

# **The 2024 aerial survey of fallow deer in Tasmania**

## **Summary report**

*Report to the Department of Natural Resources and Environment Tasmania*

*June 2025*

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## Executive Summary

In 2019, baseline aerial surveys were done over central and north-eastern Tasmania to estimate the size and distribution of the fallow deer population. This helped inform the development of the *Wild Fallow Deer Management Plan 2022–2027*. The survey was repeated in October 2024 using the same methods. This report presents the results of the 2024 survey, and compares the results with the 2019 survey.

A total of 2,579 km of transect lines were flown in 2024, covering an area of around ~25,000 km<sup>2</sup>. This was a larger area than was surveyed in 2019 (~21,000). Three observers counted deer along the flying transects from a low-flying helicopter, and the data was used to calculate the average number of deer per km<sup>2</sup> within different parts of the survey area. These estimates were then used to estimate the number of deer in each area.

A comparison of the population estimates for 2019 and 2024 calculated within the same area showed a marked increase from 53,660 (+/- 19%) deer in 2019 to 71,655 (+/- 19.6%) deer in 2024. Over the equivalent area, the population may have risen at the least 12% in five years (~2% per year), and in the worst case scenario 55% over 5 years (~9% per year).

Density distribution mapping over the same area showed that since 2019 deer have spread outwards within the 2019 survey boundaries, with denser populations now adjacent to the boundaries of the 2019 survey area, and close to high-value conservation areas around the Walls of Jerusalem National Park and the Central Plateau. This degree of change in a five year period was not anticipated, and we recommend that surveys need to be done more frequently (every 2–3 years) to monitor whether the deer management goals of the current management plan are being met. Citizen-science may also have a role to play in reporting deer spreading into new areas so that early control is possible.

## Introduction

Fallow deer (*Dama dama*) are an introduced species in Tasmania. Wild-living herds are common in parts of the state, mainly in the central and north-east regions. Fallow deer were introduced to Tasmania in the 19<sup>th</sup> Century, and populations initially remained small. However, from about the year 2000, the population grew exponentially. This led to major concern about the impacts that unmanaged deer populations were having on agriculture, forestry, and conservation.

## The 2019 aerial survey

To obtain an accurate snapshot of the size and distribution of the deer population, in September-October 2019 a baseline aerial survey of fallow deer was done over central and north-eastern Tasmania. The survey covered an area of around 21,000 km<sup>2</sup>.

Analysis of the 2019 survey estimated that the fallow deer population in central and north-eastern Tasmania numbered around 53,660 individuals. The average population density in the surveyed area was estimated to be 2.7 deer per km<sup>2</sup> (Lethbridge *et al.*, 2020).

## Deer management since 2019

The 2019 aerial survey informed the development of the current deer management plan, the *Tasmanian Wild Fallow Deer Management Plan 2022–27* (Department of Natural Resources and Environment Tasmania, 2022). Overall, the management plan aims to reduce the deer population, prevent the outward spread of deer into new areas, and maintain a smaller but sustainable deer population for hunting.

The management plan defines different zones of the state for different purposes. Zone 1 is the 'traditional deer range', Zone 2 is a buffer zone around Zone 1 where the aim is to suppress the growth and spread of the population. Zone 3 is the remaining area of the state where historically there have been no, or very few, deer, and where the aim is to monitor and control any new appearances of deer.

Since the deer management plan was developed, the deer population has been managed using a mixture of hunting, culling by the Department of Natural Resources and Environment Tasmania (the department), and the issue of control permits to landholders.

## Repeat of the aerial survey in 2024

The *Tasmanian Wild Fallow Deer Management Plan 2022–27* requires an aerial survey of deer to be done every five years, to monitor whether the population management goals for each management zone are being met. The 2024 aerial survey is the first follow-up aerial survey that has been done since the baseline survey in 2019. It is therefore the first opportunity there has been to monitor whether current management practices are working.

In 2019 a ground-based survey was also done and the results of this were compared with the aerial survey (see Lethbridge *et al.* 2020). A similar comparison was not requested in 2024, and this report therefore relates to an aerial survey only.

The department commissioned Ecolknowledge to carry out the 2024 aerial survey, following a similar format to the 2019 survey. All data were collected and analysed by Ecolknowledge, and results were reviewed by Game Services Tasmania.

# Methods

## Key principles of aerial wildlife surveys

When surveying wildlife populations over very large areas, it is not feasible to count every individual animal in the landscape. The approach used is therefore to count a representative sample of the population throughout the landscape.

Based on this count, the average population density (the average number of animals counted per km<sup>2</sup>) is calculated. The average population density is then multiplied by the total area of the landscape that has been surveyed. This produces an estimated population size.

