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A Research and Education Agenda for Biology?

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For some time, biologists have argued that a greater federal investment in biological research and education is required to move science forward and solve urgent societal problems. Arguably, this call has been heard, but a response has been muted by the lack of a clear articulation of need from the scientific community. However, recent efforts from within the community suggest that biologists might be attempting to define plans that will advance science and solve real-world problems.

"Plants are central to the future of scientific discovery, human well-being, and the sustainable use and preservation of the world's natural resources," says Andrea Kramer, executive director of the US Office of Botanical Gardens Conservation International. Yet, Kramer and others warn that federal agencies have failed to make investments in research and training that will drive discovery and inform decisionmaking. Kramer and colleagues recently convened academic scientists, government managers, and representatives from nongovernmental organizations. The meeting, held at the Chicago Botanic Garden, assessed the nation's botanical capacity.

"The project itself was prompted by anecdotal reports that botanical capacity was declining in many sectors," Kramer says, including education and training and research infrastructure; moreover, there is a lack of qualified candidates for government positions, and fewer academic botany departments to produce qualified scientists. "Botany departments at universities [are] being subsumed into more general or interdisciplinary departments and subsequently losing resident expertise as professors retire," warns Kramer.

The issues that prompted the botanical capacity summit are not new, and present a challenge to federal policymakers struggling to invest historically limited resources in programs that must support a range of scientific fields while solving societal problems. There is a lack of disciplinary strength—too few qualified organismal biologists—according to many participants at the Chicago conference. A growing stack of reports, however, asserts that there is a need for scientists with the skills and training to work in interdisciplinary teams. This, in short, is a recommendation in two reports released this year: *Transitions and Tipping Points in Complex Environmental Systems*, published by the National Science Foundation (NSF), and *A New Biology for the 21st Century*, published by the National Research Council (NRC).

Former NSF assistant director for biology James Collins described the *Tipping Points* report earlier this year: "The...focus on environmental complexity and the need to understand how our social systems integrate with the rest of Earth's systems is an important message. Research at the interface of natural and human systems forms the underpinnings for the adaptation and mitigation strategies needed for a changing planet."

Scientists cannot continue to study the components of environmental systems in isolation from each other, according to Susan Stafford, of the Department of Forest Resources at the University of Minnesota and chair of the NSF committee that authored *Tipping Points*.

Kramer agrees that interdisciplinary collaboration is necessary for progress, but questions what will happen if too many programs become dominated by interdisciplinary researchers. "Rather than focusing on specific disciplines that should be integrated, what is lacking is training in effective communication skills that are translatable beyond the realm of academia, as well as training in effective collaboration," argues Kramer.

The NSF and NRC reports press the need to invest in biological and environmental research. Some scientists who have read the reports find them to be refreshing. They call for interdisciplinary research and skills development, but recognize that these efforts require a strong foundation of disciplinary research. The NRC report, for example, references the importance of organismal biology and evolution for solving environmental, food, energy, and health problems.

The NRC report, which some have described as biology's call to action, or "moon shot," argues that a blend of research and new funding models should be implemented to achieve the ambitious goals proposed in the nearly 100-page document. Although the NRC neglected to place a price tag on its proposal or to outline a government engine that should be used to drive a "New Biology," the authors have been clear that a multiyear commitment and new funding—substantial resources beyond existing program budgets—are required. Some familiar with the plan speculate that an investment of $50 billion over the next 10 years is required.

Although $50 billion is significant, even in Washington, DC, a question worth asking is what the cost would be if the nation fails to build a research infrastructure that can deliver safe and nutritious food, functional ecosystem services, cleaner and sustainable energy, and quality, personalized medicine.

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