

SPATIAL CHANGES OF WEST NILE VIRUS CIRCULATION IN PIANURA PADANA, NORTHERN ITALY, FROM 2013 TO 2015

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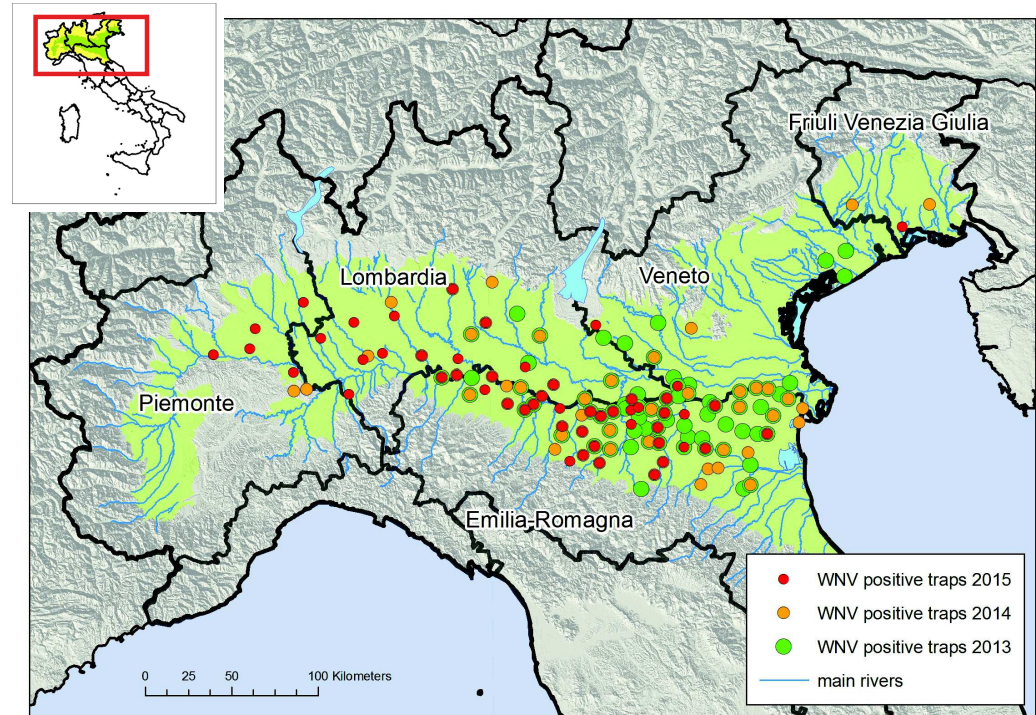
Introduction



West Nile Virus (WNV) is an emerging threat in Europe, with more than 1,000 human cases reported since 2010. After the first detection in Tuscany in 1998, WNV reappeared in north-eastern Italy in 2008-2009 affecting the regions of Emilia-Romagna, Veneto, and Lombardy, with several human cases. The virus was repeatedly detected in subsequent years, with different strains circulating over the years and in different areas of the involved regions. The environmental surveillance, particularly based on entomological and bird sampling, resulted highly efficient to early detect the circulation of WNV often before the appearance of human and equine cases. From 2013 five neighboring Regions of Northern Italy activated a similar entomological surveillance, allowing the monitoring of the whole Pianura Padana area (about 46,000 km²). We compared WNV circulation from 2013 to 2015 in north Italy using spatial interpolation and exploratory spatial data analysis methods (Kernel Density Estimation, Directional distribution, Mean center evaluation), to assess how the disease spread on the territory.

