Avian Mitigation Plan: Kenetech Model Wind Turbines, Altamont Pass WRA, California

by

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Introduction

The objective of the avian mitigation plan is to take immediate action to reduce the number of avian fatalities associated with the operation of Kenetech-designed wind turbines in the Altamont Pass Wind Resource Area (AWRA). The plan, a group of treatments, was developed through analysis of past AWRA research, evaluation of current avian use patterns, identification of potential treatments, and implementation of actions based on these findings. The plan is being implemented in accordance with consultations between U.S. Fish and Wildlife Service (FWS) personnel in both the Portland and Sacramento offices, the current owners of the Kenetech-designed wind turbines, and their consultants. The implementation plan is being funded by a consortium of owners operating Kenetech-designed wind turbines in the AWRA.

The need to take immediate action was prompted by three factors. The first is the California Energy Commission (CEC) report of 1992. Estimates presented in this report of the number of raptors killed by windfarm-related injuries raised the issue to a high level of concern among the various stakeholders. This concern motivated concerned parties to put pressure on the FWS to take steps to stop these fatalities. Second, the high level of fatalities reported over the years by the wind plant operators to the FWS, and Alameda County has not declined. Third, regulatory agencies and many other stakeholders feel that enough study of the problem has taken place, and that there is sufficient information to proceed with specific remedial actions.

Review of Existing Research

This implementation plan was developed in part by synthesizing and analyzing the work of others, and by analysis of the Wildlife Response and Reporting System database. This database was developed by U.S. Windpower (later Kenetech Windpower) and has been continued by the present owners. The implementation plan assumes the validity of the research and fact-finding efforts discussed below. It employs a weight of evidence approach. That is, when observations are confirmed by multiple sources, we considered them to constitute an appropriate base of information upon which to develop a treatment. Although identical techniques were not employed in all the studies, each study employed accepted standard practices.

AWRA Research Base.—Concern about raptor fatalities in the Altamont was first identified by Anderson and Estep (1988). The ensuing CEC study conducted in 1989-91 (Orloff and Flannery 1992) was a primary reference point for the development of this avian mitigation plan. Although the

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methodology of that study was challenged by some, a variety of decision makers have continued to rely on it as the seminal analysis of avian mortality issues in the Altamont. That study was funded and administered by the CEC and was prepared by BioSystems Analysis, Inc. A report on a continuation of the CEC study was released in August 1996 (Orloff and Flannery 1996). Richard L. Anderson of CEC was the project manager. References here to "the CEC report" refer to both the initial study (1992) and the follow-up study (1996).

In the late 1980s, prior to the CEC study, U.S. Windpower personnel were finding bird carcasses in the wind plant. In an effort to determine what was happening, the company funded several studies by Judd Howell Associates; these are listed in the Literature Cited section.

After publication of the initial CEC report (1992), Kenetech responded by initiating an extensive research effort, which was developed and directed by an Avian Research Task Force (ARTF) under the chairmanship of *Dr. Tom Cade* of the Peregrine Fund. Other task force members included *Dr. Mark Fuller*, Director of the Raptor Research and Technical Assistance Center, a cooperative research unit with Boise State University and the U.S. Department of the Interior; the late *Dr. Melvin Kreithen*, Associate Professor, Department of Biological Sciences, University of Pittsburgh, a leading authority on the sensory physiology of pigeons (including sight, sound and smell); *Dr. Vance Tucker*, Professor of Zoology, Duke University, one of the world's foremost authorities on avian aerodynamics, particularly of raptors; and *Dr. Charles Walcott*, Professor of Neurobiology and Behavior and (at that time) Louis Agassiz Fuertes Director of The Laboratory of Ornithology, Cornell University, an authority on the navigation of homing pigeons. A multi-year research and development program was initiated by the ARTF in an effort to enhance the collision avoidance capabilities of birds, particularly raptors, that use the Altamont Pass WRA.

