

# Electrocution Assessment - Power Lines Serving a Wyoming Oil and Gas Field



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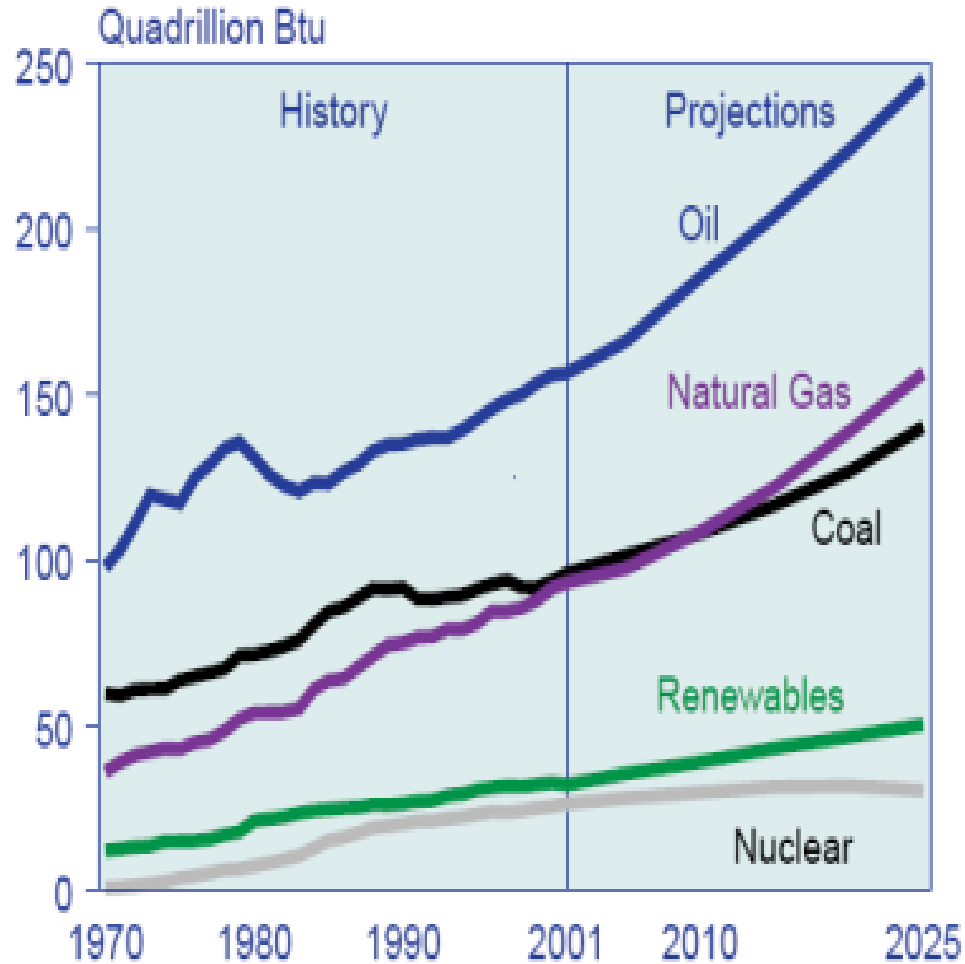


# ENERGY TRENDS



# Raptor Electrocutions

## Energy trends





# **HISTORIC MORTALITY**

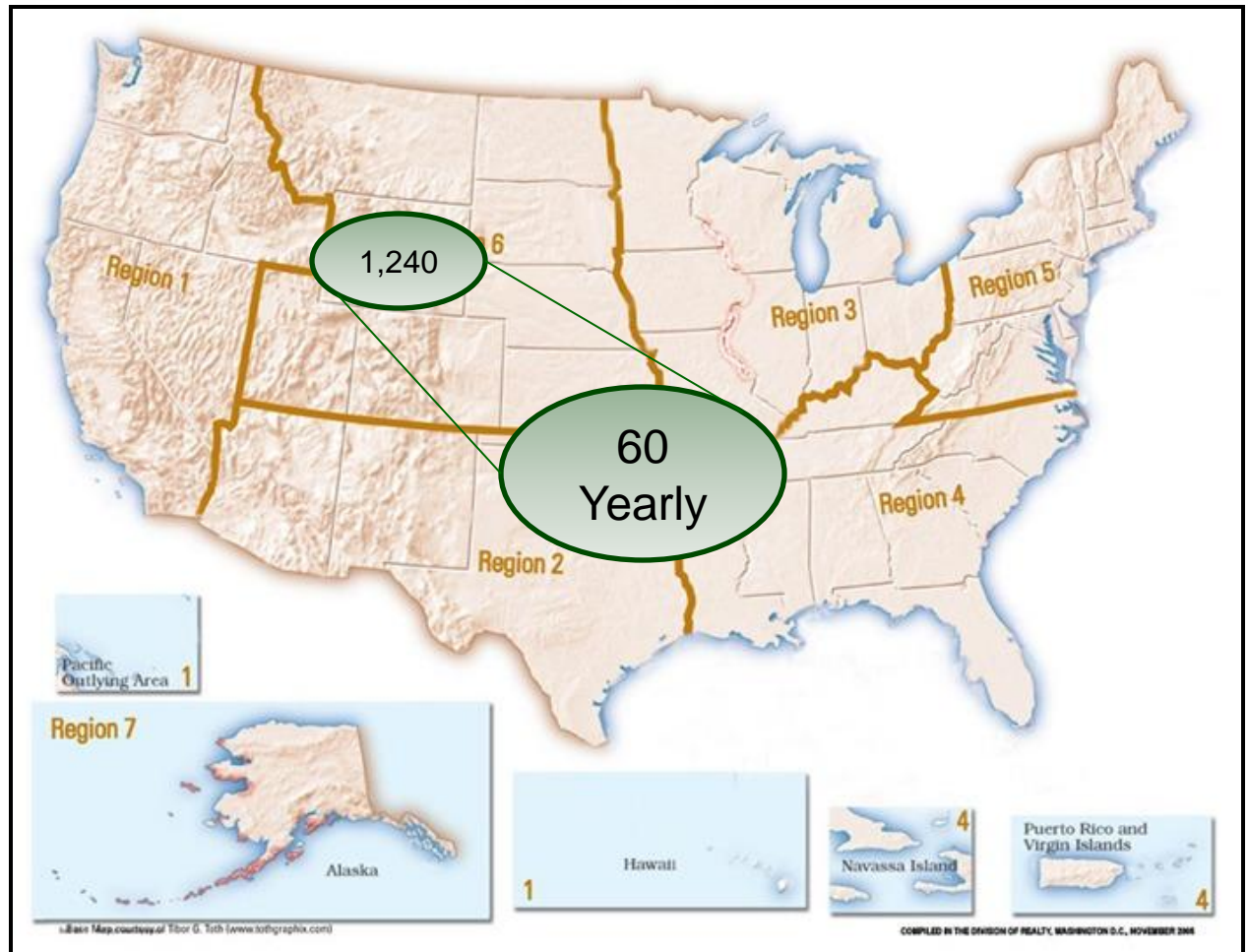


# Raptor Electrocutions

## Scope of Issue

n = 1,240 Eagles

Years: 1990 – 2010  
Source: USFWS LE



# Raptor Electrocutions

## Scope of Issue



Eagle Rates are Inaccurate:

1. Detection Bias
2. Scavenging Bias
3. Crippling Bias
4. Hard to Diagnose Some Electrocutions
5. Reporting



**Lehman et al. 2011 - Carcass Removal Trials** — Estimated a mean removal rate of 6.8% eagles under power lines in the ROF located in western Colorado. N=29 Eagles, 27 GOEA, 2 BAEA

**Lehman et al. 2011 – Necropsies** — Conducted necropsies on 108 raptor carcasses as part of a power line survey effort. Could not determine the cause of death for 34% of carcasses (n=27). 48% Electrocution, 18% Other

**Dwyer 2006 - Electric Shock Injuries** - 15 of the 85 HRSH captured had injuries. Breakdown: 7 birds (8%) with confirmed electric shock injuries. 7 birds (8% ) with suspected electric shock injuries. 1 bird with non-electric injuries.

**Dwyer and Mannan. 2007. Carcass Reporting in an Urban Environment** - Placed 23 raptor carcasses at distances ranging from 7–220 m from the nest. Of these, five were reported by residents within 1 d and two more were reported within 3.5 d. No carcasses were reported after 3.5 d.



# **ELECTRICITY 101**



**Conductor Phases (Hot)**  
A - B - C

**A**

**B**

**C**

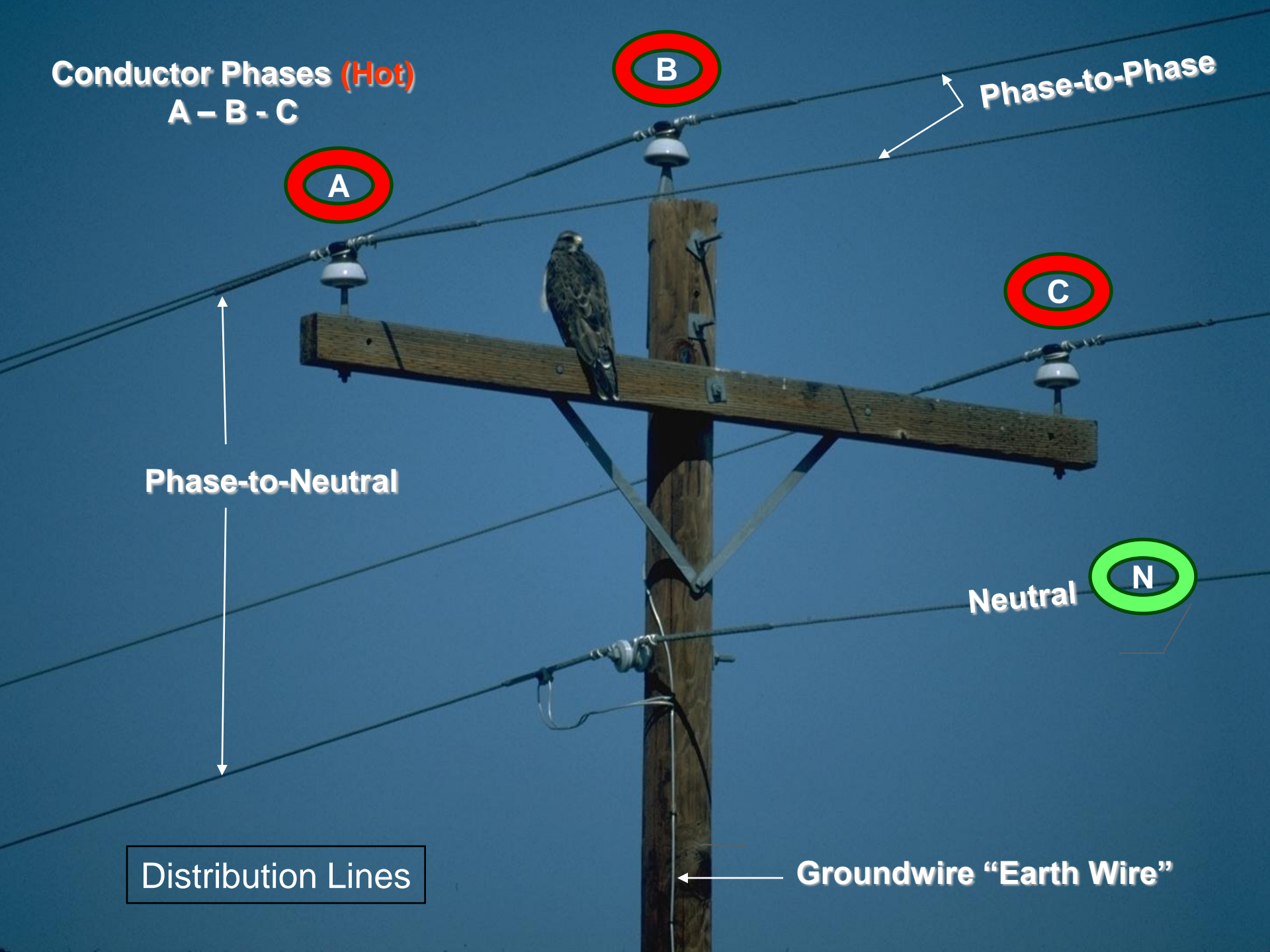
**Neutral**  
**N**

Phase-to-Neutral

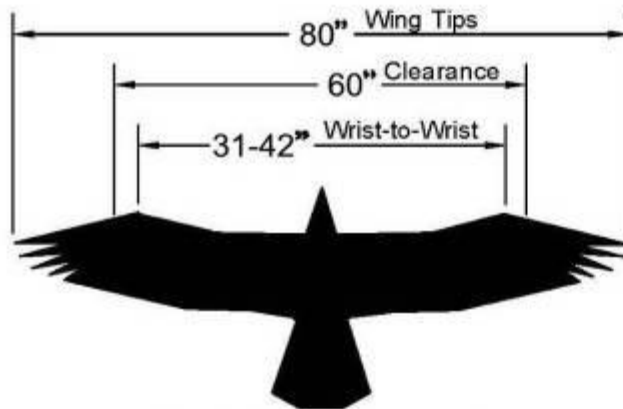
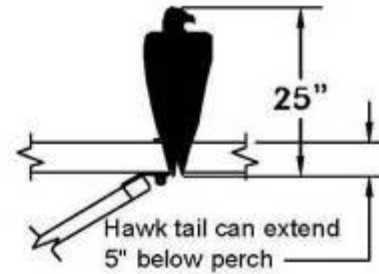
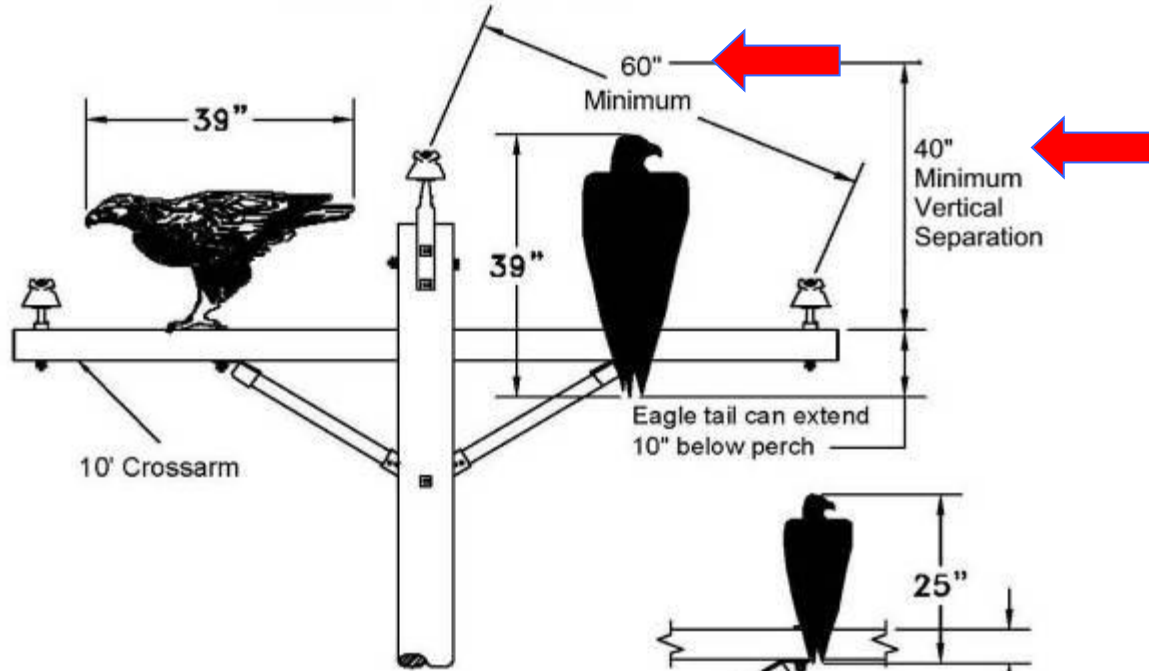
Phase-to-Phase

Distribution Lines

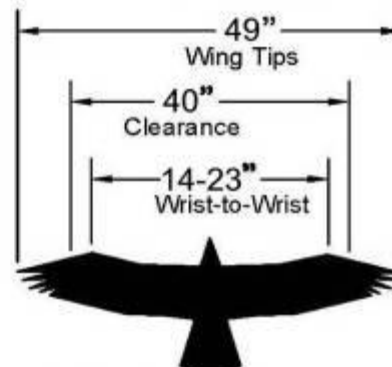
Groundwire "Earth Wire"



