Power analysis to determine sample size for blade painting study
by Julie Yee

Revision 13NOV07: This repeats the analysis described in P57 and P57b (see Method below) with the following changes:
1) Use fatality rates based on South-side turbines (see "fatality rates" sheet).
2) Corrected an error (typo) in Sep program that could have led to incorrectly inflated powers; this error affected the power estimates for only the wintertime shutdown (Sep 18 version).
3) Assume 15 WEG turbines treated and 5 WEG controls (as per AWI 10/19/07 version of blade painting design)
4) New acronyms for combined species:
   --> AGR = AMKE + GOEA + RTHA
   --> ABGR = AMKE + BUOW + GOEA + RTHA
5) Calculate power for other significance levels (α=0.05, 0.10, and 0.15)
6) To save computing time, I restricted to the following scenarios:
   a) sample sizes (170 painted and 136 controls; 250 painted and 150 controls)
   b) od=1.3

Revision 18SEP07: This analysis follows the same methods as in document P57 (described below) with several changes:
1) Calculate powers for all species combined, and combined species excluding BUOW.
2) Simulate new data incorporating a 4-month winter shutdown of all turbines. Shutdown effects differ by species and also by whether the turbine blades lock or feather. The estimated shutdown effects used for the simulation were pulled from documents M16d and M16e. Out of the 17 months in the projected study period (July 2008 - Nov 2009), 5 months fall in winter (Nov-Feb) during this 17 month period. As a reminder, no recommendation has been made by the SRC regarding shutdown during the 2008-09 winter.
Additional changes to shutdown simulations:
   a) Assume 13 WEG turbines (250kW) are painted and 7 are controls. Only the WEGs lock.
   b) Add in a scenario for 25% reduction.
   c) Add in a 1.3 level of overdispersion as another data point.

Method: Fatality numbers per turbine and monthly survey were randomly simulated using various sample sizes, overdispersions, and actual reductions (see below). Assuming monthly surveys from July 2008 through November 2009 (17 months) and up to 400 turbines, there were 6800 turbine searches simulated per each dataset simulation. Each simulated dataset was statistically analyzed to determine the probability, or power, of detecting a statistical difference between painted and non-painted blades, given that a specified effect was actually occurring (10%, 30%, or 50% reduction). This power was calculated from 200 iterations of simulating and analyzing datasets. This was repeated for various sample sizes to determine which sample sizes would achieve a high power of detection. Several rates of dispersion were also simulated.

Mean rates of deaths: see "fatality rates" sheet

Numbers of turbines: Two variations on the sample size were simulated:

# control turbines	# painted turbines
136	170
250	150

Overdispersion: 1.3

Actual reduction: The probability of detecting a reduction depends on the actual reduction. Large reductions (such as 50%) are more likely to be detected than small reductions (such as 10%). Three levels of actual reductions were simulated:

Actual reductions
25%
30%
40%
50%

Worksheets: The following tables are contained in this file:

1. FATALITY RATES
   Fatality rates used in 12NOV07 revision of power analysis, plus comparison of rates with those used in Sep 2007 versions of power analysis.
2. SHUT_ALPHA05
   Probability (power) of finding a statistically significant reduction in fatalities, based on 4-month winter shutdown (plus a fifth month for Nov 09). Test at α=0.05 significance level.
3. NOSHUT_ALPHA05
   Probability (power) of finding a statistically significant reduction in fatalities, based on no winter shutdown. Test at α=0.05 significance level.
4. SHUT_ALPHA10
   Probability (power) of finding a statistically significant reduction in fatalities, based on 4-month winter shutdown (plus a fifth month for Nov 09). Test at α=0.10 significance level.
5. NOSHUT_ALPHA10
   Probability (power) of finding a statistically significant reduction in fatalities, based on no winter shutdown. Test at α=0.10 significance level.
6. SHUT_ALPHA10
   Probability (power) of finding a statistically significant reduction in fatalities, based on 4-month winter shutdown (plus a fifth month for Nov 09). Test at α=0.15 significance level.
7. NOSHUT_ALPHA10
   Probability (power) of finding a statistically significant reduction in fatalities, based on no winter shutdown. Test at α=0.15 significance level.

