

**Spring and Fall Eagle and Osprey Surveys  
for the Beech Ridge Wind Energy Project,  
Greenbrier and Nicholas Counties, West Virginia  
March-May and September-October, 2011**

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**NATURAL RESOURCES ♦ SCIENTIFIC SOLUTIONS**

## **EXECUTIVE SUMMARY**

Beech Ridge Energy LLC, a wholly-owned subsidiary of Invenergy LLC, has developed the Beech Ridge Wind Energy Project (BRWEP) in Greenbrier and Nicholas Counties, West Virginia. The West Virginia Public Service Commission (WV PSC) permit issued for the project included a requirement for a one-year post-construction study of eagle and osprey use at the BRWEP. The Technical Advisory Committee for the BRWEP determined that raptor migration surveys conducted during the migration seasons would fulfill this requirement in part. The principal objectives of the study were to: (1) provide site-specific osprey, eagle, and other raptor use data that would be useful in evaluating potential impacts from the Project; and (2) fulfill WV PSC permit requirements.

Raptor migration surveys were conducted at five survey stations in spring between March 16 and May 13, and in fall between September 7 and October 28, 2011. All surveys were conducted between the hours of 0900 and 1600 on days conducive to raptor migration. Over 253 surveys, mean use for all raptors, including vultures, was 2.93 birds per observer-hour, and overall species richness was 1.25 raptor species per survey. Spring mean raptor use, excluding vultures, was 0.71 birds per observer-hour, while fall raptor use was 0.95 birds per observer-hour. In spring, vulture use was 2.98 vultures per observer-hour; in fall vulture use was 1.14 vultures per observer-hour. One osprey was observed during spring surveys, and three were observed during fall surveys. More eagles were observed in spring, with one bald eagle in spring and none in fall, and six golden eagles in spring and four in fall.

The highest mean raptor and vulture use in spring was at Station 5, with 7.92 birds per observer-hour, while Station 4 had the highest use in fall, with 2.63 birds per observer-hour. Daily raptor and vulture use peaked in the middle of the day, during the 1200 hour. Bird use fluctuated throughout the spring and fall survey periods. In spring, raptor use peaked on April 26 with 15 individuals observed, while vulture use peaked on April 3 with 47 individuals observed. In fall, raptor use peaked on September 28 with 31 individuals while vultures had two peaks, on September 9 with 26 individuals and on October 24 with 24 individuals observed.

For raptors observed flying within 800 meters (m) of the survey station, 50.9% were observed flying in the rotor-swept height (RSH; 41.5 to 118.5 m [136.2 to 388.8 feet] above ground level), while 42.8% of vultures were observed flying in the RSH. Two of the three ospreys observed within 800 m were observed within the RSH. One bald eagle and one golden eagle were observed flying within 800 m of the survey stations, and both were flying in the RSH.

Data collected during spring and fall surveys suggest that the BRWEP receives relatively low use by ospreys and eagles, which each accounted for approximately or less than one percent of all raptor use. When averaged over all survey days to provide a comparable metric to other hawk watch sites, raptor use during the spring and fall study periods was 1.11, and was substantially lower than average use at four other Hawk Watch sites in the same geographic region for data from the same survey days (range of 9.15 to 56.85 raptors per observer-hour).

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## **INTRODUCTION**

Beech Ridge Energy LLC (BRE), a wholly-owned subsidiary of Invenergy LLC, has developed a wind-energy facility, the Beech Ridge Wind Energy Project (BRWEP), in Greenbrier and Nicholas Counties, West Virginia (Figure 1). BRE contracted Western EcoSystems Technology, Inc. (WEST) to monitor wildlife resources as part of fulfilling West Virginia Public Service Commission (WV PSC) permit requirements for the BRWEP.

The WV PSC permit issued for the project included a requirement for a one-year post-construction eagle and osprey study at the BRWEP. The Technical Advisory Committee for BRWEP determined that raptor migration surveys conducted during the migration seasons would fulfill this requirement in part. An additional raptor migration study was completed in the BRWEP's proposed expansion area and is described in a separate report. The principal objectives of the study were to: (1) provide site-specific osprey, eagle, and other raptor use data that would be useful in evaluating potential impacts from the BRWEP; and (2) fulfill WV PSC permit requirements. The following report contains results of the 2011 spring and fall surveys, conducted for ospreys (*Pandion haliaetus*), eagles, and other raptors.

## **METHODS**

Surveys at the BRWEP during 2011 consisted of raptor migration surveys during the spring and fall migration seasons, and incidental observations of raptors while field biologists were on site. Raptor migration surveys were designed to provide visual coverage over large areas and generally survey for large birds, specifically eagles and ospreys, as well as other raptor species and vultures.

### **Raptor Migration Surveys**

#### *Survey Stations*

Five point-count survey stations were established within the BRWEP to survey for raptors (Figure 1). Point count stations were established on top of ridges in open, non-forest habitats to provide good visual coverage in roughly 360 degrees around the station. This maximized visibility of diurnal migrant raptors over long distances. Each survey plot included an unlimited distance viewshed centered at the station as with typical raptor migration surveys. The location of each station was recorded with GPS coordinates and on a hardcopy map.

Beech Ridge Wind Energy Project  
 Eagle and Osprey Survey Report, Spring and Fall 2011

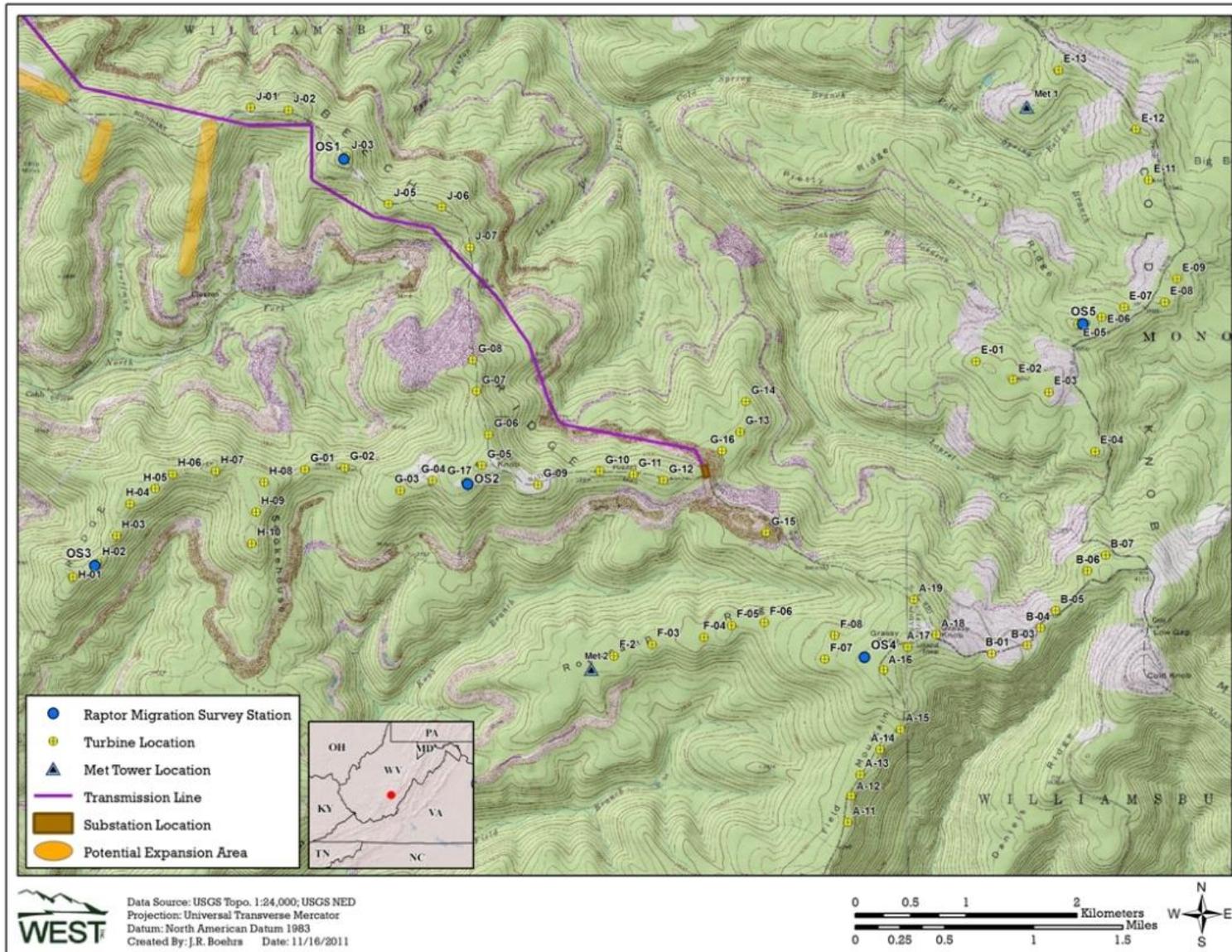


Figure 1. Overview of the Beech Ridge Wind Energy Project and raptor migration survey stations.

