Validation of NEXRAD Data and Models of Bird Migration Stopover Sites in the Northeastern US

Interim Project Update

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RESEARCH ARTICLE

Radar analysis of fall bird migration stopover sites in the northeastern U.S.

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ABSTRACT

The national network of weather surveillance radars (WSR-88D) detects flying birds and is a useful remote-sensing tool for ornithological study. We used data collected during fall 2008 and 2009 by 16 WSR-88D radars in the northeastern U.S. to quantify the spatial distribution of landbirds during migratory stopover. We geo-referenced estimates based on radar reflectivity, of the density of migrants aloft at their abrupt evening exodus from daytime stopover sites, to the approximate locations from which they emerged. We classified bird stopover use by the magnitude and variation of radar reflectivity across nights; areas were considered "important" stopover sites for conservation if bird density was consistently high. We developed statistical models that predict potentially important stopover sites across the region, based on land cover, ground elevation, and geographic location. Large areas of regionally important stopover sites were located along the coastlines of Long Island Sound, throughout the Delmarva Peninsula, in areas surrounding Baltimore and Washington, along the western edge of the Adirondack Mountains, and within the Appalachian Mountains of southwestern Virginia and West Virginia. Locally important stopover sites generally were associated with deciduous forests embedded within landscapes dominated by developed or agricultural lands, or near the shores of

OBJECTIVES

1. Calibrate NEXRAD radar data of bird stopover density by collecting ground survey data of bird densities

2. Improve NEXRAD-based predictive models of important stopover sites for USFWS Region 5 by incorporating two more years of radar data, a more sophisticated modeling method, and better explanatory variables
   - Process fall data from 16 NEXRAD and 4 TDWR sites from 2008-2014

3. Validate the updated NEXRAD-based predictive statistical models for USFWS Region 5 using ground survey and NASA radar observations

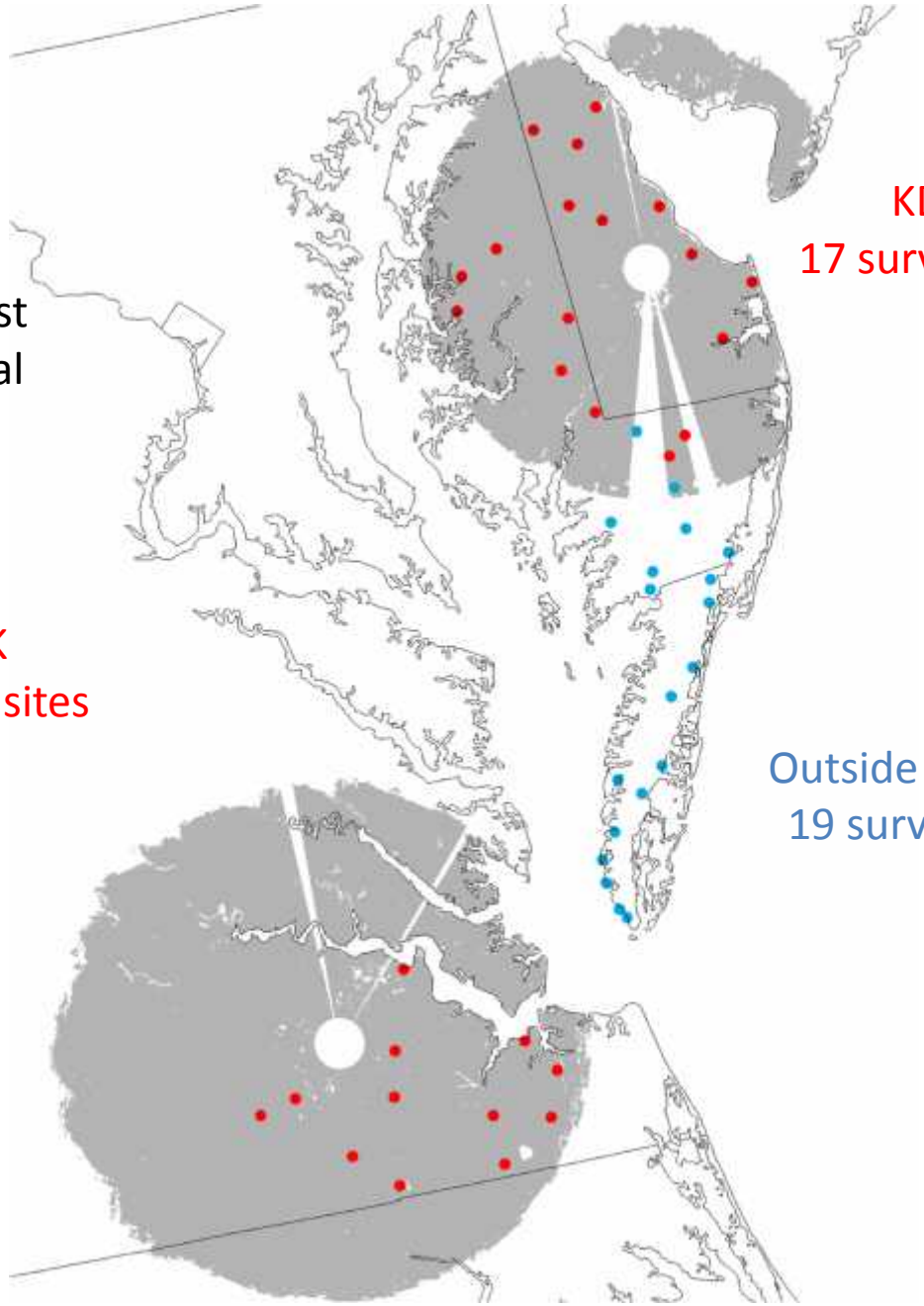
4. Assess habitat use of migrants in relation to food abundance, habitat, and landscape features in the Mid-Atlantic Coastal Plain

Sponsors/Partners

- USFWS (NEXRAD & TDWR radar data analysis, 24 VA & DE surveys sites, update of predictive models)
- Virginia Department of Game and Inland Fisheries
  - (NPOL radar data analysis)
- NASA (collection of NPOL radar data)
- USGS (radar data screening)
- Maryland Department of Natural Resources
  - (12 MD survey sites)
- Virginia Coastal Zone Management Program
  - (12 VA surveys sites during 2013)
- University of Delaware
  - (12 VA surveys sites during 2014)

OBJ 1) Radar data verification & calibration

48 hardwood forest survey sites in total



Ground survey effort fall 2013

Survey season = August 15 to November 7 (85 days)

Total sites = 48

Field crew = 8 people

Alan Moss, Ben Hodgkins, Ben Zyla, Blake Hepner, Conor Higgins, Eric Cali, Marissa Buschow

Total surveys = 836

Birds: 500m transect, 30 min.
3 sites per day (~18 repeat visits per site)
Distance sampling
16,103 individuals detected (~20 per visit)

