Avian-Friendly Design & Planning

IMPACTS PREVENTION FOR HIGH PERFORMING ENERGY PROJECTS

Washington Area Branch
Int'l Assoc. for Impact Assessment
Washington, DC
September 19, 2019

IAIA
International Association for Impact Assessment

Rick Harness & Duncan Eccleston
EDM International, Inc.
Fort Collins, Colorado, USA
rharness@edmlink.com, deccleston@edmlink.com
970-204-4001

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Avian-Power Line Interactions

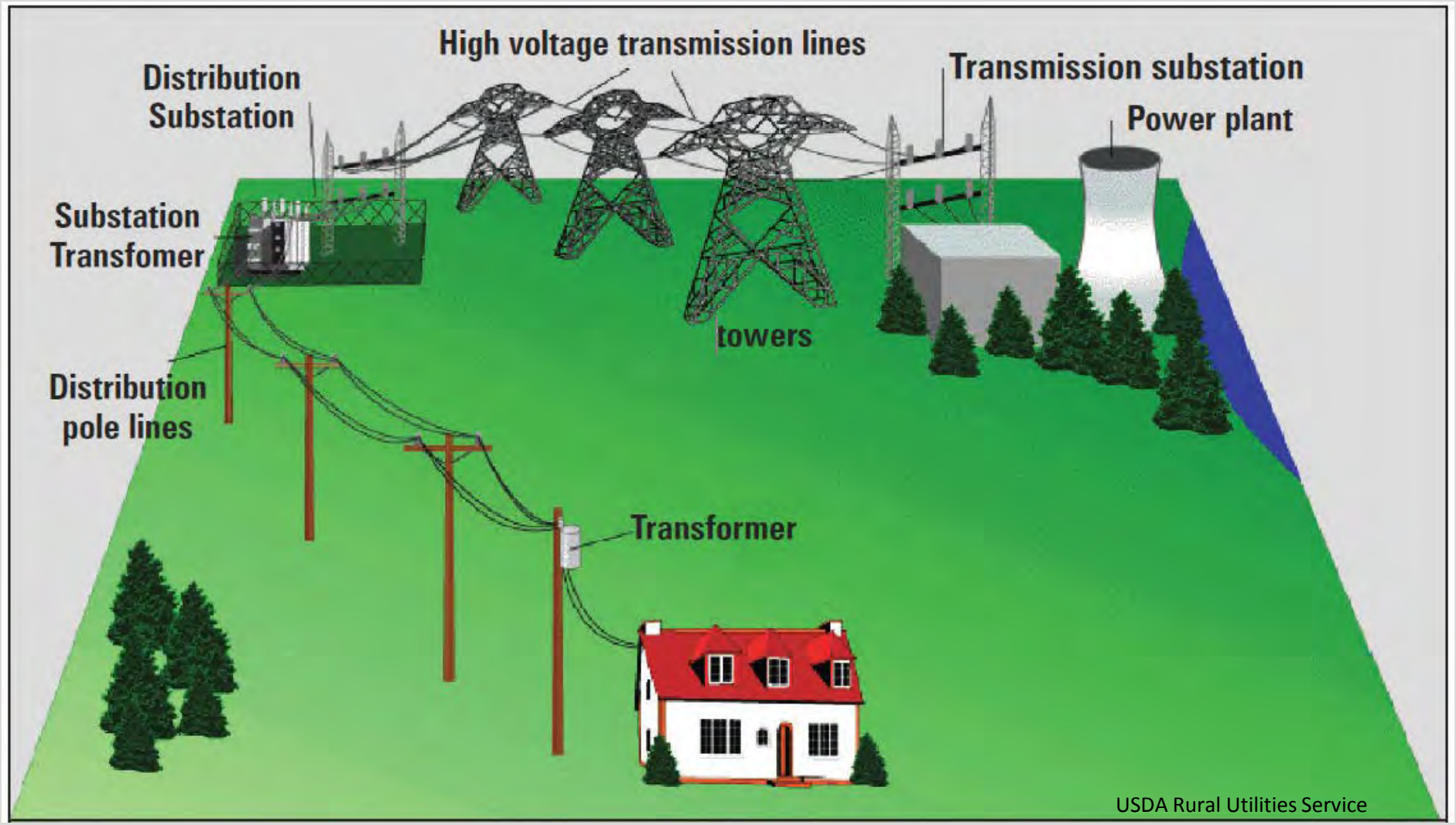
- Operational conflicts:
  - Electrocution/reliability
  - Collision/public relations
  - Nesting/fire, access, outages
  - Feces/reliability
  - Woodpeckers/damage
- Risk assessment, management & mitigation
- Peer-reviewed research
- U.S. Regulations and International Best Practice

1 INTRODUCTION AND OUTLINE

Power-Prosperity Spiral

Electricity 101

GRID COMPONENTS



Trend: Renewables Development

- 4.1 GW new capacity by 2030 in developing countries (Pew 2015)
- ~2/3 renewables
- $5T investment in developing world
- Wind, solar ~600% increase worldwide, 2012-2030

https://www.youtube.com/watch?v=8NAAzBArYdw

Trend: Increased Transmission

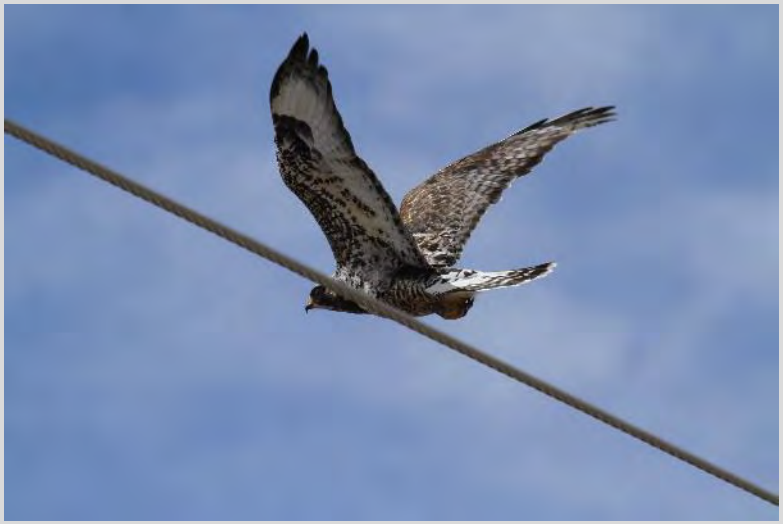
- Large scale renewables far from markets
- Greater transmission need
- More and longer transmission lines crossing sensitive habitats
- Growth of market (Pwr. Tech. 2013)
  - $32.1B (2014)
  - $37.6B (2020)
  - $78.1B (2025)

Trend: Rural Electrification

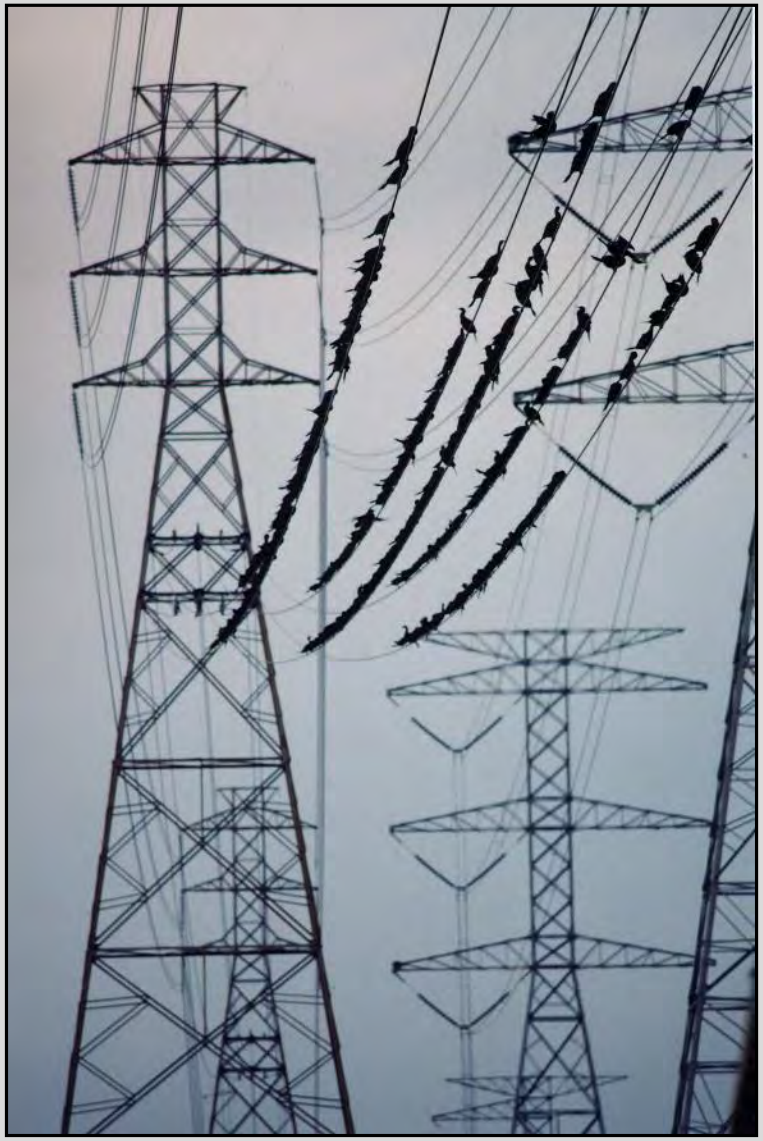
- Democratized access to power brings opportunity to new areas
- Generated locally or transported from a distance
- Distribution grid expands into high value wildlife habitat
- Kenya: connected 15M ppl to grid, 2010-2017 (Woflram 2017)

Avian-Grid Interactions

- Electrocution
- Collision
- Feces
- Nesting

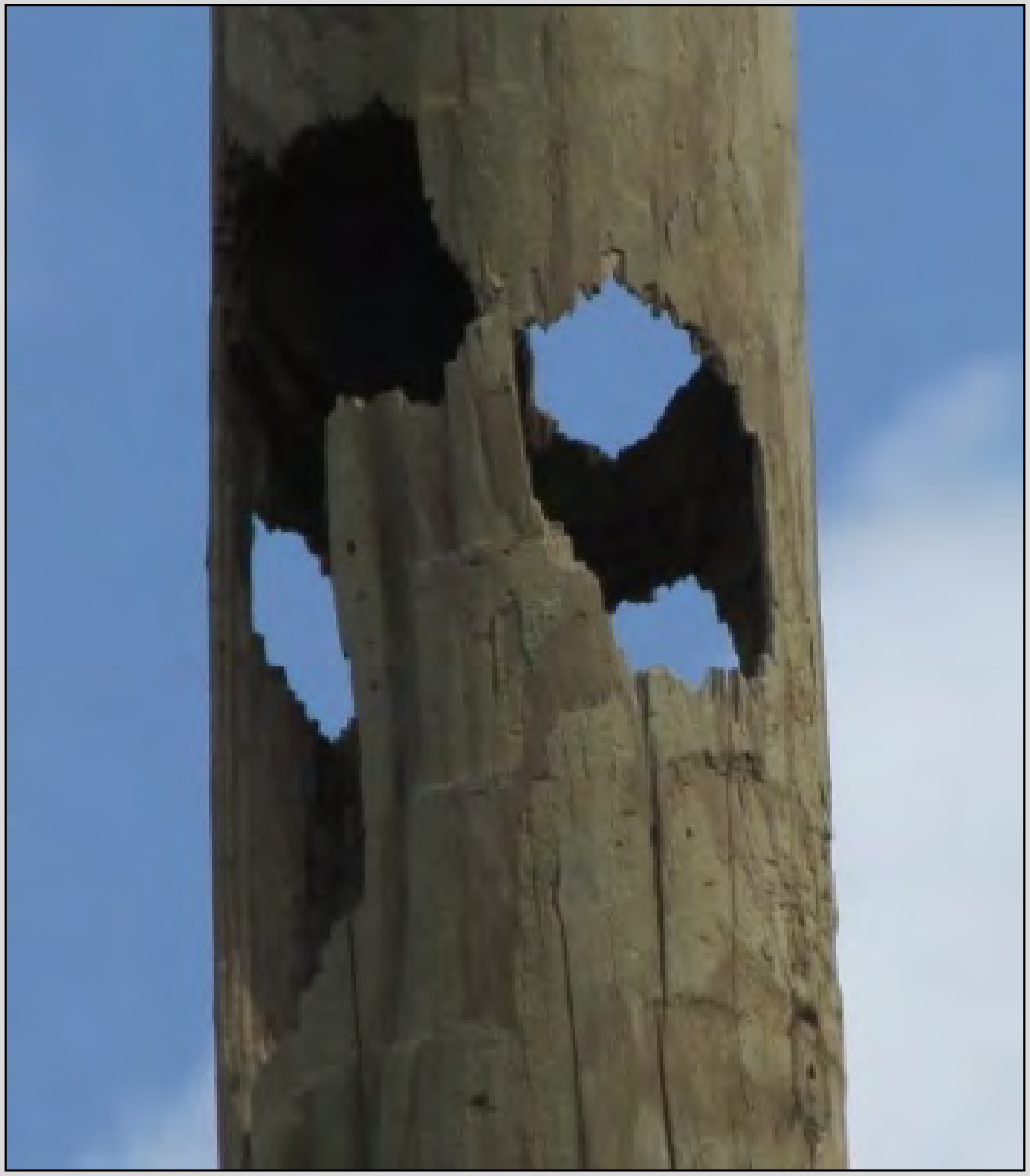


Interactions: Habitat Loss and Fragmentation



Interactions: Entanglement

Interactions: Pole Damage



Interactions: Chewing


Gray Squirrel Damage – Tennessee USA


Cockatoo Damage - Australia
Photo: Australia ESB Electric

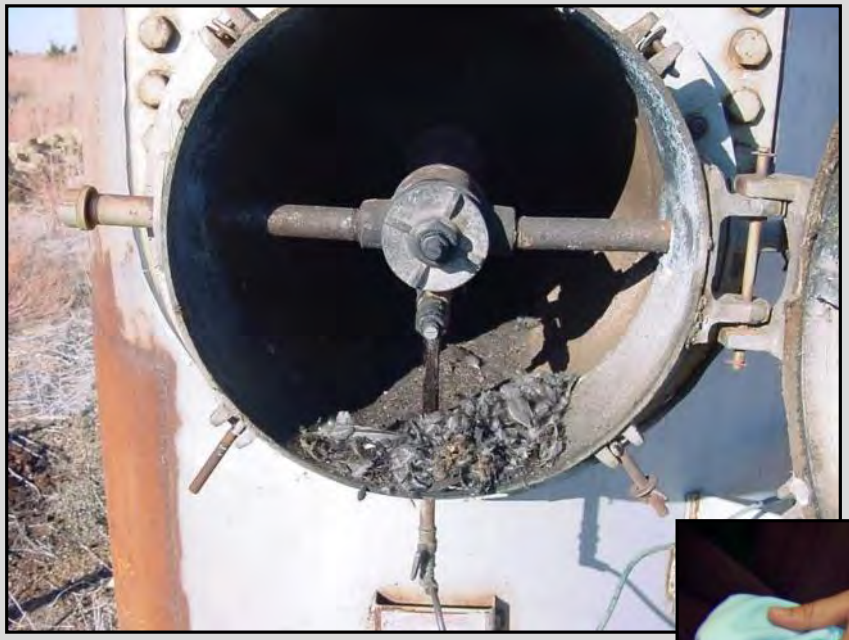
Photo: Australia ESB Electric

Issues: Chewing
Scope: Localized and seasonal
Solutions: Variable depending on species

Interactions: Wildfire Ignition

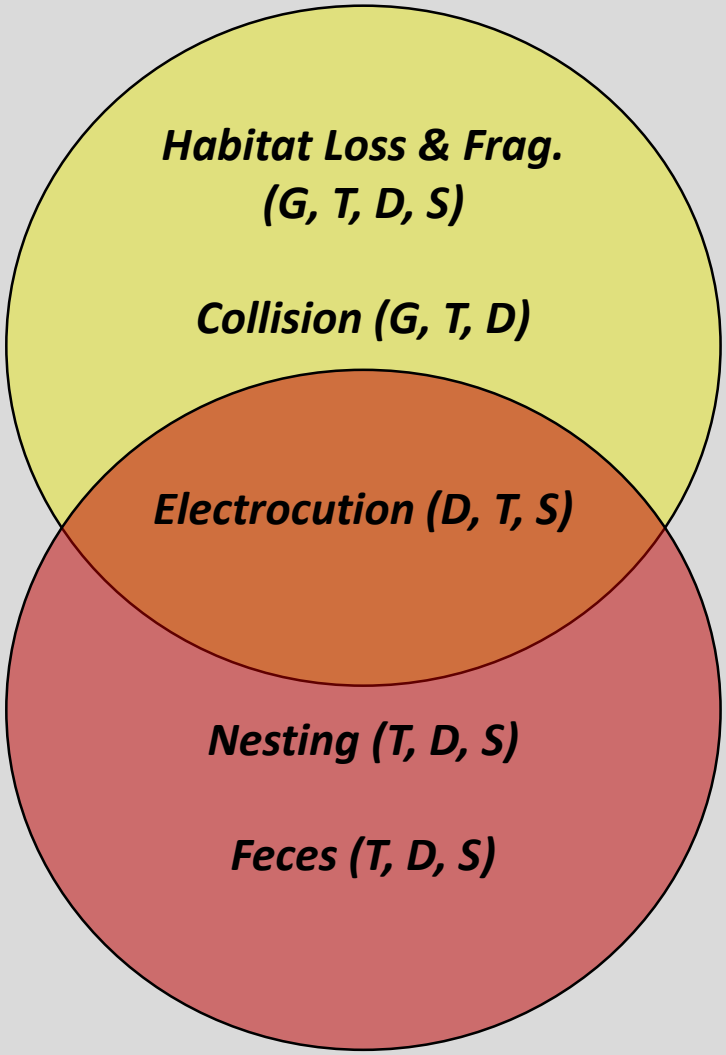
Interactions: Subsidized Predation

Interactions: Vents, Stacks, Flares



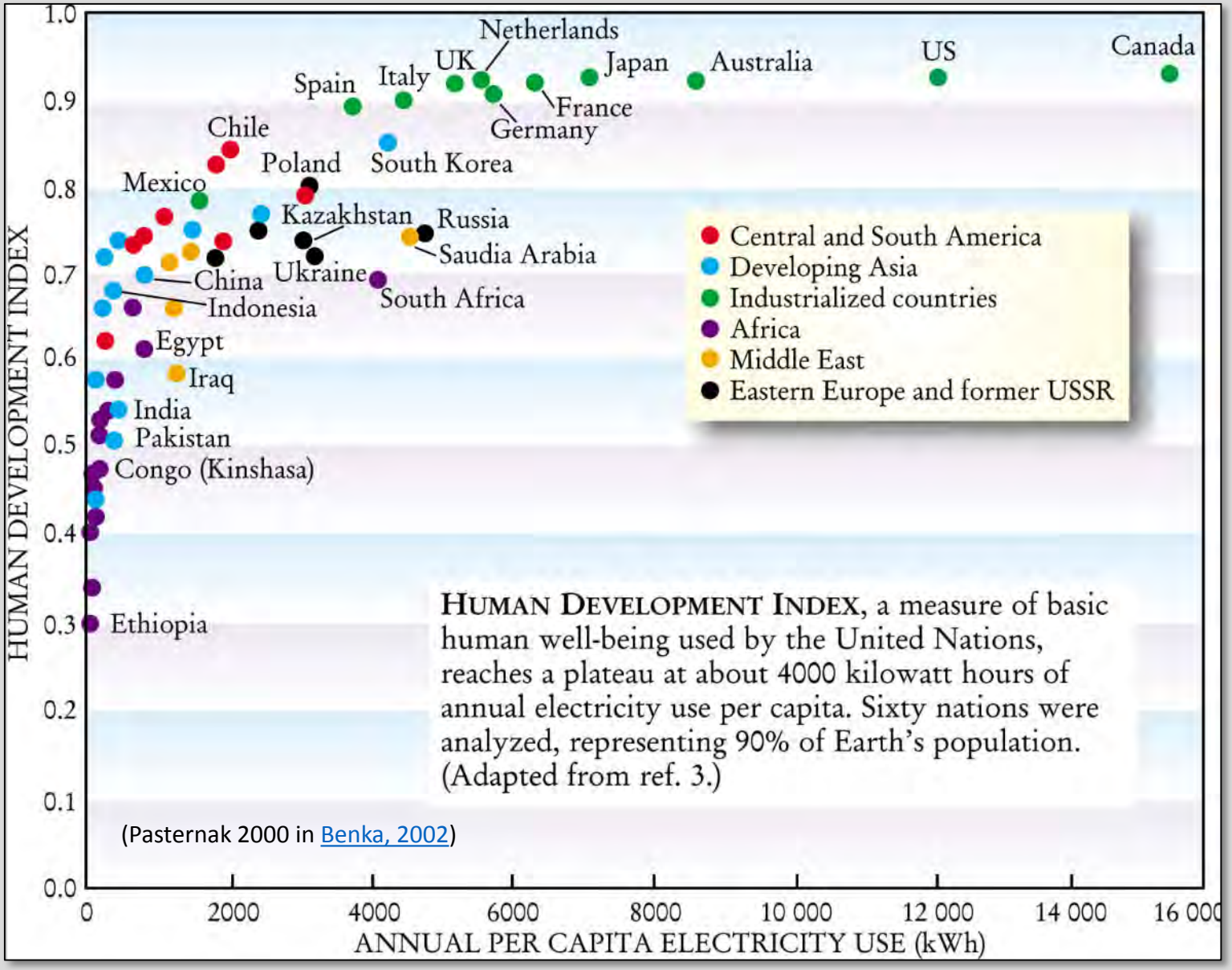
Interactions: Toxic Ponds

Avian-Grid Context



SUSCEPTIBILITY:
Generation (G)
Transmission (T)
Distribution (D)
Substations (S)

Power-Prosperity Correlation



(Pasternak 2000 in Benka, 2002)

Presentation Goals

AVIAN-FRIENDLY, HIGH PERFORMING SYSTEMS

- Awareness of avian-power line interactions
- Understanding of impacts for birds and electrical systems
- Prevention through planning and design
- Mitigation strategies
- Resources for better projects
- Case studies

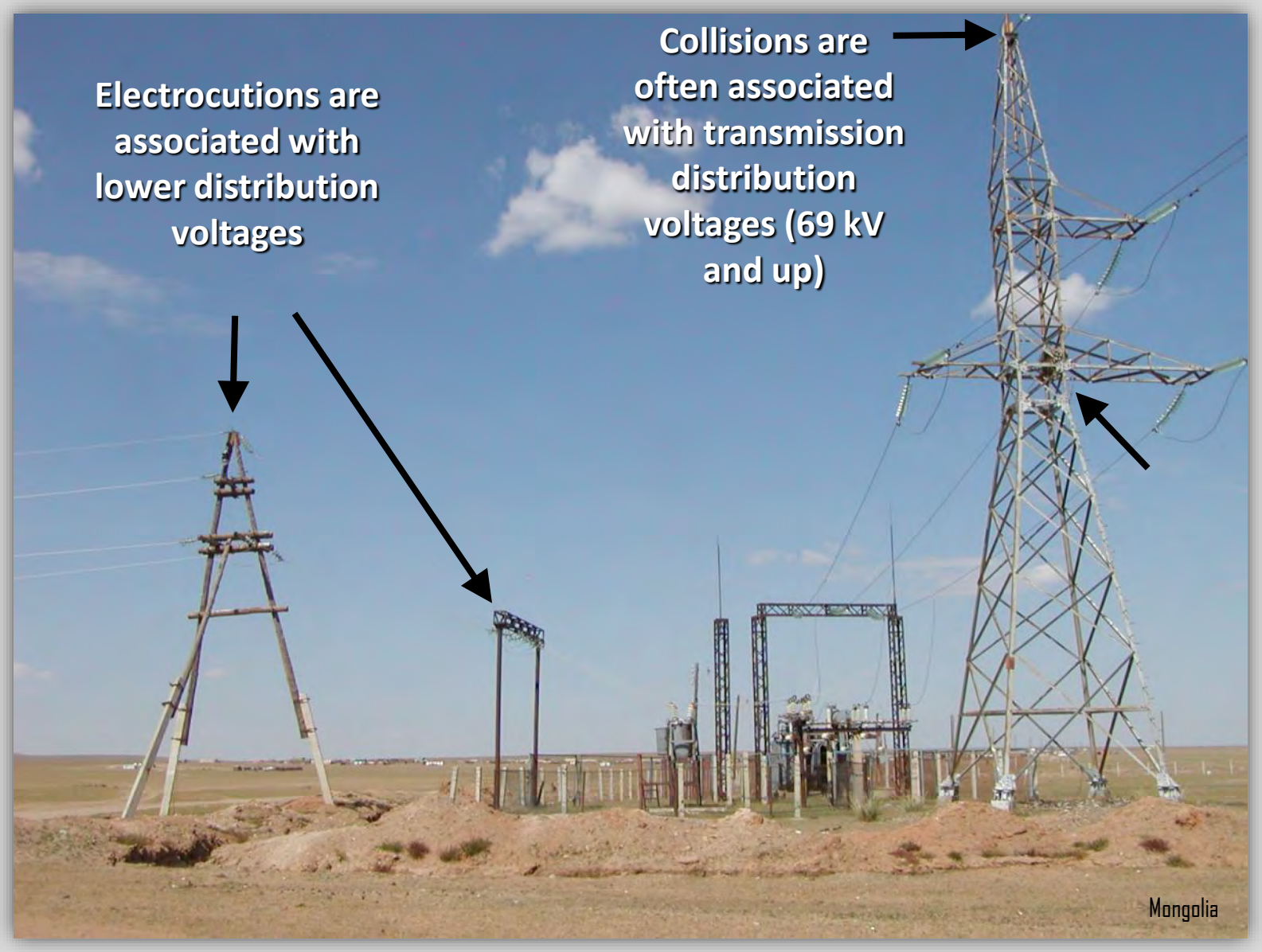
Outline

- Wildlife Electrocution
- Avian Collision
- Avian Feces
- Avian Nesting
- Prevention in Planning
- Additional Resources

