Post-Construction
Meteorological Tower Fatality Study
at the
Shiloh I Wind Project Site
Solano County, California

Final Report

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EXECUTIVE SUMMARY

The Shiloh I Wind Power Project Area is situated on roughly 6,800 acres of agricultural land in the Montezuma Hills, near Rio Vista in Solano County, California. The project consists of 100 wind turbines rated at 1.5 MW each for a total capacity of up to 150 MW. All one hundred turbines went on-line in March 2006. Four temporary meteorological towers, operated by enXco, are installed within the Shiloh I Wind Power Project area. These towers remained in place after the sale of the Shiloh I Wind Power Project.

This report details the results of twenty-three (23) months of a post-installation study of meteorological tower related fatalities at the Shiloh I wind power project. This is the second of three fatality studies of temporary met towers installed in the Collinsville Montezuma Hills Wind Resource Area (CMHWRA). Data from the Shiloh I study is compared with data collected from the adjacent Hamilton Ranch (FPL) and Shiloh II projects (enXco). These three surveys will be used to evaluate the risk of met towers to avian species, and to provide data to help determine if ongoing studies are needed at such towers.

At the four temporary meteorological towers, 20 incidents were found during 103 rounds of standardized surveys. Of these 20 incidents, 15 were songbird species, 1 was a raptor, an American Kestrel, 1 was a Killdeer, and 3 were other birds (Mourning Dove and Rock Pigeon). Of the 15 songbirds, two-thirds were Red-winged Blackbird (6) and Western Meadowlark (4). Thirty-five percent of all incidents occurred during only four (17%) of the 23 months of surveys, between September and December of 2006. Incidents were distributed with slightly greater numbers in the northern region of the project area than the south, with 83% of these incidents found at 3 (of the 4) met towers alone. There were six times greater numbers of passerines north of Birds Landing Road than south, which accounted for the difference in avian distribution; however the number of incidents found at met towers is too few at this time to draw conclusions. All met tower related incidents found were of small to medium size, and were within 52 meters (all but one of these were within 40 meters) of the towers, indicating the 55m search radius is sufficient for this type of survey. Within that 40 meter radius area, incidents were distributed fairly evenly throughout the distance ranges.

We analyzed the incident data at a neighboring site, Shiloh II, to determine if met tower height affected numbers of incidents found at towers. We were not able to separate height from guy wire configuration as these two variables were the same within each height grouping, thus the degree to which each of these variables attributed to the fatality rate at each tower height was not determined. Based on the number of surveys conducted at met towers of each height, we would expect 1.5 times more incidents to occur at the 60 meter towers. There were significantly more bird incidents found at 60 meter towers than would be expected based on a random distribution. All 10 doves and pigeons were located at the 60 meter towers (with a ratio of 0:10) while there were nearly 15 times more songbirds at the 60 meter towers than the shorter towers (ratio 1:14.5).

Comparison of unadjusted fatality rates (number of incidents per met tower per year) between species groups at the Shiloh II, Shiloh I and Hamilton project areas shows a greater fatality rate

for passerines at Hamilton than the two Shiloh sites, with 3 times more passerine incidents at this site (6.55 birds/tower/year). The lowest passerine fatality rate occurred at Shiloh II (1.81 birds/tower/year), however this rate was not dissimilar from Shiloh I (2.15 birds/tower/year). Other birds (doves and pigeons) were found in the greatest numbers at Shiloh II, however due to a single dove found at the Hamilton met tower, the fatality rate for this group was also greatest at the Hamilton site. Overall bird fatality was virtually the same between the two Shiloh sites.

1.0 INTRODUCTION

The Shiloh I Wind Power Project Area (hereafter, the "Project"), operated by Shiloh Wind Partners, LLC, encompasses approximately 6,800 acres of agricultural land in the Montezuma Hills, near Rio Vista in Solano County, California. The project is within the Collinsville Montezuma Hills Wind Resource Area (CMHWRA) and is west of the 90 turbine High Winds, LLC project which became operational in 2003.

There are four temporary meteorological towers (METs A, B, C, and F) installed in the wind plant. Each met tower corresponds to a wind turbine row of the same letter name (rows A, B, C and F). These temporary met towers are 50 meters tall. Each met tower is a single pole stabilized by four sets of 6 guy wires, one set on each of the four sides. The guy wires anchor to the ground at approximately 30 meters from the base of the pole. Meteorological data (wind speed and direction, temperature) is collected at each tower in a logger box mounted 5' to 6' above ground. Anemometers and wind direction gauges are mounted on booms attached to the towers at three levels beginning at the top and spaced at 10 meter intervals.

The Collinsville-Montezuma Hills Wind Resource Area (WRA) consists of approximately 40,300 acres of area. The current development area of the existing wind plants including Shiloh I, consists of approximately 17,300 acres. The WRA in which the turbines and met towers are arrayed is situated about 3 miles west of Rio Vista in Solano County, California. The landscape consists of rolling hills with elevations ranging between near sea level adjacent to the Sacramento River to about 250 - 300 feet (61-91 m) in elevation above sea level. Turbines and met towers are placed on the highest ground and do not run through low-lying valleys. The northern boundary of the WRA for the present is California State Highway 12. The southern boundary is the Sacramento River Deep Water Ship Channel. The Sacramento River Deep Water Ship Channel is about 1.5 miles to the South of the southernmost location where turbines are located and most turbines are more than 4.5 miles from this waterway. Moving from south to north the terrain becomes more uniform with less elevation differential between the ridges and the valleys. On the west is the Suisun Marsh. The Suisun Marsh is a minimum of 1.25 miles from where the nearest turbine is located, with most turbines being located more than 1.5 miles from these wetlands. The terrain is generally uniform along the east-west axis.

