NORTH ATLANTIC LANDSCAPE CONSERVATION COOPERATIVE GRANT 2015 PROGRESS REPORT

Quarter: (circle one) 2015 1st 2015 2nd 2015 3rd 2015 4th

Grant Program, Number and Title: Grant 2011-07; **ASSESSING PRIORITY AMPHIBIAN AND REPTILE CONSERVATION AREAS (PARCAS) AND VULNERABILITY TO CLIMATE CHANGE IN THE NORTH ATLANTIC LANDSCAPE CONSERVATION COOPERATIVE**

Organization: Association of Fish and Wildlife Agencies, University of Maine (USGS MCFWRU), Clemson University, Tennessee State University

Project Leader: Priya Nanjappa**,** Association of Fish and Wildlife Agencies
Project Scientists: Cynthia Loftin, U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit
Bill Sutton, Tennessee State University
Phillip deMaynadier, Maine Department of Inland Fisheries and Wildlife
Kyle Barrett, Clemson University
Allison Moody, University of Maine (resigned from project August 2014)

Were planned goals/objectives achieved last quarter? The UMaine and Tennessee State University team have made significant progress towards completing project goals and objectives. We are on track to continue this progress in the next quarter. Details are provided below.

April-June 2015 Activity Summary
Objective 1: *Work directly with state fish and wildlife agency personnel throughout the NA-LCC states to gather data toward PARCA criteria review and proposed conservation area identification.*

Species Distribution Model development:

Overview of Model Development process: SDM development has been an iterative process of compiling and evaluating point datasets provided by the states, supplementing these data with available online resources, spatially filtering species occurrence data by evaluating point clustering and extent within individual species ranges, developing background data points to complement the species' point data (e.g., Figure 1), evaluating correlations among explanatory variables and revising variable lists for each species, creating logistic model output for each species, evaluating models with reference to species ranges, point spread, and thresholds, removing species for which models do not meet criteria indicating good model fit, and repeating these steps until the resultant SDMs are determined acceptable. We initially developed models for 75 priority (conservation concern) species, and we pruned the species' model set to 64 SDMs based on our visual inspection of prediction surfaces and comparison of model fit metrics as we proceeded iteratively through the steps described below. Sources of poor SDM fit that could not be resolved, leading to the species' elimination from the modeled set included insufficient number of occurrences, severe point clustering or point distribution that poorly represented the species' range, and restricted range extent.

Variable selection: Our initial approach for selecting explanatory variables to include in each SDM was guided by the assessment of variables important to each species by three experts, which was then compiled into four model structures (models termed no1, no2, yes1, yes2) based on the number of experts in agreement for including or omitting a variable in explaining a species' occurrence. As we evaluated this approach for model development and how variables were included and omitted into individual species models, we developed a modified approach that simplified the model set. We determined that several temperature and precipitation variables were correlated (average annual temperature was correlated with tmax, tmin, julytemp; average annual precipitation was correlated with precipgs; growing degree days was correlated with temp, tmax, tmin, julytemp). We removed these correlated variables from the species variable lists and included average annual temperature and average annual precipitation in all models, owing to our assumption that temperature and precipitation variables affect species' distributions at the scale of the project region. Additional environmental variables that quantify environmental conditions at a smaller scale that were identified by two experts as being important for the species were included in the SDMs in addition to precipitation and temperature variables (Table 1). We added, removed, and added elevation into all models; this variable improved SDMs for species found in high and low elevation (e.g., coastal plain) areas but did not affect model performance for species distributed in mid-elevation regions or across a broad elevation range. We identified acceptable SDMs with AUC >0.70, and those with AUC <0.70 were removed from the model set (Table 2). Models for 11 species did not converge on acceptable solutions and therefore were omitted from the model set (Table 2), yielding a final total of 64 quality priority species models.

<u>Conversion of SDMs to binary form based on suitability thresholds:</u> We evaluated each MaxEnt SDM logistic output with several threshold metrics (minimum training presence, fixed cumulative (FC) 1, FC5, FC10, Maximum training sensitivity plus specificity) to identify the most appropriate threshold to represent habitat models in binary form of acceptable or unacceptable habitat (Figure 2). Model runs included threshold calculations for each species. We evaluated the logistic output and threshold maps within the species range limits for approximately a dozen species representing widely distributed, geographically limited, broad point spread, limited point spread, and common and rare species. We determined that the FC5 and FC10 threshold models, which eliminate 5% and 10% of data points, respectively, provided acceptable models for this subset of species, and we created the binary maps indicating suitable and unsuitable habitat for each SDMs (Figure 2).

Compiling the SDMs into a PARCA algorithm:
The PARCA criteria and implementation guidance (PARCA Guidance; Sutherland and deMaynadier 2012) specifies criteria describing landscape integrity (Criterion 1), species rarity (Criterion 2, 3), regional responsibility (Criterion 4), and species richness (Criterion 5) to guide PARCA determination. We are using Ecological Integrity rasters (University of Massachusetts Landscape Ecology Lab) to represent Criterion 1 (see below). We reviewed the global/national status, state conservation status, and NEPARC regional responsibility matrix for each modeled species, and assigned each species to one of 3 tiers addressed in Criterion 2-4 (described below). We created amphibian and reptile species richness rasters by scaling summed species counts to maximums within ecoregions within states (to address latitudinal effects on richness) to represent Criterion 5 (see below). We are evaluating a variety of approaches to spatially compile these criteria in our PARCA algorithm, beginning with the following simple summation approach (Figure 3):

<u>Criterion 1. Landscape Integrity.</u> We have evaluated the Designing Sustainable Landscapes Index of Ecological Integrity rasters for representing the Landscape Integrity criterion, and we will use the Ecoregion and the HUC6-scaled IEI rasters to represent this criterion (Figure 4). We are partitioning these rasters into integrity classes (0-25%, 26-50%, 51-75%, 76-100%), and the reclassified raster will be partitioned into polygons to overlay and visually evaluate the proportion of each PARCA within these categories. We also will evaluate more complex approaches to incorporating this criterion, such as establishing proportional thresholds of integrity in each integrity class that a PARCA must include in order to be considered a PARCA, so that individual PARCAs can be rated with respect to the landscape condition scaled to HUC6 or ecoregion within the PARCA. This criterion is applied in our PARCA delineation process following application of Criteria 2-5 (Figure 3).

Criterion 2. Presence of Globally or Nationally Vulnerable Species. The PARCA Guidance assigns priority to species listed as globally or nationally vulnerable. We assigned species with the following status to Tier 1 for this Criterion: IUCN CR, EN, VU; USESA E, T; Natureserve G1-G3, T1-T3 (Table 1). The binary threshold surfaces for these species receive a weight = 1.0 in the PARCA summation algorithm.

