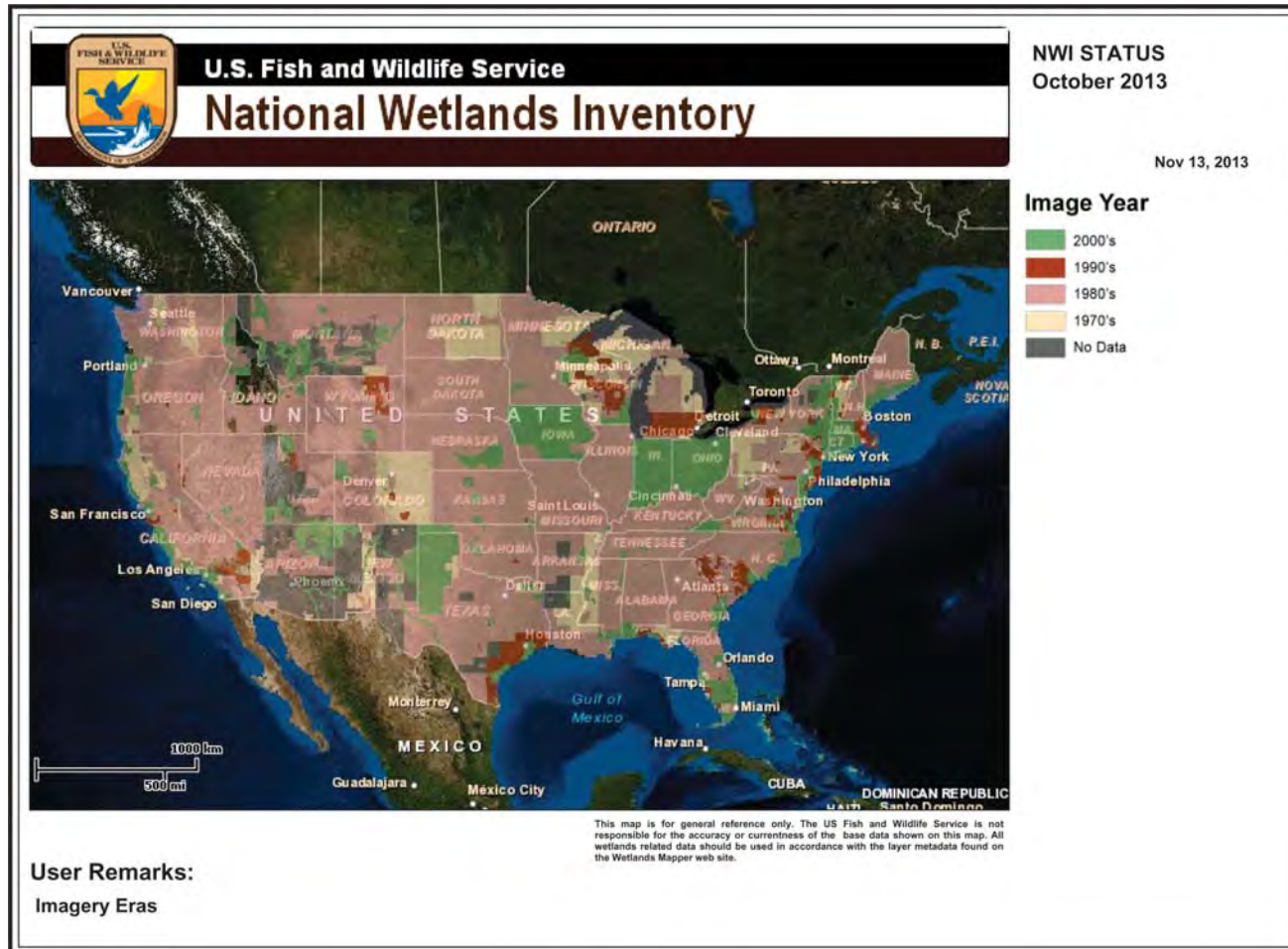

NWI+ Data – What It Is and How It is Being Used

Ralph Tiner
U.S. Fish & Wildlife Service
Northeast Region, Hadley, MA
November 20, 2013
ralph_tiner@fws.gov

National Wetlands Inventory (NWI)

- Mapping wetlands across the country since mid-1970s

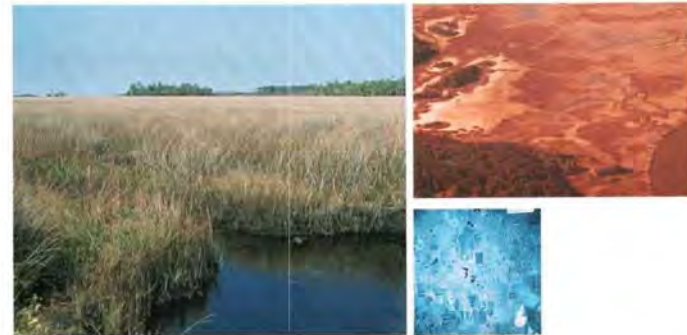


NWI Classification

- NWI mapping uses the Cowardin et al. system
- Hierarchical system
 - Ecological System
 - Marine, Estuarine, Riverine, Lacustrine, Palustrine
 - Subsystems
 - Class
 - Emergent, Scrub-Shrub, Forested, etc.
 - Subclass
 - Modifiers – water regime, water chemistry, soil, and special

FWS/OBS-79/31
DECEMBER 1979
Reprinted 1992

Classification of Wetlands and Deepwater Habitats of the United States

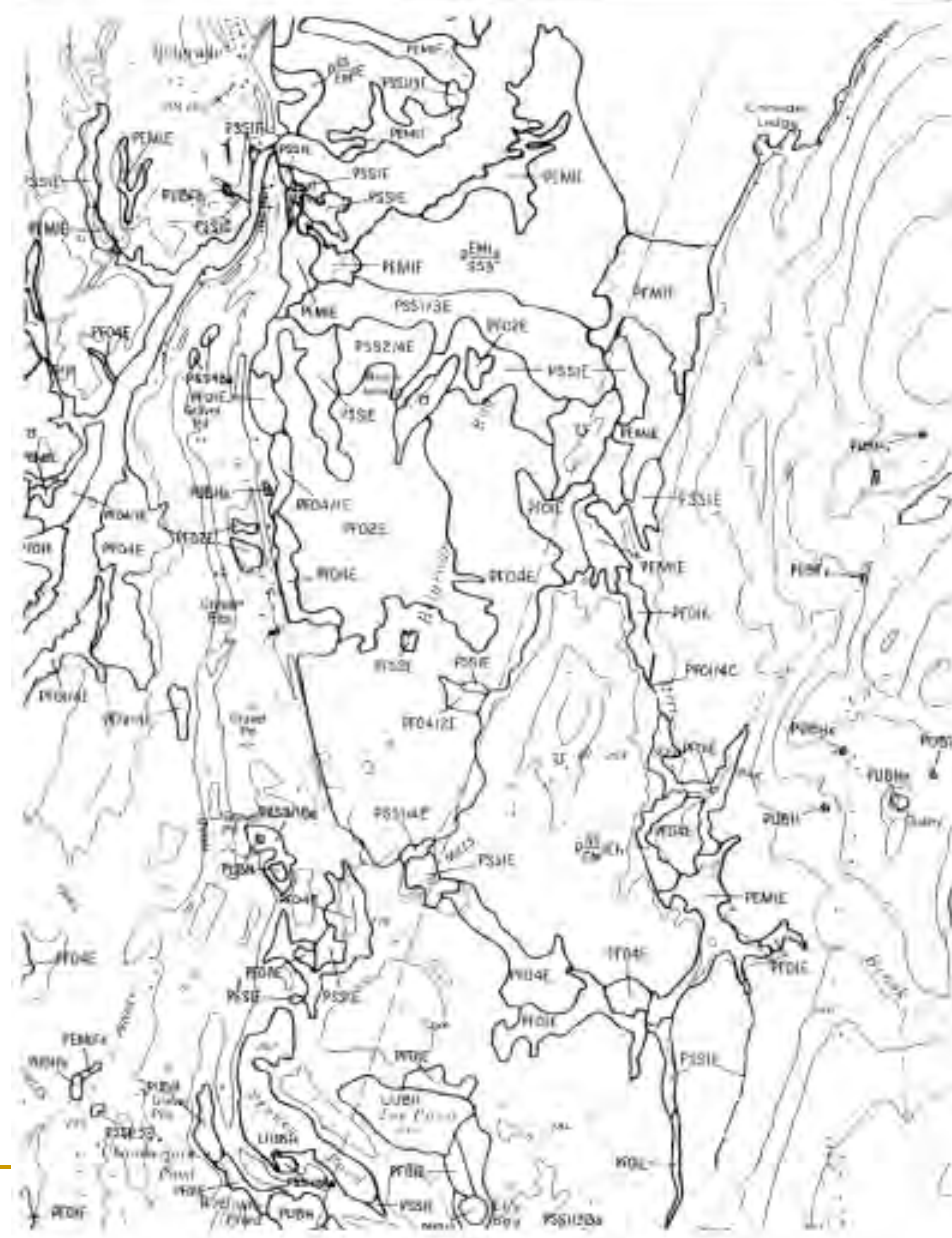


U.S. Department of the Interior
Fish and Wildlife Service

NWI Classification: Emphasis

- Vegetation or Substrate
 - Hydrology (Water Regime)
 - Water Chemistry (pH and halinity/salinity)
 - Human Impacts (Special Modifiers)
-
- Purpose: Mainly to provide consistent terms for wetland classification and mapping
-

NWI Types –
originally
results shown
on maps
(before GIS)



Some Questions to Answer

How many wetlands are there – not polygons?

What is the size range of wetlands or a given type – not polygons?

How many wetlands are in various size classes?

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 or waters?

What types of ponds are there and what is their extent?

What wetlands are likely to be important for certain functions?

Virtually all trends studies show increases in ponds and losses of vegetated wetlands, how does this affect functions?

-
- Some questions can be answered by GIS manipulation (e.g., merging polys)
 - Others require additional classification and possibly additional linework to further divide polys as appropriate (but not done to date).
-

What is the NWI classification missing?

- **FEATURES THAT CAN BE SEEN ON A TOPOGRAPHIC MAP**
 - Abiotic Properties including
 - Landscape Position
 - Is the wetland a river, stream, lake, reservoir, or pond?
 - Is it not associated with a waterbody? Perhaps completely surrounded by upland (dryland).
 - Landform
 - Is the wetland situated in a depression, on a flat, on a floodplain, or on a slope?
 - Is it in shallow water or along a waterbody in an area frequently flooded?
 - Water Flow Path
 - Where is the water coming from and going to from this wetland?
 - Mostly an issue for Palustrine Wetlands which account for 95% of the wetlands in the lower 48 states
 - **Also missing surficial geology and groundwater relations but that's beyond what can be done through aerial mapping**
-

HGM Classification

- Dr. Mark Brinson developed the “hydrogeomorphic classification system” to address abiotic features that influence wetland functions
 - His main purpose was to be able to classify wetlands for developing “reference wetlands” for assessing wetland impacts and “condition” (departure from reference), and helping design appropriate mitigation
 - Unfortunately the HGM classification was not planned as an add-on to the Cowardin et al. system and in the process used some of the same terms as Cowardin (riverine and lacustrine) but defined them differently
-

Basic Goal of NWI+ = Integrate Concept of HGM into NWI Mapping

- Given GIS technology ... add HGM-type descriptors to NWI types to expand classification for:
 - Better characterization of wetlands and waterbodies (especially Palustrine types)
 - Increase functionality of the NWI database for use in:
 - Predicting wetland functions at the landscape level
 - Identifying potential wetland restoration sites
 - Apply when updating NWI data
-

NWI+

- Takes the basic concept of HGM and applies descriptors for landscape position, landform, water flow path, and waterbody type to NWI data to create an expanded database:

NWI+ Database

Note: These data are not a standard product of the NWI; they are a special product that is typically user-funded or user-produced.

What do NWI+ Data Include?

■ **Standard Data**

- ❑ Expanded wetland classification
 - Hgm-type descriptors
- ❑ Wetlands of potential significance for many functions

■ **Optional Data**

- ❑ Potential wetland restoration sites
 - ❑ Areas that may support wetlands based on soil mapping
-

Standard NWI+ Data

- HGM-type Descriptors
 - Landscape Position
 - Landform
 - Water Flow Path
 - Waterbody Type
 - Wetlands Significant for 11 Functions
-

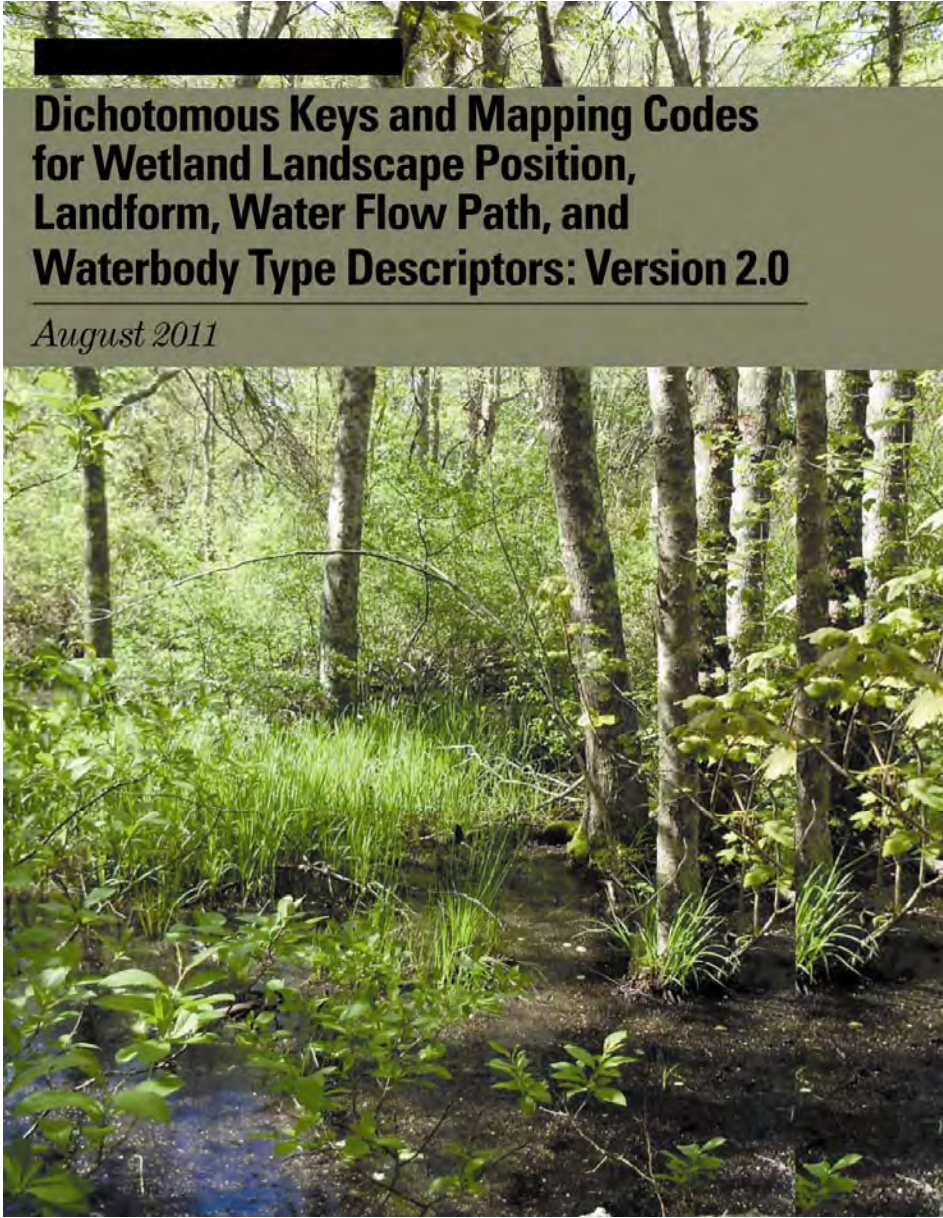
HGM-Type Descriptors

- Landscape Position – the relationship of a wetland to a contiguous waterbody
- Landform – the physical shape of the wetland
- Water Flow Path – the directional flow of water related to the wetland
- Waterbody Type – more descriptive of lakes, ponds, estuaries, rivers, and streams

Called “**LLWW Descriptors**”.

