Bald eagle nest-site selection along the Upper Mississippi River, 1990-2012

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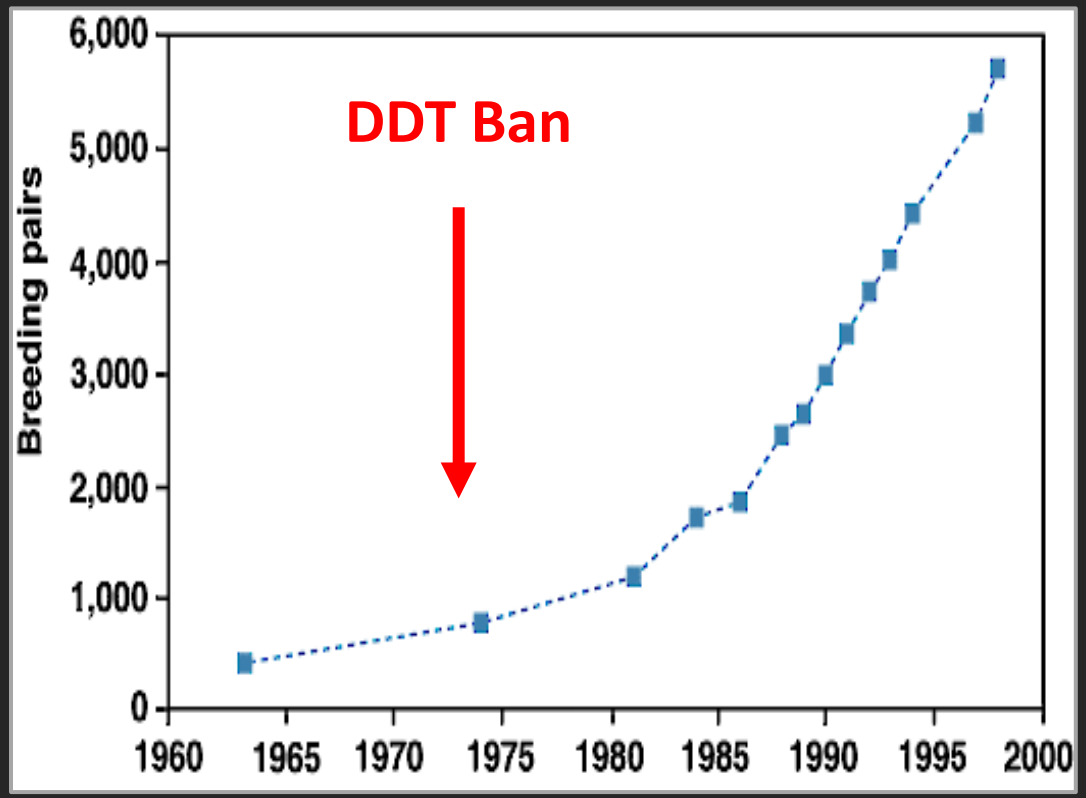
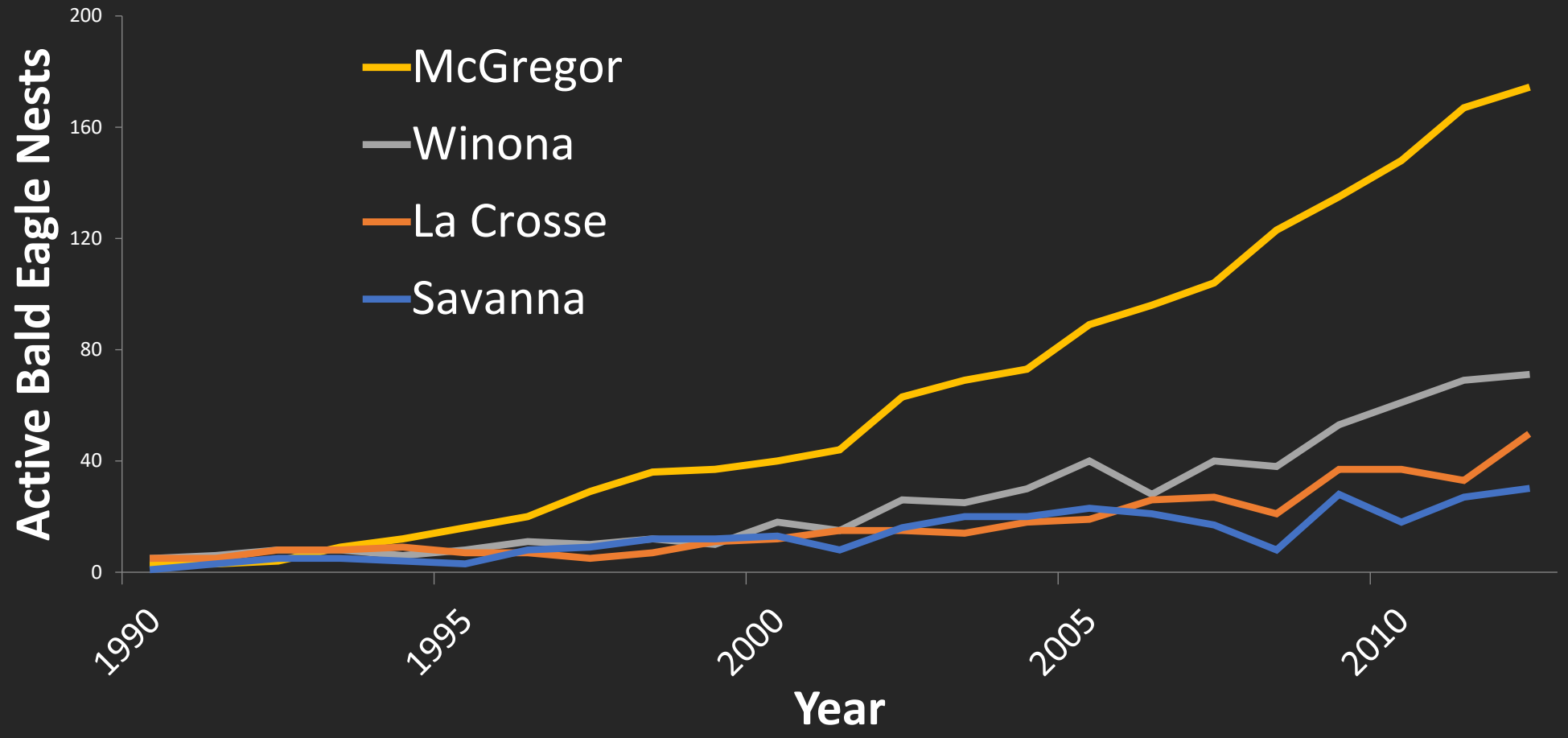
Bald Eagles in the Lower 48

