Terrestrial Vertebrate Surveys – some design and analysis considerations

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“What entities to measure and how they should be measured is best guided not by a generic framework but rather by well-defined and scientifically tractable questions” (Lindenmayer and Likens 2010)

Background to the presentation

Field survey techniques

Recording the vertebrate fauna assemblage in a potential impact area - trapping and trapping layout patterns, digging in effects, trap hygiene, trap deaths, disease risk

- Trapping site layout - design considerations for assemblage detections,
- Drift fences
- Pit-traps
- Funnel traps
- Cage traps
- Aluminium box traps
- Incidental observations
- Spotlighting

Format of the presentation

- **General considerations of survey design and approach**
- **Methodologies employed for mammals and reptiles**
- **Considerations of ethics**
- **Basic analytical considerations**

General considerations - Standards for vertebrate surveys

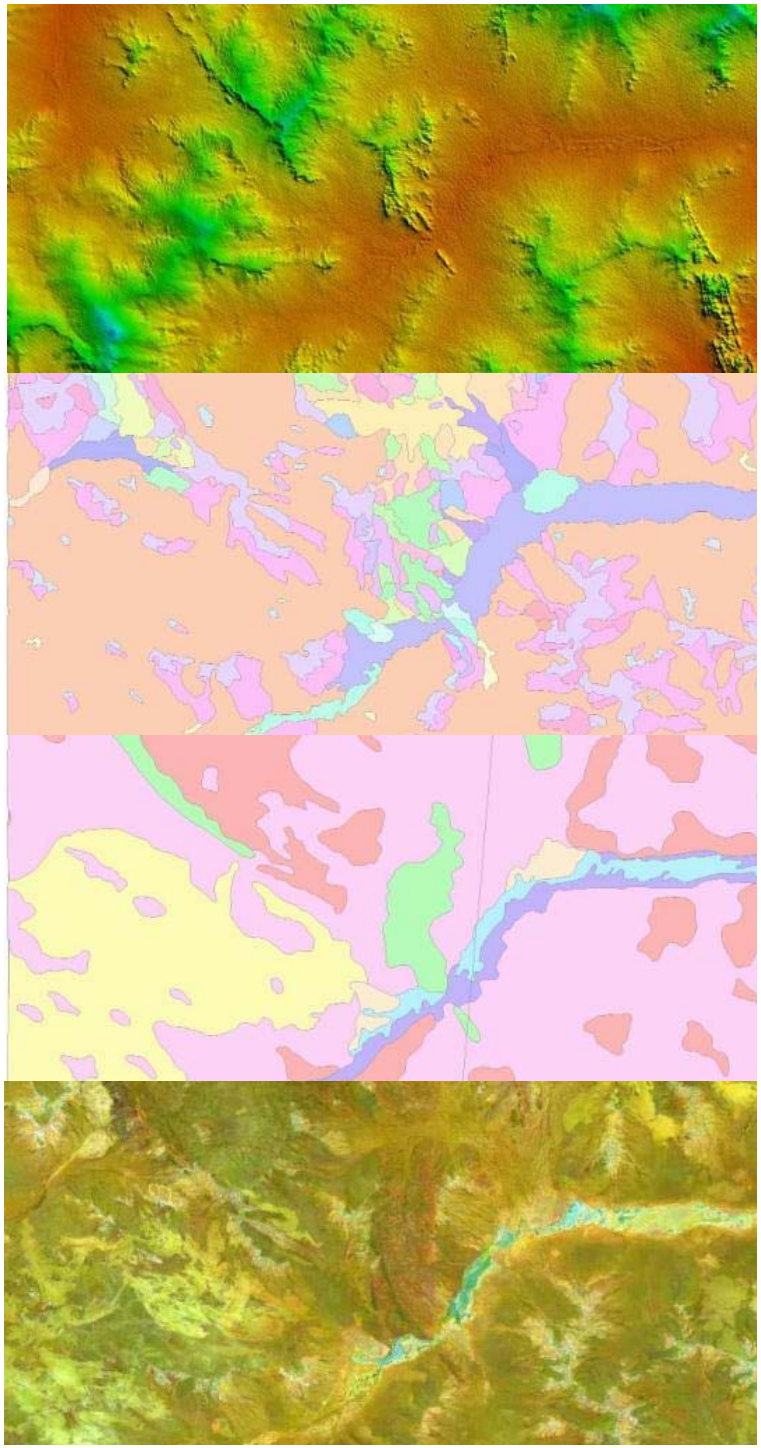
Project objectives are met by appropriate design and sampling methods

- Considerations of sampling
  - Stratified
  - Replicated
  - Repeatable
  - Verifiable

“Most information for least effort”

General considerations - Site Selection

- Examination of available spatial data.
  - Digital elevation models
  - Landsystem mapping
  - Vegetation mapping
  - Satellite imagery
  - Aerial Photography
  - Surface geology
- Fire History
- Climate data
- Reconnaissance of predetermined sites



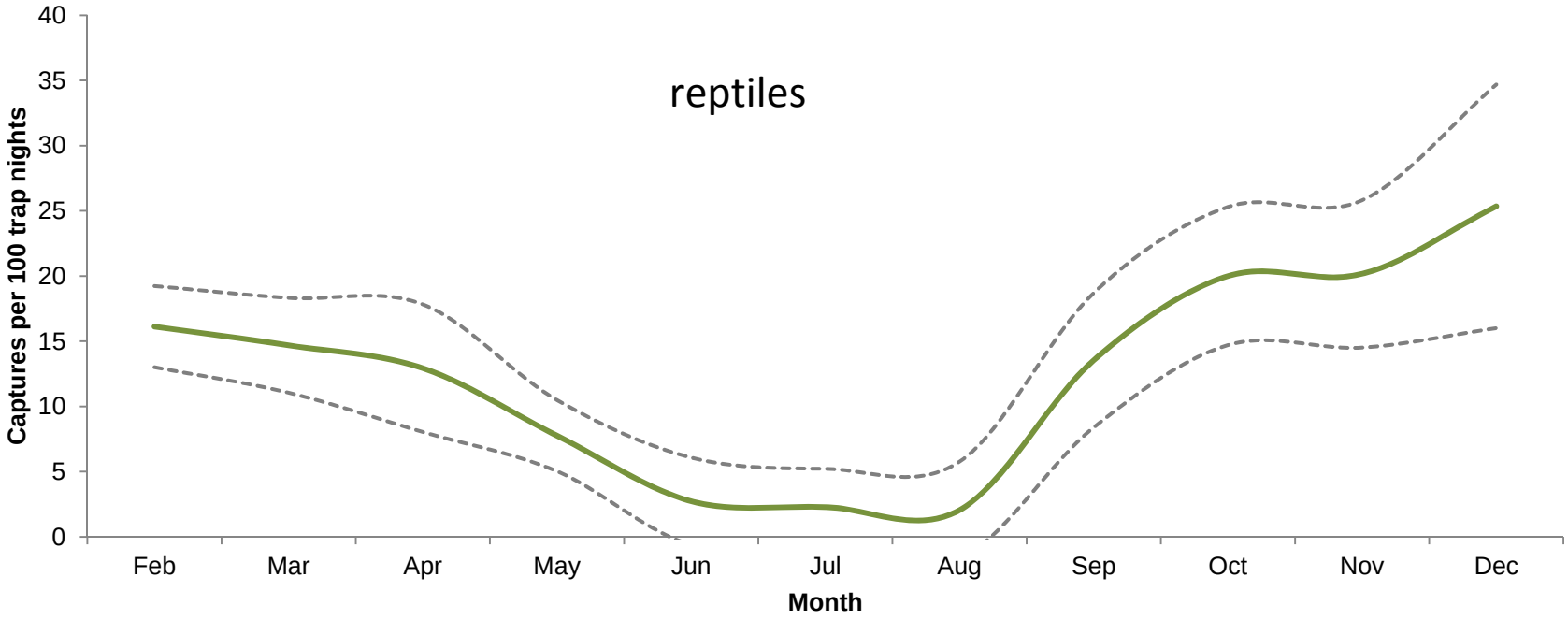
General considerations - Species group and major survey detection methods

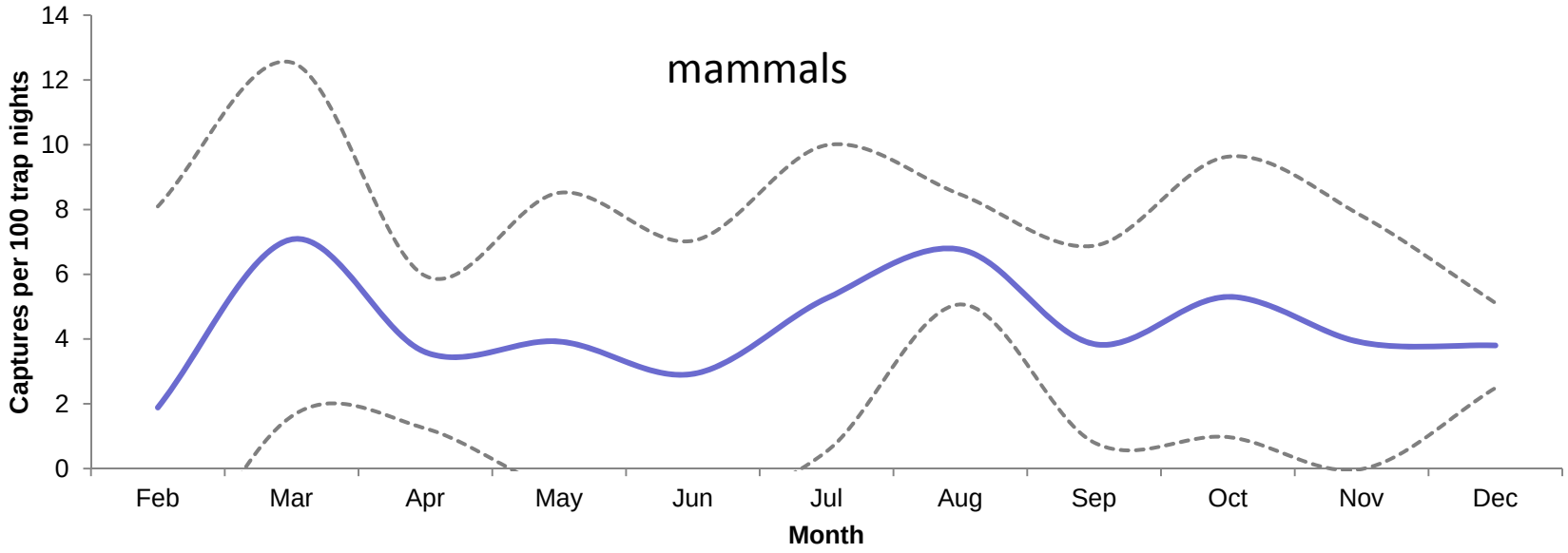
Group	Pit traps	Funnel Traps	Medium Aluminium Box	Large Aluminium Box	Cage	Spot-lighting from vehicle	Spot-lighting on foot	Head torching	Diurnal Observation/ Active Searching	Searching for tracks & signs etc	Sound/ calls	Recording Techniques including Anabat	Mist netting	Harp traps	Trip lines	Remote camera	Hair tubes
Small Mammals < 30g (eg Sminthopsis)	X		X			S	S			S						S	S
Medium Mammals <2500g (eg Isoodon)	S		X	X	X	X	S			X						S	S
Large Mammals >2500g (eg Petrogale)				X	X	X	S	S	X	X						S	S
Bats (Megachiroptera)									X				X		X		
Bats (Microchiroptera)							S	S	X			X	X	X	X		
Birds						S	S		X	S	X	S	S				
Small snakes <45cm(eg Parasuta)	X	X				X	X	X	X								
Medium-Large Snakes> 45cm (Demansia)		X				X	X	X	X	S							
Small –medium Lizards <150mm(eg Pogona)	X	X	S			S	S	X	X								
Large lizards>150mm (Varanus)	S	X		S	S	S	S	S	X	X							
Frogs	X	S				S	S	X	X	S	X	X					

Environmental Protection Authority and Department of Environment and Conservation (2010) *Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (eds B.M. Hyder, J. Dell and M.A Cowan). Perth, Western Australia.

