(847) 345-8730

Environmental Issues with Wind Development: What Research and Monitoring Has Taught Us About Impacts from Wind Energy Development

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Environmental Issues - Agenda

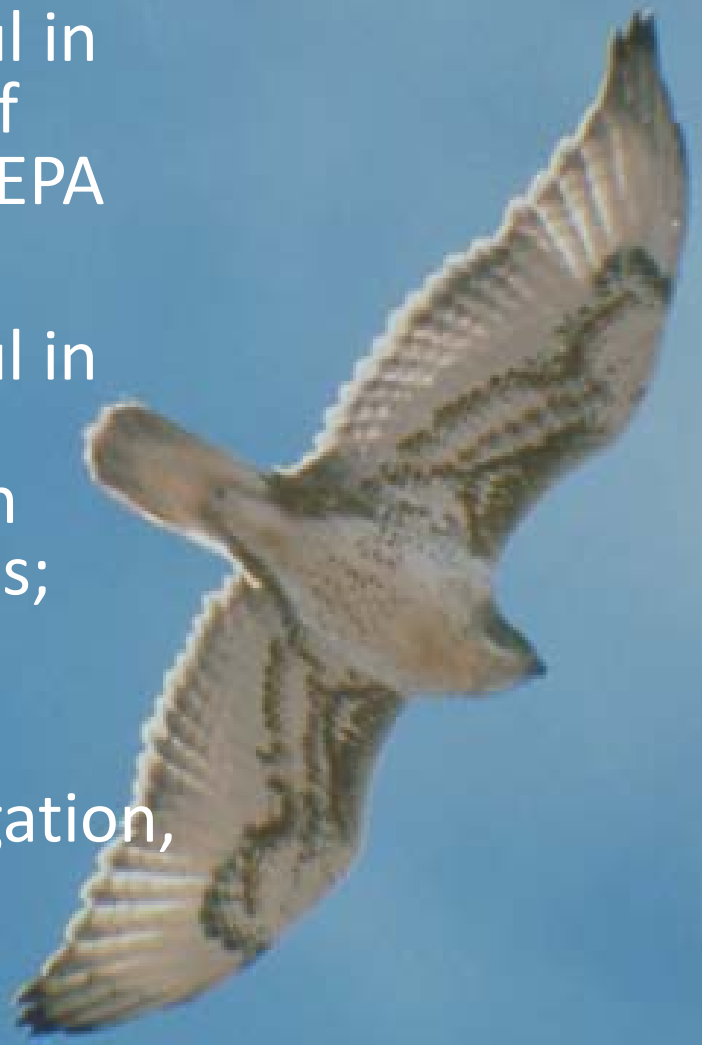
- **Impact Assessment – Approaches to Monitoring to Determine Impacts**
  - **Pre-construction studies – objective and studies**
  - **Post-construction studies – objectives and studies**

- What We Know / What we have learned from studying wind-wildlife interactions

- Mitigation Opportunities
  - Pre-construction – design phase mitigation
  - Construction
  - Post-construction – operation phase mitigation
  - Other Opportunities

PRE-CONSTRUCTION STUDY OBJECTIVES

1. Provide site specific data useful in estimating potential impacts of proposed projects, often for NEPA review
2. Provide site specific data useful in project planning – macro- and micro-scale siting; construction timing; sensitive resource areas; conservation measures; etc.
3. Provide recommendations for further studies, potential mitigation, and/or monitoring.

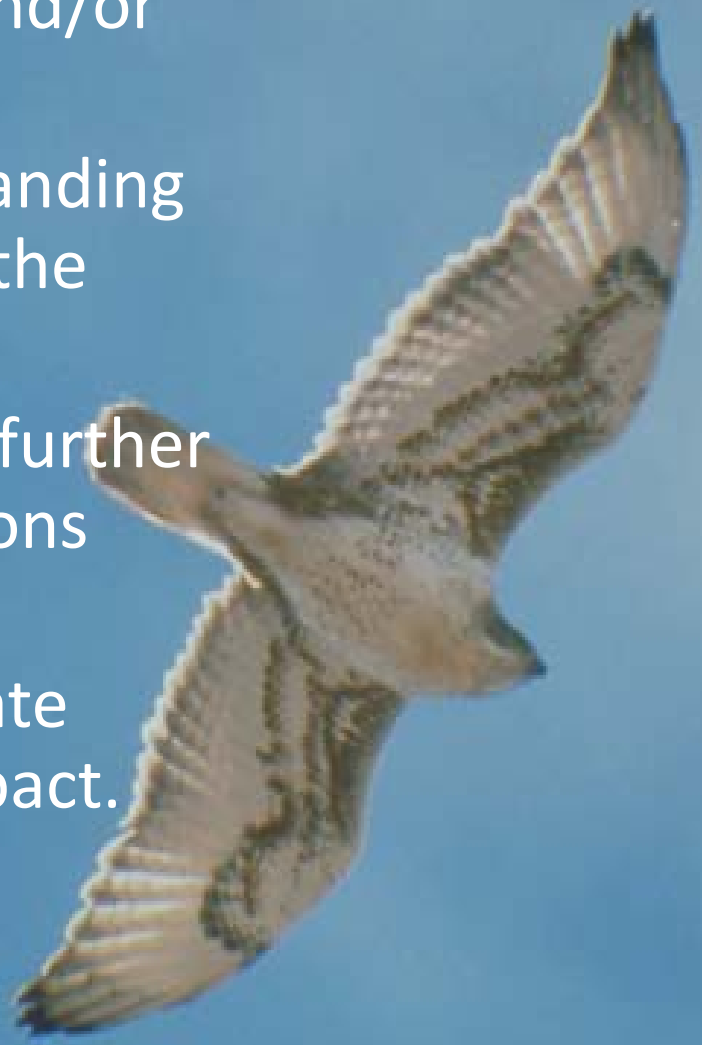


Pre-Project "Baseline" Studies (Tier 3)

- Typical Components:
  - Avian Use Surveys
  - Raptor Nest Surveys
  - Acoustic Bat Surveys
  - Sensitive Species Surveys
  - Habitat/Vegetation Mapping
- Others (project specific):
  - Other Bat Surveys (netting, caves)
  - Nocturnal Migration
  - Breeding Bird
  - Big Game Species
  - Lek Surveys
  - Waterfowl Surveys
  - Prey Availability Surveys

POST-CONSTRUCTION STUDY OBJECTIVES

1. Measure the impact – direct and/or indirect impacts.
2. Provide data useful in understanding the interaction of wildlife and the facilities.
3. Provide recommendations for further studies or management decisions (adaptive management).
4. Provide the basis for appropriate mitigation – mitigating the impact.



Monitoring Studies - Mortality

- Components:
  - Standardized Casualty (fatality + injured) Searches.
  - Searcher Efficiency Trials.
  - Carcass Removal Trials.
  - Vegetation (visibility) and Plot Mapping

Research Studies – Disturbance - Tier 5

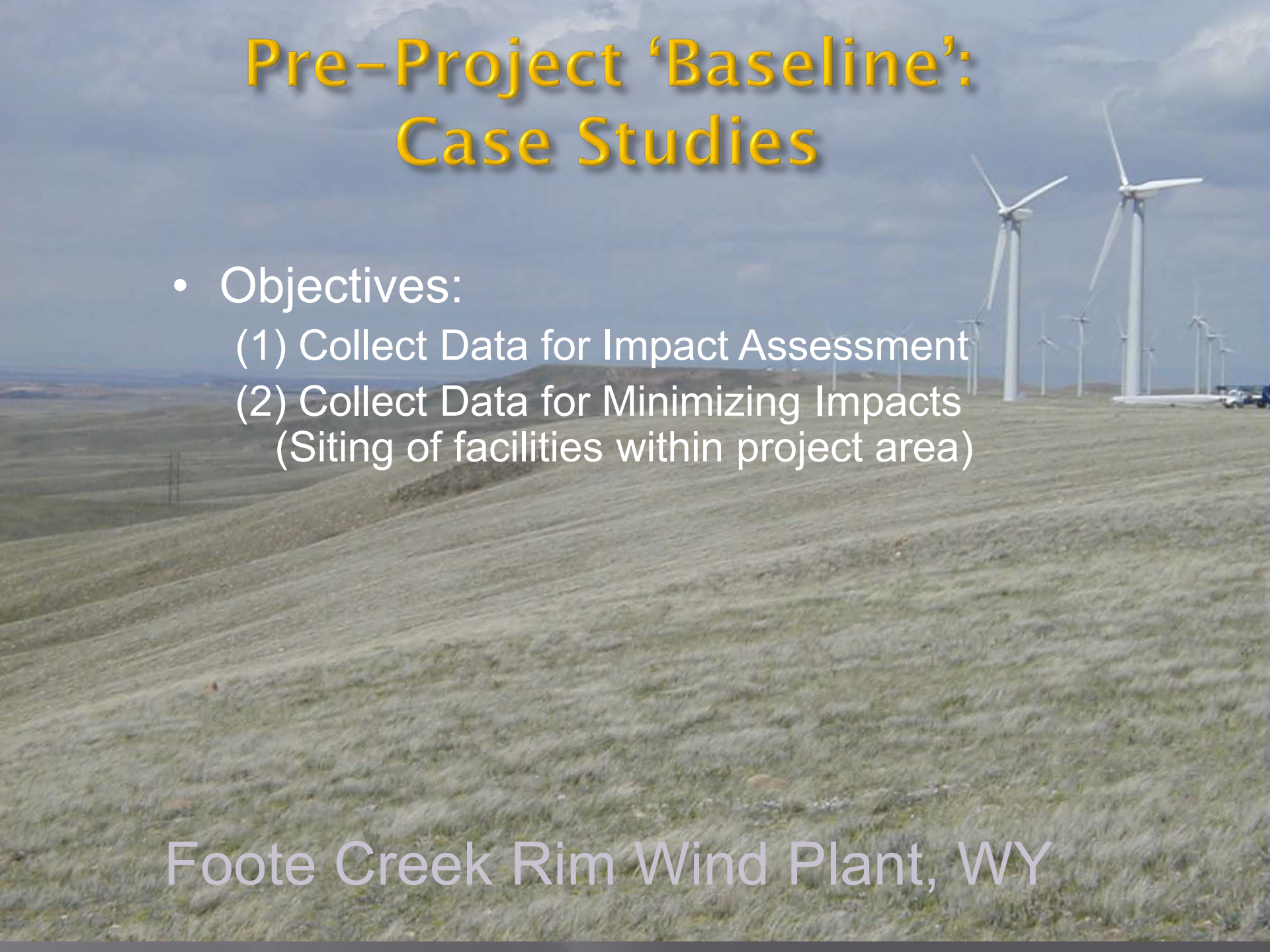
- Components:
  - Variable Depending on Species/Resource of Concern (e.g., breeding birds, nesting raptors, prairie grouse, sensitive species)
  - Breeding Bird surveys (e.g., point counts, transect surveys)
  - Raptor Nest Surveys and Monitoring.
  - Prairie Grouse - lek surveys, telemetry.
  - Big Game species - telemetry
  - Sensitive Species Monitoring.

