



Draft Sample Design and Field Methods For APWRA Adaptive Management Plan Research and Monitoring

September 2005
Preliminary Draft

The management goal for the APWRA is a significant and substantial reduction of fatalities of priority avian species within the APWRA. The short-term (i.e., 5 year) management objective is to reduce target raptor fatalities of target raptor species (golden eagle, red-tailed hawk, American kestrel and burrowing owl) by 45% through management actions including, but not limited to seasonal shut-downs, shutdown, removal and/or relocation of high risk turbines, removal of derelict turbines, electrical modifications, etc. Because of the uncertainty regarding the effectiveness of the proposed management actions in achieving the management objective, the initial management actions will be implemented in a stepwise fashion to achieve reductions in target raptor mortality.

Initial goals of the monitoring and research program are to evaluate the effectiveness of the seasonal shutdowns of wind turbines, and the relocation/shutdown of turbines considered high risk in reducing overall raptor mortality within the APWRA. Another goal of the monitoring and research program is to provide additional information regarding risk prediction within the APWRA to be used for directing future management actions, off-site mitigation and repowering. The monitoring and research program will be conducted for a minimum of three years. The monitoring and research program will consist of fatality searches, raptor use and behavior surveys, and prey base surveys. This document describes the primary hypotheses, experimental design and field methods. This document has not been independently peer reviewed, and is considered draft and preliminary until such a review is conducted.

Hypotheses


The monitoring and research program is designed to evaluate two primary hypotheses:

H₁: Shutting down large numbers of turbines during the winter period will substantially reduce equal mortality of target raptor species.


And,

H₁: Relocating turbines predicted as high risk because of their location to less risky locations and permanent shutdown and removal of predicted high risk turbines without relocating them can substantially reduce target raptor mortality within the APWRA.


These two hypotheses will be addressed and tested based on pre-management baseline avian behavior and fatality data collected between 1998 and 2003 (Smallwood and Thelander 2004a, 2004b), and new avian behavior and fatality data collected after

implementation of the management actions. Risk prediction is based substantially on models developed in Smallwood and Thelander (2004b), and Smallwood and Spiegel (2005a, 2005b, and 2005c). Testing of both hypotheses will be influenced by the adequacy of these risk predictions and fatality rate estimates. Data collected to test these hypotheses will also assist in the evaluation and improvement of the risk predictions. 

Overall Sample Design


The sampling design for testing these hypotheses can generally be characterized as a Before/After/Control/Impact Design (BACI, Anderson et al. 1999, Morrison et al. 2001), with fatality, avian use and behavior metrics and statistical models estimated prior to management actions compared to these metrics and models estimated after implementation of the management actions. In the case of the seasonal shutdown management action, the BACI design is combined with a cross-over experiment  and optimize this management action.

Sampling Universe

All turbines of participating companies within the APWRA were considered, with the exception of the Buena Vista turbines that are planned for repowering. This resulted in approximately 4,800 turbines available for study (i.e., sample universe). 

Primary Stratification of the APWRA

Two primary levels of stratification (geographic location and turbine size) were considered in designing the experiments for this monitoring and research study. The first stratification (geographical location) is used for the implementation of the seasonal shutdown management action and to provide some level of interspersion of the sample sites across the entire APWRA. The North/West Stratum includes turbines from participating companies located in the western portion of the area defined by: north of I-580 and north of Altamont Pass Road in both Alameda and Contra Costa County (Figure 1). The South/West and the South/West stratum consists of the western and eastern portions of the remaining turbines (Figure 1).

Turbine size was also considered to help balance sample sizes among different turbine sizes, and as an indirect result, provides some balanced representation among turbine types and turbine owners. Turbines were grouped into three levels of turbine size based on nameplate turbine size category. The three categories were: 

Very Small:	40-65 kW
Small:	100-150 kW
Medium:	≥ 250 kW



Sampling Blocks

All turbine strings were grouped into sampling blocks using a Geographic Information System (GIS). The number of turbines per block varied from approximately 10 to 60 turbines and 1 to 7 strings. Turbine strings were grouped into blocks based on turbine size and type, proximity of strings to each other (Figure 1). Samples of these turbine blocks are selected based on the sampling scheme below. All turbines within a selected block will be searched for fatalities during a given search day. This sampling approach (blocks of strings instead of individual strings) is more efficient and increases the time spent searching and subsequently decreases the time necessary to travel between search areas.