The project is dissected by Shiloh Road, Birds Landing Road, Montezuma Hills Road and Talbert lane. These roads are bounded by narrow weedy (mostly grasses) strips and a few homesteads complete with houses, yards, barns, driveways, and other structures necessary for farming. The land is privately owned and is largely agricultural. Where turbines, met towers and project roads are located the land use is rotating agricultural crops and grazed pastures. Crops include wheat, barley, hay, safflower and fallow fields. A multi-year rotation is the norm with wheat, fallow, and grazing alternating being the regime used most often. There are some isolated wetlands (mostly cattail marsh) and one small reservoir within the project boundaries, but these are not within the project footprint.

Treed areas within the project are limited to the areas close to homes and in a few valleys. No trees were removed to construct the project. Many of the trees are non-native eucalyptus, olive, and other species, although some native oaks and junipers are present near homes. There is a

large olive grove to the east of the project area. These treed habitats provide havens and nesting substrate for birds that do not use farmland and other birds that forage in tilled fields.

2.0 METHODS

2.1 Clean Sweep Surveys

Prior to the start of the carcass surveys, a single "clean sweep" survey was conducted at four temporary meteorological towers (MET A, B, C, and F) between May 11 and May 15, 2006, to remove all carcasses and carcass remains from the survey area. The thoroughness of the sweep was adopted to increase the likelihood that all carcasses found during the subsequent surveys would be associated with incidents that occurred during the course of the systematic surveys, and remove the possibility that scavengers or wind could relocate remains between towers. Clean sweeps were conducted using the same protocol as used in the standardized carcass surveys (see below). Standardized surveys at these same 4 met towers commenced on the 16th of May.

2.2 Standardized Surveys

During the first nineteen and a half months of this project, carcass surveys were conducted approximately once per week at the same four temporary meteorological towers between May 16, 2006 and December 27, 2007, for a total of approximately 72 total rounds. These met tower surveys were conducted alongside the standardized wind turbine tower surveys, in which consecutive rounds were started 3 towers beyond where the previous survey had started, thus met towers surveys were insured to be surveyed at various times of day.

The survey consists of searchers walking in concentric circles around the met tower's base at distances of 10, 20, 30, 40, and 50 meters, and also around the base of each tower (Figure 1). While walking around each ring, the searcher using the unaided eye, alternately scans an area that extends for 5m in either side of his track, yielding a total of 55 meters scanned (an area of 9503.3 square meters). The surveyors use range finders to initially establish and periodically check the distance of each circular route from the tower. Data recorded at the beginning of the surveys includes meteorological data (cloud cover, temperature, and wind velocity) and ground cover information (crop type and height). In addition, the start and finish times are recorded for each tower searched (see Appendix A).

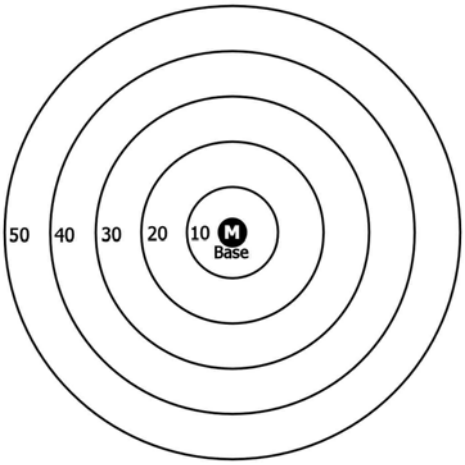

Figure 1. Search pattern for meteorological tower carcass survey (distance in meters)

When a carcass or injured bird or bat is found, the searchers perform a thorough investigation and documentation of the incident using the protocols listed in the Wildlife Response and Reporting System (WRRS). An incident report number is assigned and an incident report form filled out for each find (Appendix B). A GPS is used to determine geographic coordinates, and a range finder and compass are used to determine distance and bearing from the tower. The carcass is photographed in the position in which it is found (in situ) using a digital camera. After identifying the animal by species (including age and sex when possible), an examination is performed to determine the nature and extent of any injuries, and whether any scavenging or insect infestation has occurred. The time since death is estimated and recorded. In case of dismemberment, the surveyors search the vicinity to locate all body parts. Loose feathers are only considered fatalities if enough feathers are found to represent a dead bird. All loose feathers are collected in order to avoid identifying the feathers as an additional kill during the next survey of the tower. The carcass is then placed in a plastic bag labeled with date, species, met tower number, and incident report number, and taken to a freezer to be stored in accordance with the FWS permit requirements. When carcasses are found at times and locations outside of one of the standardized surveys conducted as part of this study, such as while driving between sites, the carcass is processed as above but it is classified as an "incidental" find, and is not included as part of the standardized incident data set.

When an injured animal is found, the searchers record the same data collected for a carcass (noting however, that it is an injury and not a fatality). The searchers then capture and restrain the animal in a manner to avoid either further injury to the animal or injury to the survey crew. Once the animal is secured it is transported to a wildlife rehabilitator or veterinarian. The hospital accession number and the final disposition of the animal are recorded on the report form.

Only in those cases where the injury to the animal can be linked to a specific met tower is a tower number recorded as the location in the report. When no corroborating information that the injury is linked to a tower is available, the animal is simply recorded as having been found "ON SITE". For instance, if a bird is found injured with a broken wing but is still mobile, it would not be associated with a specific met tower because it could have moved and the cause of incident cannot be assigned.

