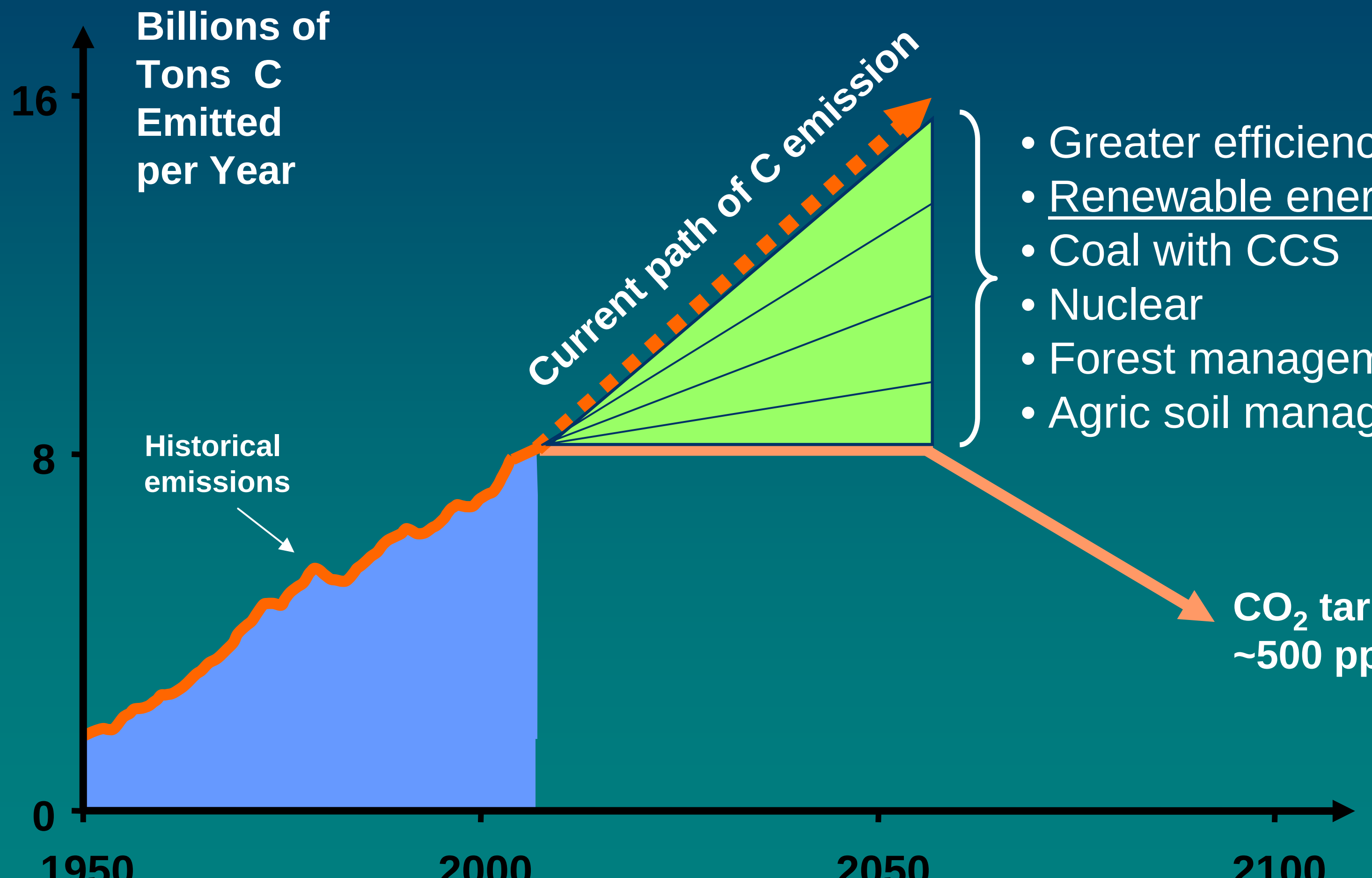
Appalachian Wind Energy and Raptors: Moving Forward in a Data Vacuum

David Brandes (Lafayette College)
Todd Katzner (National Aviary)
Tricia Miller & Michael Lanzone
(Carnegie Museum Powdermill Avian Research Center)
Dan Ombalski (Tussey Mtn Spring Eaglewatch)

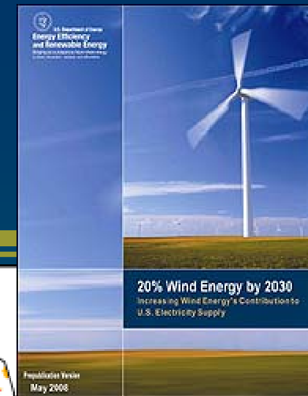
The “carbon emission gap”

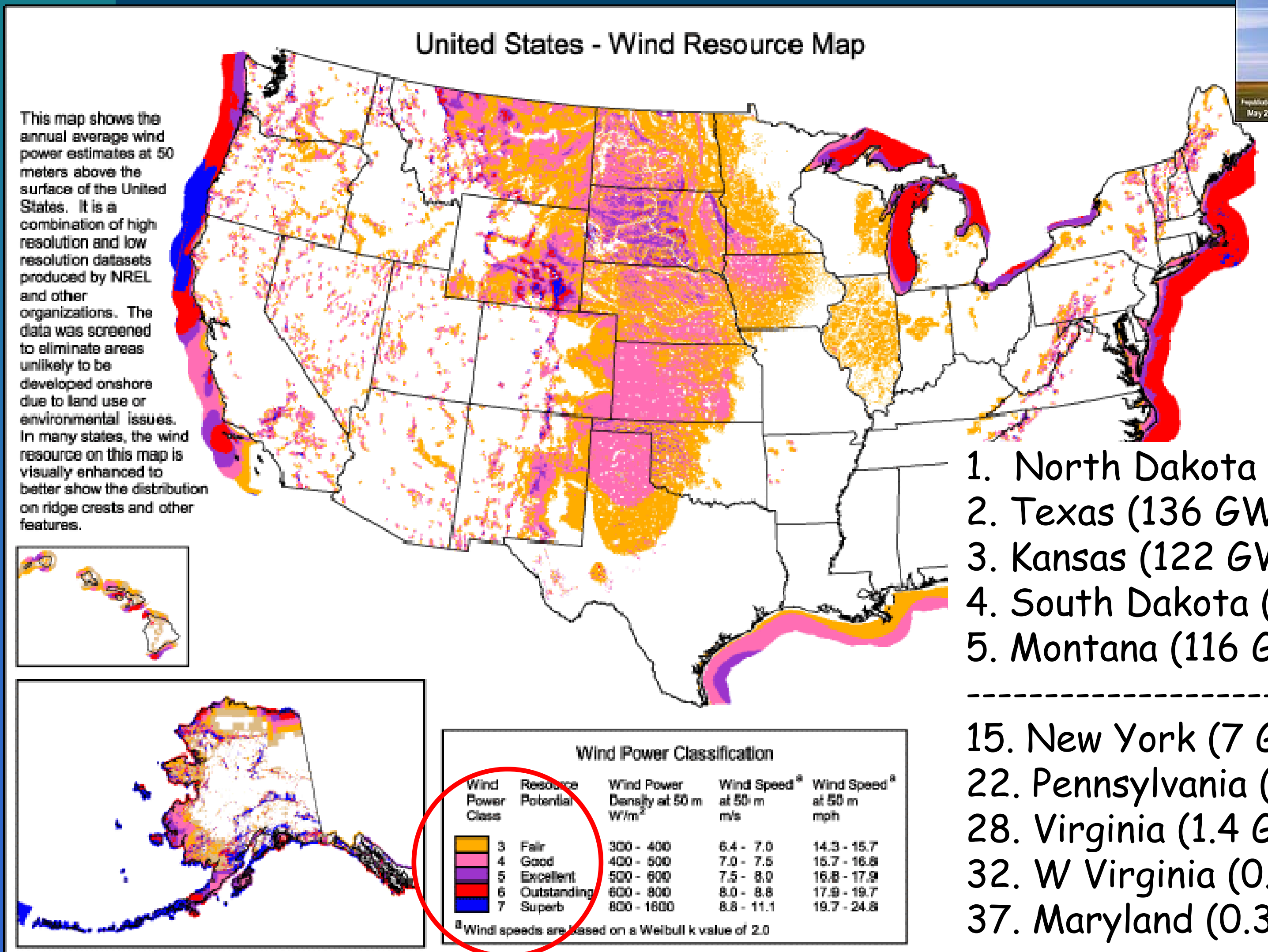


see Pacala & Socolow, *Science* (2004)