Sample Selection

A random sample (or census in some cases) of turbine blocks was selected within each of the combinations of stratum yielding approximately 2000 turbines in the sample for the first winter and 1600 for the remaining months of the first monitoring year (Table 1). Modifications to the sample size may be made in the 2nd year, depending on the results of the first year's monitoring, subject to review by the SRC. Fatality searches will be conducted at all turbines within the selected turbine blocks.

40-65 kW Turbines

All small turbines within the sample universe will be sampled during the first year (Table 1), which includes approximately 313 turbines in the North/East stratum (40 and 65 kW), and 449 in the South/East stratum (65 kW). The larger sample in the South/East stratum is being conducted at least for the first year because most of those turbines have been searched on systematic basis since January 2005, and this will allow for continuity and additional information.

100-150 kW Turbines

This category has the largest number of turbines, and includes primarily KCS 56-100 turbines on lattice towers, but also includes Danwin 110 kW turbines, Vestas V-17 and V-19 turbines, and Bonus 120 kW and 150 kW turbines. To ensure interspersed samples among turbine types and geographical areas within the APWRA, the following approach is used to sample from this stratum.

Approximately 550 turbines will be sampled in the North/East and North/West strata, and 550 turbines will be sampled in the South/East and the South/West strata during the winter period based on the random sample of turbine blocks identified in Figure 1. This will be decreased by approximately 1/3 during the remaining seasons (last 1/3 of turbines randomly selected).

Table 1. Approximate total number of turbines and turbines identified to be sampled within the North/West and North/East stratum (combined into North) and South/West and South/East stratum (South) within three turbine size classes. This selection process is subject to review and may change.

Size Class	<u>Approximate No. Sample Turbines</u>					
	Approximate No. Turbines Considered ^a		Winter Season		Non-Winter Season	
	North	South	North	South	North	South
Smallest (40 – 65 kW)	313	449	313	449	313	449
Small (100 – 150 kW)	2300	1654	550	550	360	360
Medium (250 – 400 kW)	108	37	108	37	108	37
Subtotal	2721	2140	971	1036	781	846

^a does not include turbines from non-participating companies or turbines at the Buena Vista site, which are planned to be repowered

> 250 kW Turbines

This stratum includes the WEG 250 kW turbines, KVS-33 400 kW turbines, and the Howden 330 kW turbines. All turbines of this size will be sampled year-round (Figure 1, Table 1) given the small number of turbines in this category. The Howden 330 kW turbines have been searched on a monthly basis since spring 2005.

Field Methods

Fatality Searches

To ensure comparable data, fatality searches will be conducted using a protocol similar to the one used by Smallwood and Thelander (2004b). Searches will be conducted within rectangular search plots with boundaries a minimum distance 50 m from the turbines within each selected sample block. Plots at the newer and larger turbines (≥ 660 kW) will be extended to 75 m to account for their larger size. To allow an estimate of total fatalities, carcass removal and carcass detection bias will be estimated following the methods described in (Erickson et. al. 2004). Searches will be conducted at each of the selected turbines on an approximately monthly basis. During set up (late September/early October) and an initial search at the end of October, all fatalities will be documented and removed for the start of the winter season and the seasonal shutdown experiment.

Avian Use and Behavior


Studies have previously quantified avian use and behavior within the APWRA (Orloff and Flannery 1992, Smallwood and Thelander 2004a,b). During this study, approximately 1 avian use and behavior station will be located and surveyed for every turbine block (every other block for Very Small turbines) selected for year-round fatality sampling, resulting in approximately 50 survey stations for documenting raptor use and behavior from 360° visual scan surveys. This number of stations results in approximately 1 station located every 1 square miles within the APWRA. An additional 10 stations will be located in association with areas where no turbines exist (reference sites). The final locations will be determined in the field, and will be established to ensure good viewsheds and proper identification of bird species near turbine strings, but far enough away from turbines to minimize observer bias.


