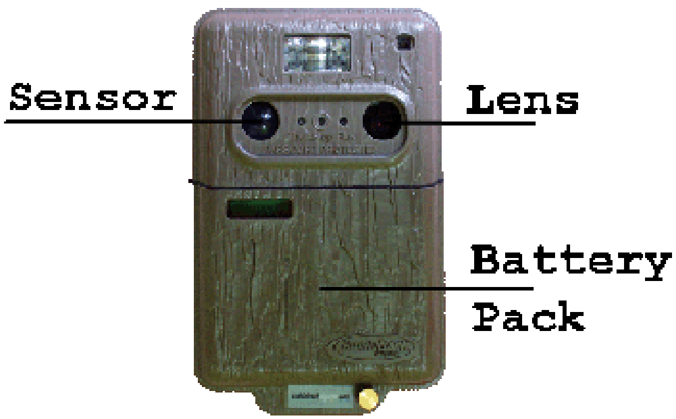
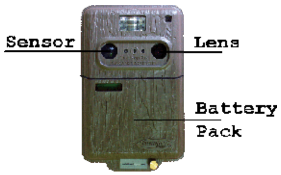


Camera trapping 101

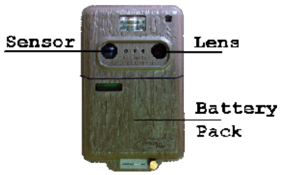
A brief overview of considerations
and methods of analysis



What is the question?

The first consideration is to account for the research question as we decide what study design to use and what data to collect.

Are we looking at change over time? Between sites? Following a treatment (adding wildlife water)? Or just a survey to see whats in the area (scouting)?



Camera traps

A camera trap is like a stationary observer at a fixed location (and direction), over a given time period, who is recording everything that passes directly in front of them – 24/7.

Basics

Think conceptually about what a camera lens is and what a photograph means. What are we actually sampling??

A picture is worth a thousand words…

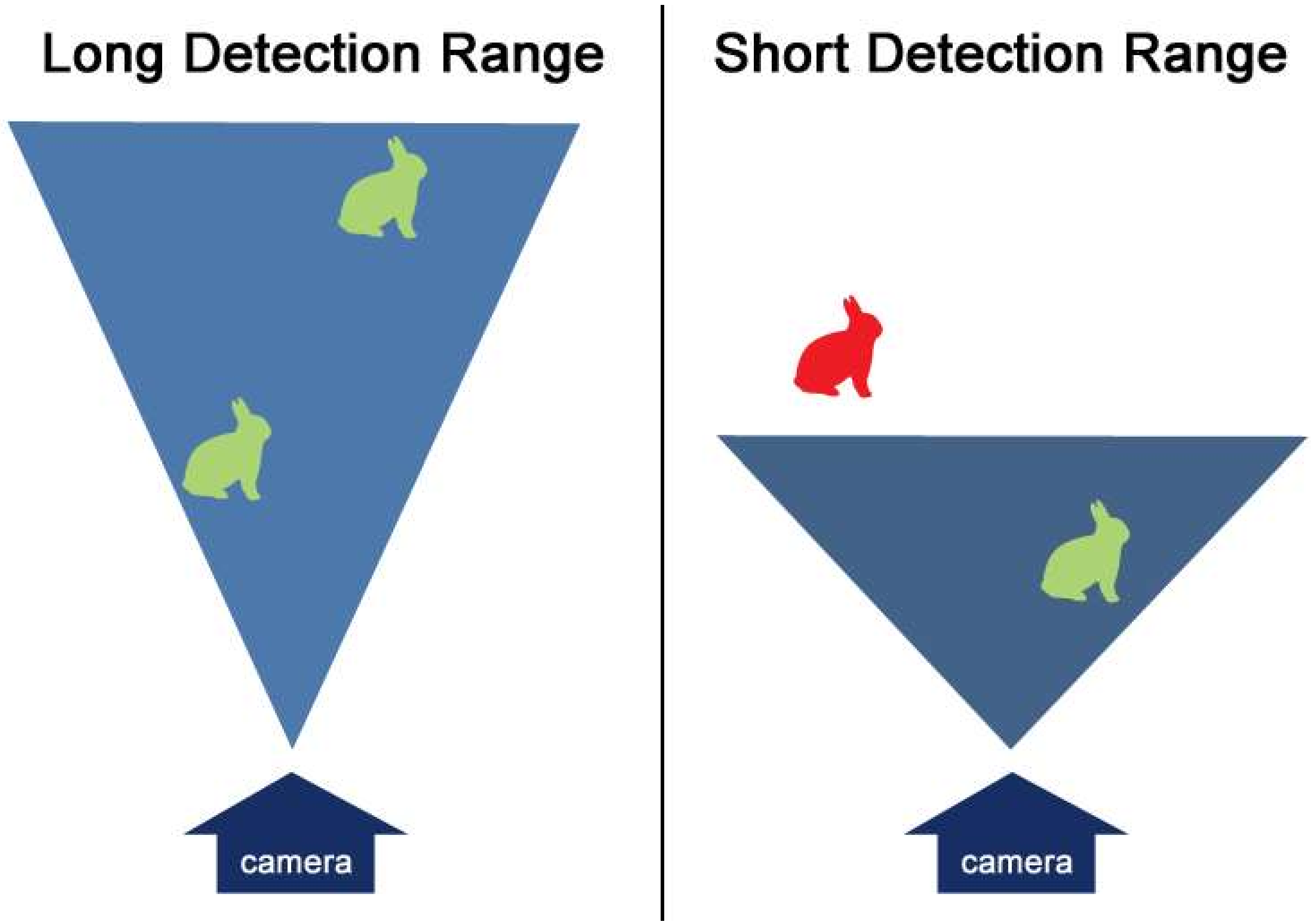
What can we learn by looking at a photograph?

Species
Behavioral inference
Unique markings (ind)
Sex (male/female)
Animal condition
Reproductive cond.
Topical parasites
Habitat type
Time (activity patterns)
Date (moon phase)

