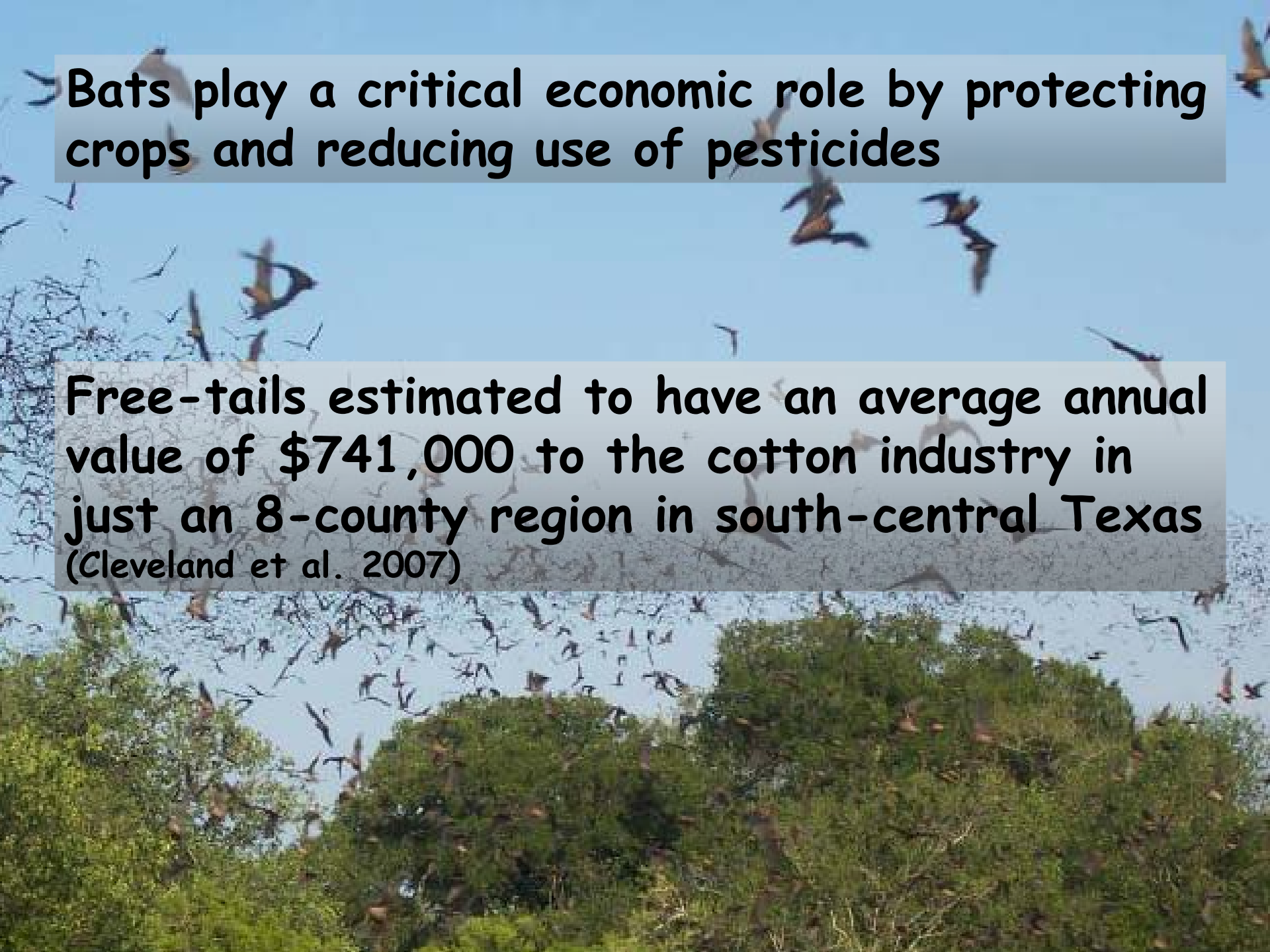
Patterns of Bat Fatality at Wind Development Facilities

Edward B. Arnett, Bat Conservation International

Biological Diversity: over 1,100 species identified…>one-quarter of the world's mammals…

Broad and unique ecological niches and provide vital ecological services…key pollinators, seed dispersers, and predators of insects…

Big brown bat



Bats play a critical economic role by protecting crops and reducing use of pesticides

Free-tails estimated to have an average annual value of $741,000 to the cotton industry in just an 8-county region in south-central Texas (Cleveland et al. 2007)


Eco-tourism!! Millions of dollars for Austin's local economy alone.

Long-lived, slow reproducing…populations are susceptible to additive mortality factors…

Silver-haired bat

In 2003, between 1,398 and 4,031 bats estimated to have been killed at the Mountaineer Wind Energy Facility in West Virginia

Bats and Wind Energy Cooperative

Bats and Wind Energy Cooperative organized by BCI, AWEA, the US Fish & Wildlife Service, and the National Renewable Energy Lab (DOE) in late 2003, initiated in May 2004

Organized a technical experts meeting to discuss existing data, information gaps, and set priorities

Conducted intensive studies from 2004 to present on post-construction fatality and bat interactions with turbines, pre-construction assessments, deterrents, and operational mitigation

Findings published in reports posted on website and published in scientific journals

www.batsandwind.org

BWEC
bats and wind energy cooperative

Overview

Research

Products

Resources

Events

NWCC Wind Wildlife Research Meeting
October 27-29, 2008 Milwaukee, WI
Details

Featured

Patterns of Bat Fatalities at Wind Energy Facilities in North America (Arnett, et al - 2008)

Download Publication

eNewsletter Signup

Email: Sign Up

Arnett, E. B., et al. 2008. Patterns of fatality of bats at wind energy facilities in North America. Journal of Wildlife Management 72: 61-78.

