Memorandum

Date:	November 9, 2010
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From:	Jesse Schwartz, Senior Analyst Doug Leslie, Project Manager
Subject:	**Implementation of the New Study Design in the First Quarter of the 2010 Bird-Year**

The Altamont Pass Wind Resource Area (APWRA) monitoring program is implemented by a Monitoring Team (MT) under advisement of the APWRA Scientific Review Committee (SRC). Potential revisions to the monitoring program (M52) were discussed in June and July of 2010 during in-person and conference call meetings between the SRC and the MT (P164, P169, & P170). Suggested revisions to the monitoring program were incorporated in revised designs (M53 and M53V2) and a draft Detailed Implementation Plan (DIP) for the October 2010–September 2011 bird-year (hereafter referred to as the 2010 bird-year) showing the specific turbines proposed for selection using criteria identified in the Study Plan was circulated for review.

The revised Study Plan and DIP for the 2010 bird-year were developed to help ensure that the specific monitoring locations were sufficient to evaluate long-term status and trends in avian fatality rates, and to effectively inform the repowering of the APWRA. During the first month of operations several new elements of the monitoring program were implemented on a conditional basis so that new techniques and procedures could be reviewed and adapted to the conditions of the APWRA and the logistical requirements of the monitoring resources. These outcomes were reviewed on a daily basis and have been used to update the work schedule and field protocols. The purpose of this memo is to provide the SRC and the public with more detailed information concerning how the sampling scheme was developed, what the current monitoring protocols are, and to provide a road map to the monitoring program.

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Operating Group Boundaries

Each turbine had been previously assigned to an *Operating Group* based on unique combinations of turbine type, project site, and owner/operator. These operating group designations have been used as a unit of aggregation for analysis and reporting. During August, 2010 the MT reviewed the table of turbine addresses using the database and geographic information systems (GIS). MT members participated in a workshop where all turbines were reviewed in terms of their spatial position and meta-data. Turbine meta-data and operating group identification (ID) were used to develop a Base Layer of Operating group Boundaries (BLOB).

Each BLOB ID includes a *distinct and discernible* set of turbines that are relatively close in space and share one or more operating group ID. They are essentially refined operating groups. Blobs were used to geographically stratify the sample design based on the techniques and recommendations outlined in the revised monitoring plan. Similarly, BLOB ID was used to order, organize, and schedule the search effort for the 2010 bird-year.

Turbine information and BLOB ID assignment were reviewed by interested parties in September of 2010. The revised turbine status, BLOB ID, and other meta-data were used to refine the 2010 bird-year sample design, and these changes were reflected in the Turbines table of the APWRA database as of October 15, 2010. The GIS shapefile of turbine location (including BLOB IDs) was also revised and can be made available to turbine owner/operators on request. The BLOBs have proven to be a useful unit of aggregation, and we have not encountered any difficulties in scheduling or deploying search teams within and across these collections of turbines.

Sampling Locations

Turbines represent the actual item of interest in the APWRA monitoring program. However, many turbines in the APWRA are tightly spaced and have overlapping search areas. These collections of turbines share a *String ID* and are always surveyed together on a single overlapping transect. The sampling design and search order for these old generation turbines is managed at the string level due to these logistical constraints.

For the past four years the MT has surveyed 46 strings in Contra Costa County which include 347 turbine addresses with a nameplate capacity of ~59 Megawatts (MW). The currently installed capacity of those addresses includes 256 turbines with a nameplate capacity of ~49 MW. These turbines were searched September 19, 2010.

The turbines in Contra Costa County were not included in the 2010 bird-year DIP because they are scheduled for removal for repowering during the current bird year. However, the SRC directed the MT to continue monitoring these locations until there was increased certainty surrounding the timing of the removal. Therefore, all strings in Contra Costa County that were part of the previous monitoring design were surveyed on October 20, 2010, and will continue to maintain a 30–35 search interval until they are removed or the monitoring plan is revised. Four strings (76, 79, 309, & 321.99) include turbines in both Alameda and Contra Costa Counties. These strings were treated as if they were in Alameda County in the 2010 bird-year DIP.

The MT selected a sub-sample of turbines to be monitored for the 2010 bird-year using randomization routines and the design requirements outlined previously (M52) as amended by the recommendations of the SRC (P170). The turbine strings were selected from the 2052 turbines that were monitored during the 2005–2009 period, as well as the 1177 turbines that have not been monitored over these past four years (Table 1). Turbine models 250kW, Polenko, V-47, and Windmatic were excluded from the 2010 bird-year design based on recommendations of the MT as modified by the SRC.