Dichotomous Keys for Classification

(since 1997; due for
minor additions in
2014)



**Dichotomous Keys and Mapping Codes
for Wetland Landscape Position,
Landform, Water Flow Path, and
Waterbody Type Descriptors: Version 2.0**

August 2011



Landscape Position

- Relationship between a Wetland and a Waterbody
 - MARINE
 - ESTUARINE
 - LOTIC
 - LENTIC
 - TERRENE
-

Marine (associated with ocean)

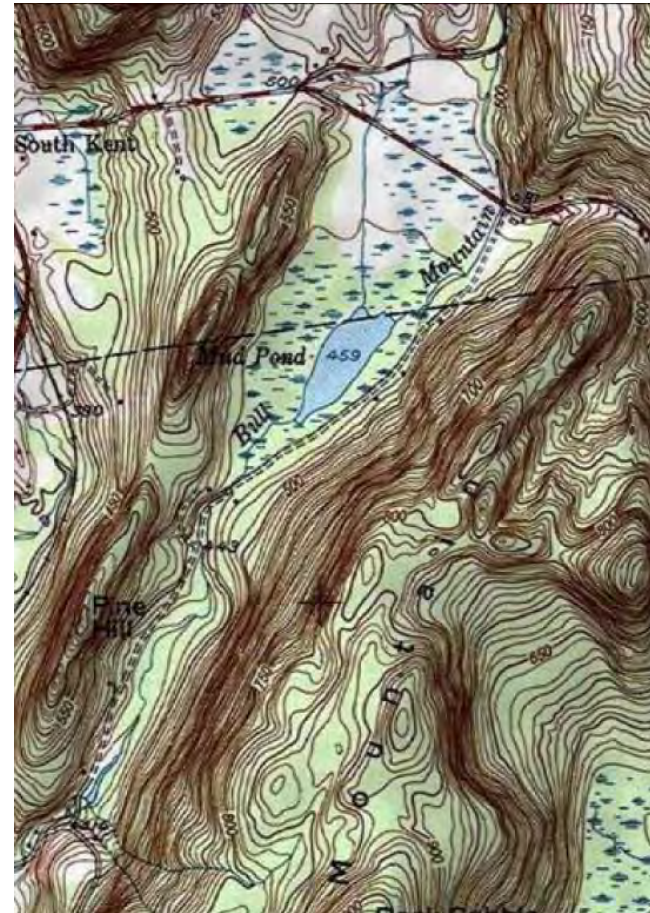


Estuarine (associated with estuaries)



Lentic

(associated with lakes and reservoirs)

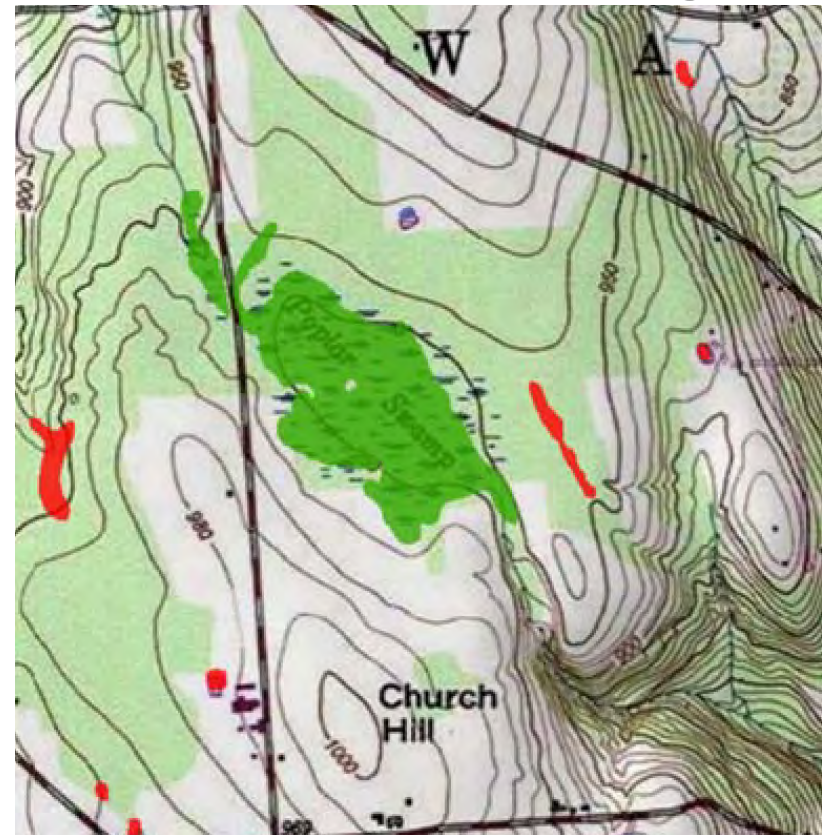


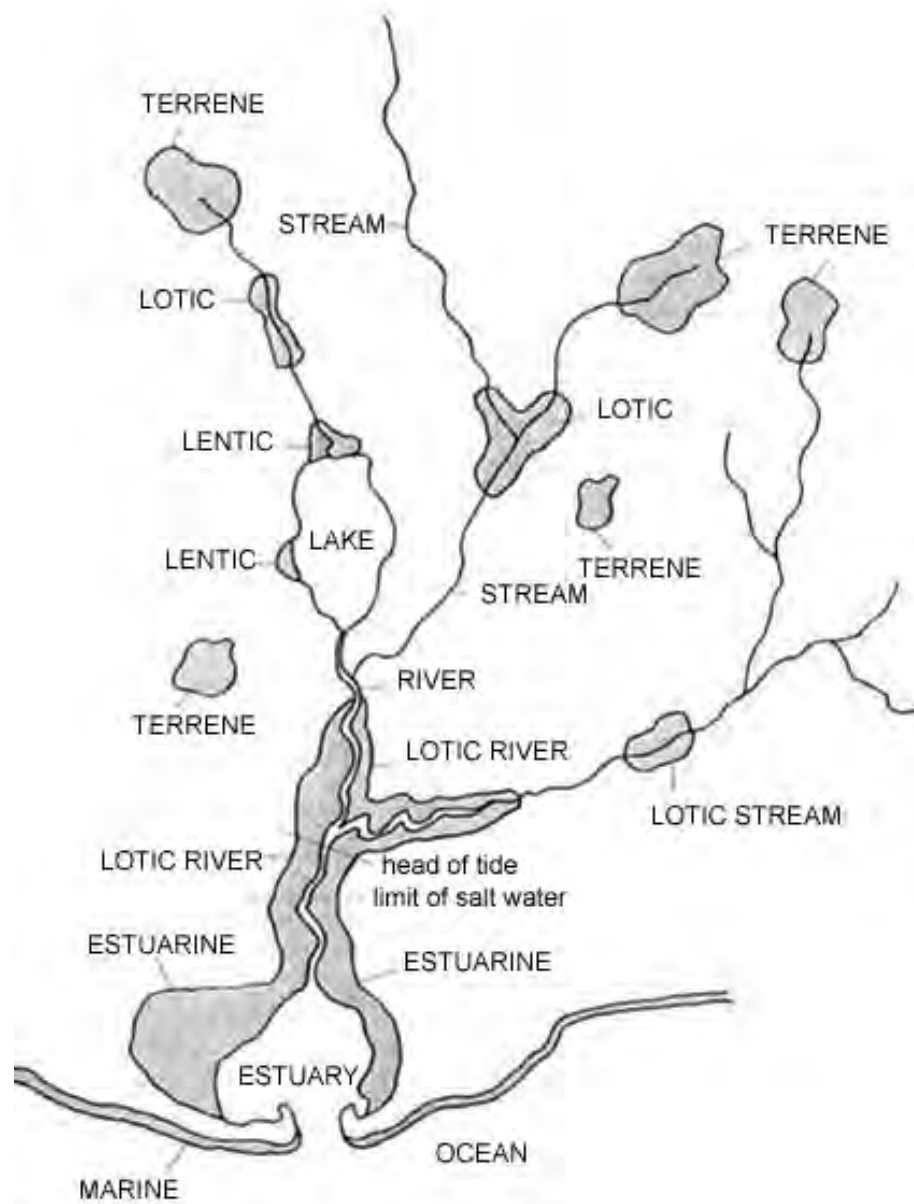
Lotic

(associated with rivers and streams)



Terrene (isolated, source of stream, or hydrologically decoupled from stream; latter types often are groundwater discharge sites)



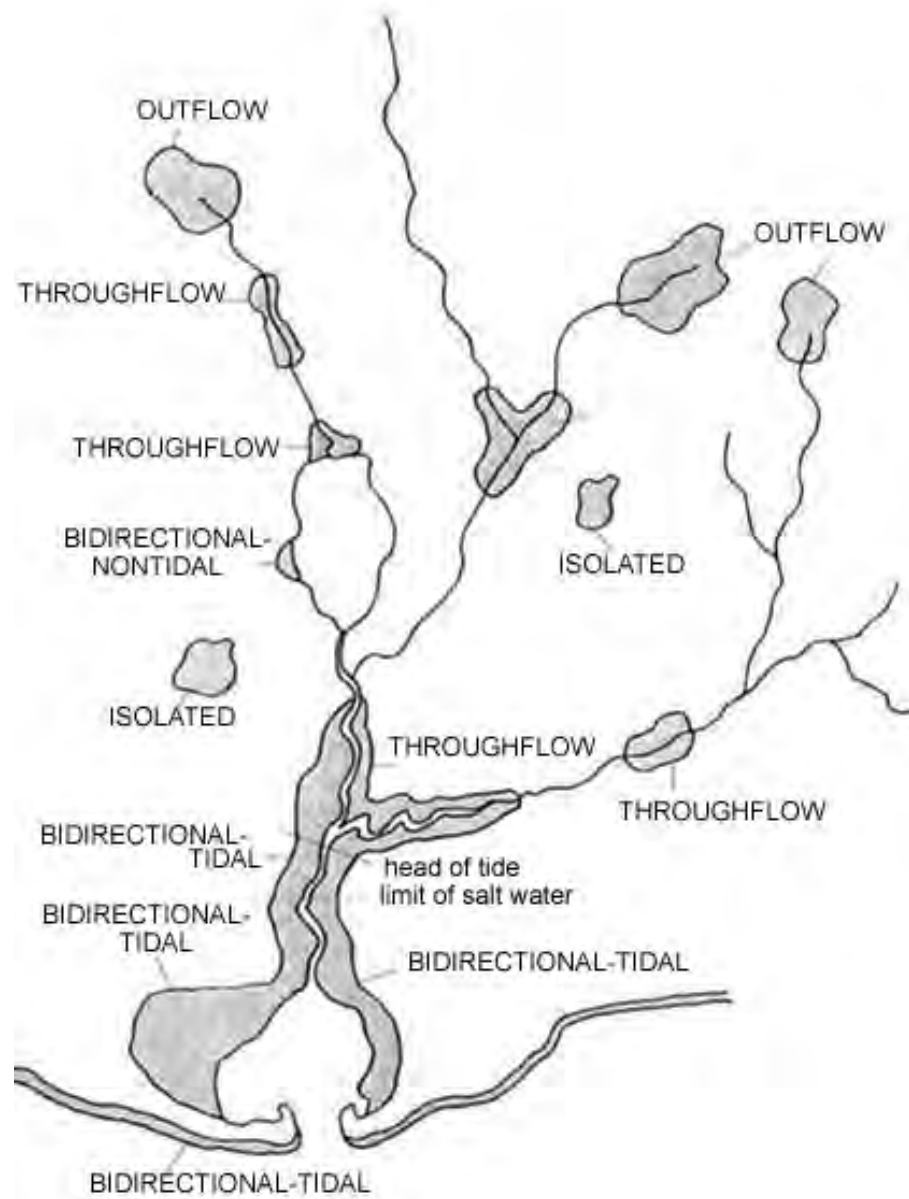


Landforms

- Slope (>2%)
 - Island (coastal - e.g., delta, river, bay)
 - Fringe (coastal – e.g., barrier island, bay, bay island; inland – pond, lentic, lotic)
 - Floodplain (basin, flat, island)
 - Basin
 - Flat
-

Water Flow Path

- **Bidirectional Tidal** (artificial)
 - **Bidirectional Nontidal** (artificial)
 - **Throughflow** (perennial, intermittent, entrenched, artificial)
 - **Outflow** (perennial, intermittent, artificial)
 - **Inflow**
 - **Isolated** (other descriptors to show any connectivity between isolated types in “isolated complex”)
 - **Paludified**
-



Waterbody Types

- More specific types:
 - Estuary: Drowned River Valley, Bar-built;
 - Macrotidal, Mesotidal (6-12 ft tides), Microtidal
 - Circulation patterns – salt-wedge, homogenous, partially mixed
 - Rivers/Streams: gradients, dammed
 - Lakes: natural, dammed (reservoir)
 - Ponds: natural (woodland-wetland, woodland-dryland, sinkhole-woodland, sinkhole-prairie, Carolina bay, cypress dome, vernal-woodland, interdunal, floodplain, grady, other), dammed/impounded (aquaculture, agriculture, industrial, golf, stormwater, etc.), excavated (etc.), beaver
 - Note: Can add other types of interest – list is a first cut.
-

Other Descriptors - Examples

- Headwater*
- Floating mat
- Drainage divide
- Partly drained
- Coastal island
- Freshwater wetland discharging directly into an estuary*
- Overwash
- Tidally restricted (road or railroad)*
- Fragmented

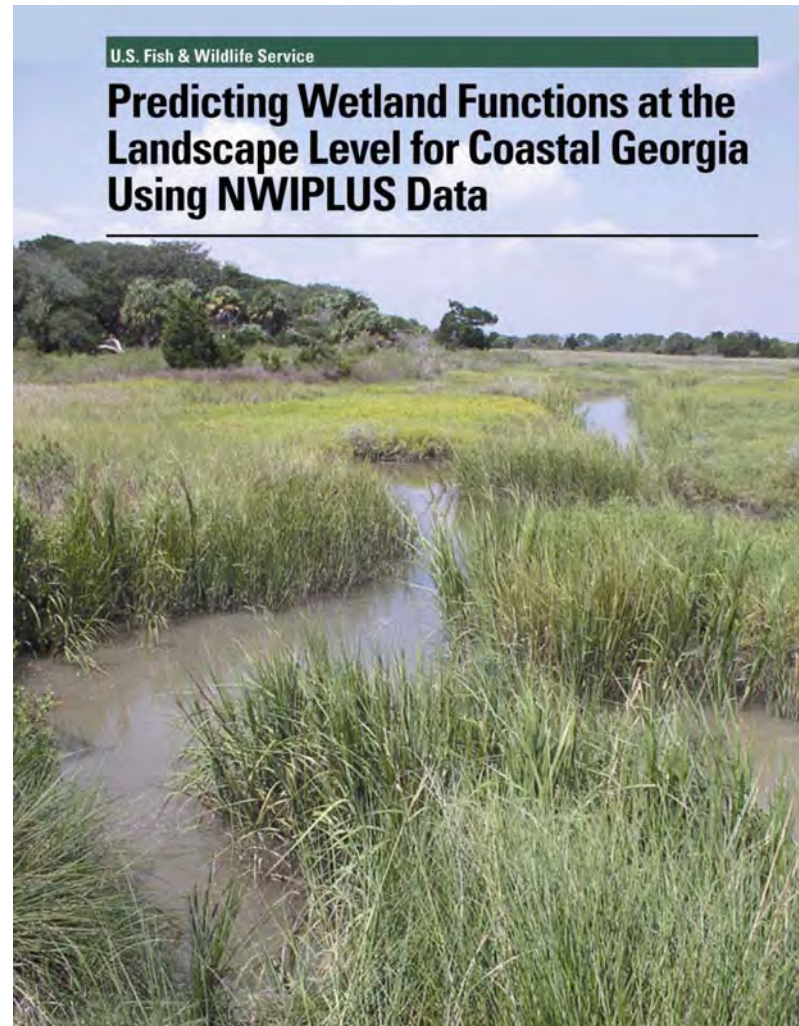
*Applied for all projects

NWI+ for Functional Assessment

- Landscape-level Assessment
 - Preliminary
 - Based on existing geospatial data
 - Apply to watershed, coastal zone, county, or entire state
 - Correlate descriptors in NWI+ database with wetland functions
-

