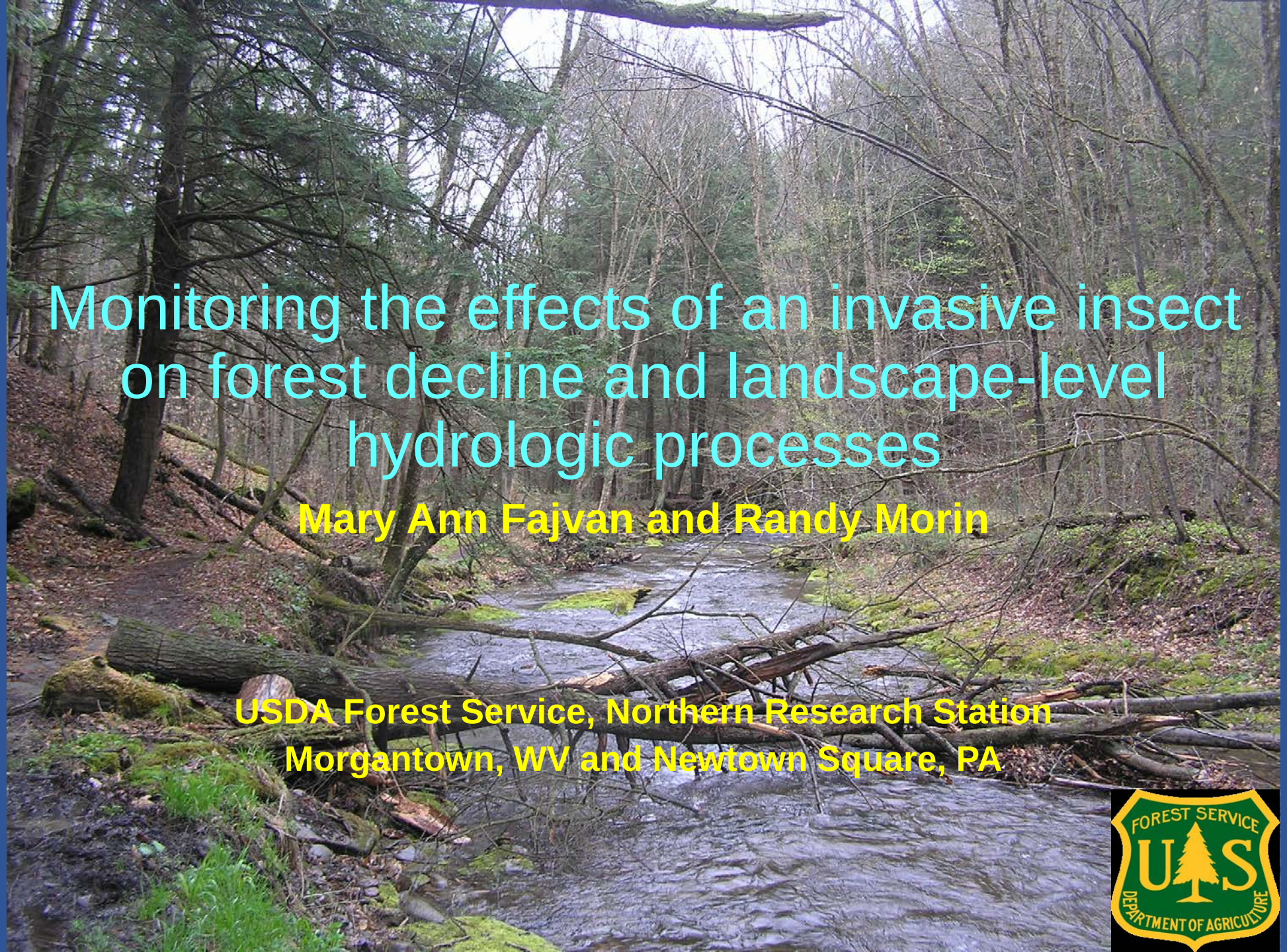

Monitoring the effects of an invasive insect on forest decline and landscape-level hydrologic processes

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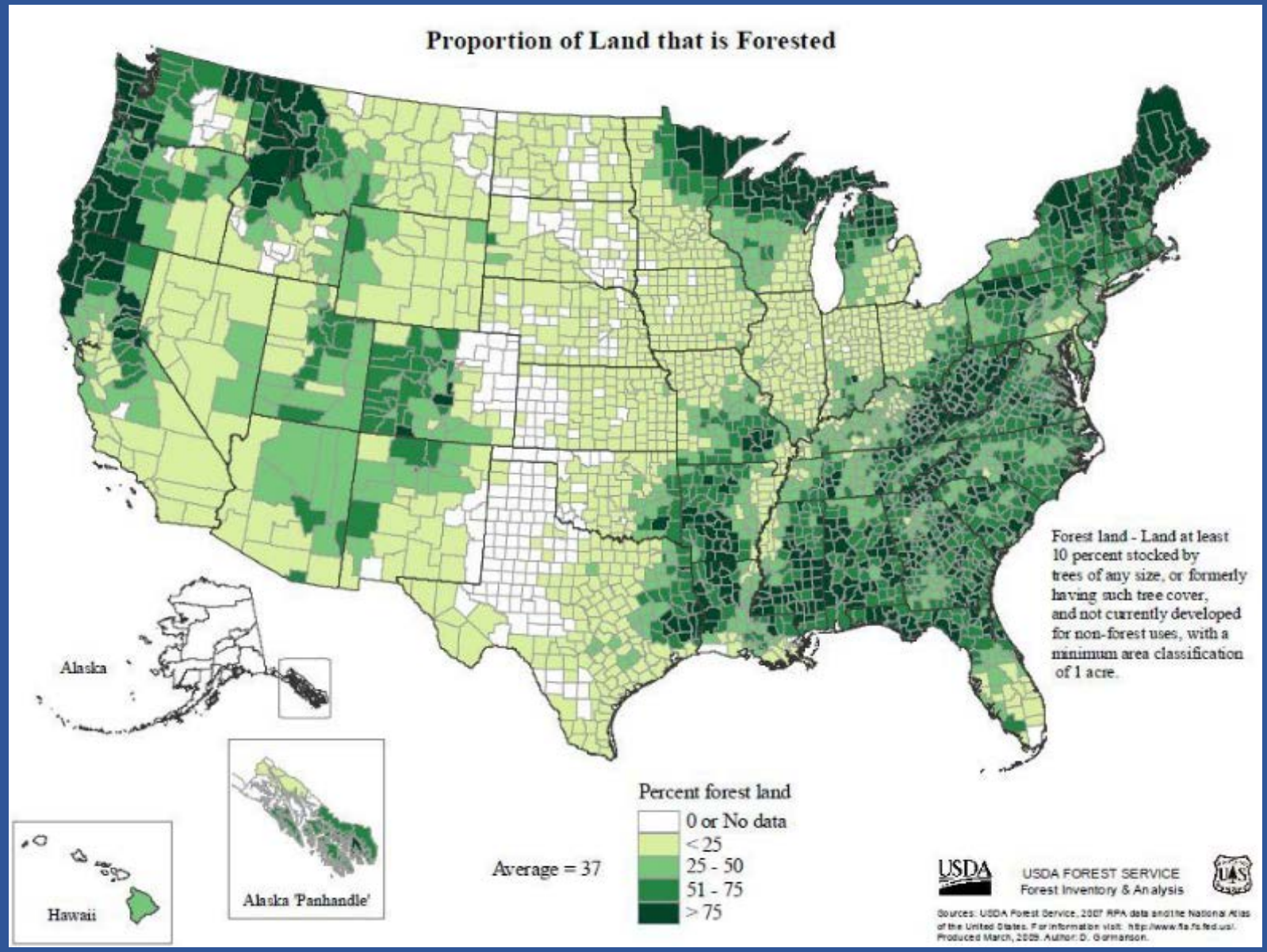
Morgantown, WV and Newtown Square, PA