Agenda

- Impact Assessment – Approaches to Monitoring to Determine Impacts
  - Pre-construction studies – objective and studies
  - Post-construction studies – objectives and studies
- **What We Know / What we have learned from studying wind-wildlife interactions**
  - **Avian Impacts**
  - **Bat Impacts**
  - **Habitat Impacts – Direct and Indirect**
  - **Other Wildlife**
- Mitigation Opportunities
  - Pre-construction – design phase mitigation
  - Construction
  - Post-construction – operation phase mitigation
  - Other Opportunities

Pre-Project 'Baseline': Case Studies

- Objectives:
  (1) Collect Data for Impact Assessment
  (2) Collect Data for Minimizing Impacts
  (Siting of facilities within project area)



Foote Creek Rim Wind Plant, WY

RAPTOR OBSERVATION DATA SHEET: FIXED POINT & INSTANTANEOUS COUNT *Foote Creek Rim Station D*

DATE 12/27/99 OBSERVER JG START TIME 1325 END TIME 1405 Page____of____

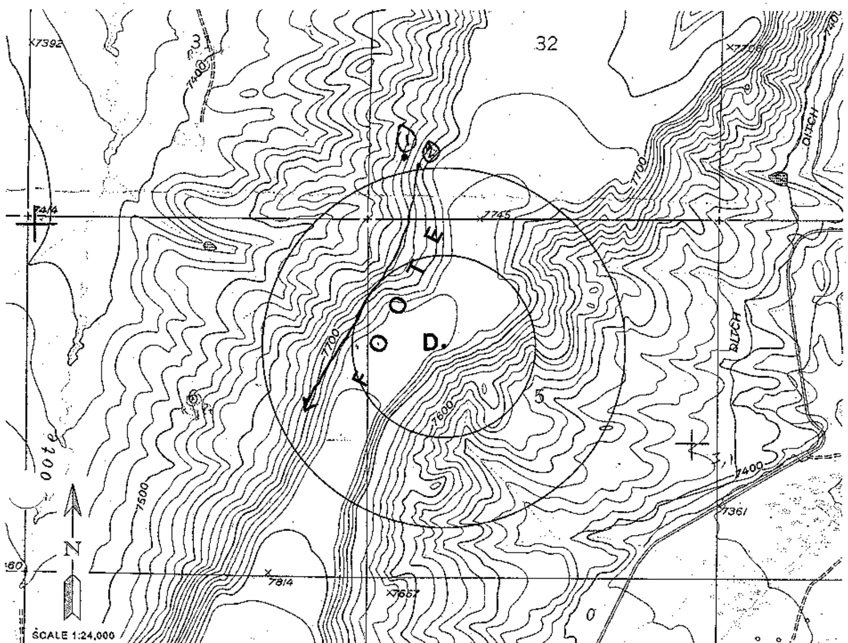
WEATHER: VISIBILITY(circle one) (good) fair poor CLOUD COVER(%) 2 TEMP(°C) 3

WIND: DIRECTION (circle one) N NE E SE S SW (W) NW n/a SPEED(kph) Low: 15 High: 80

PRECIPITATION(circle one) (none) light rain rain light snow snow sleet hail other ________

Obs. no.	Species	Sex	Age	No. of individs	Distance (m) from observer (√box <800m)	Activity	Flight Height (meters) P	1-18	19-62	63-100	>100	Direction of Flight	Habitat	Inst. Count (height/distance) I1	I2	I3	I4	I5	Notes
1	RLHA	u	u	1	900 ☐	PE SO| FL FH CS HU GL OT			30			N NE E SE S SW W NW CH| GP	SB AS SG| MM CO CR HA OT						
2	GOEA	u	u	1	850 ☐	PE SO| FL FH CS HU GL OT			30			N NE E SE S SW| W NW CH GP	SB AS SG| MM CO CR HA OT						
					☐	PE SO FL FH CS HU GL OT						N NE E SE S SW W NW CH GP	SB AS SG MM CO CR HA OT						
					☐	PE SO FL FH CS HU GL OT						N NE E SE S SW W NW CH GP	SB AS SG MM CO CR HA OT						
					☐	PE SO FL FH CS HU GL OT						N NE E SE S SW W NW CH GP	SB AS SG MM CO CR HA OT						
					☐	PE SO FL FH CS HU GL OT						N NE E SE S SW W NW CH GP	SB AS SG MM CO CR HA OT						
					☐	PE SO FL FH CS HU GL OT						N NE E SE S SW W NW CH GP	SB AS SG MM CO CR HA OT						

COMMENTS: ____________________

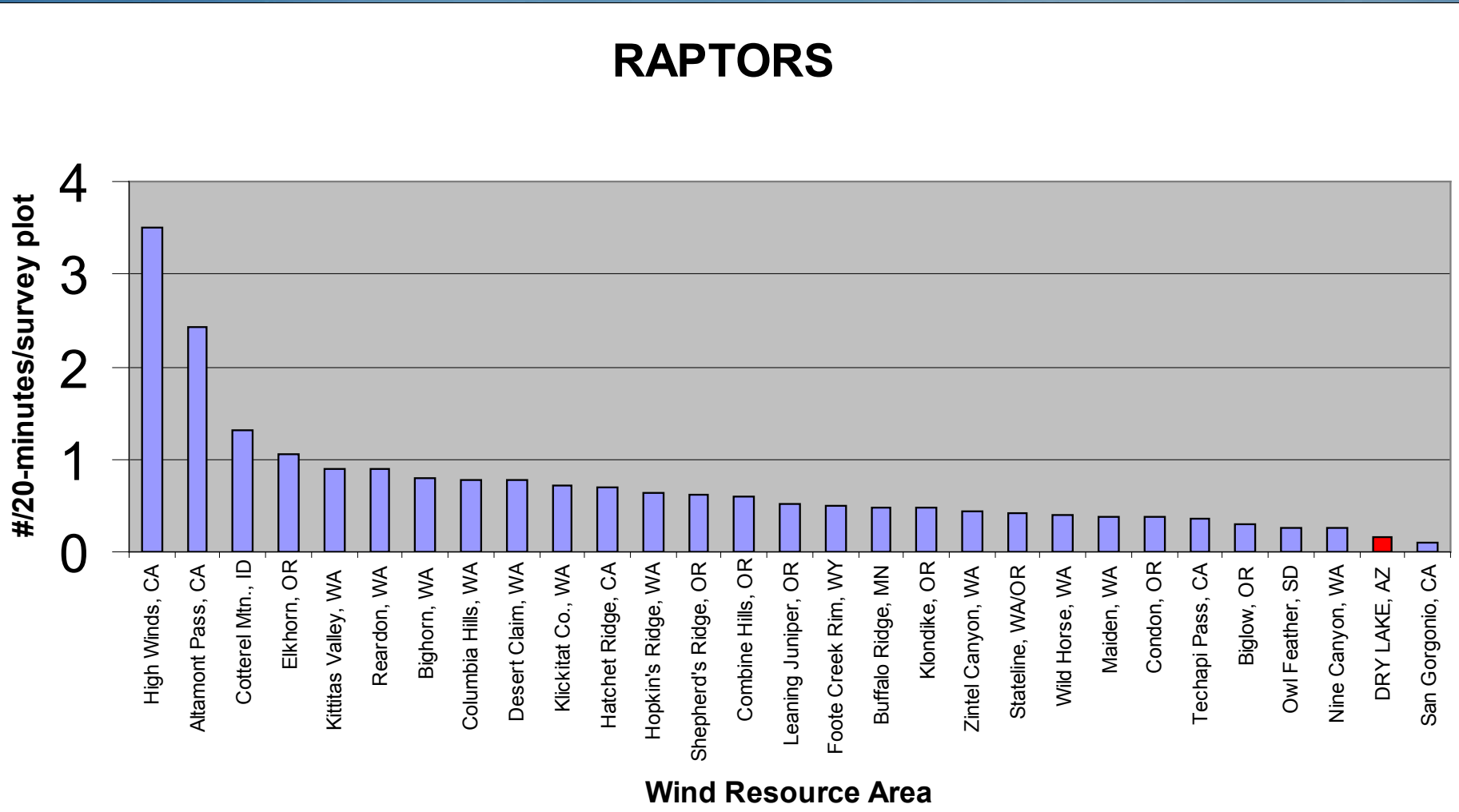


Pronghorn Observations		
Obs. no.	No. of Individs	Distance from (m) observer

Data Entry	
Entered by:	R6
Date entered:	10/15/00
Record Nos.:	3075 - 3076

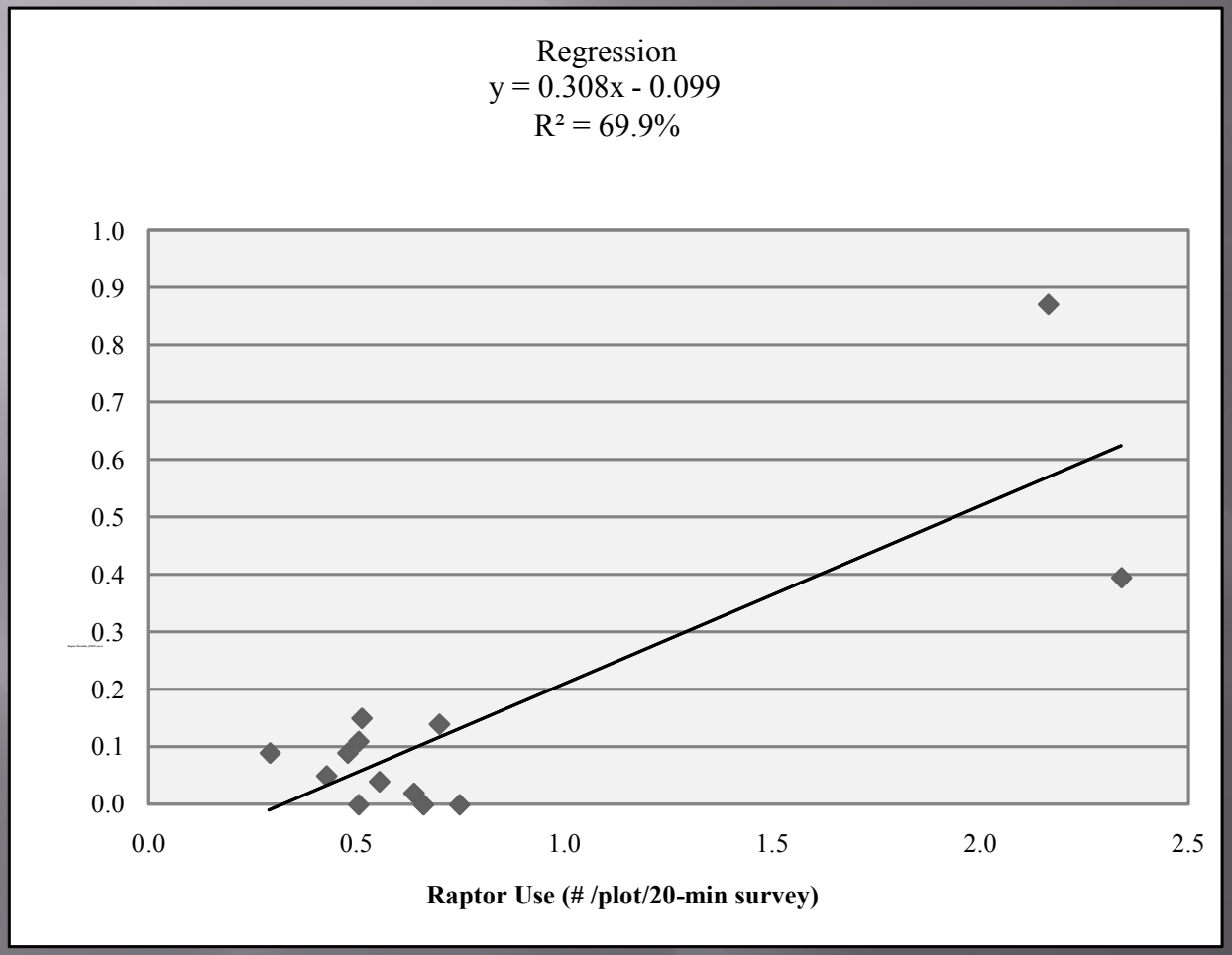
WYOMING WIND PLANT:
WILDLIFE MONITORING
STUDIES - 1998

Pre-Project "Baseline" Studies



Pre-Project "Baseline" Studies

(1) Impact Assessment: Estimating impacts to raptors based on pre-project use estimates.