Fatality rates used in power analyses by Julie Yee

	fatalities per MW per YEAR				fatalities per MW per MONTH (divide yearly rates by 12)			
Source	AMKE	BUOW	GOEA	RTHA	AMKE	BUOW	GOEA	RTHA
Smallwood (CEC data)	1.02300	1.34800	0.12300	0.36500	0.08525	0.11233	0.01025	0.03042
Yee (MT data) 1	*0.77770*	*1.12860*	*0.09502*	*0.57430*	*0.06481*	*0.09405*	*0.00792*	*0.04786*
Yee (MT north data)	*0.36350*	*1.09740*	*0.11330*	*0.55650*	*0.03029*	*0.09145*	*0.00944*	*0.04638*
Yee (MT south data)	*1.24270*	*1.10950*	*0.07006*	*0.57680*	*0.10356*	*0.09246*	*0.00584*	*0.04807*

1 Yee estimates derived by Poisson model (such as in docs M16) and represent fatality rates prior to scavenging.

		counted fatalities per MW per MONTH			
	Source	AMKE	BUOW	GOEA	RTHA
	Smallwood (CEC data)	**0.08525**	**0.11233**	**0.01025**	**0.03042**
	Yee (MT data) 2	0.02160	0.03135	0.00739	0.04467
	Yee (MT north data)	0.01010	0.03048	0.00881	0.04328
Actual redu	Yee (MT south data)	**0.03452**	**0.03082**	**0.00545**	**0.04486**

2 Adjust Yee ests for scavenging by multiplying a factor of 0.33 to small raptors and 0.93 to large raptors.

Rates in bold used for blade painting power analyses. (Smallwood rates used in Sep 2007 power analyses.
Yee rates used in Nov 2007 power analysis)

There is a large difference between the Smallwood and Yee calculations for counted fatalities.
To provide at least some kind of a crude check on my calculations, I calculated the average counted fatalities per MW per survey. This is a crude approximation of monthly fatality counts, since the WEST and MT surveys were not always exactly one month apart. Based on the size of the crude rates, I decided to proceed with my south estimates.

	counted fatalities per MW per SURVEY			
North and South	0.01708	0.03743	0.01003	0.07583
North	0.01064	0.04745	0.01412	0.08941
South	0.02317	0.02796	0.00616	0.06299

				reduction			
species	ncontrols	ntreats	od	25%	30%	40%	50%
ABGR	136	170	13	0.335	0.450	0.775	0.950
ABGR	150	250	13	0.375	0.520	0.830	0.990
AGR	136	170	13	0.250	0.345	0.545	0.760
AGR	150	250	13	0.255	0.370	0.670	0.895
AMKE	136	170	13	0.075	0.095	0.195	0.320
AMKE	150	250	13	0.080	0.110	0.280	0.440
BUOW	136	170	13	0.160	0.205	0.395	0.565
BUOW	150	250	13	0.165	0.240	0.470	0.635
GOEA	136	170	13	0.010	0.010	0.005	0.010
GOEA	150	250	13	0.070	0.080	0.085	0.105
RTHA	136	170	13	0.160	0.210	0.355	0.550
RTHA	150	250	13	0.195	0.255	0.440	0.685

powers > 80% are highlighted bright yellow
powers > 50% are highlighted light yellow

				reduction			
species	ncontrols	ntreats	od	25%	30%	40%	50%
ABGR	136	170	13	0.325	0.515	0.770	0.945
ABGR	150	250	13	0.400	0.565	0.855	0.985
AGR	136	170	13	0.285	0.425	0.620	0.850
AGR	150	250	13	0.300	0.475	0.725	0.925
AMKE	136	170	13	0.115	0.150	0.290	0.490
AMKE	150	250	13	0.130	0.175	0.355	0.580
BUOW	136	170	13	0.145	0.180	0.305	0.445
BUOW	150	250	13	0.160	0.210	0.355	0.510
GOEA	136	170	13	0.010	0.010	0.005	0.010
GOEA	150	250	13	0.070	0.080	0.085	0.105
RTHA	136	170	13	0.180	0.240	0.430	0.600
RTHA	150	250	13	0.195	0.280	0.495	0.710

