

**Pre-Construction
Meteorological Tower Fatality Study
at the
Hamilton Ranch Wind Power Project
Solano County, California**

Final Report

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EXECUTIVE SUMMARY

This report details the results of 15 months of a pre-construction meteorological tower fatality study of the proposed Hamilton Ranch wind power project. This is one of three fatality studies of temporary meteorological towers installed in the Collinsville Montezuma Hills Wind Resource Area (CMHWRA). Data from the Hamilton Ranch (FPL Energy) study is compared with data collected from EnXco owned met towers on the adjacent Shiloh II and Shiloh I projects. These tower 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.

During 15 months of this study, standardized carcass surveys were conducted once per week at a single met tower between February 6, 2007 and April 29, 2008, for a total of 65 complete rounds at this tower. A clean sweep survey was conducted once at the tower one week prior to start of standardized surveys.

A total of 8 avian incidents were recorded by searchers during standardized met tower surveys, representing 4 species. All were fatalities (none were injured birds). Of the 8 incidents, 2 were Mourning Doves and 6 were songbirds, 3 Red-winged Blackbirds, 2 Western Meadowlarks, and 1 Loggerhead Shrike. None of the carcasses or injured birds found is listed as federally or state threatened or endangered. The Loggerhead Shrike is a California Species of Special Concern.

All incidents occurred in only four of the fifteen months of the study, during May, July, and November of 2007 and March of 2008. The majority (75%) of these incidents were found in May and July.

Of the 8 incidents found during standardized surveys, 75% were located between 21 and 40 meters of the met tower. All incidents found were medium sized carcasses. One incident was found between 11 and 20 meters, and one (the most distant) was found at 41 meters.

Seventy-five percent (75%) of incidents were found at compass bearings of north to east of the met towers, while wind direction, for 61% of surveys where wind direction was recorded, was from the opposite direction, from the south to west southwest. Wind appears to be a likely factor in determining the location of fatalities.

The vegetation surrounding the met tower was recorded, and for the entire 15 month study period, consisted entirely of grazed fallow for 88% of the surveys, and shallow tilled soil for the remaining 12% of surveys. All but the last incident (Mourning Dove) was found on grazed fallow.

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 more bird incidents

found at 60 meter towers than would be expected based on a random distribution. All but one of 13 doves and pigeons were located at the 60 meter towers (with a ratio of 1:12) while there were 6 times more songbirds at the 60 meter towers than the shorter towers. However, there was not enough data to make a determination of statistical significance.

Comparison of unadjusted fatality rates (number of incidents per met tower per year) between species groups at the Shiloh I, Shiloh II and Hamilton project areas shows a greater fatality rate for passerines at Hamilton than the two Shiloh sites, with 2.5 times more passerine incidents at this site (4.80 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 (1.92 birds/tower/year). Other birds (doves and pigeons) were found in the greatest numbers at Shiloh II, however due to two doves 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.

Differences in bird abundance and use of the sites could account 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. Although counter-intuitive, this 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, and provides haven for songbirds and doves during drier years.

The numbers of fatalities recorded at the site in this report are unadjusted. It is recognized that the number of carcasses found under the towers is lower than the total number of birds likely to have been killed. There are at least two factors that need to be accounted for. The first is the possibility that the searchers will miss carcasses. A second possibility is that the carcasses are removed prior to the time the searchers arrive on location after the collision event occurred.

However, these incidents did not involve threatened and endangered species and are dispersed among several avian species. The impact of the guyed temporary towers is not biologically significant. Enough data has been gathered to enable the county to make informed decisions about the use of these monitoring structures.

1.0 INTRODUCTION

One temporary meteorological tower, operated by FPL Energy, is installed at the Hamilton Ranch Wind Power Project area (Figure 1). The temporary meteorological tower was searched once per week for carcasses, between February 6 and April 29, 2008. Prior to standardized carcass surveys, on January 30, 2007, a clean sweep survey was conducted at the tower to remove any carcasses present prior to the study. A total of 63 individual standardized met tower searches were conducted during this 15 month study.

