THE CERULEAN WARBLER IN MORGAN-MONROE AND YELLOWWOOD STATE FORESTS, INDIANA: PRE-TREATMENT DATA ON ABUNDANCE AND SPATIAL CHARACTERISTICS OF TERRITORIES

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Abstract.—The cerulean warbler (*Setophaga cerulea*) is a small Neotropical migrant songbird that is currently experiencing population declines. We monitored the number of cerulean warblers, as well as size and spatial attributes of territories, before two methods of silvicultural treatments took place in six of nine study units involved in the Hardwood Ecosystem Experiment within the Morgan-Monroe and Yellowwood State Forests in southern Indiana. Data were collected during the 2007 and 2008 breeding seasons. Relative abundance was apparently greater in 2008, but this increase was not consistent at each individual site. Territory sizes also increased from 2007 to 2008 and this trend was consistent across most study sites. Territories were spatially clustered in both years. These findings are similar to other research involving cerulean warblers in southern Indiana. There were no significant differences in the number of cerulean warbler detections or the size of territories among the three study groups (control, even-aged, and uneven-aged) for the two combined pre-treatment years. Future studies will examine how cerulean warblers respond to silvicultural prescriptions.

INTRODUCTION

Cerulean warbler (*Setophaga cerulea*[2]) is a small migratory songbird with a breeding range covering much of the Midwest, northeastern portions of the United States, and parts of Ontario and Quebec (Hamel 2000a, Robbins et al. 1992). It winters primarily on the slopes of the Andes in South America (Hamel 2000a). Cerulean warbler has experienced such long-term population declines at both the local and range-wide levels as to become a species of concern (Hamel 2000a, Robbins et al. 1992). For the past 40 years, this species has experienced annual population declines estimated at 4.1 percent (Sauer et al. 2008) based on Breeding Bird Surveys. This decline represents the greatest annual rate of decline of any North American wood warbler and songbird (Jones et al. 2008, Robbins et al. 1992). As a result, it is listed as a top priority species for conservation action by Partners in Flight (Hamel et al. 2004). It has been listed as "Vulnerable" by the International Union for Conservation of Nature (Birdlife International 2004) and was petitioned for listing as a threatened species under the Endangered Species Act (U.S. Fish and Wildlife Service 2002). However, the petition to list was denied (U.S. Fish and Wildlife Service 2006).

In Indiana, cerulean warblers declined by 2.7 percent over the last 40 years (Hands et al. 1989). From 1980 through 1998, Breeding Bird Surveys conducted in Indiana indicated a relative abundance estimate of 0.29 birds/route for the entire survey period (Hamel 2000b). This abundance value was the lowest for any state in which an estimate could be calculated (Hamel 2000b). Cerulean warblers, once considered common

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[2] Formerly *Dendroica cerulea*

summer breeders in Indiana, were listed as a "species of special concern" (Bruner 1998) but are now listed as endangered in the state (Indiana Department of Natural Resources-Division of Nature Preserves 2010).

The cerulean warbler is an area-sensitive species (Hamel 2000a, Robbins et al. 1992) with a preference for large contiguous tracts of mature deciduous forest. Robbins et al. (1992) concluded that 700 ha was the minimum tract size of forest for cerulean warblers in the Middle Atlantic states. In Wisconsin, however, cerulean warblers could be located in tracts ranging from as small as 16 ha to larger than 32 ha (Hands et al. 1989), suggesting that minimum tract size requirements may differ between regions. In Indiana, cerulean warblers are most commonly associated with forests that exhibit heterogeneous canopy structure with a preference for large, dominant trees (Jones and Islam 2006). Although the geographic limits of the breeding range for cerulean warblers have changed little over time, the abundance of the species in its breeding range has declined (Hamel 2000a). Much of the deciduous forest that makes up the breeding range throughout the Midwest has been converted for agricultural use (Hands et al. 1989), resulting in loss of habitat and further fragmentation of remaining habitat. Northern Indiana has been severely fragmented and now has less than 10 percent forest cover, while southern Indiana has nearly 80 percent forest cover (Fauth 1999).

Despite long-term declines in cerulean warblers' overall relative abundance, some authors have documented that the species is expanding to the northeast (Oliarnyk and Robertson 1996, Robbins et al. 1992, Sauer et al. 2003), possibly due to changes in climate and land use. In this region, large areas of agricultural land have been allowed to succeed to mature forests (Hamel 1992), which suggests that forest management practices have the potential to benefit cerulean warblers.