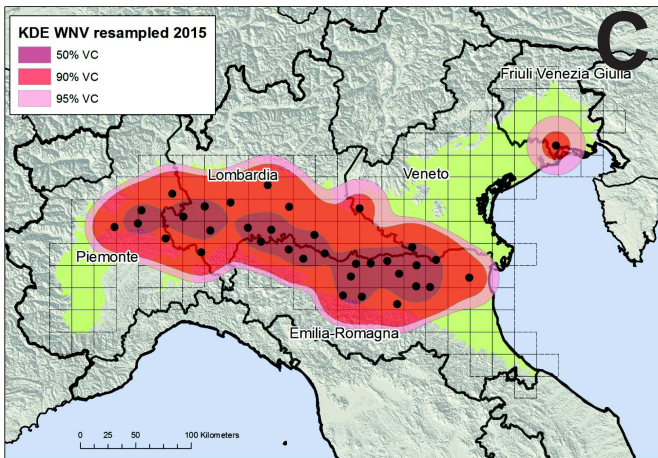
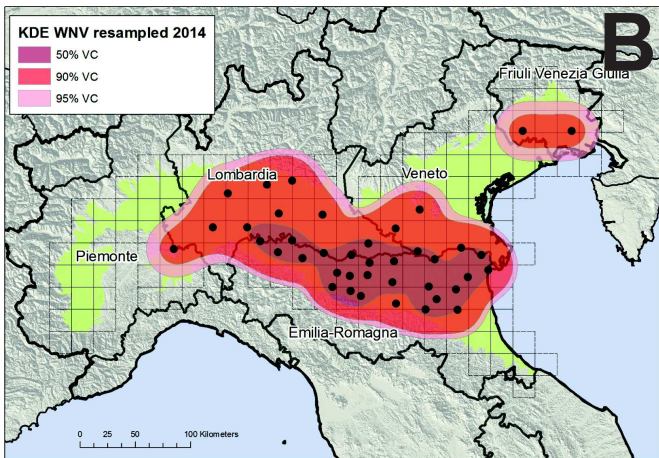
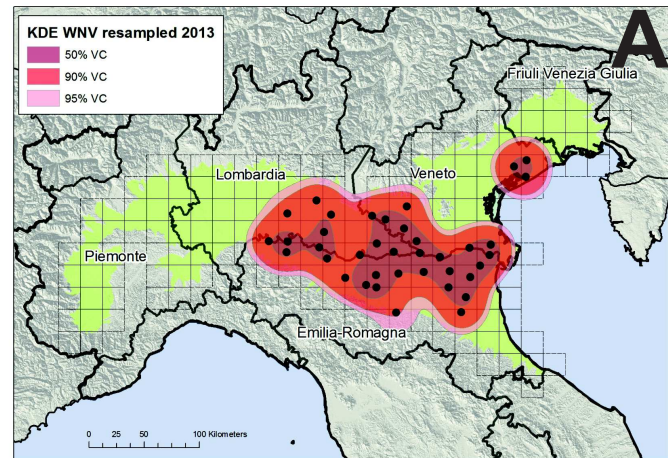
Materials and Methods

A mean of 246 mosquito traps/year were activated in the five region from June to September and a total of 127 traps cached WNV-positive mosquitoes (73 in 2013, 67 in 2014 and 53 in 2015). Features of the Regional entomological plans of surveillance are described elsewhere (Calzolari et al. 2015, Capelli et al. 2013, Pautasso et al. 2013, Mulatti et al. 2014). To standardise data and spatially comparing WNV circulation from 2013 to 2015 we resampled the total positive WNV traps in a 20 km grid and a circulation area was created using Kernel Density Estimation (KDE) for each year. KDE areas were converted into Percent Volume Contour (VC) which represent areas that contain respectively 50, 90, 95 percent of the volume of the probability density distribution; optimum bandwidth size for each KDE surface was calculated using Biased Cross Validation (BCV). To quantitatively evaluate the direction and the movement of the phenomenon, two exploratory spatial data analysis methods were used: directional distribution analysis and mean center evaluation. The movement of west front of the circulation was calculated comparing the three KDE areas (95% VC) generated from resampled data. Comparison data of the three WNV circulation areas are reported in the ending table.



WNV positive mosquito sampling stations activated in the summer 2013, 2014 and 2015 in five regions (Veneto, Emilia-Romagna, Lombardia, Friuli-Venezia-Giulia, Piemonte) of Pianura Padana (green area).

