

Using GIS to Monitor Nest Distribution of Bald Eagles near Areas with High Concentration of Lead Ammunition

An Exercise in Python Scripting and Automation for ArcGIS

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Traditional Outline

- Introduction
- Motivation
- Methodology
- Results
- Conclusion



See'em? He's right there.

Introduction

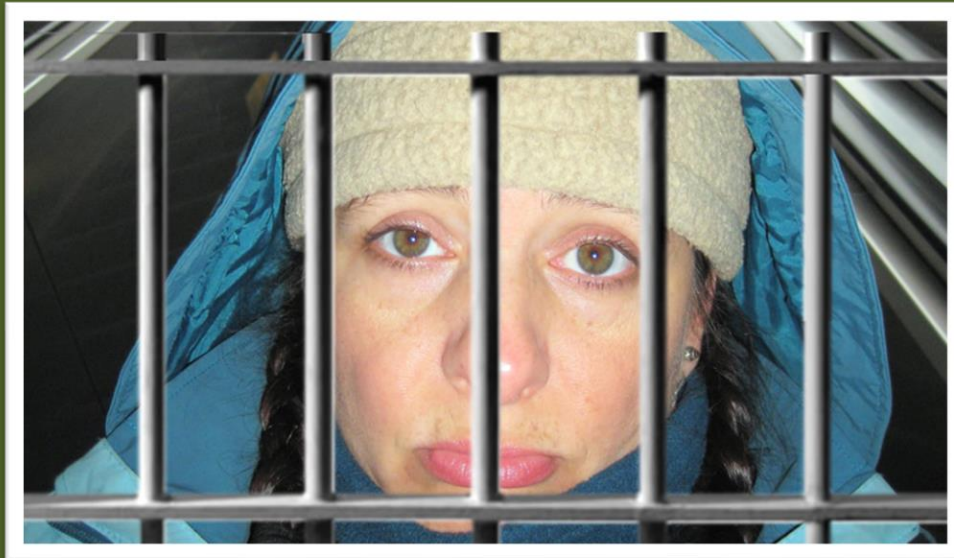
- After 40 years of conservation the bald eagle is no longer protected by the federal Endangered Species Act (ESA).
- On August 8, 2007, it was removed.
- Still protected under the Bald and Golden Eagle Protection Act of 1940 and the Migratory Bird Treaty Act of 1972.
- The Eagle Act protects all bald eagles from destruction or any disturbance that may cause the eagles to abandon their nest.
- The Migratory Bird Treaty Act prohibits the taking of any migratory bird or any part, nest, or egg.



Introduction

BIG FINES

- First offense \$100,000 fine or \$200,000 fine for organizations.
- and/or imprisonment for one year.
- Second offense is a felony.



Introduction

- Most states have their own regulations and/or guidelines for bald eagle management.
- In 2009, the bald eagle was removed from Iowa's threatened species list.
- Upgraded to a species of "special concern."

yeah!



Introduction

BRIEF HISTORY

- Bald Eagles are a North American species that historically occurred throughout the contiguous United States and Alaska and Canada.
- There were once at least 25,000 breeding pairs.
- First listed as endangered in 1967 under the Endangered Species Prevention Act.
- In 1973 transferred to the threatened and endangered species list under the ESA.
- At that time their population had declined to 417 breeding pairs.
- Due to habitat loss and the use of DDT.



