Australian Government
Department of Sustainability, Environment, Water, Population and Communities



Survey guidelines for Australia's threatened reptiles

Guidelines for detecting reptiles listed as threatened under the *Environment Protection and Biodiversity Conservation Act* 1999

Authorship and acknowledgments

This report updates and expands on a draft report prepared in January 2004 by Ross Sadlier, Glenn Shea and Glenn Muir, reviewed by Hal Cogger and approved by former AMBS Senior Project Manager Jayne Tipping. All species accounts were prepared by Ross Sadlier and Glenn Shea. This report includes additional species accounts prepared by Ross Sadlier and Glenn Shea and has been reviewed and updated by Hal Cogger, James Bevan and AMBS Senior Project Manager Glenn Muir.

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HOW TO USE THESE GUIDELINES

The purpose of this document is to provide proponents and assessors with a guideline for surveying Australia's threatened reptiles listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

These guidelines will help you to determine the likelihood of a species' presence or absence at a site. They have been prepared using a variety of expert sources, and should be read in conjunction with the Australian Government Department of the Environment's *Significant impact guidelines 1.1 - Matters of national environmental significance*.

These guidelines are not mandatory. Proposals failing to meet these survey guidelines for reasons of efficiency, cost or validity will not necessarily default to a judgement that referral is required (that is, that a significant impact is likely), especially where the proponent issues an evidence-based rationale for an alternative survey approach. Alternatives to a dedicated survey may also be appropriate. For example, a desktop analysis of historic data may indicate that a significant impact is not likely. Similarly, a regional habitat analysis may be used to inform judgement of the likely importance of a site to the listed reptiles. Proponents should also consider the proposal's impact in the context of the species' national, regional, district and site importance to establish the most effective survey technique(s).

Failing to survey appropriately for threatened species that may be present at a site could result in the department applying the precautionary principle with regard to significant impact determinations. That is, if no supporting evidence (such as survey results) is presented to support the claim of species absence, then the department may assume that the species is in fact present. The department will not accept claimed species absence without effective validation such as through these survey guidelines, other survey techniques (for example, a state guideline or an accepted industry guideline), or relevant expertise. Where a claim of absence is made, proposals should provide a robust evaluation of species absence.

Biological surveys are usually an essential component of significant impact assessment, and should be conducted on the site of the proposed action prior to referral. Surveys help to evaluate the impact on matters of national environmental significance by establishing the presence or the likelihood of presence/absence of a species. Before undertaking a survey, proponents may wish to contact the department's relevant assessment section to discuss their project and seek advice on appropriate survey effort and design.

Executing a survey to this standard and identifying listed species presence does not in itself predict a significant impact. The presence of a species is one of many factors that will increase the likelihood of a significant impact. Proponents should use the presence of a species as a consideration in establishing whether a significant impact is likely or certain. As part of the assessment process, sufficient information is usually required to determine if a species' presence at a site constitutes a 'population' or 'important population' as defined in the *Significant impact guidelines 1.1* publication. Information on whether the occurrence constitutes a 'population' or 'important population' will not necessarily be generated by surveys conducted using these guidelines.

These guidelines help determine presence or the probability of presence. They **do not** establish or assess species abundance, as the effort in terms of cost and time required for an abundance survey is much greater than that determining presence/absence. Effective abundance surveys would need to compare survey effort and techniques with further exploration of a proposal’s context, including important population location(s), habitat importance, ecological function and species behaviour.

INTRODUCTION

These survey guidelines provide guidance on what should be considered when planning and undertaking species presence surveys for threatened reptiles relevant to a referral to the Federal Environment Minister under the EPBC Act. The individual taxa (species or subspecies) accounts provide a guide as to the survey methods and effort that are appropriate for assessment of whether those listed taxa occur at or near a specified site ('study area'). Consequently, the guidelines focus on assessing the presence or likelihood of presence of taxa in a study area, and not on an assessment of the abundance of individuals.

The survey guidelines are limited to recommending the effort with selected techniques to establish whether a target species is present or absent in a project area. A survey is interpreted as the first step in a process towards assessing the impact of a proposed project on any threatened reptile species. The approaches in each species profile should be regarded as a minimum and should be included in any general fauna survey program that seeks to determine the presence of species of conservation significance. If threatened species are found to be present during the survey, different techniques may be required to establish if the project area contains important habitat (shelter sites, foraging sites, water sources and movement corridors) for those threatened species.

The taxa accounts relate to the 48 terrestrial and freshwater reptile taxa that are classified as threatened under the EPBC Act (see Table 1) as at July 2010. They do not include the six marine reptile species currently listed as threatened by the EPBC Act (all of which are sea turtles). However, it is recognised that the EPBC Act threatened species list is dynamic and that survey guidelines are likely to be applied to some taxa not currently listed. Conversely, it is hoped that with ongoing conservation programs the populations of some taxa will recover and they can be removed from this list.

If habitat suitable for a threatened species occurs in the area, and an appropriate survey is not conducted to determine presence/absence, the department may follow the precautionary principle and assume that the species is in fact present.

In some cases, species have been so rarely recorded that it may be premature to outline a recommended survey method. In these situations a review of previous survey methods and their success rate is provided, but further research may be needed before guidelines can be set. All of these species are, by the nature of their listing, either rare or have very restricted distributions. Therefore, it is unlikely that we yet know enough about their ecology, reproduction or habitat use to say with confidence that any survey method or effort will guarantee a species detection. However, the standard survey methods recommended in this report will provide a baseline of survey effort required with adherence to the precautionary principle essential in the place of research results.

Table 1: Threatened reptile species (terrestrial and freshwater) listed under the EPBC Act as at July 2010.

Scientific name (as listed on EPBC Act)	Common name	EPBC Act Status *
Anomalopus mackayi	Long-legged worm skink	Vulnerable
Aprasia parapulchella	Pink-tailed worm lizard	Vulnerable
Aprasia pseudopulchella	Flinders Ranges worm lizard	Vulnerable
Aprasia rostrata rostrata	Hermite Island worm lizard	Vulnerable
Bellatorias obiri [1]	Arnhem Land egernia	Endangered
Christinus guentheri	Lord Howe Island gecko	Vulnerable
Coeranoscincus reticulatus	Three-toed snake-tooth skink	Vulnerable
Ctenophorus yinnietharra	Yinnietharra rock dragon	Vulnerable
Ctenotus angusticeps	Airlie Island ctenotus	Vulnerable
Ctenotus lancelini	Lancelin Island skink	Vulnerable
Ctenotus zastictus	Hamelin ctenotus	Vulnerable
Delma impar	Striped legless lizard	Vulnerable
Delma labialis	Striped-tailed delma	Vulnerable
Delma mitella	Atherton delma, legless lizard	Vulnerable
Delma torquata	Collared delma	Vulnerable
Denisonia maculata	Ornamental snake	Vulnerable
Egernia rugosa	Yakka skink	Vulnerable
Egernia stokesii aethiops	Baudin Island spiny-tailed skink	Vulnerable
Egernia stokesii badia	Western spiny-tailed skink	Endangered
Elseya belli	Namoi River elseya (Namoi River, NSW)	Vulnerable
Elusor lavarackorum	Gulf snapping turtle	Endangered
Elusor macruros	Mary River tortoise	Endangered
Emydura macquarii signata (Bellinger River, NSW) [2]	Bellinger River emydura	Vulnerable
Eulamprus leuraensis	Blue Mountains water skink	Endangered
Eulamprus tympanum marnieae	Corangamite water skink	Endangered
Furina dunmalli	Dunmall's snake	Vulnerable
Hoplocephalus bungaroides	Broad-headed snake	Vulnerable

1. Current scientific name *Bellatorias arnhemensis*
2. Current scientific name *Emydura macquarii*

Lepidodactylus listeri	Christmas Island gecko	Vulnerable
Lerista allanae	Retro slider	Endangered
Lerista vittata	Mount Cooper striped lerista	Vulnerable
Liasis olivaceus barroni	Olive python (Pilbara subspecies)	Vulnerable
Liopholis kintorei	Great Desert skink	Vulnerable
Liopholis pulcha longicauda	Jurien Bay skink	Vulnerable
Liopholis slateri slateri	Slater's skink, floodplain skink	Endangered
Lucasium occultum [3]	Yellow-snouted gecko	Endangered
Nangura spinosa	Nangur spiny skink	Critically endangered
Niveoscincus palfreymani	Pedra Branca or red-throated skink	Vulnerable
Notechis scutatus ater [4]	Krefft's tiger snake (Flinders Ranges)	Vulnerable
Oligosoma lichenigera	Lord Howe Island skink	Vulnerable
Ophidiocephalus taeniatus	Bronzeback snake lizard	Vulnerable
Paradelma orientalis	Brigalow scaly-foot	Vulnerable
Pseudemydura umbrina	Western swamp tortoise	Critically endangered
Rheodytes leukops	Fitzroy tortoise	Vulnerable
Tiliqua adelaidensis	Adelaide blue-tongue lizard	Endangered
Tympanocryptis pinguicolla	Grassland earless dragon	Endangered
Typhlops exocoeti	Christmas Island blind snake	Vulnerable
Underwoodisaurus sphyrurus	Border thick-tailed gecko	Vulnerable

3. Current scientific name *Diplodactylus occultus*

4. Current scientific name *Notechis ater ater*

CONDUCTING SURVEYS IN SIX STEPS

STEP 1: Identify taxa that may occur in the study area

The first stage in the design and optimisation of surveys is to generate a list of threatened reptiles that could potentially occur in the study area. A process is suggested below.

(i) Characterise the study area

The boundaries of the study area must be established clearly. A detailed map of the study area should then be constructed revealing the type, locations and condition of native vegetation and important habitat features for reptiles, such as wetlands and rock outcrops. This process is not only critical to establishing which threatened species may occur in the area, but also in the selection of appropriate survey methods and effort. An appropriate map will aid almost every survey regardless of survey technique.

(ii) Establish the regional context

This stage requires an assessment of the habitat frequency and function. The regional context will help develop judgements of significance associated with the loss or disturbance of habitat. A useful test will involve the following questions:

- Are the habitats rare or common?
- Are the habitats likely to be critical to species persistence?
- Are the habitats likely to be permanent or ephemeral?
- How is the species likely to use the site (for example, breeding, foraging, etc)? Survey design may need to be adjusted to determine these aspects if necessary.

(iii) Identify those threatened reptiles that are known to, likely to or may occur in the region

This stage involves consulting a range of sources to determine which threatened reptiles could occur in the region surrounding and including the study area. There are a range of sources that should be consulted to create a list of taxa. These include:

- Australian Government Department of Environment databases, including the protected matters search tool and species profiles and threats (SPRAT) database that allow you to enter the site of interest and generate predictive maps and information relating to threatened species distributions
- state, territory and local government databases and predictive models
- national and state threatened species recovery plans and teams
- reference books such as *A complete guide to reptiles of Australia* (Wilson and Swan 2003)

- museum and other specimen collections
- published literature
- unpublished environmental impact reports
- local community groups and researchers.

(iv) Prepare a list of threatened taxa that could occur in the study area

This can be determined by comparing the habitat requirements of each threatened taxa identified in *stage iii* with the habitat types and features present within the study area (*stages i and ii*).

The taxa identified in this process are referred to as 'target' taxa.

STEP 2: Determine optimal timing for surveys of 'target' taxa

For any proposal, the timing of fieldwork is critical to the surveying and reporting process. Careful consideration of the necessary lead-time is required, as it may be necessary to undertake surveys at specific times of the year depending on the ecology of the species in the subject area. Surveys over multiple years may be required where a single year's data is not adequate to detect the species or to address the environmental factors. There may also be a time lag due to the availability of appropriate faunistic expertise. Proponents should make allowance for this lag when planning projects. Commissioning biodiversity surveys as early as practicable in the planning/site selection phase of a project will help avoid potential delays in approvals.

Effective surveys should always begin with a thorough examination of the literature to identify the best times, locations and techniques for surveys. The profiles in this document provide a basis for effective surveys for reptile species currently listed as threatened at a national level in Australia.

If it is not possible to survey for target taxa that have been previously recorded in the general location of the study area during the appropriate time of day or season, it should be assumed that these taxa do occur in the study area if suitable habitat exists (NSW DEC 2004).

Species richness and capture rates have been shown to be dependent upon the time of year, time of day or night, the length of the survey period and weather conditions. In general, surveys for reptiles should be conducted at times when the target species or communities are known to be active because periods of reptile activity are more likely to lead to capture success (for most species). In northern Australia, effective audits of the reptilian biota of an area may require that surveys be conducted during both wet and dry seasons. In southern Australia, reptilian surveys must be undertaken during the warmer months of the year, as many reptiles become inactive and retire to winter refugia during the colder months, making them difficult to detect. Typically, in the temperate parts of Australia, most reptile species are best surveyed in late spring and early summer, and should not be surveyed between May and September.

Weather conditions at the time of survey can also strongly influence results, with cool or very high temperatures, strong winds and rain or overcast skies all reducing numbers and diversity of active reptiles. Similarly, time of day can also strongly influence results, with diurnal surveys usually best undertaken from 10.00 am to 4.00 pm. Nocturnal surveys should be undertaken during the first five hours after dusk.

It should be noted that the optimal survey period among species varies in terms of length, time of year and weather conditions. There are also some exceptions to the general information provided above; for example, records of some species can be obtained by searching winter refugia. In addition, on hot days in some areas the best search time may be before 9.00 am, before the day becomes too hot and reptiles seek refuge. For these reasons, information regarding reptile activity periods is included in the species-specific survey guidelines provided.

STEP 3: Determine optimal location of surveys

Habitat stratification

In some circumstances, the study area of interest will be small enough to allow a comprehensive search of the entire area within a reasonable period of time. The size of what is a searchable area will depend on the nature of the target taxa and the habitat and topography of the study area. For example, searching for highly cryptic secretive species will take far longer than searching for large, conspicuous species that are surface-active. If a comprehensive search of the whole area or target unit/habitat is feasible, then sampling will not be required as the data collected will be representative of the entire area. In many cases, however, the study area will be too large to permit a complete search within a reasonable time frame, and selective searches or sampling procedures will be required (Royle & Nichols 2003).

Many study sites will be comprised of a variety of distinct habitat types, especially if the area is extensive. Some of these habitats may be unsuitable for occupancy by the targeted taxa. An effective strategy to maximise the likelihood of detecting a particular taxon is to concentrate search efforts within habitat that is favoured by the targeted taxon (Resources Inventory Committee 1998). This will require that the study area is divided up, or stratified, into regions of similar habitat types.

When stratifying a study area, the study area is usually partitioned first on biophysical attributes (for example, landform, geology, elevation, slope, soil type, aspect, water depth), followed by vegetation structure (for example, forest, woodland, shrubland, sedgelands). Strata can be pre-determined based on landscape features indicative of habitat which can be derived from topographic maps, aerial photographs that show habitat types, or existing vegetation maps. Preliminary assessment of the study area prior to commencing the surveys will be useful to check stratification units and further stratify the area if necessary (NSW DEC 2004). In other situations, such as the inundation of vast floodplains, there may be little alternative but to implement a form of stratified sampling based on accessibility of habitat during the course of the survey.

Focusing search effort on favoured habitat can be a valuable strategy to maximise the likelihood of detecting target taxa. However, this approach requires that the habitat preferences of target taxa are adequately known, which for many threatened species may not be the case. The fewer the number of habitat association records that have been reported for a taxon, the more likely that any apparent habitat preference will be an artifact of the small sample. Furthermore, subsequent surveys tend to focus on these apparently preferred habitats, which can further distort the perception of habitat preference. Consequently, investigators should not exclude particular habitat strata from survey designs unless it is well established that these habitat types are consistently less favoured by the target taxa than other types within the study area.

Targeted searches

An extension of focussing search effort on preferred habitat strata is the targeted search. In this case, search effort is confined to particular resources or habitat features that the target taxa/taxon are known to seek out, at least for some part of the day or season. Once located, these sites can be watched at appropriate times to determine if they are visited by the target taxa/taxon.

STEP 4: Establish sampling design and survey effort

The previous sections on survey timing and location highlight important strategies to help increase the chance of detection. However, replicated sampling will often be required either to reveal the target taxa/taxon or satisfy the argument that the taxon is absent or occurs at very low abundance within the study area. Information on species that occur at very low abundance may be important when considering the likelihood of a significant impact from the proposed actions. Sampling can be replicated in space (different locations at the same time) and time (same location at different times) or a combination of both (different locations at different times).

Spatial sampling

Replication in space will often be necessary to detect populations that are at low densities or clumped distribution. Even after stratification, sampling may still be required if the area of favoured habitat is large or if the habitat preferences of the target taxa are variable or poorly known. There are two basic spatial sampling designs:

- *Random sampling* – when all locations within the study area (or selected strata) have an equal chance of being sampled; and
- *Systematic sampling* – when units are spaced evenly throughout the study area (or selected strata).

Systematic sampling will generally be superior because it produces good coverage, is easier to implement and is less subject to site selection errors. It is also recommended that sampling units are placed to avoid boundaries of environmental stratification and local disturbances such as roads, mines, quarries and eroded areas (Resources Inventory Committee 1998, NSW DEC 2004).

In general, sampling units should be positioned sufficiently far apart that individuals are unlikely to be detected from more than one sampling location, ensuring the samples are independent. The distance between sampling positions will usually depend on the territory or home range size of individuals in the target population and their detection distance. The inter-sample distance will also depend on the survey technique being employed. The number of sampling units within the study area (or strata) should be proportional to its size, a principle referred to as area-proportionate sampling (MacNally & Horrocks 2002). However, a linear increase in sample number with area will become impractical at very large study areas.

For detection studies, a formal sampling design as outlined above may be less important than for studies aimed at estimating abundance. However, a formal sampling design is still preferable, especially if stratification is required (Resources Inventory Committee 1998).

Temporal sampling

Temporal replication may be necessary to detect populations that fluctuate in abundance, occurrence or detectability with time, especially when these fluctuations are unpredictable. Regular sampling during and throughout the time of year when the taxa are most likely to occur at the study area is desirable. Some locations may be occupied by target taxa/taxon in some years but not others, depending on environmental conditions.

Sampling over many years will rarely be feasible. In some cases, previous records can provide information on the use of such sites by particular taxa. If threatened taxa have been recorded in the general location of the study area when conditions were appropriate, it would be expected that these species will return again, unless the habitat has been irreparably changed. Where previous data are few or absent, assessment of the habitat will be vital and could provide the only indication of whether the site is likely to support these species when conditions are suitable in the future.

Temporal sampling may also be required when the study area is small. In this situation, the individuals of some taxa will have territories or home ranges that include, but are not restricted to, the study area. As a result, at any one time, some of these individuals will be absent from the study area and go undetected (Mac Nally & Horrocks 2002). Regular sampling over time is recommended as it will increase the probability that these individuals will be detected on at least one occasion. Off-study area sampling is another means to address this problem, whereby sampling is conducted in suitable habitat in the area surrounding the study area. This procedure effectively increases the study area, allowing greater spatial sampling, and enhances the probability of detecting individuals with home ranges larger than the core study area. In practice, this is a useful strategy because temporal replication is often more costly to implement than spatial replication, as additional travel may be required to and from the study area.

STEP 5: Select appropriate personnel to conduct surveys

The single most essential component of any survey is competent observers (Resources Inventory Committee 1998). EPBC Act assessors expect that surveys be conducted by appropriately experienced observers who have excellent identification skills, including a good knowledge of reptile behaviour, at least in relation to the taxa or group being targeted. Observers should have recognised relevant skills or experience. Observers should also have access to appropriate equipment (for example, binoculars or torch). The need for excellent field identification skills of observers cannot be overstated.

Personnel engaged to conduct surveys on nationally threatened reptiles must be familiar with the particular species, experienced with the methods described in this document, and/or demonstrate adequate training from an expert prior to conducting the survey. Survey leaders should assess all contributors and, where necessary, provide training and guidance to maximise the effectiveness of all observers (for example, Saffer 2002). The identity of observers should always be recorded to allow for the detection and possible statistical correction of differences between observers if necessary (Resources Inventory Committee 1998). Some indication of the previous experience of observers with the target taxa, and the identification challenges inherent in surveying for these taxa should also be provided to help assess the competency of observers and reliability of observations.

Investigators working on surveys targeting threatened species should:

- have the skills to reliably identify the threatened species that might be encountered in the area. Generally this will not be a problem with the majority of threatened reptiles currently listed. Some, however, will or could occur in areas where there is the possibility of encountering superficially similar species. The investigator should have the skills to be able to both anticipate potential problems with identification and to consult with specialists, when necessary, to resolve taxonomic or other problems involved in ensuring an accurate identification.
- have the skills and knowledge of the biology of the species involved to determine in the field the most appropriate survey methodologies.
- be sufficiently aware of the status of knowledge of threatened species in a broad geographical context to recognise the significance of unusual or extralimital records made during the course of survey work.

STEP 6: Document survey methods and results

Survey methods and level of search effort vary widely between studies. For this reason it is essential that survey reports include detailed information on the methods used and the level of search effort adopted. This should include who was involved, what work was carried out and where, when the survey was conducted (both date and time of day) and how the survey was conducted, as well as the climatic conditions at the time. The survey report should follow the standard aims, methods, results and discussion format common to all scientific research. Without this information it is difficult to interpret the survey results, and impossible to replicate the study for comparative purposes (Resources Inventory Committee 1998). It is useful to record the GPS location of all sampling units and provide maps of the study area. Detailed descriptions of the habitat should also be recorded. Information on the condition of the habitat at the time of the survey should be included, as this may be useful in later analysis (for example determining whether species presence/absence is due to temporary factors such as drought). Documenting the habitat occupied by target taxa during the survey process, and a site description, will add value to the survey at minimal extra expense (NSW DEC 2004). Documentation of observers and their skills is also important (see above). Presentation of all reptile taxa recorded is essential as it can provide a measure of survey effort and effectiveness.

It is important that reports contain suitable information to demonstrate the survey was sufficient to draw the conclusions. Documenting the survey effort will be particularly important for species that might be present at very low abundance in the project area. Findings should be supported wherever possible by information such as:

- site photos showing equipment placement and habitat structure
- photos/records of scat or other trace material
- summary tables with measurements and diagnostic observations from captures
- photos of reptiles if no samples can be taken.

Tabulated GPS coordinates of sites and equipment placement will allow precise determinations of occurrence within a project area.

Maps should be included that show the location of planned infrastructure over the top of aerial photographs (ideal) or other geographical layers that represent the habitats present in the area. Indicating the location of transect paths and equipment placement, such as trapping grids, will allow a better understanding and interpretation of survey effort.

Reports should also carry some justification of the survey design, whether it be opportunistic, systematic or focused on certain likely habitats. This would include information on the habitat types present and the survey effort given to each. The design should also distinguish between known or potential foraging, sheltering and commuting habitats. For species that might be present at very low abundance, it is important to describe the likelihood of presence based on habitat descriptions made as part of the survey. Explanations on the timing of the survey, suitability of the weather, the speed and duration of transects and observations recorded should also be given.

Survey data should be made available to state and territory environment departments to be included in fauna databases where appropriate.

DETECTION METHODS FOR REPTILES

The use of multiple survey techniques, where possible, is often necessary to determine the presence or absence of rare or cryptic species. Survey techniques typically applied to the detection of snakes and lizards include diurnal hand-searches of appropriate habitats, visual searches, nocturnal spotlight searches, pitfall traps, funnel traps, or a combination of the above. Survey techniques typically applied to the detection of freshwater turtles include diving with a face mask and snorkel and/or baited traps.

Diurnal hand searches

Diurnal hand searches are used for reptile species that shelter in or under particular microhabitats (typically rocks, exfoliating rock outcrops, fallen timber, leaf litter, bark, debris, or decorticating bark on the trunks of both living and dead trees). Searches should be tailored to the biology and ecology of the species in question. Because the microhabitats used are variable, information regarding specific microhabitats is included in the survey guidelines.

Hand searches can be systematic or opportunistic, depending on the purpose of the survey. Systematic searches involve searching a defined area of suitable habitat for a defined period of time. In general, hand searches should be undertaken between mid-morning and late afternoon, but this may vary according to local weather conditions (for example, start searches earlier on days of extreme heat).

It is important to note that hand searches can be destructive of the habitat of targeted species and of a range of other species, especially invertebrates. Care should be taken to minimise the extent of physical disturbance and searchers should replace searched items in the position in which they were found. However, this is not always possible, and some species may abandon areas after habitat disturbance. Indeed, even modest disturbance of cover may render an area unsuitable for further surveys for an extended period. The survey guidelines note species that have particularly limited microhabitats and indicate possible alternative techniques.

Visual searches

Visual searches are typically undertaken for species whose behaviour involves surface activity or for species that are difficult to detect by hand-searches or pitfall trapping. A variety of techniques are used.

Scanning areas of potential habitat from a distance using binoculars can be used for species that are active on the surface during the day, particularly early in the day when diurnal reptiles emerge from cover (such as burrows, hollow logs and spinifex) and bask in direct sunlight. Other species may be detected by walking transects through areas of suitable habitat.

Species that are relatively inactive are sometimes best detected by visual searches of suitable microhabitats (such as cracks, crevices and burrows) with the assistance of a torch or endoscope, especially when the latter has a camera or video attachment. This may be a particularly useful technique where habitat disturbance is an issue.

Nocturnal spotlight searches

Numerous reptile species are active at night, including geckos and nocturnal snakes. Many diurnal reptiles are also sometimes active at night, particularly in the hour or two after sunset following warm days. Survey techniques for these species typically include searches using head torches or spotlights at night.

