4. SITE ASSESSMENT AND MONITORING

4 SITE ASSESSMENT AND MONITORING

4.1 Ecological site assessment

The aim of this section is to provide a general idea of ecological site assessment principles. This is not suggesting that environmental officers should undertake such works, but rather is intended to help them understand the terminology presented in contracts and fee proposals.

4.1.1 General principles of ecological site assessment

Ecological site assessment is the ecological evaluation of a site that may be completed prior to detailed planning, design and construction work. There are many techniques available to assess a site that ensure the effectiveness of fauna sensitive road design measures.

- General principles:
- To enable a broad understanding, ecological assessments at multiple locations along the road alignment may be undertaken, although the entire alignment may be assessed if appropriate.
    - Adhering to the SMART technique is useful (Specific, Measurable, Achievable, Realistic, Timeframed; refer Section 3.4).
    - Determine site assessment objectives prior to field surveys. This assists in the determination of what is measurable and what is achievable.
        - Time and financial constraints will determine whether management options can be adopted within the scope of the project.
        - Determine timeframes with assistance from consultants and researchers.

4.1.2 General methods for ecological site assessment

The following are some areas and methods to consider during an ecological site assessment. The described methods are not an exhaustive list.

a) Vegetation distribution and condition

- Purpose:
    - Identify areas of intact vegetation within the broad study area.
    - Identify mature native vegetation that could enhance the success of a fauna mitigation measure.
    - Identify vegetation quality.
    - Identify weed locations.
- Methods:
    - Desktop analysis:
        - Maps of remnant vegetation are available from the Department of Environment and Resource Management (DERM).
    - There are a number of vegetation assessment methods including the Specht and Beard-Webb Schemes.
        - Sonic Tomograph:
- Measures the amount of decay and hardwood of trees.
- Advantages:
    - Revegetation costs can be limited if areas of suitable vegetation are identified and utilised to maintain existing connectivity in conjunction with fauna structures.
    - Vegetation that suits target fauna species can be maintained.
    - Identification of weeds ensures that management practices can be in place early and therefore maximise the success of fauna connectivity structures by minimising weed infestation.

b) Target species

- Purpose:
  - Identify possible target species to ensure structural designs and mitigation measures (including monitoring) are effective.
- Methods:
  - Methods employed during fauna surveys need to be well-documented to enable replication across projects: pre-, during and post-construction.
  - Methods are often target species-specific.
  - Desktop analysis.
  - Contact local experts.
  - Fauna monitoring.
- Advantages:
  - By identifying target species early in the concept phase of road design, fauna monitoring will be more effective and ensure the appropriateness of structures installed.

c) Fauna movement patterns

- Purpose:
  - Identify established fauna movement patterns to ensure fauna crossing structures are located appropriately.
- Methods:
  - Use appropriate monitoring methods listed in Section 4.2.3: Monitoring methods, including roadkill analysis and general fauna monitoring methods.
- Advantages:
  - The success and use of fauna structures is increased if constructed in established fauna movement corridors.

d) Fauna roadkill analysis

- Purpose:
  - Detect presence of fauna species.
  - Detect hotspots of roadkill.
- Methods:
  - Refer to Section 4.2.3 d: Roadkill survey.
- Advantages:
  - Identified fauna roadkill hotspots benefit from the installation of fauna mitigation measures.
  - Provides information on species present within adjacent habitat areas.

e) Identification of potential environmental risks

- Purpose:
  - Identify specific baseline environmental conditions.
  - Identify potential legal compliance issues.
- Methods:
  - Desktop analysis (for example, RCEA, regional ecosystem maps and so on).
  - Site visits.
  - Soil and water sampling.

- Flora and fauna monitoring.
- Cultural heritage assessment.

- Advantages:
  - Early identification of possible environmental risks increases the effectiveness of management strategies.
  - Reduces the likelihood of cumulative environmental impacts.

f) Topographical features

- Purpose:
  - Ensure fauna sensitive road design measures are appropriate and cost effective in the area of concern.
- Methods:
  - Analysis of topographic maps.
  - Site visits.
- Advantages:
  - Careful planning can ensure that structures are located to complement topographical features.
  - For example, the cost of excavation may be decreased by using natural undulating areas for fauna underpasses and/or overpasses.

g) Current and future land use

- Purpose:
  - Identify areas that may not complement fauna structures in the future.
    - For example, fauna structure designs should accommodate any future upgrade or expansion works.
    - A fauna structure should connect suitable land on both sides to accommodate target species in the long-term.
  - Identify areas of land that are suitable for fauna structures.
  - To ensure the long term effectiveness of fauna crossing structures installed.
- Methods:
  - Determine if adjacent lands will be developed in the future which may reduce a structure's effectiveness.
    - Review relevant planning schemes, land use plans and strategic regional plans.
- Advantages:
  - Appropriate financial investment.

4.2 Fauna monitoring

4.2.1 General principles of fauna monitoring

Monitoring is used to assess the impact roads have on fauna and the level to which fauna sensitive road designs can be used to mitigate this impact.

- Prior to commencing monitoring, determine success criteria. For example, how will success be measured, how often monitoring will occur and for what period of time monitoring will continue?
- Document initial fauna surveys to be undertaken during the site assessment phase to ensure methodological consistency is employed pre-, during and post-construction.
- Note certain methods undertaken to survey populations are specific to certain groups of animals (refer to methods described in Section 4.2.3: Monitoring methods).

