Validation and comparison of habitat suitability models using camera trap and GPS collar data

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QUEENSLAND GOVERNMENT

History of pigs in Australia

- Invasive globally
- Introduced to Australia in 1788
- Population ≈ 3 million (2000)
- Risk to production and environment
- Vectors for disease

Feral pigs represent one of the top 100 invasive species globally – they are a highly successful invasive species that, unlike many other invasive species, are omnivorous generalists, meaning they can act as both large herbivores and predators.
As such, they pose significant and often multi-faceted risks to their introduced ranges, both to the flora and fauna.
Since they were introduced to Australia in 1788, they have gone on to grow to an estimated population size of 3 million as of the year 2000, causing impacts to the environment as well as agriculture and production systems. Concerningly, pigs also act as vectors for disease which pose significant threats to the livestock industry. Of particular concern are African swine fever, foot and mouth disease, Japanese encephalitis…among many others.

As such, understanding their ecology and how they interact with the landscape can help identify where and how to manage feral pigs, thus reducing their potential impacts.

What we don't know…

- Does intensive management change their behaviour?
  - Home range size
  - Home range location
  - Interaction zones between individuals
- Important as could influence control in a disease outbreak
- Control programs/dispersal

In terms of an aerial control, some aspects of pig spatial behaviour and habitat use are still poorly understood.
For example, does intensive management, specifically aerial shooting which represents a significant disturbance to feral pigs, change their behaviour in terms of their home range size (do they expand/contract their range?), home range location (do they shift their home range to another area?), and interaction zones (do they split apart of come together following control?).
Understanding these factors is important for determining how to best manage feral pigs in the event of a disease outbreak, thus reducing transmission, spread, and impacts on industry.

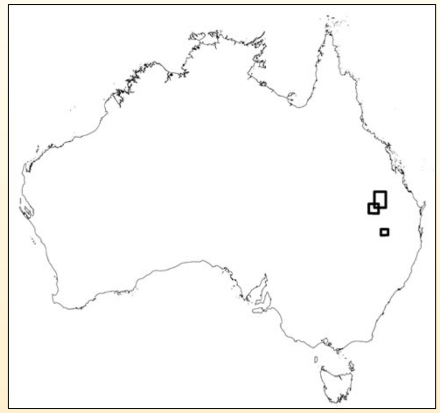
Impact of aerial control

- GPS collars
  - 73 pigs (41 used in analyses)

So, using GPS collars of 73 feral pigs at three different sites in Queensland and New South Wales (these black boxes here), I examined how pigs respond spatially to aerial shooting as a control method (these two smaller boxes) and compared that the how pigs respond to rainfall at a site with no aerial control (this larger, northern box). What I looked at specifically was changes in their home range size, home range location, interaction zones, and changes in their use of cover (presumably as a prey animal, that is, an animal that gets preyed upon, use of cover should increase in response to perceived predation threats). Just for context as well, I split the data into “before” and “after periods”. These are one month periods either side of a cull, or, for the environmental conditions, one month periods based on rainfall (that is dry-dry (where both months were both below average rainfall), wet-wet (where both months both above average rainfall), a wet-dry period (where the first month was above average rainfall and the second was below) and a dry to wet period (vice versa).

Impact of aerial control

- GPS collars
  - 73 pigs (41 used in analyses)
- Three sites
  - 2 sites with aerial control
  - 1 site with no control



