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Assessing the effectiveness of regulation to protect threatened forests

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A B S T R A C T

Deforestation threatens the earth's biodiversity and the ecosystem services upon which humans depend. Formal regulation is a key mechanism by which governments seek to protect forests. However, whether regulation can effectively protect remaining areas of the most threatened and most heavily cleared forests is unknown. We addressed this question using forest loss data for Queensland, Australia between 2000 and 2014 under existing vegetation clearing regulation (*Vegetation Management Act 1999*). This regulation is specifically designed to provide the greatest protection for threatened forest types that have already lost the greatest amount of their original extent. Importantly, enforcement and governance of this regulation is relatively strong allowing an assessment of regulation design. We applied path analysis to model the direct and indirect effects (mediated by variables representing deforestation pressure) of forest protection level on clearing rates. There was strong evidence for a decline in clearing rates over time, except of clearing for non-agricultural purposes. However, threatened forest types, which have already lost > 70% of their original extent and should have the greatest level of protection under the regulation, continue to be cleared 2.7–2.9 times faster than non-threatened forest types. There was also little evidence that the regulation has driven greater reductions over time in the clearing rates of threatened versus non-threatened forests types. There was much greater support for the indirect than direct effect of protection level. This is because protection level was correlated with variables associated with deforestation pressure, resulting in higher clearing rates for threatened compared to non-threatened forest types. We hypothesise that this arises because the additional protection afforded to threatened relative to non-threatened forests is insufficient to counter the continuing higher level of deforestation pressure on threatened forests. We argue that a potential solution is to build explicit targets for forest retention into regulation, below which no further forest loss is permitted. This could be combined with spatially targeted enforcement and incentive strategies where threats are highest.

1. Introduction

In the first decade of this century, 13 million ha of forest was lost each year globally (Food and Agriculture Organization of the United Nations, 2010) and forests continue to be cleared as human land-uses expand (Hansen et al., 2013; Hosonuma et al., 2012; Houghton, 2012; Margono et al., 2014). Weak governance, legislative protection, and enforcement in many countries are some of the key causes of uncontrolled forest loss (Laurance, 1999). But, even in developed countries, where over half of the world's primary forests occur (Mackey et al., 2015), and where regulatory protection and enforcement is relatively strong, forest loss still exceeds gain (Hansen et al., 2013). This raises questions about the effectiveness of even strongly enforced regulation to contain deforestation rates. Consequently, understanding the role of regulation design for successfully protecting remaining forests, particularly those that are most threatened, is crucial.

With only 13% of the Earth's land area in gazetted protected areas, the vast majority of the world's forests lie outside of protected areas (Joppa and Pfaff, 2009; Schmitt et al., 2009). The rate at which forest is lost from these non-protected areas is determined by many individual land-holder decisions and activities occurring on private and government owned land. Influencing, or controlling, the decisions of land-holders to achieve positive environmental outcomes is therefore a central problem for forest conservation (Nepstad et al., 2014; Robinson et al., 2014; Soares-Filho et al., 2015). To achieve this, governments apply a range of approaches, including suasive approaches (such as education), market-based approaches (including incentives such as subsidies and tax exemptions) and coercive approaches (such as direct

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regulation). Of these, regulatory approaches are almost universally used to varying degrees and provide a critical component of the suite of mechanisms for protecting forests. There is good evidence that regulation is important in reducing deforestation rates and the consequences of enforcement on deforestation is reasonably well understood (Busch and Ferretti-Gallon, 2017). However, the role of regulation design for deforestation is less well understood.

Regulation most commonly controls forest loss through assessments of the impact of individual development activities and an approval/non-approval process for those activities (Glasson et al., 2012). Other things being equal, under strongly enforced regulation, the number of clearing approvals will tend to be the primary determinant of the rate of forest loss. This number depends on the number of clearing applications (i.e., deforestation pressure) and the proportion of those applications that are permitted under the regulation (i.e., an outcome of regulation design). Controlling deforestation most in threatened forests (i.e., those under the greatest deforestation pressure) therefore requires regulation that ensures a smaller proportion of applications are permitted in threatened forests than in less threatened forests. Yet, regulation is rarely designed to explicitly limit clearing activities based on the threatened status of forests, potentially leading to inadequate protection of those forest that need the greatest protection. For example, the European Commission's *Environmental Impact Assessment Directive (85/337/EEC)* regulates the types of activities requiring environmental impact assessment, including activities that impact forests. However, a suite of activities are permitted irrespective of the level of threat. Similarly, in the United States, forests are protected through a range of Federal and State laws, including the *National Environmental Policy Act 1969* and the *Endangered Species Act 1973*, but the extent to which the level of protection scales with threat is limited. Assessing the effectiveness of regulation that is specifically designed to be most restrictive for threatened forests would be an important step in better informing the design of regulation to protect threatened forests.

