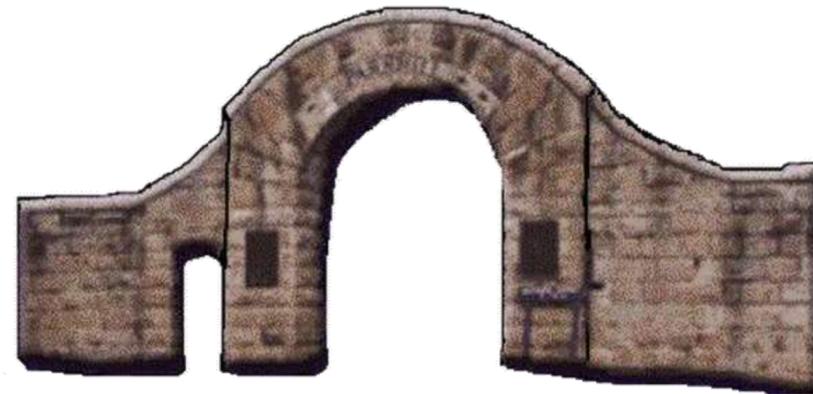


Comparing ground and UAV surveys after fire in an urban bushland

Geoff Lambert¹, Judy Lambert¹, Jeremy Randle²

1. North Head Sanctuary Foundation,
2. Centre for Field Robotics, Sydney University.

**North Head
Sanctuary
Foundation**



Australian Government

Sydney Harbour Federation Trust



We acknowledge the Traditional Custodians of the land, the Gai-mariagal peoples on whose land we now stand. We pay our respects to the Elders past and present.

Our standard acknowledgement to the Gai-mariagal people when we are on North Head

North Head is where Europeans first saw Indigenous peoples' land management by fire – midday, 28-May-1788

ESBS Eastern Suburbs Banksia Scrub
in decline because of disturbance (e.g. lack of fire?)
needs preservation and restoration
species mix legally-defined
critically-endangered ecological community
Recovery Plan exists:- inaction is not an option

The question Can ESBS be restored by fire?

The programme Attributes, richness, diversity and fidelity measures before and after fire.

The technique Ground-based quadrat surveys of 1% of the site.

The problem Can we extrapolate to the entire site?

The test Pin the ground-based surveys to a high-resolution aerial survey of the entire site.

The conclusion? Perhaps.

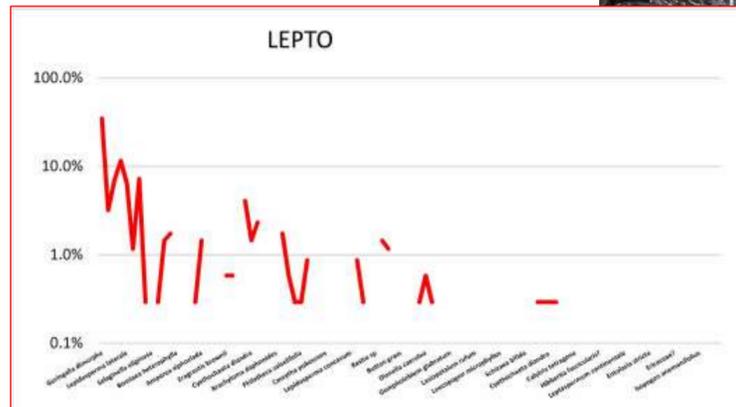
The underlying question of this longitudinal project:
 Can we test whether THIS ...



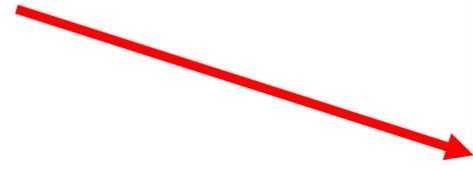
HAZARD REDUCTION BURN 2012

The fire crew are standing opposite Quadrat Q23, to be examined in later slides.

... can turn THIS ...



... back to THIS?



