CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

Sixteenth meeting of the Plants Committee
Lima (Peru), 3-8 July 2006

Review of Significant Trade in specimens of Appendix-II species

Species selected following CoP11 and CoP12

EVALUATION OF THE HARVEST OF *PRUNUS AFRICANA* BARK ON THE BIOKO ISLAND (EQUATORIAL GUINEA): GUIDELINES FOR A MANAGEMENT PLAN

1. This document has been submitted by Spain.

Background

2. Given the historic ties between Spain and Equatorial Guinea, and the *Prunus africana* bark exports to Spain, the Spanish CITES Scientific Authority decided to carry out a pilot project in Equatorial Guinea and the bark-harvesting area on Bioko Island. The model for this survey, which could be applied to other countries and areas, was promoted and funded by the General Directorate for Biodiversity of the Ministry of the Environment, which is the CITES scientific Authority of Spain, in June 2004.

3. A multidisciplinary team[1] from the University of Cordoba and the Cordoba Botanic Garden developed this project. The Ministry of Agriculture and Forestry and the Ministry of Fisheries and the Environment of Equatorial Guinea provided personnel to collaborate on fieldwork. Logistical support came from the Spanish company NATRA S.A.

4. The general objective of the project was to study the current range of *Prunus africana* on Bioko Island in order to determine level of present bark harvest, evaluate stocks, and propose the pertinent recommendations for designing a management plan to enable sustainable use of the species. The following specific objectives were established to achieve this general objective: survey of the distribution of dominant types of vegetation by means of a Landsat 7 ETM + image; characterization of the forests where *Prunus africana* occurs in current and potential harvest areas in terms of their structure, composition of the vegetation, wealth and diversity of tree species; estimate of bark yield; and establishment of silvicultural criteria for sustainable use of *Prunus africana* forests. An abstract of the whole project is submitted to the Plants Committee below:

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Material and methods

Study area

5. The study area comprised the island in its entirety for determining the distribution of vegetation types by satellite imagery. The field study was conducted in the areas where bark is being harvested, i.e. Pico de Basilé and Moca. The specific zone was defined using a digital terrain model with 90 m spatial resolution over the altitude range of *Prunus africana*, between 1.200 m and 2,500 m. (http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp)

6. The theoretical area where *Prunus africana* could potentially be distributed, between 1,200 m and 2,500 m as initially proposed by Sunderland and Tako (1999), was confined to 31,969.3 ha. Of this area, 16,000 ha were located on Pico de Basilé and the remainder around Moca and the eastern region of Caldera de Luba.

Classification of Bioko forest ecosystem through analysis of Landsat 7 ETM+ Imagery: sensor and pre-processing of the image

7. A Landsat 7 ETM+ satellite image (30 x 30 metre resolution) of the study area taken in March 2003 was used. The image was already geometrically corrected.

8. Radiometric adjustments were made to the three images by means of standard methods for converting digital data into spectral radiance values with Markham and Barker's formula (1986). The geometric and radiometric corrections were made using the header file coefficients for each of the bands from 1-5 and 7 of the Landsat images. Six of the eight bands were used to study the Bioko forests where *Prunus africana* occurs, disregarding the thermal (6) and the panchromatic (8) bands.

9. Two supervised classifications of the Bioko forest and Afromontane forests were performed using ERDAS 8.6 software. This method created three cluster classifications with 9, 11 and 14 classes each.

Design of sampling, data collection in the field, and data analysis

10. The selected design was a systematic inventory with a random starting point and data collection every 100 metres along existing harvest lanes. At the outset, the entire area of the forest was stratified into two altitude zones (Guinea 1949). After the first few field visits, sampling sites were identified where bark had been harvested. One was on the road to Pico de Basilé, between kms 14 and 20. Another was near the village of Moca in an area connected to the road that had been harvested in 1998. The third site was along a strip around Lake Biaó where bark had been harvested in April 2005.

11. These three sites were felt to be representative of the study area, and the harvest lanes in use originated at these points. The plot distribution had to be adapted to existing lanes because opening new lanes was deemed impossible. Estimates indicated that it would take an hour to clear 100 metres of pathway.

