Mapping of West Nile Virus Risk in the Northeastern United States Using Multitemporal Meteorological Satellite Data

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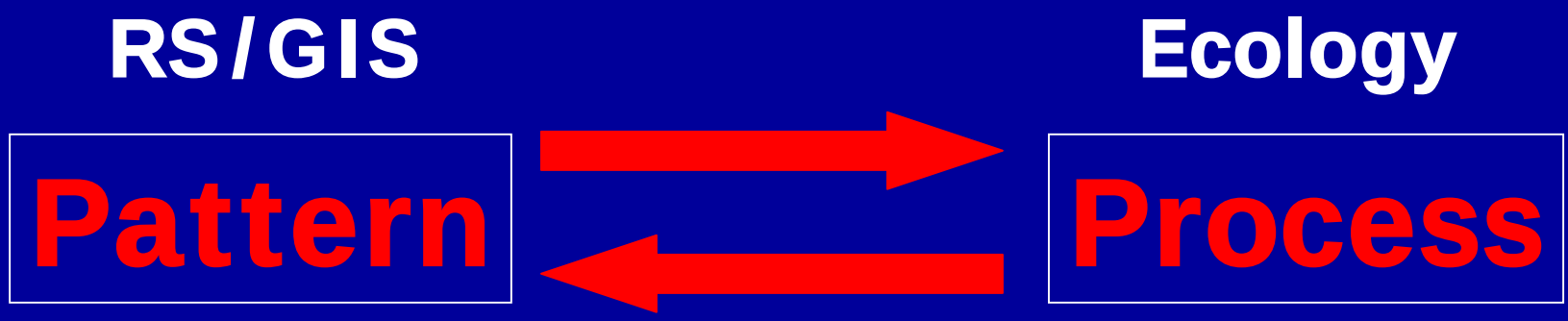
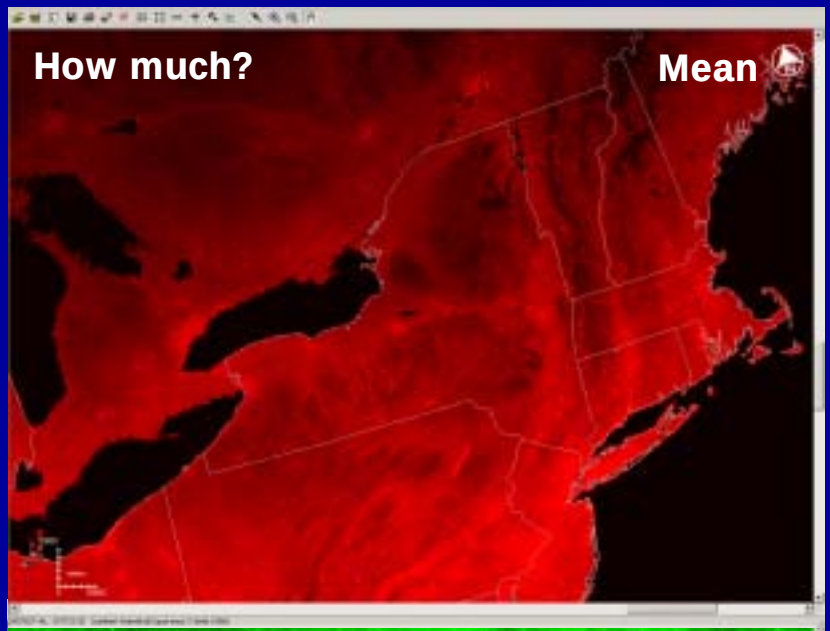
The Relationship Between Remote Sensing/GIS and Ecology/Epidemiology