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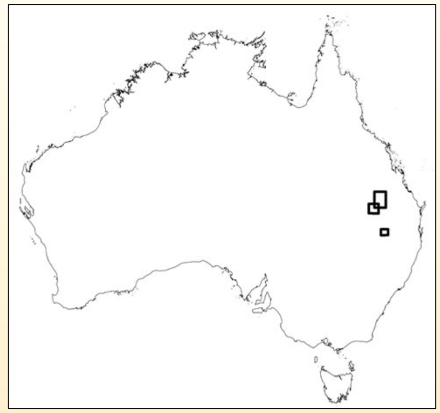
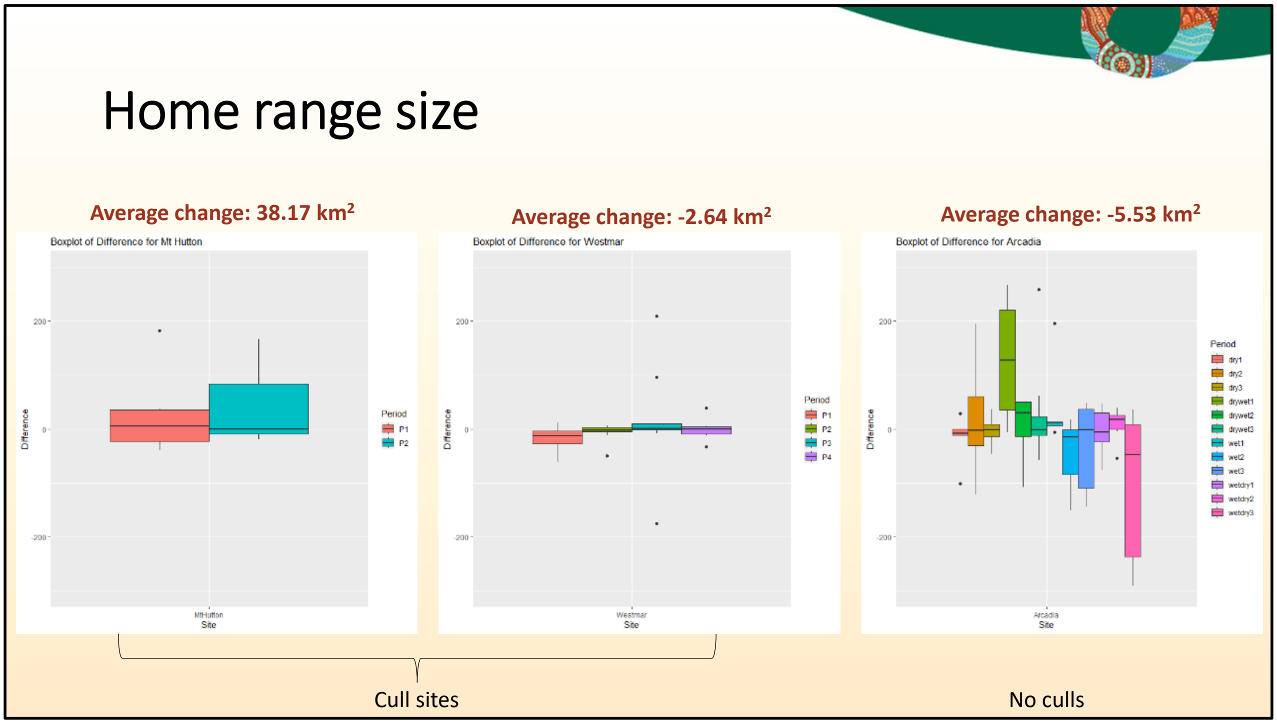
Impact of aerial control

- GPS collars
  - 73 pigs (41 used in analyses)
- Three sites
  - 2 sites with aerial control
  - 1 site with no control
- Response to culling and environmental conditions
  - Home range size
  - Home range location
  - Interaction zones
  - Daily behaviour and use of cover



Using continuous time movement models, I specifically looked at changes in their home range size, home range location, interaction zones, and changes in their use of cover (presumably as a prey animal, that is, an animal that gets preyed upon, use of cover should increase in response to perceived predation threats). Just for context as well, I split the data into “before” and “after periods”. These are one month periods either side of a cull, or, for the environmental conditions, one month periods based on rainfall (that is dry-dry (where both months were both below average rainfall), wet-wet (where both months both above average rainfall), a wet-dry period (where the first month was above average rainfall and the second was below) and a dry to wet period (vice versa).



First, when looking at home range size – these are plots of the changes in home range size for all the different periods. These two on the left are the two cull sites (Mt Hutton with two culls that were undertaken and Westmar where four culls were undertaken). On the right we have the control site with no culling operations, Arcadia. All these boxes represent the different periods I examined (dry, wet, wet to dry, and dry to wet).

If culling operations had a significant effect on home range size, we would see that these two graphs here would be much lower or higher than what we're seeing with the control site. As you can see, that isn't the case – in fact, you can see from the control site just how variable pig home ranges are between different rainy periods. You can also see that these changes aren't very consistent. Based on t-tests comparing changes between periods, none of the changes in home range size either in response to control, or in response to environmental conditions were significant.