Invited Paper

Patterns of Bat Fatalities at Wind Energy Facilities in North America

EDWARD B. ARNETT,[1] *Bat Conservation International, Austin, TX 78746, USA*
W. KENT BROWN, *Terrestrial and Aquatic Environmental Managers Ltd., Calgary, AB T3C 3G9, Canada*
WALLACE P. ERICKSON, *Western EcoSystems Technology, Inc., Cheyenne, WY 82070, USA*
JENNY K. FIEDLER, *Tennessee Valley Authority, Regional Natural Heritage Program, Knoxville, TN 37902, USA*
BRENDA L. HAMILTON, *BLH Environmental Services, Pincher Creek, AB T0K 1W0, Canada*
TRAVIS H. HENRY, *Tennessee Valley Authority, Regional Natural Heritage Program, Knoxville, TN 37902, USA*
AAFTAB JAIN,[2] *Iowa Cooperative Fish and Wildlife Research Unit, Iowa State University, Ames, IA 50011, USA*
GREGORY D. JOHNSON, *Western EcoSystems Technology, Inc., Cheyenne, WY 82070, USA*
JESSICA KERNS,[3] *Appalachian Laboratory, University of Maryland, Frostburg, MD 21532, USA*
ROLF R. KOFORD, *United States Geological Survey, Iowa Cooperative Fish and Wildlife Research Unit, Iowa State University, Ames, IA 50011, USA*
CHARLES P. NICHOLSON, *Tennessee Valley Authority, Environmental Stewardship and Policy, Knoxville, TN 37902, USA*
TIMOTHY J. O'CONNELL, *Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, OK 74078, USA*
MARTIN D. PIORKOWSKI,[4] *Department of Zoology, Oklahoma State University, Stillwater, OK 74078, USA*
ROGER D. TANKERSLEY, JR., *Tennessee Valley Authority, Regional Natural Heritage Program, Knoxville, TN 37902, USA*

ABSTRACT Wind has become one of the fastest growing sources of renewable energy worldwide, but widespread and often extensive fatalities of bats have increased concern regarding the impacts of wind energy development on bats and other wildlife. We synthesized available information on patterns of bat fatalities from a review of 21 postconstruction fatality studies conducted at 19 facilities in 5 United States regions and one Canadian province. Dominance of migratory, foliage- and tree-roosting lasiurine species (e.g., hoary bat [*Lasiurus cinereus*]) killed by turbines was consistent among studies. Bat fatalities, although highly variable and periodic, consistently peaked in late summer and fall, coinciding with migration of lasiurines and other species. A notable exception was documented fatalities of pregnant female Brazilian free-tailed bats (*Tadarida brasiliensis*) in May and June at a facility in Oklahoma, USA, and female silver-haired bats (*Lasionycteris noctivagans*) during spring in Tennessee, USA, and Alberta, Canada. Most studies reported that fatalities were distributed randomly across turbines at a site, although the highest number of fatalities was often found near the end of turbine strings. Two studies conducted simultaneously in the same region documented similar timing of fatalities between sites, which suggests broader patterns of collisions dictated by weather, prey abundance, or other factors. None of the studies found differences in bat fatalities between turbines equipped with lighting required by the Federal Aviation Administration and turbines that were unlit. All studies that addressed relationships between bat fatalities and weather patterns found that most bats were killed on nights with low wind speed (<6 m/sec) and that fatalities increased immediately before and after passage of storm fronts. Weather patterns may be predictors of bat activity and fatality; thus, mitigation efforts that focus on these high-risk periods could reduce bat fatality substantially. We caution that estimates of bat fatality are conditioned by length of study and search interval and that they are biased in relation to how searcher efficiency, scavenger removal, and habitat differences were or were not accounted for. Our review will assist managers, biologists, and decision-makers with understanding unifying and unique patterns of bat fatality, biases, and limitations of existing efforts, and it will aid in designing future research needed to develop mitigation strategies for minimizing or eliminating bat fatality at wind facilities. (JOURNAL OF WILDLIFE MANAGEMENT 72(1):61–78; 2008)

DOI: 10.2193/2007-221

KEY WORDS bat fatality, fatality searches, North America, wind energy facilities, wind turbines.

As concerns about climate change (see review in Inkley et al. 2004) and increasing costs and long-term environmental impacts from the use of fossil fuels have heightened (McLeish 2002), wind has become an increasingly important sector of the energy industry and one of the fastest growing sources of renewable energy (Pasqualetti et al. 2004). Wind-generated electricity is renewable and generally considered environmentally clean, and recent technological advances and tax subsidies have allowed commercial wind generation to compete with energy produced from fossil fuels and nuclear power (Gipe 1995, Redlinger et al. 2002). Unfortunately, fatalities of bats have been recorded at wind facilities worldwide, including Australia (Hall and Richards 1972), North America (Johnson et al. 2003*a*, *b*, 2004; Fiedler 2004; Arnett 2005), and Europe (Ahlen 2002, Bach and Rahmel 2004, Dürr and Bach 2004, Brinkman 2006). Small numbers of bats were first recorded in the United States at wind energy projects in California, USA, during avian fatality searches (Orloff and Flannery 1992, Thelander and Rugge 2000). However, bat fatalities at wind energy facilities generally received little attention in North America until 2003 when an estimated 1,400–4,000 bats were killed at the Mountaineer Wind Energy Center in West Virginia, USA (Kerns and Kerlinger 2004). High bat fatalities continued at the Mountaineer facility in 2004, and large kills also have been reported at facilities in Pennsylva-

[1] *E-mail: earnett@batcon.org*
[2] *Present address: Curry and Kerlinger, Syracuse, NY 13224, USA*
[3] *Present address: Western EcoSystems Technology, Inc., Ithaca, NY 14850, USA*
[4] *Present address: Cornell Lab of Ornithology, Ithaca, NY 14850, USA*

Bats Have Not Been Well Studied

Few studies, short duration, other sampling issues

Potential sources of sampling bias (carcass removal, searcher efficiency, habitat variation) have been poorly accounted for…

Past estimates of bat fatality are conditioned on sampling effort…fatality estimates must be interpreted very carefully!

Possible Explanations Why Bats Are Being Killed by Wind Turbines?

- Linear Corridor
- Roost Attraction
- Landscape Attraction
- Low Wind Velocity
- Heat Attraction
- Visual Attraction
- Acoustic Attraction
- Echolocation Failure
- Electromagnetic-Disorientation
- Decompression
- Thermal Inversion

(from Kunz et al. 2007)

Patterns of Bat Fatality:

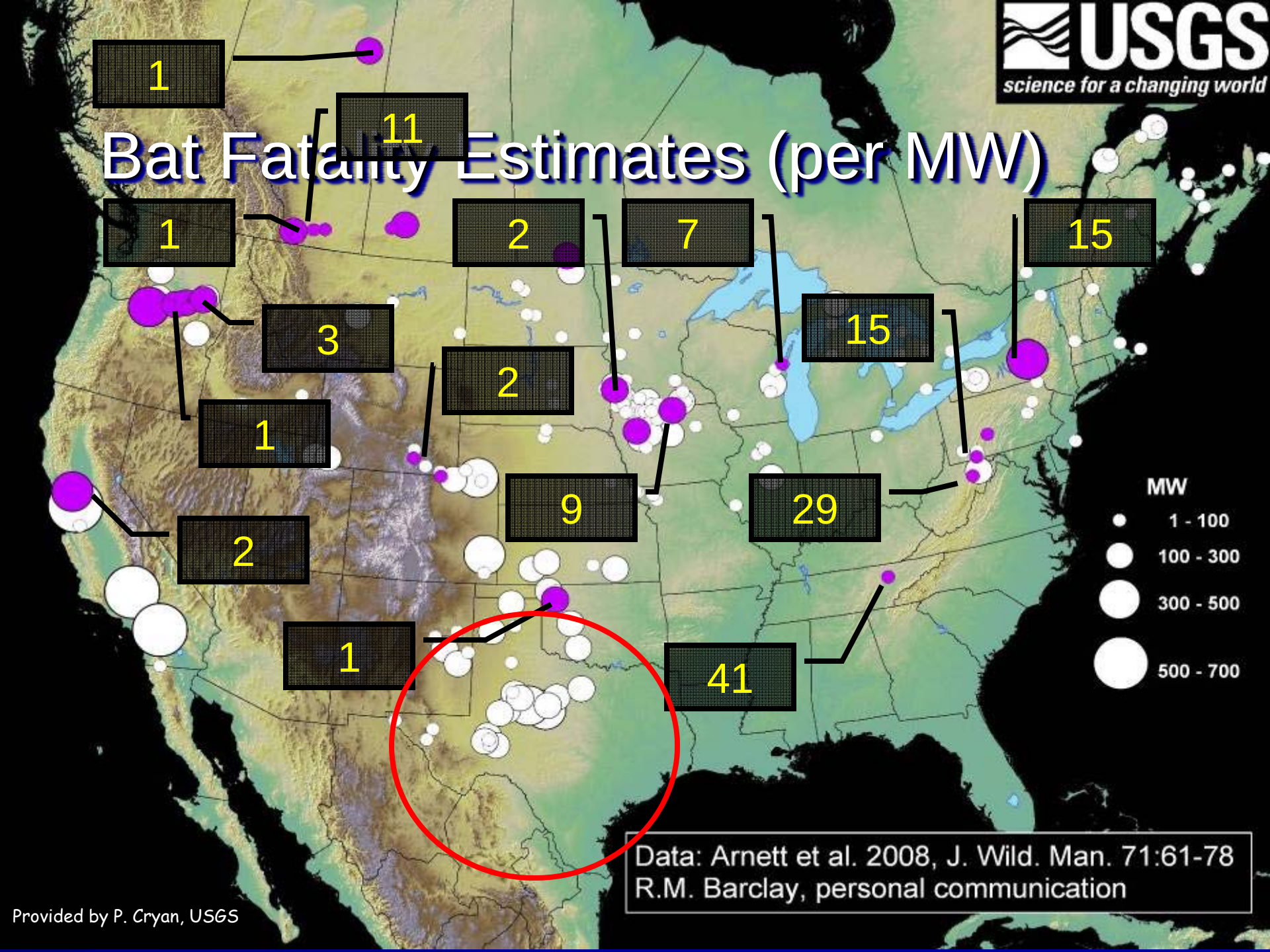
Extent of the Problem

Bat fatalities have been documented at wind facilities worldwide across a wide range of habitats…

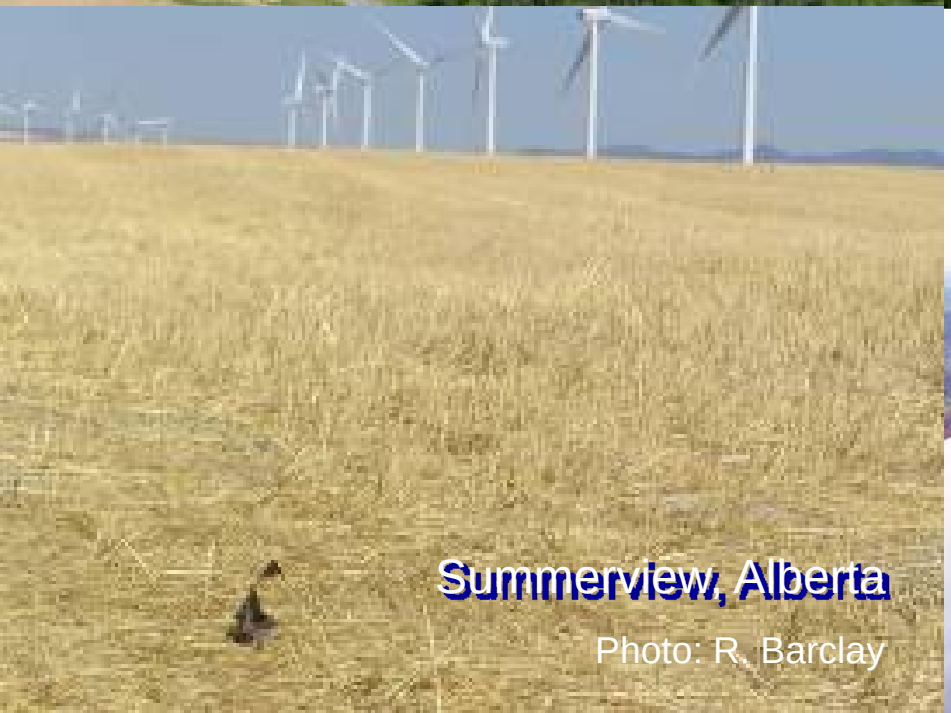
appear to be highest at sites on forested ridges in eastern U.S…but…

Recent studies have found higher than expected bat fatalities in open prairie in Alberta…~11/MW

Mixed agriculture/forest habitats in New York (~15/MW)


USGS
science for a changing world
Bat Fatality Estimates (per MW)
1
11
1
2
7
15
3
15
2
1
9
29
2
1
41
MW
1 - 100
100 - 300
300 - 500
500 - 700
Data: Arnett et al. 2008, J. Wild. Man. 71:61-78
R.M. Barclay, personal communication
Provided by P. Cryan, USGS

Sites with High Fatality Rates



Species of Bats Killed by Turbines

Eleven of the 45 species north of Mexico have been found killed by turbines…

16 species in Mexico…

Fatalities are heavily skewed to migratory tree roosting bats (based on facilities monitored to date)

Species involved in North America

n = 3,974

Provided by P. Cryan, USGS

Data: Arnett et al. 2008; J. Wild. Man. 72:61-78

Woodward Wind Energy Facility, Oklahoma

Dearth of information…little or no data from the many areas (e.g.,Southwest)

