CSFI COROZAL SUSTAINABLE FUTURE INITIATIVE

Freshwater Creek Forest Reserve

Belize, Central America

Sustainable Forest Management Strategy

2016 - 2116

Members of the working group:

Caspar Bijleveld (President ITCF)
Heron Moreno (Director CSFI)
Maut Star Busmann (Forest Engineer)
Pascal Walter (Forest Engineer)
Silas Hobi (Project Leader)

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Forest activities are not benefiting us, but future generations.

> *Forests are slow developing ecosystems. Therefore a long term planning is fundamental for sustainable forest management. Results from today's activities will benefit future generations. Short term profit maximizing cannot be a priority.*

Forest should eventually work for us, and not the reverse.

> *Forest management activities consider local conditions and enforce the natural forest dynamic. Our activities enable the forest to develop naturally, but geared towards production.*

Operational costs of forestry activities are usually and at least partially covered by the income generated by forest products.

> *Heavily depleted forests take time to recover, and will not cover costs in initial years. Hence, return on investments will be difficult to achieve and forest restoration will need support.*

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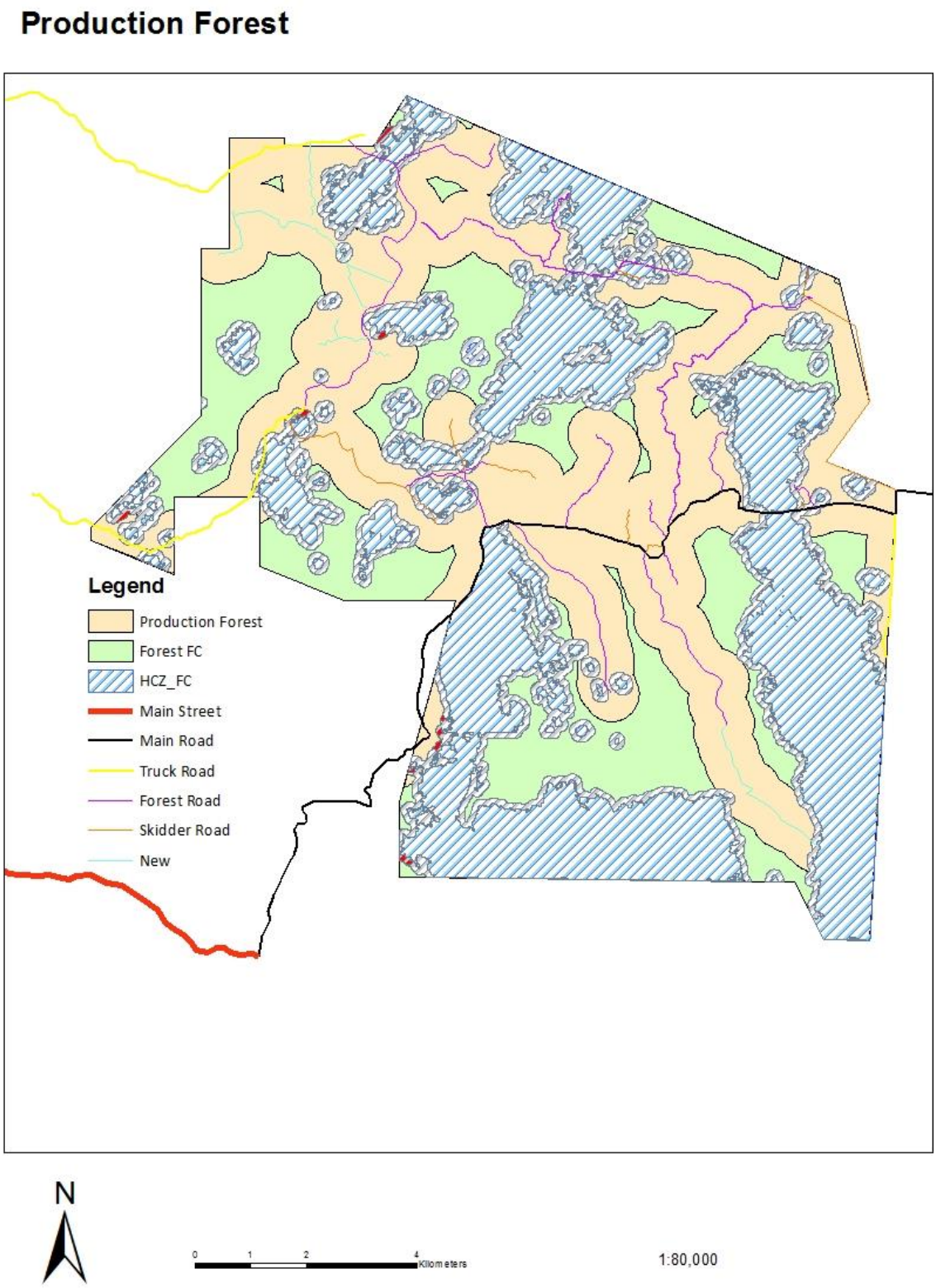

Figure 1: A 500m buffer around the existing roads was desgnated as production forest.

