1 The SCOPE Ecosystem Functioning of Biodiversity Program

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1.1 BACKGROUND

As natural ecosystems are increasingly impacted by human activities, resulting in disruptions of system interactions and losses of populations, and even species, there has been increasing concern about how we are modifying the ecosystem processes that originate from and maintain these systems, and that benefit humankind. The Scientific Committee on Problems of the Environment (SCOPE) launched a program in 1991 to assess the state of our knowledge of the role of biodiversity, in all its dimensions, in ecosystem and landscape processes. This effort was part of the larger program, DIVERSITAS, which focuses on the science of biodiversity and was initially cosponsored by SCOPE, the International Union of Biological Sciences (IUBS) and UNESCO (United Nations environmental, Scientific, and Cultural Organization). The SCOPE program was guided by a Scientific Advisory Committee that included David Hawksworth, Brian Huntley, Pierre Lasserre, Brian Walker, Ernesto Medina, Harold Mooney, Valeri Neronov, Ernst-Detlef Schulze and Otto Solbrig.

The overarching questions that were agreed upon for this program were:

1. Does biodiversity "count" in system processes (e.g. nutrient retention, decomposition, production, etc.), including atmospheric feedbacks, over short- and long-term time spans, and in face of global change (climate change, land-use, invasions)?
2. How is system stability and resistance affected by species diversity, and how will global change affect these relationships?

The SCOPE program was designed not only to synthesize our knowledge for

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the functional role of biodiversity, but also to develop the basis for an experimental program for inclusion in the International Geosphere Biosphere Programme. As is discussed in Chapter 17 (Conclusions), the information base from which we build was not especially designed to answer the questions posed above. Until recently, and with exceptions in part due to stimulation from this program, there has been virtually no experimentation in this rather central area. One reason for this has been the past separation of the research areas of population ecology and ecosystem ecology, a separation which this program attempted to bridge.

In the following sections we outline the structure of the SCOPE program, followed by a description of an expansion of the program under the auspices of the Global Biodiversity Assessment conducted by the United Nations Environmental Programme.

1.2 THE SCOPE PROGRAM

The SCOPE program consisted of a series of activities between 1991 and 1994, culminating in an overall synthesis meeting at Asilomar, California, in 1994. The program was launched in October 1991 with a meeting on background issues held in Bayreuth, Germany. This meeting brought together ecologists and population biologists, both directed toward evaluating the consequences of human-driven disruption of natural systems. In particular, there was an examination of the degree of redundancy within systems, the ubiquity of keystone species, the tightness of species interactions (from mutualisms to food webs), the resilience of system to perturbations, and the interaction of landscape units. The few direct studies on species numbers and ecosystem function were evaluated. The interaction of policy and science in this area was also explored. The highlights of this meeting were described in Chapin *et al.* (1992) and the full results in Schulze and Mooney (1993).

The second phase of the program consisted of a series of meetings focusing on specific biotic regions of the world. These meetings took place during 1992–1993. The regions selected represent particularly critical areas in terms of threats to diversity losses, or are particularly sensitive to global change effects, or are especially amenable to experimentation. The same issues were discussed for each system, as noted below, in order to get uniform treatment of the nature of the diversity of that system, how that particular system is being modified, and the potentially differential structural/functional relationships among systems. However, the reality of the information available meant that not all issues were necessarily discussed, or if they were the discussion was not even across systems. It will be seen that, as always, the material available determines the structure and hence the diversity of ways of approaching the same theme.

