



Appendix E | Landscape Level Functional Wetland Assessment

Red Cedar River

Watershed Management Plan

June 25, 2015

RED CEDAR RIVER WATERSHED

Landscape Level Wetland Functional Assessment

(Enhanced NWI)



RED CEDAR WATERSHED

Wetland Resources Status and Trends

Pre-settlement Wetland conditions

- 92,367 Acres of Wetlands
- 4,749 Polygons
- Average Size – 19 Acres

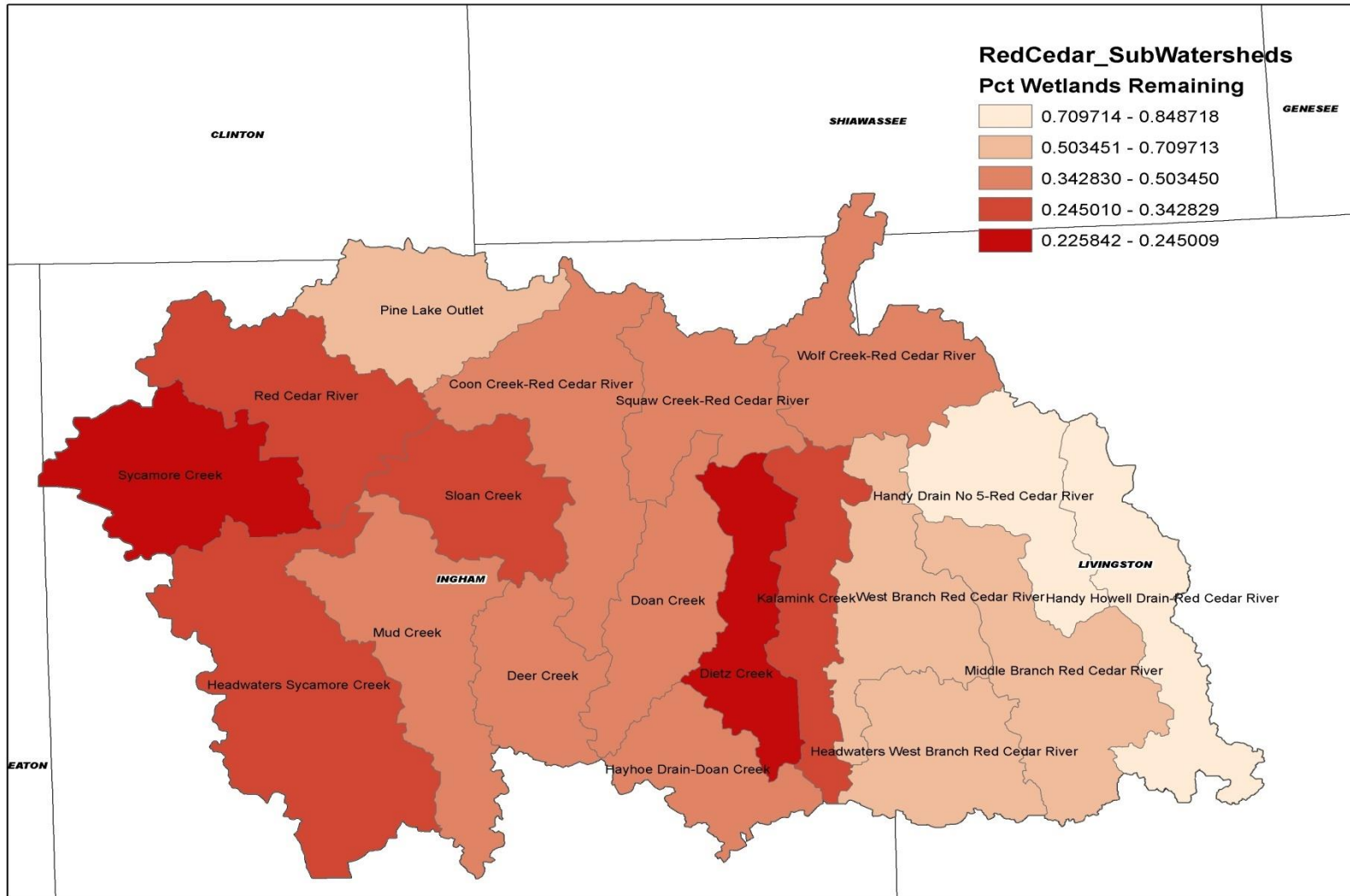
2005 Wetland Condition

- 40,681 Acres of Wetlands
- 7,225 Polygons
- Average Size – 5.6 Acres

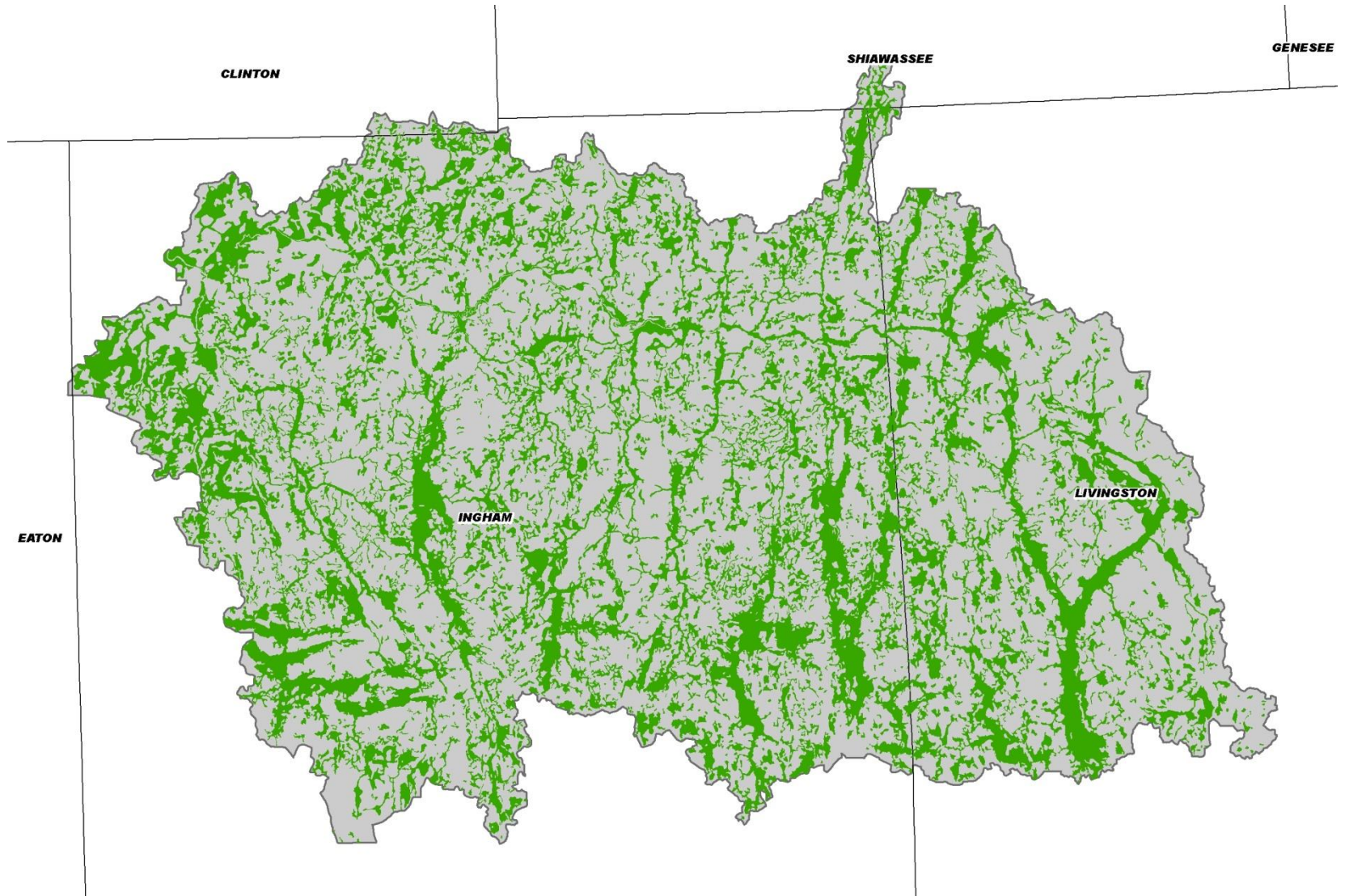
**44% OF ORIGINAL WETLAND ACREAGE REMAINS
56% LOSS OF TOTAL WETLAND RESOURCE**

TOTAL ACREAGE LOSS OF:
51,686 ACRES

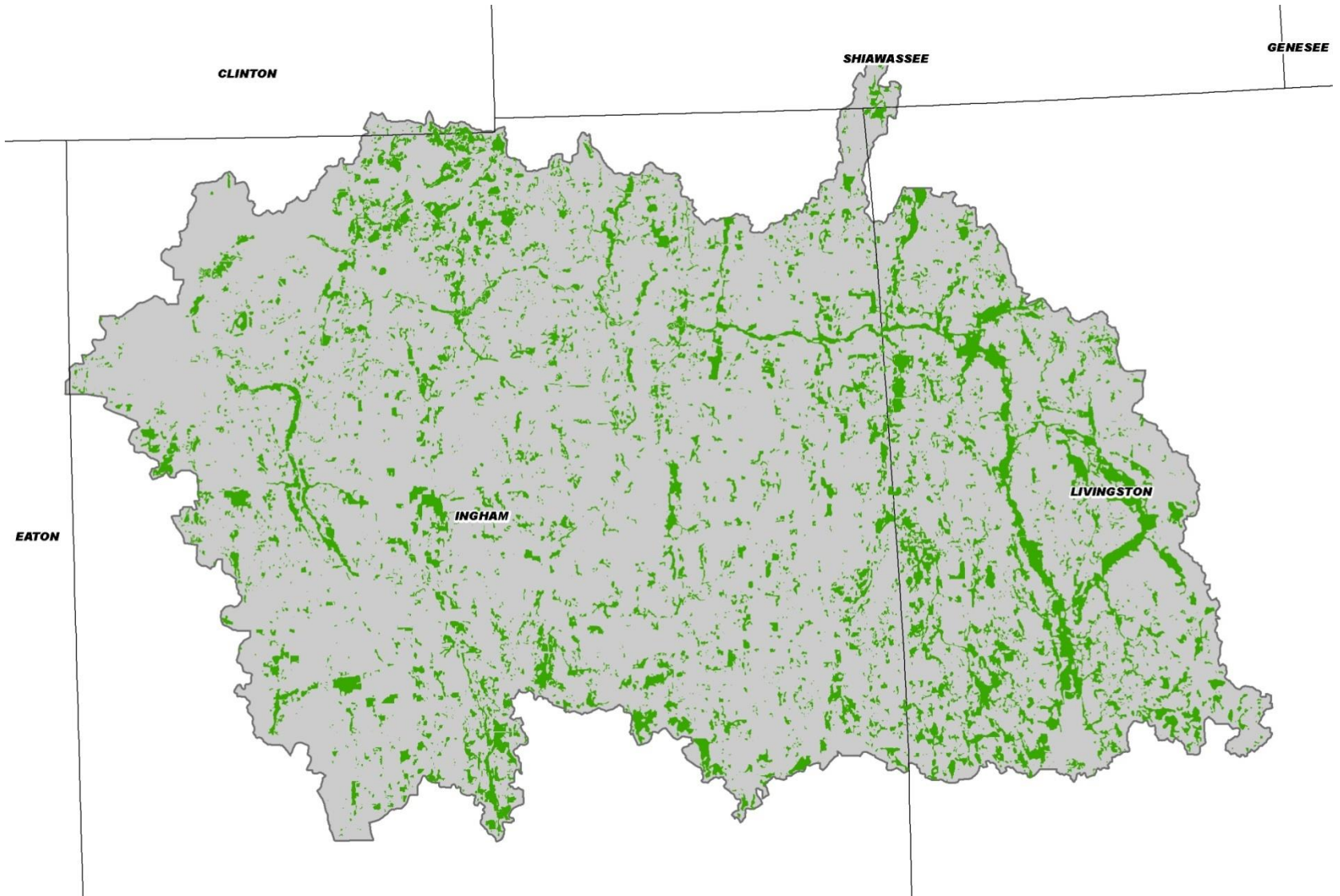
Percentage of Remaining Wetlands



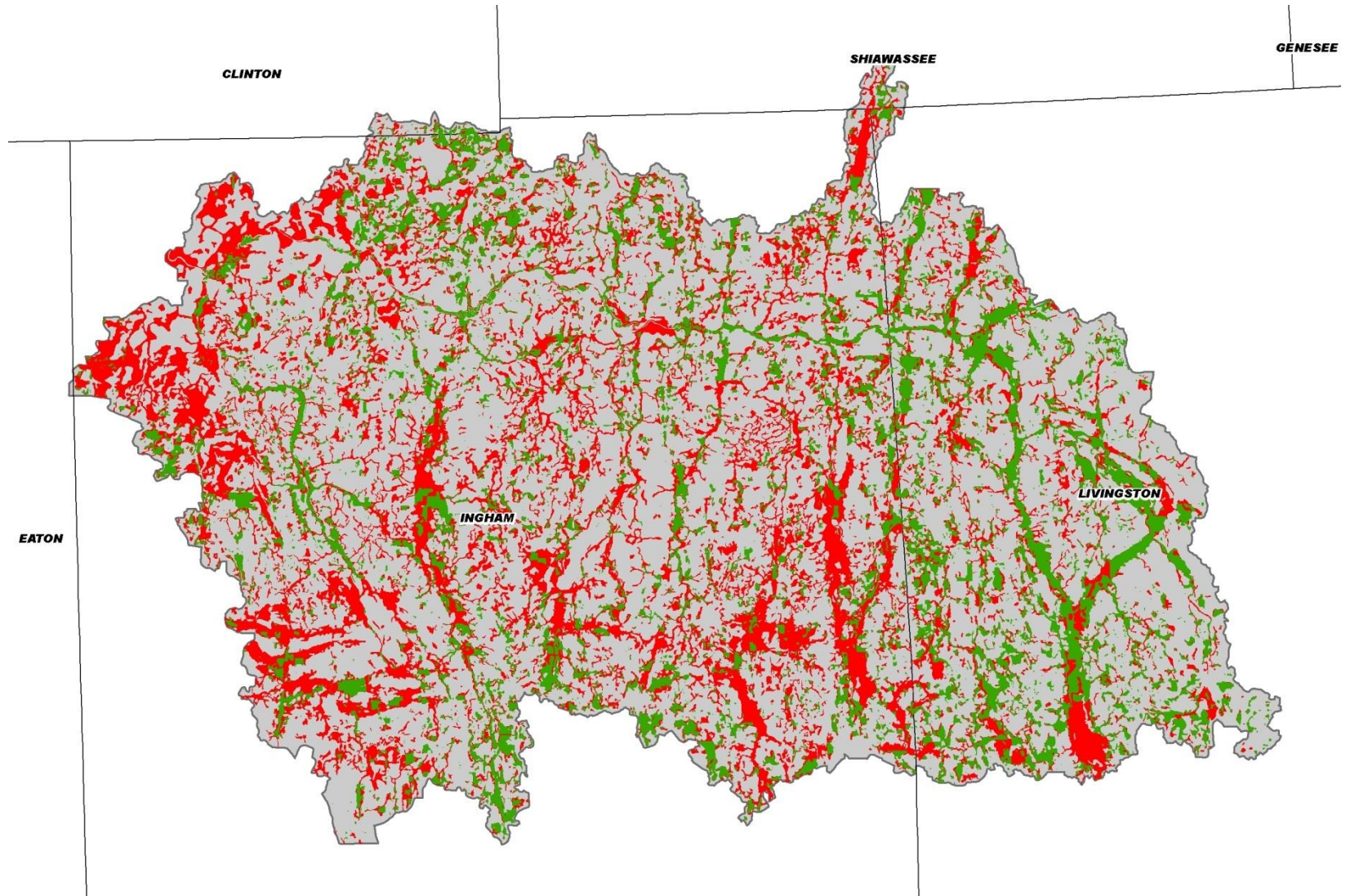
PRE-EUROPEAN SETTLEMENT WETLAND COVERAGE



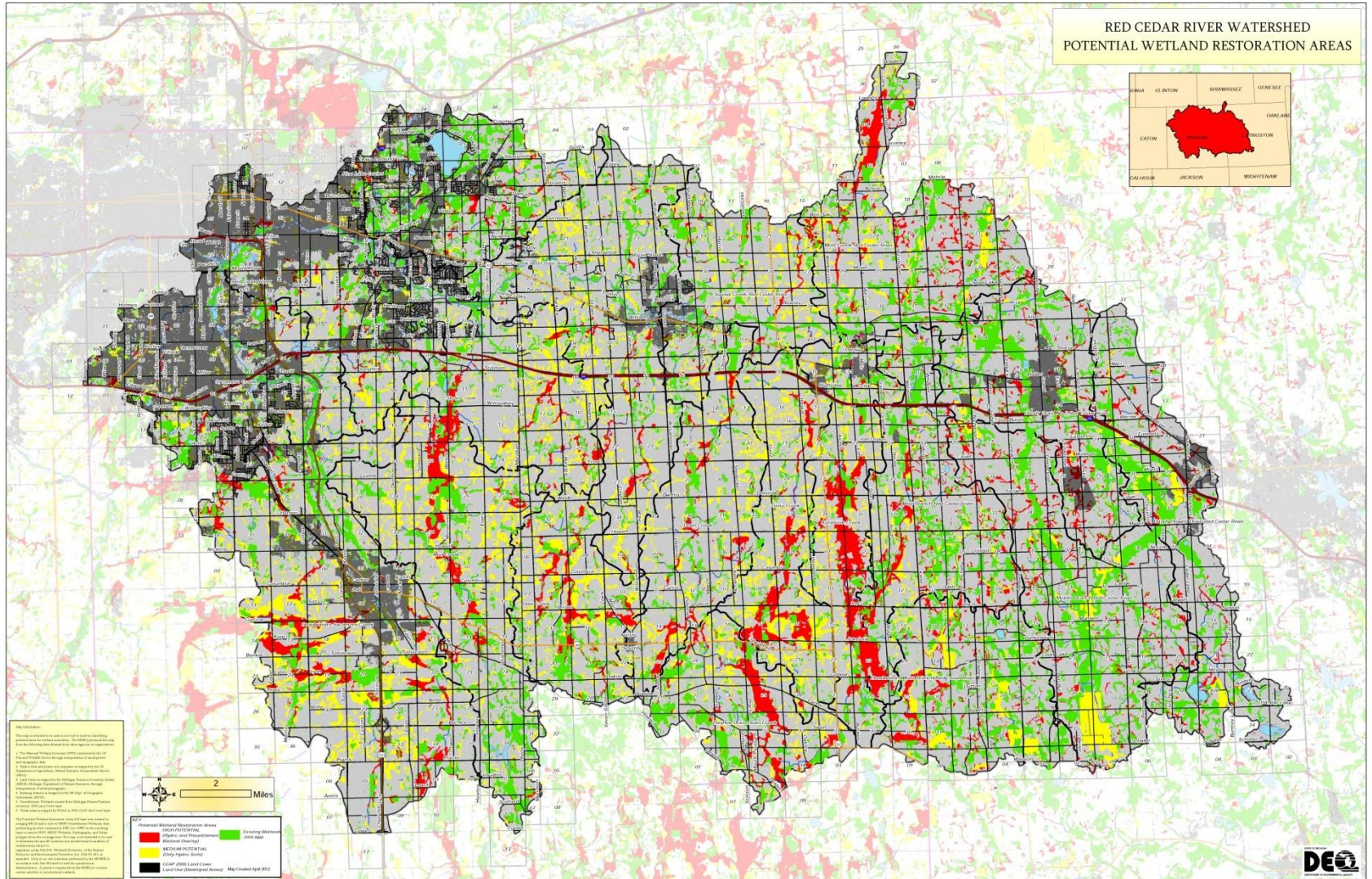
2005 WETLAND COVERAGE



APPROXIMATE WETLAND LOSS PRE-EUROPEAN SETTLEMENT TO 2005



RED CEDAR WATERSHED



NWI TYPE COMPARISON

Table 1: Generalized NWI type comparison

Wetland Type	Pre-European Settlement Acres	2005 Acres of Wetlands	Net Acres Remaining
Palustrine Emergent	5,400	13,505*	100%
Palustrine Forested	80,664	21,189**	26%
Palustrine Shrub-Scrub	6,301***	5,787****	91%
Other Palustrine			
Ponds	0*****	1,376	100%
Total	92,365	41,857	45%

*Includes mixed emergent wetland classes and mixed communities where subclasses include Forested and Shrub-Scrub Areas