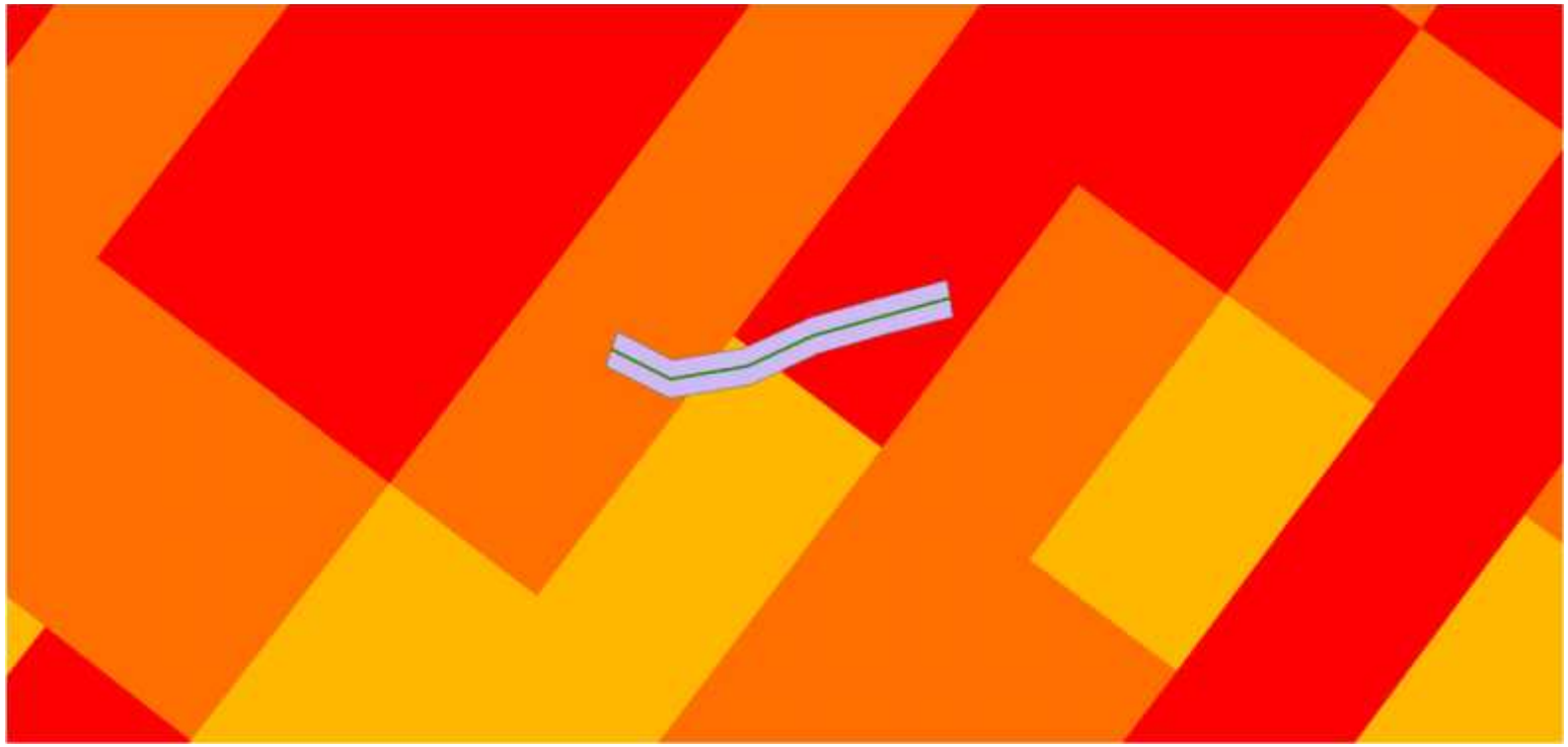
Food Availability:
Fruit counts within 3 plots (20x20m) along transect per visit
Insect visual counts and branch clippings at 3 locations per visit

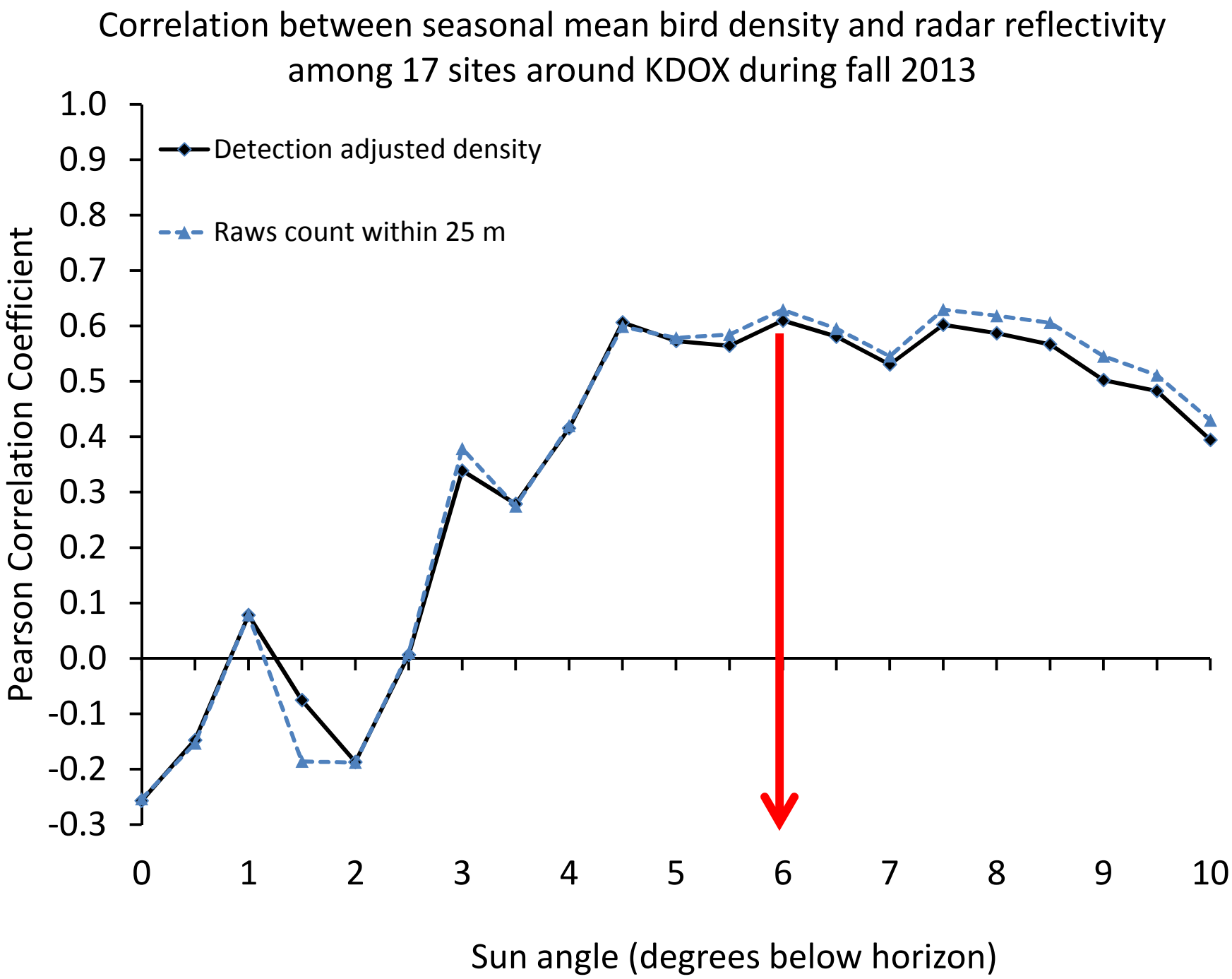
Habitat structure and vegetative composition:
Used a modified James and Shugart protocol at 4 locations per transect

