# ALTAMONT AVIAN PLAN:

Status Report to the U. S. Fish and Wildlife Service
By The Consortium of Altamont Owners
December, 1997

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# EXECUTIVE SUMMARY

In consultation with the US Fish and Wildlife Service, a consortium of owners of Kenetech wind turbines operating in the Altamont Wind Resource Area near Livermore, California have developed a plan to reduce the risk of avian fatalities involving their wind turbines and related facilities. The following is a status report of the actions that have been taken to date to implement this plan.

Implementation activity highlights include:

- Completion of the first quantitative analysis of Golden Eagle and Red-tailed Hawk fatalities in the Windplant. This information was employed to redesign the implementation strategy for designating turbine towers for treatment. High risk turbines and topographic situations have been targeted to receive priority consideration in scheduling treatment.
- The Wildlife Response and Reporting System has been continued as committed to in the plan. The data collected since 1989 was utilized in the analysis cited above and will continue to be collected and utilized as a key part of the adaptive management element of the plan.
- Design, construction and testing of more than a dozen potential perch guards for turbine towers using captive Golden Eagle and Red-tailed Hawks in a simulated setting. The devices were redesigned based on these tests and are in production for field application beginning in mid-December.
- Establishment of a timetable for installation of perch guards and visual cues for modification of flight behavior for the 1997-98 off season period.
- Development of an outside peer reviewed program to evaluate the efficacy of perch guards and flight behavior modification devices. The BACI design was employed in this program and where appropriate in every other evaluation program employed in this plan. Pre-treatment observations have been completed.
- Completed retrofitting of 81% of the poles designated for modifications in the Windplant electrical distribution system. The balance will be retrofitted by December 31, 1997 as scheduled in the plan.
- Provided assistance to the Alameda County operated ground squirrel control program to assure uniformity of treatment application pre and post treatment monitoring of the treated areas and broad based rancher participation. The result is that fewer Golden Eagles now utilize those areas where the prey base has been reduced. This modification of the avian plan to incorporate the prey - predator relationship is an example of adaptive management.

The Consortium of owners looks forward to the opportunity of meeting with the Service in the field and/or at the appropriate office location(s) to discuss the actions that have been taken to date.

# BACKGROUND

Plan Description

On May 2, ~~1977~~ 1997, the Altamont Avian Plan was submitted to the Portland Office of the US Fish and Wildlife Service (FWS) by a consortium of owners in the Altamont Windplant (see list below). The plan represents a commitment by these owners to reduce the risk of avian fatalities involving Kenetech manufactured wind turbines and related facilities. There were four elements to the plan as submitted:

- Perching behavior modification

  The plan proposes the development and installation of perch guards on 400 wind turbines during the 1997-1998 off season for wind generation. A monitoring system designed to ascertain the effectiveness of the anti-perching devices will be developed and implemented. Additional deployments of these treatments will be made during the 1998-1999 and subsequent off-season periods, as necessary.

- Flight behavior modification

  The plan proposes the identification of hazardous sites: single tower locations involving two or more fatalities or a group of towers involved in multiple fatalities. Those tower sites which appear to require treatment(s) designed to modify flight behavior will be prioritized. Initial treatments that are proposed include visual cues such as marker pylons. Further testing of avian visual acuity will be undertaken at Boise State University. The purpose of this research is to generate the same type of information that was utilized to develop the blade painting treatment of the KVS-33 model turbine blades in order to apply it to the development of a treatment for the KCS-56 model turbine blades. The blades on this turbine model are smaller and rotate at a different speed than the blades of the KVS-33 model turbines.

- Prevention of electrocutions on the Windplant distribution system

  The plan proposes to complete a retrofitting program of all of the 157 riser poles in the 59 mile Windplant distribution system. Riser poles are those locations where the underground collection lines surface and become part of the overhead internal distribution system of the Windplant. The modifications to the riser poles are designed to eliminate further electrocutions at these sites.

- Continuation of the Wildlife Response and Reporting System

  The Wildlife Response and Reporting System was developed by Kenetech Windpower. The plan proposes to continue this program of documenting all reported avian incidents within that portion of the Altamont Windplant that is under the control of the owners listed below.

*** The Consortium of Altamont Ownerships includes the following entities: ESI Bay Area Inc.; WPP87, Partnership, ENIVEST, Inc. G.P.; Mountain Energy; Energy Investors Fund; and, Kenetech Windpower, Inc. (KWI) [whose holdings will be acquired effective January 31, 1998]. The new owner will assume responsibility for the implementation of this plan as part of the purchase agreement.

Subsequent Meetings and Communications

- On May 24, 1997, a meeting was held in Burlingame, CA in order to receive input from the local FWS enforcement agent Steve Furrer, regarding the plan and the efforts being made by the owners. Attending the meeting were owner representatives Steve Ponder, Bob Thomas, John Zimmerman as well as Ms. Joan Stewart from the avian team. At this meeting agent Furrer suggested that the avian team look at the prey - predator relationship.

- The FWS responded in a letter dated June 20th with a request for a more expansive treatment schedule than the initial proposal to modify 400 turbines with perch guards and further requested that the implementation plan be extended to five years. In addition, the FWS encouraged the owners to make adaptations to the plan based on findings developed during the course of plan implementation.

- On September 24, 1997, a plan briefing and field visit was provided to Mr. Gary Taylor and Dr. Gary Falxa of the FWS Sacramento Field Office . This report follows the agenda of that meeting and incorporates both a status report on implementation activities regarding original plan elements and includes new actions that have been taken in the interim.

## PLAN IMPLEMENTATION

In reverse order of their presentation in the plan, we will discuss those actions that have been taken to date to implement the Altamont Avian Plan.

- Wildlife Response and Reporting System

  The Wildlife Response and Reporting System has been continued unabated under the direction of Joan Stewart of Kenetech Windpower, Inc.(KWI) since 1989. Ms. Karen Lougheed implements the program and in that capacity: responds to all reported avian incidents; documents each event; and, provides monthly reports to the FWS.

  Data collected through this program is being used to identify hazardous sites within the Windplant. The implementation team has completed the first quantitative analysis of Golden Eagle and Red-tailed Hawk fatalities in the Windplant to identify risky turbines and topographic situations. This report is attached as Appendix A.

- Electrical System Upgrades.

  The plan calls for completing the following retrofits on the 157 riser poles in the Altamont Windplant by years end:
  - Replacing existing 5 kV insulated jumper wires with 15 kV insulated wire;

- Insulating all underground cables of fused cut -out risers so that concentric ground wires are not exposed;
- Insulating metal T - end sections on the fiberglass cross arms of fused cut-out risers;
- Correcting any potential pathway from terminal connections, grounding, bonding wires, or ineffective wildlife boots;
- Reorienting fused cut-outs to increase the distance between components and decrease the accessibility; and
- Removing some of the existing PVC perch deterrents on fiberglass T - mounts of fused cut-out risers and the main cross arm of switched risers.

In addition, to the 157 riser poles mentioned in the initial plan, 8 dip poles were identified for treatment. Dip poles are those poles which are located on either side of a section of the distribution system lines which have been placed underground for any reason. As of December 12, 1997, 131 or (81%) of the 165 poles designated for modification have been treated and a complete retrofit of the remainder will be completed by December 31, 1997. It is important to note that only one golden eagle has ever been electrocuted in the Windplant's distribution system and that fatality occurred in 1993. The electrocutions of radio tagged Golden eagles reported in Grainger Hunt's Golden Eagle Study occurred on transmission lines belonging to Pacific Gas and Electric (PG&E).

- Flight Behavior Modification

Prioritizing Sites for Treatment

The first step in the development of treatments was to identify and prioritize those locations within the Windplant where the treatments were to be applied. The report, "Analysis of Golden Eagle and Red-tailed Hawk Fatalities at Consortium of Altamont Owners Facilities" attached as Appendix A, provides the basis for determining priority site areas for treating wind turbines with perch guards and/or flight behavior modification devices. This analysis is based on the fatalities of Golden Eagles and Red-tailed Hawks reported through the Wildlife Response and Reporting System (WR&RS) that has been carried out by KENETECH Windpower personnel since 1989.

The analysis shows that 459, or 13.4%, of the 3,412 KCS 56-100 model wind turbines are responsible for all of the Golden Eagle and Red-tailed Hawk fatalities reported by the WR&RS.

The analysis also confirms that end of row turbines, turbines on either side of mid string gaps (irregular spacing) between turbines and turbines located in topographical related dips or notches in the interior of a string of turbines account for 67.9% of the Golden Eagle and 60.3% of the Red-tailed Hawk fatalities. Roughly 325 turbines or 9.5% of all turbines in the Windplant have these site characteristics and are the location of the percentage of fatalities cited above.

The data show that avian fatalities are not randomly distributed within the Windplant. Some locations clearly pose a much higher risk than others. This analysis of the data and field verifications strongly suggest that more of the fatalities might be flight related than previously considered. Sites representative of this assessment were shown to FWS personnel in the field on September 24th.

In this context, treatment of 400 turbines identified in this analysis represents a much more aggressive approach to addressing a major part of the problem than was perceived prior to having this information. It is becoming clear that not all, or even most, of the turbines may require treatment. Therefore, it is our intent to aggressively treat clusters of turbines that have been the sites of numerous fatalities. Extensive field work has shown that there is usually a topographic relationship between locations of turbines that are involved in avian fatalities. A series of internal flyways have been identified through this analysis of the data. The Sacramento Office personnel reviewed, in the field, two of the three areas that have been identified for the initial installation of perch guard and visual treatments.

Modification of sites with visual cues

End of row turbines and mid row turbines that are the site of fatalities suspected of being "flight related" will be treated with the installation of visual cues. These cues or flight deterrents will consist of one or more telephone poles and attachments as needed, to which mylar or other material is affixed. The purpose of the mylar is to provide motion making the pole or pylon as visually obvious as possible to birds flying toward the turbines.

At mid row locations the cues will be arrayed so as to direct the birds through the passageway similar to the way airport approaches are laid out. At end of row turbines visual cues will be mounted on pylons arrayed in such a way as to create the affect of providing a new ending to the turbine string. The strategy is to alert the birds to the hazard and guide them around the "new" end of the string. In those instances where it is evident (from prior observations, the accumulation of whitewash on the tower, etc.) that perching also occurs at the location, the end turbine(s) will be perch guarded and an alternative perch or perches may be erected if the location is determined to be a potentially high perching area (using historical data and current site conditions such as prey abundance).

In the absence of available birds trained to make controlled flights, it will be necessary to evaluate the effectiveness of the proposed flight deterrent treatments by comparing flight behavior before and after initial installation. In the report entitled, "Altamont Wind Resource Area Avian Safety Program: Evaluation of Perch Guards and Flight Deterrents", and attached as Appendix B, the study protocols are detailed.

As the schedule shows in Figure 1, the visual treatments will be installed in the early Spring of 1998. This will allow for the maximum collection of flight behavior data at the proposed treatment sites prior to installation and will maximize the utilization of the period when the turbines are operating less frequently for the installation of perch guards. Visual cues can be erected when the Windplant is in operation because they are not affixed to the tower structure and do not necessarily require the adjacent turbines to be shut down during installation.

Boise State University Research

Prior to blade painting, visual cues will be installed along internal flyways. This type of treatment addresses hazards attributable to turbine locations within the Windplant. A treatment of the structure itself is also contemplated by attempting to make the rotor swept area more visible by painting the blades.

Blade painting treatments will be based on the research program at Boise State University which has been resurrected through the implementation of this plan. By February of 1998, 8 scientific and 6 wind industry reports are scheduled to be completed. Contracts are being negotiated to resume additional laboratory tests which are essential if a design is to be developed for the KCS 56-100 model turbines. Differences in blade size and rotation speed require that additional research be conducted prior to painting designs on KCS 56-100 model turbine blades. April, 1999 is the anticipated starting date for painting blades for initial application in the field.

- Perching Behavior Modifications

Prototype Development

In August and September treatment prototypes were designed and built and on September 24, the first set of prototypes were tested with captive birds from the Lindsay Museum of Walnut Creek, California. FWS personnel were in attendance at that time. Some treatments were immediately discarded and others required further modifications. A treatment was discarded if the bird could settle down with relative ease and not require constant movement of wings and feet to maintain perch position. In some instances the material utilized was not strong enough to maintain the separation between the perch guard and the horizontal beam which was the preferred perching location.

On October, 22nd, two prototypes were selected after a second and final testing procedure was employed, once again using captive birds. In all, a dozen designs were constructed and tested. In designing treatments it is important to consider: windsmith access to various parts of the turbine and their safety; wind loading effects; the impact of the elements on the durability of materials utilized in the devices; and, maintenance considerations. The bottom line is that the device must be effective in thwarting the bird's desire to perch or utilize the structure for a roost or a hunting platform

A total of four types of perch guards will be placed on designated towers as described below and shown in the photographs attached as Exhibit 1.

1. Platform cover (Shroud): a polyester mesh material (used to cover dump truck loads to prevent blowing loads away at highway speeds) will be placed around the catwalk (work platform for windsmiths)

which provides a very stable, shaded and highly preferred perch for raptors just under the nacelle. Based on field observations, this is the preferred perching location on the 60 foot lattice type tower. The platform cover will completely enclose this space. The original design was modified to make it easier for the windsmiths to move it when performing maintenance operations. Ease of access and minimal reinstallation are key factors in insuring that the cover will be replaced after each use by the windsmiths. The cost of each cover is $111.00.

2. Hardware Cloth: 1/2 inch galvanized wire positioned to prevent perching on cross members #4 and #5.

3. Wire Mesh: galvanized 4"X4" wire fencing material 18-24" wide which will be affixed about 6" above cross member #3. This spacing above the cross member will allow foot access for windsmiths who need to move along the beam to carry out maintenance activities. This is one of two optional treatments designed for application on cross member #3.

4. Electrical shocking device: a non insulated wire strung about 9" above cross member #3 (on all three sides of the tower) and affixed to insulators on each leg of the tower is the second type of treatment applied to this cross member. A pulsed (every 5+ seconds) electrical shock will be delivered to the wire from a 9-volt battery. The device is the same used for livestock (horses, cattle, hogs, etc.) fences. Tests have shown that the device is not harmful to raptors and that it delivers a rapid and obvious negative stimulus to individuals that ground the wire. A second non-charged wire will be strung in close proximity to the charged wire which will provide a second grounding situation for the bird if the bird attempts to perch on the wire. It is anticipated that the primary grounding will occur when the bird lands on the cross member and makes contact with the charged wire.

Evaluations

As described in Appendix B, a BACI design will be utilized to evaluate the efficacy of perch guards and flight deterrents. Evaluations have been designed to answer the questions in the shortest possible time while still maintaining the integrity of data collection. The schedule for conducting

It is important to evaluate the effectiveness of the various treatments both in the short term and over the course of the year. In the short term we will be assessing the initial effectiveness of the treatment and the behavior of the birds in response to the treatment. A major issue that must be addressed involves displacement of the bird. Does the bird move to a less desirable location on the treated tower or does it seek an alternative location which still meets the need to perch for resting, hunting or roosting on an untreated structure within the treatment area? Post treatment observations of this latter type of displacement behavior will be employed to determine the scope of treatment that must be applied to a specific treatment area. We will use the birds themselves to show us which towers are require treatment and which do not.