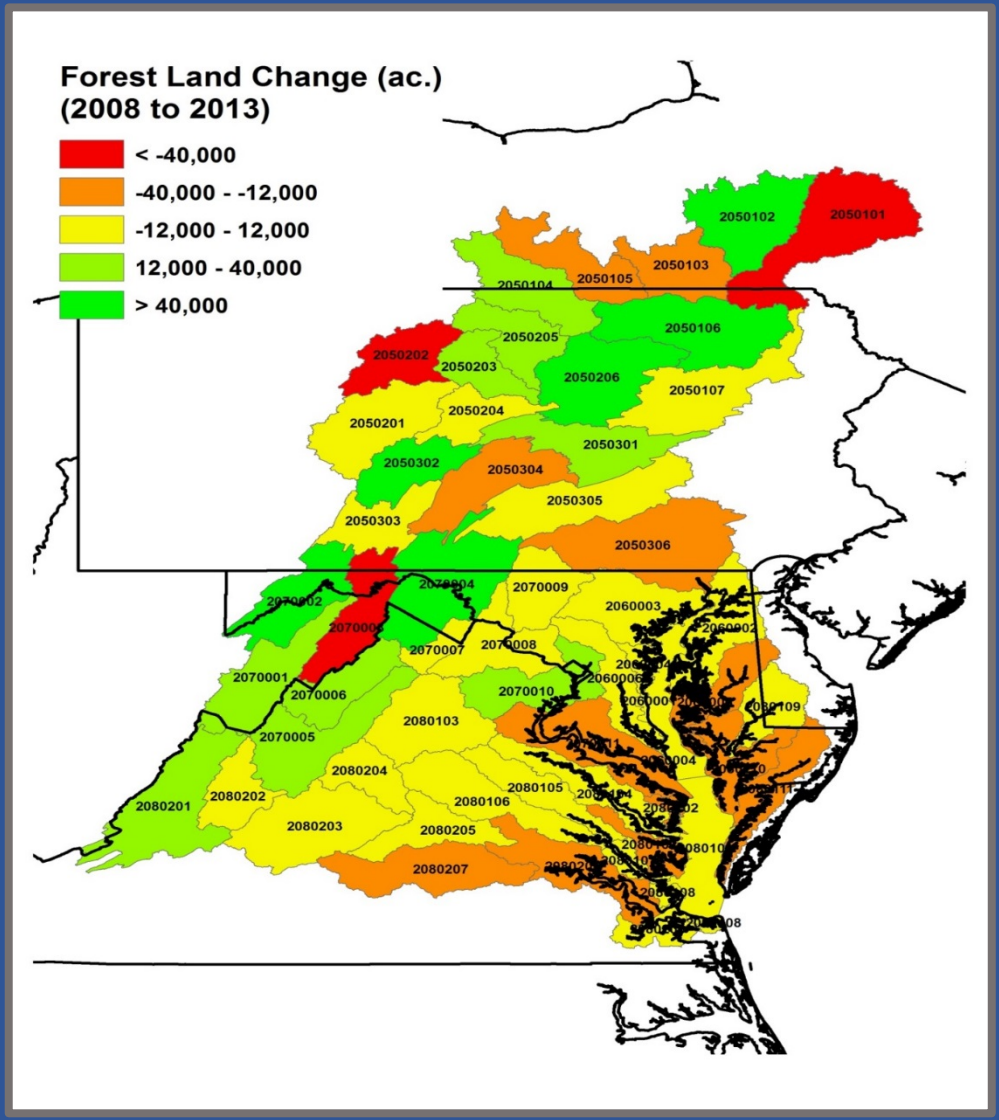
Proportion of Land Area that is Forested

FIA Standard sampling intensity: 1 plot cluster per 2400 ha.



Forest Cover in the Chesapeake Bay Watershed

(Determined according to USGS Hydrologic Unit Codes)



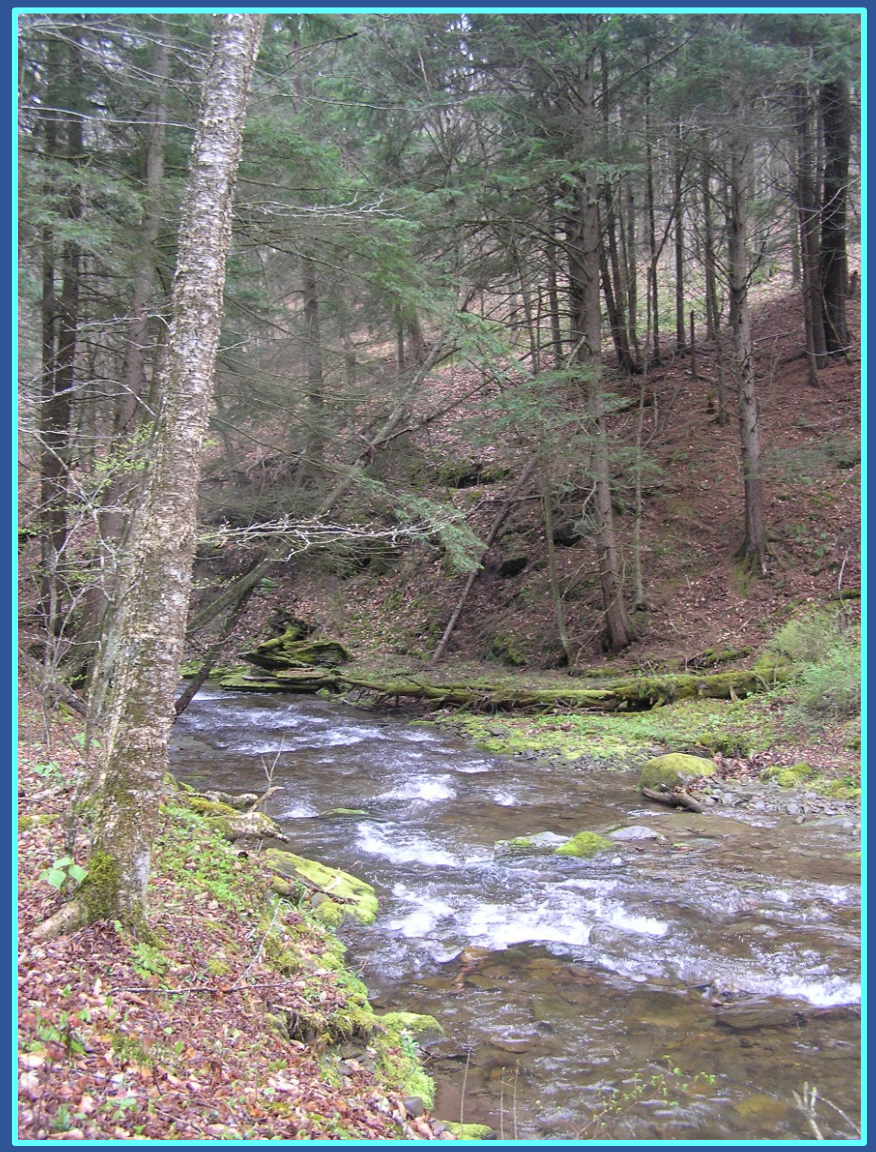
- Forests account for 55% of the total land are
- Play a critical role in regulating hydrologic processes by moderating timing and magnitude of streamflow.
- Hydrologic processes are sensitive to disturbances that reduce tree vigor and transpiration, cause mortality.
- What are effects of insect outbreaks on landscape-level hydrologic processes?

