Forest set-asides benefit aboveground carbon stocks and associated plant diversity in RSPO plantations

A science-for-policy brief by the SEnSOR programme
Forest set-asides in oil palm plantations provide important habitat for wildlife. Here we test whether High Conservation Value areas (HCV areas) provide additional benefits for aboveground carbon stocks (hereafter termed ‘carbon stocks’) and plant diversity in oil palm plantations. We use new field data from 14 forest set-asides (most of which were HCV areas) in RSPO plantations in Sabah to address three questions:

**Question 1: Do forest set-asides improve the carbon stocks of oil palm plantations?**
Forest trees store and sequester much more carbon from the atmosphere than oil palms. Therefore, conserving forest set-asides within plantations could improve the carbon stored across the plantation and help mitigate the greenhouse gas emissions from oil palm agriculture.

**Question 2. Do forest set-asides with high carbon stocks also support high plant diversity?**
If this is true, it would mean that conservation and management of set-asides for high carbon stocks would provide co-benefits for rainforest biodiversity in oil palm plantations.

**Question 3: Will forest set-asides continue to support high carbon stocks in future?**
We compared trees and seedlings in set-asides with those in continuous forest to examine the potential for set-asides to regenerate and store more carbon in future. We used continuous forest as a comparison because it supports exceptionally high carbon stocks and biodiversity.

**Methods**

To answer **Question 1**, we estimated the aboveground carbon stocks of living trees and palms in 49 plots across 14 forest set-asides in RSPO-certified oil palm plantations (following Réjou-Méchain et al. 2017). We estimated time-averaged oil palm carbon stocks for a 30-year plantation cycle based on Carlson et al. (2012, 2013).

To answer **Question 2**, we tested the relationship between plant diversity and carbon stocks for our plots in set-asides.

To answer **Question 3**, we compared the size of adult trees, and the density of seedlings, saplings and adult trees between plots in set-asides and plots in continuous forest.

![Fig. 1. A forest set-aside (foreground) in an oil palm plantation in Sabah, Malaysia. Photo credit: Robin Hayward.](image)
Benefits of conservation set-asides in RSPO-certified plantations for aboveground carbon stocks and associated plant diversity.

**Question 1:** Do forest set-asides improve the carbon stocks of oil palm plantations?

- The average carbon stocks of living trees and palms in set-asides (52.8 t ha⁻¹) was more than 1.5-times the carbon stocks of oil palm (30.3 t ha⁻¹) (see figure 2).
- Oil palm plantations with 10% of their area as forest set-asides can contain up to 20% more carbon than oil palm plantations with no set-asides.
- So, HCVs and other forest set-asides can improve the carbon stocks of oil palm plantations.
- However, carbon stocks of plots in set-asides were highly variable (range 7.8-115 t ha⁻¹), and could be less than that of oil palm or as high as continuous forest. This suggests that in many set-asides the carbon stocks can be considerably improved.

**Question 2.** Do forest set-asides with high carbon stocks also support high plant diversity?

- Set-asides with higher carbon stocks also had higher plant diversity.
- However, seedling diversity was not related to carbon stocks, so co-benefits of carbon stocks and plant diversity may decline in future without careful management.

**Question 3: Will set-asides continue to support high carbon stocks in future?**

- Set-asides had significantly fewer seedlings than continuous primary forest, suggesting that potential for regeneration is lower, with possible negative impacts for future tree diversity and carbon stocks in set-asides.

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**Findings**

![Figure 2: Average carbon stocks of oil palm, forest set-asides and continuous forest. Different letters at the top of the graph represent significant differences between the carbon stocks of each land-use type: forest set-aside carbon stocks are significantly higher than oil palm and significantly lower than continuous forest, but the carbon stocks of continuous logged and continuous primary forest were not significantly different.](image)

![Figure 3: Seedlings on the forest floor in Danum Valley, Sabah (continuous primary forest). Regeneration of large trees in future depends on seedlings. Photo credit: Emily Waddell.](image)
Recommendations

1. **HCV areas and other forest set-asides in RSPO plantations** improve plantation carbon stocks, and provide co-benefits for plant diversity. However, set-aside carbon stocks are highly variable. Improving the carbon stocks in degraded forest set-asides would help mitigate greenhouse gas emissions from oil palm agriculture without reducing the area of land used for cultivation.

2. Set-asides had fewer seedlings than continuous primary forest, so we recommend management to prevent future declines in tree diversity. This could include cutting vines, and enrichment planting of tree seedlings. Planting fruiting trees and/or reconnecting isolated forest patches could help attract seed-dispersing mammals and birds, and help improve forest regeneration in future (Meijaard et al. 2005).

3. Continuous forest had significantly higher levels of carbon than set-asides (figure 2). Therefore, conserving very large tracts of continuous forest is crucial for protecting the areas of highest carbon storage.

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References

Carlson, K. M. et al. (2013). Carbon emissions from forest conversion by Kalimantan oil palm plantations. Nature Climate Change, 3(3), 283–287. [https://doi.org/10.1038/nclimate1702](https://doi.org/10.1038/nclimate1702)


Meijaard, E. et al. (2005). Life after logging: reconciling wildlife conservation and production forestry in Indonesian Borneo. [https://doi.org/10.17528/sifer.004663](https://doi.org/10.17528/sifer.004663)


Cover photo: Koompassia excelsa tree, Danum Valley.

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