The ability of the treatment to stand up to the testing of the birds and to the elements is another important issue which will require a longer term assessment.

In some instances multiple treatments will be applied where a high hazard area has been identified. FWS personnel from Sacramento wanted to make sure that we would take the time to adequately document the efforts being made so that we would be able to discriminate between the effectiveness of the multiple treatments that will be applied in these situations.

Implementation

The quantitative analysis of Golden Eagle and Red-tailed Hawk fatalities in the Windplant provided the basis for reviewing and redesigning both the strategy and the scope for applying perch guards within the Windplant.

Treatment sites were selected for initial installation and on October 23rd a proposed implementation schedule was discussed with field maintenance. Pre and post treatment evaluations will be made to assess the effectiveness of treatments applied in the initial phase of the treatment program. The schedule is displayed in Figure 1 below.

Figure 1 – Schedule of Installation of Treatments

Develop estimate of needs and identification of sources of manpower and materials October 28 and 29.

Description of Locations and Numbers

- Marie Gomes Farm North (N=111)
    - 31 initial installations of perch guards December 15 – 31, 1997.
    - 30+ additional installations of perch guards in Feb.-March, 1998 (precise locations to be determined by post treatment observations).
    - 5 installations (20 poles) of flight deterrents in March-April, 1998 and on going.

- Altamont Landfill (Oakland Scavenger), (N=92)
    - 32 initial installations of perch guards January 5 – 16, 1998.

- 30+ additional installations of perch guards in Feb.-March, 1998 (precise locations to be determined by post treatment observations).
- 8 installations (32 poles) of flight deterrents in March-April, 1998 and on going.

- Walker Family Trust (N=150)
    - 29 installations of perch guards January 17 – 29, 1998.
    - 30+ installations of perch guards Feb.-March, 1998 (precise locations to be determined by post treatment observations).
    - 15 installations (60 poles) of flight deterrents in Feb.-March, 1998 and on going.

Proposed Schedule

- Pre treatment observations November - December 1997 (60 hours per site)
- Sites available for installation December 15, 1997
- Post treatment observations will begin following completion of each area (60 hours per site)
    - Gomes North – early January, 1998
    - Altamont – mid-January
    - Walker early February
- Sites available for next phase of perch guard installation
    - Gomes North January, 1998
    - Altamont February, 1998
    - Walker mid-February, 1998

## A NEW PLAN ELEMENT

Information obtained during the early stages of implementation also provided the basis for developing a new element of the avian protection plan. That information involves the abundance of prey within the Windplant and the impact on raptor use of the area and specifically the lattice type turbine towers utilized with the Kenetech model wind turbines.

- Prey Base Management

Background

The literature clearly establishes the relationship between the distribution and abundance of prey and predators. Prey base management has been discussed as an important factor in avian/wind turbine interaction in a variety of venues. With respect to the Altamont specifically, the California

Energy Commission Report by Orloff and Flannery included prey base management as an option for further action, the National Renewable Energy Laboratory (NREL) funded Golden Eagle Study confirmed a high number of ground squirrel carcasses in the course of nest searches. The California ground squirrel is an important part of the nestling diet. Local raptor researcher Hans Peters has also advocated prey base management as an option to be considered. FWS enforcement agent Steve Furrer also strongly encouraged that this approach be considered. His interest was expressed in a meeting with KENETECH personnel and representatives of equity owners in May cited above. Although it was discussed in early conversations, the plan submitted to the Service in May did not address the prey base management issue.

In June, Grainger Hunt observed a marked change in use patterns of the radio tagged Golden Eagles he is tracking in the Altamont Wind Resource Area WRA) and vicinity. Fewer locations of radio tagged birds were being recorded south of Interstate 580 in the Mulqueeny Ranch area. He contacted Karen Lougheed of KENETECH Windpower who has responsibility for the Wildlife Response and Reporting System. She confirmed that there had been a decline in reported fatalities in the same area of the Windplant and noted that operators of the Mulqueeny Ranch had been actively participating in the Alameda County ground squirrel control program.

Hunt and Lougheed conducted an impromptu driving survey of the property in question to determine the effectiveness of the ground squirrel treatment program. In touring the ranch they observed only one ground squirrel. They immediately proceeded to other areas of the Windplant where the tracking data indicated high use levels by the tagged birds. At these locations a much higher level of ground squirrel activity was observed.

Based on these initial observations a systematic driving survey was conducted throughout the KENETECH Windplant. Two, two-person teams drove all of the roads within the KENETECH operations of the Altamont WRA. Based on these observations, each of the land ownership's were characterized by the amount of ground squirrels observed from low (less than 3 ground squirrels per 0.3 miles) to high densities (12 ground squirrels per 0.3 miles). These driving surveys were completed by the end of July.

To test for a relationship between ground squirrel and eagle distribution in the KENETECH WIND AREA (KWA), Hunt selected five areas of high estimated ground-squirrel density and five of low density. Using the GIS mapping software, he then created circles with 1.0 and 2.0 km diameters centering on the selected areas, avoiding overlap in all cases. He then overlaid the relocation points for all radio-tagged sub adults and "floaters" (unmated adults) located in the airplane surveys from September 1996 through June 1997. A report on these activities is included as Appendix C.

## Ground Squirrel Density and Eagle Relocations

| KWA | GPS # | Landowner | Score | LATITUDE | | LONGITUDE | | 2/22/97 - 7/21/97 | | 9/1/96 - 7/21/97 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1 Km diameter | 2Km diameter | 1 Km diameter | 2Km diameter |
| N | 8 | CCWD | **High** | 37 | 47.513 | 121 | 43.578 | 1 | 5 | 1 | 9 |
| N | 9 | Walker-NW | **High** | 37 | 47.991 | 121 | 42.310 | 10 | 27 | 12 | 39 |
| N | 10 | Walker-SW | **High** | 37 | 47.521 | 121 | 42.203 | 5 | 17 | 5 | 26 |
| N | 17 | Gomes (N) | **High** | 37 | 47.231 | 121 | 37.895 | 0 | 7 | 3 | 13 |
| S | 2 | Gomes (S)-Corral | **High** | 37 | 42.877 | 121 | 36.515 | 2 | 6 | 2 | 10 |
| S | 15 | Gate 8E / ACWMA | **Low** | 37 | 42.551 | 121 | 38.992 | 0 | 0 | 0 | 0 |
| S | 16 | Gate 4W / ACWMA | **Low** | 37 | 42.904 | 121 | 38.431 | 0 | 3 | 0 | 3 |
| S | 13 | Mulqueeney-S | **Low** | 37 | 40.491 | 121 | 34.633 | 0 | 0 | 0 | 0 |
| S | 4 | Mulqueeney-C | **Low** | 37 | 41.051 | 121 | 34.768 | 0 | 2 | 0 | 2 |
| S | 12 | Mulqueeney-N | **Low** | 37 | 41.459 | 121 | 35.072 | 0 | 1 | 0 | 1 |

There is a statistically significant difference in the number of eagles located over areas with high density of ground squirrel activity when contrasted to those with low levels of ground squirrel activity. This compelling graphic prompted further investigation of the cause(s) for the disparity in ground squirrel activity.
It was learned from discussions with operators and owners of property within the Windplant, that those ranches that were actively participating in the Alameda County ground squirrel control program were also the areas where there was a marked reduction in ground squirrel activity and recorded radio tagged eagle activity.

Assessment and coordination with the County treatment program

In discussions with ranchers and the county agent who administers the program we learned that:

- the treatment utilized grain treated with an anti-coagulant *diphacinone* which was broadcast on the ground from an applicator placed on the back of a pick up truck and an ATV (on two of the ranches).
- under the county program treatment applications could either be administered by the landowners or county personnel.
- if the objective were to achieve standardization in the application process all treatments would have to be administered by county personnel.
- those who participated in the county administered program considered the program to be highly effective.
- since the county began charging for the grain there was a decrease in the number of ranchers participating in the program.
- the most effective period for treatment runs from June until mid-September and consequently there was a short window of opportunity left for completing the treatment program for this year.
- some ranches could not be effectively treated this year due to the recent harvest of grain.
- the county had manpower limitations which would limit the scope of the treatment program for the remainder of this years treatment season.

It was determined that if we wished to continue to test the relationship between ground squirrel activity and Golden Eagle distribution with consistent conditions, we would have to coordinate with the existing program in order that specific objectives could be met. We sought to incorporate the following elements in the program:

- All treatment applications were to be administered by the county according to its guidelines to insure consistency in applications and to be in conformance with the county permit and Department of Fish and Game guidelines.
- Encourage as many owners as possible to participate in the program in order to achieve maximum treatment effectiveness. With the Contra Costa Water District in place, a control area was already available as a reference site.

- Encourage as many owners as possible to participate in the program in order to achieve maximum treatment effectiveness. With the Contra Costa Water District in place, a control area was already available as a reference site.
- Encourage the owners to commit to a five year program in order to maximize the effectiveness of the county program and to coincide with the avian plan timeline.
- Provide personnel support to assist in the removal of surface kills as a protection against secondary poisoning.

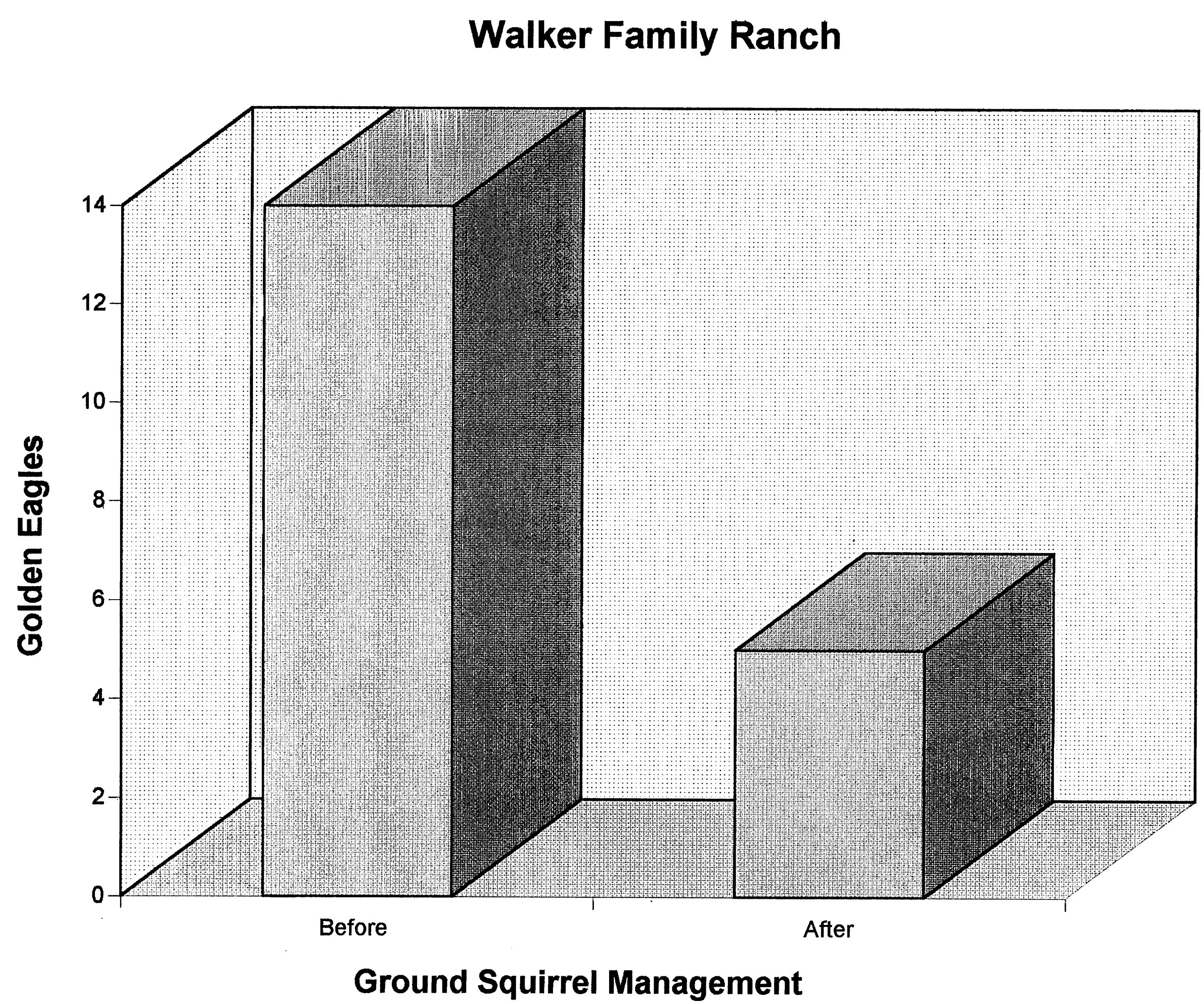
Implementation and initial evaluation

Five ranches were treated by the county this year in accordance with the program elements cited above. On every treated area a carcass survey and pickup was conducted according to CA Fish and Game (F&G) guidelines. This activity was funded as part of this Avian Mitigation Plan. Nine other ranches were treated prior to the implementation of this approach. Five ranches received no treatments for a variety of reasons but most, if not all are expected to begin participating next year.