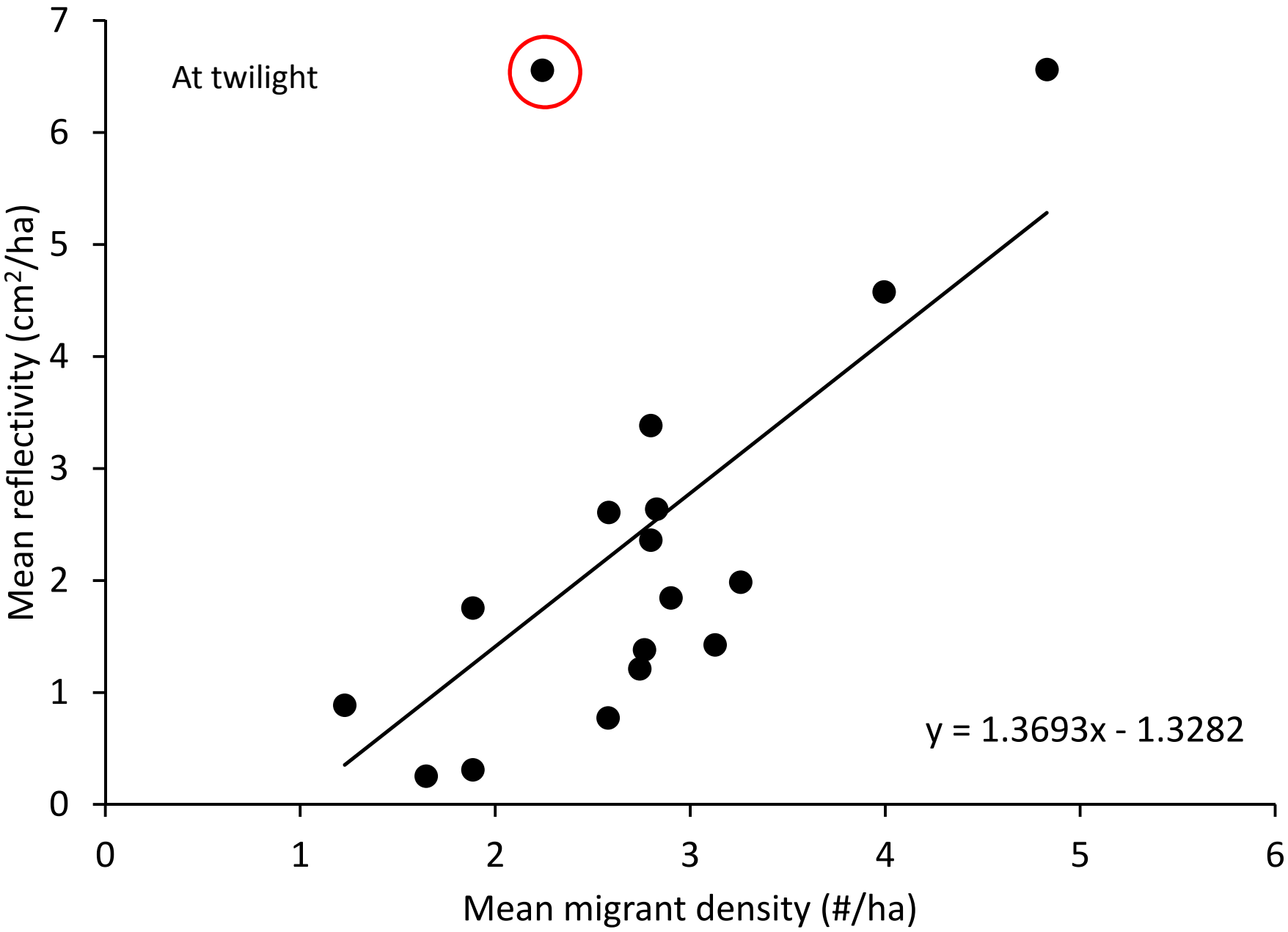
Extracting radar data for transects

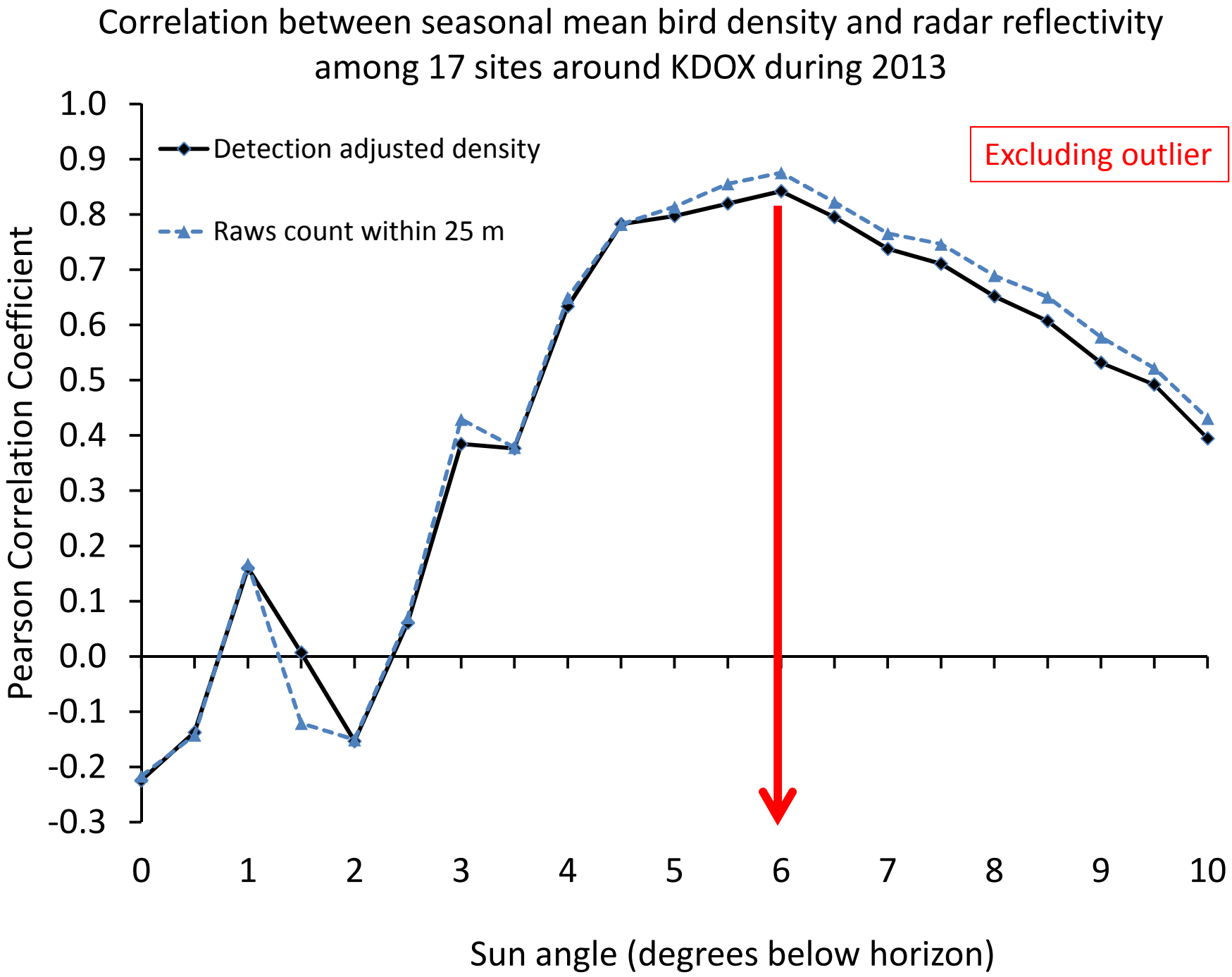
(clip from 25 m wide buffer around transects)