If the population is very unequally distributed within different parts of the landscape, then separate population estimates can be calculated for different areas for greater accuracy.

Depending on the survey (type of aircraft, the species being counted, whether one seat in the aircraft needs to be dedicated to a hazard spotter), either two or three aerial surveyors may count animals at the same time. Counts by two observers generally result in lower estimates. Using a third observer means a statistical correction (mark-recapture) can be applied to the two-person population density estimate, based on testing one person's counts against another. This usually revises the population estimate upwards.

## Approach used in 2024

The methods of the 2024 aerial survey of fallow deer remained consistent with the 2019 aerial survey so that the results can be compared fairly. As in 2019, in 2024 three observers counted deer from a low-flying helicopter, which flew along pre-determined flight lines (transects). The transects were spaced at regular intervals throughout the survey area to systematically sample the landscape.

The survey took place in October 2024. The same flying height and ground speed were used as in the 2019 survey. Ground speed was held at 93 km per hour (50 knots), with a flying height of 61 m (200 feet) above ground level. The pilot used a GPS receiver to keep on track.

Surveys were done in the early morning and late afternoon. These are the times of day when deer were expected to be most active and therefore visible. Surveying was avoided when weather conditions would affect visibility of animals, or if the pilot considered the conditions unsafe to fly.

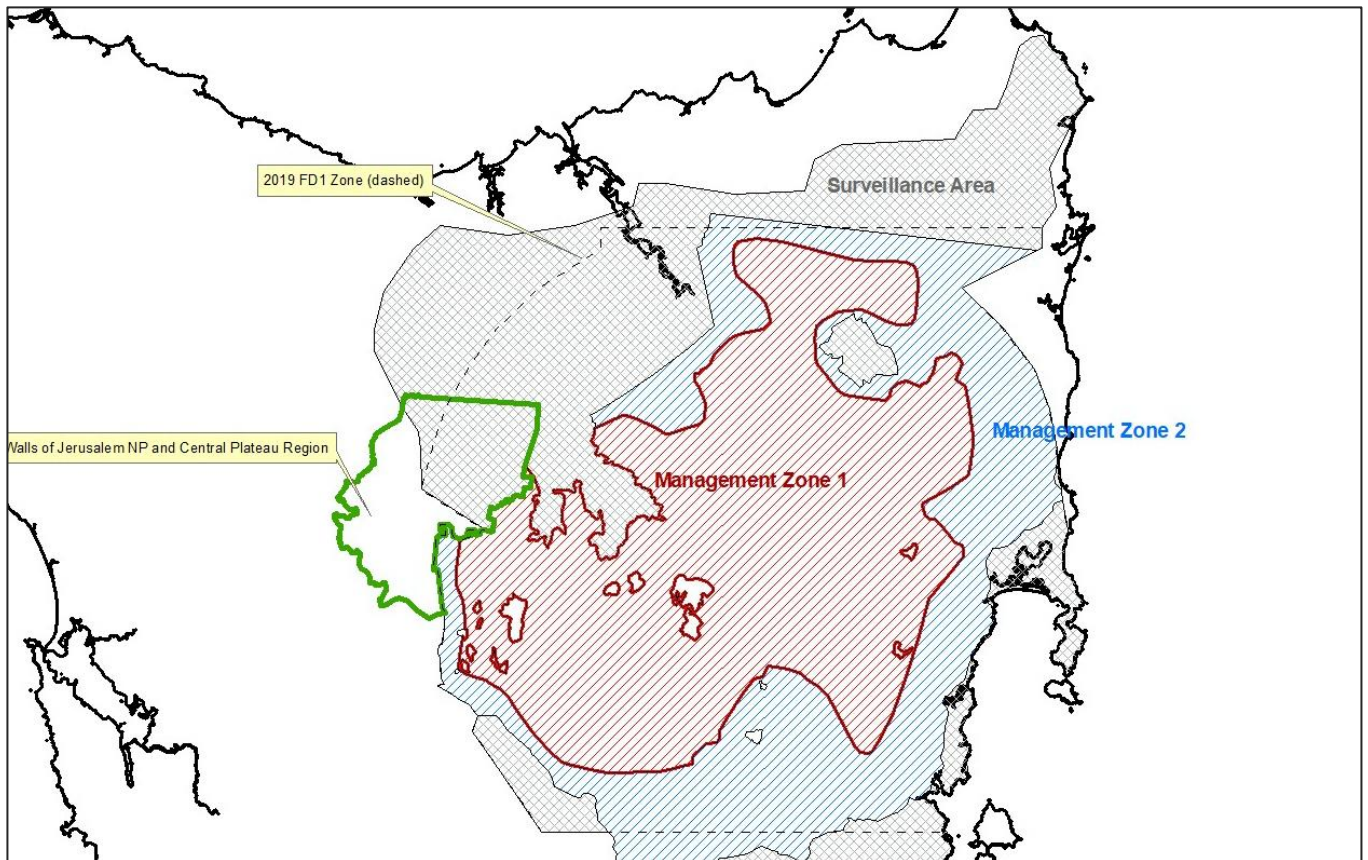
## Survey area

A larger area (~25,000 km<sup>2</sup>) was surveyed in 2024 than in 2019 (~21,000). At the time of the 2019 survey, the deer management zones in the *Tasmanian Wild Fallow Deer Management Plan 2022–27* had not yet been defined (see Introduction). The 2024 survey area therefore needed to be expanded to make sure that of each of the current management zones was surveyed.