based on www.princeton.edu/wedges/

U.S. wind resources



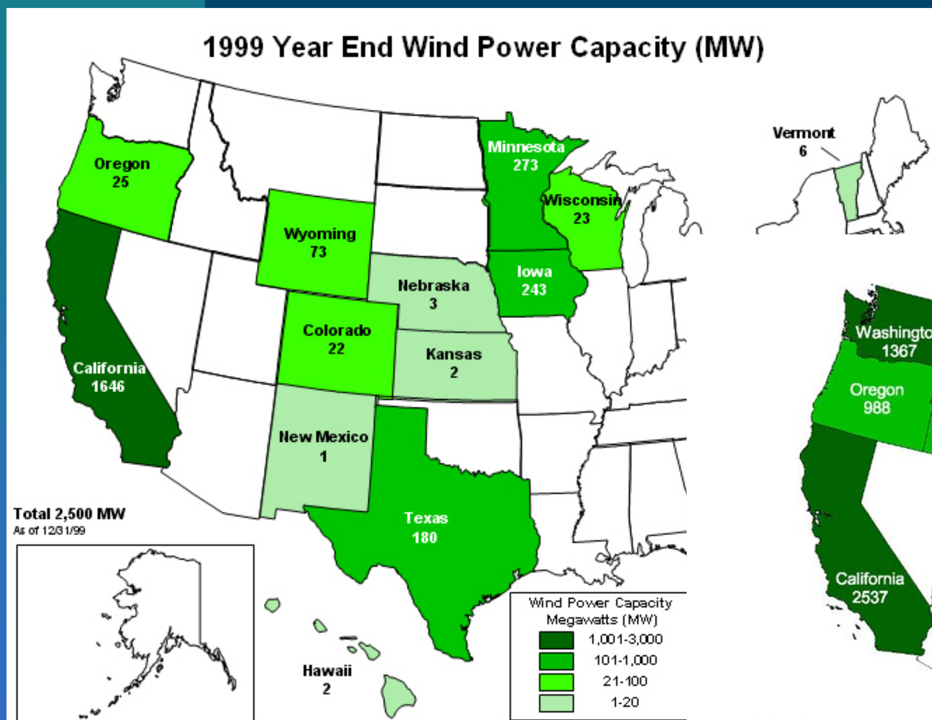


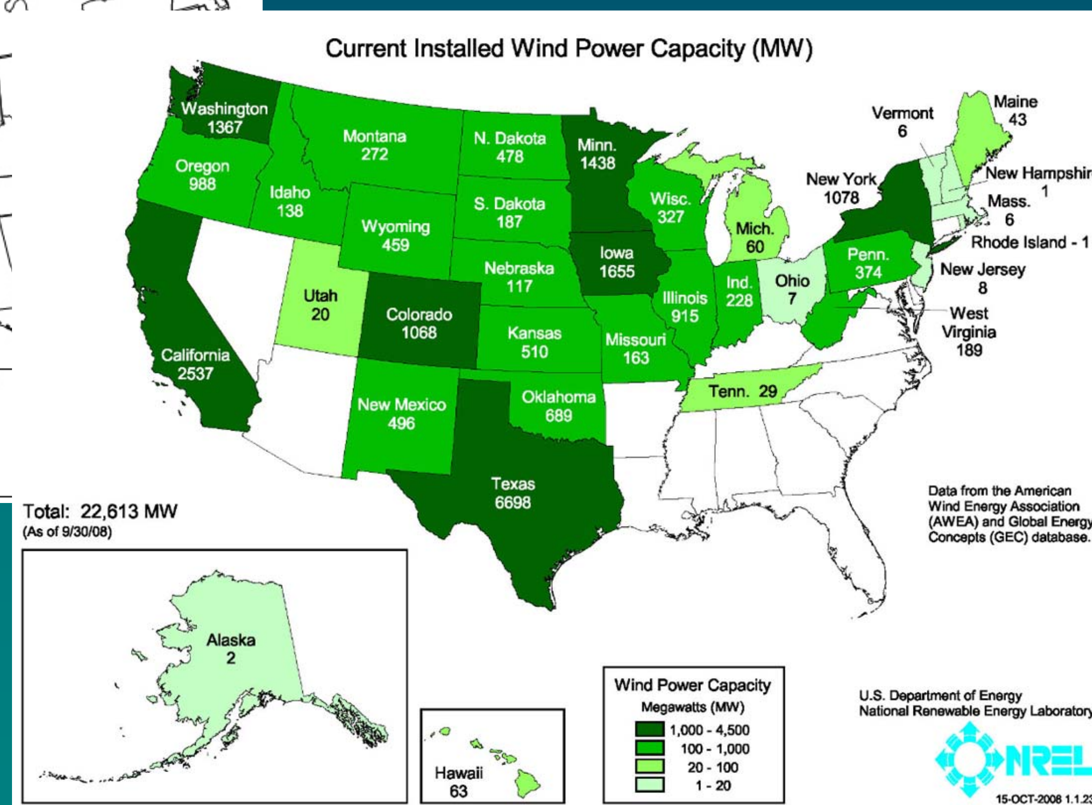
1. North Dakota (138 GW)
2. Texas (136 GW)
3. Kansas (122 GW)
4. South Dakota (117 GW)
5. Montana (116 GW)

----

15. New York (7 GW)
22. Pennsylvania (5 GW)
28. Virginia (1.4 GW)
32. W Virginia (0.59 GW)
37. Maryland (0.34 GW)

Installed Capacity 1999-2008





Wind Energy Potential – a tale of two states

"Renewable/Alternative Energy Portfolio Standards":
PA 18% by 2020, MD 20% by 2022

	Onshore (AWEA data)	Offshore*	Total	Current Generation Capacity (all sources)	Wind potential as % of current capacity
PA	5 GW	2.5 GW	7.5 GW	~50 GW	~15%
MD	0.34 GW	9.7 GW	10 GW	~12 GW	~85%

**offshore values estimated using NREL offshore wind resource data and assuming 1 km spacing w/ 3 MW turbines at 50% capacity factor*

- Installed wind capacity (AWEA data):
  - PA = 361 MW + 234 MW under construction (all onshore)
  - MD = 0