If the carcass or injured animal found is listed as a threatened or endangered species, the Avian Respondent, listed in the WRRS, is notified immediately by phone, and collection of the dead animal is delayed until specific direction for proceeding is received from the U.S. Fish and Wildlife Service. All Golden Eagle fatalities or injuries (if found) are reported to the U.S. Fish and Wildlife Service.

3.0 RESULTS

3.1 Clean Sweep Surveys

A total of 1 round of clean sweep surveys was conducted May 11 through the 15th, 2006, totaling 4 individual met tower surveys at towers A, B, C, and F. No carcasses were found during these surveys.

3.2 Standardized Surveys

A total of 85 near-complete rounds (n = 84.75) of standardized searches were conducted alongside wind turbine tower surveys, between May 16, 2006 and December 27, 2007 (Table 1) on 282 days, for a total of 339 complete individual meteorological tower searches. MET B was surveyed 84 times while MET A, C, and F were each surveyed 85 times. Due to being short one met tower survey, the average number of met towers surveyed during the first 19.5 months of this project was just below 4 (n=3.99). The average number of days between successive searches for each met tower was 7.0 days (Standard Deviation = 1.35).

Table 1. Summary of rounds of fatality searches during 23 months of Shiloh I carcass surveys at meteorological towers: clean sweeps and standardized surveys

Year	Round No.	Dates Surveyed
Clean Sweep of 4 Met Towers (Met A, B, C & F)		
2006	Complete Round	May 11, 12, 15
Carcass Surveys of 4 Met Towers		
2006	Round 1	May 16, 17, 19 *(Met B not surveyed)*
	Round 2	May 22, 23, 24, 25
	Round 3	May 30 & June 1, 3
	Round 4	June 5, 7, 8
	Round 5	June 11, 12, 14
	Round 6	June 17, 21, 22
	Round 7	June 26, 28, 29
	Round 8	July 3, 5, 6
	Round 9	July 11, 12, 13, 14
	Round 10	July 18, 19, 21
	Round 11	July 25, 26, 27, 28
2006	Round 12	July 31 & August 1, 2, 3
	Round 13	August 7, 8, 9, 10

Year	Round No.	Dates Surveyed
	Round 14	August 14, 15, 17
	Round 15	August 21, 22, 23, 24
	Round 16	August 29, 30, 31 & September 1
	Round 17	September 5, 6, 7, 8
	Round 18	September 11, 13, 14
	Round 19	September 18, 19, 21, 22
	Round 20	September 25, 27, 28, 29
	Round 21	October 2, 4, 6, 7
	Round 22	October 9, 11, 12, 13
	Round 23	October 17, 19, 20
	Round 24	October 23, 25, 26
	Round 25	October 30 & November 1, 3
	Round 26	November 7, 8, 9
	Round 27	November 14, 15, 16, 17
	Round 28	November 20, 21, 22
	Round 29	November 28, 29, 30 & December 1
	Round 30	December 4, 5, 6
	Round 31	December 11, 13, 14
	Round 32	December 18, 19, 20, 22
	Round 33	December 26, 27, 28, 30
2007	Round 34	January 2, 3, 4, 5
	Round 35	January 8, 9, 11
	Round 36	January 15, 16, 17, 18
	Round 37	January 24, 26, 27
	Round 38	January 31 & February 1, 2
	Round 39	February 5, 6, 7
	Round 40	February 13, 14, 15
	Round 41	February 18, 19, 20, 22
	Round 42	February 27, 28 & March 1, 2
	Round 43	March 8, 10
	Round 44	March 13, 14, 15
	Round 45	March 19, 20, 22
	Round 46	March 26, 27, 28
	Round 47	April 2, 3, 4
	Round 48	April 9, 10, 12
	Round 49	April 16, 17, 18, 19
	Round 50	April 23, 24, 25
	Round 51	April 30 & May 2, 4
	Round 52	May 7, 8, 9, 10
	Round 53	May 14, 15, 16, 17
	Round 54	May 21, 23, 24, 25
	Round 55	May 29, 31 & June 1
	Round 56	June 4, 6, 7
	Round 57	June 11, 12, 13, 14
	Round 58	June 18, 19, 21
	Round 59	June 26, 27, 28
	Round 60	July 3, 4, 5
	Round 61	July 9, 10, 11
2007	Round 62	July 16, 17, 18
	Round 63	July 23, 24, 25

Year	Round No.	Dates Surveyed
	Round 64	July 30 & August 1
	Round 65	August 6, 7, 8
	Round 66	August 13, 14, 15, 16
	Round 67	August 20, 21, 23
	Round 68	August 27, 28, 29
	Round 69	September 3, 4, 6, 7
	Round 70	September 10, 11, 12, 13
	Round 71	September 18, 19, 20
	Round 72	September 24, 25, 26
	Round 73	October 1, 2, 3
	Round 74	October 8, 9, 10
	Round 75	October 15, 16, 17
	Round 76	October 22, 23, 24
	Round 77	October 29, 31 & November 1
	Round 78	November 5, 7, 10
	Round 79	November 12, 13, 15
	Round 80	November 19, 20, 21
	Round 81	November 26, 27, 28, 29
	Round 82	December 3, 6, 7
	Round 83	December 10, 11, 12
	Round 84	December 17, 19, 20
	Round 85	December 23, 24, 27
	Round 86	December 29, 30, 31 & January 2,3
	Round 87	January 7, 9-13
	Round 88	January 14-17
	Round 89	January 21-26
	Round 90	January 28-30 & Feb 1
	Round 91	February 4-6
	Round 92	February 11-13
	Round 93	February 18-21
	Round 94	February 25-28
	Round 95	March 3-5
	Round 96	March 11-13
	Round 97	March 17-19, 21
	Round 98	March 24-27
	Round 99	March 31 & April 1-3
	Round 100	April 7-10
	Round 101	April 14-17
	Round 102	April 21-24
	Round 103	April 28-30 & May 1

