Mpingo Conservation & Development Initiative

MCDI Tanzania Community-Managed Forests FSC Group

ED04 Forest Monitoring Procedures Manual

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Contents

Definition of Terms

Basal Area – the total area of tree bole cross-sections (as determined from DBH) within a surveyed area; usually there is a minimum DBH for inclusion.

CBH – Circumference at Breast Height (130cm)

DBH – Diameter at Breast Height (130cm)

FMU – a Forest Management Unit; large forests or those with distinct heterogeneous parts maybe partitioned into two or more FMUs, each of which is managed separately.

GPS – Global Positioning System

Large Tree – defined for the purpose of these monitoring procedures as any tree with DBH ≥ 30cm

LMDH – the Legal Minimum Diameter for Harvesting of a given tree species under Tanzanian law

MCDI – the Mpingo Conservation & Development Initiative, Tanzanian registered NGO no. 1350

MNRT – the Ministry of Natural Resources & Tourism, United Republic of Tanzania

NTFP – Non-Timber Forest Product, can include firewood and charcoal, and other forest products which consume wood.

PFM – Participatory Forest Management, the legal process in Tanzania under which rural communities can take control over their local forests.

RTES – Rare, Threatened or Endangered Species

UTM – Universal Transverse Mercator projection used in mapping; under this system each unit increment corresponds to 1m. In Kilwa coordinates typically are in the range (5XX,XXX : 9,0XX,XXX).

VLFR – Village Land Forest Reserve, an area of forest set aside by a Village under the PFM process

VNRC – Village Natural Resources Committee, the sub-committee of the Village Government with responsibility for over-seeing management of community-owned forests.

Introduction

This document sets out the approved methodology for monitoring forests managed by rural communities in MCDI's Group Certificate Scheme. It covers the following aspects of forest health and integrity:-

- Stand Structure
- Biodiversity including rare, threatened & endangered species
- Regeneration
- Pests & Diseases
- Fire Events
- Impacts of Forest Operations (logging and early burning)

A variety of methods are used to monitor each of these components; permanent sample plots (PSPs), specific bird monitoring visits, and general forest patrolling. For the most part the monitoring is designed to be carried out participatorily – i.e. by the community forest managers themselves – but this is complemented by additional surveys by professional experts.

PFM Context

Participatory Forest Management (PFM) is the legal process in Tanzania under which rural communities can take control over their local forests, and is defined within the 2002 Forest Act and supplementary regulations and supporting documents. The end result is known as a Village Land Forest Reserve (VLFR), and is governed by a management plan and local byelaws.

The methods set out in these guidelines apply to community-managed forests established under the PFM process, and hence incorporate constraints of the PFM process. In particular, in south-eastern Tanzania, where this method was developed, selective logging is the norm. Individuals of target species are scattered unevenly across the forest. The VLFRs which are set aside by communities in following the PFM process may be quite small (as low as ~500ha in size).

Normally, under PFM, a forest management plan lasts for five years, so monitoring shall be geared towards producing useful information within that time frame and which can be fed into the process of revising management plans.

Under the MCDI group certificate scheme community forest managers are required to set aside 10% of any certified VLFR as a no-take Conservation Zone. This shall receive particular attention in the monitoring plans.

Indicators Used

Stand Structure

We shall use basal area as a proxy for overall forest health, with a positive trend taken to indicate recovering forest. Basal area shall only be calculated for trees on transects with CBH ≥ 30cm, and shall cover all species.

Biodiversity

For the time being we shall use two primary indicators of biodiversity:

1. Total tree 'species' count (with CBH ≥ 10cm) in PSPs reckoned according to vernacular names. Due to the problems of using vernacular names[1] this will only be a rough proxy of actual tree species diversity, but will avoid the necessity for professional taxonomic input.
2. Encounter frequency of three indicator bird species: Crested Guineafowl (*Guttera pucherani*), African Broadbill (*Smithornis capensis*), and the Dark-backed Weaver (*Ploceus bicolor*) during early morning monitoring within the Conservation Zone.

The first two species were identified for MCDI by a team of British and Tanzanian ornithologists who visited Kilwa in 2008, and baselines established. They commented:

> "Of all the species recorded during surveys of coastal forests, only six are good indicators of forest health, being recorded in the majority of un-degraded forest and being absent from degraded forest. Of these, two: African Broadbill and Crested Guineafowl are easy to identify. The African Broadbill would make a highly effective indicator of forest health as it makes a highly distinctive and far-carrying noise during display flights and is sufficiently abundant for meaningful abundance indices to be calculated. The Crested Guineafowl is likely to be well known by villagers as it is hunted for food, but it can be rather shy and retiring. Moreover, it has a tendency to congregate in flocks and as such abundance indices are highly sensitive to whether or not a flock is detected. We thus recommend the use of African Broadbill abundance as an effective biological indicator of sustainable forest management." (Maclean *et al.* 2008)

Inclusion of the Dark-backed Weaver was recommended by Neil Baker from the Tanzanian Bird Atlas. MCDI also considered adding Crowned Eagle, which has been used as an indicator of good forest quality elsewhere in Tanzania. However, Crowned Eagles primarily prey on monkeys which are monitored with other large mammals (see RTES monitoring below), so data on Crowned Eagles, which have low population densities, would not add significantly to our knowledge of the forest.

These indicators will be complemented by professional surveys of tree and avifauna biodiversity every five years involving experience taxonomic specialists. Further biodiversity indicators using other taxonomic groups may be developed in future.

Rare, Threatened and Endangered Species

Regular RTES monitoring will focus on large mammals which are well known to communities. Sightings and other evidence of presence will be recorded on forest patrols.

The above mentioned professional surveys of tree and avifauna biodiversity will provide updated species lists every five years, and highlight RTES that are present.

In addition MCDI, as group manager, and individual group members will maintain lists of species believed to be present (or likely to be present) within the certified forests.

Regeneration

Regeneration will be monitored across the forest using regular checkpoints on permanent transects.

