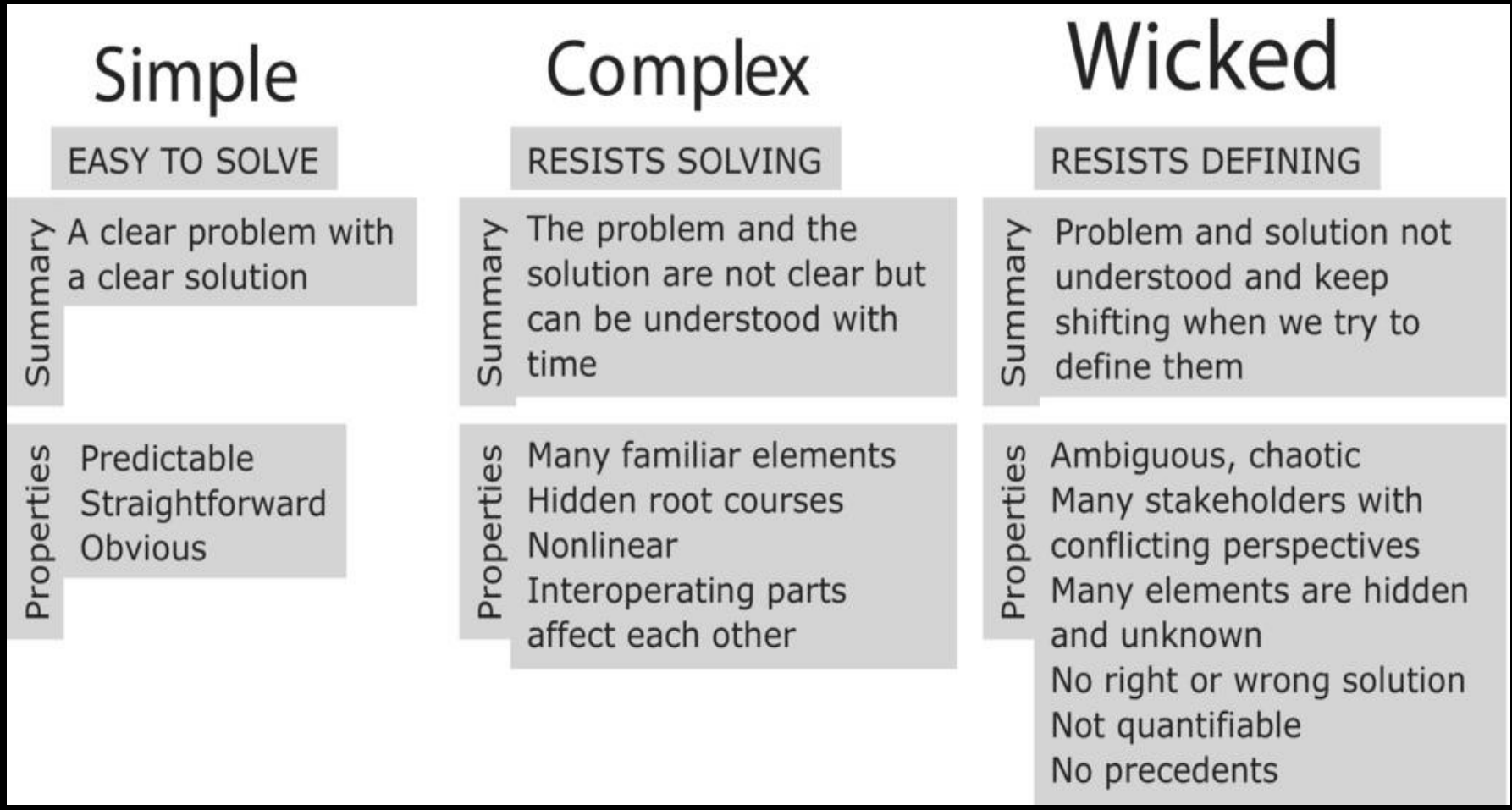
Bats and Wind Energy: A Crash Course in a Wicked Problem