Criterion 3. Presence of State Imperiled Species. The PARCA Guidance acknowledges state listing status for a species. Our PARCA algorithm incorporates this Criterion as Tier 2 species, with a greater weight (0.75) to these species within the states in which they are listed than within states where they are not state-listed (weight = 0.50). Each species threshold map is multiplied by its state-level weight raster, and the product is summed with weighted rasters for the other state-listed species to be combined with the summed tier 1 species rasters (Figure 3).

Criterion 4. Presence of State Rare Species or Species of High Regional Responsibility. The PARCA Guidance acknowledges regional responsibility for each species. These species also are listed as species of regional responsibility in the NEPARC matrix or have ≥50% of their range in the NEPARC region. All species not included in Tiers 1 or 2 (Criteria 2-3) are addressed with this Criterion. Our PARCA algorithm incorporates this Criterion as Tier 3 species (Figure 3). The binary threshold surfaces for these species receive a weight = 0.50 in the PARCA summation algorithm.

(The SDMs, weighted based on the criterion in which the species is placed, is summed, and the sum is scaled to the maximum raster pixel value within the raster prior to combining with the scaled richness rasters. See Figure 3.)

Criterion 5. Presence of an Exceptional Diversity of Amphibian or Reptile Species. The PARCA Guidance acknowledges reptile and amphibian species diversity. Our PARCA algorithm incorporates this Criterion as a raster for reptile species richness and a raster for amphibian richness. Each pixel value in these rasters has been weighted by the maximum species richness within the state and ecoregion within which the pixel occurs, with values ranging 0-1.0. These rasters are combined with Criteria 1-4 in our PARCA algorithm (Figure 3).

Converging PARCAs:
The PARCA algorithm results in a continuous value raster, with greater pixel values indicating greater sums across the Criteria (and thus higher relative levels of combined rarity and richness). Although we will supply this version of the PARCA algorithm output to state biologists, we are exploring approaches to coalescing the PARCAs across clusters into fewer, larger PARCAs while removing those smaller than the >1500 acre area threshold advised by Sutherland and deMaynadier (2012). Initially we will use the Getis-Ord hotspot analysis statistic on the summation of Tiers 1-5 to identify clusters. We will be exploring alternative approaches to combine or eliminate PARCAs during July-September; our analysis will include assessment not only of the cluster distributions, but also their location relative to areas of high Ecological Integrity and land conservation status (Objectives 3 and 4).

Objective 2*: Provide spatially-explicit maps of current and future climatic suitability for priority amphibians and reptiles in the NA-LCC region, and then use these data a) to rank species vulnerability to climate change based projected losses in the species' ranges, and b) to identify areas within the NA-LCC where either there are high losses of vulnerable species or there is high potential for climatic refugia for priority species, and c) identify species for which this Objective cannot be completed due to gaps in current known distributional data and thus identifies priorities for species data acquisition.*

No recent activity.

***Objective 3**: Summarize these results with respect to species occurring on lands under current state and federal management.*

No activity has been completed on this objective. We are evaluating the Protected Areas Database (http://gapanalysis.usgs.gov/padus/) and the National Conservation Easement Database (http://conservationeasement.us/) to address this Objective during July-September 2015.

***Objective 4:** Conduct an analysis of candidate PARCAs to help identify those highest priority conservation areas supporting reptiles and amphibians in the Northeast that are not currently protected.*

No work has been completed for this objective at this time. This objective will be addressed during July-September 2015 based on draft PARCAs.

***Objective 5**: Incorporate climate vulnerability projections into final PARCA analysis, including a ranking of high priority current and future conservation areas.*

Significant progress on this objective has been completed. We will apply the vulnerability framework developed by Drs. Sutton and Barrett to candidate PARCAs during July-September 2015.

***Objective 6:** Communicate results to key state, federal, and NGO partners via publications and a Northeast regional workshop.*

No activity during this quarter on this objective. We will solicit feedback from key state, federal, and NGO partners on draft PARCAs during September-October 2015. Plans for distributing the draft PARCAs and receiving feedback are in development. Initially we will distribute maps of draft PARCAs to biologists in Maine, New Hampshire, Massachusetts, and Virginia during August 2015 to receive feedback on the format of the materials so that these suggestions can be incorporated into the maps distributed for expert review and feedback during September-October 2015. In late July we will be participating in a PARC Symposium at the Society for the Study of Amphibians and Reptiles annual meeting in Lawrence, Kansas, where we will present the climate vulnerability analysis and draft Northeast PARCA delineation. We plan to meet at this meeting with scientists working on other regional PARCA projects to discuss their approaches to soliciting state-level feedback on draft PARCAs so that we may incorporate similar methods as appropriate.

Activities Anticipated Next Quarter:

- Complete draft PARCA delineation and development of feedback process
- Distribute draft PARCA maps to state experts for feedback
- While draft PARCAs are in state-review, we will evaluate thresholds for restricting PARCAs based on species numbers (i.e., evaluate the number of species of each tier in each pixel within each PARCA to identify PARCAs based on a minimum species count), evaluate alternative approaches for incorporating IEI into the PARCA algorithm and PARCA cluster merging, and evaluate draft PARCAs with respect to conservation lands.
- We will begin incorporating feedback on draft PARCAs as we receive review materials from state biologists.
- Participate in PARC Symposium at the 2015 Society for the Study of Amphibians and Reptiles annual meeting in Lawrence, Kansas.

Expected End Date:

June 30, 2016

Costs:

Total life to date expenses (include this quarter):
University of Maine= $164,439.82

University of Maine will reimburse $2,481.87 to WMI pending receipt of a Supplier record by WMI in the University of Maine vendor system (http://www.maine.edu/UMSVENDOR). Please note, this address is case sensitive. UMaine also will also require WMI to submit a W-9 or W-8 form to umsvendor@maine.edu. Please see the instructions in the online form. If you have questions regarding this request please feel free to contact Adam Corrigan – adam.corrigan@maine.edu / 207-581-2674.

Dr. Sutton will submit the Tennessee State University expenses report separately.

Total Approved Budgeted Funds: Original budget to UMaine was revised to $161,957.95.

Are you within the approved budget plan and categories? UMaine revised the contract to move $27,000 to Tennessee State University; an additional $2,481.87 in overhead was removed from the available funds. These funds were already spent, thus UMaine is returning $2,481.87 to WMI upon receipt of an invoice from WMI. See attached statement for details.

