Using GIS to Develop a Cost-Effective Raptor Protection Plan For Electrical Utilities

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INTRODUCTION

The Migratory Bird Treaty Act (MBTA) protects the vast majority of birds in the U.S., with the exception of a few species, such as the introduced house sparrow, European starling, and rock dove. The purpose of the MBTA is to afford protection to migratory birds, their parts, nests, and eggs. Migratory bird electrocutions violate the misdemeanor provisions of the MBTA. The United State Fish And Wildlife Service (USFWS) has determined electrical utilities fall under the provisions of the Act, as their utility structures and lines are causing a "take" when electrocutions occur. Bald and golden eagles, eggs, and their nests are protected under both the MBTA and Bald Eagle Protection Act (EPA). Utility vehicles and equipment can be forfeited for misdemeanor violations in addition to individual and organizational fines and possible imprisonment.

In light of an increasing awareness of the regulatory environment regarding raptor interactions with distribution power line structures, many electric utilities have chosen to proactively develop Avian or Raptor Protection Plans (RPP). A RPP would begin with the following tasks:

- Identification of birds-of-prey that occur within the utility's service territory
- Assessment of electrocution risks to those species
- Identification of lethal poles
- Field inspections – review of existing power lines
- Recommendation of retrofitting measures
- Review of construction design standards
- Schedule to complete retrofitting

Many poles that were built prior to the development of raptor-safe construction standards are still in use today, and it is cost-prohibitive to replace all of them. Effective retrofitting of lethal or potentially lethal power lines requires good information on existing electrocution problems and habitat. Unfortunately many utilities lack this information as many electrocutions go undetected. The best way to collect this information is to survey power lines for mortality but again this can be cost prohibitive. It is much more effective to simply survey potentially lethal poles located in suitable habitat. This can be done by creating maps in a geographic information system (GIS) that identify high raptor use areas in proximity to overhead distribution lines.

What is GIS? It is a computer system for capturing, managing, integrating, manipulating, analyzing, and displaying data that is spatially referenced to the Earth. GIS enables the display and analysis of difference maps or file (layers) with common geography in reference to each other. GIS is useful for data analysis, development of research and monitoring programs, and for tracking efforts. GIS is an effective communication tool for disseminating results and information to others. Information is visually displayed and easier to interpret than tabular or textual data.

In our RPP, the GIS maps visually illustrated two primary factors responsible for electrocutions, surrounding habitat and pole/line design. The overhead distribution lines in areas identified as high risk were subsequently field surveyed to verify potential problem areas and to identify specific poles in need of retrofitting. The focus of this paper is to describe the generation of these raptor protection project maps on a GIS platform.

METHODS

Digital Data Collection

Much information on raptors and habitats already exists. Our initial efforts focused on collection of all available, pertinent data and integration of these data into a useful spatial format.

The first step was to identify which species are primary candidates for electrocution risk within a utility's service area. Digital data on those species identified as important in the service area was gathered from a variety of possible sources including Natural Heritage programs, state departments of Fish and Wildlife or Natural Resources, the U.S. Fish and Wildlife Service, Audubon societies and other local birding groups or individuals, etc. The biological data consisted of two types: 1) point observations for individual occurrences, nests, and roost locations; and 2) polygons representing "priority habitats" and nesting and breeding concentration areas for species of concern.

Next, the utility's CAD/GIS department was contacted to obtain a copy of the overhead line system network and substation locations. Most utilities have their system data digitized and available in at least a CAD format, if not already in a GIS format. If the data from a CAD system are associated with a map datum they may be converted to a GIS format.

Digital elevation models (DEM) were used for background imagery. DEMs may be downloaded for free or purchased on CD for nominal fees. Digital ortho quads (DOQQs) may also be used as background imagery and are available via FTP download or on CD for varying fees. Although both DEMs and DOQQs require preprocessing to enable viewing them in a GIS package such as ArcView GIS, DOQQs require an image processing package to manipulate and/or mosaic the imagery.