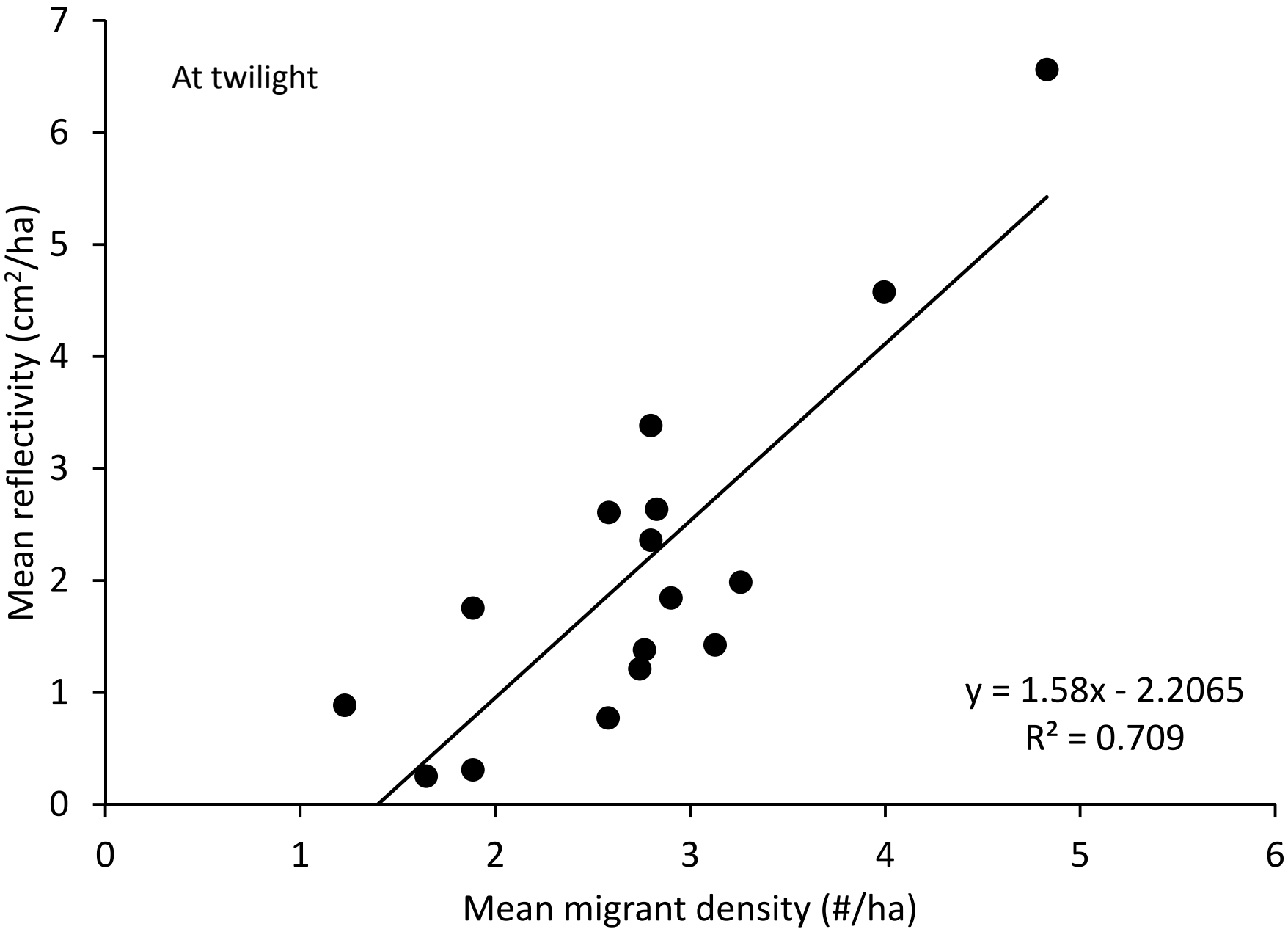
Seasonal geometric mean reflectivity

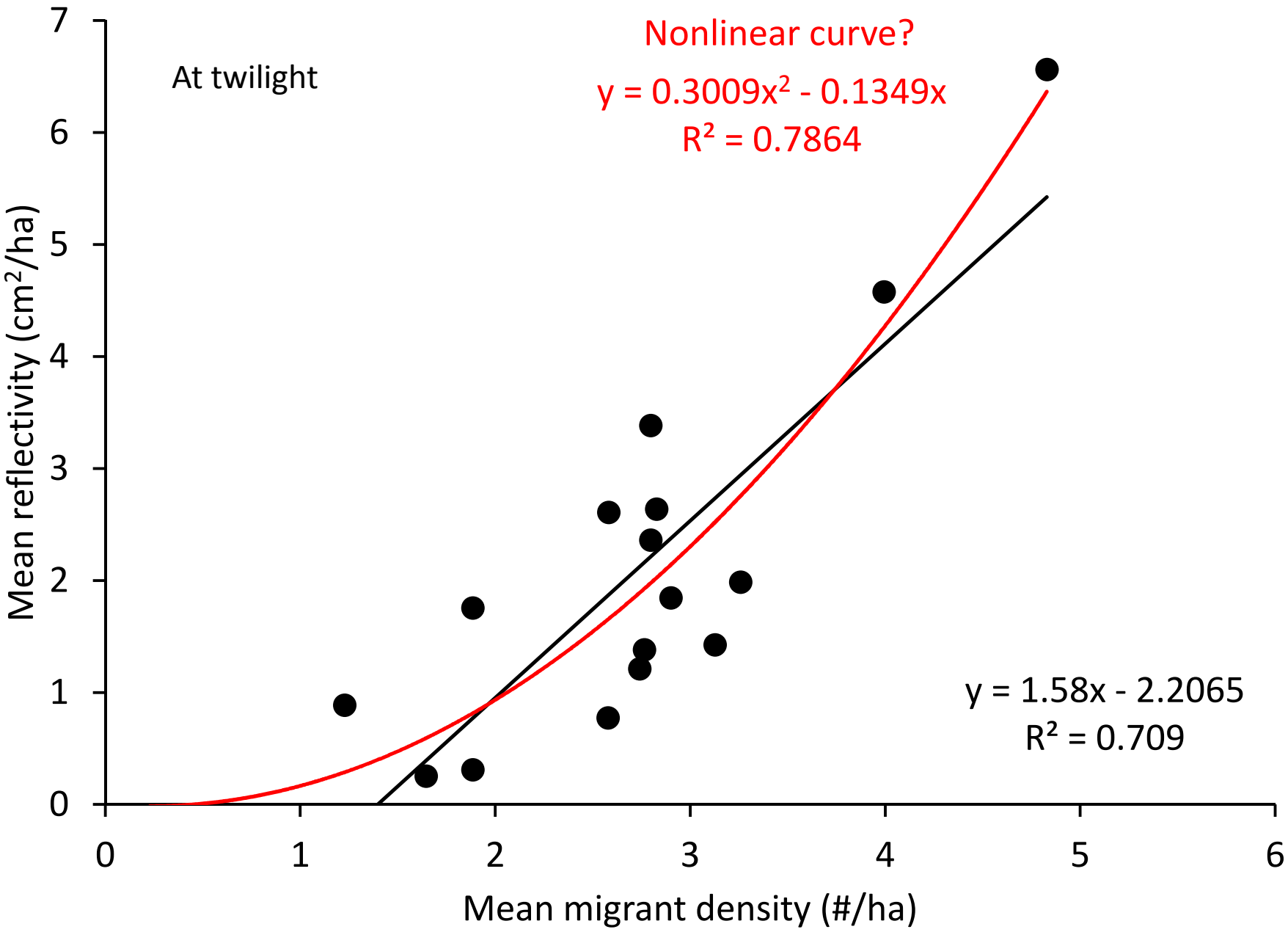



Correlation between seasonal mean bird density and radar reflectivity among 17 sites around KDOX during fall 2013
Detection adjusted density
Raws count within 25 m
Pearson Correlation Coefficient
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
0
1
2
3
4
5
6
7
8
9
10
Sun angle (degrees below horizon)


At twilight
y = 1.3693x - 1.3282
Mean reflectivity (cm²/ha)
Mean migrant density (#/ha)
0
1
2
3
4
5
6
7

