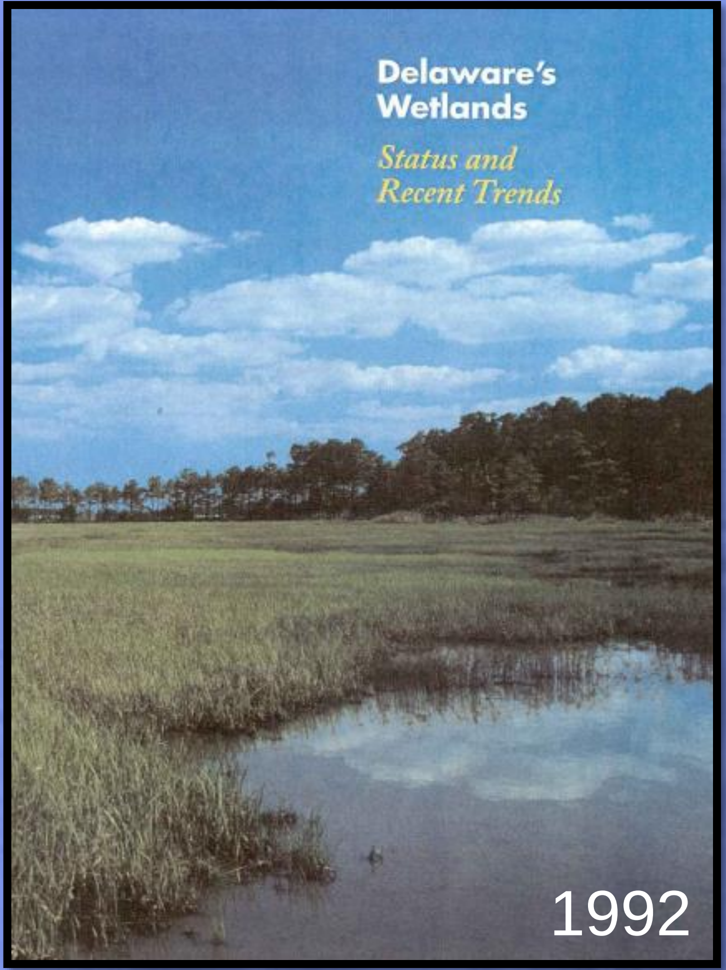
Landscape-level and Site-level Based Functional Assessment and Implications Due to Climate Change.

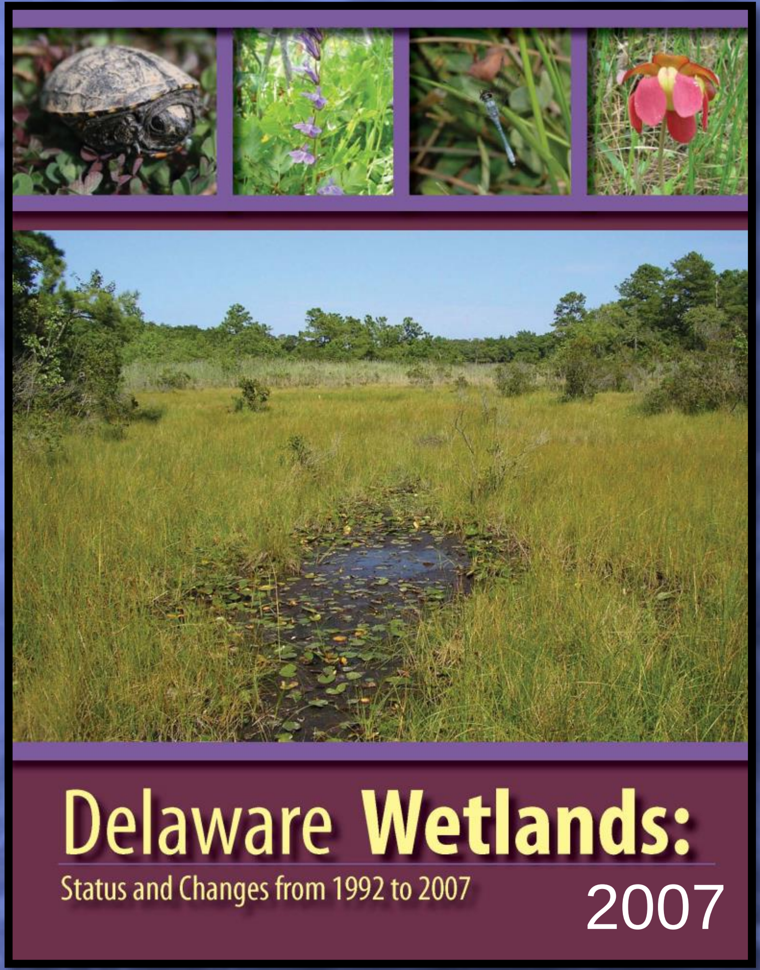
Mark Biddle, PWS
Environmental Program Manager
Delaware Department of Natural Resources and Environmental Control

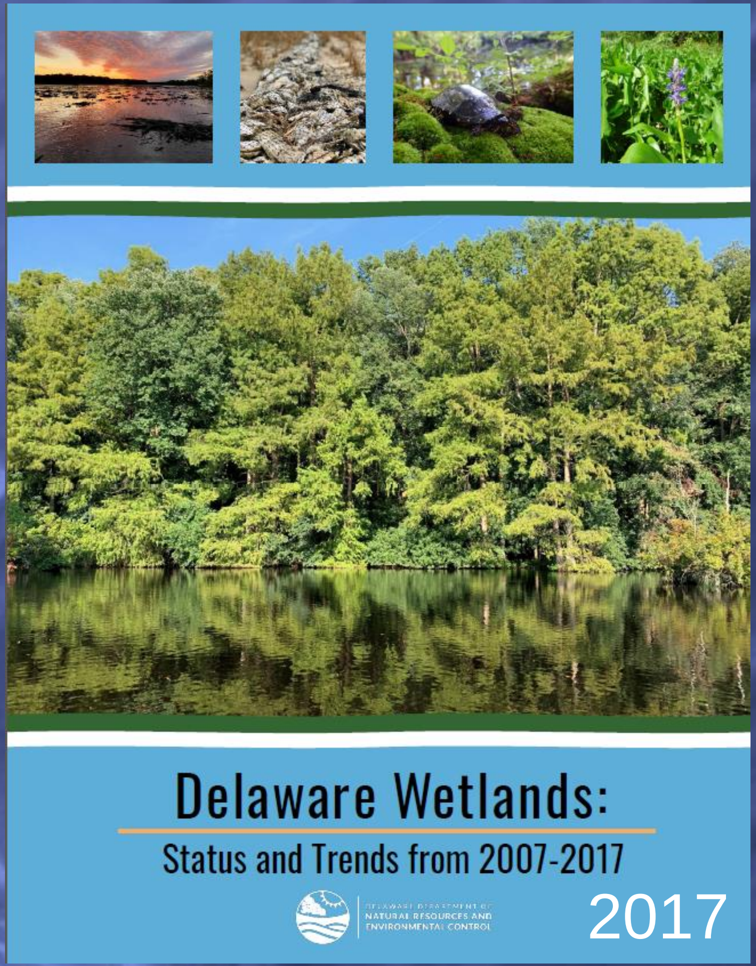
DELAWARE DEPARTMENT OF
NATURAL RESOURCES AND
ENVIRONMENTAL CONTROL

Delaware Wetlands
Purify Provide Protect
http://de.gov/delawarewetlands

MAWWG/NEBAWWG 11.13.2024







- Have four statewide wetland mapping efforts (1982, 1992, 2007, 2017)
- Status and Changes reports
- Ability to track wetland acreage and change in type, gains and losses
- LLWW can assess at the landscape level the potential of wetlands to perform certain functions

