

# Appendix 5B-4: Emergent and Submerged Aquatic Vegetation Coverage in the Stormwater Treatment Areas Based on Aerial Imagery

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The Everglades Stormwater Treatment Area (STA) Vegetation Mapping program has several objectives: (1) document areal coverage of emergent aquatic vegetation (EAV), submerged aquatic vegetation (SAV), and open-water areas based on aerial images; (2) map dominant vegetation types on an as-needed basis; and (3) monitor changes in vegetation coverage in problematic cells. Ground-truthing via field trips has supplemented the aerial imagery as needed. Aerial images of the STAs are taken once a year.

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## INTERPRETATION OF WY2016 AERIAL IMAGERY

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Aerial imagery for Water Year 2016 (WY2016) was obtained on May 11 from STA-5/6 and June 7 to 27, 2015 from STA-1 East (STA-1E), STA-1 West (STA-1W), STA-2, and STA-3/4 by Aerial Cartographics of America Inc. utilizing a Microsoft UltraCam Eagle digital camera mounted on a Cessna 206 aircraft. The aircraft was flying at an approximate altitude of 4,770 meters (15,650 feet) above ground level, with 60 percent image end lap and 40 percent image side lap. The images were collected under conditions that minimized clouds, cloud shadows and glare from the water surface, maximized light penetration within waterbodies, and were free of smoke. Image acquisition took place when the sun angle was between 25 and 55 degrees above the horizon. The raw imagery has a ground sampling distance of 30.5 centimeter (12 inches).

Raw images were processed using Vexcel UltraMap (version 3.0, Microsoft Corporation, Redmond, Washington) to Level 3 TIFFs. The four color bands are a four-band stack (red, green, blue, and intensity) of level 3 images. Dewberry<sup>®</sup> provided professional services to review the raw imagery to ensure completeness of coverage, readability of files, and correct formatting. Vegetation cover maps for the six STAs were produced using unsupervised classification of the color infrared bands of this imagery. Image processing software (ERDAS Imagine, 2011, Intergraph Corporation, Huntsville, Alabama) was used to reclassify, filter, and aggregate the initial classification. Expert knowledge and ground-truthing of vegetation composition were employed to conduct final edits, calculate acreage, and output results cartographically using geographic information system software (ArcGIS version 10.2, ESRI, Redlands, California).

The most significant limitations of the STA aerial imagery are (1) photographic overflights are conducted only once a year, preferably during the dry season; (2) the inability to always discriminate between areas covered with SAV versus open-water areas; and (3) rapid changes in the wetland plant community associated with changing water levels. It is often impossible to distinguish actual SAV coverage in the aerial images; therefore, some portion of areas mapped as SAV may include open water without plants. Since acquiring aerial imagery requires clear weather with a cloudless sky, flights have occurred during periods when the water levels in the STAs were receding (e.g., during the dry season). Wetland vegetation

38 coverage can change quickly depending on hydrologic conditions. For example, some SAV/open-water  
 39 areas may rapidly change to EAV when water level recedes and conditions become conducive for EAV  
 40 growth. For the STA maps and data summaries presented in this appendix, coverage is distinguished among  
 41 areas covered with EAV, areas covered with open water or SAV, and bare areas. Bare area includes areas  
 42 of exposed soil or dead grasses and often was less than 1 percent of total vegetation coverage. Floating  
 43 aquatic vegetation was grouped in with the SAV/open water category for this mapping program. Note that  
 44 these cover estimates do not reflect vegetation density or health.

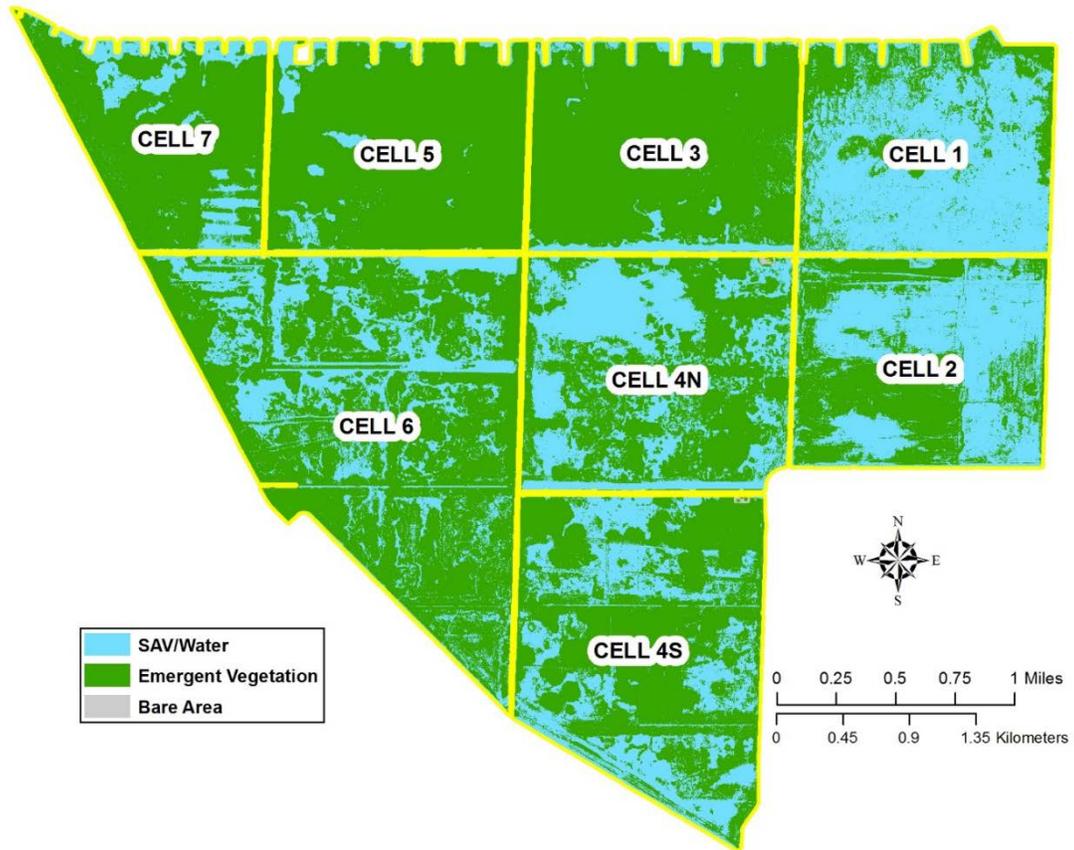
## 45 STA-1E VEGETATION COVERAGE

46 **Table 1** and **Figure 1** describe vegetation coverage in STA-1E for WY2016.