Eastern Hemlock *(Tsuga canadensis)*

- Distributed widely throughout the northeastern USA and the higher elevations of the southern Appalachian Mountains .

- Stands are characterized by a dense, evergreen canopy that creates a unique micro-environment within a broader forest landscape, which is dominated by deciduous species in this region.

Hemlock Ecology

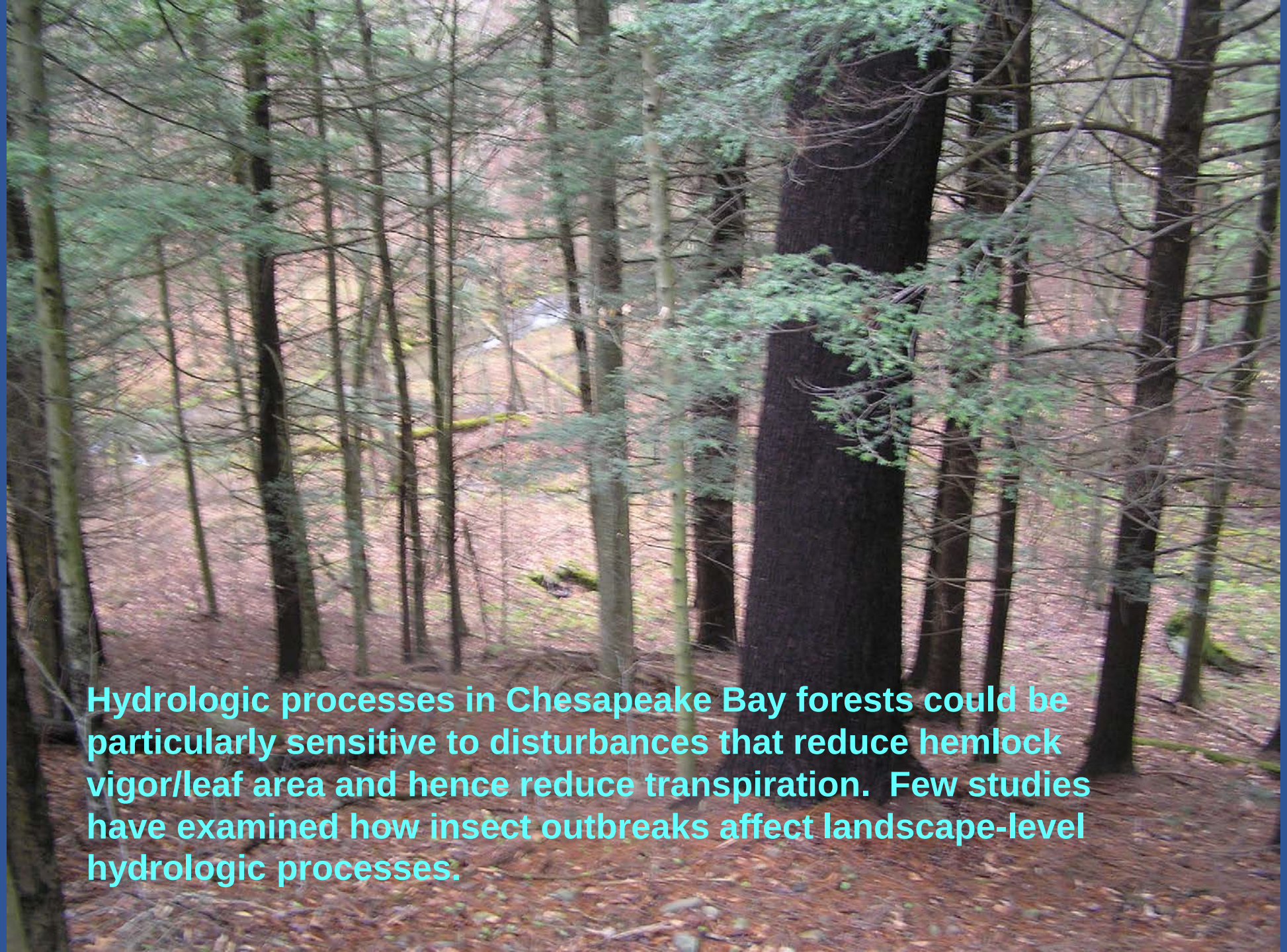


- Hemlock is a long-lived, shade tolerant species that is considered a foundation species, especially in riparian and cove habitats, where trees can be highly concentrated along riparian corridors. Grows best in soils with consistent moisture.

Ecohydrological Roles of Hemlock

- Evergreen: Maintains year-round transpiration; 50% occurs in winter/early spring when other trees are still dormant.

- Dense canopy supports high rainfall interception rates and effects stream temperatures, physio-chemical properties and biotic characteristics.

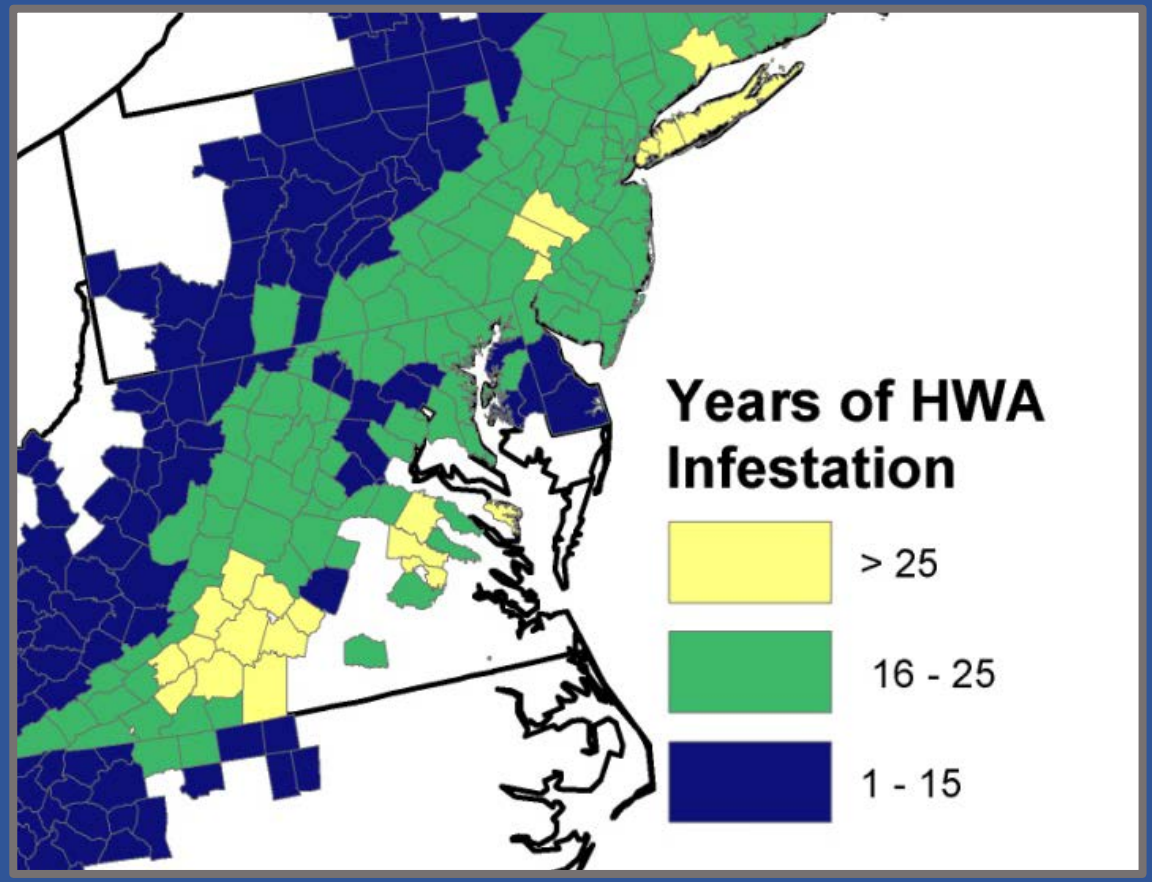


Hydrologic processes in Chesapeake Bay forests could be particularly sensitive to disturbances that reduce hemlock vigor/leaf area and hence reduce transpiration. Few studies have examined how insect outbreaks affect landscape-level hydrologic processes.