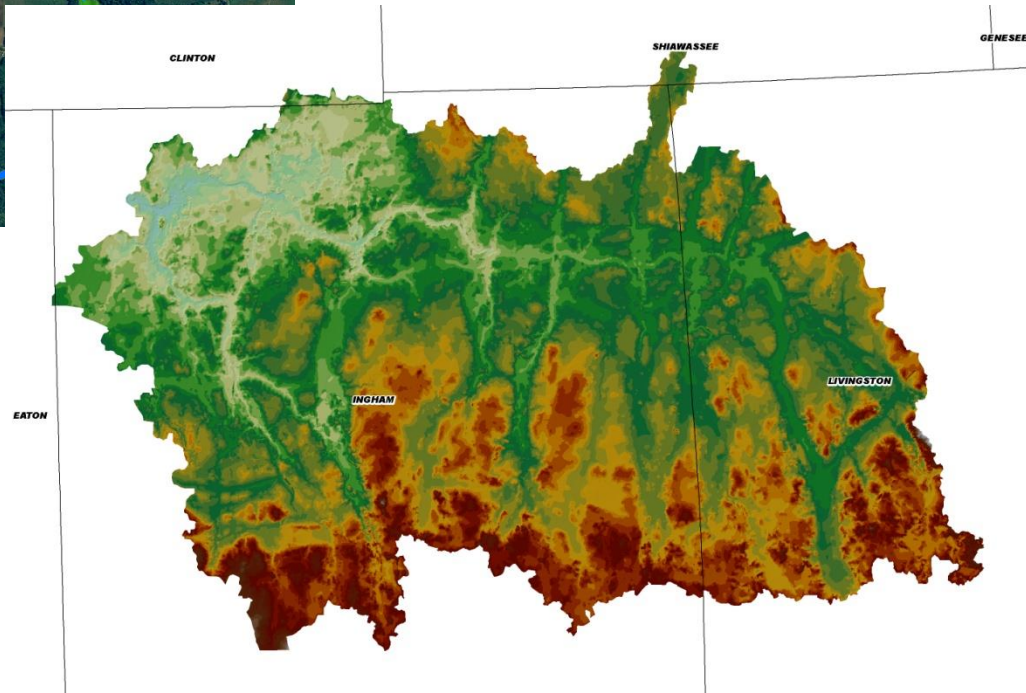
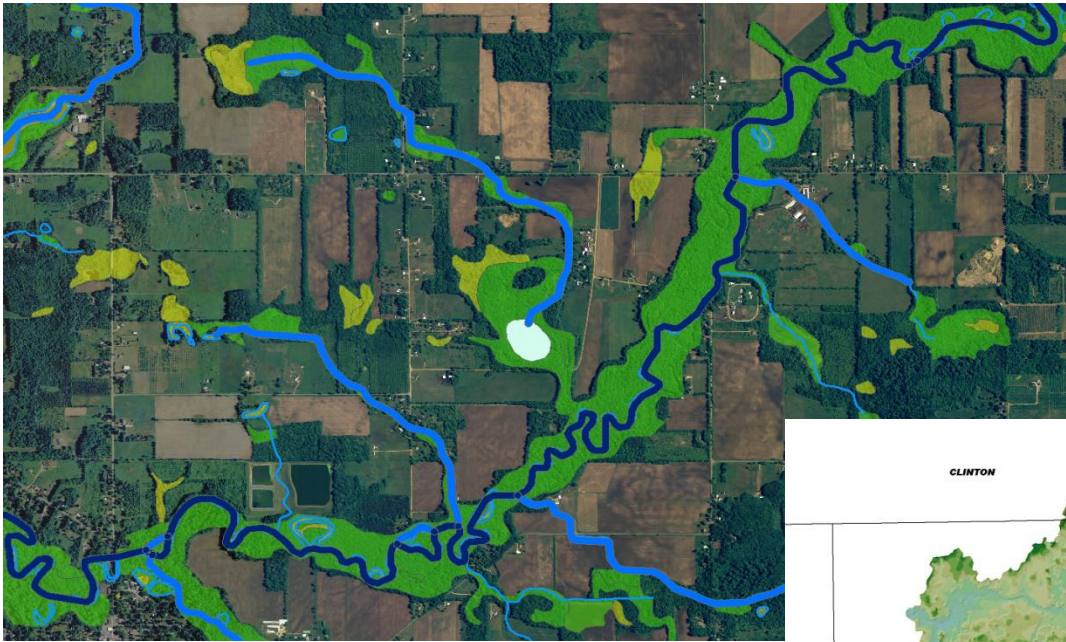
**Includes mixed forested wetland classes and mixed communities where subclasses include Emergent and Shrub-Scrub Areas

*** Includes mixed Shrub-Scrub/Emergent communities

****Includes mixed shrub-scrub wetland classes and mixed communities where subclasses include Emergent, Forested and Shrub-Scrub

***** Little acreage in ponds due to mapping differences between Pre-Settlement and Current wetland coverage's.

ENHANCING NWI FOR LANDSCAPE-LEVEL WETLAND FUNCTIONAL ASSESSMENT IN THE RED CEDAR RIVER WATERSHED



Using NWI for Functional Assessment

- Lack of hydro-geomorphic (HGM) information
 - No landscape position
 - No landform
 - No water flow direction
 - General pond classification
 - Features important for assessing many functions are lacking
- *Most of these features can be interpreted from the maps*

What information can we extract from NWI?

How many wetlands are there?

What is the size range of wetlands?

What is the average size of a given wetland type?

How many wetlands are in various size classes?

...With HGM information added?

How much and how many

- occur along rivers?
- along streams?
- in lake basins?
- are isolated?
- are sources of streams?
- have inflow but no outflow?
- are connected to other wetlands?
- What types of ponds are there and what is their extent?