Nocturnal spotlighting involves thoroughly searching suitable substrates for reptiles, using spotlights or head torches with a bright focussed beam. Many reptiles are detected primarily by their reflective eye shine. Suitable substrates are generally the ground, fallen logs and branches, rock outcrops and tree trunks, especially along roads and tracks. Driving roads and tracks at night is also a useful technique in some situations. Searches should be tailored to the biology and habitat use of the species in question. Because the substrates used are variable, information regarding specific habitats is included in the species-specific survey guidelines.

Pitfall traps

Dry pitfall trapping is a useful technique for detecting reptile species that are active on the ground by day or night, particularly species that are secretive and difficult to detect by other methods or that are difficult to identify. Individual pitfall traps may be placed at points along natural ‘runs’ (such as between large boulders on a rocky slope, or along the edge of a fallen tree trunk), but are most often used in combination with a ‘drift fence’. Drift fences typically increase the taxonomic range and numbers of animals captured. The intention is that ground-active reptiles encounter the drift fence and move along it until they fall into a pit, where they are trapped.

The pit usually consists of a PVC pipe or plastic bucket dug into the ground (so that the pit is lined with a vertical tube of plastic or similar material that non-climbing reptiles cannot grip). Buckets with strong, sealable lids are preferred if multiple surveys are planned, as the traps can be closed and made inoperable between surveys, minimising both effort (in digging holes for traps and filling them in after use) and disturbance of the habitat. Care should be taken to ensure the traps are secure and not likely to be disturbed (for example by stock trampling). The top of the pit should be at or just below ground level, and the soil filled in around the outside edge. Shelter should be placed in the base of each pit (rock or wood and dirt and leaves) to provide a refuge and shade for trapped animals. If rain is likely during the survey period, a floating shelter (such as a polystyrene platform, bark or twigs) should also be placed in the pit.

There are numerous pitfall trap designs and layouts and the design of pitfall trap systems can have significant impacts on capture rates. These guidelines recommend a general use of pitfall trap lines comprising one or more modules of six 10 litre buckets spread along a 15 metre drift fence, with variations in trap size, trap shape and drift fence length to accommodate variation in size of the target species or the type of habitat to be surveyed. Drift fences are constructed by erecting a vertical barrier composed of material that non-climbing reptiles will find difficult to grip (silt fence, shadecloth, plastic or similar) and supported by steel pegs. Fences should be 20–30 centimetres high with the lower edge either buried in the soil or having any openings sealed by piling a little soil on each side of the fence line. The fence should cross the centre of each trap opening so that animals moving along either side will fall into the trap.

Circular traps are not essential and square or rectangular traps may be used. Rectangular traps can extend further from the drift line and may be easier to dig. They can also be used to isolate captures on either side of a drift fence, if differences between the biota approaching either side of the trap line are being investigated (for example, along a habitat boundary). Recommended pit dimensions and survey effort for different reptile species are included in the species-specific survey guidelines. It should be noted that some studies that have targeted a range of reptiles and/or other fauna (for example, ground-active mammals) have used 20 litre buckets, or a combination of 20 litre buckets and PVC pipes approximately 15 centimetres in diameter and 50 centimetres deep.

It is essential when pitfall trapping that trapped animals are released as soon as possible and at the correct time of day. Pits should be checked as regularly as is feasible, preferably three times a day (dawn, late morning and late afternoon) in hot climates or hot weather, and twice a day (dawn and late afternoon) if conditions are cooler. If pits are in unshaded positions in high summer then 30 minute checks may be required.

Trapped animals also represent sources of easy prey for many predators (for example, snakes and birds) that can easily enter and escape from the pits. Other predators (for example, large spiders, centipedes and small carnivorous marsupials) may remain trapped after they enter the pits. Traps should not be placed near large ant nests and if such predators are numerous then pit inspections should be more frequent. Consequently, it is essential to periodically observe traps from a distance and to review survey procedures daily.

Other trapping techniques

Funnel traps are typically a wire frame wrapped with shade cloth, approximately 75 centimetres long and 18 × 18 centimetres square, with a funnel opening of 45 millimetres diameter at both ends. The traps are commonly used in conjunction with pitfall traps, often in an alternating fashion and utilising a drift fence. The advantage of funnel traps is that they are capable of trapping medium-sized and large terrestrial diurnal snakes and some of the widely foraging, medium-sized skinks, medium-sized dragon lizards and arboreal geckos that climb out of dry pitfall traps.

Sticky traps consist of board or plastic with strips of glue. These commonly utilize a cockroach pheromone to lure lizards that readily forage and feed on cockroaches. The scent, undetectable by people but easily sensed by lizards, lures targeted lizards to the trap, where they become stuck on the glue. Animals are subsequently released by dissolving the glue with the application of vegetable oil. The traps are best placed in 'pathways' where lizards are expected to travel.

Elliot traps, which are designed for mammals, have also been used to successfully capture some reptiles. It is especially important to provide shade for these metal traps; use local soil or sand if no leaf litter is available. Cage traps have been useful in catching some large skinks (for example, *Tiliqua* spp. in Western Australia).

All traps should be checked as regularly as is feasible, preferably three times a day (dawn, late morning and late afternoon) in hot climates or hot weather, and twice a day (dawn and late afternoon) if conditions are cooler. If traps are in unshaded positions in high summer then 30 minute checks are essential.

Aquatic surveys

Snorkelling, where possible, appears to be the preferred and generally most successful means of surveying the majority of threatened turtle species occurring in rivers. In some cases this may not be possible because of the threat of saltwater crocodiles.

Trapping also effectively samples some species. Commercially available 'yabby' traps (60 centimetres x 45 centimetres x 25 centimetres) are sufficient to capture moderately large turtles such as the Namoi River elseya *Elseya belli*, the Bellinger River emydura *Emydura macquarii signata*, and the Fitzroy tortoise *Rheodytes leukops*. Larger species such as the Mary River tortoise *Elusor macrurus* may require specially built and designed traps. Traps are baited with fresh meat (liver) or sardines. Perforated sardine tins have been used;

however, the practice puts highly aromatic oil into the stream environment. It is recommended that if tinned sardines are to be used, they are first taken out of the tin, drained on paper towels or newspaper, and put in a muslin or similar mesh bag for hanging in the trap.

Placement of traps is critical. These should be suspended from branches overhanging the water (depending on the incline of the bank) with the top 3–5 centimetres of the trap out of the water to allow the turtles to breathe between trap checks. Alternatively, the traps can be suspended from floats that are anchored to the bank by a rope.

Traps should be checked several times within the first hour or two of being set, to ensure that turtle densities are not so great as to cause large numbers to enter the traps, causing them to sink and drown their captures. After this, traps need to be checked several times during the day and then several hours after sunset before being inspected again early in the morning. Where there is a risk of trapping excessive numbers of individuals, if traps cannot be checked every hour they should be removed from the water until regular checking can be resumed.

Seining has also been used with success in capturing many species of chelid turtles in lagoons, streams and lakes where there are relatively few snags and other obstacles. The use of nets usually requires special authorisation by the relevant fishing authority. The use of traps, seines or snorkelling may be impractical in waterbodies in northern Australia occupied by saltwater crocodiles *Crocodylus porosus*.

Quantitative surveys

A range of quantitative methods have been developed for application to the survey techniques described above. These mostly involve transects conducted over specific distances and time frames, searches of specific areas and time frames, or establishing traps and/or fence/trap lines in patterns that reflect variations in particular habitat qualities.

The use of transects in sampling provides a more quantitative evaluation of sampling intensity. Road transects and walking transects involve travelling by vehicle or foot pre-determined distances at a set speed. Milton (1980) reported that road transects returned the highest capture efficiencies and the greatest variability in return. Walking transects consist of walking at a predetermined rate, and during this time turning all logs, stones and bark and searching the area (ground and canopy) by eye.

SURVEY GUIDELINES: SPECIES PROFILES

Effort

Survey sites or project areas may range in size from a single to thousands of hectares, and be either relatively uniform or contain a variety of landforms and vegetation types. The survey guidelines should be used as a reference for modifying survey effort to accommodate different sites.

For example, a project site of 500 hectares with uniform landform and vegetation composition might only require the same survey effort as a 50 hectare site, provided that sampling sites are chosen across the project site. If however the 500 hectare site contained several distinct vegetation types (rainforest, woodland, riparian) or significant landform types (gorge country, plains, caves) then sampling effort should be increased and stratified to give adequate coverage and representation. When undertaking a survey on a project site significantly larger than 50 hectares you should consider contacting Australian Government and state/territory environment departments to discuss the appropriate level of effort.

Some justification of the sampling effort used, in reference to the survey guidelines, would be expected in your report.

Animal welfare and legislation

The welfare of target and other taxa should always be paramount. Surveys should be conducted in a way that minimises harm to wildlife and damage to habitat (for example, trampling of vegetation). The survey approaches outlined for each species below are regarded by experienced researchers as being appropriate for that species, and are described in accordance with the guiding principle that they be conducted in a way that minimises disturbance to the species.

These survey guidelines do not recommend that specimen collections are made for the purposes of identification, due to the threatened status of the species. Alternatives such as non-lethal tissue biopsies (such as a tail tip) could be made after the appropriate state or territory permissions are given. A good quality photograph is recommended; showing, as far as possible, the distinguishing characters of the species.

The legislative and animal welfare requirements vary amongst states and territories in Australia and consultants must be aware of their legislative obligations. Please note that many of the survey techniques described in this document may involve activities that are regulated by individual institutional animal care and ethics procedures, or may be subject to legislative constraints under particular state or Commonwealth laws and regulations. For example, trapping surveys can require a permit under the EPBC Act and local or state government regulations. Consultants should ensure that they have the necessary permits and approvals required to undertake surveys for the threatened species.

Adelaide blue-tongue lizard

Tiliqua adelaidensis

Summary information

Distribution: most recent records are from the Burra area, northern Mt Lofty Ranges and hinterland, South Australia (Milne 1999), although historical records range as far south as Marion, to the south of Adelaide (Ehmann 1982). An isolated population exists just south-east of Peterborough (Milne 1999).

Habit and habitat: inhabits disused vertical spider burrows in hard packed soils in native grassland, including *Lomandra*, *Stipa* and *Danthonia* (Milne 1999). Pygmy blue-tongues rarely move far from their burrows, except during the breeding season, or to ambush prey, although they regularly partially emerge to bask, rapidly retreating fully into the burrows with any disturbance (Hutchinson et al. 1994; Milne & Bull 2000).

Activity period: aside from basking at the entrance to the burrow in warmer months, there is little activity beyond the immediate vicinity of the burrow at any time. The species is believed to be a “sit and wait” forager for at least late summer and autumn, moving only short distances from the burrow to capture prey (Hutchinson et al. 1994). From September to October, most of the day is spent basking, while from November to December, with warmer temperatures, basking activity is greater in the early morning (Milne 1999). During the breeding season (November) males are more likely to leave their burrows for periods of a day or longer (Milne 1999).

Survey methods

The most effective means of surveying this species is to use a fibre-optic endoscope (of diameter 8 millimetres or less) and portable light source to inspect burrows for the presence of lizards (Milne 1999; Milne & Bull 2000; Milne et al. 2002). The burrows used are constructed by spiders, and have a round entrance hole. The burrows should not be excavated unless absolutely necessary to collect individual lizards, as they are not constructed by the lizards and are a limiting resource.

Lizards may be readily captured from burrows by ‘fishing’ with an insect tied to fine fishing line suspended from the end of a long fishing rod, and dangled just beyond the burrow (Milne 1999; Smith et al. 2009).

Pitfall trapping is less effective for this species, as it rarely moves far from its burrow. Using six 25 centimetre sections of 15 centimetre diameter PVC pipe as buckets, evenly spaced along 30 metre lengths of fly-wire drift fence 30 centimetres high, at the locality with the highest population density, capture rates were 1.3 lizards per 100 trap days during the peak active season (November to December) but nil during February (Milne 1999). Further, the digging in of pit buckets is potentially damaging to the limiting resource of spider burrows.

Similar species in range: it is unlikely that this species could be confused with any other similarly sized skink in the region. It is very different from all other sympatric species in both appearance and behaviour. It is recommended that any new locality for the species be verified with a close-up photograph, lodged with the South Australian Museum.

Key references for Tiliqua adelaidensis

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Ehmann, H. 1982. The natural history and conservation of the Adelaide pygmy bluetongue lizard *Tiliqua adelaidensis*. Herpetofauna 14: 61-76.

Hutchinson, M.N., Milne, T. & Croft, T. 1994. Redescription and ecological notes on the Pygmy Bluetongue *Tiliqua adelaidensis* (Peters 1863). Transactions of the Royal Society of South Australia 118: 217-226.

Milne, T. 1999. Conservation and ecology of the endangered Pygmy Bluetongue Lizard *Tiliqua adelaidensis*. Ph.D. thesis, Flinders University.

Milne, T. & Bull, C.M. 2000. Burrow choice by individuals of different sizes in the endangered pygmy bluetongue lizard *Tiliqua adelaidensis*. Biological Conservation 95: 295-301.

Milne, T., Bull, C.M. & Hutchinson, M.N. 2002. Characteristics of litters and juvenile dispersal in the endangered Australian skink *Tiliqua adelaidensis*. Journal of Herpetology 36(1): 110-112.

Smith A. L., Gardner M. G., Fenner A. L. & Bull C. M. (2009) Restricted gene flow in the endangered pygmy bluetongue lizard (*Tiliqua adelaidensis*) in a fragmented agricultural landscape. Wildlife Research 36: 466-78.

Airlie Island ctenotus

Ctenotus angusticeps

Summary information

Distribution: the species is so far only known from Airlie Island just offshore from Onslow, and Thangoo Station on Roebuck Bay south of Broome, Western Australia.

Habit and habitat: this species is terrestrial, surface-active. Found in *Acacia* shrubland, coastal spinifex and tussock grass (Airlie Island), and coastal samphire flats (Roebuck Bay).

Activity period: presumably year round. It is active late morning to afternoon in the temperate months of the year, gradually changing to early morning and probably late afternoon in the hotter months of the year.

Survey methods

The account by Browne-Cooper and Maryan (1990) indicates they observed 35 individuals over a two day period. By contrast, the account of Sadlier (1993) indicates the species was difficult to observe and accurately identify, and was only reliably recorded from captures made by pitfall trapping.

Detection of the species at a site is reliant upon positive identification. For most species in this genus sight records are in most instances unreliable, given that it is not unusual for several morphologically similar species of *Ctenotus* to occur in sympatry. Pitfalls have proved to be a reliable way of trapping species of *Ctenotus*. If the survey involves a targeted search for this species, a series of pitfall trap lines comprising six 10 litre buckets spread along a 15-metre fence would be adequate for detecting the species, although other pitfall arrangements could be trialled.

Similar species in range: the genus *Ctenotus* is the largest and arguably the most challenging group of Australian skinks to identify. There are likely to be several similarly sized and patterned species within the range of the Airlie Island ctenotus and unequivocal identification can be difficult. For this reason, collection of tissue samples is recommended.

Key references for Ctenotus angusticeps

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Browne-Cooper, R. & Maryan, B. 1990. Observations of *Ctenotus angusticeps* (Scincidae) on Airlie Island. Herpetofauna 20(1): 1-2.

Sadlier, R.A. 1993. A range extension for the scincid lizard *Ctenotus angusticeps* of northwestern Australia. Herpetofauna 23(1): 7-8.

Arnhem Land egernia

Bellatorias obiri

Note: Until recently this species was considered part of the genus *Egernia*, with dual names in use: either *E. arnhemensis* (Sadlier 1990) or *E. obiri* (Wells & Wellington 1985). *Bellatorias obiri* is used here, as this is the name listed under the EPBC Act.

Summary information

Distribution: recorded only from the western edge of Arnhem Land in the vicinity of the East Alligator and South Alligator River drainages, Northern Territory.

Habit and habitat: found in the sandstone escarpment of the Arnhem Land Plateau. The original description of *Egernia arnhemensis* (Sadlier 1990: p.32) cites the species as having been observed in 'thickly vegetated, wet, rocky gorges with numerous deep crevices' the sites being 'closed forest' and 'rocky crevice' habitats, with individuals having been 'observed active in the vicinity of deep crevices in the late afternoon' and collected in small mammal traps set late in the day and checked early the following day.

Activity period: probably active for most of the year. Presumably diurnal, though published observations of this species active are few. The capture of this species in mammal traps, usually set late in the day and checked early the following day, indicates some level of nocturnal or crepuscular activity.

Survey methods

All available information suggests that trapping with mammal cage traps at appropriate sites is likely to be the most effective method for detecting this species. A research project which targeted the near relative, the Major skink *Bellatorias frerei* (Fuller et al. 2005), used Elliot traps baited with peanut butter, rolled oats and honey (the standard small mammal bait used in these traps). Trapping for the Arnhem Land egernia with Elliot traps might also be enhanced by the use of bait. Trapping could be supplemented by searching during the late afternoon hours for individuals sheltering in rock crevices or by distant observation with binoculars of likely areas near hiding places where active individuals might be seen.

Capture rates with mammal traps are low. Recent targeted surveys for the species caught only a single individual, and another was observed (cited as Armstrong & Dudley 2004 in DEWHA 2010).

Similar species in range: none. Sadlier (1990) provides diagnostic traits for differentiating the Arnhem Land egernia from its nearest congener, the Major skink *Bellatorias frerei*, from eastern Australia and southern New Guinea. The Arnhem Land egernia has more numerous midbody scale rows (44–48 vs 30–36), more numerous paravertebral scales (59–65 vs 44–56) and a lack of differentiation in colour between the dorsal and lateral surfaces in contrast to a variety of colour patterns in the Major skink, including dorsal and lateral differentiation and a distinct laterodorsal zone (Sadlier 1990).

Key references for Bellatorias arnhemensis:

Armstrong, M. & Dudley, A. 2004. The Arnhem Land egernia *Egernia obiri* in Kakadu National Park. Report to Parks Australia (North).

DEWHA. 2010. *Bellatorias obiri* in Species Profile and Threats Database, Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra. Available from: www.environment.gov.au/sprat. Accessed 2010-01-19T09:36:20.

Fuller, S.J., Bull, C.M., Murray, K. & Spencer, R.J. 2005. Clustering of related individuals in a population of the Australian lizard, *Egernia frerei*. Molecular Ecology 14: 1207-1213.

Gardner, M. G., Hugall, A. F., Donnellan, S. C., Hutchinson, M. N., & Foster, R. 2008. Molecular systematics of social skinks: phylogeny and taxonomy of the *Egernia* group (Reptilia: Scincidae). Zoological Journal of the Linnean Society 154: 781-794.

Sadlier, R.A. 1990. A New Species of Scincid Lizard from Western Arnhemland, Northern Territory. The Beagle 7(2): 29-33.

Wells, R. & Wellington, C.R. 1985. A classification of the Amphibia and Reptilia of Australia. Australian Journal of Herpetology, Supplementary Series 1-61.

Atherton delma

Delma mitella

Summary information

Distribution: originally described from two individuals from the Atherton Tablelands, Queensland (Herberton and near Koombooloomba) (Shea 1987). More recent surveys targeting pygopod lizards in the Atherton Tablelands by the North Queensland Herpetological Society have failed to locate further individuals (M. Anthony pers. comm.). More recently, collected individuals came from the vicinity of Paluma (Conroy 1999).

Habit and habitat: almost unknown. The Paluma specimens were collected in open forest and at the ecotone between open and closed forest (Conroy 1999).

Activity period: not known, but possibly peaking in spring if the breeding season is similar to that of other *Delma* species. The paratype specimen was found dead on a road in November at 7.05 pm. Active time of day is unknown.

Survey methods

Data on this infrequently-collected species is insufficient to assess the efficacy of potential collection methods given that most individuals have been found serendipitously. However, on the basis of collection methods for other *Delma* species, it is likely that the Atherton delma could be collected by a combination of active hand-searching under sheets of tin and other large items on the ground such as rocks and logs, and by pitfall trapping. If the survey involves a targeted search for this species, a series of pitfall trap lines are recommended, comprising six 10 litre buckets spread along a 15 metre fence, although it is probable that trap returns would be very low and the pits may need to be deeper than for other *Delma*. Conroy (1999) pitfall trapped only a single individual of this species in 6840 trap nights (or 0.01 per 100 trap nights, a figure lower than for two other rare *Delma* species; see striped legless lizard *D. impar* and collared delma *D. torquata*). This species is very large for a *Delma*, and it is possible that pitfall traps may need to be deeper than for other *Delma* to prevent trap escapes (the single individual trapped by Conroy [1999] was a juvenile [Queensland Museum specimen]).

Similar species in range: the species overlaps in distribution with two other *Delma* species, *D. tincta* and the striped-tailed delma *D. labialis*. It differs from the striped-tailed delma in lacking the dark dorsolateral stripe along the tail, and in having a broader, blunter snout. It differs from *D. tincta* in adult size, being much larger than that species. However, juvenile Atherton delmas are of similar size to adult *D. tincta*, and have a similar pattern, with a dark head interrupted by several narrow pale bands. The two species may be differentiated by the Atherton delma having the fourth supralabial below the eye (vs the third), 16 midbody scales (vs usually 14) and the dorsal margin of the rostral scale flat rather than peaked. Given the difficulty in distinguishing between juvenile Atherton delma and *D. tincta* within the range of the former species, it is recommended that tissue samples be taken for any small *Delma* (snout-vent length less than 9 centimetres) in north-east Queensland with a dark hood interrupted by pale bands on the head. Photo voucher specimens are recommended for any records beyond the known distribution.

Key references for Delma mitella

Anthony, M. North Queensland Herpetological Society. Personal Communication.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Conroy, S. 1999. Lizard assemblage response to a forest ecotone in northeastern Australia: a synecological approach. Journal of Herpetology 33(3): 409-419.

Shea, G.M. 1987. Two new species of *Delma* (Lacertilia: Pygopodidae) from northeastern Queensland and a note on the status of the genus Aclys. Proceedings of the Linnean Society of New South Wales 109(3): 203-212.

Baudin Island spiny-tailed skink

Egernia stokesii aethiops

Summary information

Distribution: known only from Baudin Island, Western Australia. The taxonomic status of this subspecies is uncertain. Aplin and Smith (2001) note unpublished studies by Aplin and colleagues that consider the Baudin Island spiny-tailed skink to be merely a variant of the Houtman Abrolhos spiny-tailed skink *E. s. stokesii* (recently collected on the adjacent mainland) or a population of hybrid origin.

Habit and habitat: closely tied to crevices in limestone outcrops, spending active periods basking close to sheltering sites, in which they seek refuge on any disturbance. Brief periods of diurnal foraging, usually within a few metres of the chosen crevice. Other subspecies live in small family groups in these crevices; the social structure in the Baudin Island spiny-tailed skink is not studied, but is presumed to be similar. Other subspecies may also inhabit crevices in timber, in cracks in branches, or hollows. Such shelters are probably rare on Baudin Island.

Activity period: not known specifically, but likely to bask and feed in mornings and afternoons, avoiding the heat of the day in crevices. Peak activity is likely to be spring and early summer under warm to hot conditions. Activity period should not affect the efficacy of survey methods. The type series was collected in August.

Survey methods

The Baudin Island spiny-tailed skink is readily detected by direct observation of individuals in crevices. Care should be taken to avoid damaging the friable limestone. The Baudin Island spiny-tailed skink is known to adopt communal defecation sites, and the resulting scat piles are an indication of the presence of this or related species.

Similar species in range: The Baudin Island spiny-tailed skink is a medium to large skink (maximum snout-vent length 16 centimetres), dark in colour, with a very short, flattened tail, and the body and tail dorsum covered with hard, sharp posteriorly directed spines. It cannot be confused with any other reptile species occurring on Baudin Island. If it were discovered on the mainland, it could be confused with other subspecies of *E. stokesii*, or with the pygmy spiny-tailed skink *E. depressa*. It differs from other subspecies of *E. stokesii* in its evenly dark black-brown coloration, and additionally from the pygmy spiny-tailed skink in its larger size, in having the nasal scales usually separated (not in contact) and the scales on the back with one or two small spines (not one large and two small spines).

Given the taxonomic uncertainty of the subspecific status of this taxon, any records that are from localities other than Baudin Island should be verified with preferably tissue samples for genetic studies.

Key references for Egernia stokesii aethiops

Aplin, K.P. & Smith, L.A. 2001. Checklist of the frogs and reptiles of Western Australia. Records of the Western Australian Museum Supplement (63): 51-74.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Storr, G.M. 1978. The genus *Egernia* (Lacertilia, Scincidae) in Western Australia. Records of the Western Australian Museum 6(2): 147-187.

Storr, G.M, Smith, L.A. & Johnstone, R.E. 1990. Lizards of Western Australia. I. Skinks. Second Edition. Western Australian Museum, Perth.

Bellinger River emydura

Emydura macquarii signata

Summary information

Distribution: known from the Bellinger River catchment between Winch Flat and the tidal zone, north coast of New South Wales (Spencer et al. 2007).

Habit and habitat: found in long shallow waterholes (less than 3 metres deep) with a rocky substrate and vegetation, especially *Hydrilla verticillata*, in permanently flowing rivers and large creeks of the Bellinger River catchment.

Activity period: unknown; presumably late spring and through summer. Active morning and afternoon, and presumably throughout part of the night.

Survey methods

The species has been recorded while snorkelling, using cathedral traps and by dip netting from a boat at night. While most species of *Emydura* readily enter cage traps, this technique is at best likely to only be of limited success.