2 WILDLIFE ELECTROCUTION

Mechanism

ANIMAL AS ENERGY PATHWAY – Electricity 101

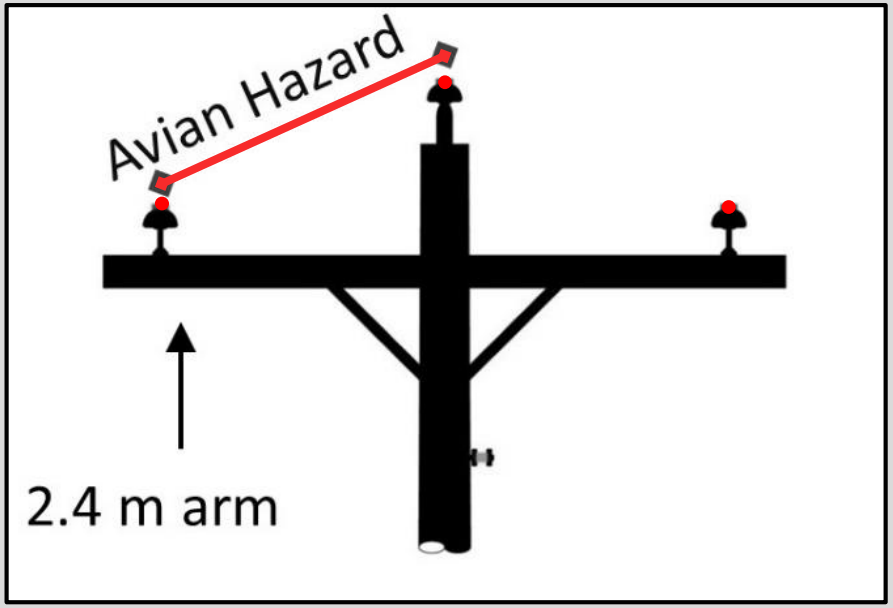


Distribution – Substation - Transmission

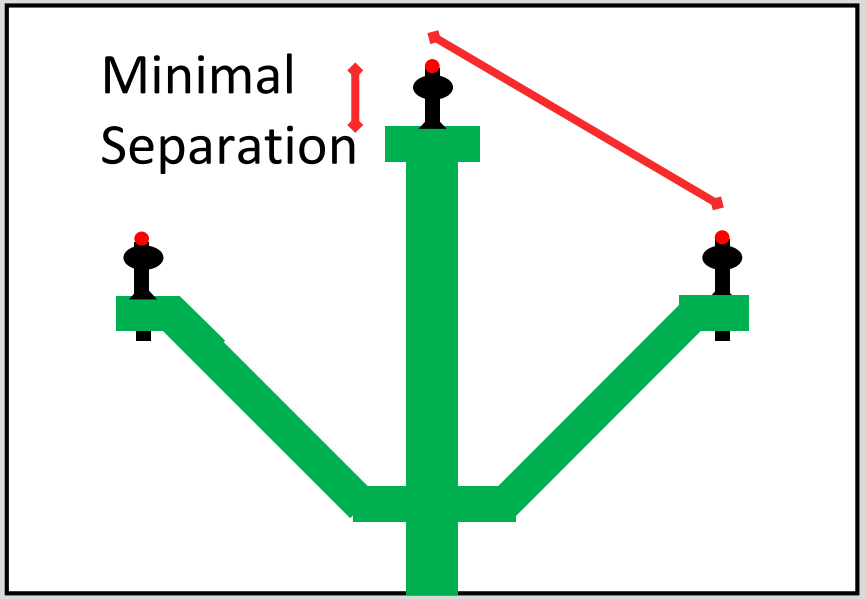
Different Challenges, Worldwide

WOOD VS. CONCRETE/STEEL

Wood Pole & Arm



Grounded Pole & Arm



(Eccleston and Harness 2018)

Wood Structure

Your House = 120 V
Versus 7,200 V

Primary Wire - B

Primary Wire - C

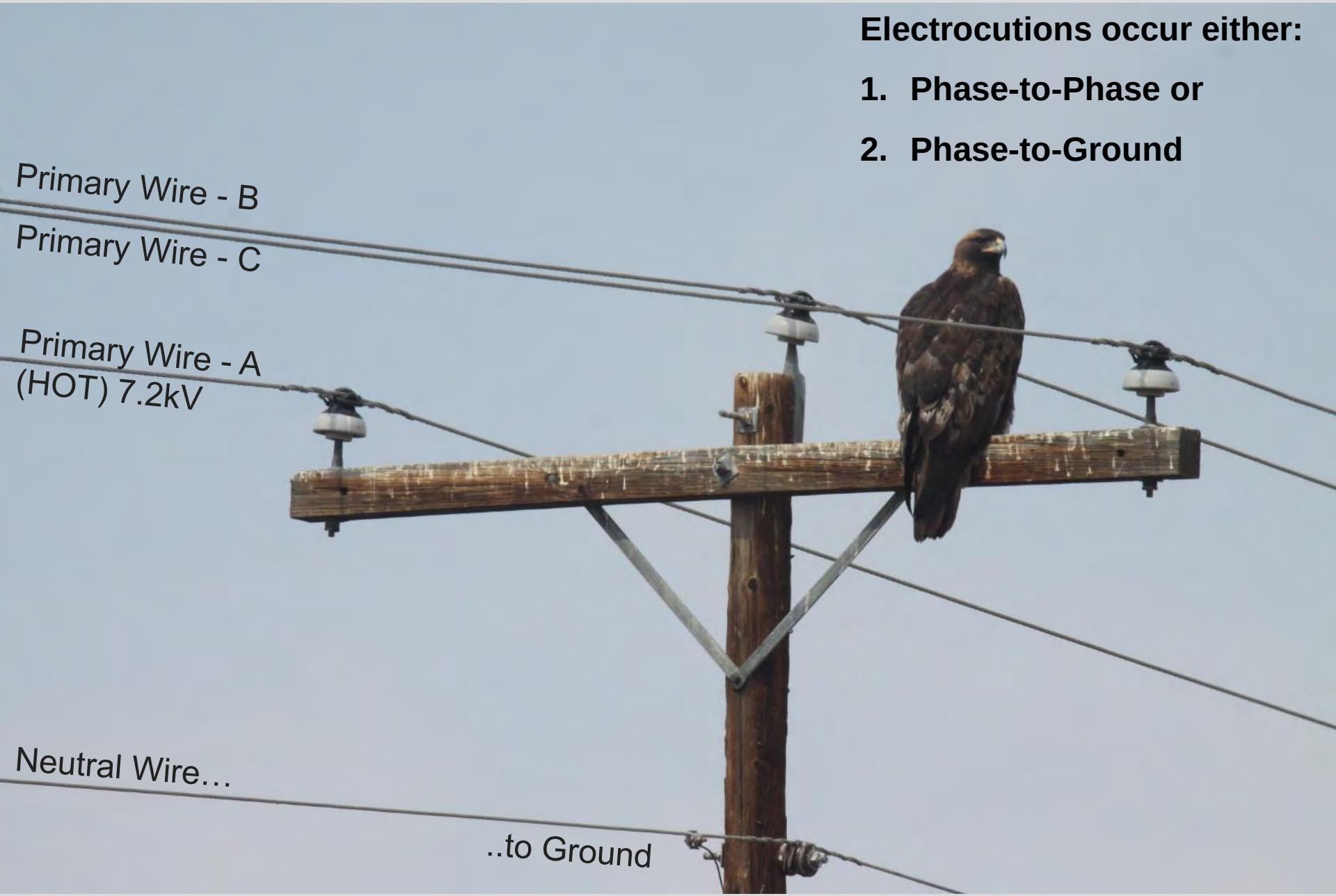
Primary Wire - A
(HOT) 7.2kV

Neutral Wire…

..to Ground

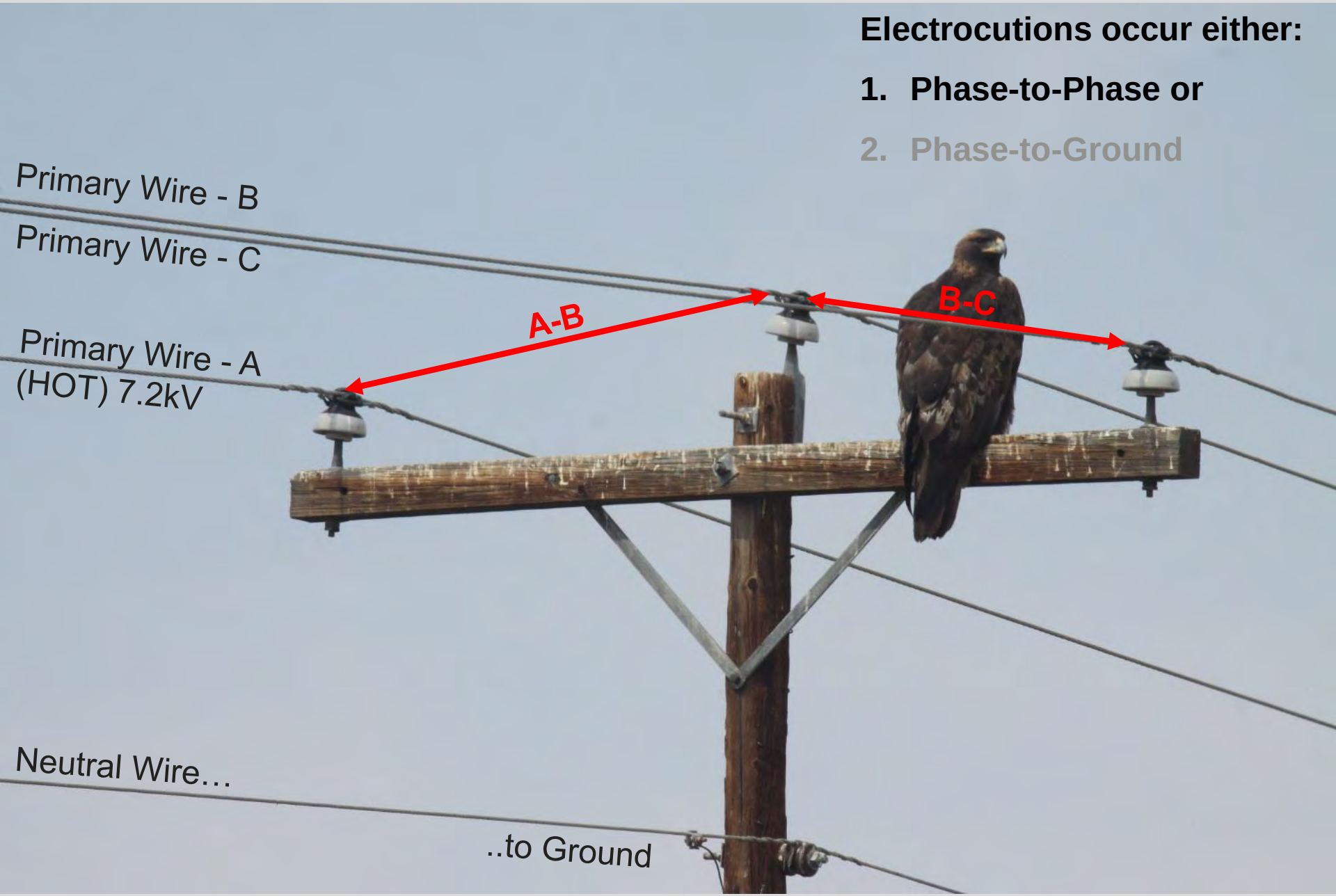
12 kV Configuration.
Using Wood Poles

Golden Eagle – Wyoming USA


Electrocutions occur either:
1. Phase-to-Phase or
2. Phase-to-Ground
Primary Wire - B
Primary Wire - C
Primary Wire - A
(HOT) 7.2kV
Neutral Wire…
..to Ground

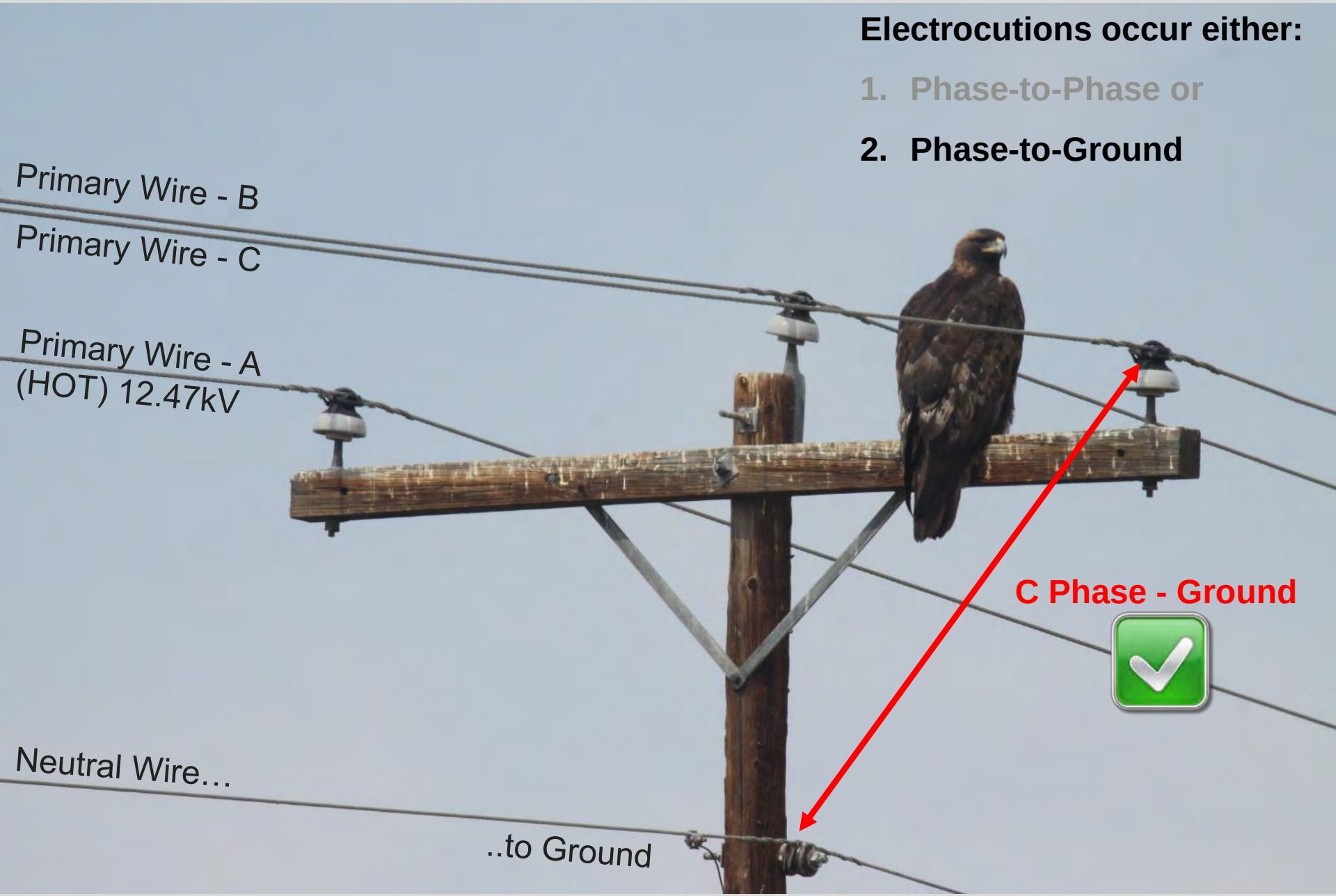
Electrocutions occur either:

1. **Phase-to-Phase or**
2. **Phase-to-Ground**



Electrocutions occur either:

1. Phase-to-Phase or
2. **Phase-to-Ground**



Concrete and Steel

220 V

Primary
Wire - B

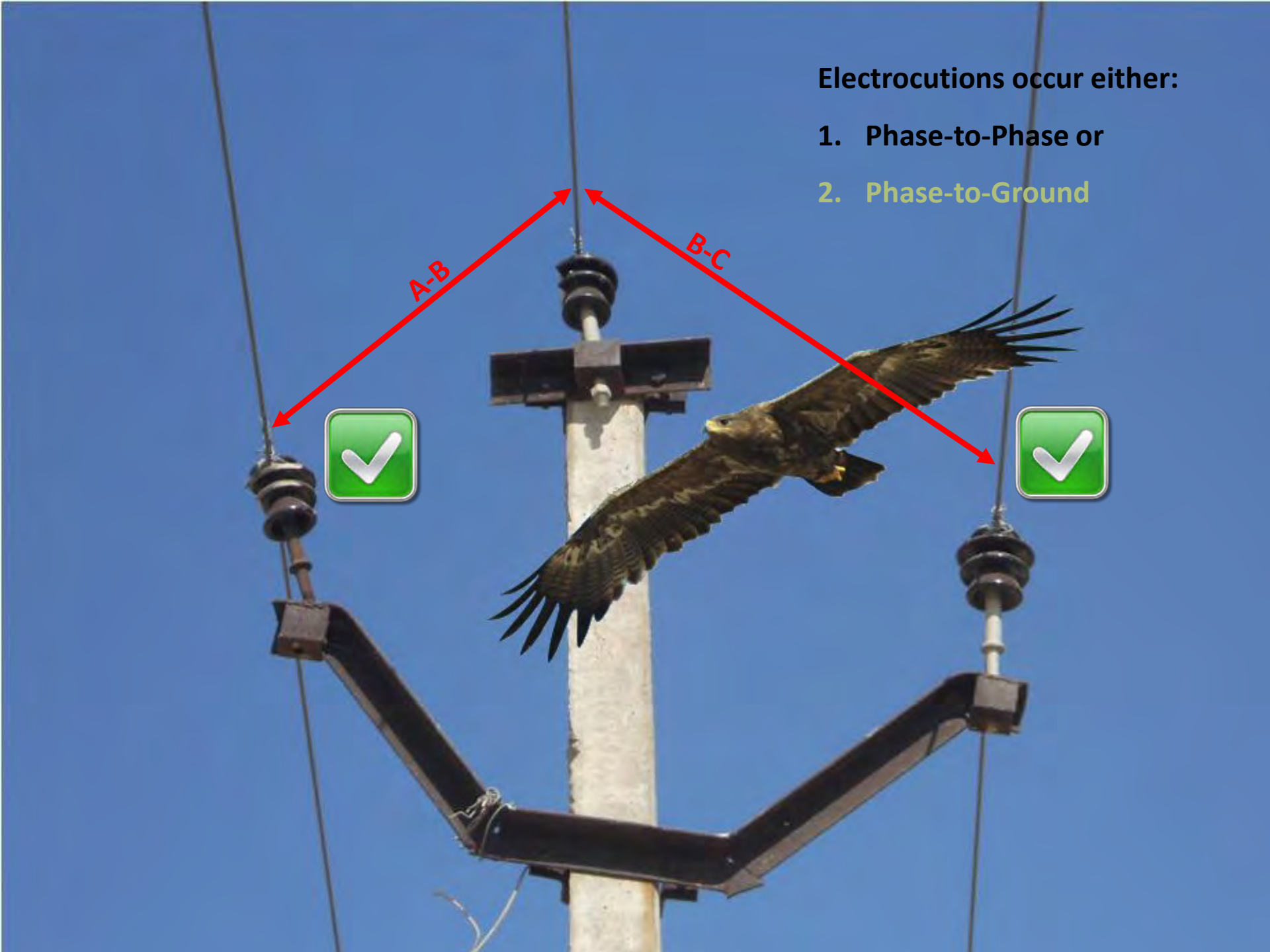
Ground

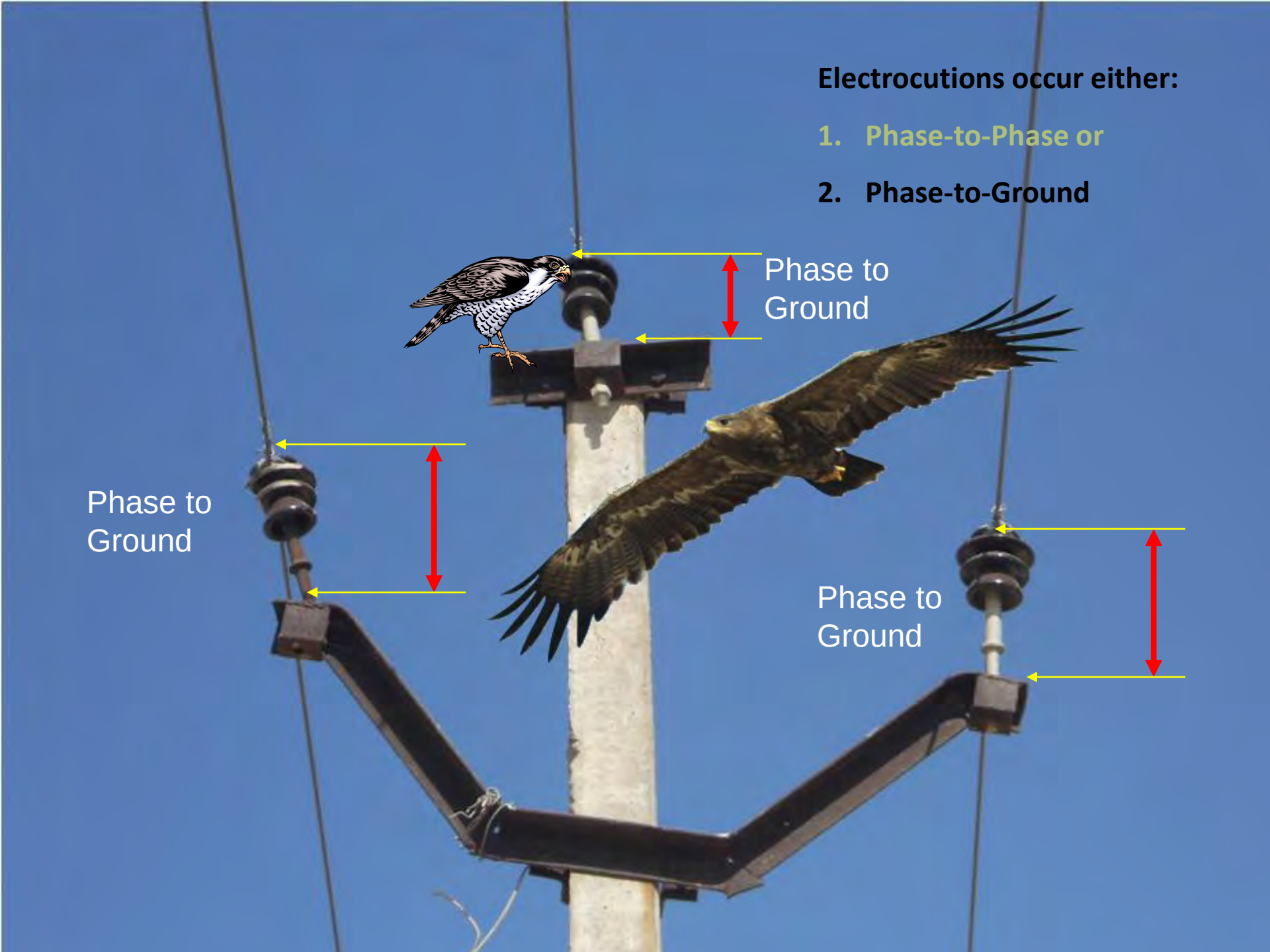
Ground

Primary Wire - A
(HOT) 11 kV

Primary Wire - C

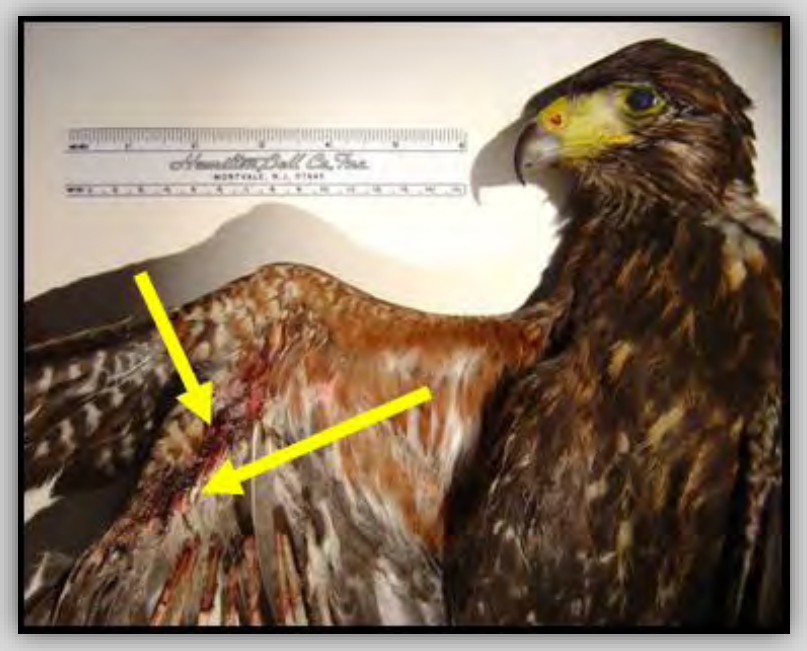
Steppe Eagle - India

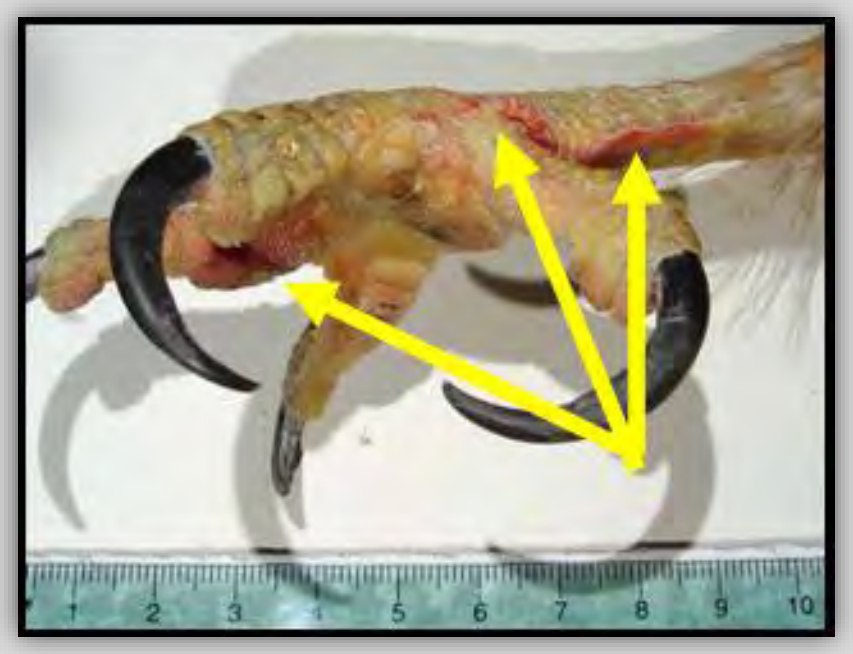

Electrocutions occur either:
1. Phase-to-Phase or
2. Phase-to-Ground
A-B
B-C


Electrocutions occur either:
1. Phase-to-Phase or
2. Phase-to-Ground
Phase to Ground
Phase to Ground
Phase to Ground


Electrocutions occur either:
1. Phase-to-Phase or
2. Phase-to-Ground

Diagnosing Electrocutions





When a bird either contacts two differentially energized wires (Phases), or touches one energized wire and a ground, there is typically an entrance wound and an exit wound following the path of electricity through the body.

https://www.youtube.com/watch?v=ql7JNlqn6GE

Scope:

Loss et al. (2014) estimate between 0.9 and 11.6 million birds killed by electrocution at U.S. power lines.

Electrocutions impact declining species.


Kestrels - Mongolia


Saker Falcon - Mongolia

Global Population Impacts (Raptors)

Common Name	Scientific Name	Electrocution	IUCN Status	Continent
Martial Eagle	*Polemaetus bellicosus*	Yes	Near Threatened	Africa
Cape Vulture	*Gyps coprotheres*	Yes	Vulnerable	Africa
White-backed Vulture	*Gyps africanus*	Yes	Endangered	Africa
Egyptian Vulture	*Neophron percnopterus*	Yes	Endangered	Africa
Lappet-faced Vulture	*Torgos tracheliotos*	Yes	Vulnerable	Africa
Blakiston's Fish-Owl	*Ketupa blakistoni*	Yes	Endangered	Asia
Eastern Imperial Eagle	*Aquila heliaca*	Yes	Vulnerable	Asia (primarily)
Saker Falcon	*Falco cherrug*	Yes	Endangered	Asia (primarily)
Spanish Imperial Eagle	*Aquila adalberti*	Yes	Vulnerable	Europe
Red Kite	*Milvus*	Yes	Near Threatened	Europe (primarily)
Orange-breasted Falcon	*Falco deiroleucus*	Yes	Near Threatened	South America

BirdLife International 2012. Species reports. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 19 September 2013. Search strategy: keywords = buzzard, condor, eagle, falcon, harrier, hawk, kite, lammergeier, osprey, owl, and vulture. Excluded species of least concern and data deficient species. Searched each remaining species page for the word “power” as in power line collision or power line electrocution.

Global Concern

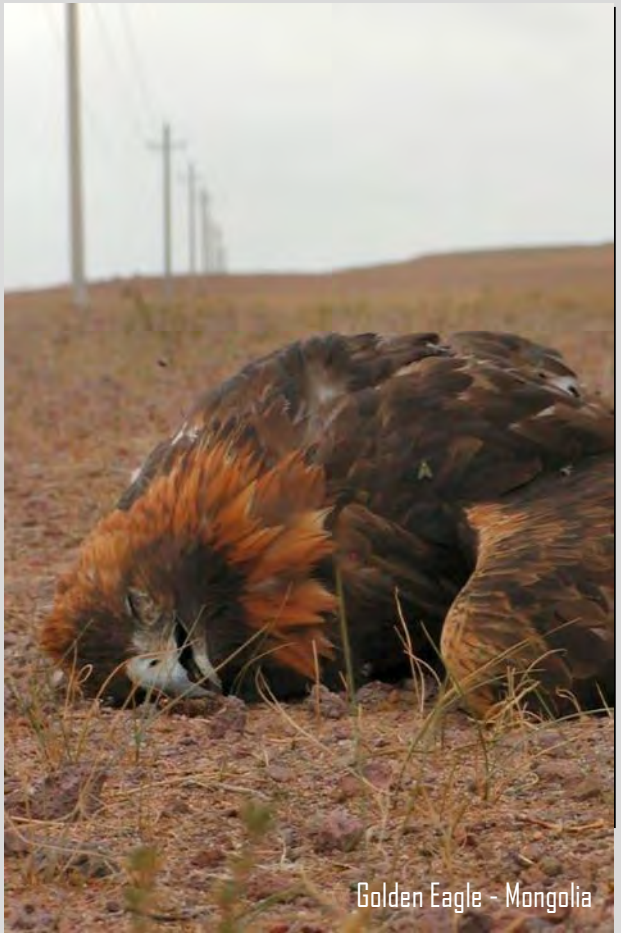
Despite 45+ years of work…Golden eagle (*Aquila chrysaetos*) electrocution on power poles is a global conservation problem with an estimated 504 eagles electrocuted annually in North America (USFWS).

Country	Citations
Bulgaria	Stoychev and Karafeisov 2003
France	Bayle 1999, Schürenberg et al. 2010
Germany	Bayle 1999
Hungary	Demeter 2004, Horvath et al. 2008
Kazakhstan	Karyakin and Barabashin 2005, Lasch et al. 2010
Mongolia	Harness et al. 2008, Amartuvshin and Gombobaatar 2012, Dixon et al. 2013, Gombobaatar et al. 2013
Morocco	Amezian et al. 2015
Portugal	Infante et al. 2005
Spain	Bayle 1999, Guzmán and Castaño 1998, Janss 2000, Perez-Garcia 2010 , Guil et al. 2011
Sweden	Schürenberg et al. 2010

Even New Lines are Problematic:

1 Bird Carcass every 7 poles – Mongolia (Harness and Gombobaatar 2008)

1 Bird Carcass every 3 poles – India (Harness et al. 2013)



Wildfire

Wildfire

Photo: John Ledger

88 kV Kite Structure Outages – South Africa

Equipment Damage

Video: https://www.youtube.com/watch?v=u_byIq6hlKI

Image: Southern Company

Marketplace AFRICA

Monkey causes nationwide blackout in Kenya

By Tiffany Ap and Lonzo Cook, CNN
Updated 12:27 AM ET, Wed June 8, 2016

KenGen posted a photograph of what appears to be a vervet monkey crouching on top of electrical equipment.

Story highlights

NEW: "This is the first such disruption we've had by a monkey," utility says

The monkey survived and was taken in by wildlife authorities

(CNN) — Talk about monkey business.

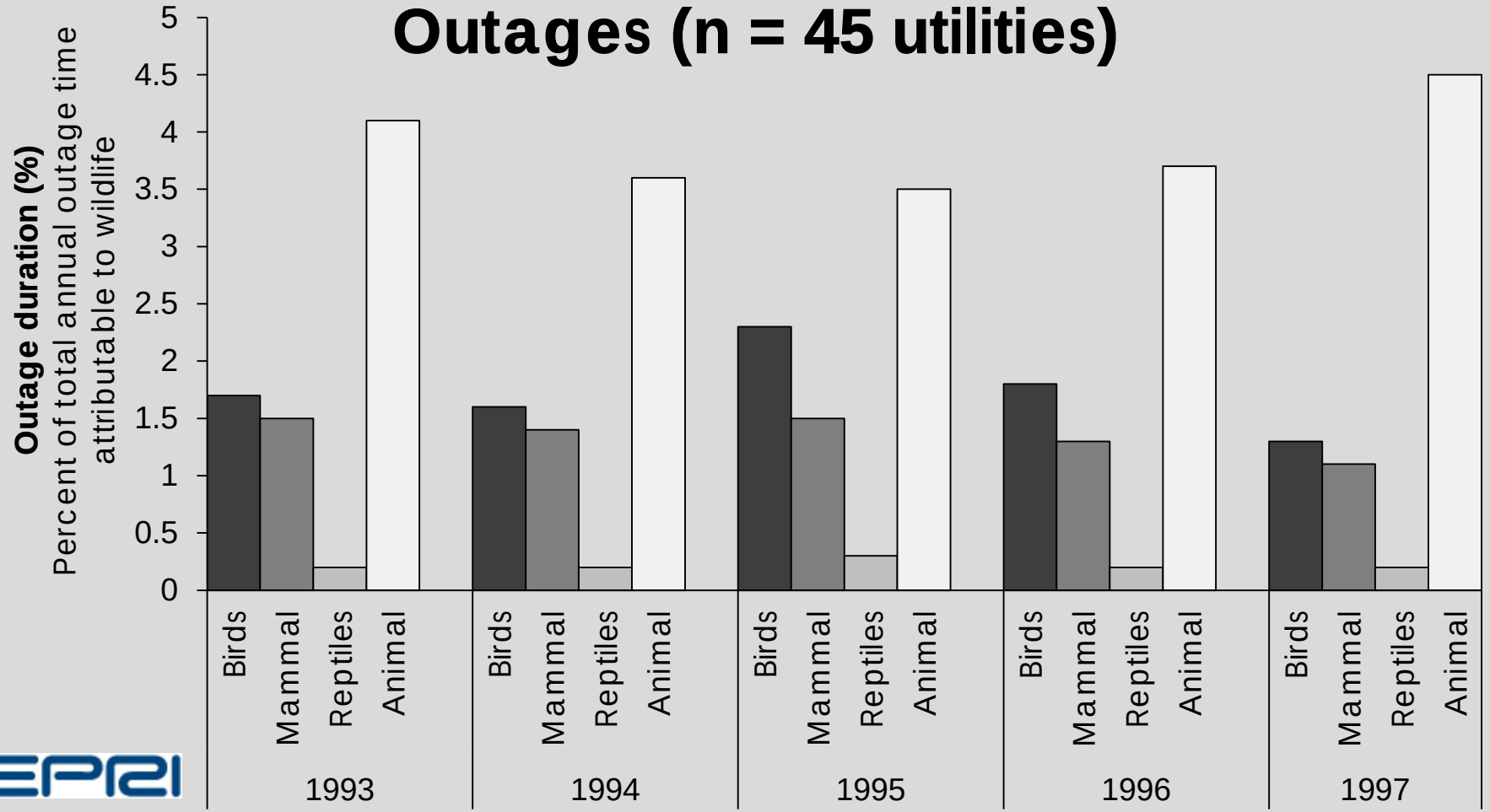
Kenya -- yes, the entire country -- was left without power for 15 minutes Tuesday after a rogue monkey got into a power station and triggered a blackout.

That's 4.7 million households and businesses.

The primate fell onto a transformer at the Gitaru hydroelectric power station, according to Kenya Electricity Generating Company, or KenGen, which owns the facility. The station is the largest generator in the country.

"This monkey tripped a transformer. This triggered a cascading effect on the other generators which ended up disrupting power generation and distribution in the whole country," Kenya Power

Distribution Reliability Impacts

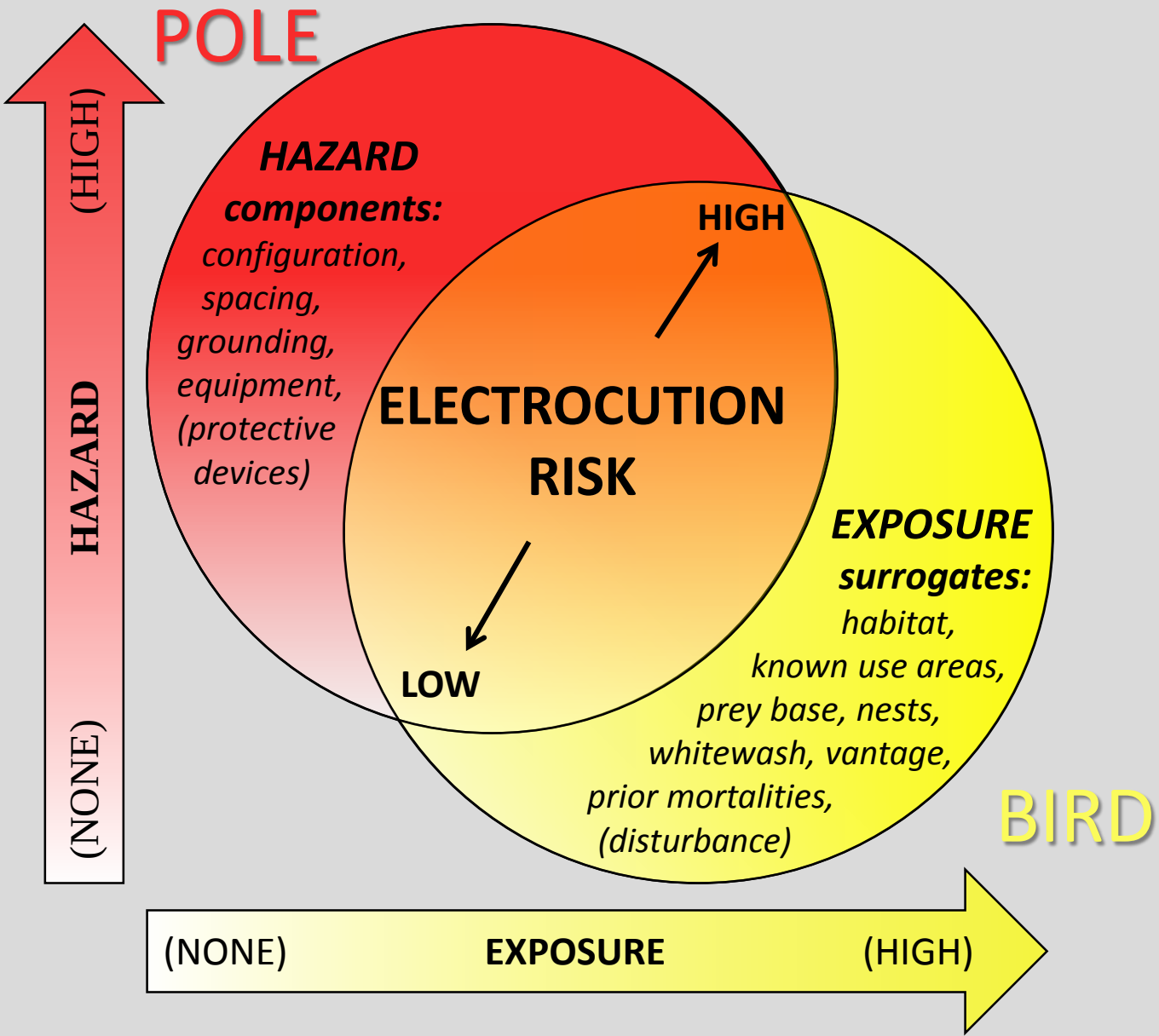


Plus an Additional 9.5% of All Outages are Unknown!

9% of outages by frequency [1].

Electrocution Risk Factors

LARGE ANIMALS AT GREATER RISK

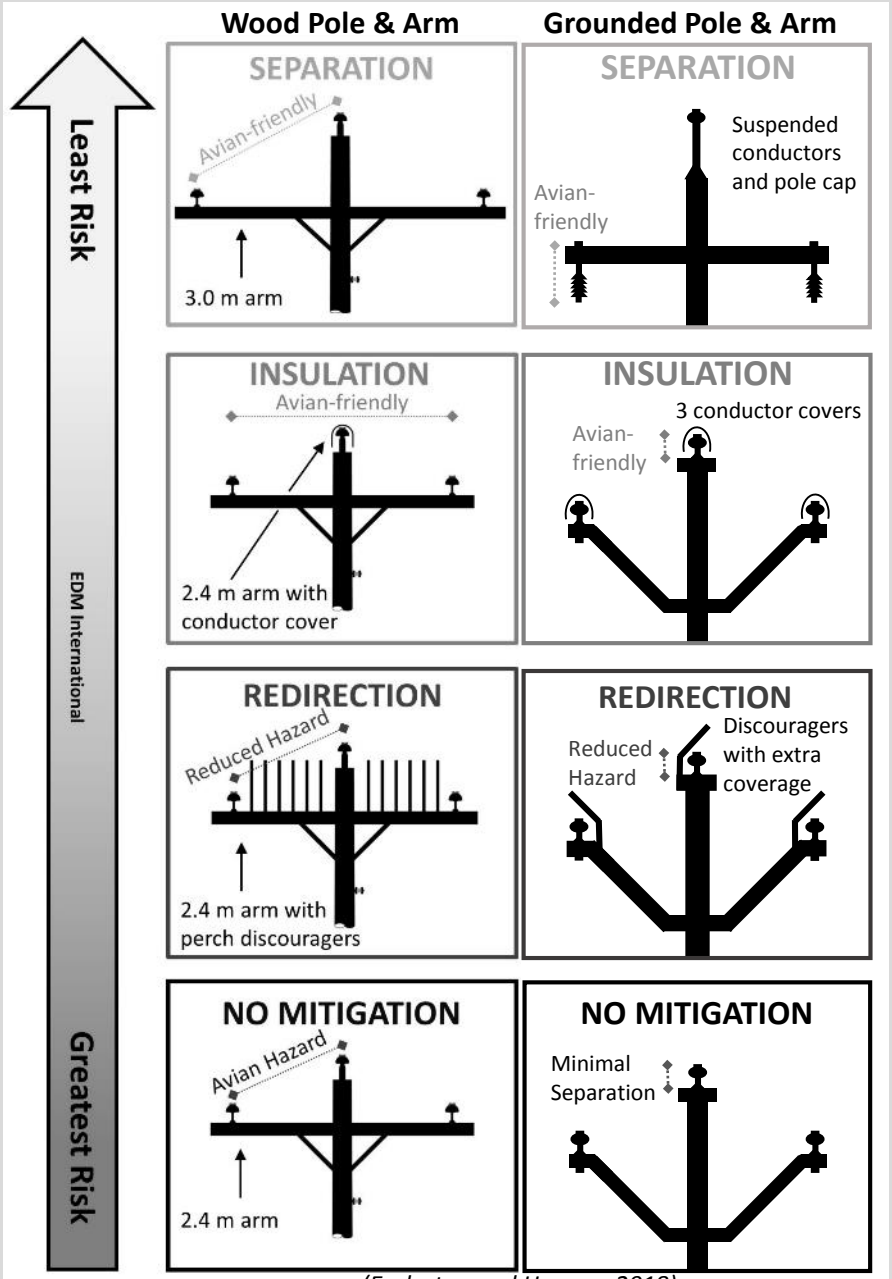


Prevention: Clearances

AVIAN POWER LINE INTERACTION COMMITTEE (2006) RECS

Mitigation and Prevention

- Redirection: shift perching to safer location (not reliable)
- Insulation: strategic cover-up (requires maintenance)
- Separation: preferred approach is durable and reliable (project design)

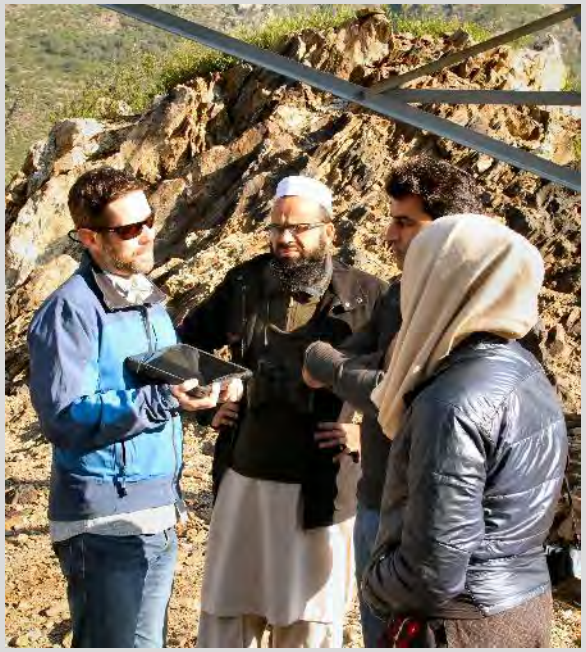


(Eccleston and Harness 2018)

Electrocution Risk Model

DWYER ET AL. (2014)

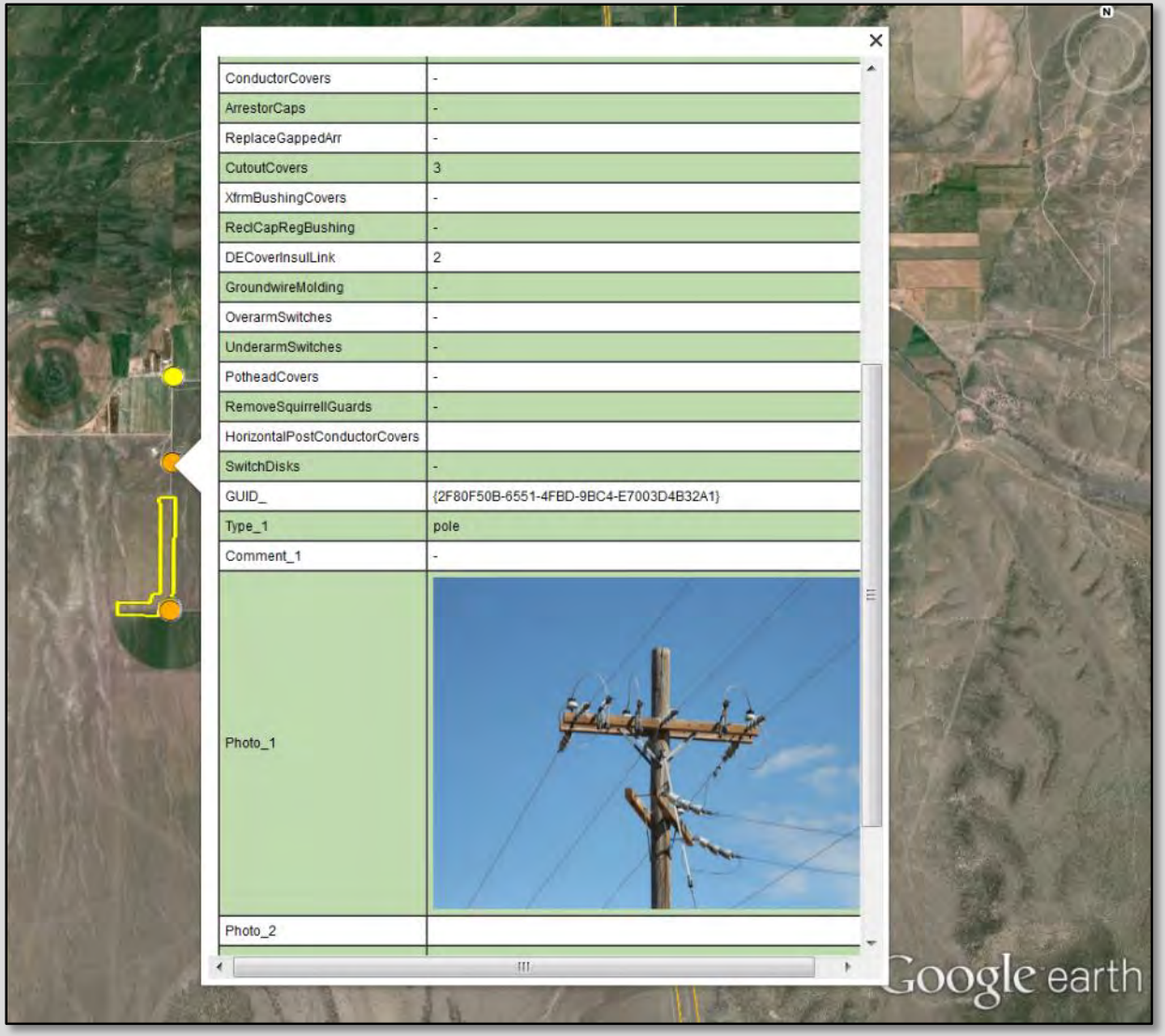
- Key factors:
  - Phases
  - Jumpers
  - Grounding
  - Habitat
  - -> Risk Index
- Objective and accessible assessment
- Automated in CartoPac mobile data collection Avian Module (EDM 2019)

