SUPPLEMENTARY RESULTS

West Nile virus incidence analysis with county resolution. At the national extent, barren land, pasture, woody wetlands, all three forest types, and all four developed land covers were significantly negatively associated with human West Nile virus (WNV) disease incidence. Grassland, crops, and herbaceous wetlands were significantly positively associated with human disease incidence, whereas shrub land cover was not significantly associated in either direction (Table 1). The

SUPPLEMENTAL TABLE S1

Regional associations between human WNV disease incidence and developed land cover after combining all four developed land cover classes

Region	Pearson	*P* value	Spearman	*P* value
Upper Plains	–0.41	$< 2.2 \times 10^{-16}$	–0.52	$< 2.2 \times 10^{-16}$
Deep South	0.04	0.39	0.17	0.0004
Mid-South	0.01	0.83	0.16	0.0004
Great Lakes	0.22	3.17×10^{-6}	0.24	5.11×10^{-7}
New England	0.36	0.003	0.58	3.16×10^{-7}
Mid-Atlantic	0.09	0.18	0.37	7.04×10^{-9}
Northwest	–0.38	4.19×10^{-8}	–0.38	2.94×10^{-8}
South Central	–0.05	0.17	0.02	0.68
Southwest	0.09	0.17	0.16	0.02

Land cover types in bold font are statistically significant at $\alpha = 0.01$.

SUPPLEMENTAL TABLE S2

Correlation values for analysis of association between WN fever cases and WNV meningitis and encephalitis disease cases ($P < 0.00001$ in all cases)

Year	Pearson
2002	0.815
2003	0.864
2004	0.808
2005	0.865
2006	0.844
2007	0.875
2008	0.684
All years	0.822

SUPPLEMENTAL TABLE S3

Correlation values between WNV meningitis and encephalitis disease incidence and the proportion of each land cover with a state resolution at the national extent

Land cover type	Pearson	*P* value	Spearman	*P* value
Developed, open space*	–0.44	0.001	–0.40	0.004
Developed, low intensity*	–0.49	0.0004	–0.48	0.0004
Developed, medium intensity*	–0.39	0.01	–0.57	1.96×10^{-5}
Developed, high intensity*	–0.29	0.04	–0.53	9.47×10^{-5}
Barren land	0	1	–0.10	0.51
Deciduous forest*	–0.58	1.51×10^{-5}	–0.54	5.85×10^{-5}
Evergreen forest	–0.21	0.15	–0.25	0.08
Mixed forest*	–0.53	7.72×10^{-5}	–0.59	7.21×10^{-6}
Shrub	0.23	0.11	0.17	0.24
Grassland*	0.65	3.65×10^{-7}	0.53	7.52×10^{-5}
Pasture	–0.27	0.06	–0.20	0.16
Crops*	0.29	0.04	0.40	0.004
Woody wetland*	–0.33	0.02	–0.36	0.01
Herbaceous wetland	–0.01	0.95	–0.18	0.22

* Land cover types that are statistically significant at $\alpha = 0.05$.

SUPPLEMENTAL TABLE S4

Associations between WNV meningitis and encephalitis disease incidence and land cover at the regional extent

Land cover type	Positive	Negative
Developed, open space	New England	Northwest
Developed, low intensity	New England	Upper Plains, Northwest
Developed, medium intensity	Great Lakes, New England, Mid-Atlantic	Upper Plains, Northwest
Developed, high intensity	Great Lakes, New England, Mid-Atlantic	Upper Plains, Northwest
Barren land	None	None
Deciduous forest	None	Upper Plains, Mid-Atlantic
Evergreen forest	None	New England, Mid-South, Northwest
Mixed forest	None	New England, Northwest, South Central
Shrub	None	None
Grassland	Upper Plains, Northwest	None
Pasture	None	None
Crops	Deep South	None
Woody wetlands	None	Upper Plains
Herbaceous wetlands	None	Mid-South

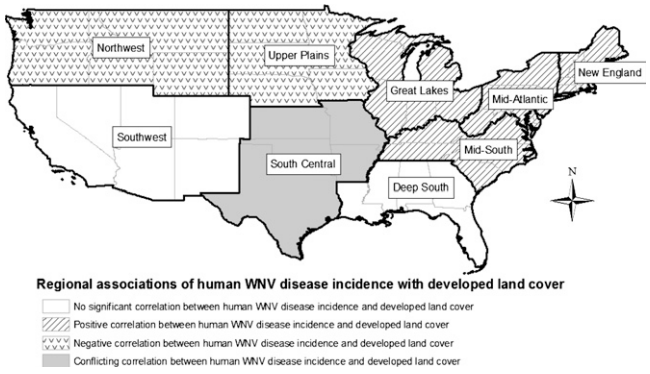
Regions are listed by significant positive or negative associations with specific land cover types.