Survey Summary Table

Standardized Surveys	Total # Field Days	355*
	Total (Average) # of Rounds	103
	Average # of Towers Surveyed/Round	4.00
	Total # of Individual Surveys	412
	Total # Searcher-Hours in Field	123.6
	Average # Searcher-Hours per Survey	0.30

Clean Sweep Surveys	Total # Field Days	3*
	Total (Average) # of Rounds	1
	Average # of Towers Surveyed/Round	4
	Total # of Individual Surveys	4
	Total # Searcher-Hours in Field	1.53
	Average # Searcher-Hours per Survey	0.38

* Met tower surveys were conducted on the same days as wind turbine tower surveys. There were 358 total days in the field in the 23 month period.

During the first 23 months of this study, a total of 20 incidents were recorded at meteorological towers during standardized surveys (Table 2; Appendix C). The number of incidents per met tower surveyed per year was calculated for site to site comparison. No carcasses were found at met towers incidentally. Approximately 2.5 incidents were found per met tower per year.

Table 2. Number of meteorological tower incidents per species during 23 months of carcass surveys, per number of meteorological towers per year, at the Shiloh I Project Area, May 2006 – through April 2008, found during standardized surveys

Bird Species	# Met Tower Incidents	# Incidents per Met Tower/Year*
American Kestrel	1	0.1269
American Pipit	1	0.1269
Killdeer	1	0.1269
Mourning Dove	2	0.2538
Rock Pigeon	1	0.1269
Barn Swallow	1	0.1269
Lincoln's Sparrow	1	0.1269
Red-winged Blackbird	6	0.7614
Western Meadowlark	4	0.5076
Unidentified Swallow spp.	1	0.1269
Unknown Passerine spp.	1	0.1269
Total	**20**	**2.5370**

* The number of incidents per met tower per year was calculated by dividing the number of incidents by 4 met towers and then by 1. 917years (23months/ 12 months/year).

Of the 20 incidents, 15 were songbird species, and 67% of these were Red-winged Blackbird (6) and Western Meadowlark (4). The five remaining incidents were those of an American Kestrel, Killdeer, Mourning Dove (2) and Rock Pigeon (Tables 2 and 3). The single raptor incident, the American Kestrel whose remains consisted only of feathers, could not be identified to age.

Table 3. Number of meteorological tower related incidents per species grouping for the first 19.5 months of this study, found during standardized surveys

Species Group	# of Incidents

Species Group	# of Incidents
Raptor (American Kestrel)	1
Water Bird (Killdeer)	1
Passerine (including unidentified bird spp.)	15
Other Bird (Mourning Dove, Rock Pigeon)	3
Total	**20**

The number of meteorological tower associated incidents found during standardized surveys was calculated per month for each species grouping. Thirty-five percent (n=7) of incidents occurred between the months of September and December 2006, 15% (n=3) in July 2006, 10% (n=2) in March through June 2007, 30% (n=6) in August through September 2007 and 10% in January 2008 (Table 4). The single American Kestrel incident occurred in October during fall migration. The single Killdeer incident occurred in October of 2007 and the single Rock Dove in November of 2007. The two Mourning Dove incidents occurred in September, 2007 and January, 2008 respectively.

Table 4. Number of meteorological tower related incidents per species grouping per month*

	2006								2007												
Species Group	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 08**	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**
Raptor						1															1
Water Bird																		1			1
Other Bird									1								1		1		2
Passerine			3		2	2	1	1	1		1			1		1	1			1	14
Total			3		2	3	1	1	2**		1			1		1	2	1	1	1	20**

*Estimated month of death, calculated by subtracting estimated number of days since death or injury from the report date.
** Two fatalities occurred in January, 2008, an American Pipit and a Mourning Dove.

3.3 Locations of Incidents

The general locations of the 20 incidents found during standardized surveys are given in Figure 2. For detailed information on each met tower incident, refer to Appendix C.

3.3.1 Spatial Distribution: North - South Regions

To determine if there are a statistically greater number of incidents occurring in one area than another, we divided the wind project area into two areas for spatial distribution analyses. These two areas are defined as follows: 1) North of Birds Landing Road, which encompasses 3 temporary met towers (METS A, B, and C), hereafter referred to as "the north"; and 2) South of Birds Landing Road, with 1 met tower (MET F), referred to as "the south". In comparison to the north, the southern area consists of steeper hills of higher elevations, which open up to a broad plain running south to the Sacramento River and Suisun Marsh. Based on observation from the

first sixteen and a half months of this study, there also appears to be less variety of crops in the south, with the land used for growing mostly hay, and to a lesser degree wheat and oats.

If the incidents are randomly spread throughout the area, with no difference between the north and the south, the number of incidents would be proportionate to the number of met towers surveyed in each of these areas. There are 3 met towers north of Bird Landing Road, and 1 in the south. Therefore the number of incidents would be expected to reflect a 3 to 1 ratio in these two regions if there is no difference between the north and south regions.

