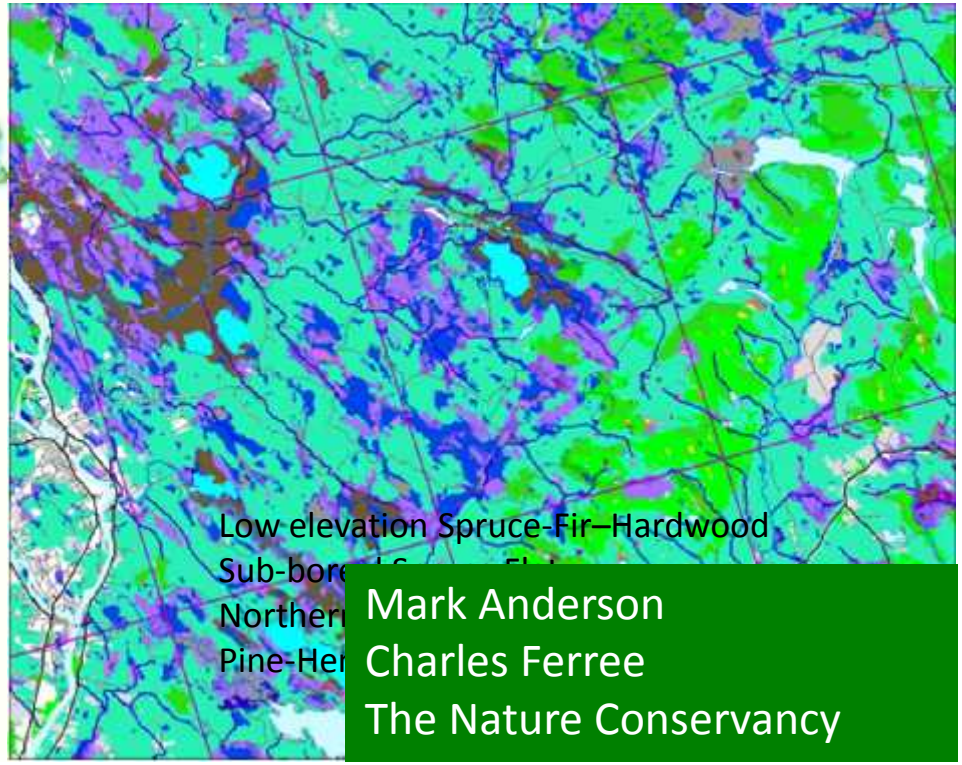
Mapping Ecological Systems in the Northeast:

The Northeast Terrestrial Habitat Map



Mark Anderson
Charles Ferree
The Nature Conservancy

Outline

Overview of Mapping project
- Approach & Classification
- Foundation data
- Basic methods

Methods
- Matrix forest types
- Wetlands and Patch communities
- Accuracy

Strengths and Weaknesses

Lessons Learned
- Habitat guides
- Revisions

Key Partners

Northeast Natural Heritage Programs
NatureServe
Northeast Association of Fish and Wildlife Agencies
USFW North Atlantic LCC
USGS Northeast Climate Science Center
Atlantic Canada Conservation Data Centre
Nature Conservancy Canada
Canadian National Vegetation Classification
Steering Committee of Northeast Scientists
Help from Todd and Alexa SE GAP

Based on a Standard Ecological System Classification (2-years to develop)

NORTHEASTERN TERRESTRIAL WILDLIFE HABITAT CLASSIFICATION

The Northeast Habitat Classification and Mapping Project

NatureServe

NEAFWA

a report to the Virginia Department of Game and Inland Fisheries
on behalf of the Northeast Association of Fish and Wildlife Agencies
and the National Fish and Wildlife Foundation

Susan C. Gawler
NatureServe
Boston, Massachusetts

November 2008

Field Key to the Ecological Systems and Habitat Systems of the Northeastern United States

NatureServe

Susan C. Gawler
Regional Vegetation Ecologist
NatureServe
Boston, Massachusetts
December 2008

Ecological Systems: Various Levels of Classificaiton

GAWLER et al. 143 types.

We mapped 121 types -
sometimes collapsed to 96

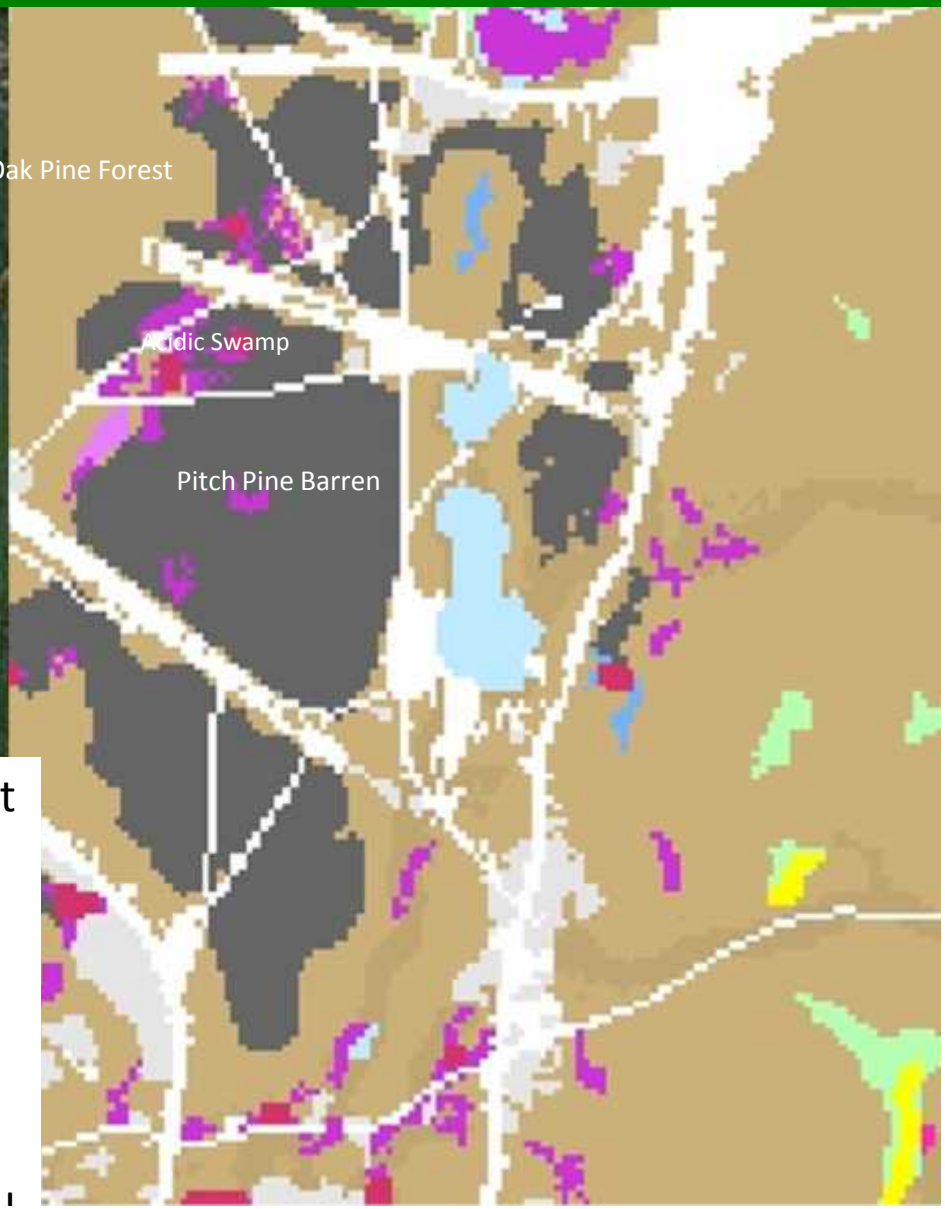
MACROGROUP	Upland Habitats	Original Ecological System Name
Alpine	Acadian-Appalachian Alpine Tundra	Acadian-Appalachian Alpine Tundra
Boreal Upland Forest	Acadian Low Elevation Spruce-Fir-Hardwood Forest	Acadian Low Elevation Spruce-Fir-Hardwood Forest
	Acadian Sub-boreal Spruce Flat	Acadian Sub-boreal Spruce Flat
	Acadian-Appalachian Montane Spruce-Fir-Hardwood Forest	Acadian-Appalachian Montane Spr-Fir-Hwd Forest
	Central and Southern Appalachian Spruce-Fir Forest	Central and Southern Appalachian Spruce-Fir Forest
Central Oak-Pine	Allegheny-Cumberland Dry Oak Forest and Woodland	Allegheny-Cumberland Dry Oak Forest and Woodland
	Central and Southern Appalachian Montane Oak Forest	Central and Southern Appalachian Montane Oak Forest
	Central Appalachian Dry Oak-Pine Forest	Central Appalachian Dry Oak-Pine Forest
	Central Appalachian Pine-Oak Rocky Woodland	Central Appalachian Pine-Oak Rocky Woodland
	Glacial Marine & Lake Mesic Clayplain Forest	Glacial Marine & Lake Mesic Clayplain Forest
	North Atlantic Coastal Plain Hardwood Forest	North Atlantic Coastal Plain Hardwood Forest
	North Atlantic Coastal Plain Maritime Forest	North Atlantic Coastal Plain Maritime Forest
	North Atlantic Coastal Plain Pitch Pine Barrens	North Atlantic Coastal Plain Pitch Pine Barrens
	Northeastern Interior Dry-Mesic Oak Forest	Northeastern Interior Dry-Mesic Oak Forest
	Northeastern Interior Pine Barrens	Northeastern Interior Pine Barrens
	Piedmont Hardpan Woodland and Forest	Piedmont Hardpan Woodland and Forest
	Southern Appalachian Montane Pine Forest and Woodland	Southern Appalachian Montane Pine Forest and Woodland
	Southern Appalachian Oak Forest	Southern Appalachian Oak Forest
	Southern Piedmont Dry Oak-Pine Forest	Southern Piedmont Dry Oak-Pine Forest
	Southern Ridge and Valley / Cumberland Dry Calcareous Forest	Southern Ridge and Valley / Cumberland Dry Calcareous Forest
Central Oak-Pine/Longleaf Pine	Southern Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest / Upland Longleaf F	Southern Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest / Upland Longleaf F
Cliff and Talus	Acidic Cliff and Talus	Central Interior Acidic Cliff and Talus
		Cumberland Acidic Cliff and Rockhouse
		Laurentian-Acadian Acidic Cliff and Talus
		North-Central Appalachian Acidic Cliff and Talus
		Southern Appalachian Montane Cliff and Talus
	Calcareous Cliff and Talus	Central Interior Calcareous Cliff and Talus
		Laurentian-Acadian Calcareous Cliff and Talus
		Southern Interior Calcareous Cliff
	Circumneutral Cliff and Talus	North-Central Appalachian Circumneutral Cliff and Talus

Ecological System Definition: NatureServe

A mosaic of plant community types/associations that

- co-occur within landscapes with similar ecological processes (nutrient cycling, disturbance, flooding, fire)
- similar substrates, and/or similar environmental gradients (elevation, moisture regime, topographic setting/local climate, …),
- in a pattern that repeats itself across landscapes.

A classification not a land cover map



Hemlock-N. Hardwood Forest
Pine Barren
Acidic swamp
Dry Oak-Pine Forest
Rocky woodland
Wet flatwoods
Rich swamp
Circumneutral Cliff and talusu

A Terrestrial Habitat Map for the Northeastern United States

Charles Ferree M.S., Landscape Ecologist, The Nature Conservancy, Eastern North America Division, cferree@tnc.org, 99 Bedford Street, Boston, MA 02111

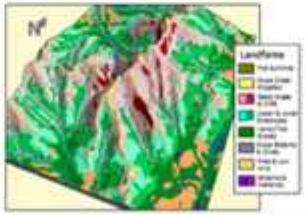
Region- Wide Grids of Ecological Information

Confirming Points

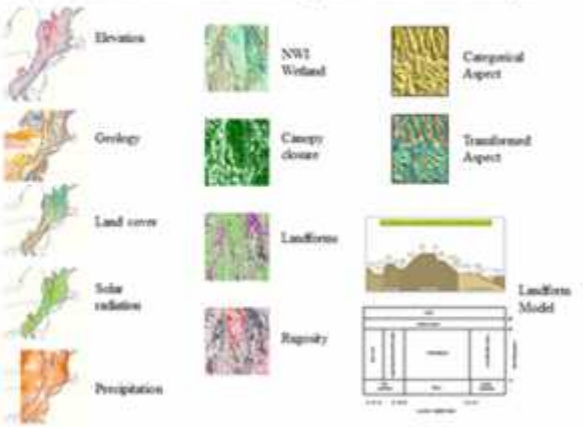
Models for each System

Region Wide Grids of Ecological Information

We began by assembling regional spatial datasets on bedrock and surficial geology, elevation, slope and aspect, waterbodies and streams, wetlands, land position and landforms, topographic rugosity, climate, solar influx, and landcover and canopy cover. About 60 variables were derived for use in the analysis. The landform model was developed from a 30 meter DEM using land position, slope, and flow accumulation (below).



Examples of framework data for the Lower New England / Northern Piedmont Ecoregion



Confirming Points

Natural Heritage Community Element Occurrences and Plot Data: The State Natural Heritage Programs (NHPs) track the locations of rare and unusual communities and the best examples of common communities. State occurrences were cross-walked and tagged to an ecological system type by state ecologists, in conjunction with NatureServe and TNC ecologists. In addition, many NHPs have extensive sets of plots taken during the course of ecological inventories, and these were put to a similar use. Accuracy of the habitat/system tags was evaluated by attributing confirming points and polygons with basic environmental information and viewing them in a GIS. Over 50,000 occurrences and plots were provided by the Heritage programs for use in this project.

Vegetation Maps: Detailed vegetation and natural community maps were available in many parts of the region. These were converted into points and tagged to the appropriate ecological system types by Natural Heritage and NatureServe ecologists in conjunction with TNC scientists.

Forest Inventory and Analysis Points: We received over 21,000 actual-location FIA plots from the USDA-Forest Service for the states in our region. These forest stands are sampled by Forest Service staff in perennial inventories. The points were filtered to removed highly altered stands, then classified into homogeneous vegetation units based on their tree composition and ecological settings using a cluster analysis. The homogeneous units were then cross-walked to the regional ecosystem units by TNC scientists in consultation with NatureServe Ecologists.

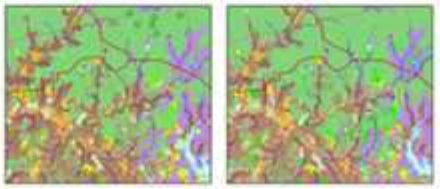
Natural Heritage Occurrences | Community Maps | Forest Inventory & Analysis Plots

Models for Matrix-forming and Patch Communities

Matrix forming Forest Systems: We proceeded through the project area ecoregion by ecoregion. Matrix forest types for each ecoregion were modeled using RandomForest-generated classifications, with 100 acre hexagons as the basic analytical units. First, hexagons constructed around each confirmed location of a specific forest habitat type were attributed with the ecological information described above (solar radiation, land cover, topography, etc). The RandomForest algorithm uses this information to construct models for each of the matrix forest types. Hundreds of thousands of hexagons covering the ecoregion in a tessellated pattern were attributed in the same way, and every hexagon was classified to the most probable ecological system type by running it through the RandomForest-built decision trees.

Patch Communities: Patch communities and wetlands for each ecoregion were modeled individually, based on locations of known occurrences of each habitat/system type that occur in the region, and on NatureServe-published descriptions of and ecological criteria for those types. Information on habitat ranges, elevation limits, edaphic/geologic factors, landcover and canopy cover, topographic factors like exposure, solar influx, and surface roughness, and other landscape characteristics, all played important parts in patch model construction.

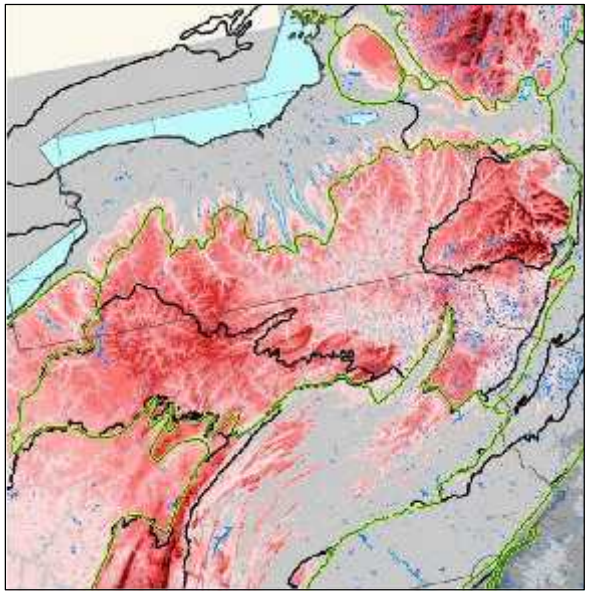
Image showing Hexagon Units | Data transferred to Landscape Units



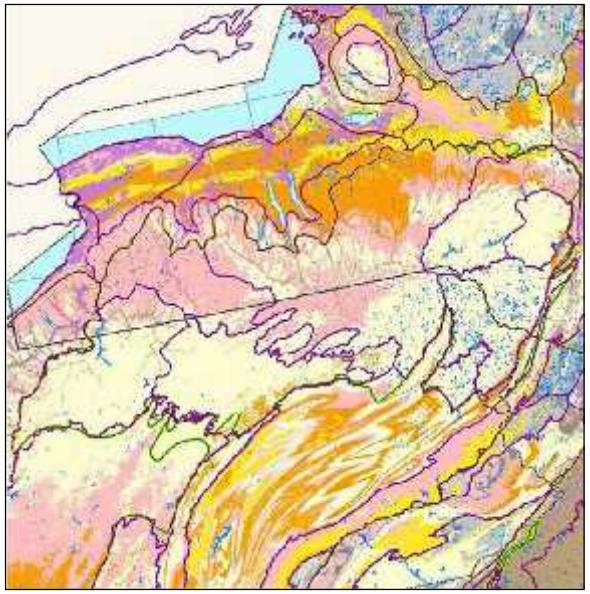
A final step in the mapping process was to transfer the hexagon-based habitat information onto natural topographic units. Thematic segmentation software was used to break large "landscape units" based on simplified landforms into smaller discrete shapes. Next, we identified the 100-acre hexagon that each of the discrete landscape units was within (or mostly within). We then wrote a set of decision rules to assign each landscape unit to a given ecological system type, based on the RandomForest-assigned system for its parent hexagon. For example, low hills or cool slopes associated with a hexagon classified to the more mesic oak forest systems would get that system assignment, while a warm upper slope or ridgetop associated with that same hexagon would "flip" to the dry oak-pine system. The RandomForest-generated probabilities for the matrix forest systems within each hexagon helped guide this information transfer.