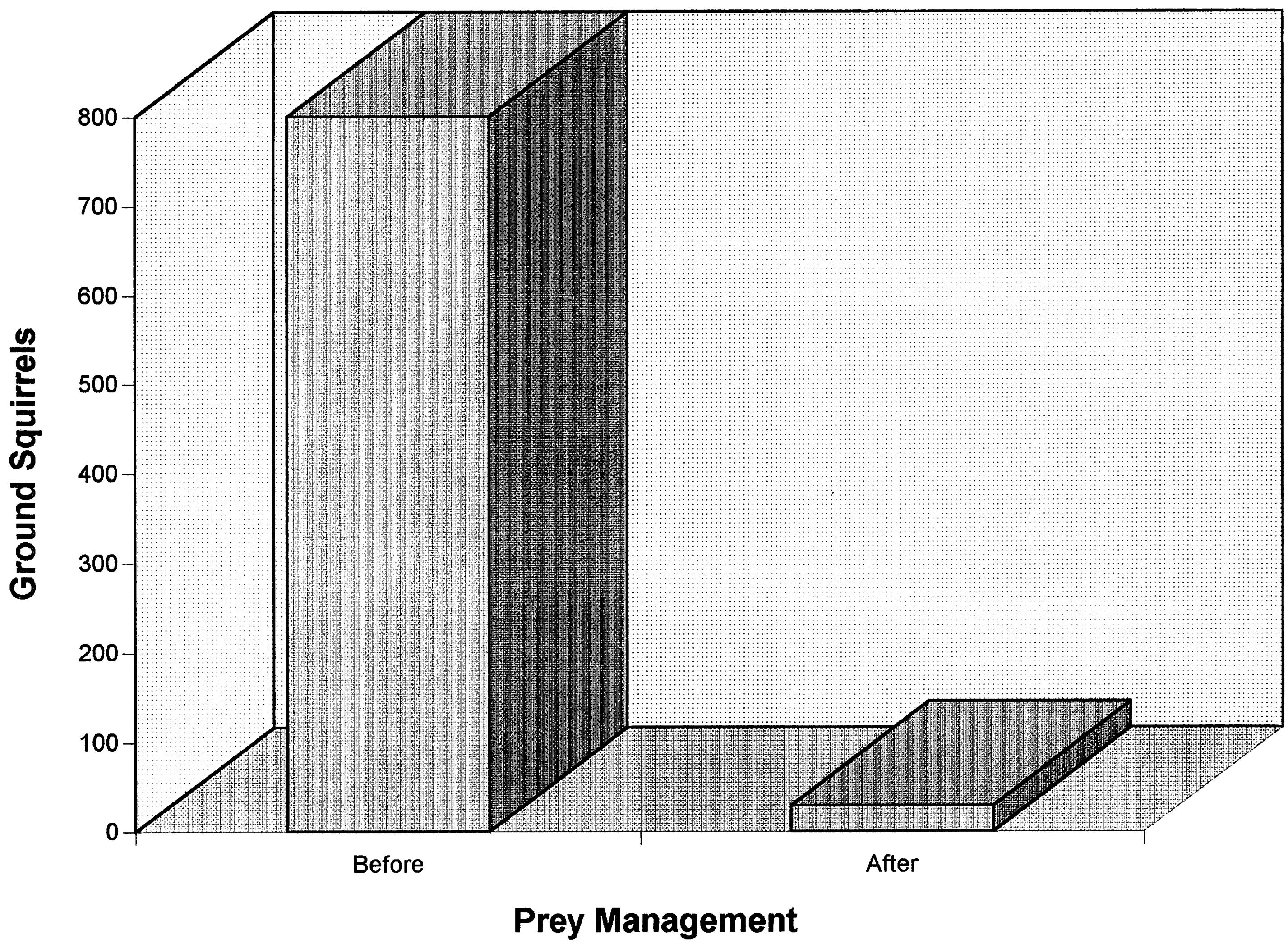
The program also funded post treatment surveys of ground squirrel activity in treated and untreated areas. Ground surveys of raptor activity were made at the same time. These surveys were completed October 31 and a written report is in preparation. Radio tracking of the radio-tagged Golden Eagles will only continue if funds become available. The NREL study is completed and it is our understanding that further funding by NREL is not contemplated. If funds permit, a follow up report will be prepared by Grainger Hunt of the Santa Cruz Predatory Bird Research Group. However, preliminary analysis has been completed with the following results:

- The efficacy of the ground squirrel management program for reducing the number of Golden Eagles foraging in the area around the turbines operated by the Altamont Consortium is readily apparent in Chart 1 and 2.
    - Chart 1 shows that the number of Golden Eagles observed on the Walker Family Ranch went from a high of 14 in a single pre treatment observation period to a high of 5 in a post treatment observations. A reduction of 64.3%.
    - Chart 2 shows that the highest pre treatment count of ground squirrels on the Walker Family Ranch was 800 squirrels. Within a few days of the treatment application, only 29 ground squirrels were observed, a reduction of 96.4%.

- There are two possible explanations for the fact that Golden Eagles still occupied the site after the ground squirrels had nearly disappeared.
    - First, they may at time forage on prey species other than ground squirrels, which are still present after ground squirrel management.


Walker Family Ranch
Golden Eagles
14
12
10
8
6
4
2
0
Before
After
Ground Squirrel Management

## Walker Family Ranch



    - Second, the birds that were seen may have been birds foraging in the nearby Contra Costa Water District (CCWD) where there is no ground squirrel management. The abundance of ground squirrels on the CCWD attracts eagles, which may wander onto the Walker Family Ranch.
- It should also be noted that the reduction in numbers of eagles seen may represent either a true reduction in numbers of eagles foraging on the Walker Family Ranch or it may be the same number of eagles foraging for less time on the ranch. In either case, the risk of impact with turbines on those eagles is potentially reduced via the prey management program.

## NEXT STEPS

The Consortium of Owners would like to meet with the Fish and Wildlife Service either in the field or in the appropriate agency offices in Sacramento and/or Portland to discuss the implementation of the avian plan.

Implementation will continue with the installation of perch guard devices and visual cues in the three treatment areas and the conduct of post treatment evaluations. These activities will continue throughout the Spring of 1998.

Upon completion of these tasks, the process of selecting the 1998 treatment areas will begin and pre treatment observations will commence. This cycle will continue for the balance of the five year implementation period. As recommended by the Service, Adaptive management will be employed to modify the program as needed.

# APPENDIX A

# Analysis of Golden Eagle and Red-tailed Hawk Fatalities on Altamont Ownership Consortium Property within the Altamont Wind Resource Area (AWRA)

14 October 1997

Report Prepared as part of the Altamont Avian Plan
for the Altamont Ownership Consortium

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**Executive Summary: Analysis of Golden Eagle and Red-tailed Hawk Fatalities on the Altamont Ownership Consortium Property within the Altamont Wind Resource Area (AWRA)**

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An analysis of Golden Eagle and Red-tailed Hawk fatalities at Kenetech Windpower Corporation/Altamont Ownership Consortium turbines located in the AWRA was conducted to determine how many and which turbines were involved. Specifically, the role of topographic and other discontinuities along turbine strings were examined via statistical and graphical analysis. The analysis revealed that discontinuities in turbine strings account for about two-thirds of all fatalities, but these occur at only a small minority of turbines. Three types of discontinuities were identified with fatalities: turbines at the end of turbine strings (especially those that were lower than turbines in mid-string), turbines situated at gaps in turbine strings (wider spacing than among evenly spaced turbines), and dips or notches (lower points in strings where valleys pass through ridges). In addition, there was suggestive evidence implicating a few turbines that were at the pinnacle of hills, especially those that were higher than others in the strings. The following bullets provide specific information about the analyses.

1. Fatalities of Golden Eagles and Red-tailed Hawks are highly nonrandom, occurring in clusters at a small proportion of turbines in the AWRA.
2. Of 3,412 turbines in 308 strings, 459 (13.4%) are responsible for all Golden Eagle and Red-tailed Hawk fatalities.
3. End and second to end turbines are responsible for nearly one-half (about 45%) of all fatalities, yet account for only one-third (34.1%) of all turbines.
4. 16 turbines (0.5% of all turbines) are responsible for 19.2% of all Golden Eagle fatalities; 27 turbines (0.8% of all turbines) are responsible for 16.6% of all Red-tailed Hawk fatalities (several turbines are responsible for both hawk and eagle deaths).
5. Gaps in turbine spacing in mid-string are responsible for 7% of Golden Eagle and 6.2% of Red-tailed Hawk fatalities.
6. Dips and notches in mid-string are responsible for 14.2% of Golden Eagle and 14.5% of Red-tailed Hawk fatalities.
7. Together, end turbines, gaps, and dips/notches are responsible for 67.9% of Golden Eagle and 60.3% of Red-tailed Hawk fatalities.
8. Turbines at the end of strings, and in gaps and dips/notches that are responsible for fatalities of both species total roughly 325 turbines (9.5% of all turbines)

These statistics are presented in Tables 1, 2, and 3, as well as in the attached Figures.

Our analysis strongly indicates that prevention of fatalities would be best accomplished by focusing on the turbines that have caused fatalities, primarily those associated with multiple fatalities and discontinuities (end of string turbines on steep hillsides that are lower than mid-string turbines, spacing gaps in turbine strings, and dips/notches where valleys cut through turbine strings resulting in turbines that are lower than mid-string turbines). Treating those turbines that fit these criteria and have a history of fatalities is recommended as the best strategy for reducing fatalities at Kenetech 56-100 turbines in the AWRA.

13 October 1997

Summary of Kenetech/Altamont Ownership Consortium Altamont Wind Resource Area Fatality Analysis - Golden Eagles and Red-tailed Hawks

Analysis done from Kenetech maps of eagle and hawk fatalities as reported in Kenetech Windpower Corporation's Wildlife Response and Reporting System provided to Curry and Kerlinger (1989-1996, 1997 data not included)

**Table 1**. Numbers of Kenetech/Altamont Ownership Consortium turbines involved in Golden Eagle and Red-tailed Hawk fatalities in the Altamont Wind Resource Area, Livermore, CA. Data set includes birds collected from 1989-1997, hence the discrepancy with Table 2 in numbers of birds involved). pt indicates number of fatalities per turbine.

| | Number of Turbines Involved | |
|---|---|---|
| | Golden Eagle | Red-tailed Hawk |
| 1 Fatality | 147 | 292 |
| 2 Fatalities | 13 | 23 |
| 3 Fatalities | 3 | 4 |
| Total Turbines | 163 (4.8%) | 319 (9.3%) |
| Number of Birds Involved | 182 | 350 |
| (Total Number of Turbines = 3,412) | | |
| Multiple Fatality Turbines | | |
| 2 and 3 Fatalities | 16 (35 eagles) | 27 (58 hawks) |
| Percent of All Turbines | 0.5% | 0.8% |
| Percent of Fatalities | 19.2% | 16.6% |
| All Fatalities | 182 eagles (1.12pt) | 350 hawks (1.10pt) |
| Total Turbines Involved | 163 | 319 |

**Table 2**. Summary of Golden Eagle and Red-tailed Hawk fatalities by location of in turbine strings for the Kenetech turbines in the entire Altamont Wind Resource Area, Livermore, CA.

| | | Fatalities (percent, per turbine) | |
|---|---|---|---|
| | | Golden Eagles | Red-tailed Hawks |
| Mid-string Turbines | 2,248 (65.9%) | 87 (53.7%, 0.039pt) | 181 (55.7%, 0.081pt) |
| End and 2nd-end Turbs (combined) | 1,161 (34.1%) | 75 (46.3%, 0.064pt) | 144 (44.3%, 0.124pt) |
| Total Turbines | 3,412 | | |
| Total Fatalities | | 162 | 325 |
| End-string Turbines | 615 (18.0%) | 44 (27.2%, 0.072pt) | 92 (28.3%, 0.150pt) |
| 2nd-end string Turbines | 546 (16.1%) | 31 (19.1%, 0.056pt) | 52 (16.0%, 0.095pt) |
| End and 2nd-End Turbines (combined) | 1,161 | | |
| Number of Turbine Strings | 308 | | |

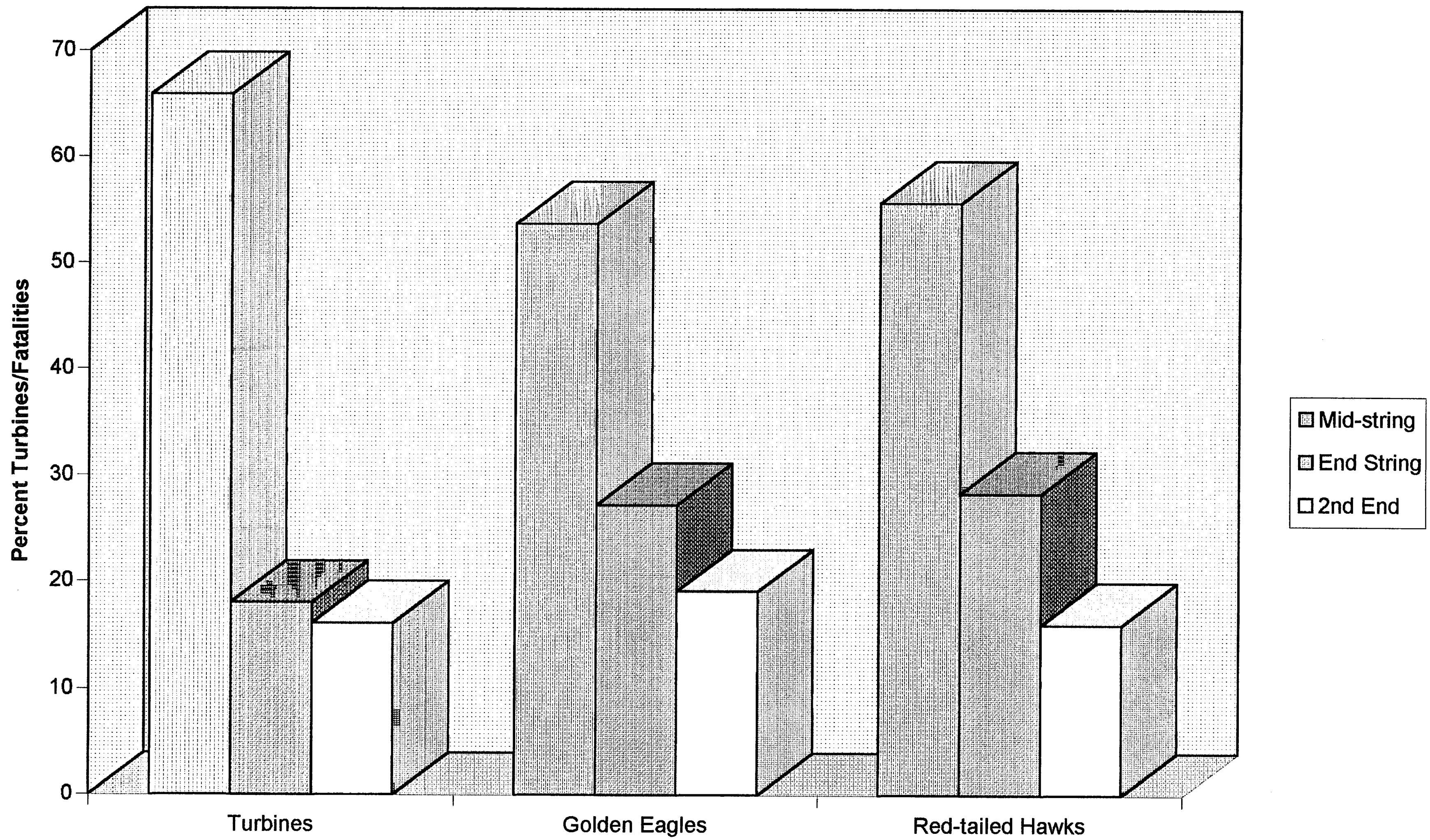
**Table 3**. Role of topographic features and turbine spacing discontinuities in Golden Eagle and Red-tailed Hawk fatalities among mid-string (more than second from the ends) turbines among Kenetech/Altamont Ownership Consortium turbines in the Altamont Wind Resource Area, Livermore, CA (1989-1996).