Data Conversion and Map Production

After all pertinent data is collected from local, state, and Federal sources, it must be compiled into one useful source. The approach we have taken is to convert vector data into ArcView shape (SHP) files in a common projection and datum to ensure proper alignment with underlying raster-based DEMs. The RPP maps were compiled and created through the use of ArcView GIS (ESRI).

First, the USGS 10-meter 24K (7-1/2 min) DEMs for topographic quads within the utility's service territory were mosaiced together to create a composite DEM background layer. Application of a grayscale hillshading theme to this composite DEM layer created the appearance of topographic relief.

Next, base data including the county boundaries, a grid depicting USGS 7-1/2 minute topographic quad boundaries, a grid for townships and sections, and watercourses were overlaid on the DEM layer. Data showing the locations of cities/towns and roads/streets were also added to the maps.

Then, the background layers of DEMs and base data were overlaid with the biological information for raptors and other sensitive species. As mentioned above, these data consisted of two types: 1) point observations for individual occurrences, nests, and roost locations; and 2) polygons (areas) representing "priority habitats" and nesting and breeding concentration areas for species of concern.

Additionally, some biological information was manually plotted on the maps. Observations of historical nest sites, roosts, perching, and other types of information were added from personal communications with various agency personnel and footnoted on individual map sheets.

Finally, the utility's substation locations and network of overhead distribution lines were added to the maps. These overhead distribution lines were classified and color-coded by phase type (one-, two-, or three-phase).

Field Inspections

Careful review of the RPP maps promoted more focused field inspection efforts concentrated in areas where overhead lines intersected with important bird habitat or concentrations. The use of these maps eliminated the need to survey thousands of poles located in unsuitable habitat, greatly reducing the survey costs. During field inspection pictures of structures (and bird carcasses if located) were taken. The final report to the utility included the printed maps with field note annotations, pictures of structures inspected, and recommendations for retrofit priorities and solutions for problem poles.

RESULTS AND DISCUSSION

The resulting RPP maps clearly illustrated areas for potential raptor interaction with overhead lines and were very useful for narrowing the scope of field inspections. The

utility will now use the maps as the basis for on-going avian protection monitoring. Data on priority species observations and habitat classification can easily be modified and updated.

Enhanced Multimedia Maps

Field inspections could be supplemented using MediaMapper™ to document pertinent structures, birds, or bird carcasses in the field. MediaMapper™ is a technology that enables the collection of digital still images or video that are indexed with GPS data. These geo-referenced multimedia files and other informational documents such as structure drawings could also then be attached to the RPP maps inside the GIS as hotlinked items.

Potential Future Analyses

GIS may be used to predict electrocution risk by classifying utility poles using a combination of surrounding habitat type, phase and pole design, and proximity to known areas of bird concentration or nesting sites. Topography and surrounding habitat could be used to model potential electrocution "hot spots."

CONCLUSION

The majority of electrocutions typically occur at a few poles. The goal of effective retrofitting is to determine where birds are at greatest risk. GIS can be an important tool in remedying electrocution problems on a company's electrical distribution system. GIS maps which depict relevant species and habitat information in conjunction with a utility's network of overhead lines are very useful for identifying potential risk areas within the utility's service area. Focused field inspections of high-risk areas and appropriate retrofitting measures can aid in cost-effective prevention of bird electrocutions. These maps can be updated as new data become available and may become part of a utility's on-going avian protection monitoring program.

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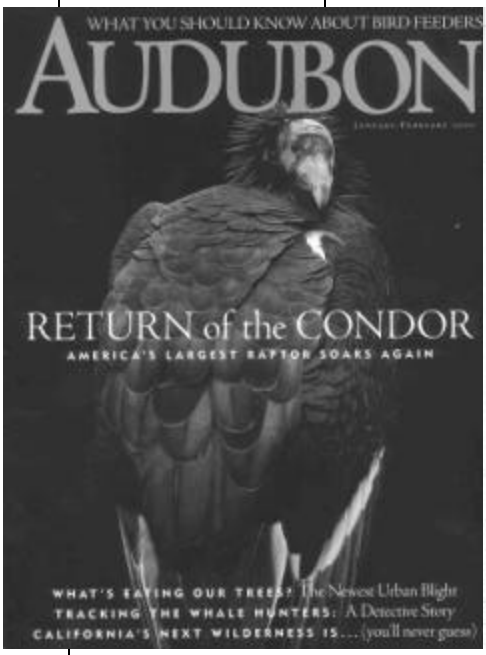
Avian Protection Legislation

