

# Monitoring Wetland Conservation Accomplishments Through Remote Sensing

Ralph Tiner  
National Wetlands Inventory Program  
U.S. Fish & Wildlife Service  
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# Wetland Conservation Goals

- No-net-loss
  - Acreage vs. Function
- Net gain



# Wetland Conservation Initiatives

- Wetland Protection
  - Regulation
  - Acquisition
  - Policies discouraging wetland alteration
  - Voluntary stewardship
- Wetland Restoration



# Resource Concerns

- Loss
  - Dredging and Other Excavation
  - Filling
  - Impoundment
  - Drainage
  - Natural Processes
- Degradation
  - Pollution
  - Hydrologic Alteration
  - Removing Vegetative Buffers



# Tracking Loss and Degradation By Remote Sensing

- Detection of changes in
  - Wetland extent
  - Wetland functions (specific wetland types)
  - Wetland and waterbody buffers
  - Land use/cover in watershed
  - Extent of ditching
  - Water quality (turbidity; eutrophication)



# Impacts Not Detected By Remote Sensing

- Hydrologic Alteration from
  - Groundwater withdrawals
  - Diversions
  - Tile Drainage (?)
- Chemical contamination (?)
- Water Pollution (some forms)
- Some Invasive Species



# Focus on What NWI Has Done with Remote Sensing

- Emphasis on photointerpretation
- Satellite Imagery has great potential
- First-level Assessments
  - NOT a substitute for field-based studies



# Changes in Wetland Extent

- Conventional wetland trends studies
  - National
  - Regional
  - State
  - Watershed
  - Local



# Changes in Wetland Functions

- Landscape-level
  - Need to enhance NWI data to include properties such as:
    - Landscape Position
    - Landform
    - Water Flow Path
    - Waterbody Type
- Better characterization of wetland types than standard NWI



# Changes in Vegetated Buffers

- All studies point to significance of vegetated buffers for water quality protection
- Also important for wildlife habitat
- Identify condition of buffers around
  - Wetlands
  - Rivers and Streams
  - Other Waterbodies



# Changes in “Natural Habitats”

- Extent of “natural habitats”
  - What is happening in the watershed?
  - Perspective on human impact
  - How much habitat is left?
  - Quantitative vs. Qualitative
- What are “natural habitats”?



# “Natural Habitats” = Significant Wildlife Habitats

- Forests
- Meadows and Prairies
- Shrub Thickets
- Wetlands
- Waterbodies
  - Rivers, Streams, Lakes, and Ponds
- Other Natural Areas



# Human-created Habitats

- Urban/Suburban Development
- Industrial Development
- Cropland
- Feedlots
- Orchards, Cultivated Bogs
- Mined Lands

Many = pollution sources that degrade

All have replaced “natural habitats”



# Three Main Assessment Products

## Produced by NWI to Date:

- Standard wetland trends studies
- Landscape-level functional assessments of wetlands (special projects)
- Watershed characterizations based on “natural habitat integrity” indicators (special projects)



# Standard Wetland Trends Studies

- Statistical sampling for large areas
- Full-scale assessment for small areas
- Results
  - Acreage losses/gains
  - Broad groupings of wetlands
  - No functional assessment



# Landscape-level Functional Assessments of Wetlands

- Currently for watershed assessment
- Potential for national/regional trends
- Enhanced NWI to add descriptors for:
  - Landscape Position
  - Landform
  - Water Flow Path
  - Waterbody Type
- Map interpretation & GIS analysis



# Steps in Enhancing NWI

## Classification and GIS analysis

1. Combine NWI digital data with stream data
2. Interpret new features and add to database

Landscape Position – wetlands along estuary, river, stream, lake, pond, or “isolated” wetlands

Landform – basin, flat, floodplain, fringe, etc.

Water Flow Path – inflow, outflow, throughflow, “isolated”, bidirectional flow

Waterbody Type – natural/artificial ponds and lakes, dammed rivers, channelized streams, etc.