Dr. Erin F. Baerwald,

Ecosystem Science and Management,

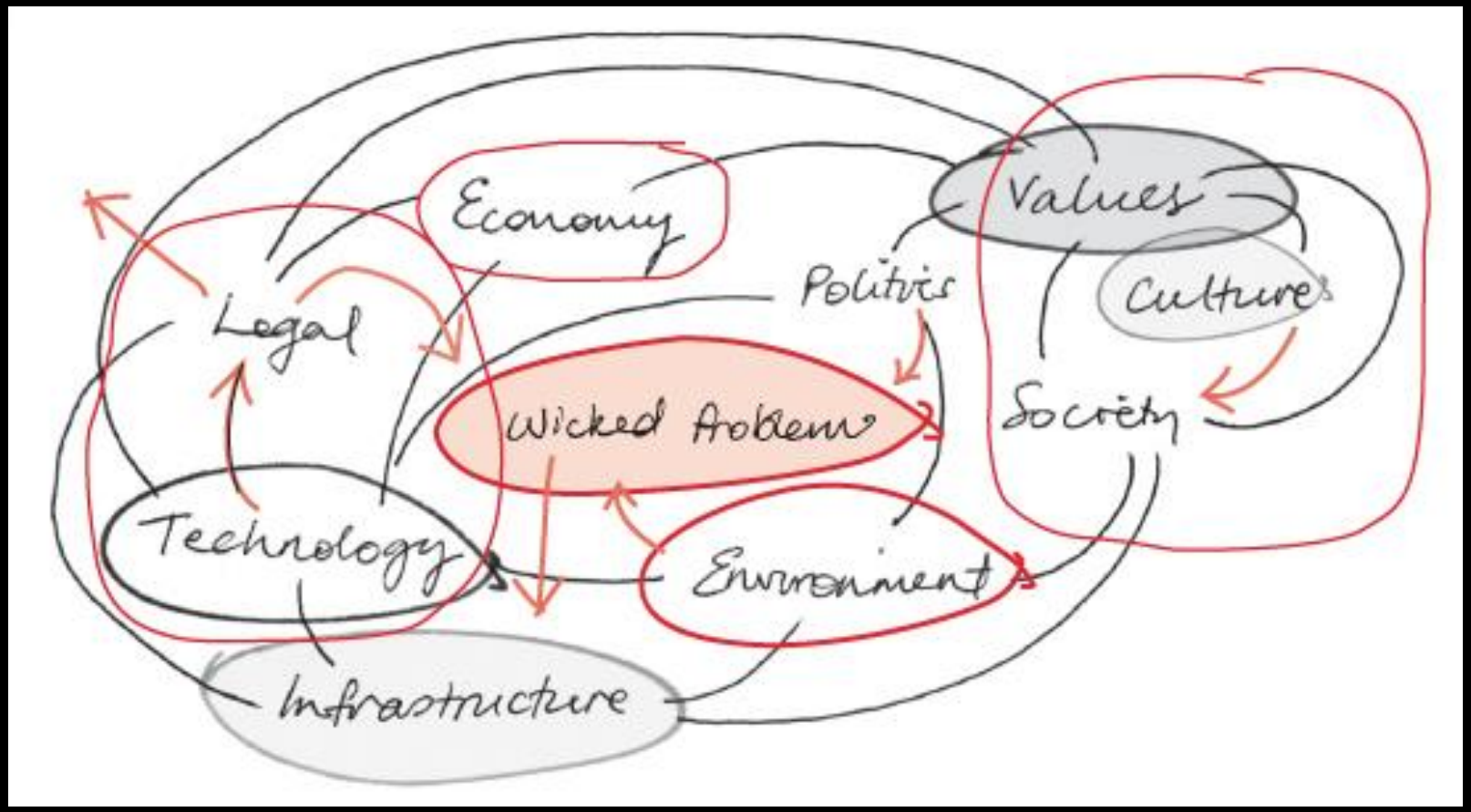
University of Northern British Columbia

Wicked Problem?

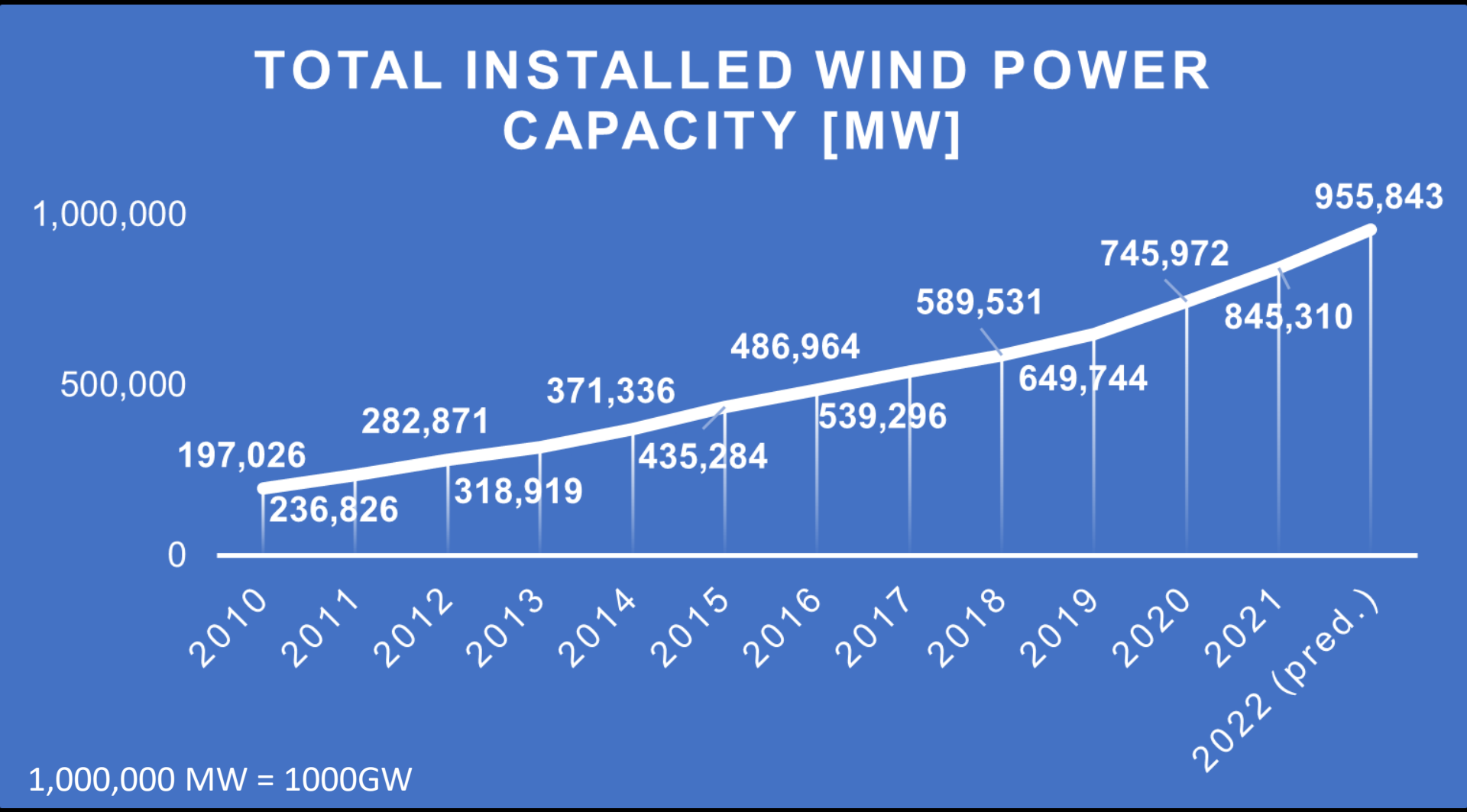


Conservation Biology, Volume: 30, Issue: 3, Pages: 450-455, First published: 25 April 2016, DOI: (10.1111/cobi.12689)

Wicked Problem?

