Report of Additional Wind Turbine Hazard Ratings in the Altamont Pass Wind Resource Area by Two Members of the Alameda County Scientific Review Committee

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Following a recommendation of the Alameda County Scientific Review Committee (SRC), the County of Alameda and some of the wind companies in the Altamont Pass Wind Resource Area (APWRA) arranged for two members of the SRC to rate hazard levels of wind turbines not previously rated by the SRC.[1] We developed a data sheet, which was finalized with SRC and public input. The Alameda County Avian Monitoring Team prepared maps of wind turbines previously rated and not yet rated. They also identified wind turbine strings that were previously rated but which warranted another look due to new information, such as new wind turbine arrangements due to removals or insertions, or due to additional fatalities since the SRC's first ratings.

METHODS

The data sheet we used and its data field definitions are presented in the Appendix. Once in the field, we quickly revised our rating approach, opting to rate turbines in 0.5-point increments from 7 to 10 but rating all other turbines < 7. We realized early on that assigning more specific values to turbines rated < 7 would have taken much too long and would have introduced false precision. We adopted a rating system that we felt comfortable with and that enabled us to complete the task in a reasonable timeframe.

We did not visit every wind turbine that was previously unrated. The rating process was too time-consuming to rate all the unrated turbines, so we often skipped wind turbines in strings that were incompletely rated by the SRC in 2007. In some cases during the 2007 visit, the SRC recorded turbine ratings at hazardous sites along strings and did not record ratings for portions of strings considered to be less- or non-hazardous. Thus, in many cases we assumed that unrated turbines in previously visited strings would have been rated low by the SRC, or that they were rated low by default. However, unrated turbines in previously visited strings were visually scanned for changes in the string since 2007, such as turbine removals that result in gaps in the string. Where these types of potentially hazardous situations were observed, these turbines were rated.

Most of the vacant addresses were not rated, but we did rate some of the vacant addresses owned by Altamont Winds, Inc. We rated AWI's vacant addresses on request from AWI, so the tallies of ratings should be interpreted with these ratings in mind. Other vacant addresses were not

[1] See Alameda County SRC (Smallwood, K. S., S. Orloff, J. Estep, J. Burger, and J. Yee). December 11, 2007. SRC selection of dangerous wind turbines. Alameda County SRC document P-67. 8 pp. http://www.altamontsrc.org/alt_doc/p67_src_turbine_selection_12_11_07.pdf

rated, so if the wind companies plan to relocate wind turbines to those addresses in the future, we recommend consulting with the SRC regarding hazard levels.

We note that we were routinely advised of burrowing owl fatalities, but to be consistent with the first SRC ratings, we did not consider burrowing owl fatality records in our ratings. The Tier classification of Smallwood and Spiegel (2005) remains the only ratings of turbines that factored in burrowing owl fatalities. Also, some of our ratings were based solely on fatality records of golden eagle, red-tailed hawk, and American kestrel because we observed no other factors that would normally have influenced our ratings. In other words, we encountered fatality patterns that did not fit our conceptual models of collision mechanisms. Notable situations included wind turbines on knolls and hilltops on the east slope of the APWRA, north of the AES Altech site and south of the Buena Vista site. Another pattern included red-tailed hawk and golden eagle fatality clusters on the north sides of hilltops.

In other cases when we encountered fatality clusters that did not make sense to us based on topography, we sometimes rated turbines moderately high where we predicted golden eagles would pass through the string or where we felt that American kestrels or red-tailed hawks would frequently hover or kite. We also sometimes did not rate the turbines highly, but instead made notes on the data sheets stating our concern about the turbine string.

We sometimes assumed that fatalities assigned to one turbine likely were caused by a neighboring turbine because the neighboring turbine exhibited topographic or other features we normally associate with greater collision hazard. We assume that wind turbines attributed to fatalities are often incorrect because many of the old-generation wind turbines are located very close together.