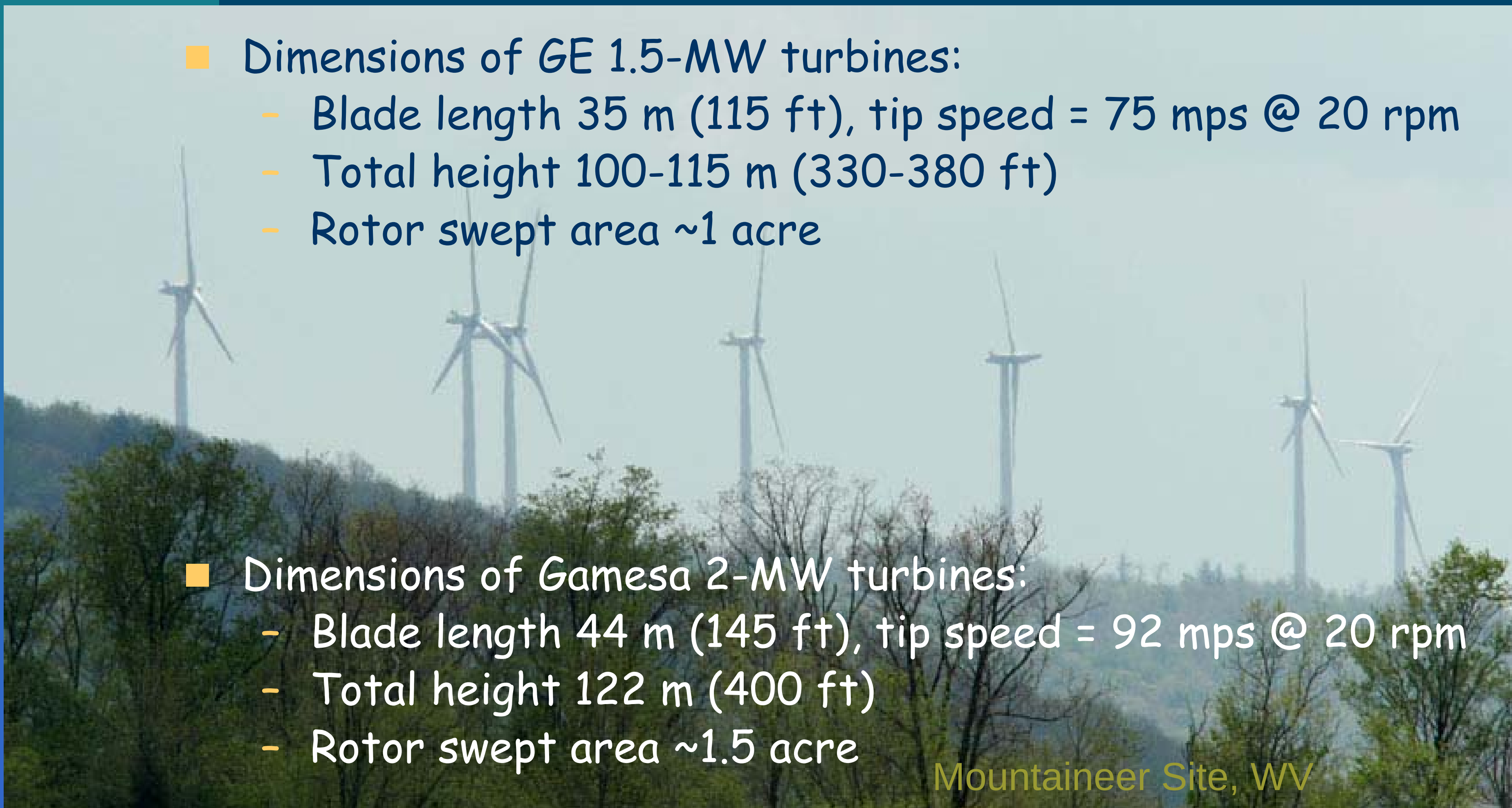
Appalachian wind energy

- ***Benefits***
  - Mature technology and inexpensive compared to other renewable sources
  - No air pollution or CO_2 emissions
- ***Drawbacks***
  - Wind is intermittent (turbines generate ~10-35% of rated capacity depending on season)
  - Land intensive (~2000 turbines = 1 conventional 1000-MW power plant)
  - Potential for adverse environmental impacts:
    - Collisions – primarily bats & birds
    - Interior forest habitat loss or degradation
    - Possible impacts on headwater streams
    - Aesthetics/noise/viewshed issues

Modern wind turbines

Modern wind turbines

- Dimensions of GE 1.5-MW turbines:
  - Blade length 35 m (115 ft), tip speed = 75 mps @ 20 rpm
  - Total height 100-115 m (330-380 ft)
  - Rotor swept area ~1 acre



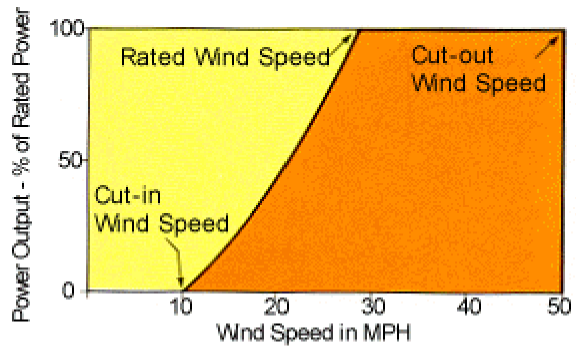
- Dimensions of Gamesa 2-MW turbines:
  - Blade length 44 m (145 ft), tip speed = 92 mps @ 20 rpm
  - Total height 122 m (400 ft)
  - Rotor swept area ~1.5 acre

Mountaineer Site, WV

Wind turbine power equation

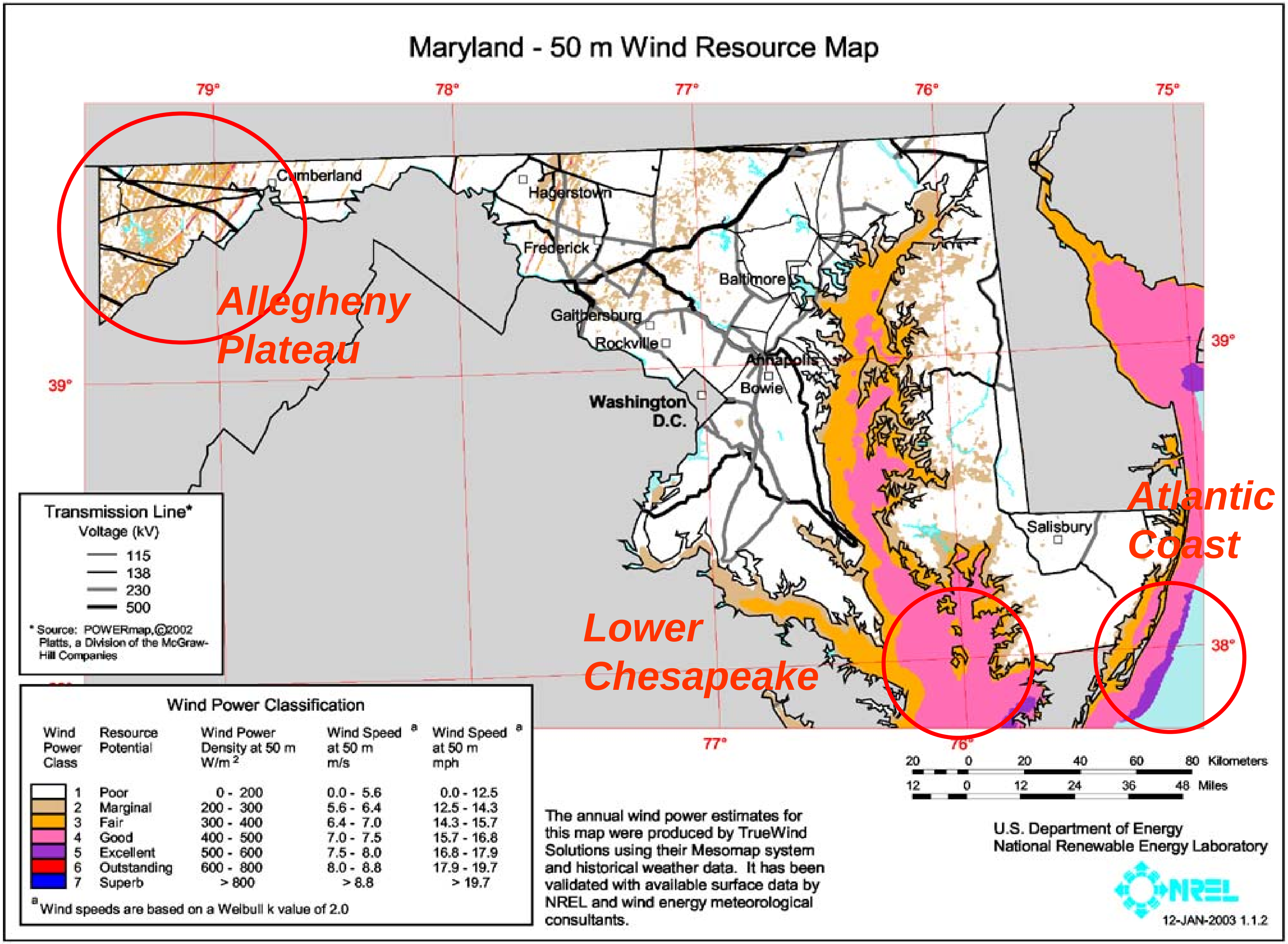
$$Power = C \cdot \rho_a \cdot \pi \cdot Blade\ Length^2 \cdot Wind\ Speed^3$$

- Power is sensitive to **blade length**
  - 2X longer blade gives 4X more wind power
- Power is highly sensitivity to **wind speed – thus highest elevation regions targeted for devel**
  - 2X more wind speed gives 8X more wind power!
  - Rated capacity of turbine (e.g. 1.5-MW) is at peak conditions, typically ~25-30 mph wind

