June 2021 Webinars

EMRRP

US Army Corps of Engineers

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

DISCOVER | DEVELOP | DELIVER

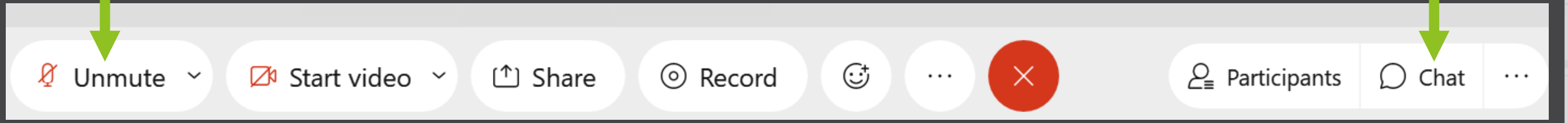
Model to Assess Species and Habitat Migration Due to Climate Change

Webinar Logistics:

- The webinar will begin at 11:00 am CDT.
- To access the audio select “Call Me” – this is the preferred option to reduce feedback.
- If you are unable to connect via the “Call Me” feature,
  - Dial: 1-844-800-2712
  - Access: 199 565 7227#

Webinar Instructions

- All lines are muted.
- Submit questions or comments in the Chat Box to "Everyone".
- The webinar is being recorded and will be shared following the meeting.



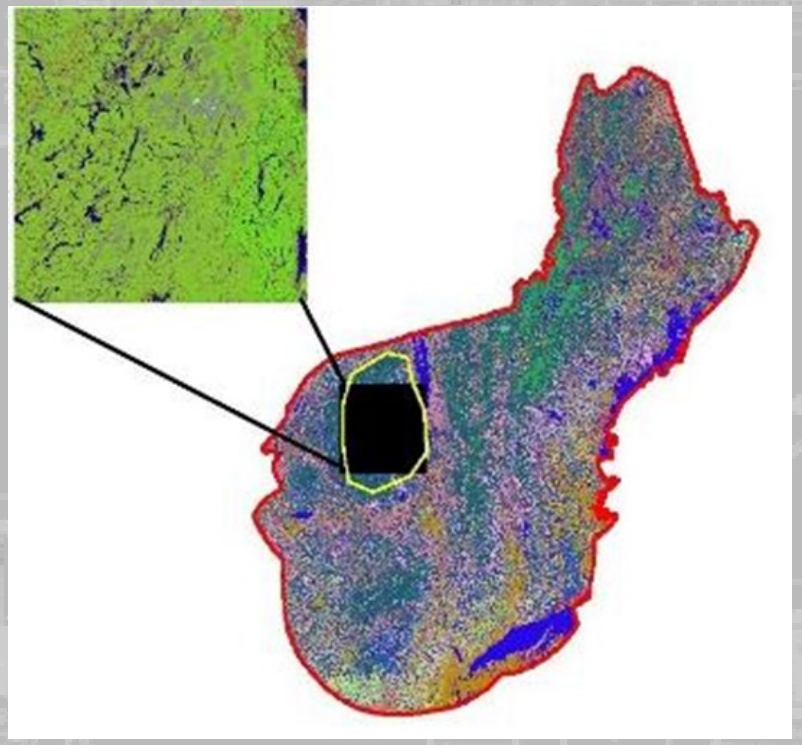
Presenters

Jacob Jung is a Research Wildlife Biologist in the Environmental Laboratory, Ecological Resources Branch at ERDC and he is part of the Wildlife Team.
His background is focused on ornithology, habitat management, and wildlife monitoring.

Christina Saltus is a Research Geographer in the Environmental laboratory, Environmental Systems Branch at ERDC and is part of the Geospatial Data Analysis Facility team.
Her background is in remote sensing, GIS, and geospatial tool development for the ecosystem research.

DATA ASSESSMENT OF SPECIES AND HABITAT MIGRATION DUE TO CLIMATE CHANGE

Jacob Jung and Christina Saltus
Research Wildlife Biologist/Research Geographer
2015-ER-14
Date: 15 June, 2021



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Project Purpose

- SON: 2015-ER-14: Data Assessment of Species and Habitat Migration due to Climate Change

- Need: A large number of species/geographic areas are impacted by climate change, and a framework is needed to enable easy investigation and comparison of impacts across sites to allow for prioritization of restoration efforts

- Purpose: Provide a model framework and output for visualization in GIS software that allows USACE Districts to best manage for ecosystem restoration projects with ongoing changes as a result of climate change

Benefit

- Benefit: Allow users to visually see how habitats are predicted to change in the future, thereby allowing for a more proactive management approach to ecosystem management. Rather than focusing simply on a wildlife species range shift or highlighting areas that are most vulnerable, this model visualizes the most likely habitats to occur within an area during future climate scenarios.

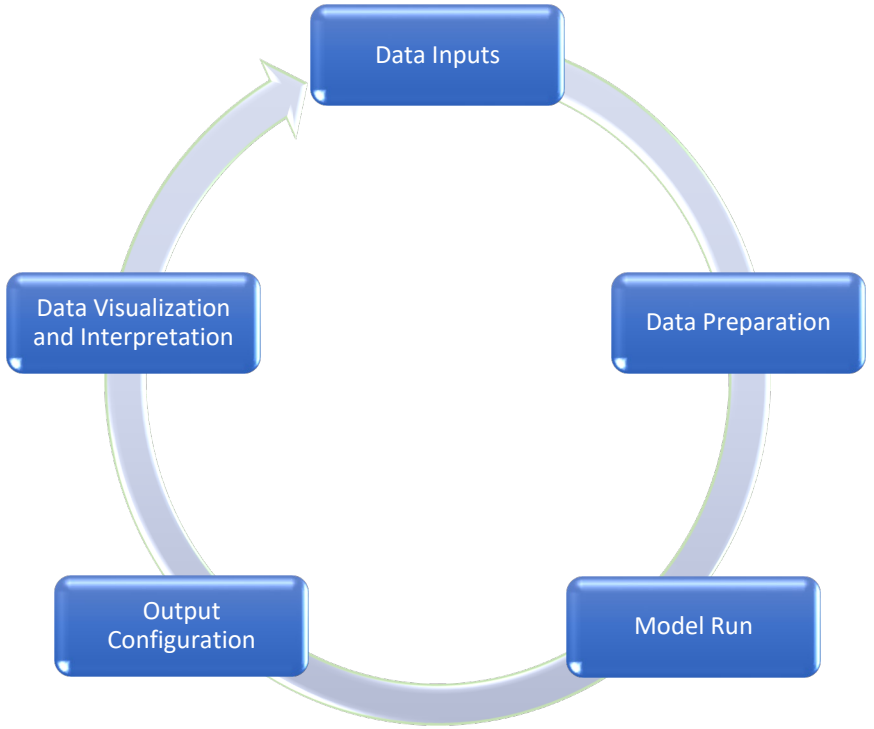
Model Methodology

- How will climate projections affect habitat shifts across the landscape and what are the most likely habitats that will colonize the impacted areas?
- The geographical framework was developed as a simple terrestrial vegetation prediction model
- The base layers of the framework include vegetation type and predicted climate data
- Dynamic habitat shifting simulation
- Multiple iterations are run to obtain a list of the most likely vegetation habitat to colonize the impacted habitats

Model Design

- Software and Coding Requirements:
  - Rust programming language (https://rustup.rs)
  - Rust Cargo
  - Python 3.7
- Hardware Requirements:
  - Windows 10 with minimum 32GB RAM
- Displays Results via GIS-based software
  - i.e. ArcGIS, QGIS
- Limitation
  - Applicable to regional or reservoir scale areas
  - Data and time intensive analysis
  - Currently requires programming knowledge
  - Requires significant storage space (e.g. external storage drive)

