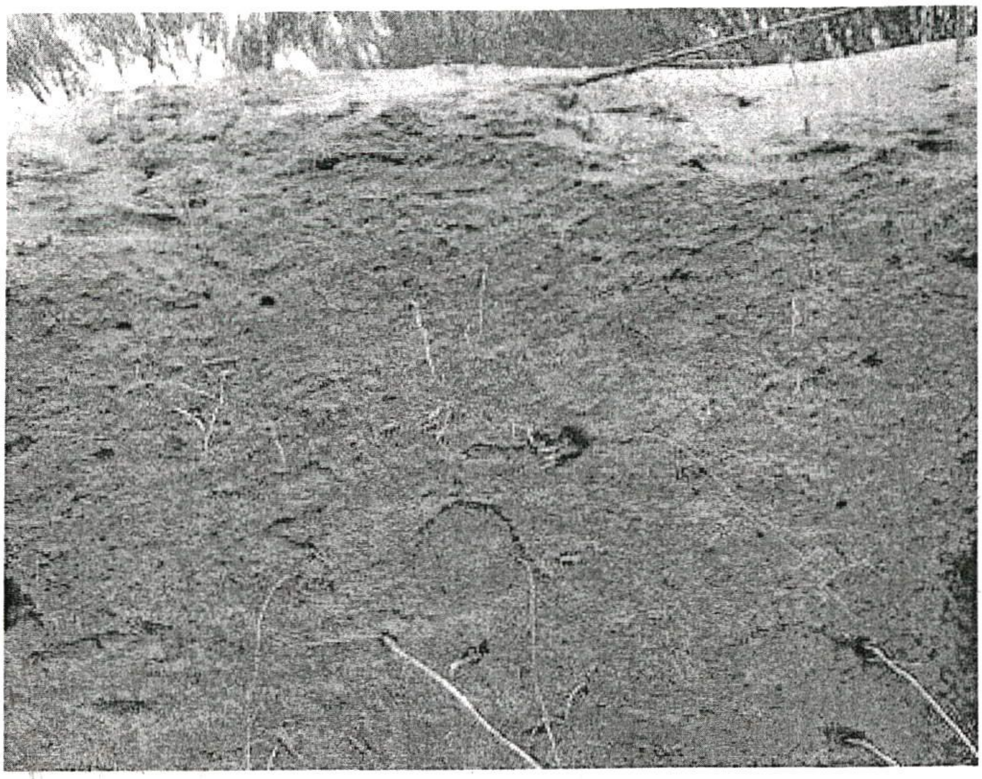
Manual for Marsupial Mole Survey and Monitoring by Trenches. Version 1.0

Report to Anangu-Pitjantjatjara Land Management and the Department of heritage and Environment (SA)



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March 2005

Why monitor marsupial moles?

Marsupial moles (*Notoryctes typhlops* and *N. caurinus*) are little known subterranean animals that inhabit the vast sandy deserts of Central Australia. Elusive, enigmatic, and the sole representatives of a unique and ancient lineage, these species are rarely encountered and are listed as Endangered nationally, although even this is uncertain due to the paucity of information available about their population trends and ecology (Benshemesh 2004).

While direct examination of marsupial mole ecology is virtually impossible due to the apparent rarity of the animals and their cryptic subterranean habits, studies on the Anangu-Pitjantjatjara Lands have shown that indirect methods provide a means for examining the distribution and abundance of marsupial moles. Given that marsupial moles may be declining, data on the distribution and abundance is urgently needed both to assess the current status of the species, and to monitor trends in the species through time.

The most efficient means of achieving the important goals of survey and monitoring of marsupial moles is to count the number of marsupial moles signs ('moleholes') underground. These signs persist for several years and thus accumulate underground, providing high yield of counts relatively easily. For example, in the dunes in the Walalkara and Watarru IPAs, there is about a 70% chance of detecting moleholes in a single trench that may take 20 minutes to excavate. In contrast, we encounter marsupial moles signs on average about every 20km or so of tracking (5-8 hours walking), and in about 1-2% of predator scats (involving at least 10 hours collection for 100 scats).

This document outlines methods that were developed in the Anangu-Pitjantjatjara Lands to survey and monitor marsupial mole abundance. The study was supported by Anangu-Pitjantjatjara Land management, DEH (SA), Earthwatch Institute, DIPE (NT), and the Natural Heritage Trust.