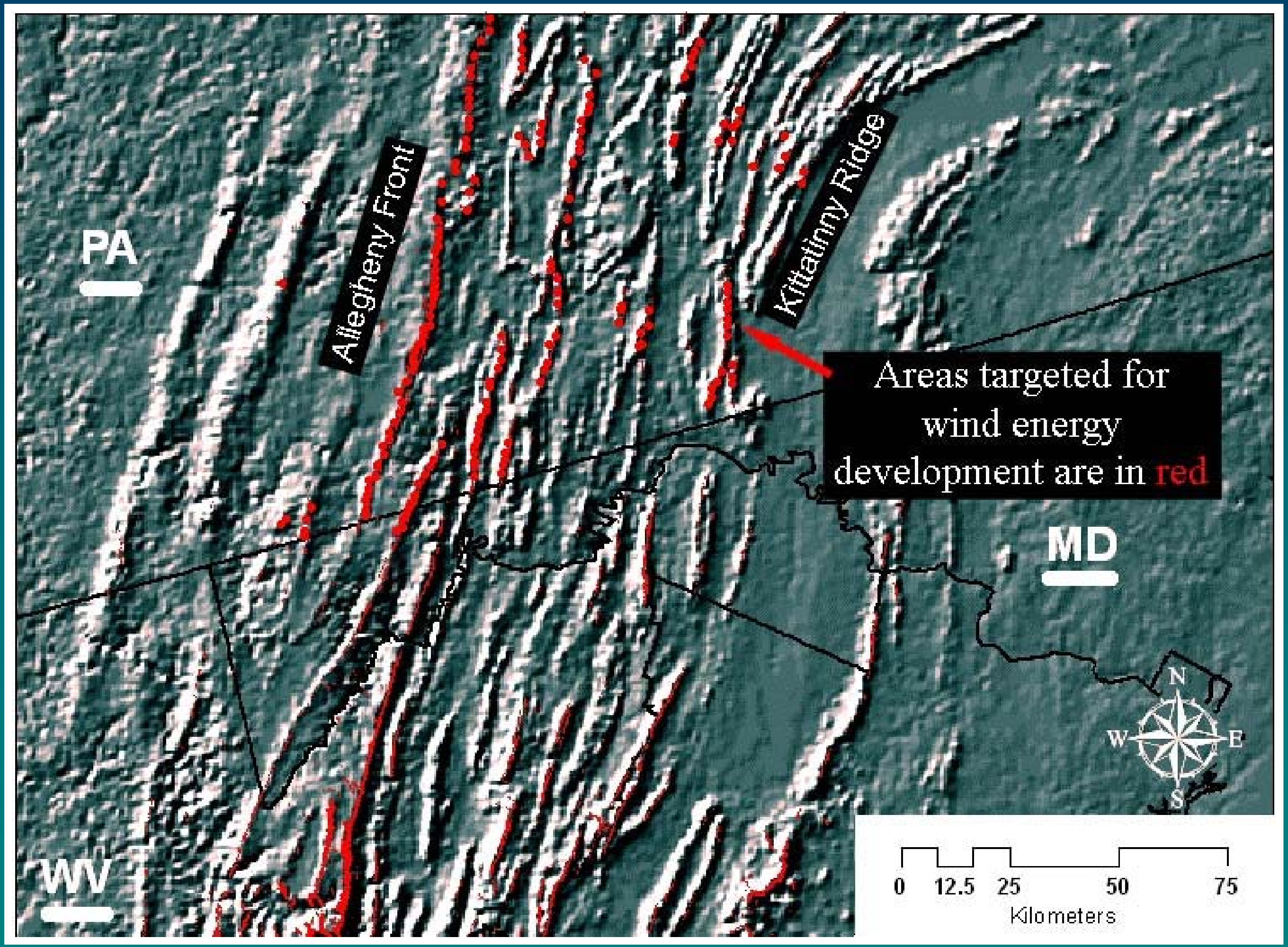


from www.awea.org

Idealized Power Curve for a Wind Turbine


Maryland - 50 m Wind Resource Map
79°
78°
77°
76°
75°
39°
38°
Cumberland
Hagerstown
Frederick
Baltimore
Gaithersburg
Rockville
Annapolis
Bowie
Washington D.C.
Salisbury
Allegheny Plateau
Lower Chesapeake
Atlantic Coast
Transmission Line*
Voltage (kV)
115
138
230
500
* Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
Wind Power Classification
Wind Power Class
Resource Potential
Wind Power Density at 50 m W/m 2
Wind Speed a at 50 m m/s
Wind Speed a at 50 m mph
1 Poor 0 - 200 0.0 - 5.6 0.0 - 12.5
2 Marginal 200 - 300 5.6 - 6.4 12.5 - 14.3
3 Fair 300 - 400 6.4 - 7.0 14.3 - 15.7
4 Good 400 - 500 7.0 - 7.5 15.7 - 16.8
5 Excellent 500 - 600 7.5 - 8.0 16.8 - 17.9
6 Outstanding 600 - 800 8.0 - 8.8 17.9 - 19.7
7 Superb > 800 > 8.8 > 19.7
a Wind speeds are based on a Weibull k value of 2.0
20 0 20 40 60 80 Kilometers
12 0 12 24 36 48 Miles
The annual wind power estimates for this map were produced by TrueWind Solutions using their Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-JAN-2003 1.1.2

Central Appalachian areas targeted for wind energy



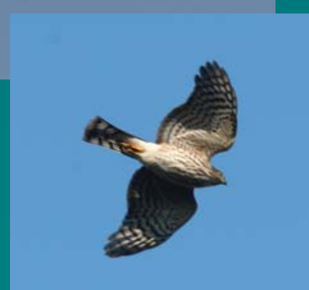
From USFWS *Assessing Bird and Bat Migration over Appalachian Ridges*

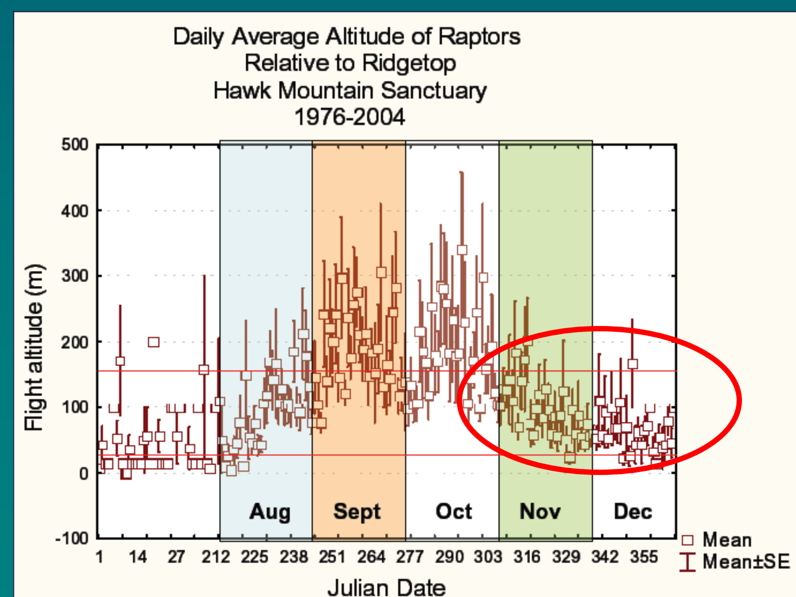

Hawk Mountain on the Kittatinny Ridge
B. Hayes


There are many ridges that
raptors can use during migration

Altitude of raptor migration

- Raptors using ridge updrafts (slope soaring) for migration are often below 400 ft - typical new generation turbine height (pers. obs.; Kerlinger, 1989; Farmer et al, 2006)
- When thermals are strong, flight is typically much higher than 400 ft & flight patterns are not closely tied to topography (pers. obs.; Hopkins, 1979; Kerlinger, 1989)





Raptor monitoring at Appalachian wind energy sites

- Few raptor fatalities reported; however, post-construction studies (carcass counts) have so far been at low-risk sites (i.e. few raptors)
  - Turbines now being proposed and built on known migration "flyways" (e.g. Allegheny Front in WV, MD, and PA)
- Typically unpublished studies, little if any peer-review process
- A **lack of quality data and scientific study throughout Appalachians,** esp post-construction monitoring to understand flight behavior near turbines

Bottom line from all available studies:

- High collision rates are correlated with high rates of raptor use, esp foraging
  - Some Appalachian ridges have high seasonal concentrations of raptors, thus there is potential for problems…

  - But, collisions likely to be episodic, related to specific weather conditions, poor visibility, etc

Indirect impacts also …

- Sub-lethal effects v difficult to determine
  - Will **avoidance** of 1000s of turbines along ridge-tops lead to raptors abandoning preferred migration routes, thus expending 2-4X more energy during migration??
- Loss of forested ridge-top habitat

What do unbiased sources have to say about all this?

"concerns may be well-founded because significant development is proposed in areas that contain large numbers of species or are believed to be migratory flyways."

"only a few studies exist concerning ways in which to reduce wildlife fatalities at wind power facilities"

- USGAO Report to Congress *Wind Power Impacts on Wildlife*, 2005

"in light of the lack of follow-up studies of environmental impacts of these facilities, more careful tracking of bird and bat populations, behavior, migration corridors, and other factors that may affect their risk of collisions with turbines is warranted, esp for threatened or endangered species"

- National Research Council Report to Congress *Environmental Impacts of Wind Energy Projects*, 2007

The windows & cats smokescreen

- Plate glass windows and domestic cats are among the leading causes of songbird mortality
  - Glass: est 100 million to 1 billion birds per year, primarily songbirds (both neotropical migrants and residents)
  - Domestic Cats: est over 500 million birds per year, primarily songbirds, particularly species that nest and forage on the ground
- Wind turbines are clearly not going to kill nearly as many birds… BUT:
  - Number of **eagles** killed by wind turbines? **100s/year**
  - Number of **eagles** killed by window glass? **0**
  - Number of **eagles** killed by domestic cats? **See next slide**

Sylvester the bird-killer meets his match

- Careful Siting is Key - Two Worst-Case Scenarios

Altamont Pass, CA

- One of first sites in U.S., ~5000 turbines - varying designs
- High densities of resident, migrant, and esp wintering raptors due to large prey base