The 2024 survey covered largely the same areas of Tasmania as in 2019, that is, the central and north-east of the state. The smaller boundaries of the 2019 survey area were contained almost entirely within the expanded 2024 boundaries (see Figure 1). This means that the deer population estimates from both years can be compared when calculated over the same area.

An additional area of National Parks and Wildlife land of high conservation value was also added to the 2024 survey. This area includes the Walls of Jerusalem National Park, Central Plateau and

surrounds. This area is part of zone 3 defined in the *Wild Fallow Deer Management Plan 2022–27*, but it was added to the 2024 survey because of concerns that deer are now spreading into this area.



**Figure 1** The fallow deer survey area for 2024, showing the deer management zones (Zone 1, red; Zone 2, blue; Surveillance area, grey) and the National Parks and Wildlife survey area (green). The northern and southern boundaries of the 2019 survey area are shown with a dashed line.

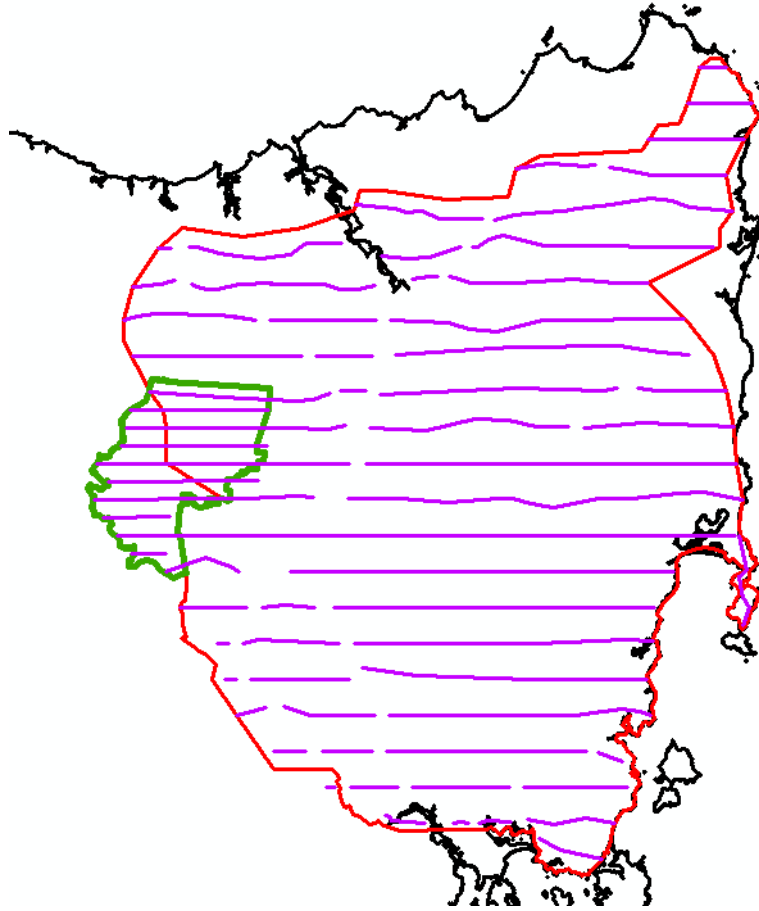
## Aerial survey & data collection

### *Transects*

For consistency with the 2019 survey, the 2024 survey was laid out similarly. Nearly all the transects (flight lines) were parallel, were orientated east-west, and were evenly spaced at ~10 km apart (see Figure 2).

Some gaps and slight variations in the orientation of the transects were needed in places. This was to avoid flying low over built-up areas, and because of aerial hazards such as towers, transmission lines, and catenary wires strung across valleys.

The National Parks and Wildlife survey area was surveyed more intensively than the rest of the landscape, with parallel transect lines spaced ~5 km apart.