Snorkelling tends be more successful in clearer, upstream sections of river. Snorkelling should consist of either swimming along the surface or diving. Extra time should be spent searching around logs and submerged snags, because the turtle is harder to detect in these places.

Where poorer visibility and long waterholes exclude snorkelling, turtles can be captured using long-handled dip nets off a small boat. This has been successful at night-time in the deeper waterholes around Bellingen. Portable spotlights should be used to locate turtles.

Baited cathedral traps placed next to the riverbank in the vicinity of good microhabitat (for example, logs, overhanging banks, aquatic vegetation) can also be used to capture turtles. Traps should be supported by tying the upper parts of the traps to overhanging trees. Traps can be baited with sardines, with part of the bait held loosely in nylon mesh bags and available for the turtles to eat, and part of the bait held in perforated cans. Traps should be checked at intervals of 4–10 hours and re-baited after approximately 24 hours. Traps can be left in place for 24–48 hours.

Similar species in range: The Murray turtle *Emydura macquarii* is broadly sympatric with Georges' turtle *Elseya georgesi* in the Bellinger River. The head and neck of the Murray turtle is grey with a single yellow stripe running from the rear of the jaw, and pale yellow crescent bordering the underside of the jaw. The dorsal and lateral side of the head is usually smooth. Georges' turtle similarly has a yellow stripe running from the rear of the jaw, but also has a bold yellow patch on the underside of the throat and a distinctive horny casque over the top of the head and predominant low rounded tubercules on the side of the head typical of species of *Elseya*.

Potential records of the Murray turtle from the Bellinger River catchment and smaller rivers to the north and south should be supported by a good quality colour photograph and where possible a tissue sample for genetic analysis. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum for positive identification and databasing of the record, and tissue samples sent to the state museum.

Note: The taxonomy of Australian freshwater turtles is still being refined, particularly the status of morphologically distinctive but genetically similar (Georges & Adams 1992) populations of *Emydura* from the coastal and inland rivers systems of the east coast. Cann (1998) recognised a number of populations of *Emydura* from the eastern flowing drainages of NSW as distinct subspecies of the Murray turtle, but refrained from naming the Bellinger River population pending acquisition of further specimens and data. McCord and colleagues (2003) recognised a further two subspecies of Murray turtle from Queensland.

More recent work (Georges et al. 2007) suggests that the Bellinger River emydura is within the range of normal genetic and morphological variation for the Murray turtle. The subspecies has recently been removed from the NSW *Threatened Species Conservation Act 1995* on the basis that “turtles of this catchment are now thought to be part of a much larger population extending over north-east NSW, and current knowledge indicates that the total number of mature individuals of the taxon is not low. There is no evidence of a moderately large reduction in the taxon, nor is it moderately restricted” (DECCW 2009).

Key references for Emydura macquarii signata

Blamires, S.J. & Thompson, M.B., 2003. Survey of Bellinger River Turtles, *Elseya georgesi* and *Emydura macquarii* ssp.: an assessment of potential impacts of foxes. Internal Report: University of Sydney.

Blamires, S.J., Spencer, R. J., King, P. & Thompson, M.B. 2005. Population parameters and life-table analysis of two coexisting freshwater turtles: are the Bellinger River turtle populations threatened? Wildlife Research 32: 339-347.

Cann, J., 1998. Australian Freshwater Turtles. Beumont Publishing Pty Ltd, Singapore.

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DECCW. 2009. *Emydura macquarii* (Gray, 1830) – species delisting. Final determination of the NSW Scientific Committee, Department of the Environment, Climate Change and Water. Available from: www.environment.nsw.gov.au/determinations/emyduramacquariiFD.htm. Accessed 2010-01-18.

Georges, A. & Adams, A., 1992. A phylogeny for Australian chelid Turtles based on allozyme electrophoresis. Australian Journal of Zoology 40: 453-476.

Georges, A., Walsh, R., Spencer, R.J., Welsh, M. & Shaffer, H.B. 2007. The Bellinger Emydura. Conserve or Eradicate? Report to NSW National Parks and Wildlife Service, Sydney, by the Institute for Applied Ecology, University of Canberra. July 2007.

McCord, W.P., Cann, J. & Joseph-Ouni, M. 2003. A taxonomic assessment of *Emydura* (Testudines: Chelidae) with descriptions of new subspecies from Queensland, Australia. Reptilia 27(60): 59-63Spencer, R.J. & Thompson, M.B. 2001. The ecology and status of *Emydura macquarii* and *Elseya georgesi* in the Bellinger River. Report to the NSW Parks and Wildlife Service. Sydney: University of Sydney.

Spencer, R.J., Georges, A. & Welsh, M. 2007. The Bellinger Emydura: Ecology, population status and management. Unpublished report by Institute for Applied Ecology, University of Canberra, for NSW NPWS.

Blue Mountains water skink

Eulamprus leuraensis

Summary information

Distribution: Blue Mountains, New South Wales. The species is restricted to the high, dissected Narrabeen group sandstone plateau between Hazelbrook in the east and Newnes in the west, and is known from only 12 sites (LeBreton 1996).

Habit and habitat: The Blue Mountains water skink occupies sedge and shrub swamps, a restricted and specialised habitat (LeBreton 1994, 1996). These swamps form where Wentworth Falls Claystone is exposed. They are characterised by sandy-peaty soil which is permanently wet, and by Button Grass *Gymnoschoenus sphaerocephalus* and a suite of other plant species. Swamp area, soil moisture, and proximity to other swamps all appear to influence the suitability of habitat for the species, which is terrestrial and surface active.

Activity period: The Blue Mountains water skink is a diurnal species that, like other members of its genus, basks to regulate its body temperature. The species has been recorded active from pitfall trap captures during the summer months of December to February (LeBreton 1994, 1996), and has been observed active in March, retreating to the shelter of dense grass tussocks or down holes (possibly yabby burrows) when disturbed (Shea & Peterson 1984). Presumably it hibernates during the cooler late autumn and winter months. LeBreton (1994) notes that pitfall buckets were generally empty in the mornings in February.

Survey methods

The most comprehensive field research has been done by LeBreton (1994, 1996). In the first survey, pitfall traps were used consisting of two or three 10-litre buckets buried flush with the ground, with moist vegetation placed in the bottom of each trap to provide shelter from exposure and predators. A fence of 50 centimetre high plastic was placed between and over the buckets. In the second survey, no fences were used and this was still deemed suitable for detecting the presence of the species.

Appropriate survey methodology for detecting the presence of the Blue Mountains water skink would be targeted pitfall trapping in December to February when the species is most likely to be active, using a line of three 10 litre buckets each approximately 5 metres apart (although other pitfall trap arrays could be trialled). No drift fence would be required.

Similar species in range: two other species in the genus, *Eulamprus heatwolei* and the eastern water skink *Eulamprus quoyii*, occur within the range of the Blue Mountains water skink. It is however readily distinguished by the series of pale yellow lines running down its back, which are absent in the other two species.

Potential records of the Blue Mountains water skink should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (Australian Museum) for positive identification and databasing of the record.

Key references for Eulamprus leuraensis

LeBreton, M. 1994. Endangered fauna survey of the Blackheath and Katoomba Water Board Catchment Areas, Blue Mountains, NSW. Amphibians and Reptiles. Unpublished report for the Water Board. 63pp.

LeBreton, M. 1996. Habitat and distribution of the Blue Mountains swamp skink (*Eulamprus leuraensis*). Unpublished Honours Thesis, University of New South Wales. 45pp.

Shea, G. M. & Peterson, M. 1984. The Blue Mountains Water Skink, *Sphenomorphus leuraensis* (Lacertilia: Scincidae): a redescription, with notes on its natural history. Proceedings of the Linnean Society of New South Wales. 108(2): 141-148.

Border thick-tailed gecko

Underwoodisaurus sphyrurus

Summary information

Distribution: recorded from a number of localities on the Northern Tablelands of New South Wales and adjacent areas of Queensland, ranging from Wollemi in the south to the Stanthorpe area in Queensland, and west to Inverell and Moree.

Habit and habitat: most of what is known of this species comes from observations made on the Tablelands. The border thick-tailed gecko is a nocturnal species that shelters by day under exfoliating rocks, and appears to occupy a variety of rocky habitats in open woodland.

Activity period: presumably active in the warmer months of the year, that is, late spring and through summer. Like most nocturnal lizards, the border thick-tailed gecko is probably active in the first three to four hours after sunset.

Survey methods

Nocturnal saxicoline species are typically recorded by turning objects under which they shelter by day, or searching areas in which they might be active by night by spotlighting.

Searching rock outcrops by day will only sample a subset of rocky sheltering sites, as rocks too large to lift or deep crevices cannot effectively be searched. The effect of disturbing exfoliations by active searching involving lifting are not yet clear, but it is generally perceived that breakage or inappropriate replacement of rocks could affect their future suitability as sheltering sites and cause short- to medium-term deleterious changes in an area's lizard population. For this reason it is recommended that rock-turning searches not be undertaken and that a torch be used to search sheltering sites by day or that funnel traps be used at night.

The species is active on the ground at night during the warmer months of the year and, like other geckos of its size, would probably have a bright red reflective eye shine in torchlight.

To detect the presence of the species in an area, it is recommended that survey work be undertaken in the warmer months of the year (November to February). Both day searches of sheltering sites and spotlighting of rocky habitat and adjacent woodland for active animals in the first three hours of darkness should be undertaken.

Similar species in range: The border thick-tailed gecko has a characteristic 'carrot-shaped' tail, as does the other species in the genus, the thick-tailed gecko *Underwoodisaurus milii*. The two species overlap in distribution in the Northern Tablelands and north-western Slopes of NSW. The two species are readily distinguished by colour and pattern, and Cogger (2000) depicts individuals representative of both species.

Potential records of the border thick-tailed gecko should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (Australian Museum) for positive identification and databasing of the record.

Key references for Underwoodisaurus sphyrurus

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Brigalow scaly-foot

Paradelma orientalis

Summary information

Distribution: the core of the species' distribution is the central Brigalow Belt of Queensland (Cogger 2000; Ingram & Raven 1990). More recently, the distribution has been extended to the west (to the Chesterton Range near Charleville), to the south (Eena State Forest near Inglewood) and to the north (Ulcanbah Station and Bacchus Downs Station) (Schulz & Eyre 1997; Kutt et al. 2003). The Eena State Forest record is only 40 kilometres north of the NSW border, raising the possibility that the species extends into NSW.

Habit and habitat: the species has generally been considered to be largely restricted to brigalow *Acacia harpophylla*, woodland, although it has been recorded in eucalypt associations within this broad habitat type (Shea 1987; Cogger et al. 1993), a view concordant with the distribution of the species centred over the Brigalow Belt Bioregion. Wilson and Knowles (1988) indicated it was particularly common in association with sandstone ridges in this region, where it could be found under rocks. However, more recent surveys have extended the range of habitat preferences and localities beyond the Brigalow Belt. On Boyne Island, where the species is common, it inhabits a tall woodland of *Corymbia* and *Eucalyptus* species (*E. clarksoniana,* narrow-leaved ironbark *E. crebra*, and Queensland peppermint *E. exserta*), with a sparse upper-mid-stratum of mountain hickory *Acacia falciformis*, which the species uses for sap-feeding (Tremul 2000). The soils are shallow and stony, though there are few large rocks. In the northern part of the distribution, at Ulcanbah Station, the species occurs in gidgee *Acacia cambagei* woodland with occasional *Eremophila* and *Carissa*, and a ground cover of forbs and grasses with abundant fallen timber on cracking alluvial clays. On Bacchus Downs, the Brigalow scaly-foot occurs in poplar box *Eucalyptus populnea* woodland with occasional *Eremophila* on sandy-clay alluvial soils (Kutt et al. 2003). The extreme westernmost locality has an understorey of spinifex *Triodia mitchelli*, while at the southernmost locality the species has been found in open forest of narrow-leaved ironbark *Eucalyptus crebra* and grey box *E. microcarpa* with a subcanopy of Bribie Island pine *Callitris columellaris* and buloke *Allocasuarina luehmanni* on a loose sandy clay substrate, and in buloke closed forest with narrow-leaved ironbark emergents (Schulz & Eyre 1997). Many records are from *Corymbia citriodora* and ironbark-callitris associations on coarse-grained sediments (e.g. sandstone).

The Brigalow scaly-foot has been found by day only in sheltering sites (under rocks, fallen timber, sheets of bark on the ground in leaf litter at the base of trees and rarely under bark of fallen logs raised off the ground; Shea 1987; Wilson & Knowles 1988; Schulz & Eyre 1997; Kutt et al. 2003), and by night active on the ground and also on the lower trunks of rough-barked *Acacias* (Tremul 2000).

Activity period: on Boyne Island, the only population to have been subjected to any ecological study, *Paradelma* were found active at night between late August and early June, but only on nights when the maximum temperature was above 19°C (Tremul 2000). Individuals were recorded on trees between 7.00 pm and 1.20 am, but most observations were between 7.00 pm and 9.00 pm. There is no published evidence for diurnal activity by this species.

Survey methods

Until recently, most individuals have been collected by hand by opportunistic searching in likely sheltering sites, including under rocks on sandstone ridges (Wilson & Knowles 1988) and under timber and fallen bark on soil, particularly under slabs of stringybark and ironbark fallen from dead trees (Shea 1987; Schulz & Eyre

1997; Kutt et al. 2003). Tremul (2000) found the Brigalow scaly-foot to be readily located by nocturnal spotlight searches of preferred feeding stations: the trunks of the rough-barked mountain hickory *Acacia falciformis*, usually less than 2 metres above ground, and often close to the base of the tree. At these sites, the lizards lapped exuding sap from the trees, although they also feed on insects and spiders on the evidence from scats (Tremul 2000). Night surveys over a 48 day period (6 August to 22 September) at the beginning of the active period recorded 10 individuals, but only at ground temperatures above 19°C, and with a maximum ground temperature of 27°C. Surveys conducted later in the active period (25 February and 8 March) over a 12 night period when ground temperatures at the time of observation were 24°C or more, and maximum temperatures between 30–36°C, recorded 23 individuals.

Hence, it is recommended that the most appropriate survey method for this species combines diurnal hand-searches under rocks, fallen bark and timber and raking through piles of leaf litter with nocturnal spotlight searches on the ground as well as lower trunks of rough-barked, sap-exuding trees on warm nights, in appropriate habitats. A drift fence array with funnel traps is also a useful survey technique.

Similar species in range: *Paradelma* is morphologically similar to other large pygopods (*Pygopus* and *Delma* species), but can be readily differentiated from *Delma* species by having preanal pores, and from *Pygopus* species by having smooth dorsal and lateral body scales rather than slightly ridged to strongly keeled scales. It is possible that an inexperienced surveyor could mistake *Paradelma* for one of the large burrowing skinks, particularly *Anomalopus verreauxii* or *A. leuckartii*, but these have styliform front and hindlimbs with terminal claws on at least the front limbs rather than no trace of any front limbs, and a flattened flap-like hindlimb.

Potential records of the Brigalow scaly-foot should be supported by a good quality colour photograph. Photo vouchers or skin sloughs should be forwarded to the state fauna authority and appropriate state museum (Queensland Museum) for positive identification and databasing of the record.

Key references for Paradelma orientalis

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Ingram, G.J. & Raven, R. 1990. An Atlas of Queensland's Frogs, Reptiles, Birds & Mammals. Queensland Museum, Brisbane.

Kutt, A.S., Hannah, D.S. & Thurgate, N.Y. 2003. Distribution, habitat and conservation status of *Paradelma orientalis* Günther 1876 (Lacertilia: Pygopodidae). Australian Zoologist 32(2): 261-264.

Schulz, M. & Eyre, T. 1997. New distribution and habitat data for the pygopodid, *Paradelma orientalis* (Günther, 1876). Memoirs of the Queensland Museum 42(1): 212.

Shea, G.M. 1987. Notes on the biology of *Paradelma orientalis*. Herpetofauna 17(1-2): 5-6.

Tremul, P.R. 2000. Breeding, feeding and arboreality in *Paradelma orientalis*: a poorly known, vulnerable pygopodid from Queensland, Australia. Memoirs of the Queensland Museum 45(2): 599-609.

Wilson, S.K. and Knowles, D.G. 1988. Australia's Reptiles. A photographic reference to the terrestrial reptiles of Australia. Collins, Sydney.

Broad-headed snake

Hoplocephalus bungaroides

Summary information

Distribution: recorded from a number of locations on the sandstone ranges between Colo north of Sydney to Nowra on the NSW south coast, with an outlying population in the west near Bathurst (Cogger et al. 1993).

Habit and habitat: arboreal and rock-dwelling, depending on the season. The species has a complex biology which involves movement between outcropping sandstone bluffs used as over-wintering sites and adjacent dry forest of the ridges during summer by males and non-gravid females (Webb & Shine 1997a, b). Gravid females remained near cliffs during summer.

During summer months, broad-headed snakes that move into the adjacent dry forest use large dead trees with numerous hollows (Webb & Shine 1997a), typically grey gums and Sydney peppermint *Eucalyptus piperita*.

Activity period: nocturnal. Late spring through to mid-summer appears to be the period of greatest movement.

Survey methods

Most records for this species have been obtained by searching suitable sheltering sites (under rocks or in crevices) on westerly-facing sandstone cliffs by day during winter (Webb & Shine 1997b). The effect of disturbance to sandstone exfoliations by active searching that involves lifting are not yet clear, but it is generally perceived that breakage or inappropriate replacement of rocks could affect their suitability as sheltering sites. For these reasons, searching appropriate sheltering sites with torches during winter to detect the presence of the species in an area is recommended. Searching rock outcrops by day will only sample a subset of rocky sheltering sites; in particular deep crevices will not be thoroughly examined.

Similar species in range: juvenile diamond pythons *Morelia spilota spilota* are superficially similar in overall appearance to the broad-headed snake, and are likely to occur in the same general area throughout the species range.

Potential records of the broad-headed snake should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (Australian Museum) for positive identification and databasing of the record.

Key references for Hoplocephalus bungaroides

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Webb, J.K. & Shine, R. 1997a. Out on a limb: conservation implications of tree-hollow use by a threatened snake species (*Hoplocephalus bungaroides*: Serpentes, Elapidae). Biological Conservation 81: 21-33.

Webb, J.K. & Shine, R. 1997b. A field study of spatial ecology and movements of a threatened snake species, *Hoplocephalus bungaroides*. Biological Conservation 82: 202-217.

Bronzeback snake-lizard

Ophidiocephalus taeniatus

Summary information

Distribution: known only from several localities in recent times, ranging from Abminga just south of the Northern Territory/South Australia border south to near Coober Pedy, generally along watercourse country (Cogger et al. 1993).

Habit and habitat: the bronzeback snake-lizard occurs along temporary watercourses lined by gidgee open woodland (Cogger et al. 1993). It is a fossorial species that inhabits sandy clay loam float on well drained deep cracking soils overlain by deep loose undisturbed leaf litter (Ehmann 1981); it was not recorded from sand dune habitat in the general vicinity of the Abminga site. An individual was also collected from leaf litter underneath a mulga, *Acacia aneura*, on an open rocky plain 8 kilometres from the nearest major watercourse, but in the vicinity of a small braided waterway. This record indicates the species may inhabit a broader range of habitats in the arid region.

The bronzeback snake-lizard might also undergo dramatic local fluctuations in extent and abundance (Ehmann 1992) with climatically induced changes to habitat.

Activity period: probably year round with the exception of the coldest months. Peak activity is likely to be late spring and early summer. Not active on the ground surface by day, and would only be active between sheltering sites at night. Probably closer to the interface between overburden and soil in late afternoon and early morning.

Survey methods

The bronzeback snake-lizard appears to be a specialist inhabitant of leaf litter mats under gidgee and mulga. Appropriate survey methodology for detecting the presence of this species would be searching sheltering sites of leaf litter by raking. It has not been recorded in pitfall traps set in areas where the species was successfully detected by hand searching. Downes and colleagues (1997) comment that searches at Arckaringa were most successful after rain the previous night.

Similar species in range: the bronzeback snake-lizard is the only completely limbless (other than small hindlimb flaps typical of pygopod lizards) burrowing lizard in this and adjacent regions.

Potential records of the bronzeback snake-lizard should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (South Australian Museum or Northern Territory Museum) for positive identification and databasing of the record.

Key references for Ophidiocephalus taeniatus

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Downes, S., Foster, R. & Molnar, C. 1997. New insights into the distribution and habitat of the vulnerable Bronzeback legless lizard *Ophidiocephalus taeniatus*. Herpetofauna 27(1): 11-13.

Ehmann, H. 1981. The natural history and conservation of the Bronzeback (*Ophidiocephalus taeniatus* Lucas and Frost) (Lacertilia, Pygopodidae). Proceedings of the Melbourne Herpetological Symposium. Zoological Board of Victoria, 7-13.

Ehmann, H. 1992. The apparent severe decline of the Bronzeback Legless Lizard (*Ophidiocephalus taeniatus*) at Abminga. Herpetofauna 22(1): 31-33.

McDonald, P. & Fyfe, G. 2008. A Survey for the Bronzeback Snake-Lizard (*Ophidiocephalus taeniatus*). New Crown and Umbeara Pastoral Leases, Northern Territory. Department of Natural Resources, Environment the Arts and Sport, Alice Springs.

Christmas Island blind snake

Typhlops exocoeti

Summary information

Distribution: the only specific locality from which it has been recorded is Field 22 at Stewart Hill, Christmas Island. All other records for the species bear no other locality information other than Christmas Island. The first record for approximately 30 years was made in 2009.

Habit and habitat: Terrestrial, fossorial. Found in closed forest.

Activity period: presumably year round. Not active on the ground surface by day, and if its behaviour is typical of that of other blind-snakes, it would only be active between sheltering sites at night, usually after rain.

Survey methods

Blind-snakes are usually recorded by turning objects under which they shelter, or in pitfall traps. Pitfall trapping would be logistically very difficult given the habitat and unique situation of the island with regard to the abundant and widespread terrestrial crabs in the forest, and the more recent infestations of yellow crazy ants (*Anoplolepis gracilipes*) at many locations. If patifalling were used, trap design would need to exclude the larger crabs from entering buckets. Trap lines comprising pitfall traps with fences 15 metres in length with six 10 litre buckets per plot would be suitable. Extensive trials have been conducted to determine whether it is feasible to establish a pitfall line that can exclude the larger crabs from entering buckets. Trials are continuing, but they have so far not been able to exclude crabs (P. Meek pers. comm.).

Similar species in range: the introduced brahminy blind-snake *Ramphotyphlops braminus* also occurs abundantly on Christmas Island. The two species are very similar in appearance but do differ markedly in adult size. The Christmas Island blind snake grows to a maximum length of 350 millimetres, whereas the brahminy blind-snake is much smaller as an adult reaching a maximum length of only 170 millimetres. Otherwise the two species can only be reliably distinguished from one another by subtle features of head and body scalation.

Key References for Typhlops exocoeti

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Cogger, H.G. & Sadlier, R.A. 1981. The terrestrial reptiles of Christmas Island, Indian Ocean. Australian Museum, Sydney. 194 pp. Report to the Australian National Parks & Wildlife Service.

Cogger, H.G., Sadlier, R.A. & Cameron, E.E. 1983. The terrestrial reptiles of Australia's island territories. Australian National Parks & Wildlife Service Special Publication 11: 1-80.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Meek, P. NSW Department of Environment, Climate Change and Water. Personal Communication.

Christmas Island gecko

Lepidodactylus listeri

Summary information

Distribution: known from a number of sites located across Christmas Island, ranging from the coastal terraces to the central plateau.

Habit and habitat: the Christmas Island gecko is a nocturnal tree-dwelling species. It has been recorded sheltering beneath the exfoliating bark of trees during the day or active on the trunks of trees at night. It appears to be most abundant in the primary forest of the plateau, but will occupy disturbed habitats in this area including secondary growth forest. It was absent from all mined areas, including those covered by regeneration (Cogger & Sadlier 1981; Cogger et al. 1983).

The Christmas Island gecko was not recorded during the 2000 survey of the island by Cogger and Sadlier, nor during a reptile survey conducted for the Department of the Environment, Water, Heritage and the Arts in 2008 (M. Schultz pers. comm.). Its apparent absence was possibly due to a previous severe dry period. The first confirmed sighting of this species since 1979 was made in October 2009.

Activity period: most sightings were made between 8.00 pm and 11.00 pm during the survey conducted in May 1979 by Cogger and Sadlier (Cogger & Sadlier 1981). The species is active year-round.

Survey methods

The species was commonly recorded by spotlighting with head torches alone during the 1979 survey by Cogger and Sadlier.

Appropriate survey methodology for detecting the presence of the Christmas Island gecko would be spotlighting. At this stage it is unknown whether time of year is likely to have a significant effect on detection of the species, given that the only systematic surveys were both done in May (20 years apart). It is more likely that previous weather conditions with respect to rainfall could affect survey results, with surveys undertaken prior to or during extended dry periods being less optimal for detecting the species.

Similar species in range: two introduced gecko species, the Asian house gecko *Hemidactylus frenatus* and stump-toed gecko *Gehyra mutilata*, occur on Christmas Island. Juvenile and sub-adults of these species, particularly the stump-toed gecko, could be confused with the Christmas Island gecko. The two introduced species generally tend to occur around disturbed habitats, including the edge of large tracks cut through primary forest.