47 **Table 1.** Vegetation coverage in the STA-1E treatment cells estimated from the 2015  
 48 aerial imagery, categorized by the dominant vegetation communities (EAV or  
 49 SAV/open water) or exposed ground/dead grasses (bare area).

Cell	Coverage Type	Estimated Coverage (acres)	% Coverage	Cell Area (acres)
CELL 1	SAV/Water	397.4	73.5	540.7
	EAV	143.3	26.5	
	Bare Area	0.0	0.0	
CELL 2	SAV/Water	290.6	53.8	540.4
	EAV	249.9	46.2	
	Bare Area	0.0	0.0	
CELL 3	SAV/Water	56.0	9.8	572.1
	EAV	516.2	90.2	
	Bare Area	<0.1	<0.1	
CELL 4N	SAV/Water	289.7	45.6	634.8
	EAV	344.1	54.2	
	Bare Area	1.0	0.2	
CELL 4S	SAV/Water	254.3	34.8	731.6
	EAV	476.4	65.1	
	Bare Area	0.9	0.1	
CELL 5	SAV/Water	45.4	8.4	542.3
	EAV	496.9	91.6	
	Bare Area	0.1	<0.1	
CELL 6	SAV/Water	305.3	29.6	1,033.0
	EAV	727.6	70.4	
	Bare Area	0.2	<0.1	
CELL 7	SAV/Water	79.2	19.9	397.8
	EAV	318.6	80.1	
	Bare Area	<0.1	<0.1	

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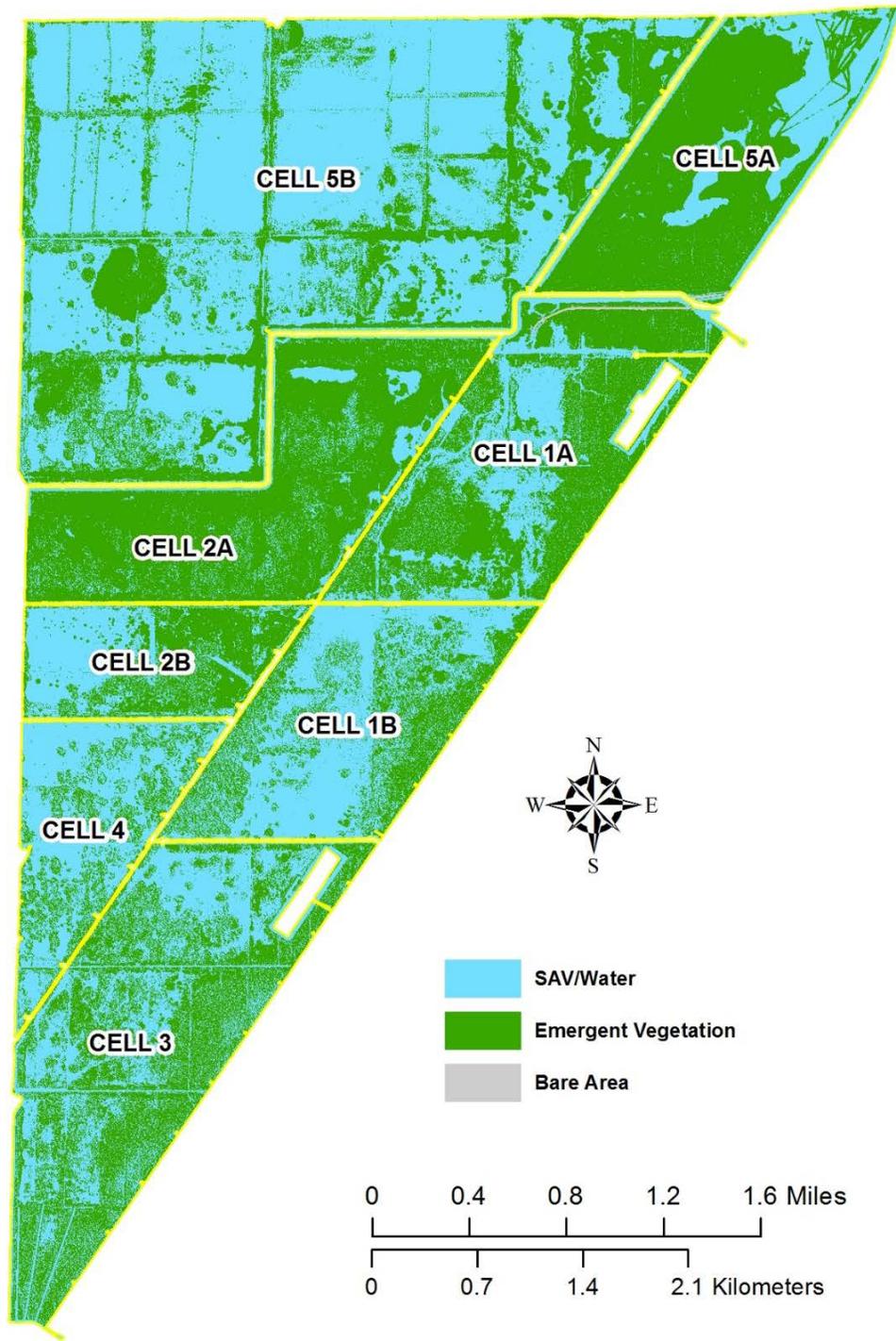
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**Figure 1.** Vegetation coverage map of STA-1E based on the 2015 aerial imagery, categorized by the dominant vegetation communities (EAV or SAV/open water) or exposed ground/dead grasses (bare area).

