

## MONITORING DESIGN for track-based surveys



National Environmental Science Programme

Arid Australia is a vast and mostly very remote region. Many species have large distributions but are rare within those ranges; many are nomadic, move long distances and persist in small populations until good rainfall occurs. This can make it challenging to detect species during surveys. Track-based plot surveys offer a practical approach for monitoring elusive animals, or those found in low density, over large spatial and temporal scales in arid Australia.

Track-based surveys involve searching an area or a transect to record animal presence based on their tracks, scats, diggings, or other signs. Track-based surveys are carried out to meet many different objectives of people from the Kimberley, the Pilbara, through the western and central deserts and down into South Australia. Data collected from such surveys can contribute to regional or national monitoring of native and feral species, improve our understanding of ecological processes operating across time and space, and allow us to evaluate the outcome of management actions. Importantly, track-based surveys also offer excellent opportunities for skills-sharing and inter-generational knowledge transfer. To be most useful, surveys should be well-designed, and data must be recorded reliably using standard sampling methods.

Track-based surveys are great for detecting species that live in sandy deserts, but not as good for species that prefer rocky habitats, or species with distributions that are mostly outside the central deserts. Other survey methods will be better for these types of animals.

The method also works best for larger-bodied animals with tracks that are easily identified, such as mulgara, goannas, bilby, cats, dingoes, and camels. If you want to monitor smaller animals, like small mice and dasyurids (e.g. dunnarts), small reptiles, and small birds, then there are better survey methods to use.

### DESIGNING TRACK-BASED SURVEYS

Like all biological surveys, track-based surveys need to be designed carefully to provide data that can be used to answer questions about species distributions, habitat preferences, trends or management effectiveness. The most appropriate monitoring design is influenced by how common species are, how easily their sign is detected, and the monitoring objective. For these reasons, you could consider getting advice from an experienced ecologist to help design your survey. We summarise general guidelines on where, how many, and how often to survey sites in the table below, and provide more detail on key issues in the text below the table.

This table summarises how the monitoring objective affects decisions about where to put sites, and whether you need to revisit them over time:

1. Monitoring objective	2. Where should sites be?	3. How many sites?	4. Do you need to revisit the same sites over time?*
Share knowledge, including between generations	Go to the places that can support that experience	Any number	Not for western science reasons, but there may be cultural reasons or logistic reasons to revisit sites.
Describe what species are present on country, and what habitat they prefer	Put sites across a wide area, spread across habitat types	No hard limits, but the more sites you do, over time, the better information you will gain about where species are. Roughly, you need to have at least 20 detections of a particular species before you can do habitat suitability models. Recording 'absences' is important (information about the sites where the species is not recorded), as this can improve the quality of distribution models.	No: it is better to cover more country, rather than going to the same places over time.
Monitor change over time in common and widespread species	Put sites across a wide area, spread evenly across habitat types	This depends on how common species are, and how sensitive you want the monitoring program to be. You also need to decide whether you want to be able to detect large or small changes in animal populations. More sites will be needed to detect small changes in populations or to detect declines in rarer species, while fewer sites will be needed to detect larger changes in populations, or declines in more common species. It may be best to ask an ecologist to do a power analysis to advise how many sites you need.	Yes: because if you keep going to different places each year, changes between years could be something to do with the change in sites, and not related to time or management.  Monitoring your sites every year is ideal but if this is not feasible, aim to revisit sites at least twice in five years. A rotating sampling design can be useful, for example, where you sample 30 sites each year from a larger set of 60 sites, so every individual site gets sampled once every two years.
Monitor change over time in species that are less common or have small distributions	Concentrate some sites within the range of this species, but make sure some other sites are also located outside the range, so you can pick up range expansions. You could use local		However, if you are interested in changes of a species with a small population (rare), you may need to survey a larger number of sites, and/or survey more often.