Hemlock Woolly Adelgid *(Adelges tsugae)*

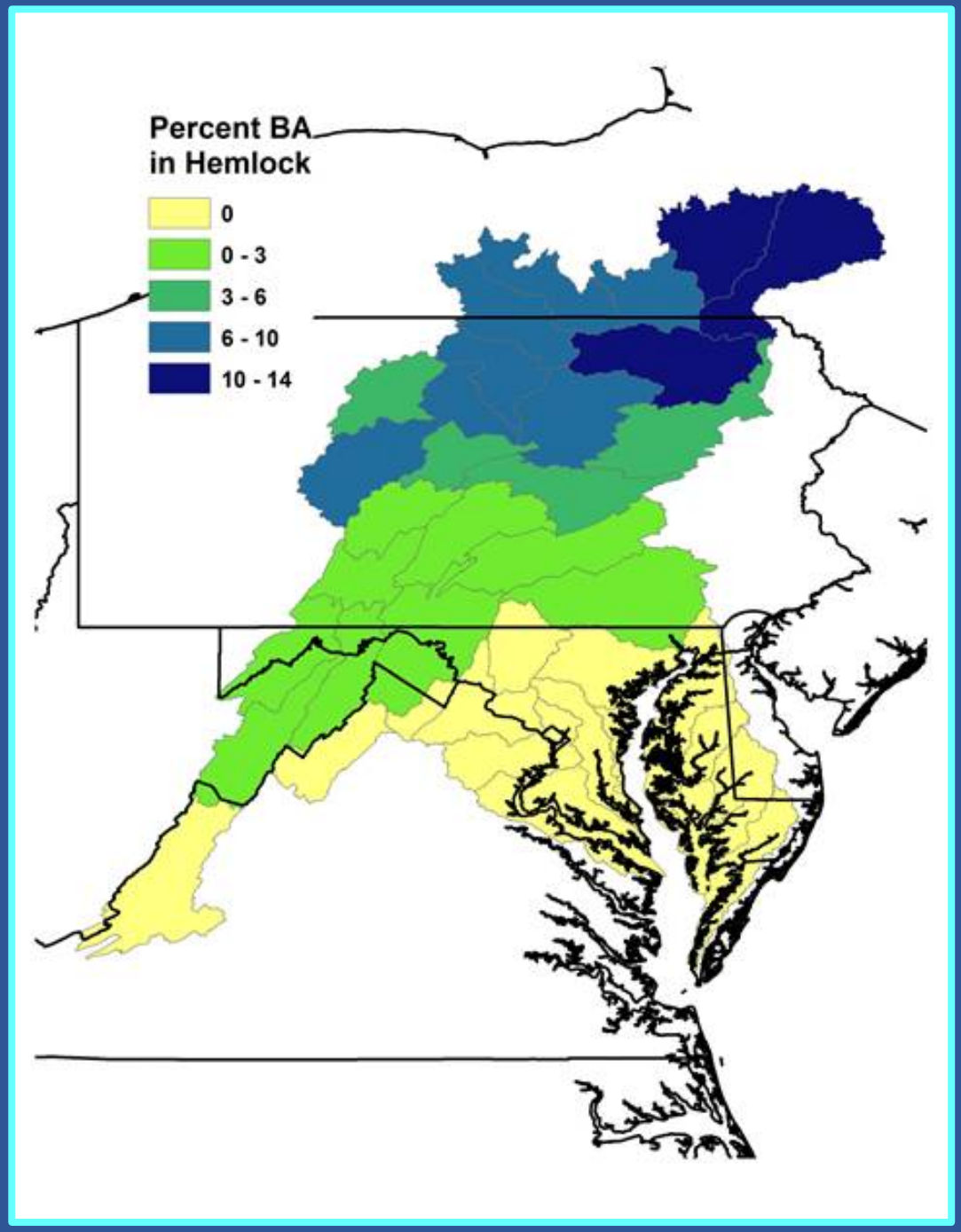
- Non-native insect introduced from Asia in the 1950s

- Has spread to infest hemlock in at least 18 eastern states and caused widespread decline and mortality in all age classes of hemlock, typically within 4-10 years.



Mortality results in permanent reductions in winter transpiration rates but eventual increases during the growing season as hemlock is replaced by deciduous species. A study in the southern Appalachians* documented that streams draining watersheds where hemlock has been lost, demonstrated permanent reductions in yield and transient increases in peakflow during large-flow events.

** Brantley, S.T., Miniat, C.F., Elliott, K.J., Laseter, S.H., and J.M. Vose. 2014. Changes to southern Appalachian water yield and stormflow after loss of a foundation species. Ecohydrology. DOI: 10.1002/eco.1521.