1 Introduction

The forests of Freshwater Creek Forest Reserve (FCFR) have been heavily depleted and degraded in the past decades. They nevertheless still represent an important reservoir of biodiversity and hardwood phenotypes.

The total surface of the FCFR is about 133 km^2. In 2014, 56% of the total area of FCFR have been classified as strict conservation zones, including 20% of high forest. Inside these zones, no forestry operations are to be allowed other than seed collection. The remaining 44% of the area (14,250 acres or 5,850 hectares) have been designated as "production forests" (FCFR annual report, 2014).

Since some parts of this production area are difficult to access, our initial phase will focus on a 500m buffer around the existing forest roads and major trails (fig. 1). This results in a total management area of 4'654 ha or 35% of the total area of FCFR. Thus, the protected forest area *de facto* increases from 20% to 29%.

A 25-year cutting cycle, as used for hardwood species such as Mahogany (*Swietenia macrophylla*) is to be implemented, which in turns gives an annual harvest area of 185 ha.

The re-measurement of permanent plots established by the Government of Belize in the early 1990s, allowed for the estimation of volume increase which by extrapolation amount to 35m^3 per hectare.

The goal of the project "Sustainable Forest Management" at Freshwater Creek Forest Reserve is to restore the forests as production forests, while applying sustainability at all levels. In due course, the understanding of forest dynamics but also potential should increase with local or regional communities, while adequate structures and management will be implemented to ensure long-term operations.

2 Goals

Forest management activities guarantee the existence of a healthy forest ecosystem benefitting local communities now and in the future.

The remaining degraded forest increases quality in terms of higher biodiversity and higher economic value through silviculture implementations and time for regeneration. Forest plays an important role for the social development of the local people.

Local community increases understanding of the forest ecosystem and know-how of sustainable forest management and establish structures to benefit from the forest products.

3 Methods

High conservation value areas (HCVs), where no human impact (except monitoring, seed collecting and scientific research) is allowed have to be defined, controlled and protected.

Silviculture treatments are implemented to increase the health, stability, quality and biodiversity of the forest ecosystem of FCFR.

Sustainable forestry activities are divided in four cycles, covering the whole of Freshwater Creek Forest Reserve, and extending over 100 years.

Commercial harvesting is reduced to a minimum within the first cutting cycle, in order to let stocks increase.

Priority is initially given to pre-commercial thinning, in order to enhance seed-bearing mother trees, while also freeing future harvestable trees of competition.

Existing anthropogenic or natural gaps will be opened in order to enrich the area with high value timber species.

The employees get trained in forest management activities, knowledge about local and international timber market gets improved and timber and non-timber products will be defined.

4 First 25-years cycle (2016-2041)

4.1 Goals

1. Avoid all agricultural and illegal-logging activities;
2. Establish a (wildlife and forest) monitoring program covering the whole area of FCFR;
3. Increase stock, number of trees with a high DBH and number of valuable timber species;
4. Establishment of efficient and modern forest management structures;
5. Improvement of the road and trail network system;
6. All construction material will be provided by FCFR;
7. Cover CSFI's operational costs with income from timber and non-timber forest products;
8. Achievement of a sustainable forest management certificate (e.g. FSC) enabling access to foreign markets;
9. Be part of the REDD+ program of Belize;

4.2 Methods

1. Patrolling combined with community engagement, in order to avoid agricultural encroachments and other illegal activities;
2. Collaboration with one or several institutions (e.g. FAO, CIFOR, CATHIE, UB, FD, WSL, WVS, CODOC (Switzerland)) ensuring long term monitoring and research activities.
3. In each hectare within the productive forest area, the following four actions wille be implemented:
    a. Harvesting of the leafs from *Sabal morrisiana* (Wano Palm);
    b. Stock survey, mapping and documentation of trees;
    c. (Pre-)commercial thinning;
    d. Clearing of gaps and planting of *Swietenia macrophylla* (Mahogany).
4. Investment in technical and untechnical staff, forest equipment and training of employees;
5. Improvement of knowledge, education, know-how, incentives and working conditions of employees;
6. Investment in road and trail network system;
7. Establishment of local and international trading networks and timber-markets;
8. Diversification of forest products.