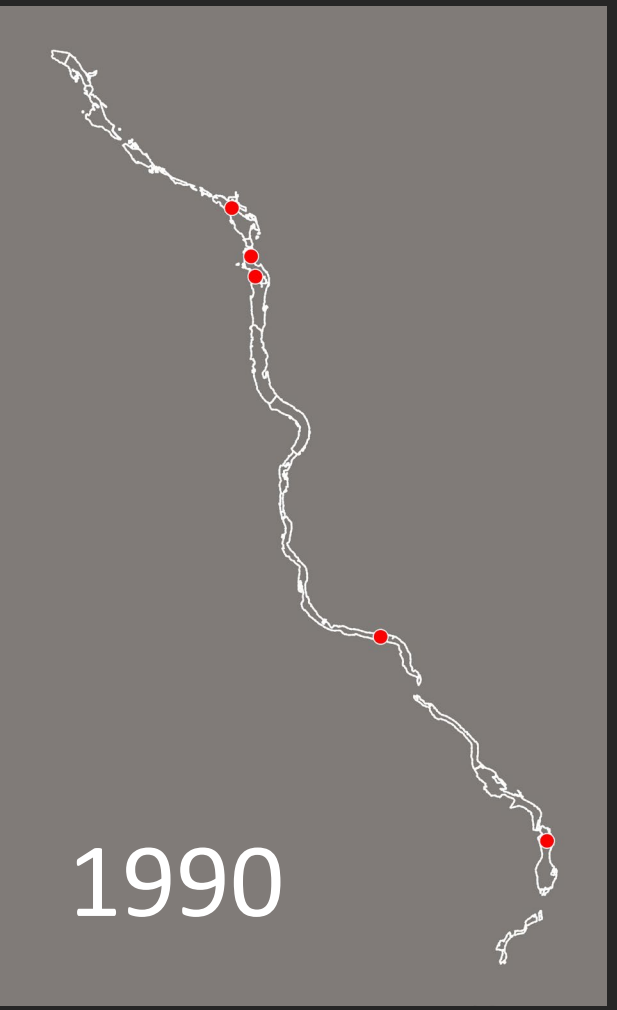
- Population declines in early 1900s
  - Habitat destruction
  - Shooting
  - DDT
- Population rebounding since 1970s
  - Restoration programs
  - Legal protection
  - DDT ban
- Delisted in 2007