Introduction

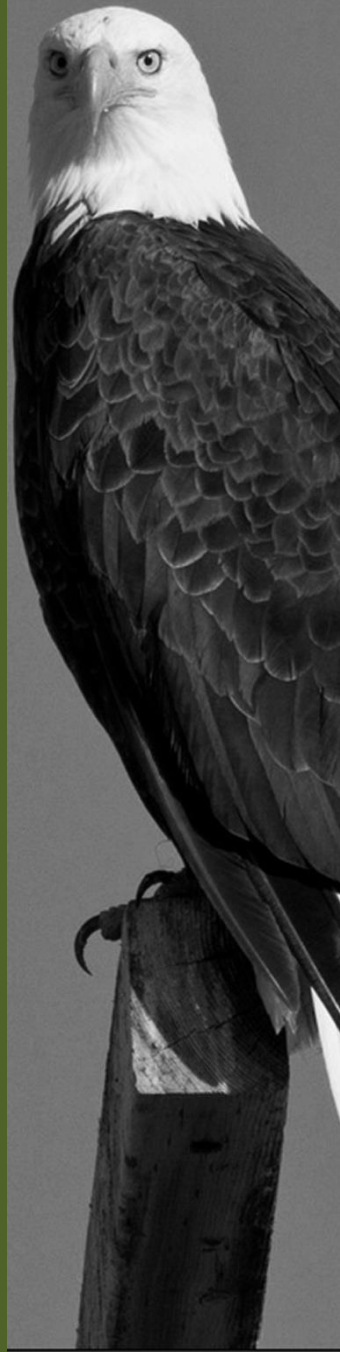
BRIEF HISTORY

- Bald eagle recovery began when the EPA banned the use of DDT in the US in 1972.
- The DDT pesticide altered the birds ability to metabolize calcium resulting in egg shells that could not support an incubating adult – nests failed, and no offspring were produced.
- Today, the DNR estimates that 3,000 eagles will be sighted while migrating south.
- These concentrations can be seen along the Iowa River in early January.
- 350 breeding pairs have been established in Iowa, very different from 1 nest in 1977.



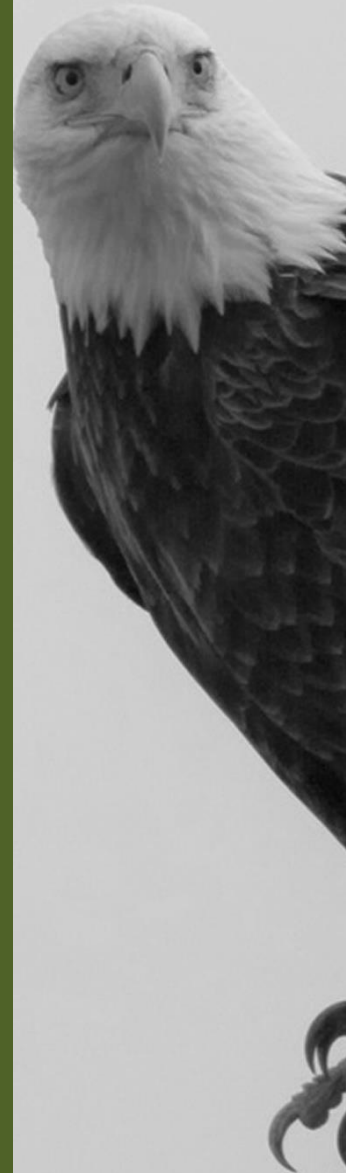
Motivation

- Bald eagles are still a species of concern.
- Still being monitored closely because of the controversy surrounding the use of lead shot for hunting upland game birds.
- Research has shown that mourning doves, bald eagles, California condors, and loons can die from lead shot, lead bullet fragments, and lead sinkers that have been ingested.
- In September of 2011, Iowa opened its first dove hunting season since 1918.
- The Natural Resource Commission was concerned about additional lead shot load in the environment, and adopted a ban on the use of lead shot for dove hunting.



Motivation

- Which was later over turned by the Governor of Iowa, Terry Brandstad, by Executive Order; which effectively snubbed the DNR's Campaign promoting "Get the Lead Out!"
- The entire state of Iowa is open to dove hunting; however lead shot is still prohibited in public wildlife areas and are designated as non-toxic shot only.



