Conservation Biology Institute
San Diego Office

A 501(c)3 tax-exempt organization

815 Madison Avenue
San Diego, California 92116
Phone: (619)296-0164
Email: *wdspencer@consbio.org*
www.consbio.org

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Subject: Preliminary Recommendations of Independent Science Advisors for the APWRA Conservation Plan

Dear APWRA Steering Committee and Interested Parties:

This memo summarizes some preliminary recommendations that emerged from the November 16-17, 2009, workshop of the Independent Science Advisors for the Altamont Pass Wind Resource Area Conservation Plan (Plan) and our review of various documents provided by the Plan consultants (ICF Jones & Stokes). The memo focuses on issues that should be raised early to ensure your planning efforts stay on schedule. Additional recommendations and details will be included in the science advisors' report (scheduled for completion following the second workshop, expected to be scheduled for early 2010). Please note that not all advisors have had opportunity to fully review and approve all contents of this memo, and any mistakes are those of the facilitator. These preliminary recommendations could change as advisors continue to research, discuss, and think through these issues in more detail.

Overarching Recommendation

Given the unique nature of this Plan (which should cover both near-term actions to minimize mortality of birds and bats due to wind-turbine operations as well as longer-term repowering with new turbines) and given the large amount of uncertainty about mortality rates, population-level impacts, and the various factors that interact to influence these under both current and potential future conditions, the advisors strongly *recommend that the Plan be developed incrementally on an adaptive management foundation.*

To clarify this recommendation: Usually, conservation plans are developed more-or-less sequentially, with maps of future land uses developed early (e.g., delineating where biological reserves versus other land uses will be located), followed by designation of specific mitigation and conservation actions for different areas and actions, followed last by the design and implementation of a plan to manage reserve areas and monitor the effects (i.e., an adaptive management and monitoring plan). In contrast, the APWRA Conservation Plan would benefit from at least partially reversing this order—by *developing an adaptive management and* *monitoring approach up front and implementing adaptive management studies as the conservation or land-use map and mitigation actions are being defined and refined.* In other words, due to the inherent uncertainties in how a repowered APWRA (with new-generation turbines arranged differently on the landscape than the current turbines) will affect Plan species, the Plan should use a learn-as-you go approach to repowering, based upon explicit hypothesis testing and valid experimental design. This is not to say that some up-front mapping and mitigation design is not possible, because there is sufficient empirical information (thanks largely to the impressive body of work by the APWRA Scientific Review Committee [SRC] and other researchers) to make some firm recommendations about where existing turbines should be removed and future turbines sited (or not), as well as some specific mitigation actions that could reduce turbine impacts and benefit Plan species in the near term. However, these actions should be viewed as experiments that are subject to revision based on results of ongoing monitoring studies. We attempt to clarify and elaborate on this general recommendation in specific sections below, after making some specific recommendations concerning the scope of the Plan.

Scope of the Plan

The scope of an HCP/NCCP includes its goals, geographic extent, permit duration, species and ecological communities to be addressed, and actions to be permitted.

Goals and Objectives – The advisors reviewed a memo entitled APWRA Conservation Plan Draft Biological Goals and Objectives for Terrestrial Plan Species (ICF Jones & Stokes, October 30, 2009). The memo presented working draft biological goals and objectives (BGOs) for a sample of species and communities, organized at three scales: landscape, natural communities, and species. We agree in general with this hierarchical approach to establishing biological goals and objectives. However, we urge recognition that these preliminary BGOs should be subject to refinement as the Plan proceeds and the results of various analyses (see recommendations below) become available.

BGOs should be measurable under the Plan's adaptive management and monitoring program, but this does not necessarily mean that all BGOs can or should be numerical in nature. Some example objectives in the memo we reviewed had placeholders for numerical targets or thresholds to be developed later (e.g., numbers of acres or populations to be conserved by the Plan). The Advisors urge recognition that it may not always be possible to establish meaningful numerical targets based on available data and scientific methods alone. In many cases, such numerical targets are likely to be negotiated based on uncertain biological information as well as other factors (e.g., legal and financial constraints). In other cases, specific numerical thresholds may not be feasible or desirable (e.g., for species whose populations are highly variable due to factors not controlled by the Plan). In many cases, more meaningful metrics may include population vital rates, occupancy patterns, or population trends measured over years to decades. Finally, we also urge recognition that BGOs developed early, to guide plan development, may differ from the ultimate terms and conditions developed by the permitting agencies for take authorizations under state and federal laws.