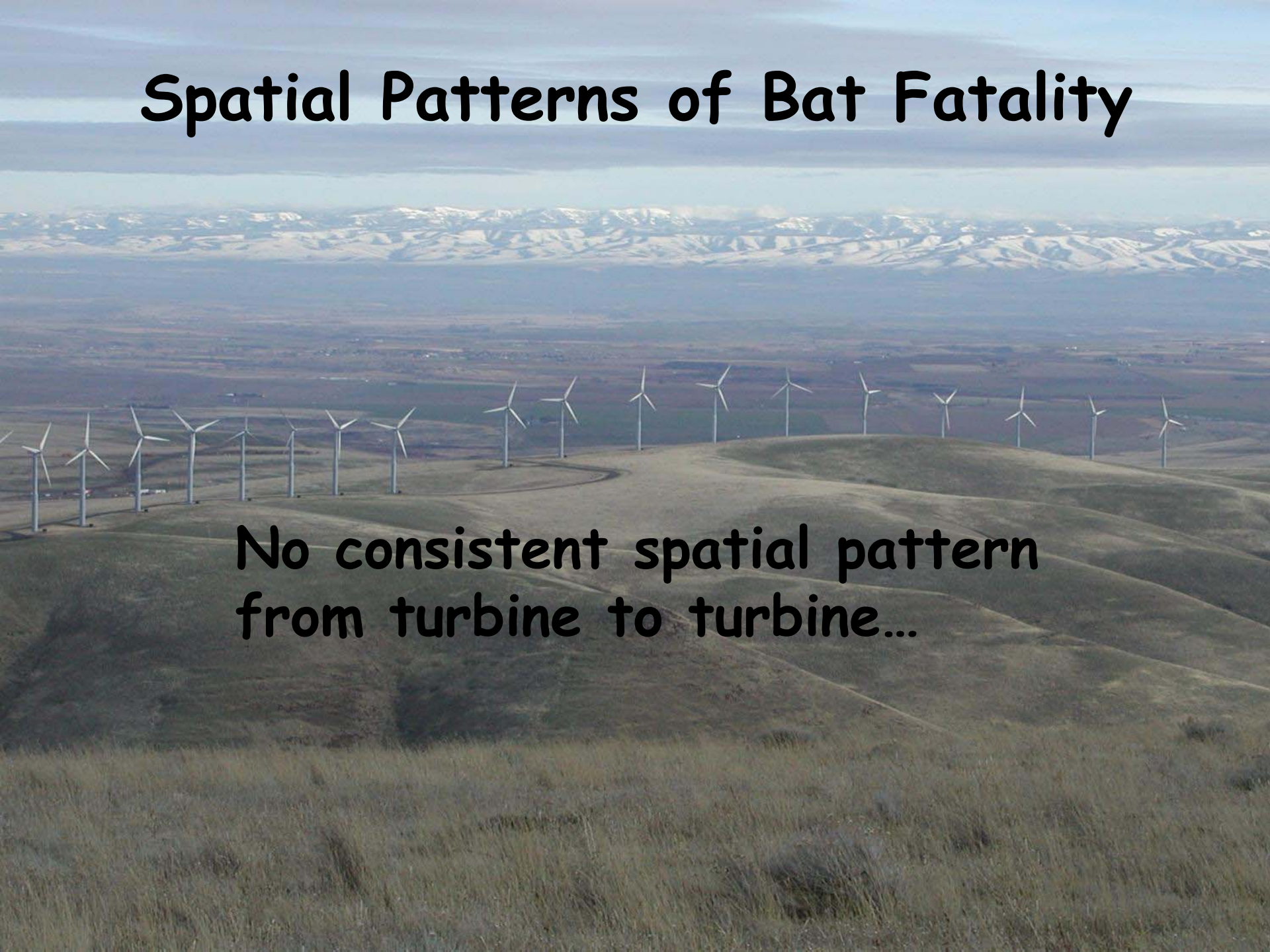
Mexican free-tailed bat

To date, no threatened or endangered species has been found at wind facilities…

No federal nexus

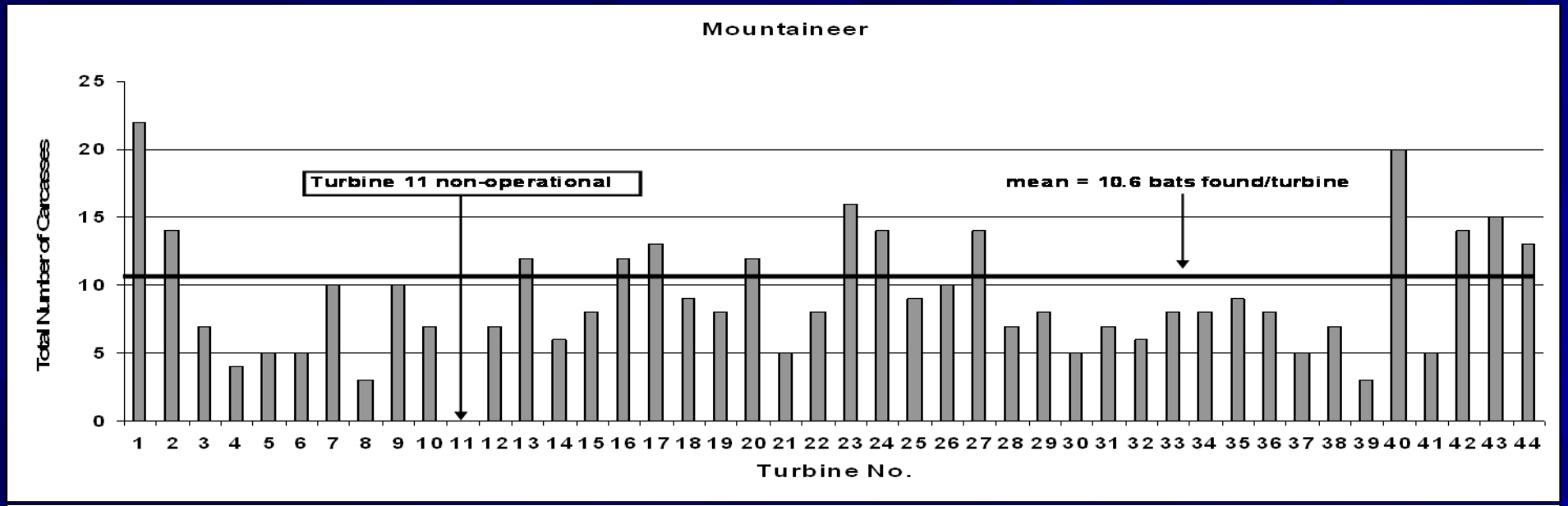
but future is uncertain, given projected expansion of wind