12. The inventory procedure was systematic in each transect. Following the recommendations from Hall (2000), a tree-by-tree inventory of *Prunus africana* covered each transect to account for a possible copse distribution. Forest mensuration data were collected for all the individuals along a 20 m strip on either side of the harvest lane.

13. Information on the proper sample size for tropical forest surveys, particularly those that evaluate non-timber forestry resources, to reflect dynamic processes, is scarce. In mountain forests with a simpler structure and just a few main species, as on Bioko, a minimum size of 1.000 m^2 and a minimum total surface area of 5,000 to 10,000 m^2 is considered a sufficient working sample (Cain and Oliveira, 1959; Bonham, 1989).

14. A circular-shaped plot with a 20-metre radius and a surface area of 1,256.636 m^2 was defined for sampling. The next step was to locate plots of these dimensions all along the inroad, identifying the centre of each plot by GPS. Forty-one sample plots were laid out: 20 in the Pico de Basilé area, and 21 in the Moca area.

15. The procedure was as follows:

   a) For the selection of transects:

      - Selection of *Prunus africana* harvest lanes (six on Pico Basilé and fice on Moca) that were already open. These lanes varied in length from 500 to 2,000 m.
      - Systematic establishment of a plot every 100 m, first determining the centre and then marking a circle with a 20 m radius around it [Magellan Meridian Color GPS navigator, average error (EPE) = 15 m.].
      - Measurement of the slope of the terrain with a clinometer.
      - Inventory of all trees with a Diameter at Breast Height (DBH) of more than 10 cm.
      - GPS Georeferencing of all exploitable *Prunus africana* individuals (> 30 cm).

   b) Parameters sampled

      - Forest mensuration and silvicultural data:

         i) Abundance – existing tree species according to number of individuals.
         ii) Dimensions of each tree – estimated height (m), DBH (cm).
         iii) Crown class of each tree and vertical stand structure.
         iv) Condition of *Prunus africana* trees in defoliation classes proposed by Sunderland and Tako (1999).
         v) Year(s) that bark is harvested – direct communication with harvesting team foremen.
         vi) Bark thickness (cm) – measured with a Suunto bark gauge.
         vii) Extent of intervention in the forest – none, little, some, or much.

   c) Bark samples taken from one tree every three plots to measure thickness and specific weight

16. The vegetation structure of the plots was analysed by calculating values for relative and average basal area, and species density and frequency. In an attempt to find common structural patterns for the areas studied, the species population structure was analysed on the sole basis of grouping individuals of the most significant species into diameter classes.

17. To determine specific weight, random 10 x 20 cm samples (N = 10) were gathered at a height of 0.80-1.30 m. The thickness of the living bark, and the surface area of the bark sample were the parameters analysed. Bark thickness was measured with a calliper (error: 0.1 mm.), and the total surface area of the sample was determined in order to find the specific weight of the bark (g/cm^{-3}).

18. For estimates of fresh bark yield and regeneration, field data on bark thickness (N = 264), DBH, and height up to where the bark had been removed were taken with a Suunto bark gauge, measuring regenerating bark on trees that had already been harvested (N = 192), and the bark on trees that were still intact (N = 72). In both cases, the measurements were made at a height of 1.20 m. Bark yield per tree and the evolution of bark thickness over time were surveyed by means of simple/multiple regression analysis between the bark thickness/age variables, or between fresh bark weight/debarking height and DBH.

19. Data analysis involved calculating and interpreting linear, potential, exponential, logarithmic, square and cubic models. A statistical analysis was performed with the *SPSS 8.0* programme. In the process of selecting the best prediction model for bark regeneration, specifications for valid explanatory models resulted from the analysis of the inventoried population sample. This analysis consisted of:

   – Measuring goodness of fit, using the coefficients R for correlation, R^2 for determination, and *SE* to express an estimated standard estimating error; and

   – Testing goodness of fit: analysing variance to contrast the statistical significance of R^2 by calculating the F ratio and the p value.