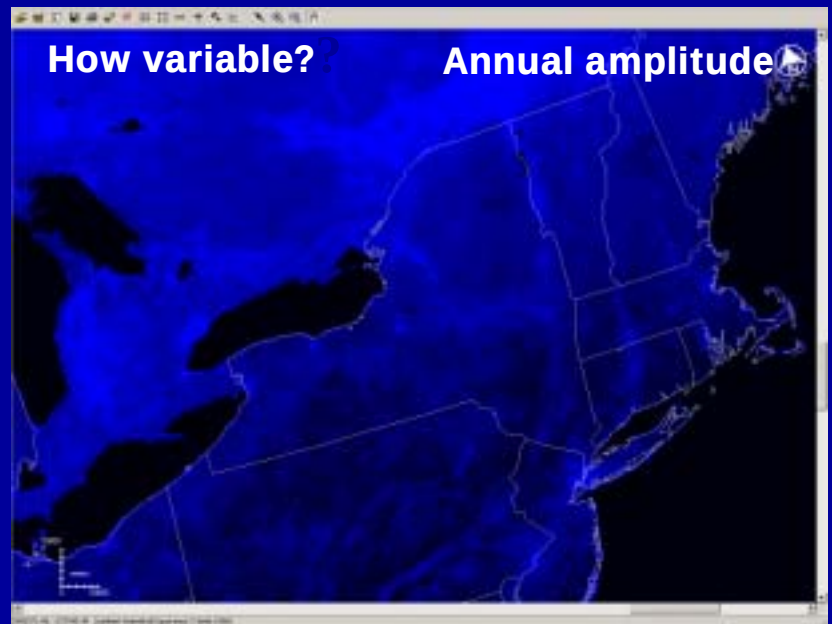


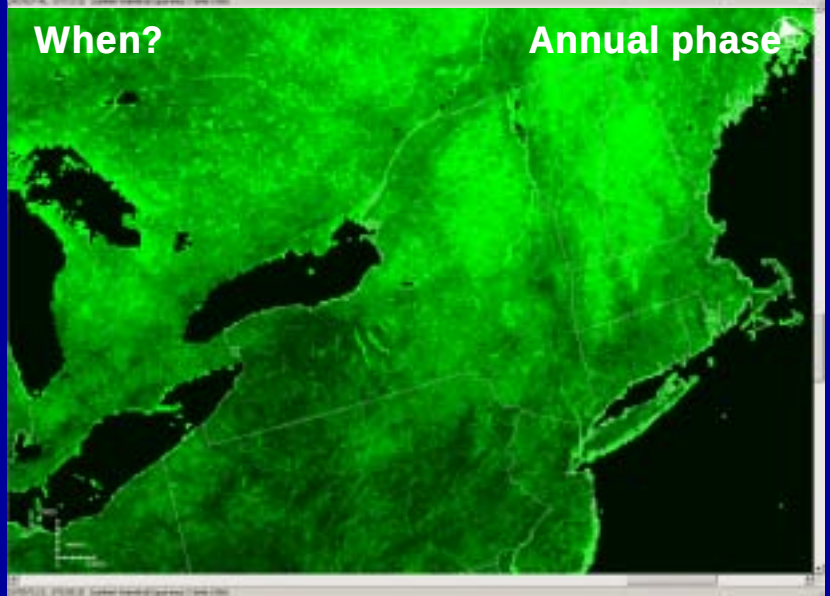
Models are: **Statistical** **Biological**

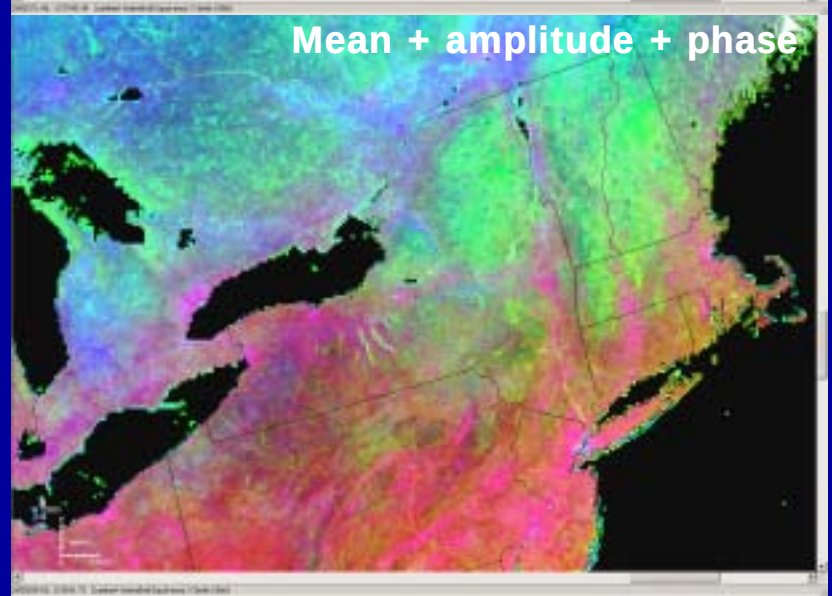
Multi-temporal data help us to move between pattern and process

NE States Land Surface Temperature (LST) temporal Fourier images









West Nile Virus Risk Mapping: GOALS

1. To gather geo-coded data on the distribution of WNV in the USA.
2. To describe WNV distribution using multi-variate methods with satellite and other (e.g. vector and host distribution) data.
3. To produce risk maps identifying likely areas of infection for state and local authorities.
4. To examine satellite and other archival data for recent changes in the key predictor variables.
5. To develop a web-based data and analysis dissemination system to aid control authorities in the USA.