1. Techniques: Overview and issues

Survey and monitoring of marsupial mole abundance involves digging trenches in order to expose a vertical wall of sand, allowing the wall to thoroughly dry, and then inspecting the wall for old tunnels of marsupial moles. These tunnels are backfilled with sand and appear as circular or oval shaped outlines (henceforth 'moleholes') depending on the angle they make with the trench wall (Figure 1). In the Anangu-Pitjantjatjara Lands, moleholes typically have a minimum diameter of 38-42 mm while their maximum diameter may be as long as a trench if the tunnel happens to be parallel to the trench wall. Usually, few if any moleholes are apparent when a trench is first excavated due to soil moisture. However, as the trench face dries, moleholes become apparent in time.

The survey process involves excavating a series of trenches in selected areas and then waiting for the trench walls to dry. This waiting period is determined by inspecting a representative set of trenches ('Dryness indicator trenches') daily until the number of moleholes counted levels off (Figure 2). This period of time varies with soil moisture and ambient condition but is typically 3-5 days. In very dry condition with little soil moisture, the asymptote may be reached within a day or two, whereas when the soil is damp and ambient conditions are cool the asymptote may take much longer to reach. When the asymptote is reached (ie. the number of moleholes levels off), all the survey trenches can be inspected in detail with the knowledge that a standard level of drying has been achieved. This process makes results from different times more comparable and should not be overlooked.

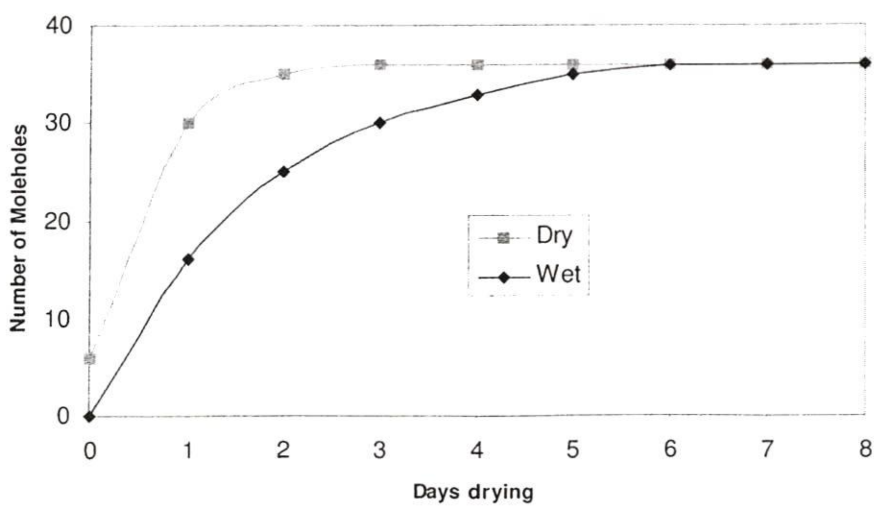

Figure 2. Total number of moleholes counted in a set of hypothetical trenches under differing conditions. When the soil is damp or condition as are cool, drying takes longer than when the soil is dry and conditions are hot. When the counts of moleholes levels off, trenches are ready for final inspection and measurement.

Reading trenches involves detecting all the moleholes apparent on the trench wall, and measuring their position, appearance and condition. These data are important for verification and for estimating the age of the moleholes, as well as providing information on the habits of marsupial moles.

Monitoring involves the same processes as survey. However, as the objective of monitoring is to track changes in time, it is important to determine the persistence of moleholes in the soil structure in order to interpret results and understand the frequency with which monitoring should occur. This can be achieved most efficiently by routinely examining the decay of real and simulated marsupial mole signs previously made in the walls of trenches, and correlating these results with rainfall and soil moisture. Simulated moleholes have been installed at a number of sites in the Anangu-Pitjantjatjara lands for this purpose, and comprise tunnels that have been emptied of sand and then refilled with loose sand in order to simulate the tunnelling of marsupial moles. We know the date these tunnels were created, and by periodically revisited them we can learn about the degradation process of real marsupial mole tunnels. When the simulated moleholes have degraded to the point of being faint or invisible, monitoring could be conducted with knowledge that most real moleholes have been created since the last monitoring effort, rather than being old signs that were recounted.

