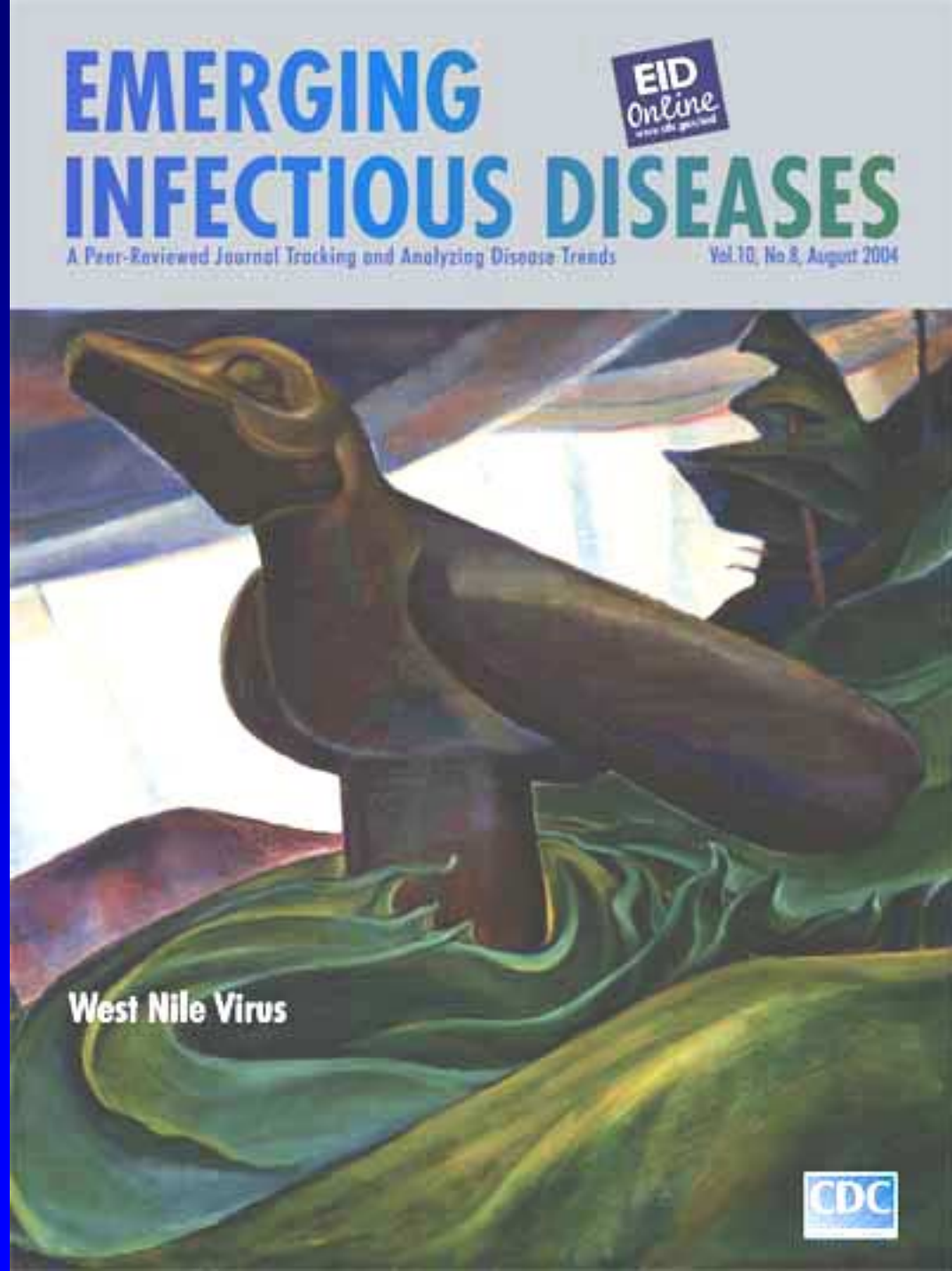
Developments in Avian Mortality Surveillance for WNV

Millicent Eidson,
MA, DVM, DACVPM (Epid.)
State Public Health Veterinarian and Director, Zoonoses Program
New York State Department of Health
Associate Professor, Department of Epidemiology
University at Albany School of Public Health



Acknowledgements

Information in this overview includes results based on the work of the following groups and individuals, as well as the authors of the scientific references listed on the slides.

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  - **Zoonoses Program: Y Hagiwara, A Ellis, G Johnson, K Schmit, et al.**
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  - **New York City Department of Health: M Layton, A Fine et al.**
  - **Nassau County Department of Health: D Ackman et al.**
  - **Suffolk County Department of Health Services: B Harper et al.**
- **United States Department of Agriculture Wildlife Services**
  - **New York Office: R Chipman et al.**
- **CDC, USGS (see slides)**
- **Other States, including California, Florida, Illinois, Indiana, New Jersey, Texas, Virginia (see slides)**

Why Real-Time Surveillance?

- WNV continues to cause morbidity and mortality in people, horses, and wildlife
- Vector control and personal protection—when?
  - Vector control is expensive; there may be concerns about adverse consequences
  - Personal protection may be infrequently adopted; there may be concerns about adverse consequences
- Need to identify areas of greater WNV risk to prioritize vector control and education
  - Need to appropriately warn when risk is high
  - Need to avoid false alarms when risk is not high
- Timing is critical to interrupt transmission during the WNV season

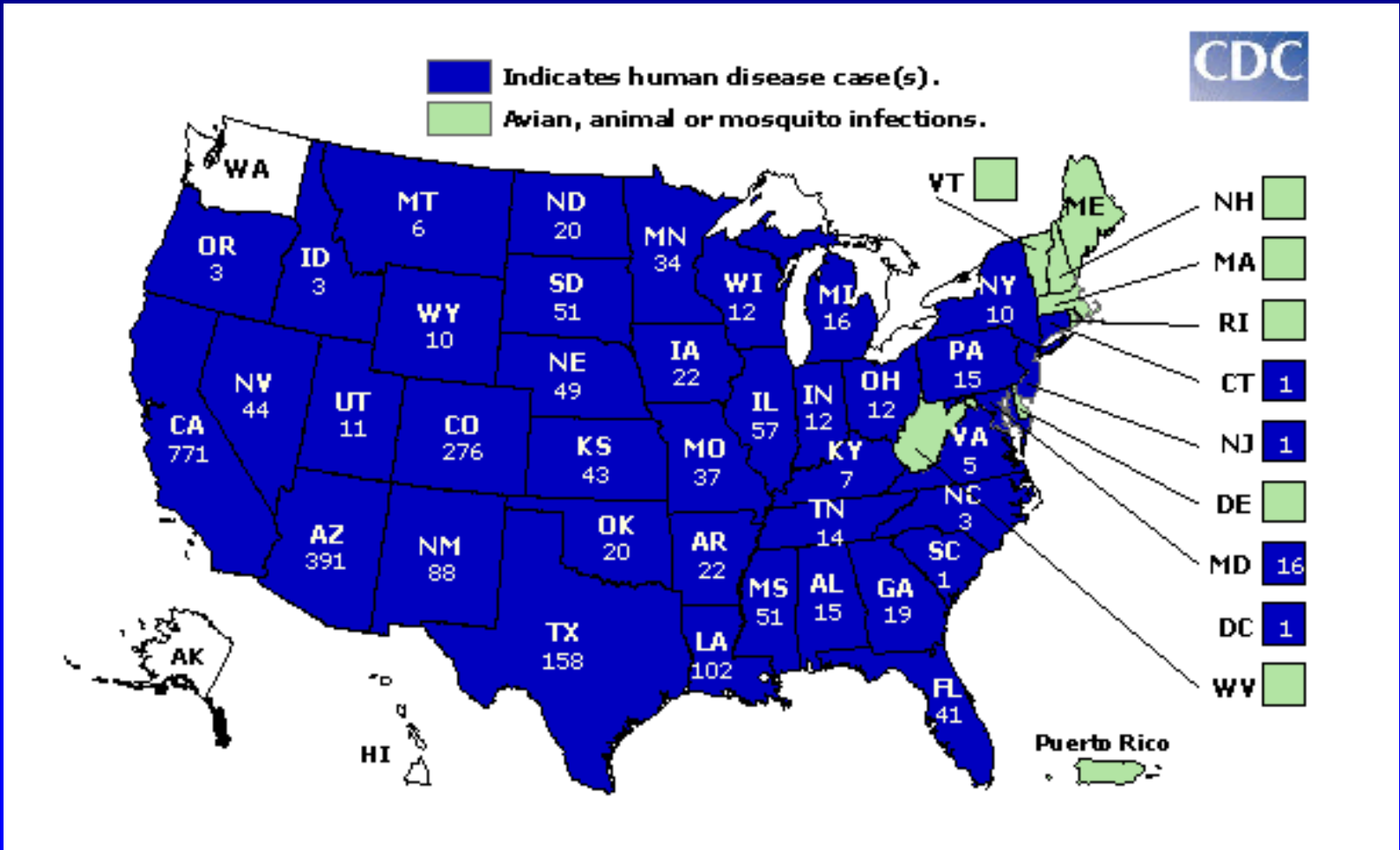
Types of Bird Data
*reviewed in this summary

- Avian mortality reports (not tested for WNV)*
- Laboratory-confirmed WNV + dead birds*
  - Representing ~200 species (Komar. Advances in Virus Res. 2003;61:185-234)
- Serosurveys of live birds
- Christmas bird counts and other population-based studies of live birds
- Periodic testing of sentinel flocks
- Laboratory research (e.g., studies of transmission, clinical course, etc.)

Dead Bird Data is available from CDC

2004 WNV Activity in the United States

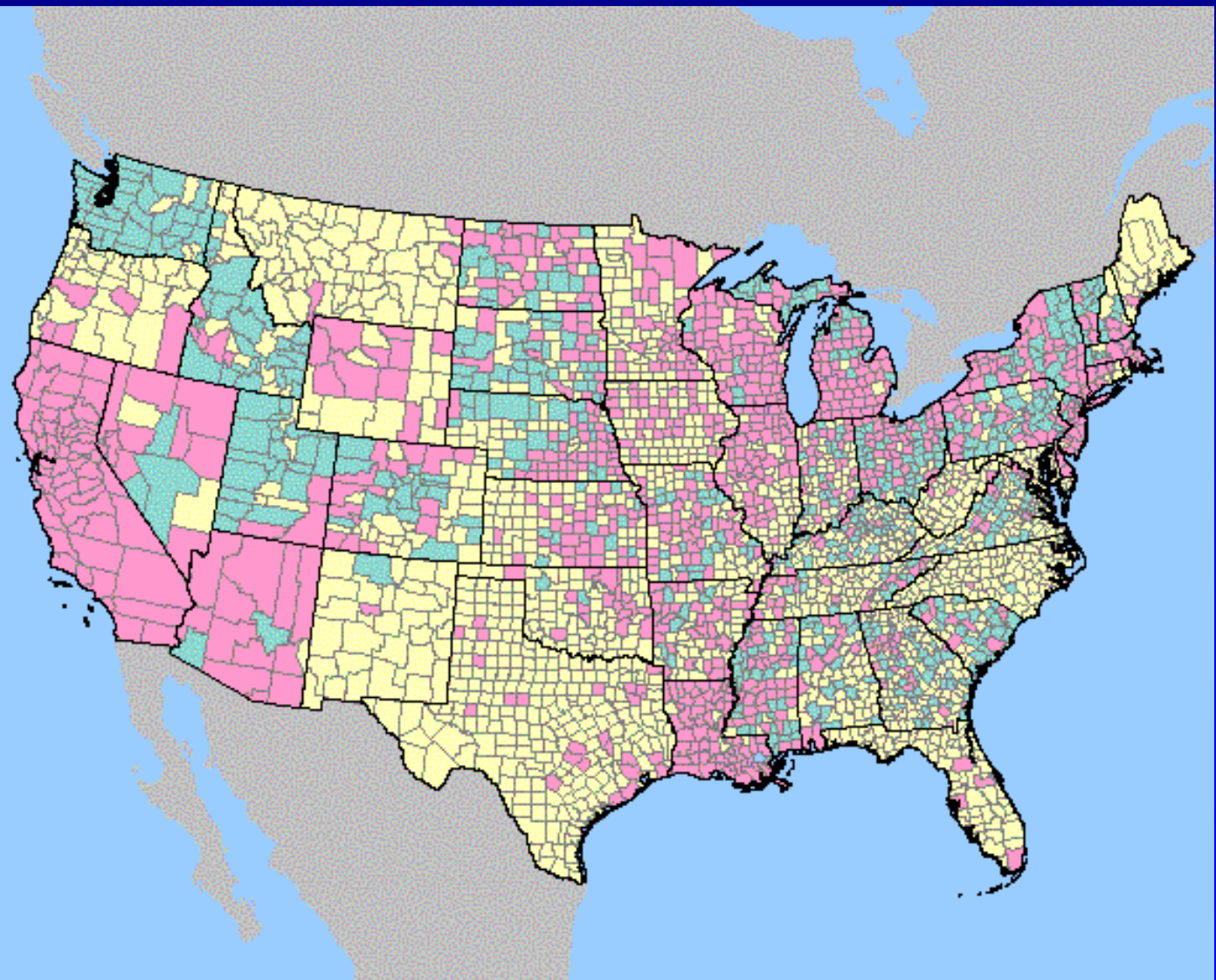
(reported to CDC as of January 11, 2005)*