55 **STA-1W VEGETATION COVERAGE**56 **Table 2** and **Figure 2** present vegetation coverage in STA-1W for WY2016.57 **Table 2.** Vegetation coverage in the STA-1W treatment cells estimated from the 2015  
58 aerial imagery, categorized by the dominant vegetation communities (EAV or  
59 SAV/open water) or exposed ground/dead grasses (bare area).

Cell	Coverage Type	Estimated Coverage (acres)	% Coverage	Cell Area (acres)
CELL 1A	SAV/Water	269.5	37.8	713.4
	EAV	438.5	61.5	
	Bare Area	5.6	0.8	
CELL 1B	SAV/Water	379.9	65.8	577.2
	EAV	197.3	34.2	
	Bare Area	0.1	<0.1	
CELL 2A	SAV/Water	116.8	16.7	701.4
	EAV	584.6	83.4	
	Bare Area	0.1	<0.1	
CELL 2B	SAV/Water	154.2	49.9	309.1
	EAV	154.9	50.1	
	Bare Area	<0.1	<0.1	
CELL 3	SAV/Water	431.7	49.0	880.8
	EAV	448.9	51.0	
	Bare Area	0.2	<0.1	
CELL 4	SAV/Water	257.3	71.7	358.7
	EAV	101.4	28.3	
	Bare Area	<0.1	<0.1	
CELL 5A	SAV/Water	168.4	28.0	602.3
	EAV	432.9	71.9	
	Bare Area	1.1	0.2	
CELL 5B	SAV/Water	1,730.7	72.1	2,401.4
	EAV	670.8	27.9	
	Bare Area	0.2	<0.1	

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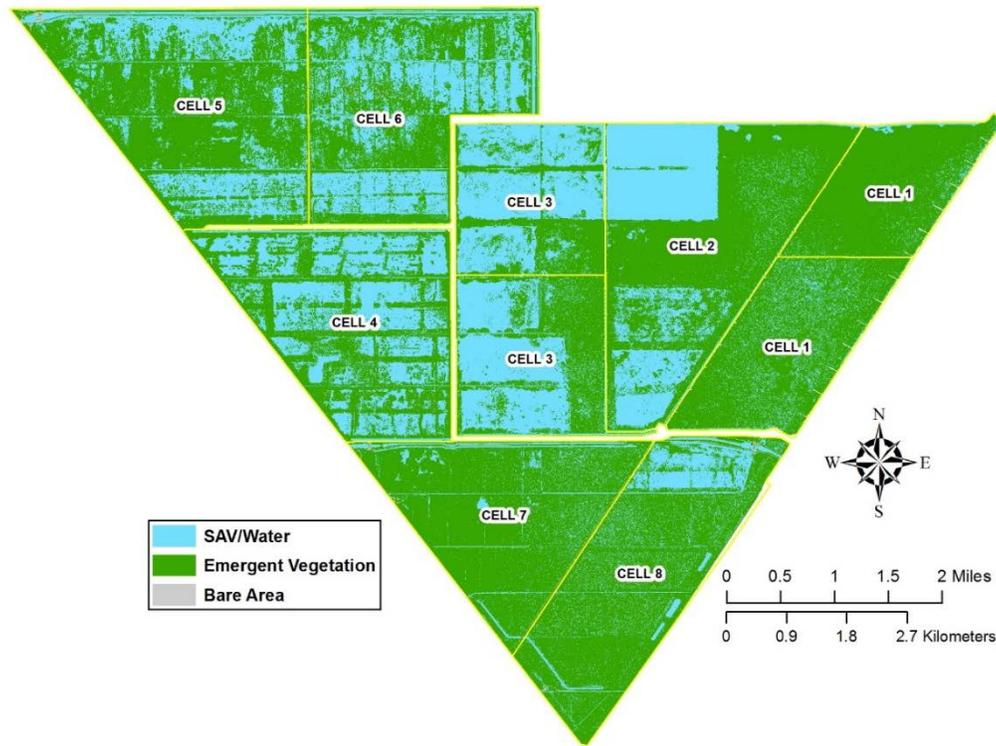
**Figure 2.** Vegetation coverage map of STA-1W based on the 2015 aerial imagery, categorized by the dominant vegetation communities (EAV or SAV/open water) or exposed ground/dead grasses (bare area).

65 **STA-2 VEGETATION COVERAGE**66 **Table 3** and **Figure 3** present vegetation coverage in STA-2 for WY2016.67 **Table 3.** Vegetation coverage in the STA-2 treatment cells estimated from the 2015  
68 aerial imagery, categorized by the dominant vegetation communities (EAV or  
69 SAV/open water) or exposed ground/dead grasses (bare area).

Cell	Coverage Type	Estimated Coverage (acres)	% Coverage	Cell Area (acres)
Cell 1	SAV/Water	227.4	11.2	2,032.6
	EAV	1,805.1	88.8	
	Bare Area	0.1	<0.1	
Cell 2	SAV/Water	957.4	40.3	2,373.2
	EAV	1,415.7	59.7	
	Bare Area	0.1	<0.1	
Cell 3	SAV/Water	1,401.8	61.0	2,296.3
	EAV	894.4	39.0	
	Bare Area	0.1	<0.1	
Cell 4	SAV/Water	997.5	51.4	1,942.0
	EAV	942.0	48.5	
	Bare Area	2.6	0.1	
Cell 5	SAV/Water	770.7	33.5	2,300.4
	EAV	1,514.0	65.8	
	Bare Area	15.8	0.7	
Cell 6	SAV/Water	938.0	46.9	2,000.4
	EAV	1,043.3	52.2	
	Bare Area	19.1	1.0	
Cell 7	SAV/Water	183.7	11.4	1,608.1
	EAV	1,412.4	87.8	
	Bare Area	12.0	0.8	
Cell 8	SAV/Water	392.2	21.2	1,852.7
	EAV	1,440.6	77.8	
	Bare Area	19.9	1.1	

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**Figure 3.** Vegetation coverage map of STA-2 based on the 2015 aerial imagery, categorized by the dominant vegetation communities (EAV or SAV/open water) or exposed ground/dead grasses (bare area).