Foundation Datasets

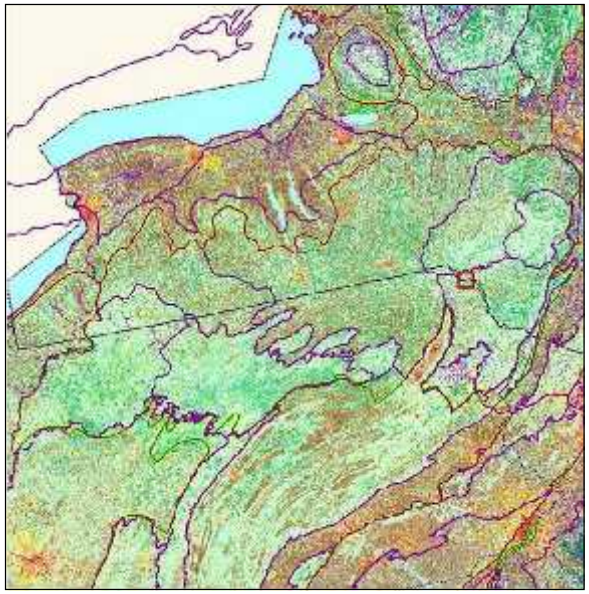
Elevation

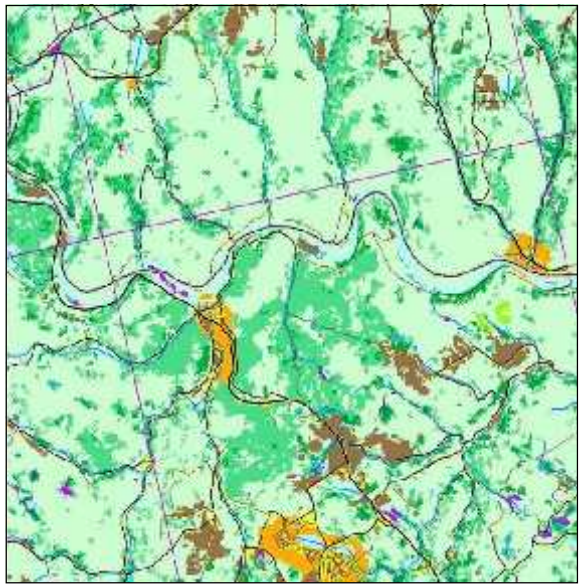


Geology



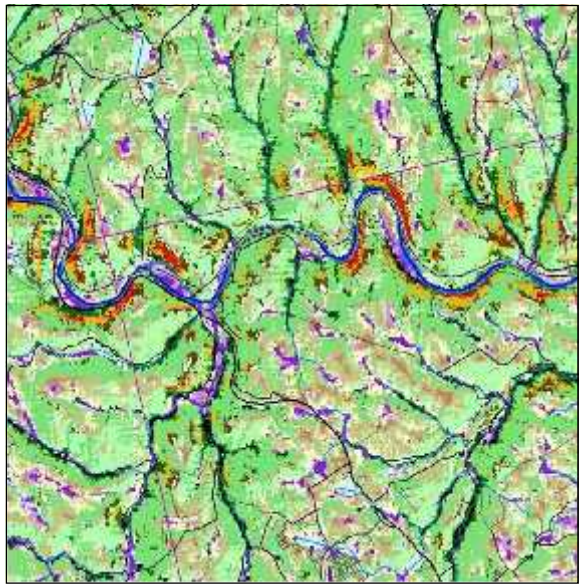
Landcover





NWI wetlands over NLCD

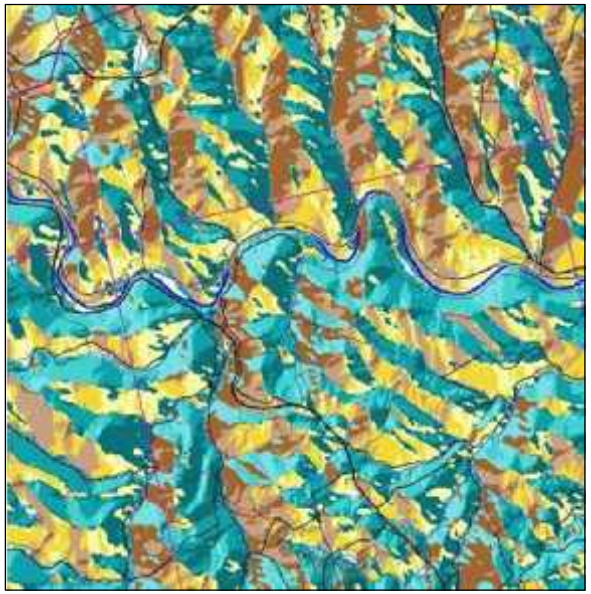
Canopy closure



Landforms

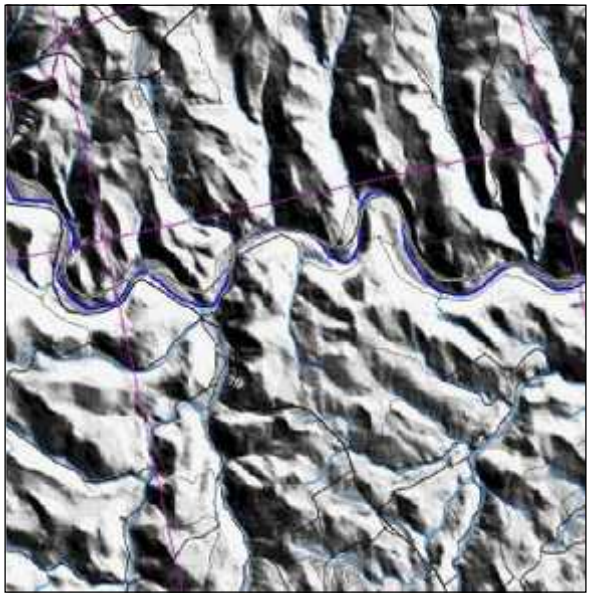
Foundation Datasets

Categorical Aspect

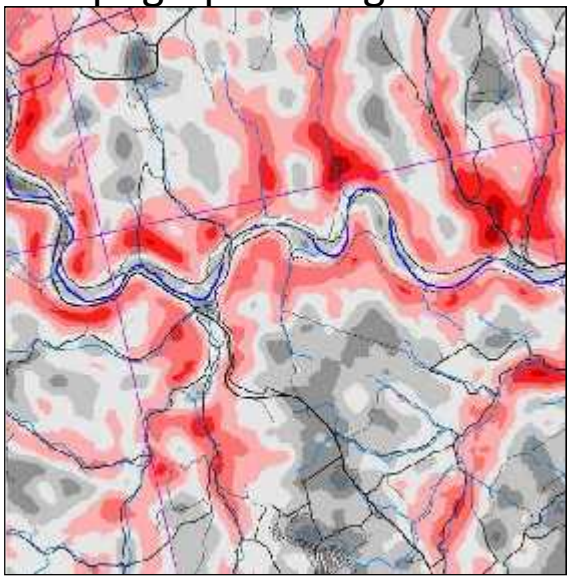


Quantitative Aspect

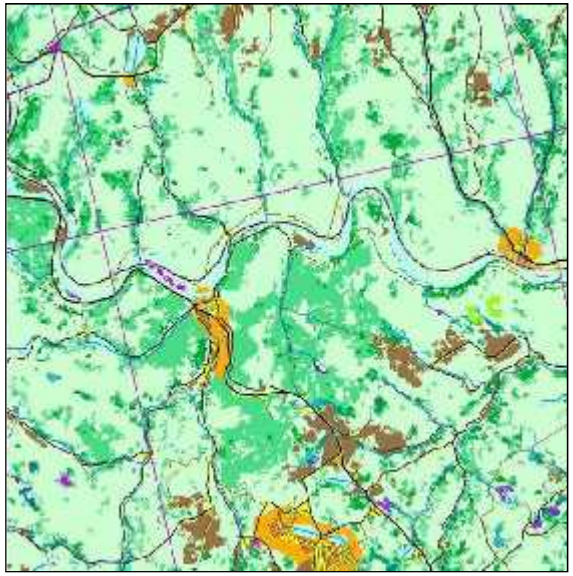
Slope-aspect Index



Topographic roughness

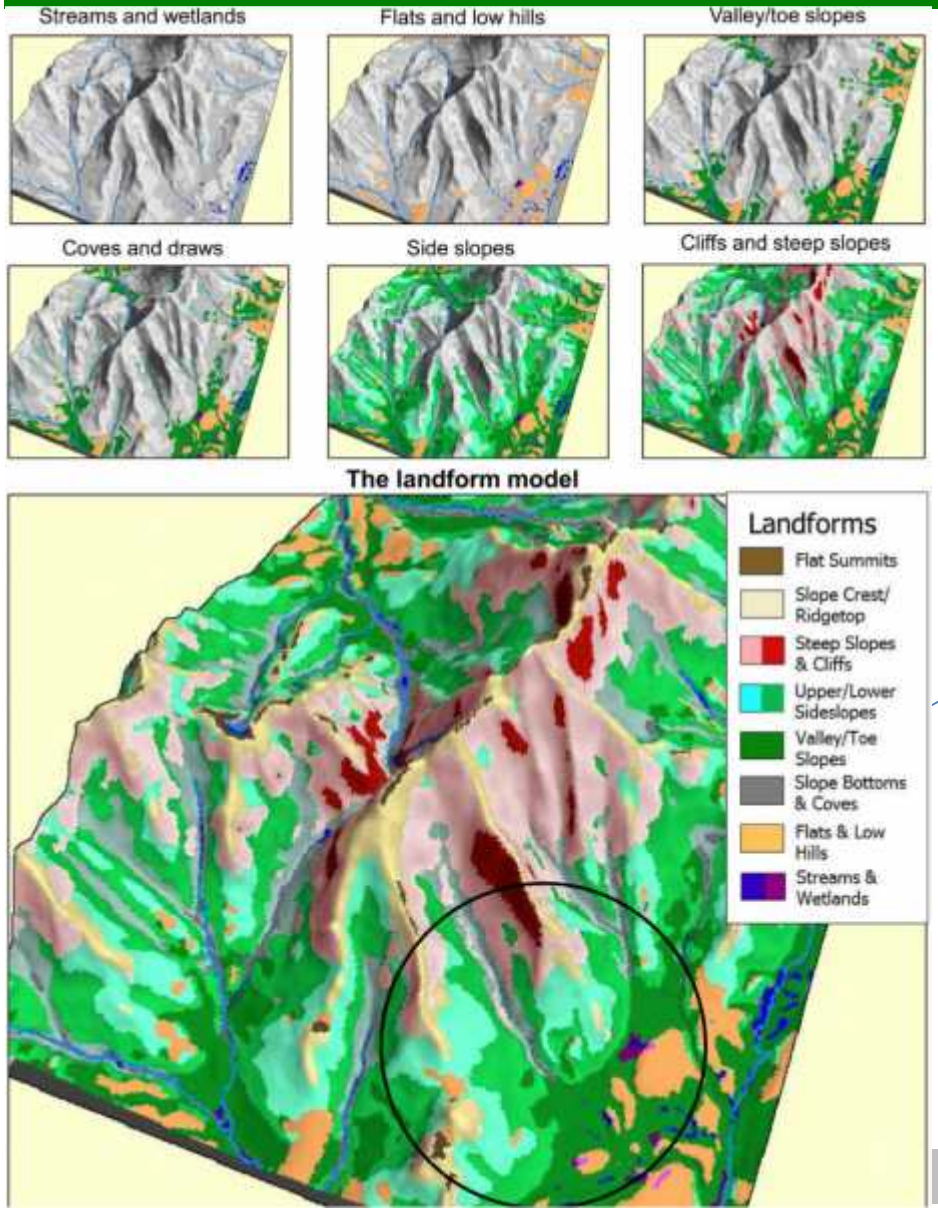


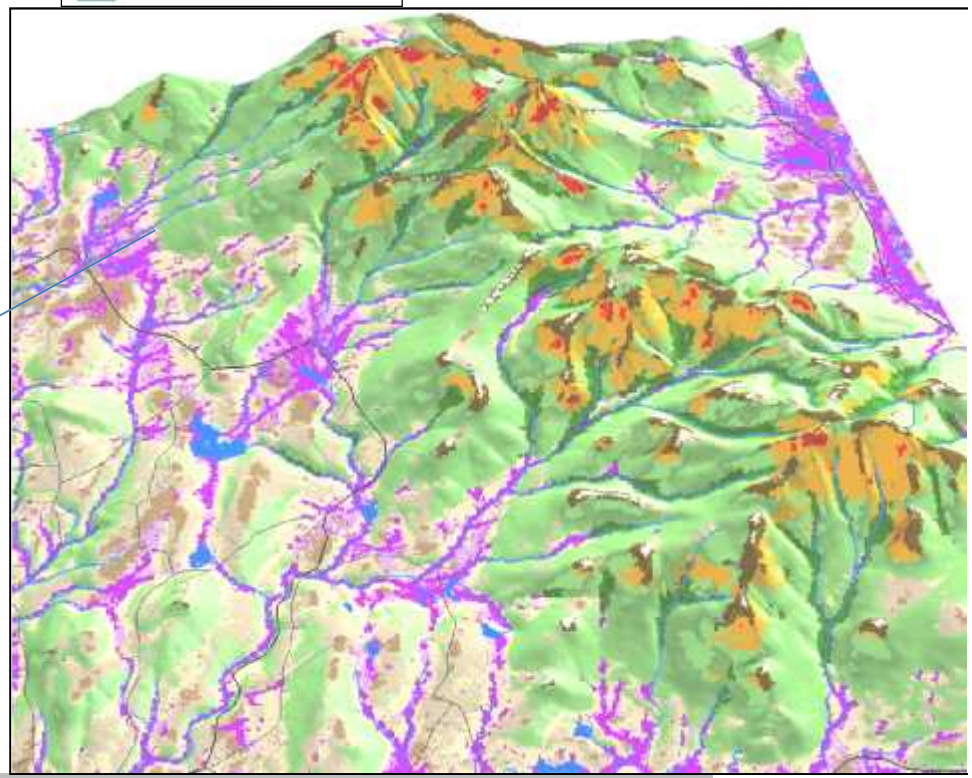
NWI wetlands over NLCD



Canopy closure

Foundation Data: Landforms

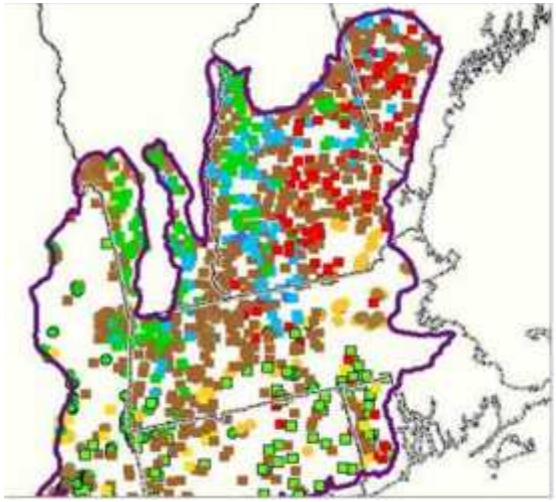




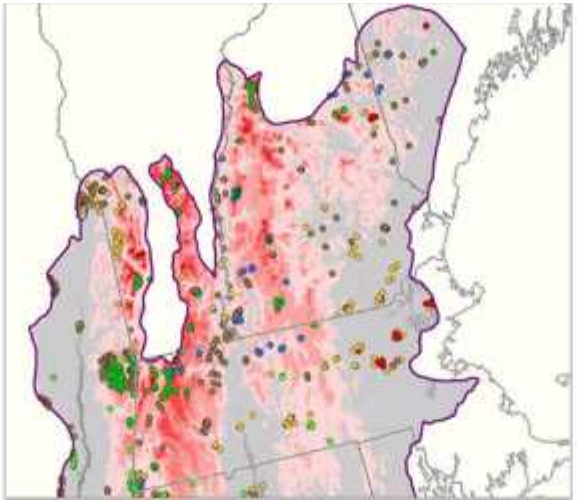
Anderson, Ferree, Olivero , Clark, Prince, Merril, Min, Biasi

Confirming Samples: US

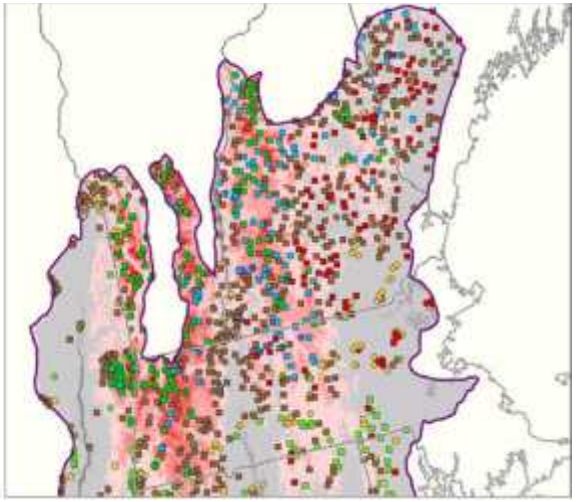
NHP



Veg Maps



FIA



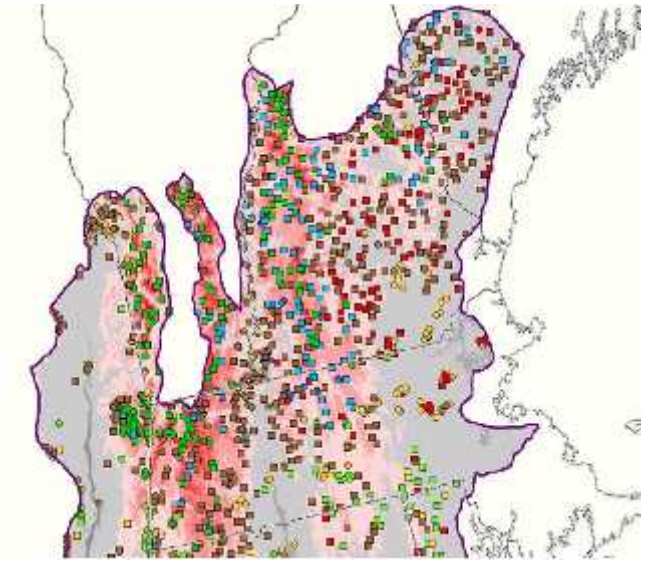
Natural Heritage Community Element Occurrences and Plot Data: 50,000+

Vegetation Maps: 100's

Forest Inventory and Analysis Points: 21,000

Time Consuming Step: tagging points

Confirming Points



All the point and polygon datasets must be attributed to the correct ecological system – CDC is critical

NORTHEASTERN TERRESTRIAL WILDLIFE HABITAT CLASSIFICATION

The Northeast Habitat Classification and Mapping Project

NatureServe

group	Sample	ELEV_VL	ELEV_L	ELEV_M	ELEV_M-H	ELEV_H	ELEV_VH	CON_L	CON_M	CON_H	LF_50s Water	LF-40s Cove	LF31 Wetflat	LF30 Dryflat	LF24 SS-C	LF23 SS-W	LF_21-32 Gentle	LF_11-13 Upper	LF_3-4 Steep	L_LPOS	ML_LPOS	MH_LPOS	H_LPOS	LPOS_FM4	reds	bafi	redm	yebi	suma	ambe	pabi	stma	wash
A	1891	-	-	-	-	5	-	5	-	-	-	-	-	-	-	-	-	5	-	-	-	-	5	3	-	-	-	5	-	5	4	-	-
A	1099	-	-	-	-	5	-	5	-	-	-	-	-	-	5	-	-	-	-	-	-	5	-	5	-	-	-	2	5	1	-	3	-
A	1848	-	-	-	-	5	-	5	-	-	-	-	-	-	-	-	-	-	5	-	-	5	-	5	3	-	-	5	4	5	-	-	-
A	623	-	-	-	-	5	-	5	-	-	-	-	-	-	5	-	-	-	-	-	5	-	-	5	3	-	-	5	5	3	-	1	-
A	841	-	-	-	-	5	-	5	-	-	-	-	-	-	5	-	-	-	-	-	5	-	-	5	1	-	-	4	5	5	-	3	-
A	845	-	-	-	-	5	-	5	-	-	-	-	-	-	5	-	-	-	-	-	5	-	-	5	3	-	-	4	5	5	-	-	-
A	993	-	-	-	-	5	-	5	-	-	-	-	-	-	5	-	-	-	-	-	5	-	-	5	2	-	-	3	5	2	5	-	-
A	1877	-	-	-	-	5	-	5	-	-	-	-	-	-	5	-	-	-	-	5	-	-	-	5	1	-	-	4	5	5	-	-	-
A	1886	-	-	-	-	5	-	5	-	-	-	-	-	-	5	-	-	-	-	5	-	-	-	5	1	-	-	3	5	4	-	-	-
A	1894	-	-	-	-	5	-	5	-	-	-	-	-	-	5	-	-	-	-	-	5	-	-	5	2	-	-	4	5	5	-	-	-
A	1902	-	-	-	-	5	-	5	-	-	-	-	-	-	5	-	-	-	-	-	5	-	-	5	3	1	-	4	4	5	-	-	-

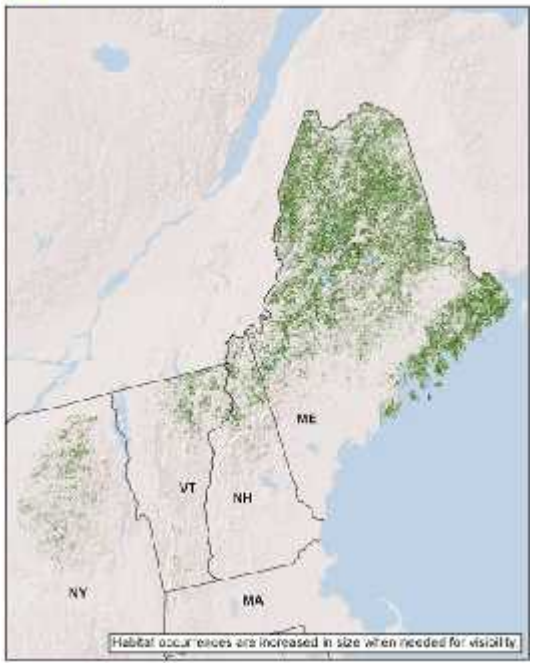
Hired NS staff,
Overlaid points on the foundation data, Used quantitative tables, systematic decisions

MODELS: Samples + Environmental Data

Final maps are based on models that relate system distribution to ecological variables.