Wetland Landscape Positions

□ Landscape Position

- Terrene
- Lentic
- Lotic River
- Lotic Stream

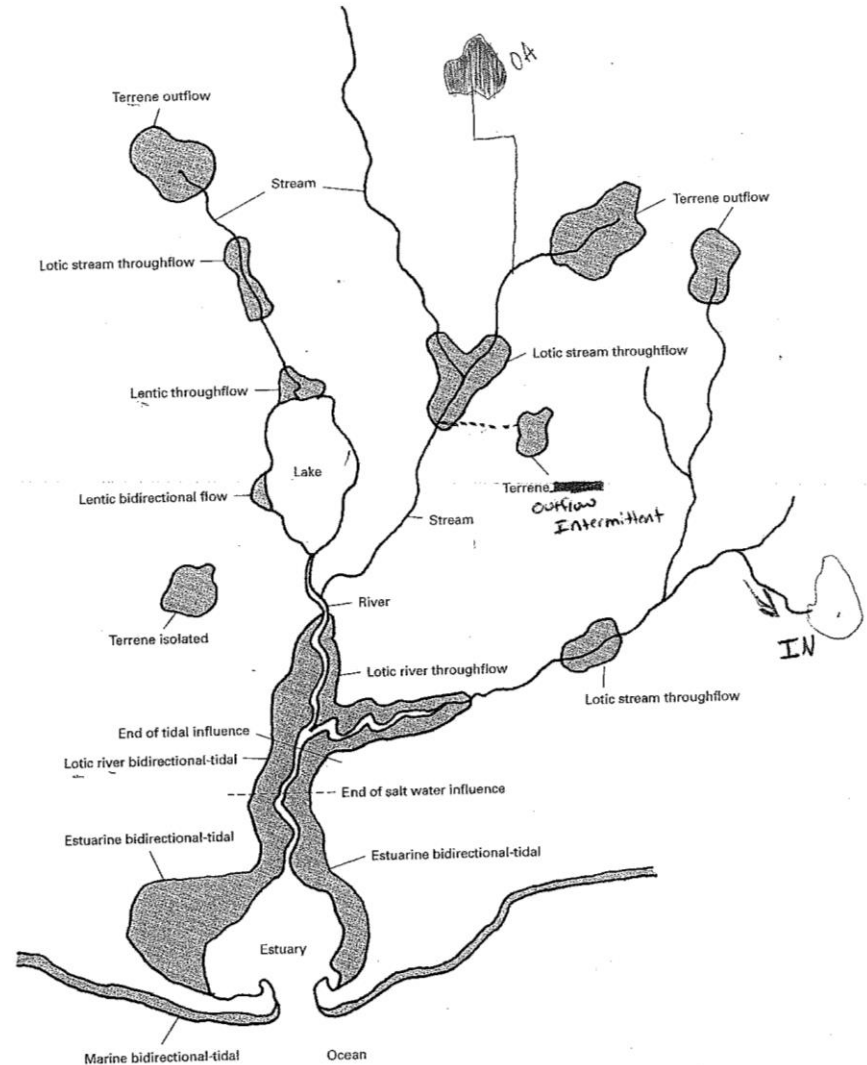


Figure 14.4. Typical wetland landscape positions and water flow paths in the eastern United States.

TERRENE



LENTIC



LOTIC



RIVER



STREAM

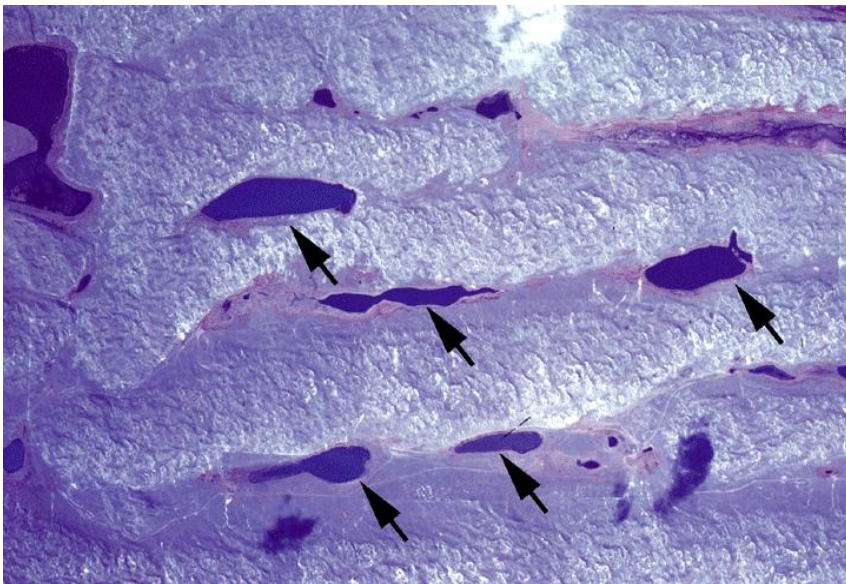
Wetland Landform Types

- Fringe
- Basin
- Flat
- Floodplain
- Slope

FRINGE



BASIN



FLAT



FLOODPLAIN



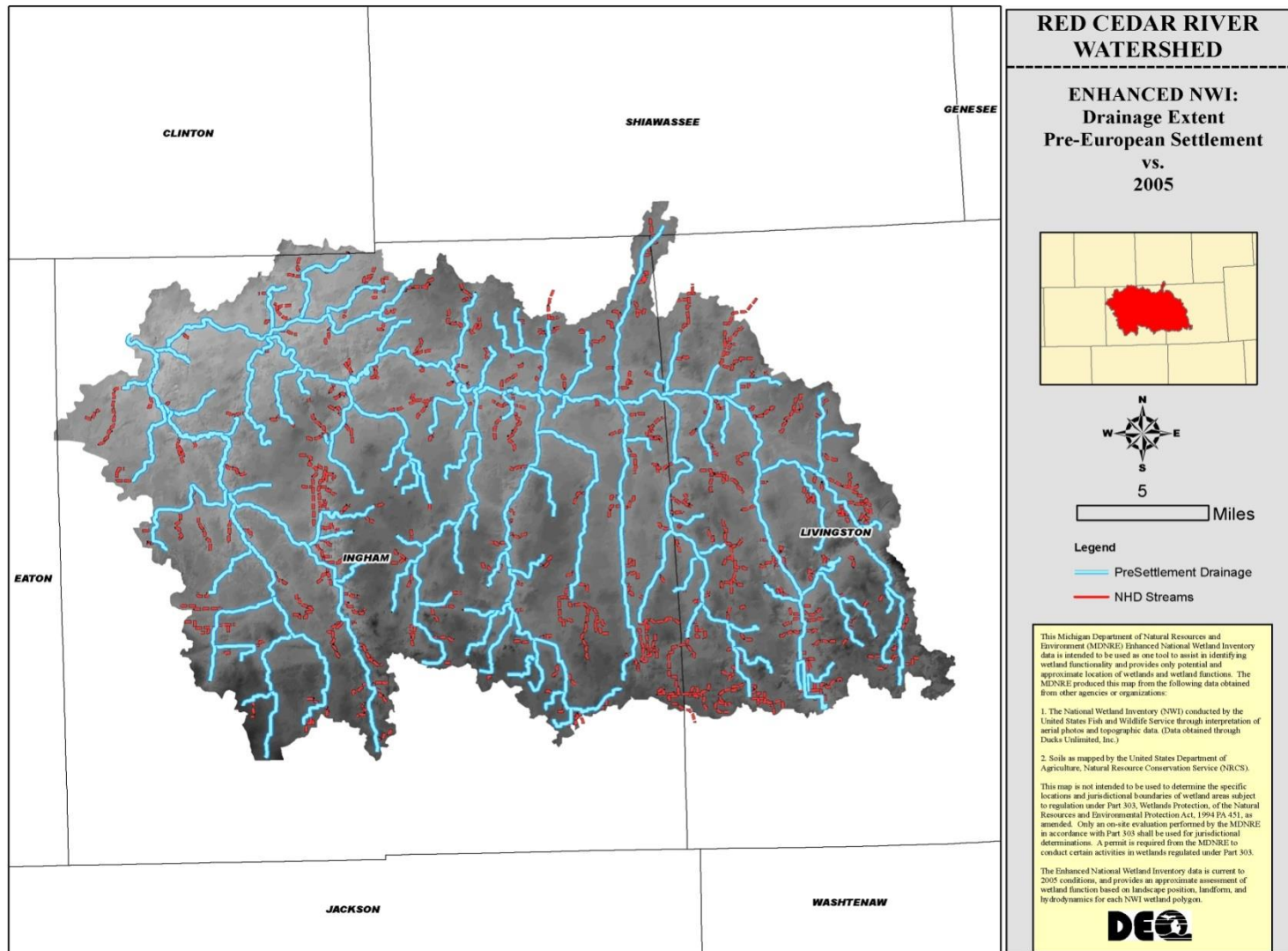
SLOPE



Evaluated Wetland Functions

- ❑ Flood Water Storage
- ❑ Streamflow Maintenance
- ❑ Nutrient Transformation
- ❑ Sediment and Other Particulate Retention
- ❑ Shoreline Stabilization
- ❑ Stream Shading
- ❑ Conservation of Rare and Imperiled Wetlands
- ❑ Ground Water Influence
- ❑ Fish Habitat
- ❑ Waterfowl/Waterbird Habitat
- ❑ Shorebird Habitat
- ❑ Interior Forest Bird Habitat
- ❑ Amphibian Habitat
- ❑ Carbon Sequestration
- ❑ Pathogen Retention

DRAINAGE EXTENT



CLINTON

SHIAWASSEE

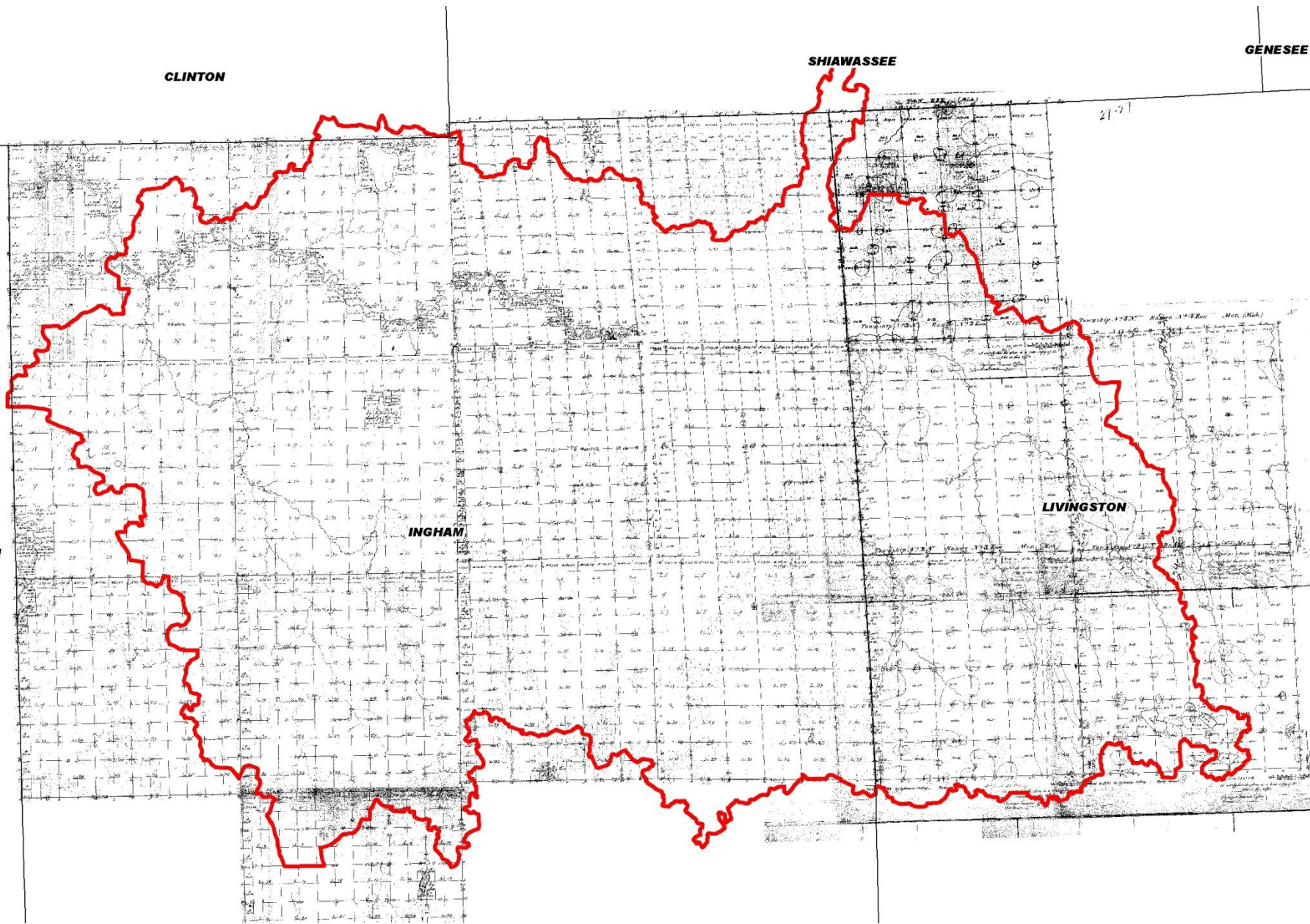
GENESEE

21-21

EATON

INGHAM

LIVINGSTON



DETAILED FUNCTIONAL COMPARISONS

Table 2: Detailed Functional Comparisons

Function	Potential Significance	Pre-European Settlement Acreage	2005 Acreage	% Change in Acreage
Flood Water Storage	High	30,750.40	20,696.75	-33
	Moderate	52,074.23	2,725.80	-95
	<i>Total</i>	82,824.63	23,422.55	-72
Streamflow Maintenance	High	65,535.45	24,176.88	-63
	Moderate	13,085.83	8,323.47	-36
	<i>Total</i>	78,621.28	32,500.35	-59
Nutrient Transformation	High	35,096.34	30,158.40	-14
	Moderate	57,271.21	10,523.30	-82
	<i>Total</i>	92,367.55	40,681.70	-56
Sediment and Retention of Other Particulates	High	35,090.54	9,901.24	-72
	Moderate	13,010.40	13,522.97	4 *
	<i>Total</i>	48,100.94	23,424.21	-51
Shoreline Stabilization	High	27,608.44	13,453.32	-51
	Moderate	44,325.34	16,464.63	-63
	<i>Total</i>	71,933.78	29,917.95	-58
Fish Habitat	High	72,758.52	8,511.63	-88
	Moderate	7,575.61	16,481.77	118 *
	<i>Total</i>	80,334.13	24,993.40	-69
Stream Shading	High	18,861.10	4,459.50	-76
	Moderate	2,789.30	1,964.60	-30
	<i>Total</i>	21,650.40	6,424.10	-70

* Increases in the moderate & high category in the functions above can be attributed to the mapping differences in the two wetland layers and may not represent the current conditions on the ground.