**Figure 2** *Layout of aerial transects for 2024 (purple). Parallel transects were spaced approximately 10 km apart over most of the survey area. Narrower spacing of approximately 5 km apart was used for the National Parks & Wildlife areas (green).*

### *Aerial observers*

Three experienced and calibrated aerial observers counted deer in each survey flight. Two observers were seated in the rear of the aircraft, and one in the front-left position next to the pilot. Observers only counted deer out of the side of the aircraft where they were seated. This means that at all times, one observer was counting on the right side of the aircraft, while two observers counted on the left (one seated in the front, one in the rear).

Having two people count on the same side of the aircraft was needed so that the mark-recapture distance sampling method could be used to estimate deer population size more precisely. Comparing the counts by two observers on the left side, who were effectively counting the same animals, allowed a statistical calculation of how closely their counts agreed. This statistic was then used to adjust the population estimate calculated from the counts of the two rear observers.

The three observers were rotated through the three different seating positions during the survey. This is to help prevent systematic bias in the counts if there are slight differences in how individuals count.

## Data recording

The observers recorded their deer counts using electronic keypads. Electronic data entry meant that data was entered almost in real time, without observers having to look away from their field of view. This should result in fewer animals being missed in the counting.

The electronic keypads were attached to a computer that synchronised with the aircraft's flying data. This means that data such as flying height, ground speed, and GPS location are logged automatically with all animal sightings. All data were recorded in a secure database that uses a proprietary file format, and cannot be accessed or edited by the surveyors.

The surveyors' field of view out of the aircraft doors was divided into five sighting distance zones using marked poles mounted on the side of the helicopter. The poles were marked with zones that corresponded with distance classes on the ground of 0–20 m, 20–40 m, 40–70 m, 70–100 m, and 100–150 m away from the aircraft. These are the same sized zones that were used in the 2019 survey.

On their keypads, the observers recorded:

- The sighting distance zone, numbered 1–5, where each deer (or group of deer) was first sighted
- The number of deer in each group (1 or more)
- Habitat structure where each group of deer was sighted. Habitat was classified as *Open* (open habitat with unobstructed view); *Medium* (view partially obstructed by terrain and/or vegetation); or *Closed* (heavy obstruction of view).

This means that the raw number of deer that were counted can be related back to factors that might have affected visibility of animals (distance away from the aircraft, the size of the group, whether observers had a clear view).

Fallow deer were the main focus of the survey, but observers also recorded other species during the same flights (forester kangaroos, Bennett's wallabies) using different buttons on the keypad. Kangaroo data are contained in a separate report.

## Analysis of aerial survey data

### *Principles of mark-recapture distance sampling*

The main factor affecting how well observers can see and identify animals is how far away they are from the aircraft. Visibility drops off gradually with increasing distance, but the steepness of the decline varies from survey to survey because of the unique combination of factors affecting visibility during that survey (e.g. what species is being counted, if animals are stationary or moving, aircraft height, habitat, sun glare).

All population density estimates take this decline in sightability into account and compensate statistically for the declining chance of observers correctly counting and identifying animals the further away they are. This is the purpose of recording which sighting zone each animal is counted in (see above).

Where population density estimates are calculated from two observers' counts, accounting for the effects of this yields what is called the 'effective strip width' – that is, the distance away from the aircraft that the observers were effectively able to count animals during that survey, not the

maximum distance they sometimes see animals. This approach is used internationally in aerial and ground surveys and dates back to the 1970's.

However, two-observer counts can sometimes result in population estimates that are lower than they really should be. This is called perception bias. It means that at any distance out from the aircraft, trained observers will still sometimes miss animals.

Adding a third observer, so that two people are now counting the same animals out of the same side of the aircraft, can test for perception bias, and if significant, adjust the survey density estimates accordingly. This is called a mark-recapture (MR) statistic. The method calculates the probability (a percentage chance) of missing animals, which can then be applied to the population density estimates.

### *Methods used to estimate deer population density & abundance in 2024*

To obtain the best population estimates possible, the 2024 fallow deer survey used a three-observer count, and mark-recapture distance sampling (MRDS), combining both distance sampling with the mark recapture method described above. This method was also used in 2019. Both the two-observer method (no mark recapture) and three-observer population method are compared. However, the population density and abundance estimates for 2024 needed to be calculated for several different areas.

First, the average population density was calculated for the entire 2024 survey area, and the mark-recapture statistic was calculated for the entire dataset. It was also informative to calculate density and abundance estimates for the different management zones individually.