Motivation

LEAD

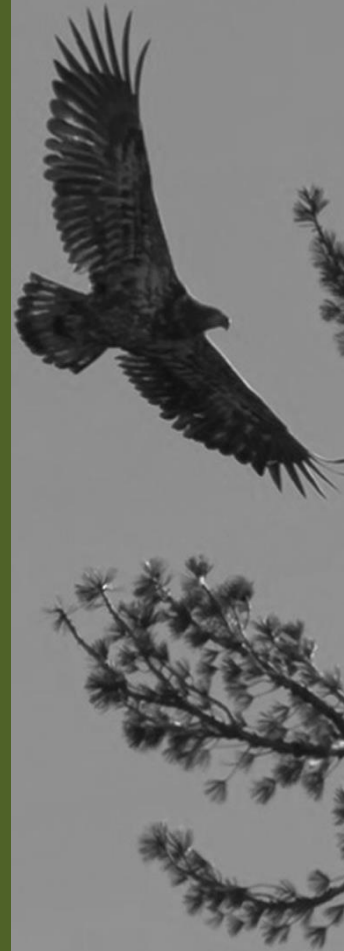
- Lead is an accumulative metabolic poison, meaning when ingested, it collects in the body over time.
- The accumulative effect can have an impact on animals and people who are long lived, and Bald eagles can live 30 or more years in the wild.
- It is also possible for game birds to graze on lead shot at gun ranges where most of the lead shot has missed its mark and fallen to the ground.
- Moreover, Iowa is a major corridor for bald eagles migrating south, which collides with dove hunting and deer hunting season in the fall. This situation creates the perfect environment for concentrated lead shot poisoning in Iowa.



Motivation

LEAD

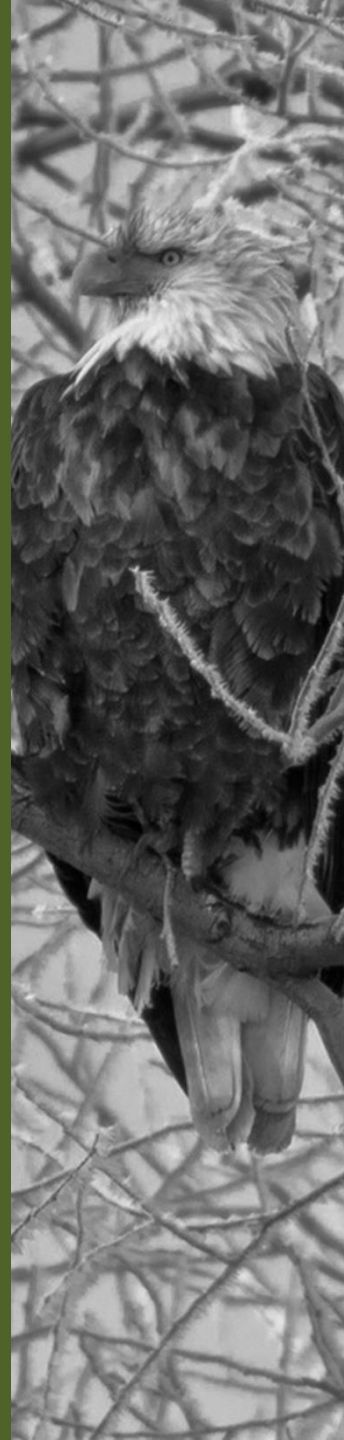
- 130 bald eagles were admitted to wildlife rehabilitators between 2004 -2009.
- 60% were diagnosed with abnormal levels of lead in their blood.
- Hunting activities are not the only source of lead ammunition in wildlife areas.
- Shooting ranges, firing ranges, and clay-pigeon shoots amass large volumes of lead shot that are easily accessible to mammals and terrestrial birds.



Motivation

LEAD

- Not many studies address this source of lead exposure to wildlife.
- None use spatial analysis to monitor nest sites and their close proximity to lead contaminated shooting ranges.
- Due to strict guideline and the heavy fines and penalties levied for human activity near a bald eagle nest, it can be difficult to conduct research around them.
- Therefore, spatial analysis is a useful non-invasive tool for managing bald eagles.



Methodology

The purpose of this script: To look at each bald eagle nest and determine how many gun ranges fall within a buffer zone surrounding the nest, and assess whether total county mortality is related to proximity to gun ranges.