Few studies have examined cerulean warblers' response to silvicultural treatments[3] (Hamel et al. 2006, 2010). However, some evidence suggests that large-scale habitat alterations can be detrimental to this species. In Arkansas and Ontario, ice storms negatively affected cerulean warbler relative abundance (Hamel et al. 1998, Jones et al. 2001). In West Virginia, cerulean warblers occurred at a lower abundance and frequency within 15- to 18-year-old regenerating clearcut stands compared to 70- to 80-year-old mature second-growth forests (Wood et al. 2006). Hamel et al. (2004) indicated that studying cerulean warblers' response to experimental habitat manipulation is an important way to determine which characteristics of vegetation structure are preferred by the birds and how to produce these characteristics on the landscape.

The objectives of our study were to explore the abundance and spatial characteristics of cerulean warbler territories in the Hardwood Ecosystem Experiment (HEE) before silvicultural treatments. Our specific objectives were to determine:

1. If cerulean warbler relative abundance differed among the three groups (control, uneven-aged, and even-aged),
2. If cerulean warbler territory sizes differed among the three groups (control, uneven-aged, and even-aged), and
3. The spatial distribution of cerulean warbler territories across the landscape of the HEE.

STUDY AREA

Nine management units, ranging from 303 to 483 ha in size, were established in southern Indiana, with four units in Morgan-Monroe State Forest and five units

[3] Cerulean Warbler Conservation Initiative, Joint AFO/COS/WOS conference, Kearney, NE, 9-13 March 2011, personal communication.

in Yellowwood State Forest (Kalb and Mycroft, this publication: Fig.1). Within each management unit, a 1.96-km^2 (196-ha) study site was overlain over a 200-ha core area. Pre-treatment data at each of the nine study sites were collected from 1 May - 8 August in 2007 and 2008.

MATERIALS AND METHODS

Point Count Surveys

Each study unit was overlain with a 7 point x 7 point grid study site with points 200 m apart for a total of 49 survey points (Fig. 1). We conducted point counts at each study site once per year using a 100-m radius at each survey point to locate male warblers. Survey points were spaced 200 m apart to minimize detection of the same bird twice. According to Jones et al. (2000) and Hamel et al. (2009), male cerulean warblers were found to broadcast their songs up to 100 m. The edge of each study site was surrounded by a 50-m buffer to minimize edge effects. Surveys were carried out between 05:30 and 10:30 EST. Surveys were not conducted during periods of rain, wind, or any other phenomenon that could have prevented vocalizations from being heard.

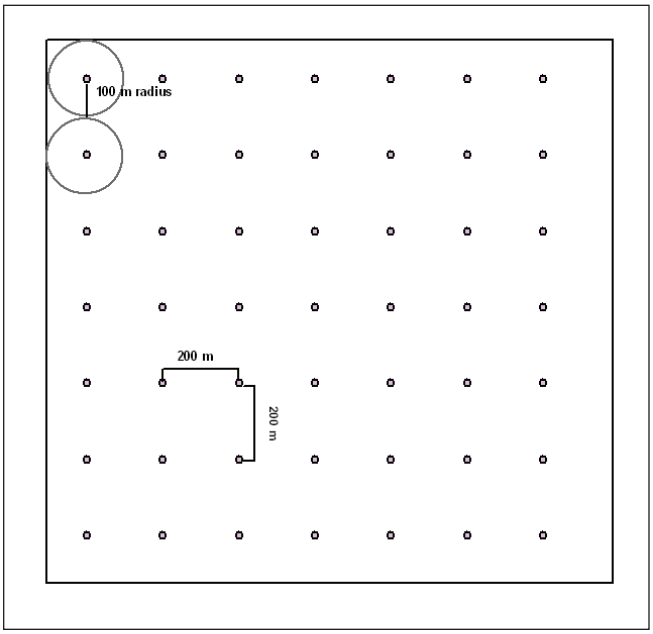

Figure 1.—Protocol established for cerulean warbler (*Setophaga cerulea*) surveys within nine study units located in Morgan-Monroe and Yellowwood State Forests in southern Indiana during pre-treatment years of 2007 and 2008. Seven transects, 200 m apart, were surveyed. Each transect contained seven survey points.

Observers listened for vocalizations for 2 minutes after arriving at the point, used playback of cerulean warbler songs for 1 minute, and then listened for an additional 2 minutes (Falls 1981). Compass direction and an estimate of the singer's distance were recorded for every vocalization to distinguish between multiple individuals. At each survey point, males were detected aurally and/or visually. The number of males detected at each study site was divided by the total area of each study site (196 ha) to determine number of males/km^2 for each unit. Point counts were conducted between 1 May - 8 June 2007 and 2008. To eliminate potential bias between time (day of month) of bird survey at a particular study site and the number of cerulean warbler detections, the order of survey of study sites was determined by drawing from a random numbers table for each year.

