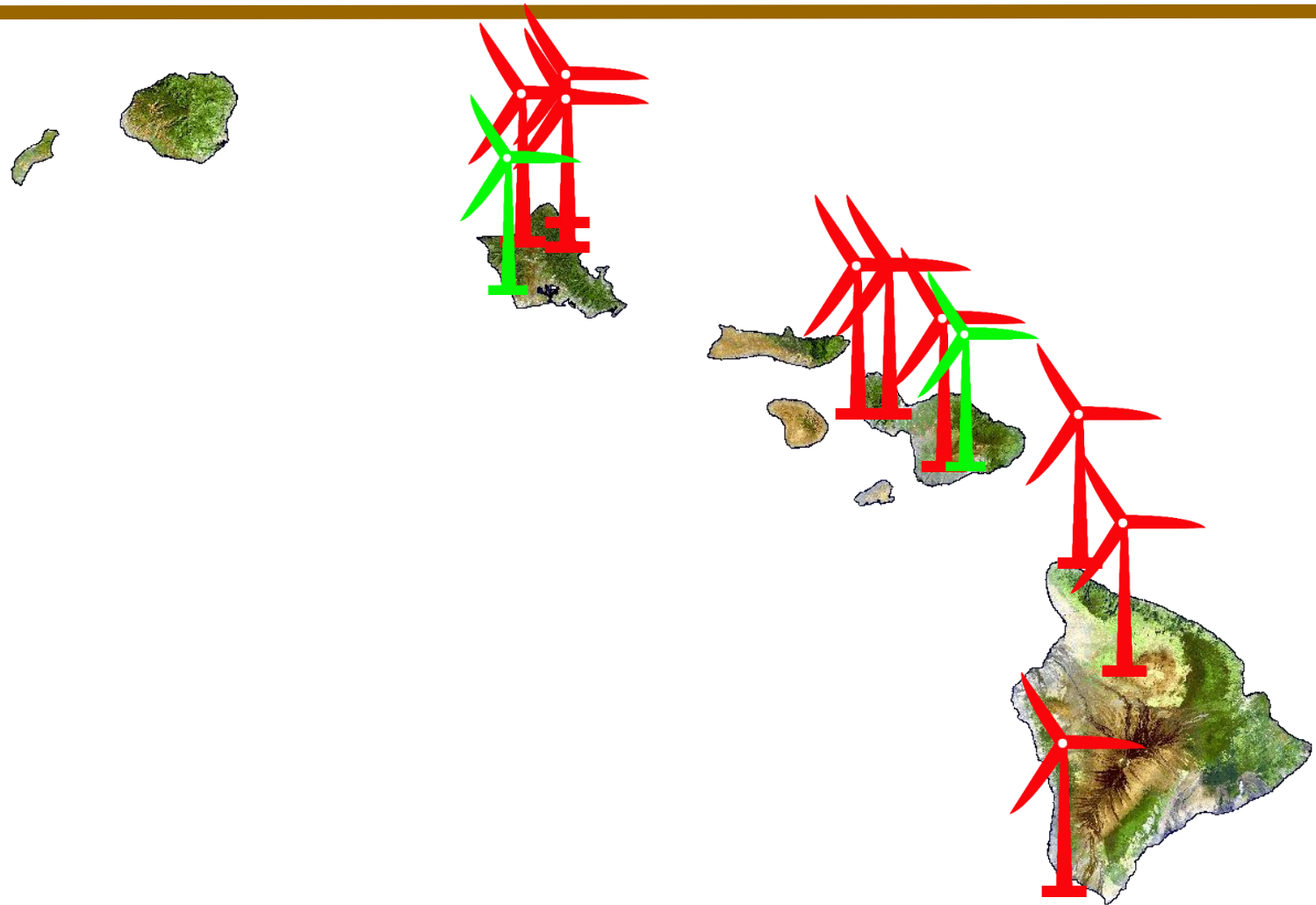


# Low Wind Speed Curtailment



Loyal A. Mehrhoff  
March 6, 2020

# Hawaiian Hoary Bat

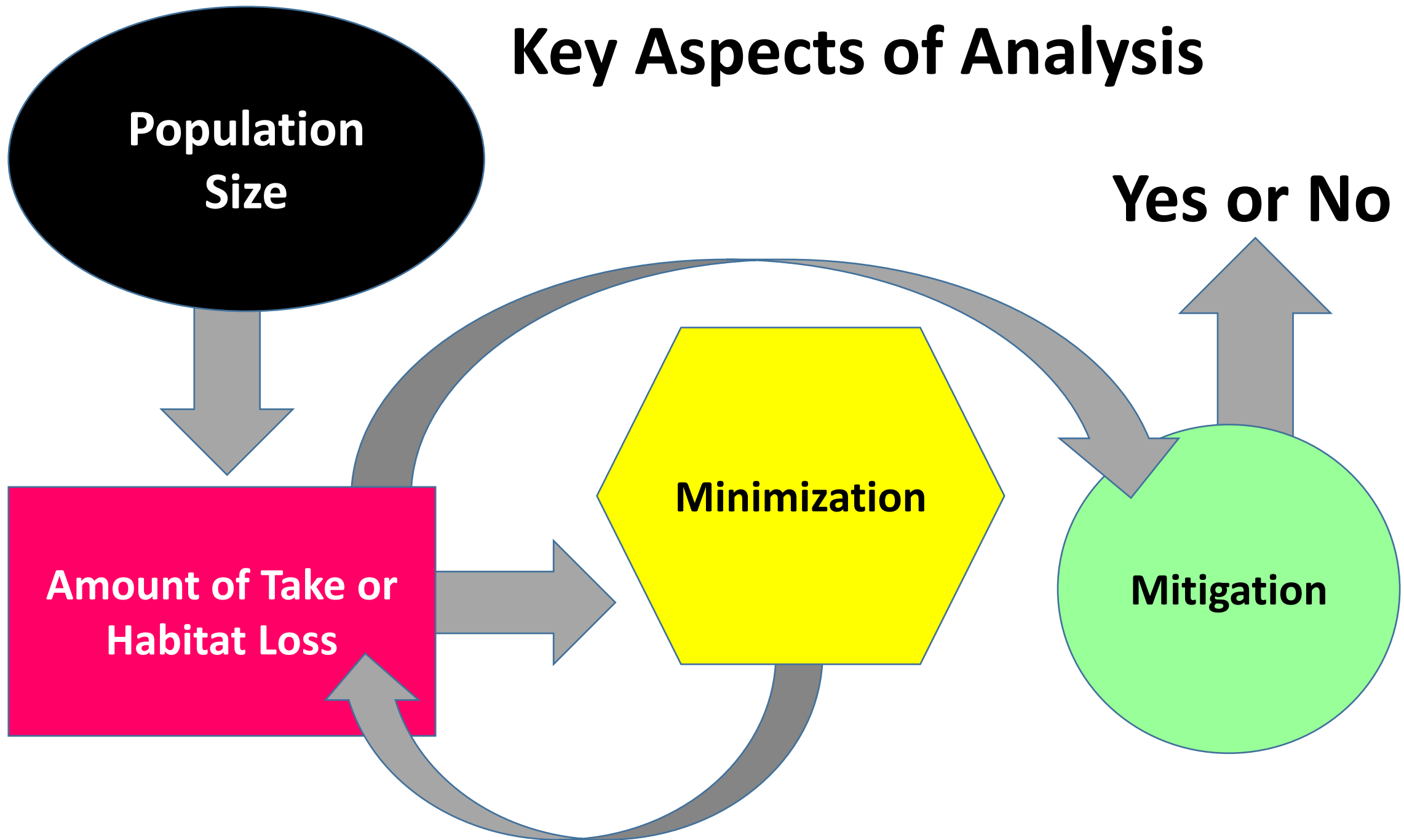
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- **Endangered**
- **11 wind projects with potential take – with more expected**
- **Requested take has increased from 4→30/yr**

