



Understanding the Population Impacts Between Birds and Wind Turbines

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September 2017

Understanding the Interactions



General Approach to Meta Analysis

Methods

- Gather and screen appropriate studies
- Standardized fatality rates
- Provide species-specific fatality estimates
- Compare rates to population sizes



Selection of Studies

Included

- Could be standardized
- Searcher efficiency
- Carcass removal
- Multiple seasons



Not Included

- Lack of capacity to be standardized
- Used older methods
- Inappropriate search intervals
- Conducted at older-generation facilities



General Meta Analysis

Standardized

- Plot Search Area
- Survey Length

Adjustment

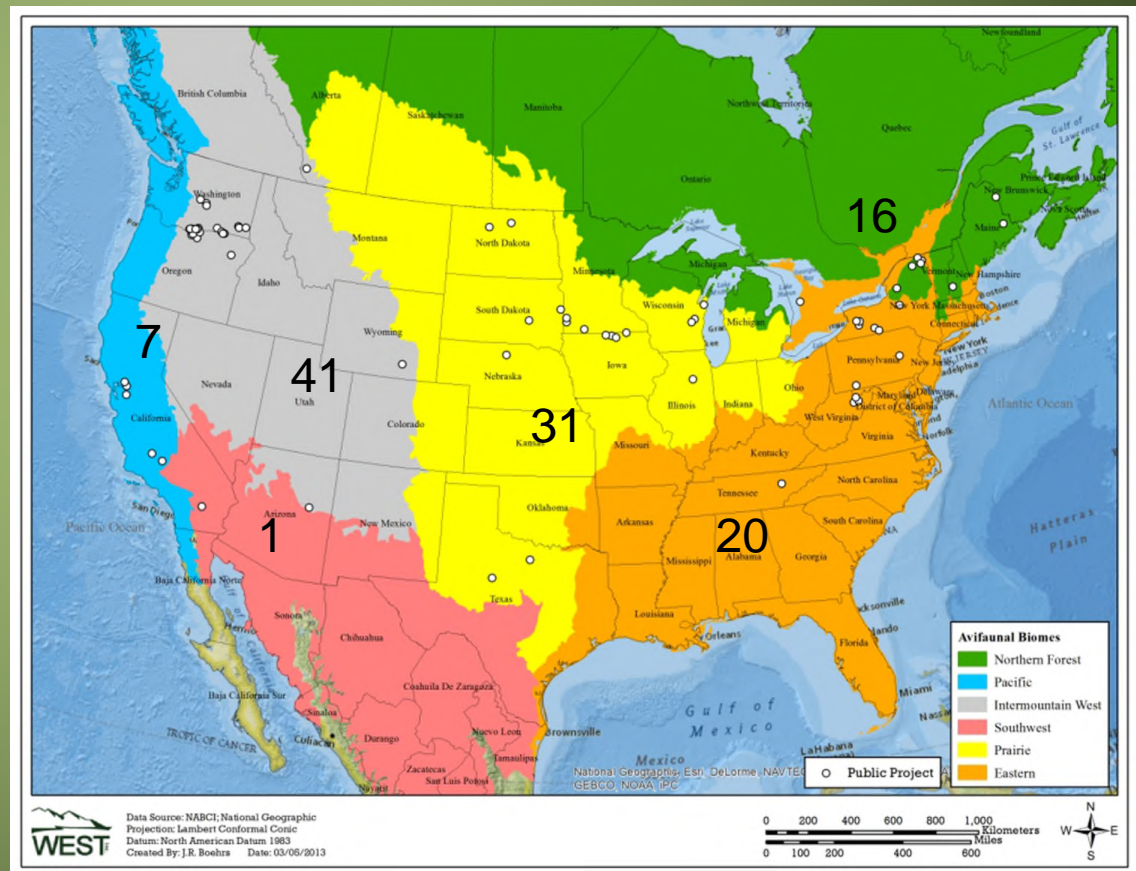
- Small bird from all bird only estimates
- Converted zero raptor estimates based on probability of detection
- Estimator Biases
 - Searcher efficiency, carcass removal, search interval
 - Two bias adjustments provided; represents a range of estimates these are *not confidence intervals*



Passerine Mortality Meta-analysis

- Erickson, W.P. M. Wolfe, K. Bay, D. Johnson, and J. Gehring. 2014. A Comprehensive Analysis of Small-passerine Fatalities from Collision with Wind Turbines at Wind Energy Facilities. PLOS ONE. Vol. 9, Issue 9.