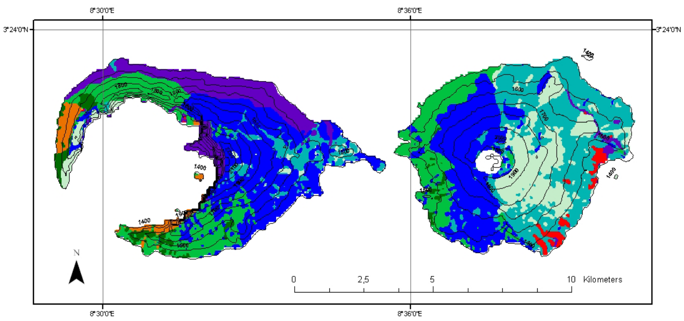
20. The damage to *Prunus africana* trees through bark harvest was evaluated on a scale from 0 to 5, depending on the extent of defoliation the trees presented (Sunderland and Tako, 1999). A value of 0 was assigned in the absence of damage, and 5 meant the tree was dead (100% defoliation).

Results

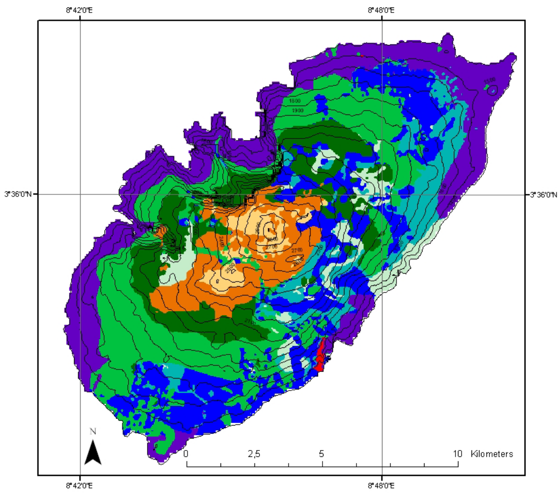
21. The range of *Prunus africana* was established from 1,400 to 2,500 m, occurring chiefly in connection with the araliaceous forest. While some authors (Sunderland and Tako, 1999) cite distribution of the species between 1,200 and 2,500 m on Bioko Island, the results of the present study partially coincide with Ocaña's findings (1960), associating the araliaceous forests with altitudes from 1,400 to 2,500 m, although Ocaña did not specifically mention *Prunus africana* in this type of forest.

22. The estimated surface areas of each vegetation type according to the digitized version of Ocaña's map were compared to the supervised classification with the 2003 Landsat ETM + image. The total surface area of the main vegetation types nearly coincided, but the area covered by the araliaceous forest was noticeably smaller. Ocaña found this formation to occupy an area of 29,280 ha, while the present study shows an expanse of 8841 ha.

23. Table 1 shows the results of supervised classification of the areas occupied by the main vegetation formations between 1,400 and 2,500 m, the elevation boundaries of *Prunus africana*'s range. The main non-degraded areas where *Prunus africana* occurs are located on Pico de Basilé: 7,043 ha of araliaceous forest and 2,030 ha of lowland Afromontane forest. Nevertheless, a larger expanse of secondary Afromontane forest – 3,443 ha – did appear in the Moca area. These lands were formerly devoted to cattle raising and were abandoned in the mid-20th century. *Prunus africana*, with its heliophilous temperament, has adapted easily and thrives here.



Moca and Grand Caldera de Luba



Pico de Basilé

Legend

- 100-m elevation contours
- Afro-alpine vegetation
- Agriculture
- Araliaceae forest, lower type
- Araliaceae forest, upper type
- Ericaceous shrubland
- Guineo-Congolian rainforest with Afromontane elements
- Secondary Afromontane forest
- Secondary Afromontane forest, mature type
- Secondary Afromontane grassland

Figure 1. Mountain vegetation of southern Bioko and Pico Basilé, 1,400 m and above.

24. Recently abandoned areas were identified around the village of Moca. There has not been enough time for regeneration of *Prunus africana* here, nor for the establishment of any secondary woodland formation, so these areas appear as herbaceous prairies in the supervised classification – 1,370 ha of

degraded Afromontane forest – in locations where *Prunus africana* would naturally occur. In any case, the herbaceous prairies on Pico de Basilé (degraded Afromontane forest) only cover 175 ha and these are chiefly the result of regeneration after forest fires.

25. Another point to bear in mind is that the elevation boundaries of the Afromontane forest vary depending on the area and the orientation of the hillside. This is why a relatively large patch of Guineo-Congolian rainforest appears on the north side of Pico de Basilé, above the altitudinal limit of its range, mixed with Afromontane elements. The reverse situation also takes place, when the altitudinal limit of the Afromontane forest descends to the level of the Guineo-Congolian rainforest (e.g. on the southern side of Basilé) and is equally defined in the supervised classification as Guineo-Congolian rainforest mixed with Afromontane elements.