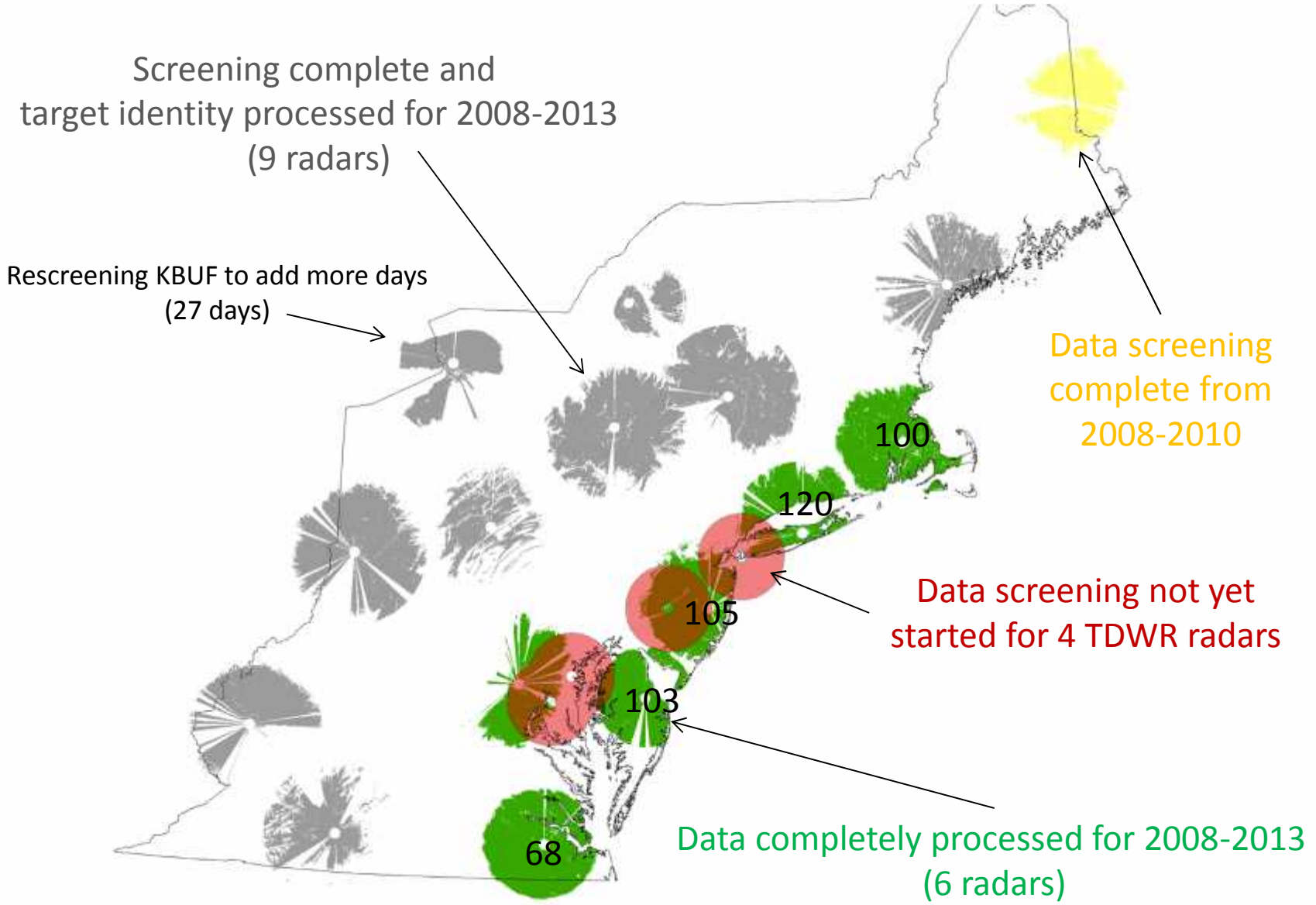

Correlation between seasonal mean bird density and radar reflectivity among 17 sites around KDOX during 2013
Detection adjusted density
Raws count within 25 m
Excluding outlier
Pearson Correlation Coefficient
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
0
1
2
3
4
5
6
7
8
9
10
Sun angle (degrees below horizon)


At twilight
Mean reflectivity (cm²/ha)
Mean migrant density (#/ha)
y = 1.58x - 2.2065
R² = 0.709
0
1
2
3
4
5
6
7


At twilight
Nonlinear curve?
y = 0.3009x² - 0.1349x
R² = 0.7864
y = 1.58x - 2.2065
R² = 0.709
Mean reflectivity (cm²/ha)
Mean migrant density (#/ha)
0
1
2
3
4
5
6
7

OBJ 2) Updating radar data and models

NEXRAD data processing



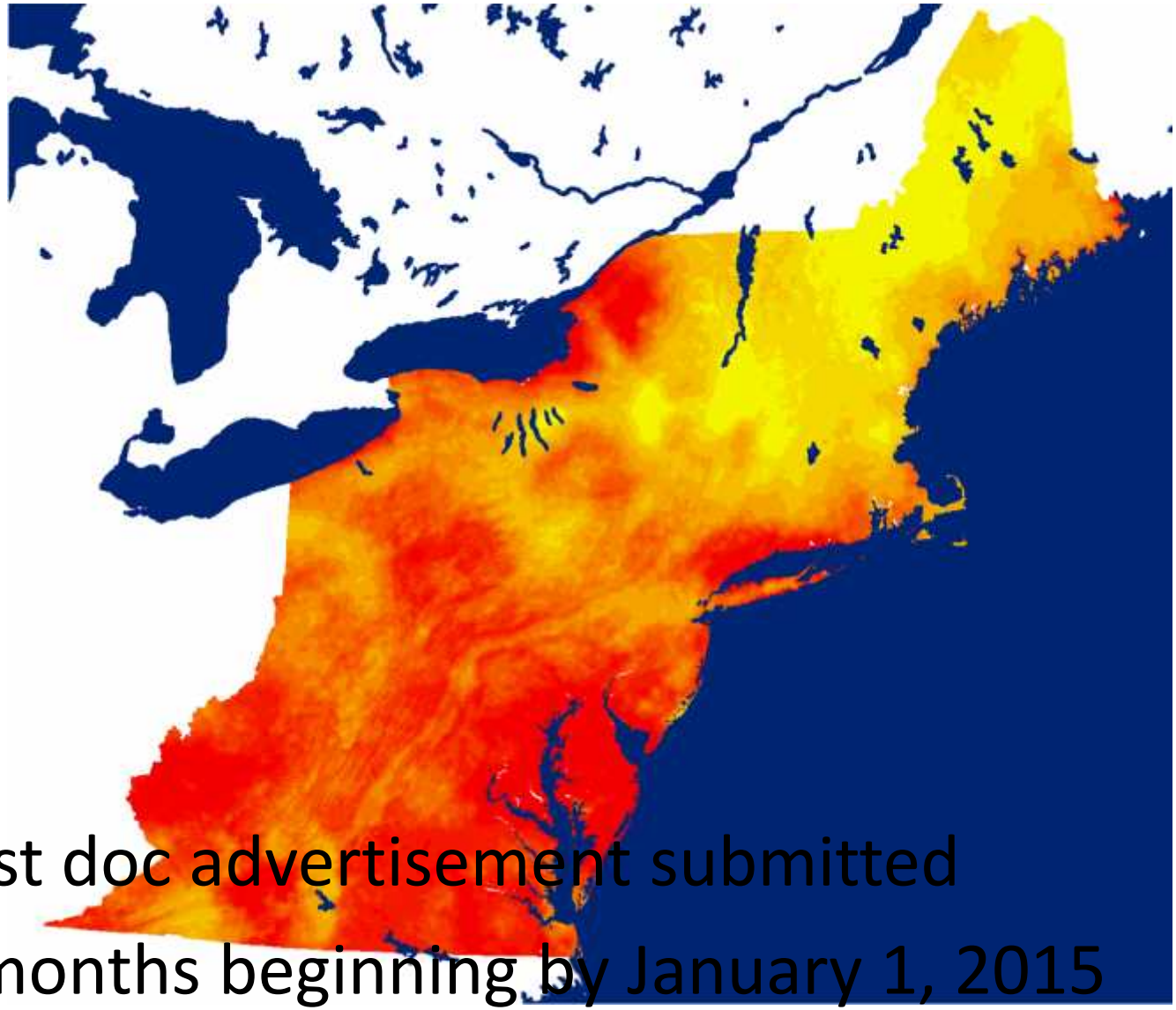
6,970 total days will be screened

Expanding predictor variable set…

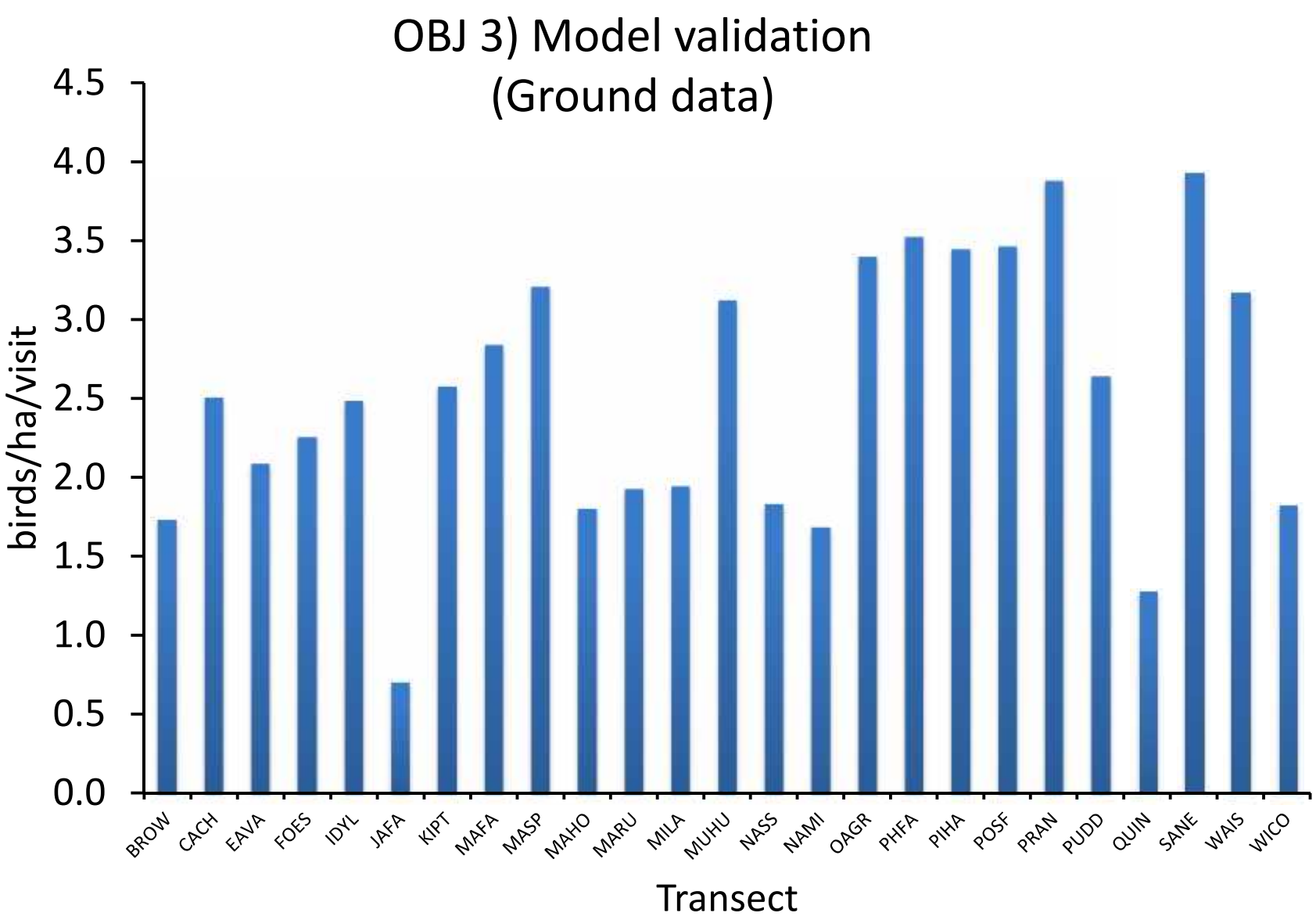
We have compiled MODIS NDVI data from 2008-2013