Altamont Pass






Altamont Pass

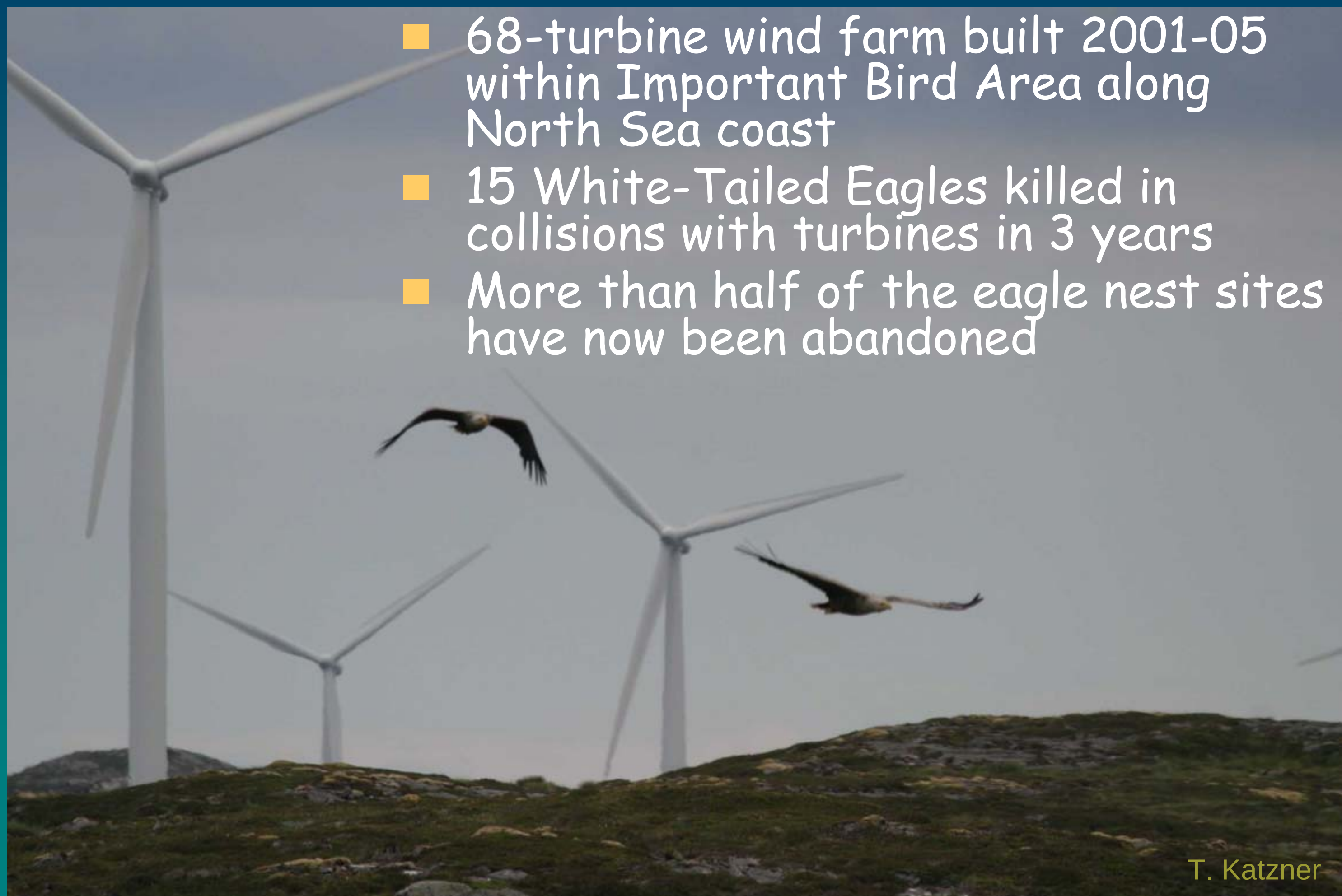
- Current estimates are that **1000-2000 raptors killed annually**, including burrowing owls, kestrels, red-tails, barn owls, and golden eagles (Smallwood & Thelander, 2008)

(from *Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area*).

- Raptor fatalities highest near sloping ground and at ends of turbine clusters; hover-hunting a high risk behavior
- Due to multiple lawsuits in the mid 2000s, ~200 turbines removed, half the turbines shut down from Nov to Feb each year, gradual replacement of older turbines with newer designs – so far results not very encouraging (Altamont Pass Avian Monitoring Team, 2008)

Smøla, Norway

- 68-turbine wind farm built 2001-05 within Important Bird Area along North Sea coast
- 15 White-Tailed Eagles killed in collisions with turbines in 3 years
- More than half of the eagle nest sites have now been abandoned



But many wind energy sites pose minimal risk to raptors

- Flat to gently rolling open land without raptor concentrations
  - Maple Ridge Site, Tug Hill Plateau NY
  - Garrett Site, Somerset Co PA
  - Turnpike Site, Somerset Co PA


Garrett Site, PA


Maple Ridge Site, NY

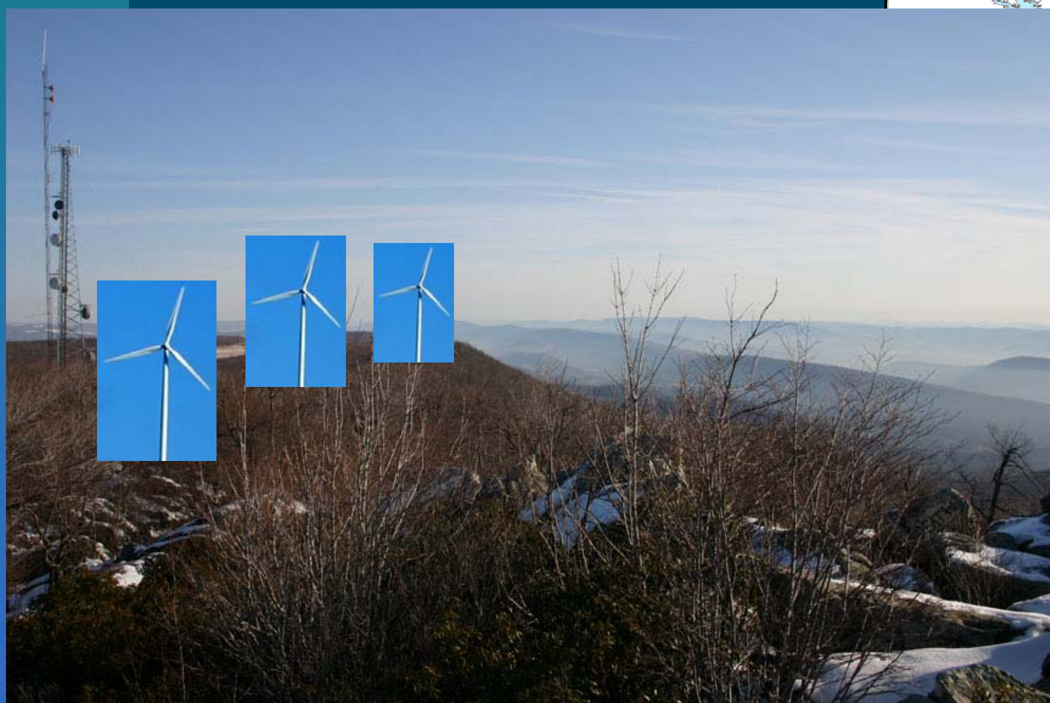
from www.mapleridgewind.com

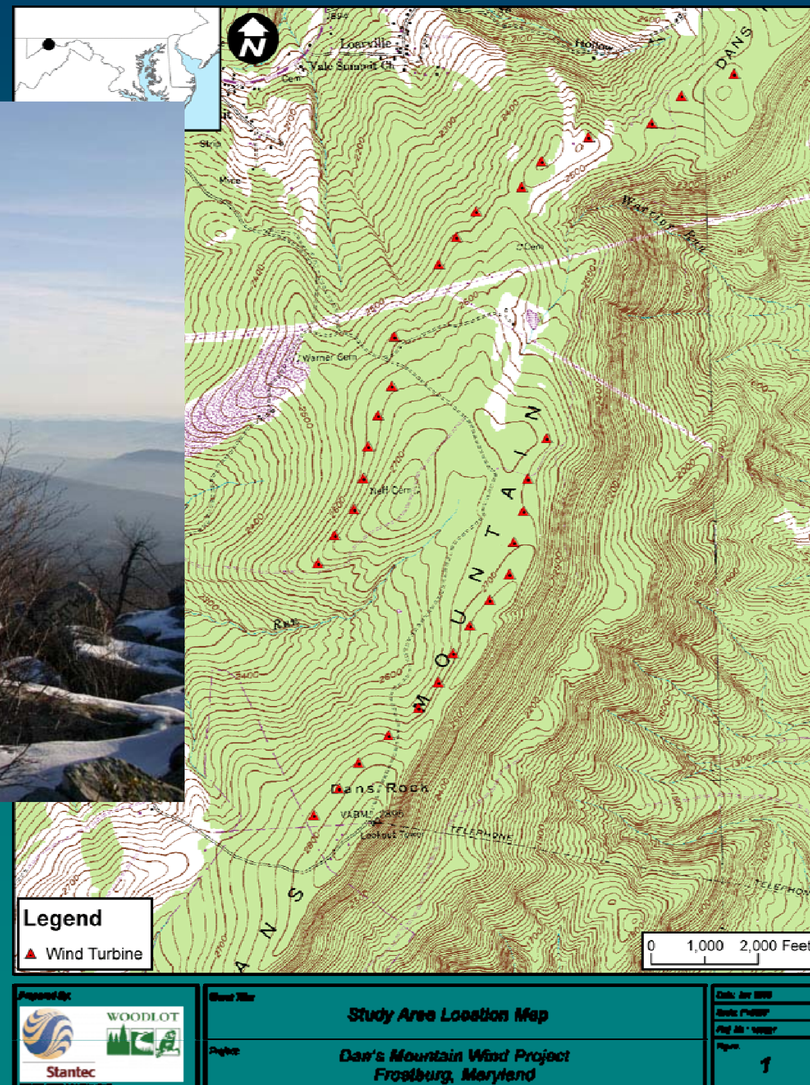
Golden Eagle is likely the raptor species at highest risk from wind energy development in the Appalachians