# AVIAN FRIENDLY CONSTRUCTION CRITICAL DIMENSIONS



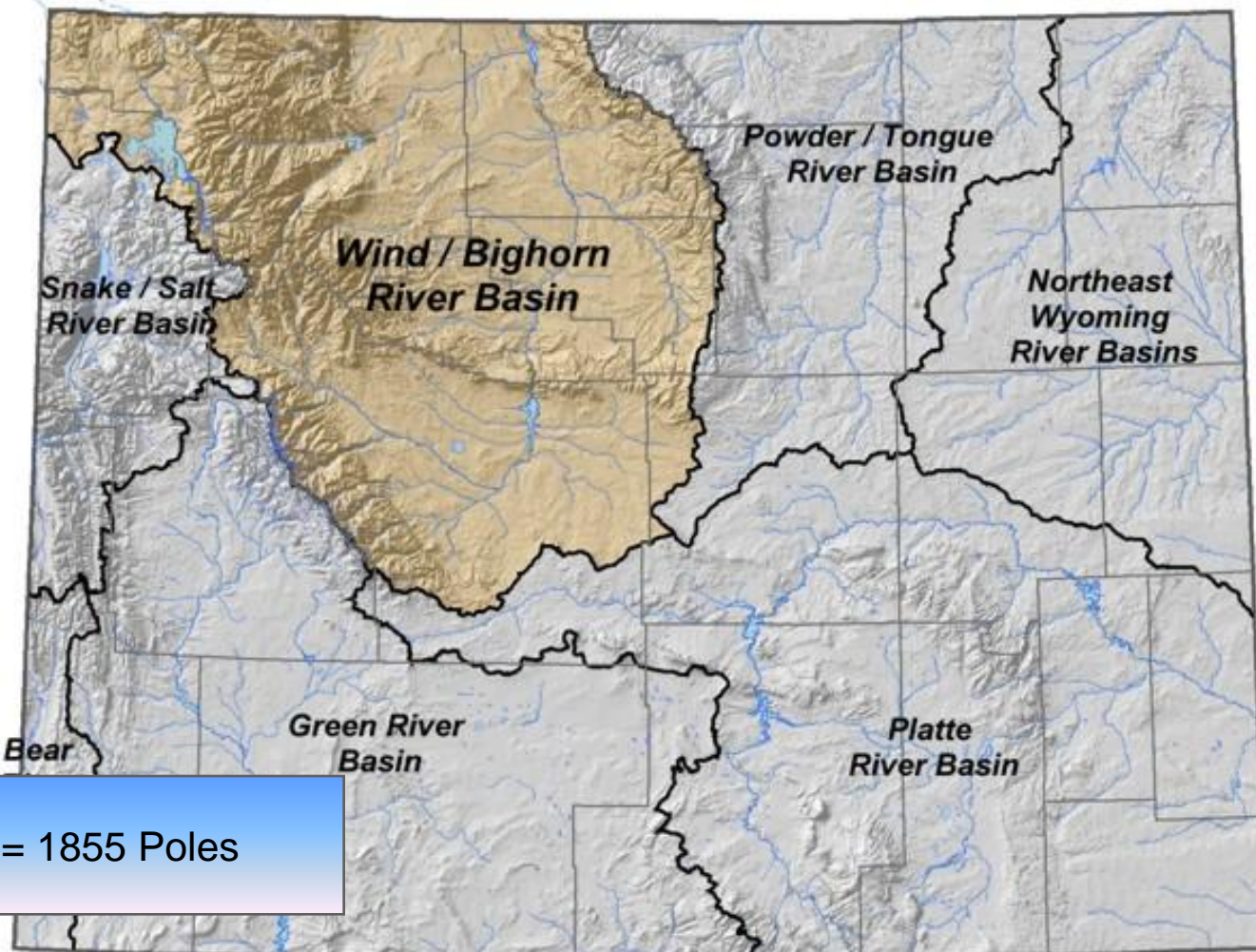
Eagle Measurements



Red-tailed Hawk Measurements



# Project Area WYOMING



N = 1855 Poles



SURVEY METHODS

RECORD POLE  
CONFIGURATION

HABITAT

RECORD ANY  
FATALITY

RECORD SIGNS OF  
BIRD USE

N = 1855 Poles



Pole Configuration												Retrofit Recommendations											
Top Primary Unit	Unit		Existing Equipment									BC		C	AC		IJ	CG	TRI	RG	COC	EP	
Top Construction A=Single Phase B=Two Phase C=Three Phase	Low Construction	Retrofit Priority	Cutouts	Arresters	Potheads	Metal Bkts	XFMR's	Reclosers	Capacitors	Regulators	Poletop	Ground	Exist BC	Need BC	Need PHC	Exist AC	Need AC	Need IJ	Need CG	Need TRI	Need RG	Need COC	Need EP
C8		2	2	2			2						1				2	Y		4			
C1-NP	2 PHASE RISER	2	2	2	2	1									0		2	Y				2	
C1-NP	1 PHASE RISER	2	1	1	1	1									0		1	Y				1	
C7-5FT XARM	2 PHASE RISER	2	2	5		1									0		5	Y		2		2	
C7		2	3	3		1	3						3				3	Y				3	
C8		2	2	2			2						2				2	Y				2	
C7	C7	3																Y					
B7		2	1	2		2	1						1				2	Y				0	
C8	3 PHASE RISER	1	3	3	3	1									0		3	Y		4		3	
C5	3 PHASE RISER	2	3	3	3	1									0		3	Y				3	
A1		3	1	1		2	1						1				0	Y					
C9-1ND		3	2	2		1	2							2			2	Y				2	
C9-1ND		3	3	3		1	3						3				3	Y				3	
C9-1ND		3	3	3			3							3			3	Y				3	
A6		3	1	2		2		3					2					Y					
C9-1ND		3	3	3			3							3			3	Y				3	
A1		3	1	1		2	1						1				0	Y				1	