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	knowledge and the AZM detection and habitat suitability maps to help decide where to put sites for target species.		
Understand if management is working	Split your sites between areas with and without management. For example, if you are controlling cats in an area, put half your sites where cats are being controlled, and the other half in similar habitats where cats are not being controlled, so that you can compare areas.	It depends on how big an effect you expect the management to make: fewer sites will be needed if the effect of the management is greater.	

**\*When to revisit sites more than once within the same year:** For the most powerful analyses of changes over time or from management, you need to estimate 'detectability'. To estimate detectability, you need to revisit at least 10% of your monitoring sites twice in one year. More detail below.

### 1. What do you want to know?

Define the *monitoring objective* early, because this affects decisions about where to survey, how many sites to survey, and how often to re-visit them. Examples of monitoring objectives include:

- Get out on country with an activity that supports skill-sharing and knowledge transfer.
- Get a 'snapshot' (inventory) of the species present in an area.
- Track the trends in species detection rates, or occupancy, over time.
- Understand what factors drive changes in relative abundance, or occupancy.
- Learn about management effectiveness, such as prescribed burning or predator control, over time.

### 2. Where to survey?

- If your objective is to support skills sharing and knowledge transfer, then go to the places where that is best achieved, and worry less about the survey design. The information you collect will still be useful in regional and national data collations.
- If your objective is to build up a species inventory, then you should try to survey at sites that are in different types of habitat, and spread across your area.
- If the objective is to monitor trends in widespread species, then sites should be dispersed reasonably widely, and the exact placement may not need much thought. However, consider stratifying sites across vegetation types, fire histories and levels of management to learn about the effect of threats or management on target species. For example, if you split sites across regions of different fire frequencies or severities, you can compare relative abundance or occupancy in these contrasting areas and determine what fire management benefits populations the most.

- Site placement is more important for rarer species with narrow distributions. For these species, sites need to be established in locations where these species are known to occur. Although this sounds obvious, it highlights that you need some understanding of the likely distribution of species before monitoring. You may use local knowledge and the AZM detection or habitat suitability maps to help determine these locations.

Important tip: At a fine-scale, sites should be set up in sandy areas with a good tracking surface to maximise the chance of detecting tracks or sign. Sites with a poor tracking surface might be occupied by species of interest, but if observers can't detect the track or sign, the species won't be recorded and it will appear as though the species absent from the broader area.

### 3. How many sites?

- For an area the size of a property or Indigenous Protected Area (i.e. 100,000 ha to 400,000 ha), where the objectives are to monitor changes over time, you are likely to need 40-80 sites, depending on the size of the area, and what your monitoring objectives are. Fewer sites are needed for smaller areas, and surveys that focus on common species. More sites are needed for larger areas, and for surveys that include a focus on rare species.
- The number of sites needed to detect an effect of management or the impact of a threat will depend on the stratification of that management or threat across sites. It also depends on the magnitude of the change your monitoring objective aims to detect.
- For a regional monitoring program, that aims to track changes over time, approximately 200 sites are needed to have a high chance at detecting moderate (~30%) declines in occupancy for most species (based on data from South Australia). This assumes that sites are in suitable habitat and searched by experienced observers. More sites will be needed to detect smaller declines (i.e. 10% declines), while fewer sites will be needed to detect larger declines. More sites may be needed if the monitoring program includes rare species, or species with small ranges, as you may need to put extra sites in these areas.
- For a national monitoring program that aims to track changes over time in medium-large mammals and larger reptiles and birds, based on the analysis of South Australian data, we estimate that at least 400 sites are needed. Two hundred sites should be spread through the southern deserts, with an additional 200 sites in the northern deserts. In both north and south, sites should be dispersed across the area, with some extra sites clustered within the ranges of key species with smaller distributions (such as great desert skink in the north, and dusky hopping mouse and crest-tailed mulgara in the south).

### 4. Do you need to revisit sites?

- To monitor changes over time, or changes due to management, you need to revisit sites. This is because if you keep going to different places each year, changes between years could be something to do with the change in sites (e.g. a disturbance such as a fire), and not related to time or management.
- To monitor changes in detection rates or occupancy, monitoring every year is ideal but may not be feasible. Surveying each site less frequently can work, as long as the interval between surveys at the same site is not too long. Aim to survey each site at least twice over a period of 5 years.