- Monitoring is essential for:
  - Assessing the effectiveness of fauna mitigation measures.
  - Ensuring the efficiency of structures through feedback (specifically, successes and failures).
  - Determining whether fauna structures require alteration to maximise effectiveness.
- To maximise monitoring effectiveness three phases of monitoring should occur:
  - Pre-construction monitoring:
    - Develop a baseline for comparison with construction and post-construction surveys. This may include:
      - species and population richness and abundance and size;
      - whether fauna has attempted to cross the road;
      - relationship of individuals on either side of the road;
      - existing fauna passageways;
      - fauna community composition (age, age ratios, gender, gender ratios, breeding patterns).
  - During-construction monitoring:
    - Undertake regular site assessment to ensure fauna structures are constructed to specifications. Design drawing should also be regularly reviewed.
    - Establish a post-construction monitoring regime with adequate budget prior to finalisation of the construction project.
    - Monitor sensitive sites to ensure no damage is caused by construction (for example, site inspections of nesting sites, water monitoring and so on).
  - Post-construction monitoring:
    - Should occur for several years (at least five years) and focus on multiple species.
    - Use results to compare pre-construction baseline survey information with effectiveness of fauna mitigation measures.

4.2.2 Principles for monitoring fauna structures

- Monitoring is an integral part of achieving effective fauna sensitive road design.
- Failure to undertake monitoring can jeopardise the success of fauna sensitive road design (particularly in the long term).
- The success of mitigation structures is measured in terms of:
  - Compliance.
  - Use of structures by fauna.

a) Compliance

- Audit fauna sensitive road design measures to ensure they have been constructed and delivered to the satisfaction of the expert environmental advice and documentation provided.
- Compliance may be aided by adopting the following concepts:
  - Keeping communication open between all parties.
    - Poor communication with the environmental expert during the road project may result in the construction of structures that do not meet the original purpose or design. Failure to comply with all design details may render an otherwise suitable mitigation structure unusable or ineffective.
  - Comply with specifications and guidelines through all stages of the project.
  - Be mindful of the different stakeholders involved in all levels of the project.

- Each stage of development involves different people who have varying levels of interest in fauna movement.

b) Use of structures by wildlife

- Specific criteria are required to evaluate the effectiveness of fauna sensitive road design measures:
  - Identify criteria prior to construction.
  - Identify criteria by developing clear and concise evaluation questions and definitions of effectiveness.
- Criteria that could be used to measure fauna sensitive road design success are:
  - Fauna using structures.
  - Reduction in roadkill.
  - Maintenance of habitat connectivity.
  - Retained genetic interchange.
  - Dispersal and recolonisation.
  - An increase in the viability of local populations (or prevention of reduced population viability).
- When assessing the effectiveness of fauna structures the following should be noted:
  - Although the presence of fauna using structures indicates a level of structure success, structure use or a reduction in roadkill alone does not necessarily indicate that road impacts have been sufficiently mitigated or that structures are effective.
    - For example, only a few individuals from a population may use a structure that was previously a major migration route prior to construction.
  - Are positive effects local or do they encompass the whole population?

4.2.3 Monitoring methods

- When developing a monitoring program for fauna structures consider using the following:
  - Conduct monitoring regularly, consistently and systematically: pre-, during and post-construction.
    - Employ the same sampling techniques across a project (where applicable) as those used pre-construction to maintain consistency and allow for meaningful comparisons.
  - Use a variety of monitoring methods to encompass a wide range of species.
  - Determine the area to be monitored. This should include adjacent habitats.
    - Are all species present in adjacent habitats likely to use the fauna structures?
    - What is the proportion on each species likely to use the fauna structures? Does this correlate to adjacent population sizes?
  - Monitoring should occur across different seasons to ensure all species are recorded. Also, allow for differences occurring across time, lunar cycles and weather.
  - Ensure methods are scientifically-based so they can be replicated and compared.
  - Ensure all scientific and animal ethics permits have been obtained.
- Considerations affecting the form and timing of monitoring are:
  - Species home ranges:
    - Sampling areas need to consider a species home range.
    - Often change over time (for example, breeding seasons, weather and lunar periods).
    - Can be difficult to determine if monitoring is only undertaken for a short time period. This period may not include seasonal fluctuations in populations, as a result of breeding activities, food availability and migration events (Wormington 2006).

- Seasonality:
  - Changes in food availability, breeding, migration patterns and so on.
- Weather:
  - Some monitoring methods are less effective in particular weather conditions. For example, sand plots are less effective and reliable during the wet weather periods.
  - Weather affects species movements and activities. For example, nocturnal species are active earlier on overcast days, frogs are more active during and soon after rain events.
- Topography and landscape structure:
  - Home ranges may be different across landscape types.
  - Some techniques are not suitable for slopes, for example sand plots.
- Lunar cycles:
  - Animal activity level changes throughout the lunar cycles.
  - Some monitoring techniques have different levels of effectiveness depending on lunar cycles (for example, spotlighting is less effective during a full moon).