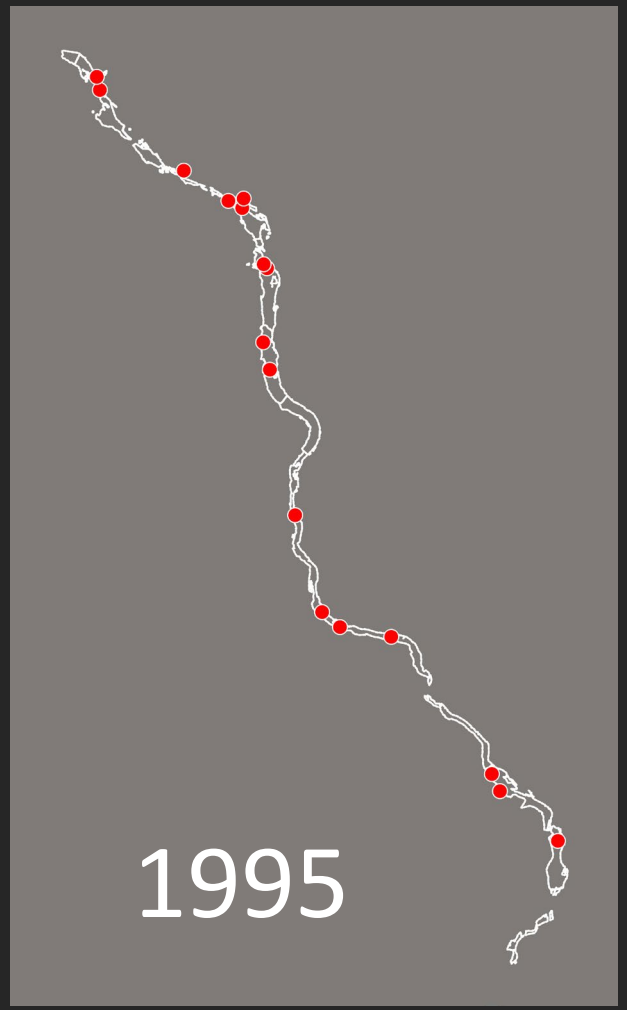


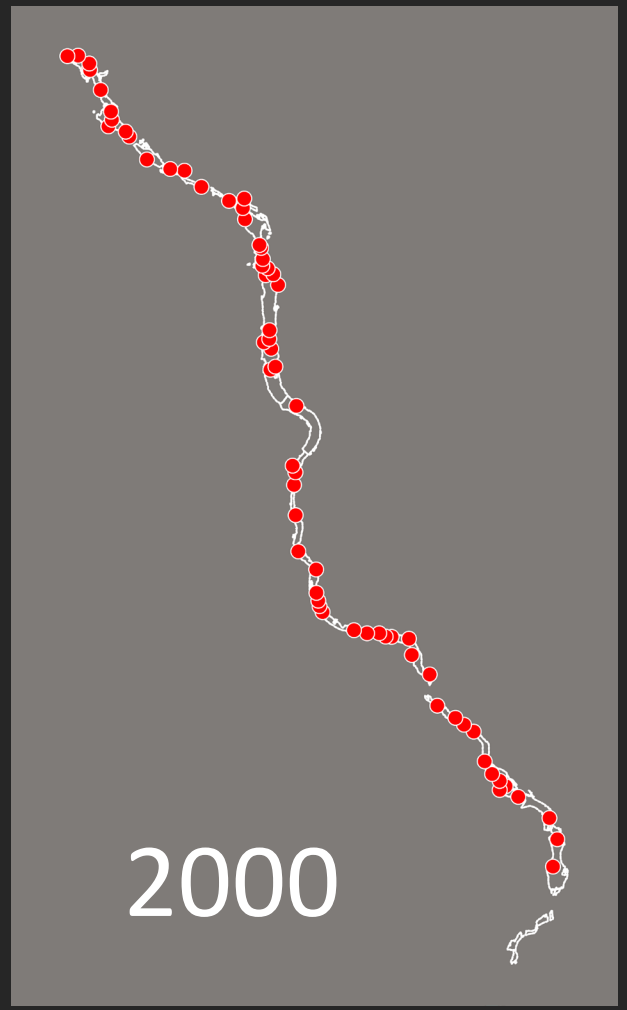
Bald Eagles in Study Area



Bald Eagles in Study Area







Bald Eagle Nesting

- Population essentially recovered → Assess habitat selection
- Normally nest in mature forests (Peterson 1986, Stalmaster 1987, Garrett et al. 1993)
  - Our study area = smaller patches of forest
- Currently nesting closer to human activity (Guinn 2004)
