Introduction and context
Rainforest Alliance’s BACP-funded project in South Sulawesi, Indonesia, has worked to protect critical habitats and ecosystems by promoting the adoption of biodiversity-friendly cocoa agroforestry, certified according to the Sustainable Agriculture Network (SAN) standard, in critical areas within Bantaeng Regency. Specifically, the project is training farmers to promote adoption of the SAN standard and its component conservation-friendly best management practices.

Critical to the conservation strategy at this site is the maintenance of existing conservation values – and the rehabilitation of lost conservation values – within the production landscape. This landscape consists of a mosaic of cocoa agroforestry under varying levels of shade cover, alongside a variety of other crops including rice, cloves, and other crops grown in smaller quantities mostly for household consumption and local sale. The production landscape itself contains very little natural forest, which is mostly contained within a few small community forest reserves as well as some areas of very steep slopes unsuitable for agriculture. However, the production landscape does contain a considerable amount of tree cover, particularly in the higher elevation portions of the district (closer to the Gunung Lampobatang Protection Forest), comprising both native species and a variety of non-native trees planted for fruits, fiber, fuelwood, and other uses.

The purpose of this report is to characterize the remaining high value ecosystem patches in the Bantaeng cocoa-producing landscape, and to compare the biodiversity on these patches to that on a representative sample of cocoa agroforestry plots in the landscape. Within the SAN standard, high value ecosystems are defined to include primary and mature secondary forests as well as habitat of importance for native plant and animal populations or for the provision of critical ecosystem services. Remaining patches of natural habitat within the Bantaeng landscape would generally fall under this definition. Although these sites are not pristine (due to prior human disturbance, edge effect, and relatively small patch size) they nonetheless provide the best available reference condition against which to compare conservation values on cocoa farms.

For the analysis of high value ecosystem patches and agroforestry plots, we used vegetation composition and structure as a proxy for overall biodiversity, including conservation value for native fauna. Vegetation has been demonstrated to be a suitable proxy for many animal taxa, but is easier to monitor than faunal assemblages and is also likely to respond more rapidly and more directly to site-level management changes of the type that are being promoted under the SAN standard. The field
assessment was carried out using the Natural Ecosystem Assessment methods that are described in BACP deliverable 13, which was submitted in June 2013.

Assessment results
Results of the assessment are presented below in three sections: 1) a basic summary of the vegetation sample conducted; 2) characterization of vegetation composition and structure; and 3) a land use map showing the location of high value ecosystem patches within the broader landscape.

Sampling summary
We sampled the largest cocoa farming plot for each of the 141 out of 750+ cocoa farmers participating in the BACP project in Bantaeng regency. These farms were selected using a stratified sampling approach to represent a range of livelihood zones and farmer wealth groups from among the BACP farmer population. We also selected 15 reference sites (high value ecosystem plots) for comparison. For each cocoa farm plot, we sampled between 3 and 5 vegetation quadrats (each 10 x 10m in size). For each reference site, we sampled 4 vegetation quadrats. Table 1 summarizes the land uses of the 432 cocoa farm quadrats and 60 reference site quadrats sampled.

Table 1. Summary of vegetation sampling effort and number of trees sampled on cocoa farms and reference sites. “Emergent trees” denote all trees taller than 20m or larger than 80cm diameter at breast height (dbh), across the full extent of the farm plot or reference site. “Other trees in quadrats” include only those trees larger than 5cm dbh on the 10m x 10m vegetation quadrats sampled on each farm plot or reference site.

