

USING GEOGRAPHIC INFORMATION SYSTEMS TO DETERMINE POTENTIAL BALD EAGLE NESTING SITES IN WASHINGTON COUNTY, MN

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Abstract

In North America, there is only one native eagle, the bald eagle (*Haliaeetus leucocephalis*). The bald eagle population in the lower 48 states of the United States of America has declined dramatically. The population was estimated to be as much 500,000 in the 1700s, and it has fallen to approximately 20,000 in 2000. In 2000, Minnesota had an estimated 680 breeding pairs of bald eagles. Sixteen of the thirty-five active breeding sites in the Twin Cities Metro Area are located in Washington County. Geographic Information Systems (GIS) helped to determine where potential nesting sites are in Washington County. Slope and aspect of the known nesting sites were measured to determine the GIS model. The GIS helped establish other characteristics of the existing nests, such as distance to open water, proximity to roads, railroads and other man-made features. By developing and analyzing the GIS model of bald eagle nests, it was concluded that of the 1,015 square kilometers in Washington County, 88 square kilometers would be suitable for bald eagle nests.

Introduction

The bald eagle (*Haliaeetus leucocephalis*) is the only eagle that is native to North America. It is currently on the nations 'threatened species' list and is protected under the *Migratory Bird Treaty Act* and the *Bald and Golden Eagle Protection Act*. These acts 'prohibit the taking or possession of and commerce in bald and golden eagles, with limited exceptions.' Currently, the vast majority, approximately 35,000, of the United States bald eagle population resides in Alaska.¹ Minnesota has approximately 700 bald eagle breeding areas.²

When the first Europeans arrived in North America the bald eagle population was estimated to be greater than half a million.¹ As humans expanded their territory in North America the bald eagle's habitat was taken away. Humans started to take away the bald eagle's food sources. Bald eagles are mainly fish eaters, but will scavenge or eat almost any meat they can find.³ This is why the expansion of humans into the western part of the current United States directly led to a decline in North America's bald eagle population.

The first attempt to protect this incredible bird of prey in the United States was in the mid 1900's, when the 1940 Bald Eagle Act was passed.¹ Later, in the 1960's and 1970's many states began to put the bald eagle on their endangered species lists. In 1967, the bald eagle was officially placed on the United States government's endangered species list.

Statement of the Problem

This geographic information systems (GIS) project will be used to study the following question: Are there any potential bald eagle nesting sites in the Washington County? My hope for this project is that the knowledge of these potential nesting sites could lead to possible protection of or at least further exploration of these sites. In order to guarantee the expansion and growth of the bald eagle population in Minnesota there must be better understanding of a bald eagle's requirements for habitat. The potential sites will be determined first by using known facts pertaining to bald eagles, such as the need to be near water and the need to have large trees to support their massive nests⁴, and additionally by characteristics found in the analysis of existing nesting sites. A study done by Applied Ecological Services, Inc. helped in determining which characteristics will be useful to describe.

The Ontario Ministry of Natural Resources did a study in June of 1987 that described regulations for existing bald eagle nesting sites for southern Ontario. Their study characterized buffer zones for the protection of the current sites, and the zones extended as far out as a one half-mile. Each zone contained

specific restrictions, which limit human interaction (logging, new construction, air traffic, etc.) with the sites. Three main buffer zones were set-up for the sites.

The Ontario Ministry of Natural Resources study³ found that bald eagles have a tendency towards using areas that had already been logged or burned.³ They concluded that this was because there was more room for their large nests. They found that bald eagles preferred forested areas with approximately 30–50% of canopy cover, and it was typical for the eagles to choose large living trees for nests.³ Another finding by the ministry was that the effect of human disturbance was variable among eagles and breeding pairs.

Livingston did another study on bald eagle habitat in Maine in 1990. He found that river nest sites ended up close to the shores of rivers and had little forest edge.⁵ The lake nest sites that Livingston studied were found to have little human disturbance and were near to the water. Livingston⁵ also calculated an average home/hunting range of 1.5 km from the eagles nest. Along with the Ontario Ministry of Natural Resources study, Livingston found that human disturbance varied between individual eagles.⁵ He found that a nest should be considered disturbed when a human or other eagle came within 500 meters of that nest.