- Migratory Bird Treaty Act (MBTA)
- Eagle Protection Act (EPA)
- Endangered Species Act (ESA)
- Penalties - USFWS
  - 1st time non-compliance (MBTA): $5000-$15,000 fines and/or six-month jail term
  - Further non-compliance: $250,000-$500,000 fines and up to two-year jail term



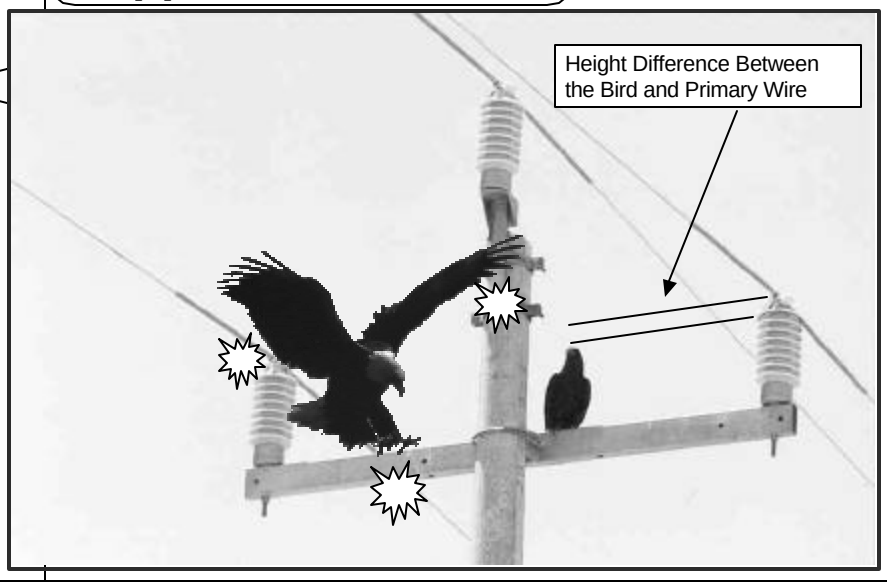

[INCITE]

Zapped!

For years, power lines have been electrocuting golden eagles and other raptors. Thanks to a recent court decision, utility companies are now being held liable.

BY TED WILLIAMS

Zapped!



Unfortunate Result

Raptor Protection Plan

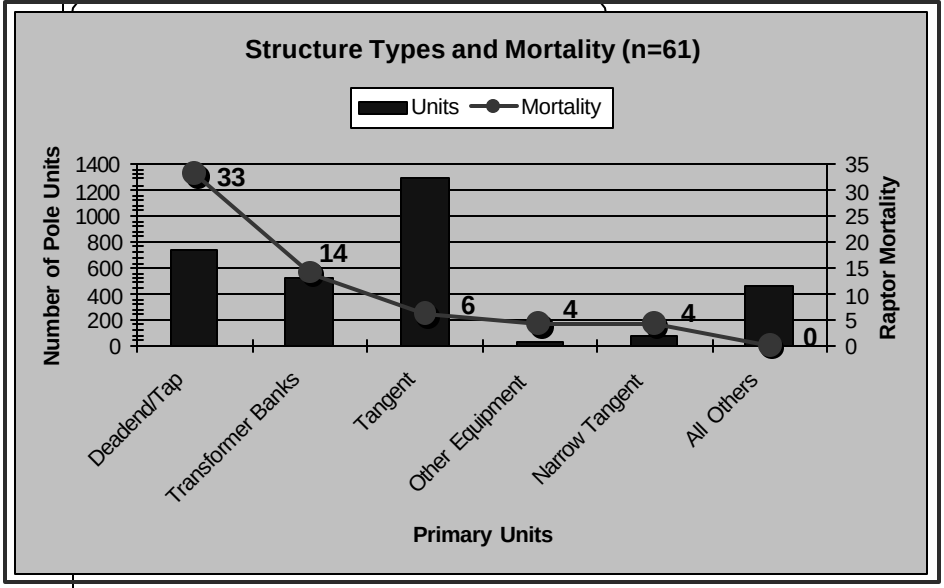
- Identification of birds-of-prey that occur within the utility's service territory
  - Typically larger birds
- Assessment of electrocution risk to those species
  - Immature Golden eagles?
- Identification of lethal poles
  - What poles cause the most problems?
- Field inspections - review of existing power lines
- Recommendation of retrofitting measures
- Review of construction standards
- Schedule to complete retrofitting