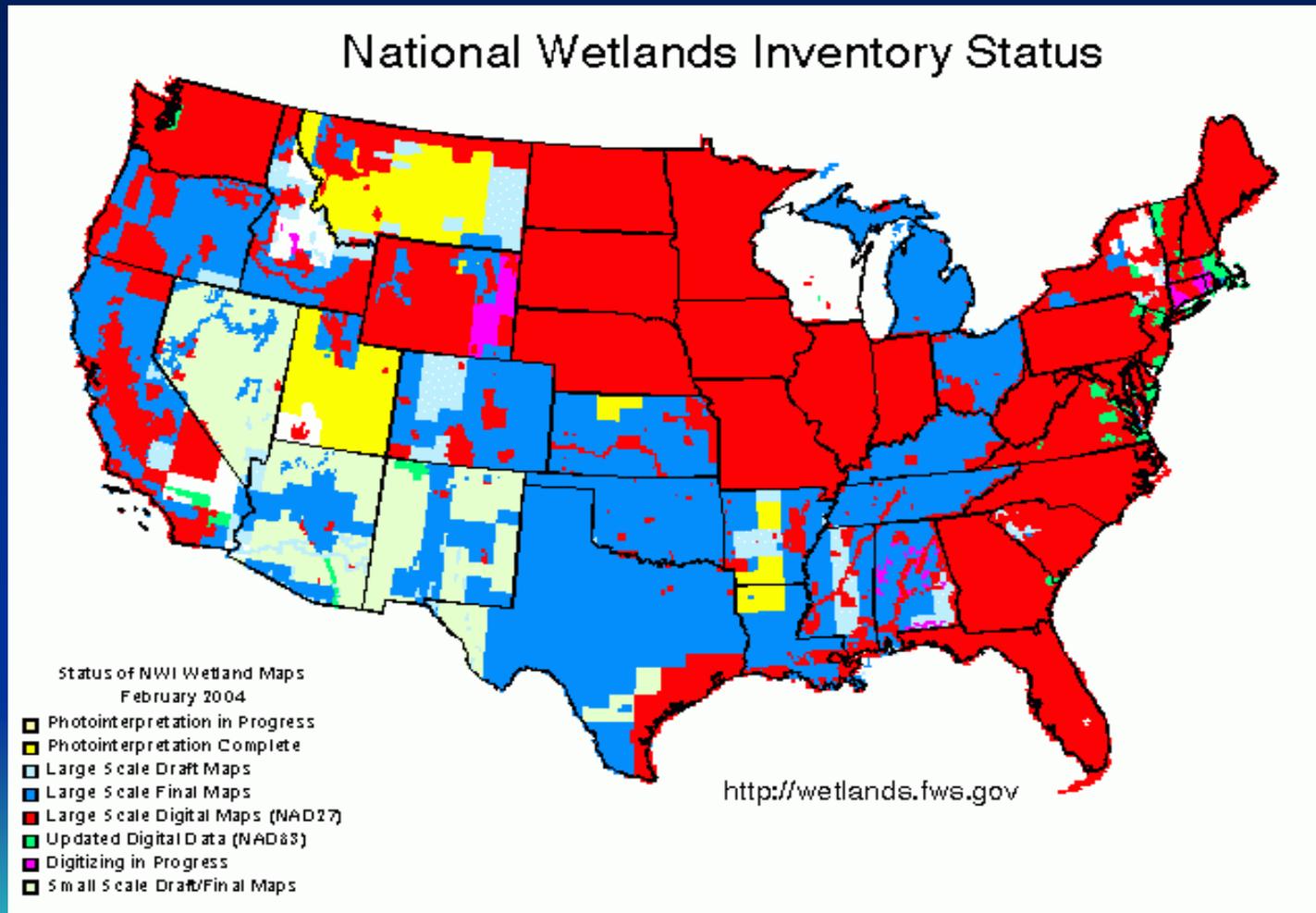


# Steps in Enhancing NWI

3. Apply correlations re: wetland characteristics and function (**report available for the Northeast**)
4. Generate maps and stats for peer review
5. Review/field check as needed
6. Produce final maps, stats, and report