Ground-based Survey Program

Quadrat-based (32 x 25 m² quadrats, 11 fenced)

Quadrat attributes:

Soil type

Surface type

Plant attributes:

Species ID

% cover

Count

Life-cycle stage

Mean height

Derived Measures:

Simpson diversity

Shannon-Weiner Diversity

Plant richness

Species richness

Fidelity to ESBS





Survey site "S2", showing the location of quadrats (SW corners) within the site

UAV stitched imagery





One month pre-fire



One day post-fire



Three years post-fire



Six years post-fire

The Site

Location: North Fort area of Sydney Harbour Federation Trust's "North Head Sanctuary" in Sydney Harbour.

0.7 ha area, with a core of intact ESBS, surrounded by an annulus of *Leptospermum*-dominated scrub.



The HR Burn (September 2012)

Surveyed 24 months pre-fire; 6, 12, 36 and 60 months post-fire.

- Initially, more vigorous regrowth in quadrats protected from rabbit predation.
- At five years, little difference between fenced and unfenced quadrats.

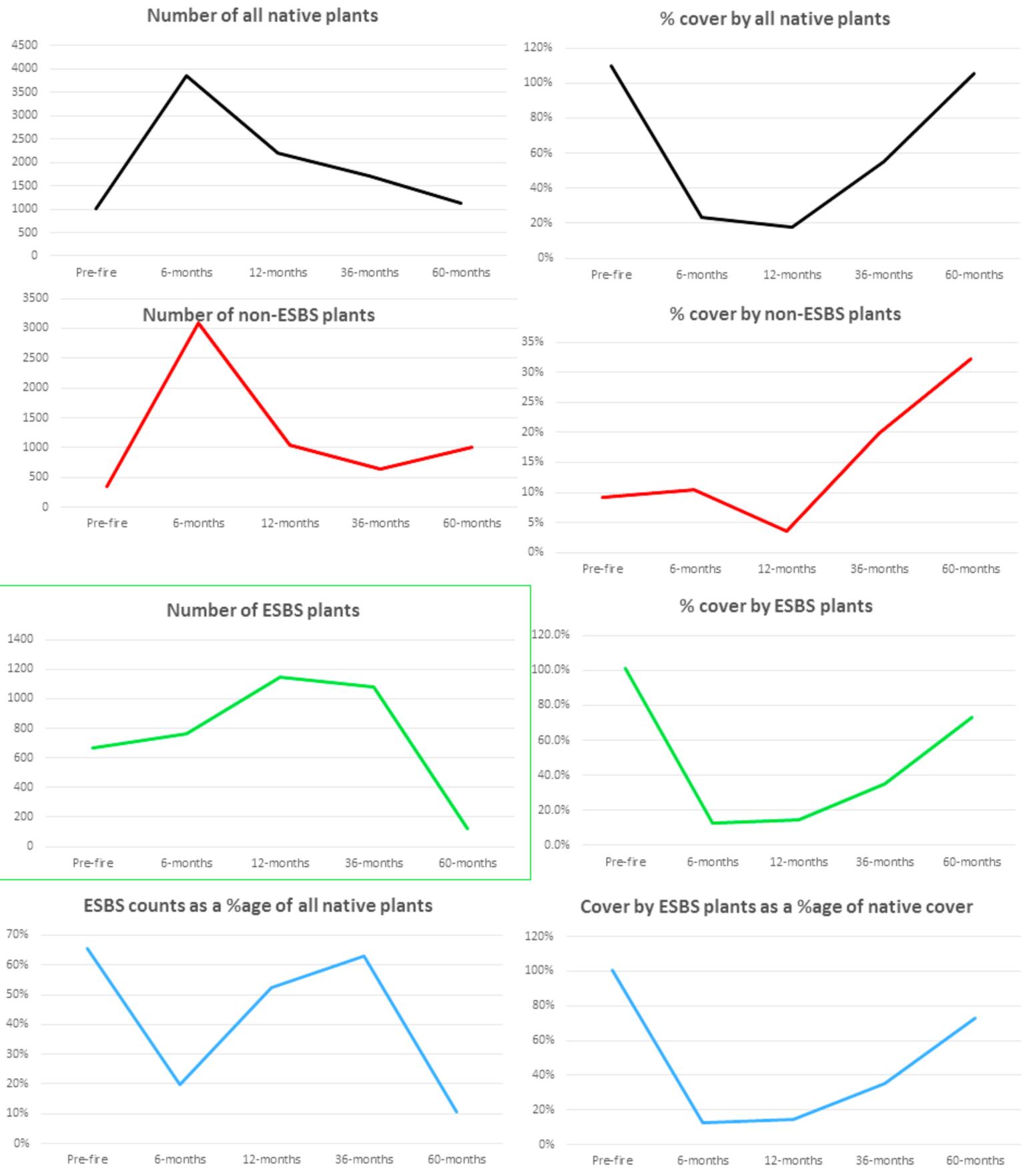
Five-year trends for vegetation counts and cover.

