

## Precision urban forest monitoring Town of Cottesloe

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## REVISION SCHEDULE

Revision	Report Description	Submission Date	Author(s)
A	Town of Cottesloe Urban Forest Monitoring		Dr Harry Eslick

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The height stratified canopy data has been derived remotely from multispectral imagery; data has not been verified on the ground by appropriate personnel. Due to the limited availability of reliable alternate information sources on canopy cover, a thorough assessment of accuracy has not been possible. Care must be taken when analysing and drawing conclusions from the data so as not to over-estimate the precision of the figures. Based on analysis of the consistency of results between years and when compared to manual digitisation across small sample areas, the current level of precision for suburb canopy cover percentage is believed to be  $\pm 1\%$ .

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Any conclusion and/or recommendation contained in this document reflect the professional opinion of ArborCarbon Pty Ltd and the author(s) using the data and information supplied. ArborCarbon Pty Ltd has used reasonable care and professional judgement in its interpretation and analysis of data in accordance with the contracted Scope of Works.

## Executive Summary

ArborCarbon was engaged by the Town of Cottesloe (the client) to acquire and analyse high-resolution multispectral imagery and produce accurate baseline and temporal change data of tree canopy cover within the Town.

High-resolution (0.4m pixels) multispectral airborne imagery was acquired on 20<sup>th</sup> May 2017. Imagery was radiometrically and geometrically corrected, processed and analysed to determine the vegetation cover stratified into height classes (<3m, 3-10m, 10-15m, >15m) within the Town.

The main findings of this study are:

- Total vegetation cover within the Town of Cottesloe is 124.6 ha (31.8%).
- The area of vegetation above 3m height (canopy) is 51.1 ha (13.1%).
- South Ward has the greatest proportion of vegetation cover (35%) followed by East Ward (31%), Central Ward (30%) and North Ward (29%).
- Total canopy cover (vegetation above 3m) was greatest in the East Ward (17%) followed by the Central Ward (14%), Northern Ward (12%) and South Ward (10%).
- The total area of canopy cover has remained stable in all wards over the past 5 years.

Vegetation cover, particularly tree canopy (>3m) provides many benefits to urban areas such as the Town of Cottesloe. Urban tree canopies are important habitats for native fauna and provide significant amenity value to the local community. Importantly shade from tree canopy can reduce the urban heat island effect thus provide significant benefits to the health and well-being of local residents and the environment.

This high-resolution mapping of urban canopy cover provides accurate data on the height stratified canopy cover within the town. This provides a valuable tool for the Town to manage its urban forest area and accurately track changes of canopy area, as well as tree health at an individual tree level. This data can be compared over time to provide accurate feedback against management targets.

The total canopy area within all wards of the Town of Cottesloe has remained stable over the past 5 years, with a possible trend emerging of increasing canopy cover. This is a positive outcome, as many councils are seeing a steady decline in canopy cover over time.

Based on the findings of this project we recommend the following:

- Airborne multispectral vegetation surveys conducted over Cottesloe should be repeated on an annual or periodic basis to track changes in vegetation cover and condition over time and measure progress against management goals.
- Periodic multispectral surveys should be used to detect changes in canopy condition and tree health. This data can be used as an early warning system for the onset of symptoms of tree decline allowing early management intervention which can significantly increase the survival of established urban trees.
- Conduct additional analysis to compare the height-stratified vegetation cover in different land-use categories (LUC's i.e. streets, parks, commercial, residential etc.) and provide very valuable insight into the link between management of these LUC's, canopy and green cover.

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# 1 Introduction

ArborCarbon was engaged by the Town of Cottesloe (the client) to acquire and analyse high-resolution multispectral imagery and produce accurate baseline and temporal change data of tree canopy cover within the town. Over recent years ArborCarbon has developed the capability to very precisely quantify and map vegetation condition and cover in urban areas using high resolution airborne multispectral imagery. This imagery is used to map total vegetation cover and height stratified vegetation cover for accurate monitoring and analysis of urban forests.

