

Preface

During the last four decades an increasing interest for ecosystem theory has emerged as a consequence of our increasing concern for the environment. The ecological and environmental literature from the last four decades contain many papers which focus on systems ecology, i.e., the system properties of ecosystems, and the question, how an ecosystem functions as a system. As a consequence of these trends in system ecology and ecosystem theory, Otto Fränze, Winfried Schröder and Felix Müller decided to publish a German handbook in ecosystem analysis and its application in environmental science and management. It was published in 1997 under the title 'Handbuch der Umweltwissenschaften'. A number of German speaking authors covered various themes not only about systems ecology, but also about environmental science and management, mainly from a holistic view point. The volume was published as a folder which will be supplied with new chapters every 6 months to cover an increasing spectrum of themes. As English is the dominant language in science, it was, therefore, not difficult for us, the editors of this volume, to decide in 1996 that a publication of an English edition with a much wider selection of authors from all over the world would be a natural step to take. It was, however, decided to limit the focus only to ecosystem theory and its immediate application in management.

The ecological literature from the last two decades presents many different ecological theories. It is our ambition to present all or at least most of these theories in this volume to allow the readers a comparison of the different viewpoints. We attempt to illustrate that these theories, to a certain extent, are consistent and form a pattern (see Chapter II.10) which is an excellent basis for a more profound understanding of ecosystems. Ecosystems are incredibly complex, and it is therefore not surprising, that many different viewpoints are needed to obtain a more complete image of an ecosystem. A pluralistic approach is a 'must' if we want to cover most of the different aspects of ecosystem characteristics.

The volume encompasses three Sections including an introduction, a presentation of the different theories and general outlines for the immediate application of ecosystem theory in environmental management.

Section I, ECOLOGICAL AND EMPIRICAL FOUNDATIONS, deals with the following questions: What are ecosystems? Which tools can we use to study them and to uncover their characteristic properties? It consists of chapters with the following topics: Ecosystems as Complex Systems, Ecosystems as Structural Entities, Ecosystems as Functional Entities, Uncertainty in Ecology and Ecological Modelling, Fundamentals of Ecosystem Theory from General Systems Analysis, Methods of Ecosystem Theory, stemming from Ecosystem Research, Ecological Statistics and Ecological Modelling. As seen, these first chapters deal with an introduction of typical ecosystem properties, while the last chapters cover the tools applicable to ecosystem research, namely system analysis, ecological research, statistics and modelling.

Section II is entitled DIFFERENT APPROACHES IN RECENT ECOSYSTEM THEORY. It covers a wide spectrum of different theoretical approaches in system ecology, presented by authors who have published relevant topics in scientific papers. The first chapter in this Section focuses on the use of thermodynamics in ecosystem theory. It consists of three subchapters that cover the application of the three basic thermodynamic laws in ecosystem theory, a recent theory based on an extended version of the second law of thermodynamics and on a new tentative fourth law of thermodynamics. The second chapter in Section II deals with the self-organisation of ecosystems, while the third chapter looks into the application of information theories in order to obtain a better understanding of ecosystems.

The fourth chapter describes cybernetics and the fifth chapter applies hierarchical theory in our effort to develop ecosystem theory. The sixth chapter is a presentation of the concept emergy, used to facilitate a better understanding of ecosystem behaviour. The

seventh chapter covers several facets considering ecosystems as networks where various components are dependent on each other through the particular webs of the considered elements. The chapter presents the ascendancy as a central concept in quantification of the network, the indirect effects which can be shown to exceed the direct effects in many cases and utility theory which looks into the cycling of matter and energy for instance by expressing how many times we are using the same energy and matter.

Chapter eight analyses ecosystem dynamics. Are ecosystems stable in mathematical terms? Are ecosystems resilient systems? Is catastrophe theory applicable to describe ecosystem behaviour under certain circumstances? Do ecosystems show chaotic behaviour? Are they operating on the edge of the chaos as self-organised critical systems? How do the dynamics of ecosystems operate in space and time?

The ninth chapter combines ecosystem theory and landscape ecology. This is followed by the formation of a pattern up to that point described from different approaches.

Section III: APPLICATIONS OF ECOSYSTEM THEORETICAL ASPECTS overviews the direct application of ecosystem theories and their potential contributions to environmental practice. In addition, there are several indirect applications. For instance, ecosystem theory is applied in ecological modelling. We can most probably develop better models by using our knowledge about ecosystems to improve the models and have them become better tools in environmental management. A better knowledge about ecosystem reactions has also a general indirect application in corners of environmental management. Section III is however entirely devoted to the direct applications of ecosystem theory in conservation biology, in assessment of ecosystem health, integrity and sustainability and in the two recently developed ecological disciplines ecological engineering and ecological economics. The direct applications use various theoretically based orientors to a high extent. Section III is therefore terminated by a chapter that serves as an overview of the applicable orientor approach, entitled as 'Ecological Orientors - A Path to Environmental Applications of Ecosystem Theories'.

It has been our ambition to collect different contributions about ecosystem theories in a useful book. We do, therefore, hope that it has been possible to produce a handbook which may be of general applicability for environmental managers and systems ecologists who want to have a quick access to more knowledge about ecosystems. As it can be seen from the list of authors and the titles of the chapters, this book covers a very wide range of differing viewpoints and concepts in ecosystem theory which has made it difficult to avoid a certain overlap. We acknowledge this as a weak point of the present handbook, but we have deliberately made this choice rather than omit a facet of the ecosystem theoretical complex.

We would like to express our sincere gratitude to Otto Fränze and Søren Nors Nielsen who gave us good advice during the development of this book project and supported us in our effort to find the most appropriate content for a handbook of ecosystem theory. We also owe the many excellent authors a special debt of gratitude for their excellent contributions without which the book never would have been realised. The expert assistance of Gerti Rosenfeld and Paulette Clowes in converting the manuscripts to the present book form is also gratefully acknowledged.