Meteorological tower related incidents were distributed predominantly in the northern region of the project area, with 85% of these incidents found at 3 (of the 4) met towers alone (Figure 2). There were slightly greater numbers of passerines north of Birds Landing Road than south (Table 5), however the number of incidents found at met towers are too few at this time to draw conclusions.

Table 5. Comparison of all incident distribution (by species group) to meteorological tower distribution*

	Number			Ratio	
	North	South	Total	North	South
Number of Met Towers	3	1	4	3	1
Incidents					
Raptor (Am. Kestrel)	1	0	1	1	0
Water Bird	1	0	1	1	0
Passerine	13	2	14	6	1
Other Bird	2	1	2	1	1
Total	**17**	**3**	**20**	**5**	**1**

*Project area divided into two regions, North and South of Birds Landing Road. Note: Includes data from standardized surveys only.

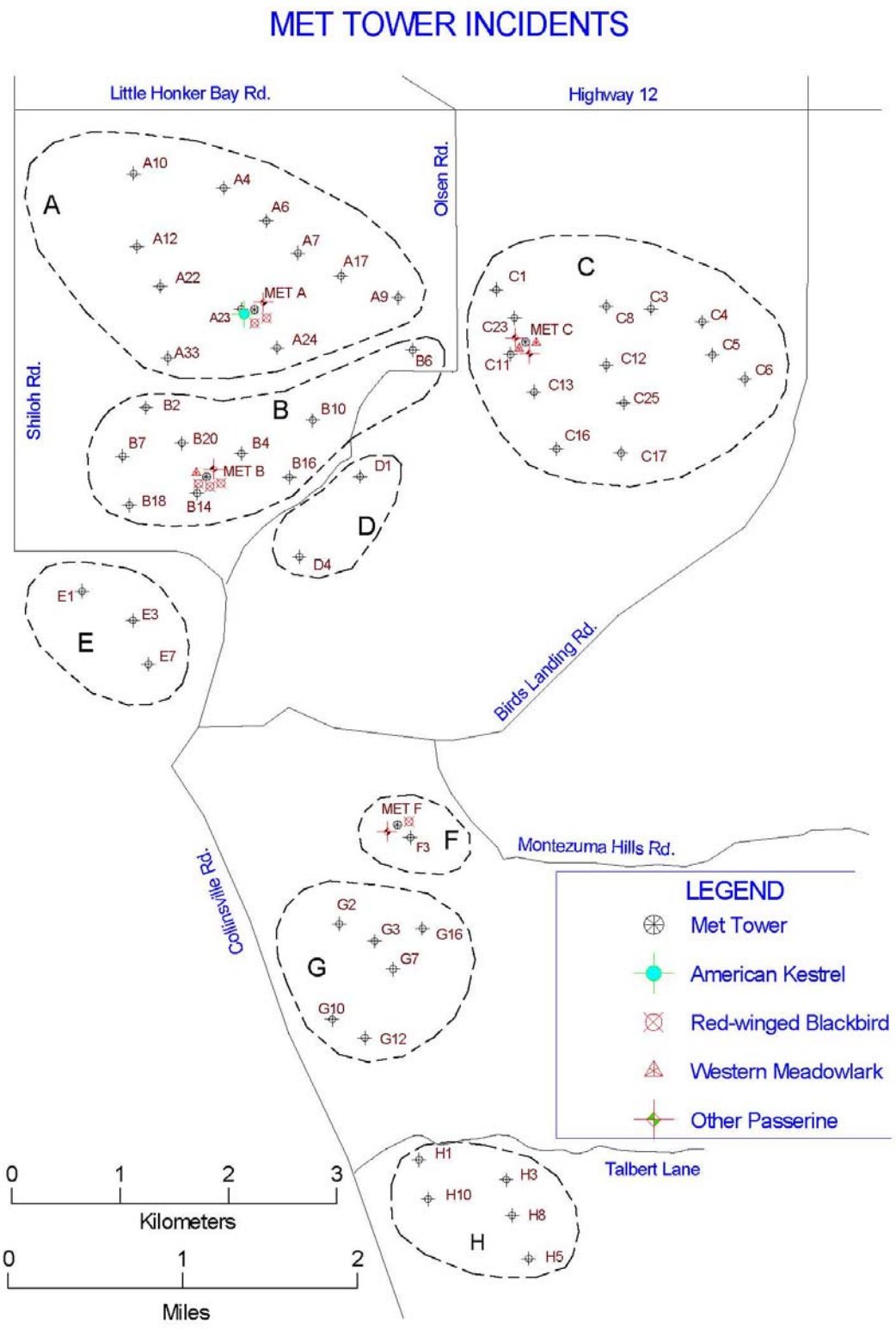

Figure 2. Locations of meteorological tower related incidents found during standardized surveys in the Shiloh I Project Site, May 2006 through April 2008

3.3.2 Distance from Towers

Species were lumped into size groupings (Table 6) to determine if species size influences distance of a carcass from a met tower, and also to determine if surveying a 55 meter radius area is an effective method for finding the majority of carcasses. The numbers of incidents found during standardized surveys within each size grouping were then tabulated based on distance (range) from the met tower.

Table 6. Species size groupings used in analyses.

Category	Description
Small Bird	≤ 8" length (most smaller passerines)
Medium Bird	8" < X ≤ 14" length (kestrels, flickers, starlings, blackbirds, doves, rails)
Large Bird	> 14" length (most raptors, moorhens, coots, ducks, pheasants)

All met tower related incidents found were of small to medium size, and were found within 52m indicating the 50m radius which scans a 55m radius area is sufficient for this type of met tower survey (Table 7). The majority of incidents (94%) were found within 40 meters, and within that area these incidents were distributed fairly evenly throughout the distance ranges.

