, D., & Bauhus, J.	Canada, Germany	10.1016/j.foreco.2012.12.006
Risk of invasion by frequently traded freshwater turtles.	Biological Invasions	Masin, S., Bonardi, A., Padoa-Schioppa, E., Bottoni, L., & Ficetola, G. F.	Italy	10.1007/s10530-013-0515-y
Invasion biology in non-free-living species: interactions between abiotic (climatic) and biotic (host availability) factors in geographical space in crayfish commensals (Ostracoda, Entocytheridae).	Ecology and Evolution	Mestre, A., Aguilar-Alberola, J. A., Baldry, D., Balkis, H., Ellis, A. *et al.*	Croatia, Czech Republic, Germany, Netherlands, Spain, Turkey, United Kingdom	10.1002/ece3.897
Different traits determine introduction, naturalization and invasion success in woody plants: Proteaceae as a test case.	PLoS ONE	Moodley, D., Geerts, S., Richardson, D. M., & Wilson, J. R. U.	South Africa	10.1371/journal.pone.0075078
Phenotypic plasticity and differentiation in fitness-related traits in invasive populations of the Mediterranean forb *Centaurea melitensis* (Asteraceae).	American Journal of Botany	Moroney, J. R., Rundel, P. W., & Sork, V. L.	United States	10.3732/ajb.1200543
Niche conservatism and the potential for the crayfish *Procambarus clarkii* to invade South America.	Freshwater Biology	Palaoro, A. V., Dalosto, M. M., Costa, G. C., & Santos, S.	Brazil	10.1111/fwb.12134
Casuarina: biogeography and ecology of an important tree genus in a changing world.	Biological Invasions	Potgieter, L. J., Richardson, D. M., & Wilson, J. R. U.	South Africa	10.1007/s10530-013-0613-x
Quantifying the ecological niche overlap between two interacting invasive species: the zebra mussel (*Dreissena polymorpha*) and the quagga mussel (*Dreissena rostriformis bugensis*).	Aquatic Conservation: Marine and Freshwater Ecosystems	Quinn, A., Gallardo, B., & Aldridge, D. C.	United Kingdom	10.1002/aqc.2414

Title	Journal	Authors	Author countries	DOI/URL
Do low-head riverine structures hinder the spread of invasive crayfish? Case study of signal crayfish (*Pacifastacus leniusculus*) movements at a flow gauging weir.	Management of Biological Invasions	Rosewarne, P. J., Piper, A. T., Wright, R. M., & Dunn, A. M.	United Kingdom	10.3391/mbi.2013.4.4.02
Biogeography and ecology of *Rhizodomus tagatzi*, a presumptive invasive tintinnid ciliate.	Journal of Plankton Research	Sacca, A., & Giuffre, G.	Italy	10.1093/plankt/fbt036
Bromus tectorum invasion in South America: Patagonia under threat?	Weed Research	Speziale, K. L., Lambertucci, S. A., & Ezcurra, C.	Argentina	10.1111/wre.12047
Pest occurrence model in current climate – validation study for European domain.	Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis	Svobodová, E., Trnka, M., Dubrovský, M., Semerádová, D., Eitzinger, J. *et al.*	Czech Republic	10.11118/actaun201361010205
EASIN-Lit: a geo-database of published alien species records.	Management of Biological Invasions	Trombetti, M., Katsanevakis, S., Deriu, I., & Cardoso, A. C.	Italy	10.3391/mbi.2013.4.3.08
Is there a need for a more explicit accounting of invasive alien species under the Water Framework Directive?	Management of Biological Invasions	Vandekerkhove, J., Cardoso, A. C., & Boon, P. J.	Italy, United Kingdom	10.3391/mbi.2013.4.1.04
Impact of plant invasions on local arthropod communities: a meta-analysis.	Journal of Ecology	Van Hengstum, T., Hooftman, D. A. P., Oostermeijer, J. G. B., & van Tienderen, P. H.	Netherlands, United Kingdom	10.1111/1365-2745.12176
Potential distribution and risk assessment of an invasive plant species: a case study of *Hymenachne amplexicaulis* in Australia.	Human and Ecological Risk Assessment: An International Journal	L. J. Wearne, D. Ko, M. Hannan-Jones & M. Calvert	Australia	10.1080/10807039.2012.632293
Exotic spread of *Solenopsis invicta* Buren (Hymenoptera: Formicidae) beyond North America.	Sociobiology	Wetterer, J. K.	United States	10.13102/sociobiology.v60i1.50-55
Worldwide spread of Alluaud's little yellow ant, *Plagiolepis alluaudi* (Hymenoptera: Formicidae).	Myrmecological News	Wetterer, J. K.	United States	http://www.myrmecologicalnews.images/pdf/volume19/mn19_53-59_non-printable.pdf
Worldwide spread of the little fire ant, *Wasmannia auropunctata* (Hymenoptera: Formicidae).	Terrestrial Arthropod Reviews	Wetterer, J. K.	United States	10.1163/18749836-06001068
Worldwide spread of the difficult white-footed ant, *Technomyrmex difficilis* (Hymenoptera: Formicidae).	Myrmecological News	Wetterer, J. K	United States	http://www.antwiki.org/wiki/images/f/f2/Wetterer_2013c.pdf
Effect of geographic background and equilibrium state on niche model transferability: predicting areas of invasion of *Leptoglossus occidentalis*.	Biological Invasions	Zhu, G.-P., Rédei, D., Kment, P., & Bu, W.-J.	China, Czech Republic, Hungary	10.1007/s10530-013-0559-z
Delimiting the coastal geographic background to predict potential distribution of *Spartina alterniflora*.	Hydrobiologia	Zhu, G., Gao, Y., & Zhu, L.	China	10.1007/s10750-013-1580-z

Impacts of climate change

How can we expect the distribution of the world's species to shift as a result of climate change in coming decades? What will be the impact on ecological relationships and landscapes? Will species be able to evolve new survival strategies quickly enough to cope with rapidly warming conditions? To answer such questions, many researchers make use of the data freely available through GBIF and similar networks to develop predictive models. In some cases, this research requires very large volumes of data on hundreds or even thousands of species and millions of locations where they have been observed. Thanks to the investment by governments in the GBIF data infrastructure and the willingness of scientists and institutions to publish their data using common standards, such research is possible without the need to compile data separately from many different collections dispersed around the world.

Some examples

COMMON CUCKOO (*CUCULUS CANORUS*), A SPECIES AFFECTED BY CLIMATE CHANGE. BY TIM PEUKERT. CC-BY-SA-3.0, VIA WIKIMEDIA COMMONS.

MODELLING CLIMATE IMPACTS ON COMMON SPECIES

Warren, R., VanDerWal, J., Price, J., Welbergen, J. A., Atkinson, I., *et al*. (2013). Quantifying the benefit of early climate change mitigation in avoiding biodiversity loss. *Nature Climate Change*, 3(5), 1–5. doi:10.1038/nclimate1887
Author countries: United Kingdom, Colombia, Australia
Research funding: MacArthur Foundation/World Wildlife Fund (United States); Australian Research Council (Australia); CGIAR Research Program on Climate Change, Agriculture and Food Security (International)

Reviewing nearly 50,000 globally widespread and common species, this paper found that more than half of the plants and over a third of animal species could lose more than half of their climatic range by 2080 if nothing is done to limit greenhouse gas emissions. However, it concluded that acting quickly to mitigate climate change could reduce losses by 60 per cent and buy an additional 40 years for species to adapt.

The study defined the climate 'niche' occupied by each species, based on temperature and rainfall where they live now, and mapped the areas that would remain suitable for them according to various scenarios of future climate change. The researchers obtained data on the occurrence of plants, mammals, birds, reptiles and amphibians from around 170 million records published through GBIF by some 200 different institutions around the world.

According to the research, plants, reptiles and especially amphibians are expected to be at highest risk from climate change. The climate will become especially unsuitable for both plant and animal species in Sub-Saharan Africa, Central America, Amazonia and Australia. A major loss of plant species is also projected for North Africa, Central Asia and southeastern Europe.

“This research would not be possible without GBIF and its global community of researchers and volunteers who make their data freely available.”

Jeff Price, School of Environmental Sciences, University of East Anglia, United Kingdom

NORWAY LOBSTER (*NEPHROPS NORVEGICUS*). BY HANS HILLEWAERT. CC-BY-SA-3.0, VIA WIKIMEDIA COMMONS.

MODELLING THE FUTURE FOR MARINE SPECIES IN THE NORTH SEA UNDER CLIMATE CHANGE

Jones, M. C., Dye, S. R., Fernandes, J. A., Frölicher, T. L., Pinnegar, J. K., *et al.* (2013). Predicting the impact of climate change on threatened species in UK waters. *PLoS ONE*, 8(1), e54216. doi:10.1371/journal.pone.0054216
Author countries: United Kingdom, United States, Canada
Research funding: Department for Environment, Food and Rural Affairs (United Kingdom); National Geographic Society (United States); Natural Sciences and Engineering Research Council, University of British Columbia (Canada); Nippon Foundation (Japan); 7th Framework Programme for Research (European Union)

This study used a range of different models to explore the potential impact of climate change on marine species in the North Sea by 2050. The data used for the study included more than 5,000 records of 18 fish and crustacean species accessed via GBIF, including commercially targeted species like Norway lobster (*Nephrops norvegicus*) and Atlantic cod (*Gadus morhua*), and critically endangered species such as angelshark (*Squatina squatina*) and common skate (*Dipturus batis*).

The study projected that on average, species would move northwards by approximately 27 kilometres each decade. The researchers found there would be relatively small changes in the overlap of ranges between commercially exploited and threatened species, easing concerns about possible increases in accidental catches of rare species due to climate change. The study also predicted only small adverse consequences from climate change on the ability of marine protected areas to provide suitable habitat for the threatened species.

However, the models used by the researchers showed wide variations in the projections for individual species, and the authors argue that this shows the value of using multiple models to construct best and worst case scenarios, and apply a precautionary approach to protecting the marine environment given the uncertain response of threatened species in the face of climate change.

> *“I do consider GBIF to be a very important source of data in this study and for species distribution modelling that uses presence-only techniques in general. It also enables people to study species’ distributions for scales or areas which might otherwise be limited by logistics and cost.”*

Miranda Jones, Centre for Environment, Fisheries and Aquaculture Science, and University of East Anglia, United Kingdom.

WHITE-TAILED DEER (*ODOCOILEUS VIRGINIANUS*), HOST FOR THE PARASITE *PARELAPHO-STRONGYLUS TENUIS*. BY KEN THOMAS (PUBLIC DOMAIN), VIA WIKIMEDIA COMMONS.

PREDICTING CLIMATE RESPONSES OF PARASITES AND HOSTS

Pickles, R. S. A., Thornton, D., Feldman, R., Marques, A., & Murray, D. L. (2013). Predicting shifts in parasite distribution with climate change: a multitrophic level approach. *Global Change Biology*, 19(9), 2645–54. doi:10.1111/gcb.12255
Author country: Canada
Research funding: Canadian Bureau of International Education

This study emphasized the need to develop combined models for climate responses from multiple species in order to understand the likely future impacts of harmful parasites. The research looked at a parasitic worm that causes severe neurological damage to moose, elk, caribou, domestic sheep and goats. The worm is transmitted through white-tailed deer, which it does not harm, but also depends on a number of snail and slug species during other parts of its life cycle. To predict future occurrence of the worm under different climate scenarios, the researchers took an 'ensemble approach', modelling areas of suitability for both types of host as well as for the parasite itself. Data for white-tailed deer and the mollusc hosts were accessed through GBIF. The study concluded that the parasite was likely to decline in the Great Plains and southeastern United States, but increase in northern forest areas especially in Alberta, Canada.

SANDHILL CRANE (*GRUS CANADENSIS*). BY ANDREA WESTMORELAND. CC-BY-SA-2.0, VIA WIKIMEDIA COMMONS.