Model Workflow



Data Inputs

- **Historical and Predicted Climate Data**
  - Hadley Centre Global Environment Model v2 Temperature and Precipitation (rcp85/r1i1p1)
  - Temporal Range: 2006-2099 (monthly)
  - Data Type: Raster
  - Sources: https://data.globalchange.gov/model/hadgem2
    https://www.fs.usda.gov/ccrc/tool/climate-wizard

- **Existing Vegetation Type (ie. USGS LANDFIRE)**
  - Year: 2014
  - Data Type: Raster
  - Source: Available online https://landfire.gov/version_download.php#

- **Dispersal Distance**
  - Data Type: Comma Delimited File (CSV)
  - Source: Derived from historical changes in vegetation type

- **Climate Envelope**
  - Data Type: Comma Delimited File (CSV)
  - Source: Derived from regional climate data

Configuration File

config.toml - Notepad

File Edit Format View Help

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input="./example/ecoregions.npz"
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envelopes="./example/envelopes.csv"
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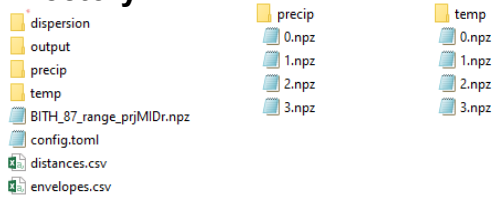
Model Directory



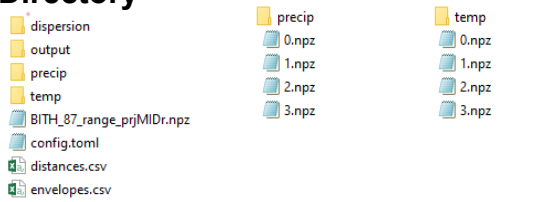
Data Preparation

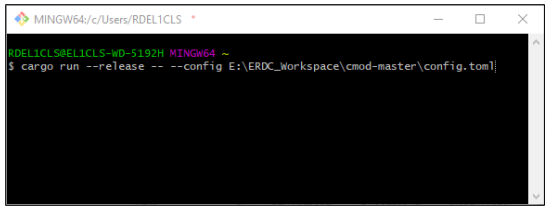
- Standardize data layers spatial reference and spatial resolution
- Clip data to your Area of Interest
  - Regional Climate Envelope (ie. Northeast)
  - Analysis Area (ie. Reservoir)
- Create Climate Envelope (1950-2005)
  - Avg Min and Max Temperature
  - Avg Min and Max Precipitation
- Calculate July Min and Max Precipitation and Temperature range (2006-2099)
- Python scripts – output compressed numpy format (.npz)

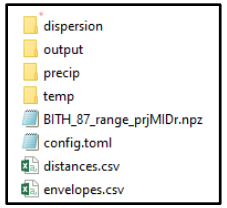
Climate Envelope

	A	B	C	D	E
1	code	temp_mx	temp_mn	precip_mx	precip_mn
2	0	29.71198654	-25.11110687	3.652477026	2.735599041
3	2	33.33710861	-14.00466347	3.600230455	3.137039185
4	3	33.33710861	-23.48329163	3.600230455	2.476728201
5	4	33.33710861	-22.63945007	3.600230455	2.476728201
6	5	33.33710861	-25.11110687	3.652477026	2.476728201
7	6	33.33710861	-23.48329163	3.600230455	2.476728201
8	7	32.83883667	-23.48329163	3.600230455	2.476728201
9	8	32.77629852	-24.93285942	3.652477026	2.476728201
10	9	33.33710861	-23.48329163	3.600230455	2.476728201
11	10	33.33710861	-23.48329163	3.600230455	2.476728201
12	11	32.49179077	-15.14382076	3.516705036	2.744009256

Model Directory





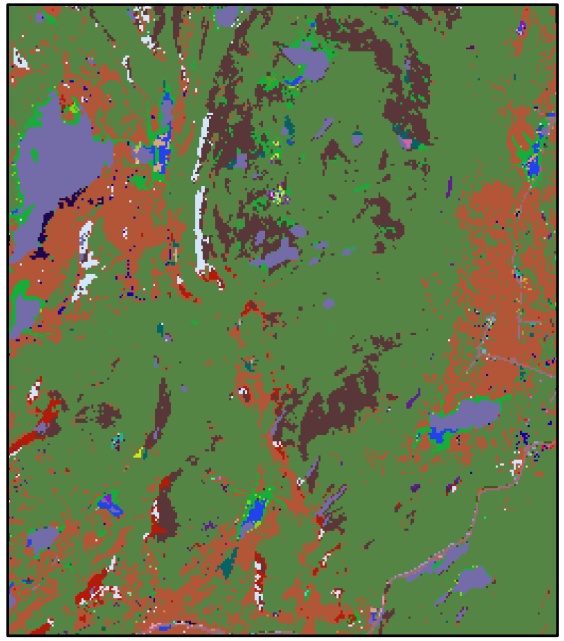


Model - Dispersion Grids

Distance.csv

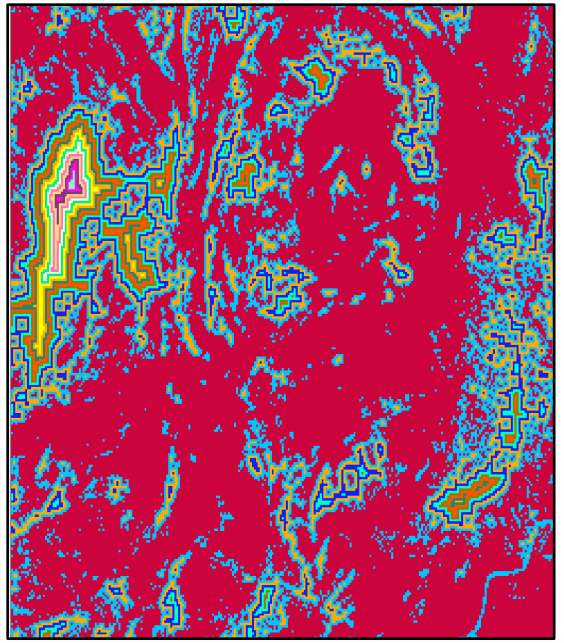
	A	B
1	code	dist (m)
2	0	0.000001
3	2	0.01
4	3	0.1
5	4	0.1
6	5	0.01
7	6	0.1
8	7	0.1
9	8	0.01
10	9	0.1
11	10	0.01
12	11	0.01
13	12	0.01
14	13	0.1
15	14	0.01
16	15	0.1
17	16	0.01
18	17	0.1
19	18	0.1
20	19	0.1
21	20	0.1
22	21	0.01
23	22	0.1
24	23	0.1
25	24	0.01
26	25	0.000001
27	26	0.000001
28	28	0.000001
29	32	0.01
30	33	0.1
31	34	0.1
32	35	0.1
33	36	0.1
34	37	0.1
35	38	0.1
36	39	0.01
37	40	0.000001