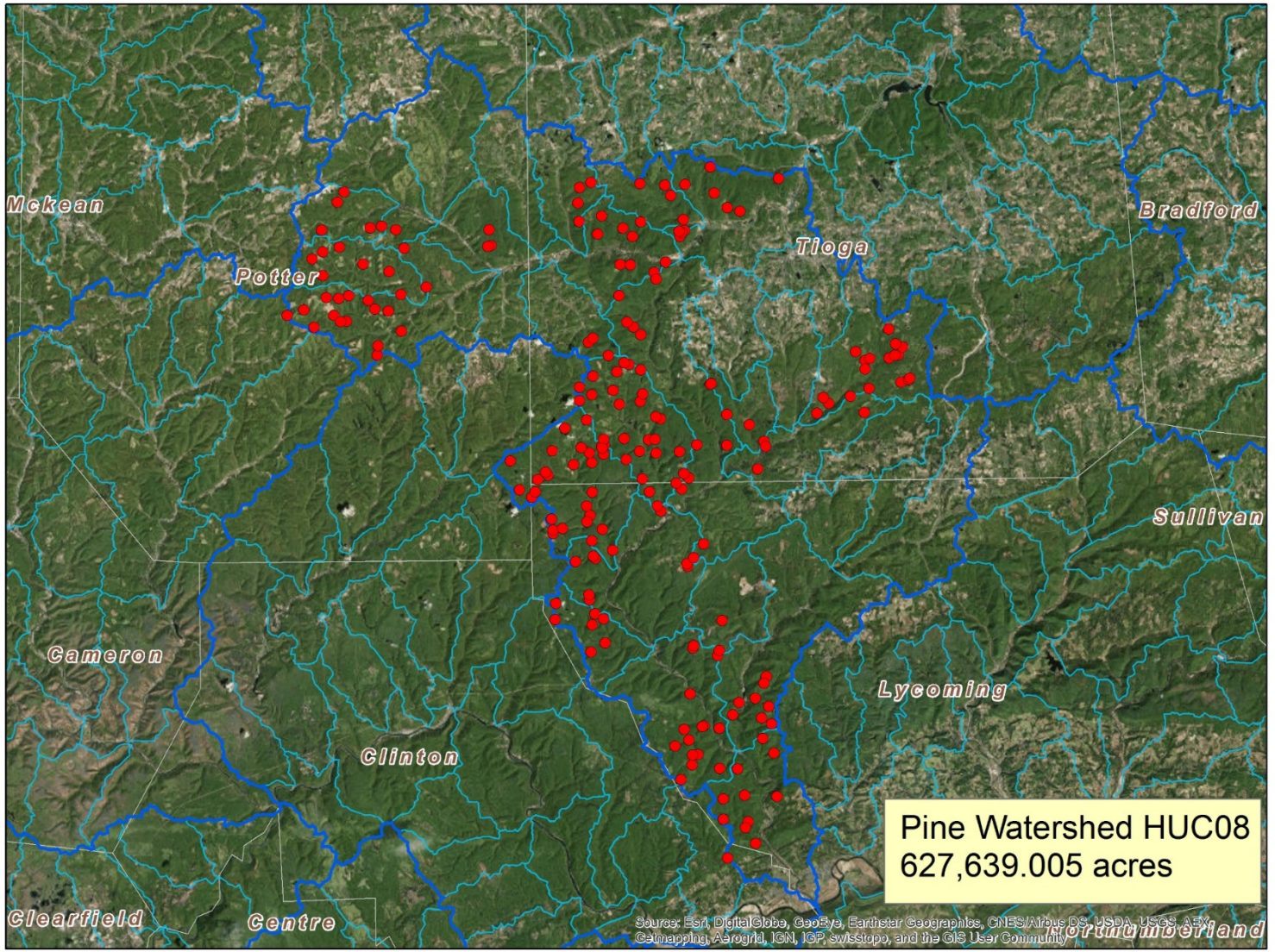


If HWA-induced hemlock mortality alters hydrologic function, land managers will be challenged to develop management strategies that restore function or mitigate impacts.

IDENTIFY THE HEMLOCK:

1. CBW boundaries were overlayed on USDA Forest Service, Forest Inventory and Analysis (FIA) field plot data. A table-making tool generated estimates of forest cover by species for each HUC for data from 2013.

2. In 2013, the watersheds with the highest percentage of hemlock were located in northern PA and southern NY.

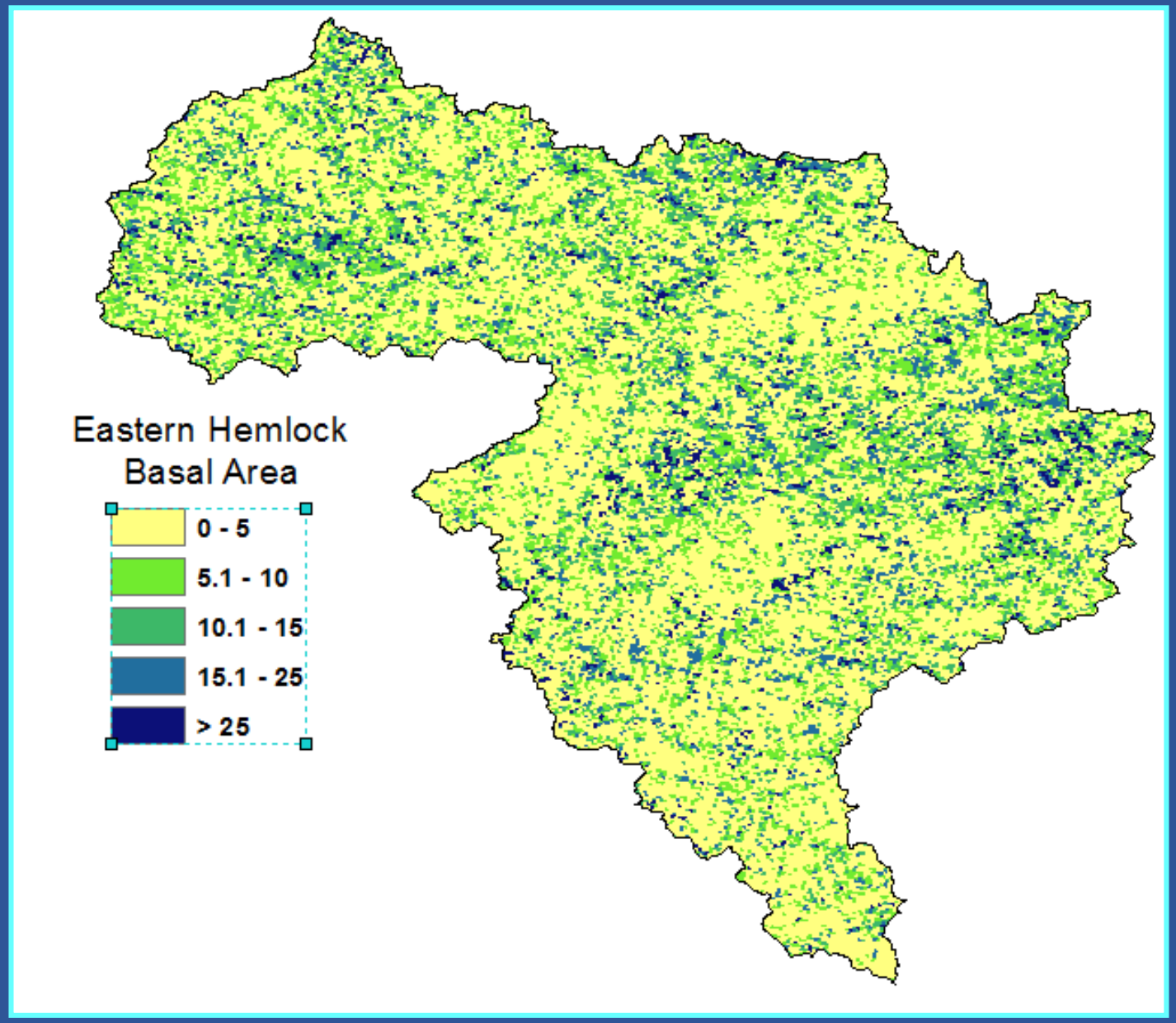


Note: In the NC study water yields were effected where hemlock was 6% basal area overall and 26% basal area in riparian areas

