The synthesis of diverse knowledge is a central part of all sciences, especially those that draw information from many disciplines, such as ecology and environmental sciences. Research and education in ecology are intrinsically synthetic—solutions for environmental challenges increasingly require synthesis. Expansion of the already vast body of relevant knowledge makes synthesis ever more important. To accelerate pure and applied advances in ecology and environmental sciences, we see a pressing need for comprehensive new programs to energize synthesis. Synthesis and related activities, which often occur through sustained, intense interactions among individuals with ready access to raw data, metadata, and sophisticated analytical tools, make it possible to

- disparate data sets and mine them from new perspectives that allow novel analyses;
- develop and use new analytical, computational, visualization, and modeling tools that may lead to greater insights;
- bring theoreticians, empiricists, modelers, and practitioners together to formulate new approaches to existing questions;
- and integrate science with education and real-world problems.

Synthesis occurs when disparate data, concepts, or theories are integrated in ways that yield new knowledge, insights, or explanations (Pickett et al. 2007). Synthesis creates emergent knowledge in which the whole is greater than the sum of the parts. By engaging experts with multiple perspectives, synthesis is capable of vetting a vast body of information for use by other disciplines or by society in general. Synthesis takes stock of what we know and generates new knowledge from novel combinations of existing information.

Teamwork speeds synthesis and thereby accelerates innovation. As the foundational knowledge of the sciences has grown, processes of innovation have changed. The “burden of knowledge” (Jones 2009) embedded in increasing numbers of journals, papers, and books requires synthesis, if problem solvers are to use that mass of information efficiently. Synthesis leapfrogs the linear and sequential progress of discovery by converting the serial steps into parallel, interacting ones. Trends in patents (Jones 2009) demonstrate the value of the process: In recent years, innovations leading to patents have been accomplished by older people who have had more time to process knowledge, in narrower specialties in which there is less relevant knowledge to consider, or, increasingly, by interdisciplinary teams that have used synthesis to integrate multiple areas of knowledge. Innovations of this latter kind can readily be accelerated by new institutions and funding mechanisms.

Synthesis is crucial for solving environmental problems and finding new, sustainable approaches for agriculture, energy, infrastructure, transportation, and other sectors. Assessments that synthesize environmental knowledge are increasingly employed for policy analysis (Miller 2009). The Inter-
Centers bring unique capabilities and create unmatched opportunities for synthesis. Social scientists who have studied the work of the NCEAS attribute its remarkable success to intense face-to-face interactions (Hackett et al. 2008). Processes such as “peer review on the fly” combine skepticism, instant criticism, and response, leading to very rapid modification of initial ideas and to conceptual advances. Centers offer isolation from distractions; provide neutral ground, leading to more openness and encouraging a greater diversity of participation; create new networks, connections, and unexpected synergies; concentrate infrastructure, which not only facilitates logistics and computing but also allows an intense focus on the science; and promotes consistency of expectations—participants come to expect, and hence work toward, fast progress on exciting questions. No other mechanism for synthesis presents these advantages.

Proven mechanisms for synthesis—individual efforts, working groups, and research networks, for example—can be supported in many ways. The NSF funds a number of synthesis activities, including those associated with centers, the Long Term Ecological Research network, new emerging networks, individual synthesis efforts, and other programs. We anticipate that rapid progress in observing platforms and self-organized networks of ecologists and field sites (Peters 2008) will create even more new synthesis opportunities.

Ecologists and scientists in closely connected disciplines in the biological, computational, atmospheric, hydrological, geological, oceanic, and social sciences need a national program of synthesis that accelerates discovery and research in basic and applied environmental science through interdisciplinary analysis and synthesis activities. The United States lacks a program specifically focused on environmental science synthesis, where ecology and multiple disciplines intersect. The need to coordinate synthesis across diverse mechanisms and disciplines calls for a new umbrella structure, a national or international program for environmental synthesis. Such a program should coordinate the various activities funded for synthesis (individual efforts, collaborative grants, networks, and centers); the interactions of ecology with the computational sciences, engineering, geosciences, paleosciences, and social sciences; and the networking of emerging synthesis activities around the world.

Ecology, a hybrid science with expanding boundaries, strives to answer core questions of crucial importance to humanity’s future. Thus ecology has been a hotbed of scientific synthesis, and synthesis has been a driver of innovation. Now is the time to build on that foundation and further refine the best practices of synthesis within ecology. It is also time to spread the culture of synthesis more extensively to undergraduate and postgraduate education, across the basic and applied spectrum toward management and governance, and beyond disciplinary boundaries into sciences allied with ecology. We must continue and accelerate the trend to share data and credit for collaborative work, and to recognize individuals who make generous contributions to collaborative science. The whole academic community, from
individual research projects to hiring and promotion processes, must change to embrace synthetic perspectives. We need fewer incentives for narrow papers and projects, and more resources for working toward the horizon. Organizations that fund research are in the key position to foster this spread of the culture and practice of synthesis and to stimulate new synthesis, which will benefit science and society.

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