



Using Climate and Genetic Diversity Data to Prioritize Conservation Seed Banking

NC STATE UNIVERSITY

John Hastings, Mark Megalos, Robert Jetton, Kevin Potter, Frank

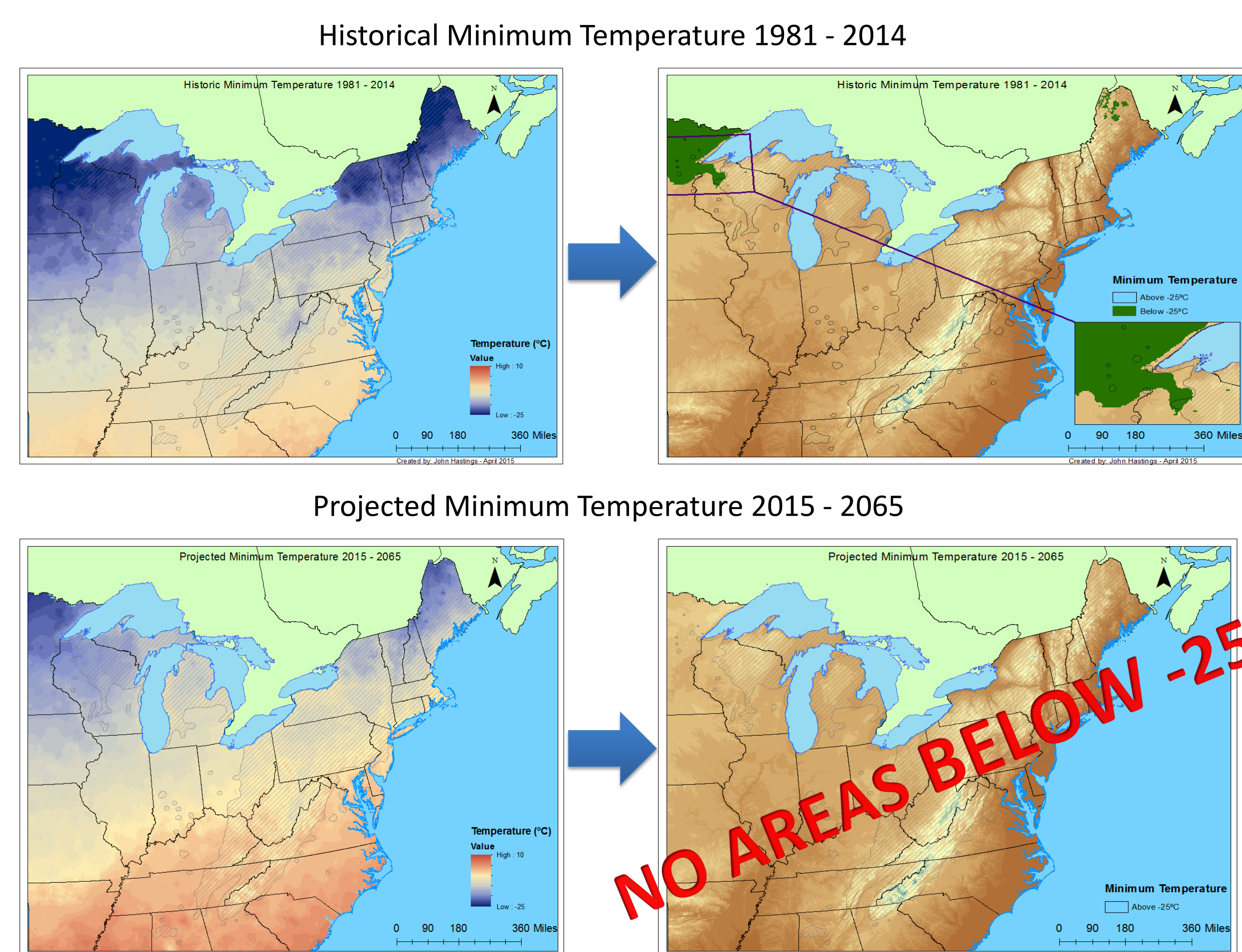
Abstract:

Hemlock Woolly Adelgid (HWA) is sweeping the native range of Eastern and Carolina Hemlock at an alarming rate. Now infesting 19 states and over 400 counties, HWA poses a threat that the eastern US native cannot handle. The current biological and chemical methods for protecting these keystone species are expensive and time consuming, and despite our best efforts hemlocks are losing the battle and face potential extirpation.