Table 1. Number of currently operational turbines that were and were not monitored during the 2005–2009 monitoring program in the Alameda County portion of the APWRA.

Turbine Model	Not Monitored	Monitored	Grand Total
250kW	0	20	20
Bonus	124	362	486
Enertech	0	133	133
Kenetech 56-100	977	994	1971
KVS 33	4	17	21
Micon	0	218	218
Nordtank	0	117	117
Polenko	0	12	12
V-47	0	31	31
Vestas	72	127	199
Windmatic	0	21	21
Grand Total	1177	2052	3229

The remaining models were included in the sampling pool for the 2010 bird-year design. For each turbine model the MT used a randomization routine to select strings from each BLOB where the turbine model was still operational. One string was randomly selected from each BLOB and included in the design until, 1) the operational strings in a BLOB were all included in the design, or 2) the total capacity needed for the design was met for the turbine model. This process was done first using turbines that were monitored during 2005–2009 period, and then for turbines that had not been monitored over these past four years, so that the resulting design included a ~50/50 split between these groups (Table 2) and achieved both the geographic and turbine type stratification objectives of the overall monitoring design.

Turbines were selected based on strings which include an irregular number of turbines, so the design is not a perfect 50/50 split. In addition one string selected for the design included two KVS 33 turbines that would have otherwise been included. Also, since all of the Enertech, Micon, and Nordtank turbines had been monitored over the past four years there were no new locations to select from. The final design includes 1327 turbines which represent 42% of the operational capacity for the turbine models included in the monitoring plan, and 41% of the total operational capacity (all models = 3229) in the Alameda County portion of the APWRA. This design was circulated a spreadsheet which represented the first annual DIP for the APWRA.

Table 2. Number of turbines by turbine model and monitoring history in the 2010 bird-year design for the Alameda County portion of the APWRA.

Turbine Model	New Turbines	From 2005-2009 Design	2010 Monitored Turbines	2010 Operational Capacity	Percent Monitored
Bonus	100	95	195	486	40%
Enertech	0	93	93	133	70%
Kenetech 56-100	314	342	656	1971	33%
KVS 33	2	0	2	21	10%
Micon	0	156	156	218	72%
Nordtank	0	77	77	117	66%
Vestas	72	76	148	199	74%
Grand Total	488	839	1327	3145	42%

Field Methods

The existing field methods and survey protocols were left mostly unchanged (see M1, M11, and M25). The search methods and documentation of fatalities have been generally well tested and are well suited to avian fatality monitoring. Two exceptions are the use of digital information systems and the processing of fatalities upon discovery (a change required to support the detection probability portion of the QA/QC plan).

In October of 2010 the MT deployed three Trimble Yuma GPS data tablets to facilitate data collection and data processing. During Q1 of 2010 these units are being deployed redundant with the paper procedures that have been used previously. Each fatality that is discovered is photographed using a digital camera, and then documented using data sheets. The fatality is secondarily photographed using the Yuma which produces geo-referenced photos with embedded GPS metadata. For carcasses and body parts the photos are stored individually by fatality number. For disperse feather piles or cases where the fatality is spread across a large area, the field staff are collecting a KML (Keyhold Markup Language) file. The individual operating the Yuma GPS walks a path along the feather trail or around the perimeter of the area taking as many photos as needed to document the fatality. The Yuma records the path or polygon around the area, and embeds the geo-referenced images into the single KML object. In all cases this GPS/photo data is being backed up in the field, uploaded to redundant hard drives in the office, and then pulled into the APWRA online database.

In addition the MT has been working to field test and refine a data entry system for collecting fatality information using the Yuma tablets. A prototype was deployed in October 2010, and a Beta application will be deployed on November 8, 2010. The field crew will continue to collect paper data and a second set of photos for all fatalities for the next two months while working to revise and refine the information management system and protocols.

In the Alameda portion of the APWRA field biologists have adopted the practice of leaving newly found fatality remains in the field. This was necessary to support the Quality Control elements of the new monitoring plan (M53). New evidence is documented, and tissue samples are collected, but the

remaining biological remains are left in place and intact. If the remains are found to be *aged* (older than 90 days) they are processed using the same methods but are then removed by the field biologist and brought back to the laboratory for processing.

Finally, all new turbines (i.e. turbines that were not part of the sampling effort prior to the 2010 bird-year) brought into the design were subjected to a *clearing search* conducted by the Field Supervisor and Assistant Field Supervisor to remove any fatalities deposited prior to the current bird-year.