Thus, monitoring the simulated moleholes is fundamental to monitoring real moleholes. Whereas monitoring simulated moleholes should be done every year, monitoring of the marsupial moles population should only occur when inspection of the simulated moleholes indicates that this would be worthwhile (ie, when a suitable proportion of the simulated moleholes have disappeared). This is likely to be at intervals of at least three years, and perhaps much longer.

Finally, it will be necessary to understand, and where possible control, the variability between recorders due to different skill levels. This variability will make trends in populations more difficult to detect. Careful training and perhaps calibration may reduce the variability in results amongst recorders.

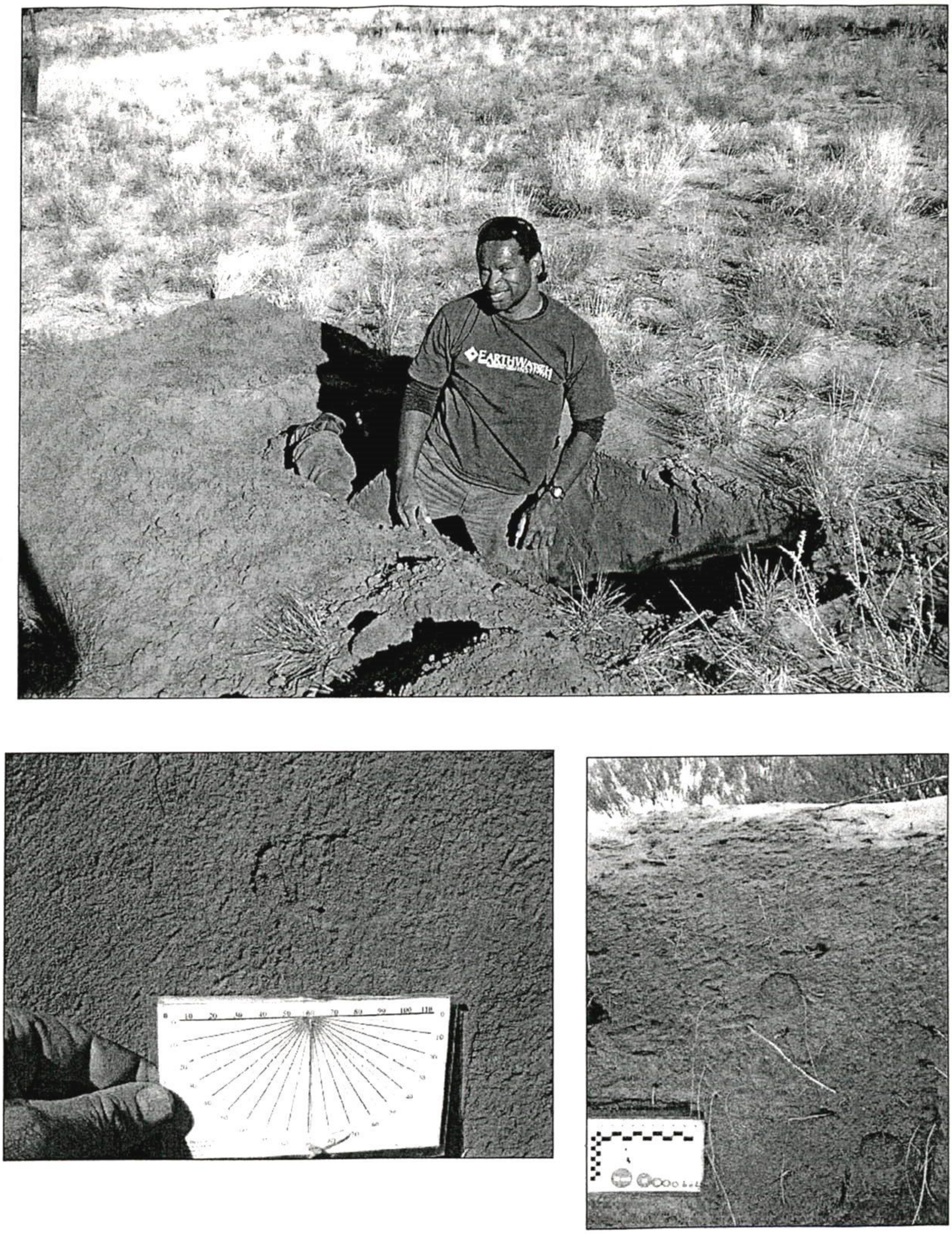

Figure 1. Typical survey trench showing step on northern wall (above) and conspicuous moleholes (below). (Top photo by Jon Aston).