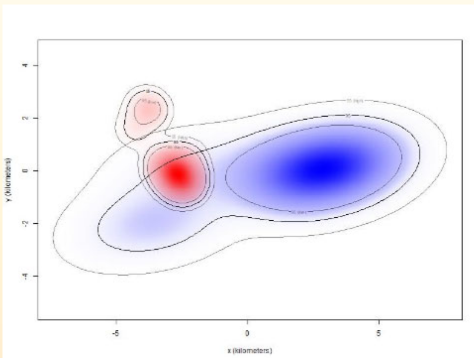
This means that aerial control doesn't impact pig home range size more than environmental conditions. As I said before, pigs will also change their home range size in response to environmental conditions and will readily expand, contract, or utilise other areas of their range to meet their physiological requirements and resource availability. This means that what might be true in one season, won't be true for another, and the pigs may be using different parts of the landscape.

Home range location

Blue = before cull
Red = after cull

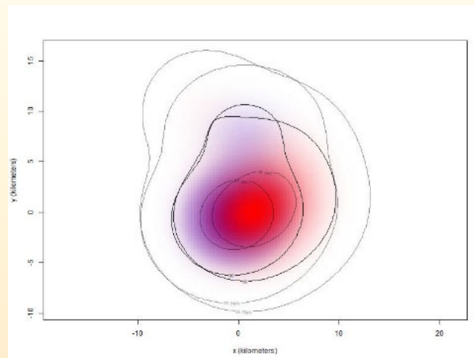
"Low" overlap

27% overlap

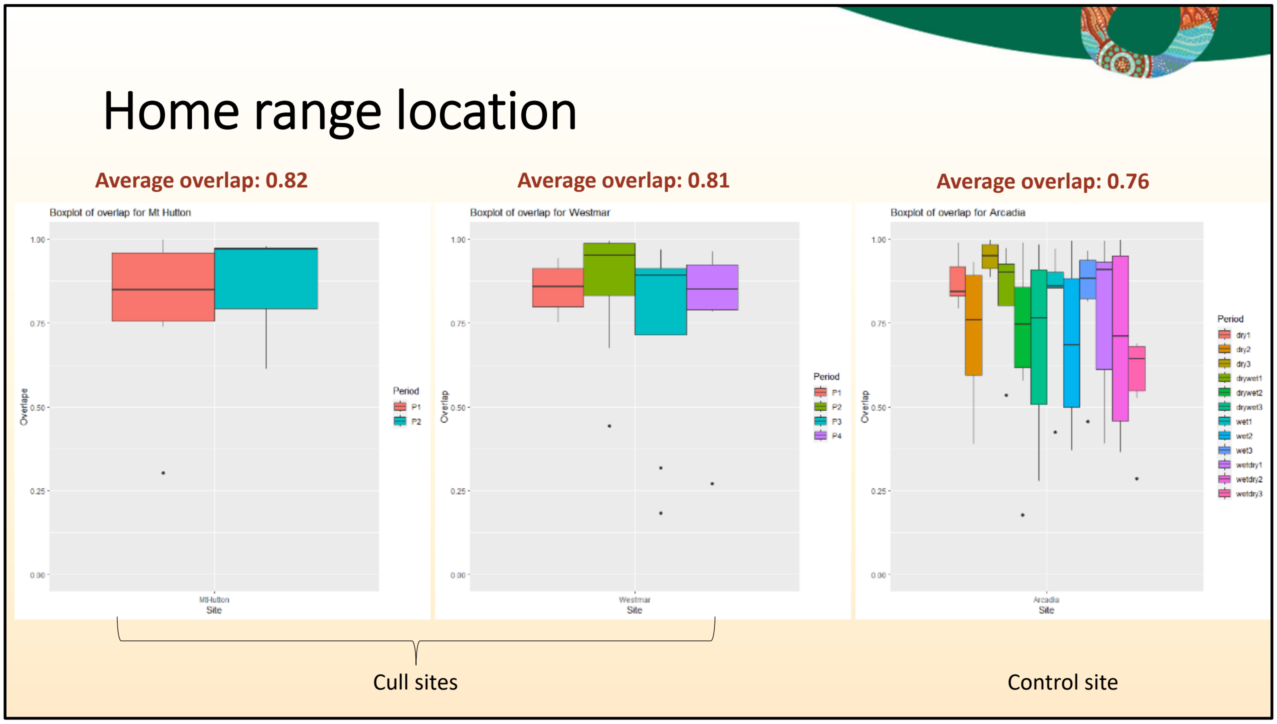


"High" overlap

100% overlap



Second, home range location. Here are two examples of changes in home range overlap of two feral pigs to show you what home range overlap looks like from the lowest overlap that I recorded (27%) to the highest possible (100%). Blue in these plots is the home range "before" a cull and red is the home range "after" a cull.
Now, let's look at summaries of these data…