The met tower installed in the proposed Hamilton project area is 50 meters tall. The met tower is a single pole stabilized by four sets of 6 guy wires guy wires, one set of 6 wires on each of the four sides. Coils are located on each guy wire approximately 12 to 15 meters apart, in an effort to provide enhanced visual deterrence and alter the flight paths around the guy wires. The guy wires anchor to the ground at approximately 40 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 report that follows examines the data generated from fatality searches conducted at temporary meteorological towers on the Hamilton Ranch site between February 6, 2007 and April 29, 2008 (a 15 month period), and compares these data with studies of guyed meteorological towers conducted for the adjacent Shiloh I and Shiloh II projects. These surveys will be used to evaluate the risk of guyed met towers to avian species, and to provide data to help determine if ongoing studies are needed at such towers.

Location of FPL-Hamilton Meteorological Tower Located in Solano County, CA



Figure 1. Locations of 1 temporary meteorological tower in the Hamilton Ranch Project Area, Solano County, California, surveyed February 2007 – April 2008.

2.0 METHODS

2.1 Meteorological Tower Carcass Surveys

2.1.1 Clean Sweep Survey: Prior to the start of the carcass surveys, a “clean sweep” was conducted at the temporary meteorological towers to remove all carcasses and remains of carcasses from the survey area. Clean sweeps were conducted using the same protocol as used in the standardized carcass surveys (see below). 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. The clean sweep was executed January 30, 2007. Standardized surveys at the tower started one week following the clean sweeps, on February 6, 2007.

2.1.2 Standardized Surveys: During the 15 months of this project, carcass surveys were conducted approximately once per week at the same single meteorological tower (named HAMILTON MET) between February 6, 2007 and April 29, 2008, for a total of 65 rounds.

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 2). 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. 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).

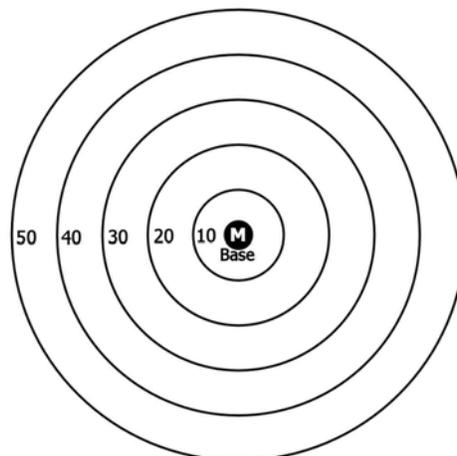


Figure 2. Search pattern for meteorological tower carcass survey (distance in meters)

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 remains are 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 Meteorological Tower Carcass Surveys

3.1.1 Clean Sweep Survey. One clean sweep survey was conducted at the single Hamilton met tower on January 30, 2007. No carcasses were found during the clean sweep survey.

3.1.2 Standardized Surveys. A total of 65 complete rounds (individual surveys) of standardized searches were conducted at the Hamilton met tower between February 6, 2007 and April 29, 2008 on 65 days (15% of the days of the 15 month period). The average number of days between successive searches at the tower was 7.00 days (Standard Deviation = 1.54).

During the 15 months of this study, a grand total of 8 incidents were recorded (Table 1). Of 8 incidents, all incidents were found during standardized surveys (Appendix C).

Table 1. Number of temporary meteorological tower related incidents per species at the Hamilton Ranch Project Area, February 6, 2007 – April 29, 2008, found during standardized surveys.

Species	# Incidents
Mourning Dove	2
Loggerhead Shrike*	1
Red-winged Blackbird	3
Western Meadowlark	2
Grand Total	8

* Denotes a California Species of Special Concern.

A total of 8 met tower related avian incidents, were recorded by searchers, representing 4 species. All of these were fatalities. Of the 4 avian species, 2 were Mourning Doves, while the remaining 3 species were passerines comprising 6 incidents (Table 2). None of the carcasses found are listed as federally or state threatened or endangered. The Loggerhead Shrike is a California Species of Special Concern. All incidents were identified as adults.

Table 2. Number of incidents per species grouping (doves, passerines), found during the first 14 months of standardized surveys at the Hamilton Ranch met tower

Species Group	Total
Dove	2
Passerine	6
Grand Total	8

The number of met tower related incidents found per tower per year was calculated to provide a comparable metric between different wind power projects (Table 3).

Table 3. Unadjusted number of incidents per species during 15 months of surveys per met tower per year, at the Hamilton Ranch Project Area, February 2007 – April 29, 2008, found during standardized surveys.

