Biodiversity monitoring Vwaza Marsh Wildlife Reserve, Malawi

Manual & Field Guide

Version 2025

Contents

LOGISTICS PAGES

DAY TO DAY PLAN

	Morning	**Afternoon**	**Evening**
Sat 6 Sep	Meet in Lilongwe, travel to Vwaza	Arrival, orientation, introductions, risk assessment	
Sun 7 Sep	Intro to projects, field safety, map orientation	Game drive around lake	
Mon 8 Sep	Elephant project training, elephant safety, elephant ID	Presentations: iNaturalist , camera trapping, hippo/night transects, bird surveys	Camera trapping
Tues 9 Sep	Research work		Night transect
Wed 10 Sep	Bird transect/Research work		Optional night transect
Thurs 11 Sep	Day off (local village market visit and other activities optional)		BE presentation
Fri 12 Sep	Bird transect/Research work		Camera trapping
Sat 13 Sep	Research work		Night transect
Sun 14 Sep	Bird transect/Research work		Optional night transect
Mon 15 Sep	Research work		Night transect
Tues 16 Sep	Bird transect/Research work		Camera trapping
Wed 17 Sep	Research work		Optional night transect
Thurs 18 Sep	Research work and pack up		Sundowners
Fri 19 Sep	Depart Vwaza 08:00	Arrive Lilongwe approx 19:00	

General timings

05:30	Bird transect or optional morning drive
07:00	Breakfast
09:00	Field work/data entry and analysis
10:00	Coffee break for those at camp
13:00	Lunch and daily review at camp
15:00	Field work/data entry and analysis
17:00	De-brief at camp
18:00	Dinner
19:00	Leave for camera trapping or night transect

Remember to stay flexible as things are likely to change

GENERAL FIELD SAFETY PROCEDURE

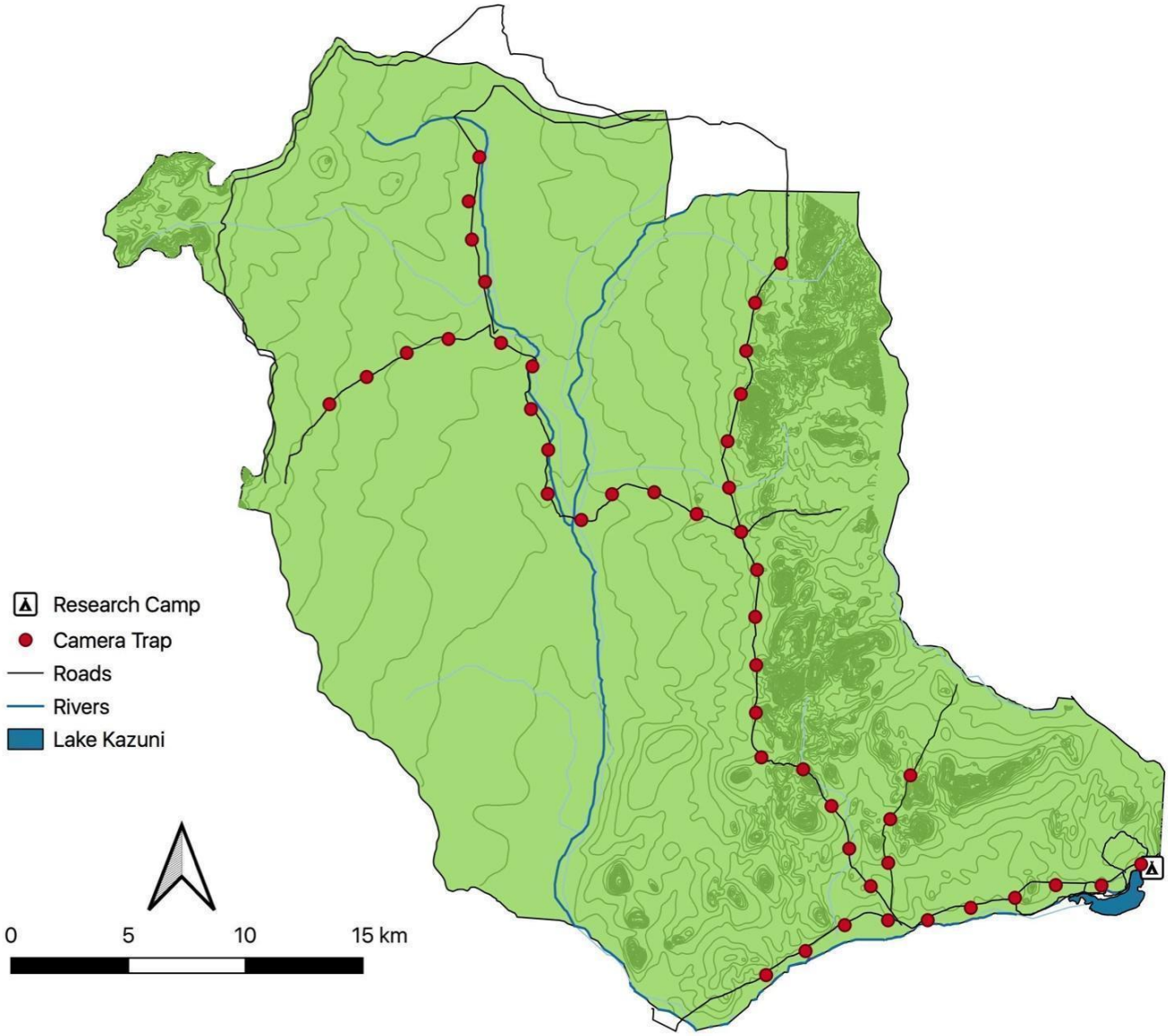
1. Always fill in the log book when leaving base so that we know what you are doing where and when you intend to return.
2. Always carry in each group (a) this sheet, (b) the mobile phone sheet, (c) at least one mobile phone, (d) a radio. Make sure devices are switched on, fully charged and loaded with airtime.
3. Stick to your route and return time. If you are going to be late, call staff or someone else who will adapt your return time. You may have to relay that message across the study site until someone at base gets it and can adapt the logbook.
4. If you are more than an hour over your return time, we will send search parties out to look for you (the first place we will head for is the route you have specified on the logbook). Please make sure you are back in time or send a message if you are delayed so that no unnecessary searches are initiated.

If you have an accident/emergency, those able to should administer first aid. If you are in a functioning vehicle, take the casualty back to the nearest location below immediately. Try to contact staff on the way so that they can get in touch with the emergency services as necessary. If you do not have a functioning vehicle or are on foot, but have mobile phone or radio coverage, try to contact staff or anyone else you can raise and ask for assistance (you may have to ask them to go for help or relay the message). If this is not possible, stay put, help the casualty to the best of your ability and have 1-2 fit people climb the nearest hill/mountain top and establish contact, or return to base. If you are unable to contact anyone, then it will be up to you to carry out an assessment. It is essential that you do this as calmly as possible and decide the best course of action, which will not make the situation worse. In most cases this will mean you will stay put, as this gives us the best chance to find you quickly (one reason to stick to your route always and fill in the logbook), but extreme situations may require extreme measures. You should never leave a casualty alone and make sure they are kept warm and/or in the shade and comfortable. Make sure you have a GPS location for the casualty.

