



ArborCam Acquisition 2023

Town of Cottesloe

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Executive Summary

ArborCarbon was engaged to acquire, process and deliver remotely sensed data over the Town of Cottesloe in March 2023. High-resolution airborne ArborCam™ imagery was acquired at 8,000 ft above ground level over the City with cloudless conditions between 13:00 and 14:00 on the 14th of March 2023. Height-stratified vegetation cover statistics were calculated in ward boundaries and across the entire LGA.

Overall, canopy cover has decreased 7.7% from March 2020 to March 2023. This is a decrease of 4.3 ha of canopy cover, from 14.1% (55.2 ha) in 2020 to 13% (51 ha) in 2023. This decrease was observed throughout the entire LGA, and within each ward. Vegetation cover in all height strata levels has decreased, except for the low vegetation (0 – 3m in height). The most significant decrease was in tall vegetation (>15m in height, 18.4%). This trend could reflect numerous new plantings of young trees over the last few years which are contributing to the 0-3m height category. It may also be due to seasonal fluctuations in health of low scrubby vegetation, particularly by coast. The loss observed in tall canopy is concerning, and is representative of loss of mature trees, possibly due to natural senescence or as the result of development. The Town should continue to increase planting and monitor trends and understand that recent plantings are unlikely to contribute to canopy cover for a number of years but may be reflected in lower height strata.

This study provides an accurate assessment of vegetation cover and change over time, in the Town of Cottesloe.

The main findings of this report are:

- The total vegetation cover in the Town of Cottesloe is 33.1% of the total Town area of 393 ha, compared to 32.4% in 2020.
- Canopy (vegetation 3m and above) covered 13% of the Council, compared to 14.1% in 2020.
- The East Ward had the greatest canopy cover as a proportion of ward area (17.2%), while the South Ward had the least (10.3%). In terms of contribution to overall Town canopy, the East Ward contributed the most (29%).
- All wards experienced a decrease in canopy cover and an increase in low vegetation.

Based on the findings of this analysis, we recommend the following:

1. Extract vegetation and canopy cover statistics from more granular boundaries, such as Council managed land (parks and streets) and privately owned land, or Land Use categories according to the Town of Cottesloe planning controls. This may provide more insight into where most loss is occurring.
2. Airborne ArborCam vegetation surveys over the Town of Cottesloe should be conducted on an annual or periodic basis to track temporal changes in vegetation cover and condition and the data used to monitor and set achievable targets for future canopy cover and condition.
3. Continue to investigate mechanisms to prevent the loss of existing canopy cover.

1 Introduction

The Town of Cottesloe (the Town) covers approximately 393ha (3.9km²) of land north of Fremantle, extending to the west of Stirling Highway. The Town consists of four wards: North, East, South and Central.

In March 2020, ArborCarbon undertook vegetation and canopy mapping for the Town of Cottesloe and identified canopy cover (vegetation >3m in height) as 14%.

ArborCarbon was engaged to acquire, process and deliver remotely sensed data over the Town of Cottesloe in March 2023. This has been used to determine current canopy cover, and quantify canopy change, and provide insight into where the Town should be targeting their efforts to increase canopy. ArborCarbon maintains a unique 11-band airborne multispectral camera system (ArborCam) optimised for the accurate detection of vegetation and subtle changes in vegetation condition. The ArborCam was used to acquire high resolution imagery to accurately quantify vegetation and canopy cover. Vegetation cover statistics were extracted and categorized into different height strata and quantified across each ward and the entire LGA boundary. Vegetation cover statistics are compared to 2020 statistics to determine where vegetation loss and gain has occurred.

2 Methods

2.1 Airborne Imagery Acquisition

High-resolution airborne ArborCam imagery was acquired at 8,000 ft above ground level over the City with cloudless conditions between 13:00 and 14:00 on the 14th of March 2023. Imagery was acquired for this project with the ArborCam system with a ground sample distance (GSD) ranging from 8 cm/pixel to 25 cm/pixel dependent on the spectral band. The thermal imagery was acquired on the 3rd of April 2023 with a GSD of 100 cm/pixel. The maximum temperature recorded on the 3rd of April at Swanbourne WA (BoM reference: 009215) was 25.8°C (bom.gov.au).