Geographic Scope – We recommend considering expanding the planning area for purposes of analyzing Plan effects, locating potential conservation actions, or both. An expanded plan area might (1) better account for regional population effects of turbine mortalities and (2) increase flexibility for siting conservation actions (e.g., mitigation areas or land-management actions) to benefit Plan species.

Turbine mortalities may be affecting populations of certain birds and bats over large areas, extending beyond current Plan boundaries. One approach to defining an expanded plan area would be to determine the geographic area over which populations of particular well-studied species (e.g., golden eagle, prairie falcon) are being affected by turbine mortalities, using a source-sink modeling approach (see the section on *Analytical Framework for Avian Population Modeling,* below).

Understanding of migration routes and the likely breeding and overwinter origins of migrating species could also be used to assess regional population impacts. We suggest that collection and analysis of tissue samples from carcasses could be used in current and future work to better delineate the geographic origins of killed animals. Stable isotope analysis methods are being rapidly developed and tested for just this purpose, especially for migratory birds (Hobson 1999, Wunder 2005, Mazerolle et al 2005). Rare earth element approaches to geochemical tracing of migrants are also in development, and we suggest that both these approaches be considered to help define the likely impact area for all species with substantial turbine-caused mortality.

Another reason to consider expanding the Plan area is that some conservation actions may be more effective outside of current Plan boundaries, and an expanded Plan area would provide greater flexibility for landscape-level adaptive land-management approaches. For example, below we recommend using a paired-design adaptive management approach to test alternative grazing management or ground squirrel controls, with management plots potentially located both inside and outside of APWRA.

Finally, actions to benefit some terrestrial species, like badger or kit fox, may be more beneficial outside the current Plan boundary. Including the southwestern portion of San Joaquin County, which is contiguous with and supports similar ecological communities as the APWRA, would be one logical expansion from a scientific standpoint.

Permit Duration – The proposed 35-year permit duration seems defensible, but the advisors urge recognition that to adequately compensate for some likely impacts of the Plan, at least some conservation actions will be required that result in permanent or very long term protection efforts, such as establishment of conservation areas under fee title or easement. Thirty-five years also seems like a short period for effective adaptive management. Responses to management actions by some ecosystem components or processes may take longer than this to become clear, especially given the incremental nature of the turbine repowering process we anticipate will occur. If this permit duration is used, the Adaptive Management Plan should clearly spell out an institutional structure and process for analyzing monitoring data on a continuing basis, with strong feedbacks to alter Plan activities as needed based on results.

Species Addressed – The advisors reviewed the list of potential Plan species in a document provided by the consultants (ICF J&S, October 2009, Working Draft Appendix D). We generally agree with the approach used to identify "Covered Species" (those covered by "take authorizations" under state and federal regulations), and "Planning Species" (species that could be affected by covered actions but for which take authorizations will not be issued). However, we recommend refining the criteria used to identify potential Covered and Planning species to also consider:

1. Species that may not be considered sensitive or of conservation concern, but whose regional populations could be significantly affected by Plan actions due, for example, to additive mortality from turbines. NCCPs are intended to conserve natural communities and their constituent species (whether sensitive or not) at the landscape scale. Significant changes in mortality rates, even for common species, may affect the natural community as a whole (e.g., through changes in food chain dynamics). We therefore recommend assessing the potential impacts of additive mortality by turbines on regional populations of species to determine if the Plan might have significant positive or negative effects on regional population size or productivity (e.g., via source-sink dynamics).
2. Species that may not occur in the Plan area, but that could enter the area within the 35-year permit duration. For example, California condor (*Gymnogyps californianus*) is not currently known within the APWRA, but the population is expanding and could conceivably enter the area in coming years.