[1] E.g. *Kingonogo* can refer to any species within the *Combretum* genus.

Pests & Diseases

Presence of pests and diseases within the forest will be monitored during forest patrols and on forest health transects.

Fire Events

Fires will primarily be monitored through annual permanent transects. In addition, evidence of recent fires will be recorded using forest patrols.

Impacts of Forest Operations

Logging operations will be monitored during their course. The Logging Supervisor will record instances of damage to vegetation apart from target trees, the number of times vehicles are driven off road, and the routes used. Details will be recorded on form SF08 Safe Timber Harvesting Checklist. See SD07 Procedures for Timber Harvesting for more information. Follow-up inspections will be made by Group Inspectors during monitoring visits.

The impacts of early burning will be monitored through annual assessments of large tree mortality. In addition its impact on avian biodiversity (especially ground-nesting birds) will be monitored every few years by professional surveys using the Timed Species Count methodology.

Forest Health Monitoring

Previously these procedures mandated the use of permanent sample plots for monitoring basal area as a primary indicator of forest health. However, sample plots are small and expensive to establish so it is difficult to establish a wide coverage of the forest as a result. Transects typically collect a lot more data for the same amount of effort. With modern GPS receivers it is also possible to establish and re-survey permanent transects. As well as basal area such large scale monitoring also allows us to track another key indicator of forest health: tree mortality. With ~50% of carbon found in trees with DBH of 30cm or more, such monitoring will also allow us to monitor the carbon storage trend in each community forest.

Sampling Design

The survey should ideally record at least 1,000 Large Trees (DBH ≥ 30cm) within each VLFR. Data from the University of Edinburgh's work in Kilwa suggests these are typically found at densities of 25 trees per hectare. Thus the transects need to cover roughly 40 hectares. Each transect is 20m wide, so at least 20km of transects need to be laid out. Some VLFRs, e.g. such as Nainokwe's, may have a lower density of trees than is normal for Miombo in a significant portion (or all) of the FMU. In such cases you may wish to raise the target length to 30km or even 40km.

The transects should be distributed evenly across the VLFR and capture a representative sample of the habitat variations in the forest. A haphazard process of locating transects (as outlined below) is considered sufficient unless the person leading this process has a particularly deep knowledge of the VLFR, in which case possible biases can easily be excluded by asking someone else, less familiar with the VLFR, to lead the process. Turning off additional informatory layers on the GIS can help in this regard.

Unless there are good logistical reasons otherwise transects should cross the entire the VLFR from one border to the opposite border. To make logistics easier the transects should normally be laid out to walk away from the village / local base, so that another transect can then be laid in the return direction making surveying easier. However, surveyors should take care to ensure that this design does not omit any important habitat zones, e.g. a river valley, which may run parallel, and thus ends up being excluded from the surveying with transects either side of it. In such cases it may be appropriate to re-align the transects to cross the landscape feature of concern, but this may make logistics much more difficult, in which a sensible compromise is simply to locate a single transect along the feature (or as along it as may be feasible in the case of a river valley). For this reason initial transect establishment should always be led by a member of MCDI staff of another recognised professional.

Once the orientation of the transects has been determined, it is easy to compute how many are needed: simply measure on the map the distance across the VLFR in the selected direction and divide into 20km, rounding up. Having done that use a ruler to plot on the map the location of each transect, evenly spacing them out, and from there determine the start and end locations in UTM coordinates. Alternatively this may be achieved using a GIS, although that has the disadvantage of not being done in front of the communities.

In order to hold to a fixed direction it is then necessary to generate a series of points each at least 50m apart that can be tracked on the GPS; these also will be used for checkpoint-based monitoring of regeneration. The Transect Checkpoint Determination spreadsheet tool will do this automatically for you. Each transect is assigned a letter, and each checkpoint a number, so that they can easily be distinguished, e.g. A11 v. B11, C3 v. C4, see separate document setting out exactly how to use that tool. The tool has been refined to allow for extra long transects: each segment between checkpoints is divided into two: an initial 50m (with an additional waypoint to assist; such waypoints are suffixed with a T, e.g. A11T) during which tree mortality will be surveyed, and then a remaining portion which can be walked as quickly as possible until you arrive at the next checkpoint, when the standard checkpoint data should be recorded (do not do this on the 'T' checkpoints), and then tree mortality surveying recommenced.

	A	B	C	D	E	F	G	H	I	J	K
1	**Transect**	**A**		**B**		**C**		**D**		**E**	
2		E	N	E	N	E	N	E	N	E	N
3	Start	500,000	9,000,000	501,000	9,010,000	505,000	9,020,000	506,000	9,025,000		
4	End	500,500	9,000,100	502,000	9,009,000	504,000	9,019,500	505,500	9,025,500		
5	Length (km)	0.51		1.41		1.12		0.71		0.00	
9	Bearing (degrees)	11		135		207		315		0	
10	Count	11		29		23		15		0	
11	Waypoint										
12	0	500,000	9,000,000	501,000	9,010,000	505,000	9,020,000	506,000	9,025,000	0	0
13	1	500,049	9,000,010	500,965	9,010,035	504,955	9,019,978	506,035	9,024,965		
14	2	500,098	9,000,020	500,929	9,010,071	504,911	9,019,955	506,071	9,024,929		
15	3	500,147	9,000,029	500,894	9,010,106	504,866	9,019,933	506,106	9,024,894		
16	4	500,196	9,000,039	500,859	9,010,141	504,821	9,019,911	506,141	9,024,859		
17	5	500,245	9,000,049	500,823	9,010,177	504,776	9,019,888	506,177	9,024,823		
18	6	500,294	9,000,059	500,788	9,010,212	504,732	9,019,866	506,212	9,024,788		
19	7	500,343	9,000,069	500,753	9,010,247	504,687	9,019,843	506,247	9,024,753		
20	8	500,392	9,000,078	500,717	9,010,283	504,642	9,019,821	506,283	9,024,717		
21	9	500,441	9,000,088	500,682	9,010,318	504,598	9,019,799	506,318	9,024,682		
22	10	500,490	9,000,098	500,646	9,010,354	504,553	9,019,776	506,354	9,024,646		
23	11			500,611	9,010,389	504,508	9,019,754	506,389	9,024,611		
24	12			500,576	9,010,424	504,463	9,019,732	506,424	9,024,576		
25	13			500,540	9,010,460	504,419	9,019,709	506,460	9,024,540		
26	14			500,505	9,010,495	504,374	9,019,687	506,495	9,024,505		
27	15			500,470	9,010,530	504,329	9,019,665				
28	16			500,434	9,010,566	504,284	9,019,642				
29	17			500,399	9,010,601	504,240	9,019,620				
30	18			500,364	9,010,636	504,195	9,019,598				
31	19			500,328	9,010,672	504,150	9,019,575				
32	20			500,293	9,010,707	504,106	9,019,553				