2.2 Data processing and analysis

The high-resolution airborne imagery datasets were geometrically corrected and orthorectified using previous ArborCarbon imagery. A Digital Surface Model was generated from the acquired imagery for the full extent of the Council, enabling the stratification of vegetation into five pre-determined height categories as follows: turf, 0-3m (excluding turf), 3-10m, 10-15m, and >15m. **For the purposes of this report, all vegetation >3m above the ground was classified as canopy.**

The co-aligned thermal imagery was radiometrically corrected and converted to Land Surface Temperature (LST) in degrees Celsius by applying a standard emissivity correction of 0.95 across the scene.

Bands across the VIS-NIR were used to detect all living vegetation in sun and shadow. Vegetation that was not photosynthesizing at the time of acquisition, such as dead wood in tree crowns and dead grass, was not classified as vegetation. Vegetation condition statistics were calculated using the Vegetation Condition Index (VCI), which combines both the near-infrared and red bands of the electromagnetic spectrum.

Height-stratified vegetation cover statistics were calculated in ward boundaries (Figure 1) and across the entire LGA.



Figure 1: Ward boundaries of the Town of Cottesloe.

3 Results and Discussion

3.1 High-resolution imagery

The acquired data was processed to produce high-resolution RGB imagery (Figure 2), False Colour Composite (FCC) imagery (Figure 3), a height-stratified vegetation cover dataset (Figure 4), land surface temperature (°C) (Figure 5) and vegetation condition index (VCI) (Figure 6) across the 393 ha of the Town of Cottesloe.

Examples of close-up imagery derived from each of these datasets and the different layers of information they provide appear in Figure 7.



Figure 2: High-resolution RGB imagery of the Town of Cottesloe.



Figure 3: False colour composite over the Town of Cottesloe showing vegetation (red pixels).

The FCC dataset was derived from a 3-band subset of the multispectral imagery (NIR, red and green). FCC imagery is commonly used in remote sensing to illustrate vegetation cover, which is displayed as red pixels.

