GOLDEN EAGLE MIGRATION CORRIDORS AND SEASONAL HABITAT SELECTION IN THE ROCKY MOUNTAINS AND WESTERN GREAT PLAINS

BRYAN BEDROSIAN¹, ROB DOMENECH², BRIAN SMITH³, ADAM SHREADING², MATTHEW HAYES⁴
• Breeding Adults (>5)
• Sub-Adults (2-5)
• Hatch-year (1)

• Conterminous US
• Canada/AK

• Spring/Summer
• Fall/Winter
• Migration
• Breeding Adults (>5)
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• Migration
Wintering

Migrants

Wintering

Wintering
MOVEMENT METRICS
AUTUMN MIGRATION

START DATES – PTT & GPS, FULL MIGRATIONS

- Sub-adults significantly earlier (median = 8 days earlier; p = 0.008)
- No difference in gender, year or study area
AUTUMN MIGRATION

HOURLY SPEED – GPS ONLY
SPRING MIGRATION
START DATES – PTT & GPS

<table>
<thead>
<tr>
<th>Study Area</th>
<th>Mean</th>
<th>SD (d)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>E MT</td>
<td>10-Apr</td>
<td>16</td>
<td>18-Mar - 27-May</td>
</tr>
<tr>
<td>MPG</td>
<td>3-Mar</td>
<td>22</td>
<td>13-Jan - 7-Apr</td>
</tr>
<tr>
<td>NORA</td>
<td>3-Mar</td>
<td>15</td>
<td>31-Jan - 6-Apr</td>
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</tbody>
</table>
SPRING MIGRATION

**DURATION – PTT & GPS**

Spring significantly shorter duration $p = 0.0261$

Spring median = 26 days
Fall median = 41 days
MIGRATION CORRIDORS
UTILIZATION DISTRIBUTION OF MIGRATORY MOVEMENTS

• Brownian Bridge Movement Models incorporate space and time

• Probability of the animal occurrence between subsequent locations depends on:
  Distance between points
  Time between points
  Speed of movement
• Only migration movement data included in all analyses
• Only GPS transmitters used in determining key flyways
• Dataset reduced to one migration/individual
  One exception where an eagle took different spring routes in subsequent years
• We used 25-40% population level use to define key corridors
  based on sample size
BBMMS – AUTUMN
BBMMS – AUTUMN

Count Overlapping Contours to ID Corridors

Fall
Number Overlapping 99% BBMM Contours
High: 7
Low: 1
BBMMS – AUTUMN

Key Fall Migration Corridors

Fall VALUE
- All
- 25% of Population
- 30% of Population
Separating eagles that stop in MT and those who continue south

40% population overlap
Key Spring Corridors
Separating eagles wintering in MT and those south of Wyoming.
MANAGEMENT IMPLICATIONS
MOVEMENTS OF YOUNG EAGLES
30 USFWS B. Smith (most nestlings)
13 E MT (wintering 1-4yr olds)
AGE AND SEASON EFFECTS
NO DIFFERENCE IN GENDER
Resource Selection Modeling

Use-availability Design
Cross-fold Validation
>100 potential covariates
  30m, 120m, 1000m, 2000m, scales
Summer Models

Hatch-Year

Sub-adult
Winter Model

Hatch-Year

Sub-adult
## Model Covariates

<table>
<thead>
<tr>
<th>Aspect</th>
<th>HY Sum</th>
<th>Sub Sum</th>
<th>HY Winter</th>
<th>Sub Winter</th>
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</thead>
<tbody>
<tr>
<td>Pasture/Hay</td>
<td>-</td>
<td>-</td>
<td>+</td>
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<tr>
<td>Cultivated Crops</td>
<td>-</td>
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<tr>
<td>Developed Roads</td>
<td>+</td>
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<td>-</td>
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<tr>
<td>Developed Urban</td>
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<tr>
<td>Elevation</td>
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<tr>
<td>Flat Topography</td>
<td>-</td>
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<tr>
<td>Forest</td>
<td>-</td>
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<tr>
<td>Slope</td>
<td>+</td>
<td>-</td>
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<tr>
<td>Introduced Annual Grass</td>
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<tr>
<td>Low Sagebrush</td>
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<tr>
<td>Tall Sagebrush SD</td>
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<tr>
<td>Terrain Ruggedness</td>
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<td>Topographic Wetness</td>
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<td>+</td>
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<tr>
<td>Emergent Herbaceous Wetlands</td>
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</table>
Acknowledgments

RVRI
Kate Stone
Phillips Ramsey

E MT
Step Wilson
Vince Slabe
Katherine Gura
Ross Crandall

USFWS Region – 6
Dale Stahlacker
Mike Lockhart
Brian Millsap
Robert Murphy
Chuck Preston
Acknowledgments

Emily Bedrosian
Hannah Beyl
Doug Bonham
Bracken Brown
Jake Chaffin
John Carlson
Kelly Castleberry
Derek Craighead
Marilyn Cuthill
Erik Enzien
Ken Furrow
Kathy Gray
Katherine Gura
Lauri Hanuska-Brown
Mosey Hardin
David Haines
Steve Hoffman
Joel Jorgensen
Bobby Laird
Erland and TheaLou Laird
Jill Learned
Jim Lish
Amy McCarthy
Beth Mendelsohn
Aiden Moon
Lisa Morse
Noel Nesmith
Aaron Nolan
Sarah Norton
Chad Olson
Victoria Park
Eric Rasmussen
Megan Ruehmann
Whitney Schwab
Mat Seidensticker
Pat Shanley
Lauren Shreading
Roger Smith
Jim Sparks
Brooke Tanner
Dave Taylor
Fred and Cathy Tilly
Kathy and Dean Townsend
Tyler Veto
Christa Weathers
Acknowledgments

Bird Conservancy of the Rockies
BLM
Charlotte Martin Foundation
Cinnabar Foundation
Craighead Beringia South
Denver International Airport
Duke Energy Renewables
Fanwood Foundation
Five Valleys Audubon
Fledgling Fund
Helena National Forest
Koret Foundation
LCAO Foundation
Llwellyn Foundation
Maki Foundation
Montana Fish, Wildlife and Parks Mountaineers Foundation
Nebraska Game & Parks Commission
Oklahoma State University
Patagonia
S.E.C. Charitable Trust
Sirtrack
Nature Conservancy
MPG Ranch
Thunder Basin National Grasslands
University of Montana
USDA Wildlife Services
USDA-ARS Central Plains Experimental Range
USFWS
Walker Family Trust
Yellowstone to Yukon