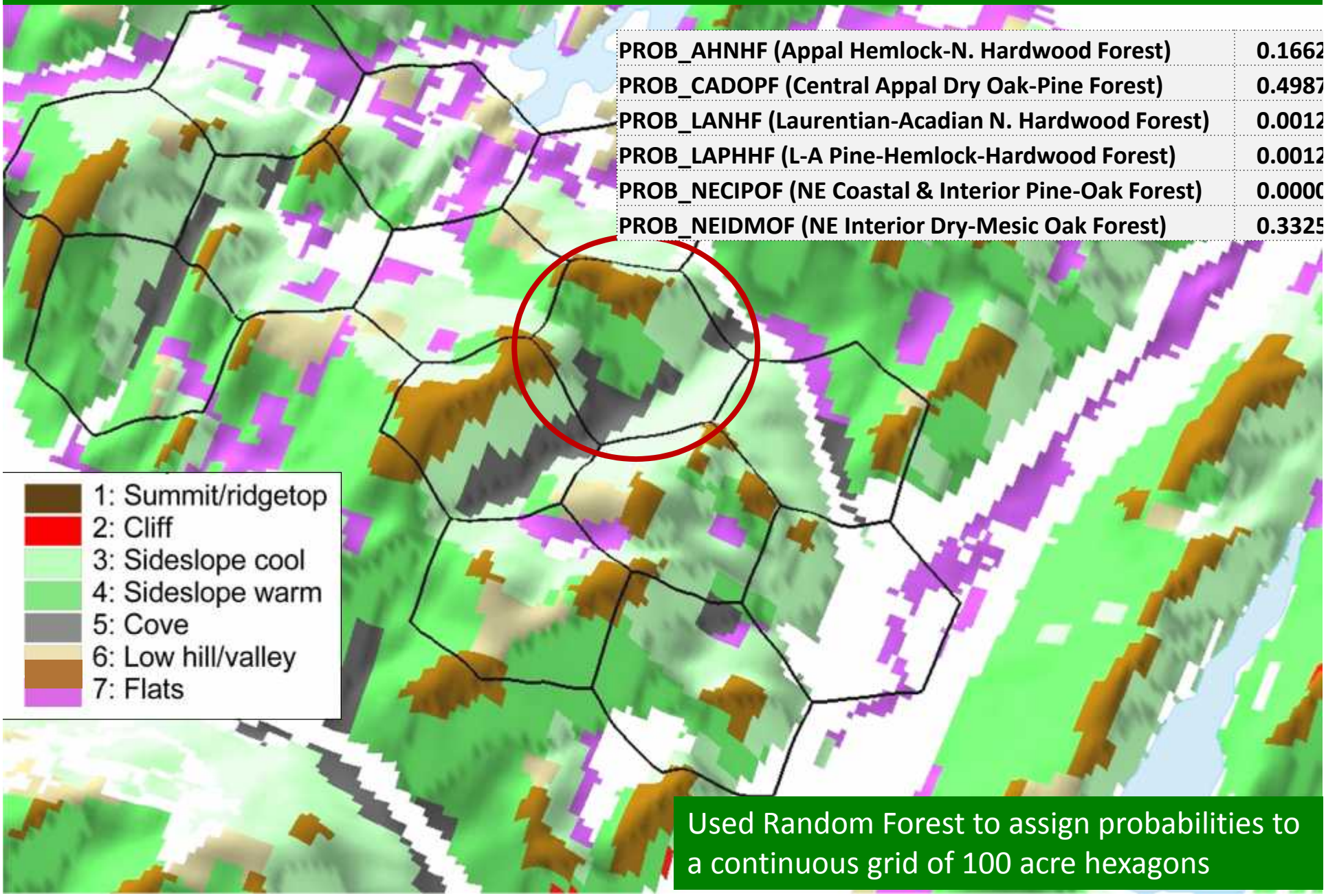
Variable	AHNHF	CADOPF	LANHF	LAPHHF	NECIPOF	NEIDMOF	MeanDecreaseAcc
ELEV_MEAN	0.29	1.11	2.57	1.37	2.76	0.94	0.66
LPOS_MEAN	0.75	1.49	-0.27	0.54	1.27	0.67	0.63
P_CONIF	0.05	1.16	1.46	2.66	3.2	1.31	0.61
SUBSEC2NAM	0.43	1.21	1.47	2.27	2.57	1.2	0.6
D2H2O_MEAN	0.71	0.93	1.13	0.36	0.91	0.85	0.57
LONG	0.16	1.03	1.64	2.05	3.13	1.1	0.55
TEMP_MAXWM	0.21	1.03	2.03	1.5	2.49	0.86	0.55
PRECIP_WQ	0.25	1.04	1.8	0.19	2.56	0.71	0.55
P_SUMMIT	0.27	1.27	-0.11	0.34	1.37	0.68	0.55
P_DECID	0.11	1.03	0.88	2.66	2.93	1.11	0.55
LAT	0.47	0.87	1.8	1.51	1.57	1.16	0.54
TEMP_MINCM	0.33	1.11	1.86	2	1.37	1.11	0.53
TEMP_MDQ	0.18	0.98	1.91	2.02	1.32	0.96	0.52
P_WETFLAT	0.15	0.89	1.28	0.91	1.43	0.5	0.48
TR_INDEX	0.28	0.85	0.73	0.73	1.72	0.55	0.47
TEMP_ANNRG	0.37	0.87	1.35	1.16	0.98	0.75	0.46
TEMP_MDR	0.26	1.02	1.25	0.86	0.72	0.4	0.46
LPOS_MIN	0.1	0.91	0.58	0.51	1.56	0.68	0.46
PRECIP_MA	0.17	0.77	1.09	0.59	1.44	0.66	0.45
SOLRAD_STD	0.18	1.05	0.63	0.44	1.34	0.13	0.45
ELEV_RANGE	0.17	0.4	0.86	0.55	1.96	0.61	0.43
P_HILLS	0.19	0.56	0.85	0.47	0.6	0.61	0.43
LPOS_STDEV	0.05	0.8	0.95	0.96	1.52	0.6	0.43
PRECIP_CV	0.14	0.94	1.12	0.63	0.94	0.58	0.42

Acadian Low Elevation Spruce-Fir-Hardwood



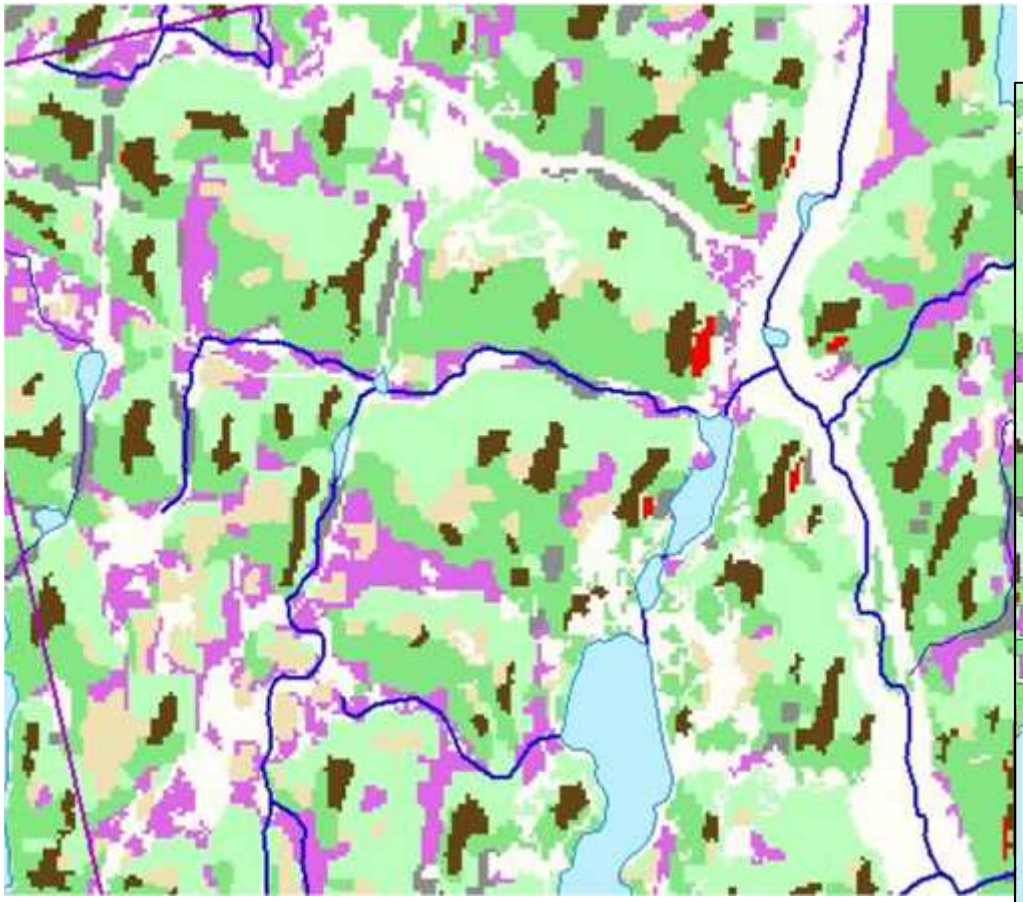
Random forest output for dominant forest types

MODELS: Matrix Types.

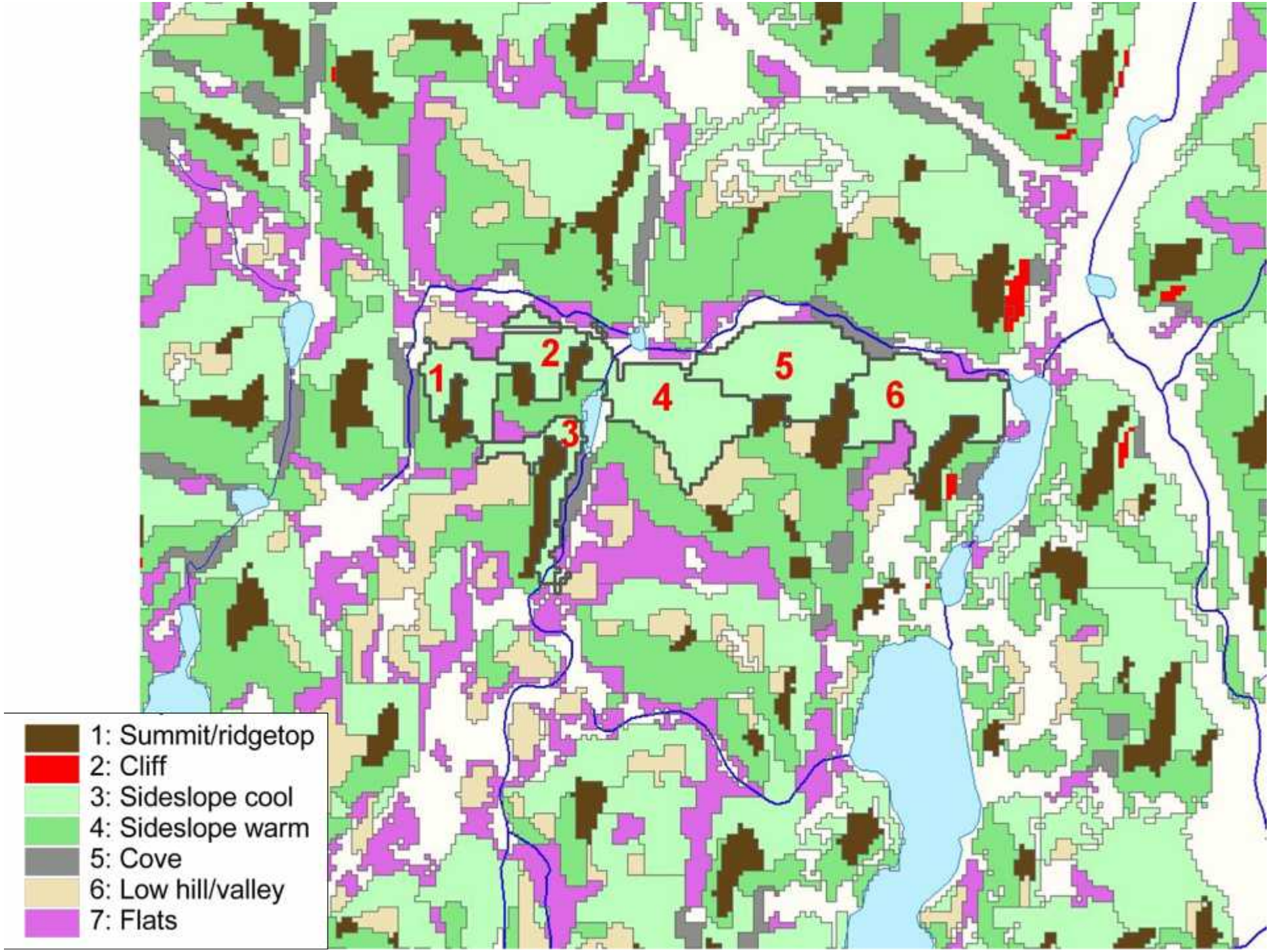


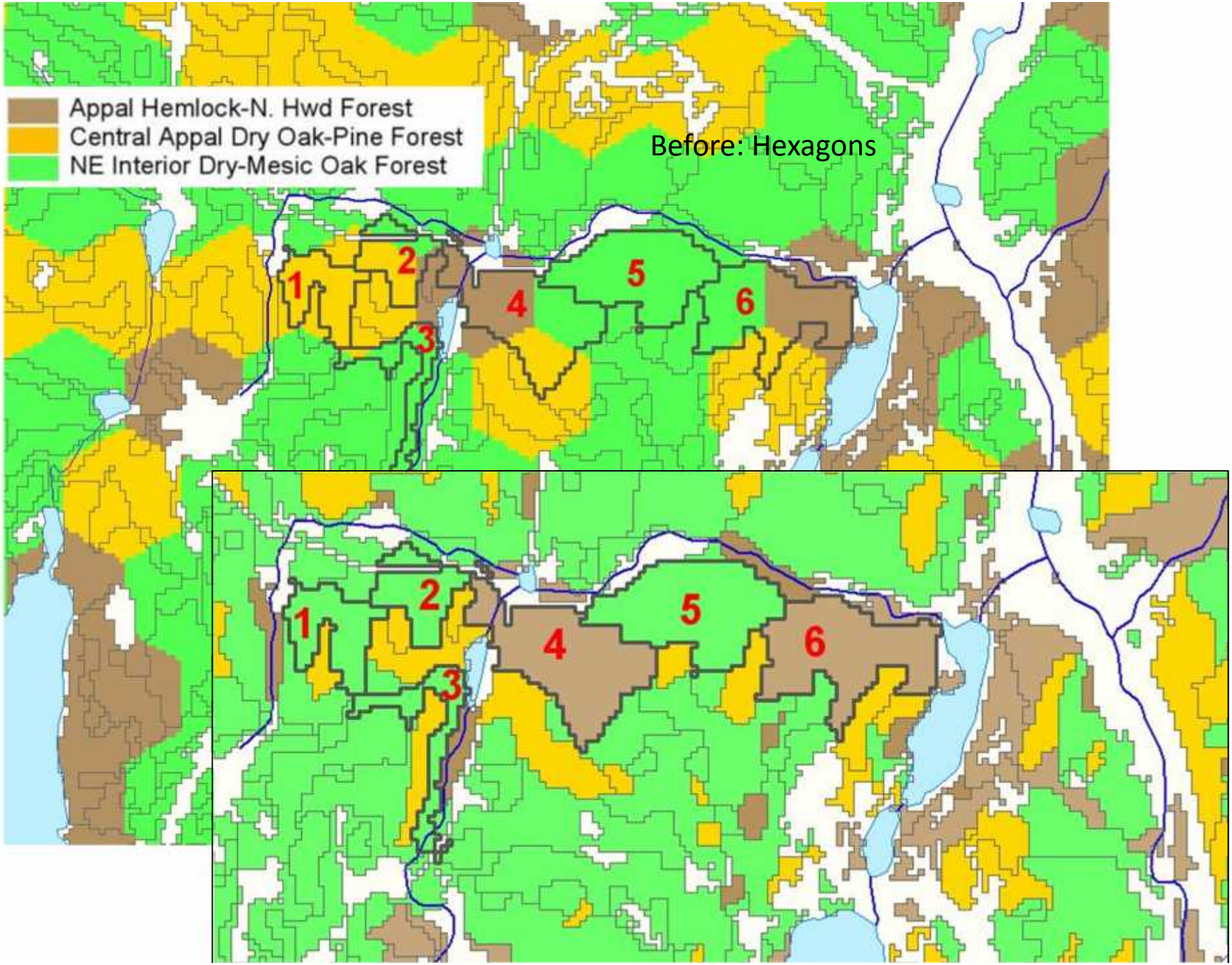
Used Random Forest to assign probabilities to a continuous grid of 100 acre hexagons

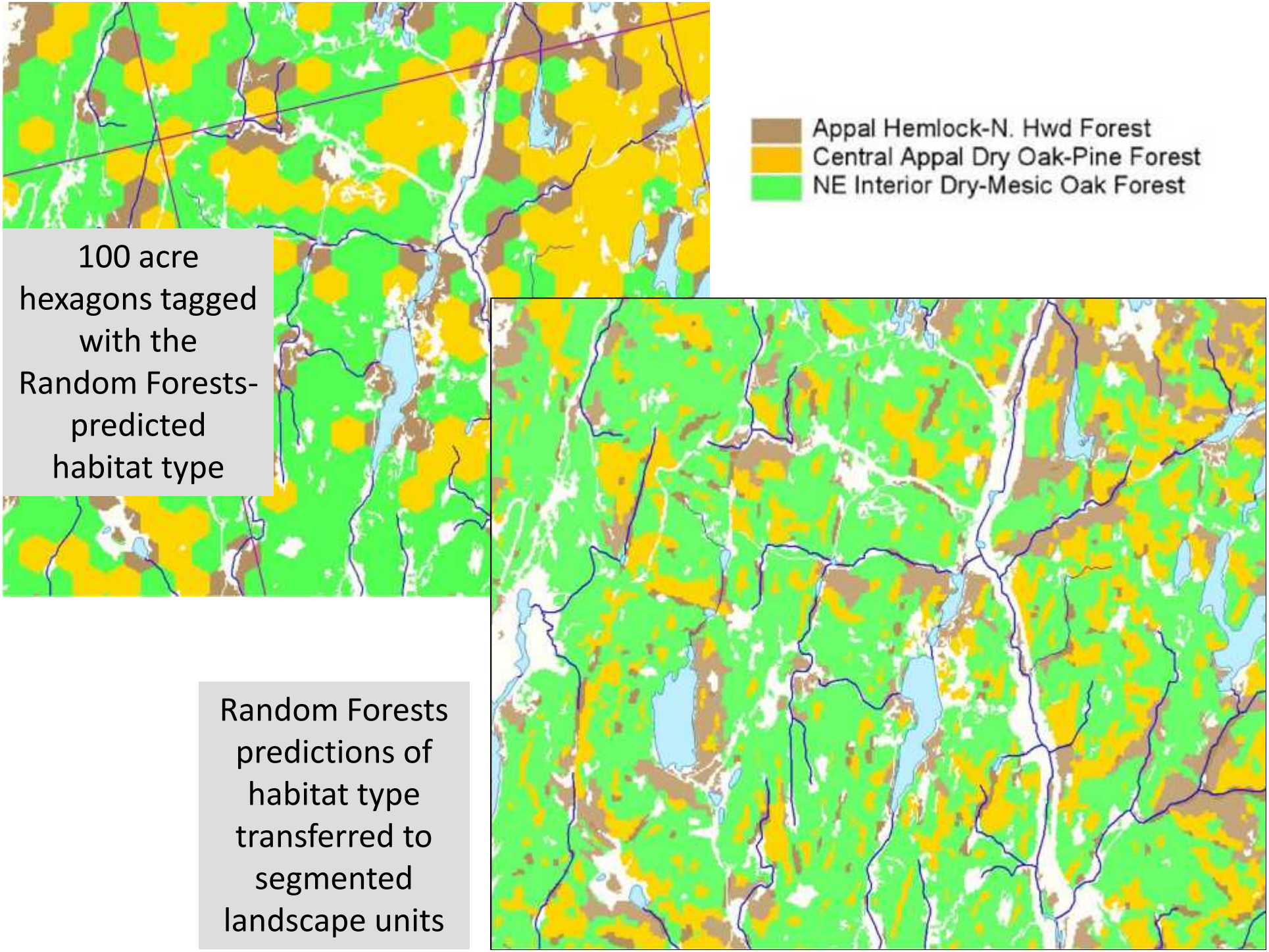
Simplified Landforms are segmented into subunits using image objects (Below)