The INTREPID/Oxford/NYSDOH Synergy Project

Modeled data, maps

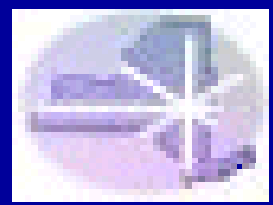
Surveillance data

Satellite data

INTREPID

DOH

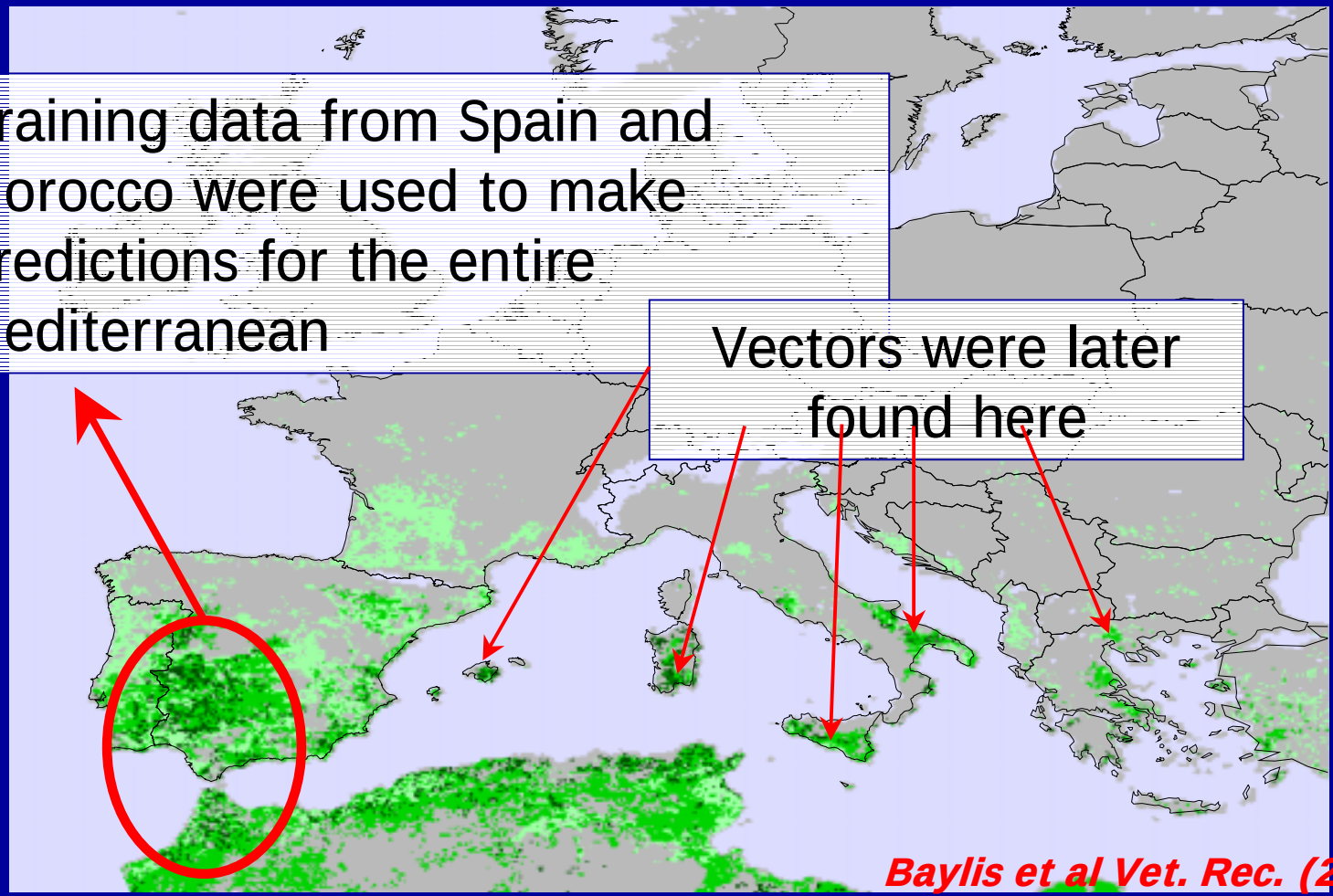
Translated info



Via HIN

Federal, State, County, and Local health officials

Previous Uses: Spread of BlueTongue Virus Vectors in Southern Europe and Northern Africa



C. imicola. Log. abundance predictions, pale green = 0.00-0.02, mid-green = 0.03-0.78, dark green = 0.95-3.63

West Nile Virus analysis

1) Data on positive and negative bird, veterinary and mosquito records for 2001 were geo-coded (to county, Zip5 or point location) and entered into a GIS database.