DETAILED FUNCTIONAL COMPARISONS CONT...

Function	Potential Significance	Pre-European Settlement Acreage	2005 Acreage	% Change in Acreage
Waterfowl/Waterbird Habitat	High	5,933.50	14,230.04	140 *
	Moderate	11,313.20	15,890.60	40 *
	<i>Total</i>	17,246.70	30,120.64	75 *
Shorebird Habitat	High	0.00	56.30	Null
	Moderate	92,367.55	40,482.15	-56
	<i>Total</i>	92,367.55	40,538.45	-56
Interior Forest Bird Habitat	High	9,302.01	8,053.80	-13
	Moderate	77,664.80	18,923.10	-76
	<i>Total</i>	86,966.81	26,976.90	-69
Amphibian Habitat	High	32,684.60	8,038.20	-75
	Moderate	4,692.30	5,384.93	15 *
	<i>Total</i>	37,376.90	13,423.13	-64
Carbon Sequestration	High	3,415.21	6,207.30	82 *
	Moderate	33,961.67	5,056.30	-85
	<i>Total</i>	37,376.88	11,263.60	-70
Ground Water Influence	High	45.40	13.13	-71
	Moderate	12,892.31	7,869.55	-39
	<i>Total</i>	12,937.71	7,882.68	-39
Conservation of Rare & Imperiled Wetlands & Species	High	Null	4,079.21	Null
	Moderate	Null	14,529.90	Null
	<i>Total</i>	Null	18,609.11	Null

* Increases in the moderate & high categories in the functions above can be attributed to the mapping differences in the two wetland layers and may not represent the current conditions on the ground.

FUNCTIONAL ACRES COMPARISON

Table 3: Functional Acres comparison

Function	Pre-European Settlement Functional Acres	2005 Functional Acres	Predicted % of Original Capacity Left	Predicted % Change in Functional Capacity
Flood Water Storage	113,575.03	44,119.30	39	-61
Streamflow Maintenance	144,156.73	56,677.23	39	-61
Nutrient Transformation	127,463.89	70,840.10	56	-44
Sediment and Other Particulate Retention	83,191.48	33,325.45	40	-60
Shoreline Stabilization	99,542.22	43,371.27	44	-56
Fish Habitat	153,092.65	33,505.03	22	-78
Stream Shading	40,511.50	10,883.60	27	-73
Waterfowl and Waterbird Habitat	23,180.20	44,350.68	191	91 *
Shorebird Habitat	92,367.55	40,594.75	44	-56
Interior Forest Bird Habitat	96,268.82	35,030.70	36	-64
Amphibian Habitat	70,061.50	21,461.33	31	-69
Carbon Sequestration	40,792.09	17,470.90	43	-57
Ground Water Influence	12,983.11	7,895.81	61	-39
Conservation of Rare & Imperiled Wetlands & Species	0	22,688.32	100	100

•Increases in the predicted percent change functional capacity in the functions above can be attributed to the mapping differences in the two wetland layers and may not represent the current conditions on the ground.

Frequency of Functions

Pre-Settlement

# of Wetlands	# of Functions	ACRES
10	1	485
14	2	757
613	3	7,891
579	4	1,692
44	5	184
232	6	5,243
716	7	15,200
1,045	8	19,075
611	9	14,724
429	10	13,930
411	11	12,856
66	12	1,709
1	13	2

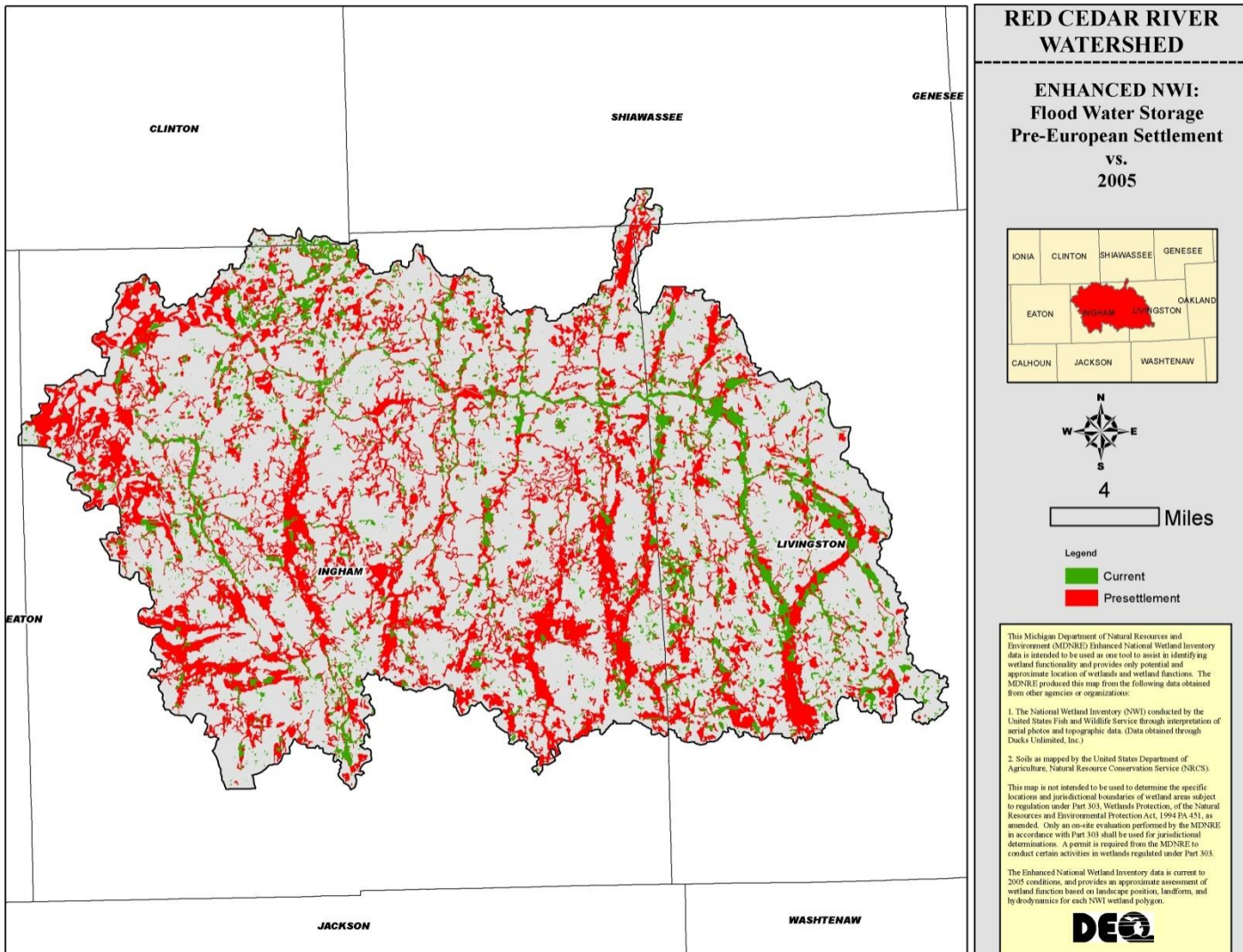
Current

# of Wetlands	# of Functions	ACRES
484	1	570
1,148	2	1,795
575	3	1,854
520	4	1,313
794	5	2,235
465	6	4,682
950	7	5,099
2,086	8	11,182
1,438	9	8,723
436	10	2,158
238	11	1,691
151	12	2,324
16	13	325

FLOOD WATER STORAGE

- ❑ This function is important for reducing the downstream flooding and lowering flood heights, both of which aid in minimizing property damage and personal injury from such events.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

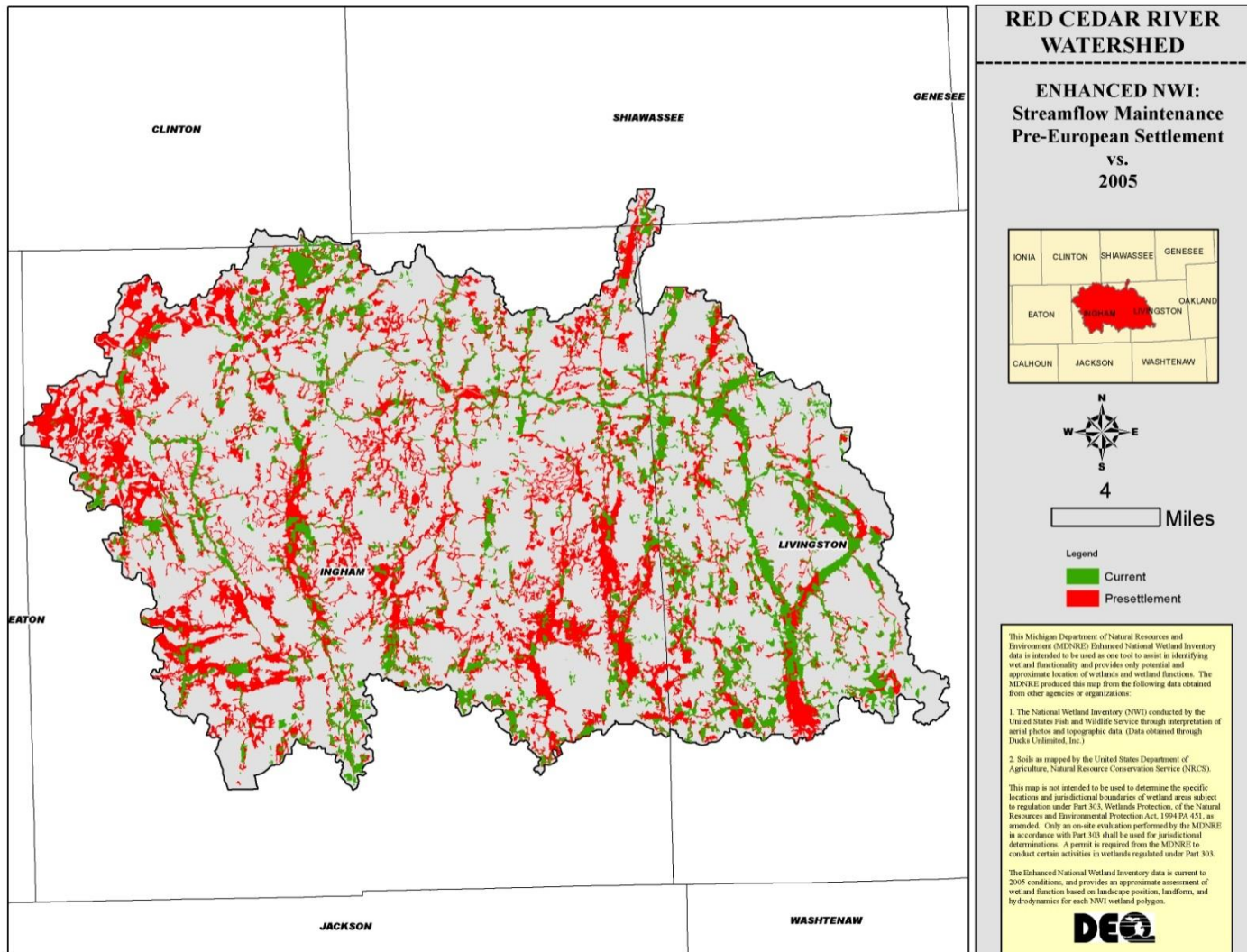
FLOOD WATER STORAGE



STREAMFLOW MAINTENANCE

- ❑ Wetlands that are sources of groundwater discharge that sustain streamflow in the watershed. Such wetlands are critically important for supporting aquatic life in streams. All wetlands classified as headwater wetlands are important for streamflow.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

