General Terrestrial Fauna Surveys Protocol

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1. Terrestrial fauna surveys are undertaken for three general purposes:
- to assess the potential impact of a development on the environment;
- to monitor changes in biodiversity or ecosystems; and
- to better understand ecosystem function or biodiversity.

Typically, consultants undertake fauna surveys for impact assessment and occasionally monitoring surveys. Researchers and government personnel typically undertake monitoring surveys and studies to better understand biodiversity and ecosystems.

2. Impact assessment

Government environmental agencies (e.g., Environmental Protection Authority; EPA) require proponents of a disturbance to obtain the necessary environmental approvals prior to changing or impacting the environment. Typically, this results in the proponent engaging consultants to prepare an environmental impact assessment (EIA). A component of an EIA is to indicate the extent to which the disturbance will impact on the flora and fauna of the area; thus the need for fauna surveys. Data gathered during these fauna surveys can also be used as baseline information to monitor the effects of disturbances or rehabilitation success.

3. Monitoring studies

Sadly, the list of extinct, endangered or vulnerable vertebrate species seems to have steadily increased in Australia over the last 100 years. Concern has been raised about the rapid loss of biodiversity, particularly for mammals between 50 and 200 g and some species of birds. Many other vertebrate species have had their geographic distribution significantly reduced by European settlement. Solutions to this problem come from a better understanding of the biology, ecology and natural history of individual species and the ecosystems in which they live. Considerable activity by researchers and government agencies, have and are, addressing the various aspects of this problem. Research is both pure and applied, and focuses from individual species to landscape level ecosystem function. Terrestrial fauna surveys provide the baseline data for these monitoring and ecological studies.

4. Understanding ecosystems and assemblages

Almost all applied ecological studies and species recovery programs depend on an understanding of the biology, ecology and natural history of the species involved. 'Pure' biological or ecological research with the aim of understanding and better appreciating ecosystem function and the elements of biodiversity are the basic building blocks for impact and monitoring studies, and developing species recovery programs. To effectively manage the biodiversity of Australia, we need to understand the biology of what we are intending to manage. Although much has been learnt about the Australian fauna, we still do not understand many of the basic systems and interrelationships (e.g. effects of fire, temporal changes, succession processes, interrelationship between reptile, bird, mammal assemblages, and soils and vegetation). All of these studies are underpinned by terrestrial fauna surveys.

The Environmental Protection Authority has recently released two documents relevant to fauna surveys and impact assessments:
- Environmental Protection Authority. (2002). *Terrestrial Biological Surveys as an Element of Biodiversity Protection*. Perth.
- Environment Protection Authority (2003). *Terrestrial fauna surveys for environmental impact assessment in Western Australia, No 56, Draft*. Perth: Environmental Protection Authority.

The first document provides very general guidelines for terrestrial fauna surveys, indicating the best practice assessment now requires that biodiversity be considered to have two key aspects:

- its biodiversity value at the genetic, species, and ecosystem levels; and
- its ecological functional value at the ecosystem level.

The latter document is an EPA draft guideline that provides little specific advice on how, where and when to undertake terrestrial fauna surveys. However, consultant intending to undertake a terrestrial fauna survey for the purposes of assessing the potential impact of the disturbance on the biodiversity of the area should familiarise themselves with the contents of this draft.

5. Trapping protocols:

5.1 Pit-traps

Either 20L PCV buckets or 125 mm, 150 mm or 175 mm PCV storm-water piping are dug into the ground (Bury & Corn, 1987; Christiansen & Vandewalle, 2000; Enge, 1997a, 2001; Hobbs & James, 1999; Hobbs, *et al*., 1994; Moseby & Read, 2001; Read & Moseby, 2001; Rolfe & McKenzie, 2000). A fly-wire drift fence, to direct fauna into the traps, normally joins the pit-traps (Gibbons & Semlitsch, 1981; Hobbs et al., 1994; Jorgensen, *et al*., 1998; Morton, *et al*., 1988). Most pit-traps are left in the ground between survey periods and opened for the survey. For 'one-off' surveys, traps are removed at the conclusion of the survey. The number of pit-traps used and survey period varies from survey-to-survey depending on the purpose of the trapping. Pit-traps need to be securely closed when not in use to minimise in advertent captures.

5.2 Elliott traps

Elliott traps come in two sizes, A and B. These are small aluminium traps, with a pedal inside, that when the animal steps on it, it closes the trap door behind the animal. Elliott traps are most commonly used to capture species such as Antechinus, Rats, Dunnarts and Marsupial Mice (Catling, *et al*., 1997; Cockburn, *et al*., 1978; Johnson, 1996; Williams & Braun, 1983). These should be covered with shade cloth or hessian when used in the field unless they are placed in shaded areas.