Genetic conservation is warranted for the long-term preservation of the species. Urgent seed collection and the preservation of genetic integrity within Hemlock's more diverse populations is ongoing. Areas of significant genetic diversity can be located and protected using GIS and genetics. Climate model projections can allow for the display of a minimum temperature threshold below which significant HWA dieback occurs. Models can also show the temporal movement of that threshold to exhibit areas likely to be exposed next.

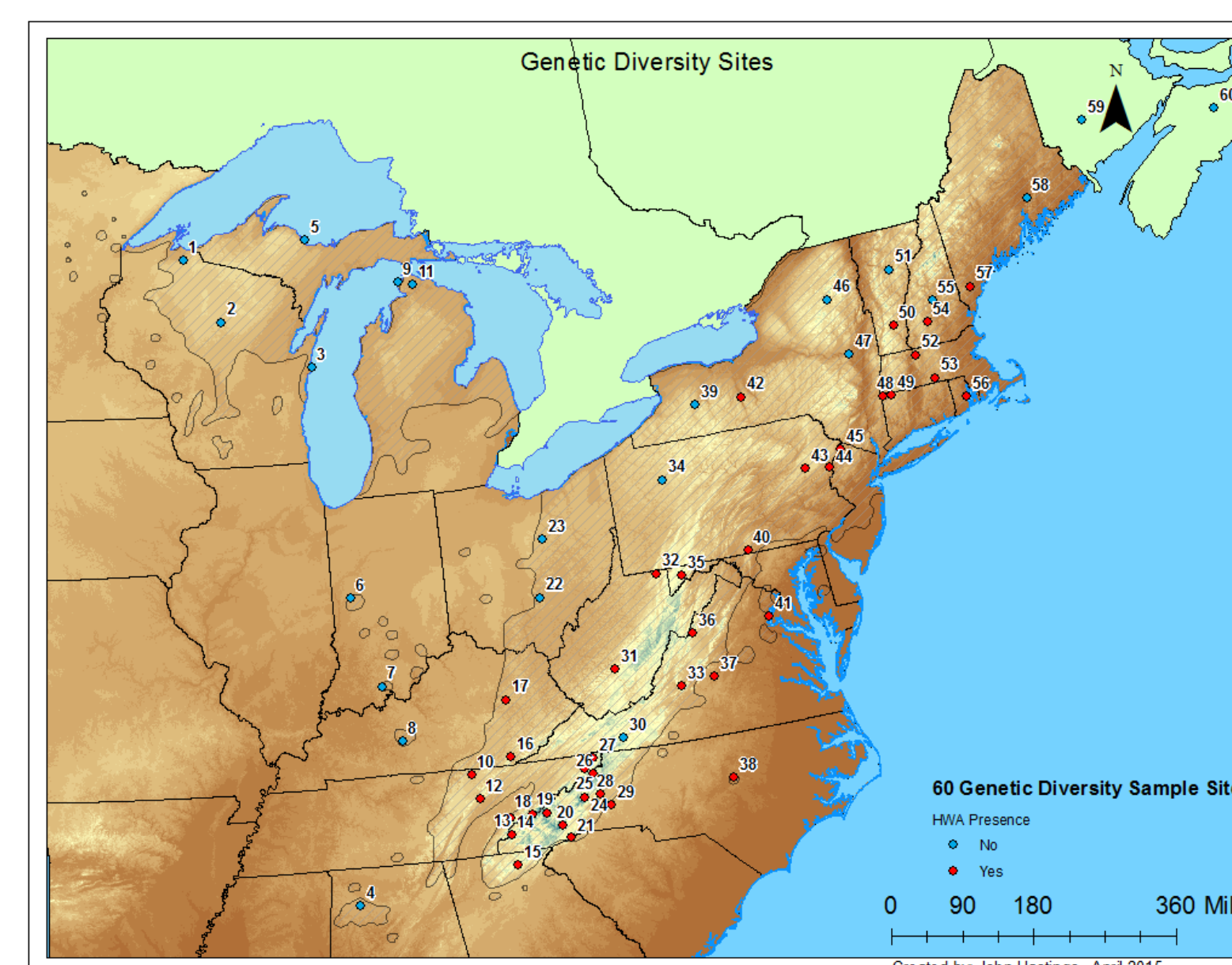
Climate Parameter:

There is some discrepancy of the exact temperature but in mid-winter (January) at a -25°C to -28°C threshold Hemlock Woolly Adelgid experiences significant dieback². Historical climate baseline average monthly temperature below -25°C compared to projected monthly average temperature below -25°C tells us which populations of Hemlock previously protected by cold weather will become susceptible to HWA.



Site:

Range wide genetic variation was sampled amplifying 13 highly polymorphic nuclear microsatellites loci in 1,180 trees across 60 populations. Forest areas were extracted from 30-meter NLCD data to ensure sampled areas were within possible Hemlock ecosystems.