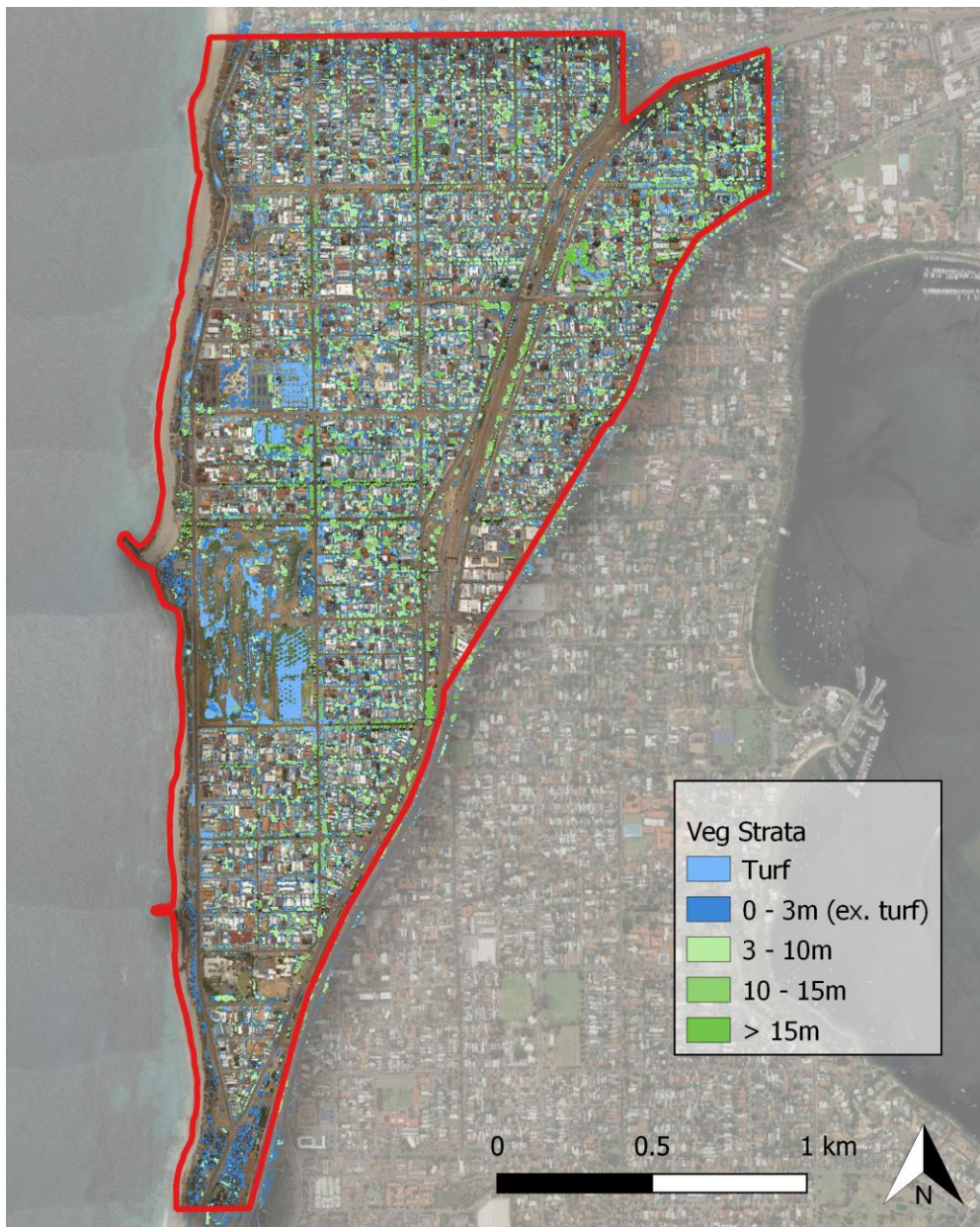


Figure 4: Height-stratified vegetation dataset of the Town of Cottesloe, with each stratum displayed in a different colour.

The height-stratified vegetation cover dataset (Figure 4) is comprised of specific height strata colourised as follows: turf (light blue), 0-3m blue, 3-10m light green, 10-15m green and >15m dark green. This colour scheme is used in all illustrations of the height-stratified dataset in this report.