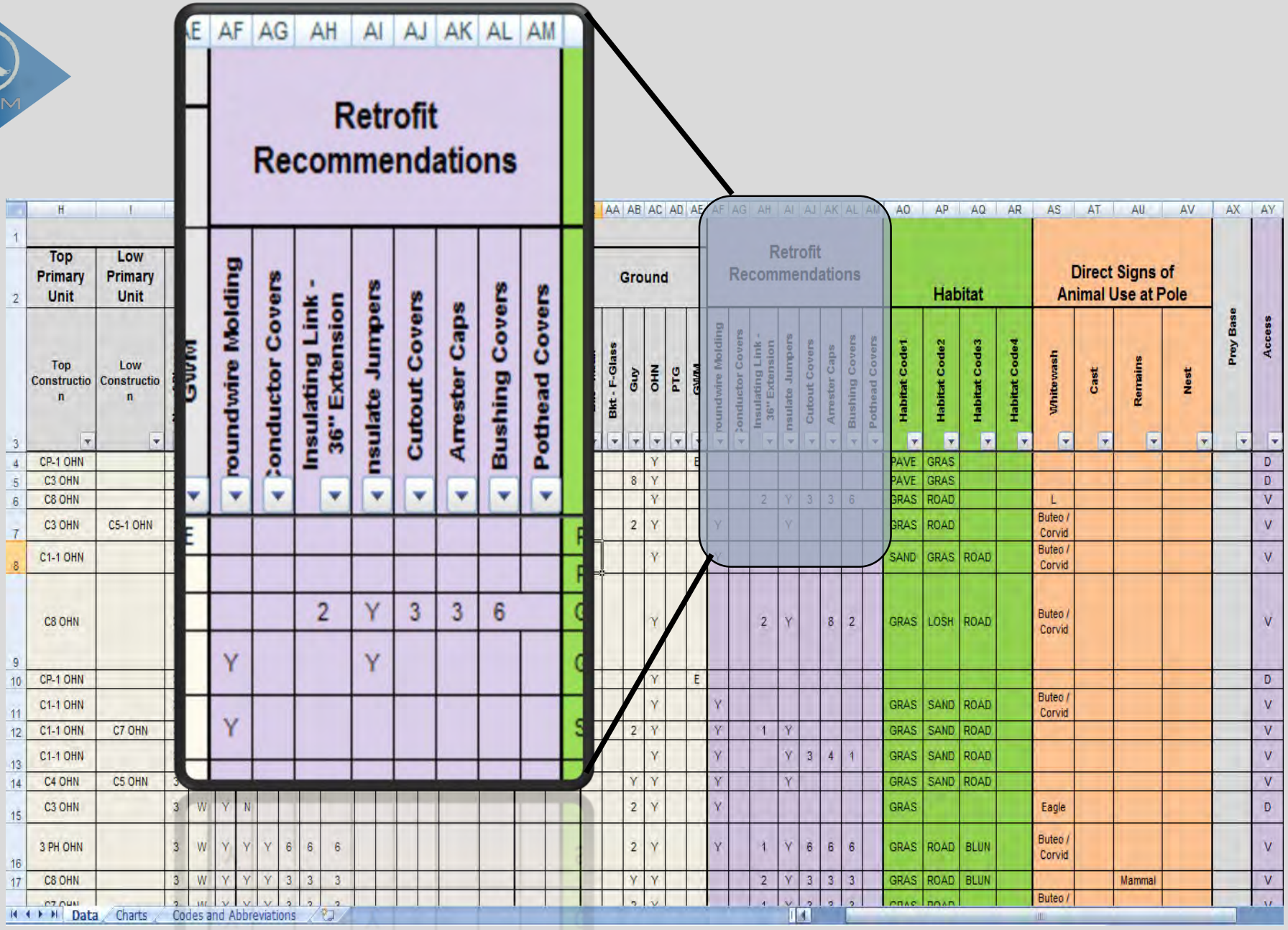


Data Deliverables

ENHANCED DIGITAL FORMATS

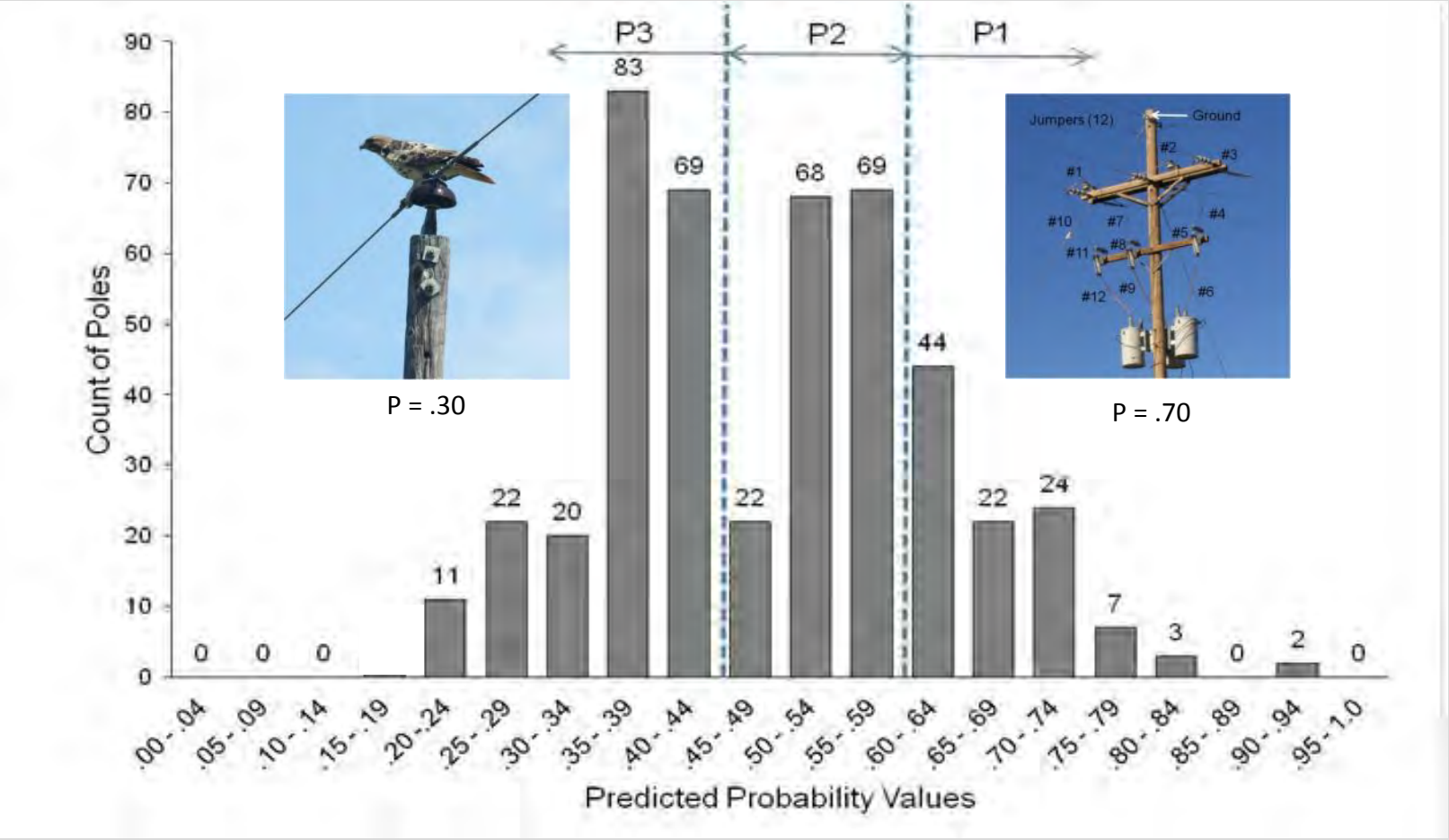
- GIS files include all pole data and ***retrofit recommendations***
- Google Earth KMZ file also includes a photo
- Organized by Priority Coded
- Can export to a spreadsheet




Retrofit Recommendations
Roundwire Molding
Conductor Covers
Insulating Link - 36" Extension
Insulate Jumpers
Cutout Covers
Arrester Caps
Bushing Covers
Pothead Covers
Ground
Habitat
Direct Signs of Animal Use at Pole
Top Primary Unit
Low Primary Unit
Top Construction
Low Construction
Habitat Code1
Habitat Code2
Habitat Code3
Habitat Code4
Whitewash
Cast
Remains
Nest
Prey Base
Access
Data
Charts
Codes and Abbreviations

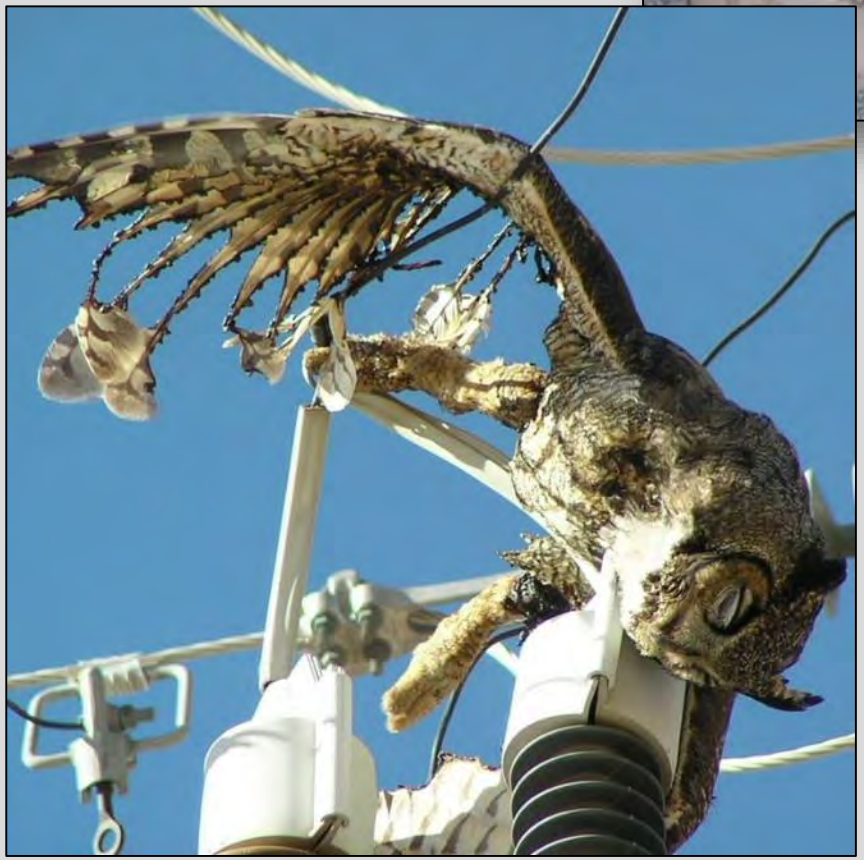
Results

- Frequency histogram

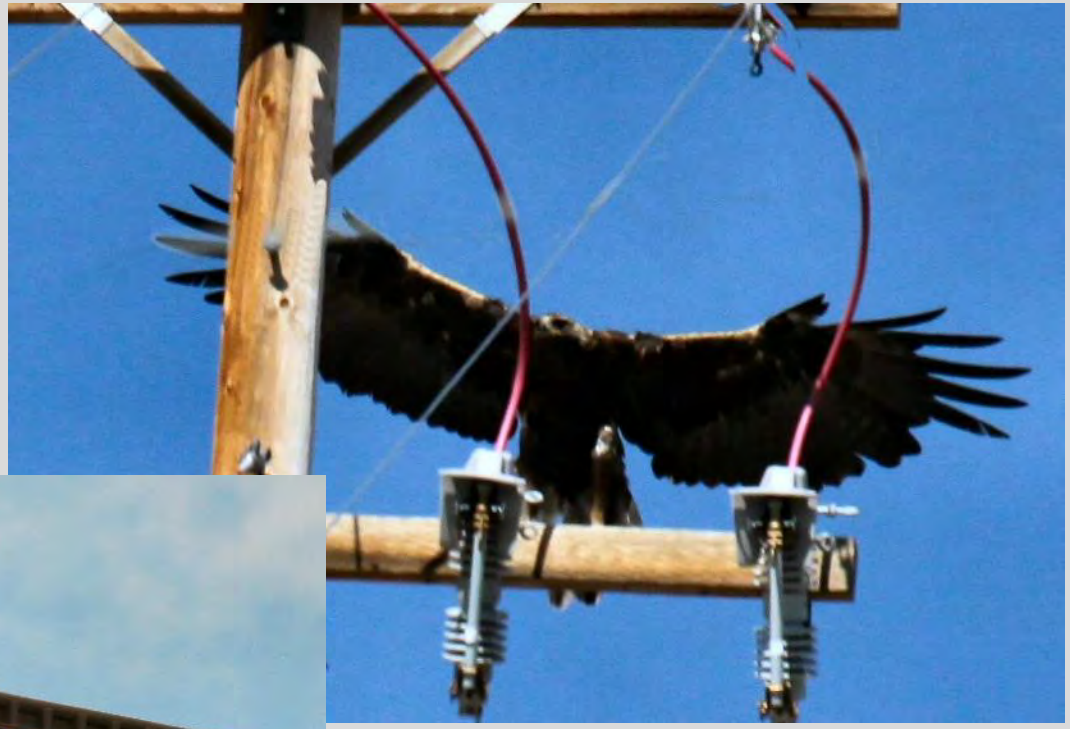


Insulation

- Materials and design matter for durability and effectiveness (EPRI 2014)
- Products must be well-matched for system (EPRI 2016)
- Small gaps kill birds (Dwyer et al. 2017)



Well-insulated Poles



Global Examples - Electrocutions

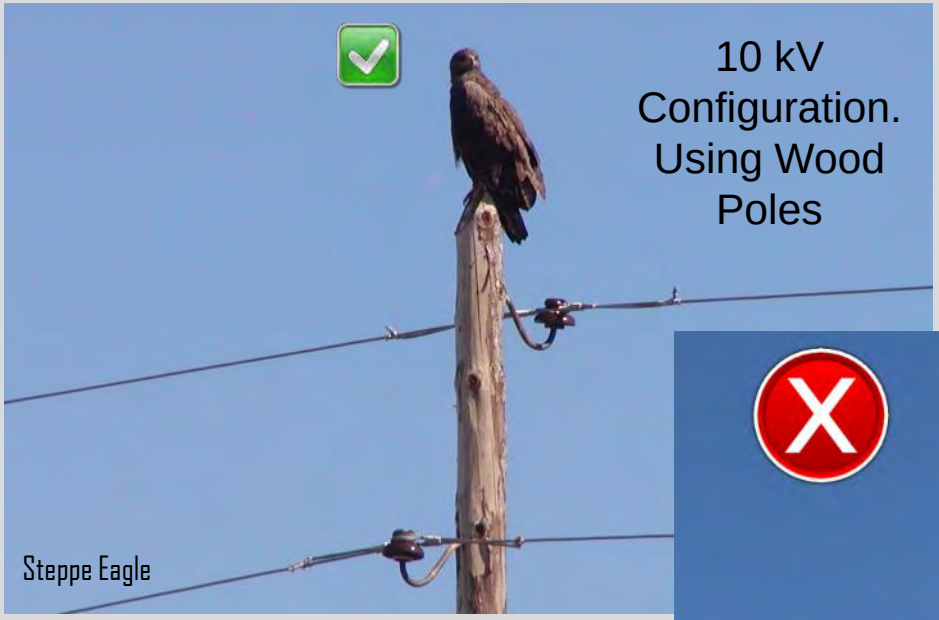
Russia

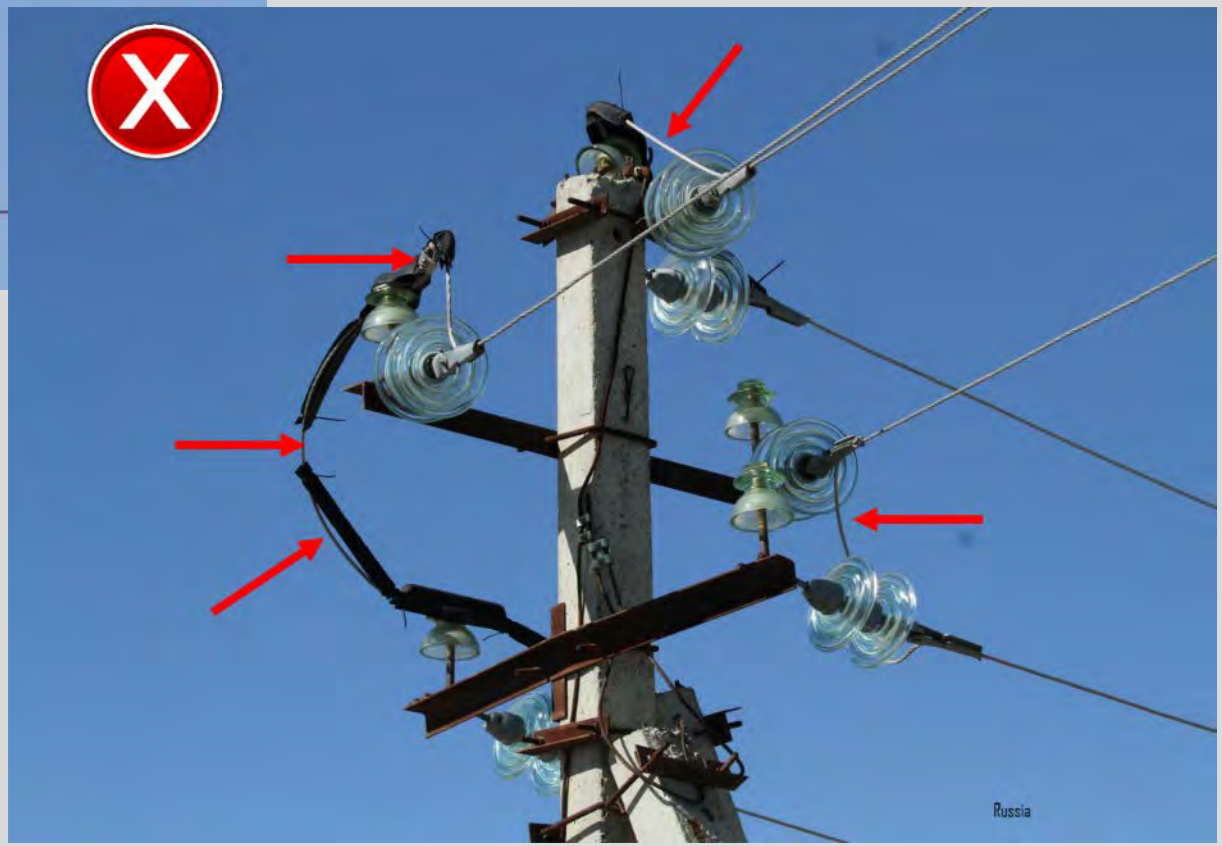
ALTAI KRAI

- Karyakin et al. (2009): 135 km line, 144 carcasses
- 10 Red-listed species
- Persistent problem…very likely it is widespread.
- Retrofitting efforts piecemeal and problematic.

II International scientific and practical conference
RUSSIA
ALTAI
2018
Russian Raptor Research and Conservation Network
Eagles of Palearctic: study and conservation

Russia: Altai Krai





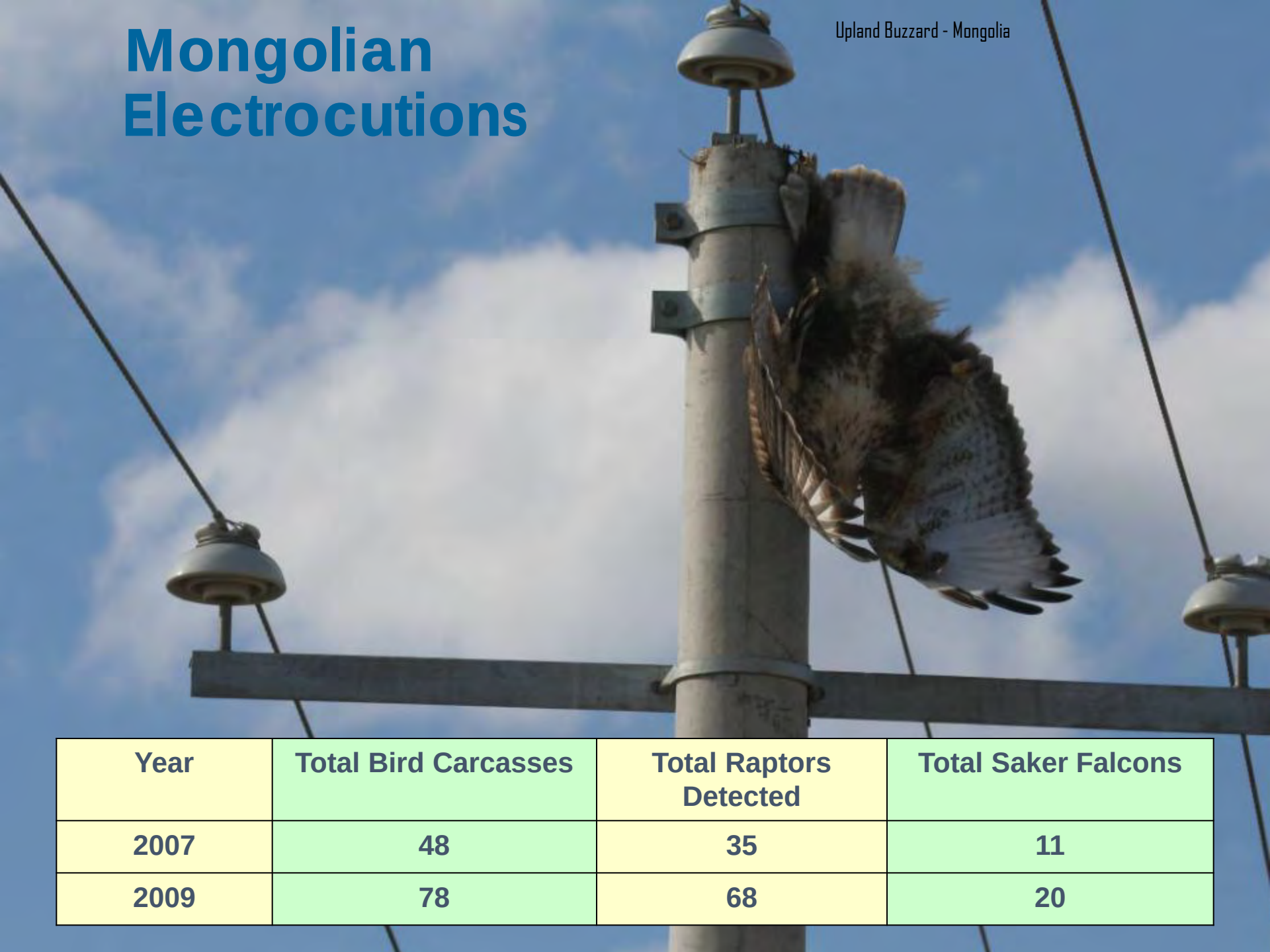
Mongolia

SAKER FALCON

- IUCN Red Book as an endangered species
- Global decline: 8,500-12,000 pairs (1990) to 3,600-4,400 pairs (2003)
- Electrocutions responsible for 54% of discovered Saker falcon carcasses (n=64) in central Mongolia between 1998 and 2004, (Gombobaatar *et al.)*

Saker Falcon - Mongolia

Mongolian Electrocutions



Upland Buzzard - Mongolia

Year	Total Bird Carcasses	Total Raptors Detected	Total Saker Falcons
2007	48	35	11
2009	78	68	20

Cinereous Vulture - Mongolia

Results- Spikes

Spikes (n=122)
33% of Structures

Year	Total Bird Carcasses Detected	Birds Under Spiked Poles	Total Raptors Detected	Raptors Under Spiked Poles	Total Saker Falcons	Sakers Under Spiked Poles
2007	48	14 (29%)	35	12 (34%)	11	5 (45%)
2009	78	31 (40%)	68	30 (44%)	20	8 (40%)

Saker Falcon - Hungary


Rick Harness

Mongolia: Status

Sheikh Mohammed acts to prevent deaths of thousands of endangered falcons by electrocution

► New Dh70 million Mohammed bin Zayed research fund seeks solutions to needless deaths caused by electricity power lines

A dead Saker falcon hangs from a power line in Mongolia, where it is estimated around 4,000 of the endangered birds die by electrocution every year. Courtesy Environment Agency Abu Dhabi

INDIA

2011: 25 MI POWER LINE SURVEYS


Eurasian Eagle Owl

SPECIES of DETECTED CARCASS	Number
House Crow	33
Indian Roller	31
Common Kestrel	5
Eurasian Collared Dove	4
White-eyed Buzzard	4
Common Myna	3
Rock Pigeon	3
Eurasian Eagle Owl	1
Spotted Owlet	1
Ring-necked Parakeet	1
Owl Species	1
Unknown Bird (non raptor)	2

Tangent: Carcasses Detected = 89


Common Kestrel

Complex Poles Most Dangerous

CONFIGURATION	Number Poles	Detected Carcasses	Value = Carcasses Per pole	1 Carcass Value
TANGENT – LOW CENTER PIN	267	89	0.33	1 Carcass Every 3.0 Poles
TANGENT – HIGH CENTER PIN	140	4	0.03	1 Carcass Every 35 Poles
JUMPER – NO EQUIPMENT	60	44	0.73	1 Carcass Every 1.4 Poles
JUMPER – TRANSFORMER/SWITCH	26	22	0.84	1 Carcass Every 1.2 Poles
TOTAL	493	159	0.32	1 Carcass Every 3.1 Poles

Ridgeway's Hawk

CITICALLY ENDANGERED

- Endemic to Hispaniola
- 300-400 remaining adults
- Peregrine Fund conservation and recovery project

Ridgway's Hawk – Dominican Republic

Ridgway's Hawk – Dominican Republic

Assisted Dispersal Results

To increase the population, The Peregrine Fund initiated a Ridgway's Hawk assisted dispersal program. From 2009 through 2012 a release of 19 birds was conducted in Punta Cana, Dominican Republic.