Historical data acquired by ArborCarbon was analysed to determine the change in vegetation cover and height stratified vegetation cover within the town. Differences in total vegetation cover and height stratified vegetation cover between the 4 wards of the town were also compared.

## 2 Methods

### 2.1 Acquisition of high-resolution airborne multispectral imagery

High-resolution (0.4m pixels) multispectral airborne imagery was acquired during cloudless conditions on 20<sup>th</sup> May 2017. The imagery is comprised of a 4-band dataset with bands strategically positioned within the blue, green, red and near infra-red (NIR) regions of the light spectrum, sensitive to subtle changes in vegetation condition. In addition, very high resolution (0.12m pixels) standard RGB photography was acquired concurrently.

### 2.2 Data Processing and Analysis

The high-resolution multispectral airborne imagery was geometrically and radiometrically corrected. The datasets were processed and analysed to develop a height model and determine height stratified vegetation cover. Vegetation cover was stratified into four height categories (<3m, 3-10m, 10-15m, >15m). This data was used to calculate baseline vegetation cover for the Town of Cottesloe in the different height classes.

Comparison was made between green vegetation and non-photosynthesizing material cover in the Town of Cottesloe. Green vegetation cover is classed as any vegetation that is photosynthesizing at the time of acquisition in May. Non-photosynthesizing materials include all substrates other than vegetation (e.g. impervious layers, water, soil etc.) and vegetation that is not photosynthesizing (dead or dormant) at the time of acquisition of imagery in May. Dead patches of tree crowns or turf grass would fall into the non-photosynthesizing materials category.