Sometimes:
Fruiting cycles
Prey species
Weather
Water volume

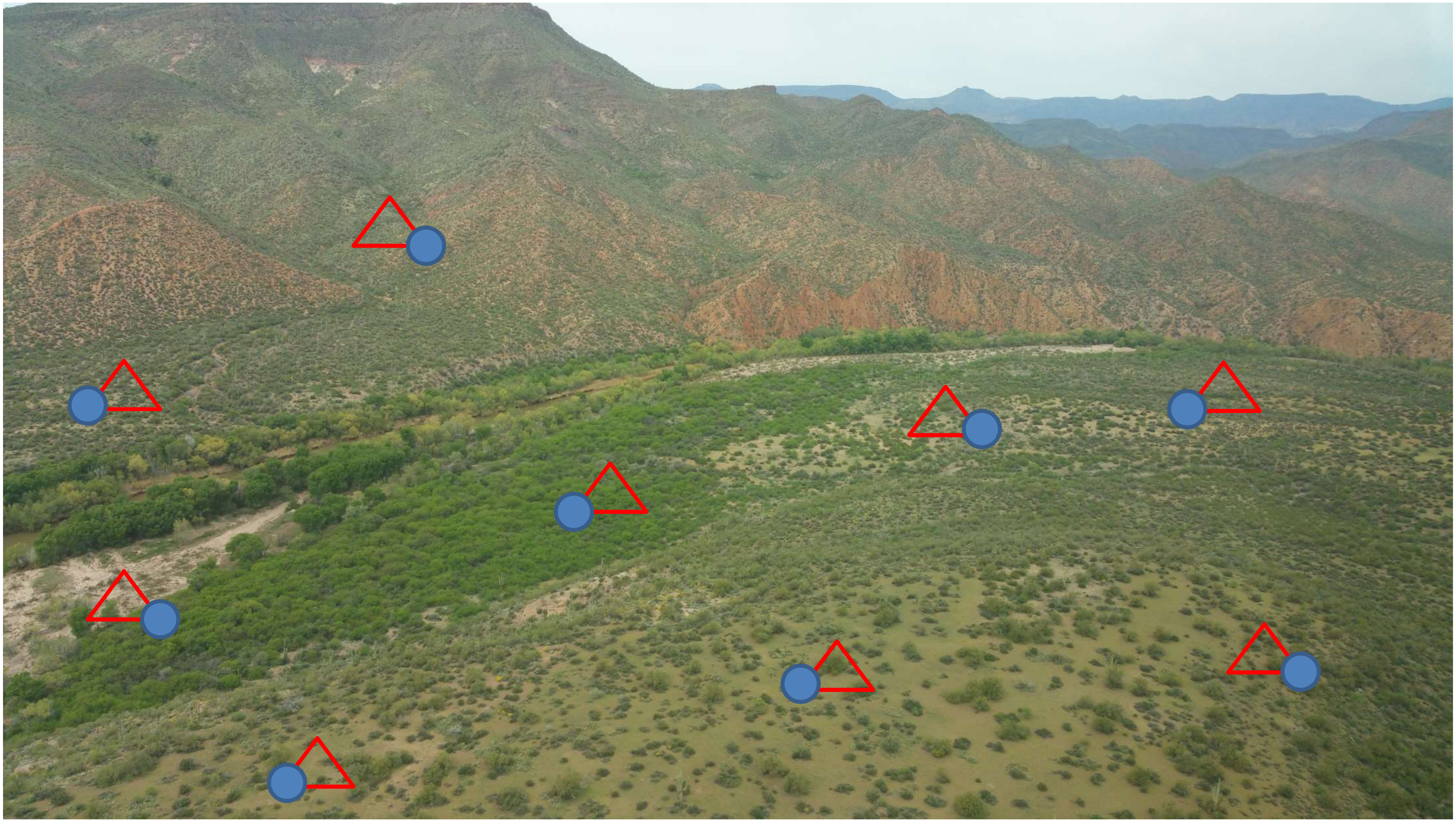
Detection probability

Detection Angle


Long Detection Range
Short Detection Range
camera
camera

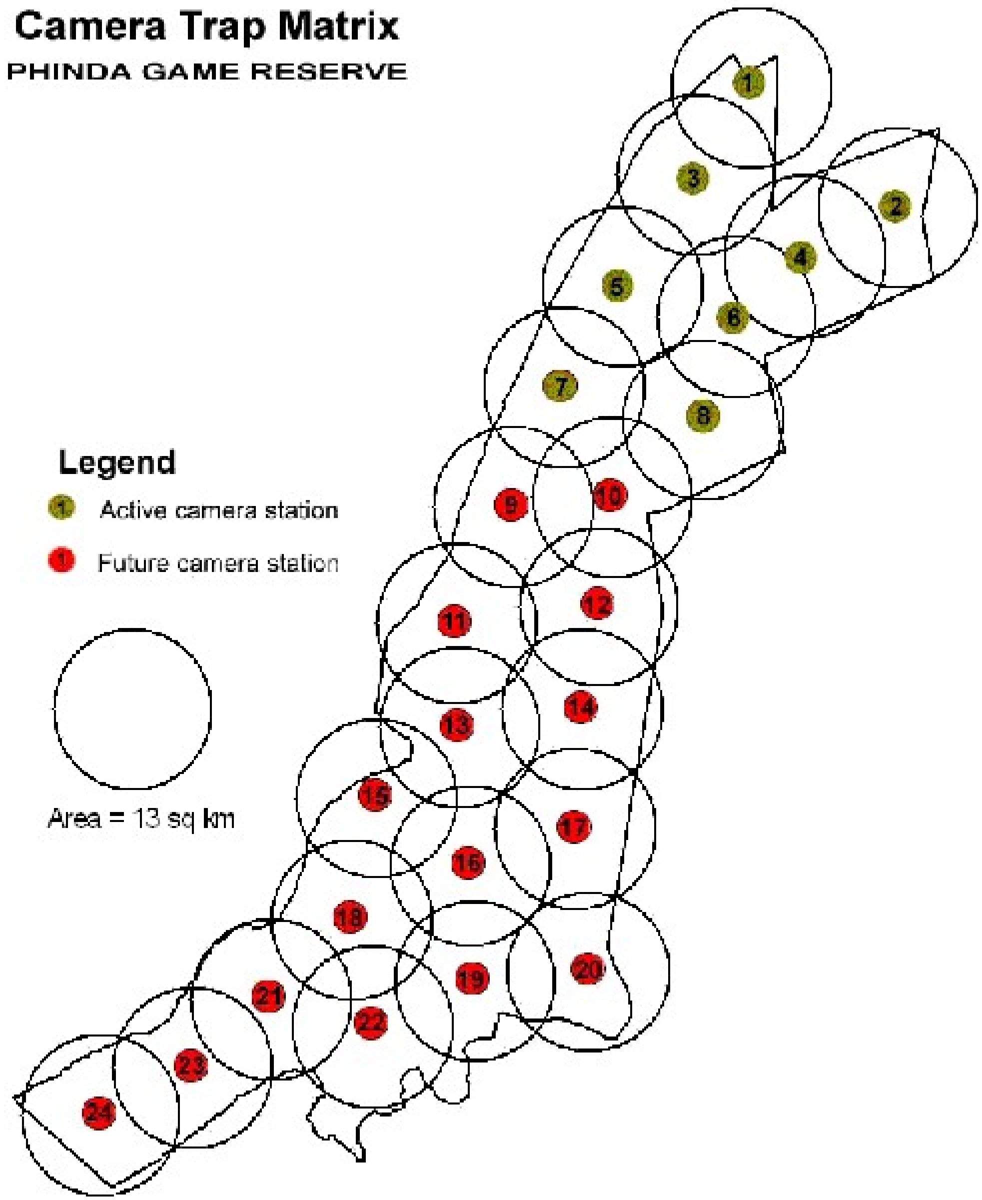
Angle + Detection Distance= Det. Area

What we are actually detecting



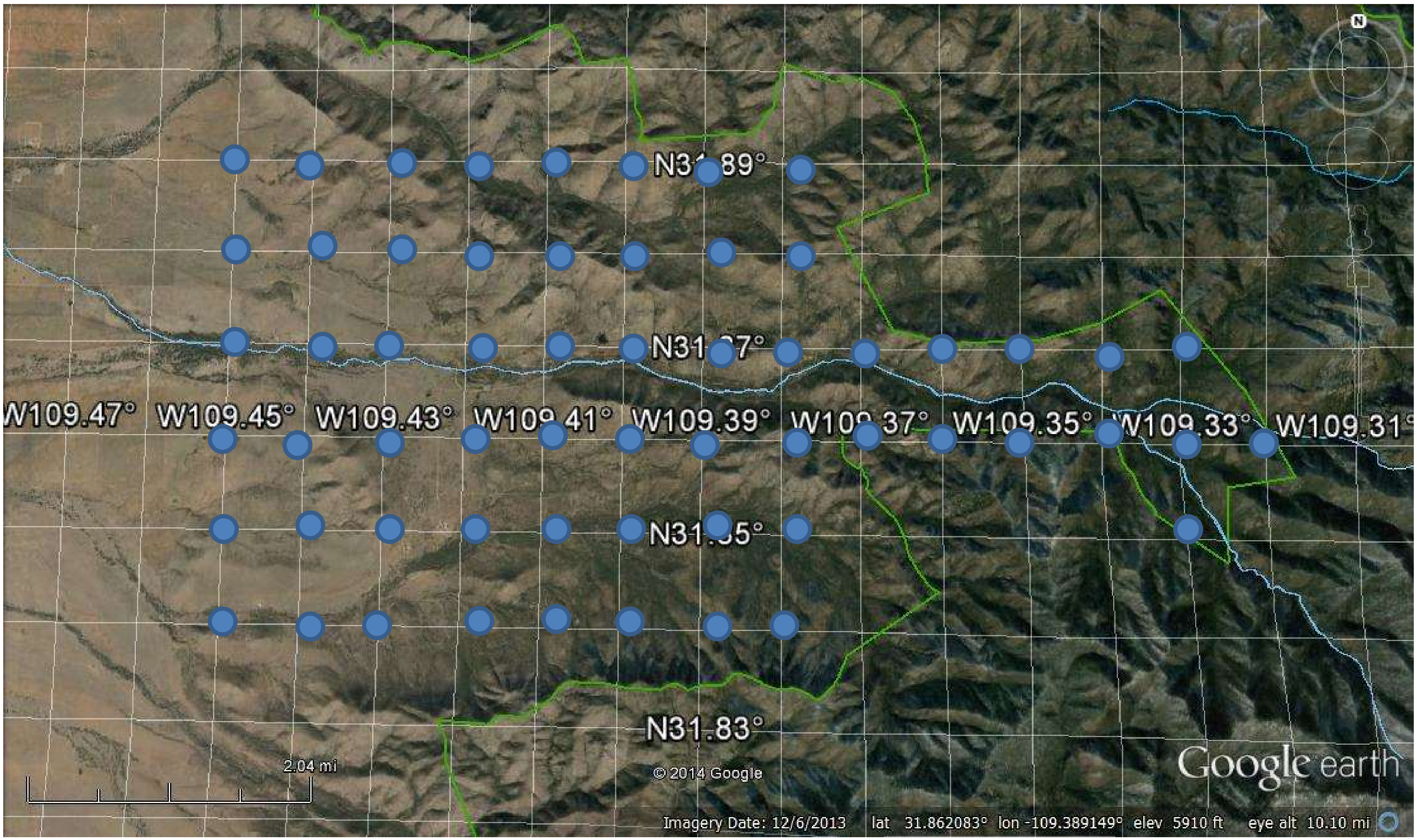
Grid design

Grid designs are very useful for site surveys and community ecology surveys, but are <u>absolutely necessary</u> for getting species specific **absolute density estimates**. A grid is the most common study design, but the spacing between cameras needs to be specific to the target animals and thus one grid is not ideal across multiple species. If you are asking “how many” you probably need a grid…



