Lotus Lake Polk County WBIC 2616900 Date: 8/31/16

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NyMOd	4 SchTa	5 StuPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
61	5.7																										
62	5.9						V																				
63	5.3	M					2																				
64	5.6						3																				
65	6.1																										
66	5.8																										
67	6.4																										
68	7.3																										
69	7.3																										
70	7.8																										
71	7.5																										
72	8.1																										
73	8.1																										
74	7.6																										
75	6.9																										
76	6.8																										
77	6.7																										
78	6.0																										
79	4.8	S					V																				
80							2																				
81	5.6	M					2																				
82	6.4																										
83	6.4																										
84	7.3																										
85	7.5																										
86	8.1																										
87	8.1																										
88	8.1																										
89	8.2																										
90	8.4																										

Lotus Lake Polk County WBIC 2616900 Date: 8/31/16

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NymOd	4 SchTa	5 StuPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
91	7.7																										
92	7.0																										
93	6.8																										
94	6.2																										
95	5.6																										
96	5.4																										
97							2																				
98	5.9						2																				
99	6.2																										
100	6.5																										
101	6.9																										
102	7.5																										
103	7.9																										
104	8.2																										
105	8.8																										
106	8.6																										
107	8.9																										
108	8.6																										
109	8.1																										
110	7.4																										
111	6.7																										
112	6.1																										
113	5.7	M																									
114	2.8	S					1	V																			
115	2.6						2		V			V															
116	5.7						1																				
117	6.0																										
118	6.3																										
119	6.8																										
120	7.2																										

Lotus Lake Polk County WBIC 2616900

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NymOd	4 SchTa	5 StuPe	6 potNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
121	7.7																										
122	7.9																										
123	8.2																										
124	8.5																										
125	8.7																										
126	8.7																										
127	8.4																										
128	7.8																										
129	6.6																										
130	5.8																										
131	5.5	M					V																				
132	5.1	M					1																				
133	2.6	S					V		1																		
134	5.3	M					1																				
135	5.8																										
136	6.2																										
137	6.6																										
138	7.0																										
139	7.5																										
140	7.9																										
141	7.9																										
142	8.4																										
143	8.4																										
144	9.1																										
145	8.9																										
146	8.4																										
147	7.5																										
148	6.7																										
149	6.0	M					1																				
150	4.5	M					V																				

Lotus Lake Polk County WBIC 2616900

Date: 8/31/16

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NyMOd	4 SchTa	5 StuPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
151	2.0	S					1	V	V																		
152	2.5	S					1		V		V																
153	5.5	M					1																				
154	8.0																										
155	8.4																										
156	8.4																										
157	9.9																										
158	9.7																										
159	10.3																										
160	10.7																										
161	10.3																										
162	11.3																										
163	11.3																										
164	11.7																										
165	10.2																										
166	6.7																										
167	5.6																										
168	5.0	M					3																				
169	4.5	M					1																				
170	2.3	M					V	V	V	V																	
171	1.2	S						V	1																		
172	3.4	S					V																				
173	5.4																										
174	5.7																										
175	5.9																										
176	6.1																										
177	6.5																										
178	6.6																										
179	6.8																										
180	6.9																										

depth finder twisted

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NeILu	2 NupVa	3 NyMOd	4 SchTa	5 SruPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
181	7.0																										
182	7.1																										
183	7.0																										
184	6.7																										
185	6.6																										
186	6.8																										
187	5.8						V																				
188	4.6						1		V																		
189	2.7						1		V																		
190	6.2	M																									
191	6.8																										
192	6.7																										
193	7.0																										
194	7.3																										
195	7.4																										
196	7.4																										
197	7.3																										
198	7.3																										
199	7.6																										
200	7.5																										
201	6.8																										
202	6.4																										
203	5.9																										
204	5.1						3																				
205	4.5						V																				
206	1.3							1			V																
207	4.7						1																				
208	6.9						V																				
209	6.2																										
210	6.2																										

Lotus Lake Polk County WBIC 2616900 Date: 8/31/16

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NymOd	4 SchTa	5 StuPe	6 PotNa	7 LemMi	8 ZizPa	9	10	11	12	13	14	15	16	17	18	19	20	21
211	6.4																										
212	6.7																										
213	6.8																										
214	7.1																										
215	6.7																										
216	6.9																										
217	6.9																										
218	6.2																										
219	6.0																										
220	5.8																										
221	5.6						1						V														
222	1.5						1		V			V		V													
223	6.2						3																				
224	6.2																										
225	5.2																										
226	5.5																										
227	5.8																										
228	5.8																										
229	6.0																										
230	5.7																										
231	5.8																										
232	5.4																										
233	5.2																										
234	4.8																										
235	4.4																										
236	3.6							V	V																		
237	—						2																				
238	~						3																				
239	4.1						1																				
240	4.5																										

Lotus Lake Polk County WBIC 2616900

Date: 8/31/16

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NypVa	3 NymOd	4 SchTa	5 StuPe	6 PotNa	7 CerDe	8 LemMi	9 EloCa	10	11	12	13	14	15	16	17	18	19	20	21
241	4.7																										
242	5.2																										
243	5.2																										
244	5.2																										
245	5.4																										
246	5.2																										
247	5.1																										
248	5.3																										
249	4.8	M																									
250	4.1	S					V																				
251	2.0	M					[illegible]		V				1	V													
252	3.1	M					V		V																		
253	3.3	M																									
254	3.8																										
255	4.5																										
256	4.5																										
257	4.6																										
258	4.8																										
259	5.0																										
260	5.1																										
261	5.0																										
262	4.2	M																									
263	3.4						1																				
264	too	shallow																									
265	2.0								V				V	V	1												
266	3.5																										
267	3.8																										
268	3.9																										
269	4.1																										
270	4.2																										

Lotus Lake Polk County WBIC 2616900 Date: 8/31/16

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NymOd	4 SchTa	5 StuPe	6 PotNa	7 LemMi	8 CerDe	9 ZizPa	10	11	12	13	14	15	16	17	18	19	20	21
271	4.8																										
272	4.9																										
273	5.8																										
274	4.9						1		V				V														
275	4.1						1						V														
276	too shallow																										
277																											
278	2.0					V			1		V		V	1													
279	2.2							V	1				V	V	V												
280	3.4																										
281	3.3																										
282	3.4																										
283	3.7																										
284	4.0																										
285	4.2																										
286	4.2						V																				
287	3.5	M																									
288	too shallow																										
289																											
290	2.0							V	2				V		V												
291	2.9						1						V														
292	3.1																										
293	3.5																										
294	4.0																										
295	4.4						1																				
296	3.9						V																				
297	3.5						V																				
298	thick lotus																										
299																											
300																											

Lotus Lake Polk County WBIC 2616900 Date: 8/31/16

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NyMod	4 SchTa	5 StuPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
301	too thick lotus																										
302	2.9																										
303	3.4																										
304	3.4																										
305	3.1						3																				
306	2.7						2																				
307																											
308																											
309	too thick lotus beds																										
310																											
311																											
312	3.3	M																									
313	3.2	M						V	V																		
314																											
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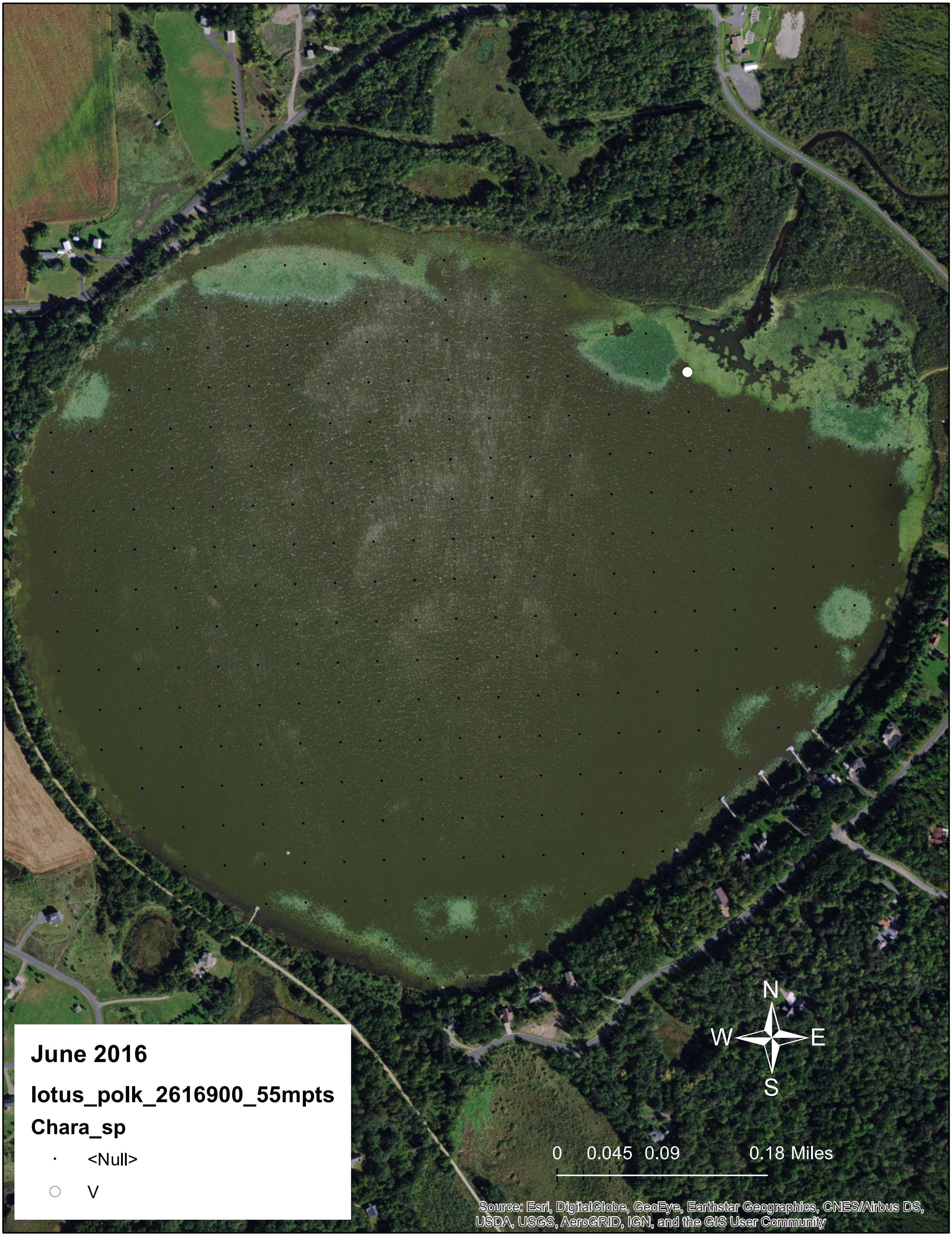

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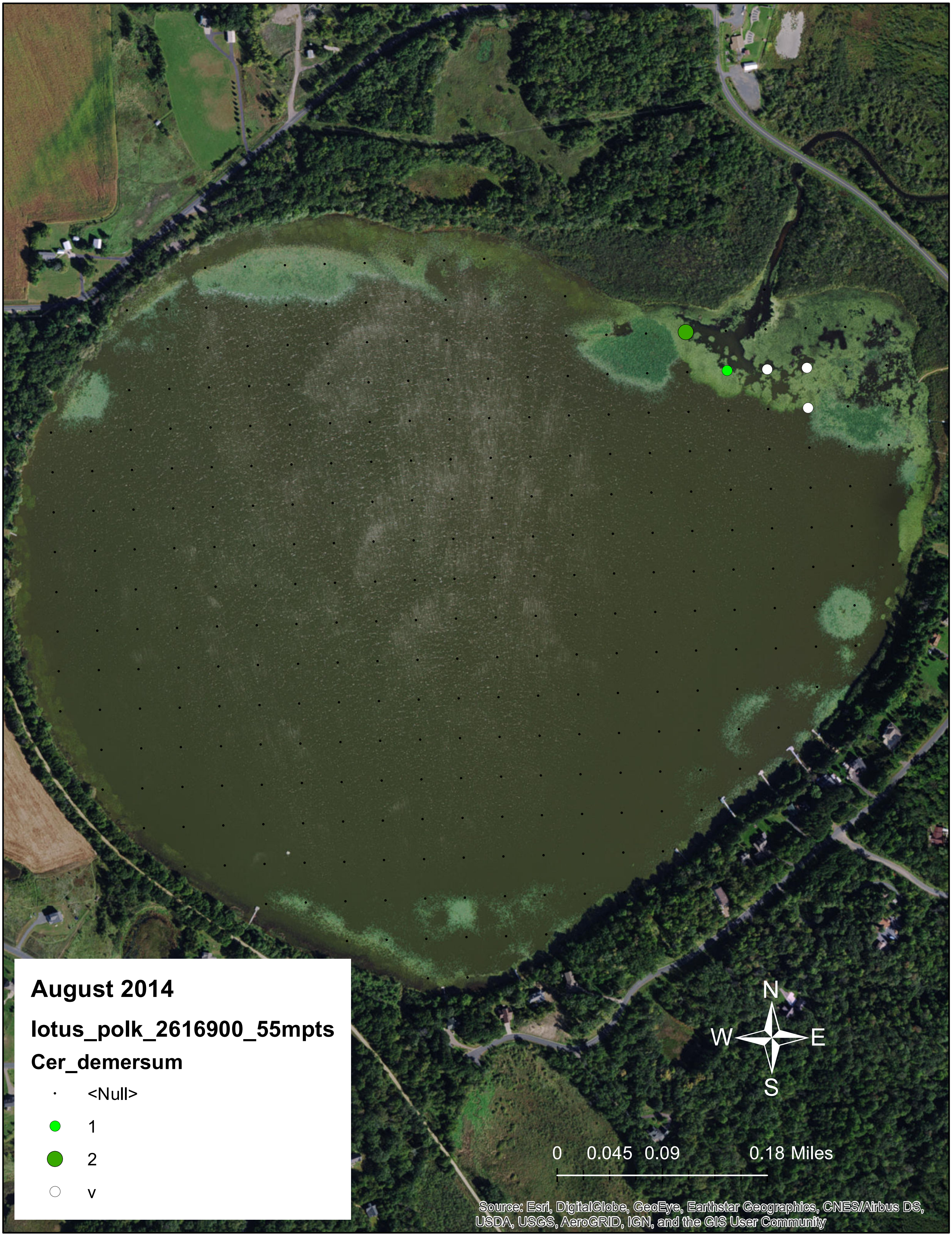
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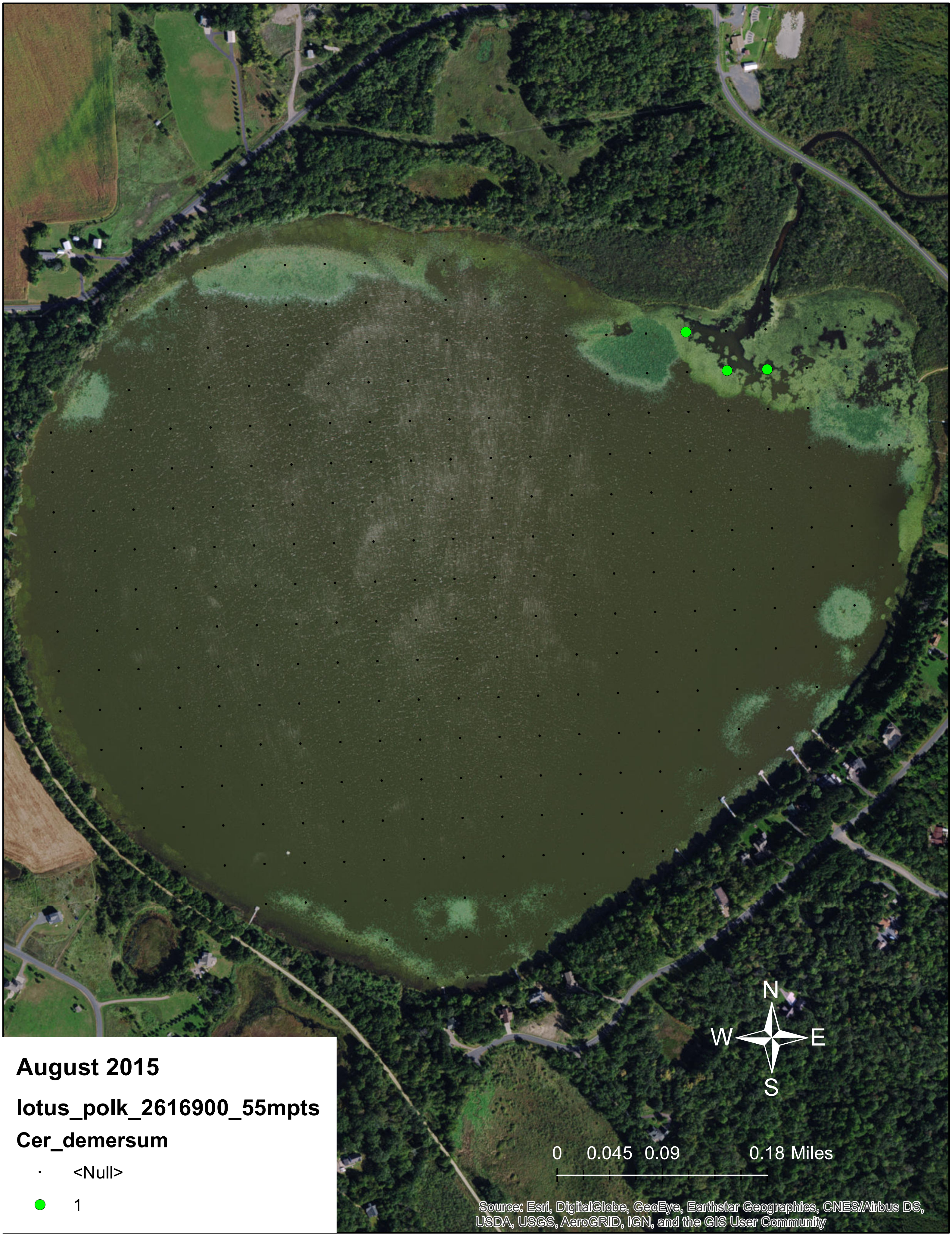

August 2015

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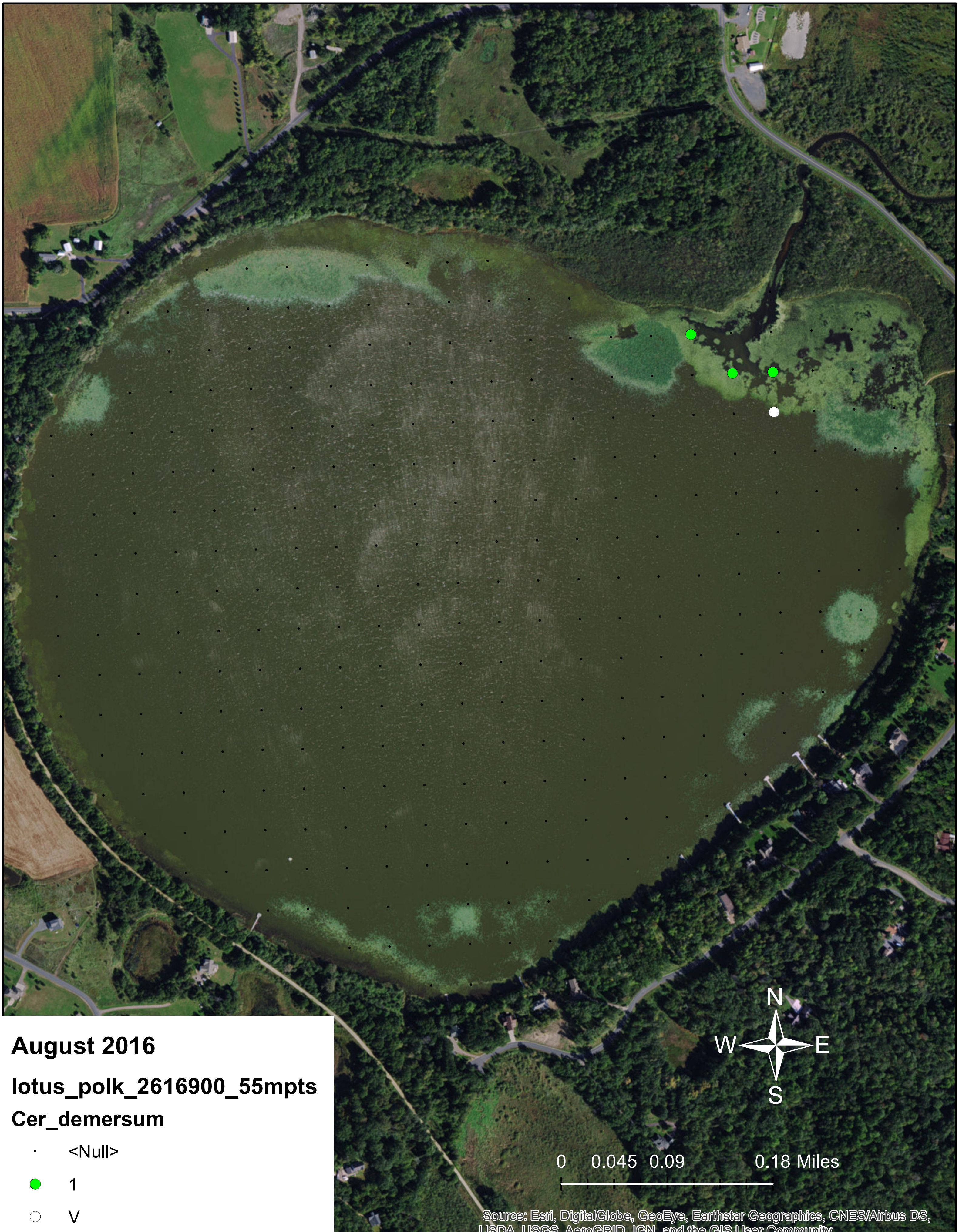

August 2016

lotus_polk_2616900_55mpts

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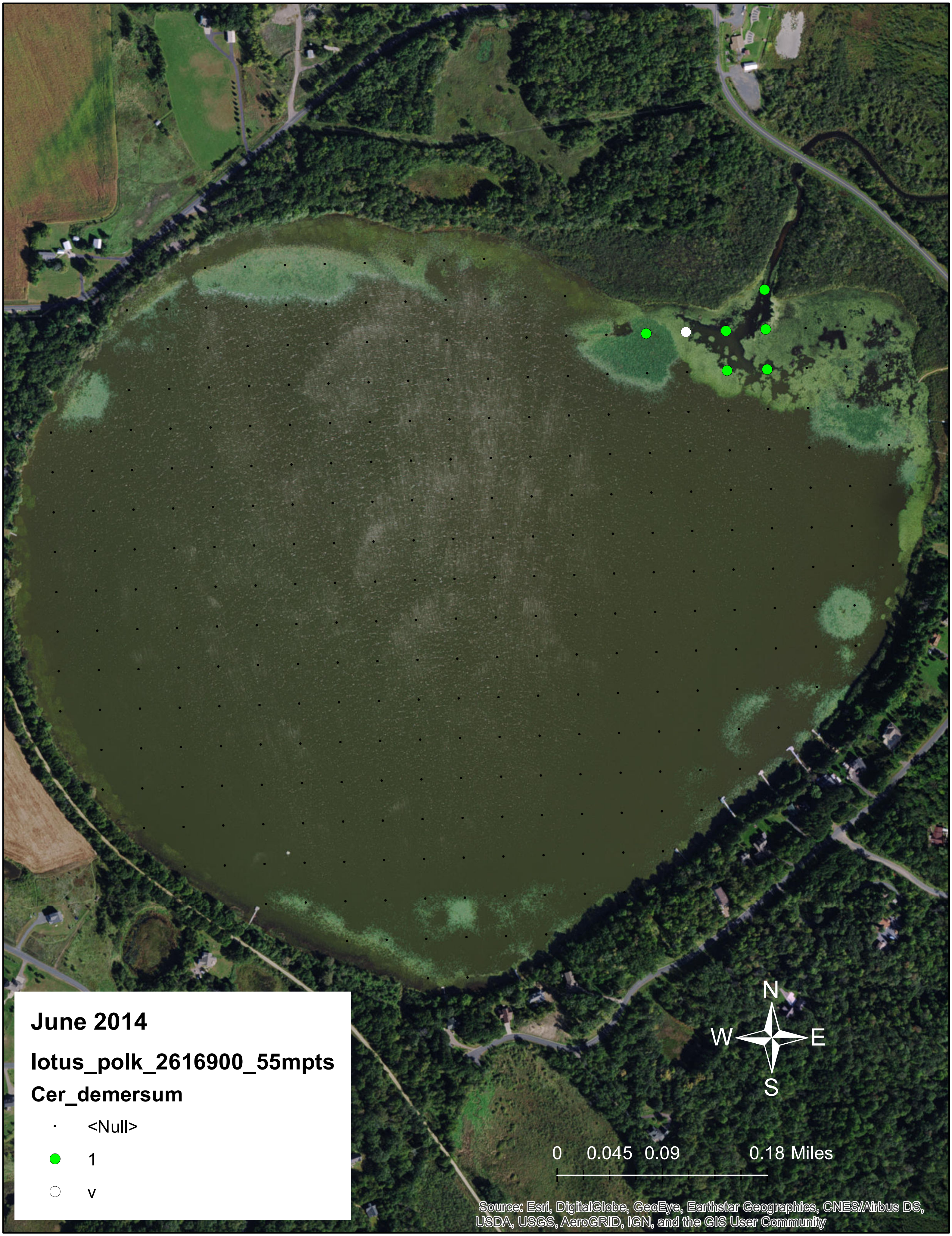
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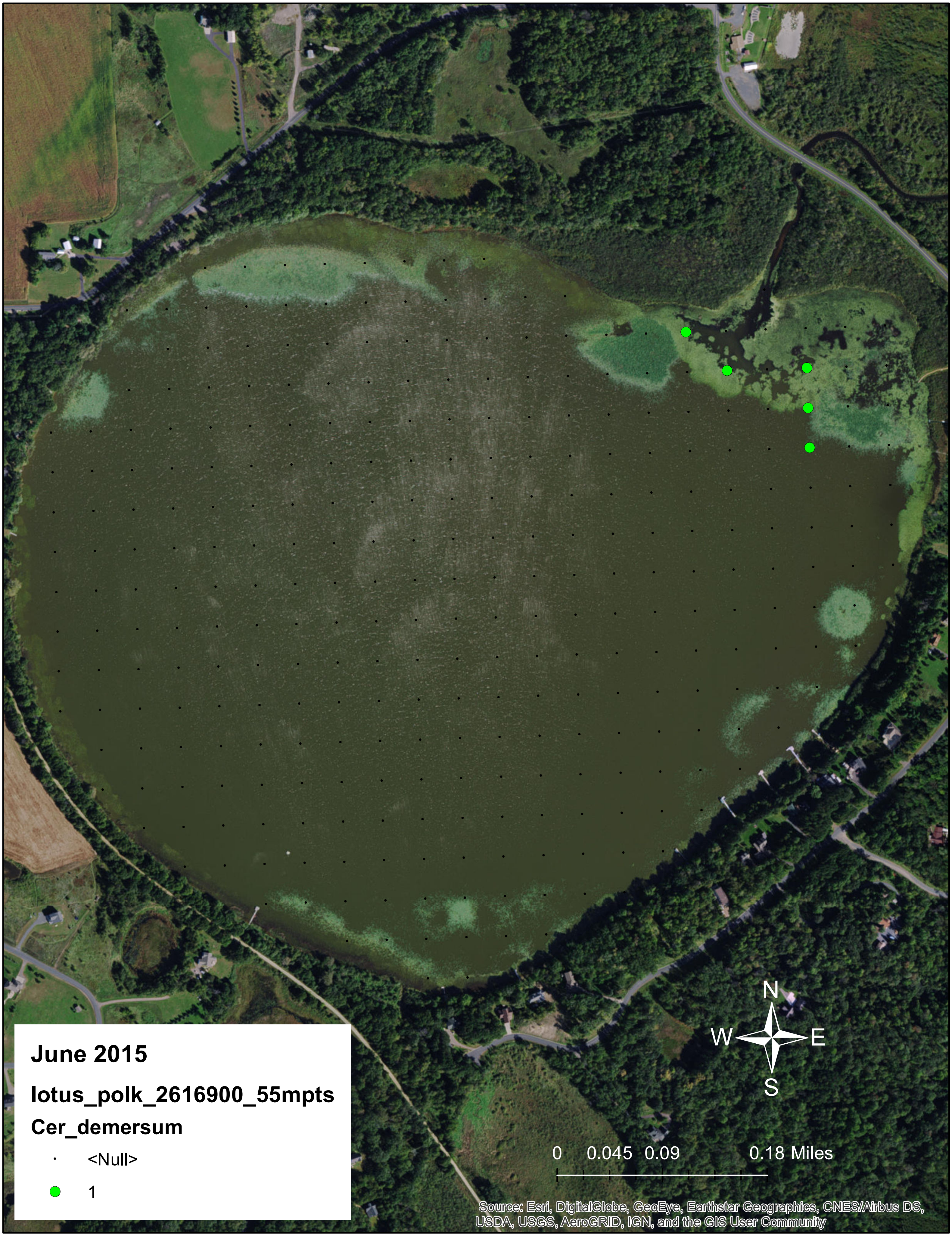
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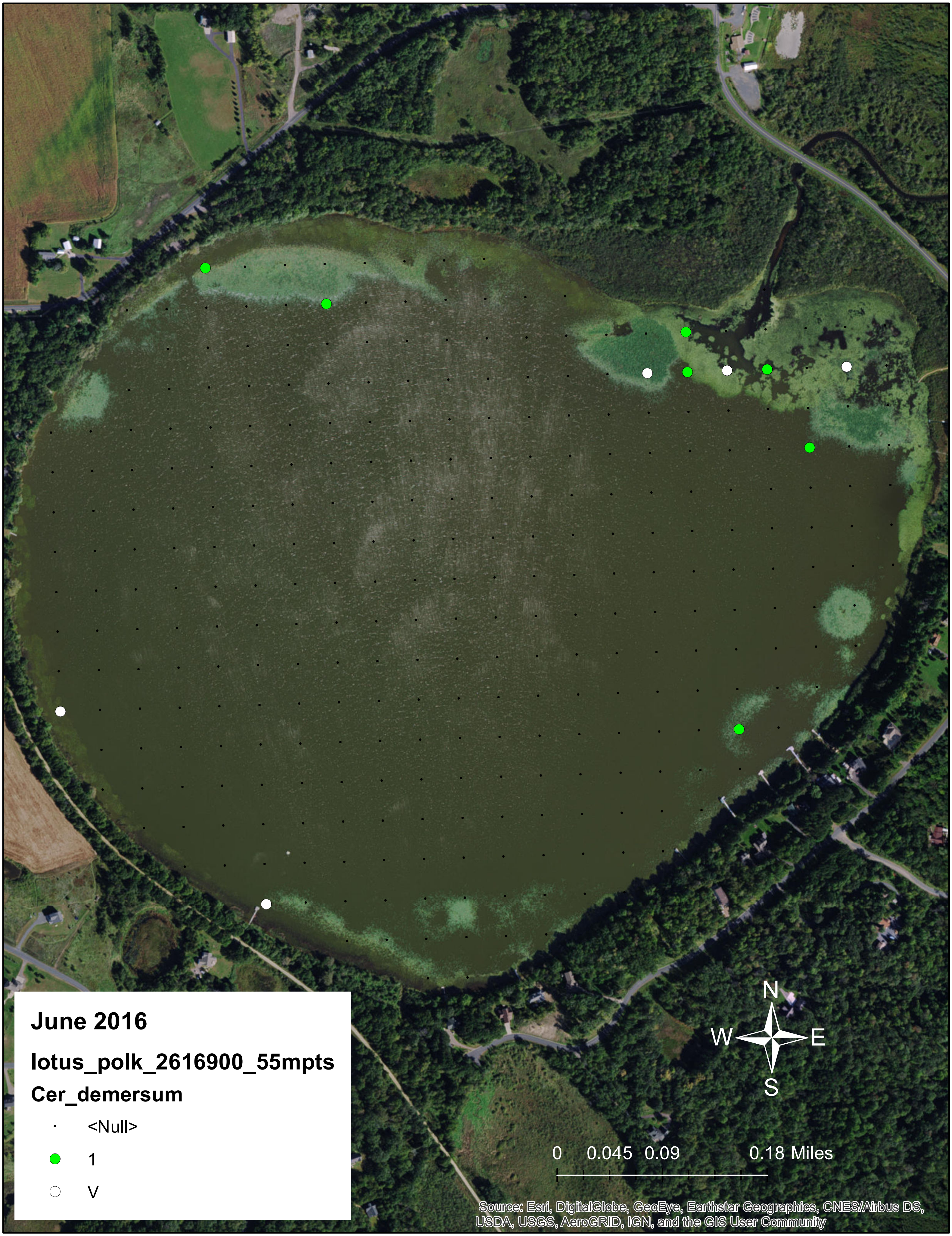
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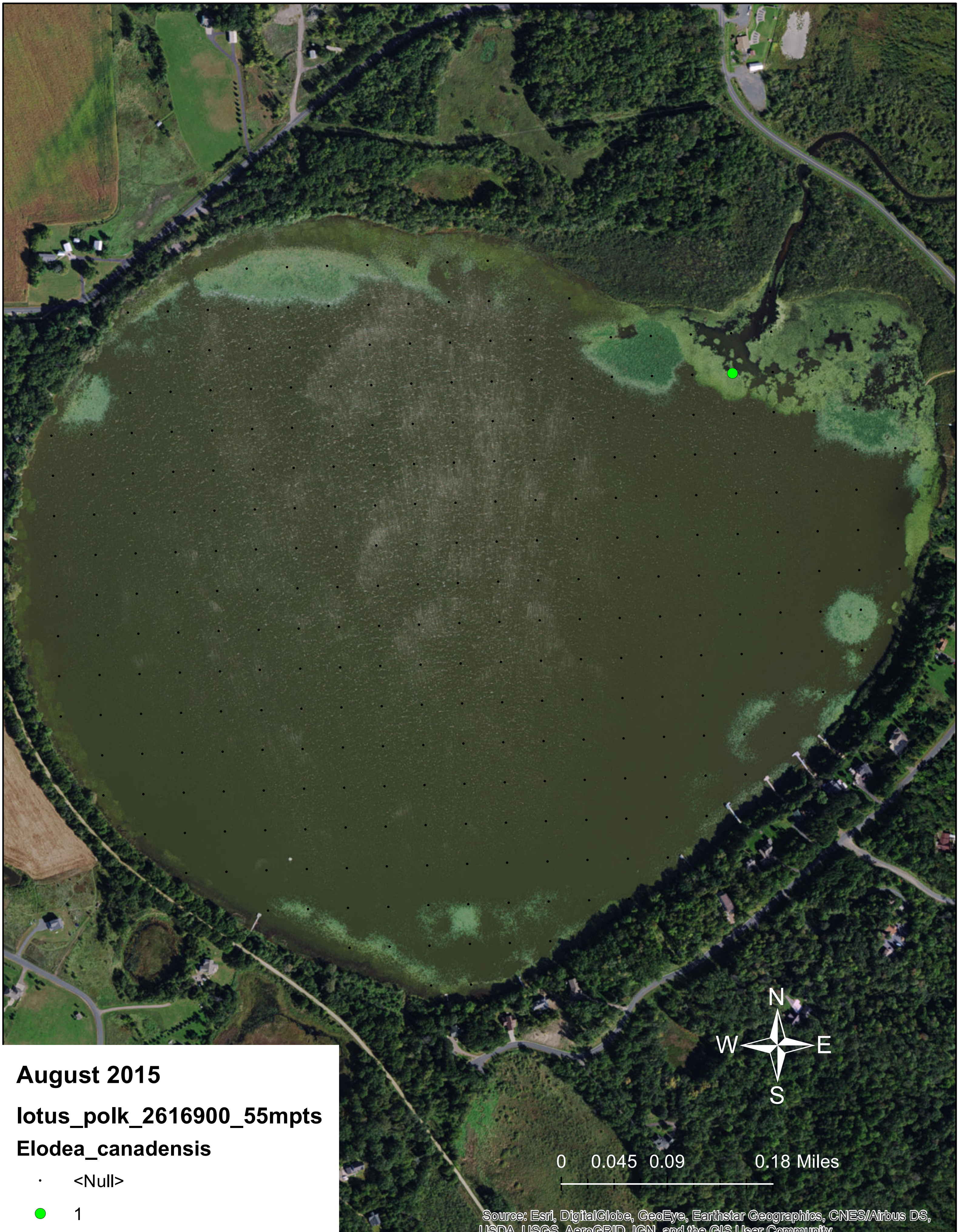

August 2015

lotus_polk_2616900_55mpts

Elodea_canadensis

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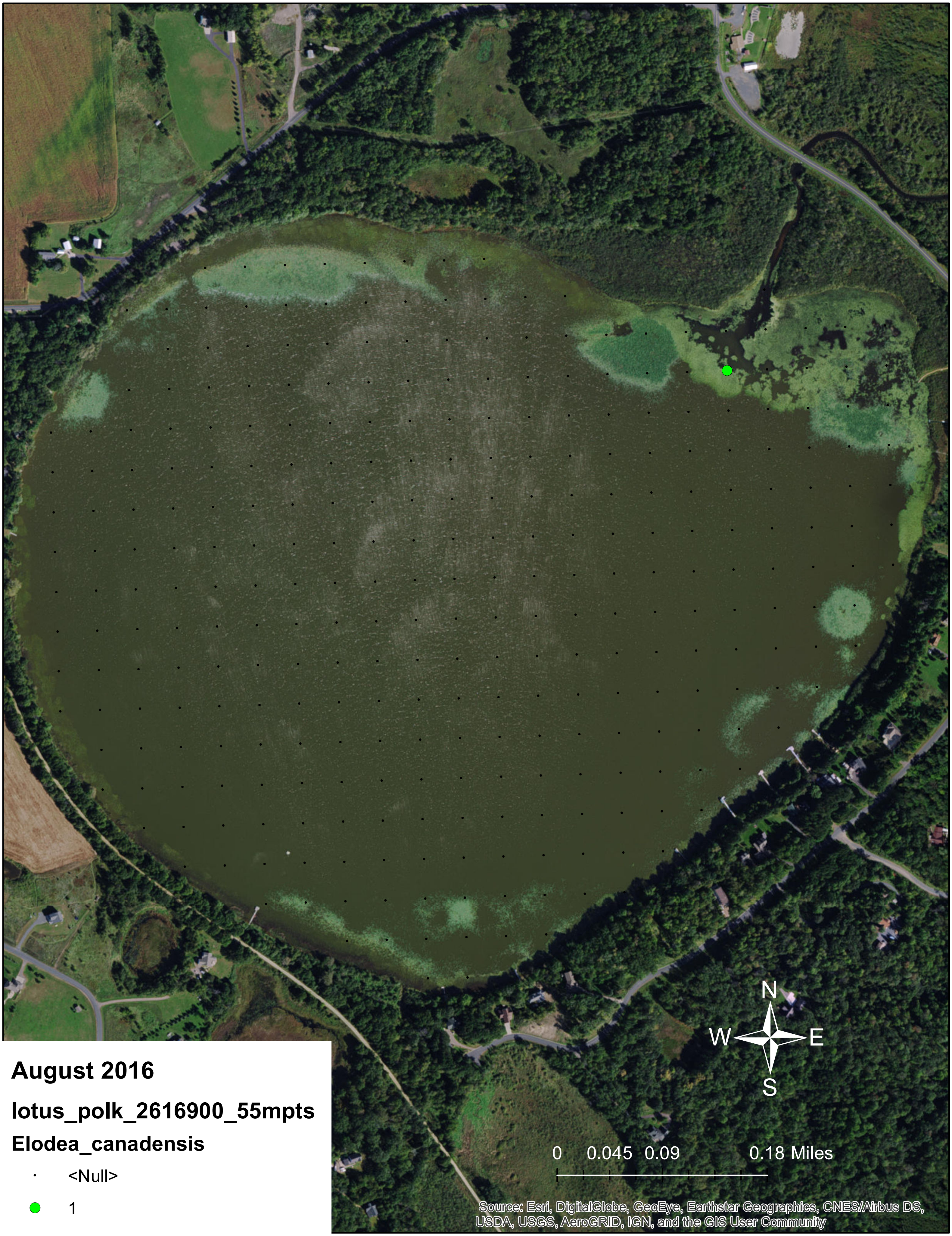
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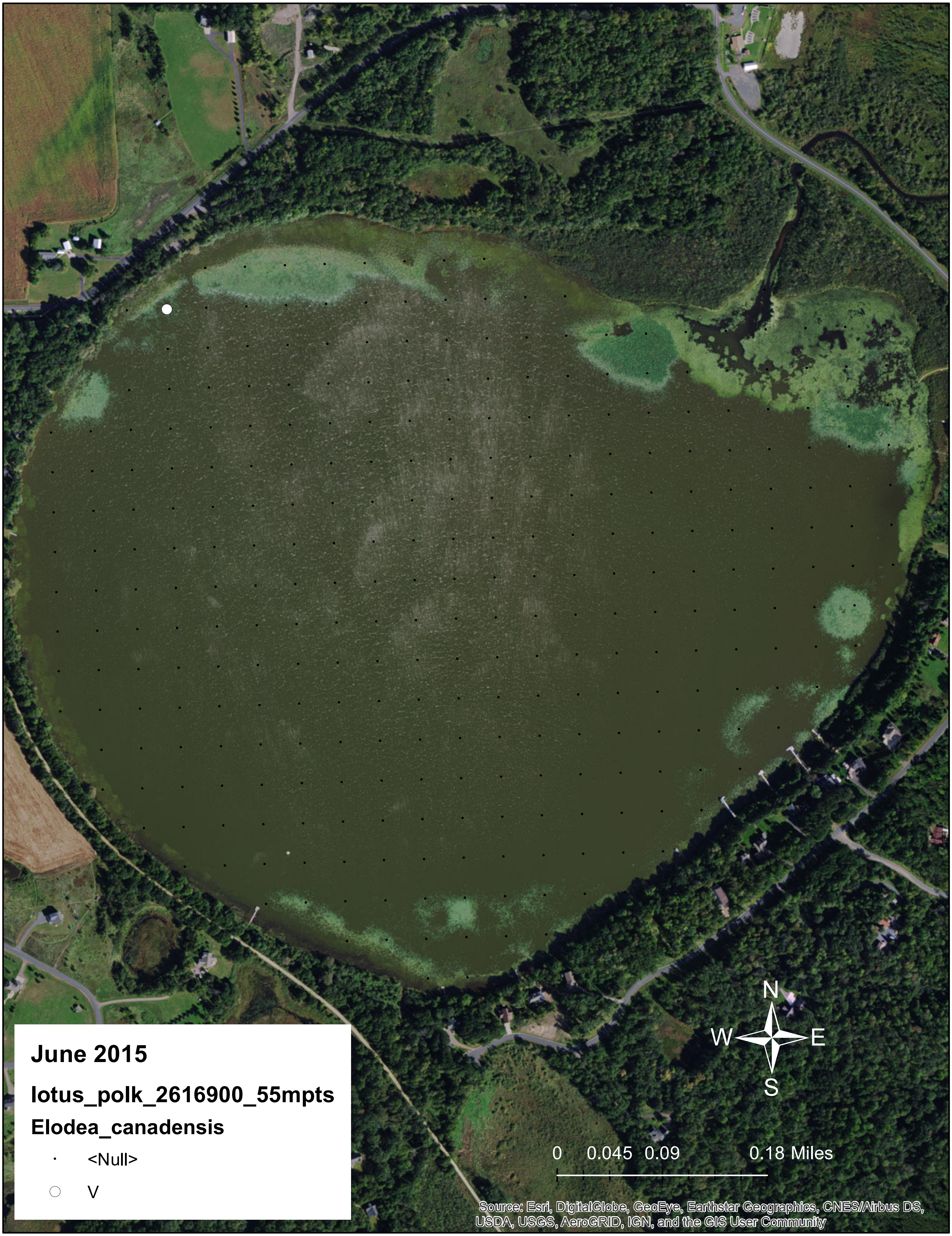
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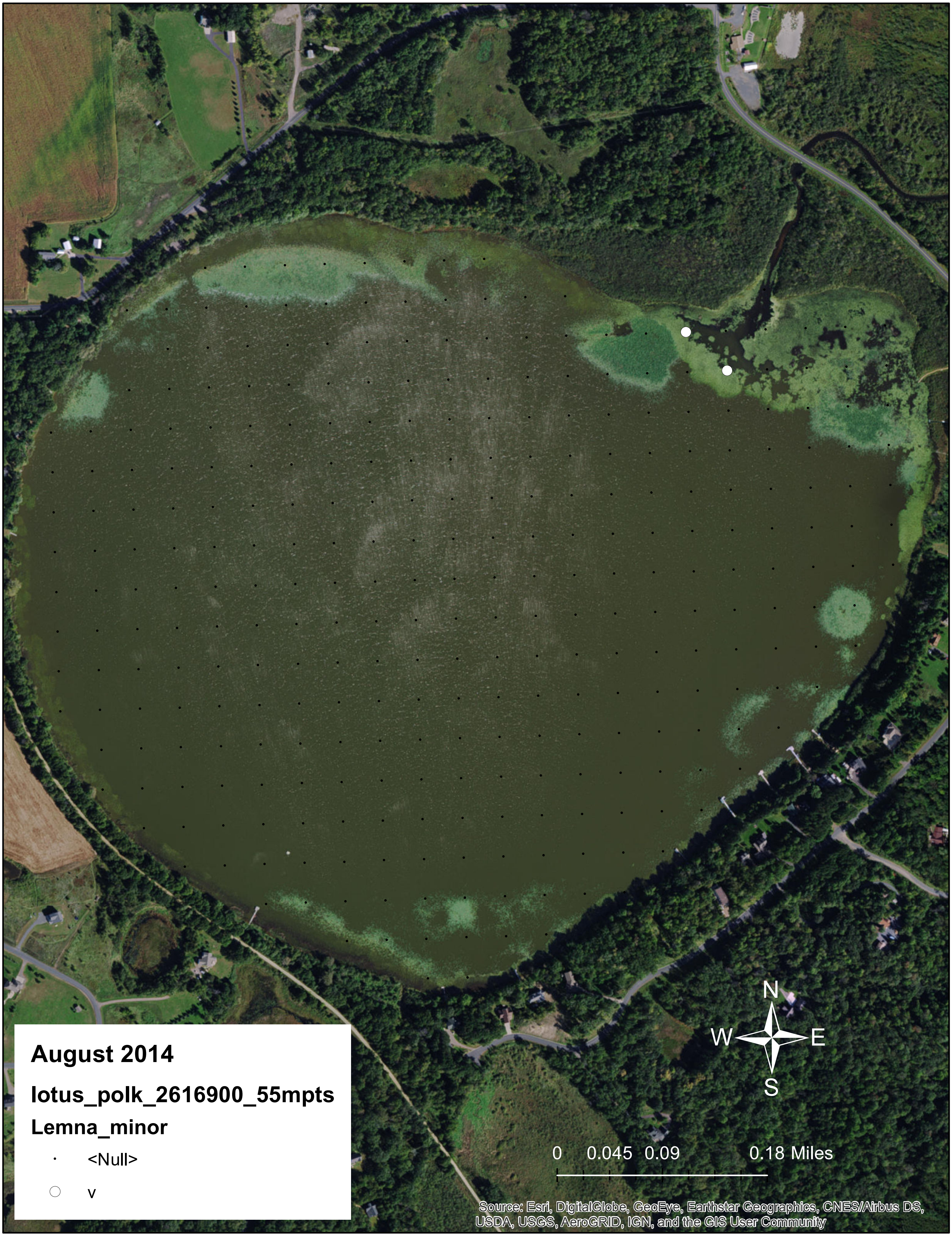
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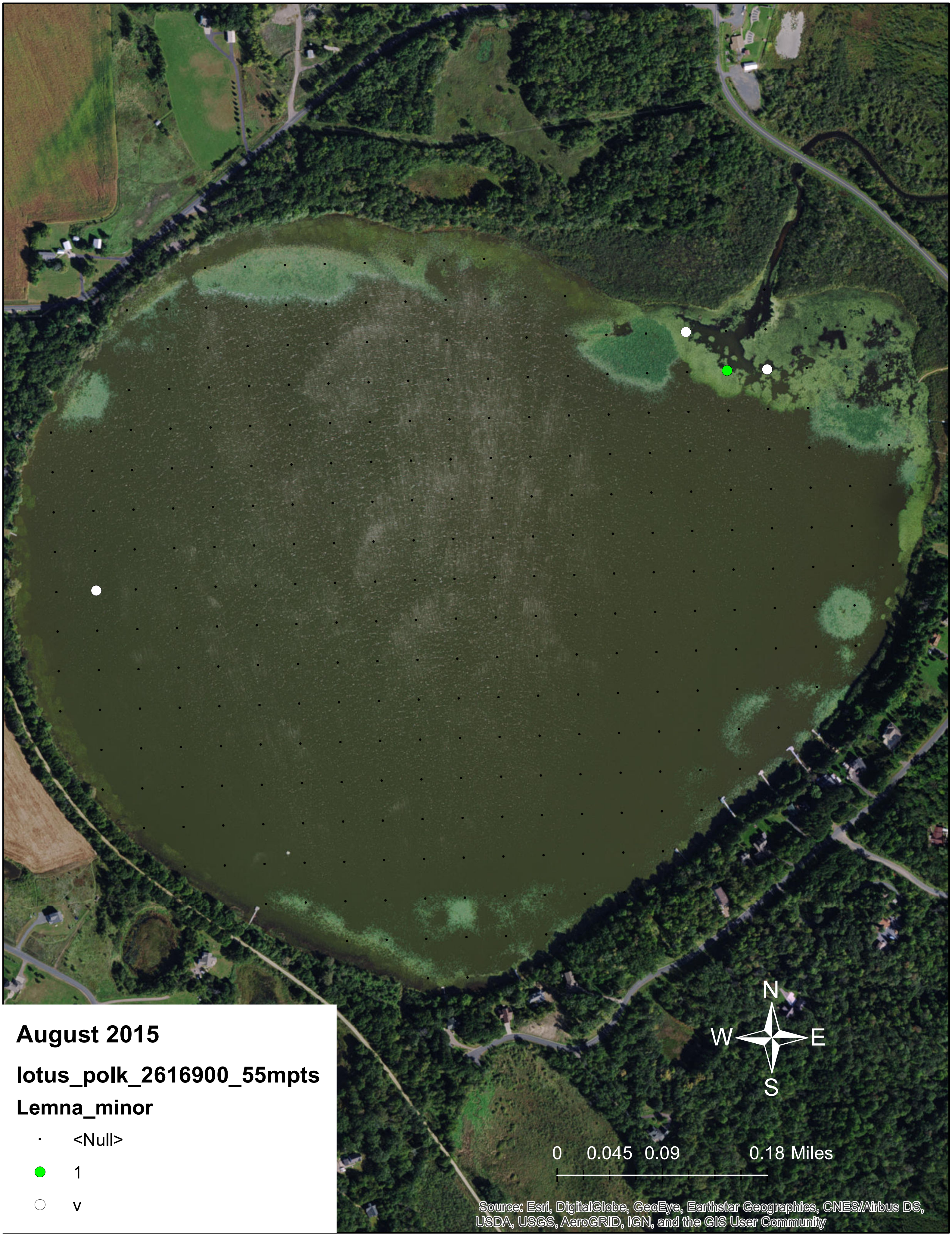
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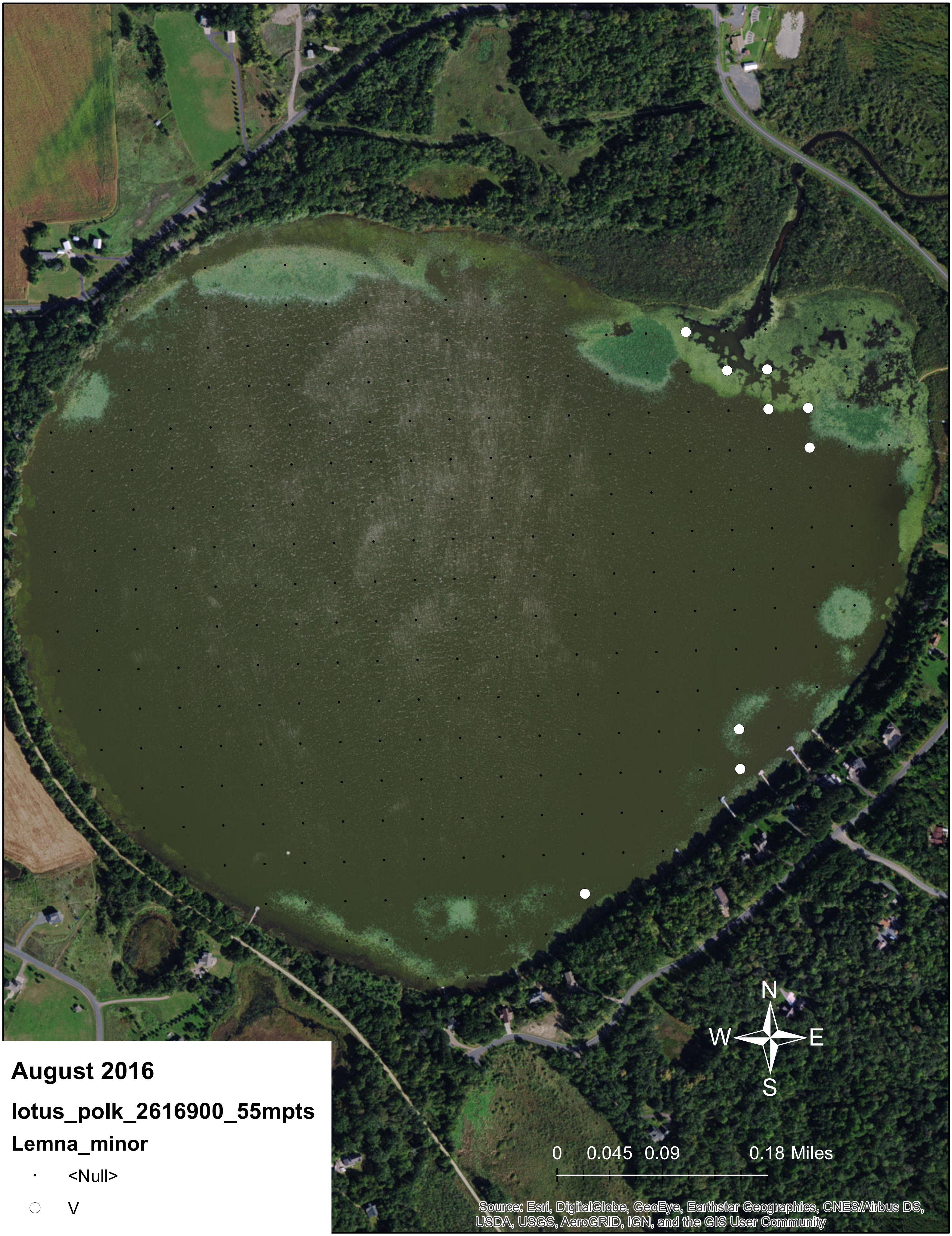