CAN SPECIES ADAPT TO 21ST CENTURY CLIMATE CHANGE?

Quintero, I., & Wiens, J. J. (2013). Rates of projected climate change dramatically exceed past rates of climatic niche evolution among vertebrate species. *Ecology Letters*, 16(8), 1095–103. doi:10.1111/ele.12144
Author country: United States
Research funding: None specified

Research by authors from Yale University and the University of Arizona aimed to test whether it may be possible for vertebrate species to adapt to the new climate conditions expected over coming decades. To do so, they estimated how quickly vertebrates had evolved new climatic 'niches' in the past, and compared that with the rate of climate change projected to the end of this century. The research looked at 270 pairs of 'sister' species of amphibians, reptiles, birds and mammals, for which it was possible to estimate when in the past they had split off from a common ancestor. The study used locality data from GBIF and other sources to determine the species' ranges, and climate data to calculate the range of conditions tolerated by the species. Across 17 clades or groups of related species, it found that on average, climate niches had changed at a rate of less than one degree Celsius per million years. This is between 10,000 and 100,000 times slower than the expected rate of warming between 2000 and 2100. While accepting limitations in the methodology of the study, the authors suggest that *in situ* adaptation of vertebrate populations to changing climate conditions would require largely unprecedented rates of climatic niche evolution – emphasizing the need for many species to move towards the poles or to higher altitudes in order to avoid extinction.

STREAM RUNNING THROUGH DENSE FOREST AT LA SELVA BIOLOGICAL STATION, SARAPIQUI, COSTA RICA. BY GEOFF GALLICE. CC-BY-2.0, VIA WIKIMEDIA COMMONS.

TROPICAL FOREST SPECIES MOVING TO HIGHER ALTITUDES

Feeley, K. J., Hurtado, J., Saatchi, S., Silman, M. R., & Clark, D. B. (2013). Compositional shifts in Costa Rican forests due to climate-driven species migrations. *Global Change Biology*, 19(11), 3472–80. doi:10.1111/gcb.12300
Author countries: United States, Costa Rica
Research funding: Conservation International, Missouri Botanical Garden, Smithsonian Institution, Wildlife Conservation Society, Gordon and Betty Moore Foundation, Fairchild Tropical Botanic Gardens, NASA, National Science Foundation (United States)

This study examined evidence for the movement of tropical tree species to cooler locations in response to warming temperatures. The research relied on annual surveys, carried out between 2003 and 2011, of ten forest-inventory plots on the slopes of Volcán Brava on the Caribbean coast of Costa Rica, ranging from 70 metres to 2,800 metres in altitude.

The surveys recorded 386 tree species from the plots. Through the GBIF data portal, the researchers downloaded all available herbarium data for these species collected in Costa Rica, and used climate maps to calculate the average temperature within the recorded range of each species.

The study found that in nine out of the ten plots, there was a shift towards species that favoured hotter climates – indicating that plant species are indeed migrating up mountain slopes in response to warming global temperatures. The researchers warn that since land area inevitably decreases at higher altitudes, many tropical species will face a heightened risk of extinction as climate change continues.

GREENLAND LANDSCAPE. BY MATS HOLMSTRÖM/NORDEN.ORG. CC-BY-2.5-DK, VIA WIKIMEDIA COMMONS.

WILL GREENLAND LIVE UP TO ITS NAME IN A WARMING CLIMATE?

Normand, S., Randin, C., Ohlemüller, R., Bay, C., Høye, T. T., *et al.* (2013). A greener Greenland? Climatic potential and long-term constraints on future expansions of trees and shrubs. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *368*(1624), 20120479. doi:10.1098/rstb.2012.0479
Author countries: Denmark, Italy, New Zealand, Switzerland
Research funding: Danish Council for Independent Research, Natural Sciences, Aarhus University Research Foundation (Denmark); European Research Council (European Union)

A study in the journal published by Britain's Royal Society examined whether Greenland is likely to become a much greener place over the next century. It projected shifts in areas climatically suitable for tree growth, for 56 species of trees and shrubs from Greenland itself, and from Arctic and subarctic areas of North America and Europe. The study used occurrence records for the plant species, accessed through GBIF. The resulting models projected substantial increases in the areas climatically suitable for trees and shrubs by 2100 – expanding even to north Greenland. However, the research cast doubt as to whether these plants would actually colonize the new areas in that time period, given the difficulties of dispersal and establishment of new vegetation in tundra, which has meant that many ice-free parts of Greenland have remained uncolonized by trees or shrubs for thousands of years despite having a suitable climate. The study concluded that introduction of species resulting from human activities in Greenland was likely to be a major factor influencing whether vegetation increases significantly over the coming decades.

Other research relating to climate change citing use of GBIF-mediated data

Title	Journal	Authors	Author countries	DOI/URL
Biodiversity ensures plant-pollinator phenological synchrony against climate change.	Ecology Letters	Bartomeus, I., Park, M. G., Gibbs, J., Danforth, B. N., Lakso, A. N. *et al.*	Sweden, United States	10.1111/ele.12170
The potential global distribution of tall buttercup (*Ranunculus acris* ssp. *acris*): opposing effects of irrigation and climate change.	Weed Science	Bourdôt, G. W., Lamoureaux, S. L., Watt, M. S., & Kriticos, D. J.	Australia, New Zealand	10.1614/WS-D-12-00106.1
Present, past and future of the European rock fern *Asplenium fontanum*: combining distribution modelling and population genetics to study the effect of climate change on geographic range and genetic diversity.	Annals of Botany	Bystriakova, N., Ansell, S. W., Russell, S. J., Grundmann, M., Vogel, J. C. *et al.*	China, Germany	10.1093/aob/mct274
Ancient DNA reveals that bowhead whale lineages survived Late Pleistocene climate change and habitat shifts.	Nature Communications	Foote, A. D., Kaschner, K., Schultze, S. E., Garilao, C., Ho, S. Y. W. *et al.*	Denmark, Germany, Australia, Netherlands, United Kingdom, Sweden	10.1038/ncomms2714
Antarctic crabs: invasion or endurance?	PLoS ONE	Griffiths, H. J., Whittle, R. J., Roberts, S. J., Belchier, M., & Linse, K.	United Kingdom	10.1371/journal.pone.0066981
Global climate change adaptation priorities for biodiversity and food security.	PLoS ONE	Hannah, L., Ikegami, M., Hole, D. G., Seo, C., Butchart, S. H. M., *et al.*	Republic of Korea, New Zealand, United Kingdom, United States	10.1371/journal.pone.0072590
Predicting the spread of *Aedes albopictus* in Australia under current and future climates: Multiple approaches and datasets to incorporate potential evolutionary divergence.	Austral Ecology	Hill, M. P., Axford, J. K., & Hoffmann, A. A.	Australia, South Africa	10.1111/aec.12105
Climate change impact on seaweed meadow distribution in the North Atlantic rocky intertidal.	Ecology and Evolution	Jueterbock, A., Tyberghein, L., Verbruggen, H., Coyer, J. A., Olsen, J. L. *et al.*	Norway, Belgium, Australia, United States, Netherlands	10.1002/ece3.541
New biological model to manage the impact of climate warming on maize corn borers.	Agronomy for Sustainable Development	Maiorano, A., Cerrani, I., Fumagalli, D., & Donatelli, M.	Italy	10.1007/s13593-013-0185-2
Assessing the exposure of lion tamarins (*Leontopithecus spp.*) to future climate change.	American Journal of Primatology	Meyer, A. L. S., Pie, M. R., & Passos, F. C.	Brazil	10.1002/ajp.22247
Burrow-dwelling ecosystem engineers provide thermal refugia throughout the landscape.	Animal Conservation	Pike, D. A., & Mitchell, J. C.	Australia, United States	10.1111/acv.12049

Title	Journal	Authors	Author countries	DOI/URL
Projecting global mangrove species and community distributions under climate change.	Ecosphere	Record, S., Charney, N. D., Zakaria, R. M., & Ellison, A. M.	United States, Malaysia	10.1890/ES12-00296.1
A simple model for predicting the global distribution of the N2 fixing host genus *Alnus Mill.*: impact of climate change on the global distribution in 2100.	Biogeosciences Discussions	Sakalli, A.	Germany	10.5194/bgd-10-13049-2013
Climate-induced range shifts and possible hybridisation consequences in insects.	PLoS ONE	Sánchez-Guillén, R. A., Muñoz, J., Rodríguez-Tapia, G., Feria Arroyo, T. P., & Córdoba-Aguilar, A.	Ecuador, Mexico, Spain, United States	10.1371/journal.pone.0080531
Metabolic scope and interspecific competition in sculpins of Greenland are influenced by increased temperatures due to climate change.	PLoS ONE	Seth, H., Gräns, A., Sandblom, E., Olsson, C., & Wiklander, K. *et al.*	Sweden	10.1371/journal.pone.0062859
Predicting the distribution of a novel bark beetle and its pine hosts under future climate conditions.	Agricultural and Forest Entomology	Smith, S. E., Mendoza, M. G., Zúñiga, G., Halbrook, K., & Hayes, J. L. *et al.*	United States, Mexico	10.1111/afe.12007
Potential impacts of climate change on distribution range of *Nabis pseudoferus* and *N. palifer* (Hemiptera: Nabidae) in Iran.	Entomological Science	Solhjouy-Fard, S., & Sarafrazi, A.	Iran	10.1111/ens.12064
Phylogeography and post-glacial recolonization in wolverines (*Gulo gulo*) from across their circumpolar distribution.	PLoS ONE	Zigouris, J., Schaefer, J. A., Fortin, C., & Kyle, C. J.	Canada	10.1371/journal.pone.0083837

Species conservation and protected areas

To conserve the diversity of life on Earth, decision makers need good, robust information based on sound science. Which areas of land, ocean and fresh water are the most critical to protect? How should our conservation policies be influenced by the projected impacts of climate change? What special measures may be needed to save the most threatened species from extinction? The science informing such decisions needs accessible data, and meeting this need is one of the key functions of the GBIF open data infrastructure. This section offers examples of how conservation science made use of GBIF during 2013.

Some examples

STERCULIA STRIATA, BRAZIL. BY JOÃO MEDEIROS. CC-BY-2.0, VIA FLICKR.

BRAZILIAN FOREST RESERVES IN A CHANGING CLIMATE

Collevatti, R. G., Lima-Ribeiro, M. S., Diniz-Filho, J. A. F., Oliveira, G., Dobrovolski, R., *et al*. (2013). Stability of Brazilian seasonally dry forests under climate change: inferences for long-term conservation. *American Journal of Plant Sciences*, 04(04), 792–805. doi:10.4236/ajps.2013.44098
Author country: Brazil
Research funding: National Council for Scientific and Technological Development (CNPq), Ministry of Science, Technology and Innovation (MCTI), Research Foundation for Goiás State (FAPEG) (Brazil)

A research team from the Universidade Federal de Goiás in central Brazil investigated whether the current network of reserves for the region's seasonally-dry forests was effective in conserving these threatened ecosystems over the long term. The study used data on 16 forest plant species, obtained through GBIF and two Brazilian databases, to model areas suitable for their survival under past, present and future climate conditions. The study concluded that many protected areas would lose importance in conserving these species in the future, due to climate change, and that current Brazilian reserves covered only a small proportion of the areas presenting stable climate conditions for the forests over time. Nevertheless, the research found that the current network may partially achieve long-term conservation of the forests, and recommended connecting the reserves to enable species to move in response to changing conditions.

LARGE-BANDED BLENNY (*OPHIOBLENNIUS STEINDACHNERI*). BY LASZLO ILYES. CC-BY-2.0, VIA WIKIMEDIA COMMONS.

HOW FAR APART SHOULD WE PLACE MARINE PROTECTED AREAS?