For large VLFRs, you may find that whatever length of transects is chosen does not adequately cover the different sub-habitats found in the forest. In which case additional transects should be added to include these sub-habitats. Where habitats are sufficiently different that the VLFR is divided into one or more distinct Forest Management Units (FMUs) then the entire exercise needs to be repeated for each FMU.

Initial Survey

Resources Required

A team of seven people should be used for transect establishment. At least 2 of these should be trained in forest inventory and the use of GPS, and one should be a trained first-aider; the remainder of the team can be comprised of community technicians who have not received training in forest inventory. A team of seven should be able to establish transects at a rate of around 300m per hour. Survey teams should be accompanied by a game guard due to the risk of encountering wild animals.

Team members responsibilities should be assigned between the following roles:

- 2 people painting trees: one marking the point of DBH measurement, and the other marking the line of the transect,
- 1 locating checkpoints with a GPS and data recorder,
- 2 for tape/rope alignment,
- 1 applying tags to trees, and
- 1 measuring DBH.

Team roles can be swapped around from time to time so that people do not get bored.

Equipment required for transect establishment includes:

- 2 GPSs with transect locations
- 100m tape measure or pre-measured rope
- 30m tape measure
- CBH or DBH tape

- 2 Clipboards and pencils
- Blank datasheets SF23 and SF24
- White paint and paintbrushes
- Aluminium tags marked with sequential numbers from 1 to 1,000
- Additional tags and hand stamps for making new tags
- Aluminium nails
- 1 Hammer
- 1m long pole (can be easily cut from bamboo or similar)
- Concrete posts for marking the beginning and end of transects
- Spare batteries
- A coin
- POM stick

Note that white paint is used to mark the transects to distinguish these from VLFR boundaries (blue), the No Take Zone (yellow) and hazard land (red).

Transect Establishment

The start of the transect should be located with GPS, and one person should then move to the point 50m along the transect by using the predefined waypoints stored in the GPS (either the next checkpoint, or the end of tree-surveying marker which is suffixed with a T). A tape measure or pre-measured rope should be run in a straight line between the start point and the 50m mark. If an obstruction, such as a large tree, prevents the tape from running in a straight line it may be necessary to complete this process in two stages. One moving from the start point to the beginning of the obstruction and another continuing from the obstruction to the 50m mark.

Once the tape measure is in place all Large Trees within 10m either side of the tape should be identified and measured. Care must be taken to determine whether trees that are close to 10m from the tape are inside or outside the survey area. A second tape measure should be run from the centre of the base of the tree back to the transect line to determine whether the tree is rooted within the 10m of the transect. For trees that are on the boundary of the survey area, if more than half of tree is rooted within 10m of the transect then it the tree should be included, otherwise it should be excluded. If the tree is *exactly* half in and half out (this happens rarely) a coin should be tossed to determine whether to include the tree or not: heads indicating the tree should be inside, tails outside.

For each tree that is present within the transect enter its details on form SF23. Identify its species (use vernacular names) if you can, or just put unknown (do not leave blanks). Enter the tree location as given on the GPS (this will make it easier to find next time). Where the tree has multiple stems at breast height you should assign each a separate tag (see below) with the same tree number but a different letter for each stem (a, b, c ...). Record each stem on a different row of SF23 (the GPS record should be the same for each); record the largest stem first and then in rough descending order of size. For each tree/stem record the CBH or DBH (amend the column heading if different), put a tick to indicate whether the tree is alive or dead, and then record the tree's status: standing / fallen, broken / unbroken, diseased / healthy.

Each tree/stem must also be marked:

- Paint a band around the tree where CBH will be measured (usually 1.3m above the ground). You can paint a band either just up or just below the BH (i.e. 1.3 m) if at 1.3m the tree has a problem e.g. flute, cancer etc to avoid the problem
- Hammer in an identification tag 20cm above the CBH measurement band on the side of the trunk from which you have come (so when next walking the transect it is easily visible).

Where a tree is seen that is thought to be large enough (i.e. DBH ≥ 30cm), but upon measuring it is found to be close to (within 15%) but not quite large enough (i.e. DBH at least 25cm but less than

30cm), then it can still be worth recording its location to ease future monitoring. In such situations tag and paint the tree, and note its GPS location, but draw a line through the other cells in the data table. However, in order to avoid a lot of additional work *you should not seek to do this exhaustively*; only where a tree was suspected of having DBH ≥ 30cm and then found not to be the case should you bother to record it.

In addition, where there are few large trees the survey team may find it helpful to paint a half band around smaller trees either side of the transect line facing the direction from which the team is walking. This will help the team to find the correct transect line again in future years.

At each checkpoint (waypoint) along the way (i.e. every 50m) check for whether woody regeneration is present within a 1m radius of the checkpoint. Regeneration is divided into 3 categories:

- Seedlings; herein defined as anything up to 1cm DBH (note diameter not circumference used here) seedlings may often not even reach breast height, and
- Saplings; defined as an individual ranging from 1cm DBH to 5cm DBH.
- Poles; defined as any small tree ranging from 5cm DBH to 15cm DBH.