Numbers

Biosphere Expedition leader – Roland Arnison	TBA a few days before expedition starts
LWT Head of Biodiversity Research – Leandra Stracquadanio	+265 (0)894 242 992
LWT Research Technician - Chimwemwe Kalulu	+265 (0)997 232 096
LWT Volunteer Manager - Gideon Banda	+265 (0)993 992 588
Emergency services (Dr Kasmani)	+265 (0)999 455 786

MAP



Map of Vwaza with camera trap locations

DATA COLLECTION PROTOCOLS

ELEPHANT DUNG COLLECTION, DNA, AND SEED ANALYSIS

Part of LWT's Malawi Elephant Research Project is dung analysis of the elephants in Vwaza. This gives us information on diet, levels of human-elephant conflict and an estimation of the age classes of the population. **New during the 2025 expedition:** We will be keeping samples of each fresh dung bolus collected to trial the creation of a DNA database for the elephants in Vwaza. This will help us count individuals and identify genetic variation amongst the population.

Dung collection

- We collect dung opportunistically throughout our daily tasks, or when we know elephants have been in an area for an extended period of time (thanks to our satellite collars).
- Wear gloves while handling dung.
- Samples are collected from fresh dung piles only (<12 hours after deposition with no signs of insect deterioration, and no evident deformations owing to impact with the ground or evident decay over time).
- Take the GPS coordinates of the dung pile.
- Record the number of total boli in the dung pile before collecting three of the most intact ones.
- Place in plastic bag. Make sure to write on the plastic bag the dung sample number.

Dung analysis

- Measure the diameter of three boli from each dung pile in order to relate to the age of the elephant (see Table 1). Measure the long and short axes of the elliptical ends of the bolus and then take the mean of those two measures to get the diameter.

- Break up the whole of the dung pile and search thoroughly for seeds. Wear gloves.
- Place seeds into a labelled pot as you find them. These pots should be labelled referencing the number of your dung sample (e.g. D01)
- Once the whole dung has been sorted, make up a solution of 1 part Dettol, 10 parts water. The solution should be cloudy and opaque.
- Pour solution into the seed pot and gently massage each seed to remove organic matter.
- The seeds should be removed from the solution using tweezers and placed into a clean dry pot that is numbered with the seed sample number.
- Use a sieve to ensure no seeds are left in the solution.
- Leave the seeds to completely dry. Ensure they are out of reach of baboons. Take caution on windy days that the pots do not blow away.
- For DNA collection, place a small amount of dung (ideally from an external section rather than internal) into a collection tube along with preservative solution.
- Label this with the date, location, and when possible, the herd ID. Store in a cool and dry place. These samples will be processed by a lab when back in Lilongwe.

Seed analysis

- Once dry, count all seeds found within the droppings.
- Photograph each seed next to a ruler on a white background. Same species seeds from the same dung sample can be photographed together.
- Enter these data and the photo number into the Master datasheet.
- Place seeds into a plastic bag, which should be labelled with the date, GPS of the dung location, and dung sample number.
- Identify the seed from the 'Trees of Southern Africa' book and from our reference collection.
- If the seed is unknown, then refer to the 'Unknown seeds' photo album on the elephant project laptop. If the seed is the same species as one of these seeds, then enter it in the species column, e.g. unknown12, unknown46.
- Calculate the percentage of occurrence of each item within the dung pile as well as the percentage occurrence of each item within the whole of the sampling (the sums for all seeds within a dung pile and across all samples can be easily calculated in Excel)

Occurrence within dung pile: $\frac{\square\square\square\square\square\square\ \square\square\ \square\square\square\square}{\square\square\square\ \square\square\ \square\square\square\ \square\square\square\square\square\ \square\square\ \square\square\square\square\ \square\square\square\square}$

Occurrence within entire diet: $\frac{\square\square\square\square\square\square\ \square\square\ \square\square\square\square}{\square\square\square\ \square\square\ \square\square\square\ \square\square\square\square\square\ \square\square\square\square\square\square\square}$

Table 1. Age classifications for elephants based on dung boli diameter (adapted from Morris et al. 2005 and Jachmann and Bell 1984).

Age Class	Age	Bolus mean diameter (cm)	
		Males	Females
Calf	1	6.4	6.4
	2	7.9	7.9
Juvenile	3	8.6	8.6
	4	9.3	9.3
	5	9.9	9.9
	6	10.4	10.4
	7	10.9	10.9
	8	11.3	11.3
	9	11.6	11.6
	10	11.9	11.9
Sub-adult	11	12.2	12.2
	12	12.5	12.5
	13	12.7	12.7
	14	13.1	13.1
Adult	15	13.4	13.3
	16	13.7	13.5
	17	13.9	13.7
	18	14.1	13.8
	19	14.3	14.0
	20	14.5	14.1
	21	14.6	14.2
	22	15.0	14.3
	23	15.1	14.4
	24	15.3	14.5
	25	15.5	14.5
	>25	18.5	15.0

ELEPHANT HERD SIGHTINGS AND GROUP OBSERVATIONS

Group and individual observations and ID

During these data collection sessions, we focus on more detailed group composition and individual identification data, whereas our collar data gives us a better understanding of movements and habitat use throughout the reserve. These data must be detailed and accurate. It is always better to get less, but accurate data than a large amount of vague data. These methods were developed as a joint project with Elephants for Africa.

Research sessions from vehicle (often *ad libitum)*

- We drive in areas with little abundance of tsetse flies (mainly around the lake) looking for elephant herds
- When we find a group, we observe them until we have accurate data.
- Elephants seen moving through thicker habitat can make data collection more difficult, but we can then be sure that the individuals seen in the group are choosing to associate with each other.
- Before starting the research session by vehicle, record the date, time, start GPS, and situational data on the data sheet (e.g. weather, temperature, wind)
- We try to drive alongside the elephants, maintaining distance, as the goal is to not alter their behaviour whilst being close enough to allow you to take pictures of them from each side. If they are uncomfortable with our presence, we will back off or leave them to move on.

Research sessions from camp / the lakeshore

The water resource in front of camp (Lake Kazuni) is utilised by elephants throughout the year for drinking, swimming, playing and to cover themselves with mud and sand. This means that large numbers of elephants congregate here, but that does not mean that they would choose to associate with one another in the absence of those resources. We therefore conduct research sessions at the lake to increase our sample size, but we must be very careful that the groups we record are those that arrive at the lake and leave together, not short-term interactions brought on by resource availability. To guarantee this, we must only record data on groups that arrive at the lake after the researchers, not on those already interacting there.

- Before starting your research session, record the date, time, and other situational data on the datasheet. We work in pairs, with one person focused on observing the elephants and one recording the data.
- Only record groups that have arrived at the lake after you have.
- Focus on one group at a time and record the group composition data first, including ages and sexes (consult the How to Age and Sex Elephants sheet for reference)
- Then take photographs of each individual (see below).
- Once you are satisfied that you have good data from all individuals in that group, move on to the next group.
- When many elephants arrive, it can get confusing and the quality of the data that you are collecting will deteriorate. Try to remain focused and organised.
- Each elephant group you observe should be assigned a letter for that day starting with A (note that the next day, you will start with A again).
- Each individual you observe will be labelled with B for bull or F for female, followed by a number in the order of which you observe them (e.g. B1).
- Make sure you are still a safe distance away from the animals when observing or photographing them.