Species	# Incidents	# Incidents per Tower/Year*
Mourning Dove	2	1.60
Loggerhead Shrike	1	0.80
Red-winged Blackbird	3	2.40
Western Meadowlark	2	1.60
Grand Total	8	6.40

* The number of incidents per tower per year was calculated by dividing the number of incidents per species by the average number of met towers surveyed throughout the survey (1), and then dividing this number by 1.25 years (15 months).

Unadjusted fatality rates were also calculated for each species grouping (doves and passerines). Passerines were found at the greatest rate, 4.8 songbirds per met tower per year (Table 4).

Table 4. Unadjusted number of incidents per species group during the first 14 months of surveys per met tower per year, at the Hamilton Ranch Project Area, February 2007 – April 2008, found during standardized surveys.

Species Group	# Incidents	# Incidents per Tower/Year*
Dove	2	1.60
Passerine	6	4.80
Grand Total	8	6.40

* The number of incidents per tower per year was calculated by dividing the number of incidents per species by the average number of met towers surveyed throughout the survey (1), and then dividing this number by 1.25 years (15 months).

The number of met tower associated incidents found during standardized surveys was tabulated per month for each species (Table 5). The estimated month of death was determined by subtracting the estimated number of days since death from the report date.

All 8 incidents occurred in only 4 of the 15 months surveyed. The greatest numbers of incidents occurred in May and July, with 3 incidents in each of those two months alone, together comprising 75% of all incidents entire study period. The remaining 2 incidents occurred in November and March 2008.

Table 5. Number of met tower related incidents per species grouping per month*

Species	2007												2008			Grand Total
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
Mourning Dove						1								1		2
Loggerhead Shrike				1												1
Red-winged Blackbird				1		1				1						3
Western Meadowlark				1		1										2
Grand Total				3		3				1				1		8

*Estimated month of death, was calculated by subtracting the estimated number of days since death from the report date. These numbers include incidents associated with met towers and found during standardized surveys only.

3.2 Vegetative Cover

Vegetation may affect distribution of incidents found during a carcass study by influencing avian use of the area, and therefore potentially the number of individuals impacted. Vegetation may also likely affect searchers' visibility of carcasses. As there is only one tower studied at the Hamilton site, comparison with vegetation and incident data from other adjacent met tower studies (Shiloh I and II), along with noting future changes in the vegetation at the Hamilton Met tower (as agricultural plots of land are allowed to fallow for a year or so and then used for planting crop, etc.), may help elucidate the role of vegetation in carcass distribution.

The vegetation surrounding the met tower was recorded, and for the entire 15 month study period, consisted of grazed fallow (88% of surveys) and shallow tilled soil (12%). The latter ground cover type (till) was present only during the last 6 surveys. These types of vegetation is short and offers reasonable to good searcher visibility, although tilled soil can sometimes obscure small or similarly colored carcasses (such as bats).

All but one incident (87.5%), the Mourning Dove found on tilled soil in March 2008, were found on grazed fallow.

3.3 Locations of Incidents

The locations of all 8 incidents found during standardized surveys at the Hamilton met tower are shown in Figure 3.



Figure 3. Locations of 8 incidents found during standardized surveys at the Hamilton Ranch met tower, February 6, 2007 through April 29, 2008.

3.3.1 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. Since all species found during this study were of medium size, and there are so few of them at this time, they are instead listed by species. The number of incidents per species (found during standardized surveys only) were then tabulated based on distance (range) from the met tower (Table 7).

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)

Of the 8 incidents found during standardized surveys, 75% were located between 21 and 40 meters of the met tower (Table 7). All incidents found were medium sized carcasses. One incident was found between 11 and 20 meters, and one (the most distant) was found at 41 meters. With such a small sample size of incidents, it is tentative to speculate on a pattern of carcass locations, however the 50 meter survey area appears to be sufficient for finding all carcasses.

Table 7. Number of incidents per species versus distance from met tower

Species (All Medium Sized)	Distance Range (m)						Grand Total
	1-10	11-20	21-30	31-40	41-50	>51	
Mourning Dove			1		1		2
Loggerhead Shrike			1				1
Red-winged Blackbird		1	1	1			3
Western Meadowlark			1	1			2
Grand Total		1	4	2	1		8

3.3.2 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. 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. Seventy-five percent (75%) of incidents (Table 8) were found north to east of the met towers, while wind direction for 61% of surveys where wind direction was recorded, was from the opposite direction, from the south to west southwest.