Notable changes applied in 2017 wetland mapping:

NWI Version 2 methodology (USFWS)

Removal of Hydric Wetland (H-wetland) polygons

Use of QL2 LiDAR and DEMs

Higher resolution imagery (9-inch statewide, 3-inch in State Parks)

* All created significant changes to final data analysis

NWI Version 2 methodology

Mapped wetland and deepwater habitats as in past and applied Cowardin et al. (1979) to all polygonal features

Incorporated hydrography data (NHD) into the mapping for a comprehensive data set of all wetlands and surface waters

Hydrography data became separate polygons (linears buffered)

Allows for more accurate adaptive management, geospatial summaries, and modeling

Imagery: Only a snapshot in time – degree of wetness varies

2007

2012

2017

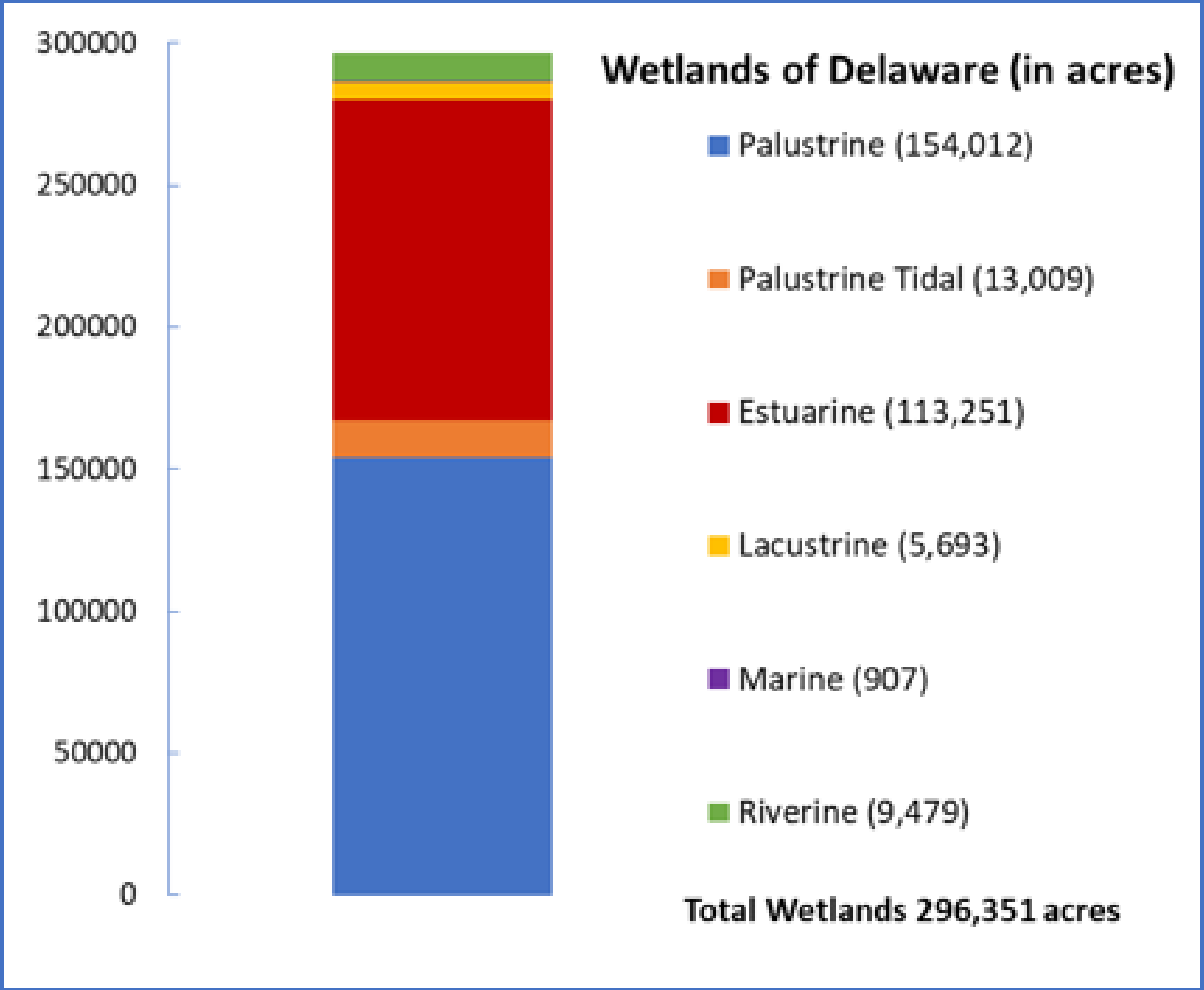
Delaware Wetland Mapping (2017)