- Examples of issues to be considered when interpreting results from monitoring:
  - A lack of a particular life stage of a species may indicate a serious issue with a population (for example, no record of sub adults).
  - A high number of individuals in a particular life stage or sex may indicate lack of dispersion due to fragmentation.
  - A high rate of disease may indicate an unusual level of stress.
  - An area recording a high number of individuals. Are individuals moving through the area or are they stagnant and is their movement constrained?
    - A high rate of moving individuals may indicate a wildlife corridor.
    - A high amount of stagnant individuals can indicate food or shelter preferences in the area.
  - Is the presence of individuals using fauna structures inhibiting other species/individuals from using fauna structures?

a) Capture-mark-recapture

- Purpose:
  - A method of analysis used to estimate population size.
  - Used to determine the dispersal or movement of species across road barriers.
  - Sex and age ratios can also be inferred.
- Typical Target Species:
  - Small and medium-sized mammals.
  - Birds.
- Method:
  - A trap is used to capture a number of live individuals. Traps are left out for a set period of time (for trapping methods refer to Section 4.2.3 f and g, pages 13-14).
    - Trapping may occur over a number of days.
    - Multiple sites can be monitored to establish movement patterns.
  - Individuals are caught and marked with a unique identifier (for example, ear tag or band) and then released back into the environment (Figure 4.2.1).

- Markings should be chosen that will not affect the survival probability of the individual (for example, avoid the use of bright coloured tags).
- Data collected on each individual caught may include sex, weight, age (juvenile or adult), measurements, and any distinguishing characteristics.

o Sufficient time is allowed to pass for the marked individuals to redistribute themselves among the unmarked population prior to subsequent trapping events.

o Methods used for subsequent trapping events should be identical (or as close as possible) to the methods used in the first period of trapping.

o Individuals captured that have been previously marked are known as recaptures.

o Animals caught for the first time are usually marked and then are released.

o Further trapping events can occur, particularly if estimates of survival or movement are desired.

- Advantages:

o Detailed data about the condition of species is collected allowing for useful post-construction comparisons.

o Population size is estimated from as few as two visits to the study area.

o Additional capture periods can simply be added to previous data by recording the dates recaptured, the newly caught individuals and the new identity tags used.

o Capture histories can be easily analysed to estimate population sizes, survival and/or movement patterns.

o Best method to achieve a full set of data on each individual.

o Genetic analysis is also possible as individuals are handled.

- Disadvantages:

o If an individual is recorded on both sides of a road, it is impossible to determine which fauna crossing structure, if any, was used to cross the road.

- For example, if there is a breach in exclusion fencing individuals may cross the road rather than use the fauna crossing structures.

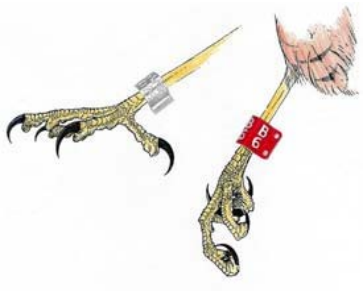
o Potentially time-consuming to trap, tag and record individuals.

o Animals may become 'trap happy' or 'trap shy', which can impact population predictions.

o Certain sexes, life stages or individuals may be prone to trapping causing biased results.

o Animals may become distressed or injured by being trapped and handled.

a)



b)

Figure 4.2.1 a) Application of a marine turtle flipper tag (Source: Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute).
b) Bird leg tags (Source: Janis Ringuette).

b) Spotlighting

- Purpose:
  - To survey the presence of nocturnal fauna.
- Target species:
  - Predominantly nocturnal fauna.
- Method:
  - At night traverse monitoring area, preferably utilising transects (set lines within the survey area) with a light to spot target species.
  - Transects (usually perpendicular to roads) can be marked with coloured/reflective tape to be followed at night.
  - Search time along each transect is controlled and recorded to ensure that differing results are not a direct consequence of the search effort.
    - When comparing separate areas, the time of night should be consistent.
    - Weather should be recorded as this can affect results (for example, nocturnal species tend to be more active earlier in the night on overcast nights).
    - Species may require different spotlight strength to maximise visibility and minimise stress on animals.
    - Refer to Section 7: Target Species Design Considerations, tables for information about when species are most active and therefore most likely to be spotted.
    - Consult a lunar calendar before spotlighting as some nocturnal species may be less active during a full moon.
    - Daytime observations of den locations may enhance spotlight survey results.
  - Post-construction spotlighting will have increased frequency over time. Such increased frequency recognises the habituation process (of the target species to the constructed fauna structure).
- Species-specific information
  - Ringtail possums
    - Cover spotlights with a neutral density filter to reduce light intensity to 7W.
    - Conduct between 1800 and 2400 hours.
  - Other possums
    - Lower than 55 W (30 W recommended) with a filter (semi-opaque) to prevent blindness and stress (Wilson 1999).
    - Having a lower watt is much more important than a filter to reduce stress on possums.
  - Gliders
    - Spotlighting for gliders is best at low vehicular speed, approximately 500 metres/hour.
    - Half-moon nights with warm and fine conditions are the best conditions to undertake spotlighting for gliders.
    - Use a maximum 50 W spotlight with a red filter, connected to a 12V battery.
- Advantages:
  - An effective method for surveying nocturnal fauna.
  - Cheap and results are instantaneous.
  - Information on the habitat use by species.
  - May provide information about animal interactions.

- Determination of the success of species reintroduction programs.

- Disadvantages:
  - Generally limited to nocturnal fauna.
  - Ineffective for some nocturnal species that move quickly when a torch is shone on them.
  - Survey limitations due to lunar and weather cycles.
  - Bias may result across different sites due to varying light penetration (into vegetation).
  - The spotter's background knowledge and skill will impact the results.
  - Different individual search techniques may affect results if a number of people are undertaking the works.
  - Repeated and frequent spotlighting may have a detrimental effect on the fauna.
  - Often sex and age cannot be identified and population health cannot be inferred.

c) Radio tracking

- Purpose:
  - Identify movement patterns of fauna.
  - Identify how fauna interact.
  - Location of dens/nests.
- Target species:
  - Most species (depending on size or tracking device).
- Method:
  - The animals are caught and a transmission device is attached (for trapping methods refer to Section 4.2.3 f and g).
  - Individuals are released at the site of capture.
  - There are three types of transmitters:
    - Satellite;
    - High frequency radio waves; and
    - GPS units utilising mobile telephone networks.
  - Radio tracking methods generally fall into three categories:

1. VHF transmitters:
   - A transmitter attached to an animal sends out radio signals which are picked up using large antennae.
   - Fixes are achieved by using a triangulation technique.
   - This method can be error prone and not suitable for animals that travel large distances.