4.3 First 5 years (2016-2021)

4.3.1 Goals

1. Capacity-building in pre-commercial thinning and gap planting of *Swietenia macrophylla* within 185 ha annually;
2. Enrichment of all former agricultural areas with Mahogany;
3. 20'500 Mahogany seedlings produced and planted annually;
4. All initial activities (signs, monuments, construction work) completed;
5. 12 employees working for CSFI exclusively in forest activities;
6. Two governmental permanent plots regularly measured and maintained;
7. Employees complete a forest management training program;
8. Establish a specific label or brand for CSFI-products.

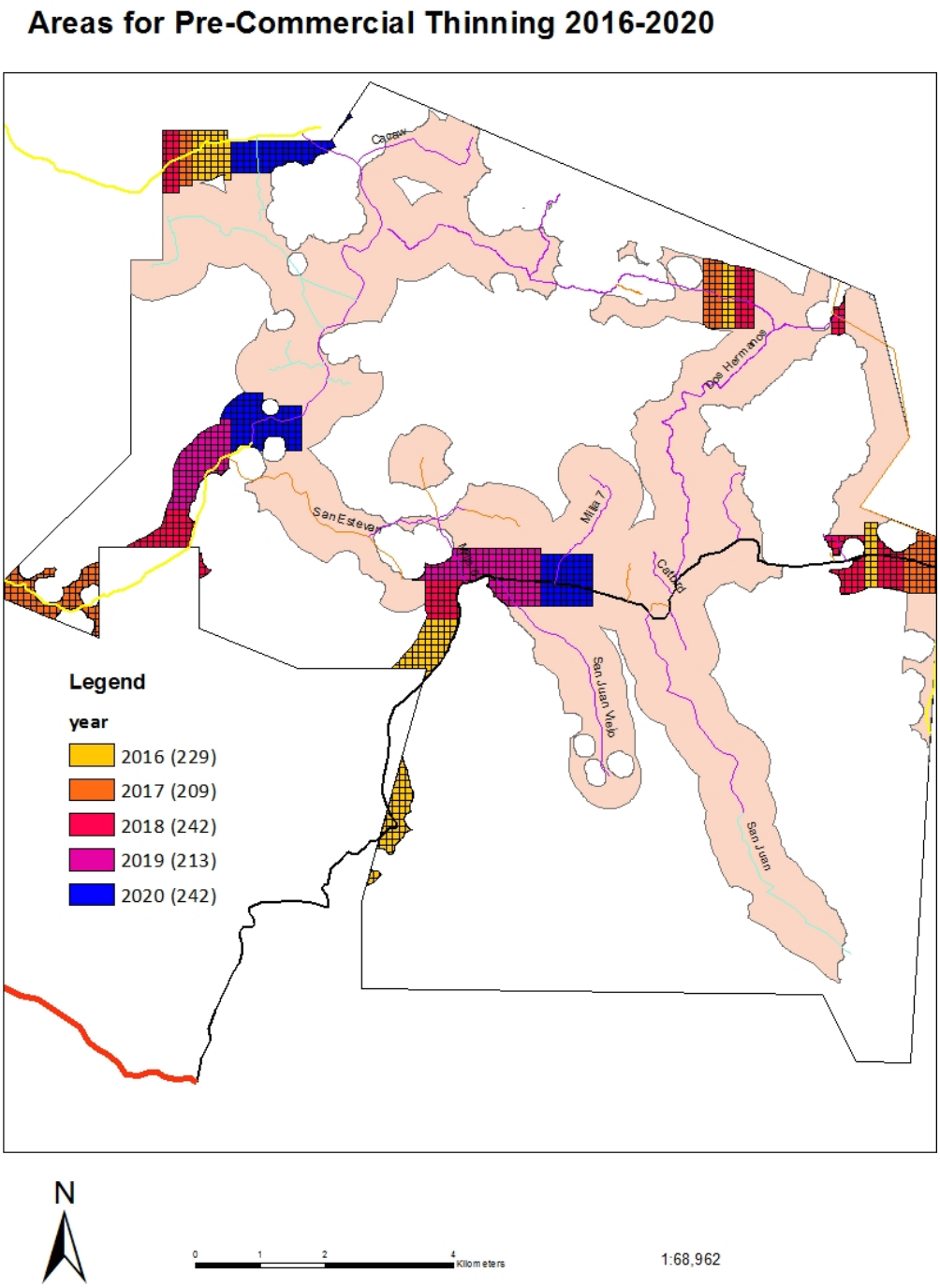

Figure 2: Areas, where the pre-commercial thinning activities will take place within the next five years.