Improving modeling framework…

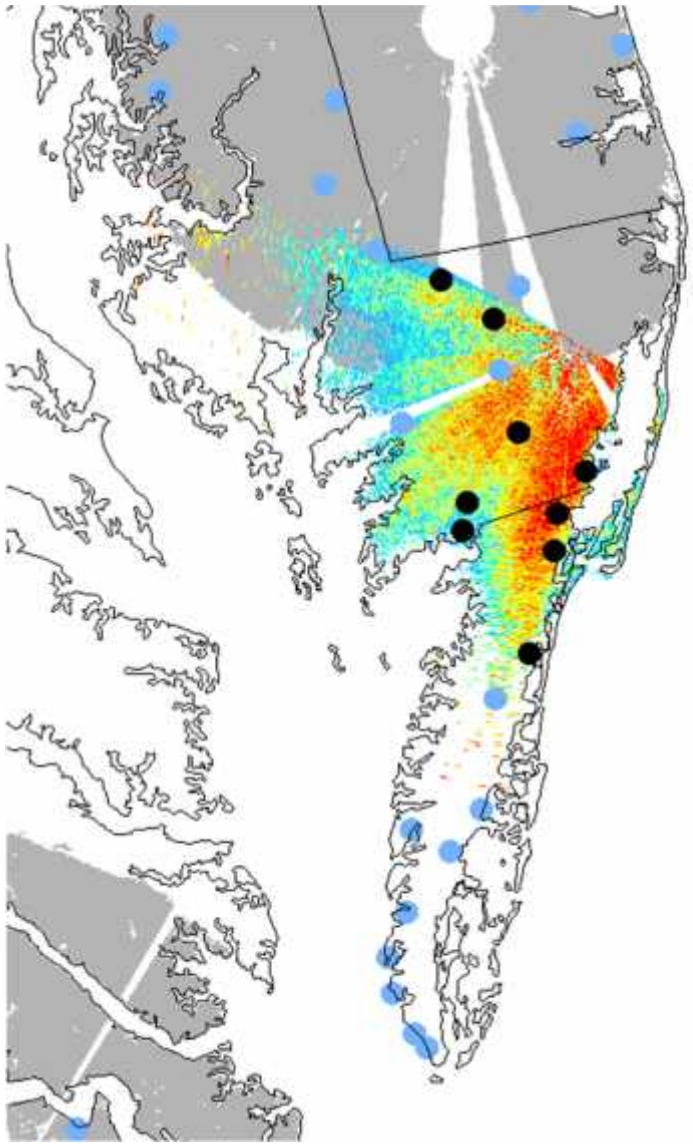
Mixed model Geographically-weighted regression



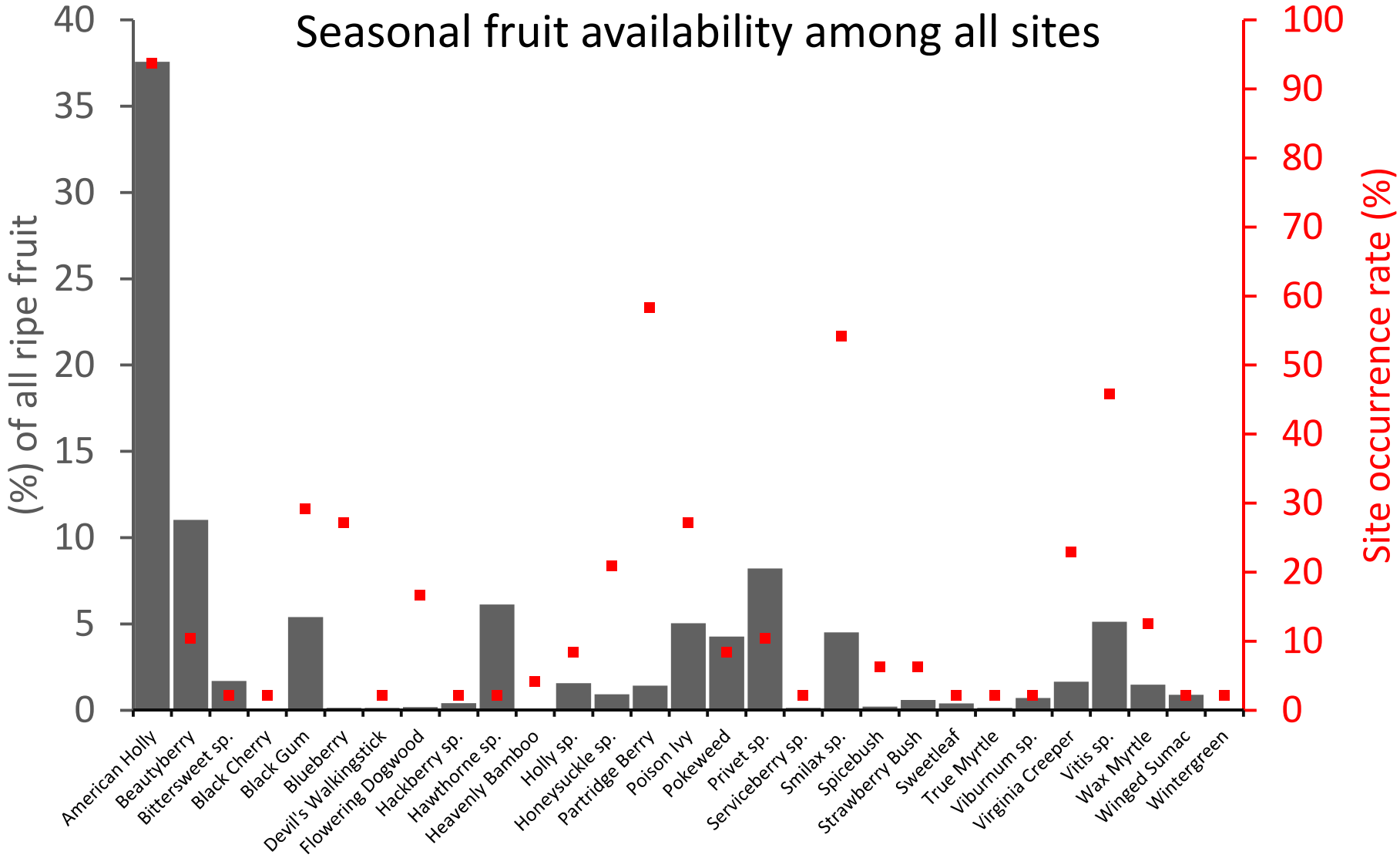
- Post doc advertisement submitted
- 6 months beginning by January 1, 2015