Signature: Cynthia S. Loftin

Date: July 13, 2015

Table 1. Environmental variables used in Species Distribution Models compiled for draft PARCAs in the North Atlantic–LCC region. Detailed descriptions of source data for variables created by the UMass DSL project are available at http://jamba.provost.ads.umass.edu/web/lcc/DSL_documentation_spatial_data.pdf.

Variable	Description	Data Source
aspect	Aspect in degrees	UMass DSL project
canopy	Percent tree canopy	NLCD
elevation	Elevation above mean sea level	NED/NHD
flow	Directional flow	UMass DSL project
gdd	Growing degree days (sum of # days mean daily temp >10 °C	UMass DSL project
geology	Rock type	USGS Mineral Resources
gradient	Percent slope derived from USGS DEM, NHD flowlines and flow accumulation	UMass DSL project
lulc	Land use, land cover type	TNC
precip	Mean annual precipitation	UMass DSL project
slope	Slope derived from NER	UMass DSL project
soilca	Calcium content of soil and water	UMass DSL project
soildepth	Depth to restrictive layer below ground surface	UMass DSL project
temp	Mean annual temperature	UMass DSL project
traffic	Traffic rate (average # vehicles/day)	UMass DSL project
wetness	Combination of flow accumulation and precipitation	UMass DSL project
lake	Lake	NWI
river	River	NWI
pond	Pond	NWI
stream	Stream	NWI
wetland	Wetland	NWI/TNC

Table 1. Species for which Distribution Models were developed, Guideline Criterion applied in the draft PARCA algorithm, and explanation for poor model fit for species models not compiled in PARCA algorithm.

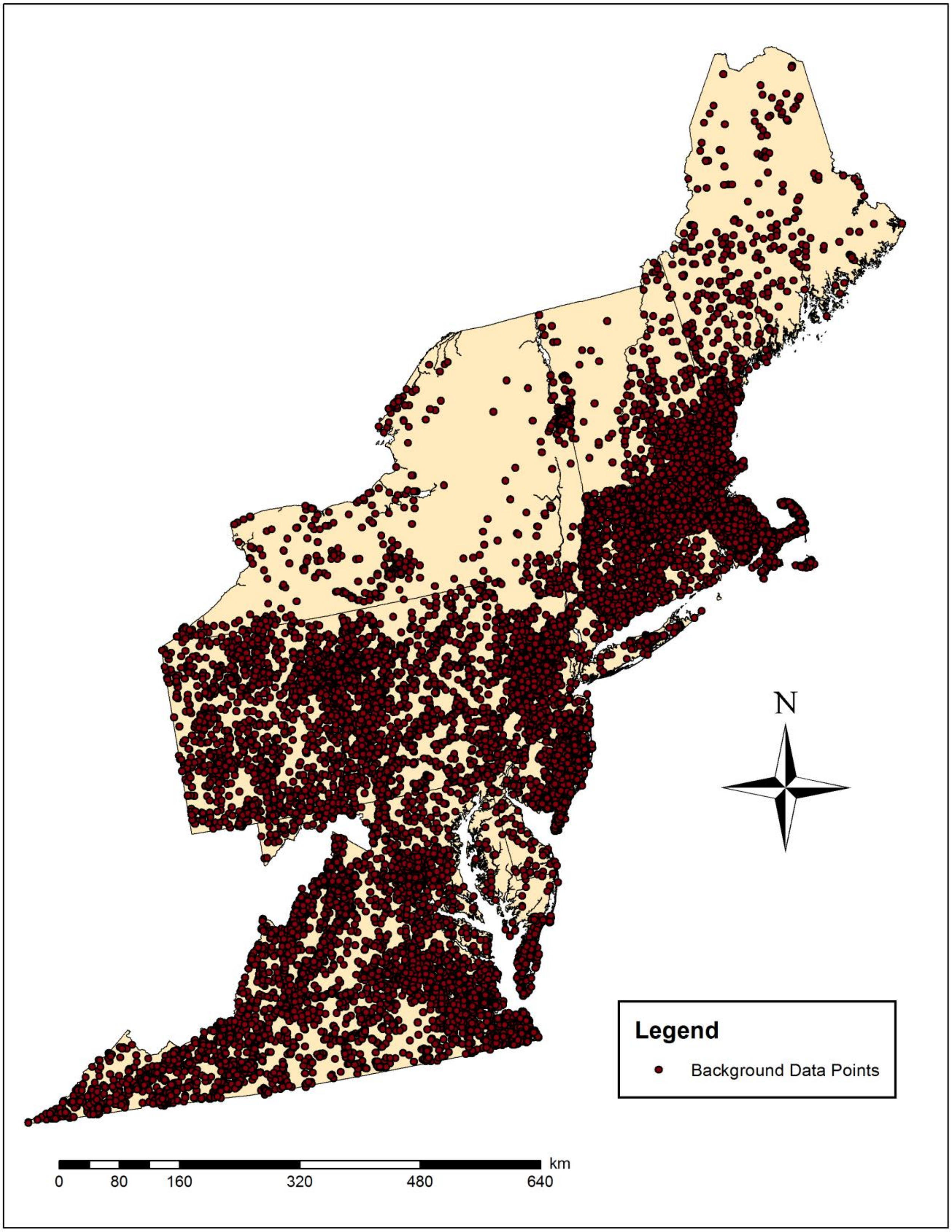
Species	Common Name	Modeled	Guideline criterion applied in algorithm	Source of poor model fit
Anurans				
Acris crepitans	Northern Cricket Frog	yes	3	
Anaxyrus fowleri	Fowler's Toad	no	4	Adequate # of points, but inadequate spatial distribution
Gastrophryne carolinensis	Eastern Narrowmouth Toad	yes	3	
Hyla andersonii	Pine-Barrens Treefrog	no	3	Very poor model fit; inaccurate geographic habitat projection
Hyla chrysoscelis	Gray Treefrog	no	3	Adequate number of points, but inadequate spatial distribution
Hyla gratiosa	Barking Treefrog	yes	3	
Lithobates pipiensi	Northern Leopard Frog	yes	4	
Lithobates sphenocephalus	Southern Leopard Frog	yes	3	
Lithobates virgatipes	Carpenter Frog	yes	4	
Pseudacris brachyphona	Mountain Chorus Frog	yes	3	
Pseudacris kalmi	New Jersey Chorus Frog	yes	3	
Scaphiopus holbrookii	Eastern Spadefoot	yes	3	
Salamanders				
Ambystoma laterale	Jefferson’s Blue-spotted species complex	yes	3	
Ambystoma mabeei	Mabee’s Salamander	yes	3	
Ambystoma opacum	Marbled Salamander	yes	3	
Ambystoma tigrinum	Tiger Salamander	yes	3	
Aneides aeneus	Green Salamander	yes	2	
Cryptobranchus alleganiensis	Eastern Hellbender	yes	2	
Desmognathus fuscus	Northern Dusky Salamander	yes	4	
Desmognathus monticola	Seal Salamander	yes	4	
Desmognathus ochrophaeus	Allegheny Mountain Dusky Salamander	yes	4	
Desmognathus organi	Northern Pygmy Salamander	yes	2	
Eurycea bislineata	Two-lined Salamander	yes	4	
Eurycea longicauda	Long-tailed Salamander	yes	2	

