Flying-fox survey manual

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Introduction

Flying-foxes have been a focus of management concern for much of Australia's European settlement period. This concern has generally been focused on flying-fox impacts on agriculture and amenity but has recently included disease transmission risks, e.g. Lyssa and Hendra virus. At the same time there are concerns about the conservation status of a number of flying-fox species, in particular the grey-headed (*Pteropus poliocephalus*) and spectacled (*Pteropus conspicillatus*) flying-foxes. Meanwhile uncertainty about the status and trends of the species means that there is limited opportunity for informing public debate with data or for determining appropriate management actions or assessing their effectiveness. This highlights a pressing need for a rigorous national monitoring program; one that provides data directly relevant to management decision making, and to the on-going public debate.

Monitoring the size and distribution of flying-fox populations is challenging due to the animals large ranges and extreme mobility. These traits mean that standard approaches to population monitoring based on random sampling of a population will not provide reliable results, primarily due to violations of assumptions about population closure, sampling of a consistent proportion of the population and low detectability. Instead they suggest that an appropriate monitoring regime will be i) camp based, ii) rapid and completed across the species' range in a matter of days, iii) conducted as a census of known camps rather than a sample.

Modelling of the performance of different enumeration approaches identifies ground counts as the method that can be best implemented in a cost effective manner and satisfy the relevant experimental design criteria for large-scale monitoring of flying-foxes. Thus, we recommend the use of ground counts. Importantly, this modelling also concluded that the by far the greatest effect on the error came not from counting error in the camps, but from missed camps. Therefore, it is critical that significant effort is invested in locating camps in each of the regions.

The aim of this monitoring program is to :

i) provide an estimate of population size, distribution and the spatial and temporal dynamics of these

ii) provide estimates of trends in these parameters with estimates of their accompanying errors and accuracy

iii) identify the drivers of flying-fox distribution and abundance and allow for the prediction of risks associated with them, e.g. agricultural and amenity impacts and the risk of disease spillover

iv) do these things with an accuracy and precision appropriate to management needs and on appropriate timeframes.

v) This database would be managed as part of established national databases, e.g. ERiN (SEWPaC) or the Atlas of Living Australia.

Survey Preparation

As outlined in the introduction, it critically important that as high a proportion of the camps are surveyed as possible, which makes the survey preparation the most important part of the project.

Before the surveys as much information on camp locations in each of the regions should be gathered from sources including:

- Existing records
- Existing tracking projects
- National Parks personnel
- Conservation groups
- Property owners, particularly orchard growers
- Media campaigns
- Observing fly-outs

For each camp the land tenure and relevant contact person needs to be determined so that permission for access can be gained. For camps on public land this is generally fairly easy, involving contacting local parks or council people. However on private land this will often involve visiting the location. If possible each of these people should be visited personally to establish a repour and to explain the purpose of the project to them. For each camp the following information needs to be collected:

- Name of camp. If it is an established camp then the original name will be used, otherwise the name should be based on a nearby geographical feature; ie. Creek name, Park etc.
- Camp location. The town, suburb or area where the camp is located
- Latitude and Longitude (decimal degrees)
- Details of how to get access, including person to contact for access
- Site expert. Details of the person who knows the site the best. Might be the landholder, ranger or researcher who regularly works there
- History. Any information on the history of the animals in the area

All of this data should be recorded and sent your state coordinator..

Equipment required for the surveys

- Essential
    a. Good pair of Binoculars
    b. Aerial photo of camp
    c. Datasheets
    d. Penc ils
    e. Field clothing; ie Hat, boots, long sleeves, suncream, insect repellant etc.
- Optional
    a. Rangefinder
    b. Smartphone with area estimation app

How to conduct a survey

Before any surveys are conducted the relevant state and regional Parks offices should be notified. Surveyors should also talk to the contacts for all the camps in the region to assess which camps may be occupied, and to obtain permission for access. All camps should be visited unless somebody reliable has definitely observed no animals present in the days leading up to the count.

Initial view

The first thing that needs to be established when viewing a camp is whether it is occupied. This is done by looking, hearing and smelling for animals while walking through the known area of the camp. Camps frequently move short distances but remain undetected, so it is often useful to seek local knowledge from neighbours or other community members about camp locations.