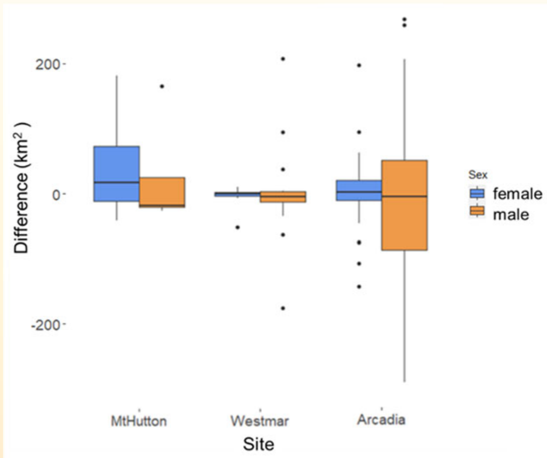


As with the home range size plots, these boxes represent the overlap between the before and after periods for the cull sites (left) and control site (right).
Here, you might expect pigs to shift home range in response to aerial control – but as you can see at Mt Hutton and Westmar, there is extremely high overlap in their home ranges before and after, indicated aerial control had little or no impact on their home range. And again, if this was different from normal behaviours in response to environmental conditions, we'd expect these boxes to be much higher or lower than the pigs responding to rainfall on the right here. As you can see, that isn't the case. Pigs home range overlap is highly variable on a month to month basis, regardless if there was aerial control.

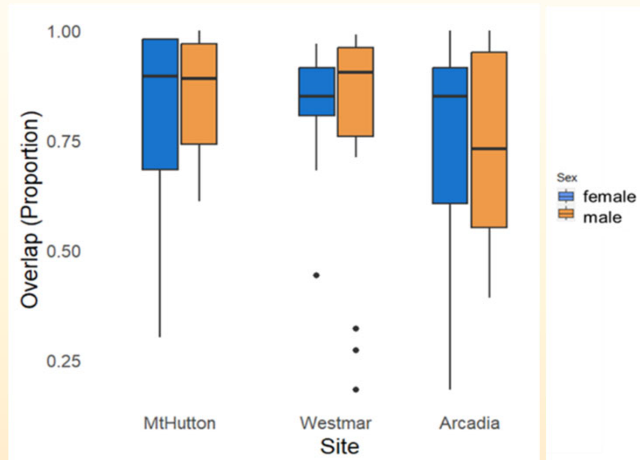
After model selection examining changes in home range size and location, none of the examined variables contributed to changes in home range size except sex.

Sex differences

Home range size



Home range overlap

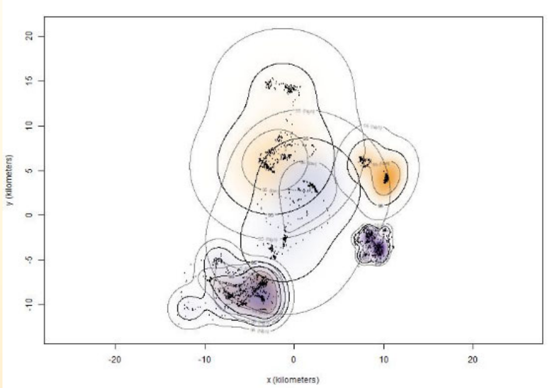


…and, based on my results, the difference between male and female home range sizes varied from male home ranges being one-third larger (20 km2 for females and 29 km2 for males on average), to male home range being six-times larger (11 km2 for females and 62 km2 for males on average). One male I examined (who was non-range resident, so non-transient, had a home range size of 1408km2. This was more than four times the size of the maximum observed female home range of 317 km2. However, there were no significant sex-specific differences in home range overlap and the magnitude and direction of differences varied between all periods.