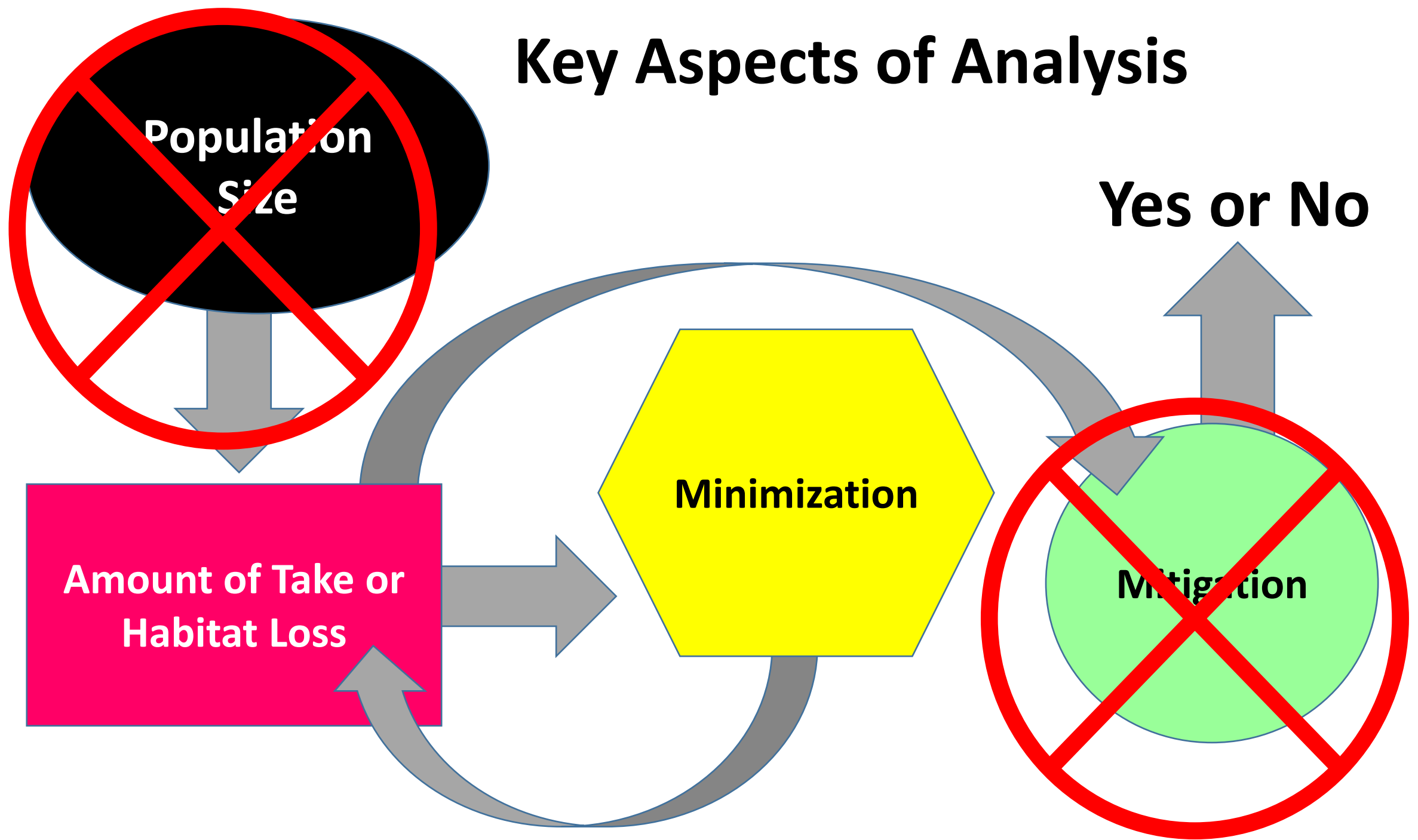
## **Complicated by:**

- **No reliable island population estimates (100s to many 1,000s)**
- **Mitigation not documented to increase bat populations**