Potential records of the Christmas Island gecko should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum for positive identification and databasing of the record. Tail shape and toe morphology in particular will help distinguish the species (see Cogger et al. 1983 for key to species and illustrations of diagnostic characters).

Key references for Lepidodactylus listeri

Cogger, H.G. & Sadlier, R.A. 1981. The terrestrial reptiles of Christmas Island, Indian Ocean. Australian Museum, Sydney. 194 pp. Report to the Australian National Parks & Wildlife Service.

Cogger, H.G., Sadlier, R.A. & Cameron, E.E. 1983. The terrestrial reptiles of Australia's island territories. Australian National Parks & Wildlife Service Special Publication 11: 1-80.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Shultz, M. 2009. Personal Communication.

Collared delma

Delma torquata

Summary information

Distribution: most records are from south-east Queensland, in the western suburbs of Brisbane and inland to the Bunya Mountains, with outlying records from Ulam, and more recently, the Blackdown Tableland and Western Creek State Forest near Millmerran (Kluge 1974; Hines et al. 2000) west to stock routes between Roma and Mitchell (DERM unpubl. data). The Millmerran locality is only approximately 70 kilometres north of the NSW border, and it is possible that the species' distribution extends into NSW.

Habit and habitat: the majority of records are from woodland sites, including open dry eucalypt woodland dominated by narrow-leaved ironbark *Eucalyptus crebra*, *E. intermedia* and *E. maculata*, and an understorey of grasses and creeping lantana *Lantana montevidensis* on stony soils or rocky ridges (Porter 1998). In the Bunya Mountains, the species inhabits forest red gum *E. tereticornis* woodland on dark cracking clays, while at Western Creek State Forest, it inhabits brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) forest with wilga (*Geijera parviflora*) midstorey on fine grey cracking clay soils (Hines et al. 2000). The most westerly records are all from alluvial poplar box (Eucalyptus populnea) with no rock content (DERM unpubl. data).

Collared delmas have mostly been found under stones or coarse woody debris on soil, sometimes in association with termite nests, but have also been observed moving through low grass (Porter 1998). The type specimen was dug from soil (Kluge 1974), leading to speculation that the species was fossorial. Recent records have been hand-raked from fine flood-washed humus and debris and from the surface soil directly under leaf litter and from within thick grass tussocks (DERM unpubl. data). Some individuals were found sheltering in termite holes when disturbed (Porter 1998). They are mostly active from October to February but can be found year-round, except for winter months. There is some suggestion that the species may be grazing-sensitive, as all Brigalow Belt records are from ungrazed or rarely grazed areas (DERM unpubl. data).

Activity period: pitfall trap and sight records suggest that the species is diurnal (Porter 1998). The same study, which conducted pitfall trapping for two weeks over every eight-week period during one year, only trapped individuals between October and February, with four of six captures in December, suggesting that activity was greatest during this period. However, animals were able to be located under rocks throughout the year, and were usually active when disturbed beneath the rocks (Porter 1998), suggesting at least limited activity throughout the year. In the western part of the distribution, detectability seems to be impacted by soil moisture, suggesting they are relatively inactive or inhabit hard-to-search refugia during dry times.

Survey methods

Most early records of this species were collected serendipitously. A single study has been undertaken into the ecology of this species, using a combination of hand-searching under rocks and pitfall trapping (Porter 1998).

Pitfall trapping proved to be less effective than turning rocks in locating the species, with only six captures during the 12 months of the study, all from the period October to February. The study used 20 4-litre plastic buckets, arranged in lines of five buckets 1 metre apart, and bridged by 20 centimetre high aluminium mesh drift fences. Capture rate of the pitfall trap array was 0.306 animals per 100 trap nights, comparable to studies of the related striped legless lizard *Delma impar*.

Individuals were collected by hand from under rocks on soil throughout the year, at a rate of approximately one lizard per 150–200 rocks turned (or one lizard per 1.75 hours of searching). Porter observed a short-term effect of rock turning on lizard captures, with few captures at sites disturbed by previous rock-turning within the previous three months, although this effect appeared to be temporary, with normal recapture rates at such sites at the end of the study.

Similarly, of collared delma reported by Hines and colleagues (2000) and DERM (unpubl. data 2010) over surveys of numerous sites, two were pitfall trapped, while 20 were collected by hand.

Consequently it is recommended that appropriate survey methods for this species be one-off hand searches (including raking through leaf litter) in appropriate habitats, together with pitfall trapping during late spring to summer. A series of pitfall trap lines comprising six 4–10 litre buckets and funnel traps spread along a 15 metre fence would be an appropriate trap design.

Similar species in range: there are several small to medium-sized *Delma* species within the range of the collared delma: *D. inornata*, *D. plebeia* and *D. tincta*. The collared delma may be difficult to distinguish from juveniles of these species, particularly by the inexperienced surveyor, except with a hand lens or microscopic facilities. The collared delma has dark marbling on the throat (lacking in *D. inornata* and *D. tincta*), dark markings separated by narrow pale bands on the top of the head and neck (lacking in *D. inornata*, and without the pale bands in *D. plebeia*), a greyish belly (pale in *D. inornata*, *D. plebeia* and *D. tincta*), and only two preanal scales (three in *D. inornata* and *D. tincta*).

The collared delma is similar in body shape and degree of limblessness to several burrowing skink species, but all lack the characteristic head markings of the collared delma.

Key references for Delma torquata

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Hines, B.M., Hannah, D., Venz, M. & Eyre, T. 2000. New distribution and habitat data for the vulnerable pygopodid, *Delma torquata* (Kluge 1974). Memoirs of the Queensland Museum 45(2): 391-393.

Kluge, A.G. 1974. Taxonomic revision of the lizard family Pygopodidae. Miscellaneous Publications of the Museum of Zoology, University of Michigan (147): vi. 221 pp.

Porter, R. 1998. Observations on a large population of the vulnerable pygopodid, *Delma torquata*. Memoirs of the Queensland Museum 42(2): 565-572.

Corangamite water skink

Eulamprus tympanum marnieae

Summary information

Distribution: areas to the east and north of Lake Corangamite in south-western Victoria.

Habit and habitat: the only published information on the species' biology is in the original description by Hutchinson and Rawlinson (1994). It is recorded as a diurnal heliothermic skink, but unlike other members of the genus it is extremely wary and difficult to approach. It is recorded from grassy open woodland and cleared pastures dotted with ephemeral swamps and lakes, on rocky basaltic soils. The lizards inhabit rocky mounds that provide moist sheltering sites. It is usually observed from a distance perched on a rock pile or dry stone wall.

Activity period: it appears to be active from mid-spring (September/October) to late autumn probably most active under warm but not overly dry conditions. Presumably active late morning to afternoon in the temperate months of the year, gradually changing to early and probably late afternoon in the hotter months of the year.

Survey methods

Given the apparent rarity of the species (only 10 extant populations remain [Peterson 2002]) and the likely sensitivity of the preferred sheltering sites to disturbance, it is recommended that likely suitable habitat (for example, rock piles) be searched by observation using binoculars to detect the presence of the species. It may also be possible to use Elliot traps for this species.

Similar species in range: The only other species of *Eulamprus* in the 'water skink' complex in the general range of the Corangamite water skink is the southern water skink *E. tympanum tympanum*. The two species are diagnosed from one another by a combination of smaller body scales in the Corangamite water skink (usually 43 or more rows mid body) and a bold dorsal pattern where the dark markings are arranged as short, irregular transverse bars, compared with larger body scales in the southern water skink (usually 42 or fewer rows mid body) and a dorsal pattern where the dark markings are present as small black flecks.

Potential records of the Corangamite water skink should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (Museum of Victoria) for positive identification and databasing of the record.

Key references for Eulamprus tympanum marnieae

Hutchinson, M.N. & Rawlinson, P.A. 1995. The water skinks (Lacertilia: *Eulamprus*) of Victoria and South Australia. Records of the South Australian Museum 28(2): 185-207.

Peterson, G. 2002. Water skinks do need water: the implications of a four-year drought for the endangered Corangamite Water Skink. Abstracts, Australian Society of Herpetologists 29th General Meeting: 34.

Dunmall's snake

Furina dunmalli

Summary information

Distribution: The species is found on the low to mid elevation from Yeppoon in the north to Oakey, Glenmorgan and Inglewood in the south in Queensland (Cogger et al. 1993), west to Expedition Range, and a recent record from Bebo State Forest in New South Wales (Date & Paull 2002).

Habit and habitat: Its habitat is poorly known. Preferred habitat appears to be Brigalow (*Acacia harpophylla*), cypress (*Callitris* sp.) and bulloak (*Allocasuarina leuhmanni*) forest and woodland growing on cracking black clay and clay loam soils. This snake is also found on spotted gum (*Corymbia citriodora*) and ironbark (*Eucalyptus crebra*) associations on coarse-grained sediments (sandstone). The species is terrestrial and predominantly nocturnal, feeding on small lizards.

Activity period: poorly known. It is not active on the ground surface by day, and would only be active between sheltering sites at night. Presumably active late spring through summer to early autumn, with peak activity likely to be early summer through to the wet season.

Survey methods

None known to reliably detect the species. Recommended methods are active searching of sheltering sites (under large objects on the ground such as rocks, logs or human-made debris), pitfall trapping, or road driving at night (particularly after wet weather). However, all of these methods are likely to yield low returns.

Similar species in range: this species is superficially similar to several other small to moderate-sized elapids with predominantly dark brown to black dorsal coloration, including the curl snake *Suta suta*, eastern small-eyed snake *Rhinoplocephalus nigrescens*, and *Suta carpentariae*. The high number of scales at midbody (21) will separate it from all of these other than occasional curl snakes. Dunmall's snake often has small yellow flecks over the temporal region and lips, which differs from the characteristic facial pattern of curl snakes.

Because of the potential for confusion with these species, it is recommended that any record of this species be accompanied by good quality clear photographs of the whole snake and of the side of the head, sufficiently clear to show the individual head scales and facial markings, and a count of midbody scales.

Photo vouchers should be forwarded to the state fauna authority and appropriate state museum for positive identification and databasing of the record. A scale clip preserved in ethanol would also be of use as a genetic sample.

Key references for Furina dunmalli

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Date, E.M. & Paull, D.C. 2002. Forestry in Western New South Wales. Fauna Survey of the North-West Cypress/Ironbark Forests. State Forests of New South Wales, Dubbo.

Fitzroy tortoise

Rheodytes leukops

Summary information

Distribution: The Fitzroy tortoise is only found in the Fitzroy basin, Queensland, including the Fitzroy, Mackenzie, Dawson, Connors and Isaac Rivers (Queensland Conservation Council 2004).

Habit and habitat: the mid-reaches of the drainage is characterised by large deep pools with rocky, gravelly, or sandy substrates, connected by shallow riffles, with high water quality (Cogger et al. 1993). The Fitzroy tortoise has a preference for fast water (Legler & Cann 1980). In the area where the types were collected, river width ranges from 30 metres in narrow incised channels and riffles to 190 metres between the riverbanks. Base flow depths vary from 0.2–0.5 metres in the riffles to 2–6 metres in pools. By late dry season, flow is reduced and the pools are connected by trickles of water through the riffle zones (Tucker et al. 2001).

The species is relatively sedentary, and site fidelity (at least to a given pool) is maintained despite seasonal fluctuations. The overall distribution of turtles (Tucker et al. 2001) tends to not be far from riffle zones (mean distance to closest riffle 310 metres). During a recent study by Tucker and colleagues (2001) most observations were made in shallow water over rocky (52 per cent) or sandy (10 per cent) substrates, while associations with submerged logs (38 per cent) were in deeper sections of pools.

Legler and Cann (1980) record insects and freshwater sponge in the diet of the Fitzroy tortoise collected in October, but Cann (1998) records that it also feeds extensively on ribbon weed.

Activity period: unknown; presumably late spring and through summer. Active morning and afternoon.

Survey methods

The Fitzroy tortoise is readily observed in the riffle zones by diving with a face mask and snorkel (Legler & Cann 1980), or collected by seine netting. However, the presence of saltwater crocodiles *Crocodylus porosus* in the mid to lower reaches of the river presents a hazard to survey work.

The effectiveness of drum traps to sample this species is unknown; neither Legler and Cann (1980) nor Cann (1998) make reference to having used this technique. The partly carnivorous diet of the Fitzroy tortoise reported indicates it might be attracted to meat baits and this methodology should be trialled to determine its suitability for detecting the presence of the species.

Similar species in range: Other short-necked freshwater turtles recorded in the Fitzroy River drainage by Legler and Cann (1980) include Krefft's river turtle *Emydura kreffti*, Victoria River snapping turtle *Elseya dentata*, and the saw-shelled turtle *Elseya latisternum*. Cogger (2000) illustrates diagnostic features to distinguish *Rheodytes* from the species of *Elseya* and *Emydura*.

Potential records of the Fitzroy tortoise should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (Queensland Museum) for positive identification and databasing of the record.

Key references for Rheodytes leukops

Cann, J. 1998. Australian Freshwater Turtles. Beumont Publishing Pty Ltd, Singapore.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Legler J.M. & Cann, J. 1980. A new genus and species of chelid turtle from Queensland, Australia. Contributions in Science, Natural History Museum of Los Angeles County 324: 1-18.

Queensland Conservation Council 2004. Available from: pandora.nla.gov.au/pan/40013/20050123-0000/www.qccqld.org.au/rivers_alive/Turtle.htm. Accessed 2010-01-20.

Tucker A. D., Limpus C. J., Priest T. E., Cay J., Glen C. & Guarino E. 2001. Home ranges of Fitzroy River Turtles (*Rheodytes leukops*) overlap riffle zones: potential concerns related to river regulation. Biological Conservation 102: 171-81.

Flinders Ranges worm lizard

Aprasia pseudopulchella

Summary information

Distribution: Found in South Australia: Flinders Ranges and Mt Lofty Ranges to Adelaide. See Cogger and colleagues (1993) for a more detailed summary of distribution to that time.

Habit and habitat: terrestrial and fossorial. Occurs in open woodland, native tussock grassland, riparian habitats, and rocky isolates. Found under stones on clay soils (Cogger et al. 1993).

Activity period: not active on the ground surface by day, and would only be active between sheltering sites at night. Peak activity is likely to be late spring and early summer under warm, but not overly dry, conditions. The Flinders Ranges worm lizard is more likely to be difficult to detect during hot dry periods.

Survey methods

The following methodology adopted by Osborne and colleagues (1991) to survey for the pink-tailed worm lizard, is likely to be the most appropriate for the Flinders Ranges worm lizard:

- searches restricted to an area of relatively homogeneous habitat within each site and a search beneath all rocks that can be turned is made.
- stone cover density rather than fixed area size determines a plot, and 150–200 stones need to be turned to be reasonably confident of determining the species presence.
- search success appears would be highest in spring and early summer on warm but not hot days, preferably after a period of rainfall extending over several days.
- during summer months surveys are conducted in the mornings or on cloudy days when soil temperatures beneath the rocks are not too high.
- during late autumn and winter surveys are conducted on clear sunny days as warming of the rocks appears to attract individuals to the soil surface beneath the rocks.

Similar species in range: See the account for the pink-tailed worm lizard regarding taxonomy of the pink-tailed worm lizard and the Flinders Ranges worm lizard.

Key References for Aprasia pseudopulchella

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Grassland earless dragon

Tympanocryptis pinguicolla

Summary information

Distribution: The grassland earless dragon is a specialist inhabitant of native temperate grasslands, which have been greatly depleted since European settlement (less than 1 per cent remains). The species is currently now known to occur only in the ACT and adjacent parts of the southern highlands of NSW in the vicinity of the ACT and Cooma. It appears to have become extinct in Victoria.

Habit and habitat: the species is small and cryptic. Very few animals have been observed active, most records coming from pitfall trap captures or individuals found under sheltering sites (usually under rocks) or 'arthropod traps'. The species shelters in grass tussocks during the warmer months, though in the rocky habitat near Cooma the species also shelters under rocks. In the grassy habitat in and near the ACT, the species also shelters in burrows made by wolf spiders (*Lycosa* spp.) or the Canberra raspy cricket (*Cooraboorama canberrae*).

The preferred habitat (in the ACT region) appears to be naturally treeless areas that still support a perennial grass cover of predominately native species such as wallaby grasses (*Austrodanthonia* spp.), spear grasses (*Austrostipa* spp.) and *Poa* spp. (Osborne et al. 1993; Robertson and Evans 2009). Slightly open habitat with shorter tussocks of *Danthonia* spp. as well as a substantial, but not complete, cover of taller grasses is preferred. Tall dense grass swards completely dominated by *Themeda trianda* and *Stipa bigeniculata* may be avoided, although lizards can occur at the edges.

The pattern of captures at the Majura Field Firing Range (Evans & Ormay 2002) between 11 February and 22 March 2002 showed that most captures in February were the adults from the previous year, while smaller lizards (including that year's juveniles) were captured during March. These results indicate that surveys for adults should probably be carried out in the early summer months, when both adults and juveniles are present in the population, increasing the chance of detecting the species.

Activity period: Warmer months of the year (late spring to early autumn), though individuals have been observed to briefly come out of torpor on sunny winter days in cooler months. The grassland earless dragon is diurnal and active during the warmer parts of the day, from mid-morning to late afternoon.

Survey methods

Most early survey effort has involved the use of pitfalls of various combinations. Osborne and colleagues (1993) report using a cross shaped arrangement of 20 buckets (11 litre) with five buckets along each 25 metre arm. The results at four sites where traps were left open for 20 weeks indicate either low densities or low trap success. Eleven individuals were recorded at one site, while the remaining three sites had only two to three individuals recorded over the four month period.

More recently surveys have tended to use 'arthropod traps' to monitor the presence and abundance of the grassland earless dragon in sites around the ACT. These are constructed of PVC piping inserted vertically into the substrate level with the opening level with the surface, an inner tube is placed into this to allow removal of trapped animals or debris, and inspection of tubes is carried out by torch. A metal roof is placed over each trap to shelter animals from sun and rain, and to assist in locating tubes. Prior to placing the traps, ground cover vegetation for a 1 metre radius was slashed short to improve visibility of the artificial burrows to the dragon. The animals are free to move in and out of the tubes and for this reason these need not be checked daily.

Most of the survey work using ‘arthropod tubes’ has been conducted by the Wildlife Research and Monitoring Unit of Environment ACT (Nelson et al. 1996, 1998, 2000; Evans & Ormay 2002). Methodology in trap layout has varied over time. The most recent survey protocol using this trap design (Evans & Ormay 2002) at the Majura Firing Range was designed for long-term monitoring of abundance, and incorporated grids of 56 (i.e. 7 x 8) traps placed at 10 metre intervals. In this study, four grids were established (total of 224 traps). Traps were checked once every two to three days over a five week period. Overall trap success reported for the Majura survey was 39 captures (25 individuals and 14 recaptures) over 16 inspection days, or 1.1 per cent (39 captures over 3584 trap days). However, transects of traps are likely to increase the probability of detection at sites because they are likely to sample a greater range of habitats.

A comparison of pitfall trapping (using 90 millimetre diameter x 120-millimetre deep dry insect pitfall traps and metal drift fence) and ‘arthropod traps’ (Nelson et al. 1996) showed no difference in first captures of adults or young, but a highly significant recapture rate in spider tubes, indicating the animals use these as refuge sites.

There appears to be little difference in detection rates between ‘arthropod traps’ and pitfall trapping. ‘Arthropod traps’ require less work to install, check, maintain and remove. They are not true traps, which means that checking does not need to be daily (checking can be skipped during inclement weather) and are also able to be closed more readily in situ should this be required. Given these benefits over pitfall trapping, it would appear ‘arthropod traps’ are the more suitable methodology for targeted detection of the grassland earless dragon.

Similar species in range: The distribution and taxonomic status of the species was recently reviewed by Smith and colleagues (1999), and it was elevated to the rank of a distinct species. In overall appearance the grassland earless dragon might be confused with the mountain dragon *Rankinia diemensis* or juvenile jacky lizards *Amphibolurus muricatus*, but the presence of a distinct ear opening or tympanum in these species will readily distinguish them from the grassland earless dragon. Cogger (2000) illustrates diagnostic features to distinguish the grassland earless dragon from the mountain dragon (as *Tympanocryptis diemensis*).

Potential records of the grassland earless dragon should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (Australian Museum) for positive identification and databasing of the record.

Key references for Tympanocryptis pinguicolla

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Evans, M. & Ormay, P. 2002. 2001 – 2002 survey and monitoring program for the Grassland Earless Dragon *Tympanocryptis pinguicolla*. Internal Report 2002/01, Wildlife Research and Monitoring, Environment ACT. 11pp.

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Osborne, W.S., Kukolic, K., Davis, M. & Blackburn, R. 1993. Recent records of the earless dragon *Tympanocryptis lineata pinguicolla* in the Canberra region and a description of its habitat. Herpetofauna 23(1): 16-25.

Robertson, P. & Evans, M. 2009. National Recovery Plan for the Grassland Earless Dragon *Tympanocryptis pinguicolla*. ACT Department of Territory and Municipal Services, Canberra.

Smith, W.J.S., Osborne, W.S., Donnellan, S.C., & Cooper, P.D., 1999. The systematic status of earless dragon lizards, *Tympanocryptis* (Reptilia: Agamidae), in south-eastern Australia. Australian Journal of Zoology 47: 551-564.

Stevens, T. A., Evans, M. C., Osborne, W. A. and Sarre, S. D. 2010. Home ranges of, and habitat use by, the grassland earless dragon (*Tympanocryptis pinguicolla*) in remnant native grasslands near Canberra. Australian *Journal of Zoology*, 2010, 58, 76–84.

Great Desert skink

Liopholis kintorei

Summary information

Distribution: Great Sandy Desert, Gibson Desert, Great Victoria Desert and Tanami Desert. Historic records extend from the vicinity of Broome in the north-west, through sandy and stony desert areas to Kathleen Valley and Skipper Knob in the south-west, and east through the north-west corner of South Australia to Yuendumu in the Northern Territory (Storr 1968; McAlpin 2001a). There is also one record of an individual from further south, from 60 miles east of Kalgoorlie, which is morphologically intermediate between the Great Desert skink and the night skink *Egernia striata* (Storr 1968).

Since 1980, there have been no records from the easternmost, north-western and south-western parts of the historic distribution, with the current south-western limit from near Warburton, north-western limit at Rudall River National Park, eastern limit at Uluru National Park, and north-easternmost limit from Rabbit Flat in the Tanami Desert. Most observations since 1980 have come from the northern Tanami Desert, Uluru National Park, and the area between Warburton and Gibson Desert Nature Reserve (McAlpin 2001a; Pearson et al. 2001). Reports from Indigenous communities indicate that the species has declined in many parts of its former distribution (McAlpin 2001a).

Habit and habitat: most populations inhabit sandplains vegetated with *Triodia* and scattered shrubs on red sandy soils, although in the Gibson Desert they inhabit open areas of lateritic gravel and small stones on fine sand on the hilltops and slopes of rira habitats. Such habitats also have *Triodia* as the dominant plant species, with scattered gidgee *Acacia pruinocarpa* and mulga *A. aneura*. In South Australia, the species occurs in open mulga and *Acacia minyura* woodland over woollybutt grass and *Triodia*. In the Tanami Desert, they may also occupy lateritic soils with *Melaleuca* shrubland along paleodrainage lines (McAlpin 2001a). There is some suggestion that most of the active burrows are located in areas that have been burnt no more than 25 years before (McAlpin 2001a,b), with populations in less recently burnt areas (greater than 15 years) declining.

The Great Desert skink inhabits complex permanent burrow systems as family groups (usually one adult pair and the juveniles from two breeding events). Burrow systems are occupied and extended for many years, and may extend over 1 metre deep and 10 metres in diameter, with up to 10 entrances, although there is much movement between burrow systems over time. Active burrows are characteristically open, with signs of freshly dug sand at one or more entrances, and have at least one communal scat pile (up to 3 square metres). The species may also invade and modify burrows of other species, including mulgara *Dasycercus cristicauda*, spinifex hopping mouse *Notomys alexis*, night skink and sand goanna *Varanus gouldii* (McAlpin 2001a).

Activity period: there is little information on the activity period. The Great Desert skink is reported to hibernate in winter (McAlpin 2001b; Baker et al. 1993), and to be most active during the cooler parts of the day and evening, retreating within their burrow systems during the heat of the day (Baker et al. 1993).

Survey methods

Because burrow systems are occupied for many years, it is not recommended that burrow systems be excavated unless absolutely necessary to extract the animals. The most appropriate survey technique is to locate burrow systems by walked transects, employing experienced observers familiar with the appearance of burrows of this species (particularly utilising local aboriginal experience), and then observe those burrows that show signs of activity (active latrine site, recently dug soil at entrances) for the emergence of animals.

Descriptions of burrow systems and means of differentiating the burrows of this species from other reptiles and mammals are discussed by McAlpin (2001b).

Trapping (using pitfall traps and/or Elliot traps) may allow some individuals to be caught with minimal damage to burrow systems, although there is no published data on the efficacy of different traps and trap patterns (but see list of reports to be checked below).

McAlpin (2001b) reports the optimum time for monitoring burrows as late summer and early autumn, before the lizards enter hibernation, at which time the maximum number of individuals inhabit the burrow systems.

Similar species in range: adult Great Desert skinks are unlikely to be confused with any other lizard species from the western and central deserts. They are larger than any of the other burrowing desert *Egernia* species, attaining a total length of about 440 millimetres, and a mass of about 350 grams (McAlpin 2001a). The only other sympatric skinks attaining such a size are the two desert blue-tongues: the western blue-tongued lizard *Tiliqua occipitalis* and Centralian blue-tongued lizard *T. multifasciata*, which are non-burrowing species with strong bands across the dorsum.

