# Collision Course?: Golden Eagles and the Development of Wind Energy.

## Introduction

Every year, hundreds of eastern golden eagles migrate to their winter and summer territories through what research shows to be an unchanging 30-60 mile wide corridor of air space. The flight paths of these golden eagles, however, overlap with land areas that hold significant potential for wind power development, setting these birds on a potential collision course with fast-moving turbine blades.

Wind power development is the world's fastest growing energy technology and has many environmental benefits. Therefore, researchers have come together to track and map the movements of the golden eagle in order to provide this information to land managers and government officials for consideration during the siting, permitting and construction phases of wind farm development.

## Goal

Captured golden eagles are outfitted with a telemetry unit that collect and store data points every 15 minutes. Students will use real-life flight data of five different golden eagles and graph their flight maps. Students will plot the migration patterns of the golden eagle in order to make a map that shows areas of high and low risk to the birds from the development of wind turbines.

Students may also use their maps to find a line best-fit line to show where building wind turbines is unsafe to the well-being of the eastern golden eagle.

*Suggested time:* Two to four consecutive class periods.

## Math Skills to Highlight

1. Researching, reading, and interpreting data
2. Using data to draw conclusions and make predictions
3. Creating graphs, tables, or charts
4. Finding a line of best fit, determining slope and writing the equation
5. Using technology in problem solving

# Special Materials/Equipment

Reference articles and links about the golden eagle and migration patterns; Reference articles and links about the development of wind energy; colored pencils; rulers. Optional: Internet access for research; overhead projectors and transparences; PowerPoint or interactive whiteboards for presentations.

# Development

- Begin this project by looking at pictures of the Golden Eagle.
  Photo Gallery
  Opening discussion points to link to prior knowledge and/or hook student interest:
  Wing span as related to birds and people, GPS systems and uses student can think of, local birds or the largest birds seen by students.
- Share the audio clip: "Golden Eagle Released with GPS Tracking Device" and the video clip "Golden Eagle Soars Again" and ask students to discuss any math applications heard or seen in the clips.
- Further discussion points: Telemetry, migration, development of wind energy, conservation, local geography.
- Distribute copies of the "Region Map" or the "Topographic Region Map" and "Golden Eagle Flight Data" to students. *Note: Maps modified for easy math show actual golden eagle flight paths, however the (x,y) coordinates have no relation to locations on the map.*
- Optional: Distribute copies of the "Eagle Information Sheet" so students can learn about the golden eagles they are tracking.
- Instruct students to use the "Golden Eagle Flight Data" to plot the flight path of each eagle on their map. For consistency and ease of comparison, students should use the indicated color pencil as listed next to each data point. Students should also use the blank box provided to make a legend.
- Remind students to title their graph and to label the x-axis and y-axis.
- Plan on using half of a class period for the introduction of the golden eagle, video and audio clips, and discussion of math related concepts.
- Reserve one class period for students to plot the flights of the five golden eagles, and to correctly label their graphs.

# Development – Project Expansion

- Have students determine the area that best summarizes the data and construct a best-fit line and label the line the "no-build line."
- Use the line to determine the slope and to write equations in slope-intercept form and/or point-slope form.
- Remind students to select points that go through an exact (x,y) coordinate for easier math.

- Modification of the best fit line: Use the width of a ruler to trace both outside lengths of the ruler and label the area the "no build zone." For best results, use a clear ruler so students can see the paths of the birds inside the ruler. Find the slopes of both lines to incorporate parallel slopes.
- Common error #1. When calculating slope, students will use data points from the eagle flight path rather than data points on the best-fit line, therefore causing errors in their equations. Remind students that the line best summarizes the flight data, but their chosen points to do math with does not necessarily have to be a plotted-point on any eagle's flight path but must lie on their best-fit line.
- Common error #2: Describing the best-fit line as a no-build line (or zone), leads some students to logically construct a horizontal line in order to save all eagles. Ask these students where they would safely build their wind turbines, and grabble with how that would affect their line.
- Reserve an additional class period if constructing a line of best fit (no build zone).

# Wrap-up

Compare student graphs to technology produced flight maps:
Amenia/Tufts Golden Eagle Flight Spring 2011 Migration Map, Fall 2011 Migration Map
Flight map of Clinch Mountain, VA
Flight Map of Virgil Cane

# Extension

- Discuss the math involved in converting 3-D latitude and longitude flight data into 2-D x and y points. Coordinate Conversion Guide
- Cross-curricular: Have students write a persuasive essay supporting or opposing the development of wind energy. Harvesting the Wind, Harvesting the Wind Podcast, Harvesting the Wind Resources

# Articles

- Golden Eagle Released With GPS Tracking Device. Your Public Media. Mar 29, 2011
- Rehabbed eagle released, tagged for study. The Charleston Gazette. June 21, 2011
- Rehabilitated Golden Eagle to be Released Near NY/CT Border. Tufts Now. March 25, 2011

# Primary Resource

- Katzner Lab
  Todd Katzner's research group in the Division of Forestry and Natural Resources at West Virginia University focuses on conservation ecology of wildlife in North America and worldwide.

# Additional Resources

- **The Center for Conservation Biology**
  The Center for Conservation Biology is a research and education organization at the College of William & Mary and Virginia Commonwealth University. Our particular focus is the development of information resources needed for effective, science-based conservation
- **Center for Conservation Medicine at Tufts**
  Through the practice of Conservation Medicine, Tufts CCM brings together veterinarians, physicians, ecologists, and conservation professionals to develop education and research activities that explore the relationships among animal, human, and environmental health
- **$e^2$ series**
  An ongoing PBS series about the economics of being environmentally conscious.
- **Seaturtle.org**
  Created as "Turtle Tidings" in 1996, seaturtle.org was founded out of a desire to support research and conservation efforts in the sea turtle community.
  The site hosts Golden Eagles of Virginia, USA page
- **Virginia Golden Eagle Research and Conservation**
  Virginia Department of Game and Inland Fisheries is responsible for the management of inland fisheries, wildlife, and recreational boating for the Commonwealth of Virginia.

# Credits

- This lesson plan was designed by Jessica Reed Roach, a high school Mathematics teacher from Southbury, CT.
- Actual golden eagle flight data and maps provided by Dr. Todd Katzner, Research Assistant Professor and Trish Miller, Wildlife Biologist, from the Division of Forestry and Natural Resources at West Virginia University.
- The format for the lesson plan was modeled from the book "Hands-On Math Projects with Real-Life Applications." Second Edition. Authored by Judith A. Muschla and Gary Robert Muschla.