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Promoting landscape heterogeneity to improve the biodiversity benefits of certified palm oil production: Evidence from Peninsular Malaysia

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ABSTRACT

The Roundtable on Sustainable Palm Oil (RSPO) is responsible for the certification of palm oil producers that comply with sustainability standards. However, it is not known whether RSPO-certified plantations are effective in maintaining biodiversity. Focusing on Peninsular Malaysia, we show that both RSPO-certified plantations and uncertified large-scale plantations are characterized by very low levels of landscape heterogeneity. By contrast, heterogeneity measures were many times higher in palm oil producing smallholdings, despite their lack of RSPO certification. The low heterogeneity of large-scale oil palm plantations, including those certified by the RSPO, is likely to severely limit their value for biodiversity conservation. Uncertified smallholdings, in contrast, are much more heterogeneous and therefore hold substantially greater promise for the integration of palm oil production and biodiversity conservation than large-scale plantations. With oil palm agriculture further expanding, certification schemes should mandate producers to improve biodiversity conservation through landscape management that promotes greater landscape heterogeneity.

1. Introduction

Oil palm agriculture has been controversial because of the global conversion of vast areas of natural tropical rainforests to oil palm monocultures (Donald, 2004; Fitzherbert et al., 2008; Danielsen et al., 2009; Wilcove and Koh, 2010; Sayer et al., 2012). Industrial oil palm expansion has caused tremendous loss of biodiversity and habitat destruction in the tropics (Immerzeel et al., 2014). Existing oil palm plantations are known to maintain few species compared to native forests (Koh, 2008; Edwards et al., 2010; Fayle et al., 2010; Azhar et al., 2011). Large-scale oil palm agriculture is growing rapidly in biodiversity-rich, but poverty-stricken rural regions of the Amazon, Equatorial Africa, and Southeast Asia. Many areas of natural rainforests are now surrounded by oil palm monocultures. Most large-scale oil palm plantations consist of a single commodity crop, and the oil palm matrix can exert multiple pressures (e.g. poaching, encroachment and forest fire) on the remaining natural forest patches (Harvey et al., 2008).

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The palm oil industry has been heavily criticized by environmental NGOs for causing massive deforestation and unprecedented biodiversity loss in the tropics (Tan et al., 2009). In response, in 2004, oil palm stakeholders established the Roundtable on Sustainable Palm Oil (RSPO). The RSPO aims to improve environmental performance of producers and users of palm oil (Laurance et al., 2010). In spite of heavy criticism from environmental NGOs, the RSPO is widely accepted to be one of very few effective multi-stakeholder initiatives aiming to reconcile oil palm production and environmental conservation (Wilcove and Koh, 2010; Schouten and Glasbergen, 2011). With a growing membership already exceeding 800 certified manufacturers, retailers and growers, GreenPalm, the sustainable palm oil certificate-trading programme, has traded eleven million certificates, and RSPO-certified palm growers have collectively earned premiums of over US$73 million over the past six years (Roundtable on Sustainable Palm Oil, 2014).

At present, the RSPO has implemented 39 sustainability criteria, organized under eight general principles, which are designed to limit environmental and social impacts of growing and processing palm oil (Laurance et al., 2010; Roundtable on Sustainable Palm Oil, 2013). Surprisingly, the RSPO has sidelined landscape heterogeneity in its criteria. One principle emphasizes 'environmental responsibility and conservation of natural resources and biodiversity'. The criteria associated with this principle focus on issues such as reducing pesticide impacts, air pollution, and biodiversity loss, as well as on social and legal concerns. With respect to biodiversity conservation, the RSPO has rightly stressed the importance of areas that contain High Conservation Value (HCV) biodiversity features. Biodiversity features are assumed to be present if there are natural forest patches in or around the plantation, or if the plantation contains or shares borders with other natural habitats. However, relatively few plantations abut or contain natural forest patches, and where they do, plantation stakeholders may lack both the legal mandate and the necessary technical expertise to effectively manage such patches. Moreover, the potential function of the oil palm matrix in biodiversity conservation has been largely overlooked by stakeholders. Evidence from farmland around the world strongly suggests that the heterogeneity of farmland is a highly influential driver of biodiversity (Benton et al., 2003; Bennett et al., 2006; Karp et al., 2012). Oil palm plantations that are structurally complex at local-scale, particularly in the understory, may increase biodiversity (Aratrakorn et al., 2006; Azhar et al., 2011; Nájera and Simonetti, 2010). By contrast, large, homogeneous (e.g. equal stand age) areas of oil palm monocultures are particularly likely to be detrimental to *in-situ* biodiversity conservation and to species movements.

In Southeast Asia, exotic oil palm crops are commercially planted either in large-scale plantations or in smallholdings (area $<$ 50 ha) (Lee et al., 2013; Azhar et al., 2014). Palm oil produced in smallholdings has been shown to be generally more environmentally friendly than palm oil grown in large-scale plantations (Azhar et al., 2011; Lee et al., 2013; Azhar et al., 2014)—with very few exceptions, e.g. potentially higher poaching rates (Azhar et al., 2013). However, it is unknown whether RSPO-certified plantations are actually more biodiversity-friendly than non-certified planted areas (including large-scale plantations as well as smallholdings) (Savilaakso et al., 2014). If oil palm landscapes are to be included as part of comprehensive conservation strategies, it is essential to understand what landscape characteristics are associated with different types of oil palm management, and how landscapes can be designed for better conservation outcomes (Harvey et al., 2008).

In this study, we predicted that smallholdings would be characterized by higher landscape heterogeneity, improving their likely benefits for biodiversity, than large-scale plantations, irrespective of their certification status. We distinguished between compositional heterogeneity, defined as the number of different elements present and their relative proportions (Bennett et al., 2006), and configurational heterogeneity, defined as the spatial pattern of patches (Fahrig et al., 2011). We proposed three hypotheses: (1) that compositional landscape heterogeneity represented by the number of different types of patches in oil palm smallholdings is higher than that in large-scale RSPO-certified and uncertified plantations; (2) that configurational landscape heterogeneity in oil palm smallholdings is higher than that in RSPO-certified and uncertified large-scale plantations, corresponding to a smaller mean patch size in smallholdings; and (3) that edge density for the uncertified smallholdings is greater than in RSPO-certified and uncertified large-scale plantations.

2. Materials and methods

2.1. Site selection

To identify potential study landscapes, we used Google Earth (GE) Pro to select 210 landscapes in the states of Negeri Sembilan, Selangor, and Perak on the west coast of Peninsular Malaysia (between 4° 7′ 17.28″N, 100° 44′ 22.29″E and 2° 36′ 33.73″N, 101° 48′ 48.16″E) (Fig. 1). Landscapes were randomly identified on GE images, and the latitude and longitude coordinates of the centre of the sampled landscape were specified. Each landscape was a circular plot with a 1 km diameter (Fahrig et al., 2011). Seventy spatial replicates were sampled for each of RSPO-plantations, uncertified large-scale plantations, and uncertified smallholdings. We used the RSPO online database http://www.rspo.org/en/rspo_members to determine the membership status of private businesses that were managing the plantations. The replicates did not include riparian habitats and forest patches. Such exclusions were taken in order to consider plantations established before the onset of RSPO certification scheme. These plantations are unlikely to retain natural areas and therefore have low heterogeneity, even if these plantations have subsequently become RSPO-certified. In addition, we are aware of the spill over effect from these natural areas on farmland biodiversity (Gilroy et al., 2014; Lucey and Hill, 2012). Consistent with widely used standards in the social sciences, the identity of plantation and smallholding operators is kept anonymous in this study.