http://www.biolsci.monash.edu.au/avet/image/leopard/matrix.gif

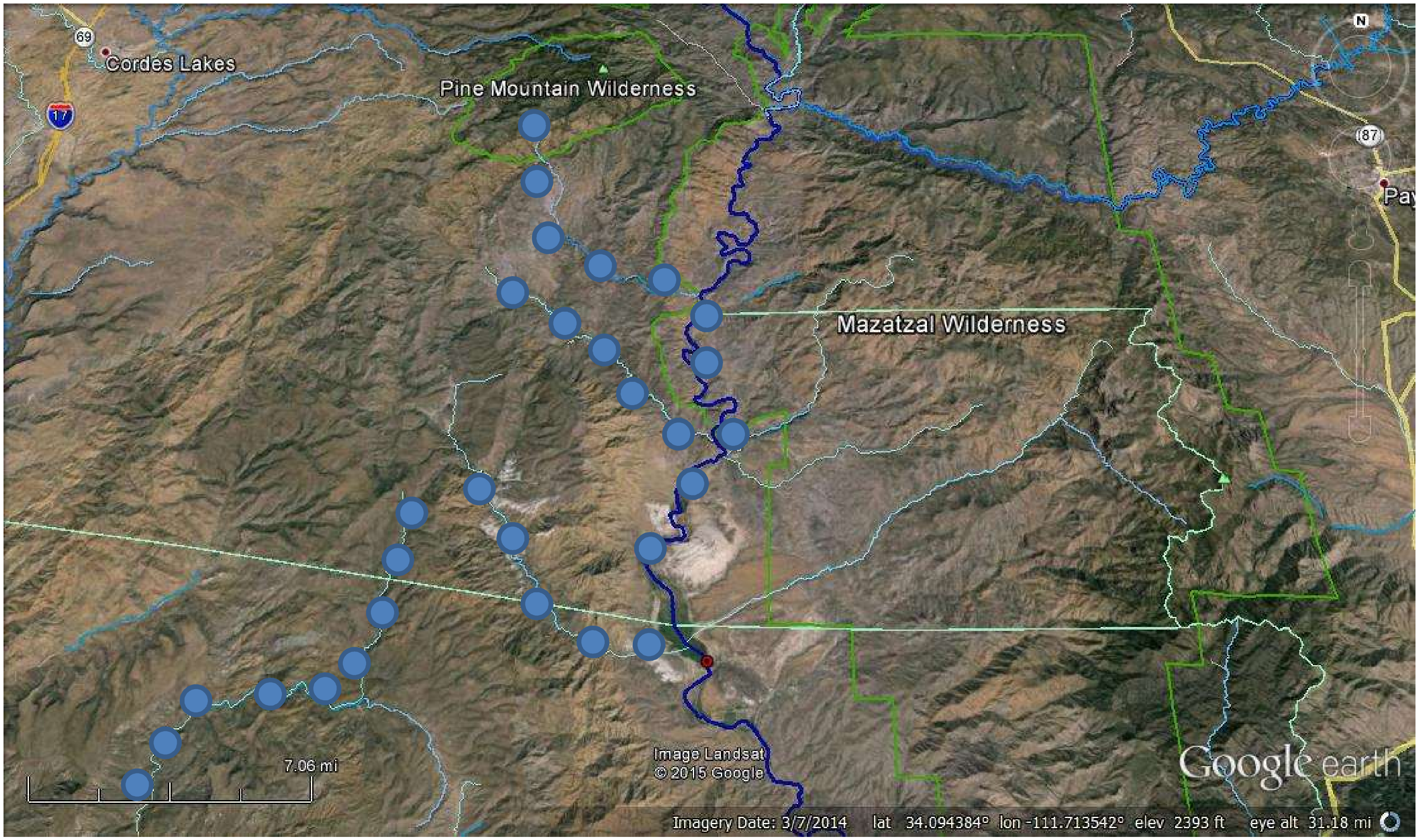
Example: Chiricahuas



Linear Design

Linear designs are necessary when the habitat or area sampled is linear, when measuring along ecological gradients, and when sampling does not require specific density estimates. Linear sampling is often done along roadways and rivers, as elevational (or otherwise) transects or when grid sampling is otherwise not possible (terrain/access limitations for example). Care needs to be taken in stratifying the sample in linear designs.

Example: Verde River “Wild Water”

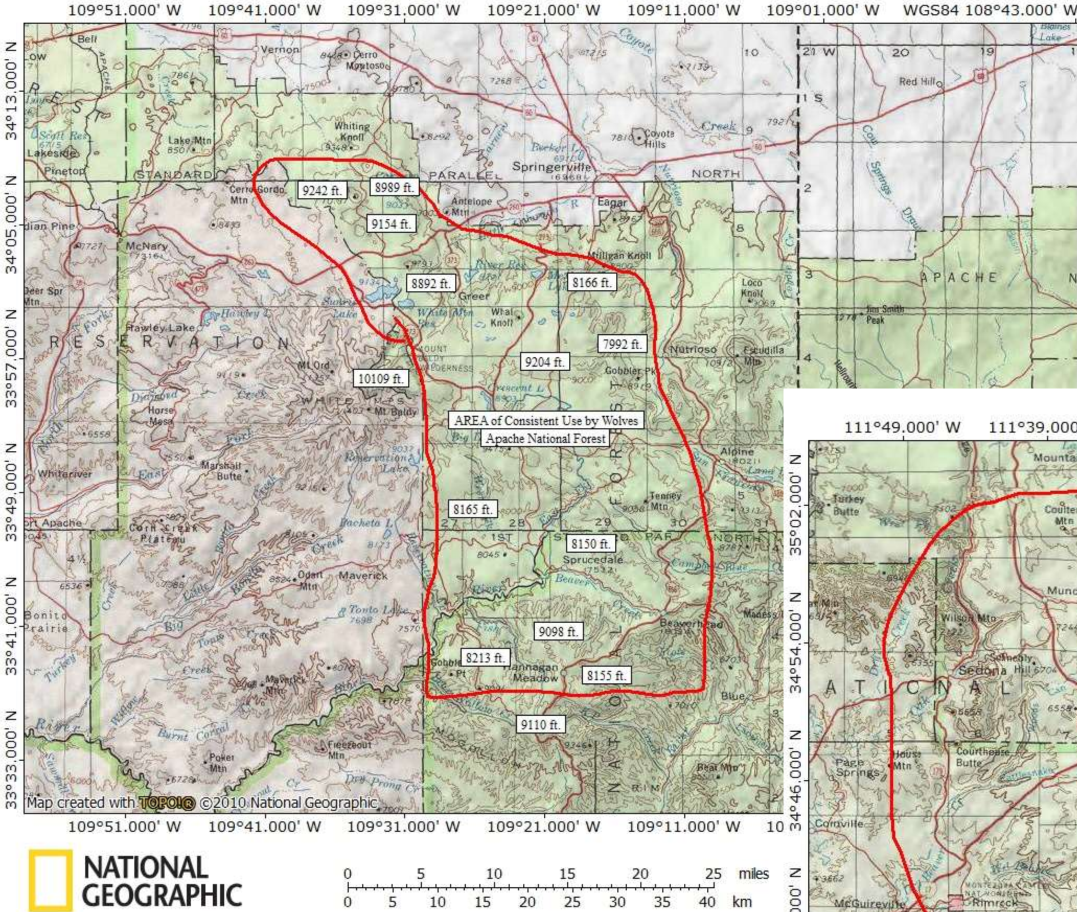


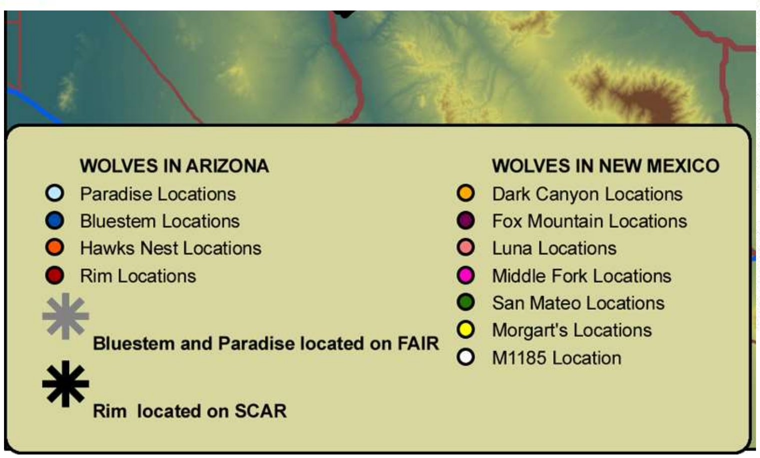
Sample stratification

- Often times we want to know the difference between areas, or treatments.
- Does reintroducing Mexican wolf have an impact on wildlife community structure?
- What would we need to do this study?

