



An assessment of coastal land cover and off-road vehicle tracks adjacent to Ningaloo Marine Park, north-western Australia



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ABSTRACT

This paper examines environmental characteristics of a remote coastline adjacent to an extensive fringing coral reef in a World Heritage Area impacted by tourism and extensive use of off-road vehicles. Hyperspectral remote sensing imagery combined with field validation were used to map and characterise the 300-km coast including shore type, land cover and vehicle track footprint. Adjacent to Ningaloo Marine Park, only sparse coastal vegetation cover was present. However, there exists an extensive (1256 km) vehicle track network with the highest densities near accommodation nodes and sandy beaches (over 65% of tracks). Areas managed for conservation had fewer tracks and the lowest track density (0.3 km/km²) compared to pastoral stations (~1.9 km/km²). The cumulative lengths of tracks were highest on pastoral stations used for livestock grazing, coastal access and camping (945 km out of the total of 1256 km of tracks). The fragility of the arid landscape and this assessment of off-road vehicle impact obtained through detailed mapping of tracks indicate the need for management measures to mitigate the damage and cope with the increasing numbers of visitors.

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1. Introduction

Tourism in coastal areas is very important to local and regional economies but its rapid growth has often resulted in a range of degradation issues (e.g. Davenport and Davenport, 2006). Globally, there is a growing recognition of the decline in environmental condition of coastal areas and the need for appropriate management (e.g. Defeo et al., 2009). The land adjacent to the coast is often highly modified by human activities as well as being subject to natural pressures such as strong winds and wave action (Harvey and Caton, 2003). Coastal areas with high frequency of access are particularly vulnerable to a range of anthropogenic impacts. These typically include erosion caused by vehicles and people accessing the coastal zone, introduced plants and litter (Defeo et al., 2009; Priskin, 2003a; Schlacher and Thompson, 2008). The direct impacts of vehicles lead to modification, fragmentation and destruction of vegetation and habitats (Pickering and Hill, 2007; Kociolek et al., 2011; Trombulak and Frissell, 2000). Biota that use sandy beaches, such as turtles and birds, are also particularly vulnerable during their nesting seasons (Gibbs and Shriver, 2002).

The north west of Australia is sparsely populated and the main economic activities include mining, agriculture in the form of pastoral stations for the grazing of goats, sheep and cattle and, in recent years, tourism and recreation. This relatively remote area has seen visitor numbers grow every year, with Ningaloo Marine Park (NMP) and Cape Range National Park (CRNP) being the key destinations, highlighted by their recent inclusion as a World Heritage Area (DEHWA, 2010). Growing numbers of visitors to this coast pose a range of challenges for managers. As the area is semi-arid with naturally sparse vegetation and occasional cyclones, coastal erosion forms a particular threat. Along such coasts, even areas only moderately disturbed by humans can quickly decline during severe weather conditions (Nott, 2006; Paling et al., 2008). Furthermore, in the past five decades, a number of coastal locations in Western Australia have experienced significant degradation due to excessive and unregulated visitor access by off-road vehicles and this trend is only likely to continue (e.g. Priskin, 2003a, 2003b; Stevens and Collins, 2011).

In many remote regions little detailed baseline data exists on land or vegetation cover. Remote sensing data are particularly suitable for mapping such large and distant areas. Hyperspectral sensors have the main advantage of being able to map vegetated and bare areas to a greater level of thematic accuracy compared to

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multispectral sensors, even those with very high spatial resolution. Additionally, digital remote sensing offers a range of quantitative, repetitive and operational methods suitable for establishing

baseline and monitoring data sets. Such an approach is also cost effective in coastal areas where access and logistics can be a challenge.