Territory Mapping

To demarcate territories, survey points where cerulean warblers were detected for a given year were revisited from 1 June - 15 July in 2007 and 2008. Trees where male birds were observed singing during the territory demarcation period (1 June - 15 July) were flagged with tape. Not all territories were demarcated in 2008 because of the early initiation of silvicultural treatments. Global Positioning System (GPS) coordinates of the trees were recorded, as well as tree species. GPS points were recorded as Universal Transverse Mercator (UTM) units in a Garmin GPS 76 handheld unit (Garmin International, Inc., Olathe, KS). Territories were considered to be completely mapped when 4-12 trees were flagged, depending on territory size.

Whenever possible, we revisited known territories multiple times before final demarcation of the territory's perimeter was determined. Depending on the individual bird, territory marking took several hours to several days. The coordinates of all points collected while demarcating territories were imported into ArcMap (ESRI, Redlands, CA). These data were used to create territory polygons using the minimum convex polygon method. Distances between the centroids of each territory and the nearest neighboring territory were used as part of a nearest neighbor analysis (Krebs 1989), which was performed using the average nearest neighbor tool in ArcMap.

Data Analysis

Normal probability plots of cerulean warbler abundances for the two pre-treatment combined years (2007 and 2008), generated in Minitab16© (Minitab, Inc., State College, PA) for the control sites and each of the treatment sites (even-aged and uneven-aged study sites), were normal. However, territory size data for each of the three groups were negatively skewed and these data were transformed to approximate a normal distribution. One-way analysis of variance (ANOVA) was performed to determine if there were differences in the number of cerulean warbler detections and size of territories among even-aged, uneven-aged, and control sites for the pre-treatment years. ANOVAs were performed with Minitab16© at $\alpha = 0.05$ level to test for significance.

RESULTS

Two hundred eighteen male cerulean warblers were detected in 2007 (94) and in 2008 (124) (Table 1) in the nine sites surveyed. Cerulean warblers were located in all nine units for the combined pre-treatment years with the number of individual birds identified per unit ranging from 0 to 47. Relative abundance estimates ranged from 0 to 23.98 males/km^2, averaging 6.18 males/km^2 (Table 1). Although the number of detections increased overall from 2007 to 2008, this trend was not consistent at each individual site. Sites 3 and 8 had the most detections and sites 1 and 2 had the fewest detections over the 2-year period (Table 1). However, there was no significant difference ($F = 2.57$, $df = 215$, $P = 0.11$) in the number of detections among the three groups for the two combined years.

Table 1.—Yearly cerulean warbler relative abundance in Yellowwood and Morgan-Monroe State Forests in southern Indiana according to site and harvest type for the pre-treatment years of 2007 and 2008. n = Number of males detected and R.A. = Relative abundance (males/km^2).

	2007		2008	
Site/harvest	n	R.A.	n	R.A.
Uneven-aged				
1	0	0.00	5	2.55
7	15	7.65	15	7.65
8	40	20.41	47	23.98
Even-aged				
3	9	4.59	20	10.20
6	8	4.08	4	2.04
9	9	4.59	13	6.63
Control				
2	1	0.51	4	2.04
4	4	2.04	9	4.59
5	8	4.08	7	3.57
Total	94	5.33	124	7.03

In 2007 and 2008, 120 cerulean warbler territories were demarcated (Table 2, Appendix 1). The number of territories demarcated at each study site ranged from 0 to 24. Overall territory sizes averaged from 0.11 ha to 0.86 ha (Table 2). We were unable to sample all territories in 2008 due to the initiation of the silvicultural treatments, which explains the apparent decrease in the number of territories for that year (see Materials and Methods: Territory Mapping above). There was no significant difference ($F = 0.29$, $df = 217$, $P = 0.75$) in the size of territories among the three groups for the two combined years. Mean distance of territories to the nearest neighboring territory in 2007 and 2008 was 126.5 m and 188.4 m, respectively. Based on the results of a nearest neighbor analysis, 83 percent of the territories were clustered in 2007 and 52 percent were clustered in 2008. These results suggest that most territories were spatially clumped and not randomly or uniformly distributed across the landscape.

Table 2.—Yearly cerulean warbler territory sizes in Yellowwood and Morgan-Monroe State Forests in southern Indiana according to site and harvest type for the pre-treatment years of 2007 and 2008. Values reported as mean ± 1 S.D.