http://www.epa.wa.gov.au/EPADocLib/3281_Faunatechnicalguide.pdf

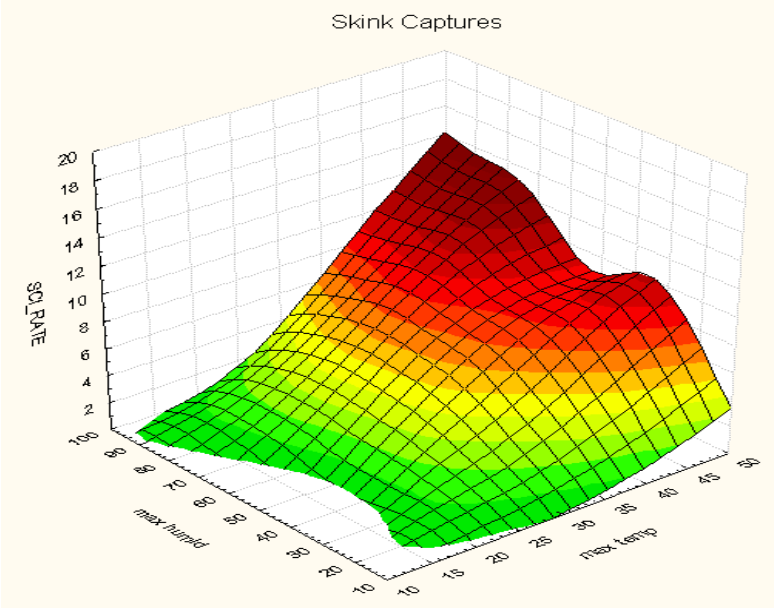
General considerations-seasonal capture of reptiles and mammals

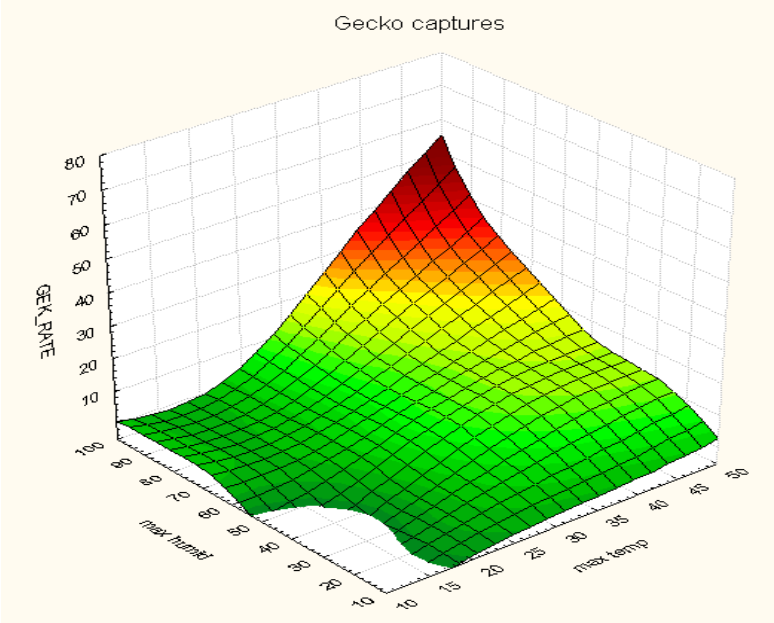




General considerations-humidity and temperature

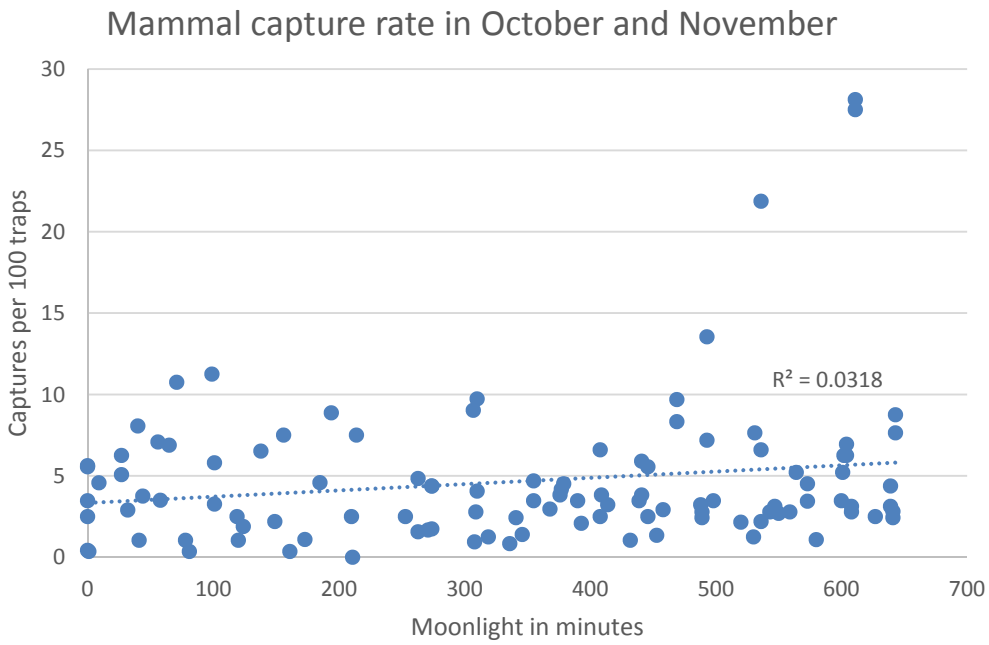
- Interpolated surfaces for skinks and geckos from the Murchison Bioregion
- Data derived from more than 200 trap nights using 2666 captures for skinks and 3743 for geckos
- Skinks show moderate increases in activity from temperature alone
- A combination of humidity and temperature are associated with high captures of geckos

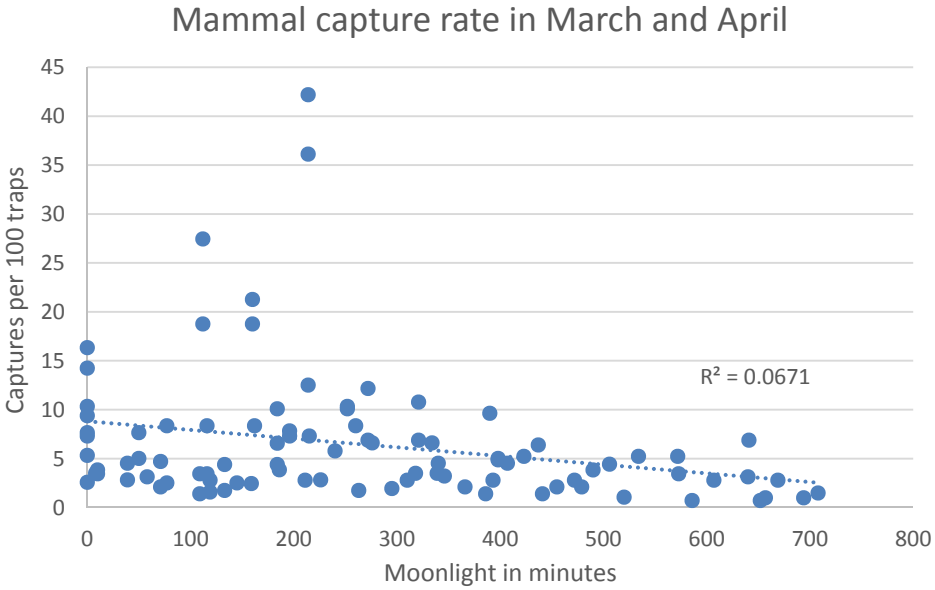




General considerations-moonlight

- Frequently asserted that bright moonlight decreases mammal captures.
- Complex to analyse
- Examined pit capture rates in two seasons
- No significant change with moonlight in either season.





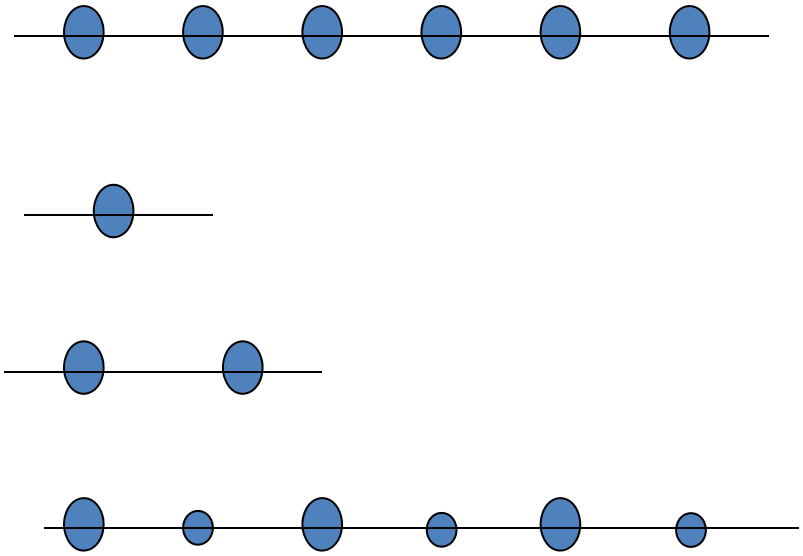
General considerations - Summary

Methodologies must be appropriate to the objectives of the study

- Considerations should be given to
  - Knowledge of the natural history
  - Trophic niche of the group considered
  - Seasonality
  - Temperature
  - Humidity
  - Moon phase

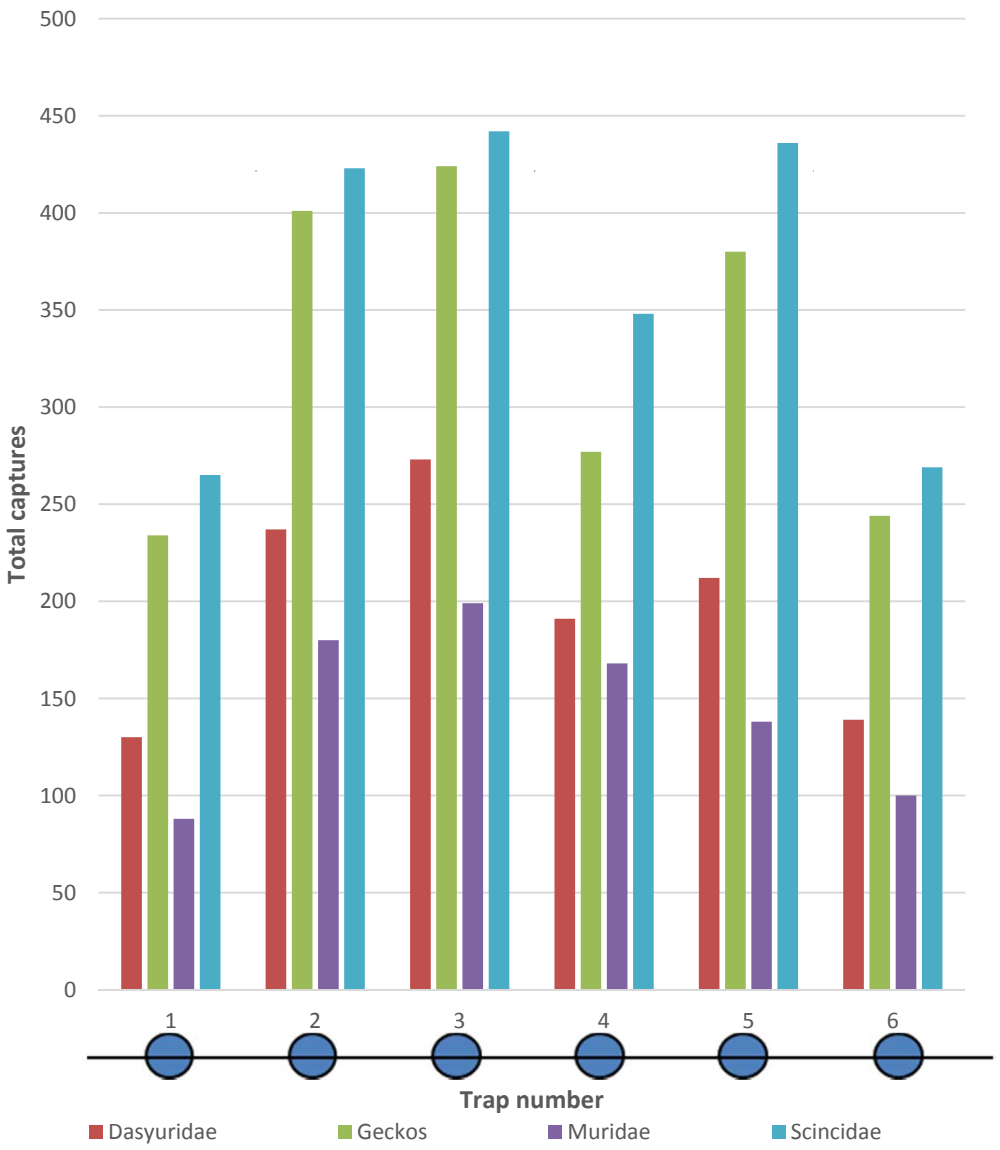
Methodology - Pit and funnel traps

- Distance between traps
- Alternating trap types
- Trap type efficiency
- Continuous lines versus individual traps or other designs
- Number of traps per site
- Number of trap days