However, juvenile Great Desert skinks are similar in size to several of the other burrowing *Egernia* species found in the desert areas: *E. inornata*, night skink *E. striata* and Slater's skink *E. slateri*. These can be difficult to differentiate, particularly for the surveyor unfamiliar with these species. Also confusing is the ontogenetic change in colour pattern in this species (Pearson et al. 2001), with juveniles having greyer flanks, more contrasting to the dorsal coloration, than adults. The night skink has been reported to be readily distinguished by its elliptical pupil (Storr 1968). However, the pupil of Great Desert skinks also becomes noticeably elliptical when exposed to strong lighting (Pearson et al. 2001). In general, the Great Desert skink has a greater number of longitudinal scale rows at midbody (43–52, usually greater than 46) than the other three species (combined range of variation, 34–46) and usually has eight to nine supralabial scales (rarely seven) while the other three species usually have seven supralabials, less commonly six or eight (Storr 1968). Potential records of the Great Desert skink, particularly individuals with a snout-vent length of less than 110 millimetres, should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and state museum for positive identification and databasing of the record.

Key references for Liopholis kintorei

Baker, L., Woenne-Green, S. & the Mutitjulu Community. 1993. Anangu knowledge of vertebrates and the environment. pp. 79-132 in, Reid, J.R.W., Kerle, A. & Morton, S.R. (eds.). Uluru Fauna. The Distribution and Abundance of Vertebrate Fauna of Uluru (Ayers Rock-Mount Olga) National Park, N.T. Kowari 4. Australian National Parks and Wildlife Service, Canberra.

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Pearson, D., Davies, P., Carnegie, N. & Ward, J. 2001. The Great Desert Skink (*Egernia kintorei*) in Western Australia: Distribution, reproduction and ethno-zoological observations. Herpetofauna 31(1): 64-68.

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Gulf snapping turtle

Elseya lavarackorum

Summary information

Distribution: known only with certainty from the Gregory River and Lawn Hill Creek, although White (1999) comments that adult Gulf snapping turtles were observed in the Roper River near Mataranka in the Northern Territory. Given that no review of the species of *Elseya* in northern Australia has been published, the species' distribution is limited here to the Gregory River and Lawn Hill Creek.

Habit and habitat: found in permanently flowing rivers and large creeks. White (1999) comprehensively surveyed the Gregory River and Lawn Hill Creek for the presence of this species. The areas surveyed include the mid-reaches of the Gregory River at Riversleigh, the upper reaches of the Gregory River, and Lawn Hill Creek. The Gulf snapping turtle was not recorded in the upper reaches of the Gregory River and only two sub-adults recorded in the mid-reaches of this river. The species was recorded much more frequently in the Lawn Hill Creek, with the majority of records from the vicinity of 'tufa' dams that occur in this creek, these being limestone barriers that form across the water channels to create natural weirs.

The species was observed feeding on floating figs that had fallen from overhanging trees. These observations indicate that vegetable matter may be a significant part of this species' diet, at least for adults.

Activity period: likely to be year round. The survey by White (1999) was conducted in the early to mid dry season in June. The species probably actively forages by day and night.

Survey methods

White (1999) recorded no trap success during the June survey using mesh-lined barrel traps (1.3 metres in length by 0.5 metres diameter with a 30 centimetre funnel entrance). The same traps and the baits used successfully trapped large numbers of the freshwater Worrel's short-necked turtle *Emydura worrelli* at the same sites surveyed. It was suggested that the Gulf snapping turtle was 'trap shy' to funnel-necked traps, or that if the species is highly frugivorous at this time of year, alternative non-meat baits need to be trialled.

The trap record of a single saw-shelled turtle *Elseya latisternum* from the upper Gregory drainage may shed some light on the trap efficacy of the traps used by White. This species is often locally abundant and trapped in good numbers in Cape York using barrel or box traps of string or plastic mesh. It is possible the wire meshed used at the entrance funnel inhibited entry of the trap by the *Elseya* species.

The species appears to be best detected by diving where this technique can be safely employed. The middle to lower reaches of rivers where the salt-water crocodile *Crocodylus porosus* co-habits should be avoided.

Similar species in range: Worrel's short-necked turtle and the saw-shelled turtle were both recorded by White (1999) from the Gregory River drainage. The species of *Elseya* all typically have a distinctive horny casque over the top of the head and distinctive low rounded tubercules on the side of the head. The dorsal and lateral side of the head of Worrel's short-necked turtle is usually smooth (except in occasional large individuals). The Gulf snapping turtle grows to a much larger adult size than the saw-shelled turtle. Cann (1998) records that maximum carapace length for adult saw-shelled turtles is around 240 millimetres and individuals over 260 millimetres are rare, whereas the Victoria River snapping turtle *Elseya dentata* (the species from which the Gulf snapping turtle was recognised) grows to 300 millimetres or more in northern Australia. Young Gulf snapping turtles or saw-shelled turtles are likely to be particularly difficult to distinguish from each other and effective diagnostic characters need to be found to allow future survey work to reliably distinguish the two species. Given the similarity between the two species, it is recommended that any new locality for the Gulf snapping turtle be verified with a photo voucher specimen, preferably including a tissue sample for DNA. Voucher specimens and tissue samples should be forwarded to the appropriate state museum for accession and positive identification.

Key references for Elseya lavarackorum

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White, A.W. 1999. Initial observations and survey results of freshwater turtles in the Gregory River and Lawn Hill Creek, northwestern Queensland. Herpetofauna 29(2): 37-48.

Hamelin ctenotus

Ctenotus zastictus

Summary information

Distribution: known only from a single small area about 20 kilometres south of Hamelin homestead via the track to Coburn homestead, Shark Bay region, Western Australia. The five individuals in the type series were collected 16–17 kilometres south of Hamelin homestead.

Habit and habitat: The Hamelin ctenotus is a surface-active terrestrial species that shelters in spinifex (*Triodia*) tussocks when pursued. The habitat at the only known locality is *Triodia* grassland with eucalypts on a red sandplain, about 150 square kilometres in area (Storr 1984).

Activity period: not known specifically, but all closely related species are diurnal, and individuals of the Hamelin ctenotus have been observed active by day (G. Shea pers. obs.). The time of year active is not specifically known, but on the basis of knowledge of congeneric species, peak activity is likely to be spring and early summer under warm to hot conditions. The type series was collected in August and November, and additional individuals have been observed active in May (G. Shea pers. obs.).

Survey methods

The Hamelin ctenotus has been observed active, moving around the fringe of *Triodia* tussocks by day (G. Shea pers. obs.).

Due to the small extent of the known habitat for this species, it is important that there is minimal disturbance to the spinifex at the site during survey activities.

Ctenotus species are readily pitfall trapped during the time of year when they are active. If the survey is a targeted search for this species only, then a series of pitfall trap lines comprising six 10 litre buckets spread along a 15 metre fence should be adequate for detecting the species.

Similar species in range: The Hamelin ctenotus is a small to medium-sized skink (maximum snout-vent length 60 millimetres) with well-developed front and hindlimbs, each with five digits, and a long slender tail, more than twice snout-vent length. It has a colour pattern of narrow pale stripes (paravertebral, dorsolateral, midlateral and ventrolateral), together with a single series of pale spots between the paravertebral and dorsolateral stripes, and between the dorsolateral and midlateral stripes, all on a black background. The belly is pale, tinged greenish. It is only likely to be confused with other species of *Ctenotus*, of which seven are known from the broader Shark Bay area: western limestone ctenotus *C. australis* (usually referred to in Western Australian literature as *C. lesueurii*), *C. fallens*, *C. mimetes*, *C. pantherinus*, *C. schomburgkii*, *C. severus*, and *C. youngsoni*. The blackish ground colour in combination with the sharply defined narrow pale stripes and lines of spots in the positions described will help to differentiate the Hamelin ctenotus from other *Ctenotus* species of the region. However, given the difficulties in differentiating most *Ctenotus* species, and the potential for cryptic species in this genus, it is recommended that tissue samples be taken to verify any records of this species from beyond the known distribution.

Key references for Ctenotus zastictus

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Hermite Island worm lizard

Aprasia rostrata rostrata

Summary information

Distribution: known with certainty only from Hermite Island, Western Australia on the basis of two individuals collected in 1952, prior to the British atomic tests on nearby Trimouille and Alpha Islands in 1952 and 1956. The taxonomic distinction of this species from the closely related Exmouth worm lizard *Aprasia fusca* (Storr 1979) is unclear. The Exmouth worm lizard was originally described as a subspecies of *A. rostrata*, and was subsequently considered specifically distinct by Storr and colleagues (1990) without any further consideration of differences. Aplin and Smith (2001) mention unpublished studies by Aplin that refer to an individual from North-West Cape, previously identified as the Exmouth worm lizard, as *A. rostrata*, as well as recognising two new species from near Geraldton and between Gnaralloo station and Cape Cuvier. Hence, it is possible that the distribution of *A. rostrata* may extend to the mainland, and, depending on the taxonomic status afforded the above-mentioned populations, be much more extensive than Hermite Island.

Habit and habitat: Habits of the Hermite Island population are not known, but it is presumed to be fossorial on the basis of ecology of congeners, including related mainland populations. Based on the range of habitats available on Hermite Island and the ecology of congeners, the Hermite Island worm lizard is likely to occur in loose sandy soil under limestone, *Triodia* and other grasses. On the mainland, related populations have been found on *Triodia* covered red dunes and under *Acacia* leaf litter on white dunes.

Activity period: not known specifically, but on the basis of a study done on a similarly sand-dwelling species *A. aurita* (Robertson & Edwards 1994), it may peak during the breeding season in spring. One Australian Museum specimen of the Exmouth worm lizard *A. fusca* was collected in October in 1981. This species is likely to be diurnal, with greatest surface activity when air temperatures are above 25°C (Robertson & Edwards 1994).

Survey methods

The Hermite Island worm lizard, if still extant, should be encountered by turning rocks on sand and soil, and should also be detectable by pitfall trapping. Congeners (including closely related mainland populations) that inhabit similar loose-soil substrates, have been collected by raking soil under mats of dead vegetation, logs and rocks, and under slabs of limestone or concrete. They are also collected in pitfall traps.

If the survey is a targeted search for this species, multiple series of pitfall trap lines comprising six 10 litre buckets spread along a 15 metre drift fence, combined with hand-searches as described above, should be adequate for detecting the species.

It is likely that trap returns will be very low. Burbidge and colleagues (2000) reported no captures from three pitfall trap sites over a minimum of two four-day periods in 1994 (22 May to 7 June). Each site consisted of five rows of paired 20 litre buckets. Rows were spaced 15–20 metres apart, and 5 metres separated buckets within each pair. Pairs of buckets were traversed by 10 metres of aluminium fly-wire drift fences. Extensive hand-searching as described above over the same period also failed to locate the Hermite Island worm lizard.

Similar species in range: *Aprasia rostrata* is a small slender wormlike lizard, with a total length of up to about 15 centimetres. The snout is strongly protrusive in profile, there are no traces of front limbs, and the hindlimbs are represented only by tiny flattened flaps on either side of the vent. The body bears narrow brown stripes.

It is not likely to be confused with any other reptile on the Montebello Islands.

The Hermite Island worm lizard could be confused with the Exmouth worm lizard *A. fusca* and other *Aprasia* species on the mainland. It reportedly differs from the Exmouth worm in having paler lateral and ventral surfaces. It differs from other *Aprasia* species in having the combination of 14 midbody scale rows, five upper labials, a pale brown head and a strongly protrusive snout in profile.

Given the taxonomic uncertainty about various mainland populations, and the lack of genetic samples for the Hermite Island population, it is recommended that tissue samples (for example, tail tip samples) be taken from any individuals located from Hermite Island and any mainland records.

Key references for Aprasia rostrata rostrata

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Burbidge, A.A., Blyth, J.D., Fuller, P.J., Kendrick, P.G., Stanley, F.J. & Smith, L.A. 2000. The terrestrial vertebrate fauna of the Montebello Islands, Western Australia. CALM Science 3(2): 95-107.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

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Storr, G.M. 1979. Five new lizards from Western Australia. Records of the Western Australian Museum 8(1): 134-142.

Storr, G.M., Smith, L.A. & Johnstone, R.E. 1990. The Lizards of Western Australia. III. Geckos and Pygopods. Western Australian Museum, Perth.

Jurien Bay skink

Liopholis pulchra longicauda

Summary information

Distribution: the islands of Jurien Bay, Western Australia, specifically the four largest islands in the group: Favourite, Boullanger and Whitlock (Ford 1963a, b) and Escape Island (Ford 1965). Surveys of other nearby islands between Dongara and Lancelin (Ford 1963a), and of the adjacent mainland (Ford 1965) failed to locate it elsewhere. The nearest populations of the nominate subspecies, *Liopholis pulchra pulchra*, are from Nanga Brook (Ford 1965) and Julimar Forest (Storr et al. 1999) in the Darling Ranges, 290 kilometres to the south.

Habit and habitat: Varies depending on the presence of related species. It generally inhabits rock outcrops, sheltering in crevices, and has never been observed creating its own burrows, unlike its sympatric congener the bull skink *Liopholis multiscutata* (Ford 1963b). On islands where both taxa are sympatric (Favourite, Boullander, Escape), the Jurien Bay skink inhabits crevices between limestone rocks, while the bull skink inhabits self-constructed shallow burrows in adjacent sandy soils. On islands where the Jurien Bay skink is absent (for example, Sandland Island and Middle Essex Rock) the morphologically similar bull skink also inhabits rock crevices and burrows under rocks (Ford 1963a, b). On Whitlock Island, in the absence of the bull skink, the Jurien Bay skink also utilises petrel burrows (Ford 1963a, b). On Escape Island, in the presence of King's skink *Egernia kingii*, which utilises petrel burrows, the Jurien Bay skink is restricted to crevices between rocks in the centre of the island, foraging in dense leaf litter under low scrub (Ford 1965). King's skink may also shelter under limestone slabs in the absence of the Jurien Bay skink (for example, on Cervantes Island; Ford 1963a). On Escape Island, the Jurien Bay skink has also been found under other objects (for example, cardboard sheets) on the ground (Ford 1965). (Note: in Ford's publications, the bull skink *L. multiscutata* is referred to as *Egernia bos*, a synonym).

Activity period: The Jurien Bay skink is most likely active from mid-spring (September/October) to late autumn. Ford (1963b) was able to locate them on visits to the islands in May, August, October and November. They are probably partially or completely inactive during winter. Based on knowledge of closely related species, the Jurien Bay skink is likely to be active late morning to afternoon in the temperate months of the year, gradually changing to early morning and probably late afternoon in the hotter months of the year.

Survey methods

While other *Liopholis* species are readily captured in pitfall traps, this method is only like to routinely work for the Jurien Bay skink at sites where it forages away from rock outcrop shelters, such as when the bull skink and King's skink are absent or in low numbers. If pitfall traps are used, they should be set during late spring and early summer, when the species is most likely to be active. A line of five 10 litre buckets each approximately 5 metres apart is likely to be suitable. Its combination with a drift fence would greatly enhance capture success. At sites where the Jurien Bay skink is restricted to rock outcrops by the presence of related species, pitfall traps will be difficult to set. In such situations, targeted searches of rock piles by day (at times when the lizards are active) using binoculars to observe the species from a distance, are likely to be more effective. If rock piles are surrounded by dense vegetation, precluding visual observation at a distance, the most effective method of searching is direct examination of rock crevices for sheltering lizards.

Similar species in range: On the Jurien Bay islands, the Jurien Bay skink is readily confused with the bull skink, which is similarly sized and patterned, and in some circumstances inhabits similar habitats. The Jurien Bay skink has weakly tricarinate keels on the dorsal scales, which are absent in the bull skink. When dorsal patterning is present (some individuals are unpatterned dorsally), the Jurien Bay skink has single pale spots in the dark longitudinal dorsal stripes, while the bull skink has pairs of pale spots along the length of the dark longitudinal dorsal stripes. The Jurien Bay skink also has a shallower head than the bull skink.

On some of the islands, the Jurien Bay skink is also sympatric with King's skink. While adult King's skink are much larger than the Jurien Bay skink, juvenile or sub-adult King's skink could potentially be confused with adult Jurien Bay skink, as both have keeled scales and similar body shape. King's skink have more strongly keeled scales, and have a pattern of pale spots in a darkly mottled background, while Jurien Bay skinks have broad dark dorsal stripes containing rows of pale spots.

While the Jurien Bay skink is not yet known from the adjacent mainland, it could occur there (the Lancelin Island Skink *Ctenotus lancelini*, another skink generally restricted to the near-coastal south-western islands, has been recorded from the mainland adjacent to Lancelin Island). On the adjacent mainland, the Jurien Bay skink could be confused with the south-western crevice skink *Egernia napoleonis*, which is common in the region (Ford 1965, as *Egernia nitida*). The two species share similar body shape, tricarinate scales and an orange venter, but may be distinguished by the much stronger scale keeling of the south-western crevice skink, and the presence of multiple nuchal scales in that species (vs a single pair of nuchals in the Jurien Bay skink).

The Jurien Bay skink is distinguished from *L. p. pulchra*, which occurs on the mainland to the south, by having a proportionally longer tail (original, unregenerated tails are 196–226 per cent of snout-vent length vs 160–193 per cent of snout-vent length in *L. p. pulchra*), the nasal scales usually in contact (vs usually not in median contact) and the ventral surface is bright orange (vs usually whitish) (Ford 1963b; Storr et al. 1999).

Potential records of the Jurien Bay skink should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (Western Australian Museum) for positive identification and databasing of the record.

Key references for Liopholis pulchra longicauda

Ford, J. 1963a. The reptilian fauna of the islands between Dongara and Lancelin, Western Australia. Western Australian Naturalist 8(6): 135-142.

Ford, J. 1963b. The distribution and variation of the skinks *Egernia pulchra* and *E. bos* in Western Australia. Western Australian Naturalist 9(2): 25-29.

Ford, J. 1965. The reptilian fauna of the islands between Dongara and Lancelin, Western Australia: additional notes. Western Australian Naturalist 9(7): 174-175.

Gardner, M. G., Hugall, A. F., Donnellan, S. C., Hutchinson, M. N., & Foster, R. 2008. Molecular systematics of social skinks: phylogeny and taxonomy of the *Egernia* group (Reptilia: Scincidae). Zoological Journal of the Linnean Society 154: 781-794.

Storr, G.M., Smith, L.A. & Johnstone, R.E. 1999. Lizards of Western Australia. I. Skinks. Western Australian Museum, Perth.

Krefft's tiger snake (Flinders Ranges)

Notechis scutatus ater

Summary information

Distribution: known from the southern Flinders Ranges, South Australia, in the Mt Remarkable region, south to the mouth of the Broughton River. There are unsubstantiated old reports of black snakes, which may represent Krefft's tiger snake (Flinders Ranges) from further north in the Flinders Ranges (Mirtschin & Bailey 1990).

Habit and habitat: reported from along creeks lined with river red gum Eucalyptus camaldulensis and sugar gum *E. cladocalyx* in narrow valleys in the lower Flinders Ranges. The steep rocky slopes above the creeks are lined with long-leaved box *E. goniocalyx* and have loose, poorly-vegetated scree slopes (Mirtschin & Bailey 1990). These creeks gradually dry during summer and the snakes are commonly found in the residual waterholes at this time. During the wetter months, the snakes shelter in debris piles created by higher water flow (Mirtschin & Bailey 1990).

Activity period: Krefft's tiger snake (Flinders Ranges) is diurnal and is active at least October to February, possibly most of year other than winter. Mirtschin and Bailey (1990) report dates of collection for 48 individuals of this subspecies from a single study site near Melrose. All were collected, apparently while active, between 19 October and 15 February, over a four year period. However, the authors did not provide details of the times of the year that their surveys were carried out, and hence the activity period may be more extensive than indicated by these capture records.

Survey methods

Large snakes are difficult to trap. They are most commonly found either active in warmer weather, or by active hand searching in likely sheltering sites, such as under objects on the ground.

Mirtschin and Bailey (1990) report that the subspecies is readily located in the residual ponds in drying stream beds during summer (November to February), where they enter the water in search of food. Walked transects through such habitats at this time of year are likely to be effective in locating the subspecies. Mirtschin and Bailey (1990) note that it is predominantly females that are active in the water in summer.

Similar species in range: within its distribution, this subspecies is readily differentiated from most other similarly sized snakes. It could potentially be confused by the inexperienced surveyor with very dark coloured individuals of brown snakes, *Pseudonaja* spp., and the mulga snake *Pseudechis australis*. It is readily differentiated from both by having all single subcaudal scales, and additionally from brown snakes by having a distinct temporolabial scale. The black to grey (not yellowish) ventral surface also aids in distinguishing it from the mulga snake.

Potential records of Krefft's tiger snake (Flinders Ranges) should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (South Australian Museum) for positive identification and databasing of the record.

Key references for Notechis scutatus ater

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Mirtschin, P.J. & Bailey, N. 1990. A study of the Kreffts Black Tiger Snake *Notechis ater ater* (Reptilia: Elapidae). South Australian Naturalist 64(3/4): 52-61.

Lancelin Island skink

Ctenotus lancelini

Summary information

Distribution: known only from Lancelin Island, 80 kilometres north of Perth, Western Australia, although there is a single 1994 record from the opposite mainland (Maryan & Browne-Cooper 1995). Despite subsequent intensive searching on the mainland, no further individuals have been found in this area (Jones 1996). The area of Lancelin Island is 7 hectares, of which about 6.5 hectares is vegetated (Jones 1996).

Pearson and Jones (2000) reported that allozyme electrophoretic studies of the Lancelin Island skink and mainland populations of *C. labillardieri* confirmed the genetic distinction of the Lancelin Island skink (with 15 per cent fixed differences). However, they also noted that two individuals identified as *C. labillardieri* from the mainland localities at Meelup and Pinjarra had only one fixed difference from the Lancelin Island skink. This raises the possibility that some northern mainland populations currently identified as *C. labillardieri* may ultimately prove to be Lancelin Island skinks.

Habit and habitat: terrestrial, surface-active; found in low shrubland and grassland on coastal limestone and white sands. They were previously reported, on the basis of hand collection and searching under rock slabs, to only occur in association with three small limestone outcrops on opposite ends of the island (Cogger et al. 1993), and to shelter in depressions in the sand under exfoliating slabs of limestone (Ford 1963). However, the Lancelin Island skink was collected by pitfall trapping in all habitats on Lancelin Island by Jones (1996). The pitfall trapping had highest capture rates of the species in areas with a north-eastern aspect and a rise of several metres to the south or south-west (these were areas that were warm and less windy during the season of maximum activity). It is unclear whether these different trap rates reflect habitat preferences or merely different activity cycles.

Degradation of the preferred habitat by the invasion of exotic weeds in recent times has been identified (Browne-Cooper & Maryan 1992) as a possible cause in species decline. However, this may simply reflect the denser vegetation either hiding rock slabs, or shading rock slabs and forcing lizards to use other sheltering sites, in both cases reducing the effectiveness of locating lizards by turning rocks. Jones (1996), on the basis of pitfall trapping, found that there was little or no effect of vegetation on trapping rates overall and found no evidence for a decline in the population. However, she did note that continued survival of the species on the island was probably dependent on maintenance of the limited area of suitable nesting sites.

Activity period: Jones (1996) reported highest captures of adult Lancelin Island skinks in pitfall traps between mid-September and mid-January, with a peak in November. Few or no adults were captured at other times of the year. During the active period, male capture rates peaked in late October, while female capture rates peaked in mid to late November (when females were gravid). Juveniles were pitfall trapped from mid-January to April.

Jones (1996) did not present data on diurnal variation in trapping rates. However, most *Ctenotus* are diurnally active, particularly in sunny conditions, and it is likely that the Lancelin Island skink shows a similar activity pattern. Jones (1996) did not observe the species basking in sunlight, and suggested that basking was probably undertaken in loose sand. The active period each day is presumably late morning to afternoon in the temperate months of the year, gradually changing to early morning and probably late afternoon in the hotter months of the year.

Survey methods

Until 1992, most individuals of this species were found by active searching, lifting slabs of limestone on sand (M. Peterson pers. comm.).

Recent work has concentrated on pitfall trapping (Jones 1996), a technique which has been successfully used to collect a number of *Ctenotus* species in a variety of habitats across Australia. Jones used square grids of nine buckets spaced 10 metres apart; the buckets were square-section plastic containers 19 centimetres deep and 18 centimetres wide. No drift fences were able to be used because of the disruption associated with seabirds and their burrows. Because of the possibility that the lizards actively foraged under shelter, and to avoid predation of trapped lizards by seabirds, buckets were covered with plywood sheets 30 x 30 centimetres in size.

Using this system (and with a total of 13 such grids on the 7 hectare island), capture rates during the active season ranged between 0.4–16.2 Lancelin Island skinks per 100 trap days for each grid, with an average of 6.1 Lancelin Island skinks per 100 trap days.

If the survey involves a targeted search for this species on the mainland, where seabird burrows and activity is of less concern, multiple series of pitfall trap lines comprising six 10 litre buckets spread along a 15 metre fence, combined with hand-searches as described above, should be adequate for detecting the species. The apparent low density of the species on the mainland (if mainland populations exist rather than the single recorded individual being a waif) may require extended surveys. Jones (1996) did not trap any Lancelin Island skinks at the mainland site in 882 trap days (during the same period, she trapped 91 Lancelin Island skinks on Lancelin Island).