Herd sightings and group composition

- To reduce confusion when distinguishing between elephants, assign each group a letter per day (not per sighting; i.e the next day you will start at A again), and each individual a number per day (not per sighting), e.g. individual 1 from group A.
- Each individual you observe will be labelled with B for bull or F for female followed by a number in the order of which you observe them (e.g. B1).
- It is best to have a few people assisting on identifying the elephants and filling in the datasheet, as you will need to keep track of individuals who are often moving.
- We record:
  - Group size
  - Group Size Confidence Level (on a scale from 1-3, with 1 = you are 100% certain that all elephants in the group were seen, 2 = you are 50% certain, and 3 = you are not certain at all that all members were seen).
  - Group leader – the elephant who is in front when walking anywhere (if identifiable)
  - Habitat: Woodland (W), Grassland (G), Dambo (D) or Floodplain (FP).
  - GPS coordinates and the perpendicular distance to the centre of the group. Remember that the coordinates you record are your location, not that of the elephants, so you will need to determine the perpendicular distance from yourself to the centre of the group.
  - Compass angle: this is the angle of the group in its relation to true North.
  - Number of adults, subadults, juveniles and infants, as well as number of adult males and adult females.
  - ID photo numbers of each individual. Quality of data is more important than quantity, so focus on one elephant at a time.

ELEPHANT INDIVIDUAL IDENTIFICATION

ID photographs and descriptions

Elephants live in matriarchal societies, meaning that a female leads her herd's movements. Bulls generally split from their maternal herd when reaching roughly 15 years of age, but can attach themselves to other males to form smaller bachelor herds. They will then only join a breeding herd again when they are looking to mate. The identification of bulls and matriarchs of breeding herds allow for continuous monitoring of movements, condition and, for the latter, demographics and herd compositions. Re-sightings of particular herds and bulls over time can provide important information on their breeding success and sex ratios within a certain area.

We use photos of the notches and holes on the ears, in combination with the shape and size of the tusks to individually identify elephants. Identification is easiest done through photographs. When taking photographs of elephants, be sure to take detailed photos of their ears, face-on, and full body. When back at camp, look through the photos carefully for identifying characteristics.

- Record both ears and both tusks. Take a photo of each side profile and one head-on of each individual, as well as a full body photograph.
- Optimise the light conditions for the highest clarity of details (no back-lighting, in sunlight if possible).
- Avoid taking photos of elephants when they are partly wet. If the ear is completely wet or completely dry then it can work, but the patterns on the ear from water drops can hide the actual details.
- Take as many photographs as you need.
- Make sure that <u>at the time of capture</u> you make a note of which photo numbers refer to which elephants, rather than having to go through hundreds of photos during data entry, when you may not recall which elephant is which.
- When switching between individuals, take a few frames of the ground so that you can identify the switch in your photo sequence later.
- If, when you review the photos, they are not clear enough, record that elephant as unidentifiable.
- Data from these sheets are used to supplement the ID identification data on the Group Composition and ID Data Sheets, and should be used to amend those data.
- When back in camp, look through established IDs to see if it is an elephant that has been seen before. If it is, then change the letter you gave it in the field to its official ID number, e.g. B32 (B for Bull) or F104 (F for female). If it is new, then create a new ID code in the database
- Distinguishing characteristics include detailed information about the ears, tusks, tails and general appearance of each elephant, physical condition, and musth status of males
- Photos are stored on the laptop in specified folders by date, group and individual.
- We also make a drawing of the individual ear characteristics and record individual descriptions on the Elephant ID Descriptives Data Sheet following the standard terminology.

ELEPHANT ID GUIDE

- Focus on the general body shape, the shape of the head, and the thickness of the tusks and genitalia.
- Males have more massive and rounded foreheads, and thicker, more conical tusks.
- Females have smaller, more pointed or square foreheads, and more slender tusks. Adult females have two breasts between their front legs.
- Males tend to carry their heads higher than their shoulders, and their abdomens slope downward from their forelegs to hind legs.
- Females tend to carry their heads lower and their abdomens are more curved.
- In males, the penile sheath bulges out below the tail and curves forward.
- In females, the genitalia look like a funnel with the vulva opening pointing downward.

Male elephant age classes

Class	Height (cm)	Age (yrs)	Description	
1	204-228	10-15	Male head shape more noticeable; tusk circumference and shoulder height greater than females of the same age.	
2	229-243	16-20	At about 17 yrs male reach same height as largest adult female over 40 yrs.	
3	244-275	21-25	Taller than most females, but head still slender and narrow compared to older males.	
4	276-296	26-35	Head shape changes to an hourglass shape. Head breadth and height increases with age.	
5	>297	36+	Very big, tower over largest female by three feet or more at shoulder, neck thick, tusk circumference at lip strikingly greater than younger males and all females.	

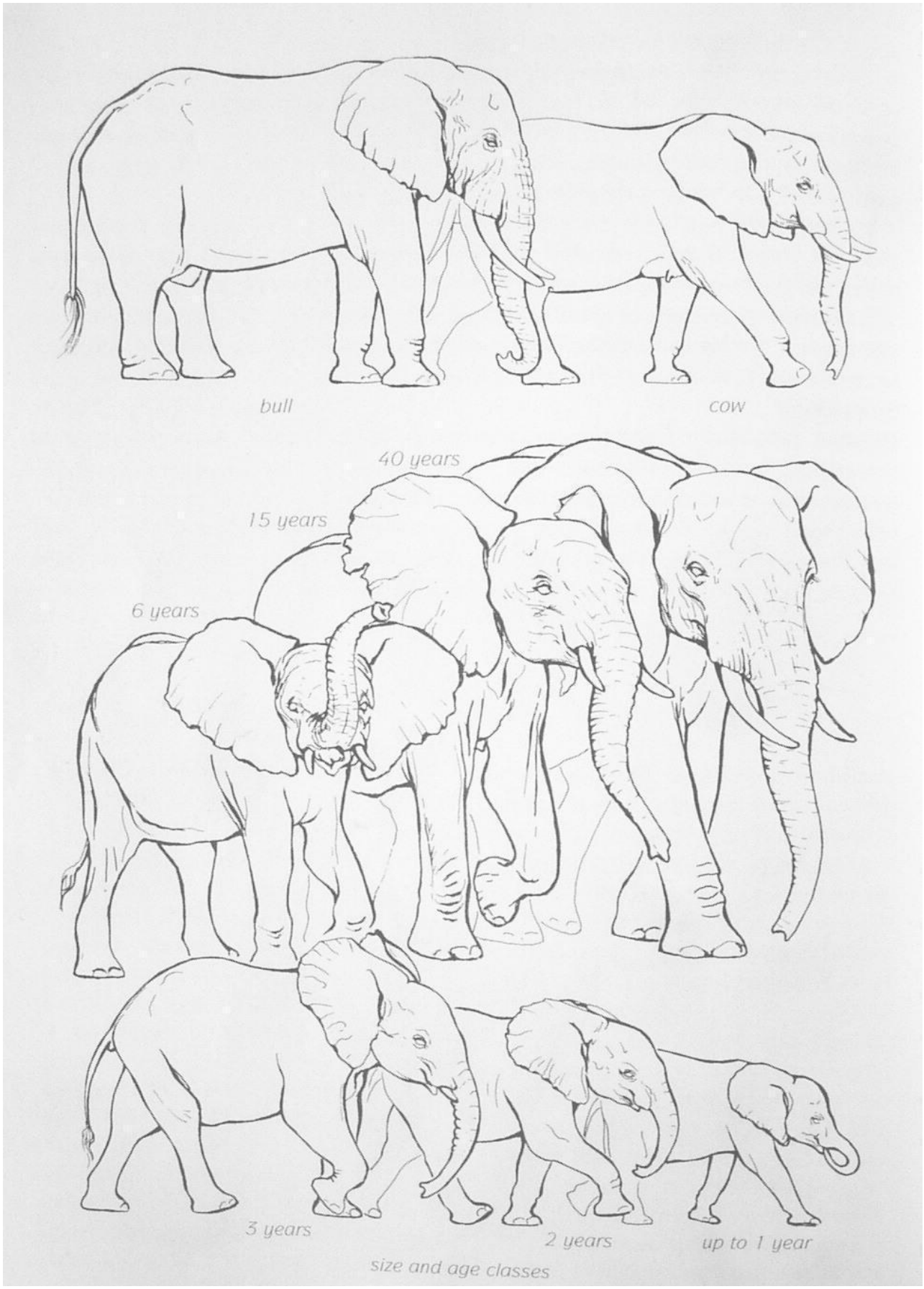
Female elephant age classes (10+ years)

Class	Age (yrs)	Description
1	10-15	Thin tusks, probably still splayed rather than convergent; more square in body shape than older females who are rectangular.
2	15-20	Tusks begin to take on their adult configuration that is convergent, straight or asymmetrical with one higher than the other.
3	20-35	Circumference of tusks at base distinctly bigger than teenaged females.
4	35-50	Tusks marginally thicker; back has lengthened so that animal appears long in body.
5	50+	Hollow above the eyes, ears held lower, longer back length, sometimes long tusks.