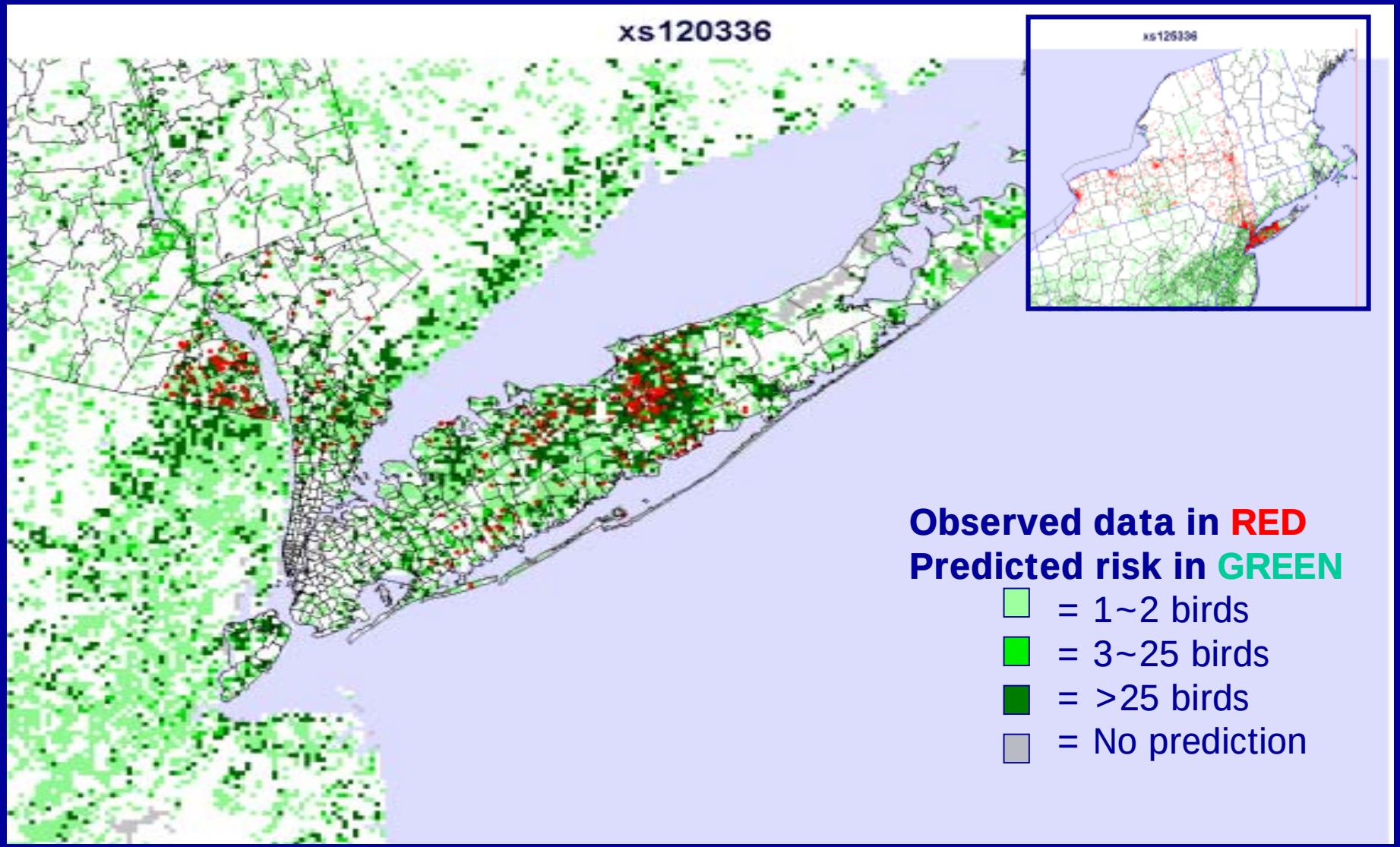
2) These data were overlaid on satellite imagery processed to capture habitat seasonality. Satellite data were extracted for all positive and negative sites.

3) Disease and satellite data were related using maximum likelihood procedures based on discriminant analysis. This established the links between the epidemiological data and remotely sensed information.

4) Relationships established were then used to produce predictions of WNV risk at satellite-pixel resolution.