1. Satellite Systems:
   - The transmitter system calculates and transmits location information from Earth to a satellite.
   - Information is then transmitted to a receiving station where the information is available via the Internet.
   - This method is extremely quick and accurate, but has a high cost.

2. GPS units:
    - GPS units attached to transmitters regularly take a location fix and store it for future collection.
    - Some systems are programmed to 'unlatch' at a certain time or when their databanks are full.
    - Increasingly mobile phone networks are being used to transmit location information via a text message.
  - Most tracking devices are custom made.
    - Attach tracking devices using a soft leather band where viable to reduce irritation to the animal's skin. Leather bands are also more resistant to gnawing and general use than PVC straps.

- Species-specific information:
  - Squirrel gliders
    - Studies showed single-stage brass loop design radio collars in the 151 MHz and 150 MHz frequencies were effective for squirrel gliders (Ball and Goldingay 2007).
  - Gliders
    - Studies showed single-stage tuned-loop radio-transmitters were effective for gliders (Wilson *et al.* 2007).
  - Koalas
    - Figure 4.2.2.
    - Conduct night tracking between sunset and midnight.
    - Some research indicates for the first two and a half years it is recommended all tagged koalas be tracked five days per week. For the following six months, tracking should occur once a week (Matthews *et al.* 2007).
- Advantages:
  - Enable determination if fauna crossing structures are being utilised.
  - May provide information on species interactions.
  - Fauna movement routes may be identified.
  - Nests and food sources may be located.
  - May be comparatively less time consuming and labour intensive than other methods (depending on method used).
  - Location information can be very accurate.
- Disadvantages:
  - Comparatively expensive, as most items need to be custom-made.
  - Can be labour intensive depending on device used (VHF).
  - Causes disruption to animals.

Figure 4.2.2 Koala with radio tracking collar and ear tag (Source: Friends of the Koala Inc.).

d) Roadkill survey

- Purpose:
  - To identify where and when roadkill occurs in a defined area.
  - To determine the target species for the design and location of safe fauna crossing structures and other mitigation strategies.
  - Provide species location data.
- Target species:
  - Most species.
  - Less effective for soft bodied fauna (amphibians and reptiles) due to decay rates.
- Method:
  - Surveys take place either on foot or in a slow moving vehicle (40 km/h).
  - Roadkill is best recorded in the early morning.
  - Survey both sides of the road (particularly if carrying out the survey from a car or surveying a road with multiple lanes)
  - Information which should, if possible, be recorded:
    - Species or species group;
    - Date and time found;
    - Sex;
    - Age (juvenile/adult);
    - Context of roadkill (rural, residential, commercial);
    - Road design (bend, cut and fill, fencing etc);
    - Vegetation in the area (forest, cleared etc).
  - Mark roadkill if multiple surveys in the same area are conducted within short timeframes to prevent double-counting.
  - Data may be recorded and analysed using a database with GPS software or maps.
  - Analyse roadkill data in conjunction with local population data. This ensures a more complete view of how roadkill is affecting local population size and movement patterns.

- Advantages:
  - Survey method is inexpensive and results can be processed easily.
  - Clear knowledge of where and what fauna crossing structures may be required.
- Disadvantages:
  - Untrained individuals may incorrectly identify species.
  - Not very effective for soft bodied creatures as they degrade quickly.
  - Sometimes only species group and not species can be identified.
  - There are risks associated with traversing roads by foot (particularly to mark carcasses).
  - May not provide a complete understanding of species assemblage.

e) Genetic surveying

- Purpose:
  - Provides a detailed measure of dispersal across a road barrier.
- Target species:
  - Primarily for those species for which genetic markers exist, although markers can be developed if required.
  - Check Internet databases to determine if the target species has existing markers:
    - Genbank Searchable database: http://www.ncbi.nlm.nih.gov/sites/entrez?db=Nucleotide
    - http://www.uga.edu/srel/Msat_Devmt/Microsatellites--home.htm
- Method:
  - Conducted by trained researchers, not ecological consultants and should be management focused.
  - Genetic sampling stages are:
    - Capturing individuals (refer to parts 6 and 7 for capture techniques);
    - Blood sampling;
    - Genetic laboratory analyses;
    - Statistical analyses;
    - Interpretation.
  - A minimum of 20 individuals are needed to be sampled from each population with the genetic analysis undertaken for each individual.
  - Baseline time frames for results using this technique have not been established. The length of a study will depend on life cycle and migration habits of the target species.
- Advantages:
  - Comparatively cheaper and less time consuming than other forms of field surveying.
  - Provides an estimation of population dispersal and genetic transfer rates.
  - Longitudinal studies can be conducted over the years to provide information regarding the short and long-term impact of road infrastructure and the effectiveness of fauna structures.
  - Adds scientific rigour to the management of road infrastructure undertaken in a fauna sensitive manner.
  - More specifically, it can be used as a measureable target when managers apply the SMART approach to fauna sensitive road design.
- Disadvantages
  - Must be conducted by professionals.