- 116 studies at over 70 wind energy facilities across North America



Raptor Mortality Meta-analysis

- Bay, K. J., W.P. Erickson, S. Howlin, and M. Wolfe. 2017. A Comprehensive Analysis of Raptor Fatalities from Collision with Wind Turbines at Wind Energy Facilities. In Prep.

- 146 studies at over 85 wind energy facilities



North American Population Estimates

Partners in Flight Population Estimates for U.S. and Canada used as a comparison.

Partners in Flight Science Committee (2013)
Population Estimates Database, version 2013.
Available at <http://rmbo.org/pifpopestimates>.
Accessed on 31 December 2013.

Carcasses Found During Turbine Fatality Studies

Bird type	# Fatalities	% Composition
Passerines	3,842	60.2
Diurnal Raptors	508	8.0
Unidentified Birds	375	5.9
Upland Game Birds	546	8.6
Doves/Pigeons	275	4.3
Waterfowl	170	2.7
Owls	100	1.6
Rails/Coots	81	1.3
Shorebirds	66	1.0
Vultures	94	1.5

Passerine Mortality Meta-analysis

- 15% of 2016 operating capacity represented in the U.S. and Canada.
- Fatality Rate: 2.10 to 3.35 small-passerines/MW/year
- 186,000 to 319,000 small-passerine fatalities per year in the U.S. and Canada.