Based on such considerations, we tentatively recommend further consideration of the following as potential covered or planning species (Note that additional recommendations may be included in the advisors' report):

- Prairie falcon (*Falco mexicanus*) – Turbine mortality may affect a significant proportion of this species' regional population (D. Bell, personal communication) and the species exhibits risky behavior in the vicinity of turbines (Smallwood et al. 2008).
- California condor (*Gymnogyps californianus*) – Although this Endangered species is not currently known to occur in the Plan area, reintroduced condor populations are expanding in California, and it is quite possible they will enter the Plan area within the proposed 35-year permit duration.
- Ferruginous hawk (*Buteo regalis*) – Ferruginous hawks winter in fair numbers around the APWRA. They are occasionally found dead near turbines, but their mortalities might be under-estimated due to occasional mis-identification as red-tailed hawks. Even low numbers of mortalities could potentially be significant due to low population sizes and productivity rates.
- Horned lark (*Eremophila alpestris*) – Although a relatively low to moderate percentage of killed passerine birds were horned larks at APWRA (Smallwood and Thelander 2008), a much higher percentage of this species is killed at other wind turbine areas in North America (West Inc. 2009). The discrepancy could potentially be a result of the carcass search time intervals (i.e., small birds such as the horned lark may be underrepresented because

correction factors for predation are not adequate). The Plan should assess whether additive mortality rates are sufficient to depress regional population levels.

- Western meadowlark (*Sturnella neglecta*) – This species is the most common grassland-nesting songbird in the Altamont Pass area (Gennet 2007) and apparently the most commonly killed native passerine in the APWRA (Smallwood and Thelander 2008). Although the species is widespread and unlikely to become listed as Threatened or Endangered, the additive mortality due to turbines could be sufficient to reduce regional population levels.
- Grasshopper sparrow (*Ammodramus savannarum*) – This species is expected to be similarly affected by turbines as horned lark and meadowlark due to its grassland nesting and foraging habits. The species is declining and poorly studied statewide (Unitt 2008). Local density of grasshopper sparrows is very low (Gennet 2007). Consequently, even infrequent mortality events from turbine strikes could have significant impacts on the local population.
- Western red bat (*Lasiurus blossevillii*) – This species is expected to be similarly affected by turbines as the hoary bat (*L. cinereus*; which is already a Plan Species), although it is less common and fatalities may be fewer. Western red bat is a Species of Special Concern in California and has potential for federal Threatened or Endangered listing, largely due to habitat loss.
- Showy golden madia (*Madia radiata*) – Appropriate grassland habitat for this species is found in and near the current planning area, but surveys for this species have not been completed. It is a CNPS 1.B.1 species, and has potential to be listed during the 35-year permit duration.

In addition to Planning and Covered species, we recommend considering additional surrogate or “analysis” species. These are species that may not be of conservation concern, but they could be impacted in large numbers by turbines and therefore could be used to increase monitoring sample sizes for statistical models and other analyses described below. For example,

- Rock pigeons (*Columba livia*) and European starlings (*Sturnus vulgaris*) are abundant and non-native, but they are killed in large numbers by turbines, may interact with turbines in similar ways as some Plan Species, and therefore may be good surrogates in statistical models. We recommend analyzing whether their mortality patterns and behavioral interactions with turbines are sufficiently similar to those of other Plan Species that their data can be pooled in statistical analyses described below, thus increasing sample sizes and predictive power of models.
- Mexican free-tailed bat (*Tadarida brasiliensis mexicana*) is expected to be the most commonly killed species of bats in a re-powered APWRA. Although the species is common, with little or no chance of becoming listed as Threatened or Endangered, it may be killed in large numbers and might serve as a useful species for monitoring and analysis.

