

Preface



Antecedents

This book is the first in a series that recommends standardized methods for measuring biological diversity. Three conditions led to its production. For some time, Mercedes Foster recognized the need for such books and was willing to invest the time needed to bring them to fruition. About the same time, the Biological Diversity in Latin America (BIOLAT) program in the National Museum of Natural History, Smithsonian Institution, was seeking new areas for program development. Foster presented her ideas to the BIOLAT steering committee (chaired by Ronald Heyer and consisting of Jonathan Coddington, Kristian Fauchald, Mercedes Foster, Vicki Funk, and

Richard Vari), which enthusiastically provided the resources to initiate the series. At the same time, the scientific community was learning of an ostensible worldwide decline in some conspicuous amphibian populations in relatively undisturbed habitats. Scientists who study amphibian populations recognized the potentially critical nature of the situation, and, under the guidance of David B. Wake, some among them mobilized to address the issue.

Two disturbing problems were immediately encountered. First, much of the information on amphibian declines was anecdotal. Second, standardized methods critical for documenting population changes either did not exist or were not generally known. Because of the perceived need for and interest in standardized sampling meth-

ods for amphibians, this group was selected as the subject of the first book in the series.

Foster set up a core committee to plan the book and oversee the production of a manuscript on amphibians. The committee included Maureen A. Donnelly, W. Ronald Heyer, Robert F. Inger, and Roy W. McDiarmid. The committee and Foster met in April 1990 and decided to contact individuals with experience with the inventory and monitoring of amphibians, in order to request their input about the value of the proposed book and about the techniques and issues that should be covered. Overall the response from the 35 individuals throughout the world who were contacted was positive and enthusiastic. In December 1990 the core committee asked the respondents to form working groups and to draft manuscripts to be included. Copies of the draft manuscripts were circulated prior to a workshop that was held 29–31 March 1991 in Arlington, Virginia. The participants at the workshop were Stephen Corn, Martha Crump, Maureen Donnelly, Lee-Ann Hayek, Ronald Heyer, Robert Jaeger, Roy McDiarmid (Workshop Chair), Norman Scott, Jr., Bradley Shaffer, Bruce Woodward, and Barbara Zimmerman. Robert Inger was unable to attend. Crump, Donnelly, Hayek, Heyer, Jaeger, and McDiarmid continued working on 1 and 2 April 1991 to complete tasks identified during the workshop.

Just before the workshop, David Wake asked the group developing the book to serve as the Working Group on Protocols for the Declining Amphibian Populations Task Force (DAPTF) of the International Union for the Conservation of Nature and Natural Resources (IUCN) Species Survival Commission (SSC). The group agreed.

The workshop participants completed three large tasks in a brief time: (1) They identified and recommended a set of standard procedures for measuring amphibian biological diversity by monitoring populations and inventorying species. Partly as a result of that process, they also developed the essentials of the final outline of

the book. (2) They wrote all or substantial parts of three chapters. (3) They outlined and assumed responsibility for the tasks needed to complete the book.

Maureen Donnelly, Lee-Ann Hayek, Ronald Heyer, and Roy McDiarmid took on the responsibilities of compiling and editing the publication. Contributions of a few additional experts were sought for the final manuscript. For publication purposes, the order of the editors was determined randomly. Mercedes Foster's editorial contribution to the book so exceeded that of a traditional series editor that the first four editors added her as a fifth editor to the volume.

A draft of the manuscript was completed in early December 1991. It was reviewed, revised, and sent for outside review in May 1992. The final draft was sent to press in September 1992.

Authorship

The text of this book was developed by many individuals. The editors asked the chairs of the working groups to identify as *authors* those who participated significantly in the writing of the manuscript and to identify as *contributors* those who provided information. All sections for which authorship is not assigned were written either by the core committee, the editors, or the workshop participants as a group.

Acknowledgments

During the preparation of this book the authors and editors were aided by many people. The editors especially want to thank Sarah Klontz, who provided assistance with the initial manuscript and integrated the chapter bibliographies into a single document, and Robert B. Hole, Jr., who tirelessly attended to hundreds of details for

the editors, including verification of all bibliographic citations. Carolyn S. Hahn provided expert assistance in locating library reference materials. Cassandra Phillips, Linda Wolfe, and Fiona Wilkinson incorporated numerous manuscript corrections into computer files and provided other assistance. Rosemary Sheffield provided expert advice on editorial matters.