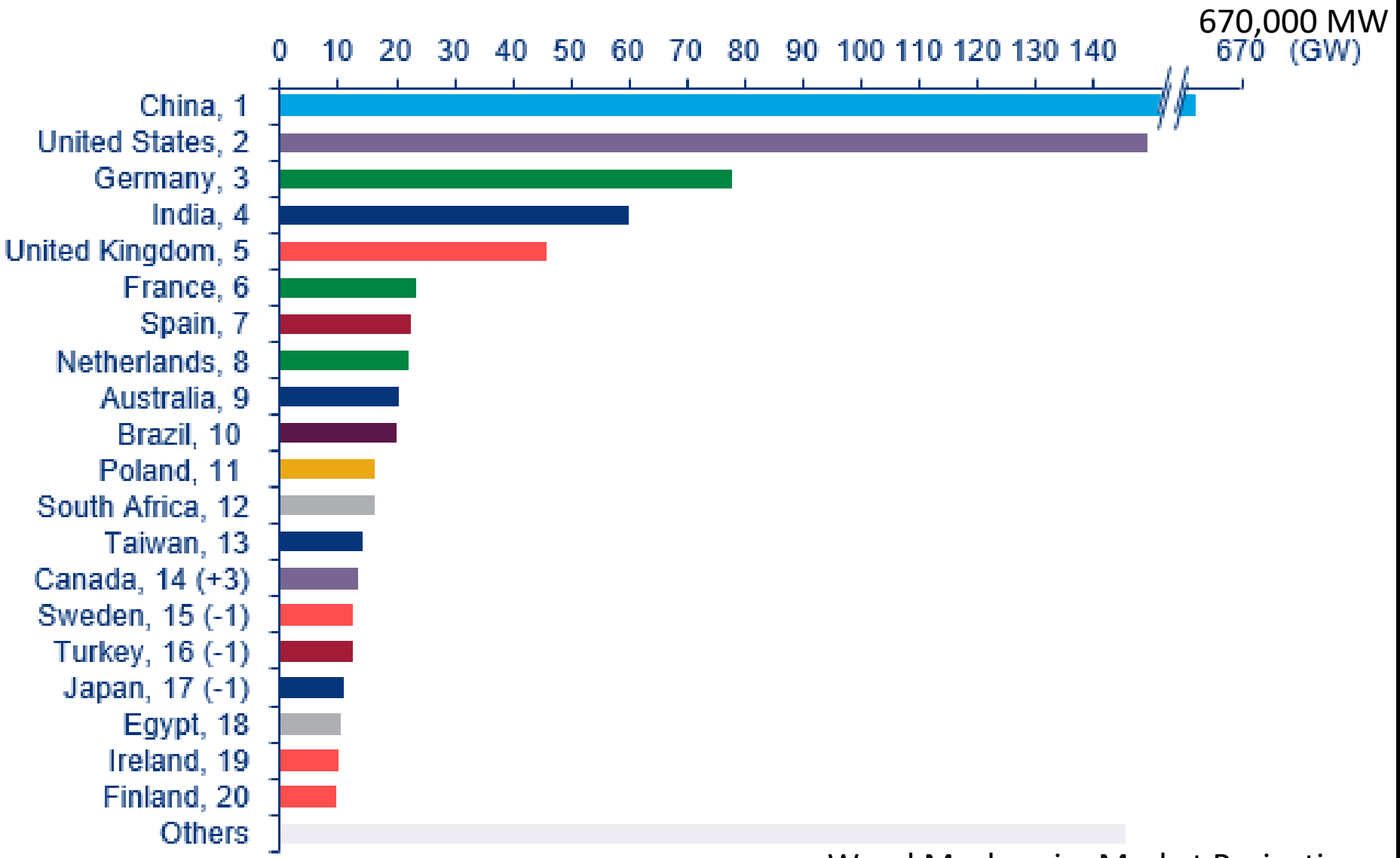


Global installed wind energy capacity

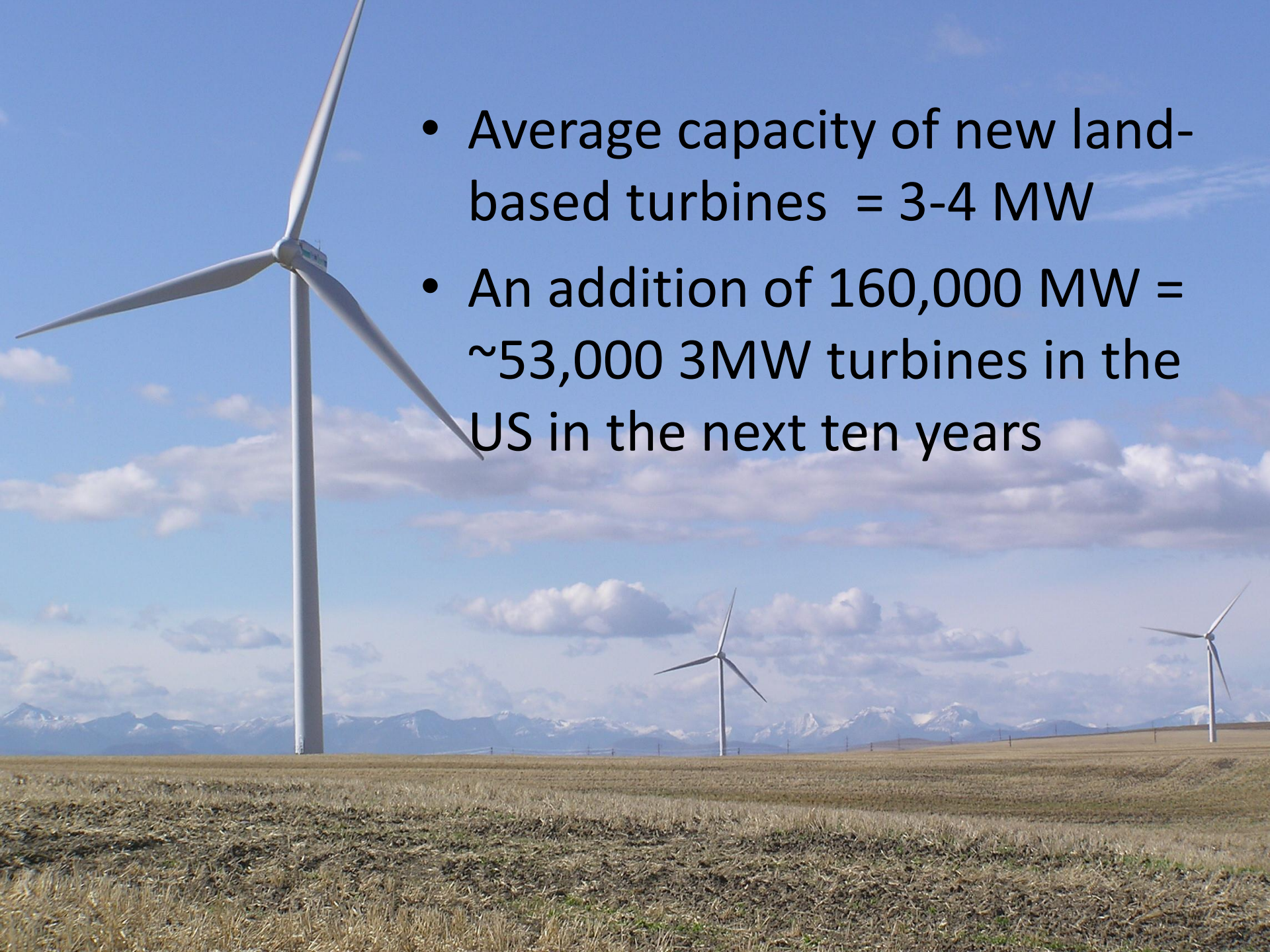


WWEA mid-year report, 2022

Top 20 markets: new capacity 2022-2031



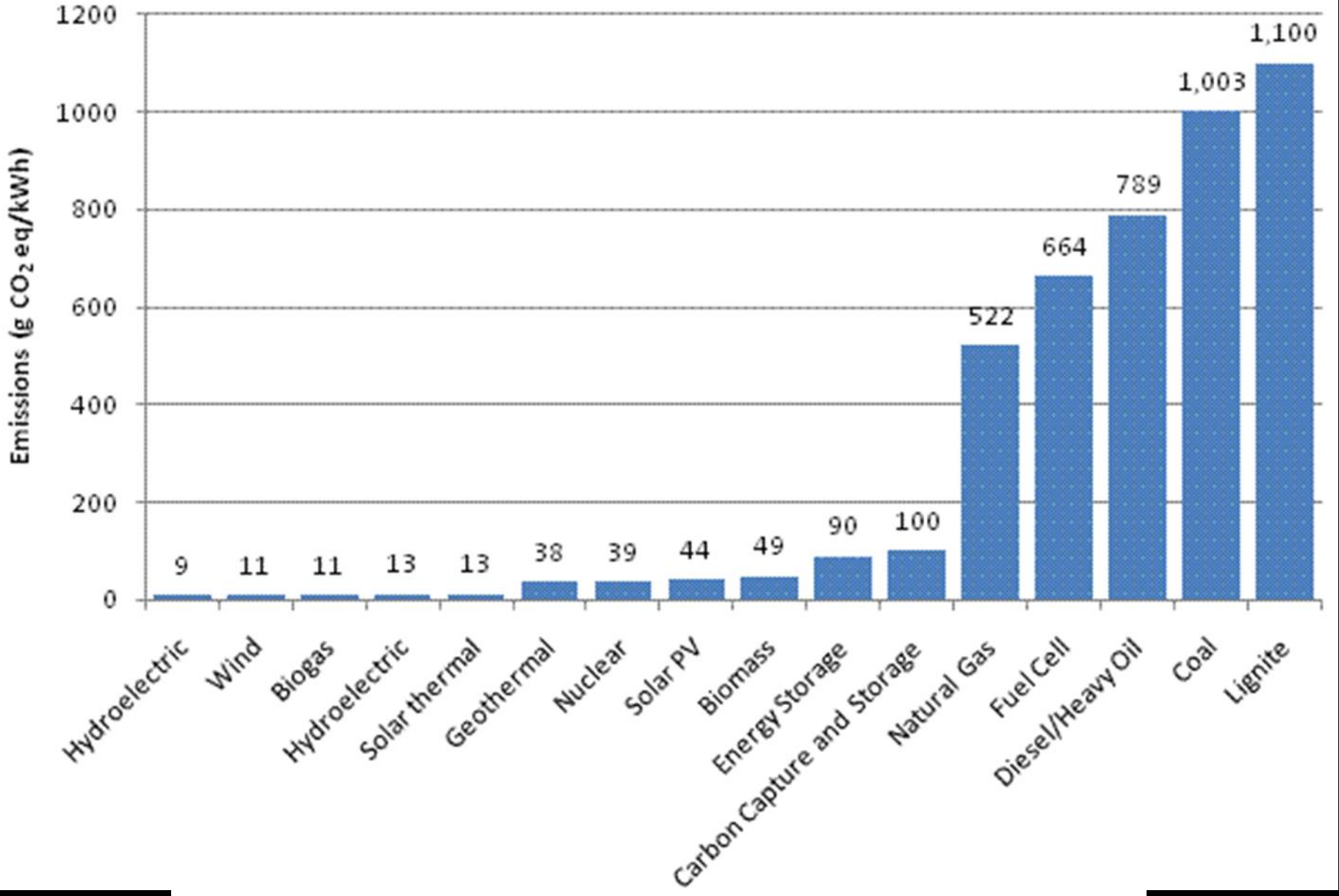
Wood Mackenzie: Market Projections



- Average capacity of new land-based turbines = 3-4 MW
- An addition of 160,000 MW = ~53,000 3MW turbines in the US in the next ten years


• 1.21 GW
• 403 3MW wind turbines

CO_2 EMISSIONS BY ENERGY SOURCE



SOURCE: Intergovernmental Panel on Climate Change.

Cumulative bat fatalities in the USA and Canada from **2000-2011** ranged from **840,486 - 1,690,696**

Arnett and Baerwald 2013

Annual Fatality Estimates in NA*

- American Wind Wildlife Information Centre (AWWIC) median = 2.66 bats/MW/yr in the U.S. (as of July 2018)
  - 109,795 MW installed as of October 2020
  - **292,055 bats/yr in the U.S.**

- Zimmerling and Francis (2016) median = 11.4 bats/turbine/yr in Canada
  - 13,413 MW (~6,707 turbines) installed as of October 2020
  - **76,460 bats/yr in Canada**

Composition of fatalities

- 25 of 47 possible species in Canada and the U.S.
- Fatalities primarily open-air foragers during autumn (global pattern)
- 74% are three species of migratory tree-roosting bats

Silver-haired bats = 19% of all NA bat fatalities

(BSC 2019, AWWIC 2019)