(As a result, no trees between 15cm DBH and 30cm DBH will be recorded at any point as part of these transects.)

As well as looking for alive individuals of each regeneration class, the presence of dead regeneration should also be recorded for each class. Note that in each case the requirement is only to note presence (represented by a tick) or absence (represented by a cross or zero); it is not necessary to count how many seedlings, saplings and poles there are. No cells should be left blank. Where there is some doubt as to whether an individual is within the 1m radius use the 1m long pole to check.

Finally, record whether or not the checkpoint has been burned since the end of the last rains. This is tested by considering the ground immediately at your feet, rather than the whole 1m radius. If any part of that has been burned then enter a tick, if not a cross. Where the checkpoint is actually centred on a tree, then the test becomes that of whether looking at the ground immediately surrounding the tree and the state of bark at the base of the trunk, whether the centre of the checkpoint would been burned if it were not for the tree being there. Use form SF24 for recording checkpoint data; normally this can be done by one person while the rest of the team measure the trees.

Repeat Monitoring

The exact protocol for repeat monitoring is still to be determined after further trials. In order to make it easy to find trees again during repeat monitoring a simple map of each transect will be produced on GIS software to indicate the relative locations of trees either side of the transect. In order to facilitate rapid monitoring it is only necessary to re-measure DBH/CBH every 5 years, but mortality data should be collected on an annual basis.

Avifauna Monitoring

Avifauna monitoring shall take place on a monthly basis in the Conservation Zone. Three indicator species will be monitored: African Broadbill (*Smithornis capensis*), Crested Guineafowl (*Guttera pucherani*) and the Dark-backed Weaver (*Ploceus bicolor*). Before beginning monitoring the VNRC and patrol team (or other representatives of the forest manager as appropriate) will be trained in how to recognise these particular species and their calls, and the importance of ensuring that they are not confused with similar species. (Rural people who spend regularly any significant time in the forest should know the species concerned, but will not be accustomed to scientific exactitude.)

Monitoring will take place in the early morning, for approximately two hours after sunrise. To facilitate this and avoid encounters with dangerous wildlife (elephants and buffalos) the forest manager shall construct a rough camp banda inside or close to the Conservation Zone. The monitoring team will stay overnight in this banda, lighting a fire to deter elephants and other wildlife, before conducting the monitoring in the morning. A normal monitoring team will consist of at least 3 people so that if any one person is injured, one can stay with him/her, and the other can go for help.

The same route through the forest will be taken each time and will not stray too far from the camp for safety reasons. The team will proceed ***quietly*** through the forest, and at set points roughly 300m apart the monitoring team will stop and listen for 5 minutes, and record any sightings or calls heard of the three species of interest. Data will be recorded on form SF17 Bird Monitoring Record; upon returning to the village a second copy of the form will be made so that one can be kept with the forest manager's records, and one given to MCDI.

Forest managers who are earning little money from their forest may, at the Group Manager's discretion, be compensated for their costs in conducting this monitoring. Compensation will be based on a formula for 4 people staying out overnight and hiring bicycles (to reach the forest).

Encounter Rates v Numbers Seen

It is important that the patrol team understand the difference encounter rates and numbers of individuals seen.

For each patrol we are interested in knowing at what proportion of stop points were indicator species detected. This will give us a presence rate; a key indicator of forest quality. At any given stop point, if one or more individuals are seen (or heard) that counts as a single successful encounter.

For some species, e.g. African Broadbill, we are not interested in knowing how many birds are encountered at each stop, just whether or not they were encountered at all. These species are mostly encountered only singly or in pairs, and may be secretive making it difficult to monitor population levels.

For other species, e.g. Crested Guineafowl, we are also interested in roughly how many birds are seen at each stop point. It may not always be possible to exactly count a flock, in which case the rough number should be estimated. When aggregated over a patrol, this result will give us a proxy indicator for the local population of this species in the forest along the patrol route.

Mammal Encounters

Whilst undertaking the patrol the team should also look out for mammal presence and record in the normal way as they would for any other patrol, see next section. (There is space on SF17 to list this, it is not necessary to separately fill out SF16.) Note when recording mammal encounters the same distinction between encounter rates and numbers seen applies as above. (Mammals encountered either side of a given stop point almost certainly will belong to the same group, and so a maximum of one encounter should be recorded per stop point.)

Forest Patrolling

Certified forest managers are required to patrol the VLFR at least twice a month. These patrols may take the same or variable routes. Since one objective is to deter and catch illegal loggers working in the VLFR timing will be deliberately irregular. A patrol team is typically 5-6 people though not may go on patrol every time, and they may split into two sub-teams during the course of a patrol.

We shall use the patrols to monitor the following:-

- Evidence of large mammal presence (actual sightings, scats and tracks).
- Signs of tree pests and diseases.

In conducting a forest patrol, the patrol team will fill in SF16 Forest Patrol Record. At least one patrol each month shall pass through the Conservation Zone.

The patrol team shall follow the protocol set out below:

1. The date and starting time shall be noted.
2. The weather shall be described as one of clear skies, partly cloudy, mostly cloudy, raining, and wind strength estimated as either none, mild or strong.
3. The team shall proceed ***quietly*** through the forest in order to maximise sightings.
4. One member of the team shall be responsible for completing the form SF16. If the team splits up during the patrol then both sub-teams should have a copy of the form, with all the data being transferred to one 'master' form at the end of the patrol. Data should only be recorded on the secondary form whilst the team is split up to avoid double counting.
5. Whilst walking note any large mammals detected by species and means of detection (seen, heard, scats observed, tracks encountered).
6. Note any signs of pests or disease affecting trees in the forest, and estimate the numbers and species of trees infected.
7. Record any evidence of fires since the last time this route was patrolled.
8. Note any other signs of disturbance including unsanctioned activities in the forest. If any illegal logging is detected the team shall fill in a copy of SF12 Notification of Unauthorised Harvesting upon returning to base and alert MCDI.
9. Upon completion the finishing time shall also be noted.
10. Finally, if it was not done whilst *en route* a second copy of (each) form SF16 should be completed so that one copy can stay with the forest manager's records, and one given to MCDI.