# Key Aspects of Analysis

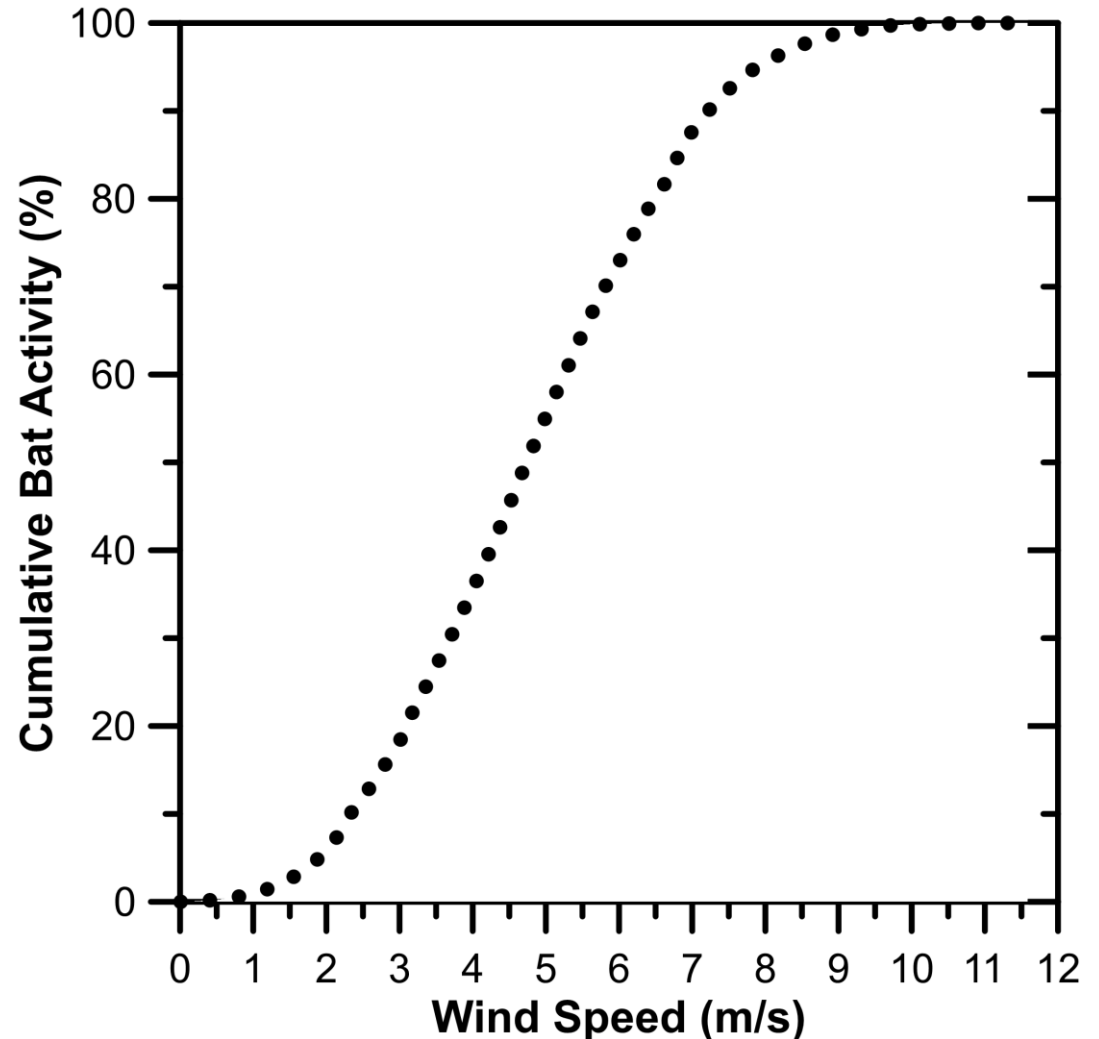


# Key Aspects of Analysis



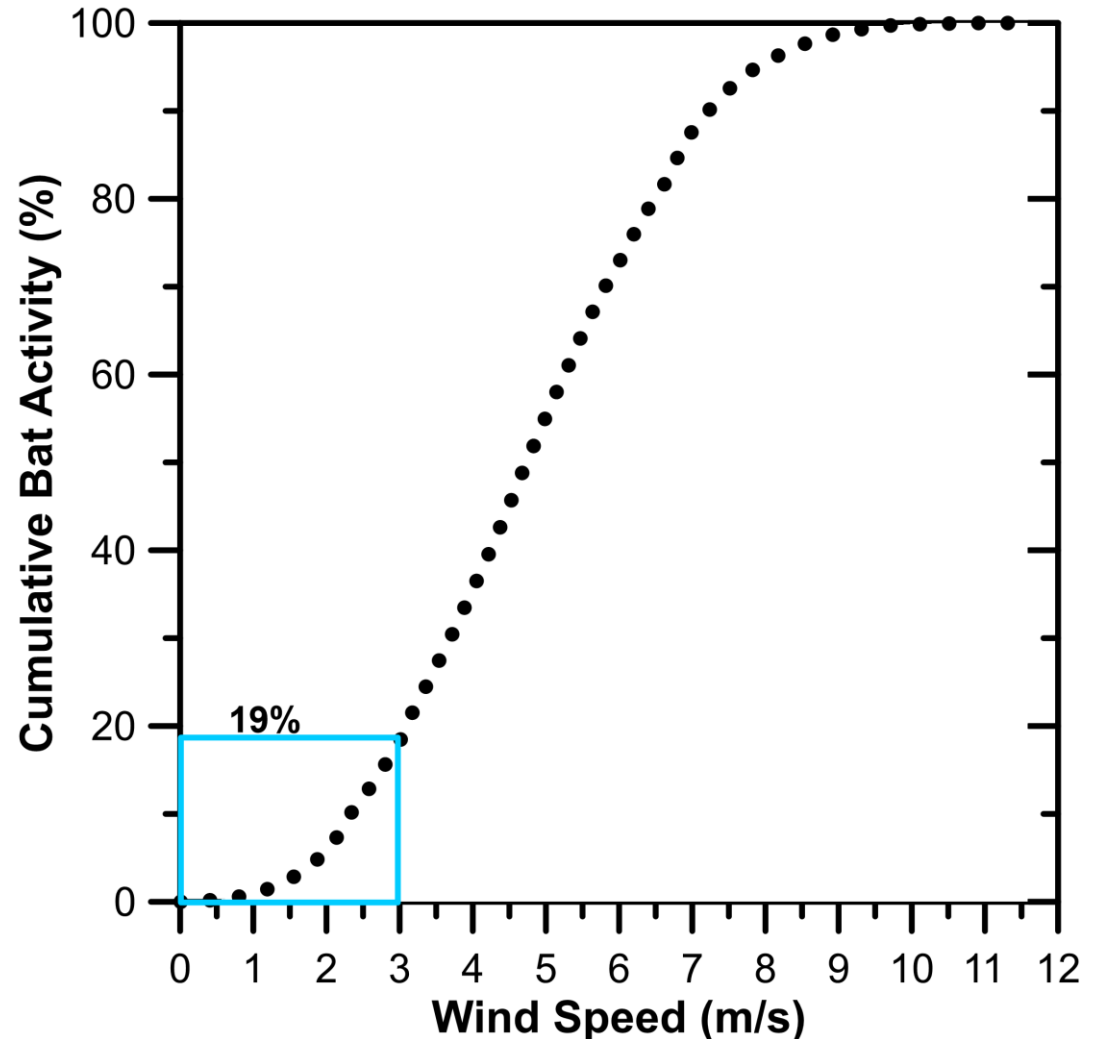
# Low Wind Speed Curtailment

- Prevents turbines from operating at lower wind speeds (which have high bat activity)