Vegetation Type
EcoGrid of Habitats

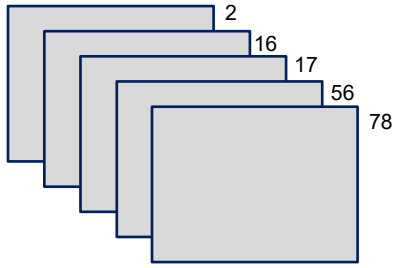


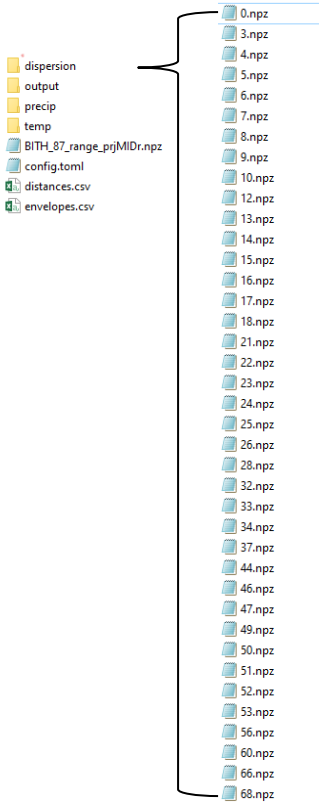
Value	CLASSNAME
32	Central Interior and Appalachian Riparian Herbaceous
33	Laurentian-Acadian Northern Hardwoods Forest
34	Northeastern Interior Dry-Mesic Oak Forest
35	Southern Piedmont Mesic Forest
36	Southern and Central Appalachian Cove Forest
37	Central Interior and Appalachian Riparian Shrubland
38	Northern Atlantic Coastal Plain Hardwood Forest
39	Gulf and Atlantic Coastal Plain Floodplain Herbaceous
40	Appalachian Shale Barrens
41	Southern Atlantic Coastal Plain Mesic Hardwood Forest
42	Boreal Jack Pine-Black Spruce Forest

Dispersion Grid
Ecocode 33

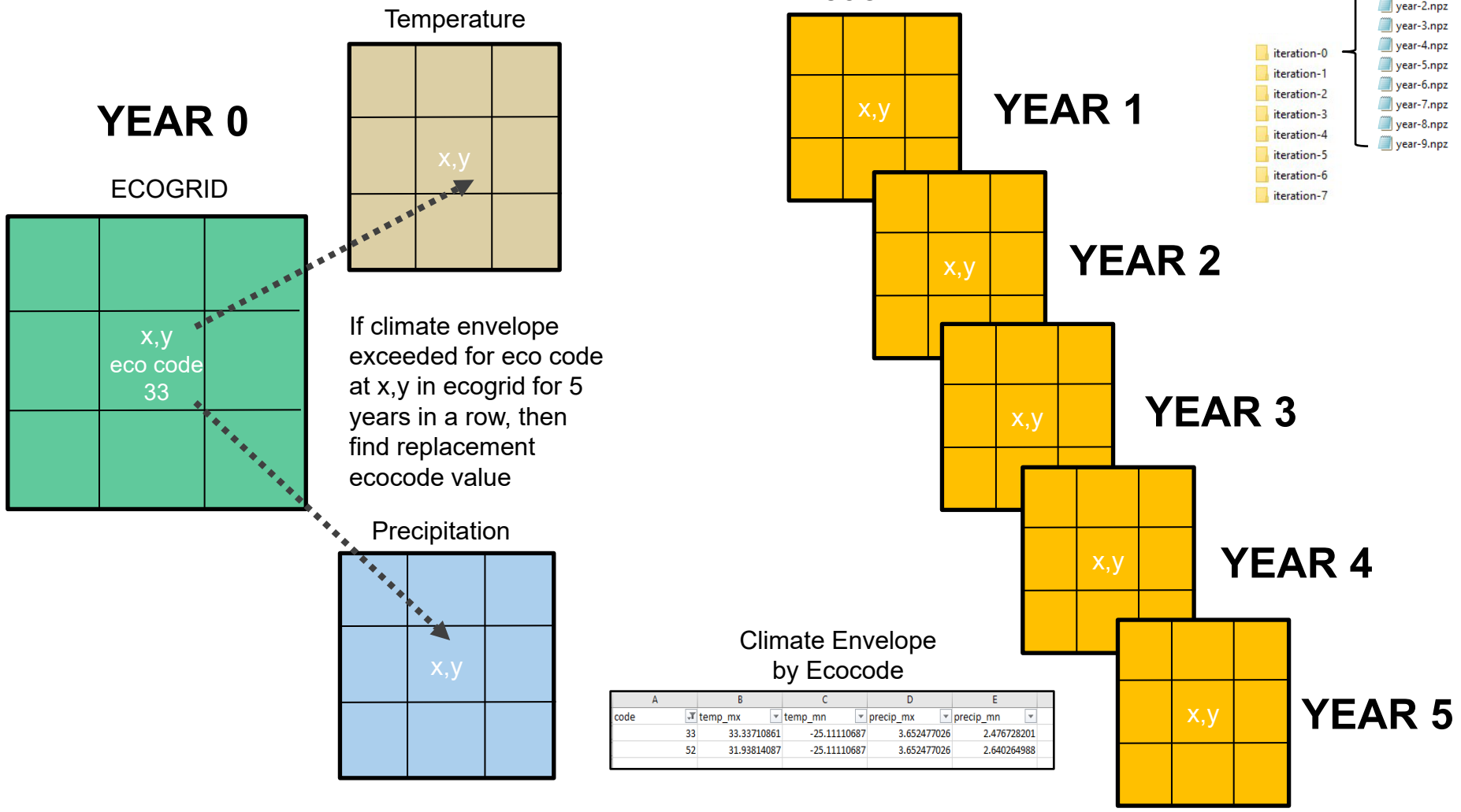


Dispersion Grid created for each Ecocode





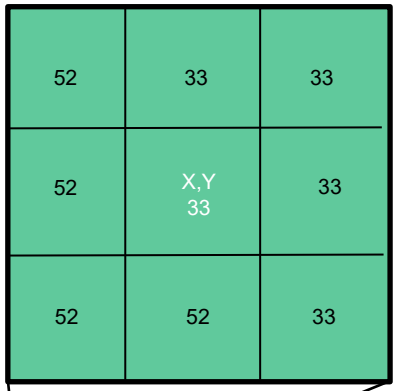
Model – Climate Evaluation

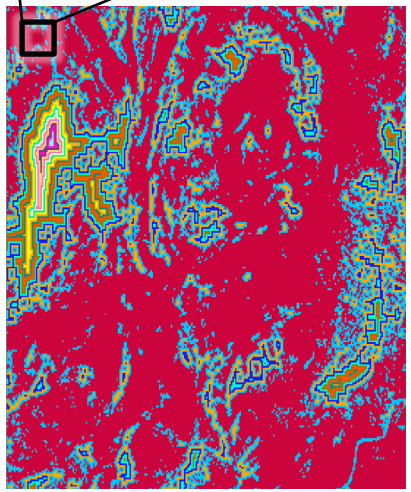


code	temp_mx	temp_mn	precip_mx	precip_mn
33	33.33710861	-25.11110687	3.652477026	2.476728201
52	31.93814087	-25.11110687	3.652477026	2.640264988

Model – Habitat Switching

ECOGRID





ECOCODE 33
Dispersion Grid

Climate Envelope

code	temp_mx	temp_mn	precip_mx	precip_mn
33	33.33710861	-25.11110687	3.652477026	2.476728201
52	31.93814087	-25.11110687	3.652477026	2.640264988

Climate Envelope Exceeded >5 yrs

↓

Evaluate Dispersion Grid

↓

Gather List of Candidate Ecocodes

[14, 45, 72, 34, 25, 61…]

↓

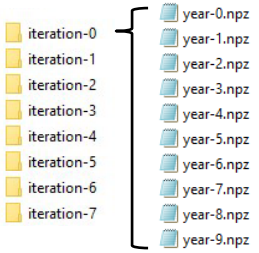
Compare Candidate Ecocodes to Climate Envelope

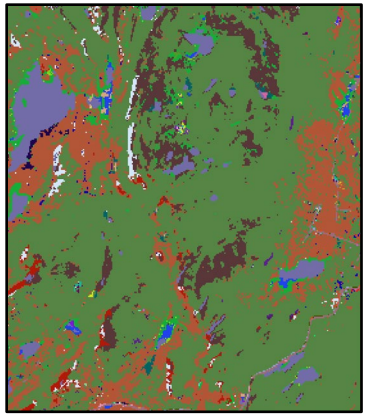
code	temp_mx	temp_mn	precip_mx	precip_mn
33	33.33710861	-25.11110687	3.652477026	2.476728201
52	31.93814087	-25.11110687	3.652477026	2.640264988