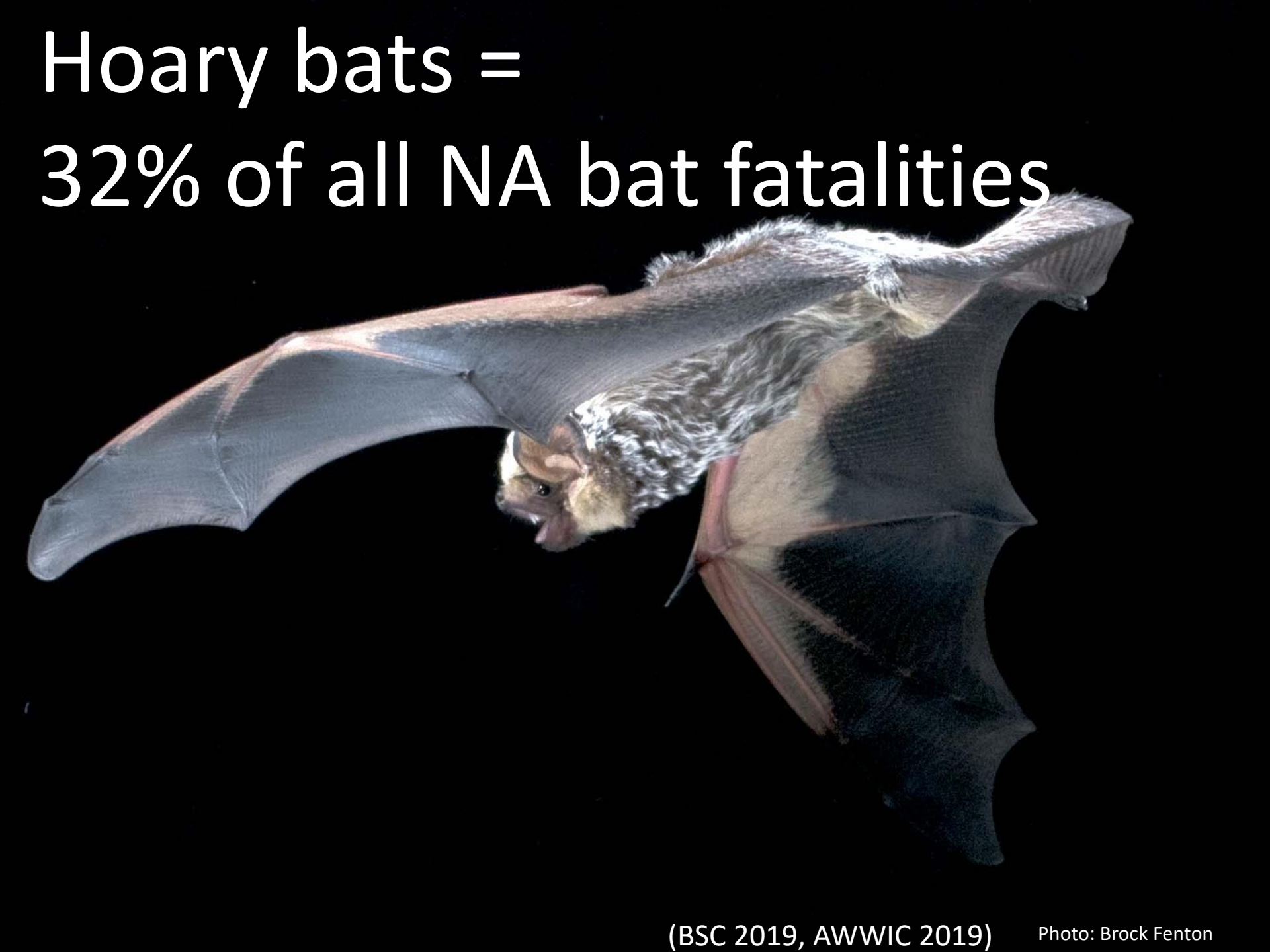
Photo: Brock Fenton

Eastern red bats = 23% of all NA bat fatalities

(BSC 2019, AWWIC 2019)