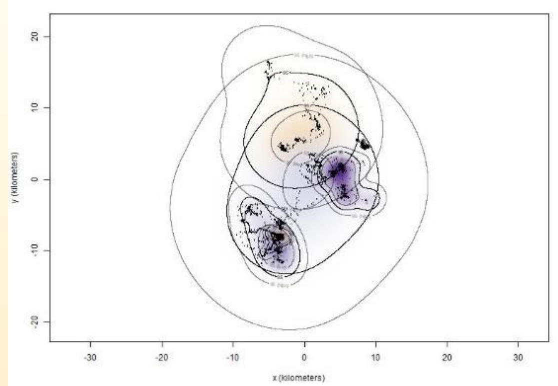
REMAKE GRAPHS

Interaction zones

Before

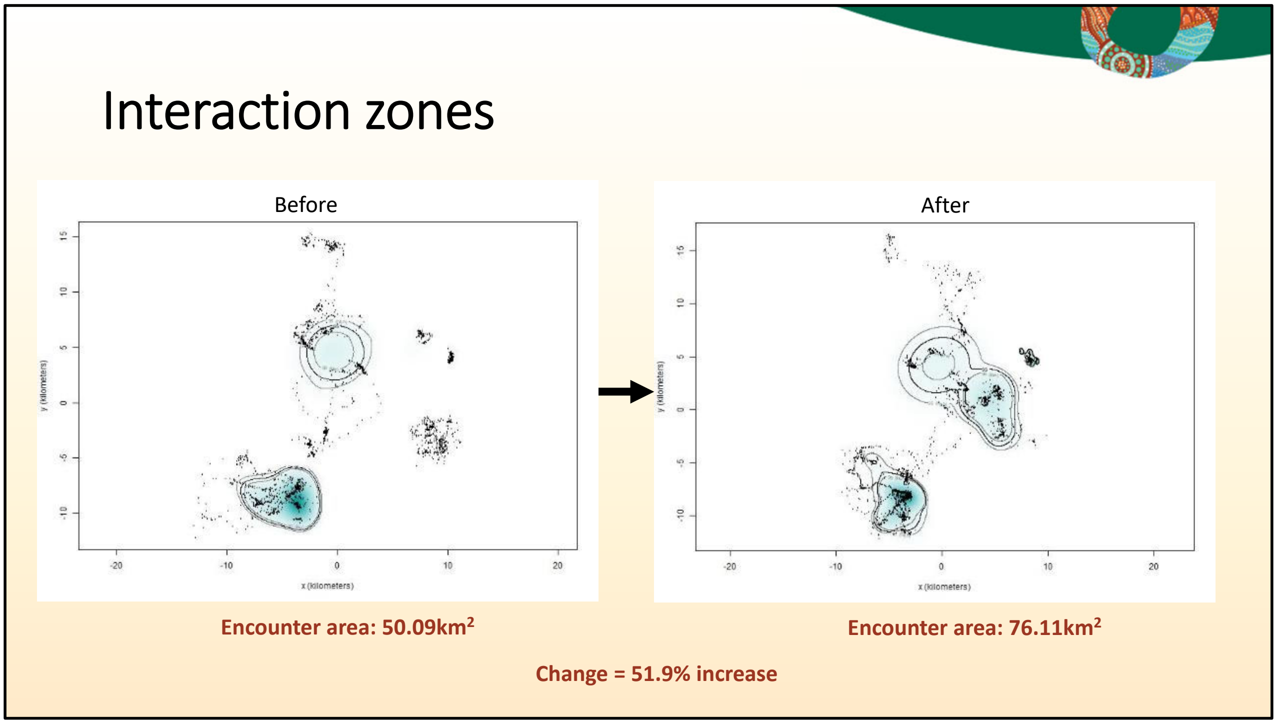


After



OK, so interaction zones represent areas of overlap in the home range of different pigs. These plots are an example of the home ranges of six different pigs before (left) and after (right) a cull period. When looking specifically at interaction areas…

((example of overlap))

