

Forecasting and Minimizing Avian Mortality in Siting Wind Turbines

ESRI EGUG Conference
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Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

UCRL-PRES-204092

Acknowledgement

**Shawn Smallwood, Ph.D. for
all of the avian data and for
collaboration on the modeling
analysis**



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Site Footprints

San Geronio
Altamont
Pacheco
Tehachapi
Solano

GIS Fly Throughs

Tehachapi
Altamont

Altamont GIS Demo

Avian Study Results

Bathymetry Overview

North Coast
Mid Coast
South Coast
San Diego

Overview



- List of Tasks
- What we have accomplished ...
- Altamont
- Web Capabilities
- Deliverables
- The Next Step

California Wind Resource Analysis Site

Funding provided by:
California Energy Commission
Lawrence Livermore National Laboratory

Solano
Altamont
Pacheco
Tehachapi
San Geronio

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GIS Fly Throughs
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Bathymetry Overview
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Reports

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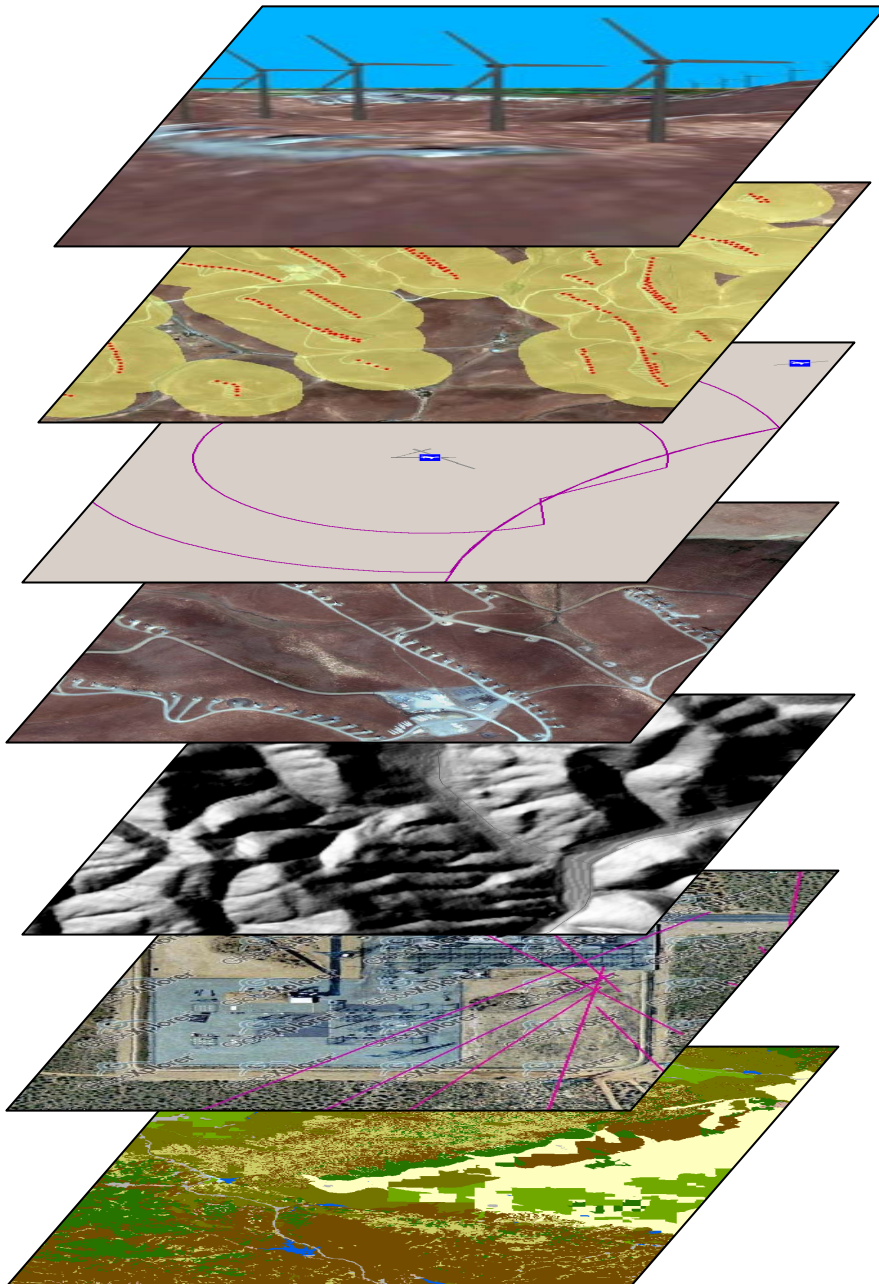
What we have accomplished



1. **Procured Satellite Imagery**
2. **Assembled required data layers to support the project**
3. **ArcGIS Server Structure**
4. **Avian Data Modeling**
5. **Demonstration Website**



Data acquired for each of the five sites



Lat/Lon for most turbine locations

Footprint of turbine area
with a 200m buffer

FAA data – airspace, airports and
runways

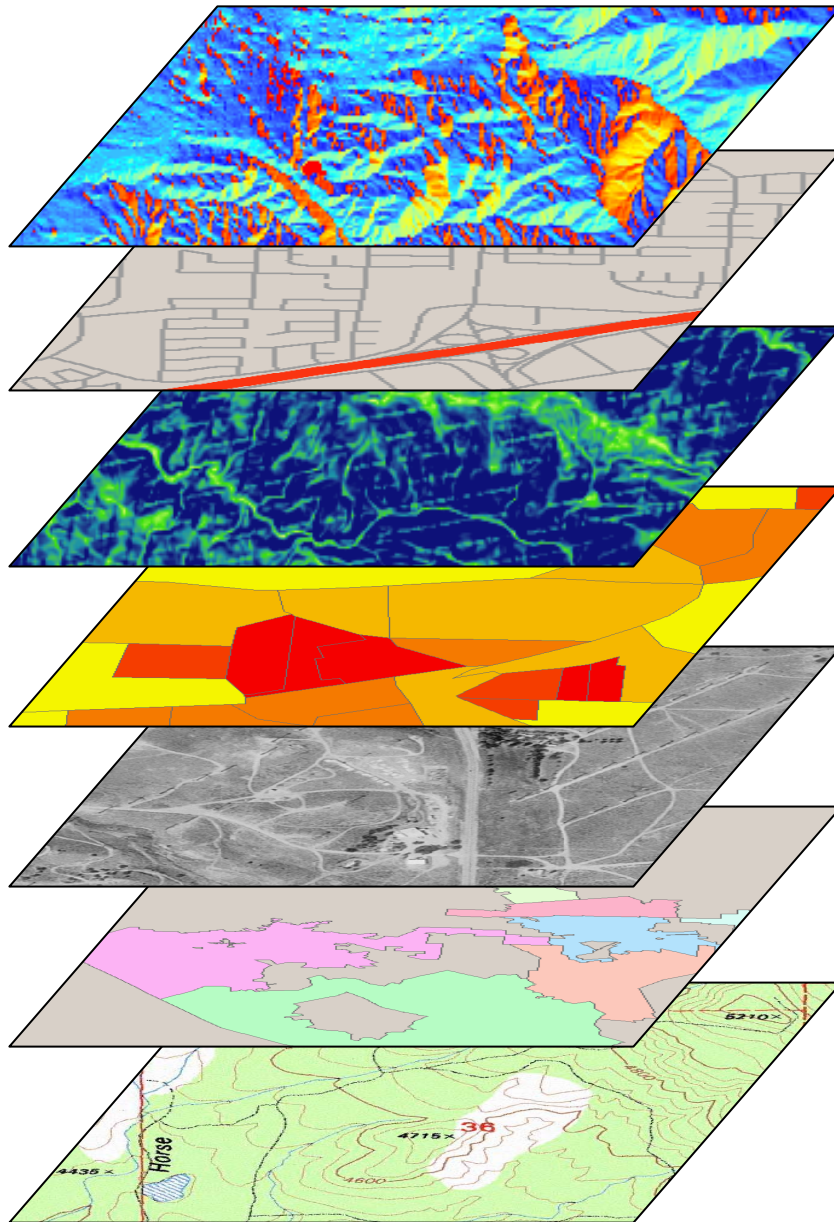
Satellite Imagery

Digital Elevation Models (DEM)
10 and 30m

Transmission lines and substations

Landcover / landuse

Data acquired for each of the five sites



Aspect

Street network

Slope

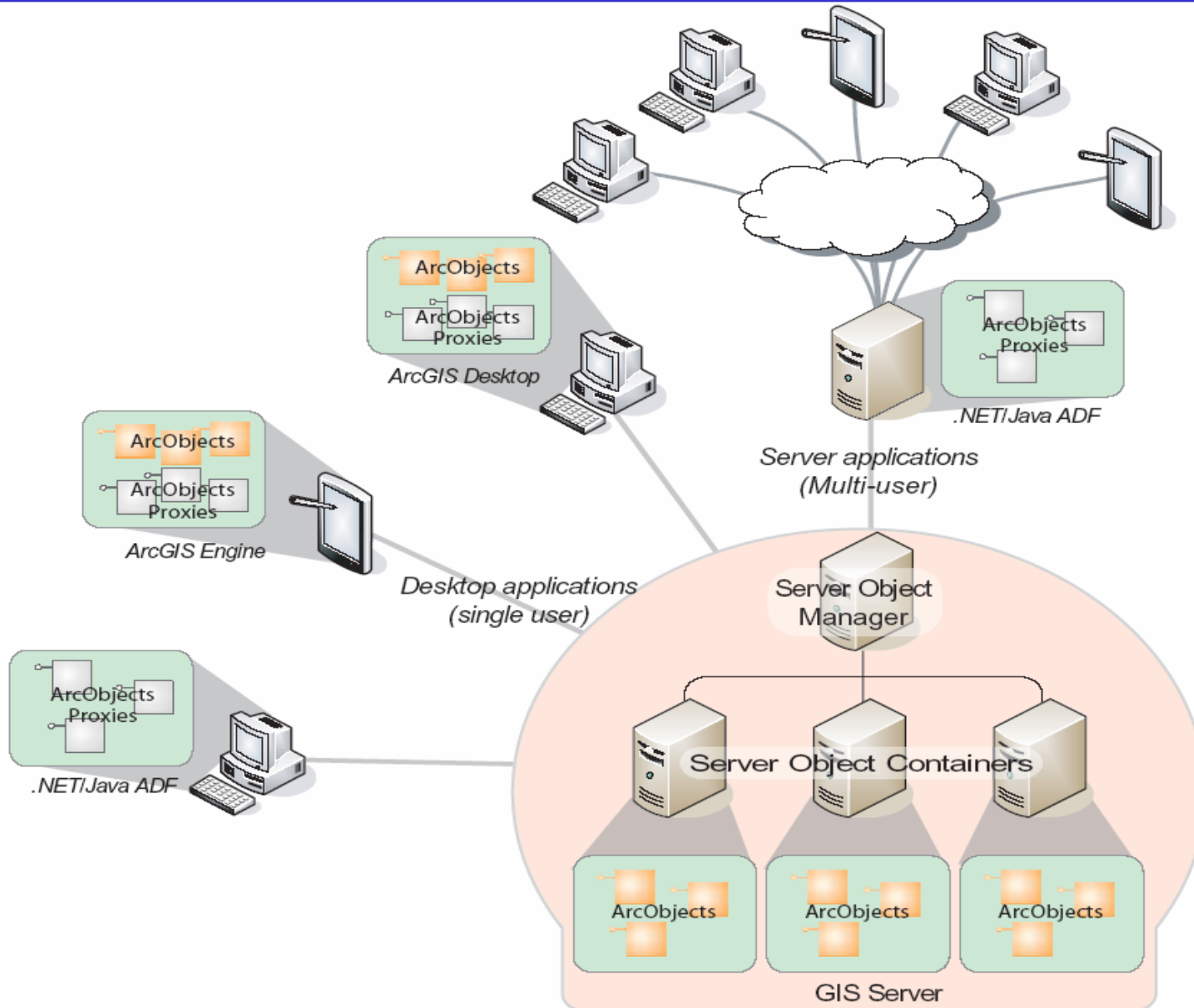
Population Density

Digital Ortho Quarter Quads (DOQQ)