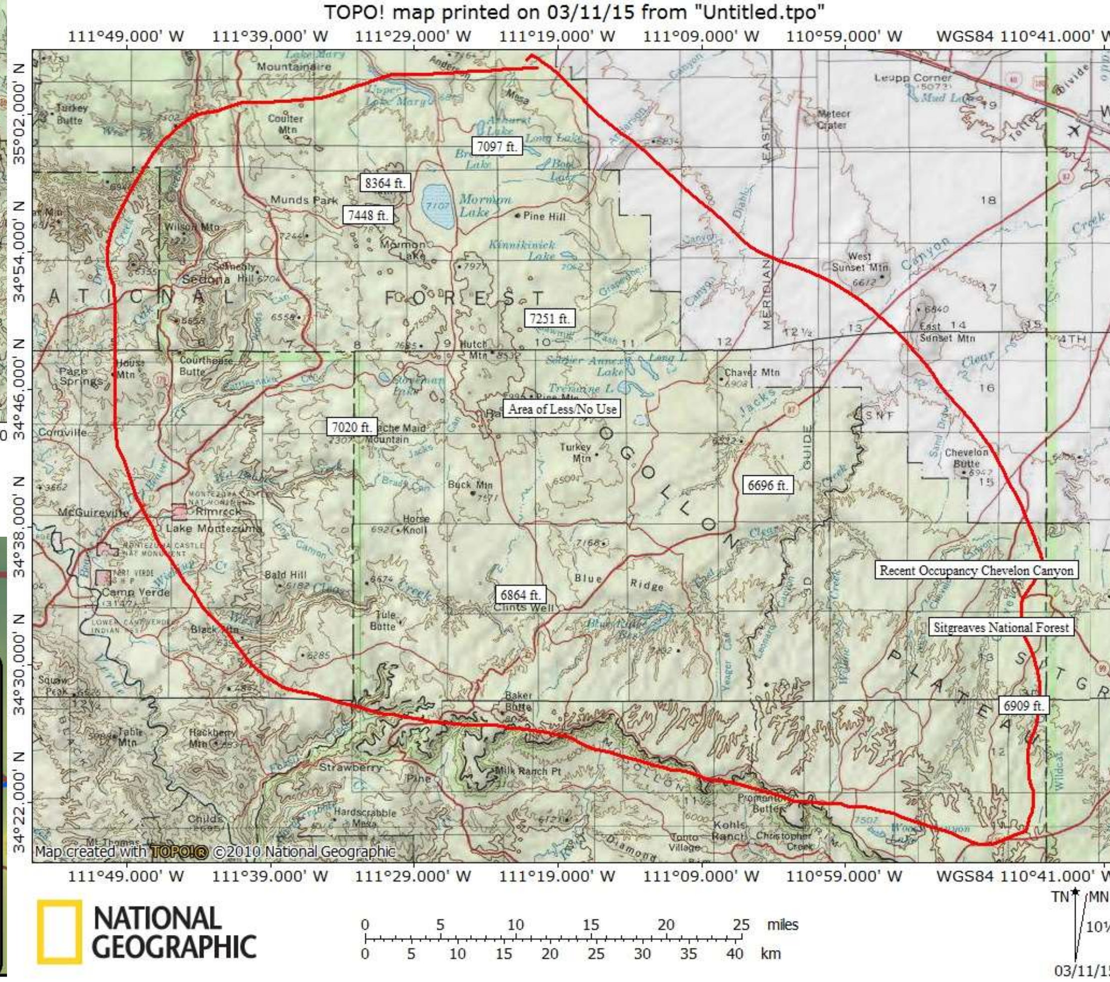
At least two large areas where almost everything is identical (covariates) except that one area is occupied by reintroduced wolves (for a significant time) and another is vacant.

TOPO! map printed on 03/11/15 from "Untitled.tpo"





TOPO! map printed on 03/11/15 from "Untitled.tpo"



Replication

- Projects are limited by resources and time – but want to ensure they have covered a large enough area and have sufficient replication across response variables.
- How many cameras do I need to answer my question?

This is an extremely important but difficult question. The answer is usually as many as you can manage with the resources you have. If this is a grid design you will need enough to cover a large area, if linear you need enough to represent all variation adequately.

Scale

- Whether a project is linear or grid – based on the question we need to address the issue of spacing.
- How much distance do I put between cameras?

There are different answers depending on design. If this is a grid based study looking at absolute density then you assume a closed-population model and you need to ensure there are no "gaps" in the grid where a species could be undetected (scale to home range size). Most studies employ a 1km spacing for large animals.

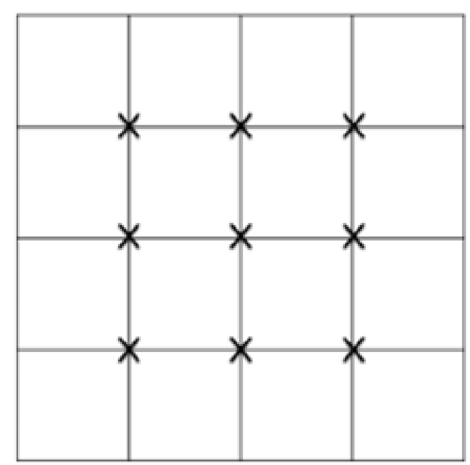
Ideal grid

If you had 9 cameras (90 would be better)....

If distance is 1km, what is sample area?