Methods

Overview of Analysis

The purpose of this analysis was to describe and quantify the characteristics bald eagles require in the selection of their nesting sites. In addition, the data found in the analysis of the current nesting sites was used to assess the potential for new nesting sites. A GIS model of the nesting sites allowed for analysis of many different characteristics of the existing nesting sites.

The first step in the analysis was to determine the proximity of water, roads, and other man-made features to each of the sixteen nesting sites. Then the slope and aspect for each site were determined using the slope and aspect functions in ArcGIS 8.2. For each site a viewshed (areas which are visible from a given observation point) was calculated to see what man-made features can be seen from each nest.

Once the characteristics of the existing nesting sites had been calculated, the second step of the analysis was begun. The characteristics found in the first analysis were applied to all of Washington County. These characteristics were used to determine where new potential nesting locations are located in Washington County.

Nest Sites

The bald eagle's habitat is typically restricted to large rivers and lakes. They build their nests along cliffs, in large trees, and even on the ground if nothing else is available.¹ Bald eagle's home/hunting range can span an area of 1,700 acres to 10,000 acres.¹

The nest of a bald eagle can be quite massive, reaching weights of up to two tons.⁶ Typically, the nest is approximately five feet in diameter. A nest can take many different shapes. They can be cylindrical or conical when the nest is placed in a deep crotch of a tree. Disk shaped nests are found when the nest is made on level braches or on the ground. Lastly, bowl shaped nests are associated with trees which have smaller branches.¹

The Natural Heritage and Nongame Research Program of the Division of Ecological Services chose the locations of bald eagle nest sites, which were used for this analysis. These sites were located through direct observation by employees of the Minnesota Department of Natural Resources.⁷ There are 16 bald eagle nests located within Washington County.

Database Construction

Data for this project were manipulated and analyzed using ArcInfo command line and ArcGIS 8.2: ArcCatalog, ArcMap, and ArcToolbox. All coverages and data used for this project were projected to the Universal Transverse Mercator projection, Zone 15, Datum NAD83, with units in meters.

Data for this project was obtained through internet download from the US Census Bureau's website. The data collected was from the 2000 US Census. The eagle nesting sites data layers were acquired from

the Natural Heritage and Nongame Research Program of the Division of Ecological Services, Minnesota Department of Natural Resources (see Appendix A).

Data Layers

The subsequent data layers were utilized in the creation and analysis of this project:

- *Roads, railroads, utility lines, state and US highways, and community outline:* Shapefiles representing these features were used at a scale of 1: 100 000. These files were obtained through the US Census Bureau. Each shape file was extracted from the Topologically Integrated Geographic Encoding and Referencing (TIGER) files.
- *Water:* Shapefiles were used to represent the lakes and rivers in Washington County. These files were obtained from the US Census Bureau's website. Lines were used to represent minor streams and rivers, and polygons were used to represent lakes and the St. Croix River. These files were at a scale of 1: 100 000.
- *Slope and Aspect:* Slope and aspect were obtained using ArcGIS 8.2's slope function and aspect function. This was done by using the Spatial Analyst extension. These raster files were derived from a digital elevation model (DEM) for Washington County provided by the University of Wisconsin – River Falls. The DEM has a 30-meter resolution and is at a scale of 1: 100 000.
- *Bald Eagle Nest Locations:* Bald Eagle nest locations were given from the data acquired from the Natural Heritage and Nongame Research Program of the Division of Ecological Services, Minnesota Department of Natural Resources (see Appendix A). The nest sites layer is at a scale of 1: 24 000.
- *Viewshed:* The viewshed function identifies cells that can be seen from a given observation point. A viewshed was created for each of the 16 nest sites that were being studied using ArcGIS 8.2's viewshed tool. This was done through the Spatial Analyst extension. No limit was specified for the

radius of the viewshed. The height for which the viewshed was to be taken from was set at 20 meters.