Towns and cities

Digital Raster Graphics (DRG)

ArcGIS Server Structure



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GIS Fly Throughs

- Statewide
- Tehachapi
- Altamont

Altamont GIS Analysis

Avian Study Results

Bathymetry Overview

- North Coast
- Mid Coast
- South Coast
- San Diego

Reports

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Site Footprints

San Geronio
Altamont
Pacheco
Tehachapi
Solano

GIS Fly Throughs

Statewide
Tehachapi
Altamont

Altamont GIS Analysis

Avian Study Results

Bathymetry Overview

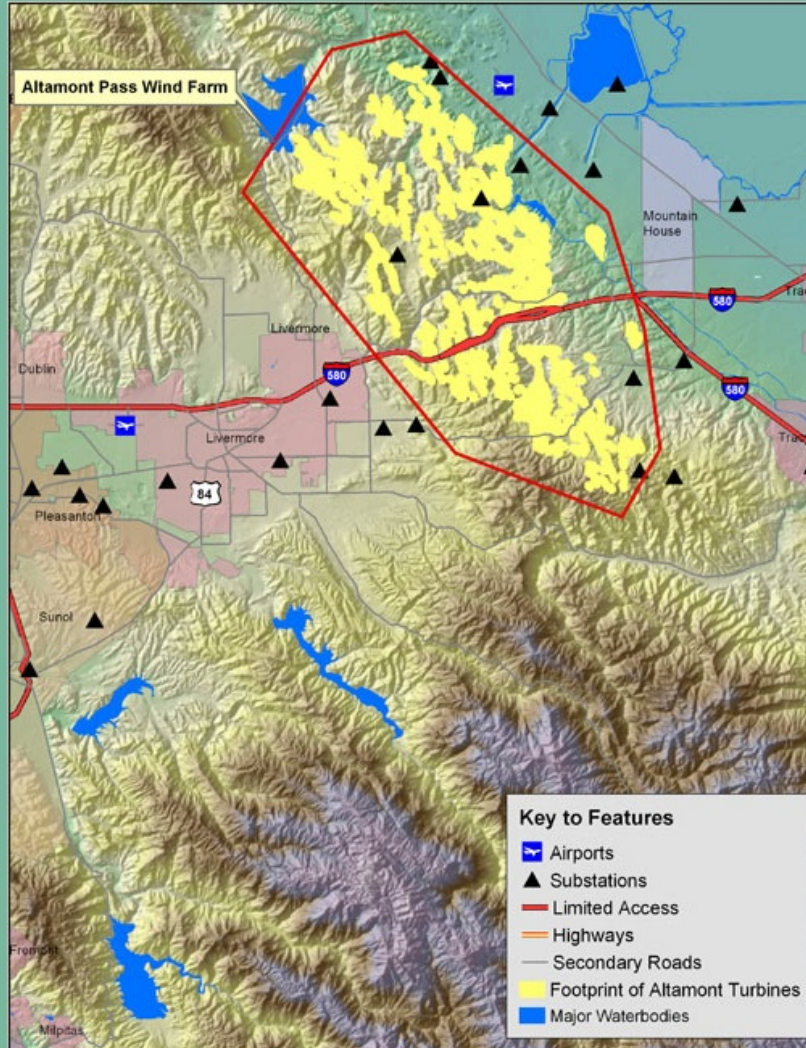
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Reports

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Altamont Wind Farm



The Altamont Pass Wind Resource Area (APWRA) encompasses 20,050 acres

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- Altamont
- Pacheco
- Tehachapi
- Solano

GIS Fly Throughs

- Statewide
- Tehachapi
- Altamont

Altamont GIS Analysis

Avian Study Results

Bathymetry Overview

- North Coast
- Mid Coast
- South Coast
- San Diego

Reports

Contact Us



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Visibility / Lighting Analysis on the website


1) Set your parameters

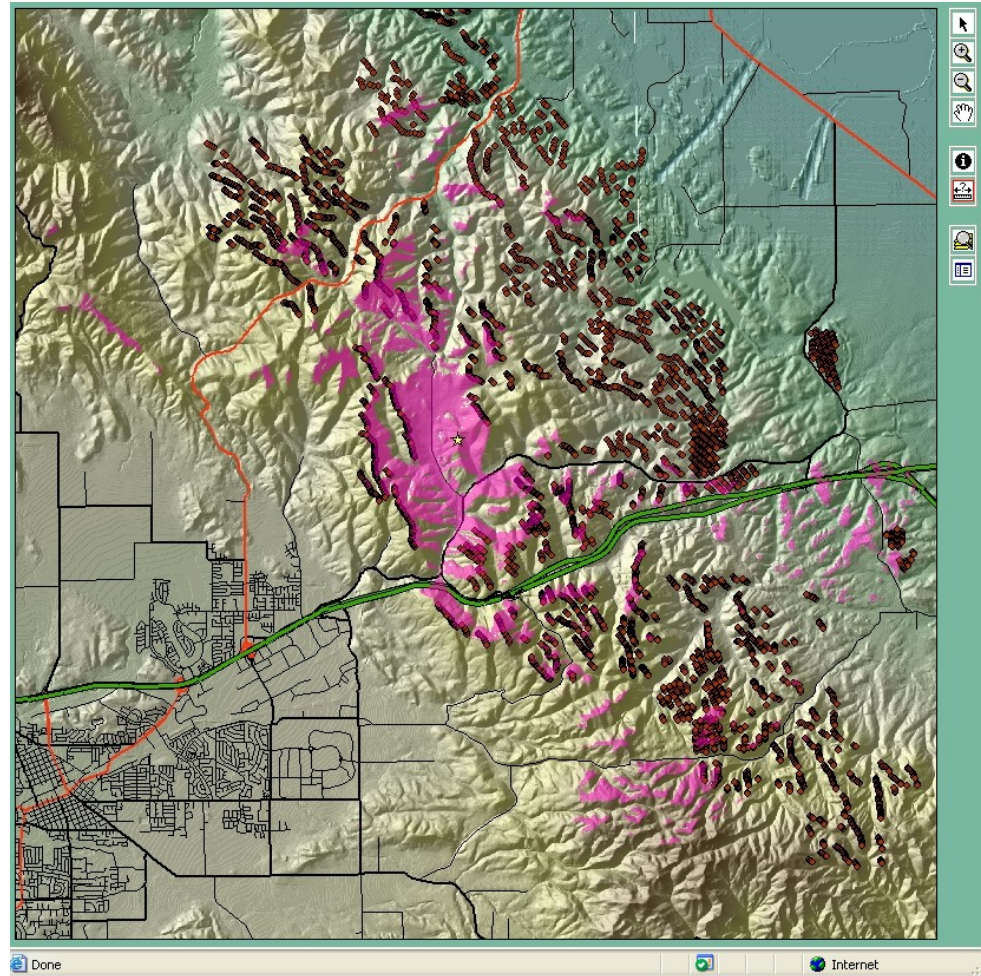
Do Visibility

1. Change observer height and radius (if needed).

Height of observer: meters

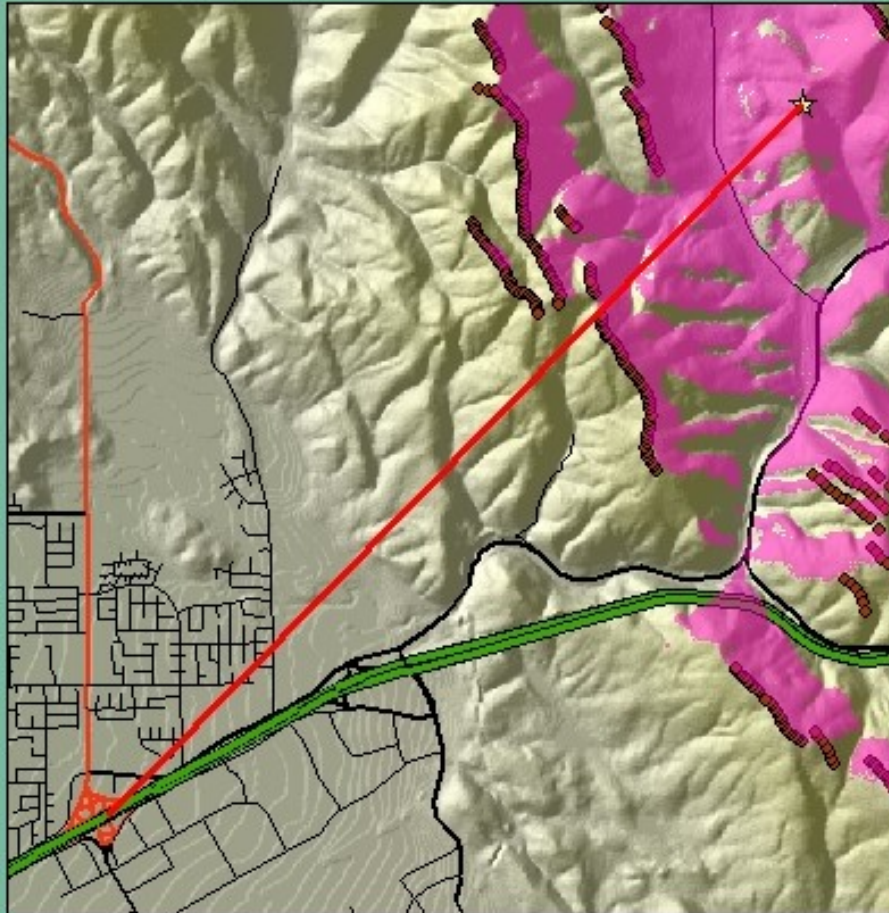
Radius from observer: meters

2. Place observer by clicking on the map with the  pointer.



Print your results

Measure Result



Print

Close

Start = -121.722749, 37.709506 (NAD83)

Stop = -121.671402, 37.75008 (NAD83)

Length = 3.97 miles

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GIS Fly Throughs

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Altamont GIS Analysis

Avian Study Results

Bathymetry Overview

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Reports

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Altamont Pass Wind Resource Area (APWRA)



About 5,400 wind turbines of older designs

Permitted capacity of 580 MW, but output averages about 35-40% of nameplate capacity during summer and about 16% during winter

More than 20 years of operation by a dynamic ownership

Wind turbine sites are leased from cattle ranchers

APWRA provides about 29% of California's 3.5 billion kilowatt-hours of emission-free energy, which is important to one of the state's renewable energy portfolio standards of meeting 20% of the state's electricity needs through renewable energy sources by 2010

However, the APWRA has violated the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act, and it has run into problems with the federal Endangered Species Act and the California Environmental Quality Act (CEQA)

Estimates of Mortality in the APWRA



Smallwood and Thelander searched for fatalities around:
1,526 wind turbines from May 1998 through September 2002
2,548 wind turbines from November 2002 through May 2003

Estimated Ranges by Species

- 75 to 116 Golden Eagles
- 209 to 300 Red-tailed Hawks
- 15 to 24 Ferruginous Hawks
- 73 to 333 American Kestrels
- 99 to 380 Burrowing Owls
- 8 to 10 Great Horned Owls
- 36 to 49 Barn Owls
- 881 to 1,300 raptors
- 9 to 23 California Gulls
- 59 to 154 Mallards
- 116 to 704 Mourning Doves
- 309 to 2,557 Western Meadowlarks
- 18 to 49 Common Ravens
- 23 to 115 California Horned Larks
- 23 to 176 Loggerhead Shrikes
- 1,767 to 4,721 birds