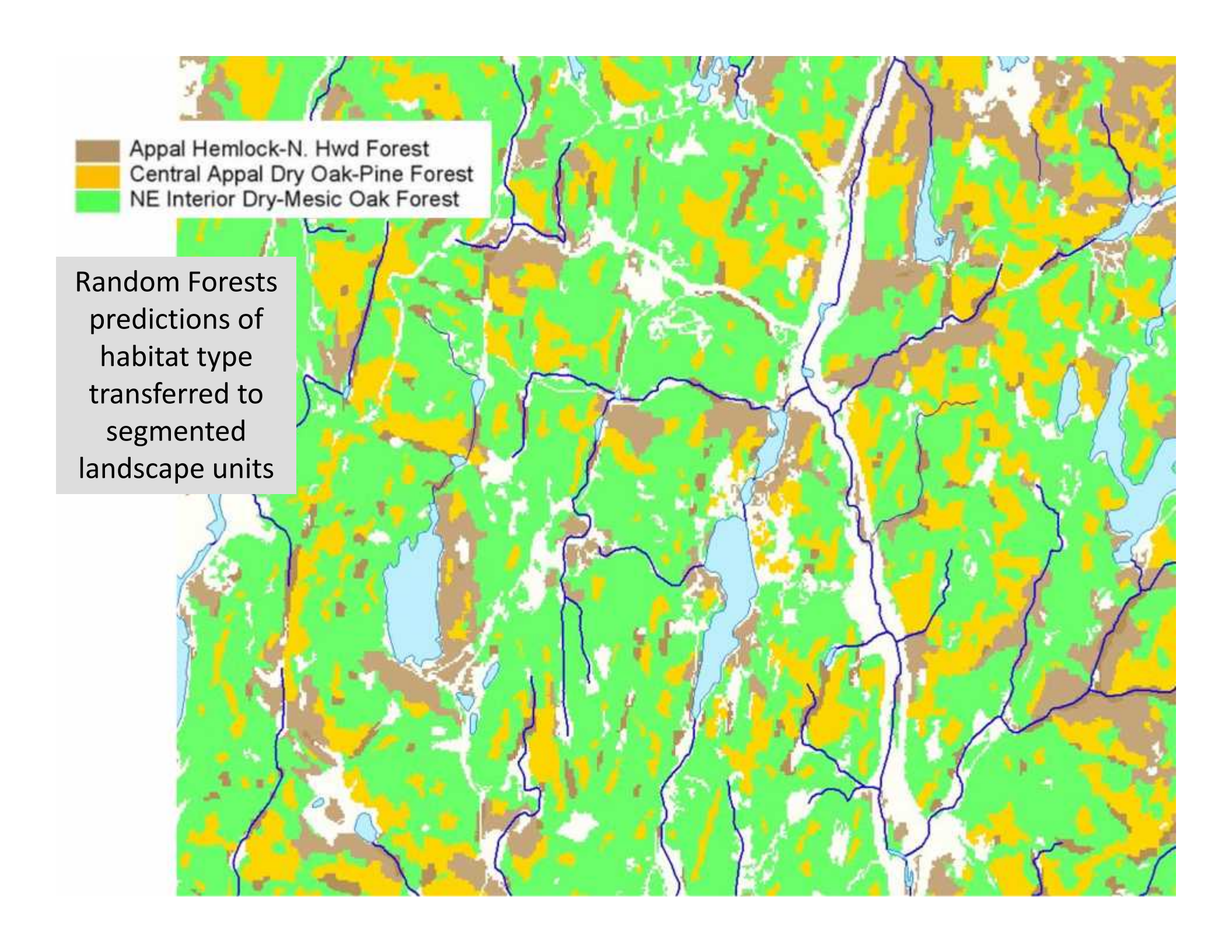


Thanks to Alexa and Todd, who did this work


1
2
3
4
5
6
1: Summit/ridgetop
2: Cliff
3: Sideslope cool
4: Sideslope warm
5: Cove
6: Low hill/valley
7: Flats


Appal Hemlock-N. Hwd Forest
Central Appal Dry Oak-Pine Forest
NE Interior Dry-Mesic Oak Forest
Before: Hexagons
1
2
3
4
5
6
1
2
3
4
5
6

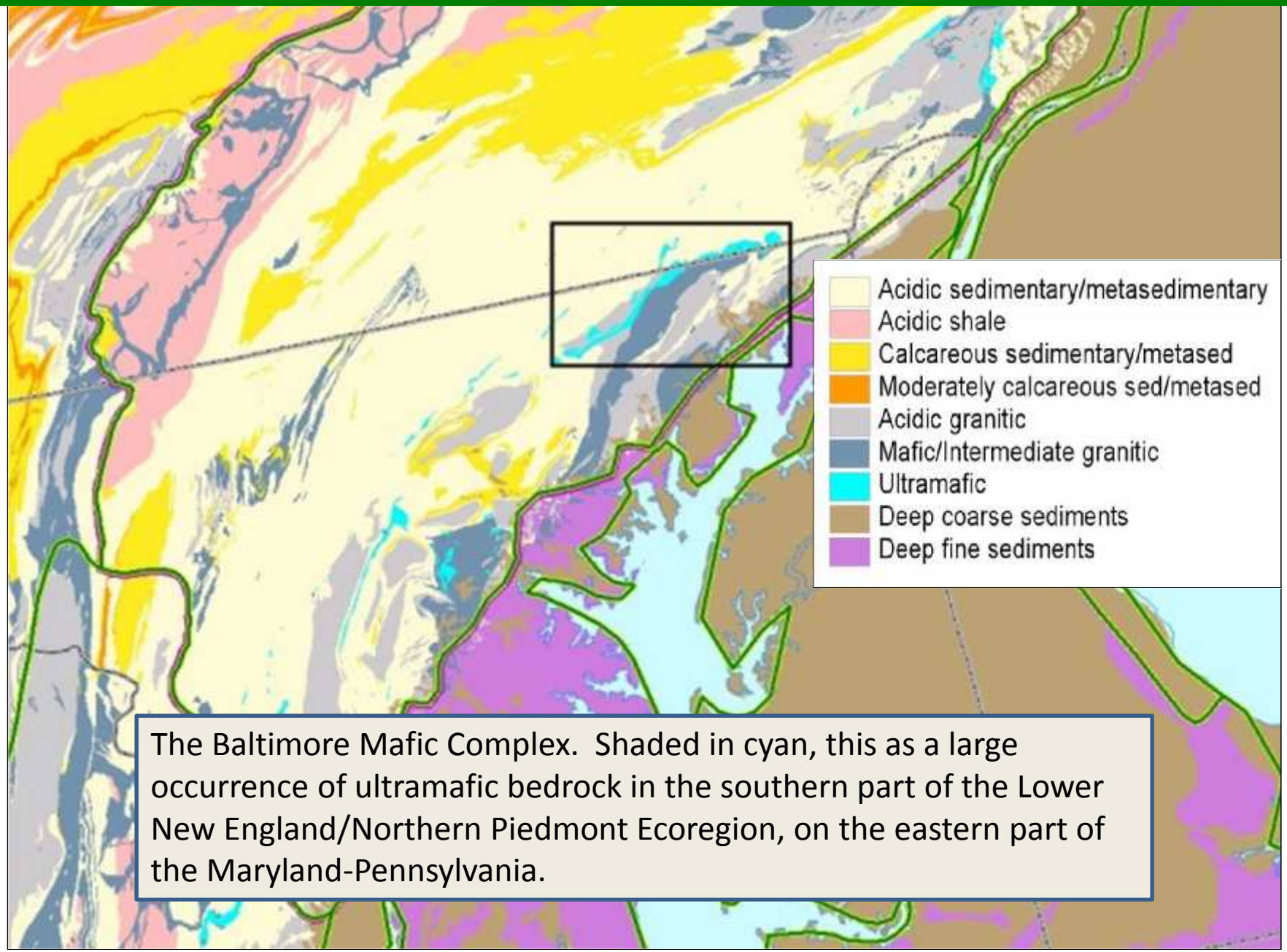

Appal Hemlock-N. Hwd Forest
Central Appal Dry Oak-Pine Forest
NE Interior Dry-Mesic Oak Forest
100 acre hexagons tagged with the Random Forests-predicted habitat type
Random Forests predictions of habitat type transferred to segmented landscape units



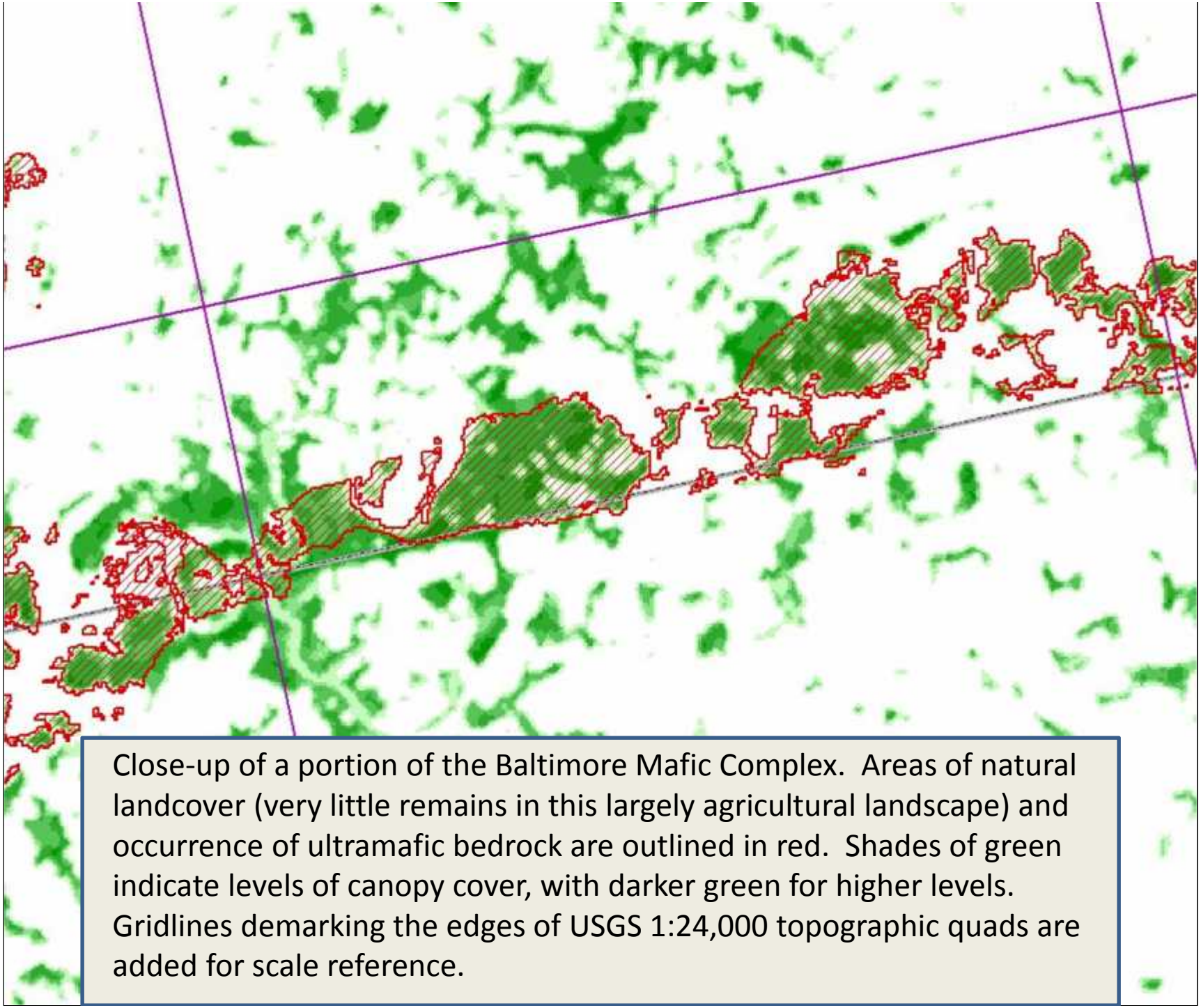
Random Forests predictions of habitat type transferred to segmented landscape units

Figure 10 (previous slide): Transferring habitat classifications from 100 acre hexagons to landscape units (LSUs): Step 2. In this figure, LSUs and a few local hexagon shapes have been draped over a three dimensional model of a landscape in Harriman State Forest in southeastern New York. Dry, oaky hills are common in this area. The patches of probably exposed, dry, shallow-soiled summit (brown) and warm sideslope (deeper green) have given the circled hexagon a high Central Appalachian Dry Oak-Pine Forest (CADOPF) score, but there are also substantial acres of cooler slopes and protected coves within the hexagon that are unlikely settings for the dry oak-pine system. The cooler landscape units within this hexagon can be assigned to appropriate habitats other than CADOPF, such as the NE Interior Dry-Mesic Oak Forest or Appalachian (Hemlock-)Northern Hardwood Forest systems.

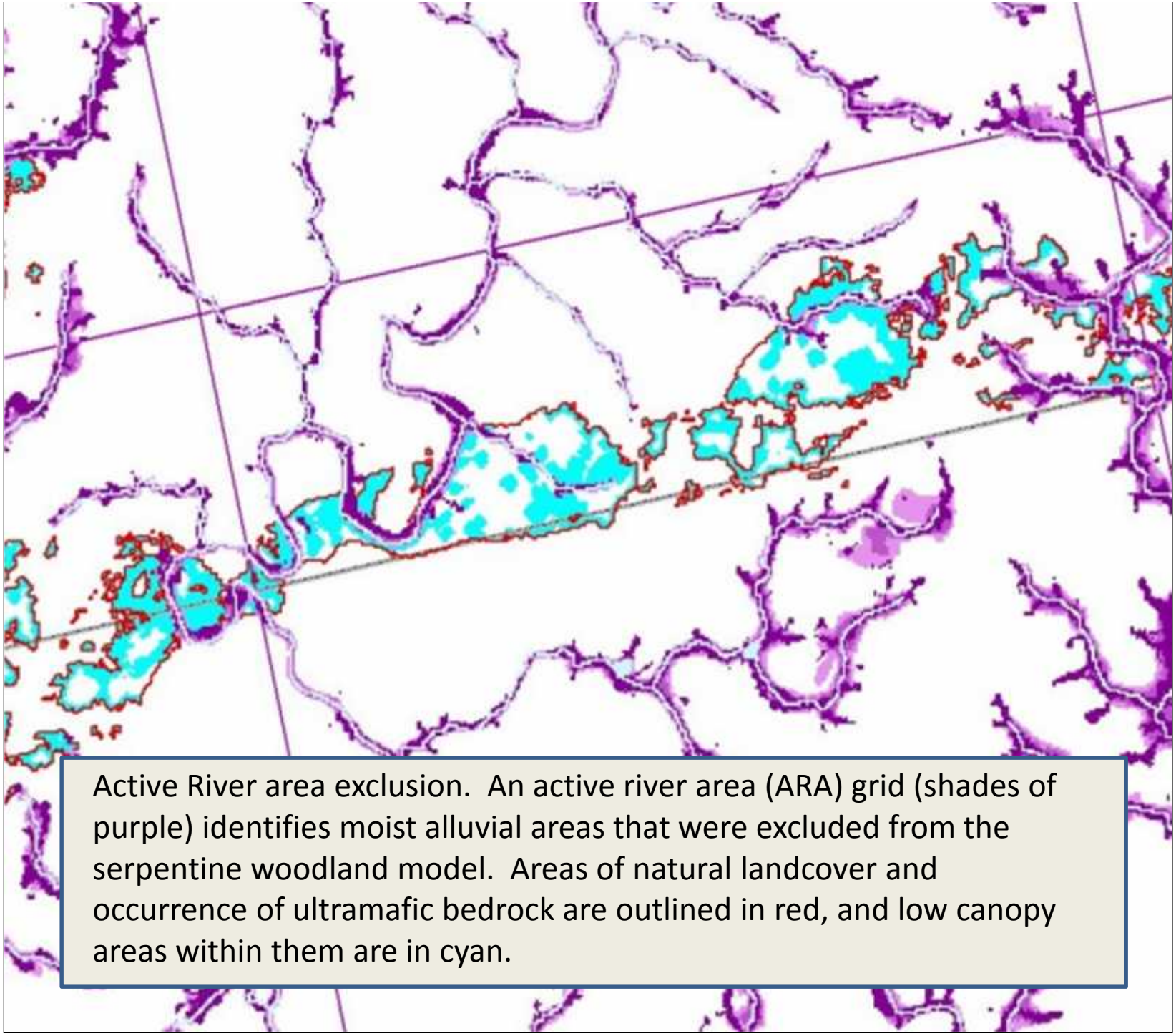
MODELS: Patch Types – Serpentine Barren



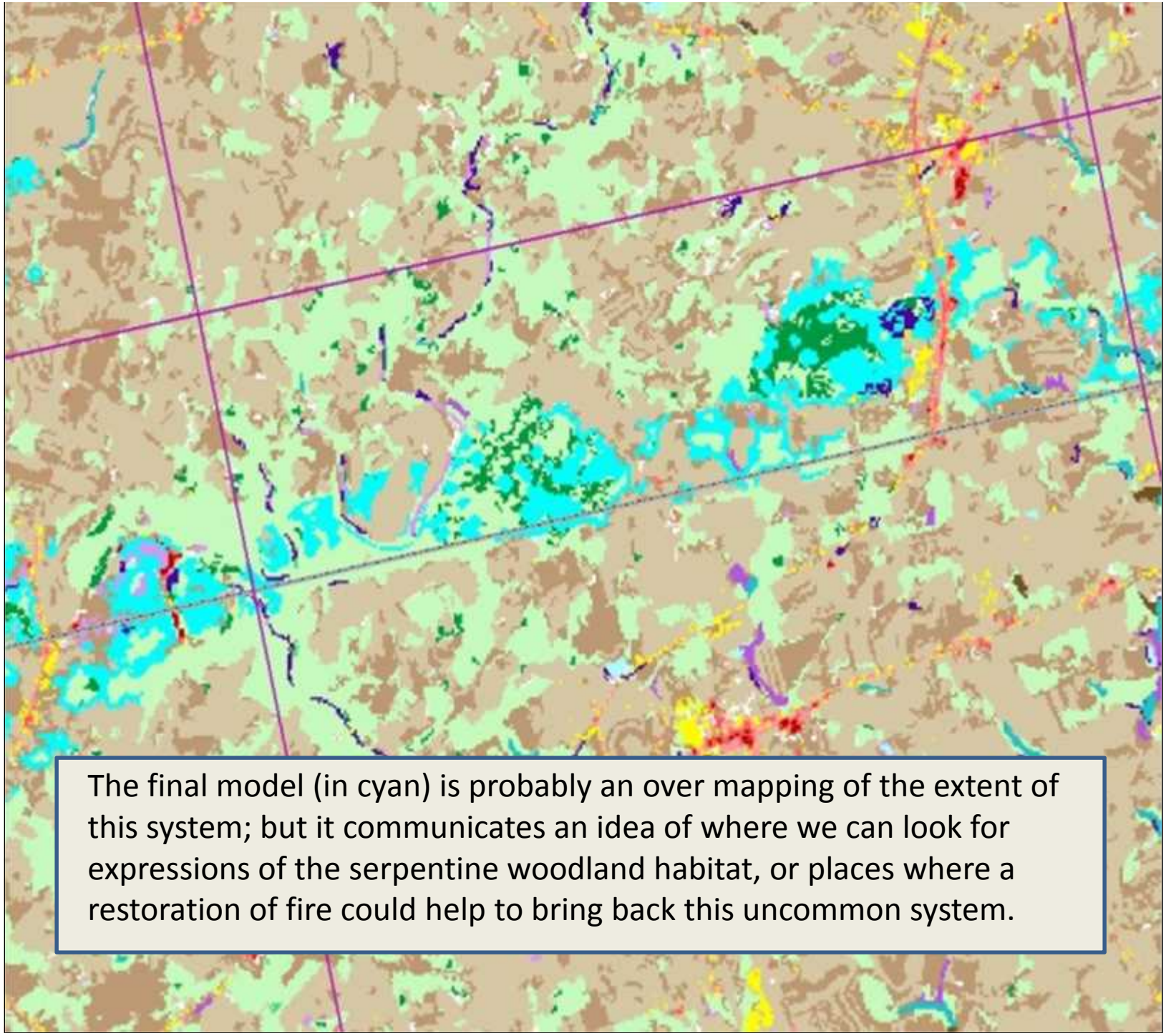
The Baltimore Mafic Complex. Shaded in cyan, this as a large occurrence of ultramafic bedrock in the southern part of the Lower New England/Northern Piedmont Ecoregion, on the eastern part of the Maryland-Pennsylvania.