Facilities

High Winds, CA

Diablo Winds, CA

Hopkins Ridge, WA

Klondike. OR

Klondike II. OR

Stateline. WA/OR

Nine Canyon, WA

Foote Creek Rim, WY

Vansycle, OR

Buffalo Ridge, MN

Combine Hills, OR

Wild Horse, WA

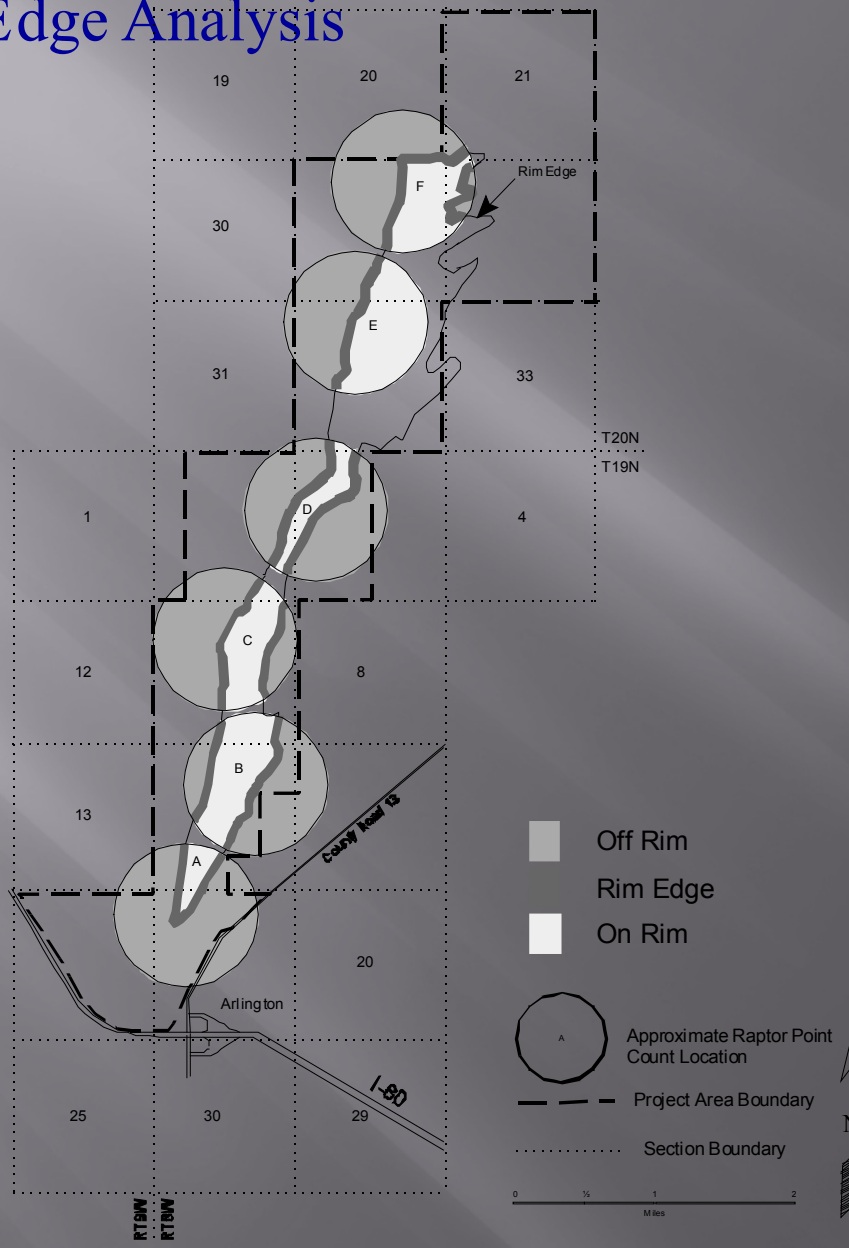
Zintel Canyon, WA

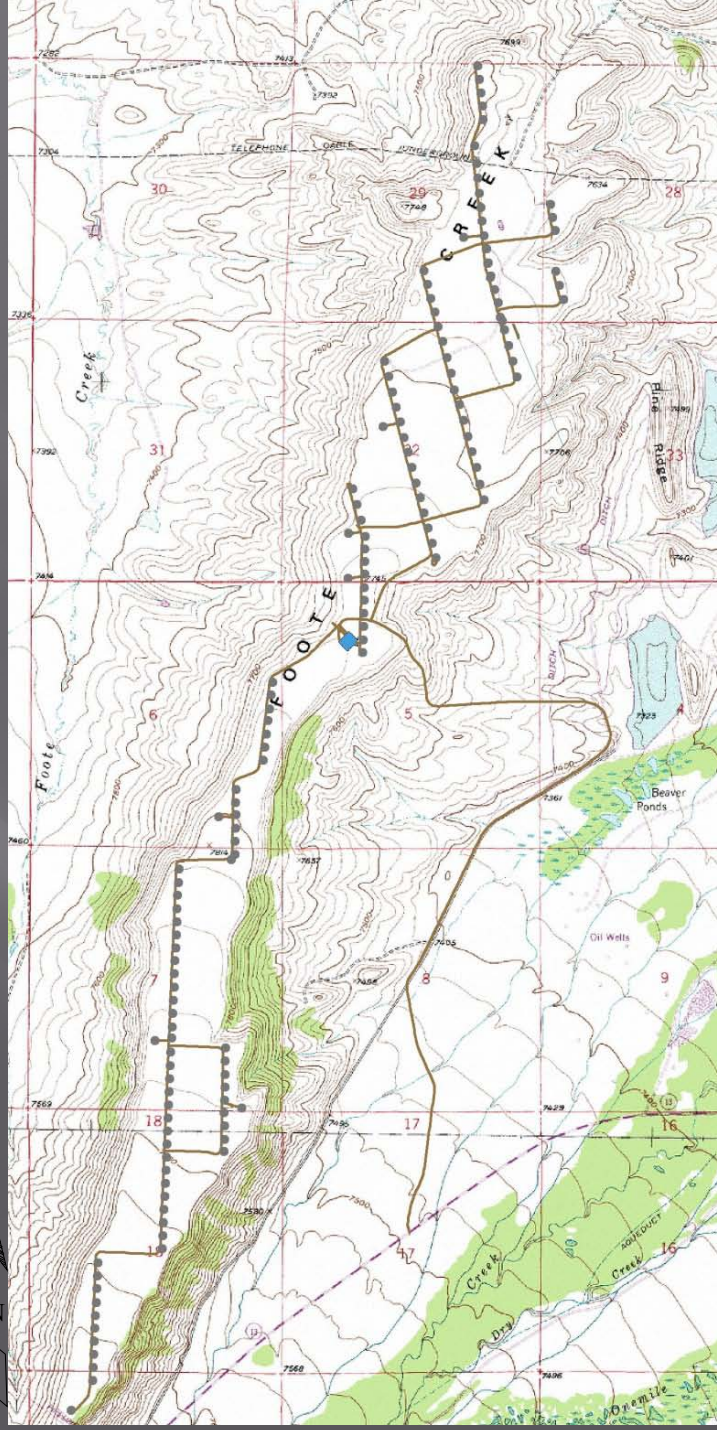
Bighorn, WA

Figure 1. Regression analysis comparing raptor use estimations versus estimated raptor mortality at Western U.S. wind resource areas.