CEC Behavior Study



4,691 raptor observations recorded during 2002 and 2003

1,152 observations of raptors in flight

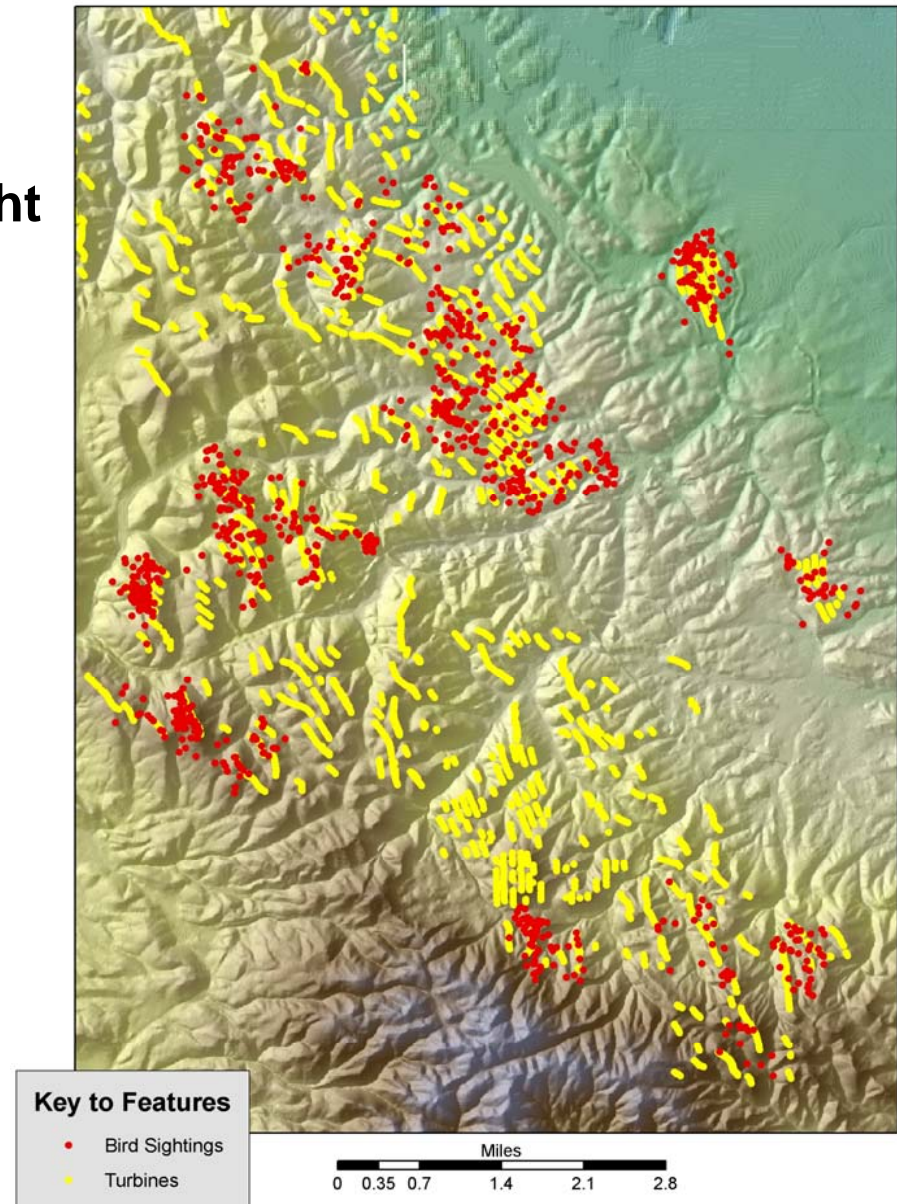
Observations made during 240 sessions at 60 observation points

Observation plots included 1,500 wind turbines

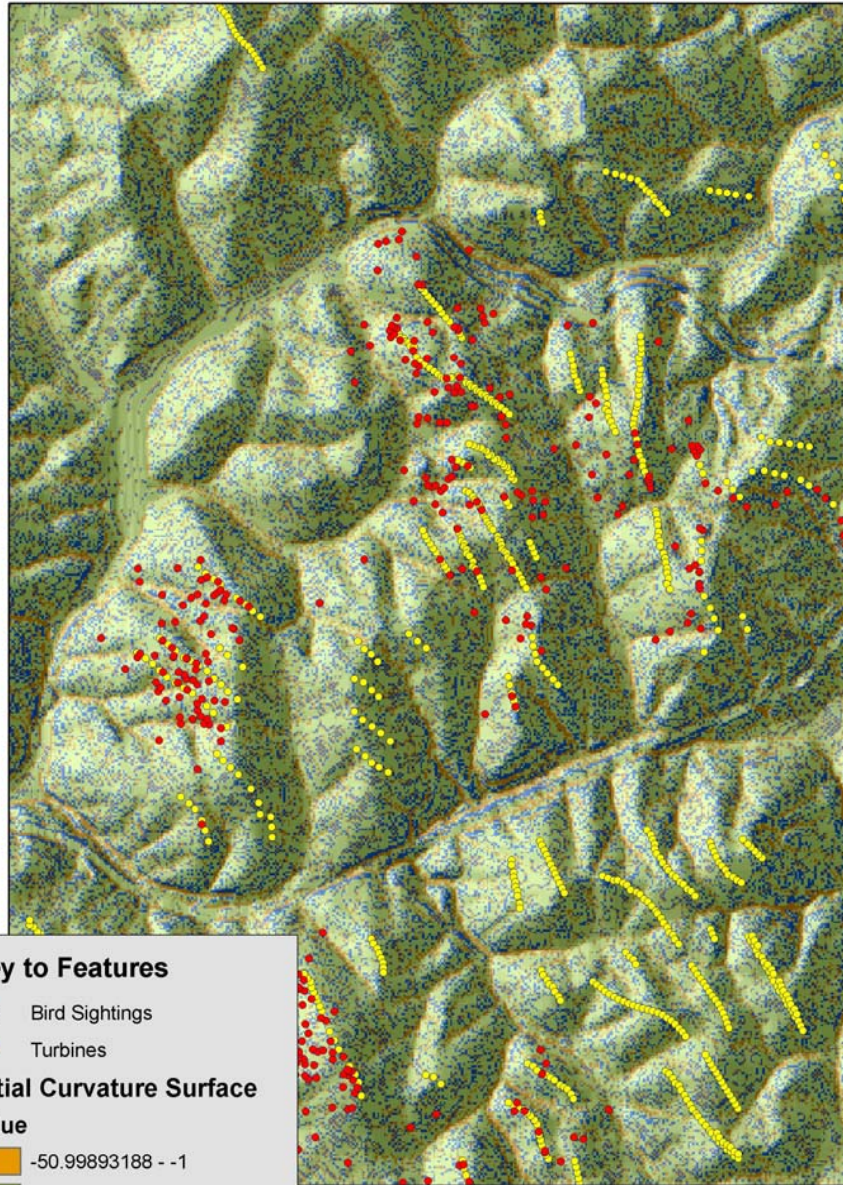
Focal species used in our analysis included:

- Golden eagle**
- Red-tailed hawk**
- American kestrel**
- Burrowing owl**

Bird Observation Data Points



Initial Curvature Analysis

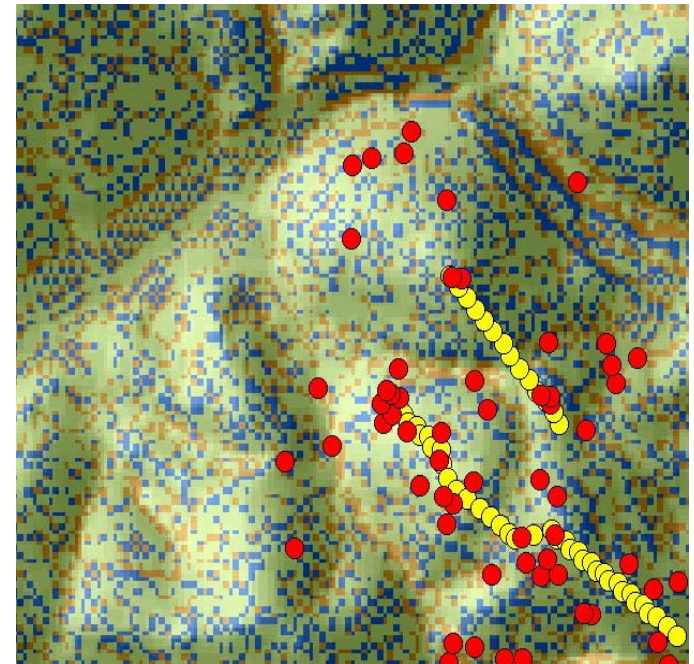


Key to Features

- Bird Sightings
- Turbines

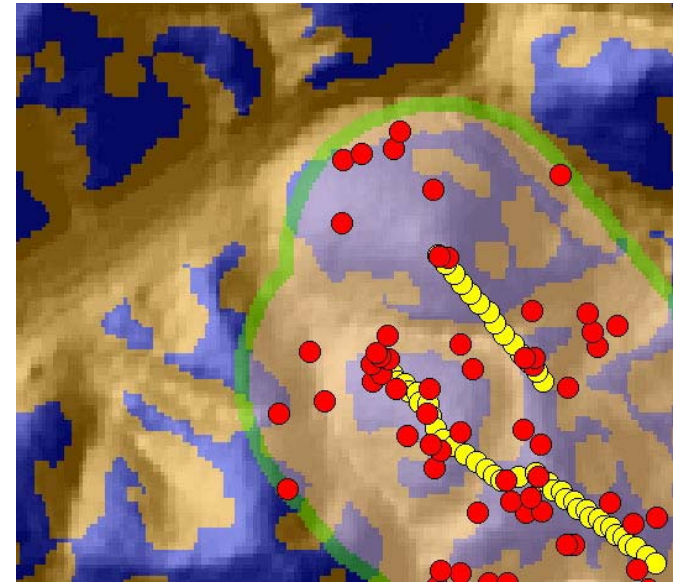
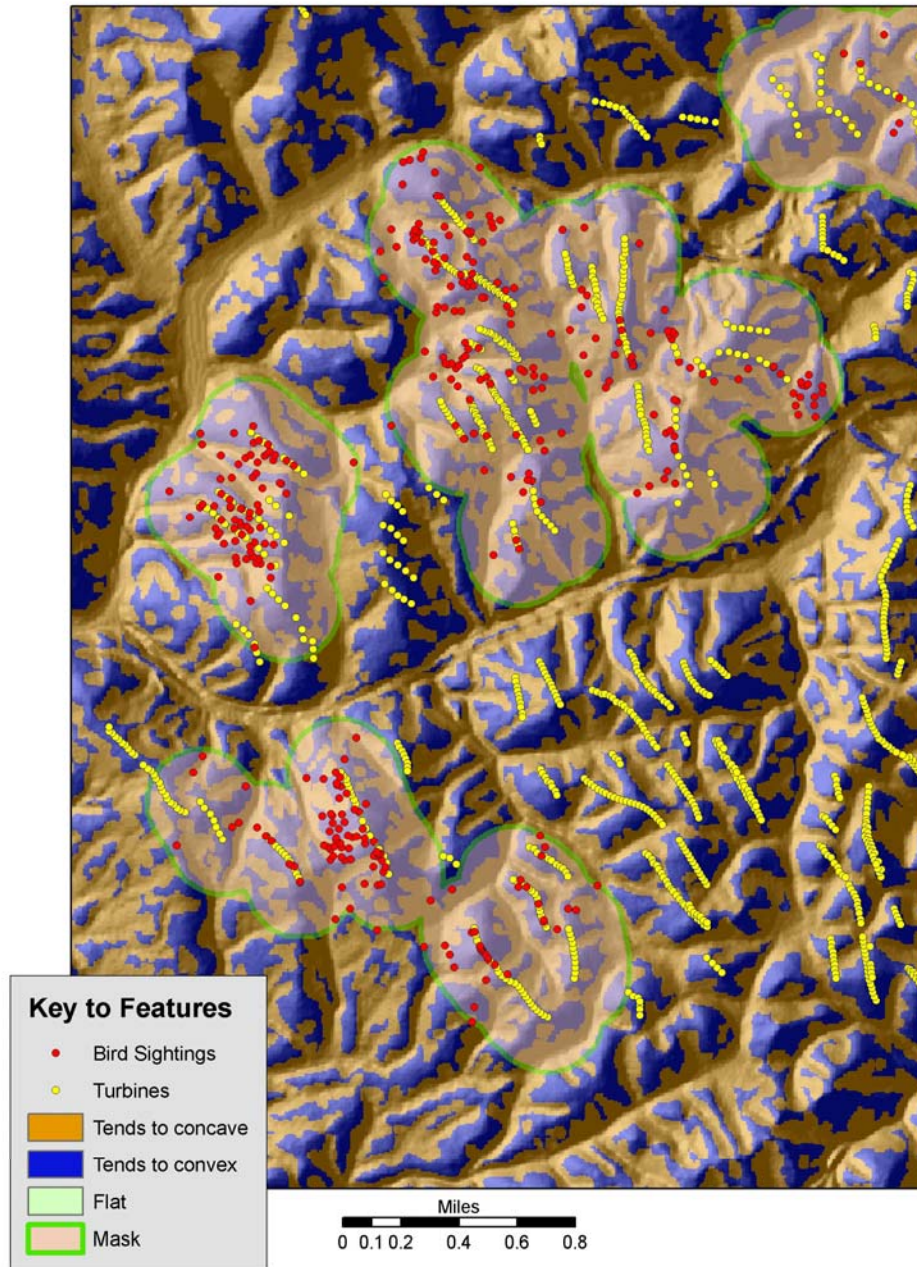
Initial Curvature Surface Value