Ecological Communities – In addition to the Planning and Covered species, we recommend covering sensitive ecological communities in the Plan. The Draft BGO’s and Reserve Design Principles provide a framework for effective conservation and adaptive management of these communities. We consider the following communities sensitive due to their limited extent, and recommend that they be added to the Natural Community BGO's, if not already included, and considered for coverage by the Plan:

- Serpentine Bunchgrass Grassland
- Valley Sink Scrub
- Mixed Willow Riparian Scrub
- Mixed Serpentine Chaparral
- Alkali Meadow and Scalds
- Perennial Freshwater Marsh
- Seasonal Wetland
- Alkali Wetland

Approach for Fatality Risk Modeling

The Science Advisors have strong concerns about the adequacy of the proposed statistical modeling approach as proposed by the consultants for predicting avian mortality risks to avian species (ICF J&S, October 30, 2009, Memo entitled Fatality Risk Modeling for the APWRA Conservation Plan; and presentation by Steve Citron-Pousty on November 16, 2009).

- We disagree with the rationale for not analyzing mortalities at the turbine level and instead pooling data at the string level. We think that available empirical evidence and laws of probability suggest that the nearest turbine to a carcass is the most likely one to have caused the mortality, and that pooling mortality data at the string level, using the centroid of the string to represent location for statistical comparisons, will unnecessarily weaken analysis of how specific topographic features influence the probability of strikes. At the very least, we suggest analyzing at both the string and turbine levels, or using mortality location within a string as a factor in statistical analyses.
- As the analysts are aware, the proposed analysis approach ignores the processes, especially scavenging, that influence carcass detection following a strike. This means that large amounts of available data must be excluded ("filtered") from the analysis, in order to have constant survey intervals.
- Most importantly, not considering post-kill processes means that the analysis does not allow any estimation of actual mortalities; rather it would only estimate spatial and temporal differences in relative numbers. While this goal is still valuable, we believe that an analysis that leads to estimates of actual kills would be far more useful, as it would provide information for estimating population-level effects of turbine mortalities and assessing source-sink dynamics.

We suggest an alternative approach to the analysis of past monitoring data, which we believe will correct some or all of these limitations. The key modifications that we suggest are:

- Model both the strike and the scavenging processes, so that the analysis can use data taken at different survey intervals and generate estimates of mortality rates, not just relative strike patterns.
- Make the unit of analysis individual mortalities, rather than numbers of strikes per turbine string.
- Pool data from multiple species to increase statistical power, using estimates of size- and guild-dependent mortality and scavenging rates. This could also entail including data from additional, non-covered species, such as pigeons and starlings, to increase statistical power (so long as analyses show that pooling these with other species is justified based on species behavior relative to turbines, scavenging rates, and mortality patterns).

The analysis we suggest would involve constructing alternative statistical models for both the strike process (resulting in predictions of different spatial patterns of strikes, dependent on turbine and landscape features, seasonal effects, etc) and the scavenging process (size and time of year dependence of scavenging rates, for example). These alternative models could be fit using MCMC (Markov-chain Monte Carlo) or maximum likelihood approaches and contrasted for predictive power using Akaike information criterion (AIC), deviance information criterion (DIC), or related methods (Burnham and Anderson 2002, Gelman et al. 2004). Ideally, the analysts would use Doug Bell's experimental data as well as past monitoring data in this model-fitting.

We recognize that this approach relies on a series of assumptions that can only be partially tested, such as the relationship between carcass locations and actual strike locations, and the constancy of scavenging effort through time. However, these or similar assumptions are inherent in the consultant's proposed analyses as well. Furthermore, the ability of this approach to better estimate the variables of real interest – risk factors of turbines, risk factors of different birds, and true turbine mortality rates – makes this approach far more useful.

Past mortality monitoring entailed exhaustively searching the area within 50 m of sampled turbines. If a carcass was found it was located using GPS. Distance and direction to the nearest turbine were also recorded. These data allow analysis using carcass locations rather than strings. The turbines and strings of turbines are non-randomly located in the AWPRA so it would not make sense to compare carcass locations to a random sample of points from the landscape. Instead, risk factors at carcass locations can be compared to values for those factors at a random sample of points drawn from the surveyed area. The bird carcass was most likely found in the vicinity of where the bird was stuck. If the scale of that vicinity is less than the searched area for the entire string, important risk factors might also be detectable at that neighborhood scale. Spatial autoregressive modeling (autocorrelation in independent variables and/or spatial autoregressive [SAR] error models) performed at several different scales of spatial aggregation (Dormann et al. 2007) would be appropriate for such an analysis. A multi-modeling approach using AIC could be used to compare models of varying complexity at a particular aggregation scale.