Available at http://www.cdc.gov/ncidod/dvbid/westnile/surv&control04Maps.htm

Dead bird data is available from USGS

Cumulative 2004 Data as of 3 am, Jan 11, 2005

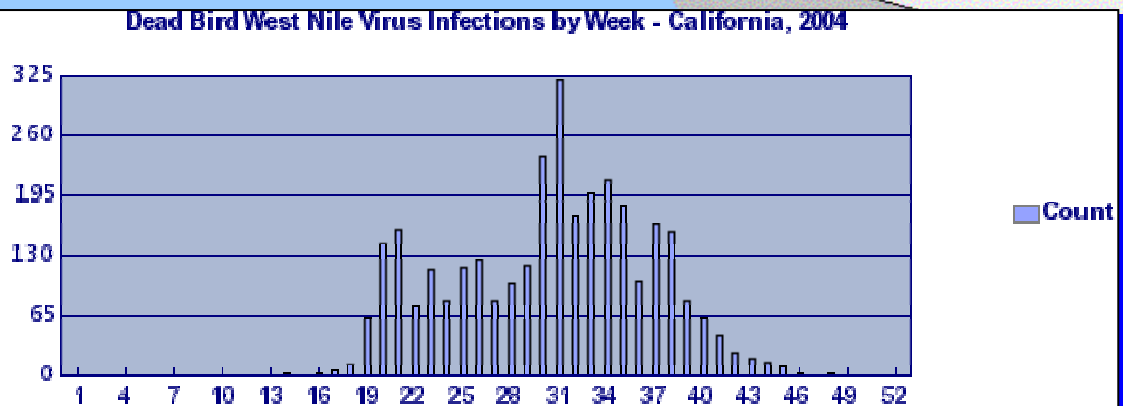


Legend

- Positive Test Results
- Samples Submitted
- No Data

Available at http://westnilemaps.usgs.gov/us_bird.html

State-specific dead bird data, USGS maps



Cumulative Dead Bird Infections by County - California, 2004

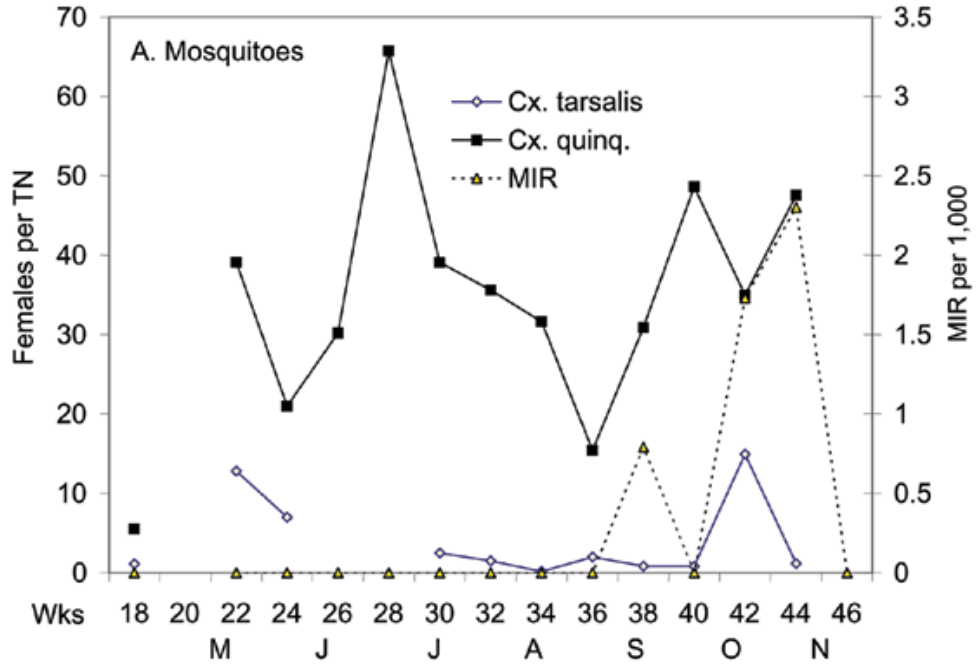
Alameda County	23
Alpine County	3
Amador County	9
Butte County	118
Calaveras County	10
Colusa County	21
Contra Costa County	18
Del Norte County	3
El Dorado County	22
Fresno County	115
Glenn County	75
Humboldt County	17
Imperial County	1
Inyo County	12

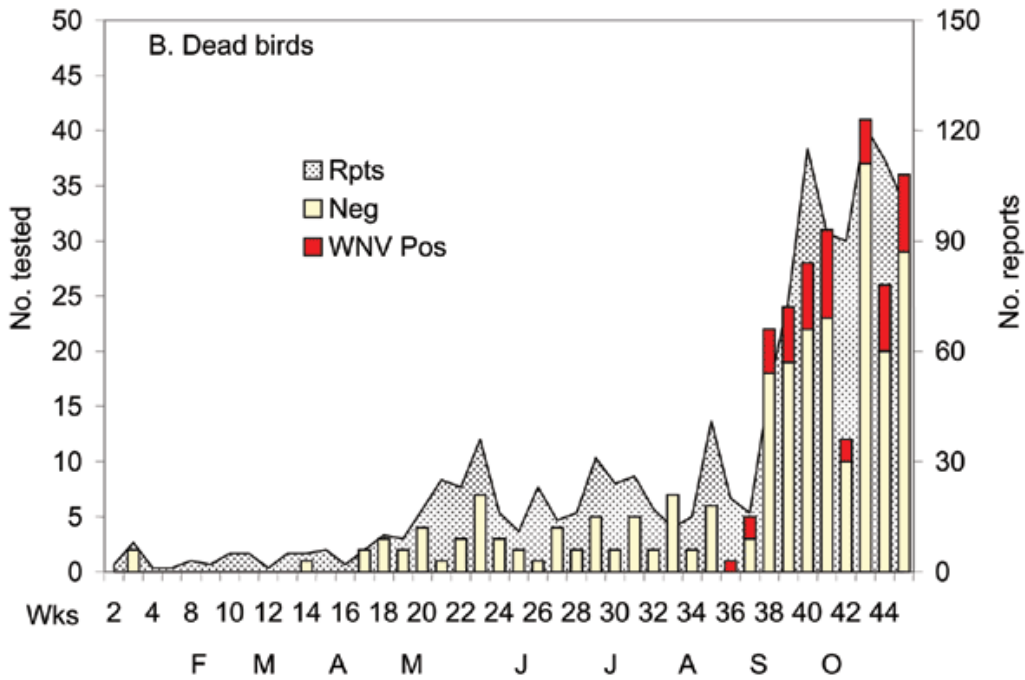
Avian mortality results are associated with results from other surveillance systems

2003, California:

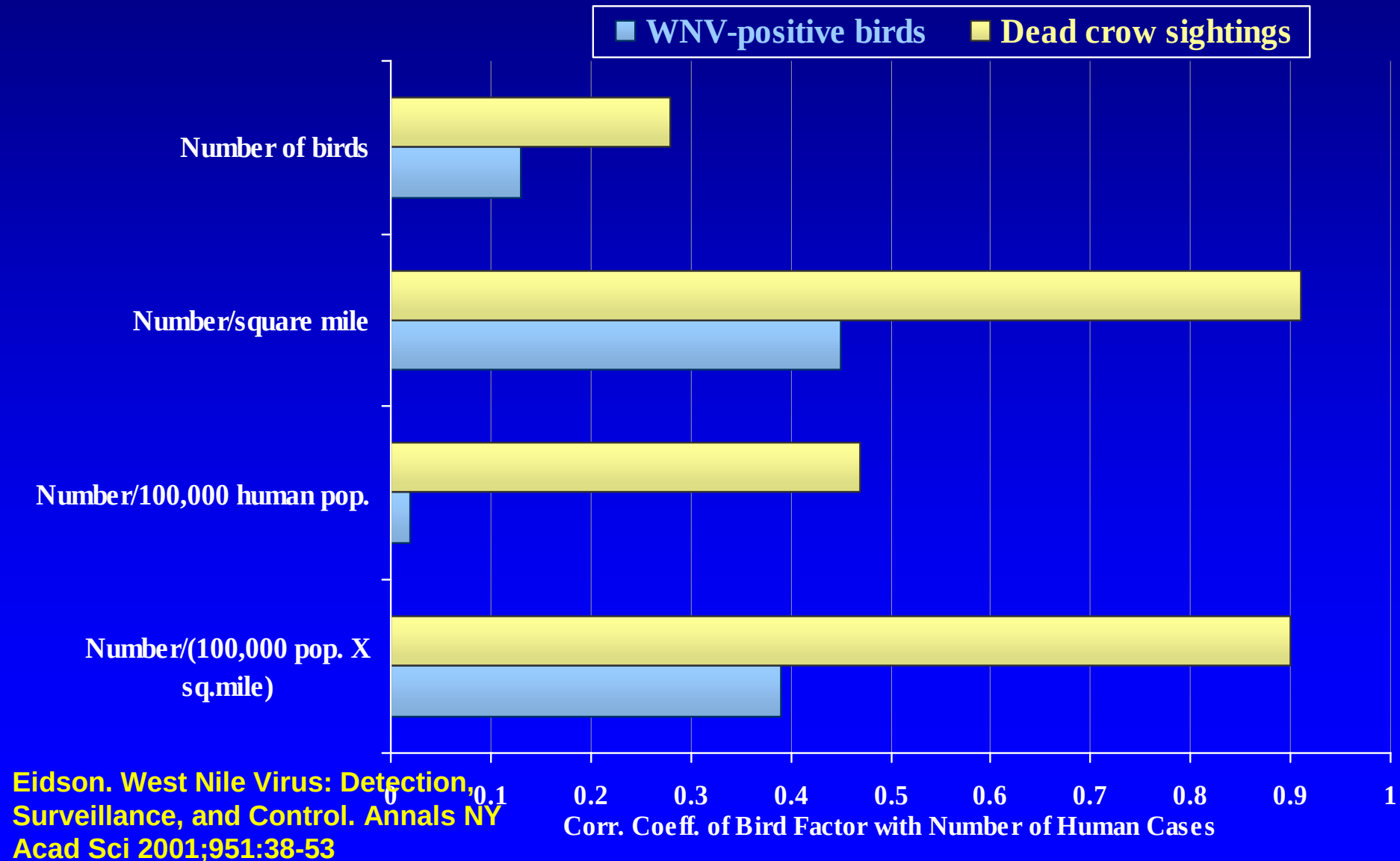
MIRs increase in same time period as dead bird reports and positive birds