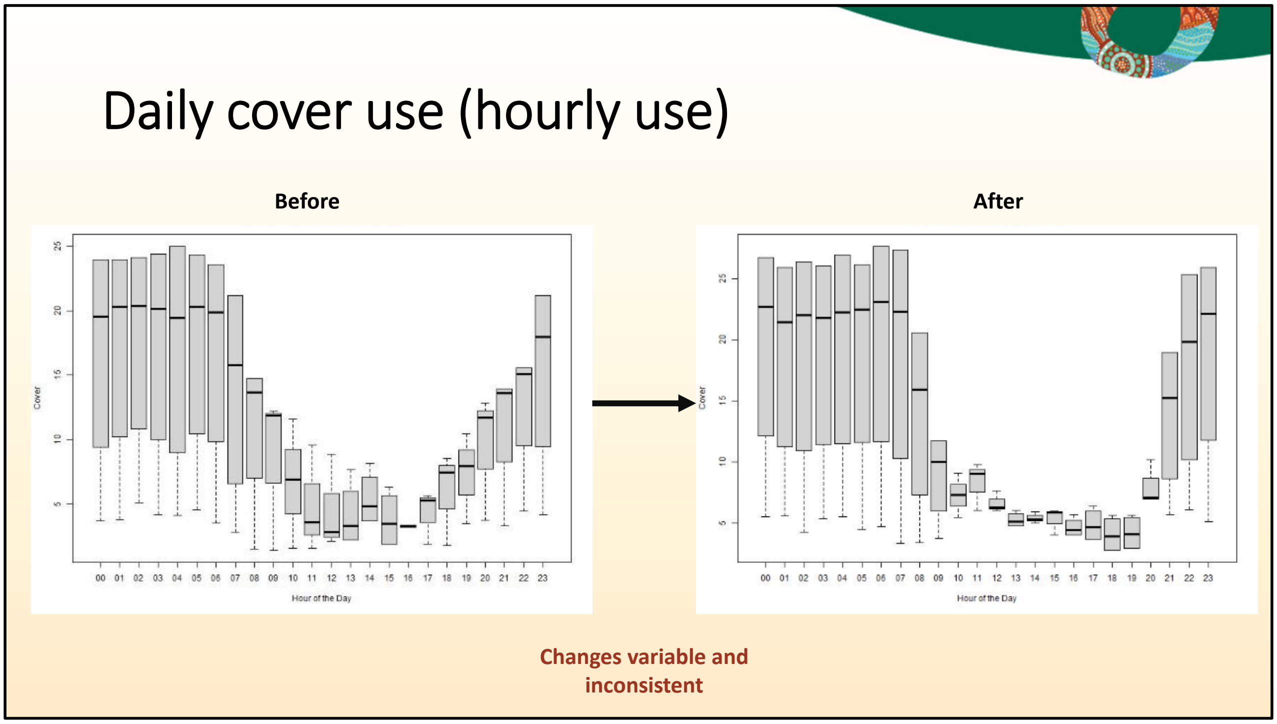


These blue areas represent those home range overlap areas. If the pigs were to scatter in response to aerial control, we would see these areas decrease. If the pigs were to group together following control, they would increase.

Now, while this period exhibited a 50% increase in overlapping area, this was not consistent across all sites and all periods. During cull periods, these areas both increased and decreased, and at the control site with no aerial management, these overlapping areas also increased and decreased, and to different extents.

This indicates that pig grouping behaviour varies in response to environmental conditions, but aerial control does not cause the pigs to either scatter nor come together at rates greater than what they naturally exhibit on a month to month basis.

((example of overlap))

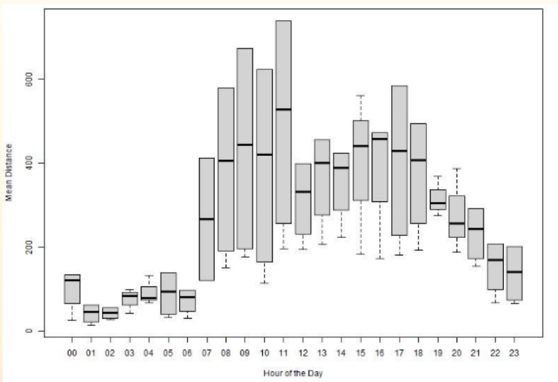


I also looked at how pigs changed their use of cover in between different periods to see if they exhibited increased use of cover as an anti-predator response following aerial control. If that were the case, I'd imagine these graphs (with cover % on the y axis and time of day on the x axis) to look very different. You can see in this example here that in both periods, we have higher use of cover at night and lower use during the diurnal hours as they go out to forage. Now you can see the scales are a little different on the one on the left (meaning the density of the cover that was used was a little higher), but if aerial control had an impact, I would expect these diurnal hours to be much higher on the right hand side than they are. Now, statistically, while some of the periods exhibited significant differences in cover use, the direction (i.e., more or less cover) varied between periods; this was the same for the site with no aerial control.
That means that pigs don't change their daily behaviours or use of cover in response to control.