One phase of the research examined the sensory capacities of American Kestrels and Red-tailed Hawks—specifically, to determine what visual stimuli are most effective in improving their ability to avoid wind turbines. This work was conducted by *Dr. Hugh McIsaac* at Boise State University. Information gained in this research on the visual acuity of raptors was used to design avoidance cues such as patterns for painting blades. A painting design was created for the KVS-33 turbine model, and some controlled Red-tailed Hawk flights were conducted around the turbines both before and after the blades were painted.

A second phase documented avian behavior within the Kenetech segment of the Altamont. Observations were made of flight behavior of wild birds and of trained birds in controlled flights. These observations were obtained under a variety of ambient conditions and circumstances. The objective was to develop research-based modifications to wind turbines, and/or to the siting and operation of the turbines, to reduce avian fatalities. Flights were recorded by a specially designed tracking device that simultaneously measured the vertical angle, horizontal angle, and range of the bird as it maneuvered around the turbines.

Another related project was a radar study of bird movements near a windpower facility in Tarifa, Spain. That project was conducted by Brian Cooper of ABR Inc.

Unfortunately, the untimely bankruptcy of Kenetech Windpower stopped all ARTF work being done in the Altamont, the sensory perception research at Boise State University, and the radar work in Spain.

Raw data acquired in these projects have not been analyzed or reported due to the sudden cessation of funding. Verbatim transcripts of periodic ARTF summary reports to Altamont WRA stakeholders are the only extant written record.

In addition to our experience in working with the Avian Research Task Force, we relied on the Wildlife Response and Reporting System (WRRS) developed by Kenetech Windpower. The WRRS is a database of reported finds of dead birds on the properties where Kenetech model wind turbines are located. These finds have been recorded systematically since 1989. Finds come from a variety of sources, including incidental finds by field personnel of the operating companies; systematic searches by researchers (e.g., the CEC and Howell studies); and incidental finds reported by others. These records have been rejected by some due to the inclusion of dead birds found by incidental search methodology as well as some systematic studies. We elected to use these records as evidence of the locations where reported fatalities occurred. We have not used them as the basis for estimating the total number of incidents associated with the Kenetech model turbines deployed in the AWRA. The locations of these finds constitute a key element in developing our strategy for applying initial treatments in the Altamont, as we explain below.

Building upon a recommendation in the 1992 CEC report, Kenetech Windpower participated with the Electric Power Research Institute (EPRI) and the National Renewable Energy Laboratory (NREL) to fund the use of video cameras to record avian behavior around wind turbines. The system was later adapted to assess the effectiveness of newly installed perch guards in keeping raptors off the treated towers, and to photograph interactions between birds and perch guards. A composite tape of raptor perching behavior was utilized in this implementation plan.

Another key research effort from which the development of this mitigation plan has benefitted is the NREL-funded Golden Eagle Population Project at Altamont Pass. On 1-2 September 1993, Kenetech convened a conference that included representatives of the FWS, California Department of Fish and Game (CDF&G), the CEC (Anderson), NREL, Dr. Tom Cade, and raptor experts Grainger Hunt, Hans Peeters, and Pete Bloom. The meeting's purpose was to design a study of the local Golden Eagle population. NREL expressed an interest in funding the project and the work was conducted under the direction of Dr. G. Hunt of The Predatory Bird Research Group at the University of California, Santa Cruz. Kenetech funded the first several months of trapping and nesting surveys to avoid delaying the project for a year while the NREL contracts were being worked out. We used information gained from Hunt’s radio telemetry tracking of Golden Eagles, and from his visual observations of raptor hunting and perching behavior in the Altamont (which were also a part of that study). We also consulted with him regarding the development of perch guard treatments.

Planning Assumptions Based on Prior AWRA Research.—From these varied sources and experiences the following picture emerges:

- *Raptors are the species most at risk in the AWRA.* Orloff found that mortality among the five most common raptor species was not related to the abundance of those species. She noted that American Kestrels, Red-tailed Hawks, and Golden Eagles were killed more often than she would have predicted from their abundance in the study area. The opposite was true for Turkey Vultures and Common Ravens.