Reisen, et al. EID 2004;10:1369-78



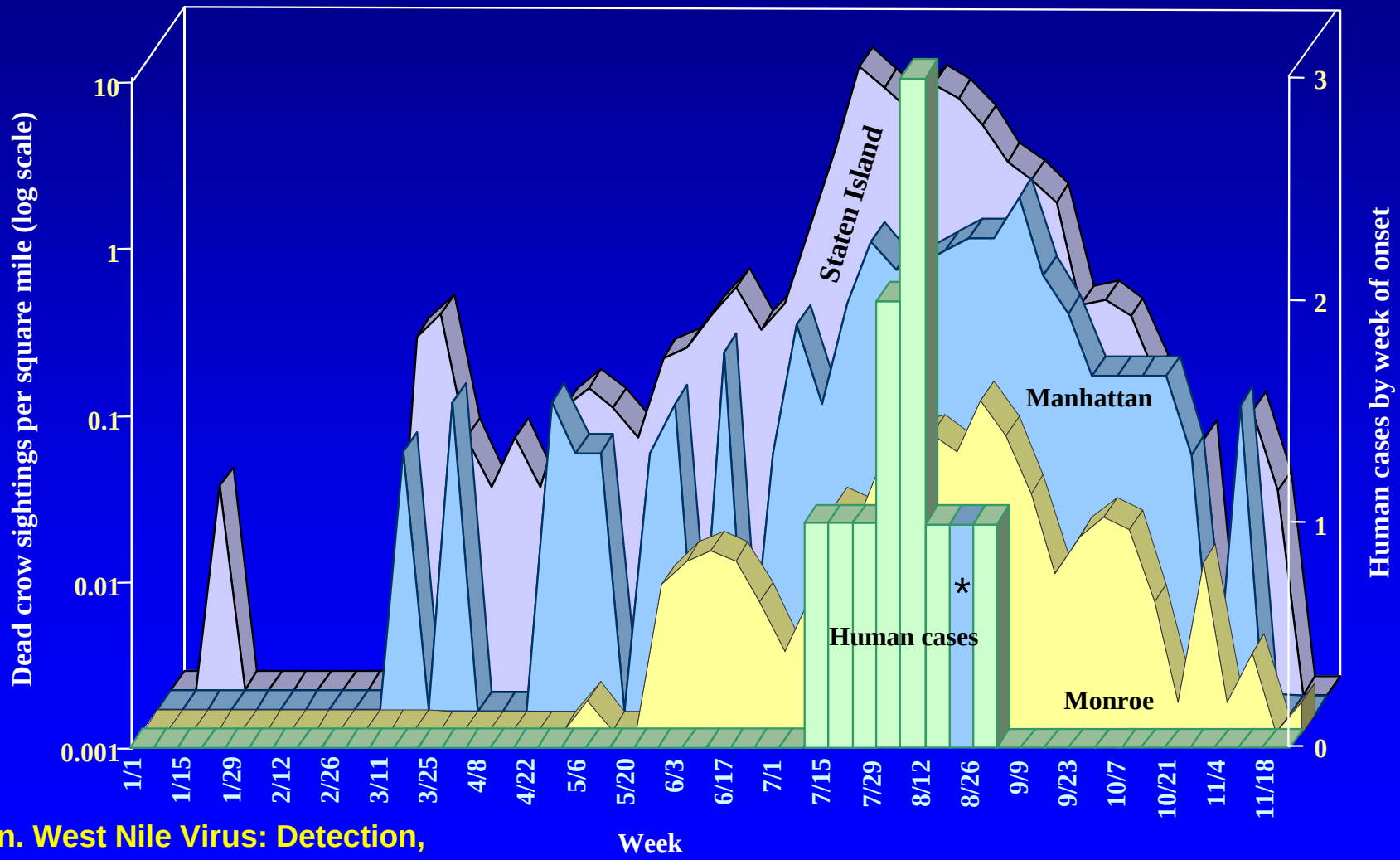


Correlations between Number of Human WNV Cases and Dead Bird Surveillance Factors by County, New York State, 2000



Eidson. West Nile Virus: Detection, Surveillance, and Control. Annals NY Acad Sci 2001;951:38-53

Weekly Number of Human Cases versus Number of Dead Crow Sightings per Square Mile, New York State, 2000

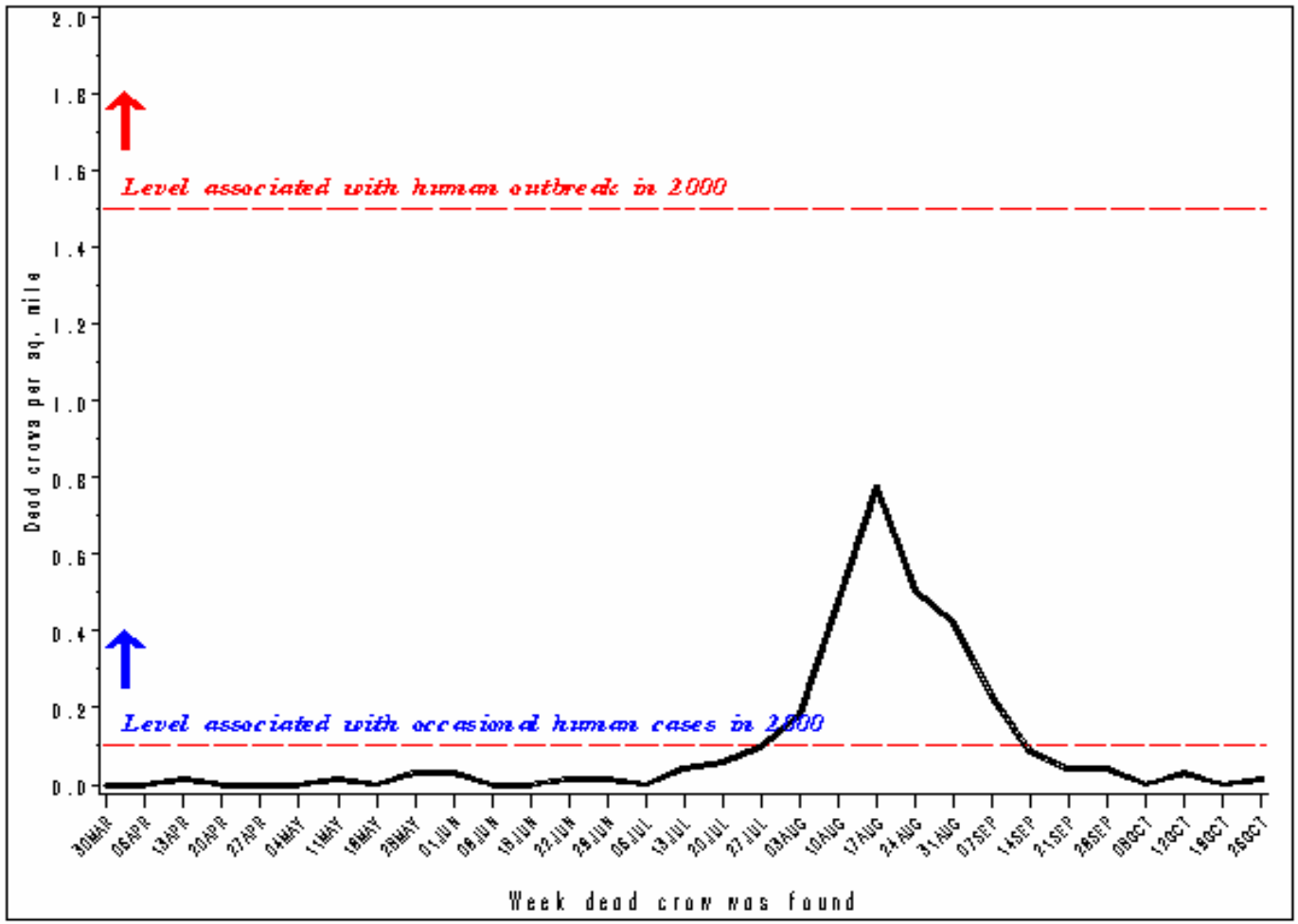


Eidson. West Nile Virus: Detection, Surveillance, and Control. Annals NY Acad Sci 2001; 951:38-53

* Only human case in Manhattan, all others in this figure were in Staten Island.

Example of real-time automatically generated dead crow density curve on New York State's Health Information Network

Weekly Dead Crow Sightings per Square Mile

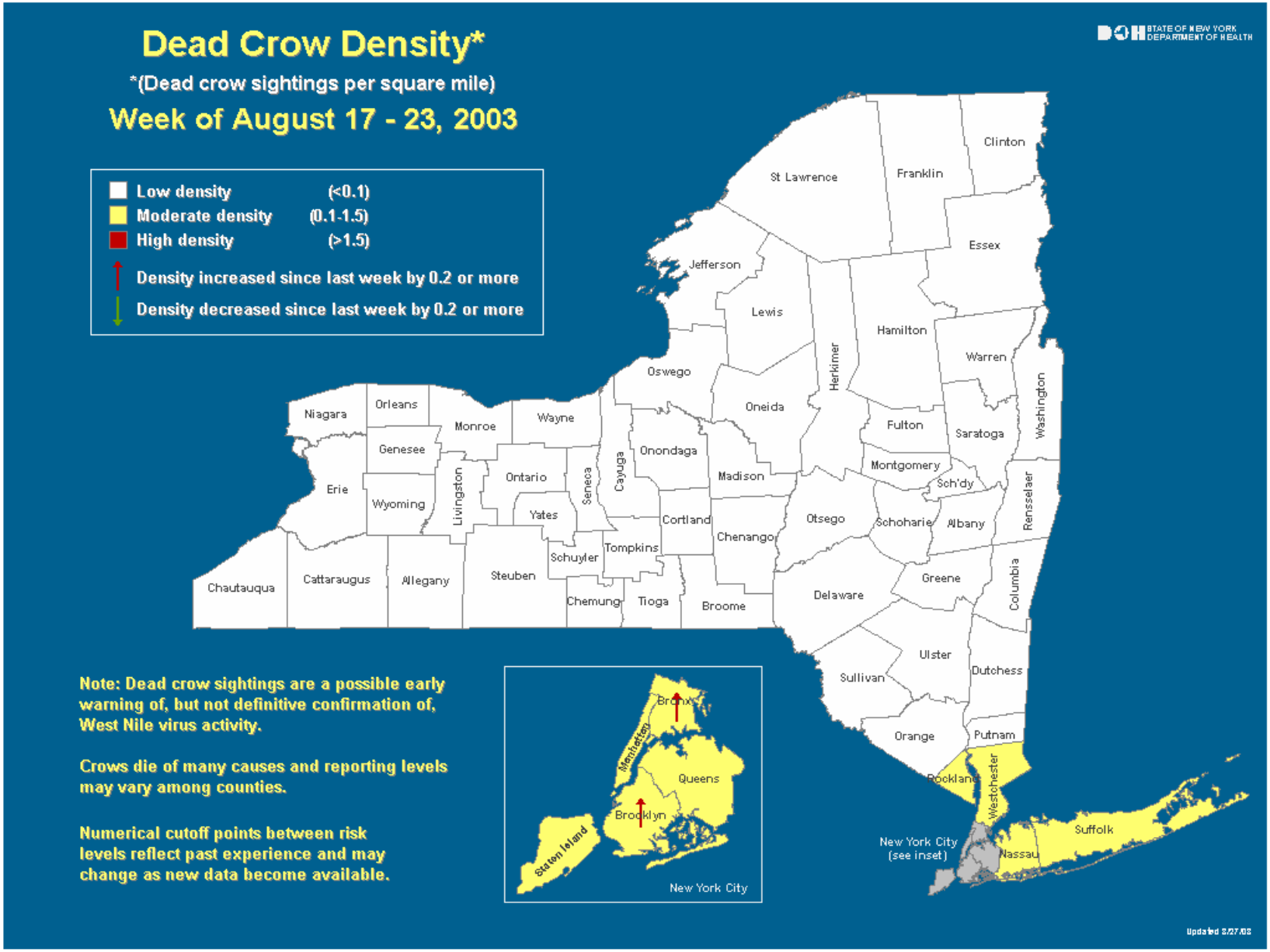


County	Year
KINGS	2003

Note: This graph does not provide a definitive prediction of human cases. Instead, it indicates when viral activity, as measured by the number of dead crows per square mile, is at a level associated with the occurrence of human cases in 2000. It should be used with other surveillance data to assess the need for increased WNV control activities.