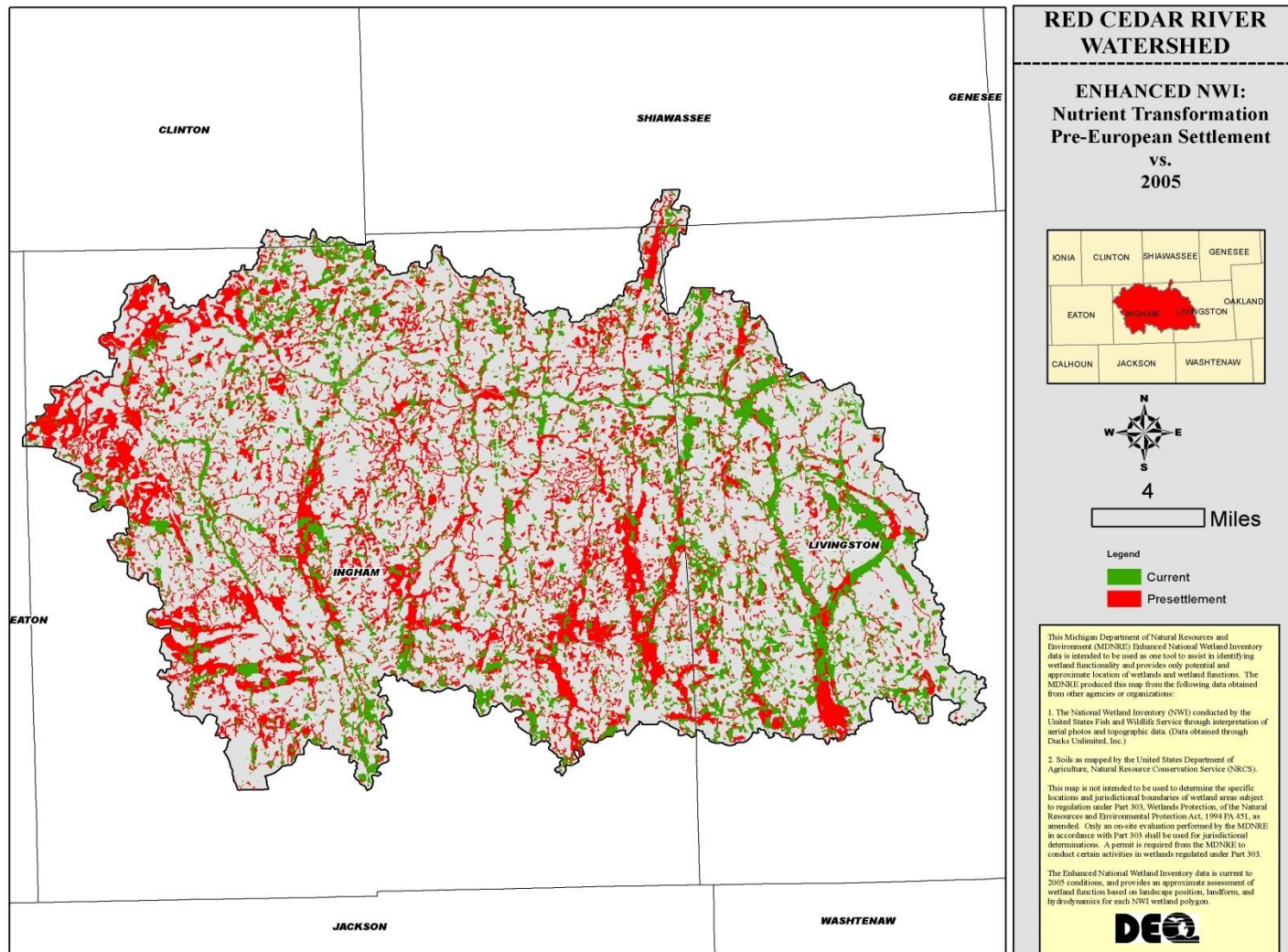
STREAMFLOW MAINTENANCE



NUTRIENT TRANSFORMATION

- ❑ Wetlands that have a fluctuating water table are best able to recycle nutrients. Natural wetlands performing this function help improve local water quality of streams and other watercourses.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

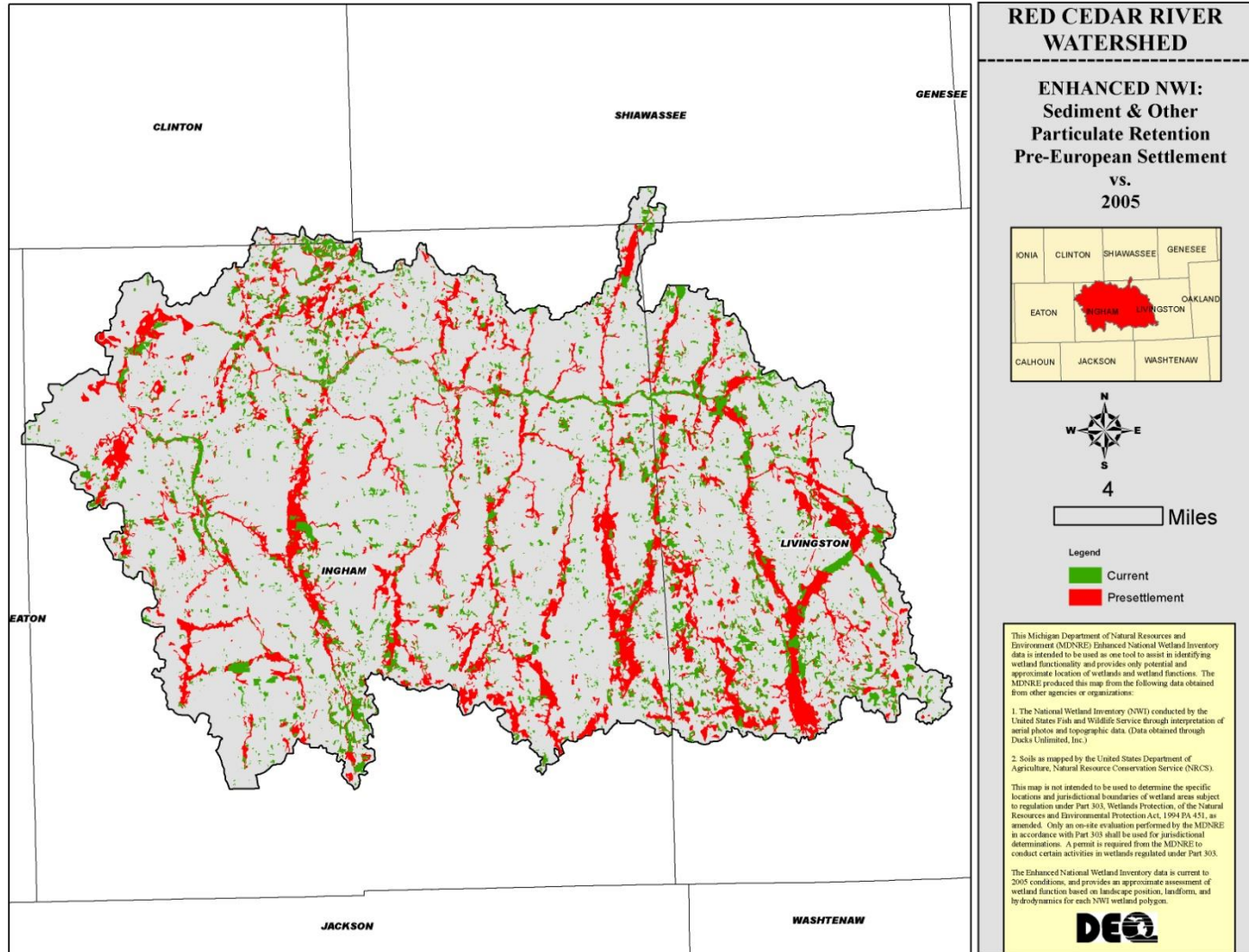
NUTRIENT TRANSFORMATION



SEDIMENT AND OTHER PARTICULATE RETENTION

- ❑ This function supports water quality maintenance by capturing sediments with bonded nutrients or heavy metals. Vegetated wetlands will perform this function at higher levels than those of non-vegetated wetlands.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

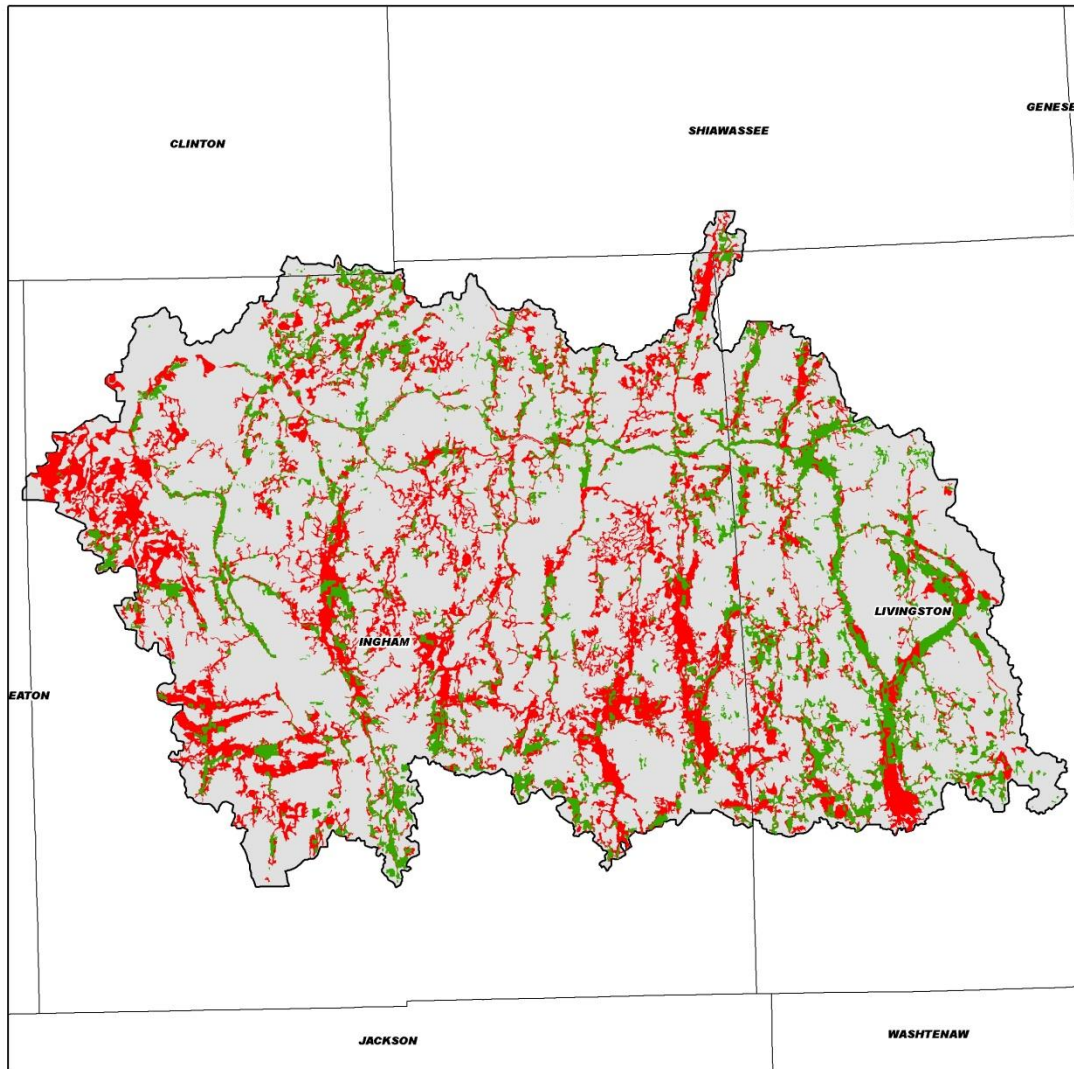
SEDIMENT AND OTHER PARTICULATE RETENTION



SHORELINE STABILIZATION

- ❑ Vegetated wetland along all waterbodies (e.g. estuaries, lakes, rivers, and streams) provide this function. Vegetation stabilizes the soil or substrate and diminished wave action, thereby reducing shoreline erosion potential.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

SHORELINE STABILIZATION



RED CEDAR RIVER WATERSHED

ENHANCED NWI: Shoreline Stabilization Pre-European Settlement vs. 2005



4 Miles

Legend

- Current
- Presettlement

This Michigan Department of Natural Resources and Environment (MDNRE) Enhanced National Wetland Inventory data is intended to be used as one tool to assist in identifying wetland functionality and provides only potential and approximate location of wetlands and wetland functions. The MDNRE produced this map from the following data obtained from other agencies or organizations:

1. The National Wetland Inventory (NWI) conducted by the United States Fish and Wildlife Service through interpretation of aerial photos and topographic data. (Data obtained through Ducks Unlimited, Inc.)

2. Soils as mapped by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS).

This map is not intended to be used to determine the specific locations and jurisdictional boundaries of wetland areas subject to regulation under Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. Only an on-site evaluation performed by the MDNRE in accordance with Part 303 shall be used for jurisdictional determinations. A permit is required from the MDNRE to conduct certain activities in wetlands regulated under Part 303.

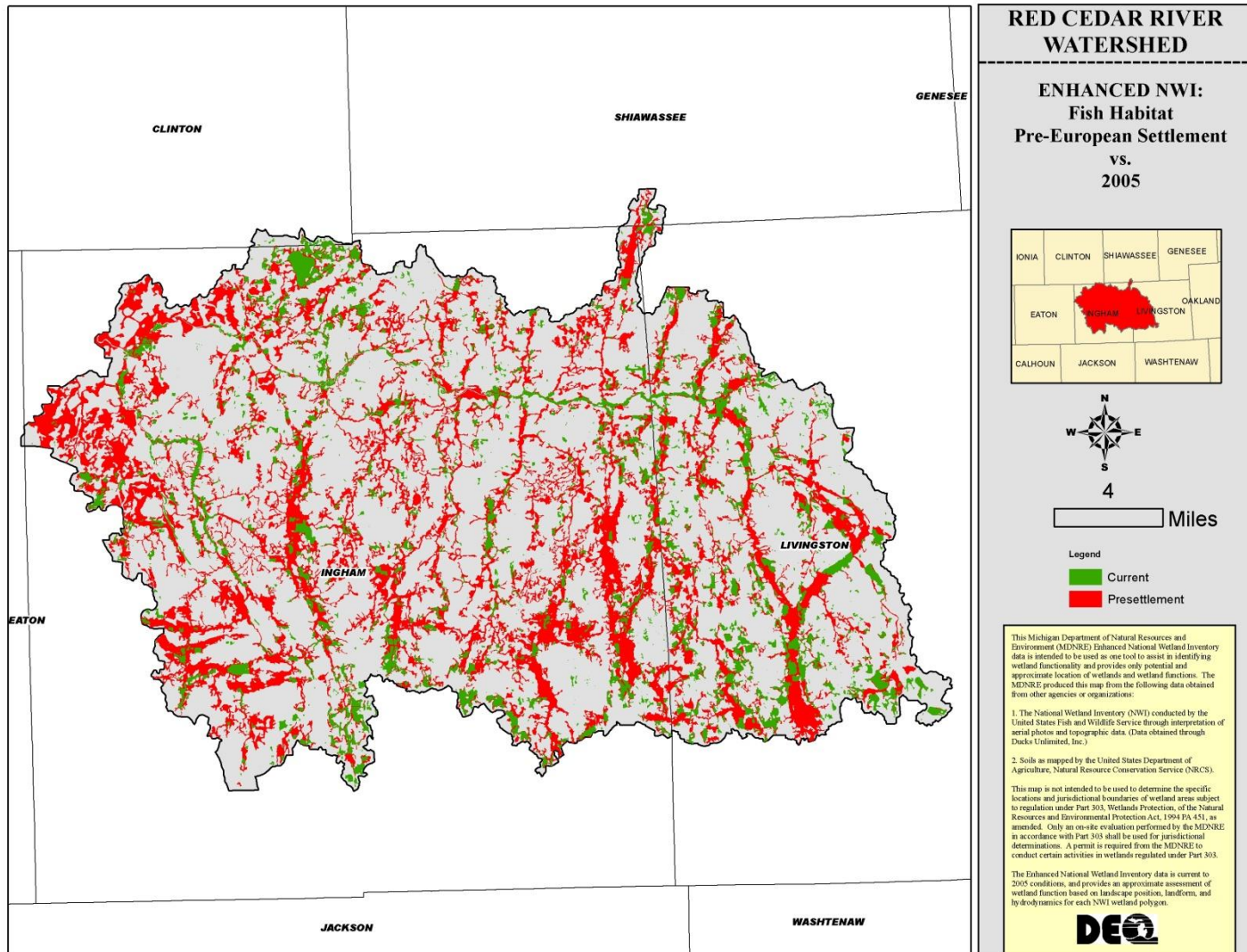
The Enhanced National Wetland Inventory data is current to 2005 conditions, and provides an approximate assessment of wetland function based on landscape position, landform, and hydrodynamics for each NWI wetland polygon.