- Uses the relationship between wind speed and bat activity to reduce bat exposure to blades



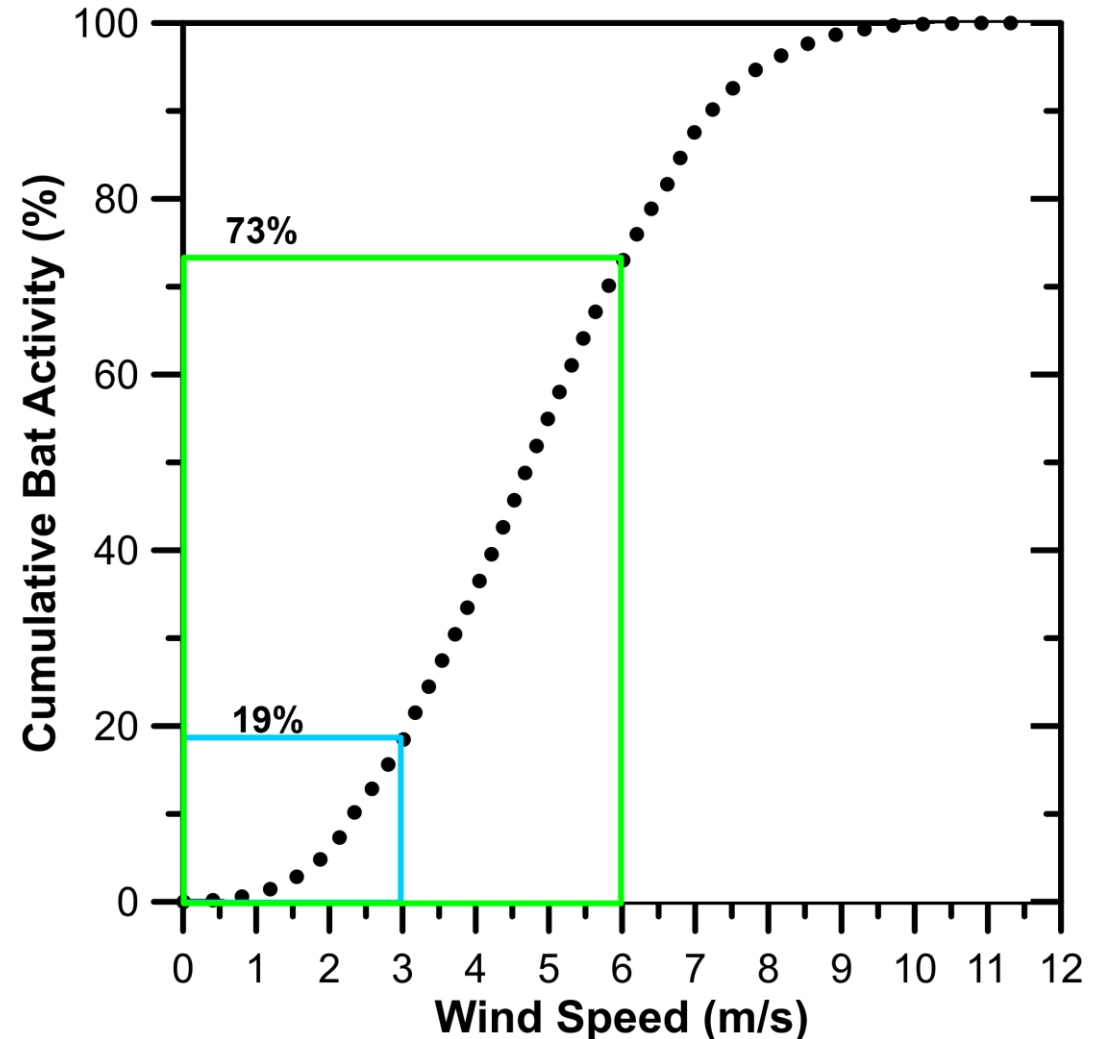
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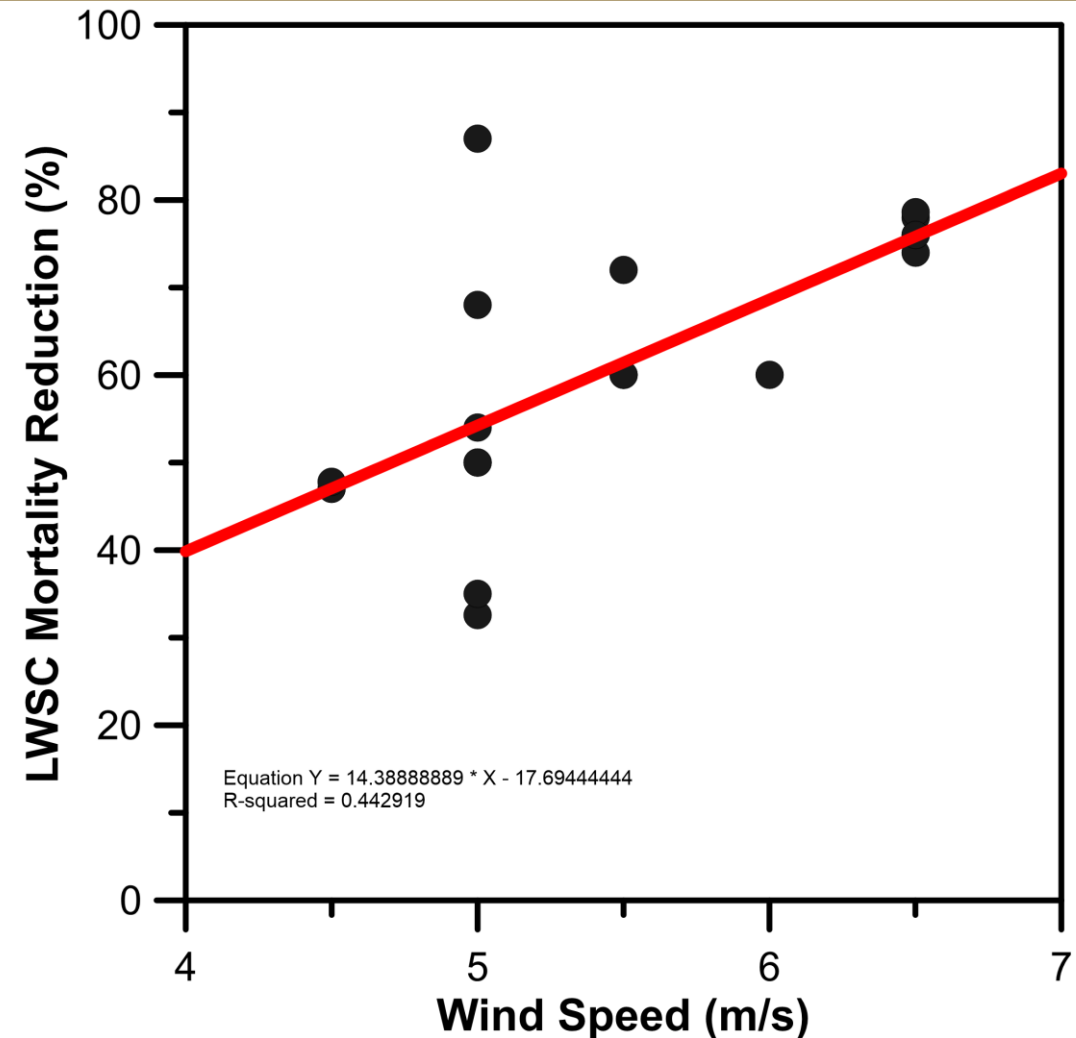
- Prevents turbines from operating at lower wind speeds (which have high bat activity)
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Wind Speed (m/s)	Cumulative Activity (%)	Reduction in Fatalities (%)
3.5	26.9	
4.0	36.3	
4.5	44.5	
5.0	54.9	
5.5	64.8	
6.0	73.2	
6.5	80.0	
7.0	88.0	
8.0	95.6	