August 2016
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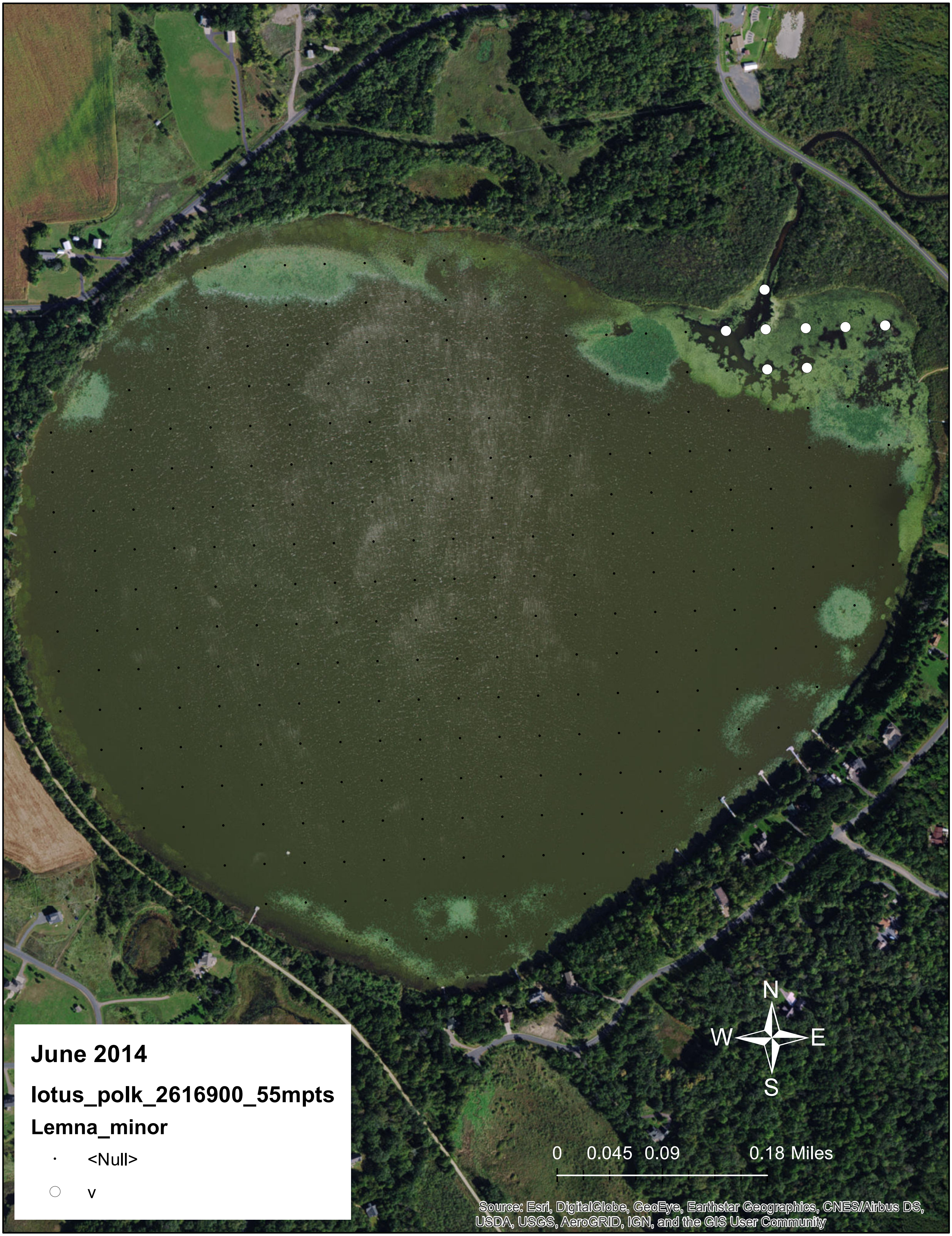
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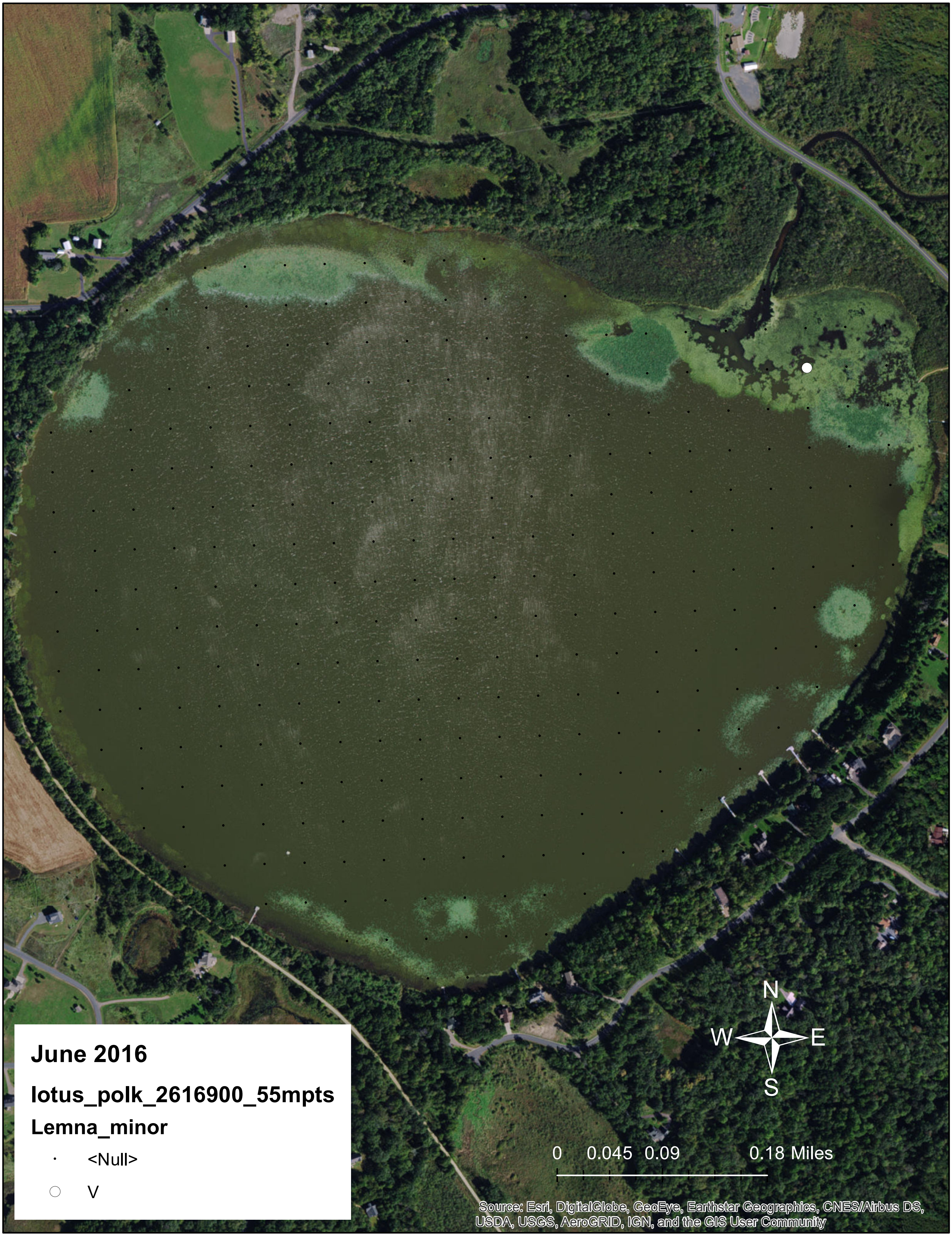
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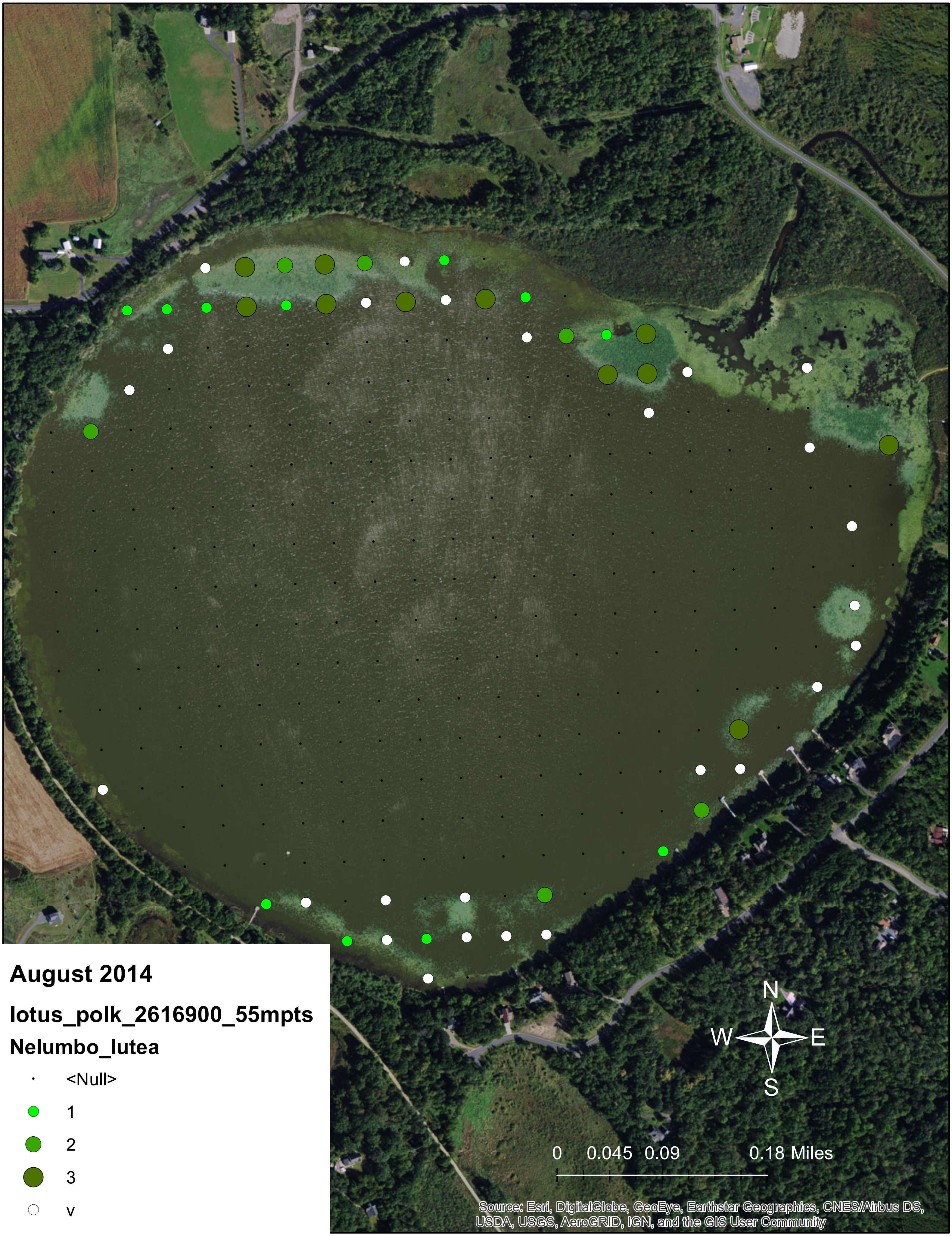
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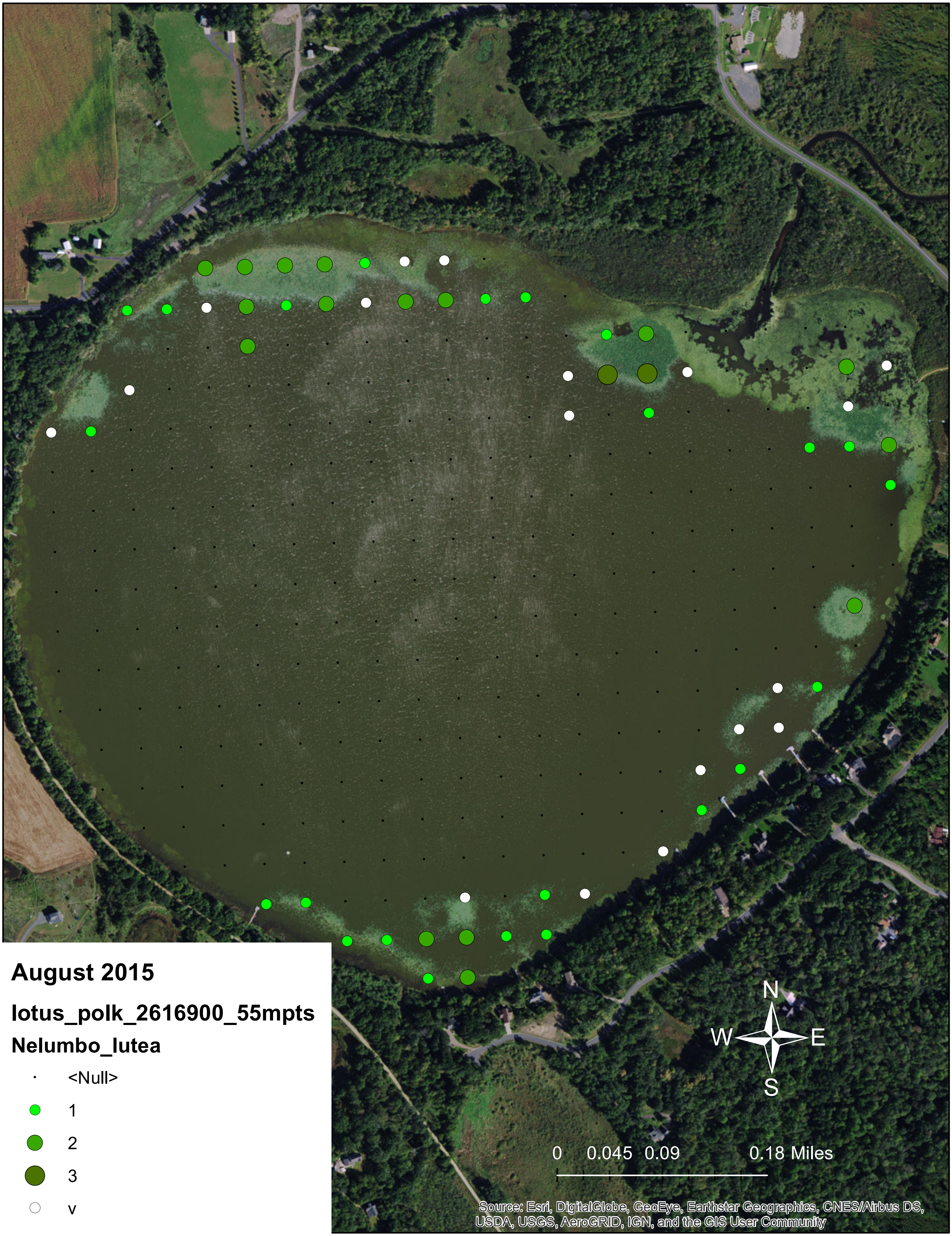
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



August 2015
lotus_polk_2616900_55mpts
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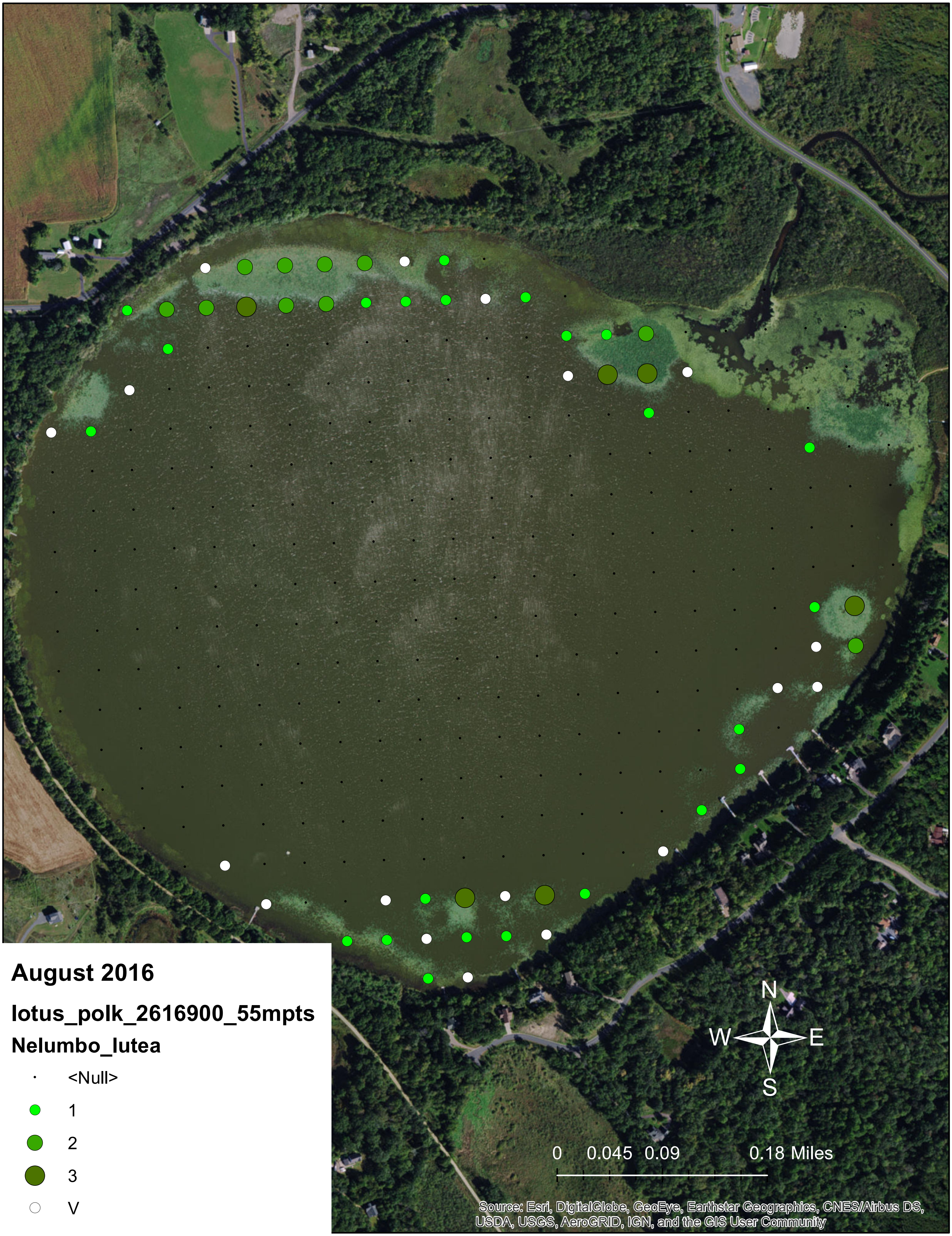
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


August 2016
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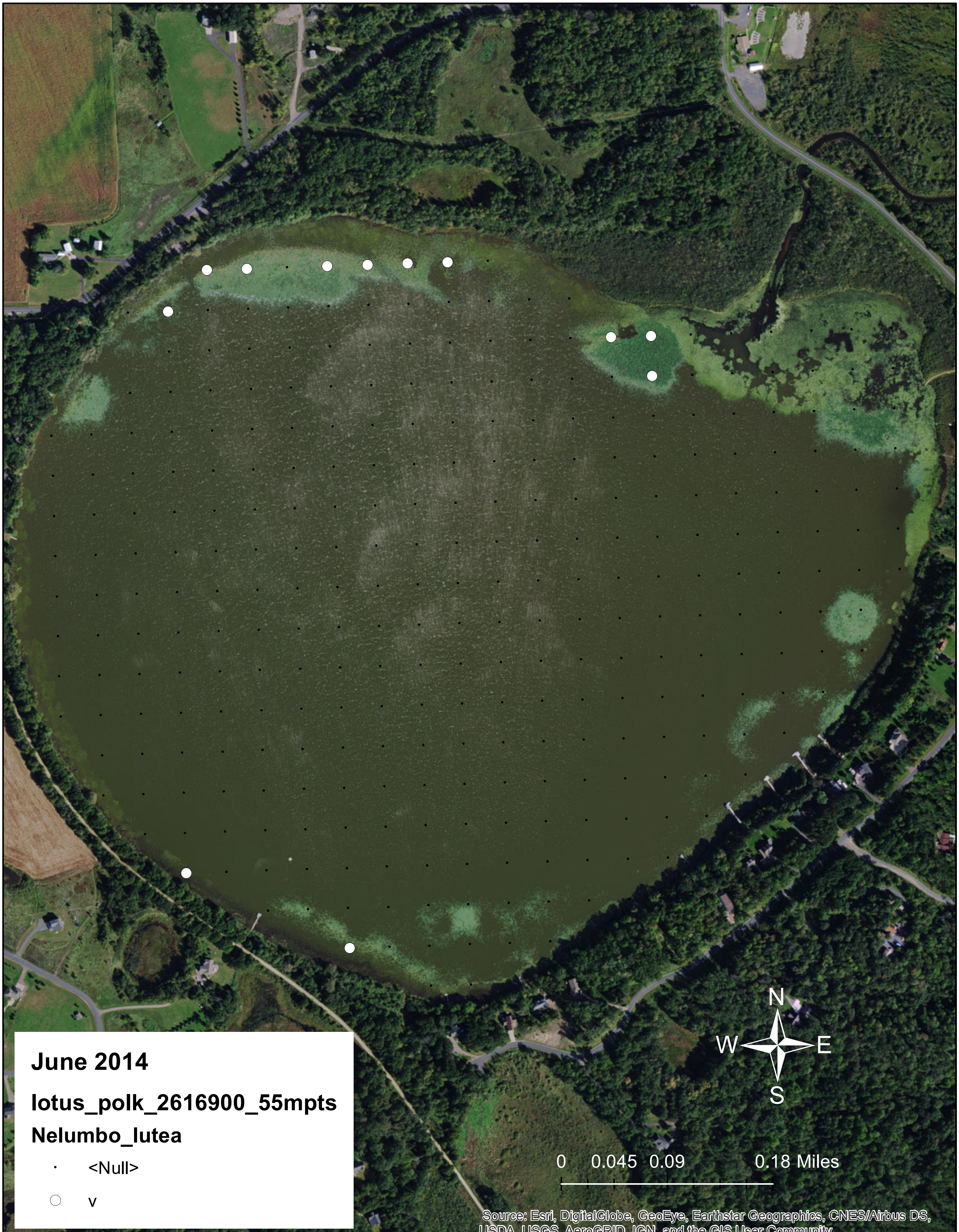

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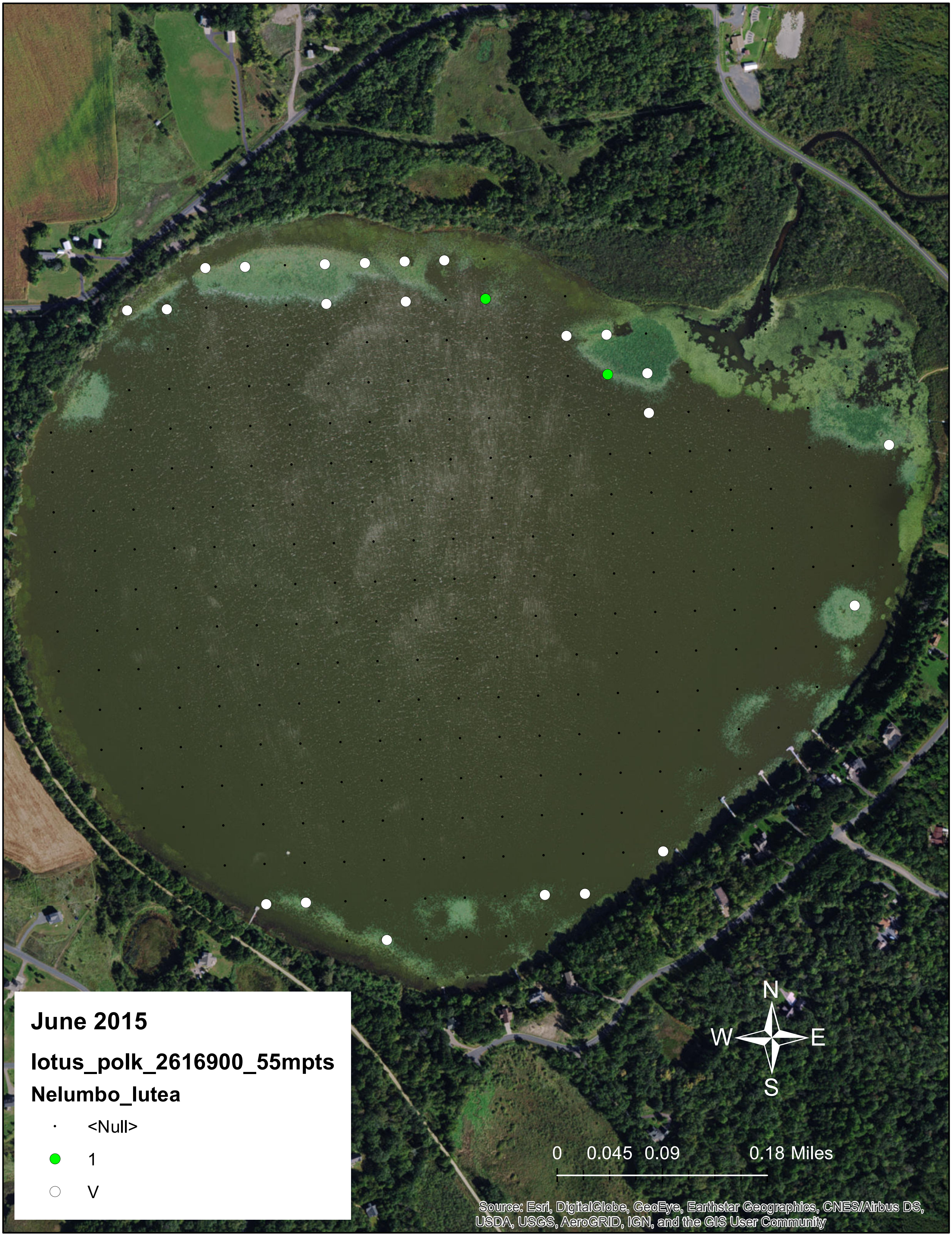

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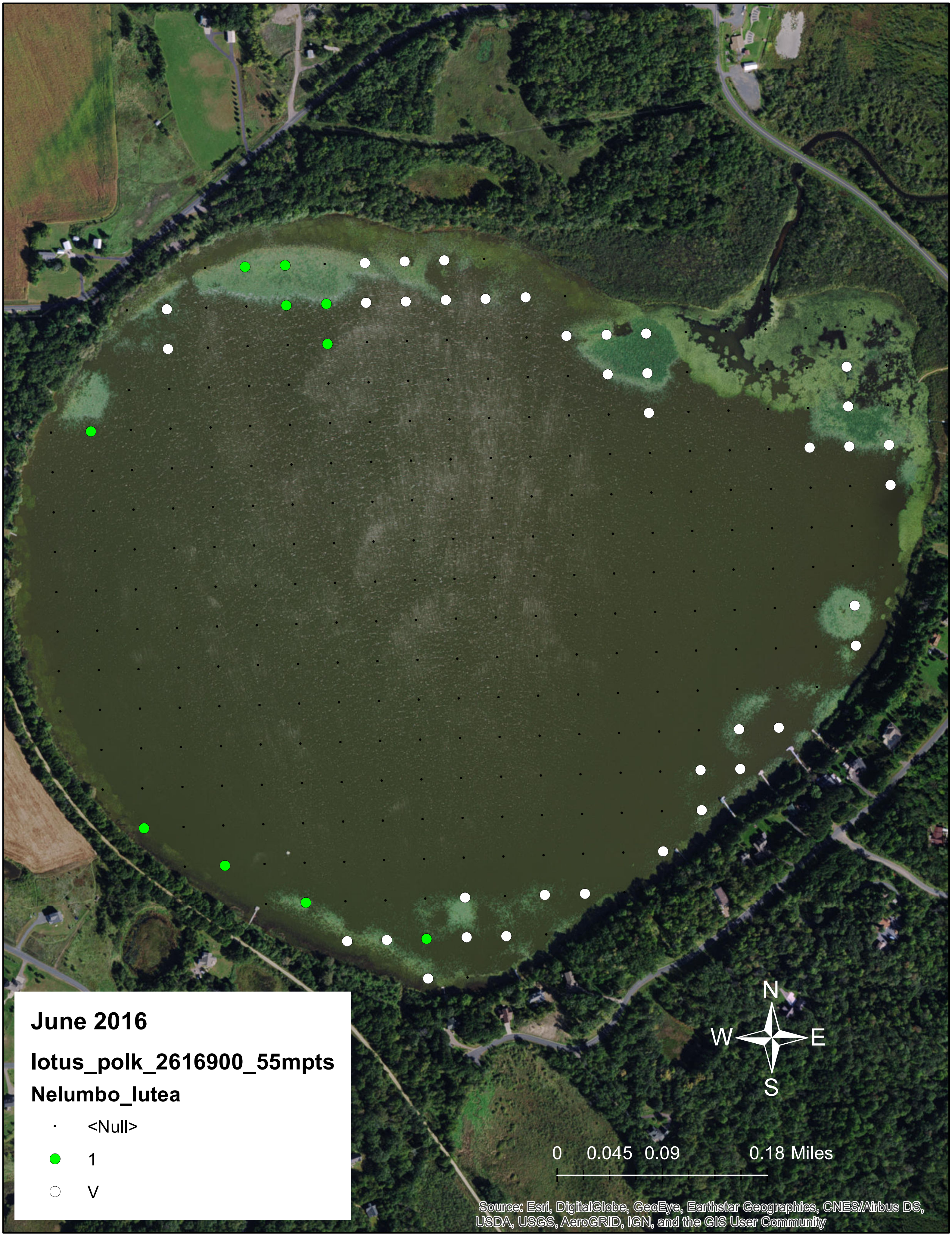