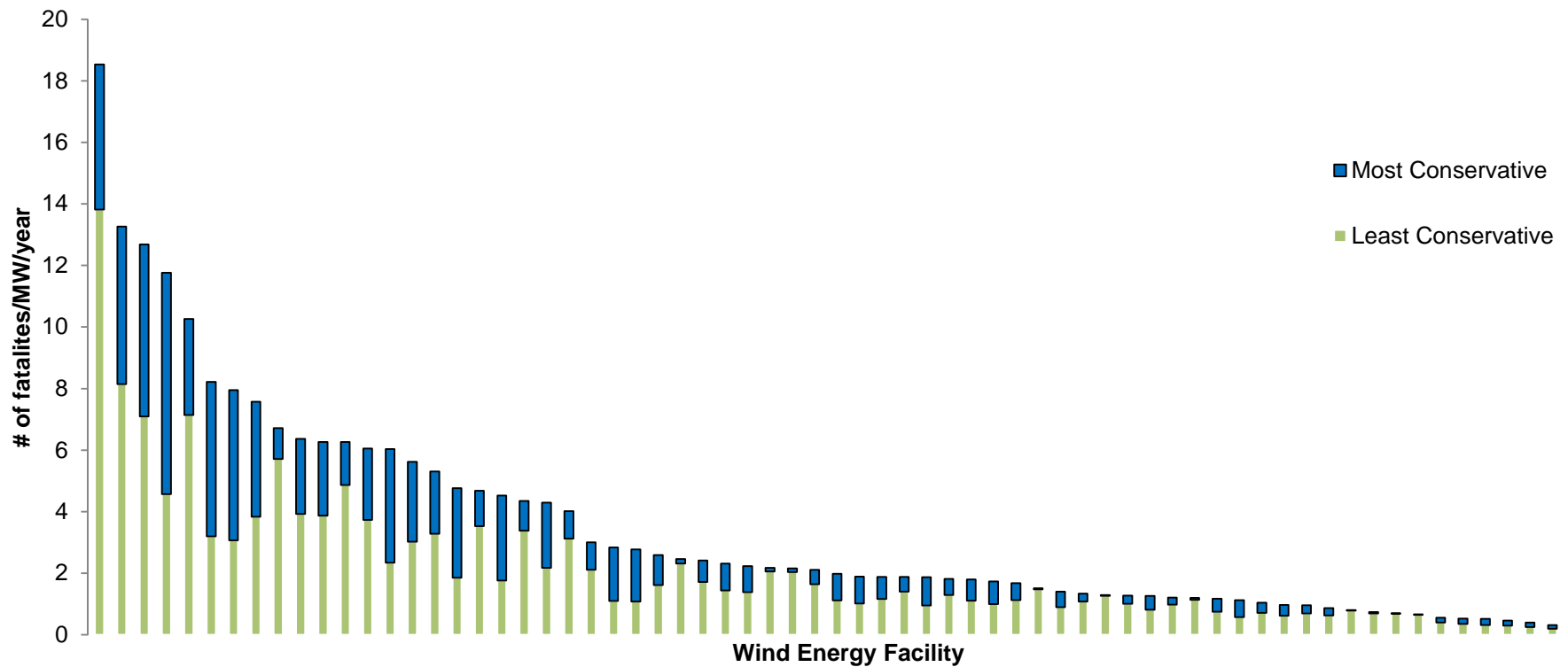


Wind Turbine Passerine Mortality: Population Impacts

Species	Avg. fat. Est. (high adjusted)	Avg. fat. Est. (low adjusted)	Pop. Est. for U.S. & Canada	% Pop. affected (high)	% Pop. affected (low)
tree swallow	10,268	5,702	17,000,000	0.060	0.034
black-throated blue warbler	1,240	845	2,100,000	0.059	0.040
horned lark	42,459	25,020	80,000,000	0.053	0.031
brown thrasher	2,393	1,299	3,500,000	0.049	0.027
yellow-throated vireo	1,693	932	4,900,000	0.048	0.027
spotted towhee	994	559	2,200,000	0.045	0.025
sedge wren	2,393	1,299	6,200,000	0.039	0.021
bushtit	798	433	2,300,000	0.035	0.019
western meadowlark	8,537	5,265	30,000,000	0.028	0.018
rose-breasted grosbeak	1,147	676	4,100,000	0.028	0.016