Table 7. Number of incidents per size grouping versus distance from meteorological tower

	Distance Range (meters)						
Species Size Group	0-10	11-20	21-30	31-40	41-50	51-60	Total
Small Bird		2		1		1	4
Medium Bird	3	2	5	5			15
Unknown Bird Species*		1					1
Total	3	3	5	6		1	20

* All unknown bird species were small or medium sized passerines.

3.3.3 Bearing from Towers

Compass bearing was recorded for all incidents from tower to carcass (see Appendix C for individual incident bearings given in degrees geographic north), and is likely to correspond roughly to wind direction. Wind direction was recorded during 97% of the surveys. While the wind direction recorded during surveys may not accurately represent the direction of the wind blowing at the moment of the incident, wind direction is in general somewhat seasonal and similar from one day to the next. Approximately 72% of incidents were found northeast to south southwest of the met towers (Table 8), while wind direction for 84% of surveys where wind direction was recorded, was from the opposite direction, from the southwest to north northeast.

Table 8. The number of incidents within each species group found at each compass bearing*.

Compass Bearing*	# Incidents				Total Incidents	
	Raptor	Water Bird	Other Bird	Passerine	#	%
NE				3	3	16.7
ENE				2	2	11.1
SE		1		2	3	16.7
SSE				1	1	5.6
S				1	1	5.6
SSW			2	1	3	16.7
SW				2	2	11.1
NW				1	1	5.6
NNW	1			1	2	11.1
Grand Total	1	1	2	14	18**	100.0

* Bearing was recorded in degrees Geographic North, and represents degrees from met tower to carcass.
** Bearing not available for 2 of the carcasses.

4.0 DISCUSSION

This report details the results of the twenty-three month post-installation study of meteorological tower related fatalities at the Shiloh I wind power project. This is the second of three fatality studies of temporary met towers installed in the Collinsville Montezuma Hills Wind Resource Area (CMHWRA). Data from the Shiloh I study is compared with data collected from the adjacent Hamilton Ranch (FPL) and Shiloh II projects (enXco). These three surveys will be used to evaluate the risk of met towers to avian species, and to provide data to help determine if ongoing studies are needed at such towers.

Due to the similarity of terrain and land use practices throughout the CMHWRA we would expect to find an overlap of met tower-related incident species composition among the wind project developed areas of the WRA. In addition, because the same team of individuals has been conducting the surveys at the Shiloh I, Shiloh II and Hamilton projects using the same protocols, it is reasonable to expect that the data collected should be comparable. If there are biases or idiosyncrasies for better or worse they too remain constant.

4.1 Fatalities at Three Adjacent Sites

Table 9 compares specific attributes of these three adjacent developments within the CMHWRA.

Table 9. Comparison of Shiloh I, Shiloh II and Hamilton attributes or metrics (includes standardized data from variable periods, inclusive of all data collected from the beginning of each study through the end of April 2008)

Attribute or Metric	Shiloh I	Shiloh II	Hamilton Ranch
Number of Met Towers	4	10	1
Height (AGL)	50m	50m (4), 60m (6)	50m
Duration of Study (months)	19.5	22	11
Study Dates	May 16, 2006 – December 27, 2007	February 22, 2006 – December 26, 2007	February 6, 2007 – December 26, 2007
Search Interval (in days)	7 days	7 days	7 days
Number of Birds Found	20	51	8
Number of Raptors Found	1	1	0
Number of Songbirds Found	15	31	6
Number of Birds Killed per Met Tower per Year	2.560	2.632	6.40
Number of Raptors Killed per Met Tower per Year	0.128	0.052	0
Number of Songbirds Killed per Met Tower per Year	1.920	1.806	4.80

* The number of incidents per tower per year was calculated by dividing the number of incidents per species group by the average number of met towers surveyed throughout the survey, and then dividing this number by the number of years the site was surveyed.

When comparing the fatality rates of each species recorded between the three sites (Table 10), we find not as much overlap in the species impacted as would be expected based on similarities in met tower structure, study methods, and general geographic location, habitat, and terrain. With the exception of the methodology, which was the same for each study, these other factors may have contributed to differences in incident composition between sites.

Of the three sites, raptors were only found at Shiloh I and II, an American Kestrel (1) and a Barn Owl (1), respectively. Along with the Barn Owl, species found only at Shiloh II included: the Brewer's Blackbird (3), Dark-eyed Junco (1), Horned Lark (5), Pacific-slope Flycatcher (1), Savannah Sparrow (3), White-crowned Sparrow (1), and Common Moorhen (1). A single Loggerhead Shrike was found at Hamilton Ranch, a California Species of Special Concern not found at either of the other two sites. Species found only at the Shiloh I site included the American Kestrel (1), a Barn Swallow (1), and a Lincoln Sparrow (1). The only species overlapping between sites were American Pipit, Mourning Doves, Rock Pigeons (not present at Hamilton), Red-winged Blackbirds, Killdeer and Western Meadowlarks.

The number of incidents per species is low, so conclusions about differences in fatality rates will be limited to comparing larger sample sizes by lumping species into species groups.