Coordinated Effort To Develop Correlations

- Reviewed literature
- Worked with wetland specialists in the Northeast
 - Maine Wetland Advisory Group
 - NYCDEP
 - Nanticoke Wetlands Study Group
 - FWS biologists
 - Others
- Correlation Report (2003) and Tables (2013)
- Should review prior to use in other geographic regions
 - Reviewed/revise for coastal **Georgia**, Wisconsin, and New Mexico
- User Adaptable (can modify functions of interest)



Preliminary Functional Assessment

- Surface Water Detention (inland wetlands)
 - Coastal Storm Surge Detention
 - Streamflow Maintenance
 - Bank and Shoreline Stabilization
 - Nutrient Transformation
 - Carbon Sequestration
 - Sediment and Other Particulate Retention
 - Provision of Fish and Wildlife Habitat
 - Fish and Aquatic Invertebrates
 - Waterfowl and Waterbirds
 - Other Wildlife
 - Provision of Habitat for Unique, Uncommon, or Highly Diverse Wetland Plant Communities (formerly Conservation of Biodiversity; *based on mapped types not through field surveys*)
-

Developing Functional Correlations

- Correlate Functions with Characteristics
 - Some emphasize LLWW descriptors
 - Surface Water Detention
 - Streamflow Maintenance
 - Some only use general wetland type/water regime
 - Nutrient Transformation
 - Habitat for Other Wildlife
 - Others rely on general wetland type/water regime + LLWW
 - Bank and Shoreline Stabilization
 - Sediment Retention
 - Habitat for Fish and Aquatic Invertebrates
 - Habitat for Waterfowl and Waterbirds
 - Habitat for Unique, Uncommon, or Highly Diverse Wetland Plant Communities
-

Limitations of Landscape-level Assessment

- First approximation
 - Source data limitations
 - All wetlands not shown
 - Possible upland inclusions
 - All streams not shown
 - Age of data (not an issue if done with updated data!)
 - Enhanced wetland classifications based largely on photo and map interpretation plus merging with other databases (e.g., streams)
 - Correlations between functions and characteristics = adaptable to different regions and user interests
-

Examples of Watershed Reports Using NWI+ Database

- Assessment of Hackensack River Watershed Wetlands
 - Historic Assessment of Wetlands in the Nanticoke Watershed
-

Hackensack River Watershed – Characterization and Functional Assessment

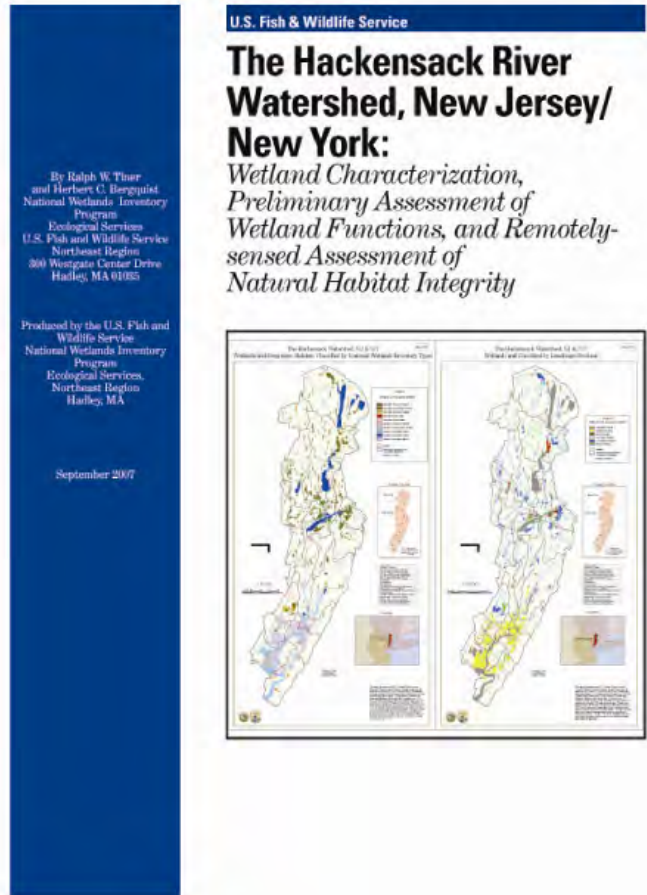


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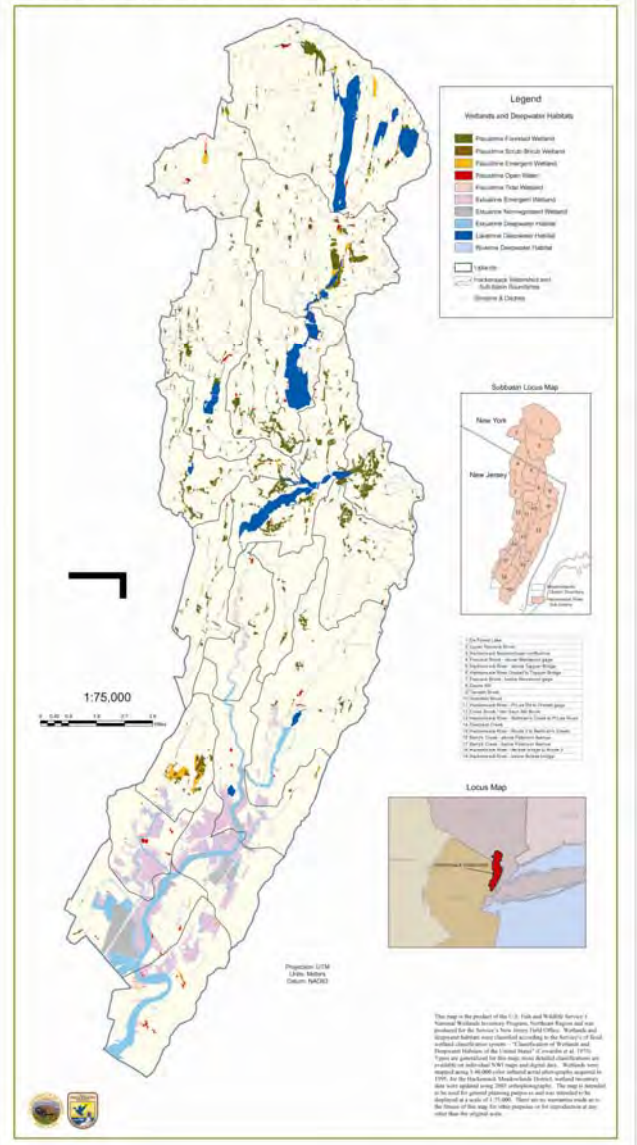
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Watershed-Wetland Stats

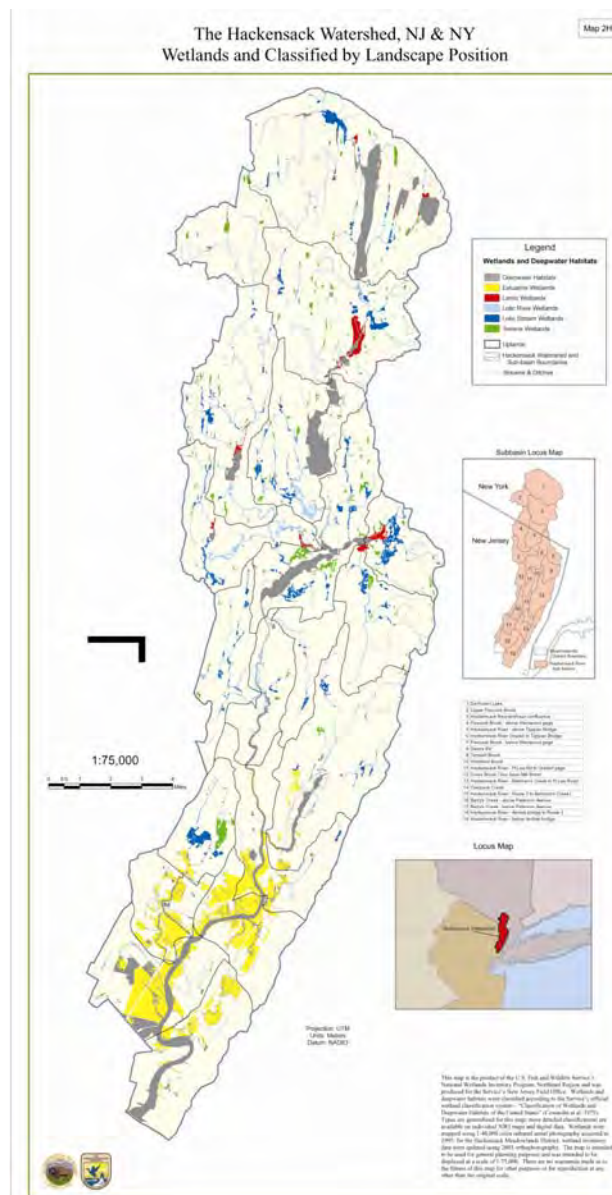
- 9,650 acres
 - 42% estuarine emergent
 - 33% palustrine forested
 - 13% estuarine unconsolidated shore
 - 25% lotic
 - 5% lentic
 - 11% terrene
 - 4% ponds
 - 61% tidal
 - 25% throughflow
 - 7% outflow
 - 5% isolated
 - 2% bidirectional-nontidal
-

Thematic Maps: NWI Types

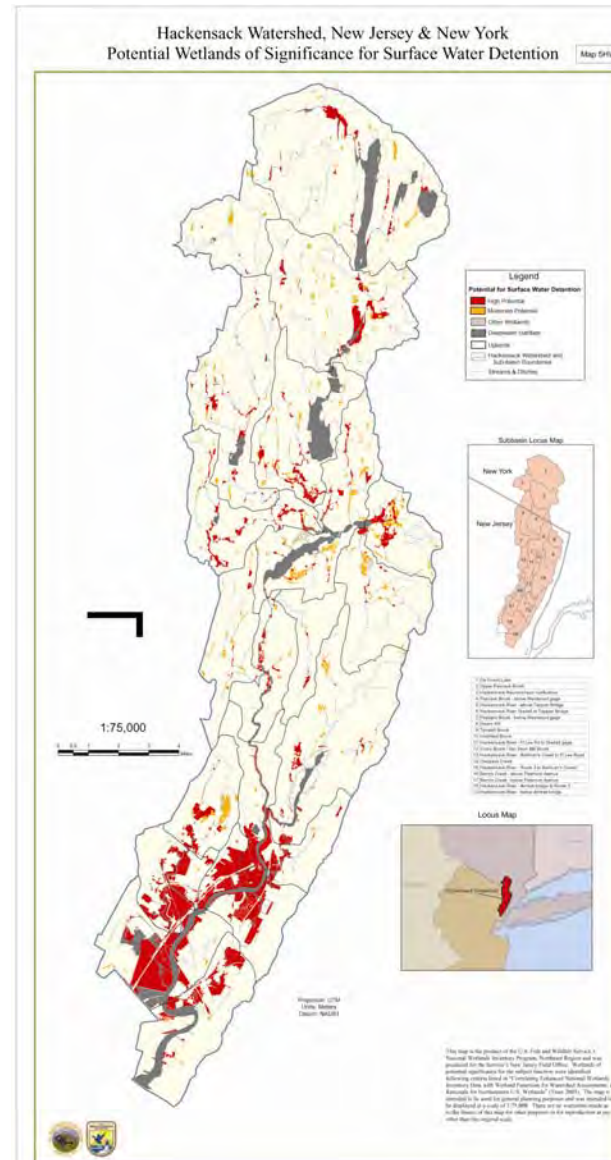
The Hackensack Watershed, NJ & NY
Wetlands and Deepwater Habitats Classified by National Wetlands Inventory Types



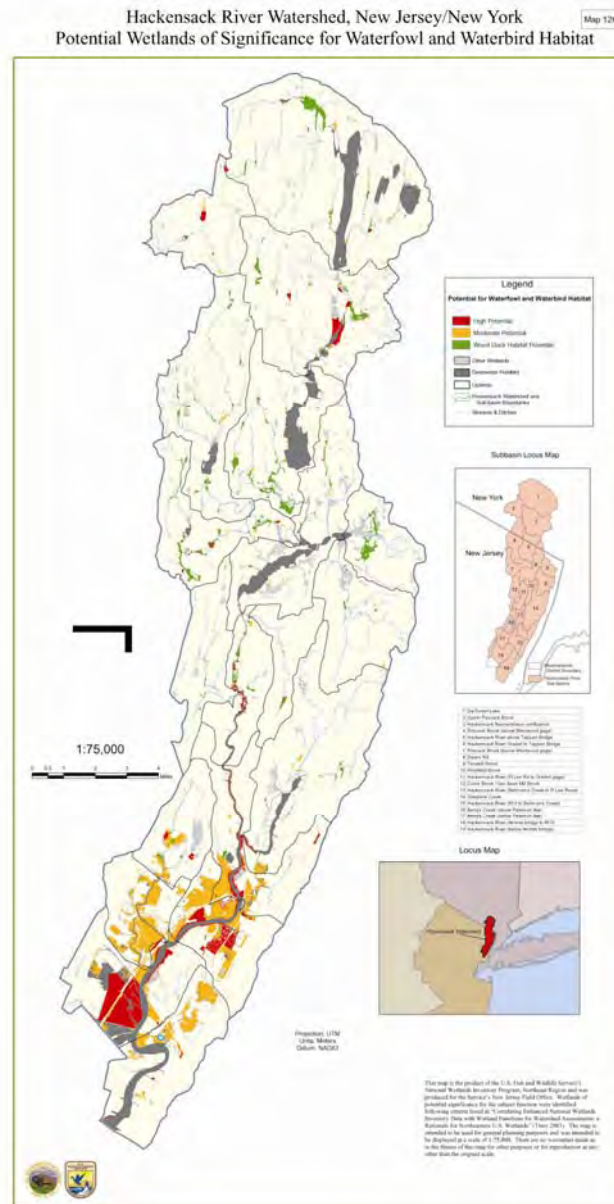
Landscape Position



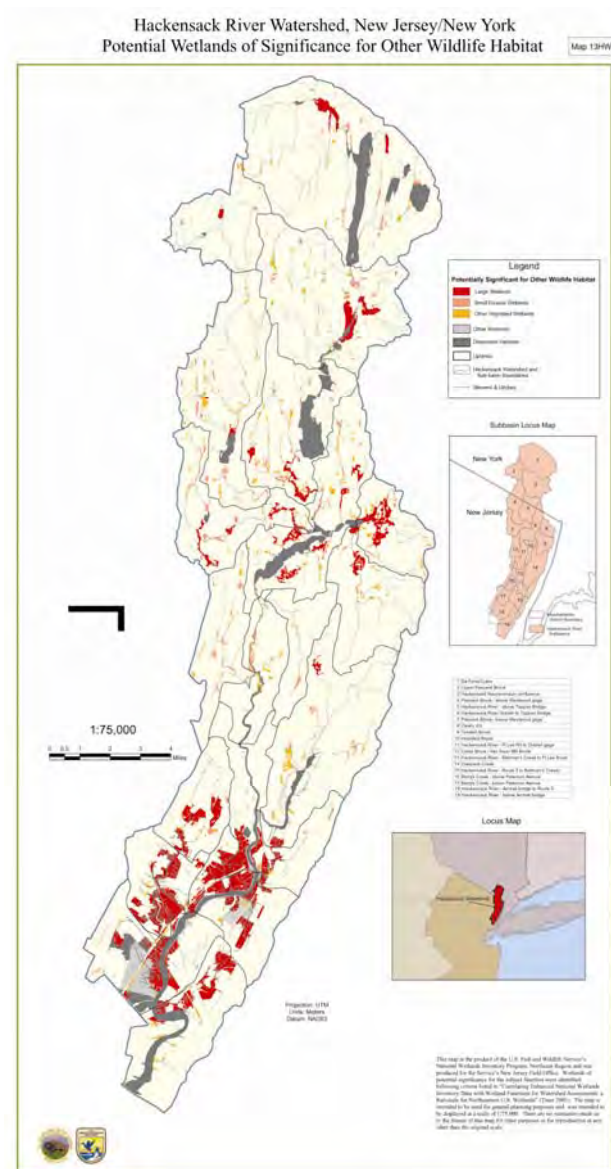
Wetland Function: Surface Water Detention