# Low Wind Speed Curtailment

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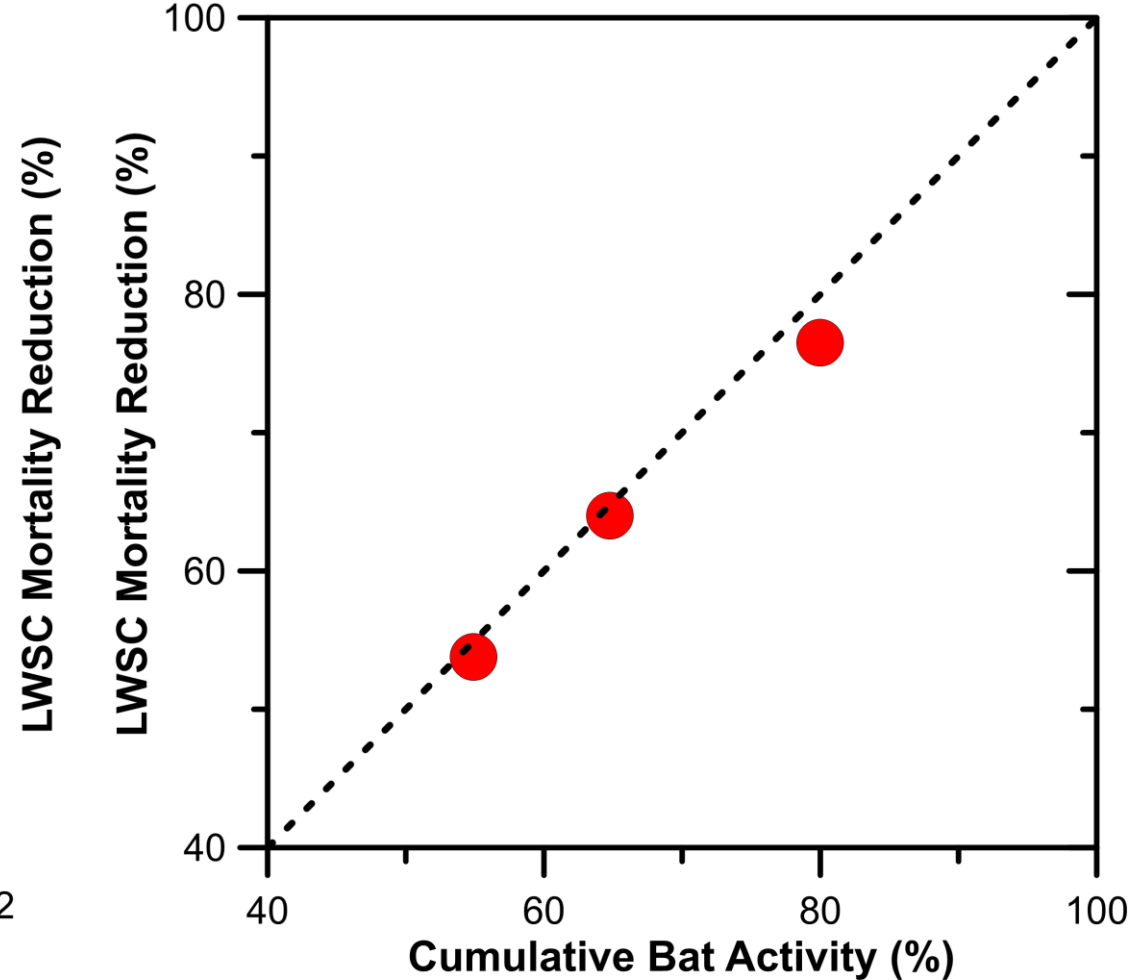
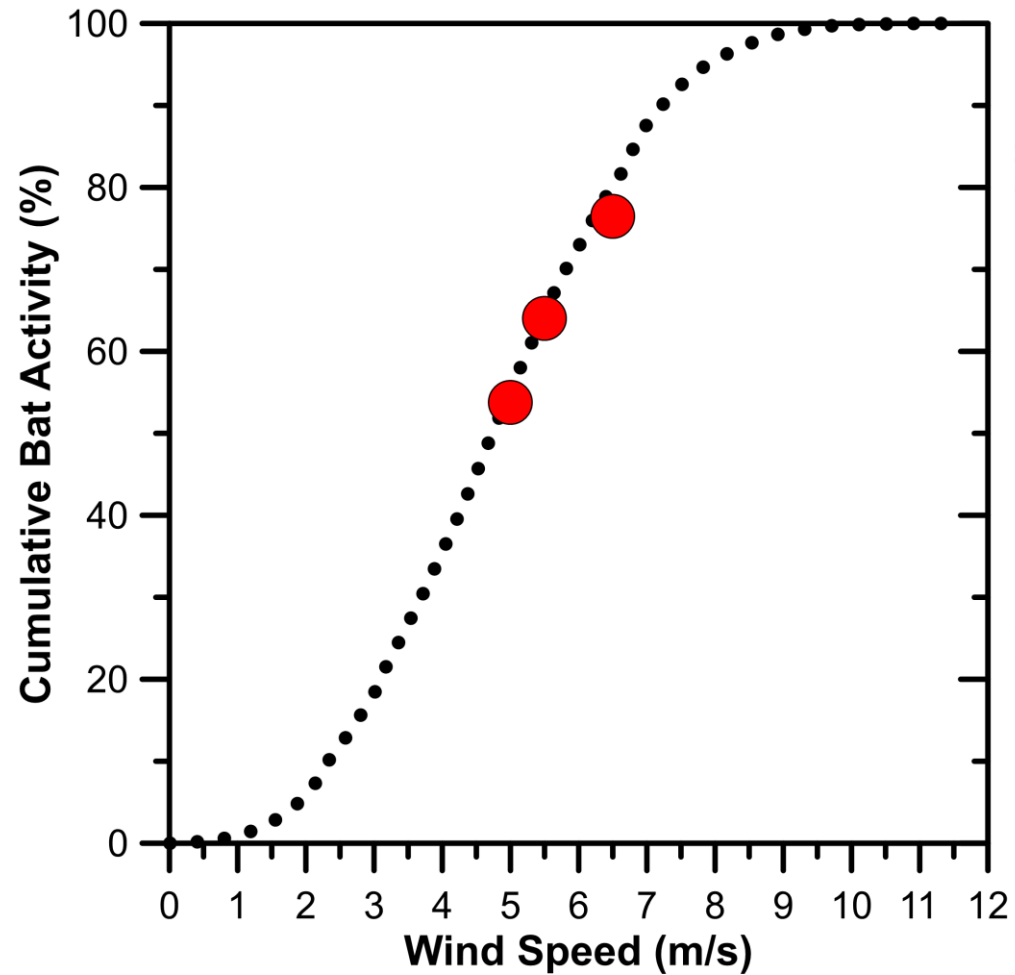


# Low Wind Speed Curtailment

- Prevents turbines from operating at lower wind speeds (which have high bat activity)
- Uses the relationship between wind speed and bat activity to reduce bat exposure to blades
- Hawaii 5.0, 5.5, 6.9 m/s