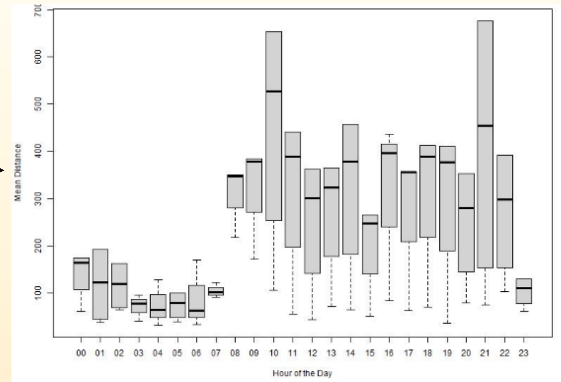
((example of cover use))

Daily activity (hourly)

Before



After



Changes variable and inconsistent

Likewise, their daily activity (measured here as the mean distance travelled for each hour of the day) didn't change as much as one would expect. Their main period of activity was during the day, and their main period of inactivity was at night., and aerial control had no more impact on these behaviours than environmental conditions on a month to month basis

Limitations

- Only adult pig movement examined
  - Pigs under 35kg excluded from study due to ethical requirements.
- Low sample size
  - May not be representative of every feral pig behaviour
- Naivety level of feral pigs
- Presence of cluster fences
  - The presence of cluster fences on the property may limit or influence movement

This study does have several limitations that need to be acknowledged. First, these data are only representative of adult feral pigs. Due to ethical requirements, collars could not weigh more than 5% of the animals body weight, limiting us to animals that were 35kg and above. Future studies that include smaller individuals would help to fill a significant knowledge gap here.

Second, due to the sporadic nature of the GPS collaring regime, there were some periods with a low sample size. IN addition, this study included only collared animals in similar habitats in south-east Queensland. As such, these data may not be representative of all feral pig responses to aerial control.

Following on from that, feral pigs in the study area experience regular exposure to helicopters (from farm management activities) and gunshots. As such, aerial culling may not have represented a significant enough stimuli to induce behavioural change in this population, and a naïve population may respond differently.

Finally, the presence of cluster fences on the property may have influenced the movement of feral pigs at the Westmar site. Feral pigs here still had the opportunity to move elsewhere on the property, but this is still a limitation that should be acknowledged.

Conclusions

- Aerial control did not cause pigs to change home range size or location
  - In an emergency animal disease outbreak, pigs are unlikely to disperse due to control

So, in summary what we have learnt from these pigs is that aerial control does not cause pigs to change home range size or location. This means that in an emergency animal disease outbreak, feral pigs are unlikely to spread or disperse due to control measures. Understanding that feral pigs don't immediately shift their home ranges in response to control supports response decision-making regarding establishing control zones for disease containment.

Conclusions

- Aerial control did not cause pigs to change home range size or location
  - In an emergency animal disease outbreak, pigs are unlikely to disperse due to control
- Aerial control did not impact interaction zones
  - In an emergency animal disease outbreak, pigs don’t all come together or all split apart.

Second, aerial control does not have an impact on the interaction zones. That is, following aerial control, feral pigs don’t all group together or spread apart. This is good to know in the event of an outbreak as either clustering in higher densities or spreading out could facilitate the spread of a disease.

Conclusions

- Aerial control did not cause pigs to change home range size or location
  - In an emergency animal disease outbreak, pigs are unlikely to disperse due to control
- Aerial control did not impact interaction zones
  - In an emergency animal disease outbreak, pigs don't all come together or all split apart.
- Aerial control did not cause pigs to change their habitat use
  - Don't have to change focus areas to adapt to different behaviours

Third, aerial control did not cause feral pigs to change their daily activity or use of cover. This makes the population more predictable in terms of their behaviour. It is easier to locate and control feral pigs when they aren't under cover, so knowing that the pigs don't immediately flee to cover and stay there as a response to aerial culling means that control in a disease outbreak doesn't have to accommodate those changes.

Ultimately, this really shows how flexible pigs are to adapting to their surroundings. They are already a difficult and secretive animal to control, so understanding how their behaviour changes (or doesn't), is important to knowing how to best control feral pig populations in an emergency animal disease outbreak.

Thank you

"Woodlands" management and staff
Scott Bridle
Participating Landholders
African Swine Fever Prevention and Preparedness Project (DAF)

Thank you ☺