- 50.99893188 - -1
- 0.999999999 - 1
- 1.000000001 - 37.99920654



Geospatial steps from here to reduce intermediate curvature values (green)

Data Points Only Analyzed Under 300m Mask

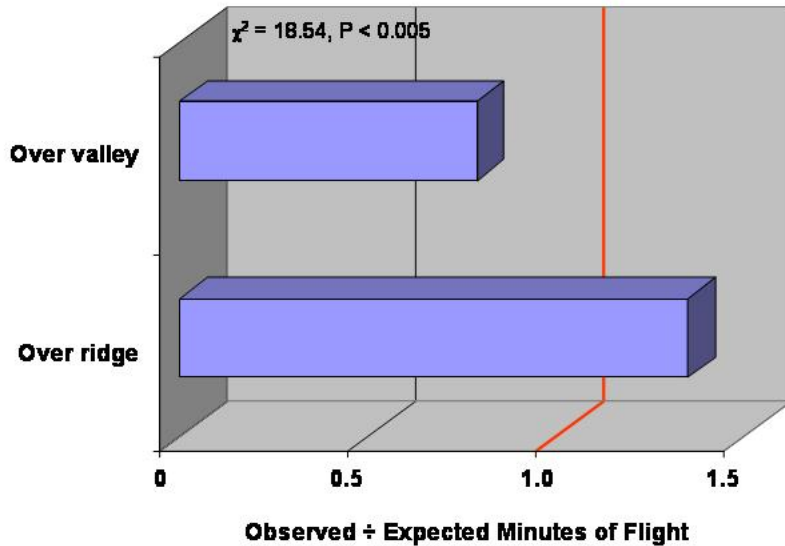


Our derived coverage of the topography indicated that 37.057% of the study area was composed of convex (ridge) features, and the remaining 62.943% was composed of concave-trending features (valleys).

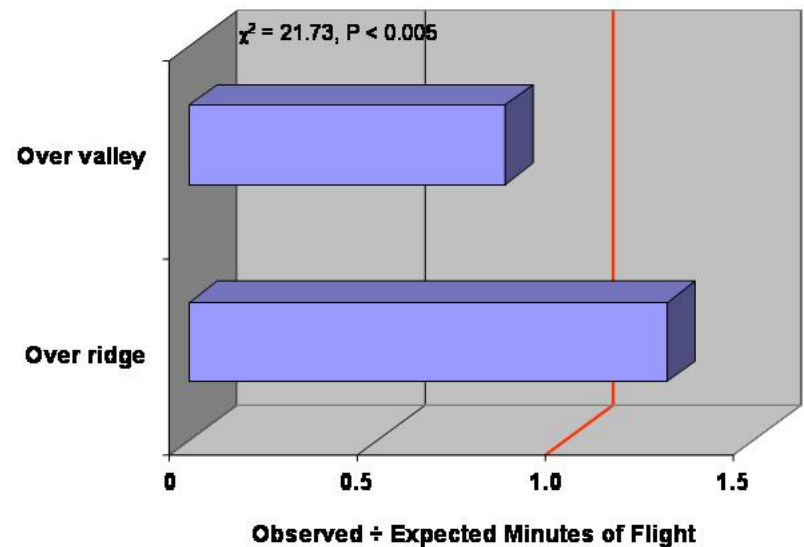
Flight Preferences at Altamont



American Kestrel Flight Preferences at Altamont

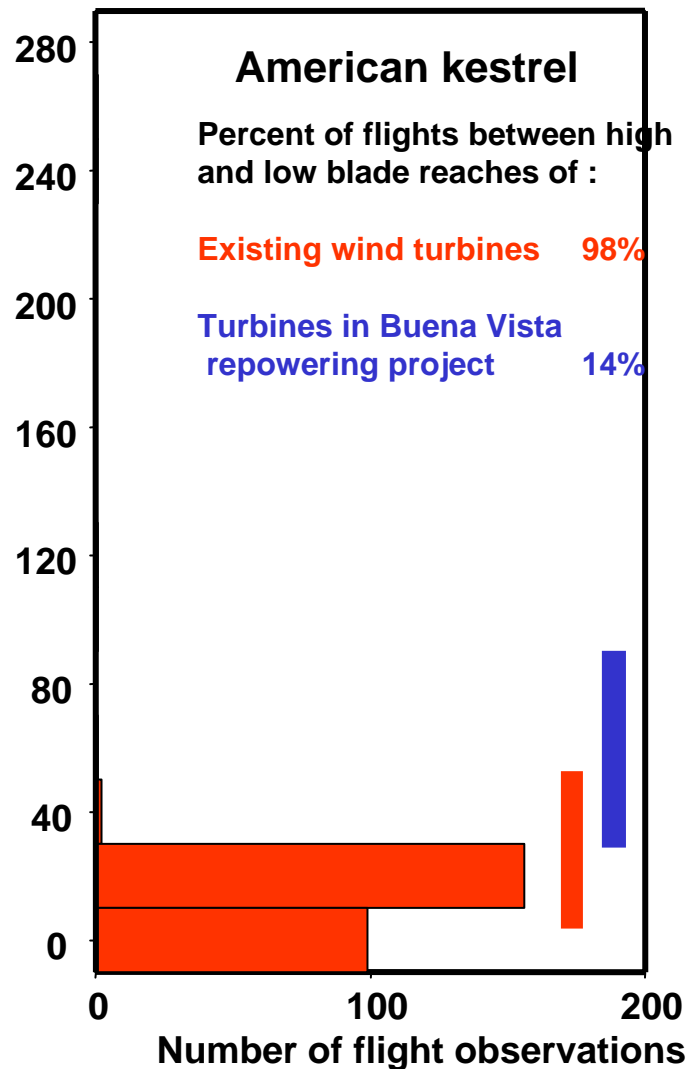
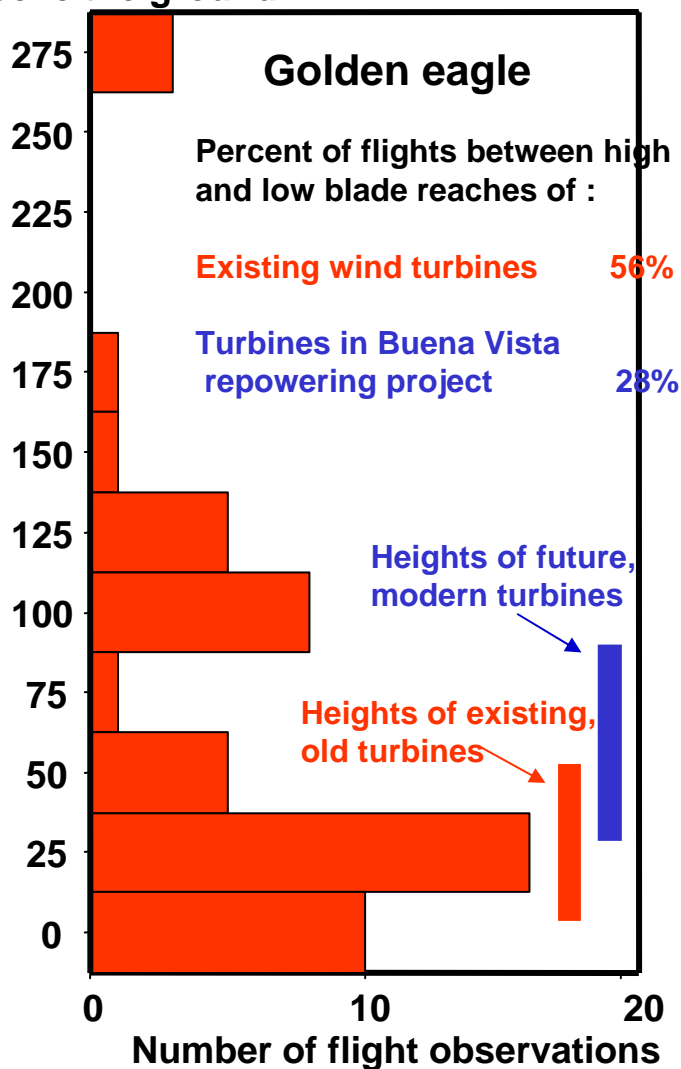


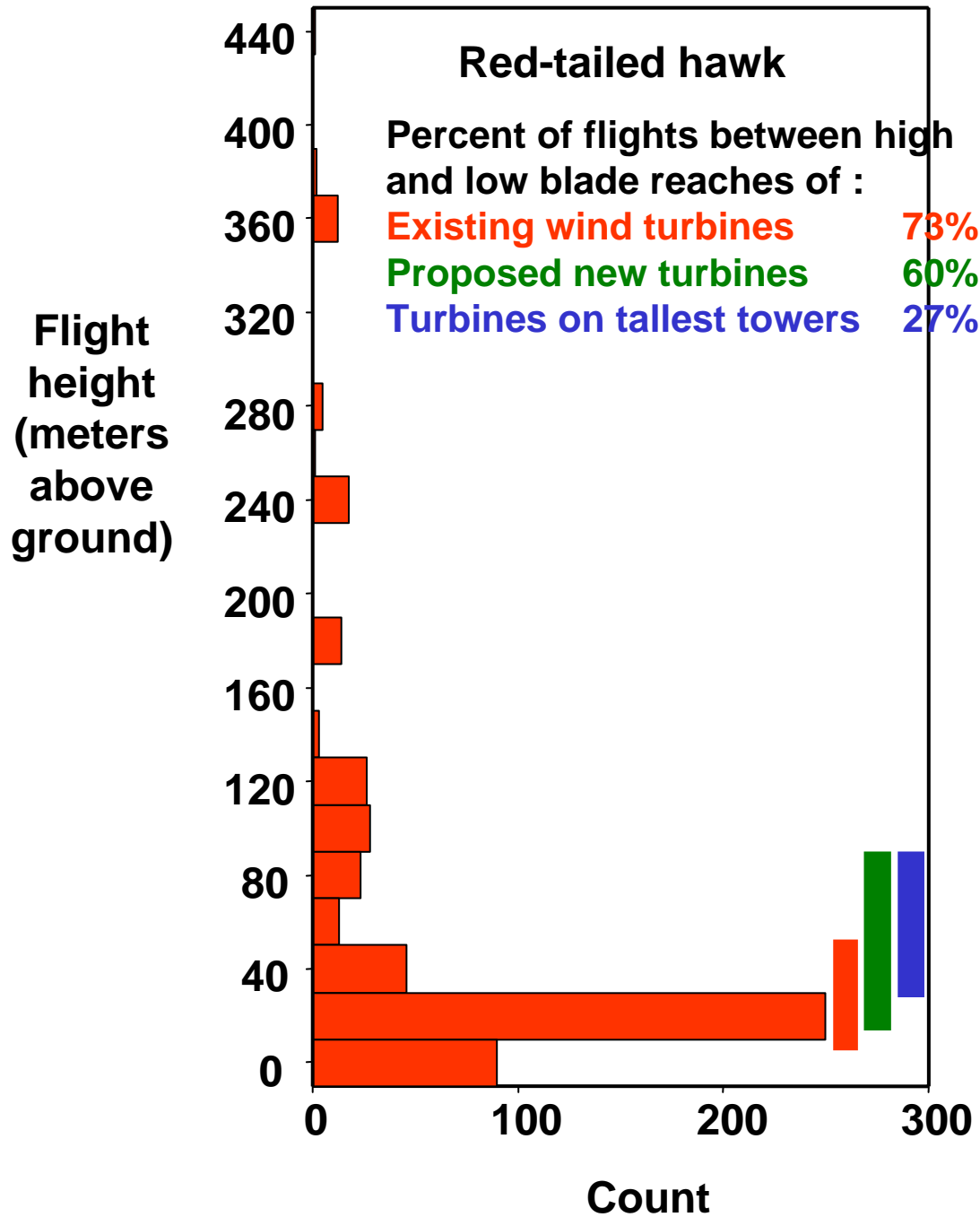
Red-tailed Hawk Flight Preferences at Altamont