The duration of each 360° visual scan will initially be set at 30-minutes. One to two visits to each survey point will be conducted each month during the monitoring period. Bird use and activity sampling effort will be stratified by time of day. Thus, behaviors will be divided between those observed during morning and afternoon sessions. The morning sessions start at 0700 hrs and continue until 1200 hrs. The afternoon sessions last from 1201 hrs until 1800 hours. Environmental conditions recorded at the beginning of each session include temperature, wind speed, and cloud cover. Surveys will not be conducted when the wind speed reaches more than 55 km/h.


Data recorded for each observation will follow similar methods used by Smallwood and Thelander (2004a, b). When raptors and large birds are detected, the corresponding information will be entered onto data sheets and maps using an alphanumeric coding system. The location of each bird or flock is marked sequentially on the map every minute. With a topographic map available for each observer on each plot and each session, the observer can plot sequential numbers onto the map corresponding with the locations of raptors observed at regular intervals (1-minute). Attributes will be associated with each plotted number including species, number of individuals seen, whether it is the same individual or group as previously recorded, specific behavior (e.g., soaring, contour hunting, “fly-through”), height above ground, and type of perch being used. If perching is observed, the time and specific perching structure will be recorded. Perching structures are grouped into four different categories according to their characteristics: (1) turbine devices, (2) electrical distribution poles, (3) metal/electrical towers, and (4) landscape features (e.g., rock piles, fences, etc.). After the observation session, these attributes will be entered into a computer spreadsheet. All plotted numbers which are linked to the attribute data will then be digitized and managed as a GIS database, and analyzed to test specific hypotheses that matter to this and other wind power projects.

Carcass Removal Studies

Carcass removal studies will be conducted throughout the monitoring year. Estimates of carcass removal will be used to adjust carcass counts for removal bias in overall fatality estimates, and will also be used to adjust the fatality data for differences in search


intervals from the pre-management  od and the post-management period. Carcass removal includes removal by predation or scavenging, or removal by other means.

During the first year of monitoring, approximately 20 bird carcasses will be distributed during the start of each of six trials, resulting in a total of approximately 120 trial carcasses used in carcass removal studies for the first year of monitoring. The start dates of each trial may be spread over a few days. However, the start dates of each trial should be at least 3 weeks apart. The resulting data will be evaluated to determine the need for this component of study in the subsequent monitoring years. Species such as rock doves, hen mallards, fresh raptors (those approved of by USFWS), and hen pheasants will be used  these carcasses will be randomly placed within 50 m of turbine strings that are not part of the sample for fatality searches or left as found if a fresh turbine fatality.


It is expected that carcasses will be checked as follows, although actual intervals may vary. Carcasses will be checked for a period of 60 days to determine removal rates. They will be checked approximately every day for the first 3 days, and then approximately every 4 to 6 days depending on schedules of other surveys. Experimental carcasses will be marked discreetly using a piece of tape on one leg for recognition by searchers and other personnel. Experimental carcasses will be left at the location until the end of the carcass removal trial. Any remaining trial carcasses will be removed at the end of the 60-day period. Comparisons of carcass removal rates will be made between raptors and other groups used (e.g., rock doves). 

Searcher Efficiency Studies



Searcher efficiency studies will be conducted in the same areas as carcass searches. Estimates of searcher efficiency will be used to adjust the number of carcasses found, correcting for detection bias.

Personnel conducting the searches will not know when trials are conducted or the location of the detection carcasses. During the first year of monitoring, approximately 20 bird carcasses will be distributed during the start of each of six trials, resulting in a total of approximately 120 trial carcasses used in carcass removal studies for the first year of monitoring. Species such as rock doves, hen mallards, and hen pheasants, and raptors will be used. 

All carcasses will be placed at random locations within areas being searched prior to the carcass search on the same day. If avian scavengers appear attracted to the placement of the carcasses, the carcasses will be distributed before dawn. Carcasses will be dropped from waist height.

Each trial carcass will be discreetly marked so that it can be identified as a study carcass after it is found. The number and location of the detection carcasses found during the carcass search will be recorded. The number of carcasses available for detection during each trial will be determined immediately after the trial by the person responsible for distributing the carcasses. 

