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Geodiversity underpins biodiversity – examples from Australia

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Current approaches and outcomes in environmental baseline studies and management are focused on ecosystems, biodiversity, rare and endangered species, other biological aspects of the environment, hydrology and water chemistry as it relates to human health and ecosystem functioning, and cultural aspects, Indigenous and archaeological aspects. While geology is implied in the 'ecosystem approach' to protected area management, and addressed in some studies as a component of a framework for description of landscape and habitats and for hydrogeology, geodiversity (as distinct from 'geology') generally is missing in such environmental baseline and management studies. This presentation focuses on geodiversity and how it underpins biodiversity and is an important part of environmental and ecosystem management.

Geodiversity is the natural variety of geological, geomorphological, geochemical, pedological, hydrological features of a given area, from the purely static features at one extreme (*i.e.*, shorelines, sandy spits, or river canyons, amongst many others), to geological/geomorphologic features with their formative processes at the other (*e.g.*, active parabolic dunes forming under a given wind regime). We apply the term 'geodiversity', which etymologically means "the diversity of geological features", only to region-specific or site-specific geological features. *Biodiversity* is the natural diversity of biota expressed in the variety and richness of taxa and assemblages, and in the variety of phenotypic responses to the environment. For a given large-scale area with its regional species pool (gamma diversity of Whittaker), and leaving aside the effects of climate, biodiversity reflects variation in landforms, aspect, lithology, geochemistry, soils, depth to water, water-logging, hydrochemistry, amongst other abiotic features - that is, the diversity of Earth features in a region from the large scale to the small scale. For instance, weathering of a mosaic of mineralogically and texturally different rocks results in a plethora of geochemical and textural variations in Earth surface materials, each potentially with different hydrological properties, and hence variation in habitats. In combination with hydrology and hydrochemistry (themselves both expressions of geodiversity of the Earth) these products of rock weathering become major determinants of the characteristics of habitats. As such, geodiversity results in habitat diversity. A step further, this can be expressed as 'geodiversity underpins biodiversity' – and, drawing species from the regional species pool, at the alpha diversity level, a rich geodiversity results in a rich biodiversity in terms of species richness, assemblages, and phenotypic responses.

Case studies from various locations in Australia illustrate these principles, and are selected to show the variety of geological, geochemical, pedogenic, and hydrologic/hydrochemical controls on habitat development and the resulting response in biota. The case studies are drawn from a dissected sandstone plateau, *viz.*, the Blue Mountains of New South Wales, coastal mangrove habitats of Darwin in Northern Australia, arid zone rocky terrains of the Dampier Archipelago of Western Australia, a Quaternary dune terrain of diverse landforms and substrata of the Swan Coastal Plain in south-western Australia, a modern barrier dune and associated estuary, *viz.*, the Leschenault Peninsula and Leschenault Inlet estuary of south-western Australia. The link that geodiversity underpins biodiversity has clear

implications for management and conservation - we stress that robust management of ecosystems and environments ultimately must address conservation and management of geology and geodiversity.