Random Selection of Ecocode that Meets Criteria

↓

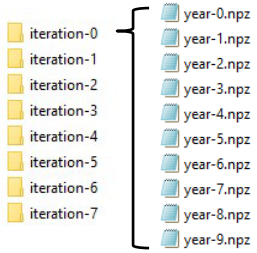
Replacement of the Ecocode at the Pixel Location X,Y



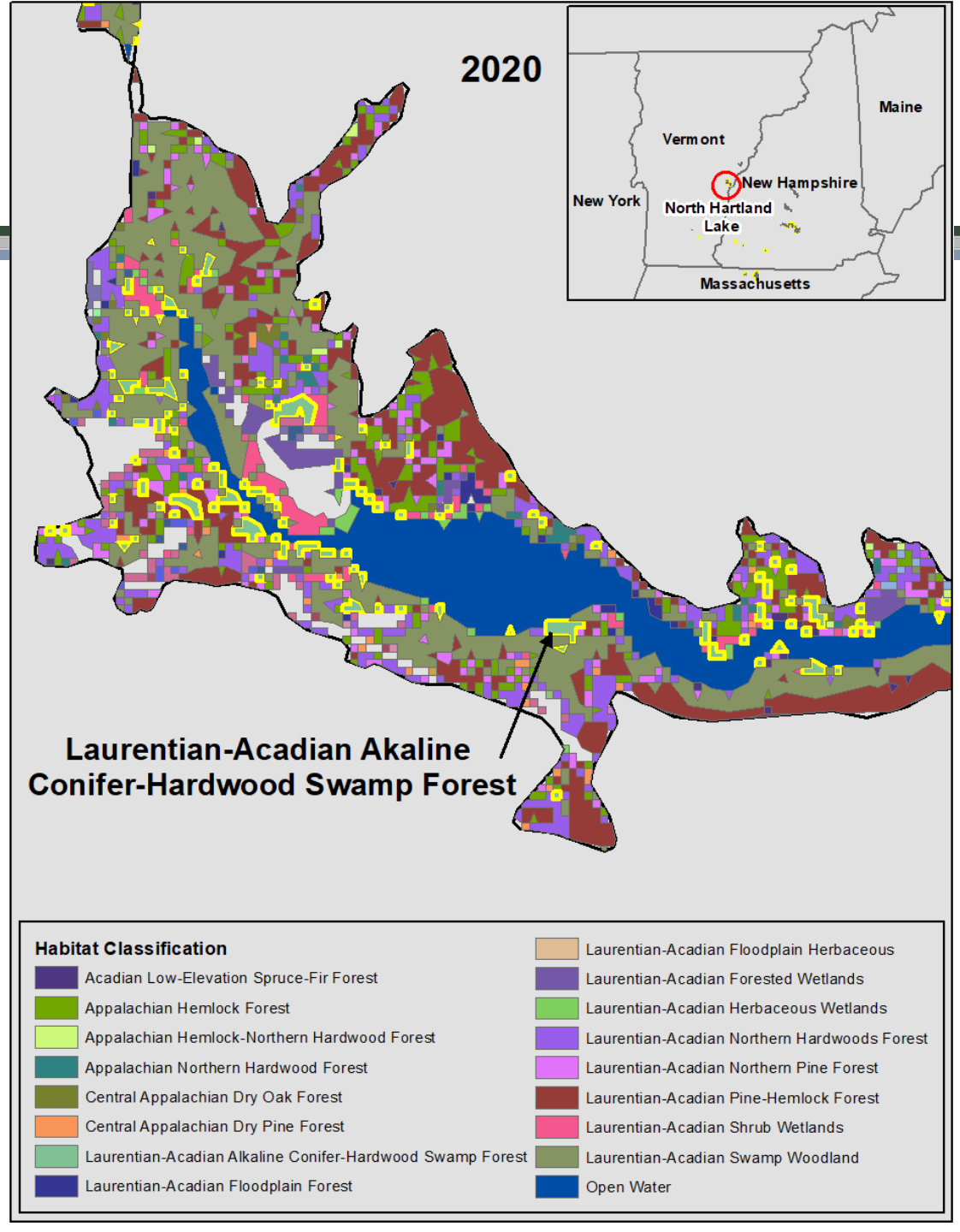


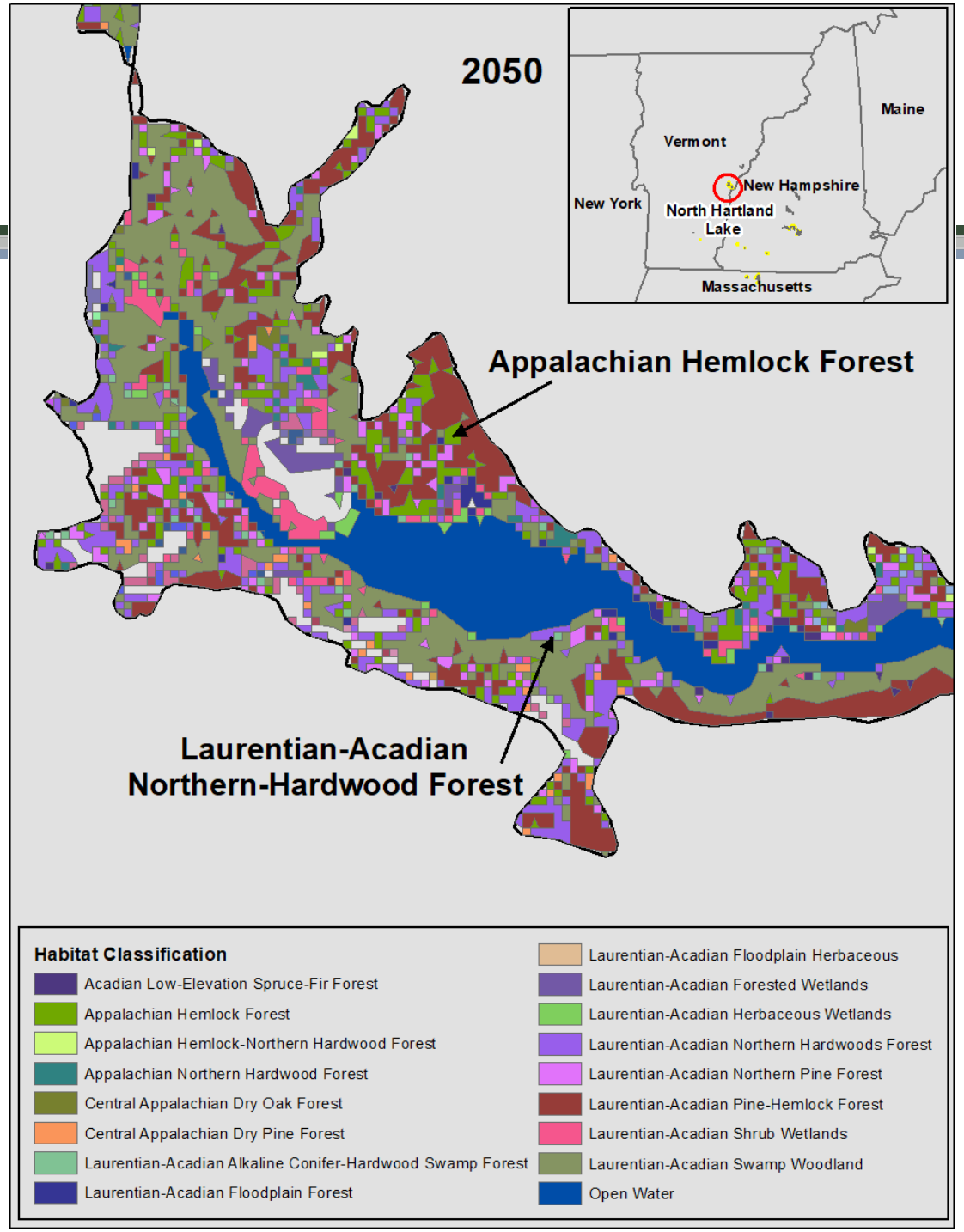
Output

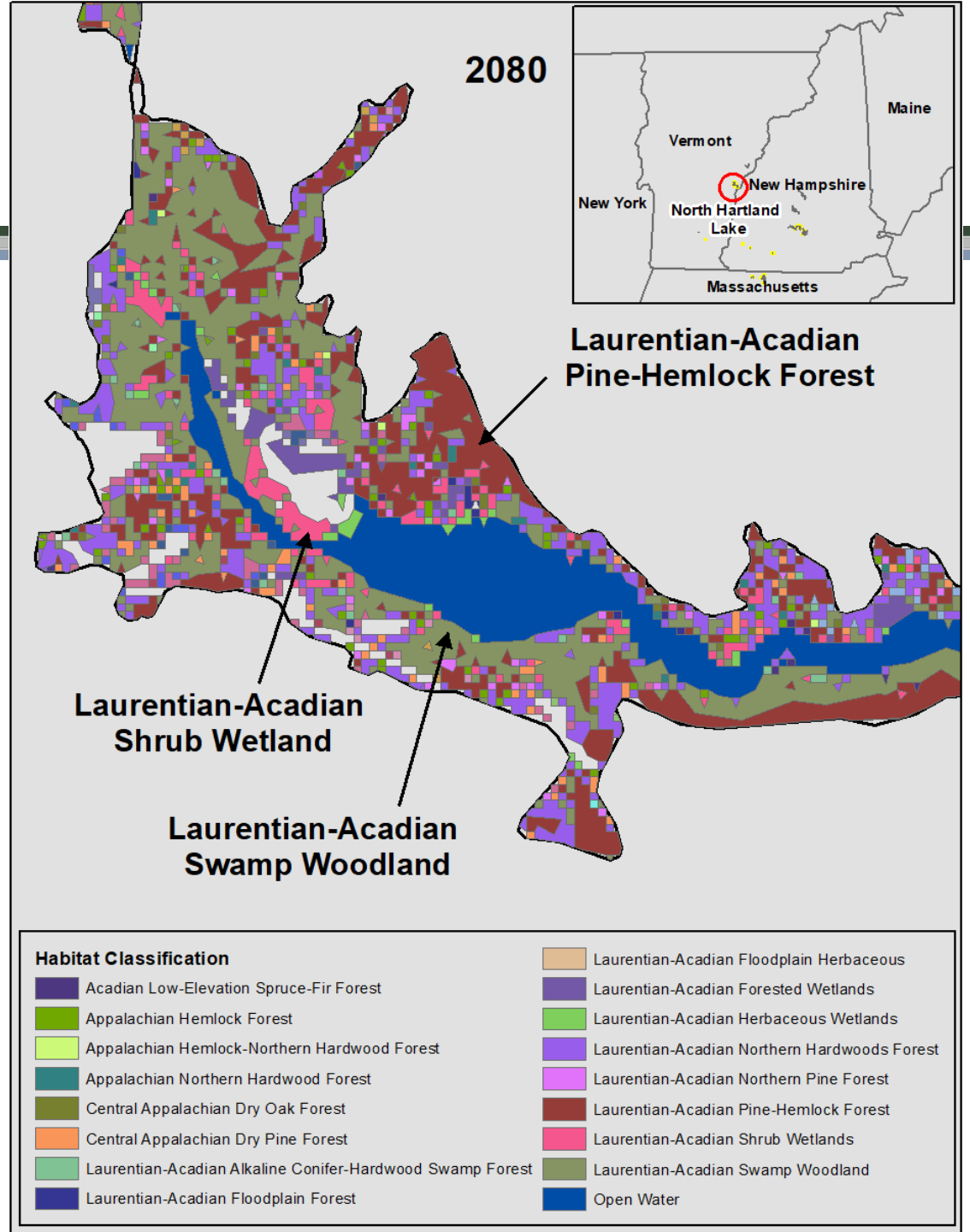
- Ecocode Grid output conversion to a tif file format for display in GIS software application
- Majority overlay analysis (2020, 2050, 2080, 2100)
- Summarizing habitats by area of interest



Insert Video HERE


2020
Maine
Vermont
New Hampshire
New York
North Hartland
Lake
Massachusetts
Laurentian-Acadian Akaline
Conifer-Hardwood Swamp Forest
Habitat Classification
Acadian Low-Elevation Spruce-Fir Forest
Appalachian Hemlock Forest
Appalachian Hemlock-Northern Hardwood Forest
Appalachian Northern Hardwood Forest
Central Appalachian Dry Oak Forest
Central Appalachian Dry Pine Forest
Laurentian-Acadian Alkaline Conifer-Hardwood Swamp Forest
Laurentian-Acadian Floodplain Forest
Laurentian-Acadian Floodplain Herbaceous
Laurentian-Acadian Forested Wetlands
Laurentian-Acadian Herbaceous Wetlands
Laurentian-Acadian Northern Hardwoods Forest
Laurentian-Acadian Northern Pine Forest
Laurentian-Acadian Pine-Hemlock Forest
Laurentian-Acadian Shrub Wetlands
Laurentian-Acadian Swamp Woodland
Open Water


2050
Maine
Vermont
New Hampshire
New York
North Hartland
Lake
Massachusetts
Appalachian Hemlock Forest
Laurentian-Acadian
Northern-Hardwood Forest
Habitat Classification