### *Survey Methods*

Surveys were conducted according to methods used by the Hawk Migration Association of North America (HMANA) and Hawk Watch International (HWI) with observers continuously scanning overhead for migrating raptors. Binoculars were frequently used throughout each survey period to aid in locating migrating raptors. The date, start and end time of the survey period, and weather information such as temperature, wind speed, wind direction, barometric pressure, percent cloud cover, precipitation, and maximum visibility estimates were recorded for each survey. Weather information was recorded using a Kestrel® 2500 pocket wind meter. Time of observation, species or best possible identification, number of individuals, age and sex (if possible), estimation of distance from observer, flight height, and flight direction were recorded for each raptor observation.

### *Observation Schedule*

During spring migration, each survey station was surveyed approximately three times per week from March 16 to May 13, 2011. During fall migration, each station was surveyed twice weekly from September 7 to October 28, 2011. These periods were selected based on information obtained from regional hawk migration surveys and covered the periods when most migrant raptors, including eagles and ospreys, were observed at these other hawk watch sites during spring and fall migrations (HMANA 2011). Survey duration at each station was one hour and surveys were conducted between approximately 0900 and 1600 hours (hrs), which is the peak daily period for migrating raptor activity. Surveys were only conducted on days when weather conditions were conducive to raptor migration (e.g., warm, clear, high pressure conditions).

### **Incidental Wildlife Observations**

The objective of incidental wildlife observations was to record raptors seen outside of standardized surveys. All raptors observed while the field biologist was on site but not conducting a standardized survey were recorded in a similar fashion as those observed during a survey. The observation number, date, time, species, number of individuals, sex/age class, activity, estimated distance from observer, and height above ground (for flying birds), and habitat were recorded.

### **Statistical Analysis**

Following field surveys, observers inspected data forms for completeness, accuracy, and legibility. A Microsoft® ACCESS database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. A sample of records from the electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer and/or project manager. All data forms, field notebooks, and electronic data files were retained for reference.

### *Raptor Diversity and Species Richness*

Raptor diversity was represented by the total number of species observed. Species richness was represented by the mean number of species observed per survey. Species richness for a visit<sup>1</sup> was calculated by averaging the number of species observed across all surveys in that visit. Species richness for a survey station was calculated by averaging across all visits. Overall species richness for the season was calculated by averaging across all visits within the season.

### *Raptor Use, Percent of Use, and Frequency of Occurrence*

For raptor migration surveys, observations of birds detected within an unlimited viewshed were used in the analysis. The common standardized metric for raptor migration surveys is the mean number of birds per observer-hour. This metric allows comparison between sample locations, over time (e.g., hours, days, weeks, seasons), or with other studies where similar data exist. Mean use was calculated by dividing the total number of birds observed during a survey by the number of hours in the survey. To calculate mean use for any given visit, use was averaged across all the stations that were surveyed on that date or for that visit. To calculate overall mean use, the mean use for each visit was averaged for all visits in the season.

To investigate changes in use over time of day, mean use was averaged across all stations for each time block (e.g., 1000 – 1100 hrs, 1100 – 1200 hrs, etc.). This accounts for variation in survey effort among stations and visits.

Frequency of occurrence was calculated as the percent of surveys in which a particular species or raptor type was observed. Percent of use was calculated as the proportion of the overall mean use that is attributable to a particular species or raptor type. Frequency of occurrence and percent of use provide relative estimates of species exposure to the wind energy facility. For example, a species may have high use estimates for the site based on just a few observations of large groups; however, the frequency of occurrence will indicate that the species occurs during very few of the surveys and, therefore, may be less likely affected by the facility.

### *Bird Flight Height*

For observations of raptors within 800 meters (m) of the survey station<sup>2</sup>, the approximate flight height was recorded at the point where the bird was first observed. This flight height was used to calculate the percentage of raptors flying within the rotor-swept height (RSH; 41.5 to 118.5 m [136.2 to 388.8 feet] above ground level) for the BRWEP turbines.

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<sup>1</sup> A visit is defined as the period or effort required to conduct a complete round of surveys at all five stations.

<sup>2</sup> Due to the difficulty with estimating flight height when there are few reference points, flight height was not estimated for observations of birds greater than 800 m from the survey station.

*Comparison with Other Hawk Watch Sites*

Established hawk watch sites are typically surveyed from one location for a period of time (hours) each survey day. To calculate daily raptor use for hawk watch sites, the total number of raptors observed is divided by the total number of observer-hours. To calculate an overall mean use for the study period at hawk watch sites, the daily mean number of raptors per observer hour is averaged across all days surveyed.

To generate a metric that would be comparable for the BRWEP study area, daily mean raptor use was calculated as the average number of raptors per observer hour for all survey stations visited on that day. To calculate a comparable overall mean use for the study period, this daily use value was averaged across all days surveyed. Data for the established hawk watch sites for the same survey days as those at BRWEP were tallied and averaged across all days surveyed for comparison.

## RESULTS

Raptor migration surveys were conducted at each of the five stations between 26 and 28 times from March 16 to May 13, and between 23 to 24 times from September 7 to October 28, 2011 (Table 1).

**Table 1. Summary of raptor use and species richness during spring and fall raptor migration surveys at the Beech Ridge Wind Energy Project.**

Station	Total Number of Surveys	Total Number of Species	Mean Use (number of birds/hour)	Mean Number of Species/Survey
<b>Spring</b>				
1	26	8	3.78	1.5
2	27	5	1.77	1.04
3	26	6	2.69	1.46
4	28	8	2.78	1.43
5	28	8	7.92	1.54
<b>Total</b>	<b>135</b>	<b>11</b>	<b>3.68</b>	<b>1.34</b>
<b>Fall</b>				
1	24	10	2.42	1.33
2	24	6	1.51	1.04
3	23	7	1.72	1.13
4	23	8	2.63	1.35
5	24	8	2.61	0.96
<b>Total</b>	<b>118</b>	<b>12</b>	<b>2.09</b>	<b>1.14</b>
<b>Overall (Spring and Fall)</b>				
1	50	11	3.13	1.42
2	51	7	1.64	1.04
3	49	8	2.23	1.31
4	51	9	2.71	1.39
5	52	10	5.47	1.27
<b>Total</b>	<b>253</b>	<b>13</b>	<b>2.93</b>	<b>1.25</b>

### Raptor Diversity and Species Richness

A total of 968 raptors and vultures was observed in the BRWEP during the surveys, representing 13 species and one unidentified accipiter (Table 2), with an overall mean species richness of 1.25 species per survey for both seasons (Table 1). Turkey vulture (*Cathartes aura*) was the most commonly recorded species during the surveys, composing 69.4% of all observations (Table 2). Excluding vultures, 284 raptors were recorded (Table 2). Four ospreys were observed, with one in spring and three in fall, accounting for 1.4% of total observed raptors and 0.4% of all individuals. Ten golden eagles (*Aquila chrysaetos*) were observed, with six in spring and four in fall, representing 3.5% of total observed raptors and 1.0% of all individuals. Only one bald eagle (*Haliaeetus leucocephalus*) was observed in spring and none in fall.

**Table 2. Total number of groups and individuals for each raptor subtype and species observed during spring and fall raptor migration surveys at the Beech Ridge Wind Energy Project.**

Species/Type	Scientific Name	Spring		Fall		Overall	
		Number of Groups	Number of Individuals	Number of Groups	Number of Individuals	Number of Groups	Number of Individuals
<b>Diurnal Raptors</b>		<b>105</b>	<b>127</b>	<b>111</b>	<b>157</b>	<b>216</b>	<b>284</b>
<u>Accipiters</u>		16	18	17	18	33	36
Cooper's hawk	<i>Accipiter cooperii</i>	4	5	4	4	8	9
sharp-shinned hawk	<i>Accipiter striatus</i>	12	13	12	13	24	26
unidentified accipiter		0	0	1	1	1	1
<u>Buteos</u>		81	99	80	125	161	224
broad-winged hawk	<i>Buteo platypterus</i>	30	37	17	37	47	74
red-shouldered hawk	<i>Buteo lineatus</i>	25	30	17	25	42	55
red-tailed hawk	<i>Buteo jamaicensis</i>	26	32	46	63	72	95
<u>Northern Harrier</u>		0	0	1	1	1	1
northern harrier	<i>Circus cyaneus</i>	0	0	1	1	1	1
<u>Eagles</u>		5	7	4	4	9	11
	<i>Haliaeetus</i>						
bald eagle	<i>leucocephalus</i>	1	1	0	0	1	1
golden eagle	<i>Aquila chrysaetos</i>	4	6	4	4	8	10
<u>Falcons</u>		2	2	6	6	8	8
American kestrel	<i>Falco sparverius</i>	2	2	5	5	7	7
merlin	<i>Falco columbarius</i>	0	0	1	1	1	1
<u>Osprey</u>		1	1	3	3	4	4
osprey	<i>Pandion haliaetus</i>	1	1	3	3	4	4
<b>Vultures</b>		<b>279</b>	<b>506</b>	<b>119</b>	<b>178</b>	<b>398</b>	<b>684</b>
black vulture	<i>Coragyps atratus</i>	4	7	2	5	6	12
turkey vulture	<i>Cathartes aura</i>	275	499	117	173	392	672
<b>Overall</b>		<b>384</b>	<b>633</b>	<b>230</b>	<b>335</b>	<b>614</b>	<b>968</b>

### Raptor Use, Percent of Use, and Frequency of Occurrence

Combined raptor and vulture use was higher in spring (3.68 birds/hour) than fall (2.09; Table 3). In spring, mean raptor and vulture use varied from 1.77 birds per observer-hour at station 2 to 7.92 birds per observer-hour at station 5 (Table 3). In fall, mean raptor and vulture use ranged from 1.51 birds per observer-hour at station 2 to 2.63 birds per observer-hour at station 4 (Table 3).