Close-up of a portion of the Baltimore Mafic Complex. Areas of natural landcover (very little remains in this largely agricultural landscape) and occurrence of ultramafic bedrock are outlined in red. Shades of green indicate levels of canopy cover, with darker green for higher levels. Gridlines demarking the edges of USGS 1:24,000 topographic quads are added for scale reference.



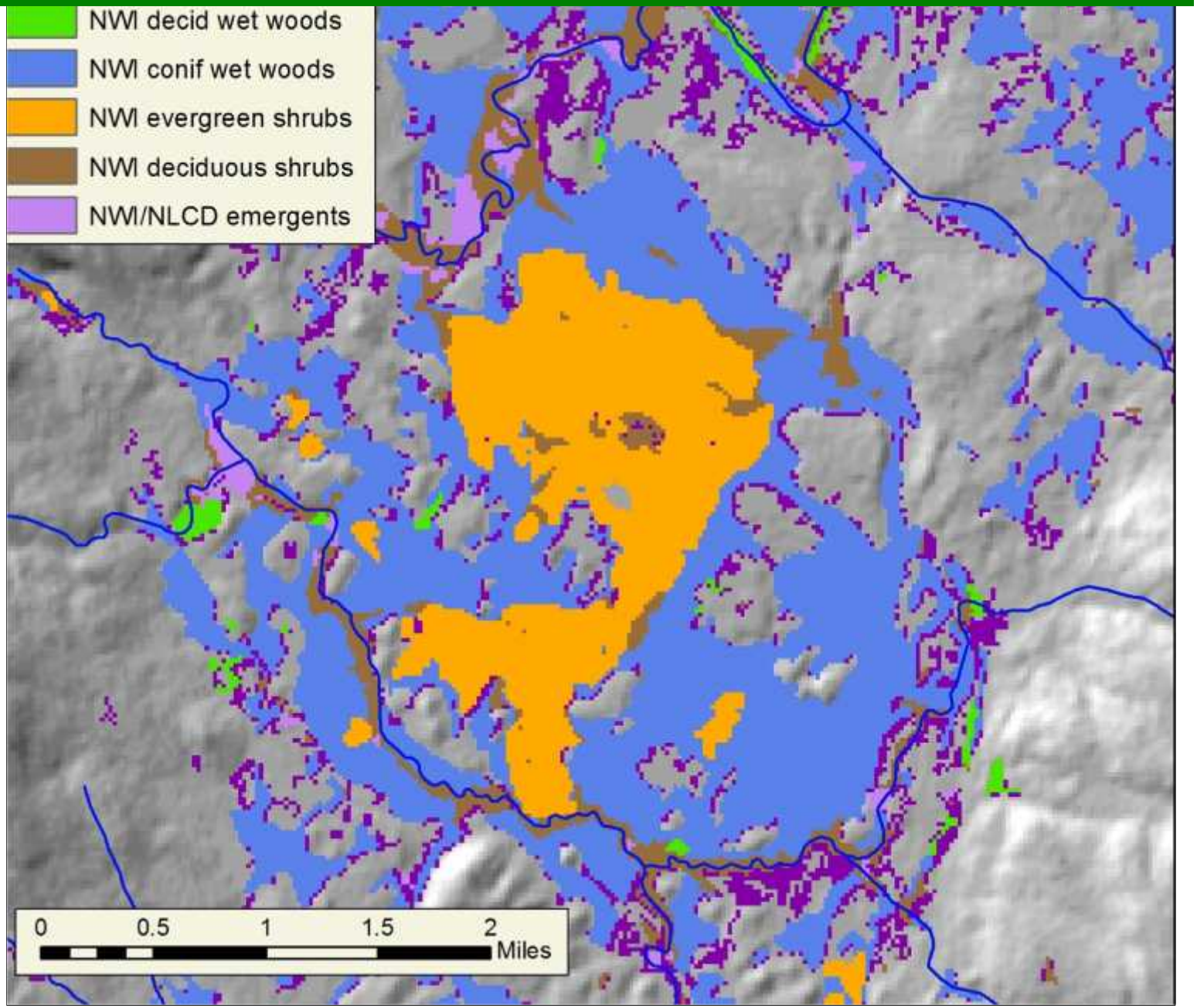
Active River area exclusion. An active river area (ARA) grid (shades of purple) identifies moist alluvial areas that were excluded from the serpentine woodland model. Areas of natural landcover and occurrence of ultramafic bedrock are outlined in red, and low canopy areas within them are in cyan.



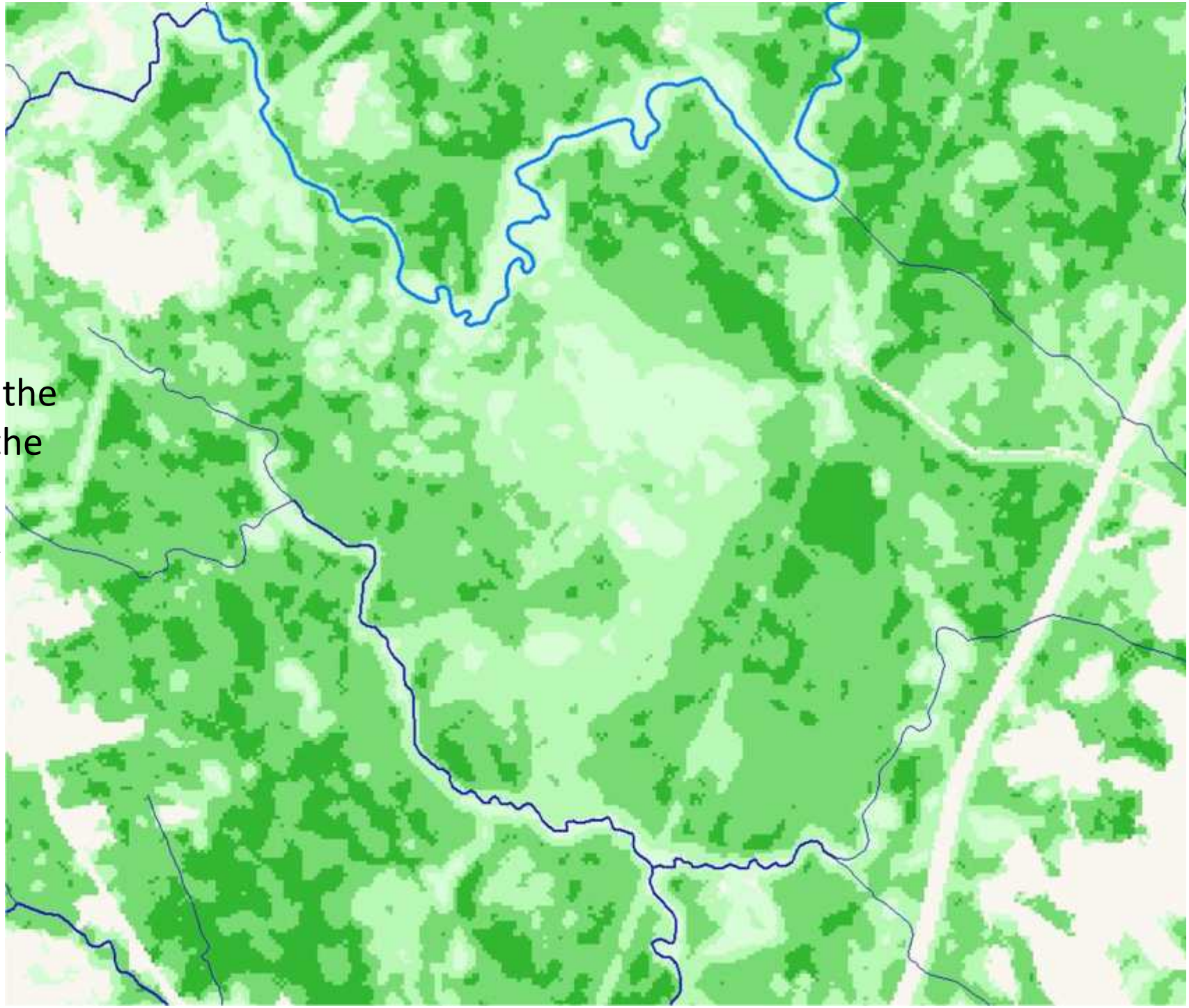
The final model (in cyan) is probably an over mapping of the extent of this system; but it communicates an idea of where we can look for expressions of the serpentine woodland habitat, or places where a restoration of fire could help to bring back this uncommon system.

MODELS: Patch Types – Wetlands

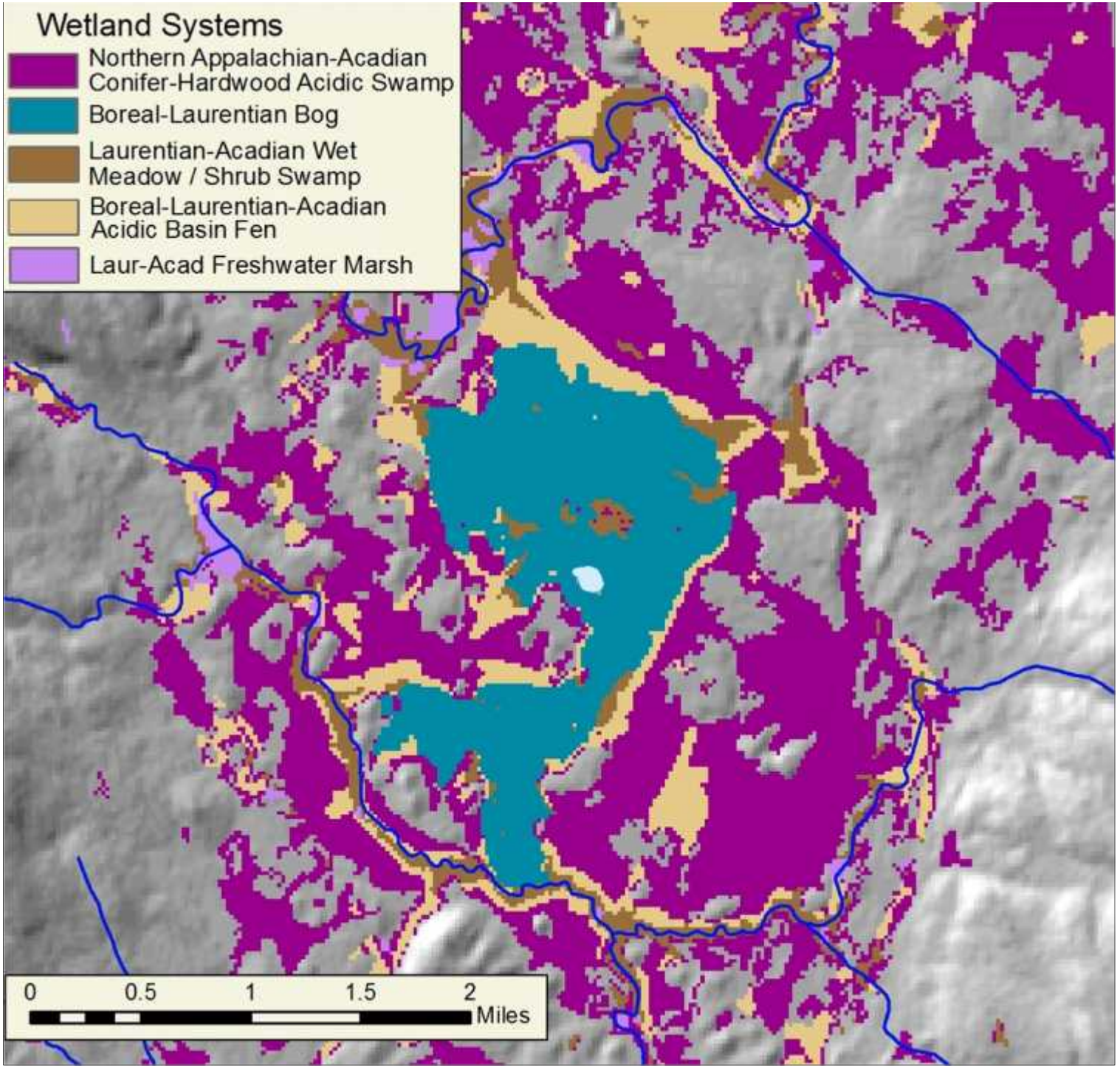
A wetland complex in northern Maine (Northern Appalachian/ Boreal Forest Ecoregion)



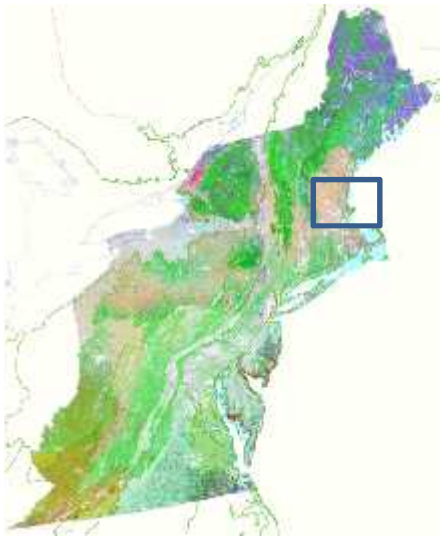
Canopy cover in the area of the wetland complex



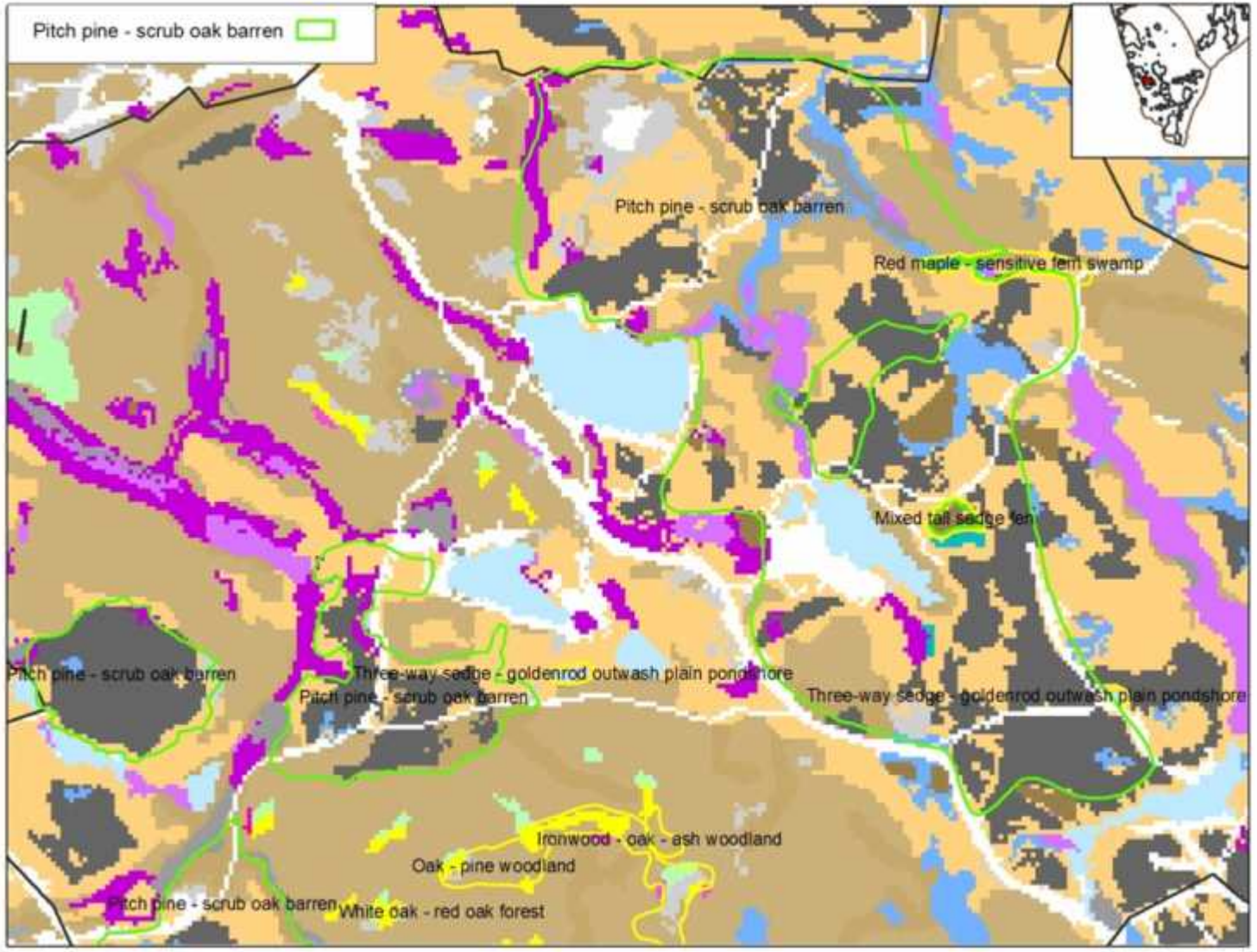
Wetland systems in the complex



Accuracy tests only by overlay



Pitch Pine Barren
Acidic Swamp
Rocky Oak Woodland
CI Pine-Oak Forest
App Hemlock-N
Hardwood Forest



Accuracy: overlay

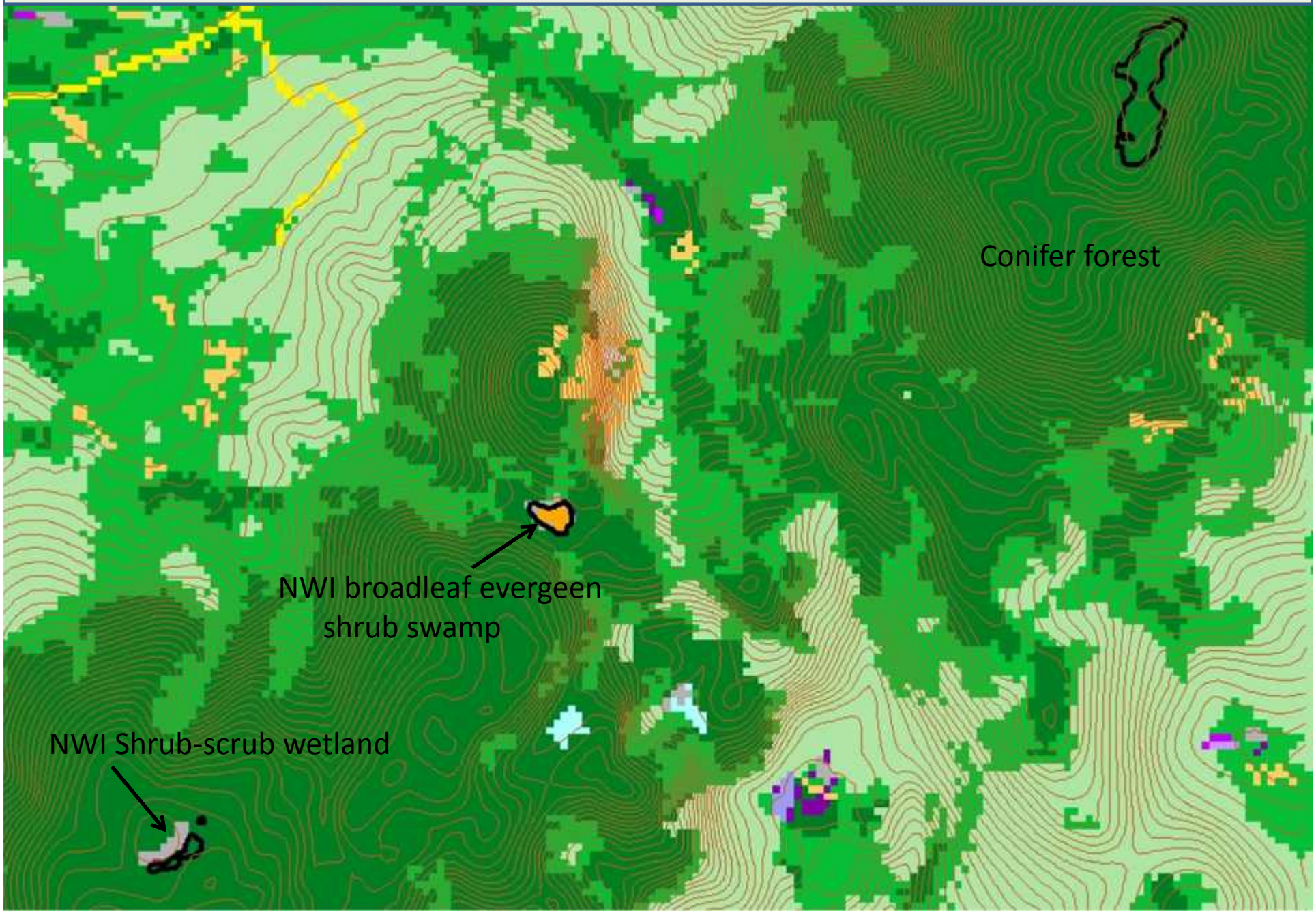
System	Communities	Count
Appalachian Shale Barrens		**136**
	Central Appalachian Shale Barren VA	55
	Shale barren vegetation WV	31
	Shale Barren MD	30
	Virginia pine - mixed hardwood shale woodland PA	11
	Red-cedar - mixed hardwood rich shale woodland PA	5
Central Appalachian Alkaline Glade and Woodland		**25**
	Shale barren vegetation WV	6
Central Appalachian Dry Oak-Pine Forest		**192**
	Shale barren vegetation WV	13
	Dry Oak-hickory-hophornbeam Forest VT	10
	Appalachian oak-hickory forest NY	6
	Chestnut oak forest NY	6
	Oak / Heath Forest VA	5
Northeastern Interior Dry-Mesic Oak Forest		379
	Shale barren vegetation WV	26
	Montane Depression Wetlands VA	13
	Herbaceous vernal pond PA	12
	Marsh & river marsh WV	11
	Appalachian oak-hickory forest NY	10