(Data are shown for April through October, the months when mosquitoes are typically active in New York.)

Summary of Dead Crow Densities on New York's Public Website (www.health.state.ny.us)



Assessment of Dead Crow Density Graphs New York State, 2001-2003

- **Persons in counties with dead crow density ≥ 0.1 per square mile had ~3 times the risk of WNV than persons in counties with lower dead crow densities**
  - **Risk was slightly decreased using only reports in database at the time—better early warning if data in system quickly**
  - **148/163 (91%) of human cases preceded by county dead crow density ≥ 0.1, 2000-2003**
  - **False + signal (elevated density with no human cases) in 6/58 counties (2000), 3/56 (2001), 2/45 (2002), 2/46 (2003)**
- **This is a rapid, automated system that does not require lab testing, geocoding, or mapping.**
- **Does not define focal areas of risk within a county.**

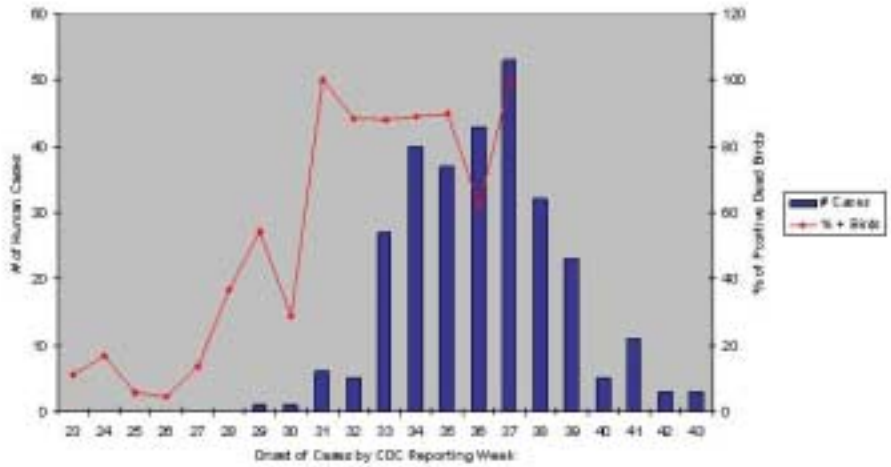
Measures of early season crow WN activity* associated with human WN disease

2000	RR	95%CI	Sens	Spec	PPV
Crows/area	7.0	2.1-23.2	0.7	0.86	0.54
% + crows x human pop	7.0	2.1-23.2	0.7	0.86	0.54
2001					
Crows/area	3.9	1.8-8.2	0.4	0.94	0.67
% + crows x human pop	7.4	3.1-17.8	0.67	0.94	0.77

Julian, et al. EID 2002;2:145-155

***In 7 NE states, 6/17/00-7/28/00, comparing counties with high (75th%) vs. low activity**

Human Cases of WNV 2002 and Percentage of Positive Dead Birds

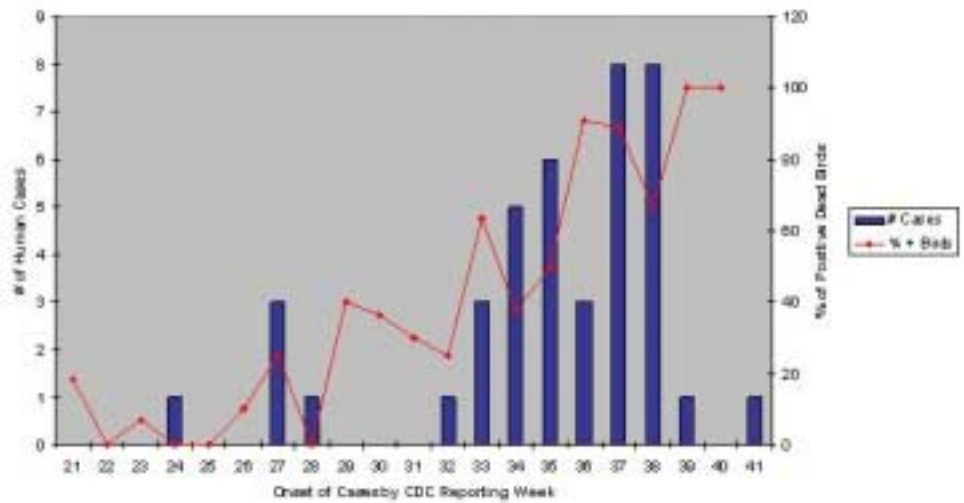


Indiana: increase in avian mortality prior to onset of human cases by at least a few weeks

Dead bird data with MIRs provide the basis for public warnings, and local control including larviciding and adulticiding

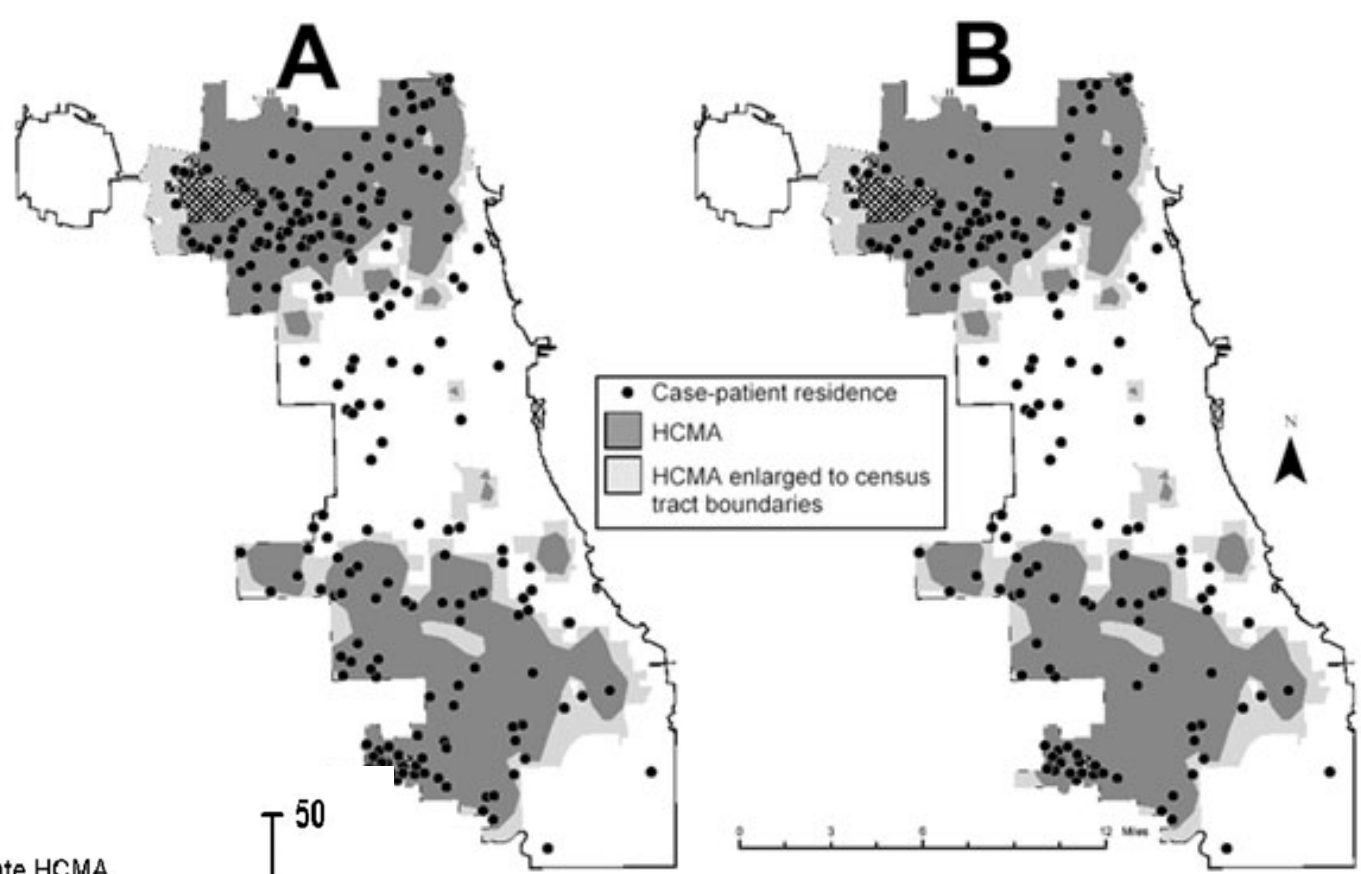
M. Sinsko, Indiana State Dept. of Health

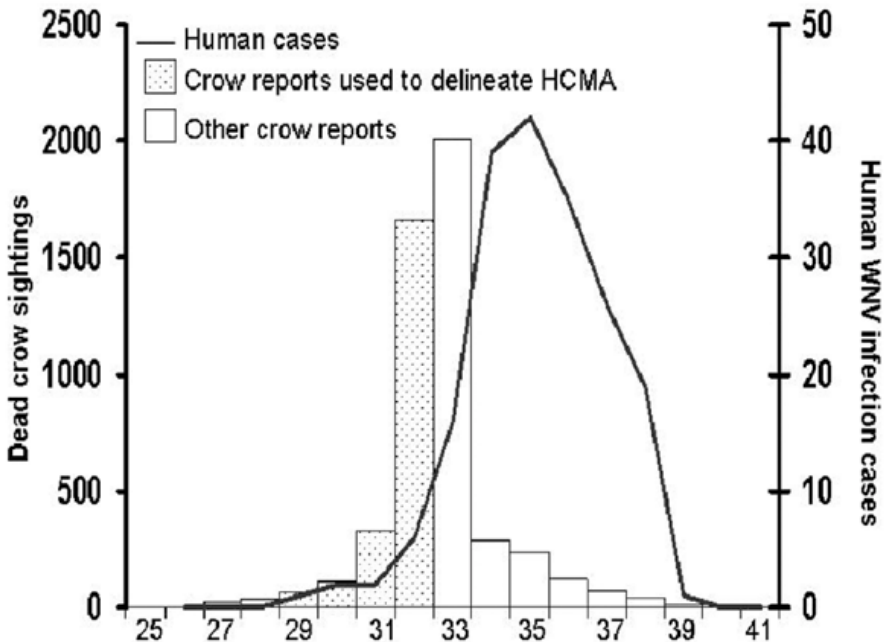
Human Cases of WNV 2003 and Percentage of Positive Dead Birds



Association of dead crow reports and human cases, Chicago, 2002

(Watson, et al. EID 2004;10:938-40)





