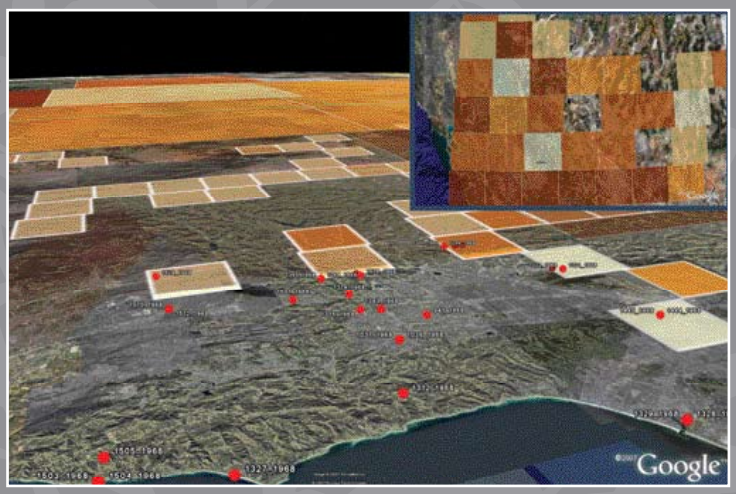
Monitoring Our Changing Global Biodiversity

by Robert Guralnick, Curator of Invertebrate Zoology

Our planet is in the midst of a biotic crisis almost certainly caused by human activities. This crisis is of an unprecedented scope and rate, and may lead to half the species on earth going extinct by the end of this century. The ability to track the predicted continued changes to the diversity and distribution of Earth's organisms in relation to environmental factors is a key tool for defining strategies and mechanisms for conserving our current biodiversity. Such ability is also essential for understanding and predicting future responses of biodiversity to shifting landscapes and changing climate.

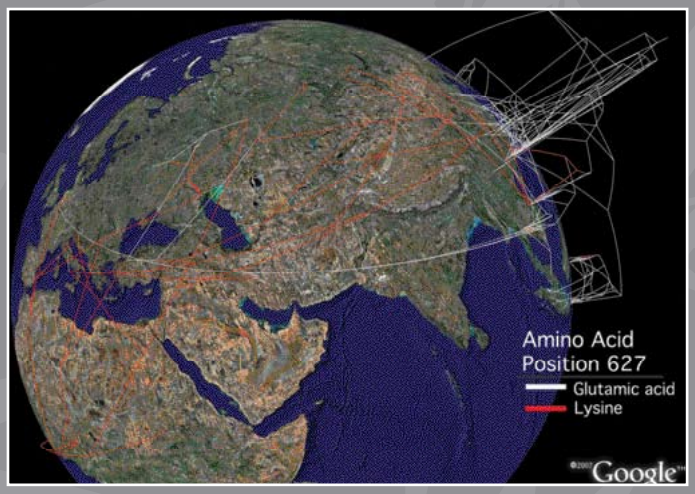


A screenshot from the KML of Species Occurrence Record Density (K-SORD) tool. In the foreground are individual record distributions of Thomomys bottae *(Botta's Pocket Gopher) in western North America; at further distances from point-of-view are progressively larger boxes that summarize record density in the given area. Darker tones represent greater density of records.* ***Inset*** *The same region of western North America as viewed from altitude.*

A major barrier to advancing our biodiversity knowledge is lack of biodiversity data in many regions of the world. Although more biodiversity records are steadily being acquired, it is still difficult to find past and current biodiversity data for anything but well-studied taxa that occur in well-studied areas. It has been even harder to aggregate data from multiple sources in order to ask new questions not envisioned by those performing the initial surveys. We are often unable to answer very simple, fundamental biodiversity questions for most regions in the world, such as "what biodiversity has been found in region X?" and "has previous sampling been sufficient to support confidence in biodiversity estimates?"

A partial solution to the problem of data availability is a global mechanism that facilitates sharing of biodiversity data that is housed in natural history collections throughout the world. These collections hold vast troves of specimens collected over three centuries. This legacy includes on the order of 1 to 2 billion records of biological diversity and a substantial percentage of the total are records collected prior to major alterations of native landscapes. Thus, these specimen data are the best possible resource with which to construct baselines to measure changes in biodiversity over time.

The Global Biodiversity Information Facility (GBIF) has developed a worldwide information infrastructure through which natural history collections (as well as other institutions and organizations) can publish their databases, and thus become part of a distributed global network of shared biodiversity data. Any user with Internet connectivity can access a vast queryable global biodiversity data service. As of June 2008, the GBIF data portal mediates access to approximately 160 million species-occurrence records from over 1600 collections housed in approximately 225 institutions from all regions of the world.



Screenshot of the spread of H5N1 avian influenza lineages across the Eurasian continent. Here, we illustrates the mutation of a key amino acid that may be involved in changing transmissibility among mammals. The lineages colored red have that mutation while white lineages do not - at the same point that phylogenetic lineages spread westward out of Eastern Asia.

My lab has tackled the daunting challenge of both increasing the quantity and quality of global biodiversity databases, and building the tools needed to explore this data and use it for biodiversity assessment. This includes distributing 315,000 of the University of Colorado Museum of Natural History's biological occurrence records to the GBIF portal; developing tools that increase the utility of all GBIF data; and tools that allow us to begin exploring quantitative assessment of how well biodiversity has been sampled for different groups of organisms across different regions of the world. For example, we were part of an international collaboration to develop Biogeomancer (http://www.biogeomancer.org) a web tool that converts textual locality descriptions (eg. 3.1 miles West and 5 miles South of Boulder) into latitude and longitude values, that can be used fro mapping. This tool is essential in performing retrospective georeferencing since so much of our legacy data has these textual descriptions but lacks computer-readable coordinates. We also developed GBIF-MAPA (http://gbifmapa.austmus.gov.au/mapa/), in collaboration with the Austrian Museum, to explore biodiversity patterns across space and time, and to assess where to go to find more biodiversity.

These tools are just the start of the Museum's efforts towards developing a global, collaborative infrastructure for biodiversity assessment. Such an infrastructure can help us meet the challenge of monitoring global biodiversity. As importantly, we can extend biodiversity data to a much broader audience than is reached using traditional methods, which is crucial to our ability to combat the accelerating biodiversity crisis.