  - Our study area = several potential sources of human disturbance

Bald Eagle Nesting

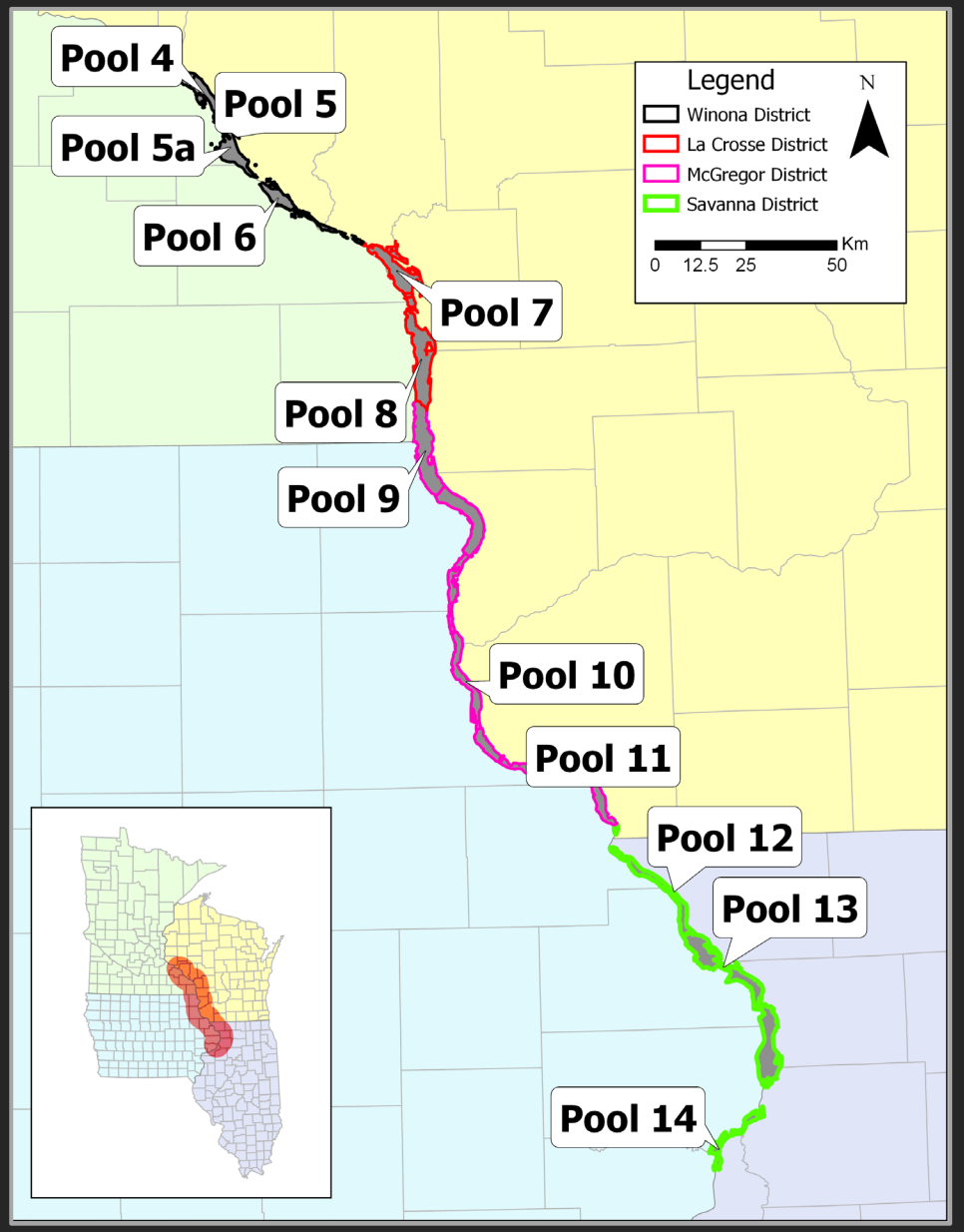
- Nesting habitat variable (Guinn 2004)
  - Across broad habitat range
- Selected wet forest + open water (Mundahl et al. 2013)
- Selected against agriculture + developed lands (Mundahl et al. 2013)
- Larger study area → suitable location to assess use
- Prevent future negative impacts