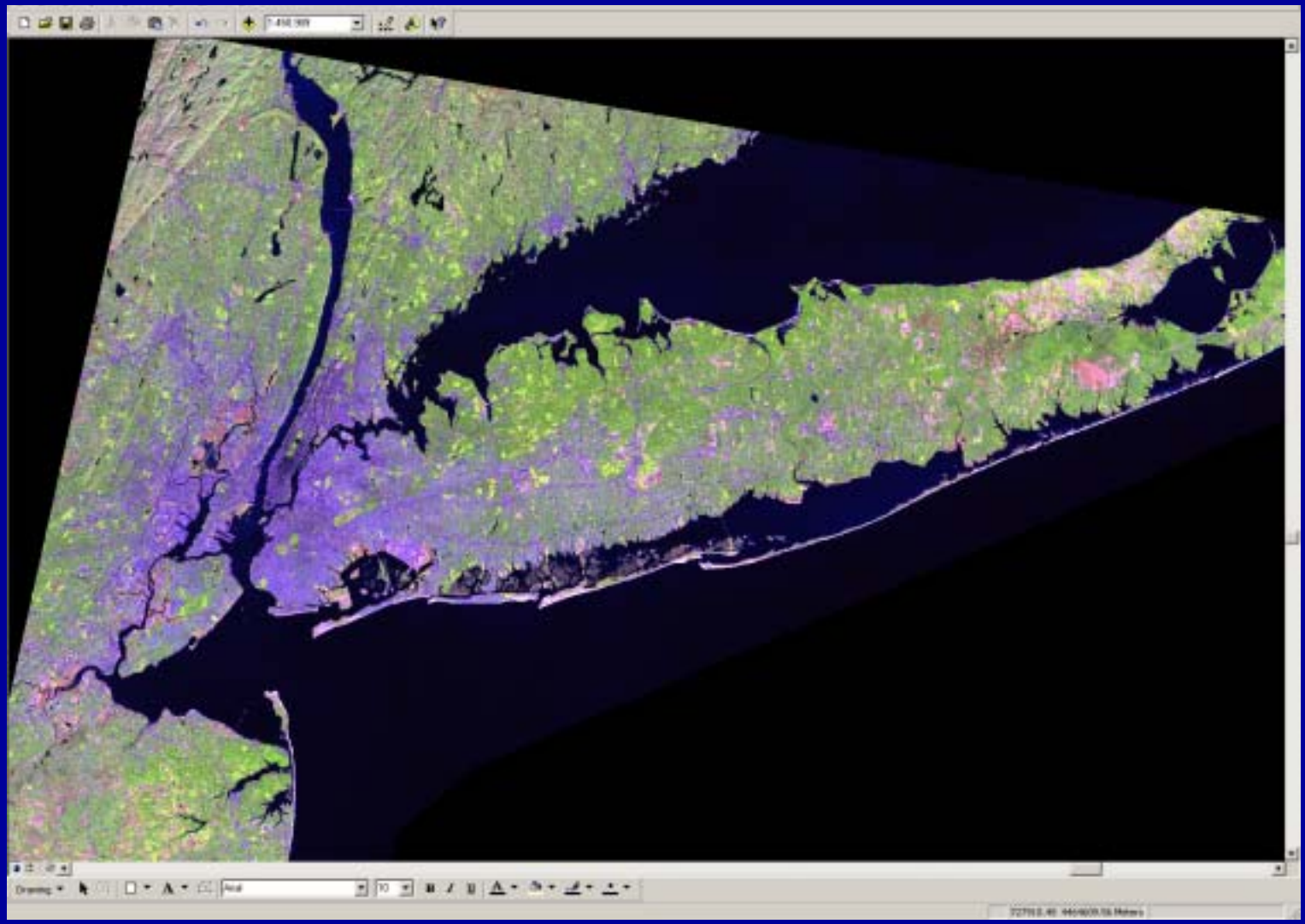
West Nile Virus results for BIRDS

(2001 data, New York State, Zip5 coding)



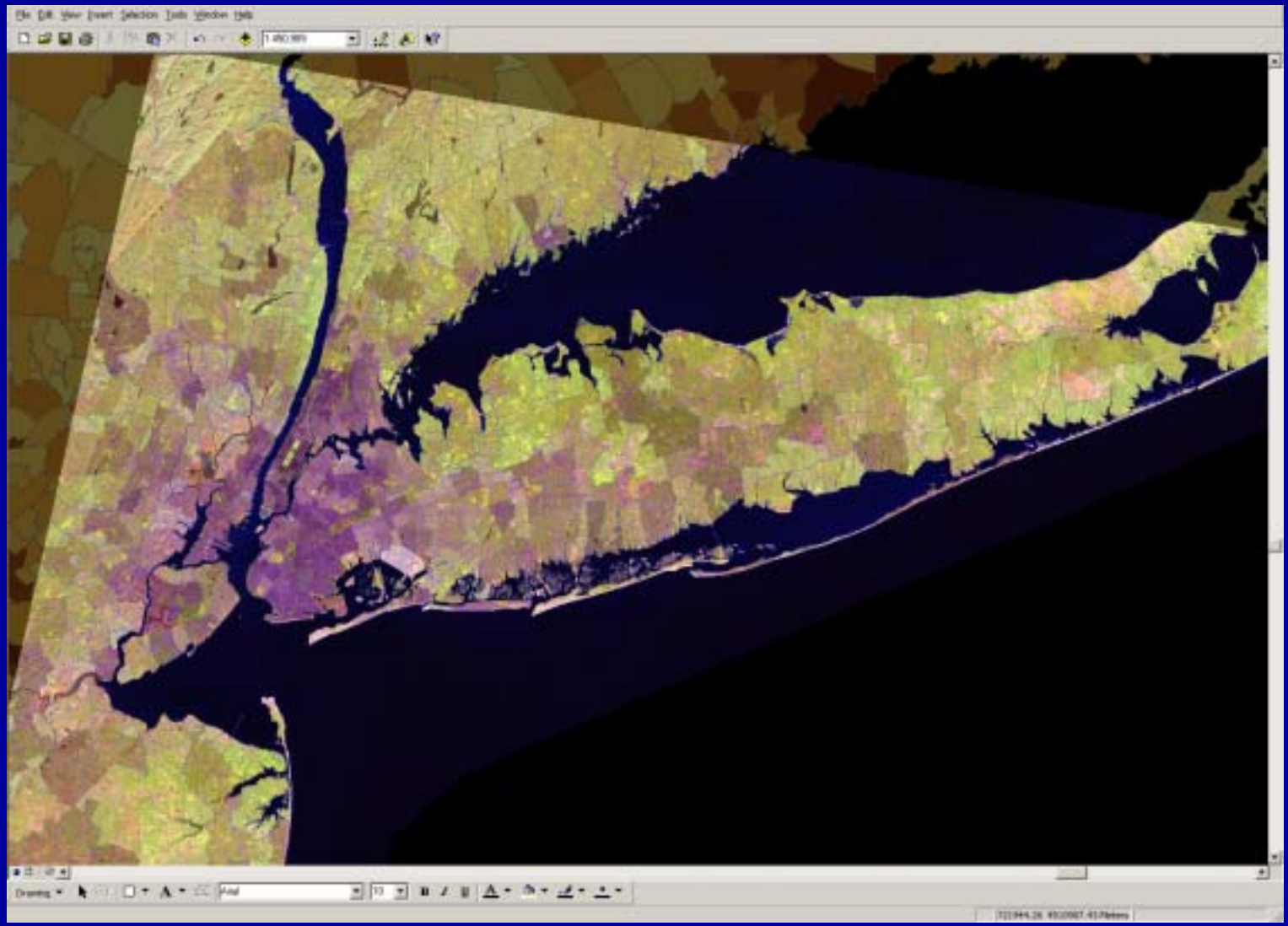
Constructing “more useful” human risk maps for West Nile Virus in the USA