Forest managers who are earning little money from their forest may, at the Group Manager's discretion, be compensated for their costs in conducting this monitoring. Compensation will be based on a formula for 5 people hiring bicycles (to reach the forest); no direct compensation will be paid for patrol members' time, but it is expected that the forest manager may do so out of patrolling proceeds, e.g. fines levied on offenders apprehended whilst on patrol.

Encounter Types

Actually seeing an animal is not necessary to be aware of its presence, and patrol teams should be encouraged to actively look out for all the various signs of mammal presence. SF16 allows the patrol team to record four different types of encounters: sighted, heard, recent scat seen, or recent tracks encountered. An encounter does not have to include a direct sighting to be listed, but generally only for sighted encounters will it be possible to record the number of individuals (see the above discussion on Encounter Rates v Numbers Seen under Avifauna Monitoring). For other such encounters, the number seen should simply be listed as zero.

In addition, as from 2013 two additional encounter types have been added:

- Pre-breeding behaviour (e.g. nest building)
- Breeding success (eggs or young directly seen or heard, or food seen taken into a nest)

This will give us information on where habitat quality is good enough for animals to consider breeding, and where (even better) they are succeeding.

Quality Control on Community Monitoring

Community monitoring is central to successful community management of the forest. It is vital that the communities themselves understand what is happening in their forest, and also that they understand how key numerical indicators are computed from data that they have collected. However, scientific monitoring is a new concept to them: the scientific collection of data requires precision and robustness to a level that few will have previously encountered, and that will have to be learned over time. In particular, the uselessness of incorrectly recorded data will be a new thing, that will not be appreciated until communities have begun to analyse the data themselves.

Good training will play an important role, see ED03 for more details on training on monitoring. However, it is likely that, especially in the early years, a proportion of monitoring forms will not be correctly completed. To some extent these problems will be alleviated by the regularity at which data is collected; it is not necessary to have every data point to detect a clear trend, so long as analysis procedures are designed to be robust to such issues. The low cost of community-based monitoring compared to professional monitoring is a major factor in this respect.

Nonetheless, some minimum standards of quality control will be required in order to ensure that sufficient data is available for analysis. The following table summarises the minimum standards under the MCDI Group Certificate scheme; failure to meet these will lead to a Remedy Instruction being issued.

Number of Years in Scheme	Minimum Proportion of Correctly Completed Forms
1	50%
2	60%
3	70%
4	80%
5+	90%

Defining Correctly Completed

There shall be three categories of form completeness:

- Fully Complete – all boxes filled in with the correct information. Value = 1.
- Partially Complete – one or two boxes not correctly completed, but not so as to render the entire form useless. Value = ½.
- Invalid – where either critical information is missing or more than two boxes have not been correctly completed. Value = 0.

The difference between Partially Complete and Invalid can best be summed up by way of a couple of examples: a form without a date cannot be used later (and is therefore Invalid), but one with erroneous data about one species can still provide valid data about other species (Partially Complete).

MCDI Group Inspectors may also assess a form as either Partially Complete or Invalid if the data appears suspect. For instance, elephants frequent the forests, especially during the wet season, but are not often seen. Instead patrol teams should be coming across new dung piles and tracks. Patrol forms which do not record this suggest that the team was not properly recording this kind of evidence, and the form should be graded Partially Complete as a result.

In assessing whether the benchmark has been met, the average completeness value of all forms should be computed and compared to the quality control threshold as set out in the table above.

Rare, Threatened & Endangered Species

The general forest patrols will provide regular information about presence of easily identifiable large mammals, one significant component of the RTES populations.

In addition MCDI, as group manager, and individual group members will maintain lists of species believed to be present (or likely to be present) within the certified forests. These lists will be compiled through a multi-stage process.

1. MCDI will seek from biodiversity scientists and other relevant professionals information on what RTES they believe are likely to be present within the certified forests.
2. Such species are classified in two key ways:
    a. Is the RTES likely to be readily identifiable by community members who frequent the forest (e.g. patrol team members), either directly (by local name) or with the help of photographs (where good images are available)?
    b. If it is not readily identifiable, should it be assumed to be present? Such assumptions may be based on habitat-related criteria as described by the literature.
3. Note that many of the obscurer species (e.g. rare plants) have very little if any information publicly available, in such cases no further follow-up is possible.
4. As part of the process to draw up this master list, the literature is surveyed (the online IUCN Red List is a key source) for known threats to the species, and therefore what additional precautions, if any, are appropriate. Common threats and their solutions are as follows:
    a. Habitat loss – simply establishing the VLFR and then properly implementing the management plan should suffice.
    b. Over-logging in which case the quotas imposed as part of the forest management will provide the necessary conservation.
    c. Hunting – subsistence hunting is banned inside the VLFR, while quotas for commercial hunters are managed by the government wildlife authorities.
    d. Fire in which case the fire abatement programme through early burning should protect the species.
5. Changes to this master list are reflected in the form SF26 RTE Species Present List. This allows community members to say which of the readily identifiable species are known from the forest. It also lists all the species whose presence should be assumed based on known habitat criteria.
6. Form SF26 is filled in by each VNRC at the start of each five year management plan period. Additionally, if major revisions are made to the list, an updated form should be collected from each village within one calendar year.
7. Finally MCDI collates the species listed on SF26 into a unified list of known and assumed species present throughout the group certified forests.

All of the above information can also be complemented by occasional professional surveys as set out in the following section.

Professional Surveys

Professional surveys, monitoring and data analysis will be used to complement the participatory monitoring, to give MCDI a better understanding of more complex ecosystem dynamics, and a view across the entire group. E.g. results for any single pair of controlled burn plots in a VLFR are likely to be subject to local conditions and stochastic events, but across the group results should give a clearer picture of the impact of early burning.