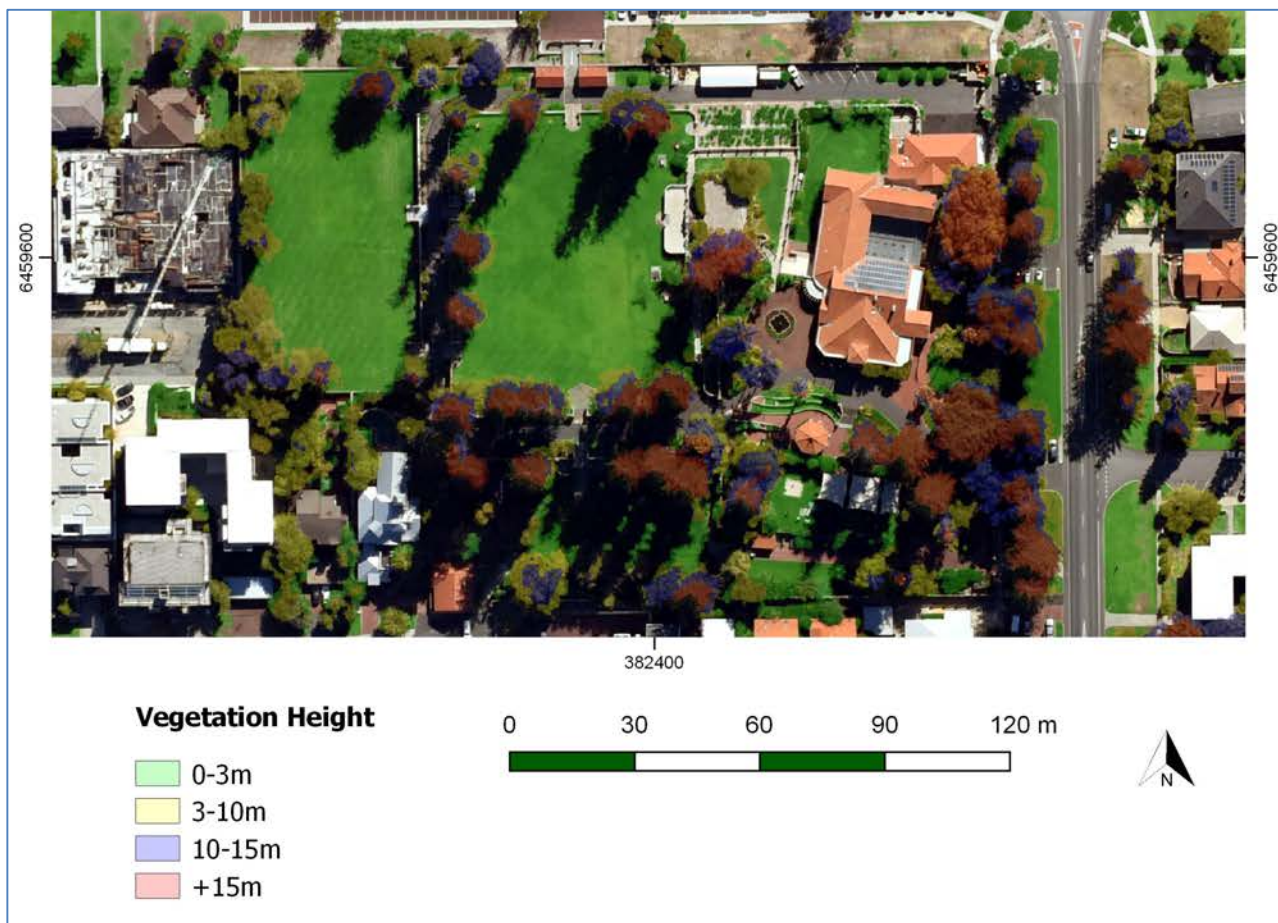


Figure 1: Detailed view of the Cottesloe Civic Centre, demonstrating the resolution of the imagery and the accuracy of the height-stratified vegetation cover layer.

### 3 Results and Discussion

The total area of the Town of Cottesloe is approximately 3.928 square kilometers (392.8 ha). The figures below (Figures 2, 3 and 4) give examples of the type of data acquired and generated over the Town area.