## Each Pole Record:

- Existing Animal Protection Measures
- Recommended Retrofitting Products



# **RESULTS**

## **Single Phase**

### **274 Poles**

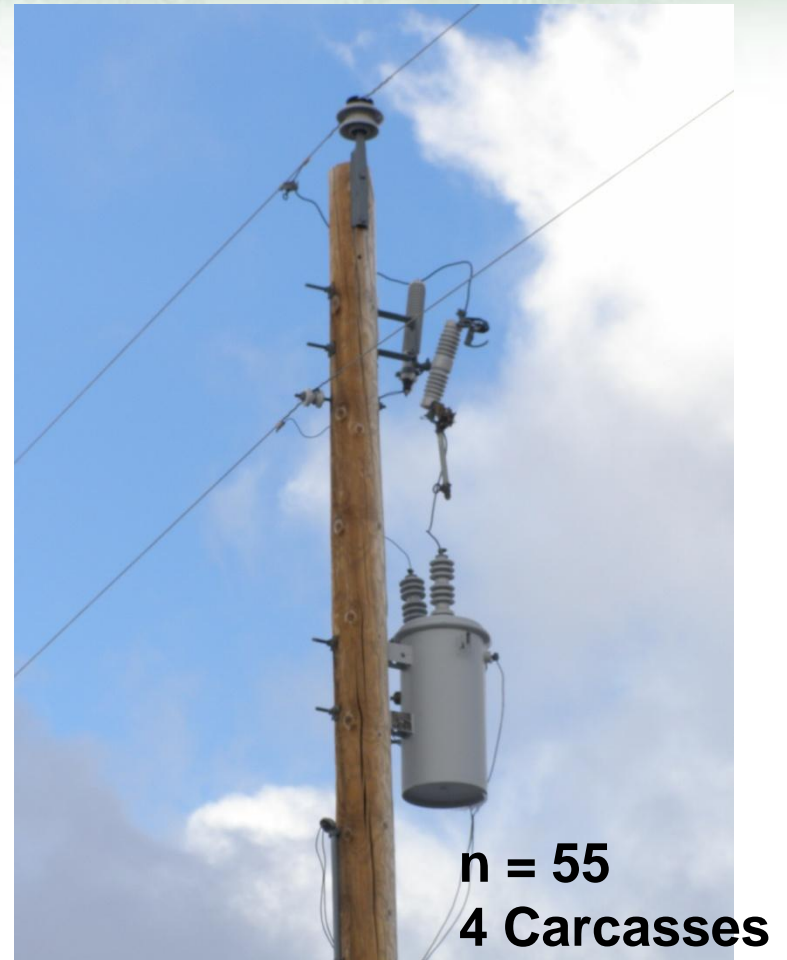


# Electrocutions

## Single Phase



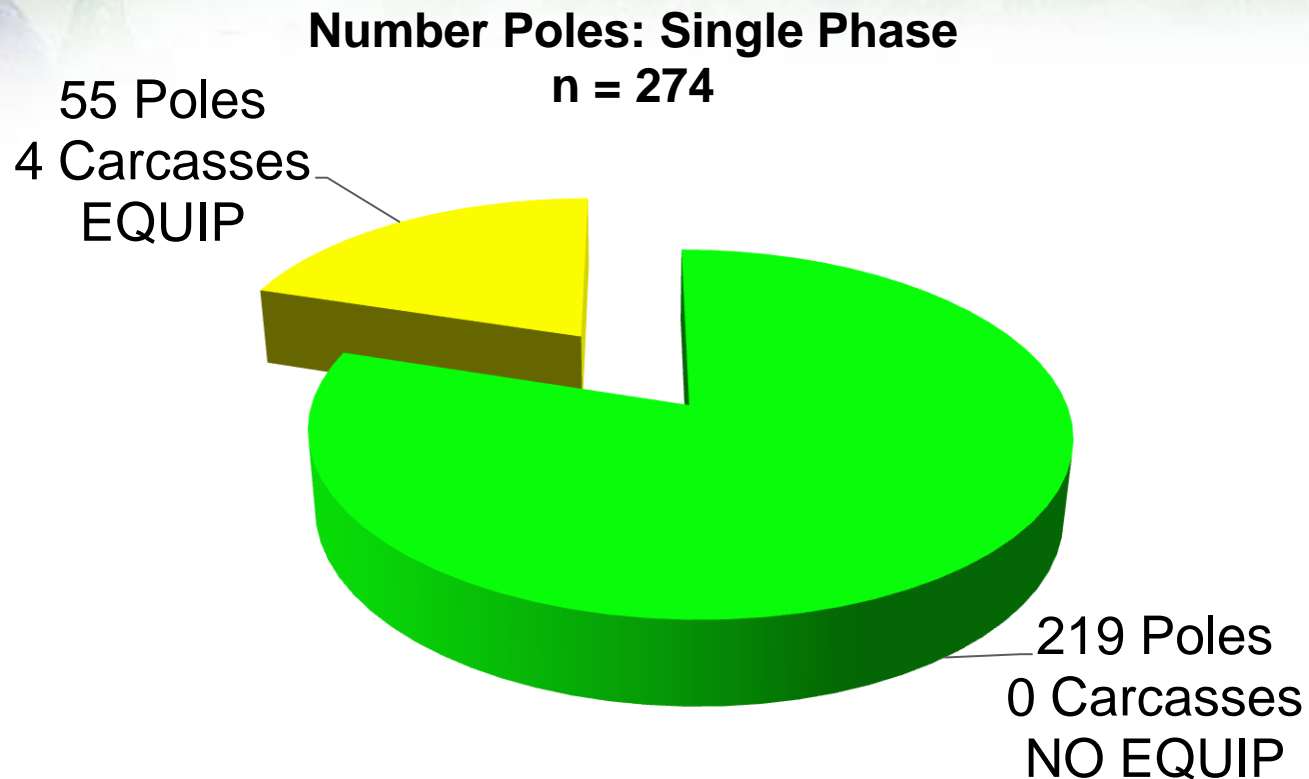
**TANGENT – NO EQUIP.**



**TANGENT – EQUIP.**

# Electrocutions

Single Phase