Analytical Framework for Avian Population Modeling

We offer the following comments on the approach proposed by the consultants for predicting effects of alternative conservation approaches on populations of birds (ICF J&S, October 30, 2009, Memo entitled APWRA Conservation Plan Analytical Framework for Avian Population Modeling; and presentation by Jesse Schwartz on November 16, 2009).

The goal of addressing population-wide effects of the mortality caused by the Altamont turbines is one that the science advisors strongly support. However, we did not feel that the proposed approach was likely to be very informative, and indeed, felt that it might be quite misleading in its conclusions. The construction of the model was not clearly or comprehensively described, but seems to focus on methods or results that are not likely to be very informative. These include (1) model structures focused on high-resolution spatial analysis inside the APWRA area and (2) focusing the analysis on extinction risk. This second point is the most worrisome, as we cannot see how extinction risk estimates can be meaningfully made for either of the proposed focal species. This focus on extinction risk is also likely to be misleading, as substantial population reductions over large areas could occur at high turbine mortality rates, with no substantial risk of extinction to the species, due to their even larger geographic distributions. We recommend that the population modeling should concentrate instead on regional population source-sink dynamics, with an emphasis on estimating the geographic region of effect, and the regional population size effects, of turbine mortality. Relatively simple source-sink models (e.g., Wootton and Bell 1992, Doak 1995; see also Jonzen et al 2004) are more suited to the limited data available for most species of interest, and can provide these types of results. Finally, we feel that the array of species considered in these models be broadened to include most or all of the avian and bat species listed above.

Conservation Design Approach for Repowering

Building on our overarching recommendation that the approach to repowering be based on an adaptive management framework, the advisors recommend using a hierarchically structured and incremental spatial approach to siting repowered turbines that treats each phase of repowering, and each potential mitigation action, as an adaptive management experiment. This approach will allow for incremental learning from early actions to inform subsequent actions.

The approach must also be spatially comprehensive and landscape-wide, applying conservation reserve-design principles broadly across the Plan area to delineate an interconnected series of large, turbine-free, biological conservation zones and, conversely, discrete zones within which power production can be maximized. Because this broad-scale approach cannot be effectively implemented on a leasehold-by-leasehold or parcel-by-parcel basis, we also strongly recommend that existing caps on power production for particular leaseholds or parcels be removed. Existing caps on power production were established prior to development of newer-generation turbines. These new turbines allow for increased power production using fewer turbines on less total area, and with less reason to arrange turbines in “strings,” which arrangements appear to increase avian mortalities. Arbitrarily constraining how much power can be produced on particular areas would preclude a comprehensive, landscape-level approach to repowering with a goal of maximizing both power production and biological benefits. The approach we advocate would entail clustering repowered turbines in discrete zones that have naturally lower mortality risks with sufficient turbines to produce more power than may currently be allowed under the caps.

We recommend the following hierarchical approach to siting repowered turbines. At the broadest, landscape level, large portions (measured in thousands to tens of thousands of acres) of the current wind turbine area should be kept entirely free of turbines, with turbines concentrated within smaller areas (discrete polygons, measured in hundreds of acres, surrounded by turbine-free zones). This arrangement will allow raptors and other species to forage at greatly reduced risk within the turbine free zones. The turbine-free zones should be continuously interconnected and open to areas beyond the APWRA, to allow unimpeded movement by species in and through the area and adjoining areas without risk of turbine encounters. Existing information on raptor observations, movement patterns, and fatality clusters should be comprehensively analyzed to identify turbine-free zones using the basic principles of reserve design. We understand that the SRC once identified potential movement corridors through the APWRA, based primarily on known fatality clusters from studies in the area, but that these corridors were never documented. Reviewing these fatality data again, along with digitized data on bird use from monitoring studies, can be used to identify areas of high bird use and high mortality. Data on raptor behavior and movements relative to landscape features can also be very useful. For example Smallwood and Neher (2009) documented concentrated movements by raptors along series of ridge saddles that serve as movement corridors for golden eagles. We also note that radiotelemetry methods are fast improving, and now allow tracking of flight paths at rapid intervals. We suggest that these technologies could be used to map landscape features at Altamont that funnel birds into areas where turbine strikes could occur.