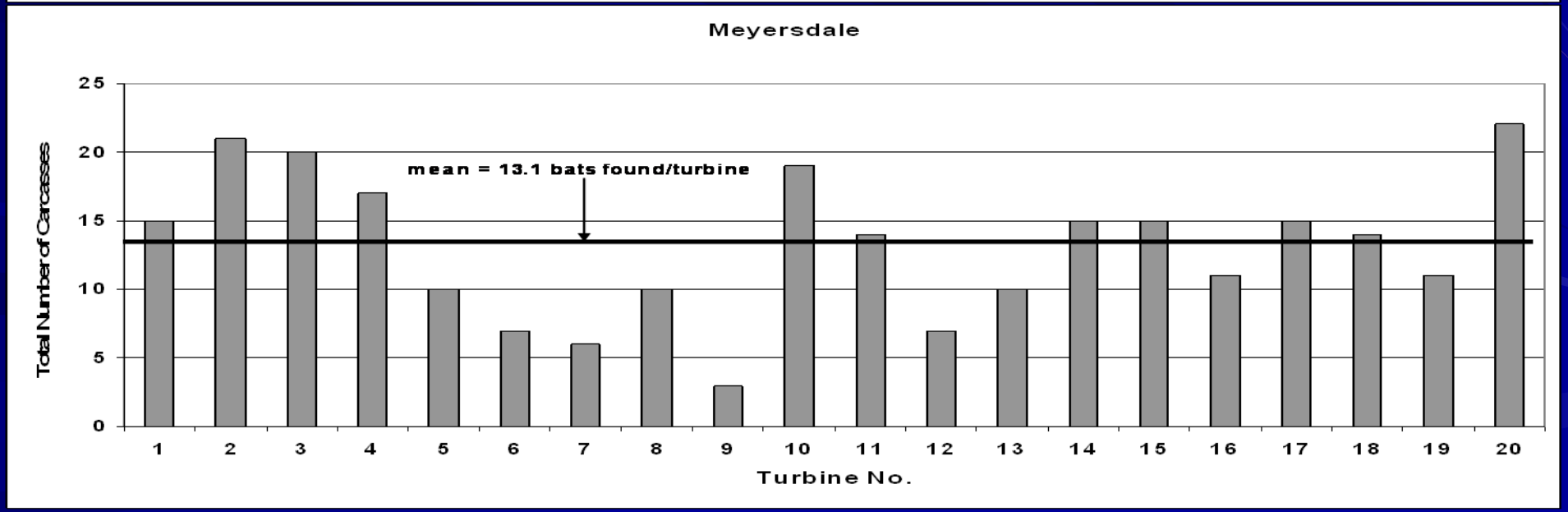
Spatial Patterns of Bat Fatality



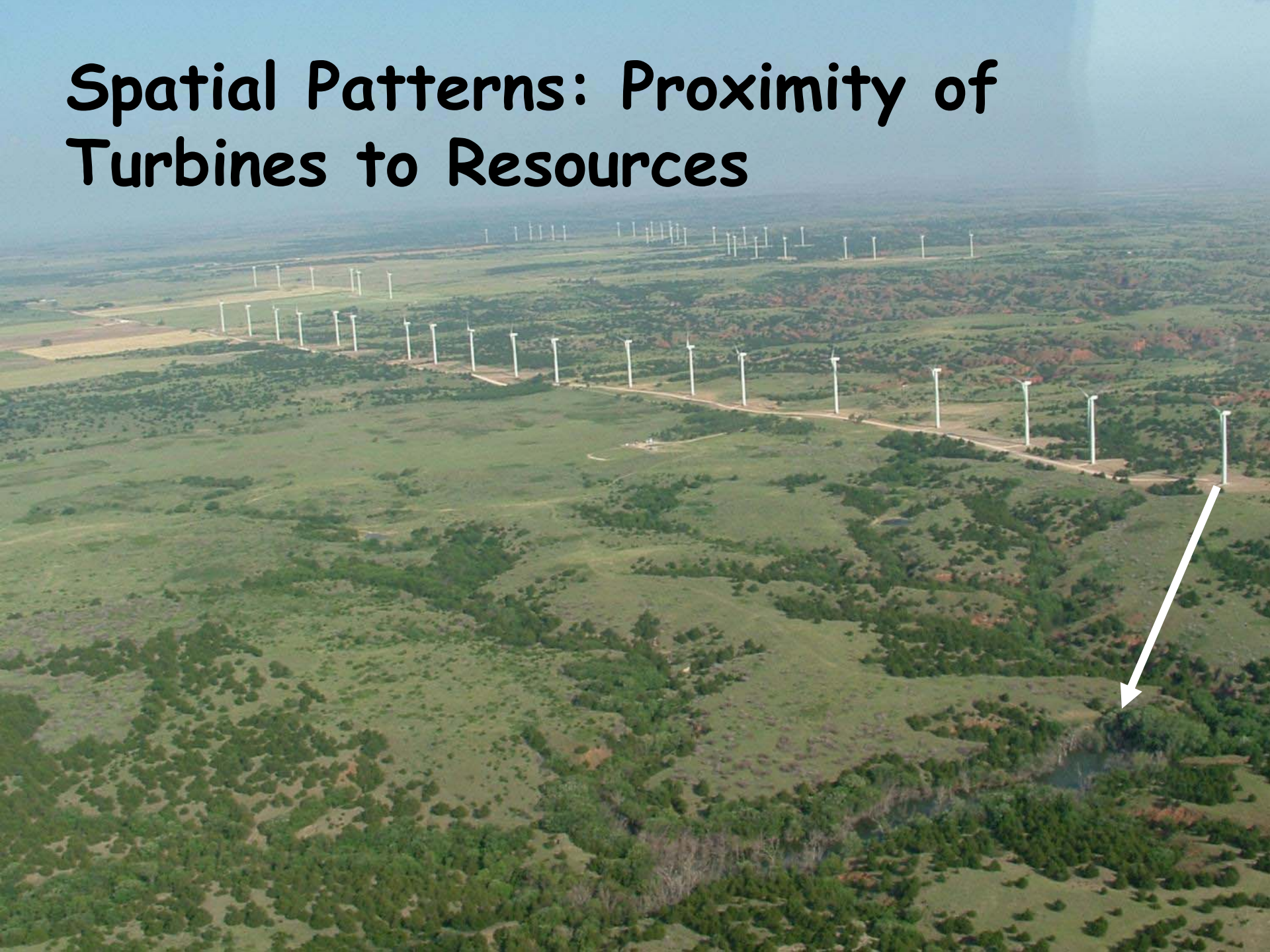
No consistent spatial pattern from turbine to turbine…