- Waiting periods for analysis may be significant.

f) Netting and capturing

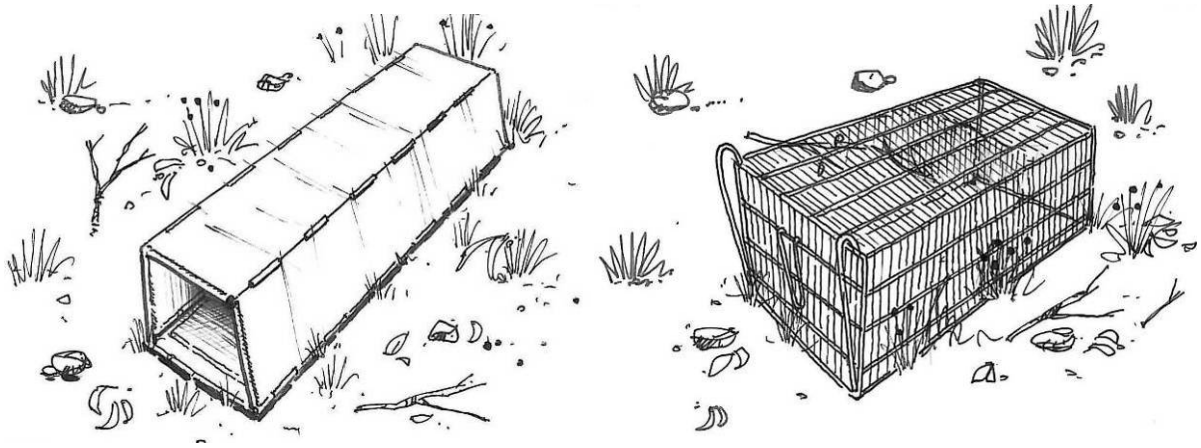
- Purpose:
  - Used to capture animals for use in other techniques (for example, mark recapture, genetic sampling and general species presence and abundance measures).
- Target species:
  - Most species.
- Methods:
  - Methods vary according to the species being sampled.
  - Some methods include:
    - Tranquilising. For example, nocturnal species should be tranquilised early in the night so the anaesthetic wears off in time for animal to recover and feed before returning to den (Wilson 2007).
    - Mistnetting (Figure 4.2.3).
    - Harp trap (Figure 4.2.3).
- Advantages:
  - Several survey techniques can be used simultaneously (for example, mark recapture and genetic sampling).
- Disadvantages:
  - Direct capture can be stressful on individuals.

a) b)

Figure 4.2.3 Netting and capture equipment.
a) Mistnet (Source: Dawn Balmer).
b) Harp trap (Source: Ecobiological).

g) Elliott traps and cage devices

- Purpose:
  - Used to capture animals for use in other techniques (for example, mark recapture, genetic sampling, and general species presence and abundance measures).
- Target species:
  - Most species.
- Methods:
  - There are a number of different designs and methods (for example, Figure 4.2.4).
  - Trap information is highly species-specific:
    - Some species require shelter to be placed in traps (for example, cotton wool or paper).
    - If traps are not waterproof they may need to be covered with plastic.
    - Some traps entice animals to the device using bait.
    - The bait used is species-specific and related to the target species' diet. In general, baits can consist of peanut butter, rolled oats, vanilla essence, honey and/or creamed honey. Traps in tree trunks may be sprayed with dilute honey to attract certain species.
  - Traps may be placed above the ground:
    - Hanging traps are generally 2.5 metres above the ground.
    - Elliott traps can be attached to poles and trees with wire and/or bracketed platforms.
  - Traps may need to be left in the same place for three or four nights to allow habituation, but they will need checking daily.
  - Traps should not interfere with normal fauna pathways or cause changes to an animal's behaviour.
  - Data collected from trapped fauna may include:
    - Body weight;
    - Teeth condition;
    - Breeding status;
    - Sex;
    - Weight;
    - Age (juvenile or adult);
    - If gliders, then the glider membrane colour may be recorded.
  - Traps come in different sizes to suit different target species.
- Species-specific information:
  - Koalas
    - If transporting koalas, crates must be 420 x 470 x 580 mm with only one koala per crate.
- Advantages:
  - The technique can be used to infer a large amount of information (presence, abundance, genetic variability).
- Disadvantages:
  - Direct capture can be stressful on individuals.
  - May catch non-target species.



a) b)

Figure 4.2.4 a) Small Elliott trap
b) Cage device (Note: figures not to scale).

h) Scats

- Purpose:
  - o Infer species presence and their movement patterns.
  - o Can indicate regular fauna movement routes.
- Target species:
  - o Mainly used for mammals.
- Method:
  - o Collected for a set area.
    - May be collected from underpasses, transects and/or around specific trees.
  - o Analysed and identified to the lowest subset, if species cannot be identified.
  - o Hairs attached to or within scats can also be used for identification or used in genetic analysis.
  - o Scat information can be collected from canopy bridge structures to indicate use. Scats are collected by erecting a shade cloth slung under the structure.
  - o Scat collection can be undertaken on glider poles using shade-cloth circles above the metal pole guards.
- Species-specific information:
  - o Koalas
    - Scats are usually collected from the base of eucalypts over 100 mm in diameter in a 1 m^2 quadrant.
    - Pellet counts can be used to predict estimates of koala abundance.
- Advantages:
  - o Can indicate fauna movement patterns.
  - o Indicates feeding trees and preferred habitats.
  - o Shows predation of species.
- Disadvantages:
  - o Cannot distinguish between individuals.
  - o Waiting time for analysis results and performing analysis may be significant.