#### Raptors

Mean raptor use, excluding vultures, was 0.71 birds per observer-hour in spring and 0.95 birds per observer-hour in fall (Table 3). Buteos had the highest use of all raptor subtypes (0.56 birds per observer-hour in spring and 0.77 in fall), composing 15.2% of all use in spring and 36.9% of all use in fall. Buteos were observed during 35.7% of spring surveys and 35.0% of fall surveys. Broad-winged hawk (*Buteo platypterus*) was the buteo most commonly observed in spring with

37 individuals, while red-tailed hawk (*B. jamaicensis*) was the most commonly observed buteo in fall with 63 individuals observed (Table 2). Eagles were observed during 3.6% of spring surveys and 3.2% of fall surveys. Eagle use in spring was 0.04 birds per observer-hour and eagles represented 1.1% of overall spring raptor and vulture use (Table 3). In fall, eagle use was 0.02 birds per observer-hour and eagles accounted for 1.2% of overall fall use (Table 3). Osprey were observed in only 0.7% of spring surveys and osprey use in spring was less than 0.01 ospreys per observer-hour, representing less than 0.1% of overall use (Table 3). Fall osprey use was 0.01 ospreys per observer-hour, ospreys represented 0.6% of overall use, and they were observed in 2.4% of all surveys (Table 3).

### Vultures

Two vulture species were recorded within the BRWEP, turkey vulture and black vulture (*Coragyps atratus*). In spring, vulture use was 2.98 vultures per observer-hour; in fall vulture use was 1.14 vultures per observer-hour (Table 3). Vultures composed 80.9% of overall use in spring and were observed in 71.4% of spring surveys (Table 3). In fall, vultures composed 54.4% of overall use, and they were observed in 41.4% of fall surveys (Table 3).

**Table 3. Mean use (number of birds per observer-hour), percent of overall use, and frequency of occurrence for each raptor subtype observed during the spring and fall raptor migration surveys at the Beech Ridge Wind Energy Project.**

Species	Mean Use		Percent of Use		Percent Frequency	
	Spring	Fall	Spring	Fall	Spring	Fall
<b>Overall - All Stations</b>						
Diurnal Raptors	0.71	0.95	19.1	45.6	40.7	50.4
<u>Accipiters</u>	0.09	0.10	2.5	4.8	9.3	13.8
<u>Buteos</u>	0.56	0.77	15.2	36.9	35.7	35.0
<u>Northern Harrier</u>	0	0.02	0	1.0	0	4.0
<u>Eagles</u>	0.04	0.02	1.1	1.2	3.6	3.2
<u>Falcons</u>	<0.01	0.02	0.2	1.1	1.4	4.0
<u>Osprey</u>	<0.01	0.01	<0.1	0.6	0.7	2.4
Vultures	2.98	1.14	80.9	54.4	71.4	41.4
<b>Overall</b>	<b>3.68</b>	<b>2.09</b>	<b>100</b>	<b>100</b>		
<b>Station 1</b>						
Diurnal Raptors	0.97	1.08	25.6	44.4	53.8	58.3
<u>Accipiters</u>	0.10	0.09	2.7	3.8	15.4	12.5
<u>Buteos</u>	0.79	0.87	20.9	36.0	42.3	45.8
<u>Northern Harrier</u>	0	0.02	0	0.9	0	4.2
<u>Eagles</u>	0.08	0.03	2.0	1.2	7.7	4.2
<u>Falcons</u>	0	0.02	0	0.9	0	4.2
<u>Osprey</u>	0	0.04	0	1.7	0	8.3
Vultures	2.81	1.35	74.4	55.6	73.1	50.0
<b>Overall</b>	<b>3.78</b>	<b>2.42</b>	<b>100</b>	<b>100</b>		

**Table 3. Mean use (number of birds per observer-hour), percent of overall use, and frequency of occurrence for each raptor subtype observed during the spring and fall raptor migration surveys at the Beech Ridge Wind Energy Project.**

Species	Mean Use		Percent of Use		Percent Frequency	
	Spring	Fall	Spring	Fall	Spring	Fall
<b>Station 2</b>						
Diurnal Raptors	0.31	1.03	17.3	68.7	25.9	41.7
<u>Accipiters</u>	0	0.04	0	2.9	0	8.3
<u>Buteos</u>	0.29	0.99	16.3	65.7	22.2	41.7
<u>Osprey</u>	0.02	0	1	0	3.7	0
Vultures	1.46	0.47	82.7	31.3	70.4	33.3
<b>Overall</b>	<b>1.77</b>	<b>1.51</b>	<b>100</b>	<b>100</b>		
<b>Station 3</b>						
Diurnal Raptors	0.86	0.74	31.8	43.0	53.8	52.2
<u>Accipiters</u>	0.14	0.14	5.1	8.1	11.5	17.4
<u>Buteos</u>	0.66	0.53	24.6	30.9	50.0	34.8
<u>Eagles</u>	0.06	0.07	2.1	4.0	3.8	8.7
Vultures	1.83	0.98	68.2	57.0	73.1	43.5
<b>Overall</b>	<b>2.69</b>	<b>1.72</b>	<b>100</b>	<b>100</b>		
<b>Station 4</b>						
Diurnal Raptors	0.72	1.06	26.0	40.2	42.9	47.8
<u>Accipiters</u>	0.09	0.09	3.4	3.4	10.7	13.0
<u>Buteos</u>	0.54	0.86	19.2	32.7	35.7	39.1
<u>Eagles</u>	0.08	0	2.7	0	7.1	0
<u>Falcons</u>	0.02	0.11	0.6	4.1	3.6	17.4
Vultures	2.06	1.57	74.0	59.8	67.9	47.8
<b>Overall</b>	<b>2.78</b>	<b>2.63</b>	<b>100</b>	<b>100</b>		
<b>Station 5</b>						
Diurnal Raptors	0.82	0.98	10.3	37.4	35.7	45.8
<u>Accipiters</u>	0.15	0.17	1.9	6.5	10.7	20.8
<u>Buteos</u>	0.64	0.75	8.1	28.9	35.7	20.8
<u>Eagles</u>	0	0.03	0	1.3	0	4.2
<u>Falcons</u>	0.02	0	0.2	0	3.6	0
<u>Osprey</u>	0	0.02	0	0.8	0	4.2
Vultures	7.11	1.63	89.7	62.6	85.7	41.7
<b>Overall</b>	<b>7.92</b>	<b>2.61</b>	<b>100</b>	<b>100</b>		

### Temporal Use

For mean use throughout the day, raptor use peaked in the 1200-1300 hour block (1.47 birds/observer-hr/survey; Figure 2). Eagles were observed between 1100 and 1600 hrs, with peak use occurring in the 1400-1500 hour (0.09 birds per observer-hour; Figure 2). Osprey observations were recorded between hrs 1000 and 1200 with no discernable peak due to so few observations. Vulture use peaked during the 1200-1300 hr (Figure 2).

### Seasonal Use

Daily raptor activity fluctuated between zero and 15 individuals through the spring study period, with the peak in activity on April 26 (Figure 3a). Raptors were not observed on four survey days during the study period (March 16, March 28, April 1, and May 4; Figure 3a). Vulture activity ranged from zero to 47 individuals per day (Figure 3a). Vulture activity peaked earlier than raptors, on April 3 (Figure 3a). The days with the fewest vultures observed occurred on March 16 and April 1 with zero individuals, and March 25 with two individuals observed (Figure 3a).

In fall, raptor activity was variable, with peak activity on September 28 with 31 individuals observed, and zero observed on September 23, October 20-21, and October 27-28 (Figure 3b). Vulture activity patterns in fall were different than raptors, with observation peaks on September 9 with 26 individuals, and on October 24 with 24 individuals observed. Zero vultures were observed on 11 different days throughout the fall study period (Figure 3b).