**Conclusion: Carcasses are more likely to be found under an equipment pole.**

Fisher Exact Probability Test: P = 0.002



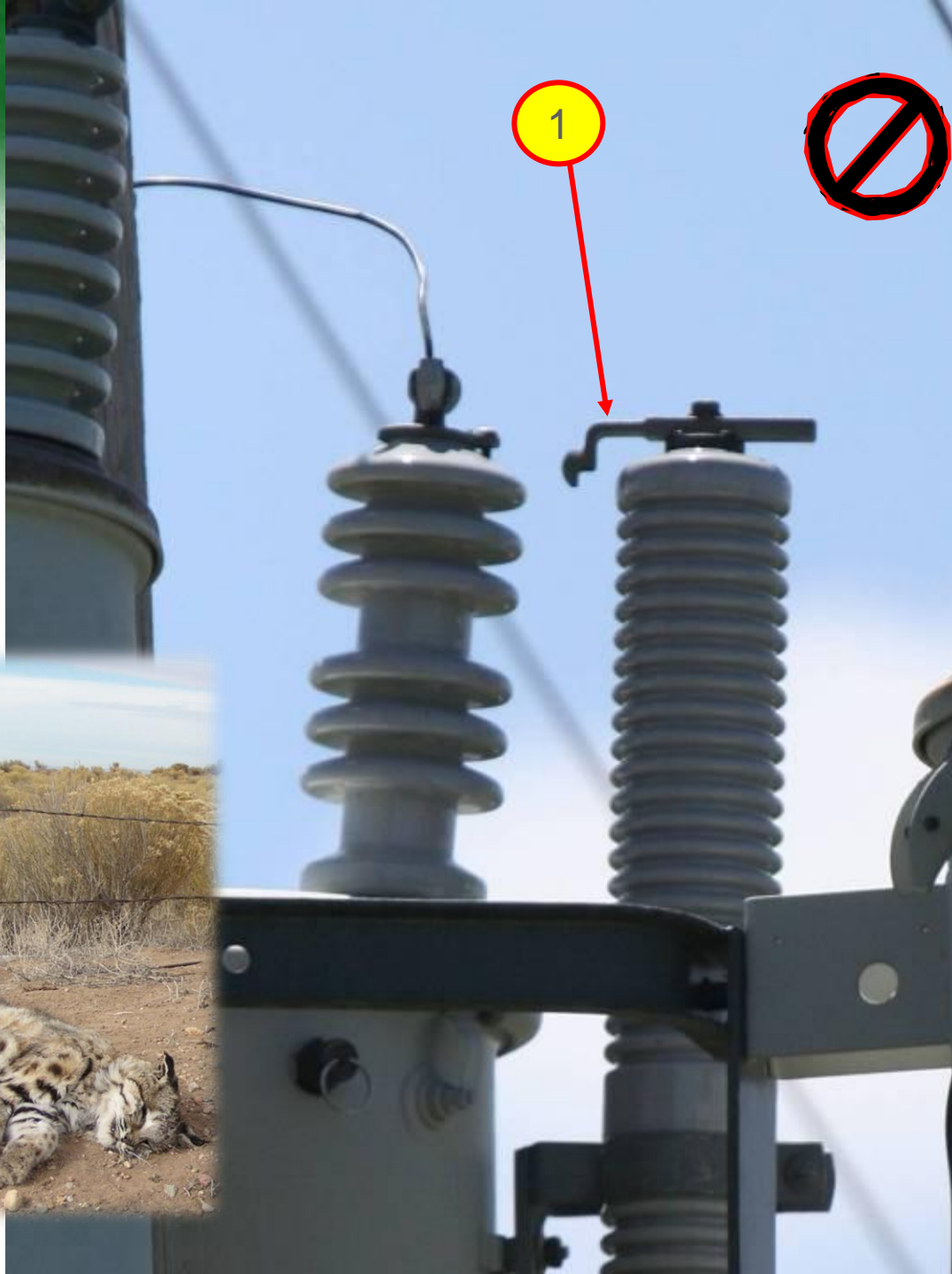


Gapped Arresters:  
Transformer Units with Gapped Arresters = 4

Carcasses Under 3 of 4 Units  
GHOW/Hawk/Bobcat

Mitigation:

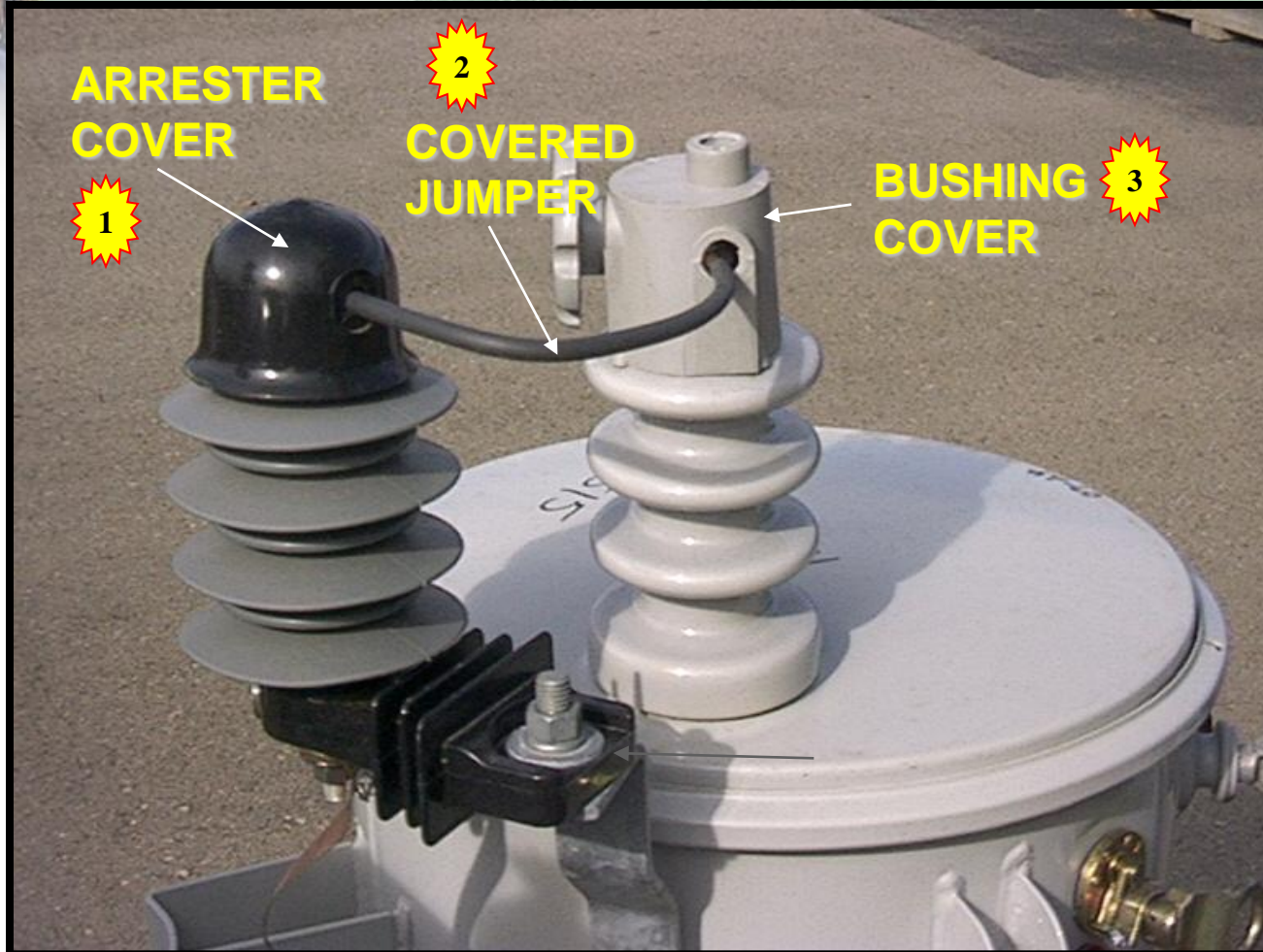
Eliminate all gapped arresters.  
These should always be replaced  
with non-gapped units.