Acadian Low-Elevation Spruce-Fir Forest
Appalachian Hemlock Forest
Appalachian Hemlock-Northern Hardwood Forest
Appalachian Northern Hardwood Forest
Central Appalachian Dry Oak Forest
Central Appalachian Dry Pine Forest
Laurentian-Acadian Alkaline Conifer-Hardwood Swamp Forest
Laurentian-Acadian Floodplain Forest
Laurentian-Acadian Floodplain Herbaceous
Laurentian-Acadian Forested Wetlands
Laurentian-Acadian Herbaceous Wetlands
Laurentian-Acadian Northern Hardwoods Forest
Laurentian-Acadian Northern Pine Forest
Laurentian-Acadian Pine-Hemlock Forest
Laurentian-Acadian Shrub Wetlands
Laurentian-Acadian Swamp Woodland
Open Water


2080
Maine
Vermont
New Hampshire
New York
North Hartland
Lake
Massachusetts
Laurentian-Acadian
Pine-Hemlock Forest
Laurentian-Acadian
Shrub Wetland
Laurentian-Acadian
Swamp Woodland
Habitat Classification
Acadian Low-Elevation Spruce-Fir Forest
Appalachian Hemlock Forest
Appalachian Hemlock-Northern Hardwood Forest
Appalachian Northern Hardwood Forest
Central Appalachian Dry Oak Forest
Central Appalachian Dry Pine Forest
Laurentian-Acadian Alkaline Conifer-Hardwood Swamp Forest
Laurentian-Acadian Floodplain Forest
Laurentian-Acadian Floodplain Herbaceous
Laurentian-Acadian Forested Wetlands
Laurentian-Acadian Herbaceous Wetlands
Laurentian-Acadian Northern Hardwoods Forest
Laurentian-Acadian Northern Pine Forest
Laurentian-Acadian Pine-Hemlock Forest
Laurentian-Acadian Shrub Wetlands
Laurentian-Acadian Swamp Woodland
Open Water