Some of the work will be carried out by MCDI in-house, such as more sophisticated analysis of participatory monitoring data, and the monitoring of timber tree growth rates. Others, e.g. avifauna surveys, may utilise the services of outside experts such as the Tanzania Bird Atlas and the Tanzania Botanical Research & Conservation Programme. Such larger scale professional surveys will be commissioned on roughly five-year bases, depending on financial resources (i.e. where revenue from the forest is sufficient to cover such an activity in addition to the basic management costs).

Impact of Early Burning on Avifauna Diversity

An exception to the five year rule is the professional surveying of avifauna biodiversity (and ground-nesting birds in particular) which from 2013 onwards will be monitored by way of timed-species counts. These need to be conducted by a professional, and preferably by the same professional from one year to the next, in order to avoid observer bias. This monitoring should capture any significant impacts of early burning operations on ground-nesting birds, the visible taxonomic guild most likely to be affected. It will be conducted annually, funds permitting.

Community Monitoring Data Analysis

As much as possible data analysis will be kept as simple as possible and as participatory as possible so that local Forest Managers can have a direct understanding of how data they have collected relates to changes in the forest. Calculations will be performed in the village using flip charts and communities will be trained in how to complete the simple steps required to compute quantitative indicators, and on their meaning.

Specific indicators to be computed and monitored in this way are:

1. Basal Area on transects
2. Total tree species counts from transects
3. Tree health, pest and diseases encounter rates
4. Frequency of regeneration (juvenile presence percentage at transect checkpoints)
5. Frequency of fire events, proportion of forest burned in early and late season
6. Avifauna indicator species encounter rates, including calendar graphs showing presence variation over the course of a year, as per the protocol below.
7. Large mammal species encounter rates (proportion of patrols encountering signs of presence)
8.
9.
10. Impacts of logging:
    a) Trees damaged
    b) Number of off-road tracks driven by vehicles during log extraction

Data will be analysed on an annual basis, and form SF18 Monitoring Data Analysis Summary completed as evidence that this has been done.

As data accumulates MCDI expects to be able to establish a reference set of figures against results can be compared, thus allowing absolute as well as relative conclusions to be drawn.

Avifauna Indicators

Community Analysis Protocol

The first step in the analysis is to prepare a table set out as follows, with one row per patrol.

Year	Month	African Broadbill rate	Dark-backed Weaver rate	Crested Guineafowl rate
2009	Sept	17%	17%	17%
2009	Oct	40%	20%	60%
...	...	...	...	...

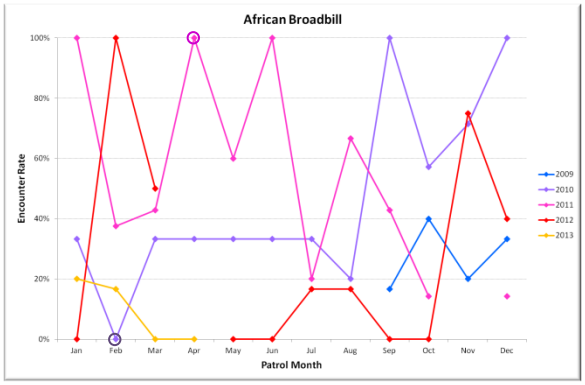
The first two columns are self-explanatory. The remaining three columns give the encounter rate for each species respectively on that patrol, this is computed from the following simple formula:

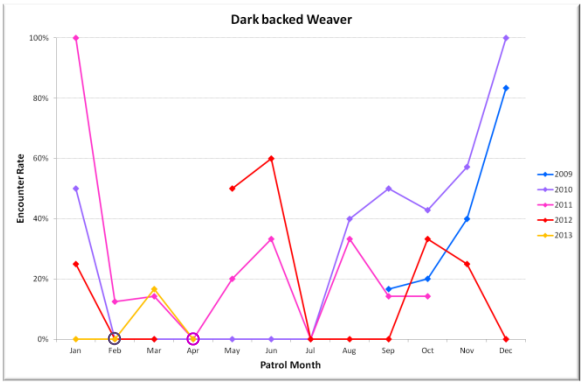
$$Encounter\ rate = \frac{Number\ of\ encounters\ recorded}{Number\ of\ stops\ made}$$

The encounter rate should be recorded as a percentage and rounded off to the nearest full percentage point. Thus if the patrol stopped 6 times and on only one of those occasions a Broadbill was observed or heard then the encounter rate is 1/6 = 17%.

Warning: occasionally a patrol records more encounters than stops made, this is potentially valid or may have been a data recording error. Either way a maximum encounter rate of 100% should be listed; where the above formula gives a number higher than 100% just enter 100%.

From the analysis table it is possible to construct three separate graphs, one per species, that show how the frequency of encounters varies over the course of the year. Each calendar year is a separate data series (ideally drawn in a different colour), so long term trends can be observed, see the examples below from Kikole village. The graphs should be drawn on flipcharts to facilitate discussion, and then copied on to form SF18 at the end.





As can be seen from these the data can be very messy. Nonetheless it is possible to draw some basic conclusions:

- African Broadbill appears to be found year round in Kikole's forest
- Dark-backed Weavers and Created Guineafowl, in contrast, decline in abundance during the early part of the dry season.
- Numbers in all three species were down substantially in early 2013.

Apparently anomalous figures should be checked against the original paperwork, e.g. in the case above the sightings of Dark-backed weavers in April and May 2012 are not consistent with other years. Maybe there were inexperienced people on the patrol that month who misidentified the birds? Answers such as these should be discussed with the VNRC and patrol team jointly so that the quality of data collected can be improved over time. Other anomalies may result from specific environmental conditions pertaining at the time of the patrol, e.g. it was raining heavily (see also discussion of confounding variables below) or there was a fire burning. Such anomalies should be circled (see above examples for Feb 2010 and Apr 2011) and a note made of the explanation.