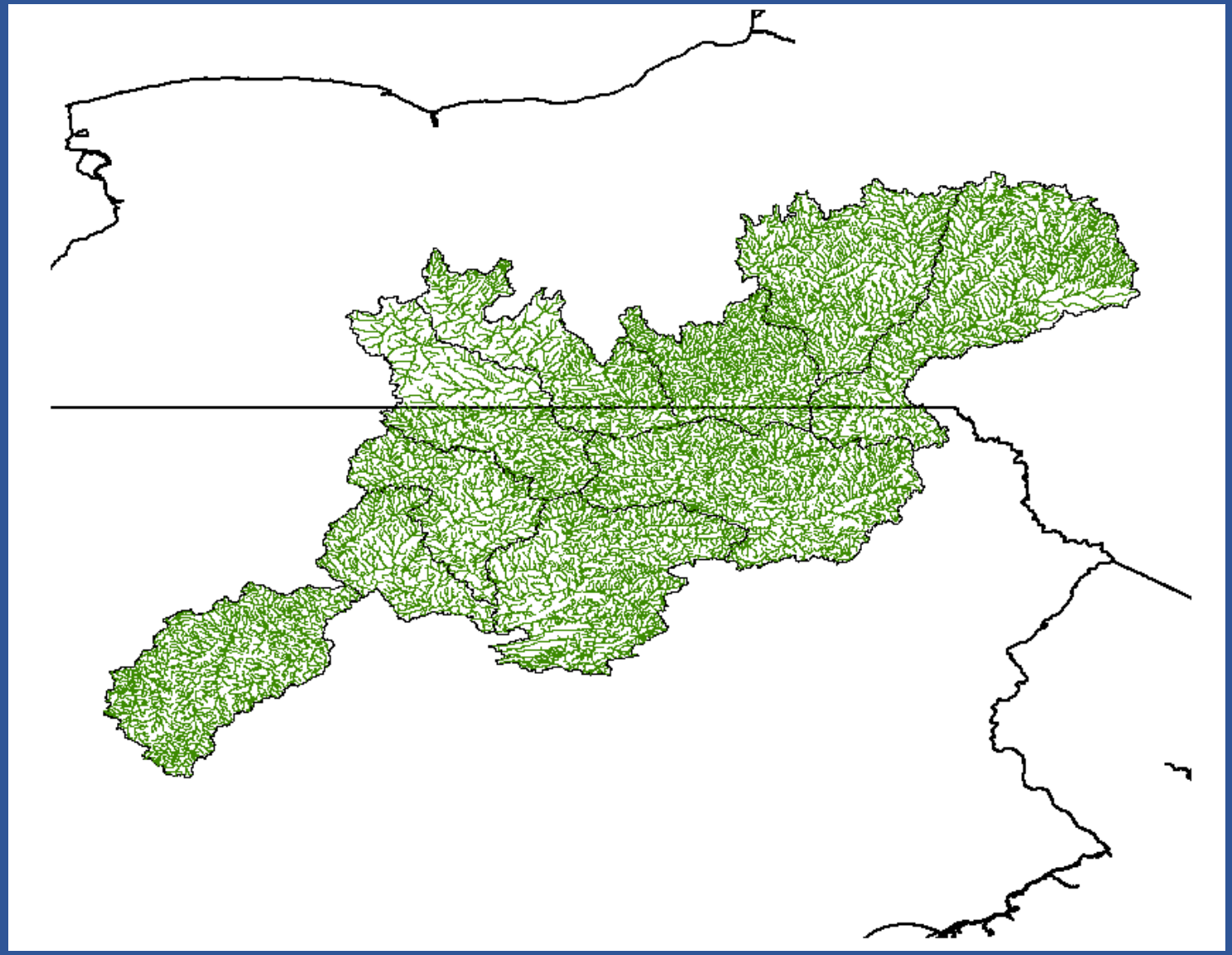
Nearest-neighbor imputation approach used to map hemlock basal area using FIA plots and moderate resolution raster data*

- Integration of vegetation phenology derived from MODIS satellite imagery and raster data.
- Relevant environmental variables combined with field plot tree data incorporated into model.
- Locations with > 10% hemlock basal area were identified: 96,000 acres or 15% of the watershed.

*Wilson et. Al. 2012. Forest Ecology & Management.



Stream Layer* of the Ten Watersheds with Highest Hemlock Basal Areas



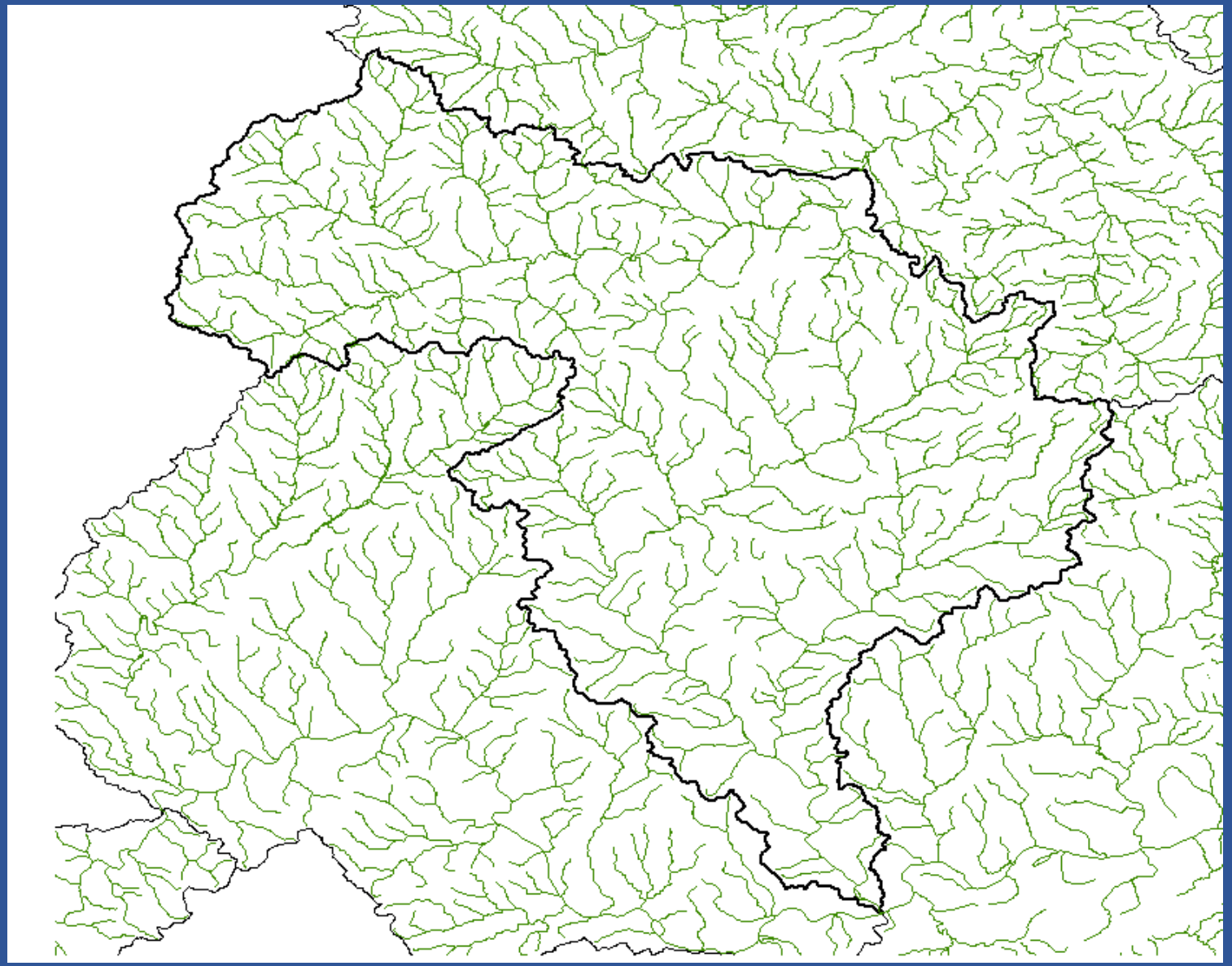
*USGS National Hydrography Dataset: https//nhd.usgs.gov/

Percent Hemlock Basal Area for Riparian Areas of 250 m or 500 m in Ten Watersheds of Chesapeake Bay