In addition Paul Ustach used his considerable talent to illustrate the amphibian life cycle in Figure 1; Jennifer Shoemaker and Dale Crawford prepared standardized versions of most of the figures; and Dale Crawford and Frances Irish provided artwork to enliven the text. Victor Krantz took the photograph for Figure 32. Charles R. Mann prepared the novel random numbers table.

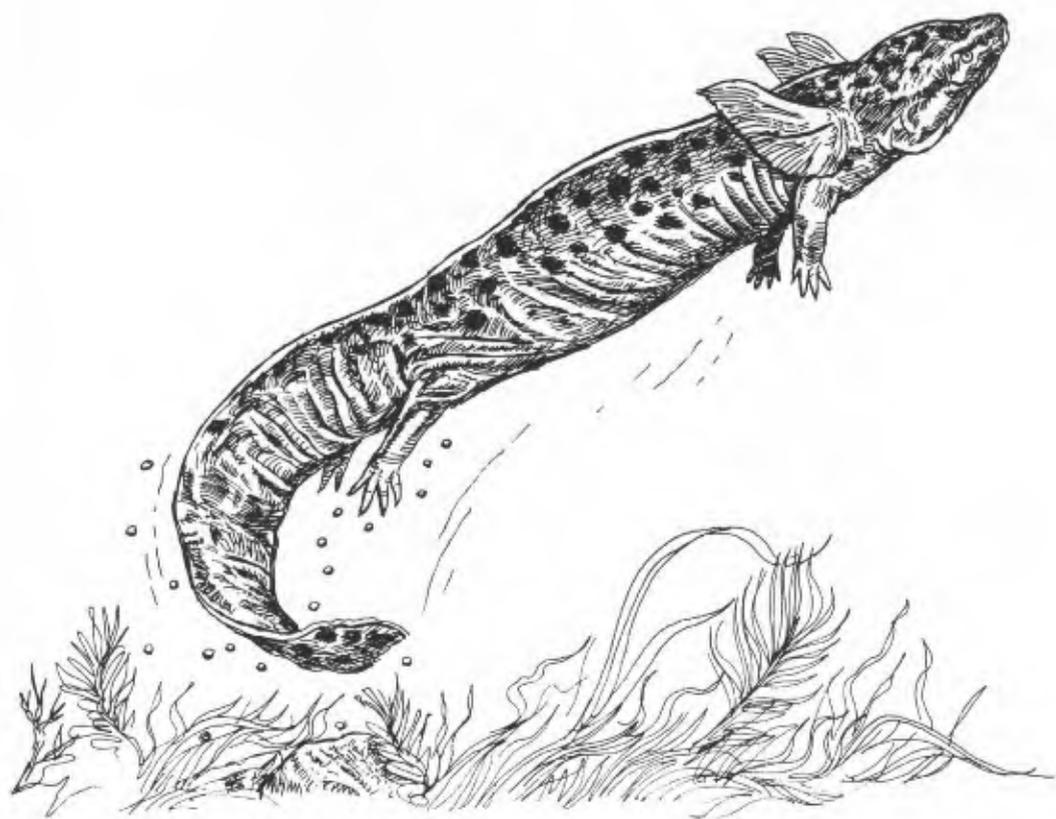
Robert Inger critically read the entire manuscript in its penultimate version, and several anonymous reviewers commented on specific sections. Their comments helped us immeasurably in improving the final draft of the book.

John Carr (Conservation International), Peter Cannell (Smithsonian Institution Press), Robert Unash (The Nature Conservancy), Adele Conover (*Smithsonian* magazine), and Don Wilson (Biodiversity Programs, National Museum of Natural History) attended the workshop as observers and provided useful input.

Finally, the editors want to acknowledge the authors, contributors, and workshop participants for their substantial efforts. Without their cooperation and advice, this volume would not have been possible. To all of these persons, we express our sincerest thanks.

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The Volume Editors



Introduction



Biological diversity is the term used to describe the variety of all living organisms on earth. It encompasses at least three levels of biological organization: genetic (individual), species, and ecosystem. This book focuses on biological diversity at the species level, which is basic to the study of organisms. Studies of the abundance and distribution of species have provided a wealth of basic knowledge, led to the development of a large body of ecological and evolutionary theory, and formed the underpinning of a considerable body of research in the areas of ecology, systematics, biogeography, and conservation biology.