Gyrinophilus porphyriticus	Northern Spring Salamander	yes	3	
Necturus maculosus	Common Mudpuppy	yes	4	
Plethodon glutinosus	Slimy Salamanders (White-spotted, Slimy, Cumberland)	yes	3	
Plethodon hoffmani	Ridge and Valley Salamander	yes	4	
Plethodon hubrichti	Peaks of Otter Salamander	yes	2	
Plethodon punctatus	Cow Knob Salamander	yes	2	
Plethodon shenandoah	Shenandoah Salamander	yes	2	
Plethodon sherando	Big Levels Salamander	no	2	Only one geographic location
Plethodon virginia	Shenandoah Mountain Salamander	yes	2	
Plethodon wehrlei	Wehrle's Salamander	yes	4	
Plethodon welleri	Weller's Salamander	yes	2	
Pseudotriton montanus	Mud Salamander	no	3	Extremely poor model fit; AUC < 0.50
Pseudotriton ruber nitidus	Red Salamander	yes	3	
Lizards				
Ophisaurus ventralis	Eastern Glass Lizard	no	3	Only two locations in occurrence databases
Plestiodon anthracinus	Coal Skink	yes	2	
Plestiodon fasciatus	Common Five-lined Skink	yes	3	
Plestiodon laticeps	Broad-headed Skink	no	4	Extremely poor model fit; AUC < 0.60
Sceloporus undulatus	Eastern Fence Lizard	yes	3	
Snakes				
Agkistrodon controtrix	Northern Copperhead	yes	3	
Carphophis amoenus	Eastern Wormsnake	yes	3	
Cemophora coccinea	Scarlet Snake	yes	3	
Clonophis kirtlandii	Kirtland's Snake	no	3	Only ten locations and poor model projection
Coluber constrictor	Northern Black Racer	yes	2	
Crotalus horridus	Timber Rattlesnake	yes	3	
Diadophis punctatus	Northern Ring-necked Snake	yes	4	
Farancia erytrogramma	Rainbow Snake	no	3	Very poor model fit; AUC < 0.65
Heterodon platirhinos	Eastern Hognose Snake	yes	3	
Nerodia erythrogaster	Red-bellied Watersnake	yes	3	
Opheodrys aestivus	Rough Greensnake	yes	3	
Opheodrys vernalis	Smooth Greensnake	yes	4	
Pantherophis alleganiensis	Black Rat Snake	yes	3	
Pantherophis guttatus	Red Cornsnake	yes	3	
Pituophis melanoleucus	Northern Pine Snake	yes	3	

Regina septemvittata	Queensnake	yes	3	
Sistrurus catenatus	Eastern Massassaga	no	2	Very limited access to locations in PA (< 10); no locations in NY
Storeria dekayi	Northern Brownsnake	yes	4	
Thamnophis brachystoma	Short-headed Gartersnake	no	4	Very limited access to locations in PA (< 10)
Thamnophis sauritis	Ribbon Snake	yes	4	
Virginia valeriae	Earthsnake	yes	3	
Turtles				
Apalone spinifera	Spiny Softshell Turtle	yes	3	
Chrysemys picta	Painted Turtle	yes	4	
Clemmys guttata	Spotted Turtle	yes	2	
Deirochelys reticularia	Chicken Turtle	yes	3	
Emydoidea blandingii	Blanding’s Turtle	yes	2	
Glyptemys insculpta	Wood Turtle	yes	2	
Glyptemys muhlenbergii	Bog Turtle	yes	2	
Graptemys geographica	Common Map Turtle	yes	3	
Kinosternon subrubrum	Eastern Mud Turtle	yes	3	
Malaclemys terrapin	Diamondback Terrapin	yes	3	
Pseudemys rubriventris	Northern Red-bellied Turtle	yes	2	
Terrapene carolina	Eastern Box Turtle	yes	2	

Figure 1. Background point dataset used to develop Species Distribution Models (a) for all species and for (b) *Terrepene carolina*

(a)



(b)