# Status of NWI Maps/Digits

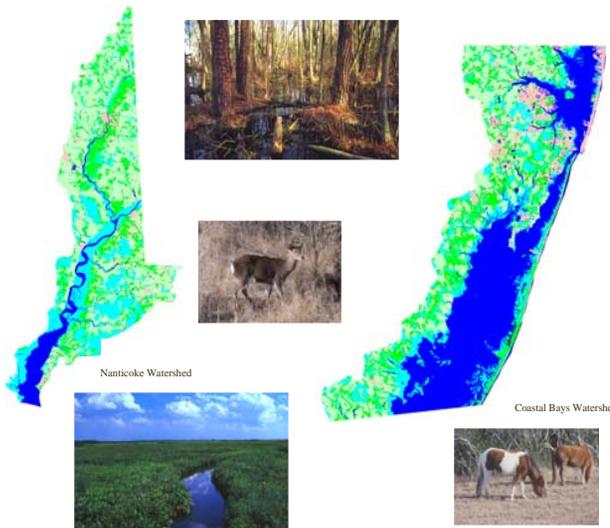


# Example of Enhanced NWI for Functional Analysis

- CD Version
- View on Internet at:  
<http://wetlands.fws.gov>

National Wetlands Inventory

Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watersheds:  
A Preliminary Assessment Report



Nanticoke Watershed

Coastal Bays Watershed

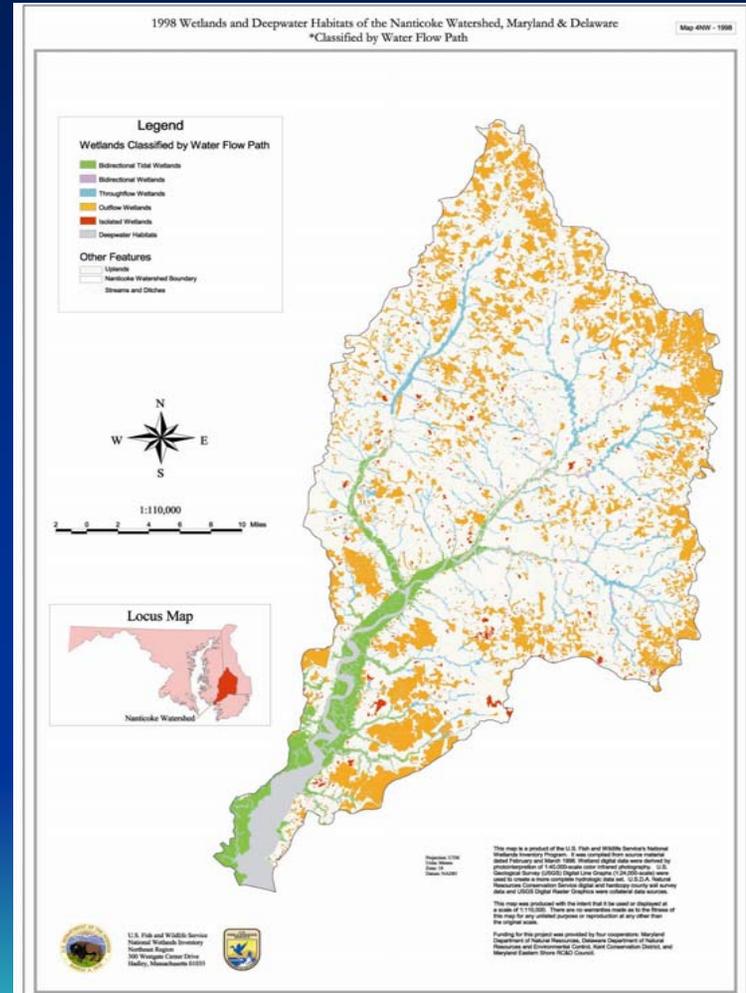
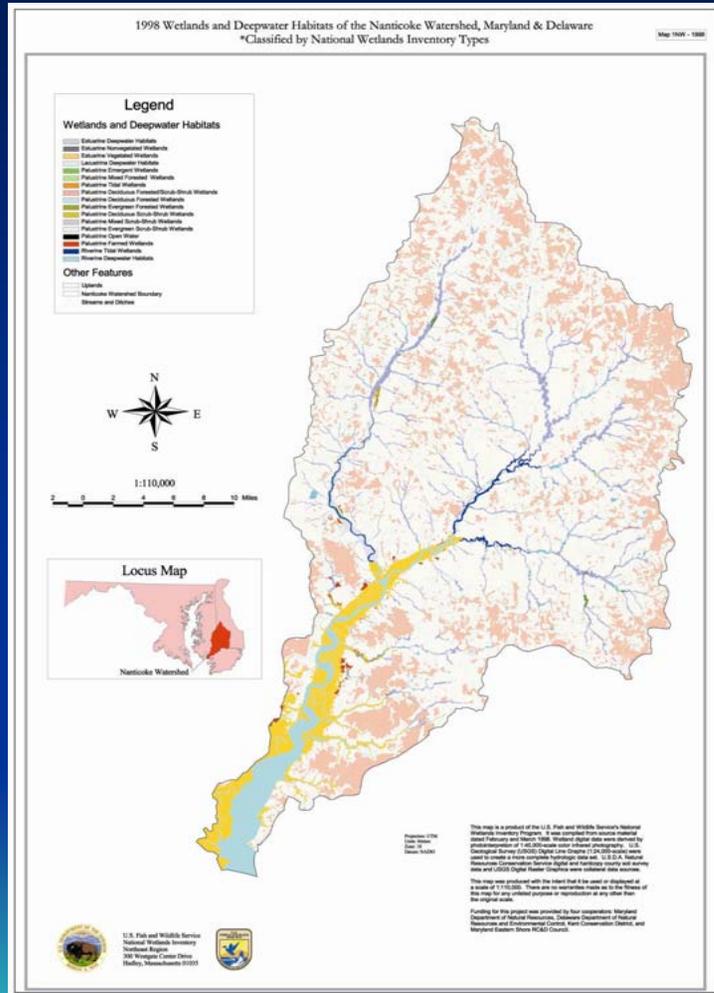