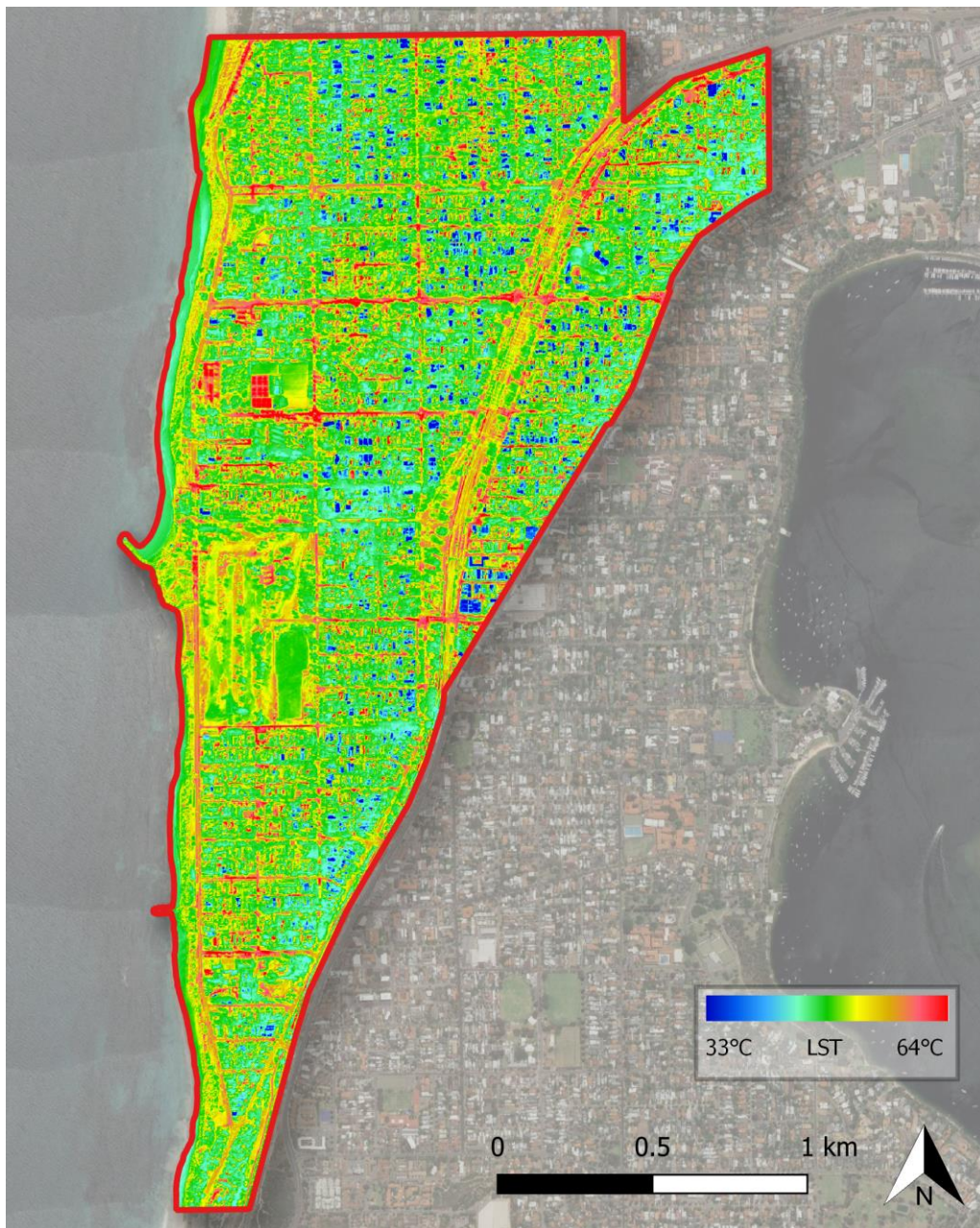


Figure 5: Radiometrically corrected thermal ortho land surface temperature of the Town of Cottesloe ranging from 33°C (blue) to 64°C (red).



Figure 6: Vegetation Condition Index (VCI) of Town of Cottesloe ranging from low (red) to high (purple).