<table>
<thead>
<tr>
<th>Measure of sampling effort</th>
<th>Cocoa farm assessment*</th>
<th>Reference site (high value ecosystem) assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sites sampled</td>
<td>141</td>
<td>15</td>
</tr>
<tr>
<td>Number of quadrats sampled:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural forest</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Disturbed forest</td>
<td></td>
<td>44</td>
</tr>
<tr>
<td>Agroforest with high shade (&gt;40%)</td>
<td>97</td>
<td>12</td>
</tr>
<tr>
<td>Agroforest with low shade (10-40%)</td>
<td>323</td>
<td></td>
</tr>
<tr>
<td>Unshaded cocoa</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Other perennial</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Total # of quadrats</td>
<td>432</td>
<td>60</td>
</tr>
<tr>
<td>Number of cocoa trees sampled</td>
<td>2321</td>
<td></td>
</tr>
<tr>
<td>Number of other trees sampled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergent trees</td>
<td>209</td>
<td>109</td>
</tr>
<tr>
<td>Other trees in quadrats</td>
<td>759</td>
<td>254</td>
</tr>
<tr>
<td>Total # of non-cocoa trees sampled</td>
<td>968</td>
<td>363</td>
</tr>
</tbody>
</table>

* Includes data only for farms participating in the BACP project (not control farms).

Tree species assemblages (species richness and composition)
Although we sampled only 15 reference sites totaling 3.75 hectares of sampled area, we observed 120 different tree species on these sites (Table 2). This high level of species richness indicates that the reference sites likely retain a significant portion of the area’s original native tree diversity, even though these sites now exist as small patches surrounded by agricultural land. Of the 120 species observed on
the reference sites, 47 were present as emergent trees while 87 were present as smaller trees on one or more of the 60 sampled quadrats.

Total tree species richness on cocoa farms was considerably lower – a total of 56 species – even though we sampled a much larger area of cocoa farms than of reference sites. In addition, trees on cocoa farms tended to be concentrated in just a few species, typically those of utility to farmers (Table 3). The ten most abundant tree species on cocoa farms comprised about 70% of all observed trees, whereas the ten most abundant tree species on the reference sites comprised only 32% of all observed trees.

For both cocoa farms and reference sites, the observed species richness is likely an underestimate of total tree species richness because our sampling protocol sampled only a representative subset of vegetation on each farm (typically about 5% of the farm’s total area) or reference site (about 16% of the site), plus all emergent trees taller than 20m.

Table 2. Summary of tree species richness, abundance, and size on BACP cocoa farm plots and reference sites.

<table>
<thead>
<tr>
<th></th>
<th>Cocoa farms</th>
<th>Reference sites (high value ecosystem)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Species richness:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On quadrats</td>
<td>49</td>
<td>89</td>
</tr>
<tr>
<td>Emergent trees</td>
<td>30</td>
<td>47</td>
</tr>
<tr>
<td>Total</td>
<td><strong>56</strong></td>
<td><strong>120</strong></td>
</tr>
<tr>
<td><strong>Mean diameter at breast height (cm):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On quadrats</td>
<td>12.3</td>
<td>18.9</td>
</tr>
<tr>
<td>Emergent trees</td>
<td>38.2</td>
<td>66.5</td>
</tr>
<tr>
<td>Mean total basal area (m²/ha, extrapolated)</td>
<td>4.6</td>
<td>32.1</td>
</tr>
<tr>
<td>Mean # of emergent trees per plot</td>
<td>1.48</td>
<td>7.27</td>
</tr>
<tr>
<td>Mean # of other trees per quadrat (excluding cocoa trees)</td>
<td>1.76</td>
<td>4.23</td>
</tr>
</tbody>
</table>