Inside the plots, the proportion of, and coverage by, ESBS and other native plants varies with time.

Initially both increase but, with time, the larger plants crowd out the smaller.

The fire has done SOMETHING, but it has not restored the 2012 state.

The question is – did this happen over the entire burn area?



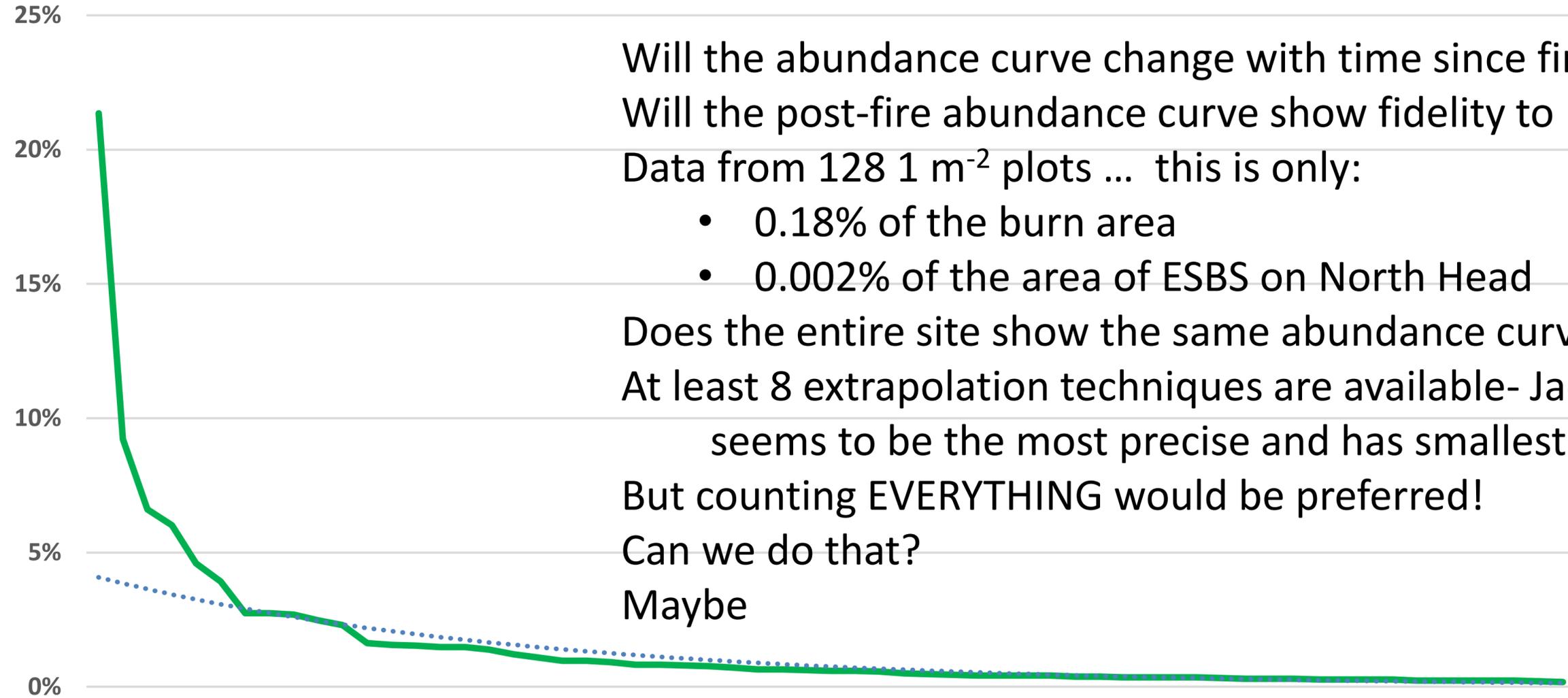
The classic sampling problem:

Can we extrapolate to the entire site?