- *Raptors are abundant in the Altamont.* Howell and Orloff reported similar levels of relative abundance per 10-minute scans during raptor surveys that they conducted in the Altamont (1.11 and 1.2 respectively). Hunt found that one of the highest concentrations of nesting Golden Eagles in the world is located adjacent to the AWRA.

- *There is a substantial prey base in the AWRA.* Hunt and Orloff both noted the abundance of the California ground squirrel in the Altamont and suggested that raptor foraging behaviors may make raptors susceptible to collision with wind turbines. Hunt observed foraging Golden Eagles frequently engaged in contour hunting (flying/gliding about a meter above the ground). They less frequently stooped for prey.

- *The Kenetech model wind turbines are the turbine type most associated with raptor deaths in the AWRA.* Both the 1992 CEC study and the 1996 continuation report found that more fatalities were associated with horizontal axis turbines mounted on horizontal-lattice towers than all other types combined. Most of the Kenetech model turbines were mounted on 60', horizontal-lattice towers. At the time of the Orloff studies, turbines of this type constituted a majority of the turbines operating in the AWRA. Moreover, the availability rate of the fleet was in the 97-98% range; that is, when the wind was blowing 97-98% of the turbines were in operation.

- *The horizontal-lattice tower structure of the Kenetech model turbines provides ideal perching platforms.* Orloff and Hunt observed that, of all the wind turbine types, the horizontal-lattice type towers were the preferred perching platform. Howell identified the most-frequented perching locations on the Kenetech wind turbines. All three researchers observed that the raptors generally perched on inactive turbines, and rarely attempted to land on moving turbines. Howell reported birds leaving wind turbines when start up procedures were activated and before the blades began to rotate.

- *The position of the turbine in a string, and its association with topographic features, are important factors in raptor fatalities.* Orloff identified end-of-row turbines as having a higher number of avian fatalities. Howell identified mid-row depressions (swales) and ridge-ends (shoulders) as features associated with avian fatalities. Our analysis of the WRRS data indicates that 60% of the recorded fatalities are associated with these topographic features.

- *Avoidance of wind turbines is the normal response of birds, including raptors, in the AWRA.* Research efforts in the Altamont by the Kenetech Avian Task Force included observations of raptor flight behavior and observations of controlled releases of homing pigeons in varying situations in the wind plant. The pigeon tests called for at least half of the birds to be released at specific locations where they would have to negotiate the adjacent string of turbines in order to return to their loft. The birds demonstrated a pattern of avoidance of turbines, with flight strategies generally dictated by (1) how close the birds were released to the turbine strings, (2) wind speed, and (3) wind direction. Birds recognized operating versus inactive turbines, and used gaps in strings as flight corridors. Flight strategies based on energy conservation were also observed during these controlled pigeon flights.

- *Providing a visual contrast between the turbine blade and the background is an important element in providing visual cues to birds flying around the rotating blades of the turbines*. Visual acuity research by McIsaac was used to develop a high-contrast blade pattern. This research was undergoing testing in the Altamont when funding was interrupted. While funding was still available, raptor flight behavior around unpainted turbines was documented, and initial flights were conducted after blades painted with a highly contrasting pattern were installed. Because birds can see in the UV part of the spectrum (Kreithen and Eisner 1978), the team wanted to be sure that a contrast was presented to the birds across the full range of their vision. A special white paint was developed so that the contrast between the black and white portions of the design remained strong at the UV end of the spectrum. Initial indications suggest that flight behavior around the turbines may be influenced by the provision of visual cues but more research is needed. Additional research by McIsaac demonstrates that a Red-tailed Hawk can distinguish, with a high degree of regularity, photographs that do and do not contain wind turbines. Unfortunately, McIsaac's proposals to study the effect of rotation and light on raptors' visual acuity, and to test differences in conspicuousness between the root and tip of the blade, remain unfunded.