Quality Assurance and Quality Control

The new APWRA monitoring program incorporates several Quality Assurance Quality Control (QA/QC) measures to help improve the estimates of avian fatality rates in the APWRA. Part of this plan is the implementation of measures to monitor searcher efficiency and detection probability within a mark-recapture conceptual framework, which has been commonly referred to as the QA/QC study, but which is more appropriately thought of as a part of the overall QA/QC plan.

Quality Assurance

The Quality Assurance measures were deployed to manage the fatality monitoring process and assure that the intended procedures are being implemented to minimize procedural errors. Searchers are deployed as defined teams with a defined work plan to survey a set of turbine strings that are believed to be operational. Each team is deployed with an up-to-date checklist of the turbines and strings to be monitored, the last recorded status of those turbines, and a map book of their locations. The timing of each search event is recorded in the field, along with a summary of the fatalities found and their treatment (i.e. processed or left in the field). The use of the digital information system provides an additional quality assurance measure because it allows the user to simultaneously record (with the submeter accuracy) the location, timing, and condition of detections which can later be rectified against important metadata such as the nearest turbine assignment and biological attributes.

Quality Control

Quality Control measures were implemented to evaluate the fatality monitoring process in terms of its efficiency (i.e. detection probability). The monitoring process, even when well implemented, has imperfect efficiency and does not detect all fatalities at monitored turbines. Some fatalities are missed by field biologists, and some fatalities are removed from the search area during the interval between searches. Four quality control measures have been integrated into the 2010 bird-year monitoring program to evaluate these efficiencies so that they can be incorporated into deliverables, controlled, and maximized:

1. Team assignments
2. Double surveys
3. Supervisor surveys

4. Fatality placements

Team Assignments

The APWRA field crew has been broken into teams with different roles and assignments. The Field Supervisor (currently Levin Nason) is responsible for managing the quality control measures, and has an Assistant Field Supervisor (currently Brian Karas) who acts as a backup for the Field Supervisor. The assistant field supervisor is also assigned to a three person team (Team A) that has a specific set of search assignments. A second three person team (Team B) has a different set of assignments and schedules as described below. Sixty six percent of the time, search teams are deployed in groups of two, with the remaining team member addressing other responsibilities such as bird use monitoring.

Double Surveys

Teams are *blind* to each other's schedules or results except for rare occasion where logistics require substitution of team assignments or augmentation of teams and in the case of monitoring turbines in Contra Costa County. Each team is assigned a set of strings (by BLOB) to conduct the *primary* search for a rotation (defined as one pass through the complete set of turbines being monitored). The searches are scheduled so that each team can move across the APWRA in an efficient manner such that primary searches can be conducted at all turbines in the design within an approximately 30–35 day interval.

Each rotation a set of turbines is selected for double-sampling during that interval. The number of turbines to be double-sampled is dependent on the workload and available resources. The current estimate is that ~25% of the turbines in the design will be double-sampled each rotation in the Alameda County portion of the APWRA.

The search schedule is randomized so that a variety of intervals ranging from 1 to 30 days between the primary and secondary searches can be implemented during each rotation. However, constraints are placed on the randomization so that a disproportionately high number of secondary searches occur within one week of the primary search. The Secondary search is conducted using the same field protocols as the first, and the second team is blind to the results of the primary search.

Primary searchers leave the remains of fatalities in the field to provide the secondary search with the opportunity to detect (or not) fatalities that were detected by the primary search. Secondary searchers leave the remains of fatalities in the field because they are blind to the fact that they are conducting a secondary and not a primary search. Secondary searches are also exposed to fatalities that get deposited in the interval between the primary and secondary search, and will leave remains in the field so they can be collected and then redistributed by the field supervisor (see below).

The primary and secondary searches produce *detections* of fatalities. Results are processed by the Field Supervisor (or Assistant) using a set of data models (Microsoft Excel and web applications) that allow detections to be assigned to single fatality numbers based on the cumulative results of all searches. The results will be used to derive an estimate of detection probability for different fatality

types (feather sports versus carcasses), bird groups (raptor/non-raptor by size) intervals, and searchers.

For example, BLOB 27 includes 62 Kenetech 56-100 turbines that are in the 2010 bird-year design. The field supervisor cleared 35 of those turbines on October 18, 2010 because they were newly brought into the design, and found two fatalities, the remains of which were left in the field. These turbines were searched by Team A on October 27, 2010 and by Team B on November 2, 2010. Neither of these fatalities were discovered by these two teams. Interestingly, these locations were revisited by the Field Supervisor on November 4, 2010 (see below) and the remains were documented to still be available for detection. Obviously this is a very small sample size and is not indicative of the programs performance, but the results are representative of the type of information that will be generated by the QA/QC program.