In Australia, the State of Queensland has historically had one of the highest rates of deforestation of any developed country over the last half of the 20th century (Bradshaw, 2012; Evans, 2016; Lepers et al., 2005). In response to these high levels of deforestation, the Queensland Government introduced the *Vegetation Management Act 1999* (VMA) in 2000 (Kehoe, 2006). This legislation regulates the clearing of native vegetation, including native forests (State of Queensland, 2016a). Although the VMA was weakened slightly in 2013 (State of Queensland, 2013), by international standards, it provides strong regulatory protection and enforcement (McGrath, 2007). In common with most regulation of this kind, exemptions are available for a range of activities, including those with impacts less than a certain size, essential management activities (e.g., to establish fences and fire breaks), and case-by-case approvals for larger impacts from urban and mining development. Nonetheless, an important feature of the VMA is that it is designed to provide higher levels of protection for vegetation communities that have historically been most extensively cleared. This gives us a unique opportunity to assess the effectiveness of regulation designed in this way for conserving threatened forests.

We addressed this using data on the monitoring of vegetation clearing in Queensland between 1999 and 2014 (Department of Science Information Technology Innovation and the Arts, 2015; Nelder et al., 2012). We quantified the rates at which native forests have been lost over this time period for forests under different levels of regulatory protection. We then used path analysis to quantify the direct effect of protection level on deforestation rates and an indirect effect that captures how the effect of protection level is mediated by drivers of deforestation pressure. We show that threatened forest types continue to be cleared more rapidly than other forest types, despite higher levels of protection, and also find little evidence that clearing rates for threatened forests have declined more rapidly over time than less threatened forests. Importantly, we find much stronger support for an indirect, than a direct effect, of protection level in explaining this pattern. We hypothesise that this most likely arises because the more stringent protection levels for threatened forests are simply insufficient to mitigate the ongoing higher deforestation pressures associated with threatened forests. However, limited evidence for a direct effect of protection level on deforestation rates also suggests that more stringent protection levels for threatened, compared to non-threatened, forests per se may not have been achieved. We suggest that setting explicit targets for forest retention may be an alternative way to design regulation to better ensure the protection of threatened forests in the long-term.

2. Materials and methods

2.1. Study region

The State of Queensland is located in northeast Australia, between 10°S–29°S and 138°E–153°E, and spans an area of approximately 1.83 million km^2. The climate ranges from temperate to tropical close to the coast, with arid and extensive semi-arid regions toward the interior of the Australian continent. Average temperatures in January (summer) range from 18 to 27 °C, and from 6 to 24 °C in July (winter), with average annual rainfall varying from 50 to 3000 mm (Australian Government Bureau of Meterology, 2017). The original vegetation comprised three main types: eucalypt forests and woodlands (42.5%), acacia and mixed woodlands (25.2%), and grasslands (21%). Other forest types, including rainforests, melaleuca woodlands, and *callitris* woodlands together formed 7.4%, while coastal vegetation and wetlands made up the remaining 3.9%. Since European settlement in the 19th century, native vegetation has been selectively removed for the purposes of agriculture, mineral and other resource extraction, infrastructure and settlement. Although approximately 80% of Queensland retains its native vegetation, much of it is used for activities such as cattle grazing and, in areas of high agricultural productivity, native vegetation extent has been reduced to < 10% of its former extent (State of the Environment 2011 Committee, 2011).

2.2. Regulatory context

When the VMA was introduced in 2000 it, along with the *Integrated Planning Act 1997* (IPA), regulated the clearing of native vegetation on freehold land, which covered approximately 26% of the state at the time (McGrath, 2007). From 2004 onwards the legislation was incrementally amended to incorporate leasehold land (thus encompassing approximately 94% of the state) and, as of 2006, the legislation brought an end to broadscale clearing (clearing for purposes other than normal land management) (McGrath, 2007). However, the VMA was weakened in 2012/2013 following the election of a conservative government in 2012, that again permitted broadscale clearing for high value agriculture and allowed property managers to self-assess proposed vegetation clearing for purposes such as fodder and ‘thinning’ (Reside et al., 2017; State of Queensland, 2013). Since the inception of the VMA, the extent of clearing of native forest cover has declined from 505,000 ha/year in 1999/2000 to 103,000 ha/year in 2013/2014, although this has increased somewhat since 2009/2010 (Department of Science Information Technology Innovation and the Arts, 2015).

The VMA classifies native vegetation (referred to as remnant vegetation in the VMA) into three classes (VMA Classes): (1) *Least Concern*; (2) *Of Concern*, and (3) *Endangered*. These classes primarily reflect the proportion of the original pre-clearing extent remaining of each vegetation type and hence are related to the amount of vegetation cover already lost. Each class is defined as follows (State of Queensland, 2016b):

- *Least Concern* communities are those where the remnant vegetation is over 30% of its pre-clearing extent across the bioregion, and the remnant area is > 10,000 ha.
- *Of Concern* communities are those where the remnant vegetation is