| | Fatalities (percent) | |
|---|---|---|
| | Golden Eagles | Red-tailed Hawks |
| Mid-string Turbines (N=2,248) | 87 (53.7%) | 181 (55.7%) |
| Totals | 162 | 325 |
| Mid-string Turbines | | |
| Gaps (wider spacing) | 12 ( 7.0%) | 20 ( 6.2%) |
| Topographic Notches/Dips | 23 (14.2%) | 47 (14.5%) |
| Gaps and Topo Notches/Dips (sum) | 35 (21.6%) | 67 (20.6%) |
| End String Turbines (N=1,161) | 75 (46.3%) | 144 (44.4%) |
| Sum of Fatalities at End Turbines, Gaps and Topo Notches (Discontinuities in Turbine Strings) | 110 (67.9%) | 211 (60.3%) |
| Fatalities at Mid-string Turbines less Gaps/Notches | 52 (32.1%) | 114 (35.0%) |
| Percentage of all Mid-string Fatalities Explained by Gaps/Notches | 40.2% | 37.0% |

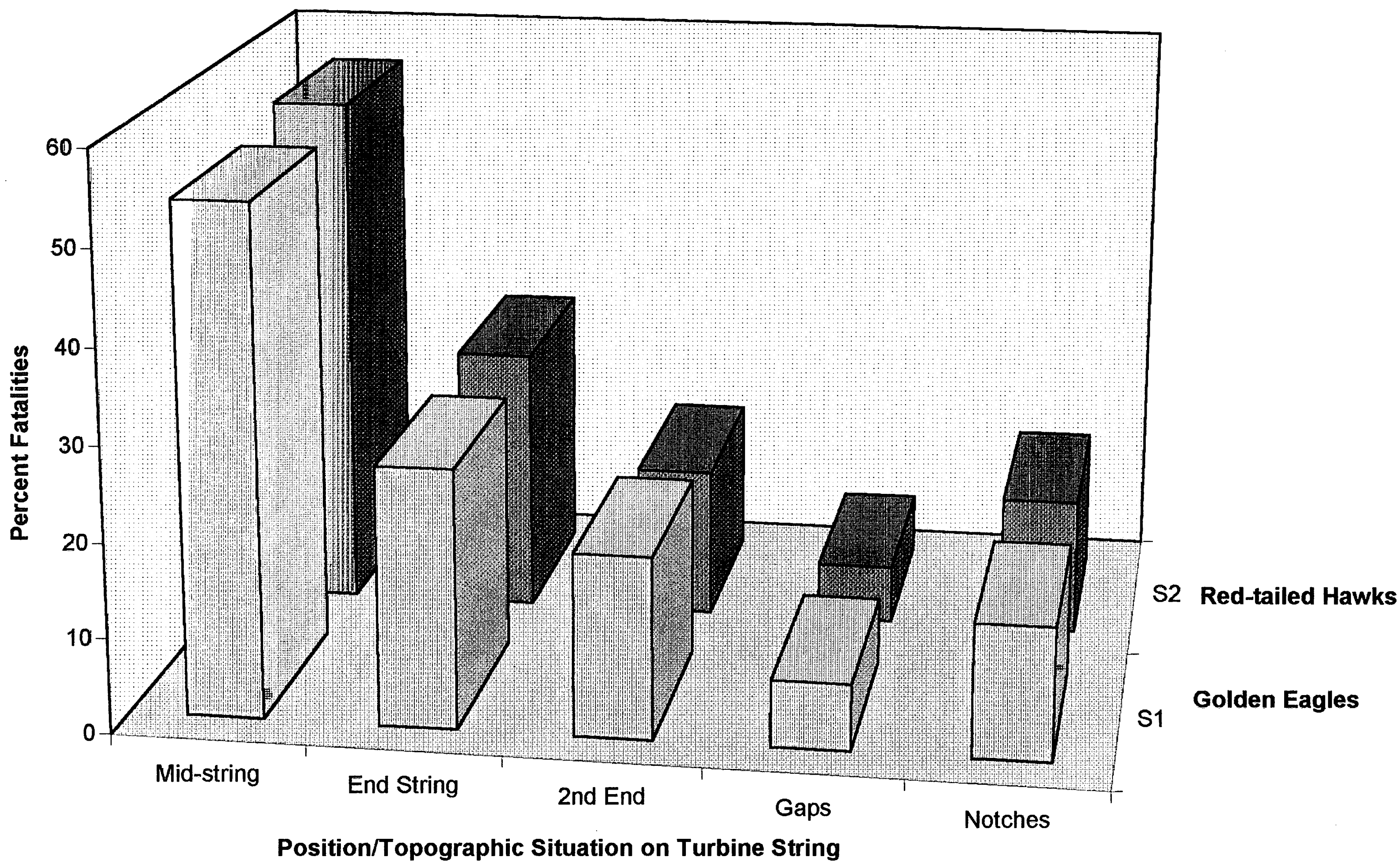
Figure 1. Golden Eagle and Red-tailed Hawk fatalities at end string and mid-string turbines as compared to the relative abundance of these turbines (Kenetech/Altamont Ownership Consortium turbines in the AWRA, Livermore, CA). Total number of turbines = 3,412. Note the disproportionately greater percentage of fatalities at end turbines as compared to mid-string turbines.

Figure 2. Comparison of the percentage of Golden Eagle and Red-tailed Hawk fatalities occuring at mid-string, end string, 2nd from end string, gaps, and notches. Gaps and notches are, respectively, mid-string turbines that occur where the spacing is greater between turbines or a slight depressions in ridges occur. Note the virtually identical patterns (correlation) for eagles and hawks strongly suggesting a similar causal mechanism of fatal incidents.

## Eagle and Hawk Fatalities at End and Mid-string Turbines



## Eagle and Hawk Fatalities by Position/Topographic Situation on Turbine String



# APPPENDIX B

# ALTAMONT OWNERSHIP CONSORTIUM AVIAN SAFETY PROGRAM: EVALUATION OF PERCH GUARDS AND FLIGHT DETERRENTS

26 October 1997

Revised 8 November 1997 as per Peer Review

Project Conducted for:

Altamont Ownership Consortium

Project Conducted by:

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## Introduction and Background

Fatalities of birds, particularly Golden Eagles and Red-tailed Hawks, are a major stumbling block for the continued operation and development of new windpower facilities in the United States and beyond. A large proportion of recorded fatalities have been associated with the Kenetech Windpower Inc. 56-100 turbines, especially those placed on KCS-56 60 foot tall, lattice towers located in the Altamont Wind Resource Area. These towers are the numerically dominant turbines in this area, which is near Livermore, California. These towers account for more than 90% of the >3,400+ turbines located there.

To date, several explanations have been proposed to explain how eagles and hawks are killed. All presuppose that raptors are attracted to the area by abundant ground squirrels, a favored prey. Raptors are then killed while attempting to perch or take off from turbine towers while the turbine blades are revolving. Fatalities is also suspected to be related to flight patterns of birds either flying through the Altamont wind plant or flight patterns related to hunting within the wind plant. Most likely, a combination of the above factors is responsible for raptor deaths. That is, ground squirrel availability is the proximate reason for the high density of raptors within the area and that behaviors associated with hunting in the Altamont are responsible for collisions with turbines. Birds that seek prey within the Altamont fly around the area looking for favorable areas in which to hunt, they hunt from the air, as well as perches, upon which they sometimes rest. All of these behaviors place birds at risk of colliding with turbines and do not necessarily work independently.

The project outlined herein is part of a renewed attempt to provide safety measures that will reduce and prevent deaths of Golden Eagles and Red-tailed Hawks (as well as other birds) in the Altamont Wind Resource Area. Specifically, the project details an evaluation procedure that will provide information for managers as to which turbine towers should be equipped with perch guards and which areas need flight deterrents. After the installation of several types of perch guards and flight deterrents, observations will be made to test the efficacy of these devices.

## General Objectives

1. To determine patterns of perching by Golden Eagles and Red-tailed Hawks primarily on KCS-56, 60 foot (and to a lesser degree, 80 foot) lattice towers on which 56-100 turbines are now operating

2. To determine the effectiveness of several devices for deterring Golden Eagles and Red-tailed Hawks from perching on KCS-56 towers and to evaluate their specific behavior at treated towers as well as at adjacent towers that have not been treated

3. To determine flight patterns and flight behaviors of birds within discrete units of the Altamont Wind Resource Area in relation to topography, wind, and turbine placement

4. To determine the effectiveness of visual flight deterrents placed at high risk locations where Golden Eagle and Red-tailed Hawk fatalities are clustered

## Methodology

### Selection of Study Sites

Three study areas were selected within Kenetech Windpower's wind plant near Livermore. The areas were selected because they included large numbers of raptor deaths during the period 1989-1997 reported by Kenetech Windpower Corporation's Wildlife Response and Reporting System. The system includes all deaths reported by field personnel, researchers, and others. Identification of these sites was made via mapping and analysis by Kerlinger and Curry (1997, report to owners of the wind plant and US Fish and Wildlife Service). The numbers of raptors that use the areas varies somewhat depending on current levels of ground squirrel control being implemented by farmers and county agricultural staff. All sites have historically hosted large numbers of raptors. A current effort to monitor ground squirrel and raptor abundance is being completed.

Within each of the three areas an observation point (OP) was selected to maximize several factors: large number of turbines, good visibility of the turbines, unimpeded visibility of a variety of topographic features including those identified as being risky to raptors, and that the presence of an observer at the OP would not inhibit or affect the behavior of raptors in the area (with the exception of the turbines immediately surrounding the OP).

These three sites are designated as:

1. Altamont Landfill - 92 turbines visible, OP at turbine number 4725
2. Gomes North - 111 turbines visible, OP at turbine number 6157
3. Walker Family Trust - 159 turbines visible, OP at turbine number 2677

## Description of Perch Guards and Flight Deterrents

### Perch Guards

A total of four types of perch guards will be placed on towers as described below and in EXHIBIT ~~Figure~~ 1 (diagram of KCS-56 turbine tower with position of perch guards).

1. Platform Cover: a polyester mesh material will be placed around the maintenance platform for workers and shady location for raptors - under nacelle. The flexible nature of the material and its high visibility will make it very difficult for raptors to perch. In addition, its high visibility will help birds to learn that they cannot perch on the platform cover. Platform covers will be installed on towers that are high risk sites based on records of previous deaths and on towers where behavioral information shows birds perch preferentially on certain towers.

2. Hardward Cloth: 1/2 inch galvanized wire will be positioned so that raptors are physically prevented from perching on cross-members #4 and #5 (all three sides of tower). This device

**Hypotheses to be Tested**

Hypothesis I: Perching is nonrandomly distributed in the wind plant - certain turbines (end of string) and topographic situations (higher on hillside) are used preferentially by raptors. and nonrandomly distributed on the structures themselves (certain portions of structures are preferred).

Test: Pretreatment observations will be designed to identify and document those locations that are favored or important perch sites, if they exist. Previous observations suggest greater amount of perching at end turbines, especially those located at the edge of a ravine/valley where unhampered visibility facilitates hunting from those perches. Data collection will facilitate decision making regarding the placement of perch guards in favored perching locations. Perching sites will be compared with fatality hotspot locations as identified by Kerlinger and Curry (1997).

Hypothesis II: Flight paths of raptors through and within the wind plant are non-randomly distributed (i.e., there are favored flight paths through the turbine strings including long valleys that narrow to a bottleneck/notch where killer turbines are situated; there are gaps [uneven spaces] between turbines through which raptors fly at low altitudes placing them at risk; there are flight paths around the end of turbines that are on steep hillsides bringing raptors into the proximity of rotating turbine blades).

Test: Pretreatment and Post-treatment observations will be designed to determine whether there are favored and well used flight paths through the wind plant that place birds in close proximity to revolving turbines, thereby placing them at risk. Behavioral observations will be designed to elucidate the location of flight paths and high risk areas. These flight paths will be compared to fatality hotspot locations as identified by Kerlinger and Curry (1997)

Hypothesis III: Perch guards reduce the frequency and duration of perching and perching attempts of raptors in the wind plant.

Test: Pretreatment observations of the frequency and behavior of perching will be compared to frequency and behavior of perching following installation of perch guards on turbines in two phases of perch guarding (prototype phase and larger implementation phase). Thus, there will be two, nonindependent tests of the efficacy of several types of perch guards.

Hypothesis IV: Flight deterrents alter or influence the flight paths of birds approaching high risk areas of the wind plant.

Test: Pretreatment and post prototype perch guard installation observations of flight paths and behavior of raptors moving into and out of discrete sections of the wind plant will be compared to flight paths and behaviors of raptors following flight deterrent installation. Flight deterrents will be designed to alert birds approaching risky areas as to the presence of revolving turbine blades. Moment to moment changes in direction and altitude of flight as birds approach flight deterrents will provide insight as to whether these devices are effective, as will changes in flight paths between the pre-flight deterrent treatment and following such treatment.

## Analysis and Interpretation of Data

Data will be collected via field data sheets of two types. The first will describe the behavior of birds with respect to presence in the wind plant and perching. The second will describe the flight paths of birds through and within the observation area during operations. This latter field sheet will be a map of the turbines being observed from the OP. Each bird's pathway will be mapped through the observed section (i.e., Gomes North) of the wind plant such that each birds path will appear as a line on the map along with notes on its behavior.

As data are collected by the two field technicians they will be entered from field data sheets into an Access data base/spread sheet. From this database, analyses will be made.

We anticipate the use of several types of statistical procedures to test the hypotheses listed above. Most importantly, contingency tables and Chi-Square analyses will be used to analyze frequency data. In concert, histograms of the frequencies will be constructed to demonstrate the magnitude of the results in a visual format. Chi-square analyses will show disproportional distributions of frequencies within tables that correspond to refutation of the null hypothesis made for each field test. For example, if the frequency and proportion of birds (number of birds that perch divided by number of birds present) in Gomes North is lower following installation of perch guards then the null hypothesis that no change in perching resulted from the installation. Similar analyses can be made to test the difference in effectiveness of the different types of perch guards.

A second type of analysis can be used to test the hypothesis that perch guards reduce perching of raptors on treated towers. Because duration of perching events will be recorded as a continuous variable, a parametric statistical test such as an ANOVA or t-test can be used to test the null hypothesis. Graphical presentation of the data will also be used to demonstrate the magnitude of the affects, if any.

Because of the nature and diversity of the audience (law enforcement officials, policy makers, business representatives, and concerned conservationists) that will be evaluating these results, we wish to keep statistical analyses as simple as possible. However, we feel that by providing a robust design (large numbers of observations and three replications - OPs) and by using the powerful tests outlined above, we will insure that statistically valid decisions can be achieved that will survive the scrutiny of scientific peer review.

Another result of the analyses and behavioral observations will be to create a set of rules for preventing fatalities of eagles and other raptors within wind plants. These rules are of crucial importance to the wind industry because they can be used to determine safe layout patterns of towers within wind plants, thereby reducing the overall risk of turbines to birds. Results of the analyses will also provide rules for constructing safety models/best practises for the industry as well as for regulators who oversee the development of future wind power facilities.