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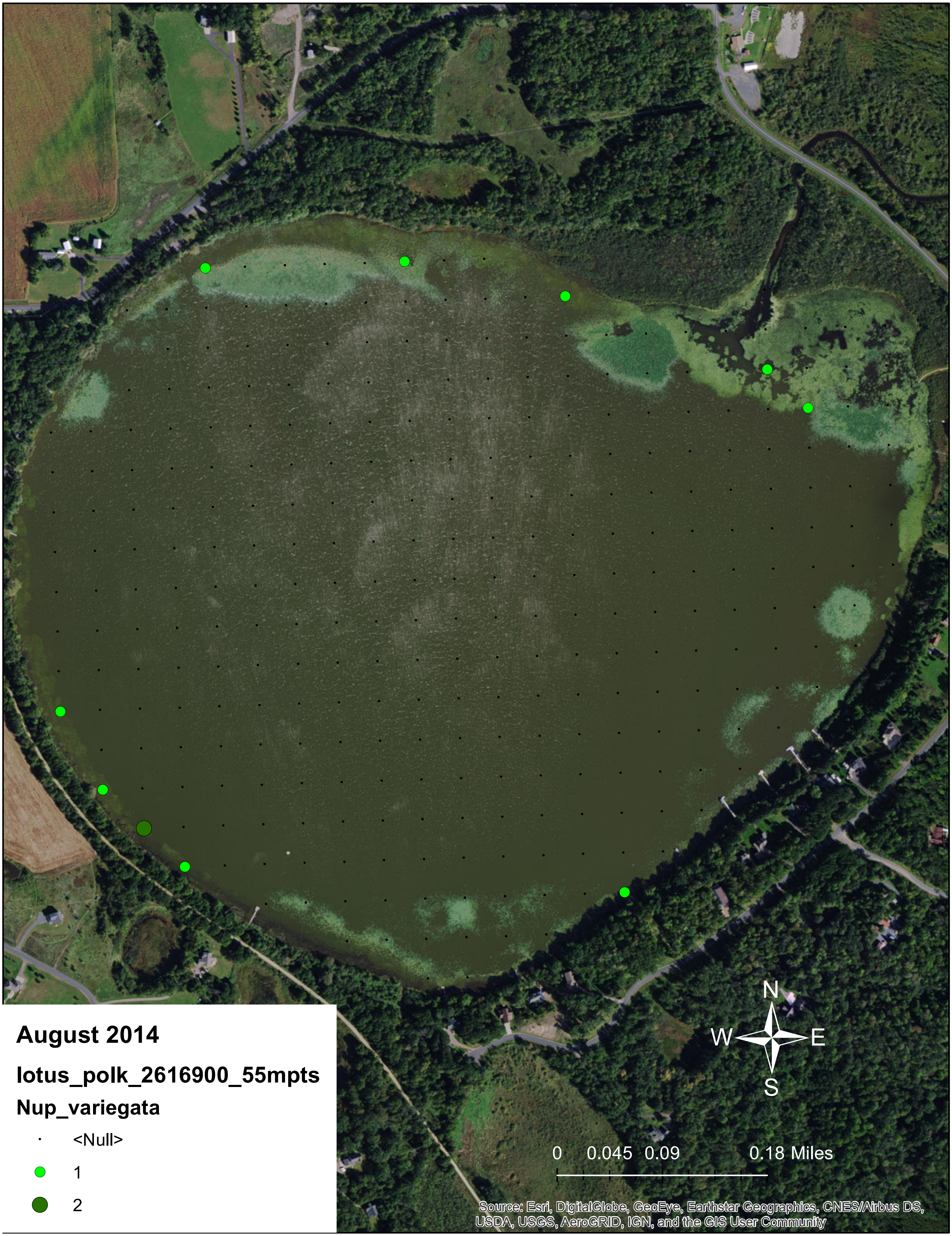
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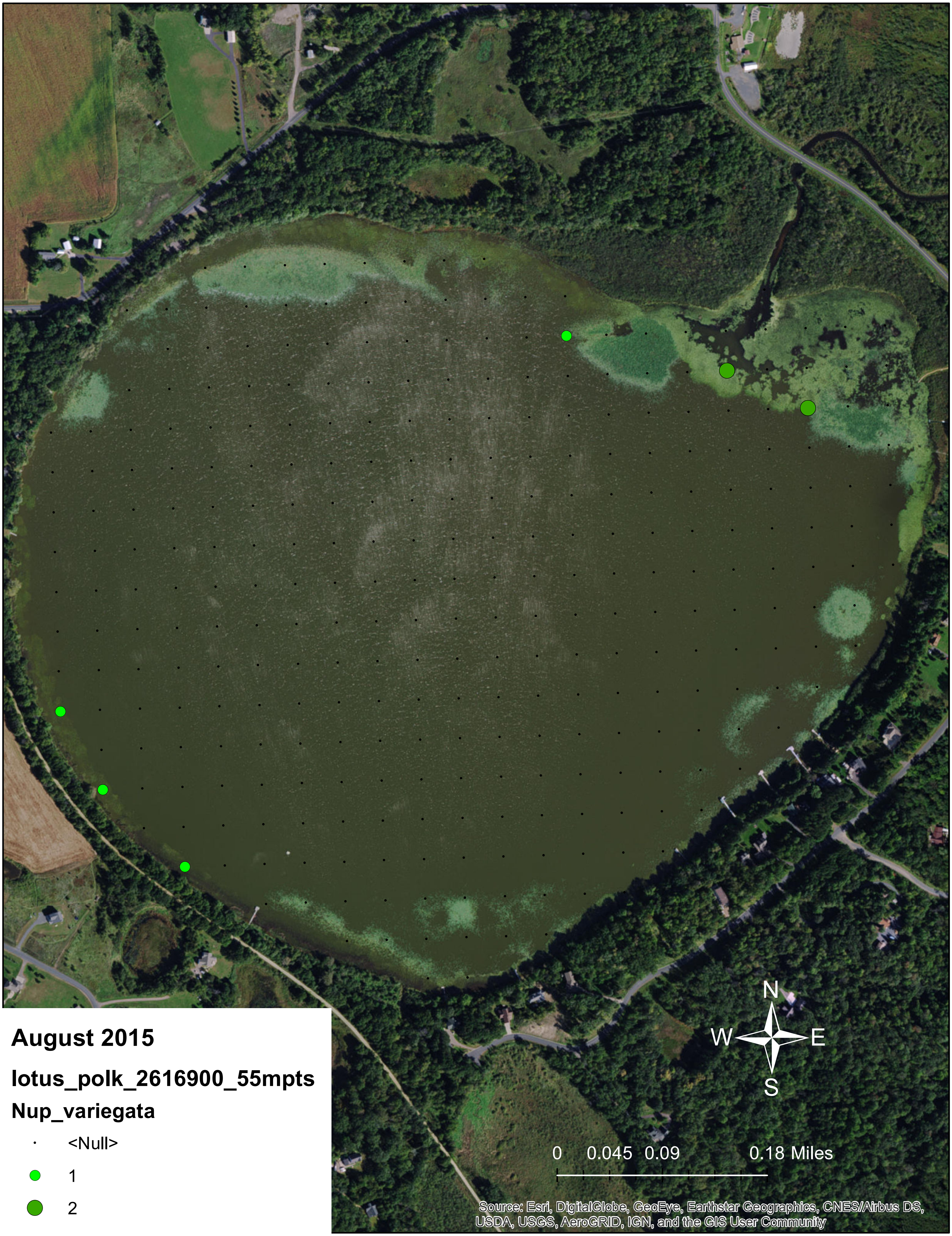
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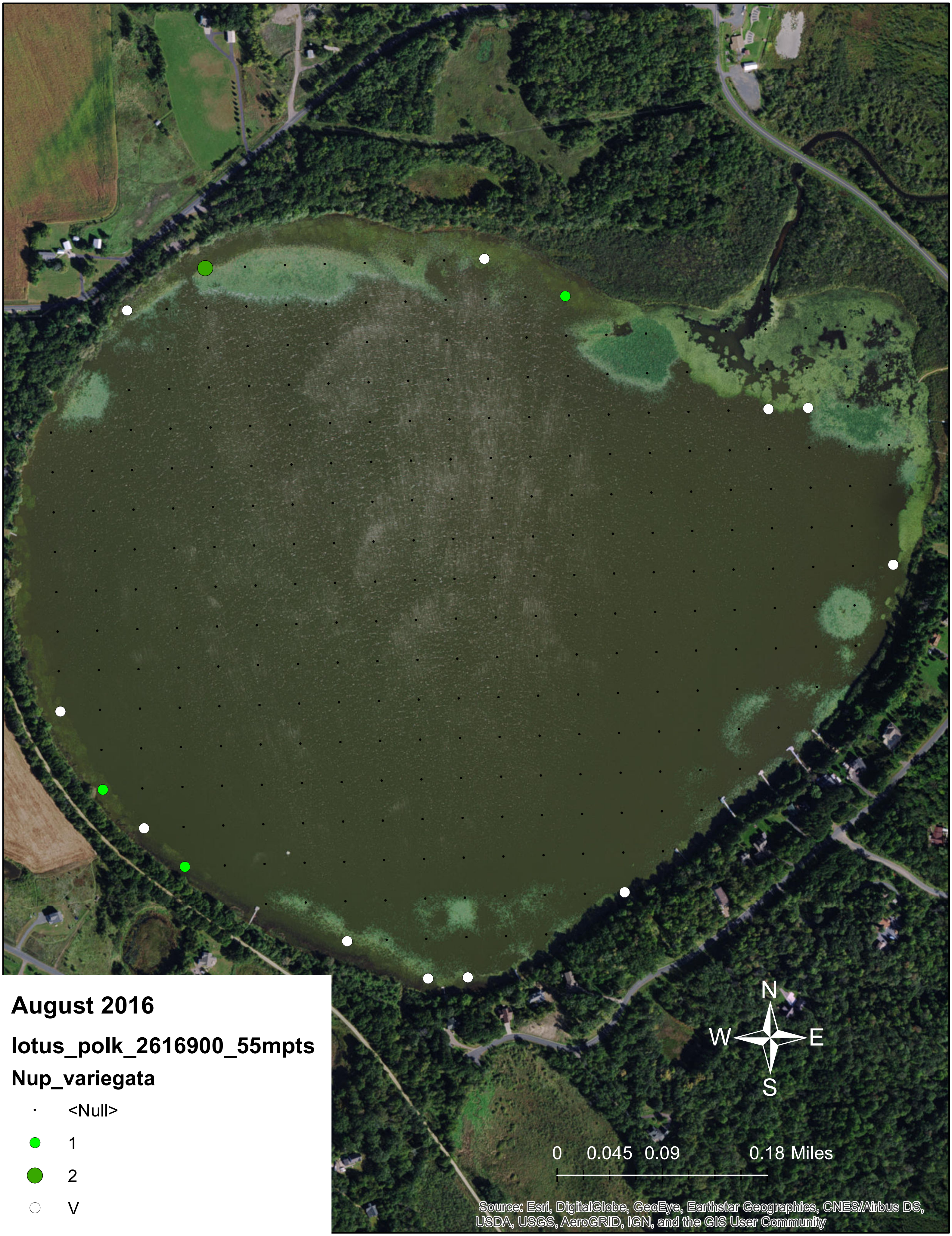
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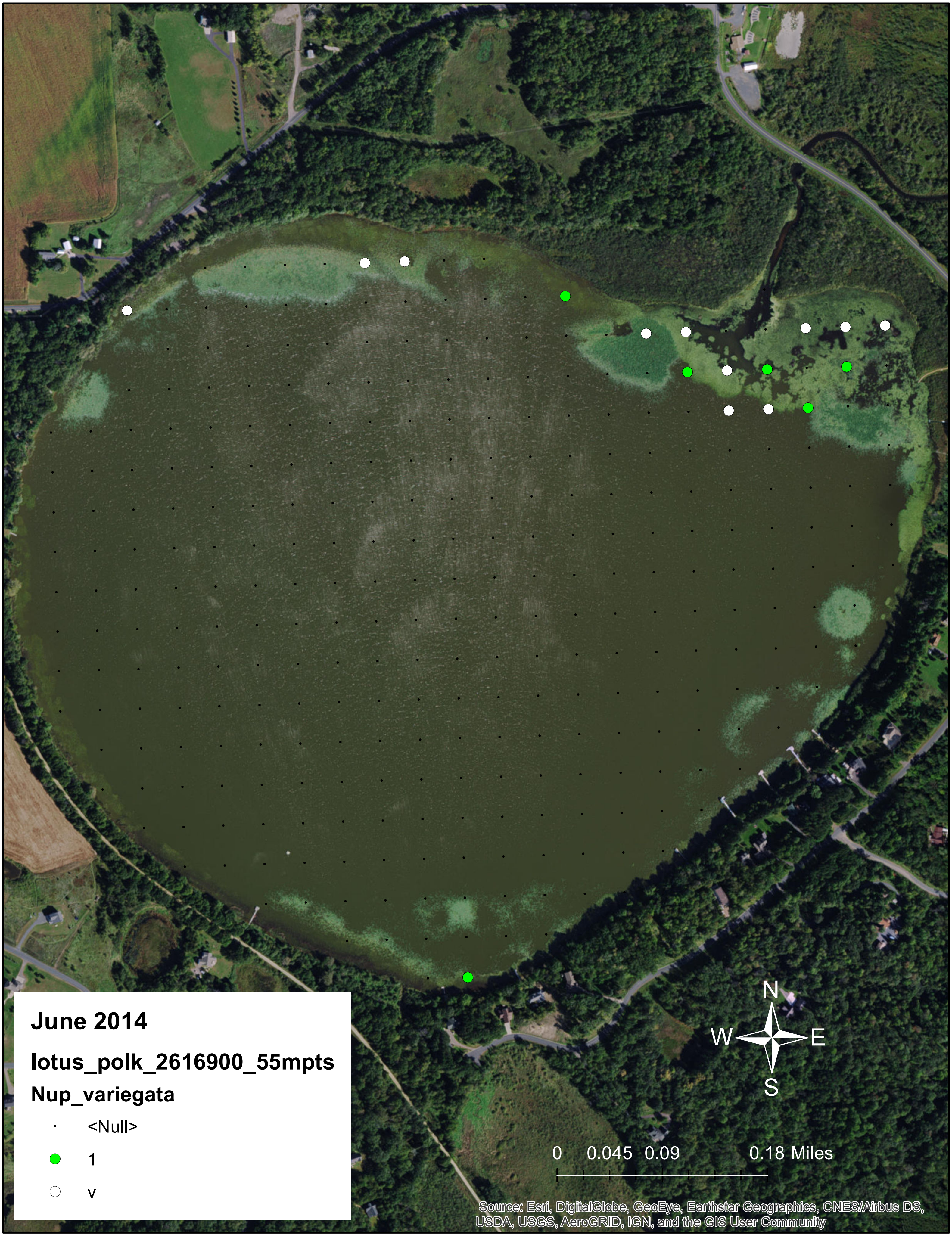
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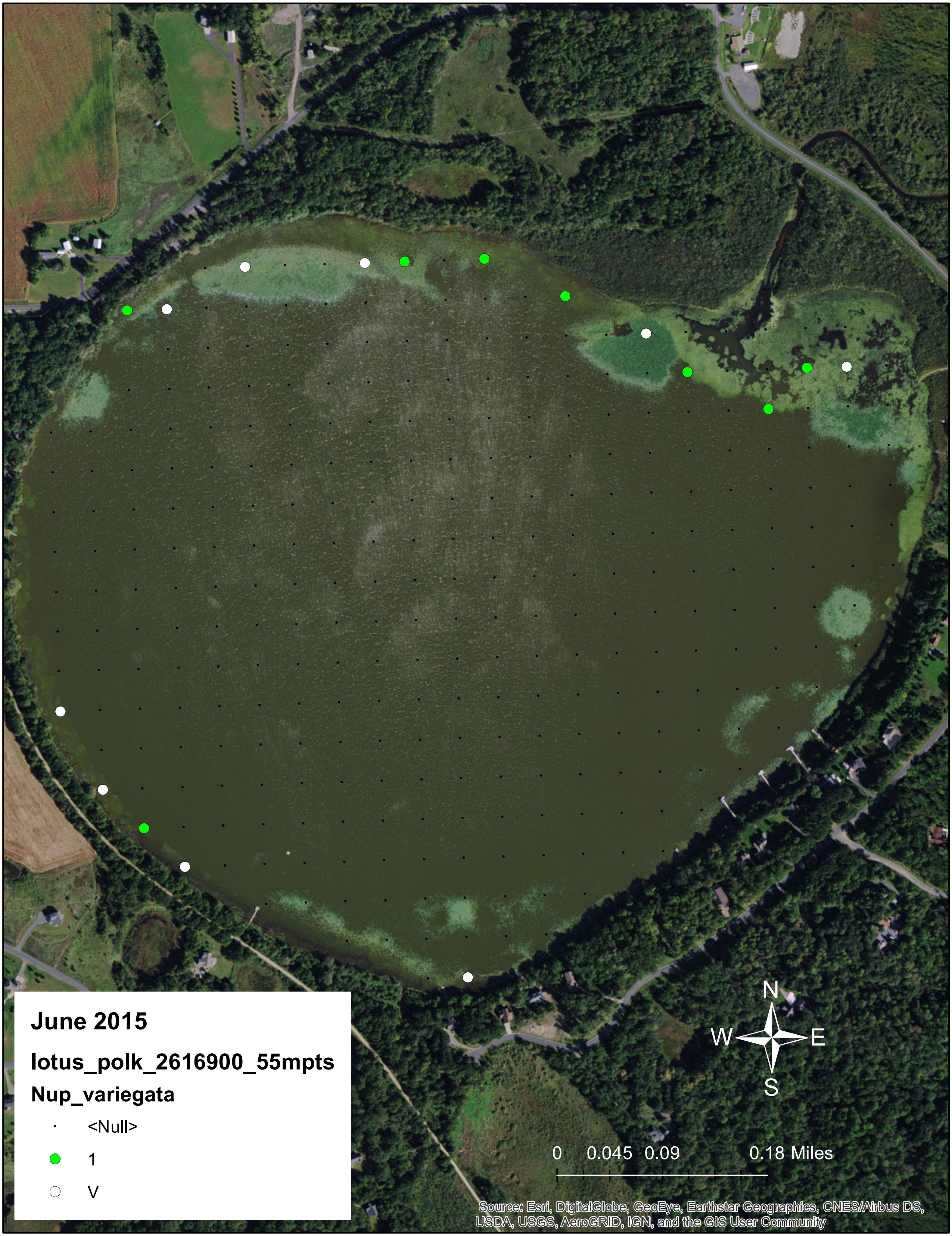
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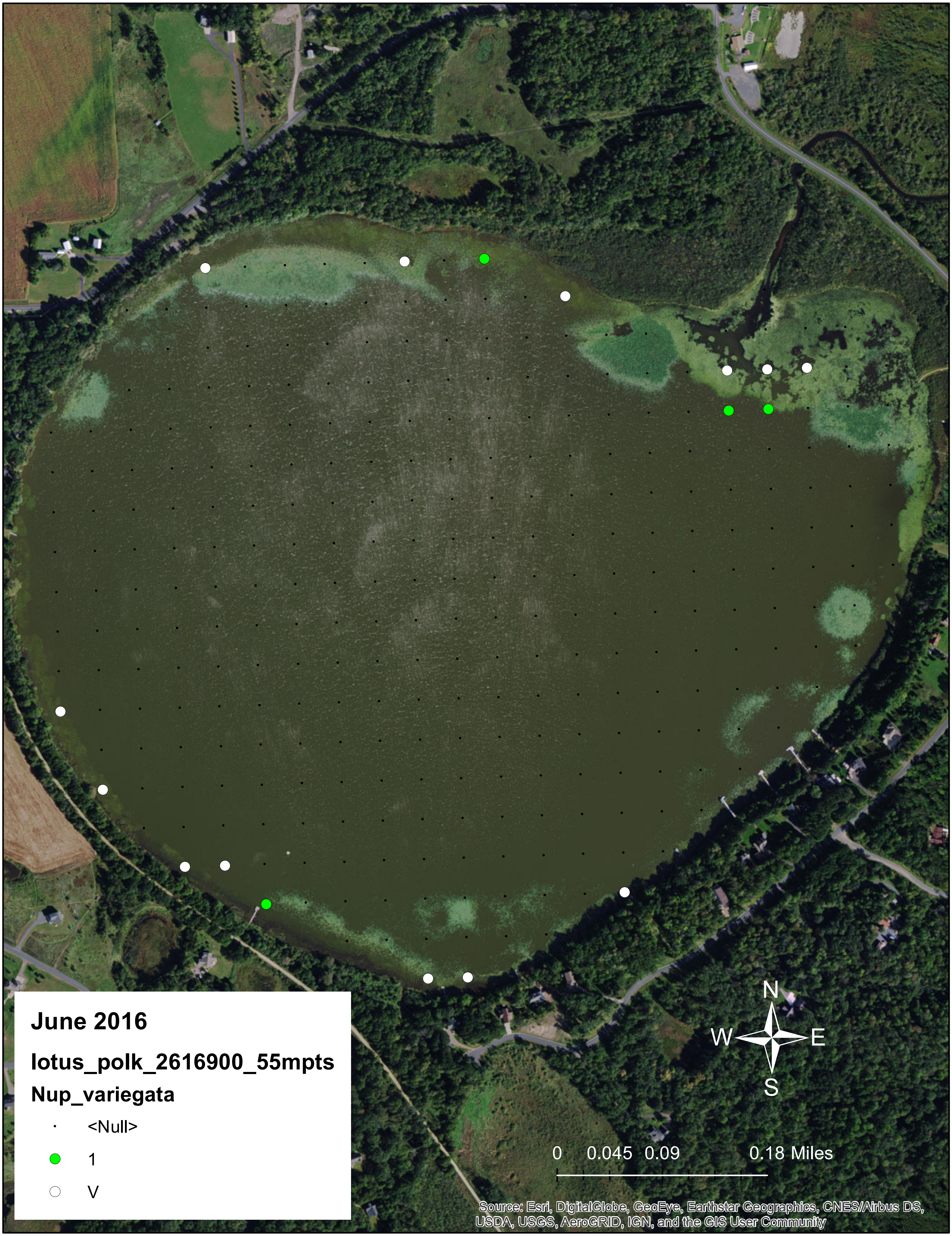
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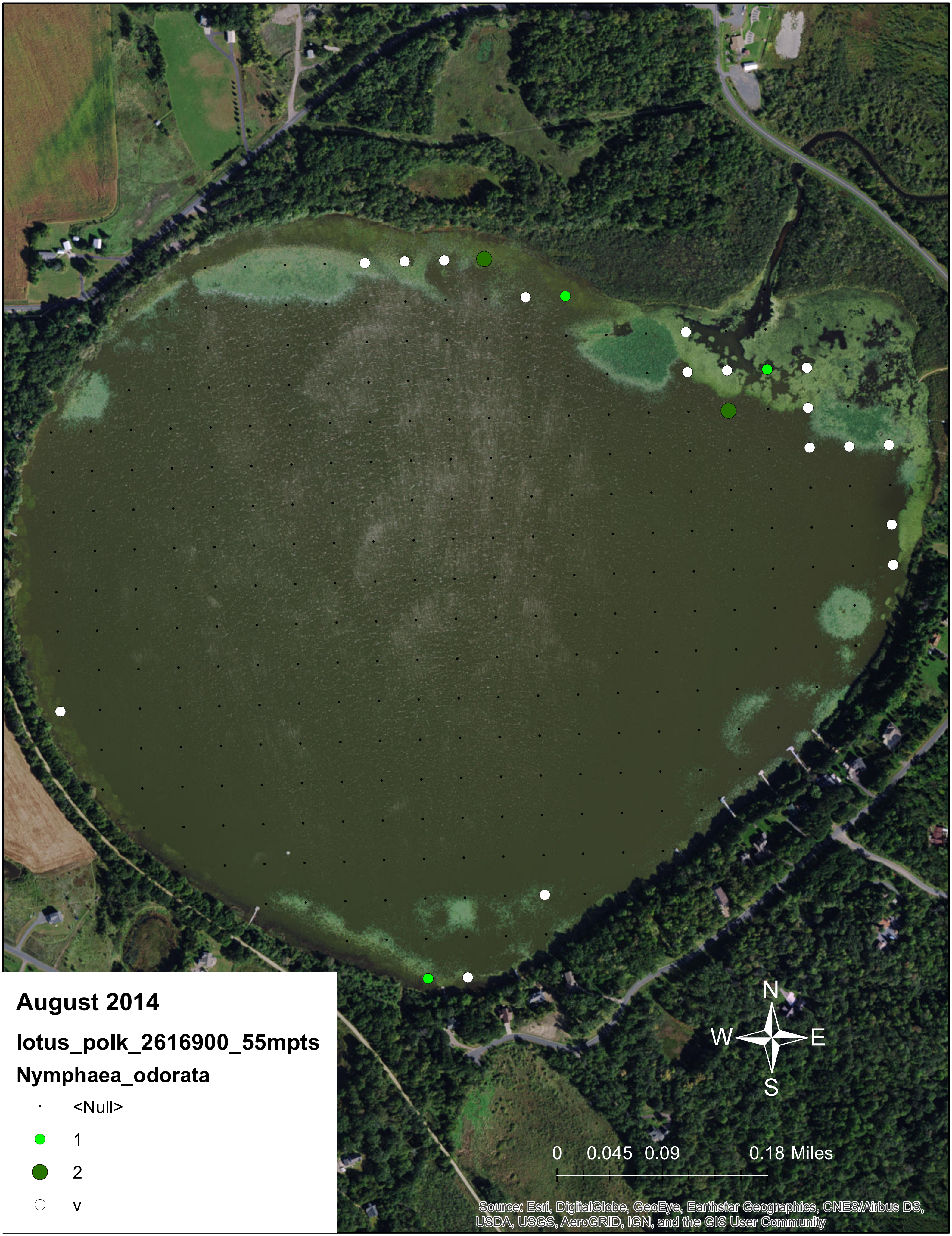
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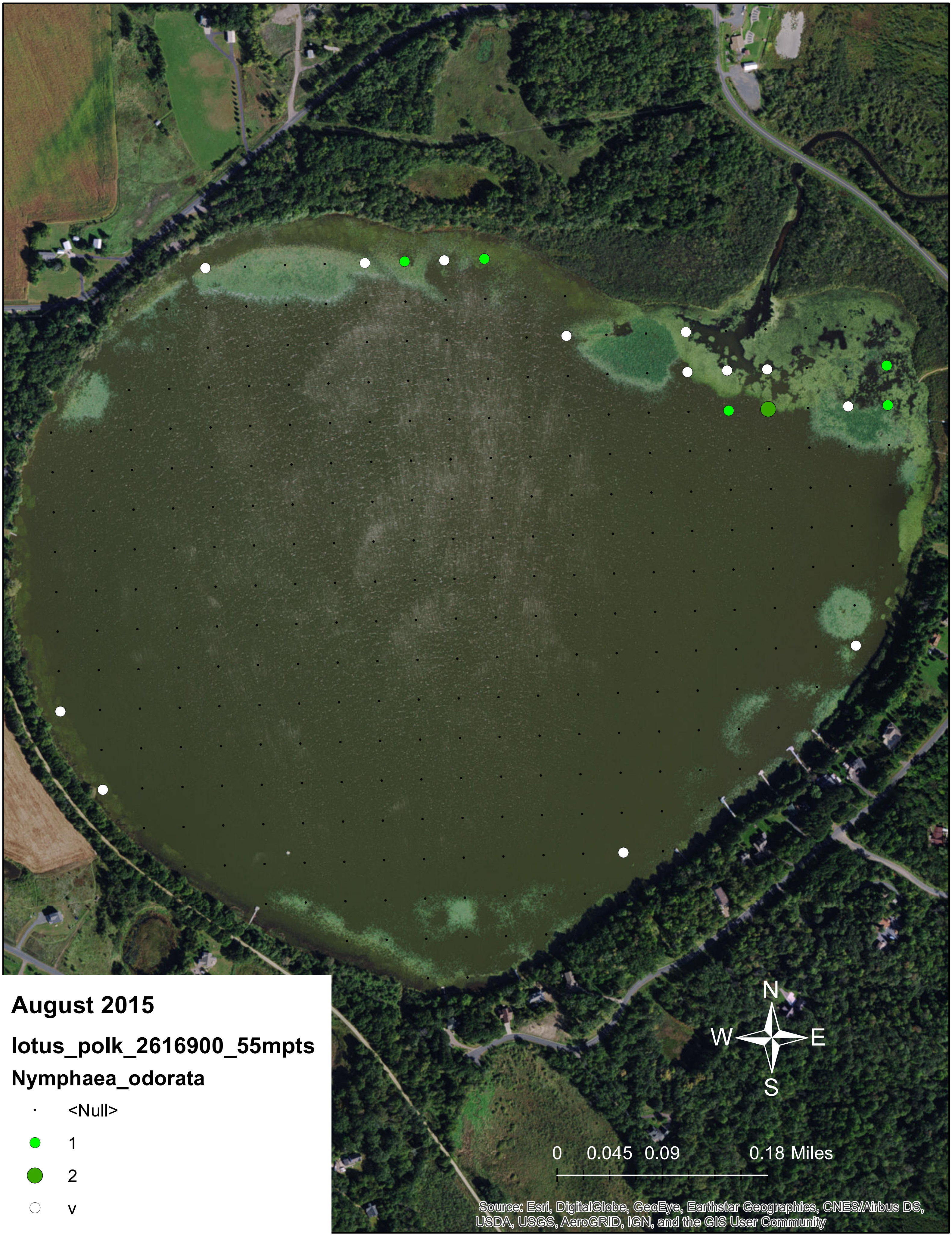
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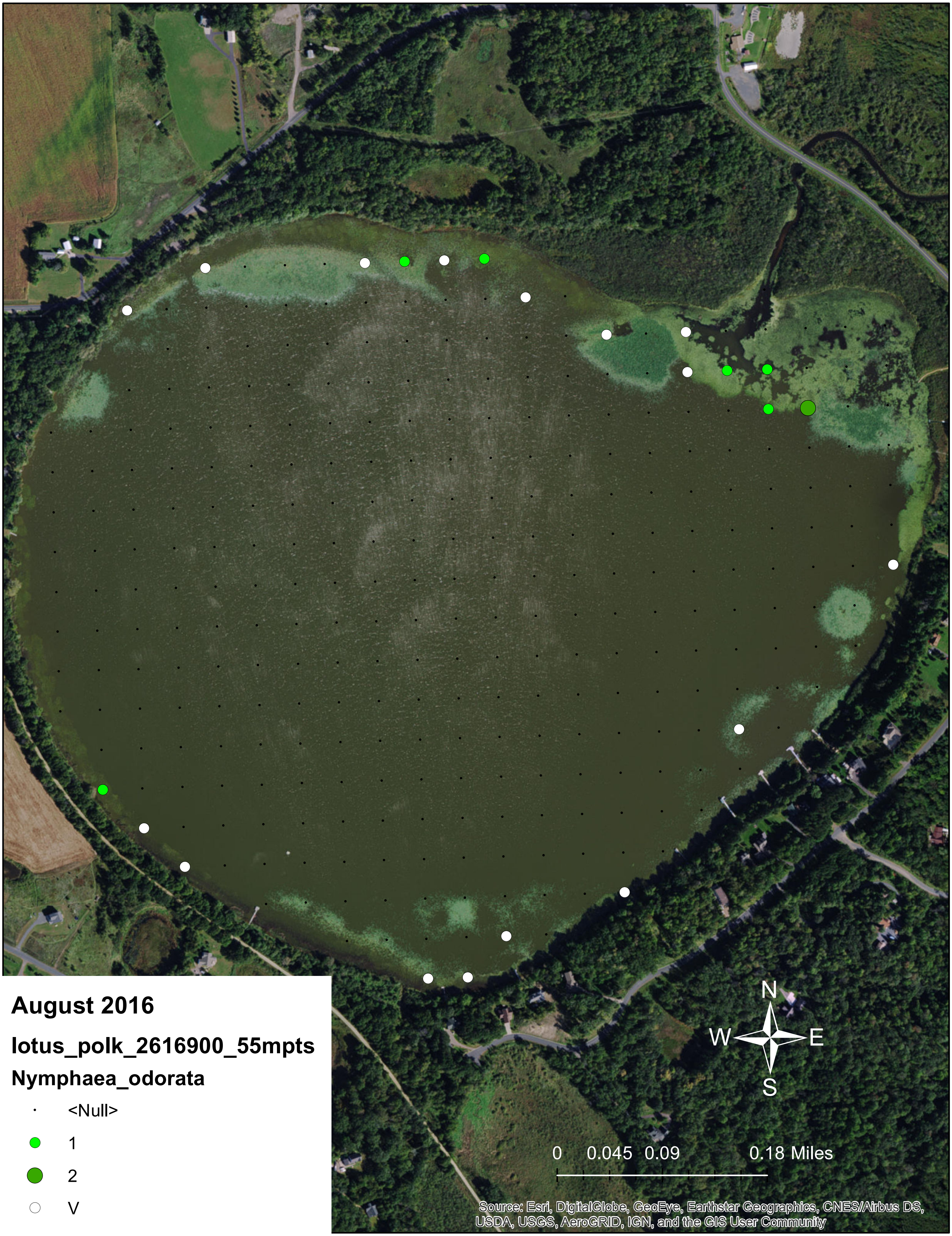
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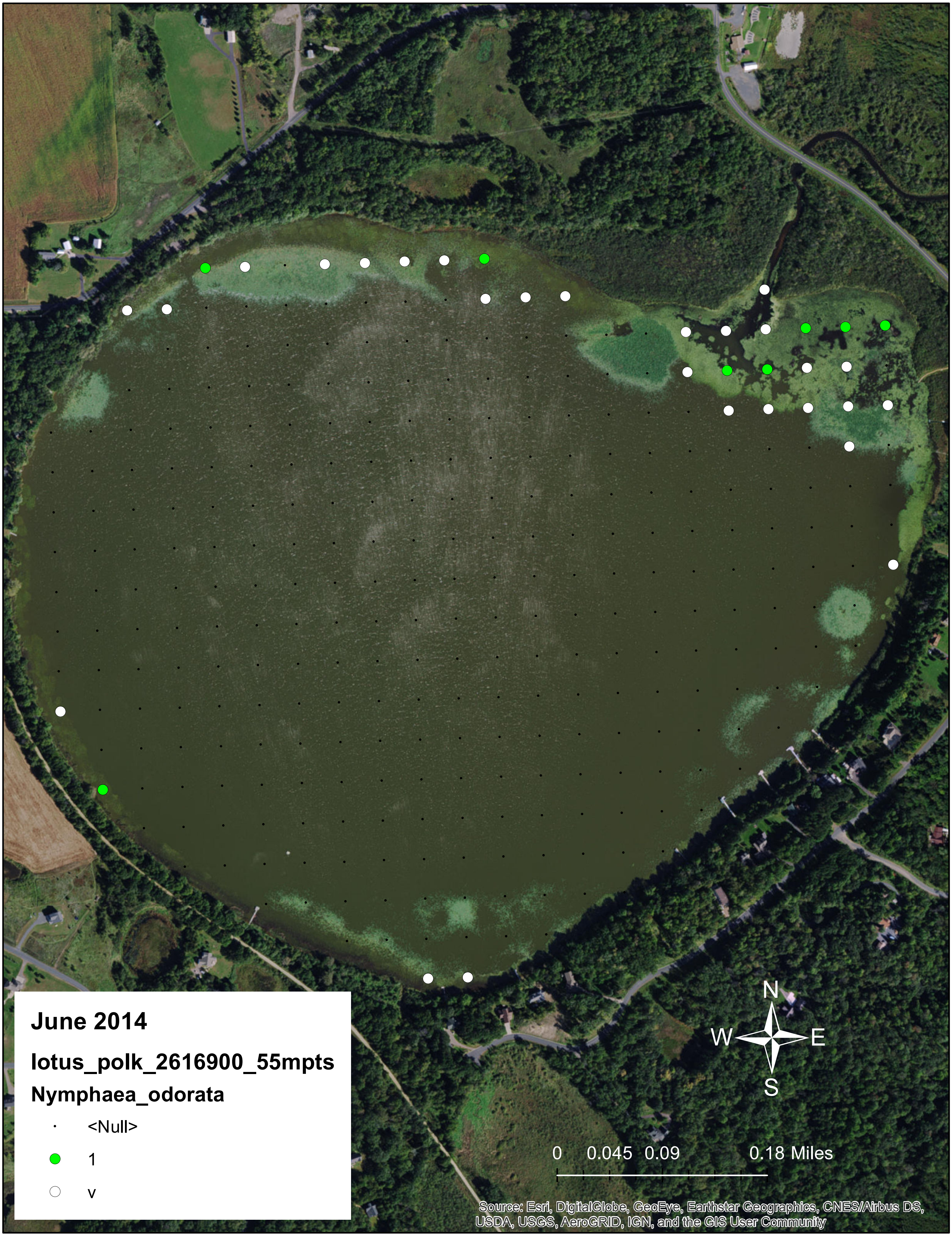
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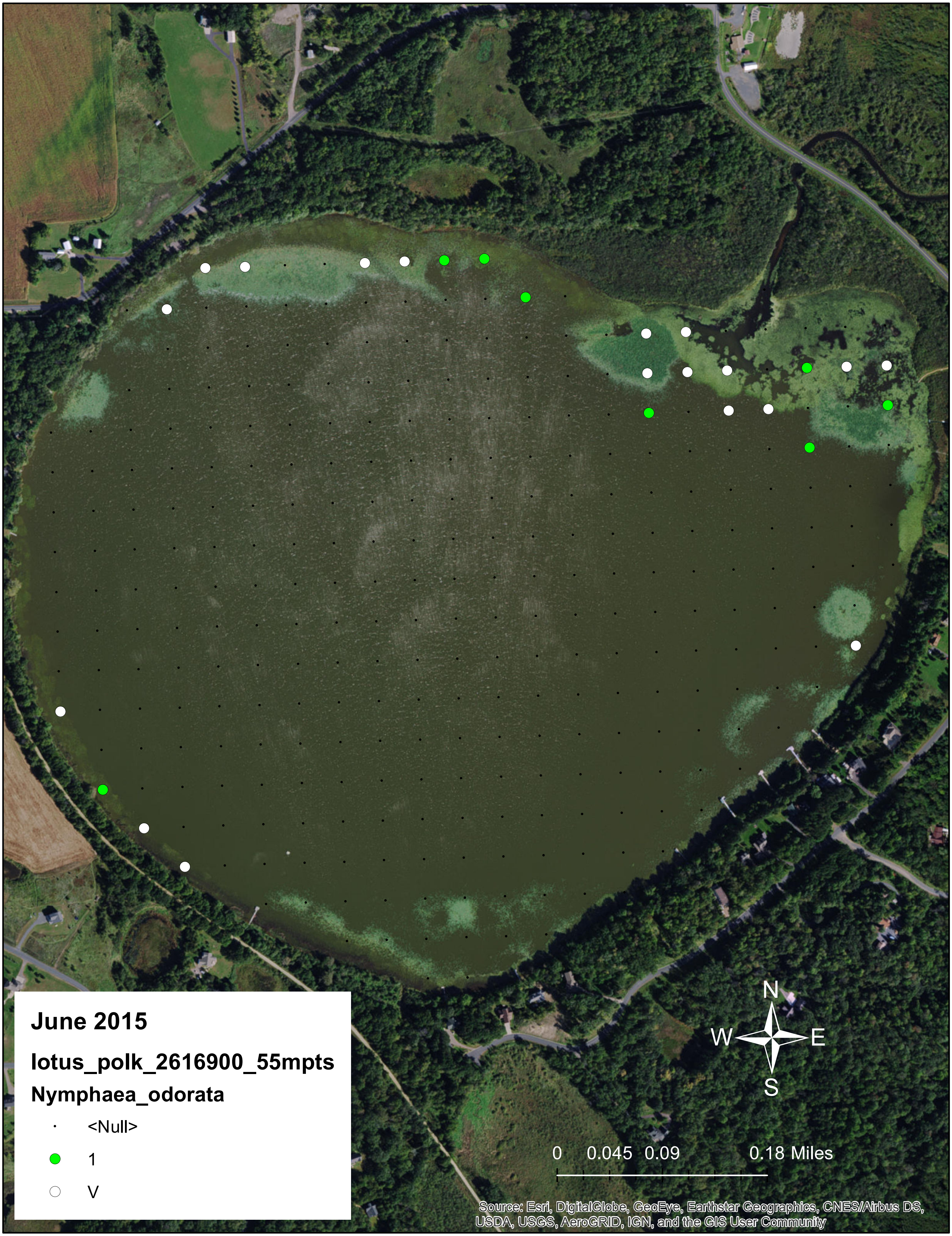
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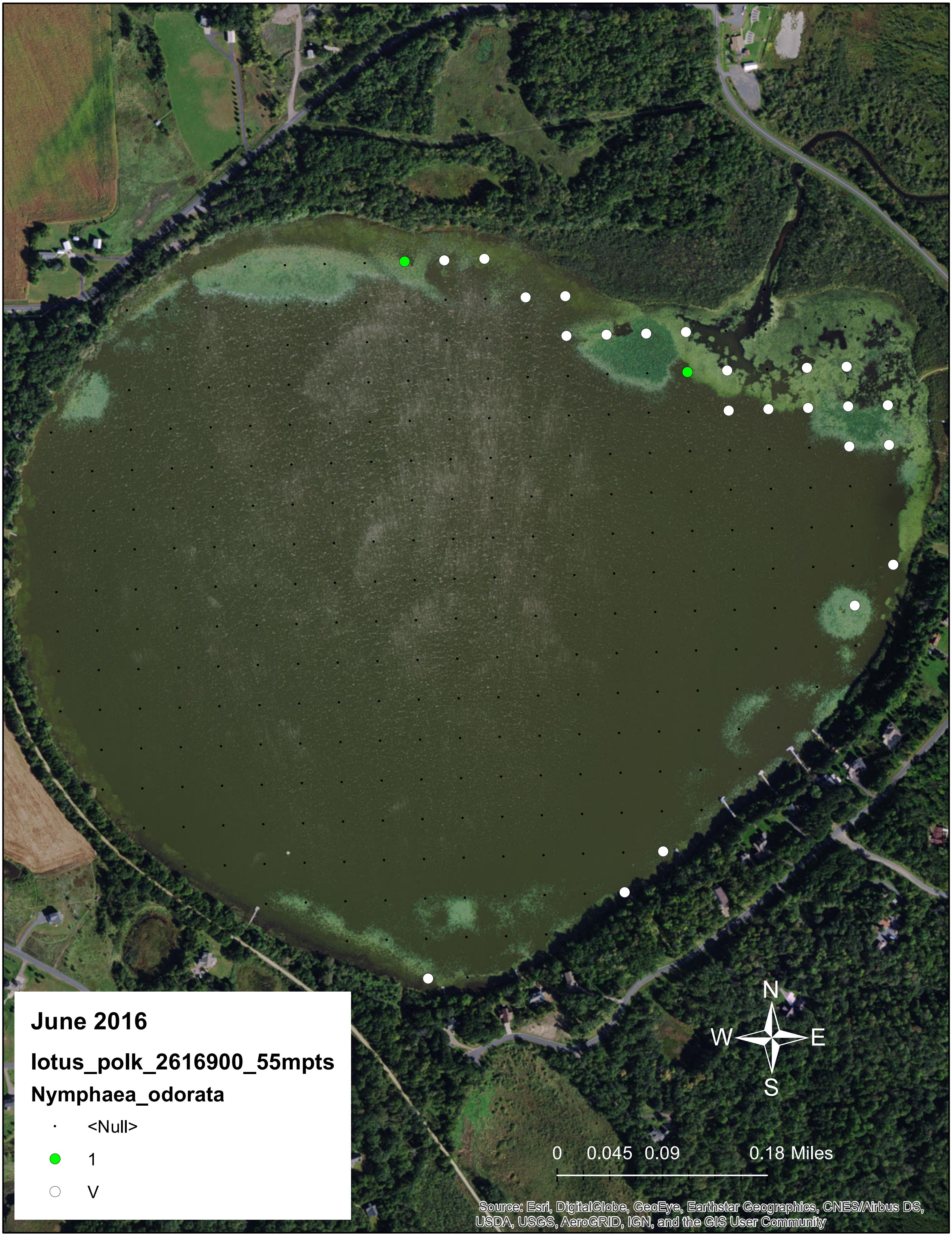
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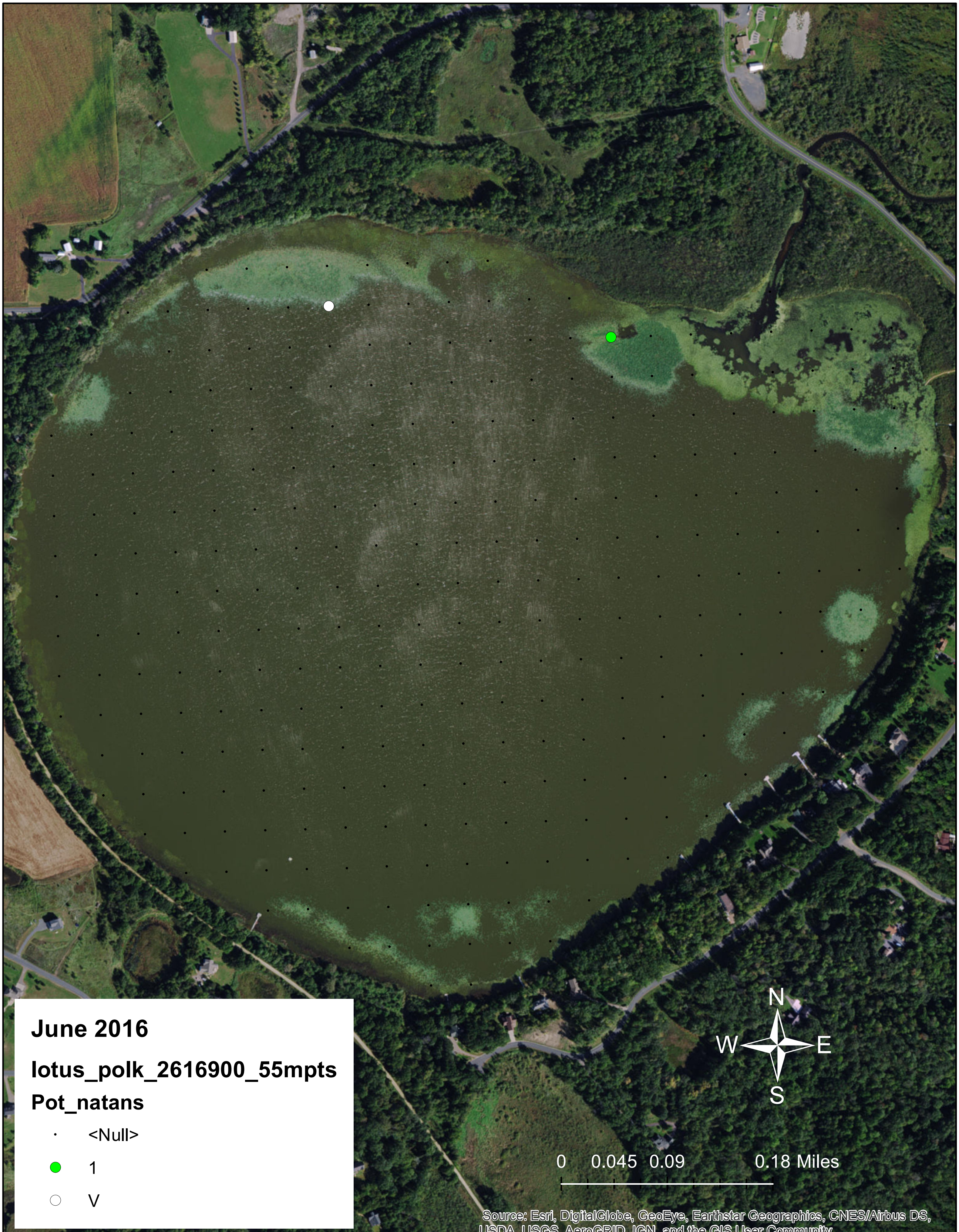
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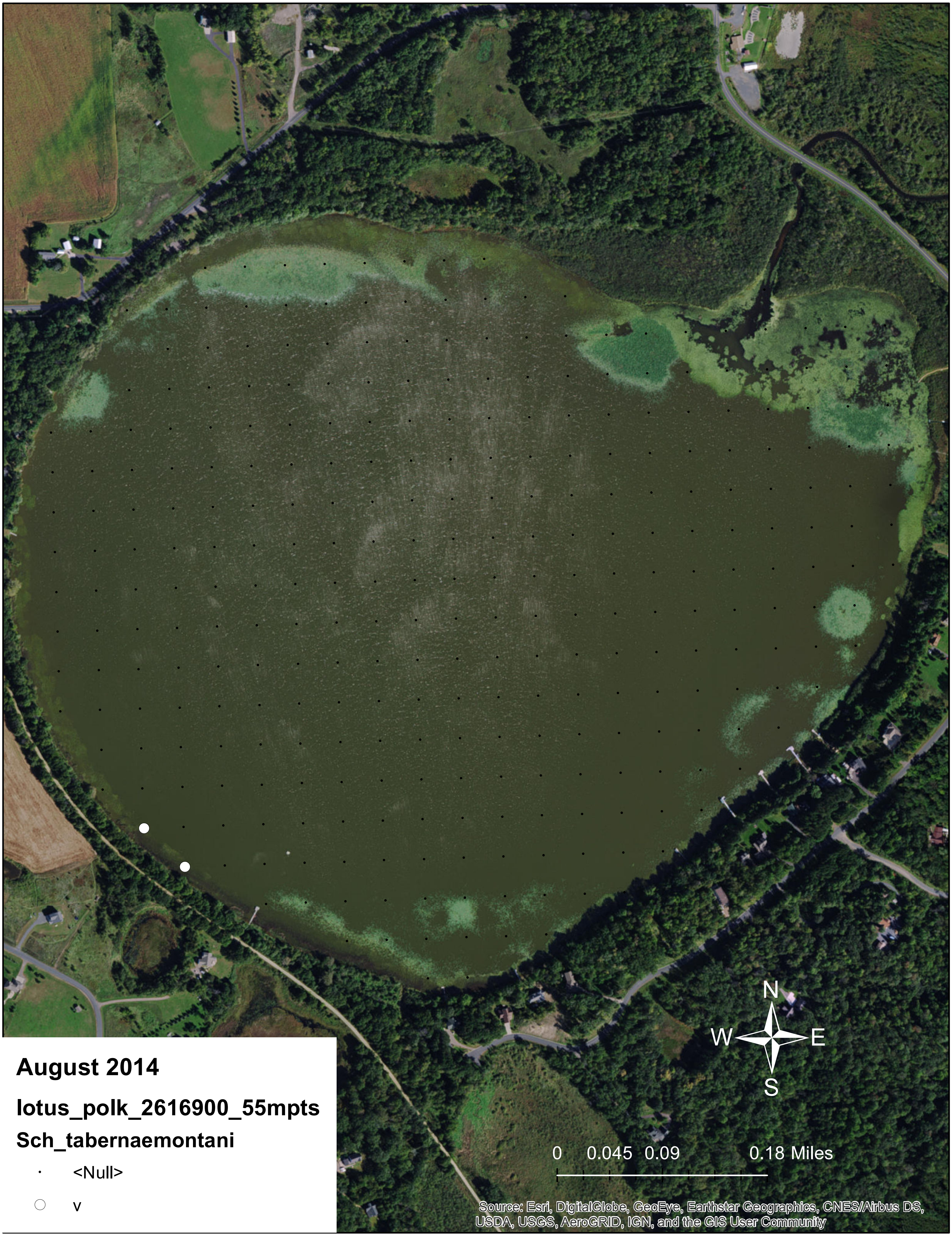