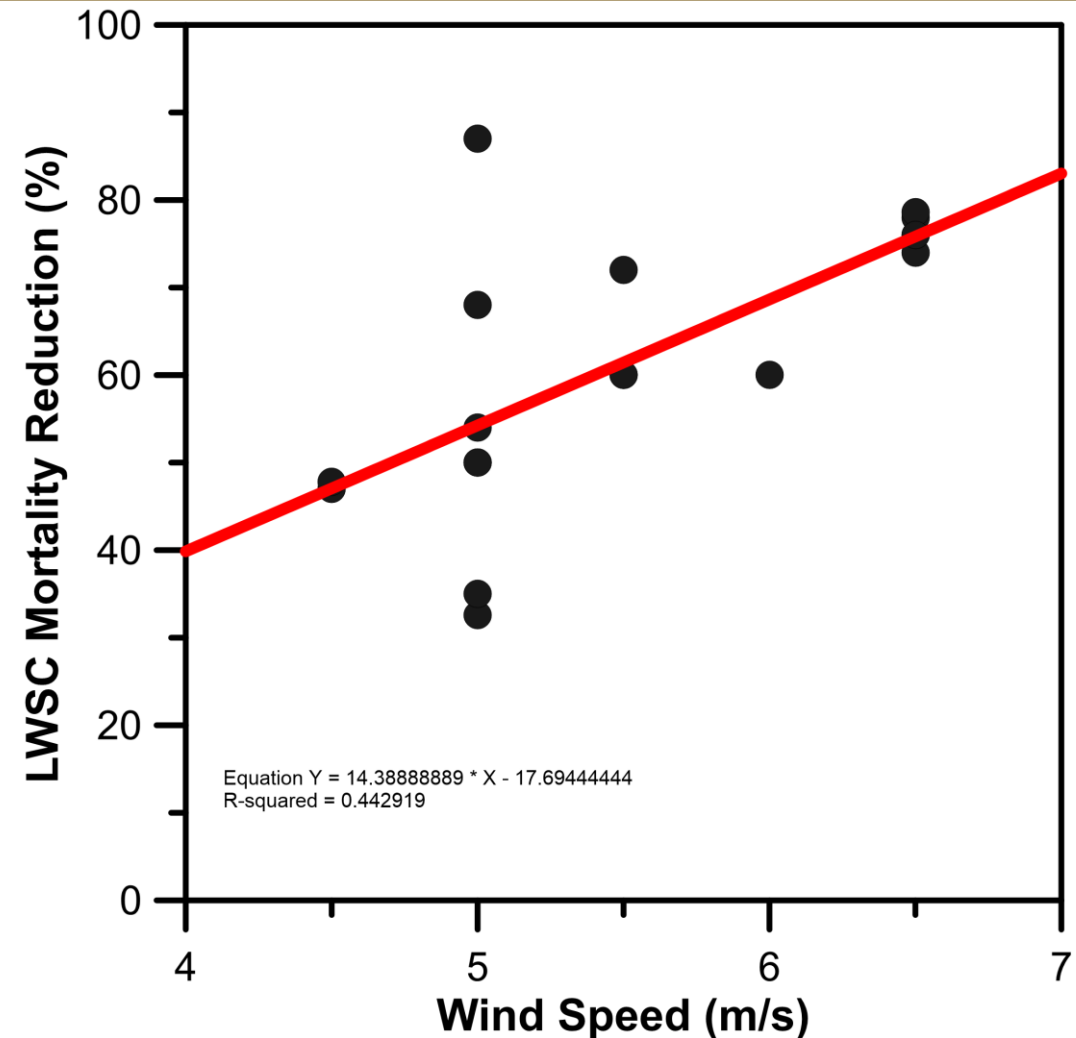
Wind Speed (m/s)	Cumulative Activity (%)	Reduction in Fatalities (%)
3.5	26.9	
4.0	36.3	
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5.5	64.8	64.0
6.0	73.2	
6.5	80.0	76.5
7.0	88.0	
8.0	95.6	

# Curtailment Fits Expectations



# Low Wind Speed Curtailment

- Prevents turbines from operating at lower wind speeds (which have high bat activity)
- Uses the relationship between wind speed and bat activity to reduce bat exposure to blades



# Techniques for Curtailment Triggering

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## Rolling averages of wind speed:

- Typically based on 10-minute averages
- One study found a non-statistically significant 30% reduction in take when switching to 20-minute averages
- 1 Hawaii project uses 20-minute; others 10-minute
- NOTE: May want to recommend 20-minute to start up; 10-minute to turn off

# Techniques for Curtailment Triggering

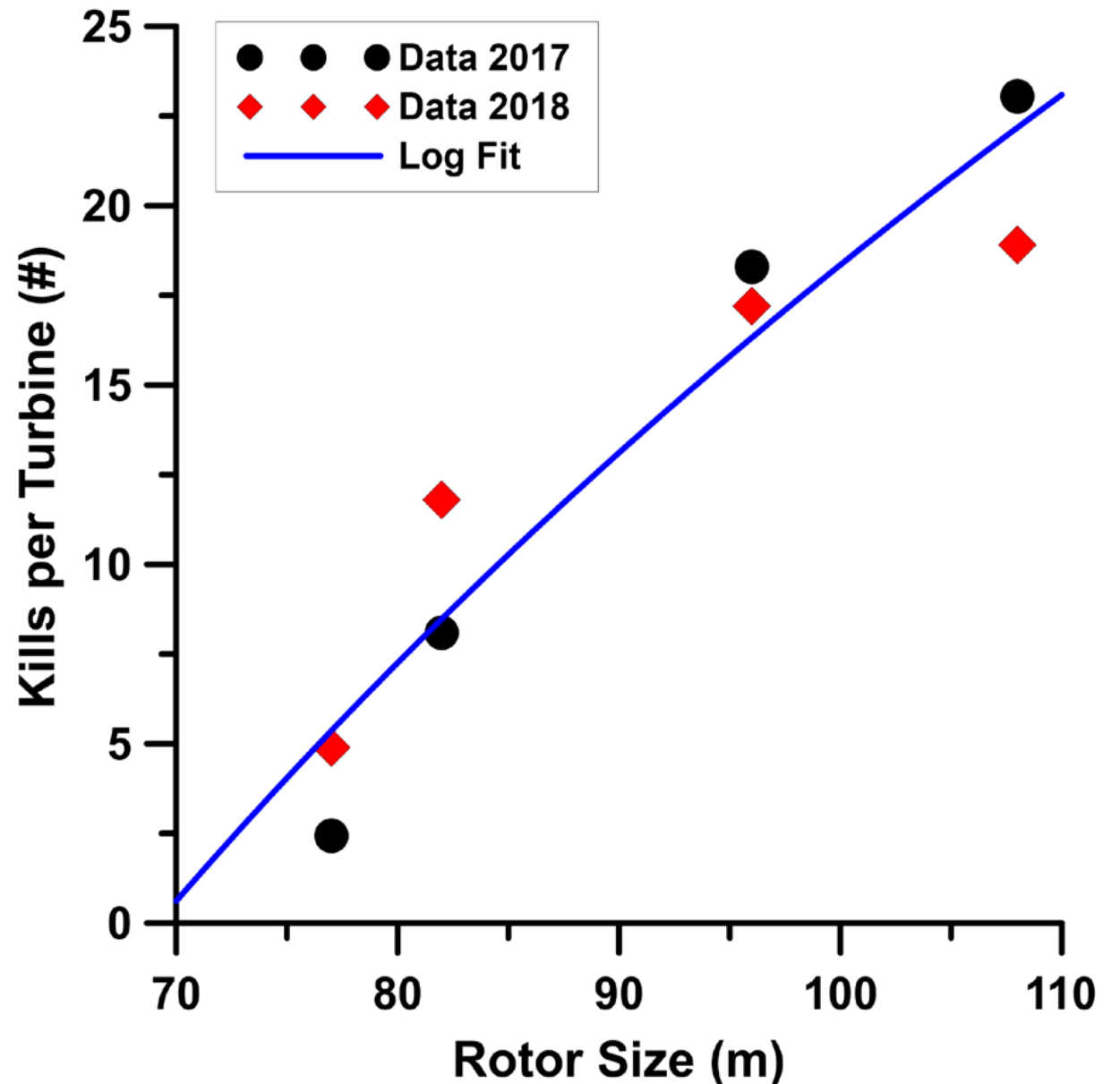
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**Use of meteorological towers to get curtailment wind speed versus using turbine wind meters:**