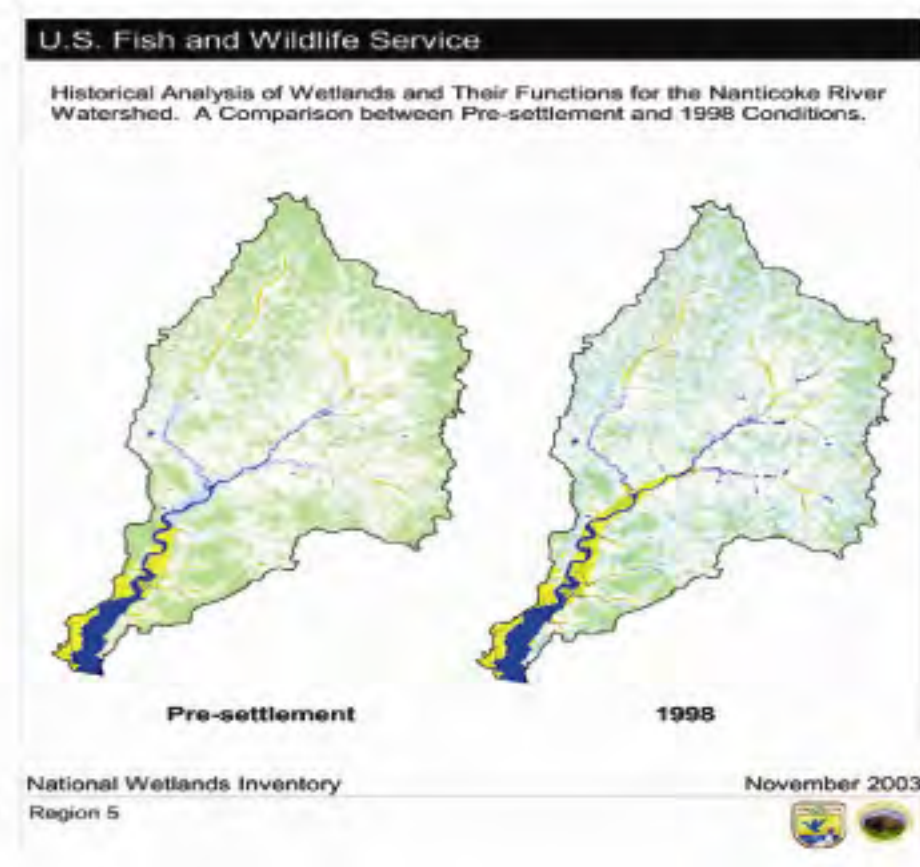
Waterfowl & Waterbird Habitat



Other Wildlife Habitat



Assessing the Impact of Wetland Changes: Historic Changes for Nanticoke Watershed



Nanticoke Wetland Stats

Pre-settlement

- 230,000 acres
- 2,814 wetlands
- 72% outflow wetlands
 - Average size = 433 acres

1998

- 142,000 acres (62% of pre-settlement acreage)
 - 5,810 wetlands
 - 43% decrease in outflow wetlands
 - Average size = 44 acres
 - Palustrine wetlands – lost 40%
 - Estuarine wetlands – lost 28%
-

Wetland Functions Watershed-wide (1998)

- >95% for surface water detention and sediment/other particulate retention
 - 84% nutrient transformation
 - 83% other wildlife habitat
 - 79% fish and shellfish habitat
 - 71% waterfowl-waterbird habitat
 - 70% shoreline stabilization
 - 58% coastal storm surge detention
 - 30% streamflow maintenance
-

Impact of Wetland Changes on Functions *(Pre-settlement to 1998)*

- Surface Water Detention = -36%
 - Streamflow Maintenance = -64%
 - Nutrient Transformation = -47%
 - Sediment Retention = -46%
 - Coastal Storm Surge Detention = -23%
 - Fish-Shellfish Habitat = -33%
 - Waterfowl-Waterbird Habitat = -34%
 - Other Wildlife Habitat = -41%
-

Summary of Uses of NWI+

■ **Better characterization of wetlands**

- Can use for descriptions of wetland types in the area of interest and as aid in selecting sites for monitoring and research
 - NWI+ doesn't address all the reasons behind unique wetland characteristics (e.g., water chemistry differences due to surficial geology and groundwater connections; Azzolina et al. 2007) but there are provisions through Cowardin et al. and LLWW to include water chemistry (pH, salinity) and groundwater interactions in the classification of individual wetlands
-

■ **Landscape-level Assessment of Wetland Functions**

□ Preliminary

- Current capacity of “area of interest” to provide functions

□ Can use to assess possible effect of cumulative losses on wetland functions since “settlement”

□ Can use to assess significance of wetland changes on wetland functions between time periods

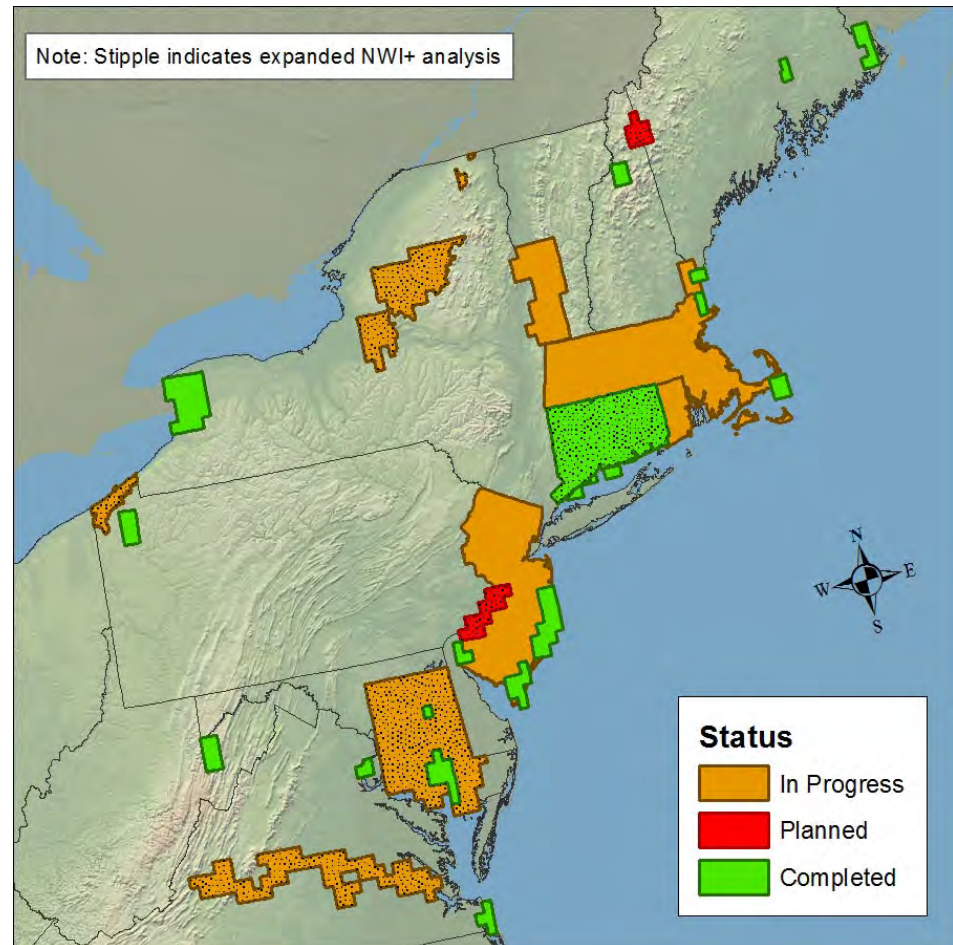
- Increase in some types while other types decline will alter performance of certain wetland functions

- When applied to **potential wetland restoration sites** (former hydric soils with restoration potential), provides perspective on likely functions to be improved
-

Applications of NWI+ To Date

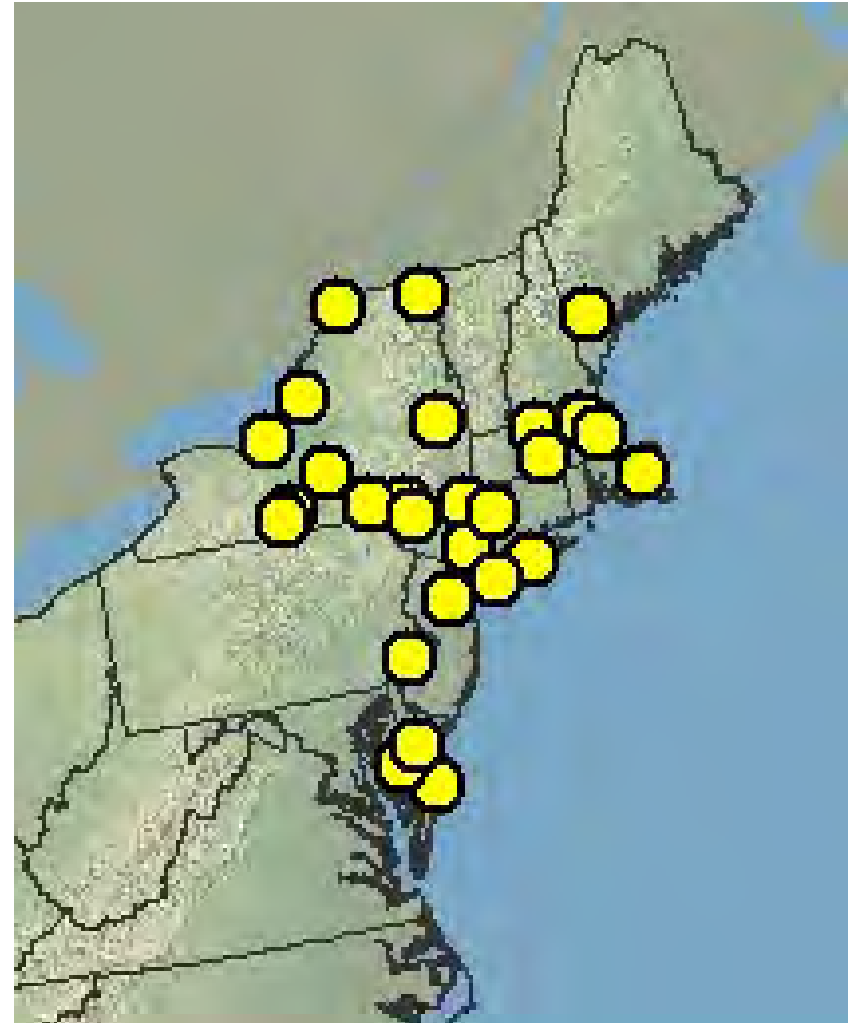
Status of NWI+ in the Northeast

- Approximately 1000 USGS quads done to date
- Virginia Tech's Conservation Management Institute
 - Key partner in the process
- Working with us for about a decade
- Speckled areas – maximum NWI+ data



NWI+ Reports

- ❑ 3 Massachusetts watersheds
- ❑ Casco Bay watershed, ME (~21 quads; ME State Planning Office)
- ❑ Nanticoke watershed, MD/DE (~20 quads; state funded)
- ❑ Coastal Bays watershed, MD (~5 quads; state funded)
- ❑ Delaware Estuary Coastal Zone of PA (11 quads; state funded)
- ❑ 12 small watersheds in NY State (~50 quads; NYSDEC funded)
- ❑ New York City water supply reservoirs (~65 quads; NYCDEP funded)
- ❑ Hackensack River watershed (~7 quads; field office funded)
- ❑ Cape Cod and the Islands, MA (~12 quads; completed)
- ❑ Boston Harbor Islands (7 quads; NPS funded)
- ❑ Long Island, NY (~47 quads)



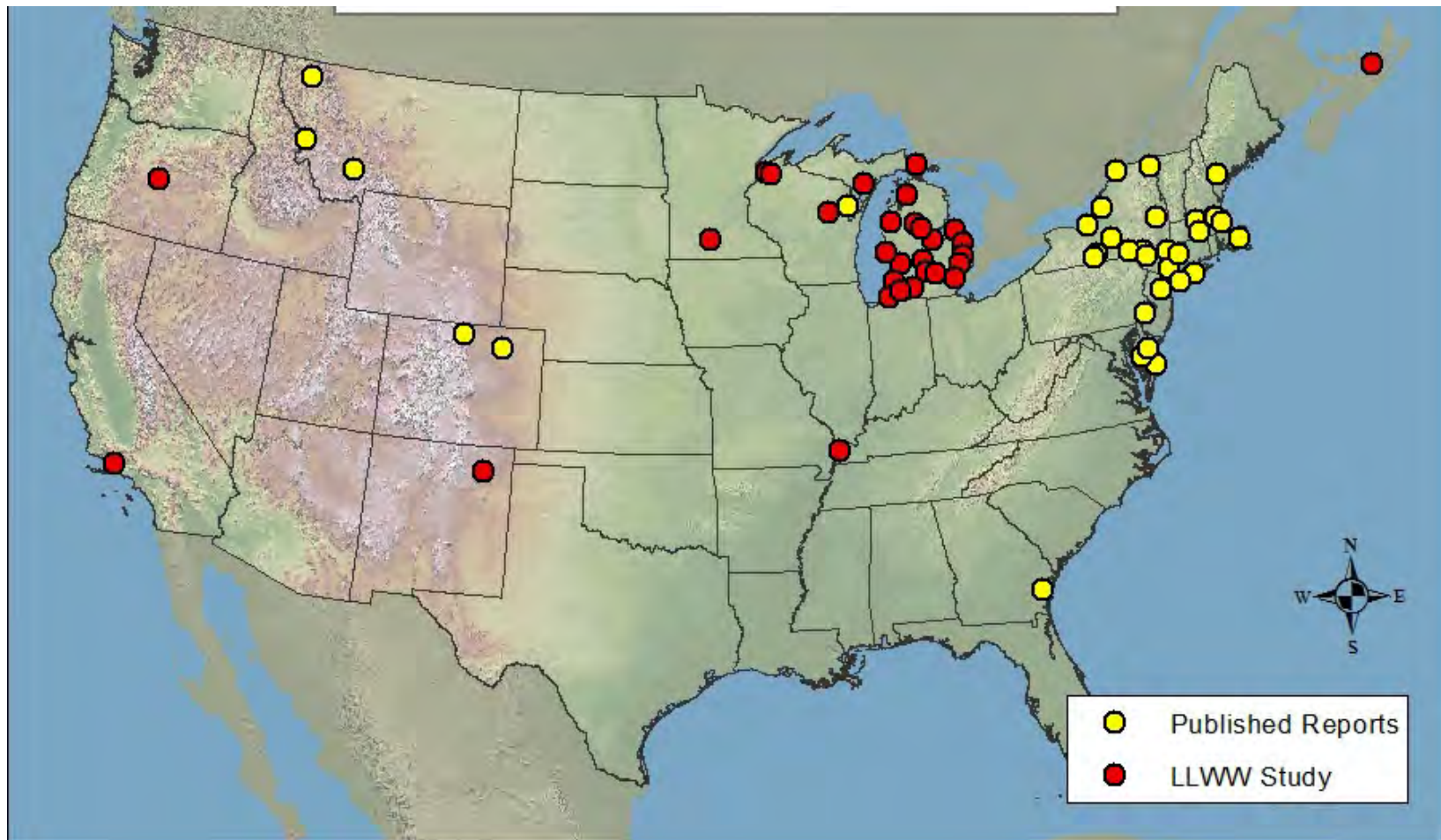
NWI+ Pilot Applications in Other Regions

- Region 1: Ventura watershed, CA (~4 quads; project completed except for report)
- Region 2: Corpus Christi, TX (7 quads; initial classification done, QC done, finalizing)
- Region 3: Redwood River Basin, MN (2 quads; classification done)
- Region 4: Horry (26 quads) and Jasper (28 quads) counties, SC; coastal Mississippi (37 quads)
- Region 6: Shirley Basin, WY (5 quads; classification done)
- Region 7: Matanuska-Susitna Borough (4 quads; classification completed)

Results posted online as “First Approximations”

Will be preparing area-based functional assessment reports as time permits (geospatial data posted on the “NWI+ Web Mapper”)