Foote Creek Rim

Rim Edge Analysis



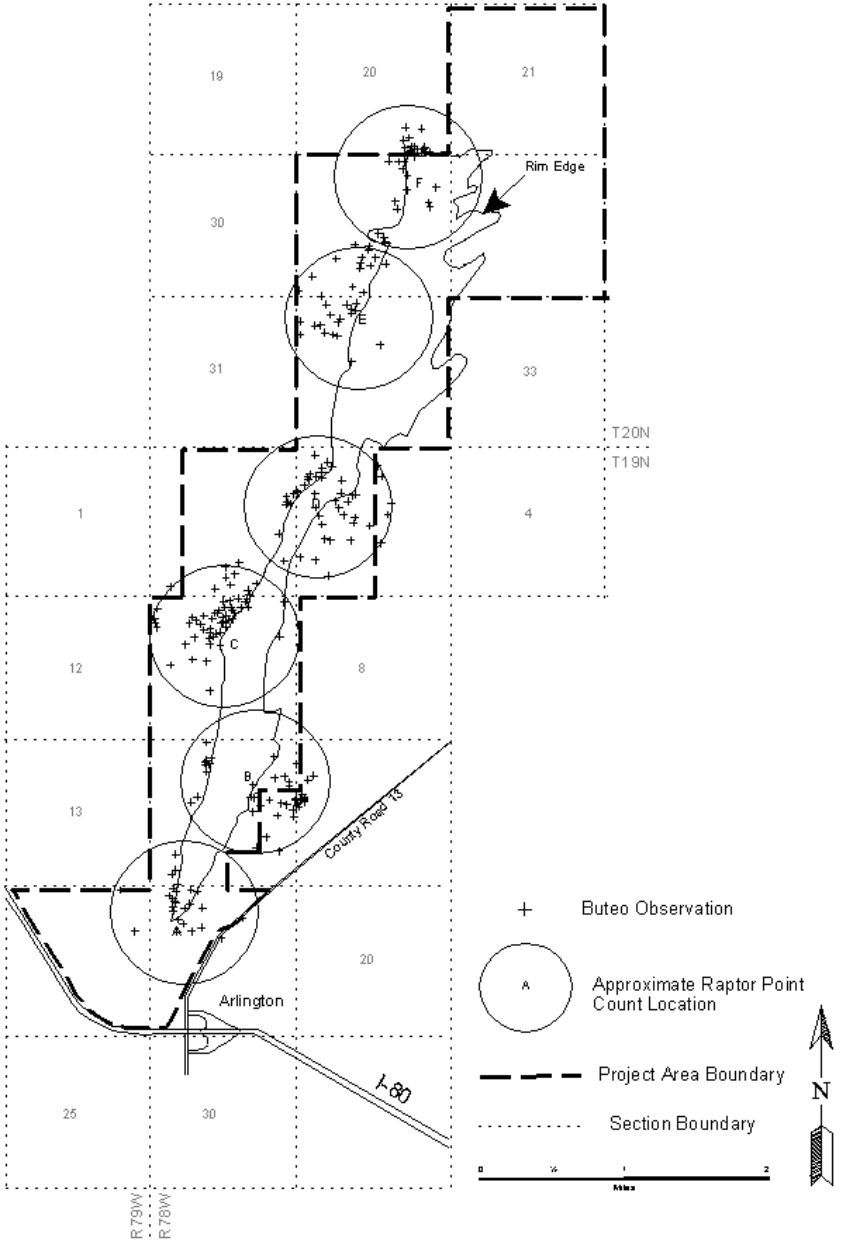


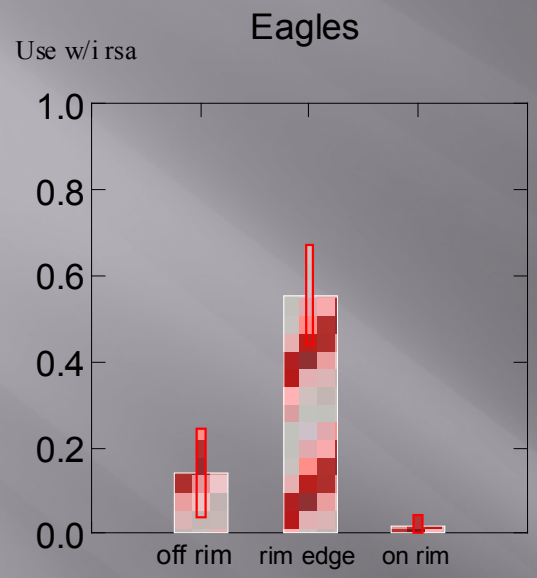
EAGLES

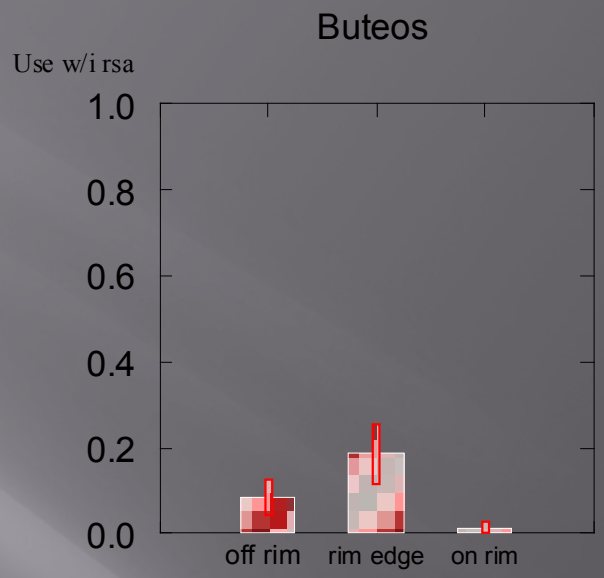
1999

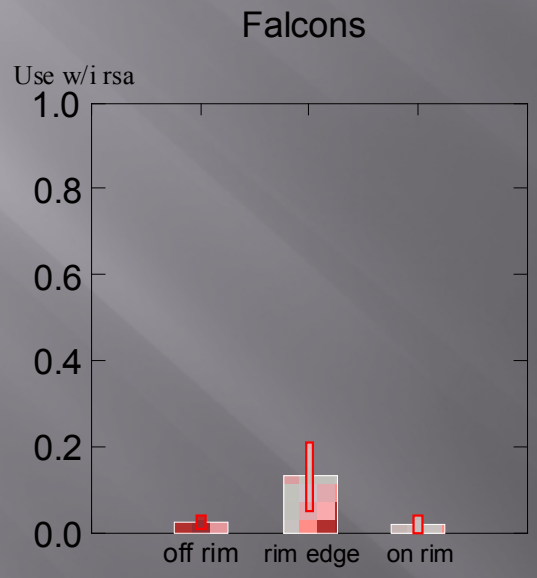
BUTEOS

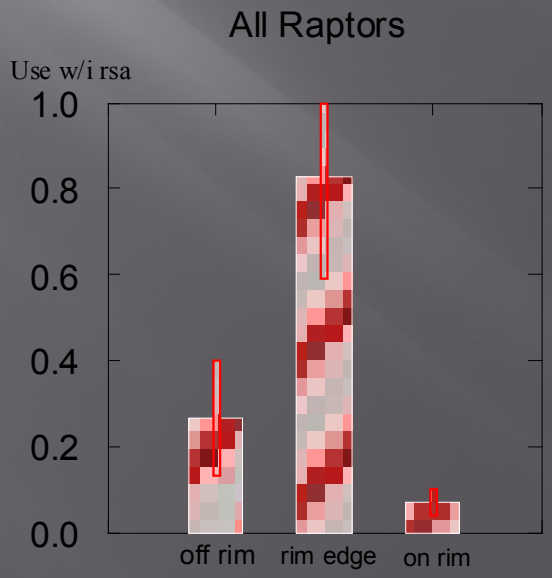
1999



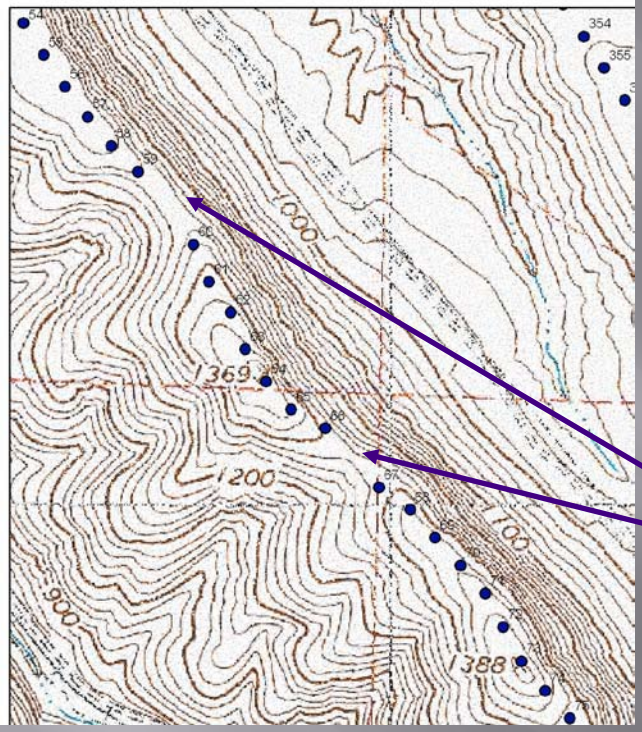

Eagles
Use w/i rsa
1.0
0.8
0.6
0.4
0.2
0.0
off rim
rim edge
on rim


Buteos
Use w/i rsa
1.0
0.8
0.6
0.4
0.2
0.0
off rim
rim edge
on rim


Falcons
Use w/i rsa
1.0
0.8
0.6
0.4
0.2
0.0
off rim
rim edge
on rim


All Raptors
Use w/i rsa
1.0
0.8
0.6
0.4
0.2
0.0
off rim
rim edge
on rim

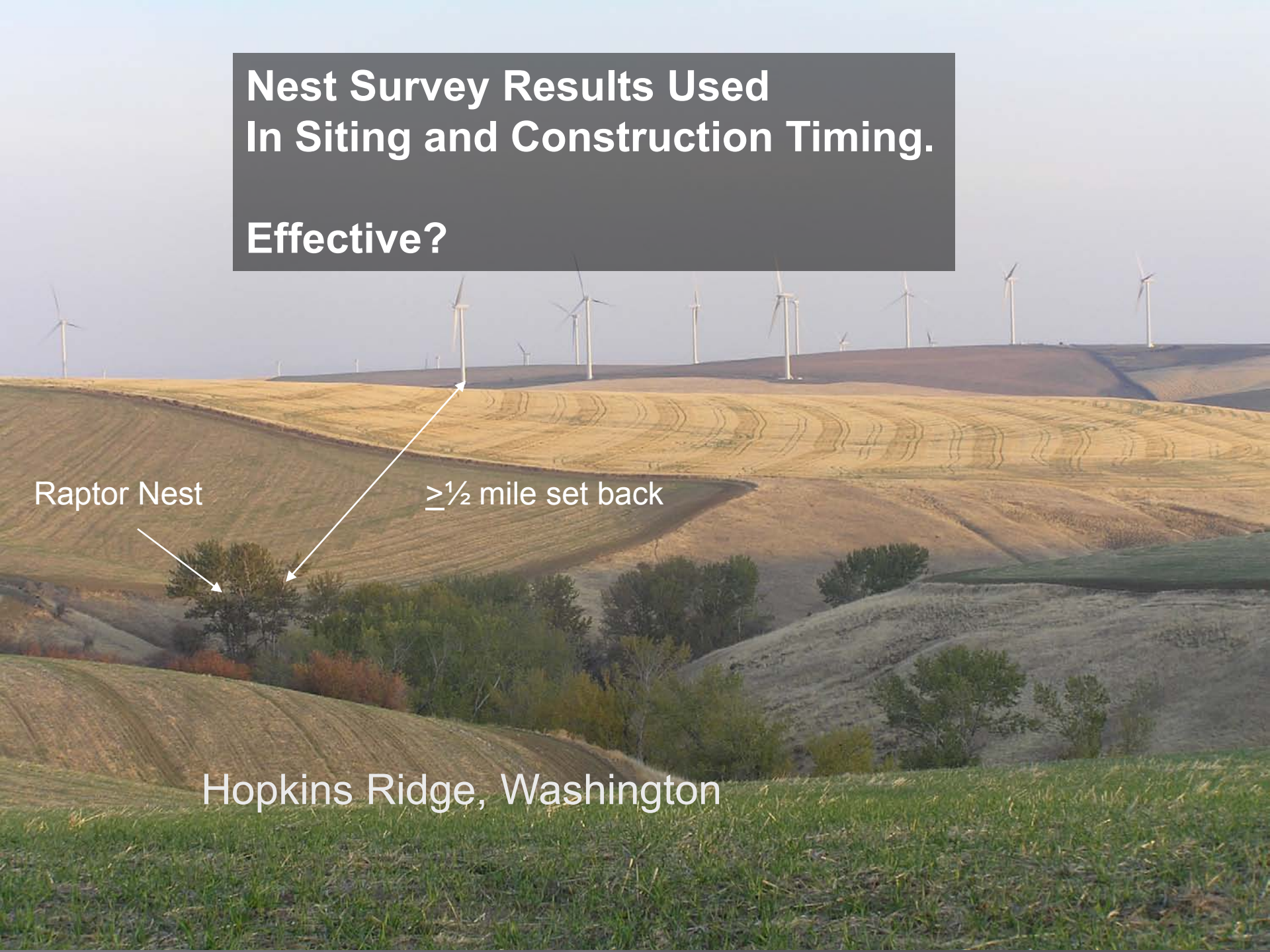

Recommended a minimum 50 m setback from edge.



Pre-project avian use data suggested higher bird use in "saddles" along ridges.

Recommendation:
Avoid Placing turbines
in prominent saddles

Stateline Wind Project, WA/OR

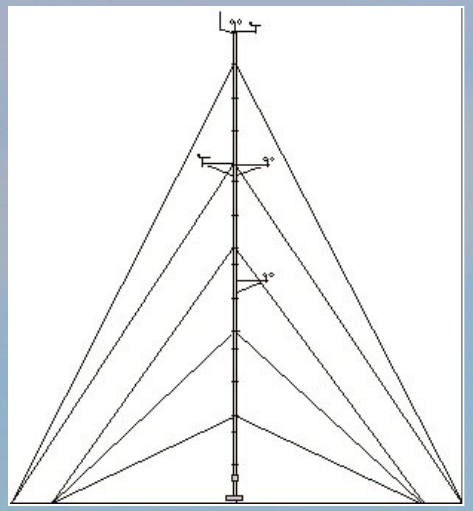

Nest Survey Results Used
In Siting and Construction Timing.
Effective?
Raptor Nest
≥½ mile set back
Hopkins Ridge, Washington

Use of similar efforts to address concern regarding golden eagles?

- Nest surveys – survey area?
- Nest setbacks useful?
- Use surveys – density of points?
- Duration?
- How demonstrate no net effect?

Avian Mortality – What have we learned?

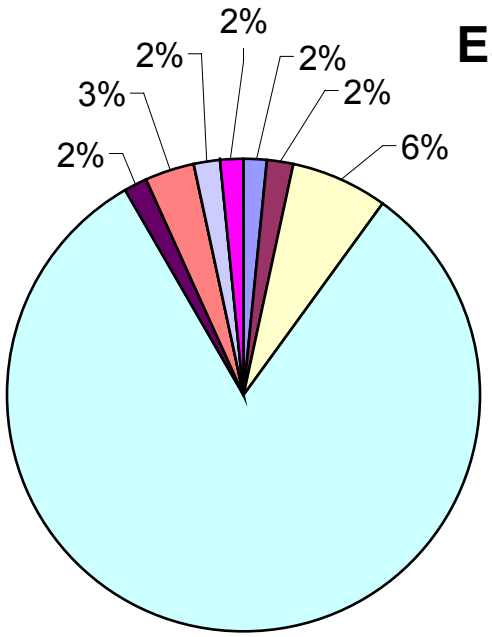
- Wind turbine collisions
- Met tower collisions
- Powerline collisions and/or electrocutions
- Vehicle collisions



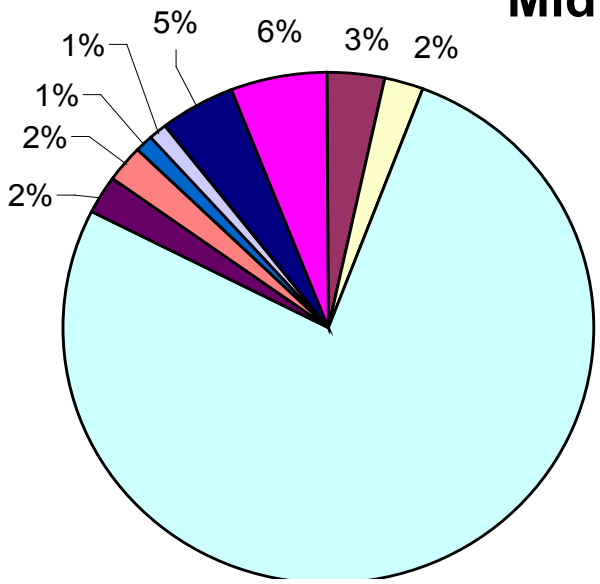
Composition of Avian Fatalities

- Songbirds
  - mixture of resident and nocturnal migrants
  - No large mortality events
- Upland Gamebirds
  - introduced species primarily in Pac-NW
  - Many or most unlikely turbine kills
- Raptors
  - American kestrels, red-tailed hawks, golden eagles, other species in fewer numbers
- Waterfowl
  - generally low numbers relative to amount of use
- Others
  - ravens and turkey vultures
  - often high use but low mortality