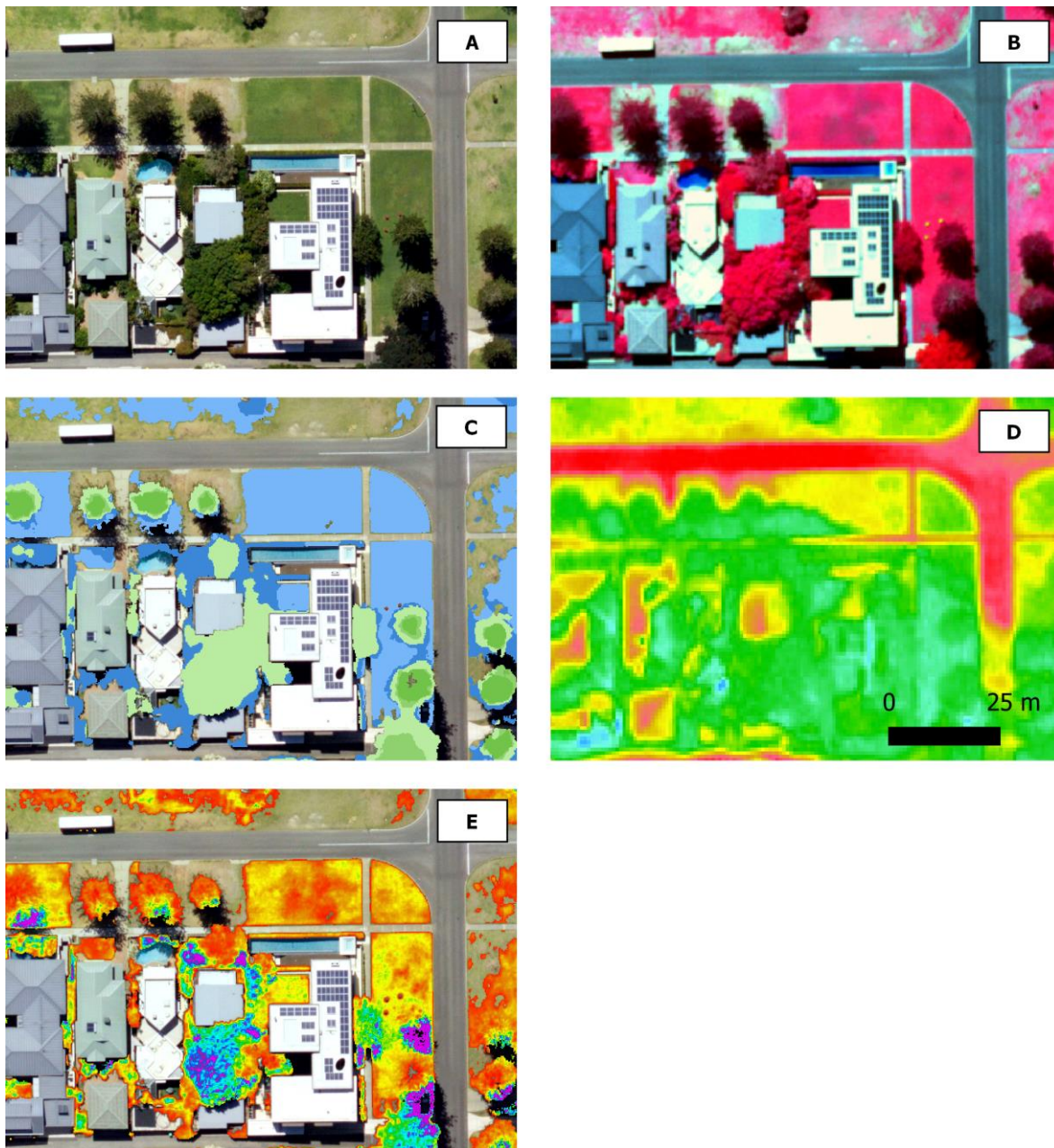


Figure 7: Close-up image of each of the datasets generated for the Town of Cottesloe: A) High-resolution RGB imagery; B) False Colour Composite (FCC) showing vegetation in red; C) Height-stratified vegetation cover, with each stratum displayed as a different colour; D) Land Surface Temperature (LST) ranging from 33°C (blue) to 64°C (red); and E) Vegetation Condition Index (VCI) ranging from low (red) to high (purple).

3.2 Vegetation Cover

Height stratified vegetation cover was calculated for each ward and the Town as a whole.

3.2.1 Council Wide

The Town has an entire area of 393 ha. Approximately a third (33.1%, 129 ha) of the Council area was covered by vegetation. The remaining 66.9% (263 ha) was non-vegetated surfaces, such as buildings, roads, exposed soil and dead grass (Figure 8). Vegetation classified as turf occupied 6.5% (25.7 ha) of the area, and 13.5% (53.2 ha) was classified as vegetation 0-3m in height. **Canopy (vegetation 3m and above) covered 13% (51 ha) of the Town.**

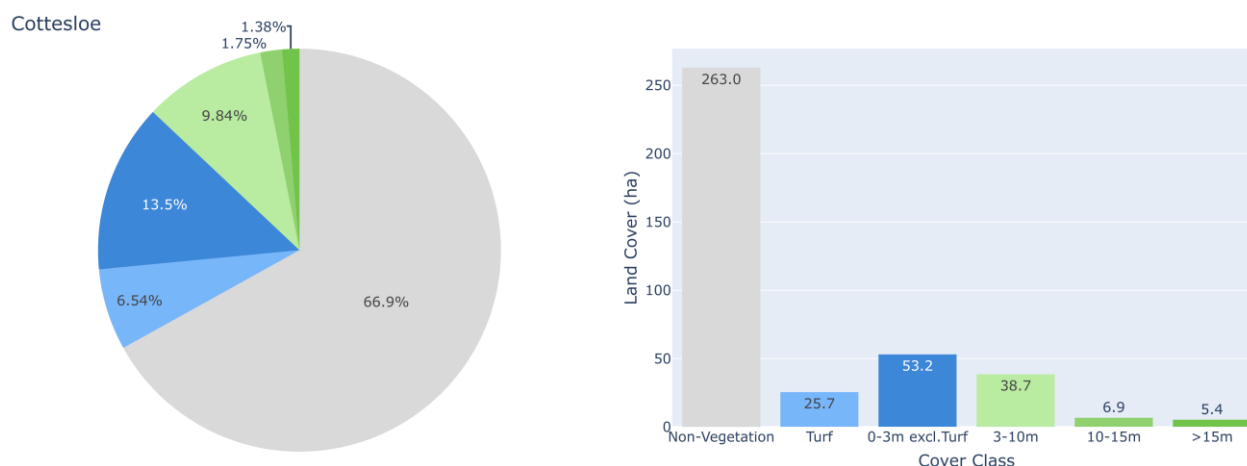


Figure 8: Land cover classification proportion (%) (left) and hectare coverage (right) of the entire Town of Cottesloe LGA boundary.

3.2.1.1 Change 2020 – 2023

Overall, vegetation cover has slightly increased from 2020 to 2023 (Table 1). This is a result of increased proportional cover of low vegetation (0-3m height category). Vegetation cover in this category increased from 11.2% to 13.5%, a 17.8% increase. **However, tall vegetation cover has decreased, resulting in an overall reduction of canopy cover across the LGA.** Canopy cover decreased from 14.1% in 2020 to 13% in 2023, a 7.7% decrease.