5.3 Cage traps

These are larger wire mesh cage traps (Catling et al., 1997). There are two types of cage traps; one is where the bait is simply placed at the back of the trap and the animal steps on a pedal which automatically closes the cage door (similar to the Elliott trap mechanism) or the other type involves the bait being placed on a hook and when the animal pulls on the hook, it triggers the door to close behind the animal. The size for these traps varies in accordance with what is the surveyors are trying to catch. These should be covered with shade cloth or hessian when used in the field unless they are placed in shaded areas.

5.4 Bait

There are many different types of baits that can be used in Elliott and cage traps to capture small mammals, such as bread and jam, sardines, etc. But the most commonly used bait is a mixture of rolled oats, peanut butter, honey and sometime sardines; this is commonly referred to as the 'universal bait'.

5.5 Funnel traps

There are a couple of types of funnel traps. Most overseas surveys use rolled flywire with

wire funnels (Crosswhite, *et al*, 1999; Enge, 1997b; Fair & Henke, 1997; Fitch, 1951, 1992; Greenberg, *et al*., 1994). We use a modified fish trap as funnel traps. These traps are opened at both ends and are placed adjacent to drift fences. They must be used with shade covers. These are particularly useful for catching snakes, legless lizards and fast moving, active foraging skinks.

5.6 *Foraging, raking and searching*

Some small reptiles are difficult to catch in any of the above trapping strategies (Corn & Bury, 1990; Fair & Henke, 1997; Fitch, 1992; Rolfe & McKenzie, 2000). Consultants and researchers often employ foraging, raking and hand searching strategies to catch small reptiles that are not easily caught by other strategies. Experience and knowledge of species microhabitat significantly improves catch rates.

5.7 *Night searches of roads*

Many of the small reptiles, mammals and frogs species are nocturnal (Fair & Henke, 1997). Searching roads at night is an effective strategy for locating these species. It is often done in conjunction with other trapping strategies. Searchers drive slowly along infrequently used roads searching for small vertebrates using spot lights.

5.8 *Cover boards*

Many small reptiles seek shelter under boards, sheets of iron, and other flat material (Fitch, 1992; Grant *et al*., 1992). 'Cover-boards' can be laid with the specific intention of providing an artificial shelter that will attract species for trapping purposes. They are often left *in situ* for months before being used in the trapping program. Our experience is they are expensive, difficult to transport and are not very effective.

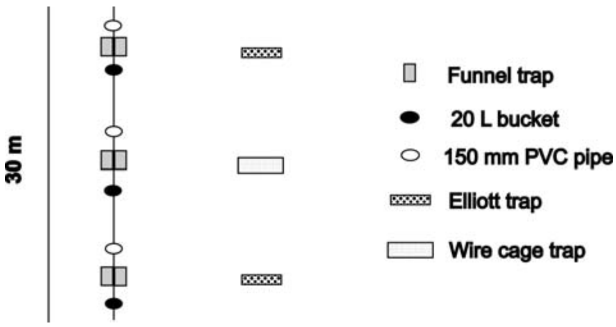
5.9 *Hair tube and hair traps*

Hair traps are funnels of various sizes with a bait enclosed in a cage in the rear of the trap (Catling *et al*., 1997; Lindenmayer *et al*., 1999; Lindenmayer, *et al.*, 1994; Wilson & Delahay, 2001). Sticky tape around the entrance of the funnel, traps hair samples when mammals are attracted to the bait. Hair samples are examined to identified the mammal species that have been attracted to the bait. Trapping success varies appreciably with locality.

6. Fauna surveys

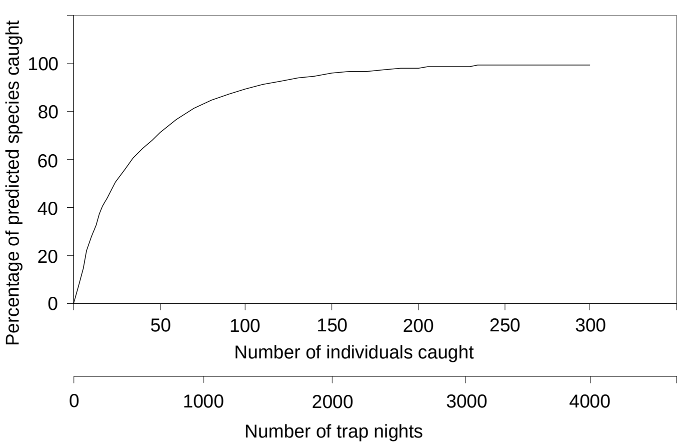
6.1 *Trap types*

We use 20 L PVC buckets with plastic lids, 150 mm PVC pipes with metal lids and funnel traps (see photo above). All traps are placed along a 30 m fly-wire drift fence that is dug into the ground. We also place Elliott traps and wire cages with these other traps. As a general rule for trapping a biotope we lay the traps out as shown in the adjacent diagram.