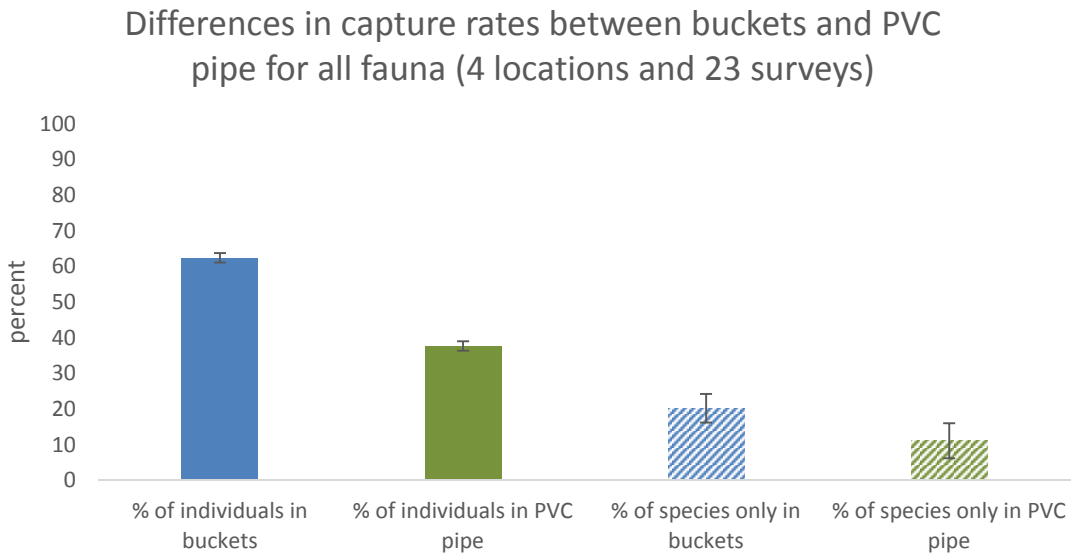


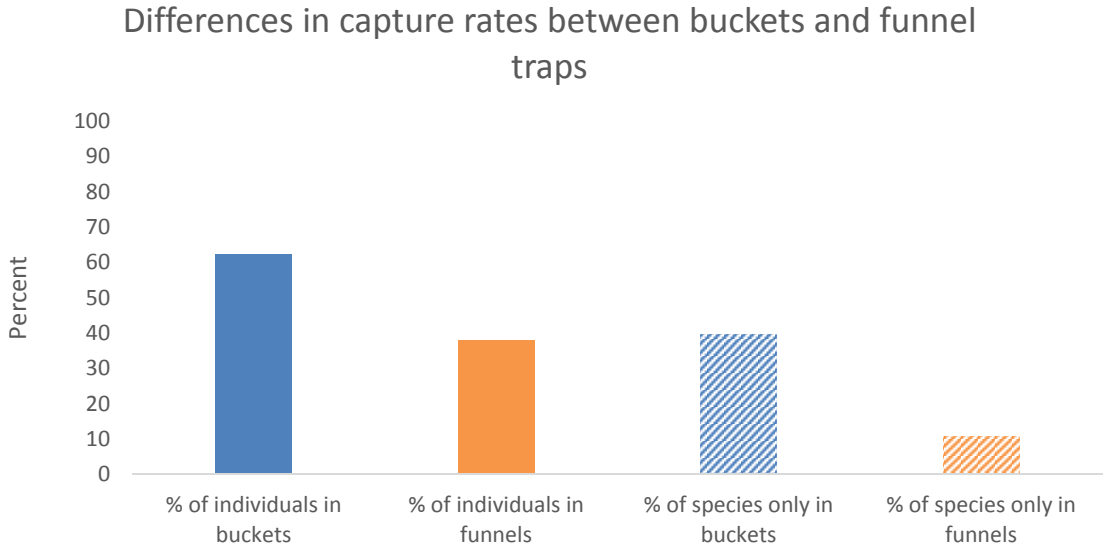
Methodology – Pit trap position

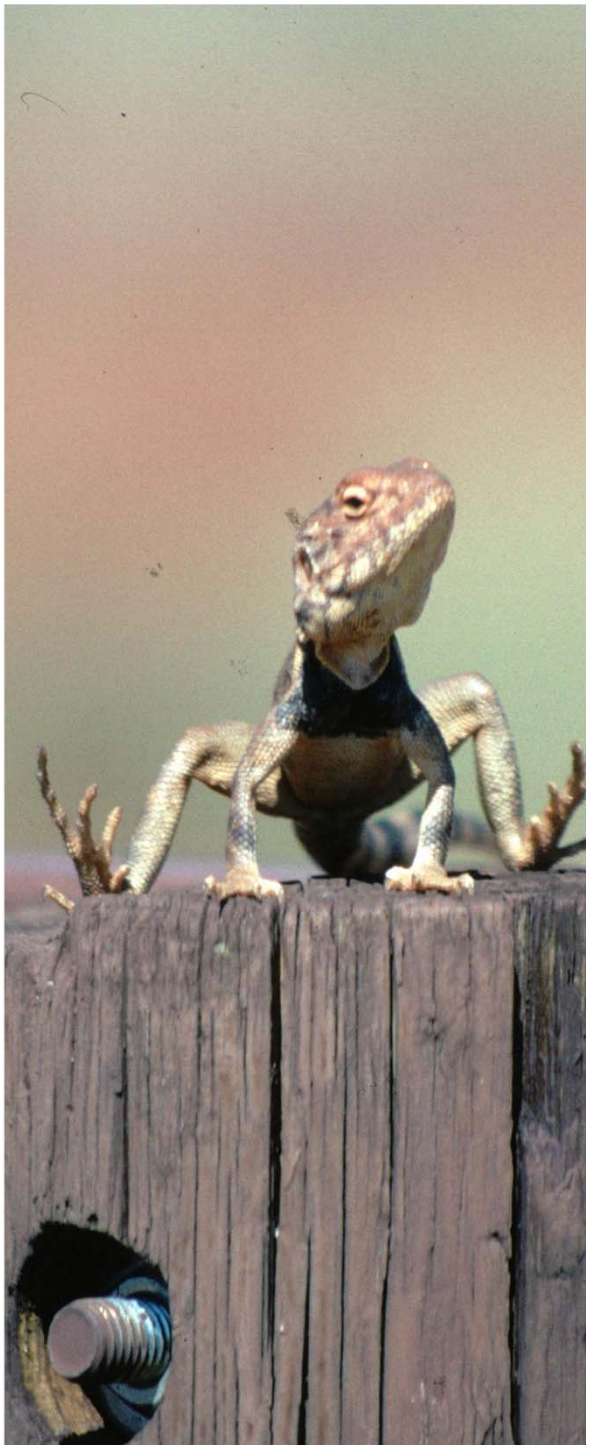
- Capture rates in relation to trap position
- Data is from Lorna Glen and accumulated for 48 pit lines
- Inside traps capture significantly more than end traps
- End traps capture ~ 2/3 of inside traps