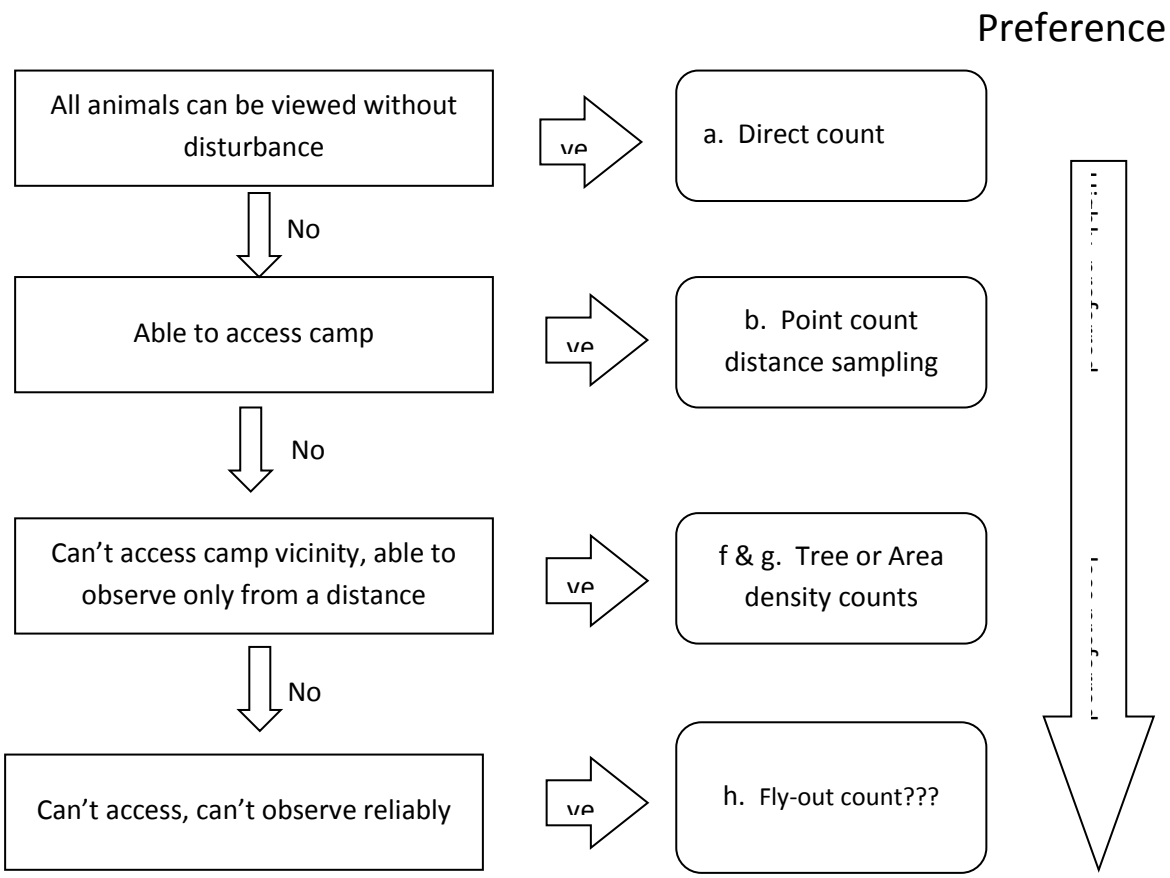
If animals are found then a preliminary assessment needs to be made, particularly of the approximate number of animals and the area of the camp.

Ideally when monitoring flying-fox populations we would use a single, error free method. Unfortunately, no methods are error free and the nature of flying-foxes and their camps make it impossible to use a single method – what works at one site doesn't necessarily work elsewhere. As a consequence we seek to use methods whose errors can be assessed (and hopefully improved over time) and we are forced to adopt a few different methods. The method used at a camp is determined by the circumstances encountered at that camp.

When the camp is small, less than ~ 1,000 animals, and the flying-foxes are easily to view, then it is possible to use a direct count of all individuals to determine camp size. However, at many camps these ideal conditions won't exist and some form of sampling will need to be used to determine the camp size. There are different techniques described below and the technique that is chosen will be determined largely by the physical access to the camp. In particular, can the observer access the edge of the camp, and can they walk into the camp without disturbing the animals too much. The decision must be made by the observer at the beginning of the survey.

We have a strong preference for direct counts and for larger camps, distance sampling. The advantage of distance sampling is that confidence limits are calculated that show the confidence we can have in the result. Other methods should only be used when these two methods cannot be employed.

The following flowchart can be used to help this assessment:



How to count flying-foxes

Binoculars should be used as distant flying-foxes can be missed and numbers of individuals in clusters can be difficult to assess when relying on eyesight alone.

Where ever possible, surveys should be conducted by 2 surveyors. One person will be the observer, while the other will record the data. The advantage of this is that the observer can concentrate on looking at the animals without having to look down at the clipboard between readings. These roles can be changed between points, in which case the observers initials should be noted next to each point.

Fly-out counts always require multiple observers, often large numbers of observers.

