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Rocky outcrops: A hard road in the conservation of critical habitats

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ABSTRACT

Rocky outcrops are geological features that encompass a wide variety of physical environments, including escarpments, overhangs, cliffs, tors, boulder-heaps and insular domes (inselbergs). They support high levels of species diversity and endemism, and provide stable micro-climates for thousands of years. They provide critical breeding sites for many top order mammalian and avian predators; nesting sites for colonial species such as seabirds, bats and swifts and ecological refuges for ancient lineages. Rock overhangs and caves also provide important insights into our ecological past where they contain the remains of extinct species. Because rocky environments are generally less fertile, steep-sided and less accessible than the surrounding landscape, they are typically less prone to human disturbances. Nonetheless, many rocky outcrops, particularly in commodity production landscapes, face a variety of threats including soil compaction and erosion caused by livestock; nutrient enrichment and weed invasion; introduced predators; and physical damage caused by recreational and quarrying activities. Even rocky outcrops in seemingly pristine environments may be affected by altered fire regimes, air pollution (including acid rain) and potentially climate change. In agricultural landscapes, various approaches have been taken to conserve rocky outcrops, including land acquisition for conservation, fencing from livestock and private land conservation agreements with landholders. In more intact landscapes, targeted actions to conserve rock-dwelling fauna include limiting human access to critical breeding sites, baiting to reduce pressure from introduced predators, restoring rock microhabitat and translocation of endangered species. Future management actions will need to involve better inventory of the biophysical attributes and fine-scale mapping to improve the awareness of these small natural features.

1. Introduction

Rocky outcrops are examples of small natural features (SNF) — features which have an ecological role extending beyond their area, much like keystone species but at an ecosystem scale (Hunter, 2017–in this issue). Being hard and inorganic, they provide long-lasting landscape features that provide stable micro-climates and ecological refuges for thousands of years (Couper and Hoskin, 2008), in contrast to many other SNFs. Nonetheless, they share many conservation challenges and solutions with other SNFs (see Hunter et al., 2017–in this issue).

Rocky outcrops are defined as geological features that protrude above the surface of the surrounding land. They are found on all continents, in most climate zones and vegetation types, and form when softer parts of the landscape erode over millions of years leaving behind a hard core of parent rock (Twidale, 2012). Over long periods, wind, water and sunlight interact to produce outcrops with distinctive shapes and unique features (Fig. 1). For example, outcrops of granite, which is one of the most common rock types in the world, are often dome-shaped and have distinctive flared slopes (Withers, 2000; Migon, 2006). Large dome-shaped rocky outcrops are often termed inselbergs due to their 'island-like' appearance of protruding from relatively flat landscapes (Twidale, 2012). Inselbergs vary in size and shape, and specific names are given to particular landforms depending on morphology. In Africa, granite outcrops are called kopjes (Trager and Mistry, 2003) and in Brazil, they are called serras, serrotes and chapadas depending on their size (Mares, 1997). Glacial islands of rock called 'nunataks' are another example of rocky outcrops which protrude above the surrounding landscape, and in these cases, isolated rocky mountain peaks protrude above glacial ice fields. Rocky outcrops also form in many other different rock types and include landscape features such as sandstone escarpments, limestone cliffs and karsts, basalt columns and gneissic tors (Larson et al., 2005; Twidale and Romani, 2005). Prominent aspects of most rocky outcrops are that they are

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Fig. 1. Examples of different rocky outcrops (clockwise from top left): granite boulders, south-eastern Australia (photo: D. Michael); small sandstone isolate in agricultural landscape in eastern Australia (photo: D. Michael); sandstone slabs, Arnhem Land, northern Australia (photo: J. Fitzsimons); low rocky range, Little Sandy Desert, Western Australia (Photo: J. Fitzsimons); seacliffs at Cliffs of Moher, Ireland (photo: J. Fitzsimons); mountain cliffs, Isle of Skye, Scotland (photo: J. Fitzsimons); sandstone escarpment, Kakadu National Park, Australia (photo: J. Fitzsimons); gnamma (rock hole) in granite, south-eastern Australia (photo: D. Michael).

often steep, spatially isolated and in many cases represent relatively undisturbed natural habitats.

2. The ecological, cultural and economic values of rocky outcrops

Rocky outcrops provide habitat for a broad range of endemic, and often specialized, flora and fauna (Porembski and Barthlott, 2000). Across multiple spatial scales, rocky outcrops influence vegetation patterns, either directly, because they constitute a particular type of environment, or due to their influence on microclimatic conditions and/or drainage (Carlucci et al., 2015). In arid environments, they provide moist conditions that allow for the development of mesic-adapted plants, and conversely, in tropical climates, protruding outcrops provide conditions that support xeric-adapted plant species (Porembski, 2007). Shallow soils and variable environmental conditions are characteristic of rocky outcrops and have led to the convergent development of specific plant traits that enable species to survive under extreme environments (Porembski, 2011; Poot et al., 2012). One group of highly specialized species is the desiccation-tolerant vascular plants (Porembski, 2011). These plants are often referred to as resurrection plants due to their ability to lose virtually all of their free internal water without dying, and then rehydrating rapidly following rain (Bartels and Hussain, 2011). The position of rocky outcrops in the landscape can influence the formation of other small natural features; springsoaks (Calhoun et al., 2017–in this issue) and springs in more arid environments (Davis et al., 2017–in this issue).