FISH HABITAT

- ❑ Wetlands that are considered essential to one or more parts of fish life cycles. Wetlands designated as important for fish are generally those used for reproduction, or feeding.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

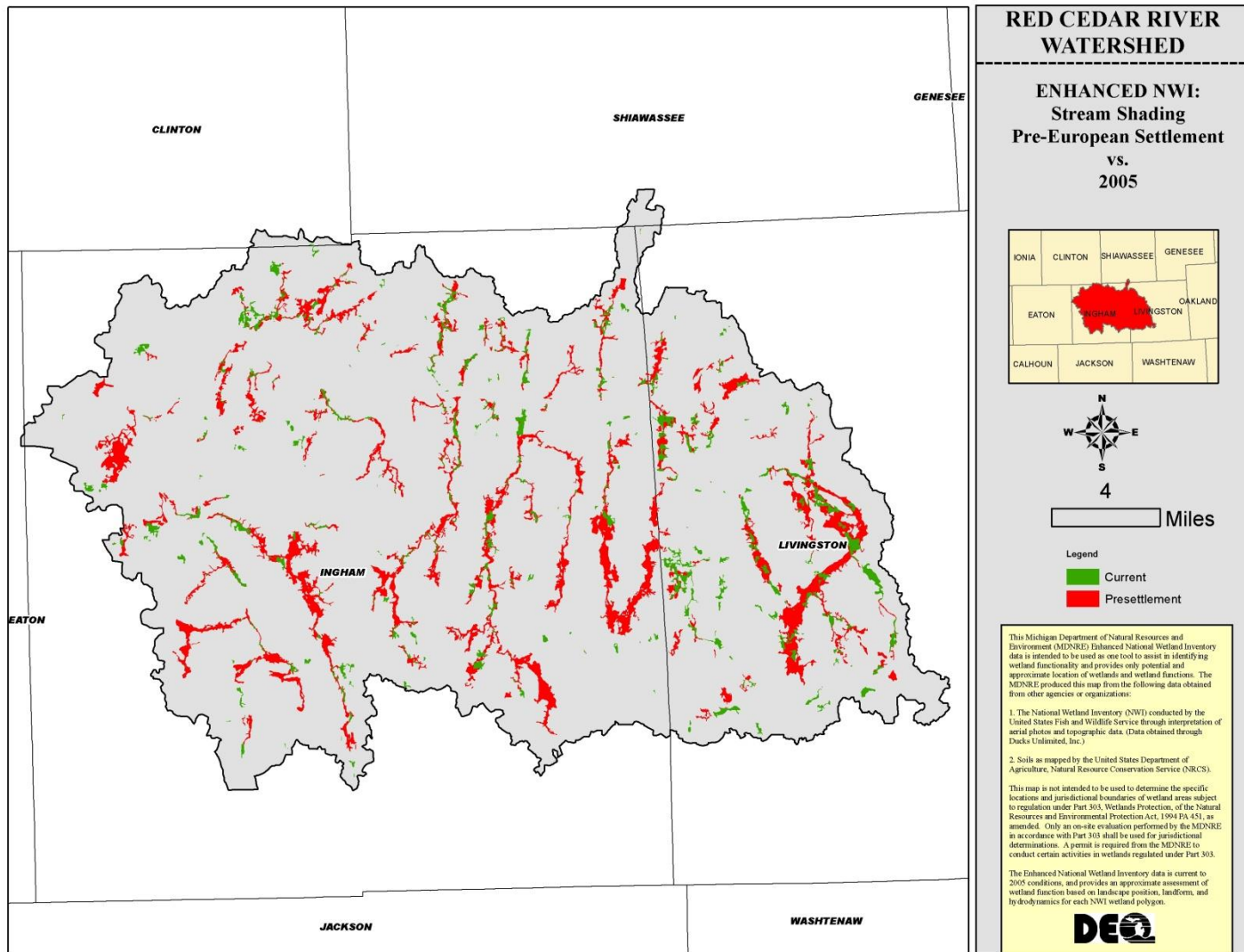
FISH HABITAT



STREAM SHADING

- ❑ Wetlands that perform water temperature control due to the proximity to streams and waterways. These wetlands generally are Palustrine Forested or Scrub-Shrub.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

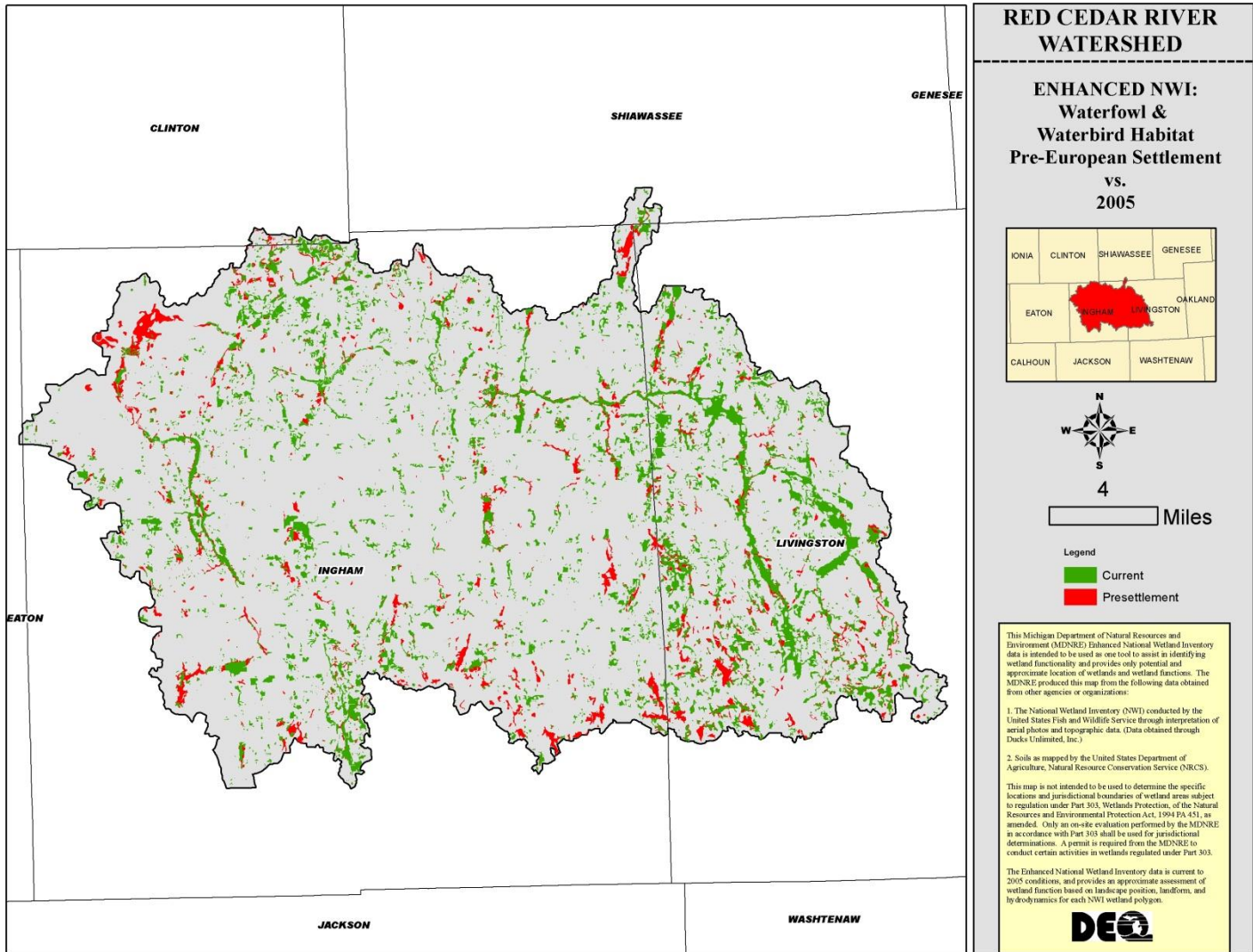
STREAM SHADING



WATERFOWL AND WATERBIRD HABITAT

- ❑ Wetlands designated as important for waterfowl and waterbirds are generally those used for nesting, reproduction, or feeding. The emphasis is on the wetter wetlands and ones that are frequently flooded for long periods.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

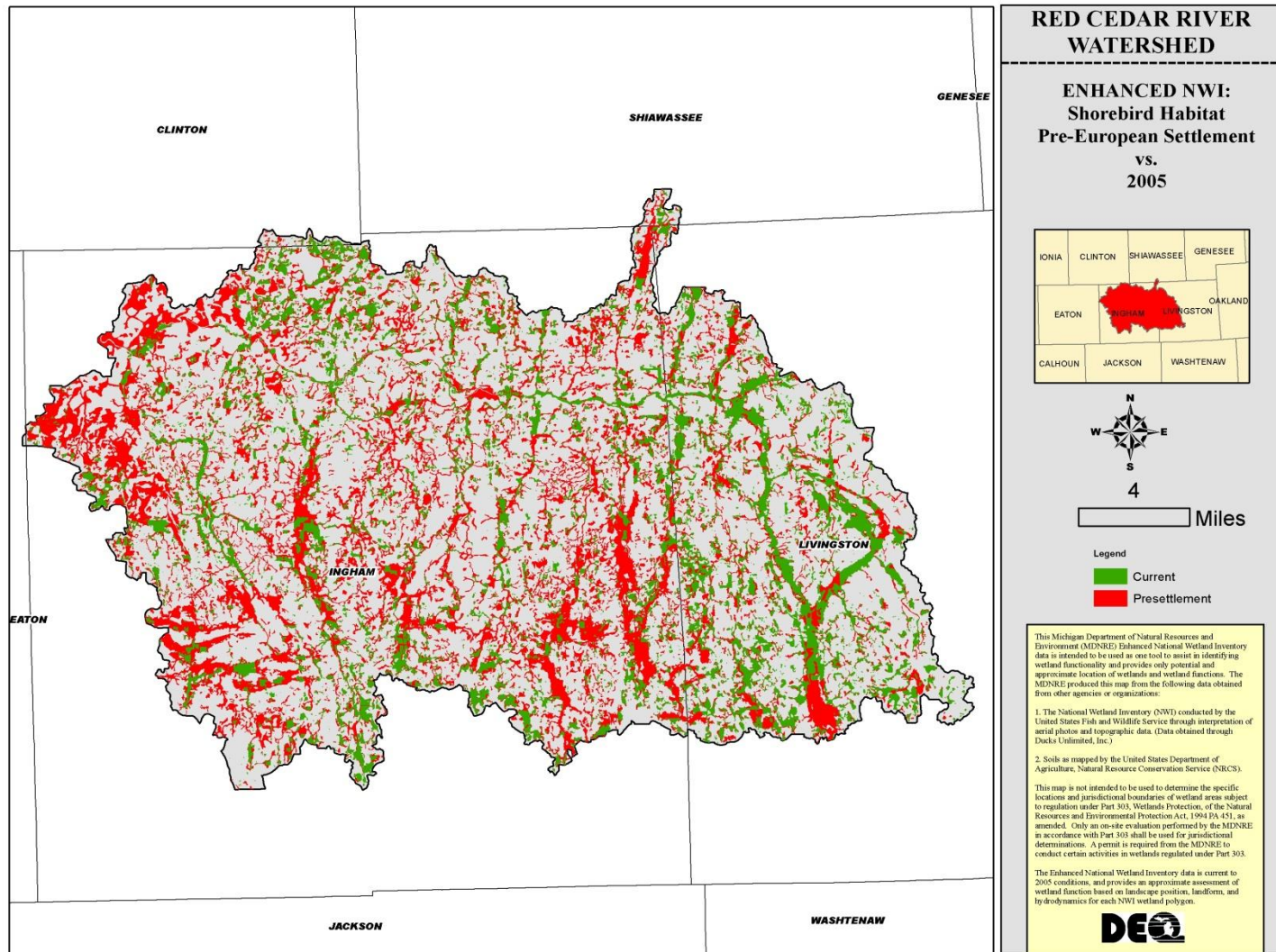
WATERFOWL & WATERBIRD HABITAT



SHOREBIRD HABITAT

- ❑ Shorebirds generally inhabit open areas of beaches, grasslands, wetlands, and tundra and undertake some of the longest migrations known. Along their migration pathway, many shorebirds feed in coastal and inland wetlands where they accumulate fat reserves needed to continue their flight. Common species include; plovers, oystercatchers, avocets, stilts, and sandpipers. This function attempts to capture wetland types most likely to provide habitat for these species.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