# Mitigating Measures

## Single Phase Problems





**Electrocution**

**Three Phase**



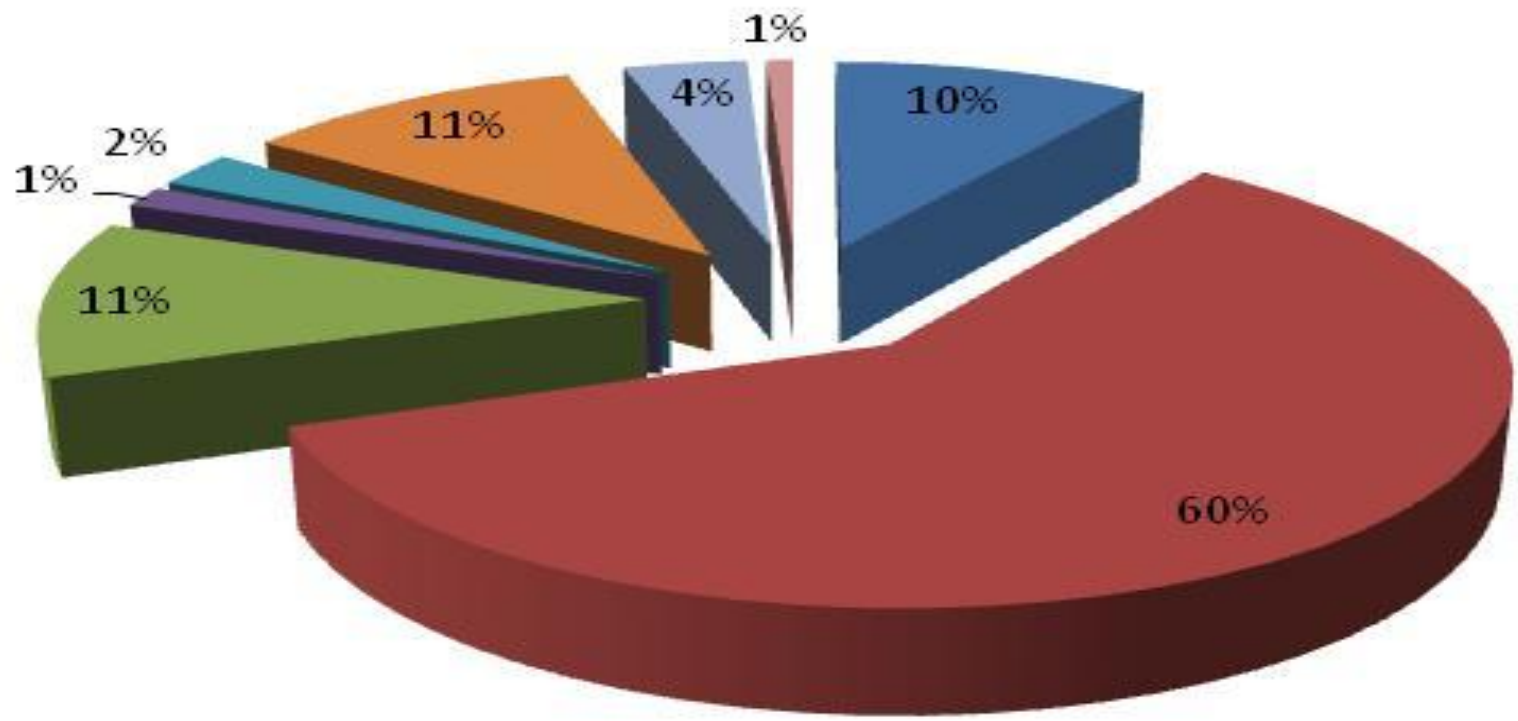
# **RESULTS**

**Three Phase**

**1581 Poles (83%)**

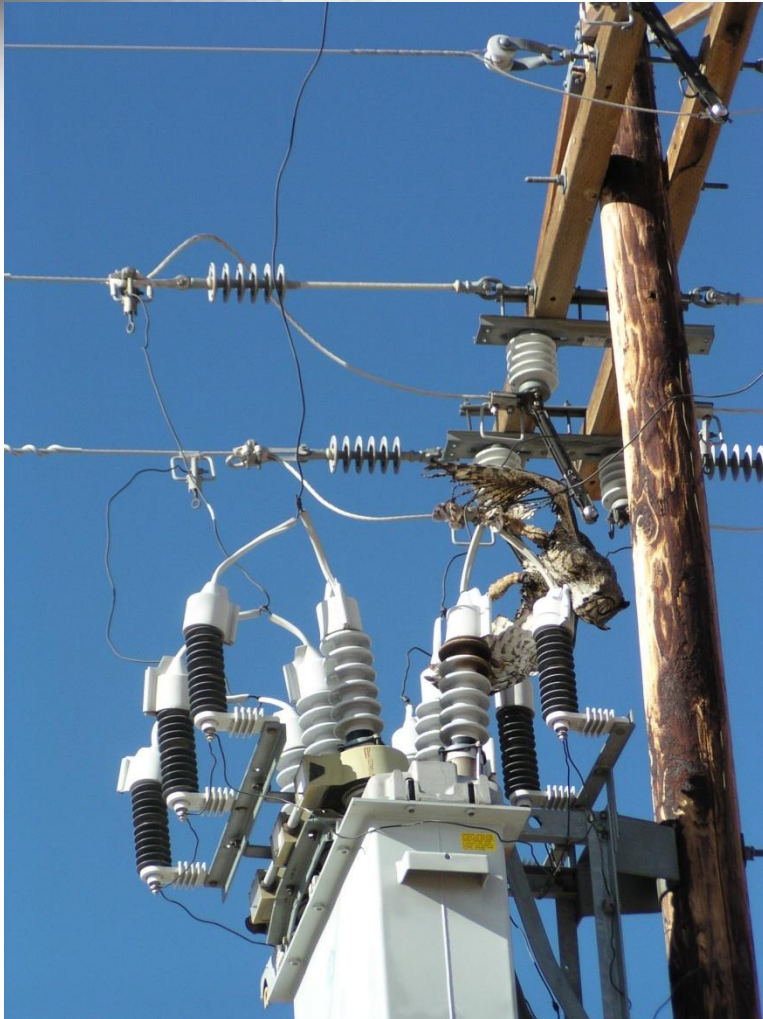
**27 Carcasses**

- Tangent - Delta
- Tangent - Flat
- Tap Pole - Tangent w/ Tap
- Intersection 4-WAY
- Intersection 90 Turn
- Deadend
- Double Deadend
- Vertical





# Equipment



Transformers  
Reclosers/Capacitors/Regulators  
Cutouts/Switches  
Surge Arresters  
Grounded Metal Brackets



Three Phase				
Type:			No Carcasses	
Tangent - Delta	Equipment		1	
Tangent - Delta			0	
Tangent - Flat	Equipment		3	
Tangent - Flat			9	
Tap Pole - Tangent w/ Tap	Equipment		0	
Tap Pole - Tangent w/ Tap			3	
Intersection 4-WAY	Equipment		2	
Intersection 4-WAY			2	
Intersection 90 Turn	Equipment		4	
Intersection 90 Turn			0	
Deadend	Equipment		2	
Deadend			0	
Double Deadend	Equipment		1	
Double Deadend			0	
Vertical	Equipment		0	
Vertical			0	

Three Phase				