- **The only study found turbine wind meters overestimated actual winds by 1 m/s**
- **Statistically significant 81% increase in mortality when using turbine wind data vs met tower data**

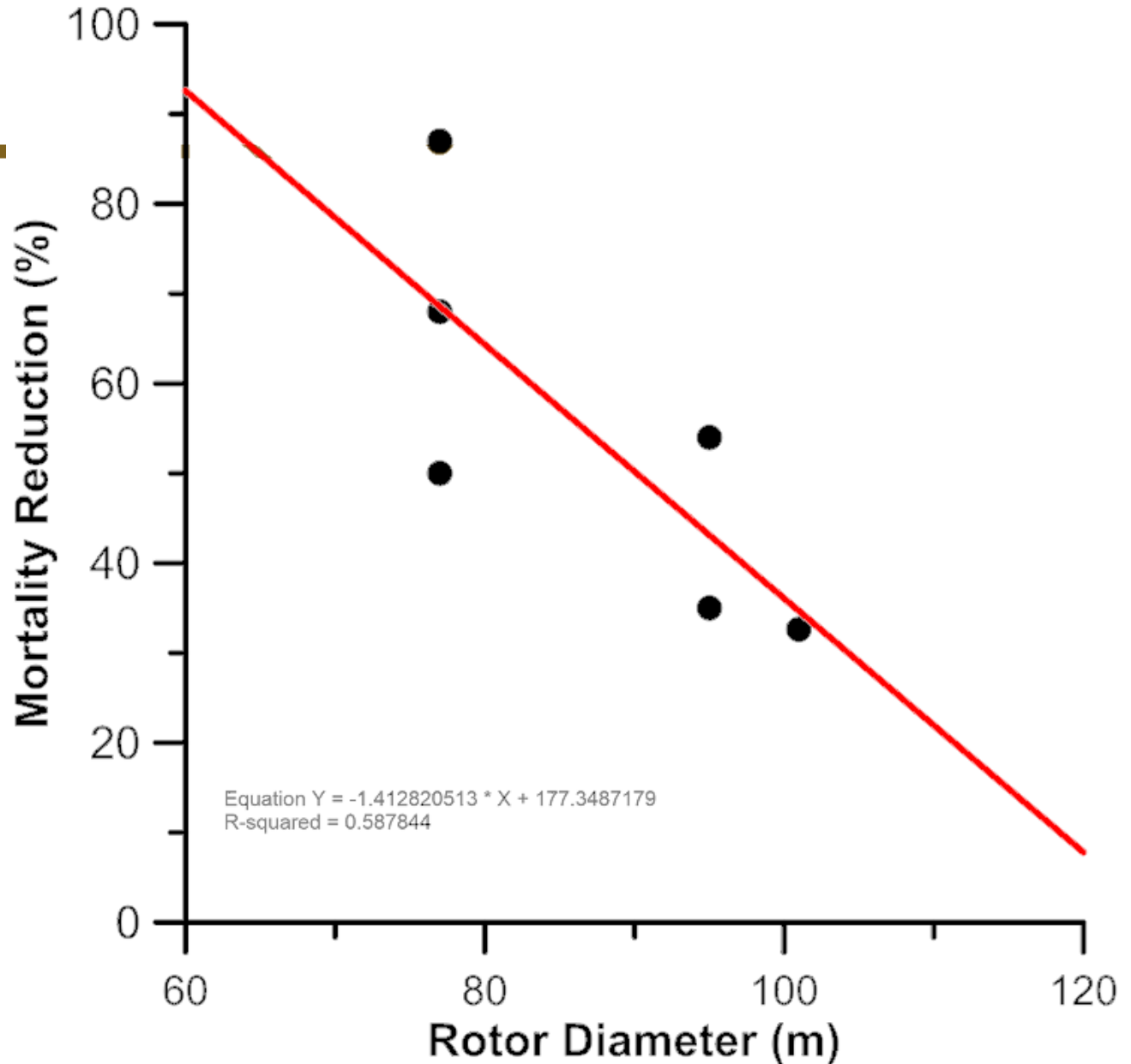
# Rotor Size

- Regressing data from Good et al. (2018, 2019) showed a correlation between rotor diameter and bat mortality
- Larger turbines killed more bats
- 4 rotor sizes with 4 manufacturers



# Rotor Size

- Affect of rotor size on curtailment benefits
- Curtailment is less than half as effective for larger rotors
- Used different data than Good et al. (2018, 2019)





# Rotor Size

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- **Larger rotors kill more bats and have reduced curtailment benefit**
- **Current estimates of curtailment benefits are based on studies with smaller rotors**

# Conclusions

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- 1. Low Wind Speed Curtailment benefits are documented**
- 2. Higher LWSC kills fewer bats**
- 3. Questioning Costs to Benefits is valid**
- 4. Still much variation in those benefits**
- 5. In addition:**
  - 20-minute rolling averages for LWSC may be better**
  - Potentially need to use met tower data or validate turbine wind speed data**
  - Large turbines (>90 m) seem to kill more bats outright and have reduced benefits from LWSC**

# QUESTIONS

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