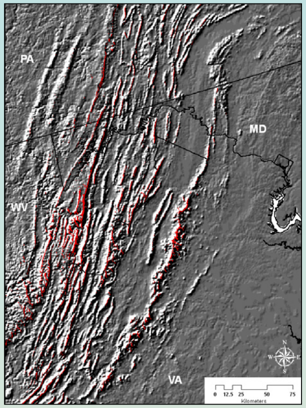
Assessing Patterns of Nocturnal Bird Migration through the Appalachian Region

Deanna Dawson, USGS Patuxent Wildlife Research Center, Laurel, MD
Tim Jones, USFWS, Atlantic Coast Joint Venture, Laurel, MD
Sarah Mabey, North Carolina State University, Raleigh, NC*
David Mizrahi, New Jersey Audubon Society, Cape May Court House, NJ

Interest in developing wind power as an alternative renewable energy source has increased in recent years. In the eastern United States, exposed summits or ridge crests in the Appalachian Mountains have high wind power potential, and numerous wind power projects are being developed or proposed. While generally supportive of energy development from renewable sources, the U.S. Fish & Wildlife Service, state wildlife agencies, non-governmental organizations, and the public are concerned about potential impacts of wind power development on wildlife. Large numbers of birds and bats cross or follow these landforms during their seasonal migrations, and wind power development potentially could impact populations of several species of concern.



Digital elevation model showing areas with high wind potential (wind power class ≥4, US Dept. Energy 1986).

We are studying the spatial and temporal distribution patterns and flight characteristics of birds that migrate nocturnally through the Appalachian Region of the Mid-Atlantic states (MD, PA, VA, WV). The overall objective of the project is to increase our understanding of the characteristics and dynamics of nocturnal migration through the Appalachians, so that informed and scientifically sound recommendations can be made to reduce the risk to migrants of proposed and operational wind power projects.

Specific objectives:

- Document broad-scale patterns of nocturnal migration through the Appalachians.
- Document site-specific passage rates, flight directions, and flight altitudes of migrating birds during fall and spring at multiple locations.
- Obtain information on the identity and relative abundance at each location of bird species that call while migrating.
- Model the effects of geographic location, topography, weather, and other variables on migrant abundance and flight characteristics.

* Currently at Sweet Briar College, Sweet Briar, VA

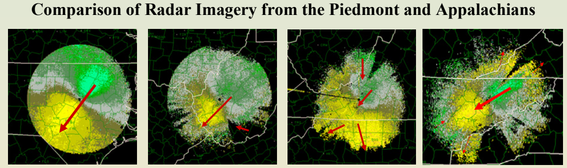
Broad-scale Patterns of Migration

Radars (WSR-88D: NEXRAD) in the National Weather Service's nationwide weather surveillance system can detect migrating birds in flight, and provide information on their location, density, and direction and speed of movement. We are analyzing NEXRAD data collected on nights during Fall 2004 and Spring 2005 from the weather radar stations that are closest to the study region (see map below).

Radar images from roughly 4-hr intervals between dusk and dawn were screened to identify those with migratory bird targets; targets are assumed to be migrating birds if they are moving in a seasonally appropriate direction at >10 knots above wind speed. For each usable image, the direction of the main vector of target movement is assessed. This information is being used to describe the temporal movements of migrants as they approach and move through the Appalachians, and to model the relationship of mean flight direction with time of night or season, location, topography, and weather. We also are exploring ways to estimate target density from radar reflectivity data in order to map and model the spatial distribution of migrants through the night and season, cross-validating data collected in the field. If data from these two seasons increase our understanding of regional migration patterns, NEXRAD data from additional years will be analyzed to assess seasonal variation in migration through the region.

NEXRAD Locations

Comparison of Radar Imagery from the Piedmont and Appalachians



These NEXRAD radial velocity images show the direction of movement, relative to the radar, of targets that likely are migrating birds, on 4 Sept 2003, 23:00 EDT. Green-coded data represent targets moving TOWARDS the radar; yellow-coded targets are moving AWAY from the radar. Data coded gray or brown indicate targets with no velocity relative to the radar. No velocity is registered when targets are moving perpendicular to the radar beam (possibly including birds rapidly changing altitude) or when the directions of targets are inconsistent and cancel each other out.

Note the clean hourglass-like pattern typical for Raleigh, located in the Piedmont, indicating one primary traffic vector. In contrast, migration passage through the Charleston, Roanoke, and Knoxville areas often shows discontinuities in direction and larger areas of ambiguity, indicating birds moving in multiple directions, possibly in response to topography. Ragged edges to the sampled areas occur where topography blocks radar coverage.