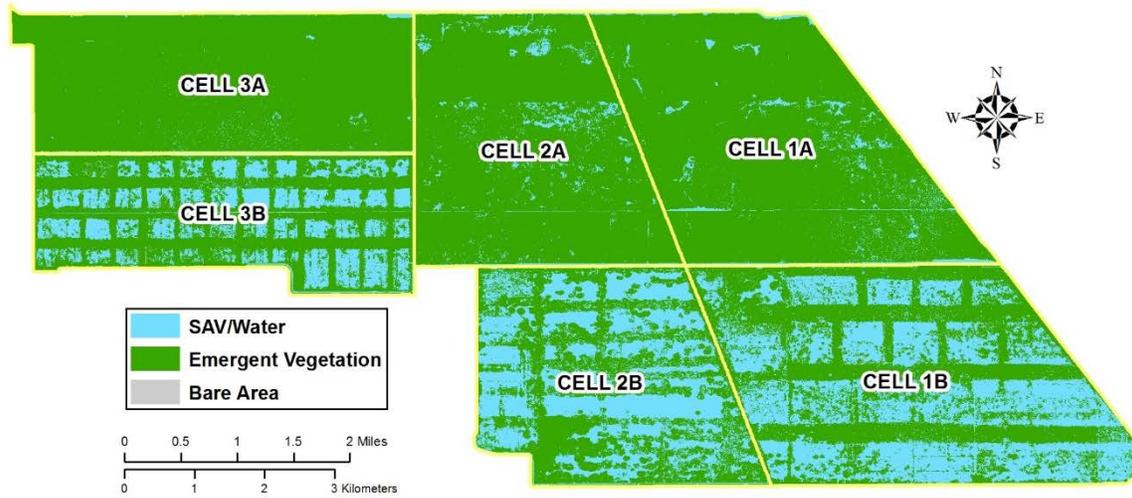
76 **STA-3/4 VEGETATION COVERAGE**

77 **Table 4** and **Figure 4** present vegetation coverage in STA-3/4 for WY2016.

78 **Table 4.** Vegetation coverage in the STA-3/4 treatment cells estimated from the 2015  
 79 aerial imagery, categorized by the dominant vegetation communities (EAV or  
 80 SAV/open water) or exposed ground/dead grasses (bare area).

Cell	Coverage Type	Estimated Coverage (acres)	% Coverage	Cell Area (acres)
CELL 1A	SAV/Water	169.6	5.6	3,019.6
	EAV	2,847.1	94.3	
	Bare Area	2.8	0.1	
CELL 1B	SAV/Water	1,672.7	48.4	3,456.1
	EAV	1,773.4	51.3	
	Bare Area	10.1	0.3	
CELL 2A	SAV/Water	154.7	6.2	2,505.6
	EAV	2,349.7	93.8	
	Bare Area	1.2	0.1	
CELL 2B	SAV/Water	1,196.4	49.9	2,396.5
	EAV	1,195.8	49.9	
	Bare Area	4.2	0.2	
CELL 3A	SAV/Water	57.4	2.4	2,415.2
	EAV	2,356.0	97.6	
	Bare Area	1.7	0.1	
CELL 3B	SAV/Water	768.5	36.8	2,086.7
	EAV	1,315.0	63.0	
	Bare Area	3.2	0.2	

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**Figure 4.** Vegetation coverage map of STA-3/4 based on the 2015 aerial imagery, categorized by the dominant vegetation communities (EAV or SAV/open water) or exposed ground/dead grasses (bare area).

86 **STA-5/6 VEGETATION COVERAGE**

87 **Table 5** and **Figure 5** present vegetation coverage in STA-5/6 for WY2016.

88 **Table 5.** Vegetation coverage in the STA-5/6 treatment cells estimated from the 2015  
 89 aerial imagery, categorized by the dominant vegetation communities (EAV or  
 90 SAV/open water) or exposed ground/dead grasses (bare area).

Cell	Coverage Type	Estimated Coverage (acres)	% Coverage	Cell Area (acres)
CELL 5-1A	SAV/Water	69.9	8.3	840.3
	EAV	769.9	91.6	
	Bare Area	0.4	0.1	
CELL 5-1B	SAV/Water	695.9	56.9	1,223.2
	EAV	527.2	43.1	
	Bare Area	0.2	<0.1	
CELL 5-2A	SAV/Water	61.4	7.3	844.7
	EAV	783.4	92.7	
	Bare Area	0.1	<0.1	
CELL 5-2B	SAV/Water	627.5	50.9	1,233.1
	EAV	605.6	49.1	
	Bare Area	<0.1	<0.1	
CELL 5-3A	SAV/Water	201.4	19.2	1,047.0
	EAV	845.7	80.8	
	Bare Area	<0.1	<0.1	
CELL 5-3B	SAV/Water	599.7	65.2	920.3
	EAV	320.5	34.8	
	Bare Area	0.1	<0.1	
Cell 5-4A	SAV/Water	564.5	27.5	2,056.0
	EAV	1,481.9	72.1	
	Bare Area	9.6	0.5	
Cell 5-4B	SAV/Water	364.3	76.1	479.3
	EAV	111.4	23.3	
	Bare Area	3.6	0.8	
Cell 5-5A	SAV/Water	443.6	17.3	2,562.1
	EAV	2,106.1	82.2	
	Bare Area	12.5	0.5	
Cell 5-5B	SAV/Water	440.5	61.3	718.8
	EAV	273.1	38.0	
	Bare Area	5.3	0.7	