Estimating the number of unseen species: How many words did Shakespeare know?

BY BRADLEY EFRON AND RONALD THISTED
Department of Statistics, Stanford University, California

Relative abundance all sites 12 months post fire



Will the abundance curve change with time since fire?
Will the post-fire abundance curve show fidelity to ESBS?

Data from 128 1 m² plots ... this is only:

- 0.18% of the burn area
- 0.002% of the area of ESBS on North Head

Does the entire site show the same abundance curve?

At least 8 extrapolation techniques are available- Jackknife procedure seems to be the most precise and has smallest errors.

But counting EVERYTHING would be preferred!

Can we do that?

Maybe

Species in the survey

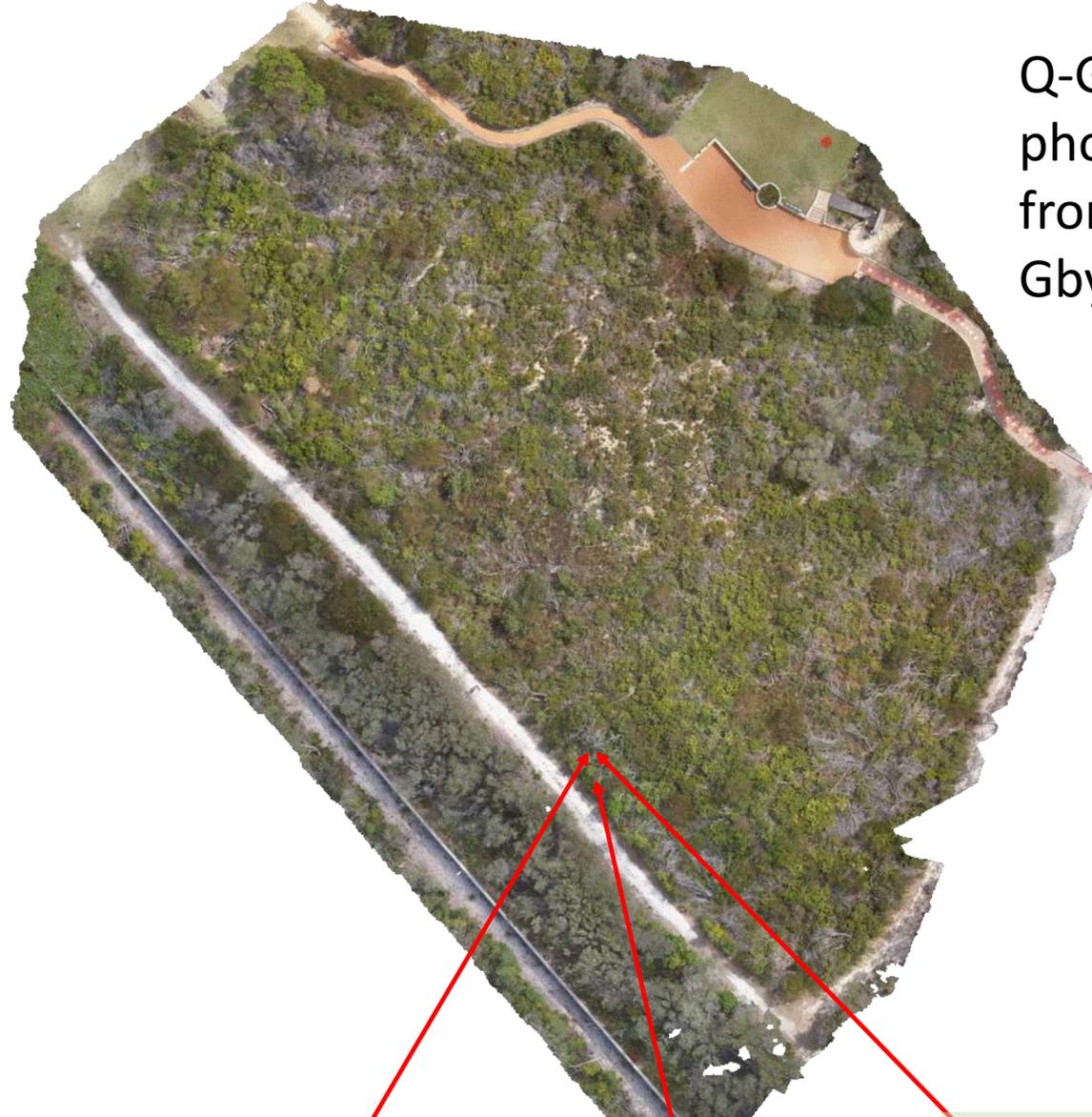