2. Simulated moleholes

Installation

Equipment:

- Shovel
- Aluminium or PVC tube (approx .38 mm external diameter, about 80-100 cm length)
- Aluminium tags
- Dental floss
- Tapper (20 mm circular dowel, about 10 cm longer than coring tube)
- Pen, notebook
- GPS

Simulated moleholes are produced with a piece of aluminium tube (recommended) or PVC conduit with a serrated end which is rotated to cut through the trench wall. It is important not to use excessive force, but to let the rotating action of the serrated end saw its way through the lightly cemented sand. When 5-10 cm of sand has collected in the tube it should be removed and emptied into a bucket for later use. Care should be taken to remove the tube without damaging the walls of tunnel being created. Proceeding in this manner, a tunnel of 60 cm or more should be created at an angle sloping downwards 5-10°.

Once the end of the tunnel is complete, an aluminium tag, marked with date and ID, is tied to a length of dental floss and carefully inserted into the tunnel and placed at the far end. Great care should be taken to ensure the tunnel is not damaged in this process (fold sharp corners back over the tube). The other end of the dental floss is tied to another tag that will mark the entrance of the tunnel. The date and simulated molehole ID is written on both tags.

Filling the tunnel involves scooping 10-15 cm of sand from the bucket into the end of the coring tube, inserting it into the tunnel and gently tapping it out at the far end of the tunnel. If too much sand is scooped it is difficult to tap the sand out and the tunnel may be damaged. The objective is to completely fill the tunnel with loose sand and without air spaces.

Simulated moleholes are produced at depths of 10, 25 and 50 cm from the surface (to examine differences) and are replicated at least 3 times in each trench. Thus, a grid of 3 by 3 is typically formed (see Figure 3). Each trench is marked with stakes to indicate the edges of the working face or wall, and plastic flagging should be draped down the face in line with the tags to indicate the face itself and location of the simulated moleholes. Care should be taken to ensure the flagging tape is flush with the wall when refilling the trench. The trench should be re-filled up to the original surface and lightly tapped down to minimise subsidence.