Table 10. Comparison of unadjusted number of incidents per species per met tower per year at Shiloh II (24.7months of surveys), Shiloh I (23.4 months), and Hamilton Ranch (15 months), found during standardized surveys

	Shiloh II		Shiloh I		Hamilton	
Species	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr
American Kestrel			1	0.1280		
American Pipit	4	0.2064	1	0.1280		
Barn Owl	1	0.0516				
Barn Swallow			1	0.1280		
Brewer's Blackbird	3	0.1548				
Common Moorhen	1	0.0516				
Dark-eyed Junco	1	0.0516				
European Starling	1	0.0516				
Horned Lark	6	0.3096				
Killdeer	1	0.0516	1	0.1280		
Lincoln's Sparrow			1	0.1280		
Loggerhead Shrike					1	0.8000
Mourning Dove	6	0.3096	2	0.2560	2	1.6000
Pacific-Slope Flycatcher	1	0.0516				
Red-winged Blackbird	9	0.4645	6	0.7679	3	2.4000
Rock Pigeon	7	0.3613	1	0.1280		
Savannah Sparrow	3	0.1548				
Western Meadowlark	5	0.2580	4	0.5119	2	1.6000
White-crowned Sparrow	1	0.0516				
Unidentified Passerine spp.			1	0.1280		
Unidentified Sparrow	1	0.0516				
Unidentified Swallow spp.			1	0.1280		
Grand Total	**51**	**2.5596**	**20**	**2.6320**	**8**	**6.400**

When comparing fatality rates of species groups, we see dramatic differences between sites (Table 11), however numbers are still low at this time. Looking at unadjusted fatality rates between sites, the highest rate of passerine fatality, with over three times the rate occurring at either of the two other sites, occurred at Hamilton (4.80birds/tower/year). The lowest passerine fatality rate occurred at Shiloh II (1.81 birds/tower/year), however this rate was not dissimilar from Shiloh I (1.92 birds/tower/year). Other birds (doves and pigeons) were found in the greatest numbers at Shiloh II, however due to a single dove found at the Hamilton met tower, the fatality rate for this group was also greatest at the Hamilton site. Overall bird fatality was virtually the same between the two Shiloh sites, and approximately two and one half times as great at Hamilton Ranch.

Table 11. Comparison of unadjusted number of incidents per species grouping per met tower per year at Shiloh II (24 months of surveys), Shiloh I (23 months), and Hamilton Ranch (15 months), found during standardized surveys

	Shiloh II		Shiloh I		Hamilton	
Species Group	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr
Raptor	1	0.0585	1	0.1538		
Water Bird	1	0.0585	1	0.1538		
Other Bird	10	0.5853	3	0.3077	2	1.6000
Passerine	31	1.8143	15	2.1538	6	4.8000
Grand Total	**43**	**2.5596**	**20**	**2.6320**	**8**	**6.4000**

Differences in bird abundance and use of the sites may be responsible for the greater observances of incidents per tower searched at the Hamilton site. The 2005-2006 rainy season was extraordinarily wet, while 2006-2007 was unusually dry which would affect vegetation and food abundance, which may have resulted in higher fatality rates during the 2007 Hamilton study, as this site is proximal to an olive orchard and a human habitation on which water is available.

4.2 Shiloh I: Post-Construction Wind Turbine – Met Tower Comparison

For the purpose of determining the potential relative impact of meteorological towers on birds, we can compare met tower related incidents to wind turbine related incidents at Shiloh I, where wind turbine tower carcass searches were conducted in tandem with met tower searches. The number of birds killed or injured associated with wind turbines at the site for the study period was 2.93 birds per wind turbine per year (Table 12). The fatality rate at met towers was 2.61 birds per met tower per year. There were 50 species (plus unidentified birds) found at wind turbines, whereas there were only 9 species (plus unidentified birds) at met towers. While species diversity of incidents and fatality rate of all bird species combined was greater at wind turbine towers than met towers, the fatality rate of passerine species was nearly the same between met towers (1.96 songbirds/tower/year) and wind turbine towers (1.93 songbirds/tower/year). Interestingly, bat fatalities were recorded only at wind turbine towers, and were found at none of the three project areas at met towers.

Table 12. Comparison of unadjusted number of incidents per species grouping per wind turbine and per met tower per year at Shiloh I, found during standardized surveys

SHILOH I	Wind Turbine Towers April 10, 2006 – April 14, 2008		Meteorological Towers May 16, 2006 – April 14, 2008	
Species Group	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr
Bird Species				
Raptor	47	0.4668	1	0.1305
Waterfowl	4	0.0397	0	0
Water Bird	14	0.1390	1	0.1305
Other Bird	35	0.3476	3	0.3916
Passerine	194	1.9268	15	1.9582
Unknown bird spp.	1	0.0099	0	0
Subtotal Bird Species	**295**	**2.9299**	**20**	**2.6109**
Bat Species	90	0.8939	0	0
Subtotal Bat Species	**90**	**0.8939**	**0**	**0**
Grand Total	**385**	**3.8238**	**20**	**2.6109**

4.2.1 Shiloh I Chi-square Analysis of Incidents at Towers Adjacent to Meteorological Towers

We conducted chi-square tests for independence for the number of bird incidents (all species) detected at turbines adjacent to meteorological towers versus non-adjacent turbines at Shiloh I.

We found no significant deviation from the expected number of bird incidents between turbines adjacent vs. turbines not adjacent to meteorological towers (Yates[1] $\chi^2 = 0.03$, $df = 1$, P = 0.86, ns).

Table 13. Contingency table showing the proportion of bird incidents at turbines adjacent to meteorological towers vs. non-adjacent turbines at Shiloh I.

	# turbines	# Bird Incidents	Sum
Met_Adj Turbines	4	19	23
Not Adjacent	46	206	252
Sum	50	225	275

1 The expected frequency was less than 5 in more than 20% of the contingency test cells, necessitating the use of Yates' correction.