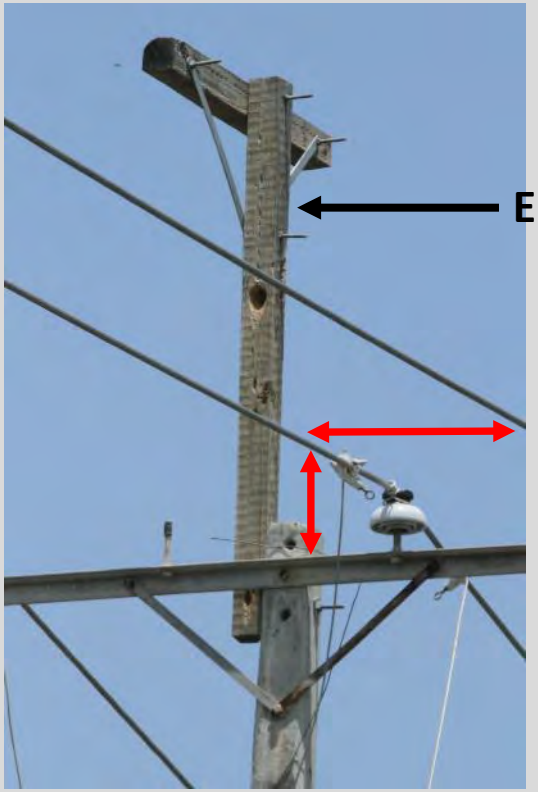
Year	Number Released	Number Electrocuted
2009	3	?
2010	5	?
2011	6	2
2012	5	1
TOTAL	19	3

The electrocutions resulted in suspension of the program and initiation of a power line retrofitting program.

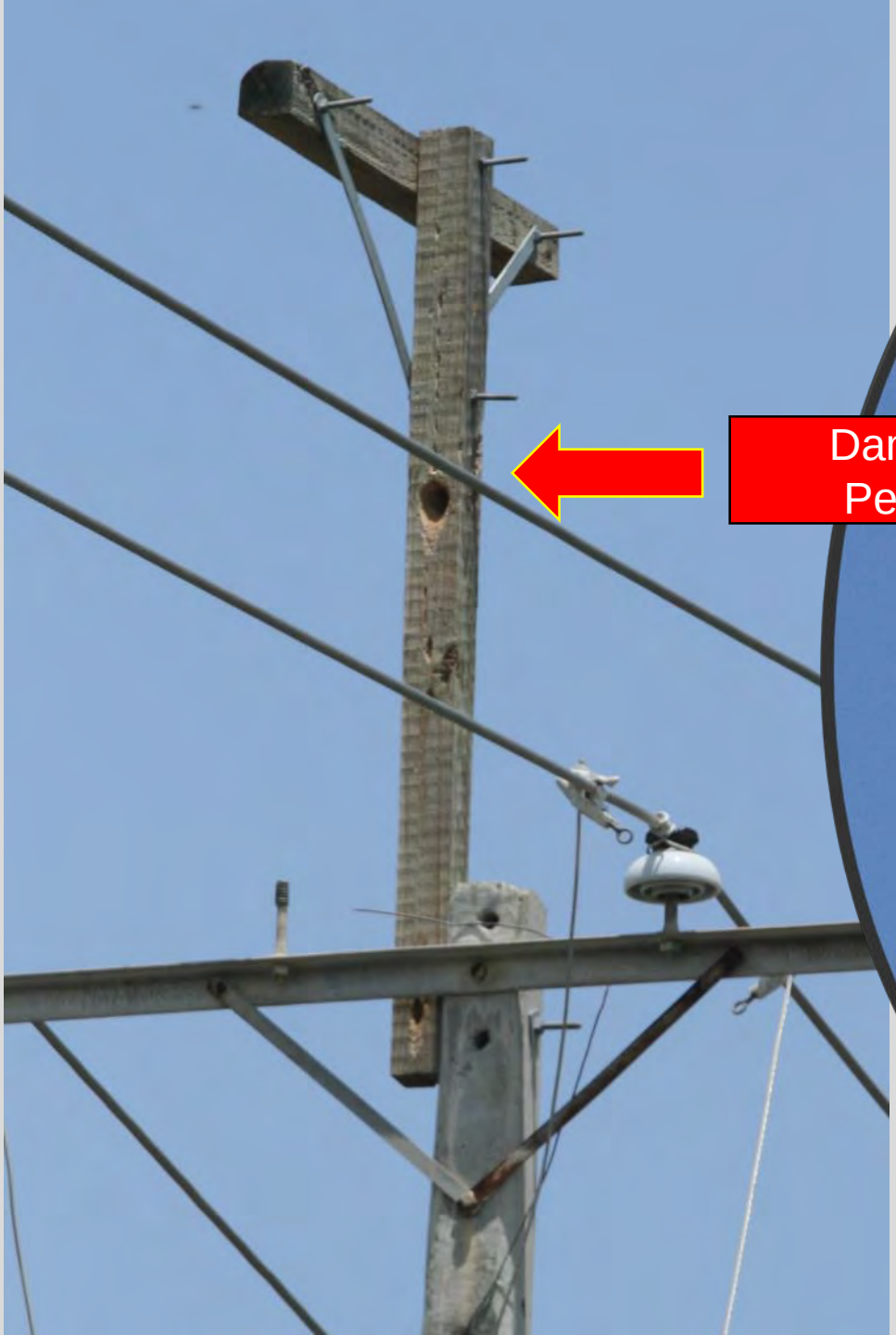
Retrofitting Results

- 2013, 50 poles in high quality habitat near the release site were fitted with elevated perches. No insulation was installed…

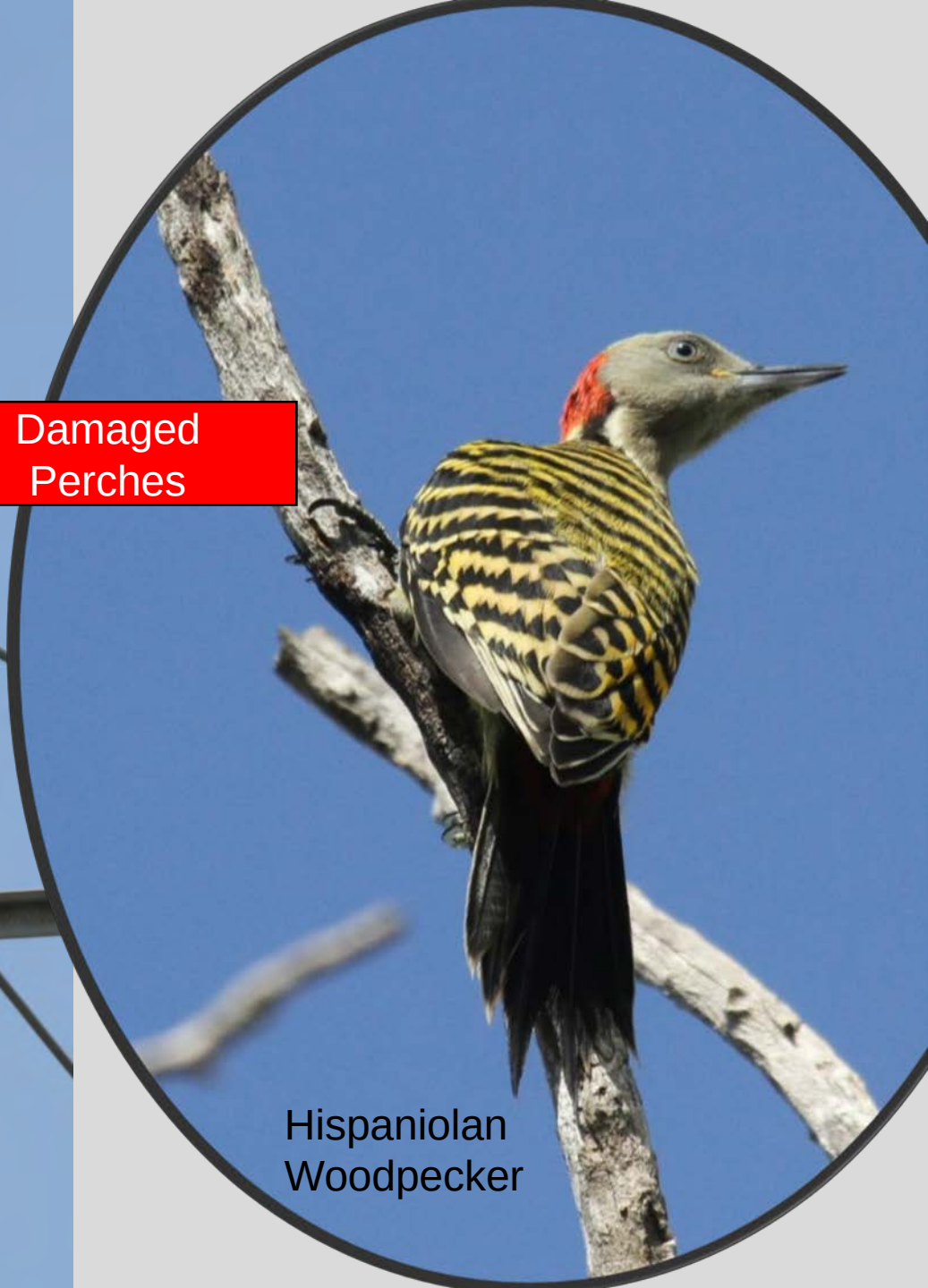
Year	Number Released	Number Electrocuted
2014	29	7*



* Unfortunately, 7 (24%) birds were electrocuted; 6 on poles fitted with the elevated perches.



Damaged
Perches



Hispaniolan
Woodpecker

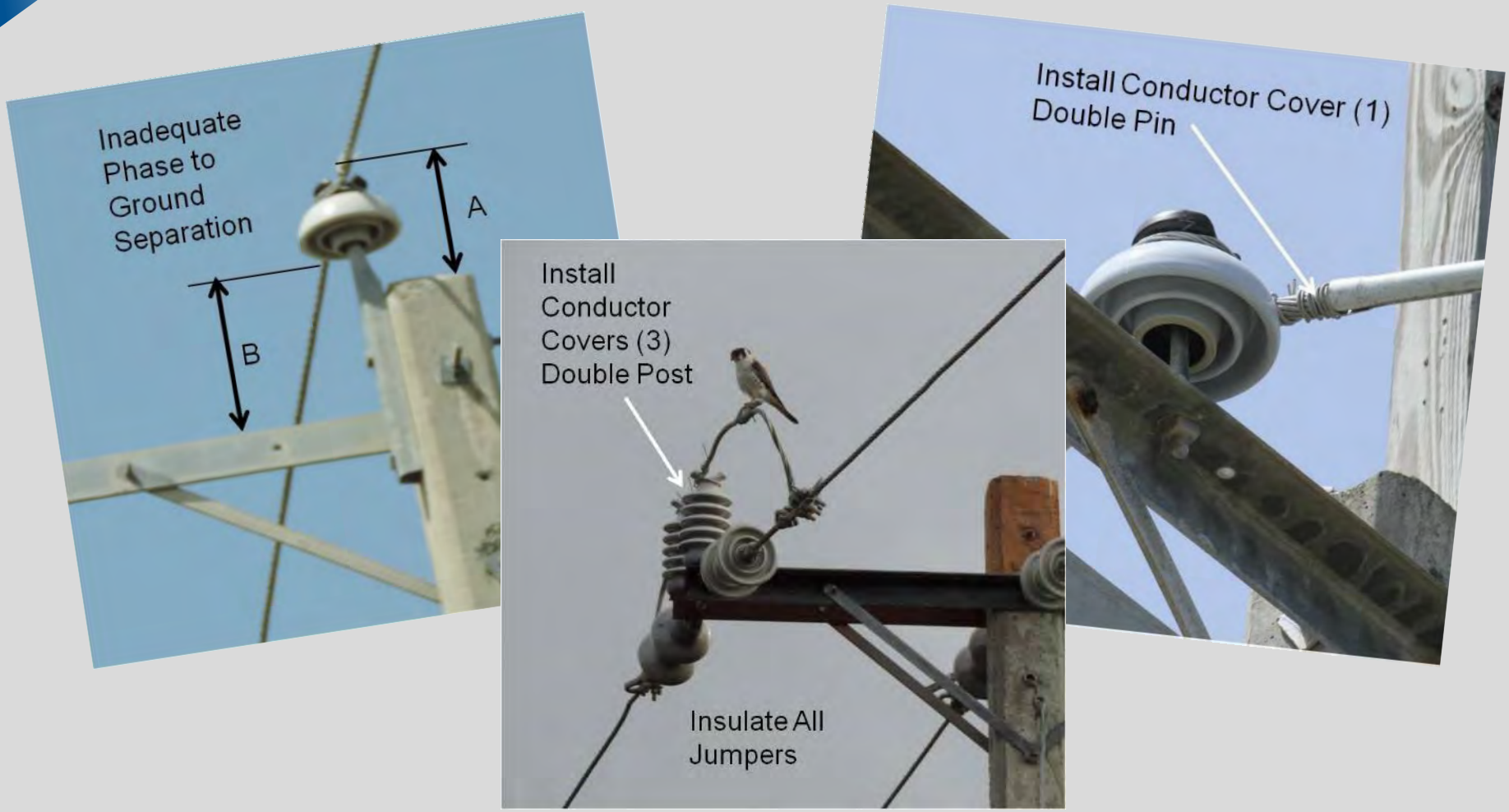
Problematic Configuration

Elevated Perch

Elevated perches alone are not an effective solution

Problematic Configuration

Power Line Surveys – July 2014



EDM International, Inc. partnered with The Peregrine Fund to survey and document problem pole configurations. EDM also provided insulating solutions for 101 poles.

Results

Year	Number Released	Number Electrocuted
2009	3	?
2010	5	?
2011	6	2 (33%)
2012	5	1 (20%)
2014	29	7 (24%)
2015 - 2016	55	2* (4%)

1st Dispersal

Elevated Perches

2nd Dispersal

Insulation

3rd Dispersal

* July 2016 we inspected the retrofitted poles to insure the insulation was not blowing off during high winds and tropical storms. Two hawk electrocutions (4%) were detected, all located *under partially retrofitted poles*, missing either covered jumpers or protective equipment covers. *No birds were found under fully retrofitted poles!*

Dominican Republic-Status

- Success!
- Power line retrofitting will continue to focus on **insulating** potential phase-to-phase and phase-to-ground contact points.
- Power line retrofitting should ***not*** consist solely on perch management (i.e. using elevated perches and perching discouragers).
- Good fitting products should be selected to withstand environmental degradation and storm events.
- Equipment such as transformers, fused cutouts, surge arresters, and jumpers should also be insulated.
- Proper product installation and training of utility linemen is key.

Costa Rica

MONKEY ELECTROCUTIONS

- 1995-2007: population decline >50% (Sanchez 2007)
- Electrocution major cause: 789 in 5 years in Tempisque conservation area.
- 2016: Minister of Envt. proposes EDM coordinate conference on solutions
- 2019 Ministry report: 4K in 5 years, directive to prevent.
- Cost a barrier to mitigate—PREVENTION PREFERRED
- EDM Denver zoo collaboration

Electrocution Conclusions

- Electrocutions and outages are preventable through appropriate new construction standards.
- Existing issues can be resolved with insulation (retrofitting).
- A Risk Assessment is a proactive approach to addressing incidents.
- Using mobile data collection with a risk model provides consistent results across the utility system.

3 AVIAN COLLISIONS

Scope

- Loss et al. (2014) estimate between 8 and 57 million birds are killed each year at U.S. power lines by collision.
- Rioux et al. (2014) estimate between from 2.5 million to 25.6 million birds are killed per year by Canadian transmission lines.
- Collisions impact declining species, such as Trumpeter Swans (*Cygnus buccinator*) and Whooping Cranes (*Grus americana*).

Demoiselle Crane: Mongolia

Species

- Large, heavy-bodied species
- High wing loading, poor maneuverability
- Flocking behavior
- Wading birds
- Waterfowl
- BUT ALSO passerines (Harness et al. 2012) and raptors (Mojica 2009)

Population Impacts (Raptors)

Common Name	Scientific Name	Collision	IUCN Status	Continent
Cape Vulture	*Gyps coprotheres*	Yes	Vulnerable	Africa
Egyptian Vulture	*Neophron percnopterus*	Yes	Endangered	Africa
Lappet-faced Vulture	*Torgos tracheliotos*	Yes	Vulnerable	Africa
Eastern Imperial Eagle	*Aquila heliaca*	Yes	Vulnerable	Asia (primarily)
Red Kite	*Milvus*	Yes	Near Threatened	Europe (primarily)
California Condor	*Gymnogyps californianus*	Yes	Crit. Endangered	North America
Crowned Solitary Eagle	*Harpyhaliaetus coronatus*	Yes	Endangered	South America
Orange-breasted Falcon	*Falco deiroleucus*	Yes	Near Threatened	South America

BirdLife International 2012. Species reports. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 19 September 2013. Search strategy: keywords = buzzard, condor, eagle, falcon, harrier, hawk, kite, lammergeier, osprey, owl, and vulture. Excluded species of least concern and data deficient species. Searched each remaining species page for the word "power" as in power line collision or power line electrocution.

Great Indian Bustard

SPECIES ON THE BRINK

- IUCN Critically Endangered
- 80% decline in 50 years, now ≤150 indiv
- Poor frontal vision, low flights
- 75% of adult mortality since 1989 b/c power line collision
- Large-scale wind dev't—and T&D lines

Will India's RE push kill the critically endangered great Indian bustard?

Amid the hubbub surrounding India's renewable energy ambitions, few people have likely heard the last wails of a critically endangered great Indian bustard as it chars to death on a power transmission line or fatally collides with a wind turbine.

APRIL 2, 2019 PREETI VERMA LAL

COMMERCIAL & INDUSTRIAL PV | COMMUNITY | GRIDS & INTEGRATION | INSTALLATIONS | LEGAL | MARKETS | MARKETS & POLICY | POLICY | RESIDENTIAL PV | TECHNOLOGY | UTILITY-SCALE PV | ASIA | INDIA

Image: Wikimedia Commons

WILDLIFE & BIODIVERSITY

There are 150 Bustards in the Desert National Park, claims report

Wildlife Institute of India pegged the species' total population for the whole country at 150 during 2018

Routing

SPECIES AND HABITATS

- Factors
  - Elevated exposure
- Best practices
  - Identify wetlands and open water along route—GIS
  - Identify species and concentration areas
  - Avoid habitat or concentration areas

ebird.org

Routing

MOVEMENT CORRIDORS

- Factors
  - Concentration areas
  - Migration stopovers
  - Landscape features
- Best Practices
  - Wildlife biologist analysis
  - Lines parallel to movement
  - Avoid perpendicular crossings

Routing

EXPOSURE

- Factors
  - Lines at flight altitude
- Best Practices
  - Find shielding features
  - Bridges, trees, buildings
  - Alert birds to climb
  - Line height can affect susceptibility—site specific

Design

"AERIAL NET"

- Factors
  - Each wire plane is a hazard
- Best Practices
  - Reduce number of planes
  - Horizontal not vertical configurations

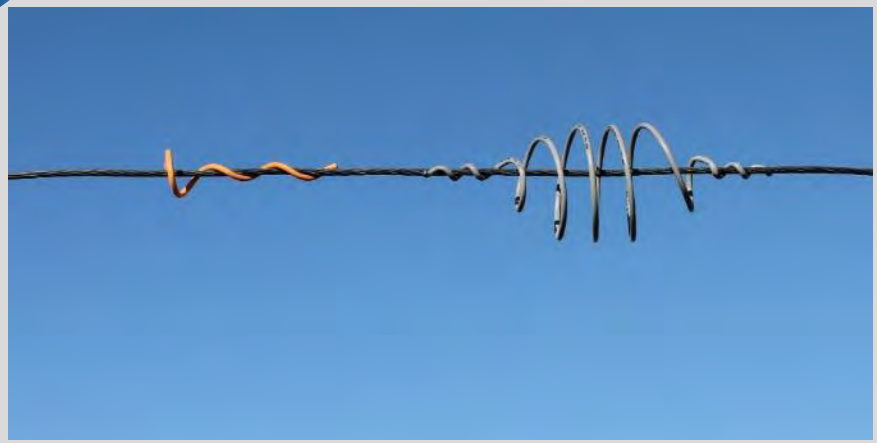
Design

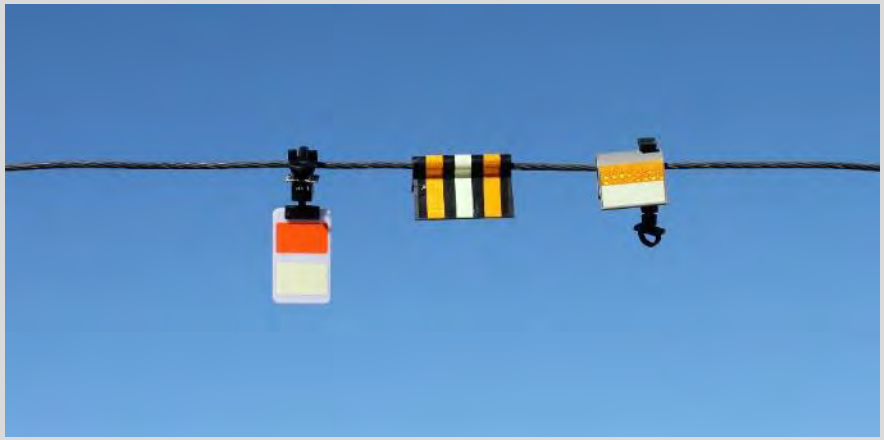
POOR VISIBILITY

- Factors
  - Small wires, esp. shield-- 68% (Pandey et al. 2007)
  - Low light/bad weather
- Best Practices
  - Bundled conductors
  - Shared ROWs
  - Line marking
  - T2 (flat) conductor