Table 1: Change in proportion of land cover of the total LGA since 2020 (%). Green indicates increase, red indicates decrease.

		Proportional Change (%) 2020 - 2023									
	Class	Non-Veg	Turf	0-3m	3-10m	10-15m	>15m	All Veg	Canopy	Non-Canopy Veg	
LGA	2020 (%)	67.7	6.8	11.5	10.5	1.9	1.7	32.3	14.1	18.3	
	2023 (%)	66.9	6.5	13.5	9.8	1.7	1.4	33.1	13.0	20.1	
	Change (%)	-1.1	-3.5	17.8	-6.1	-7.3	-18.4	2.2	-7.7	9.9	

3.2.2 Wards

Proportional land cover for each ward is presented in Figure 9. Land cover for each ward is also presented as pie graphs in Appendix A.

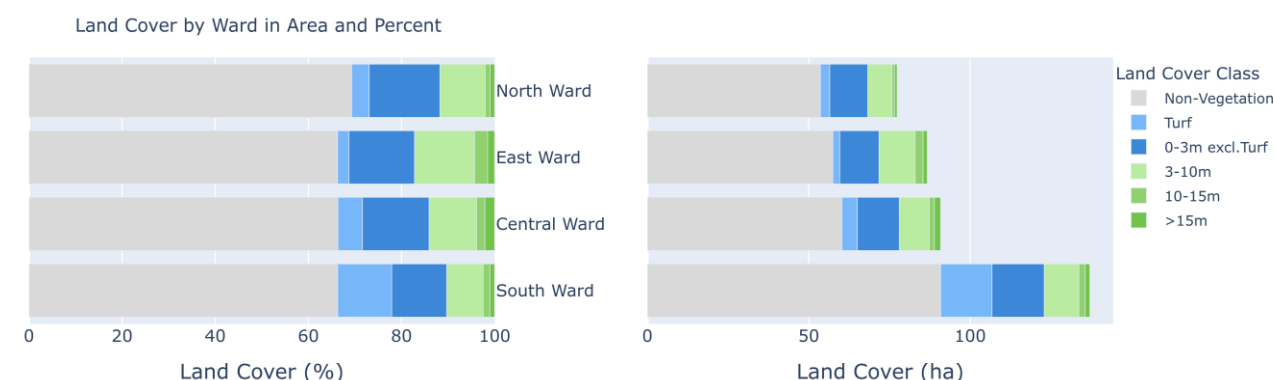


Figure 9: Bar graph illustrating the percentage of each ward covered by each land cover class.

Canopy cover (vegetation 3m and above) was calculated for each ward within the Town of Cottesloe (Figure 10). The East Ward had the highest proportional canopy cover (17.2%) while the South Ward had the lowest (10.3%).

Additionally, canopy of each ward as a proportion of the total Town-wide canopy cover was calculated (Figure 11). This shows how much each ward contributes to the Town's total canopy cover. The East Ward contains nearly a quarter of the Town's canopy cover (22.5%, 14.9 ha) while the North Ward contributed the least (17.9%, 9.1 ha).