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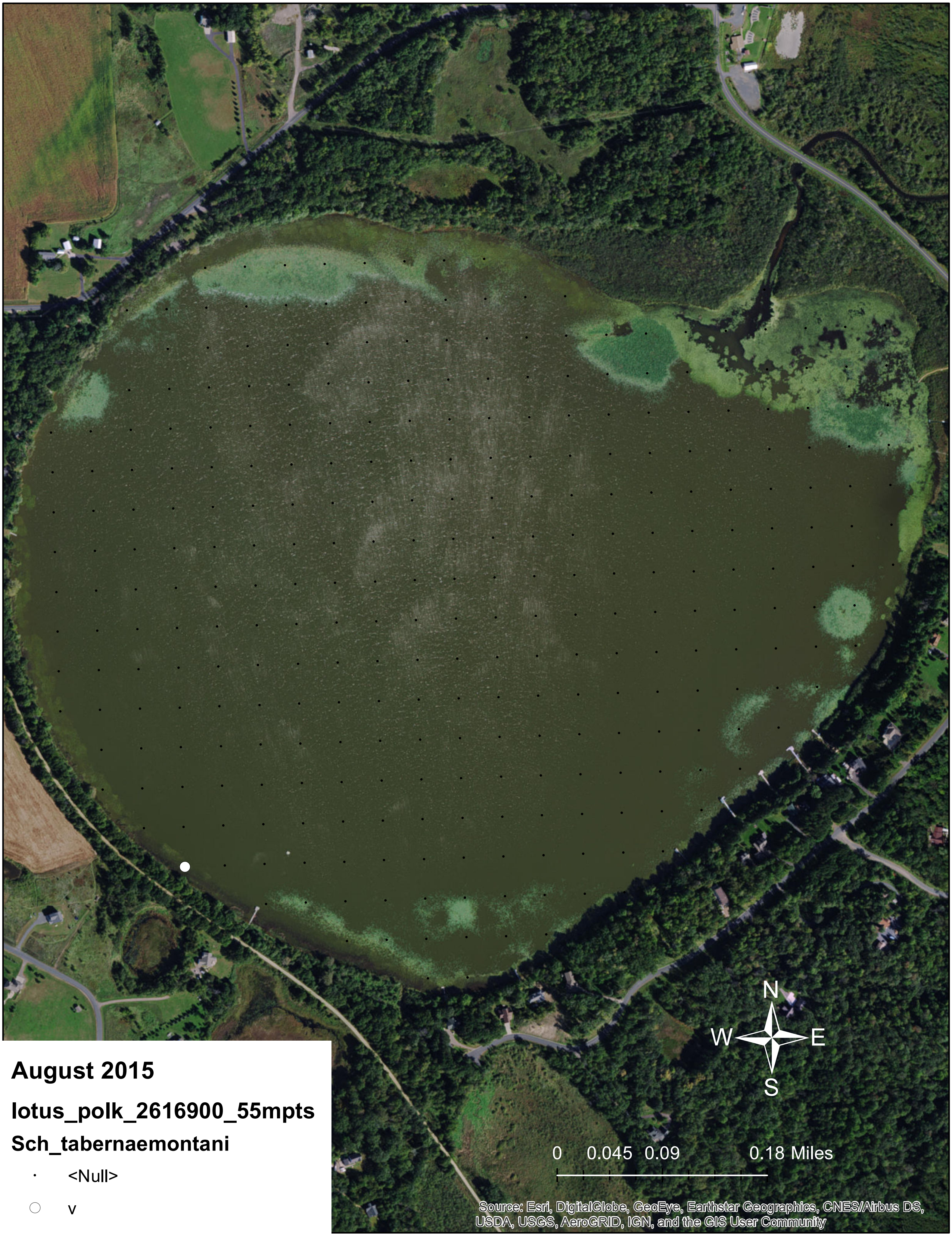
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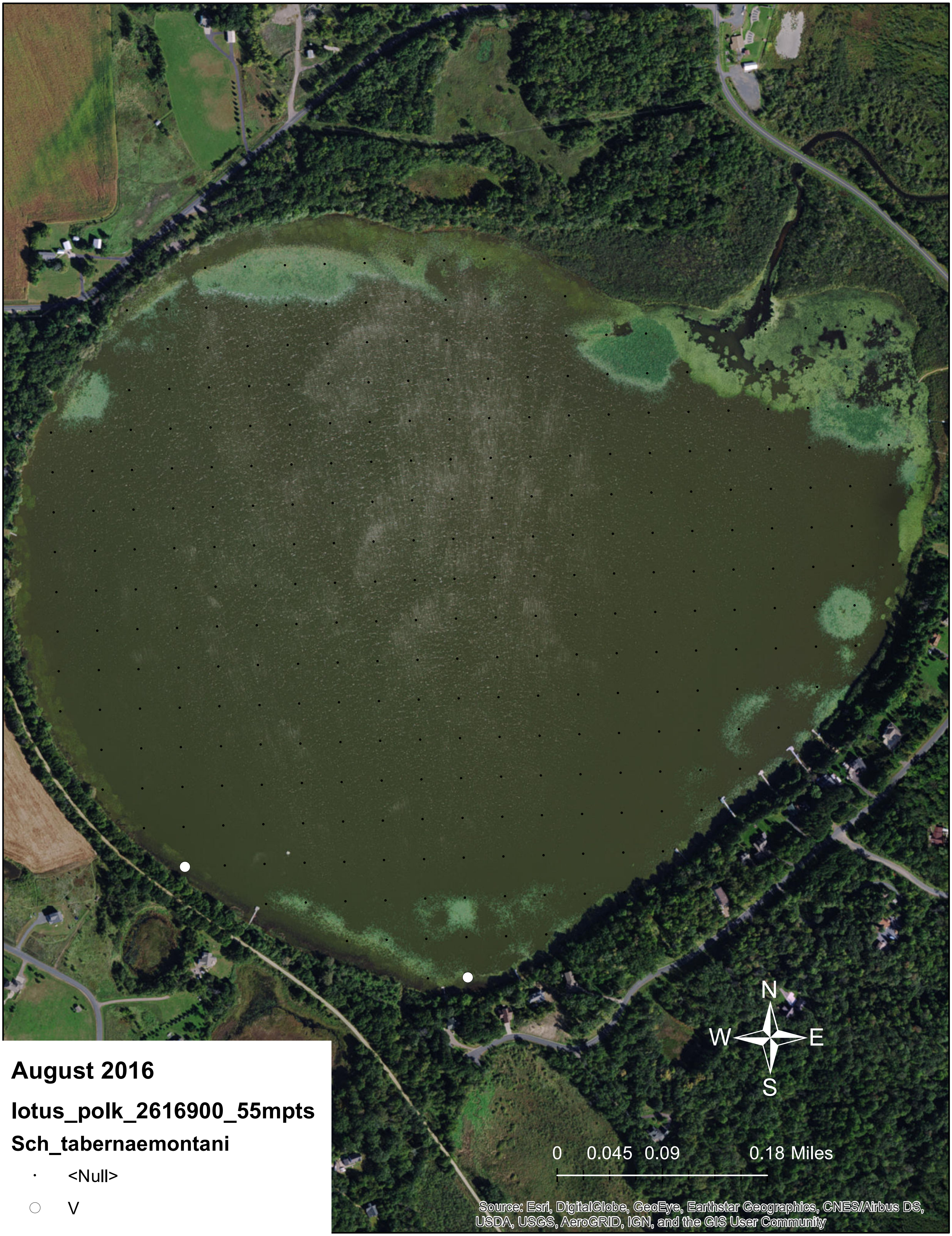
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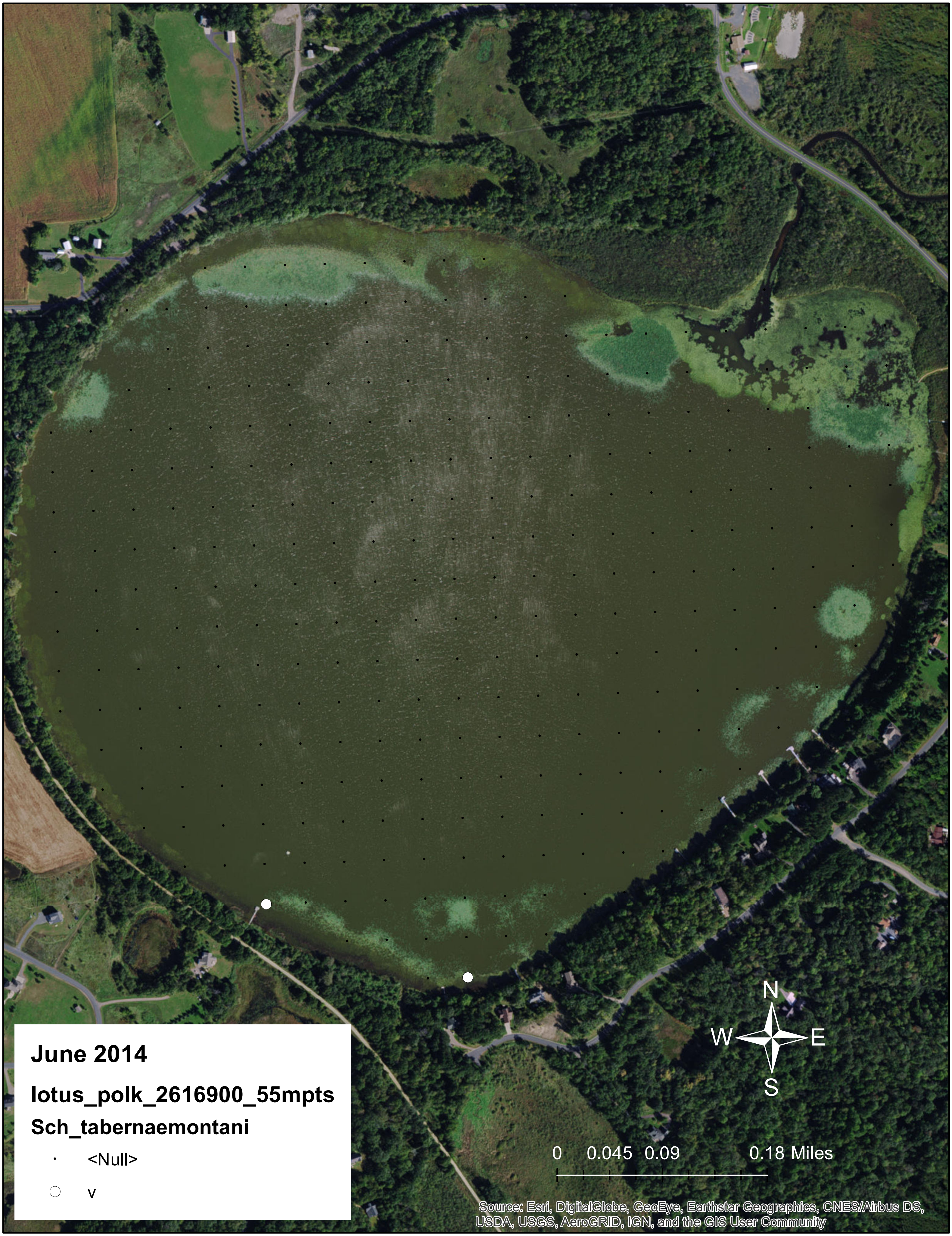
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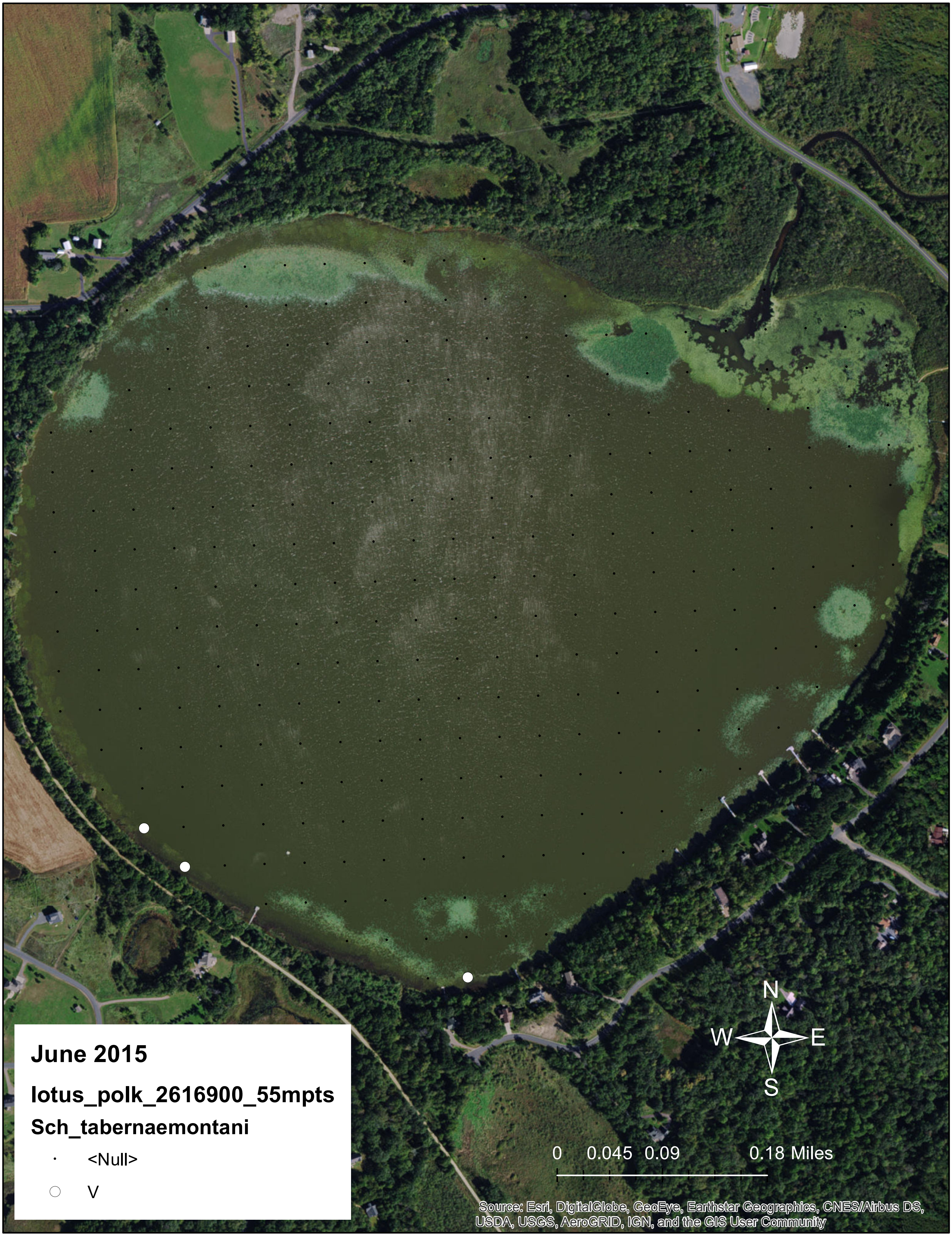
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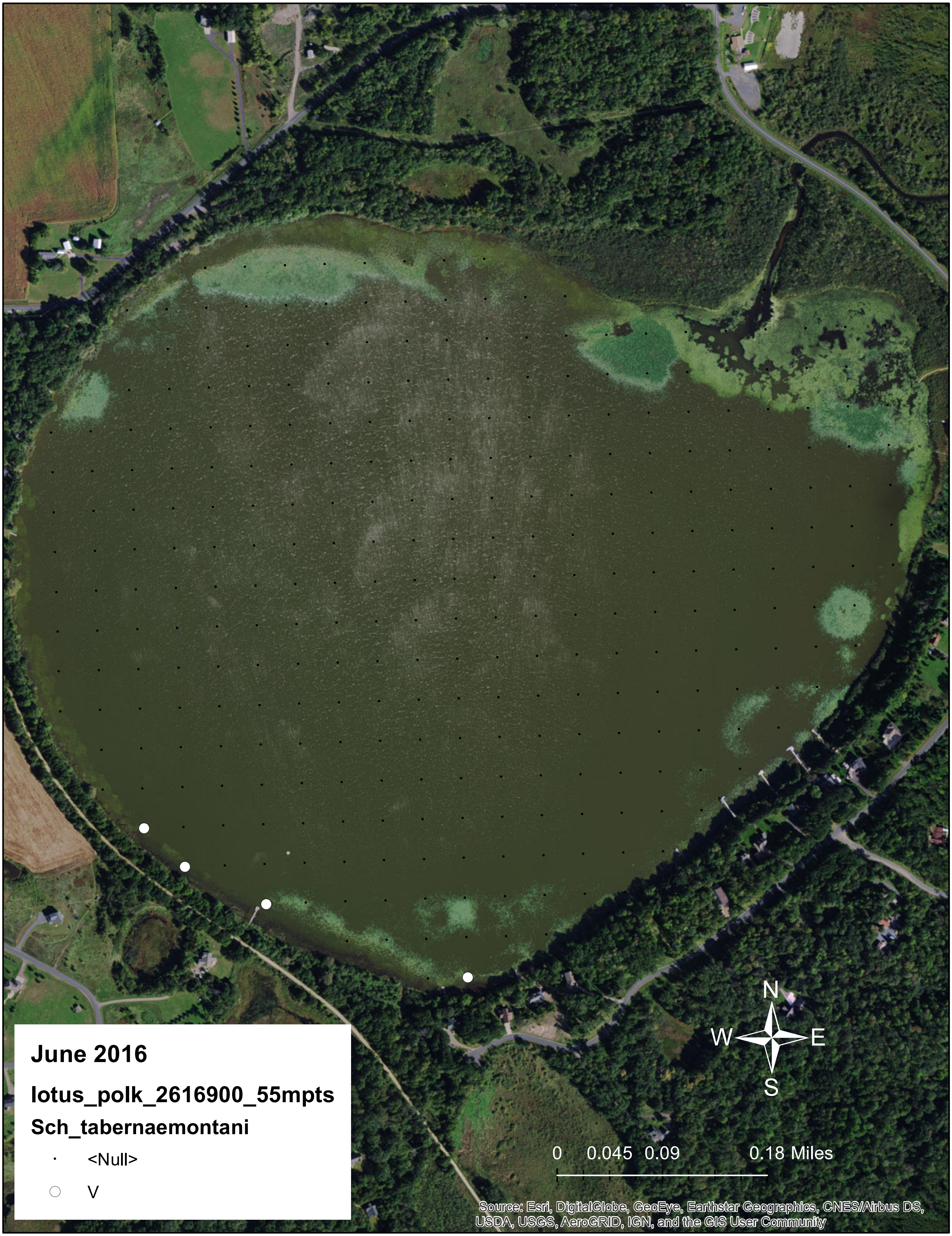
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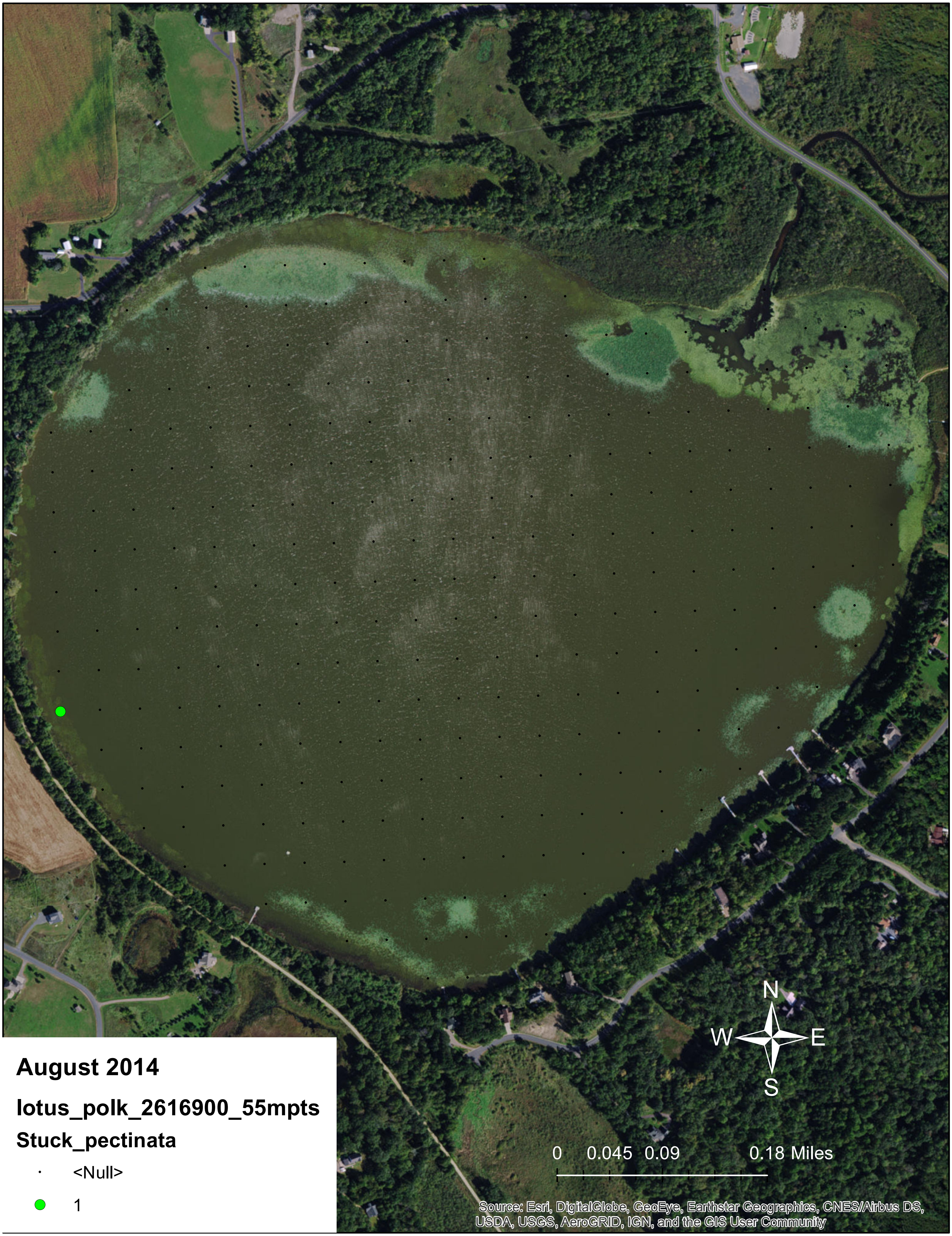

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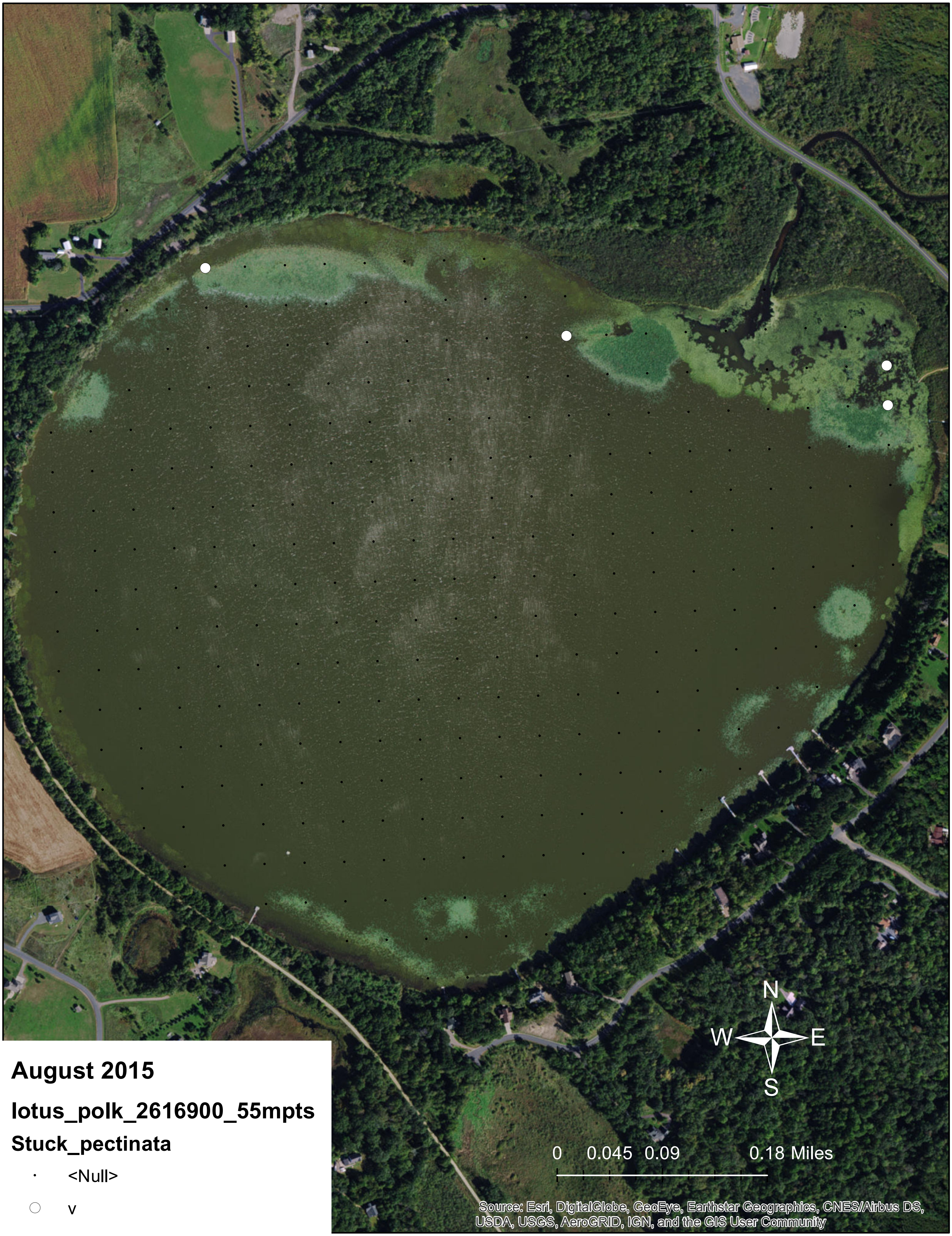
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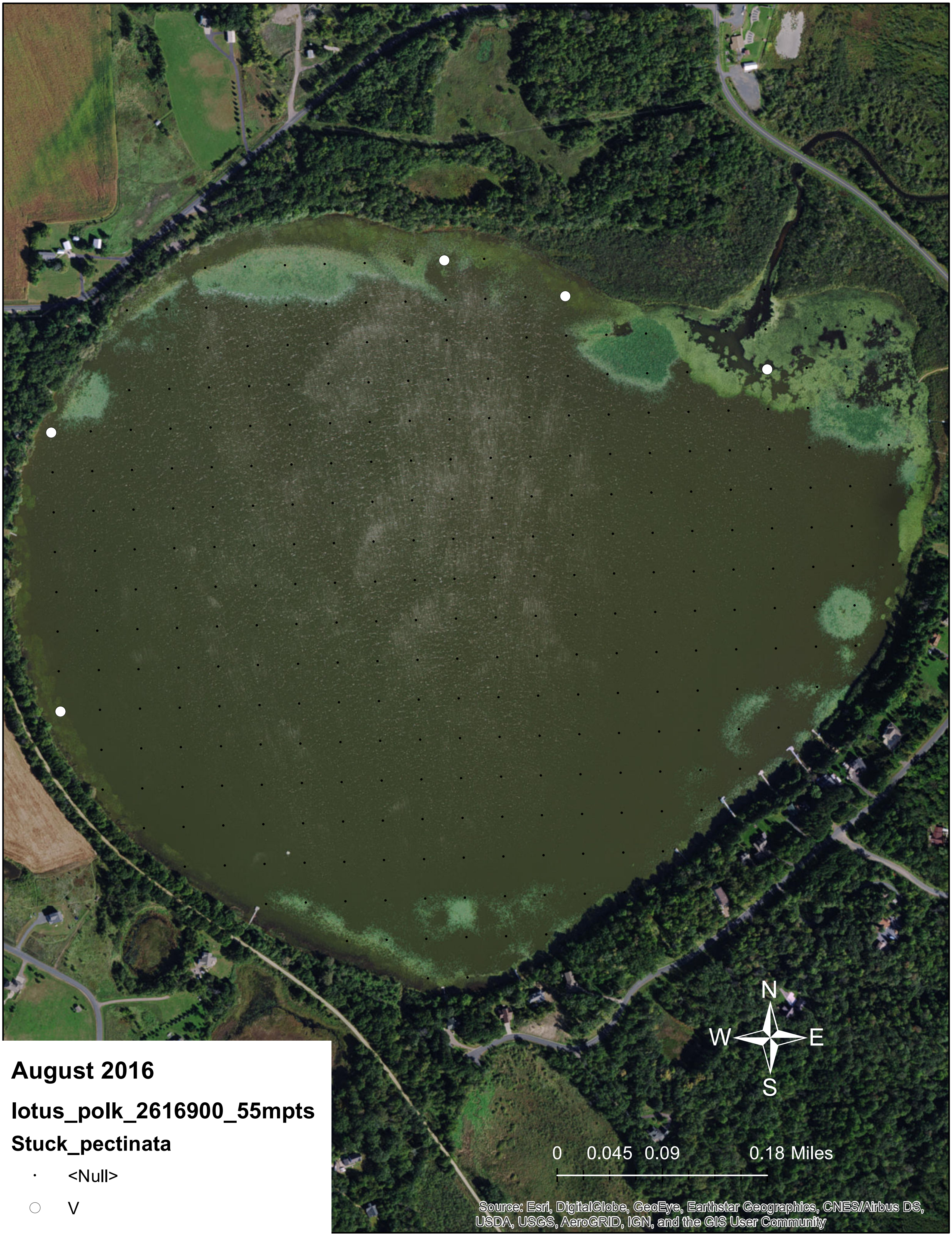
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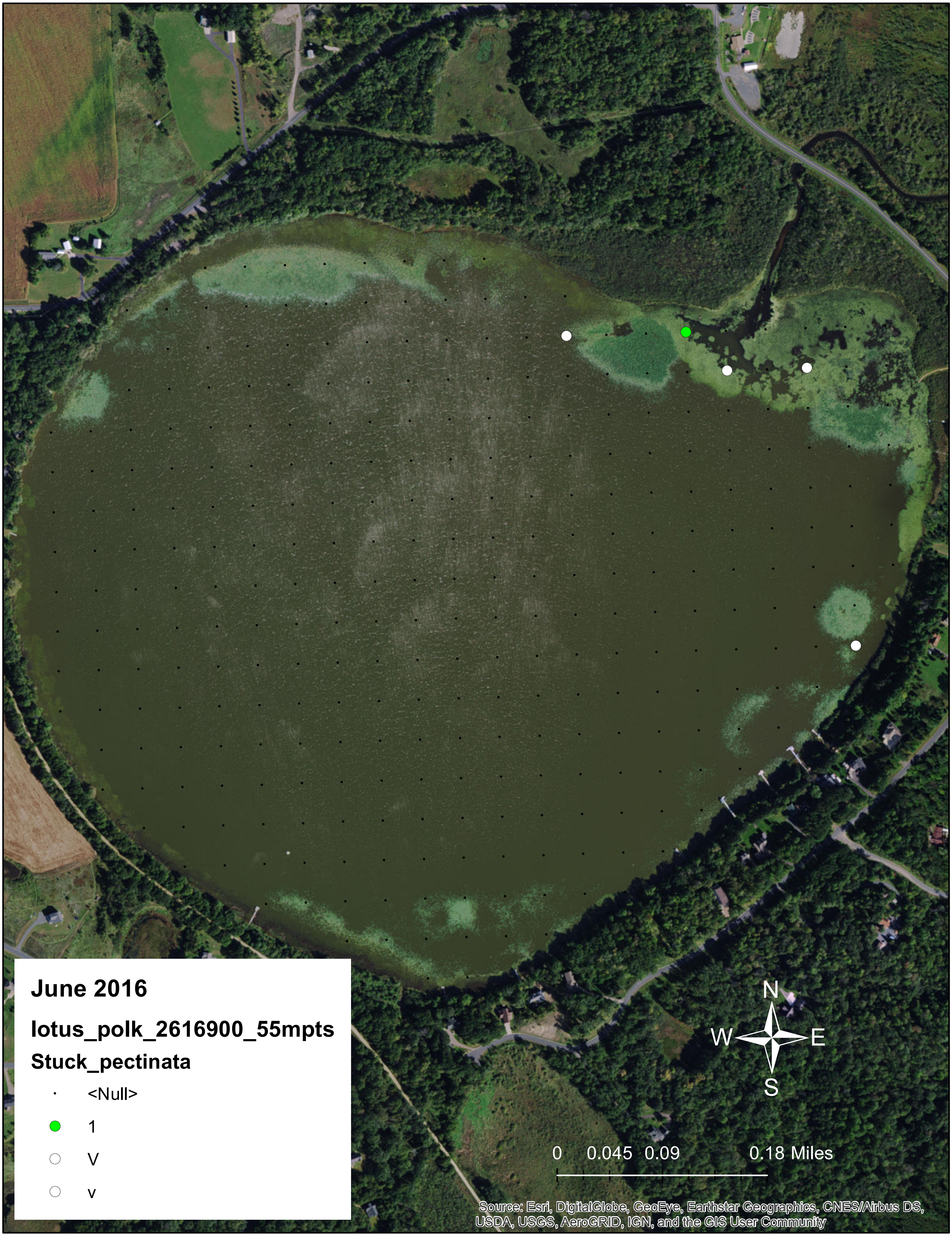
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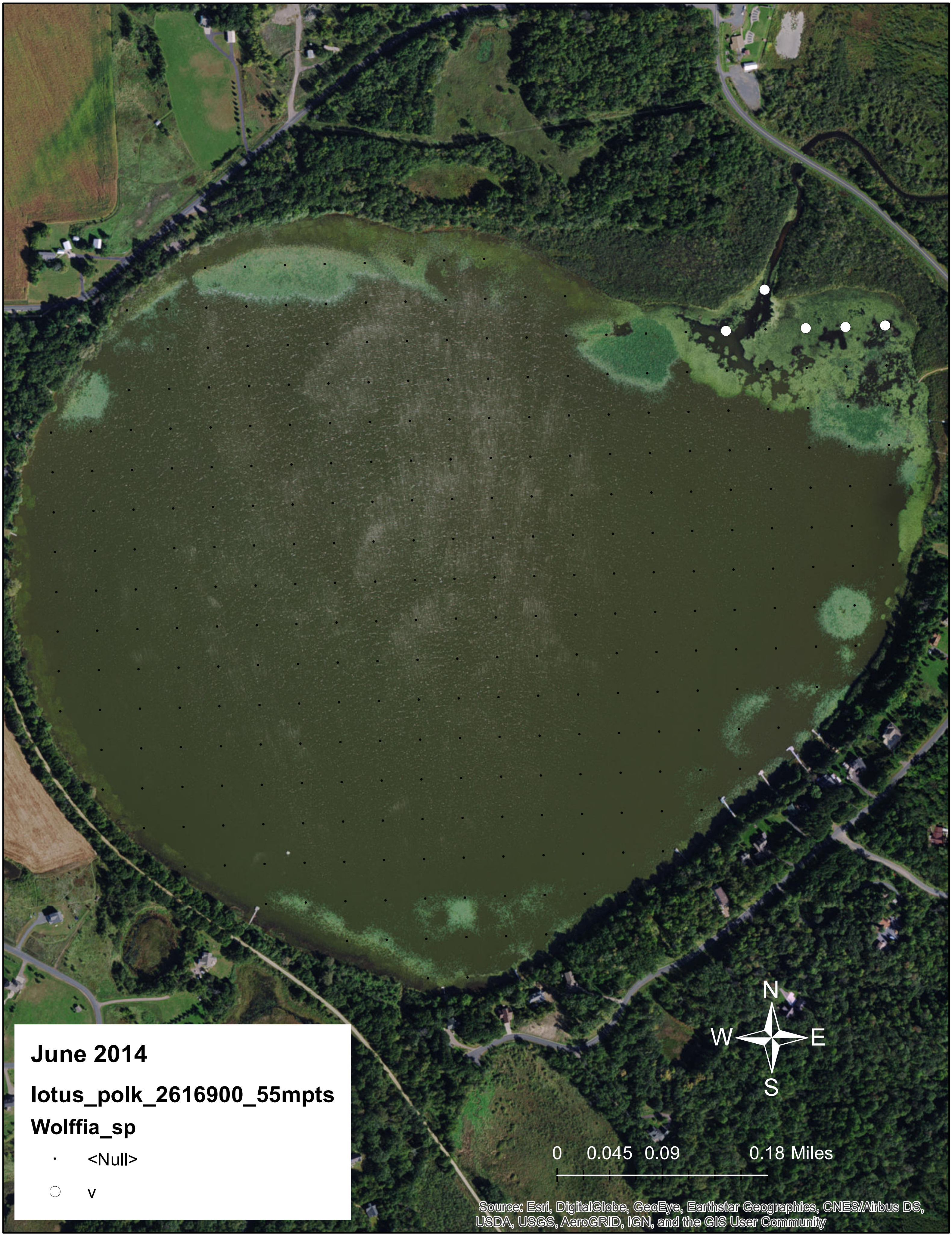
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


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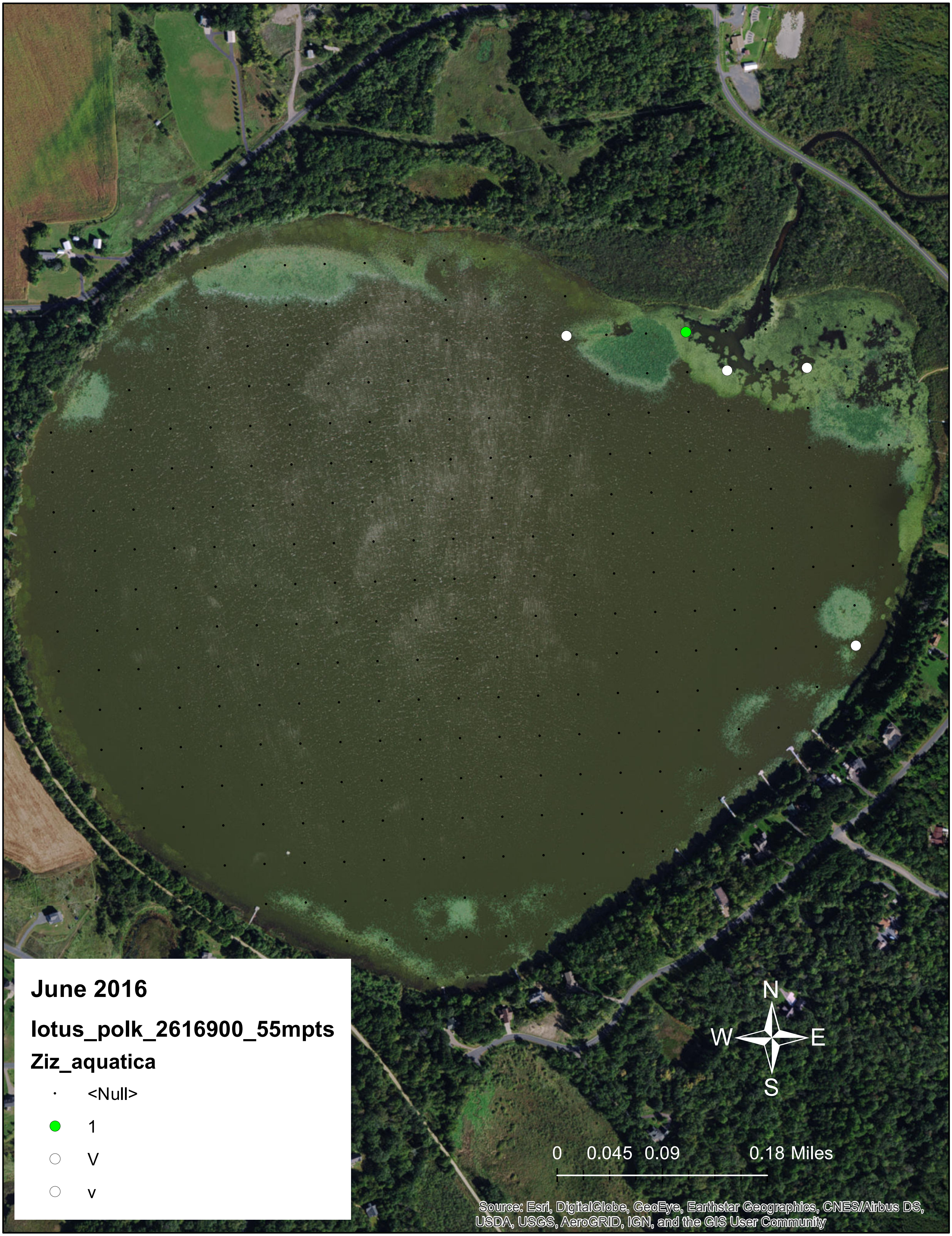
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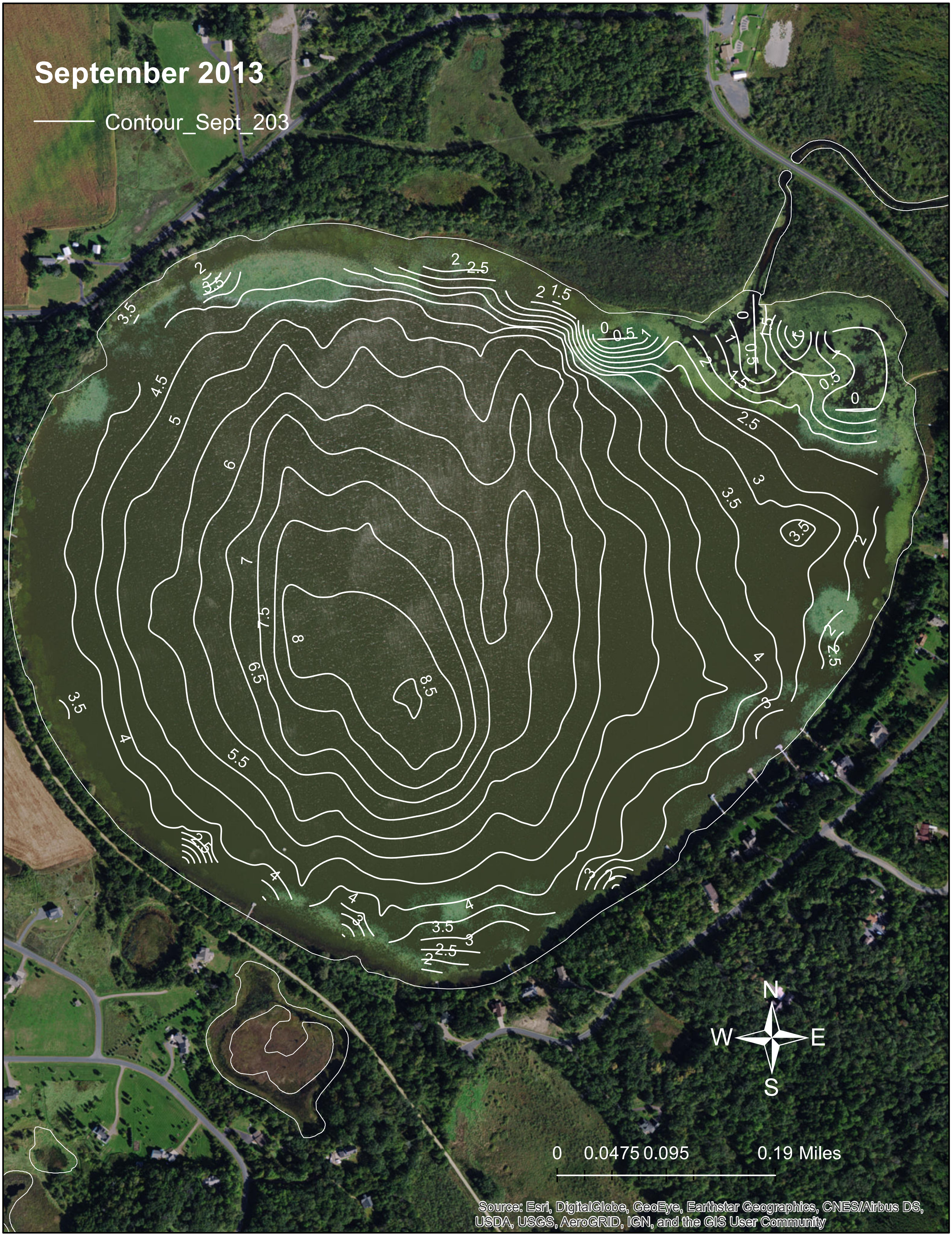
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


September 2013
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


June 2014
Contour_jun_2014
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

August 2014
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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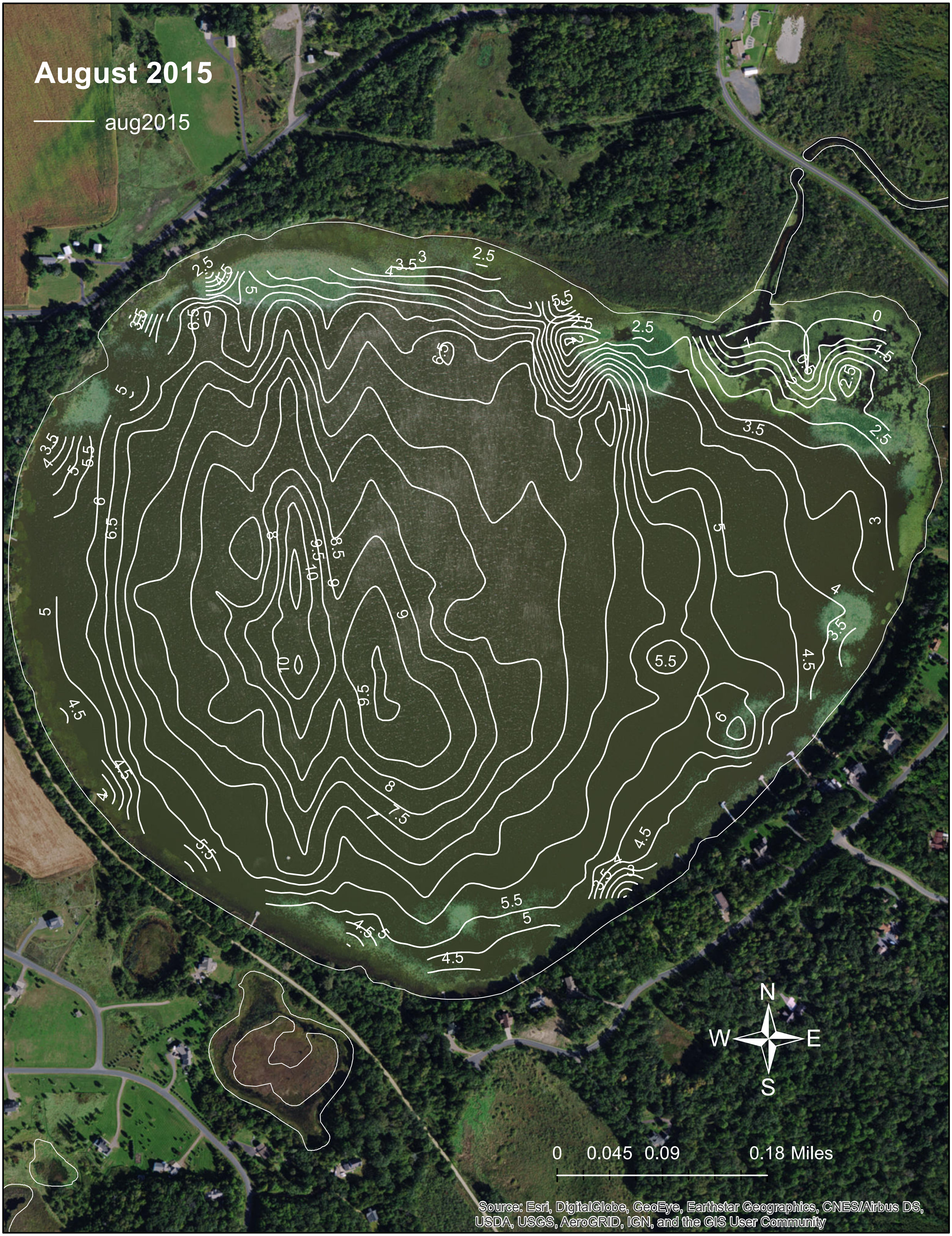
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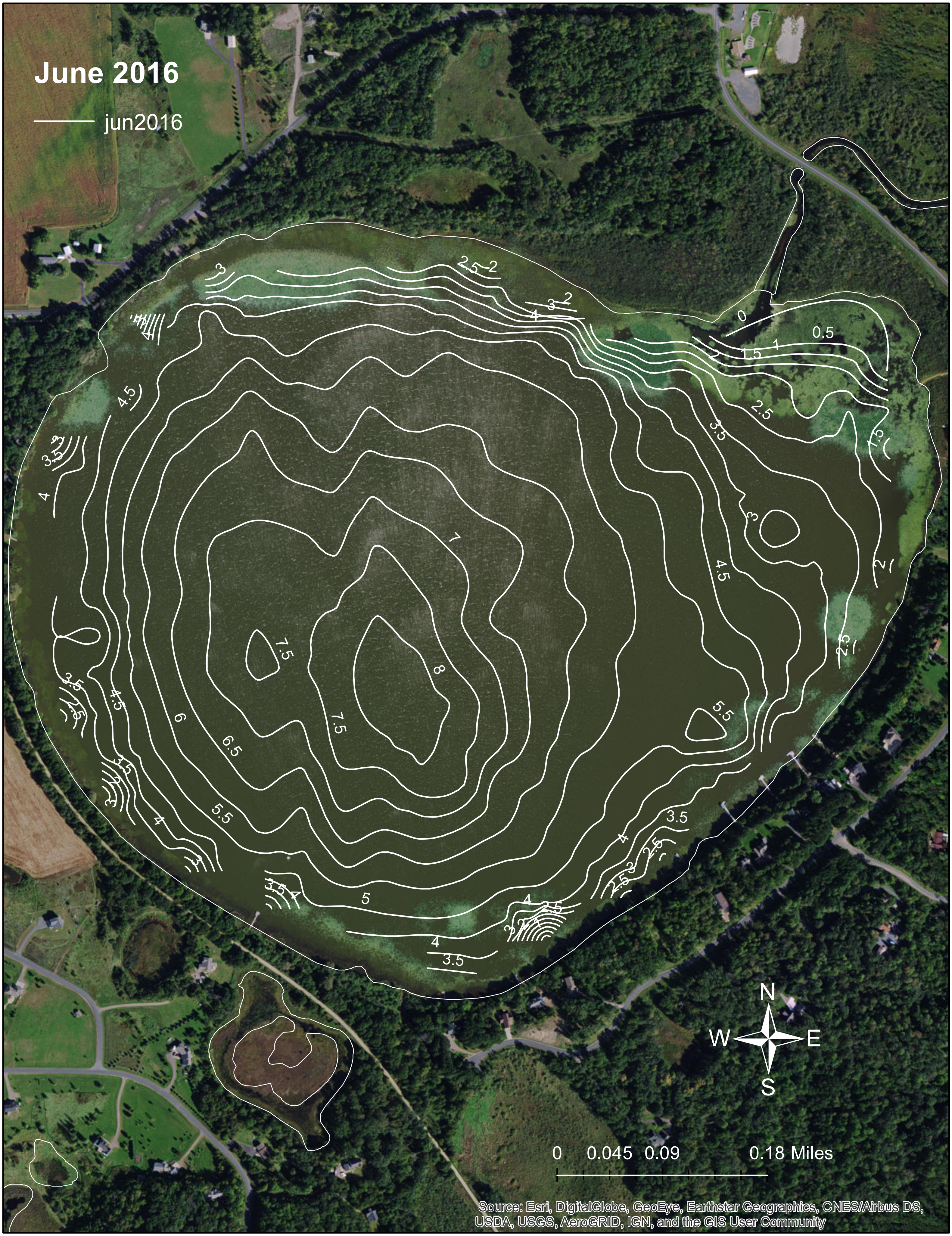
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix H