Figure 2: High resolution RGB image of the Town of Cottesloe in May 2017





Figure 3: False colour composite image of the Town of Cottesloe in May 2017



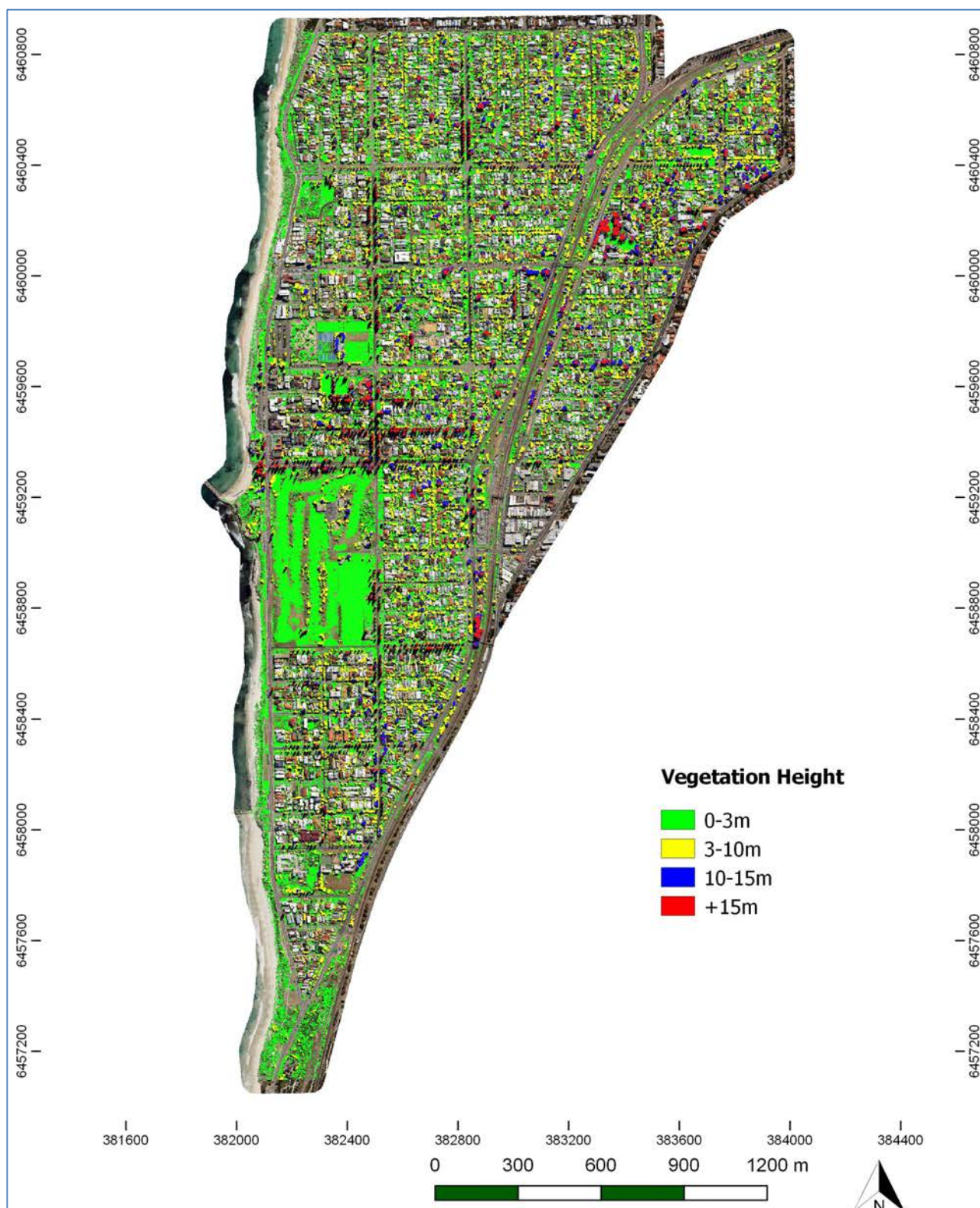


Figure 4: Height stratified vegetation cover in the Town of Cottesloe overlaid onto the high resolution RGB image. Vegetation height is displayed in 4 classes; green <3m, yellow = 3-10m, blue = 10-15m, red >15m.

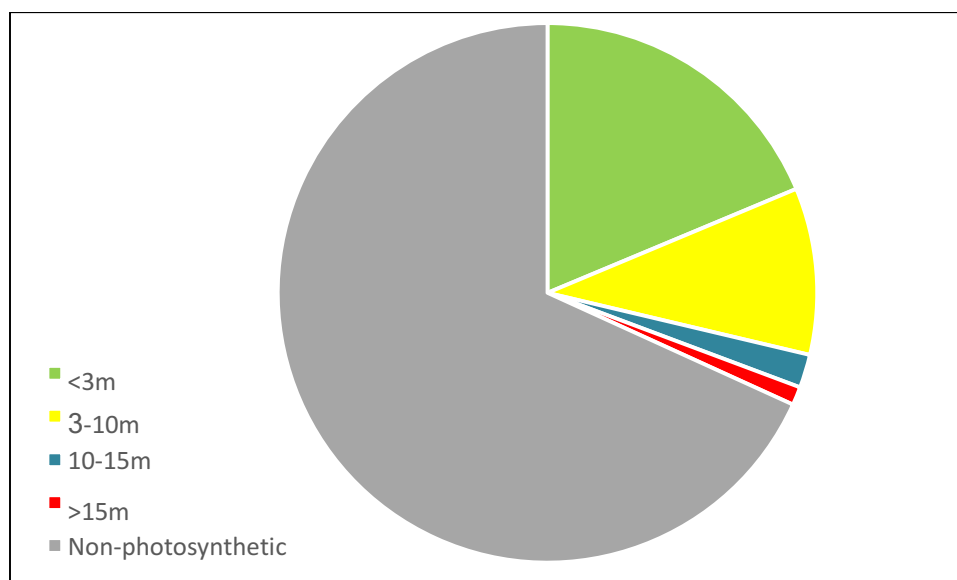
Photosynthetic vegetation occupies 31.8% of the Town area (Table 1). The majority of vegetated cover was comprised of vegetation in the <3m height class, forming 18.7% of the total Town area. Vegetation above

3m was considered as tree canopy cover. Tree canopy cover comprised 13.1% of the total land area. Canopy cover above 3m is particularly important as this vegetation provides many benefits including visual amenity, shade and habitat for native fauna. The area of vegetation cover within the Town of Cottesloe declined with height. The majority of canopy cover was found within the 3-10m height class (10%), vegetation 10-15m in height comprised 2.0% of the land area, and 1.1% of vegetation was greater than 15m.