Example Passerine Mortality Rates by Facility

Eastern Biome Small Passerine Fatality Rates



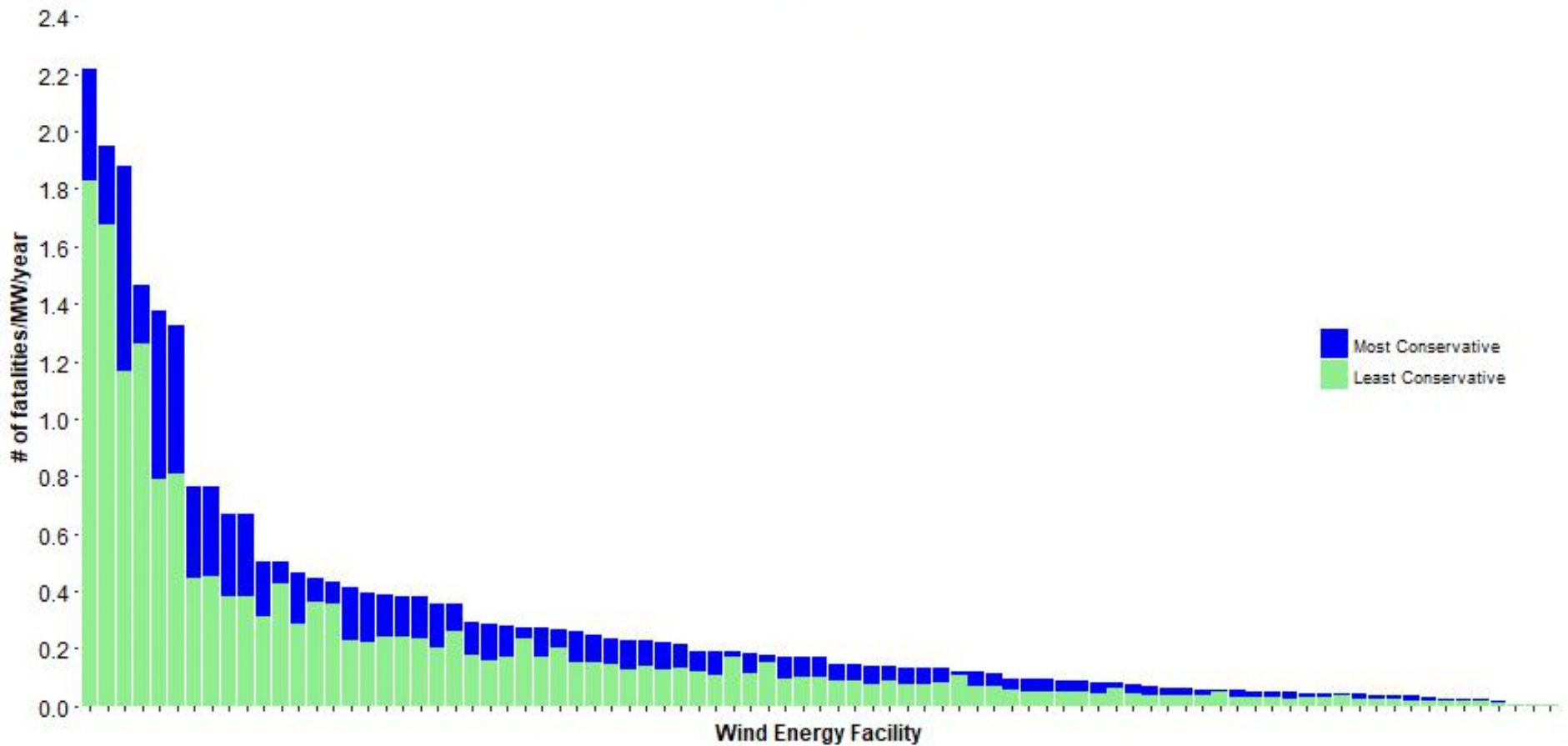
Diurnal Raptor* Mortality Meta-analysis

- 16% of the 2016 operating capacity represented
- Fatality Rate:
0.10 to 0.21 raptors/MW/year
- 8,300 to 17,600 raptor fatalities per year in U.S.
 - 1,200 to 2,500 in Canada



Raptor Mortality Meta-analysis

Raptor Fatality Rates



Wind Turbine Raptor Mortality: Population Impacts

Species	Avg. Fat. Est. / yr (high adjusted)	Avg. Fat. Est. / yr (low adjusted)	Pop. Est. for U.S. & Canada	% Pop. affected (high)	% Pop. affected (low)
peregrine falcon	33	15	6,010	0.554	0.257
American kestrel	9,309	4,317	2,200,000	0.423	0.196
ferruginous hawk	205	95	80,000	0.257	0.119
red-tailed hawk	4,902	2,312	2,000,000	0.245	0.116
golden eagle	249	116	130,000	0.192	0.089
sharp-shinned hawk	816	406	500,000	0.163	0.081
prairie falcon	100	46	70,000	0.143	0.066
white-tailed kite	100	46	78,400	0.127	0.059
rough-legged hawk	275	127	300,000	0.092	0.042
northern harrier	466	216	700,000	0.067	0.031
Swainson's hawk	345	160	540,000	0.064	0.030

Fatality Summary for passerines, raptors, & other in U.S. and Canada

- 186,000 to 319,000 small-passerine fatalities per year.
- 9,500 to 20,100 raptor fatalities per year.
- 96,000 to 155,700 other species fatalities per year.
- 291,500 to 494,800 total birds.

Human Sources of Bird Mortality

Cause of Mortality ^a	Bird Fatalities/year
Cats	1.4 – 3.7 billion
Buildings and Windows	365 – 988 million
Vehicles/Roads	89 – 340 million
Pesticides	17 – 91 million
Overhead Lines	12 – 64 million
Communication Towers	6.5 million
Lead ingestion	1 – 2 million
Mowing, agricultural cultivation	1 – 2 million
Commercial fishing	750,000 – 2 million
Oil pits	500,000 – 1 million
Forestry	300,000 – 1 million
Wind Energy	291,500 - 494,800



^a References provide on last three slides

Conclusions

Avian fatality estimates for wind energy are more precise and accurate than estimates for other mortality sources

Wind energy fatality rates vary among regions

Proportion of populations in U.S. & Canada affected by collisions with turbines is small

Cumulative impacts of all sources on songbirds and raptors is still a concern



Acknowledgements

- Data were provided by numerous wind energy development companies
- Funding was provided by the American Wind Wildlife Institute



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Cause of Mortality	Reference
Cats	Loss et al. 2013
Buildings and Windows	Loss et al. 2014a
Vehicles/Roads	Loss et al. 2014b
Pesticides	Mineau 2004, 2005
Overhead Lines	Loss et al. 2014c
Communication Towers	Longcore et al. 2012
Lead ingestion	Scheuhammer and Norris 1995, Kendall et al. 1996
Mowing, agricultural cultivation	Tews et al. 2013
Commercial fishing	Manville 2005, Brothers et al. 2010
Oil pits	Trail 2006
Forestry	Hobson et al. 2013

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