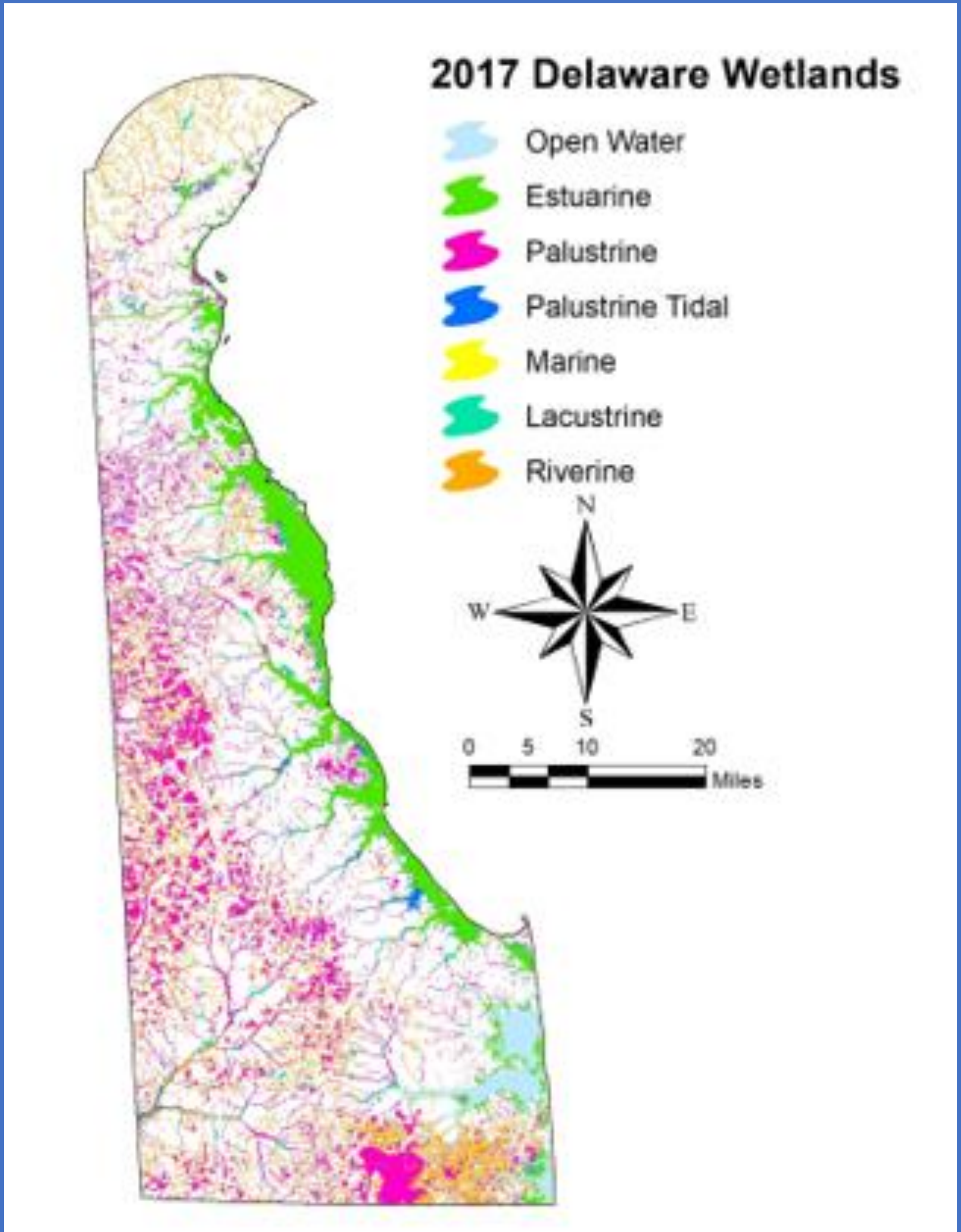
Statewide Totals

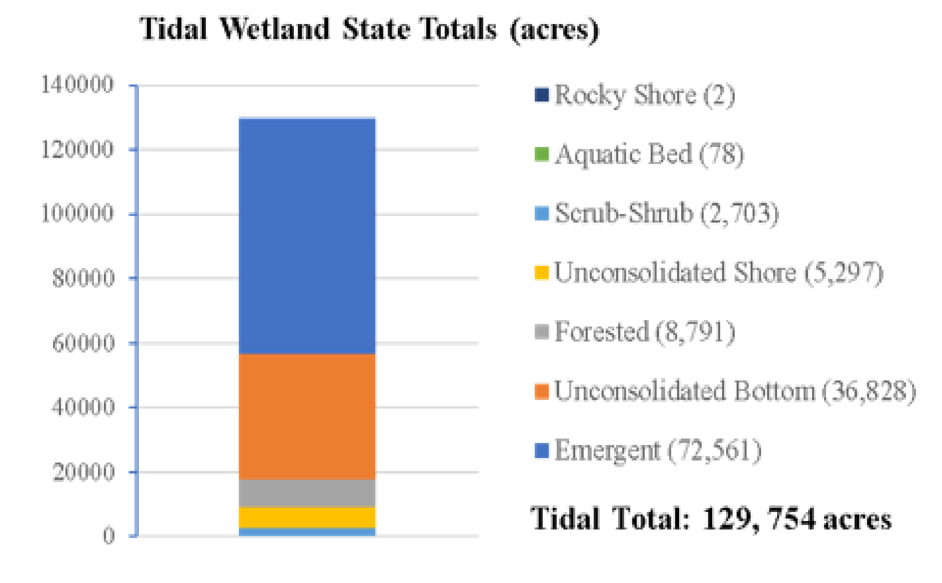
*320,076 acres in 2007

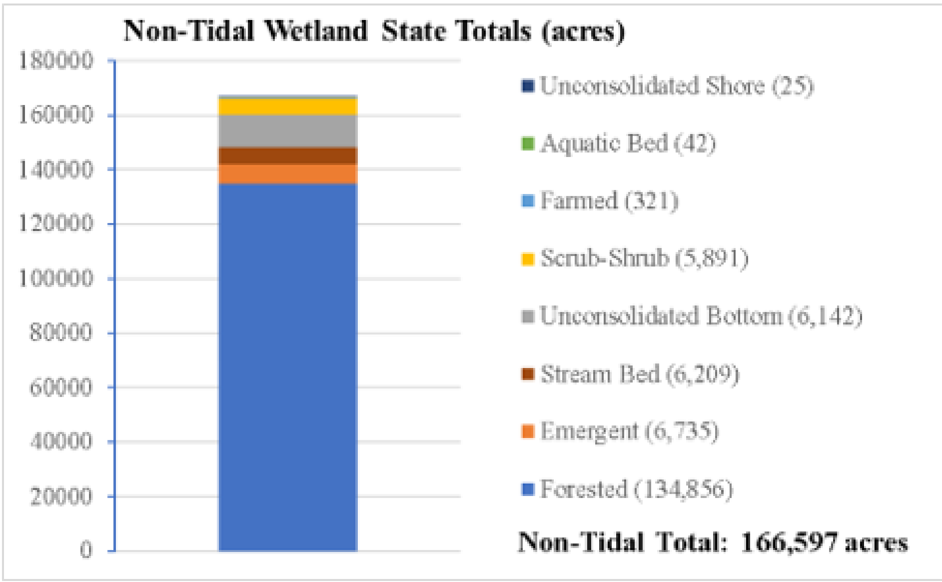
-- H-wetland removal

-- NHD now as polygons




2017 Delaware Wetlands
Open Water
Estuarine
Palustrine
Palustrine Tidal
Marine
Lacustrine
Riverine
N
W
E
S
0
5
10
20
Miles


Tidal Wetland State Totals (acres)
140000
120000
100000
80000
60000
40000
20000
0
Rocky Shore (2)
Aquatic Bed (78)
Scrub-Shrub (2,703)
Unconsolidated Shore (5,297)
Forested (8,791)
Unconsolidated Bottom (36,828)
Emergent (72,561)
Tidal Total: 129, 754 acres


Non-Tidal Wetland State Totals (acres)
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
Unconsolidated Shore (25)
Aquatic Bed (42)
Farmed (321)
Scrub-Shrub (5,891)
Unconsolidated Bottom (6,142)
Stream Bed (6,209)
Emergent (6,735)
Forested (134,856)
Non-Tidal Total: 166,597 acres

Assessing Wetland Loss, Gain, and Change 2007-2017 (acreage and function)

Mapping provides opportunity to track loss/gain/change over time for spatial extent and functional prediction