**Figure 2. Mean use (number of birds per observer-hour) by time period (hour) for the spring and fall raptor migration surveys for all birds, diurnal raptors, and vultures at the Beech Ridge Wind Energy Project.**

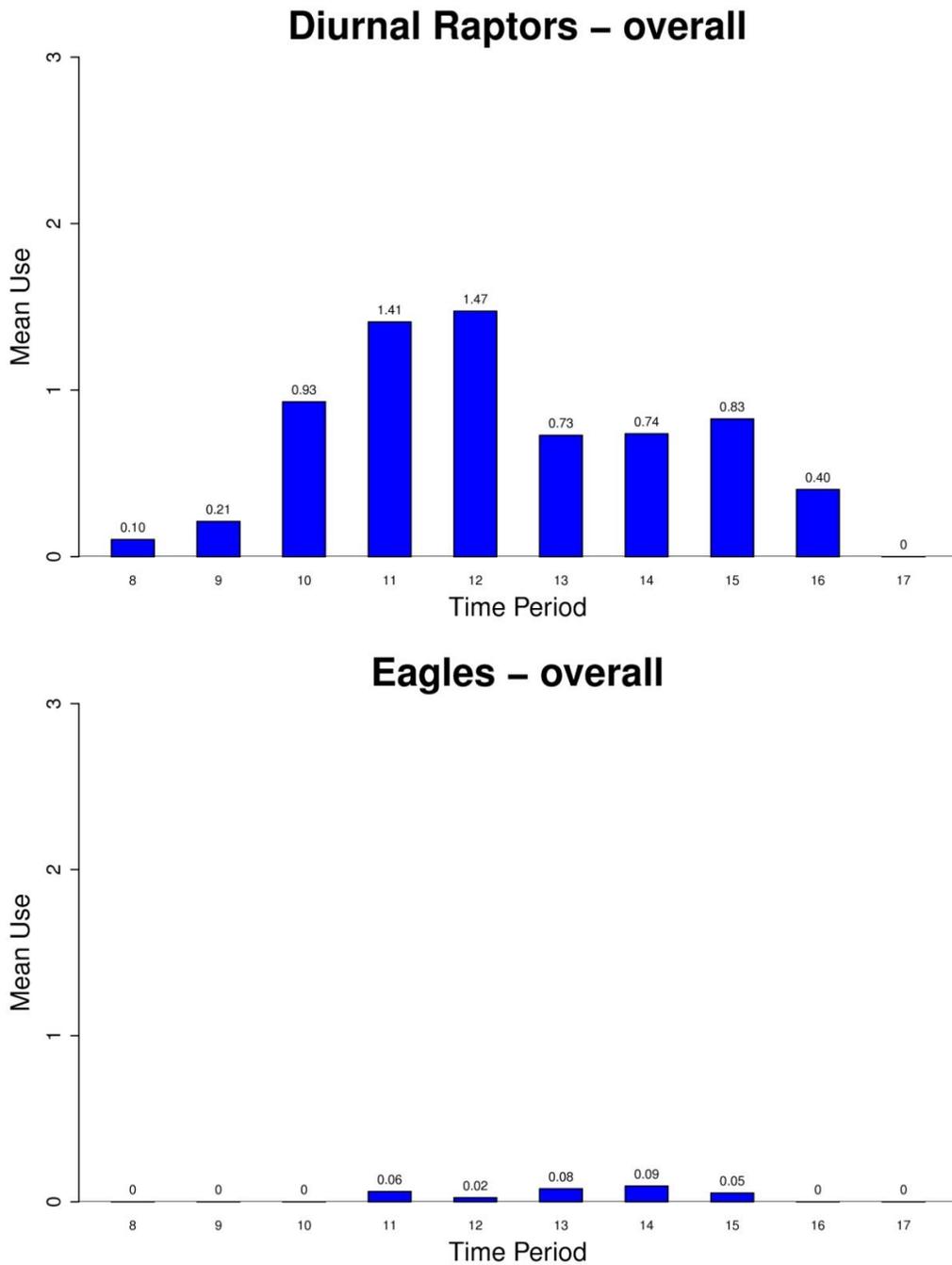
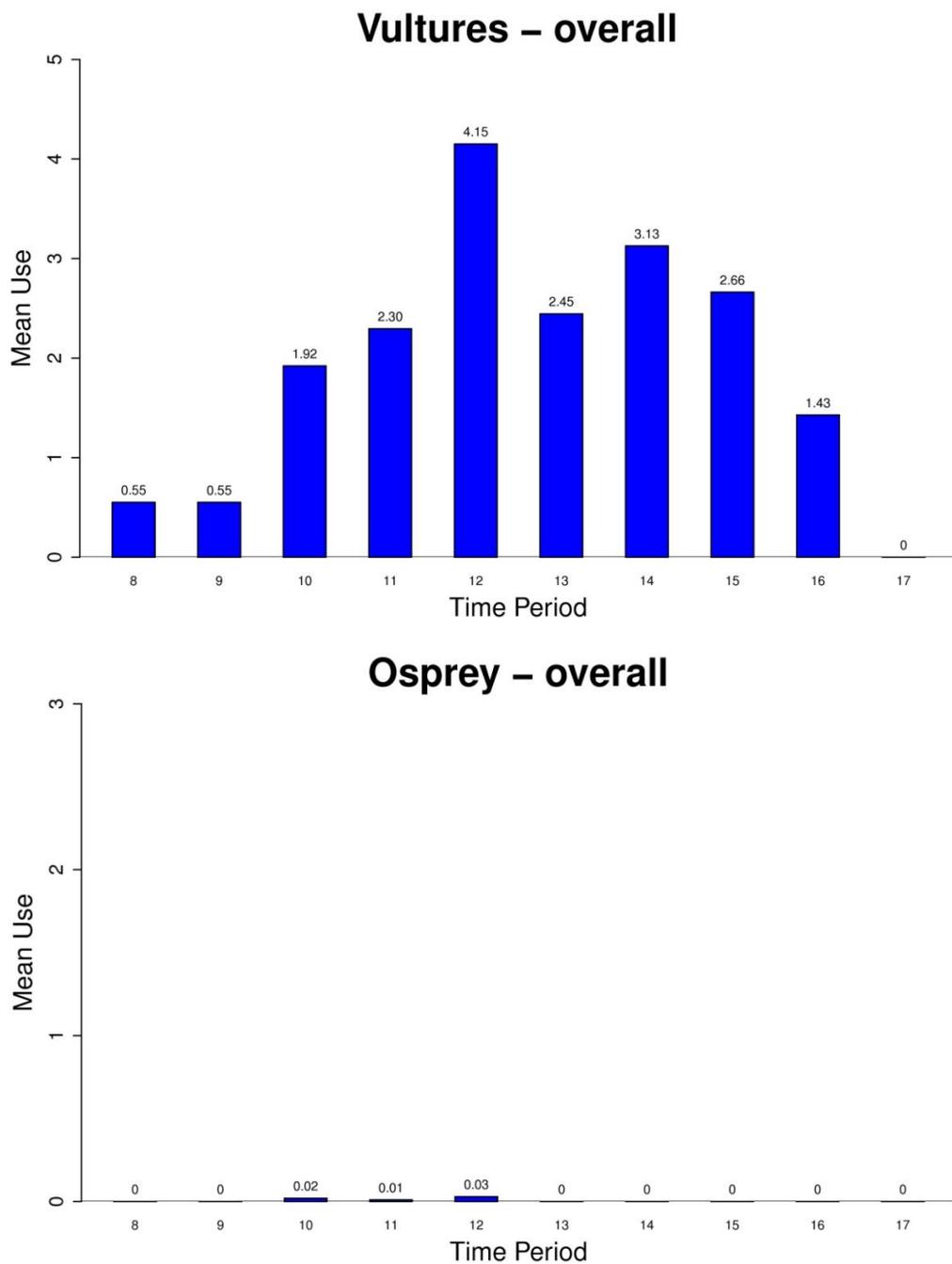
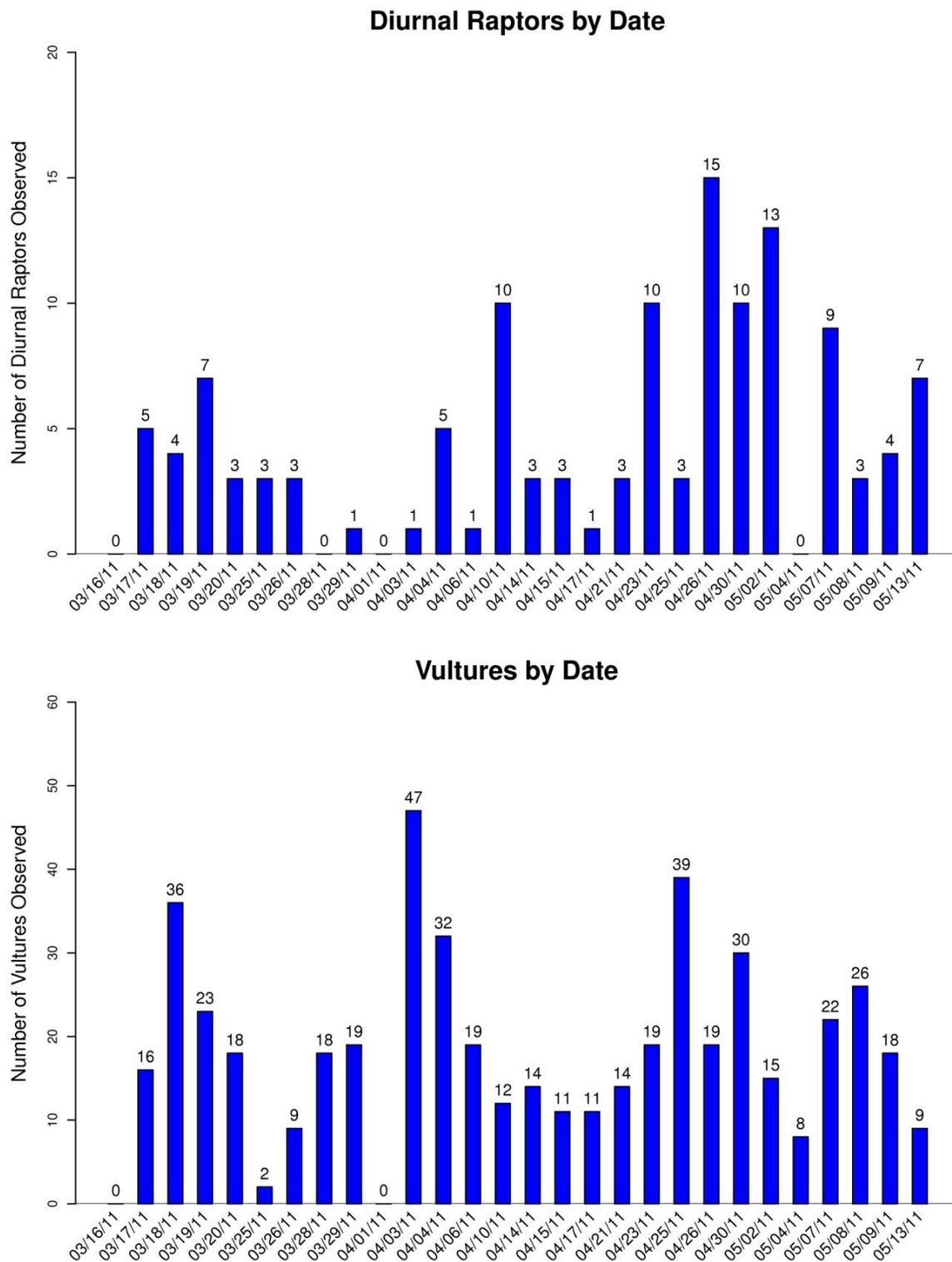