4.3.2 Methods

1. From January to June, two members of staff harvest Sabal morrisiana leaves in 185 ha (fig. 5). They follow a group responsible for pre-commercial thinning and harvest within the same areas. Leaf harvesting typically occurs between the full moon up until two days before the new moon. Reportedly, leaves harvested outside this period deteriorate significantly and more rapidly than those cut in the correct phase of the moon. Ideally, all but two leaves are harvested from each individual plant. Two young fully-formed leaves are left on each plant.

   As soon as harvest reaches satisfactory numbers, leave bundles are to be shipped to San Pedro. Palm trunks removed during pre-commercial thinning may also be sold for pier or seawall construction.

2. Eight employees are needed to conduct stock surveys, pre-commercial thinning and gap cleaning from January to June (fig. 5). A maximum of 15-20m^3 per hectare can be cut down in order to remove competition trees. After this initial passage, no other forest operations are to take place during the next 25 years (excluding maintenance of planted trees). A method for stock surveys, classification of trees, pre-commercial thinning and a complete material list is described in detail in the annex 1. In one day, four staff members can implement the following three steps in a one hectare unit: First, identification and classification of the trees, second, girdling and cutting the competition trees and finally, clearing gaps.
   Hence, two teams of four people will be able to "treat" 185 ha (excluding 20 ha of agriculture) within five months (in the absence of unforeseen natural phenomenon preventing work).

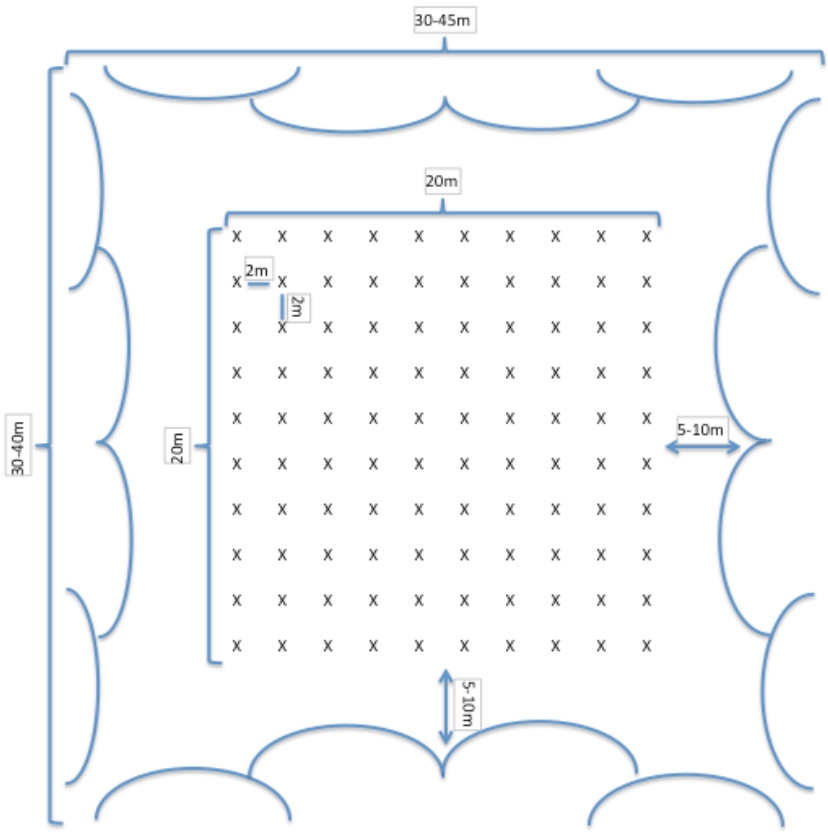

Figure 3: Sketch of Mahogany planting site.

3. Annually, 185 ha are enriched with *Swietenia macrophylla* seedlings. In gaps of around 35X35m, 100 *Swietenia macrophylla* are planted within a 20X20m area (fig. 3). Due to crown closure, a distance of around 5-10m (from the planting site to the next stem) is needed to ensure enough light for the young trees.