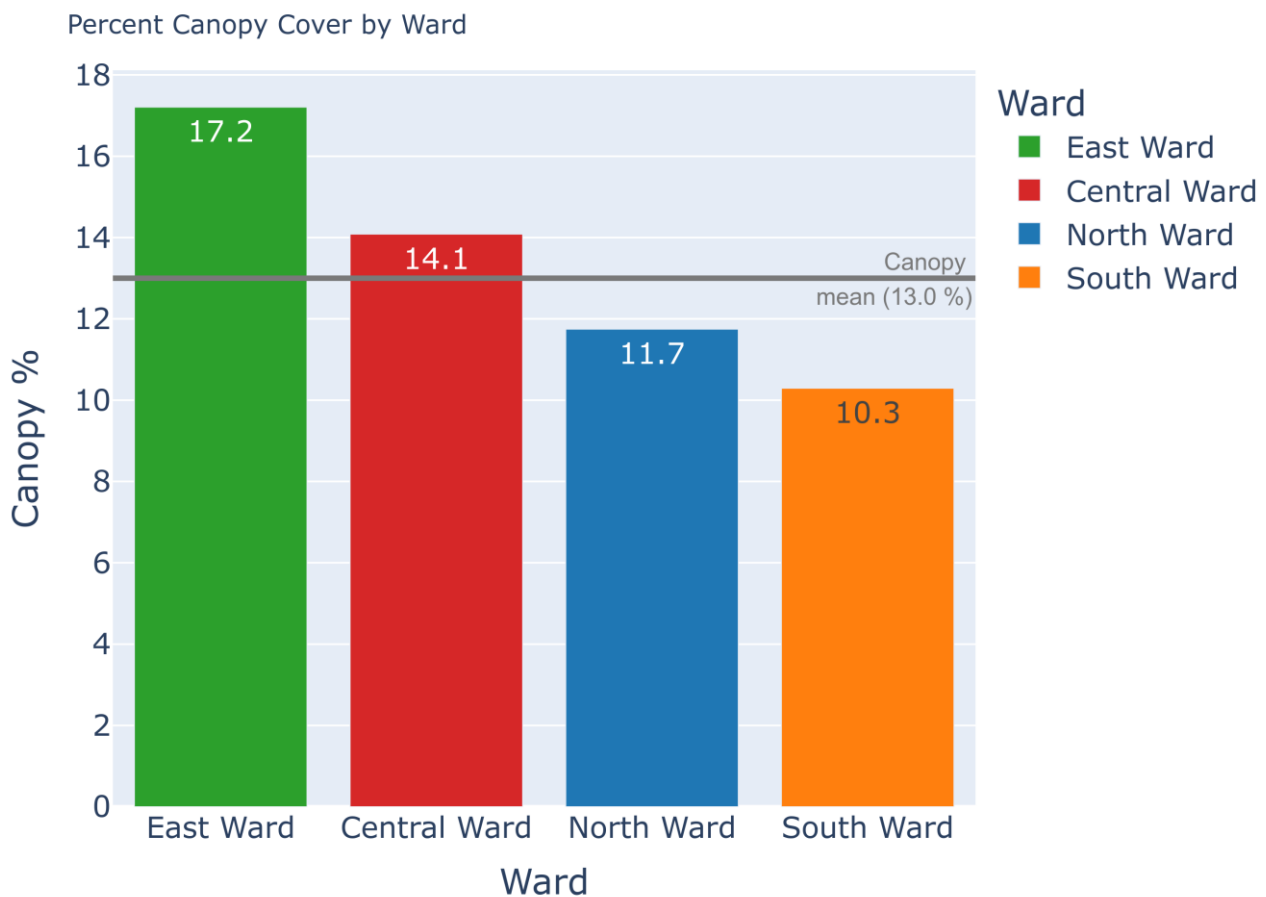


Figure 10: Bar graph illustrating the percentage of each ward covered by canopy (vegetation >3m in height).

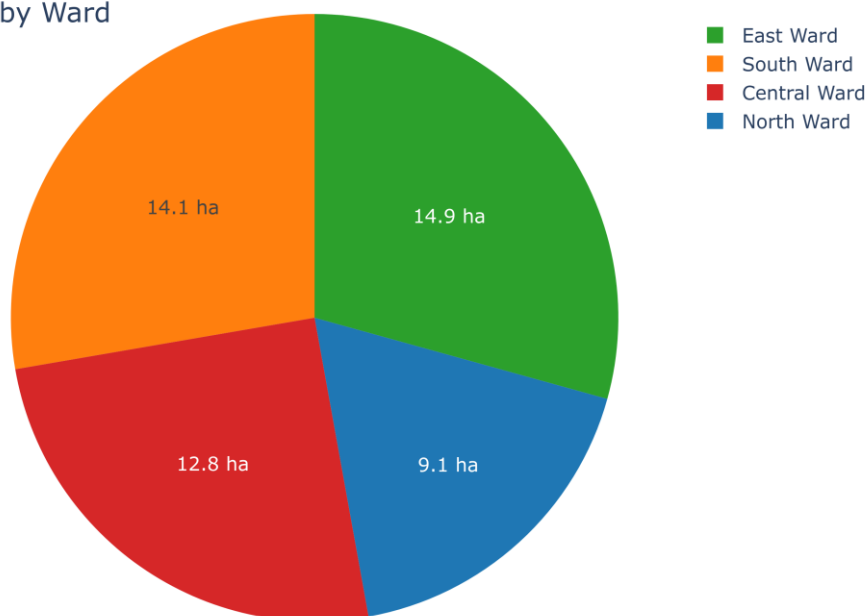
Distribution of Canopy Cover
by Ward

Figure 11: The proportion of the total LGA canopy area contained in each ward.