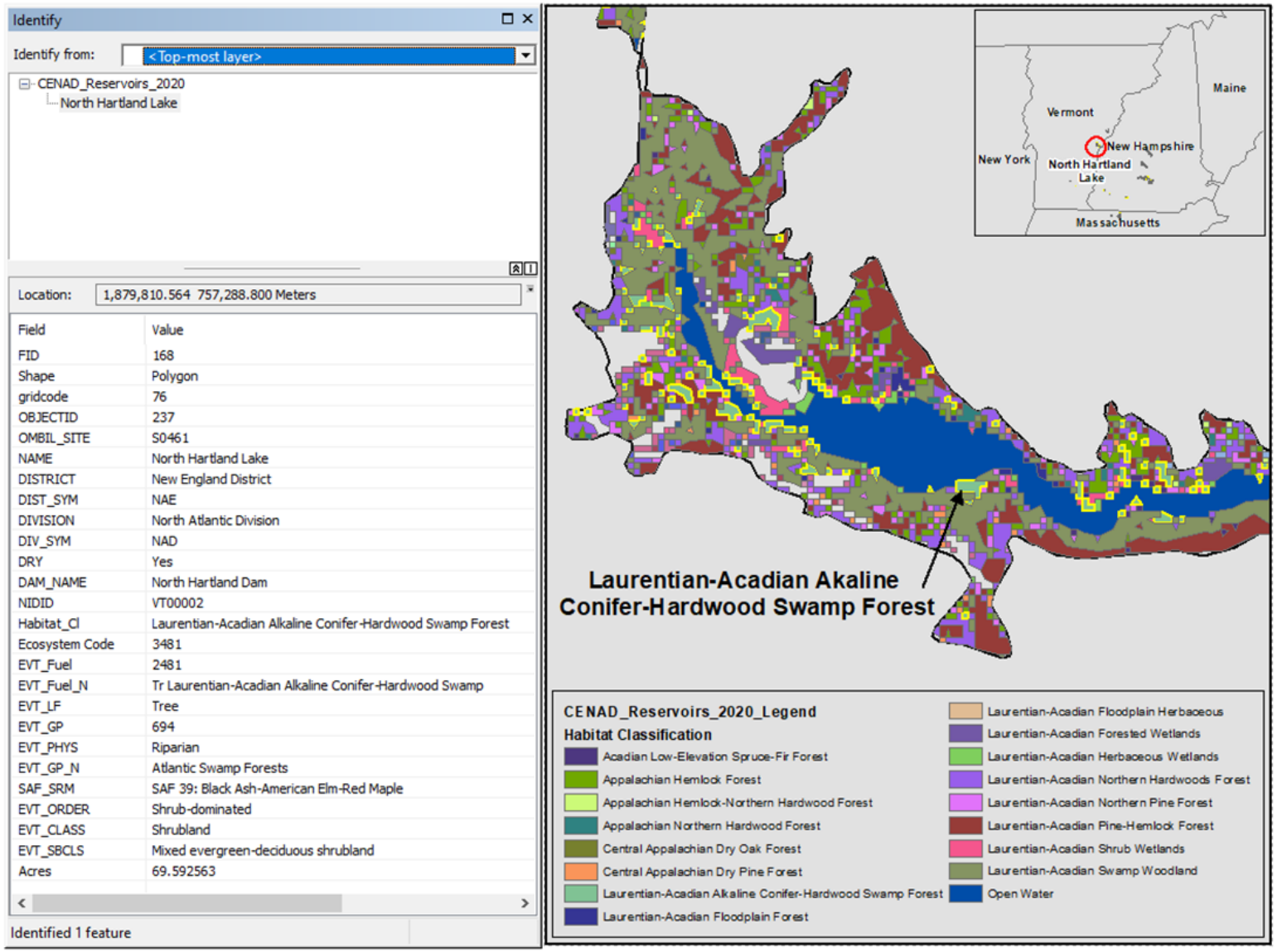
Percentage of Predicted Habitat Shifts: Present (2020) to 2100

		Year		
Current Habitat (2020)	**Predicted Habitat in Future**	**2050**	**2080**	**2100**
Laurentian-Acadian Alkaline Conifer-Hardwood Swamp Forest				
	Acadian Low-Elevation Spruce-Fir Forest	1.1		
	Appalachian Hemlock Forest	1.6	1.7	1.7
	Central Appalachian Dry Oak Forest	1.6	1.7	1.7
	Central Appalachian Dry Pine Forest	3.2	3.3	3.3
	Central Interior and Appalachian Swamp Forest	7.4	7.6	7.6
	Eastern Cool Temperate Developed Ruderal Deciduous Forest	1.8	1.8	1.8
	Eastern Cool Temperate Developed Ruderal Shrubland	6.6	7.1	7.1
	Eastern Cool Temperate Undeveloped Ruderal Shrubland	1.6	1.6	1.6
	Eastern Cool Temperate Urban Shrubland	1.0	1.1	1.1
	Laurentian-Acadian Forested Wetlands	6.9	6.9	6.9
	Laurentian-Acadian Northern Hardwoods Forest	**11.3**	**12.6**	**12.6**
	Laurentian-Acadian Northern Pine Forest	1.0		
	Laurentian-Acadian Pine-Hemlock Forest	4.9	5.6	5.6
	Laurentian-Acadian Shrub Wetlands	5.3	5.6	5.6
	Laurentian-Acadian Swamp Shrubland	2.4		
	Laurentian-Acadian Swamp Woodland	**33.5**	**34.9**	**34.9**

Percentage of Predicted Habitat Shifts: Present (2020) to 2100

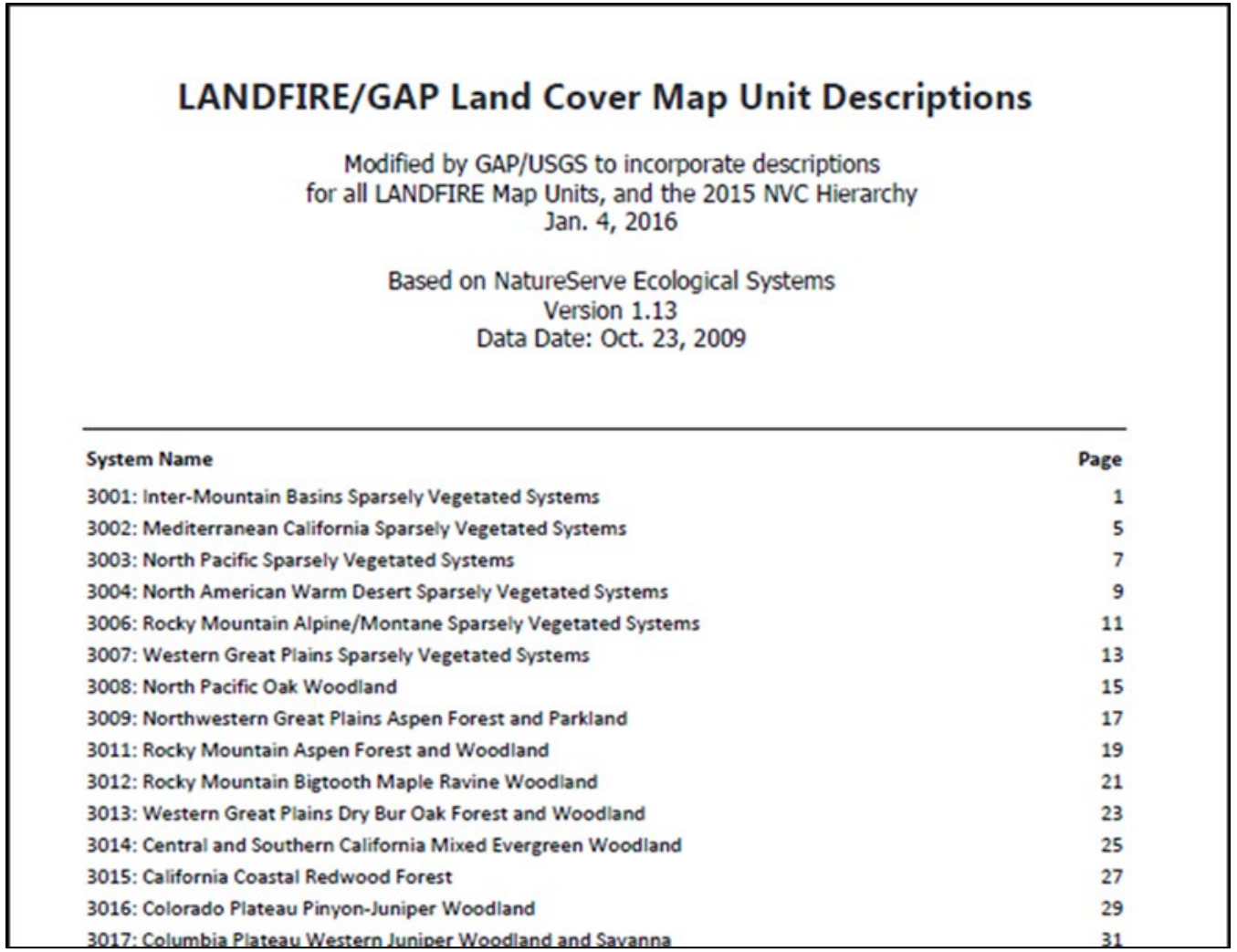
Current Habitat (2020)	Predicted Habitat in Future	2050	2080	2100
Appalachian Hemlock Forest				
	Appalachian Hemlock Forest	**56.9**	**57.0**	**57.0**
	Central Appalachian Dry Pine Forest	8.0	9.0	9.0
	Central Interior and Appalachian Swamp Forest	2.2	2.3	2.3
	Eastern Cool Temperate Developed Ruderal Shrubland	1.1	1.2	1.2
	Laurentian-Acadian Northern Hardwoods Forest	8.1	9.0	9.0
	Laurentian-Acadian Northern Pine Forest	3.3		
	Laurentian-Acadian Pine-Hemlock Forest	9.1	**10.2**	**10.2**
	Laurentian-Acadian Swamp Woodland	2.1	2.5	2.5