Table 1: Estimates of the area occupied by the main vegetation formations on the Bioko Island (Pico de Basilé, Moca, and Gran Caldera de Luba) at altitudes above 1,400 metres, according to supervised classification.

Vegetation type	**Supervised classification (Landsat ETM + 2003)**	
	Pico de Basilé (ha)	**Moca and Gran Caldera de Luba (ha)**
Guineo-Congolian rainforest mixed with Afromontane elements	1568	390
Low Afromontane forest	2030	435
Afromontane herbaceous prairies	793	0.5
Afromontane heath shrubbery (Ericaceae)	1131.37	20.25
Grasslands	17	76
Secondary Afromontane forest	1735	3443
Herbaceous prairies (degraded Afromontane forest)	175	1370
Highland Afromontane forest (Araliaceae)	7043	1393
Degraded Guineo-Congolian rainforest	1.5	14
Young Guineo-Congolian rainforest mixed with crops	115	35
Old secondary Guineo-Congolian rainforest	0	0.5
Primary Guineo-Congolian rainforest	0.36	0
Total	14,609.23	7177.25

Species composition of the forests sampled

26. Forest inventories identified a total of 355 individuals, belonging to 37 different tree species. Besides *Prunus africana*, the species most often found were *Schefflera mannii*, *S. barteri*, *Neboutonia macrocalix*, *Trichilia priureana*, *Bersama abysssinica*, *Maesa lanceolata*, *Xymalos monospora*, *Polyscias fulva*, *Oxyanthus* spp., and *Ficus clamydocarpa*. *Hypericum lanceolatum*, a characteristic species of the ericaceous upper storey, appeared sporadically, chiefly in areas disturbed by fire, always accompanied by the aforementioned *Polyscias fulva*, which was even more abundant. The shrub stratum was made up of species such as *Uragoga manii*, *Oxyanthus tenuis*, and *Solanum* spp., with *Anchomanes diformis*, *Piper guineense*, and *Aframomun* sp., among many others, on the herbaceous stratum, but these strata were not inventoried in this project. The best-represented family of ligneous species was *Rubiaceae*, with a total of eight different species in the genera *Cephaelis*, *Psychotria*, *Oxyanthus*, and *Uragoga*. Other ligneous species besides those recorded in the forest inventories were also identified in the study area. Examples include *Ficus exasperata*, *Macaranga* spp., *Alangium begonifolium* and *Dracaena* sp.

Range of *Prunus africana*

27. The forest inventory found *Prunus africana* individuals from 1400 up to 2500 m on the Bioko Island. The 41 plots inventoried in the potential range showed a theoretical distribution of the species at elevations between 1,400 and 2,500 m, with an average slope of 17%.

28. The potential surface areas obtained for the altitudinal range proposed here (1400-2500 m) were smaller than those that would have been obtained by considering an altitudinal range from 1200-2500 m (Sunderland and Tako, 1999). In this case, the total theoretical surface area estimated for

the island would be 31,969.3 ha, of which 16,000 ha would be located on Pico de Basilé and 15,969.3 ha in the Moca-Gran Caldera de Luba area.

29. Nevertheless, following the supervised classification and the altitude limits established (1,400-2,500 m), the total surface area of potential distribution would reach 21,620.12 ha, most of which would be located on Pico de Basilé (14,492.37 ha), and the remaining 7,127.75 ha would be divided between Moca (3,559 ha) and Caldera de Luba (3,568 ha). Furthermore, fieldwork gave a sense that actual distribution in Moca was probably lower as a result of deforestation for former livestock use in the area.

30. As for the extent of interventions in the forest, the results indicated that most of the sampled plots had been subject to "little intervention" for some years. They are areas where *Prunus africana* bark had been harvested, but no other plant harvesting activity had taken place. The main reason for the degradation of the forest was fire, although these could not yet be labelled regenerated secondary forest areas. The Monguibus (Moca) area was an exception, since it was used for livestock purposes in the early 20th century and then abandoned, becoming a secondary forest with *Prunus africana* as the principal species 60 years later.