Similar species in range: on Lancelin Island, there is little likelihood of confusing the Lancelin Island skink with other species. The only other *Ctenotus* on the island is *C. fallens* (Storr 1973). The Lancelin Island skink has two supraoculars contacting the frontal and three presuboculars, while *C. fallens* has three supraoculars contacting the frontal and two presuboculars. The colour pattern of the Lancelin Island skink is also more mottled and lacks a narrow dark vertebral stripe, present in *C. fallens*.

Although it should be simple to identify the Lancelin Island skink on Lancelin Island, the number of *Ctenotus* species on the adjacent mainland makes misidentification of any mainland records a significant possibility. Hence, any mainland records of the Lancelin Island skink should be accompanied by tissue samples or a good quality, close-up colour photograph submitted to the Western Australian Museum for identification.

Key references for Ctenotus lancelini

Browne-Cooper, R. & Maryan, B. 1992. Notes on the status of the skink *Ctenotus lancelini* on Lancelin Island. Western Australian Naturalist 19(1): 63-65.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

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Ford, J. 1963. The reptilian fauna of the islands between Dongara and Lancelin, Western Australia. Western Australian Naturalist 8(6): 135-142.

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Peterson, M. 2009. Personal Communication.

Storr, G.M. 1973. The genus *Ctenotus* (Lacertilia, Scincidae) in the South-west and Eucla Divisions of Western Australia. Journal of the Royal Society of Western Australia 56(3): 86-93.

Long-legged worm skink

Anomalopus mackayi

Summary information

Distribution: western slopes in north-east NSW and south-east Queensland.

Habit and habitat: terrestrial, fossorial, found in open woodland, possibly riverine plains woodland. It is a burrowing species, located in recent times under fallen timber and rocks on black soils in the eastern part of its range in NSW (Shea & Milgate 1987).

Activity period: not known specifically, but detectability increases when moisture makes soil cracks close, which forces the animals to the surface. Increased soil moisture under surface debris (e.g. logs, windrows of slashed grass or bales of hay) also increases detectability. Peak activity is likely to be late spring and early summer under warm but not overly dry conditions. Not active on the ground surface by day and would only be active between sheltering sites at night.

Survey methods

Crepuscular burrowing species are usually recorded by turning objects under which they shelter, or in pitfall traps. On several occasions in recent times it has successfully been located by turning rocks or fallen timber on the ground and raking the surface layer of soil.

Appropriate survey methodology for detecting the presence of the long-legged worm skink is searching sheltering sites in combination with pitfall trapping at a time of year when the species is most likely to be active. If the survey is a targeted search for this species, a series of pitfall trap lines each comprising six 10 litre buckets spread along a 15 metre fence could be employed, however the species is more likely to burrow between the soil and the bucket. A successful technique has been to deploy artificial structures, such as bales of hay of different thicknesses, over a long period (over 6 months) and periodically check underneath.

Similar species in range: the long-legged worm skink is an elongate species of skink with very short fore and hindlimbs. It is only likely to be confused with *Anomalopus leuckartii.* The two species come into close contact along the western edge of the North Western Slopes of NSW. The long-legged worm skink can be distinguished by having three toes on the front foot, whereas *A. leuckartii* has two; however, determination of these characteristics can be difficult (see Swan et al. 2004). It is recommended that tissue samples be taken, along with photographs (using a macro lens or function) of the toes.

Key References for Anomalopus mackayi

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

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Lord Howe Island gecko

Christinus guentheri

Summary information

Distribution: Lord Howe Island – now restricted to a small area near the settlement, Blackburn (Rabbit Island), probably all Admiralty Islands and Balls Pyramid.

Norfolk Island – known only from the offshore islands of Philip and Nepean, and small rocky islets adjacent to Norfolk.

Habit and habitat: Lord Howe Island – closed coastal forest on Lord Howe Island and tussock grassland and rocky isolates on offshore islands.

Norfolk Island – coastal cliffs, rock outcrops and open woodland on Phillip Island, and tussock grassland and rocky isolates on all offshore islands.

On Philip Island it was abundant in both vegetated and rocky habitats.

Activity period: The peak activity period is probably mid-spring to mid-summer. The Lord Howe Island gecko is a nocturnal species, active on trees and on the coastal rocks, with a peak activity between sunset and the first three hours after dark. It shelters by day under a variety of rocky habitats and presumably also in the hollows of trees.

Survey methods

The species has not been systematically surveyed on Lord Howe Island in recent times, with the last published report being that of Cogger (1971). An extensive survey of Norfolk Island, the main offshore Islands of Phillip and Nepean, and some small islets of Norfolk was undertaken in 1978 (Cogger et al*.* 1983) and in 2005 (Cogger et al*.* 2006a, b). On both surveys, day searches under loose rocks detected the species at Philip and Nepean Islands, and on several smaller offshore islets. Further night spotting on Philip Island resulted in significantly greater numbers of observations.

To detect the presence of the species in an area, it is recommended where feasible that spotlighting be undertaken in the warmer months of the year (November to February).

Similar species in range: The Lord Howe Island gecko is the only native gecko on either group of islands. However, the species has been extinct on Norfolk's main island since European settlement and it is on this island that an Asian house gecko (*Hemidactylus frenatus*) was first recorded as an accidental exotic introduction in 2005. While currently these two species are not known to occur together on any island, there is a high risk that the house gecko might invade Norfolk's offshore islands and impact on the ecology of the native gecko. They are very different in size and markings, but the house gecko may also be distinguished from the Lord Howe Island gecko by lacking a greatly enlarged pair of terminal pads under the tip of each toe.

Key references for Christinus guentheri:

Cogger H. 1971. The Reptiles of Lord Howe Island. Proceedings of the Linnean Society of New south Wales 96(1): 23-38.

Cogger, H., Muir, G. & Shea, G. 2006a. A survey of the terrestrial reptiles (*Christinus guentheri and Oligosoma lichenigera*) of Norfolk Island - March 2005: 1. Executive Summary and Background Document. Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra, 17 pp. www.environment.gov.au/biodiversity/threatened/publications/pubs/norfolk-island-reptiles-summary.pdf

Cogger, H., Muir, G. & Shea, G. 2006b. A survey of the terrestrial reptiles (*Christinus guentheri and Oligosoma lichenigera*) of Norfolk Island - March 2005:2. A qualitative assessment of the relative abundance of the Norfolk and Lord Howe Island reptiles *Christinus guentheri* and *Oligosoma lichenigera* and comparison with previous surveys. Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra, 20 pp www.environment.gov.au/biodiversity/threatened/publications/pubs/norfolk-island-reptiles-abundance.pdf

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Lord Howe Island skink

Oligosoma lichenigera

Summary information

Distribution: Lord Howe Island, New South Wales – the species has not been systematically surveyed in recent times, with the only published report being that of Cogger (1971). Opportunistic collections have since recorded the species from Erskine Valley on Lord Howe, Roach Island and Balls Pyramid in 2000 (Australian Museum records).

Norfolk Island – the first record of this species from the islands of the Norfolk Island complex was made by a resident from Phillip Island and first published in the report of a systematic survey by Cogger and colleagues (1979) conducted in November 1978. The Lord Howe Island skink was located at five sites scattered over Philip Island, but not on any of the other offshore islands surveyed at that time. A similar pattern of occurrence was found in a more recent formal survey in 2005 (Cogger et al. 2006a, b).

Habit and habitat: Lord Howe Island – beach front boulders in Howea palm forest, and on islets of the lagoon amongst loose basalt boulders.

Norfolk Island – on Philip Island it was recorded from a range of habitats but preferred areas with a groundcover of dense tussocks (Cogger et al. 1993).

Activity period: probably active from very late afternoon to early evening. It was reported as nocturnal on Lord Howe Island (Cogger 1971). The records from Philip Island are of animals located by day under shelter, active at night, or found in the early morning in pitfall traps set in the afternoon and left open overnight. This indicates a low level of activity during the day (Cogger et al. 1979). The peak activity period is probably mid-spring to mid-summer.

Survey methods

Pitfall trapping would be the preferred methodology at sites where it is feasible to establish lines. A pitfall trap line of approximately 15 metres in length, comprising a low fence over and between five buckets (each 2 litres in size), was used effectively by Cogger and colleagues (1979) on Philip Island. Such a system could also be used on Lord Howe Island, but with the caveat that because rats are present on Lord Howe's main island, exclusion meshing would probably be essential to prevent rats entering the traps on the island.

Small rocky islets off the coast of Lord Howe Island or Norfolk Island are likely to be logistically surveyed only by active searching under sheltering sites (rocks, logs or debris) by day or by camping overnight on the islands to carry out nocturnal surveys.

Similar species in range: Lord Howe Island: the skink *Lampropholis delicata* is a recent introduction to the island and appears to be widespread at low elevation. The Lord Howe Island skink is a much larger skink reaching a maximum adult size of 80 millimetres body length, whereas *L. delicata* only reaches an adult body length of 40 millimetres. However, juvenile Lord Howe Island skinks could be confused with *L. delicata* and it is recommended that photos of individuals less than 50 millimetres body length be taken to confirm the identity of the record.

Norfolk Island: the Lord Howe Island skink is the only skink recorded from the offshore islands.

Key references for Oligosoma lichenigera

Cogger H. 1971. The Reptiles of Lord Howe Island. Proceedings of the Linnean Society of New south Wales 96(1): 23-38.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Cogger, H., Muir, G. & Shea, G. 2006a. A survey of the terrestrial reptiles (*Christinus guentheri and Oligosoma lichenigera*) of Norfolk Island - March 2005: 1. Executive Summary and Background Document. Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra, 17 pp. www.environment.gov.au/biodiversity/threatened/publications/pubs/norfolk-island-reptiles-summary.pdf

Cogger, H., Muir, G. & Shea, G. 2006b. A survey of the terrestrial reptiles (*Christinus guentheri and Oligosoma lichenigera*) of Norfolk Island - March 2005:2. A qualitative assessment of the relative abundance of the Norfolk and Lord Howe Island reptiles *Christinus guentheri* and *Oligosoma lichenigera* and comparison with previous surveys. Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra, 20 pp www.environment.gov.au/biodiversity/threatened/publications/pubs/norfolk-island-reptiles-abundance.pdf

Cogger, H.G., Cameron, E.E. & Sadlier, R.A. 1979. The terrestrial reptiles of islands in the Norfolk Island complex. Australian Museum, Sydney. 122 pp. Limited circulation report for Australian National Parks & Wildlife Service.

Cogger, H.G., Sadlier, R.A. & Cameron, E.E. 1983. The terrestrial reptiles of Australia's island territories. Australian National Parks and Wildlife Service Special Publication 11:1-80.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Mary River tortoise

Elusor macrurus

Summary information

Distribution: Mary River, Queensland, downstream as far as Tiaro, upstream to near Kenilworth (Cann pers. comm.) and at various localities along Tinana Creek in the northern reaches and Yabba Creek in the southern reaches (Flakus 2002).

Habit and habitat: Deep pools in moderately broad mid-reaches of the river (Cogger et al. 1993; Cann pers. comm.), and highly oxygenated waters associated with riffles (Flakus 2002). It is a turtle that likes to bask either at the water surface or on dead wood in the water (Cann pers. comm.).

Historical data suggests the Mary River tortoise mass nests on traditional sandbanks. Substantial sandbanks are uncommon along the river. Female turtles confine their movements to a small area during the non-breeding season or winter months, but during the breeding season the proximity of a female turtle's foraging area to a nesting sandbank determines the extent (up to 2 kilometres) to which they move. Available data indicates males are using only a small section of river and that their movements are less extensive than females. During periods of flooding, individuals positioned themselves in backwaters and eddies during high flow events, returning to their former positions as flow intensity decreased.

Activity period: warmer months of the year (late spring and through summer). They have been seen basking on emergent logs in the morning and afternoon.

Survey methods

Diving when the water is clear is the most effective method of capture (Flakus 2002), but it is time consuming, dependent upon water clarity. Other methods employed include baited traps set along banks among overhangs and fallen submerged trees, and seine netting shallow areas (up to 3 metres depth). The latter method was particularly suitable for turbid water and on one occasion 82 turtles were caught in five hours in December 1997 (Flakus 2002). Basking animals can be observed from a distance with binoculars during the morning and afternoon hours.

Similar species in range: Three other species of 'short-necked' turtles, Krefft's River turtle *Emydura krefftii*, saw-shelled turtle *Elseya latisternum*, and Victoria River snapping turtle *Elseya dentata* may occur with the Mary River tortoise. The Mary River tortoise can be distinguished from Krefft's River turtle by the presence of a distinctive horny casque over the top of the head and large 'barbells' or rounded tubercules under the chin. The dorsal and lateral side of the head of Krefft's River turtle is usually smooth and the 'barbells' under the chin small. Both the saw-shelled turtle and the Victoria River snapping turtle have a distinctive horny casque over the top of the head like the Mary River tortoise. The saw-shelled turtle can be distinguished by the presence of serrations along the rear edge of the carapace in adults and juveniles whereas these are absent in adult Mary River tortoise. The Victoria River snapping turtle can be distinguished by having low blunt tubercules on the neck, whereas these are long and sharp on the Mary River tortoise.

Potential records of the Mary River tortoise should be supported by good quality colour photographs. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (Queensland Museum) for positive identification and databasing of the record.

Key references for Elusor macrurus

Cann, J. 1998. Australian Freshwater Turtles. Beumont Publishing Pty Ltd, Singapore.

Cann, J. 2009. Personal Communication.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Flakus, S.P. 2002. Ecology of the Mary River Turtle, *Elusor macrurus*. Master of Science Thesis, University of Queensland - Department of Zoology and Entomology.

Mount Cooper striped lerista

Lerista vittata

Summary information

Distribution: known from an area centred on Mt Cooper Tableland, Queensland (Cogger et al. 1993).

Habit and habitat: a burrowing species located in loose leaf litter and loose soil under logs in semi-deciduous vine thicket on sandy soils, and adjacent open patches of low vegetation on heavier soils (Cogger et al. 1993).

Activity period: unknown but probably year round with the possible exception of the coldest months. Peak activity is likely to be late spring and early summer under warm but not overly dry conditions. The Mount Cooper striped lerista was commonly encountered under sheltering sites in September (Australian Museum database records). Based on habits of similar congeners, it would not be active on the ground surface by day and would only be active between sheltering sites at night.

Survey methods

Crepuscular burrowing species are usually recorded in pitfall traps or by turning objects under which they shelter. Appropriate survey methodology for detecting the Mount Cooper striped lerista would be searching sheltering sites (leaf litter or logs) in combination with pitfall trapping at a time of year when the species is most likely to be active. If the survey is a targeted search for this species, only a series of pitfall trap lines comprising six 10 litre buckets spread along a 15 metre fence would be adequate for detecting the species.

Similar species in range: several other species of elongate bodied, near-limbless species of *Lerista* occur in northern Central Queensland. The Mount Cooper striped lerista *Lerista cinerea*, *Lerista colliveri*, and *Lerista wilkinsi* all have the front limb absent or reduced to a stump, and two or fewer digits on the hindlimb. However, only the Mount Cooper striped lerista has a colour pattern that has a broad, dark, upper lateral band along the side of the body. The other species have a pattern of fine dark lines down the back and side of the body (Cogger, 2000).

Given the similarity of the Mount Cooper striped lerista to these other species, potential records of either species should be supported by tissue samples and photo vouchers. These should be forwarded to the appropriate state museum (Queensland Museum) for positive identification and databasing of the record.

Key references for Lerista vittata

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Namoi River elseya

Elseya belli

Summary information

Distribution: headwaters of the Namoi and Gwydir Rivers in New South Wales, and possibly Bald Rock Creek in southern Queensland.

Habit and habitat: found in shallow to deep pools in permanently flowing rivers and large creeks flowing through granitic bedrock.

Activity period: morning and afternoon, and presumably throughout part of the night. The time of year that the species is most active is unknown, but is presumably late spring and through summer.

Survey methods

Diving or cage traps. Cann (1998) comments that they are carnivorous and readily trapped, being attracted to meat baits.

Similar species in range: none; the Murray turtle *Emydura macquarii* is the only other short-necked turtle likely to occur in the western flowing rivers within the range of the Namoi River elseya.

Potential records of the Namoi River elseya should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum for positive identification and databasing of the record.

Key references for Elseya belli

Cann, J. 1998. Australian Freshwater Turtles. Beumont Publishing Pty Ltd, Singapore.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Nangur spiny skink

Nangura spinosa

Summary information

Distribution: Known from two sites in Queensland: Nangur State Forest 20 kilometres north of Murgon, and Oakview State Forest approximately 40 kilometres to the east of Nangur State Forest.

Habit and habitat: The habitat at Nangur State Forest is described as semi-evergreen vine thicket (Covacevich et al. 1993) on dry, hard, black basaltic soils and at Oakview State Forest as Araucarian Notophyll Vine Forest on Quarternary alluvial soils at approximately 600 metres elevation (Hannah et al. 1997). Much of the latter site has been planted with hoop pine *Araucaria cunninghami*. The Nangur spiny skink appears to live in small colonies and inhabits permanent burrows. At Nangur State Forest, the retreat burrows lie on a gently sloping bank of a seasonal creek (Covacevich et al. 1993) and at Oakview State Forest the burrows were located along and uphill of a road embankment (Hannah et al. 1997). They appear to be relatively sedentary (DEWHA 2010) with activity centred on burrows which are used as retreat sites, and from which active individuals 'ambush' prey (Hannah et al. 1997). Defecation sites are associated with each burrow, and are located about 30 centimetres from the burrow entrance (Covacevich et al. 1993).

Activity period: predominantly crepuscular, but also diurnal, when individuals have been observed with their heads slightly emerging from retreat burrows or on the resting platforms next to burrow entrances (Hannah et al. 1997). However some level of nocturnal activity has also been observed. Activity is most likely to be during warmer months (spring, summer and autumn; DEWHA 2010), particularly spring/summer when most temperate species of lizards are reproductively active.

Survey methods

The species can be seen by searching visually for active burrows and using binoculars to observe the species from a distance. Surveys by Hannah and colleagues (1997) detected 24 active burrows and 36 individuals at Oakview State Forest over a six day period from February to March 1997. During daylight hours, individuals were observed with their heads or tails protruding out of burrow entrances, or out on resting platforms. Burrow entrances were usually remote from ground cover, or associated with rocks, tree bases or surface roots. Burrows are roughly horizontal, with an oval entrance.

Similar species in range: an experienced investigator could not confuse the Nangur spiny skink with any other described species of lizard in the region.

Key references for Nangura spinosa

DEWHA. 2010. *Nangura spinosa* in Species Profile and Threats Database, Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra. Available from: www.environment.gov.au/sprat. Accessed 2010-01-19T10:38:15.

Covacevich, J.A., Couper, P.J. & James, C. 1993. A new skink, *Nangura spinosa* gen. et sp. nov., from a dry rainforest of southeastern Queensland. Memoirs of the Queensland Museum 34(1):159-167.

Hannah, D., Agnew, G., Hamley, B. & Hogan, L. 1997. New information on the narrowly restricted skink, *Nangura spinosa*. Memoirs of the Queensland Museum 42(1):90.

Olive python (Pilbara subspecies)

Liasis olivaceus barroni

Summary information

Distribution: known from a number of sites throughout the Pilbara region of Western Australia (see Pearson 1993 for distribution map of the species), ranging from near Wallareenya Station (50 kilometres south-south-east of Port Headland) in the north, east to Bamboo (approximately 55 kilometres north-east of Marble Bar), south Newman and south-west to Mt Augustus (and possibly as far south as Yinnietharra). Its distribution then extends north-west to the Barlee Range and Ashburton River (near Nanutarra Roadhouse) and then turns abruptly north to the Cane River and remains on the eastern side of the North West Coastal Highway. Apart from its occurrence at Burrup Peninsula and Dolphin Island, the species' distribution along the Pilbara coast remains unresolved (Pearson 2001).

Habit and habitat: a large, primarily nocturnal python, ranging from 2.5–4 metres in length and weighing 5–15 kilograms. It feeds on a wide variety of vertebrate prey. Breeding takes place during the cool months of June to August, and males travel up to 3 kilometres in search of mates (Pearson undated – Landscope). Smith (1981) gives sizes of several individuals.

The olive python (Pilbara subspecies) is mostly known from localities associated with drainage systems, particularly Coongan, Shaw, Yule, Harding, Fortescue, Ashburton and Robe Rivers. It is also reported from areas with localised drainage and semi-permanent watercourses such as Tom Price, northern Chichester Range, Mt Augustus and Burrup Peninsula. Previously the preferred habitat of the species was reported as rocky areas in proximity to seasonally dry watercourses or the vicinity of permanent waterbodies in rocky ranges (Pearson 1993; Pearson 2001). Recent survey work in the Pannawonica region has shown the python is also found in riverine vegetation along the Robe River, but will also move away from riverine habitat, often during the cooler months, into the adjacent stony ranges for long periods. In the Millstream area it is similarly associated with riverine vegetation.

The olive python population on the coastal Burrup Peninsula occurs in an area of extensive rock piles vegetated with spinifex. There are no large waterbodies and the semi-permanent small pools may dry up entirely during dry periods. The python was occasionally found in adjacent spinifex grasslands. The population in this area has large home ranges and may move vast distances (Pearson 2001).

Activity period: almost entirely nocturnal, emerging from daytime shelters soon after dark (depending on temperature) and continue to move until the early hours of the morning. Olive pythons are also occasionally observed active during daylight hours. The activity pattern appears to shift during the hotter summer months, with a later emergence time (when rocks have cooled down) and activity continuing until around sunrise. During winter months adult pythons may become more sedentary and will bask in the morning sun (Pearson 2001, 2002).

Survey methods

Search methodology varies according to the attributes of the site. Areas that have roads can be surveyed by night driving through rocky areas near permanent water. A rate of encounter of one python per two nights of night driving is possible at exceptional locations during suitable weather for them to be active. At other locations, where there are rocky ranges close to water, they can be searched in north-facing cliffs during the cooler winter months as they bask at the entrance of small caves in the morning, or lie at the entrance to these sheltering sites just after dark.

Searches for faecal pellets or sloughed skins at rocky outcrops may give some indication of the presence of the species in the area (D. Pearson pers. comm.). This latter technique can be particularly useful for detecting the species' presence in areas where large waterbodies are not present (Burrup Peninsula). Sloughed skins can be readily identified by their colour, lack of pattern, and high number of scales around the middle of the body (>30) relative to the skins of elapids. Faecal pellets have a large white cakey piece of uric acid and several cylindrical sections (similar to dog droppings) but contain whole hard animal parts such as fur, feathers, bones, teeth or claws.

Pearson (pers. comm.) states that walking the open gorges during the morning hours looking for basking pythons was largely unsuccessful.

Key references for Liasis olivaceus barroni

Pearson, D.J. 1993. Distribution, status, and conservation of pythons in Western Australia in Herpetology in Australia ed. Lunney, D. and Ayers, D. Surrey Beatty & Sons, Chipping Norton, NSW. 414pp.

Pearson, D. undated. Giant Pythons of the Pilbara. Landscope: 34-39.

Pearson, D. 2001. Potential occurrence of the Pilbara Olive Python and its habitat on the proposed Burrup Ammonia Plant site near Hearson Cove. Unpublished Report for Burrup Fertilisers Pty. Ltd. 30pp.

Pearson, D. 2002. Report on a survey for Pilbara Olive Pythons on the proposed Western Stevedores loading facility and laydown area, Dampier Public Wharf South. Unpublished Report.

Pearson, D. 2009. WA Department of Environment and Conservation. Personal Communication.

Smith, L.A. 1981. A revision of the *Liasis olivaceus* species-group (Serpentes: Boidae) in Western Australia. Records of the Western Australian Museum 9(2):227-233.

Ornamental snake

Denisonia maculata

Summary information

Distribution: confined to the Brigalow Belt within the drainage system of the Fitzroy River, Queensland (Cogger et al. 1993).

Habit and habitat: important habitat appears to be gilgais or melon-hole country, often with an overstorey of brigalow (*Acacia harpophylla*). It has also been recorded in woodlands and open woodlands of coolabah, poplar box, belah and fringing vegetation along watercourses and even grasslands.

Activity period: nocturnally active, sheltering during the day under fallen timber, rocks, bark and in deep soil cracks. Probably active year round with the exception of the cooler months, with peak activity likely to be early summer through to the wet season. During dry times the snake can remain inactive in its shelter sites for long periods (months).

Survey methods

No survey methods are known to reliably detect the ornamental snake during dry weather/seasons. The species is most likely to be encountered by searching around suitable gilgai habitat while frogs are active. Driving roads at night, particularly after wet weather when frogs are active, may be necessary if wet weather precludes access to suitable (gilgai) habitat. Diurnal searches under sheltering sites (rocks, logs or other large objects on the ground) could also be employed. Pitfall and funnel trap arrays could be trialled. These methods are all likely to yield low returns.

It is recommended that all records be photographed and copies lodged with both the state National Parks Service and the Queensland Museum (Brisbane) for confirmation of identification.

Key references for Denisonia maculata

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Pedra Branca skink

Niveoscincus palfreymani

Summary information

Distribution: Pedra Branca Island 26 kilometres off the south-east coast of Tasmania.

Habit and habitat: Pedra Branca skinks are confined to small areas of the island which provide suitable shelter in the form of burrows under boulders and in deep crevices, or extensive tunnels in weathered dolerite (Rounsevell et al. 1985; Cogger et al. 1993).