In this report, we report deer population density and abundance estimates for the following areas:

- The area equivalent to the area surveyed in 2019, so that any change in population abundance can be fairly assessed
- The different deer management zones identified in the *Tasmanian Wild Fallow Deer Management Plan 2022–27* (Deer Management Zones 1 and 2, and part of zone 3 (called the surveillance area), and
- The National Parks and Wildlife zone.

### *Population distribution mapping*

To assess how the distribution of the deer population might have changed in Tasmania since 2019, population density maps for 2019 and 2024 were produced. These maps show deer population density as a gradient – with areas of higher and lower density arranged in concentric bands – in a similar way to a rainfall map. The bands were set to the same width for both years so results can be compared on a consistent basis.

A separate gradient map was also produced which highlights which areas have an increased population density than in 2024, and which areas have a decreased density.

# Results

## Deer population density & abundance in 2024

Over the entire survey area, the average deer population density for 2024 based on the two-observer counts was 2.322 deer per km<sup>2</sup>. After applying the mark-recapture correction factor (multiplying the population density by 1.2513), the estimated average population density over the entire survey area increased to 2.906 deer per km<sup>2</sup>.

When the survey data was broken down into the smaller zones (see Table 1), highest population density was seen in Zone 1 (the ‘traditional deer range’; ~6.7 deer per km<sup>2</sup>). This is around a six times greater population density than Zone 2 (~1.1 deer per km<sup>2</sup>). Lower population densities were present in the Surveillance Zone and the National Parks and Wildlife areas.

When the 2024 survey data was averaged over the 2019 survey area (which significantly overlaps the other zones), population density for 2024 was ~3.6 deer per km<sup>2</sup>. Comparisons with the density and population size data for 2019 are shown in the following section of the report.

**Table 1      2024 population density & population size estimates for fallow deer in central & north-eastern Tasmania**

| Survey zone  | Area (km <sup>2</sup> ) | Population density estimates (average no. of deer per km <sup>2</sup> ) |           | Estimated deer population size for 2024* |
|--|-------------------------|---|-----------|--|
|  |                         | Uncorrected   | Corrected |  |
| <b>2024 data within 2019 survey area</b>               | 19,905                  | 2.877   | 3.600     | <b>71,655 (+/- 20%)</b>                  |
| <b>Management Zone 1</b>                               | 9,420                   | 5.343   | 6.685     | <b>62,977 (+/- 18%)</b>                  |
| <b>Management Zone 2</b>                               | 6,360                   | 0.872   | 1.091     | <b>6,939 (+/- 31%)</b>                   |
| <b>Zone 3 (surveillance area)</b>                      | 9,199                   | 0.300   | 0.375     | <b>3,453 (+/- 34%)</b>                   |
| <b>National Parks &amp; Wildlife areas<sup>†</sup></b> | 1,605                   | 0.329   | 0.412     | <b>661 (+/- 67%)</b>                     |

† Note that Management Zones 1 & 2, the Surveillance area, and the National Parks survey area, completely or partially overlap with the boundaries of the 2019 survey zone. It is therefore not valid to add together all the population size estimates to obtain the total population size.

\* For simplicity of presentation, the areas of the survey zones and the population size estimates are shown rounded to the nearest whole number. Population size estimates were calculated by multiplying by the area before rounding, so a slightly different figure will be obtained by multiplying the corrected density estimates by the areas shown in the table.

## Change in deer population size since 2019

Comparisons between deer population size in 2019 and 2024 are shown in Table 2. Comparisons are made for data collected within three different (but overlapping) areas: within the boundaries of the 2019 survey area, Management Zone 1, and Management Zone 2.

Note that comparisons were not possible for the Surveillance Zone or the National Parks and Wildlife areas because these areas were not surveyed in their entirety in 2019, so there is no baseline comparative data.

Regardless of which zone is considered (2019 survey area, Zone 1, Zone 2), the estimated number of deer has increased markedly over the last five years (Table 2). The percentage error in each estimate means that the exact number of deer in both years carries a degree of uncertainty, which is always the case for population estimates. However, an estimate towards the middle of the range is statistically more likely than those at the upper or lower ends of the range. An upward trend in the population is seen consistently, and there is no evidence of a decline in the deer population in any area included in this comparison.

When compared within the broad geographical boundaries of the 2019 survey, the overall estimated population of deer in this area grew by nearly 18,000 individuals between 2019 and 2024. When the same calculation was done for Management Zone 1 (the 'traditional deer range'), the estimated deer population here increased by ~22,000. Zone 1 is contained within the 2019 survey boundaries, so all else being equal, this area should have seen a smaller estimated population increase than the 2019 survey area as a whole. Instead, the estimated population increase for Zone 1 was larger than that of the broader area. Because the comparison within the 2019 survey boundaries is averaged over a very large area (nearly 20,000 km<sup>2</sup>) with areas of very high and very low population density, the estimate for Zone 1 is probably more representative.