New Hampshire NHB Alpine-subalpine bog systems – overlap with terrestrial habitats

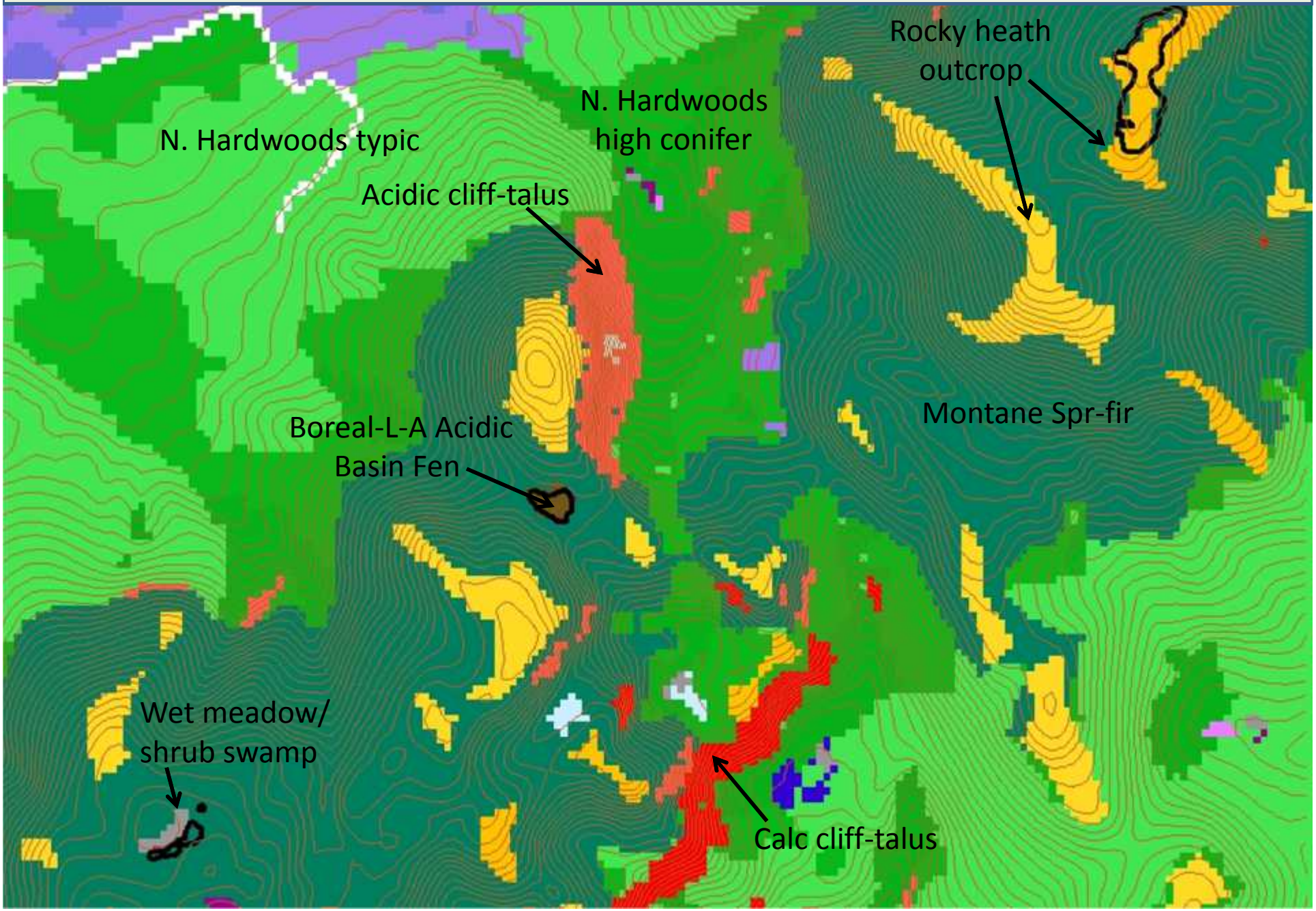
SYSTEM_NHB	SYSTEM_TNC	Percent
alpine/subalpine bog system	Acadian-appalachian montane spruce-fir-hardwood forest	39
alpine/subalpine bog system	Acadian-appalachian alpine tundra	2
alpine/subalpine bog system	Laurentian-acadian acidic cliff & talus	10
alpine/subalpine bog system	N. appalachian-acadian rocky heath outcrop	28
alpine/subalpine bog system	Laurentian-acadian calcareous rocky outcrop	20
alpine/subalpine bog system	N. appalachian-acadian conif-hardwood acidic swamp: isolated	1
alpine/subalpine bog system	Acadian-Appalachian Subalpine Woodland & Heath-Krummholz	Added

Black text: "correct"
Red-brown text: "questionable to incorrect"
Green text: newly added additional correct crosswalk

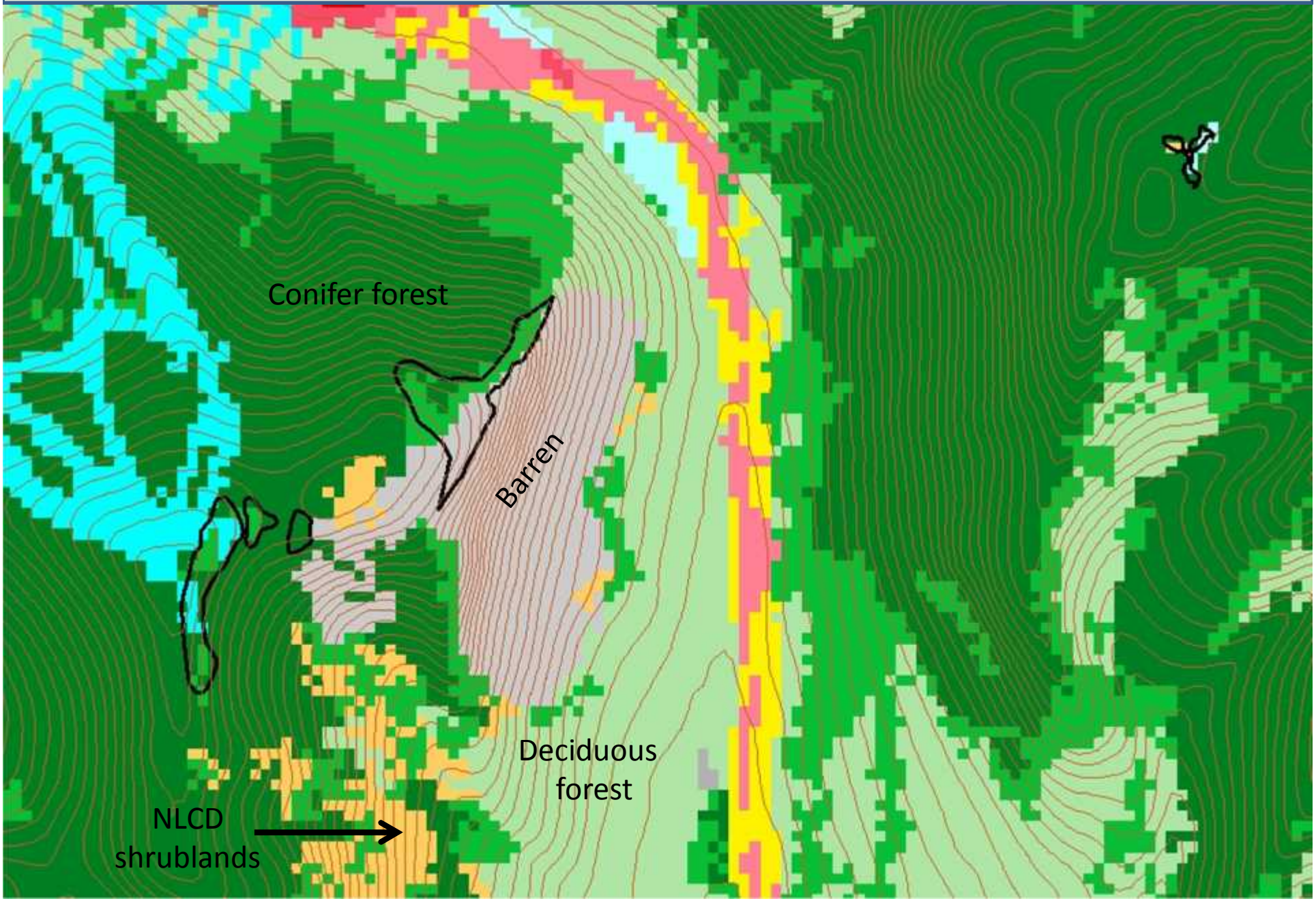
New Hampshire NHB Alpine-subalpine bog systems – NLCD-NWI



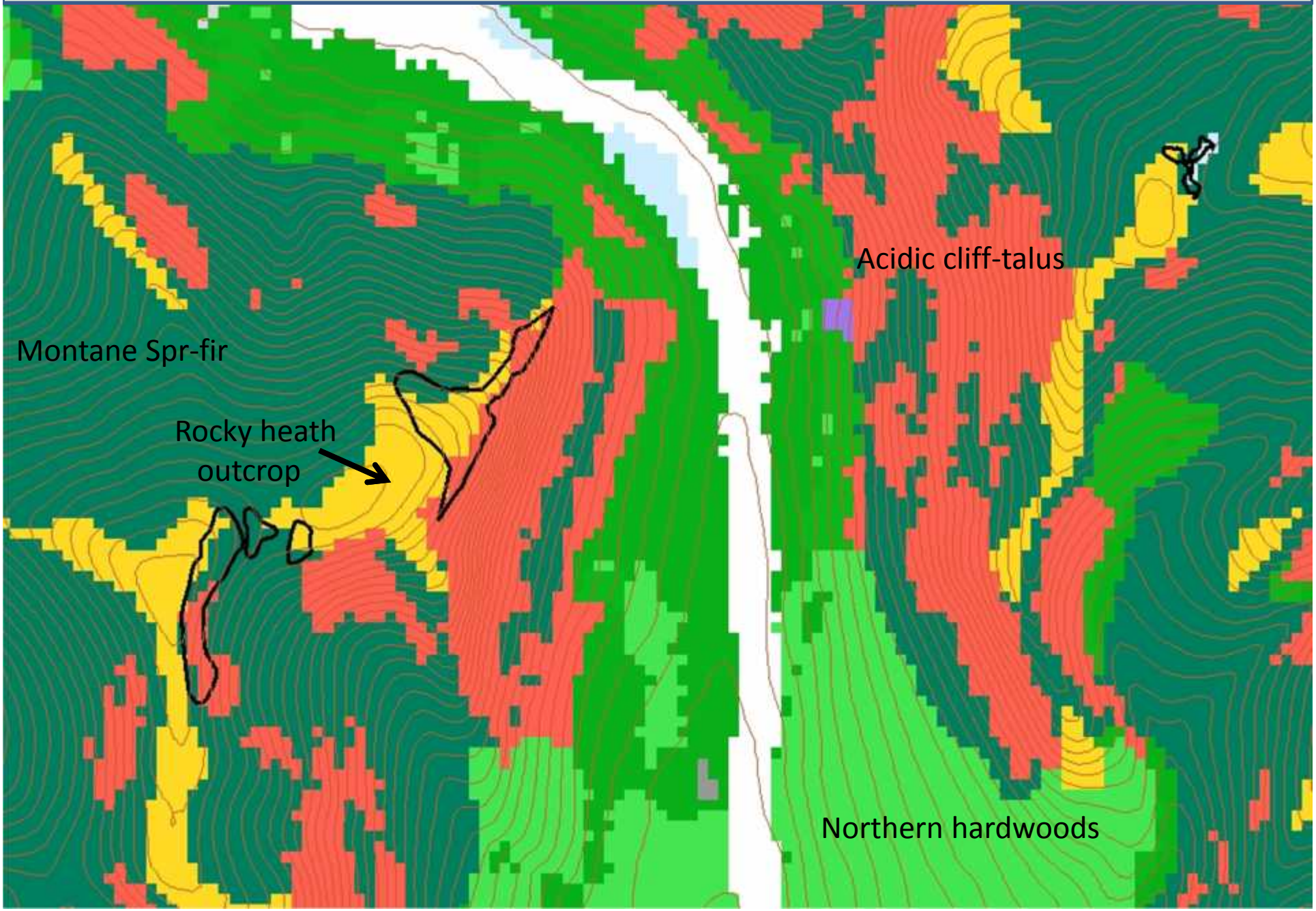
New Hampshire NHB Alpine-subalpine bog systems – NE Terrestrial Habitats



New Hampshire NHB Alpine-subalpine bog systems – NLCD-NWI



New Hampshire NHB Alpine-subalpine bog systems – NE Terrestrial Habitats



Lessons Learned

Have you any idea of the unsettled-ness this induces? I can't get to all the places your models predict we have some interesting system (habitat? community?), I don't believe all the predictions, but can't counter them. Part of the plan, I suppose, try to get us to go and look. Might even work! - P.Swain MA Ecologist

-Good buy-in, Folks like the ecologically based models, Northern New England, WV and NY are really trying to use it in their SWAP plans.

- Agency biologists largely do not understand the classification. To resolve we created the habitat guides

-Need systematic process for incorporating revisions: Should be easy to upgrade with new NLCD for instance. Already incorporated more info for floodplains, high mountain wetlands, shale barrens, red spruce uplands

-Essentially ignores ruderal habitats – these are of interest to many

North-Central Interior Large River Floodplain

Macrogroup: Large River Floodplain

State Distribution: MD, NY, PA, VA, WV

Total Habitat Acreage: 70,068

Percent Conserved: 15.6%

State	State Habitat %	State Acreage	GAP 1&2 (acres)	GAP 3 (acres)	Unsecured (acres)
PA	54%	37,533	1,842	6,623	29,069
NY	29%	20,643	8	951	19,685
WV	14%	9,906	90	1,294	8,522
VA	2%	1,672	44	110	1,518
MD	0%	314	4	0	310

Crosswalk to State Name Examples:
Montane - Piedmont Bottomland Forest (MD), Riparian Thickets/Forests (PA), Piedmont / Central Appalachian River Birch - Sycamore Forest (VA), Floodplain Forests And Swamps (WV)

Description:
A complex of wetland and upland vegetation on floodplains of medium to large rivers in the Ohio River drainages. Vegetation is variable, dominants often include silver maple, sycamore, green ash, American elm, sweet gum, pin oak, and swamp white oak. Understory species are mixed, but include sedges and shrubs such as buttonbush. A single occurrence may extend from river's edge across the outermost extent of the floodplain or to where it meets a wet meadow or upland system. Examples may contain well-drained levees, terraces and stabilized bars, herbaceous sloughs and shrub wetlands. Most areas are inundated at some point each spring; microtopography determines how long the various habitats are inundated.

Ecological Setting and Natural Processes:
Occurs along large rivers or streams where topography and alluvial processes have resulted in a well-developed floodplain. Soils range from very well-drained sandy substrates to very dense clays. Occasional severe floods can alter the system; exotic shrubs and herbs are a greater threat to floodplain communities than to other terrestrial habitats.

Similar Habitat Types:
Natural processes are similar to those of other large river floodplain systems. Vegetation may be most similar to Central Appalachian Large River Floodplains. Only a small northeastern portion of the large geographic extent of this system is in our region.

Crosswalk to State Wildlife Action Plans:
Riparian Thickets/Forests (PA), Wetland Habitat - Forested (VA), Floodplain Forests and Swamps (WV)

System Descriptions: 1

- Map
- Description (NS)
- Similar Habitats
- Ecological Setting
- Securement
- Wildlife
  - Birds
  - Herptiles
  - Mammals
  - (From Literature)

Places to Visit this Habitat:

Conewango Swamp Wildlife Management Area | NY
Hartson Swamp Wildlife Management Area | NY
Erie National Wildlife Refuge - Seneca Division | PA
Meadow River Wildlife Management Area | WV
Monongahela National Forest | WV

Associated Species: *Appendix lists scientific names*

BIRDS: american bittern, bald eagle, cerulean warbler, green heron, prothonotary warbler, virginia rail, warbling vireo, willow flycatcher

HERPTILES: eastern hog-nosed snake, eastern massasauga, eastern ribbonsnake, northern leopard frog, red-eared slider, spiny softshell, upland chorus frog

INSECTS: blue-faced meadowhawk, broad-winged skipper

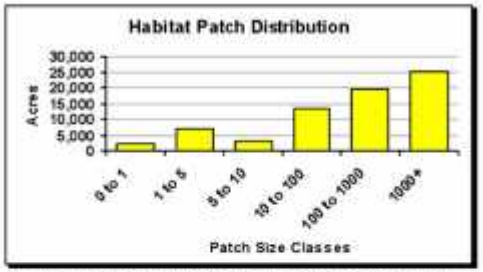
PLANTS: greater bladderwort (Utricularia macrorhiza), green arrow-arum (Peltandra virginica), hairy swamp loosestrife (Decodon verticillatus), harbinger-of-spring (Erigenia bulbosa), northern water-plantain (Alisma triviale), poison-sumac (Toxicodendron vernix), purple-rocket (Iodanthus pinnatifidus), river seedbox (Ludwigia leptocarpa), shootingstar (Dodecatheon meadia), sword bogmat (Wolffiella gladiata)

Species of Concern (G1-G4): *Appendix lists scientific names*

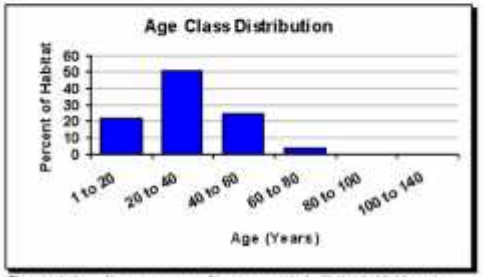
HERPTILES: green salamander, hellbender, jefferson salamander

INSECTS: eyed brown, two-spotted skippper

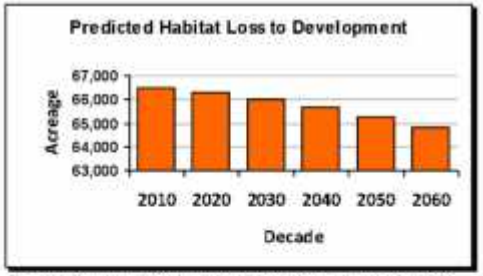
PLANTS: Appalachian sedge (Carex appalachica), hard-stemmed bulrush (Schoenoplectus acutus), large marsh St. John's-wort (Triadenum tubulosum), nodding rattlesnake-root (Prenanthes crepidinea), stout smartweed (Polygonum robustius)



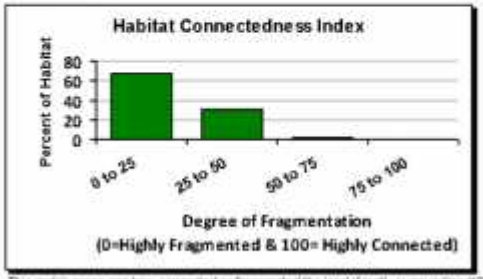
The average patch size for this habitat is 7 acres and the largest single patch is 2,249 acres. This chart shows the proportion of the habitat that is in each patch-size class.