Unlike the turbine-free conservation zones, turbine-designated zones should be discrete polygons of relatively low raptor use, surrounded by turbine-free zones. The turbine zones should be configured to minimize the amount of perimeter edge as much as possible (i.e., using relatively circular, rather than long or convoluted zone shapes, to minimize edge-interior ratios).

At a finer spatial scale, repowered turbines should be located within the turbine-designated zones based on criteria such as those recommend in the map-based repowering approach of Smallwood and Neher (2009) and Smallwood et al. (2009a). Siting criteria should also be informed by the results of the avian fatality risk analysis described above. A comprehensive review of all data and literature on raptor behavior and mortality in the APWRA and discussions with the SRC should be used to establish explicit guidelines for siting turbines relative to landscape features and each other. For example, we support the following guidelines to reduce avian fatality at the repowered turbines as recommended by the SRC (2008a) and Smallwood et al. (2009b), with incremental testing and refinement of the guidelines within the adaptive management framework:

- Cluster turbines as much as possible rather than arraying them in strings.
- Place turbines away from ridge saddles, especially where saddles converge with a draw or canyon, or where saddles are in line with another saddle on a parallel ridge.

- Place turbines away from steep slopes, streams, ponds, and transmission towers.
- Minimize isolated turbines (those remote from other wind turbines).

The definition of ridge saddles (depth and length) and steep slopes (degree slope) could be more precisely characterized by GIS spatial analysis of fatality data. The distance that turbines should be safely placed from these features may also be informed by a spatial analysis.

Operations of Repowered Turbines

The advisors recommend that the Plan fully consider and describe potential prescriptive actions to reduce turbine impacts, and strive to optimize turbine operations for both energy production and biological goals. This requires better defining when impacts occur, and under what environmental conditions (e.g., time of day, season, wind speed, and temperature). Intensive ground searches for bird and bat mortalities using human observers and dogs, conducted at selected periods could provide sufficient data resolution to evaluate these factors. Based on such knowledge, managers could fine-tune turbine operations to reduce mortalities and potentially increase power. For example, recent research demonstrating that bat activity and fatalities are highest on nights with low to moderate wind speeds (Arnett 2005, Arnett et al. 2006, Weller 2008) has led to mitigation experiments where cut-in speeds of turbines have been raised to reduce bat fatalities. These mitigations have led to > 50% reductions in bat fatalities with minimal changes to power output (Arnett et al. 2009, Baerwald et al. 2009).

We recommend further study into the interactions between date, meteorological conditions, and fatality risk of both bats and birds as a means of optimizing curtailment strategies recommended in the NCCP. For instance, the current winter shutdown (4 months) assumes that there is an equal probability of raptor fatality regardless of date within winter or meteorological conditions. If either of these influence raptor flight behavior, there may be opportunities to optimize this mitigation so that turbines could continue to operate when raptor fatalities were unlikely. Although such strategies may have been untenable with previous-generation turbines, it is likely to be more feasible once modern, SCADA-controlled turbines are deployed at the APWRA.

Mitigation at Existing Turbines

The advisors recognize that considerable attention has already been paid to this issue by the SRC, and generally concur with recommendations the SRC has made for mitigating risks of existing turbines. Specifically we support the following SRC recommendations:

- Implement SRC guidelines for removing hazardous turbines (SRC 2007, SRC 2008b) and extend them to cover the entire WRA. The SRC high-risk turbine evaluation covered only part of the WRA. Applying the same principles over all of the WRA would likely reduce mortality even more. In addition, because the SRC evaluation was partly based on characteristics that change over time (e.g., turbine position in row and gaps in row) this evaluation should be updated at least annually.