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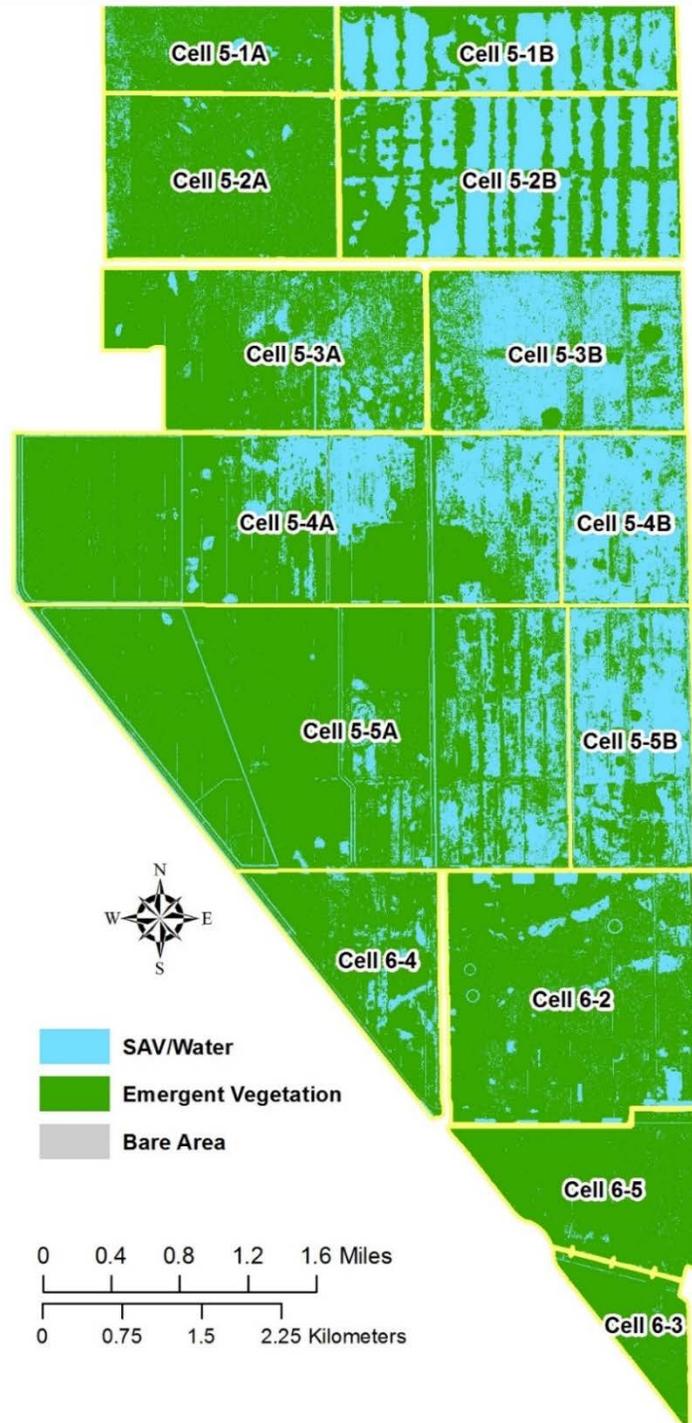
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**Table 5.** Continued.

<b>Cell</b>	<b>Coverage Type</b>	<b>Estimated Cover- age (ac)</b>	<b>% Coverage</b>	<b>Cell Area (ac)</b>
Cell 6-2	SAV/Water	183.2	13.5	1,361.4
	EAV	1,178.2	86.5	
	Bare Area	<0.1	<0.1	
Cell 6-3	SAV/Water	6.9	2.9	241.9
	EAV	235.0	97.2	
	Bare Area	<0.1	<0.1	
Cell 6-4	SAV/Water	86.4	14.8	583.1
	EAV	493.6	84.7	
	Bare Area	3.1	0.5	
Cell 6-5	SAV/Water	10.9	1.8	621.2
	EAV	610.3	98.3	
	Bare Area	<0.1	<0.1	

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**Figure 5.** Vegetation coverage map of STA-5/6 based on the 2015 aerial imagery, categorized by the dominant vegetation communities (EAV or SAV/open water) or exposed ground/dead grasses (bare area).

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## VEGETATION COVERAGE TRENDS (CY2007–CY2015)

### 100 STA-1E VEGETATION COVERAGE

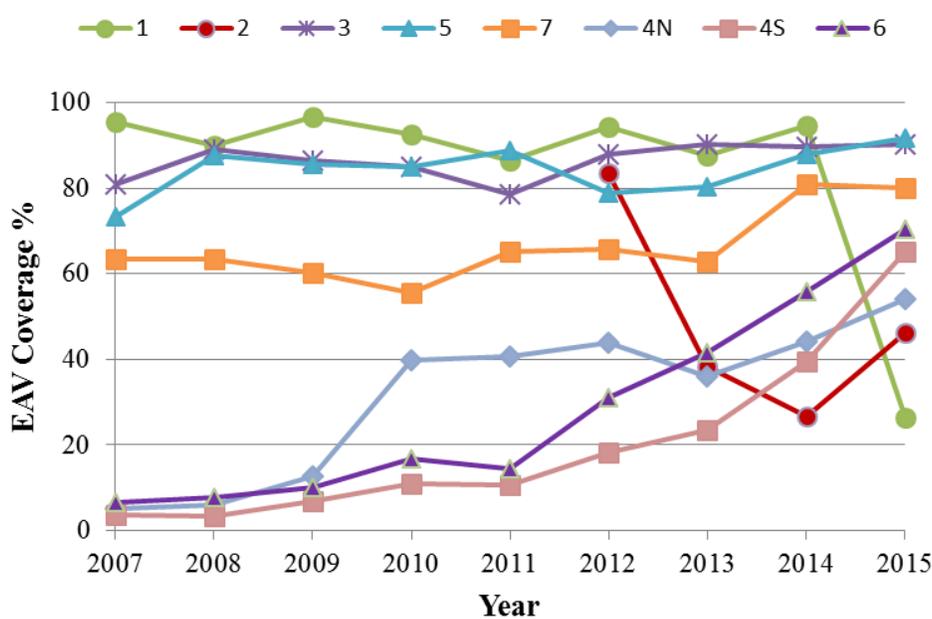
101 There was little change in EAV coverage in Cells 3, 5, and 7 between Calendar Year 2014 (CY2014)  
 102 (January 1, 2014–December 31, 2014) and CY2015; EAV coverage in these cells ranged from 80 to 92  
 103 percent (**Table 6** and **Figure 6**). There was a moderate increase (10 percent) in EAV coverage in Cell 4N.  
 104 There also were moderate increases in EAV coverage in SAV Cells 2 and 6 (14 to 18 percent), and a larger  
 105 increase in SAV Cell 4S (26 percent). The largest decrease occurred in EAV Cell 1 with a 68 percent re-  
 106 duction in EAV coverage.