Flight-lines, pre-burn 2017

- Falcon-8 Octocopter, with either:
 - Olympus digital camera or
 - GoPro Hero5 4-channel (infrared) camera;
- Flightlines pre-programmed to suit site topography;
- Aircraft software records image GPS coordinates
- Echidnas also surveyed!

Flightlines with Quadrats



Q-GIS geo-referenced
photomosaic (down-sampled
from 245 stitched images, 3
Gbyte in original).



Google Earth
200 mm

NearMap
70 mm

UAV
5 mm



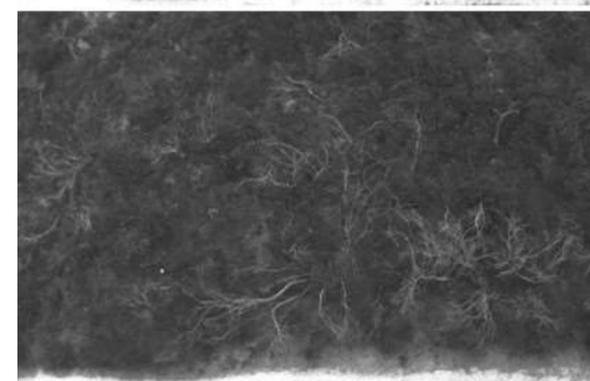
Resolutions compared (52 months post-fire)



RGB



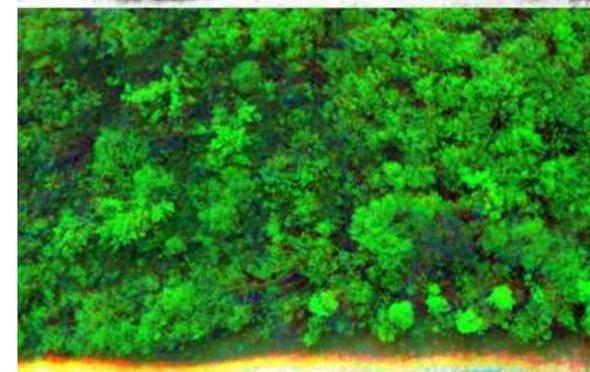
GREEN



RED



Near Infrared (NIR)



False Colour



The southwest (reference) corner of Quadrat #Q23.
This a fenced quadrat, with a 22-cm reference disk
sitting atop the corner star picket, at UTM