- Researchers must have scat identification knowledge.

i) Hair tubes/funnels

- Purpose:
  - Monitor the use of fauna structures by animals.
  - Measure the presence of animals.
- Target species:
  - Mammals
- Method:
  - Line funnel or tube entrances with double-sided tape and attach to glider poles, any natural (tree) or man-made (pole) structure or to the ground.
    - Hair tubes are usually PVC and 100 mm long x 40 mm diameter with holes drilled through the middle.
    - Tubes are usually nailed to structures approximately four metres off the ground (unless being used in fauna underpasses) or pegged to the ground (Figure 4.2.5).
  - Bait may be used to attract species to enter the tubes.
  - Can be utilised on glider poles during intensive monitoring periods (Figure 4.2.6).
- Species-specific information:
  - Squirrel gliders.
    - Spray tubes with a mixture of water and diluted honey to attract squirrel gliders.
- Advantages:
  - Items are cost-effective and simple to install.
  - Can indicate use of fauna structures immediately.
  - Can gain genetic information from samples.
- Disadvantages:
  - Analysis of hair samples at a species level can be expensive.
  - Waiting time for analysis results and performing analysis may be significant.
  - Not always accurate when distinguishing between similar species.

Figure 4.2.5 Hair funnel pegged to the ground (Source: FaunaTech Austbat).

Figure 4.2.6 Hair funnel used for monitoring. Tube is mounted on a glider pole at Compton Road, Brisbane (Robinson-Wolrath 2007).

j) Observational and audio methods

- Purpose:
  - o Indicate the use of fauna structures by species.
  - o Audio is often used to supplement other monitoring data and provide evidence of species presence.
- Target species:
  - o Observational - all species.
  - o Audio - Vocal species (particularly birds, frogs and bats).
- Methods:
  - o Observational - note any animals observed during movements within the study area.
  - o Observational studies may benefit from placement of artificial shelter sites, such as concrete pavers, particularly when reptiles and invertebrates are part of the target group of species.
  - o Observational – monitor at different times (for example, dawn, midday, dusk and after dark) as species activities and locations will change throughout the day.
  - o Observational - At night, night vision equipment including image intensifying goggles or infra-red video cameras may be utilised to visualise microbats.
  - o Audio - recording devices (for example, Anabat) are used to record sounds (including ultrasonic) or vocalisations made by animals.
- Advantages:
  - o Quick and easy.
  - o Can provide additional rigour to other survey techniques.
  - o Audio can indicate the presence of species that cannot be monitored by other methods (trap-shy species and birds).
  - o Can monitor the presence of insects.
  - o Less invasive to species than other survey methods.

- Disadvantages:
  - Can be time-consuming listening to recorded audio.
  - Identification of species requires a detailed knowledge base.
  - Direct observation is not useful for all species (for example, microbats) and may not allow for species-specific information.

k) Active searches

- Purpose:
  - Establish use of fauna structures for cryptic and shy species.
  - Locate nesting and breeding locations.
- Target species:
  - All species.
  - Particularly useful to monitor shy species.
- Method:
  - Move through a particular area and actively search for fauna.
    - This includes overturning rocks, searching through leaf litter, tree hollows and logs.
  - When performing active searches:
    - Do not disturb nests during searches.
    - Replace all rocks and logs picked up and/or turned over in the same spot with same side touching the ground. Do not leave rocks and habitat structures overturned.
- Advantages:
  - Surveys species when other techniques are inappropriate.
  - Results are immediate.
  - Cost-effective as no equipment is required.
- Disadvantages:
  - Individual must have sufficient knowledge to accurately identify species.

l) Sand plot monitoring

- Purpose:
  - Monitors the use of fauna structures by recording tracks of species left in sand plots located at the entrance and exit of the fauna crossing structures.
- Target species:
  - All species.
- Method:
  - Sand is placed in trays or directly onto the ground at the entrance and exit of fauna structures (Figure 4.2.7).
  - The placement of track beds depends on the gait of fauna being studied.
  - Numerous types of sand may be used.
    - Silver sand is most commonly used as it can be used to get prints of small mammals and does not harden or dry out.
    - Alternative substrate types may be pure sand, sieved agricultural gypsum powder, marble dust, bricklayers loam or any combination. Loose soil and clay/loam mixtures have also been used.

- Sand should be 20-50 mm in depth and 1-2 metres wide and cover the breadth of the fauna structure.
- Place sand 1-2 metres from the entrance to limit disturbance from the wind and rain.
- Moisten sand (fine spray of water) to hold animal prints longer.
  - If sand is placed straight on a soil substrate it will not dry out and prints will be well preserved.
- Check plots regularly and identify and record species prints.
  - The configuration of plots will vary according to the structural constraints of crossings.
- Identify tracks on site and then rake over to achieve a smooth surface.
- Document methods used to determine if animal tracks constitute a complete crossing to maintain consistency across surveys.
  - A complete crossing is usually denoted by a set of prints by the same taxa in all sand plots, facing the one direction.
  - A probable crossing is usually denoted by a set of prints recorded in all but one sand plot facing the one direction (not applicable if only one or two plots are used).
- Monitoring between two and three times a week optimises the opportunity to identify animals tracks.
  - Triggs (1996) may be used for track identification.