Activity period: active all year when there is sun on the colonies. Probably active during the warmer parts of the day, from mid-morning onwards.

Survey methods

The only known population is managed and monitored by the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE). Should targeted surveys for this species be required, advice should be sought from DPIPWE.

Best surveyed by observations by direct sight on a sunny day. If capture is required, this can be done by catching in calico bags or small buckets with fish bait.

Similar species in range: none.

Key references for Niveoscincus palfreymani

Brothers, N., Wiltshire, A., Pemberton, D., Mooney, N., & Green, B. 2003. The feeding ecology and field energetics of the Pedra Branca skink (*Niveoscincus palfreymani*). *Wildlife Research*, 30, 81–87.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Rounsevell, D., Brothers, N. & Holdsworth, N. 1985. The status and ecology of the Pedra Branca skink, *Pseudemoia palfreymani*. In: Grigg, G., Shine, R. & Ehmann, H. (eds.). *Biology of Australasian Frogs and Reptiles*. pp 477-480. Surrey Beatty & Sons, Sydney.

Pink-tailed worm lizard

Aprasia parapulchella

Summary information

Distribution: recorded from a number of sites within the ACT (see Osborne & McKergow 1993), the Molonglo River to the north of the ACT/NSW border, near Tarcutta (see Osborne et al. 1991), Buddigower Nature Reserve near West Wyalong, and sites near Bathurst and Dubbo.

Habit and habitat: terrestrial, fossorial. Nearly all records for this species are from it having been found under shallowly embedded rocks.

In the Canberra region, the sites where the species occurs are characterised by: a cover of predominately native grasses (particularly kangaroo grass *Themeda triandra*); sparse or no tree cover; little or no leaf litter; and scattered small rocks lightly embedded in the soil surface, or resting on soil on top of more deeply buried rocks (see Osborne et al. 1991). It was found only in areas underlain by Mid–Late Silurian acid to intermediate volcanics and appeared to be most abundant where the surface rocks were well weathered with a considerable amount of fracturing, resulting in a high density of broken surface rock material. Small burrows were located under most rocks from which the species was recorded.

Individuals found at Tarcutta were from beneath exfoliations from granodiorite boulders (Osborne et al. 1991).

Activity period: The pink-tailed worm lizard can be found throughout the year by searching under rocks, however, it appears to be more difficult to detect during hot dry periods (Osborne et al. 1991). Peak activity is likely to be late spring and early summer under warm, but not overly dry, conditions. It is not active on the ground surface by day and would only be active between sheltering sites at night.

Survey methods

The following survey methodology was adopted by Osborne and colleagues (1991):

- searches restricted to an area of relatively homogeneous habitat within each site and a search beneath all rocks that can be turned is made.
- rock cover density rather than fixed area size determines a plot, and 150–200 rocks need to be turned to be reasonably confident of determining the species' presence.
- search success appears to be highest in spring and early summer on warm but not hot days, after a period of rainfall extending over several days.
- during summer months surveys are carried out in the mornings or on cloudy days when soil temperatures beneath the rocks are not too high.
- during late autumn and winter surveys are carried out on clear sunny days as warming of the rocks appears to attract individuals to the soil surface beneath the rocks.

Similar species in range: differentiation between the pink-tailed worm lizard and the Flinders Ranges worm lizard is on the basis of modal characteristics and mean values. Therefore, it is quite possible that single specimens might not clearly identify with one species or another. Individuals of the pink-tailed worm lizard from NSW and the ACT are recognised as belonging to the same species largely on the basis of geographic proximity, and are unlikely to be confused with any other 'limbless' species of lizard. Allocating individuals from

Victoria to one or the other species, particularly on the basis of single individuals from a location, appears to be less certain. Given the taxonomic uncertainty of the species, we would recommend tissue samples, several where possible, be taken from locations outside species core distribution (that is, areas other than the ACT and adjacent areas in NSW).

Key References for Aprasia parapulchella

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Osborne, W.S., Lintermans, M., & Williams, K.D. 1991. Distribution and conservation status of the endangered Pink-tailed legless lizard *Aprasia parapulchella* (Kluge). ACT Parks and Conservation Service. Research Report 5. 36 pp.

Osborne, W.S. & McKergow, F.V.C. 1993. Distribution, population density and habitat of the Pink-tailed legless lizard *Aprasia parapulchella* in Canberra Nature Park. ACT Parks and Conservation Service. Technical Report 3. 40 pp.

Retro slider

Lerista allanae

Summary information

Distribution: the species is known from three sites (Retro Station, Logan Downs, and Clermont) all in close proximity to one another between Clermont and Capella, Queensland (Covacevich et al. 1996). Recent surveys found the skink at new sites in general proximity to Retro Station (Borsboom et al. 2010).

Habit and habitat: habitat is described by Covacevich and colleagues (1996) as undulating downs (plains formed on Tertiary basalt, Permian shales, sandstone and unconsolidated sediments of the Oxford Land System). Early records of the skink (ca 1940s) describe its habitat as 'scattered timber and stone, stony coolibah ridges, heavy scrub with stony hills, some slope gullies and stone, plain, ti-tree scrubby and gravelly ridges, plain with lightly scattered bauhinia, black soil fairly heavy scrub, open tableland coolibah and bloodwood/open plain, inter alia...' (Queensland Department of Lands as cited in Covacevich et al. 1996). This habitat now appears to be extensively altered, and little original vegetation remains. Recent records of the skink were from leaf litter and friable surface soils beneath trees and shrubs (Borsboom et al. 2010). The soils for these recent records were described as chocolate to dark chocolate coloured non-cracking clay-based soils (30–64 per cent clay content) in Queensland regional ecosystems (REs) 11.8.5 and 11.8.11/11.8.5 or were from sites where these REs were mapped as cleared (Borsboom et al. 2010).

Time of year active: unknown but probably year round with the exception of the coldest months. Based on the habits of similar congeners, the Retro slider is probably nocturnally active.

Survey methods

Crepuscular burrowing species are usually recorded by raking surface soil under logs or at the base of bushes or trees, turning objects under which they shelter, raking leaf litter and associated surface soils or in pitfall traps. Appropriate survey methodology for detecting the presence of the Retro sider would be raking leaf litter and associated surface soils under trees and shrubs, raking surface soils under logs, loose surface rocks, corrugated iron, etc in combination with pitfall trapping at a time of year when the species is most likely to be active. If the survey is a targeted search for this species, a series of pitfall trap lines comprising six 10 litre buckets spread along a 15 metre fence would be adequate for detecting the species, although other pitfall trap arrays could be trialled. An artificial cover array (e.g. roof tiles, ply wood squares, etc) may be worth trialling where a longer survey period is possible.

Similar species in range: Couper and Ingram (1992) redefined the Retro slider, restricting it to the area between Clermont and Capella, and recognising a new species *Lerista colliveri* for a number of populations from just east of Townsville to Hughenden that were formerly placed under the Retro slider. The two species are distinguished by a combination of colour pattern and limb morphology. In the Retro slider, the forelimb is absent and the colour pattern of the body is marked by longitudinal lines of dark spots, whereas the forelimb of *L. colliveri* is still represented by a small stump or nubbin, and the dark longitudinal lines on the back are continuous. In the area between Clermont and Capella they also identify two other species of reduced-limbed skinks in the genus, *Lerista punctatovittata* and *Lerista fragilis*, as regionally sympatric with the Retro slider. The absence of forelimbs and presence of a hindlimb with a single clawed digit will readily distinguish the Retro slider from these, or any other reduced limb skink in the region such as *Anomalopus brevicollis*.

Given the similarity of the Retro slider and *Lerista colliveri*, support of potential records of either species by tissue samples and photo vouchers is recommended. These should be forwarded to the Queensland Museum for positive identification and databasing of the record. Tissue sampling should only be undertaken with appropriate ethics approval, state permits to collect and training in tissue preservation. Where possible, photo vouchers should include close-up colour shots of the limb areas, and the head, body and tail dorsally, ventrally and laterally. Dead specimens (e.g. roadkills) should be frozen and advice on preservation and lodgement sought from the Queensland Museum.

Key references for Lerista allanae

Borsboom, A.C., Couper P.J., Amey, A., Hobson, R & Wilson, S.K. 2010. Rediscovery of the endangered Retro Slider (*Lerista allanae*) in the Clermont region of central Queensland. Queensland Department of Environment and Resource Management and the Queensland Museum, Brisbane. 25 pp.

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Slater's skink

Liopholis slateri slateri

Summary information

Distribution: Extant populations of Slater's skink are known from the Northern Territory, from Finke Gorge National Park, Tempe Downs Station, Illamurta Springs Conservation Reserve, Owen Springs Reserve, sites on the Finke River and Ellery Creek near Hermannsburg, and Loves Creek Station. The species appears to have disappeared from some of the early collection locations, including the type locality near Alice Springs and a site on the Palmer River on Tempe Downs Station (Pavey 2007). Storr and colleagues (1990) reported *E. slateri* (subspecies not noted) from the Bungle Bungle Range in the Kimberley of Western Australia but Aplin and Smith (2001) noted that the identity of these specimens, recently collected, was uncertain, with some similarities to *E. striata*, a more likely identification on the basis of distribution. There also remains doubt over the distribution of the subspecies *E. s. virgata*. It is only known from three specimens that lack precise localities (Storr 1968, Shea ms.). However, the lack of any individuals within the samples of Slater's skink of known provenance resembling *E. s. virgata* in colouration suggests it is distinct, and has a separate distribution. This may include the Oodnadatta region of South Australia (Storr 1968).

Habit and habitat: At most known sites, Slater's skink occurs in shrubland on alluvial soils close to drainage lines. However, at Finke Gorge National Park the species has also been located on an isolated dune, low calcareous rises vegetated with Spinifex and on elevated narrow rocky creek lines (Pavey 2007). A recently discovered population on Loves Creek Station appears to be restricted to narrow creek lines which dissect low stony rises (P. McDonald pers. comm.). Slater's skink constructs a complex multi-entranced burrow system under small trees and shrubs, particularly *Eremophilas* (Pavey 2007). The burrows are dug into the mound of soil that generally forms underneath these shrubs. Animals hunt by sitting on the mound and waiting for prey to approach.

Activity period: not known, but likely to be most active during warmer weather, particularly during the likely spring/summer reproductive period (based on other desert members of the *E. whitii* species group). Slater's skink is diurnal to crepuscular.

Survey methods

Slater's skink burrow systems are readily identifiable once the field observer has become familiar with the typical size and shape of burrow entrances. The closely related desert skink *Liopholis inornata* will also construct a burrow system at the base of shrubs but this species only occurs on sandy soils and the burrow system is generally simpler with smaller entrances and a conspicuous 'fan' of loose substrate at the entrance to the main burrow (P. McDonald pers. comm.). Frequently, there will also be an external latrine (scat pile) in the vicinity of the burrow system of Slater's skink. Scat-piling behaviour is not commonly observed in other species of lizards that occur in sympatry with Slater's skink (P. McDonald pers. comm.). Once likely burrows are located, confirmation of the identity of the inhabitants could be gained by observations of sandy mounded shrubs. Pitfall trapping near known burrow systems may also be useful.

Pavey and colleagues (in preparation) have developed the following searching method to detect lizards as they bask during the day. The method is based on the fact that the species is an obligate burrower and a 'sit and wait' forager. The methodology consists of an observer initially looking for active or basking animals by scanning each mounded shrub containing burrows from a distance of >10 metres using a pair of 10 x 40 binoculars and then moving to within a distance of 5–6 metres and repeating the search. Finally, if no animal is seen, the observer moves to within 1 metre of the mounded shrub and thoroughly checks each burrow entrance to see if an animal is located partially out of the burrow. All mounded shrubs with burrows were searched using this method on each visit to each area containing potential suitable habitat for the species.

Similar species in range: Slater's skink is morphologically very similar to the desert skink *L. inornata*, but has a generally darker colour pattern of black streaks on a more muted grey-brown ground colour (vs a bright yellow-brown or red-brown ground colour). The venter is a paler dull blue-grey than the glossy white or pink-white venter of the desert skink. There are also statistical differences in average number of scales at midbody (37–44, usually 38 or 40 in *E. slateri*, vs 34–42, mean 37 in desert skinks), and central Australian desert skinks are usually smaller (maximum snout-vent length 79 millimetres, vs maximum 93 millimetres for Slater's skink) (Storr 1968).

Because of the subtle differences between the two species, it is recommended that any new locality for Slater's skink be verified with a tissue sample for DNA sequence extraction to confirm that the specimen is not the desert skink. Photo voucher specimens and tissue samples should be forwarded to the appropriate state museum for accession and positive identification.

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Striped legless lizard

Delma impar

Summary information

Distribution: The striped legless lizard is largely restricted to native grasslands in south-eastern Australia. In South Australia, the species is known from only two localities, Bool Lagoon Game Reserve and a nearby site east of Naracoorte (Shea 1991), and has not been recently collected (the Bool Lagoon specimens were taken before 1970). In Victoria, although there are a number of historical sites, the recent distribution is restricted to a few sites near Hamilton, Ballarat and Melbourne (Coulson 1990). In New South Wales, the species is known from sites near Goulburn (Husband 1995), Cooma (Shea 1993; Dorrough et al. 1996) and from non-recent records from the Tumut-Batlow region, near Yass and Sutton (Shea 1991; Osborne et al. 1993). In the ACT, it is known from a number of sites (Osborne et al. 1993; Osmond 1994; Nunan 1995; Ruahala et al. 1995).

Habit and habitat: in the ACT, the species has mostly been reported from areas of relatively undisturbed native grasslands, with a dense cover of perennial tussock grasses, particularly spear grass *Stipa bigeniculata* and kangaroo grass *Themeda triandra* (Kukolic 1991; Kukolic & Osborne 1993). The highest densities of the species were reported from sites with a *Themeda* ground cover of more than 70 per cent (Kukolic 1991); although Ruahala and colleagues (1995), using association analysis, considered that the presence of *Stipa* was a more important indicator of core habitat. The striped legless lizard in the ACT has rarely been located at sites without *Stipa*, although it has been suggested that the introduced *Phalaris aquatica*, in the early stages of its replacing native species, may be able to be utilised temporarily by the striped legless lizard (Ruahala et al. 1995)

Victorian populations, as well as those in the Cooma region of NSW, inhabit sites with basalt rocks in the grassland and cracking clay soils. In these regions, the species shelters under rocks and in earth cracks (Coulson 1990; Kutt 1992; Dorrough et al. 1996).

Occasional records have come from exotic pastures (Coulson 1990; Husband 1995), although these are often close to native grassland or have been left unploughed for many years (Kukolic 1991).

Activity period: this species shows strong seasonal activity, with most pitfall trap records coming from the period October to November (Osborne et al. 1993). They have also been collected from under basalt rocks in the Cooma area during the same time (Dorrough et al. 1996). Other individuals collected opportunistically by hand have been found during cooler months (April to August) when they have apparently been hibernating (Coulson 1990; Husband 1995). This interpretation accords with the observations on captive animals in outdoor enclosures in the Melbourne area (Banks et al. 1999), which were rarely observed during the period May to September.

Observations on captive animals suggest that the species is most active in the morning and early afternoon, and prefers high temperatures for activity and basking (ground temperatures up to 45°C; Banks et al. 1999), and this accords with opportunistic observations of the activity of lizards in the field (Coulson 1990). In contrast, Jenkins and Bartell (1980) suggest the species is nocturnal in warm weather; however, other of their statements on the biology of this species, such as diet, have proven to be inaccurate (Coulson 1990), and this statement is also considered suspect.

Survey methods

The striped legless lizard is a cryptic species and may not be detected by surveys even when present at a site. Reference sites may need to be monitored during the expected active period of the species and used to guide survey timing at the target site(s).

Visual observation of active individuals is generally unsuccessful, due to the dense vegetation preferred by the species, together with its small size (Kutt 1993). Early records were mostly from ploughing activities and gardening activities (Coulson 1990). Given the damage to the habitat resulting from such activities, they are not recommended for surveys.

Surveys for the striped legless lizard are primarily undertaken during the active period of the species (between September and May). Some survey techniques (such as active searching) may be undertaken during the cooler months of the year, but often with less success.

In areas with surface rock, artificial shelter site surveys or rock turning should be the primary technique (with supplementary techniques employed as appropriate). However, rock turning can be detrimental to striped legless lizard populations, especially when undertaken regularly. Therefore, this method should be used only when other methods are unavailable and it should never be employed for long-term monitoring.

In areas with little to no rocky habitat (such as the ACT), artificial shelter site surveys or pitfall trapping should be used in conjunction with hand searches around tussocks. Detection rates using artificial shelter sites are nearly double that of pitfalling when undertaken during spring.

Artificial shelter sites should be installed at least three months prior to the initial survey/checks (that is, by June). They should typically be placed in vegetated areas (not bare ground). In Victoria, the Department of Sustainability and Environment recommends at least six months of survey.

Tile grids should consist of 50 tiles, at five metre spacing between tiles, arranged in a grid of 10 tiles by five, preferably positioned on a northerly aspect. As a minimum, two tile grids should be used for sites less than 2 hectares in size, one grid per 3 hectares for sites up to 30 hectares, and 10 grids for sites greater than 30 hectares in size.

Artificial shelter sites should be checked at least twice a month, and ideally once a week during spring to early summer (that is, between early September to December). Shelter sites should not be checked more than once a week as this may lead to striped legless lizards abandoning the artificial shelters. Shelter sites should be checked when ambient temperatures do not exceed 28 °C. Grids may be checked during summer/autumn for the presence of shed skin.

Active searching (checks under surface rock and debris and around tussocks) can generally be undertaken throughout the year as long as any limitations with respect to this survey technique are clearly outlined. Surveyors need to ensure that rocks, logs and other refugia are placed back in the same position. This technique has a low success rate and usually leads to disturbance of refuge sites. It should only be used where necessary. Dorrough and colleagues (1996) reported a success rate for locating the species of approximately one individual per 150 rocks. Further, studies on another species of *Delma* (collared delma *D. torquata*) reported that *Delma* were rarely found under rocks at sites on which rocks had recently been turned, suggesting that rock-turning had at least a short-term detrimental effect on utilisation of this resource by the species (Porter 1998). Consequently, rock-turning and hand collection are only considered useful as an adjunct to pitfall trapping or artificial shelter site surveys.

Pitfall trapping is typically conducted in vegetated areas (not bare ground), and is undertaken in warmer months (September to January). Each pitfall should have a minimum drift line of 5 metres. Various pitfall configurations can be used, but should include up to five pits per configuration. As a minimum, two pitfall configurations should be used for sites less than 25 hectares in size, with a minimum of 10 pitfall traps. At least 50 pitfall configurations should be used for sites greater than 25 hectares. Daily checks should be conducted for at least 10 days, though a longer survey period (28 days) is preferable to detect populations at low abundance.

Trapping success rates during the active period (centred over November to December) are of the order of 0.3–0.4 striped legless lizards per 100 trap days (Kutt 1992, 1993) in Victoria, but are generally higher in the ACT, between 0.1–5.65 per 100 trap days, and usually greater than 1.0 (Rauhala et al. 1995; Dunford 1998; Rauhala 1996, 1997, 1999).

There is some evidence that rainfall patterns may reduce lizard activity, with repeated trapping in November to December at sites in the ACT over several years showing low capture rates in drought years (Rauhala et al. 1995), but recovering subsequently (Rauhala 1999). Surveys in November to December may be male-biased in capture rates, particularly in November (Rauhala 1999).

In addition to pitfall traps actually trapping the species, a number of individuals have been found inhabiting the soil gap between the buckets and the holes (Rauhala et al. 1995).

Similar species in range: The striped legless lizard occurs sympatrically with *Delma inornata*, though rarely (Osborne et al. 1993; Rauhala et al. 1995; Rauhala 1996, 1999). *D. inornata* has a wider range of habitat preferences (Osborne et al. 1993). The two species may be distinguished by colour pattern and the configuration of scales on the snout (Cogger 2000), although both coloration and head scalation are subject to some variation (Coulson 1990), and the latter requires at least a hand lens for examination. The striped legless lizard usually has the nasal scale fused to the first supralabial scale anterior to the nostril, and usually has several well-defined narrow pale dorsolateral and lateral stripes along the body, broadly edged with dark brown or black. These markings are poorly developed or absent in juveniles.

It is also possible that small individuals of this species could be confused by inexperienced investigators with the pink-tailed worm lizard *Aprasia parapulchella*, which occurs in the same region in NSW and the ACT, and shares with the striped legless lizard fusion of the nasal and first supralabial scales, and 14 midbody scales. It may be differentiated from *Delma* species by having a median scale between the first pair of infralabial scales behind the mental scale on the lower jaw, and by lacking wide ventral scales on the body. Again, these are features that may require magnification.

Because of the potential for confusion with other species, it is recommended that any new site for the species, particularly if founded on juvenile individuals, is verified by a tissue sample for positive identification.

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Striped-tailed delma

Delma labialis

Summary information

Distribution: between the Paluma-Rollingstone area and Mt Abbot on the Queensland mainland, and on Magnetic Island, South Molle Island, Shaw Island and Keswick Island (Shea 1987; Couper et al. 2000).

Habit and habitat: poorly known. Individuals have been collected or observed in low open forest with a grassy understorey, near beaches, on dry, very open rocky hill slopes, seasonally dry paperbark tea-tree *Melaleuca viridiflora* swamp, and in wet sclerophyll forest, suggesting a wide range of habitats are inhabited by the species. They have been found under sheets of tin on the ground, and active on the ground (Shea 1987; data associated with Queensland Museum specimens).

Activity period: possibly peaking in spring (presumed breeding season), but not definitely known. The two type specimens were collected in April and August, and subsequently collected individuals have been found in May, June, July, September and December (single records for each month). Individuals have been observed active by day (Shea 1987), according with knowledge of most other *Delma* species.

Survey methods

Data on this infrequently collected species is insufficient to assess the efficacy of potential collection methods given that most individuals have turned up serendipitously. However, on the basis of collection methods for other *Delma* species, it is likely that the striped-tailed delma could be collected by a combination of active hand-searching under sheets of tin and other large items on the ground such as rocks and logs, and by pitfall trapping. If the survey is a targeted search for this species, a series of pitfall trap lines comprising six 10 litre buckets spread along a 15 metre fence would likely be adequate for detecting the species, although it is probable that trap returns would be very low (see trap success for striped legless lizard *D. impar*, Atherton delma *D. mitella* and collared delma *D. torquata*).

Similar species in range: the species overlaps in distribution with two other *Delma* species, *D. tincta* and the Atherton delma *D. mitella*. It differs from both in having a narrow dark dorsolateral stripe along the tail, and pale bars on the lips and side of the neck (some *D. tincta* may have the latter markings as well). The snout is also more slender and elongated than either *D. tincta* or the Atherton delma. Within its known distribution, it could also be confused by inexperienced surveyors with juvenile Burton's legless lizard *Lialis burtonis*, but differs from this species in both the coloration features noted above. Given the paucity of records and their serendipitous nature, it is possible that the distribution of this species could be more extensive than currently reported, and tissue samples are recommended for any records beyond the known distribution.

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Three-toed snake-tooth skink

Coeranoscincus reticulatus

Summary information

Distribution: recorded from a number of sites in south-east Queensland and north-east NSW. Cogger and colleagues (1993) provide a more detailed summary of distribution to that time.

Habit and habitat: The three-toed snake-tooth skink is a fossorial species. It is usually found sheltering under leaf litter or moist rotting logs or in loose friable soil beneath sheltering sites. It is usually recorded from rainforest habitat on loamy basaltic soils, and wet sclerophyll forest supporting a rainforest understorey, a vegetation type typically located adjacent to rainforest. It has also been recorded from moist forest on sands at Cooloola, and from coastal open forest on sand at Crescent Head in NSW.

Activity period: peak activity is likely to be late spring and early summer under warm, but not overly dry, conditions. It is not active on the ground surface by day and would only be active between sheltering sites at night.

Survey methods

Crepuscular burrowing species are usually recorded by turning objects under which they shelter, or in pitfall traps. The species has been recorded a number of times (but never commonly) by turning rocks or fallen timber on the ground and raking the surface layer of soil. It has also been collected in pitfall traps during the course of general biodiversity survey work in the Border Ranges region in 1988, 1989 and 1993. An estimate of catch rate is not available but is expected to be low.

Detection of the species by active searching relies on the presence of suitable sheltering sites. For this reason it is recommended that this approach not be relied on solely, and be used in combination with pitfall trapping.

Similar species in range: the three-toed snake-tooth skink is a moderately large and elongate skink with very short limbs and only three digits on each limb. It is unlikely to be confused with any other species of skink within its range other than Verreaux's skink *Anomalopus verreauxii*, a species of similar size and proportions, but with only one digit on the hindlimb (see Swan et al. 2004), which also tends to occupy drier habitats.

The three-toed snake-tooth skink's distribution in the core of its range is reasonably well documented, but recent records from Crescent Head (nearly 200 kilometres south of its former southern limit and in a different habitat to that normally occupied) indicate its range and habitat preferences are still not fully understood. For these reasons we recommend tissue samples be taken when recorded outside of the species' core distribution around the Border Ranges and Brisbane Ranges.