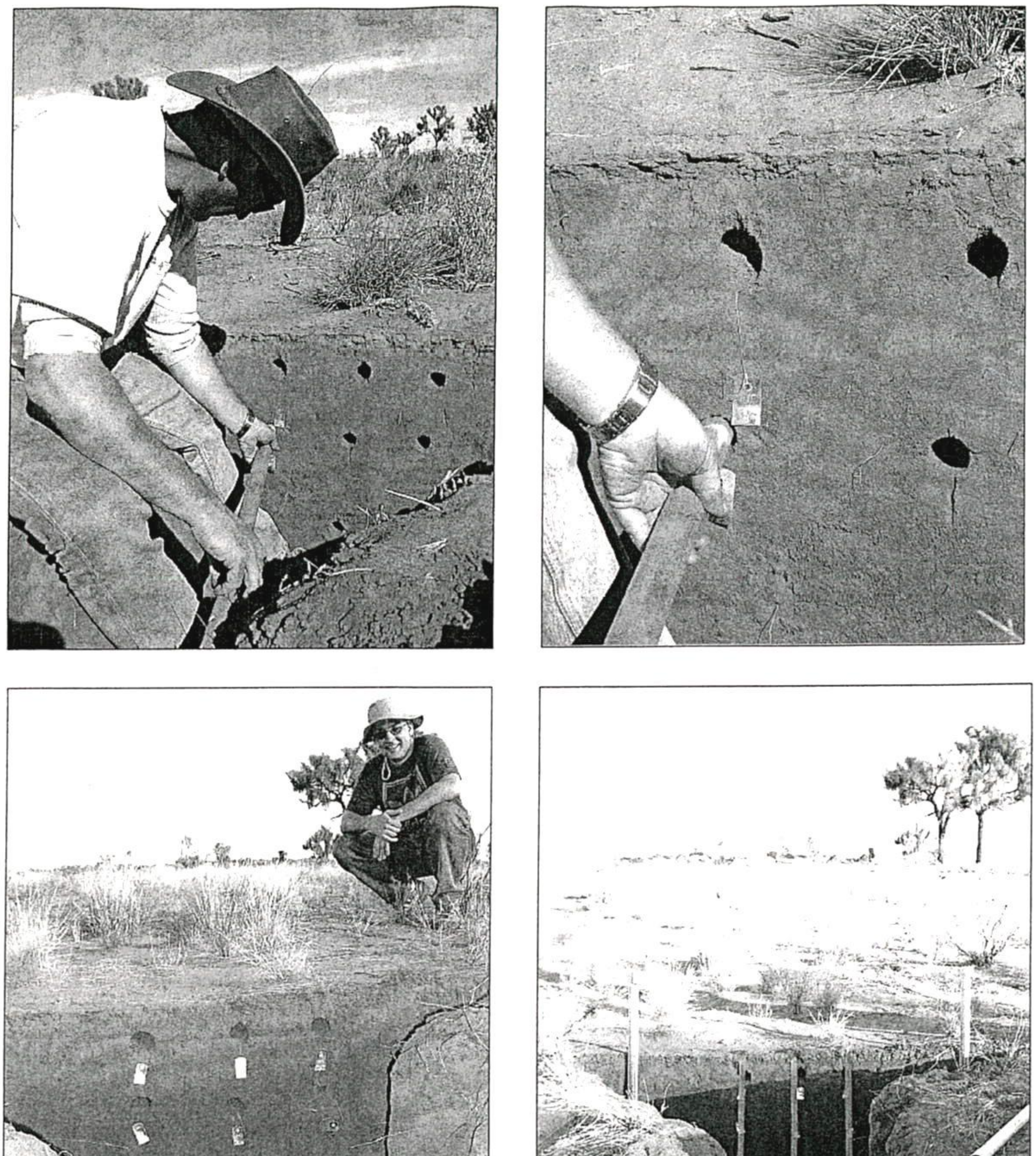

Figure 3. Construction of simulated molehole trench showing coring (and subsequent filling) of simulated holes using aluminium tube (top left and top right), series of 9 backfilled holes at three depths with aluminium tags (bottom left), and finished trench before being refilled (bottom right) showing tags, marker tape, and marker posts.

Periodic inspections of Simulated Molehole trenches

Equipment:

- Shovel
- Calipers or small steel ruler
- Pen, notebook
- GPS

Monitoring of simulated moleholes should occur every year or two. Simulated moleholes should excavated and measured in exactly the same way as those made by Itjaritjari (see below).

Note that in the APL, techniques of marking simulated moleholes have evolved in time. At Watarru, Nyapirri and at some sites at Walalkara simulated moleholes are tagged only at the trench wall, and there is no dental floss marking their length or tag at the distal end.

Soil moisture dataloggers

Soil moisture loggers have been installed at simulated molehole trenches at Walalkara (SA) and Watarrka (NT). These are currently being downloaded by myself. This section will be updated if there is a need for the dataloggers to be downloaded by others in the future.

3. Survey and Monitoring of moleholes

Preparing trenches

Equipment:

- Shovel
- Pen, notebook
- GPS
- Compass (to determine approximate east-west line)

Site selection

Monitoring

For monitoring, trench locations should be determined by previous monitoring/survey efforts. Trenches should thus be placed on the same dune and same level on the dune, but not in exactly in the same location of other trenches. Old trenches should not be re-opened for monitoring as marsupial moles may plausible avoid or be attracted to the changed soil structure within the old trench.

Survey

The design of the survey and the particular questions that are examined determines trench locations. A suitable design for general survey is to excavate one trench at each of three levels on a dune: near the crest (within 10m); mid slope (about a third to half way down from crest); and base of dune (where the vegetation changes and the slope levels off). Trenches are excavated on the north or western side of dunes to maximise drying by sunlight. In the absence of dunes, a set of three trenches about 100m apart provides and alternative. By placing only 3 trenches at a site, this design provides little detail of marsupial moles abundance at each site, but maximises the number of sites that can be surveyed for a given effort.

Where to dig

Topography

A suitable design for general survey is to excavate one trench at each of three levels on a dune: near the crest (within 10m); mid slope (about a third to half way down from crest); and base of dune (where the vegetation changes and the slope levels off). Trenches are excavated on the north or western side of dunes to maximise drying by sunlight. In the absence of dunes, a set of three trenches about 100m apart provides and alternative.