Raptor Protection Plan

- On-going monitoring
- Predictive modeling

Raptor-Safe Poles

- Many poles built prior to development of raptor-safe construction standards still remain
- Replacement
  - Cost-prohibitive
- New Construction
  - Variable from few $$ to $100s
  - 8’ to 10’ cross arms
- Retrofitting
  - Upwards of $210 per pole (Moon Lake)

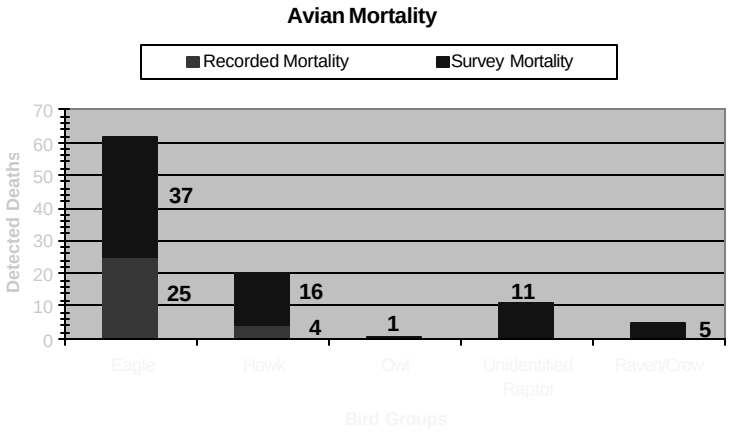


Cost-Effective Retrofitting Measures

Q: How do you decide where to retrofit?

A: Use GIS to create "Raptor Protection" maps which help identify high raptor use areas in proximity to overhead distribution lines

Review Utility's Existing Mortality Data

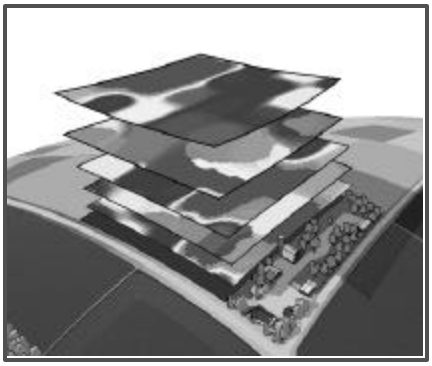


What is GIS?

- GIS … Geographic Information Systems
- Computer system for capturing, managing, integrating, manipulating, analyzing, and displaying data that is spatially referenced to the Earth

Capabilities of GIS

- Display and analysis of different maps or files (layers) with common geography in reference to each other



Capabilities of GIS

- Analyze data, develop research and monitoring programs, and track efforts
- Effective communication tool
  - Useful for disseminating results and information to others
  - Information is visually displayed and easier to interpret than textual data
- Powerful and essential tool for cost-effective bird protection

Utilization of GIS – Raptor Protection Plan

- Identify high raptor use areas in proximity to overhead distribution lines
  - Develop GIS maps which display raptor data overlaid with the location of power lines
- Narrow scope of field inspections to existing power lines in high raptor concentration areas
  - More efficient, cost-effective field inspection effort

High Raptor Use Area!

GIS Maps

- Digital Data Collection
- Data Conversion and Map Production

GIS Maps

- Digital Data Collection
  - Information already exists
    - Natural Heritage Programs
    - State Depts. Of Fish and Wildlife
    - State Depts. Of Natural Resources
    - USFWS
    - Audubon Societies, other local birders or birding groups
  - Efforts focused on collection and integration
- This is no easy task!