Double-crested Cormorant

Mitigation: Line Markers





Low Light Markers

NEW EMPHASIS ON REFLECTION & GLOW

Low-Light Markers

NEW EMPHASIS ON REFLECTION & GLOW

Marker Effectiveness

- Markers don't eliminate collisions
- Reduction 55-94%, average 78% (Barrientos et al. 2011)
- Published studies biased toward success
- Little/no valid data to compare effectiveness between products (Bernardino et al. 2018)

Line Marker Installation

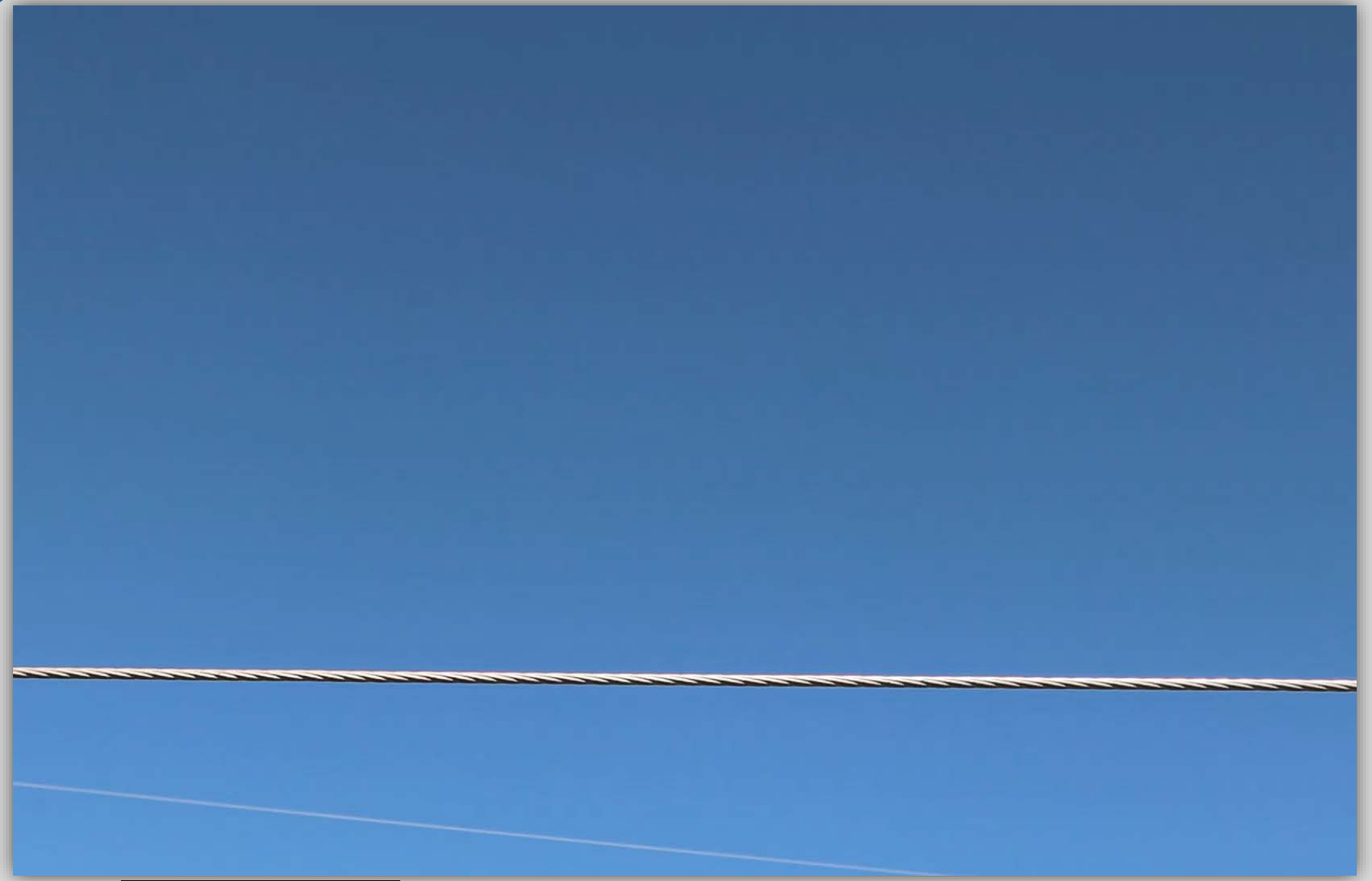
BUCKET TRUCK

Line Marker Installation

HELICOPTER

Line Marker Installation

UAV



CITATION(S): EPRI. 2018. Automated Collision Marking System Demonstration. Final EPRI Report, EPRI, Palo Alto, CA

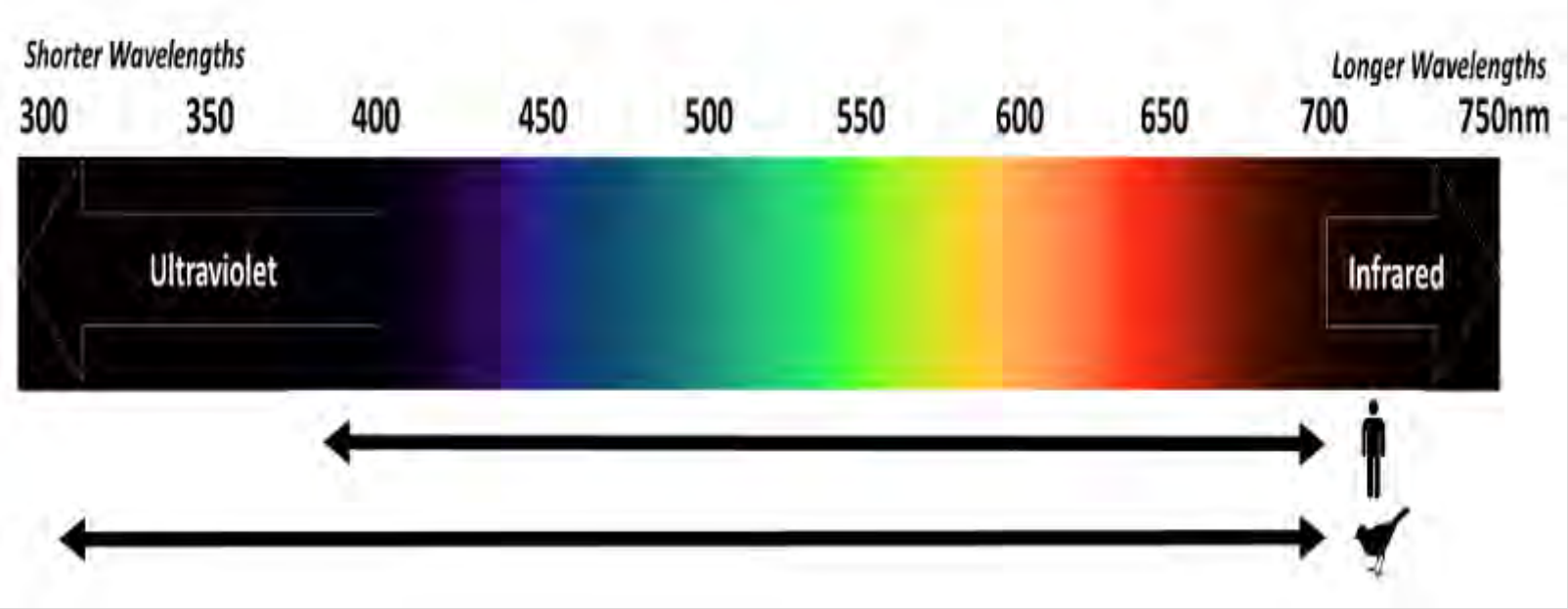
Conowingo Dam Install

Credit: Exelon, EPRI

Helicopter vs. UAV

- Cost to install 2000 markers :
  - Helicopter: $121K
  - UAV: $48K
- Worst case scenario
  - Helicopter crash
  - UAV crash

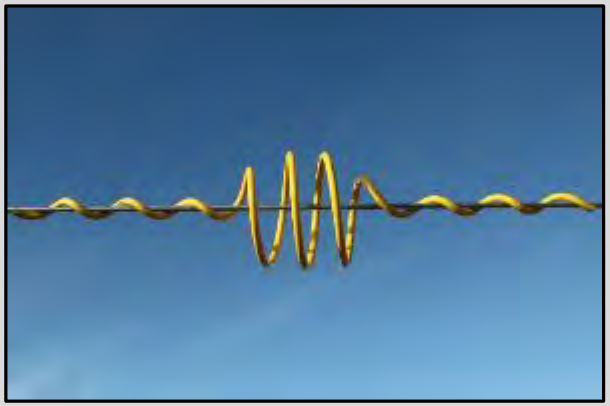
Avian Vision

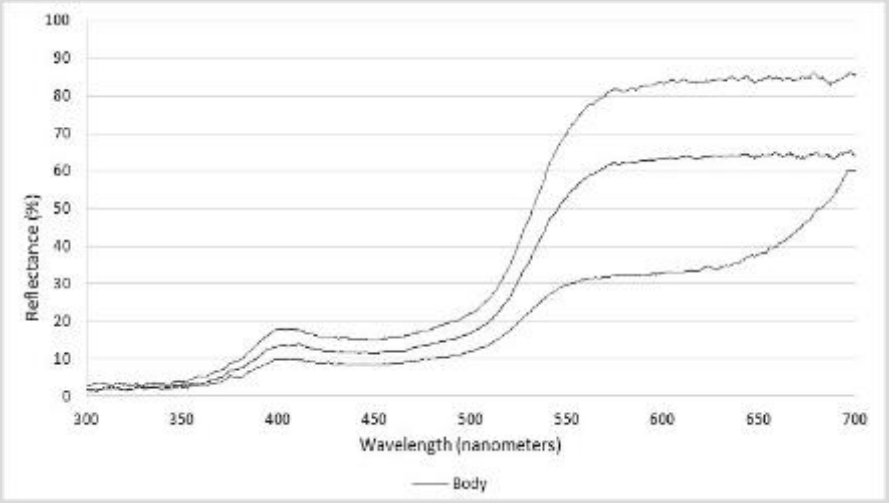


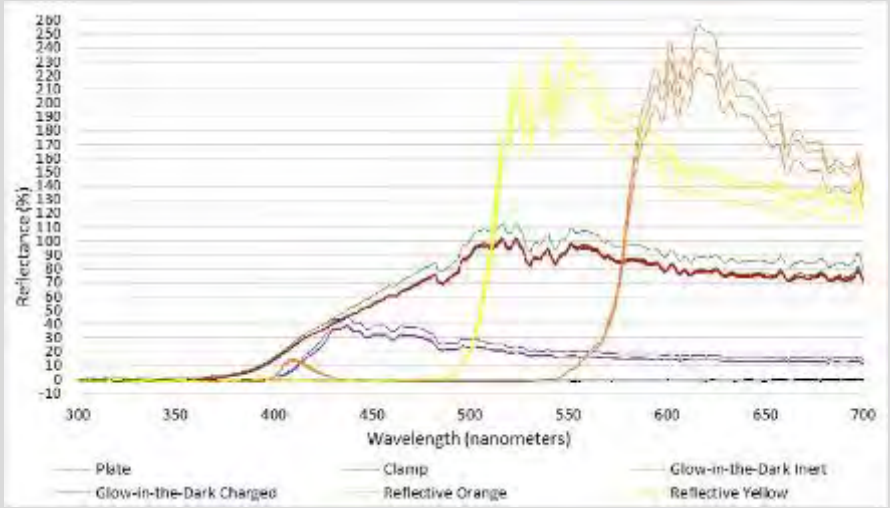
- Birds see differently than humans
- Little data on markers' visual properties, relationship to avian perception.
- Bird vision specific to taxonomic group, even species.

CITATION(S): EPRI. 2016. Power line collision mitigation and avian vision. Final EPRI Report, EPRI, Palo Alto, CA (In Press)

Spectral Reflection of Markers







- Markers should be matched to species based on visual properties
- Markers should be visible under all relevant lighting conditions

CITATION(S): EPRI. 2016. Power line collision mitigation and avian vision. Final EPRI Report, EPRI, Palo Alto, CA (In Press)

Avian Collision Avoidance System (ACAS) Testing:

EPRI ELECTRIC POWER RESEARCH INSTITUTE

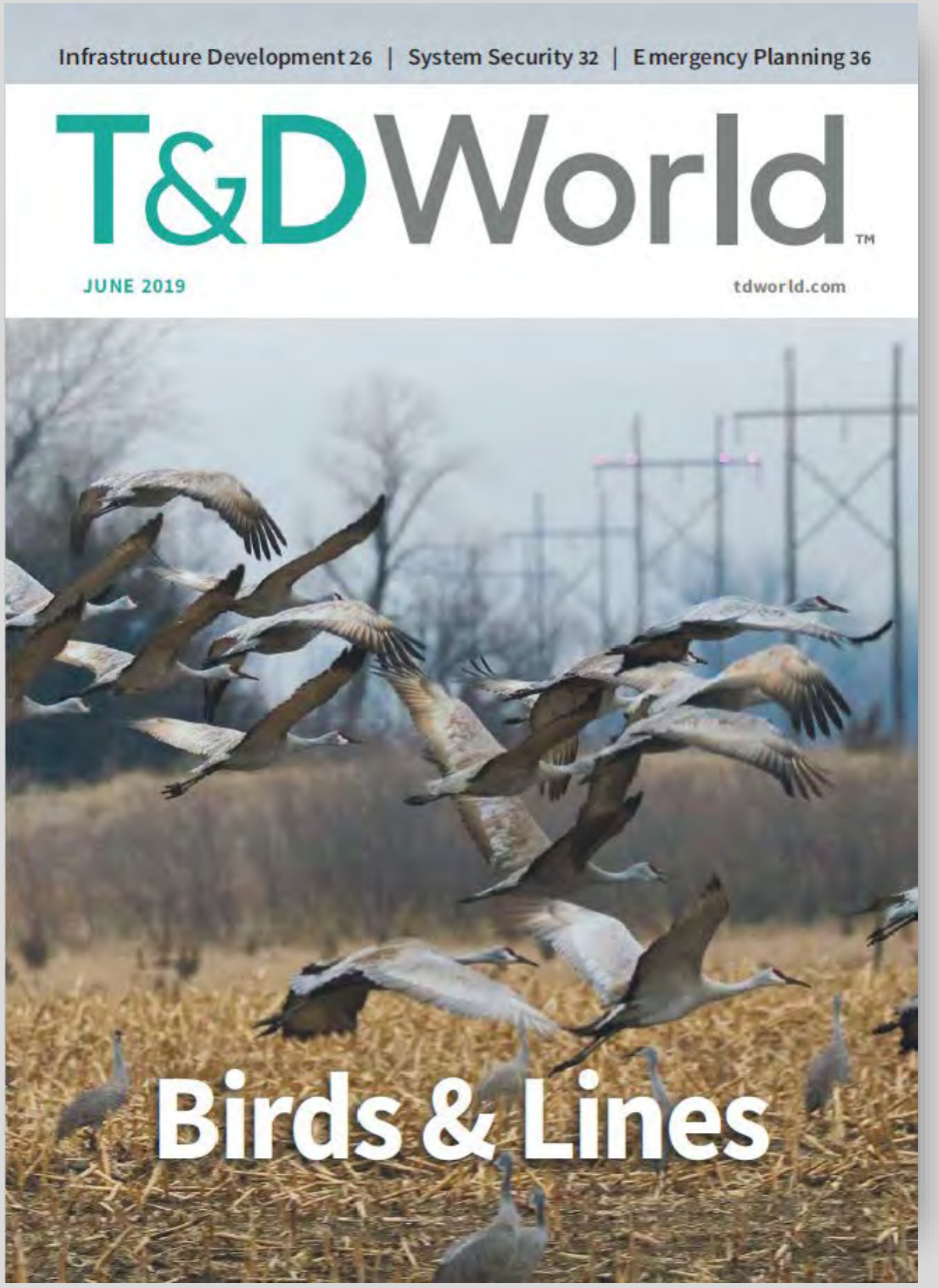
Citation(s): EPRI. 2018. Avian Collision Avoidance System – Phase 2 Final EPRI Report, EPRI, Palo Alto, CA

ACAS - Control: System Turned Off

DWYER ET AL. 2019

ACAS - Results

- ACAS off 19 nights
  - 48 Sandhill Crane collisions
  - 1 White Pelican Collision
  - 211 of 704 flights high risk (30%)
- ACAS on 19 nights
  - 1 Sandhill Crane collision
  - 42 of 551 flights high risk (7%)



Challenges to Understanding

DOES THIS LINE HAVE A PROBLEM?

- Detection
  - Access
  - Vegetation
  - Water
- Scavenging
- Crippling
- Surveyor
- Nocturnal
- Monitoring must be:
  - Frequent
  - Systematic
  - Labor intensive
  - Properly focused

Monitoring - Automation

Difficult to detect events at night, during inclement weather, and at remote locations.

Technologies being used include:

- Bird Strike Indicator (BSI)
- Smart Cameras

Bird Strike Indicator technology major funders:

EPRI ELECTRIC POWER RESEARCH INSTITUTE

CALIFORNIA ENERGY COMMISSION

Western Area Power Administration

Study Tool

PANDEY, A., R.E. HARNESS, AND M.K. SCHRINER. 2008. Bird strike indicator field deployment at the Audubon National Wildlife Refuge in North Dakota – phase two - final report. California Energy Commission, PIER Energy-Related Environmental Research Program. CEC-500-2008-020.

Bird Strike Indicator (OPGW)

(A)

(B)

- Base, ≤30 monitors, cell connex
- BSI does not invalidate OPGW warranty
- US, Canada, Italy, Netherlands, Brazil (?)

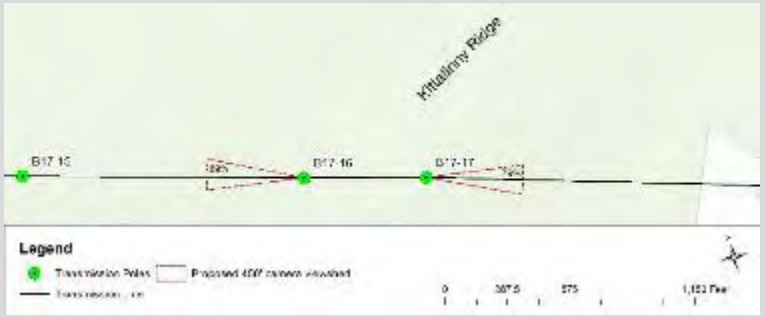
Study Tool – CEC/EPRI/WAPA funded technology

Murphy, R.K., S.M. McPherron, G.D. Wright, and K.L. Serbousek. 2009. Effectiveness of avian collision averters in preventing migratory bird mortality from powerline strikes in the Central Platte River, Nebraska, 2008 - 2009 Final Report.

Smart Vision Cameras

Thermal Imaging Cameras:

- 24/7 Monitoring
- Solar powered
- Algorithm eliminates cloud and moving wires due to wind
- Block detection in unwanted fields of view



Study Tool

EPRI initiative to develop an Animal Activity Monitor. This includes research on an algorithm to filter out unwanted activity.

4 AVIAN FECES

Phantom Cause

"UNKNOWN" OUTAGES

- Known since 1920's, but not widely acknowledged
- Low performing lines
  - Adequate insulation
  - Problem phase
- Problem areas, structures
- "Tried everything else"

Locally Very Important

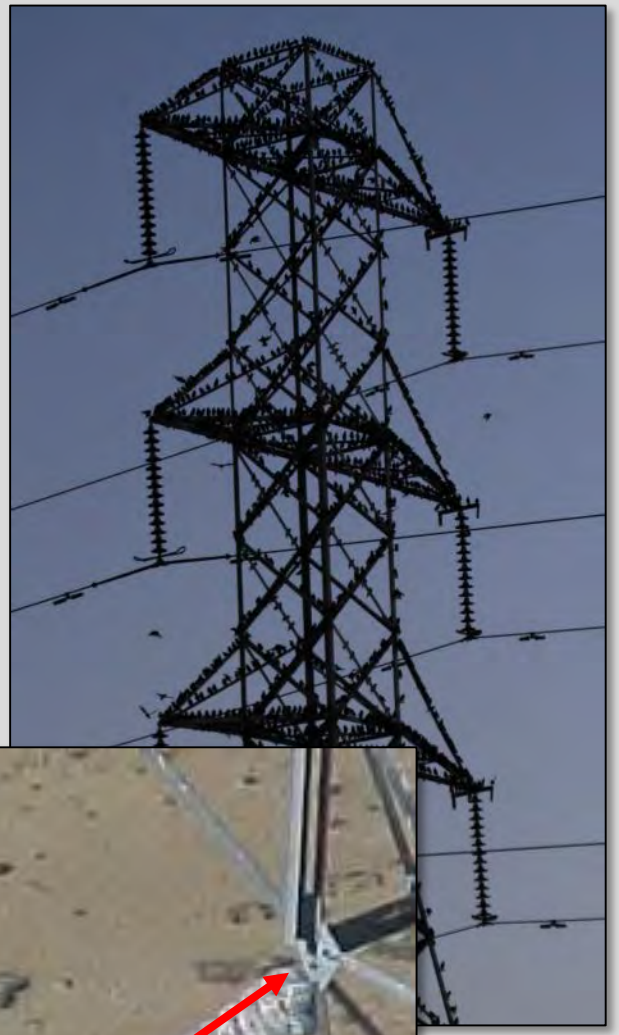
HUGE RELIABILITY FACTOR

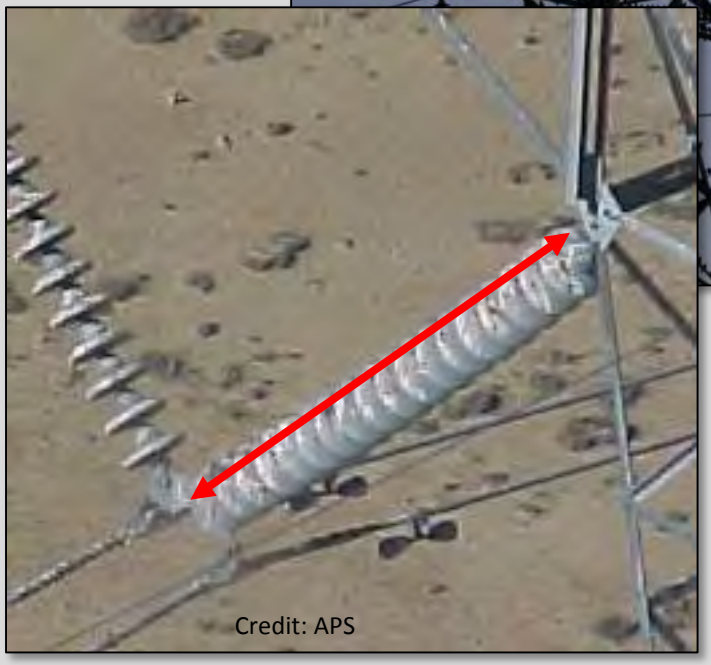
- Harness et al. (2002)
  - decrease faulting by >80%
  - ROI in <2 yrs
  - Save >$2M/yr
- Jenkins et al. (2013)
  - decrease faulting by >75%
  - ROI in <1 yr
  - Save >$260K/yr
- Van Rooyen et al. (2002)
  - decrease faulting by 92%
  - ROI in <1 yr

Feces Pollution

INSULATOR CONTAMINATION

- Large or small birds
- Slow accumulation—or fast
- Light precipitation, fog
- Phase-ground across insulator
- Heavy use structures
- V-string insulators more susceptible than I-string





Feces Streamers

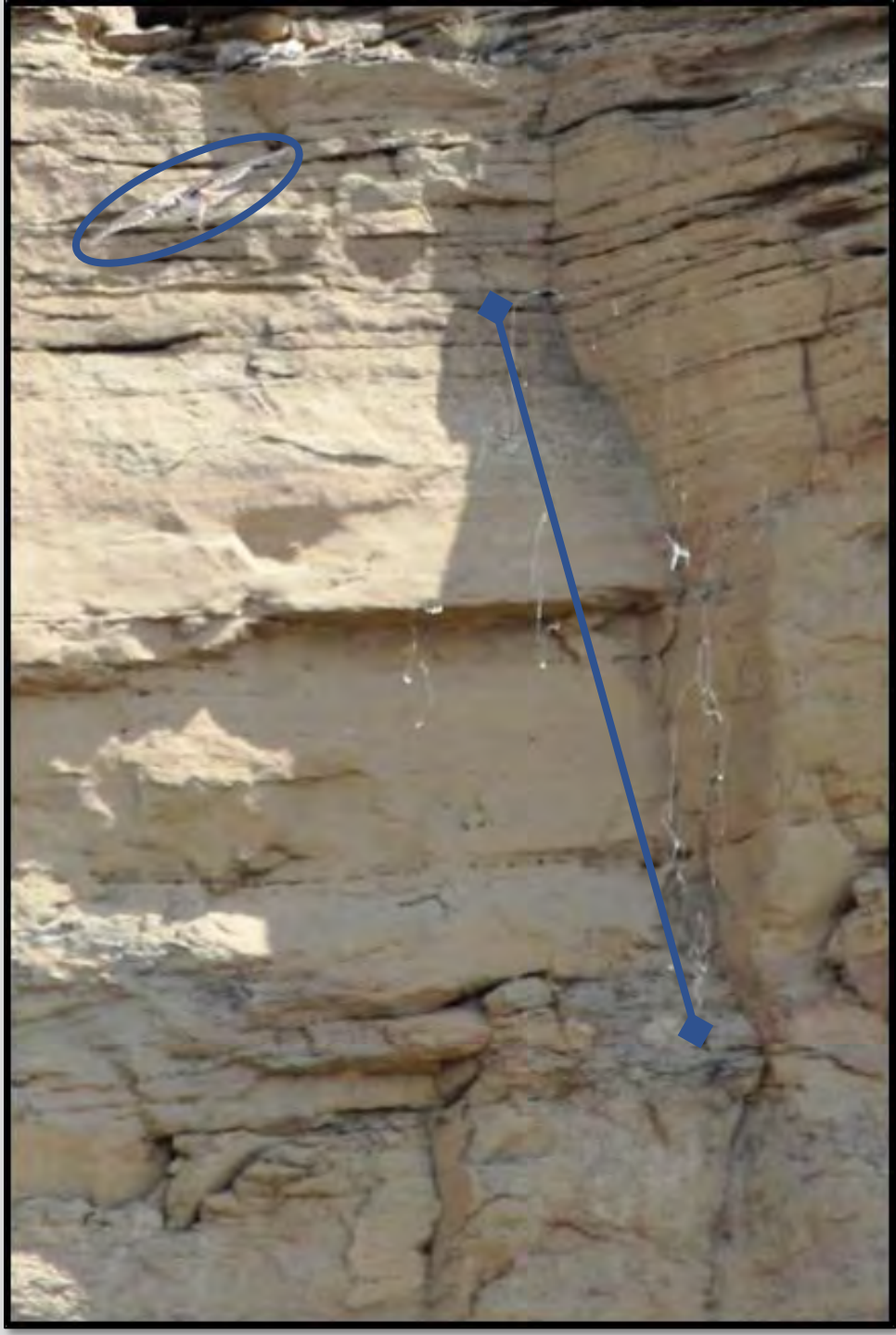
COMPROMISED AIR GAP

- Conductive feces to 60”…or more
- Large birds, only: raptors, vultures, herons
- Conductor-tower (typical)
- Flash marks hard to detect

Streamer Size

LITTLE RESEARCH

- ~60” typical in literature
- Clear underestimate
- Prairie falcon (WS ~36”)
- ~115” streamer
- Bald eagle (WS ~90”)???