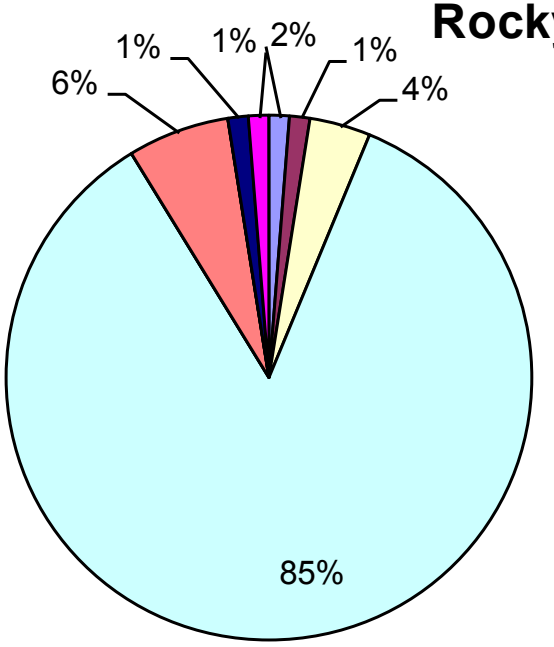
East Region



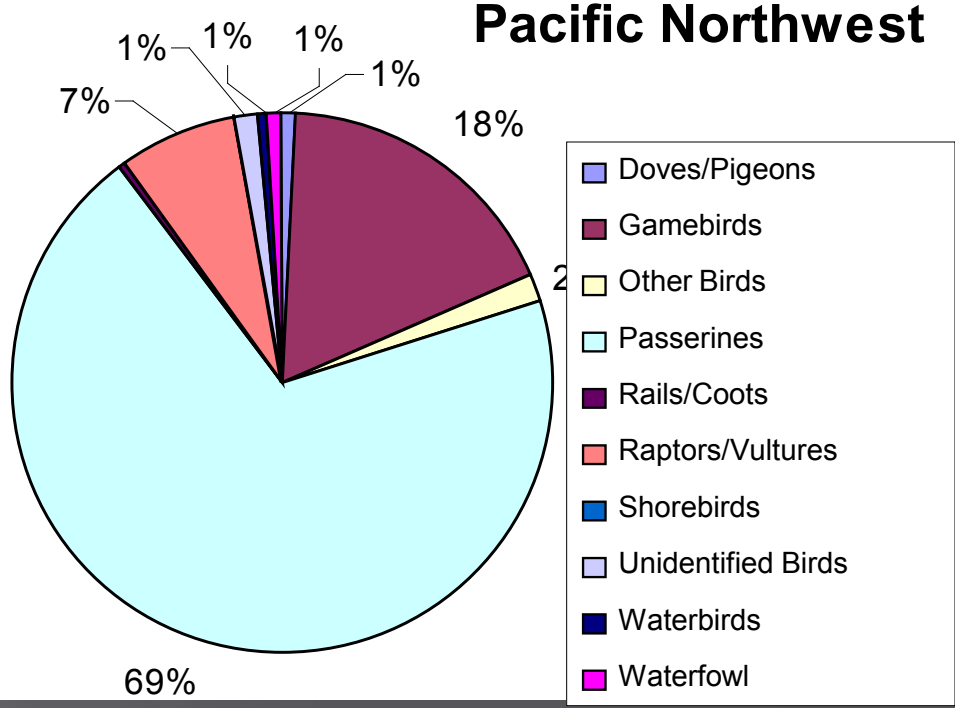
Midwest Region



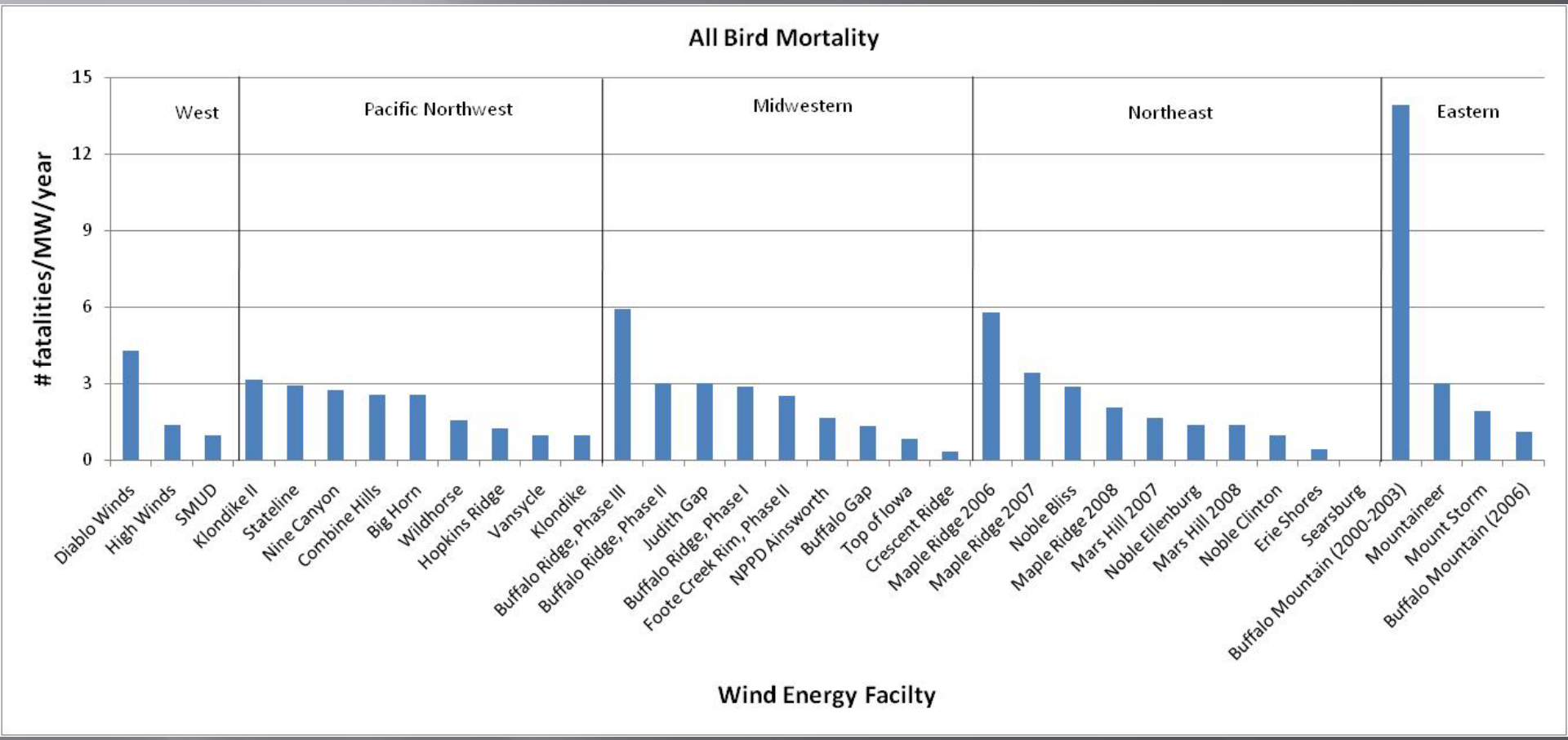
Rocky Mtn



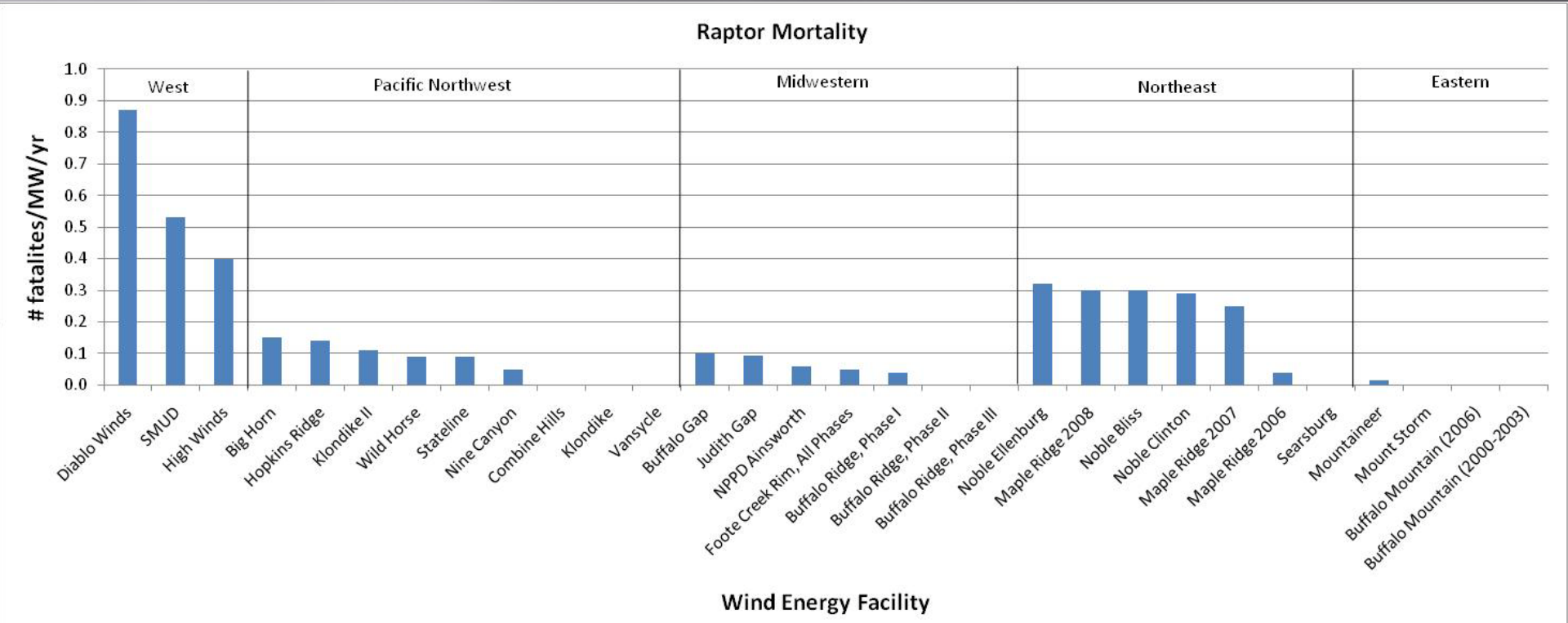
Pacific Northwest

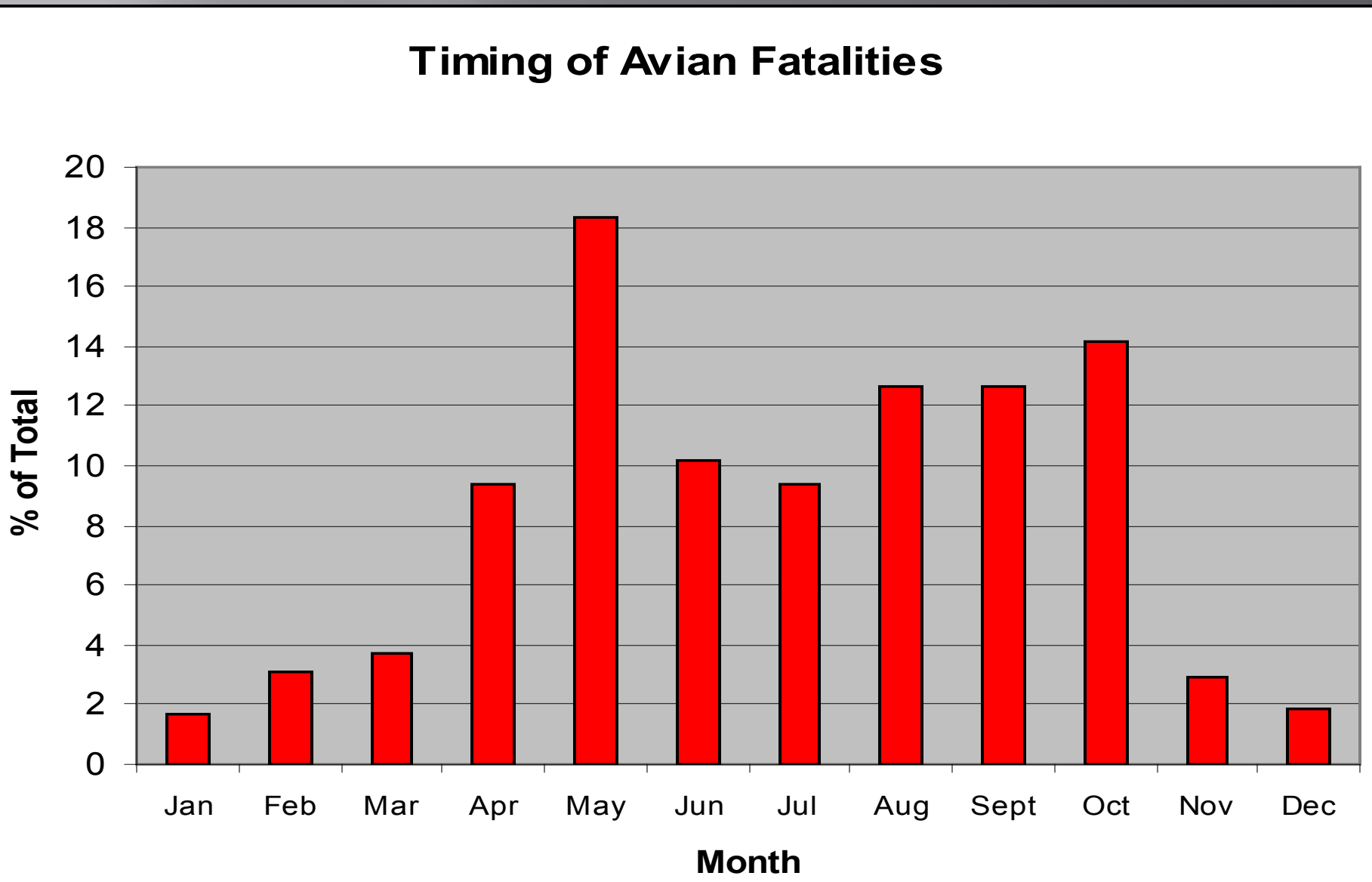


All Bird Mortality



Raptor Mortality




Timing of Avian Fatalities
% of Total
20
18
16
14
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
Month

What About Bats?

Pre-Project “Baseline” Studies

Pre-project Acoustic Data: Proceed with Caution

- Risk to bats is unequal across species and seasons – numerous studies have shown this.
- Can be misleading because effort, timing of sampling, detector settings (equipment and locations) variable among studies.
- Bats detected by recorders commonly are not species at highest risk.
- Results from some studies (Buffalo Mtn, TN, Alberta, Canada; Maple Ridge, NY) indicate that pre-project data is not predictive of mortality.
- Data shows a general association of mortality with timing of highest number of calls (Aug-Sep).