- Advantages:
  - Set-up and maintenance of testing equipment is inexpensive when compared to other monitoring methods.
  - Results are immediate.
- Disadvantages:
  - If trays are not wide enough some species (for example, macropods) may jump over a sand tray without detection.
  - Does not distinguish between individuals.
  - Wind and rain can affect monitoring.
  - May be considered labour intensive as the plots must be monitored regularly.
  - Majority of tracks can only be identified to the level of fauna group (for example, macropod or rodent) rather than species.
  - If sand trays are not monitored regularly then tracks can overlap resulting in the loss of data.

Figure 4.2.7 Underpass with two sand plots used to monitor fauna use.

m) Still and video cameras

- Purpose:
  - Record use of fauna structures by species.
  - Collect additional information on fauna use, such as the precise time and date an animal used a structure.
- Target species:
  - Can be used for all species.
- Method:
  - Methods depend on the specific camera or video being used.
  - Combination of sensors, cameras, control box and power supply (Figure 4.2.8).
  - Attached to either natural or man-made structures.
  - Control box and/or cameras can be placed in a metal locked cage or box to prevent vandalism (Figure 4.2.9).
  - Should be waterproof.
  - Some considerations for different types of cameras and sensors are:
    - Active infra-red beam sensors:
      - Sensitivity set to allow particular animals to be photographed.
      - Sensors are very accurate.
      - Some sensors are waterproof which allows placement outside culverts and near the ground (Goosem 2005).
    - Passive infra-red sensors:
      - Uses body heat to set trigger for photograph.
      - Cannot change sensitivity and, therefore, will photograph all species.
      - Accurate for larger animals.
      - Cannot detect exothermic species such as reptiles and amphibians.
      - Can be set off by inanimate heat-emitting structures (for example, metal).

- Cover a wider area than active sensors (Goosem 2005).

- Microwave sensors:
  - Not usually used in isolation, rather used in conjunction with passive sensors.
  - Similar to the passive sensors but are not affected by shadows/heat changes.
  - New technology and is, therefore, expensive and has not been used widely (Goosem 2005).
- Remotely-triggered video camera systems:
  - Very expensive, mainly due to power use requirements.
  - Predominantly used for species with a high conservation value, due to expense.
  - Review of video footage is labour intensive.
- Motion-detecting camera system:
  - Widely used.
  - Sensitive to fog and rain.
  - High maintenance and false triggering from branches often occurs.
  - Regularly clear stored images as the camera can be triggered by insects, vegetation, rain and fog and memory card may fill quickly.
  - Set up cameras at either end of a rope tunnel to detect complete crossings.
- Digital cameras:
  - Able to store a large number of images.
  - Can store time and date information with pictures.
  - Difficulty in capturing images of fast moving species as it may take up to five seconds to take a picture.
  - Flashes are usually of lower quality.
  - High power demand.
  - Some types cannot take footage in the dark.

o Considerations before installation:
- Ease of accessibility (to cameras, control boxes and power supplies).
- Equipment required to complete the installation.
- Safety concerns.
- The side of the fauna crossing and direction the cameras are to face.
- Distance between cameras, control box and power source.

- Advantages:
  - o Provides information on species utilising fauna structures and frequency of use.
  - o Indicates use of fauna structures by predator species and/or humans.
  - o Provides information on the precise time and date fauna structures are used. This may indicate fauna passage patterns.
  - o Provides information on animals undetected by other means of monitoring.
  - o Possible to obtain environmental data (for example, temperature, light, humidity).
- Disadvantages:
  - o Prone to vandalism.
  - o May be costly and time-consuming.

- May not indicate complete crossings by individuals. This can be overcome if detectors and cameras are placed at both ends of the fauna structure.
- Power sources can be unreliable.

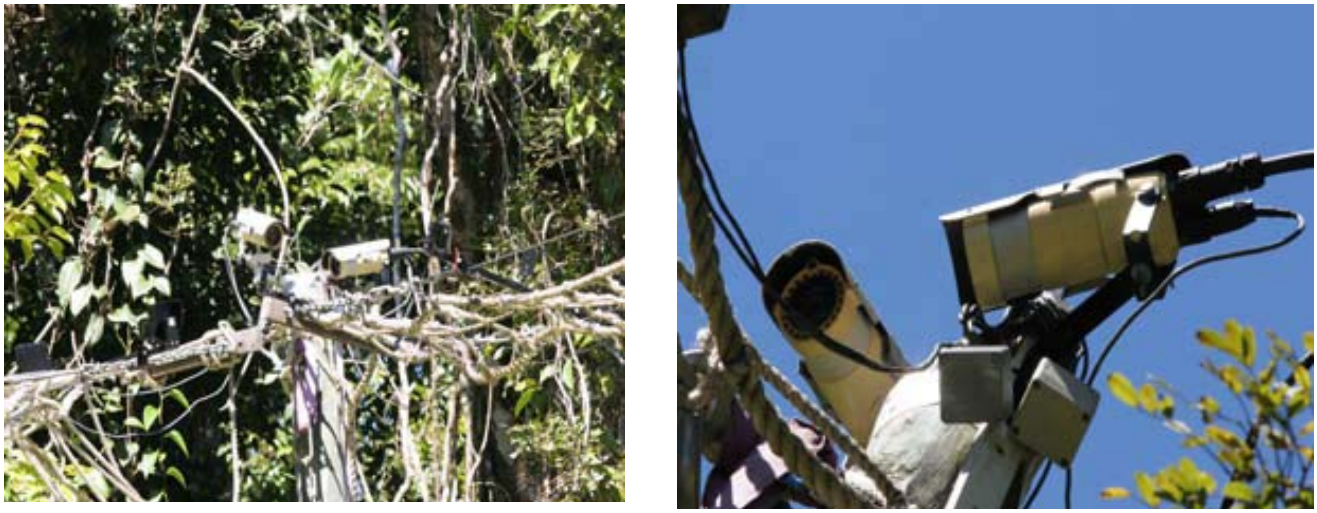


Figure 4.2.8 Camera and sensors used to monitor use of canopy bridges at Palmerston Highway (Cohen 2008).

