

Quantifying ecological effects of land use and climate change using historical collections

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Short Summary: The University of California has an array of unparalleled world-class research, reserve and forestry centers. This project will bring together efforts from ANR/REC, NRS and CFF and join them with the historical depth provide by the BNHMs and cutting edge ecoinformatics of the Keck funded Predictive Biosystems Informatics Engine. This project will develop tools and lay the groundwork for future cross-unit efforts addressing critical natural resource questions and issues. The primary focal area of this project is to address the shifting spatial structure of California's natural resources in three of our research centers in northern California by analyzing historical specimen data held in collections and looking for significant change or stasis with regard to environmental change and disparate land use and management regimes. The secondary focal area addresses tools for land change science, and in particular, to engage students through their inclusion in the project and the broader public using both the citizen science online experience and in sessions of the California Naturalist Program.

Project Summary: The next generation of predictive models of the biotic response to environmental change must meet the challenge of incorporating the effects of complex interactions among organisms, climate, and their physical and biotic environments. A great variety of data types are required to meet this challenge, including current and past species' distributions, and how these have changed in space and time, as well as empirical and modeled data on environmental and climate change. While much data are already available for natural sites, information from managed sites is just emerging; together they would allow comparison across the range of natural to highly managed environments in northern California. Given the reliance on managed systems for food, timber and their importance to wildlife, it is critical to understand the effects of global change on these systems, and anticipate expected parallels and divergence of managed and natural areas as we move into the future. The proposed effort will reveal

interactions and feedbacks between different species and their environments - both natural and managed - and how they change over time, by allowing easy and rapid access to vast amounts of disparate data, the ability to perform rapid exploratory analyses and tests for correlations and to visualize and communicate results to a broad community of users. The goal of this project is to bring data together from managed and natural systems in a comparative framework, by partnering with two major ongoing complementary bioinformatics efforts within UC/ANR: (1) Keck Foundation-funded project (co-PI Rosemary Gillespie; see <http://globalchange.berkeley.edu/ecoinformatics-engine>), which looks at the effects of complex interactions among organisms, climate, and their physical and biotic environments, incorporating information on current and past species' distributions and how these have changed in space and time, as well as empirical and modeled data on environmental and climate change. Deliverables include a mechanism to access, visualize, and analyze these rich data, and thus provide the foundation for building the next generation of models of the biotic response to global change. The focus of the Keck effort is the natural environments of the UC Natural Reserve system. Also, (2) an ANR-funded effort to organize, digitize and make Web-accessible, the data from nine of California's Research and Extension Centers (co-PIs Maggi Kelly and Lisa Fischer; see <http://www.escholarship.org/uc/item/2117459w> , <http://ucanr.edu/sites/IGIS/>). Finally, we will build on other efforts that aim to digitize specimen data throughout California: Calbug, which is digitizing select arthropods from a spectrum of UC fieldstations (R. Gillespie, K. Will; G. Roderick co-PIs; see <http://calbug.berkeley.edu/>); and the Consortium of California Herbaria for vascular plant specimens (<http://ucjeps.berkeley.edu/consortium/>). This project will fully digitize the remaining specimen records from collections held at Hopland REC and Sagehen Creek Field Station, bring in the rich collections from Blodgett Forest Research Station, and selectively database specimens held in the Berkeley Natural History Museums' (BNHM) collections. These collections, as well as some held remotely, reflect a long tradition of exploration and sampling of the biota of California, with some of the most intense and long-term efforts focused at the UC field, research and extension centers. Through the ongoing efforts mentioned, a good deal of data from these efforts are already digitally available, although there are numerous gaps and data from material collected at Blodgett (around 500 specimens of insects, 70 vertebrate specimens and around 350 plant specimens) are entirely lacking. Once we have rendered the specimens, and associated ecological data, digitally available, we propose to integrate the data, using the structure of the Keck Ecoinformatics Engine, to understand

biodiversity response to global change in a comparative framework across natural and managed systems. In addition to the development of bioinformatics tools, public awareness and outreach is vital to developing a deeper understanding of the importance of climate change to California as well as the need for evidence-based management policies to mitigate problems associated with change. Gaining the confidence of the public at large requires that they understand the issues and have a personal buy-in to the management outcomes. Citizen science projects, mediated via the internet, are now being developed and this project will take advantage of the data pipeline and user interface established by the NSF-funded CalBug project and its partnership with the highly successful crowdsourcing of data label transcriptions at Notes from Nature (<http://www.notesfromnature.org>). This project will also work with the California Naturalist Program (<http://ucanr.edu/sites/UCCNP/>) to develop workshop exercises targeted at field collection, identification, and land use change. Also the project will involve the CNP by conducting sessions that introduce Californians to the diversity of natural communities at the research stations. Through these courses it is expected that there will be an increase in participation in the online citizen science efforts thereby expanding on the learning and giving them an opportunity to have a long-term interaction with the data and gain a better understanding of the process of science as a whole. Moreover, in addition to digitizing specimens and conducting analyses of species and community change, the project will generally curate and enhance existing REC and field station biological collections as well as develop protocols for vouchering and databasing newly collected specimens.