Proportionally, the greatest increase in estimated population was seen in Management Zone 2, where estimated numbers increased by more than three-and-a-half times. This area is smaller and the percentage errors in the estimates for both years are large, so these estimates are considered less reliable. However, it is consistent with the overall upward population trend, and there is in any case no indication of a population decrease in this containment zone.

**Table 2 Comparison of estimated deer population size in central & north-eastern Tasmania – 2019 & 2024**

| Survey zone              | Area (km <sup>2</sup> ) | Population estimates by survey year |                         | Change in estimated population size <sup>†</sup> |
|--------------------------|-------------------------|-------------------------------------|-------------------------|--|
|                          |                         | 2019*                               | 2024                    |  |
| <b>2019 survey area</b>  | 19,905                  | <b>53,660</b> (+/- 19%)             | <b>71,655</b> (+/- 20%) | <b>↑ 17,995</b>                                  |
| <b>Management Zone 1</b> | 9,420                   | <b>40,941*</b> (+/- 25%)            | <b>62,977</b> (+/- 18%) | <b>↑ 22,036</b>                                  |
| <b>Management Zone 2</b> | 6,360                   | <b>1,908*</b> (+/- 50%)             | <b>6,939</b> (+/- 31%)  | <b>↑ 5,031</b>                                   |

<sup>†</sup> Note that Management Zones 1 & 2 are within the 2019 survey area, so the population size estimates for the three survey zones cannot be added together to get a total. Note that the summed areas of Management Zones 1 and 2 do not equal the area of the 2019 survey zone.

\* The population estimates for 2019 in Management Zones 1 and 2 have been calculated retrospectively from the original raw data.

## Change in deer distribution since 2019

### *Maps of population density distribution in 2019 and 2024*

Gradient maps showing deer population distribution within the boundaries of the 2019 survey area only. These are shown below for 2019 and 2024 (Figure 3). In both maps, areas with highest population density are shown in shades of red, and areas of lower density in shades of blue.

The density and distribution of the deer population has changed markedly since the baseline aerial survey in 2019.

Comparison of the two maps shows that at the time of the baseline survey in 2019, the deer population was heavily concentrated. It was focused mainly within the central north of the survey area. A smaller concentration with roughly half the population density lay a little further to the south-west. In 2019 the areas of highest population density were relatively well separated from the boundaries of the survey area.

By the time of the 2024 survey, the deer population within the 2019 survey boundaries had separated into two relatively distinct areas with similar population densities, one in the north-east, and one to the south-west of the survey area. The overall effect is that over time, the deer population has spread outwards within the 2019 survey area.

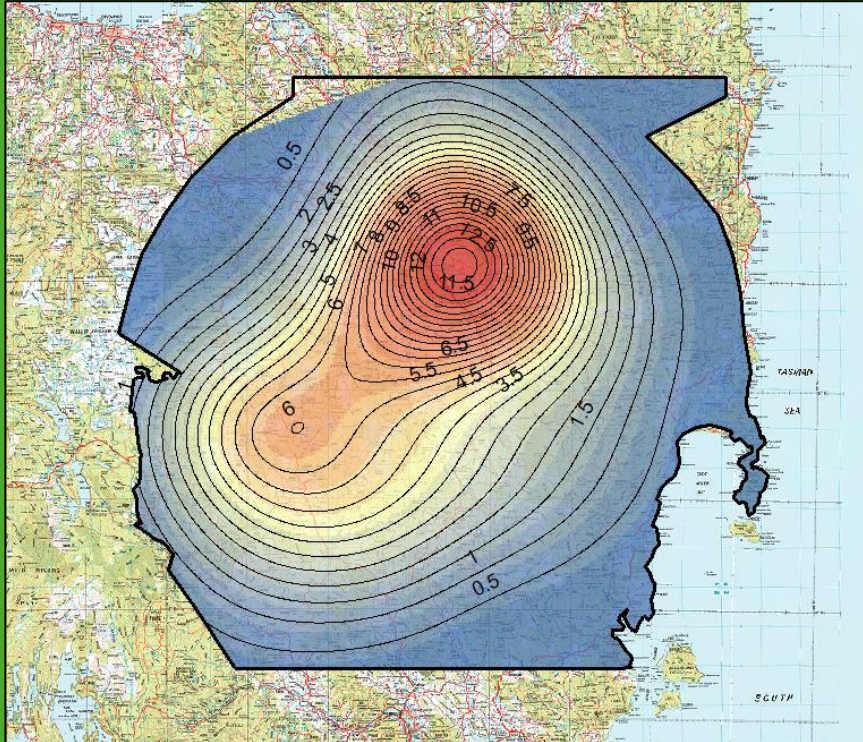
By 2024, the population that was focused in the north-central part of the survey area in 2019 had a reduced population density. It had moved south and slightly east by 2024.