# Wetland Stats: Nanticoke Watershed

- NWI Types
- Types by Landscape Position
- Landform Types
- Type by Water Flow Path
- Waterbody Types
- 68% PFO, 12% Estuarine
- 72% Terrene, 12% Lotic, 16% Estuarine, <1% Lentic
- 71% Interfluve, 11% Floodplain, 17% Fringe
- 67% Outflow, 18% Bidirectional-tidal, 10% Throughflow, 4% Isolated
- 910 Ponds, 50% isolated, 37% throughflow, 13% outflow



# Wetland Maps



# Correlate Wetland Characteristics with Functions

- Correlations developed with multi-agency input
- Northeast Correlations
  - Maine Wetland Advisory Group
  - Nanticoke Wetland Study Group
  - NYCDEP
  - FWS Biologists
  - Others



# Functional Analysis

- Surface Water Detention
- Streamflow Maintenance
- Nutrient Cycling
- Sediment and Other Particulate Retention
- Coastal Storm Surge Retention
- Shoreline Stabilization
- Fish/Shellfish Habitat
- Waterfowl/Waterbird Habitat
- Other Wildlife Habitat
- Conservation of Biodiversity



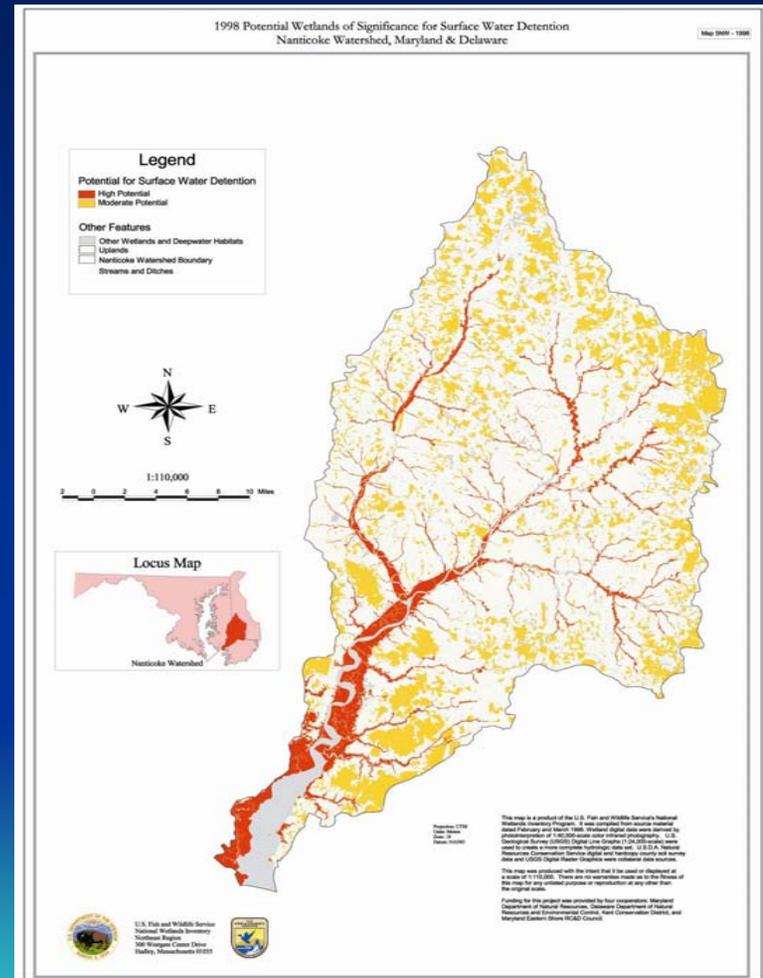
# Summary For the Nanticoke Wetland Functions

- Surface Water Detention = 97%
- Streamflow Maintenance = 75%
- Nutrient Transformation = 96%
- Sediment Retention = 31%
- Coastal Storm Surge Detention = 18%
- Shoreline Stabilization = 28%
- Fish and Shellfish Habitat = 23%
- Waterfowl/Waterbird Habitat = 20%
- Other Wildlife Habitat = 96%
- Biodiversity = 25%