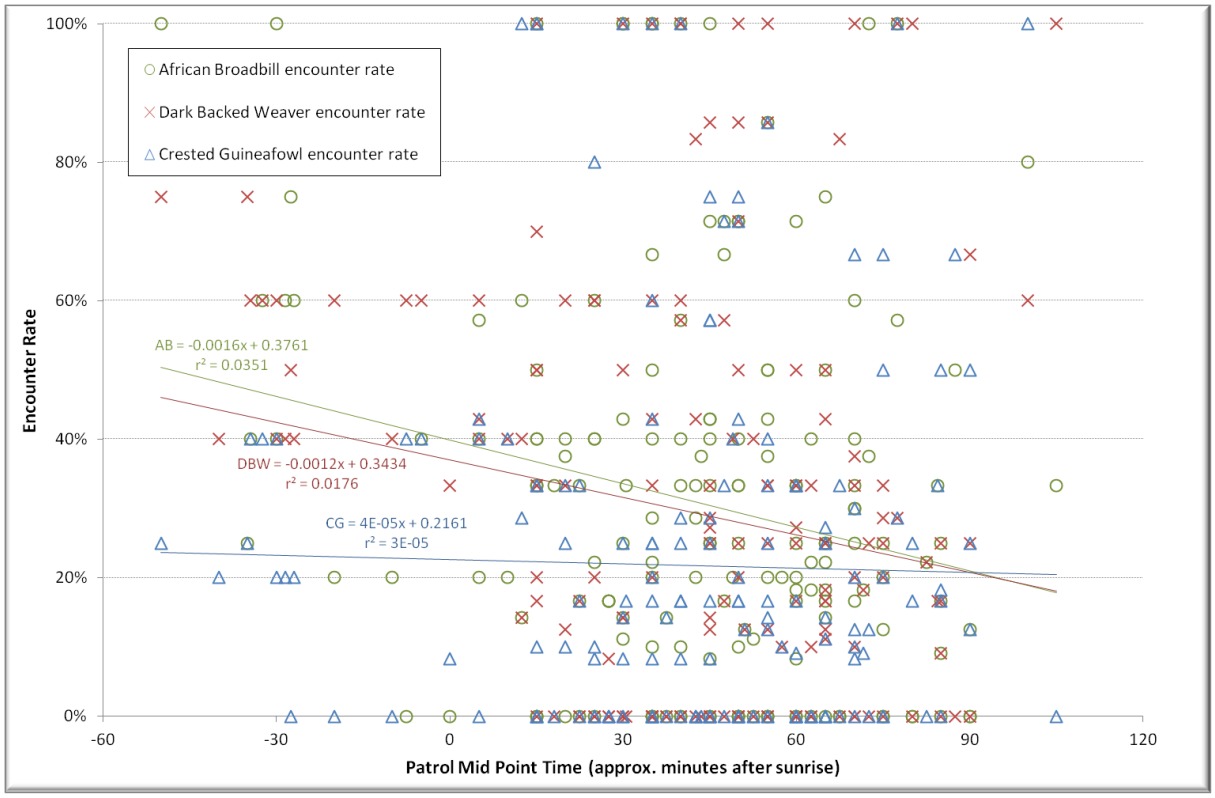
Finally longer term trends should be discussed and considered: are such changes real? If so what other changes in the forest do they relate to? Note that populations may change over time for reasons quite out of control of the community, e.g. global climate change, so not every change needs to be explained in local terms. (Facilitators from MCDI should be able to help advise on this, especially where similar trends have been noted in other certified forests nearby.) Where a species is in decline, and this decline

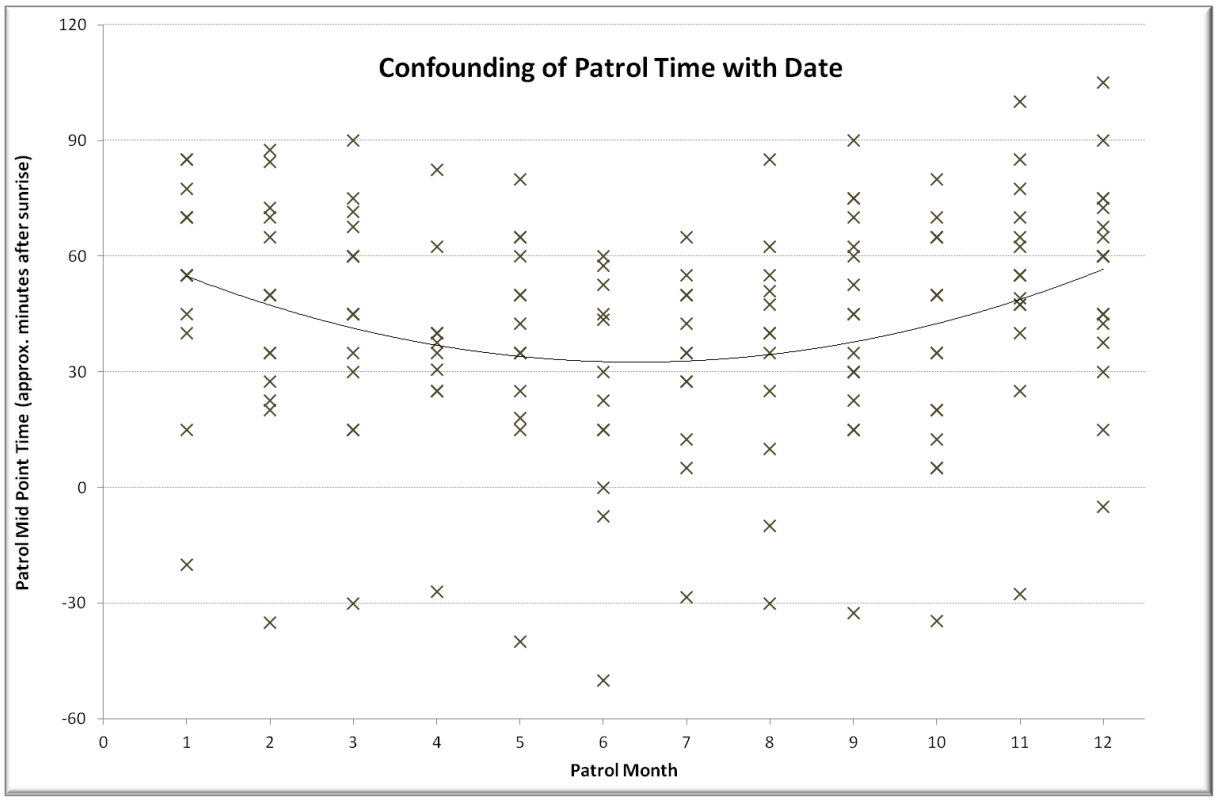
does seem to be linked to local conditions the VNRC should discuss and agree what measures are appropriate to arrest the decline.