Results and Discussion

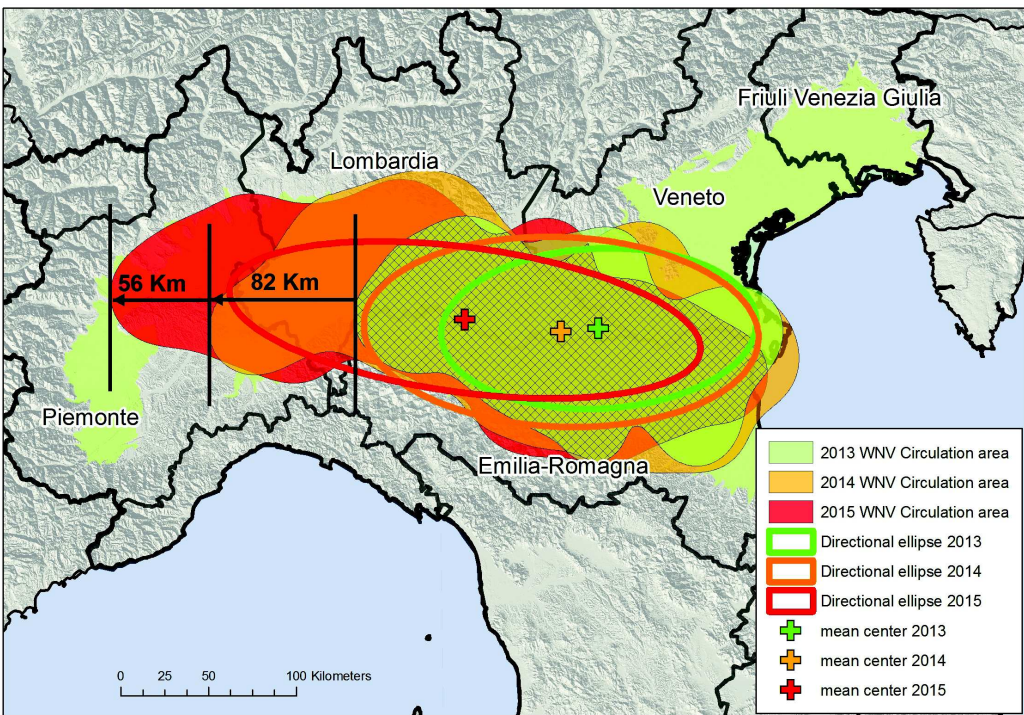


Kernel Density Estimation (KDE) converted into Percent Volume Contour (VC) Map of WNV circulation resampled in a grid of 20x20 km (dotted grids in the maps) in 2013 (A), 2014 (B) and 2015. Black dots are traps resampled in the 20x20 km grid.

The WNV Lineage 2 circulation area markedly expanded between 2013 to 2015: the KDE showed that the west front moved 82 km and 56 km from 2013 to 2014 and from 2014 to 2015 respectively, while mean centers (crosses in the map) shifted westward of around 76 km from 2013 to 2015. The directional ellipses calculated for the resampled data of the three years show a spread of the phenomenon along an horizontal axis in the center of Pianura Padana. The KDE intersection area of the three years (19,134 km²) cover north of Emilia-Romagna, south of Veneto and south-east of Lombardy region. The westward expansion of WNV circulation could be influenced from many factors (Calzolari et al. 2015) as climatic conditions and the presence of susceptible hosts of virus (birds). Absence of detailed information on WNV circulation in wild birds, does not allow to compare the distribution of WNV in the various hosts (birds, humans and horses), limiting the reliability of any inference on the spatial dynamics of the disease.

| KDE 95 Percent Volume Contour | Area (km ²) | % Variation respect to intersection area | Westward expansion (km) | Population at risk (n. inhabitants)* |
|-------------------------------|-------------------------|--|-------------------------|--------------------------------------|
| 2013 | 22,421 | 17% | 0 | 6,972,856 |
| 2014 | 34,420 | 80% | 82 | 10,704,516 |
| 2015 | 35,236 | 84% | 56 | 10,958,496 |

*Population at risk estimated from EU raster data (Gallego F.J., 2010, A population density grid of the European Union, Population and Environment. 31: 460-473)



Comparison of WNV circulation areas from 2013 to 2015. Gridded area is the KDE intertersection area of the three years.

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