SUPPLEMENTAL TABLE S5

Regional associations between WNV meningitis and encephalitis disease incidence and developed land cover after combining all four developed land cover classes

Region	Pearson	*P* value	Spearman	*P* value
Upper Plains	–0.86	0.06	–0.80	0.13
Deep South*	–0.75	0.14	–1.00	0.02
Mid-South	–0.21	0.73	–0.20	0.78
Great Lakes	0.72	0.17	0.70	0.23
New England*	0.91	0.01	0.81	0.05
Mid-Atlantic	0.73	0.06	0.64	0.18
Northwest*	–0.93	0.02	–1.00	0.02
South Central	–0.43	0.47	–0.60	0.35
Southwest	–0.04	0.94	–0.03	1.00

* Land cover types that are statistically significant at $\alpha = 0.05$.



SUPPLEMENTAL FIGURE S1. A map showing the association between developed land cover and each region in our study. A conflicting correlation refers to a positive association with one type of developed land cover and a negative association with another type of developed land cover.

SUPPLEMENTAL TABLE S6

Results from a generalized additive model with vector species presence, land cover type, and county centroid as predictors

Predictor	Estimate	Standard error	*t* value	*P* value
Culex pipiens present	0.568	0.093	6.102	1.18×10^{-9}
Cx. pipiens and *Cx. tarsalis* present	0.778	0.046	17.067	2.20×10^{-16}
Cx. pipiens and *Cx. quinquefasciatus* present	0.512	0.074	6.917	5.59×10^{-12}
Cx. tarsalis and *Cx. quinquefasciatus* present	0.759	0.061	12.392	2.20×10^{-16}
Cx. pipiens, *Cx. tarsalis*, and *Cx. quinquefasciatus* present	0.614	0.031	19.646	2.20×10^{-16}
Crop land cover	0.471	0.067	7.063	2.01×10^{-12}
Total developed land cover	0.284	0.111	2.552	0.011

Centroid: $F = 181.4$, $P = 2.20 \times 10^{-16}$, estimated degrees of freedom = 28.59, and deviance explained = 80.4%.

results from the peak year analysis agreed with these results (Table 2). Repeating the original analysis with all developed land cover types combined also yielded the same results (i.e., significant negative association with human WNV disease incidence) (Supplemental Table S2).

At the regional extent, all developed land cover types were positively associated with human WNV disease incidence in the Mid-South, Great Lakes, New England, and Mid-Atlantic regions, whereas they were negatively associated with incidence in the Upper Plains and Northwest. In the South Central region, low-intensity developed land cover was negatively associated with incidence, whereas high-intensity developed land cover was positively associated with incidence. Barren land was found to be positively associated with human WNV disease incidence in the Mid-Atlantic but negatively associated with incidence in the Deep South, Great Lakes, and Southwest. Although none of the forest land cover types were found to be positively associated with human WNV disease incidence in any region, at least two of the three forested land covers were negatively associated with incidence in the Upper Plains, Deep South, Mid-South, Great Lakes, Northwest, South Central, New England, and Southwest regions. Deciduous forest was also negatively associated with incidence in the Mid-Atlantic.