0-10 years old age classification (male and female)
(calf sizes are relative to an adult female 25-45 years old with a shoulder height of about 250 cm)

Class	Age	Shoulder height	Development
1	Newborn	Top of shoulders reach lower wrinkles below mother's 'elbow'; can easily walk beneath her.	Thin, stiff-legged; sometimes part of umbilical cord attached; whites of eyes often red; backs of ears bright pink; often hairy on head and back.
2	2-3 weeks	Same as above.	Walking well; more filled-out in body; backs of ears non longer pink; trunk is short and slender but exploring, picking up sticks.
3	3-4 months	Reaches to mother's elbow point.	More rounded, fatter; begins trying to feed on grass; spends time away from mother; plays with other calves.
4	8-9 months	Reaches elbow; can still pass under mother but probably scraping.	Feeding adeptly and continuously for long stretches; capable of drinking with trunk.
5	1 year	Shoulder taller than breast level of mother, reaching to wrinkles above elbow.	Head and ears look in proportion to each other and body.
6	1-2 years	Top of shoulder midway between elbow and junction of leg with torso, the 'armpit' of mother.	Trunk looks more in proportion; tusks of male calves may show beyond lip from 18 months on.
7	2-3 years	Reaches mother's armpit.	Tusks of most calves and many female calves will show; mother may show signs of trying to wean calf.
8	3-4 years	Top of shoulder above mother's armpit; back almost level with anal flap and reach lower quarter of mother's ear.	Almost all calves will show at least 5-7 cm of tusks; most calves still suckling, but some may be weaned.
9	4-5 years	Reaches mothers' anal flap or above.	Tusks are 15-18 cm long; has probably stopped suckling and may have a younger sibling.
10	5-6 years	Appears to be about one-quarter the size of an adult female; back almost level with middle of mother's ear.	Tusks are about 15-18 cm long; differences in male and female behaviour become more pronounced: female calves allomother younger calves; male claves seek out other males for sparring.
11	6-7 years	Shoulder and back height above base of mother's tail and above middle of ear.	Tusks begin to splay out in both males and females; sexual differences discernible: males have thicker tusks and heavier bodies.
12	7-8 years	Back level with adult female's eye and well above base of tail.	Tusks are usually splayed by now; no longer looks calf-like, but more like a small adult.
13	8-9 years	Overall size in height and length over half an adult female.	Tusks are about 25-30 cm.
14	9-10 years	Overall size almost three quarters of an adult female.	Males are larger than females of same age and spend more time on periphery of family; females are more integrated in family.

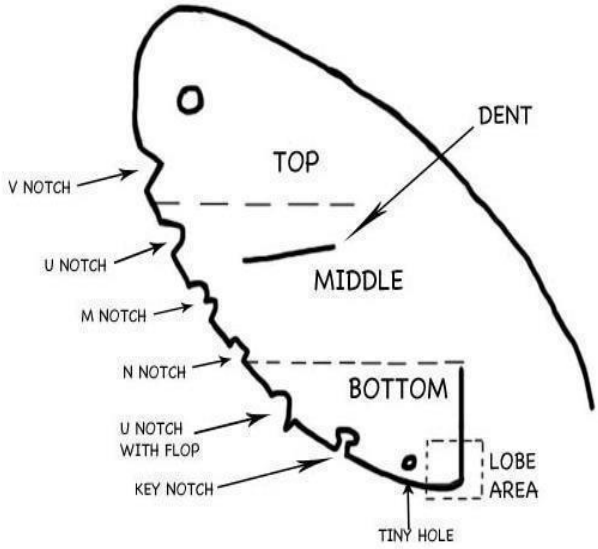
Elephant age and sex



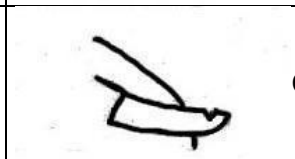
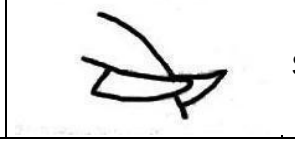
Elephant individual ID standard terms

Ears

CHARACTERISTIC	SHAPE	SIZE / DEFINITION
Slit		
Notch	U	Large
	V	
	M	Small
	N	
Flop		Piece of skin hanging down
Dent		
Hole	Round	Large
	Bean	
	Triangle	Tiny
	Oval	
Floppy		Ear flops over at the top
Tatty		Ear edge too tatty to draw it all
Pink pigmentation on back of ear		



Tusks

Broken		Chipped		Splayed	
Groove		Chiselled		Convergent	
Shorter		Straight		Straight	

TAIL
Short Hair
Kink
No hair
No tail
Incomplete tail
Most hair on one side

OTHER
Scar
Lump
Pink markings on penis
Other

Code	**Physical Condition**
1	Emaciated: Very, very thin
2	Very thin. Shoulder blades, pelvic bone visible
3	Thin. Shoulder blades, pelvic bone and backbone are visible
4	Good. Slight sinking in front of pelvic bone.
5	Fat. No sign of shoulder blade, pelvic bones or backbone protruding and fat hangs from body.

