



Review and synthesis

Opening the silvicultural toolbox: A new framework for conserving biodiversity in Chilean timber plantations

Tyler N. McFadden*, Rodolfo Dirzo

Department of Biology, Stanford University, Stanford, CA 94305, United States



ARTICLE INFO

Keywords:

Forest management
Chile
Pinus radiata
Eucalyptus
Understory
Land-use change

ABSTRACT

Intensively managed timber plantations represent 7% of global forest cover and may partially compensate for deforestation-related biodiversity loss, yet are often criticized as ‘green deserts’ which support limited biodiversity. Growing concerns about the environmental impact of plantations in Chile have prompted numerous calls for a new forestry paradigm. Here, we systematically review the literature on biodiversity maintenance or loss in Chilean timber plantations and outline a new framework for biodiversity conservation therein, envisioning plantations as potential habitat that can be improved through informed management. Our review (N = 67 relevant publications) shows a strong taxonomic bias towards plants, mammals, birds, and invertebrates, as well as biases in the age and species composition of plantations studied. Most studies (78%) examined *Pinus radiata* plantations, 48% examined mature stands, and 46% did not specify stand age. Research to date is difficult to translate into conservation policy, since most studies simply compare biodiversity within versus outside of plantations, and do not evaluate alternative management options. To better inform conservation, we identify six critical stages of plantation development during which management decisions may greatly influence biodiversity outcomes. Within each stage we discuss the effects of specific management practices on Chilean biodiversity, highlighting opportunities and key knowledge gaps. Strategies which promote structural complexity, understory cover, and landscape connectivity should help convert plantations into a less hostile matrix that provides adequate habitat for substantial native biodiversity. Given the global proliferation of plantations and their consequences for biodiversity, similar studies are needed in multiple regions of the world.

1. Introduction

Despite recent reductions in the rate of global forest loss, deforestation and land-use change persist as primary drivers of current and future biodiversity change (Dirzo et al., 2014; Pereira et al., 2010). Highly productive timber plantations have the potential to reduce pressure on natural forests and provide secondary habitat for biodiversity where natural forests are scarce, yet they may also replace natural forests and are often criticized as ‘biological deserts’ that support little biodiversity (Brockerhoff et al., 2008; Paquette and Messier, 2010). Timber plantations are increasing in area by 2.5 M ha annually and now represent 7% of global forest cover (Keenan et al., 2015). Identifying strategies to effectively manage plantations for maintaining biodiversity is therefore a critical challenge to sustainable forest management and biodiversity conservation.

Chile contains 2.95 M ha of plantation forests, making it one of the top 10 countries in the world in terms of area dedicated to timber plantations (FAO, 2015). Plantation forestry was first promoted in the

early 1900s to stabilize soils in degraded agricultural areas, and later rapidly expanded in the 1970s and 1980s during the military government of Augusto Pinochet. In addition to implementing neoliberal economic reforms, Pinochet enacted the Decree Law 701 of 1974 (D.L. 701), which subsidized 75% of the costs of plantation establishment and remained in effect through 2012 (Niklitschek, 2007). The Chilean forestry sector now provides about 300,000 jobs, and represents the country’s second largest export industry, generating US\$5.9 billion in 2011 (Salas et al., 2016).

The Valdivian Rainforest Ecoregion (35–48° S) in southern Chile is recognized as a global biodiversity hot spot due to its rich diversity, high levels of endemism, and extensive habitat loss (Myers et al., 2000). Indeed, the rapid expansion of exotic timber plantations in this ecoregion during the last four decades has prompted concerns about the impacts of plantations on native biodiversity and ecosystem function (Reyes and Nelson, 2014). Ninety-five percent of Chile’s timber production comes from intensively managed monoculture plantations of exotic species such as Monterey pine (*Pinus radiata*, hereafter ‘pine

* Corresponding author.

E-mail address: tyler.neal.mcfadden@gmail.com (T.N. McFadden).

plantations’) and *Eucalyptus* spp. (INFOR, 2016). Furthermore, nearly a quarter of all new plantations from 1986 to 2011 were established on lands that were native forests before 1986 (Heilmayr et al., 2016). Numerous studies highlight the deleterious effects of plantations on Chilean biodiversity (Estades et al., 2012), clean water provisioning (Fierro et al., 2016; Lara et al., 2009), fire risk (Úbeda and Sarricolea, 2016), and rural communities (Andersson et al., 2016). In the austral summer of 2016–2017, Chile experienced its worst wildfire season in history, burning 600,000 ha and launching the debate over plantations into the national spotlight (Kozak, 2017). Several scientists wrote prominent editorials in national newspapers arguing for a new forest management paradigm (e.g. González et al., 2017), while international newspapers ran stories tying the fires to the neoliberal economic policies of Chile’s former dictator Pinochet (Kozak, 2017). The mayor of Valparaíso, Chile’s third largest city, went so far as to call for the removal of all *Eucalyptus* plantations within the metropolitan area (see *Ahora Noticias*, 2017).