Structure of forests where *Prunus africana* occurs

31. Table 2 shows the average structural attributes obtained for forests with *Prunus africana* on Pico de Basilé and Moca. They are expressed as total tree density, density of *Prunus africana*, canopy cover fraction – both overall and specifically for *Prunus africana* – in units per hectare and average stand height in metres.

Table 2: Structural attributes of the vegetation in the ecosystems where *Prunus africana* occurs on Pico de Basilé and Moca, showing absolute values for total density, density of *Prunus africana*, average stand height, and canopy cover fraction (CCF).

Site	Total tree density (trees/ha)	*P. africana* density (trees/ha)	Average stand height (m)	Total tree CCF (%)	*Prunus africana* CCF (%)
Pico de Basilé and Moca	69.29	7.18	24	77.16	14.7

32. Earlier estimates on Pico de Basilé (Monforte, 2000) gave much higher values for density per hectare than those found in the present forest inventory.

Forest inventory

33. Inventories to determine the abundance of *Prunus africana* in the two areas where bark is currently harvested provide precise data on the stocks in each sector (Table 3).

Table 3: *Prunus africana* density and distribution values (%) by diameter classes.

Zone	*Prunus africana* (stems/ha)	≤40 cm	40-60 cm	80-100 cm	100-120 cm	120-140 cm	140-160 cm	160-180 cm	180-200 cm	> 200 cm
						%				
Pico Basilé	**7.56**									
Low area	2.65	1.41	5.63	14.08	18.31	22.54	11.27	12.68	7.04	7.04
High area	15.38	8.45	2.82	11.27	15.49	12.68	15.49	8.45	7.04	18.31
Moca	**6.82**									
Pico Biaó	6.37	16.90	28.17	7.04	2.82	1.41	0.00	0.00	0.00	0.00
Monguibus	5.68	2.82	8.45	4.23	1.41	0.00	0.00	0.00	0.00	0.00
Low area	9.95	8.45	21.13	9.86	2.82	0.00	0.00	1.41	0.00	0.00

34. *Prunus africana* stands showed great heterogeneity due to factors that are difficult to pinpoint, such as ecological variations, natural forest dynamics, or historic use patterns. This led to a selection of five different zones: two on Pico de Basilé and three in Moca. Abundance varied significantly; more

on Basilé than in Moca. The average abundance per zone, however, remained relatively constant (7.5-6.8 stems/ha^{-1}), which are very high values compared to other natural populations studied, meaning that these forests can be considered rich in this species. It is important to highlight the imbalance found in the distribution of *Prunus africana* diameter classes, as other authors had already indicated (Cunningham and Mbenkum, 1993; Sunderland and Tako, 1999).

<u>Bark yield and calculation of estimated yield by zones</u>

35. The inventory provided the basis for a thorough study of potential bark yield in the current harvest areas. The specific weight of the bark was established at 0.57 g/cm^3 and used as a parameter in determining bark yield. Bark thickness varied from 0.8 to 1.5 cm, depending on the diameter class, which was consistent with figures shown in the literature, if slightly lower (Tonye *et al.*, 2000). These data made it possible to calculate dry bark yield by diameter class and debarking height, which oscillated between 15 kg/tree^{-1} (diameter ≤30 cm) and 231 kg/tree^{-1} (diameter ≥200 cm). Estimation of average dry bark weight was based on a 50% weight loss in the drying process. The average yield per ha was established considering stem distribution by diameter class (Table 4).

Table 4: Average dry bark yield per ha for current and potential harvest areas according to distribution of diameter classes.

Harvest area	Yield of the average tree (kg/tree^{-1})	Density (stems/ha^{-1})	Average dry bark yield (kg/ha^{-1})
Pico de Basilé – high area	107.11	15.38	1647.35
Pico de Basilé – low area	115.92	2.65	307.19
Pico de Basilé – south area	111.5 (estimated)	7.56 (estimated)	842.94
Pico de Basilé – east area	111.5 (estimated)	7.56 (estimated)	842.94
Moca – low area	39.68	9.95	394.82
Moca – Monguibus	30.87	5.68	175.34
Moca – Biaó	35.04	6.37	223.21

36. The harvest areas in the present study were estimated as: 2,741 ha for Pico de Basilé and 457 ha for Moca, according to the following breakdown: Pico de Basilé high area (1,622 ha), Pico de Basilé low area (1,119 ha), Moca low area (282 ha), Moca-Monguibus (103 ha) and Moca-Biaó (72 ha). The proposed new areas in the southern and eastern foothills of Pico de Basilé were estimated to reach 2500 ha, given maximum harvesting distances and accessibility. The maximum potential dry bark yield of each harvest site was determined on the basis of the estimated total surface (Table 5).