Vegetation

To minimise disturbance to vegetation, trenches should be excavated at least three metres from the trunks of shrubs and trees. The presence of roots also makes excavating and reading trenches very difficult. It is an advantage to position trenches just downslope from patches of grass, spinifex, or debris as such structures offer some protection to the north-facing wall of the trench from large animals, windblown sand, and erosion.

Trench size, shape and orientation

Trenches are placed with their longest side facing north (ie. longest side orientated east-west) in order to maximise sunlight on their most southern side (ie. north facing wall). Standard trench size is excavated to be about 120 cm long by 80 cm deep, and 40 cm wide. The objective is to expose a vertical north facing wall of about 100cm long (top and bottom) by 70 cm deep. Only the north facing wall is inspected for moleholes, and this side should be protected from shovel mark and other disturbance. To increase the sunlight reaching into the trench, a step of about 30 cm is dug into the northern wall (south facing) along its full length (Figure 1, Figure 4).

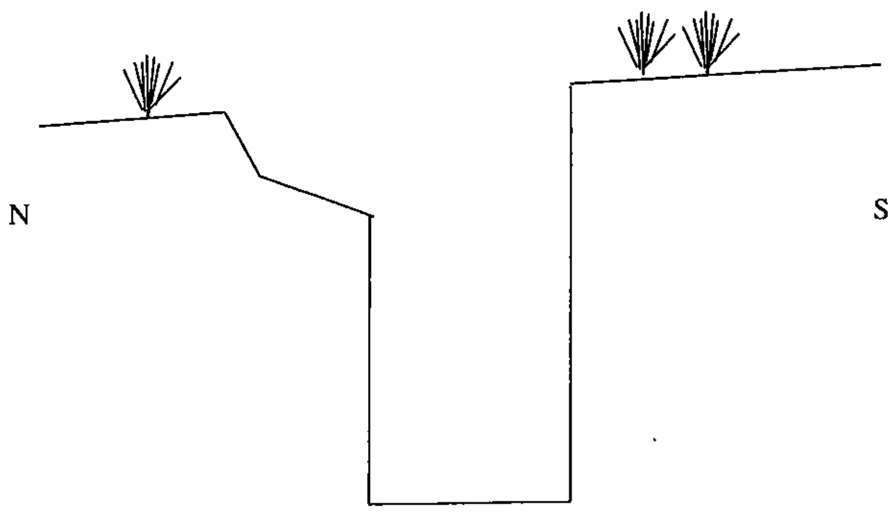

Figure 4. Cross-section of trench structure. The step in the northern wall increases sunlight onto the southern wall of the trench.

Face preparation

The southern (north facing) wall is then made flat, smooth and near vertical by vigorously rubbing the face. Roots should be dealt with very carefully: it is often better to work around roots than to risk disturbing the face by treating roots roughly. The smoother and flatter the face the easier it will be to detect moleholes later. Any moleholes that are apparent at this stage should be noted, however it is common for few or no signs to be apparent even if the soil seems dry.

Escape routes

Branches should be placed in each trench and arranged as an escape route for any animals that fall into the trench.

Detecting and measuring moleholes

Equipment:

- Shovel
- Pen, notebook
- GPS
- Tape measure (3 m)
- Molehole measure card (or callipers/small steel ruler and protractor)
- Sand bags

Drying time

Survey and monitoring trenches may be read once the dryness indicator trenches show that the number of moleholes detected has levelled off. Alternatively, if conditions are dry, warm and sunny, trenches should be read at least five days after they have been excavated.

Detecting moleholes

Starting at a corner, carefully scan the surface for signs and circle any symmetrical sand filled oval shaped structures larger than 25 mm in smallest diameter. Lightly rub the surface of the entire north facing wall to make the surface as smooth and flat as possible, but being careful not to rub off more than a couple of millimetres off the wall (stop if damp sand is encountered; moleholes are generally only visible on a dry surface).

Using handfuls of dry, loose sand, lightly throw sand over the trench face working systematically so that the entire face is covered. The objective is to give the face a light sand blasting, and the result should be a finely pitted surface. If in doubt, use more sand rather than less but continue working the surface gently. This process tends to make even very faint moleholes more apparent. Lightly circle any signs you find with a point and number them.

<u>To be counted as a molehole, a structure should meet all of the following criteria:</u>

- The structure is filled with sand, with little if any airspace.
- At least two thirds of a molehole's circumference is discernible.
- The structure is symmetrical.