At the same time, the lower-density population in the central-west of the survey area seen in 2019 had expanded by 2024, and had moved further west towards the western boundary of the 2019 survey area. The deer population here has grown denser and now covers a larger area. It has spread westwards towards the edge of the 2019 survey area, bordering the National Parks and Wildlife survey areas (see Figure 1). A further comparison of the change in deer population density distribution is made in the following section.

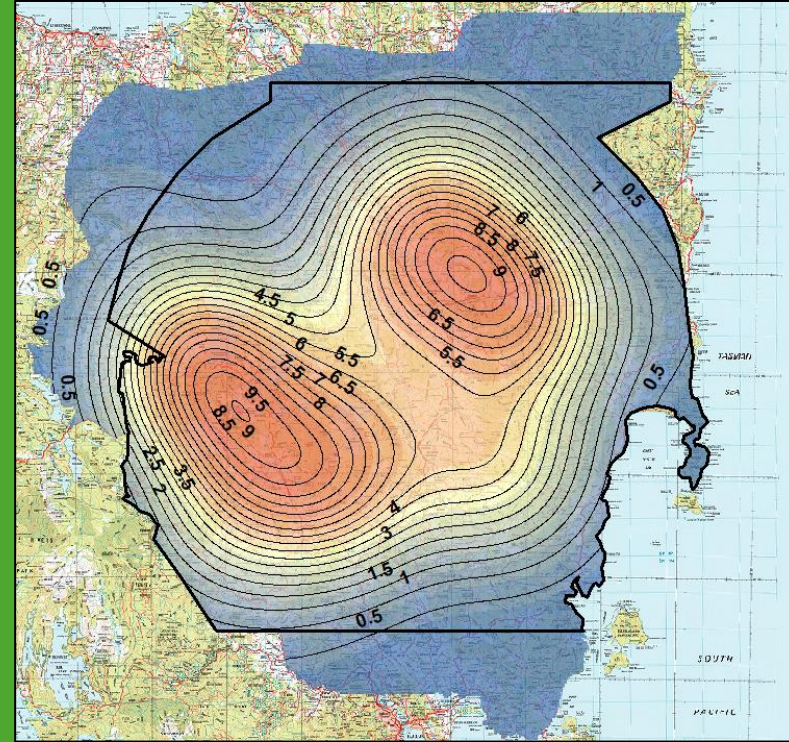
It is important to note that the density distribution mapping was based only on the deer count data collected within the boundaries of the 2019 survey area for the purposes of comparing data between years, even though the gradient lines in Figure 3 extend outside this area.

**Figure 3**

Population density maps of the Tasmanian deer population, compared within the 2019 survey boundaries.



**2019**



**2024**

**Note:** The black border shows the boundaries of the 2019 survey area. The map for 2024 was produced using data collected within the 2019 boundaries. The wider survey area in 2024 is shown in blue outside of the 2019 boundaries.