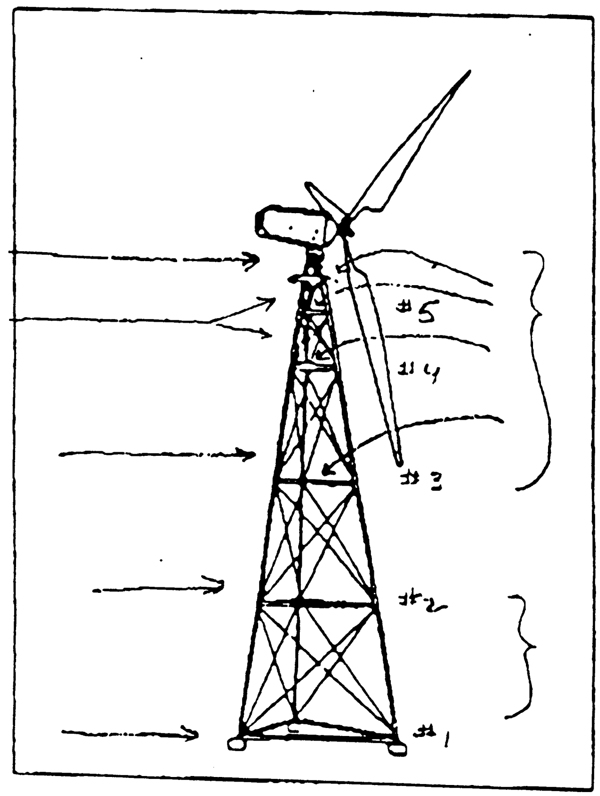
**Project Timetable**

| | |
|---|---|
| Pre-Treatment Observations<br>(3 weeks, 48 hours at each OP) | November- December 1997 |
| Perch Guard Installation - Prototypes | December 1997-January 1998 |
| Post Treatment Perch Guard Observations | January 1998 |
| Gomes North | Jan 5 (commence) |
| Altamont Landfill | Jan 17 |
| Walker Family Trust | Jan 30 |
| (3 weeks, 48 hours at each OP) | |
| Evaluation of Treatments | February 1998 |
| Completion of Perch Guard Installation<br>Gomes North<br>Altamont Landfill<br>Walker Family Trust | Mid April 1998 |
| Installation of Flight Deterrents | April-May 1998 (and ongoing) |
| Post Second Round of Treatments Observations<br>3 weeks, 48 hours at each OP | As treatments are completed |
| Evaluation of Treatments | April-May 1998 |
| Ongoing Observations Post Treatment<br>(one day per week, 2 hours per OP) | April-May through September |

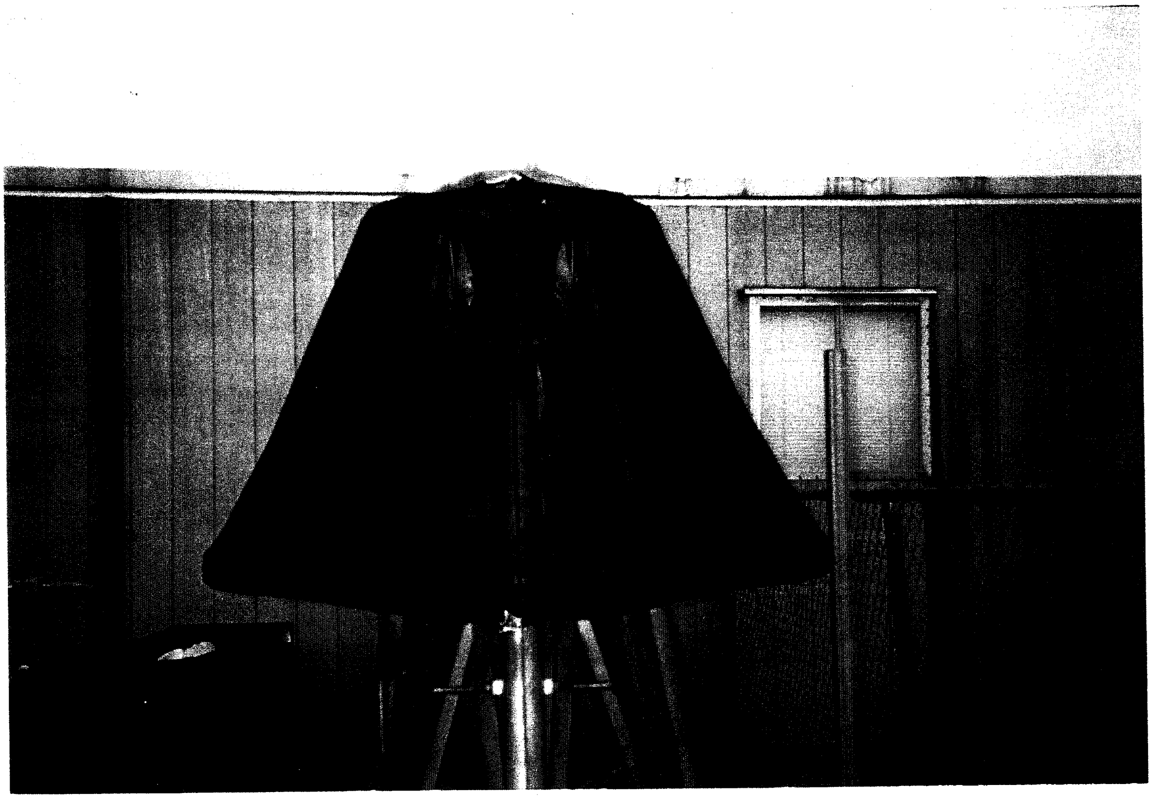
EXHIBIT ONE

PERCH GUARD DEVICES

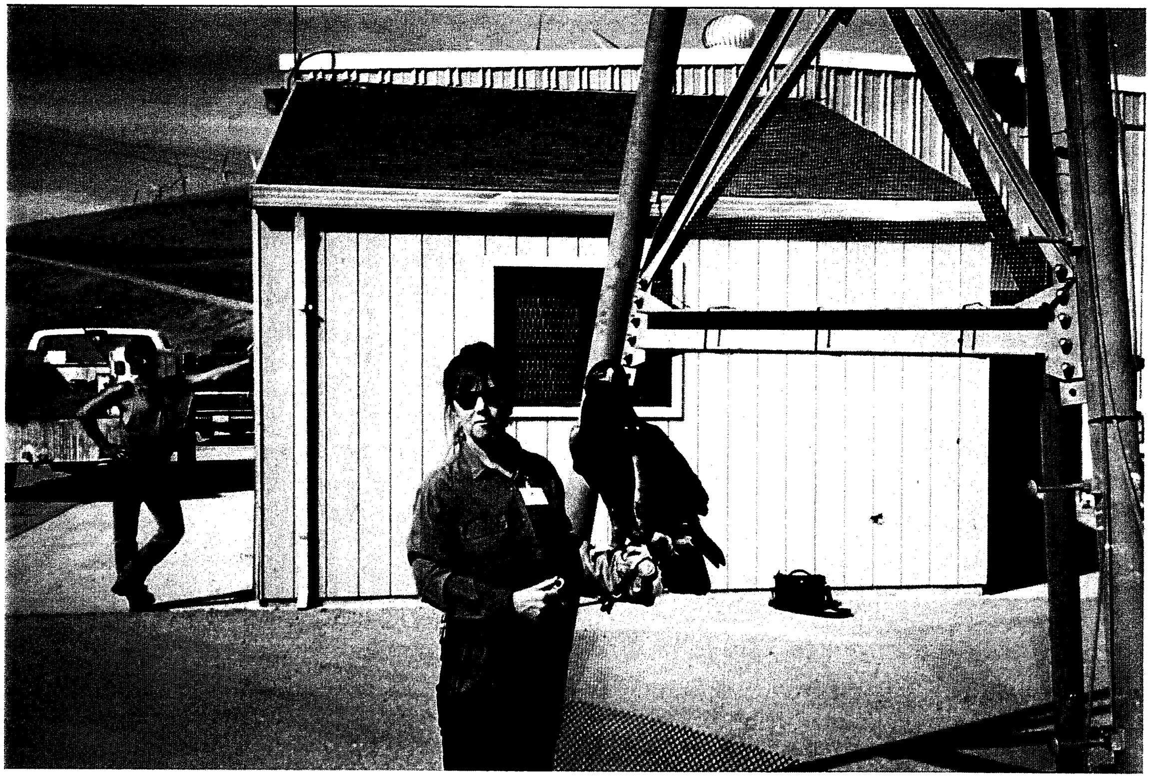
PERCH GUARDS FOR AVIAN SAFETY PROJECT



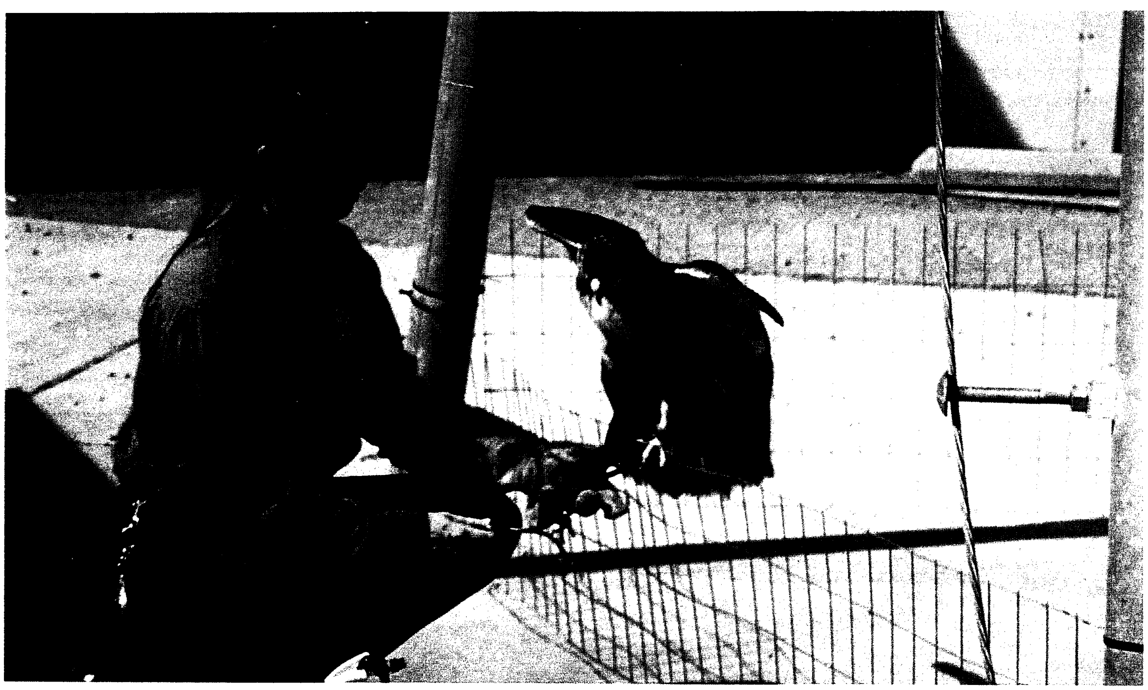
# PLATFORM COVER



HARDWARE CLOTH 1/2" MESH

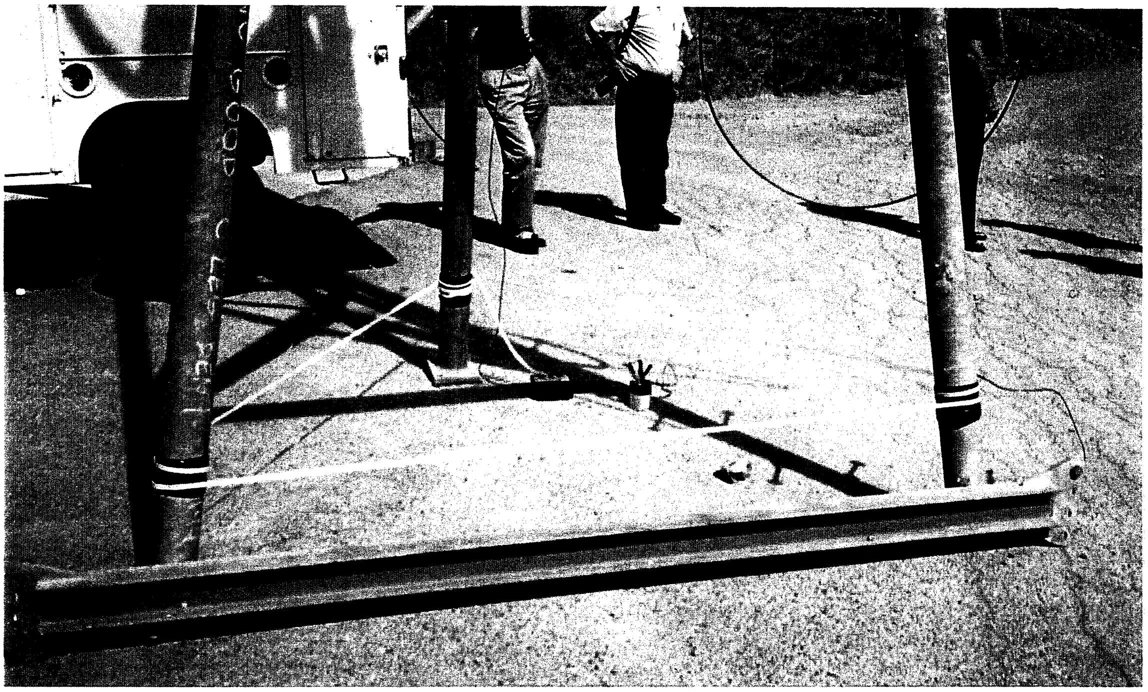


WIRE MESH



Note: The mesh shown here is 2"X4" and will be changed as indicated above in the report.

ELECTRICAL SHOCKING DEVICE
Initial Prototype



Note: After these tests were conducted, this device was replaced by the wires described earlier. In addition, the power source will come from the wind turbine system and will not rely on a battery as pictured above for power. In the initial installations the electrical shocking device will be installed on every other tower. The 4"X4" wire fencing material will be used on an alternating basis with the electrical shocking device.