	2007		2008	
Site/harvest	# of territories	Area (ha)	# of territories	Area (ha)
Uneven-aged				
1	0	0	1	0.44 ± 0
7	7	0.18 ± 0.08	7	0.86 ± 0.59
8	24	0.18 ± 0.17	21	0.19 ± 0.10
Even-aged				
3	8	0.18 ± 0.14	13	0.28 ± 0.16
6	6	0.16 ± 0.15	0	0
9	9	0.13 ± 0.13	5	0.31 ± 0.27
Control				
2	1	0.11 ± 0	3	0.40 ± 0.11
4	4	0.40 ± 0.46	2	0.44 ± 0.04
5	6	0.11 ± 0.07	3	0.69 ± 0.24
Total	65	0.18 ± 0.19	55	0.36 ± 0.34

DISCUSSION

The average estimate of 6.18 males/km^2 for the two pre-treatment years, although slightly higher, is comparable to previous density estimates in southern Indiana in the Hoosier National Forest, and Morgan-Monroe and Yellowwood State Forests. In 2000 and 2001, relative abundance estimates for these forested areas varied from 0 birds/km^2 to 3.9 birds/km^2 and the 2-year average for 2004 and 2005 was 3.58 males/km^2 (Islam and Basile 2002, Islam et al. 2006). A study at Big Oaks National Wildlife Refuge indicated an average relative abundance estimate of 1.78 birds/km^2 for 2002 and 2003 (Islam and Roth 2004). Despite the overall decline in cerulean warbler populations, density estimates in southern Indiana for the past 8 years have been similar. These results are a good indication that the population is continuing to persevere in some of Indiana's southern forests.

The number of territories and size of each territory differed among sites, with an average size of 0.28 ha. These results are similar to and within the range of territory sizes from previous studies (Islam and Basile 2002). In the Hoosier National Forest, and Morgan-Monroe and Yellowwood State Forests, mean territory size (n=59) was 0.34 ha (Islam and Basile 2002). At Big Oaks National Wildlife Refuge (n=51), mean territory size was estimated at 0.21 ha (Islam and Roth 2004). In contrast, the mean for territories mapped (n=18) in Ontario was 1.04 ha (Oliarnyk and Robertson 1996), which is much larger than the mean territory size for this study or previous studies of territory size in southern Indiana.

According to Barg et al. (2006), territory size can be influenced by many factors, which can lead to variation in territory sizes. Factors that may affect territory size include habitat quality and resource distribution. These factors may explain why territories in this part of the cerulean warblers' breeding range are smaller than territories in Ontario.

Territories' occurring in clumps can also be an explanation for territory size. Cerulean warblers are known to exhibit clustered territoriality (Roth and Islam 2007). We found reduced clustering in 2008 as compared to 2007, but our territory sampling effort was reduced in 2008 due to the beginning of the silvicultural treatments.

There were no significant differences in the number of cerulean warbler detections or the sizes of territories among the three groups (control, even-aged, and uneven-aged treatments). These results are encouraging as any changes that occur in detection rates or the size and spatial arrangements of territories after silvicultural treatment will likely be a response to that treatment.

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APPENDIX 1.

The following sets of UTM coordinates demarcate cerulean warbler territories in Morgan-Monroe State Forest (units 1-4) and Yellowwood State Forest (units 5-9) in southern Indiana for 2007 and 2008. Projection is North American Datum 1983 UTM zone 16N.

Year	Unit	Bird name	Easting	Northing
2007	2	LP2E4	548427	4354817
			548420	4354815
			548410	4354822
			548446	4354793
			548465	4354785
			548478	4354771
			548476	4354778
			548477	4354755
			548479	4354749
2007	3	MH3E4	547978	4352263
			547995	4352332
			548020	4352270
			547921	4352230
			547913	4352253
			547903	4352230
			547946	4352249
2007	3	LP3D	547648	4351993
			547640	4351998
			547658	4351987
			547643	4351986
			547625	4351962
			547556	4351968
2007	3	MH3G2A	548279	4351991
			548298	4351984
			548293	4351996
			548273	4351998
			548303	4351997
			548331	4352000
			548320	4352028
			548319	4352022
2007	3	MH3G2B	548331	4352029
			548326	4352035
			548332	4352056
			548345	4352047
			548324	4352062
			548334	4352042
			548342	4352090
2007	3	MH3G3	545350	4352164
			548367	4352131
			548393	4352063
			548397	4352084
			548397	4352078
			548388	4352154
			548385	4352149
			548361	4352180
2007	3	MH3F4	548160	4352366
			548111	4352356
			548104	4352333
			548091	4352324
			548108	4352326
			548084	4352336
			548058	4352344
2007	3	LP3EA	547866	4352147
			547862	4352164
			547881	4352203
			547864	4352198
			547872	4352200
			547869	4352192
			547894	4352168
			547841	4352183
2007	3	MH3E3B	547958	4352152
			547963	4352141
			547955	4352138
			547954	4352150
			547967	4352154
			547010	4352162
			547013	4352164
			548005	4352152
2007	4	LP4C7	549482	4351227
			549437	4351291
			549450	4351300
			549454	4351304
			549443	4351258
			549345	4351239
			549324	4351257
			549329	4351309
			549325	4351335
2007	4	N4C7	549377	4351462
			549408	4351529
			549430	4351530
			549412	4351558
			549439	4351499
			549420	4351506
2007	4	MHF6	550196	4351137
			550280	4351157
			550251	4351155
			550266	4351165
			550304	4351169
			550317	4351158
			550307	4351173