   In previously cleaned gaps, four members of staff can plant *Swietenia macrophylla* in two hectare units per day. By extrapolation, eight employees can enrich the 185ha within three months from June to August (fig. 5).

   Additional, 20ha of uncleaned agricultural areas have to be enriched with *Swietenia macrophylla* seedlings annually. Per hectare unit, 100 *Swietenia macrophylla* are to be planted. Each hectare is divided in four plots 10X10m, and 25 *Swietenia macrophylla* are planted in each plot (fig. 4). Eight employees can plant one hectare a day. At the end of August within two weeks, 20ha will be enriched with *Swietenia macrophylla*.

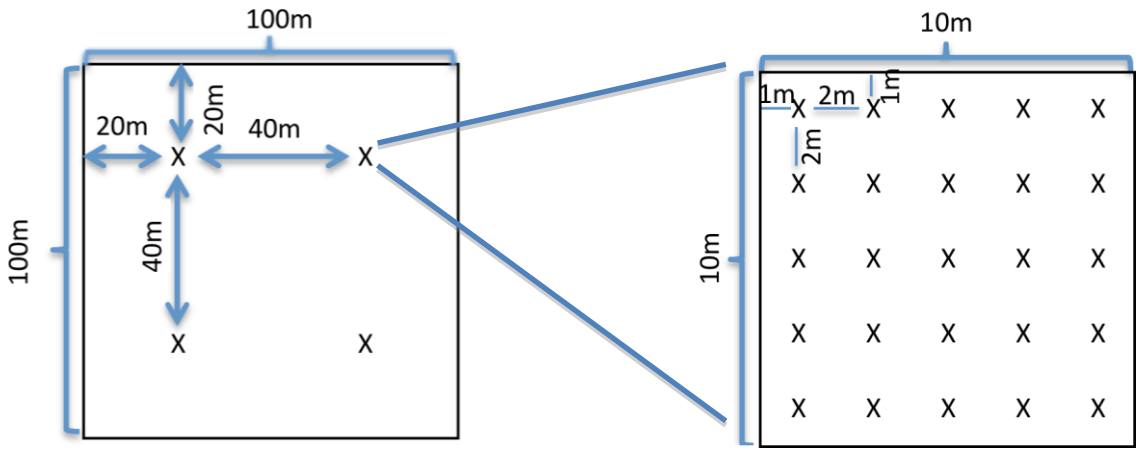

Figure 4: Sketch of Mahogany planting site at an agricultural area.

In order to make these plantations possible, a total of 20'500 Mahogany seedlings are needed annually. Two employees, the same responsible for the harvest of Wano leaves, are to collect ca. 450-500 mahogany seed capsules in February and plant these in March/April. In years with many seeds, as much seeds as possible have to be collected to build up a seed bank.