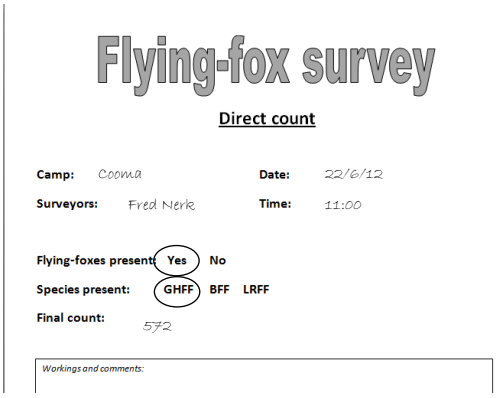
Datasheets have been designed for each of the survey types. It is important that the basic information, camp name, date surveyor and recorder are noted for each survey.

Brief descriptions of the different survey types

Full details of these techniques are found at the end of the document

Direct count

- All animals in the camp are sighted and counted



Flying-fox survey

Direct count

Camp: Cooma Date: 22/6/12

Surveyors: Fred Nerk Time: 11:00

Flying-foxes present: Yes No

Species present: GHFF BFF LRFF

Final count: 572

Workings and comments:

Point density estimate within camp

- Point counts involve the surveyor moving to a number of points in and around the camp
- at each point flying-foxes are counted and the distance to each animal or to each cluster of animals is estimated
- The total area of the camp is estimated by mapping the boundary
- Density of bats, and therefore the number of animals is calculated using distance Sampling models.

Point #	Arc of counting	# FFs	distance	species
1	360	5	0	GHFF
1	360	15	2	GHFF
1	360	8	12	GHFF
1	360	43	10	GHFF
1	360	21	17	GHFF
1	360	3	21	GHFF
2	360	0	0	GHFF
3	360	24	1	GHFF
3	360	3	5	GHFF
3	360	7	15	GHFF
3	360	6	8	GHFF
3	360	32	28	GHFF
4	180	8	14	GHFF
4	180	4	30	GHFF

Tree density estimate

- The average number of bats in each tree is calculated
- Trees may grouped according to species or size
- The average number of animals in the trees is multiplied by the total number of trees in the camp

Area density estimate

- The average number of bats in a known area (m^2) is calculated
- If multiple areas are used then the average number of animals per unit area is calculated
- This number of animals per unit area is multiplied by the total area of the camp

When you can't access the camp, and only see a small proportion of it...

- you have very limited options and a fly-out count may be your only choice.

Note on flyout counts

If flyout counts are to be used then a daytime ground assessment needs to be conducted to determine species composition in the camp. Additionally, there are often large numbers of animals still in the camp at the end of the flyout counting period, so a further ground assessment is required as soon as the counting has finished to assess this number.

Camp area estimation

Most of these estimation techniques produce an estimate of the density of animals, i.e. number of animals per unit area. To determine the total population of the camp this density estimate needs to be multiplied by the total area of the camp.

Estimating the total area can be done in several ways.
1) The observer needs to walk around the camp if possible, otherwise observe the boundaries of the camp using binoculars. While doing this the perimeter of the camp is marked on a map, a printout of an aerial photo (e.g. a screenshot from Google Earth) or a mapping app on a smartphone or tablet computer. The easiest is to mark out the perimeter of the camp using a smartphone/tablet app such as "Geo Measure". This program allows you to draw the camp perimeter over an aerial photo of the camp, calculates the area of the camp, and allows you to send this information and the kml file of

the camp boundary as an email. Additionally, having access to Google Earth type imagery is also very useful when trying to find camps, and determining what sort of survey technique should be used. If you are in an area without phone coverage these apps will generally require that you download the imagery prior to loosing phone coverage.

If the camp perimeter has been recorded on a printout then the final area result will need to be entered into Google Earth, saved and forwarded in Google Earth kml format. To do this you will need access to Google Earth, or a similar mapping program. The basic technique involves drawing the camp perimeter onto the Google Earth imagery, and then saving the result. This is explained here:
http://speciesmapping.pbworks.com/w/page/17654413/How%20to%20create%20polygons%20in%20Google%20Earth
If the camp is split into multiple groupings then the camp area will involve multiple polygons. The technique to use in this case is to create a folder in Google earth, and then create multiple polygons within this folder. You can then save the whole folder a a single kmz file. This is outlined in:
http://www.academia.edu/458951/Draw_Multiple_Polygons_and_make_one_kmz_in_Google_Earth

Sexing & ageing

Sexing and Ageing the bats is often best done after the population surveys have been completed so as not to interrupt the counting technique. The most likely exception to this is when conducting point counts, where the animals in a tree or a number of trees can be sexed at the completion of the population count for each point.

At least 15 trees or clusters of flying-foxes are chosen at random positions in the camp. It is important that the sample covers both the interior and exterior of the camp, as the sex ratios and age classes can be quite different in either location. The animals in the trees are assigned to 3 sex groupings, Male, Female and unassigned and 3 age classes, Adult, Juvenile and unassigned.