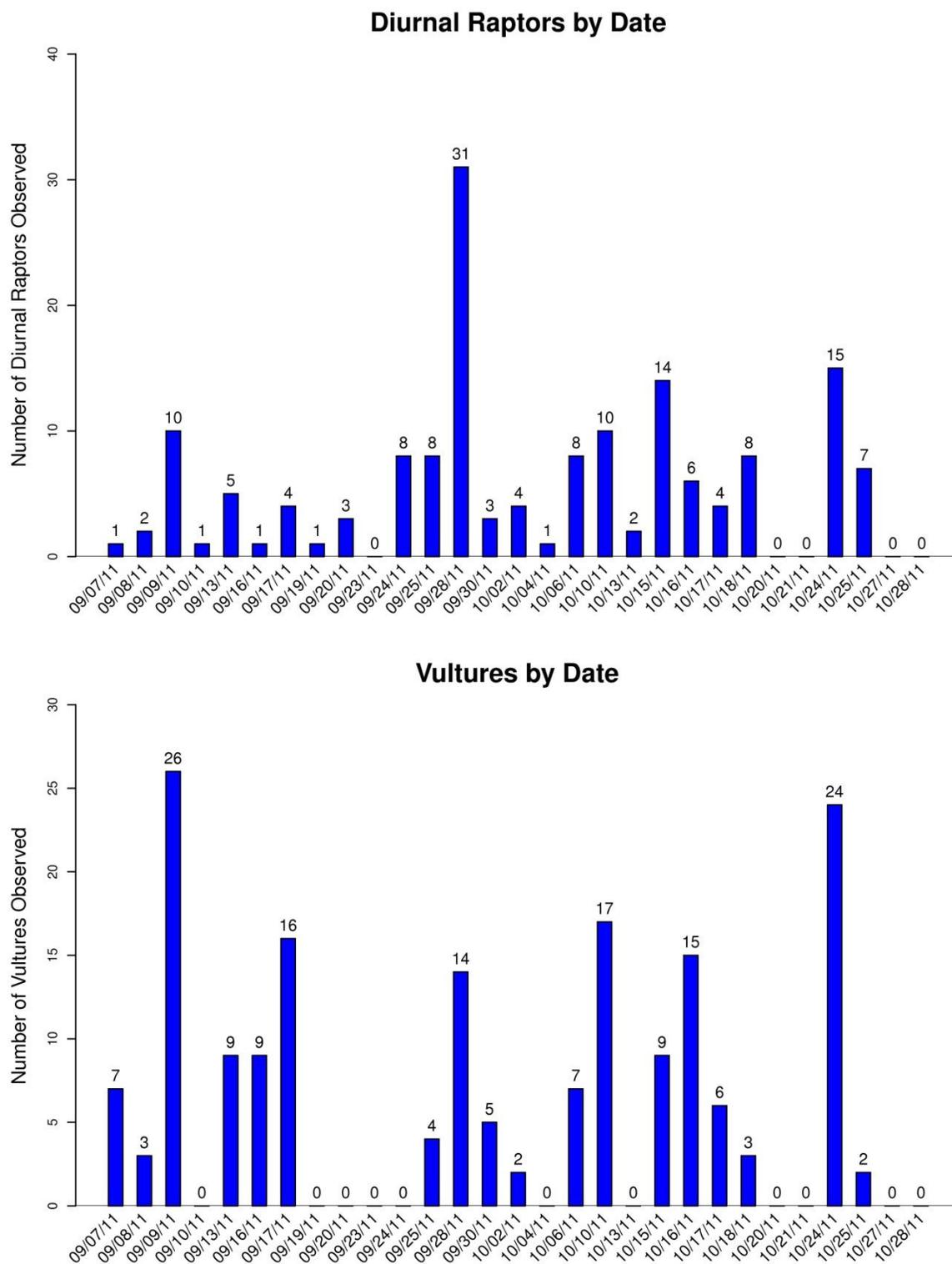
Figure 2 (continued). Mean use (number of birds per observer-hour) by time period (hour) for the spring and fall raptor migration surveys for all birds, diurnal raptors, and vultures at the Beech Ridge Wind Energy Project.



**Figure 2 (continued).** Mean use (number of birds per observer-hour) by time period (hour) for the spring and fall raptor migration surveys for all birds, diurnal raptors, and vultures at the Beech Ridge Wind Energy Project.



**Figure 3a. Total number of individuals observed by survey day for diurnal raptors and vultures during spring raptor migration surveys at the Beech Ridge Wind Energy Project.**



**Figure 3b. Total number of individuals observed by survey day for diurnal raptors and vultures during the fall raptor migration surveys at the Beech Ridge Wind Energy Project.**

### Flight Height Characteristics

Approximately 51% of raptors observed flying within 800 m of the survey stations were observed flying in the RSH (Table 4). Two of the three ospreys observed within 800 m were observed within the RSH. One bald eagle and one golden eagle were observed flying within 800 m of the survey stations, and both were flying in the RSH. For turkey vultures observed within 800 m of the survey station, 42.8% were observed within the RSH (Table 4).

**Table 4. Flight height characteristics of raptor subtypes, species, and vultures observed during the spring and fall raptor migration surveys<sup>a</sup> at the Beech Ridge Wind Energy Project.**

Species/Type	Number of groups	Number of individuals	Mean Flight Height (m)	Median Flight Height (m)	Percent in Flight	Percent Within RSH <sup>b</sup>
<b>Diurnal Raptors</b>	<b>99</b>	<b>114</b>	<b>40.66</b>	<b>25.0</b>	<b>40.1</b>	<b>50.9</b>
<i>Accipiters</i>	20	21	42.10	35.0	58.3	61.9
Cooper's hawk	5	5	74.00	70.0	55.6	100
sharp-shinned hawk	15	16	31.47	25.0	61.5	50.0
<i>Buteos</i>	66	80	42.20	23.5	35.7	50.0
broad-winged hawk	21	24	38.19	16.0	32.4	37.5
red-shouldered hawk	12	13	44.42	37.5	23.6	69.2
red-tailed hawk	33	43	43.94	25.0	45.3	51.2
<i>Eagles</i>	2	2	52.50	52.5	18.2	100
bald eagle	1	1	25.00	25.0	100	100
golden eagle	1	1	80.00	80.0	10.0	100
<i>Falcons</i>	8	8	15.38	12.0	100	12.5
American kestrel	7	7	15.57	10.0	100	14.3
merlin	1	1	14.00	14.0	100	0
<i>Osprey</i>	3	3	56.67	65.0	75.0	66.7
osprey	3	3	56.67	65.0	75.0	66.7
<b>Vultures</b>	<b>187</b>	<b>271</b>	<b>28.99</b>	<b>20.0</b>	<b>39.6</b>	<b>42.8</b>
black vulture	2	2	47.50	47.5	16.7	50.0
turkey vulture	185	269	28.79	20.0	40.0	42.8
<b>Overall</b>	<b>286</b>	<b>385</b>	<b>33.03</b>	<b>20.0</b>	<b>39.8</b>	<b>45.2</b>

<sup>a</sup>Limited to observations within 800 m.

<sup>b</sup>RSH = rotor-swept height of 41.5 to 118.5 m (approximately 136.2 to 388.8 feet) above ground level.

## **Spatial Variation**

In spring, raptor use by station ranged from 0.31 birds per observer-hour at station 2 to 0.97 at station 1. In fall, use by station for all raptors ranged from 0.74 birds per observer-hour at station 3 to 1.08 at station 1 (Table 3; Figure 4). In spring, ospreys were observed only at station 2 (0.02 birds per observer-hour), while in fall, ospreys were observed at stations 1 and 5 (Table 3, Figure 5). In spring, eagles were observed at stations 1 and 4, both with 0.08 eagles per observer-hour. Eagles were observed during fall surveys at stations 1, 3, and 5 with use ranging from 0.03 to 0.07 birds per observer-hour (Table 3, Figure 5). Vulture use in spring and fall was greatest at station 5 (7.11 and 1.63 birds per observer-hour, respectively), while vulture use recorded at other stations ranged from 1.46 to 2.81 birds per observer-hour in spring and 0.47 to 1.57 in fall (Table 3; Figure 4).