This chart shows the average age of trees associated with this habitat based on forest inventory data. For non-forested systems or small habitats the average age is influenced by the surroundings.



This chart shows the predicted loss of habitat over the next five decades (1,659 acres) if loss continues at the same rate as 1990-2000. The average rate of loss is 33 acres per year.



This metric measures how connected or fragmented the land directly surrounding (10 square miles) the habitat is, this the chart shows the proportion of the habitat in each connectedness class.

System Information: 2

- Photo
- Rare Species
- Crosswalk to State Names
- Places to see the Habitat
- Stand Age and Size
- Facts of interest

A Terrestrial Habitat Map for the Northeastern United States

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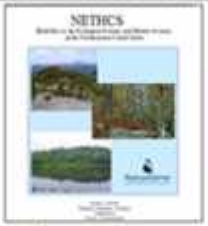
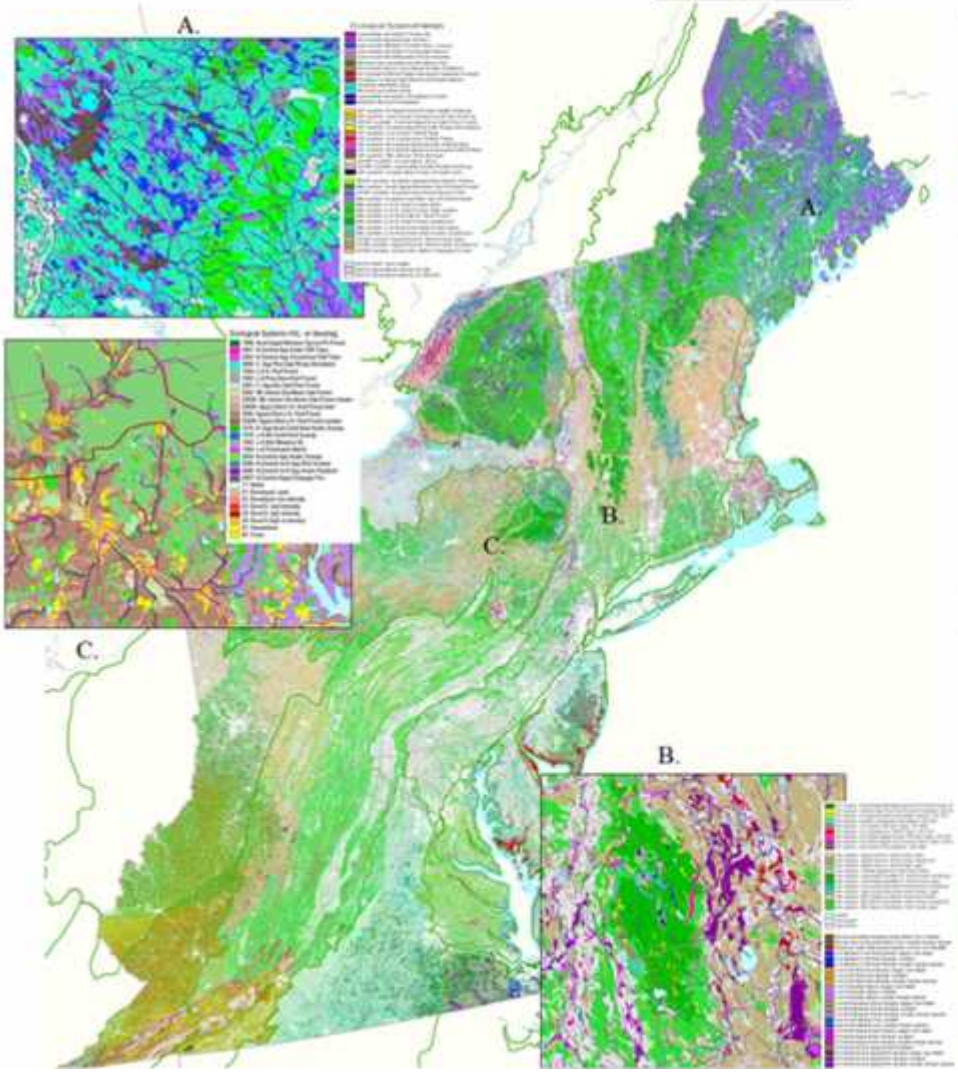
Objective

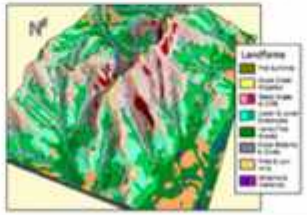
Produce a map of wildlife habitats/ecological systems for the Northeast, including all states from Maine to Virginia, west to New York, Pennsylvania and West Virginia. The map will consist of a spatially comprehensive GIS grid of 30 meter pixels with a legend portraying the Northeastern Terrestrial Habitat Classification System (NETHCS). The NETHCS is based on NatureServe's Ecological Systems Classification, augmented with additional information from individual state wildlife classifications and other information specific to wildlife managers.



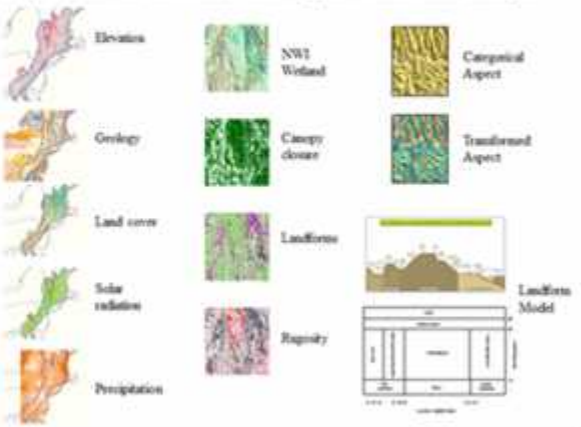


Region Wide Grids of Ecological Information

We began by assembling regional spatial datasets on bedrock and surficial geology, elevation, slope and aspect, waterbodies and streams, wetlands, land position and landforms, topographic rugosity, climate, solar influx, and landcover and canopy cover. About 60 variables were derived for use in the analysis. The landform model was developed from a 30 meter DEM using land position, slope, and flow accumulation. (below).



Examples of framework data for the Lower New England / Northern Piedmont Ecoregion



Confirming Points

Natural Heritage Community Element Occurrences and Plot Data: The State Natural Heritage Programs (NHPs) track the locations of rare and unusual communities and the best examples of common communities. State occurrences were cross-walked and tagged to an ecological systems type by state ecologists, in conjunction with NatureServe and TNC ecologists. In addition, many NHPs have extensive sets of plots taken during the course of ecological inventories, and these were put to a similar use. Accuracy of the habitat/system tags was evaluated by attributing confirming points and polygons with basic environmental information and viewing them in a GIS. Over 50,000 occurrences and plots were provided by the Heritage programs for use in this project.

Vegetation Maps: Detailed vegetation and natural community maps were available in many parts of the region. These were converted into points and tagged to the appropriate ecological systems types by Natural Heritage and NatureServe ecologists in conjunction with TNC scientists.

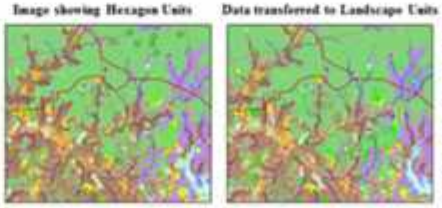
Forest Inventory and Analysis Points: We received over 21,000 actual-location FIA plots from the USDA-Forest Service for the states in our region. These forest stands are sampled by Forest Service staff in perennial inventories. The points were filtered to removed highly altered stands, then classified into homogenous vegetation units based on their tree composition and ecological settings using a cluster analysis. The homogenous units were then cross-walked to the regional ecosystem units by TNC scientists in consultation with NatureServe Ecologists.

Models for Matrix-forming and Patch Communities

Matrix forming Forest Systems: We proceeded through the project area ecoregion by ecoregion. Matrix forest types for each ecoregion were modeled using RandomForest-generated classifications, with 100 acre hexagons as the basic analytical units. First, hexagons constructed around each confirmed location of a specific forest habitat type were attributed with the ecological information described above (solar radiation, land cover, topography, etc). The RandomForest algorithm uses this information to construct models for each of the matrix forest types. Hundreds of thousands of hexagons covering the ecoregion in a tessellated pattern were attributed in the same way, and every hexagon was classified to the most probable ecological system type by running it through the RandomForest-built decision trees.

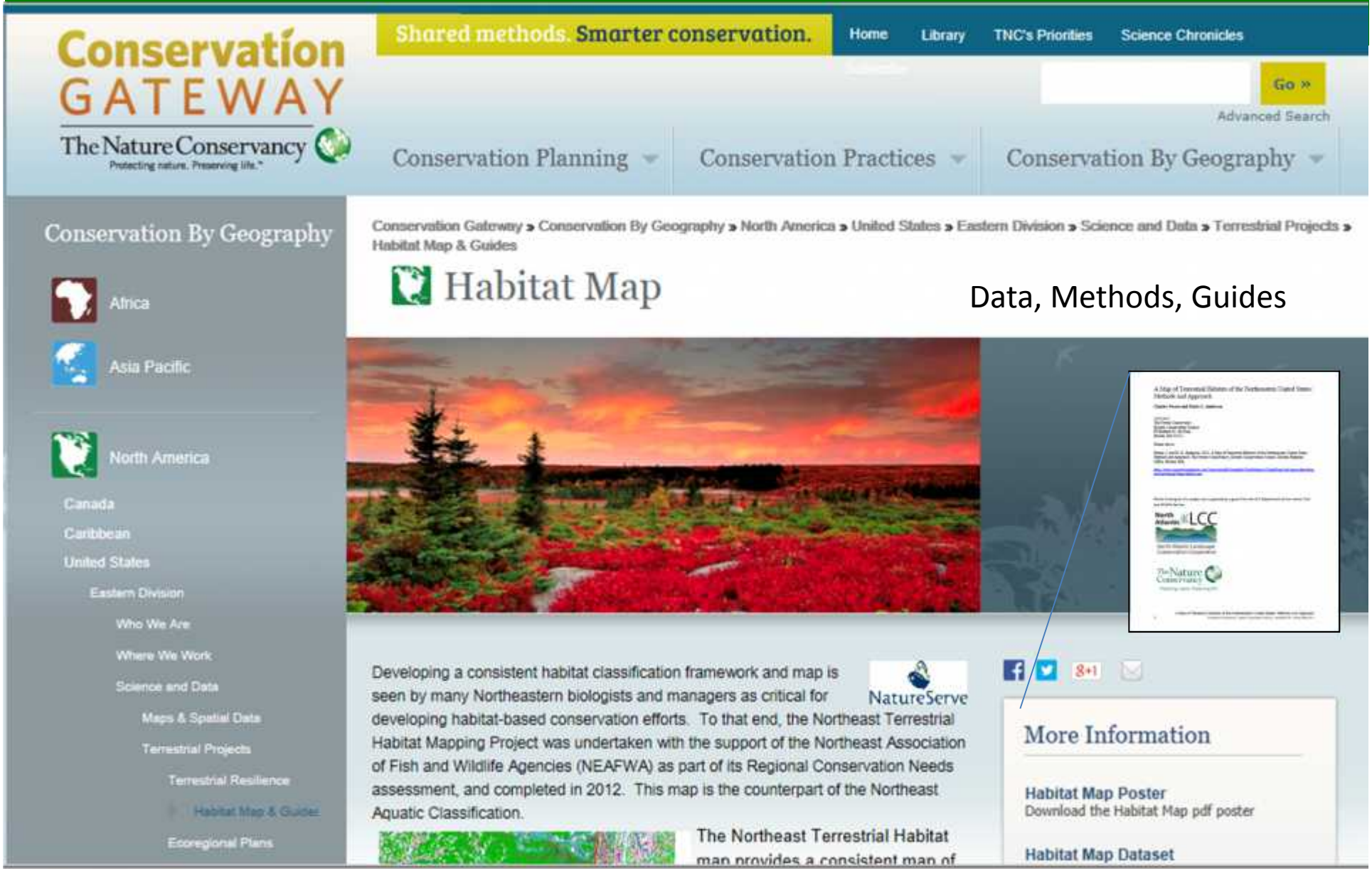
Patch Communities: Patch communities and wetlands for each ecoregion were modeled individually, based on locations of known occurrences of each habitat/system type that occur in the region, and on NatureServe-published descriptions of and ecological criteria for those types. Information on habitat ranges, elevation limits, edaphic/geologic factors, landcover and canopy cover, topographic factors like exposure, solar influx, and surface roughness, and other landscape characteristics, all played important parts in patch model construction.

Image showing Hexagon Units **Data transferred to Landscape Units**

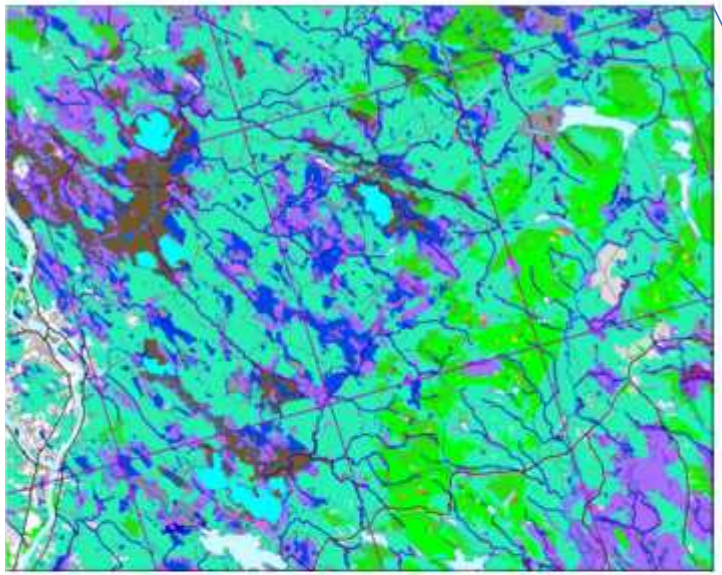


A final step in the mapping process was to transfer the hexagon-based habitat information onto natural topographic units. Thematic segmentation software was used to break large "landscape units" based on simplified landforms into smaller discrete shapes. Next, we identified the 100-acre hexagon that each of the discrete landscape units was within (or mostly within). We then wrote a set of decision rules to assign each landscape unit to a given ecological system type, based on the RandomForest-assigned system for its parent hexagon. For example, low hills or cool slopes associated with a hexagon classified to the more mesic oak forest systems would get that system assignment, while a warm upper slope or ridgetop associated with that same hexagon would "flip" to the dry oak-pine system. The RandomForest-generated probabilities for the matrix forest systems within each hexagon helped guide this information transfer.

Conservation Gateway

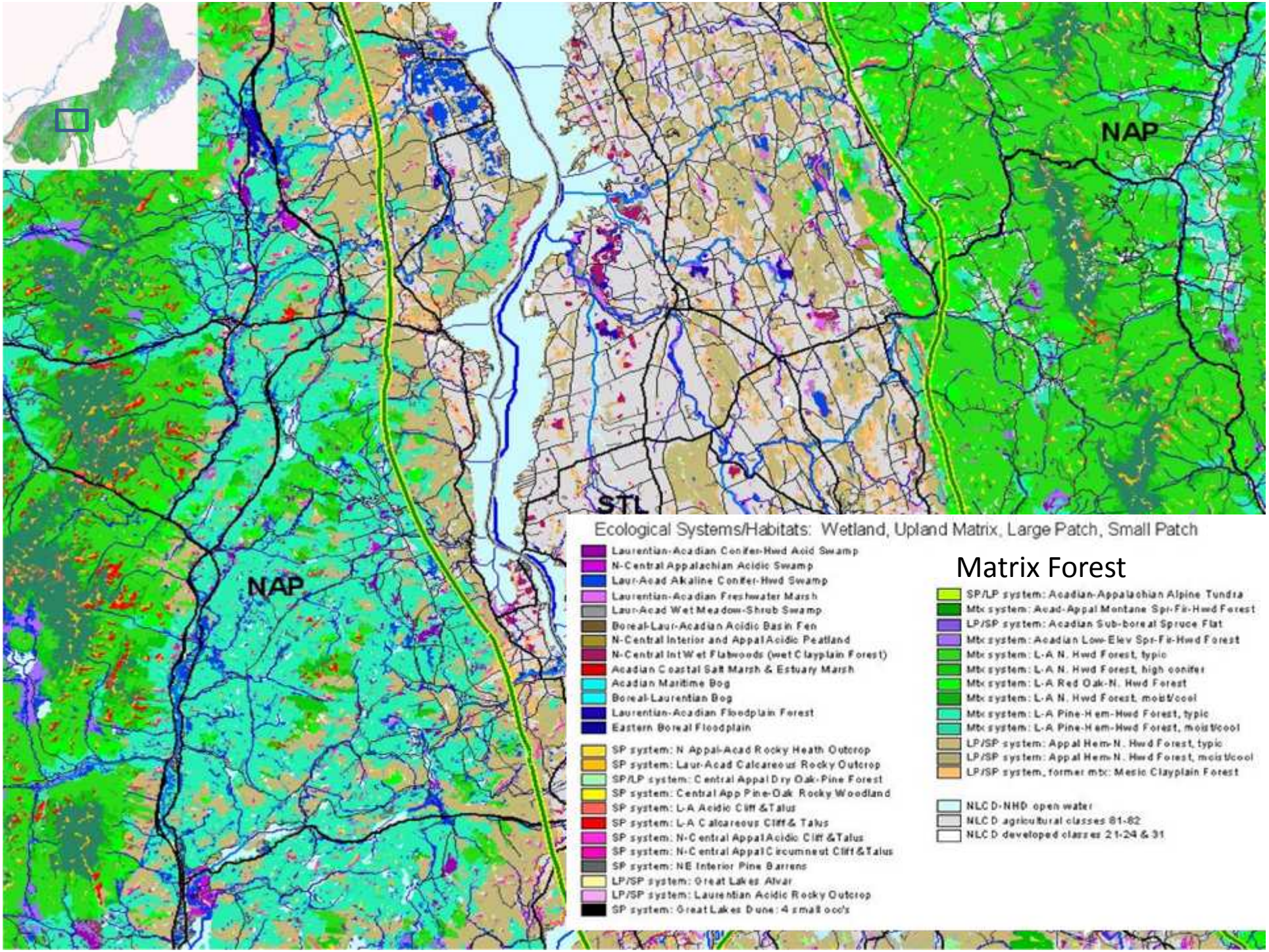


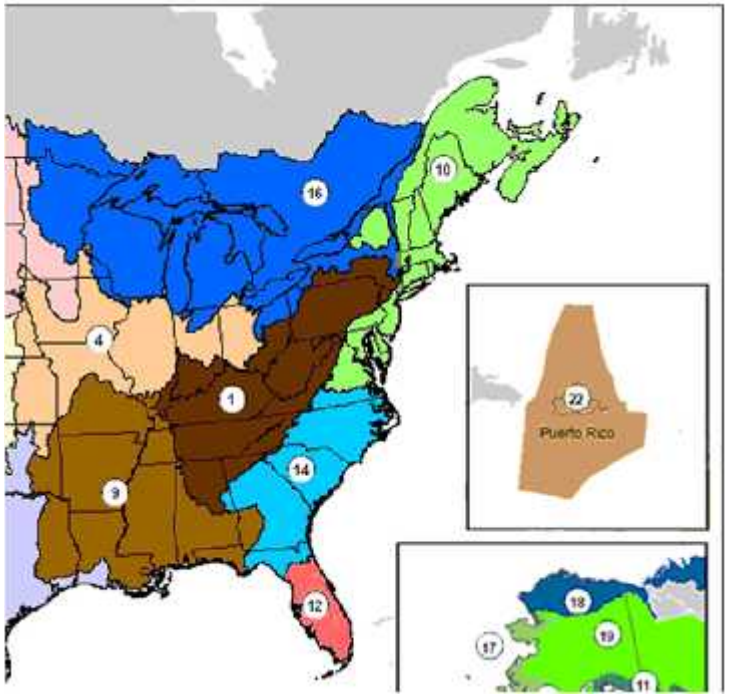
THANK YOU

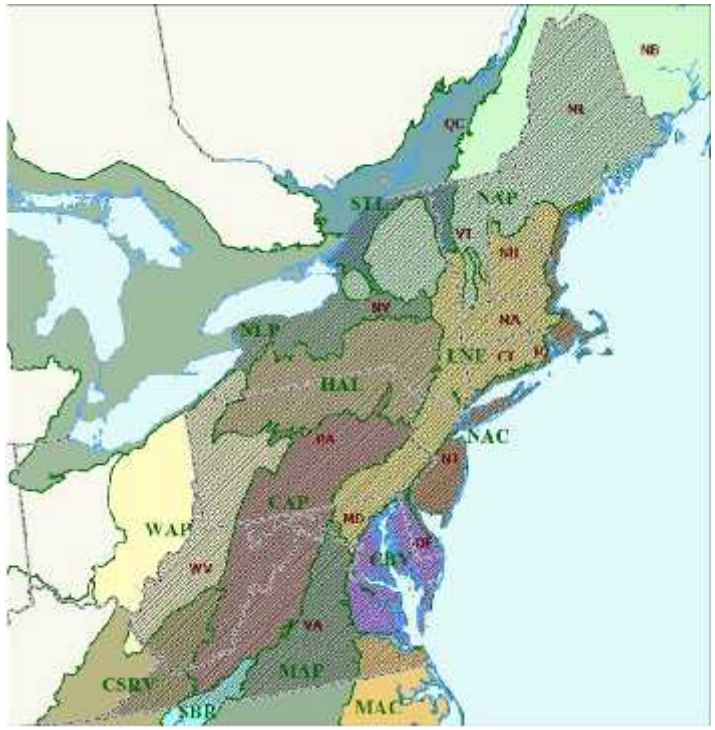


Low elevation Spruce-Fir–Hardwood
Sub-boreal Spruce Flat
Northern Hardwood forest
Pine-Hemlock Hardwood Forest

