

**Estimating the benefit of well-managed protected areas for threatened species conservation**

STEPHEN G. KEARNEY, VANESSA M. ADAMS, RICHARD A. FULLER, HUGH POSSINGHAM and JAMES E. M. WATSON

SUPPLEMENTARY TABLE 1 The threat classifications faced by Australian threatened species, the typical conservation action taken to mitigate these and a reasoning for the choice of this action. Threat classifications, their description and conservation actions are taken from .

Major threat classification	Description	Sub-threats	Key conservation actions	Actions required beyond protected area boundary?	PA threat management scenario	Reasoning
Residential & commercial development	Threats from human settlements or other non-agricultural land uses with a substantial footprint	Commercial & industrial areas, housing & urban areas, Residential & commercial development, tourism & recreation areas	Site/area protection	No	Unmanaged	A protected area is sufficient to abate the impacts of urban development.
Agriculture & aquaculture	Threats from farming & ranching as a result of agricultural expansion & intensification, including silviculture, mariculture & aquaculture (includes the impacts of any fencing around farmed areas)	Agriculture, aquaculture, livestock farming/grazing, timber plantations	Site/area protection	No	Unmanaged	Protection is adequate to remove the direct impacts of agriculture to threatened species in Australia.
Energy production & mining	Threats from production of non-biological	Oil & gas drilling, mining, quarrying &	Site/area protection	No	Unmanaged	While it depends on the legislation of the state or territory, a protected area

	resources	renewable energy				may not be able to remove the threat of resource & energy production. However, it is the most that can be done to combat these threats.
Transportation & service corridors	Threats from long narrow transport corridors & the vehicles that use them including associated wildlife mortality	Roads & railroads, shipping lanes, transportation & service corridors, utility & service lines	Site/area protection	No	Unmanaged	Just the designation of a protected area is sufficient to abate the impacts or roads & other transport corridors. Although in some cases where roads & service lines are required within the PA, management to minimise impacts is needed.
Biological resource use	Threats from consumptive use of "wild" biological resources including both deliberate & unintentional harvesting effects; also persecution or control of specific species	Fishing/ harvesting/ collecting/ gathering terrestrial, marine & aquatic species	Site/area protection, Site/area management & compliance & enforcement	No	Well-managed	As protected areas are not immune to illegal harvesting of species, additional enforcement is required with protected areas to adequately protect threatened species
		Commercial logging	Site/area protection	No	Unmanaged	In a country with strong legislation such as Australia, protection alone is sufficient to protect species from logging
Human intrusion & disturbance	Threats from human activities that alter, destroy & disturb habitats & species associated with non-consumptive uses of biological resources	Human intrusion & disturbance, recreational activities, work & other activities, war, civil unrest & military exercises	Site/area protection & site/area management	No	Well-managed	Management & control of human activities within protected areas is required to abate the impacts of human disturbances
Natural system modifications	Threats from actions that convert or degrade habitat in service of "managing" natural or semi-natural systems, often to improve human welfare	Dams & water management	Policies & regulations	Yes	Landscape management	As water management impact species & ecosystems both up & downstream from them, landscape scale management is required to ensure threatened species conservation (Dudgeon et al. 2006; Gordon et al. 2008). While PAs play a major role in lessening the impact of these threats, as most PAs do not cover entire catchments, they alone are insufficient. Additional management

		Fire & fire suppression, other ecosystem modification	Site/area protection & site/area management	No	Well-managed	actions such as improved agricultural practices & sufficient environmental flows is needed to appropriately manage these threats. Returning an ecosystem to its natural fire regime requires on-ground management to ensure the optimal frequency & severity is maintained. Other ecosystem modifications require a number of on-ground management & restoration actions.
Invasive & other problematic species, genes & diseases	Threats from non-native & native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread &/or increase in abundance	Invasive non-native species, problematic native species	Site/area protection & invasive/problematic species control	No	Well-managed	Invasive plant, vertebrate & invertebrate species requires on-ground actions to mitigate their impact on threatened species.
		Invasive diseases, pathogens & parasites	Invasive/problematic species control & legislation (biosecurity)	Yes	Landscape management	Threats such as diseases, pathogens & parasites impact Australian species across a number of taxonomic groups, however plant, amphibian & aquatic species are particularly susceptible (Barrett et al. 2008; Beebee & Griffiths 2005; Poulin et al. 2011). The difficulty of controlling the spread of diseases across protected area boundaries means that management across the broader landscape is needed. These threats require a coordinated effort involving halting further spread of the disease & various actions where the disease is already established to limit its impact on species (Commonwealth of Australia 2005, 2006, 2014)
Pollution	Threats from introduction of exotic &/or excess materials or energy from point &	Garbage & solid waste	Site/area management & compliance & enforcement	No	Well-managed	It is well established that garbage & solid waste are having a dramatic impact on marine species (Gall & Thompson 2015). In terrestrial &

	nonpoint sources					freshwater ecosystems, the illegal dumping of rubbish must be managed with monitoring, enforcement of laws & regulations & waste removal. Agricultural effluents are threats that require management across the broader landscape (Dudgeon et al. 2006; Gordon et al. 2008).
		Agricultural & forestry pollutants, excess energy, urban sewage & waste water; industry/military pollution	Legislation & policies & Regulations	Yes	Landscape management	
Geological events	Threats from catastrophic geological events	Landslides	Habitat & natural process restoration	No	Well-managed	A number of on-ground management actions can be taken to reduce the likelihood of a landslide as well as restoring an area once a landslide has occurred
Climate change & severe weather	Threats from long-term climatic changes which may be linked to global warming & other severe climatic/weather events that are outside of the natural range of variation, or potentially can wipe out a vulnerable species or habitat	Climate change, severe weather, droughts, storms & flooding, temperature extremes, habitat shifting/alteration	Habitat & natural process restoration & species re-introduction	No	Well-managed	We consider the impacts of climate change as being able to be mitigated by a well-managed PA given large scale protection, restoration & translocation of species are management actions that can considerably lessen the impact of climate change (Gross et al. 2015; Watson et al. 2013; Martin & Watson 2016)

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