Delaware has three Status and Changes reports

- 1982-1992 (10 years) – 1,905 acres net vegetated loss
- 1992-2007 (15 years) -- 3,126 acres net vegetated loss
- 2007-2017 (10 years) – 3,011 acres net vegetated loss

Ability to attribute cause of loss/gain/change

Wetland CHANGE 2007-2017

Swamp Milkweed
(*Asclepias incarnata*)
B.Haywood

Total wetland change 10-year period = 13,822 acres

Change of wetland from one type to another

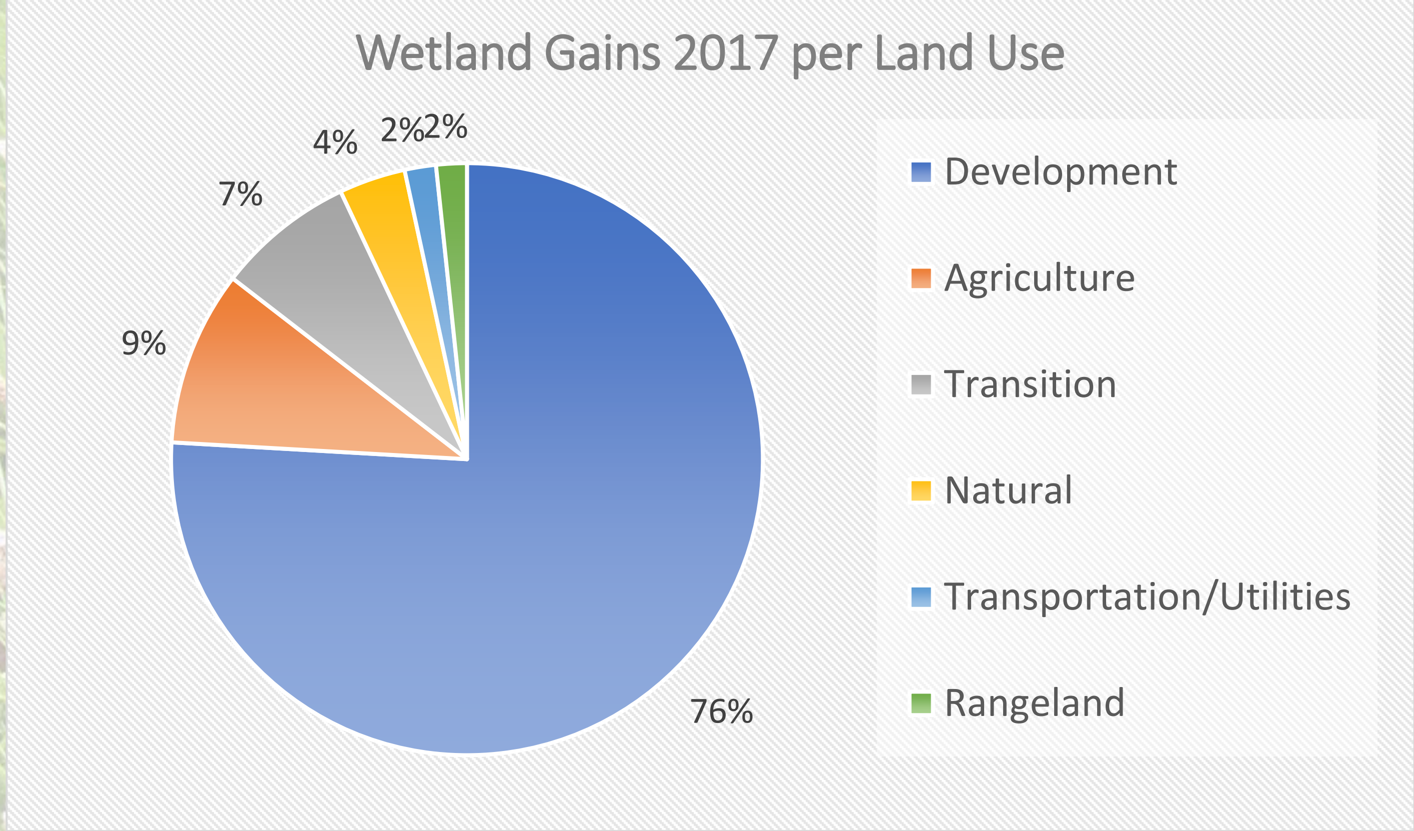
64% tidal changes from vegetated to intertidal flat or open water
875 acres from tidal palustrine to estuarine
-- clear effects of sea level rise and saltwater intrusion

Majority of nontidal wetland acreage change due to succession or mapping technique improvement

Wetland CHANGE 2007-2017

Wetland Type	Change Type (2007-2017)	Change Description	Acres
Tidal	Saltwater intrusion:	Tidal palustrine to estuarine	919.3
	Vegetation growth from:	Estuarine unconsolidated bottom	559.2
		Intertidal unconsolidated shore	93.2
		Tidal freshwater ponds/lakes	14.8
	Vegetation loss to:	Intertidal unconsolidated or rocky shore	2,562.0
		Estuarine unconsolidated bottom	1,411.1
		Tidal freshwater ponds/lakes	5.9
	Vegetation changes:	Succession	172.8
		Increased flooding	431.4
	Total Tidal Changes		**6,169.7**
Non-tidal	Tidal regime:	Non-tidal to tidal	1,181.3
	Vegetation growth from:	Non-tidal freshwater ponds/lakes	729.8
	Vegetation loss to:	Freshwater ponds/lakes	266.6
	Vegetation changes:	Succession	2,772.6
		Increased flooding	314.3
		Deforestation	2,387.9
	Total Non-tidal Changes		**7,652.5**

Wetland GAIN 2007-2017



Blackgrass Rush
(*Juncus gerardii*)
B.Haywood

Development	893.274705
Agriculture	112.408322
Transition	88.504761
Natural	42.782315
Transportation/Utilities	20.136748
Rangeland	19.696792
Grand Total	**1176.803643**

(in acres)

Wetland GAIN 2007-2017

Total wetland gain 10-year period = 1,176 acres

Most gains are stormwater ponds from residential development *

Sand/gravel operations

Restoration/mitigation

*stormwater ponds only provide a fraction of wetland functions compared to natural wetlands