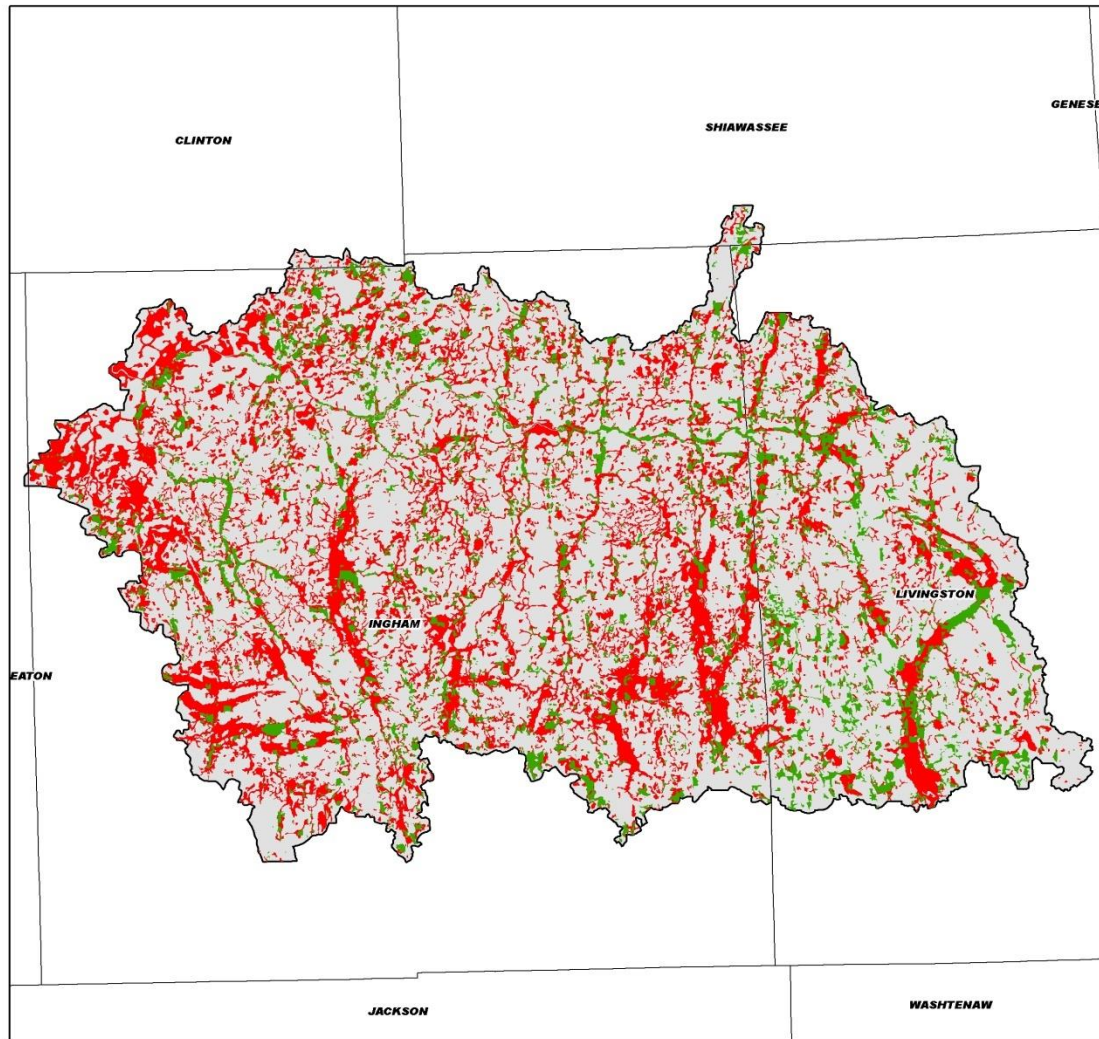
SHORE BIRD HABITAT



INTERIOR FOREST BIRDS

- ❑ Interior Forest Birds require large forested areas to breed successfully and maintain viable populations. This diverse group includes colorful songbirds such as; tanagers, warblers, vireos that breed in North America and winter in the Caribbean, Central and South America, as well as residents and short-distance migrants such as; woodpeckers, hawks, and owls. They depend on large forested tracts, including streamside and floodplain forests. It is important to note that adjacent upland forest to these riparian areas are critical habitat for these species as well. This function attempts to capture wetland types most likely to provide habitat for these species.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

INTERIOR FOREST BIRD HABITAT



RED CEDAR RIVER WATERSHED

ENHANCED NWI: Interior Forest Bird Habitat Pre-European Settlement vs. 2005



4

Miles

Legend

- Current
- Presettlement

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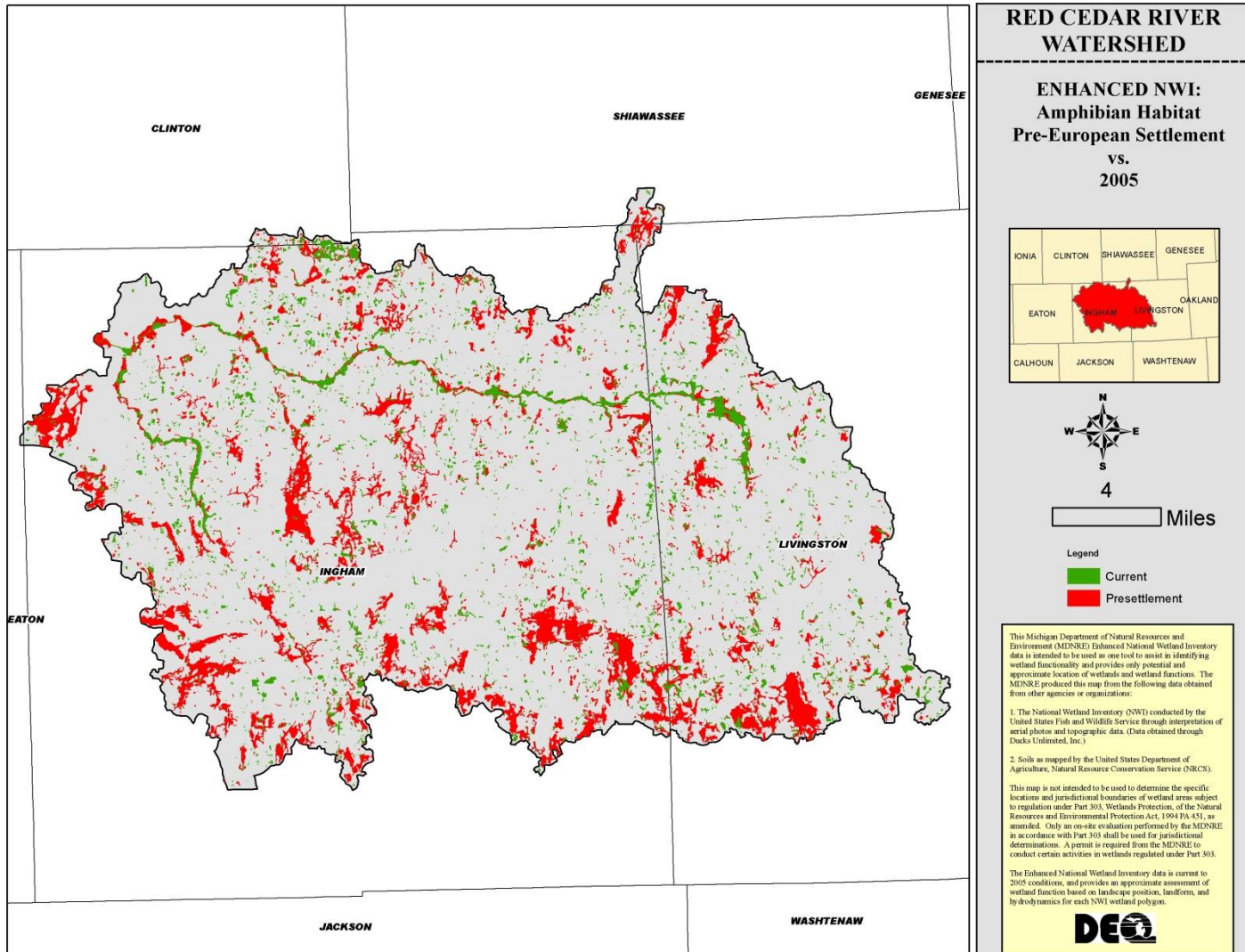
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AMPHIBIAN HABITAT

- ❑ Amphibians share several characteristics in common including wet skin that functions in respiration and gelatinous eggs that require water or moist soil for development. Most amphibians have an aquatic stage and a terrestrial stage and thus live in both aquatic and terrestrial habitats. Aquatic stages of these organisms are often eaten by fish and so for certain species, successful reproduction may occur only in fish-free ponds. Common sub-groups of amphibians are salamanders, frogs, and toads. This function attempts to capture wetland types most likely to provide habitat for these species.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

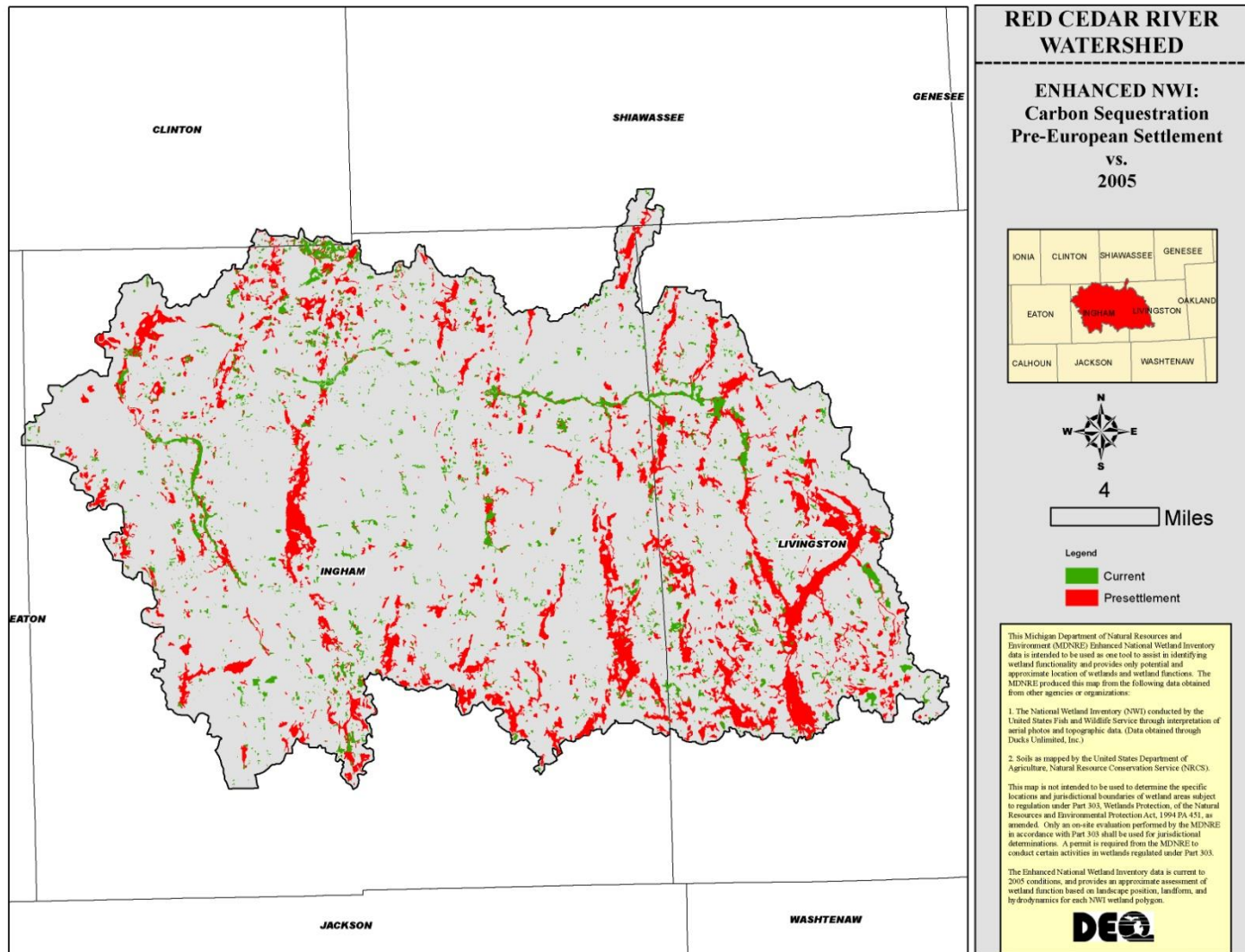
AMPHIBIAN HABITAT



CARBON SEQUESTRATION

- ❑ Wetlands are different from other biomes in their ability to sequester large amounts of carbon, as a consequence of high primary production and then deposition of decaying matter in the anaerobic areas of their inundated soils.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