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**Table 6.** Summary of EAV coverage in STA-1E based on aerial imagery from CY2007 to CY2015.

[Note: ND indicates that no data are available for the year.]

Calendar Year	Percent EAV Coverage of Total Cell Area							
	EAV Cells					SAV Cells		
	1	2	3	5	7	4N	4S	6
2007	95.4	ND	80.9	73.3	63.4	5.0	3.7	6.4
2008	90.1	ND	89.1	87.7	63.4	6.0	3.4	7.8
2009	96.7	ND	86.5	85.7	60.3	12.7	6.9	10.1
2010	92.6	ND	85.0	85.0	55.5	39.8	11.0	16.7
2011	86.5	ND	78.6	88.8	65.3	40.6	10.7	14.5
2012	94.4	83.7	88.0	78.8	65.8	43.9	18.2	31.0
2013	87.7	38.2	90.1	80.4	62.9	36.0	23.3	41.5
2014	94.7	26.8	89.8	87.9	81.0	44.3	39.5	55.7
2015	26.5	46.3	90.2	91.6	80.1	54.2	65.1	70.4
<b>Average</b>	<b>85.0</b>	<b>48.7</b>	<b>86.5</b>	<b>84.4</b>	<b>66.4</b>	<b>31.4</b>	<b>20.2</b>	<b>28.2</b>



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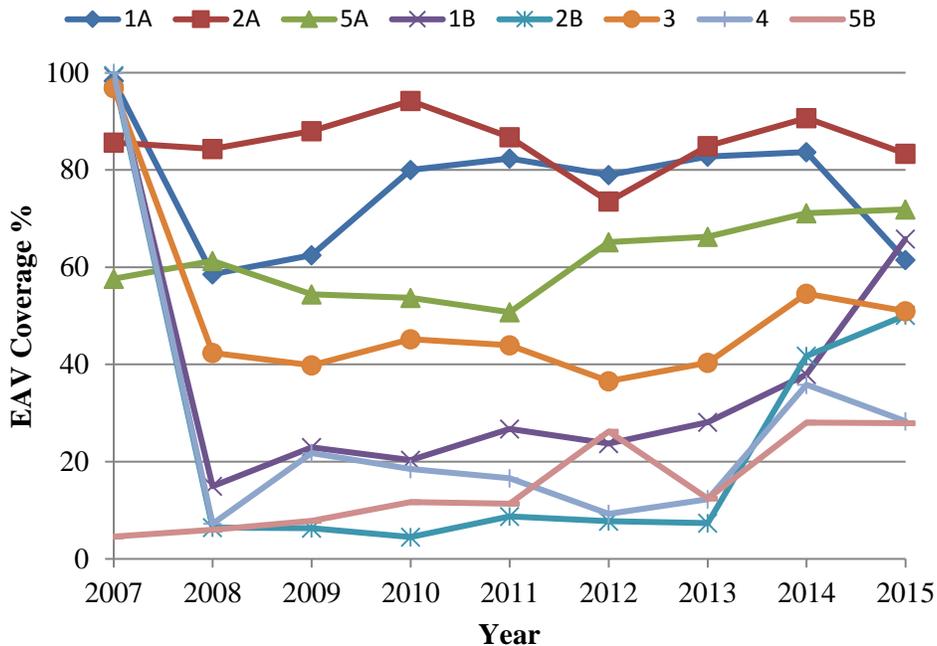
**Figure 6.** Percent EAV coverage in STA-1E treatment cells from CY2007 to CY2015.

112 **STA-1W VEGETATION COVERAGE**

113 Over the last two years (CY2014 to CY2015), EAV coverage changed little in Cells 5A and 5B, de-  
 114 creased slightly (< 5 percent) in Cell 3, and increased by about 8 percent in Cell 2B (**Table 7** and **Figure**  
 115 **7**). EAV coverage in Cells 2A and 4 decreased by about 8 percent. Conversely, larger changes in EAV  
 116 coverage occurred in Cell 1A with a 22 percent decrease and in Cell 1B with a 28 percent increase.

117 **Table 7.** Summary of EAV coverage in STA-1W based on  
 118 aerial imagery from CY2007 to CY2015.

Calendar Year	Percent EAV Coverage of Total Cell Area							
	EAV Cells			SAV Cells				
	1A	2A	5A	1B	2B	3	4	5B
2007	98.3	85.6	57.6	99.2	99.5	96.8	100	4.6
2008	58.6	84.4	61.3	15.0	6.5	42.4	7.2	6.0
2009	62.5	88.0	54.5	22.9	6.3	39.8	21.8	7.8
2010	80.0	94.2	53.7	20.3	4.5	45.2	18.5	11.7
2011	82.4	86.7	50.7	26.8	8.7	43.9	16.6	11.4
2012	79.0	73.5	65.2	23.7	7.7	36.6	9.3	26.2
2013	82.7	84.9	66.3	28.1	7.4	40.4	12.3	12.4
2014	83.7	90.7	71.1	38.0	41.7	54.6	35.9	28.0
2015	61.5	83.4	71.9	65.8	50.1	51.0	28.3	27.9
<b>Average</b>	<b>76.5</b>	<b>85.7</b>	<b>61.4</b>	<b>37.8</b>	<b>25.8</b>	<b>50.1</b>	<b>27.8</b>	<b>15.1</b>