$E0342393.4 \pm 0.01$

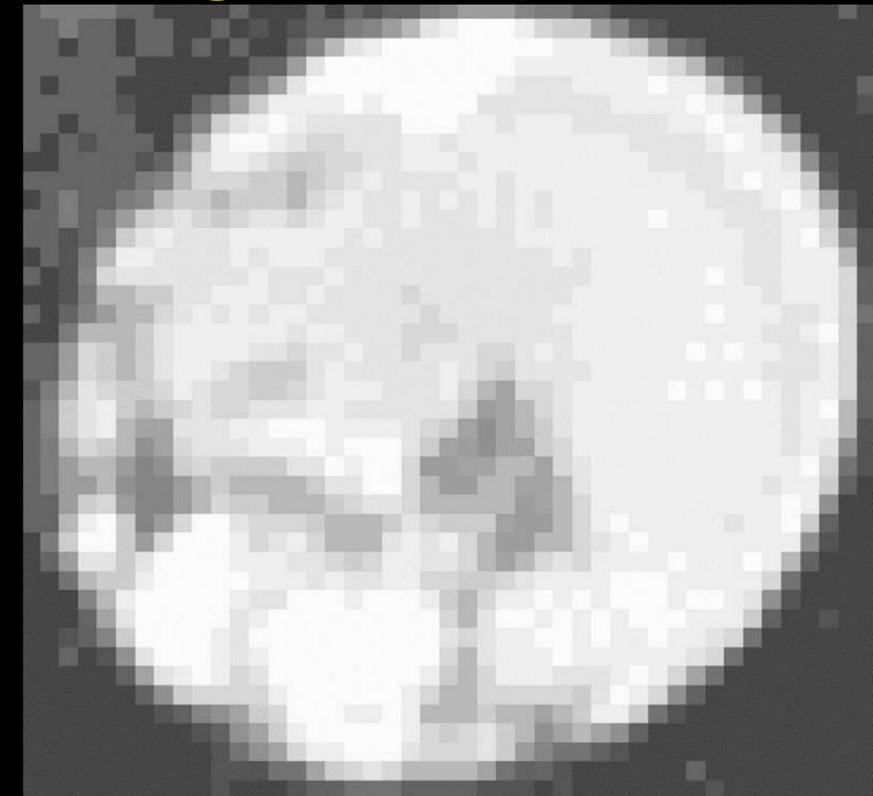
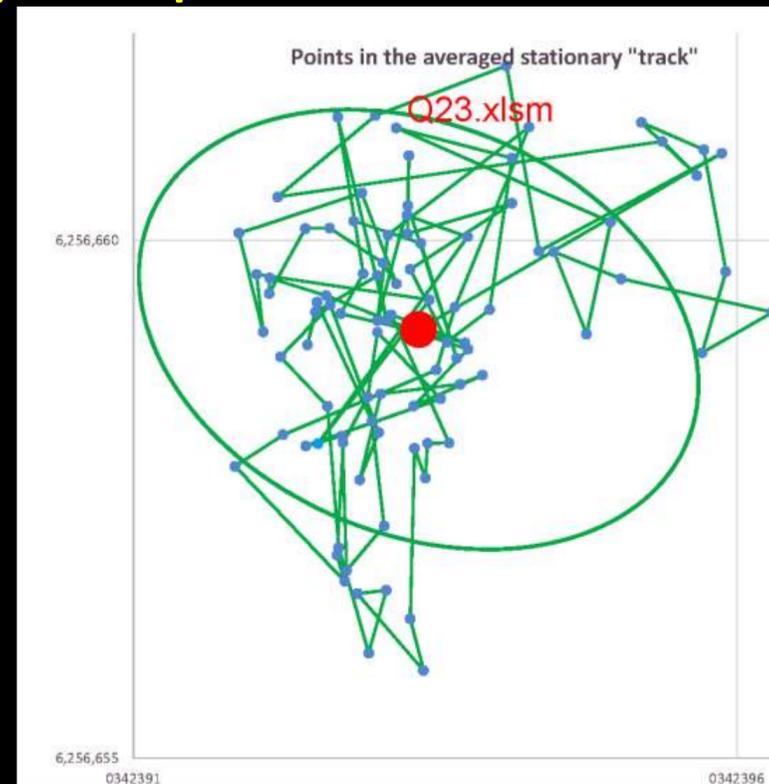
$N6256659.1 \pm 0.01$

(C.E.P from 30-minute GPS averaging, middle lower).

The image is georeferenced to 19 such points.

UAV altitude was 48 m relative to ground (which
slopes down 5 metres, North-South).

The resolution of the imagery is 5-6 mm , as shown
by the pixel count for the disk, right lower).