Wetland LOSS 2007-2017

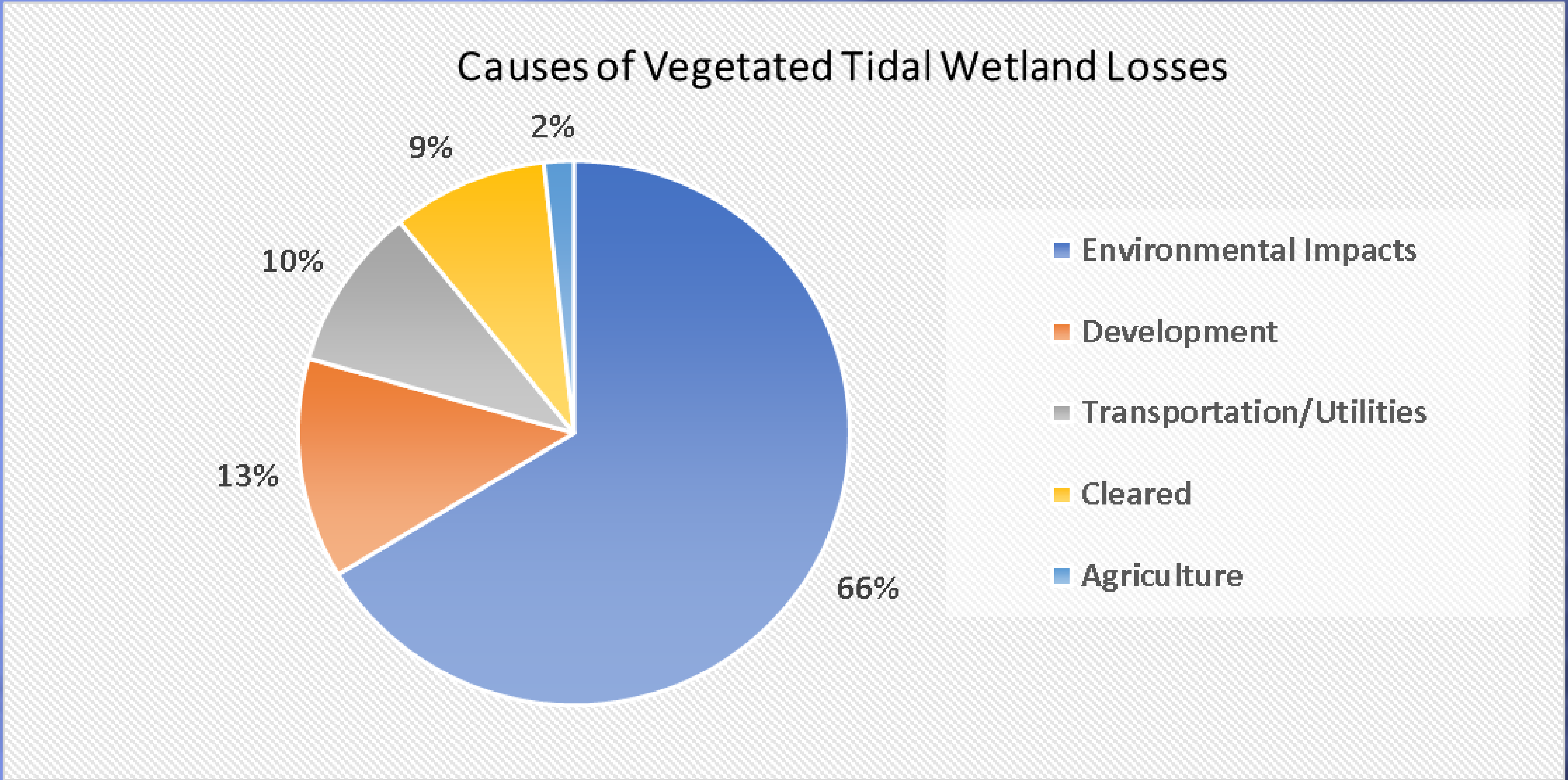
Total wetland loss 10-year period = 3,011 acres

2,773 acres of nontidal wetlands
238 acres to tidal wetlands

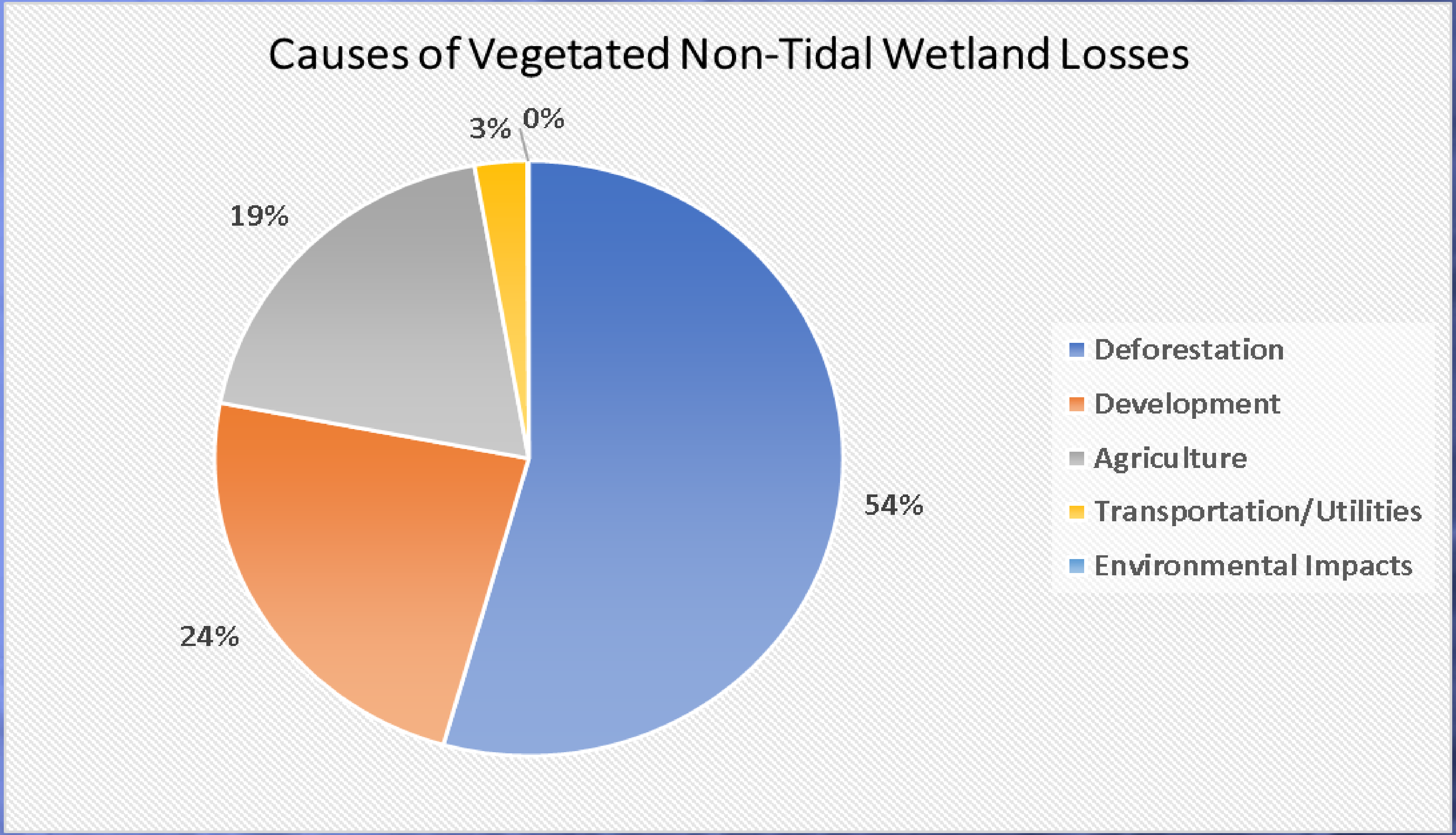
Spotted Water Hemlock
(*Cicuta maculata*)
B.Haywood

Loss to nontidal wetlands is mostly due to human-induced causes

Loss to tidal wetland is mostly due to natural causes



Proportions of vegetated tidal wetland losses from different causes between 2007 and 2017. Only wetlands ≥ 0.25 acres in size were included in calculations of proportions.