Digital Data Collection

- Raptor Data
  - distribution and habitat
  - point observations for individual occurrences, nests and roost locations
  - polygons (areas) representing “priority habitats” and nesting and breeding concentration areas

Digital Data Collection

- Overhead line network and substation locations
  - line locations and phase
  - pole configurations
- Digital Elevation Models (DEMs)
  - topographic relief
  - provides context for habitat data
- Base Maps
  - cities/towns
  - roads
  - streams
  - political and administrative boundaries

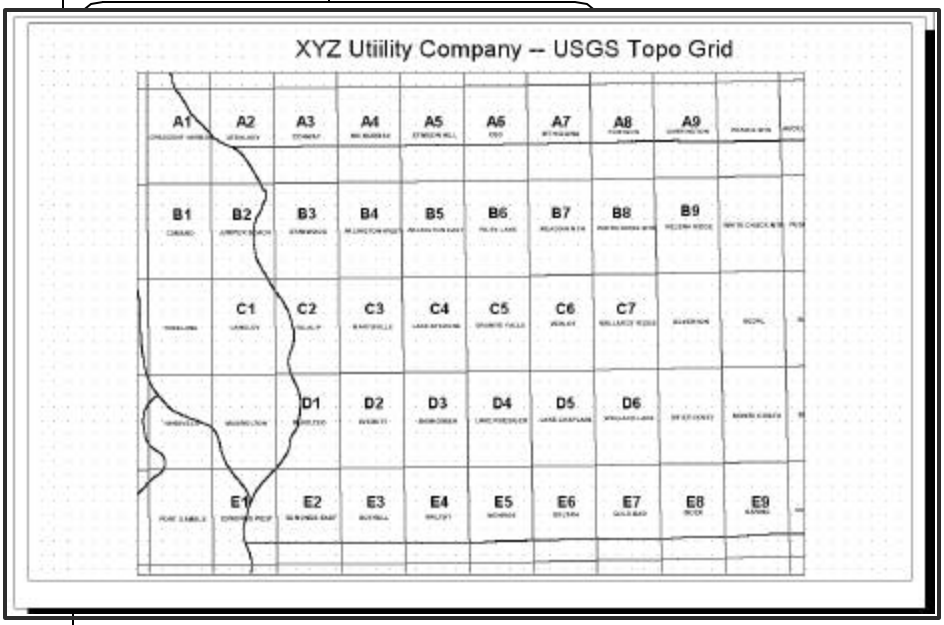
Data Conversion

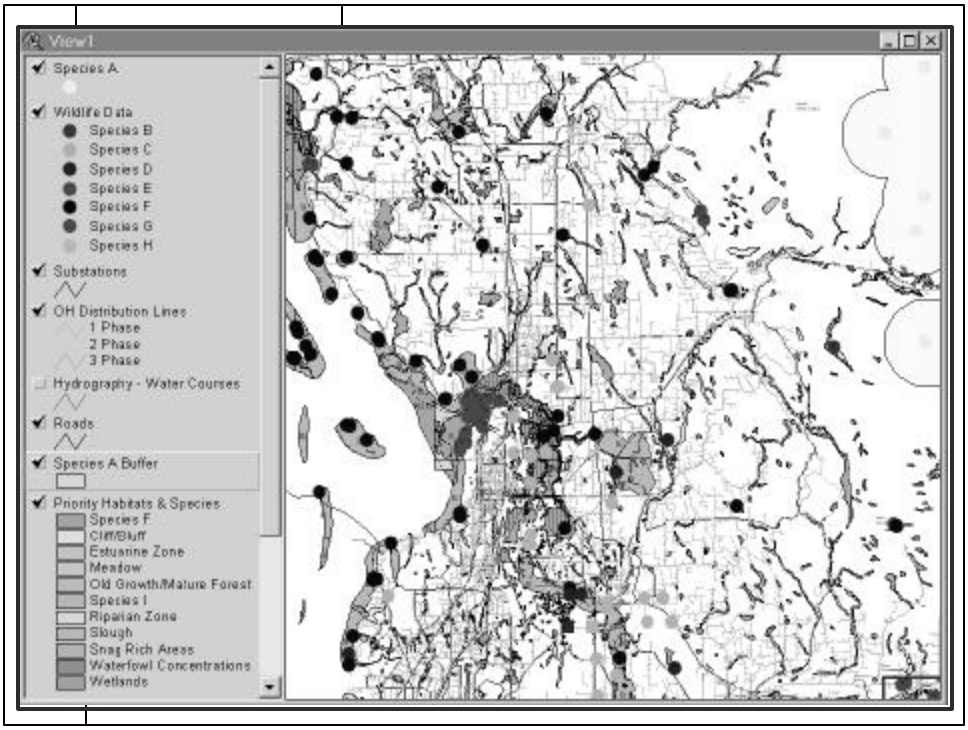
- Convert vector data to common
  - datum and projection
  - ArcView shape file format (SHP)

