Making the University of Michigan the Nexus for Global Change Biology

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Executive Summary

Global Change Biology seeks to understand the responses of organisms, communities and ecosystems to the encompassing ways that humans are modifying the environment. Although organisms have modified the Earth's climate in the past (i.e., evolution of oxygenic photosynthesis that filled the atmosphere with O_2), current human activities are exerting disproportional impacts on the rate and magnitude of environmental change (i.e., via Global Change drivers, including climate change, landscape change, pollution and species introductions). Just as the frequency and magnitude of the impacts are accelerating, scientists, policy makers and managers lack the ability to accurately predict how anthropogenic changes will alter organisms, communities and ecosystems that provide human society with critical benefits, like clean water, climate mitigation, food, fiber, as well as natural products that serve as pharmaceuticals. A major intellectual barrier to achieving diagnostic and prognostic insights lies on our ability to conduct experiments at an appropriate scale in time and space that will provide the information necessary to understand and anticipate the specific place-based responses of organisms, communities and ecosystems. For example, we can parameterize changes in the geographic distribution of a species under global warming, as this process is continental in scale and takes centuries to millennia, but we can't accurately predict how a particular organism or population might fare in response to the next decade of local weather.

Research groups around the world are tackling individual aspects of how Global Change factors are affecting biological systems. In the last decades, advancements in specific fields have been admirable, e.g., we can reliably simulate behavioral animal responses to environmental changes that can aid with future forecasts, and we do understand the physiological basis of plant responses to future concentrations of atmospheric CO_2 and other atmospheric pollutants. Still, efforts thus far have failed to provide the outcomes most needed for society, i.e., near-term predictions of the effects of Global Change at scales relevant to organisms, populations, ecological communities and humans. For that, connecting basic and user-inspired biological research across relevant disciplines is essential to the development of a *comprehensive understanding of the synergistic effects of Global Change on organisms across temporal and spatial scales*. To achieve this task, **we propose the creation of a Global Change Biology research hub at the University of Michigan**.

Right now, U. Michigan has several research groups working in this area, as well as considerable existing infrastructure; these assets are distributed over multiple units and were created with minimal collaboration among them. We propose a series of targeted hires and the creation of the institutional infrastructure to build a globally-recognized **Institute for Global Change Biology** (a niche that has not been fulfilled by any other institution). We have identified two major needs to reach this goal:

1) We need the 'connectors,' a series of strategic hires that would allow inter-lab, inter-departmental and inter-school collaborations. Right now, we are intellectually too spread out to make collaborations optimal.

2) We lack the institutional connectivity and infrastructure that would 'make the team larger than the sum of the parts'. As such, an **Institute for Global Change Biology** could systematically promote collaboration through seminar series, colloquiums, curriculum, and/or certificates. The School for Environment and Sustainability-SEAS, designed to be interdisciplinary with porous boundaries, could be the center of mass for this Institute and would be ideally positioned to connect research programs, infrastructure and resources from across UM.

Executive Summary (cont.)

By mapping Global Change Research scientists across the University, we have identified the two new hiring priorities that would cover major gaps across scales and disciplines in our research program and that would facilitate collaborations across university teams (Fig. 1).

Position 1. Ecophysiologist: Ecosystem physiologist, focus on Atmosphere-Vegetation Interactions

Predicting vegetation responses to Global Change has become essential for developing forecasts of ecosystems productivity and functioning. In addition, reliable forecasts of regional climatic conditions and ultimately of water, agricultural and forest resources will require a deep understanding of how the vegetation responds to the local weather and climate. Furthermore, the vegetation also regulates the local climate through transpiration and emissions of volatile organic compounds. Thus, research in this area, how the atmosphere and vegetation interact, is critical for near-term and local predictions of future environmental conditions. While UM has modelers that work on simulating some of these processes (e.g., work in CLaSP and CEE), and has the infrastructure to measure ecosystem scale fluxes (e.g., UMBS), we are lacking an ecosystem physiologist that works across scales, from individual performance to processes at the ecosystem level. This position would be essential to connect Community and Ecosystem biologists with engineering work in Climatology and Hydrology.

Position 2. Quantitative Ecologist: Dynamic Ecosystem modeler, focus on Local to Landscape Scales

Understanding how biological systems are affected by Global Change drivers requires the integration of data on genomic, organismal, population and community responses to local, regional and global natural and anthropogenic factors. Dynamic ecosystem modeling provides the means to bring these data sources together into a framework aimed at producing information at the temporal and spatial scales relevant to conservation, management and restoration. Current UM researchers address many of the processes involved in these models, but we do lack the biological expertise that brings this information together to forecast ecosystems dynamics. Given the integrated nature of this position, a quantitative ecologist working on dynamic ecosystem models would likely collaborate with most of the Global Change researchers at UM, in particular this expertise could bring together Genetics, Organismal, Population and Community biologists with Earth scientists.

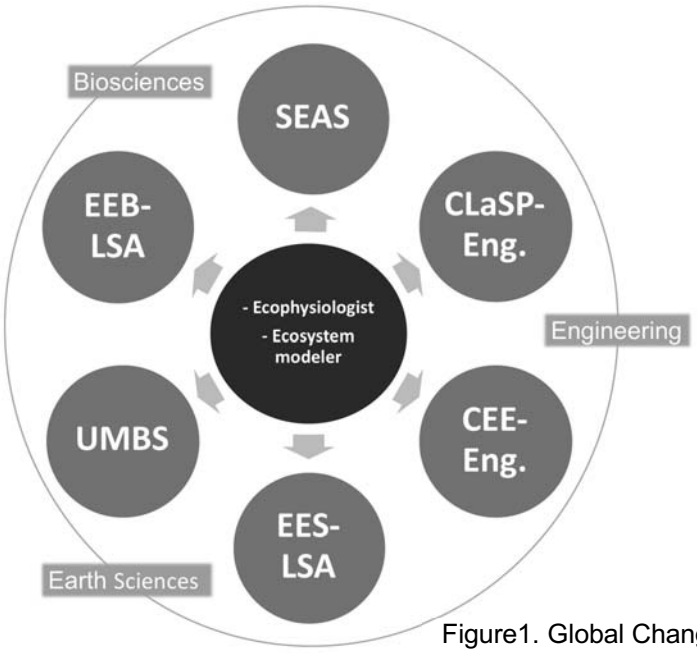

Figure1. Global Change Biology at UM

The **Institute for Global Change Biology** would leverage existing research labs (in LSA, SEAS and Engineering) and infrastructure (e.g., UMBS, atmospheric towers, field properties, MICDE) at the University of Michigan. We have identified principal investigators among the Biological and Earth Sciences and in Engineering, that we anticipate would be interested in being affiliated with this Institute (Fig. 1). The two positions proposed would be critical to connect research across scales and disciplines.