Analysis of Wildlife Response and Recovery System (WRRS) Dataset.—The WRRS is the longest continuously-collected and most complete dataset documenting avian fatalities associated with wind plant operations, including locations and species. The WRRS only documents fatalities associated with Kenetech model wind turbines, plus other wind plant-related fatalities on properties where these turbines are operating. This dataset is not directly comparable with the standard carcass surveys generally used to monitor wind energy developments. The dataset is a nine year record including both incidental finds by trained wind plant operating personnel, and finds during standard carcass surveys and other field studies (Orloff, Howell, Hunt, Kenetech Avian Research Task Force, etc.). As we discuss below, we will attempt to calibrate this survey method with the more traditional search techniques, at least with respect to a few raptor species.

As stated above, Orloff found that turbines mounted on horizontal/lattice type towers (i.e., the Kenetech model 56-100 turbine with a 60' horizontal/lattice tower structure) were associated with more avian fatalities than all other turbine types in the AWRA combined. However, when we examined the WRRS dataset, we found that factors other than turbine type may help explain raptor fatalities.

An analysis of several hundred Golden Eagle and Red-tailed Hawk fatalities in the WRRS dataset shows that collisions with turbines are rare events and are non-randomly distributed among turbines (Kerlinger and Curry 1997). Only 459 of more than 3400 Kenetech turbines (13%) were implicated in fatalities of these species. For Golden Eagles, only 4.8% of all turbines have been associated with fatalities, and 16 turbines (out of 3400+) account for 19.2% of all known eagle fatalities. Those 16 turbines have killed either 2 or 3 eagles each over the nine-year period. For Red-tailed Hawks, 27 turbines have killed either 2 or 3 hawks, or one sixth (16.6%) of all Red-tailed Hawks documented in the dataset.

The locations of these fatalities in the wind plant are instructive in identifying the risk associated with individual turbines. Although end- and second-from-end turbines account for only one-third (34.1%) of all the Kenetech model turbines, they account for nearly one half (46.3%) of all Golden Eagles killed and 44.3% of all Red-tailed Hawks killed on this equipment. Although more than one half of all eagles and hawks were killed at mid-string turbines, those located in dips and notches (steep mid-string valleys) and those with irregular spacing between turbines account for a good percentage of these fatalities. Overall, 67.9% of Golden Eagle and 60.3% of Red-tailed Hawk fatalities can be explained by position in string and topography.

As an example of the importance of topography, and how end-of-string turbines and topography are related, one high fatality area of the wind plant (a single ranch) was examined. At this site, the 65 turbines were associated with 18 Golden Eagle and Red-tailed Hawk kills—a much higher number than the overall plant average. These fatalities were related to steep nature of the slopes. Kills of these species were mostly confined to the lower two turbines in the strings. Of the 8 strings, no fatalities occurred at end-of-row turbines at the tops of hills, whereas 5 of the 8 end-of-string turbines (62.5%) that were lowest in the valley incurred fatalities. Eleven of the 18 kills (61.1%) occurred at the bottom-end or second-from-end turbines, although those turbines accounted for only one-quarter of all turbines deployed in that area. The fatalities were associated with steepness of slope, with turbines lowest in the valleys (called canyons, dips, draws, or notches) being most dangerous.

The conclusion that we reached from these findings is that turbines situated on steep hillsides or in valleys, particularly those that are end-of-string turbines, are much more dangerous than turbines situated in mid-string and on fairly level topography. The data also strongly suggest that topography may be even more important than position in string, but that remains to be fully tested.

The non-random distribution of the fatalities reported in the WRRS provides direction for treatment of the problem. By focusing on those turbines or areas where fatalities were most frequent, a cost-effective and efficient means of treatment can be devised. Individual turbines in areas where fatalities are low or non-existent do not need to be treated with the same urgency as turbines and areas where multiple fatalities occur. By using the WRRS as a tool for guiding where treatments should be implemented, we stand a much greater chance of reducing kills than if a random strategy were used.