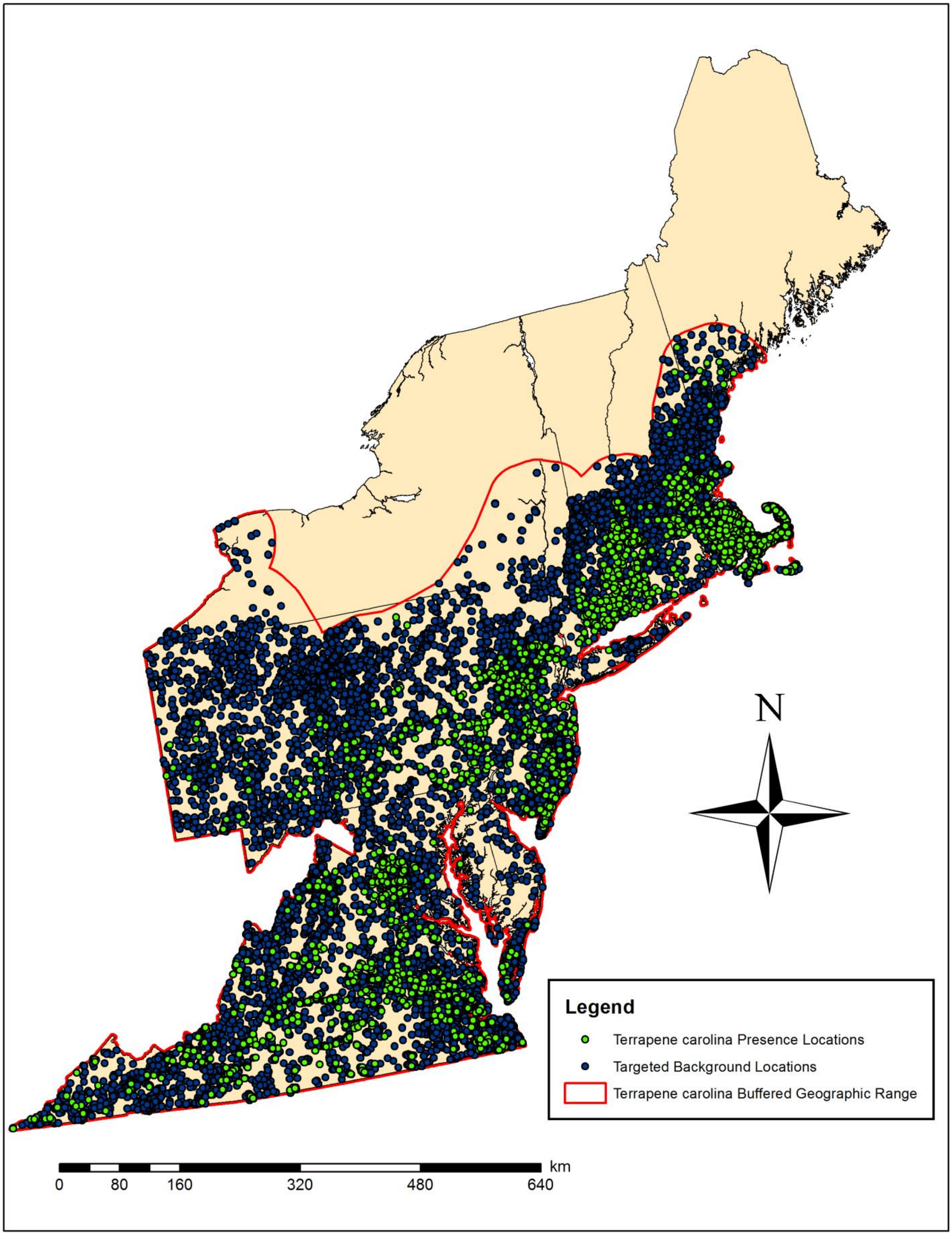
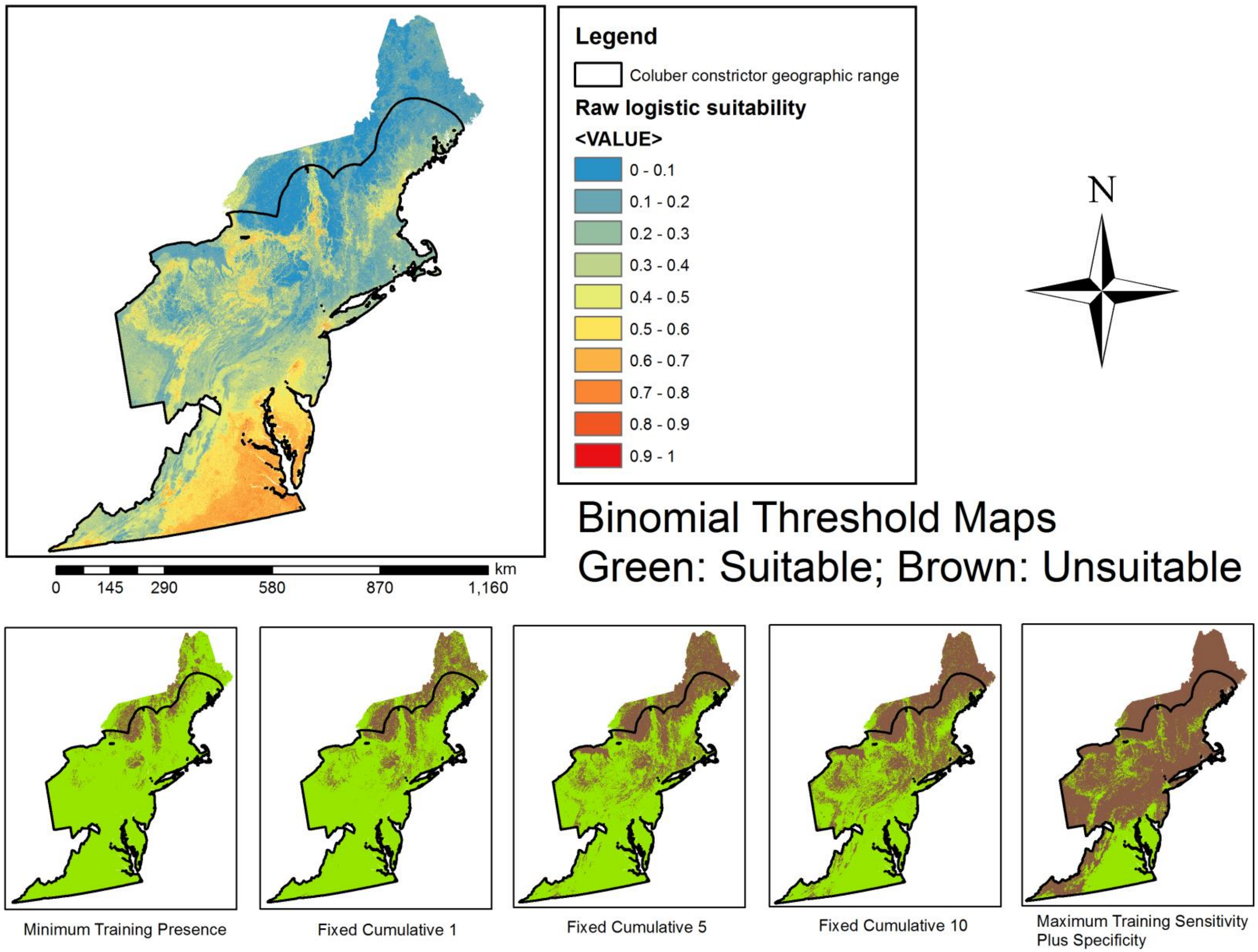
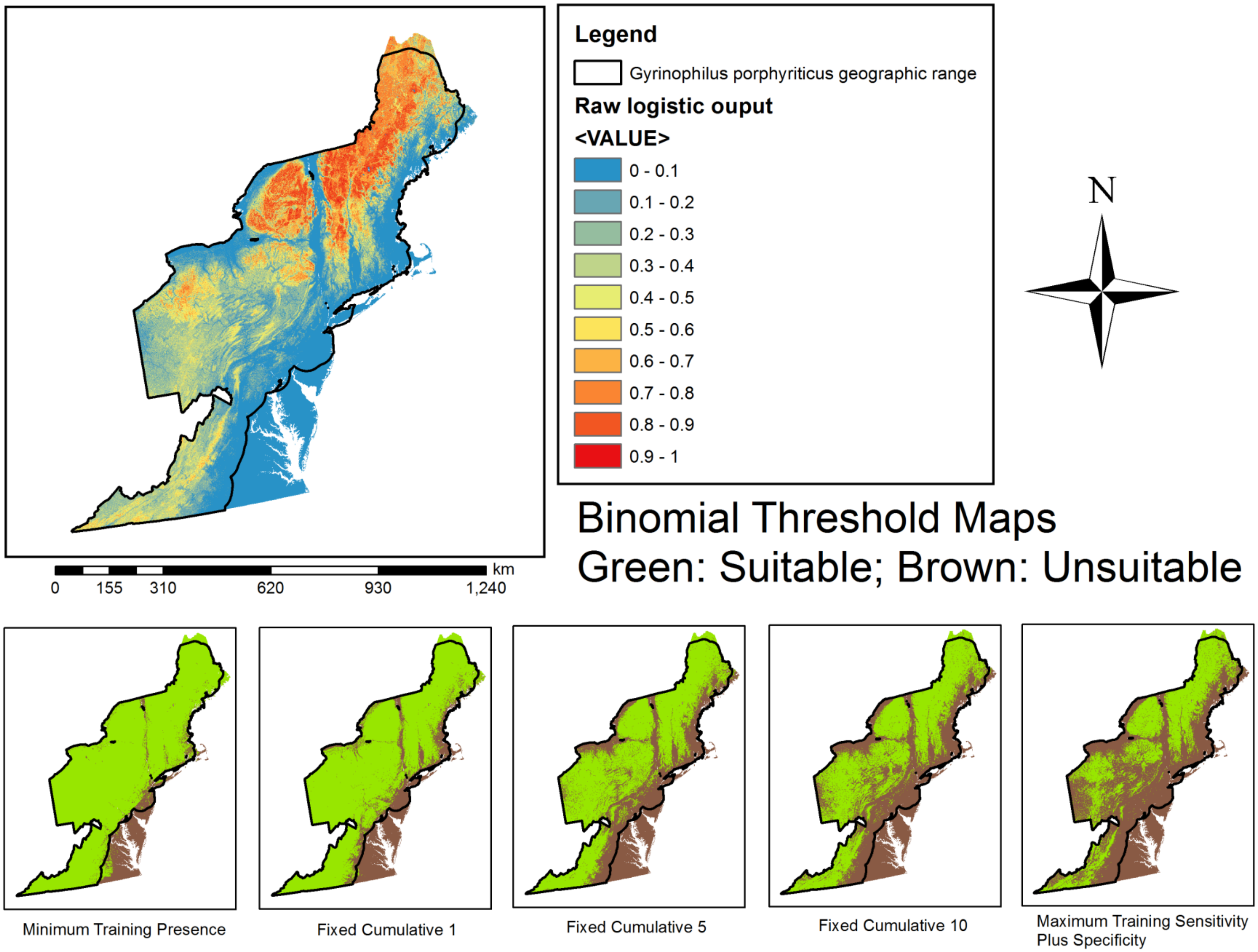