DATA

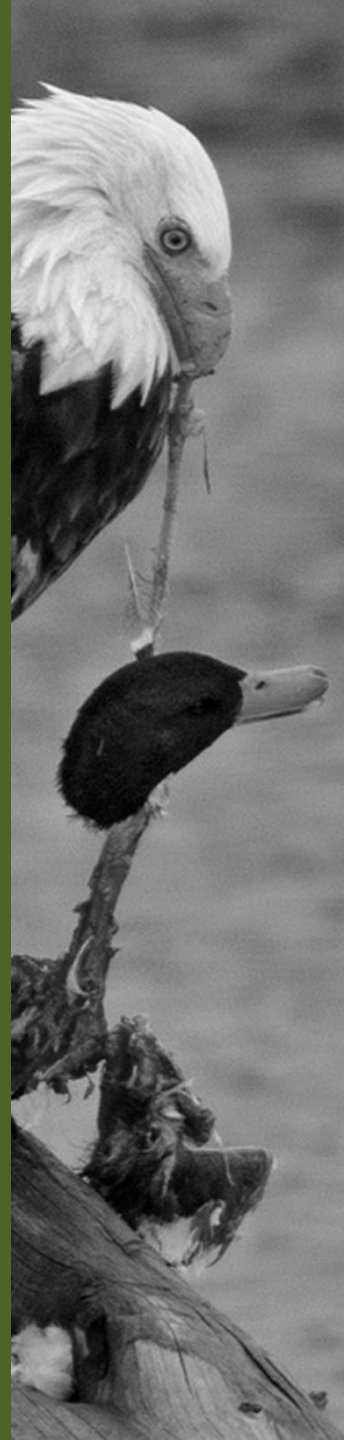
- 130 Bald eagle nest locations were acquired from the Iowa Department of Natural Resource's Sentinel Territories map. It is not a complete record of all nests in Iowa (~350).
- 79 gun ranges throughout Iowa were hand-plotted using Google Earth to acquire initial x-y coordinates.
- 114 eagle mortalities per county due to lead poisoning from 2004 to 2009, which was provided by Kay Neumann, Executive Director of Saving Our Avian Resources (SOAR).



Methodology

SCRIPT

1. Given no guidance in the literature, I assumed that the average nearest neighbor distance (ANND) between all eagle nests provided a good search radius for proximity analysis.
2. The script searched for distances between nests and gun ranges and filtered out those with distance greater than the ANND.
3. Looped through the distance table for unique nests and for each unique nest counted the number of shooting ranges within the ANND search radius.
4. Then for each unique nest, it searched the original eagle nest table for corresponding mortality and geographic information.
5. Finally, I plotted and analyzed the resulting table in Excel.



Methodology

SCRIPT

```
# import modules
import arcpy

try:

    # Local GIS variables:
    Workspace = "C:/Users/CMJSG/Desktop/Lead_Shot/"
    Ranges = "Data/ShootingRanges.shp"
    NestTable = Workspace + "Data/EaglesNests.shp"
    DistanceTable = Workspace + "Tables/DistanceTable20"
    ReportTablePath = Workspace + "Tables/AnalysisTable30.txt"

    # Eagle nest variables
    NID = 0 # Nest ID
    OID = 0 # Old Nest ID used to help eliminate duplicate nest records
    NUM = 0 # Number of Shooting ranges near a nest
    Nx = 0.0 # X-coordinate of the nest
    Ny = 0.0 # Y-coordinate of the nest
    County = "" # County
    Nfats = 0 # Number of Fatalities

    arcpy.env.workspace = Workspace

    print "Success Setting Workspace"

    # Calculate the Average Nearest Neighbor Distance between eagle nests (ANN)
    ann_out = arcpy.AverageNearestNeighbor_stats(NestTable, "EUCLIDEAN_DISTANCE", "GENERATE_REPORT", "#")

    print "Success Calculating Nearest Neighbor Distance"

    # Generate the Near Table using the nearest neighbor distance as the search radius
    arcpy.GenerateNearTable_analysis(NestTable, Ranges, DistanceTable, ann_out[4], "LOCATION", "NO_ANGLE", "ALL", "0")

    print "Success Generating Near Table"

    Drows = arcpy.SearchCursor(DistanceTable) # Drow is the search cursor for distance table
    drow = Drows.next() # go to first row in table

    print "Success Creating Search Cursor 1"

    Nrows = arcpy.SearchCursor(NestTable) #Nrow is the search cursor for nest table
    nrow = Nrows.next() # go to first row in table

    print "Success Creating Search Cursor 2"

    # Open output file
    ReportTable = open(ReportTablePath, 'w')

    print "Success Opening Output File"

    # Create Headers for output table
    ReportTable.write('Nest_ID,County,X,Y,Number_Fatalities,Number_ShootingRanges\n')

    print "Success Writing Header to Output Table"
```