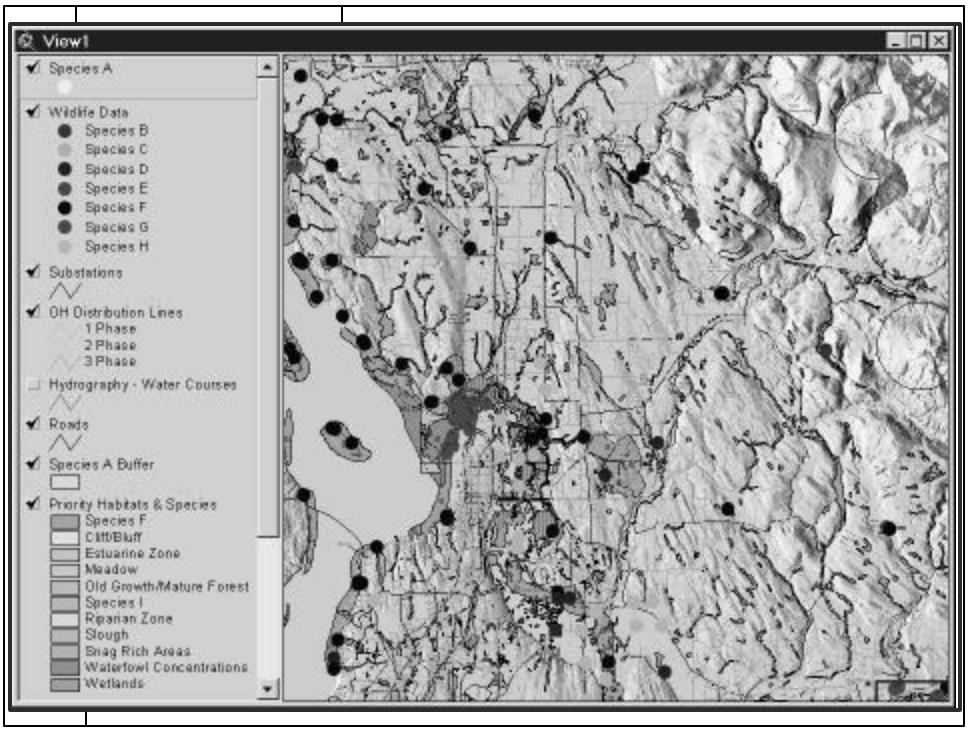
Map Production

- Add available data layers
- Name layers and label appropriately
- Apply pertinent themes to best visually represent the data through the use of color and labels
  - Theme point observations by species type and label with use codes
  - Classify overhead lines to designate phase-type
  - Apply hillshade to background DEM layer for appearance of topographic relief
- Print hardcopy maps by USGS quad for field use