N
Legend
Terrapene carolina Presence Locations
Targeted Background Locations
Terrapene carolina Buffered Geographic Range
km
0
80
160
320
480
640

Figure 2. Example Species Distribution Models in logistic and threshold forms for (a) *Coluber constrictor*, (b) *Gyrinophilus porphyriticus*, and (c) *Terrepene carolina*.

(a)



(b)


Legend
Gyrinophilus porphyriticus geographic range
Raw logistic ouput
<VALUE>
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1
N
km
0
155
310
620
930
1,240
Binomial Threshold Maps
Green: Suitable; Brown: Unsuitable
Minimum Training Presence
Fixed Cumulative 1
Fixed Cumulative 5
Fixed Cumulative 10
Maximum Training Sensitivity Plus Specificity

(c)

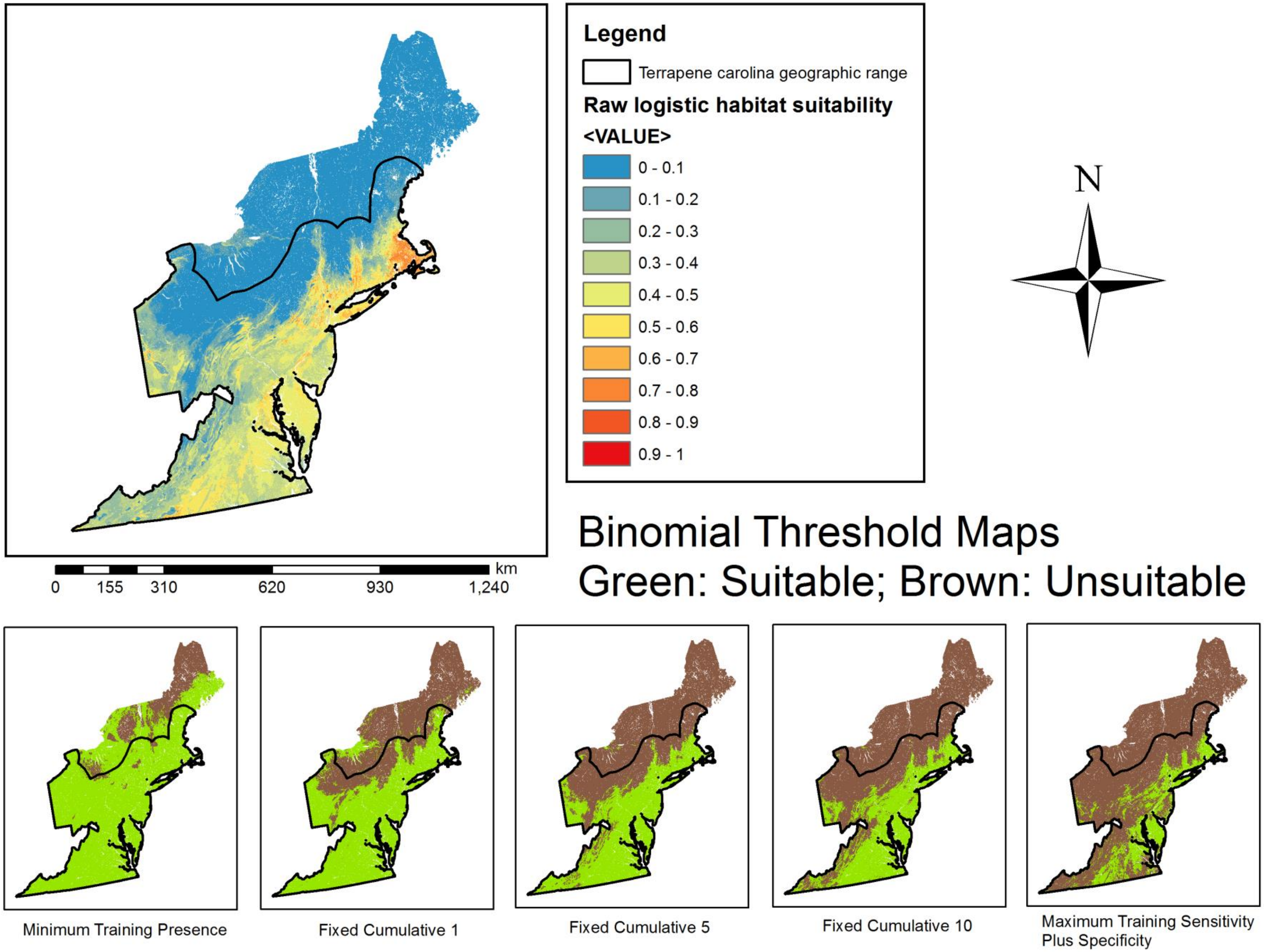

Legend
Terrapene carolina geographic range
Raw logistic habitat suitability
<VALUE>
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1
N
km
0
155
310
620
930
1,240
Binomial Threshold Maps
Green: Suitable; Brown: Unsuitable
Minimum Training Presence
Fixed Cumulative 1
Fixed Cumulative 5
Fixed Cumulative 10
Maximum Training Sensitivity Plus Specificity

Figure 3. Algorithm to apply PARCA System Criteria and Implementation Guidance in compiling SDM threshold maps to identify Draft PARCAs.