Anadón, J. D., del Mar Mancha-Cisneros, M., Best, B. D., & Gerber, L. R. (2013). Habitat-specific larval dispersal and marine connectivity: implications for spatial conservation planning. *Ecosphere*, 4(7), art82. doi:10.1890/ES13-00119.1
Author country: United States, Spain
Research funding: None specified

This study looked at methods of designing networks of marine protected areas in a way that enables species to move between the areas. As a measure of this connectivity, the research focussed on the distance covered by the larvae of fish species, indicating whether species would be able to recover from local extinctions. It used data from GBIF and its Mexican partner CONABIO to identify 64 fish species occurring in the Gulf of California, and studied distribution patterns of larvae for each of those species. Based on this information, the paper assessed proposals for 54 priority conservation areas off the Mexican coast and various rules applicable to minimum and maximum recommended distances between protected areas. The research concluded that the current proposals would provide connectivity for most of the studied species, but recommended specific spacing rules for each habitat to ensure efficient marine conservation planning.

DRY TROPICAL FOREST, CHAMELA-CUIXMALA BIOSPHERE RESERVE, MEXICO. BY AEDRAKE09. CC-BY-SA-3.0, VIA WIKIMEDIA COMMONS.

FILLING DATA GAPS FOR CONSERVATION MANAGEMENT

Pino-Del-Carpio, A., Ariño, A. H., Villarroya, A., Puig, J., & Miranda, R. (2013). The biodiversity data knowledge gap: assessing information loss in the management of Biosphere Reserves. *Biological Conservation*. doi:10.1016/j.biocon.2013.11.020
Author country: Spain
Research funding: Association of Friends of the University of Navarra, Ministry of Science and Innovation (Spain); European Regional Development Fund (European Union)

This study looked at ways in which species data published and accessed through GBIF can supplement other sources of information in the development of conservation strategies. It took as an example the network of UNESCO Biosphere Reserves in Mexico, created with the aim of reconciling biodiversity conservation with sustainable use of the resources within their boundaries. The researchers assessed the records of vertebrate species in the management plans for Mexico's 41 Biosphere Reserves, and compared them with vertebrates recorded for these areas both through the GBIF digital data network, and in published literature based on nearly 200 research papers. From GBIF, they identified nearly 70,000 occurrence records for 1,776 vertebrate species within the reserves. The researchers found that while the existing management plans recorded over 80 per cent of the species identified from all three sources, both GBIF and the published literature filled significant gaps in knowledge. More than 200 species, for example, were absent both from the management plans and published literature and found only through GBIF. In the case of threatened species the gaps were even more striking: 50 per cent of threatened freshwater fishes, for example, were not registered in management plans. The study concludes that consulting alternative resources for species information such as GBIF and scientific literature may improve management of Biosphere Reserves.

Other research relating to species conservation and protected areas citing use of GBIF-mediated data

Title	Journal	Authors	Author countries	DOI/URL
A new method for calculating Risk Tolerance in the assessment of threatened flora.	Journal for Nature Conservation	Alonso-Redondo, R., De Paz, E., Alonso-Herrero, E., García-González, M.-E., & Alfaro-Saiz, E.	Spain	10.1016/j.jnc.2013.07.001
Germinating seeds or bulbils in 87 of 113 tested Arctic species indicate potential for *ex situ* seed bank storage.	Polar Biology	Alsos, I. G., Müller, E., & Eidesen, P. B	Norway	10.1007/s00300-013-1307-7
A systematic approach towards the identification and protection of vulnerable marine ecosystems.	Marine Policy	Ardron, J. A., Clark, M. R., Penney, A. J., Hourigan, T. F., Rowden, A. A. *et al.*	Australia, New Zealand, United States	10.1016/j.marpol.2013.11.017
Conservation status of the narrow endemic gypsophile *Ononis tridentata* subsp. *crassifolia* in southern Spain: effects of habitat disturbance.	Oryx	Ballesteros, M., Foronda, A., Cañadas, E. M., Peñas, J., & Lorite, J.	Spain	10.1017/S0030605312001688
Distribution and status of the extant Xenarthrans (Mammalia: Xenarthra) in the Southern Cone Mesopotamian savanna, Argentina.	Edentata	Bauni, V., Capmourteres, V., Homberg, M. A., & Zuleta, G. A.	Argentina	10.5537/020.014.0105
Unravelling biodiversity, evolution and threats to conservation in the Sahara-Sahel.	Biological reviews of the Cambridge Philosophical Society	Brito, J. C., Godinho, R., Martínez-Freiría, F., Pleguezuelos, J. M., Rebelo, H. *et al.*	Finland, France, Morocco, Portugal, Spain, United Kingdom	10.1111/brv.12049
The efficient management of Park resources: Natural and cultural data in the Alpi Marittime Park area.	Information Systems	Bruno, G., Gasca, E., & Monaco, C.	Italy	10.1016/j.is.2013.12.001
Vertebrate dissimilarity due to turnover and richness differences in a highly beta-diverse region: the role of spatial grain size, dispersal ability and distance.	PLoS ONE	Calderón-Patrón, J. M., Moreno, C. E., Pineda-López, R., Sánchez-Rojas, G., & Zuria, I.	Mexico	10.1371/journal.pone.0082905
The eStation, an Earth Observation processing service in support to ecological monitoring.	Ecological Informatics	Clerici, M., Combal, B., Pekel, J. F., Dubois, G., van't Klooster, J. *et al.*	Italy	10.1016/j.ecoinf.2013.08.004
Confronting expert-based and modelled distributions for species with uncertain conservation status: A case study from the corncrake (*Crex crex*).	Biological Conservation	Fourcade, Y., Engler, J. O., Besnard, A. G., Rödder, D., & Secondi, J.	Germany, France	10.1016/j.biocon.2013.08.009
Biodiversity sampling using a global acoustic approach: contrasting sites with microendemics in New Caledonia.	PLoS ONE	Gasc, A., Sueur, J., Pavoine, S., Pellens, R., & Grandcolas, P.	France, United Kingdom	10.1371/journal.pone.0065311

Title	Journal	Authors	Author countries	DOI/URL
Phylogeography and postglacial expansion of the endangered semi-aquatic mammal *Galemys pyrenaicus*.	BMC Evolutionary Biology	Igea, J., Aymerich, P., Fernández-González, A., González-Esteban, J., Gómez, A. *et al.*	Spain, United Kingdom	10.1186/1471-2148-13-115
Ensemble distribution models in conservation prioritization: from consensus predictions to consensus reserve networks.	Diversity and Distributions	Meller, L., Cabeza, M., Pironon, S., Barbet-Massin, M., Maiorano, L. *et al.*	Finland, France, Italy, United States	10.1111/ddi.12162
Toward Target 2 of the Global Strategy for Plant Conservation: an expert analysis of the Puerto Rican flora to validate new streamlined methods for assessing conservation status.	Annals of the Missouri Botanical Garden	Miller, J. S., Krupnick, G. A., Stevens, H., Porter-Morgan, H., Boom, B. *et al.*	United States	10.3417/2011121
Conservation priorities for *Prunus africana* defined with the aid of spatial analysis of genetic data and climatic variables.	PLoS ONE	Vinceti, B., Loo, J., Gaisberger, H., van Zonneveld, M. J., Schueler, S. *et al.*	Italy, Colombia, Austria, Kenya, Belgium	10.1371/journal.pone.0059987
Jaguar Panthera onca habitat modeling in landscapes facing high land-use transformation pressure —findings from Mato Grosso, Brazil.	Biotropica	Zeilhofer, P., Cezar, A., Tôrres, N. M., de Almeida Jácomo, A. T., & Silveira, L.	Brazil	10.1111/btp.12074
Phylogeography of the California Gnatcatcher (*Polioptila californica*) using multilocus DNA sequences and ecological niche modeling. United States	The Auk	Zink, R. M., Groth, J. G., Vázquez-Miranda, H., & Barrowclough, G. F.	United States	10.1525/auk.2013.12241

Biodiversity and human health

The complex relationship between infectious diseases and ecology brings biodiversity science into contact with the public health research community. The emergence of new diseases, and the shift of known diseases into new regions, has been linked to a number of changes people are making to the environment, including climate change, deforestation and patterns of livestock production. Understanding and predicting changes in disease patterns often involves creating models of the distribution of the wild animals that act as hosts to the disease organisms – and this requires data. In this way, GBIF has contributed to studies focussed on improving public health policies and targeting communities likely to face increased risk from emerging diseases.

Some examples

WOLF'S MONA MONKEY (*CERCOPITHECUS WOLFI*). BY CBURNETT. CC-BY-SA-3.0, VIA WIKIMEDIA COMMONS.

ANIMAL HOSTS HELP FORECAST SHIFTING DISEASE RISK UNDER CLIMATE CHANGE

Daszak, P., Zambrana-Torrelio, C., Bogich, T. L., Fernandez, M., Epstein, J. H., *et al.* (2013). Interdisciplinary approaches to understanding disease emergence: the past, present, and future drivers of Nipah virus emergence. *Proceedings of the National Academy of Sciences of the United States of America*, 3681–8. doi:10.1073/pnas.1201243109
Author country: United States
Research funding: National Institutes of Health, National Science Foundation, National Institute of Allergy and Infectious Diseases, US Department of Homeland Security, US Agency for International Development (United States)

Thomassen, H. A., Fuller, T., Asefi-Najafabady, S., Shiplacoff, J. A. G., Mulembakani, P. M., *et al.* (2013). Pathogen-host associations and predicted range shifts of human monkeypox in response to climate change in Central Africa. *PLoS ONE*, 8(7), e66071. doi:10.1371/journal.pone.0066071
Author countries: Democratic Republic of Congo, Germany
Research funding: Deutsche Forschungsgemeinschaft, Tübingen University (Germany)

In the first of these studies, Daszak *et al.* examined the potential for ecological niche modelling to inform current and future management of emerging infectious diseases, and to support surveillance strategies aimed at improved detection and eventually reducing the risk of outbreaks. The authors note that the establishment of GBIF and other online networks has brought about a rapid expansion in the availability of spatial data on species distributions, and these data enable research using disease hosts as a proxy for changing patterns in the diseases themselves. A case study looked at potential future distribution of lethal emerging viruses known as *Henipavirus*. The researchers used data from GBIF and the Smithsonian Institution to model the impact of climate change on thirteen species of bat associated with this type of virus. From this, they concluded that by the middle of this century, habitats suitable for these host species would significantly increase in parts of western Africa, western India and northern Australia, among other regions. The authors suggest their findings could help monitoring and prevention efforts in the areas most at risk from future spread.

In the second study, Thomassen *et al.* used similar techniques to model the spread of the monkeypox virus, an emerging infectious disease of growing concern in tropical Africa. In this case, the researchers looked at the likely change in distributions of 11 mammal species, including pangolins, porcupines, monkeys, rats and rope squirrels, identified as potential 'reservoir' species for the virus. They obtained data for the occurrence of these species from GBIF and the Mammal Networked Information System (MaNIS). In addition to climate, the study looked at other factors affecting transmission of the virus, including deforestation. It concluded that under projected climate change scenarios for 2080, areas suitable for outbreaks of the disease are likely to shift eastwards from the current range, creating greater risks in the eastern part of the Democratic Republic of Congo (DRC), and parts of Uganda, Kenya and Tanzania – while other regions including much of western Africa will be at reduced risk. The authors of this study also suggest these results can help prioritize future disease surveillance efforts.