Shoreline Inventory

GPS points

FID	ident	Latitude	Longitude	y_proj	x_proj
0	093	45.33983	-92.600621	45.33983	-92.600621
1	094	45.339224	-92.60167	45.339224	-92.60167
2	095	45.33902	-92.601736	45.33902	-92.601736
3	096	45.338335	-92.602351	45.338335	-92.602351
4	097	45.338063	-92.602508	45.338063	-92.602508
5	098	45.337923	-92.602811	45.337923	-92.602811
6	099	45.337187	-92.603163	45.337187	-92.603163
7	100	45.336932	-92.603224	45.336932	-92.603224
8	101	45.336176	-92.603347	45.336176	-92.603347
9	102	45.331072	-92.596135	45.331072	-92.596135
10	103	45.331075	-92.596	45.331075	-92.596
11	104	45.331205	-92.595128	45.331205	-92.595128
12	105	45.331228	-92.595065	45.331228	-92.595065
13	106	45.331312	-92.594801	45.331312	-92.594801
14	107	45.331348	-92.594714	45.331348	-92.594714
15	108	45.332673	-92.592037	45.332673	-92.592037
16	109	45.332763	-92.591905	45.332763	-92.591905
17	110	45.333329	-92.591181	45.333329	-92.591181
18	111	45.333382	-92.591086	45.333382	-92.591086
19	112	45.333678	-92.590466	45.333678	-92.590466
20	113	45.333733	-92.590397	45.333733	-92.590397
21	114	45.333948	-92.590143	45.333948	-92.590143
22	115	45.33407	-92.590005	45.33407	-92.590005
23	116	45.334264	-92.589692	45.334264	-92.589692
24	117	45.3343	-92.589605	45.3343	-92.589605
25	118	45.334672	-92.589299	45.334672	-92.589299
26	119	45.334747	-92.589236	45.334747	-92.589236
27	120	45.340207	-92.599159	45.340207	-92.599159
28	121	45.33999	-92.600445	45.33999	-92.600445

Shoreland Vegetation Survey

FID	Id	Waypoint	Gen_distu	Dom_veg	Tall_shore	Barren__ba	shoreline_
0	0	119-120a	Undisturbed	Organic-leaf pack/needles	Present		2760.16
1	0	119-120b	Undisturbed	Organic-leaf pack/needles	Present		2313.51
2	0	120-121	Undisturbed	Organic-leaf pack/needles	Present		365.09
3	0	121-93	Disturbed	Impervious surface	Present		73.4123
4	0	93-94	Undisturbed	Organic-leaf pack/needles	Present		369.377
5	0	94-95	Disturbed	Mowed vegetation	Present	Barren, bare dirt present	128.21
6	0	95-96	Undisturbed	Organic-leaf pack/needles	Present		301.88
7	0	96-97	Disturbed	Mowed vegetation	Present		98.2201
8	0	97-98	Undisturbed	Organic-leaf pack/needles	Present		90.1293
9	0	98-99	Disturbed	Mowed vegetation	Present	Barren, bare dirt present	296.844
10	0	99-100	Undisturbed	Organic-leaf pack/needles	Present		97.704
11	0	100-101	Disturbed	Mowed vegetation	Present		285.349
12	0	101-102	Undisturbed	Organic-leaf pack/needles	Present		2967.01
13	0	102-103	Disturbed	Organic-leaf pack/needles	Present	Barren, bare dirt present	44.2171
14	0	103-104	Undisturbed	Organic-leaf pack/needles	Present		232.646
15	0	104-105	Disturbed	Mowed vegetation	Present		32.1294
16	0	105-106	Undisturbed	Organic-leaf pack/needles	Present		80.1389
17	0	106-107	Disturbed	Mowed vegetation	Present	Barren, bare dirt present	40.6155
18	0	107-108	Undisturbed	Organic-leaf pack/needles	Present		871.018
19	0	108-109	Disturbed	Mowed vegetation	Present		47.0592
20	0	109-110	Undisturbed	Organic-leaf pack/needles	Present		270.814
21	0	110-111	Disturbed	Short unmowed vegetation <3 feet tall	Present		34.6981
22	0	111-112	Undisturbed	Organic-leaf pack/needles	Present		197.056
23	0	112-113	Disturbed	Barren, bare dirt	Present	Barren, bare dirt dominant	44.1769
24	0	113-114	Undisturbed	Organic-leaf	Present		84.2868

FID	Id	Waypoint	Gen_distu	Dom_veg	Tall_shore	Barren__ba	shoreline_
				pack/needles			
25	0	114-115	Undisturbed	Short unmowed vegetation <3 feet tall	Present		59.8427
26	0	115-116	Undisturbed	Organic-leaf pack/needles	Present		115.127
27	0	116-117	Disturbed	Barren, bare dirt	Absent	Barren, bare dirt dominant	35.9883
28	0	117-118	Undisturbed	Organic-leaf pack/needles	Present		171.798
29	0	118-119	Disturbed	Mowed vegetation	Present		48.1438

Dock/pier

FID	type	ident	Latitude	Longitude	y_proj	x_proj
0	WAYPOINT	124	45.339211	-92.601605	45.339211	-92.601605
1	WAYPOINT	126	45.337662	-92.602871	45.337662	-92.602871
2	WAYPOINT	127	45.3373	-92.603167	45.3373	-92.603167
3	WAYPOINT	128	45.336824	-92.603212	45.336824	-92.603212
4	WAYPOINT	129	45.336567	-92.603228	45.336567	-92.603228
5	WAYPOINT	130	45.332099	-92.59919	45.332099	-92.59919
6	WAYPOINT	131	45.331305	-92.595998	45.331305	-92.595998
7	WAYPOINT	132	45.331344	-92.595107	45.331344	-92.595107
8	WAYPOINT	133	45.331476	-92.594951	45.331476	-92.594951
9	WAYPOINT	137	45.332877	-92.592136	45.332877	-92.592136
10	WAYPOINT	138	45.333381	-92.591181	45.333381	-92.591181
11	WAYPOINT	139	45.333742	-92.590559	45.333742	-92.590559
12	WAYPOINT	140	45.334041	-92.590018	45.334041	-92.590018
13	WAYPOINT	141	45.334317	-92.589731	45.334317	-92.589731
14	WAYPOINT	142	45.33626	-92.588953	45.33626	-92.588953
15	WAYPOINT	143	45.337669	-92.587912	45.337669	-92.587912
16	WAYPOINT	144	45.337992	-92.587764	45.337992	-92.587764
17	WAYPOINT	145	45.33832	-92.587815	45.33832	-92.587815

Woody structure

FID	type	ident	Latitude	Longitude	y_proj	x_proj
0	WAYPOINT	122	45.339774	-92.600717	45.339774	-92.600717
1	WAYPOINT	123	45.339407	-92.601383	45.339407	-92.601383
2	WAYPOINT	125	45.337875	-92.602525	45.337875	-92.602525
3	WAYPOINT	134	45.331542	-92.594863	45.331542	-92.594863
4	WAYPOINT	135	45.331734	-92.594187	45.331734	-92.594187
5	WAYPOINT	136	45.332165	-92.5932	45.332165	-92.5932

Appendix I

Shoreline Restoration

Lotus Lake Shoreline Restoration/Rain Garden Workshop

Monday, July 11th
9 -11 AM
Polk County Government Center, Balsam Lake
County Board Room

9:00 Introductions

9:05 Presentation on shoreline restoration and rain gardens

Healthy Lakes Grants 101
Importance and benefits of native plantings
Site evaluation
How to install a practice
Moving forward, next steps

11:15 Review resources for native plantings

11:30 Sign up for individual lot site evaluations for project design

11:00 Adjourn

Katelin Anderson
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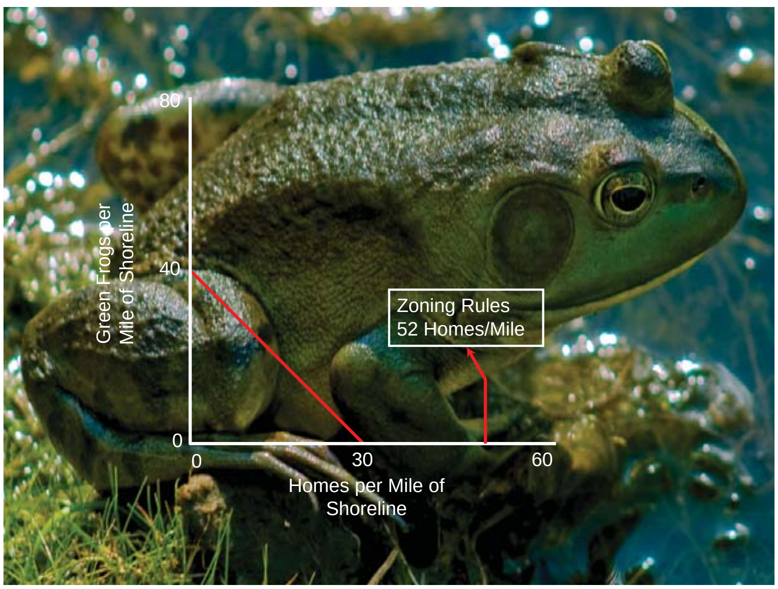
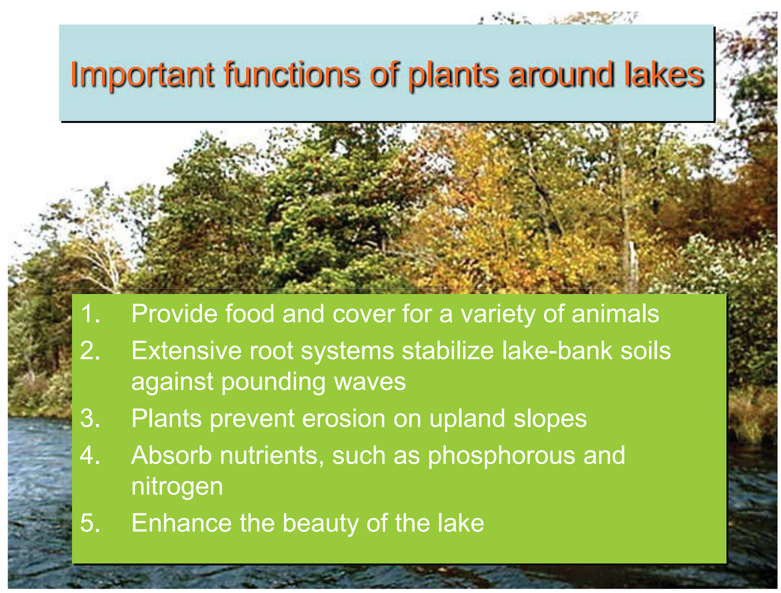
Jeremy Williamson
(715) 485-8639
jeremyw@co.polk.wi.us


Shoreline Restoration
Improving water quality and wildlife habitat


Problems with Traditional Lakeshores
• Shoreline erosion and sedimentation
• Excessive plant growth and algal blooms
• Loss of wildlife habitat
• Nuisance animals
• Loss of leisure time


80
40
0
Green Frogs per Mile of Shoreline
Zoning Rules 52 Homes/Mile
0
30
60
Homes per Mile of Shoreline

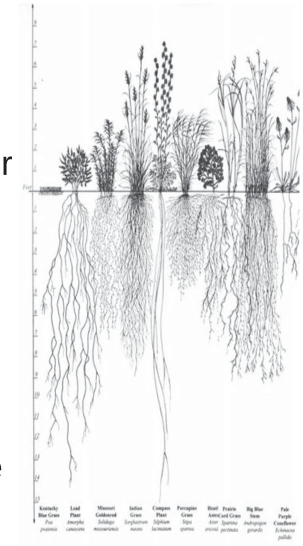

Important functions of plants around lakes
1. Provide food and cover for a variety of animals
2. Extensive root systems stabilize lake-bank soils against pounding waves
3. Plants prevent erosion on upland slopes
4. Absorb nutrients, such as phosphorous and nitrogen
5. Enhance the beauty of the lake

Root Systems

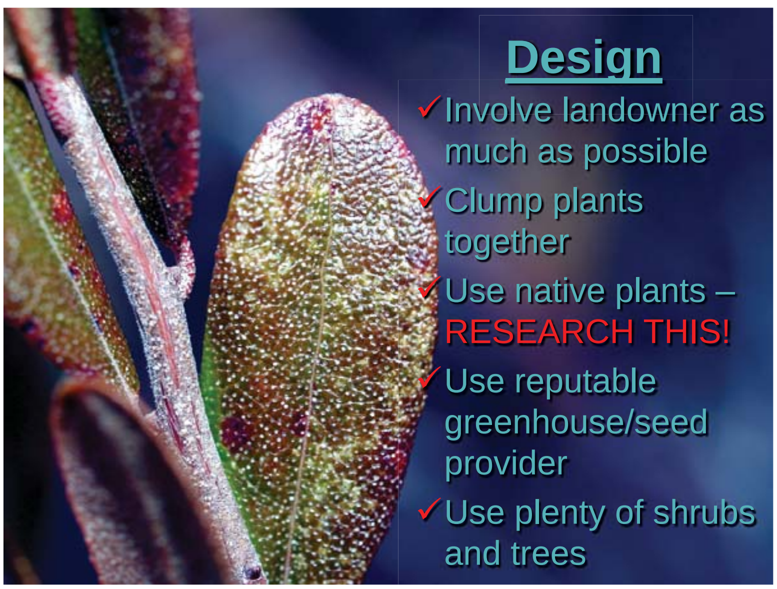
- Stabilize banks
- Stabilize shoreline
- Absorbsion of nutrients
- Absorbsion of water

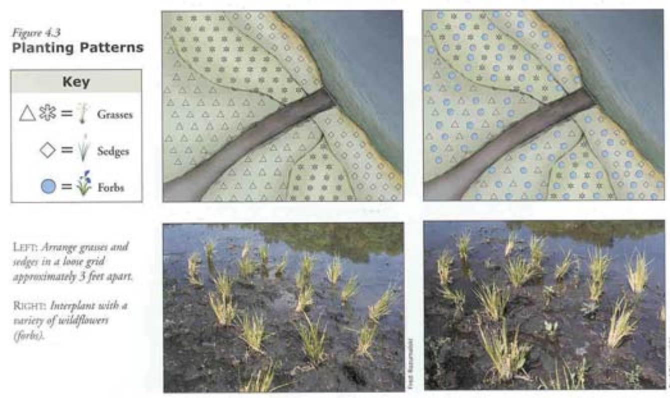
Why it works

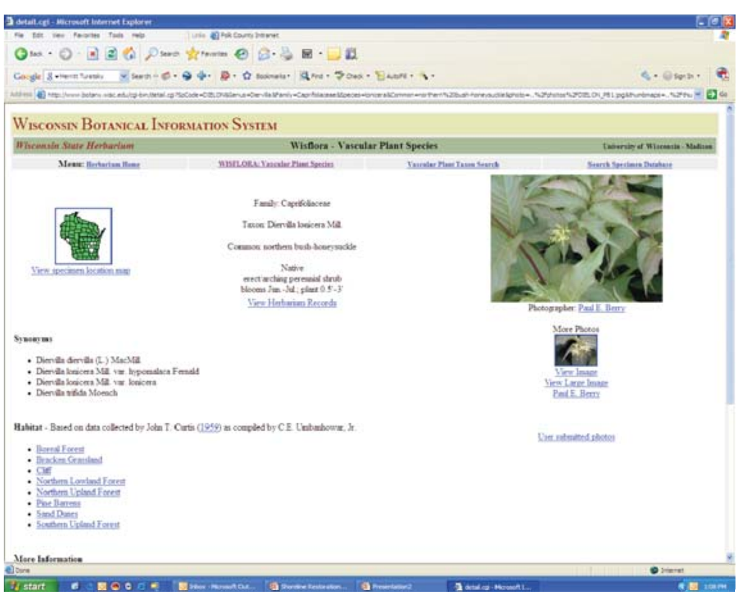
- In turf grass (i. e. lawn) water can only evaporate 0.4 meters out of the soil
- Native vegetation will evapotranspirate water from 2 meters or more from the soil.
- Wet Sponge vs. Dry Sponge

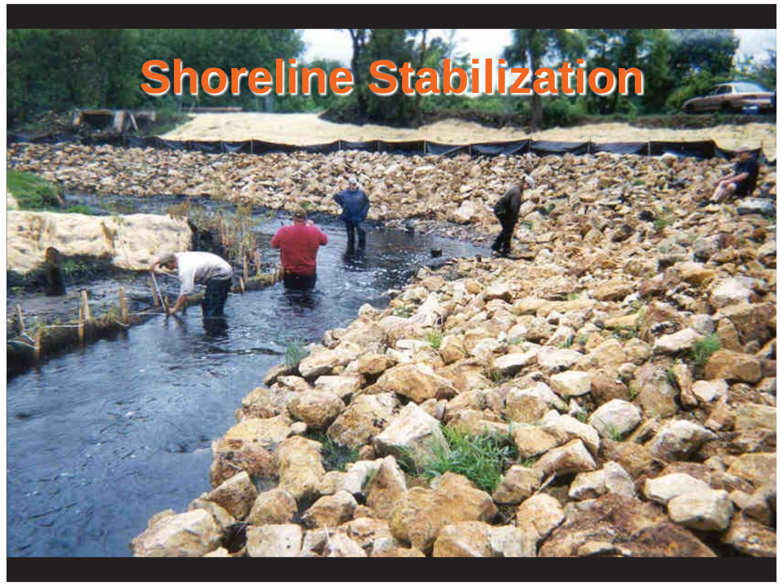


Root Systems of Prairie Plants








Shoreline Stabilization

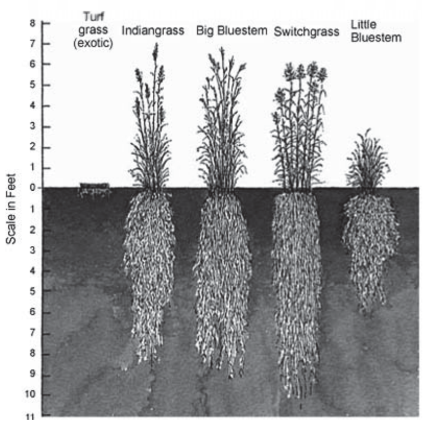
Questions?

Rain Gardens

Rain Gardens

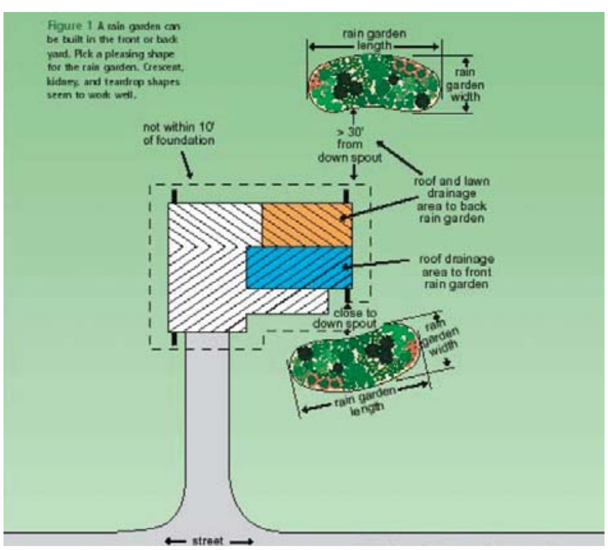
- Increases the amount of water filtering into ground
- Recharges groundwater
- Provides wildlife habitat
- Enhances beauty of yard and neighborhood
- Protects against flooding and drainage problems
- Protects lakes from damaging flows and reduces erosion
- Reduces the need for costly municipal stormwater treatment structures

Why They Work



Where Should the Rain Garden Go?

- At least 10 feet from house
- Flat area
- Below down spouts
- Not over septic system or sewer lateral
- Not where yard is wet
- Not directly under a large tree
- Not high traffic area



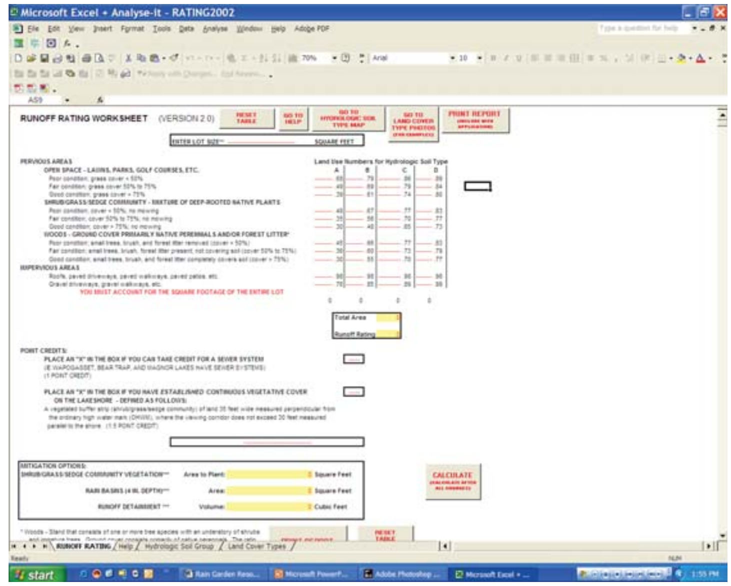
How Big should the Rain Garden Be?

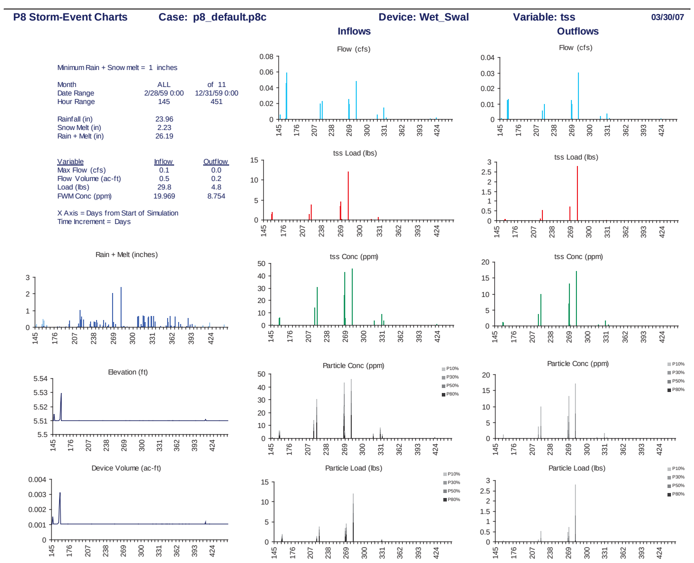
- How deep?
- What type of soil?
- How much roof and lawn drain to it?

Rain Garden Size Factor

	less than 30 ft from down spout			more than 30 ft from down spout
Soil	3-5 in. deep	6-7 in. deep	8 in. deep	All Depths
Sand	0.19	0.15	0.08	0.03
Loamy	0.34	0.25	0.16	0.06
Clayey	0.43	0.32	0.2	0.1

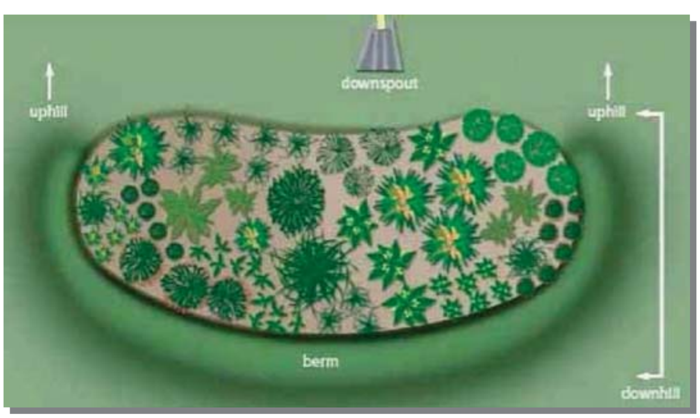
*If the recommended rain garden area is much more than 300 ft. divide it into smaller rain gardens





Design

- Water should flow evenly across the entire length
- Length should be perpendicular to slope and downspouts
- Rain gardens should have a maximum length of 15 ft (esp. on 8% slope or more)



Notice Length is Perpendicular

Burnsville

Maplewood

Plant Selection

- **Native**
- **Soil**
- **Sun/Shade**
- **Incorporate plenty of grasses, sedges and, rushes (allows for normal growth patterns)**
- Height of plant
- Bloom time
- Color

Example Plant List: Well Drained Soils

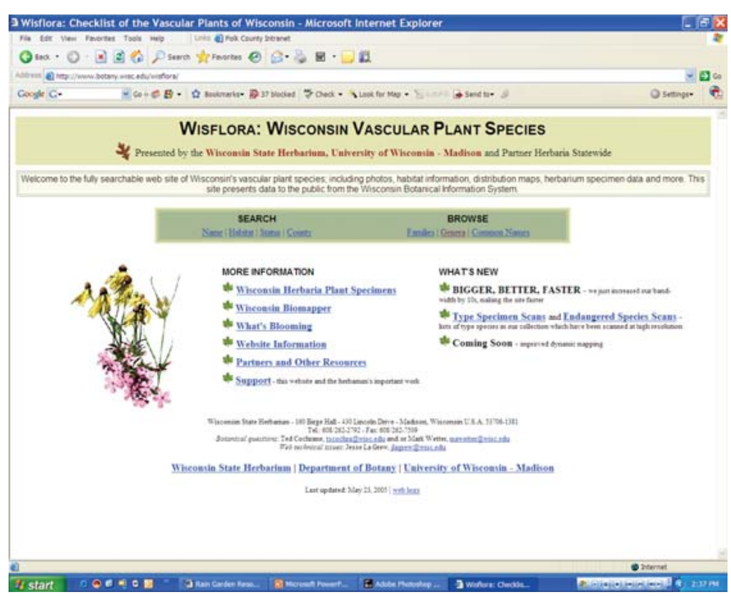
New England aster *Aster novae-angliae*
Spotted Joe-Pye weed *Eupatorium maculatum*
Sneezeweed *Helenium autumnale*
Torrey's rush *Juncus torreyi*
Prairie blazing star *Liatris pycnostachya*
Cardinal flower *Lobelia cardinalis*
Great blue lobelia *Lobelia siphilitica*
Wild bergamot *Monarda fistulosa*
Mountain mint *Pycanthemum virginianum*
Green bulrush *scirpus atrovirens*
Stiff goldenrod *Solidago rigida*
Culver's root *Veronicastrum virginicum*
Golden Alexander *Zizia aurea*

Example Plant List: Clay Soils

Sweet flag *Acorus calamus*
Swamp milkweed *Asclepias incarnata*
Water plantain *Alisma subcordatum*
Bottle brush sedge *Carex comosa*
Fox sedge *Carex vulpinoidea*
Wild blue flag iris *Iris virginica shrevei*
Torrey's rush *Juncus torreyi*
Cardinal flower *Lobelia cardinalis*
False dragon's head *Physostegia virginiana*
Arrowhead *Sagittaria latifolia*
Green bulrush *Scirpus atrovirens*
River bulrush *Scirpus fluviatilis*
Soft-stemmed bulrush *Scirpus validus*

Example Plant List: Shady Areas

Caterpiller Sedge *Carex crinita*
Cardinal Flower* *Lobelia cardinalis*
Ostrich Fern* *Matteuccia struthiopteris*
Virginia Bluebells *Mertensia virginica*
Sensitive Fern *Onoclea sensibilis*
Black Chokeberry *Aronia melanocarpa*
Red Osier Dogwood *Cornus serecia*
Low Bush Honeysuckle *Diervilla lonicera*
Pussy Willow *Salix caprea*
Blue Arctic Willow *Salix purpurea* Nanna



Special Case: Shoreland Area

- Should not replace native shoreland vegetation
- Should help protect riparian veg. from excessive flow and debris

Questions?

Jeremy Williamson
Water Quality Specialist
(715) 485-8639
jeremyw@co.polk.wi.us

Designed SEG Date 12/11/17 Drawn Checked Approved		Polk County Land & Water Resources Department 100 Polk County Plaza - Suite 120 Balsam Lake, WI 54810 715-485-8699 715-485-8601 fax	PROJECT: LOTUS LAKE PARK COUNTY: POLK	PLAN VIEW BOAT LANDING PLANTING PLAN	SHEET

Designed	SEG	Date 12/11/17
Drawn		
Checked		
Approved		

Polk County Land & Water
Resources Department
100 Polk County Plaza - Suite 120
Balsam Lake, WI 54810
715-485-8699
715-485-8601 fax

PROJECT: Lotus Lake Park

COUNTY: Polk

PLAN VIEW

SHEET

Appendix J

Modeling

Date: 1/5/2017 Scenario: LOTUS 2014

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248 acre
Lake Volume <V>: 1364 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.12 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	371.38	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.47	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.73	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.71	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.3	0.5	0.8	

# capita-years	477.79			
% Phosphorus Retained by Soil	98	90	80	
Septic Tank Loading (kg/year)	2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	0.0
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	0.0
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/5/2017   Scenario: 27

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 82.03 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.45
Internal Load: 216 Lb   98 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 95.7 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 82 days
Sediment Phosphorus Release Rate: 0.5 mg/m^2-day   1.33E-003 lb/acre-day
Internal Load: 17 Lb   8 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3

Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 81.5 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 22.5 mg/m^2-day   6.11E-002 lb/acre-day
Internal Load: 279 Lb   127 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.5 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.5 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 11.5 mg/m^2-day
Period of Anoxia: 82 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	62	145	248
Internal Load: (kg)	28	66	113

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb   342 kg

	Lb	kg	%
From A Complete Mass Budget:	216	98	22.3
From Growing Season In Situ Phosphorus Increases:	17	8	2.2
From In Situ Phososphorus Increases In The Fall:	279	127	27.0
From Phososphorus Release Rate and Anoxic Area:	145	66	16.1

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	60	68	128

Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	216	147.8	145
Internal Load (kg):	98	67.0	66
External Load (Lb):	336	753	1916
External Load (kg):	152	342	869

Total Load (Lb):	552	901	2061
Total Load (kg):	250	409	935

Phosphorus Prediction and Uncertainty Analysis Module CASE 1

Date: 1/5/2017   Scenario: 24
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
Back calculation for SPO total phosphorus: 115 mg/m^3
Back calculation GSM phosphorus: 159.5 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 68 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-19	-22
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-23	-27
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-35	-41
Rechow, 1979 General	11	24	60	-62	-72
Rechow, 1977 Anoxic	53	119	304	33	38
Rechow, 1977 water load<50m/year	30	68	172	-18	-21
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	25	40
Vollenweider, 1982 Combined OECD	29	57	122	-17	-23
Dillon-Rigler-Kirchner	17	38	97	-24	-39
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-25	-34
Larsen-Mercier, 1976	36	81	205	19	31
Nurnberg, 1984 Oxic	47	69	129	-17	-20

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	811	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	1256	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	2722	GSM
Rechow, 1979 General	13	48	FIT	2293	GSM
Rechow, 1977 Anoxic	68	238	FIT	456	GSM
Rechow, 1977 water load<50m/year	37	137	P	806	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	42	184	FIT	450	SPO
Vollenweider, 1982 Combined OECD	27	112	FIT	1006	ANN

Dillon-Rigler-Kirchner	22	76	P	1025	SPO
Vollenweider, 1982 Shallow Lake/Res.	23	98	FIT	1133	ANN
Larsen-Mercier, 1976	48	160	P Pin	487	SPO
Nurnberg, 1984 Oxic	40	120	P	1137	ANN

Phosphorus Prediction and Uncertainty Analysis Module CASE 2

Date: 1/5/2017 Scenario: 25
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
Back calculation for SPO total phosphorus: 326.84 mg/m^3
Back calculation GSM phosphorus: 453.26 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 128 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-19	-22
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-23	-27
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-35	-41
Rechow, 1979 General	11	24	60	-62	-72
Rechow, 1977 Anoxic	53	119	304	33	38
Rechow, 1977 water load<50m/year	30	68	172	-18	-21
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	25	40
Vollenweider, 1982 Combined OECD	29	57	122	-17	-23
Dillon-Rigler-Kirchner	17	38	97	-24	-39
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-25	-34
Larsen-Mercier, 1976	36	81	205	19	31
Nurnberg, 1984 Oxic	74	95	155	9	10

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	2304	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	6415	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	27108	GSM
Rechow, 1979 General	13	48	FIT	6517	GSM
Rechow, 1977 Anoxic	68	238	FIT	1297	GSM
Rechow, 1977 water load<50m/year	37	137	P	2290	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A

Walker, 1977 General	42	184	FIT	1280	SPO
Vollenweider, 1982 Combined OECD	27	112	FIT	3598	ANN
Dillon-Rigler-Kirchner	22	76	P	2913	SPO
Vollenweider, 1982 Shallow Lake/Res.	23	98	FIT	3725	ANN
Larsen-Mercier, 1976	48	160	P Pin	1385	SPO
Nurnberg, 1984 Oxic	58	156	P	3481	ANN

Water and Nutrient Outflow Module
Date: 1/5/2017 Scenario: 14
Average Annual Surface Total Phosphorus: 82.03mg/m^3
Annual Discharge: 1.85E+003 AF => 2.28E+006 m^3
Annual Outflow Loading: 394.2 LB => 178.8 kg

Expanded Trophic Response Module
Date: 1/5/2017 Scenario: 34
Total Phosphorus: 86.12 mg/m^3
Growing Season
Chorophyll a: 39.54 mg/m^3
Secchi Disk Depth: 0.27 m
Carlson TSI Equations:
TSI (Total Phosphorus): 68 TSI (Chlorphyll a): 67 TSI (Secchi Disk Depth): 79

Expanded Trophic Response Module
Date: 1/5/2017 Scenario: 35
Total Phosphorus: 86.12 mg/m^3
Growing Season
Chorophyll a: 39.54 mg/m^3
Secchi Disk Depth: 0.27 m
Wisconsin Statewide Prediction Equations:

	Natural Lakes		Impoundments	
	Stratified	Mixed	Stratified	Mixed
Secchi Disk Depth using Chlorophyll_a:	1.0	0.8	1.1	0.7
Secchi Disk Depth using Total Phosphorus:	1.1	0.7	0.8	0.8
Chlorphyll_a using Total Phosphorus:	16.4	23.7	45.8	26.0

Expanded Trophic Response Module
Date: 1/5/2017 Scenario: 36
Total Phosphorus: 86.12 mg/m^3
Growing Season
Chorophyll a: 39.54 mg/m^3

Secchi Disk Depth: 0.27 m

Wisconsin Regional Prediction Equations:

	Region	Stratified Seepage	Stratified Drainage	Mixed Seepage	Mixed Drainage
Use Chlorophyll_a To Predict Secchi Disk Depth (m)	South	0.9	0.9	0.7	0.6
	Central	1.6	0.9	0.3	No Data
	North	1.3	0.9	1.0	1.0
Use Total Phosphorus To Predict Secchi Disk Depth (m)	South	1.1	0.7	0.5	0.6
	Central	2.6	0.3	0.5	No Data
	North	1.7	0.9	1.0	0.8
Use Total Phosphorus To Predict Chlorophyll_a (mg/m^3))	South	17.1	57.8	26.2	34.5
	Central	15.4	165.5	24.3	No Data
	North	8.5	23.4	18.2	12.7

Expanded Trophic Response Module

Date: 1/5/2017 Scenario: 37

Total Phosphorus: 86.12 mg/m^3

Growing Season

Chorophyll a: 39.54 mg/m^3

Secchi Disk Depth: 0.27 m

Cholorphyll a Nuisance Frequency

Chla Mean Min: 5

Chla Mean Max: 100

Chla Mean Increment: 5

Chla Temporal CV: 0.62

Chla Nuisance Criterion: 20

Mean	Freq %	ml	z	v	w	x
5	0.5	1.4	2.546	0.016	0.541	0.005
10	7.7	2.1	1.428	0.144	0.678	0.077
15	21.9	2.5	0.774	0.296	0.795	0.219
20	37.8	2.8	0.310	0.380	0.907	0.378
25	52.0	3.0	-0.050	0.398	0.984	0.480
30	63.5	3.2	-0.344	0.376	0.897	0.365
35	72.3	3.4	-0.593	0.335	0.835	0.277
40	79.0	3.5	-0.808	0.288	0.788	0.210
45	84.1	3.6	-0.998	0.242	0.751	0.159
50	87.9	3.7	-1.168	0.202	0.720	0.121
55	90.7	3.8	-1.322	0.167	0.695	0.093
60	92.8	3.9	-1.462	0.137	0.673	0.072
65	94.4	4.0	-1.591	0.112	0.654	0.056

70	95.6	4.1	-1.711	0.092	0.637	0.044
75	96.6	4.1	-1.822	0.076	0.623	0.034
80	97.3	4.2	-1.926	0.062	0.609	0.027
85	97.8	4.3	-2.024	0.051	0.598	0.022
90	98.3	4.3	-2.116	0.043	0.587	0.017
95	98.6	4.4	-2.203	0.035	0.577	0.014
100	98.9	4.4	-2.286	0.029	0.568	0.011

Date: 1/30/2017   Scenario: Lotus Lake 2014 (carp scenario)

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 41

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 82.03 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.45
Internal Load: 216 Lb   98 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 95.7 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Time Period of Stratification: 82 days
Sediment Phosphorus Release Rate: 0.5 mg/m^2-day   1.33E-003 lb/acre-day
Internal Load: 66 Lb   30 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3

Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 81.5 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 184.8 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 4.2 mg/m^2-day   1.15E-002 lb/acre-day
Internal Load: 210 Lb   95 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 184.8 acre
End of Anoxia Anoxic Sediment Area: 184.8 acre
Phosphorus Release Rate As Calculated In Method 2: 0.5 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.5 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 2.4 mg/m^2-day
Period of Anoxia: 82 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	247	577	989
Internal Load: (kg)	112	262	449

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb   342 kg

	Lb	kg	%
From A Complete Mass Budget:	216	98	22.3
From Growing Season In Situ Phosphorus Increases:	66	30	8.1
From In Situ Phososphorus Increases In The Fall:	210	95	21.8
From Phososphorus Release Rate and Anoxic Area:	577	262	43.4

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	60	66	214

Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	216	137.8	577
Internal Load (kg):	98	62.5	262
External Load (Lb):	336	753	1916
External Load (kg):	152	342	869

Total Load (Lb):	552	891	2493
Total Load (kg):	250	404	1131

Date: 1/26/2017   Scenario: Lotus 2014 Direct

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 7899.7 acre-ft/year
Areal Water Load <qs>: 31.9 ft/year
Lake Flushing Rate <p>: 5.79 1/year
Water Residence Time: 0.17 year
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	84.397	0.50	1.00	3.00	1.5	17	34	102
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	186.016	0.10	0.30	0.50	1.0	8	23	38
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	110.162	0.05	0.10	0.25	0.2	2	4	11
Wetlands	44.488	0.10	0.10	0.10	0.1	2	2	2
Forest	584.2	0.05	0.09	0.18	0.9	12	21	43
Lake Surface	248.0	0.10	0.30	1.00	1.3	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8			
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	1.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	5120.8	5762.7	100.0
Total Loading (kg)	53.4	2322.8	2613.9	100.0
Areal Loading (lb/ac-year)	0.47	20.65	23.24	
Areal Loading (mg/m^2-year)	53.17	2314.40	2604.49	
Total PS Loading (lb)	0.0	4815.9	4941.6	94.0
Total PS Loading (kg)	0.0	2184.5	2241.5	94.0
Total NPS Loading (lb)	89.2	185.8	431.2	4.9
Total NPS Loading (kg)	40.5	84.3	195.6	4.9

Wisconsin Internal Load Estimator

Date: 1/26/2017   Scenario: 35

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 82.03 mg/m^3
Phosphorus Inflow Concentration: 238.4 mg/m^3
Areal External Loading: 2314.4 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.54
Observed Phosphorus Retention Coefficient: 0.66
Internal Load: -587 Lb   -266 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 95.7 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 82 days
Sediment Phosphorus Release Rate: 0.5 mg/m^2-day   1.33E-003 lb/acre-day
Internal Load: 17 Lb   8 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3

Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 81.5 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 22.5 mg/m^2-day   6.11E-002 lb/acre-day
Internal Load: 279 Lb   127 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.5 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.5 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 11.5 mg/m^2-day
Period of Anoxia: 82 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	62	145	248
Internal Load: (kg)	28	66	113

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 5121 Lb   2323 kg

	Lb	kg	%
From A Complete Mass Budget:	-587	-266	-12.9
From Growing Season In Situ Phosphorus Increases:	17	8	0.3
From In Situ Phososphorus Increases In The Fall:	279	127	5.2
From Phososphorus Release Rate and Anoxic Area:	145	66	2.8

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	-25	116	130

Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	-587	147.8	145
Internal Load (kg):	-266	67.0	66
External Load (Lb):	118	5121	5763
External Load (kg):	53	2323	2614

Total Load (Lb):	-469	5269	5908
Total Load (kg):	-213	2390	2680

Date: 1/30/2017 Scenario: Lotus Lake 2014 Direct (modeled hydraulic loading)

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1904.7 acre-ft/year
Areal Water Load <qs>: 7.7 ft/year
Lake Flushing Rate <p>: 1.40 1/year
Water Residence Time: 0.72 year
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	84.4	0.50	1.00	3.00	7.0	17	34	102
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	186.0	0.10	0.30	0.50	4.6	8	23	38
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	110.2	0.05	0.10	0.25	0.9	2	4	11
Wetlands	44.5	0.10	0.10	0.10	0.4	2	2	2
Forest	584.2	0.05	0.09	0.18	4.4	12	21	43
Lake Surface	248.0	0.10	0.30	1.00	6.2	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8			
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	2.87	23.89	76.45	4.9

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	1075.4	1611.7	100.0
Total Loading (kg)	53.4	487.8	731.1	100.0
Areal Loading (lb/ac-year)	0.47	4.34	6.50	
Areal Loading (mg/m^2-year)	53.17	486.02	728.42	
Total PS Loading (lb)	0.0	770.5	790.7	71.7
Total PS Loading (kg)	0.0	349.5	358.6	71.7
Total NPS Loading (lb)	89.2	185.8	431.2	23.5
Total NPS Loading (kg)	40.5	84.3	195.6	23.5

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 36

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 82.03 mg/m^3
Phosphorus Inflow Concentration: 207.6 mg/m^3
Areal External Loading: 486.0 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.60
Internal Load: 143 Lb   65 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 95.7 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 82 days
Sediment Phosphorus Release Rate: 0.5 mg/m^2-day   1.33E-003 lb/acre-day
Internal Load: 17 Lb   8 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3

Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Water Column Phosphorus Concentration: 81.5 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 22.5 mg/m^2-day   6.11E-002 lb/acre-day
Internal Load: 279 Lb   127 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.5 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.5 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 11.5 mg/m^2-day
Period of Anoxia: 82 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	62	145	248
Internal Load: (kg)	28	66	113

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 1075 Lb   488 kg

	Lb	kg	%
From A Complete Mass Budget:	143	65	11.7
From Growing Season In Situ Phosphorus Increases:	17	8	1.5
From In Situ Phososphorus Increases In The Fall:	279	127	20.6
From Phososphorus Release Rate and Anoxic Area:	145	66	11.9

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	33	83	110

Osgood, 1988 Lake Mixing Index: 1.7

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	143	147.8	145
Internal Load (kg):	65	67.0	66
External Load (Lb):	118	1075	1612
External Load (kg):	53	488	731

Total Load (Lb):	260	1223	1757
Total Load (kg):	118	555	797

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/30/2017   Scenario: 32
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
Back calculation for SPO total phosphorus: 115 mg/m^3
Back calculation GSM phosphorus: 159.5 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 83 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	9	83	124	-3	-3
Canfield-Bachmann, 1981 Natural Lake	15	81	108	-5	-6
Canfield-Bachmann, 1981 Artificial Lake	14	63	79	-23	-27
Rechow, 1979 General	4	34	51	-52	-60
Rechow, 1977 Anoxic	18	166	249	80	93
Rechow, 1977 water load<50m/year	10	95	142	9	10
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	13	122	182	60	97
Vollenweider, 1982 Combined OECD	12	74	104	0	0
Dillon-Rigler-Kirchner	6	53	80	-9	-14
Vollenweider, 1982 Shallow Lake/Res.	9	65	93	-9	-12
Larsen-Mercier, 1976	12	112	169	50	81
Nurnberg, 1984 Oxic	41	90	117	4	5

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	32	122	FIT	940	GSM
Canfield-Bachmann, 1981 Natural Lake	25	233	FIT	1273	GSM
Canfield-Bachmann, 1981 Artificial Lake	20	181	FIT	2745	GSM
Rechow, 1979 General	13	52	FIT	2307	GSM
Rechow, 1977 Anoxic	66	241	FIT	469	GSM
Rechow, 1977 water load<50m/year	36	142	P	818	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	40	202	FIT	461	SPO
Vollenweider, 1982 Combined OECD	24	127	FIT	1030	ANN

Dillon-Rigler-Kirchner	21	78	P	1053	SPO
Vollenweider, 1982 Shallow Lake/Res.	21	110	FIT	1159	ANN
Larsen-Mercier, 1976	46	160	P Pin	499	SPO
Nurnberg, 1984 Oxic	46	140	P	1111	ANN

Water and Nutrient Outflow Module

Date: 1/30/2017   Scenario: 19

Average Annual Surface Total Phosphorus: 82.03mg/m^3

Annual Discharge: 1.90E+003 AF => 2.35E+006 m^3

Annual Outflow Loading: 406.3 LB =>   184.3 kg

Date: 1/5/2017   Scenario: LOTUS 2015

Lake Id: Lotus Lake 2015
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 96 mg/m^3
Observed growing season mean phosphorus (GSM): 142.36 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/5/2017   Scenario: 28

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 122.99 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.18
Internal Load: 422 Lb   192 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 152 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 91 days
Sediment Phosphorus Release Rate: 0.6 mg/m^2-day   1.68E-003 lb/acre-day
Internal Load: 23 Lb   11 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96 mg/m^3

Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Water Column Phosphorus Concentration: 53.1 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 12.6 mg/m^2-day   3.44E-002 lb/acre-day
Internal Load: 157 Lb   71 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.6 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.6 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 6.6 mg/m^2-day
Period of Anoxia: 91 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	69	161	276
Internal Load: (kg)	31	73	125

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 753 Lb   342 kg

	Lb	kg	%
From A Complete Mass Budget:	422	192	35.9
From Growing Season In Situ Phosphorus Increases:	23	11	3.0
From In Situ Phososphorus Increases In The Fall:	157	71	17.3
From Phososphorus Release Rate and Anoxic Area:	161	73	17.6

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	101	57	131

Osgood, 1988 Lake Mixing Index: 1.7

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	422	90.1	161
Internal Load (kg):	192	40.9	73
External Load (Lb):	336	753	1916
External Load (kg):	152	342	869

Total Load (Lb):	758	843	2077
Total Load (kg):	344	382	942

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/6/2017   Scenario: 26
Observed spring overturn total phosphorus (SPO): 96.0 mg/m^3
Observed growing season mean phosphorus (GSM): 142.4 mg/m^3
Back calculation for SPO total phosphorus: 177.78 mg/m^3
Back calculation GSM phosphorus: 263.63 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 101 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-75	-53
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-79	-55
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-91	-64
Rechow, 1979 General	11	24	60	-118	-83
Rechow, 1977 Anoxic	53	119	304	-23	-16
Rechow, 1977 water load<50m/year	30	68	172	-74	-52
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	-9	-9
Vollenweider, 1982 Combined OECD	29	57	122	-62	-52
Dillon-Rigler-Kirchner	17	38	97	-58	-60
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-70	-59
Larsen-Mercier, 1976	36	81	205	-15	-16
Nurnberg, 1984 Oxic	62	83	143	-59	-41

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	1340	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	2704	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	7954	GSM
Rechow, 1979 General	13	48	FIT	3790	GSM
Rechow, 1977 Anoxic	68	238	FIT	754	GSM
Rechow, 1977 water load<50m/year	37	137	P	1332	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	42	184	FIT	696	SPO
Vollenweider, 1982 Combined OECD	27	112	FIT	1796	ANN

Dillon-Rigler-Kirchner	22	76	P	1584	SPO
Vollenweider, 1982 Shallow Lake/Res.	23	98	FIT	1946	ANN
Larsen-Mercier, 1976	48	160	P Pin	753	SPO
Nurnberg, 1984 Oxic	50	140	P	1922	ANN