6.2 *How much?*

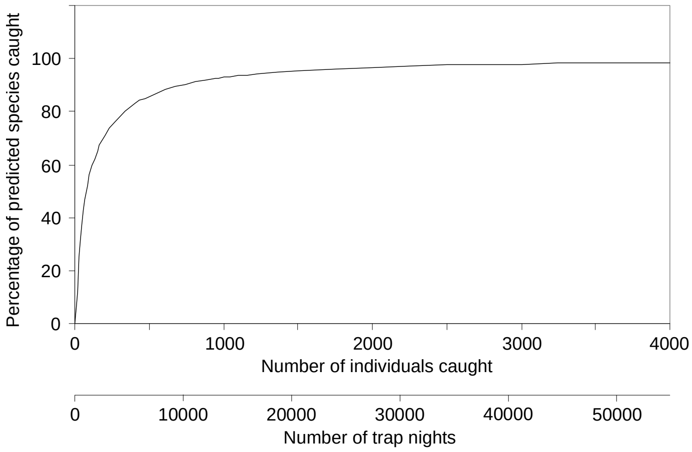
We are currently working on the problem of determining how much trapping is required in an area to catch a nominated proportion of the species in that area. Species accumulation curves can be used to estimate the trapping effort required (see Thompson & Withers, 2003; Thompson, *et al*, 2003). The two adjacent species accumulation curves have been prepared from extensive surveying in the goldfields region of WA. They can be used as a guide to determine the trapping effort for a biotope and a landscape scale



Averaged species accumulation curve using pit-traps and funnels for a biotope

terrestrial fauna survey using the trapping layout shown above.

At this stage our data suggests that we need to catch between 150 and 200 individual reptiles at a particular site to have caught at least one individual from each of the available trappable species. For a landscape scale survey we think you need to catch between 800 and 1000 individuals to be sure that you have caught most of the trappable species, but this will depend on trap location and trap site selection. The trapping effort to catch this number of individuals will vary with location, season and daily ambient conditions. The trapping effort indicated on the two figures is the minimum trapping effort in the goldfields to catch the number of species shown.



Averaged species accumulation curve using pit-traps and funnels for a landscape

6.3 Trapping strategy

Traps are left open for the duration of the survey. They are normally cleared in the morning; this process starts just after first light. All caught animals are identified, weighed and measured. For reptiles body and tail length are the normally measured, for mammals skull width and length, and hind-foot length are measured. Unless voucher a specimen is required, individuals are released near where they were caught, but far enough away to minimise immediate recapture.

For more general fauna surveys, we will often supplement the pit and funnel traps with Elliott traps, cage traps and hand searches. Elliott traps are not very effective in catching reptiles and do not perform as well as pit-traps in catch small mammals. The combination of trap types and search strategies will vary depending on the specific objectives for the survey.

7. Ethical issues

7.1 Trapping deaths

Trapping deaths occur using all strategies. Deaths in pit-traps are due mostly to:

- heat and cold stress,
- predation by ants, spiders and centipedes,
- predation by carnivores, and
- drowning.

All traps are cleared daily. Every effort is made to clear all traps before mid-day, reducing the exposure to heat. PVC pipes are normally 500 mm deep. This depth and their narrow diameter means direct light sun light seldom gets to the bottom of the pit-trap, reducing deaths due to heat stress. We place shade cloth covers over funnel traps to reduce exposure to the sun. It is mostly *Mus musculus* (house mouse) that dies due to cold stress, but this seldom occurs during pit-trapping in the warmer months. We use polystyrene trays in the bottom of PVC buckets (like the ones you get at the butchers) to provide shelter from the sun. To avoid drowning in pit-traps, all PVC buckets have holes in the bottom and polystyrene trays act as rafts. PVC pipes have a fly-wire bottom and rarely fill with water.

We use ant powder to reduce deaths due to ant predation. Spiders and centipedes are cleared daily to minimise deaths due to these invertebrates.