Results:

Using the GFDL-ESM2G (USA) MACA Statistical Downscaling Method model and two genetic diversity results (gene pool rarity and number of unique alleles) the following locations should be prioritized for conservation and seed banking:

Genetic Diversity Parameter:

- Gene Pool Rarity: Southern populations
- Unique Alleles: Cross Village Michigan, Lowell State Park, Vermont

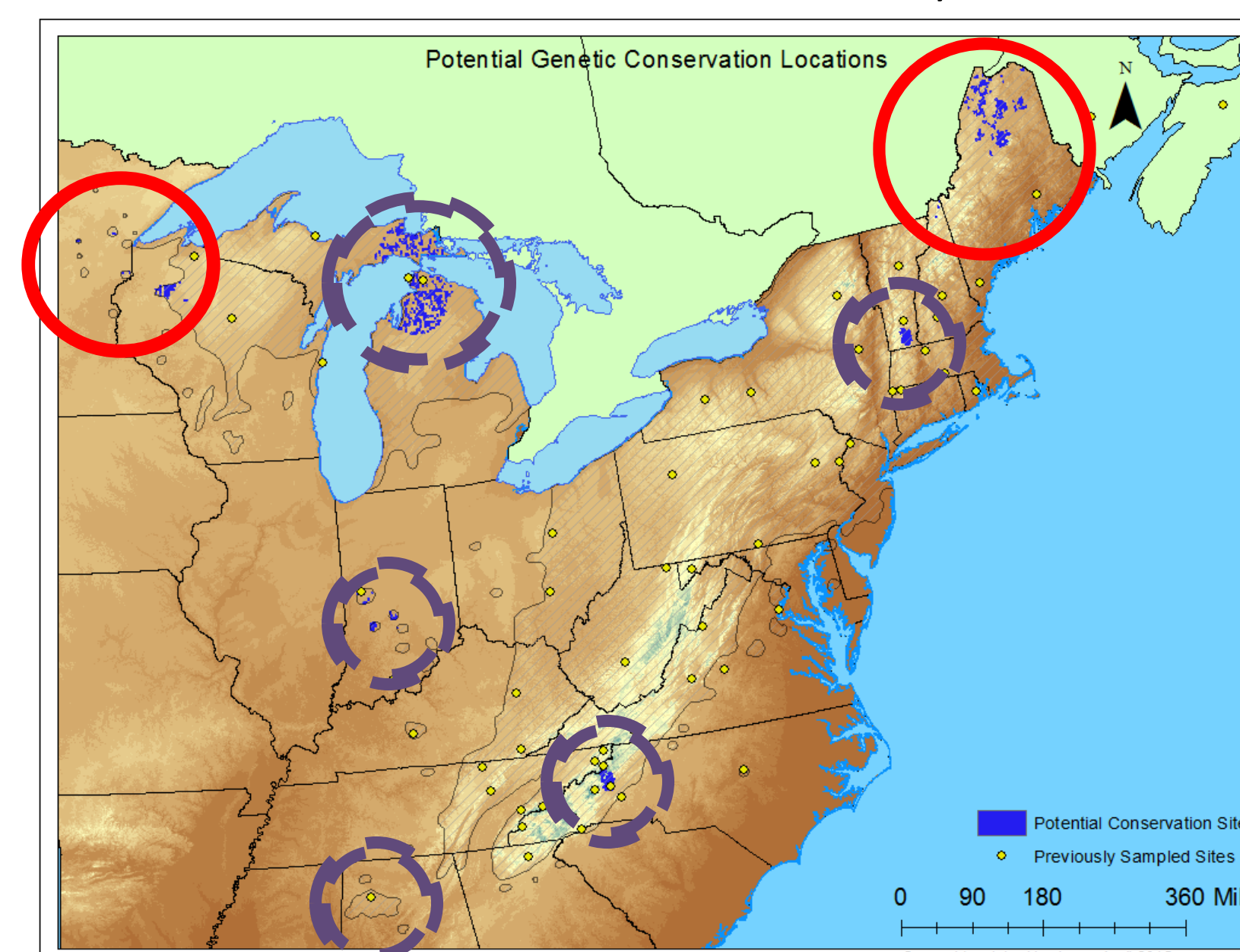
Climate Parameter:

- All areas below -25°C threshold

Other Considerations:

- Disjunct populations in Indiana and Northern Alabama

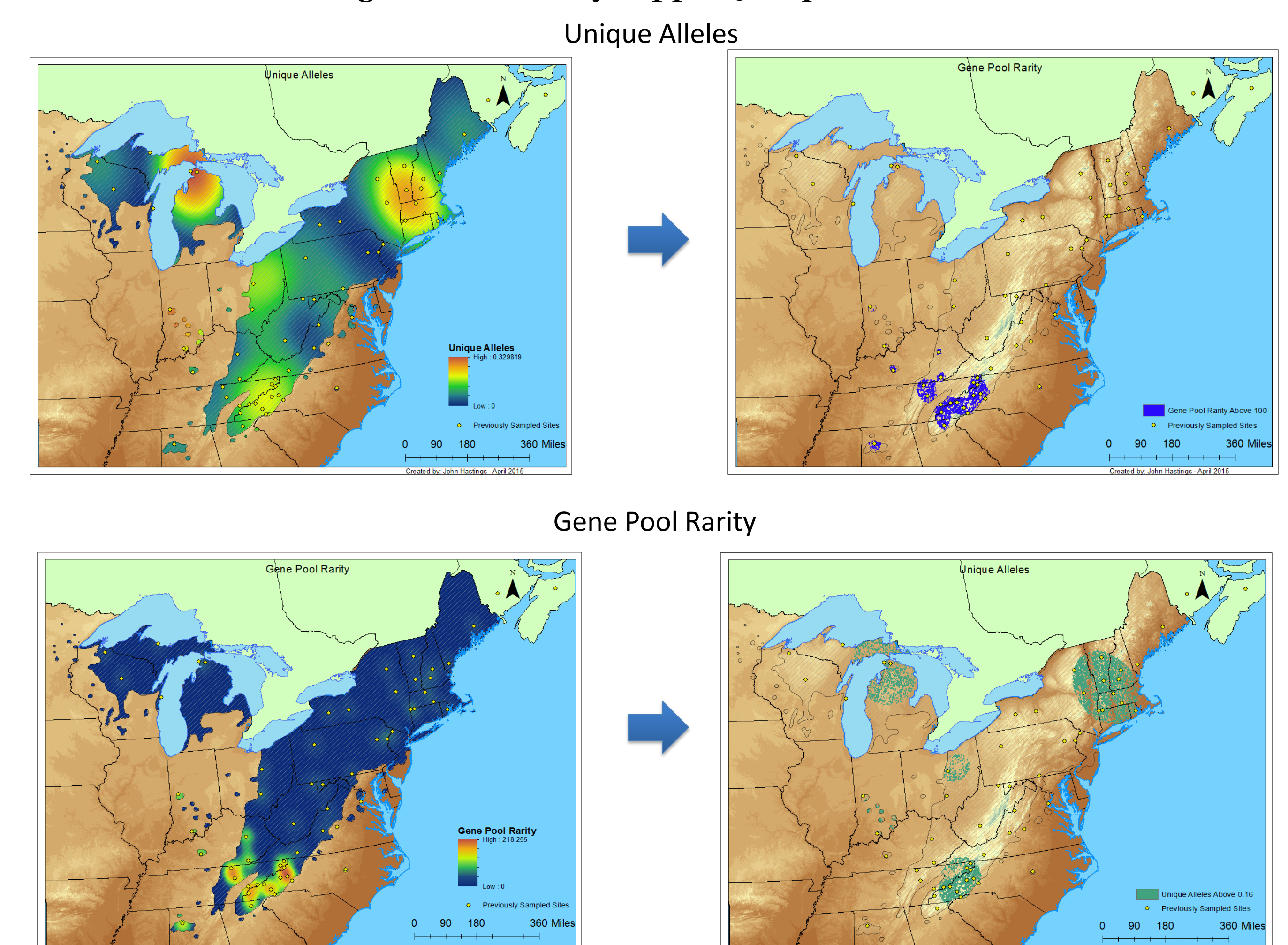
Potential Seed Banking Locations Below -25°C Threshold and within 75th Percentile of Genetic Diversity Parameters



ⓐ Genetic Diversity Parameter ○ Climate Parameter

Genetic Diversity Parameter:

The number of unique alleles and gene pool rarity of the 60 populations⁶. Were the diversity parameters selected for analysis in our study. To prioritize seed banking efforts, Kernel density was used for a range-wide magnitude calculation to select genetic diversity (upper 50th percentile).



Future Efforts:

- For the most accurate representation of minimum temperature projection, all 20 MACA models should be averaged over the future time period.
- The long-term sustainability of Hemlock could further benefit from additional genetic diversity sampling including allele richness, number of loci that are polymorphic, and number of gene pools present in the population.
- Predatory beetle release may play a significant role in the future of Hemlock conservation and should be accounted for when considering conservation locations and seed banking.

References:

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