Step 1: Landsat TM image processed to highlight urban/rural differences (5,4,3 in RGB)



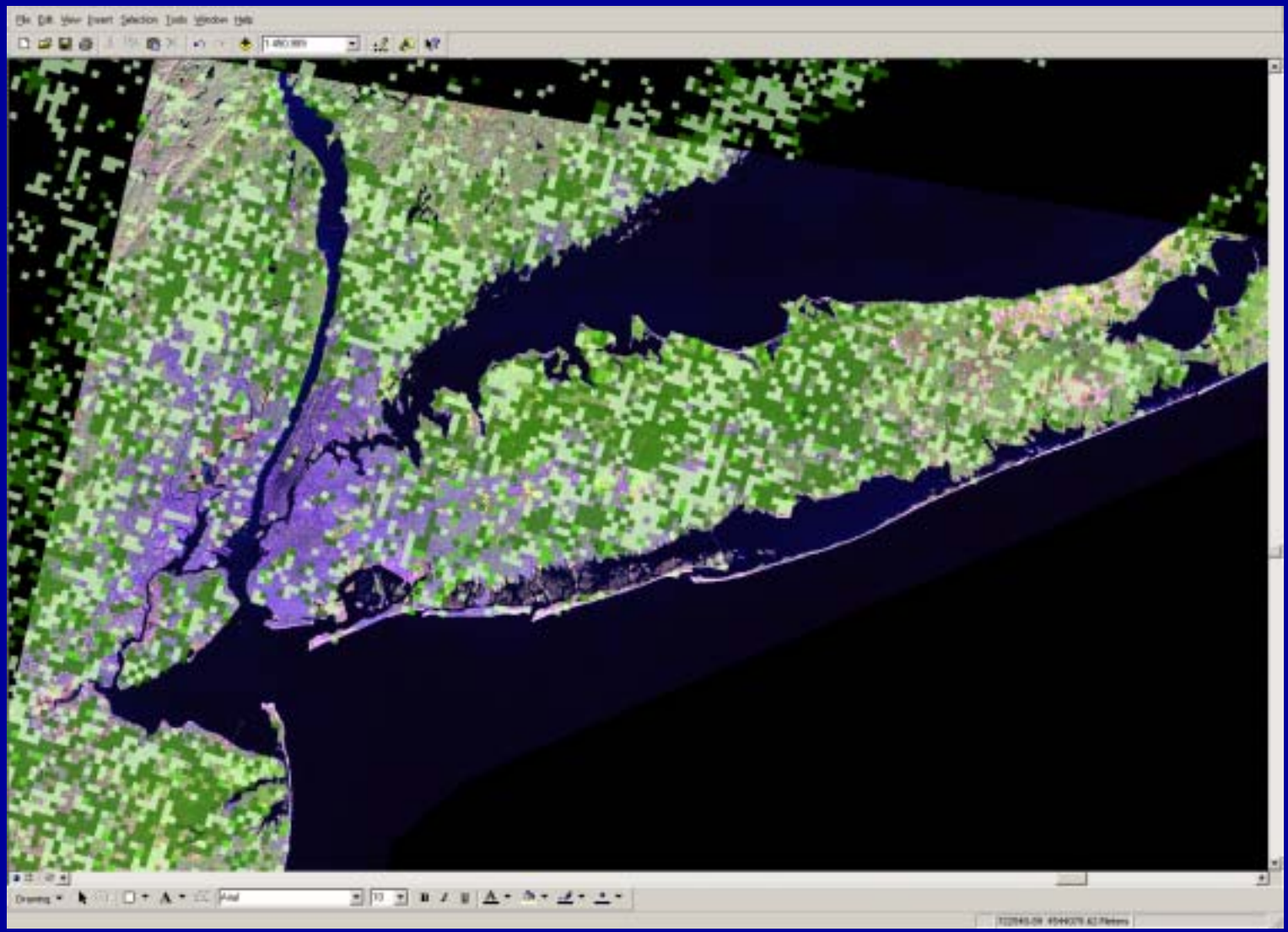
Constructing “more useful” human risk maps for West Nile Virus in the USA