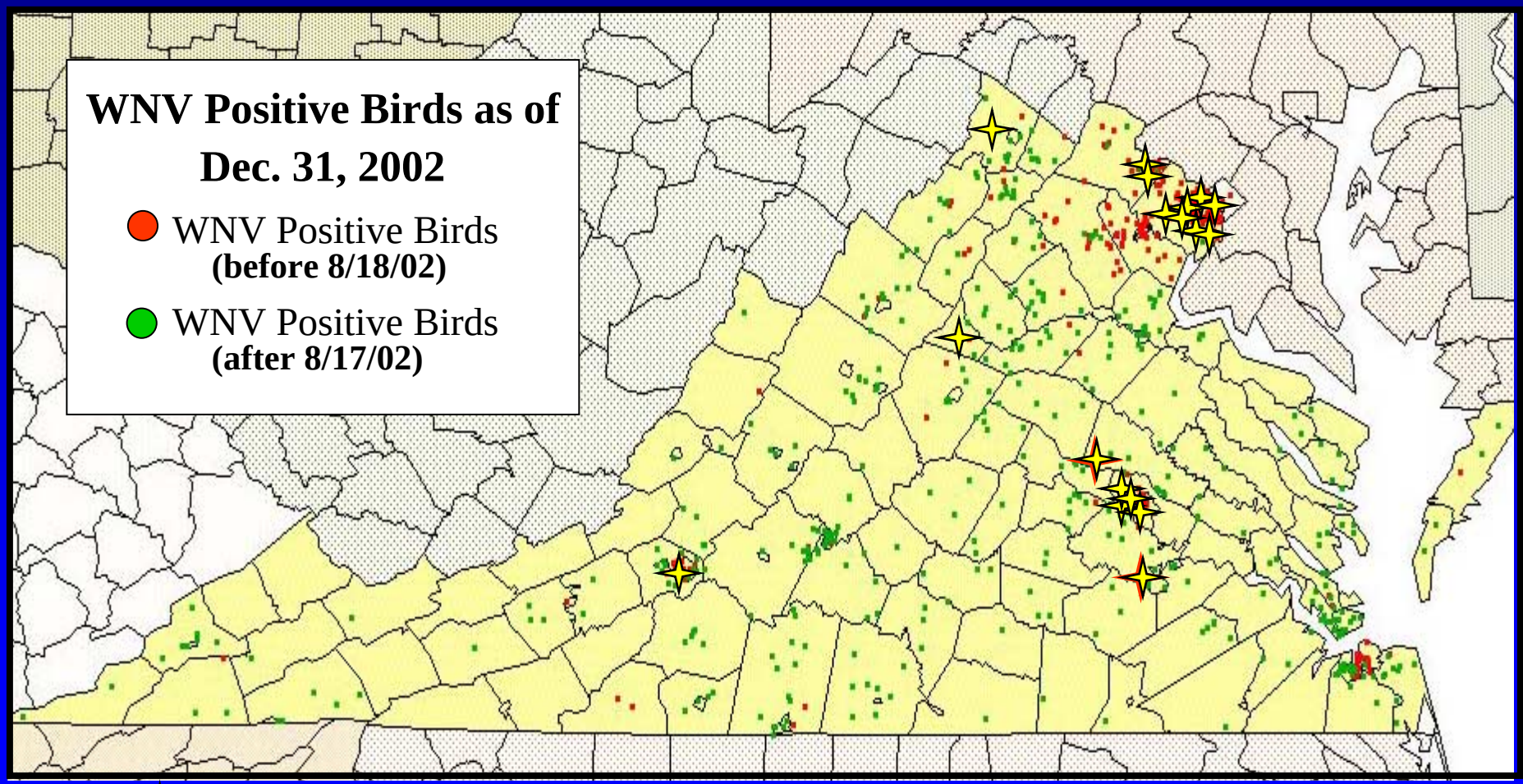
- Spike in dead crow reports preceded spike in human cases
- High crow-mortality areas (HCMAs) overlapped areas of human cases
- 311 city service calls of dead crow reports predicted human cases—now used for larviciding (*Time*, Feb. 7)

Other Avian Mortality Surveillance Findings

- U.S., 2000: in all 10 counties reporting human cases, a WNV+ bird was found an average of 44 days before human illness onset
  - Number of dead bird reports in each county increased many weeks before the first human cases (Marfin, et al. EID 2001;4:730-5)
- U.S., 2001: counties that reported a WNV-infected dead bird before 8/5 were more than 6 times more likely than other counties to report a human case (Guptill et al. EID 2003;9:483-4)
- New York, 2000: % positive crows associated with higher MIRs and human cases (Bernard et al. EID 2001;7:679-85).
- Florida, 2001: corvid mortality most sensitive predictor of WNV activity (Blackmore et al., Am J Trop Med Hyg 2003;69:141-50)
  - Dead bird reports/100,000 persons correlated well with intensity of WNV activity in the county measured by other surveillance systems
  - Corvid mortality peaked on average 2.8 weeks prior to disease onset of their human case for some (not all) counties
- Illinois: Significant clustering of human cases in 2002 in areas with shorter distance to + dead bird (other factors also associated) (Ruiz, et al. Int J Health Geo 2004; 3:)
- Harris County, Texas: most + birds were Blue Jays (Lillibridge, et al. Am J Trop Med Hyg 2004;70, 676-81)
- New Jersey: mosquito control agencies use avian mortality reports in surveillance and control decisions

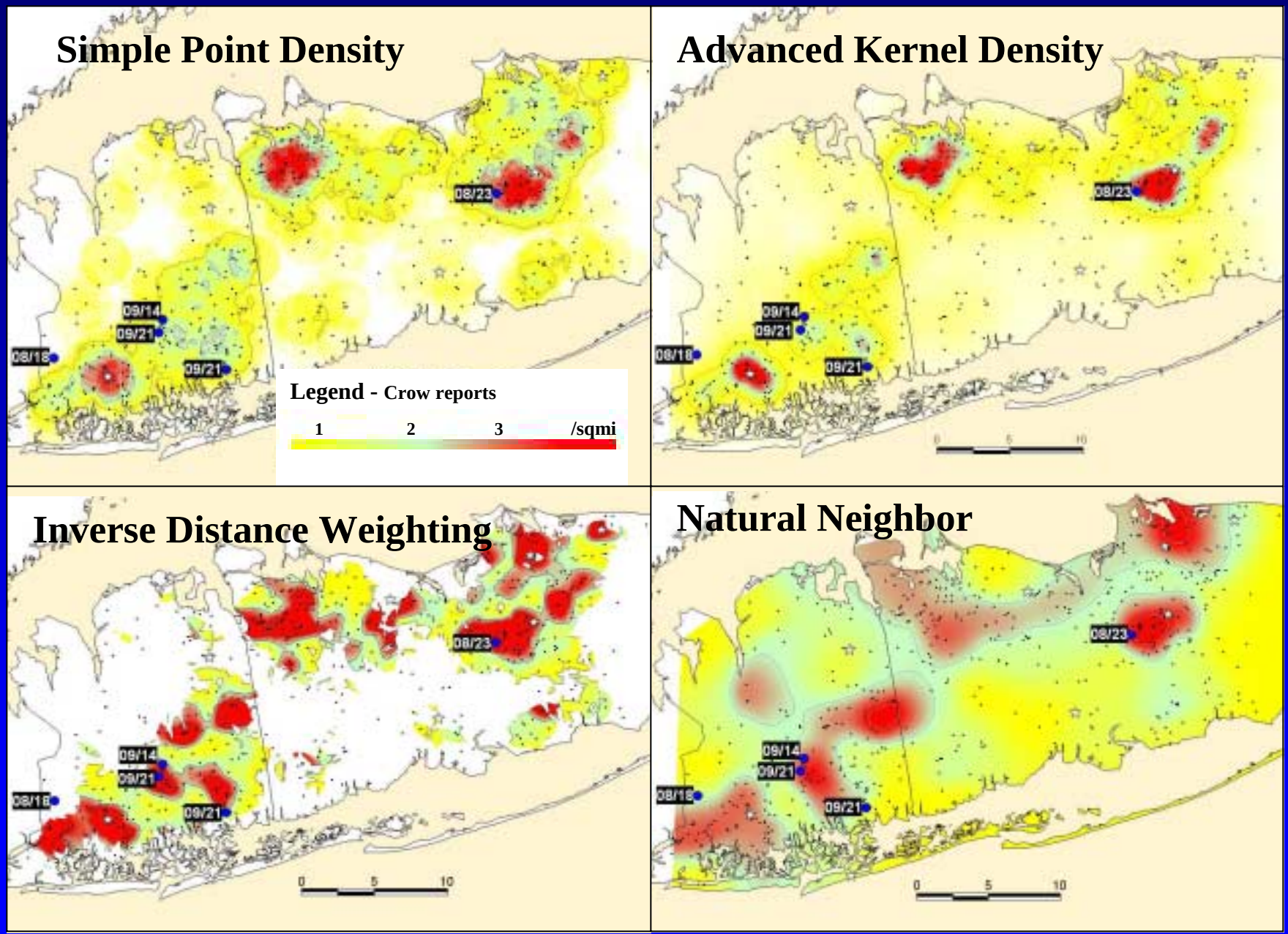
Spatial and temporal distribution of WNV positive birds in Virginia in 2002; mid-August cut off date between early and late birds (similar pattern for 2003)

(D. Gaines, Virginia Dept. of Health)



Human WNV Cases (29 total cases as of Dec. 31, 2002)

Dead Crow Density: Interpolation Methods – Long Island, NY, 2001



Choosing an Interpolation Method for Estimating Dead Crow Density

ADVANCED KERNEL DENSITY METHOD

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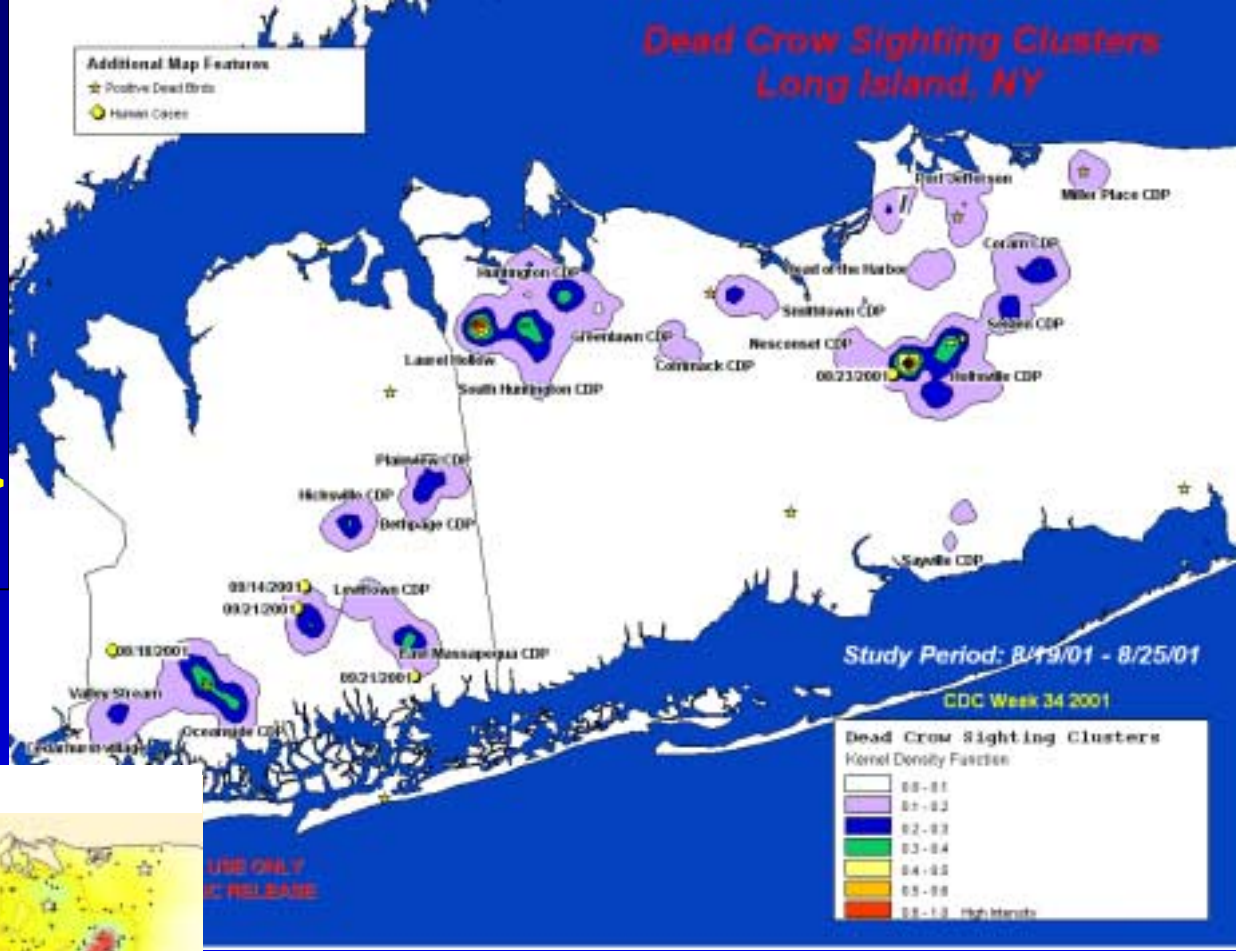