Non-photosynthetic material comprised 68.2% of the total land area within the Town (Figure 5).

*Table 1: Land area (ha) occupied vegetation at different height classes (<3m, 3-10m, 10-15m, >15m), total canopy cover (>3m) and total vegetation cover in the Town of Cottesloe in May 2017.*

Land cover class	Area (ha)	Percent
<3m	73.6	18.7%
3-10m	39.2	10.0%
10-15m	7.8	2.0%
>15m	4.2	1.1%
Total Vegetation Cover	124.6	31.8%
Total Canopy Cover	51.1	13.1%
Non-photosynthetic Material	268.3	68.2%



*Figure 5: Proportion of land area occupied by vegetation at different height classes (<3m, 3-10m, 10-15m, >15m), and Non-Photosynthetic material in the Town of Cottesloe.*

Photosynthetic vegetation cover has remained relatively stable over time since data was first captured in 2012 (Figure 6). The <3m height class varies between 18.7% in 2017 to 20.9% in 2016. This is largely due to seasonal differences in in vegetation cover, particularly grasses, as areas of dead grass are classified as non-photosynthetic material in this analysis. Minor increases in canopy (>3m) are observed over time, but these are generally within the 1% margin of error associated with this analysis and may not represent true trends. There is also a noticeable increase in canopy area from 2014 to 2015 and this noticeable increase may be partly associated with improvements in the algorithm used to calculate canopy cover.

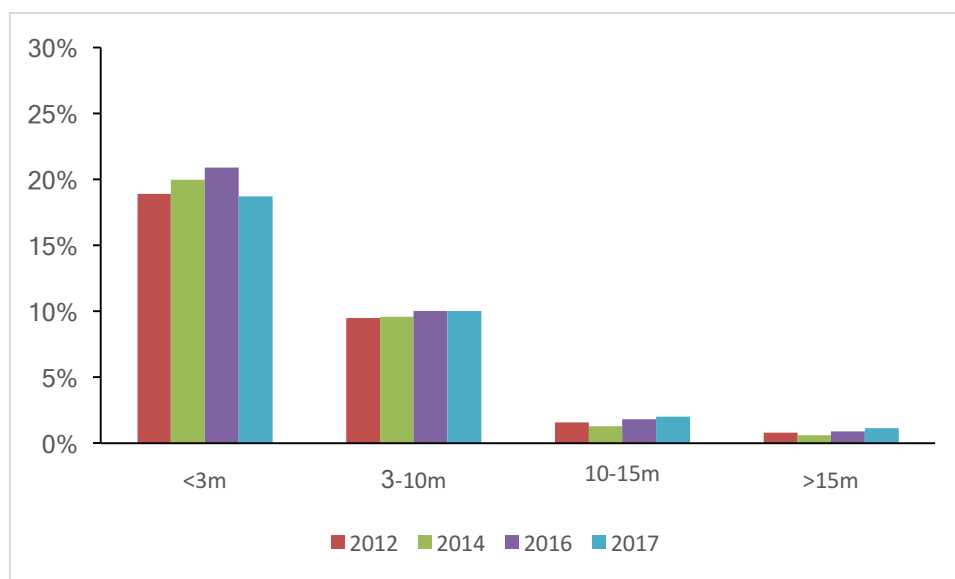


Figure 6: Change in height stratified canopy cover within the Town of Cottesloe over the four years of imagery capture.