Photo: Brock Fenton

Hoary bats =
32% of all NA bat fatalities

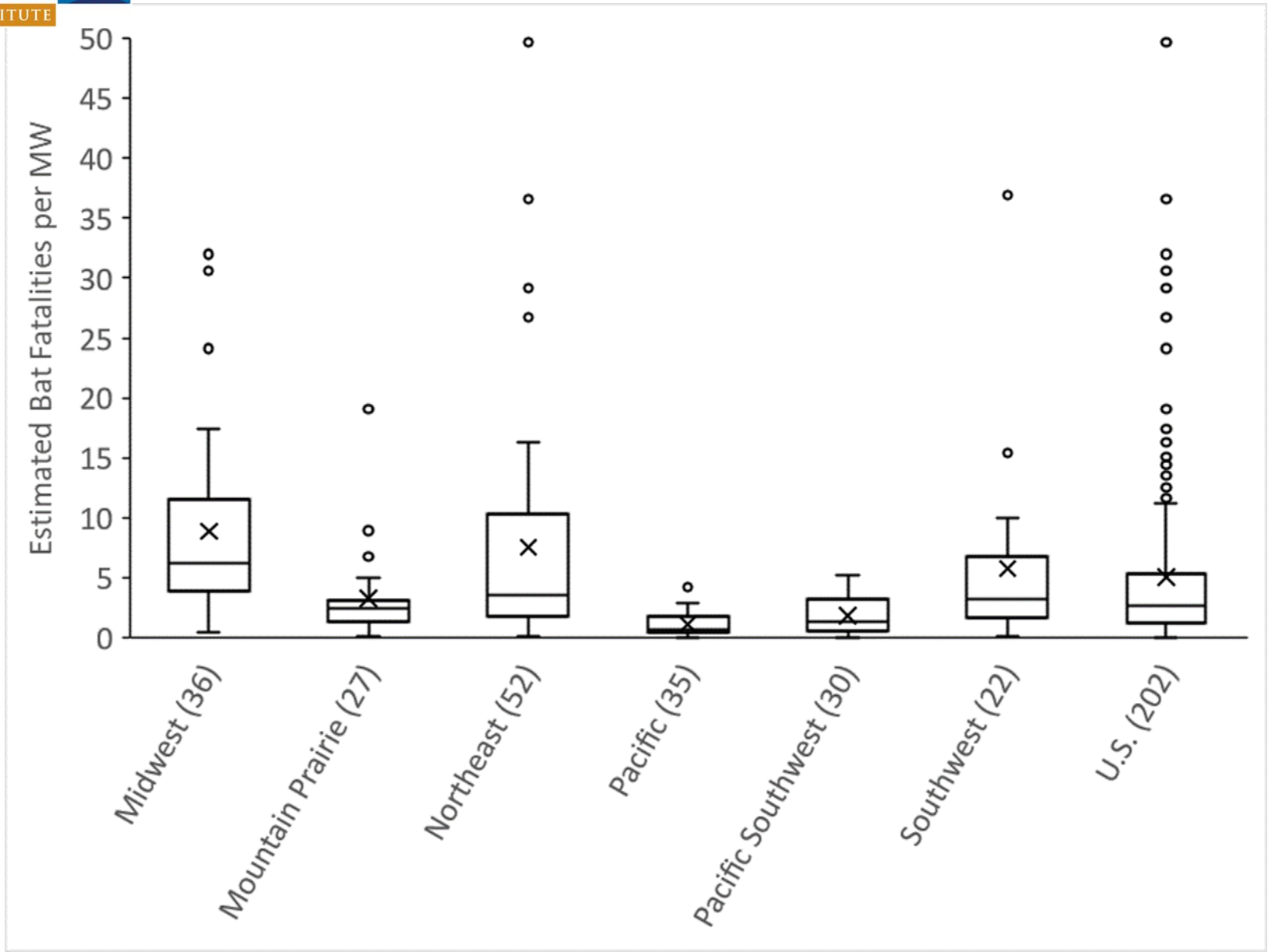


(BSC 2019, AWWIC 2019)