Extract from DSC08038.JPG, including quadrat 23. The image has been rotated in a different way, to show the quadrat aligned on the UTM grid, with the coordinates for the SW corner shown.

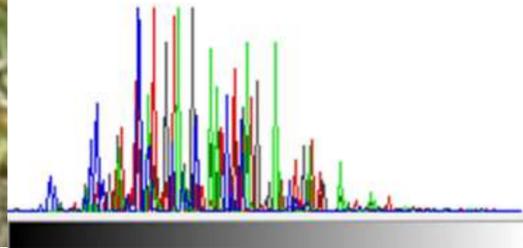
The red lines lie along the fence lines which form a 7x7 metre rabbit enclosure (note the yellow caps on the star pickets at right). The black square represents the boundaries of the 5x5 metre survey quadrat itself. The blue lines represent, approximately, the four 1x1 metre vegetation survey plots (from the top) V3, V4, V1 and V2.

Species are counted and identified in subsequent slides.

Data	Plant COUNTS and COVER 60-months S1_S2 Q23 only.xlsx				
S_Q	Scrub type	Plot	<i>Genus and species</i>	%cover	count
2_23	ESBS	v1	Lambertia formosa	60	2
2_23	ESBS	v1	Lepidosperma concavum	90	19
2_23	ESBS	v1	Acacia longifolia	60	1
2_23	ESBS	v2	Lepidosperma concavum	100	17
2_23	ESBS	v2	Orchid sp	1	1
2_23	ESBS	v3	Cassytha glabella	1	1
2_23	ESBS	v3	Acacia longifolia	40	2
2_23	ESBS	v3	Persoonia lanceolata	1	1
2_23	ESBS	v3	Lepidosperma concavum	80	9
2_23	ESBS	v3	Lasiopetalum rufum	1	1
2_23	ESBS	v3	Allocasuarina distyla	2	1
2_23	ESBS	v3	Lambertia formosa	2	1
2_23	ESBS	v4	Eriostemon buxifolius	10	1
2_23	ESBS	v4	Xanthorrhoea resinosa	20	1
2_23	ESBS	v4	Lasiopetalum rufum	40	5
2_23	ESBS	v4	Lepidosperma concavum	30	5
2_23	ESBS	v4	Lambertia formosa	10	2
2_23	ESBS	v4	Leptospermum laevigatum	1	2

Species in the previous slide

(More or less in position in image, with samples of colour histograms)

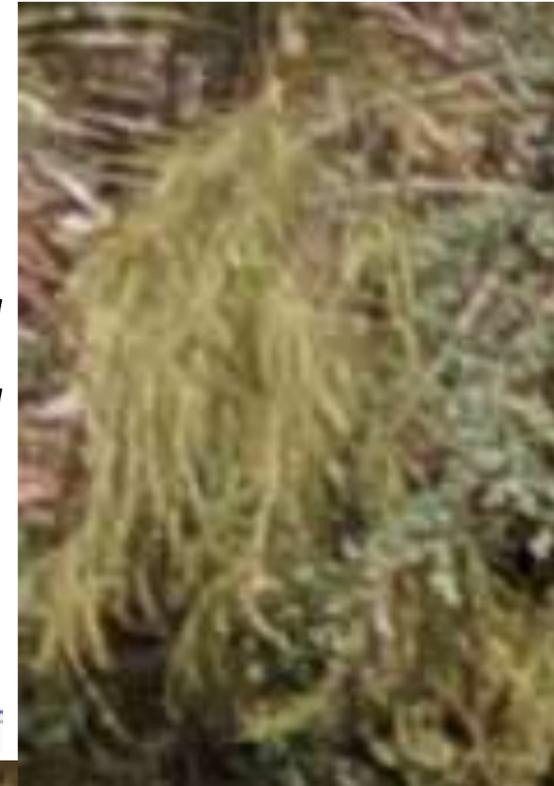
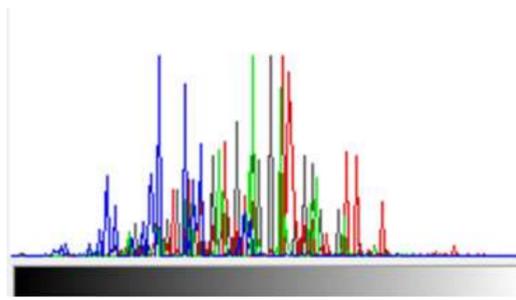