- The structure is rounded (most vertebrate tunnels have flat bases, whereas scorpion tunnels have flattish roofs).
- The structure is continuous and does not disappear or reduce in minimum dimension when rubbed.

Measurements

Molehole measures are used to describe various aspects of molehole location, shape and condition. Before measurements are taken, the edges of the face being examined should be delineated by vertically scraping the sand on the left and right edges of the face. The face should be rectangular with its top of similar length to its base so that equal areas are represented for each depth from the surface.

Dmin, Dmax: The minimum and maximum diameter of each molehole

Angle: The angle of the long axis of the molehole from the *vertical* (convention; Figure 5). To measure this, align the long axis of the molehole with the long edge of the molehole card (Figure 6) and read the angle indicated by the plum bob.

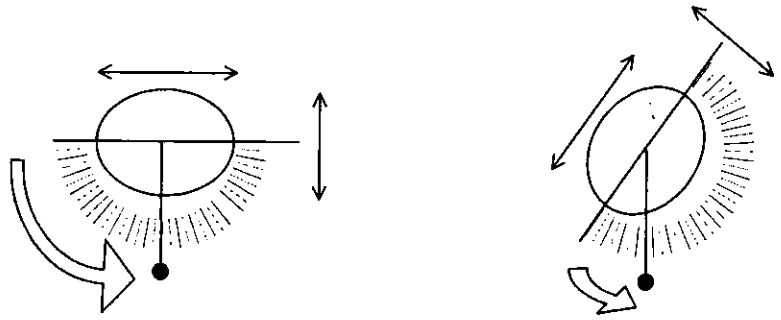

Figure 5. Diagrammatic representation of various measures obtained from two moleholes that differ in orientation. Dmin= minimum diameter; Dmax= maximum diameter; Angle= angle in degrees of long axis of molehole with the vertical plane (as measured with the mole measuring card Figure 6).

Molehole Depth: depth of the molehole, measured from the surface to the middle of the molehole

X: the distance from the left edge of the trench face to the molehole. This measure is useful for statistical reasons.

Trench face size: The length and depth of the rectangular trench face that has been examined for moleholes.

Subjective scores

Moleholes vary in appearance as well as shape; some are very distinct whereas others may be barely discernible. Several subjective scores (1-3) are used to record how distinct each mole-hole is:

Clarity: Score the clarity of the sign you are describing on a scale from 1 (unclear) to 3 (very clear). 0 is reserved for moleholes that were visible, but disappeared when measurements were taken (this occasionally occurs when very faint moleholes are lightly rubbed and can not be made to re-appear)

Confidence: Score your confidence that what you are looking at is in fact a mole hole on a scale from 1 (unconfident) to 3 (very confident). 0 is reserved for moleholes that were visible, but disappeared when measurements were taken.

Tap Test: Lightly tap a few centimetres from the molehole but at the same depth to gauge the hardness of the substrate in such a way as to just disturb the surface, and then continue this strength of tapping at the centre of the molehole. Record if there is any difference in terms of how much sand falls away between in outside and the centre of the molehole. Score the response in the molehole as 1 (no difference), 2 (some difference) or 3 (lots of difference). Alternatively, use a penetrometer to obtain a reading inside the molehole, and at some arbitrary point outside the molehole at the same depth (ie. 5cm to the right of the molehole).

Age: Age is a subjective evaluation of the general appearance of the molehole. The following is a guide rather than a set of definitions:

- Fresh: Loose sand pours out of the molehole with little or no provocation
- Recent: Clear and typically sharp edged, sand inside the molehole very soft but not free flowing
- Oldish: Moleholes neither recent nor highly degraded. This is usually the most common category
- Old: Molehole quite faint and easily missed, sand inside molehole appears firm but is actually softer than surrounding sand.
- Very old: Very faint and very easily missed, but often made apparent by flinging sand.

Finishing off

After all the moleholes in each trench have been inspected and measured, trenches should be filled in and their GPS location recorded. When new sites are surveyed, it is also a good idea to collect sand samples from three depths in each trench (about

References

Benshemesh, J. 2004. Recovery Plan for Marsupial Moles *Notoryctes typhlops* and *N. caurinus*. 2005-2010 (Draft).Northern Territory Department of Infrastructure, Planning and Environment, Alice Springs, NT.