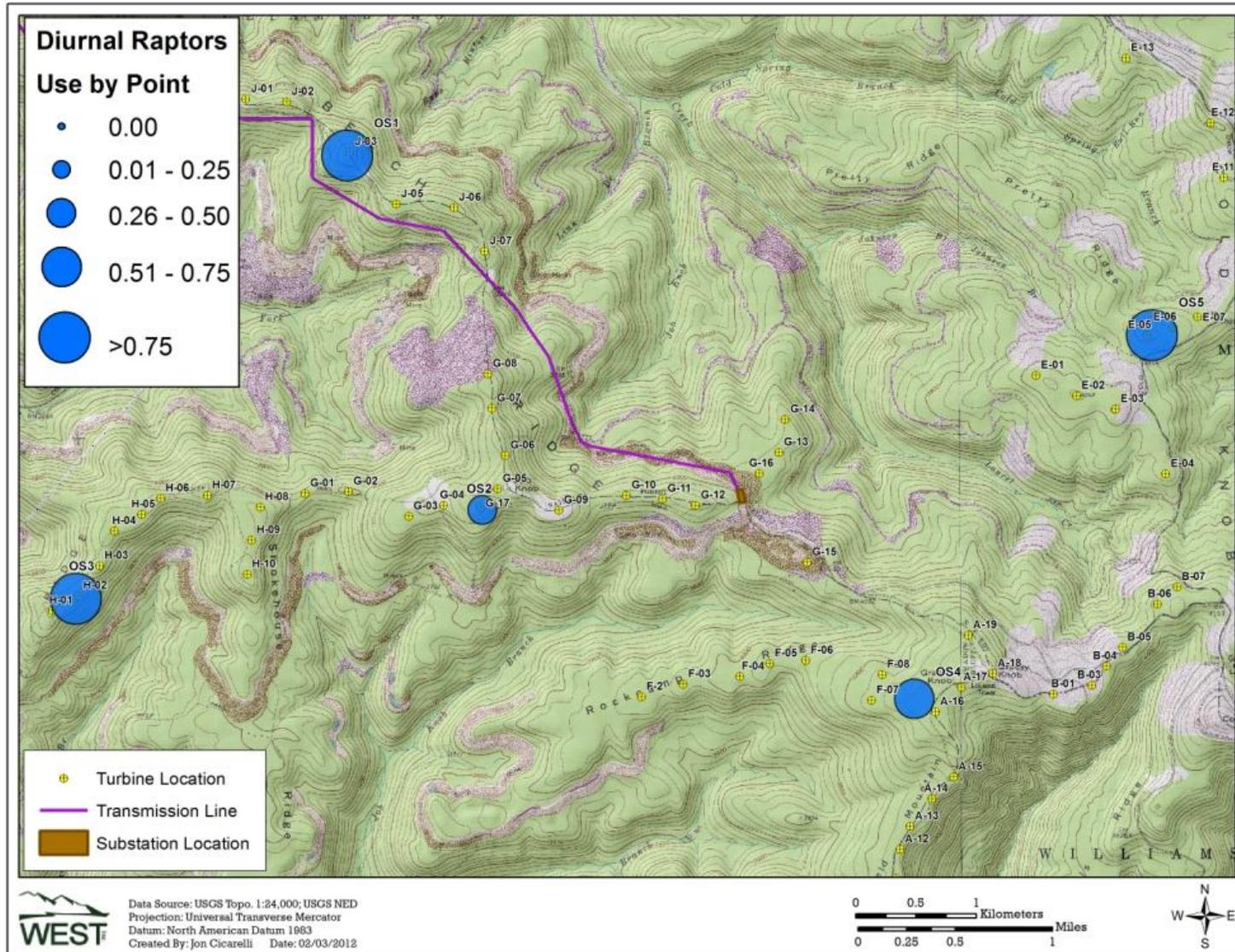


Figure 4a. Bubble plots of diurnal raptor use (number of raptors per observer-hour) by all raptor species during the spring raptor migration surveys.

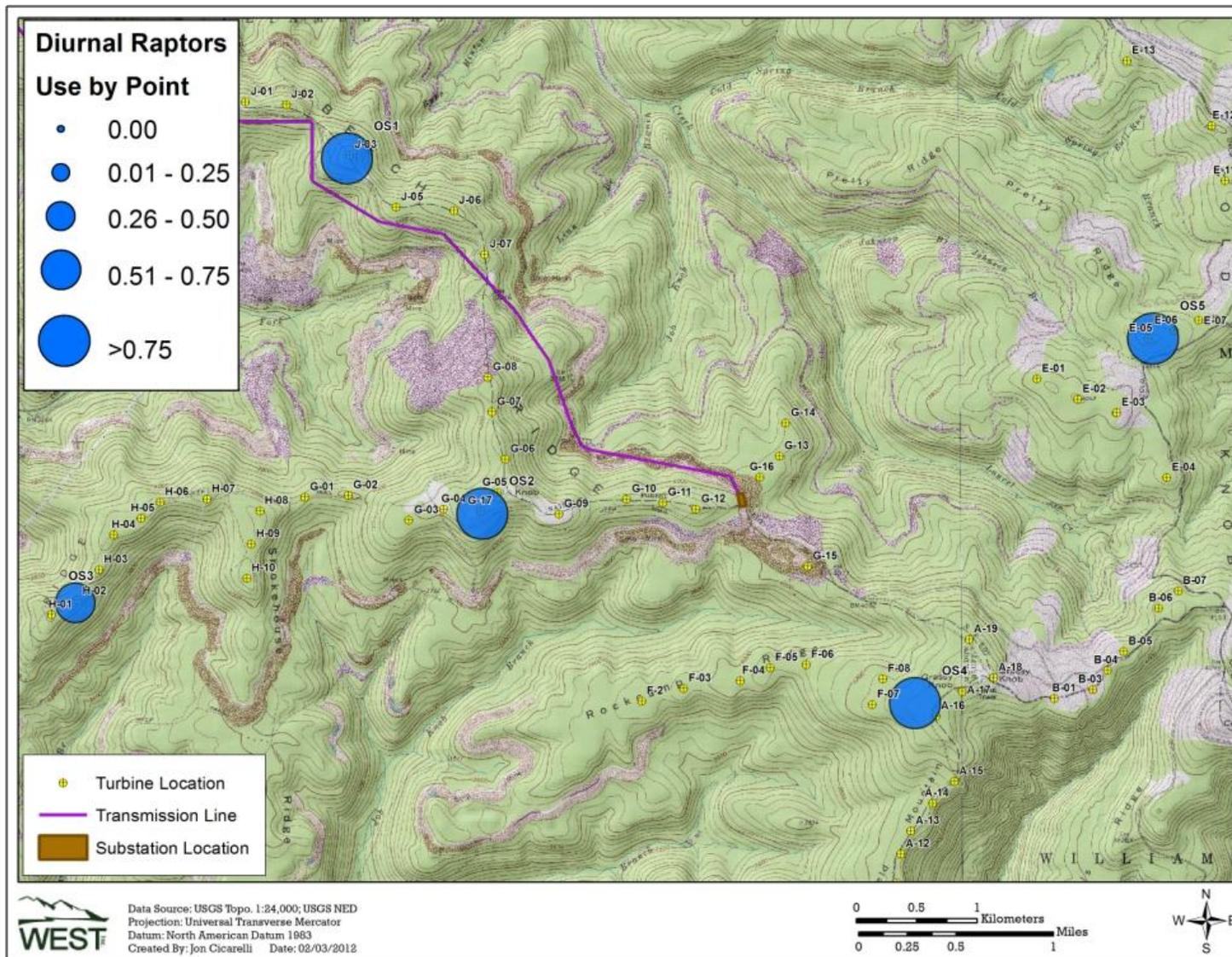


Figure 4b. Bubble plots of diurnal raptor use (number of raptors per observer-hour) by all raptor species during the fall raptor migration surveys.