- The best survey frequency also depends on logistical constraints (how easily can you get to each site), the status of target species (i.e. it might be more important to monitor threatened species with small populations more often) and generation length of target species. For example, you might decide to monitor species at risk of local extinction more often than otherwise.
- If sites can only be surveyed every so often, try to time surveys so they synchronise with natural peaks and troughs in population cycles. For example, only survey in years with average rainfall, or only survey after years with high rainfall, when populations are booming.

### **Repeat visits with a year**

- Even experienced observers will sometimes miss animal signs during 2-ha plot surveys. The chance of missing sign that is present at sites is known as ‘detectability’. Failing to account for detectability will bias estimates of occupancy and in some cases may lead to false conclusions that a population is changing when in fact it is not.
- Detectability varies greatly between species and depends on the age of the sign. It is also influenced by the quality of the tracking surface at a site and whether there has been a lot of recent rain or wind. These factors can be partially controlled for by only surveying sites with good tracking surfaces, and in good conditions.
- Making sure that observers are well-trained, and data are collected rigorously, is crucial for maximising detectability. It is important to keep the survey effort similar across sites, so if there are more trackers searching a site, reduce the length of time they spend there.
- To estimate detectability, you need repeat observations from at least some monitoring sites. Replicates can be collected by several independent observers at the same time, or they can be collected by the same observer revisiting a site a few days or weeks later, or by spatial subsampling of a site.
- For most species, sites only need to be re-visited twice within a survey year (i.e. replicates) to ensure that sign present has a very high chance of being detected. Visiting sites three times has relatively little additional benefit; the time and effort saved is probably better spent on additional sites.
- It may not be feasible to survey all sites more than once within a year. There is no guide on how many sites should be repeatedly surveyed within a year to estimate detectability, but analyses carried out by the Arid Zone Monitoring Project suggests that re-surveying only a small subset (e.g. 20 out of 200) should be enough to account for detectability when estimating occupancy trends, and re-visiting more sites will be helpful.

### **Other guidance – when to survey?**

- Ideally, monitoring should occur around the same time each year to avoid seasonal changes in the distribution and/or activity of species. For example, movement behaviour of foxes or emus might vary between seasons.
- Surveys should be carried out when tracking conditions are good. That means avoid doing surveys immediately after rain or strong winds that will remove or obscure tracks or sign.
- In general, it is also better to carry out surveys when the light helps make tracks more visible, that is, in the mornings and late afternoons. However, recent analyses of 2-ha plot data suggest the time of day or extent of shadowing has little effect on the ability of *experienced* observers to detect sign for most species (with the exception of fox sign, which was detected slightly more regularly in times of more distinct shadow).

- **Try to keep sites more than 4-5 km apart from each other. This will keep your sites 'independent', so it's unlikely that the same individual animals are leaving prints across adjacent plots.**

#### **Other guidance – what is a site?**

- There are different ways of collecting track-based data. The most common method is a 2 ha plot survey (sometimes called a sign survey, track survey, 2 hectare plot, cybertracker survey or Tracks App survey). In the 2 ha plot survey, observers search a 2 ha area for signs of animal presence, ideally for a set period of time.
- If the 2 ha plot is near a track, keep the search area off the track itself, by at least 30 m. This is because some animals (such as dingoes and foxes) prefer to use roads, and other animals avoid them. The sign along roads is a biased sample of what is present. To get a good sample of all animals present, set up a 100m transect along the track near to the 2 ha plot, and record the sign on this transect as well as the sign in the 2 ha plot. It is very important to keep the data from the plot and the road transect separate in your datasheet, so that biases can be taken into account during analysis
- The Arid Zone Monitoring project worked with tracking experts to develop a *standard data collection sheet for track-based surveys*, with instructions on data collection, that can be used anywhere across Australia.