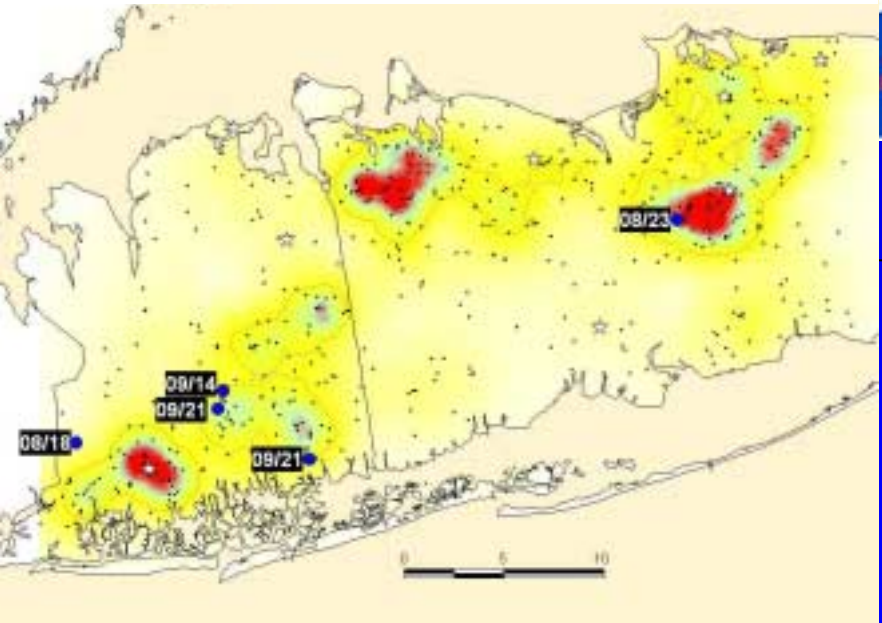

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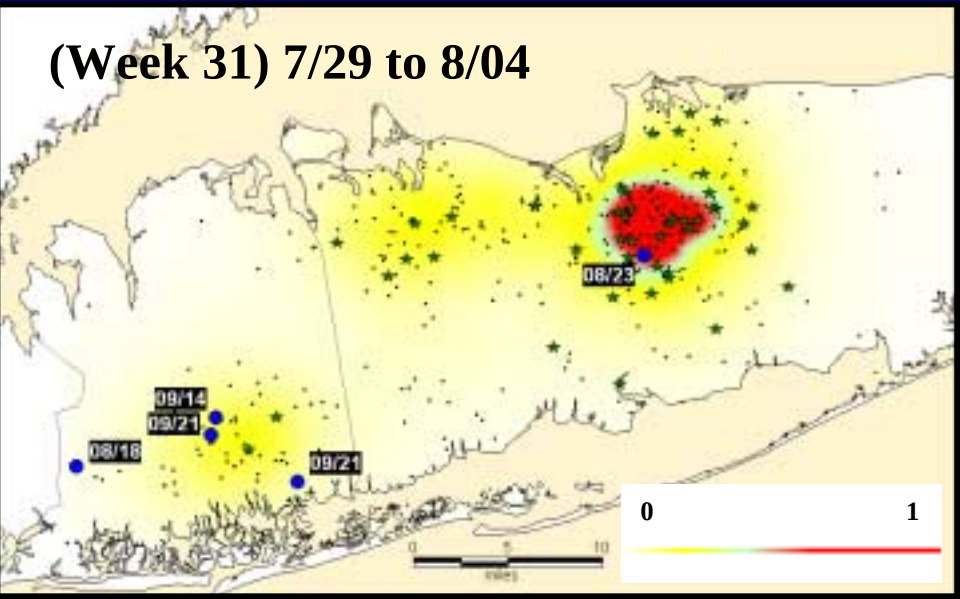
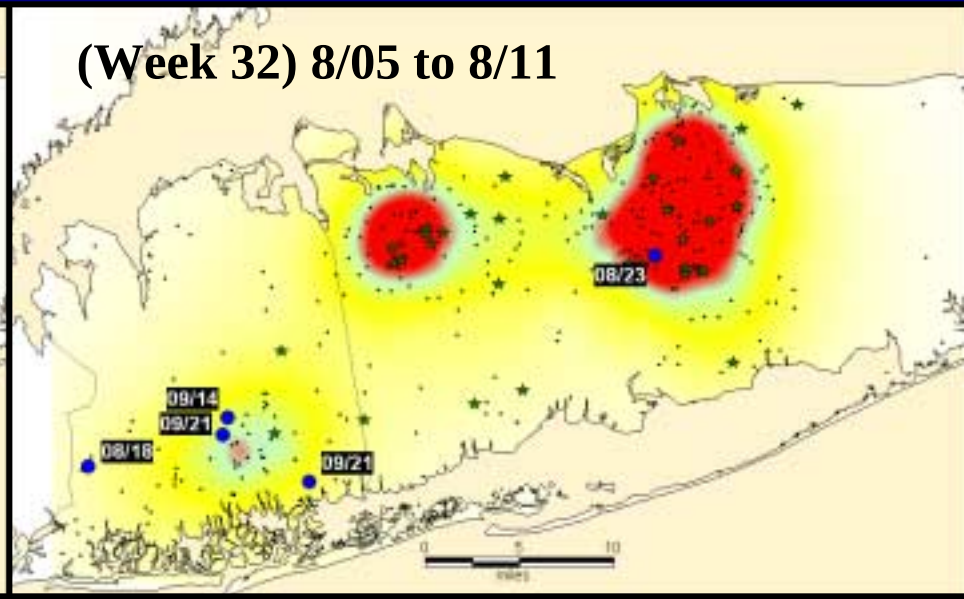
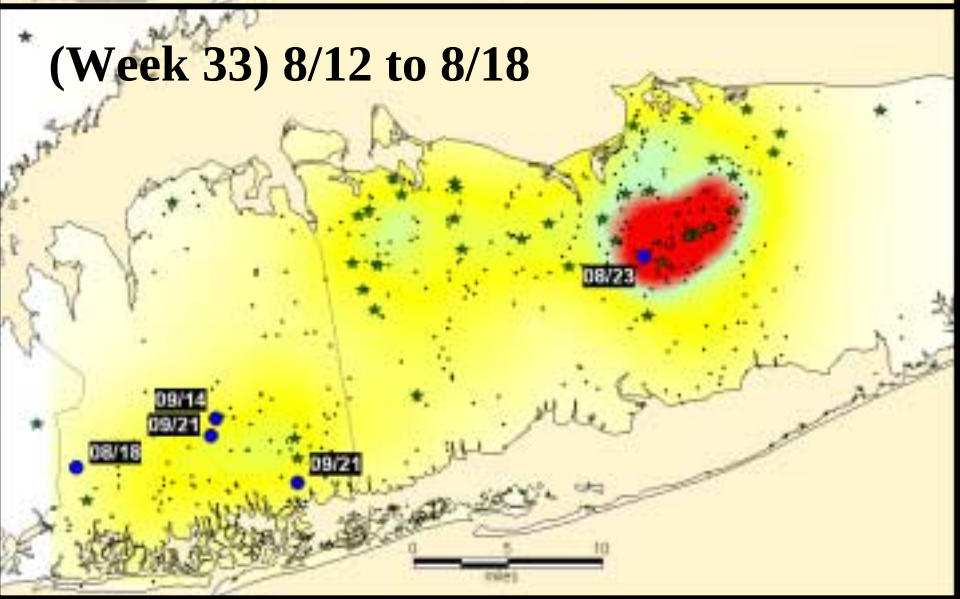
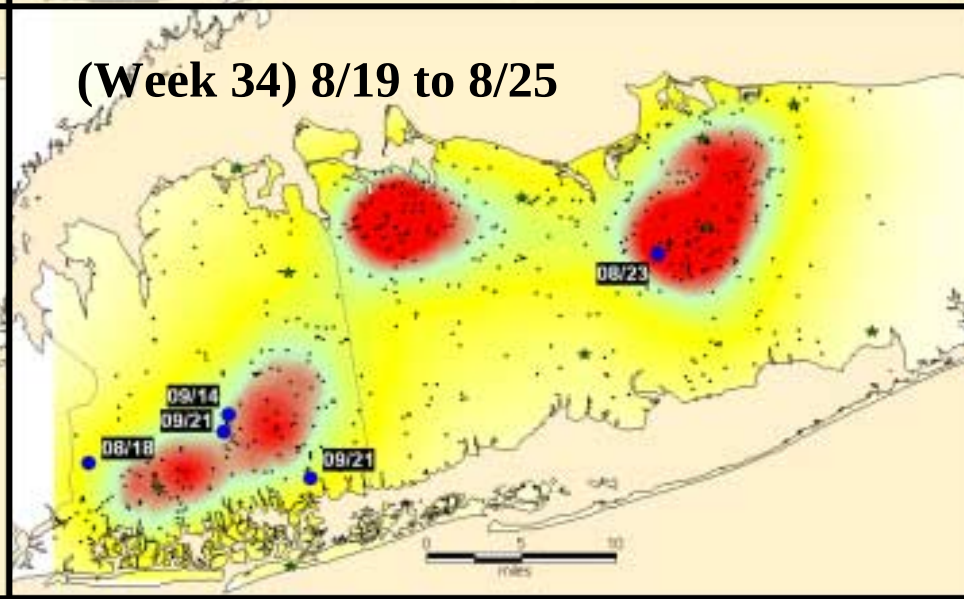
Advanced Kernel Density for Identifying Clusters of Dead Crows, NYS, 2001