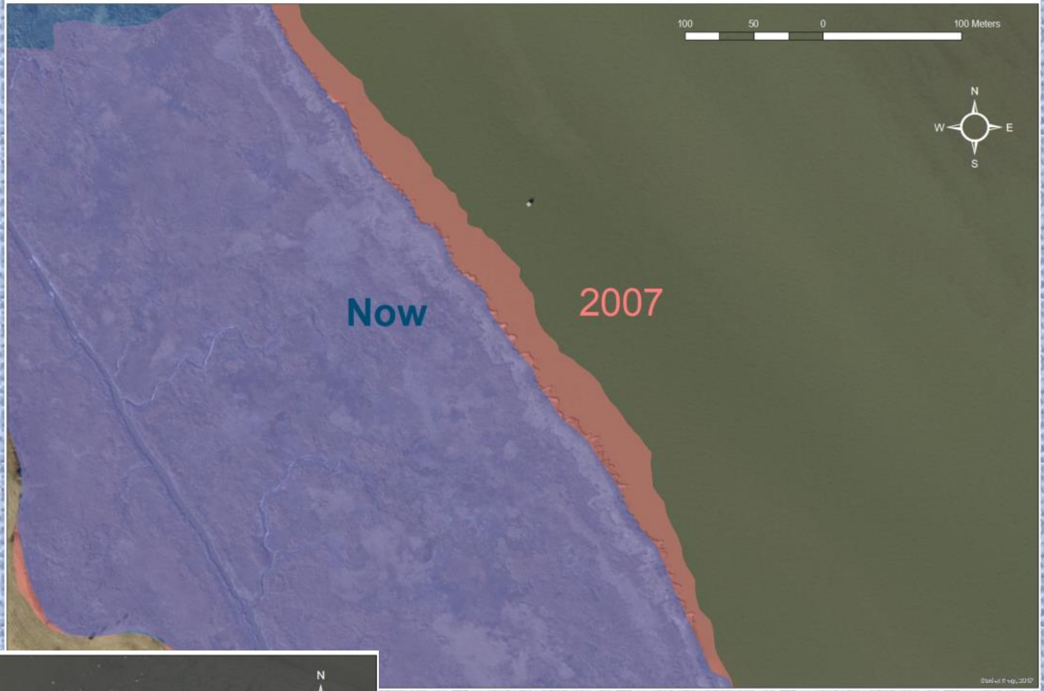


Proportions of vegetated non-tidal wetland losses from different causes between 2007 and 2017. Only wetlands ≥ 0.25 acres in size were included in calculations of proportions.

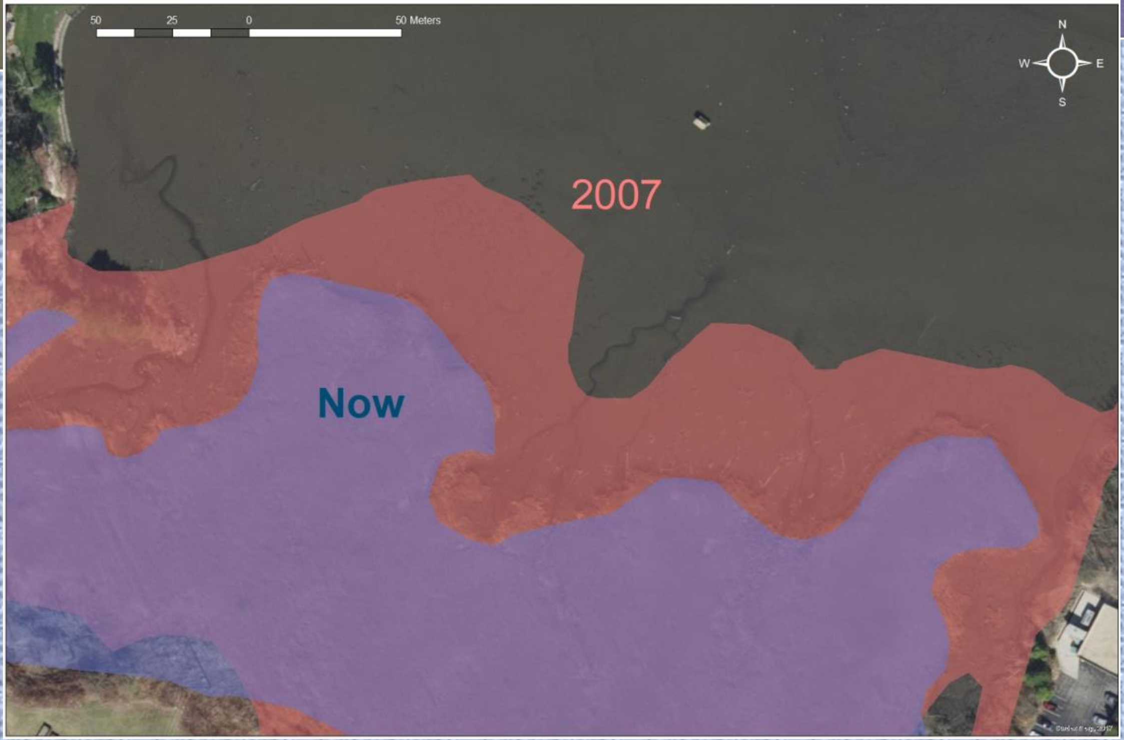
LOSS to Development Projects

LOSS to Natural Causes

Bombay Hook NWR



Cedar Swamp SWA



Millsboro

Wetland Functional Analysis

Use of abiotic features to predict wetland functions

LLWW (Tiner, 2003)
Landscape Position, Landform, Water Flow Path, Waterbody Type (derived from HGM classification)

First applied in Delaware as part of the 2007 statewide wetland mapping

Ability to predict at landscape level the potential for wetland types to perform 11 functions at a high or moderate level