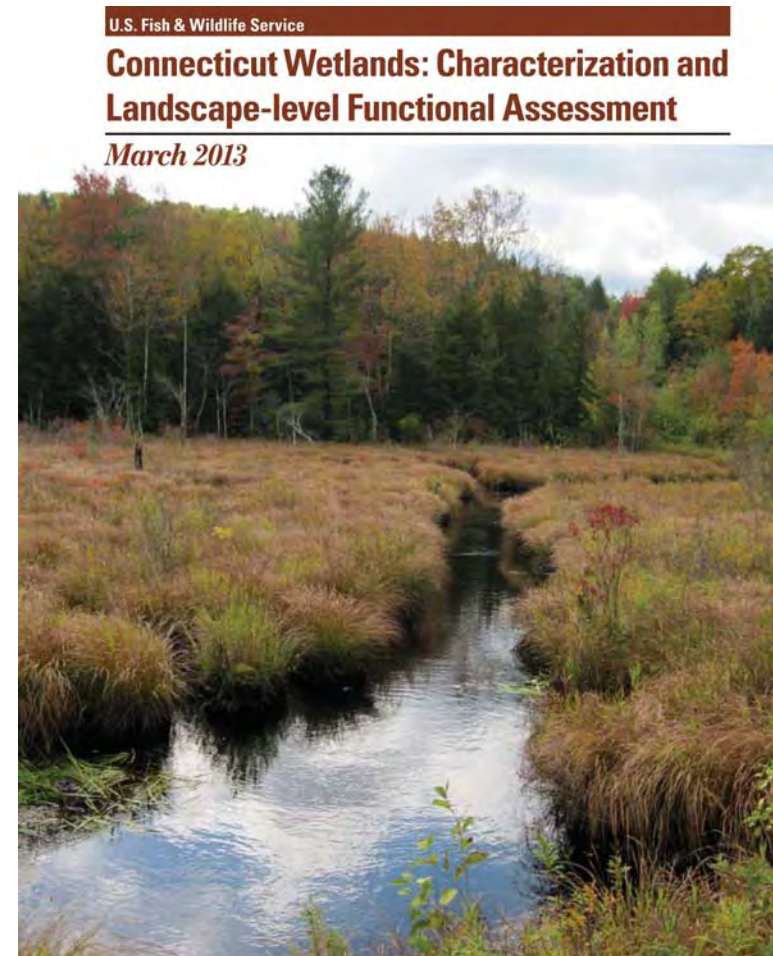
NWI+ By Others and Reports



Some Noteworthy Projects By
Others or By FWS with Funding
from Other Agencies

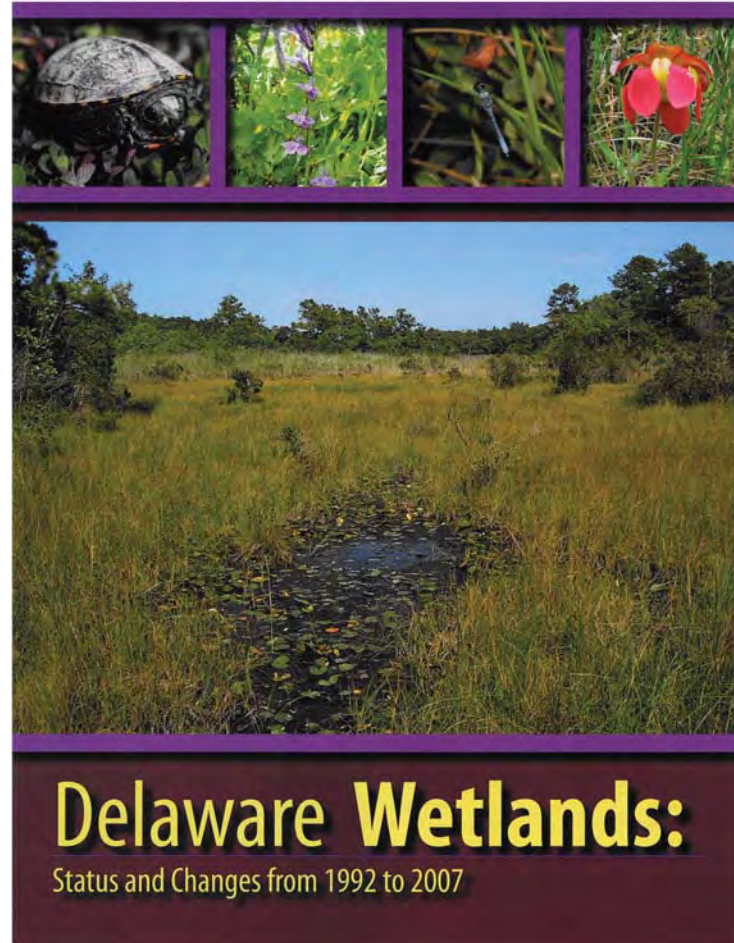
Connecticut – Statewide Assessment

- Statewide NWI+ Database (4872 sq. mi.)
- Four reports
 - Status
 - Characterization/Functional Assessment
 - Restoration Site Inventory
 - Trends
- Funded by CTDEEP



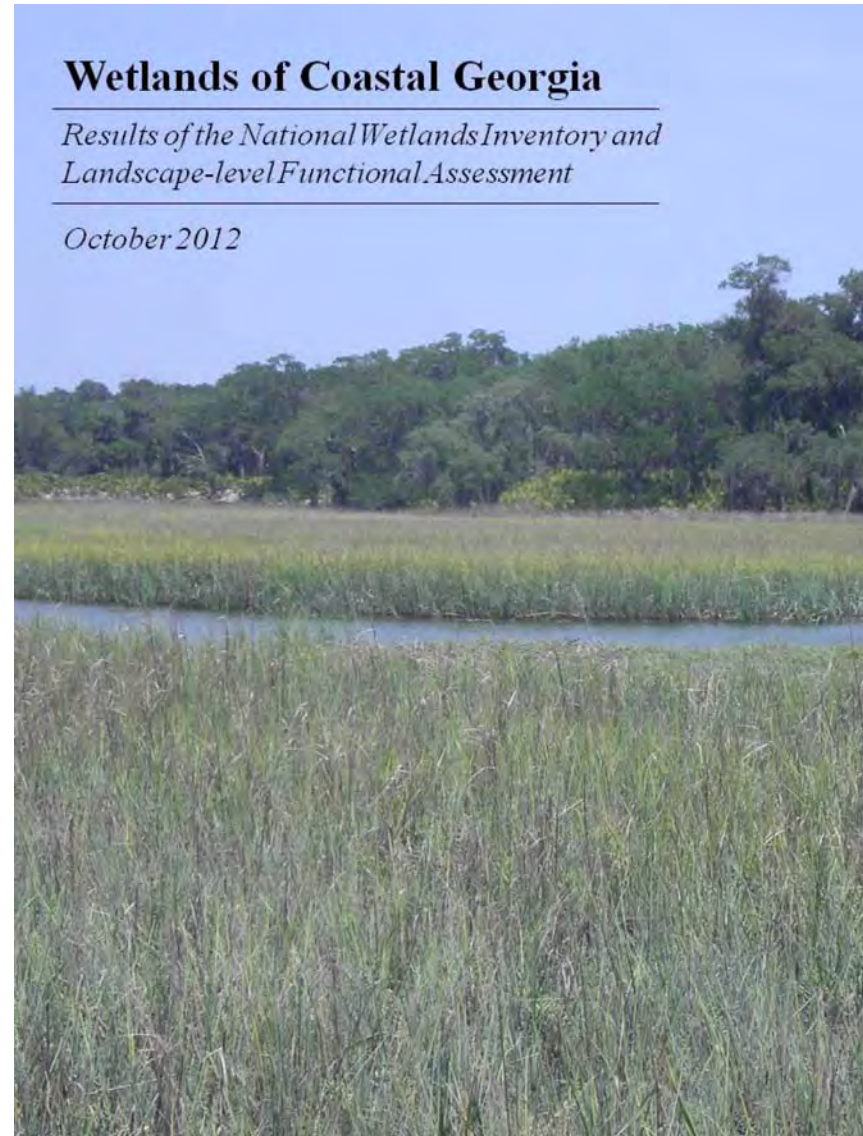
Delaware – Statewide Assessment

- Statewide Database (1932 sq. mi.)
 - NWI
 - LLWW
 - P-wet areas
 - Restoration Site Inventory
 - Trends
- Single Summary Report
- Partially funded by DNREC



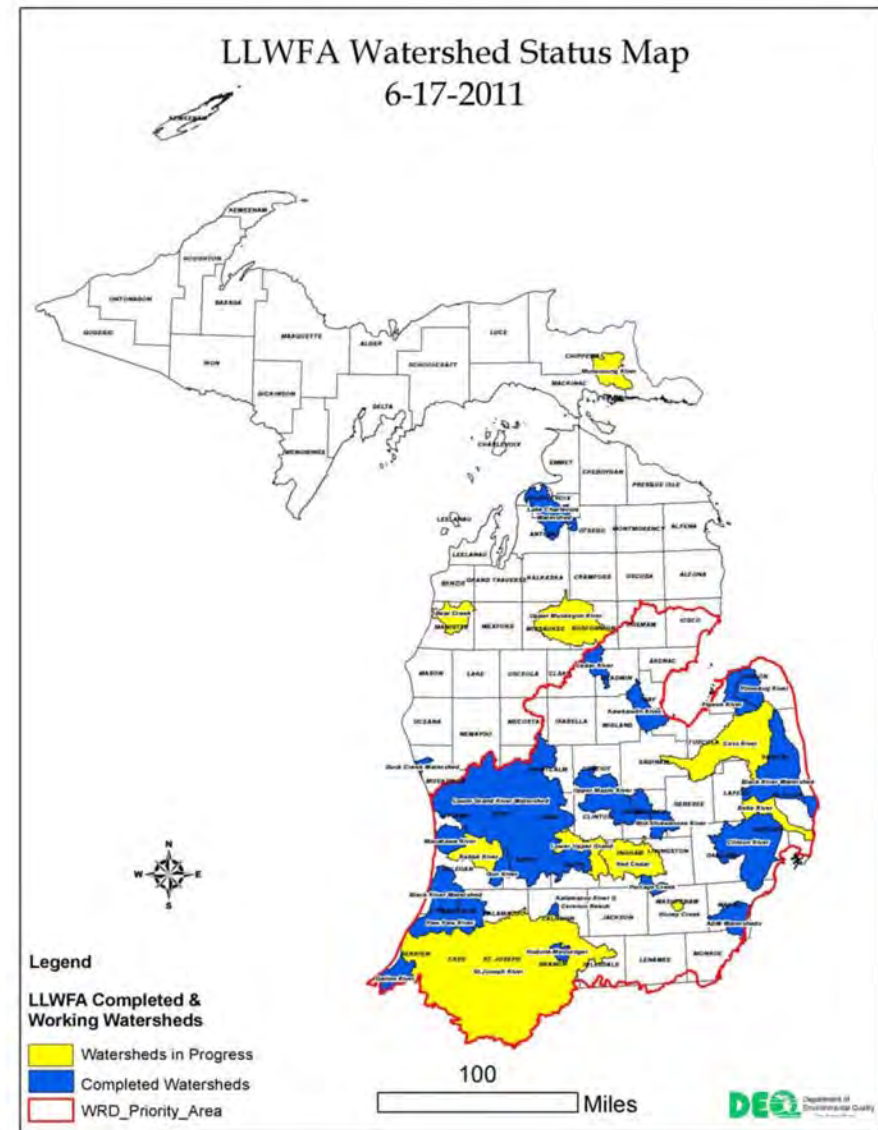
Georgia - Coast

- Georgia – coastal counties (3150 sq. mi.)
- GADNR-CRD/Atkins
- Coastal County Database
 - NWI
 - LLWW
 - Functional Assessment
- Report



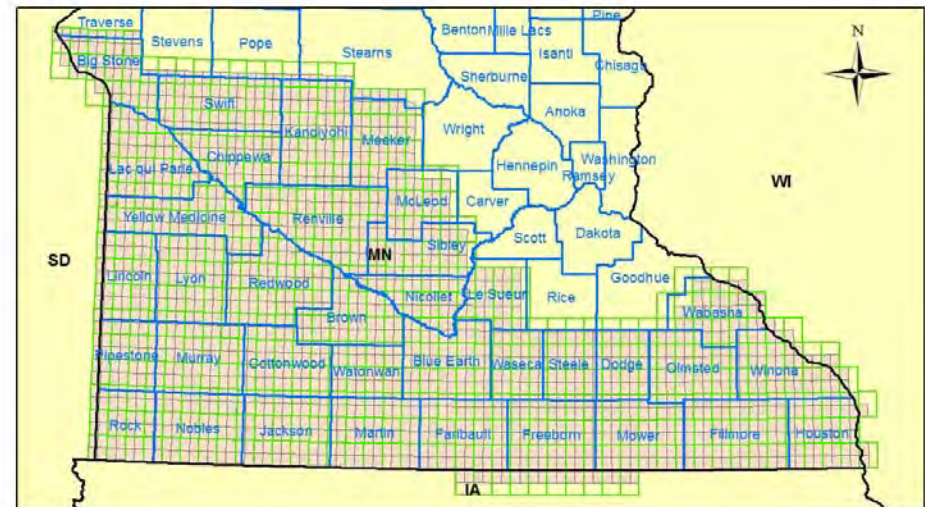
Michigan

- MIDEQ working with watershed associations
- Many watersheds completed or in progress
- 2011 progress report



Minnesota

- Plan to do entire state as funding permits
- Work by St. Mary's University of MN
- Southern MN counties underway
- **Note: SMUMn is working on ~1200 quads in 6 states (MN, WI, IL, MO, NM, CO)**



Southern Project Area
Update of Minnesota National Wetlands Inventory

0 15 30 60 90 120 Miles

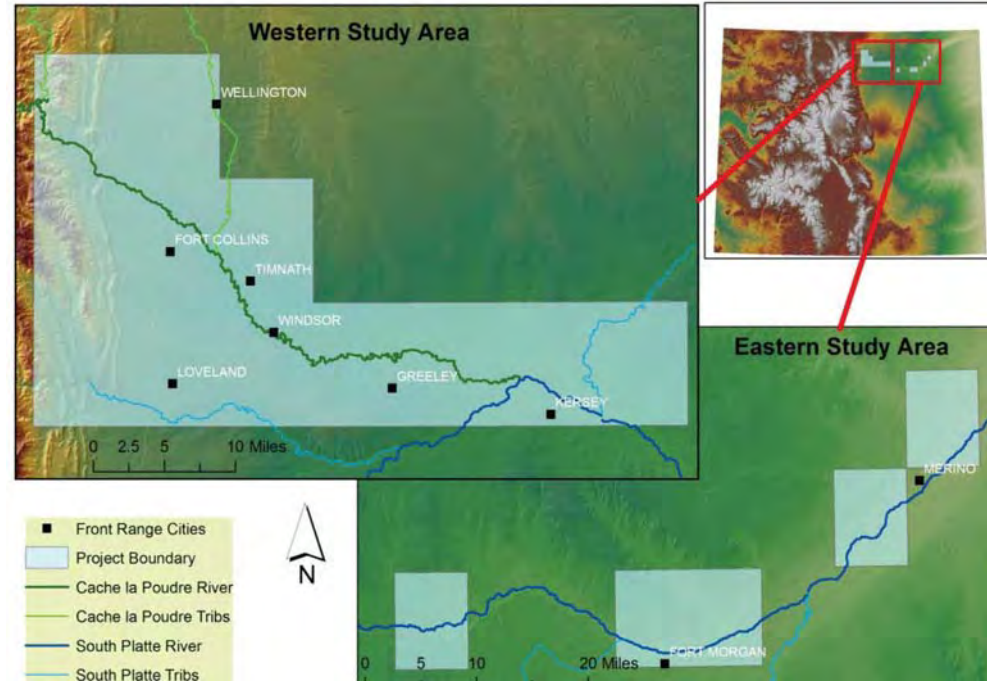
■ Southern MN Project Area (rev. 8/31/12) - 1/4 Quadrangles
■ USGS 7.5 Minute Quadrangle Boundaries
■ Minnesota Counties

Montana

- Developing a semi-automated procedure for applying LLWW to many watersheds
 - Prior work in a few watersheds:
 - Flathead Valley
 - Bitterroot Valley
 - Gallatin Valley
-