Eastern Golden Eagles

- Small isolated eastern U.S. population breeds in Quebec, winters primarily in central/southern Appalachians
  - Long-lived, slowly reproducing, a few thousand total
- The highest known concentrations in the east are during migration through PA and NY in early spring and late fall when thermal lift is relatively weak – extensive use of ridge updrafts
- Large fraction (> 50%) of breeding-age adults follow narrow migration corridor along southwestern ridges of PA – also MD/WV?

US WindForce Dan's Mountain Project





Avian Risk Assessment report

- Raptor monitoring focused on Bald Eagles migrating Oct - Dec as per USFWS recommendation (letter dated Oct 22, 2004)
- Subcontractor picked 20 days with "good visibility" Oct 16 - Dec 20, 2007:
  - 339 raptors, mostly vultures, 4 bald eagles, 4 golden eagles
- "Based on the low migration traffic rates of raptors reported, including Bald and Golden Eagles, risk is likely to be minimal" (Curry & Kerlinger, 2008)

Dan's Rock

Wilson Bull., 94(2), 1982, pp. 176–184

THE INFLUENCE OF SEASONALITY AND SELECTED WEATHER VARIABLES ON AUTUMN MIGRATION OF THREE SPECIES OF HAWKS THROUGH THE CENTRAL APPALACHIANS

KIMBERLY TITUS AND JAMES A. MOSHER

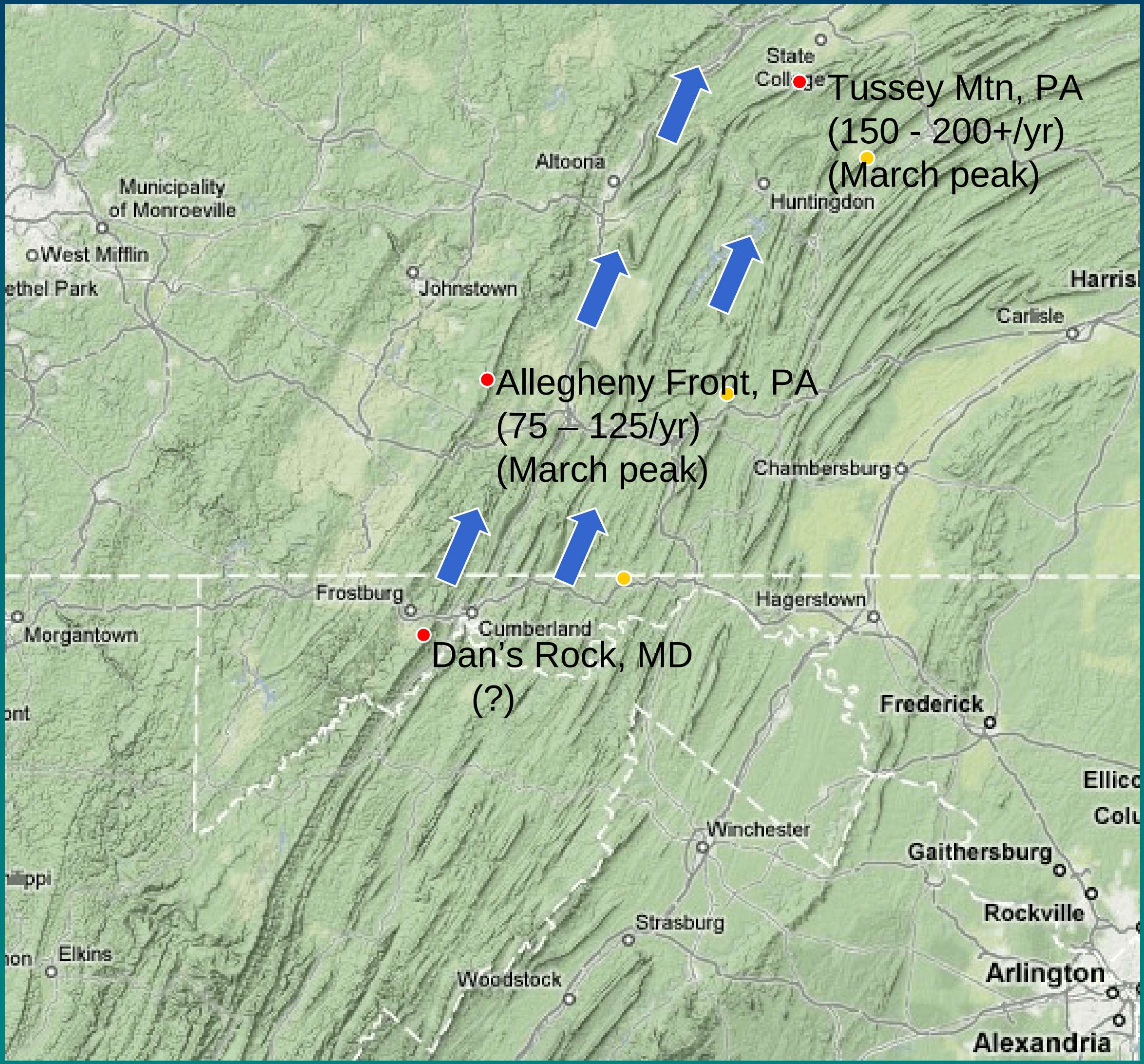
Few studies have reported the magnitude of autumn hawk migration through the central Appalachians. DeGarmo (1953) conducted a 5-year study of autumn hawk migration through West Virginia, but his data included full-season coverage from only a single point. Robbins (1950) reported hawk-count results obtained on a single day from 13 major and minor ridges in Maryland.

The physiographic features and weather associated with the large concentrations of migrating hawks in the northern-middle Atlantic states are well documented (see review in Haugh 1972, Brett and Nagy 1973, Dunne and Clark 1977). Unique physiographic features are absent from the ridge and valley system of the central Appalachians, as are the large concentrations of hawks such as those seen at Hawk Mountain (Brett and Nagy 1973) and at coastline sites (Allen and Peterson 1936, Mueller and Berger 1961, Hofslund 1966, Haugh 1972, Alerstam 1978).

Our objectives were to evaluate the influence of seasonality and selected weather variables on autumn hawk migration at two look-outs in the central Appalachians. Univariate and multivariate procedures were employed (see Richardson 1978) to evaluate the data which were collected according to the format recommended by the Hawk Migration Association of North America.

- Long known as a good site for viewing migrating raptors, primarily broad-winged hawks (Robbins, 1950; Heintzelman, 1979; Titus & Mosher, 1982)

Spring Golden Eagle migration



I was keen to get others to see this rare bird, especially Gwen Brewer, my partner, but I had a problem. She was at work (I am retired), it was after 4 PM, and the sun was going to set soon. She and others could only hope the bird remained overnight. At dawn on January 24, she and I met Tom Feild and others at the frozen pond; unfortunately, the bird was not present. After many additional tries, I was unable to relocate this bird. Clearly this bird was in transit, as are many gulls that time of year.

On the next day, January 25, I found three LBBGs that had not been there on all my previous visits, but still no California Gull. The only advice I can give for finding rare birds like the California Gull is to be persistent. Learn the varied plumages, learn the habitat the birds frequents, go often (with or without a date), study large flocks carefully, and eventually you will get lucky. Gull watching can be frustrating due to complexities of the group, but can also be very exciting when you find something unusual. —*George Jett*

Record Golden Eagle Flight, Dan's Rock

Dan's Rock on the Allegheny Front near Frostburg has long been known as a good spot to catch the fall Broad-winged Hawk flight. The discovery of early spring flights of Golden Eagles (GOEAs) in central Pennsylvania over the past 10 years got me thinking that similar flights likely occur in western Maryland. Because the Allegheny Front is a prominent topographic feature that stretches southward some 75 miles into West Virginia, it seemed to me that Dan's Rock should be a prime spot for spring GOEA migration, especially when winds are southeast and perpendicular to the Front.