The Chilean forestry sector is at a crossroads. Plantation managers are under increasing public pressure to balance timber production and environmental stewardship (CONAF, 2017). While 52% of Chilean plantations are now certified under the Forest Stewardship Council’s sustainability certification scheme, these environmental standards are largely implemented in the areas surrounding plantations (in the form of conservation reserves), and the plantations themselves continue to be managed using intensive methods (Salas et al., 2016). Despite a substantial body of research documenting the negative effects of plantations on Chilean biodiversity (e.g. Estades et al., 2012), less is known about the role of innovative forest management practices in mitigating or exacerbating these impacts. Some recent studies indicate that appropriately managed plantations may provide important habitat for native biodiversity, serve as a ‘softer’ matrix than alternative anthropogenic land uses (e.g. pasture), and may even be critical to the conservation of some threatened species (Acosta-Jamett et al., 2003; Estades et al., 2012; Heinrichs et al., 2016). While many studies examine plantation-associated changes in biodiversity, documentation of these changes alone provides limited guidance to landowners or policy makers who may wish to manage plantations for increased biodiversity. Here, we review the literature of biodiversity maintenance in Chilean plantations and complement it with insights derived from studies in plantations from other parts of the world, leading us to outline a new framework for managing timber plantations for biodiversity in Chile, but with potential relevance for plantations elsewhere.

This review synthesizes the results of 67 studies of biodiversity in Chilean timber plantations, with the aim of identifying strategies that managers can utilize to conserve biodiversity in working plantations. We begin by conducting a systematic review to identify key trends and knowledge gaps in the field. We then summarize the literature on the effects of plantations on Chilean biodiversity, which we analyze in the context of critical silvicultural decisions made at six stages of plantation management. We discuss the state of the art regarding the effects of specific management practices on biodiversity in Chile and throughout the world, and identify areas where more research is needed to inform sustainable plantation management. In doing so, we lay out a new framework for the conservation of biodiversity in Chilean timber plantations, in which plantations are viewed as potential habitat that can be improved through informed management. Given the global proliferation of plantations and the consequences for biodiversity thereof, our study is of broad significance (Fitzherbert et al., 2008; Paquette and Messier, 2010).

2. Systematic review: Biodiversity in Chilean timber plantations

We conducted a systematic search of the peer-reviewed literature in Web of Science on April 4, 2017, using the search terms “plantation OR pine OR eucalyptus” AND “Chile” AND “biodiversity OR wildlife OR animal OR invertebrate OR insect OR vertebrate OR bird OR mammal

Table 1

Criteria governing inclusion of literature for the systematic database, and data collected from each study.

Criteria	Publication characteristics	Data collected
Inclusion	<ul style="list-style-type: none"> • Empirical studies conducted in Chilean Regions V, VI, VII, VIII, IX, X, or XIV^a, and • Peer-reviewed primary research, and • Examine effects of timber plantations on Chilean biodiversity, or • Document biodiversity in Chilean plantations 	<ol style="list-style-type: none"> 1. Chilean region in which study was conducted 2. Taxa studied 3. Species of tree planted 4. Stage of stand development^b 5. Control (reference) habitats (if any)
Exclusion	<ul style="list-style-type: none"> • Examine plantations only as driver of land-use and land cover change, or • Only examine effects of management treatments on pests or planted trees 	

^a These seven regions contain > 98% of Chilean timber plantations (INFOR, 2016).

^b Stand development stages: mature (> 8 yrs), young (3–8 yrs), new (< 3 yrs), clear cut (harvested but not yet replanted), mature abandoned (abandoned plantation with trees > 8 yrs), thinned (stand recently thinned), unspecified (no information provided), and multiple pooled (authors grouped multiple stages together).

OR reptile OR amphibian OR plant OR tree OR fungus”. Our search returned a list of 504 results, which we refined using inclusion criteria presented in Table 1. The resulting database includes 67 studies (Table A1) published from 1987 to 2017, with 72% being published in the last decade (Fig. 1).

At least one study took place in each of the seven Chilean regions included in our analysis, but the studies were unevenly distributed geographically (Fig. 2). Eighty-four percent of studies (56 of 67) occurred in the Maule or Biobío Regions, which combined contain 64% of Chile’s timber plantations (INFOR, 2016). Relatively few studies occurred in the Araucanía Region, which is Chile’s third largest timber producing region and also the epicenter of conflicts between the timber industry and the Mapuche People (Reyes and Nelson, 2014). Eleven studies simultaneously examined two or more regions.

Plants were the most commonly studied taxa, followed by mammals, birds, and invertebrates (Fig. 3). Very few studies examined other vertebrate taxa, microbes, or fungi. Most notably, no studies examined amphibians, although south-central Chile supports a high diversity of forest-associated frogs, many of which are threatened and/or endemic to the region (Vidal and Díaz-Páez, 2012). Most studies focused on

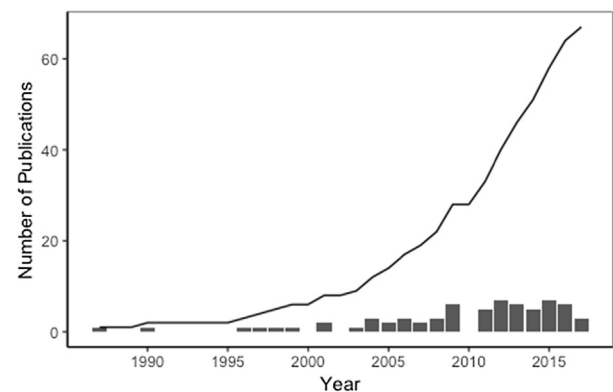


Fig. 1. Time course of publications (n = 67) examining the effects of timber plantations on Chilean biodiversity (Regions V-X, and XIV). Vertical bars represent the number of publications per year. Line shows the cumulative number of publications since 1987.

Download English Version:

<https://daneshyari.com/en/article/6541555>

Download Persian Version:

<https://daneshyari.com/article/6541555>

[Daneshyari.com](https://daneshyari.com)