Appendix I

**Species Codes**

| Primary Focal Species | Abbreviation/Code |
| --- | --- |
| Red-tailed Hawk | RTHA |
| Golden Eagle | GOEA |

| Secondary Focal Species* | |
| --- | --- |
| American Crow | AMCR |
| American Kestrel | AMKE |
| Burrowing Owl | BUOW |
| Common Raven | CORA |
| Ferruginous Hawk | FEHA |
| Northern Harrier | NOHA |
| Rough-legged Hawk | RLHA |
| Turkey Vulture | TUVU |

* (to be done only if time permits, i.e. primary focal species are not present)

Appendix II

**Behavioral and Other Codes - Instructions for Data Collection/Completing Data Sheets**

| | |
|---|---|
| Observer: | Observer Initials |
| Date/Time: | Example: 10-30-97/0900 |
| Site: | Name of site - Walker Family Trust, Altamont Landfill, or Gomes North |
| Weather: | |
| Temperature | Degrees F at beginning of observation period |
| Wind | Direction from in cardinal directions (e.g., NE, SW, etc.) and speed in mph |
| Cloud Cover | Percent of sky covered with clouds |
| Visibility | Excellent, Good, Fair, Poor, Fog/Haze (note which is appropriate |
| Notes | Raining, rain just ended, wind beginning at 1030, etc. |
| Turbine Blades | |
| R | Revolving - generating power or borderline generating power |
| NR | Not revolving (could be moving very slowly but not regularly turning) |
| S | Scout turbine turning, but others not |
| No. | On each day number observations with one observation number for each individual bird |
| Species: | Species initials, eg. RTHA, GOEA - see Appendix I, and note age where possible (A = adult, I = not adult) |
| IN | Time bird entered study area |
| OUT | Time bird left study area |
| Flight | |
| Low hunting | LH - coursing low over ground obviously searching for prey |
| Soaring | SO - slowly soaring in circles |
| Flapping | FL - flapping wings in direct flight |
| Flap and Glide | FG - flapping and gliding intermittently - moving directly |
| Gliding | GL - gliding on fixed wings - moving directly |
| Altitude | In feet above ground level |
| Direction | In cardinal directions (NE, SW, W, etc.) |
| Perching (use combination of codes below) | |
| Tower | Tower number |
| Y | Bird attempted to perch |
| N | Bird did not attempt to perch |
| 0 | Bird had no difficulty perching |
| 1 | Some difficulty encountered - wing movements and walking after which bird settled with wings folded |
| 2 | Great difficulty encountered - wing movements, walking, and |

| | |
|---|---|
| | leaving perch |
| 3 | Bird flared - not landing - avoiding perch - aborted perching attempt |
| Duration | Record the duration of time a bird spends on perch - up to three minutes - after which break off observations and look for next bird |
| 2nd | If bird goes to second perch after first, record as "2nd" and continue data as with first perch site, "3rd" is third perch etc. |

Perching Location (use combinations if necessary)

| | |
|---|---|
| PLT | Platform |
| C1-C5 | Crossmember numbers from 1 just above ground level to 5 just below platform |
| PG | Landed on perch guard |
| NA | Nacelle |
| OB | On turbine blade |
| CW | Crosswire |
| PG | Climbing Peg |
| TR | Transformer Box |
| ME | Meteorology Tower |
| GR | Ground/rocks |
| OT | other objects - indicate |

Turbine Blades (observations should be made for every bird that flies through the area - if turbine blades move the entire time that will be indicated in introductory notes above)

| | |
|---|---|
| R | Turbine blades revolving |
| NR | Turbine blades not revolving or moving very slowly but not entire revolutions |

| | |
|---|---|
| Comments | Variety of behavioral comments - interactions with blades, flaring when encountering blades, struck by blade, went between moving blades, etc. |

Flight Observations:

For the first 10 birds during each observation a flight map will be completed showing flight path over the ground and in relation to turbines. In addition, flight observations will be made on the regular data sheets in the "Flight" section. A map for each site (OP) (Figure 2) will be provided that shows where turbines and roads are located, as well as other landmarks that will help observers map flight behavior. On each map will provide space to record date, page number, species, and other pertinent information. The observer will commence the flight path lines where bird enters the observation area and use lines to track bird's course over the ground. Altitude, flight type (SO = soaring, FL = flapping, FG = flap and glide, LH - low hunting gliding, and GL = gliding will be recorded), whether a bird perches (cross referencing to data sheets will be via time), and other pertinent information will be written directly on the map adjacent to the flight paths. For paths that cross turbine strings observer should indicate whether bird went through string below, within, or above rotor swept area. For birds that fly around end turbines or through gaps in strings the distance to turbines and height compared to rotor swept area should be recorded.

**Perching and Flight Behavior Field Data Form**

page _____ of _____

Observer: ___________ Date/Time: __________ Site: __________________ Weather: Temp _____ Wind _________ %CC ______

Visibility: _______________ Turbine Blades _______ Notes ____________________________________________

| No. | Species | IN | OUT | FLIGHT | PERCHING | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | | | |
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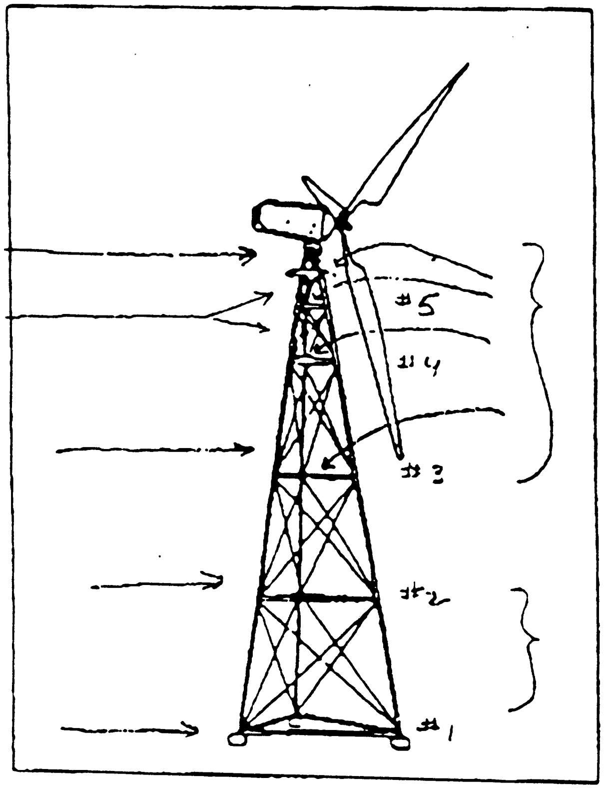
PERCH GUARDS FOR AVIAN SAFETY PROJECT



HAWK MOUNTAIN

**Hawk Mountain**
**Sanctuary Association**
1700 Hawk Mountain Road
Kempton, PA 19529-9449

Phone: 610•756•6961
Fax: 610•756•4468

30 October 1997

Dr. Paul Kerlinger
31 Jane Street, 14D
New York, NY 10014

Dear Paul,

Thank you for asking me to participate in the review of your wind-power proposal dated 26 October 1997.

Attached please find my review, together with marked-up copy of the proposal. My report consists of (1) general comments, (2) specific comments, and (3) numerous comments on the draft proposal.

Overall, I found the proposal to be both extremely well reasoned and well written. Therefore, most of my comments, especially those on the margins of the proposal, concern style, format, and proposal flow.

The comments that follow are intended to help you refine what appears to be a significant effort in practical conservation. Please feel free to contact me if any of my comments are unclear.

I have spent a total of four hours working on this review. The Sanctuary's consulting fees are set at $50 per hour. Please make the check out to hawk mountain Sanctuary Association, and send it to the Sanctuary c/o Keith L. Bildstein.

I look forward to your response.

Sincerely,

Keith L. Bildstein

Keith L. Bildstein
Director of Research
Encls.

# APPENDIX C

# THE INFLUENCE OF HIGH GROUND SQUIRREL DENSITIES ON THE OCCURRENCE OF GOLDEN EAGLES ON ALTAMONT OWNERSHIP CONSORTIUM PROPERTY

November 25, 1997

Report Prepared as part of the Altamont Avian Plan
for the Altamont Ownership Consortium

Report Prepared by:

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University of California
Santa Cruz, CA 95064
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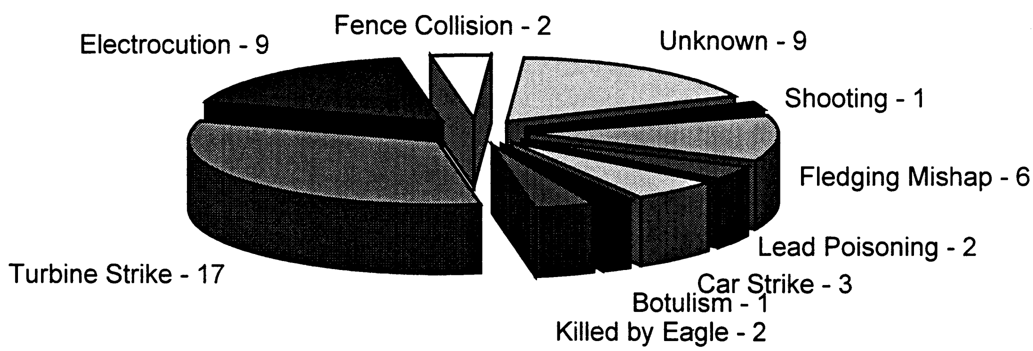
On the basis of foot surveys along the rows of wind turbines at the Altamont Pass Wind Resource Area (WRA) of California, Orloff and Flannery (1992) estimated that about 40 golden eagles (*Aquila chrysaetos*) are annually killed, principally by turbine blade strikes. Reports by Kenetech employees and others of 26 turbine-killed eagles in 1993 and 29 in 1994 within the WRA provide support for that estimate and suggest the possibility of even higher numbers of casualties. Because golden eagles are slow to reach maturity and reproduce less rapidly than most raptors, the U.S. Fish and Wildlife Service and others have expressed concern for the welfare of the population. Golden eagles are classified as a Species of Special Concern in California and are protected under the federal Bald Eagle Protection Act.

In January 1994, the Predatory Bird Research Group (PBRG) began a field investigation to estimate the impact of the turbine kills on the demographic trend of the population. The work, funded by Kenetech and by the National Renewable Energy Laboratory (NREL), centered on estimating survival and reproductive rate. Methods included the aerial monitoring of a large sample of radio-tagged eagles and an annual survey of breeding pairs. Results, detailed in two progress reports to NREL (Hunt et al. 1995,1996) and a final report soon to be completed, reveal a variety of human-related mortality agents operating upon the population, including turbine strikes, electrocutions, wire strikes, and lead poisoning, vehicle collisions, etc. (see below). Of 52 fatalities among the radio-tagged eagles recorded throughout the region through June 1997, at least 34 (65%) were human related. Twenty-six (50%) resulted from electrical generation or transmission (17 turbine blade strikes and 9 electrocutions). None of the electrocutions were in the WRA.

**Figure 6.1. Fatalities of 52 Golden Eagles Radio-tagged in the Diablo Range**




While investigating ways to reduce the rate of turbine-related mortality, Kenetech has experimented with increasing the conspicuity of turbine blades and with preventing eagles and other raptors from perching on the towers. Whether such measures would prove effective remains unknown, and equipment modifications may take several years to implement after corrective features are identified. An interim strategy would be to identify the factors attracting golden eagles to the WRA and to modify those factors in ways that would reduce the attraction. If, for example, prey were determined to be the primary reason golden eagles occur in the WRA, reducing prey numbers in the vicinities of the turbines might have the effect of reducing the numbers of eagle fatalities. Another solution might be to modify habitat factors affecting prey vulnerability, e.g., prey visibility or access to eagles, around the turbines.

During the course of PBRG's investigation, it soon became apparent that California ground squirrels (*Spermophilus beecheyii)* were the primary prey of golden eagles in the area. Of 339 prey items collected from golden eagle nests in the study area, the California ground squirrel comprised 69 percent of prey numbers and 64 percent of prey biomass. The next most important species were the black-tailed jackrabbit (*Lepus californicus*) at eight percent biomass and the black-tailed deer (*Odocoileus hemionus*) at six percent. PBRG researchers saw eagles attacking ground squirrels on many occasions both within and outside the WRA, the primary foraging mode being "contour hunting" in which the eagles glide low along the hillsides, surprising squirrels at close range. On windy days, these coursing flights along the turbulent ridges where wind machines are situated may render eagles especially vulnerable to collisions with turbine blades. Although no blade collisions have been witnessed, we have seen eagles fly close to the moving blades and even pass between adjacent turbine towers at or near blade level. These observations suggest that golden eagles are not appropriately aware of the danger associated with wind turbines.

This report describes our preliminary results and conclusions regarding the hypothesis that golden eagles are attracted to areas of high ground squirrel density in the WRA and that, as a result of this attraction, higher numbers of eagles are killed in such areas.

**Methods**

*Radio-telemetry*. From January 1994 to July 1996 we radio-tagged 179 golden eagles within about 30 km of the WRA. Of these, there were 79 juveniles (<1 year old), 45 subadults (1-3 years), 17 floaters (non-territorial adults), and 38 breeders (territory-holders). The effective samples in the advanced age categories enlarged during the study because surviving juveniles became subadults one year after fledging, near-adults survived to become adults, and several itinerant eagles became territorial. Each transmitter was designed to operate for at least four years and was equipped with a "mortality switch" controlling the pulse rate, a feature that allows the ready detection of fatalities.

Weather permitting, we conducted roll-call censuses of the study area once per week by airplane, beginning 14 January 1994. For this purpose we used a single engine Cessna (Skylane 182) fitted with side-facing antennas on the wing struts and a switch box in the cabin enabling separate monitoring of antennas. In each survey flight, we scanned all transmitter frequencies along a course designed to locate all the birds in the sample. The surveyed area extended from the Oakland Hills south through the Diablo Range to San Luis Reservoir. We recorded eagle locations by means of a GPS receiver and mapped the relocations on digitized habitat maps with Atlas GIS software.

*Ground Squirrel Surveys*. We conducted a visual survey of ground squirrels within the Kenetech Wind Area (KWA) in Alameda and Contra Costa Counties. From 14 to 26 June 1997, two teams drove all accessible roads daily at 10-15 mph within the KWA and counted (with hand counters) every ground squirrel visible to the unaided eye. We surveyed during times of assumed high above-ground activity so that counts would more accurately reflect actual numbers. In earlier (1994) surveys by PBRG, we found that above-ground squirrel activity was highest in the morning (once sunlight was upon burrows) and early evening (after midday temperature declined), so long as temperatures remained below 90 degrees. Based on these preliminary observations, we performed the surveys from 0700 to 1200 hours and at 1600 to 1900 hours. Survey hours varied according to weather conditions; surveys were not conducted on afternoons when temperature exceeded 95 degrees.

Each two-person team surveyed each area at least once. In general, the two teams surveyed two different areas simultaneously; with one team in an area of suspected or confirmed high ground squirrel numbers, and the other in an area of suspected low ground squirrel concentration. We counted ground squirrels on either side of the vehicle, each surveyor scanning his or her respective side. We recorded mileage, temperature, and other factors at the threshold of each surveyed area and at subsequent intervals defined by obvious landmarks, e.g., fences, buildings, or towers. Survey segments varied in size. When it was apparent that squirrels were clustered, segments greater than approximately 0.6 mile were reduced to reveal these local concentrations. We transferred ground squirrel density data and golden eagle sightings to detailed maps of the KWA.

We began by surveying the entire KWA twice. Each survey segment was then categorized as containing either high, moderate, or low numbers of ground squirrels, while areas of poor visibility, e.g., due to high, dense vegetation, were identified and excluded from categorization. High-density areas were defined as those where more than 12 ground squirrels were counted per 0.3 mile, and low areas as those with less than 3 seen per 0.3 mile. We conducted additional surveys (3-5) in medium-density segments and some in low-density segments to isolate ground squirrel concentrations within the area and/or to validate designations. For example, a high-density population might have initially been scored at a lower value because an unseen disturbance (predator, car) prior to our arrival caused squirrels to go into burrows. The reason for conducting the additional surveys was apparent in the behavior of squirrels we surveyed. As we drove along, squirrels typically ran for their burrows or stood erect and made alarm calls when we drove toward them. In one instance, we heard alarm calls and saw burrows and runways, but the count indicated a low- to medium-density of squirrels. We saw two eagles soaring in the area prior to our arrival which remained throughout the survey. The second time we surveyed this area, a high count was made. Counts were generally higher during the weekends when less people, e.g., windsmiths, were on site.