Not surprisingly, tree abundance was much higher on reference sites than on cocoa farm plots for both emergent trees and smaller trees. The total tree basal area, which may be considered as a rough proxy for aboveground tree biomass, was about seven times higher on reference sites than on cocoa farms.
Table 3. The ten most commonly observed trees on BACP cocoa farms. For each species, the table indicates the relative frequency, whether the species is native or exotic in Bantaeng, and the primary uses for the species.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Tree species</th>
<th># observed</th>
<th>% of total</th>
<th>Type</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kapuk Randu (Ceiba pentandra)</td>
<td>159</td>
<td>16.4%</td>
<td>Exotic</td>
<td>Fiber, lumber</td>
</tr>
<tr>
<td>2</td>
<td>Cengkeh (Zysygium aromaticum)</td>
<td>141</td>
<td>14.6%</td>
<td>Exotic</td>
<td>Spice (cash crop)</td>
</tr>
<tr>
<td>3</td>
<td>Gamal (Gliricidia sepium)</td>
<td>77</td>
<td>8.0%</td>
<td>Exotic</td>
<td>Fuelwood, fodder, shade</td>
</tr>
<tr>
<td>4</td>
<td>Langsat (Langsium domesticum)</td>
<td>72</td>
<td>7.4%</td>
<td>Exotic</td>
<td>Fruit for self-consumption and cash crop</td>
</tr>
<tr>
<td>5</td>
<td>Rambutan (Nephelium lappaceum)</td>
<td>47</td>
<td>4.9%</td>
<td>Exotic</td>
<td>Fruit for self-consumption and cash crop</td>
</tr>
<tr>
<td>6</td>
<td>Jambu mente (Anacardium occidentale)</td>
<td>42</td>
<td>4.3%</td>
<td>Exotic</td>
<td>Self-consumption and cash crop</td>
</tr>
<tr>
<td>7</td>
<td>Sengon (Paraserianthes falcataria)</td>
<td>38</td>
<td>3.9%</td>
<td>Native</td>
<td>Fodder, fuelwood, lumber</td>
</tr>
<tr>
<td>8</td>
<td>Durian (Durio zibethinus)</td>
<td>36</td>
<td>3.7%</td>
<td>Exotic</td>
<td>Fruit for self-consumption and cash crop</td>
</tr>
<tr>
<td>9</td>
<td>Jati Putih (Gmelina arborea)</td>
<td>36</td>
<td>3.7%</td>
<td>Exotic</td>
<td>Lumber</td>
</tr>
<tr>
<td>10</td>
<td>Pisang (Musa Sp.)</td>
<td>33</td>
<td>3.4%</td>
<td>Exotic</td>
<td>Fruit for self-consumption and cash crop</td>
</tr>
</tbody>
</table>

Map of high value ecosystem patches and other land use types

Figure 1 provides a land cover map of the portion of Bantaeng Regency where the BACP cocoa project is focused. Natural forests comprise only a small portion of the project area, although additional forest exists outside of the mapped area.
Figure 1. Land cover map of the portion of Bantaeng Regency where the BACP cocoa project is focused. “Reference sites” are high value ecosystem patches where we conducted vegetation sampling.
Lessons learned and recommendations for future assessments

The assessment protocol proved to be a useful approach to document baseline conditions in a cocoa-producing landscape and to help identify key challenges and needs that might be addressed through the project. (These challenges and needs, as informed by the Natural Ecosystem Assessment data, are presented in Deliverable 16.) Although we will not know for certain until after the follow-up study is conducted, the method appears to provide an appropriately detailed level of information to monitor the types of vegetation changes that are expected to occur as a result of training and certification oriented around the SAN standard.

Following are some observations, lessons learned, and challenges to consider for future natural ecosystem assessments in agricultural landscapes of biodiversity concern:

1) Land cover classification is often quite challenging to conduct in mosaic landscapes with a high degree of heterogeneity. Taking the time to carefully pre-define land cover classes and provide clear visual examples of each, as well as specific criteria for the minimum mapping unit, can contribute to ensuring consistent image interpretation and an accurate land cover map.

2) Vegetation canopy cover is difficult to quantify consistently, and detailed assessment of mid-story strata in cocoa agroforests may be of limited interpretive value where these are dominated by cocoa trees. Alternative methods of quantifying tree canopy cover should therefore be explored.

3) Although the logic of monitoring vegetation composition and structure is sound from the standpoint of being able to track the effects of the training and certification interventions, certain key biodiversity information is missed by taking this approach. For instance, community mapping exercises carried out as part of this project revealed that bird hunting is commonplace and therefore many bird species are rare in the landscape. Where resources permit, monitoring of animal taxa should be considered as a complement to vegetation monitoring to be able to detect such conditions and evaluate whether an intervention focused on conservation-friendly agriculture is helping to ameliorate them.