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

Compass Bearing	# Incidents				Total Incidents	
	Loggerhead Shrike	Mourning Dove	Red-winged Blackbird	Western Meadowlark	#	%
N			1	1	2	25.0
NE			1		1	12.5
ENE				1	1	12.5
E		1	1		2	25.0
NW		1			1	12.5
NNW	1				1	12.5
Grand Total	1	2	3	2	8	100.0

4.0 DISCUSSION

This report details 15 months results of a pre-construction study of fatalities found at the Hamilton Ranch temporary meteorological tower. This is one of three fatality studies being conducted concurrently at met towers installed in the Collinsville Montezuma Hills Wind Resource Area (CMHWRA). The Hamilton met tower study, along with the adjacent Shiloh I and II met tower studies, will provide an expanded opportunity to examine and compare the impact of temporary met towers on the avian fauna in the CMHWRA.

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

Attribute or Metric	Shiloh I	Shiloh II	Hamilton Ranch
Number of Met Towers	4	10 (av. 9.43)	1
Height (AGL)	50m	50m (4), 60m (6)	50m
Average Number** of Months Surveyed (used for calculations)	23.4	24.7**	15
Study Dates	May 16, 2006 – April 28, 2008	February 22, 2006 – April 29, 2008	February 6, 2007 – April 29, 2008
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	35	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.

** Two sets of 5 met towers at Shiloh II were surveyed for different numbers of months, together averaging 24.7 months, used for fatality rate calculations: towers 732, 733, 734, 734, 738 were surveyed ~26 months, and towers 724, 736, 737, 739, and 740 were surveyed ~23 months.

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: Brewer's Blackbird (3), Dark-eyed Junco (1), European Starling (1), Horned Lark (6), 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 species overlapping between sites were American Pipits, Killdeers, Mourning Doves, Rock Pigeons (not present at Hamilton), Red-winged Blackbirds, and Western Meadowlarks.

The number of incidents per species is low at this time, so conclusions about differences in fatality rates will be limited to comparing larger sample sizes by lumping species into species groups (Table 11).

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

Species	Shiloh I		Shiloh II		Hamilton	
	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr
American Kestrel	1	0.1280				
American Pipit	1	0.1280	4	0.2064		
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	0.1280	1	0.0516		
Lincoln's Sparrow	1	0.1280				
Loggerhead Shrike					1	0.8000
Mourning Dove	2	0.2560	6	0.3096	2	1.6000
Pacific-Slope Flycatcher			1	0.0516		
Red-winged Blackbird	6	0.7679	9	0.4645	3	2.4000
Rock Pigeon	1	0.1280	7	0.3613		
Savannah Sparrow			3	0.1548		
Western Meadowlark	4	0.5119	5	0.2580	2	1.6000
White-crowned Sparrow			1	0.0516		
Unidentified Passerine	1	0.1280				
Unidentified Sparrow			1	0.0516		
Unidentified Swallow	1	0.1280				

Species	Shiloh I		Shiloh II		Hamilton	
	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr
Total	20	2.5596	51	2.6320	8	6.4000

When comparing fatality rates of species groups, we see dramatic differences between sites (Table 11), however numbers are still low at this time, and do not take into account variables which may need to be factored into the equation, like scavenger removal of carcasses and searcher efficiency. Looking at unadjusted fatality rates between sites, the highest rate of passerine fatality, with approximately 2.5 times the rate occurring at either of the two other sites, occurred at Hamilton (4.80 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 (1.92 birds/tower/year). Other birds (doves and pigeons) were found in the greatest numbers at Shiloh II, however due to two doves 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 a 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 I (23.4 months of surveys), Shiloh II (24.7 months), and Hamilton Ranch (15 months), found during standardized surveys

Species Group	Shiloh I		Shiloh II		Hamilton	
	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr
Raptor	1	0.1280	1	0.0516		
Water Bird	1	0.1280	2	0.1032		
Other Bird	3	0.3839	13	0.6709	2	1.6000
Passerine	15	1.9197	35	1.8063	6	4.8000
Grand Total	20	2.5596	51	2.6320	8	6.4000

4.2 Met Tower Height and Guy Wire Configuration

The single 50 meter tall met tower at Hamilton Ranch differs from towers in the neighboring Shiloh II and Shiloh I study sites, which do not have coils on the guy wires. Differences between met tower structures at the three sites are given in Table 12. The Hamilton met tower is equipped with coils on the guy wires to deter flight through the wires, and to prevent bird collisions. Of the ten met towers at Shiloh II, four were 50 meters tall and six were 60 meters tall. The 50 meter towers were equipped with 4 sets of 6 guy wires while the 60 meter towers were equipped with 4 sets of 7 guy wires. The four Shiloh I met towers and single Hamilton met tower were all 50 meters tall with sets of 6 guy wires on each of four sides, for a total of 24 guy wires.