APPENDIX 1. (continued)

Year	Unit	Bird name	Easting	Northing
2007	4	RBMB4G5	550372	4350873
			550357	4350878
			550360	4350882
			550362	4359878
			550361	4350857
2007	5	LP5C6	554289	4339828
			554310	4339802
			554302	4339802
			554333	4339861
			554305	4339822
			554322	4339819
			554314	4339793
2007	5	CP5D6	554396	4339728
			554397	4339724
			554402	4339713
			554413	4339731
			554410	4339731
			554397	4339725
2007	5	RS5E6	554672	4339747
			554720	4339776
			554729	4339756
			554716	4339749
			554729	4339752
			554717	4339760
			554714	4339740
2007	5	RS5G3A	555153	4339209
			555087	4339177
			555093	4339187
			555121	4339176
			555076	4339204
			555140	4339202
			555149	4339188
2007	5	RS5G3B	555096	4339175
			555063	4339170
			555038	4339150
			555086	4339173
			555035	4339148
			555096	4339147
			555059	4339118
2007	5	RS5G3C	554992	4339188
			555006	4339189
			555010	4339187
			555020	4339193
			554990	4339177
			555013	4339198
			555010	4339185
2007	6	MH6B6A	554606	4330539
			554626	4330576
			554637	4330577
			554648	4330545
			554655	4330502
			554618	4330519
			554633	4330566
2007	6	MH6B6B	554574	4330631
			554577	4330639
			554551	4330644
			554531	4330646
			554579	4330618
			554536	4330647
			554567	4330646
2007	6	MH6B6C	554533	4330685
			554501	4330674
			554516	4330689
			554527	4330683
			554517	4330675
			554537	4330673
			554528	4330672
2007	6	RS6C7A	554795	4330659
			554781	4330603
			554795	4330605
			554796	4330642
			554827	4330666
			554793	4330673
			554827	4330679
2007	6	RS6C7B	554780	4330727
			554783	4330728
			554768	4330750
			554769	4330730
			554774	4330725
			554770	4330720
			554772	4330730
2007	6	RS6D3	554956	4329828
			554957	4329897
			554903	4329853
			554945	4329841
			554907	4329856
			554974	4329850
			554926	4329945
2007	7	LP7G3B	559556	4331524
			559574	4331515
			559566	4331497
			559578	4331505
			559550	4331564
			559574	4331495
			559590	4331446
2007	7	MH7B6	558455	4332053
			558438	4332053
			558459	4332055
			558432	4332043
			558401	4332030
			558407	4332003
			558392	4331998
			558455	4332077

APPENDIX 1. (continued)

Year	Unit	Bird name	Easting	Northing
2007	7	RS7B5A	558613	4331831
			558603	4331812
			558589	4331821
			558603	4331876
			558596	4331897
			558633	4331835
			558606	4331823
			558610	4431819
			558615	4331809
2007	7	RS7B5B	558430	4331756
			558429	4331764
			558410	4331774
			558448	4331722
			558436	4331725
			558468	4331612
			558464	4331618
			558422	4331762
2007	7	R57B4	558453	4331640
			558452	4331634
			558437	4331586
			558514	4331534
			558501	4331555
			558440	4331610
			558462	4331605
			558423	4331605
2007	7	LP7G3A	559635	4331588
			559661	4331607
			559625	4331590
			559630	4331586
			559656	4331557
			559660	4331541
			559656	4331538
			559685	4331655
2007	7	LP7G3C	559607	4331417
			559615	4331441
			559641	4331445
			559643	4331432
			559636	4331470
			559632	4331485
			559624	4331498
			559631	4331437
2007	8	MH8G4	559071	4329676
			559109	4329734
			559126	4329752
			559128	4329743
			559111	4329720
			559112	4329725
			559105	4329745
2007	8	MH8G5	559085	4329856
			559077	4329845
			559074	4329829
			559074	4329850
			559050	4329880
			559021	4329847
			559100	4329850
			559111	4329786
2007	8	MH8E5B	558515	4329806
			558530	4329819
			558532	4329810
			558543	4329818
			558546	4329828
			558539	4329831
			558533	4329846
			558506	4329810
2007	8	MH8E5A	558638	4329738
			558630	4329731
			558644	4329728
			558626	4329782
			558635	4329763
			558618	4329766
			558650	4329765
			558632	4329762
2007	8	MH8E6	558758	4329971
			558784	4329989
			558744	4329980
			558744	4329989
			558806	4330005
			558777	4329970
			558823	4329981
2007	8	MH8G2Z	559151	4329263
			559151	4329254
			559151	4329258
			559151	4329234
2007	8	RS8B5S	557894	4329678
			557914	4329720
			557891	4329721
			557847	4329645
			557847	4329629
2007	8	RS8B5B	557974	4329778
			558002	4329702
			557977	4329786
			558136	4329694
			558030	4329748
2007	8	MH8F7C	558859	4330401
			558850	4330372
			558868	4330378
			558859	4330372
			558896	4330320
			558923	4330338
			558905	4330349