Methodology – Buckets, PVC Pipe & Funnels

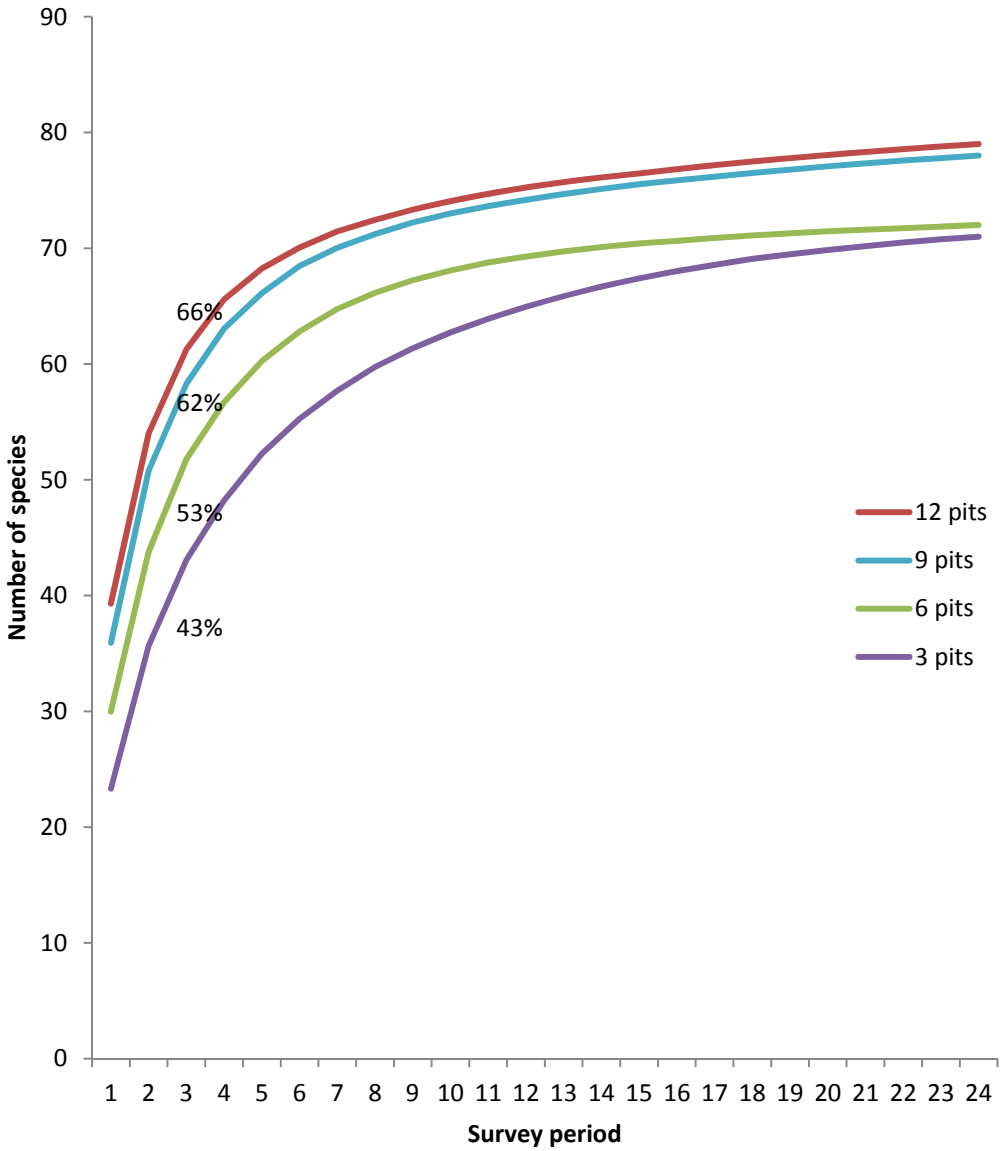






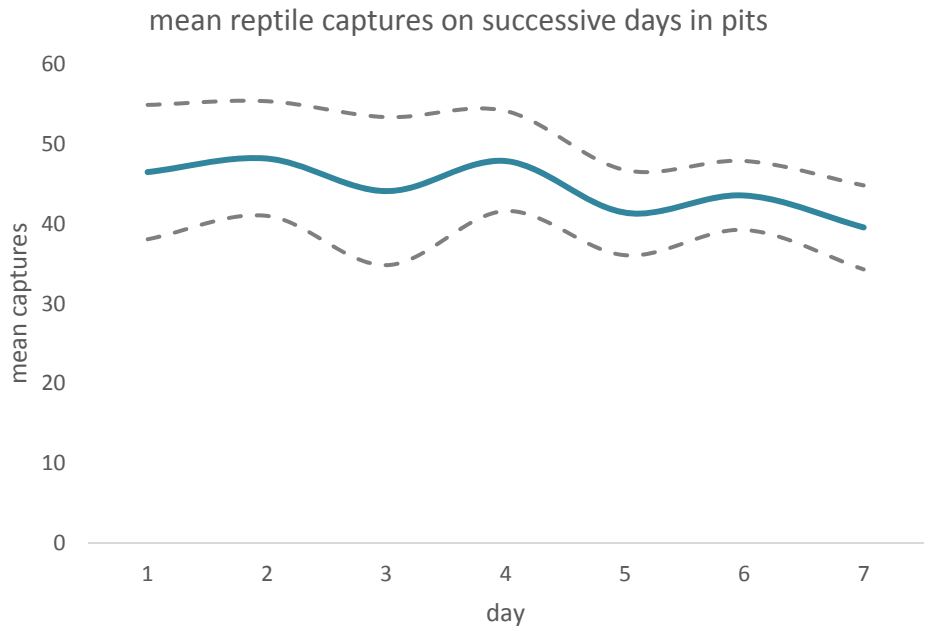
Methodology – Number of pits

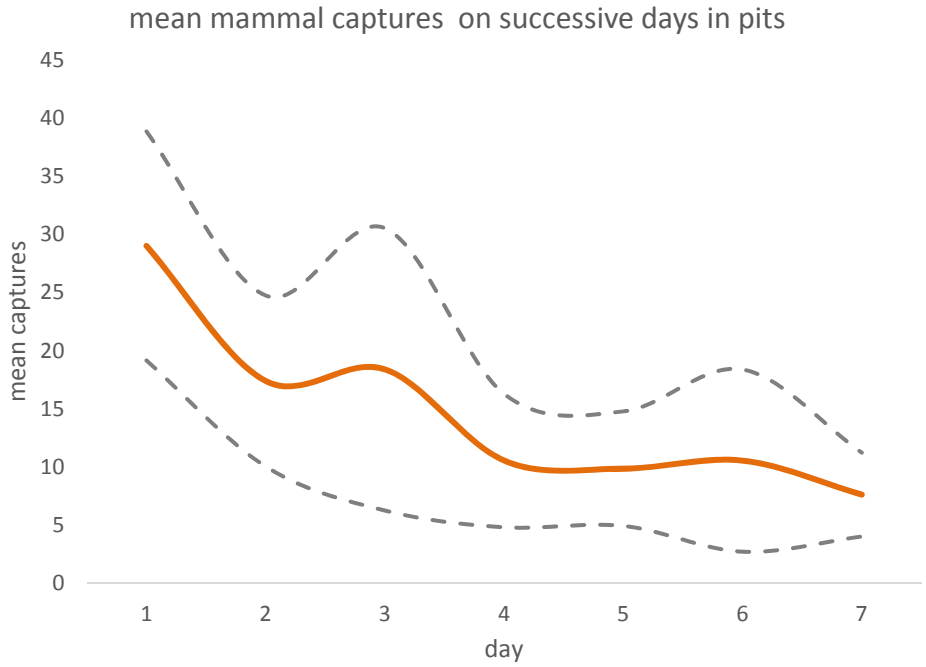
- Data from a species rich environment
- Predicted total number of species from the Chao1 estimator is 82
- Number of species caught is 79 for reptiles and small mammals
- Increasing number of traps increases species accumulation



Methodology- captures on sequential days

- 13 survey periods with 24 sites and 12 across two lines at each site
- 4043 reptile captures
- 1343 mammal captures
- There is little reduction in capture rates for reptiles
- Mammals show a marked reduction





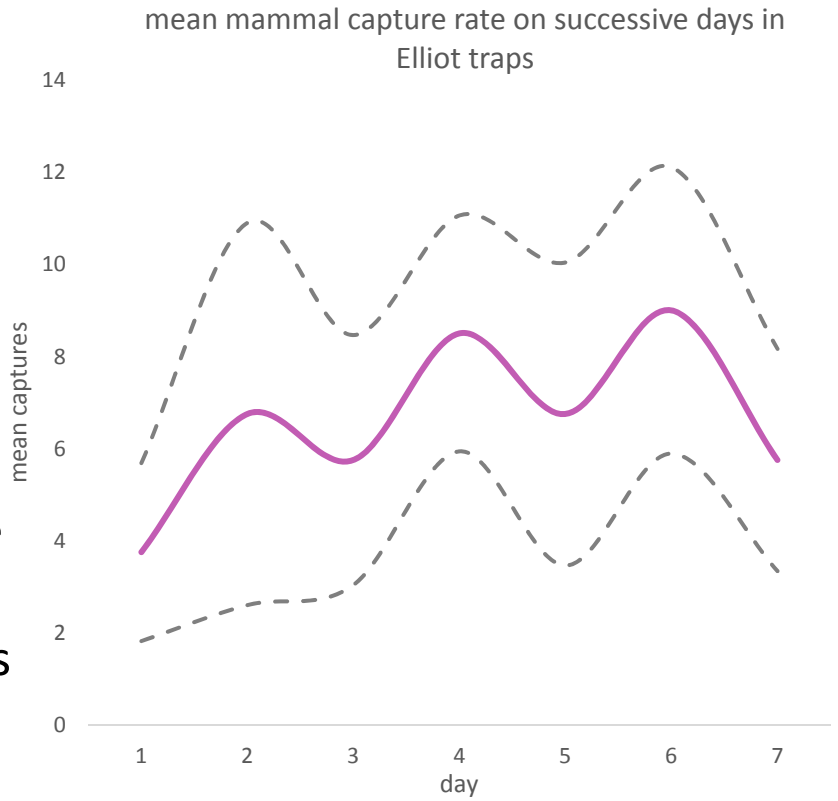
Methodology - Mammal trapping

Focus on Elliott traps and cages

- Density, type and arrangement of traps has to reflect objectives of survey
- Effective for larger mammals and rodents, less effective for small dasyurids (eg *S. longicaudata*)
- In areas where no large mammals remain pits are generally better.
- Variable species response to trap type and timing

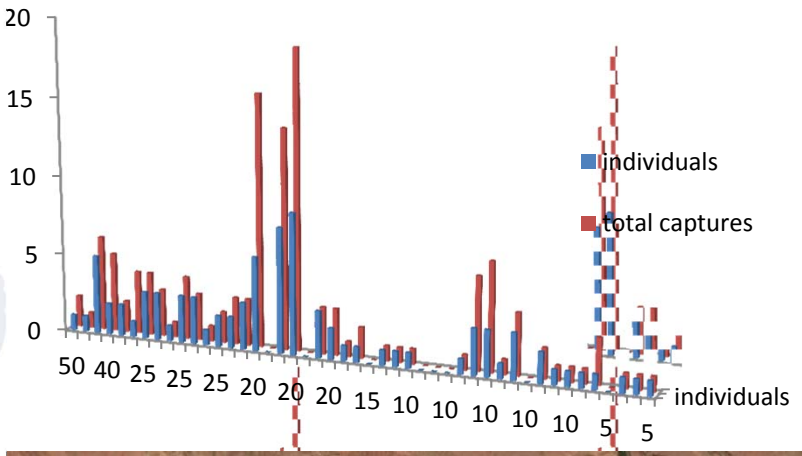
Mammalian considerations- Elliott captures on successive days

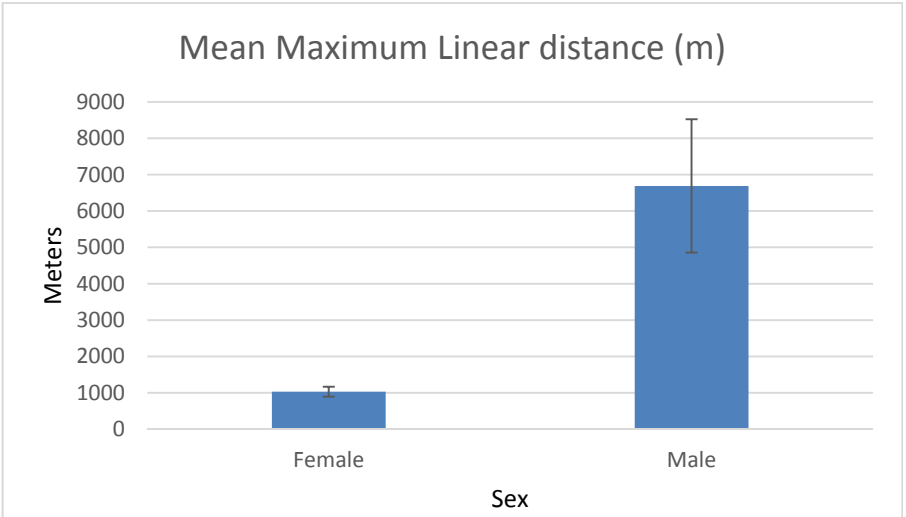
- Data from four surveys with 12 Elliott traps at each of 24 sites
- Traps run for 7 consecutive nights
- A total of 185 small mammal captures
- Quite variable but trend is opposite to that of pit traps with increased capture rates over successive nights

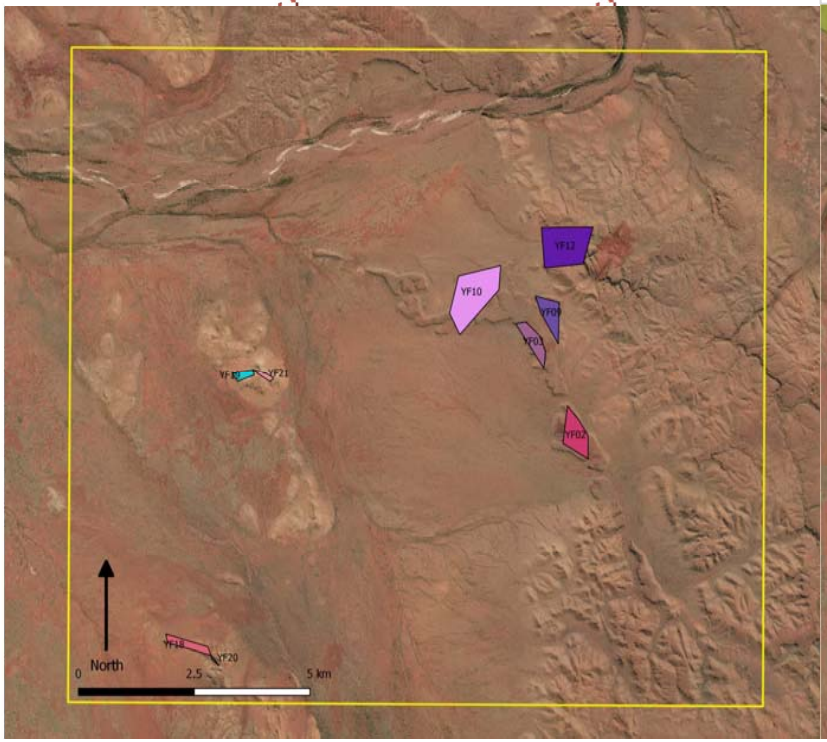


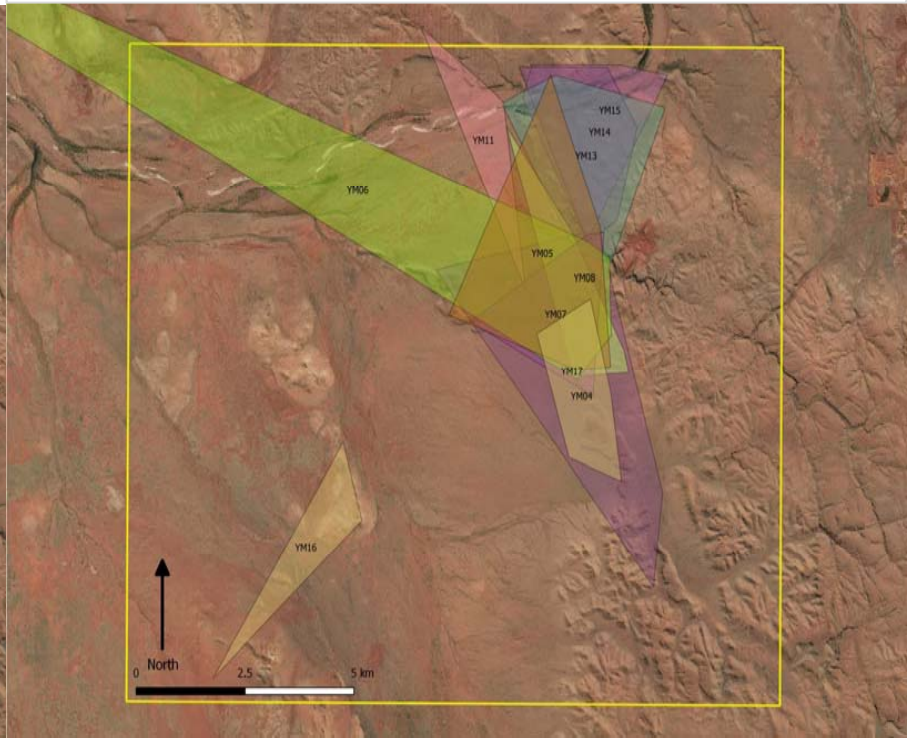
Mammalian considerations – *D. hallucatus* monitoring

Individual and total captures of quolls with different trap numbers









Mammalian considerations – non invasive methods

- Cameras
- Searching for sign
- Hair tubes (targeted)
- Sand pad surveys (difficult to identify many species reliably)
- Spotlighting/ head torching
- Incidental records