Define GIS Variables

Define Local Variables

Average Nearest Neighbor Distance

Create Near Table

Setting Search Cursors

Preparing Output Text File

Create Headers



Methodology

SCRIPT

Loop Through Distance Table to Find Unique Nest IDs and Count the Number of Surrounding Shooting Ranges per Nest ID

```
#Loop through each record in the table and for each eagle's nest count the number of nearby shooting ranges
# and get from the eagles nest table the corresponding country, total number of counties and x-y coordinates of the nest.
for drow in Drows:

    NID = drow.getValue("IN_FID") # Get nest ID from distance table for the current row

    if NID != OID: # If the current nest is not equal to the previous nest ID (because there are duplicate nest ID's)
        # then proceed to write the set of records from the previous iteration.

        if OID != 0: #Write new record to output table
            ReportTable.write(str(NID) + ',' + County + ',' + str(Nx) + ',' + str(Ny) + ',' + str(Nfats) + ',' + str(NUM) + '\n')

        OID = NID
        NUM = 1

        for nrow in Nrows: # Search eagle nest table for corresponding information FID, COUNTY, FATALITIES, X, Y

            if NID == nrow.getValue("FID"):
                County = nrow.getValue("COUNTY")
                Nfats = nrow.getValue("FATALITIES")
                Nx = nrow.getValue("X")
                Ny = nrow.getValue("Y")
                break

            elif NID == OID: # If a new nest ID has not been encountered then increase the shooting range count by 1

                NUM = NUM + 1

ReportTable.close()

print "Finished running script"

except:
    # error handling
    ReportTable.close()
    print "Error in script execution"
    print arcpy.GetMessages(2)
```

For the current unique Nest ID loop through the Nest Table (Shapefile) to find the corresponding XY coordinates, fatalities, and county.