### 3.1 Comparison between wards

In 2017, the South Ward contained the greatest proportion of total vegetation cover at 35%, followed by East Ward (31%), Central Ward (30%) and North Ward (29%) (Figure 7). However, a large majority of this was in the <3m range due to the inclusion of the Sea View Golf Club. When focusing on canopy cover (vegetation greater than 3m) the South Ward contained the least total canopy cover at 10.4%. The East Ward contained the greatest canopy cover at 17.3%, as well as the greatest cover in 3-10m and 10-15m height classes. Central Ward contained the greatest area of canopy in the >15m height category, possibly due to the high density of Norfolk Island Pines (*Araucaria heterophylla*) in this Ward (Table 2).

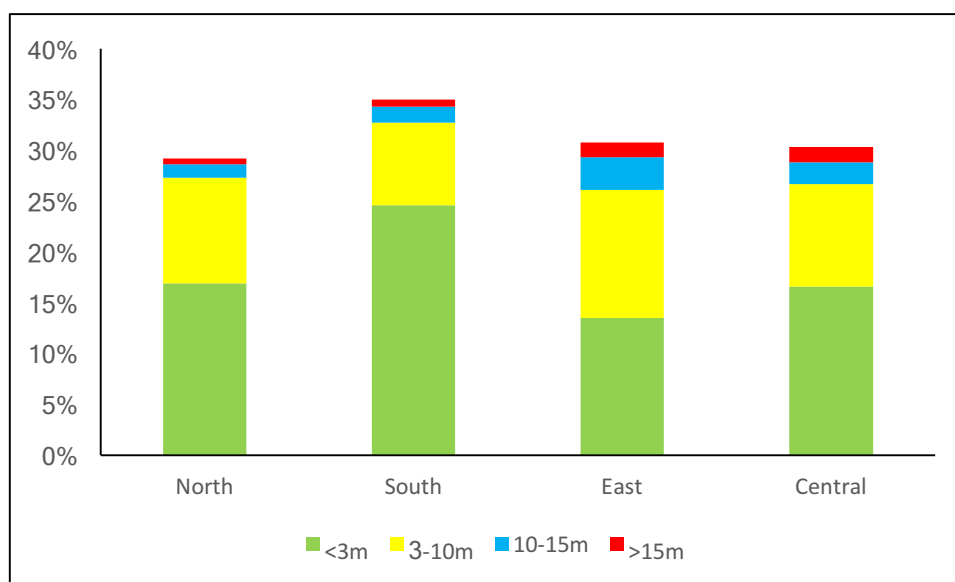


Figure 7: Comparison of height stratified vegetation cover in 2017 between wards within the Town of Cottesloe.



Table 2: Height stratified canopy cover (ha), total vegetation cover (ha) and total canopy cover (ha) in each ward of the Town of Cottesloe.

	North	South	East	Central
Total Area	77.51	137.61	86.68	90.98
<3m	13.10	33.85	11.70	15.10
3-10m	8.06	11.15	10.92	9.19
10-15m	1.01	2.20	2.77	1.91
>15m	0.47	0.96	1.30	1.36
Total Vegetation Cover	22.64	48.16	26.69	27.56
Total Canopy Cover	9.54	14.31	14.99	12.46

The greatest variation in vegetation cover over time was observed in the <3m height class. The cause of this is most likely due to seasonal variation in grass cover as described above. The South Ward (Figure 8) which showed the greatest variation in the <3m height class also had the greatest proportion of vegetation in that height class. Canopy cover (>3m) has remained relatively stable in all wards over the past 5 year, with a possible trend to increasing canopy cover over time. Canopy cover in all three classes increased from 2014 to 2015, possibly related to improvements in the algorithm used to calculate canopy cover. The notable exception was a marginal decrease in the 3-10m class in the east ward.