Study Objective

To determine how individuals of the Upper Mississippi River bald eagle population are selecting nest-sites.

The Refuge

- Upper Mississippi River National Wildlife and Fish Refuge
  - 240,000 acres
  - 420-km stretch of the Mississippi River
  - Pools 4-14
  - 19 counties in 4 states
- Refuge Administration
  - Winona + HQ
  - La Crosse
  - McGregor
  - Savanna

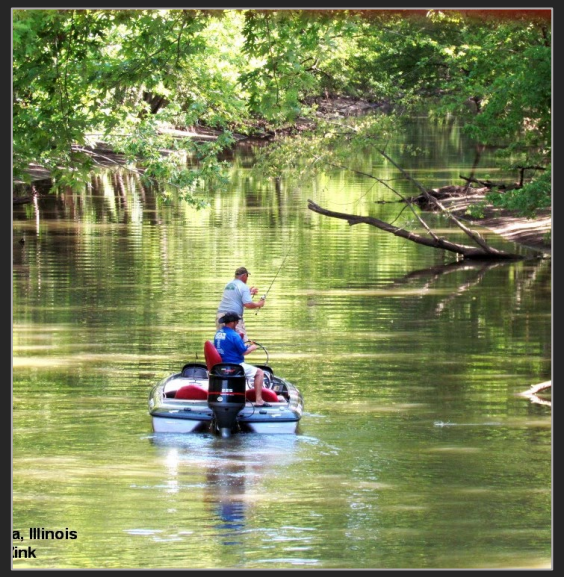


Environment

- River complexities
  - Various flow velocities
  - Steep, wooded bluffs
  - Groups of islands
  - Backwater channels
- Vegetative communities
  - Submerged aquatic vegetation
  - Emergent aquatic vegetation
  - Floodplain forest
  - Grassland