Results

OUTPUT TABLE

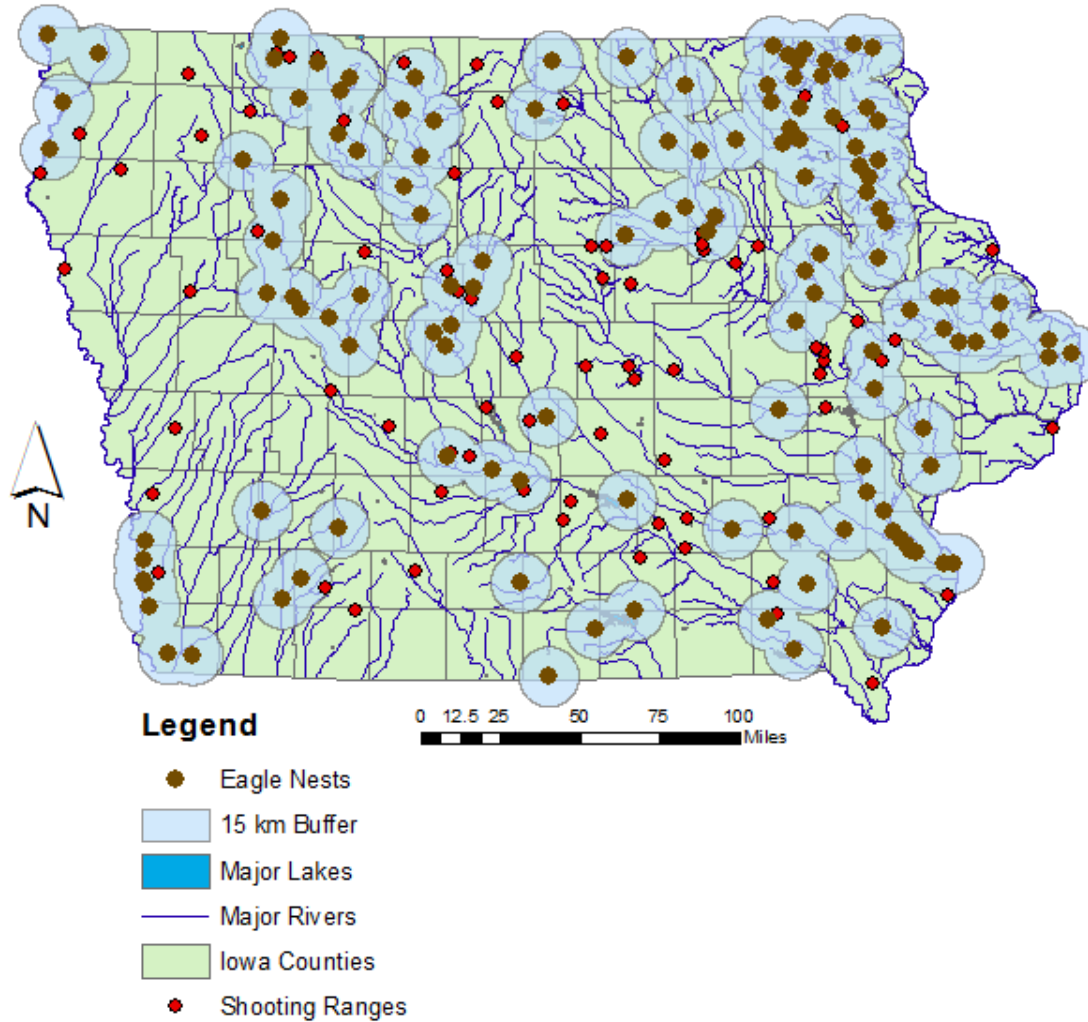
Filtered out nests with shooting ranges in the search radius.

Nest_ID	County	X	Y	Number_Fatalities	Number_ShootingRanges
5	Mills	261856.28854552332	261.507	2	1
6	Mills	261856.28854542261	251	2	1
7	Mills	262771.85724540430	113	2	1
16	Adams	341052.988	4543634.604	1	1
17	Palo Alto	360279.93244767491	171	1	1
23	Kossuth	399191.60564796331	588	3	1
24	Winneshiek	610230.20964776646	859	3	1
32	Winneshiek	593749.97164781224	703	3	1
33	Winneshiek	605194.58144796789	372	3	1
50	Winneshiek	590545.48094796331	588	3	1
51	Linn	630830.50724658080	702	5	2
64	Linn	631746.076	4638853.757	5	1
68	Washington	591918.834	4566523.824	2	1
69	Warren	452752.37934592617	534	1	1
70	Polk	437645.49444598568	731	3	1
78	Dallas	415214.05934604977	712	5	2
89	Polk	466028.12664625120	226	3	1
91	Van Buren	577269.73354522118	738	0	1
92	Dickinson	331439.51584816016	316	0	2
93	Dickinson	328235.02514805487	275	0	2
96	Emmet	350208.67584804113	922	0	2
99	Cerro Gordo	459619.1452	4779851.35	0	1
102	Butler	505397.58424716219	319	0	1
103	Bremer	550718.23894725832	791	0	2
107	Black Hawk	547513.74814718966	026	0	3
110	Allamakee	627626.01654780766	918	0	1
121	Clayton	622132.60384761539	974	0	1
127	Sac	327319.45634713930	397	0	1
128	Webster	417045.19684691498	962	0	4
129	Hamilton	433067.65054702943	572	0	1