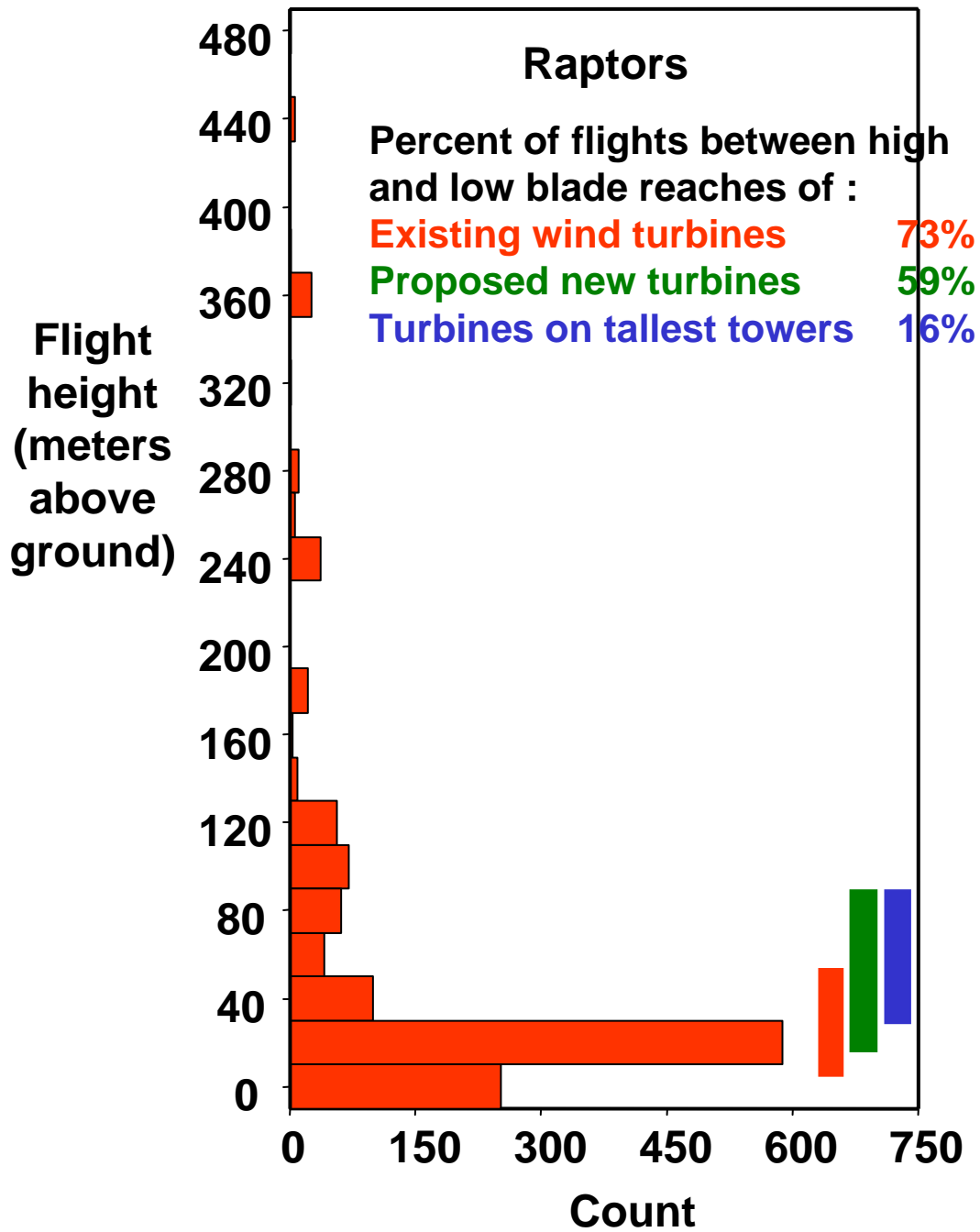


New, modern wind turbines should reduce collisions 50% for golden eagle, 86% for American kestrel, and 78% for all raptors