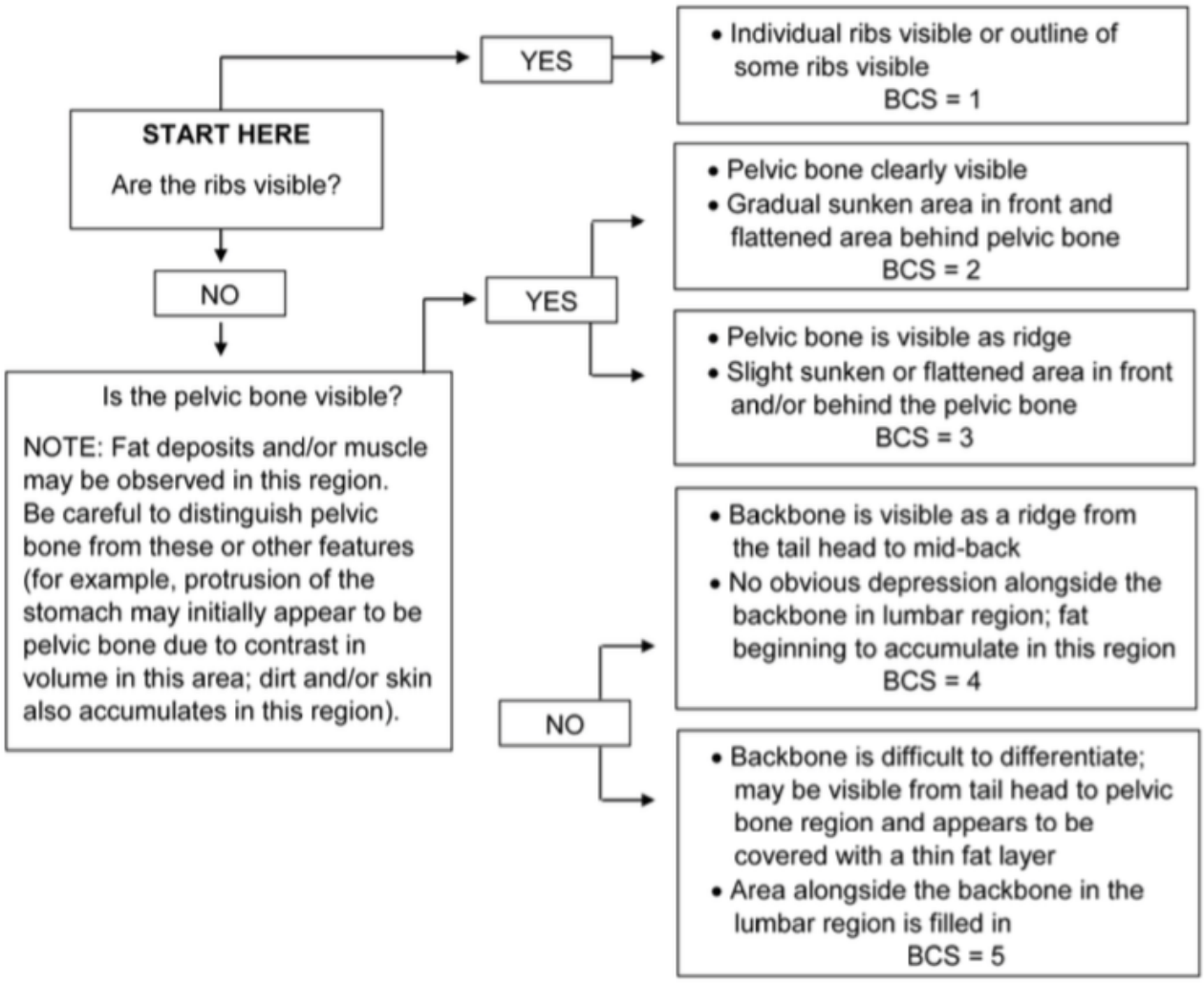


Figure 4. Body condition scoring flow chart for female African elephants.
doi:10.1371/journal.pone.0093802.g004

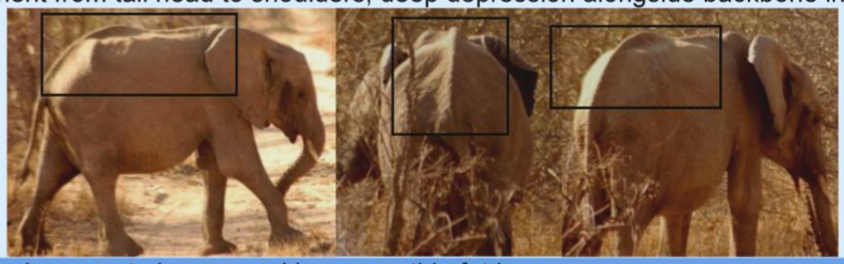
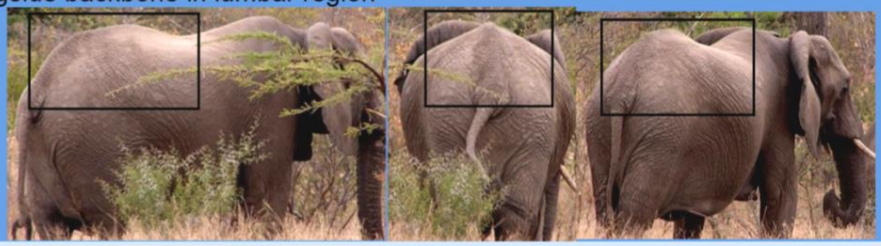
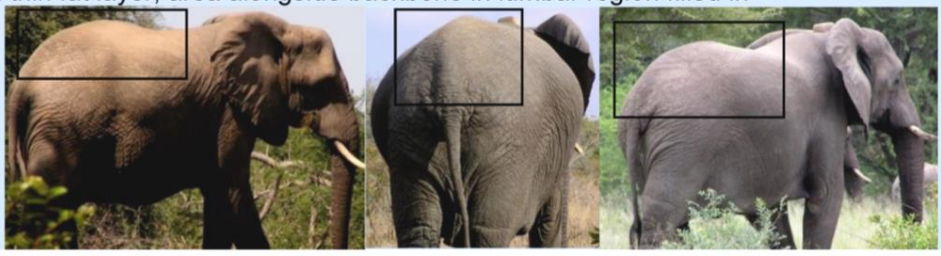
BCS	Description and example photographs
1	**Ribs:** Clearly visible **Pelvic Bone:** Protrudes, deep depression in front and depression or flattened area behind pelvic bone **Backbone:** Prominent from tail head to shoulders, deep depression alongside backbone in lumbar region 
2	**Ribs:** Not visible and appear to be covered by a very thin fat layer **Pelvic Bone:** Clearly visible, gradual sunken area in front and flattened area behind pelvic bone **Backbone:** Clearly visible from tail head to mid-back, depression alongside backbone in lumbar region 
3	**Ribs:** Not visible **Pelvic Bone:** Visible as a ridge, entire pelvic bone may not be visible, slight sunken or flattened area in front and/or behind pelvic bone **Backbone:** Visible from tail head to mid-back, sloping alongside backbone in lumbar region 
4	**Ribs:** Not visible **Pelvic Bone:** Not visible **Backbone:** Visible as ridge from tail head to mid-back, no obvious depression and fat beginning to accumulate alongside backbone in lumbar region 
5	**Ribs:** Not visible **Pelvic Bone:** Not visible **Backbone:** Difficult to differentiate, may be visible from tail head to pelvic bone region and appears to be covered with a thin fat layer; area alongside backbone in lumbar region filled in 

Fig. 1. Illustration of the amount of secretion from the temporal glands. See text for explanation.