Sources of Bias & Confounding Variables

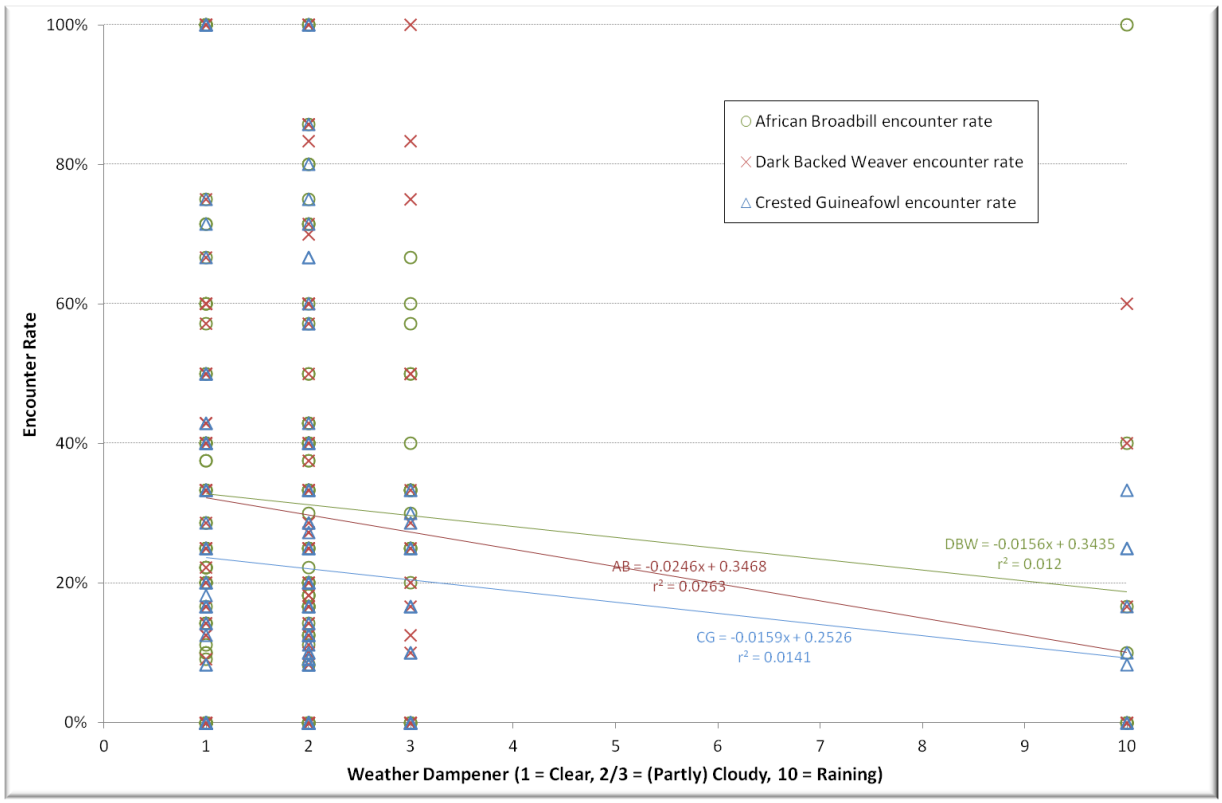
Data collected by communities between 2009 and early 2013 was checked and subjected to preliminary analysis. Three possible sources of bias were checked for their impact on the data: time of patrol, weather (clear / cloudy / raining) and wind speed.

Although the time of patrol does appear to have some impact on the encounter rate for African broadbills and Dark backed weavers, see first figure below, the overall effect is low ($r^2 < 5\%$), and the effect can safely be ignored, unless it is significantly confounded with the patrol date (which is expected to be an instrumental variable). There is some evidence for this, see second figure below, but the effect is limited – an average variation of about 20 minutes – and it appears mostly to be a case of communities not adjusting their patrol times for the shifting time of sunrise. We should not read too much into this because accuracy of patrol team timepieces (watches and mobile phones) may also be limited. Hence time of patrol can safely be excluded as a source of bias in this data.





Substantial rainfall can be expected to reduce detectability as birds take cover and stay quiet. To test this the weather conditions were scored on a scale of one to ten, but failed to find much of an effect, see figure below. Perhaps this is because when the rain is particularly heavy the patrol does not go out at all, and when rainy conditions are recorded it is only light drizzle or short showers with do not much suppress bird movements. Similarly no impact was found when data was checked against wind speed.



These analyses lack a certain robustness due to their reliance on subjective recording of weather conditions which is likely to differ from one community patrol team to another. But given the variable

reliability of monitoring data recorded by rural communities the findings are sufficient to support analysis of that data based on a single primary instrumental variable set out above.

Management Feedback Loop

Monitoring results will be fed back into management at three scales:

1. Annually, after results have been computed as above, the Forest Manager will discuss what conclusions have been drawn and note them on form SF18 Monitoring Data Analysis Summary. These may lead to changes in current management, e.g. patrol frequency.
2. Every five years, upon renewal of the management plan, all monitoring results will be explicitly considered, and changes made where appropriate.
3. Across the entire group, MCDI will compare changes evident in different VLFRs and look for wider trends that may need to be addressed.