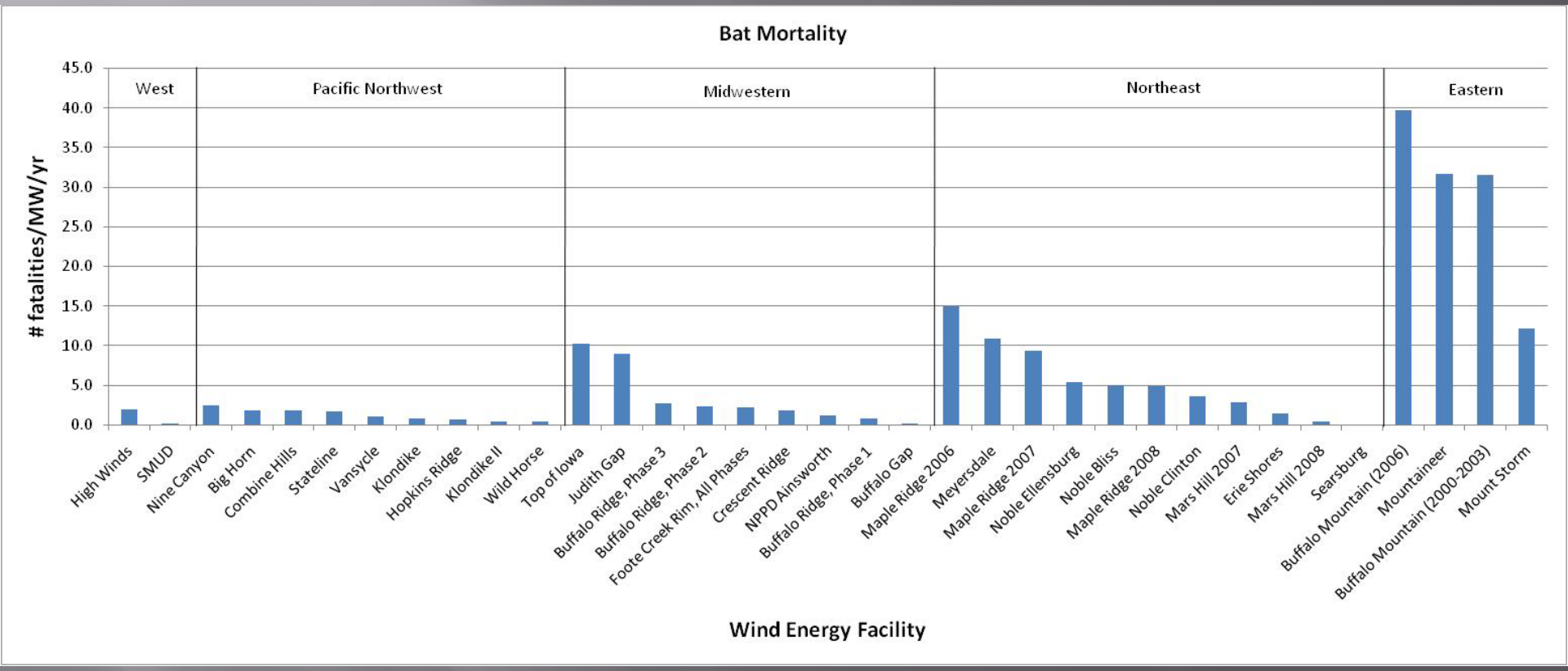
Use Vs. Mortality

Wind projects in the U.S. with both AnaBat sampling data and mortality data for bat species.

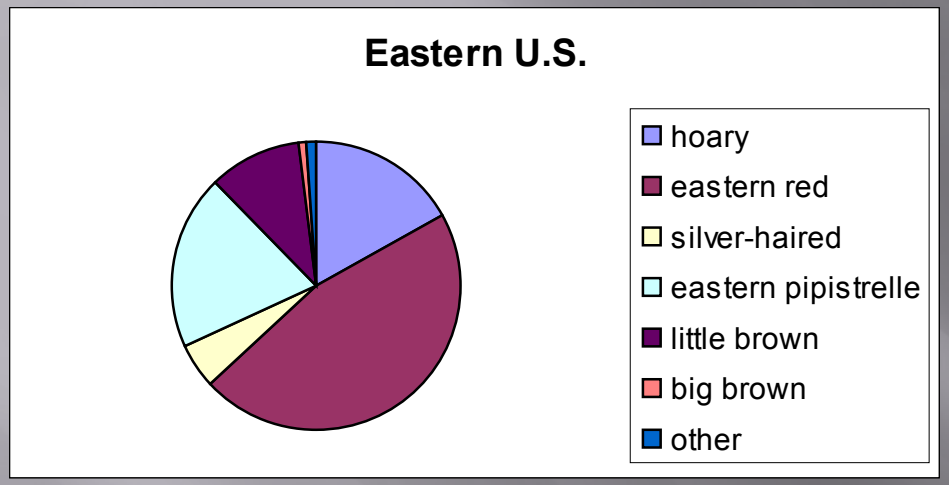
Project Area	Study Period	Detector nights	Bat activity (#/detector/night)	Mortality (#/turbine/yr)	Reference
Buffalo Ridge, MN	Jun 15-Sep 1, 2001	216	2.1	2.2	Johnson et al. 2003
Foote Creek Rim, WY	Jun 15-Sep 1, 2000-01	39	2.2	1.3	Gruver 2002
Mount Storm, WV	Mar 23-Jun 14, 2009	442	16.1	7.45	Young et al. 2009b
Buffalo Mountain, TN	Apr 1-Sep 30, 2001-02	149	23.7	20.8	Fiedler 2004
Top of Iowa, IA	May 26-Sep 24, 2004	42	34.9	10.2	Koford et al. 2005
Mount Storm, WV	July 17-Oct 17, 2008	560	35.2	24.2	Young et al. 2009a
Mountaineer, WV	Aug 1-Sep 14, 2004	33	38.3	38.0	Arnett 2005

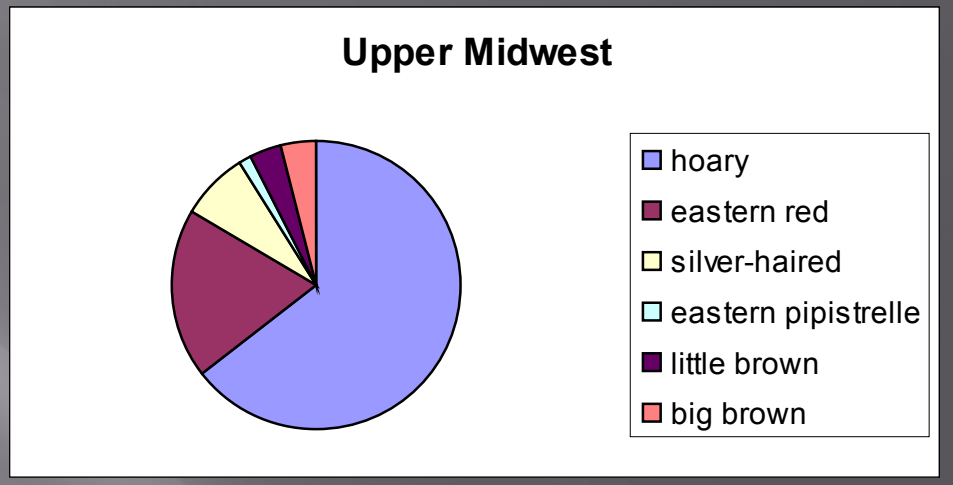
But, bat impacts are unequal across species and seasons – most bat detections are of common resident species (e.g., Myotis, Eptesicus) not at high risk.