Type:		Number	No Carcasses	Detection Rate
Tangent - Delta	Equipment	7	1	14%
Tangent - Delta		147	0	0%
Tangent - Flat	Equipment	56	3	5%
Tangent - Flat		888	9	1%
Tap Pole - Tangent w/ Tap	Equipment	13	0	0%
Tap Pole - Tangent w/ Tap		165	3	2%
Intersection 4-WAY	Equipment	4	2	50%
Intersection 4-WAY		20	2	10%
Intersection 90 Turn	Equipment	10	4	40%
Intersection 90 Turn		30	0	0%
Deadend	Equipment	163	2	1%
Deadend		5	0	0%
Double Deadend	Equipment	33	1	3%
Double Deadend		27	0	0%
Vertical	Equipment	0	0	0%
Vertical		13	0	0%



# Three Phase

Type:	Number	No Carcasses	Detection Rate
-------	--------	--------------	----------------

At alpha = 0.05, the statistics say:

For all species combined on 1-phase or 3-phase structures, carcasses are more likely to be found under equipment poles.

1 → 14%

0 → 0%

3 → 5%

9 → 1%

0 → 0%

3 → 2%

2 → 50%

2 → 10%

4 → 40%

0 → 0%

2 → 1%

0 → 0%

1 → 3%

0 → 0%

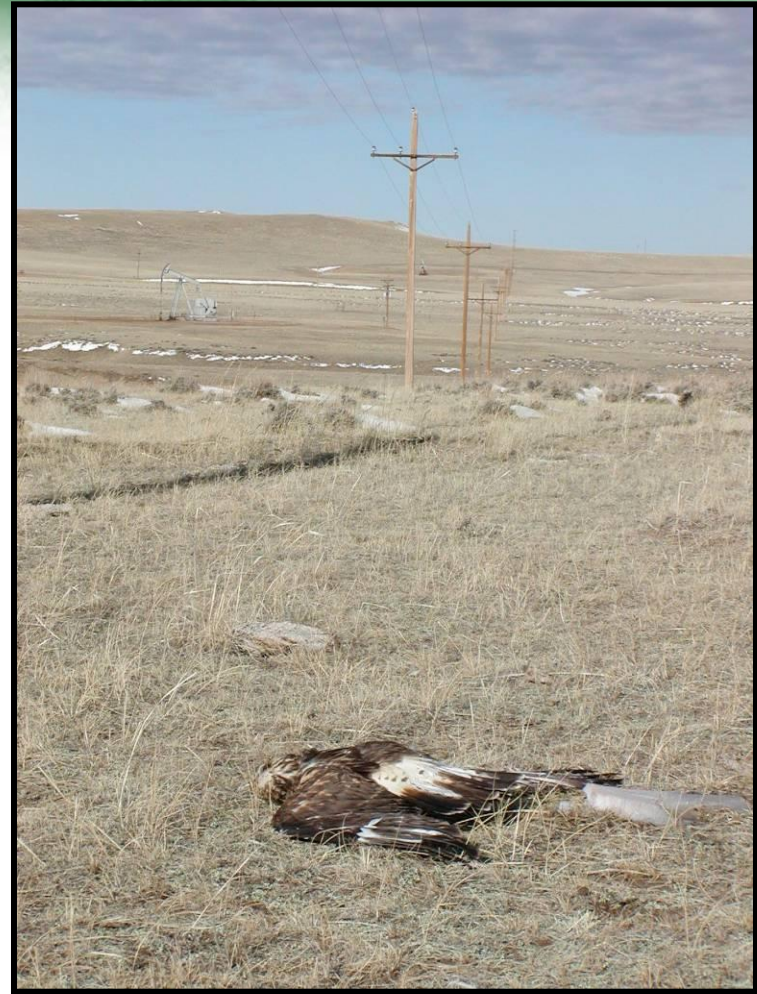
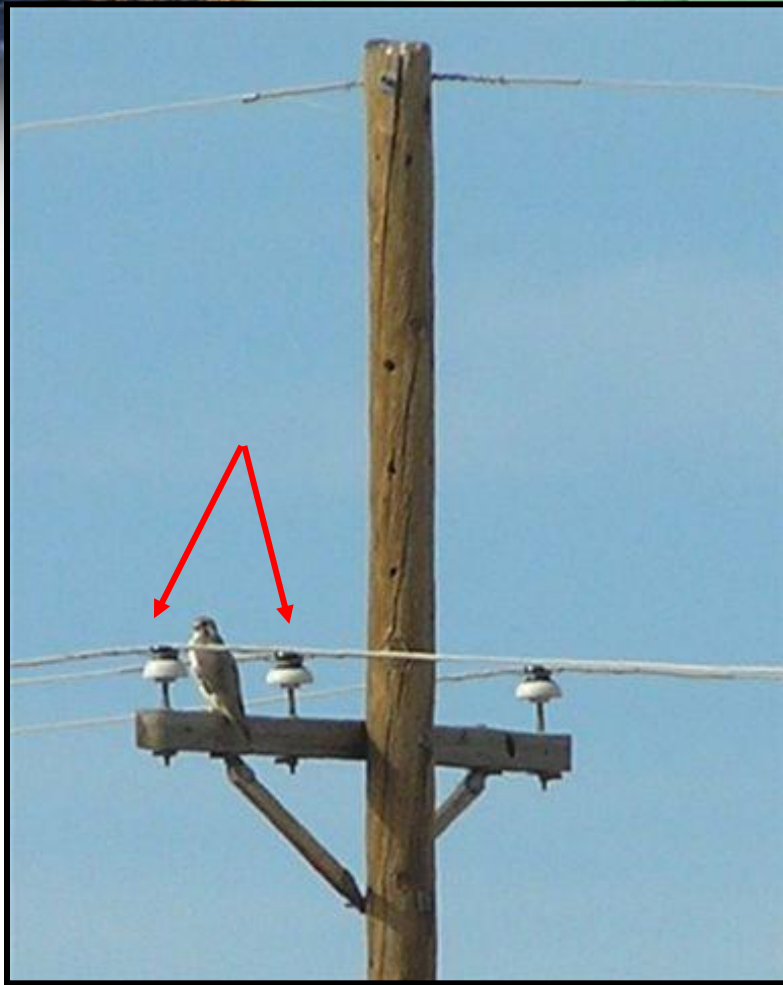
0 → 0%

