Brown, J; Miller, PC; Tieszen, LL; Bunnell, FL (eds.). 1980. An Arctic Ecosystem: the Coastal Tundra at Barrow, Alaska. Dowden, Hutchinson & Ross, Inc. (Stroudsburg, PA). 571 pp. ISBN: 0-87933-370-7 (US/IBP synthesis series: 12).

PREFACE

Tundra covers about 5.5% of the land surface of the earth (Rodin et al. 1975), but justification for studying it goes far beyond its areal extent. Of the world's major ecosystems, tundra has the lowest temperatures and the shortest growing seasons. Thus we may expect to find there the limits of biological accommodation and adaptation to low temperature. Largely because of the climate, which is so inhospitable for humans and so unsuitable for traditional forms of agriculture, tundra areas have never really been developed. However, increasing demands have been placed upon tundra to provide energy, minerals, food, and recreation. Often, alternative uses of tundra resources are not compatible. There are conflicting demands for wilderness, recreation areas, development of natural resources, and retention of the traditional life-styles of the indigenous people.

The research within the U.S. Tundra Biome was developed as part of both the U.S. IBP Analysis of Ecosystems program (National Academy of Sciences 1974, Blair 1977), consisting of five Biomes (Grassland, Desert, Tundra, Western Coniferous Forest and Eastern Deciduous Forest), and the International Tundra Biome program, comprising some 14 other national study sites (Rosswall and Heal 1975, Wielgolaski 1975a, b, Bliss 1977, Heal and Perkins 1978, Sonesson 1980, Bliss et al. 1981).

It had become apparent by early 1970 that a field program centered on the coastal tundra at Barrow, Alaska, would be required to develop fully the U.S. IBP ecosystem approach. The area around Barrow had a long heritage of ecological research (Reed and Ronhovde 1971, Britton 1973, Gunn 1973), and this research contributed significantly to the planning and initiation of the U.S. Tundra Biome program (Brown et al. 1970). Because of a combination of circumstances relating to the rapidly expanding oil developments in arctic Alaska and the new wave of environmental consciousness, a modest program of basic and applied research in tundra was initiated in 1970 (Brown 1970). The following year, a full-fledged Biome program was officially recognized, with Barrow chosen for intensive ecosystem research. Prudhoe Bay, the site of major arctic oil development, became an area for comparative coastal tundra research (Brown 1975). Two alpine sites, Eagle Summit in central Alaska and Niwot Ridge in the Colorado Front Range, provided comparative data from high- and mid-latitude alpine tundras (see map inside front cover).

The 1970 field program concentrated on initiating the field design and establishing a series of field experiments and control plots. During the summers of 1971, 1972 and 1973 a vast array of field data were gathered from the Biome research area at Barrow. Summer 1974 was devoted to initial synthesis in a summer-long workshop that formed the basis of this volume, a companion aquatic volume (Hobbie 1980), and a volume on primary producers (Tieszen 1978a).

Several broad objectives guided the research design of the U.S. Tundra Biome program from its inception: 1) to develop a predictive understanding of how the tundra system operates, particularly as exemplified by the wet coastal tundra of northern Alaska; 2) to obtain the necessary data base from a variety of cold-dominated ecosystems represented in the United States so that their behavior could be modeled and simulated and the results compared with similar studies underway in other circumpolar countries; and 3) to bring basic environmental knowledge to bear on problems of degradation, maintenance, and restoration of the temperature-sensitive and cold-dominated tundra and taiga ecosystems.

The ecosystem approach and the use of ecological models were integrating and research tools of the U.S. IBP Biome studies. Miller et al. (1975) summarized the development of "box and arrow" representations of the tundra ecosystem. Modeling in the U.S. Tundra Biome program emphasized processes rather than the total ecosystem. This was done to maximize the interactions among field observation, hypothesis formulation, experimentation, and incorporation of results into working models. Such models are regarded as necessary steps leading to the eventual development of meaningful whole-ecosystem simulations.

The ecological model is a research tool, not an objective. Because of this, modeling cannot be separated from field experiments, and discussions of the two are intertwined throughout much of the volume. Bunnell (1973) emphasized the heuristic value of models that fail to predict accurately or to mimic adequately the behavior of the real world. Such failure indicates that either the model structure, certain parameter values, or the basic hypotheses are incorrect, and thus contributes directly to our understanding. Many hypotheses and model structures have been tried and modified or replaced as our understanding has developed. In this book the models that incorporate our understanding as of the mid-1970's are discussed and used to explore the behavior of organisms and processes under a variety of conditions. In some cases, the predictions of models have been subjected to testing, and results are presented. In other cases, the evaluation of model behavior remains a topic for future research.

Our intent has been to produce an integrated discussion of a tundra ecosystem rather than a collection of independent papers on its component parts. We hope that the reader will be motivated to read the book as such. Books suffer from the constraint that they are necessarily unidi-

mensional. Although the reader may begin and end at any point, he must proceed linearly between those points. We view ecosystems as multidimensional, with complex lines of interaction and influence running throughout. In resolving this complexity into the linear structure of this volume, we have fallen back on the relatively familiar divisions of abiotic setting, primary production processes, soil and decomposition processes, and herbivory. Within each of these subdivisions, the reader will find the common theme of the limitation of rates of biological processes by low temperature and related conditions of short growing season and the presence of permafrost.

The Editors