3.2.2.1 Change 2020 – 2023

The general trend across the LGA was observed across each ward as well (see tables below). In each ward, vegetation 0-3m in height increased, resulting in an increase in all vegetation and non-vegetation aggregates as well. However, taller vegetation has decreased, resulting in an overall decline in canopy cover across all wards.

Table 2: Change in proportion of land cover of the Central Ward since 2020 (%). Green indicates increase, red indicates decrease.

		Proportional Change (%) 2020 - 2023								
	Class	Non-Veg	Turf	0-3m	3-10m	10-15m	>15m	All Veg	Canopy	Non-Canopy Veg
Central Ward	2020 (%)	67.4	5.8	11.5	10.9	1.9	2.5	32.6	15.3	17.3
	2023 (%)	66.3	5.2	14.3	10.2	1.8	2.1	33.7	14.1	19.6
	Change (%)	-1.5	-8.8	24.3	-6.7	-7.1	-15.5	3.2	-8.2	13.3

Table 3: Change in proportion of land cover of the East Ward since 2020 (%). Green indicates increase, red indicates decrease.

		Proportional Change (%) 2020 - 2023								
	Class	Non-Veg	Turf	0-3m	3-10m	10-15m	>15m	All Veg	Canopy	Non-Canopy Veg
East Ward	2020 (%)	67.9	2.4	11.4	13.4	2.9	1.9	32.1	18.2	13.8
	2023 (%)	66.3	2.4	14.1	12.9	2.8	1.5	33.7	17.2	16.5
	Change (%)	-2.5	-0.2	23.7	-4.2	-3.0	-19.8	5.2	-5.6	19.5

Table 4: Change in proportion of land cover of the North Ward since 2020 (%). Green indicates increase, red indicates decrease.

	Class	Proportional Change (%) 2020 - 2023								
		Non-Veg	Turf	0-3m	3-10m	10-15m	>15m	All Veg	Canopy	Non-Canopy Veg
North Ward	2020 (%)	70.5	3.7	12.9	10.6	1.1	1.2	29.5	12.9	16.6
	2023 (%)	69.3	3.8	15.2	9.7	1.0	1.0	30.7	11.7	19.0
	Change (%)	-1.7	0.4	18.3	-8.2	-8.8	-14.5	4.2	-8.8	14.3

Table 5: Change in proportion of land cover of the South Ward since 2020 (%). Green indicates increase, red indicates decrease.

	Class	Proportional Change (%) 2020 - 2023								
		Non-Veg	Turf	0-3m	3-10m	10-15m	>15m	All Veg	Canopy	Non-Canopy Veg
South Ward	2020 (%)	65.9	12.0	10.8	8.3	1.6	1.4	34.1	11.3	22.8
	2023 (%)	66.3	11.6	11.8	7.8	1.4	1.0	33.7	10.3	23.4
	Change (%)	0.6	-3.0	9.0	-5.9	-11.9	-22.7	-1.1	-8.8	2.7

4 Conclusion and Recommendations

Overall, canopy cover has decreased 7.7% from March 2020 to March 2023. This is a decrease of 4.3 ha of canopy cover, from 14.1% (55.2 ha) in 2020 to 13% (51 ha) in 2023. This decrease was observed throughout the entire LGA, and within each ward. Vegetation cover in all height strata levels has decreased, except for the low vegetation (0 – 3m in height). The most significant decrease was in tall vegetation (>15m in height, 18.4%). This trend could reflect numerous new plantings of young trees over the last few years which are contributing to the 0-3m height category. It may also be due to seasonal fluctuations in health of low scrubby vegetation, particularly by coast. The loss observed in tall canopy is concerning, and is representative of loss of mature trees, possibly due to natural senescence or as the result of development. The Town should continue to increase planting and monitor trends and understand that recent plantings are unlikely to contribute to canopy cover for a number of years but may be reflected in lower height strata.

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5. Airborne ArborCam vegetation surveys over the Town of Cottesloe should be conducted on an annual or periodic basis to track temporal changes in vegetation cover and condition and the data used to monitor and set achievable targets for future canopy cover and condition.
6. Continue to investigate mechanisms to prevent the loss of existing canopy cover.

Appendix A – Ward land cover pie graphs

Proportional Land Cover by Ward