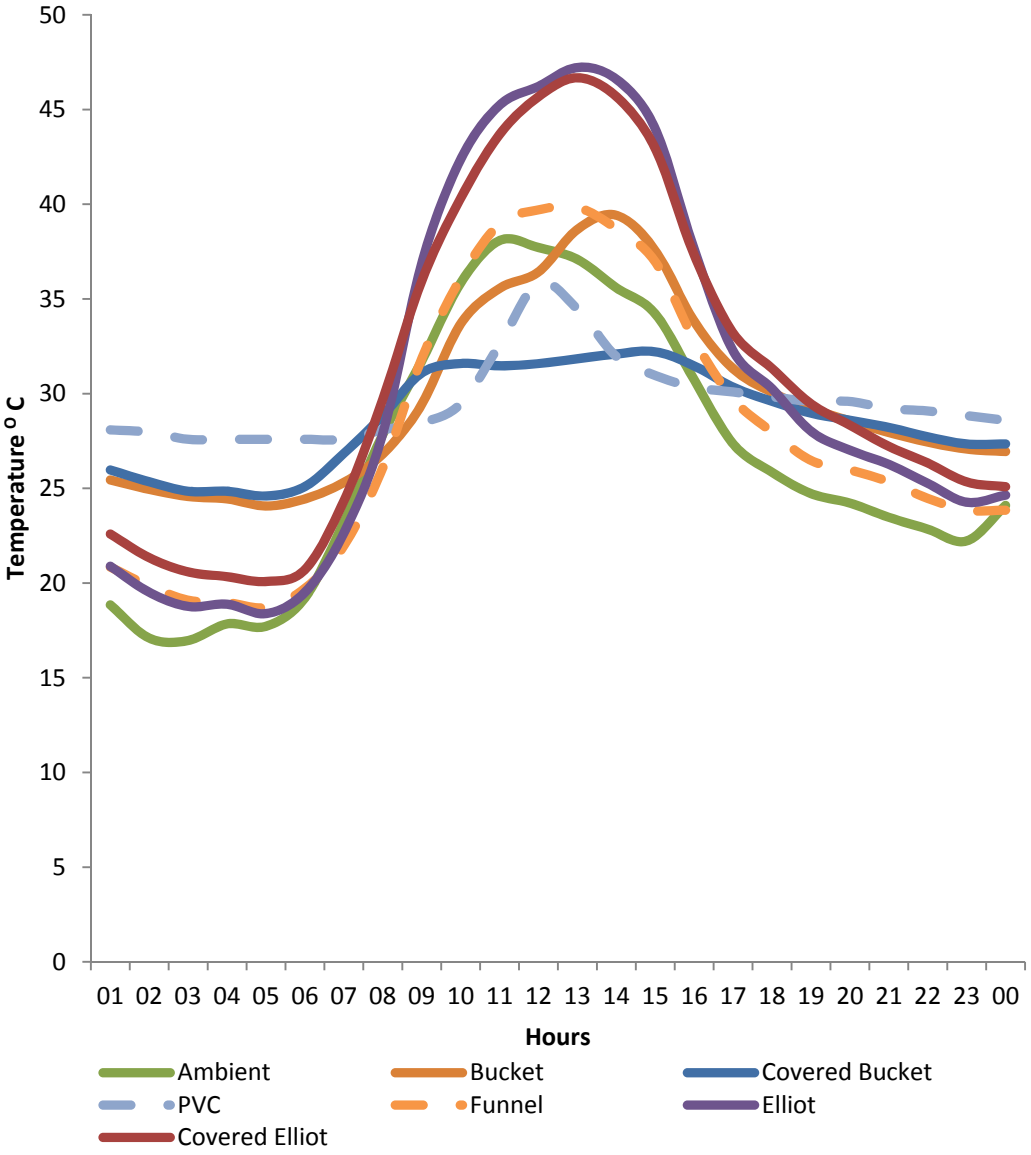
Summary of selected methodology

- Seasonality and weather conditions
- Trap type
- Distances between pits
- Number of successive days of trapping
- Number of traps per site and in array
- Type of design dependant on environment and target group(s)
- Assumptions about traps
- Supplementary methods but suffer in terms of quantifiable data

Ethical considerations - Trap deaths and or injuries

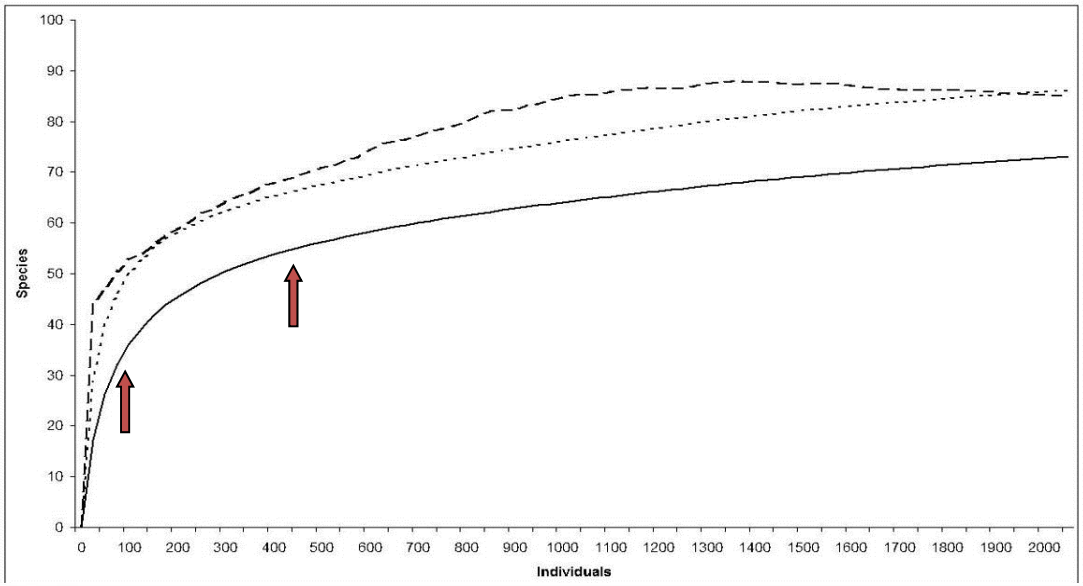
- Exposure to heat or cold
- Predation or attack by other animals
- Physical injury resulting from the trapping
- Handling
- Trap hygiene

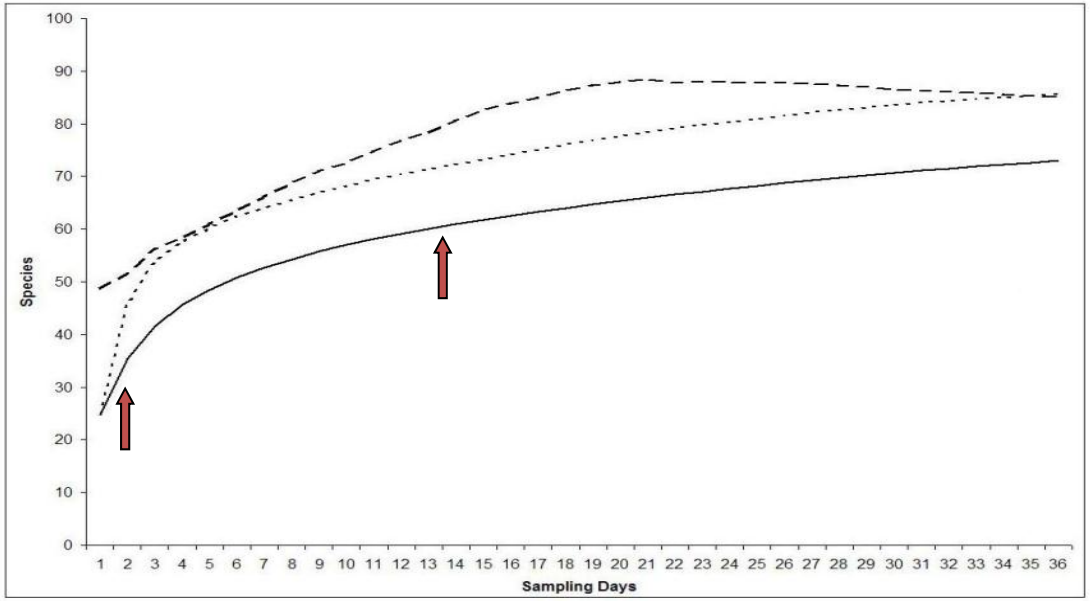
Ethical considerations – Environmental exposure



Analysis- adequacy of sampling

- 50% of the total species number caught after 103 individuals and 2 days
- 75% of the total species number caught after 437 individuals and 14 days
- Chao1 and Jacknife 1 estimators close agreement
- Indicates that by the end of the survey ~ 88% of trappable species caught.





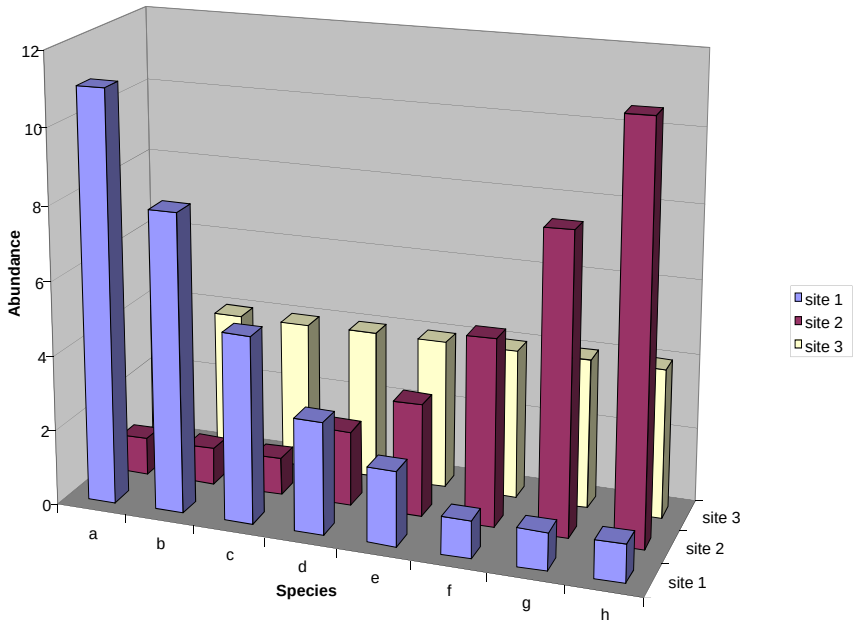
M. Cowan unpublished

Analysis - assemblages

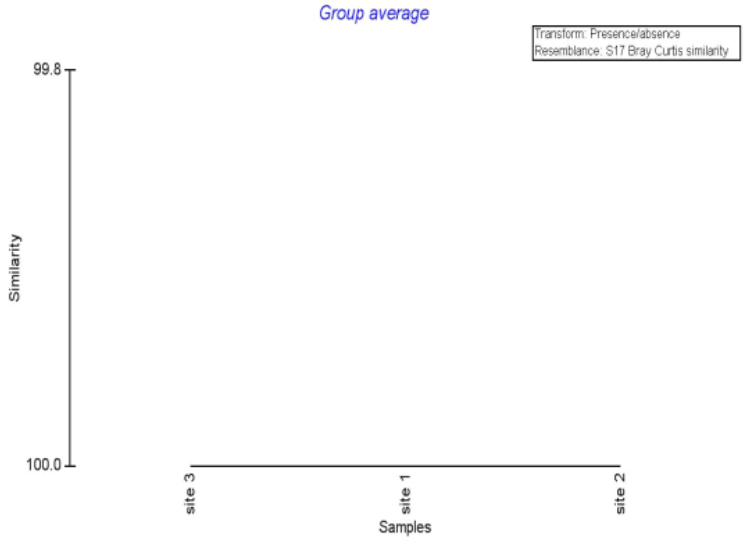
A

species	site 1	site 2	site 3
a	11	1	4
b	8	1	4
c	5	1	4
d	3	2	4
e	2	3	4
f	1	5	4
g	1	8	4
h	1	11	4