Table 5: Maximum potential dry bark yield of harvest sites by total surface area and average dry bark yield.

Harvest site	Surface area (ha)	Average dry bark yield by diameter classes * (kg/ha^{-1})	Maximum potential dry bark yield (t)
Pico de Basilé – high area	1622	1647.35	2672.00
Pico de Basilé – low area	1119	307.19	343.75
Pico de Basilé – southern area	1500 (estimated)	842.94 (estimated)	1264.41 (estimated)
Pico de Basilé – eastern area	1000 (estimated)	842.94 (estimated)	842.94 (estimated)
Moca – low area	282	394.82	111.34
Moca – Monguibus	103	175.34	18.06
Moca – Biaó	72	223.21	16.07

***** 50 % fresh weight / dry weight yield

37. The estimated growth of *Prunus africana* bark by harvest season indicated that it would take the trees 8 to 10 years to regenerate the minimum bark thickness for a second harvest. Data on productivity enabled an analysis of the advantages and disadvantages of the current situation, and to identify the most important recommendations to ensure a successful management plan.

Definition of production units and estimate of harvest quotas

38. Table 6 includes all the data that was used to calculate the estimated annual potential yield per harvest area, for a theoretical situation of unharvested bark. The factors taken into consideration were the harvest area, the proportion of area under exploitation (P = 80%), *Prunus africana* density, the proportion of exploitable trees (P = 90%), estimated yield per tree, and two possible scenarios: a 10-year harvest cycle and an 8-year harvest cycle. A potential harvest quota was determined for the accessible sites using Ondigui's proposed equation (2001), assuming an unharvested stand.

Table 6: Estimated potential annual dry bark yield for an unharvested stand, by surface area to be harvested, proportion of area exploited, *Prunus africana* density, estimated dry bark yield in current and new proposed harvest areas, proportion of trees exploited, and return times (F = 10 years and F = 8 years). Values for the new proposed harvest areas are shown in boldface type.

Harvest area	**A Surface area to be harvested (ha)**	**P Proportion of area exploited (%)**	**RME *Prunus africana* density (stems/ha)**	**Y Estimated yield per tree (kg/tree-1)**	**RME x Y Estimated dry bark yield[1] (kg/ha)**	**V Proportion of exploitable trees (%)**	**Estimated potential bark yield[2] (t/yr) in unharvested condition, depending on F (No. of years between harvests)**	
							F = 10 years	F = 8 years
Current areas							Current areas	Current areas
Pico de Basilé high area	1622	80	15.38	107.11	1647.35	90	192.38	240.48
Pico de Basilé low area	1119	80	2.65	115.92	307.19	90	24.74	30.93
Moca low area	282	80	9.95	39.68	394.82	90	8.16	10.02
Moca Monguibus	103	80	5.68	30.87	175.34	90	1.30	1.62
Moca Lake Biaó	72	80	6.37	35.04	223.21	90	1.15	1.44
Total current areas[3]							227.73	284.49
New areas							**New areas**	**New areas**
Pico de Basilé – south area	1500 (estimated)	80	7.56 (estimated)	111.5 (estimated)	842.94 (estimated)	90	91.03 (estimated)	113.79 (estimated)
Pico de Basilé – east area	1000 (estimated)	80	7.56 (estimated)	111.5 (estimated)	842.94 (estimated)	90	60.69 (estimated)	75,86 (estimated)
Total with new areas[4]							**379.45**	**474.14**

[1] The estimated yield from fresh bark to dry bark was 50 %.

[2] The average yield per hectare was calculated according to the frequency of diameter classes in each harvest area.