In summary, we based final determinations of low, medium, and high ground squirrel densities on the highest numbers observed in each area, irrespective of a lower count on a different day. Our rationale was that high counts were proof of high numbers of ground squirrels. In cases where areas designated as medium- and low-density may have actually contained higher numbers of ground squirrels, we tried to minimize the bias with repeated surveys, especially in areas exhibiting runways or other signs of ground-squirrel activity.

*Statistics*. To test for a relationship between ground squirrel and eagle distribution in the KWA, we selected five areas of high ground-squirrel density and five of low density. Using the GIS mapping software, we then created circles with 2.0 km diameters centering on the selected areas. Next, we overlaid the relocation points for all radio-tagged subadults and floaters located in the airplane surveys from September 1996 through June 1997. We counted the number of eagle relocations in each circle and subjected the series to several nonparametric statistical tests, including the Wilcoxon signed rank test, the null hypothesis being that there is no difference in eagle relocation frequency between areas of high and low ground squirrel densities.

**Results and Discussion**

*Trend in Eagle Distribution*: When we began the study in 1994, we recorded golden eagles in comparable numbers in both the northern and southern portions of the WRA. For example, the 249 eagle sightings we recorded in road surveys during May to November 1994 were distributed throughout most of the WRA (Figure 1). Likewise, during the 1994 aerial surveys, we obtained many relocations of radio-tagged eagles in both the northern and southern portions of the WRA. However, as the study progressed, we detected a smaller proportion of the radio-tagged sample in the southern portion of the WRA (Figure 2). The proportion of relocations recorded in the southern WRA declined from 0.32 in 1994 to 0.16 in 1997. The four maps in Appendix 1 show change that has taken place in the relocation data during the four years, 1994-1997. In viewing these maps, remember that sample sizes of radio-tagged eagles increased through 1996.

*Trend in Kill Distribution*. The trend of these observations is also reflected in the distribution of golden eagle casualties resulting from turbine strikes as reported by Kenetech. During 1994 and 1995, there were 11 casualties on the Mulqueeny Ranch in the southern KWA and 23 on the Walker/Jackson/CCWD ranches in the northern KWA. In 1996 and 1997 (to date), there were 2 casualties recorded on the Mulqueeny Ranch and 18 on the northern ranches.

*An Initial Search for an Explanation*. We wondered if the perceived changes in the distributions of radio-tagged eagles and eagle casualties might be caused by differences in ground squirrel densities in the northern and southern portions of the WRA. Therefore, beginning at 1248 hrs. on June 4, 1997 (cloudy, temperature 71-76 degrees F), we conducted a 22-minute visual survey for ground squirrels on all major roads of the Mulqueeny Ranch south of Patterson Pass Road and observed one ground squirrel. We quickly traveled north to the Jackson Ranch, beginning our survey at 1330 hrs. We counted 136 ground squirrels in 21 minutes (partly cloudy, temperature 71-74 degrees). These observations agreed well with current relocation data of radio-tagged eagles: we had recorded very few on the southern Mulqueeny ranch for many months.

The next day, Hunt phoned Mrs. Lorie Cornwell, the manager of the Mulqueeny properties. She explained that the ground squirrel control program normally in place on the ranches had lapsed in 1994 but had been resumed in late summer 1995. As a matter of interest, in conversing with Mr. Jim Smith, the agricultural biologist for Alameda County, Lougheed learned that farmers and ranchers throughout the region practice ground squirrel control, doing so with anticoagulants administered each summer.

*KWA Ground Squirrel Survey*. The ground squirrel surveys conducted throughout the KWA during 14 - 26 June 1997 revealed dramatic area differences in squirrel densities. Not surprisingly, the surveys confirmed the conclusion suggested in our brief, earlier surveys that densities were very high on the Jackson and Walker ranches and the Contra Costa Water District in the northern portions of the KWA, and very low on the Mulqueeney ranches in the southern portion. Moreover, there were other identifiable areas of high and low squirrel densities throughout. These results presented an opportunity for comparison with the golden eagle relocation data obtained during our aerial surveys.

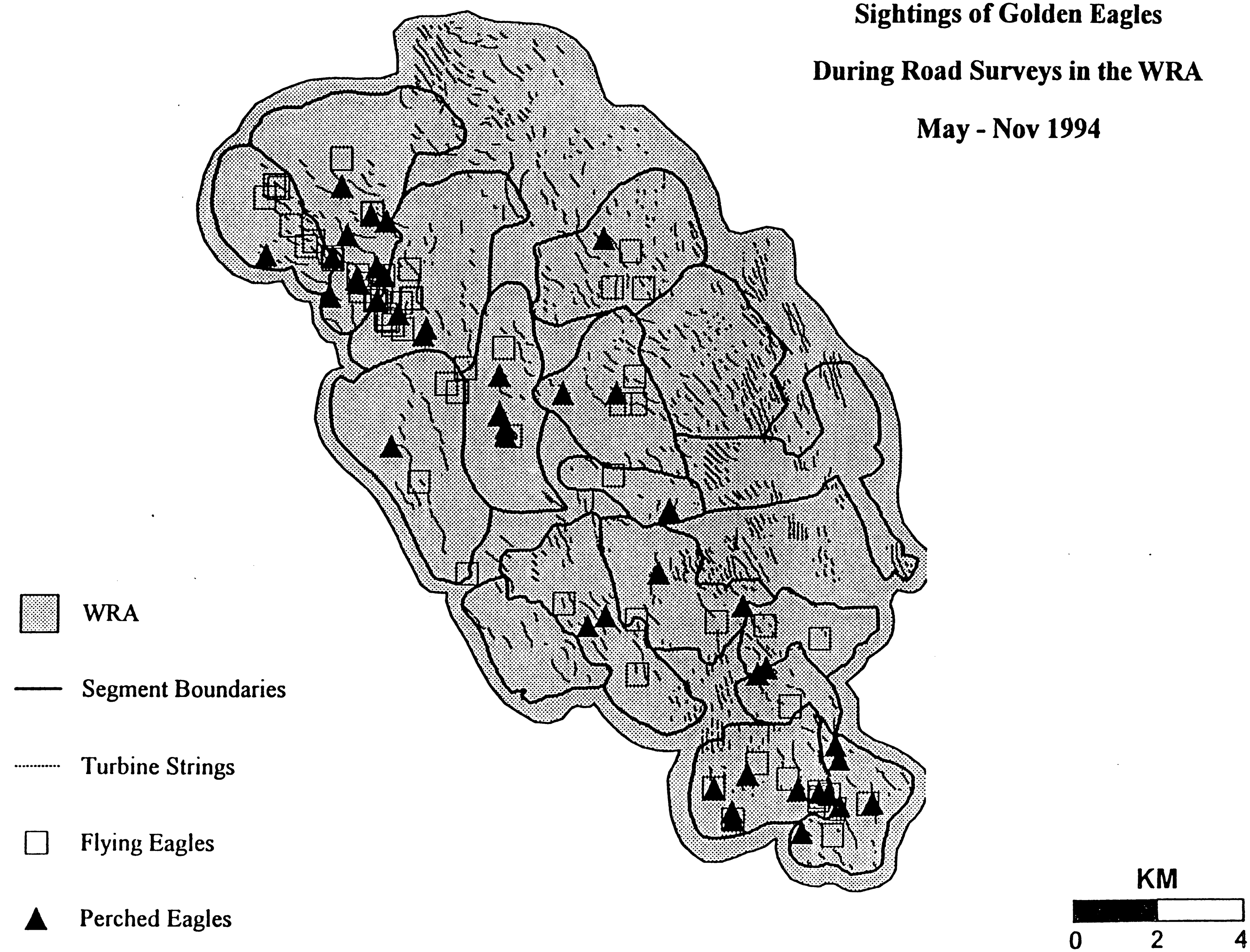
We selected ten circles in the KWA, each 2-km in diameter. Five were characterized as containing a high-density of ground squirrels and five contained low densities. We then counted the number of eagle relocations (subadults and floaters only) recorded from September 1996 through June 1997 in each of the ten circles. The null hypothesis in these comparisons was that there was no difference between the number of eagle relocations in high and low density squirrel

# Figure 1

**Sightings of Golden Eagles**

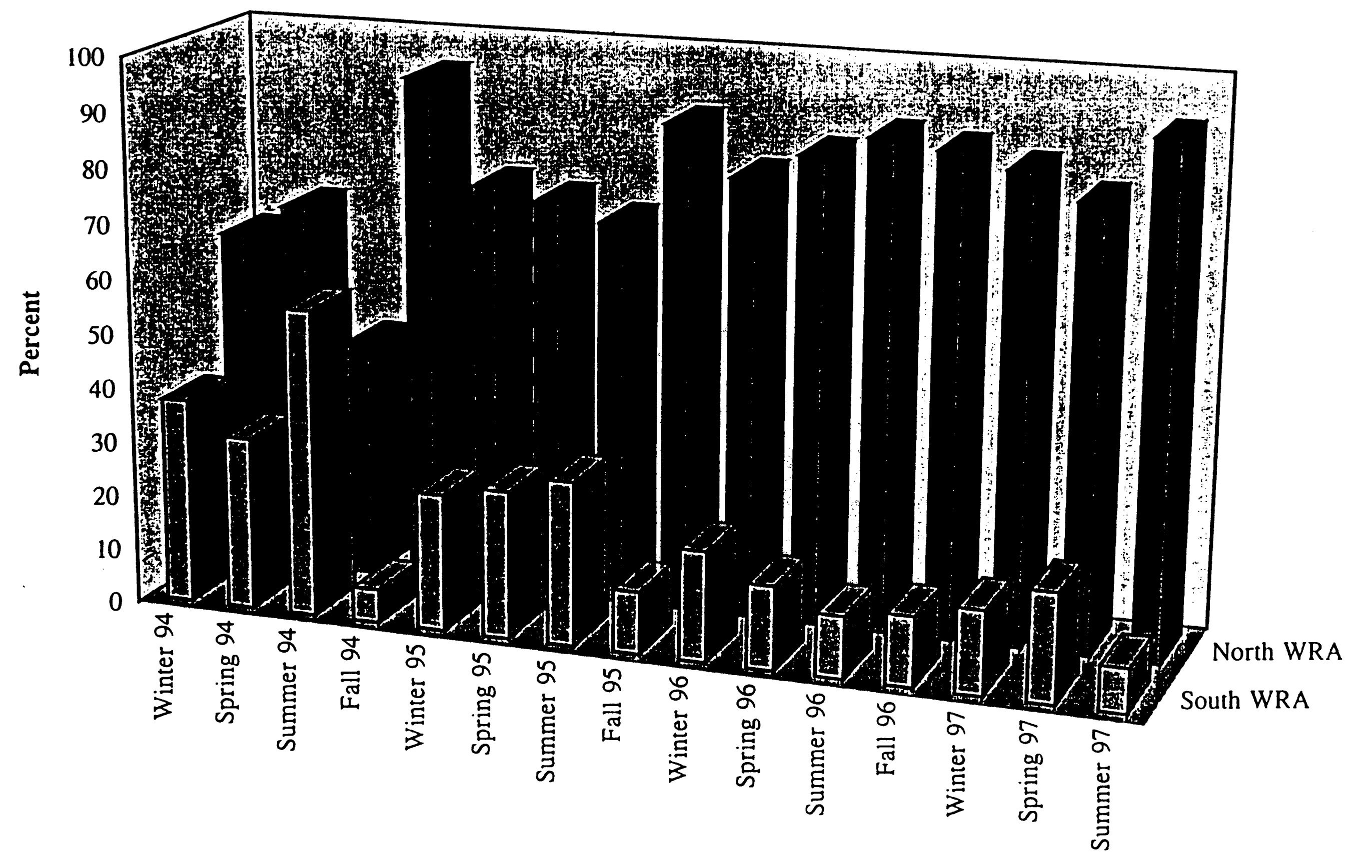
**During Road Surveys in the WRA**

**May - Nov 1994**



# Figure 2

**Percent of Itinerant Golden Eagle Relocations in the North and South WRA Per Season January 1994 - July 1997**



plots. The results were as follows: in the high density squirrel plots there were 9, 39, 26, 13, and 10 eagle relocations, and in the low density areas there were 0, 3, 0, 2, and 1 relocations. The several nonparametric tests were all significant in relating squirrel density with eagle relocations (Appendix 2).

## Conclusion

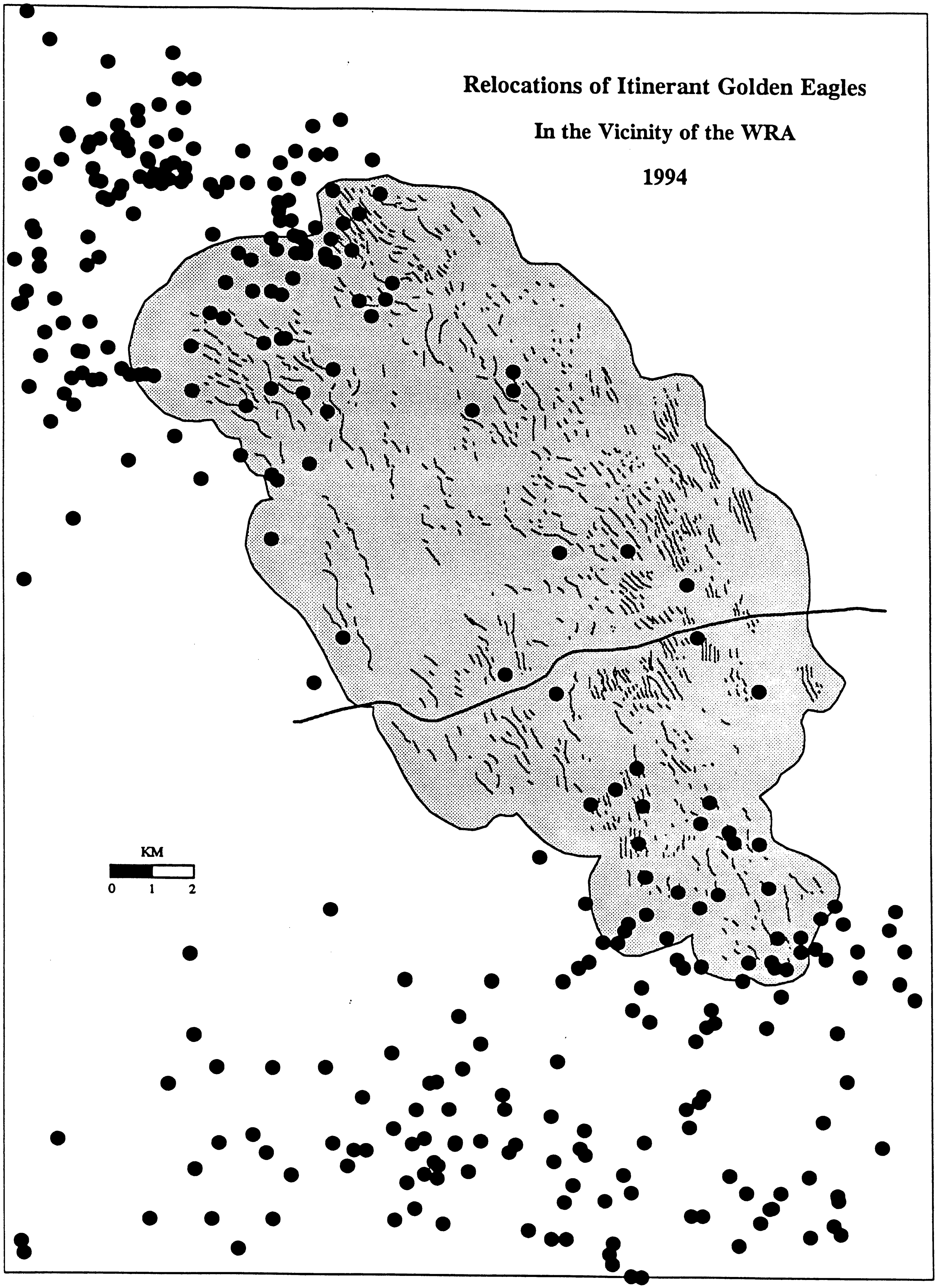
All our observations and analytical findings suggest that eagles are attracted to areas of high ground squirrel density in the WRA. Obviously, an increased risk to eagles exists where high numbers of ground squirrels frequent the vicinities of active wind turbines. It follows that a reduction in the number of ground squirrels around the turbine strings could reduce the number of eagles present and thereby reduce the number of blade strike kills.