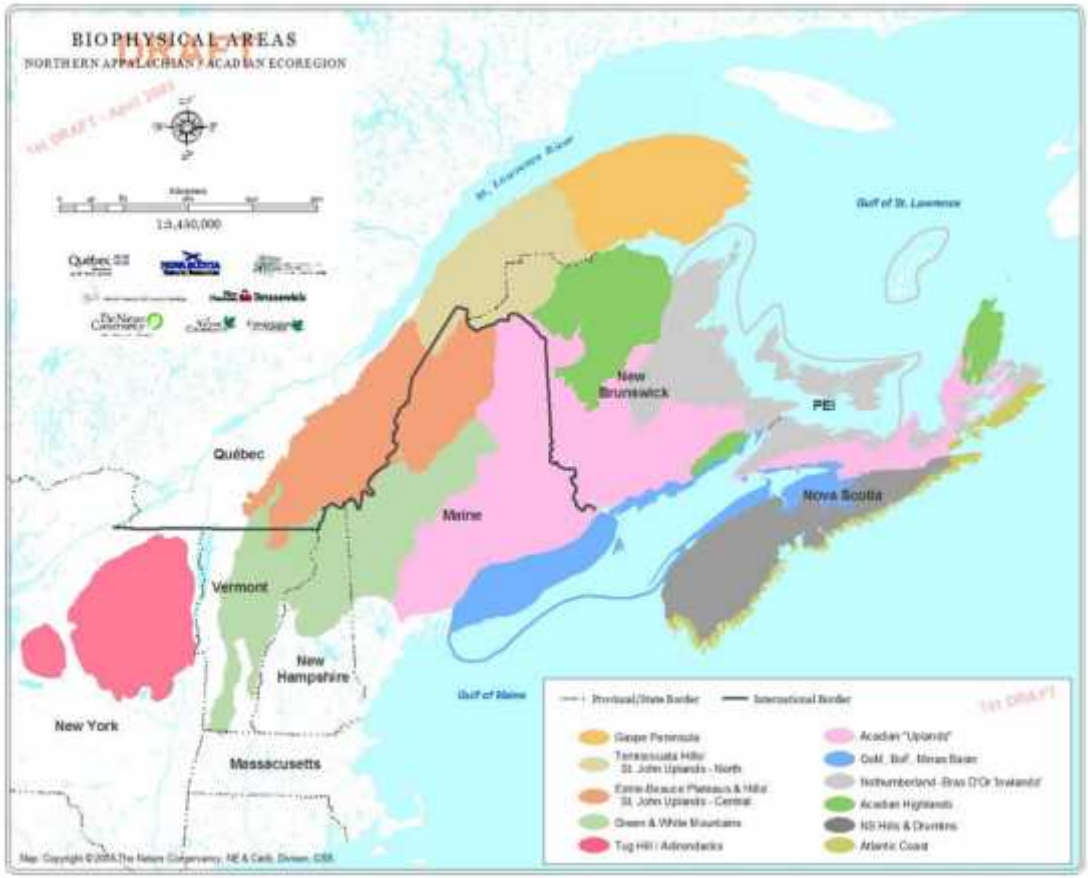
Proposed area
for expansion


NAP
STL
NAP
Ecological Systems/Habitats: Wetland, Upland Matrix, Large Patch, Small Patch
Laurentian-Acadian Conifer-Hwd Acid Swamp
N-Central Appalachian Acidic Swamp
Laur-Acad Alkaline Conifer-Hwd Swamp
Laurentian-Acadian Freshwater Marsh
Laur-Acad Wet Meadow-Shrub Swamp
Boreal-Laur-Acadian Acidic Basin Fen
N-Central Interior and Appal Acidic Peatland
N-Central Int Wet Flatwoods (wet Clayplain Forest)
Acadian Coastal Salt Marsh & Estuary Marsh
Acadian Maritime Bog
Boreal-Laurentian Bog
Laurentian-Acadian Floodplain Forest
Eastern Boreal Floodplain
SP system: N Appal-Acad Rocky Heath Outcrop
SP system: Laur-Acad Calcareous Rocky Outcrop
SP/LP system: Central Appal Dry Oak-Pine Forest
SP system: Central App Pine-Oak Rocky Woodland
SP system: L-A Acidic Cliff & Talus
SP system: L-A Calcareous Cliff & Talus
SP system: N-Central Appal Acidic Cliff & Talus
SP system: N-Central Appal Circumneut Cliff & Talus
SP system: NE Interior Pine Barrens
LP/SP system: Great Lakes Alvar
LP/SP system: Laurentian Acidic Rocky Outcrop
SP system: Great Lakes Dune: 4 small occ's
Matrix Forest
SP/LP system: Acadian-Appalachian Alpine Tundra
Mtx system: Acad-Appal Montane Spr-Fir-Hwd Forest
LP/SP system: Acadian Sub-boreal Spruce Flat
Mtx system: Acadian Low-Elev Spr-Fir-Hwd Forest
Mtx system: L-A N. Hwd Forest, typic
Mtx system: L-A N. Hwd Forest, high conifer
Mtx system: L-A Red Oak-N. Hwd Forest
Mtx system: L-A N. Hwd Forest, moist/cool
Mtx system: L-A Pine-Hem-Hwd Forest, typic
Mtx system: L-A Pine-Hem-Hwd Forest, moist/cool
LP/SP system: Appal Hem-N. Hwd Forest, typic
LP/SP system: Appal Hem-N. Hwd Forest, moist/cool
LP/SP system, former mtx: Mesic Clayplain Forest
NLCD-NHD open water
NLCD agricultural classes 81-82
NLCD developed classes 21-24 & 31

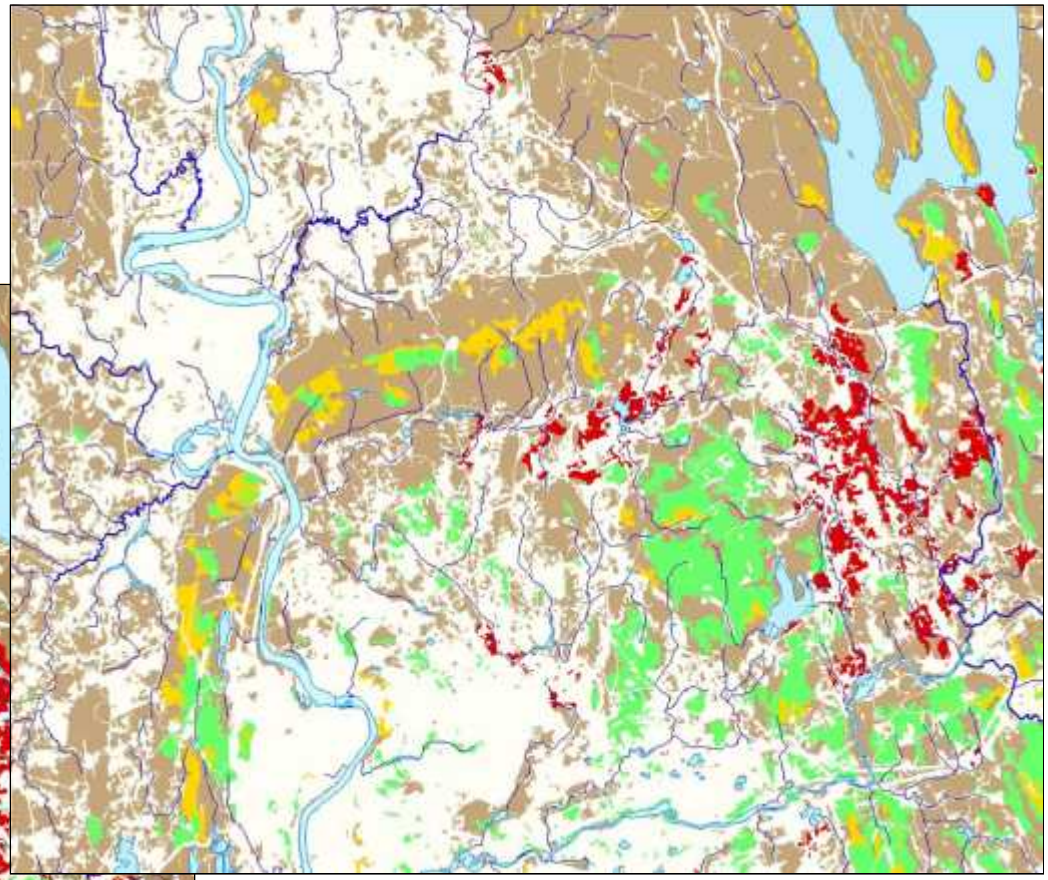




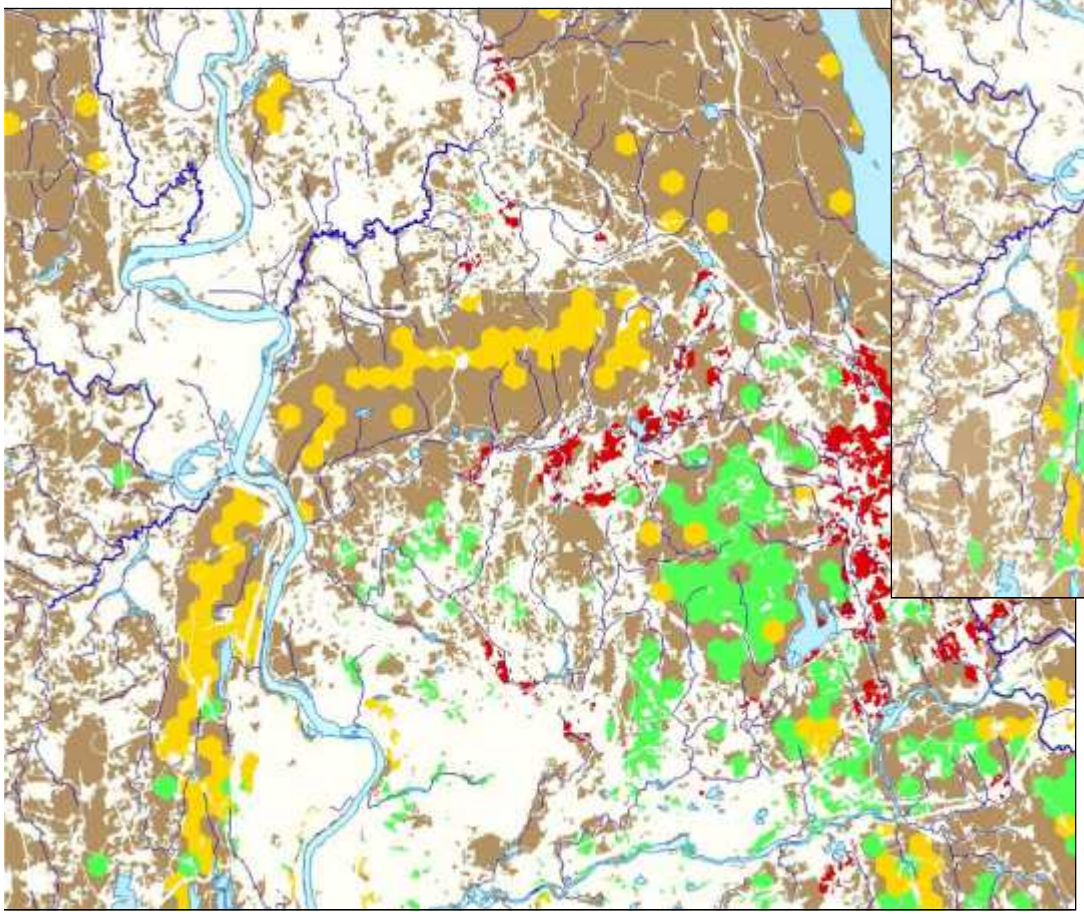
Not sure how to stratify the mapping

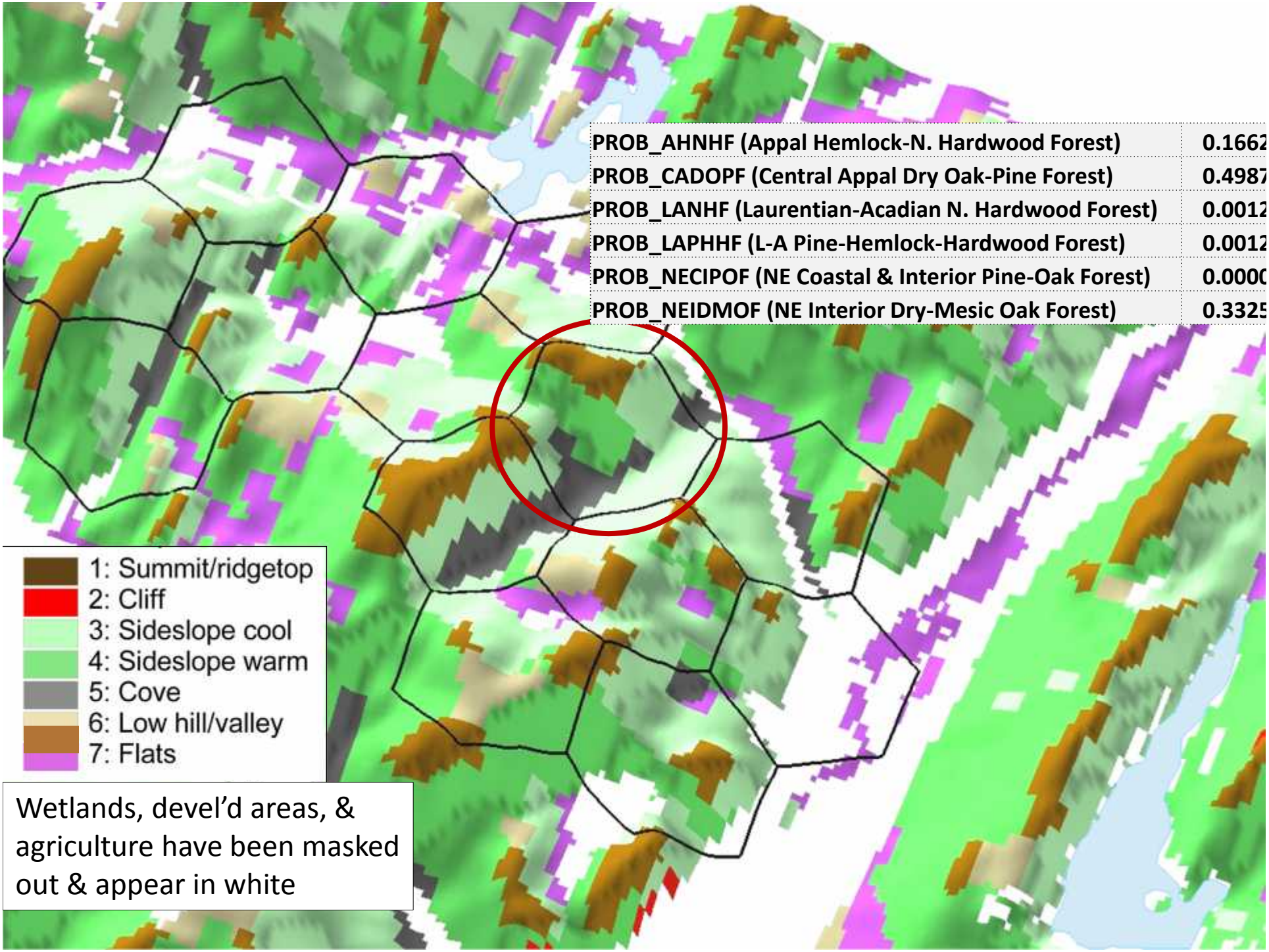


…After



Before…




PROB_AHNHF (Appal Hemlock-N. Hardwood Forest) 0.1662
PROB_CADOPF (Central Appal Dry Oak-Pine Forest) 0.4987
PROB_LANHF (Laurentian-Acadian N. Hardwood Forest) 0.0012
PROB_LAPHHF (L-A Pine-Hemlock-Hardwood Forest) 0.0012
PROB_NECIPOF (NE Coastal & Interior Pine-Oak Forest) 0.0000
PROB_NEIDMOF (NE Interior Dry-Mesic Oak Forest) 0.3325
1: Summit/ridgetop
2: Cliff
3: Sideslope cool
4: Sideslope warm
5: Cove
6: Low hill/valley
7: Flats
Wetlands, devel'd areas, & agriculture have been masked out & appear in white

We know that in this region, Central Appalachian Dry Oak-Pine Forest & Northeast Interior Dry-Mesic Oak Forest & Appalachian (Hemlock-) N. Hardwood Forest all occur in immediate proximity & grade into one another; that AHNHF occupies the lower land position, moister/cooler settings; that NEIDMOF covers many mid-slope areas; that CADOPF occupies high land position sites & warm slopes and hills

Predicted system: Prob1 / Prob2	Landscape Units				
	LS_unit 1: Summit/ridge	LS_unit 4: Sideslope warm	LS_unit 3: Sideslope cool	LS_unit 5: Cove, bottom of steep slope	Lsunit 6,7: low hills, flats
NEIDMOF / CADOPF (92,386 hexagons)	CADOPF	If prob_CADOPF >= 0.1 & if focalmean landposition < 50, CADOPF, else NEIDMOF	If prob_CADOPF >= 0.1 & if focalmean landposition < 40, CADOPF, else NEIDMOF	If prediction3 = SCIMF* & SCIMF is mapped within 600m, SCIMF; else if prediction3 = AHNHF & it is mapped within 600m, AHNHF; else NEIDMOF cool-moist	If prob_CADOPF >= 0.1 & if focalmean solar radiation >= 90, CADOPF; otherwise NEIDMOF
NEIDMOF / AHNHF (27,287 hexagons)	CADOPF	Split between CADOPF & NEIDMOF with landposition as above	Split between CADOPF & NEIDMOF with landposition as above	AHNHF cool-moist	Split between CADOPF & NEIDMOF with solar influx as above
NEIDMOF / SCIMF* (33,537 hexagons)	CADOPF	If prob_CADOPF >= 0.1 & if focalmean landposition < 45, CADOPF, else NEIDMOF	If prob_SCIMF* >= 0.1 & SCIMF is mapped within 600m & focalmean landposition > 45, SCIMF; else if prob_CADOPF >= 0.2 & focalmean landpos < 40, CADOPF; else NEIDMOF	If SCIMF* is mapped within 600m, SCIMF; else if prob_AHNHF >= 0.1 & AHNHF is mapped within 600m, AHNHF; else NEIDMOF cool-moist	If prob_SCIMF* >= 0.2 & SCIMF is mapped within 600m & focalmean landposition ge 55, SCIMF; else if prob_CADOPF >= 0.1 & focalmean solar radiation >= 90, CADOPF; else NEIDMOF

*** South Central Interior Mesophytic Forest**