APPENDIX 1. (continued)

Year	Unit	Bird name	Easting	Northing
2007	8	MH8F7B	558835	4330458
			558838	4330456
			558847	4330434
			558824	4330439
			558842	4330464
			558847	4330468
			558850	4330477
2007	8	MH8F6A	558830	4330018
			558829	4330043
			558801	4330027
			558820	4329956
			558814	4329920
			558784	4329914
			558763	4329916
			558837	4329921
2007	8	MH8G2A	559196	4329380
			559222	4329268
			559217	4329268
			559213	4329261
			559206	4329276
			559222	4329254
			559223	4329263
2007	8	LP8D3	558358	4329369
			558390	4329371
			558411	4329364
			558385	4329374
			558356	4329389
			558348	4329385
			558348	4329375
2007	8	LP8C3A	558186	4329529
			558177	4329538
			558175	4329565
			558171	4329558
			558167	4329534
			558179	4329527
			558129	4329544
2007	8	LP8C3B	558177	4329592
			558152	4329550
			558179	4329564
			558180	4329590
			558189	4329597
			558160	4329602
			558161	4329616
			558158	4329627
2007	8	RS8A12	557958	4329174
			557959	4329171
			557934	4329174
			557925	4329180
			557920	4329167
			557913	4329168
			557942	4329196
			557938	4329170
			557935	4329173
			557958	4329174
2007	8	RSA2A	557833	4329347
			557854	4329338
			557845	4329305
			557843	4329317
			557840	4329336
			557824	4329310
			557841	4329353
			557820	4329346
2007	8	RS8B2C	558160	4329270
			558152	4329224
			558139	4329219
			558140	4329203
			558140	4329212
			558150	4329190
			558127	4329232
2007	8	RS8B1B	558001	4329148
			557938	4329232
			557935	4329247
			557998	4329187
			558008	4329220
			558010	4329228
			558016	4329238
			558054	4329233
2007	8	LPC1A	558226	4329042
			558241	4329066
			558246	4329062
			558220	4329061
			558234	4329024
			558208	4329010
			558222	4329164
			558197	4329003
			558192	4329000
2007	8	RS8B1A	558022	4329059
			558056	4329016
			558053	4329027
			558075	4322902
			558058	4329027
			558043	4329038
			558044	4329018
2007	8	LP8B1W	558025	4328987
			558020	4328997
			558026	4328982
			558019	4328993
			558026	4328977
			558012	4328971
			558018	4328986
2007	8	LP8B1Q	558000	4329030
			557993	4329021
			558004	4329024
			557994	4329050
			558003	4329020
			558003	4329054
			558008	4329061
			557988	4329061

APPENDIX 1. (continued)

Year	Unit	Bird name	Easting	Northing
2007	8	RS8B1P	557978	4329126
			557968	4329132
			557949	4329131
			557955	4329105
			557967	4329077
			557971	4329085
			557972	4329090
2007	9	MH9B23	560777	4332355
			560797	4332364
			560830	4332326
			560831	4332324
			560817	4332360
			560898	4332240
			560875	4332253
			560886	4332238
2007	9	LP9A5A	560718	4332804
			560712	4332806
			560733	4332790
			760743	4332789
			760714	7332773
2007	9	LP9A5B	560729	4332688
			560728	4332705
			560732	4332705
			560730	4332716
			560723	4332704
			560726	4332680
			560731	4332681
			560756	4332729
			560711	4332721
			560715	4332730
2007	9	LP9A5C	560567	4332857
			560568	4332843
			560584	4332840
			560571	4332862
			560579	4332871
			560577	4332873
			560534	4332857
2007	9	LP9A5D	560595	4332769
			560590	4332786
			560586	4332783
			560576	4332784
			560596	4332795
			560593	4332793
			560593	4332798
2007	9	LP9B3A	560816	4332457
			560793	4332477
			560786	4332467
			560791	4332478
			560789	4332473
			560814	4332446
			560791	4332446
2007	9	MH9B3C	560785	4332404
			560763	4332394
			560767	4332398
			560777	4332384
			560804	4332389
			560413	4332435
			560784	4332385
			560463	4332378
2007	9	LP9A5Z	560616	4332747
			560618	4332750
			560639	4332738
			560638	4332761
			560624	4332751
			560635	4332760
			560646	4332755
2007	9	MH9B3B	560720	4332492
			560726	4332489
			560701	4332510
			560753	4332476
			560741	4332455
			560735	4332400
			560728	4332407
			560758	4332402
			560746	4332388