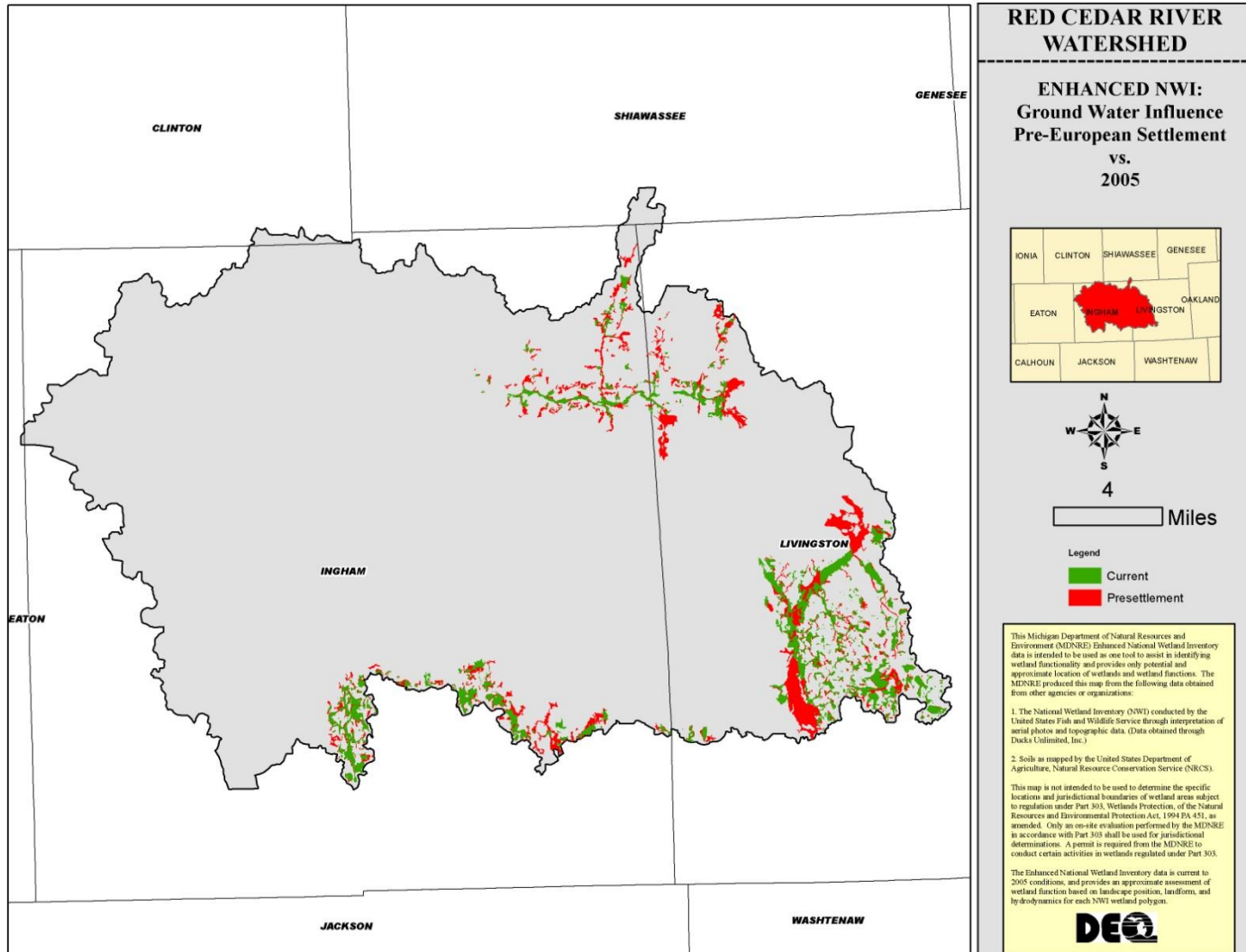
CARBON SEQUESTRATION



GROUND WATER INFLUENCE

- ❑ Wetlands categorized as High or Moderate for Groundwater Influence are areas that receive some or all of their hydrologic input from groundwater reflected at the surface. The DARCY (definition of acronym) model was the data source utilized to determine this wetland/groundwater connection, which is based upon soil transmissivity and topography. Wetlands rated for this function are important for maintaining streamflows and temperature control in waterbodies.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in two distinct time periods; Pre-European settlement (red), and wetlands circa 2005 (green).

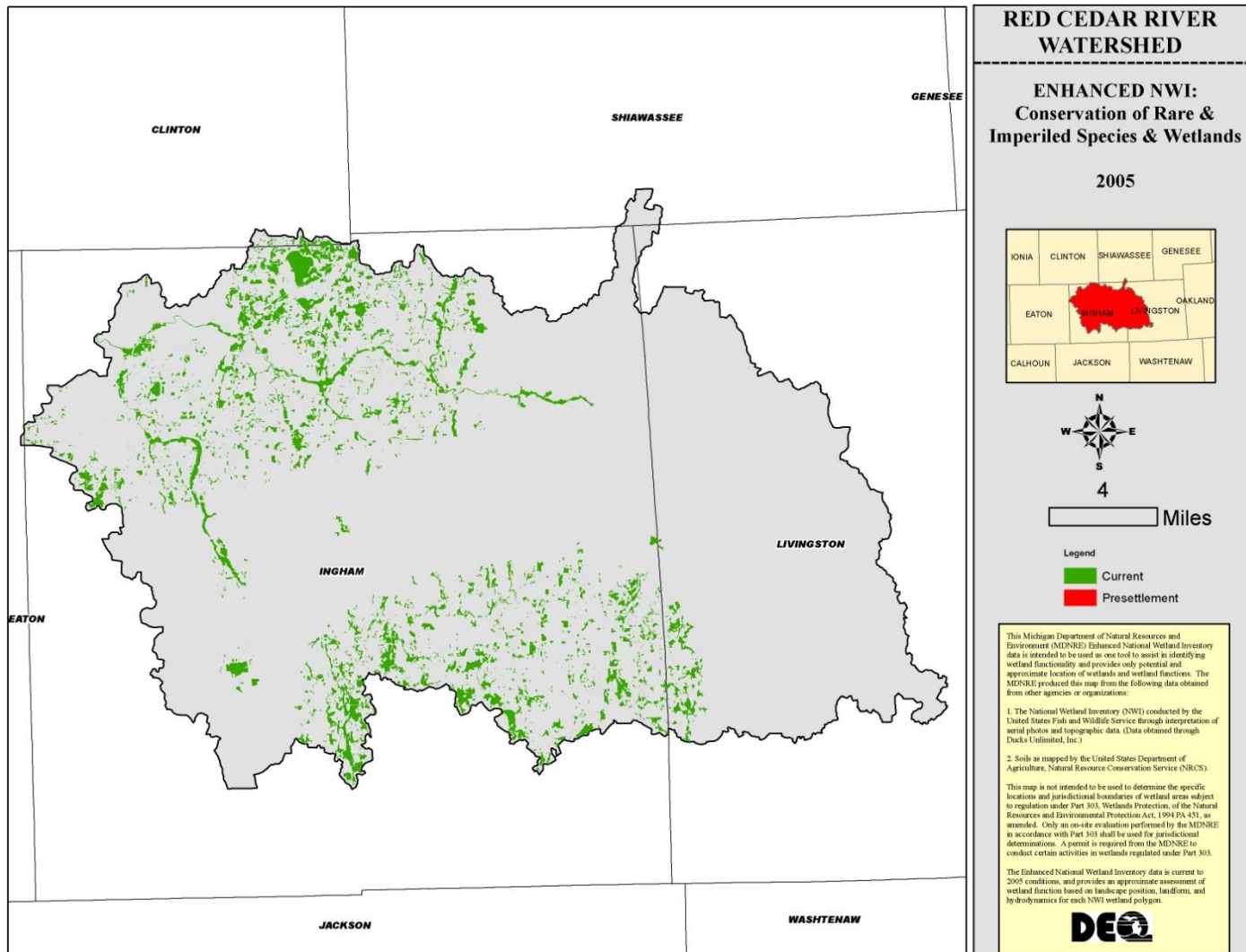
GROUND WATER INFLUENCE



CONSERVATION OF RARE AND IMPERILED WETLANDS & SPECIES

- ❑ Wetlands that are considered rare either globally or at the state level. They are likely to contain a wide variety of flora and fauna, or contain threatened or endangered species.
- ❑ This function is derived from the Michigan Natural Features Dataset (MNFI) of known sightings of threatened, endangered, or special concern species and high quality natural communities. The model values are reported on a 40 acre polygon grid for the state of Michigan, or a subset of MI. Due to this the dataset should not be used as a comprehensive inventory of Rare and Imperiled wetlands.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function are mapped in (green) circa 2005.

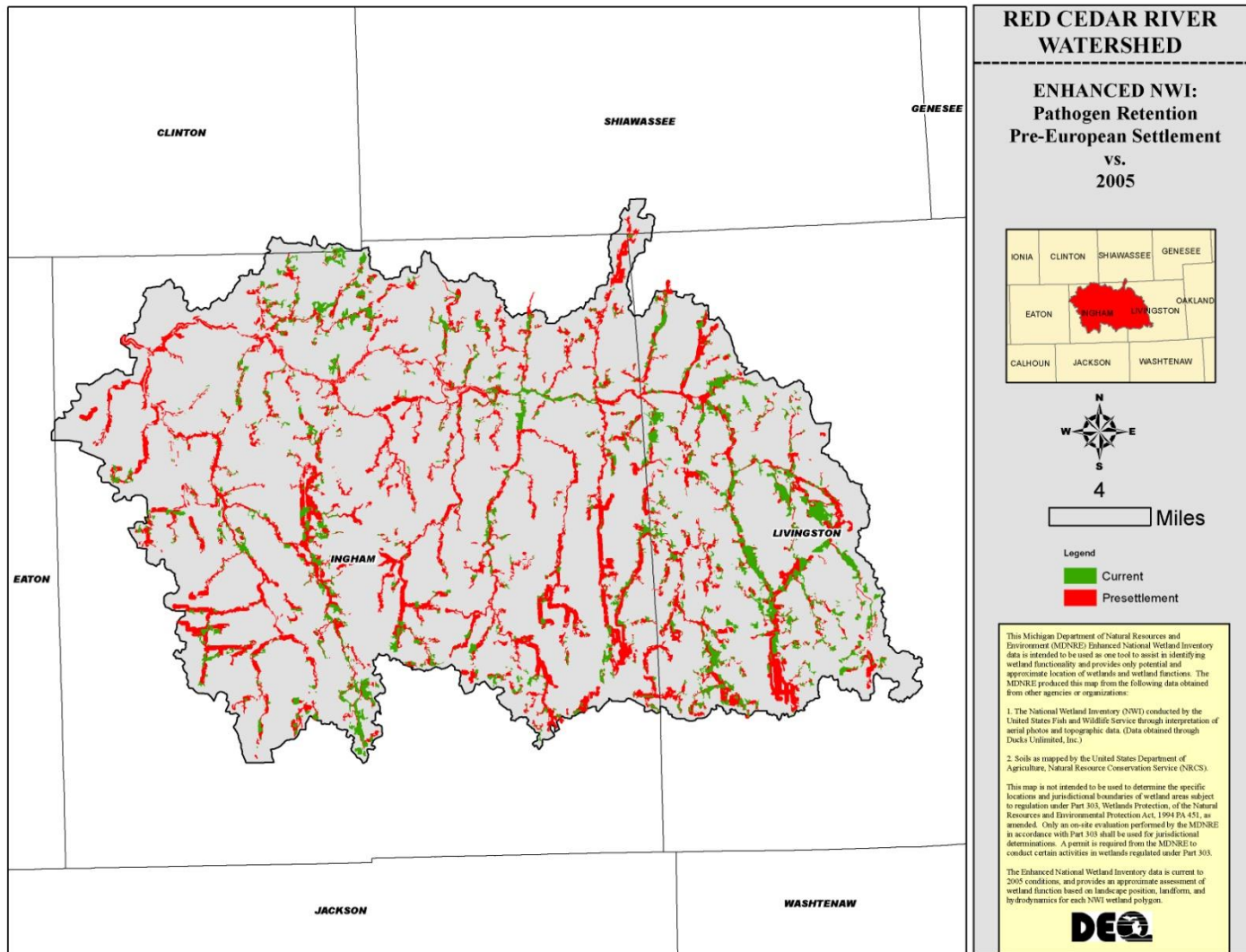
CONSERVATION OF RARE IMPERILED WETLANDS, & SPECIES



PATHOGEN RETENTION

- ❑ Wetlands can improve water quality through natural processes of filtration for sedimentation, nutrients and *Escherichia coli* (*E. coli*). *E. coli* is a sub-set of fecal coli forms whose presence in water indicates fecal contamination from warm blooded animals. The presence of *E. coli* indicates that contamination has occurred, and other harmful pathogens may also be present.
- ❑ The following map illustrates wetlands that perform the above ecological service at a level of significance above that of wetlands not designated. Wetlands deemed to be performing this function at a high level are mapped in (green) circa 2005. Wetlands deemed valuable for restoration for this function are mapped in (red).

PATHOGEN RETENTION



Data Limitations and Disclaimer

National Wetlands Inventory Plus (NWI)

- Wetland boundaries determined from Aerial Imagery
- Last updated in 2005
- Obvious limitations to Aerial Photo Interpretation:
 - Errors of Omission (forested and drier-end wetlands)
 - Errors of Commission (misinterpretation of aerials)

The 2005 NWI data was used in this analysis to report status and trends, as this is currently the best data source available. However, this data may not accurately reflect current conditions on the ground.

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Landscape Level Wetland Functional Assessment (LLWFA)

- Source data are a primary limiting factor.
- Wetland mapping limitations due to scale, photo quality, and date and time of year of the photos.
- Functional assessment is a preliminary one based on:
 - Wetland Characteristics interpreted through remote sensing
 - Professional Judgment of various specialists to develop correlations between those wetlands and their functions.
- Watershed-based Preliminary Assessment of wetland functions:
 - Applies general knowledge about wetlands and their functions
 - Develops a watershed overview that highlights possible wetlands of significance
 - Does not consider the condition of the adjacent upland
 - Does not obviate the need for more detailed assessment of various functions
- This analysis is a "Landscape Level" assessment and used to identify wetlands that are likely to perform a given function at a level above that of other wetlands not designated