Plan Elements

The plan's objective is to reduce the number of fatalities as quickly as possible by implementing the following actions:

- Perching and/or roosting on the towers is a risky behavior. Therefore, eliminate the use of the Kenetech model wind turbines, especially the 60' horizontal lattice-type towers, for perching by Golden Eagles, Red-tailed Hawks, and other raptors.
- Availability of prey is an important factor in drawing raptors into the wind plant. Therefore, evaluate the effectiveness of an existing County-administered ground squirrel management program in reducing the number of raptors in the wind plant and the time spent foraging around the wind turbines.
- As few as 13% of the Kenetech model turbines in the AWRA are actually associated with known avian fatalities. Therefore, focus initial treatments on the high risk towers. In addition, use the Green Ridge Power (GRP) repowering opportunity to maximize the removal of turbines or groups of turbines associated with reported raptor fatalities.

- 60% of the Kenetech model turbines at which Golden Eagle and Red-tailed Hawk fatalities were found are associated with specific topographic features. Therefore, utilize behavior observations at these sites to develop site specific treatments. In addition, use this information to develop siting criteria for the installation of new turbines.
- The WRRS database and current observations of flight behavior at selected locations identify specific flight paths that are used frequently by raptors. Therefore, develop techniques, including visual cues, to delineate obstructions.

Perch Guard Treatments.—Perch guards were designed based on a review of Howell (1995), "Perching prevention assessment at Kenetech 56-100 model wind turbine towers"; a review of videotapes of raptor behavior around a string of four treated towers; consultations with Grainger Hunt and Hans Peeters; and testing of various designs with a Golden Eagle and two Red-tailed Hawks provided by the Lindsay Museum, Walnut Creek, CA. Perch treatments applied to high-risk turbines included the following: cover nacelle platform area with screen; screen top bays in lattice tower; and apply deterrents to some horizontal structures within the rotor-swept area.

To determine whether the installation of these perch guards is an effective means of deterring avian predators from perching on the turbines, and whether perching is related to fatalities, we have established a series of field tests on three sites within the wind plant. The sites were chosen because they included sites where high numbers of kills have occurred, as recorded in nine years of data collected by the WRRS.

On each study site, a pre-treatment observation period consisting of 24 observation sessions, each two hours in length, was established. During this pre-treatment observation period all raptors seen on the site were noted and their behaviors recorded. These included perching, location of perch on tower, duration of perching event, and behavior while perching.

Maps were made of flight paths and flight behavior observed on the site generally, and specifically in relation to turbines where kills have been recorded previously.

Following pre-treatment observation, perch guards were installed on 30 of the 90 - 140 turbines in each of the three areas. Perch guards were placed on turbines that were either the site of a prior fatality, or on which frequent perching occurred during the pre-treatment observations.

After the perch guards were installed, a second round of observations of duration identical to the pre-treatment surveys was initiated. The purpose of this round of observations was to evaluate whether birds perched on treated towers; record their behavior around the treated towers; and determine if the perching activity moved to towers previously not used for perching within the observation area. The same information was gathered during this round of observations, with the addition of behavioral information regarding perching attempts on treated turbines.

After this round of post treatment observations is completed, an analysis will be undertaken and another round of treatment and evaluation will be conducted as needed.

The approach is to begin treatments in high risk areas, as identified in the analysis of the WRRS data, and to use perching behavior at the study site as a method by which the birds can show us which additional towers need to be treated and which do not. It is assumed that the birds' perching behavior reliably indicates which towers have little or no value to them as perch sites. Some night observations may be conducted to make sure that the untreated towers that do not appear to be used during the day are not used for roosting after dark. Some incidental observations of this behavior have been made in the Altamont. As discussed above, perched birds usually leave the towers when the turbines are activated. If the towers are also being used for night roosts, movement after dark in an operating wind plant could be highly problematic for a diurnal raptor.