Other research relating to biodiversity and human health citing use of GBIF-mediated data

Title	Journal	Authors	Author countries	DOI/URL
Regional specific pollen and fungal spore allergens in South Africa.	Current Allergy & Clinical Immunology	Berman, D.	South Africa	http://www.allergysa.org/journals/November2013/RegionalSpecific.pdf
Potential geographic distribution of Hantavirus reservoirs in Brazil.	PLoS ONE	De Oliveira, S. V., Escobar, L. E., Peterson, A. T., & Gurgel-Gonçalves, R.	Brazil, Chile, United States	10.1371/journal.pone.0085137
Ecology and geography of transmission of two bat-borne rabies lineages in Chile.	PLoS Neglected Tropical Diseases	Escobar, L. E., Peterson, A. T., Favi, M., Yung, V., Pons, D. J. *et al.*	Chile, United States	10.1371/journal.pntd.0002577
Allergy in Botswana.	Current Allergy & Clinical Immunology	Kung, S.-J., Mazhani, L., & Steenhoff, A. P.	Botswana	http://www.allergysa.org/journals/November2013/AllergyBotswana.pdf
A new benzoic acid derivative isolated from *Piper* cf. *cumanense* Kunth (Piperaceae).	Phytochemistry Letters	Parra, J. E., Patiño, O. J., Prieto, J. A., Delgado, W. A., & Cuca, L. E.	Colombia	10.1016/j.phytol.2013.07.014
The genus *Spilanthes* ethnopharmacology, phytochemistry, and pharmacological properties: a review.	Advances in Pharmacological Sciences	Paulraj, J., Govindarajan, R., & Palpu, P.	India	10.1155/2013/510298
Novel three-step pseudo-absence selection technique for improved species distribution modelling	PLoS ONE	Senay, S. D., Worner, S. P., & Ikeda, T.	New Zealand	10.1371/journal.pone.0071218
The safety assessment of *Pythium irregulare* as a producer of biomass and eicosapentaenoic acid for use in dietary supplements and food ingredients.	Applied Microbiology and Biotechnology	Wu, L., Roe, C. L., & Wen, Z.	United States	10.1007/s00253-013-5114-4

Food, farming and biofuels

Data accessed through GBIF contribute to research covering various aspects of agriculture and food security. A major theme recurring through the literature is analysis of options for adapting farming practices to climate change: conserving wild plants related to domesticated food crops, modelling the regions likely to be suitable for growing different crops in future, and projecting high-risk areas for agricultural pests. Datasets published through GBIF have also underpinned research into the potential benefits and risks of biofuel production.

Some examples

PIGEONPEA (*CAJANUS CAJAN*) SEED POD. BY FOREST & KIM STARR. CC-BY-3.0, VIA WIKIMEDIA COMMONS.

TARGETING PLANT CONSERVATION FOR FOOD SECURITY

Vincent, H., Wiersema, J., Kell, S., Fielder, H., Dobbie, S., *et al*. (2013). A prioritized crop wild relative inventory to help underpin global food security. *Biological Conservation*, 167, 265–275. doi:10.1016/j.biocon.2013.08.011
Author countries: Colombia, Germany, UK
Research funding: Government of Norway (via the Global Crop Diversity Trust)

This research funded by the Global Crop Diversity Trust carried out a worldwide inventory of wild plants whose conservation is most critical for food security in the face of a changing climate in coming decades (see www.cwrdiversity.org/checklist/). Plants that are closely related to food crops (crop wild relatives, or CWR) have the potential to provide the traits required to improve crops and to make them more resilient to changing conditions. Based on 173 priority crops, the researchers identified 1,667 taxa (plant families, genera, species and sub-species) that could be considered globally important. The researchers used GBIF to gain an insight into the effectiveness of current *ex situ* conservation efforts, using data published via the GBIF network to identify the holdings for each priority species from seed banks around the world. The study found 242 taxa to be underrepresented in these collections, and suggested that China, Mexico and Brazil are the high-priority countries for further collection of wild plant material that will help develop the crops of the future.

PONGAM OILTREE (*MILLETTIA PINNATA*). BY DINESH VALKE, CC-BY-NC-ND 2.0, VIA FLICKR.

MANAGING INVASION RISK FROM BIOFUEL CROPS

Kriticos, D. J., Murphy, H. T., Jovanovic, T., Taylor, J., Herr, A., *et al*. (2013). Balancing bioenergy and biosecurity policies: estimating current and future climate suitability patterns for a bioenergy crop. *GCB Bioenergy*. doi:10.1111/gcbb.12068
Author country: Australia
Research funding: None specified

This study used GBIF to help decision-makers assess the risk of crops used for bio-energy becoming harmful invasive species if they escaped into the environment. The researchers looked at the Indian beech or Pongam oiltree (*Millettia pinnata*, also referred to as *Pongamia pinnata*), native to the Indian subcontinent and southeast Asia. The oil produced from its seeds has many traditional uses as fuel, medicine and fodder, and the plant is now of great interest for biofuel production in Australia and elsewhere.

To assess the risk of the tree becoming an invasive weed in the Australian environment, the authors, from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) used records of its worldwide geographical distribution sourced from GBIF and the Australia Virtual Herbarium. Based on the range of conditions where the plant is found, the researchers produced a model for where it is likely to become naturalized under current and future climate conditions. It found that while under current conditions the plant would only thrive in wetter tropical regions of Australia, with irrigation it had the potential to naturalize across most of the country. The authors argue that this kind of model can support development of policies designed to manage invasion risks and balance the advantages of bioenergy with biosecurity concerns.

Other research relating to biodiversity and human health citing use of GBIF-mediated data

Title	Journal	Authors	Author countries	DOI/URL
Feeding ecology of the mangrove oyster, *Crassostrea gasar* (Dautzenberg, 1891) in traditional farming at the coastal zone of Benin, West Africa.	Natural Science	Adite, A., Sonon, S. P., & Gbedjissi, G. L.	Benin	10.4236/ns.2013.512151
Host range and potential distribution of *Aceria thalgi* (Acari: Eriophyidae): a biological control agent for *Sonchus* species.	Australian Journal of Entomology	McCarren, K. L., & Scott, J. K.	Australia	10.1111/aen.12041
Vulnerability of artisanal fisheries to climate change in the Venice Lagoon.	Journal of Fish Biology	Pranovi, F., Caccin, A., Franzoi, P., Malavasi, S., Zucchetta, M. *et al.*	Italy	10.1111/jfb.12124
Disentangling the origins of cultivated sweet potato (*Ipomoea batatas* (L.) Lam.).	PLoS ONE	Roullier, C., Duputié, A., Wennekes, P., Benoit, L., Fernández Bringas, V. M. *et al.*	France, Peru	10.1371/journal.pone.0062707
Suitable regions for date palm cultivation in Iran are predicted to increase substantially under future climate change scenarios.	The Journal of Agricultural Science	Shabani, F., Kumar, L., & Taylor, S.	Australia	10.1017/S0021859613000816
Risk levels of invasive *Fusarium oxysporum* f. sp. in areas suitable for date palm (*Phoenix dactylifera*) cultivation under various climate change projections.	PLoS ONE	Shabani, F., & Kumar, L.	Australia	10.1371/journal.pone.0083404
Use of CLIMEX, land use and topography to refine areas suitable for date palm cultivation in Spain under climate change scenarios.	Journal of Earth Science & Climatic Change	Shabani, F., Kumar, L., & Esmaeil, A.	Australia, Iran	10.4172/2157-7617.1000145
Ecogeographic survey and gap analysis of *Lathyrus L.* species.	Genetic Resources and Crop Evolution	Shehadeh, A., Amri, A., & Maxted, N.	Syria, United Kingdom	10.1007/s10722-013-9977-0
Potential and limitations of Burgundy truffle cultivation.	Applied microbiology and biotechnology	Stobbe, U., Egli, S., Tegel, W., Peter, M., Sproll, L. *et al.*	Germany, Switzerland	10.1007/s00253-013-4956-0
Spatial distribution and environmental preferences of 10 economically important forest palms in western South America.	Forest Ecology and Management	Vedel-Sørensen, M., Tovaranonte, J., Bøcher, P. K., Balslev, H., & Barfod, A. S.	Denmark	10.1016/j.foreco.2013.07.005
New records of Saprolegniaceae isolated from rainbow trout, from their eggs, and water in a fish farm from the State of Mexico.	Revista Mexicana de Biodiversidad	Vega-Ramírez, M. T., Moreno-Lafont, M. C., Valenzuela-Garza, R., Cervantes-Olivares, R., Aller-Gancedo, J. M. *et al.*	Mexico, Spain	10.7550/rmb.28627

Ecosystem services

The link between biodiversity and human societies is increasingly expressed in terms of the 'services' provided by ecosystems to economies, livelihoods and many aspects of human well-being. These include provision of products directly derived from nature, for example food, medicines, materials and fuels; 'regulating services' such as climate control and purification of air and water; and less tangible 'cultural services' including recreation and spiritual values that are nevertheless highly prized by many cultures and societies. While GBIF has not so far focussed on data that directly quantify these services, researchers have used species-related data in various ways to support analysis of the benefits that people derive from the diversity of nature. This section highlights two innovative examples.

Some examples

PHOTOMICROGRAPH OF *STREPTOCOCCUS PYOGENES* BACTERIA, A DISEASE AGENT OF SCARLET FEVER AND ONE OF THE SPECIES REFERRED TO IN THE STUDY. RELEASED UNDER PD-USGOV-HHS-CDC, PUBLIC DOMAIN, VIA WIKIMEDIA COMMONS.

HOW DIVERSE ARE SPECIES USED IN PATENTS?

Oldham, P., Hall, S., & Forero, O. (2013). Biological diversity in the patent system. *PLoS ONE*, 8(11), e78737. doi:10.1371/journal.pone.0078737
Author country: United Kingdom
Research funding: Economic and Social Research Council (United Kingdom)

This research aimed to analyse whether species used for human innovation, as reflected in the patent system, are truly representative of the diversity of life on Earth. The authors mined 11 million patent documents for six million scientific names, using web services from GBIF, to match individual patents with known species. The uses reflected in these patents ranged from pharmaceuticals and traditional medicines to genetic engineering, foods and biocides. The study also used occurrence data available through GBIF to map the global distribution of species used in patents, broken down into countries and taxonomic kingdoms.

From this analysis, the research identified more than 76,000 species names from 24,000 genera, included in 767,000 patent documents. It suggests that this represents a rather narrow section of biodiversity, around four per cent of described species and less than one per cent of the number of species predicted to exist. The research concludes that in the interests of humanity, a broader spectrum of biodiversity should be opened up to research and development, based on the principles of equitable sharing of benefits established by the Convention on Biological Diversity (CBD).

"The present research is grounded in the growing availability of taxonomic data from collections around the world under the umbrella of the Global Biodiversity Information Facility...

Greater investment is required in these initiatives to enhance the availability of digital taxonomic and biodiversity information to advance our understanding of biodiversity and its role in human innovation."

– Article authors.

XANTHORRHOEA AUSTRALIS, A SPECIES OF GRASS TREES. BY LEON BROOKS. PUBLIC DOMAIN, VIA WIKIMEDIA COMMONS.

ANALYSING PAST PLANT USES FROM MUSEUM OBJECTS

Bradshaw, F. (2013). Chemical characterisation of museum-curated ethnographic resins from Australia and New Guinea used as adhesives, medicines and narcotics. *Heritage Science*, 1(1), 36. doi:10.1186/2050-7445-1-36
Author country: United Kingdom
Research funding: Natural Environment Research Council (NERC), United Kingdom

This study examined how analysis of materials included in museum artefacts can improve knowledge of the way particular plants were used by indigenous peoples in the past. The research took specimens of plant resin from objects relating to cultures in Australia and New Guinea in the early twentieth century, held at the Pitt Rivers Museum in Oxford, United Kingdom. Resins are mainly used as adhesives, for example in making composite tools and spears, but also have functioned as medicines and narcotics. The author carried out analysis of the resins using a technique called gas chromatography-mass spectrometry, which characterizes the chemical composition of organic materials. The museum samples were then compared with resin from modern plants to help identify the species used. Some of the Australian resins originated from *Xanthorrhoea* or grass trees, and the study used GBIF and the Atlas of Living Australia (www.ala.org.au) to map the recorded distributions of eight species of this genus. This helped to verify the identification of the plant species, based on the geographical origins of the museum objects. The study concludes that this type of analysis can offer insights into the past use of natural materials and the way people adapted to new environments.