Spatial Patterns of Fatalities





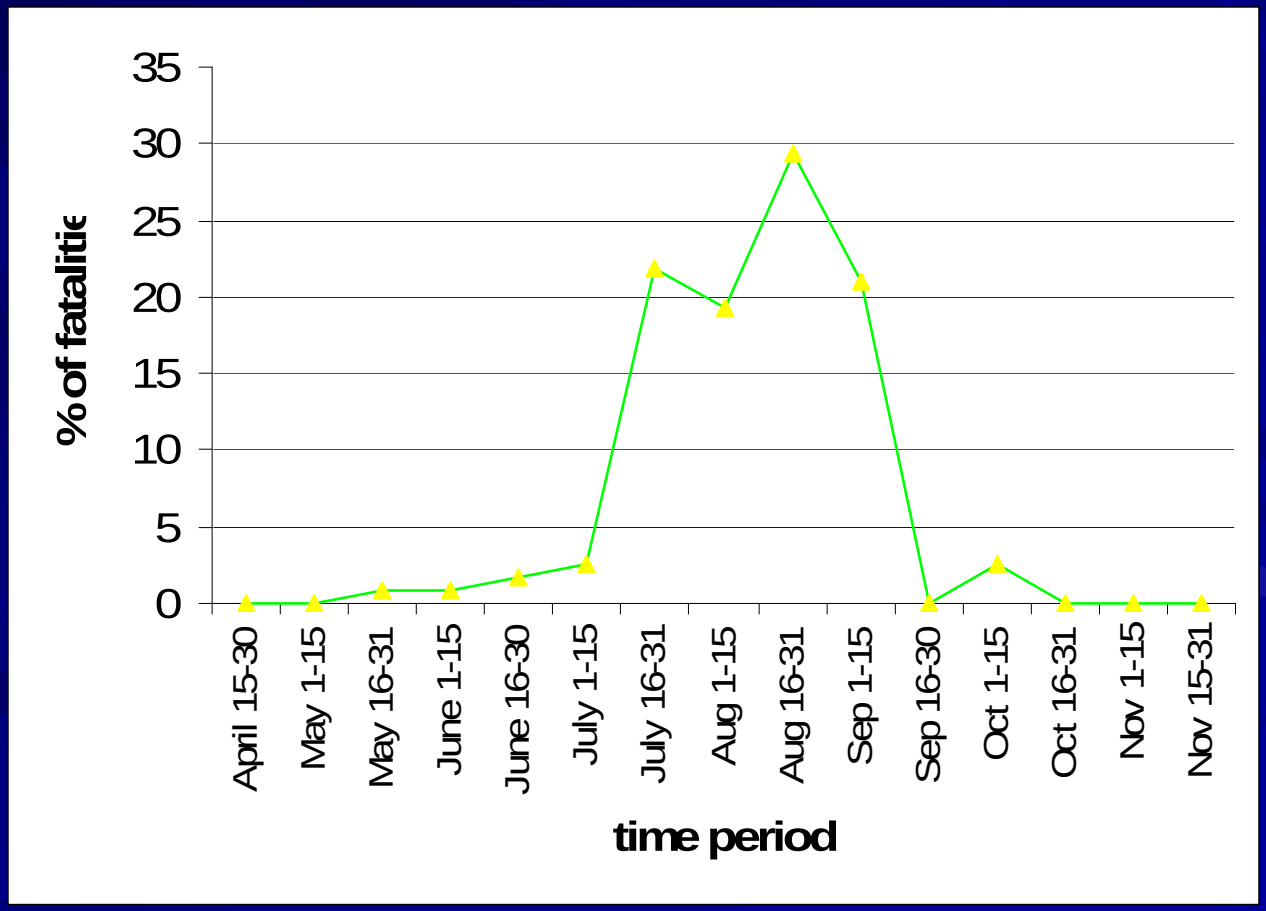
Spatial Patterns: Proximity of Turbines to Resources



Temporal Patterns of Bat Fatality

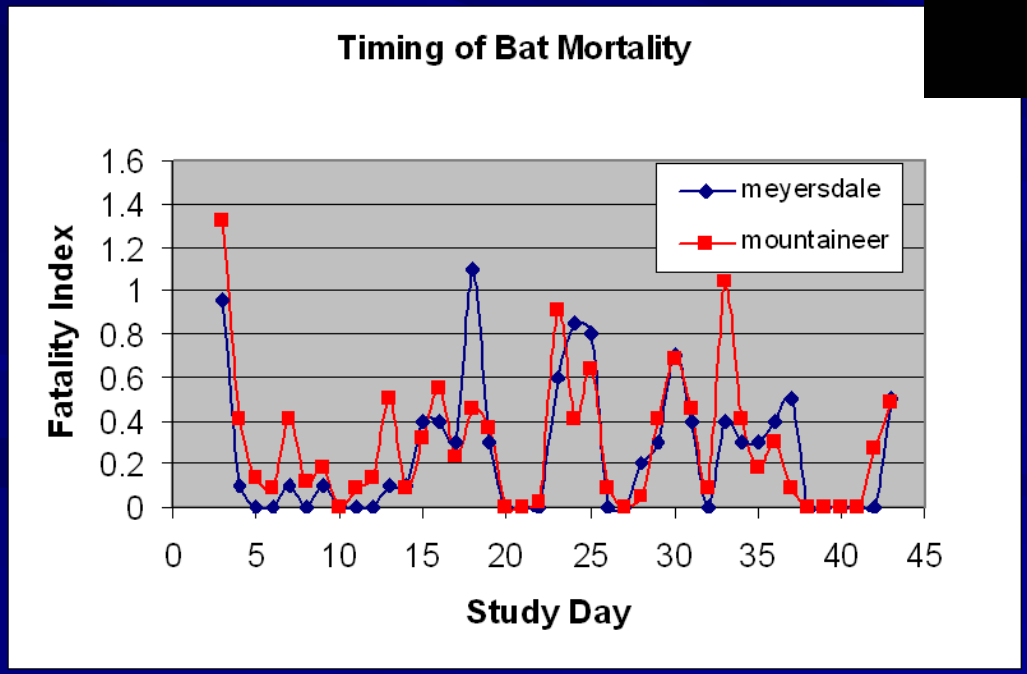
Bat fatalities occur primarily in late summer and early fall