Figure 4.2.9 Vandalism resistant cage for still camera in fauna underpass, East Evelyn (Scott 2007).

n) Ink method

- Purpose:
  - Monitors the use of fauna structures by recording tracks of species left on paper plots located at the entrance and exit of crossing structures.

- Target species:
  - Can be used for large and some small mammals.
  - Very effective for recording amphibians.
- Method:
  - The ink consists of a mixture of paraffin with some carbon powder (40 g/l oil).
  - Spread ink on a piece of plastic (with a small upright rounded edge) or mat (more effective).
  - Lay paper across the whole width of the passageway.
  - Check paper weekly for animal prints. Tracks and sheets to be replaced with new ones if more than approximately three tracks are found.
- Advantages:
  - Ink pad does not affect the movement of species.
  - Animal prints can be taken from site for analysis, decreasing field time.
- Disadvantages:
  - Only some fauna can be classified down to the species level using this method.
  - Ink may have adverse effects on fauna (particularly invertebrates).
  - Identifications of animal tracks must be undertaken by an expert.

o) Playback

- Purpose:
  - Identify the presence of species.
- Target species:
  - Vocal species.
- Method:
  - A call is recorded and played back in the field, after which the observer will listen and record responses to identify species.
- Advantages:
  - Quick and easy to use.
  - Results are immediate.
- Disadvantages:
  - Specific calls to initiate responses may not be available.
  - Relies on the observer having adequate knowledge to identify calls.

p) Sooted plates

- Purpose:
  - Used to analyse small animal use of fauna structures (mainly culverts).
  - Most appropriate for use in small culverts.
- Target species:
  - Small-sized fauna.
- Method:
  - Place an aluminium plate with soot (acetylene torch or similar apparatus) on the ground.
  - Wrap a sticky piece of plastic around the centre of the plate with the sticky side up (often clear contact is used).

  - Animal presses foot into the soot which imprints onto the sticky band allowing for identification.

- Advantages:
  - Easy to install, transport and construct.
  - Comparatively inexpensive to other monitoring methods.
  - Does not harm fauna.
  - There are no time restrictions on analysis of plates as a permanent record is created.
  - Plates can be transported for experts to analyse (unlike sand plot tracks).
  - Particularly useful to record small-sized fauna prints (for example, amphibians, small mammals and reptiles).
- Disadvantages:
  - Not effective to record presence of large-sized fauna.
  - Unable to distinguish between individuals of the same species.

q) Spotting

- Purpose:
  - Identify the presence of species and their location.
  - Commonly used to locate and remove species before clearing.
- Target species:
  - Primarily used for species with conservation status, but all types of species can be targeted.
  - Recommended for use prior to and during land clearing.
- Method:
  - Choose sites randomly (usually in a stratified pattern). However, sites may, in some circumstances, be intentionally chosen.
  - View all trees in the survey area and determine the presence of fauna.
  - Attach a tag, flag or piece of tape to the tree once 'observed' to prevent double counting. This assumes a sedentary behaviour of the observed species.
  - Can be used in conjunction with scat monitoring.
  - When an individual is sighted, data collection may include, where possible:
    - Age class.
    - Reproductive class (for example, presence of pouch with young).
    - Health status (for example, overall appearance).
    - Location (marked on a map).
  - Can record tree species information with sufficient detail to add to information about species habitat requirements.
- Advantages:
  - Allows species to be located and removed prior to clearing.
  - Applicable when specific location data of species is required.
- Disadvantages:
  - Time consuming.
  - Costly as the survey is generally carried out by a trained and registered spotter.

r) Pitfall traps

- Purpose:
  - Sample invertebrate, small mammal, reptile and amphibian species to obtain presence/absence information.
- Target species:
  - Most effective for the monitoring of invertebrates and other small terrestrial species.
- Method:
  - A number of pitfall trap types.
  - Consists of a cup or container submerged into the soil.
  - Container may be partly filled with a preservative.
  - Animals fall into the trap and cannot escape, allowing researchers to identify the presence of species.
  - Containers can be covered to prevent issues created by rain and falling debris.
  - Guide rails can be erected to guide species towards traps (Figure 4.2.10).
  - Container size varies depending on site and target species.
- Advantages:
  - Cost-effective and simple to use.
  - No field identification for invertebrates is needed. Samples can be taken from the field for identification by experts.
- Disadvantages:
  - May trap non-target species.
  - If preservative is used then all species are killed.
  - Species trapped in container may fall prey to predation.

a) b)

Figure 4.2.10 a) Pitfall trap line with guiding fence. b) Covered pitfall trap (Walters 2003).

s) Hollow surveying

- Purpose:
  - o Identify species utilising the hollow.
  - o Determine whether hollow is being utilised.
- Target species
  - o Arboreal species.
  - o Birds.
- Method:
  - o If utilised as a pre-clearing method:
    - An ecologist inspects the site (five metres on either side of carriageway) prior to vegetation clearing and marks trees as hollow, inactive (hollow not being used) or not hollow.
    - Alternatively, trees with hollows should be numbered, given a GPS position and spray-painted/tagged. This information should be provided in a map for relevant site staff to ensure care is taken around these trees if being retained.

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