Step 2: Where do people live? Overlay is human population by zip5 region, 2000



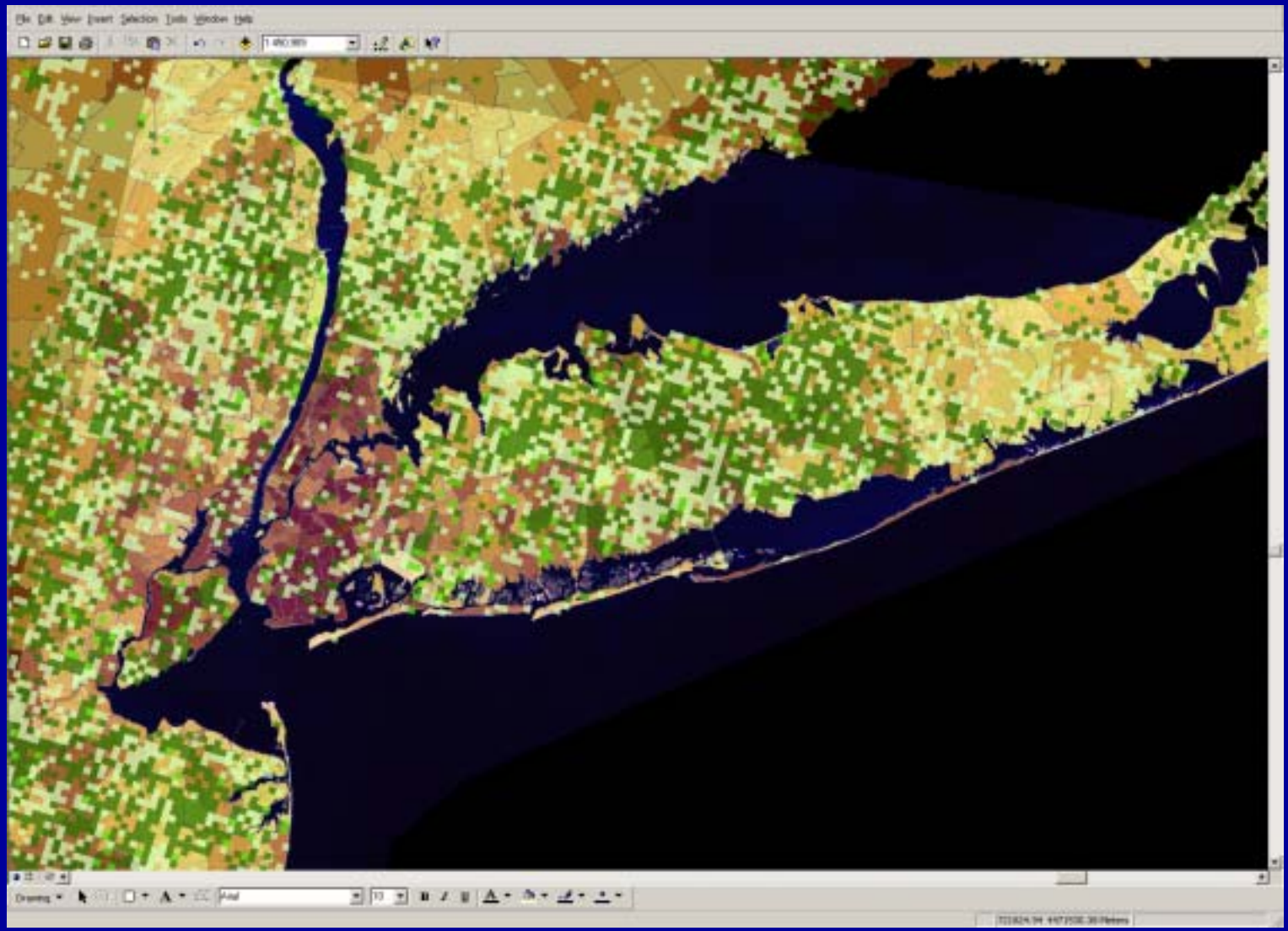
Constructing “more useful” human risk maps for West Nile Virus in the USA

Step 3: Where are infected birds predicted? Predicted bird risk 2001 on Landsat image