Advancing biodiversity science

Data accessed through GBIF in 2013 continued to inform research covering a number of scientific disciplines relating to biodiversity. These included studies examining the way groups of species evolved traits to help survive in different environments, and analysing ecological relationships between species and the way they vary in different geographical locations. These studies often involve analysis of a wide range of species, in some cases looking at multiple taxonomic groups spanning several continents. Several authors have noted the importance of GBIF in providing access to data on this scale, without which such research would be unfeasible.

Some examples

DECIDUOUS SUGAR MAPLE LEAVES, SOON TO SENESCE AS WINTER APPROACHES AT THE GATEWAY ARCH, ST. LOUIS, MISSOURI, UNITED STATES. BY AMY ZANNE.

HOW PLANTS WEATHER THE COLD

Zanne, A. E., Tank, D. C., Cornwell, W. K., Eastman, J. M., Smith, S. A., *et al.* (2013). Three keys to the radiation of angiosperms into freezing environments. *Nature*. doi:10.1038/nature12872
Author countries: United States, Australia, Canada, Netherlands, Poland, United Kingdom
Research funding: National Science Foundation (United States); Macquarie University (Australia)

This research aimed to cast new light on how plants colonized colder regions. It assembled the largest evolutionary "timetree" to show the order in which flowering plants evolved strategies such as the shedding of leaves to move into areas with cold winters.

The study used more than 47 million occurrence records accessed via GBIF to determine the distributions of over 27,000 plant species. From these records, they were able to extract minimum temperatures from the Worldclim climate database, to flag which species are exposed to freezing across their ranges.

The research team identified three repeated evolutionary shifts they believe flowering plants made to fight the cold: dropping their leaves, thus shutting down the pathways that would normally carry water between roots and leaves; making narrower water-conducting pathways, allowing them to keep their leaves while reducing the risk of air bubbles developing during freezing and thawing; or avoiding the cold seasons altogether as herbs, losing above-ground stems and leaves and retreating as seeds or storage organs underground, such as tulips or tomatoes.

The researchers also identified the order of evolutionary events. Most often, woody plants became herbs or developed narrower pathways before moving into freezing climates. In contrast, plants usually began dropping their leaves after moving into freezing climates.

> *"Without GBIF the study absolutely would not have been possible as we had no other way to access distributions for so many species. These locations allowed us then to determine whether species were exposed to freezing."*
>
> *Amy Zanne, Columbian College of Arts and Sciences, George Washington University.*

CENTRIS DECOLORATA. BY SAM DROEGE / USGS BEE INVENTORY AND MONITORING LAB. CC-BY-2.0, VIA FLICKR.

A REGENT HONEYEATER (*ANTHOCHAERA PHRYGIA*). BY JESSICA BONSELL. CC-BY-3.0, VIA WIKIMEDIA COMMONS.

FINDING PATTERNS IN BEE-PLANT RELATIONSHIPS

Giannini, T. C., Pinto, C. E., Acosta, A. L., Taniguchi, M., Saraiva, A. M., *et al*. (2013). Interactions at large spatial scale: The case of Centris bees and floral oil producing plants in South America. *Ecological Modelling*, 258, 74–81. doi:10.1016/j.ecolmodel.2013.02.032
Author country: Brazil
Research funding: São Paulo Research Foundation (FAPESP), National Council for Scientific and Technological Development (CNPq), Research Center on Biodiversity and Computing (Brazil)

This study from a team of Brazilian researchers looked at how climatic conditions affect the complex networks of relationships between bees and the plants they pollinate. It analysed interactions across South America between the widespread *Centris* genus of bee with plant species that produce oil in their flowers. Data on the occurrence of both the bees and the plants were obtained from 32 data publishers through GBIF, and from 60 datasets published from Brazil through speciesLink (http://splink.cria.org.br). The study found patterns in these interactions mainly associated with rainfall. Wetter areas tended to have higher numbers of species in the networks with each bee species having more plant 'partners'. Drier areas such as the Andes and northeast Brazil had fewer species and more specialized relationships between bees and plants. The authors conclude that the interactions observed among pollinators and plants are probably influenced by a combination of current ecological processes and past evolutionary history.

HOW A DRYING AUSTRALIA AFFECTED EVOLUTION OF BIRDS

Miller, E. T., Zanne, A. E., & Ricklefs, R. E. (2013). Niche conservatism constrains Australian honeyeater assemblages in stressful environments. *Ecology Letters*, 16(9), 1186–94. doi:10.1111/ele.12156
Author countries: Australia, United States
Research funding: National Science Foundation, St Louis Audubon Society, University of Missouri (United States)

This study by researchers in Australia and the United States tested the hypothesis of 'niche conservatism,' according to which most species remain in climates similar to those tolerated by their evolutionary ancestors. It looked at the consequences of this tendency for distributions of a large family of Australian birds, the honeyeaters (*Meliphagidae*). The analysis used more than two million records of the location of 75 species of honeyeaters, obtained through GBIF, eBird and the Atlas of Living Australia. Honeyeaters originated in wet, subtropical environments but subsequently spread to drier habitats as Australia became more arid. The research found that as predicted by niche conservatism, the species now encountered in drier areas occupy a progressively smaller section of the evolutionary tree (phylogenetic clustering), indicating that only a few species within the family evolved the adaptations that enabled them to withstand the harsher conditions of a drying Australia.

AERIAL VIEW OF THE AMAZON RAINFOREST. BY LUBASI. CC-BY-SA-2.0, VIA WIKIMEDIA COMMONS.

WHY THE TROPICS ARE MORE BIODIVERSE THAN TEMPERATE REGIONS

Jansson, R., Rodríguez-Castañeda, G., & Harding, L. E. (2013). What can multiple phylogenies say about the latitudinal diversity gradient? A new look at the tropical conservatism, out of the tropics, and diversification rate hypotheses. *Evolution*, 67(6), 1741–55. doi:10.1111/evo.12089
Author country: Sweden
Research funding: Swedish Research Council, Umeå University (Sweden)

This study by researchers from Umeå University, Sweden, tested various hypotheses for why ecosystems become relatively less rich in species as you move away from the Equator and towards the poles.

The two major competing explanations are the 'tropical conservatism hypothesis', suggesting that most branches of the tree of life originate in the older tropical environments, and that it is relatively rare for species in a lineage to move into temperate latitudes; and the 'out of the tropics model' proposing that transitions of related species from the tropics to temperate zones are quite common, meaning that a large proportion of temperate species have tropical origins.

To test these and other hypotheses, the researchers selected 111 published phylogenies, or evolutionary trees, documenting relationships between species of mammals, birds, insects and flowering plants. Using georeferenced data accessed through GBIF, they divided all the species and other taxa in these trees into those with tropical ranges, temperate ranges, and those spanning both zones.

The study then analysed the patterns for how and when branches of these clades or related groups had made a transition from tropical to temperate latitudes, and vice versa. It found that the most common type of transition was the expansion of tropical lineages to include temperate latitudes, suggesting that adaptation to new climatic conditions may not represent a major obstacle for many clades. The authors suggest their results lend support to the 'out of the tropics' model and contradict many predictions of the tropical conservatism hypothesis.

Other research relating to advancing biodiversity science citing use of GBIF-mediated data

Title	Journal	Authors	Author countries	DOI/URL
Integrating open access geospatial data to map the habitat suitability of the declining corn bunting (*Miliaria calandra*).	ISPRS International Journal of Geo-Information	Abdi, A.	Germany, Portugal	10.3390/ijgi2040935
Using environmental niche models to test the "everything is everywhere" hypothesis for Badhamia.	The ISME journal	Aguilar, M., Fiore-Donno, A.-M., Lado, C., & Cavalier-Smith, T.	Canada, Spain, United Kingdom	10.1038/ismej.2013.183
Rapid lizard radiation lacking niche conservatism: ecological diversification within a complex landscape.	Journal of Biogeography	Ahmadzadeh, F., Flecks, M., Carretero, M. A., Böhme, W., Ilgaz, C. *et al.*	Iran, Germany, Portugal, Turkey	10.1111/jbi.12121
Cryptic speciation patterns in Iranian rock lizards uncovered by integrative taxonomy.	PLoS ONE	Ahmadzadeh, F., Flecks, M., Carretero, M. A., Mozaffari, O., Böhme, W. *et al.*	Germany, Iran, Portugal	10.1371/journal.pone.0080563
Neolovenula alluaudi (Guerne and Richard, 1890) (Calanoida: Diaptomidae: Paradiaptominae): first record in Italy and review of geographical distribution.	Journal of Limnology	Alfonso, G., & Belmonte, G.	Italy	10.4081/jlimnol.2013.e20
Joint analysis of stressors and ecosystem services to enhance restoration effectiveness.	Proceedings of the National Academy of Sciences of the United States of America	Allan, J. D., McIntyre, P. B., Smith, S. D. P., Halpern, B. S., Boyer, G. L. *et al.*	Canada, United States	10.1073/pnas.1213841110
A revision of *Blindia* (Seligeriaceae) from southern South America.	The Bryologist	Andreas, B. K.	United States	10.1639/0007-2745-116.3.263
Tempo and mode of the multiple origins of salinity tolerance in a water beetle lineage.	Molecular Ecology	Arribas, P., Andújar, C., Abellán, P., Velasco, J., Millán, A. *et al.*	Spain	10.1111/mec.12605
Paleoclimatic modeling and phylogeography of least killifish, *Heterandria formosa*: insights into Pleistocene expansion-contraction dynamics and evolutionary history of North American Coastal Plain freshwater biota.	BMC Evolutionary Biology	Bagley, J. C., Sandel, M., Travis, J., Lozano-Vilano, M. De, & Johnson, J. B.	Mexico, United States	10.1186/1471-2148-13-223
Mapping the biodiversity of tropical insects: species richness and inventory completeness of African sphingid moths.	Global Ecology and Biogeography	Ballesteros-Mejia, L., Kitching, I. J., Jetz, W., Nagel, P., & Beck, J.	Switzerland, United Kingdom, United States	10.1111/geb.12039
Distribution extension for *Anolis salvini* Boulenger, 1885 (Reptilia: Squamata: Dactyloidae), in western Panama.	Check List	Bienentreu, J.-F., Hertz, A., & Lotzkat, S.	Germany	http://www.checklist.org.br/getpdf?NGD203-12