Source: USFWS, NWI

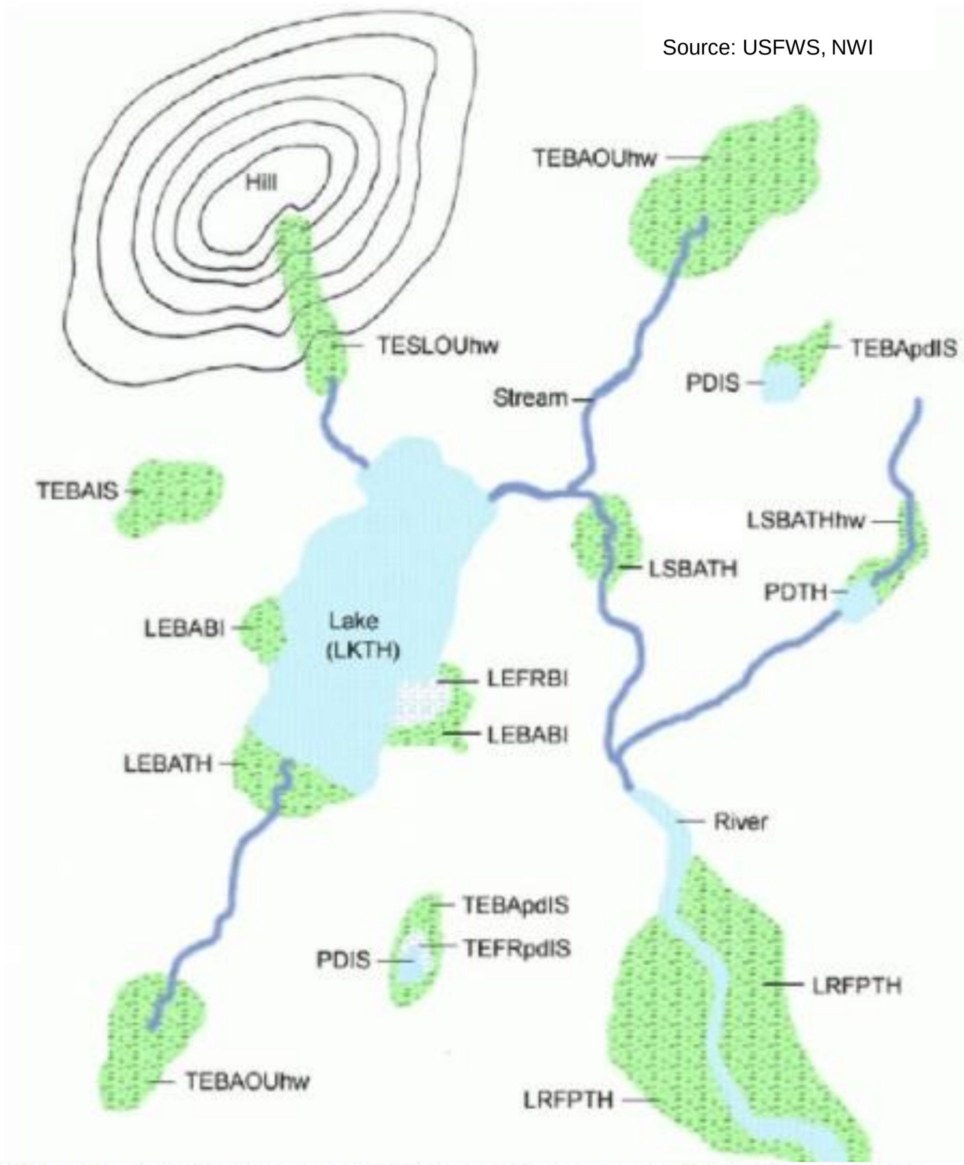


Figure 1. Application of LLWW descriptors to a region with nontidal wetlands. Landscape positions: LR – lotic river, LS – lotic stream, LE – lentic, and TE – terrene; Landforms: BA – basin, FR – fringe, FP – floodplain, SL – Slope; Water flow paths: OU – outflow, IS – isolated, TH – throughflow, BI – bidirectional-nontidal; other descriptors: pd – pond (association), hw – headwater; Waterbodies: PD – pond, LK – lake. Note: Landscape position can be added to lakes and ponds if desirable.

11 Wetland Functions (LLWW)

1. Surface Water Detention (SWD)
2. Coastal Storm Surge Detention (CSS)
3. Streamflow Maintenance (SM)
4. Nutrient Transformation (NT)
5. Sediment Retention (SR)
6. Carbon Sequestration (CAR)
7. Bank and Shoreline Stabilization (BSS)
8. Provision of Habitat for Wildlife (OWH)
9. Provision of Fish and Aquatic Invertebrate Habitat (FAIH)
10. Provision for Waterfowl and Waterbird Habitat (WBIRD)
11. Provision for Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC)

Wetland Function	2017 Acreage	% of DE's Wetlands likely performing at moderate to high levels	2007 Acreage
1. Surface Water Detention (This function is limited to freshwater wetlands; the role of coastal wetlands in water storage is handled by the Coastal Storm Surge Detention function.)	150,203	50.6	171,045
2. Coastal Storm Surge Detention (This function includes tidal wetlands plus contiguous nontidal wetlands subject to flooding during storm	94,096	31.8	85,523
3. Streamflow Maintenance (These wetlands are sources of streams or along first order perennial streams or above.)	112,825	38.1	134,620
4. Nutrient Transformation	261,078	88.0	246,847
5. Carbon Sequestration	256,802	86.6	249,012

Wetland Function	2017 Acreage	% of DE's Wetlands likely performing at moderate to high levels	2007 Acreage
6. Sediment and Other Particulates Retention	149,215	50.3	156,756
7. Bank and Shoreline Stabilization	203,469	68.6	182,105
8. Fish and Aquatic Invertebrate Habitat Stream Shading	136,087 106,349	45.9 35.8	78,230 36,935
9. Waterfowl and Waterbird Habitat Wood Duck	85,691 24,423	29.0 8.2	80,920 25,691
10. Other Wildlife Habitat	230,112	77.6	248,090
11. Unique, Uncommon, or Highly Diverse Wetland Plant Communities (The following types are included in this category: estuarine aquatic beds, regularly flooded salt marsh (low marsh), slightly brackish tidal marshes, tidal freshwater flats (e.g., wild rice beds), marshes and shrub swamps, Atlantic white cedar swamps, bald cypress swamps, and lotic fringe wetlands.)	Did not assess	N/A	54,963

- **What if we compared site-level functional condition to the landscape level prediction of functional condition?**

- Delaware has completed site-level wetland condition assessments (by type) for all watersheds statewide using HGM based methods (DECAP, DERAP).

- Wetland condition assessments evaluate levels of stressors and disturbance compared to a set of reference wetlands.

- Uses 5 functional categories to determine the Index of Wetland Condition (IWC) that shows how far removed a wetland is from the ability to perform certain functions.