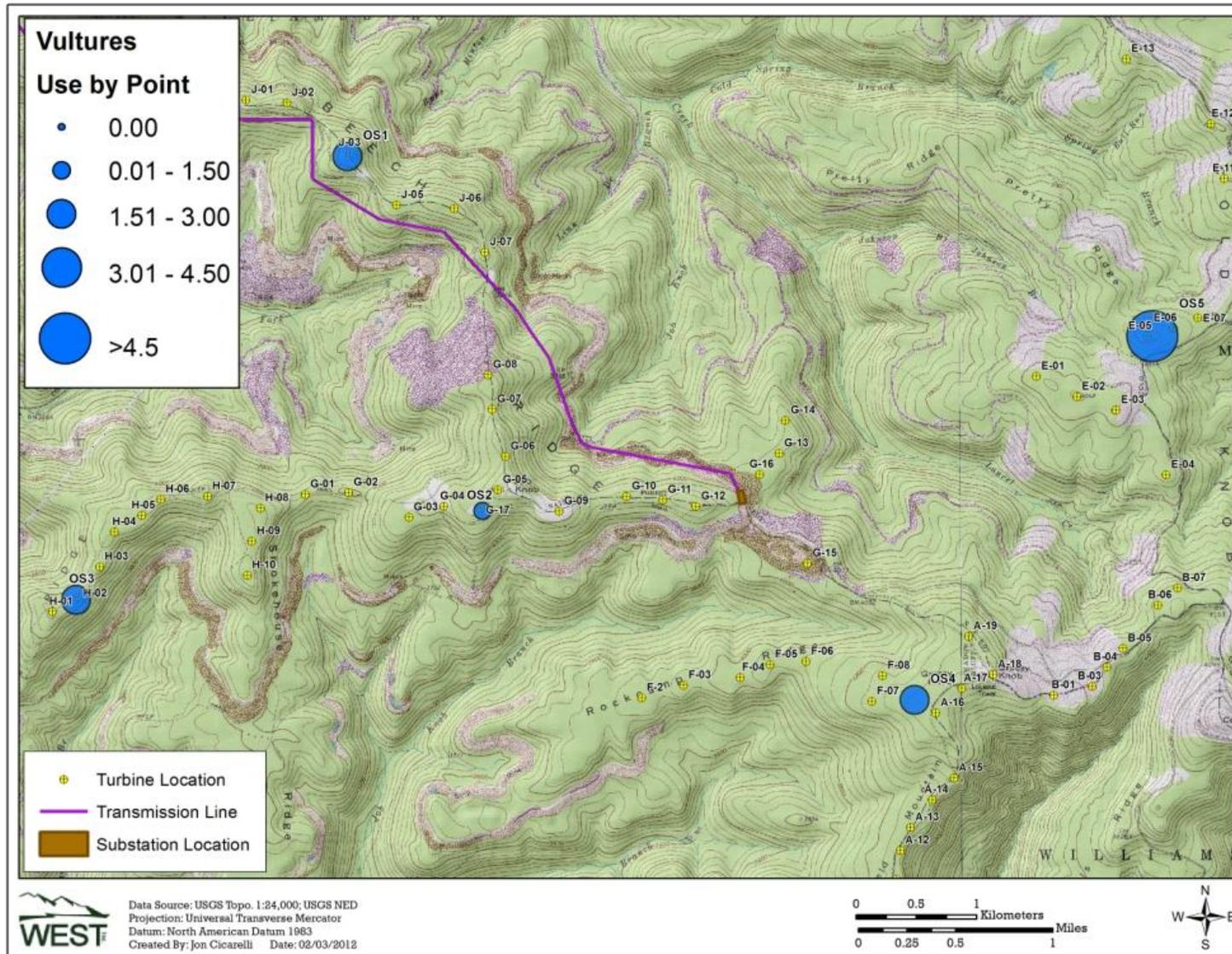


Figure 4c. Bubble plots of vulture use (number of vultures per observer-hour) during the spring raptor migration surveys.

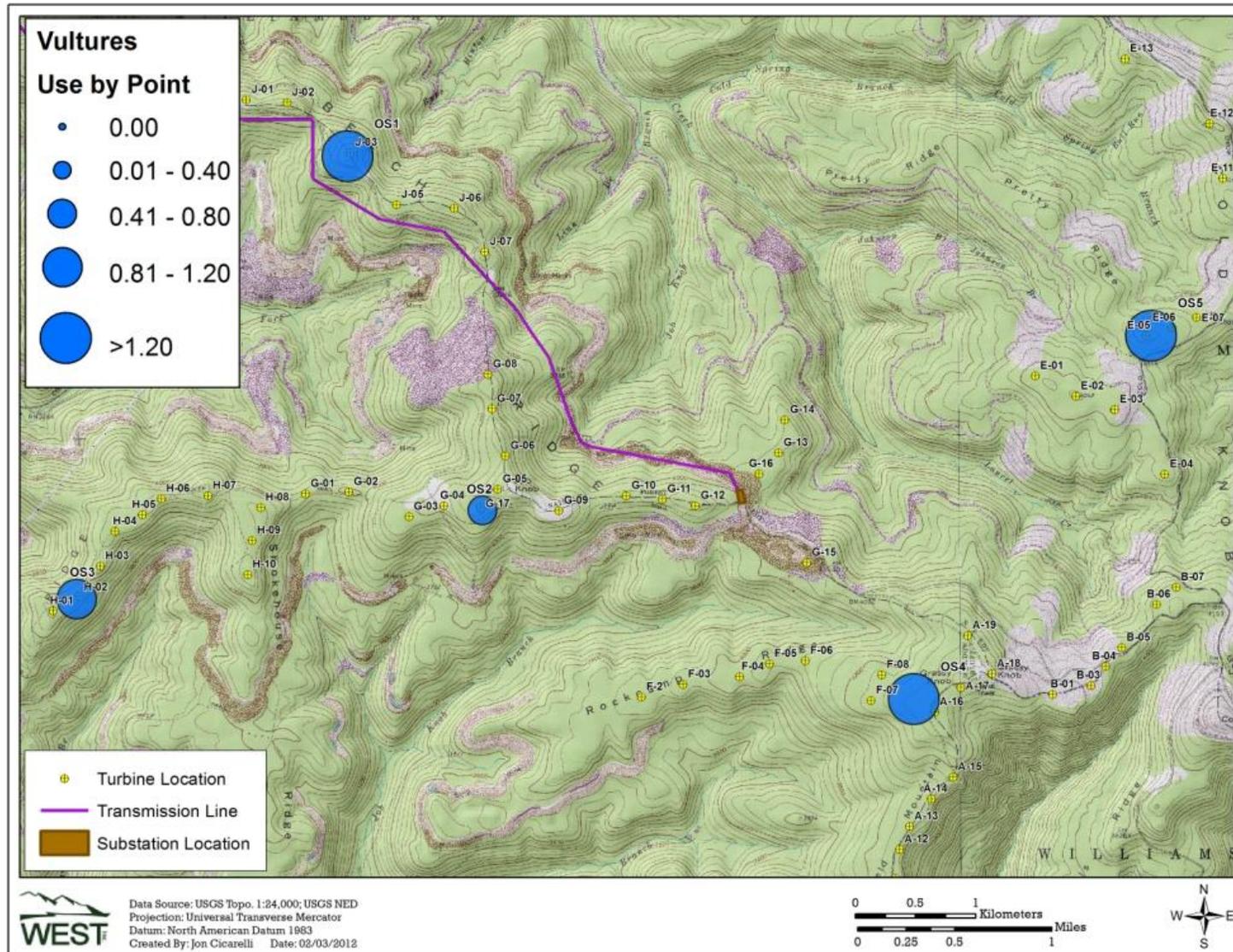


Figure 4d. Bubble plots of vulture use (number of vultures per observer-hour) during the fall raptor migration surveys

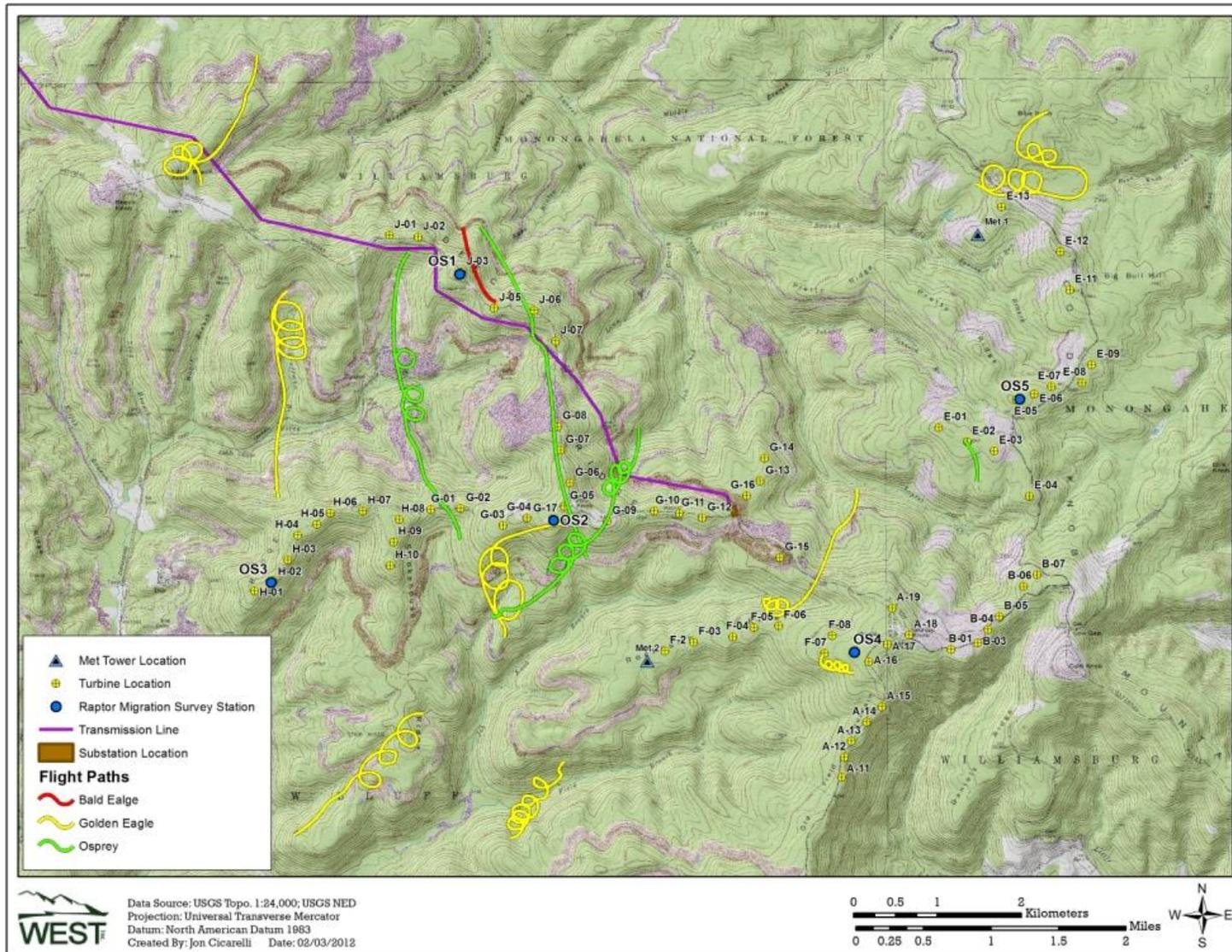


Figure 5. Flight paths of bald eagle, golden eagle, and osprey groups during the spring and fall raptor migration surveys.