Title	Journal	Authors	Author countries	DOI/URL
Spatial bias in the GBIF database and its effect on modelling species' geographic distributions.	Ecological Informatics	Beck, J., Böller, M., Erhardt, A., & Schwanghart, W.	Germany, Switzerland	10.1016/j.ecoinf.2013.11.002
The impact of modelling choices in the predictive performance of richness maps derived from species-distribution models: guidelines to build better diversity models.	Methods in Ecology and Evolution	Benito, B. M., Cayuela, L., & Albuquerque, F. S.	Spain	10.1111/2041-210x.12022
Autecological traits determined two evolutionary strategies in Mediterranean plants during the Quaternary: low differentiation and range expansion versus geographical speciation in Linaria.	Molecular Ecology	Blanco-Pastor, J. L., & Vargas, P.	Spain	10.1111/mec.12518
Re-characterization of the Red-lip *Megalobulimus* (Gastropoda: Strophocheilidae) from Peru with description of a new species.	Zoologia (Curitiba)	Borda, V., & Ramírez, R.	Peru	10.1590/S1984-46702013005 000008
The Flora of Chad: a checklist and brief analysis.	PhytoKeys	Brundu, G., & Camarda, I.	Italy	10.3897/phytokeys.23.4752
IKey+: a new single-access key generation web service.	Systematic Biology	Burguiere, T., Causse, F., Ung, V., & Vignes-Lebbe, R.	France	10.1093/sysbio/sys069
Disjunct occurrence of *Harpanthus drummondii* (Taylor) Grolle (Geocalycaceae, Jungermanniopsida) in the boreal forest of west-central Canada.	Evansia	Caners, R. T.	Canada	10.1639/079.030.0104
Taxonomy, biogeography and DNA barcodes of *Geodia* species (Porifera, Demospongiae, Tetractinellida) in the Atlantic boreo-arctic region.	Zoological Journal of the Linnean Society	Cárdenas, P., Rapp, H. T., Klitgaard, A. B., Best, M., Thollesson, M. *et al.*	Canada, Denmark, Norway, Sweden	10.1111/zoj.12056
First record of a gecko species to the fauna of Qatar: *Hemidactylus persicus* Anderson, 1872 (Gekkonidae).	Q Science Connect	Castilla, A. M., Valdeón, A., Cog, D., Gosá, A., Saifelnasr, E. O. H. *et al.*	Egypt, Qatar, Romania, Spain	10.5339/connect.2013.28
A study of using grey system theory and artificial neural network on the climbing ability of *Buergeria robusta* frog.	Open Journal of Ecology	Chang, Y.-H., & Chuang, T.-F.	Chinese Taipei	10.4236/oje.2013.32010
Reinvestigation of West African *Surirellaceae* (Bacillariophyta) described by Woodhead and Tweed from Sierra Leone.	Diatom Research	Cocquyt, C., Jüttner, I., & Kusber, W.-H.	Belgium, Germany, United Kingdom	10.1080/0269249X.2012.752411
Are Namibian "fairy circles" the consequence of self-organizing spatial vegetation patterning?	PLoS ONE	Cramer, M. D., & Barger, N. N.	South Africa, United States	10.1371/journal.pone.0070876
The Hill of Six Lakes revisited: new data and re-evaluation of a key Pleistocene Amazon site.	Quaternary Science Reviews	D'Apolito, C., Absy, M. L., & Latrubesse, E. M.	Brazil, Panama, United States	10.1016/j.quascirev.2013.07.013

Title	Journal	Authors	Author countries	DOI/URL
Nitrogen deposition alters plant-fungal relationships: linking belowground dynamics to aboveground vegetation change.	Molecular Ecology	Dean, S. L., Farrer, E. C., Taylor, D. L., Porras-Alfaro, A., Suding, K. N., *et al*.	United States	10.1111/mec.12541
Uncovering cryptic diversity and refugial persistence among small mammal lineages across the Eastern Afromontane biodiversity hotspot.	Molecular Phylogenetics and Evolution	Demos, T. C., Kerbis Peterhans, J. C., Agwanda, B., & Hickerson, M. J.	Kenya, United States	10.1016/j.ympev.2013.10.014
Interspecific variations of inner ear structure in the deep-sea fish family Melamphaidae.	The Anatomical Record	Deng, X., Wagner, H.-J., & Popper, A. N.	United States, Germany	10.1002/ar.22703
Biology and host specificity of *Anthonomus tenebrosus* (Coleoptera: Curculionidae): a herbivore of tropical soda apple.	Annals of the Entomological Society of America	Diaz, R., Menocal, O., Montemayor, C., & Overholt, W. A.	Panama, United States	10.1603/AN13020
Utility of QR codes in biological collections.	PhytoKeys	Diazgranados, M., & Funk, V.	United States	10.3897/phytokeys.25.5175
Molecular markers reveal limited population genetic structure in a North American corvid, Clark's nutcracker (*Nucifraga columbiana*).	PLoS ONE	Dohms, K. M., & Burg, T. M.	Canada	10.1371/journal.pone.0079621
ENSO signature in botanical proxy time series extends terrestrial El Niño record into the (sub)tropics.	Geophysical Research Letters	Donders, T. H., Punyasena, S. W., de Boer, H. J., & Wagner-Cremer, F.	Netherlands, United States	10.1002/2013GL058038
Activity response to climate seasonality in species with fossorial habits: a niche modeling approach using the lowland Burrowing Treefrog (*Smilisca fodiens*).	PLoS ONE	Encarnación-Luévano, A., Rojas-Soto, O. R., & Sigala-Rodríguez, J. J.	Mexico	10.1371/journal.pone.0078290
Biogeographic regions of North American mammals based on endemism.	Biological Journal of the Linnean Society	Escalante, T., Morrone, J. J., & Rodríguez-Tapia, G.	Mexico	10.1111/bij.12142
Mammal species richness and biogeographic structure at the southern boundaries of the Nearctic region.	Mammalia	Escalante, T., Rodríguez-Tapia, G., Linaje, M., Morrone, J. J., & Noguera-Urbano, E.	Mexico	10.1515/mammalia-2013-0057
Using limited data to detect changes in species distributions: Insights from Amazon parrots in Venezuela.	Biological Conservation	Ferrer-Paris, J. R., Sánchez-Mercado, A., Rodríguez-Clark, K. M., Rodríguez, J. P., & Rodríguez, G. A.	Venezuela	10.1016/j.biocon.2013.07.032
Congruence and diversity of butterfly-host plant associations at higher taxonomic levels.	PLoS ONE	Ferrer-Paris, J. R., Sánchez-Mercado, A., Viloria, Á. L., & Donaldson, J.	South Africa, Venezuela	10.1371/journal.pone.0063570
Plant collections online: using digital herbaria in biology teaching.	Bioscene	Flannery, M. C.	United States	http://www.academia.edu/4489098/Plant_Collections_Online_Using_Digital_Herbaria_in_Biology_Teaching

Title	Journal	Authors	Author countries	DOI/URL
Functional enrichment of utopian distribution of plant life-forms.	American Journal of Plant Sciences	Furze, J. Q., N., Zhu, Qiao, F., & Hill, J.	China, United Kingdom	10.4236/ajps.2013.412A1006
ModestR: a software tool for managing and analyzing species distribution map databases.	Ecography	García-Roselló, E., Guisande, C., González-Dacosta, J., Heine, J., Pelayo-Villamil, P. *et al.*	Colombia, Spain	10.1111/j.1600-0587.2013.00374.x
From southern refugia to the northern range margin: genetic population structure of the common wall lizard, *Podarcis muralis*.	Journal of Biogeography	Gassert, F., Schulte, U., Husemann, M., Ulrich, W., Rödder, D. *et al.*	Luxembourg, Germany, Poland	10.1111/jbi.12109
Island Biogeography, the effects of taxonomic effort and the importance of island niche diversity to single island endemic species.	Systematic Biology	Gray, A., & Cavers, S.	United Kingdom	10.1093/sysbio/syt060
A redescription of the post-larval physonect siphonophore stage known as *Mica micula* Margulis 1982, from Antarctica, with notes on its distribution and identity.	Marine Ecology	Grossmann, M. M., Lindsay, D. J., & Fuentes, V.	Japan, Spain	10.1111/maec.12026
Evolutionary lag times and recent origin of the biota of an ancient desert (Atacama-Sechura).	Proceedings of the National Academy of Sciences of the United States of America	Guerrero, P. C., Rosas, M., Arroyo, M. T. K., & Wiens, J. J.	United States	10.1073/pnas.1308721110
Molecular and morphological support for a Florida origin of the Cuban oak.	Journal of Biogeography	Gugger, P. F., & Cavender-Bares, J.	United States	10.1111/j.1365-2699.2011.02610.x
Influence of late Quaternary climate change on present patterns of genetic variation in valley oak, *Quercus lobata* Née.	Molecular Ecology	Gugger, P. F., Ikegami, M., & Sork, V. L.	United States	10.1111/mec.12317
The effects of the Late Quaternary glacial-interglacial cycles on Anatolian ground squirrels: range expansion during the glacial periods?	Biological Journal of the Linnean Society	Gür, H.	Turkey	10.1111/bij.12026
The diverse habitats of Hygrocybe – peeking into an enigmatic lifestyle.	Mycosphere	Halbwachs, H., Karasch, P., & G.W., G.	Germany, United Kingdom	10.5943/mycosphere/4/4/14
Mitochondrial phylogeny reveals cryptic genetic diversity in the genus *Niviventer* (Rodentia, Muroidea).	Mitochondrial DNA	He, K., & Jiang, X.-L.	Canada, China	10.3109/19401736.2013.823167
New distribution records and variation of the two common lowland salamanders *Bolitoglossa colonnea* (Dunn, 1924) and *B. lignicolor* (Peters, 1873) in Panama (Amphibia: Caudata: Plethodontidae).	Check List	Hertz, A., Lotzkat, S., & Köhler, G.	Germany	http://www.checklist.org.br/getpdf?NGD151-12
Asian origin and upslope migration of Hawaiian *Artemisia* (Compositae-Anthemideae).	Journal of Biogeography	Hobbs, C. R., & Baldwin, B. G.	United States	10.1111/jbi.12046

Title	Journal	Authors	Author countries	DOI/URL
Phylogeography of the *Robsonius* ground-warblers (Passeriformes: Locustellidae) reveals an undescribed species from northeastern Luzon, Philippines.	The Condor	Hosner, P. A., Boggess, N. C., Alviola, P., Sánchez-González, L. A., Oliveros, C. H. *et al.*	Mexico, Philippines, United States	10.1525/cond.2013.120124
Naemacyclus culmigenus, a newly reported potential pathogen to *Miscanthus sinensis*, new to Japan.	Mycoscience	Hosoya, T., Hosaka, K., Saito, Y., Degawa, Y., & Suzuki, R.	Japan	10.1016/j.myc.2013.02.002
Evidence for recent evolution of cold tolerance in grasses suggests current distribution is not limited by (low) temperature.	The New Phytologist	Humphreys, A. M., & Linder, H. P.	Switzerland, Sweden, United Kingdom	10.1111/nph.12244
Reconstructing hybrid speciation events in the *Pteris cretica* group (Pteridaceae) in Japan and adjacent regions.	Systematic Botany	Jaruwattanaphan, T., Matsumoto, S., & Watano, Y.	Japan	10.1600/036364413X661980
Epiphyte metapopulation persistence after drastic habitat decline and low tree regeneration: time-lags and effects of conservation actions.	Journal of Applied Ecology	Johansson, V., Ranius, T., & Snäll, T.	Sweden	10.1111/1365-2664.12049
A bryophilous member of the Leotiomycetes from New Zealand, *Bryoclaviculus campylopi* gen. et sp. nov.	New Zealand Journal of Botany	Johnston, P. R., Steel, J. B., Park, D., & Ludwig, L. R.	New Zealand	10.1080/0028825X.2013.815638
Correspondence in forest species composition between the Vegetation Map of Africa and higher resolution maps for seven African countries.	Applied Vegetation Science	Kindt, R., Lillesø, J.-P. B., van Breugel, P., Bingham, M., Demissew, S. *et al.*	Denmark, Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda	10.1111/avsc.12055
Nephroma helveticum and *N. tangeriense* new to Norway.	Graphis Scripta	Klepsland, J. T.	Norway	http://nhm2.uio.no/botanisk/lav/Graphis/25_2/GS_25_33.pdf
The naturalization status of African spotted orchid (*Oeceoclades maculata*) in Neotropics.	Plant Biosystems	Kolanowska, M.	Poland	10.1080/11263504.2013.824042
Linking life-history traits, ecology, and niche breadth evolution in North American Eriogonoids (Polygonaceae).	The American Naturalist	Kostikova, A., Litsios, G., Salamin, N., & Pearman, P. B.	Switzerland	10.1086/673527
Phytochemical investigation of the leaves of *Leptoderris fasciculata*.	Phytochemistry Letters	Kouamé, F. P. B. K., Silvestre, V., Bedi, G., Loquet, D., Robins, R. J. *et al.*	France, Cote d'Ivoire	10.1016/j.phytol.2013.02.009
Spatial variation in the phylogenetic structure of flea assemblages across geographic ranges of small mammalian hosts in the Palearctic.	International Journal for Parasitology	Krasnov, B. R., Pilosof, S., Shenbrot, G. I., & Khokhlova, I. S.	Israel	10.1016/j.ijpara.2013.05.001
When east meets west: population structure of a high-latitude resident species, the boreal chickadee (*Poecile hudsonicus*).	Heredity	Lait, L. A., & Burg, T. M.	Canada	10.1038/hdy.2013.54