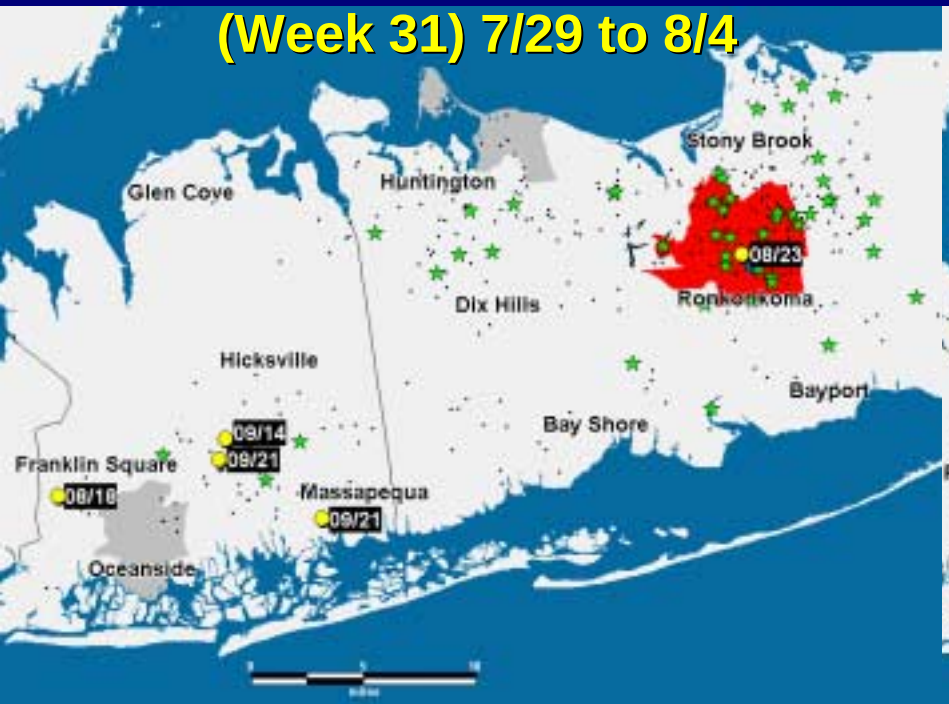


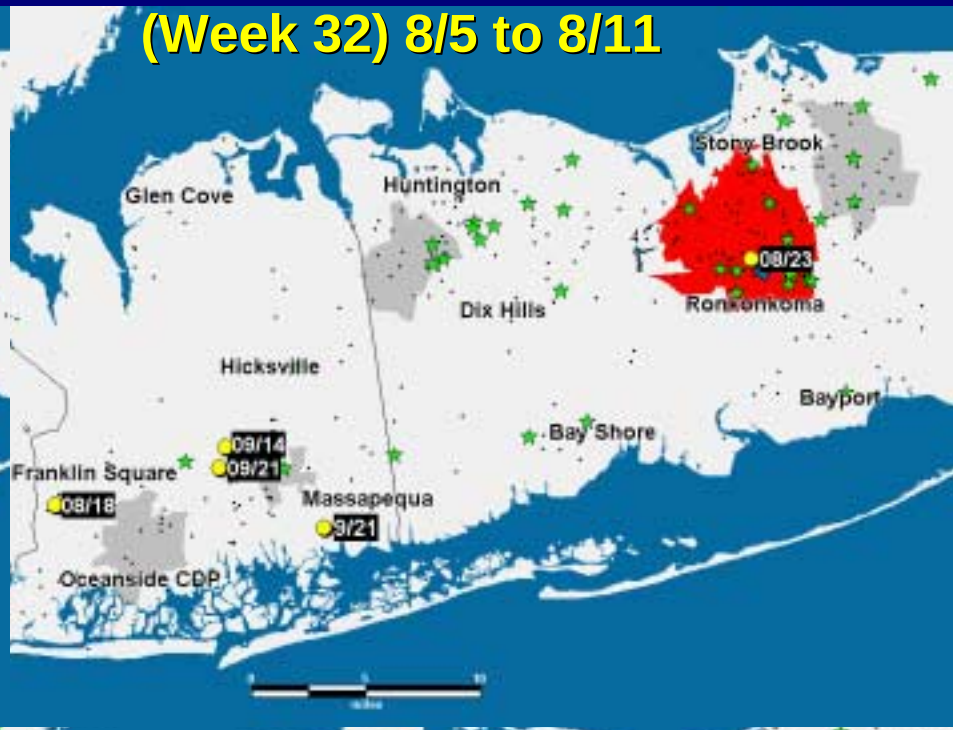




Tiny dots=dead crow sightings, larger dots=+birds, largest circles=human cases, onset date

SaTScan for Identifying Significant (p<.01) Clusters of Dead Crows, NYS, 2001





Tiny dots=dead crow sightings, green stars=+birds, yellow circles=human cases, onset dates

Assoc. of Dead Bird Clusters with Human Cases, New York State, 2002

Analysis	SatScan clusters, p<0.05	SatScan clusters, p<0.01	Kernel density hotspots
Crude (no adj)			
CMH chi-sq	2.02(1.14,3.57)	2.41(1.39,4.18)	3.49(1.94,6.28)
Poisson	2.49(1.38,4.52)	3.02(1.71,5.35)	3.95(2.18,7.16)
PH model	2.33(1.24,4.35)	2.70(1.48,4.94)	3.70(1.95,7.02)
Adj region, wk			
Poisson	2.63(1.37,5.05)	3.32(1.69,6.50)	3.61(1.91,6.81)
PH model	2.18(1.07,4.44)	2.25(1.04,4.89)	3.65(1.81,7.33)
Reg,wk,density			
Poisson	2.24(1.17,4.26)	2.95(1.56,5.59)	2.83(1.45,5.53)
PH model	2.08(1.04,4.16)	2.12(1.00,4.48)	3.27(1.56,6.89)

(Used Cochran-Mantel-Haenszel test, Poisson regression, & proportional hazards model)

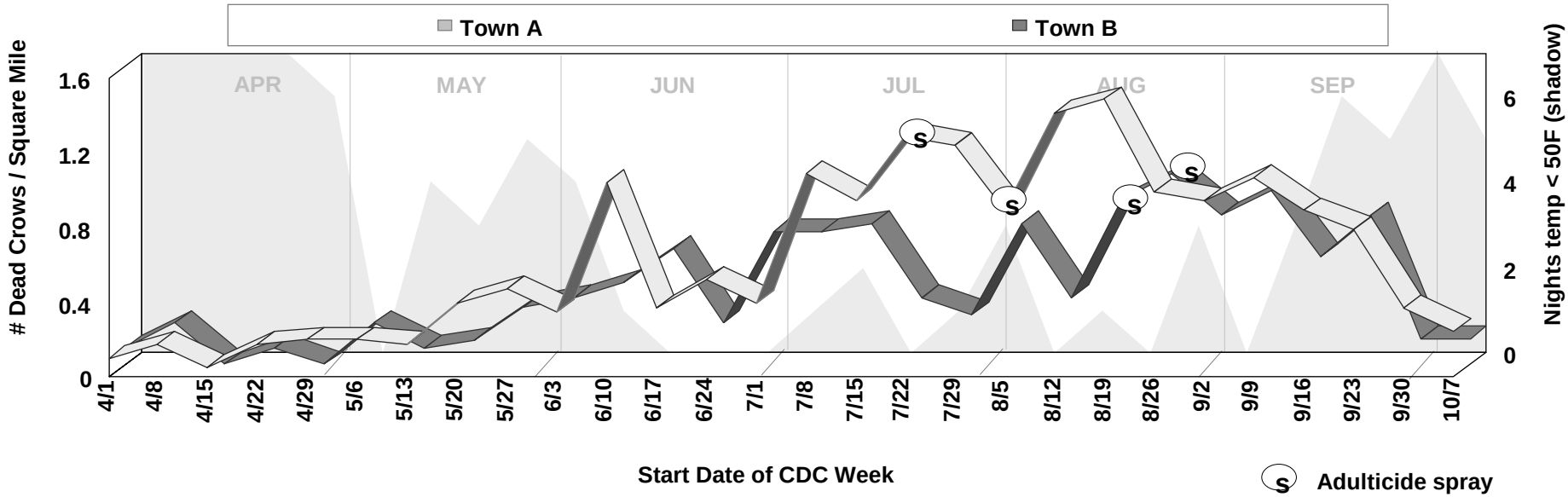
New York State Geographic Information System (GIS) Analyses, Conclusions

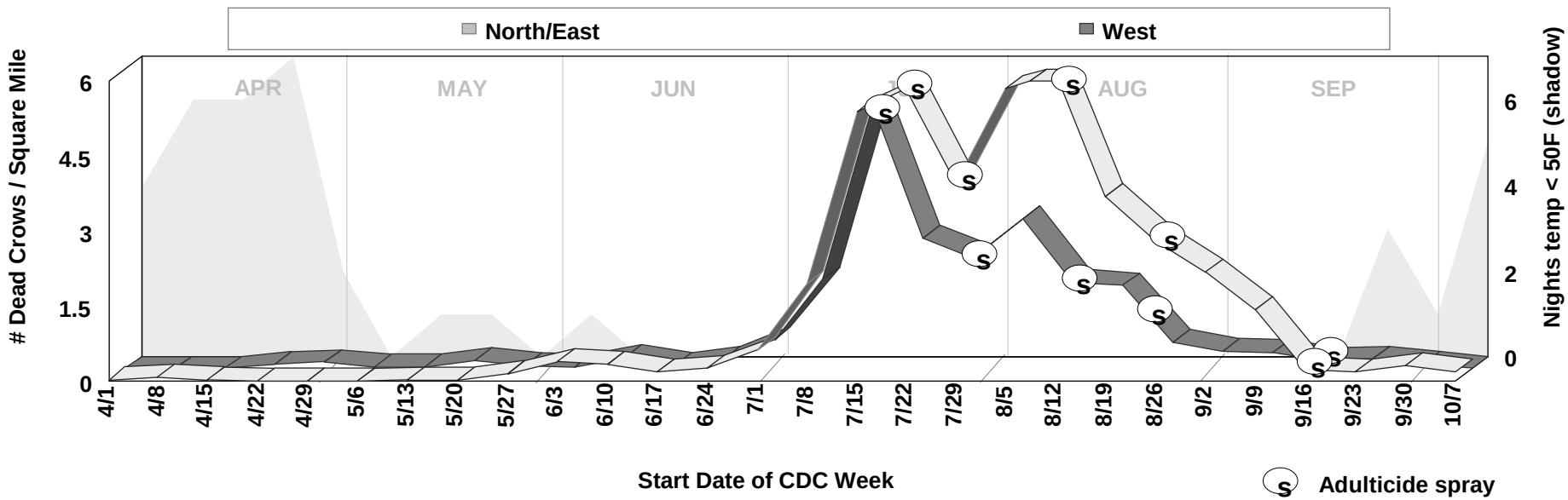
- Risk of WNV 2-3 times higher (for SaTScan) or 3-4 times higher (for kernel density) among populations in towns in/near areas of high dead crow density than among populations in towns not near areas
- Other factors that might account for higher risk (age distribution, population density of towns) were included in models, yet exposure to areas of high dead crow density still at least doubled the risk of WNV to human populations

GIS Analyses, New York City, 2001

- DYCAST system identifying nonrandom space-time interaction of dead birds successfully identified areas of high risk for human infection for 5 of 7 human cases at least 13 days prior to illness onset (Theophilides et al. AJE 2003;157:843-54)
- Spatial scan statistic: dead bird clusters--median 12 days before human onset, median 17 days before human diagnosis. In most cases, dead bird clusters also preceded time of collection of WNV-positive mosquitoes and birds (Mostashari, EID 2003;9:641-6)
- Areas with clustering receive increased vector surveillance--additional mosquito trapping
- Dead bird trends help to confirm control efficacy