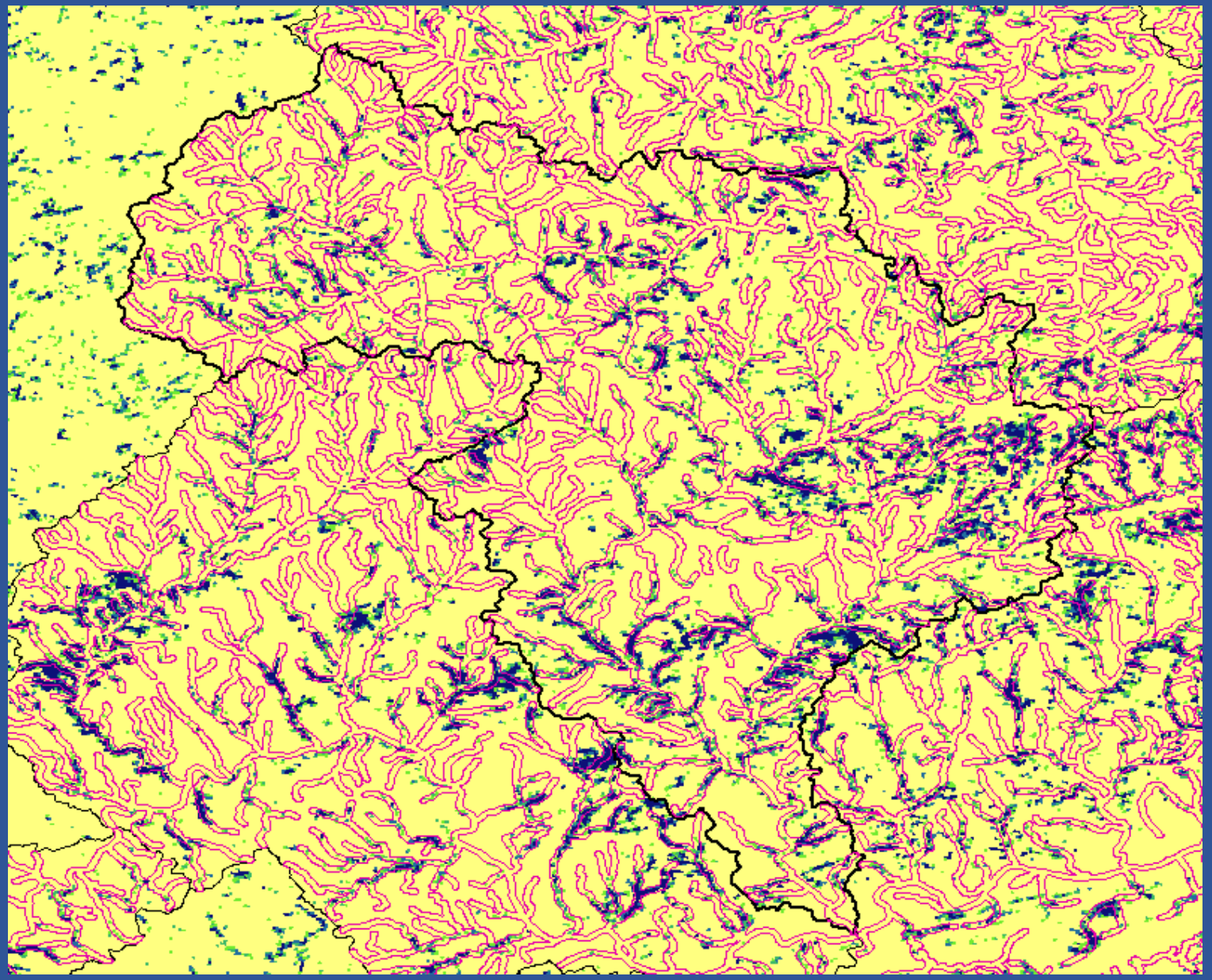
Watershed	HE %BA 250 meter	HE % BA 500 meter
Chemung	3.02	2.65
Chenango	8.02	6.94
Lower W Branch Susquehanna	10.02	7.58
Middle W Branch Susquehanna	6.63	4.81
Owego-Wappasening	7.14	6.12
Pine	6.09	4.75
Tioga	3.80	3.02
Upper Susquehanna	11.73	10.50
Up Susquehanna-Tunkhannock	8.16	7.13
Upper W Branch Susquehanna	10.08	7.07

NOTE: Percent hemlock basal area is averaged for all streams in a given watershed

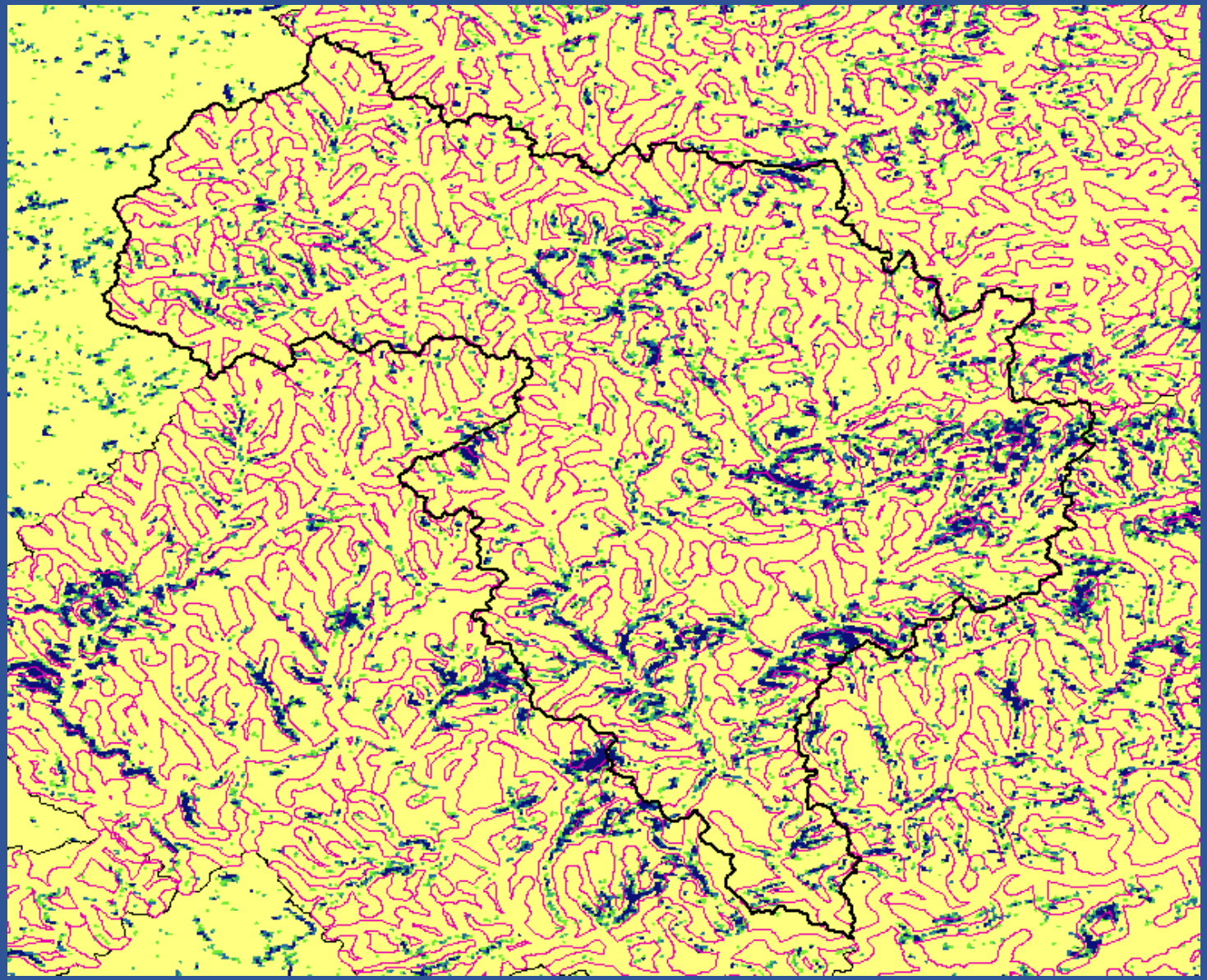
Pine Watershed with Stream Layer



Hemlock basal area with 250 m stream buffers:



Hemlock basal area with 500 m stream buffers:



A Comprehensive Assessment of Three High-Quality Headwater Streams in the Chesapeake Bay Watershed

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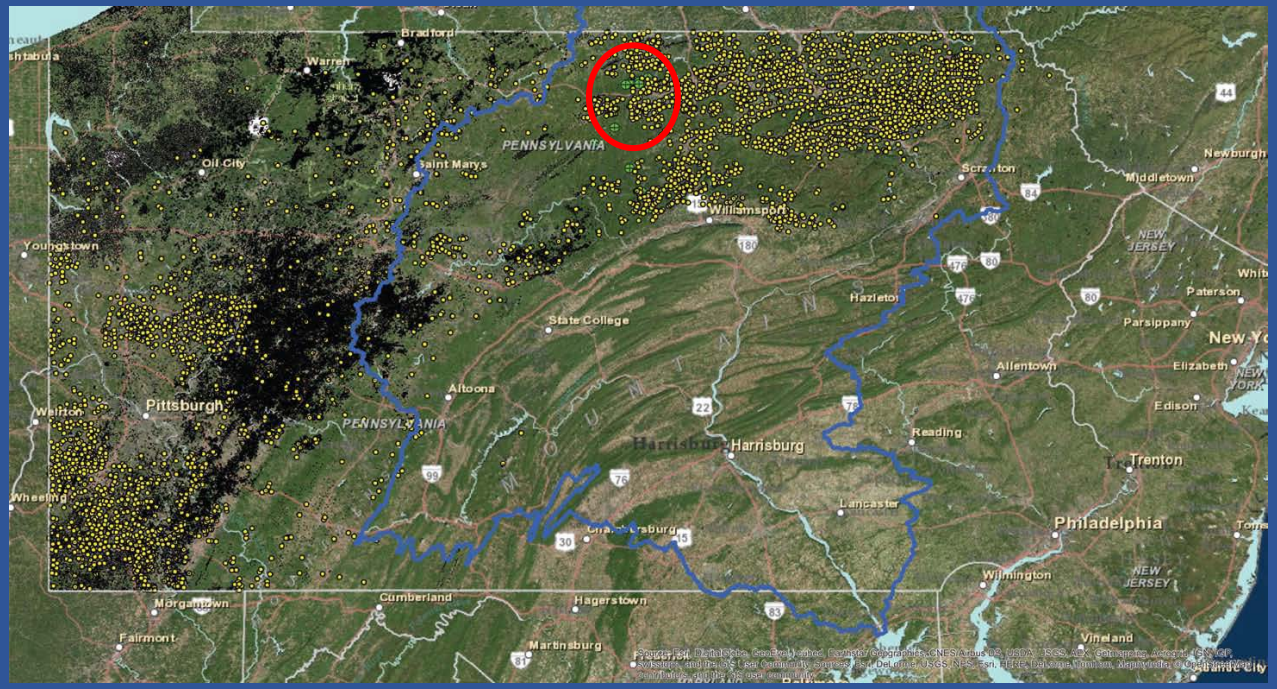
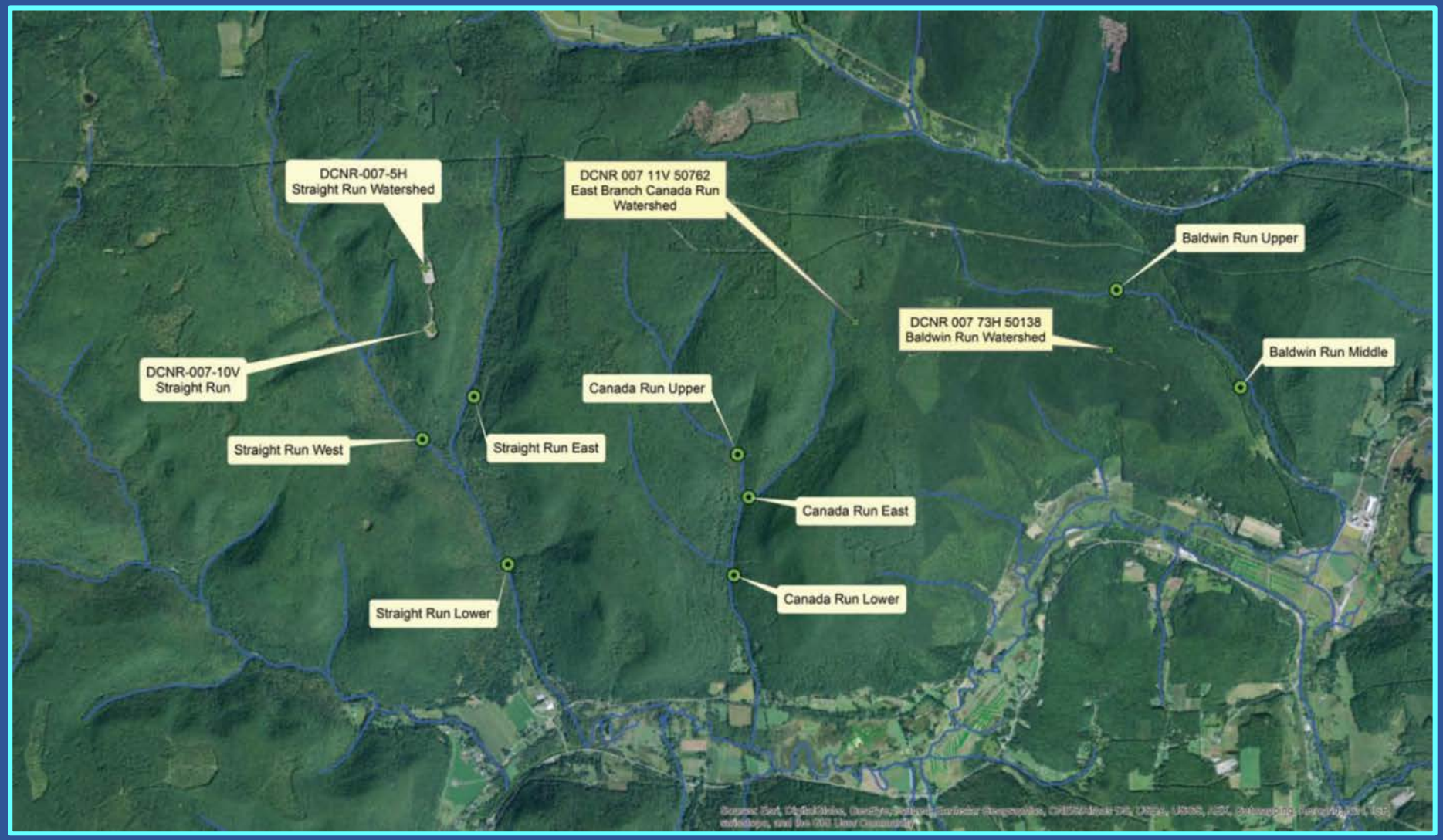
1USGS National Research Program/Eastern Branch, Reston, VA, 2USGS Northern Appalachian Research Laboratory, Wellsboro, PA



Stream sampling sites in Pine Creek Watershed



Two streams selected for hemlock monitoring in collaboration with USGS stream monitoring

Project status: HWA in Tioga Co.

- Additional inventory plot data from PA Bureau of Forestry is being incorporated into prediction model. Annual field data monitoring will be used to detect HWA presence and anticipated tree decline.

- Improvements in the spatial detail of mapping approach, has potential for regional management and planning as threats from invasive insects and other disturbances increase.


THANK YOU!