RESULTS AND DISCUSSION

The wind turbine's position on the landscape factored into all of the SRC ratings of 10, nearly all of the ratings of 9 and 9.5, and most of the ratings of 8 and 8.5 (Table 1). The wind turbine's location relative to other wind turbines and to other non-turbine structures often contributed further to ratings of 8, 8.5, and 9. Wind turbine ratings of 7 and 7.5 appeared to be affected by all factors considered, but most often by landscape feature followed by the turbine's location relative to other wind turbines and other non-turbine structures, whether fatalities were documented, and neighboring turbine status (Table 1). Detailed breakdowns of ratings by factors considered are summarized in Tables 2 through 6.

Perhaps the most common factors contributing to hazardous turbine ratings were ridge saddles and breaks in slope, especially for the higher ratings (Tables 4 and 5). The only remedy for these ratings would be to relocate or remove the turbines associated with these slope features.

Of the turbines rated 7 or 7.5, 134 (21%) could be considered less than 7 by simply changing the status of its neighboring turbine(s) or by moving the turbine away from vacant towers or from empty addresses. For these turbine ratings, landscape features were not considered particularly hazardous and other structures were not located nearby except for a few met towers. Nearness to electric distribution poles contributed to many ratings of at least 7 (Table 6), especially when we

observed that American kestrel fatalities had been documented at the turbine, so another way to reduce many SRC ratings would be to underground the distribution lines.

We note that we assigned greater hazard to wind turbines next to vacant towers than we did to vacant addresses, and in some cases we saw vacant addresses as a lessening of the hazard level we would have otherwise assigned. Also, it should be kept in mind that NextEra provided us with a longer history of fatality records at their wind turbines than was available for other wind turbines, so we warn that in cases where fatality records influenced our ratings, our ratings of NextEra's turbines may have been biased higher than our ratings of turbines owned by other companies.

RECOMMENDATIONS

In our opinion, wind turbines we rated 9 to 10 warrant removal and no further consideration of turbine operations at these sites. These are wind turbines that we confidently concluded pose the greatest collision hazard to three of the target species. Turbines we rated 8 and 8.5 warrant relocation to safer situations, unless there are mitigating circumstances. We are confident that sites rated 8 and 8.5 are relatively more hazardous than most turbine sites, but if tradeoffs are necessary, these turbine sites might be considered for continued turbine operations, if for example, the turbines are unique or for some reason cannot be relocated. Turbines rated 7 and 7.5 often warrant local adjustments of turbine layouts and operations within the string, or in some cases a conversation with the SRC about how to mitigate the hazardous situations they are associated with.

ACKNOWLEDGEMENTS

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Table 1. Summary of SRC ratings of wind turbines by major factors, including whether fatalities were documented, the status of neighboring turbines, location relative to other wind turbines, landscape feature, and whether the turbine was near other structures such as electric distribution poles, transmission towers, met towers, litter control fence, trees, or artificial rock piles.

SRC rating	No. of turbines	Fatalities		Neighboring turbine status		Turbine location relative to other turbines		Position on landscape		Near other structures	
		No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
<7	1,839	189	10.3	103	5.6	471	25.6	139	7.6	524	28.5
7	344	102	29.7	77	22.4	123	35.8	155	45.1	108	31.4
7.5	320	116	36.3	49	15.3	126	39.4	206	64.4	101	31.6
8	158	58	36.7	30	19.0	70	44.3	123	77.9	46	29.1
8.5	66	24	36.4	11	16.7	28	42.4	47	71.2	25	37.9
9	19	8	42.1	3	15.8	10	52.6	18	94.7	8	42.1
9.5	2	1	50.0	1	50.0	0	0.0	1	50.0	1	50.0
10	7	2	28.6	0	0.0	7	100.0	7	100.0	6	85.7
Total	2,755	500	18.2	274	10.0	835	30.3	696	25.3	819	29.7

Table 2. Summary of SRC ratings of wind turbines by neighboring turbine status, including whether located next two address gap (missing turbine and tower), non-address gap (e.g., wider-than-average spacing between turbines), any kind of gap, vacant tower (turbine missing), broken turbine, address gaps on both sides, or next to a vertical gap such as found in wind walls.

