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Research article

Managing military training-related environmental disturbance

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ABSTRACT

Military Training Areas (MTAs) cover at least 2 percent of the Earth's terrestrial surface and occur in all major biomes. These areas are potentially important for biodiversity conservation. The greatest challenge in managing MTAs is balancing the disturbance associated with military training and environmental values. These challenges are unique as no other land use is managed for these types of anthropogenic disturbances in a natural setting.

We investigated how military training-related disturbance is best managed on MTAs. Specifically, we explored management options to maximise the amount of military training that can be undertaken on a MTA while minimising the amount of environmental disturbance.

MTAs comprise of a number of ranges designed to facilitate different types of military training. We simulated military training-related environmental disturbance at different range usage rates under a typical range rotation use strategy, and compared the results to estimated ecosystem recovery rates from training activities. We found that even at relatively low simulated usage rates, random allocation and random spatial use of training ranges within an MTA resulted in environmental degradation under realistic ecological recovery rates. To avoid large scale environmental degradation, we developed a decision-making tool that details the best method for managing training-related disturbance by determining how training activities can be allocated to training ranges.

1. Introduction

The primary focus of military training area (MTA) management is to facilitate military training. In the late 1960s, militaries also became responsible for managing the environmental values of their MTAs (Havlick, 2011, 2014). Environmental values that can be found on MTAs include: 1. Providing habitat for threatened species, communities, and ecosystems (Gazenbeek, 2005; Warren and Büttner, 2008; Jentsch et al., 2009; Cizek et al., 2013; Fiott, 2014; Havlick, 2011). 2. Acting as buffers against biodiversity loss and the effects of climate change (European Commission, 2000; Gazenbeek, 2005; Althoff et al., 2007) and 3. Providing stepping stones and wildlife movement corridors (AyCrigg et al., 2015).

The main risk to the environmental values found on MTAs is from military training-related disturbance that results in physical damage to the environment, such as erosion from tank manoeuvres or vegetation loss due to high explosives (Doxford and Judd, 2002; Coates et al., 2011; Fiott, 2014; Lawrence et al., 2015). Not only can this disturbance be detrimental to environmental values (Lawrence et al., 2015), it also can limit military training activities. Certain instances of impacts from training activities can be substantial to a point where further training can no longer occur due to changes in environmental features that are required for training, such as places heavily contaminated with unexploded ordnance (Department of Defence, 2011). Conversely, the main limit to the military training values of a MTA are the environmental values found on these areas (Doxford and Judd, 2002; Anderson et al., 2005; Wang et al., 2007, 2014). Further complicating MTA management is that, in some circumstances, military training can create unique habitat attributes and have beneficial environmental values (Friedrich et al., 2011; Jentsch et al., 2009; Cizek et al., 2013).

A challenge in MTA management is balancing an activity that has been demonstrated as being both detrimental and beneficial to

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the environment (Fiott, 2014; Lawrence et al., 2015), to achieve both military training outcomes and environmental protection. Detrimental impacts on the environment can include contamination and high levels of disturbance (Fiott, 2014). Beneficial impacts include habitat for succession specialists and environmental refuges created as a result of areas of land being designated as MTAs (Gazenbeek, 2005). This can be achieved only by trading-off the amount of military training-related environmental disturbance against the environmental values found on a MTA (Doxford and Judd, 2002).

Military training is the instruction of defence personnel to enhance their capacity to perform specific military tasks (e.g. to shoot a rifle, drive a tank, fire artillery). It includes exercising one or more military units in a coordinated manner, such as the coordination of infantry movements with tank and air support. Military training generally occurs on dedicated MTAs, which are estimated to cover at least 2–3 percent of the Earth's terrestrial surface (Zentelis and Lindenmayer, 2015). MTAs comprise a number of training ranges designed for different types of military training activity, such as rifle and grenade ranges through to ranges for tank battle runs. Ranges can vary in size from approximately 1 ha for a small rifle range through to thousands of hectares for a tank battle run range. Ranges are designed and located to reduce the risks associated with military training to military personnel and the public (Fiott, 2014). Training activities can range from small groups of soldiers undertaking target practice through to simulated wars and battles involving thousands of personnel (Doxford and Judd, 2002).