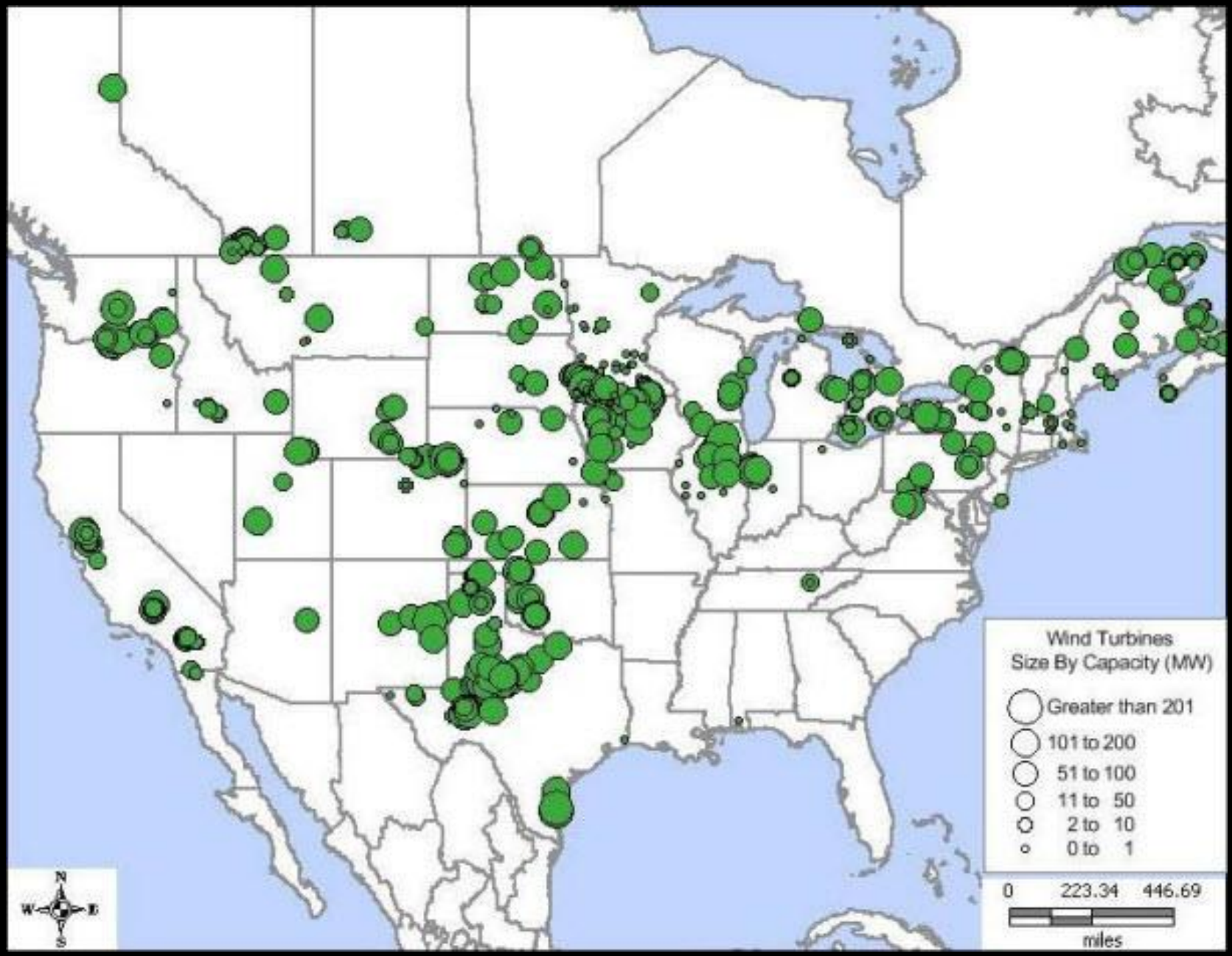
Photo: Brock Fenton

Fatality rates are highly variable

Variation in Bat Fatality Estimates by FWS Region from AWWIC



Installed Wind Capacity in NA*



Examples of variation in fatality rates from AWWIC

- Mexican free-tailed bats
  - 10% of all fatalities in the U.S.
  - Not present in 3/6 FWS regions
  - 43.7% of fatalities in SW and 53.2% in Pacific SW

- Tri-coloured bats
  - 5% of fatalities within FWS NE region
  - 0.4% of fatalities within Northern Allegheny Plateau Ecoregion
  - 11.4% of fatalities within the Ridge and Valley Ecoregion

Composition of fatalities

- Species most affected by WNS
  - Tri-coloured bat = 5%
  - Little brown Myotis = 7%
  - Northern long-eared Myotis <0.1%

Significance of fatalities


Eastern red bat

- Most species have little or no protection
- Fatalities come from large catchment areas

- Turbines are killing prime breeding age adults
- Bats have slow life-histories
- Bat populations may already be declining


Silver-haired bat

Declining populations of aerial insectivores


Photo: Andy Reago &
Chrissy McClarren


George L. Armistead/VIREO


Laure W. Neish/VIREO


Brian E. Small

Impacts of wind energy on hoary bats

- Hoary bats = “Most likely” model predicted 90% decline within 50 years (Frick et al 2017)
  - Based on expert elicitation and a suite of realistic demographic and fatality scenarios
  - Did NOT include build-out or curtailment/mitigation

Photo: Brock Fenton

Impacts of wind energy on hoary bats

- Friedenberg and Frick (2021) state that: “current levels of wind energy build-out **may have already caused substantial population declines**. Under our lowest-risk scenario of high maximum growth rate and low wind energy build-out, the median simulated population of 2.25 million hoary bats experienced a 50% decline by 2028.”

Photo: Brock Fenton

Impacts of wind energy on hoary bats

Table 2. Target reduction of bat fatalities at wind turbines to manage risk of hoary bat decline

Risk type	Abundance (millions)	Target reduction of bat fatalities (%)	
		Low build-out $\lambda = 1.18$ to 1.0	High build-out $\lambda = 1.18$ to 1.0
50% Decline by 2050	1	75–100*	88–100*
	2.25	35–100*	66–100*
	4	0–93	38–98
	10	0–30	0–63

From Friedenberg and Frick 2021

Photo: R. Hays Cummins

Are populations declining?