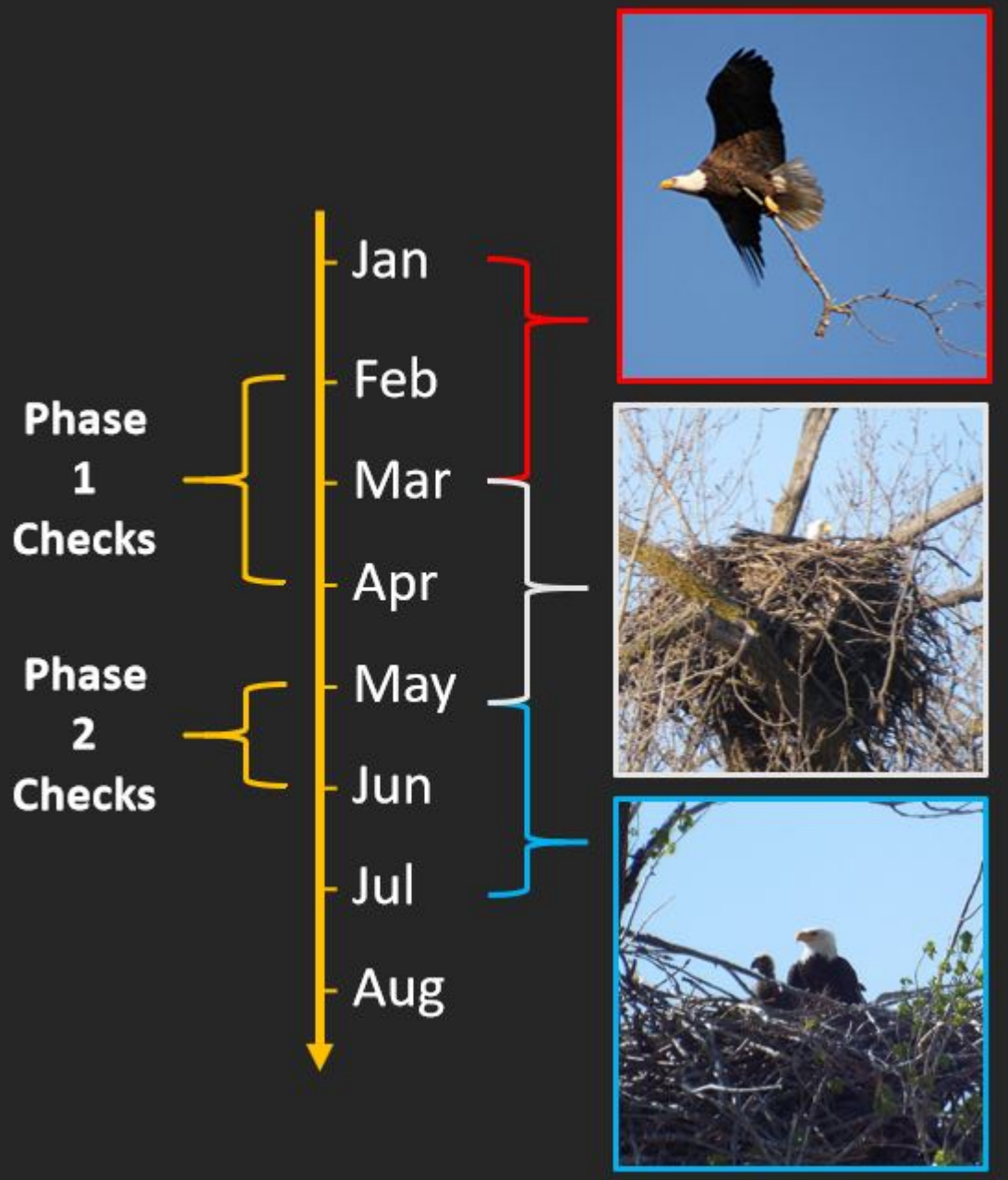
Disturbance

- Development
  - Dams
  - Main navigation channel
- Traffic
  - Barge
  - Vehicles
  - Trains
  - Recreationists



Field Data Collection

- USFWS Staff + volunteers
- 1990 – 2012
- 2 sampling phases
  - Phase 1 = Activity
  - Phase 2 = Productivity
- Vehicle, foot, boat
- Binoculars + spotting scopes
- Opportunistic



Data Review

- Monitoring database acquired from Refuge biologist
- QA/QC check completed for 5% of entire dataset
- Excluded records with ambiguous location data
- Imported into GIS geodatabase
- Geolocated nest information → Selection model