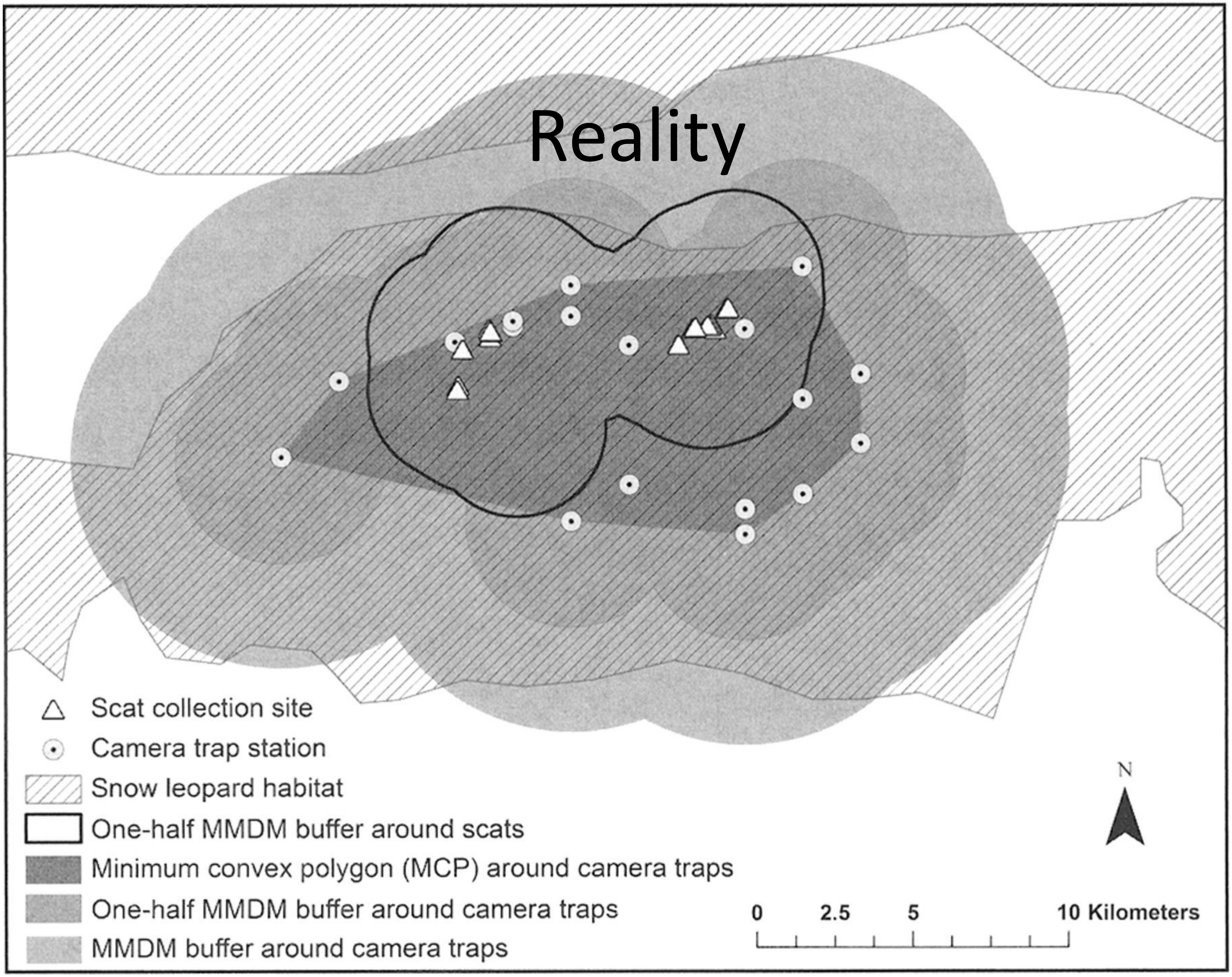
Min Convex Poly = 4km2

Buffered = 16km2

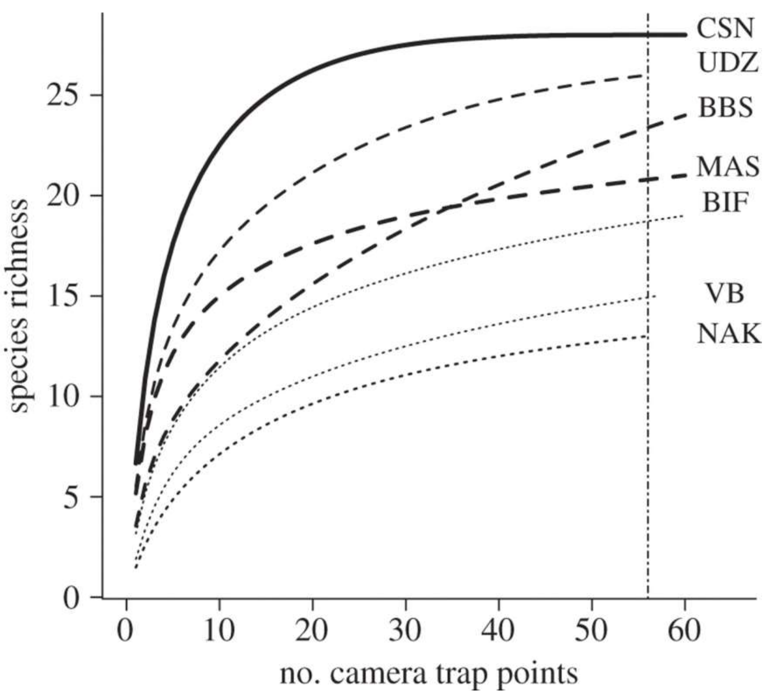


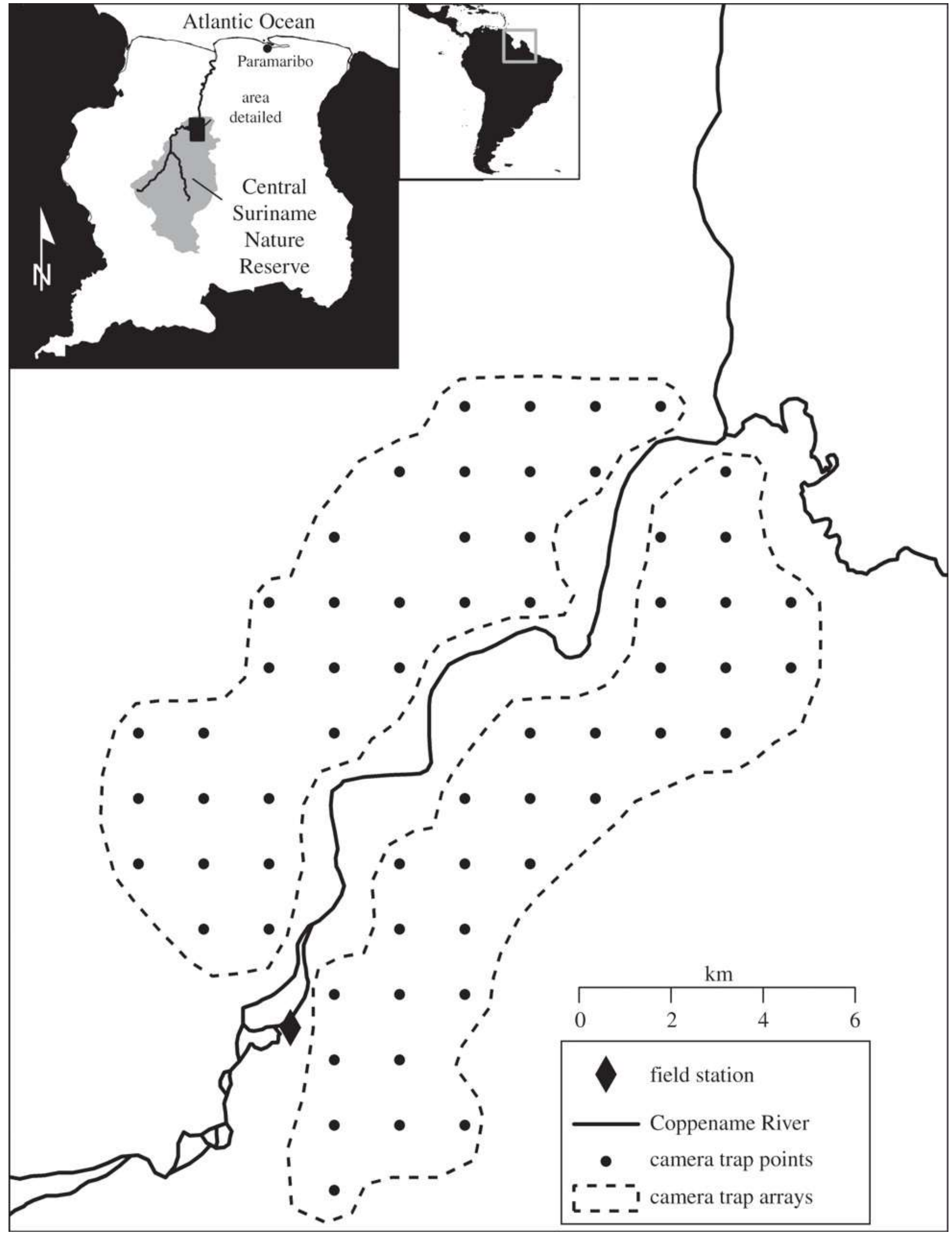
Knowing AREA is critical

For calculating DENSITY!