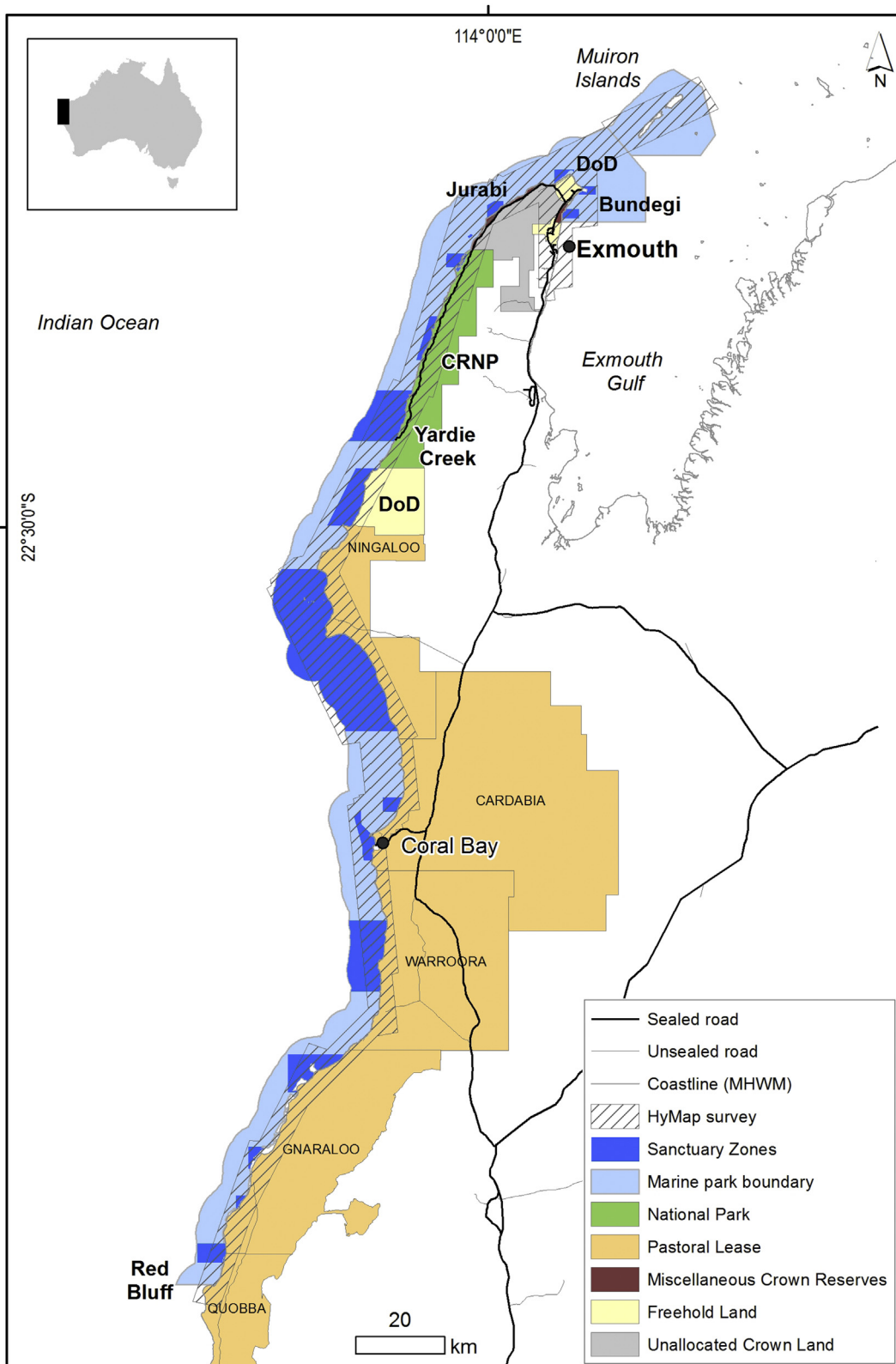


Fig. 1. Ningaloo study area and HyMap hyperspectral survey extent showing the coastal land tenures, sealed road access, pastoral leases, Department of Defence (DoD) freehold land, Ningaloo Marine Park and Cape Range National Park (CRNP) boundaries.

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