Flight height in meters above the ground

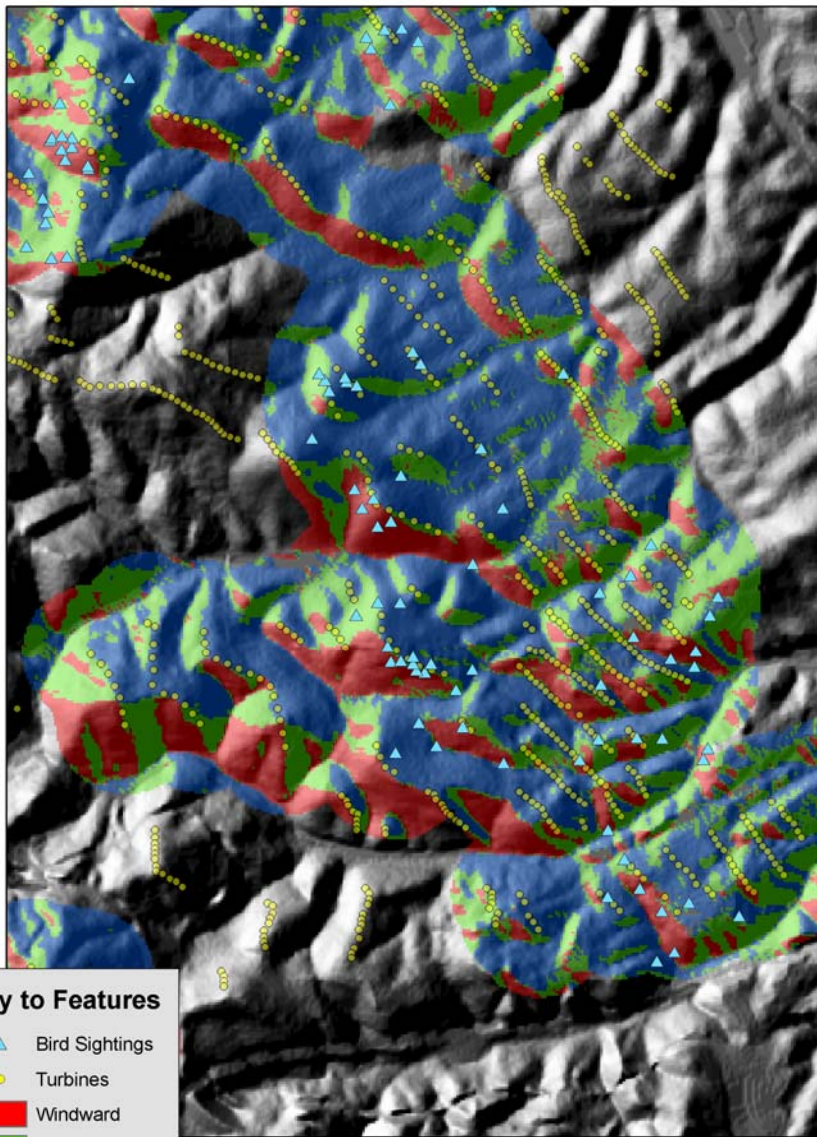








Southwest Wind Bird Observations

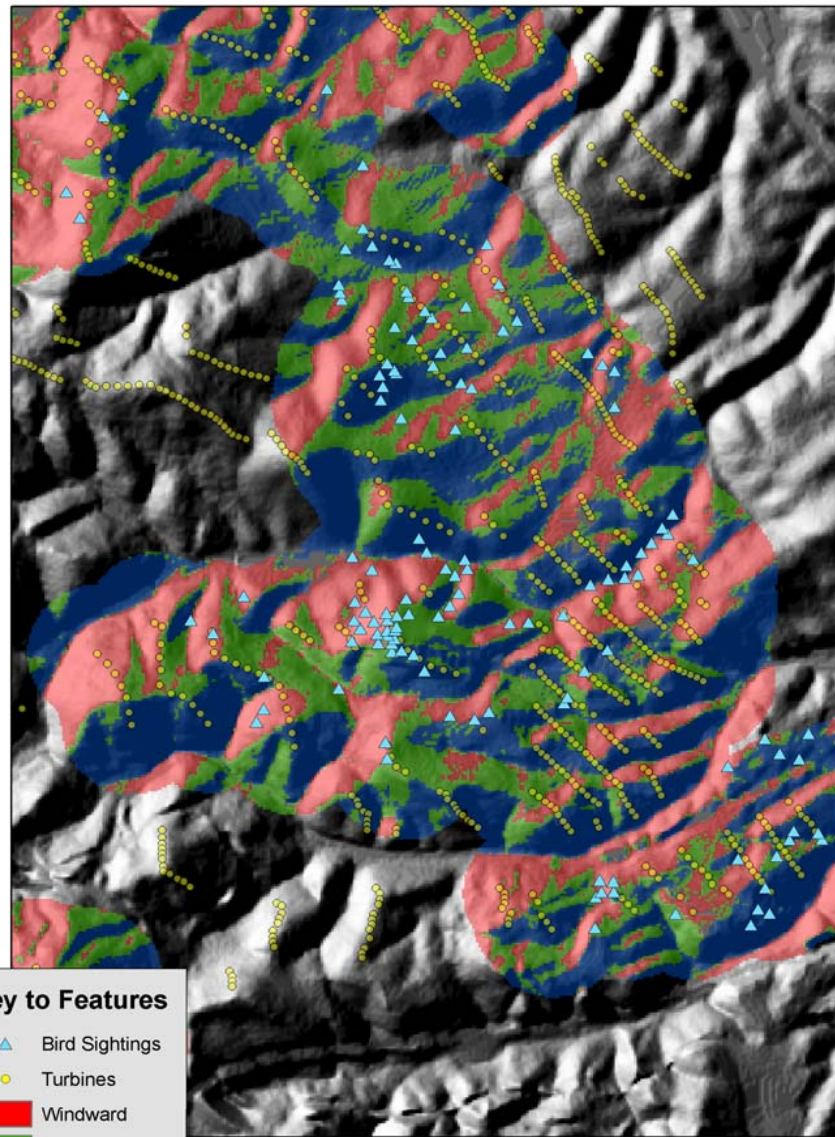


Key to Features

- ▲ Bird Sightings
- Turbines
- Windward
- Perpendicular
- Leeward

28% of wind observations

Northwest Wind Bird Observations

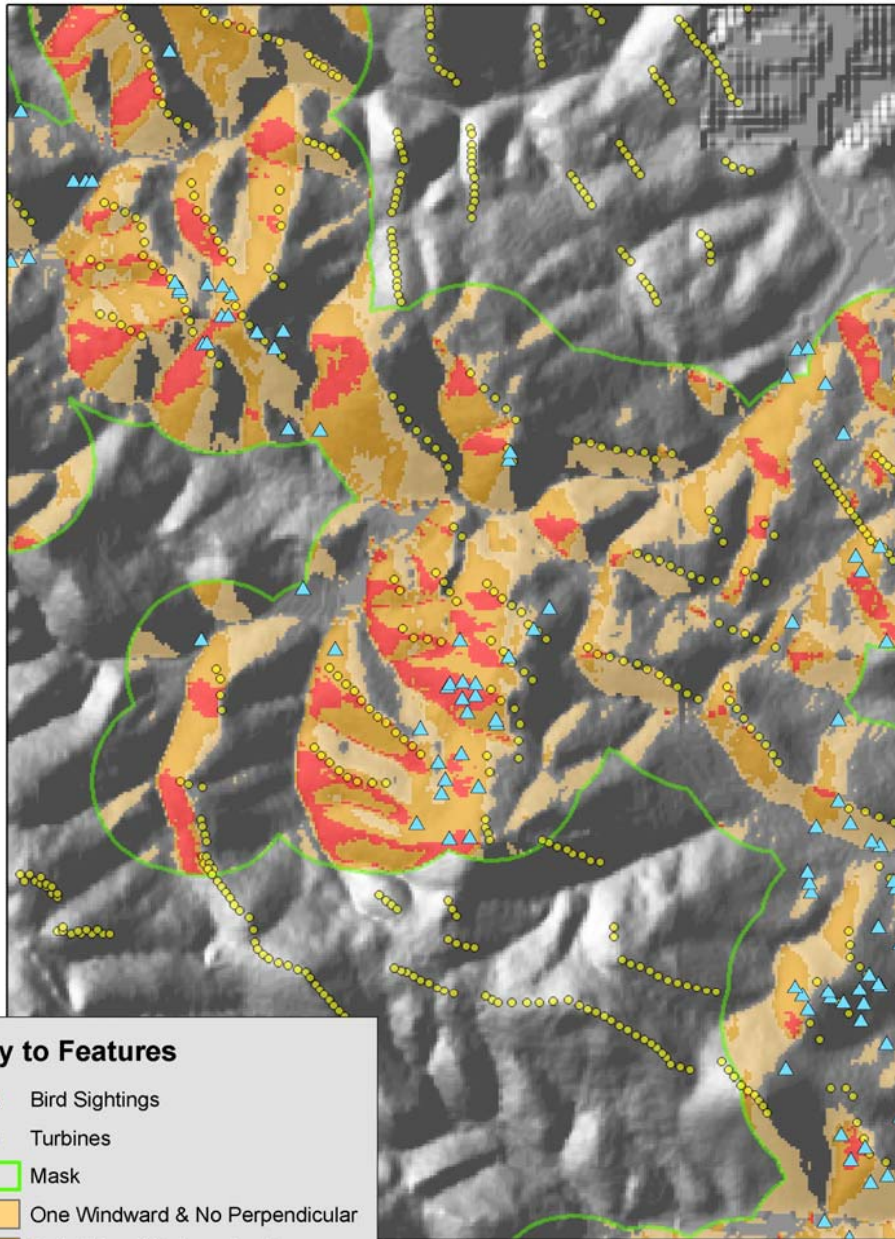


Key to Features

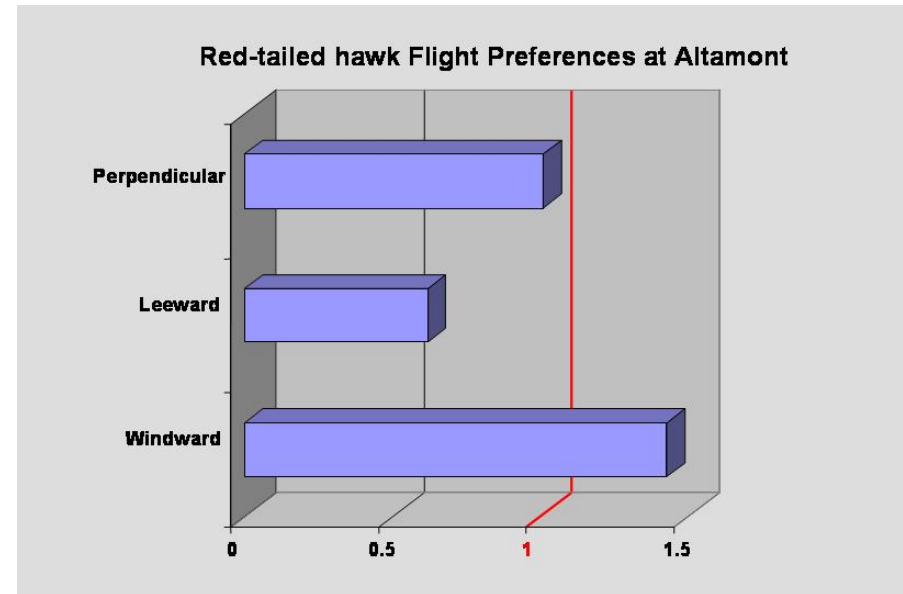
- ▲ Bird Sightings
- Turbines
- Windward
- Perpendicular
- Leeward

31% of wind observations

Orientation of DEM to NW & SW Winds



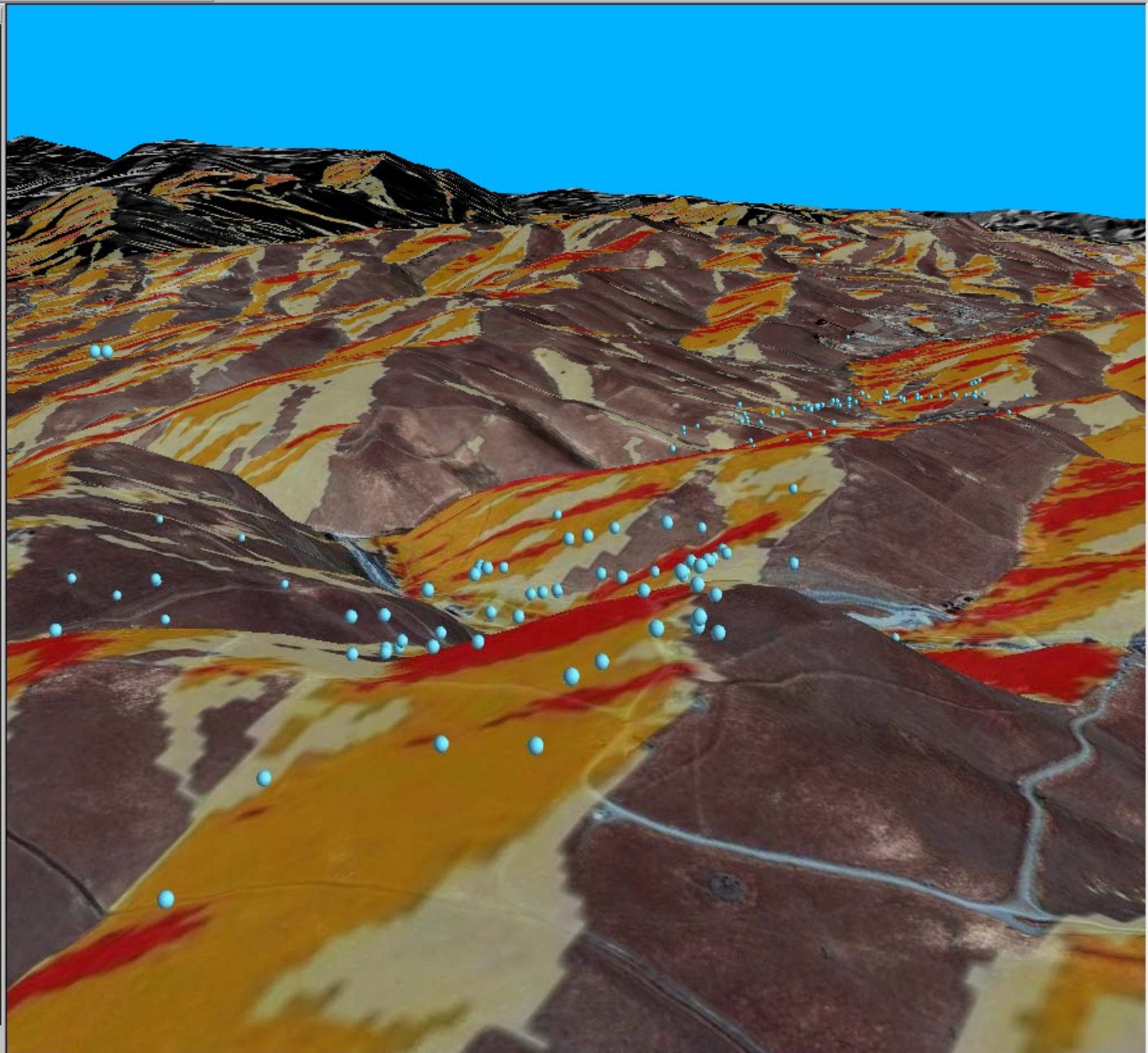
These two directions accounted for 60% of the bird observation conditions



Layer: All Bird Observations

Globe layers

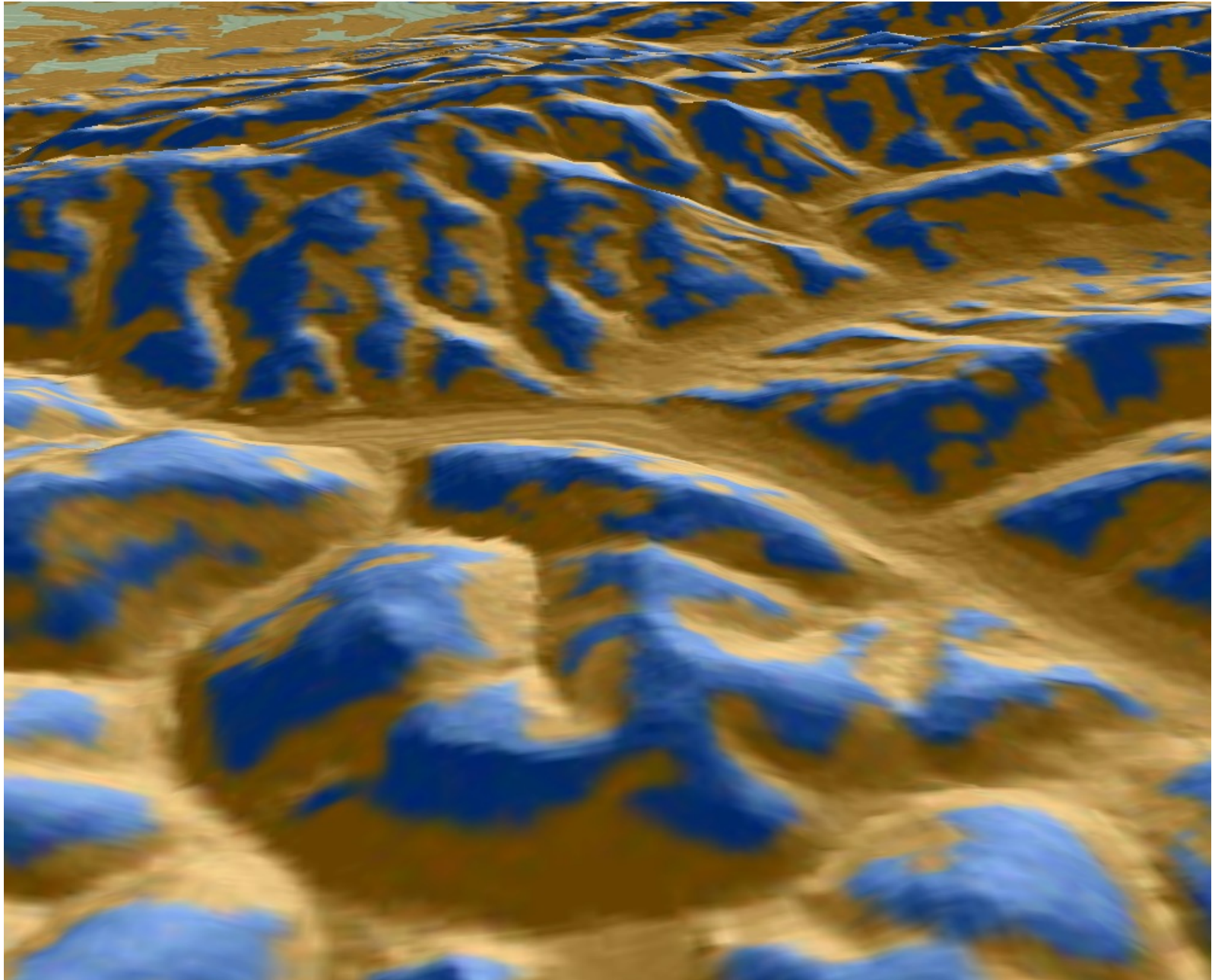
- All Bird Observations
- Aspect Ranking
 - 1
 - 2
 - 3
- Satellite.tif
- Hillshade
- World Image
- altamont