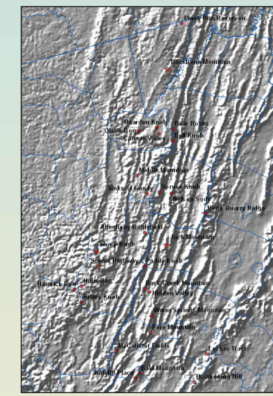
This project is funded through the USGS-FWS Science Support Program and State Wildlife Grant funds from MD, VA, and WV, matched with funds from The Nature Conservancy of VA. We thank Scott Johnston, FWS Region 5; Gwen Brewer, MD Dept. of Natural Resources; Rick Reynolds, VA Dept. of Game & Inland Fisheries; Kathy Leo & Walt Kordek, WV Division of Wildlife Resources; and Judy Dunscomb, TNC of VA, for encouragement and support. Colleen Heise assisted with screening and processing NEXRAD images and data, and Bob Fogg, Dan Kobza, & Ben Remsen conducted the portable radar sampling. We are grateful to the Bioacoustics Research Program, Cornell Laboratory of Ornithology, for technical guidance and support for the acoustic monitoring. Charlie Robinson & Ken Lavish volunteered many hours in assembling the ARUs; thanks also to Malcolm Livingston & Allan Dansie. We have received considerable assistance and logistical support from staff of the Monongahela National Forest (MNF) and George Washington & Jefferson National Forests (GWJNF): Cathy Johnson, Dan Arling, Kevin Boyle, Mary Erickson, Eric Foree, Jeff Hammes, Jay Martin, Robert Stovall, & Will Amy, MNF; Carol Hardy Croy, Terry Flaherty, & Ed Haverlack, GWJNF. Thanks also to Ken Sturm, Canaan Valley National Wildlife Refuge; Brad Kreps, TNC of VA; Thomas Minney, TNC of WV; and Jo Anna Leachman, Frostburg State University.

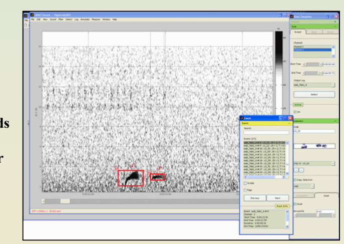
Site-specific Information on Migrant Passage and Flight

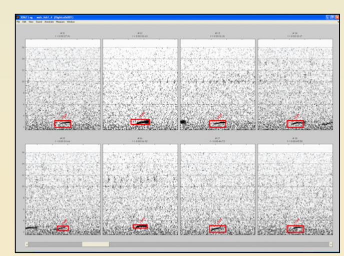
NEXRAD data provide a broad view of regional migration patterns. However, much of the Appalachian region is not covered by NEXRAD. Also, because the radar beam is set to a slight upward tilt, NEXRAD generally does not sample the altitudinal range potentially occupied by wind turbines (< 150 m above ground level). Ground-based acoustic monitoring and sampling with portable marine radar can provide site-specific information on passage rates and flight characteristics of migrants flying through this airspace.

We are conducting acoustic monitoring at 29 sites scattered through the central Appalachians, recording the flight calls made by migrating birds to index their abundance and species composition at different locations. The recordings currently are being processed, using software developed by Harold Figueroa, Bioacoustics Research Program, Cornell Laboratory of Ornithology. At three sites, acoustic monitoring is paired with portable radar sampling to provide additional information on migrant passage rates, and their flight altitudes and direction, allowing estimation of the proportion of migrants that are detected by sound.

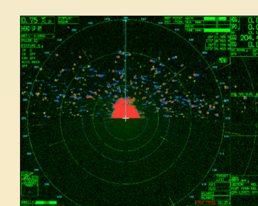

Flight call recorder, Allegheny Battlefield, Monongahela National Forest, Pocahontas County, WV. Each PVC housing, covered by a shag wind screen, contains a microphone. Sounds are recorded onto a mp3 recorder with 100-GB hard drive, housed in a watertight box bolted to a bucket holding batteries that power the recorder and mics.


Acoustic monitoring sites. Sites where portable radar sampling is also being conducted are indicated with stars.


Thrush flight calls detected by the XBAT software. XBAT scans recordings, searching for and marking sounds (events) in a specified range of frequencies or that resemble example calls (templates).


Summary page of detected calls, among hundreds recorded at Paddy Knob, VA, on 23 Sept 2005. For each night of sampling at each site, recorded calls are tallied, to relate migrant abundance to location, topography, weather, and other factors. The calls of some species are distinctive, and can be identified by matching call spectrograms to a reference set compiled by Bill Evans & Michael O'Brien (2002). Others can only be assigned to groups of species with similar calls.


NJAS radar trailer, Jack Mountain, Highland Wildlife Management Area, Highland Co., VA. The tent houses a generator, which powers the radar and computers.


Radar image showing the altitudinal distribution of targets, presumably migrating birds, at Jack Mountain, VA, 00:04 EDT, 30 Apr 2005. Birds are roughly equally distributed between 100 m and 3000 m above ground level.