Being on sabbatical this spring, I finally had a chance to test this idea. The forecast for March 3 looked good. Initially the day was very slow, but the wind shifted from south to southeast, and between 11:45 and 3:30, 35 GOEAs and 7 Bald Eagles flew by, many of them gliding past at close range (see photo). Almost all of the eagles were adult, as is the case for the early spring flight in Pennsylvania. This is a record single-day GOEA flight for Maryland, the previous record being the 23 that Ray Kiddy found in the fall at Town Hill on Nov 13, 2003.

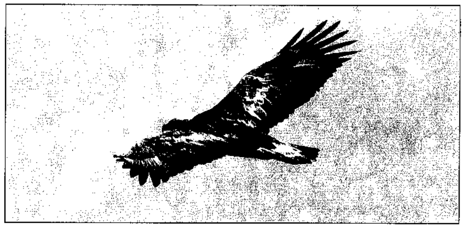
I returned on March 13 in hopes of confirming that the March 3 results were not a fluke. Although the wind conditions were not quite as good, 12 GOEAs cruised past, as well as many Red-shoulders, Red-tails, and one dark morph Rough-legged Hawk.

Although counts from just two days are not a lot of data, these results strongly suggest that the Allegheny Front is a significant spring GOEA migration pathway through Maryland, particularly when warm southeast or east winds produce miles of updrafts along the Front.

—*David Brandes*
Lafayette College, Easton, PA

Observations from Ray Kiddy

It is unclear whether the high counts in the spring (in numbers higher than one-day fall counts) is a relatively recent phenomenon or whether their passage in the spring was just not very well monitored until recently. It is also interesting that high counts in the fall seem to occur under the most difficult weather conditions (high winds, cold, often with snow, etc.) while those in the spring seem to occur on the mildest spring days with southerly winds. Whether there are fewer spring days with the right conditions than fall days with optimum conditions is unclear, as is whether the fall season is more protracted than is the spring migration. For example, the urge to get north to begin the breeding season may concentrate the movement into a shorter window while the need to move south in the fall is less urgent and thus spans a longer period. All very interesting.



Golden Eagle photographed by David Brandes on March 3, 2008.

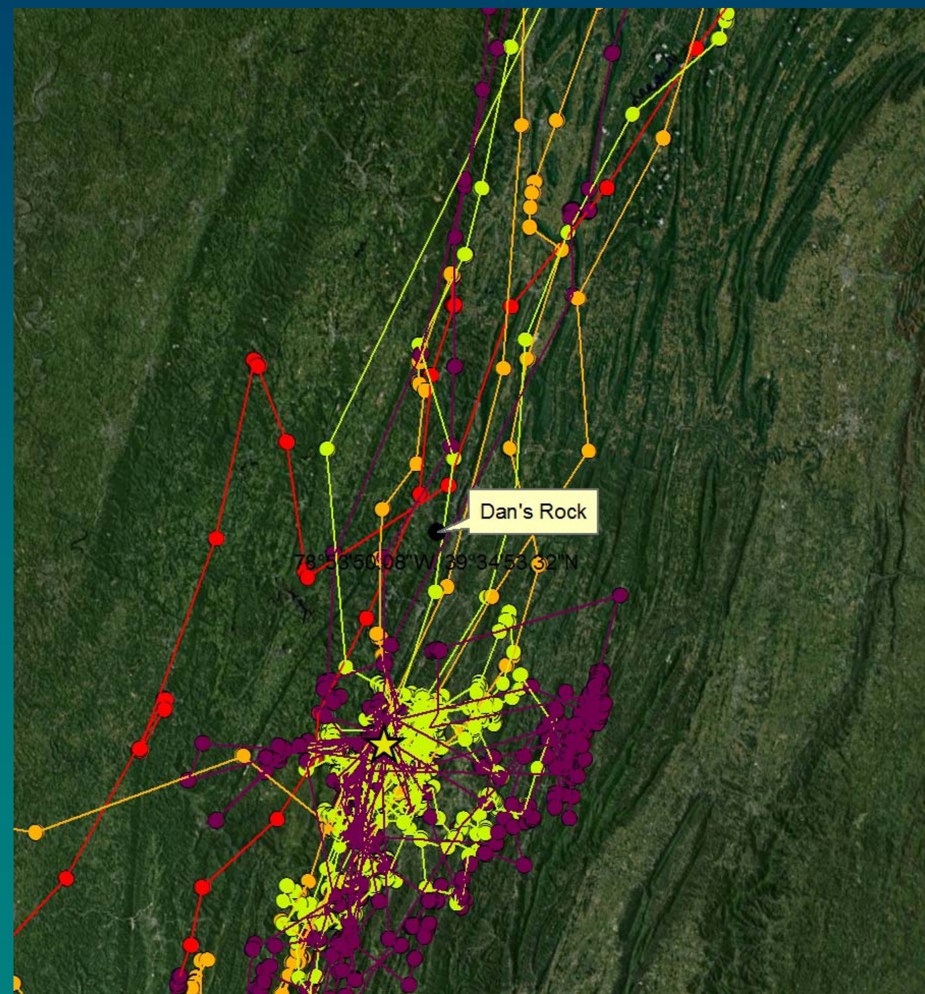
BOARD BULLETINS

- The **Maryland Birding Trail** Committee is developing a form that will let chapters, individuals, and organizations nominate their favorite birding sites, and let the committee evaluate the nominees in an even-handed way. The Committee is also exploring the possibility of grants from DNR, State Highways, Office of Tourism, and private foundations. The project is estimated to cost at least $110,000.
- Russ Kovach, Chair of the Development/Publicity Committee, is working on a **brochure for potential donors** to MOS; he would welcome input from members who have experience in this area.
- Gayle Bach-Watson, MOS rep to the Environmental Fund for Maryland, is seeking the **names of the Human Resources officers** at members' workplaces; she'd like to set up meetings where she can make a pitch for EFM and MOS.
- Bob Ringler and Matt Hafner have finished revising the **Yellowbook** and sent the material to Norm Saunders, who will do the graphs. Meantime, **the previous edition has been reprinted** and copies are available from John Malcolm, smudgie@comcast.net.
- The Board gave the go-ahead to Marcia Balestri to try out an **MOS travel Program** with Tropical Birding, starting with two trips, one domestic and one international.
- Wayne Bell is looking for volunteers to help develop **an MOS policy on alternative energy**.
- **Vacancies**: Chair, Conservation Committee. Members: Budget and Scholarship Committees.