Water and Nutrient Outflow Module

Date: 1/6/2017 Scenario: 15
Average Annual Surface Total Phosphorus: 122.98mg/m^3
Annual Discharge: 1.85E+003 AF => 2.28E+006 m^3
Annual Outflow Loading: 591.1 LB => 268.1 kg

Expanded Trophic Response Module

Date: 1/6/2017 Scenario: 38
Total Phosphorus: 142.4 mg/m^3
Growing Season
Chorophyll a: 67.3 mg/m^3
Secchi Disk Depth: 0.24 m
Carlson TSI Equations:
TSI (Total Phosphorus): 76 TSI (Chlorphyll a): 72 TSI (Secchi Disk Depth): 81

Expanded Trophic Response Module

Date: 1/6/2017 Scenario: 39
Total Phosphorus: 142.4 mg/m^3
Growing Season
Chorophyll a: 67.3 mg/m^3
Secchi Disk Depth: 0.24 m
Wisconsin Statewide Prediction Equations:

	Natural Lakes		Impoundments	
	Stratified	Mixed	Stratified	Mixed
Secchi Disk Depth using Chlorophyll_a:	0.8	0.6	1.0	0.6
Secchi Disk Depth using Total Phosphorus:	0.9	0.5	0.6	0.7
Chlorphyll_a using Total Phosphorus:	21.5	32.9	76.5	37.0

Expanded Trophic Response Module

Date: 1/6/2017 Scenario: 40
Total Phosphorus: 142.4 mg/m^3
Growing Season
Chorophyll a: 67.3 mg/m^3
Secchi Disk Depth: 0.24 m
Wisconsin Regional Prediction Equations:

	Region	Stratified Seepage	Stratified Drainage	Mixed Seepage	Mixed Drainage
Use Chlorophyll_a To Predict Secchi Disk Depth (m)	South	0.7	0.7	0.6	0.5
	Central	1.3	0.6	0.2	No Data
	North	1.1	0.7	0.8	0.9
Use Total Phosphorus To Predict Secchi Disk Depth (m)	South	0.9	0.5	0.4	0.5
	Central	2.6	0.2	0.3	No Data
	North	1.5	0.7	0.8	0.6
Use Total Phosphorus To Predict Chlorophyll_a (mg/m^3))	South	23.7	105.7	38.8	53.2
	Central	20.8	350.2	33.6	No Data
	North	9.2	35.1	23.8	13.7

Expanded Trophic Response Module

Date: 1/6/2017 Scenario: 41
Total Phosphorus: 142.4 mg/m^3
Growing Season
Chorophyll a: 67.3 mg/m^3
Secchi Disk Depth: 0.24 m

Cholorphyll a Nuisance Frequency

Chla Mean Min: 5
Chla Mean Max: 100
Chla Mean Increment: 5
Chla Temporal CV: 0.62
Chla Nuisance Criterion: 20

Mean	Freq %	ml	z	v	w	x
5	0.5	1.4	2.546	0.016	0.541	0.005
10	7.7	2.1	1.428	0.144	0.678	0.077
15	21.9	2.5	0.774	0.296	0.795	0.219
20	37.8	2.8	0.310	0.380	0.907	0.378
25	52.0	3.0	-0.050	0.398	0.984	0.480
30	63.5	3.2	-0.344	0.376	0.897	0.365
35	72.3	3.4	-0.593	0.335	0.835	0.277
40	79.0	3.5	-0.808	0.288	0.788	0.210
45	84.1	3.6	-0.998	0.242	0.751	0.159
50	87.9	3.7	-1.168	0.202	0.720	0.121
55	90.7	3.8	-1.322	0.167	0.695	0.093
60	92.8	3.9	-1.462	0.137	0.673	0.072
65	94.4	4.0	-1.591	0.112	0.654	0.056
70	95.6	4.1	-1.711	0.092	0.637	0.044
75	96.6	4.1	-1.822	0.076	0.623	0.034

80	97.3	4.2	-1.926	0.062	0.609	0.027
85	97.8	4.3	-2.024	0.051	0.598	0.022
90	98.3	4.3	-2.116	0.043	0.587	0.017
95	98.6	4.4	-2.203	0.035	0.577	0.014
100	98.9	4.4	-2.286	0.029	0.568	0.011

Summary Trophic Response Module

Date: 1/6/2017   Scenario: 2
Average Spring Mixed Total Phosphorus:: 96.0 mg/m^3
Growing Season Chlorophyll_a:: 28.2 mg/m^3
Average Growing Season Chlorophyll_a:: 67.3 mg/m^3

Natural Lake Secchi Depth (m)		Impoundment Secchi Depth (m)	
Mixed	Stratified	Mixed	Stratified
0.58	0.81	0.61	0.95

Wisconsin Trophic State Index (TSI)

Total Phosphorus::	142.4 mg/m^3	TSI = 67
Chlorophyll a::	67.3 mg/m^3	TSI = 66
Secchi Disc Depth::	0.24 m	TSI = 81

Date: 1/30/2017   Scenario: Lotus Lake 2015 (carp scenario)

Lake Id: Lotus Lake 2015
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 96.0 mg/m^3
Observed growing season mean phosphorus (GSM): 142.4 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8			
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 42

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 122.99 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.18
Internal Load: 422 Lb   192 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96.00 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 53.1 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Time Period of Stratification: 91 days
Sediment Phosphorus Release Rate: -0.5 mg/m^2-day   -1.29E-003 lb/acre-day
Internal Load: -71 Lb   -32 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96.00 mg/m^3

Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 53.1 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 184.8 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 0.8 mg/m^2-day 2.08E-003 lb/acre-day
Internal Load: 38 Lb 17 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 184.8 acre
End of Anoxia Anoxic Sediment Area: 184.8 acre
Phosphorus Release Rate As Calculated In Method 2: -0.5 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: -0.5 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.1 mg/m^2-day
Period of Anoxia: 91 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	274	640	1098
Internal Load: (kg)	124	290	498

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb 342 kg

	Lb	kg	%
From A Complete Mass Budget:	422	192	35.9
From Growing Season In Situ Phosphorus Increases:	-71	-32	-10.4
From In Situ Phososphorus Increases In The Fall:	38	17	4.8
From Phososphorus Release Rate and Anoxic Area:	640	290	46.0

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	101	36	227

Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	422	-16.7	640
Internal Load (kg):	192	-7.6	290
External Load (Lb):	336	753	1916
External Load (kg):	152	342	869

Total Load (Lb):	758	736	2556
Total Load (kg):	344	334	1159

Date: 1/30/2017   Scenario: Lotus Lake 2015 Direct (modeled hydraulic loading)

Lake Id: Lotus Lake 2014

Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1904.7 acre-ft/year
Areal Water Load <qs>: 7.7 ft/year
Lake Flushing Rate <p>: 1.40 1/year
Water Residence Time: 0.72 year
Observed spring overturn total phosphorus (SPO): 96 mg/m^3
Observed growing season mean phosphorus (GSM): 142.36 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	84.4	0.50	1.00	3.00	8.4	17	34	102
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	186.0	0.10	0.30	0.50	5.6	8	23	38
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	110.2	0.05	0.10	0.25	1.1	2	4	11
Wetlands	44.5	0.10	0.10	0.10	0.4	2	2	2
Forest	584.2	0.05	0.09	0.18	5.2	12	21	43
Lake Surface	248.0	0.10	0.30	1.00	7.4	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	5.9

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	896.3	1421.1	100.0
Total Loading (kg)	53.4	406.6	644.6	100.0
Areal Loading (lb/ac-year)	0.47	3.61	5.73	
Areal Loading (mg/m^2-year)	53.17	405.11	642.28	
Total PS Loading (lb)	0.0	591.5	600.0	66.0
Total PS Loading (kg)	0.0	268.3	272.2	66.0
Total NPS Loading (lb)	89.2	185.8	431.2	28.1
Total NPS Loading (kg)	40.5	84.3	195.6	28.1

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 38

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 122.99 mg/m^3
Phosphorus Inflow Concentration: 173.1 mg/m^3
Areal External Loading: 405.1 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.29
Internal Load: 402 Lb   182 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 152 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 91 days
Sediment Phosphorus Release Rate: 0.6 mg/m^2-day   1.68E-003 lb/acre-day
Internal Load: 23 Lb   11 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96 mg/m^3

Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Water Column Phosphorus Concentration: 53.1 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 12.6 mg/m^2-day   3.44E-002 lb/acre-day
Internal Load: 157 Lb   71 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.6 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.6 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 6.6 mg/m^2-day
Period of Anoxia: 91 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	69	161	276
Internal Load: (kg)	31	73	125

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 896 Lb   407 kg

	Lb	kg	%
From A Complete Mass Budget:	402	182	30.9
From Growing Season In Situ Phosphorus Increases:	23	11	2.5
From In Situ Phososphorus Increases In The Fall:	157	71	14.9
From Phososphorus Release Rate and Anoxic Area:	161	73	15.2

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	84	63	103

Osgood, 1988 Lake Mixing Index: 1.7

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	402	90.1	161
Internal Load (kg):	182	40.9	73
External Load (Lb):	118	896	1421
External Load (kg):	53	407	645

Total Load (Lb):	519	986	1582
Total Load (kg):	236	447	718

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/30/2017   Scenario: 35
Observed spring overturn total phosphorus (SPO): 96.0 mg/m^3
Observed growing season mean phosphorus (GSM): 142.4 mg/m^3
Back calculation for SPO total phosphorus: 177.78 mg/m^3
Back calculation GSM phosphorus: 263.63 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 63 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	10	74	117	-68	-48
Canfield-Bachmann, 1981 Natural Lake	15	71	99	-71	-50
Canfield-Bachmann, 1981 Artificial Lake	14	56	74	-86	-60
Rechow, 1979 General	4	28	45	-114	-80
Rechow, 1977 Anoxic	18	138	219	-4	-3
Rechow, 1977 water load<50m/year	10	79	126	-63	-44
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	13	101	161	5	5
Vollenweider, 1982 Combined OECD	12	64	94	-55	-46
Dillon-Rigler-Kirchner	6	44	70	-52	-54
Vollenweider, 1982 Shallow Lake/Res.	9	55	83	-64	-54
Larsen-Mercier, 1976	12	94	149	-2	-2
Nurnberg, 1984 Oxic	33	72	99	-70	-49

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	30	111	FIT	1452	GSM
Canfield-Bachmann, 1981 Natural Lake	22	204	FIT	2733	GSM
Canfield-Bachmann, 1981 Artificial Lake	17	161	FIT	7994	GSM
Rechow, 1979 General	11	44	FIT	3812	GSM
Rechow, 1977 Anoxic	57	205	FIT	775	GSM
Rechow, 1977 water load<50m/year	31	122	P	1353	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	34	171	FIT	713	SPO
Vollenweider, 1982 Combined OECD	22	111	FIT	1839	ANN

Dillon-Rigler-Kirchner	18	66	P	1627	SPO
Vollenweider, 1982 Shallow Lake/Res.	19	94	FIT	1992	ANN
Larsen-Mercier, 1976	39	137	P Pin	771	SPO
Nurnberg, 1984 Oxic	37	113	P	2119	ANN

Water and Nutrient Outflow Module

Date: 1/30/2017 Scenario: 21

Average Annual Surface Total Phosphorus: 122.99mg/m^3

Annual Discharge: 1.90E+003 AF => 2.35E+006 m^3

Annual Outflow Loading: 609.1 LB => 276.3 kg

Date: 1/6/2017   Scenario: LOTUS 2016

Lake Id: Lotus Lake 2016
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 64 mg/m^3
Observed growing season mean phosphorus (GSM): 109.12 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/6/2017 Scenario: 29

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 98.17 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.34
Internal Load: 298 Lb 135 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 122.0 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 38 days
Sediment Phosphorus Release Rate: 0.6 mg/m^2-day 1.73E-003 lb/acre-day
Internal Load: 10 Lb 5 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3

Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Water Column Phosphorus Concentration: 77.6 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 19.9 mg/m^2-day   5.41E-002 lb/acre-day
Internal Load: 247 Lb   112 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.6 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.6 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 10.3 mg/m^2-day
Period of Anoxia: 38 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	29	67	115
Internal Load: (kg)	13	30	52

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 753 Lb   342 kg

	Lb	kg	%
From A Complete Mass Budget:	298	135	28.3
From Growing Season In Situ Phosphorus Increases:	10	5	1.3
From In Situ Phososphorus Increases In The Fall:	247	112	24.7
From Phososphorus Release Rate and Anoxic Area:	67	30	8.2

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	77	65	112

Osgood, 1988 Lake Mixing Index: 1.7

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	298	128.5	67
Internal Load (kg):	135	58.3	30
External Load (Lb):	336	753	1916
External Load (kg):	152	342	869

Total Load (Lb):	633	881	1983
Total Load (kg):	287	400	899

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/6/2017 Scenario: 27
Observed spring overturn total phosphorus (SPO): 64.0 mg/m^3
Observed growing season mean phosphorus (GSM): 109.1 mg/m^3
Back calculation for SPO total phosphorus: 118.52 mg/m^3
Back calculation GSM phosphorus: 202.04 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 65 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-42	-38
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-46	-42
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-58	-53
Rechow, 1979 General	11	24	60	-85	-78
Rechow, 1977 Anoxic	53	119	304	10	9
Rechow, 1977 water load<50m/year	30	68	172	-41	-38
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	23	36
Vollenweider, 1982 Combined OECD	29	57	122	-30	-35
Dillon-Rigler-Kirchner	17	38	97	-26	-41
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-38	-44
Larsen-Mercier, 1976	36	81	205	17	27
Nurnberg, 1984 Oxic	46	67	128	-42	-38

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	1027	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	1794	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	4467	GSM
Rechow, 1979 General	13	48	FIT	2905	GSM
Rechow, 1977 Anoxic	68	238	FIT	578	GSM
Rechow, 1977 water load<50m/year	37	137	P	1021	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	42	184	FIT	464	SPO
Vollenweider, 1982 Combined OECD	27	112	FIT	1216	ANN

Dillon-Rigler-Kirchner	22	76	P	1056	SPO
Vollenweider, 1982 Shallow Lake/Res.	23	98	FIT	1352	ANN
Larsen-Mercier, 1976	48	160	P Pin	502	SPO
Nurnberg, 1984 Oxic	39	118	P	1521	ANN

Water and Nutrient Outflow Module
Date: 1/6/2017   Scenario: 16
Average Annual Surface Total Phosphorus: 98.17mg/m^3
Annual Discharge: 1.85E+003 AF => 2.28E+006 m^3
Annual Outflow Loading: 471.8 LB =>   214.0 kg

Expanded Trophic Response Module
Date: 1/6/2017   Scenario: 42
Total Phosphorus: 109.1 mg/m^3
Growing Season
Chorophyll a: 43.49 mg/m^3
Secchi Disk Depth: 0.42 m
Carlson TSI Equations:
TSI (Total Phosphorus):   72   TSI (Chlorphyll a):   68   TSI (Secchi Disk Depth):   73

Expanded Trophic Response Module
Date: 1/6/2017   Scenario: 43
Total Phosphorus: 109.1 mg/m^3
Growing Season
Chorophyll a: 43.49 mg/m^3
Secchi Disk Depth: 0.42 m
Wisconsin Statewide Prediction Equations:

	Natural Lakes		Impoundments	
	Stratified	Mixed	Stratified	Mixed
Secchi Disk Depth using Chlorophyll_a:	1.0	0.7	1.1	0.7
Secchi Disk Depth using Total Phosphorus:	1.0	0.6	0.7	0.8
Chlorphyll_a using Total Phosphorus:	18.6	27.7	58.3	30.7

Expanded Trophic Response Module
Date: 1/6/2017   Scenario: 44
Total Phosphorus: 109.1 mg/m^3
Growing Season
Chorophyll a: 43.49 mg/m^3
Secchi Disk Depth: 0.42 m
Wisconsin Regional Prediction Equations:

	Region	Stratified Seepage	Stratified Drainage	Mixed Seepage	Mixed Drainage
Use Chlorophyll_a To Predict	South	0.9	0.8	0.6	0.6
Secchi Disk Depth (m)	Central	1.5	0.8	0.3	No Data
	North	1.3	0.9	0.9	1.0
Use Total Phosphorus To	South	1.0	0.6	0.5	0.6
Predict Secchi Disk Depth (m)	Central	2.6	0.2	0.4	No Data
	North	1.6	0.8	0.9	0.7
Use Total Phosphorus To	South	19.9	76.8	31.5	42.3
Predict Chlorophyll_a (mg/m^3))	Central	17.7	235.4	28.3	No Data
	North	8.8	28.3	20.6	13.1

Expanded Trophic Response Module

Date: 1/6/2017   Scenario: 45
Total Phosphorus: 109.1 mg/m^3
Growing Season
Chorophyll a: 43.49 mg/m^3
Secchi Disk Depth: 0.42 m

Cholorphyll a Nuisance Frequency

Chla Mean Min: 5
Chla Mean Max: 100
Chla Mean Increment: 5
Chla Temporal CV: 0.62
Chla Nuisance Criterion: 20

Mean	Freq %	ml	z	v	w	x
5	0.5	1.4	2.546	0.016	0.541	0.005
10	7.7	2.1	1.428	0.144	0.678	0.077
15	21.9	2.5	0.774	0.296	0.795	0.219
20	37.8	2.8	0.310	0.380	0.907	0.378
25	52.0	3.0	-0.050	0.398	0.984	0.480
30	63.5	3.2	-0.344	0.376	0.897	0.365
35	72.3	3.4	-0.593	0.335	0.835	0.277
40	79.0	3.5	-0.808	0.288	0.788	0.210
45	84.1	3.6	-0.998	0.242	0.751	0.159
50	87.9	3.7	-1.168	0.202	0.720	0.121
55	90.7	3.8	-1.322	0.167	0.695	0.093
60	92.8	3.9	-1.462	0.137	0.673	0.072
65	94.4	4.0	-1.591	0.112	0.654	0.056
70	95.6	4.1	-1.711	0.092	0.637	0.044
75	96.6	4.1	-1.822	0.076	0.623	0.034

80	97.3	4.2	-1.926	0.062	0.609	0.027
85	97.8	4.3	-2.024	0.051	0.598	0.022
90	98.3	4.3	-2.116	0.043	0.587	0.017
95	98.6	4.4	-2.203	0.035	0.577	0.014
100	98.9	4.4	-2.286	0.029	0.568	0.011

Summary Trophic Response Module

Date: 1/6/2017 Scenario: 3
Average Spring Mixed Total Phosphorus:: 64 mg/m^3
Growing Season Chlorophyll_a:: 21.0 mg/m^3
Average Growing Season Chlorophyll_a:: 109.1 mg/m^3

Natural Lake Secchi Depth (m)		Impoundment Secchi Depth (m)	
Mixed	Stratified	Mixed	Stratified
0.46	0.65	0.51	0.82

Wisconsin Trophic State Index (TSI)

Total Phosphorus::	109.1 mg/m^3	TSI = 65
Chlorophyll a::	43.49 mg/m^3	TSI = 63
Secchi Disc Depth::	0.42 m	TSI = 73

Date: 1/30/2017 Scenario: Lotus Lake 2016 (carp scenario)

Lake Id: Lotus Lake 2016
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 64.0 mg/m^3
Observed growing season mean phosphorus (GSM): 109.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 43

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 98.17 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.34
Internal Load: 298 Lb   135 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 122.0 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Time Period of Stratification: 38 days
Sediment Phosphorus Release Rate: 0.6 mg/m^2-day   1.73E-003 lb/acre-day
Internal Load: 40 Lb   18 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3

Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 77.6 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 184.8 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 2.5 mg/m^2-day   6.90E-003 lb/acre-day
Internal Load: 125 Lb   57 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 184.8 acre
End of Anoxia Anoxic Sediment Area: 184.8 acre
Phosphorus Release Rate As Calculated In Method 2: 0.6 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.6 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 1.6 mg/m^2-day
Period of Anoxia: 38 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	115	267	458
Internal Load: (kg)	52	121	208

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb   342 kg

	Lb	kg	%
From A Complete Mass Budget:	298	135	28.3
From Growing Season In Situ Phosphorus Increases:	40	18	5.0
From In Situ Phososphorus Increases In The Fall:	125	57	14.3
From Phososphorus Release Rate and Anoxic Area:	267	121	26.2

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	77	55	152

Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	298	82.7	267
Internal Load (kg):	135	37.5	121
External Load (Lb):	336	753	1916
External Load (kg):	152	342	869

Total Load (Lb):	633	836	2183
Total Load (kg):	287	379	990

Date: 1/30/2017 Scenario: Lotus Lake 2016 Direct (modeled hydraulic loading)

Lake Id: Lotus Lake 2014

Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1904.7 acre-ft/year
Areal Water Load <qs>: 7.7 ft/year
Lake Flushing Rate <p>: 1.40 1/year
Water Residence Time: 0.72 year
Observed spring overturn total phosphorus (SPO): 64 mg/m^3
Observed growing season mean phosphorus (GSM): 109.12 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	84.4	0.50	1.00	3.00	8.5	17	34	102
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	186.0	0.10	0.30	0.50	5.6	8	23	38
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	110.2	0.05	0.10	0.25	1.1	2	4	11
Wetlands	44.5	0.10	0.10	0.10	0.4	2	2	2
Forest	584.2	0.05	0.09	0.18	5.3	12	21	43
Lake Surface	248.0	0.10	0.30	1.00	7.5	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8			
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	2.87	23.89	76.45	6.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	884.9	1402.4	100.0
Total Loading (kg)	53.4	401.4	636.1	100.0
Areal Loading (lb/ac-year)	0.47	3.57	5.65	
Areal Loading (mg/m^2-year)	53.17	399.94	633.83	
Total PS Loading (lb)	0.0	580.1	581.4	65.6
Total PS Loading (kg)	0.0	263.1	263.7	65.6
Total NPS Loading (lb)	89.2	185.8	431.2	28.5
Total NPS Loading (kg)	40.5	84.3	195.6	28.5

Wisconsin Internal Load Estimator

Date: 1/30/2017 Scenario: 40

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 98.17 mg/m^3
Phosphorus Inflow Concentration: 170.8 mg/m^3
Areal External Loading: 399.9 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.43
Internal Load: 276 Lb 125 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3
Hypolimnetic Volume: 153.9 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 122.0 mg/m^3
Hypolimnetic Volume: 153.9 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 38 days
Sediment Phosphorus Release Rate: 0.6 mg/m^2-day 1.74E-003 lb/acre-day
Internal Load: 10 Lb 5 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3

Hypolimnetic Volume: 153.9 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Water Column Phosphorus Concentration: 77.6 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 19.9 mg/m^2-day   5.40E-002 lb/acre-day
Internal Load: 247 Lb   112 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.6 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.6 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 10.3 mg/m^2-day
Period of Anoxia: 38 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	29	67	115
Internal Load: (kg)	13	30	52

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 885 Lb   401 kg

	Lb	kg	%
From A Complete Mass Budget:	276	125	23.8
From Growing Season In Situ Phosphorus Increases:	10	5	1.1
From In Situ Phososphorus Increases In The Fall:	247	112	21.8
From Phososphorus Release Rate and Anoxic Area:	67	30	7.1

Predicted Water Column Total Phosphorus Concentration (ug/l)

Nurnberg+ 1984 Total Phosphorus Model:	Low	Most Likely	High
	59	70	84

Osgood, 1988 Lake Mixing Index: 1.7

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	276	128.5	67
Internal Load (kg):	125	58.3	30
External Load (Lb):	118	885	1402
External Load (kg):	53	401	636

Total Load (Lb):	394	1013	1470
Total Load (kg):	179	460	667

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/30/2017   Scenario: 36
Observed spring overturn total phosphorus (SPO): 64.0 mg/m^3
Observed growing season mean phosphorus (GSM): 109.1 mg/m^3
Back calculation for SPO total phosphorus: 118.52 mg/m^3
Back calculation GSM phosphorus: 202.04 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 70 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	10	73	116	-36	-33
Canfield-Bachmann, 1981 Natural Lake	15	70	98	-39	-36
Canfield-Bachmann, 1981 Artificial Lake	14	56	73	-53	-49
Rechow, 1979 General	4	28	44	-81	-74
Rechow, 1977 Anoxic	18	136	216	27	25
Rechow, 1977 water load<50m/year	10	78	124	-31	-28
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	13	100	159	36	56
Vollenweider, 1982 Combined OECD	12	63	93	-24	-28
Dillon-Rigler-Kirchner	6	44	69	-20	-31
Vollenweider, 1982 Shallow Lake/Res.	9	55	82	-32	-37
Larsen-Mercier, 1976	12	93	147	29	45
Nurnberg, 1984 Oxic	36	75	101	-34	-31

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	30	110	FIT	1108	GSM
Canfield-Bachmann, 1981 Natural Lake	22	202	FIT	1816	GSM
Canfield-Bachmann, 1981 Artificial Lake	17	161	FIT	4496	GSM
Rechow, 1979 General	11	43	FIT	2922	GSM
Rechow, 1977 Anoxic	56	202	FIT	594	GSM
Rechow, 1977 water load<50m/year	30	120	P	1037	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	34	169	FIT	476	SPO
Vollenweider, 1982 Combined OECD	22	109	FIT	1244	ANN

Dillon-Rigler-Kirchner	18	65	P	1085	SPO
Vollenweider, 1982 Shallow Lake/Res.	19	94	FIT	1384	ANN
Larsen-Mercier, 1976	39	136	P Pin	514	SPO
Nurnberg, 1984 Oxic	39	117	P	1541	ANN

Water and Nutrient Outflow Module

Date: 1/30/2017   Scenario: 22

Average Annual Surface Total Phosphorus: 98.1mg/m^3

Annual Discharge: 1.90E+003 AF => 2.35E+006 m^3

Annual Outflow Loading: 485.9 LB =>   220.4 kg

Date: 2/1/2017   Scenario: Lotus Lake Combined

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 74.03 mg/m^3
Observed growing season mean phosphorus (GSM): 112.53 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8			
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 2/1/2017   Scenario: 44

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 101.06 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.33
Internal Load: 312 Lb   142 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 103.5 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 1 days
Sediment Phosphorus Release Rate: -10.2 mg/m^2-day   -2.76E-002 lb/acre-day
Internal Load: -4 Lb   -2 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3

Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 70.73 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 17.3 mg/m^2-day   4.71E-002 lb/acre-day
Internal Load: 215 Lb   98 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: -10.2 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: -10.2 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 3.6 mg/m^2-day
Period of Anoxia: 70.33 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	53	124	213
Internal Load: (kg)	24	56	97

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb   342 kg

	Lb	kg	%
From A Complete Mass Budget:	312	142	29.3
From Growing Season In Situ Phosphorus Increases:	-4	-2	-0.6
From In Situ Phososphorus Increases In The Fall:	215	98	22.2
From Phososphorus Release Rate and Anoxic Area:	124	56	14.2

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	79	60	124

Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	312	105.4	124
Internal Load (kg):	142	47.8	56
External Load (Lb):	336	753	1916
External Load (kg):	152	342	869

Total Load (Lb):	648	858	2040
Total Load (kg):	294	389	925

Phosphorus Prediction and Uncertainty Analysis Module

Date: 2/1/2017 Scenario: 37
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
Back calculation for SPO total phosphorus: 137.09 mg/m^3
Back calculation GSM phosphorus: 208.39 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 142 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-46	-41
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-50	-44
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-62	-55
Rechow, 1979 General	11	24	60	-89	-79
Rechow, 1977 Anoxic	53	119	304	7	6
Rechow, 1977 water load<50m/year	30	68	172	-45	-40
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	13	18
Vollenweider, 1982 Combined OECD	29	57	122	-36	-39
Dillon-Rigler-Kirchner	17	38	97	-36	-49
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-44	-47
Larsen-Mercier, 1976	36	81	205	7	9
Nurnberg, 1984 Oxic	80	101	161	-12	-11

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	1059	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	1881	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	4772	GSM
Rechow, 1979 General	13	48	FIT	2996	GSM
Rechow, 1977 Anoxic	68	238	FIT	596	GSM
Rechow, 1977 water load<50m/year	37	137	P	1053	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	42	184	FIT	537	SPO
Vollenweider, 1982 Combined OECD	27	112	FIT	1332	ANN

Dillon-Rigler-Kirchner	22	76	P	1222	SPO
Vollenweider, 1982 Shallow Lake/Res.	23	98	FIT	1472	ANN
Larsen-Mercier, 1976	48	160	P Pin	581	SPO
Nurnberg, 1984 Oxic	62	165	P	1281	ANN

Water and Nutrient Outflow Module
Date: 2/1/2017 Scenario: 23
Average Annual Surface Total Phosphorus: 101.06mg/m^3
Annual Discharge: 1.85E+003 AF => 2.28E+006 m^3
Annual Outflow Loading: 485.7 LB => 220.3 kg

Expanded Trophic Response Module
Date: 2/1/2017 Scenario: 54
Total Phosphorus: 101.06 mg/m^3
Growing Season
Chorophyll a: 50.11 mg/m^3
Secchi Disk Depth: 0.42 m
Carlson TSI Equations:
TSI (Total Phosphorus): 71 TSI (Chlorphyll a): 69 TSI (Secchi Disk Depth): 73

Expanded Trophic Response Module
Date: 2/1/2017 Scenario: 55
Total Phosphorus: 101.06 mg/m^3
Growing Season
Chorophyll a: 50.11 mg/m^3
Secchi Disk Depth: 0.42 m
Wisconsin Statewide Prediction Equations:

	Natural Lakes		Impoundments	
	Stratified	Mixed	Stratified	Mixed
Secchi Disk Depth using Chlorophyll_a:	0.9	0.7	1.0	0.7
Secchi Disk Depth using Total Phosphorus:	1.1	0.6	0.8	0.8
Chlorphyll_a using Total Phosphorus:	17.9	26.3	53.9	29.1

Expanded Trophic Response Module
Date: 2/1/2017 Scenario: 56
Total Phosphorus: 101.06 mg/m^3
Growing Season
Chorophyll a: 50.11 mg/m^3
Secchi Disk Depth: 0.42 m
Wisconsin Regional Prediction Equations:

	Region	Stratified Seepage	Stratified Drainage	Mixed Seepage	Mixed Drainage
Use Chlorophyll_a To Predict Secchi Disk Depth (m)	South	0.8	0.8	0.6	0.5
	Central	1.5	0.8	0.2	No Data
	North	1.2	0.8	0.9	1.0
Use Total Phosphorus To Predict Secchi Disk Depth (m)	South	1.1	0.7	0.5	0.6
	Central	2.6	0.3	0.4	No Data
	North	1.6	0.8	0.9	0.7
Use Total Phosphorus To Predict Chlorophyll_a (mg/m^3))	South	19.0	70.0	29.7	39.6
	Central	16.9	210.1	27.0	No Data
	North	8.7	26.6	19.8	13.0

Expanded Trophic Response Module

Date: 2/1/2017 Scenario: 57
Total Phosphorus: 101.06 mg/m^3
Growing Season
Chorophyll a: 50.11 mg/m^3
Secchi Disk Depth: 0.42 m

Cholorphyll a Nuisance Frequency

Chla Mean Min: 5
Chla Mean Max: 100
Chla Mean Increment: 5
Chla Temporal CV: 0.62
Chla Nuisance Criterion: 20

Mean	**Freq %**	**ml**	**z**	**v**	**w**	**x**
5	0.5	1.4	2.546	0.016	0.541	0.005
10	7.7	2.1	1.428	0.144	0.678	0.077
15	21.9	2.5	0.774	0.296	0.795	0.219
20	37.8	2.8	0.310	0.380	0.907	0.378
25	52.0	3.0	-0.050	0.398	0.984	0.480
30	63.5	3.2	-0.344	0.376	0.897	0.365
35	72.3	3.4	-0.593	0.335	0.835	0.277
40	79.0	3.5	-0.808	0.288	0.788	0.210
45	84.1	3.6	-0.998	0.242	0.751	0.159
50	87.9	3.7	-1.168	0.202	0.720	0.121
55	90.7	3.8	-1.322	0.167	0.695	0.093
60	92.8	3.9	-1.462	0.137	0.673	0.072
65	94.4	4.0	-1.591	0.112	0.654	0.056
70	95.6	4.1	-1.711	0.092	0.637	0.044
75	96.6	4.1	-1.822	0.076	0.623	0.034

80	97.3	4.2	-1.926	0.062	0.609	0.027
85	97.8	4.3	-2.024	0.051	0.598	0.022
90	98.3	4.3	-2.116	0.043	0.587	0.017
95	98.6	4.4	-2.203	0.035	0.577	0.014
100	98.9	4.4	-2.286	0.029	0.568	0.011

Date: 2/1/2017 Scenario: Lotus Lake Combined (carp scenario)

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8			
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 2/1/2017   Scenario: 47

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 101.06 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.33
Internal Load: 312 Lb   142 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 103.5 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Time Period of Stratification: 70.33 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: -17 Lb   -8 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3

Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Water Column Phosphorus Concentration: 70.73 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 184.8 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 1.5 mg/m^2-day   4.07E-003 lb/acre-day
Internal Load: 74 Lb   34 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 184.8 acre
End of Anoxia Anoxic Sediment Area: 184.8 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.7 mg/m^2-day
Period of Anoxia: 70.33 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	212	495	848
Internal Load: (kg)	96	224	385

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 753 Lb   342 kg

	Lb	kg	%
From A Complete Mass Budget:	312	142	29.3
From Growing Season In Situ Phosphorus Increases:	-17	-8	-2.3
From In Situ Phososphorus Increases In The Fall:	74	34	8.9
From Phososphorus Release Rate and Anoxic Area:	495	224	39.7

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	79	45	198

Osgood, 1988 Lake Mixing Index: 1.7

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	312	28.6	495
Internal Load (kg):	142	13.0	224
External Load (Lb):	336	753	1916
External Load (kg):	152	342	869

Total Load (Lb):	648	782	2411
Total Load (kg):	294	354	1093

Phosphorus Prediction and Uncertainty Analysis Module

Date: 2/1/2017   Scenario: 39
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
Back calculation for SPO total phosphorus: 137.09 mg/m^3
Back calculation GSM phosphorus: 208.39 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 312 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-46	-41
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-50	-44
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-62	-55
Rechow, 1979 General	11	24	60	-89	-79
Rechow, 1977 Anoxic	53	119	304	7	6
Rechow, 1977 water load<50m/year	30	68	172	-45	-40
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	13	18
Vollenweider, 1982 Combined OECD	29	57	122	-36	-39
Dillon-Rigler-Kirchner	17	38	97	-36	-49
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-44	-47
Larsen-Mercier, 1976	36	81	205	7	9
Nurnberg, 1984 Oxic	154	176	236	64	57

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	1059	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	1881	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	4772	GSM
Rechow, 1979 General	13	48	FIT	2996	GSM
Rechow, 1977 Anoxic	68	238	FIT	596	GSM
Rechow, 1977 water load<50m/year	37	137	P	1053	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	42	184	FIT	537	SPO
Vollenweider, 1982 Combined OECD	27	112	FIT	1332	ANN

Dillon-Rigler-Kirchner	22	76	P	1222	SPO
Vollenweider, 1982 Shallow Lake/Res.	23	98	FIT	1472	ANN
Larsen-Mercier, 1976	48	160	P Pin	581	SPO
Nurnberg, 1984 Oxic	110	275	P	627	ANN

Water and Nutrient Outflow Module

Date: 2/1/2017   Scenario: 25

Average Annual Surface Total Phosphorus: 101.06mg/m^3

Annual Discharge: 1.85E+003 AF => 2.28E+006 m^3

Annual Outflow Loading: 485.7 LB =>   220.3 kg

Date: 2/1/2017   Scenario: Lotus Lake Combined Direct (modeled hydraulic loading)

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1904.7 acre-ft/year
Areal Water Load <qs>: 7.7 ft/year
Lake Flushing Rate <p>: 1.40 1/year
Water Residence Time: 0.72 year
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	84.4	0.50	1.00	3.00	8.5	17	34	102
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	186.0	0.10	0.30	0.50	5.6	8	23	38
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	110.2	0.05	0.10	0.25	1.1	2	4	11
Wetlands	44.5	0.10	0.10	0.10	0.4	2	2	2
Forest	584.2	0.05	0.09	0.18	5.3	12	21	43
Lake Surface	248.0	0.10	0.30	1.00	7.5	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8			
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	2.87	23.89	76.45	6.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	884.9	1402.4	100.0
Total Loading (kg)	53.4	401.4	636.1	100.0
Areal Loading (lb/ac-year)	0.47	3.57	5.65	
Areal Loading (mg/m^2-year)	53.17	399.94	633.83	
Total PS Loading (lb)	0.0	580.1	581.4	65.6
Total PS Loading (kg)	0.0	263.1	263.7	65.6
Total NPS Loading (lb)	89.2	185.8	431.2	28.5
Total NPS Loading (kg)	40.5	84.3	195.6	28.5

Wisconsin Internal Load Estimator

Date: 2/1/2017 Scenario: 45

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 101.06 mg/m^3
Phosphorus Inflow Concentration: 170.8 mg/m^3
Areal External Loading: 399.9 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.41
Internal Load: 291 Lb 132 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 103.5 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 70.33 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day 0 lb/acre-day
Internal Load: -4 Lb -2 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3

Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Water Column Phosphorus Concentration: 70.73 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 17.3 mg/m^2-day   4.71E-002 lb/acre-day
Internal Load: 215 Lb   98 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 8.6 mg/m^2-day
Period of Anoxia: 70.73 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	54	125	214
Internal Load: (kg)	24	57	97

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 885 Lb   401 kg

	Lb	kg	%
From A Complete Mass Budget:	291	132	24.8
From Growing Season In Situ Phosphorus Increases:	-4	-2	-0.5
From In Situ Phososphorus Increases In The Fall:	215	98	19.5
From Phososphorus Release Rate and Anoxic Area:	125	57	12.4

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	62	65	95

Osgood, 1988 Lake Mixing Index: 1.7

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	291	105.4	125
Internal Load (kg):	132	47.8	57
External Load (Lb):	118	885	1402
External Load (kg):	53	401	636

Total Load (Lb):	409	990	1527
Total Load (kg):	185	449	693

Phosphorus Prediction and Uncertainty Analysis Module

Date: 2/1/2017 Scenario: 38
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
Back calculation for SPO total phosphorus: 137.09 mg/m^3
Back calculation GSM phosphorus: 208.39 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 291 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	10	73	116	-40	-36
Canfield-Bachmann, 1981 Natural Lake	15	70	98	-43	-38
Canfield-Bachmann, 1981 Artificial Lake	14	56	73	-57	-51
Rechow, 1979 General	4	28	44	-85	-76
Rechow, 1977 Anoxic	18	136	216	24	21
Rechow, 1977 water load<50m/year	10	78	124	-35	-31
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	13	100	159	26	35
Vollenweider, 1982 Combined OECD	12	63	93	-30	-32
Dillon-Rigler-Kirchner	6	44	69	-30	-41
Vollenweider, 1982 Shallow Lake/Res.	9	55	82	-38	-41
Larsen-Mercier, 1976	12	93	147	19	26
Nurnberg, 1984 Oxic	130	169	195	57	51

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	30	110	FIT	1143	GSM
Canfield-Bachmann, 1981 Natural Lake	22	202	FIT	1903	GSM
Canfield-Bachmann, 1981 Artificial Lake	17	161	FIT	4803	GSM
Rechow, 1979 General	11	43	FIT	3014	GSM
Rechow, 1977 Anoxic	56	202	FIT	613	GSM
Rechow, 1977 water load<50m/year	30	120	P	1069	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	34	169	FIT	550	SPO
Vollenweider, 1982 Combined OECD	22	109	FIT	1364	ANN

Dillon-Rigler-Kirchner	18	65	P	1255	SPO
Vollenweider, 1982 Shallow Lake/Res.	19	94	FIT	1507	ANN
Larsen-Mercier, 1976	39	136	P Pin	595	SPO
Nurnberg, 1984 Oxic	103	258	P	756	ANN

Water and Nutrient Outflow Module

Date: 2/1/2017 Scenario: 24
Average Annual Surface Total Phosphorus: 101.06mg/m^3
Annual Discharge: 1.90E+003 AF => 2.35E+006 m^3
Annual Outflow Loading: 500.4 LB => 227.0 kg

Date: 2/1/2017 Scenario: Lotau Lake Combined (modeled hydraulic load plus carp)

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1904.7 acre-ft/year
Areal Water Load <qs>: 7.7 ft/year
Lake Flushing Rate <p>: 1.40 1/year
Water Residence Time: 0.72 year
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	84.4	0.50	1.00	3.00	8.5	17	34	102
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	186.0	0.10	0.30	0.50	5.6	8	23	38
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	110.2	0.05	0.10	0.25	1.1	2	4	11
Wetlands	44.5	0.10	0.10	0.10	0.4	2	2	2
Forest	584.2	0.05	0.09	0.18	5.3	12	21	43
Lake Surface	248.0	0.10	0.30	1.00	7.5	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8			
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	2.87	23.89	76.45	6.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	884.9	1402.4	100.0
Total Loading (kg)	53.4	401.4	636.1	100.0
Areal Loading (lb/ac-year)	0.47	3.57	5.65	
Areal Loading (mg/m^2-year)	53.17	399.94	633.83	
Total PS Loading (lb)	0.0	580.1	581.4	65.6
Total PS Loading (kg)	0.0	263.1	263.7	65.6
Total NPS Loading (lb)	89.2	185.8	431.2	28.5
Total NPS Loading (kg)	40.5	84.3	195.6	28.5

Wisconsin Internal Load Estimator

Date: 2/1/2017   Scenario: 48

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 101.06 mg/m^3
Phosphorus Inflow Concentration: 170.8 mg/m^3
Areal External Loading: 399.9 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.41
Internal Load: 291 Lb   132 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 103.5 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Time Period of Stratification: 70.33 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: -17 Lb   -8 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3

Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Water Column Phosphorus Concentration: 70.73 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 184.8 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 1.5 mg/m^2-day   4.07E-003 lb/acre-day
Internal Load: 74 Lb   34 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 184.8 acre
End of Anoxia Anoxic Sediment Area: 184.8 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.7 mg/m^2-day
Period of Anoxia: 70.33 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	212	495	848
Internal Load: (kg)	96	224	385

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 885 Lb   401 kg

	Lb	kg	%
From A Complete Mass Budget:	291	132	24.8
From Growing Season In Situ Phosphorus Increases:	-17	-8	-1.9
From In Situ Phososphorus Increases In The Fall:	74	34	7.7
From Phososphorus Release Rate and Anoxic Area:	495	224	35.9

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	62	50	167

Osgood, 1988 Lake Mixing Index: 1.7

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	291	28.6	495
Internal Load (kg):	132	13.0	224
External Load (Lb):	118	885	1402
External Load (kg):	53	401	636

Total Load (Lb):	409	914	1897
Total Load (kg):	185	414	861

Date: 1/30/2017   Scenario: Lotus Lake Inlet 2014

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1643.1 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1095.4 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1163.6 acre-ft/year
Areal Water Load <qs>: 4.7 ft/year
Lake Flushing Rate <p>: 0.85 1/year
Water Residence Time: 1.17 year
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	284.554	0.50	1.00	3.00	49.7	58	115	345
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	425.086	0.10	0.30	0.50	22.3	17	52	86
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	4.203	0.05	0.10	0.25	0.1	0	0	0
Wetlands	220.769	0.10	0.10	0.10	3.9	9	9	9
Forest	708.52	0.05	0.09	0.18	11.1	14	26	52
Lake Surface	248.0	0.10	0.30	1.00	13.0	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	0.0				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	238.5	511.0	1307.0	100.0
Total Loading (kg)	108.2	231.8	592.8	100.0
Areal Loading (lb/ac-year)	0.96	2.06	5.27	
Areal Loading (mg/m^2-year)	107.79	230.95	590.69	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	216.4	444.6	1085.7	100.0
Total NPS Loading (kg)	98.1	201.7	492.5	100.0

Appendix K

Lake Management Plan Development Meetings

Lotus Lake Management Plan Development
Committee Meeting 1

Wednesday, February 8th, 2017
6-8 PM
Polk County Board Room
Polk County Government Center

6:00 Introductions, roles, and responsibilities (all)

6:15 Schedule future meetings—bring your calendar (all)
- March
- April
- May

6:20 Presentation (Polk County Land and Water Resources Department)
- Purpose of the meeting
- Lotus Lake chemistry results
- Lotus Lake survey results
- Time for questions

7:00 Brainstorming session (Management Plan Committee)
- What do you value about Lotus Lake?
- What concerns/issues do you have for Lotus Lake?

8:00 Adjourn

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Lotus Lake Management Plan Development
Committee Meeting 1 Notes

Wednesday, February 8th, 2017
6-8 PM
Polk County Board Room, Polk County Government Center

Introductions, roles, and responsibilities
Eric Lehman, Brett Stewart, Trish Carlson, Steve Liberda, Kent Stennes, Barb Stennes, Deb Goodman, Denise Kaye, Tony Havranek, Jeremy Williamson, and Katelin Anderson

Discussed roles and responsibilities (see handout)

Schedule future meetings
Wednesdays from 6-8 PM at the Polk County Government Center

March 8th
April 12th
May 10th

Presentation (see slides)

Purpose of the meeting (see handout with 2007 recommendations)
Lotus Lake chemistry results
Lotus Lake survey results

Brainstorming session

<u>What do you value about Lotus Lake?</u>
Habitat, terrestrial and aquatic
Quite lake
Trees surround the lake, undeveloped
County Park and Stowers Seven Lake Trail
Lake size—not too big, not too small
Sand (where it exists) versus muck
Educational opportunities/outdoor classroom (turtles, plants, duck hunting), the lake experience
Past conditions—viable fishery (winter fishery is still okay) and water clarity
Recreation—motorized and non-motorized boating (canoeing), a multi-use lake
Waterfowl
Committed residents
Past and current grant support
Partner support (past/potential)—Rod and Gun, Polk County, Tribe, Ducks Unlimited

What concerns/issues do you have for Lotus Lake?

Water clarity
Not swimmable (aesthetics, not health concerns)
Algae (toxins?)
Shooting range—lead
Carp
Agriculture (although it's mostly hay)
Invasive plants—purple loosestrife and curlyleaf pondweed
Aquatic plants (especially expansion of lotus), as relates to navigation issues
Proposed quarry
Water level, depth
Access, getting to main part of the lake (related to water level)
Winter dissolved oxygen is unknown
Aerator in the winter—questions regarding placement, efficiency, solar/cheaper options
Weakened environmental policy/standards—as they trickle down to Lotus Lake
Possibility that carp removal could lead to increased algae due to a lack of good plants
Muck
Loss of wild rice
Needs related to carp: teeth in the game, active management, carp barriers, IPM, and consideration of various options (pathogens, poisoned corn, experimental options)
Shoreline development, although there is state/county land there are also open lots
Options for homeowners to enforce shoreline development ordinances
Options for getting more people involved
Dredging as an option (regarding lake depth)
Is there a need to form a District? Are there benefits other than funding?