USGS Topo Grid



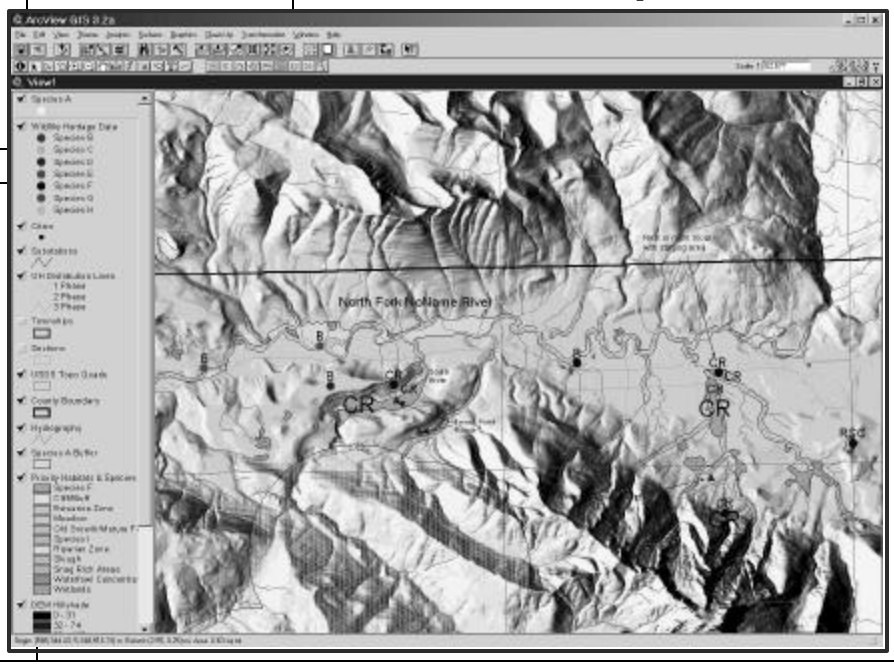




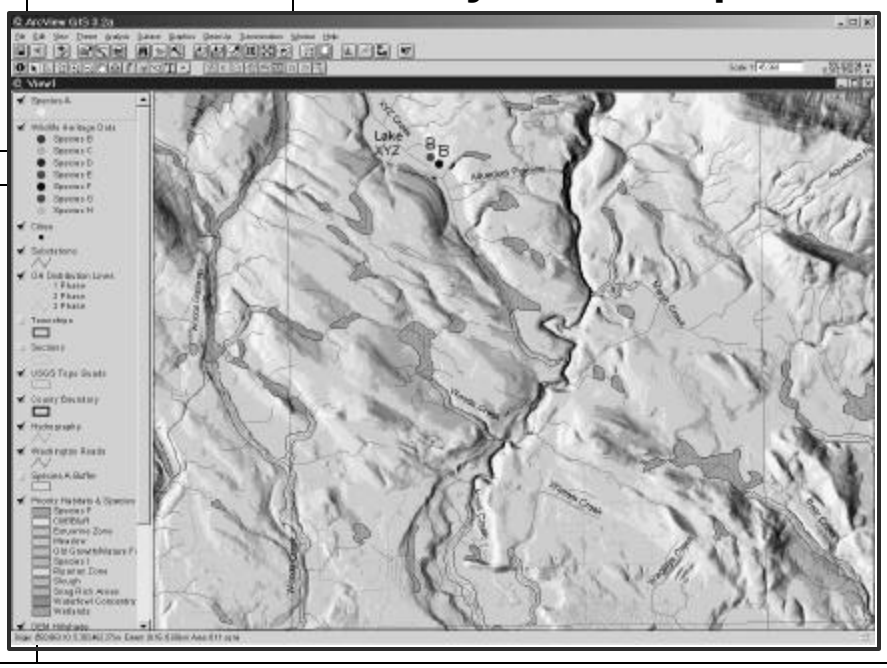
Field Inspections

- Prep for Fieldwork – Map Review
  - Prioritize site visits by using GIS maps to identify areas where overhead lines are in proximity to sensitive habitat or bird concentration areas
  - Combining bird data with roads and political/administrative boundaries, field personnel can orient themselves in the field and easily locate the areas designated as priority for inspection