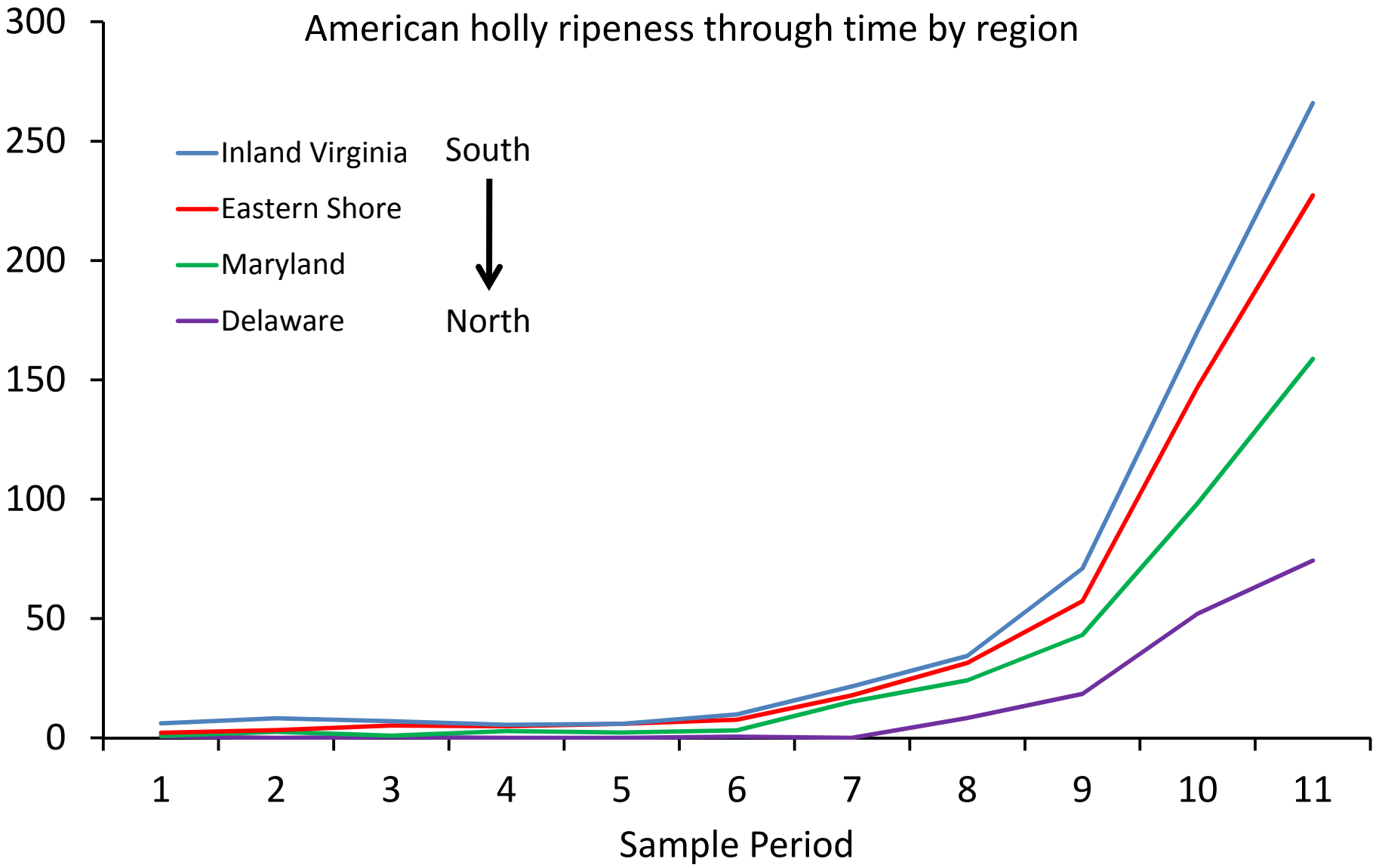

OBJ 3) Model validation
(Ground data)
birds/ha/visit
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
BROW
CACH
EAVA
FOES
IDYL
JAFA
KIPT
MAFA
MASP
MAHO
MARU
MILA
MUHU
NASS
NAMI
OAGR
PHFA
PIHA
POSF
PRAN
PUDD
QUIN
SANE
WAIS
WICO
Transect

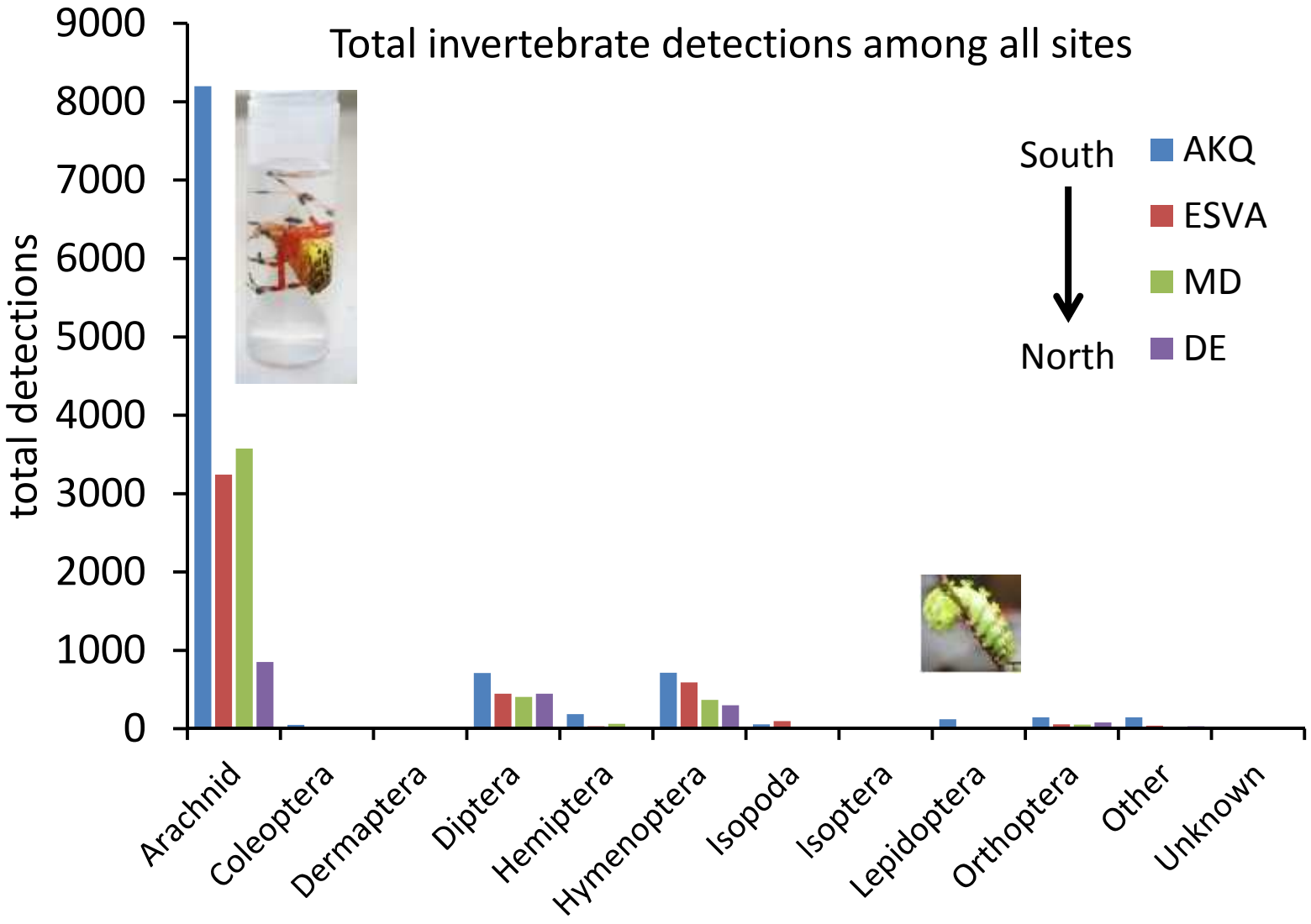
OBJ 3) Model validation (NPOL data)