# Nanticoke Watershed - Surface Water Detention

- 97% Significant
  - 28% High
  - 69% Moderate



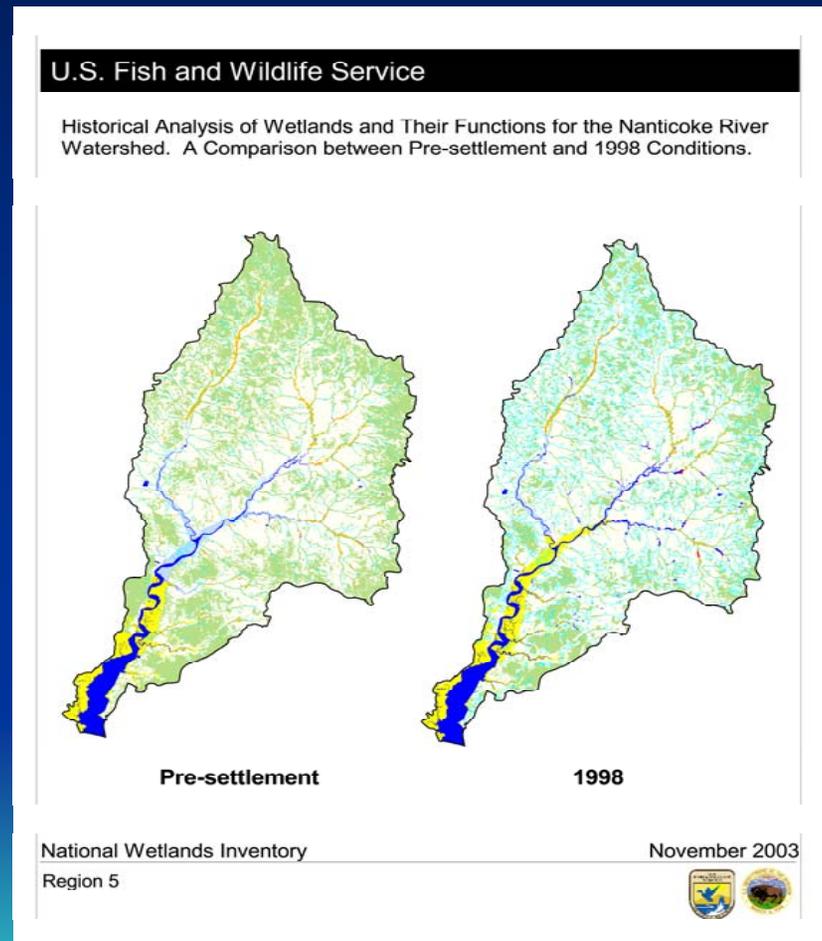
# Uses of Functional Analysis

- Wetland Characterization - Part of Watershed Profiles
- Perspective on Loss/Gain in Function from Wetland Trend Studies
- Monitoring Changes in Functions (effect of cumulative losses)
- Classification/Characterization of Potential Wetland Restoration Sites



# Wetland Trends by Function

- Nanticoke Watershed
- Pre-settlement vs. 1998
- Cumulative impacts



# Wetland Trends

## Pre-settlement

- 230,000 acres
- 2,813 wetlands
- 72% = interfluve outflow wetlands
  - Aver. Size = 433 a

## 1998

- 142,000 acres (62%)
- 5,810 wetlands
- 43% decrease in interfluve outflow type
  - Aver. Size = 44 a
- Palustrine -40%
- Estuarine -28%



# Change in Functions

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



# Limitations of Landscape-level Assessment

- First approximation = **Preliminary Assessment**
- Source data limitations
  - All wetlands and streams not shown
  - Possible upland inclusions
  - Age of existing data
- LLWW classification based mainly on map interpretation
  - Groundwater hydrologic connections must be assumed or not considered
  - All surface water connections not detected
  - Limited field review
- Correlations between functions and characteristics = work in progress (report available for Northeast US)



# Tracking Changes in Natural Habitats

- Indicators of “Natural Habitat Integrity”
  - Extent of Natural Habitat
  - Degree of Disturbance
- A first look beyond wetlands and waterbodies
- Useful metrics for an environmental report card



# Indicators of Natural Habitat Extent

- “Natural” Cover in Watershed
- Vegetated Buffers
  - Stream Corridors
  - Wetlands and Other Waterbodies
- Extent of Wetlands
- Extent of Standing Waterbodies



# Indices for Natural Habitat Extent

- Index scale 1.0 – 0.0
- Value = proportion of natural cover in subject area
- Natural Cover Index =
  - Area in Nat. Cover/Total Land Area
- Stream Corridor Integrity Index =
  - Area in Nat. Cover/Total Land Area



# Indices of Natural Habitat Extent

- Wetland Buffer Index
- Lake and Pond Buffer Index
- Wetland Extent Index
  - Area of Wetland Today/Historic Area
- Standing Waterbody Extent Index
  - Area of Water Today/Historic Area



# Indicators of Natural Habitat Disturbance

- Damming of Rivers and Streams
- Channelization
- Altered Wetlands
- Fragmentation by Roads
- Others
  - Extent of Ditching
  - Commercial Forests vs. Natural Forests
  - Fragmentation Properties



# Indices of Habitat Disturbance

- Index scale 1.0 – 0.0
- Value = proportion of habitat altered
- Dammed Stream Flowage Index =
  - Length Dammed/Total Length
- Channelized Stream Length Index
  - Length Channelized/Total Length



# Disturbance Indices (cont'd)

- Wetland Disturbance Index
  - $\text{Extent of Altered Wetlands} / \text{Total Area}$
- Fragmentation by Road Index
  - $\text{Area of Roads} \times 16 / \text{Total Area}$
- Probably need to add a ditched land index