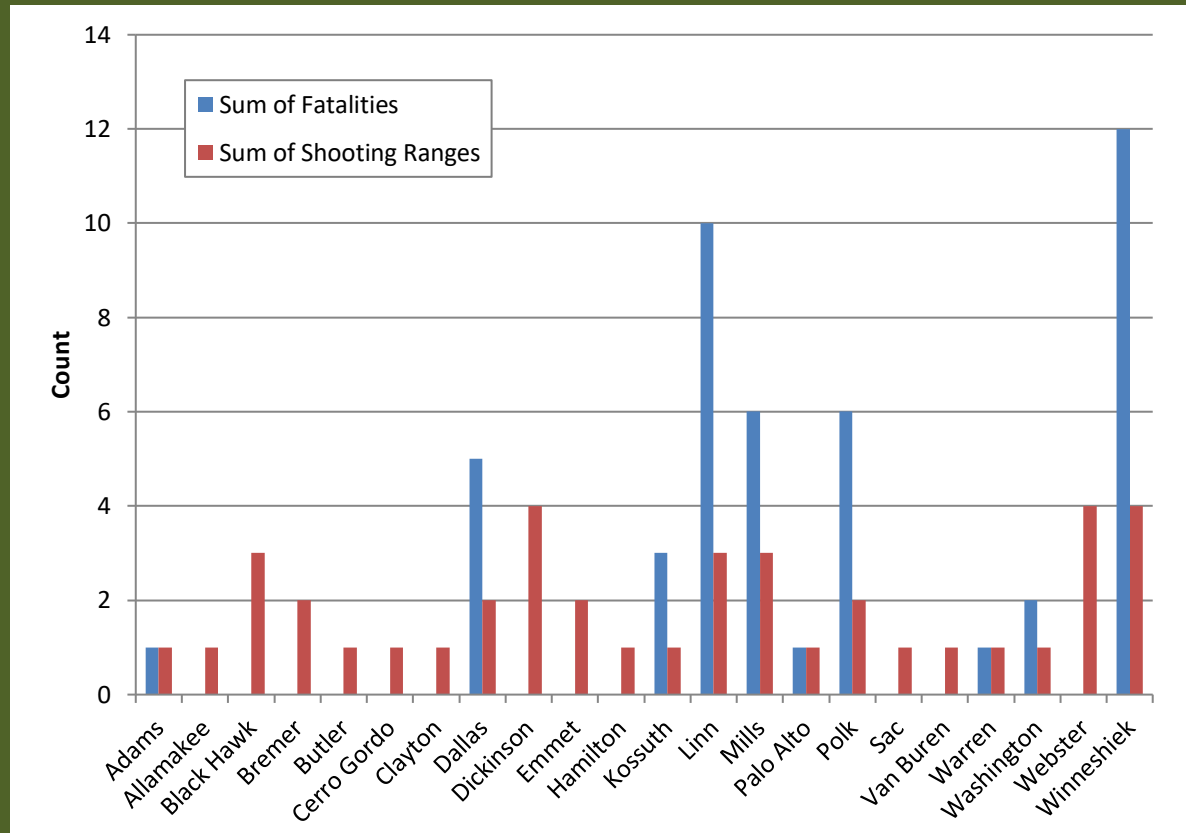
Results

Eagle Nests in Close Proximity to Shooting Ranges in Iowa



Results

Summary of Total Eagle Fatalities in Counties with One or More Shooting Ranges within the Search Radius



There appears to be a trend suggesting that the counties with more shooting ranges also tend to have a higher bald eagle fatality.



Conclusion

LIMITATIONS & SUGGESTIONS

- This project requires more thorough counts of eagle lead poisoned fatalities, eagle nesting sites, and outdoor shooting ranges at finer spatial resolution.
- Therefore, it is hard to draw conclusions from these results.
- In reference to eagle deaths, it's important to remember that where they are found is not necessarily where they are poisoned – and they move around a lot.
- However, eagle nests are good anchor points for determining home range during the breeding season.
- Also, for an eagle to ingest lead, it has to primarily be in an animal that they want to eat.
- A more thorough analysis would require more sophisticated statistical methods, but this is an interesting and reasonable first look.