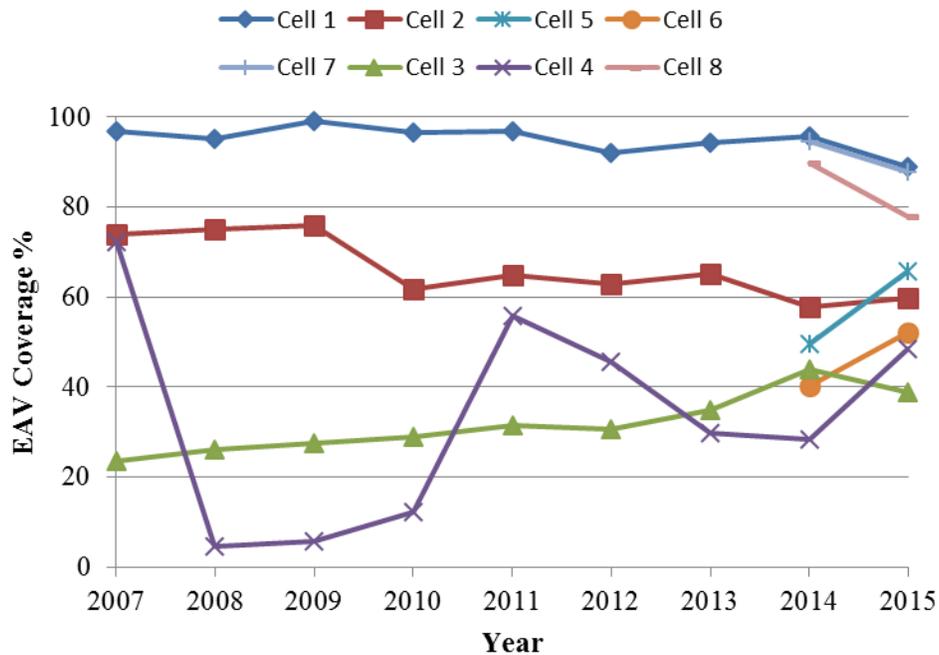
119 **Figure 7.** Percent EAV coverage in STA-1W treatment cells from CY2007 to CY2015.  
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121 **STA-2 VEGETATION COVERAGE**

122 Over the last two years (CY2014 to CY2015), there were small changes in EAV coverages in Cells 2  
 123 and 3, with coverages differing by no more than 5 percent (**Table 8** and **Figure 8**). There were moderate  
 124 EAV coverage reductions of 7 percent in Cells 1 and 7. The largest changes in EAV coverage occurred in  
 125 Cells 4, 5 and 6, which experienced 12 to 20 percent increases, while Cell 8 had a 12 percent decrease from  
 126 CY2014 to CY2015.

127 **Table 8.** Summary of EAV coverage in STA-2 based on aerial imagery from  
 128 CY2007 to CY2015. [Note: ND indicates that no data are available for this year.]

Calendar Year	Percent EAV Coverage of Total Cell Area							
	EAV Cells			SAV Cells				
	1	2	7	3	4	5	6	8
2007	96.9	73.9	ND	23.6	72.1	ND	ND	ND
2008	95.3	75.0	ND	26.0	4.6	ND	ND	ND
2009	99.1	75.8	ND	27.6	5.6	ND	ND	ND
2010	96.5	61.7	ND	28.8	12.2	ND	ND	ND
2011	96.9	65.0	ND	31.5	55.8	ND	ND	ND
2012	91.9	62.9	ND	30.7	45.6	ND	ND	ND
2013	94.4	65.1	ND	34.8	29.7	ND	ND	ND
2014	95.6	57.8	94.5	44.0	28.5	49.5	40.2	89.7
2015	88.8	59.7	87.8	39.0	48.5	65.8	52.2	77.8
<b>Average</b>	<b>95.0</b>	<b>66.3</b>	<b>91.2</b>	<b>31.8</b>	<b>33.6</b>	<b>57.7</b>	<b>46.2</b>	<b>83.8</b>



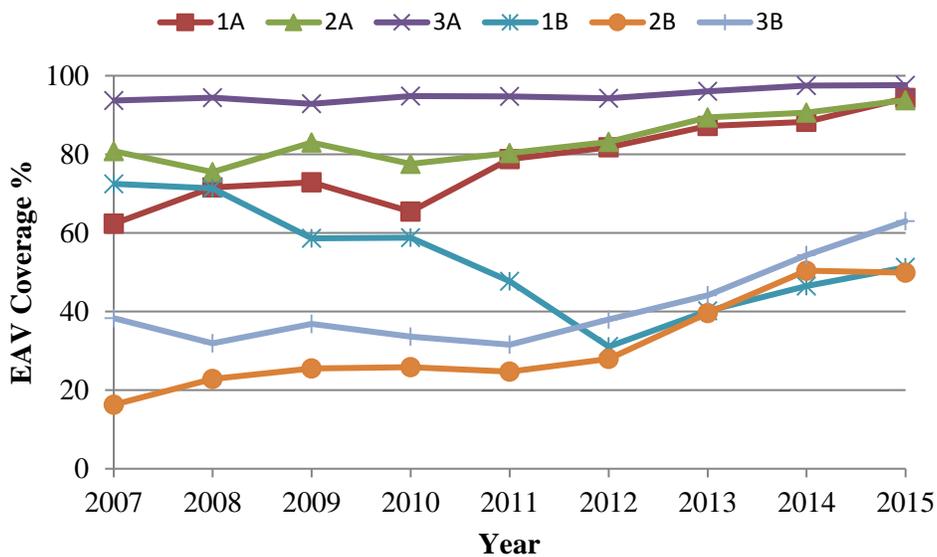
129 **Figure 8.** Percent EAV coverage in STA-2 treatment cells from CY2007 to CY2015.  
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131 **STA-3/4 VEGETATION COVERAGE**

132 Cells 1A and 3B in STA-3/4 experienced a modest increase (6 to 11 percent) in EAV coverage from  
 133 CY2014 to CY2015 (**Table 9** and **Figure 9**). There were smaller increases in EAV coverage in Cells 1B  
 134 and 2A (3 to 5 percent). EAV coverage in Cells 2B and 3A was essentially unchanged; differences between  
 135 years for both cells were less than 1 percent.