The information collected during these rounds of observations and treatment will also be used to determine whether perching behavior and/or flight behavior is correlated with fatalities. This will be accomplished via correlative analysis and by examining whether kills continue at the treated turbines as indicated by the WRRS.

Evaluation of Ground Squirrel Management.—The decision to evaluate the Alameda County ground squirrel management program developed because of observations made by Grainger Hunt in the AWRA. He observed changes in use patterns in the AWRA by Golden Eagles that he was tracking by radio telemetry. Hunt discussed these shifts with Karen Lougheed, who maintains the WRRS for Green Ridge Power et al. Ms. Lougheed noted that she was not getting reports of dead birds in the area Hunt identified as being vacated by the birds he was tracking. A quick driving survey indicated very low numbers of ground squirrels over a large section of the wind plant. Records showed that the property had been treated systematically according to county guidelines for the preceding three years.

Subsequent driving surveys were conducted on those properties upon which the Kenetech model turbines were installed. The areas were rated as low, medium or high density ground squirrel areas. Low-density areas were those where less than 3 ground squirrels per 0.3 miles were observed. Areas in which 12 or more ground squirrels were observed per 0.3 miles were designated as high-density areas.

To test for a relationship between ground squirrel abundance and eagle distribution in the areas around the Kenetech model wind turbines, Hunt selected five "high density" ground squirrel areas and five "low density" areas. Working with GIS mapping software, he created circles with 1.0-km diameters in five areas of high ground squirrel density and five areas of low ground squirrel density, avoiding overlap in all cases. He then overlaid the relocation points for all radio-tagged sub-adult and floater Golden Eagles located via airplane surveys from September 1996 to June 1997.

There was a statistically significant difference in the number of eagles located in areas with high vs. low levels of ground squirrel activity. For further details see Hunt and Culp (1997). Based on these findings, a decision was made to incorporate an evaluation of the Alameda County's ground squirrel management program into the implementation plan. A monitoring program was established to determine its effectiveness, and how the program impacts the behavior of Golden Eagles and other avian predators. Monitoring is done two times per month throughout the wind plant (areas where Kenetech model turbines are operating) in twenty 1.0-km circles. The circles, which include more than 65% of the turbines in the wind plant, were chosen to maximize the area within the wind plant that is covered and to maximize the number of turbines included in the study. Furthermore, locations identified by the WRRS database and CEC studies as being the areas with the highest number of fatalities were included.

Within each circle the roads are driven slowly, via an established route, during which all ground squirrels and raptors are counted. In addition to the counts of the avian predators, their behaviors are also recorded (perching, soaring, high altitude flight, hunting behavior, direct flights through the study site, etc.).

Because the areas within several circles are not currently treated for ground squirrels, these serve as "controls" or reference areas for comparison with areas that are treated. In addition, several circles that are being monitored were not treated by the county in 1998 but were scheduled for treatment in the near future.

Changes within these circles over time, and the differences among the circles with respect to the numbers of squirrels and avian predators, are expected to provide a robust indication of the efficacy of controlling ground squirrels and how eagles and other avian predators respond to such efforts. As of 1998, field work was scheduled to be conducted for a minimum of 18 months, although preliminary analyses were to be done to assess where ground squirrel and avian predator activity is highest. The results of these analyses will be used to design and implement additional mitigation measures, should they be necessary.