Banksia aemula



Acacia longifolia

Allocasuarina distyla



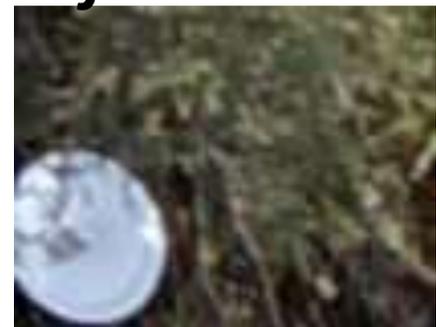
Anisopogon avenaceus



Eriostemmom australiensis

Leptospemum laevigatum

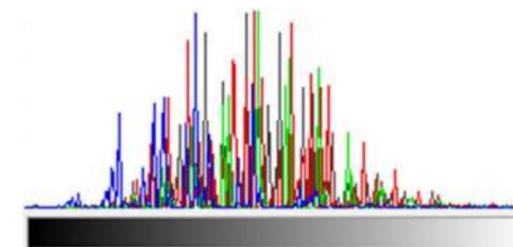
Lasiopetalum rufum



Persoonia lanceolata



Lepidosperma concavum



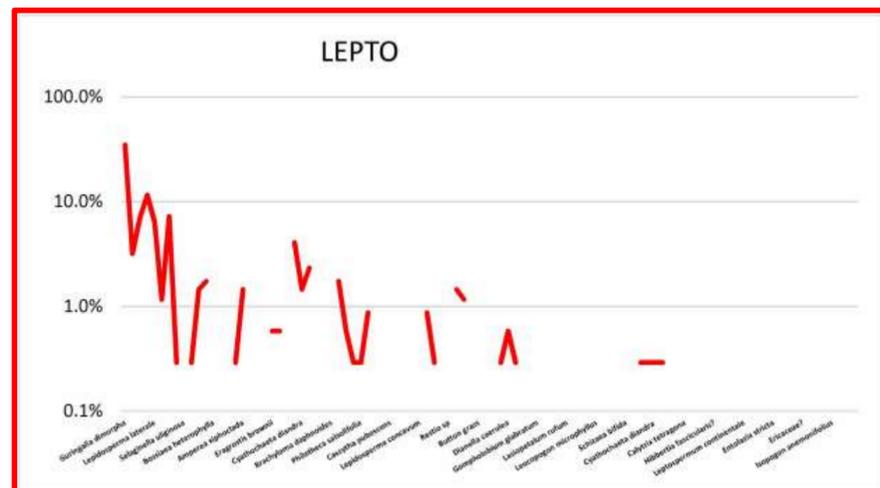
Lambertia formosa

Rarefaction and Extrapolation

- Software-based analysis of every image is extraordinarily time-consuming and is yet to be done.
- However, visual examination of the regions within and between the quadrats supports the idea that the plots are fair samples.



But ESBS is yet to be restored



Tentative conclusions on Method and Project

- Species identifiable from drone imagery by inspection & possibly by training the image analysis software;
- Plant numbers are harder to measure;
- Coverage should be measureable, with software;
- Quadrats seem to have captured a representative mix of species
∴ we *can* extrapolate;

-
- A. Plant coverage in fenced quadrats confirmed to be greater than in unfenced;
 - B. ESBS NOT restored in either intact ESBS or degraded ESBS;
 - C. Fire impacts may be more complex than we think;
 - D. The program is to continue for the new site burned in May 2018

With thanks to

- Greg (Taz) Chamitoff (NASA);
 - Sydney Harbour Federation Trust;
 - University of Sydney ;
 - Texas A&M;
 - Australian Wildlife Conservancy and;
 - NHSF volunteers
- who made it all possible