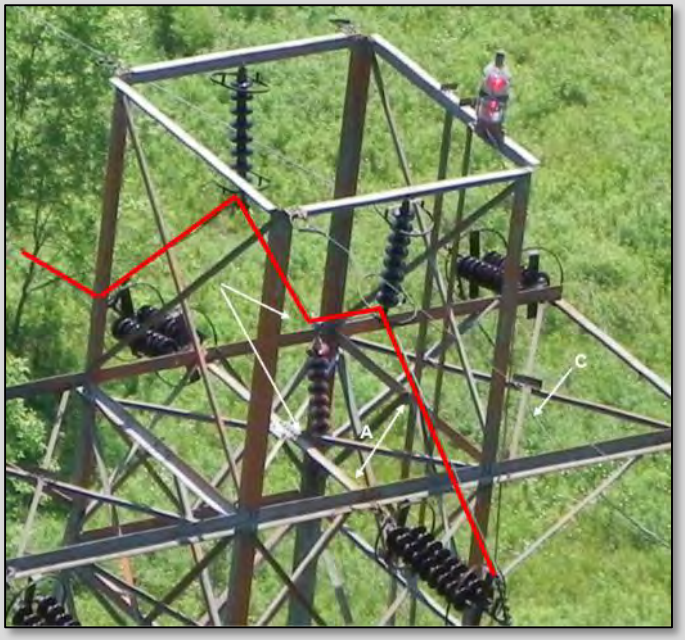
Intensive Use

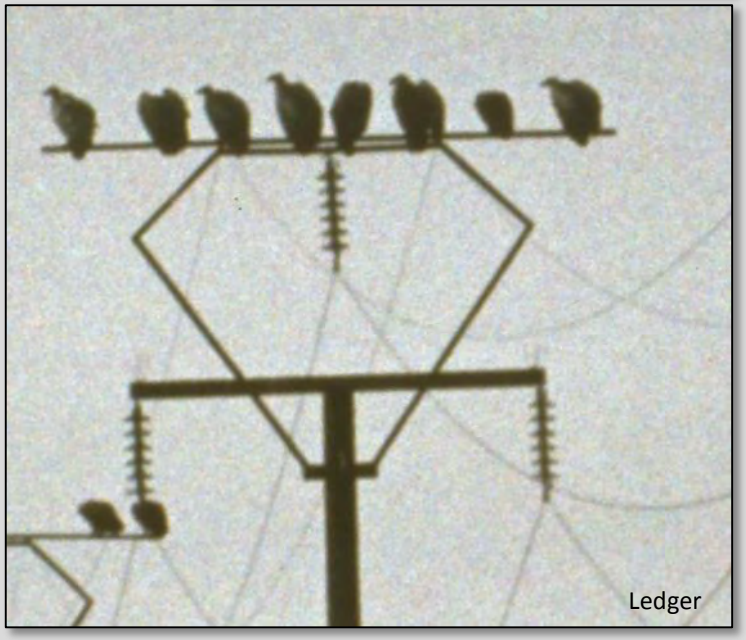
- Communal Roosts
- Foraging Areas
- Nests

Structure Vulnerabilities

- Small insulators & clearances
- But probs also possible @ 500kV
- Grounded perches above conductors
- Energized perches (posts) above grounded arms


T&D World, National Grid




Ledger

Pollution Culprits

ANY SIZE BIRD

- Flocking species
- Roosts
- Nests
- Favorite perches

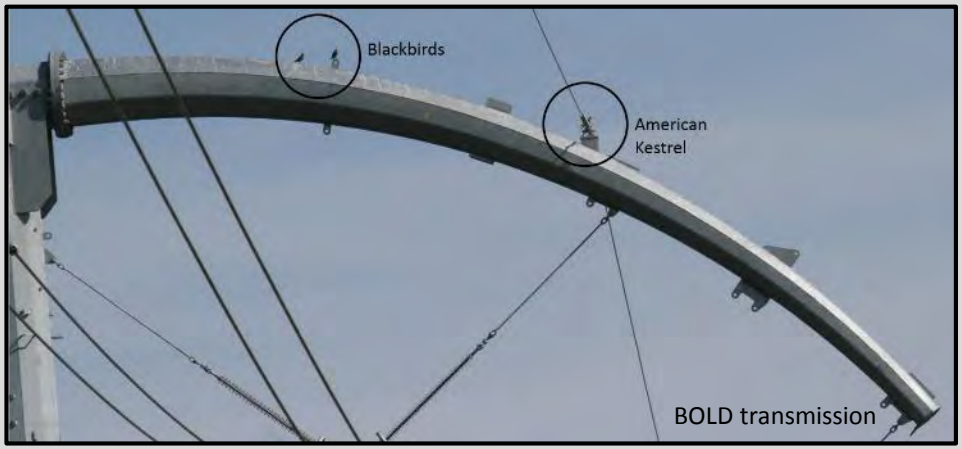
Structure Vulnerabilities

- Lattice towers
- V-strings
- Dry climates (?)

Feces Outage Prevention

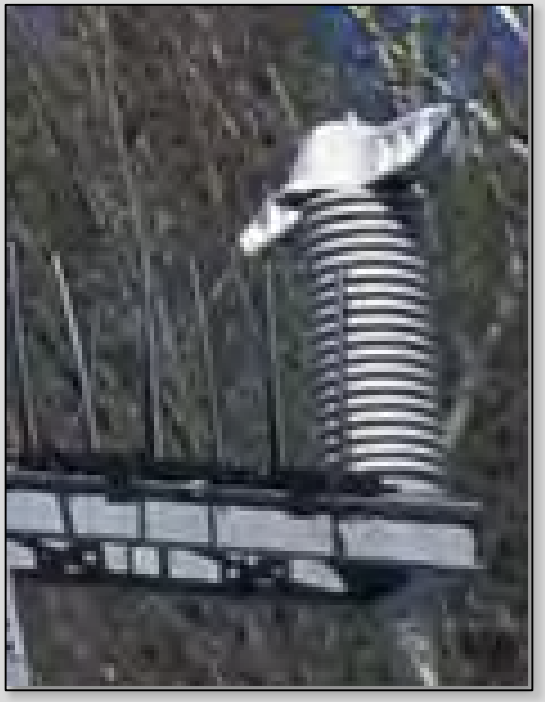
LIMIT PERCHING

- Davit arms & monopoles
  - Don’t accommodate huge flocks
  - Partially shield insulators
  - Easy to shift perching
- I-string insulators
  - Smaller target
  - Easier to mitigate, if necessary



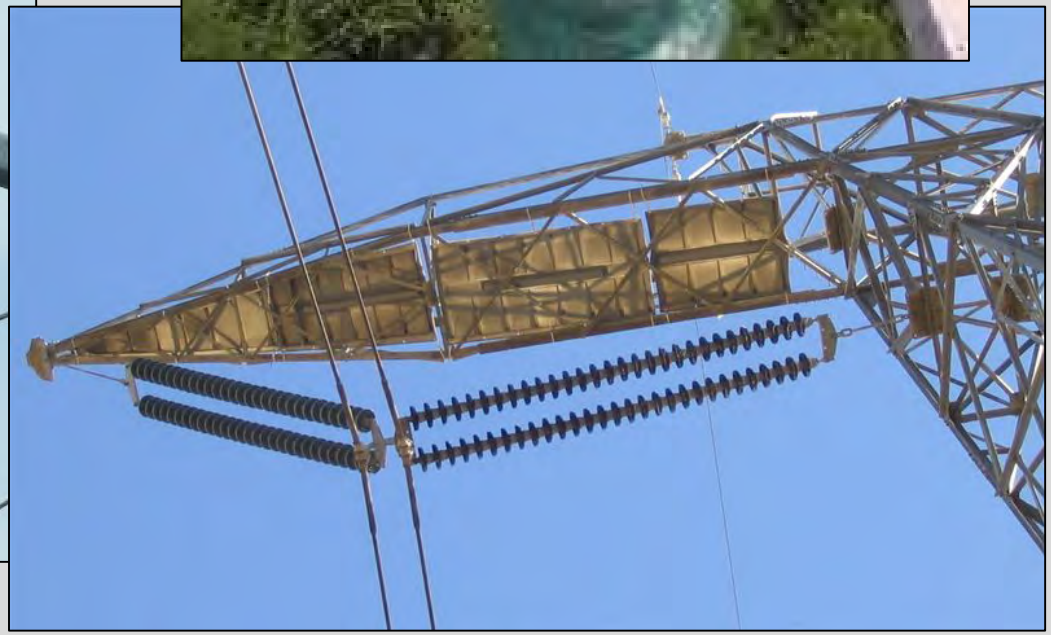
Streamer Mitigation

- Shift birds from vulnerable perches
- Barriers & shields
- Insulation (≤69kV)



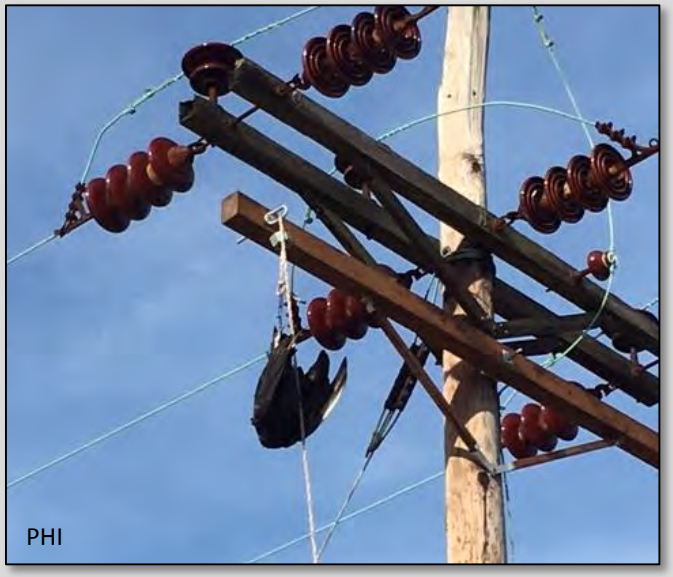
Pollution Mitigation

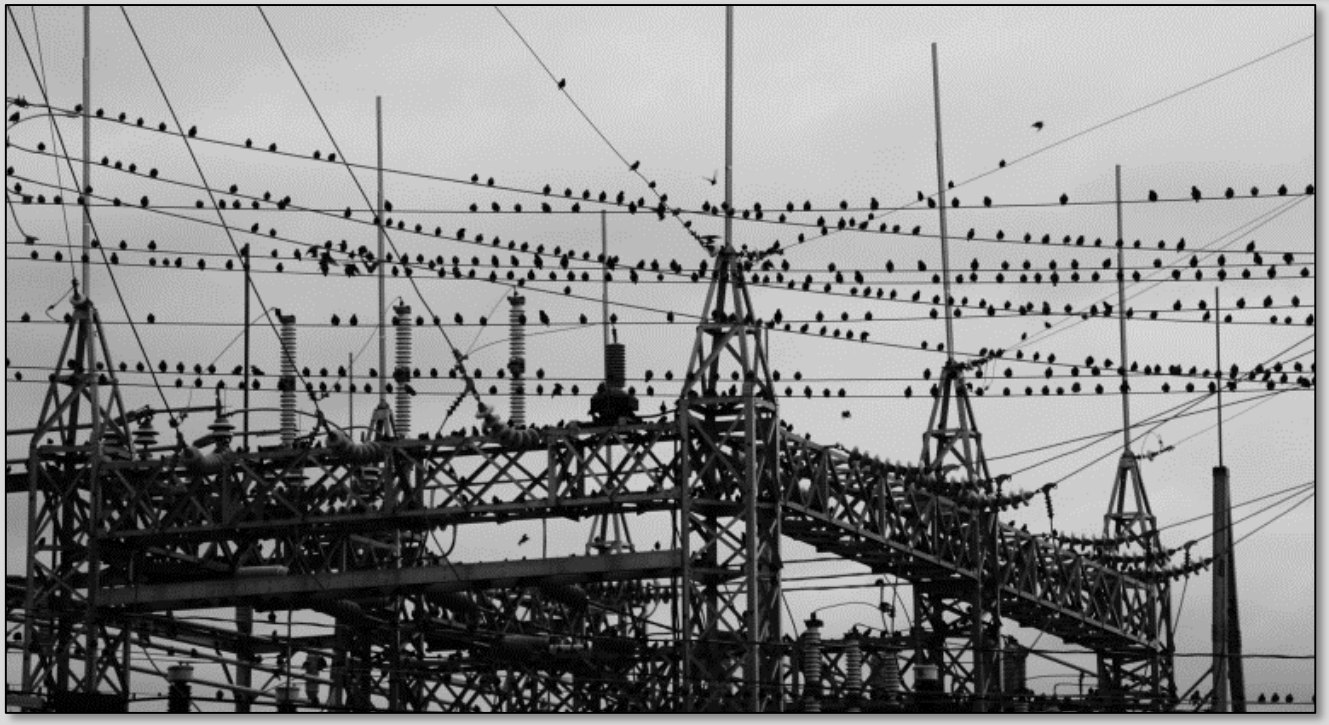
- Guano shields
- Buzzard guards
- Perch discouragers



Pollution in Substations

- Hazing (falcons, etc.)
- Depredation (trapping, etc)
- Effigies (vultures)
- Experimental: Methyl Anthranilate

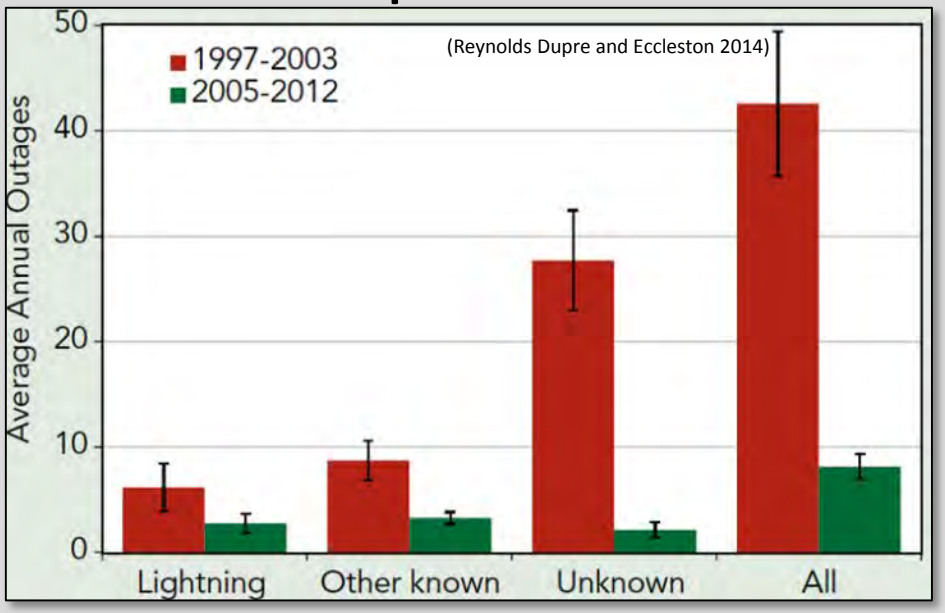




National Grid

69KV ELECTROCUTION + STREAMERS

- Unknown outages—streamers + electrocution
- Perch discouragers for electrocution
- Conductor covers for streamer protection



nationalgrid

5 AVIAN NESTING

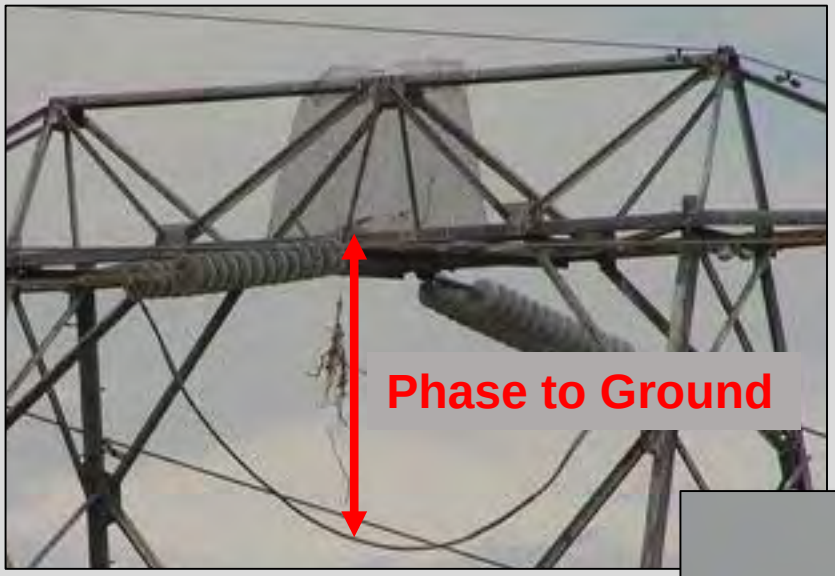
All Kinds of Nests

ONLY SOME PROBLEMATIC

Weaver Finches – South Africa

Little Falcon– South Africa

Problems: Debris



Red-tailed hawk nest – California USA

Osprey – New Jersey USA

Problems: Loading

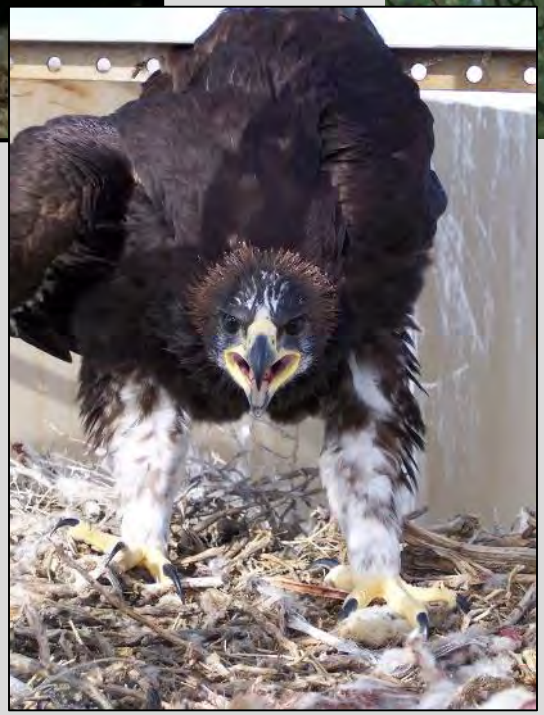
Osprey – Wyoming, USA

Problems: Loading

Pileated Woodpecker – Texas USA

Problems: Access


Imperial Eagle, Credit: Ivan Demeter

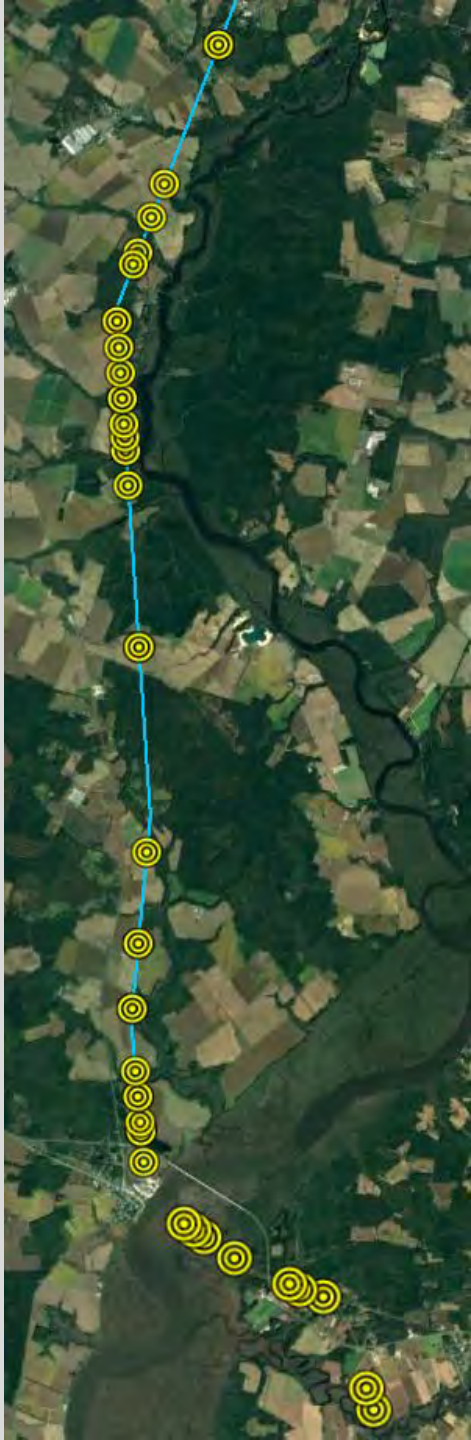

Golden Eagle Anadarko

Problems: Fire

https://www.youtube.com/watch?v=RvJDs4jSH9Y

Prevention: Routing

- Avoid good habitat with few alternative nest sites
- Avoid commanding views of foraging areas
- Expect nests when you violate these guidelines