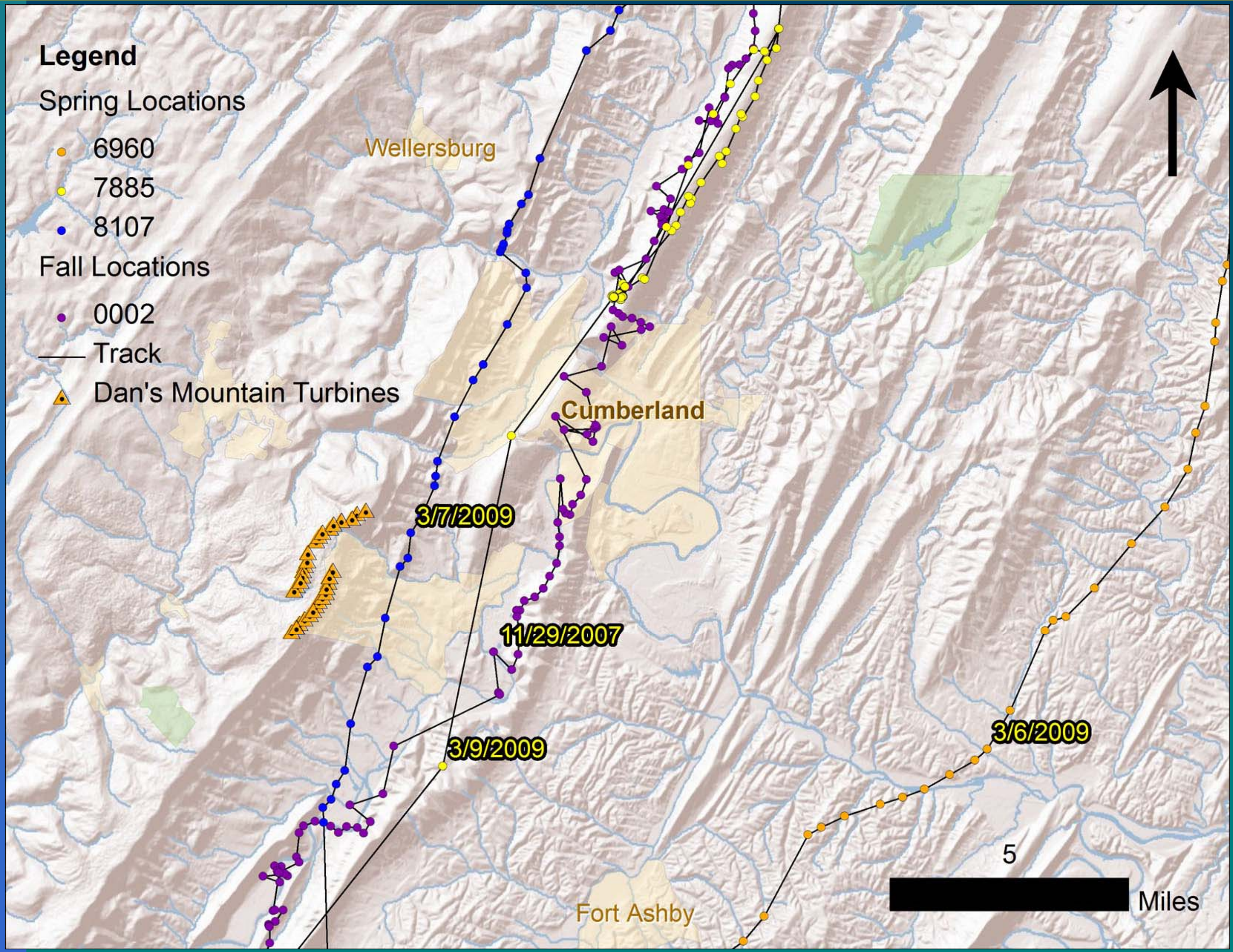
Dan's Mtn – spring eagle corridor

Remote Tracking of Golden Eagles

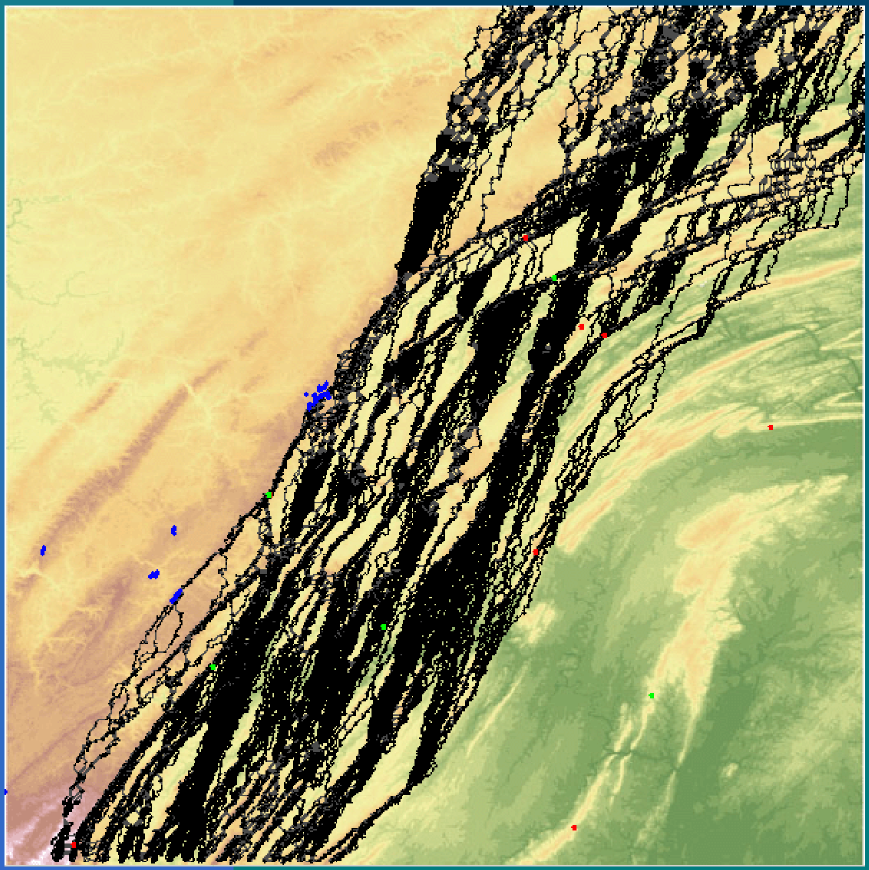
Satellite tracking data (Argos GPS)

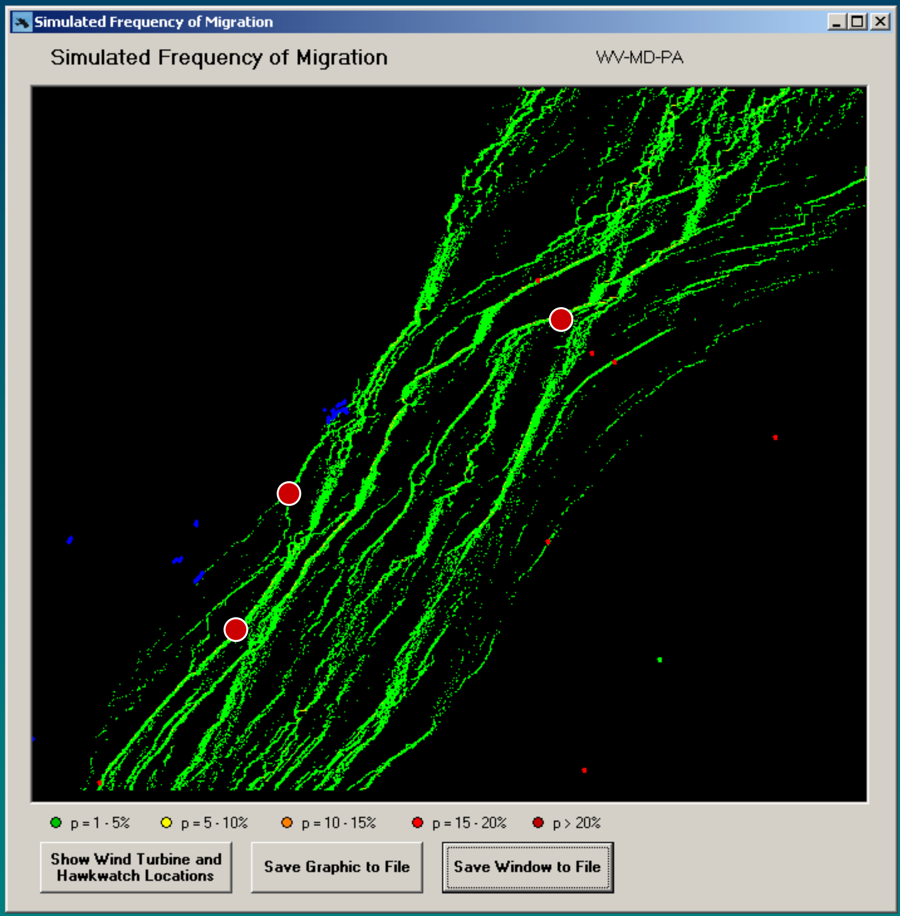


New generation high resolution tracking data



Migration modeling based on energy minimization principles





Model results for SE wind and NNE axis of migration

Summary

- Wind energy is part of the solution to our fossil fuel carbon emission problem
  - central Appalachians wind resource is small in comparison to (1) energy demand, and (2) wind resources of Great Plains and off Atlantic Coast
- Due to lack of scientific study, risks posed by wind turbines to raptors migrating along narrow ridge-tops is currently <u>unknown</u> – could be a significant threat for some rarer, long-lived species (e.g., Golden Eagles). Also a threat during wintering
- Impacts will depend on <u>site-specific</u> conditions
  - Many sites can be developed with minimal risk to raptors, but other sites will likely result in problems

A Way Forward

- Science-informed decisions
- Avoid known high risk locations (e.g. Kittatinny Ridge, edge of Allegheny Front). If not:
  - Employ micro-siting (e.g. setbacks) away from high risk flight lines - requires detailed pre-construction study
  - Adopt flexible operation schedules – e.g., temporary shut-downs during conditions most conducive to migration over site or when wintering eagles are present at site

Research/Data Needs

1. Better monitoring data: multiyear pre- and post-construction monitoring in <u>cooperation</u> with agencies and independent experts

2. Behavioral response of raptors to turbines

   A. How/when/why do collisions occur? (both during migration and wintering)

   B. Do raptors continue to move through turbine sites, or does avoidance shift flight patterns away?

3. Identify critical migration pathways and wintering areas to be avoided – many gaps in existing data


Questions?
For more info, see:
http://www.aviary.org/cons/pdf/WindEnergyRaptorsWhitePaper.pdf