Title	Journal	Authors	Author countries	DOI/URL
On the date and organ of publication for the endemic Galápagos scorpion *Centruroides exsul* (Scorpiones: Buthidae) by Wilhelm Meise, with a revision of its distribution and type material.	Journal of Arachnology	Lambertz, M.	Germany	10.1636/Ha13-37.1
Understanding the ecological niche to elucidate spatial strategies of the southernmost Tupinambis lizards.	Amphibia-Reptilia	Lanfri, S., Cola, V. Di, Naretto, S., Chiaraviglio, M., & Cardozo, G.	Argentina, Switzerland	10.1163/15685381-00002917
Local representation of global diversity in a cosmopolitan lichen-forming fungal species complex. (*Rhizoplaca*, Ascomycota)	Journal of Biogeography	Leavitt, S. D., Fernández-Mendoza, F., Pérez-Ortega, S., Sohrabi, M., Divakar, P. K. *et al.*	United States, Germany, Spain, Iran, Czech Republic	10.1111/jbi.12118
Mechanistic models for the spatial spread of species under climate change.	Ecological Applications	Leroux, S. J., Larrivée, M., Boucher-Lalonde, V., Hurford, A., Zuloaga, J. *et al.*	Canada	10.1890/12-1407.1
Process-based and correlative modeling of desert mistletoe distribution: a multiscalar approach.	Ecosphere	Lira-Noriega, A., Soberón, J., & Miller, C. P.	United States	10.1890/ES13-00155.1
Effects of a fire response trait on diversification in replicated radiations.	Evolution	Litsios, G., Wüest, R. O., Kostikova, A., Forest, F., Lexer, C. *et al.*	Switzerland, United Kingdom	10.1111/evo.12273
Geological and ecological factors drive cryptic speciation of yews in a biodiversity hotspot.	The New Phytologist	Liu, J., Möller, M., Provan, J., Gao, L.-M., Poudel, R. C. *et al.*	China, United Kingdom	10.1111/nph.12336
Conservation genetics of *Dichoropetalum schottii* (Apiaceae): is the legal protection of edge populations consistent with the genetic data?	Annales Botanici Fennici	López-pujol, J., Martinell, M. C., Massó, S., Rovira, A. M., Bosch, M. *et al.*	Spain	http://www.sekj.org/PDF/anb50-free/anb50-269.pdf
Social spiders of the genus *Anelosimus* occur in wetter, more productive environments than non-social species.	Die Naturwissen-schaften	Majer, M., Agnarsson, I., Svenning, J.-C., & Bilde, T.	Denmark, United States	10.1007/s00114-013-1106-6
Post-glacial northward expansion and genetic differentiation between migratory and sedentary populations of the broad-tailed hummingbird (*Selasphorus platycercus*).	Molecular Ecology	Malpica, A., & Ornelas, J. F.	Mexico	10.1111/mec.12614
Human and natural drivers of changing macrophyte community dynamics over 12 years in a Neotropical riverine floodplain system.	Aquatic Conservation: Marine and Freshwater Ecosystems	Martins, S. V., Milne, J., Thomaz, S. M., McWaters, S., Mormul, R. P. *et al.*	Brazil, United Kingdom	10.1002/aqc.2368
Phylogeny of Polycnemoideae (Amaranthaceae): Implications for biogeography, character evolution and taxonomy.	Taxon	Masson, R., & Kadereit, G.	Germany	http://www.ingentaconnect.com/content/iapt/tax/2013/00000062/00000001/art00009

Title	Journal	Authors	Author countries	DOI/URL
Modeling species distributions from heterogeneous data for the biogeographic regionalization of the European bryophyte flora.	PLoS ONE	Mateo, R. G., Vanderpoorten, A., Muñoz, J., Laenen, B., & Désamoré, A.	Belgium, Ecuador, Portugal, Spain	10.1371/journal.pone.0055648
Velvet ants, past and present: a county-wide checklist of the distribution and diversity of Mutillidae (Insecta: Hymenoptera) in Oklahoma including two new state records, and new behavioral observations for *Dasymutilla foxi* (Cockerell).	Entomologica Americana	Menard, K. L., & Mitchell, J. M.	United States	10.1664/13-RA-009.1
Distribution of some rare or endemic chasmophytic and rupestral species growing along the coastal cliffs of the Maltese Islands.	Webbia	Mifsud, S.	Malta	10.1080/00837792.2013.807451
Disentangling environmental correlates of vascular plant biodiversity in a Mediterranean hotspot.	Ecology and Evolution	Molina-Venegas, R., Aparicio, A., Pina, F. J., Valdés, B., & Arroyo, J.	Spain	10.1002/ece3.762
Morphological and molecular characterization of a new Nearctic species of *Calligrapha* Chevrolat, 1836 (Coleoptera: Chrysomelidae, Chrysomelinae) from Central Mexico.	Proceedings of the Entomological Society of Washington	Montelongo, T., & Gómez-Zurita, J.	Spain	10.4289/0013-8797.115.4.369
Niche modelling for twelve plant species (six timber species and six palm trees) in the Amazon region, using collection and field survey data.	Forest Ecology and Management	Moscoso, V., Albernaz, A. L., & Salomão, R. D. P.	Brazil	10.1016/j.foreco.2013.08.064
Rare species support vulnerable functions in high-diversity ecosystems.	PLOS biology	Mouillot, D., Bellwood, D. R., Baraloto, C., Chave, J., Galzin, R. *et al.*	France, Australia, United States, Switzerland	10.1371/journal.pbio.1001569
A comparative study of ancient environmental DNA to pollen and macrofossils from lake sediments reveals taxonomic overlap and additional plant taxa.	Quaternary Science Reviews	Pedersen, M. W., Ginolhac, A., Orlando, L., Olsen, J., Andersen, K. *et al.*	Denmark	10.1016/j.quascirev.2013.06.006
What determines biogeographical ranges? Historical wanderings and ecological constraints in the danthonioid grasses.	Journal of Biogeography	Peter Linder, H., Antonelli, A., Humphreys, A. M., Pirie, M. D., & Wüest, R. O.	Germany, Sweden, Switzerland, United Kingdom	10.1111/jbi.12070
Notes on the Chilean geographic distribution of several vascular plant species.	Check List	Pfanzelt, S., García, C., & Marticorena, A.	Chile, Germany	http://www.checklist.org.br/getpdf?NGD257-12
A new species of mudskipper, *Boleophthalmus poti* (Teleostei: Gobiidae: Oxudercinae) from the Gulf of Papua, Papua New Guinea, and a key to the genus.	The Raffles Bulletin of Zoology	Polgar, G., Jaafar, Z., & Konstantinidis, P.	Germany, Malaysia, Singapore	http://rmbr.nus.edu.sg/rbz/biblio/61/61rbz311-321.pdf

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Phylogeography and niche modelling of the relict plant *Amborella trichopoda* (Amborellaceae) reveal multiple Pleistocene refugia in New Caledonia.	Molecular Ecology	Poncet, V., Munoz, F., Munzinger, J., Pillon, Y., Gomez, C. *et al.*	France, New Caledonia, United States	10.1111/mec.12554
The integration of multiple independent data reveals an unusual response to Pleistocene climatic changes in the hard tick *Ixodes ricinus*.	Molecular Ecology	Porretta, D., Mastrantonio, V., Mona, S., Epis, S., Montagna, M. *et al.*	France, Italy	10.1111/mec.12203
Afrotemperate Amphibians in southern and eastern Africa: a critical review.	African Journal of Herpetology	Poynton, J. C.	United Kingdom	10.1080/21564574.2013.794866
Ascomycota macrofungi new to Romania.	Acta Horti Botanici Bucurestiensis	Radu, M.-I.	Romania	10.2478/ahbb-2013-0007
Do the elevational limits of deciduous tree species match their thermal latitudinal limits?	Global Ecology and Biogeography	Randin, C. F., Paulsen, J., Vitasse, Y., Kollas, C., Wohlgemuth, T. *et al.*	Switzerland	10.1111/geb.12040
Evaluating the significance of Paleophylogeographic species distribution models in reconstructing Quaternary range-shifts of Nearctic Chelonians.	PLoS ONE	Rödder, D., Lawing, A. M., Flecks, M., Ahmadzadeh, F., Dambach, J. *et al.*	Germany, United States	10.1371/journal.pone.0072855
Genetic, phenotypic and ecological divergence with gene flow at the Isthmus of Tehuantepec: the case of the azure-crowned hummingbird (*Amazilia cyanocephala*)	Journal of Biogeography	Rodríguez-Gómez, F., Gutiérrez-Rodríguez, C., & Ornelas, J. F.	Mexico	10.1111/jbi.12093
Genetic divergence of the Mesoamerican azure-crowned hummingbird (*Amazilia cyanocephala*, Trochilidae) across the Motagua-Polochic-Jocotán fault system.	Journal of Zoological Systematics and Evolutionary Research	Rodríguez-Gómez, F., & Ornelas, J. F.	Mexico	10.1111/jzs.12047
First pelagic record of the velvet dogfish *Zameus squamulosus* (Günther, 1877) (Squaliformes) from the southwestern Indian Ocean and some notes on its regional distribution.	Zoosystema	Romanov, E. V., Bach, P., Rebik, S. T., Le Turc, A., & Séret, B.	Île de la Réunion (France), Ukraine, France	10.5252/z2013n1a2
Niche conservatism and disjunct populations: A case study with Painted Buntings (*Passerina ciris*).	The Auk	Ryan Shipley, J., Contina, A., Batbayar, N., Bridge, E. S., Peterson, A. T. *et al.*	United States	10.1525/auk.2013.12151
Phylogeography of a rare orchid, *Vexillabium yakushimense*: comparison of populations in central Honshu and the Nansei Island chain, Japan.	Plant Systematics and Evolution	Saeki, I., Kitazawa, A., Abe, A., Minemoto, K., & Koike, F.	Japan	10.1007/s00606-013-0854-2
Bioclimatic, ecological, and phenotypic intermediacy and high genetic admixture in a natural hybrid of octoploid strawberries.	American Journal of Botany	Salamone, I., Govindarajulu, R., Falk, S., Parks, M., Liston, A. *et al.*	United States	10.3732/ajb.1200624