Prey Base Studies

Ground squirrel and pocket gopher burrow system centroids (Smallwood and Thelander 2004b) will be mapped along a sample of 300-ft g transects that begin at the selected turbine and is orientated perpendicular to the turbine string orientation. Approximately every third turbine selected for fatality searches will be sampled to provide a characterization of prey densities for each turbine string. The resulting maps of burrow systems will be related to any observed spatial pattern of raptor fatalities as well as to the GIS database of raptor flight and perch locations. A survey of prey base will be conducted once per monitoring year on each sampled transect. 



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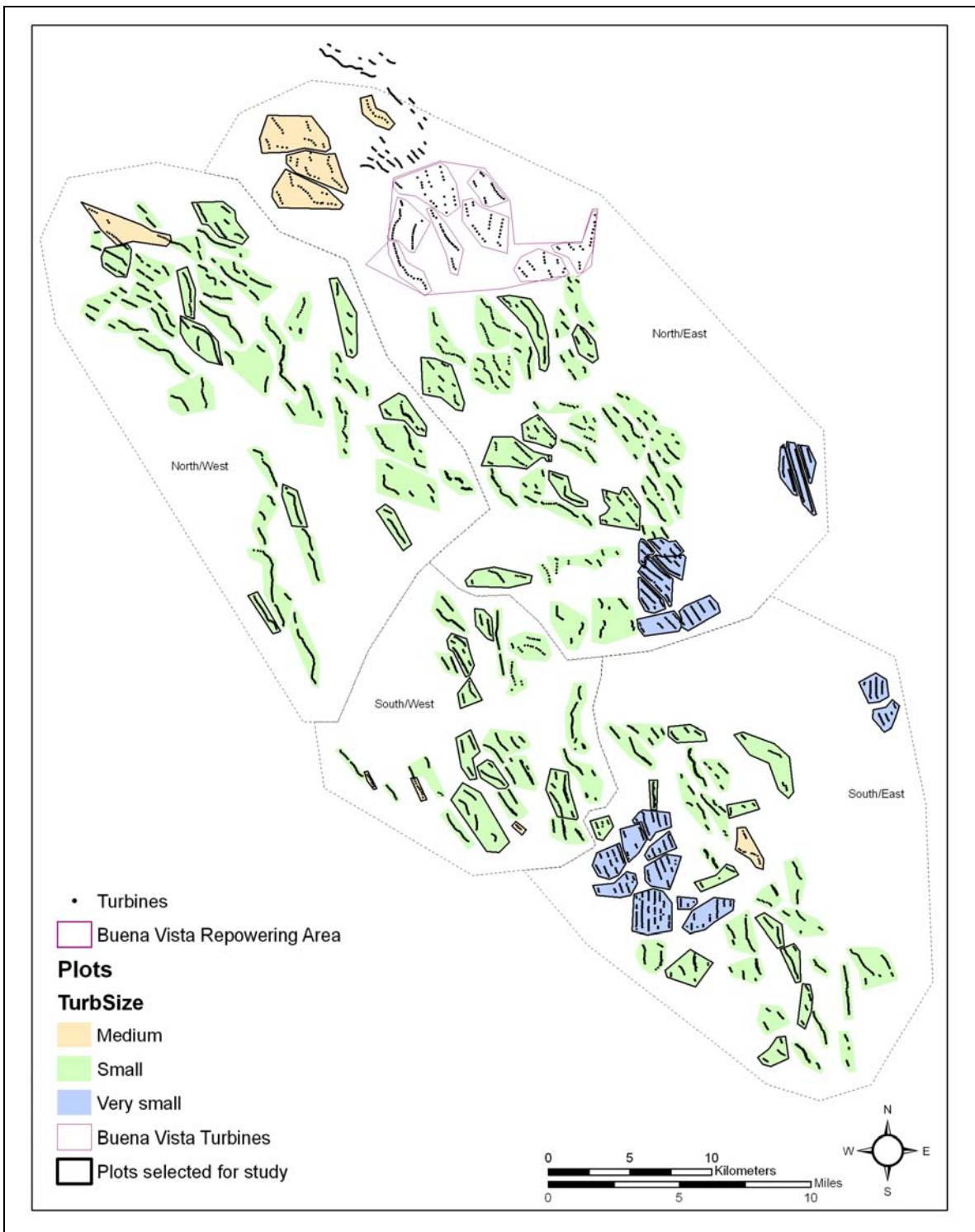


Figure 1. Location of turbine blocks within the sampling universe, and those tentatively selected for sampling.