Each regional symposium was designed to address the following issues:

1. Natural diversity of systems
   - Species
   - Populations
   - Functional groups
   - Systems
   - Landscapes
2. Impact of change on diversity
   - Climate and atmosphere
   - Land use
   - Invasions
3. Assessing diversity role on ecosystem function
   - Additions (invasion analog)
   - Subtractions (harvesting, disease, etc.)
   - Fragmentation
   - Disturbance
4. Reconstructing and maintaining diverse systems
5. Refining our knowledge through
   - Explicit experiments
   - Long-term observations

Thus, from the start, the focus on the program was on all elements of biodiversity, not just species, although species were, without question, the focus of the work since this is where the greatest information is available, and further, where the most concern has been voiced. Global change effects were addressed in their full context, i.e. land-use change, atmospheric change and invasions, rather than concentrating on a single driver, e.g. climate as is often the case.

Since little experimentation is available, as noted, surrogates were utilized for these in the syntheses. For example, biotic invasions can be considered a surrogate for experiments on the addition of biotic diversity to a system, just as selective harvesting in forestry or species-specific lethal diseases can be considered as experiments on biotic subtractions from ecosystems. However, in the case of surrogates there are usually no control measurements, nor are ecosystem functional responses necessarily measured. The main objective was to lay the groundwork for a better database for the future based on experimentation.

The greatest challenge facing the science and practice of ecology today is developing the tools to reconstruct, or repair, ecosystems that have been degraded through human activities. This research area is still poorly developed and needs considerable attention. The basis for this science lies in the kind of material discussed in this book – what species and in what combinations provide the greatest ecosystem services? What sort of species

representation is needed to ensure stability in face of fluctuating climates?

The biotic regions that were selected, on the basis of the criteria noted above, were:

- Estuaries, lagoons and mangroves
- Mediterranean systems
- Islands
- Boreal forest
- Tundra
- Coral reefs
- Savanna
- Coastal systems
- Tropical forest
- Lakes and rivers
- Temperate forest
- Arid zones

Note that although most of the above can be considered a biome type, islands of course are representative of most of the biomes. However, they are special in view of their generally relative simplicity and because of the disproportionately high human impacts they have received.

To produce some of these assessments full-scale symposia were held that included a large number of experts. In these cases a system-specific book was produced on these systems, as happened with islands, Mediterranean systems, arctic and alpine areas, savannas and tropical forests, as noted below. The chapters in this volume represent condensations of the fuller treatment contained in these books. The other systems were assessed by small groups of experts, as indicated in the authorships of these chapters. Representatives of all these systems met in Asilomar, California, in 1994 for a final discussion of the material and for cross-system comparisons (Baskin, 1994).

1.3 THE GLOBAL BIODIVERSITY ASSESSMENT

The SCOPE program was expanded somewhat following initiation by the United Nations Environmental Programme (UNEP) of a Global Biodiversity Assessment (GBA). In mid-1993, a group met in Trondheim, Norway, to prepare an outline of such an assessment. It was decided that the SCOPE effort (as well as other DIVERSITAS components) would be incorporated into the GBA, as noted in the publications below. The GBA is intended to provide the scientific underpinnings for the Biodiversity Convention.

The constraints on space for the Global Biodiversity Assessment meant that each system could only receive a few pages of text. Thus the material

had to be greatly condensed and tightly structured. For each system a number of ecosystem processes or properties were considered, and the human impacts on them were described, and the ecosystem consequences of these impacts were assessed. There were then comparisons across systems for commonalities in responses. These assessments were reviewed by a large international peer group and their comments incorporated. Since the initial and amended program all represent a single effort to understand the consequences of a change in diversity on ecosystem services, we take our concluding chapter from all of them. Thus the information gathered for this SCOPE program is held at several levels of detail. First the system-specific volumes noted above, this volume, which has lengthy considerations of a larger set of biomes, and then the GBA which has highly condensed considerations of an even larger set of biomes.

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1.4 PROGRAM PUBLICATIONS

Published

Baskin, Y. (1994) Ecologists dare ask: How much does diversity matter? *Science* **264**: 202–203.

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Hobbs, R.J. (1992) *Biodiversity in Mediterranean Ecosystems of Australia*. Surrey Beatty, Chipping Norton, Australia, 246 pp.

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In Press

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