Table 12. Height and guy wire configuration for each met tower in the Hamilton, Shiloh II and Shiloh I Project Areas.

Tower #	Met Tower Height (m)	# Guy Wires	Guy Wire Coverings
<u>Hamilton Ranch</u>			
HAM MET	50	4 sets of 6 guy wires	coils ~ 12-15 feet on every wire
<u>Shiloh II</u>			
724	50	4 sets of 6 guy wires	no flight deterrents
732	50	4 sets of 6 guy wires	no flight deterrents
734	50	4 sets of 6 guy wires	no flight deterrents
740	50	4 sets of 6 guy wires	no flight deterrents
733	60	4 sets of 7 guy wires	no flight deterrents
735	60	4 sets of 7 guy wires	no flight deterrents
736	60	4 sets of 7 guy wires	no flight deterrents
737	60	4 sets of 7 guy wires	no flight deterrents
738	60	4 sets of 7 guy wires	no flight deterrents
739	60	4 sets of 7 guy wires	no flight deterrents
<u>Shiloh I</u>			
MET A	50	4 sets of 6 guy wires	no flight deterrents
MET B	50	4 sets of 6 guy wires	no flight deterrents
MET C	50	4 sets of 6 guy wires	no flight deterrents
MET F	50	4 sets of 6 guy wires	no flight deterrents

As there was only one tower surveyed at Hamilton Ranch, determining whether height affects the fatality rate can only be extrapolated from analyses of data collected from adjacent areas, where multiple met towers of two different heights were conducted (Shiloh II). We analyzed the Shiloh II incident data to determine if met tower height affected the numbers of incidents found at towers (Table 13). We were not able to isolate the affect of the variable of tower height versus the variable of guy wire configuration. The guy wire configuration was standard for each height class of met tower. Therefore, the degree to which each of these variables attributed to the fatality rate at each tower height was not determined. However, the taller the met tower, the more extensive the network of guy wires required to support the structure and the greater the number of opportunities for flight paths within the area of tower footprint to intersect with guy wires. 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. We conducted chi-square tests for independence for the number of bird incidents (all species) detected at 50m and 60m towers at Shiloh II.

We found a significant deviation from the expected number of bird incidents between 50m and 60m meteorological towers. Incidents were higher than expected at 60m towers (Yates₍₁₎ $\chi^2 = 5.11$, df = 1, P = 0.02, sig.).

There were significantly more incidents of “Other Birds” (Mourning Doves and Rock Pigeons) and passerines found at 60 meter towers than would be expected based on a random distribution. All but one of the 13 doves and pigeons were located at the 60 meter towers (with a ratio of 1:12) while there were 6 times more songbirds at the 60 meter towers than the shorter towers. The numbers of raptors and water birds are too low to determine any trends.

Table 13. Comparison of the number of avian incidents to met tower height in meters (and guy wire configuration*) at Shiloh II met towers

	Number			Ratio	
	50m	60m	Total	50m	60m
Number of Surveys	430	645	1075	1	1.5
<i>Incidents</i>					
Raptor (owl)	1		1	1	0
Water Bird (moorhen, killdeer)		2	2	0	2
Other Bird (dove, pigeon)	1	12	13	1	12
Passerine	5	30	35	1	6
Grand Total	7	44	51	1	6.3

* Towers of similar height had similar guy wire configuration: 50m towers were equipped with 4 sets of 6 guy wires while 60m towers were equipped with 4 sets of 7 guy wires. These two variables were not separated.

The number of incidents 50 meter towers at Shiloh II is 6 times less than the rate at the 60 meter towers. Given that there were 3 times as many birds killed per met tower per year at the 50 meter Hamilton Ranch met tower than at Shiloh II, it is not unreasonable to suggest that a 60 meter met tower at the Hamilton site would yield even higher fatality rates.