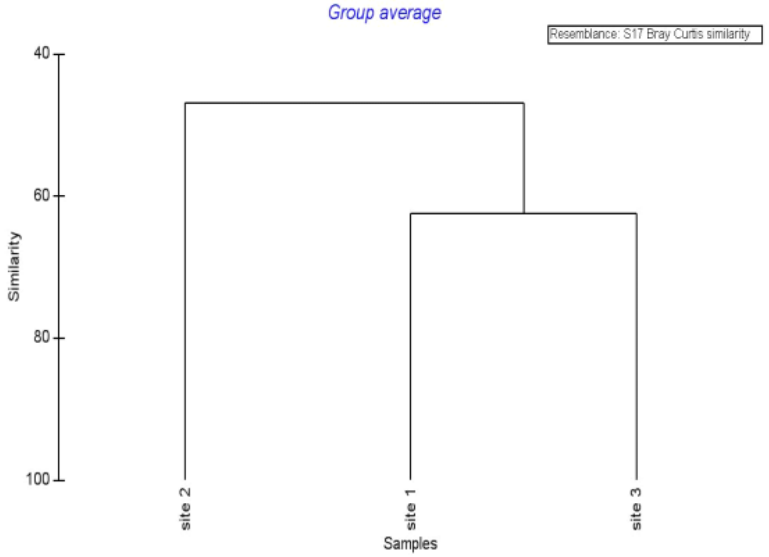
B



C



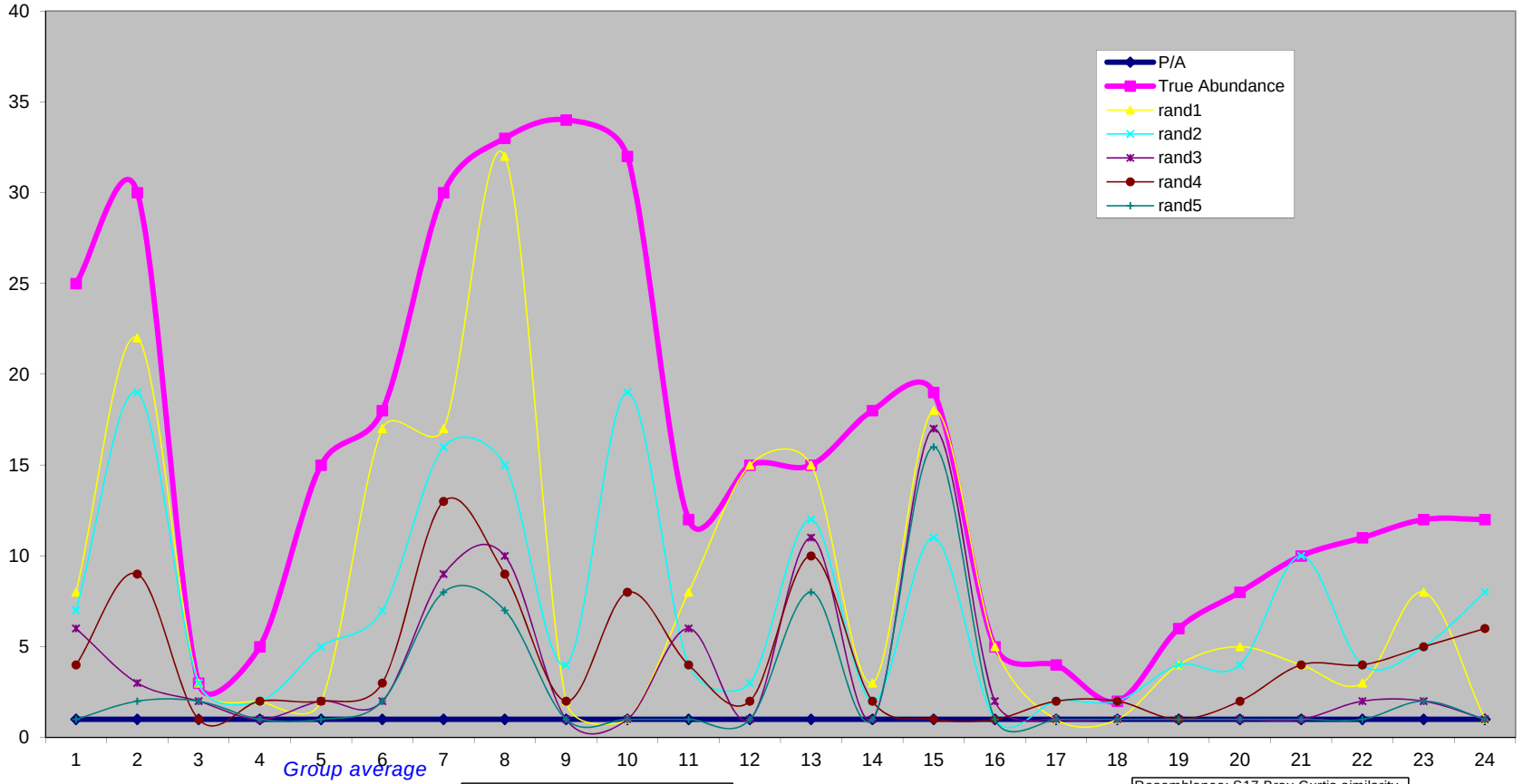
D

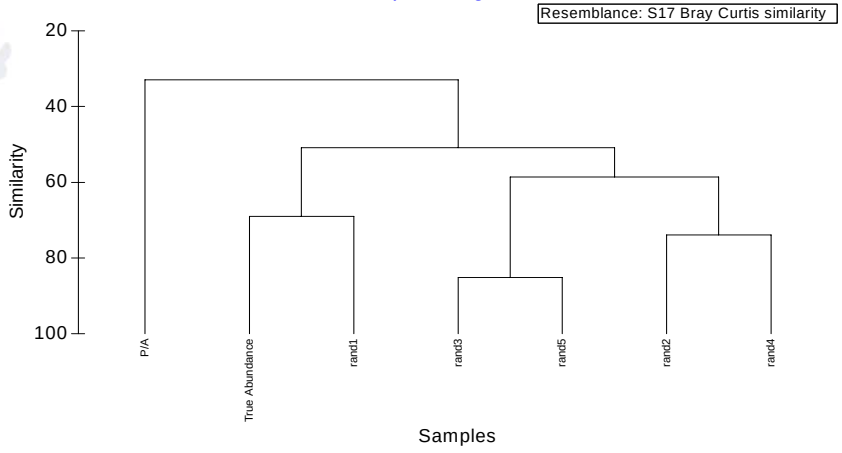


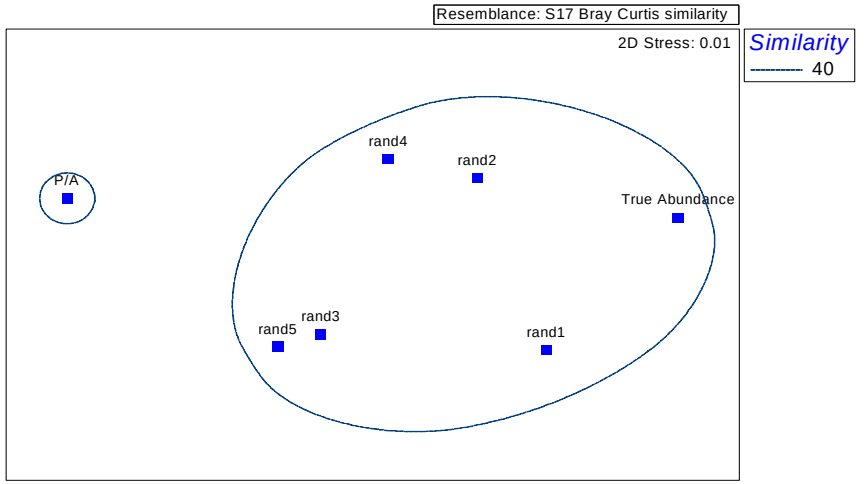
Summary

- Sampling regimes
- Examination of spatial data
- Appropriate traps defined in EPA/DPaW guidelines
- Season and climate are important
- Buckets out perform other similar traps
- Long lines and number of pits
- Sequential days
- Understanding spatial movement patterns helps with trapping
- Ethics paramount
- Determination of sampling adequacy
- Importance of abundance

Analysis – importance of abundance

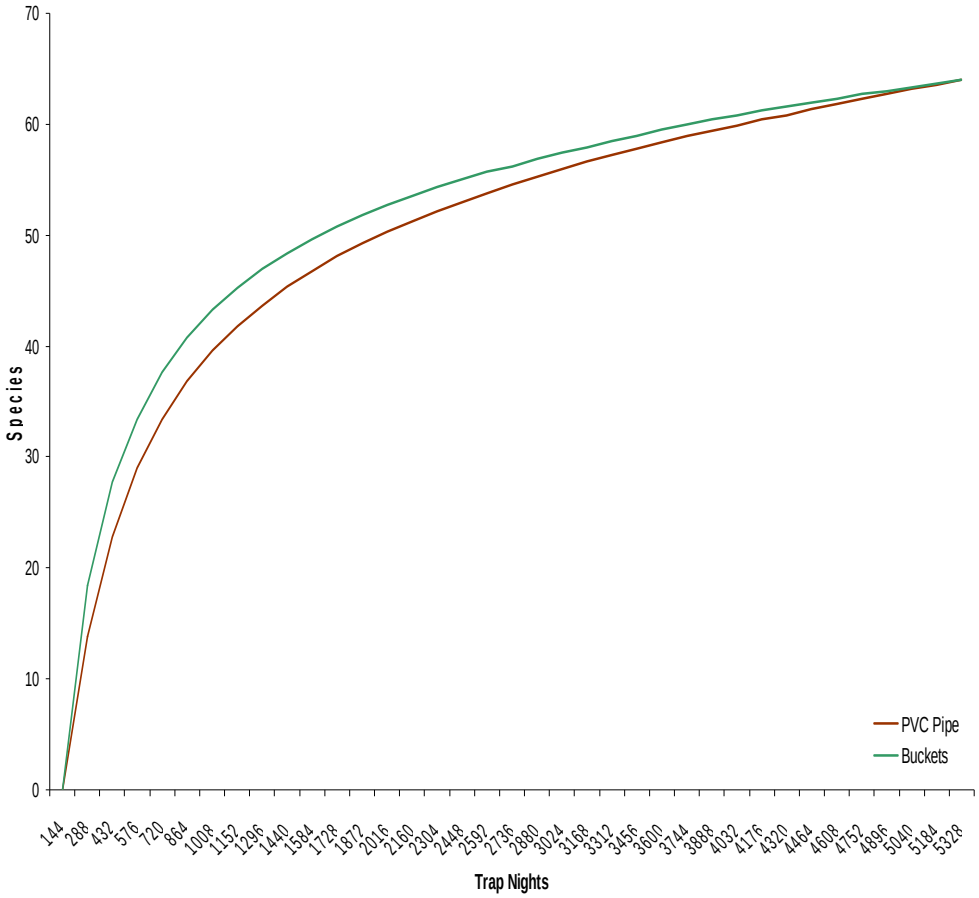




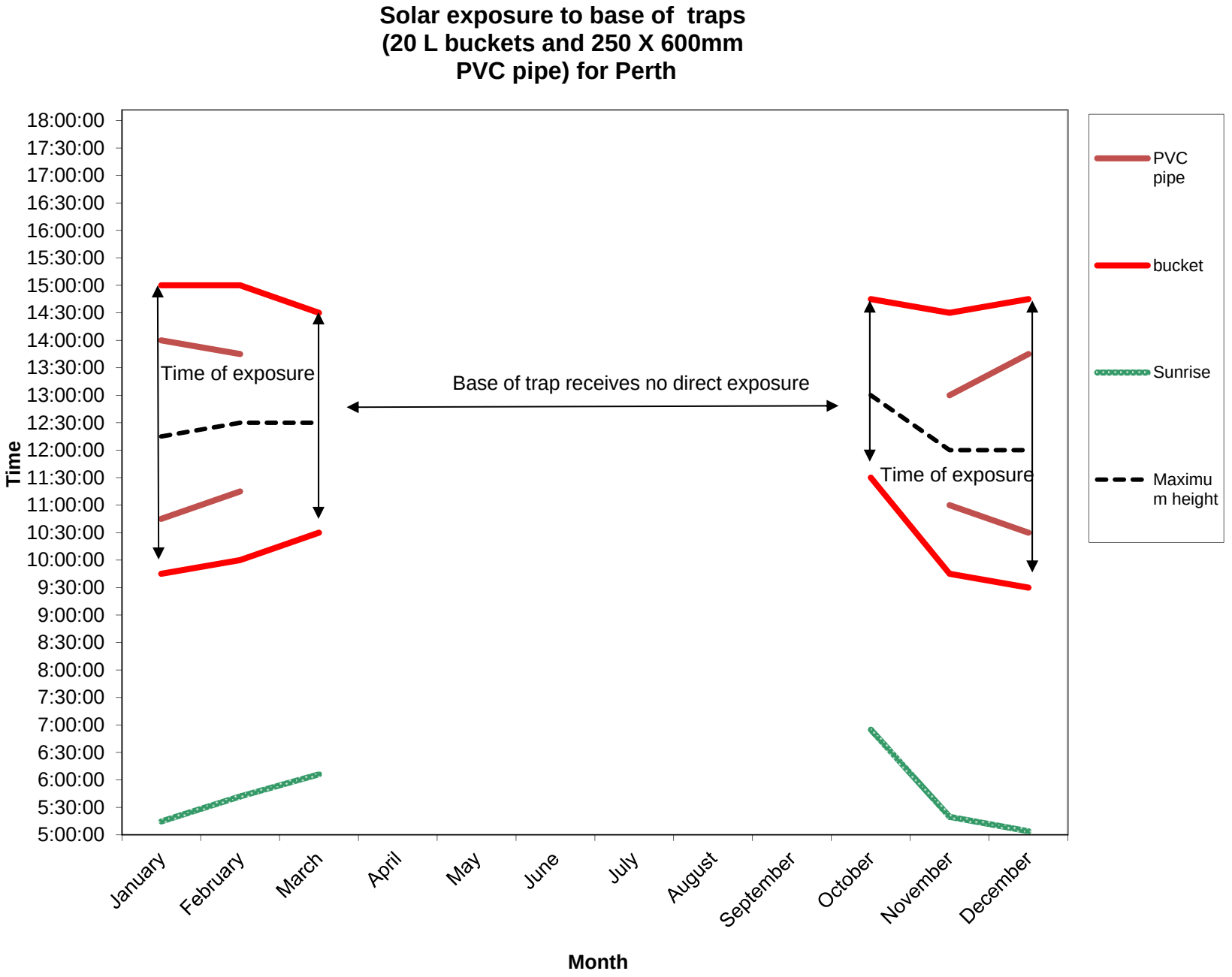


Species Accumulation Curves: Buckets vs. PVC pipes

- An example from 35 days over two years covering spring and autumn in the Goldfields
- Buckets were responsible for 1364 of 2028 individual captures, or 64.3%.- $\chi^2 = 219.21$, $p < 0.0001$
- Difference between species abundances for Buckets and PVC Pipes using Wilcoxon's matched-pairs test (test statistic 503.5, P<0.001).
- Only one species that was more abundant in pipes was statistically significant- *N. alexis* ($\chi^2 = 20.22$, $p<0.0001$)