APPENDIX 1. (continued)

Year	Unit	Bird name	Easting	Northing
2008	1	102	547888	4355833
			547903	4355853
			547863	4355852
			547809	4355898
			547910	4355914
			547884	4355906
2008	2	233	548353	4354874
			548472	4354845
			548453	4354873
			548417	4354882
			548491	4354783
			548489	4354808
2008	2	239	548580	4354690
			548557	4354739
			548546	4354697
			548587	4354719
			548606	4354711
			548608	4354675
			548627	4354680
2008	2	246	548786	4354730
			548804	4354742
			548731	4354723
			548800	4354731
			548838	4354720
			548871	4354712
			548777	4354752
			548791	4354695
2008	3	247	547416	4352483
			547409	4352524
			547389	4352517
			547421	4352490
			547401	4352465
			547383	4352484
			547361	4352477
			547356	4352482
			547355	4352453
2008	3	329	547960	4351698
			547944	4351749
			547960	4351783
			547971	4351819
2008	3	331	547883	4352174
			547886	4352170
			547877	4352170
			547935	4352186
			547928	4352214
			547862	4352276
			547879	4352342
			547862	4352276
			547866	4352173
			547870	4352201

Year	Unit	Bird name	Easting	Northing
2008	3	335	547897	4352881
			547921	4352859
			547957	4352855
			547892	4352863
			547934	4352878
			547949	4352884
2008	3	336	547826	4352875
			547754	4352895
			547837	4352896
			547770	4352841
2008	3	343	548414	4351706
			548452	4351744
			548428	4351645
			548431	4351595
			548456	4351593
			548422	4351603
			548441	4351680
2008	3	344	548363	4351983
			548414	4351946
			548396	4351920
			548388	4351932
			548363	4351975
			548353	4351958
			548381	4351982
			548323	4351981
2008	3	345	548323	4352184
			548382	4352131
			548377	4352178
			548360	4352174
			548373	4352160
			548388	4352162
			548364	4352140
2008	3	3455	548291	4352127
			548330	4352108
			548314	4352086
			548322	4352097
			548315	4352083
			548359	4352101
			548360	4352119
			548323	4352112
2008	3	346	548313	4352314
			548252	4352283
			548264	4352334
			548269	4352270
			548239	4352316
			548325	4352277
			548302	4352311
			548302	4352293
2008	3	3466	548406	4352359
			548373	4352378
			548366	4352336
			548376	4352371
			548351	4352367

APPENDIX 1. (continued)

Year	Unit	Bird name	Easting	Northing
2008	3	338	548214	4352500
			548252	4352494
			548269	4352546
			548275	4352525
2008	3	347	548423	4352441
			548426	4352446
			548505	4352467
			548515	4352467
			548504	4352423
			548465	4352459
			548449	4352439
			548387	4352485
2008	4	414	549324	4350015
			549345	4350020
			549363	4349970
			549339	4349938
			549361	4349923
			549321	4349897
			549373	4349998
			549338	4350029
2008	4	443	550221	4350205
			550218	4350217
			550183	4350199
			550177	4350207
			550246	4350185
			550222	4350196
			550212	4350213
			550225	4350172
			550229	4350153
			550311	4350151
2008	5	532	554606	4339350
			554594	4339328
			554554	4339324
			554627	4339300
			554719	4339323
			554673	4339306
2008	5	539	554848	4339286
			554852	4339299
			554805	4339271
			554872	4339274
			554786	4339250
			554733	4339207
			554858	4339241
			554871	4339226
2008	5	545	555045	4339063
			555080	4339123
			555092	4339213
			555051	4339178
			555084	4339182
			555065	4339207
			555111	4339205
			554984	4339199
2008	7	7233	558607	4331792
			558608	4331824
			558610	4331763
			558613	4331720
			558544	4331820
			558570	4331840
			558521	4331793
2008	7	730	558479	4331954
			558561	4331980
			558480	4332073
			558352	4332103
			558387	4331994
2008	7	719	559143	4331397
			559148	4331389
			559100	4331500
			559057	4331368
			559107	4331352
			559182	4331351
			559197	4331524
2008	7	706	559447	4330998
			559434	4331040
			559367	4331116
			559373	4331123
			559405	4331112
			559467	4330997
			559536	4331022
2008	7	714	559538	4331265
			559557	4331295
			559571	4331340
			559535	4331376
			559520	4331419
			559475	4331407
			559515	4331289
2008	7	715	559537	4331406
			559548	4331400
			559557	4331372
			559592	4331375
			559599	4331384
			559598	4331373
			559606	4331400
			559565	4331401
2008	7	721	559504	4331450
			559485	4331437
			559477	4331417
			559572	4331465
			559581	4331480
			559504	4331441
			559505	4331460