Detailed Inspection



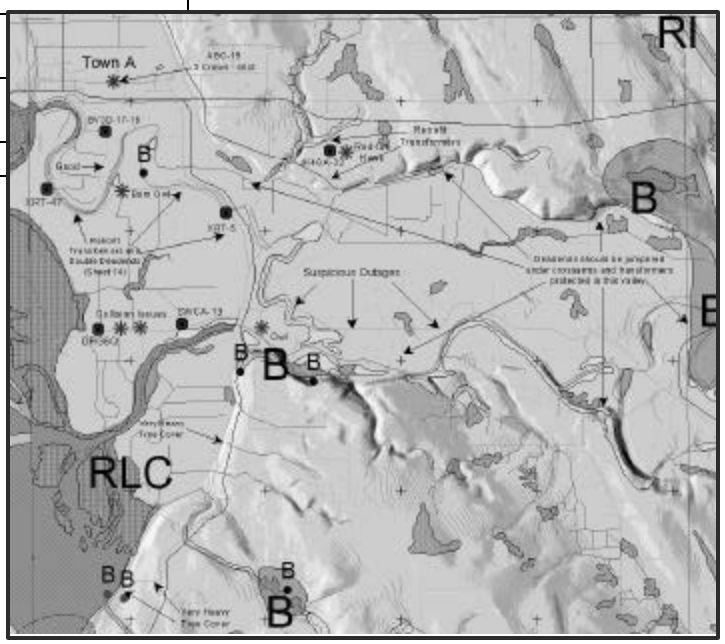
Cursory or No Inspection



Field Inspections

- Geo-referenced field observations can be added back to the maps
  - Point observations of raptor interactions
  - Locations of poles in need of retrofitting
  - Digital photos
    - Poles and/or structures
    - Birds

Field Annotations



Results

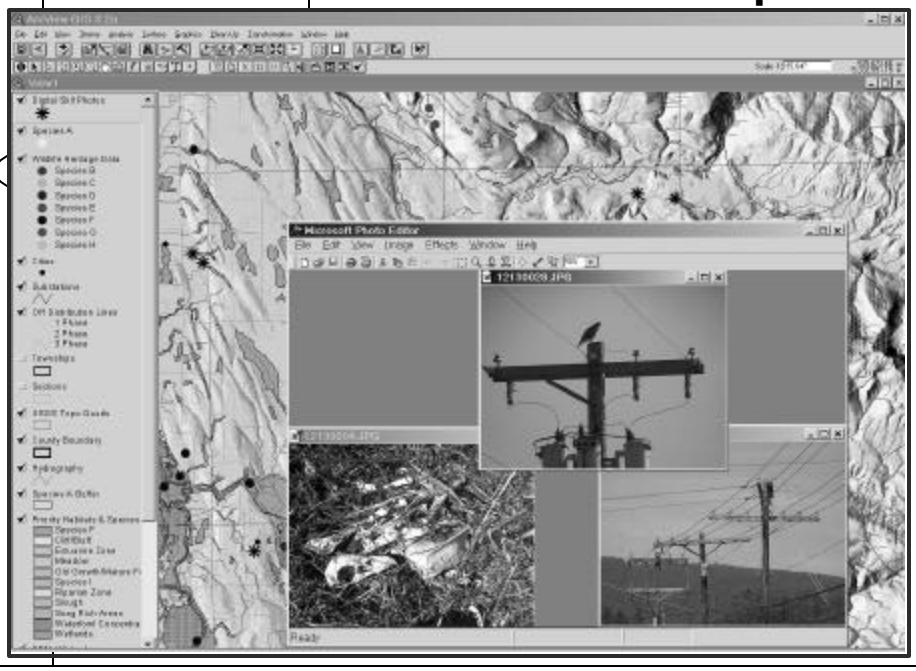
- Promoted more focused field inspection efforts
- Provided for efficient, cost-effective use of field time
- Utility will use GIS maps as a base for on-going monitoring efforts
- Digital maps are easy to update and modify

Potential Enhancements

- Multimedia Maps
  - "hot-linked" still images, video clips, sound files, and other documents

- Future Spatial Analyses or Modeling
  - Predict electrocution risk
  - Identify potential electrocution "hot spots"

Multimedia Maps



Conclusions

- GIS is a powerful tool that can aid in the development of an avian protection program
- GIS maps promote efficient, cost-effective field inspections
- Maps support on-going monitoring efforts
  - Tracking and prediction

QUESTIONS?

THANKS!

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