Adjourn

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Lotus Lake Management Plan Development Rules and Responsibilities

Overall Objective

Develop a Lake Management Plan for Lotus Lake

A management plan outlines goals and actions that everyone can live with

Ground Rules

Listen to what others are saying
Don't interrupt when others are speaking
Input is heard from everyone
Stay on topic and stick to the agenda

Management Plan Committee Responsibilities

Attend all meetings
Share your knowledge and concerns about Lotus Lake
Review background information and draft documents
Develop lake management strategies
Decide when draft document is ready to forward to board for approval

Land and Water Resources Department Responsibilities

Send out agendas and materials prior to meetings
Keep discussion on track, may need to interrupt to keep discussion focused
Summarize key study findings
Write goals, objectives, and action items for the plan using committee input
Write draft and final plan documents
Submit plan for public comment and WDNR review

Association Board Member Responsibilities

Participate as part of the committee
Review draft Management Plan
Approve draft Management Plan to forward to the WI DNR or disapprove draft Management Plan and return to committee

Lotus Lake Planning Meeting

Meeting 1

Wednesday, February 8th, 2017

Purpose of the meetings

Review data

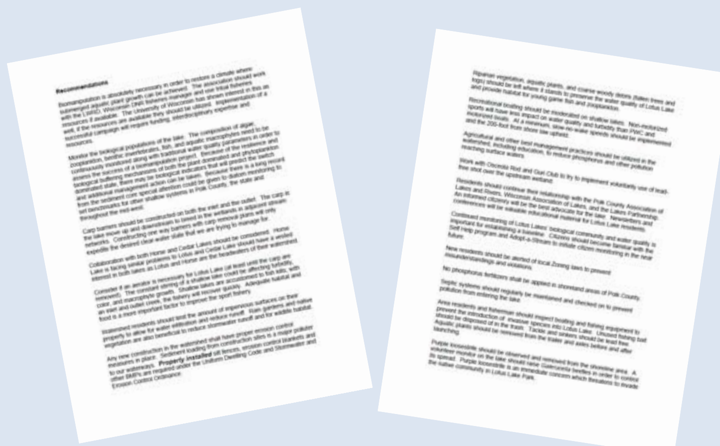
Develop lake management plan, including goals

Grant deliverables

- Lake resident survey
- Physical and chemical data (deep hole, inlet, outlet)
- Lake level and precipitation
- Phytoplankton
- Zooplankton
- Aquatic plant surveys
- Watershed delineation, land use, and modeling
- Shoreline survey and workshop

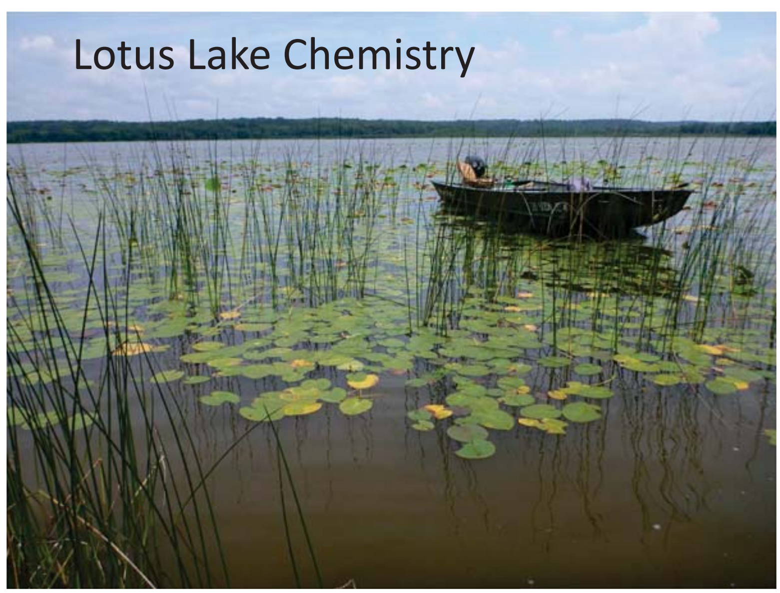
- Lake management plan

2007 recommendations



Goal 1: Reduce algae and phosphorus in the three lake system by reducing watershed runoff

Action	Timeline	Cost Estimate	Volunteer Hours	Responsible Parties	Funding Sources
Identify shoreline landowners willing to install shoreline buffers, rain gardens, and water diversions on their property	2013, ongoing	$1,000	80	Board Water quality committee	District
Provide technical assistance and cost sharing for implementation of projects	2014, ongoing	$250,000		Board Consultant	District WDNR Lake Protection Grant*
Recognize landowners that have taken steps to reduce watershed runoff	Ongoing	$50 annual		Board	District
Partner with landowners to install rain gardens, water diversions, and erosion control practices at or near the Church Pine Lake boat landing	2014, ongoing	TBD		Board Consultant	District WDNR Lake Protection Grant*
Support the work of the Horse Creek Watershed Farmer Led Council	2015, ongoing	TBD		Board LWRD	District
Work with Polk County LWRD/consultant to identify agricultural best management practices to reduce the phosphorus load from North Creek	2014, ongoing	TBD		Board LWRD Consultant	District WDNR Lake Planning Grant
Examine the economic feasibility and effectiveness of a sediment pond on North Creek	2015	$2,500		Board Consultant	District WDNR Lake Planning Grant
Partner with landowners to install rain gardens, water diversions, and erosion control practices at or near the Big Lake boat landing	2014, ongoing	TBD		Board Consultant	District WDNR Lake Protection Grant*



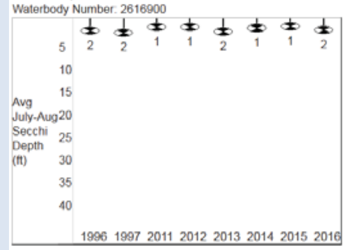
Lotus Lake Chemistry

Secchi depth

Measure of water clarity

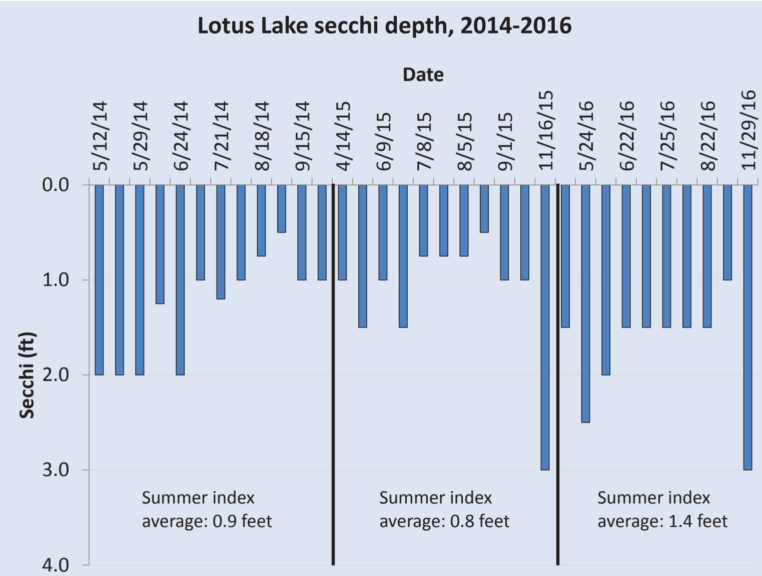
Greater numbers = greater clarity

Lotus Lake
Polk County
Waterbody Number: 2616900



Past secchi averages in feet (July and August only).

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
1996	1.83	1.75	2	3
1997	2.2	1.9	2.5	2
2011	1	1	1	4
2012	1	1	1	11
2013	1.9	1	2	10
2014	1.21	.75	1.5	7
2015	.84	.5	1	8
2016	1.58	1.5	2	6



Phosphorus (P)

Excess amounts cause plant and algae growth

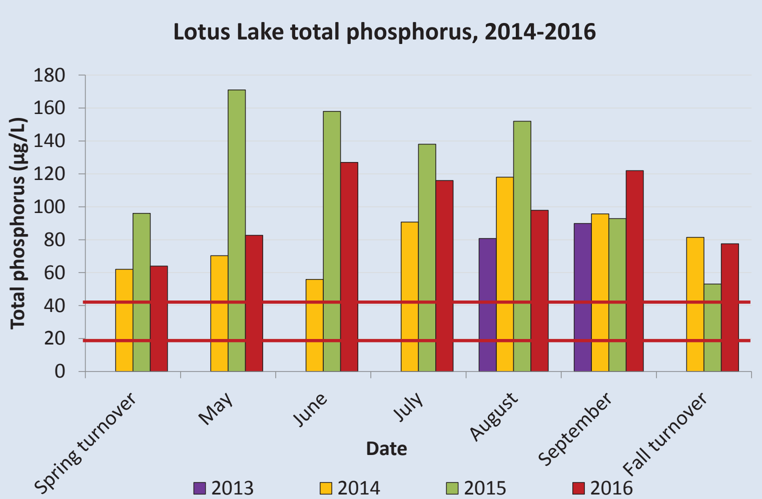
Occurs naturally in soil

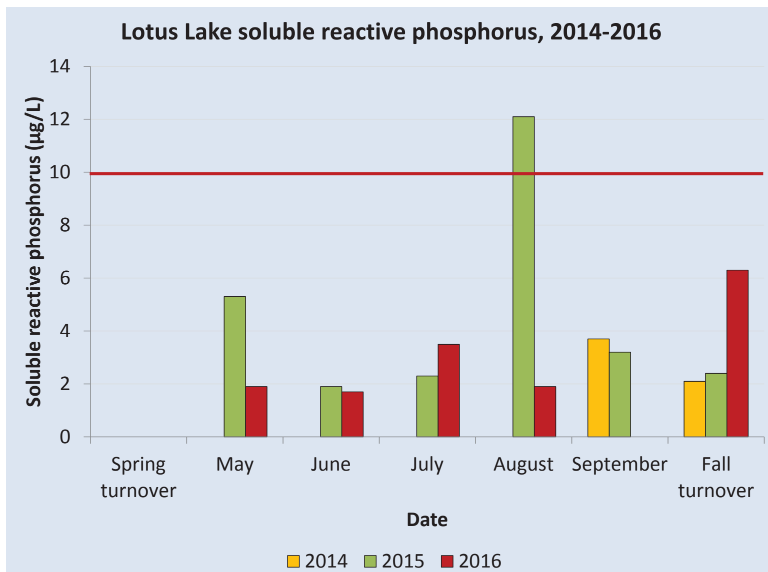
Component of fertilizer

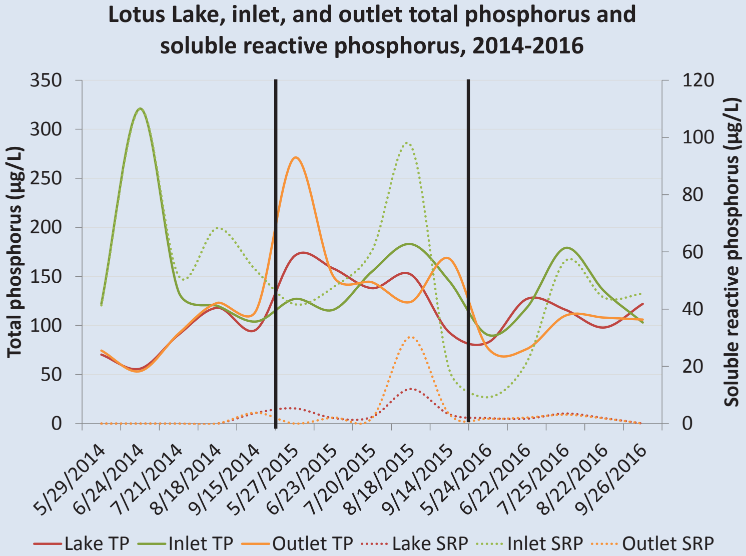
Total P= all P in a water sample

Soluble reactive P = P dissolved in water, ready for uptake by plants and algae

Summer index period averages 2014: 101 μg/L 2015: 128 μg/L 2016: 110 μg/L







Site	Total phosphorus (µg/L)	Inlet and Outlet Area (m2)	Discharge (L/s)	Total Phosphorus (lb/yr)
2014 Inlet	160.20	1.216	280	3,121
2015 Inlet	145.20	1.104	166	1,677
2016 Inlet	125.06	1.260	189	1,644
2014 Outlet	91.52	0.846	465	2,961
2015 Outlet	171.40	0.576	242	2,886
2016 Outlet	95.32	0.336	118	783

Year	Lotus Lake deep hole total phosphorus (µg/L)
2014	86.12
2015	142.36
2016	109.12

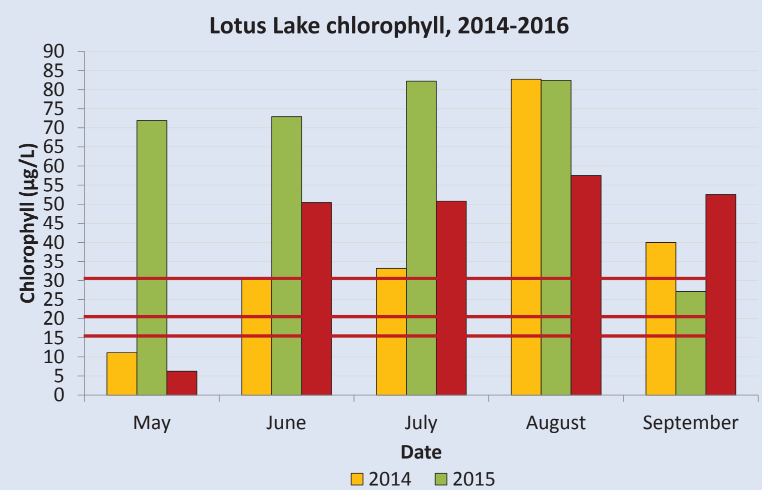
Chlorophyll

Pigment in plants and algae

Provides an indication of the amount of algae in a lake

Higher values = more algae

Summer index period averages 2014: 52 µg/L 2015: 64 µg/L 2016: 55 µg/L



Trophic state index

Serves as an indicator of water quality

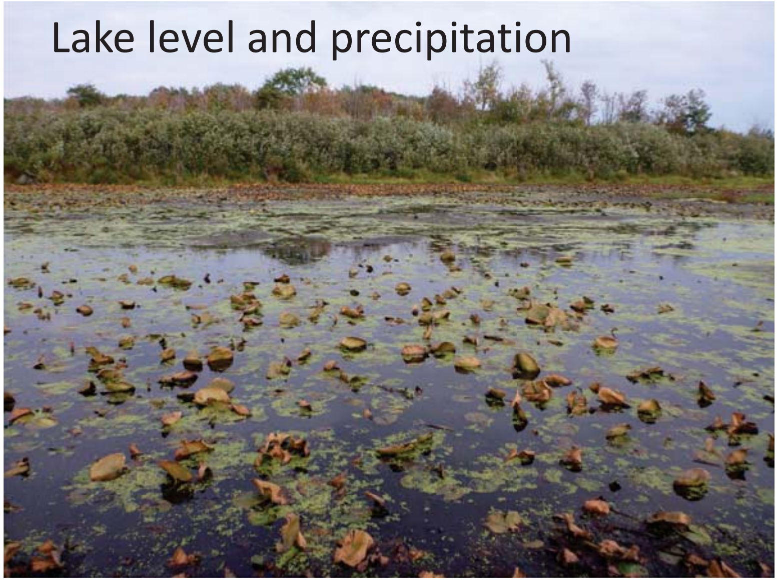
Reflects nutrient and clarity levels

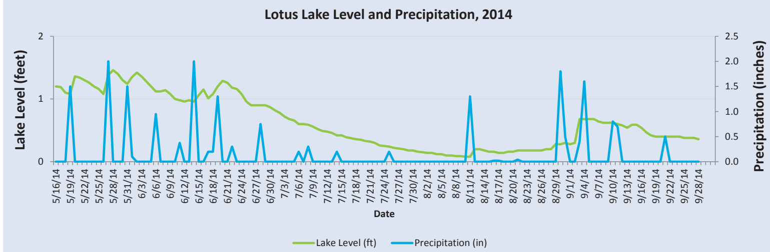
Trophic state index

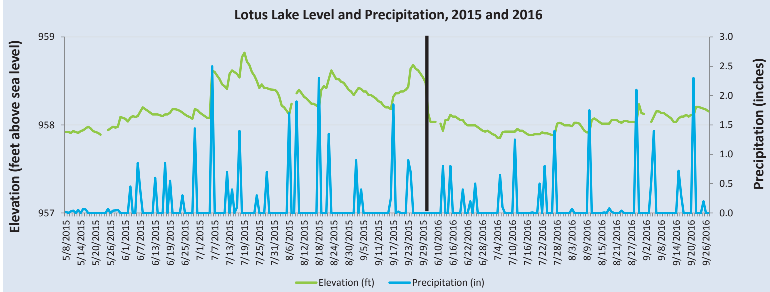
2014: 73 2015: 75 2016: 71

TSI	General Description
<30	Oligotrophic; clear water, high dissolved oxygen throughout the year/lake
30-40	Oligotrophic; clear water, possible periods of oxygen depletion in the lower depths of the lake
40-50	Mesotrophic; moderately clear water, increasing chance of anoxia near the bottom of the lake in summer, fully acceptable for all recreation/aesthetic uses
50-60	Mildly eutrophic; decreased water clarity, anoxic near the bottom, may have macrophyte problem; warm-water fisheries only
60-70	Eutrophic; blue-green algae dominance, scums possible, prolific aquatic plant growth. Full body recreation may be decreased
70-80	Hypereutrophic; heavy algal blooms possible throughout the summer, dense algae and macrophytes
>80	Algal scums, summer fish kills, few aquatic plants due to algal shading, rough fish dominate

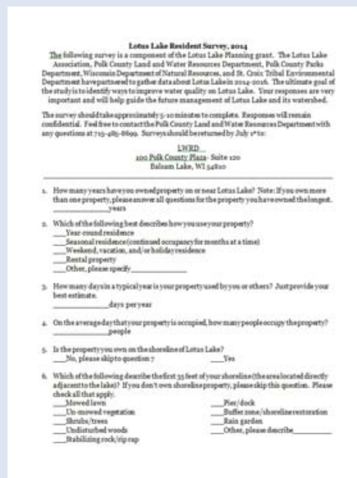
Lake level and precipitation







Lotus Lake Resident Survey



Lotus Lake Resident Survey, 2014

The following survey is a component of the Lotus Lake Planning grant. The Lotus Lake Association, Polk County Land and Water Resources Department, Polk County Parks Department, Wisconsin Department of Natural Resources, and St. Croix Tribal Environmental Department have partnered to gather data about Lotus Lake in 2014-2016. The ultimate goal of the study is to identify ways to improve water quality on Lotus Lake. Your responses are very important and will help guide the future management of Lotus Lake and its watershed.

The survey should take approximately 5-10 minutes to complete. Responses will remain confidential. Feel free to contact the Polk County Land and Water Resources Department with any questions at 715-485-8699. Surveys should be returned by July 1st to:

LWRD
100 Polk County Plaza- Suite 120
Balsam Lake, WI 54810

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1. How many years have you owned property on or near Lotus Lake? Note: If you own more than one property, please answer all questions for the property you have owned the longest.
   ______________years
2. Which of the following best describes how you use your property?
   ___Year-round residence
   ___Seasonal residence (continued occupancy for months at a time)
   ___Weekend, vacation, and/or holiday residence
   ___Rental property
   ___Other, please specify______________
3. How many days in a typical year is your property used by you or others? Just provide your best estimate.
   ______________days per year
4. On the average day that your property is occupied, how many people occupy the property?
   ______________people
5. Is the property you own on the shoreline of Lotus Lake?
   ___No, please skip to question 7 ___Yes
6. Which of the following describe the first 35 feet of your shoreline (the area located directly adjacent to the lake)? If you don't own shoreline property, please skip this question. Please check all that apply.
   ___Mowed lawn
   ___Un-mowed vegetation
   ___Shrubs/trees
   ___Undisturbed woods
   ___Stabilizing rock/rip rap
   ___Pier/dock
   ___Buffer zone/shoreline restoration
   ___Rain garden
   ___Other, please describe__________

Mailed 224 surveys in June 2014

90 respondents, 40%

Lotus Lake owners

Property ownership: 14 years

People occupying property: 2.7

Number of days property used: 289 days

Most people are full time residents (84%)

Most don't own lakefront property (83%)

Activities and public use

Activities Enjoyed

Scenic view (71%)

Peace and tranquility (51%)

Observing birds/wildlife (36%)

Fishing (25%)

Non-motorized boating (25%)

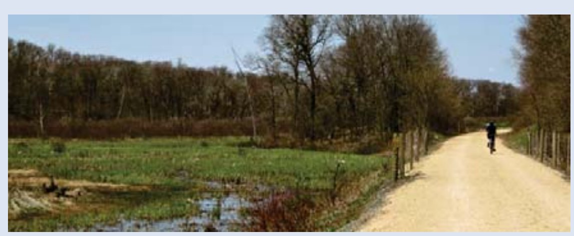
Public resource use

open water, ice on

County Park: 54%, 16%

Stowers Trail: 45%, 13%

Boat landing: 38%, 11%



Degree of concern with each issue listed below?	Rank
Decrease in overall lake health	3.2
Excessive algae blooms	3.1
Lack of water clarity or quality	3.1
Presence of common carp in the lake	3.0
Excessive aquatic plant growth	2.9
Decreased fisheries	2.8
New invasive species entering the lake	2.7
Increased nutrient pollution	2.7
Loss of natural scenery/beauty	2.5
Decreased wildlife populations	2.5
Decreased property values	2.3
Increased development	2.2
Unsafe use of motorized watercraft	2.1
Excessive noise level on the lake	1.8
Disregard for slow-no-wake zones	1.5

Current conditions on Lotus Lake

Water level
Just right (53%), unsure (27%)

Water quality
Poor (41%) or fair (22%), unsure (27%)

Change in water quality
Degraded severely (11%) or somewhat (16%), improved somewhat (9%)

Aquatic plants
Too many (51%), healthy amount (35%)

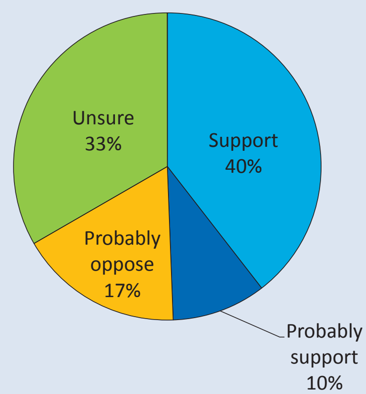
Months aquatic plants are a problem
August (45%), July (43%)

Months algae is a problem
August (56%), July (40%)

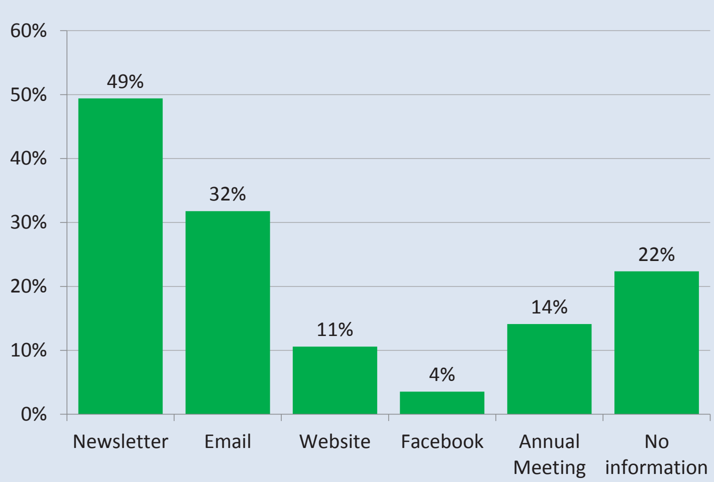
Actions to manage Lotus Lake

Ranked by priority
Programs to prevent/monitor AIS: 71%
Enhance fisheries: 70%
Upgrade non-conforming septic: 63%
Install shoreline buffers/rain gardens: 57%
Install farmland conservation practices: 43%
Lake fairs and workshops: 41%
Enforce slow no wake zones: 41%

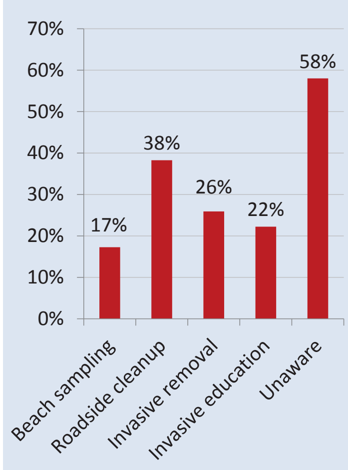
Support for carp removal

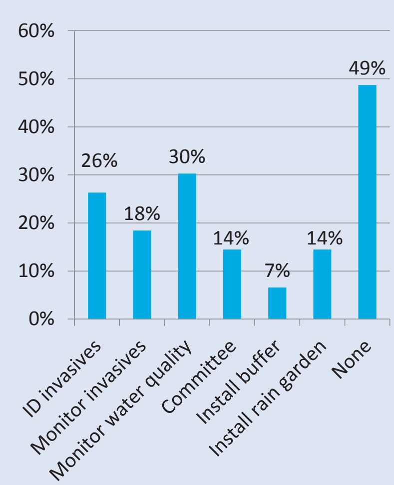


Communication



Lake association activities





Recommendations

Biomanipulation is absolutely necessary in order to restore a climate where submerged aquatic plant growth can be achieved. The association should work with the LWRD, Wisconsin DNR fisheries manager and use tribal fisheries resources if available. The University of Wisconsin has shown interest in this as well, if the resources are available they should be utilized. Implementation of a successful campaign will require funding, interdisciplinary expertise and resources.

Monitor the biological populations of the lake. The composition of algae, zooplankton, benthic invertebrates, fish, and aquatic macrophytes need to be continuously monitored along with traditional water quality parameters in order to assess the success of a biomanipulation project. Because of the resilience and biological buffering mechanisms of both the plant dominated and phytoplankton dominated state, there may be biological indicators that will predict the switch and additional management action can be taken. Because there is a long record from the sediment core special attention could be given to diatom monitoring to set benchmarks for other shallow systems in Polk County, the state and throughout the mid-west.

Carp barriers should be constructed on both the inlet and the outlet. The carp in the lake move up and downstream to breed in the wetlands in adjacent stream networks. Constructing one way barriers with carp removal plans will only expedite the desired clear-water state that we are trying to manage for.

Collaboration with both Horse and Cedar Lakes should be considered. Horse Lake is facing similar problems to Lotus and Cedar Lake should have a vested interest in both lakes as Lotus and Horse are the headwaters of their watershed.

Consider if an aerator is necessary for Lotus Lake (at least until the carp are removed). The constant stirring of a shallow lake could be affecting turbidity, color, and macrophyte growth. Shallow lakes are accustomed to fish kills; with an inlet and outlet creek, the fishery will recover quickly. Adequate habitat and food is a more important factor to improve the sport fishery.

Watershed residents should limit the amount of impervious surfaces on their property to allow for water infiltration and reduce runoff. Rain gardens and native vegetation are also beneficial to reduce stormwater runoff and for wildlife habitat.

Any new construction in the watershed shall have proper erosion control measures in place. Sediment loading from construction sites is a major polluter to our waterways. ***Properly installed*** silt fences, erosion control blankets and other BMPs are required under the Uniform Dwelling Code and Stormwater and Erosion Control Ordinance.

Riparian vegetation, aquatic plants, and coarse woody debris (fallen trees and logs) should be left where it stands to preserve the water quality of Lotus Lake and provide habitat for young game fish and zooplankton.

Recreational boating should be moderated on shallow lakes. Non-motorized sports will have less impact on water quality and turbidity than PWC and motorized boats. At a minimum, slow-no-wake speeds should be implemented and the 200-foot from shore law upheld.

Agricultural and other best management practices should be utilized in the watershed, including education, to reduce phosphorus and other pollution reaching surface waters.

Work with Osceola Rod and Gun Club to try to implement voluntarily use of lead-free shot over the upstream wetland.

Residents should continue their relationship with the Polk County Association of Lakes and Rivers, Wisconsin Association of Lakes, and the Lakes Partnership. An informed citizenry will be the best advocate for the lake. Newsletters and conferences will be valuable educational material for Lotus Lake residents.

Continued monitoring of Lotus Lakes' biological community and water quality is important for establishing a baseline. Citizens should become familiar with the Self Help program and Adopt-a-Stream to initiate citizen monitoring in the near future.

New residents should be alerted of local Zoning laws to prevent misunderstandings and violations.

No phosphorus fertilizers shall be applied in shoreland areas of Polk County.

Septic systems should regularly be maintained and checked on to prevent pollution from entering the lake.

Area residents and fisherman should inspect boating and fishing equipment to prevent the introduction of invasive species into Lotus Lake. Unused fishing bait should be disposed of in the trash. Tackle and sinkers should be lead free. Aquatic plants should be removed from the trailer and axles before and after launching.

Purple loosestrife should be observed and removed from the shoreline area. A volunteer monitor on the lake should raise *Galerucella* beetles in order to control its spread. Purple loosestrife is an immediate concern which threatens to invade the native community in Lotus Lake Park.

Lotus Lake Management Plan Development
Committee Meeting 2

Wednesday, March 8th, 2017
6-8 PM
Polk County Government Center, AB Room

6:00	Introductions
6:05	Presentation (Jeremy Williamson) Phosphorus modeling Algae
6:30	Presentation (Aaron Cole) Lotus Lake fisheries update Carp population estimates
7:00	Presentation (Tony Havranek and Jeremy Bloomquist) Wild rice restoration project Carp radio-tagging Options for carp management Carp case studies
7:30	Brainstorm goals for carp management (all)
8:00	Adjourn

Next meeting	Wednesday, April 12th 6-8 PM Polk County Government Center, AB Room

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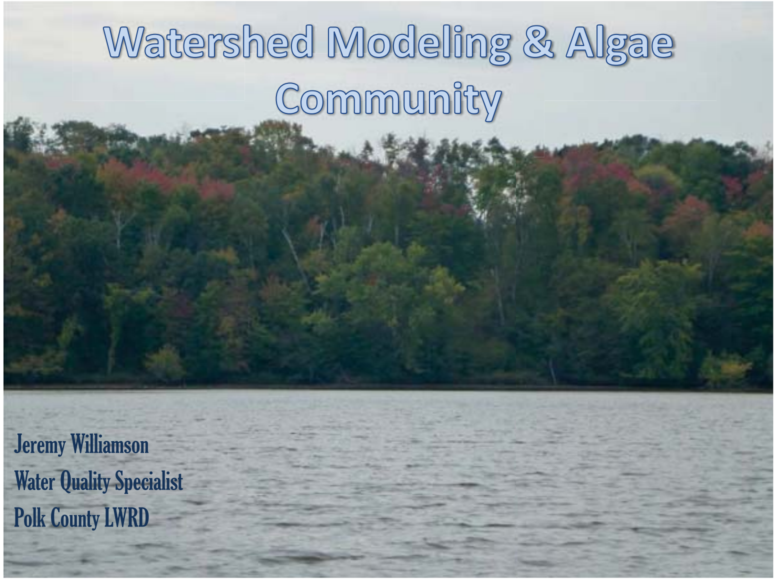
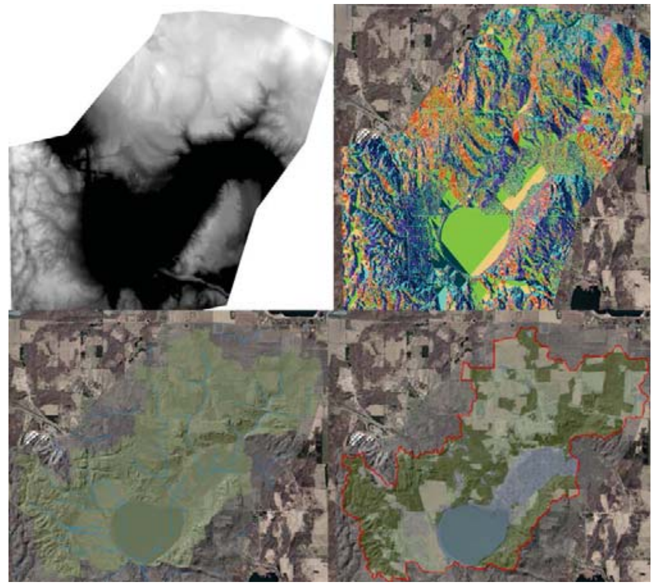
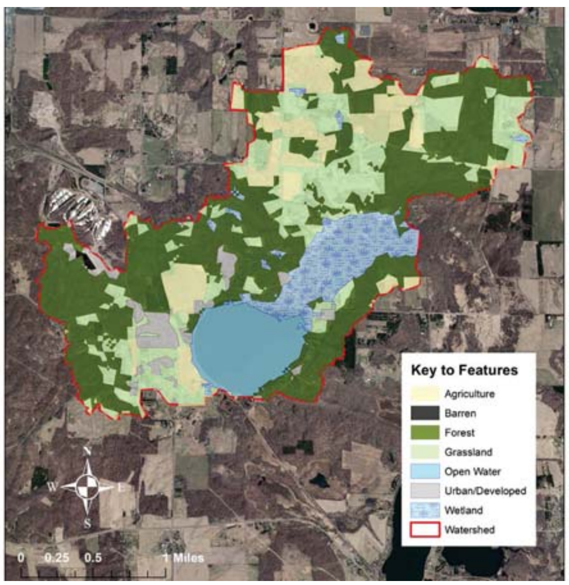
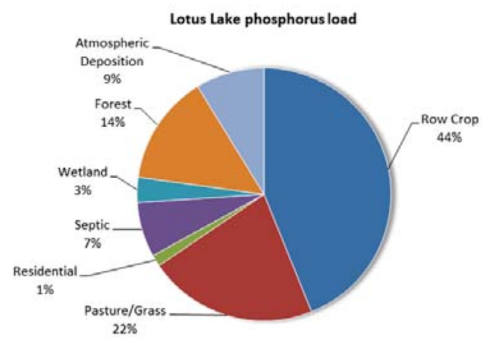
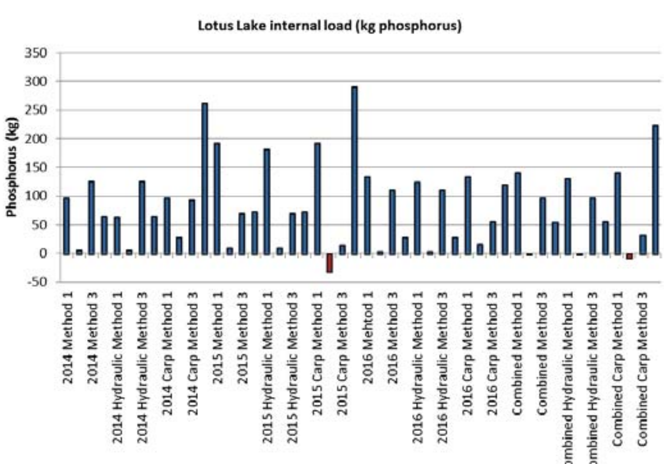






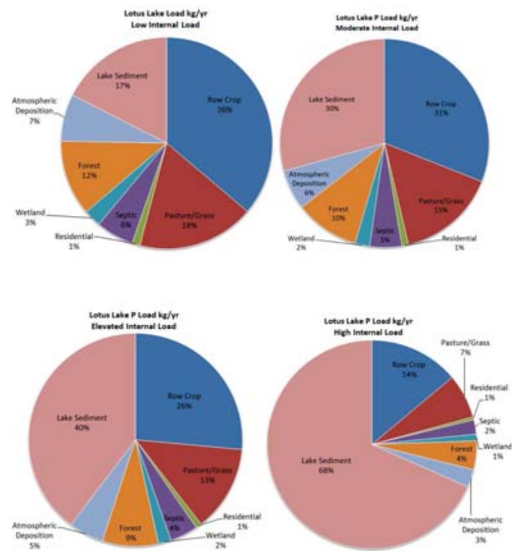
Lotus Lake Nonpoint P	
Source	Load kg/yr
Row Crop	150
Pasture/Grass	74
Residential	5
Septic	23.89
Wetland	11
Forest	48
Atmospheric Deposition	30





$$P = \frac{L_{Ext}}{q_s}(1 - R) + \frac{L_{Int}}{q_s} \text{; where } R = \frac{15}{18+q_s}$$

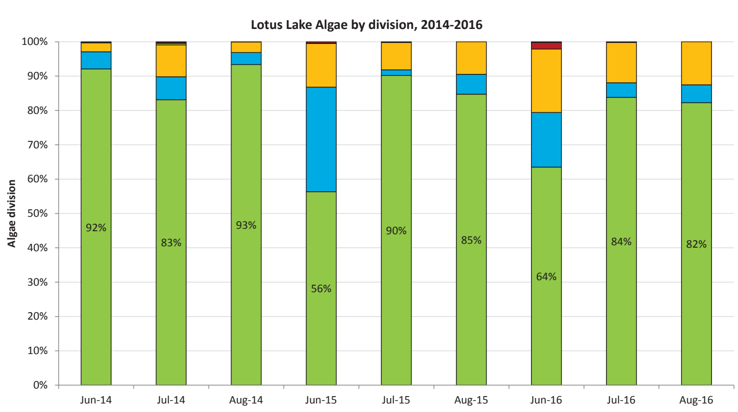
$$OI = z/\sqrt{km^2}$$

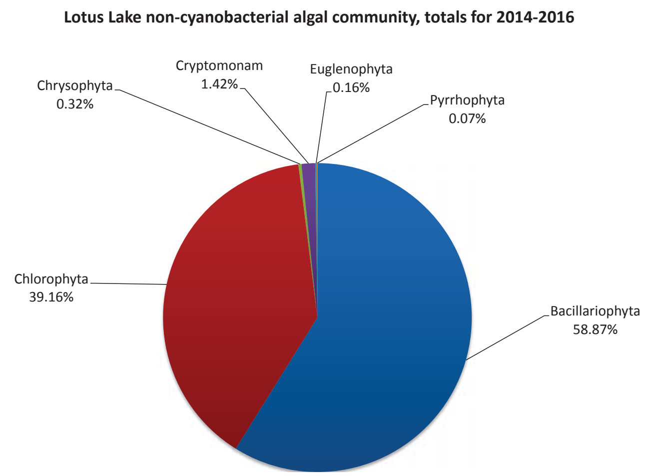


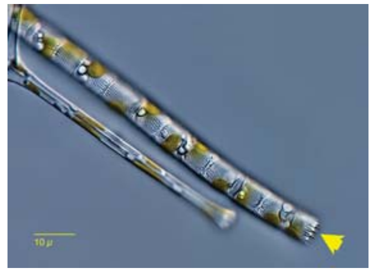
$$P = \frac{0.8L}{\left(z\left(0.0569\left(L/_{z}\right)^{0.422}\right) + p\right)}$$

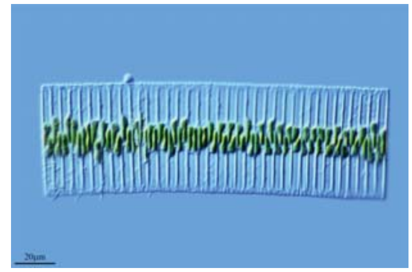
Scenario	Internal P flux mg/m² lake area	Predicted mixed-lake TP μg/l
1	0	110.5
2	47.6	122.69
3	141	145.97
4	223.11	165.33
5	733.46	272.12

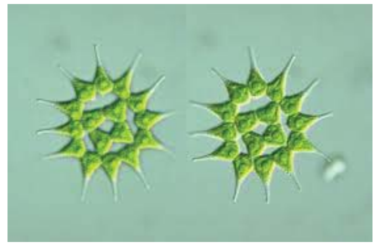
Algal Division	Common Name	Characteristics
Bacillariophyta	Diatoms	Sensitive to chloride, pH, color, and total phosphorus in water. As total phosphorus increases, diatoms decrease. Generally larger in size. Tend to be highly present in spring and late spring.
Chlorophyta	Green algae	Provide high nutritional value to consumers. Can be filamentous and intermingle with macrophytes.
Chrysophyta	Golden brown algae	A genus of single-celled algae in which the cells are ovoid. Contain chlorophyll a, c_1 and c_2, generally masked by abundant accessory pigment, fucoxanthin, imparting distinctive golden color to cells.
Cryptomonam	Cryptomonads	Bloom forming, are not known to produce any toxins, and feed small zooplankton. Cryptomonads frequently dominate the phytoplankton assemblages of the Great Lakes.
Cyanophyta	Blue green algae	Prevail in nutrient-rich standing waters. Blooms can be toxic to zooplankton, fish, livestock, and humans. Can be unicellular, colonial, planktonic, or filamentous. Can live on almost any substrate. More prevalent in late to mid-summer.
Euglenophyta	Euglenoids	Commonly found in freshwater that is rich in organic materials. Most are unicellular.
Pyrrhophyta	Dinoflagellate	Have starch food reserves and serve as food for grazers.

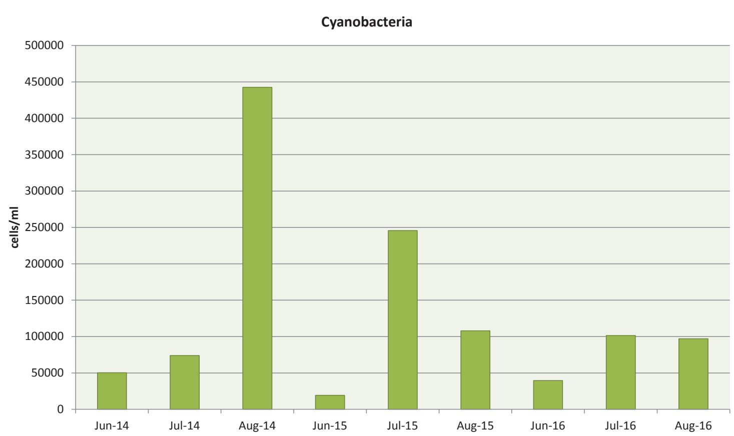


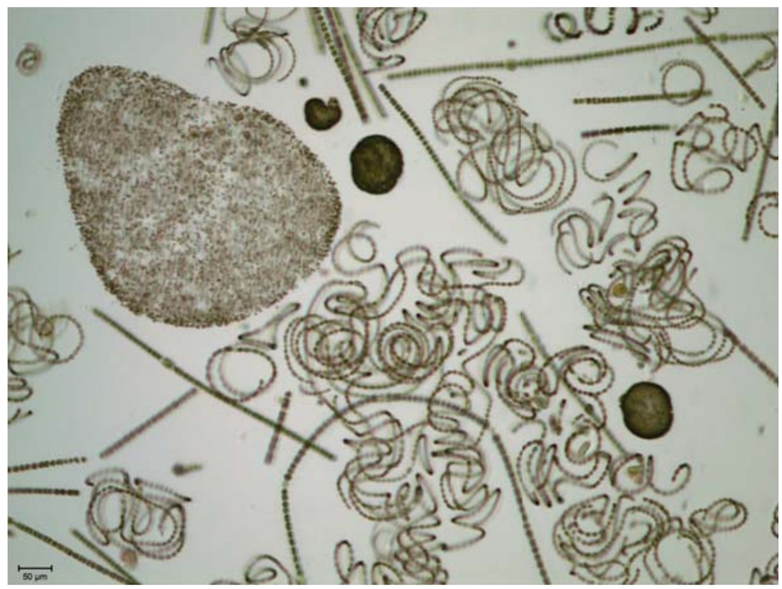




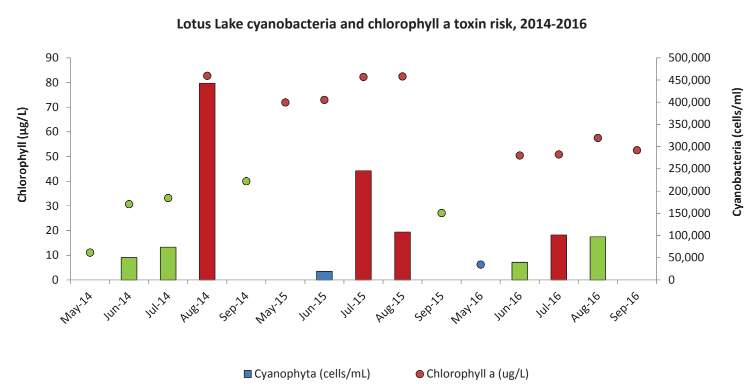


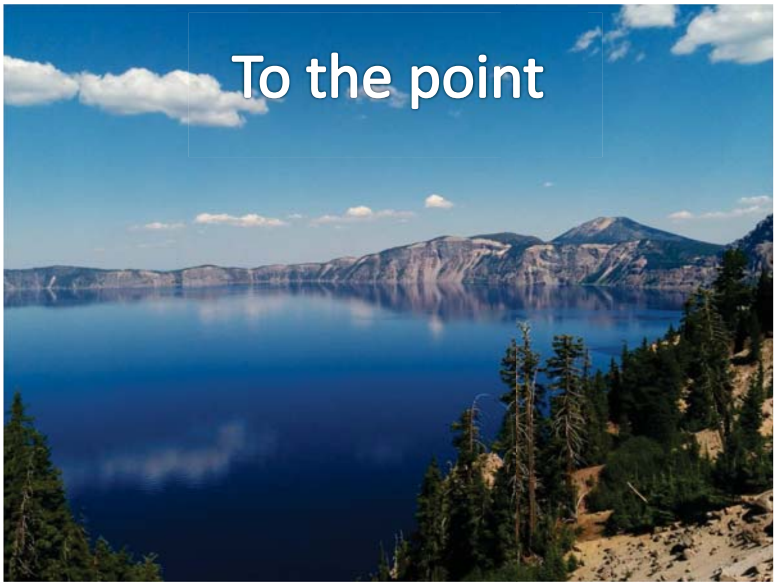


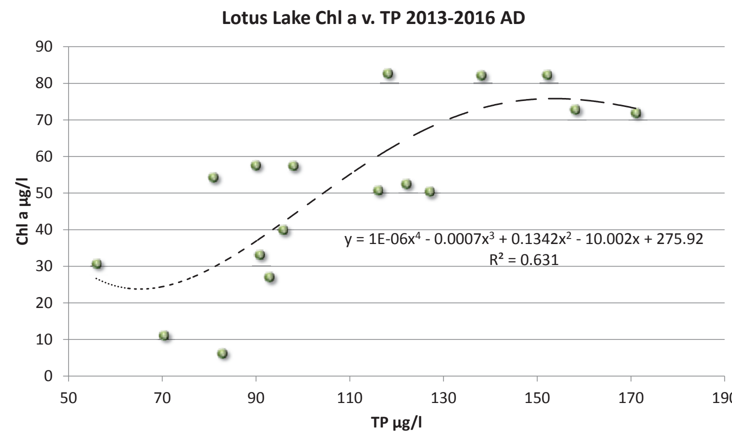


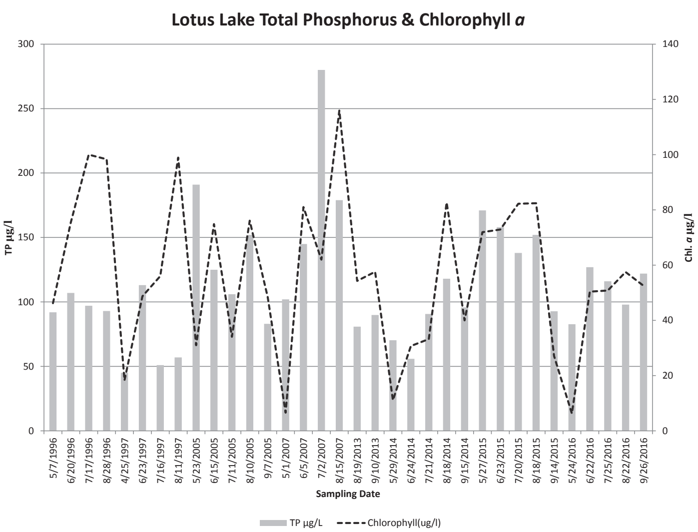


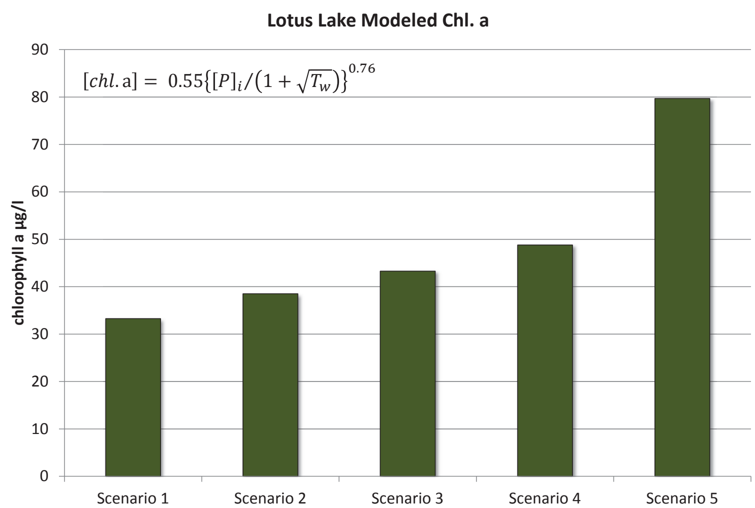
Blue green algae cell density (cells/mL)	Chlorophyll a (µg/L)	Risk
Less than 20,000	Less than 10	Low
20,000 to 100,000	10 to 50	Moderate
Greater than 100,000	Greater than 50	High