- Follow the SRC relocation guidelines for siting and relocating wind turbines (SRC 2008a). Following the hazardous turbine evaluation, the SRC developed a guidance document for identifying suitable locations for the turbines that were recommended for removal.
- Remove Derelict Turbines. Derelict turbines are used as perch sites for raptors. Smallwood et al. (2008) found that 22% of raptor perching was on turbines with no blades or non-operating turbines. Consequently, derelict turbines near operating turbines are hazardous.

Land Management Recommendations

The role of Land Owners — To meet the requirements of the NCCP Act, the Plan must achieve conservation at the landscape scale and use Adaptive Management. The draft Reserve Design Principles lay out a set of guidelines that would protect a static set of permanently protected areas to achieve this goal and mitigate project impacts. However, the natural communities and species to be covered by the Plan are dynamic, and simply establishing reserve areas without effective, landscape-scale management actions may not adequately conserve them. Many land-use activities occurring in the plan area, but not managed by the Applicants, affect ecosystem function and species interactions. For example, livestock management practices in the APWRA affect habitat characteristics such as vegetation composition and structure, which in turn affect small mammals that are primary prey for many Covered Species of raptors. Vegetation composition and structure also directly affect foraging and nesting behavior of grassland-obligate songbirds (Gennet 2007). Therefore, we recommend that, in addition to protected area reserves, the Conservation Plan include an adaptive management plan across the APWRA that involves and incentivizes cooperation by local landowners. This would greatly expand the area in which conservation activities would occur and increase the flexibility and effectiveness of the Plan over its duration.

Grazing and Ground Squirrel Management — Based on the literature we reviewed and personal experience of some advisors in the APWRA, we believe that reducing ground squirrel population densities in the immediate vicinity of turbines is likely to reduce raptor mortalities. High ground squirrel densities near turbines represent an “attractive nuisance” problem: attracting foraging raptors to the area at their peril. We recommend using appropriately structured paired-design adaptive management experiments (with replication) to test whether reducing ground squirrels in the immediate vicinity of some turbines would reduce raptor mortality. We suggest testing and comparing two ways of reducing squirrel numbers: (1) excluding cattle and (2) shooting by trained personnel (but not poisoning, which can affect non-target species, including Covered Species).

The comparison of management approaches should consider feasibility, costs, and effectiveness. Either approach would require cooperation from the landowners (see previous section). Grazing exclosures around a sample of turbines would likely require paying landowners for the reduction in grazing area. Excluding cattle would increase vegetation density and height and greatly reduce squirrel numbers, with the potential added benefit of increasing overall habitat heterogeneity for multiple species. Shooting would be performed by trained sharpshooters under strict guidelines to be worked out with the landowners and energy companies, and would need to adhere to strict experimental guidelines (i.e., shooting only within a certain distance of turbines designated by the experimental design, and no other areas).

The managed turbine plots (whether by grazing exclusion or shooting) would be paired with control plots that are similar in other characteristics (e.g., turbine type, topographic position). Monitoring would include assessing vegetation characteristics, squirrel population densities, and turbine mortality rates at the paired plots. If either or both method proves effective at reducing raptor mortalities, and is cost effective and feasible, the approach should be expanded from the initial sample of turbines to most or all turbines in the plan area, per the adaptive management process.

With either management approach, the reduction in squirrels near turbines should be compensated by actions to increase squirrel populations elsewhere, far from turbines, such as by purchase of offsite conservation easements that prohibit ground squirrel control. Such mitigation would likely benefit other plan species that rely on ground squirrels or their burrows, including California tiger salamander, red-legged frog, burrowing owl, badger, and kit fox.

Addressing Data Gaps

Bats and Small Birds — There is uncertainty about current fatality levels of bats and small birds at the APWRA. Given the relatively long search intervals (generally > 20 days), few bat fatalities have been detected at the APWRA (Smallwood et al. 2009). However, Arnett et al. (2008) suggested that bat carcasses are removed by scavengers at high rates (within 1-14 days), and the number of bat fatalities are therefore likely to be much higher than has been reported to date. To our knowledge, scavenger and searcher efficiency trials using bat carcasses have not been conducted at the APWRA. If changes in biological impacts due to re-powering are to be documented, more frequent fatality searches and bias-correction trials should be conducted prior to and after re-powering. Searching a subset of turbines on a daily basis will be needed to establish the carcass removal rate by scavengers, and thus better understand seasonal and meteorological conditions when bats and birds are killed.