Selection Model

$$ln\left[\frac{\pi(x)}{1-\pi(x)}\right] = \beta_0 + \boldsymbol{\beta_n X_n} + \gamma_i$$

- Mixed-effects resource selection function
  - GLMER in lme4 package
  - Use-availability design
- All distance and area metrics scaled and centered (z-transformed)
- Random Effect = Year
- Tested for collinearity

Habitat Covariates

- Distance to open water → Foraging
- Distance to nearest active nest → Intraspecific competition
- Island or mainland → Isolation from mainland threats
- If on island, area : perimeter → Island shape effects
- % cover type within buffer distance → Habitat surrounding nest
  - 100m buffer = local scale
  - 500m buffer = intermediate scale
  - 1 km buffer = landscape scale

Disturbance Covariates

- Distance to roads → Vehicle traffic
  - Categories
    - High = Paved, 1 or 2 lane, > 50 mph
    - Med = Paved, 1 lane, < 50 mph
    - Low = Unpaved, motorized off-road
- Distance to railways → Train traffic
- Distance to main river channel → Barge traffic

Land Cover Data

- Long Term Resource Monitoring Data
- Acquired from USGS Upper Midwest Environmental Sciences Center
- Years of land cover

Land Cover Year	Nest Record Years Used
1990	1990 - 1995
2000	1996 - 2005
2010	2006 - 2012

Land Cover Data

- 15-classes → Merged → 6-classes

1) Grass / sedge
   - Wet meadow
2) Lacustrine wetland
   - Deep Marsh
   - Open Water
3) Palustrine wetland
   - Sand/Mud
   - Shallow Marsh
   - Rooted Floating Aquatics
   - Submerged Aquatics
4) Floodplain forest
   - Wet forest
   - Wet shrub
5) Developed upland
   - Developed
   - Road/Levee
   - Agriculture
   - Grass/Forbs
6) Undeveloped upland
   - Upland forest
   - Shrub/scrub

Data Summary

Total # of nests = 561

Total # of records = 2321

Total # of random points = 11,363

All predictor variables were not correlated (i.e., < 0.40)

Preliminary Results

Habitat

- Distance to open water
- 100-meter land cover
  - Grass / sedge
  - Lacustrine wetland
  - Palustrine wetland
  - Floodplain forest
  - Developed upland
  - Undeveloped upland

Disturbance

- Distance to known active nest
- Distance to main channel
- Distance to rail
- Distance to road (High)
- Distance to road (Med)
- Distance to road (Low)

Habitat

	Coefficient	P-value
Distance to open water	-1.381	< 0.05
Grass / sedge	+0.133	< 0.05
Lacustrine wetland	+0.863	< 0.05
Palustrine wetland	+0.657	< 0.05
Floodplain forest	-0.072	0.065
Developed upland	-9.503	< 0.05
Undeveloped upland	-0.539	< 0.05

Disturbance

	Coefficient	P-value
Distance to known active nest	+0.340	< 0.05
Distance to main channel	-0.290	< 0.05
Distance to rail	+0.393	< 0.05
Distance to road (High)	-0.024	0.720
Distance to road (Med)	-0.540	< 0.05
Distance to road (Low)	-0.151	< 0.05

Eagles nesting where…

- Greater distance from other active nests
- Closer to open water (foraging)
  - Newton 1979, Stalmaster 1987, Hackl 1994
- Farther from railways
- Closer to roads (all levels) – especially medium level roads
  - Guinn 2004
- Selecting against uplands, especially developed areas
- Selecting for lacustrine and palustrine wetlands

Considerations

- Roads and main channel
  - Potential sampling bias
- Selection may only be exhibited in this specific landscape
- Preliminary results
  - More to investigate

Next modeling steps

- Additional buffer distances (i.e., 500m, 1km)
- Additional covariates (e.g., island vs. mainland)
- Model selection
- Nest code as a random effect
  - Model currently not converging
- Limit model extent to reduce potential biases related to sampling

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Questions?