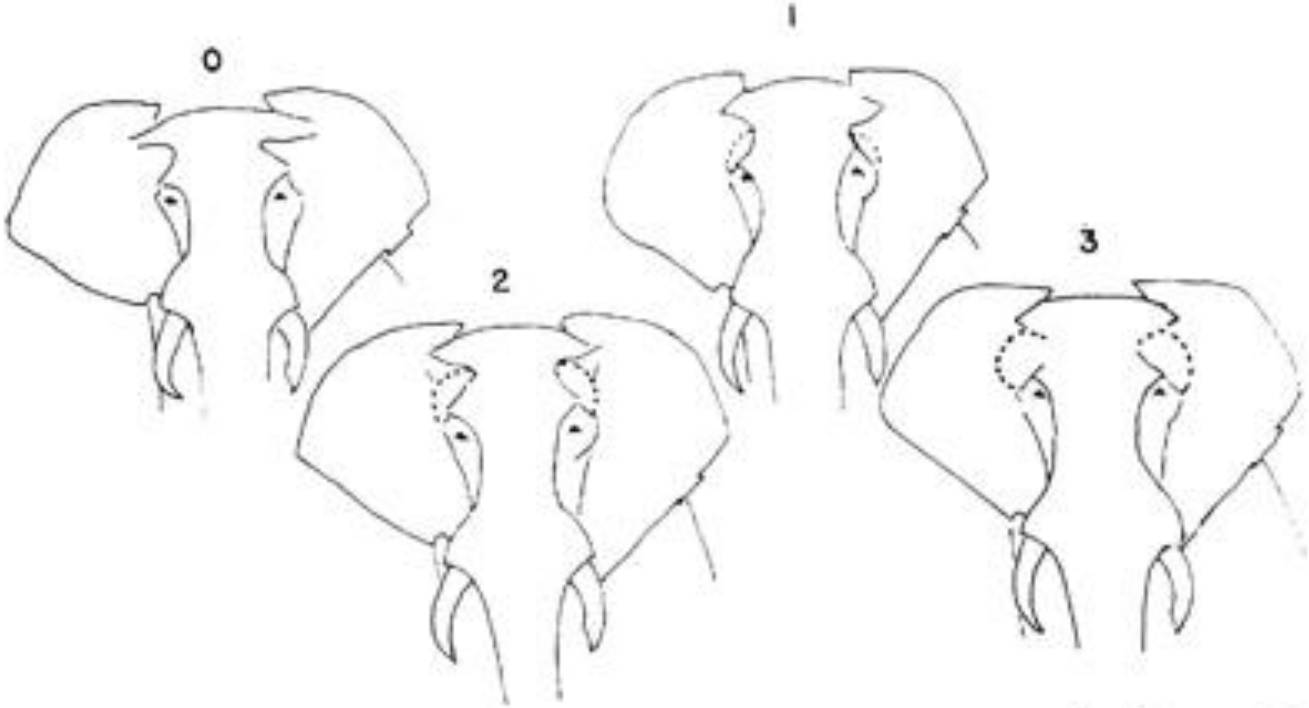


Fig. 2. Illustration of the degree of temporal swelling during musth. See text for explanation.

Signs of musth in reproductively active bulls

Musth walk: Head is carried high with chin tucked in and an overall swaggering gate.

Temporal gland secretion (1): Gland secretes an oily fluid which runs down the cheek to the chin and eventually leaves stained streaks. Musth males often rub the glands against trees (note that temporal gland secretions alone are not a reliable indicator of musth – they can also indicate stress or excitement in non-musth elephants; look for co-occurrence with other signs.)

Swollen temporal gland (2): Glands are at least the size of an orange at the peak of musth. Musth males often drape their trunks over the tusks to relieve pressure on the glands.

Frequent urine dribbling: Occurs during full musth, with penis kept inside sheath so urine sprays the hind legs. Sheath eventually stained yellow-green and legs have dark streaks running down.

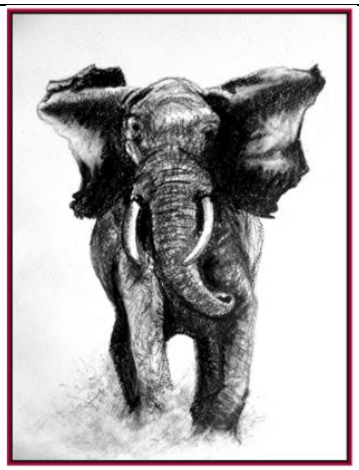
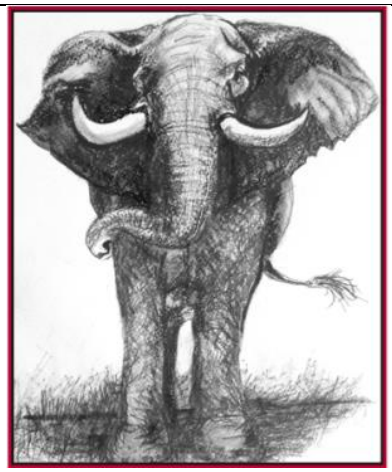
Strong smell: Musth has a distinct, strong smell that is easily discernible to humans.

Unexpected encounters with elephants on foot

- While walking in the bush, it is very important that you are quiet, stay close to the rest of the group and very vigilant of your surroundings.
- If we unexpectedly encounter elephants, look to assess whether the herd is spread, what direction they are heading and where you are in relation to where they are trying to go.
- Look for females and young; remember they get angry and scared when separated and are more likely to charge.
- Do not make any sudden movements, do not take photos and do not speak loudly.
- Bunch together with all other members of the group, DO NOT spread out; now is not the time to go for a pee!
- Make sure everyone in the group is present.
- Check to see if you are upwind or downwind of the elephants (downwind is always better).
- Watch the behaviour of the elephant(s); look out for the key behavioural warning signs (rocking front foot, flapping ears etc. – see below)
- Bear in mind we may get mock (hopefully not real) charges, in which case the scout will likely fire a warning shot. During a mock charge, the elephant is warning you to leave his/her personal space. In this event, you may have to run, throwing your bags as you go to distract the elephants and may need to make for a tree to hide behind or climb.
- DO NOT PANIC
- ALWAYS follow the instructions of scout and staff

Elephant charges

- Warning/mock charge: Rushing towards person(s) or vehicle(s), then the elephant stops abruptly, standing tall with ears spread, kicking dust with a fore foot and possibly swinging the trunk towards the opponent or vehicle. May be accompanied by trumpeting or air-blasting. Warning charges can often transition into real charges and should be taken very seriously. In response to a mock charge, leave the area you are occupying immediately, quietly and quickly.
- Real charge: Rushing towards person(s) or vehicle(s) with ears not fully spread (for greater speed). Trunk usually tightly curled up, head held low, and tusks pointing towards opponent. A real charge is fast, abrupt and silent, so pay attention and respond to early warnings before the elephants feel the need to charge. In response to a real charge: DO NOT RUN. You will not be able to outrun a charging elephant. Instead, hold your ground, making yourself big, arms up and shout at the elephant to stop.

	
Elephant mock charge	Elephant standing tall

Key elephant behaviours to look out for

Signs of uneasiness or apprehension – the elephant is deciding on a flight-or-fight response

- Chin slightly up and ears slightly spread: Usually occurs when they notice a potential threat.
- Plucking at vegetation without feeding: Vegetation may be slapped against the body.
- Foot swing: One front foot is raised and tentatively swung back and forth.
- Touching own face: The elephant touches its own face with its trunk.
- Trunk twisting: the trunk tip is twisted back and forth.
- Tail twisting: the tail is swung vigorously or held at right angles to the body and arched.

Threat displays of annoyance and aggression – retreat

- Ears spread: Faces an opponent and spreads the ears out 90 degrees from the body (not to be confused with slow, gentle ear flapping which relaxed elephants do to keep cool).
- Standing tall: Lifts head high to look taller, chin is raised so elephant looks down at adversary.
- Serious threat: Tusks point towards opponent with ears spread; more serious than standing tall.
- Trumpeting or air-blast: Trunk is used to audibly blast air with a gush, or to blow with a loud pop.
- Head shaking: An abrupt and vigorous jerking of the head so the ears flap and crack.
- Trunk swing forward: Swinging or tossing the trunk towards the opponent.
- Throwing dust, branches or objects: Objects thrown in the direction of the threat or opponent.
- Bush bashing: Tossing the head and tusks through vegetation to demonstrate strength.
- Tree pushing: Used as a show of strength (can also be done to feed on roots or leaves in which case it is not a threat behaviour).
- Tusking ground: Bending or kneeling down, pushing the trunk into ground or uprooting vegetation. Commonly used by males as a signal of aggression.
- Ear fold: Lower half of the ear forced under and backwards, a horizontal ridge appears across the ear.

HIPPO COUNT TRANSECTS

LWT is conducting a hippo population census concurrently with our other biodiversity surveys. This will allow us to keep long-term records of population trends across years and changes in anthropogenic pressures, to inform population management for DNPW.