Repowering.—The objective is to test the hypothesis that replacement of the Kenetech model turbines with newer equipment will result in a reduction in the number of eagle and hawk fatalities in the repowered areas. The new turbines will have structural and operational attributes that are believed to be safer for raptors. These changes include lower blade rotation speed (24 vs. 72 rpm); tubular vs. lattice tower; taller structures, resulting in much more space between ground and bottom of blade arc. The sheer reduction in the number of turbines in the process of repowering should have a positive effect. Howell suggests, "It appears that mortality occurred on a per-turbine basis, that is each turbine simply represents an obstacle" (Howell, 1995b). If this is so, we can anticipate a reduction in fatalities approximating the replacement ratio of old to new turbines. In the case of the GRP-owned Kenetech model turbines, replacement will occur on approximately a 7:1 basis. The repowering program also provides an opportunity for the removal of problematic turbines and the avoidance of certain topographical situations when siting new turbines. At this point, we can only project the potential impact of repowering on the reduction of avian mortality.

A monitoring program following the removal of old turbines and the installation of new turbines has been proposed to test the effectiveness of this change of equipment. Two monitoring protocols would be employed. The first is the continuation of the WRRS. That dataset is the most comprehensive record of turbine-specific avian fatalities collected to date, and will serve as a pre-treatment dataset. Alameda County is specifying the WRRS for use by the other companies proposing to repower at this time. The second monitoring protocol will be specified by Alameda County and will closely approximate the standard carcass surveys employed in wind plants (Anderson et al. 1999).

By applying the two monitoring methods concurrently, we expect to be able to calibrate the difference between the two methods for detecting dead birds in the wind plant. The intensive studies would be conducted for a period of two years following commencement of operation of the repowered turbines. Observer efficiency and scavenger removal tests, employing carcasses of the species that have been struck by turbines on these sites, would be conducted. Once the WRRS has been calibrated, this method would be used to maintain a continuing monitoring program for the duration of the repowering permits. These protocols are being developed by Jim Estep of Jones & Stokes, environmental consultant to Alameda and Contra Costa County.

Visual and Auditory Cues in High Risk Areas.—The WRRS data and the behavioral observations being recorded in both the perch-guarding site surveys and the 20 prey-base survey areas (discussed above) will be used to identify flight corridors and flight behavior around wind turbines, especially end-of-row turbines. Treatments are being developed to provide visual cues to alert foraging raptors and other birds flying through frequently used corridors to the presence of a turbine. Auditory cues may also be appropriate in some situations, such as when a raptor is kiting while scanning a slope for prey with its back to the equipment, or when birds fly in certain light and/or weather conditions that hamper visibility. Coordination with wind plant operators may provide additional options for reducing risk on a site-specific and species-specific basis

Scope and Duration

The implementation plan is a multi-year project and, as of mid-1998, was nearing completion of its first year. The level of effort is substantial. In a year's time, at least one of the aforementioned activities will have been implemented in each area where the Kenetech model wind turbines are currently deployed.

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General Discussion

Regarding the tests of pigeon flight behavior near turbines, one participant asked how late relative to sunset the tests were done. These tests continued up to ½ hour after sunset. A follow-up question concerned whether, in low-light conditions, pigeons maneuvered around the turbines based on visual or auditory cues. This is uncertain, though it was noted that, as turbines start up, there are audible cues associated with changes in blade pitch.

Would decoy towers (without functioning rotors) positioned at the ends of turbine strings reduce the number of birds approaching turbine strings? This is not known, but is one idea under consideration as a potential risk-reduction treatment, especially in areas where no ground squirrel control is done. Although provision of these alternate perches would help keep birds off the turbines, it might also attract birds to the general area of the turbines, or encourage them to remain longer.

Regarding secondary toxicity of poisoned ground squirrels, the poison used is an anti-coagulant applied to grain. It was noted that affected ground squirrels generally go into their burrows and die there. Also, the bodies that are on the surface are picked up when found. Dr. G. Hunt noted that eagles tend not to eat the intestines of ground squirrels, where poison concentrates. He said that there were no indications that any of the dead radio-tagged eagles had been killed by poison. It was also suggested that the blue dye in the poison would be evident in dead eagles if they had ingested poisoned prey.

Regarding repowering, it was noted that perch guards are being installed on turbines that will remain operational for an extended period. Perch guards are not being installed on turbines scheduled to be replaced in the near future.