Identify Habitats of Interest for a Project Area



Supporting Resources

- https://landfire.gov/documents/LF-GAPMapUnitDescriptions.pdf



LANDFIRE/GAP Land Cover Map Unit Descriptions

Modified by GAP/USGS to incorporate descriptions
for all LANDFIRE Map Units, and the 2015 NVC Hierarchy
Jan. 4, 2016

Based on NatureServe Ecological Systems
Version 1.13
Data Date: Oct. 23, 2009

Landfire Ecosystem Descriptions

3481: Laurentian-Acadian Alkaline Conifer-Hardwood Swamp Forest

Match Confidence: Good Match
Suggested Match: Laurentian-Acadian Alkaline Conifer-Hardwood Swamp

Codes: ESLF: 9345 EVT_fuel: 2481
ESP: 1481 NatureServe Id: CES201.575

BioGeographical Division : Laurentian-Acadian

NVC MacroGroup: M504 Northern Flooded & Swamp Forest

NVC Group: G046 Laurentian-Acadian-Allegheny Alkaline Swamp

1997 Standard

FGDC Division : Vegetated
FGDC Order : Tree-dominated
FGDC Class : Closed tree canopy
FGDC Subclass : Mixed evergreen-deciduous closed tree canopy

2015 Standard

NVCS Class: 1 Forest & Woodland
NVCS Subclass: 1.B Temperate & Boreal Forest & Woodland
NVCS Formation: 1.B.3 Temperate Flooded & Swamp Forest
NVCS Division: 1.B.3.Na Eastern North American & Great Plains Flooded & Swamp Forest

Summary: These forested wetlands are found across northern New England and the upper Midwest and eastern to south-central Canada in basins where higher pH and/or nutrient levels are associated with a rich flora. The substrate is typically mineral soil, but there may be some peat; often, there is an organic epipedon over mineral soil. *Thuja occidentalis* is a diagnostic canopy species and may dominate the canopy or be mixed with other conifers or with deciduous trees, most commonly *Acer rubrum* or *Fraxinus nigra*. Some examples can be almost entirely deciduous and dominated by *Fraxinus nigra*. *Cornus sericea* is a common shrub. The herb layer tends to be more diverse than in acidic swamps. Small open fenny areas may occur within the wetland. Seepage may influence parts of the wetland, but the hydrology is dominated by the basin setting.

Range: Scattered locations from New England and adjacent Canada west to the Great Lakes and northern Minnesota.

States: CT, ME, MI, MN, NY, VT, WI

Map Zones: 41:C, 50:C, 51:C, 63:C, 64:C, 65:C, 66:C

Similar: Laurentian-Acadian Alkaline Fen (CES201.585), North-Central Interior and Appalachian Rich Swamp (CES202.605), Northern Appalachian-Acadian Conifer-Hardwood Acidic Swamp (CES201.574)

3302: Laurentian-Acadian Northern Hardwoods Forest

Match Confidence: Direct Match
Suggested Match: Laurentian-Acadian Northern Hardwood Forest

Codes: ESLF: 4108 EVT_fuel: 2302
ESP: 1302 NatureServe Id: CES201.564

BioGeographical Division : Laurentian-Acadian

NVC MacroGroup: M014 Laurentian & Acadian Northern Hardwood - Conifer Mesic Forest

NVC Group: G743 Laurentian & Acadian Hardwood Forest

1997 Standard

FGDC Division : Vegetated
FGDC Order : Tree-dominated
FGDC Class : Closed tree canopy
FGDC Subclass : Deciduous closed tree canopy

2015 Standard

NVCS Class: 1 Forest & Woodland
NVCS Subclass: 1.B Temperate & Boreal Forest & Woodland
NVCS Formation: 1.B.2 Cool Temperate Forest & Woodland
NVCS Division: 1.B.2.Na Eastern North American & Great Plains Cool Temperate Forest & Woodland

Summary: These northern hardwood forests range across New England and adjacent Canada, south to northern Pennsylvania and west to Minnesota. They occur in various dry-mesic to wet-mesic settings at low to moderate elevations (generally<610 m [2000 feet]) throughout the Laurentian-Acadian Division. > *Acer saccharum, Betula alleghaniensis*, and *Fagus grandifolia* are the dominant trees (the latter only east of northern Wisconsin). *Tsuga canadensis* or, in the Northeast, *Picea rubens* are common minor canopy associates. *Ostrya virginiana* is frequent but not dominant. Oak is a minor component and absent from northern regions. Successional stands may be dominated by *Populus tremuloides, Betula papyrifera, Acer rubrum, Fraxinus americana, Prunus serotina*, sometimes with scattered *Pinus strobus*. Soils range from moderately nutrient-poor to quite enriched, with associated shifts in the herb flora. This system can include large expanses of rich forest in areas of limestone or similar bedrock, as well as forests that are relatively poor floristically in areas of granitic (or similar) bedrock or acidic till. Blowdowns or snow and ice loading, with subsequent gap regeneration, are the most frequent form of natural disturbance.

Range: This system occurs in northern New England and northern New York west across the upper Great Lakes to northern Minnesota, and adjacent Canada; occasional southwards.