Transects

- Transects are walked along the entire lakeshore (5 km).
- Upon sighting a hippo or pod, we stop perpendicular (90°) to the animal/pod and record
  - Time of sighting
  - Meters travelled along the transect (check GPS)
  - GPS of observer
  - The perpendicular distance of the observer to the centre of the pod
  - The compass angle of the pod in relation to true north
  - Total count of hippos in the pod. Spend at least 5 minutes at each pod to allow for submerged hippos to surface and be included in the count
  - Record the age classes of each hippo (if identifiable)
  - Number of animals in the water.
  - Number of animals on the shore
  - If a hippo is out of the water / on the shore, record the distance of the hippo to the nearest water's edge.

CAMERA TRAPPING

Pre-deployment

- Ensure each camera trap has enough battery life for its intended time in the field (if you are not planning on changing batteries whilst the camera is in the field).
- Check each camera trap has an SD card and that the SD card is working and has space before deployment.
- Check date and time signatures are correct. Note: If you take out the batteries on some models, this will reset the time and date.
- If your camera traps are labelled (e.g. LWT1, BE5) and the camera trap has a Station ID function, then make sure all labels correspond with the Station ID on the camera.
- Check that all cameras are set to the same parameters and that the chosen parameters are the right choice for your chosen animal (e.g. a large time delay between photos will be no good if you are trying to capture images of a large troop or herd of animals).

Choosing a camera trap site

- Select sites that your target species are known to use (e.g. for large carnivores most roads and tracks are heavily used whilst the opposite is true for ungulates). Where possible, confirm the presence of your target species through tracks, scat, calls etc.
- Try to determine the travel path of the target animal – pick a site where the target animal's travel path is limited to the area that can be photographed by the cameras.
- Try to avoid sites with lots of vegetation and moving branches/grass. Whilst this can be cut back, it is always best to avoid disturbing a site as much as possible. The more vegetation there is, the higher the chance that it will falsely trigger the camera. Over days this can lead to thousands of images to go through and use up battery life very quickly.
- Try to avoid areas of excessive sunlight. Passive camera traps will be affected by the ambient temperature and may not trigger when an animal walks past.
- Once you have selected a site, clear any vegetation that is likely to trigger the camera (large blades of grass, branches over the sensor). If you are in an area where seasonal burning is carried out, make a small fire break around your camera to ensure the camera is safe from fire.
- If you are looking to identify individuals (e.g. leopard, hyaena), then make sure your camera traps face **directly** on to the trail you are focusing on. Poorly chosen sites or poor settings will result in unusable images for your study.
- Camera stations should be at least 2 km apart.

Camera trap images showing good (left) and bad (right) camera trap placement for individual identification.

Deploying camera traps

- Cameras should be set back at least two metres from the nearest point where a target animal might travel across the sensor. This allows for clear, focused pictures and a large enough field of detection from the sensor. The longer the target animal is in the detection zone, the less chance of missing a photograph.
- Depending on your target animal, set the camera trap sensor to the appropriate height. A good rule of thumb is human waist height for general use.
- Use freshly cut sticks and branches to help prop up and secure the camera to the tree trunk or other anchor. A well-placed twig placed between the camera housing and the tree trunk can help adjust the angle in which the sensor is pointed (always use live wood to brace cameras and adjust camera angles, since dead wood is too brittle).
- Test the aim of both cameras by crossing in front of them. Do this on both the edges and the middle of the path. Most camera trap brands come equipped with an indicator light that will light up when the camera's sensor detects you. Approximate a target animal by walking in a crouch and then walking in a more relaxed fashion. Make sure that every conceivable angle at which the target animal can pass in front of the camera is tested and that in each instance a photograph is triggered.
- Before arming your camera, double-check all your parameters and time/date. Make sure you have an SD card in the camera and that it is not set to lock.
- Once you are finished setting up your site, record on the datasheets:
  - The camera and SD card ID
  - Date and time that you are setting the camera
  - The battery life
  - The location (e.g. road name) and GPS coordinates of the camera
  - Parameters set: Photo speed, camera make and model, and flash type (black, infrared, or white)
- Finally, make sure you arm the camera before leaving the site; it can be easier to forget than you think! Always do this last or you will end up using battery life and SD card memory while setting up your site.

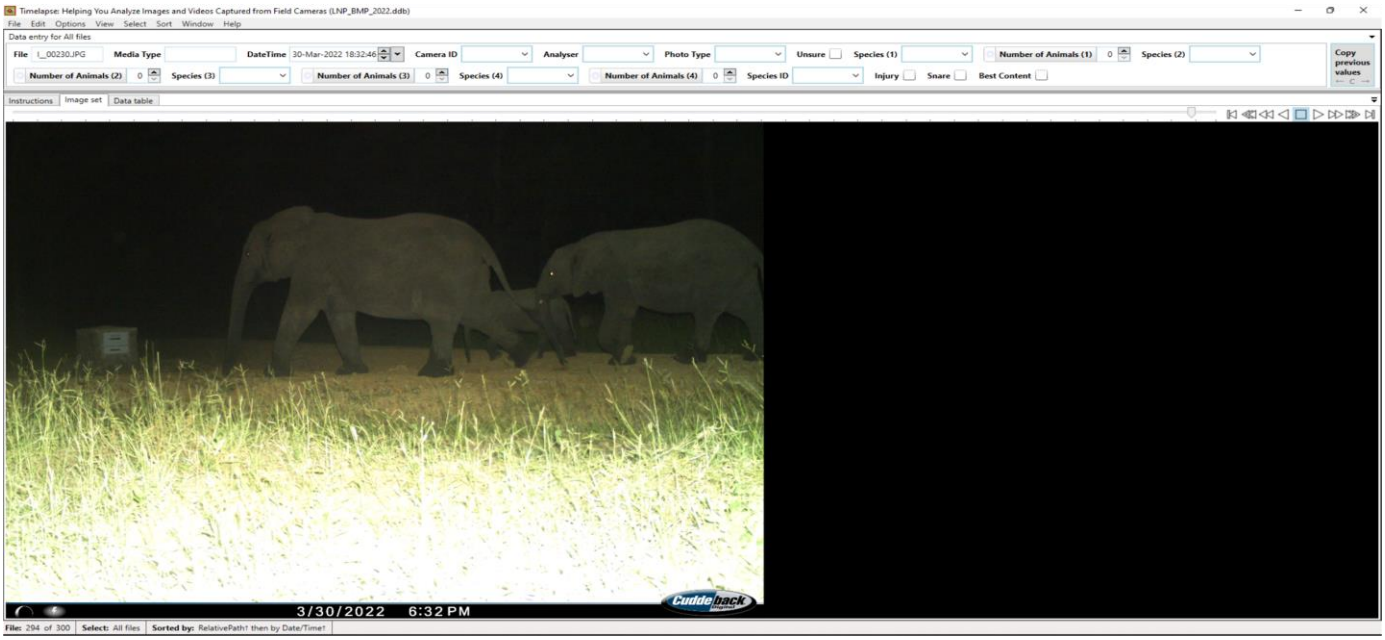
Checking camera traps

- Camera traps should not go longer than one week without being checked. This allows a reasonable number of photos to be collected without disturbing the site regularly.
- Camera traps can either be checked remotely in the field using a laptop or by swapping SD cards in the field. If you are swapping SD cards in the field, ensure that you know which SD card came from which camera.
- Use every camera trap check to ensure the parameters and time/date are still correct and swap batteries if needed.
- If you are checking camera traps in the field using a laptop, then use this opportunity to change anything about the camera positioning from the images downloaded (height, distance to path etc.).
- Make sure you organise your photos on the laptop when you remove them from the cameras into folders labelled with each Camera ID.