Reality
Scat collection site
Camera trap station
Snow leopard habitat
One-half MMDM buffer around scats
Minimum convex polygon (MCP) around camera traps
One-half MMDM buffer around camera traps
MMDM buffer around camera traps
0
2.5
5
10 Kilometers
N

How many cameras do I need?





Lures

Lures and pheromones change the “detection probability” for some species and not others, but only why lure is active – so generally discourages unless species specific research is done.

Estimating wild populations: basic numbers

How to describe species occurrences and compare between sites/times.

Species

- Density
- Relative abundance
- Diversity
- Evenness

Species composition - A list of all the species in this defined unit, along with some measure of the abundance (often the *relative abundance*).

Density

- Species density refers to the number of individuals of a species in an area. It is measured in individuals per unit area. It is a useful value that can be used to determine the health of an ecosystem
- For example , if 11 phoebes were found in 5 ha, the density would be 2.2/ha.

Some published density estimates for jaguar

(estimates range from 1.7 to 11.3 individuals per $100km^2$)

Ubicación	Altitud	Densidad de Jaguares (ind/100 km^2)	ES/DS*	Autor
Corcovado, Costa Rica	0-500	**6.98**	2.36*	Salóm *et al.* 2007
Pantanal, Brasil	89-120	**5.7**	0.84	Soizalo y Cavalcanti, 2006
Pantanal, Brasil	89-120	**5.8**	0.87	Soizalo y Cavalcanti, 2006
Belice, Gallon Jug	0-500	**8.82**	2.27	Miller 2005
Belice, Gallon Jug	0-500	**11.28**	2.66	Miller 2005
Belice-Guatemala, Gallon Jug	0-500	**9.66**	1.77	Miller y Miller 2005
Cocksomb, Belice	0-500	**8.8**	2.25	Silver *et al.* 2004
Chiquibul, Belice	0-500	**7.48**	2.74	Silver *et al.* 2004
Tucavaca, Bolivia	0-500	**3.93**	1.3	Silver *et al.* 2004
Cerro Cortado, Bolivia	0-500	**5.11**	2.1	Silver *et al.* 2004
Madidi, Bolivia	0-500	**2.84**	1.78	Silver *et al.* 2004
Tucavaca, Bolivia	0-500	**2.57**	0.77	Maffei *et al.* 2004
Tucavaca, Bolivia	0-500	**3.1**	0.97	Maffei *et al.* 2004
Cerro Cortado, Bolivia	0-500	**5.11**	2.1	Maffei *et al.* 2004
Cerro Cortado, Bolivia	0-500	**5.37**	1.79	Maffei *et al.* 2004
Ravelo, Bolivia	0-500	**2.27**	0.89	Maffei *et al.* 2004
Tuichi Valley, Bolivia	0-500	**1.68**	0.78	Wallace *et al.* 2003
Chiquibul, Belice	0-500	**7.48**	2.74	Kelly, 2003
Tucavaca, Bolivia	0-500	**3.93**	N/A	Maffei *et al.* 2002
Bolivia	0-500	**1.57-14.80**	N/A	Noss *et al.* sf

Issues

- One reason for the variation in density estimates is the lack of standards for parameterization of variables used in a study designs
- Probability of CAPTURE (detectability)
- Surface AREA

Density = individuals*/area

*probability of capture

Causes of variation to individual captures:

1. Camera site selection (trail, ridge, basin)
2. Use of attractants/lures
3. Seasonality (use vs. availability)
4. Effort (CPUE)
5. Camera settings (sensitivity, delay)
6. Camera type (SLR vs. digital)
7. Context (historical and ecological)
8. Extrinsic factors (ongoing hunting activity, dogs, edge effect, ecotones, etc)
9. Slope
10. Elevation

[redacted]