The monitoring of the met towers shows that guyed met towers are not without impact but that impact is not biologically significant and no threatened or endangered species were involved. Guyed met towers are generally replaced by unguyed met towers once the project becomes operational and are therefore a temporary installation. It is our judgment that enough data has been gathered to provide the county a basis for determining its policies regarding these structures and no further studies are needed.

APPENDIX A. SHILOH I WIND POWER PROJECT AVIAN CARCASS SURVEYS DATA SHEET

Page ____ of ____

Date_____ Observers _____

Notes:_____

Loc	Time		Fatalities		Ground Cover/Crop Type (give % cover, ave. height, whether standing or cut crop)						Weather			
Turb#	Start	Finish	#	Brief Notes	Gravel	Tilled	Wheat	Barley	Saff.	Fallow	Temp F	Wind Speed	Dir	% Cloud

APPENDIX B. SHILOH I WILDLIFE INCIDENT REPORT DATA SHEET.

SHILOH I
Wildlife Incident Report

SECTION NO. 1 - DISCOVERY DATA

Report Date: _____ Recovery Date: _____ ID#: _____

Reporting Crew: _____ Injury / Fatality Complete / Dismembered / Feathers / Bones

SECTION NO. 2 - LOCATION OF FIND

Parts: Bearing and Distance from tower/pole: Structure: _____

List parts by size:	Distance	Degrees
Part 1: _____	_____	_____
Part 2: _____	_____	_____
Part 3: _____	_____	_____

Location Remarks: _____
_____

SECTION NO. 3 - WILDLIFE IDENTIFICATION

Species: Field marks used:
_____ _____
Age: _____ Sex: _____ Band: No ___ Yes ___ Unknown ___ (Leg(s) missing)

SECTION NO. 4 - OBSERVATIONAL DATA

Describe the physical condition of the find at the time of discovery:
_____
_____
_____

Describe Scavenging Activity: _____
Estimated Time Since Death or Injury (days): <1, <4, <7, <14, <30, >30, UNK Photos: _____

Carcass Condition:
____ 1 - Fresh
____ 2 - Decomposing (early stage)
____ 3 - Decomposing (late stage)
____ 4 - Desiccated
____ 5 - N/A

Infestation Activity: ____ Yes ____ No
____ Fly Larvae (maggots)_____
____ Adult Flies _____
____ Beetles_____
____ Ants_____
____ Other_____

Eyes: __N/A __Round, Fluid Filled __Partially Dehydrated __Flat __Sunken __Amorphous/Empty

Other Field Notes: _____
_____

APPENDIX C. LIST OF 20 INCIDENTS FOUND DURING STANDARDIZED SURVEYS AT TEMPORARY METEOROLOGICAL TOWERS AT SHILOH I, MAY 2006- APRIL 2008.

ID#	Report Date	Estimated Month Death	Species Name	Fatality /Injury	Species Group	Tower	Dist (m)	Deg (GN)*	Days Since Death
SH-113-06	10/11/2006	Oct-06	American Kestrel	Fatality	Raptor	Met A	2	319	7
SH-012-08	1/23/08	Jan-08	American Pipit	Fatality	Passerine	Met A	22		7
SH-208-07	11/1/2007	Oct-07	Killdeer	Fatality	Water Bird	Met A	40	127	4
SH-168-07	9/20/2007	Sep-07	Mourning Dove	Fatality	Other Bird	Met A	22	212	7
SH-013-08	1/29/08	Jan-08	Mourning Dove	Fatality	Other Bird	Met C	22		7
SH-232-07	12/3/2007	Nov-07	Rock Pigeon	Fatality	Other Bird	Met F	21	192	7
SH-127-07	8/7/2007	Aug-07	Barn Swallow	Fatality	Passerine	Met C	52	228	4
SH-094-06	9/29/2006	Sep-06	Lincoln's Sparrow	Fatality	Passerine	Met B	39	48	1
SH-150-06	12/4/2006	Dec-06	Red-winged Blackbird	Fatality	Passerine	Met A	27	220	4
SH-077-07	3/26/2007	Mar-07	Red-winged Blackbird	Fatality	Passerine	Met A	38	159	7
SH-025-06	7/12/2006	Jul-06	Red-winged Blackbird	Fatality	Passerine	Met B	33	78	4
SH-026-06	7/12/2006	Jul-06	Red-winged Blackbird	Fatality	Passerine	Met B	24	46	1
SH-027-06	7/12/2006	Jul-06	Red-winged Blackbird	Fatality	Passerine	Met B	16	176	7
SH-081-06	9/19/2006	Sep-06	Red-winged Blackbird	Fatality	Passerine	Met F	10	334	7
SH-113-07	6/13/2007	Jun-07	Western Meadowlark	Fatality	Passerine	Met B	40	131	7
SH-106-06	10/7/2006	Oct-06	Western Meadowlark	Fatality	Passerine	Met C	5	34	7
SH-167-07	9/20/2007	Sep-07	Western Meadowlark	Fatality	Passerine	Met C	40	206	7
SH-238-07	12/19/2007	Dec-07	Western Meadowlark	Fatality	Passerine	Met A	30	315	4
SH-147-06	11/22/2006	Nov-06	Unidentified Passerine	Fatality	Passerine	Met F	16	128	7
SH-114-06	10/11/2006	Oct-06	Unidentified Swallow	Fatality	Passerine	Met A	20	74	7

* Degrees Geographic North represents degrees from met tower to carcass.