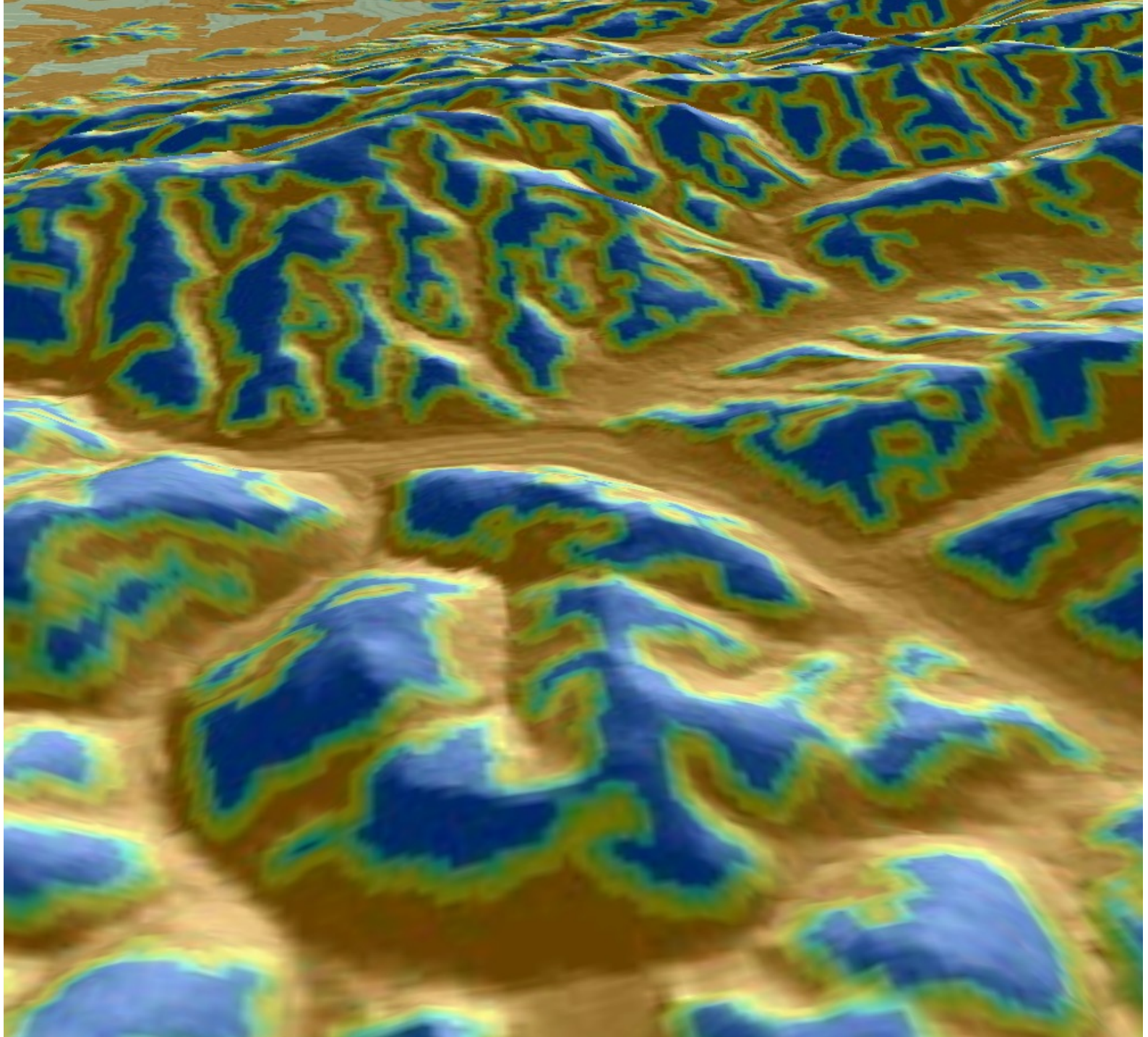


Display Source Type

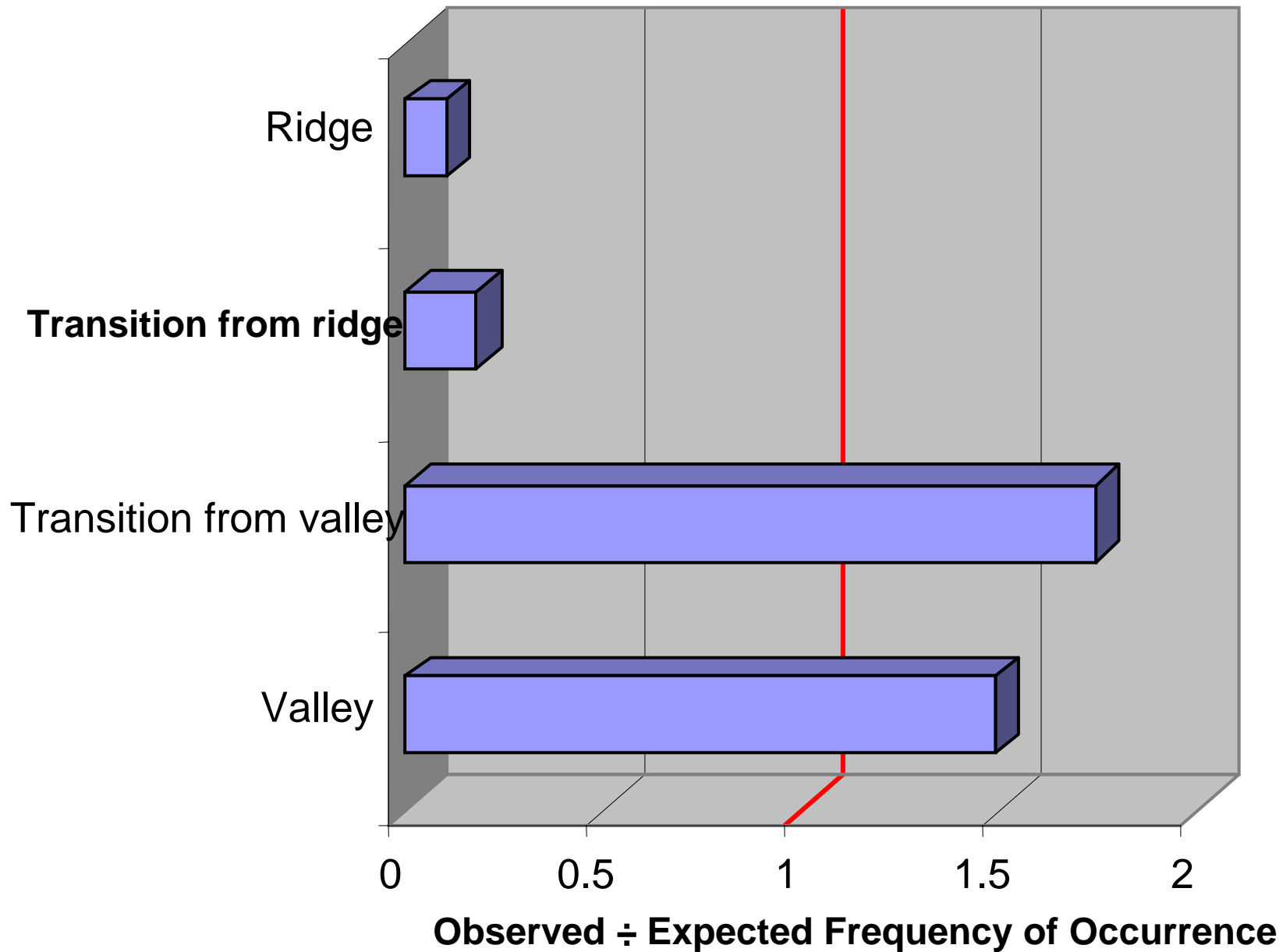
SELECTIVE WIND TURBINE SHUTDOWN

Focal Species	Shutdown of turbines in tiers 1 - 3, or 6.7% of generation capacity	Shutdown of turbines in tiers 1 - 4, or 13% of generation capacity
	Total Fatality Reduction	
Golden eagle	39%	50%
Red-tailed hawk	28%	39%
American kestrel	30%	42%
Burrowing owl	9%	23%
All raptors	27%	38%
All birds	15%	27%