0 → 0%



# Electrocutions

## Three Phase



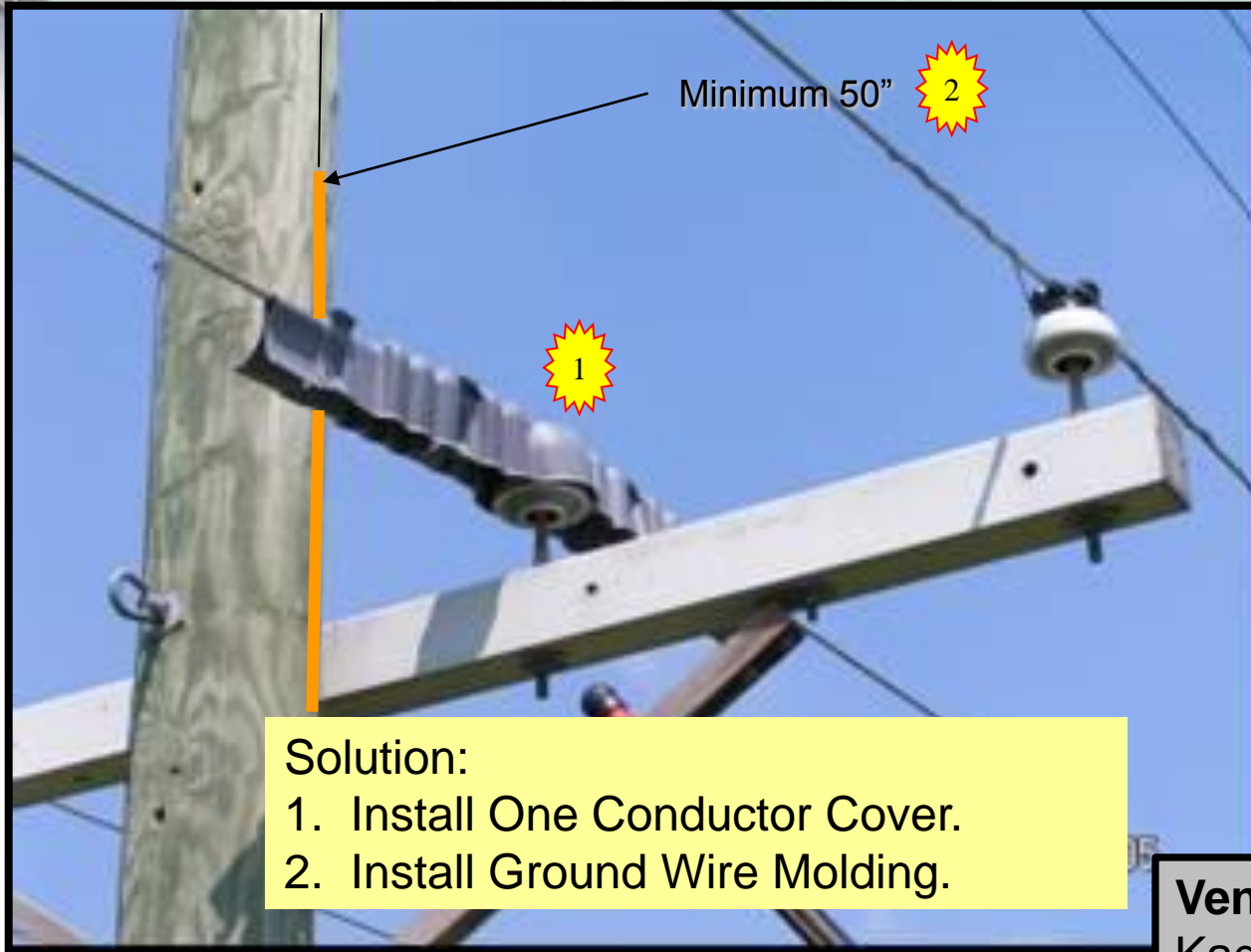
**n = 944**

Three Phase				
Type:		Number	No Carcasses	Detection Rate
Tangent - Flat	Equipment	56	3	5%
Tangent - Flat		888	9	1%



# Mitigating Measures

## Three Phase Problems



Solution:

1. Install One Conductor Cover.
2. Install Ground Wire Molding.

**Vendors:**

Kaddas  
Power Line Sentry  
Raychem

Three Phase Tangents



# Electrocutions

## Three Phase



**n = 154**

Three Phase		Number	No Carcasses	Detection Rate
Type:				
	Tangent - Delta Equipment	7	1	14%
	Tangent - Delta	147	0	0%



# Electrocutions

## Three Phase Deadend



**n = 168**

Three Phase				
Type:		Number	No Carcasses	Detection Rate
Deadend	Equipment	163	2	1%
Deadend		5	0	0%



Burn Marks



Ground

Ground

Phase





# Electrocutions

## Three Phase Double Deadend



**n = 56**

Type:		Number	No Carcasses
	Double Deadend Equipment	33	1
	Double Deadend	23	0



# Conclusions

## Raptor Protection

- Need to Understand the Configurations and Relative Occurrence
- Equipment – High Priority
- Eliminate Gapped Arresters
- Still Room For Product Improvement
- Surveys are Important to Prioritize How to Allocate Resources:  
*Three Phase Delta Tangent w/o Equipment – Low Priority*





## Acknowledgements

- ❖ US Fish and Wildlife Service
- ❖ Duncan Eccleston and James Dwyer
- ❖ Kaddas
- ❖ Raychem/TYCO
- ❖ Power Line Sentry

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