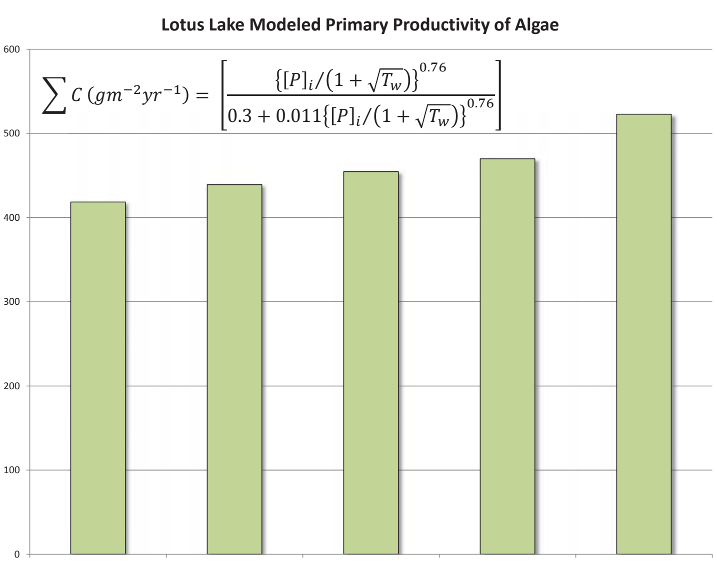


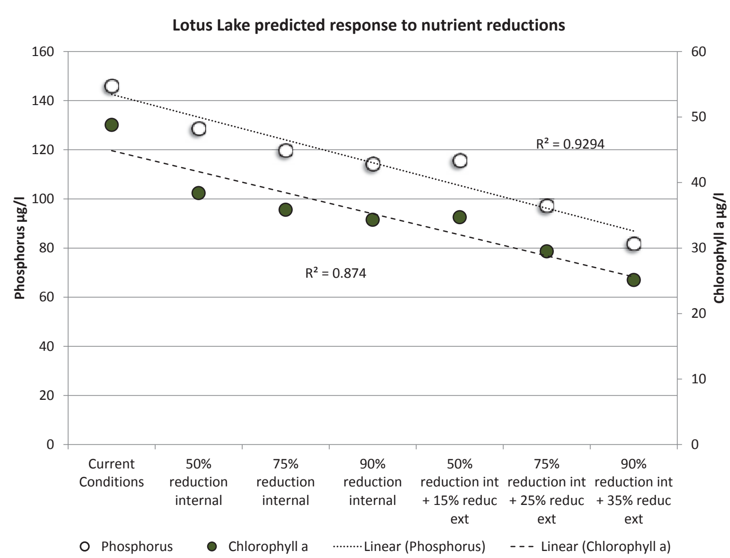

To the point

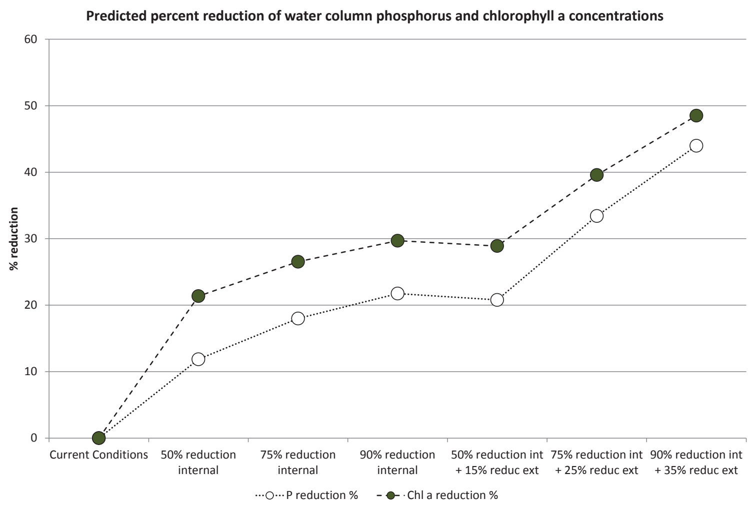

Lotus Lake Chl a v. TP 2013-2016 AD
Chl a µg/l
TP µg/l
$y = 1E-06x^4 - 0.0007x^3 + 0.1342x^2 - 10.002x + 275.92$
$R^2 = 0.631$
0
10
20
30
40
50
60
70
80
90
50
70
90
110
130
150
170
190


Lotus Lake Total Phosphorus & Chlorophyll *a*
TP µg/l
Chl. *a* µg/l
Sampling Date
5/7/1996
6/20/1996
7/17/1996
8/28/1996
4/25/1997
6/23/1997
7/16/1997
8/11/1997
5/23/2005
6/15/2005
7/11/2005
8/10/2005
9/7/2005
5/1/2007
6/5/2007
7/2/2007
8/15/2007
8/19/2013
9/10/2013
5/29/2014
6/24/2014
7/21/2014
8/18/2014
9/15/2014
5/27/2015
6/23/2015
7/20/2015
8/18/2015
9/14/2015
5/24/2016
6/22/2016
7/25/2016
8/22/2016
9/26/2016
TP µg/L
Chlorophyll(ug/l)
0
50
100
150
200
250
300
0
20
40
60
80
100
120
140


Lotus Lake Modeled Chl. a
$[chl.\mathrm{a}] = 0.55\{[P]_i/(1+\sqrt{T_w})\}^{0.76}$
chlorophyll a µg/l
0
10
20
30
40
50
60
70
80
90
Scenario 1
Scenario 2
Scenario 3
Scenario 4
Scenario 5


Lotus Lake Modeled Primary Productivity of Algae
$\sum C\,(gm^{-2}yr^{-1}) = \left[\frac{\{[P]_i/(1+\sqrt{T_w})\}^{0.76}}{0.3+0.011\{[P]_i/(1+\sqrt{T_w})\}^{0.76}}\right]$
0
100
200
300
400
500
600
Scenario 1
Scenario 2
Scenario 3
Scenario 4
Scenario 5


Lotus Lake predicted response to nutrient reductions
Phosphorus µg/l
Chlorophyll a µg/l
$R^2 = 0.9294$
$R^2 = 0.874$
0
20
40
60
80
100
120
140
160
0
10
20
30
40
50
60
Current Conditions
50% reduction internal
75% reduction internal
90% reduction internal
50% reduction int + 15% reduc ext
75% reduction int + 25% reduc ext
90% reduction int + 35% reduc ext
Phosphorus
Chlorophyll a
Linear (Phosphorus)
Linear (Chlorophyll a)


Predicted percent reduction of water column phosphorus and chlorophyll a concentrations
% reduction
0
10
20
30
40
50
60
Current Conditions
50% reduction internal
75% reduction internal
90% reduction internal
50% reduction int + 15% reduc ext
75% reduction int + 25% reduc ext
90% reduction int + 35% reduc ext
P reduction %
Chl a reduction %


Questions?

Lotus Lake fisheries update

Aaron J. Cole
WDNR Senior Fisheries Biologist
Barron & Polk counties
Aaron.Cole@Wisconsin.gov
715-637-6864

FISHERIES MANAGEMENT............we make fishing better

Fisheries Mgmt. timeline

- Surveys
  - 2000, 2012
- Aeration
  - 2004
  - Used compressed air and surface
- Carp management
  - Marked carp in 2013, 2014, and 2015
  - Carp contracts 2013, 2014, 2015, and 2016
- Considerable amount of focus for the lake

Carp population estimates

- Adult population estimates:
  - Electrofishing (Year 1 and Year 2)
  - Determine number of adult carp/acre

$$N = \frac{(M+1)(C+1)}{(R+1)} - 1$$

- Determine exploitation
  - Effectiveness of commercial removal

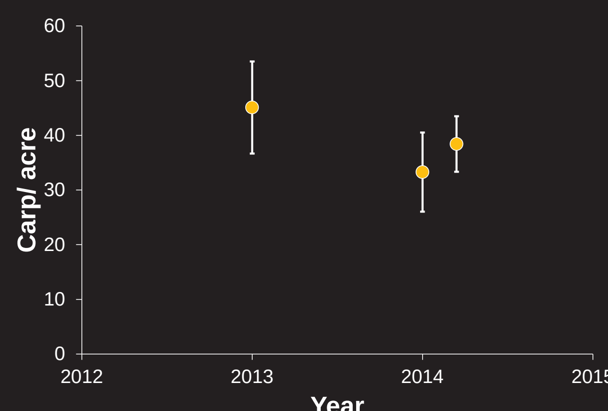
Carp marking

- 2013
  - 1,275
- 2014
  - 644
- 2015
  - 696

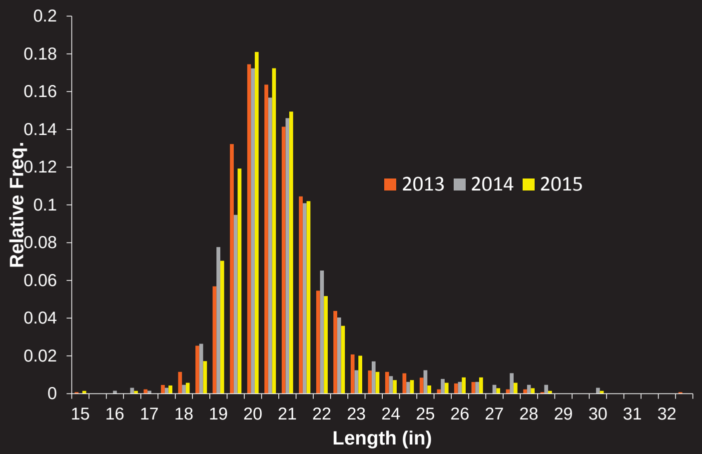
Carp Population estimates

- 2013-2014
  - PE: 10,688 (±1,996)
  - 45.1 carp/ac
  - Biomass: 197 lbs/acre
- 2014-2015
  - PE: 7,886 (±1,714)
  - 33.3 carp/ac
  - Biomass: 150 lbs./acre
- 2013,2014-2015
  - PE: 9,103 (±1,203)
  - 38.4 carp/ac
  - Biomass: 174 lbs./acre

Carp Population estimates



LFs by year



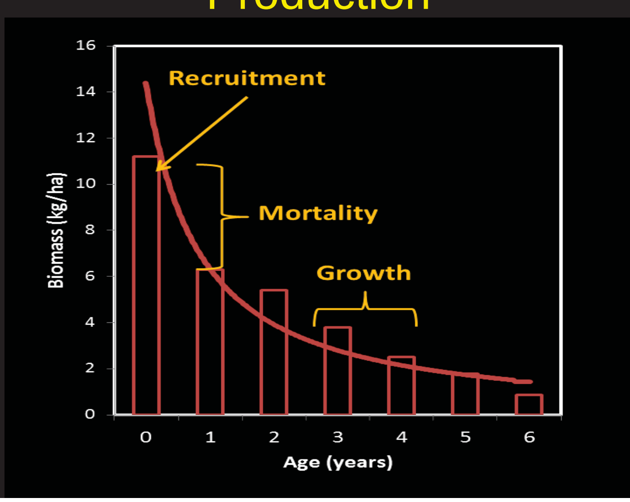
Removal efforts by year

- 2013
  - December- Seine net got stuck and no carp were removed
- 2014
  - No attempts
- 2015
  - No attempts
- 2016
  - April-an open water seining attempt
    - approximately 70 carp removed
  - June-large mesh gill net. 100-150 carp removed
    - Electrofishing also used
- ONLY ~220 CARP REMOVED OVER FOUR YEARS

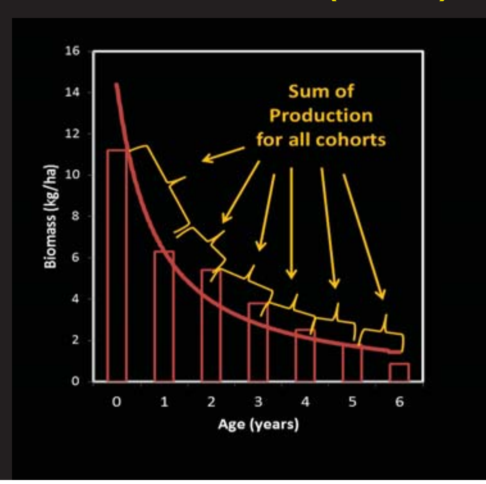
Fisheries 101

- Dynamic Rate Functions
  - Growth
  - Recruitment
  - Mortality

Production



Production (cont.)



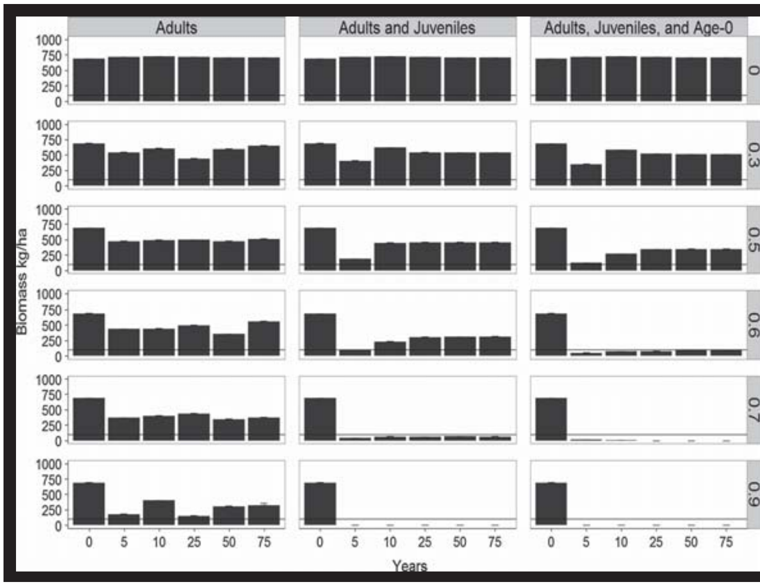
2013 Lotus Lake carp production

- Carp Biomass: 197.5 lbs./ac
- Annual Production: 33.9 lbs./ac
- Production/Biomass: 0.17

- Must remove 8039.4 lbs. carp/year
  – to BEGIN to alter population structure
  – VERY CONSERVATIVE ESTIMATE!!!
  – Invasive species in a novel habitat

Other factors

- Compensatory growth
  – Less competition…grow faster
- Compensatory recruitment
  – Less competition…survival increases
- Downstream immigration
- Recent research suggests it takes a lot more exploitation…
  – Lechelt and Bajer 2016



Lechelt and Bajer 2016

- Recruitment dynamics strongly impact ability to control common carp using physical removal
- Population control is unlikely in systems with strong internal recruitment
  – 90% annual adult removal is insufficient
  – Additional life stages need to be targeted

Carp Management

- Contracts from 2013-2016
  – AVG: 0.7% exploitation (0.07)
  – NOT ENOUGH TO ACCOMPLISH ANYTHING
- Annual carp removals
- Concerns of killing bycatch and AIS

- NO unsubsidized carp contract has drastically reduced, crashed, or “flipped” a system in WI

Lotus Lake

- Ideal conditions for carp
- High carp recruitment
- Connected to shallow marsh and Horse Creek
- Habitat, habitat, habitat…
- Removal nearly impossible

Reality

- Maintain realistic expectations
- Boom and bust winterkill lake
- Appreciate the lake for what it is
  - Small, quiet, scenic, lightly developed
- Vegetation without carp
- Role of carp in nutrient budget?

Questions?

Aaron J. Cole
WDNR Senior Fisheries Biologist
Barron & Polk counties
Aaron.Cole@Wisconsin.gov
715-637-6864

Lotus Lake Wild Rice Feasibility and Carp Management

Lotus Lake Wild Rice Feasibility and Carp Management

- Project Goals
  - Determine if wild rice would survive and mature if protected (are sediments conducive)
  - Track carp movements to compliment DNR PE and determine level of mixing and if barriers would be necessary

Lotus Lake Wild Rice Feasibility and Carp Management

Why??

- Anecdotal information
  - Tribal Elders
  - Wild Rice Regs
  - Local Knowledge
- Lake is suited
  - Depths
  - Low Development
  - Flocculent Substrates
- Interest in restoration

Lotus Lake Wild Rice Feasibility and Carp Management

Project Partners

- St Croix Tribal Environmental Department
- Polk County Land and Water
- WI DNR
- Lotus Lake Association
- USDI-BIA
- Osceola Rod and Gun Club

Lotus Lake Wild Rice Feasibility and Carp Management

Project Area

Lotus Lake Wild Rice Feasibility and Carp Management

Project Timeline

Task	2014				2015				2016			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Install Rice exclosures and monitor		■	■									
Implant Lotus radio tags			■									
Complete PE		■				■	■					
Telemetry Surveys			■	■	■	■	■	■	■	■		
Implant Horse Radio Tags							■					
Seine Attempts	■									■		
Gill Netting										■		
Seed Lotus										■		

Lotus Lake Wild Rice Feasibility and Carp Management

Wild Rice Feasibility
– 2 sites
– 1 “open area” and 1 exclosure at each site
– Installed/seeded April 2014
– Monitored through summer

WSB

Lotus Lake Wild Rice Feasibility and Carp Management

Lotus Lake Wild Rice Feasibility and Carp Management

Results
– Protected seedings did well
– Dramatic drop in water levels
– Rice matured

	Site 1 Open	Site 1 Exc.	Site 2 Open	Site 2 Exc.
Stems/m²	0	46	0	88

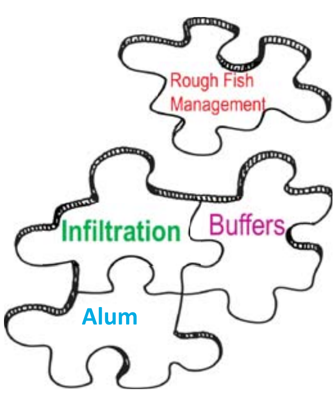
WSB

Lotus Lake Wild Rice Feasibility and Carp Management

WSB

Lotus Lake Wild Rice Feasibility and Carp Management

WATER QUALITY
IMPROVEMENT
PUZZLE



WSB

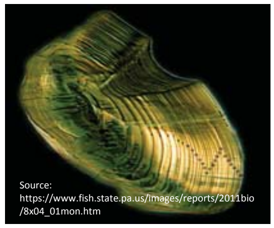
Lotus Lake Wild Rice Feasibility and Carp Management

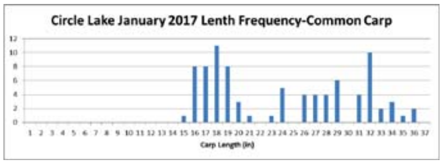
- Integrated Pest Management (IPM) Approach

WSB

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM- Data Collection
- – Assess the Population
  - Mark/Recap PE and/or CPUE
  - – Model
  - Length Frequency
  - Aging





Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM-Data Collection
- – Movement Surveys
  - Aggregations
  - Nurseries
  - Migration Routes

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM-Bio Control
  - – Use predator species
  - Egg
  - Larvae
  - Juveniles

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM- Barriers
  - – Can be temporary or permanent
  - – Consider native fish movement

Lotus Lake Wild Rice Feasibility and Carp Management

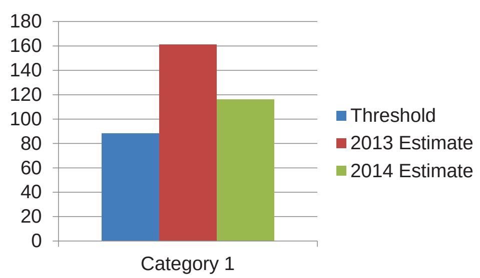
- Carp IPM- Biomass Removal

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM-Biomass Removal
  - ❖ Bajer & Sorensen (Hennepin-Hopper) developed biomass threshold of 100 kg/ha or 88 lbs/ac
  - ❖ Generally supported by obs on other projects

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM-Biomass Removal- 24-45% biomass removal necessary (6,636-17,301 pounds)



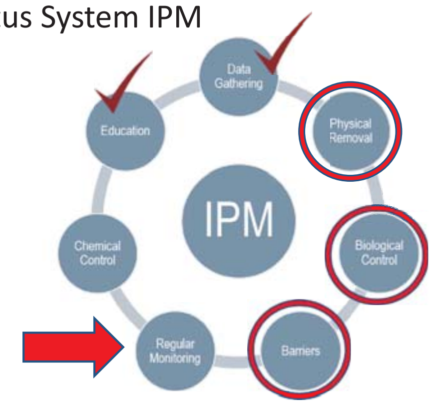
Horse= 416 lbs/acre

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM-Telemetry Surveys
  - Carp haven't aggregated well in Lotus
  - Movement out of Lotus
  - Horse Carp aggregate, move to inlet

Lotus Lake Wild Rice Feasibility and Carp Management

- Lotus System IPM



Lotus Lake Wild Rice Feasibility and Carp Management

Future Steps

- Carp/BLG YOY Surveys
  - No YOY seen yet in Lotus
  - Look in Wetlands
- Barriers
  - Multiple types could be used in many areas
  - Watch native migration (timing)
- Removal traditional/new tech
  - Seine
  - Box Net
  - Electro
  - Modified Trap

Lotus Lake Wild Rice Feasibility and Carp Management

Future Steps

- Support Predator Species
  - Bluegill
  - NOP
  - Aerator
- Wild Rice restoration
  - Habitat (fish/waterfowl)
  - Sequester P
  - Reduce effect of wind
- Monitor Carp Population
  - PE
  - Telemetry
  - PIT

Lotus Lake Wild Rice Feasibility and Carp Management

- Clam Lake- Burnett County, WI

– Restore wild rice beds
  - 84 acres in 2009-~200 by 2016
  - Seeding taking
  - Removed over 640,000 pounds
  - 92% biomass removal

Lotus Lake Wild Rice Feasibility and Carp Management

Lotus Lake Wild Rice Feasibility and Carp Management

Lotus Lake Wild Rice Feasibility and Carp Management

- Silver Lake – Ramsey/Anoka County, MN
- – Improve water clarity and lower Chlorophyll-A/ Total Phosphorus concentrations
  - 1.25 m average secchi to 2.5 m (max depth 6.7 m)
  - Decreased TP and Chl-a
  - Increased vegetation (21% to 86%)

Lotus Lake Wild Rice Feasibility and Carp Management

- Spring Lake – Scott County, MN
- Ongoing Carp management
- Removal of over 70% of carp biomass (January 2017)
  - 84.5 kg/ha to **25.9 kg/ha**
  - Facilitate alum treatment

Lotus Lake Wild Rice Feasibility and Carp Management

- Staring Lake – Hennepin County, MN
- Ongoing carp management
- Removal of over 70% of carp biomass
  - 498 kg/ha to **95 kg/ha**
- Increased early season water clarity
- Increase in vegetative richness and abundance

Lotus Lake Wild Rice Feasibility and Carp Management

Others Include

- Circle Lake-58% biomass reduction
- Phelan Chain of Lakes, West Metro, Riley-Purgatory

Lotus Lake Wild Rice Feasibility and Carp Management

Carp IPM can be successfully implemented as part of a holistic plan to improve the ecological integrity of Lotus Lake.

persevere

to persist in anything undertaken; maintain a purpose in spite of difficulty, obstacles, or discouragement; continue steadfastly.

Lotus Lake Management Plan Development
Committee Meeting 3

Wednesday, April 12th, 2017
6-8 PM
Polk County Government Center, AB Room

6:00	Introductions
6:05	Presentation (Katelin Anderson and Jeremy Williamson) Plant surveys Shoreline inventory
6:35	Brainstorm goals for lake management (all)
8:00	Adjourn

Next meeting Wednesday, May 10th
6-8 PM
Polk County Government Center, AB Room

Katelin Anderson
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Jeremy Williamson
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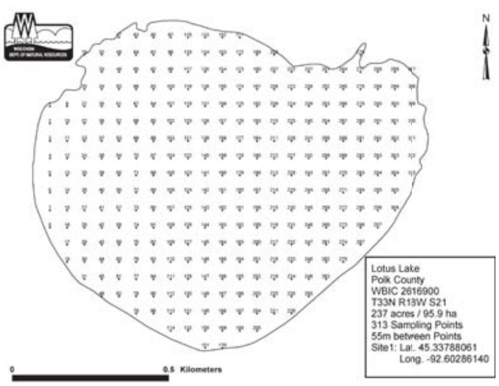
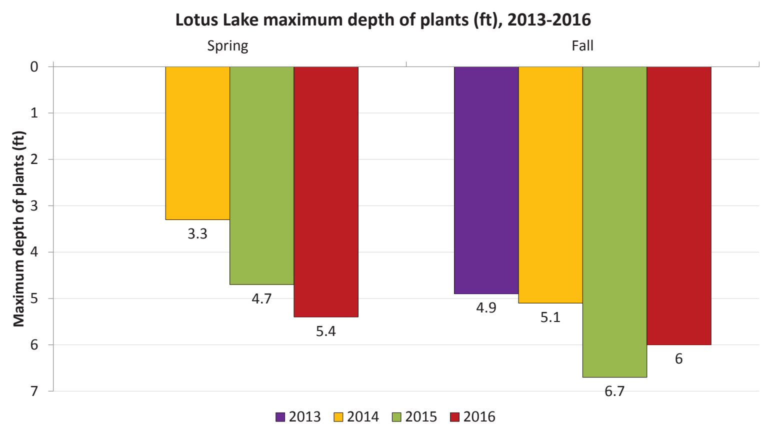
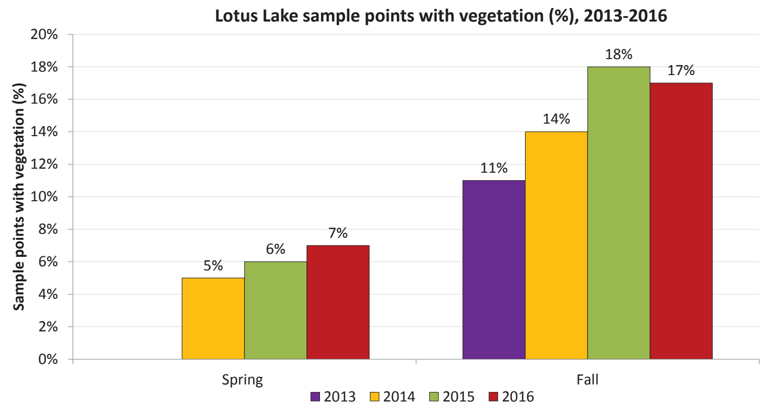


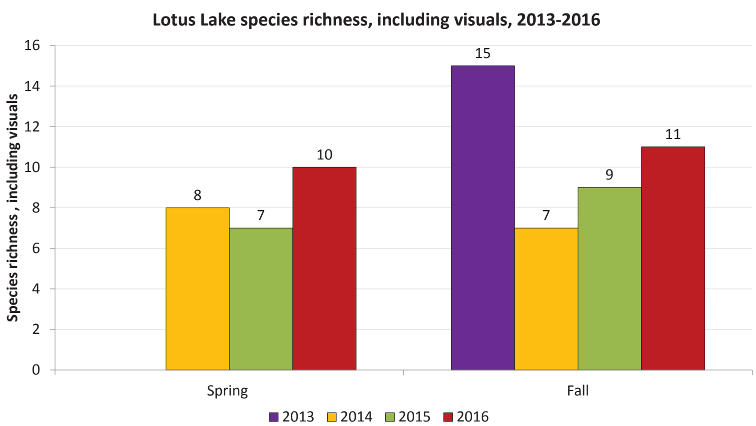


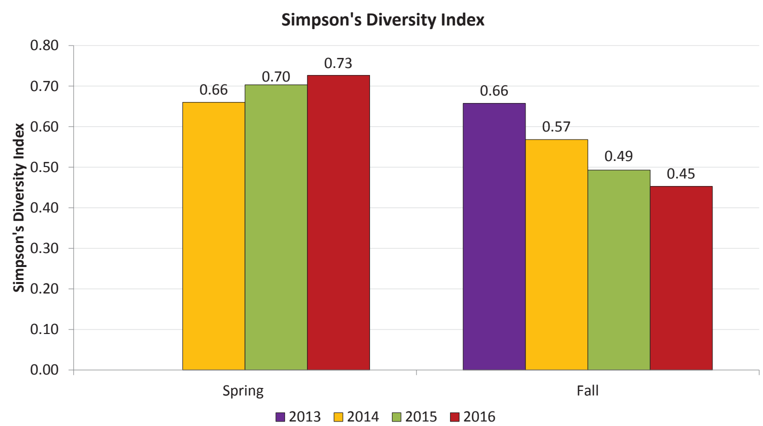
Frequency of occurrence within vegetated areas (%)	Fall 2013	Spring 2014	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Fall 2016
Ceratophyllum demersum, Coontail	6.3	35.3	4.7	26.3	5.5	31.8	6.0
Elodea canadensis, Common waterweed					1.8		2.0
Lemna minor, Small duckweed	3.1				1.8		
Nelumbo lutea, American lotus	62.5		65.1	10.5	74.5	45.5	78.0
Nuphar variegata, Spatterdock	9.4	35.3	23.3	42.1	10.9	18.2	8.0
Nymphaea odorata, White water lily	21.9	47.1	11.6	42.1	10.9	9.1	14.0
Potamogeton natans, Floating-leaf pondweed					1.8	4.5	
Schoenoplectus tabernaemontani, Softstem bulrush	6.3						
Stuckenia pectinata, Sago pondweed	3.1		2.3	5.3		4.5	
Wolffia sp.	3.1						
Filamentous algae		5.9				18.2	

Frequency of occurrence at sites shallower than maximum depth of plants	Fall 2013	Spring 2014	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Fall 2016
Ceratophyllum demersum, Coontail	1.4	18.8	1.3	4.3	1.6	4.3	1.9
Elodea canadensis, Common waterweed					0.5		0.6
Lemna minor, Small duckweed	0.7				0.5		
Nelumbo lutea, American lotus	13.5		17.9	1.7	21.9	6.2	24.8
Nuphar variegata, Spatterdock	2.0	18.8	6.4	6.9	3.2	2.5	2.5
Nymphaea odorata, White water lily	4.7	25.0	3.2	6.9	3.2	1.2	4.5
Potamogeton natans, Floating-leaf pondweed					0.5	0.6	
Schoenoplectus tabernaemontani, Softstem bulrush	1.4						
Stuckenia pectinata, Sago pondweed	0.7		0.6			0.6	
Wolffia sp.	0.7						
Filamentous algae		3.1		0.9		2.5	

Relative frequency (%)	Fall 2013	Spring 2014	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Fall 2016
Ceratophyllum demersum, Coontail	5.4	30.0	4.3	21.7	5.1	28.0	5.6
Elodea canadensis, Common waterweed					1.7		1.9
Lemna minor, Small duckweed	2.7				1.7		
Nelumbo lutea, American lotus	54.1		60.9	8.7	69.5	40.0	72.2
Nuphar variegata, Spatterdock	8.1	30.0	21.7	34.8	10.2	16.0	7.4
Nymphaea odorata, White water lily	18.9	40.0	10.9	34.8	10.2	8.0	13.0
Potamogeton natans, Floating-leaf pondweed					1.7	4.0	
Schoenoplectus tabernaemontani, Softstem bulrush	5.4						
Stuckenia pectinata, Sago pondweed	2.7		2.2			4.0	
Wolffia sp.	2.7						







Floristic Quality Index

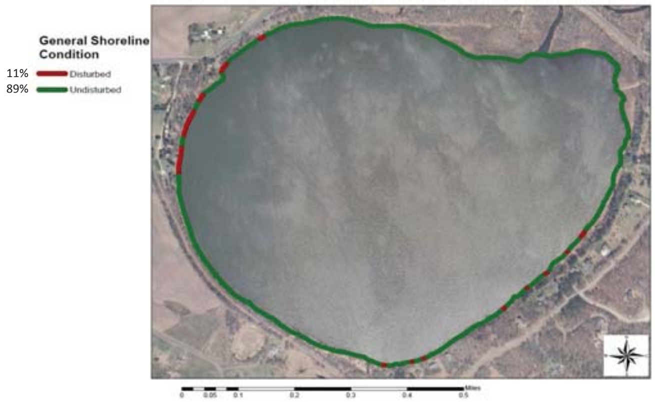
North Central Hardwood Forest

Mean species richness = 14
Mean average conservatism = 5.6
Mean Floristic Quality = 20.9

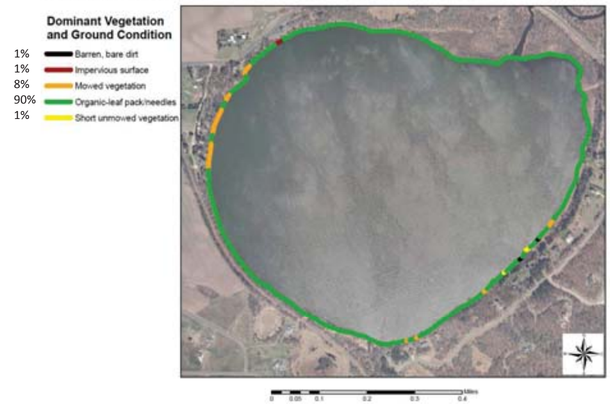
Lotus Lake

Mean species richness = 5
Mean average conservatism = 5
Mean Floristic Quality = 11

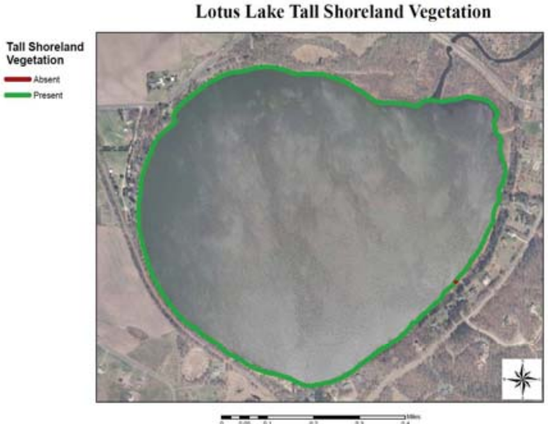
Lotus Lake General Shoreline Condition Within 35 feet



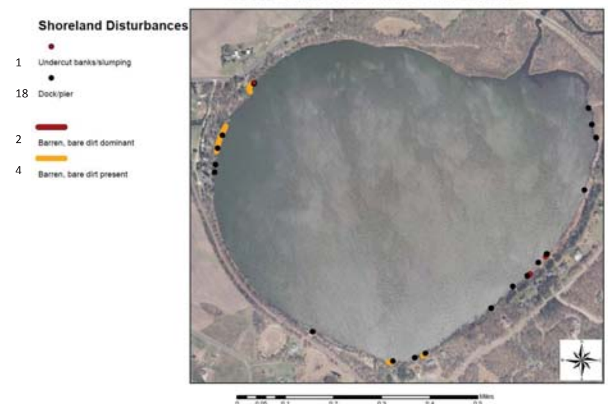
Lotus Lake Dominant Shoreland Vegetation and Ground Conditions



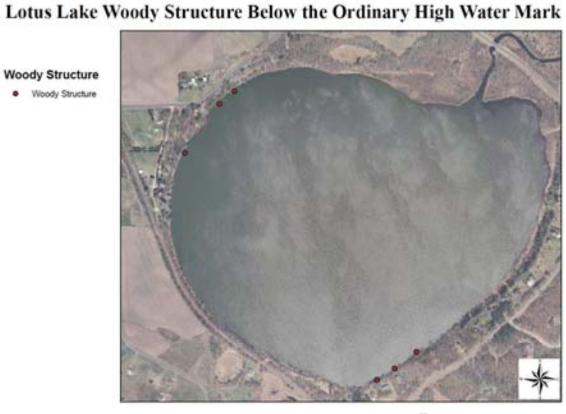
Lotus Lake Tall Shoreland Vegetation



Lotus Lake Shoreland Disturbances



Lotus Lake Woody Structure Below the Ordinary High Water Mark



Appendix L

Public Comments

From:	Tony Havranek
To:	Katelin Anderson; "Trish Carlson"; Aaron Cole; "Alex.Smith@wisconsin.gov"; Jeremy Bloomquist
Subject:	Goal 1_AJHComments
Date:	Friday, December 01, 2017 12:40:44 PM
Attachments:	image5639cd.PNG Goal 1_AJHComments.docx

Attached is the budget section.

I added a few items to address concerns previously raised and included additional items for data collection and implementation based on other project experience.

I think carp management and the other items outlined are feasible and will allow Lotus to achieve designated uses and meet federal and state mandated water quality standards.

Thanks for the opportunity to comment.

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GOAL 1. IMPLEMENT MULTIPLE INTEGRATED STRATEGIES TO ACTIVELY MANAGE THE CARP POPULATION IN LOTUS LAKE	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**
Reduce the carp population to less than 89 pounds/acre (100 kg/hectare)	Contingent on approval			LLAB, WDNR	
Remove carp through commercial fishing or contracted siening	2018-Future as needed	$10,000/year	400		BIA-CoF, USFWS-TWG, DU,
Remove carp through targeted harvesting: electrofishing/netting. Box netting has been used successfully in other smaller systems like Lotus	2018-future				
Electrofishing	2018-future	$10,300	40		BIA-CoF, USFWS-TWG, DU,
Box Netting	2018-Future	$10,533	288		
Organize a carp fishing tournament on Lotus Lake	2018				
Consider experimental options including: species specific pathogens/viruses, poisoned corn, pheromone lure traps, water level manipulations, etc.					
Eradicate carp with chemical pesticides such as rotenone	If feasible				
Carcass Disposal	2018-Future	$1,500	20		
Build a modified seine for use in Horse and Lotus to eliminate the potential spread of invasives. Modify mesh size, roller size, density, and weight.	2019	$17,000			
Monitor carp locations to increase the likelihood of successful management efforts	Contingent on funding			LLAB, WDNR, SCENRD	Contingent on removal
Radio tag/monitor carp to determine locations and formation of population aggregates *This would be for 10 high frequency radio tags in Lotus and monitoring once/week for 12 weeks/year*	2018-Future	$7,180			BIA-CoF, USFWS-TWG, DU,
Determine spawning locations for the Lotus Lake carp population	2018-2020	Included in above estimate			BIA-CoF, USFWS-TWG, DU,
Determine movement of carp between Horse Lake, Lotus Lake, and surrounding wetlands	2018-2020	$7,180			BIA-CoF, USFWS-TWG, DU,
Determine locations for the installation of carp barriers		$1,500			BIA-CoF, USFWS-TWG, DU,

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Maintain reduced carp populations in Lotus Lake	Contingent on funding			LLAB	Contingent on removal
Install carp barriers to limit carp movement into and out of Lotus Lake This cost is for fixed grate barrier at the culverts crossing the Stower	2019 or 2020	$4,000			
PIT tag Carp and NOP to confirm movement observed anecdotally and through radio telemetry. This will dictate timing of barrier install and location.	2018-2019	$22,000			
Rotating Drum or vertical barrier at Lotus outlet and fixed grate at Horse inlet	2019 or 2020	$11,000			
Stock bluegill and gamefish to sustain a reduced carp population and/or replenish the Lotus Lake fishery in the case of rotenone					
Stock bluegill in wetlands that serve as nursery ground for spawning carp					
Maintain the aerator to prevent winterkill of bluegills and gamefish- Solar	Ongoing	$14,500	30		
Assess carp population following reduction efforts	Contingent on funding			LLAB, WDNR, SCENRD	Contingent on removal
Determine number of marked fish removed from Lotus Lake to estimate population reductions- Develop a mark recap PE	2018-Future	$7,665	16		
Determine yearly carp population estimates This could be done using the ElectroFishing CPUE	2018-Future	$5,465	16		
Use existing population data to inform the need for future removal efforts to keep carp populations below 89 pounds/acre (100 kg/hectare)	2018-Future	Included in above Estimates			
Complete late summer/early fall trap netting to confirm nursery sites- Lotus, horse, wetlands, 3 net nights per site, 3 sites	2018-2021		$19,400		
Effectively communicate project goals and results to the broader community					
Use multiple methods of communication: website, Facebook, press releases, lake fair, etc.	Ongoing	$100-500	20	LLAB	-
Attend local town, village, sportsman's club, lake organization, and other community group meetings and events to share project goals and results	Ongoing	-	20	LLAB	-
Evaluate a carp-proof exclosure to provide a pilot demonstration of what Lotus Lake could look like without carp	2018	$5,200			

GOAL 2. REDUCE INTERNAL AND EXTERNAL PHOSPHORUS LOADING TO LOTUS LAKE TO LEVELS WHERE WATER QUALITY IMPROVES, ALGAE GROWTH DECREASES, AND RECREATION IS POSSIBLE	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**
INTERNAL PHOSPHORUS LOADING					
Implement multiple strategies to actively manage the carp population in Lotus Lake	**SEE GOAL 1**				

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Conduct a study of water aerators to determine the most effective system for Lotus Lake (efficiency, cost, placement)	Ongoing	-	20	LLAB	-
Re-establish wild rice and additional submerged aquatic plants in Lotus Lake	Contingent on funding/ removal	$12,000		LLAB, SCENRD	
Research the costs and benefits of installing a dam at the outlet of Lotus Lake to maintain water levels	2019?	-	40	LLAB	-
EXTERNAL PHOSPHORUS LOADING					
Install best practices including: native plantings, diversion, rock infiltration, and rain gardens using the Healthy Lakes Grant program	2020	$250 per practice	100	LLAB, LWRD	Healthy Lakes
Identify a person or committee responsible for the grant application and implementation					-
Provide information to homeowners regarding each practice and how it relates to improved water quality and decreased algae growth	Ongoing				-
Identify homeowners interested in installing grant eligible best practices					
Include the county owned boat landing and park as a Healthy Lakes site					
Apply for and implement a Healthy Lakes Grant application					
Install WDNR signage at Healthy Lakes project sites					
Organize a tour of properties where successful practices have been installed					
Support the work of the Horse Creek Famer Led Council	Ongoing	As able	-	LLAB, LWRD, HCFLWC	-
Design new homeowner packets that highlight the impact of shoreline development on water quality	2018	$100	24	LLAB, LLAC	LPL
Participate in meetings on the proposed quarry and share concerns for Lotus Lake	Ongoing	-	3	LLAB	-
If plant growth becomes problematic for recreation and navigation, develop an aquatic plant management plan which is mindful of the benefits of submerged aquatic plants	If necessary			LLAB, LWRD, CON	LPL

GOAL 3. RESTORE THE LOTUS LAKE ECOSYSTEM TO SUPPORT WILDLIFE, FISHERIES, WILD RICE, AND SUBMERGED AQUATIC PLANTS	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**
Implement multiple strategies to actively manage the carp populations in Lotus Lake	**SEE GOAL 1**				

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Re-establish wild rice and additional submerged aquatic plants in Lotus Lake	**SEE GOAL 2**				
Install best management practices including: native plantings, rain gardens, and fish sticks using the Healthy Lakes Grant program	**SEE GOAL 2**				
For fish sticks: work with fisheries biologist to determine locations for fish sticks and other habitat improvements	2020	-	25	LLAB	-
Promote practices to restore the fishery of Lotus Lake					
Determine if natural reproduction of northern pike and other species of fish is occurring					
Stock northern pike and other species of fish if natural reproduction is not occurring					
Improve natural reproduction by enhancing habitat for spawning					
Reduce populations of purple loosestrife					
Map purple loosestrife locations on Lotus Lake	Ongoing	$200-400	8	LLAB, CON	AEPP
Hire a contractor to spray for purple loosestrife	Ongoing	$75/hour	2	CON	AEPP
Determine effectiveness of contracted removal efforts	Ongoing		2	LLAB, CON	AEPP
Follow up herbicide treatment with volunteer removal of flowers and/or spot herbicide treatment	If needed	$50	40	LLAB, LLAV	AEPP
Contact Polk County LWRD to implement a bio-control program	If interest	-	50	LLAB, LWRD	AEPP
Prevent the introduction of aquatic invasive species into Lotus Lake and contain newly introduced invasive species					
Develop an active base of educated volunteers to participate in WDNR statewide AIS efforts: Clean Boat, Clean Waters; Landing Blitz; Drain Campaign; Bait Dealer Initiative; Citizen Lake Monitoring Network for AIS	Ongoing	$100-500	100	LLAB, LLAV, LWRD	AEPP
Ensure that signage at the boat landing is in place and updated as necessary	Ongoing	-	1	LLAB	-
Conduct professional level AIS monitoring at public boat landing and likely areas of introduction	Yearly	$200-400	-	LWRD/CON	LPL/AEPP
Conduct professional level whole lake point intercept plant surveys	Yearly	$800-1,600	-	LWRD/CON	LPL/AEPP
Maintain a contingency fund for rapid response to newly introduced invasive species	2018	If funds available	-	LLAB	-
Develop an Aquatic Invasive Species Rapid Response Plan	2018	-	10	LLAB, LWRD	-

GOAL 4. SUSTAIN THE IMPLEMENTATION OF THE PLAN	TIMELINE	$ ESTIMATE	VOLUNTEER HOURS	PARTNERS	FUNDING SOURCES

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Ensure that the goals of the plan are met through board delegation					
Review and document progress made towards plan implementation	Ongoing	-	10	LLAB	-
Identify actions that weren't completed and identify why they were not completed	Ongoing	-	10	LLAB	-
Report progress towards goals related to: carp management, water quality, and aquatic invasive species	Ongoing	-	10	LLAB	-
Continue current data collection efforts and expand data collection efforts to evaluate progress					
Ensure that Citizen Lake Monitoring volunteer is in place each year to collect phosphorus, chlorophyll and secchi data	Yearly	-	10	LLAB, LLAV	CLMN program
Continue to collect beach sampling for coliform bacteria	Yearly		20	LLAB, LWRD	-
Conduct spring and summer aquatic plant point intercept surveys to determine plant community recovery and expansion of American Lotus	As needed	$800-1,600	-	LWRD	LPL
Repeat the 2014-2016 water quality study in five to ten years	2019-2024	$25,000		LLAB, LWRD, CON	LPL
Develop an aquatic plant management plan to address navigation and recreation if plant growth becomes problematic as a result of carp management	If needed			LLAB, LWRD, CON	LPL
Analyze the presence of lead in fish tissues	If needed			LWRD, CON	
Determine if the culverts for the trail impacted water levels	2018			LLAB	LPL
Evaluate the costs, benefits, and feasibility of forming a District		-	80	LLAB	-

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