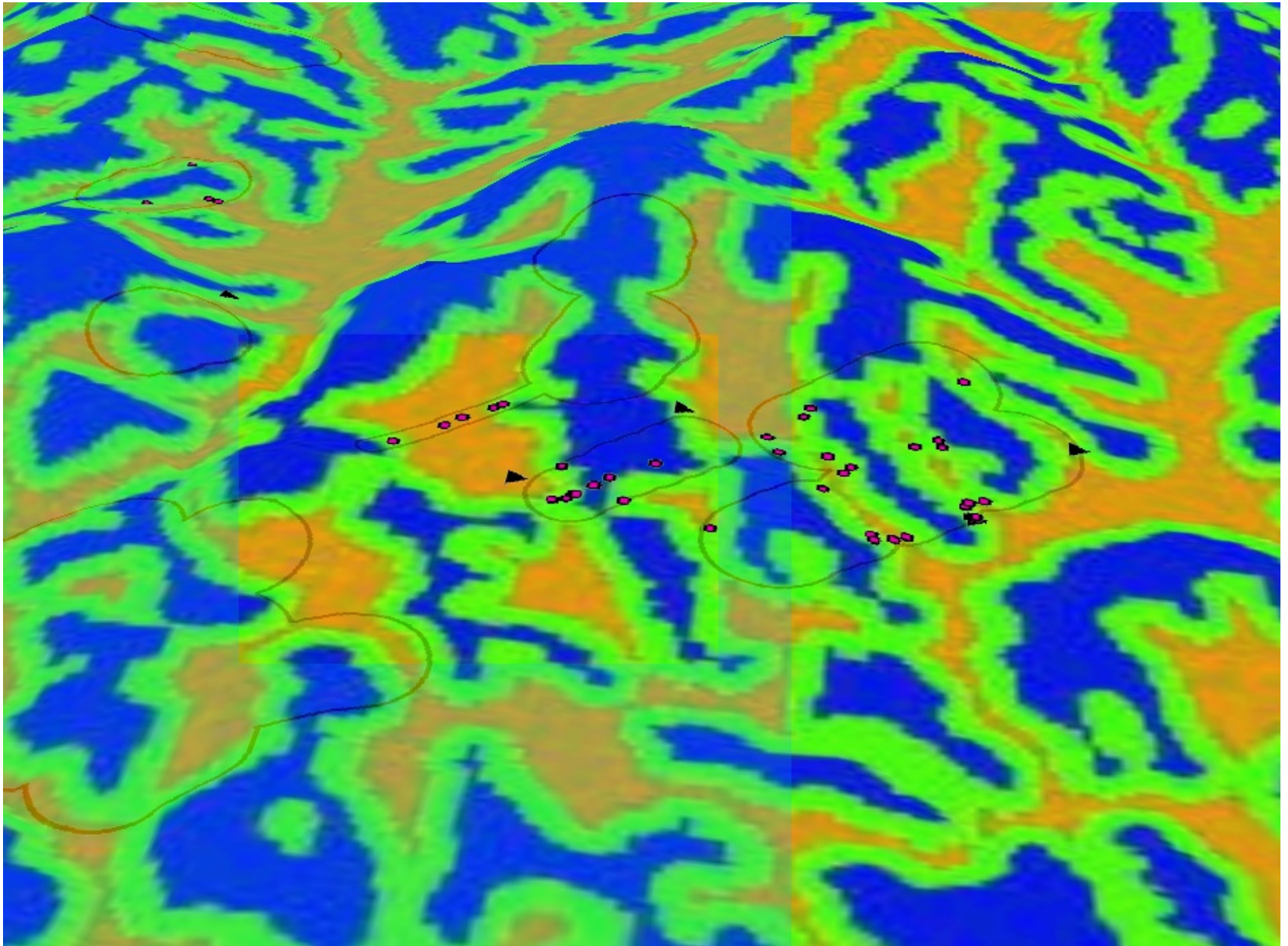




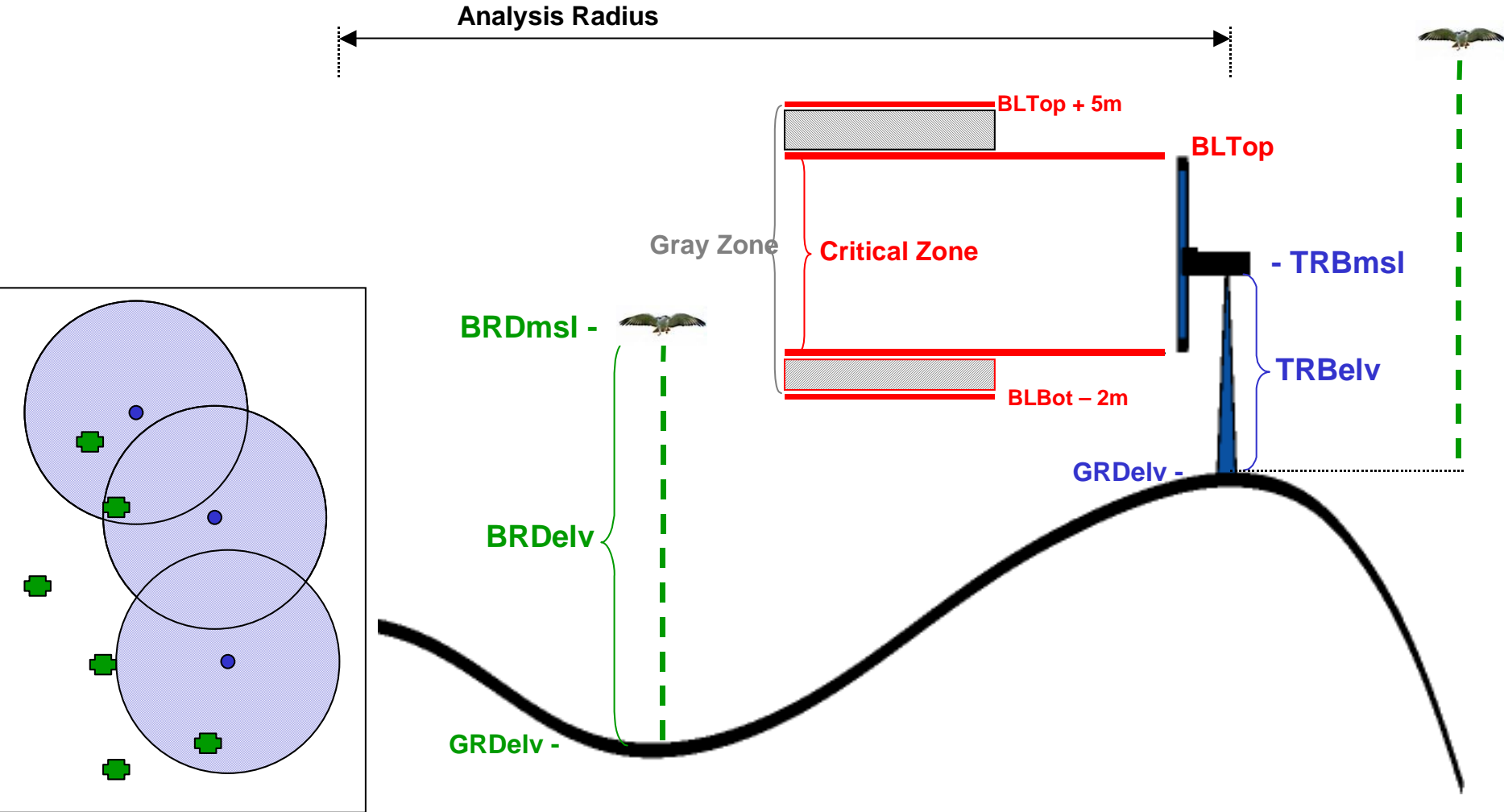
Burrowing owl burrows (n = 37)



Burrowing Owl Burrows with Sampling Area Polygons

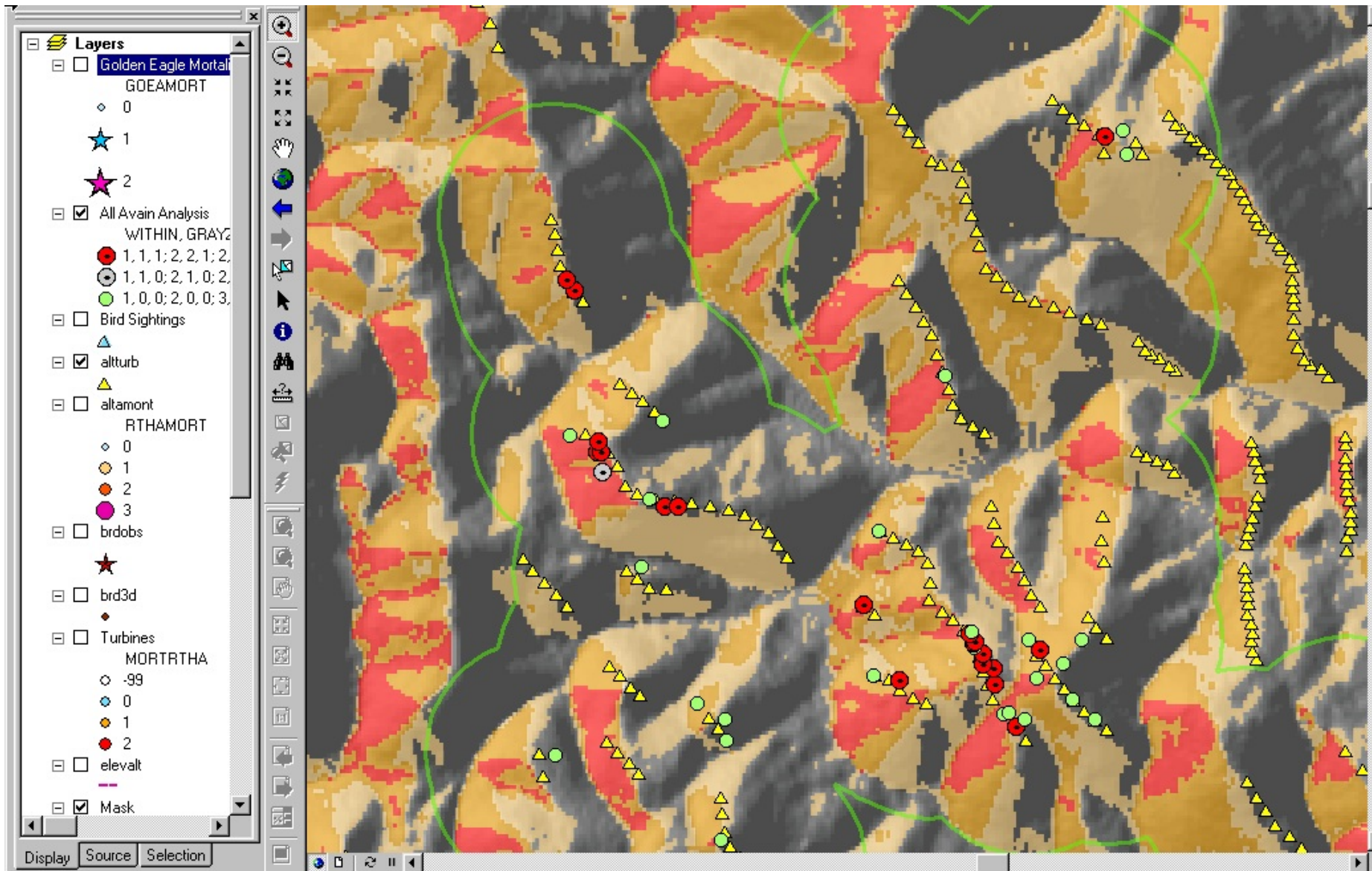


Mean Sea Level Elevation Analysis

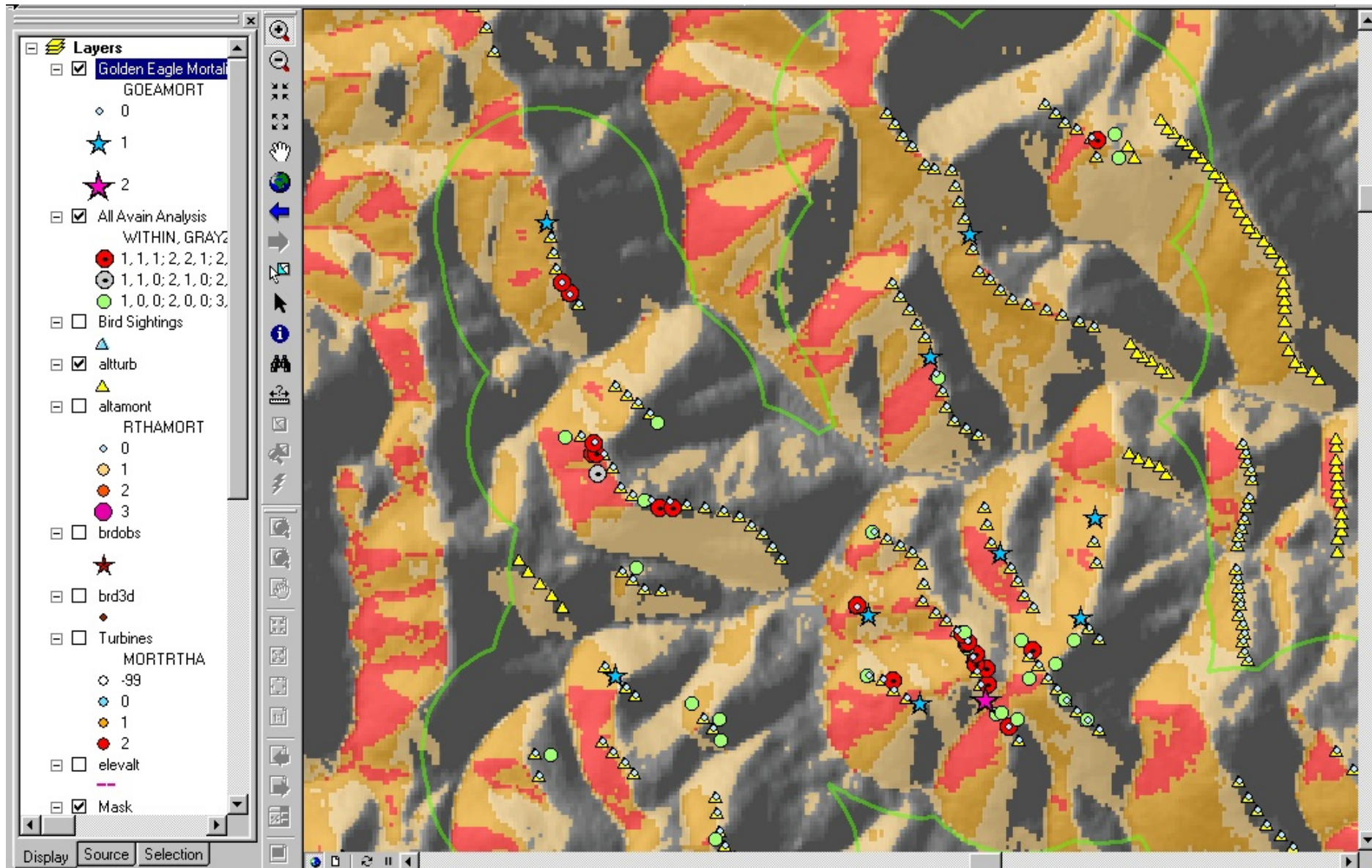


For each bird observation: increment it's "CRIT" & "GRY" items every time it falls within the analysis radius of a turbine; only if the BRDmsl falls within either the Critical Zone or the Gray Zone respectively.

Critical Zone Analysis for All Bird Observations



Golden Eagle Mortality Over critical Zones



Contact Information

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