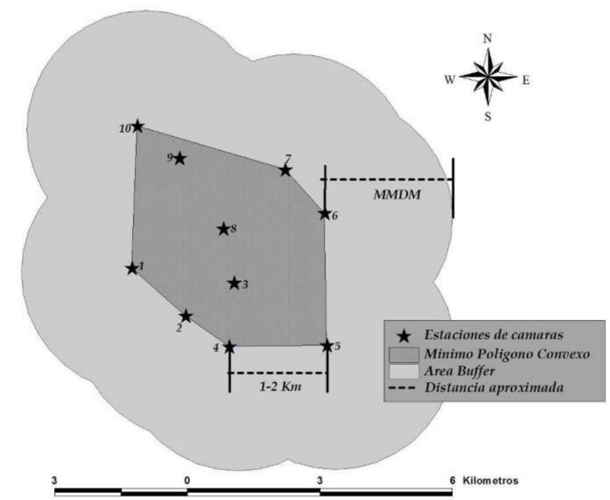
Density = individuals/area*

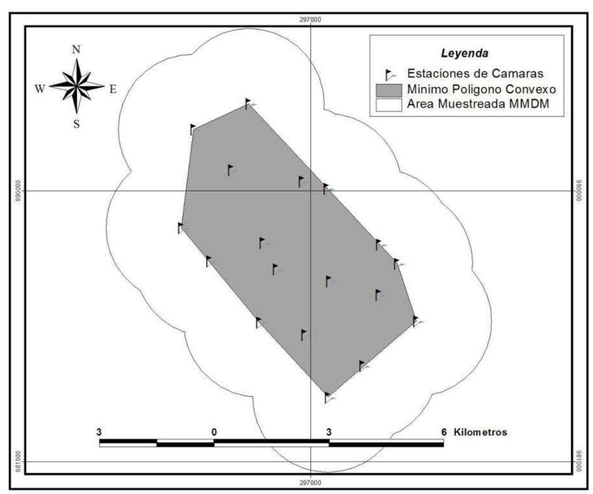
*surface area

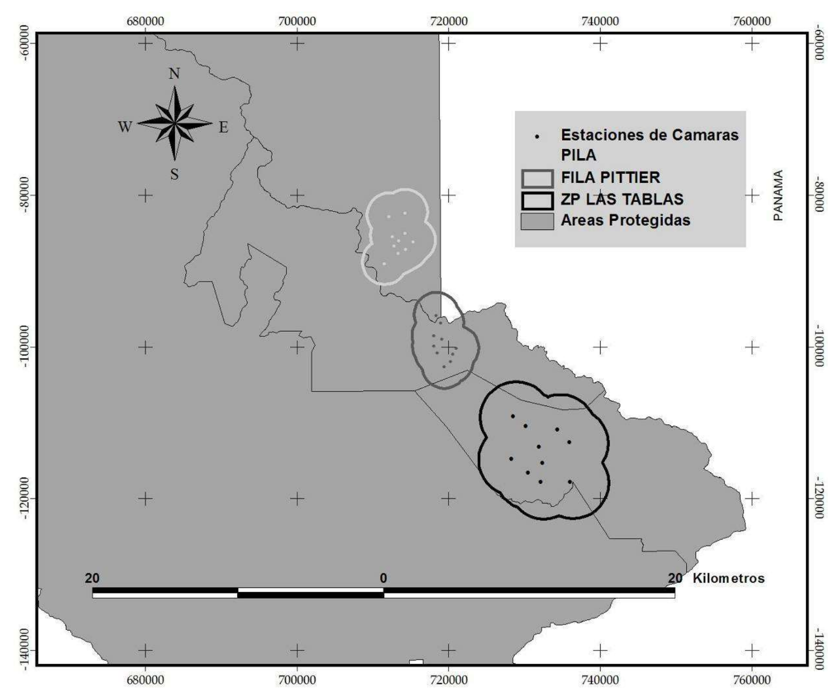
- Surface areas are not consistent
- Planimetric vs. topographic (roughness and convolutedness)
- Resources spatially limited
- Surface area not used or distributed equally
- Probability of capture correlated to slope and terrain.
- Use vs. availability

Other variables

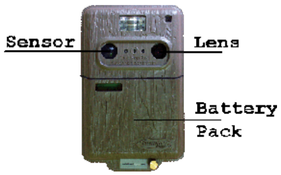
- distance between cameras
- buffer zone distance
- number of traps
- area sampled





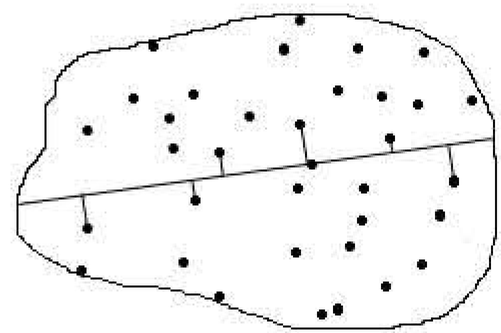


Thank You.

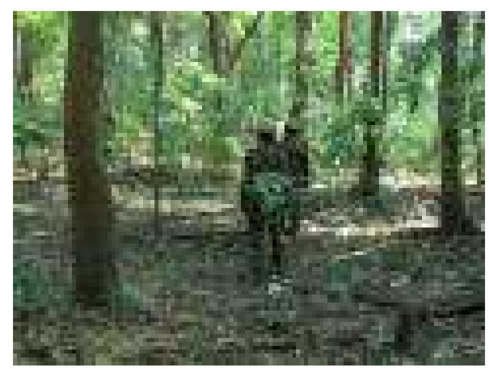


Line transect sampling

In line transect sampling an observer counts the number n of objects seen while traversing a predetermined line of length L. The perpendicular distance of each object from the transect line is also recorded. When all objects located on the line are detected with certainty, the density of objects in the area surveyed (D) is estimated as (Buckland et al., 2001):



$$\hat{D} = \frac{1}{2}\frac{n}{L}\hat{f}(0)$$



Segment 3 of 9: Monitoring Tigers - Line Transect PART 1

Relative abundance

- Relative abundance: The abundance of a species (by any measure), divided by the total abundance of all species combined.
- If there are 2.2 phoebes/ha, 3.6 flickers/ha, and 3.2 red-eyed vireos/ha, and not any other species, the relative density of the birds would be

  phoebes: (2.2/ha)/(9/ha) = 0.244

  flickers: (3.6/ha)/(9/ha) = 0.400

  vireos: (3.2/ha)/(9/ha) = 0.356

Taxonomic diversity

Biodiversity is usually plotted as taxonomic richness of a geographic area, with some reference to a temporal scale. Whittaker described three common metrics used to measure species-level biodiversity, encompassing attention to species richness or species evenness:

Species richness - the least sophisticated of the indices available.

Simpson index

Shannon-Wiener index

Species diversity

There are 3 types of species diversity: Alpha, Beta and Gamma.

Alpha diversity (ά) – Also 'local diversity' - refers to the diversity within a particular area, or Habitat.

Beta diversity (β) - refers to the difference in diversity between habitats.

Gamma diversity (γ) – Also 'regional diversity' – this refers to the diversity of species

observed in all habitats within a region, or ecosystem.

Shannon Index

The Shannon index has been a popular diversity index in the ecological literature. The measure was originally proposed by Claude Shannon to quantify the entropy (uncertainty or information content) in strings of text. The idea is that the more different letters there are, and the more equal their proportional abundances in the string of interest, the more difficult it is to correctly predict which letter will be the next one in the string. The Shannon index is dependent on the assumption that the sample used to generate it is a random sample of the community.

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Simpson Index

The Simpson index was introduced in 1949 by Edward H. Simpson to measure the degree of concentration when individuals are classified into types. It is simply the probability that any two individuals chosen randomly from the total population come from the same species. Each term of the summation is the probability that two individuals chosen randomly will come from a particular species and the summation gives the probability for all species.

$$D = \sum_{i=1}^{S} \frac{n_i(n_i - 1)}{N(N - 1)}$$

Species evenness

Species evenness refers to how close in numbers each species in an environment are. Mathematically it is defined as a diversity index, a measure of biodiversity which quantifies how equal the community is numerically. So if there are 40 foxes, and 1000 dogs, the community is not very even. But if there are 40 foxes and 42 dogs, the community is quite even. The evenness of a community can be represented by Pielou's evenness index:

$$E = \frac{H'}{H_{\max}}$$

Where E is the number derived from the Shannon diversity index and is the maximum value of , equal to:

E is constrained between 0 and 1. The less variation in communities between the species, the higher J' is. Other indices have been proposed by authors where e.g. Hurlburt's evenness index.

S is the total number of species.

$$E = \frac{H'}{H_{\max}} = \frac{-\sum_{i=1}^{s} p_i \ln p_i}{\ln s}$$

Detection probability

What affects your ability to “detect” an animal?

1. Camera placement (angle, height, etc)
2. Camera type (fast, flow)
3. Camera settings (burst images vs single)
4. Time of day
5. Weather conditions
6. Vegetation
7. Observer (noise, etc.)
8. Animal behavior (hibernation, noctural, etc.)
9. …many others