[3] Values not including new potential harvest areas

[4] Values including new potential harvest areas

39. The final proposal for a recommended quota took the following aspects of the current situation into account.

40. Exports reported in accordance with CITES regulations appeared in 1998 and ceased over the period 1999-2002. The authors of the present study, however, believe they had begun in 1996, and that average annual harvest was 199 t. Nearly all of this harvest took place on Pico de Basilé, although the low part of Moca was also harvested in 1998.

41. In 2005, with a harvest area restricted by the road and by the inward distance (1.5 km), harvesting could be concluded to focus on trees that had already been debarked. This was visible in all the transects on Pico de Basilé, indicating that a second harvest (or even a third, on occasional trees) continued to be the practice in areas of easy access. Trees harvested for the first time were only a scattered few.

42. The main problem with this second harvest is that it occurred with no knowledge of the distribution of previous seasons' harvests, resorting to trees with scant bark regeneration, showing no regard for the years gone by since the first harvest. Under these circumstances, harvesters return to exploit trees in the field with only minimum bark regeneration (≤0.5 cm), at the consequent risk of causing damage that could potentially increase future mortality. Accordingly, it would be wise to provide these trees a rest period for the bark to regenerate properly.

43. In April 2005, harvest extended into new areas where the trees were still intact, specifically around Lake Biaó, so there are stocks – albeit limited – that will be available for a second harvest. The Monguibus location is the site of easiest access for the harvesters. The Moca lowland area is the one with the largest stocks, but many of these trees have already been exploited, meaning reduced potential yield and increased risk of mortality.

44. As for the two new harvest areas, although they have yet to be visited and there are no previous surveys of their potential yield, it could be inferred that these are similarly structured Afromontane forests, so *Prunus africana* stem density should also be similar to stands in the areas that have been studied. Estimates in the present study were based on a density value of 7.56 stems/ha^{-1} and a yield per tree of 111.5 kg, in light of the results obtained for the northern part of Pico de Basilé. Thus, predictions for the new harvest areas may be offered. South Basilé would potentially bring a yield of 91.03 t/year^{-1} of dry bark with a 10-year return time, and 113.79 t/year^{-1} with an eight-year return time. East Basilé would produce 60.69 t/year^{-1} with a 10-year return time, and 75.86 t/year^{-1} leaving eight years between harvests. It would be very important to perform the pertinent preliminary studies before beginning harvest activities, and to implement the precepts of a management plan from the very outset.

45. In short, for a theoretical situation of no previous exploitation and a return time of 10 years, the total potential yield of dry bark would be 227.73 t/year^{-1} in the current harvest areas, and 379.45 t/year^{-1} with the addition of the two new areas. Given an eight-year return time, it would be 284.49 t/year^{-1} in the current areas and 474.14 t/year^{-1} with the new ones.

46. Under the current circumstances in the various harvest areas, the recommended total annual quota for 2006 was determined considering the need for a rest period so that bark might regenerate on Pico de Basilé, and also counting on fewer stocks in the Moca and Lake Biaó lowland area, having already been harvested once. Table 7 compares estimated potential bark yield (t/year) in unharvested condition and the recommended quota for 2006 based on analysis of the status in current and new harvest areas, for return times of 10 and eight years (see Table 6).

Table 7: Estimated potential bark yield (t/year) in unharvested condition and recommended quota for 2006 following analysis of status in current and new harvest areas, considering 10-year and eight-year return times.

Harvest area	**Estimated potential bark yield (t/yr) in unharvested condition depending on F (No. of years between harvests)**		**Recommended quota (t/yr) for 2006 following analysis of status in current and new harvest areas**	
	F = 10 yrs	F = 8 yrs	F = 10 yrs	F = 8 yrs
Current areas	Current areas	Current areas	Current areas	Current areas
Pico de Basilé high area	192.38	240.48	0 (bark regeneration period)	0 (bark regeneration period)
Pico de Basilé low area	24.74	30.93	0 (bark regeneration period)	0 (bark regeneration period)
Moca low area	8.16	10.02	4.08 (2nd harvest)	5.01 (2nd harvest)
Moca Monguibus	1.30	1.62	1.30 (unharvested)	1.62 (unharvested)
Moca Lake Biaó	1.15	1.44	0.58 (2nd harvest)	0.72 (2nd harvest)
Total current areas	**227.73**	**284.49**	**5.96**	**7.5**
New areas	**New areas**	**New areas**	**New areas**	**New areas**
Pico de Basilé – south area	91.03 (estimated)	113.79 (estimated)	91.03 (estimated)	113.79 (estimated)
Pico de Basilé – east area	60.69 (estimated)	75.86 (estimated)	60.69 (estimated)	75.86 (estimated)
Total with new areas	**379.45**	**474.14**	**157.68**	**197**