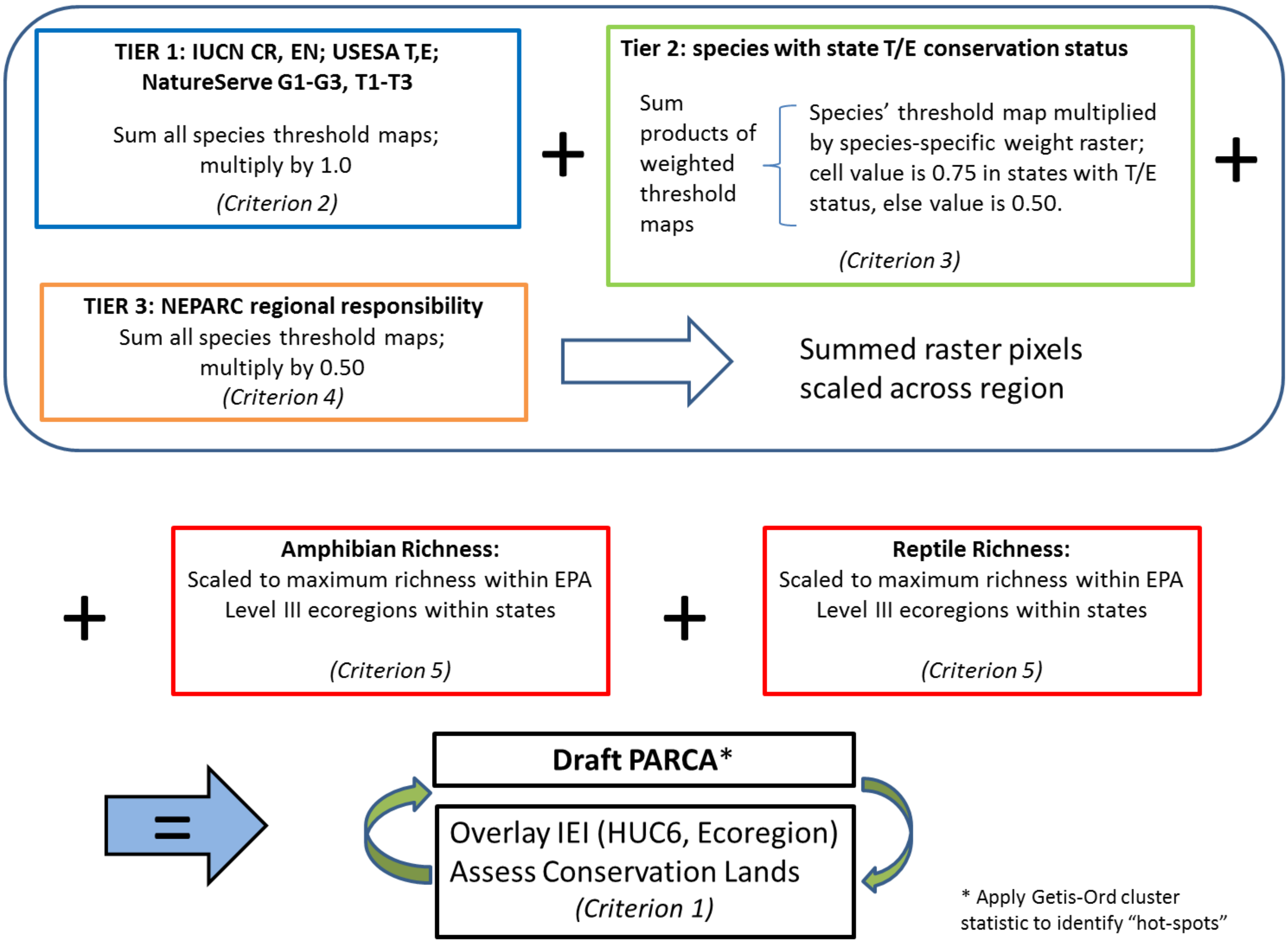
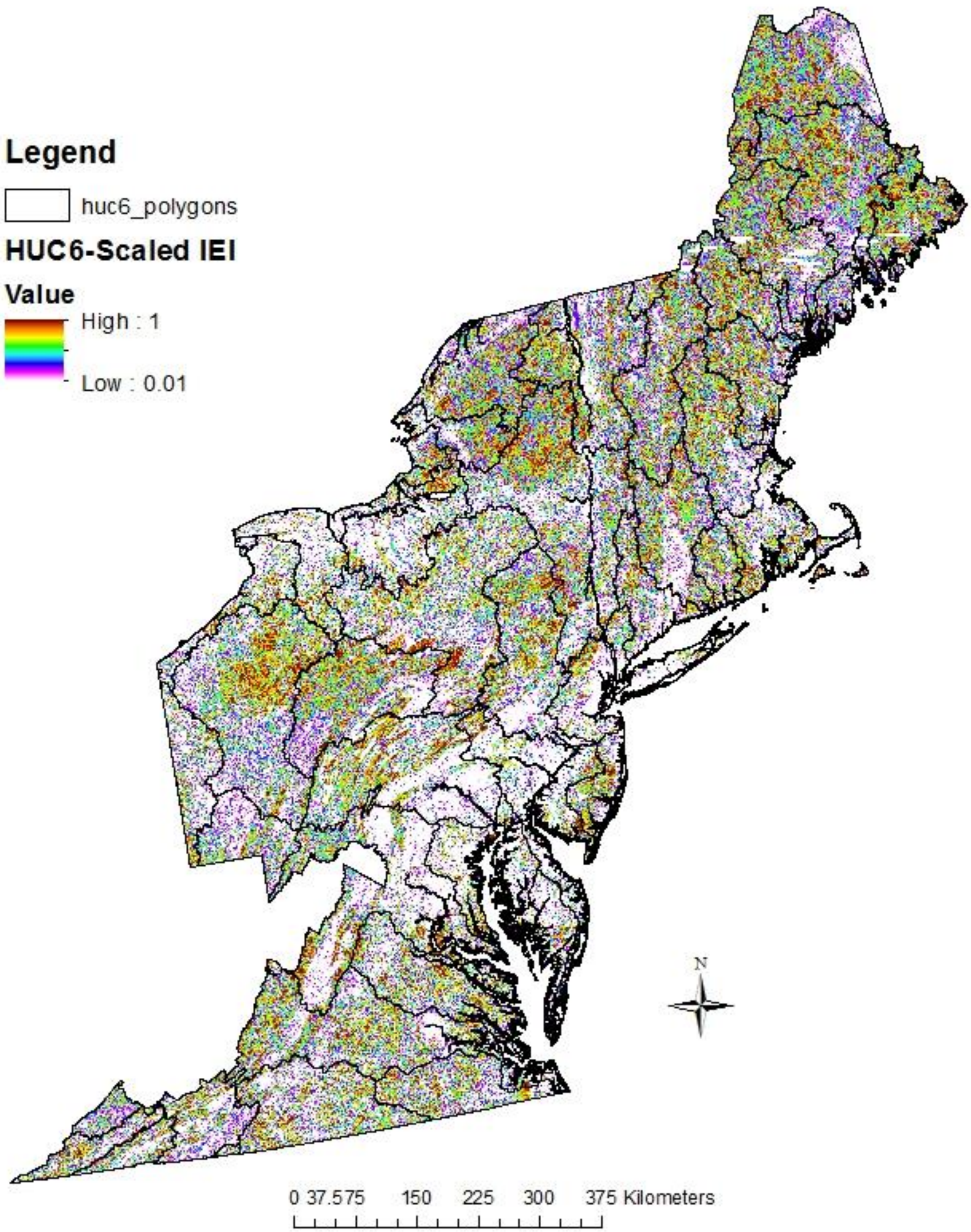
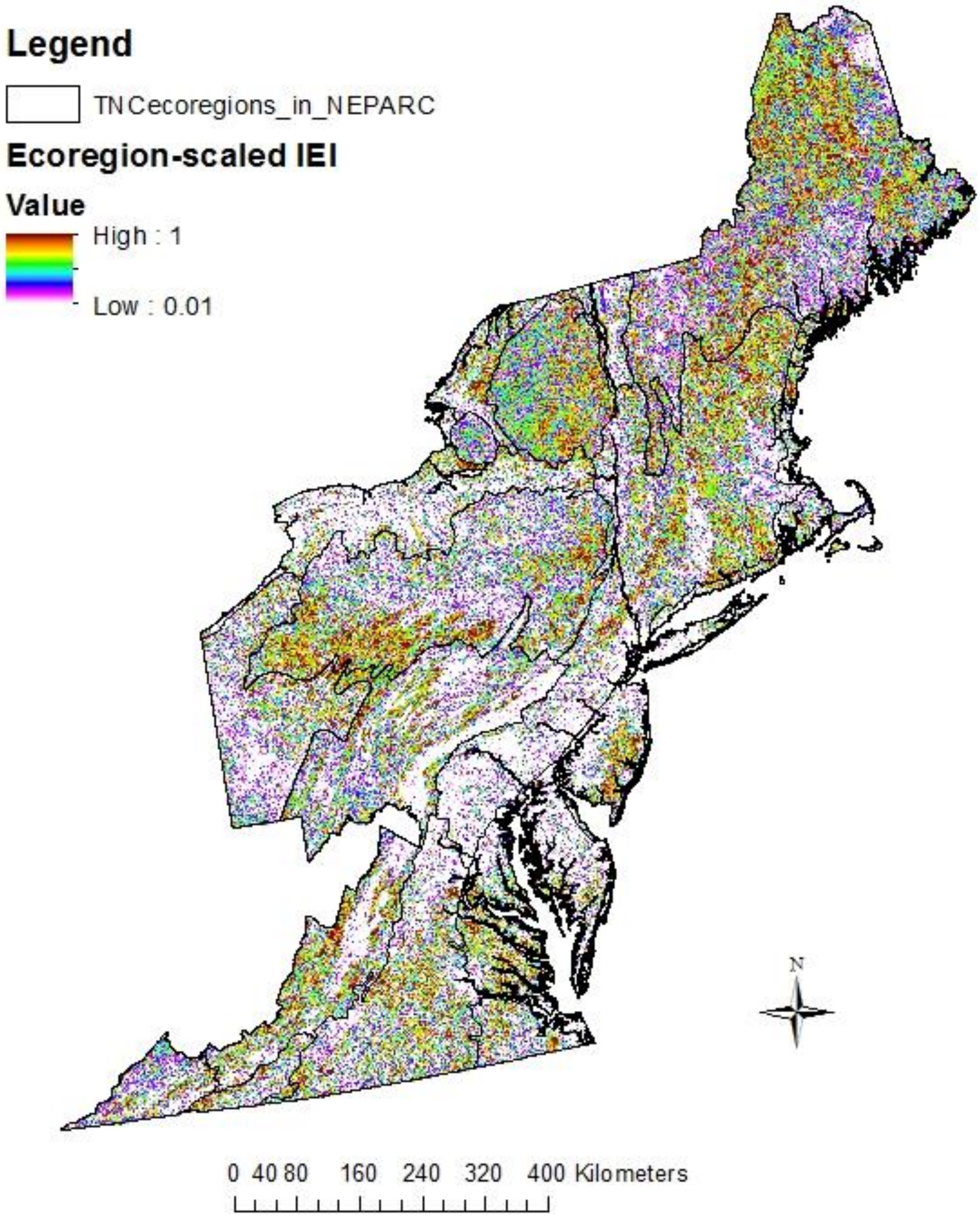


Figure 4. Index of Ecological Integrity scaled to (a) HUC6 and (b) TNC ecoregion, developed by the Designing Sustainable Landscapes project in NA-LCC. The IEI is being used to apply the PARCA System Criteria and Implementation Guidance Criterion 1 in our Draft PARCA algorithm.

(a)



(b)


Legend
TNCecoregions_in_NEPARC
Ecoregion-scaled IEI
Value
High : 1
Low : 0.01
N
0 40 80 160 240 320 400 Kilometers