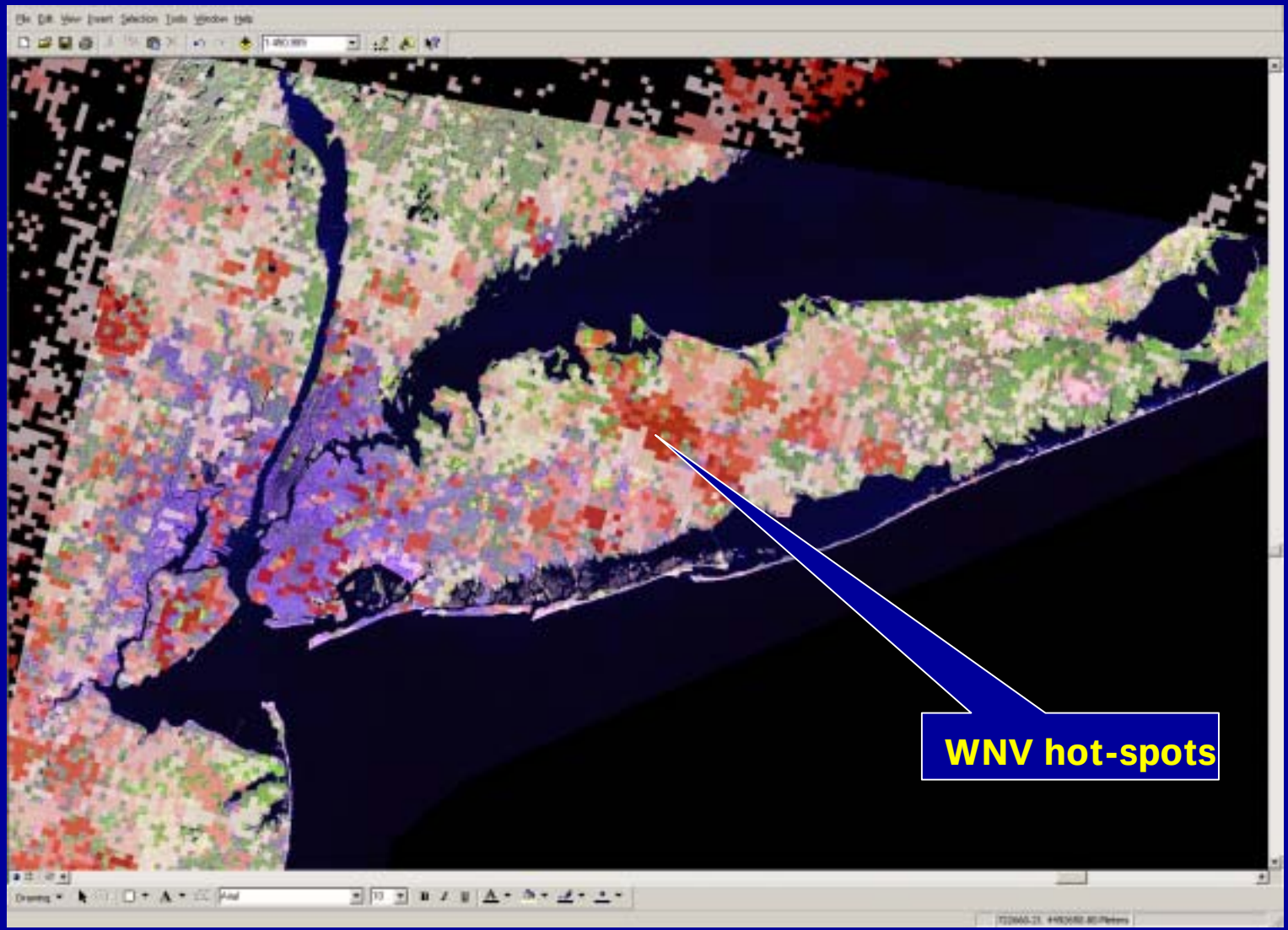
Constructing “more useful” human risk maps for West Nile Virus in the USA

Step 4: Bird-derived predicted risk (green) overlaid on population density (brown)



Constructing “more useful” human risk maps for West Nile Virus in the USA

Step 5: Human population * Infected bird risk = population-weighted WNV Risk Map



West Nile Virus Mapping Project: CONSIDERATIONS

1) **METHODOLOGICAL:** Will more precise lat/long geolocations change the maps? Initial analyses for tested birds were done with ZIP5 data.

2) **METHODOLOGICAL:** Can we combine this analysis with others, such as dead crow sightings, to make a better predictive model? Can other anthropomorphic features, such as infrastructure, be included?

3) **INSTITUTIONAL:** What is the best way to translate these data for end users? Will it support their decision making?

4) **BOTH:** What obstacles will be faced in making this a real-time system? To make this completely real-time, the following is needed on a real-time basis:
   - Satellite images
   - Lab results, and geocoded locations on birds, mammals, and mosquitoes.
   - Final risk maps

West Nile Virus Mapping Project: FUTURE?

1) NASA SYNERGY funding sought for state and local application of WNV and other vector-borne disease risk mapping into 2002.
2) Perform retrospective and prospective studies to test accuracy of models.
3) Develop partnerships with other states.
4) Partners provide geo-located information on both positive and negative birds, mosquitoes, and other animal hosts *etc.* (data confidentiality maintained).
5) Project provides remotely sensed satellite data and WNV risk predictions directly to partners (research mode) and via secure web sites (operational mode, e.g. NY HIN site).

For More Information

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