| Eagle Nest | Distance to Water (meters) | Body of Water | Distance to Human Activity (meters) | Dist to Major Road or Railroad (meters) |
|-------------------|-----------------------------------|----------------------|--|--|
| 1 | 60 | Sun Fish Lake | 407 | 550 |
| 2 | 182 | St. Croix River | 518 | 552 |
| 3 | 29 | St. Croix River | 615 | 858 |
| 4 | 805 | St. Croix River | 49 | 1891 |
| 5 | 196 | Forest Lake | 432 | 1742 |
| 6 | 314 | Rice Lake | 750 | 980 |
| 7 | 111 | St. Croix River | 150 | 2553 |
| 8 | 17 | Hardwood Creek | 134 | 897 |
| 9 | 500 | Big Carnelian Lake | 15 | 15 |
| 10 | 21 | St. Croix River | 172 | 513 |
| 11 | 166 | Sun Fish Lake | 969 | 5173 |
| 12 | 23 | Big Marine Lake | 201 | 1062 |
| 13 | 5 | Mississippi River | 192 | 849 |
| 14 | 2146 | Mississippi River | 248 | 909 |
| 15 | 199 | Bailey Lake | 85 | 152 |
| 16 | 48 | St. Croix River | 145 | 540 |

TABLE 1.1 – NEAREST FEATURES TO BALD EAGLE NESTS IN WASHINGTON COUNTY

Discussion

Results and Analysis

Using the measure tool in ArcMap, the distance of the nearest water, human activity, and major road or railroad was measured. These results are shown in Table 1.1. The nests were located relatively close to water, with the average distance being 321.5 meters. The closest nest was five meters from the nearest water and the furthest any nest was from water was 2136 meters.

Half of the nests were located near large rivers, either the St. Croix River or the Mississippi River. Seven more nests were overlooking lakes, and only one nest was not directly associated with a large body of water. This nest was located on a tributary 1070 meters away from the St. Croix River.

The average distance a bald eagle nest was located in relation to any human activity was 338.4 meters. The average distance to a major road, U.S. or State Highway, or railroad was 1282.4 meters. According to the two studies previously stated the affects of human disturbance varied among eagles. This seemed to be true with the nests in Washington County as well. There are nests that are over 5000 meters away from major roads, yet there are also nests that are with 15 meters of a major highway, Highway 36.

Using ArcMap’s spatial analyst extension, the slope and aspect were determined for each nest. The average slope was 2.1% as seen in Table 1.2. One quarter of the nests were located on flat ground with no slope or aspect. There were no nests in Washington County facing north. All nests were either on flat ground or on a slope, that was facing some other direction than north.

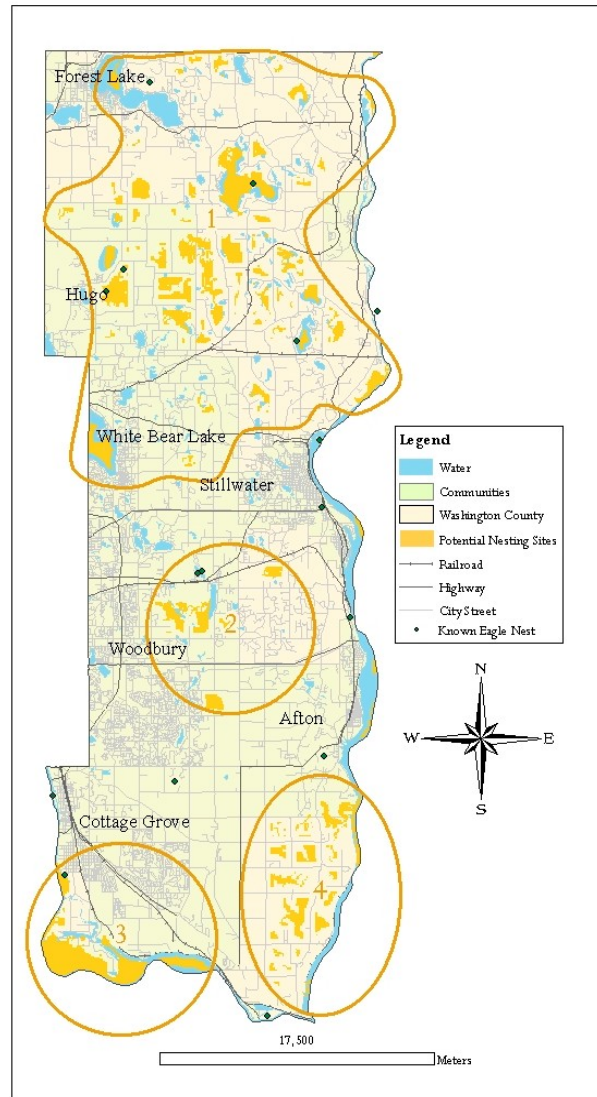
| Eagle Nest | Aspect | Slope (%) | | Eagle Nest | Aspect | Slope (%) |
|-------------------|---------------|------------------|--|-------------------|---------------|------------------|
| 1 | NW | 0.436 | | 9 | SE | 1.377 |
| 2 | NE | 4.348 | | 10 | E | 4.550 |
| 3 | Flat | 0.000 | | 11 | NE | 3.201 |
| 4 | Flat | 0.000 | | 12 | Flat | 0.000 |
| 5 | S | 0.234 | | 13 | W | 4.528 |
| 6 | Flat | 0.000 | | 14 | SW | 0.308 |
| 7 | W | 3.336 | | 15 | SW | 0.243 |
| 8 | Flat | 0.616 | | 16 | E | 7.608 |