Ethical considerations- heat risk in pit traps



Analysis – sampling adequacy

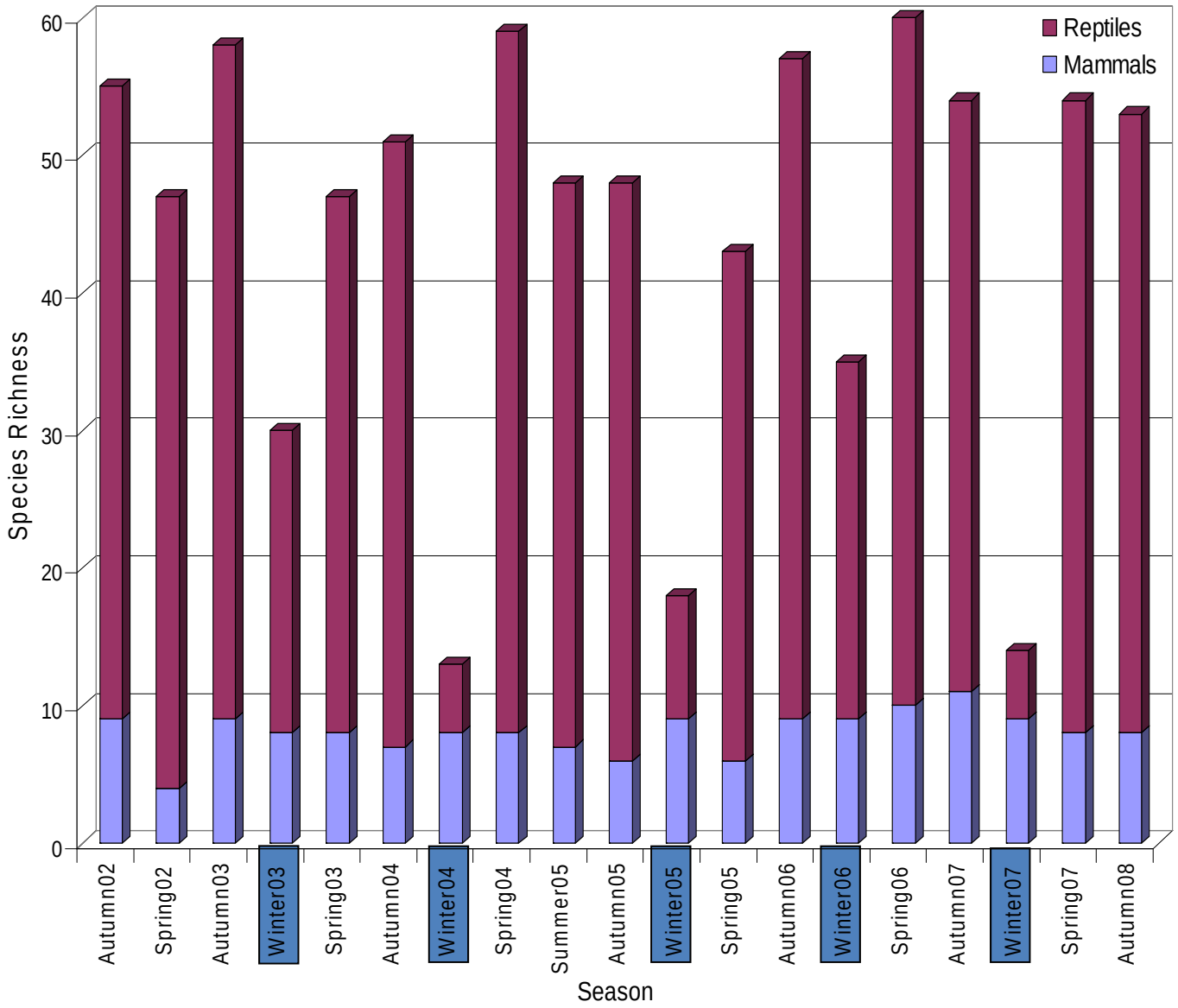
Reptiles

	Trip 1	Trip 1+2	Trip 1+2+ 3	Trip 1+2+3+4
Trip 1+2	0.82			
Trip 1+2+3	0.79	0.97		
Trip 1+2+3+4	0.80	0.96	0.98	
Trip +2+3+4+5	0.79	0.92	0.95	0.97

Mammals

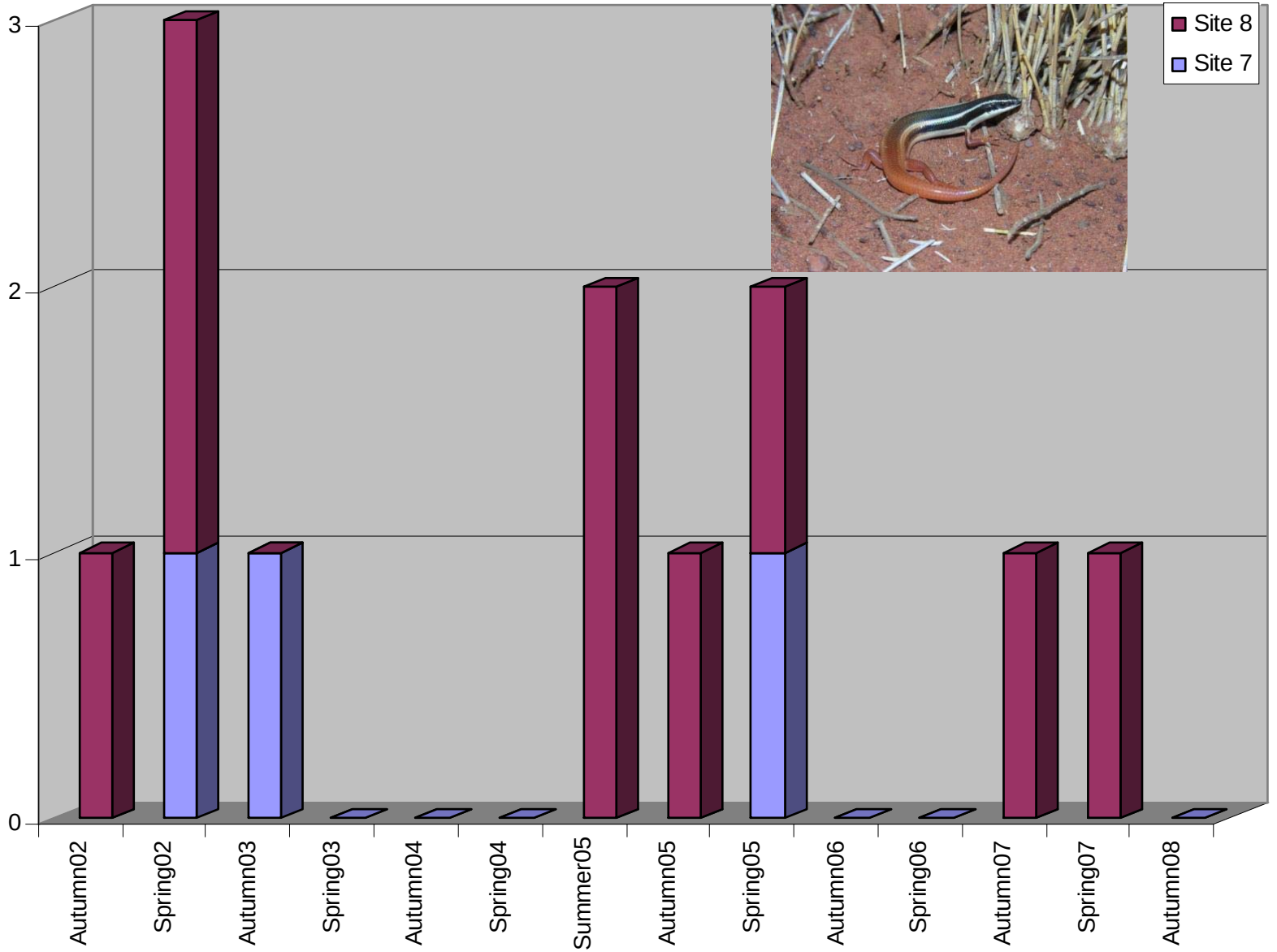
	Trip 1	Trip 1+2	Trip 1+2+ 3	Trip 1+2+3+4
Trip 1+2	0.67			
Trip 1+2+3	0.50	0.71		
Trip 1+2+3+4	0.59	0.74	0.98	
Trip +2+3+4+5	0.54	0.76	0.92	0.92