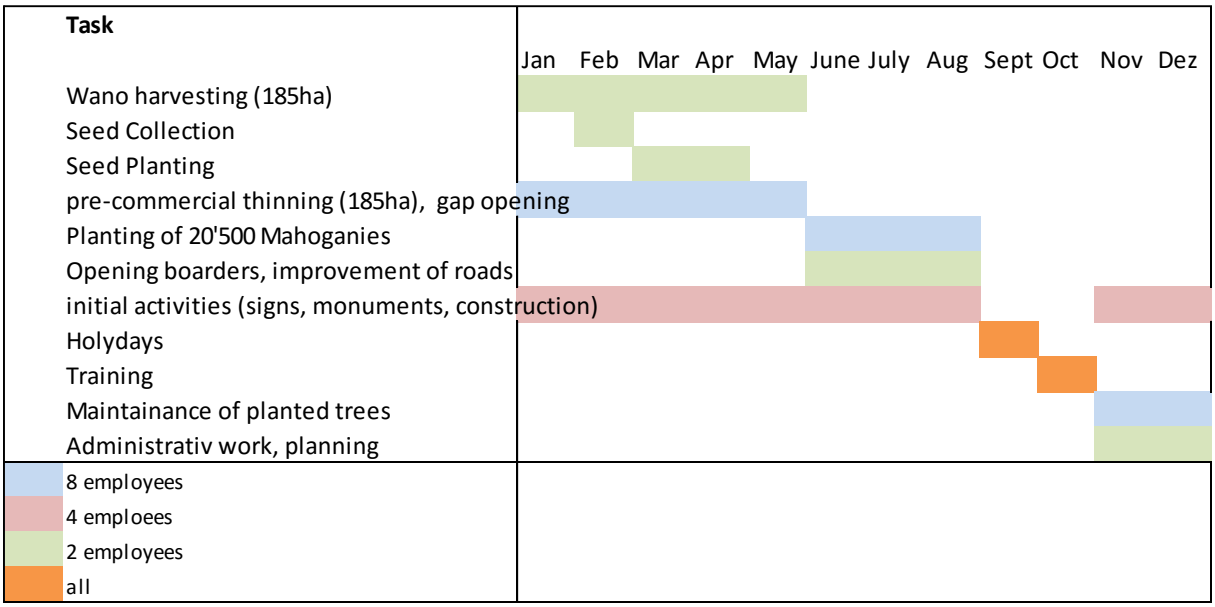

Figure 5: Annual Scedule for the CSFI team at FCFR.

4. In 2015 the two PP from the FD have to be re-measured;
5. The employees working in the forest should be trained / re-trained annually. Trainers can be local or international specialists. Exchange of experience with similar projects in the region (eg. Rio Bravo, Yucatan Peninsula in Mexico) would be favourable. Exchanges of personnel could also add much value.
   Employees have to be trained in the following domains:

   - Emergency first aid course;
   - Tree identification;
   - Basics of tree inventories (application of caliper, height measurement, etc.);
   - Safe use of chainsaws;
   - Use of compass and GPS;
   - Documentation, data entry, basic use of excel;
   - Basic use of GIS;
   - Principles of seedling planting.

   A first training block of two weeks should take place in January, before activities start in the field. A second block should take place in October, when all main activities have been implemented, and while the rainy season is on-going. As September is usually the wettest month of the year, it is suggested that forestry staff should all take their yearly break during that month.

   In November and December, maintenance work at the nursery site and of the planted *Swietenia macrophylla* can take place. Additionally, forest roads can be improved with local stones and gravel as well as the borders of the reserve can be reopened, providing funds allow for continuous staff. The rainy season from September to December is also an appropriate time to focus on administrative work such as planning, data analysis, GIS data, reports, etc.;

6. Rangers will be highly present in the area and can control the roads where their forest management activities take place. Nevertheless, information, communication and education of local communities should be increased and a regular exchange has to be established (e.g. community assembly).

4.4 5 to 10 years (2021-2026)

4.4.1 Goals

1. Consolidation of all activities;
2. A grid of PSP covering the whole area is measured;
3. Achievement of a sustainable forest management certificate (e.g. FSC) enabling access to foreign markets;
4. Achievement of REDD+ Status;
5. Development of a marketing strategy;
6. Maintenance and expansion of the road network system;
7. Construction of Forestry Operation base and one permanent fieldcamp in each block;
8. Train employees in different silvicultural activities.

4.4.2 Methods

1. Acquire more routine with established forest management activities (seed collection, plantings, pre-commercial thinning);
2. Further training of employees;

3. Start to collect seeds of other high value timber species (*Astronium graveolens, Cedrela mexicana, Cordia dodecandra* and *Platymiscium yucatenum*) in lower numbers, and plant at adequate sites;
4. Carry out a market research about international timber prices and standards. Contact wood exporters, wood importers, local and international sawmills and other important stakeholders in the timber market to develop a marketing strategy based on the knowledge about the timber potential in FCFR;
5. Establish a grid of permanent sampling plots (PSP's), distributed equally within FCFR, also in HCVs (fig. 6). As CSFI will realistically not have the resources to measure all plots (estimated at 500) and work on data, collaboration with a research institution should be sought (eg. CIFOR, CATHIE, FAO, UB, etc.). Plots must be re-measured every 10 years, in order to monitor sustainability of forest management activities, while also to be compatible with certification requirements (eg. FSC, REDD+, etc.);

Figure 6: Grid of permanent sampling plots.

6. Fulfill all criteria's of FSC and REDD+, and engage in certification processes;
7. Engage an agency to achieve the FSC-Certificate and REDD+ status;
8. Start to refill the roads with local stones (gravel);
9. Establishment of three-year forestry training program to increase skills in silvicultural knowledge.

4.5 10 to 15 years (2026-2031)

4.5.1 Goals

1. Consolidation of all activities
2. Re-measurement of Permanent Plots and Permanent Sampling Plots;
3. Completion of employees' training in timber harvesting;
4. Capacity to execute commercial harvesting in 185ha annually is complete;
5. Establishment of (international) trade relations;
6. Establishment of Forestry Research Institute of Belize.