SRC rating	Next to address gap		Next to non-address gap		Next to gap of any kind		Next to vacant tower		Next to broken turbine		Address gaps both sides		Next to vertical gap	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
<7	78	4.2	13	0.7	0	0.0	6	0.3	1	0.1	5	0.3	1	0.1
7	58	16.9	0	0.0	1	0.3	13	3.8	0	0.0	7	2.0	1	0.3
7.5	40	12.5	3	0.9	0	0.0	3	0.9	1	0.3	3	0.9	0	0.0
8	18	11.4	0	0.0	1	0.6	6	3.8	0	0.0	6	3.8	0	0.0
8.5	8	12.1	0	0.0	0	0.0	2	3.0	1	1.5	1	1.5	0	0.0
9	2	10.5	0	0.0	0	0.0	0	0.0	0	0.0	1	5.3	0	0.0
9.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0	0	0.0
10	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	204	7.4	16	0.6	2	0.1	30	1.1	3	0.1	24	0.9	2	0.1

Table 3. Summary of SRC ratings of wind turbines by location relative to other turbines, including whether the turbine was at the end of the row, isolated from other turbines, in a low-density turbine field, or at the edge of the turbine field. Also, ratings are summarized by whether the turbine is near water or a natural rock formation.

SRC rating	End-row		Isolated		Low density		Edge of turbine field		Near water		Near natural rock formation	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
<7	359	19.5	14	0.8	50	2.7	128	7.0	27	1.5	4	0.2
7	114	33.1	8	2.3	5	1.5	9	2.6	6	1.7	1	0.3
7.5	92	28.8	2	0.6	12	3.8	36	11.3	12	3.8	2	0.6
8	64	40.5	3	1.9	10	6.3	9	5.7	5	3.2	1	0.6
8.5	18	27.3	0	0.0	6	9.1	11	16.7	2	3.0	0	0.0
9	7	36.8	1	5.3	2	10.5	2	10.5	1	5.3	1	5.3
9.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
10	6	85.7	1	14.3	4	57.1	4	57.1	1	14.3	0	0.0
Total	660	24.0	29	1.1	89	3.2	199	7.2	54	2.0	9	0.3

Table 4. Summary of SRC ratings of wind turbines by landscape setting, including whether the turbine is located at a break in slope (e.g., notch, bench, dip), a steep slope, within a valley feature, or within a ridge saddle.

SRC rating	Break in slope		On steep slope		Upper aspect of steep slope		In valley		Upper aspect of valley		In saddle		Saddle at apex of concave slope facing prevailing wind	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
<7	23	1.3	16	0.9	13	0.7	19	1.0	2	0.1	34	1.8	2	0.1
7	31	9.0	13	3.8	7	2.0	28	8.1	4	1.2	38	11.0	0	0.0
7.5	38	11.9	17	5.3	10	3.1	27	8.4	1	0.3	62	19.4	19	5.9
8	30	19.0	30	19.0	8	5.1	24	15.2	5	3.2	35	22.2	15	9.5
8.5	7	10.6	1	1.5	2	3.0	4	6.1	2	3.0	14	21.2	17	25.8
9	5	26.3	1	5.3	1	5.3	3	15.8	0	0.0	6	31.6	3	15.8
9.5	0	0.0	0	0.0	0	0.0	1	50.0	0	0.0	0	0.0	0	0.0
10	1	14.3	0	0.0	0	0.0	1	14.3	1	14.3	3	42.9	2	28.6
Total	135	4.9	78	2.8	41	1.5	107	3.9	15	0.5	192	7.0	58	2.1

Table 5. Summary of SRC ratings of wind turbines by landscape setting, including whether the turbine was located on the upper slope of a ridge saddle, at the top of a trough-like slope facing a prevailing wind direction, or whether located on a slope facing south, southwest, west, or northwest.