TABLE 1.2 – SLOPE & ASPECT OF WASHIGNTON COUNTY BALD EAGLE NESTS

The average characteristics of the existing nests were used as guidelines for the second stage of analysis. A buffer of 338.4 meters was placed around all city streets in Washington County. One more buffer of 1282.4 meters was placed around all US and State highways. The areas that were not included in

these buffers were selected and made into a new layer. Another buffer of 321.4 meters was placed around all rivers and lakes.

The new layers formed around the roads and water were intersected using ArcGIS Geoprocessing Wizard. The areas which were they intersected were selected and made into a new layer, called



**MAP 1.1 – POTENTIAL BALD EAGLE
NESTING SITES IN WASHINGTON
COUNTY, MN**

'potential_nest_sites'. This layer was then converted into raster (pixels rather than points, lines, and areas) format.

A reclass was done on the aspect data layer, so all values equaled one. North facing slopes were an exception; they were given a value of zero. Using map algebra, the 'potential_nest_sites' layer and the reclassified aspect layer were multiplied together. This gave a layer of all the sites in Washington County that had the characteristics of an average nest in the county.

Conclusion

In conclusion, four main areas in Washington County are suitable for bald eagle nest based on the criteria determined in this project. The four areas are shown in Map 1.1. There is a large area in the northern half of the county. This site encompasses an area 440 square kilometers. The actual sites in region one that are suitable account for approximately 45 square kilometers. Region 2, which is located in the center of the county near Woodbury, MN, is approximately 95 square kilometers. There are roughly 15 square kilometers of land that were determined to be suitable in site 2. Region 3 is located south of Cottage Grove, MN and is approximately 110 square kilometers with about 20 square kilometers of suitable area. The final area (Region 4) is located south of Afton, MN and is approximately 115 square kilometers with eight square kilometers of suitable area.

Washington County encompasses an area of 1015 square kilometers, which is roughly 0.5% of the total area of Minnesota. Within the 1015 square kilometers of Washington County, 88 square kilometers are suitable for bald eagle nesting sites based on the critique from this research. Approximately, 8.7% of Washington County that is suitable for bald eagles.

To analyze whether or not the regions found are truly suitable for bald eagles, more extensive research and observation should be done. The species and height of the trees, along with the density of the forest the nests are located in, may have an impact on these regions, and therefore should be considered.

Additionally, it would be helpful to actually set foot on these regions, to directly observe the eagles in their natural habitat.

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Appendix A

"Data included here were provided by the Natural Heritage and Nongame Research Program of the Division of Ecological Services, Minnesota Department of Natural Resources (DNR), and were current as of April 30, 2004. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present. Permission to use these data does not imply endorsement or approval by the DNR of any interpretations or products derived from the data."

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