4.5.2 Methods

1. Before any logging activities starts, employees need intensive training to acquire skills necessary for timber harvesting, safety and machine maintenance. To increase safety, modern equipment is to be used. The following equipment is needed:

   - 4 long-blade chainsaws;
   - 2 tractors with winch;
   - 1 trailer (with crane);

2. Seven members of staff are responsible for tree harvest. Two teams of three each can work in different areas of the reserve. Two staff cut trees and branches, while one takes out stems with winch and tractor. Tractors are only to move on max. 2.5 m wide skidder trails through the centre of a given hectare. Skidder trails are to be used for forest operations during three consecutive logging cycles. Trees must be felled pointing towards skidder trails, with an approximate 30° angle.

One staff will load logs on the crane-equipped trailer and carry them to the landing place (bacadillo) or straight to a sawmill.
As only one to three trees per hectare can be harvested and extracted, three members of staff can carry out the harvest in one hectare per day;

3. Timber products can then be sold on previously defined best markets. Whenever possible, long-term agreements should be sought;
4. Collaboration with research institutions lead to permanent research activities combined with workshops & trainings for employees, local residents and Belizean students.

4.6 15 to 25 years (2031-2041)

4.6.1 Goals

1. Continuation of all activities;
2. All CSFI activities within FCFR (patrol, maintenance, forest management activities, etc.) covered by income generated by the forest;
3. Build capacity to further process the timber wood;
4. Re-measurement of the PP and PSP.

4.6.2 Methods

1. Install a sawmill to increase the value chain of the timber wood;
2. Further diversify the products from the forest (e.g. poles, charcoal, shaft etc.) to turn more of the harvested wood into economic value;
3. Improve trade relations and seek customers of bigger scale (eg. local furniture producer etc.);
4. Continuation of trainees and research activities to further improve skills and knowledge.

5. Second 25-years cycle (2041-2066)

5.1 Goals

1. Return to starting point of first cutting cycle and renew enhancement of valuable timber species on 185 ha annually;
2. Number of high valuable timber species with a DBH>20cm to reach 15 to 20 per hectare;
3. Number of valuable timber species with a DBH>50cm to reach 2 to 5 per hectare;
4. Re-measurements of the PP and PSP at least every ten years;
5. Increase capacity to further process timber wood;
6. Production of local renewable energy;
7. Local communities receive benefits from the forest;
8. Start of the transition process from CSFI to the community;
9. Annually, three people complete the three year forest training program.

5.2 Methods

1. Thinning of planted *Swietenia macrophylla* stands. Select 15-20 trees of high quality and big DBH as future trees. Harvest around 10 to 15 trees while thinning;
2. Start to apply reduced impact logging (RIL), only harvesting two or three mature trees and leaving around 2 to 5 valuable trees within the DBH-class of 35-50cm per hectare;

3. Develop local skills to further process timber (furniture, houses, bridges, guitars, high end luxury products, design, architects, carpenter);
4. Use as much wood as possible in order to reduce waste and increase efficiency;
5. Invest in the sawmill to generate high end product such as parquet and/or veneer;
6. Install a wood combined heat and power plant to generate power for the sawmill and heat for drying lumber.

6. Third 25-years cycle (2066-2091)

6.1 Goals

1. Renew enhancement of valuable timber species on 185 ha annually, while returning to the starting point of harvest cycle;
2. Number of high valuable timber species with a DBH>40cm to reach 5 to 10 per hectare;
3. Number of valuable timber species with a DBH>50cm to reach 5 to 10 per hectare;
4. Number of naturally regenerated high valuable timber species with a DBH>20 to reach 5 to 10 per hectare;
5. Re-measurement of the PP and PSP at least every ten years;
6. Duplicate the example of FCFR to other forest reserves;
7. Establish collaboration to develop knowledge about pharmaceutical purposes;
8. Develop sustainable tourism within FCFR.

6.2 Methods

1. Continue with pre-commercial thinning wherever useful and necessary to increase natural regeneration of valuable timber species and accelerating increase of DBH;
2. Harvest 5 to 10 of planted *Swietenia macrophylla* in each hectare unit. Select 5 to 10 good quality trees with a DBH>45cm as future trees;
3. Apply RIL only harvesting two or three mature trees and leaving around 5 to 10 valuable trees within the DBH-class of 35-50cm in each hectare unit;
4. Start to develop research activities to identify pharmaceutical potential of the local plants. Try to establish a collaboration with a research institution or an industrial partner;
5. Construct accommodations for tourists and develop exciting activities for environmentally interested high economy customers (promotion / marketing).