## Incidental Observations

Seven raptor species were recorded as incidental observations, representing 69 individuals including red-tailed hawk (20 individuals), broad-winged hawk (19 individuals), red-shouldered hawk (*Buteo lineatus*; 11 individuals), American kestrel (*Falco sparverius*; eight individuals), sharp-shinned hawk (*Accipiter striatus*; six individuals), Cooper's hawk (*A. cooperii*; three individuals), and barred owl (*Strix varia*; two individuals; Table 5).

Five mammal species were observed incidentally during the study period including black bear (*Ursus americanus*; 10 individuals), white-tailed deer (*Odocoileus virginianus*; 13 individuals), coyote (*Canis latrans*; two individuals), one red fox (*Vulpes vulpes*), and an unidentified flying squirrel (Table 5).

**Table 5. Incidental observations of raptors and other wildlife during the spring and fall raptor migration surveys at the Beech Ridge Wind Energy Project.**

Species	Scientific Name	Number of Groups	Number of Individuals
red-tailed hawk	<i>Buteo jamaicensis</i>	19	20
broad-winged hawk	<i>Buteo platypterus</i>	16	19
red-shouldered hawk	<i>Buteo lineatus</i>	11	11
American kestrel	<i>Falco sparverius</i>	8	8
sharp-shinned hawk	<i>Accipiter striatus</i>	6	6
Cooper's hawk	<i>Accipiter cooperii</i>	3	3
barred owl	<i>Strix varia</i>	2	2
<b>Bird Subtotal</b>	<b>7 species</b>	<b>65</b>	<b>69</b>
black bear	<i>Ursus americanus</i>	8	10
white-tailed deer	<i>Odocoileus virginianus</i>	3	13
coyote	<i>Canis latrans</i>	2	2
red fox	<i>Vulpes vulpes</i>	1	1
unknown flying squirrel		1	1
<b>Mammal Subtotal</b>	<b>4 species</b>	<b>15</b>	<b>27</b>

## **DISCUSSION**

In order to fulfill a permit requirement of the WV PSC for the BRWEP, the principal objective of the study was to provide site-specific osprey and eagle use data during the migration seasons that would be useful in evaluating potential impacts from the project. In general characteristics of raptor migration moving through the BRWEP were similar in the spring and fall. Overall species richness (average number of species per survey) was higher in the spring than fall (1.34 and 1.14, respectively). The total number of all raptors, excluding vultures, was higher in fall than spring (157 and 127, respectively); however, the total number of all observations, including vultures, was higher in spring compared to fall (633 and 335, respectively), since many more turkey vultures were observed in spring. For osprey and eagles, the number of individuals observed was low and they accounted for approximately or less than 1% of the overall raptor use recorded. Three ospreys were observed in fall and only one in the spring, and six golden eagles were observed in spring and four in fall. Only one bald eagle was observed in spring and none in fall.

In order to compare the relative magnitude of raptor migration moving through the BRWEP, the number of raptors (vultures excluded) per observer-hour available from the Hawk Migration Association of North America public website (HMANA 2011) were compiled from sites in the same region and with the same survey dates as the BRWEP and compared with results from the BRWEP (Table 6). Belmont Valley Hawk Watch Site, Virginia, is located approximately 113 miles to the west, near Charlottesville, Virginia. Pilot Mountain Hawk Watch Site, North Carolina, is located approximately 115 miles to the south. Allegheny Front Hawk Watch Site, Pennsylvania, is located approximately 168 miles north-east of the BRWEP, near Central City, Pennsylvania, and Washington Monument State Park Hawk Watch Site, Maryland, is located approximately 185 miles to the north-east, near Boonsboro, Maryland.

The number of raptors per observer-hour at the BRWEP was averaged across the survey dates to calculate a metric comparable to other established hawk watch sites, and resulted in an average of 0.91 raptors per observer-hour in the spring and 1.30 raptors per observer-hour in the fall. These estimates were lower than averages seen at other established regional sites which ranged from 2.58 to 4.39 raptors per observer-hour in the spring and 9.15 to 56.85 raptors per observer-hour in the fall (Table 6). For most of the survey dates, raptor use within the BRWEP was usually lower than raptor use recorded at the other Hawk Watch sites on the same date (Table 6).

In general, results of the studies do not suggest that the magnitude of eagle and osprey migration through the BRWEP, and the overall raptor migration, is great enough that significant impacts to these species would be expected.

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**Table 6. Number of raptors observed per surveyor hour for each survey date at the Beech Ridge Wind Energy Project and four other established hawk watch sites in the same geographic region.**

<b>Date</b>	<b>Beech Ridge, WV</b>	<b>Belmont Valley, VA</b>	<b>Pilot Mountain, NC</b>	<b>Allegheny Front, PA</b>	<b>Wash. Mon. State Park, MD</b>
Spring					
3/16/2011	0		NS	0.17	
3/17/2011	1.00			1.29	2.67
3/18/2011	0.79			1.06	
3/19/2011	1.40			2.67	
3/20/2011	0.60	0.50		7.33	
3/25/2011	0.59	4.80		0.00	2.00
3/26/2011	0.60	5.00		1.60	3.27
3/28/2011	0	0.44		0.67	
3/29/2011	0.20			0.27	3.00
4/1/2011	0			0.00	3.33
4/3/2011	0.20			0.86	10.53
4/4/2011	1.00			4.40	8.44
4/6/2011	0.20	2.00		0.73	2.50
4/10/2011	2.00	2.11		28.10	
4/14/2011	0.60			5.56	5.74
4/15/2011	0.60			25.38	18.40
4/17/2011	0.20	5.40		1.54	5.88
4/21/2011	0.60	1.00		3.33	0.86
4/23/2011	2.00	2.29		0.40	
4/25/2011	0.60	6.00		1.86	4.67
4/26/2011	3.00	1.71		2.36	0.73
4/30/2011	2.00			4.59	
5/2/2011	2.60			6.73	3.43
5/4/2011	0	2.00		0.00	1.00
5/7/2011	1.80	2.18		0.00	0.86
5/8/2011	0.60	2.00			1.33
5/9/2011	0.80	1.33			
5/13/2011	1.40				
<b>Average</b>	<b>0.91</b>	<b>2.58</b>	<b>NS</b>	<b>4.39</b>	<b>4.37</b>
Fall					
9/7/2011	0.19			0.00	
9/8/2011	0.50			4.00	
9/9/2011	2.00			0.00	
9/10/2011	1.00	2.59		2.22	4.55
9/13/2011	1.00		1.25	6.88	16.78
9/16/2011	0.20	180.84	3.73	269.89	88.40
9/17/2011	0.80	41.33	0.00	71.76	9.92
9/19/2011	0.33	2.40	8.75	4.38	405.41
9/20/2011	1.50	3.14	0.71	13.80	235.82
9/23/2011	0	0.00	0.50	0.00	

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9/24/2011	1.60	16.27	4.88	75.26	43.70
9/25/2011	1.60		1.88	51.33	180.47
9/28/2011	6.20		64.50	12.40	162.20
9/30/2011	0.60		5.33	1.57	12.00
10/2/2011	0.80			0.00	4.80
10/4/2011	0.20	2.67		0.00	18.21
10/6/2011	1.60	4.89		13.00	3.80
10/10/2011	2.00			11.60	9.24
10/13/2011	0.40			0.00	
10/15/2011	2.80			4.00	12.00
10/16/2011	1.20	5.33		6.00	9.60
10/17/2011	0.80	18.00		5.00	7.31
10/18/2011	4.00			60.24	59.70
10/20/2011	0			0.89	2.48
10/21/2011	0	4.00		0.80	4.24
10/24/2011	3.00			8.50	4.00
10/25/2011	3.50			4.82	8.73
10/27/2011	0			0.00	
10/28/2011	0			19.18	4.16
<b>Average</b>	<b>1.30</b>	<b>23.45</b>	<b>9.15</b>	<b>22.33</b>	<b>56.85</b>

Daily count data acquired from HMANA (2011)

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