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				reduction			
species	ncontrols	ntreats	od	25%	30%	40%	50%
ABGR	136	170	13	0.455	0.605	0.860	0.970
ABGR	150	250	13	0.485	0.635	0.910	0.995
AGR	136	170	13	0.360	0.445	0.665	0.860
AGR	150	250	13	0.370	0.505	0.765	0.940
AMKE	136	170	13	0.150	0.195	0.320	0.475
AMKE	150	250	13	0.160	0.205	0.375	0.560
BUOW	136	170	13	0.240	0.340	0.510	0.685
BUOW	150	250	13	0.280	0.360	0.535	0.700
GOEA	136	170	13	0.065	0.070	0.060	0.070
GOEA	150	250	13	0.095	0.115	0.145	0.165
RTHA	136	170	13	0.255	0.365	0.540	0.705
RTHA	150	250	13	0.295	0.375	0.570	0.755

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				reduction			
species	ncontrols	ntreats	od	25%	30%	40%	50%
ABGR	136	170	13	0.490	0.600	0.885	0.960
ABGR	150	250	13	0.520	0.675	0.920	0.990
AGR	136	170	13	0.390	0.490	0.745	0.910
AGR	150	250	13	0.445	0.575	0.830	0.960
AMKE	136	170	13	0.180	0.250	0.420	0.625
AMKE	150	250	13	0.225	0.275	0.500	0.705
BUOW	136	170	13	0.230	0.295	0.445	0.590
BUOW	150	250	13	0.235	0.320	0.490	0.615
GOEA	136	170	13	0.065	0.070	0.060	0.070
GOEA	150	250	13	0.095	0.115	0.145	0.165
RTHA	136	170	13	0.255	0.365	0.540	0.705
RTHA	150	250	13	0.310	0.400	0.620	0.795

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				reduction			
species	ncontrols	ntreats	od	25%	30%	40%	50%
ABGR	136	170	13	0.545	0.685	0.895	0.985
ABGR	150	250	13	0.570	0.730	0.955	1.000
AGR	136	170	13	0.410	0.505	0.760	0.910
AGR	150	250	13	0.490	0.590	0.835	0.965
AMKE	136	170	13	0.195	0.245	0.400	0.575
AMKE	150	250	13	0.235	0.300	0.455	0.680
BUOW	136	170	13	0.340	0.420	0.550	0.730
BUOW	150	250	13	0.360	0.445	0.605	0.755
GOEA	136	170	13	0.105	0.120	0.135	0.135
GOEA	150	250	13	0.140	0.155	0.175	0.195
RTHA	136	170	13	0.355	0.425	0.605	0.750
RTHA	150	250	13	0.370	0.450	0.650	0.800

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				reduction			
species	ncontrols	ntreats	od	25%	30%	40%	50%
ABGR	136	170	13	0.545	0.690	0.915	0.965
ABGR	150	250	13	0.600	0.750	0.945	0.995
AGR	136	170	13	0.470	0.555	0.795	0.925
AGR	150	250	13	0.530	0.645	0.890	0.980
AMKE	136	170	13	0.235	0.310	0.495	0.690
AMKE	150	250	13	0.280	0.375	0.575	0.765
BUOW	136	170	13	0.280	0.350	0.490	0.630
BUOW	150	250	13	0.315	0.400	0.540	0.695
GOEA	136	170	13	0.105	0.120	0.135	0.135
GOEA	150	250	13	0.140	0.150	0.175	0.195
RTHA	136	170	13	0.365	0.465	0.615	0.770
RTHA	150	250	13	0.355	0.485	0.675	0.865

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