7. Fourth 25-years cycle (2091-2116)

7.1 Goals

1. In each hectare within the production forest, 2-4 high valuable trees with a DBH>60cm to remain standing as seed-bearing mother trees;
2. Number of valuable tree species with a DBH>50cm to reach 20 to 30 per hectare;
3. About 25 to 50% of standing trees are valuable timber species and well distributed among all DBH-categories;
4. Applying RIL, harvest about 8 to 15m^3 of valuable timber per hectare;
5. Natural regeneration of valuable tree species is guaranteed thanks to high number of seed trees;
6. Wood is locally processed and a high efficient industry guaranties a maximum reduction of waste;
7. A high quantity of various goods to be produced on site, benefiting local communities;
8. All industrial processes are powered by locally produced renewable energies;
9. Plants of FCFR enable pharmaceutical products;
10. Sustainable tourism provides additional job opportunities and income.

7.2 Methods

Methods are described in the chapters above. At this state, taken measures need to be continued to carefully protect the precious ecosystem of FCFR.

5 Annex 1

Inventory Details

2 forester start identifying the relevant trees in the hectare. It is recommended to work first in one half (e.g. north) and move from the boarder to the middle path. All information is recorded directly into GPS (Trimble Juno) or similar. The following aspects need to be considered:

1. Document tree name, coordinates, DBH, DCH, height and quality of the following trees: Ziricote, Granadillo, Hobillo, Caoba or Cedro.
   → always ST and caution tape
   → Mark competition tree(s) with yellow flag tape (Document tree species, DBH and height of competition trees)
2. Document tree name, coordinates, DBH, DCH and height of the following trees with a DBH>20cm: Chechem, Machich, Santa Maria, Bullet tree, Yellow Cabbage Bark, Redwood, Red Sillion, Malerio, Katal'ox, Bastard Rosewood or other timberwood of medium value.
   - ➔ If quality is fair (slightly curved or inclined, stem <10m high)or good (straight, stem >10m high) classify as FT (red)
   - ➔ If quality is bad (dead, holes, broken top, standing deadwood, curved, forked etc.)classify as ST (red)
   - ➔ Mark competition tree(s) with yellow flag tape (document tree species, DBH and height of competition trees)
3. Document big habitat trees (e.g. Waree wood) with a DBH >60. Define tree species and category (bad, fair, good)
4. Due to their ecological importance, all specimens of Mammey, Sapodilla and Sapote macho were classified as habitat trees.
5. If forest structure allows (young forest stand, fallen trees, several marked trees together, high value seed tree present, few trees with DBH>20cm) open a gap of max. 40x40m (stem to stem) and take coordinates.

2 rangers open a small path in the middle of the plot. This path helps to orientate and will be the main access to the area for all future operations. In the second cutting cycle, this will be the skidder trail. After finishing, they start to girdle or cut the marked competition trees (yellow).

All together open a gap of max. 40X40m and remove the trees.

1. Material
    - Small light Pick up
    - 1 GPS
    - 2 Caliper with laser to measure DCH
    - 2 Diameter Measure Tapes (cm)
    - Forms inkl. Unterlage
    - Red flag tape (future tree)
    - Yellow flag tape (harvest next year)
    - Caution tape (seed tree)
    - Blue flag tape (habitat tree)
    - 2 compasses
    - 4 Machete
    - 1 chain saw
    - high measurement instrument
2. personal resources
    - 3 rangers
    - 2 foresters
3. Activities
    - Harvesting wano (one ranger)
    - Open path in the middle (two rangers)
    - Measuring and identifying FT, ST, HNY, HT
    - Girdling and cutting of HNY (2 rangers)
    - Opening gaps for planting (2 foresters and 2 rangers)

Pre-commercial Thinning

Date:__________ Surveyteam:______________________________

Ha (NE Point):_____________ Nord:_____ South:_____

red: future tree (FT) yellow: harvest next year (HNY) Caution Tape: seed tree (ST) blue: habitat tree (HT)

Tree Name	**DBH [cm]**	**High [m]**	**DCH [cm]**	**Quality**	**Classification** (FT, HNY, ST, HT)	**Treatment** (girdle, cut, extr.)	**Ycord**	**Xcord**