## Changes in deer distribution over the last five years

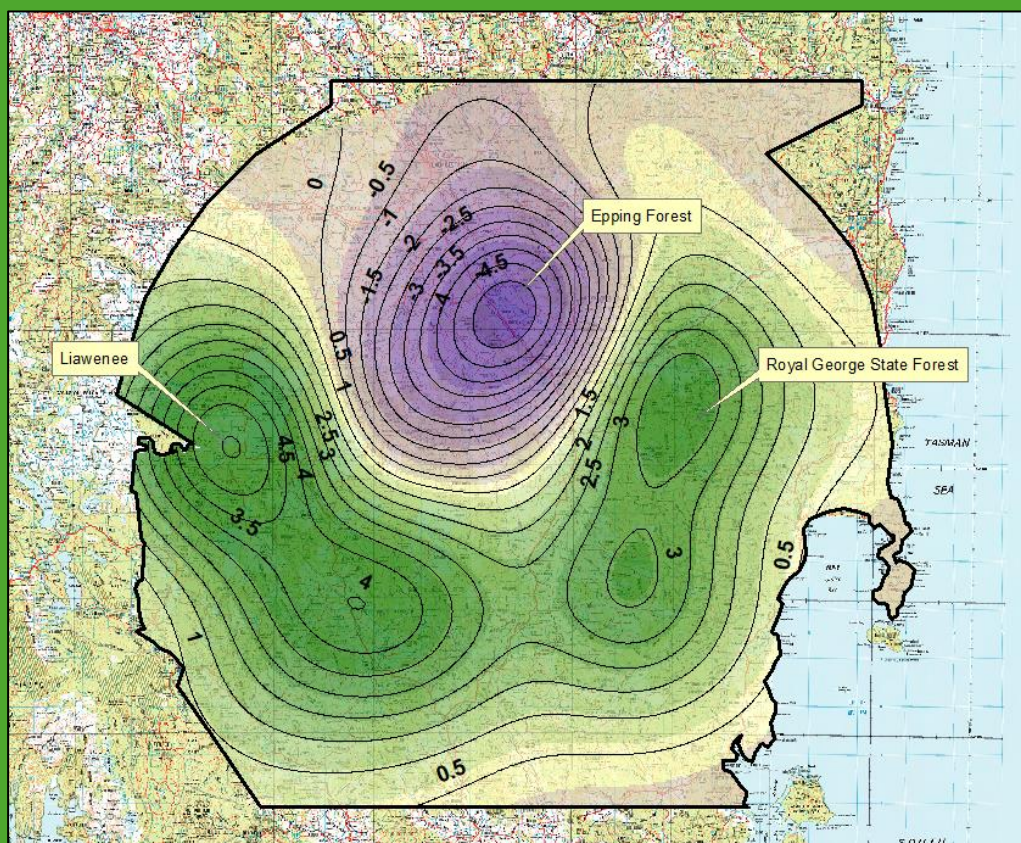
The same data used in Figure 3 were combined into a single gradient map in Figure 4. This shows relative change in deer population density distribution between 2019 and 2024, again only over the 2019 boundary for consistency.

Shades of purple show areas with a decrease in population density. This shows a distinct decline in density in the central-north area of the survey area, near Epping Forest and surrounds, where the deer population was mainly concentrated in 2019 (see Figure 3).

Shades of green show areas with an increase in deer population density in 2024 compared to 2019. These show that the deer population has spread outwards to the east and west, with increases centred around Liawenee to the west, and the Royal George State Forest near Avoca to the east.

As there are no comparative data for 2019 outside of the black survey boundaries, no assessment of any change in population density beyond those boundaries are possible for 2024. A comparison against 2024 data over a wider area will be possible in future years, provided that the aerial survey continues to cover the expanded survey boundaries used in 2024.

**Figure 4** Changes in deer population density & distribution in central and north-eastern Tasmania – 2019–2024



**Note:** The black border shows the boundaries of the 2019 survey area. Data were collected beyond these boundaries in 2024, but no comparison is possible for those areas in 2024 because of the lack of baseline data from 2019.

# Discussion & recommendations

## Summary

Overall, the results of the 2024 aerial survey show that the Tasmanian deer population has grown, and has also spread outwards over the last five years.

The overall size of the population increase is difficult to assess exactly because of the margin of error in all population size estimates. Within the boundaries of the 2019 survey area only, the population may have increased ~55% in 5 years. This is equivalent to around a 9% population increase each year. At the very least there has been around a 12% increase in 5 years. This is equivalent to about a 2% increase each year.

## Recommendations

### *More frequent aerial surveys*

The current deer management plan recommends monitoring the deer population size using aerial surveys every five years. In the time since the original survey in 2019, major changes have occurred in the Tasmanian deer population. Despite control efforts, the population has grown markedly over five years. The population has also shifted its distribution in ways that were not anticipated.

The five-year survey interval was not sufficient to detect and adapt management practices to these unanticipated population changes. It is therefore recommended that aerial surveys be done at shorter intervals of 2–3 years, at least until population management targets are met. This will allow management strategies to be adapted as needed.

### *Annual monitoring for wilderness areas*

The rate of spread of the deer population into wilderness areas needs to be abated quickly, to prevent deer populations from harming native habitats. Monitoring may therefore need to be more frequent here than elsewhere, so that management actions can be better targeted and the outcomes monitored.

A cost-effective approach might be to consider small, targeted, annual surveys in and around the sensitive wilderness areas, complementing 2–3 yearly aerial surveys over the broader landscape (see above). This could be done with small-scale aerial surveys using remote-piloted vehicles fitted with thermal imaging cameras. For added effectiveness, systematic aerial surveys could be combined with citizen-science reporting of sightings in new areas, and camera trap monitoring.

## References

Department of Natural Resources and Environment Tasmania (2022). *Wild Fallow Deer Management Plan 2022–27*. Government of Tasmania.

Lethbridge, M.R., Stead, M.G., Wells C. and Shute, E.R. (2020). *Baseline aerial survey of fallow deer and forester kangaroo populations, Tasmania*. Report to Tasmanian Department of Primary Industries, Parks, Water and Environment.

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