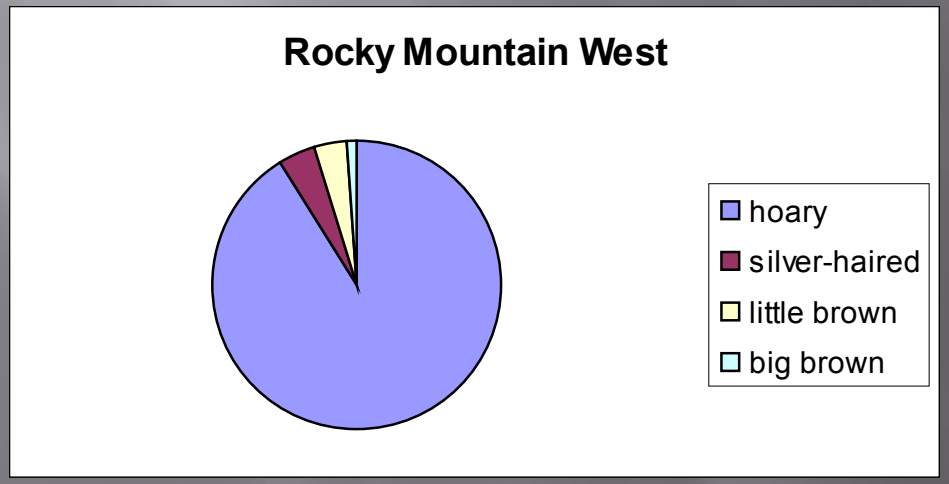
Bat Mortality

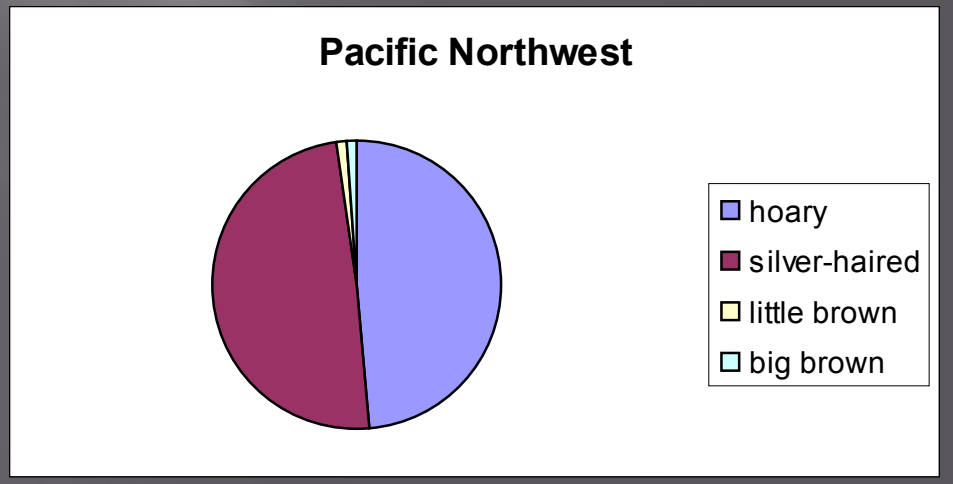


Monitoring Studies – Bat Mortality

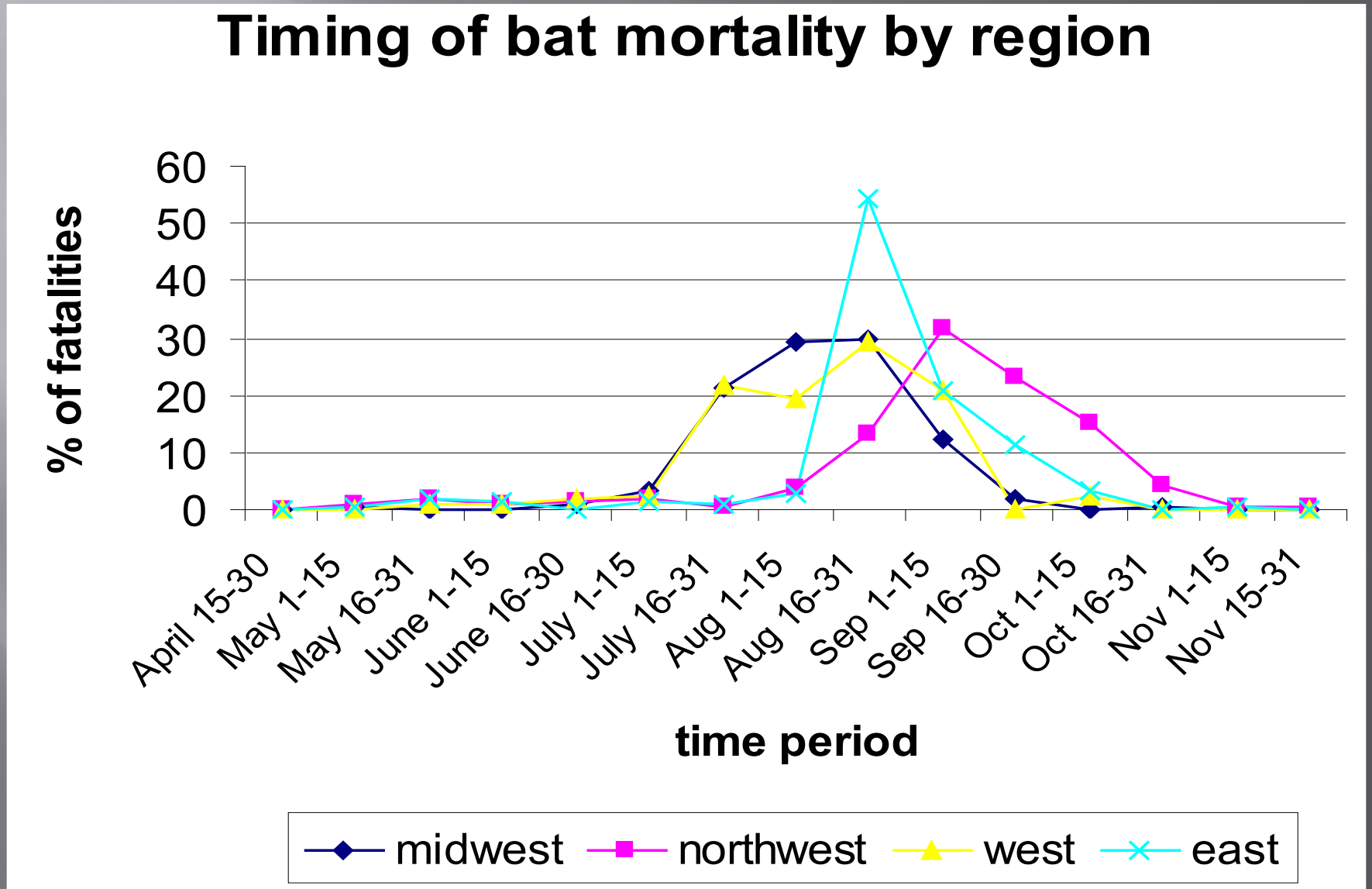






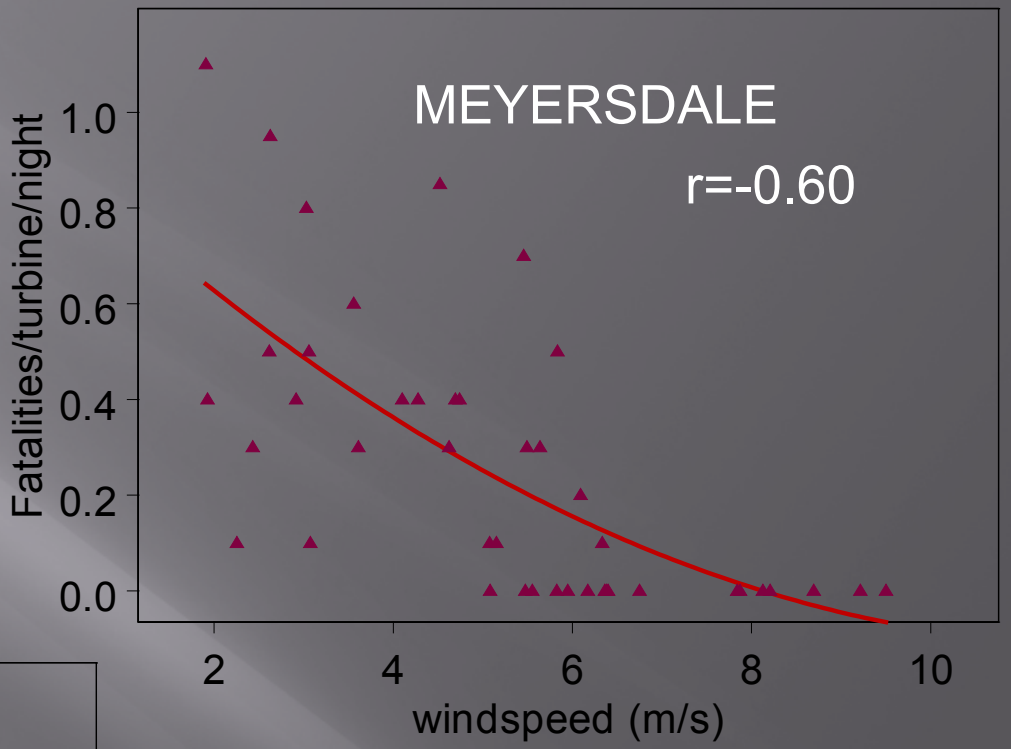


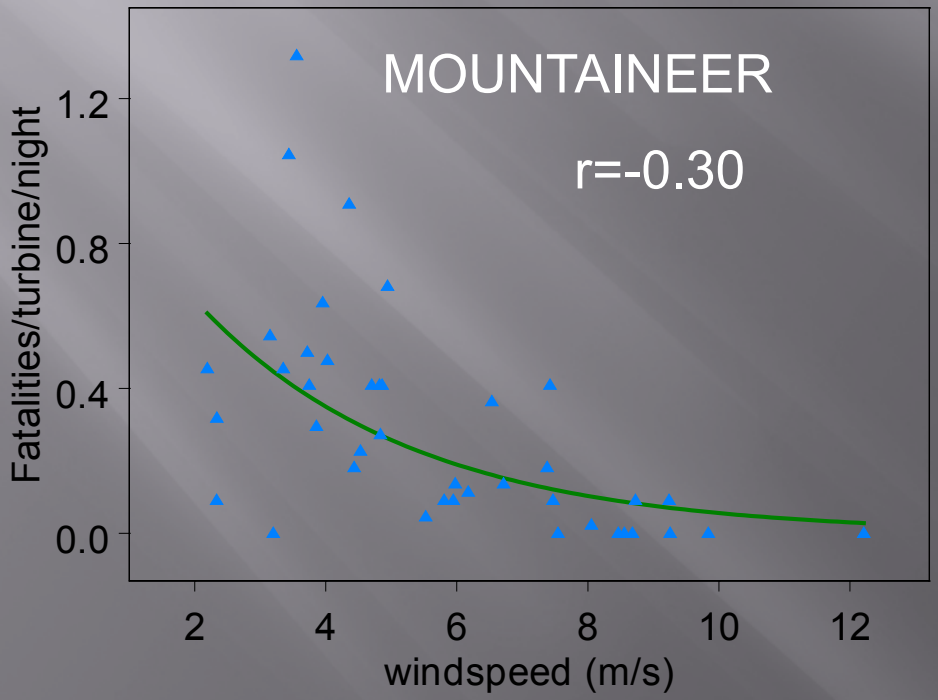
Bat mortality occurs primarily in late summer and early fall.



Estimating Bat Impacts

- Negative correlation: fatalities and wind speed
- Could be used to predict timing of impacts.





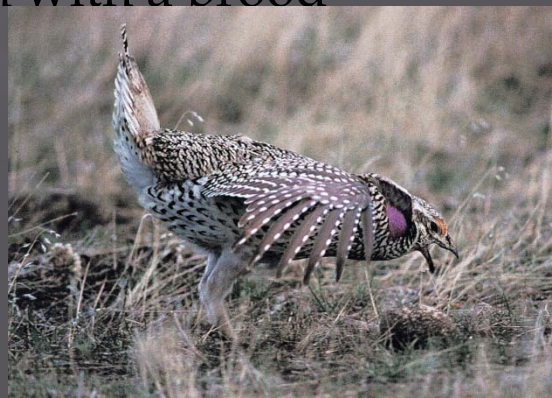
Common Results for Bats studies:

- Impacts are unequal across species, season, and locality.
- Most mortality occurs in late summer and autumn; >50% of all recorded bat fatalities have been in August.
- Mortality appears to be highest along forested ridgelines but there have been high numbers reported for other ecotypes as well.
- Most mortality involves solitary tree-roosting long-distance migrant species.
- Mortality of spring and summer resident bats is not as high as late summer /fall.