From Johnson 2005

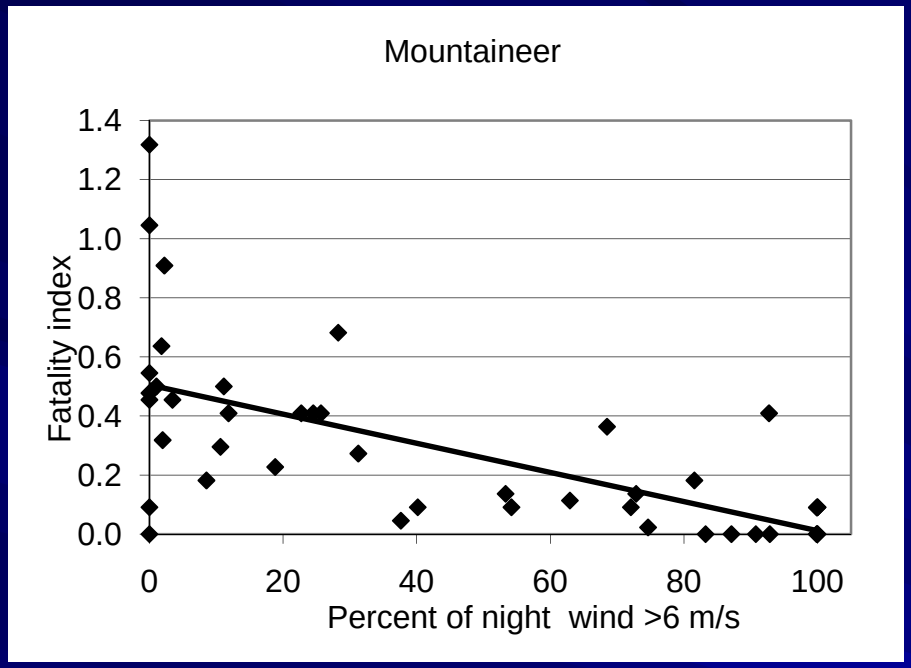


Temporal Patterns of Bat Fatality

Some evidence to suggest regional patterns in timing of fatality…perhaps related to migration, weather or food



Lower Wind = Higher Bat Fatality

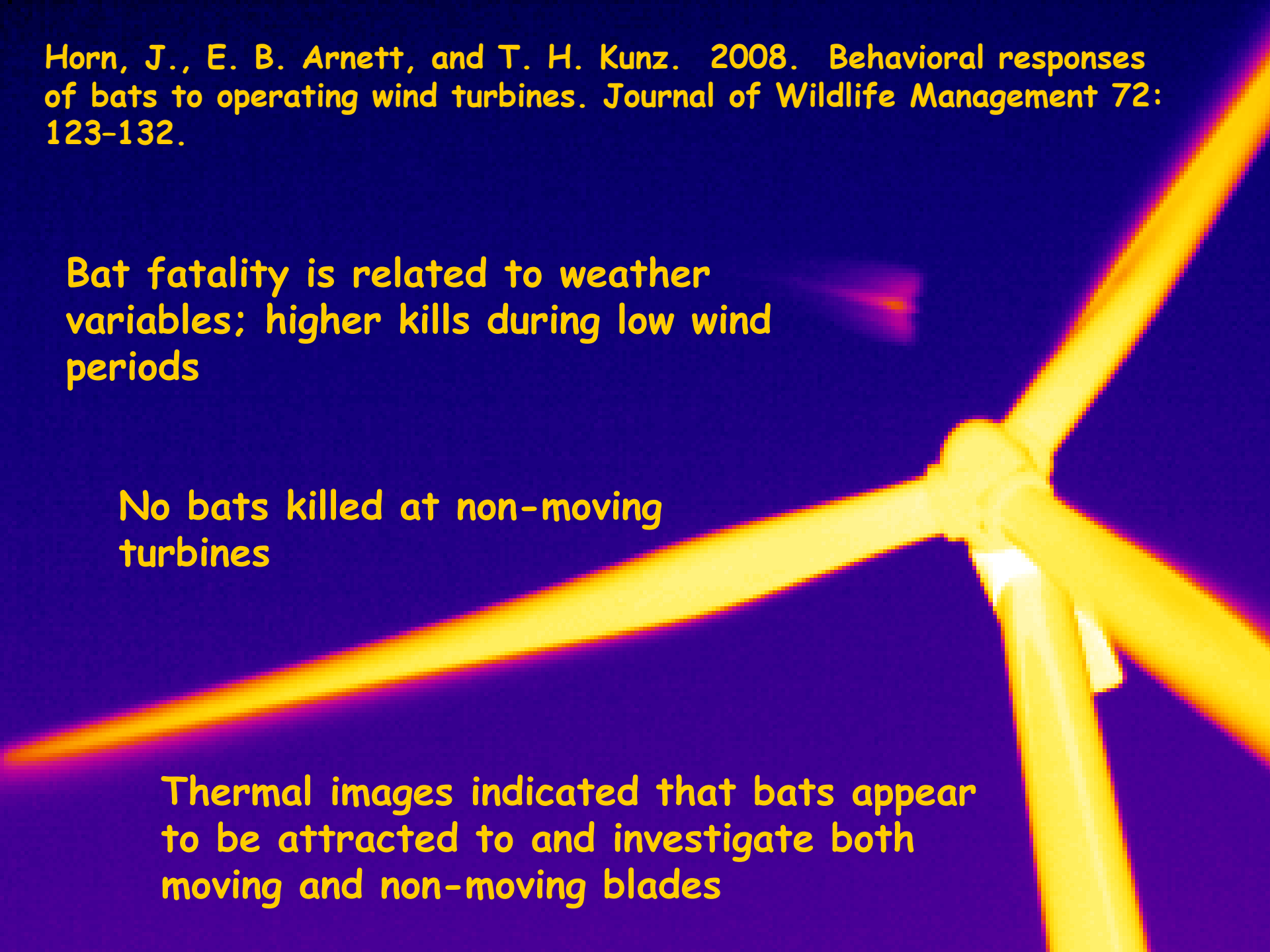


Majority of bats killed in PA, TN, WV were on low wind nights; kills negatively related to wind speed

Bat kills also associated with passage of weather fronts

Patterns may be predictable!