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Distribution extension of Proboscis bat *Rhynchonycteris naso* record for southwestern Ecuador.	Check List	Salas, J. A., Viteri, F.H., Zambrano, M.M., Benavides, V.H., & Carvajal	Ecuador	http://www.checklist.org.br/getpdf?NGD275-12
The world bacterial biogeography and biodiversity through databases: a case study of NCBI nucleotide database and GBIF database.	BioMed Research International	Selama, O., James, P., Nateche, F., Wellington, E. M. H., & Hacène, H.	Algeria, United Kingdom	10.1155/2013/240175
How does selection of climate variables affect predictions of species distributions? A case study of three new weeds in New Zealand.	Weed Research	Sheppard, C. S.	New Zealand	10.1111/wre.12021
Pterocymbium tinctorium (Merrill, 1901) (Magnoliophyta: Malvales: Sterculiaceae: Sterculioideae): New record from mainland India and extension of geographic distribution.	Check List	Singh, B., Adhikari, D., Barik, S. K., & Chettri, A.	India	http://www.checklist.org.br/getpdf?NGD098-11
Modeling environmental niche of Himalayan birch and remote sensing based vicarious validation.	Tropical Ecology	Singh, C. P., Panigrahy, S., & Parihar, J. A. I. S.	India	http://www.tropecol.com/volumes/toc/en/toc54-3.htm
Host preference of herbivorous arthropods feeding on *Ficus* (Moraceae) grown *ex situ* in Ukraine.	Environmental and Experimental Biology	Sosnovsky, Y.	Ukraine	http://eeb.lu.lv/EEB/201312/EEB_11_Sosnovsky.pdf
First fossil record of *Alphonsea* Hk. f. & T. (Annonaceae) from the late Oligocene sediments of Assam, India and comments on Its phytogeography.	PLoS ONE	Srivastava, G., & Mehrotra, R. C.	India	10.1371/journal.pone.0053177
The effects of sampling bias and model complexity on the predictive performance of MaxEnt species distribution models.	PLoS ONE	Syfert, M. M., Smith, M. J., & Coomes, D. A.	United Kingdom	10.1371/journal.pone.0055158
Divergent and narrower climatic niches characterize polyploid species of European primroses in *Primula* sect. *Aleuritia*.	Journal of Biogeography	Theodoridis, S., Randin, C., Broennimann, O., Patsiou, T., & Conti, E.	Switzerland	10.1111/jbi.12085
Climatic niche of *Dacryodes edulis* (G. Don) H. J. Lam (Burseraceae), a semi-domesticated fruit tree native to Central Africa.	Journal of Ecology and the Natural Environment	Todou, G., D'Eeckenbrugge, G. C., Joly, H. I., Akoa, A., Onana, J.-M. *et al.*	Cameroon, France	10.5897/JENE12.075
Northern range extension to Georges Bank for *Hollardia hollardi* (Reticulate Spikefish) (Triacanthodidae, Tetraodontiformes).	Northeastern Naturalist	Tyler, J. C., Collette, B. B., & Broughton, E. A.	United States	10.1656/045.020.0421
On the presence and distribution of the Gulf sand gecko, *Pseudoceramodactylus khobarensis* Haas, 1957 (Reptilia: Squamata: Gekkonidae) in Qatar.	Q Science Connect	Valdeón, A., Castilla, A. M., Cogalniceaunu, D., Gosá, A., Alkuwary, A. *et al.*	Egypt, Qatar, Romania, Spain	http://www.qscience.com/doi/abs/10.5339/connect.2013.34

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Application of consensus theory to formalize expert evaluations of plant species distribution models.	Applied Vegetation Science	Van Zonneveld, M., Castañeda, N., Scheldeman, X., van Etten, J., & Van Damme, P.	Belgium, Colombia, Costa Rica, Czech Republic	10.1111/avsc.12081
Does prescribed burning result in biotic homogenisation of coastal heathlands?	Global Change Biology	Velle, L. G., Nilsen, L. S., Norderhaug, A., & Vandvik, V.	Norway	10.1111/gcb.12448
Radically different phylogeographies and patterns of genetic variation in two European brown frogs, genus *Rana*.	Molecular Phylogenetics and Evolution	Vences, M., Hauswaldt, J. S., Steinfartz, S., Rupp, O., Goesmann, A. *et al.*	Germany, United Kingdom, Spain, Poland, Russia, France, Portugal, Italy, Croatia, Greece, Ukraine	10.1016/j.ympev.2013.04.014
The deep-sea fish *Kali macrodon*: a new record for the tropical eastern Atlantic off Cape Verde.	Marine Biodiversity Records	Vieira, R. P., Thiel, R., Christiansen, B., Coelho, R., Denda, A. *et al.*	Portugal, Germany	10.1017/S1755267212001248
Tree squirrels: A key to understand the historic biogeography of Mesoamerica?	Mammalian Biology	Villalobos, F.	Costa Rica	10.1016/j.mambio.2013.02.003
Diaspore and shoot size as drivers of local, regional and global bryophyte distributions.	Global Ecology and Biogeography	Virtanen, R.	Finland	10.1111/geb.12128
Canary Grasses (*Phalaris*, Poaceae): Biogeography, molecular dating and the role of floret structure in dispersal.	Molecular Ecology	Voshell, S. M., & Hilu, K. W.	United States	10.1111/mec.12575
Low global sensitivity of metabolic rate to temperature in calcified marine invertebrates.	Oecologia	Watson, S.-A., Morley, S. A., Bates, A. E., Clark, M. S., Day, R. W. *et al.*	Australia, New Zealand, Singapore, United Kingdom	10.1007/s00442-013-2767-8
Evolution of microgastropods (Ellobioidea, Carychiidae): integrating taxonomic, phylogenetic and evolutionary hypotheses.	BMC Evolutionary Biology	Weigand, A. M., Jochum, A., Slapnik, R., Schnitzler, J., Zarza, E. *et al.*	Germany, Slovenia	10.1186/1471-2148-13-18
Analysis of coprolites from the extinct mountain goat *Myotragus balearicus*.	Quaternary Research	Welker, F., Duijm, E., van der Gaag, K. J., van Geel, B., de Knijff, P. *et al.*	Netherlands, Spain, Switzerland	10.1016/j.yqres.2013.10.006
Range collapse in the Diana fritillary, *Speyeria diana* (Nymphalidae).	Insect Conservation and Diversity	Wells, C. N., & Tonkyn, D. W.	United States	10.1111/icad.12059

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Trioza chenopodii Reuter (Hemiptera: Psylloidea: Triozidae): new western North American records of a Eurasian immigrant.	Proceedings of the Entomological Society of Washington	Wheeler, A. G., & Hoebeke, E. R.	United States	10.4289/082.115.0202
Expanding the understanding of local community assembly in adaptive radiations.	Ecology and Evolution	Wollenberg, K. C., Veith, M., & Lötters, S.	Germany, United States	10.1002/ece3.908
Synthetodontium kunlunense (Mielichhoferiaceae, Musci), a new moss species from the Kunlun Mountain Range, China.	Novon: A Journal for Botanical Nomenclature	Yong-Ying, L., Jian-Cheng, Z., & Mamtimin, S.	China	10.3417/2011049
New records of *Thremma anomalum* (Trichoptera: Uenoidae) from Southeastern Europe with notes on its ecology.	Entomological News	Živić, I., Bjelanović, K., Simić, V., Živić, M., Žikić, V. *et al.*	Serbia	10.3157/021.123.0307
Myxomycete records from Eagle Hill in Maine.	Mycosphere	Zoll, V., & Stephenson, S. L.	United States	10.5943/mycosphere/4/3/7

Discussion of GBIF

In addition to the research uses of data accessed via GBIF, outlined in the previous sections, the network was discussed in various forms in the scientific literature during 2013. The following is a selection of journal articles in which GBIF was a significant topic of discussion.

Amano, T., & Sutherland, W. J. (2013). Four barriers to the global understanding of biodiversity conservation: wealth, language, geographical location and security. *Proceedings Biological Sciences/The Royal Society*, 280(1756), 20122649. doi:10.1098/rspb.2012.2649

Balke, M., Schmidt, S., Hausmann, A., Toussaint, E., Bergsten, J., *et al.* (2013). Biodiversity into your hands - A call for a virtual global natural history "metacollection." *Frontiers in Zoology, 10*(1), 55. doi:10.1186/1742-9994-10-55

Beck, J., Ballesteros-Mejia, L., Nagel, P., & Kitching, I. J. (2013). Online solutions and the "Wallacean shortfall": what does GBIF contribute to our knowledge of species' ranges? *Diversity and Distributions, 19*(8), 1043–1050. doi:10.1111/ddi.12083

Belbin, L., Daly, J., Hirsch, T., Hobern, D., & LaSalle, J. (2013). A specialist's audit of aggregated occurrence records: An "aggregator"s' perspective. *ZooKeys*, 305, 67–76. doi:10.3897/zookeys.305.5438

Chavan, V., Lyubomir, P., & Hobern, D. (2013). Cultural change in data publishing is essential. *BioScience, 63*(6), 419–420. doi:10.1525/bio.2013.63.6.3

Costello, M. J., Appeltans, W., Bailly, N., Berendsohn, W. G., de Jong, Y., *et al.* (2013). Strategies for the sustainability of online open-access biodiversity databases. *Biological Conservation*, 1–11. doi:10.1016/j.biocon.2013.07.042

Costello, M. J., Bouchet, P., Boxshall, G., Fauchald, K., Gordon, D. P., *et al.* (2013). Global coordination and standardisation in marine biodiversity through the World Register of Marine Species (WoRMS) and related databases. *PLoS ONE*, 8(1), e51629. doi:10.1371/journal.pone.0051629

Costello, M. J., May, R. M., & Stork, N. E. (2013). Can we name Earth's species before they go extinct? *Science, 339*(6118), 413–416. doi:10.1126/science.1230318

Costello, M. J., Michener, W. K., Gahegan, M., Zhang, Z.-Q., & Bourne, P. E. (2013). Biodiversity data should be published, cited, and peer reviewed. *Trends in Ecology & Evolution*, *28*(8), 454–61. doi:10.1016/j.tree.2013.05.002

Costello, M. J., & Wieczorek, J. (2013). Best practice for biodiversity data management and publication. *Biological Conservation*. doi:10.1016/j.biocon.2013.10.018

Droege, G., Barker, K., Astrin, J. J., Bartels, P., Butler, C., *et al.* (2013). The Global Genome Biodiversity Network (GGBN) Data Portal. *Nucleic Acids Research*, 1–6. doi:10.1093/nar/gkt928

Hardisty, A., & Roberts, D. (2013). A decadal view of biodiversity informatics: challenges and priorities. *BMC Ecology*, 13(1), 16. doi:10.1186/1472-6785-13-16

Hubbell, S. P. (2013). Tropical rain forest conservation and the twin challenges of diversity and rarity. *Ecology and Evolution*, 3(10), 3263–74. doi:10.1002/ece3.705

Oksanen, M., & Kumpula, A. (2013). Transparency in conservation: rare species, secret files, and democracy. *Environmental Politics*, 1–17. doi:10.1080/09644016.2013.775726

Otegui, J., Ariño, A. H., Encinas, M., & Pando, F. (2013). Assessing the primary data hosted by the Spanish Node of the Global Biodiversity Information Facility (GBIF). *PLoS ONE*, 8(1), e55144. doi:10.1371/journal.pone.0055144

Mesibov, R. (2013). A specialist's audit of aggregated occurrence records. *ZooKeys, 293*, 1–18. doi:10.3897/zookeys.293.5111

Skøien, J. O., Schulz, M., Dubois, G., Fisher, I., Balman, M., *et al.* (2013). A Model Web approach to modelling climate change in biomes of Important Bird Areas. *Ecological Informatics, 14*, 38–43. doi:10.1016/j.ecoinf.2012.12.003

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Ariño, A. H., Chavan, V. C., & Fatih, D. P. (2013). Assessment of user needs of primary biodiversity data: analysis, concerns and challenges. *Biodiversity Informatics*, 8 (2), 59–93.

Faith, D. P., Collen, B., Ariño, A. H., Koleff, P., Guinotte, J., *et al.* (2013). Bridging biodiversity data gaps: recommendations to meet users' data needs. *Biodiversity Informatics*, 8(2), 41–58.

Gaiji, S., Chavan, V., Ariño, A. H., Otegui, J., Hobern, D., *et al.* (2013). Content assessment of the primary biodiversity data published through GBIF network: status, challenges and potentials. *Biodiversity Informatics*, 8(2), 94–172.

Morris, R. A., Barve, V., Carausu, M., Chavan, V., Cuadra, J., *et al.* (2013). Discovery and publishing of primary biodiversity data associated with multimedia resources: the audubon core strategies and approaches. *Biodiversity Informatics*, 8(2), 185–197.

Otegui, J., Ariño, A. H., Chavan, V., & Gaiji, S. (2013). On the dates of the GBIF mobilised primary biodiversity data records. *Biodiversity Informatics*, 8(2), 173–184.

Data papers

Researchers published the following peer-reviewed data papers in 2013, based on enriched metadata for biodiversity datasets accessible through the GBIF network.

Benetti, S., Saucède, T., & David, B. (2013). Fossil echinoid (Echinoidea, Echinodermata) diversity of the Early Cretaceous (Hauterivian) in the Paris Basin (France). *ZooKeys*, 325, 65–75. doi:10.3897/zookeys.325.5085

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