GROUSE

Prairie Grouse Studies

- Nebraska Game and Parks (2006-2008)
  - Monitored greater prairie-chicken and sharp-tailed grouse leks within 2 mile radius of 36-turbine facility
  - Thirteen leks (0.3-1.59 miles from nearest turbine; avg. 0.66 miles) - total number of birds on the leks was 136 in 2006, 135 in 2007, and 134 in 2008.
- NWCC Sponsored greater prairie-chicken study, Kansas
  - BACI design – currently in before period
- Minnesota Study (Society and Toepfer 2003)
  - Documented 6 active leks within 2 mi of the 3 wind turbines, 1 lek within 0.6 mi of the nearest turbine, and 1 hen with a brood immediately adjacent to a turbine



Prairie Grouse Studies

- Wyoming Study (on-going)
  - 600 female relocations from April 1 – June 30th
  - Four nests within one-half mile of turbines (130 m, 278 m, 388 m, 486 m) and nine nests within one mile of nearest turbine
- Idaho Study (on-going)
  - >6 years of baseline radio-telemetry from a nearby population
  - Grouse in proposed project area targeted in 2009-2010

Big Game Species Displacement

- Has been identified as an issue for several projects
- Most anecdotal evidence suggests big game may avoid area during construction but habituate to wind turbines quickly – short term displacement impacts.

Foote Creek Rim Monitoring Studies – Pronghorn

Surveys:

- Winter aerial surveys
- Pellet counts – transect surveys
- Counts during avian use surveys
- Incidental/In-transit Observations
- Pre- and Post-construction surveys (BACI design)

Results:

- No winter range (concern - crucial winter range impacts)
- No difference in use metrics before and after construction
- Sample sizes small; generally low pronghorn use overall

On-going and Pending Studies:

- **Wild Horse, WA** – elk, mule deer, post-construction observations
- **Hopkins Ridge / Marengo, WA** – elk, hunt by permission program
- **Elk Horn, OR** – elk, mule deer, aerial transects, observations,
- **Antelope Ridge, OR** – elk, mule deer, GPS collar, BACI design (on-going)
- **Lonesome Bronco, WY** – elk, GPS collar (2010-2011 BLM)
- **Dunlap, WY** – pronghorn, GPS collar (2010-2011)

T&E Species – Few Reported Impacts

- Peregrine falcon and brown pelican in fatality pool from Altamont studies.
- No reported bald eagles in U.S. to date.
- One Indiana bat reported in fall 2009, no other listed bats found to date.
- Rising concerns as numbers and locations of wind projects increase.
  - e.g. Indiana bats in east, whooping crane migration corridor through midwest, black-capped vireo in Texas, potential listing of sage grouse and lesser prairie chicken
- Varied potential for impacts to listed terrestrial species; often a site specific concern especially for solar projects
  - e.g. desert tortoise

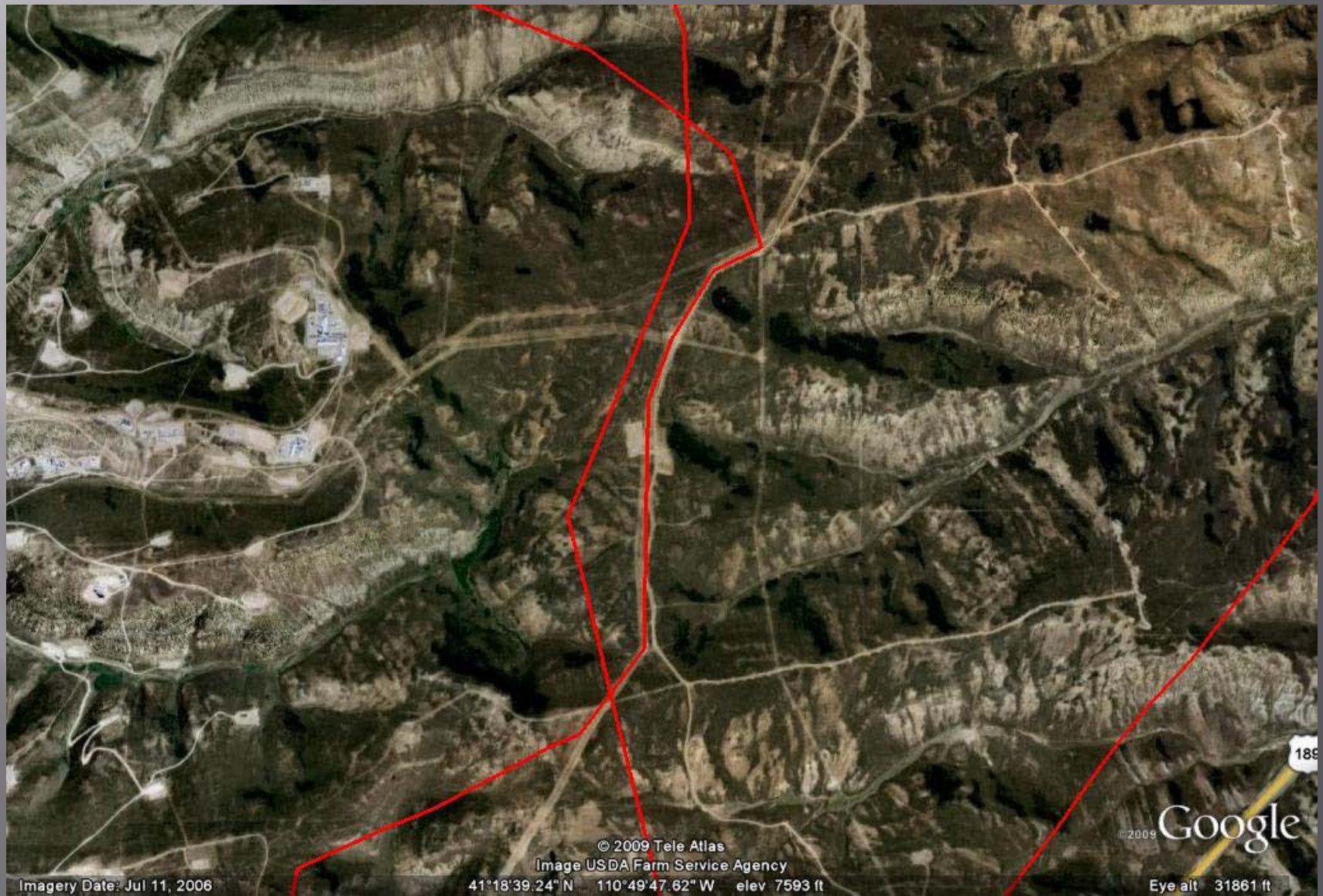
Habitat Impact and Displacement

- **Direct loss of habitat**
  - **Turbine pads, panel arrays, roads, substations, transmission lines**
- **Indirect loss of habitat**
  - **From behavioral response to project facilities**
  - **Turbines, panels, transmission lines, roads, human activity**
- **Long-term impacts**
  - **Permanent structures and/or avoidance with no habituation**
- **Short-term impacts**
  - **Construction, restoration and/or habituation**

Direct Impacts Due to Habitat Disturbance

- Permanent (operations) impacts
  - 0.7 to 1 acres/turbine
  - 0.4 to 0.7 acres/MW
- Temporary (construction) impacts from roads, pads, substation, etc.
  - 0.4 to 3.0 acres/turbine
  - 0.6 to 1.7 acres/MW
- Permanent Footprint typically <5% of a site for wind (BLM 2005)

Gas Field (Left) and Wind Facility (right) Near Evanston, WY



Fragmentation/Displacement Impacts – Indirect Habitat Loss

- Grassland songbird species
  - Several wind turbine studies
- Prairie grouse
  - Few studies to date, but several on-going – NWCC sponsored KS, Wyoming, Idaho
  - Anecdotal information and surrogate studies
- Raptors
  - A few wind turbine studies
- Big game
  - Generally anecdotal information
  - Several telemetry studies on-going

Grassland birds

- Minnesota: Grassland Songbird Displacement Studies at Buffalo Ridge
  - Small scale displacement (~180-250 m)
- Washington/Oregon: Ongoing studies of bird displacement at Stateline, Combine Hills (Erickson et al. and Young et al. 2006
- South Dakota: 1 of 3 species (grasshopper sparrow) showed reduced density within 150m of turbines (Schaffer and Johnson 2007)
- Oklahoma: No displacement for grassland species as a group (O'Connell and Piorkowski 2006)
- Wyoming: Long-term Mountain Plover study at Foote Creek Rim – suggests habituation; decline in numbers during construction; increase post construction

Agenda

- Impact Assessment – Approaches to Monitoring to Determine Impacts

- What We Know / What we have learned from studying wind-wildlife interactions

- **Mitigation Opportunities**
  - **Pre-construction – design phase mitigation**
  - **Construction**
  - **Post-construction – operation phase mitigation**
  - **Other Opportunities**

Mitigation Opportunities

- What can be done to mitigate loss of birds and bats? – After Avoid and Minimize
  - Opportunities:
    - pre-construction (design stage mitigation)
    - construction
    - post-construction (operation-stage mitigation)
  - Conventional approaches
    - e.g., replacement habitat (defined ratio)
  - Alternative/Other approaches
    - e.g., compensatory, research, project management

Mitigation Opportunities

- Design Stage Mitigation – avoid/minimize
  - Good macro-siting decisions - choosing an acceptable site or portion of a site; site in already altered landscapes
  - Good micro-siting decisions - avoid high use areas, sensitive resources, etc.
  - Design to minimize fragmentation and habitat disturbance.
  - Establish buffer zones around sensitive / high use areas in which no disturbance is allowed in
  - Facilities design – e.g., no guy wires, under ground powerlines, APLIC standards for above ground lines, no fences, minimize road length
  - Appropriate turbine layout based on micro-siting decisions (e.g., use biological constraints layers in design criteria).

Mitigation Opportunities

- Construction Stage Mitigation
  - Best Management practices to minimize footprint, control construction impacts, protect soils, weed control, etc.
  - Utilize least invasive construction methods where possible (e.g., plow in underground cables)
  - Construction timing to minimize impacts (e.g. outside nesting season, during non-growing season).
  - Delineate and avoid sensitive areas.
  - Educational material for contractors.
  - Employee environmental monitors to monitor construction compliance with restrictions.
  - Reclaim with native vegetation of local ecotypes; preserve topsoil for reclamation.
  - Control construction waste and debris.

Mitigation Opportunities

- Operation Stage Mitigation
  - Avoid lighting that attracts birds - lights with short flash durations that emit no light during the “off phase” , minimum number of flashes per minute, briefest flash duration allowable; downcast motion sensitive lights on auxiliary buildings, met towers, substations, if needed.
  - Raising “cut-in” speed to reduce turbine operation on low wind speed nights to reduce bat mortality.
  - Seasonal shutdowns of turbines; selective shutdown of turbines
  - Disrupt air flow behind turbines – reduce barotrauma.
  - Utilize an adaptive management approach with monitoring to better achieve project management objectives to reduce impacts.

Mitigation Opportunities

- Operation Stage Mitigation
  - Site management to minimize impacts – e.g., mowing schedules during non-breeding season; scheduled turbine maintenance (downtime) during August-September; minimize maintenance traffic; remove large sources of carrion (e.g., livestock); manage garbage/waste , etc.
  - Modify habitat to make the site less attractive to at-risk species – e.g. clearing forest patches to remove bat roost sites.
  - Decommission nonoperational turbines – decommissioning and reclamation plan that describes expected actions when some or all of the turbines at a wind site are nonoperational.

Mitigation Opportunities

- Alternative/Other Mitigation
  - Conservation of target species and/or habitat.
  - Protect habitat (on or off site) permanently through fee title and/or conservation easements.
  - Develop a resource management plan for appropriate property management to benefit wildlife.
  - Provide for long-term management/restoration of the property after the project is completed.
  - Provide a sufficient level of funding with acceptable guarantees to fully ensure the operation and maintenance of the property.
  - Provide for monitoring and reporting on the identified species/habitat management objectives; include adaptive management/effectiveness monitoring loop to modify management objectives, as needed.

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MITIGATION TOOLBOX

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