Horn, J., E. B. Arnett, and T. H. Kunz. 2008. Behavioral responses of bats to operating wind turbines. Journal of Wildlife Management 72: 123–132.



Bat fatality is related to weather variables; higher kills during low wind periods

No bats killed at non-moving turbines

Thermal images indicated that bats appear to be attracted to and investigate both moving and non-moving blades

Bat Fatalities at Lit and Unlit Turbines

	Mountaineer		Meyersdale	
	Lit	Unlit	Lit	Unlit
# Turbines	12	32	6	14
Mean Dead	9.3	9.7	11.9	13.2
SE	0.5	0.3	1.7	1.2

L-864
20-40 Flashes
Per minute

No difference in fatalities at lit and unlit turbines

Indirect Impacts

- Loss of foraging habitat?
- Loss of roosting habitat?
- Loss of migration corridors?
- To date, there have been no focused, quantitative studies on the impacts of wind energy development on bat foraging, roosting, or migration habitats

Provided by P. Cryan, USGS

Wildlife Fatalities - What's the Context?

How many critters are moving through the airspace in relation to fatality?

The Significance of Bat Fatalities


Eastern red bat

Species experiencing highest fatalities have little or no protection

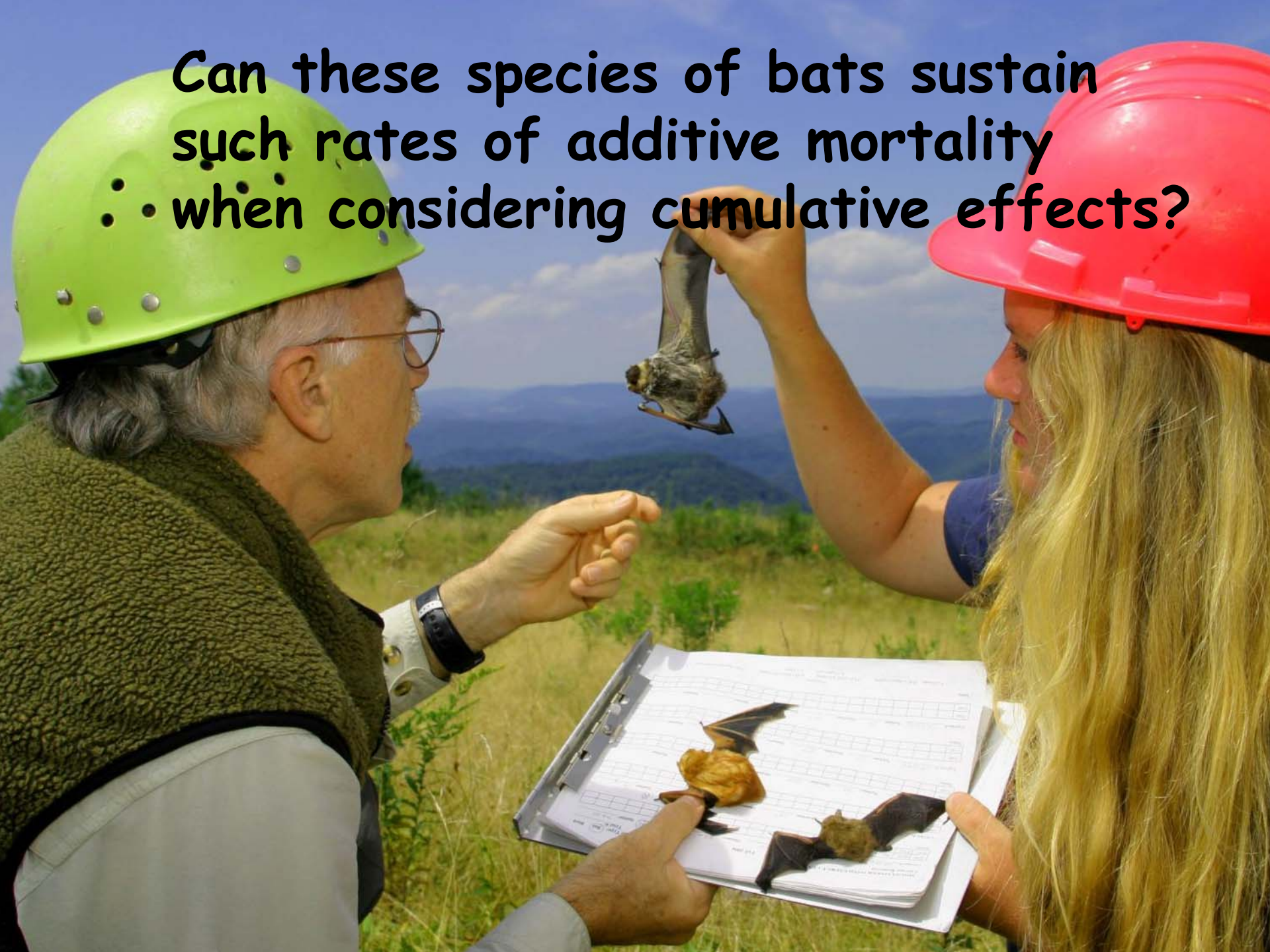
Eastern red bats already documented in decline in three mid-western States

(*Whitaker et al. 2002, Carter et al. 2003, Winhold et al. 2005*)

Bats are long-lived, slow reproducing mammals… Turbines are killing prime breeding age adults

While population impacts are unknown, considerable concern about cumulative impacts as wind energy expands…


Silver-haired bat


Can these species of bats sustain such rates of additive mortality when considering cumulative effects?

Cumulative Impacts[1]: Projected Number of Bat Fatalities/Year for the Mid-Atlantic Highlands in 2020

Bat Species	Fatality Rate	Minimum Projected Bat Fatalities/Year	Maximum Projected Bat Fatalities/Year
Hoary	0.289	9,542	17,899
Eastern red	0.344	11,358	21,306
Silver-haired	0.052	1,717	3,221
Eastern pipistrelle	0.185	6,108	11,458
Little brown myotis	0.087	2,873	5,388
Northern long-eared	0.006	198	372
Big brown	0.025	825	1,548
Unknown	0.011	396	743
Total		**33,017**	**61,935**

[1]Projections based on the NREL WinDS Model of Installed capacity

(after Kunz et al. 2007)

MITIGATION OPTIONS

Operational mitigation…
Curtailment during high risk periods that may be predictable

Pre-Construction Assessment…
Determine and avoid high risk areas

Technological…
Deter or alert the bats…


MANY THANKS!!!
QUESTIONS…
BWEC
bats and wind energy cooperative