## 6.0 Introduction

### *6.0.1 Background*

In this section, the general principles outlined in Section 5 are used to assess our current knowledge of the ecosystem-level consequences of human-induced changes in biodiversity. We provide separate assessments for a selection of the major biomes of the world because the human impacts on biodiversity and the associated ecosystem consequences differ among biomes and because decision-makers will require different information for each. Our sample includes freshwater, marine and terrestrial systems that represent a significant portion of the ecosystems on Earth.

### *6.0.2 Biome essays and ecosystem processes*

For each of the 15 biomes surveyed, the authors provide information on the consequences of human-induced changes in biodiversity for seven ecosystem processes and/or properties:

- Productive capacity and biomass
- Soil structure, nutrients and decomposition
- Water distribution, balance and quality
- Atmospheric properties and feedbacks
- Landscape and waterscape structure
- Biotic linkages/species interactions
- Microbial activity

These topics involve key ecosystem processes, such as carbon, water and nutrient cycling. They also recognize the importance of higher levels of integration in ecological systems; interactions between the Earth's surface and atmospheric properties; biotic linkages, because they result in the provision of many essential ecosystem services; and microbial activity, which fuels many ecosystem-level processes. More extensive discussions of these points with respect to each ecosystem can be found in the forthcoming SCOPE volume (Mooney *et al.* 1996).

The biome essays provide biome-specific information on (a) the drivers of change in biodiversity, (b) the impact of these drivers on biodiversity at multiple levels, and (c) the ecosystem consequences of these changes in biodiversity. For example, as outlined in the coral reef essay (6.1.10), a major driver of change in these systems is overfishing by the growing human populations that inhabit the adjacent coastlines. The impact of this driver on biodiversity is to reduce greatly the abundance and diversity of algae-grazing fishes. A significant ecosystem consequence of this change is the transformation of reefs from coral-dominated to algae-dominated systems. These changes have direct and immediate feedbacks to people who depend on coral reefs: in addition to buffering coastal environments from storms, coral reefs provide an array of highly specific taxa that are important in commercial and subsistence harvesting.

### *6.0.3 Cross-biome comparisons and syntheses*

After considering each of the 15 biomes in our sample, the authors generate cross-biome comparisons of the ecosystem consequences of human-induced impacts on biodiversity. These seven essays provide comparative analyses of the functional consequences of an increasingly modified world. We then synthesize the findings of the individual biome essays and the cross-biome comparisons to derive our final conclusions.

We have attempted throughout to provide a synthesis of our conclusions that is in a form accessible to both policy-making and scientific communities. Inevitably, our current ability to address all the questions for which one would like answers is limited in some cases. However, the hope is that future efforts will benefit from an articulation of these questions and from knowing where the gaps in scientific knowledge exist.

## Reference

Mooney, H.A., Cushman, J.H., Medina, E., Sala, O.E. and Schulze, E-D. 1996. *Functional Roles of Biodiversity: A global perspective*. John Wiley, Chichester (in press).

## 6.1 Biome essays

### *6.1.1 Arctic and alpine systems*

#### *6.1.1.1 Introduction*

Arctic and alpine ecosystems are cold-dominated ecosystems lacking trees. These ecosystems occupy about 8% of the terrestrial surface of the globe (5% Arctic, 3% alpine) but support only about 4% of the global flora (1500 Arctic species, 10 000 alpine species) and fauna. Species diversity of plants and animals in Arctic and alpine regions declines with increasing latitude and altitude, but genetic diversity within species appears unrelated to climatic severity. Within both regions species diversity of plants and animals is concentrated in areas of high vertical relief, lacking a well-developed organic mat. The vast expanses of peat-covered landscape in the Arctic and in level terrain in alpine regions have very few species (generally <10 vascular plant species per $m^2$), and these species have a widespread geographic distribution. Landscape diversity strongly influences terrestrial–aquatic exchanges, particularly in permafrost-dominated Arctic terrain, where water and nutrients flow laterally among ecosystems (Kling 1995).

#### *6.1.1.2 Productive capacity, biomass, decomposition and nutrient cycling*

*Human impacts on biodiversity.* Other than the direct impacts of land use, the most profound human impacts result from activities outside Arctic and alpine ecosystems, such as $CO_2$-induced climatic change, which may increase