APPENDIX 1. (continued)

Year	Unit	Bird name	Easting	Northing
2008	8	801	557930	4329041
			557930	4329012
			557905	4329026
			557926	4329023
			557959	4329051
			557974	4329045
			557960	4329036
			557969	4329040
2008	8	8011	557975	4329028
			557984	4329052
			557990	4329049
			557975	4329028
			557991	4329026
			557987	4329025
			558018	4329060
			557977	4329075
2008	8	802	558046	4329016
			558051	4329037
			558091	4329012
			558074	4329018
			558113	4329042
2008	8	813	558016	4329177
			558029	4329167
			558052	4329174
			558060	4329148
			558031	4329125
			558055	4329095
			557982	4329148
2008	8	8266	558149	4329621
			558145	4329632
			558170	4329650
			558145	4329624
2008	8	818	558566	4329444
			558532	4329450
			558584	4329414
			558616	4329420
			558624	4329446
			558626	4329420
			558642	4329375
2008	8	826	558202	4329590
			558211	4329597
			558167	4329595
			558172	4329581
			558220	4329576
			558150	4329582
			558175	4329561
			558133	4329578
2008	8	8265	558168	4329526
			558193	4329520
			558175	4329517
			558174	4329529
			558196	4329542
			558181	4329519

Year	Unit	Bird name	Easting	Northing
2008	8	832	558479	4329823
			558490	4329815
			558471	4329846
			558512	4329829
			558506	4329867
			558524	4329815
			558553	4329822
			558482	4329857
2008	8	833	558460	4329853
			558424	4329877
			558401	4329886
			558465	4329876
			558451	4329882
			558410	4329866
			558486	4329903
2008	8	839	558487	4330019
			558440	4330025
			558442	4330016
			558432	4330092
			558446	4330037
			558503	4330585
			558510	4330019
2008	8	805	558647	4329049
			558636	4329091
			558638	4329150
			558647	4329096
			558640	4329111
			558626	4329056
			558673	4329072
			558623	4329117
2008	8	810	558605	4329125
			558598	4329143
			558593	4329166
			558572	4329143
			558579	4329116
			558605	4329094
			558638	4329150
			558598	4329132
			558590	4329080
			558605	4329130
2008	8	825	558542	4329653
			558583	4329655
			558563	4329612
			558542	4329661
			558556	4329668
			558551	4329633
			558560	4329631
2008	8	833	558620	4329807
			558609	4329814
			558600	4329761
			558630	4329762
			558638	4329766
			558626	4329789
			558601	4329740
			558553	4329822

APPENDIX 1. (continued)

Year	Unit	Bird name	Easting	Northing
2008	8	809	558813	4329206
			558838	4329208
			558792	4329188
			558815	4329157
			558833	4329234
			558803	4329222
			558802	4329180
			558821	4329190
2008	8	819	558797	4329418
			558820	4329443
			558779	4329482
			558813	4329411
			558787	4329403
			558818	4329400
			558810	4329411
2008	8	820	558964	4329365
			558984	4329352
			558953	4329314
			558926	4329390
			558931	4329365
2008	8	821	559124	4329424
			559082	4329428
			559109	4329433
			559130	4329416
			559027	4329489
			559058	4329477
			559004	4329456
2008	8	8211	559147	4329424
			559149	4329422
			559162	4329412
			559163	4329387
			559156	4329375
			559179	4329356
			559173	4329369
2008	8	8212	559130	4329416
			559140	4329444
			559155	4329438
			559156	4329431
			559151	4329453
2008	9	903	560651	4332468
			560613	4332491
			560600	4332493
			560654	4332513
			560677	4332512
			560635	4332530
			560589	4332538
2008	9	905	560629	4332807
			560626	4332819
			560641	4332793
			560668	4332810
			560652	4332826
			560647	4332824
2008	9	906	560559	4332849
			560606	4332791
			560570	4332816
			560557	4332836
			560555	4332813
			560533	4332859
			560518	4332850
2008	9	911	560813	4332543
			560801	4332553
			560814	4332540
			560795	4332545
			560787	4332533
			560795	4332558
			560753	4332542
			560782	4332521
2008	9	918	561016	4332660
			560939	4332630
			561021	4332642
			561045	4332657
			561056	4332683
			561000	4332600
			560914	4332695

The content of this paper reflects the views of the author(s), who are responsible for the facts and accuracy of the information presented herein.