Supervisor Surveys

The Field Supervisor (and Assistant as needed) plays a pivotal role in implementing the QA/QC measures. The Supervisor and Assistant conducted clearing searches at all turbines that were scheduled for double surveys during the first search rotation (October 15–November 15, 2010). Un-aged remains were left in the field at those sites to estimate detection probability. However, those finds will not be included in annual fatality estimates since they are not part of the first interval at these new locations.

Similarly, the Supervisor will conduct *pre-surveys* at approximately 5% of the turbines (variable and work-load dependent) selected for double-sampling. This pre-survey provides an estimate of the number of fatalities that were available for detection approximately one day before the primary survey. In addition it allows the Supervisor to actively manage the artificial placement of fatalities at sites that are *fatality free* (see below). The locations to be pre-surveyed by the Supervisor are a randomly selected sub-set of the double-survey locations for each rotation.

In addition the Supervisor is conducting a *post-search-survey* at approximately 5% of the turbines selected for double-sampling, at somewhat less than 5% of the turbines that are not selected for double sampling, and at all turbines where a fatality was available for detection after the second search. Post-search-surveys will be conducted approximately one day after the last search. The locations receiving post-search-surveys by the Supervisor include sites where a fatality was detected on one search but not another, sites where no fatalities were detected, and sites where fatalities were detected by all searches in a rotation.

These three cases provide different Quality Control outputs and will be used to estimate detection probability across a variety of cases and conditions. In the case where a fatality was detected by the Supervisor or a Primary search, and then subsequently not detected, the Supervisor will re-survey the site to determine if the fatality was available for detection on the subsequent day. In the case where no fatalities were detected at a turbine the Supervisor will re-survey the site to confirm that no fatalities were available for detection and missed. In the case where fatalities were detected by all searches the Supervisor will resurvey the site to confirm that no additional fatalities were available for detection and missed, and that the condition and biology of the fatality is accurately described in the record.

Fatality Processing and Placement

Fatalities less than 90 days old (i.e. not notably aged) are being left in the field for all Supervisor pre-surveys, primary searches, and secondary searches. This is necessary to support the double-blind and double-sampling aspects of the program. The Supervisor is processing and removing all remains found during post-search-surveys. All other remains are being processed and removed by the field biologists under a schedule that is managed by the Supervisor based on travel time and efficiency, and that prioritizes fresh fatalities, whole carcasses, or remains that are from species or bird groups that are less common in the fatalities from the current season or rotation. All remains are brought back to the field station and archived.

The quality control measures provide an estimate of the efficiency of searches at monitored turbines. They are intended to provide an estimate of efficiency in parallel with, but independent of, fatality rates for any bird group. The 2010 bird-year monitoring program includes sufficient resources to conduct quality control measures on 30 fatalities per bird group per season. However, the double-blind, double-sampling, and sampling design requirements make it impossible to predict a-priori whether a sufficient number of fatalities will naturally be available for detection and/or redetection at the double sampled sites for a given rotation or season. Therefore, it may be necessary to supplement the program with volitionally placed fatalities.

The Supervisor is responsible for placing fatalities during the pre-survey searches. Fatalities will be placed within the search area at a random distance and bearing from the turbine. The location and condition of the remains will be marked using geo-referenced photography as described above. A record of placement will be made using a modified fatality sheet and the Trimble Yuma GIS data entry system. Placed fatalities will be recorded in the APWRA database as a specific fatality type and will not be used in fatality estimates.

The specific remains to be placed in the field will be selected non-randomly. The Supervisor will continually review the types of fatalities detected in the rotation and season, and will select a type of remains that are rare or missing from the Quality Control sites. The goal will be to achieve the 30 samples per season for each bird group, divided between feather spots and carcass remains. As needed the remains will be separated and placed in multiple locations by removing feathers from a portion of a carcass or breaking the carcass into two pieces. In these cases the remains will always be placed in different BLOBS.

The removal and redistribution of fatality remains requires careful tracking of the fatalities and the placed parts. It is possible that remains placed at a location could be confused with a new fatality of the same or similar species, or that the detection of placed remains could be confused as a new fatality. The APWRA database has been modified to allow the Supervisor and the MT to track all detections, fatalities, and biological samples, and to maintain explicit relationships of all placements and redetections with the actual fatality that was initially detected. As a precautionary measure we are also archiving tissue samples for all found and placed fatalities to allow for genetic testing in the rare cases when ambiguous detections are made at a turbine in a rotation.