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Western spiny-tailed skink

Egernia stokesii badia

Summary information

Distribution: this subspecies, as originally described, is restricted to the northern Wheatbelt of Western Australia, from Mullewa area south to Kellerberrin, with isolated records from Callagiddy on the lower Gascoyne and Dirk Hartog Island (Storr 1978). The taxonomic status of mainland populations from the Northern Territory, South Australia, New South Wales and Queensland is indeterminate, although they are geographically isolated from Western Australian western spiny-tailed skink. The name *E. s. zellingi* is available for them (Cogger 2000), should they prove to be different. The threatened conservation status assigned to the western spiny-tailed skink refers only to the Western Australian populations.

Habit and habitat: terrestrial, inhabiting timber and rock crevices. Habitat data is available only for a few individuals of this subspecies. One individual from Buntine Nature Reserve was found in a hollow log in gimlet *Eucalyptus salubris* and salmon gum *E. salmonophloia* woodland on a light clay soil (Chapman & Dell 1979). Several individuals were found near Wubin and Dalwallinu in piles of old mallee roots (possibly transported into the district) (Nankivell 1976). The isolated Callagiddy Station record comes from a region vegetated with *Acacia* scrub (Brooker & Estbergs 1976).

Activity period: there is no data on activity patterns for this subspecies, with most individuals located in sheltering sites. It is diurnal and probably active most of year, except winter months. The greatest activity is probably in spring/summer, coinciding with the breeding season (based on knowledge of eastern Australian populations of *E. stokesii*: Duffield & Bull 1996).

Survey methods

The paucity of data on the habitat preferences of this subspecies hampers recommendations on appropriate survey techniques. Eastern Australian populations of *E. stokesii* are most common around rock outcrops, sheltering in narrow crevices and under exfoliations. However, most of the few data for the western spiny-tailed skink suggests that this subspecies is most common in woodland habitats, sheltering in timber crevices (in hollow logs and piles of mallee roots). There is no evidence from any population of *E. stokesii* that the species is readily trapped, except by Elliot traps placed in close proximity to known individual sheltering sites, as the species seems to venture only short distances from refuge sites over short periods for feeding. Given that the initial difficulty (see below) is to locate individuals, it is likely that thorough searching of likely sheltering sites (hollow logs and roots, piles of timber, and hollow trees/branches, and possibly rock outcrops) over long time periods will give the best results.

Because individuals are mostly likely to be encountered in sheltering sites, it is not likely that time of year will greatly affect the success of surveys.

It is likely that very few individuals will be located during surveys. During an extensive series of surveys of isolated nature reserves in the Western Australian Wheatbelt (the core of the subspecies' distribution) between 1971 and 1976, the species was only recorded in a single reserve (the second largest of the 24 reserves surveyed) (Chapman & Dell 1985). Only a single individual was recorded during 27 days of intensive hand collecting spread over three field trips (August to September, May and July) by experienced reptile collectors (Chapman & Dell 1979).

Similar species in range: as for the Baudin Island spiny-tailed skink, this subspecies is only likely to be confused with the pygmy spiny-tailed skink *E. depressa*, or with other subspecies of *E. stokesii* should they occur on the mainland. Because of the latter possibility, particularly in the Shark Bay area, any new localities for this region should be accompanied by a tissue sample for genetic analysis.

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Storr, G.M. 1978. The genus *Egernia* (Lacertilia, Scincidae) in Western Australia. Records of the Western Australian Museum 6(2): 147-187.

Western swamp tortoise

Pseudemydura umbrina

Summary information

Distribution: recorded only from scattered localities in a narrow strip of the Swan River coastal plain, Western Australia. Found in areas with largely alluvial soil, running from Perth Airport at Guildford to near Pearce Royal Australian Air Force Base at Bullsbrook (Burbidge & Kuchling 2003). Now only known from Ellenbrook Nature Reserve, north-east of Perth city, and Twin Swamps Nature Reserve (the latter the result of a recent re-introduction program after natural population numbers crashed).

Habit and habitat: the species inhabits shallow, ephemeral, winter and spring wet swamps on clay or sand over clay soils with nearby suitable aestivation sites (Burbidge & Kuchling 2003).

Activity period: tortoises are active in the water after the swamps fill in June or July and remain active feeding throughout spring. They are active in the afternoon, generally from 2.00 pm to 5.00 pm. They leave the water to begin aestivation on land when the swamps are nearly dry and water temperatures rise above 28°C, usually in November. At Twin Swamps, nearly all individuals tracked spent the hot summer months underground in rabbit burrows and moved from these in April to May to spend the latter part of autumn under leaf litter, fallen branches, or dense low bushes (Burbidge & Kuchling 2003). Eggs are laid in November or early December and hatchlings emerge the following autumn or winter during or after heavy rain.

Survey methods

The only acceptable and successful trapping method is to set up lines of mesh drift fences (for example, 10-millimetre black plastic mesh) with pitfall traps or collapsible turtle traps to catch the western swamp tortoise in seasonal swamps (Kuchling 2003). If free water is available, collapsible turtle traps (Figure 1) should be attached to drift fences. Collapsible traps are joined to the drift fence by threading a metal stake through netting and fence mesh. Traps work best when water is deep enough to cover the throat of the trap. Traps have been designed to lie flush with the substrate and, if necessary, the position of the bars can be lowered. This design allows these traps to be set in shallower water than conventional traps. If trap sites dry out, pitfall traps can be dug alongside the drift fence. Small branches should be added as escape structures for trapped mammals (Burbidge & Kuchling 1996).

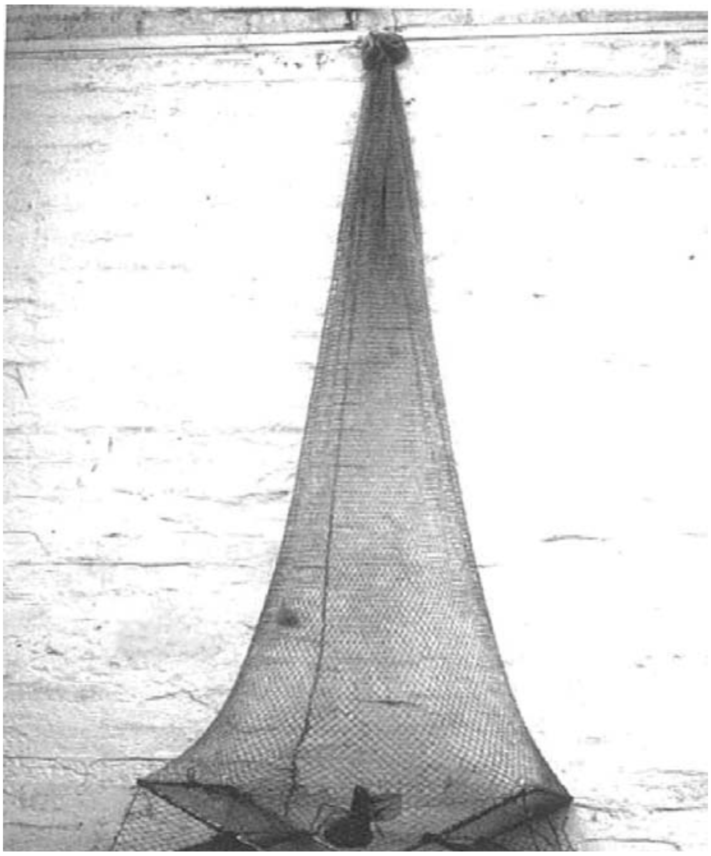

Figure 1: picture of collapsible turtle trap (reproduced with permission from Kuchling 2003).

This methodology also eliminates the risk of harming trapped turtles. Trapped turtles remain in the water so they are not subject to desiccation, direct solar radiation, or predation. The height of the net removes the possibility of drowning turtles when water levels suddenly rise due to flooding (Kuchling 2003).

Similar species in range: none.

Key references for Pseudemydura umbrina

Burbidge, A.A. & Kuchling, G. 2003. Western Swamp Tortoise Recovery Plan. Revised 3rd Edition. Western Australian Wildlife Management Program No. 37, Department of Conservation and Land Management, Perth.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Kuchling G. 2003. A new underwater trap for catching turtles. Herpetological Review 34: 126-8.

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Yakka skink

Egernia rugosa

Summary information

Distribution: the available distribution records (Ingram & Raven 1990) suggest a discontinuous, patchy distribution across Cape York Peninsula; central, mid-east, south-central and south-east Queensland. Determinants of distribution are not known.

Habit and habitat: this species is the least known of the large *Egernia* species. The species occurs in a wide variety of vegetation types including poplar box (*Eucalypus populnea*), ironbark, brigalow (*Acacia harpophylla*), cypress pine (*Callitris glaucophylla*), mulga (*A. aneura*), bendee (*A. catenulata*) lancewood (*A. shirleyi*) woodlands and open forests. Substrates can include rock, sand, clay and loamy red earth (QMDC 2008, Ehmann 1992; Schmida 1985; Hoser 1989; Wilson & Knowles 1987; Cogger 2000; Swanson 1976). They can persist in cleared land where shelter sites exist, such as log piles, however as they are long-lived and colonial their continued persistence in cleared areas is uncertain.

Colonies of presumably related individuals share a system of burrows dug under or between partly buried rocks or logs (especially very large logs, if available), into old root tracts or at the base of large trees or stumps (QMDC 2008). They may also utilise old rabbit warrens, deep gullies and tunnel erosion and sinkholes. Burrows around artificial structures such as under sheds, loading ramps and stick-raked piles are also common.

Ehmann (1992) and Wilson and Knowles (1987) report that the Yakka skink, like several related species, has communal defecation sites near permanent burrows.

A variety of habitats has been reported for this species, but most fall under the general theme of rocky or lateritic substrates on slopes, with dry sclerophyll forest, open forest, woodland or shrubland (Ehmann 1983; Schmida 1985; Hoser 1989; Wilson & Knowles 1987; Cogger 2000; Swanson 1976). Data associated with Queensland Museum specimens includes the following habitat descriptions: 'low closed scrub in gully, dead timber on ground, good grass cover, eucalypt forest adjacent' (QM J36991), 'red laterite ridge, lancewood open forest, jumbled boulders' (QM J44956) and 'open woodland (ironbark) in foothills of range, near creek' (QM J24010).

Activity period: Schmida (1985) states that the species is most active during the early morning and late afternoon, while Ehmann (1992) reports personal observations of both diurnal and (on warm nights) nocturnal activity.

The species is especially wary and will quickly retreat into its burrow shelter sites if it sees movements or disturbance.

Nothing is reported on a seasonal activity pattern, but Queensland Museum specimens have been collected in November (two), December (one), February (three) and March (two), perhaps suggesting a peak in activity in late spring and summer, like other large *Egernia* species.

Survey methods

Searching for burrow systems and communal defecation sites is the most reliable method of detection. The species can be confirmed by Elliott trapping around the burrows, by distant observation with binoculars or by shining a torch down the burrows at night. Burrows seem to often be located in situations where excavation of the burrow system to locate the lizards is impractical.

Similar species in range: this large skink is unlikely to be mistaken for any other species. The only other large skinks found within or close to its range are members of the *E. cunninghami* group (*E. cunninghami*, *E. hosmeri*) both of which have a spinose tail, *E. frerei*, which has less rugose scalation, and fewer scales at midbody (24–28 vs 30–36), and the eastern blue-tongue *Tiliqua scincoides*, which has a banded colour pattern. It is conceivably possible that juveniles could be mistaken for adult tree skinks (*Egernia striolata*) which occur within the distribution of the Yakka skink. However, tree skinks have a much more depressed head and body.

Potential records of the Yakka skink should be supported by a good quality colour photograph. Photo vouchers – including burrows (macro and microhabitat) and latrine sites – should be forwarded to the Queensland museum for positive identification and databasing of the record.

Key references for Egernia rugosa

Adler, K.K. 1958. Observations on the Australian genera *Egernia* and *Tiliqua* in captivity. Ohio Herpetological Society Trimonthly Report 1(3): 9-12.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

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Queensland Murray darling committee (QMDC) 2008. *Yakka skink.* Available online at www.qmdc.org.au/publications/download/47/fact-sheets-case-studies/reptile-recovery/yakka-skink.pdf

Schmida, G. 1985. The cold-blooded Australians. Doubleday Australia, Lane Cove.

Swanson, S. 1976. Lizards of Australia. Angus & Robertson, Sydney.

Wilson, S.K. & Knowles, D.G. 1988. Australia's Reptiles. A photographic reference to the terrestrial reptiles of Australia. William Collins, Sydney.

Yellow-snouted gecko

Lucasium occultum

Note: A recent genetic-based review of the complex of diplodactylid geckos that includes *occultum* has recognised it as part of a discrete group to which the generic name *Lucasium* is applicable (Oliver et al. 2007).

Summary information

Distribution: North-west of Kakadu National Park and the Wildman Reserve, Northern Territory (DEWHA 2010).

Habit and habitat: a nocturnal species active at night on the ground, and presumably sheltering by day beneath debris on the ground, in earth cracks or in spider burrows in the ground (as for related species of *Lucasium*). Habitat has been described as open forest dominated by Darwin woollybutt *Eucalyptus miniata* and Darwin stringybark *Eucalyptus tetrodonta* (DEWHA 2010). Association with well developed leaf litter and grasses was made for early records of the species (King et al. 1982), and later records from the Wildman Reserve include sites with a sparse to moderate cover of introduced gamba grass.

Activity period: the yellow-snouted gecko is a nocturnal species. Peak activity is likely to be between sunset and the first three hours after dark. It is probably active year round, with reduced activity in the coldest months. Peak activity is likely to be late spring and early summer.

Survey methods

Given the species is active on the ground at night, it could be searched during the part of the year when it most likely to be active by walking transects at night with a powerful torch mounted on binoculars to detect eye shine. This method is effective at detecting ground diplodactylids in open habitat types. It could also be searched for by walking with a gas light held low to detect moving individuals in the sphere of light cast by the lamp, a method more usually employed in the arid zone.

The species has also been recorded during pitfall trapping surveys of vertebrates and could be surveyed using a pitfall trap line comprising shallow (5 litre) buckets 5 metres apart and a low drift fence to intercept and direct animals to the buckets. However, capture rates reported from a number of fauna surveys in the Kakadu and Mary River region (DEWHA 2010) have been extremely low and call into question the effectiveness of this method for detecting the presence of the yellow-snouted gecko. Further, lizards caught in shallow buckets are likely to be subject to greater predation pressure by wild dogs, monitor lizards or birds.

Similar species in range: the only small gecko in the far north of the Northern Territory that the yellow-snouted gecko is likely to be confused with is the crowned gecko *Lucasium stenodactylum*. The yellow-snouted gecko is readily distinguished from the crowned gecko by its unusual back pattern and coloration of four large light brown pale patches with darker brown interspaces along the body (vs light reddish brown overall with pale vertebral markings forming a stripe down the body), and rectangular lamellae under the toes (vs small and granular in the crowned gecko).

Potential records of the yellow-snouted gecko should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (Northern Territory Museum) for positive identification and databasing of the record.

Key references for Lucasium occultum

DEWHA. 2010. *Lucasium occultum* in Species Profile and Threats Database, Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra. Available from: www.environment.gov.au/sprat. Accessed 2010-01-19T10:34:40.

King, M., Braithwaite, R.W. & Wombey, J.C. 1982. A new species of *Diplodactylus* (Reptilia: Gekkonidae) from the Alligator Rivers region, Northern Territory. Transactions of the Royal Society of South Australia. 106:15-18.

Oliver, P.M., Hutchinson, M.N. & Cooper S.J.B. 2007. Phylogenetic relationships in the lizard genus *Diplodactylus* Gray and resurrection of *Lucasium* Wermuth (Gekkota, Diplodactylidae) Australian Journal of Zoology 55: 197–210.

Yinnietharra rock dragon

Ctenophorus yinnietharra

Summary information

Distribution: known only from a small area on Yinnietharra Station, east of Carnarvon, Western Australia.

Habit and habitat: terrestrial. Inhabits low rounded granitic outcrops, often less than 1 square metre in area, and lower than 0.5 metres high, where it shelters in narrow crevices in the rock, or under thin exfoliations on the outcrops. It appears not to inhabit more massive metamorphic outcrops in the same area, which are inhabited by the ring-tailed dragon *Ctenophorus caudicinctus* (G. Shea & M. Peterson pers. obs.).

Activity period: not studied, but on the basis of its closest relative, the ornate dragon *C. ornatus*, it is likely to be active at ground temperatures above 29°C (Bradshaw & Main 1968). The Yinnietharra rock dragon is diurnal.

Survey methods

Active individuals may be observed on and around the rock outcrops on warm days (spring to summer) (Hanlon, in Storr 1981; M. Peterson pers. comm.). In colder weather, they are readily observed in the rock crevices. The thin exfoliations on many of the low outcroppings are readily damaged by lifting, and hence it is preferable to examine the crevices between outcrop and exfoliation by torchlight or reflected sunlight from an angled mirror, without lifting the exfoliation. The available habitat for this species is limited.

Pitfall trapping, a common trapping technique for many surface-active lizards, is likely to have only limited success with this species because of the very rocky habitats inhabited, which limits placement of buckets.

Similar species in range: only three other species of *Ctenophorus* occur within the distribution of the Yinnietharra rock dragon: central netted dragon *C. nuchalis* (also known in some references as *C. inermis*), western netted dragon *C. reticulatus* and ring-tailed dragon *C. caudicinctus* (M. Peterson pers. comm.). The Yinnietharra rock dragon differs from all three in having a much flatter head and body. Male Yinnietharra rock dragons have alternating broad black and white rings on the distal half of the tail. It can be further differentiated from the central netted dragon and western netted dragon by habits: both of the latter two species inhabit burrows in sandy and sometimes stony soils.

Key references for Ctenophorus yinnietharra

Bradshaw, S.D. & Main, A.R. 1968. Behavioural attitudes and regulation of temperature in Amphibolurus lizards. Journal of Zoology 154: 193-221.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra. 254 pp.

Peterson, M. Personal Communication.

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Storr, G.M. 1981. Three new agamid lizards from Western Australia. Records of the Western Australian Museum 8(4): 599-607.

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Bauer A. & Sadlier R. 1992. The use of mouse glue traps to capture lizards. Herpetological Review 23, 112–113.

Briggs S. V. 1996. Native Small Mammals and Reptiles in Cropped and Uncropped Parts of Lakebeds in Semi-arid Australia. Wildlife Research 23, 629-36.

Hobbs, T. J., Morton, S. R., Masters, P. & Jones K. R. 1994. Influence of pit-trap design on sampling of reptiles in arid spinifex grasslands. Wildlife Research 21, 483-9.

Kennet, R. 1992. A new trap design for catching freshwater turtles. Wildlife Research 19, 443-5.

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MacNally R. & Horrocks G. 2002. Proportionate spatial sampling and equal-time sampling of mobile animals: a dilemma for inferring areal dependence. Austral Ecology 27: 405–415.

Milton, D.A. 1980. A comparison of three techniques used in a reptile survey of the Conondale Ranges. Victorian Naturalist Vol 97 26-31.

Morton, S. R., Gillam, M. W., Jones, K. R. & Fleming M. R. 1988. Relative Efficiency of Different Pit-Trap Systems for Sampling Reptiles in Spinifex Grasslands. Wildlife Research 15, 571-7.

NSW Department of Environment and Conservation (NSW DEC) 2004. 'Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities' (Working draft). Department of Environment and Conservation, New South Wales.

Paltridge, R. & Southgate, R. 2001. The effect of habitat type and seasonal conditions on fauna in two areas of the Tanami Desert. Wildlife Research 28, 247-60.

Resources Inventory Committee 1998. Resource Inventory Fundamentals. Components of British Columbia's Biodiversity No. 1. Resources Inventory Branch, Ministry of Environment, Lands and Parks, British Columbia.

Royle J.A. & Nichols J.D. 2003. Estimating abundance from repeated presence-absence data or point counts. Ecology 84: 777–790.

Saffer V.M. 2002. Community involvement in the assessment of the health of selected remnants in south-western Australia. Western Australian Naturalist 23: 237.

Thompson, G. G. 2007. Terrestrial vertebrate fauna surveys for the preparation of environmental impact assessments; how can we do it better? A Western Australian example. Environmental Impact Assessment Review 27, 41-61.

Thompson, G. G. & Thompson, S. A. 2007. Usefulness of funnel traps in catching small reptiles and mammals, with comments on the effectiveness of the alternatives. Wildlife Research 34, 491-7.

APPENDIX

State and territory survey guidelines and documents used to inform development of the survey guidelines for Australia's threatened reptiles.

State or territory	Source and year	Title
NT	Biodiversity Conservation Division, Department of Infrastructure, Planning and Environment. 2005.	Draft Guidelines for the Biodiversity Component of Environmental Impact Assessment.
	Department of Infrastructure, Planning and Environment. 2002.	Biodiversity Unit Summary of Fauna Survey methods: Northern Territory.
	Department of Infrastructure, Planning and Environment. 2002.	Bioregional Surveys Habitat and Vegetation Structure Proforma.
	Department of Infrastructure, Planning and Environment. 2002.	Biodiversity Unit Summary of Fauna Survey methods: Southern: Northern Territory.
WA	Environmental Protection Authority. 2004.	Guidance Statement No. 56. Terrestrial fauna surveys for environmental impact assessment in Western Australia.
	Morris, K.D. 1992.	How to survey and collect data from potential fauna management areas.
	Burbidge et al. 2000.	Biodiversity of the Carnarvon Basin.
TAS	Nature Conservation Branch of Department of Primary Industries, Water and Environment. 2001.	Brief for Flora and Fauna Consultants: Evaluation of the impact of proposed development activities.
QLD	Eyre et al. 1997.	Proposed Vertebrate Fauna and Microhabitat Survey Methodology for Comprehensive Regional Assessment, SE Queensland.
	Environmental Protection Agency (Southern Region). 1999.	Gold Coast City Council Planning Scheme Policy: Guidelines for preparing ecological site assessments during the development process.
	Environmental Protection Agency. 2002.	Guidelines for Flora and Fauna Surveys.
	House & Smith. 1997.	Biodiversity assessment in managed forests - a review of methodologies appropriate for Montreal criteria and indicators
	Brisbane City Council. 2009.	Guidelines for Ecological Assessment Reports.
	Environment Protection Agency. 2008.	Draft Terms of Reference for an environmental impact statement.
	QLD CRA/RFA Steering Committee. 1998.	Systematic Vertebrate Fauna Survey Project. Stage 1 – Vertebrate Fauna Survey in the South East Queensland Bioregion.

State or territory	Source and year	Title
SA	Owens, H. 2000.	Guidelines for Vertebrate surveys in SA.
VIC	No formal fauna survey guidelines currently available	
ACY	No formal fauna survey guidelines currently available	
NSW	Department of Environment and Conservation. 2007.	NSW Threatened Species Survey and Assessment Guidelines: Field Survey methods.
	Department of Environment and Conservation. 2004.	Threatened Species Survey & Assessment: Guidelines for Developments and Activities. Working Draft.
	National Parks and Wildlife Service. 1997.	NSW Comprehensive Regional Assessments Vertebrate Fauna Surveys 1996–1997 Summer Survey Season Field Survey methods - Amended January 1997.
	Department of Land and Water Conservation. 1997.	Interim Guidelines for targeted and general flora and fauna surveys under the *Native Vegetation Conservation Act 1997.*
	NSW Agriculture. 1998.	Guideline 10 – Animal care guidelines for wildlife surveys.
	State Forests NSW. Undated.	Terms of Licence under the *Threatened Species Conservation Act 1995* Lower North East Region.
	Wyong Shire Council. 1999.	Flora and Fauna Guidelines for Development - Wyong Shire Council.
	Murray et al. 2002.	Flora and Fauna Survey Guidelines – Lower Hunter Central Coast Region. Lower Hunter and Central Coast Regional Biodiversity Conservation Strategy.
	Ecotone Ecological Consultants. 2001.	Lower Hunter and Central Coast Regional Biodiversity Conservation Strategy - Fauna Survey and mapping project Module 1-Fauna Surveys.
	National Health and Medical Research Council. 2004.	Australian code of practice for the care and use of animals for scientific purposes.

Note 1: The NT Department of Infrastructure, Planning and Environment is now the NT Department of Nature Resources, Environment, the Arts and Sport; the NSW Department of Environment and Climate Change is now the NSW Department of the Environment, Climate Change and Water and incorporates the former National Parks and Wildlife Service; the NSW Department of Land and Water Conservation is now the NSW Department of Water and Energy; NSW Agriculture is now part of the NSW Department of Primary Industries; State Forests NSW is now part of the NSW Department of Primary Industries. Note 2: Because legislation and government policy is frequently updated, it should not be assumed that Table 2 provides the most recent survey guidelines available. Investigators should check with the relevant authorities prior to undertaking surveys.

Consultation with fauna experts from tertiary institutions and at relevant state and territory departments and agencies was undertaken to determine the most appropriate survey techniques and survey effort for the detection of nationally threatened reptiles. This approach aimed to fill in the gaps identified during the review of existing state and territory fauna survey guidelines and to obtain the most current information with regard to the effective survey of specific rare species. The information obtained from personal communications as well as from published and unpublished reports regarding threatened species was incorporated into the species accounts and forms the basis for these guidelines.

Photo Credits

FRONT COVER IMAGES (left to right)

Brigalow scaly-foot (Tim McGrath) Grassland earless dragon (Tim McGrath) Yinnietharra Rock-Dragon (Steve Wilson).

BACK COVER IMAGES (left to right, top to bottom)

Olive Python (Cathy Zwick & the Department of Sustainability, Environment, Water, Population and Communities) Pygmy Blue-tongue Lizard (Steve Wilson) Mary River Turtle (Steve Wilson) Grassland earless dragon (Tim McGrath).




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