- Hoary bats = 90% decline within 50 years (Frick et al 2017)
- Fatality rates at wind turbines over time
  - Mostly significant declines
- Capture/acoustic detection rates
  - Mixed results
    - ~2% decline/yr in hoary bats in the PNW (Rodhouse et al 2019)
- Rabies submission rates
  - All declines

Baerwald and Barclay In Prep

Photo: Brock Fenton

Are hoary bats an appropriate umbrella species?

Other questions being considered

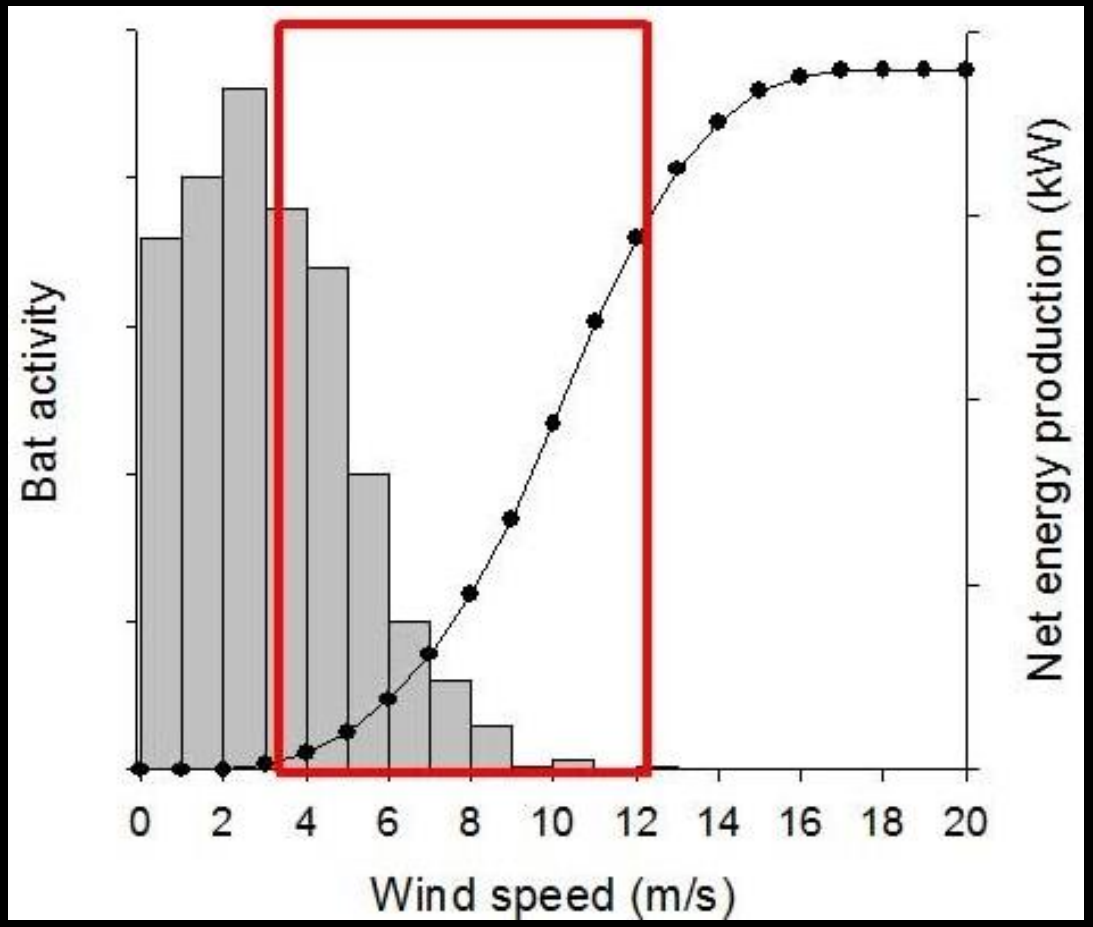
- How many bats are injured but not killed? (e.g. via barotrauma)
- Will smaller population sizes of bats exacerbate declines? (i.e. Allee effect)
- What are the effects of offshore development on bats?

Bats offshore?

- In the U.S. multiple bat species detected foraging and migrating > 40 km from shore
- In Europe, bats recorded foraging and roosting on turbines and oil and gas platforms up to 80 km offshore
- Hoary bats colonized multiple remote locations like Galapagos and Hawaii (2x)

- **Operational curtailment**

Operational Curtailment?



- Raising cut-in speed to between 5 m/sec and 6.5 m/sec reduces overall bat fatalities by ~50%
- Costs on average ~ 1% of annual power production

- **Operational curtailment**
- Acoustic deterrents

Acoustic deterrents?

- NRG Systems (Weaver et al 2019)
- Overall reduction of bat fatalities = 38-61%
- Hoary bats = 62-95% reduction
- Brazilian free-tailed bats = 41-67% reduction
- Did not reduce fatalities for all bats (i.e. yellow bats)

- **Operational curtailment**
- Acoustic deterrents
- Informed siting
- Habitat compensation
- Managing cumulative effects
- Testing hypotheses about behaviour and attraction to change behaviour

Are hoary bats the cost of increasing wind energy development?

Questions?

baerwald@unbc.ca

UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA

NSERC CRSNG

UNIVERSITY OF REGINA

UNIVERSITY OF CALGARY