SRC rating	Upper aspect of saddle		Upper aspect of saddle atop concave slope feature facing prevailing wind		Atop trough-like slope facing prevailing wind		South slope		Southwest slope		West slope		Northwest slope	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
<7	12	0.7	0	0.0	3	0.2	0	0.0	0	0.0	0	0.0	0	0.0
7	29	8.4	0	0.0	3	0.9	0	0.0	11	3.2	0	0.0	0	0.0
7.5	25	7.8	1	0.3	8	2.5	2	0.6	10	3.1	4	1.3	0	0.0
8	7	4.4	0	0.0	1	0.6	1	0.6	2	1.3	2	1.3	1	0.6
8.5	1	1.5	0	0.0	3	4.5	0	0.0	1	1.5	1	1.5	0	0.0
9	2	10.5	0	0.0	0	0.0	2	10.5	1	5.3	1	5.3	0	0.0
9.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
10	1	14.3	0	0.0	0	0.0	0	0.0	0	0.0	1	14.3	0	0.0
Total	77	2.8	1	0.0	18	0.7	5	0.2	25	0.9	9	0.3	1	0.0

Table 6. Summary of SRC ratings of wind turbines by other structures, such as electric distribution poles, transmission towers, met towers, litter control fence, trees, and artificial rock piles.

SRC rating	Near distribution pole		Near transmission tower		Near met tower		Near litter fence		Near tree(s)		Near artificial rock pile	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
<7	361	19.6	74	4.0	49	2.7	0	0.0	23	1.3	80	4.4
7	70	20.3	23	6.7	7	2.0	3	0.9	5	1.5	13	3.8
7.5	67	20.9	17	5.3	11	3.4	0	0.0	15	4.7	18	5.6
8	27	17.1	13	8.2	6	3.8	0	0.0	2	1.3	8	5.1
8.5	19	28.8	3	4.5	0	0.0	1	1.5	3	4.5	3	4.5
9	1	5.3	2	10.5	1	5.3	1	5.3	2	10.5	3	15.8
9.5	1	50.0	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0
10	1	14.3	2	28.6	1	14.3	0	0.0	2	28.6	3	42.9
Total	547	19.9	134	4.9	75	2.7	5	0.2	52	1.9	129	4.7

					Position in turbine row								Location			Terrain							Near features							
Str	Turb	Score	St	F	E	G_a	${}_aG_a$	G_n	${}_aG_n$	B_t	V_t	G_v	I	L_o	E_{dg}	Sd	Sd_u	B_s	S	S_u	V	Asp	Wa	Tr	Ro	T	D	L	O	Note

Notes (by number indicated on front of sheet)

Key to column headings:

Str	String number
Turb	Turbine number
Score	Score (1-10)
St	Status of turbine [√ for operational, BT for broken turbine, VT for vacant tower, VA for vacant address]
F	Fatality record(s); also indicate if monitored (M) or unmonitored (U)

Position in turbine row

E	End of row [write No. of turbine from end of row when near end of row]
G_a	Next to address gap
${}_aG_a$	Next to 2 address gaps
G_n	Next to non-address gap
${}_aG_n$	Next to 2 gaps, any kind
B_t	Next to broken turbine
V_t	Next to vacant tower
G_v	Vertical gap in wind wall

Location in wind farm

I	Relatively isolated
L_o	Low turbine density
E_{dg}	Edge of turbine field

Terrain

Sd	Ridge saddle [write a for 'Saddle at apex of concave slope facing prevailing wind']
Sd_u	Upper slope of ridge saddle
B_s	Notch, bench, or other break in slope
S	On steep slope
S_u	Uphill edge of steep slope
V	In ravine or canyon (write e for edge of ravine or canyon)
Asp	slope aspect: 5 = south, 6 = southwest, 7 = west, 8 = northwest

Near features

Wa	Write meters from nearby pond or stream
Tr	Write meters from nearby tree(s)
Ro	Write meters from nearby rocks, and a = artificial rock pile, n = natural rock formation, and an for both artificial and natural rock formations
TT	Write meters from nearby transmission towers
D	Write meters from nearby distribution pole
L	Write meters from nearby litter control fence
O	Write meters from nearby other perch structures

Note Number corresponding with note on back of sheet