Elliott traps and cage traps are placed under vegetation to minimise heat stress. If there is insufficient vegetation cover, they are covered with hessian or shade cloth.

7.2 Marking animals

It is important in terrestrial fauna surveys to be able to distinguish fresh caught from previously caught animals. Calculation of diversity, evenness and relative abundance are

obviously distorted if recaptures are included in the data set. Recapture rates are also a commonly used method for calculating population size and density. Growth of individuals and stability of reptile and mammal populations can also be estimated from recapture data among survey periods. It is therefore important to be able to distinguish between a 'fresh-caught' and a recaptured animal.

There are numerous strategies for permanently marking reptiles, mammals and frogs caught during terrestrial fauna surveys (Enge, 1997a; Spellerberg & Prestt, 1978; Swingland, 1978). These include toe clipping, scale clipping, tattooing, shell notching, painting or dyeing, surface or skin tags, branding, inserted transponders and radioactive markers. All have their benefits and disadvantages. We toe clip small mammals, reptiles and frogs. Some researchers notch ears of small mammals instead of cutting toes. These methods are quick and the least painful permanent marking systems. To date we have not marked legless lizards, skinks with few toes or snakes. However, if we did so we would use scale clipping. The Enge (1997a) system, or a variation on this theme, is the commonly used numbering protocol for toe clipping. A maximum of one digit is removed from each foot and maximum of two toes overall. For most of our surveys, we only need to know whether an animal has been caught before and during which survey. If this is the case we only remove a single digit.

7.3 Euthanasia

Occasionally, an animal caught in a trap needs to be euthanased. The most common reason for euthanasing captured animals is because they have been badly attacked by ants or bitten by a spider or centipede. Given that we use volunteers, often work considerable distances from a vehicle and carry equipment, it is not feasible to carry a solution of sodium pentobarbitone, a syringe and hypodermic needle to euthanise reptiles, frogs and small mammals. To euthanase, we decapitate all small vertebrates using a shape knife, then destroy the brain with the knife. This is a quick, safe, and an easily taught method for field staff. It also only requires simple, relatively easily maintained equipment that staff own and carry in the field. Volunteers and field staff, are shown and trained in this technique in the field. Carcasses are generally buried near the site of capture.

7.4 Number of animals caught

In any trapping program the abundant animals are generally readily caught. Much greater effort is required to catch the rare and difficult to trap animals (Thompson *et al*. 2003). For most terrestrial surveys at least one or a couple of individuals for each of the reptile and small mammal species should be caught to calculate diversity, evenness and relative abundance values. This is basic ecological information necessary to describe the vertebrate assemblages. For some surveys, there is a focus on rare, or endangered species, and in this case a much greater trapping effort is generally required. Knowledge of rare species is often particularly important for 'impact studies'. The effort required to catch a nominated percentage of the estimated species richness for an area can be calculated from species accumulation curves (see above).

7.5 Field assistants and volunteers

It is necessary to either employ field assistants or volunteers for many of our surveys. These people are trained in the field. They accompany either of the principal researchers or another trained person until we are confident they understand what is required of them and can manage all of the foreseen occurrences, including animal euthanasia.

7.6 Voucher specimens

A recent workshop on developing co-ordinated and integrated terrestrial vertebrate fauna survey databases in Western Australia stressed the need for accurate identification of species (Mawson & Orell, 2002; Thompson & Withers, 2002). Vouchering specimens with the Western Australian Museum most commonly achieves this objective. The number of specimens for each species that should be vouchered varies and even museum staff can give different advice. For common species we often provide up to five individuals, for rarely caught species generally only one or two individuals are provided. Only is special circumstances would an individual from a declared 'rare' or 'endangered' species be

vouchered with the Western Australian Museum. If you are not sure, then it is advisable to discuss your plans with the Western Australian Museum staff before you commence your survey.

7.7 Holding animals

Occasionally we catch an animal that we are unable to identify in the field. It is normally held in a calico bag over night where an effort is made to identify it when we have access to the appropriate texts. It is then either released near its point of capture the next day or held and given to the Western Australian Museum (WAM). WAM prefers to be given live animals as this enables staff to extract tissue from the liver and heart, as they are euthanased. Tissue samples are frozen and subsequently used in DNA analysis.

8. Training and experience

People undertaking terrestrial fauna surveys are strongly advised to seek training in site selection, laying out traps, handling, identifying and marking animals. This training is best provided in the field by others who have the experience. There are often opportunities to accumulate the necessary experience by volunteering to participate in terrestrial fauna surveys undertaken by people with experience.

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