136 **Table 9.** Summary of EAV coverage in STA-3/4 based on  
 137 aerial imagery from CY2007 to CY2015.

Calendar Year	Percent EAV Coverage of Total Cell Area					
	EAV Cells			SAV Cells		
	1A	2A	3A	1B	2B	3B
2007	62.3	80.8	93.7	72.5	16.3	38.3
2008	71.6	75.5	94.4	71.4	22.8	31.9
2009	72.8	83.0	92.8	58.6	25.6	36.8
2010	65.4	77.6	94.8	58.8	25.8	33.6
2011	78.8	80.4	94.8	47.7	24.7	31.6
2012	81.8	83.2	94.3	31.1	27.9	38.0
2013	87.2	89.4	96.1	40.2	39.6	44.2
2014	88.3	90.6	97.5	46.5	50.4	54.3
2015	94.3	93.8	97.6	51.3	49.9	63.0
<b>Average</b>	<b>78.1</b>	<b>83.8</b>	<b>95.1</b>	<b>53.1</b>	<b>31.4</b>	<b>41.3</b>



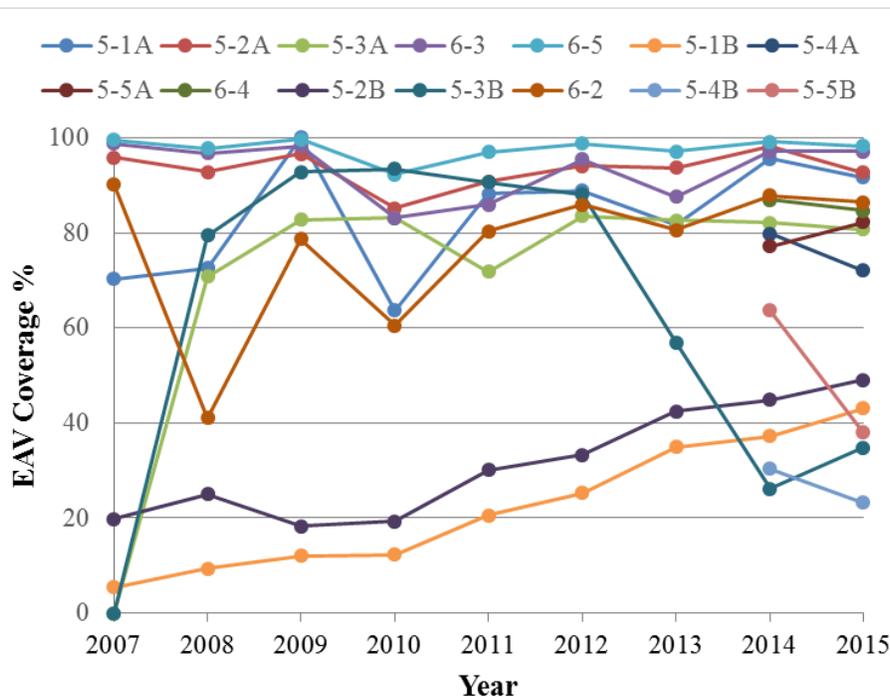
138 **Figure 9.** Percent EAV coverage in STA-3/4 treatment cells from CY2007 to CY2015.  
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140 **STA-5/6 VEGETATION COVERAGE**

141 From CY2014 to CY2015, the largest change in EAV coverage occurred in Cell 5-5B with a 26 percent  
 142 decrease (**Table 10** and **Figure 10**). Cells 5-1B, 5-3B, and 5-5A experienced moderate increases in EAV  
 143 coverage from 5 to 9 percent. Conversely, there were moderate decreases in EAV coverage from 6 to 8 per-  
 144 cent in Cells 5-2A, 5-4A, and 5-4B. EAV coverage changes in the remaining cells (Cells 5-1A, 5-3A, 5-  
 145 2B, 6-2, 6-3, 6-4, and 6-5) were all less than 5 percent over the last two years.

146 **Table 10.** Summary of EAV coverage in STA-5/6 based on aerial imagery from CY2007 to CY2015.  
 147 [Note: ND indicates that no data are available for this year.]

Calendar Year	Percent EAV Cover of Total Cell Area													
	EAV Cells								SAV Cells					
	5-1A	5-2A	5-3A	5-4A	5-5A	6-3	6-4	6-5	5-1B	5-2B	5-3B	5-4B	5-5B	6-2
2007	70.3	95.9	ND	ND	ND	98.8	ND	99.5	5.4	19.8	ND	ND	ND	90.2
2008	72.6	92.8	70.8	ND	ND	96.7	ND	97.7	9.3	25.0	79.5	ND	ND	41.0
2009	100	96.6	82.8	ND	ND	98.3	ND	99.6	12.0	18.3	92.8	ND	ND	78.6
2010	63.7	85.2	83.1	ND	ND	83.2	ND	92.3	12.3	19.3	93.5	ND	ND	60.5
2011	88.3	90.8	71.9	ND	ND	86.0	ND	97.0	20.6	30.1	90.6	ND	ND	80.4
2012	88.9	94.1	83.6	ND	ND	95.5	ND	98.7	25.3	33.2	88.1	ND	ND	85.9
2013	81.6	93.7	82.7	ND	ND	87.6	ND	97.2	34.9	42.4	57.0	ND	ND	80.7
2014	95.6	98.2	82.1	79.8	77.2	97.1	86.9	99.2	37.2	44.9	26.1	30.4	63.7	87.8
2015	91.6	92.7	80.8	72.1	82.2	97.2	84.7	98.3	43.1	49.1	34.8	23.3	38.0	86.5
<b>Average</b>	<b>83.6</b>	<b>93.3</b>	<b>79.7</b>	<b>76.0</b>	<b>79.7</b>	<b>93.4</b>	<b>85.8</b>	<b>97.7</b>	<b>22.2</b>	<b>31.3</b>	<b>70.3</b>	<b>26.9</b>	<b>50.9</b>	<b>76.8</b>



148 **Figure 10.** Percent EAV coverage in STA-5/6 treatment cells from CY2007 to CY2015.  
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