The continuing loss of biological diversity through human activities will have a major impact on our ability to pursue science and to un-

derstand the scientific complexity of our surroundings; it also will affect the ways in which ecosystems continue to function. This impact increases the urgency for scientists to comprehend exactly what is being lost and to communicate their perspective on the consequences of that loss to society, before the general quality of life on this planet suffers irreversible deterioration.

Knowledge of which species occur in which areas is fundamental to an understanding of the intricacies of biological diversity. Species lists of some conspicuous organisms (e.g., butterflies, monkeys, birds, and trees) are available for many sites in the more developed countries and for a few sites in less developed regions, but comparable data for most of the world's biota are lacking. Even when specific data on the rich-

ness and relative abundances of species at a site are available, they often vary greatly in type and have been collected using a variety of procedures, hindering their comparability.

Because amphibians are abundant and functionally important in most freshwater and terrestrial habitats in tropical, subtropical, and temperate regions, they are significant components of the earth's biota. For example, species of North American woodland salamanders of the genus *Plethodon* may occur in densities of several thousand per hectare (Merchant 1972). Their total biomass in some areas equals that of all the resident species of small mammals combined and is more than twice that of all species of birds during the peak of avian breeding activity (Burton and Likens 1975). Many species of amphibians are wide ranging and potentially could serve as key species against which to evaluate broad geographic or global changes in the environment. Other species are habitat specialists or have restricted distributions and could signal local perturbation. Certain physiological traits (e.g., permeable skin) and ecological traits (e.g., complex, biphasic life cycle) make amphibians potentially excellent indicators of environmental health.

Because amphibian populations in certain areas are declining sharply (Barinaga 1990; Blaustein and Wake 1990; Borchelt 1990; Phillips 1990) or are exhibiting significant local fluctuations (Pechmann et al. 1991), we suggest that arbitrary use of procedures to assess the status of amphibian populations is a luxury with which we should dispense. Probable species declines provide an impetus for monitoring the status of amphibian populations in a variety of biomes in many parts of the world. In this book we provide recommendations and guidelines for the inventory and monitoring of amphibians. We present a set of standardized methods whose use will ensure comparability between sites, at least within biomes, and lead toward greater understanding of amphibian species diversity in particular and biological diversity in general.

We have assumed (1) that quantitative data about an assemblage of organisms are more useful than qualitative information, and (2) that qualitative information, such as a list of species, may be derived from quantitative data, but not the reverse. Although long-term population monitoring would often be desirable, we recognize that in many cases only single inventories will be possible. Even in those cases, sampling procedures should be quantitative, so that an initial inventory can be extended into a monitoring program should the need and opportunity arise. An inventory protocol with quantitative characteristics can also facilitate comparisons with initial stages of monitoring programs and inventories elsewhere.

Previous Work

Much of the scientific community has recognized that use of standardized methods is critical to comparisons of data gathered by different workers at different times and places (e.g., Davis 1982; Fellers et al. 1988; Corn and Bury 1990). Yet the technique-related sections of publications promoting this view are either brief or specific to species or habitats. For example, the *CRC Handbook of Census Methods for Terrestrial Vertebrates* (Davis 1982) devotes only six pages to methods for censusing amphibians. The absence of standard techniques is reflected in the work of many conservation, government, and scientific groups that are beginning to assess the status and health of amphibian populations. For example, we are aware of ongoing amphibian monitoring programs in Great Britain; the province of Ontario, Canada; and Illinois, Kansas, and Wisconsin in the United States. Unfortunately, the methodologies used in these monitoring studies differ. At present, no single reference describes techniques for the inventory or monitoring of amphibians and the circumstances in which each is appropriate. Our intent is to fill this void.

Intended Audience

We have designed this book to meet the needs of conservation organizations, environmental consultants, government agencies, wildlife managers, and scientists. We also believe that it will serve as a teaching and research aid in colleges and universities at both the undergraduate and the graduate levels. We have tried to make the book comprehensive so that individuals with an undergraduate degree in science, or equivalent training, can measure the biological diversity of amphibians using only this volume. We also provide references to pertinent literature to expedite data analyses and facilitate comparisons with

information gathered in other studies. Many of the techniques require or recommend processing or marking live amphibians and preparing various types of vouchers. We have included instructions for these procedures as a series of appendices.

We have attempted to involve experts from throughout the world in the preparation of this book and to include examples from all geographic areas. Nevertheless, the volume retains a New World bias because most of the contributors work in that area. We are confident that this bias will not influence the general applicability of the methods discussed, which should be appropriate for amphibians in all parts of the world.