## Recommendation

If a program is implemented to control ground squirrel densities around the wind turbines, it is highly advantageous to document the influence of this potentially effective management action on golden eagle occurrence in the WRA and the rate of turbine strike kills relative to eagle occurrence. We propose to continue the aerial surveys for radio-tagged eagles every two weeks. NREL support for these surveys ceased in mid-June 1997, but we continued them through September with funding from Kenetech. There are still 40-50 radio-tagged subadults and floaters spread through the study area, but we propose doubling this sample to assure a sufficient number of relocations in the WRA vicinity for the accurate determination of WRA-use or non-use. The analysis would also require periodic repetition of the ground squirrel surveys by Kenetech employees or by PBRG if needed.

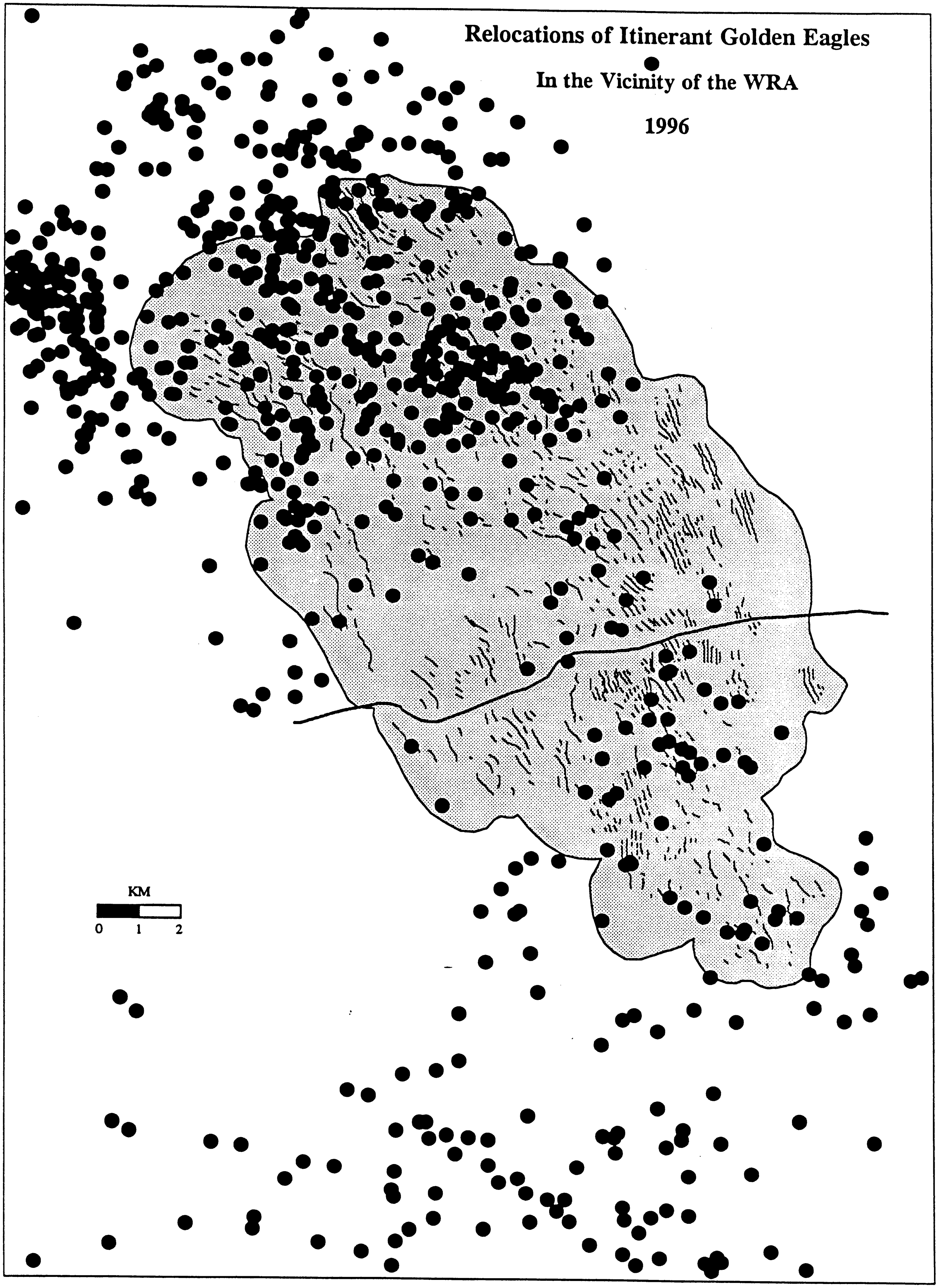
## Appendix 1

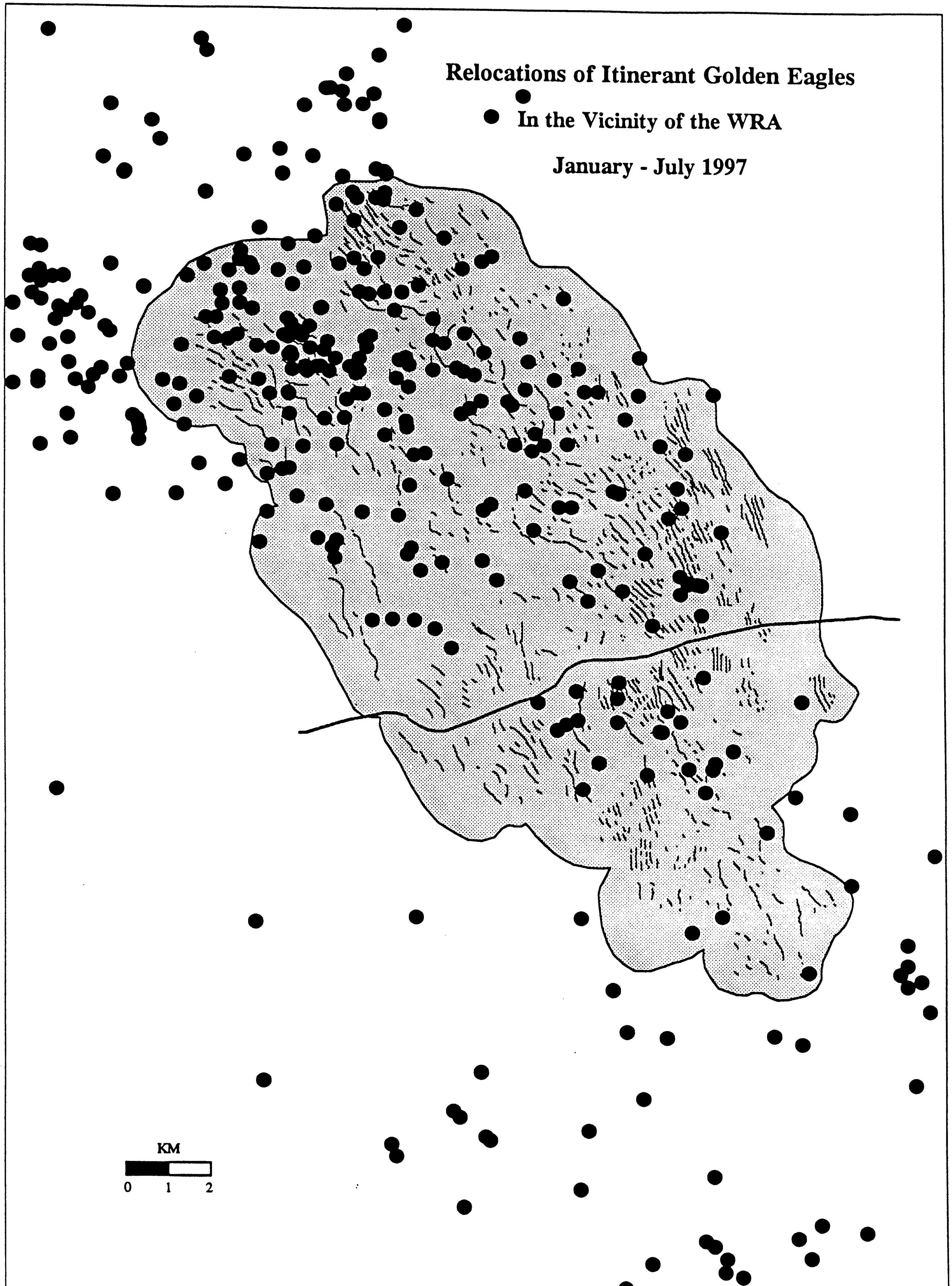
## Relocations of radio-tagged subadults and floaters in relation to the WRA



Relocations of Itinerant Golden Eagles
In the Vicinity of the WRA
1994
KM
0
1
2


Relocations of Itinerant Golden Eagles
In the Vicinity of the WRA
1995
KM
0 1 2


Relocations of Itinerant Golden Eagles
In the Vicinity of the WRA
1996
KM
0 1 2



Relocations of Itinerant Golden Eagles
In the Vicinity of the WRA
January - July 1997
KM
0 1 2

## Appendix 2

## Results of statistical tests relating the occurrence of radio-tagged eagles to ground squirrel abundance

Analysis of Variance for Variable EAGLE
Classified by Variable TRT

| TRT | N | Mean | Among MS | Within MS |
|---|---|---|---|---|
| | | | 828.100000 | 84.0000000 |
| 2 | 5 | 19.4000000 | | |
| 1 | 5 | 1.2000000 | | |
| | | | **F Value** | **Prob > F** |
| | | | 9.858 | **0.0138** |

Average Scores Were Used for Ties

Wilcoxon Scores (Rank Sums) for Variable EAGLE
Classified by Variable TRT

| TRT | N | Sum of Scores | Expected Under H0 | Std Dev Under H0 | Mean Score |
|---|---|---|---|---|---|
| 2 | 5 | 40.0 | 27.5000000 | 4.77260702 | 8.0 |
| 1 | 5 | 15.0 | 27.5000000 | 4.77260702 | 3.0 |

Average Scores Were Used for Ties

Wilcoxon 2-Sample Test (Normal Approximation) (with Continuity Correction of .5)
S = 40.0000 Z = 2.51435 Prob > |Z| = **0.0119**

T-Test Approx. Significance = **0.0331**

Kruskal-Wallis Test (Chi-Square Approximation) CHISQ=6.8598; DF=1 Prob>CHISQ = **0.0088**

Median Scores (Number of Points Above Median) for Variable EAGLE
Classified by Variable TRT

| TRT | N | Sum of Scores | Expected Under H0 | Std Dev Under H0 | Mean Score |
|---|---|---|---|---|---|
| 2 | 5 | 5.0 | 2.50000000 | 0.833333333 | 1.0 |
| 1 | 5 | 0.0 | 2.50000000 | 0.833333333 | 0.0 |

Average Scores Were Used for Ties

Median 2-Sample Test (Normal Approximation)
S = 5.00000; Z = 3.00000; Prob > |Z| = **0.0027**

Median 1-Way Analysis (Chi-Square Approximation)
CHISQ = 9.0000; DF = 1; Prob > CHISQ = **0.0027**

Van der Waerden Scores (Normal) for Variable EAGLE
Classified by Variable TRT

| TRT | N | Sum of Scores | Expected Under H0 | Std Dev Under H0 | Mean Score |
|---|---|---|---|---|---|
| 2 | 5 | 3.31116194 | 0.0 | 1.30440814 | 0.662232388 |
| 1 | 5 | -3.31116194 | 0.0 | 1.30440814 | -.662232388 |

Average Scores Were Used for Ties

Van der Waerden 2-Sample Test (Normal Approximation)
S = 3.31116 Z = 2.53844 Prob > |Z| = **0.0111**

Van der Waerden 1-Way Analysis (Chi-Square Approximation)
CHISQ = 6.4437; DF = 1; Prob > CHISQ = **0.0111**

Savage Scores (Exponential) for Variable EAGLE
Classified by Variable TRT

| TRT | N | Sum of Scores | Expected Under H0 | Std Dev Under H0 | Mean Score |
|---|---|---|---|---|---|
| 2 | 5 | 3.22817460 | 0.0 | 1.40087858 | 0.645634921 |
| 1 | 5 | -3.22817460 | 0.0 | 1.40087858 | -.645634921 |

Average Scores Were Used for Ties

Savage 2-Sample Test (Normal Approximation)
S = 3.22817 Z = 2.30439 Prob > |Z| = 0.0212

Savage 1-Way Analysis (Chi-Square Approximation)
CHISQ = 5.3102 DF = 1 Prob > CHISQ = **0.0212**

Kolmogorov-Smirnov Test for Variable EAGLE
Classified by Variable TRT

| TRT | N | EDF at Maximum | Deviation from Mean at Maximum |
|---|---|---|---|
| 2 | 5 | 0.0 | -1.11803399 |
| 1 | 5 | 1.0 | 1.11803399 |
| | ---- | ----------- | |
| | 10 | 0.5 | |

Maximum Deviation Occurred at Observation 7; Value of EAGLE at Maximum 3.00000000

Kolmogorov-Smirnov 2-Sample Test (Asymptotic)
KS = 0.500000 D = 1.00000
KSa = 1.58114 Prob > KSa = 0.0135