Factors other than tower height have influenced the differences in fatalities between met towers. Site attributes may be responsible for the difference in the relative abundance and use of a site by birds and bats. For example, recollections of one member of the survey team for the High Winds Project which is adjacent to the Hamilton Ranch met tower site recalls that the Hamilton ranch site provided multiple perching structures, a permanent water supply, grain set out for sheep and sheep dung provided an attractant to insects. Consequently, there were lots of blackbirds and pigeons observed on the property. The 2005-2006 rainy season was extraordinarily wet, while 2006-2007 was unusually dry which would affect vegetation and food abundance. This 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, making this site an attractant during drier years.

4.3 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 the post-construction site, 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 Shiloh I site for the study period was 2.93 birds per wind turbine per year (Table 14). The fatality rate at met towers at Shiloh I 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 at Shiloh I, 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 14. 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		Meteorological Towers	
	April 10, 2006 – April 14, 2008		May 16, 2006 – April 14, 2008	
Species Group	# Incidents	# Incidents /Tower/Yr	# Incidents	# Incidents /Tower/Yr
<i>Bird Species</i>				
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.	<u>1</u>	<u>0.0099</u>	<u>0</u>	<u>0</u>
<i>Subtotal Bird Species</i>	295	2.9299	20	2.6109
<i>Bat Species</i>				
<i>Subtotal Bat Species</i>	90	0.8939	0	0
Grand Total	385	3.8238	20	2.6109

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

In order to best test for differences between fatalities at met towers and turbine towers, we chose to control for geographic location. Rather than compare the number of incidents/met tower vs. the number of incidents/turbine across the entire wind project, we conducted chi-square tests for independence for the number of incidents at met towers vs. adjacent turbine towers.

There were 4 searched met towers at which we found 18 bird incidents and 0 bat incidents. There were 7 turbines adjacent to these met towers, at which we found 27 bird incidents and 8 bat incidents. We found no significant deviation from the expected number of bird incidents between met towers and adjacent turbines (Yates $\chi^2 = 0.02$, $df = 1$, $P = 0.90$, ns).

The number of bat incidents at these towers was too low to conduct a meaningful test. However, wind projects in North America with noteworthy numbers of bat incidents have similarly

reported a lack of such incidents at met towers. It is highly likely that bats do not suffer collision fatalities with met towers in any significant numbers.

The monitoring of the met towers shows that guyed met towers are not without impact but that the impact is not biologically significant and no threatened or endangered species were involved. Guyed met towers are generally replaced by free-standing 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 B. HAMILTON RANCH WILDLIFE INCIDENT REPORT DATA SHEET.

**HAMILTON RANCH
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: _____ Infestation Activity: ___ Yes ___ No
___ 1 - Fresh _____ Fly Larvae (maggots) _____
___ 2 - Decomposing (early stage) _____ Adult Flies _____
___ 3 - Decomposing (late stage) _____ Beetles _____
___ 4 - Desiccated _____ Ants _____
___ 5 - N/A _____ Other _____

Eyes: ___ N/A ___ Round, Fluid Filled ___ Partially Dehydrated ___ Flat ___ Sunken ___ Amorphous/Empty

Other Field Notes: _____

APPENDIX C. LIST OF 8 INCIDENTS FOUND DURING STANDARDIZED SURVEYS AT TEMPORARY METEOROLOGICAL TOWERS S AT HAMILTON RANCH, FEBRUARY 6, 2007- APRIL 29, 2008.

ID#	Report Date	Estimated Month Death	Species Name	Species Group	Met Tower	Dist (m)	Deg (GN)*	Days Since Death
FPL-06-07	8/6/2007	July	Mourning Dove	Dove	HAM MET	26	310	7
FPL-01-08	3/19/2008	March 08	Mourning Dove	Dove	HAM MET	41	84	7
FPL-03-07	5/14/2007	May	Loggerhead Shrike	Passerine	HAM MET	21	334	7
FPL-01-07	5/7/2007	May	Red-winged Blackbird	Passerine	HAM MET	39	44	7
FPL-04-07	7/23/2007	July	Red-winged Blackbird	Passerine	HAM MET	12	354	7
FPL-07-07	11/14/2007	Nov	Red-winged Blackbird	Passerine	HAM MET	29	94	7
FPL-02-07	5/14/2007	May	Western Meadowlark	Passerine	HAM MET	27	6	7
FPL-05-07	7/23/2007	July	Western Meadowlark	Passerine	HAM MET	32	72	7

* Degrees Geographic North represents degrees from tower to carcass.