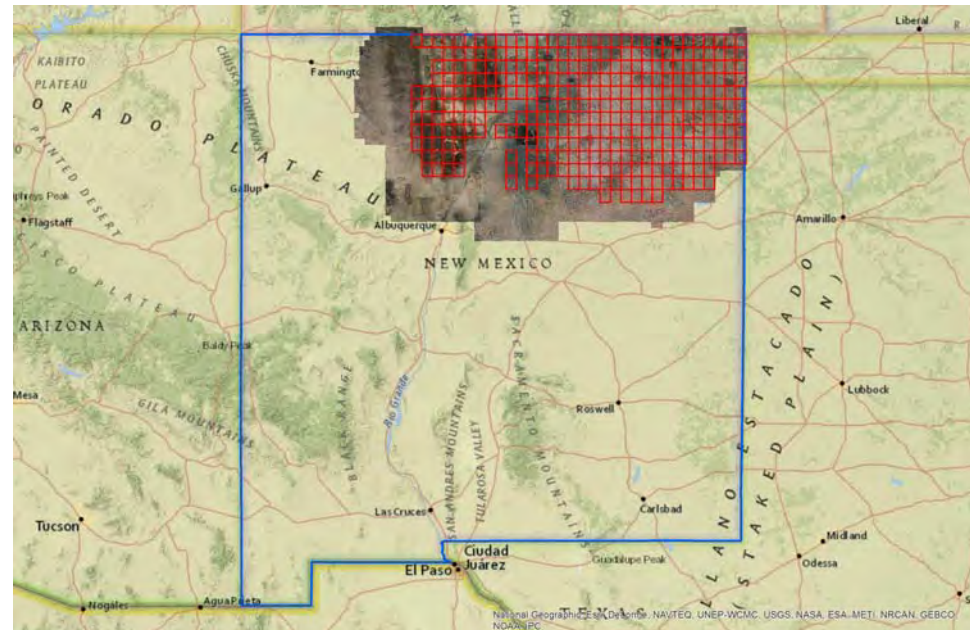
Colorado

- CO NHP
- Two watersheds
 - Cache la Poudre
 - South Platte



New Mexico

- NM Environment Dept. Surface Water Quality Bureau
- Incorporating LLWW into NWI Updates
- Work by SMUMn
- Northeastern NM underway



Oregon – Statewide Assessment

- Portland State University and Oregon Dept. of State Lands
 - Student thesis (Matthew Paroulek)
 - Automated GIS-derived classification of LLWW from existing NWI and landscape-level (level 1) assessment
 - Statewide coverage
 - Used to help identify sample frame for Level 2 (rapid) wetland functional assessment with statewide wetland monitoring program
-

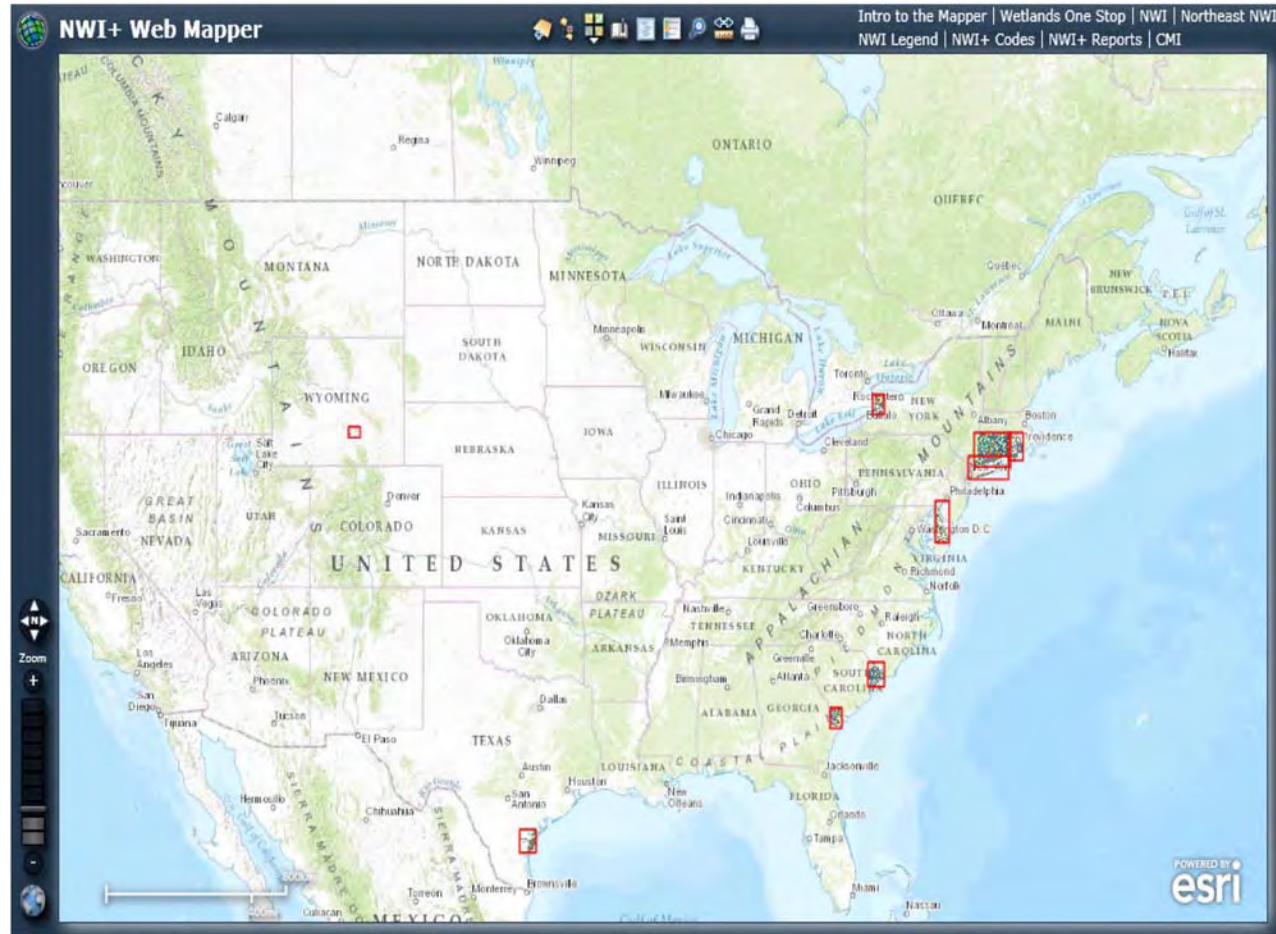
NWI+ Data and Reports By FWS Posted Online

- ASWM's Wetlands One-Stop Mapping
 - <http://aswm.org/wetland-science/wetlands-one-stop-mapping>
 - Look under the topics
 - NWI+ Mapper for display of results
 - NWI+ Reports for copies of summary reports
-

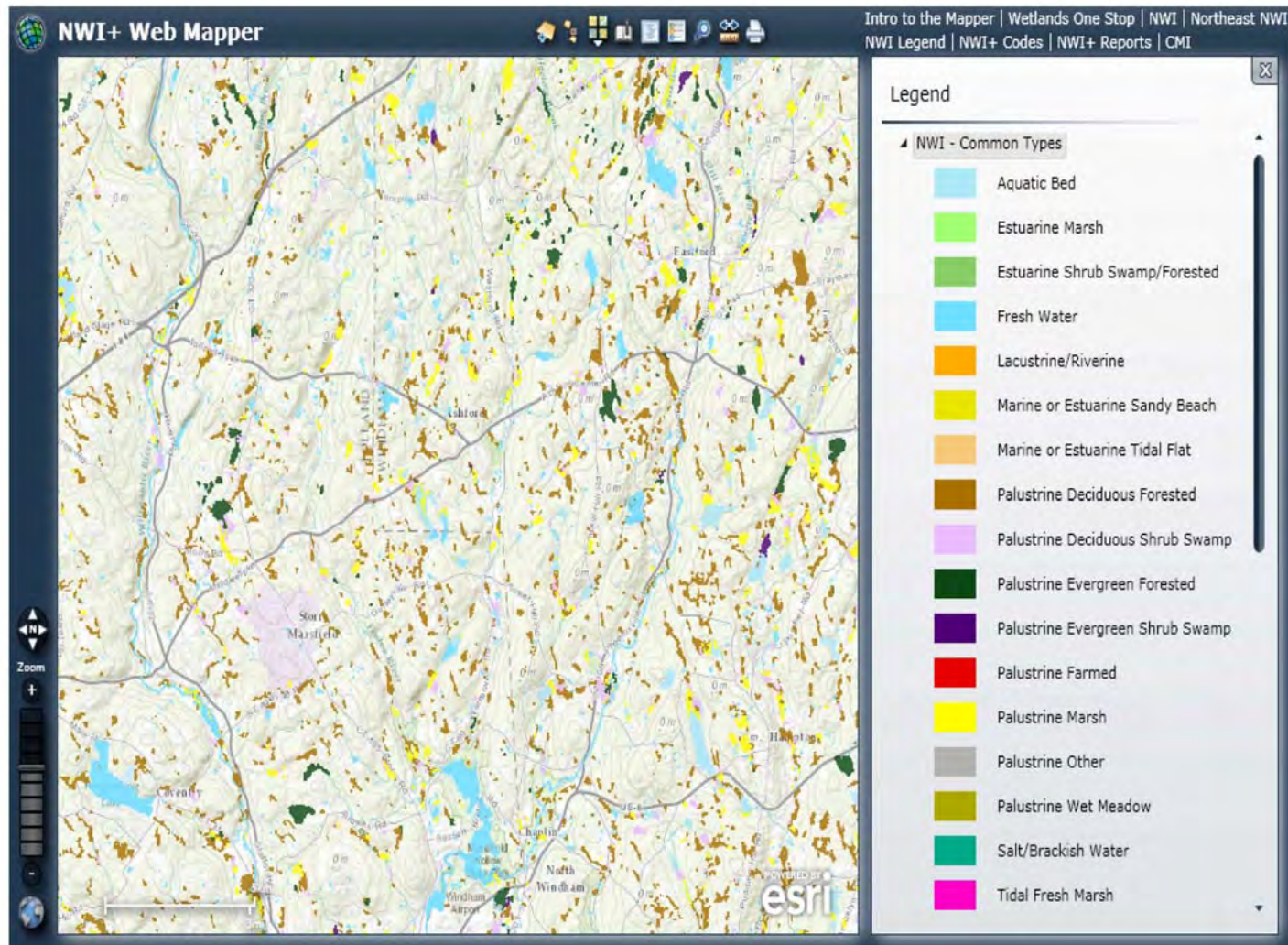
NWI+ Mapper - Views

Connecticut Examples

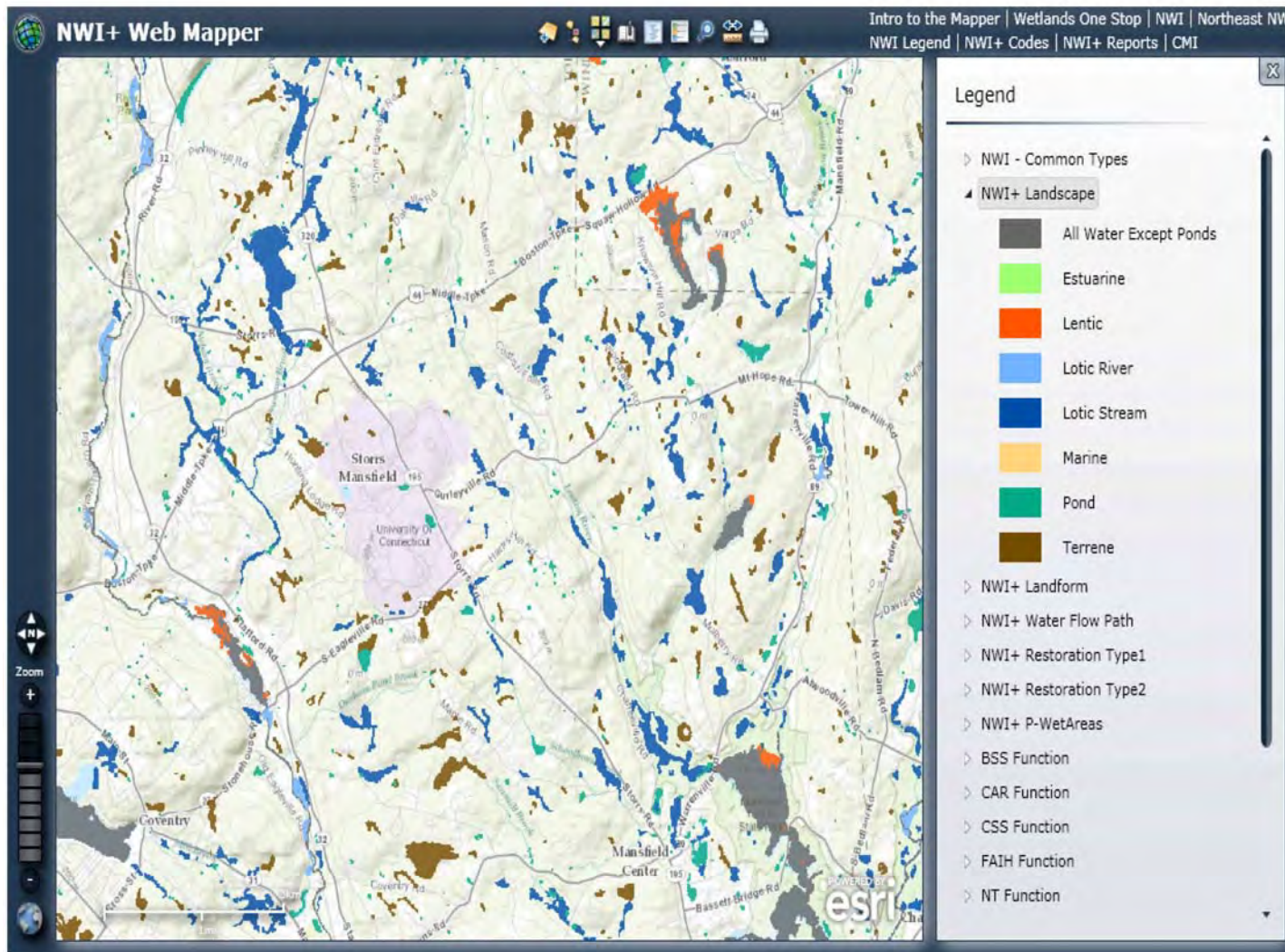
Opening Page shows Footprints of FWS Projects



NWI Types with Legend



Landscape Position with Legend



Landscape and “Wetland Code” Table

The screenshot displays the NWI+ Web Mapper interface. The main map area shows a wetland feature highlighted in blue. A popup window titled "PEM1E" is open over this feature, displaying the following data:

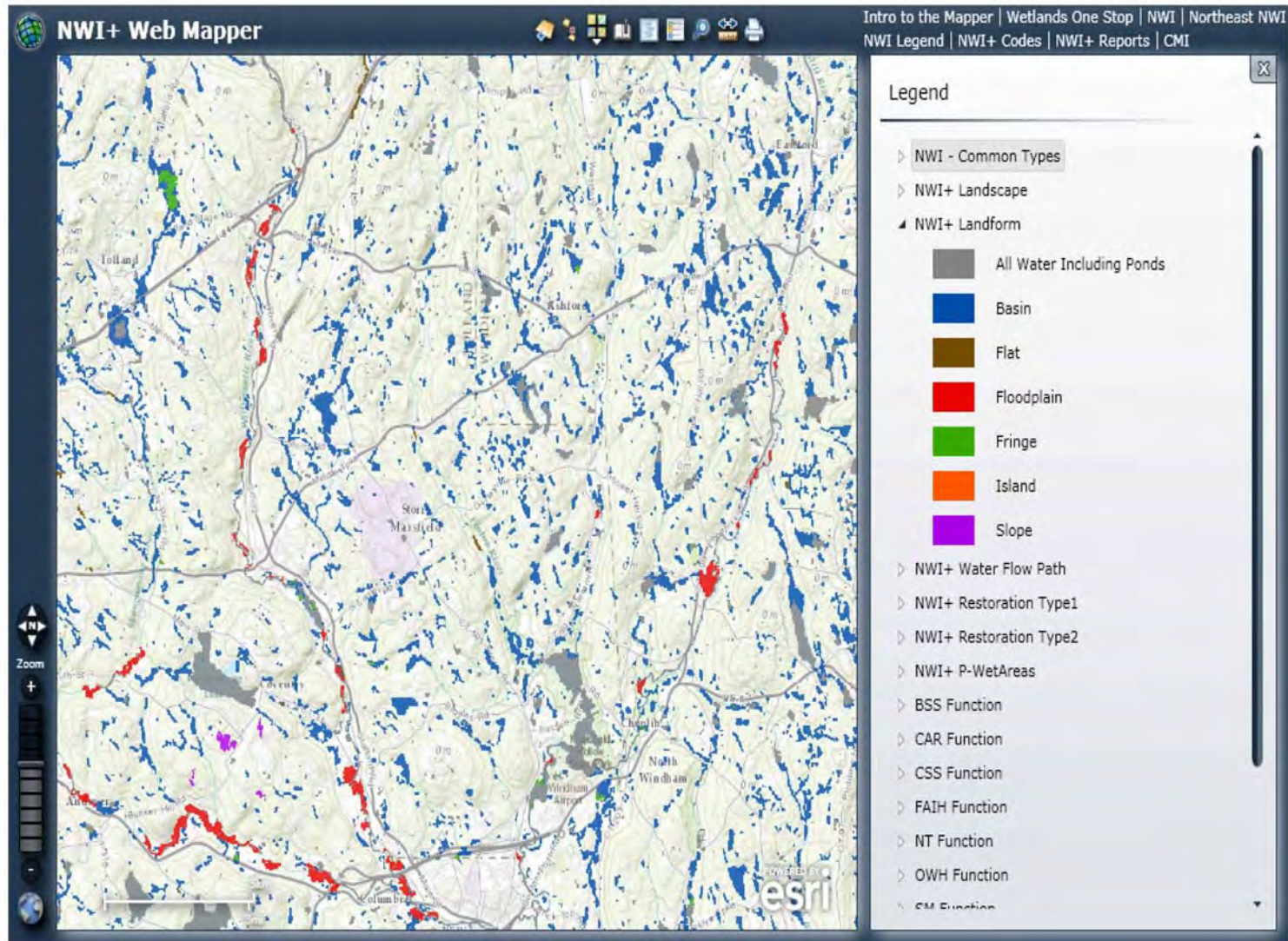
NWI Attribute Code	PEM1E
LLWW Code	LS1BATH
Acres	15.133899777444

The right-hand side of the interface features a "Map Contents" legend panel with the following items:

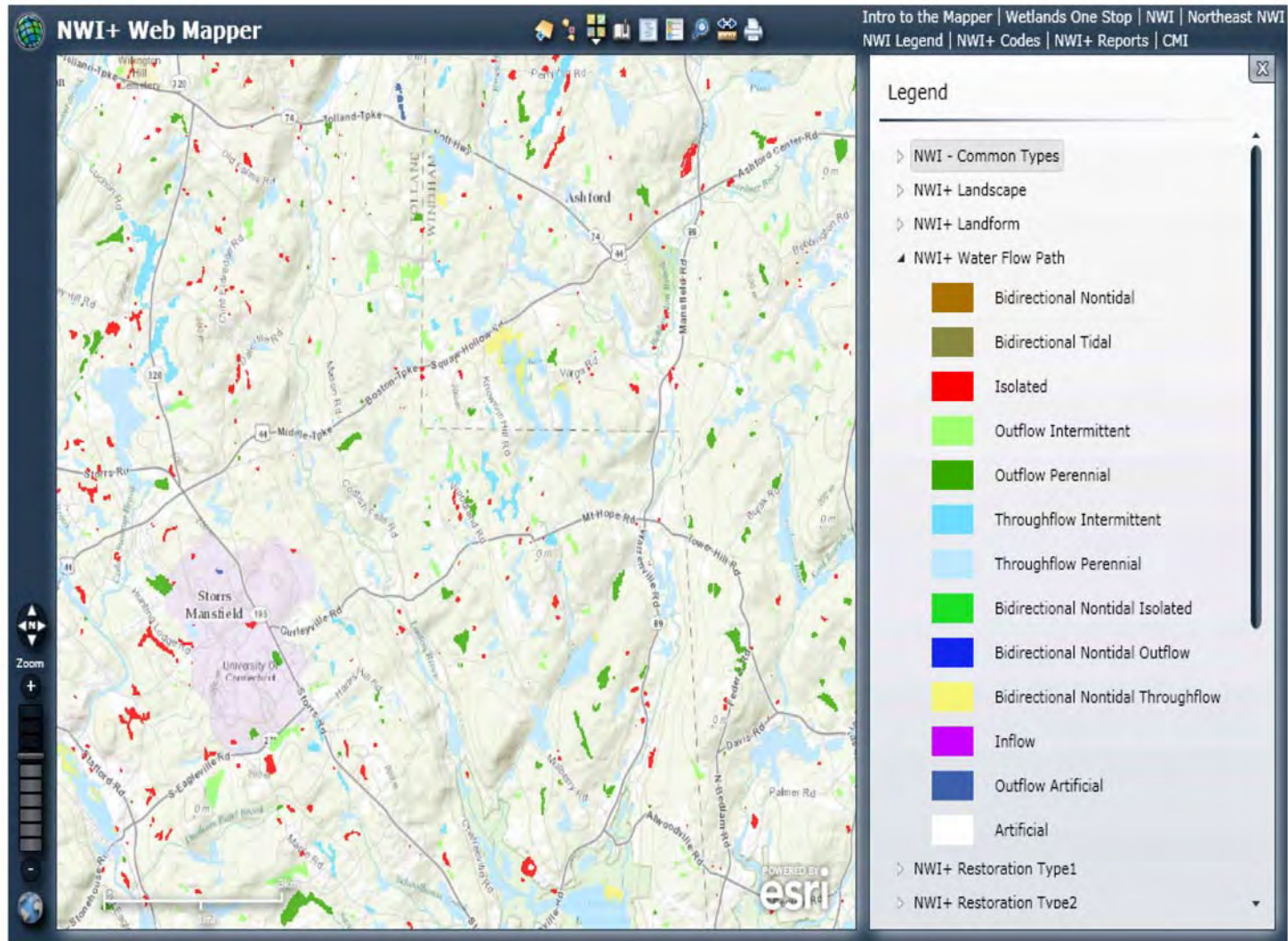
- NWI+ Footprints
- Wetland Codes
- NWI - Common Types
- NWI+ Landscape
- NWI+ Landform
- NWI+ WaterFlowPath
- NWI+ P_RestType1 SoilCodes
- NWI+ Restoration Type1
- NWI+ Restoration Type 2
- NWI+ P-WetAreas Codes
- NWI+ P-WetAreas
- BSS Function
- CAR Function
- CSS Function
- FAIH Function
- NT Function

The interface includes a navigation toolbar on the left with a north arrow and zoom controls, and a scale bar at the bottom left. The Esri logo is visible in the bottom right corner of the map area.

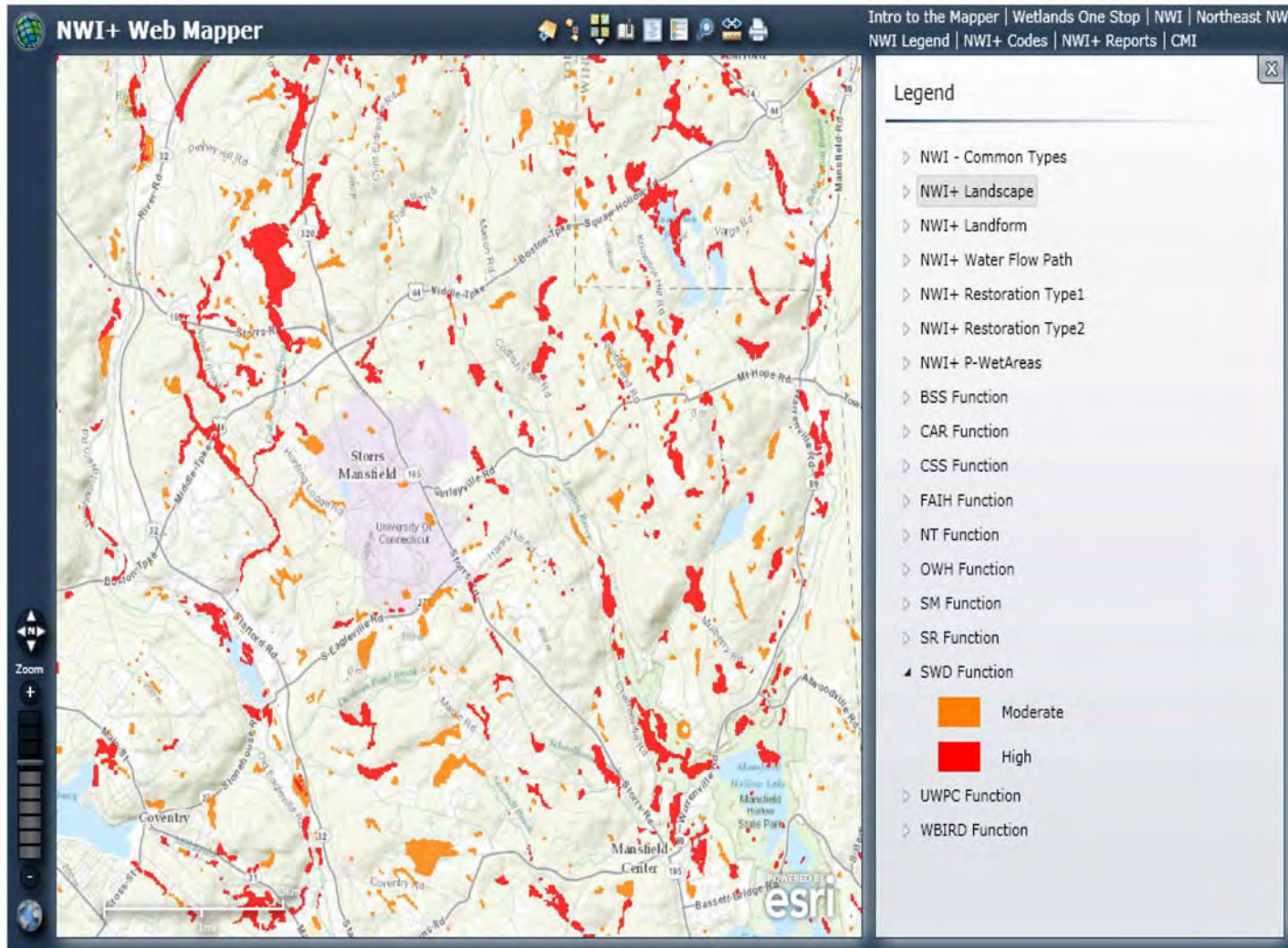
Landform with Legend



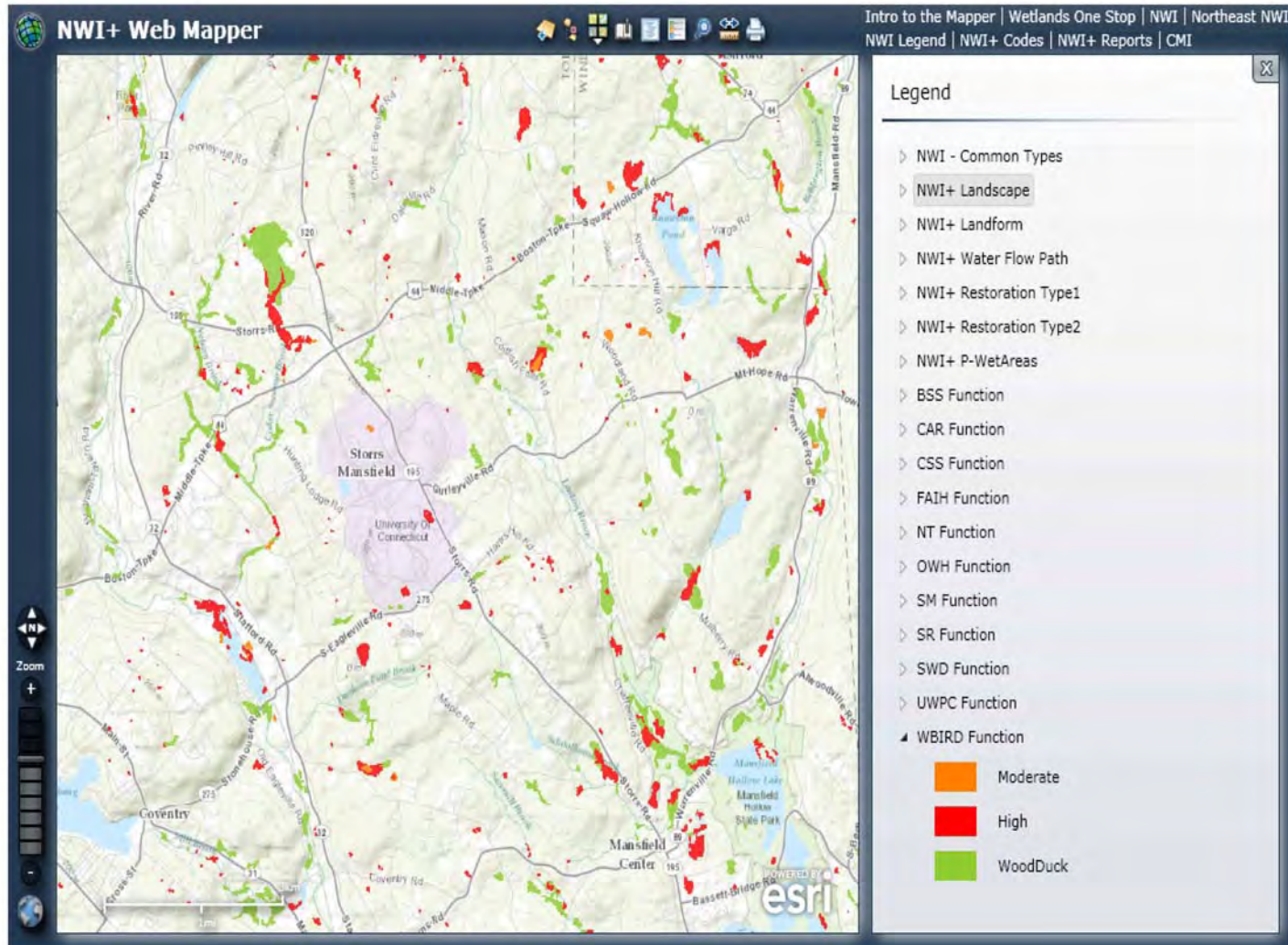
Water Flow Path with Legend



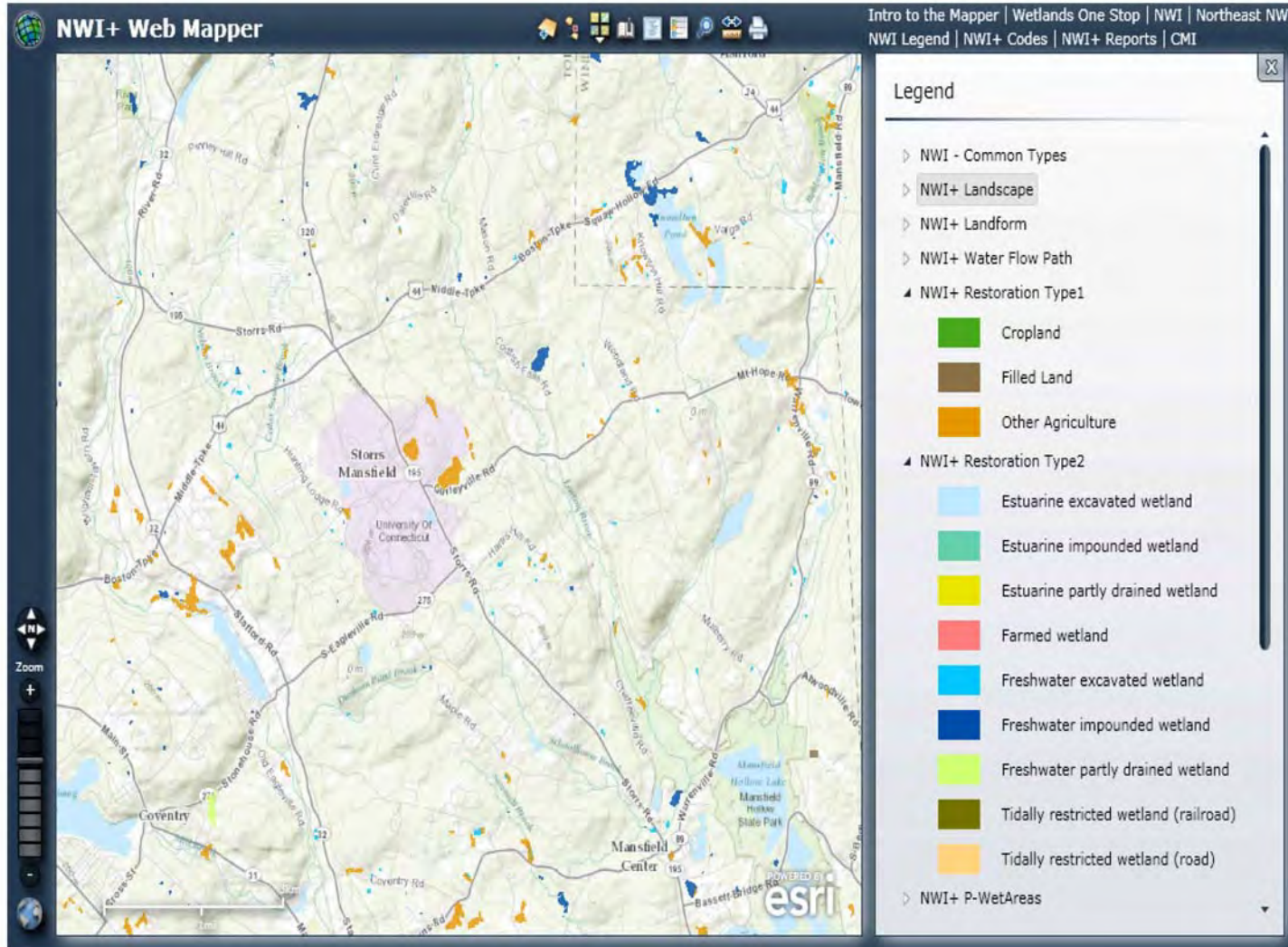
Function Map – Surface Water Detention



Function Map – Waterfowl/Waterbird



Optional Layer – Potential Restoration Sites



Restoration Type 1 with Soil Type

The screenshot displays the NWI+ Web Mapper interface. The main map area shows a green polygon representing a restoration area, with a popup window titled "Raypol silt loam" overlaid on it. The popup contains a table with the following data:

MUSYM	12
muname	Raypol silt loam

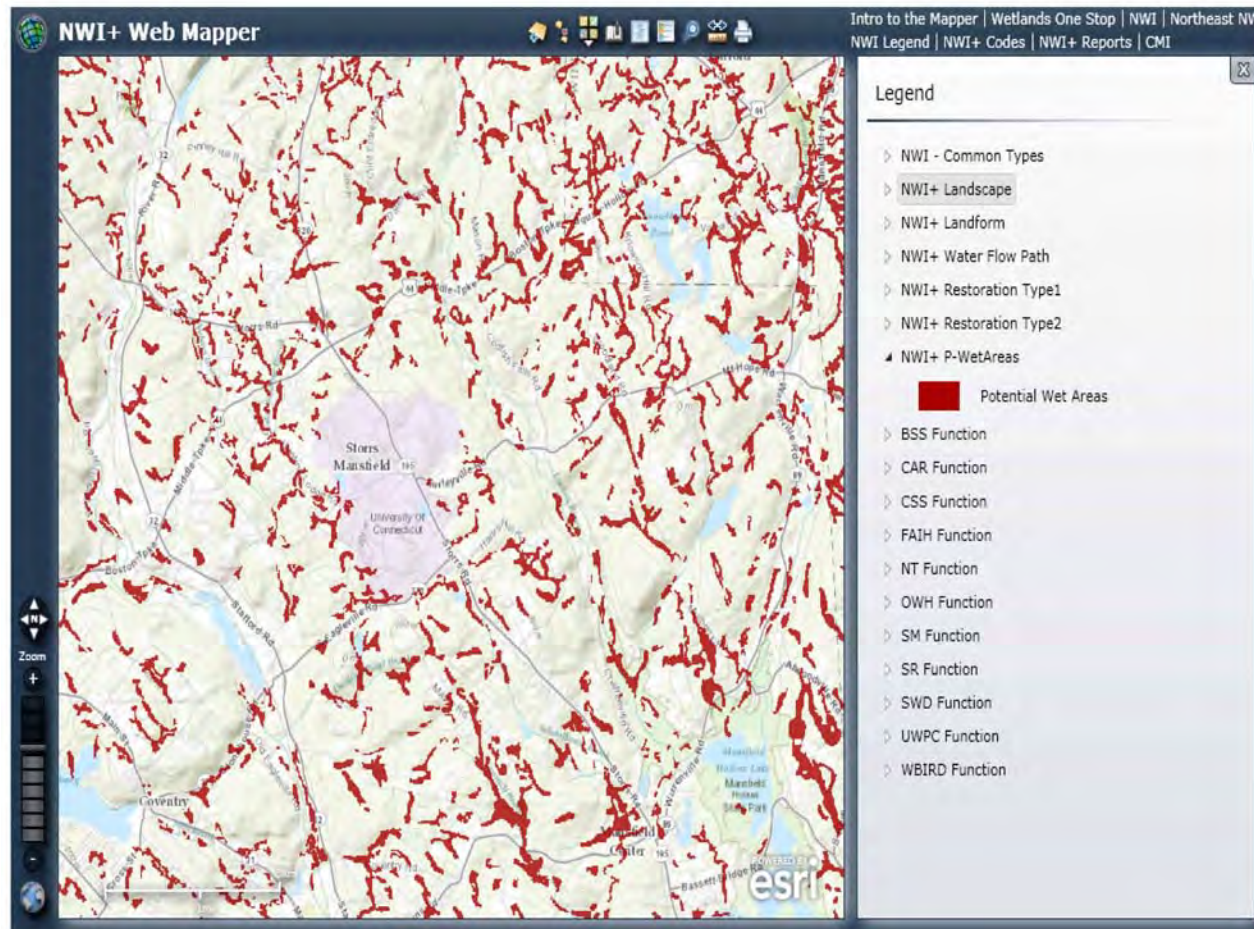
The "Map Contents" panel on the right side of the interface is visible, showing a list of layers with checkboxes. The following layers are checked:

- NWI+ P_RestType1 SoilCodes
- NWI+ Restoration Type1

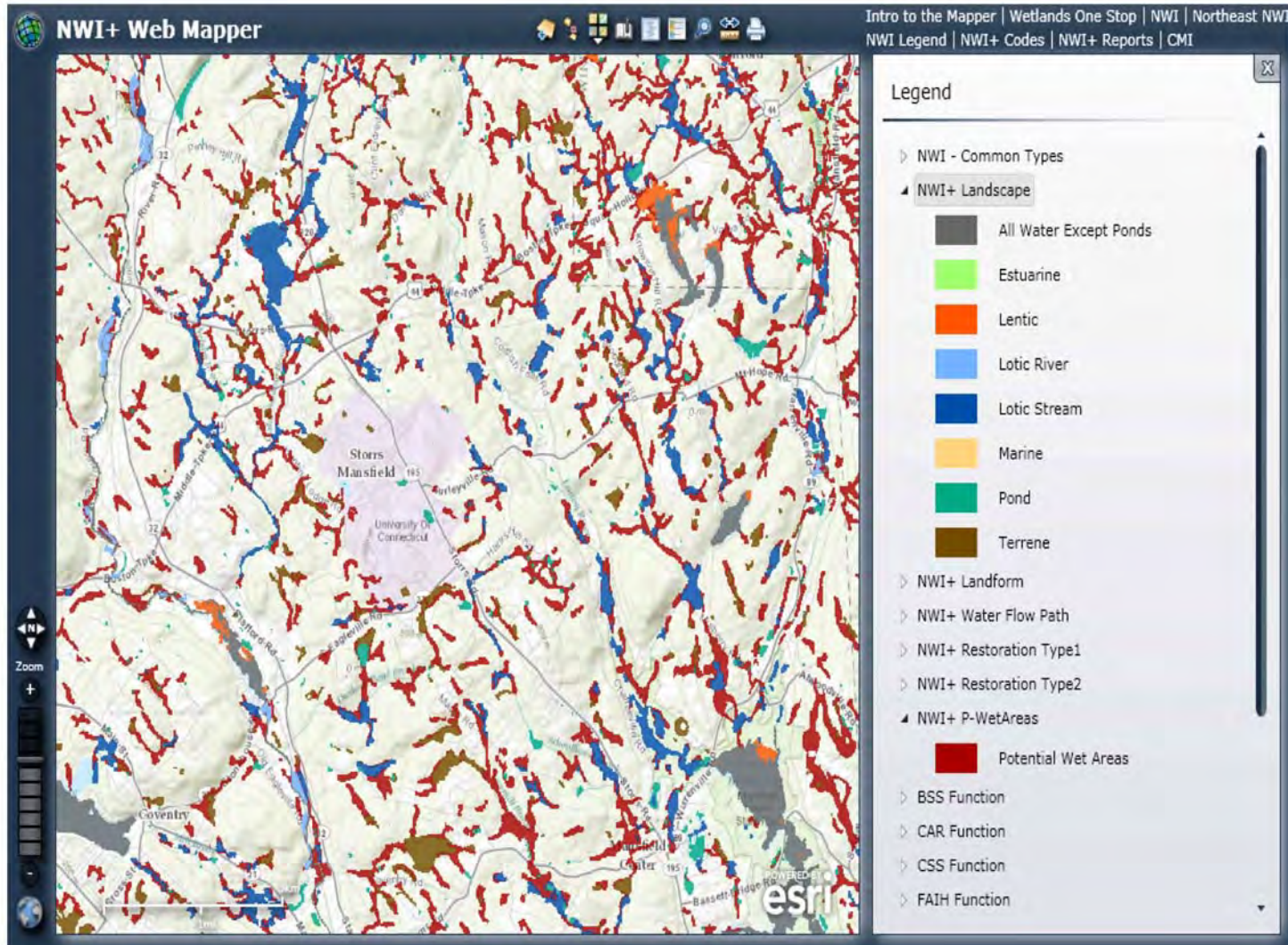
Other layers in the list include NWI - Common Types, NWI+ Landscape, NWI+ Landform, NWI+ WaterFlowPath, NWI+ Restoration Type 2, NWI+ P-WetAreas Codes, NWI+ P-WetAreas, BSS Function, CAR Function, CSS Function, FAIH Function, NT Function, OWH Function, and SM Function.

The interface also includes a navigation toolbar on the left with a compass and zoom controls, and a top navigation bar with links to "Intro to the Mapper", "Wetlands One Stop", "NWI", "Northeast NWI", "NWI Legend", "NWI+ Codes", "NWI+ Reports", and "CMI". The Esri logo is visible in the bottom right corner of the map area.

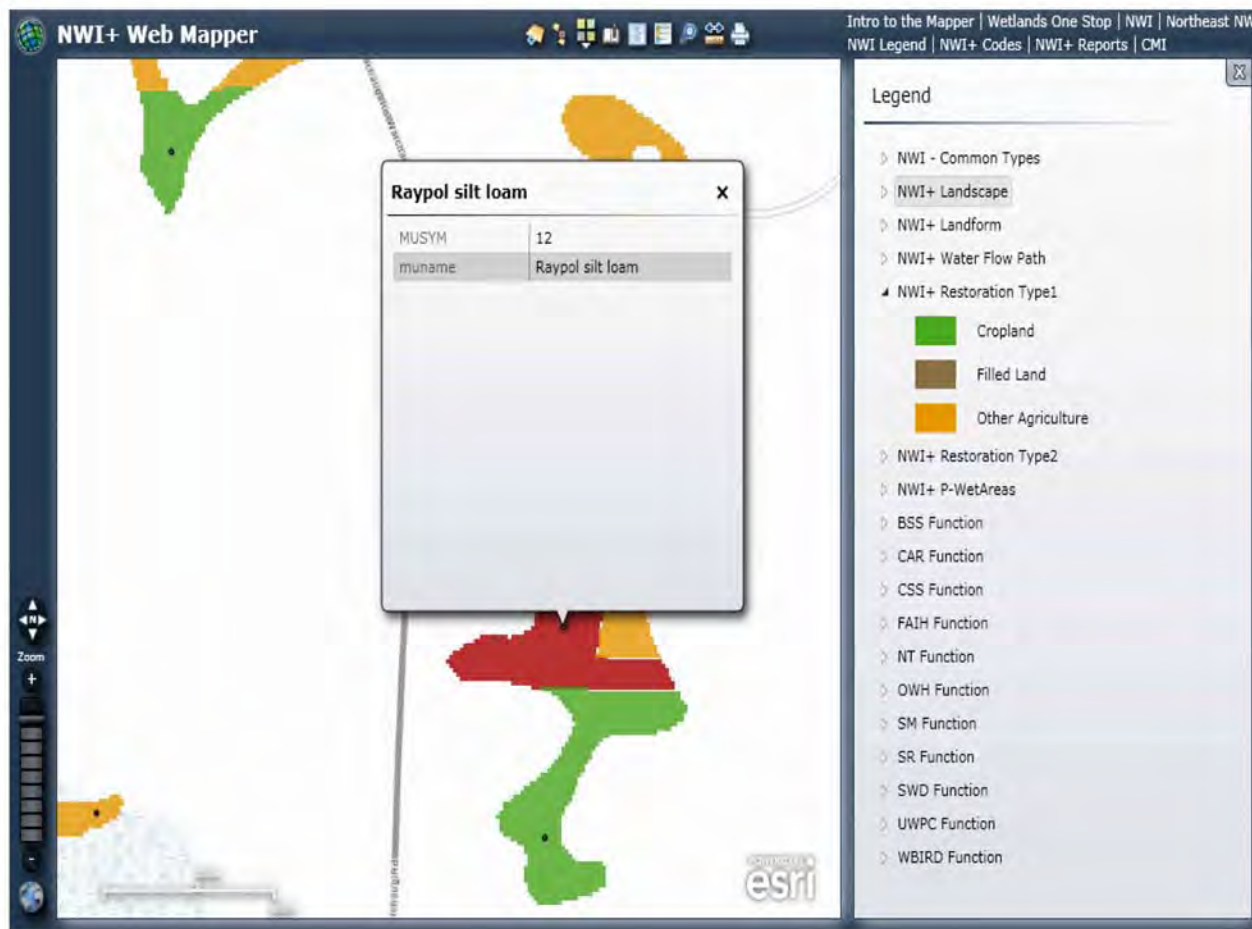
Optional Layer – Potential Wet Areas (P-wet areas based on soil mapping)



P-Wet Areas and Wetlands (Landscape)



P-Wet Area with Soil Code and Potential Type 1 Restoration Layer also Open



Posting Data From Other Agencies

- Desire to use NWI+ Web Mapper or at least the “Wetlands One-Stop Mapping” site to help the others access this information
 - Work in progress
 - Definitely interested in posting data, but need data in compatible format
 - If can't post then will at least have symbol indicating availability elsewhere and give source in dropdown table
 - Can easily post any reports
-

Support for Area-wide Functional Assessment (LLWW and NWI+)

- Center for Watershed Protection report “Using Local Watershed Plans to Protect Wetlands”
 - Mentions LLWW and watershed applications as a practical method for local wetland assessment using GIS
 - Included NWI+ techniques in another recent guidebook for local planners
 - Included NWI+ in their online “Wetlands-At-Risk Protection Tool”
<http://www.wetlandprotection.org/update-wetland-maps.html>
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- William Honachefsky's "Ecologically Based Municipal Land Use Planning" (Lewis Publishers)
 - NWI maps = most commonly used in municipal natural resource inventories
 - Recommends LLWW and functional assessment as a valuable tool for municipal planners. "...provide us with more details on the actual functions of individual wetlands – certainly valuable information for land planners...."
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- Federal Geographic Data Committee's (interagency committee) wetland mapping standard
 - lists as suggested data for future mapping (optional)
-

Conclusion

- Enhancing NWI data increases the functionality of the NWI data
 - The NWI+ database can be used to predict wetland functions for geographic regions of variable size (even statewide landscape-level assessments)
 - The application of LLWW descriptors to wetland trends data and potential wetland restoration site inventories provides valuable information that can be related to wetland functions
 - NWI+ data help researchers and managers in selecting reference and study sites for monitoring wetlands
 - While NWI+ is a useful tool for wetland managers, it is important to remember that it is not intended to replace the need for site-specific assessments and investigations.
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Also a special thanks to all the agencies that have supported or are currently supporting application of LLWW descriptors to expand their wetland databases.

Questions?