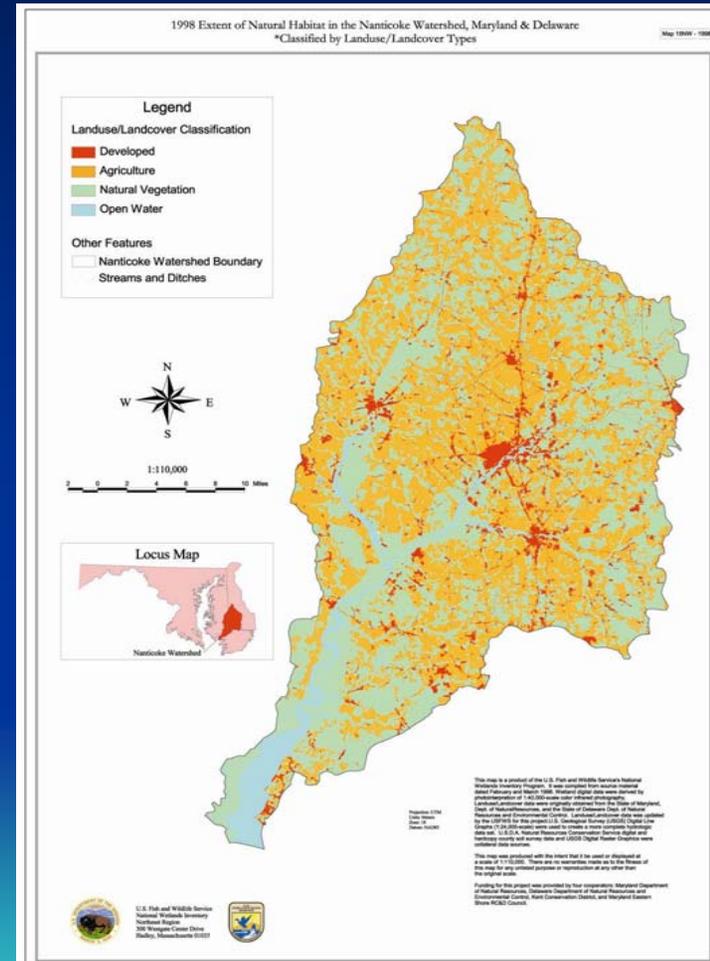
# Composite Index

- Can combine indices to yield a single number
- Sum of weighted habitat extent indices **MINUS** sum of weighted habitat disturbance indices **OR** No Weighting
  - Pros/cons
  - Single number to reflect status
  - Weighting variables
  - Must use same formula for watershed comparisons



# Watershed Characterization – Nanticoke Watershed (data –DE only)

- Natural Cover 0.41
- Riparian Corridor 0.59
- Wetland Buffer 0.36
- Pond/Lake Buffer 0.39
- Wetland Extent 0.41
- Standing Water Ext 1.0+
- Dammed Stream 0.03
- Channelized Stream 0.79
- Wetland Disturbance 0.71
- Habitat Frag/Road 0.38
- Composite – 0.29



# Values of Such Assessments

- Can do for large and small areas
  - Nationwide and Statewide
  - Watersheds and Sub-basins
- Can be repeated over time (monitoring tool)
- Produces updated wetland and landuse/cover data
- Provides consistent approach to tracking changes and evaluation of impacts
- Aids in interpreting field-based results
- Can identify potential restoration sites



# Needed Action

- Apply enhanced attributes to future wetland trend studies
- Develop correlations between wetland properties and functions for other regions
- Conduct pilot studies across U.S.
  - Wetland functional assessments
  - “Natural habitat integrity” assessments



# Needed Action (cont'd)

- Develop interagency partnerships
- Seek funding sources for national, state, and watershed-level assessments



# Bottom Line

Commitment from agencies to:

- Determine what is “no net-loss/net gain”
- Decide how to measure it
- Provide \$ support to conduct periodic assessments (**institutionalize the process**)
- Include these types of metrics in an environmental report card for the nation, state, or county.



# For Additional Information on New NWI Products

- Sample reports posted on web at:
  - <http://wetlands.fws.gov>
- Contact:
  - [ralph\\_tiner@fws.gov](mailto:ralph_tiner@fws.gov)