General considerations – seasonal variation is species richness



M. Cowan unpublished

Morethia ruficauda



M. Cowan unpublished

Pseudomys desertor

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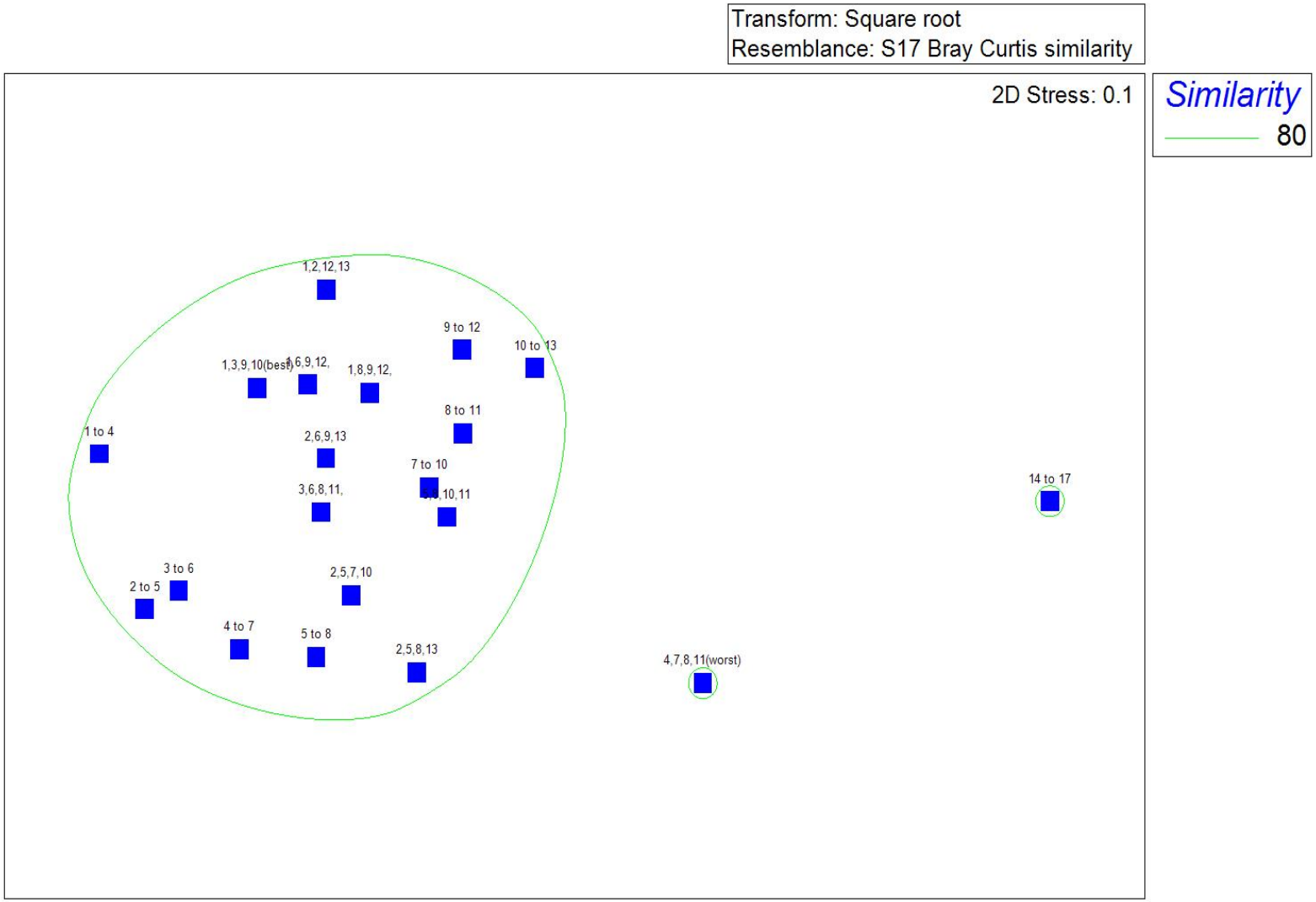
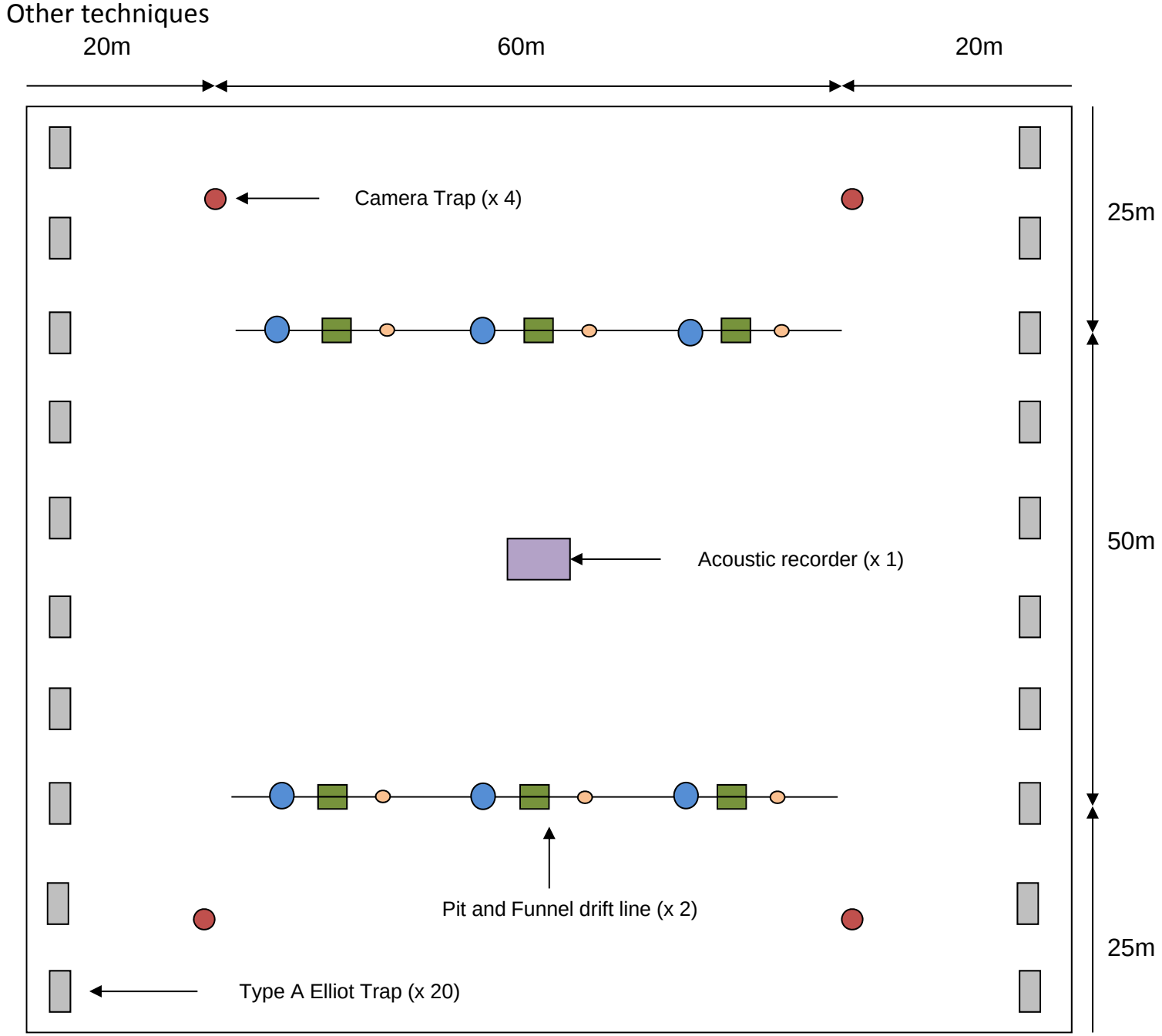
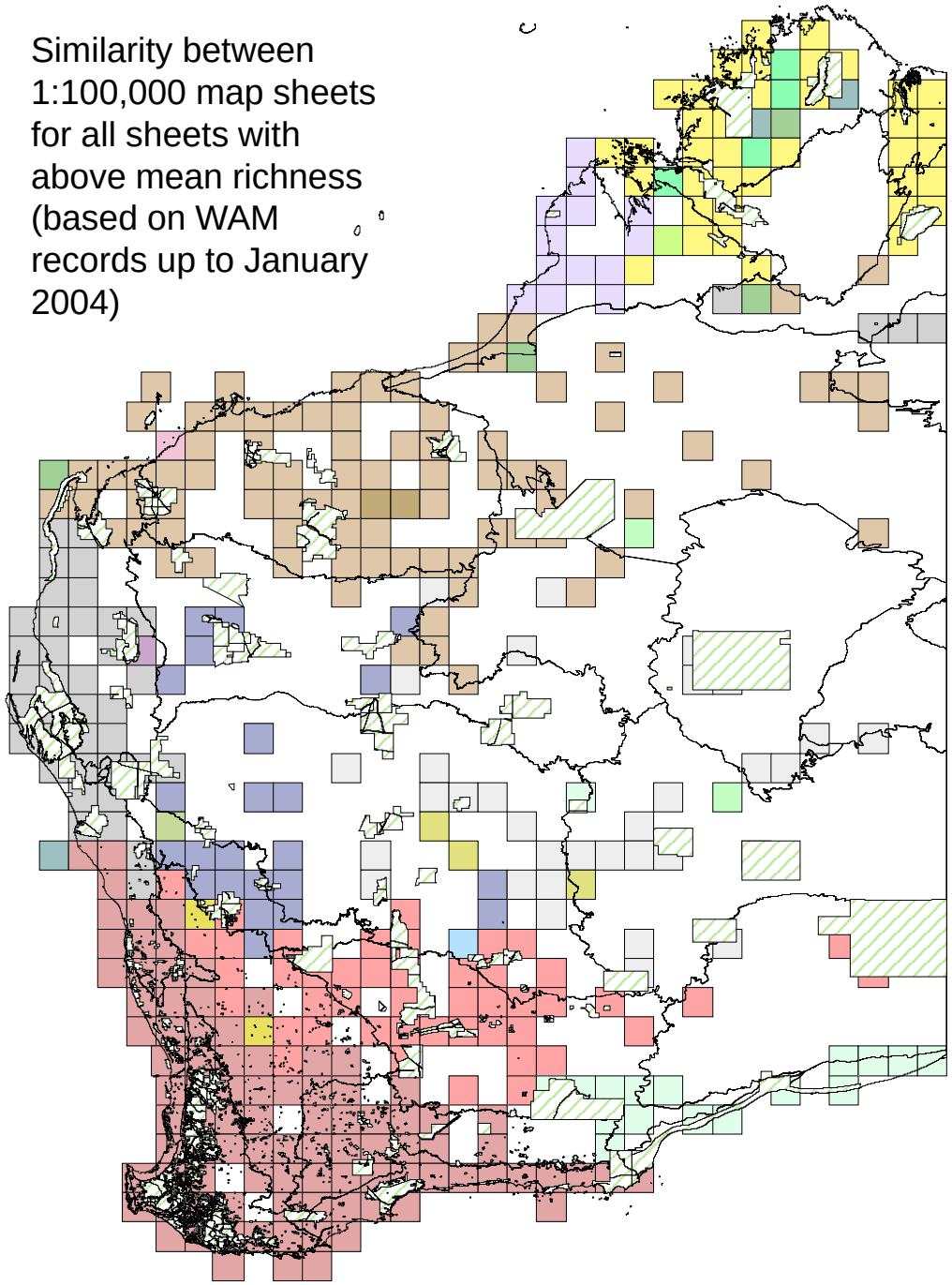

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.1
Similarity
80
1,2,12,13
9 to 12
10 to 13
1,3,9,10(best)
1,6,9,12,
1,8,9,12,
8 to 11
1 to 4
2,6,9,13
7 to 10
14 to 17
3,6,8,11,
3 to 6
2,5,7,10
2 to 5
4 to 7
5 to 8
2,5,8,13
4,7,8,11(worst)

Other techniques



Similarity between 1:100,000 map sheets for all sheets with above mean richness (based on WAM records up to January 2004)



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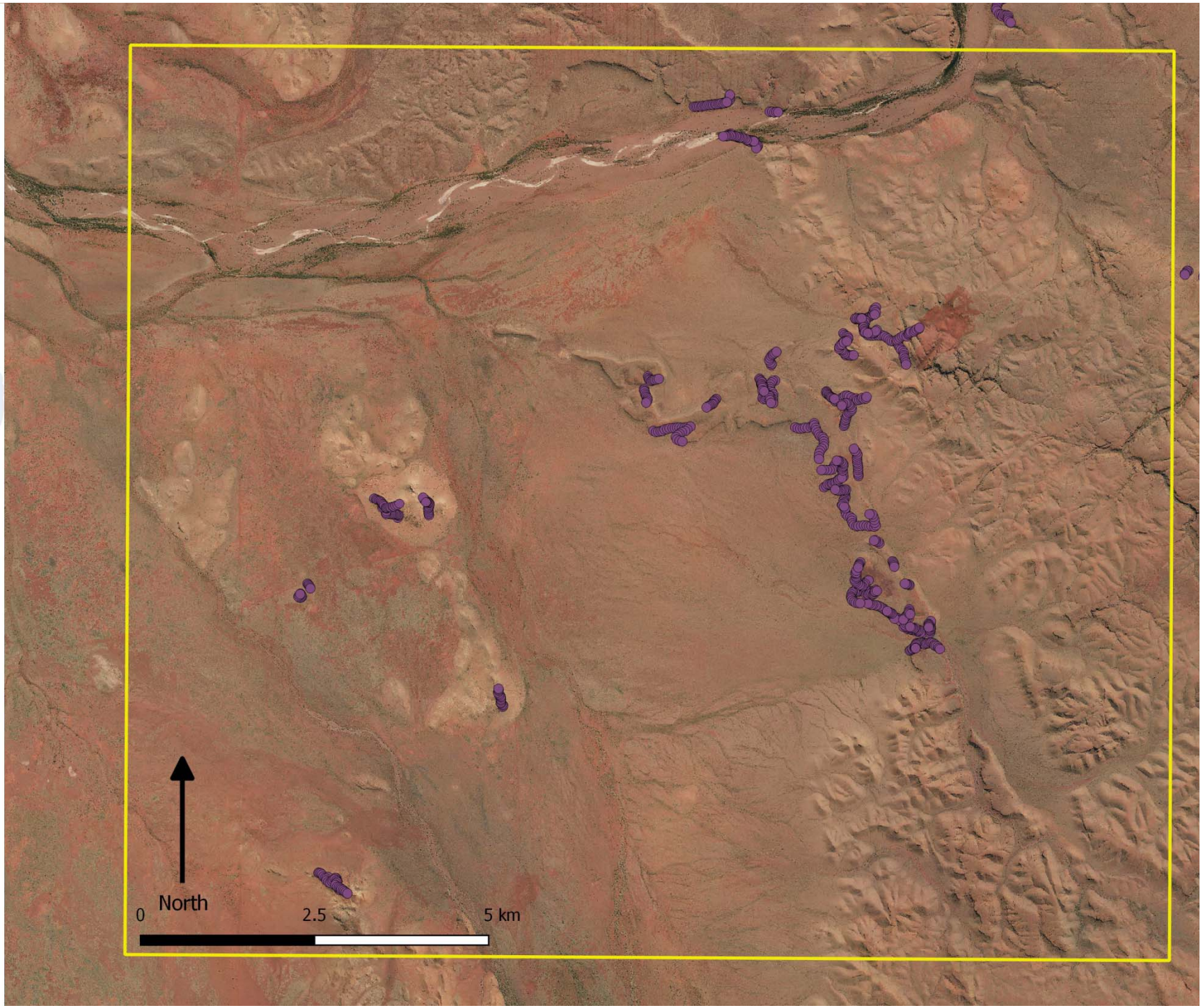
North
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2.5
5 km