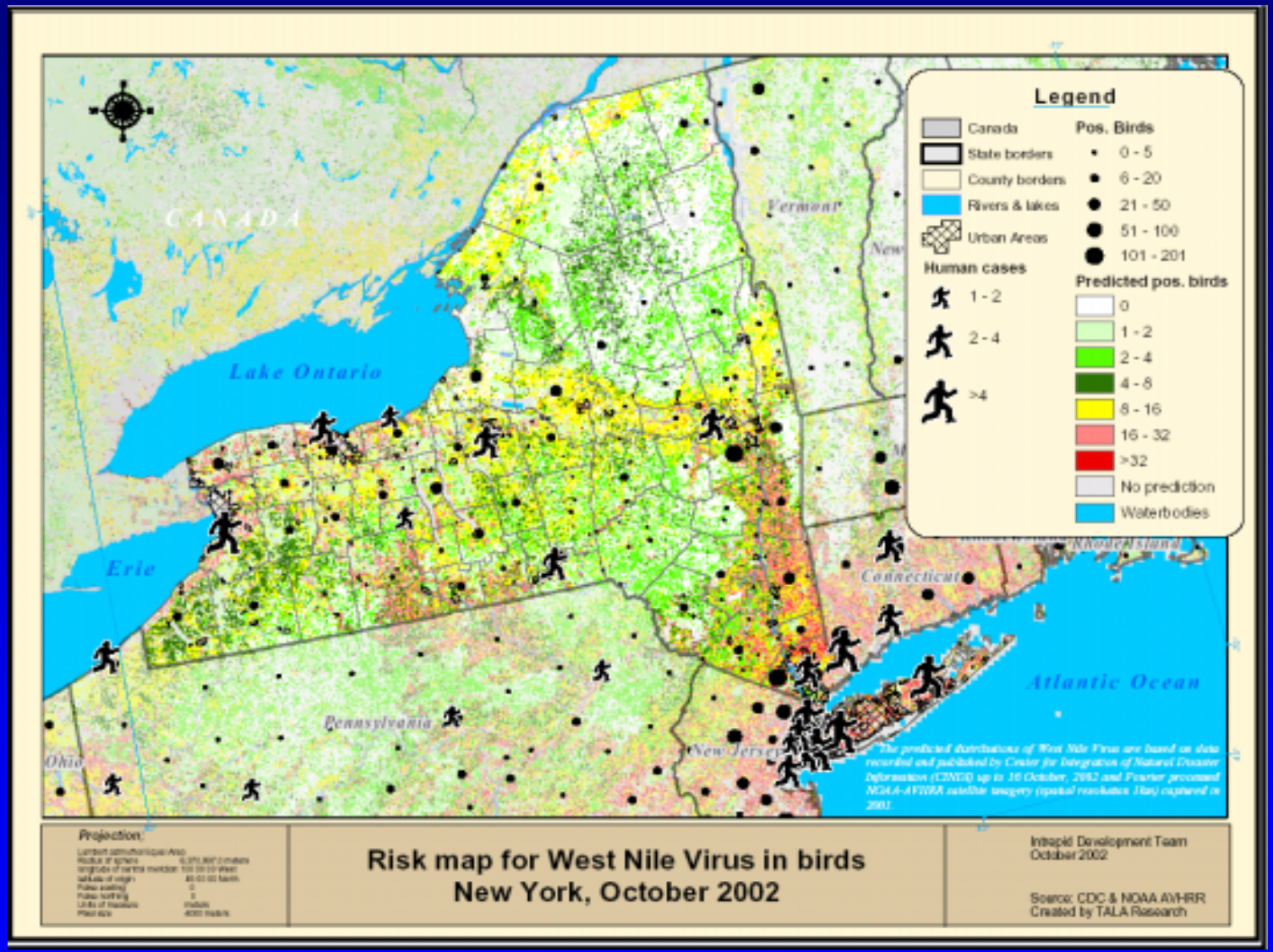
Dead crow densities and adulticide spray dates, 4 areas of New York State





Eidson. West Nile Virus: Detection, Surveillance, and Control. Annals NY Acad Sci, 2001;951:38-53

Use of Remote Sensing to Predict Risk



Approach summarized in Rogers et al. Photogrammetric Eng & RS. 2002;68:109-10.

Potential Limitations, GIS Approaches

- Purpose of cluster detection: inform county health departments where risk is high
  - if mosquito control measures are used in high-risk areas, risk might decrease; need to add in control data to assess impact
- Analyses use home address, and often can't judge whether that was location of infection (missing work history, travel history)
- Cost/resources of GIS system: in 1997-1998 national survey, only about 7% of governmental agencies that participated (mostly counties) indicated that a dept. concerned with health and human services within their organization produced or used geographic information
  - BT funds don't automatically improve this situation
  - Ruiz et al. J Med Systems 2004;28:385-95.

Bird collection, shipment, necropsy, and testing requires resources and time: Mean number of days between steps, NYS, 2002

- Person finds a dead bird

< 1 day (n=43,830)

- Person reports bird to county/hotline

8 days (n=41,843)

- Record for bird added to HIN

< 1 day (n=6,176)

- Bird received at WPU for necropsy

10 days (n=4,060)

- WPU ships specimen to lab

7 days (n=4,057)

- Lab posts result on HIN

23 days (n=4,129)

Rapid Field Test, VecTest: $8 per dipstick

- **Sensitivity**, oral specimens, Am. Crows (unless otherwise noted)
  - **87%,** (>80% some other species), NY: Stone et al., EID 2004;10:2175-81
  - **84%,** Canada: Lindsay et al., EID 2003;9:1406-10
  - **100%,** IL, Yaremych et al., EID 2003;9:1319-21
  - **40%** TX,LA oral; **46%** brain (all species), Siirin et al., VBZD 2004;4:204-9
  - **100%** MS (corvids, cloacal swabs), Henson et al. Clin Lab Sci 2004;17:218
  - **>93.5%,** Ontario, owls; <42.9% other species (oral,cloacal) Gancz et al. EID. 2004;10:2204-6.
- **Specificity**, oral specimens
  - **98%,** NY (all birds)
  - **79%** (Ontario); 94% (Manitoba, Am. Crows) (Lindsay)
  - **25%,** IL (mixed fecal, saliva, and tissue samples) (Yaremych)
  - **100%,** Ontario, owls; 85.7%, raptors (Gancz)
- **Sensitivity can be lower with lower prevalence**
  - April–June, NY: **17%, 2003**; 82%, 2004

Rapid Test, RAMP (reader $3500, cartridge $15)

New York State Wildlife Pathology Unit, 2004, compared to RT-PCR, Preliminary Results*

	Sensitivity		Specificity	
	RAMP	VecTest	RAMP	VecTest
All birds	79.8%	69.1%	97.3%	99.2%
Corvids	90.8%	80.9%	94.4%	98.6%
Am. crows	91.2%	83.3%	96.1%	100%
Blue Jays	82.8%	65.5%	89.5%	94.7%

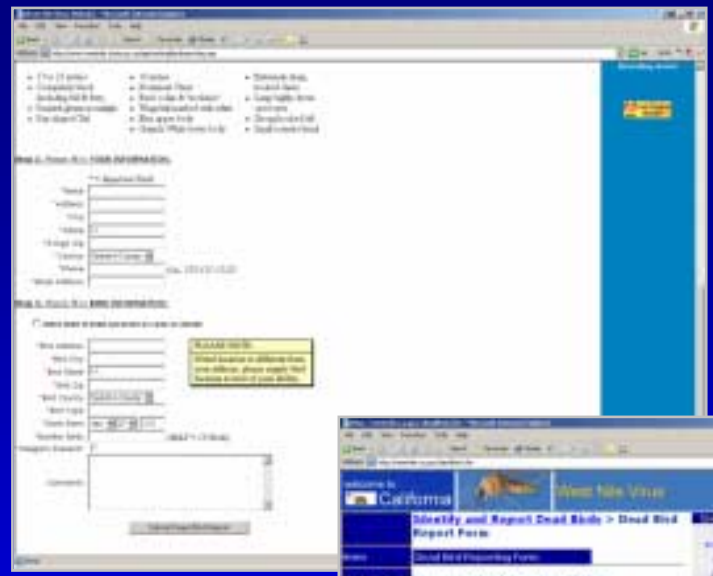
*Preliminary results provided on 2/3/05 by WPU; not yet reviewed by NYSDOH Wadsworth Center Arbovirus Laboratory or Zoonoses Program

Many States Have Maps of Dead Bird Surveillance on Public Web

Some states have online dead bird report forms

N.C.

PENN.



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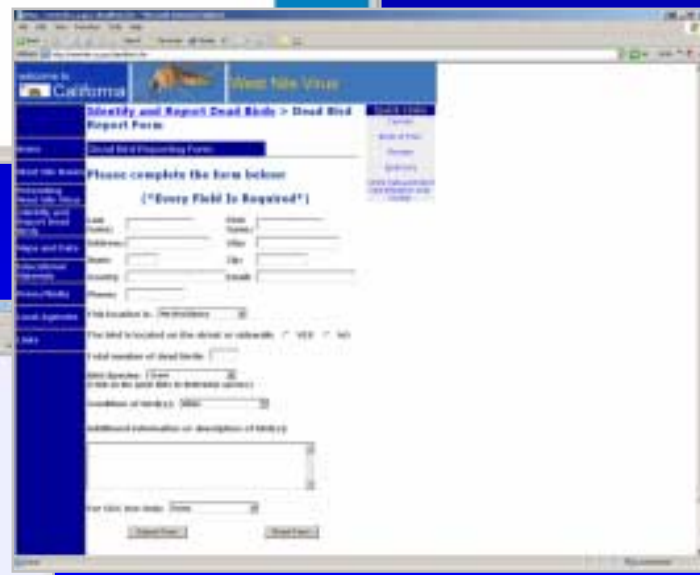
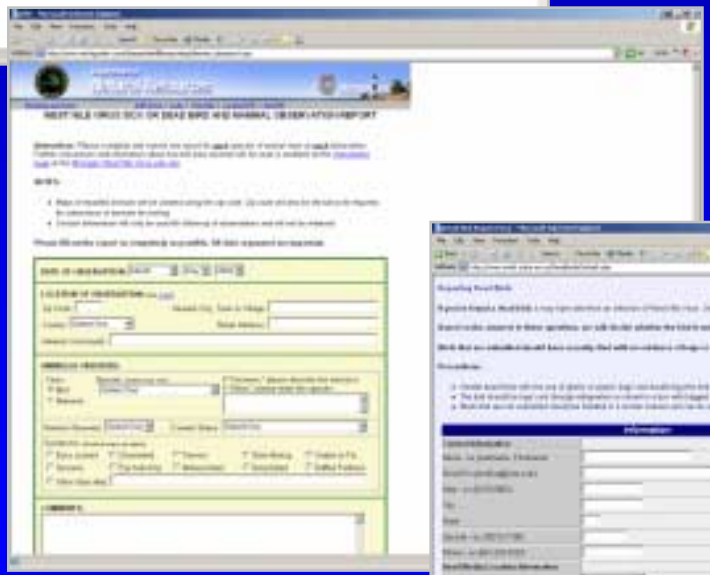




MICHIGAN

MISSISSIPPI

Tollfree dead bird reporting hotline

USDA Wildlife Services supports tollfree dead bird reporting in several jurisdictions, including NYS

	NYS*		Hotline		%
	All	Crow	All	Crow	hotline
2001	19,675	7,600	1,167	407	5.9%
2002	36,824	18,021	5,472	1,916	14.9%
2003	20,578	8,325	3,600	1,186	17.5%
2004	9,585	1,908	1,932	365	20.2%

*excluding New York City

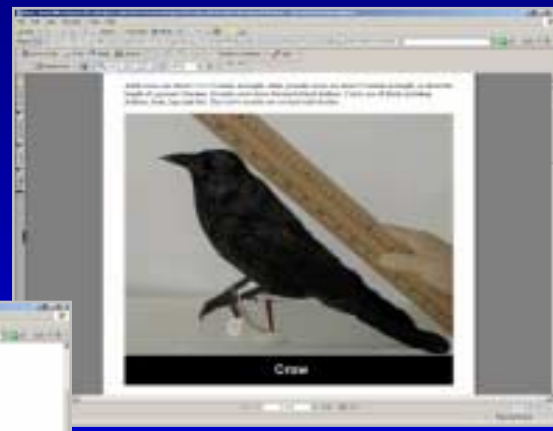
Dead bird identification tips

ALABAMA

UTAH

OK

NEW HAMPSHIRE



MAINE

WYOMING

ILLINOIS

IDAHO

Conclusions, Avian Mortality Surveillance in Real Time

- In different years and areas, dead bird reports have offered value for identifying areas of higher risk, and are widely used
- Dead crow reports are often a good, quick indicator (especially dead crow density)
- New rapid testing systems may improve timeliness and use of WNV+ data
- GIS/mapping approaches have value for focal identification of risk, but require resources
- Specific bird species and levels used for decision-making may vary