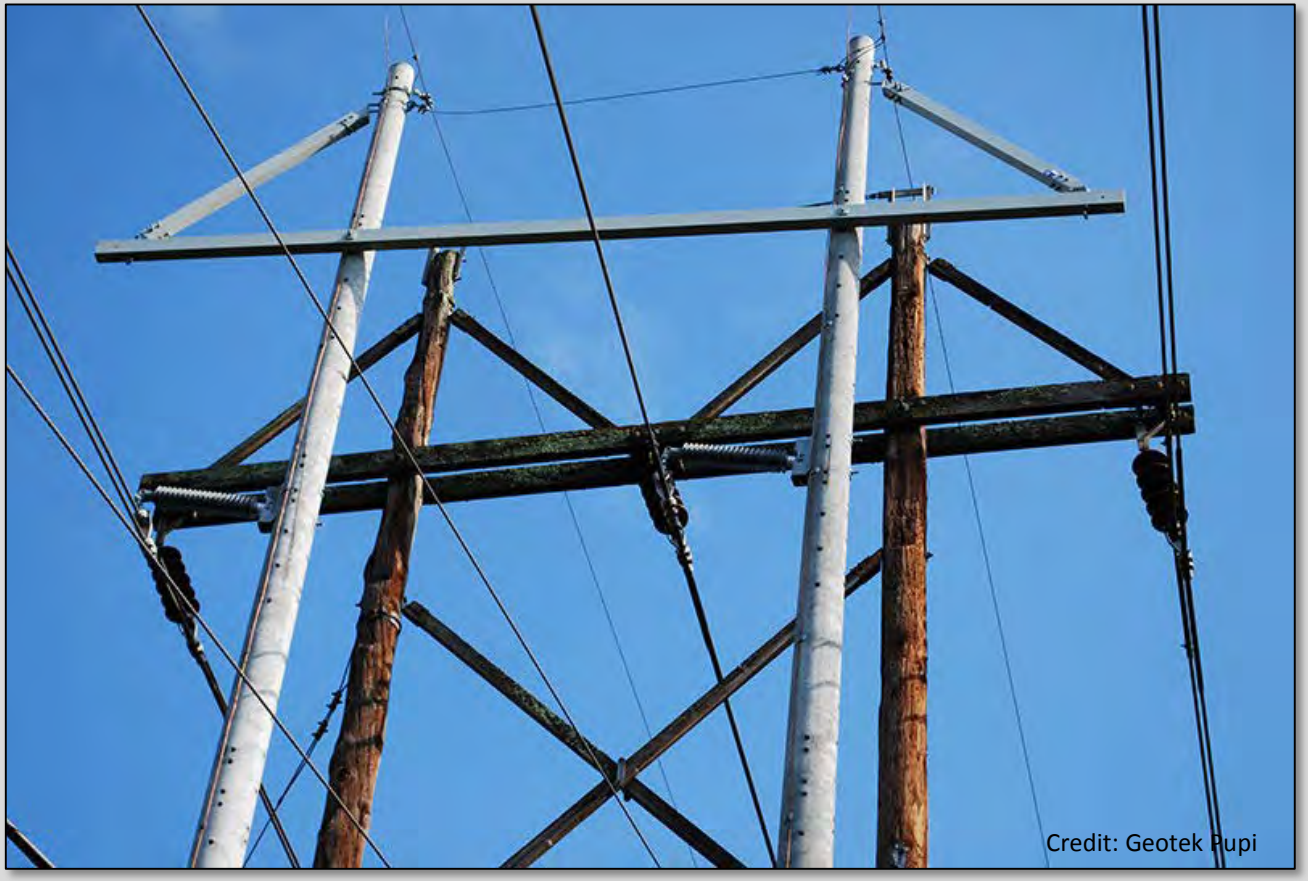


Prevention: Design (Transmission)

Monopole versus Lattice

Prevention: Design (Transmission)

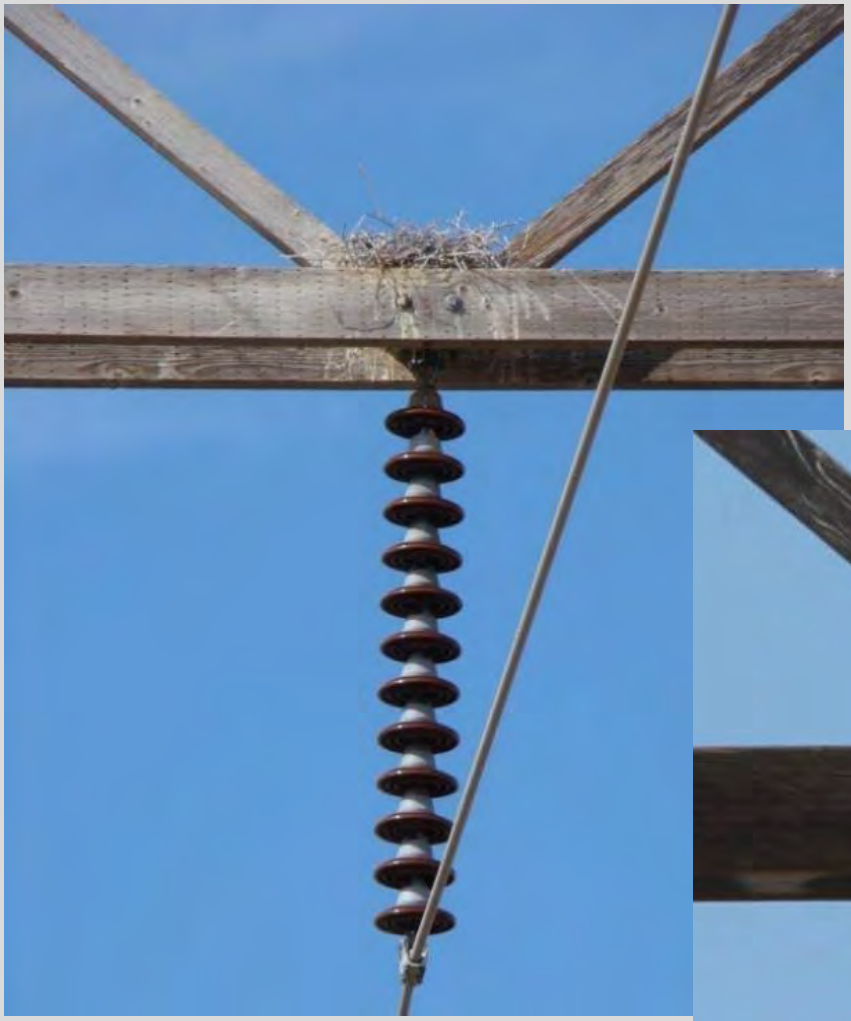
- Avoid double crossarms
- Avoid cellular attachments



Prevention: Design (Distribution)

- Avoid double crossarms

Mitigation: Stick Deflectors



Mitigation: Stick Deflectors

…BUT NOTHING IS 100%

Osprey – New Jersey USA

PHI

Photo Credits: PHI

Mitigation: Relocation

- Nest relocated away from the top of the V-strings…

Mitigation: Platforms

On-structure or on a nearby platform

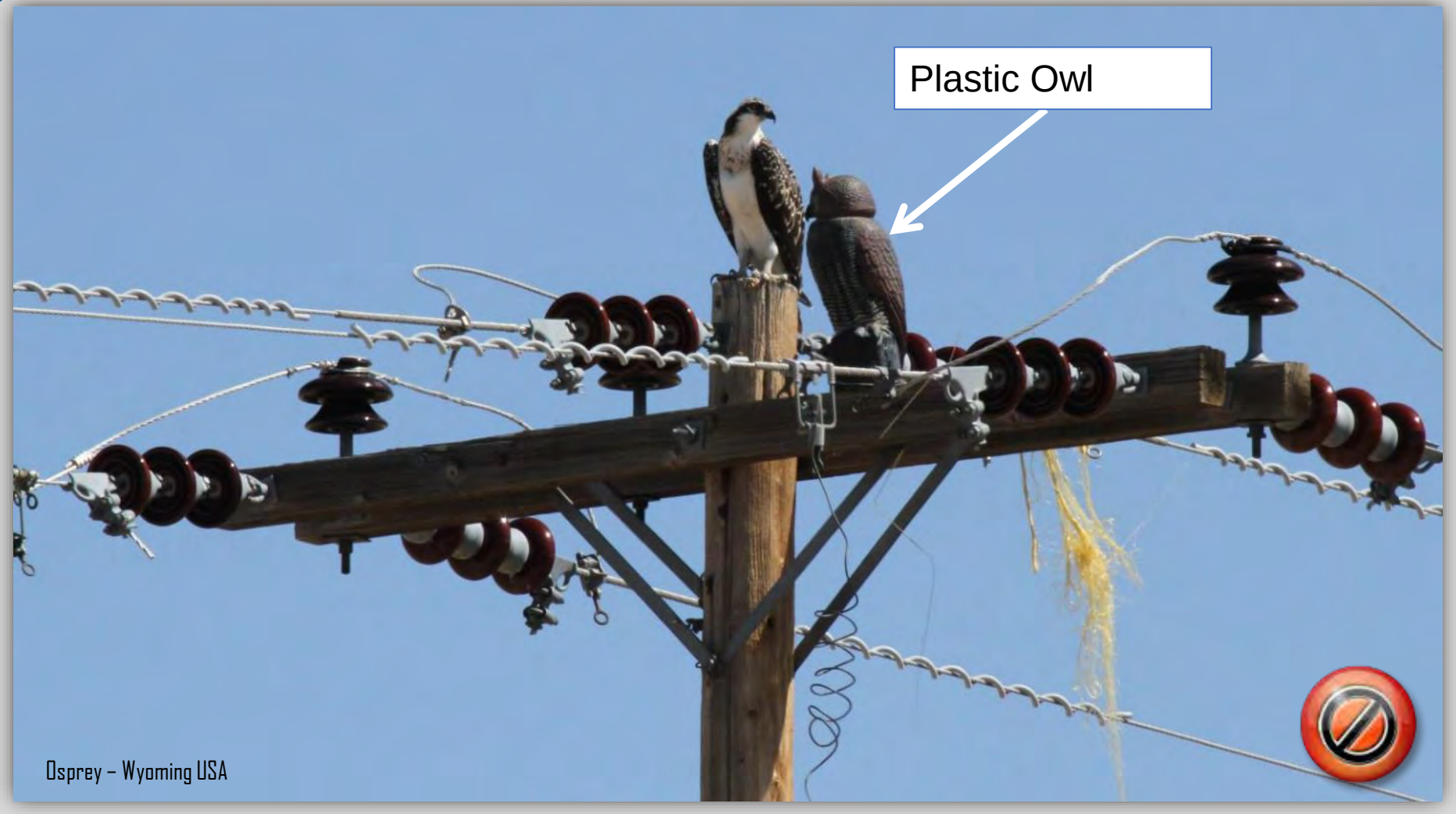
Mitigation: Platforms

On-structure or on a nearby platform

Missteps

- Avoid:
  - Elevated platform
  - Nesting material can fall into energized equipment.
  - Young can be electrocuted.
  - Cover all equipment.

Effigy



Missteps

Homemade units do not stand up to UV.

Nesting Conclusions

1. Best to Accommodate Nests
   - Prevents re-nesting
   - Birds will defend the territory
2. Platform Size is Critical
   - Osprey - 4’ x 4’
   - Eagle 5’ x 5’
3. Permits may be needed depending upon:
   - Species
   - Active or Inactive Nests

Osprey – Florida USA

6 THE POWER OF PLANNING

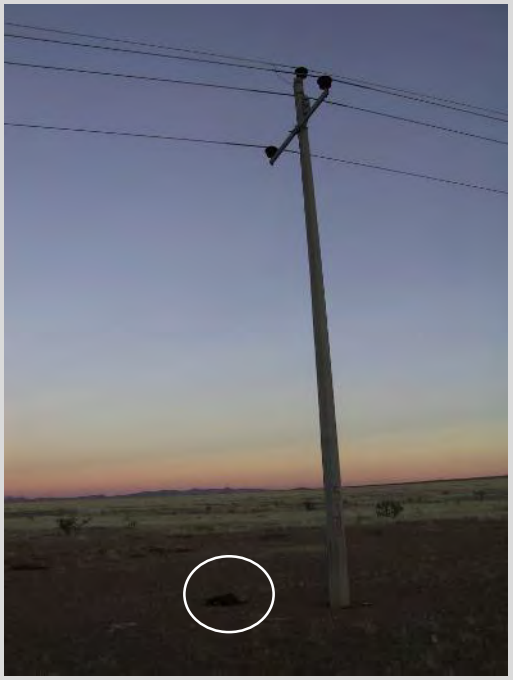
Worldwide Raptor Protections

- US, Canada, Mexico, Russia, Japan: Migratory Bird Treaty Act
- India: Wild Life Protection Act
- European Union: Directive 2009/147/EC
- Other countries also may have relevant laws
- Applicability to power lines hinges on interpretation

Legal Protections

IMPLEMENTATION IS EVERYTHING

- Transnational Golden Eagles: US and Mexico
- Great Indian Bustard, Lesser Florican:
  - Decades of listing…
  - July 2019: Supreme Court appoints blue ribbon commission
  - Tasked with developing an emergency recovery plan



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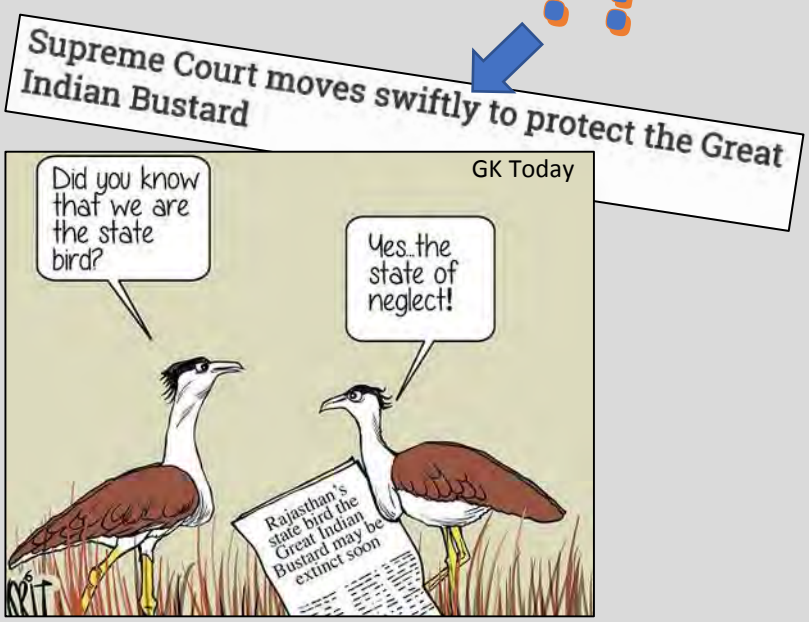


EDM Vision

DEVELOPMENT PROJECTS AS CONSERVATION VEHICLE

- Risk assessment focuses prevention and mitigation
- Capacity building grows local skills and investment
- Monitoring drives adaptive management, demos high line performance
- Performance and conservation is a strong case for wide adoption

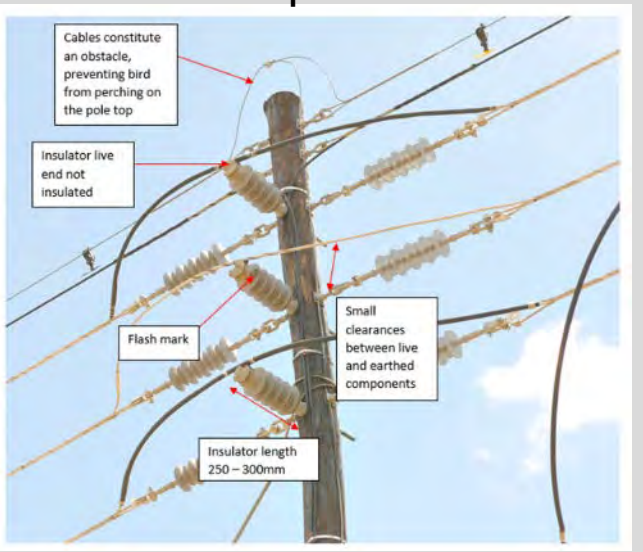
Funding…With Safeguards

INTERNATIONAL BEST PRACTICES

- IFC PS1, PS6
- World Bank ESS1, ESS6
- Equator Principles
- Nearly all energy projects have a potential avian tie—some important, some not.
- Awareness of potential avian-power line interactions during scoping

Wind farm…

…and lethal power lines



Dasu, Pakistan Transmission Line

WB FUNDED, AVIAN ISSUES FLAGGED

- 765kV transmission line along Indus River corridor
- Palas Valley: Isolated population of Western Tragopan, Himalayan Monal
- Line: habitat destruction, fragmentation, potentially avoidance
- Local partners made critical push for avoidance pre-EDM

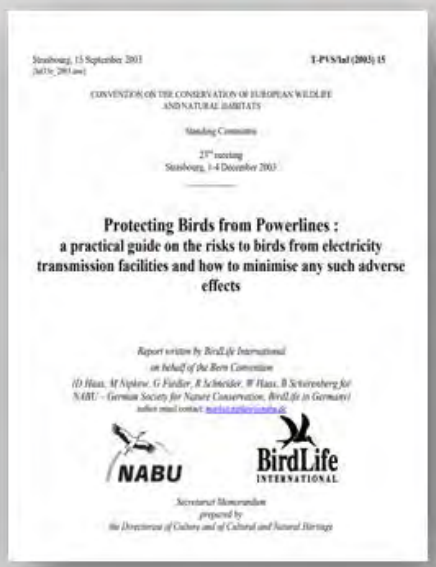
Avian-Power Line Risk

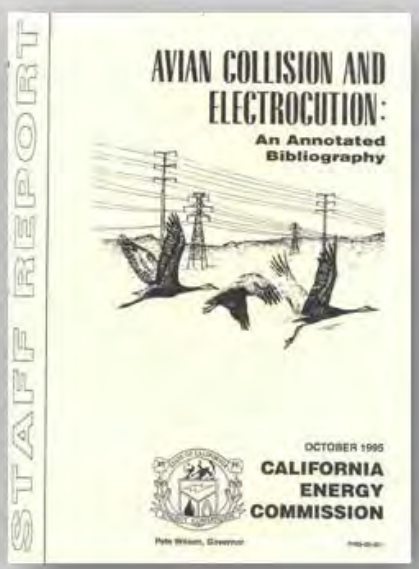
RIPE FOR AVOIDANCE

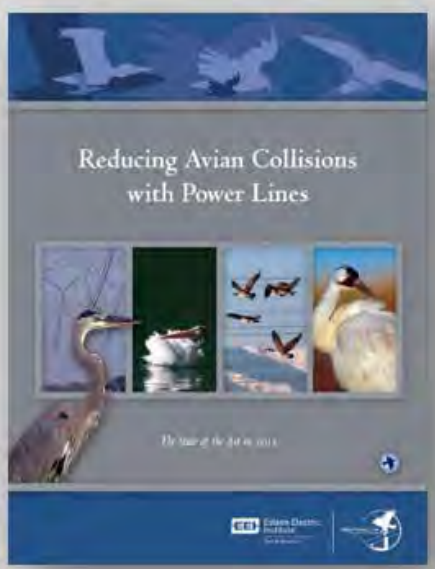
- Risk is concentrated
- Avoidance is very effective
- Avoidance is inexpensive
- Avoidance can improve system performance
- Avoidance requires awareness and planning
- Project funders have the information and levers to implement solutions

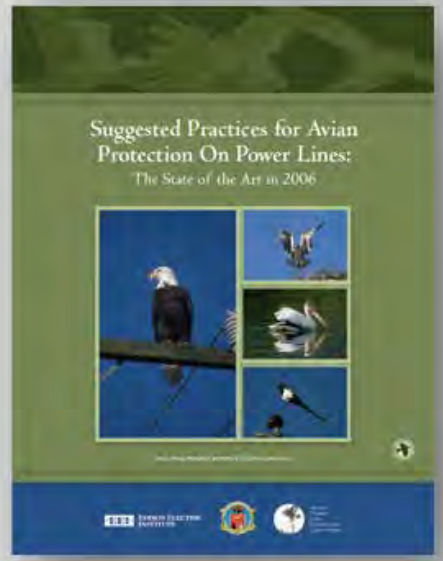
7 ADDITIONAL RESOURCES

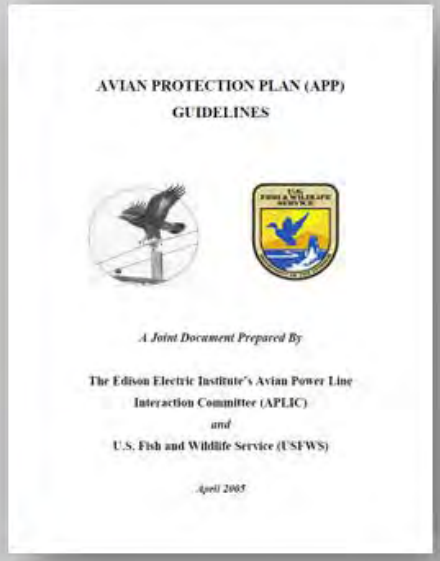
Further Resources:

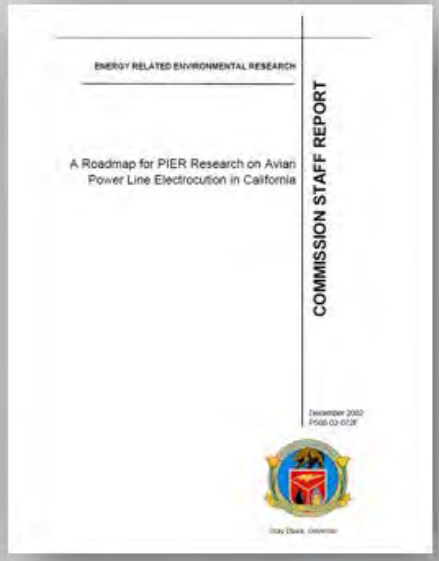


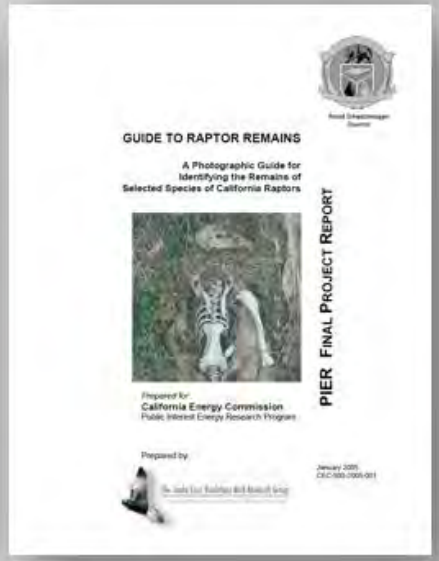




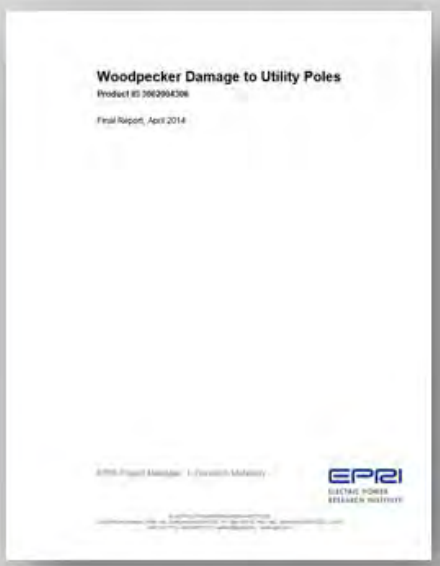


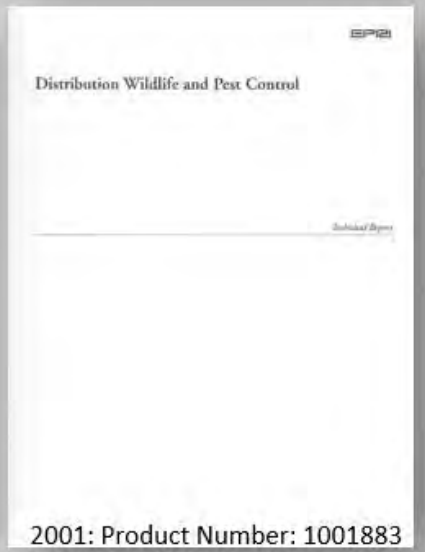






Further Resources:





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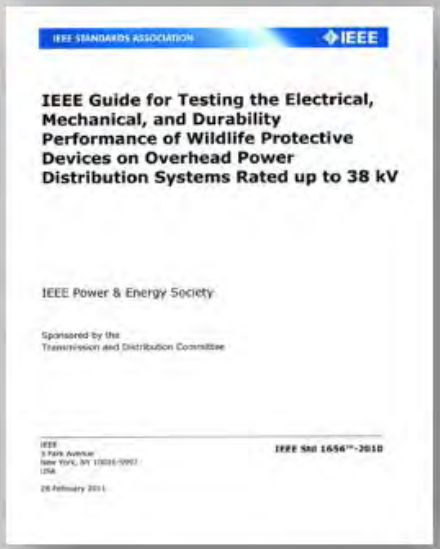

Acknowledgements

- Avian Power Line Interaction Committee (APLIC)
- California Energy Commission
- Colorado State University (CSU)
- Edison Electric Institute (EEI)
- Electric Power Research Institute (EPRI)
- National Rural Electric Association (NRECA)
- Predatory Bird Research Group
- Rural Utilities Service (RUS)
- Southern California Edison (SCE)
- Tri-State Generation and Transmission
- U.S. Fish and Wildlife Service (USFWS)
- Western Area Power Administration

Rick Harness and Duncan Eccleston

EDM International, Inc.
4001 Automation Way
Fort Collins, CO 80525 USA
01-970-204-4001
rharness@edmlink.com
deccleston@edmlink.com