States: MA, ME, MI, MN, NB, NH, NS, NY, ON, PA, QC, VT, WI

Map Zones: 41:C, 50:C, 51:C, 63:C, 64:C, 65:C, 66:C

Similar: Acadian Low-Elevation Spruce-Fir-Hardwood Forest (CES201.565), Appalachian (Hemlock)-Northern Hardwood Forest (CES202.593), Laurentian-Acadian Pine-Hemlock-Hardwood Forest (CES201.563), North-Central Interior Beech-Maple Forest (CES202.693)

NatureServe Database

NT_GLO	ELCODE	GLOBAL_NAME	SPECIES	SCIENTIFIC_NAME	G_RANK
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	159330	Acer rubrum	G5
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	125218	Caloplaca parvula	G1G2
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	140261	Cornus sericea	G5
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	144288	Cypripedium parviflorum	G5
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	160163	Fraxinus nigra	G5
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	126421	Frullania selwyniana	G2G3
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	133967	Isoetes lacustris	G5
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	152910	Larix laricina	G5
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	140538	Mimulus glabratus var. michiganensis	G5T1
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	136481	Poa paludigena	G3
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	145794	Polemonium occidentale ssp. lacustre	G5?T2Q
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	138983	Rhamnus alnifolia	G5
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	129023	Sarracenia purpurea ssp. gibbosa	G5T5
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	145680	Thuja occidentalis	G5
723030	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	160510	Tiarella cordifolia	G5

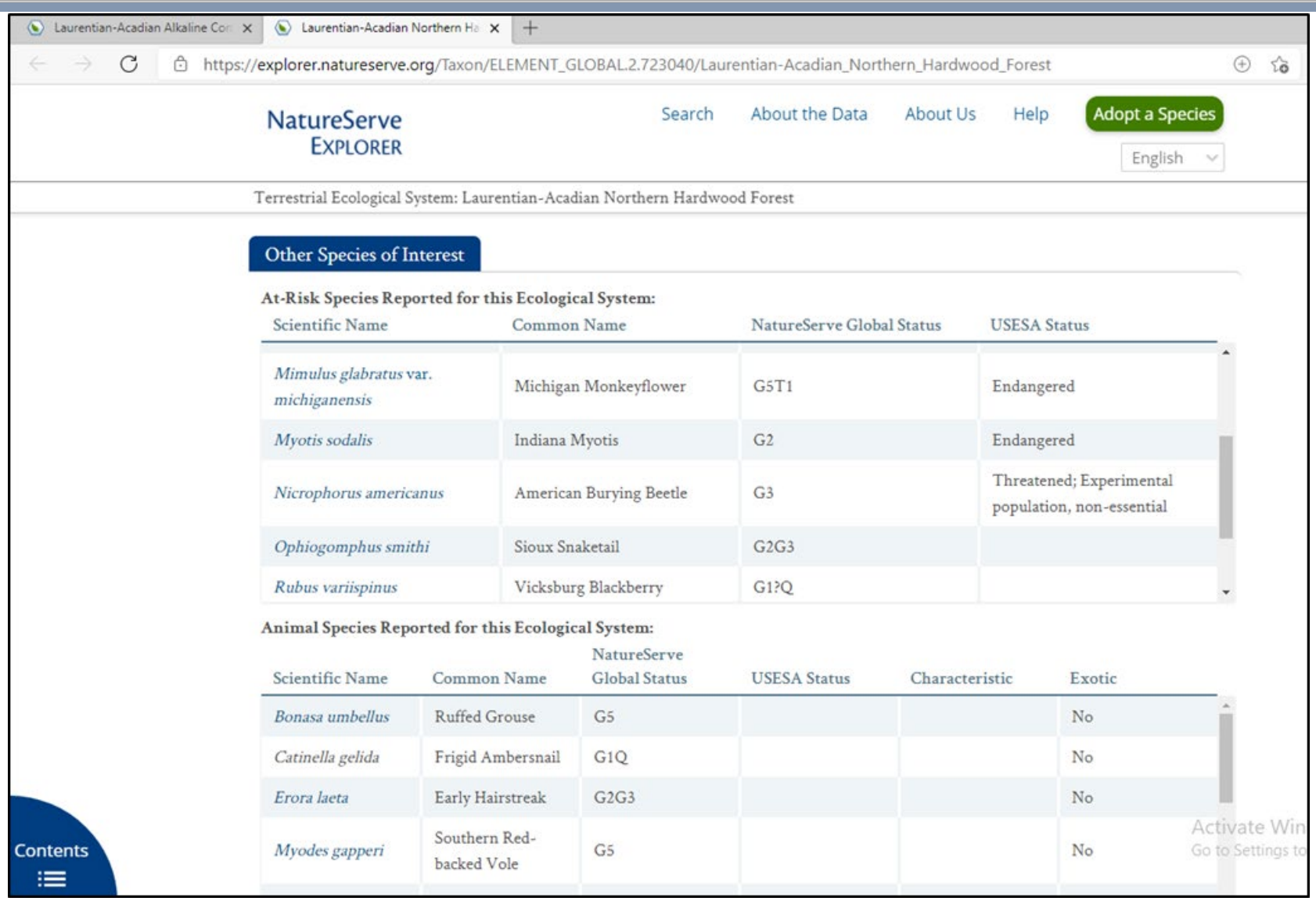
STRATUM_DES	LIFEFORM_DESC	DOM	DIAG	CONS	EXOTIC	INVASIVE
Tree canopy	Broad-leaved deciduous tree	Y	No	N	N	N
Nonvascular	Lichen	N	No	N	N	N
Shrub/sapling (tal	Broad-leaved deciduous shrub	N	Yes	N	N	N
Herb (field)	Flowering forb	N	Yes	N	N	N
Tree canopy	Broad-leaved deciduous tree	Y	No	N	N	N
Nonvascular	Liverwort/hornwort	N	No	N	N	N
Herb (field)	Fern (Spore-bearing forb)	N	No	N	N	N
Tree canopy	Needle-leaved tree	Y	No	N	N	N
Herb (field)	Flowering forb	N	No	N	N	N
Herb (field)	Graminoid	N	No	N	N	N
Herb (field)	Flowering forb	N	No	N	N	N
Shrub/sapling (tal	Broad-leaved deciduous shrub	N	Yes	N	N	N
Herb (field)	Flowering forb	N	No	N	N	N
Tree canopy	Needle-leaved tree	Y	No	N	N	N
Herb (field)	Flowering forb	N	Yes	N	N	N

NatureServe Explorer

View on NatureServe Explorer	Ecosystem Type	Upper Level Cod	Classification Code	Common Name	Scientific Name	NatureServe Global Ran	NatureServe Rounded Global Ran	Distribution
https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.723040/Laurentian-Acadian_Northern_Hardwood_Forest	TERRESTRIAL_ECOLOGICAL_SYSTEM	CES201.564	CES201.564	Laurentian-Acadian Northern Hardwood Forest	Laurentian-Acadian Northern Hardwood Forest	GNR	GNR	Canada: NB, NS, ON, QC United States: MA, ME, MI, MN, NH, NY, VT, WI
https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.729030/Laurentian-Acadian_Alkaline_Conifer-Hardwood_Swamp	TERRESTRIAL_ECOLOGICAL_SYSTEM	CES201.575	CES201.575	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	Laurentian-Acadian Alkaline Conifer-Hardwood Swamp	GNR	GNR	Canada: ON United States: CT, ME, MI, MN, NH, NY, VT, WI

- https://explorer.natureserve.org/
- Search for Ecosystem Types or Individual Species (Flora or Fauna)

NatureServe Explorer



Summary

- How models can be used to inform decisions for USACE reservoir land managers and other USACE projects.

- Models that display where habitats that include threatened, endangered and at-risk species are currently located, and to what extent these range shifts will occur, will be of great importance towards future project planning and resource management

- While this serves as a tool to inform how habitats will potentially shift in future, it is important to take other local site conditions into account when making management decisions.

Questions & Answers

Please post any questions to the "CHAT".

Coming up next!

June 29th
12:00pm CDT

Topic: Monitoring Ecological Restoration with Imagery Tools (MERIT)

Dr. Kristofer Lasko