Analysing camera trap images

- All images are saved to the "Image database" folder. Create separate folders for each camera trap (labelled by "VM" followed by the camera trap ID), and create subfolders with the ID and the check date (e.g. VM04_12.09.2022)
- Images are analysed via the Timelapse software. To open the software, go to the "Timelapse folder" and open "Timelapse2.exe"
- In the open screen, select "Load Template, Images and Video Files…" from the "File" tab in the top left corner. Select the "Biosphere_2022.tdb" file in the "Image Database" folder
- If new camera trap images have been saved on the laptop, select "Add image and video files to this data set…" from the "File" tab in the top left corner and select the entire folder for the camera trap pictures in the "Image database" folder

The following shows the layout of the analysis window:



- To begin, type in what media type it is (either jpg for a picture or MP4 for a video)
- The “DateTime” field automatically enters the required information, however, check that it has updated it correctly and change if needed
- Select the Camera ID from the dropdown menu. If you are unsure what camera ID it is, you can select the “Data Table" above the image, and browse to the file you are currently inspecting. The pathway of the image should include the correct camera ID. Go back to the “Image set” tab and enter the corresponding ID
- Select your name from the “Analyser” drop down menu
- In the “Photo Type” drop down, select what subject is seen in the picture (e.g. animal, people on food, vehicle, no animal etc.) OR tick the “Unsure” box if it is unclear what you are dealing with (e.g. in very underexposed images). If you observe any suspicious activity on any images, please notify a member of staff
- Next, select what species you can see in the image from the “Species (1)” drop down. If a species is not listed, please talk to a member of staff so it can be added to the list. Enter how many individuals are visible from the first species in “Number of Animals (1)”. If there are multiple species visible in the picture, you can select the next species field and enter numbers accordingly
- Tick the boxes “Injury” or “Snare” if you can observe either of the two cases and inform a member of staff
- Tick the box “Best Content” for images that have rare species, funny captures or are simply are stunning capture!
- To go to the next image, press the single triangle in the top right corner (showing “step over one file” when hovering the mouse over it)

- Select the backwards-facing triangle to browse through previous images
- If the following image contains the same species composition and numbers, you can press the button “Copy Previous Values” in the top right corner to speed up the process

iNaturalist

iNaturalist is an online citizen science project that aims to share general biodiversity information and connect people with nature through the practice of observing organisms in the wild and sharing information with other users. It is also used to record organism occurrence, creating catalogues of species presence for any given location across the globe. It can be used to record personal observations, aid in species identification, or providing access to other users' observations to learn more about a new environment. Evidence of any organism, from flowers and plants, invertebrates, reptiles to birds and mammals.

The LWT started using iNaturalist to create species catalogues for all the field sites they are operating in, including Vwaza Marsh Wildlife Reserve. This helps any prospective expedition participants, volunteers or researchers to connect to their environment, and acquire knowledge about the site they are working in. It is also a great way to engage in photography or simply to keep your eyes open for the smaller things around you. The application is available on all mobile devices, as well as accessible on their website through any browser. The following is a description of how to use iNaturalist through their website. The process is the same on mobile applications, however, layout may vary.

How to partake in the LWT's iNaturalist projects, including our Biosphere Expeditions biodiversity blitz:

- Go to www.inaturalist.org and create a new user account
- After logging into your account, type "LWT Biodiversity Research" into the search bar
- After clicking on the project, press "Join" in the top right corner
- This will automatically add you to all the projects for the various field sites, including Vwaza Marsh.

All the biodiversity information recorded during your Biosphere expedition will be included in the LWT/Biosphere Biodiversity Blitz - Vwaza. This will allow us to easily see the impact of your expedition!

Uploading observations:

- To upload observations from the field, press the green "Upload" button in the top right corner
- When prompted, click "Choose Files" to browse to any pictures of observations you want to upload, or select "More Import Options" to select a file through another website (e.g. Facebook, SoundCloud)
- It is possible to upload multiple observations at once. To do so, simply select multiple files after clicking "Choose Files" by holding the ctrl-button or by marking multiple files via the shift-button
- The next screen will show previews of all your observations. The selected observation currently being edited will have a green border around it. You can edit multiple observations by holding the shift or ctrl-buttons when marking them, or select all observation by ticking the "Select All" box in the bar above your observations. This is especially useful for inputting the location or dates
- When clicking into the "Species Name" bar, iNaturalist's auto identifier software will suggest species which closely match your image. Try and identify the species as narrowly as possible, but if you are unsure, simply type or select the organism's Genus, Family or Order
- You can also click on any of the suggestions to receive more information on the species, which might help you identify the organism correctly
- The observation will be automatically added to the corresponding LWT project if you joined the "LWT Biodiversity Research" project and the location has been set to one of the field sites
- Make sure to fill out all fields (Species Name, Date and Location) so that your observations can reach "Research Grade" status

- Once submitted, you can access your observations through the “Your Observations” tab at the top of the website
- Click on any observation to add additional helpful information, such as the evidence of presence (e.g. you can upload images of the organisms tracks or feces, or their vocalisations), their life stages or sexes

Exploring and identifying other users’ observations

- When pressing the “Explore” tab, you can browse through all uploaded observations
- Narrow down the species or family you are interested in in the “Species” search bar, or narrow down by location by specifying in the “Location” tab. For example, typing in "Vwaza Marsh Wildlife Reserve” will give you all observations for Vwaza, whereas specifying broader “Malawi” will show you all observations made in Malawi
- By pressing the “Identify” tab, only observations requiring additional identification are shown. These can be narrowed down through the “Species” and “Place” fields, or by applying filters
- You can help observations achieve “Research Grade” status, by identifying any observations. Observations require another user’s identification of the organism to reach said status, and be usable for research purposes (e.g. species diversity in certain locations)
- To do so, click on any observations, and select “Suggest and Identification” above the small text box below the image. You can also add a justification or simply comment on the picture
- After opening an observation, you can click of the species name to receive more information about it and view some interesting statistics (e.g. seasonality or history of submission)

Bird surveys

New for 2025, LWT is conducting a bird species census concurrently with our other biodiversity surveys. This will allow us to keep long-term records of biodiversity trends across years and changes in anthropogenic pressures, to inform population management for DNPW. Birds act as biodiversity and ecosystem health indicators. These surveys are conducted in the early morning at 5:30/6:00.

Transects

- Transects are walked along the entire lakeshore (5 km).
- Upon sighting a bird, we stop perpendicular (90°) to the animal/group and record:
  - Species.
  - Time of sighting.
  - Meters travelled along the transect (check GPS).
  - GPS location of observer.
  - The perpendicular distance of the observer to the bird(s).
  - The compass angle of the bird(s) in relation to the observer.
  - Total count of birds in the group.
  - Record the age classes of each bird (if identifiable).
  - Number of birds in the water.
  - Number of birds on the shore.

Night transects

New for 2025, LWT is conducting a survey of nocturnal mammals in Vwaza. This will involve driving transects to record any mammals seen during spotlighting surveys. The purpose of this activity is to complement the camera trapping results and build a more robust dataset on the biodiversity of Vwaza.

These surveys will begin at 19:00. We will alternate driving two transect routes, one around the lake and one along the main road within the park. During this time there will be two red light spotlights searching either side of the vehicle for mammals.

When we encounter a mammal species we will record:

- Species
- Number of individuals
- GPS location
- Age/sex class, if possible
- Behaviour, if possible.