47. The maximum annual dry bark quota recommended for 2006, with the addition of the new areas, would be 157.68 t/year^{-1} considering a 10-year return time, and 197 t/year^{-1} if the return time is set at eight years. In the future, the areas already harvested should be monitored to see how their status evolves, and preliminary surveys conducted in the new areas. This would enable thorough harvest planning and establishment of subsequent annual quota proposals in the context of an overall management scheme.

Harvest technique

48. Harvest technique obviously must be considered most carefully. An excellent starting point can be found in the numerous proposals put forward by Cameroon, which seem to have improved harvesting conditions in that country, but observations made in the course of fieldwork on Bioko Island and data obtained in this study have led to reconsideration of some aspects contained in those proposals. The following suggestions are offered:

    a) Remove bark with machetes, since they seem to be the tools the workers handle best, giving them better control so as not to damage the cambium. Use of any tool that damages to the cambium should not be permitted.

    b) Begin cutting at a height of approximately 1 m above the ground, or just above the ridges (where present).

    c) Increase the minimum diameter for harvest to trees with ≥40 cm DBH.

    d) The technique of totally stripping the bark does not seem to cause massive tree mortality (< 6 %), as this species has shown a great capacity for bark regeneration. Therefore, the system of debarking by quarters or eighths does not seem very operational. An intermediate alternative would be to leave a section of about 20 % of the perimeter intact.

    e) Another alternative that might be advisable is to remove 50 % of the bark with each 'peeling', leaving a rotation period of five years between each harvest. In any case, this is a matter for discussion, relating to the effectiveness of the system.

f) Mark trees, setting a recommended return time of eght years.

g) Condition any second harvest on the vigour of the stands. Trees with over 40 % defoliation should not be harvested.

h) Suspend harvesting activities during the rainy season, given the high risk of rotting, as well as practical considerations (accessibility, workers' welfare, etc.) that make work ill-advised at this time.

i) Leave some trees in the harvest areas for seed. One sole harvest of one tree in every 10 (≥60 cm) is recommended, not harvesting one tree in every 20 (≥60 cm).

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In light of the results of this pilot project, the Plants Committee is requested to support the following recommendations:

At the international level: Measures directed to international organizations, countries and industries with a stake in imports, exports and trade in products derived from *Prunus africana* bark.

1. Effectively foster implementation of management plans in range countries.
2. Coordinate promotion of thorough *Prunus africana* population surveys throughout its range.
3. Encourage international cooperation projects to advance the use of *Prunus africana* in agro-forestry systems and plantations, including proper genetic diversity and optimizing propagation and agro-forestry cultivation techniques.
4. Coordinate methods used on Bioko Island for evaluating *Prunus africana* production in natural ecosystems with other methodological proposals in CITES.
5. Ensure the quality of studies and follow-up of management plans for the species.

At the national level: Measures directed to the Government of the Republic of Equatorial Guinea.

1. Define, initiate and implement the *Prunus africana* management plan
2. Promote use of *Prunus africana* in agro-forestry systems and plantations, including proper genetic diversity and optimizing propagation and agro-forestry cultivation techniques, especially in the Moca area.
3. Establish *Prunus africana* plantations allowing an estimated 12-year period to reach the harvest phase. This would relieve the pressure on natural stands and maintain sustainable harvest of the species in the future.
4. Designate a skilled overseer, in coordination with harvest authorities, to ensure best practice
5. Set the 2006 harvest quota at 197 t, with an eight-year return time.
6. This quota should be scientifically evaluated and revised annually.
7. Allow only one harvesting company to operate in the area.

At the local level: Measures directed to the local population in charge of harvesting the bark, which should be taken in conjunction with the export firm:

1. Workers should receive adequate prior training on bark harvesting techniques that do not damage the tree, and they should have the proper tools for the job.
2. Free at least one worker from debarking to take charge of supervising and reviewing best harvesting practice.
3. Encourage harvesters to work for the quality rather than the quantity of bark harvested.