Sexing is done on adult animals by observing the genitals, and determining the presence or absence of testicles and penis. This is usually fairly easy during the mating season of January to May in good weather, with the male genitals being quite obvious on adults. However at other cooler times of the yearit can be difficult to accurately distinguish the sexes from each other. This process requires good visibility of the genitals, so not all the animals in a tree will be able to be sexed. Additionally, in cold or wet weather the bats wrap themselves up in their wings and in these conditions often no animals can be sexed.

Juvenile bats are bats less than 18 months of age. These are distinguished from adults by their small size and their large head relative to their body size.

If you do not feel confident about your ability to age or sex animals don't do it.

Data Management

At present the datasheets should be scanned and sent with the accompanying kml file to the state coordinator.

Detailed descriptions

◊ ***Direct count***

Using a pair of binoculars all the bats in a camp are sighted and counted. This can be done either from the edge of the camp, or by walking through the camp. With this technique it is important that the animals are not disturbed as if the animals are moving around double counting will be unavoidable.

◊ ***Point count within camp***

In this technique random points are distributed throughout the camp, with the counts from each point recording a distinct group of bats. In practise the easiest way of location random points is to choose a starting point at the edge of the camp and the slowly walk through the camp conducting a count at given distances, e.g. every 40 paces stop and conduct a count. This way points are chosen by the number of steps (which is independent of the flying-foxes) rather than because of the number of flying-foxes you can see.

It is important that the points sample the camp in a way that they are representative of the conditions in the camp. This is best achieved by random selection of the sites (as outlined above), moving as broadly through the camp as possible, and having lots of points (at least 15, preferably more).

The distance between points will vary depending on the vegetation and the size of the camp. When conducting direct counts it is important that individual animals are not counted more than once. In contrast, in methods that estimate densities of animals using distance sampling approaches, such as point counts in this survey, double counting is not a critical issue. Indeed, modelling and field studies have shown that when using distance sampling methods even very high levels of double-counting, e.g. all animals counted at least twice and most more than this, do not significantly affect the density estimate. This means that points do not have to so far apart that you can't see the last animals you counted.

Ideally the animals will not be disturbed by the observer when they are walking to these points. This can be best achieved by moving slowly and carefully through the camp. Making no sudden movements, wearing a hat and not looking up and thereby not allowing the flying-foxes to see your eyes can be surprisingly effective in keeping the animals calm. Of course, sometimes disturbance is unavoidable. This is usually a few low hanging animals moving to another perch, creating conflict and chain reaction of animals flying to another perch. In this case if the observer stops for a minute

or so, the animals will calm down and you can continue walking slowly. If too many animals are being disturbed then another technique needs to be considered.

The observer arrives at each point, and gives the bats a minute or so to settle down. During this time the point number and angle should be recorded, and the individual clusters of bats identified. Once the animals have settled, the horizontal distance to each cluster, and the # individuals of each species in each cluster is recorded. If using a rangefinder that has a horizontal distance calculation, then this reading should be used. Otherwise an object on the ground directly underneath the bats, e.g. the trunk of the tree, can be identified and the distance to that object estimated. In counting the animals in a tree care needs to be taken to move through the tree in a careful fashion to avoid double counting. While double counting between points has little effect on the density estimate, double counting at a point has a big effect.

If the count is conducted inside the camp then the count arc will be 360 °, i.e. all around you. If however the point is on the edge of the camp it will be conducted in an arc of less than 360 degrees. If this is the case then record your estimate of that arc, e.g. if the camp has a straight line edge and you are standing on that edge then it would 180°, on the corner of a square plot it would be 90°.

This procedure is repeated for all the points in the camp. As many points as possible should be recorded, with a rough rule being a minimum of 15 points, preferably more.

Once we receive the data it will be compiled and entered into distance sampling models to calculate an estimate of density as well as confidence limits for these estimates. Distance sampling analysis uses the data on numbers and distance to estimate the effects of habitat complexity on the probability that animals would be detected and to account for detection probability in the estimate.

◊ ***Tree density estimate***

Observe as much of the camp as possible to determine a representative sample of the trees inhabited by the bats. Camps will generally have a mixture of different sized trees that will have different densities of bats roosting in them. These trees should be grouped into two or three size classes, depending on the diversity of the vegetation at the camp that the bats are utilising. From these groups at least 10 trees from each size class should be selected from across the visible part of the camp. In each of these trees the number of bats of each species is counted and recorded. From this the average number of animals for each tree size class is calculated.

The number of trees in each size class is calculated either by direct counting over the whole camp, or more usually by counting over a known sized area and then extrapolating over the whole camp.

◊ ***Area density estimate***

Determine a known area of the camp, with the area calculated using a rangefinder, map or other means. Count the number of animals in this area, and then extrapolate it over the whole camp. This technique works best if multiple areas are counted and then the average extrapolated over the whole area.