Similar to the forested land covers, pasture was not positively associated with human WNV disease incidence in any region but was negatively associated with incidence in the Upper Plains and South Central regions. Shrub land cover was found to be positively associated with human WNV disease incidence only in the Deep South, whereas it was negatively associated with incidence in the Mid-South, Great Lakes, New England, and Southwest. Grassland cover was positively associated with human WNV disease incidence in the Upper Plains, Northwest, South Central, and Southwest but negatively associated with incidence in the Deep South, Great Lakes, and Mid-Atlantic. Somewhat similarly, crop land cover was found to be positively associated with human WNV disease incidence in the Deep South, Mid-South, Great Lakes, Mid-Atlantic, Northwest, South Central, and Southwest but negatively associated with incidence in the Upper Plains. One or both of the wetland land cover types were positively associated with human WNV disease incidence in the Deep South, Mid-Atlantic, and Southwest but negatively associated with incidence in the Upper Plains, Great Lakes, and South Central regions. Table 3 provides a summary of this information by land cover type.

Analysis of association between total WNV cases and WNV meningitis and encephalitis cases. We found the incidence of total human WNV disease cases and WNV meningitis and encephalitis disease cases to be highly associated in each year of the study period as well as in all years combined (Supplemental Table S1). These results provide strong support for our previous analysis using total human WNV disease cases.

WNV meningitis and encephalitis incidence analysis with state resolution. At the national extent, grassland and crops were positively associated with WNV meningitis and encephalitis incidence, whereas all developed land cover, deciduous and mixed forest, and woody wetland were negatively associated with meningitis and encephalitis incidence (Supplemental Table S3). Repeating this analysis with all four developed land cover types combined did not alter the results (Supplemental Table S4).

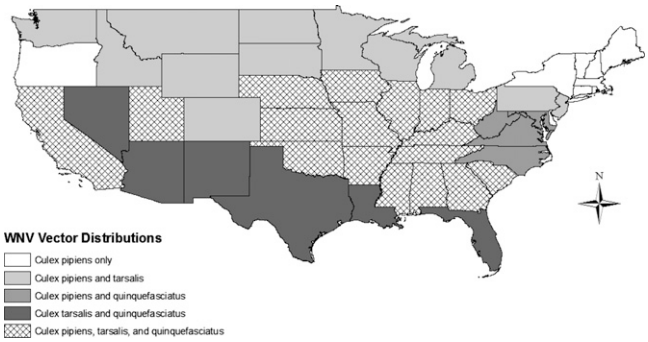
At the regional extent, all developed land cover types were negatively associated with WNV meningitis and encephalitis incidence in the Upper Plains and Northwest except for open space developed, which was only negatively associated with incidence in the Northwest. All developed land cover types were also positively associated with incidence in New England; medium- and high-intensity developed land cover were also positively associated with incidence in the Great Lakes and Mid-Atlantic. None of the forested land cover

SUPPLEMENTAL TABLE S7

Results from a generalized additive model with vector species presence and county centroid as predictors

Predictor	Estimate	Standard error	*t* value	*P* value
Cx. pipiens present	0.674	0.093	7.278	4.29×10^{-13}
Cx. pipiens and *Cx. tarsalis* present	0.877	0.043	20.295	2.20×10^{-16}
Cx. pipiens and *Cx. quinquefasciatus* present	0.645	0.072	8.931	2.20×10^{-16}
Cx. tarsalis and *Cx. quinquefasciatus* present	0.867	0.060	14.568	2.20×10^{-16}
Cx. pipiens, *Cx. tarsalis*, and *Cx. quinquefasciatus* present	0.754	0.025	30.467	2.20×10^{-16}

Centroid: $F = 204.8$, $P = 2.20 \times 10^{-16}$, estimated degrees of freedom = 28.61, and deviance explained = 80.1%.



SUPPLEMENTAL FIGURE S2. A map of the distribution of three prominent WNV vector species based on the distributions listed in Darsie and Ward (2005).

types were positively associated with WNV meningitis and encephalitis incidence in any region, but deciduous forest was negatively associated with incidence in the Upper Plains and Mid-Atlantic; evergreen forest was negatively associated with incidence in the Mid-South, New England, and Northwest, and mixed forest was negatively associated with incidence in the South Central, Northwest, and New England regions. Grassland was positively associated with WNV meningitis and encephalitis incidence in the Upper Plains and Northwest, whereas crop land cover was positively associated with incidence in the Deep South. Woody wetland cover was negatively associated with WNV meningitis and encephalitis incidence in the Upper Plains, whereas herbaceous wetland cover was negatively associated with incidence in the Mid-South (Supplemental Table S5).