Despite the vast area of land used for military training, few studies have investigated the impacts of military training and associated disturbance on the environment (Zentelis and Lindenmayer, 2015). Warren et al. (1989) developed an erosion-based classification system for the impacts associated with military training, suggesting that levels of erosion risk could inform when and where training could occur. McKee and Berrens (2001) found that military training-related disturbance was limiting the US military's ability to train due to impacts on threatened species. They argue that compensatory habitat for threatened species affected should be acquired to ensure training continuity. Doxford and Judd (2002) suggested virtual reality technology for military training could be used to reduce environmental impacts and disturbance from military training. They noted, however, that virtual reality is not a replacement for military training as there is a need to undertake “real-life” training, where the need to the manage military training-related disturbance remains. Wang et al. (2007, 2014) categorised levels of environmental disturbance associated with types of military training, finding that the level of disturbance observed is associated with both the level and type of training activity. Rowland et al. (2004) developed a neural network approach to selecting sustainability indicators for MTAs. However, none of these studies have addressed the underlying problem of how to best manage military training disturbance on MTAs. In contrast to the paucity of work investigating environmental disturbance associated with military training, a large number of studies have examined the impacts of disturbance within various vegetation types such as those associated with agriculture and forestry (see Worboys et al., 2014).

We investigated recovery times of ecosystems from disturbance events to understand how to best trade-off military training against protection of the environment. The applicability of different land management approaches commonly used in agriculture and forestry to the management of military training-related environmental disturbance was assessed by simulating different military training usage rates.

Our research focussed on: 1. Developing an understanding of the key issues relating to the management of military training-related environmental disturbance, and 2. Developing a management approach that minimises the impacts of environmental disturbance while maximising the ability to undertake military training. Specifically, we sought to answer two key questions:

1. What are the long-term impacts of repeated military training on the environment? We conducted simulations trading off environmental disturbance against the level of military training. We hypothesised that more frequent military training will reduce the period of time for ecosystems to recover from training activities and that rotating military training through the environment will protect the environment from significant impacts and degradation. This hypothesis is based on agricultural approaches to land management where land is rested from either grazing or harvesting pressure, allowing for recovery to occur (Hirst, 2015).
2. What are the best approaches to managing military training-related environmental disturbance? We investigated the applicability of four commonly used disturbance management approaches employed in agriculture, forestry and nature conservation to MTA management. Approaches investigated were retention, rotation, mixed use and intensive use. Our investigation was based on the assumption that the management of environmental disturbance, regardless of causes, can be managed using existing approaches (Jones and Schmitz, 2009).

The findings of this study lead to the development of specific guidance for MTA managers that identifies the most appropriate approaches to manage different levels of military training-related disturbance. We found the most effective approach to managing military training-related environmental disturbance was dependent on the type and level of disturbance, the period of time between disturbance events, and the ecosystem recovery rate.

2. Methods

2.1. Type of military training-related environmental disturbance

As a starting point for our analysis, we sought to understand whether variability among military training ranges in the severity of environmental disturbance was associated with the type of training conducted. Military training-related environmental disturbance can be categorised as having a high, medium or low levels of disturbance on the environment (Warren et al., 1989; Wang et al., 2007, 2014). We investigated the relationship between the level of environmental disturbance observed on MTAs and different types of military training activity.

We assessed the environmental disturbance levels at the Bergen and Munster MTAs in Germany, and the Majura and Beecroft Weapons Range MTAs in Australia. We observed levels of environmental disturbance found on MTA ranges and cross-referenced them to the types of military training untaken as recorded on the German and Australian range booking systems (IMEX SK and TASMIS). Levels of environmental disturbance were determined as high, medium and low and based on a modification of the methodology used by Wang et al. (2007, 2014). An example field data sheet, including our description of environmental disturbance, is shown in Appendix 1. All ranges at each MTA were assessed (Appendix 2). Site assessments of German MTAs were conducted in October and November 2015, with Australian MTAs assessed in April 2016. These sites were chosen to allow contrasting high impact, high intensity concentrated training activities conducted in Germany against Australia's training regime which is of lower tempo and occurs over a much broader area.