Also to our knowledge, no acoustic monitoring, mist-netting, or roost searches have been conducted for bats at the APWRA. To better understand potential impacts to bats, pre- and post-construction monitoring for bats should be conducted as outlined in Kunz et al. (2007) and the CEC and CDFG (2007) guidelines for reducing impacts to birds and bats from wind energy development. Where pre-construction and operations monitoring procedures differ markedly from the California Guidelines (CEC and CDFG 2007) justification should be provided.

Burrowing Owls — The advisors recommend conducting a study that was proposed by the SRC to investigate the causes of burrowing owl mortality in the APWRA (SRC 2008c). Recent monitoring results in the APWRA suggest an unusually high incidence of burrowing owl mortality, although the causes are uncertain. Also, the extent to which mortality is influenced by the presence of turbines and/or turbine operation has not been determined.

There are several lines of circumstantial evidence that suggest predation may be a significant cause of the high mortality, including (1) more feather piles than carcasses found during a 48-hr search interval study (ICF/Jones and Stokes 2009), and (2) higher burrowing owl mortality in the non-operation phase of the winter shutdown study. When turbines are not operating, other raptors could use turbines as hunting perches near burrowing owls colonies. Accurately estimating turbine-related burrowing mortality will require additional information on the behavior of the species and other potential causes of mortality, primarily predation by other raptor species.

The proposed observational study was designed to (1) gather data on how burrowing owls behave in the vicinity of turbines in the APWRA during periods of high recorded mortality, and (2) detect predation events at active burrowing owl colonies to determine the mechanisms of burrowing owl predation and whether the proximity of turbines facilitates predation. The study proposes to use thermal imaging cameras to observe burrowing owl behavior during dusk, nighttime, and early morning hours as it relates to potential turbine collision mortality. Secondarily, the study would investigate the mechanisms of predation of burrowing owls. The SRC recommends performing this study.

Scavenging and Observer Correction Factors — The advisors also recommend conducting a study proposed by the SRC to improve the accuracy of scavenging and observer correction factors used to estimate true mortality (ICF/Jones and Stokes 2008). The number of birds removed before the fatality search and the number missed during the search has long been a source of uncertainty in estimating true mortality. Previous studies have calculated separate values for searcher efficiency and scavenger rates (e.g. Smallwood 2007) which were then used additively to calculate adjusted mortalities. This method has been brought into question because it can potentially result in over- or under-estimations of the actual number of fatalities. In addition, these error factors interact synergistically (occur together over the survey interval) such that it is logistically and mathematically difficult to separate and identify accurate error values for each. The proposed QA/QC study uses a capture/recapture design with actual fatalities to derive one correction factor for both scavenging and observer factors. This should greatly improve the accuracy of estimating mortality.

Bird Use Data — The advisors recommend using the digitized bird use data from both the baseline and current monitoring studies (when it becomes available) to (1) help identify areas of high use for conservation planning (e.g., delineating turbine and non-turbine zones as discussed above) and (2) determine if fluctuations in mortality in both time (seasonally and annually) and space (areas within the APWRA) are correlated with bird use. There is a large amount of inter-annual variability in the mortality data (both baseline and current studies). Part of this variability likely stems from changes in bird use from year to year, so factoring in bird-use data into the comparisons of mortality data is very important.

Closing Remarks

The full advisors' report will expand on the above issues, as well as additional guidance for performing conservation analyses, adaptive management, and monitoring programs. Due to the early stage of planning, it is difficult to provide detailed recommendations on all aspects of the Plan at this point. We welcome feedback on the above recommendations, especially corrections to any factual errors and requests for clarification.

Sincerely,

Wayne Spencer

Wayne D. Spencer
Lead Scientist for APWRA Conservation Plan

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