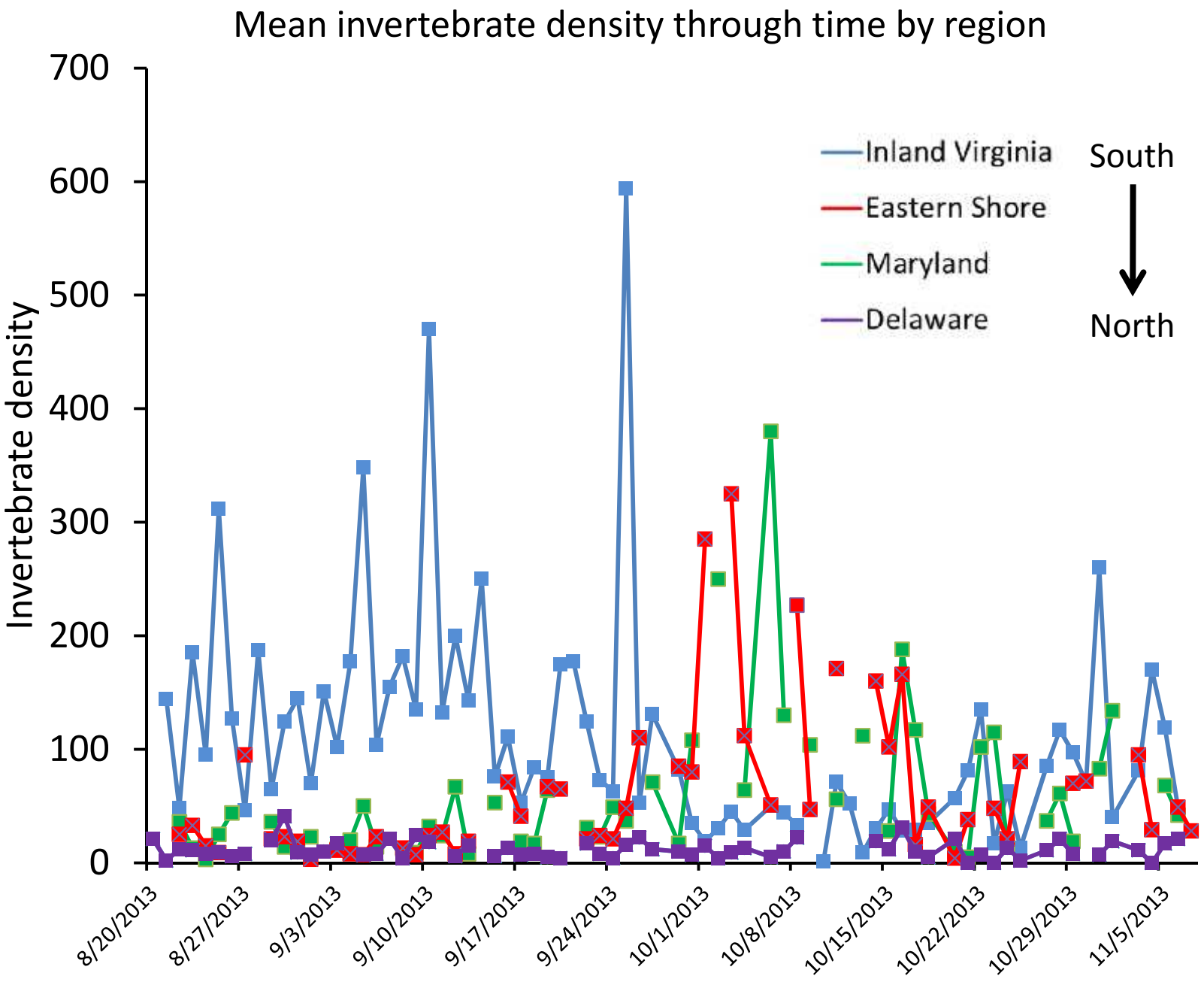


OBJ 4) Fine-scale forest habitat use of migrants

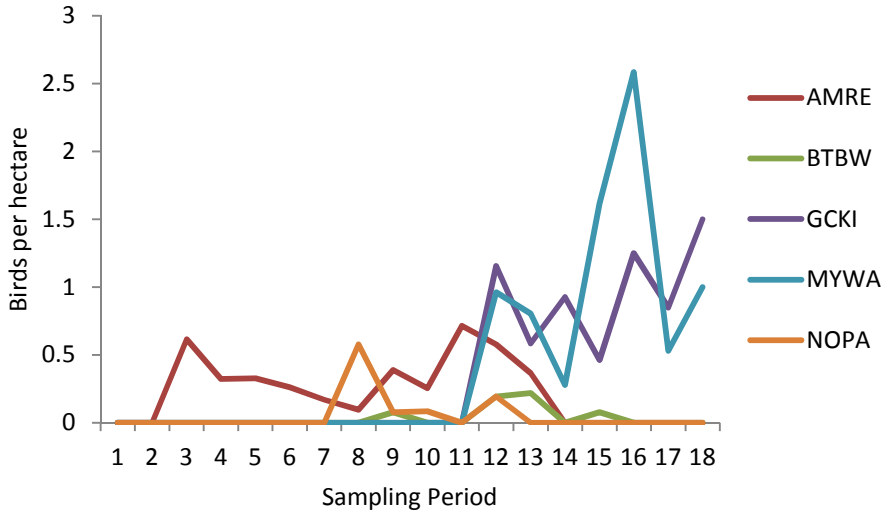



American holly ripeness through time by region
Inland Virginia
Eastern Shore
Maryland
Delaware
South
North
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
Sample Period

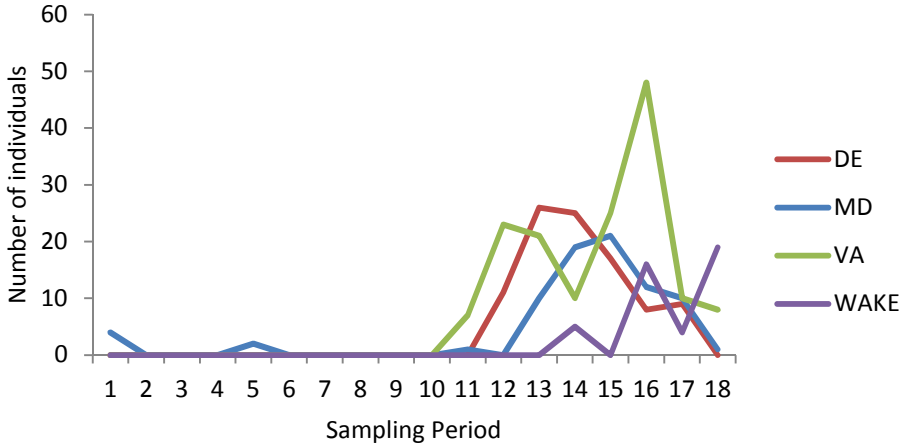

Total invertebrate detections among all sites
total detections
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
South
North
AKQ
ESVA
MD
DE
Arachnid
Coleoptera
Dermaptera
Diptera
Hemiptera
Hymenoptera
Isopoda
Isoptera
Lepidoptera
Orthoptera
Other
Unknown


Mean invertebrate density through time by region
Invertebrate density
700
600
500
400
300
200
100
0
8/20/2013
8/27/2013
9/3/2013
9/10/2013
9/17/2013
9/24/2013
10/1/2013
10/8/2013
10/15/2013
10/22/2013
10/29/2013
11/5/2013
Inland Virginia
Eastern Shore
Maryland
Delaware
South
North

Phenology of bird density through time by species



Yellow-rumped Warbler



Presentations

- 2013. Buler, J. J. *Recent applications of weather radar for understanding the stopover ecology of migrating birds,* Old Dominion University, Department of Biological Sciences, Norfolk, VA
- 2013. Arnold, A., J. J. Buler, T. Schreckengost, and E. L. Walters. *Using radar-based data to predict forested hardwood habitat use by migrants along the Eastern Shore of Virginia and Maryland: A preliminary report,* Coastal Upland Management Meeting, Eastern Shore of Virginia National Wildlife Refuge, Cape Charles, VA
- 2014. Buler, J. J. *Some revelations of bird migration and stopover ecology from weather surveillance radar observations,* Villanova University, Department of Biology, Philadelphia, PA
- 2014. Arnold, A., T. Schreckengost, J. J. Buler, and E. L. Walters. *Assessing habitat use and quality of stopover sites during fall migration,* North American Congress for Conservation Biology, University of Montana, Missoula, MT
- 2014. Buler, J. J., D. Dawson, D. La Puma, J. Smolinksy, T. Schreckengost, A. Arnold, E. Walters. *Broad-scale mapping and monitoring of migratory landbird stopover sites using the national network of weather radars,* Joint Meeting of the Northeast and Southeast Partners in Flight, Virginia Beach, VA