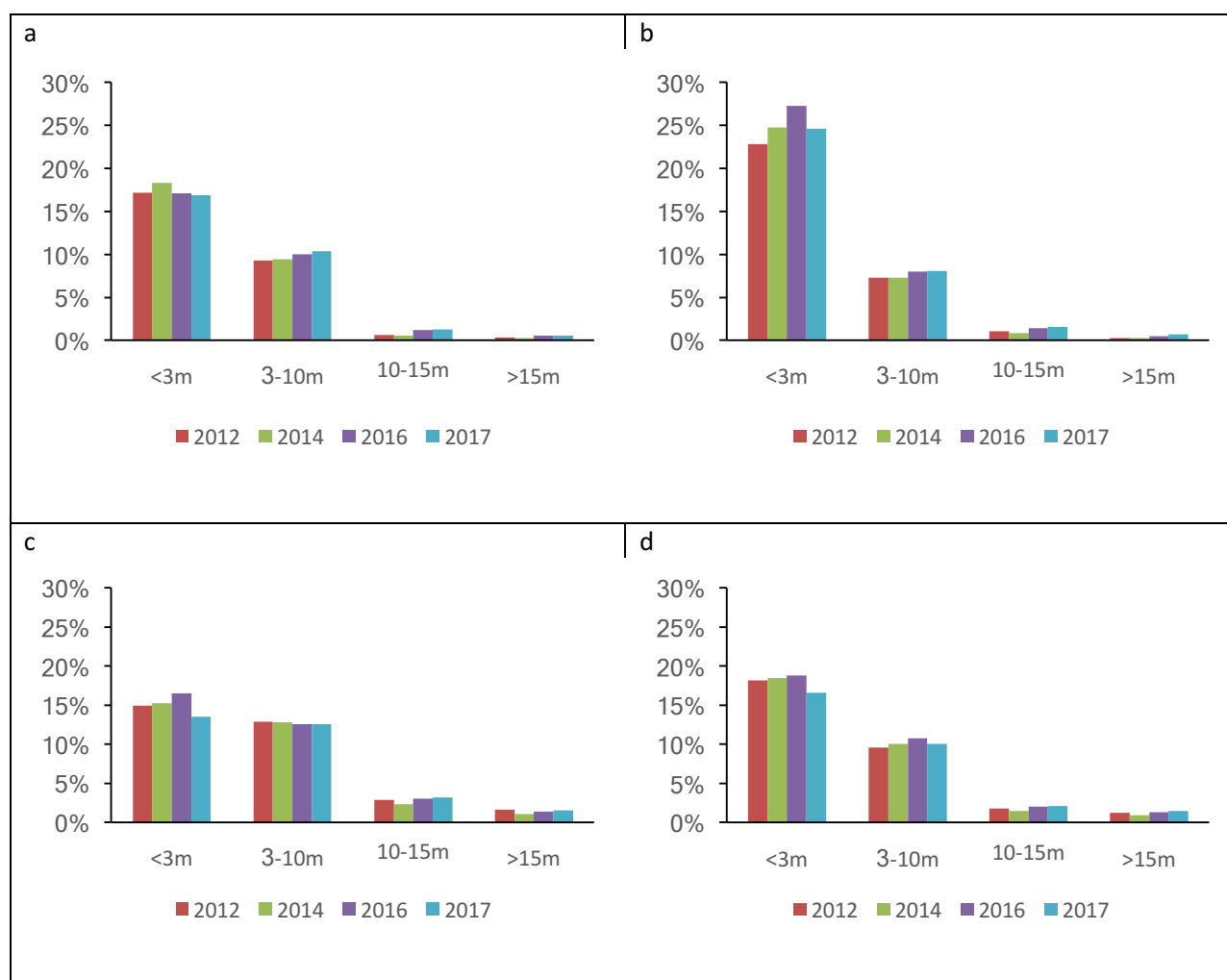


Figure 8: Height stratified canopy cover for each ward within the Town of Cottesloe during the four acquisition periods. a) North Ward; b) South Ward; c) East Ward; d) Central Ward.

## 4 Conclusion and Recommendations

This study provides accurate assessment of baseline and temporal change in vegetation cover within the Town of Cottesloe. The main findings of this study are:

- Total vegetation cover within the Town of Cottesloe is 124.6 ha (31.8%).
- The area of vegetation above 3m height (canopy) is 51.1 ha (13.1%).
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