Functional comparison

USFWS	DNREC
Surface water detention Coastal storm surge detention Streamflow maintenance	Hydrology
Nutrient transformation Carbon sequestration Sediment retention	Biogeochemistry
Shoreline stabilization Unique wetland plant community	Plant community
Stream shading Waterfowl habitat Other wildlife habitat	Habitat

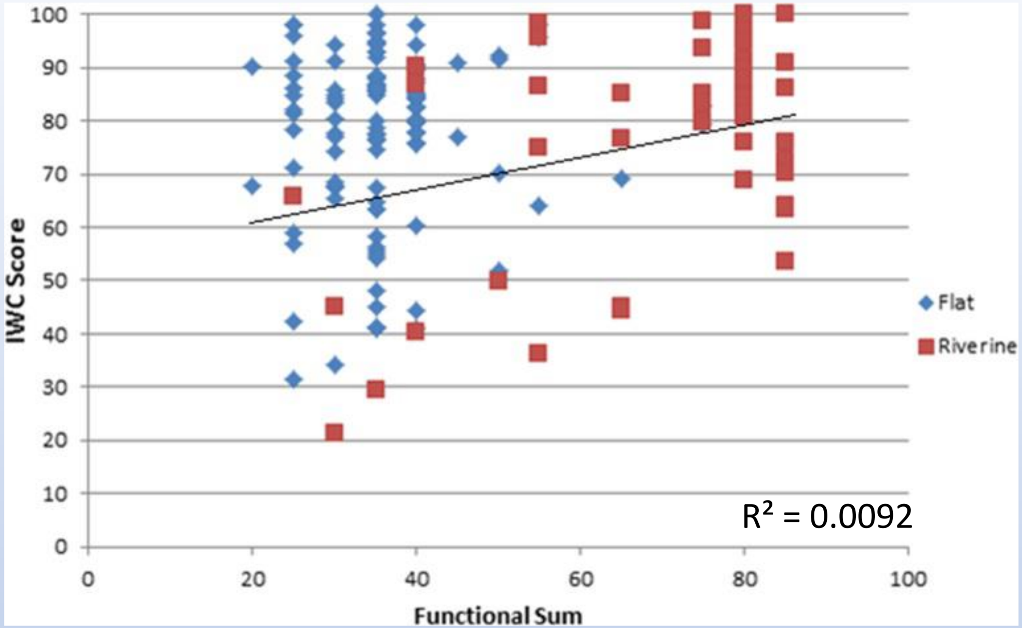
Landscape-level predicts function based on abiotic factors (LLWW) assigning a high or moderate category

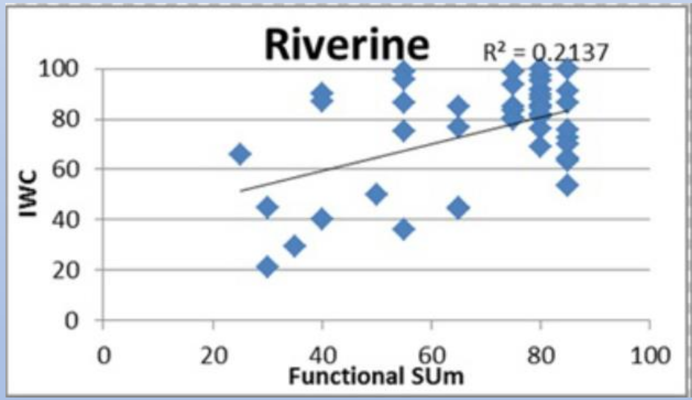
Site-level uses stressors and disturbance to determine function using wetland condition scoring

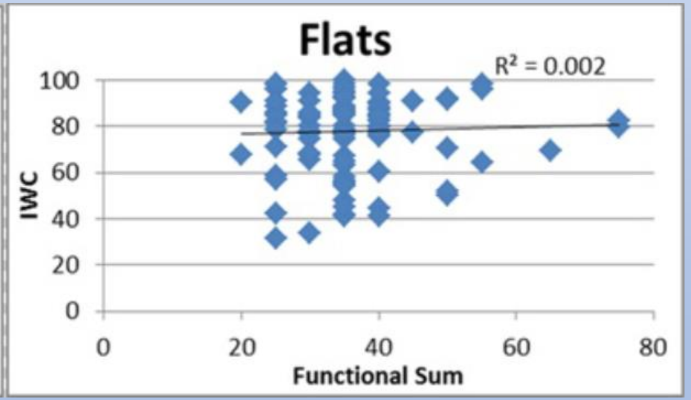
Comparing categorical rankings (landscape-level) to numeric rankings (site-level) is challenging

For numerical comparison purposes, landscape-level high were given a score of 10, and moderate 5

Allowed for summation of all predicted functions (functional sum) for comparison to site-level scores





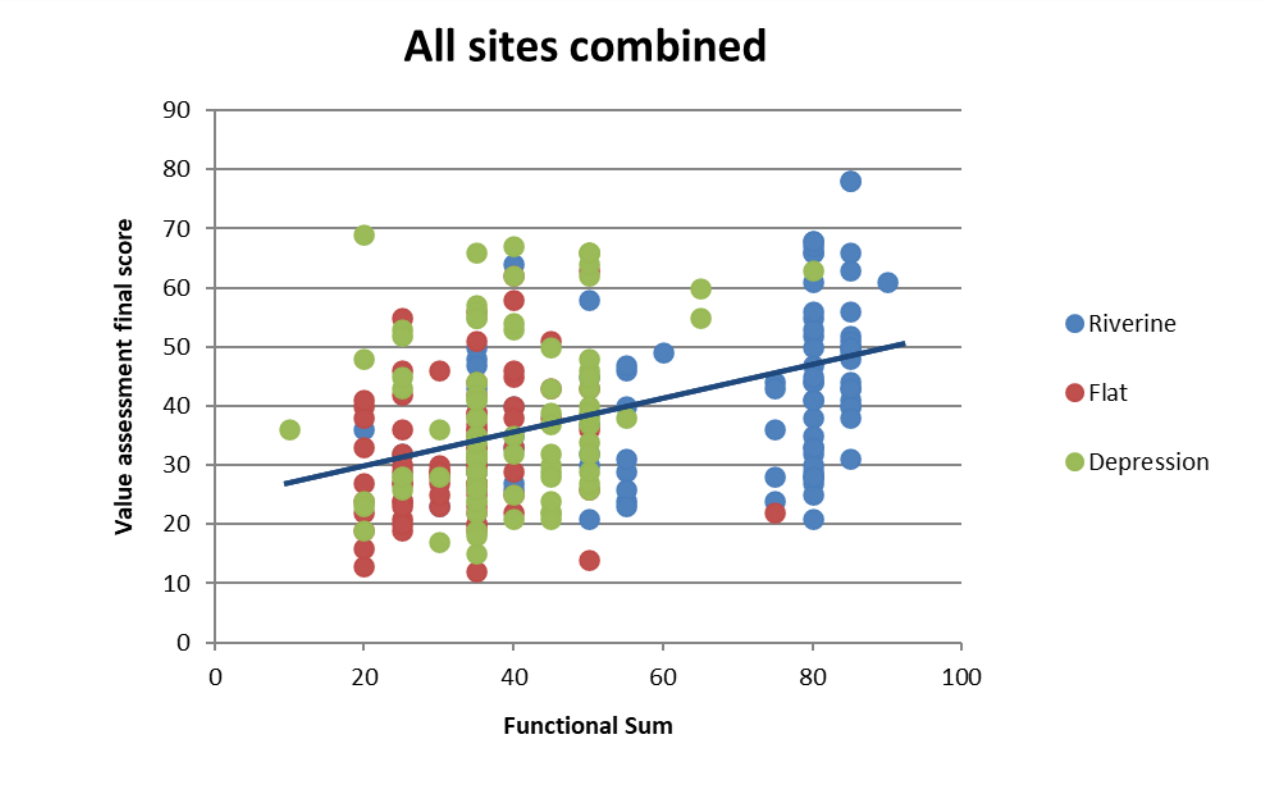


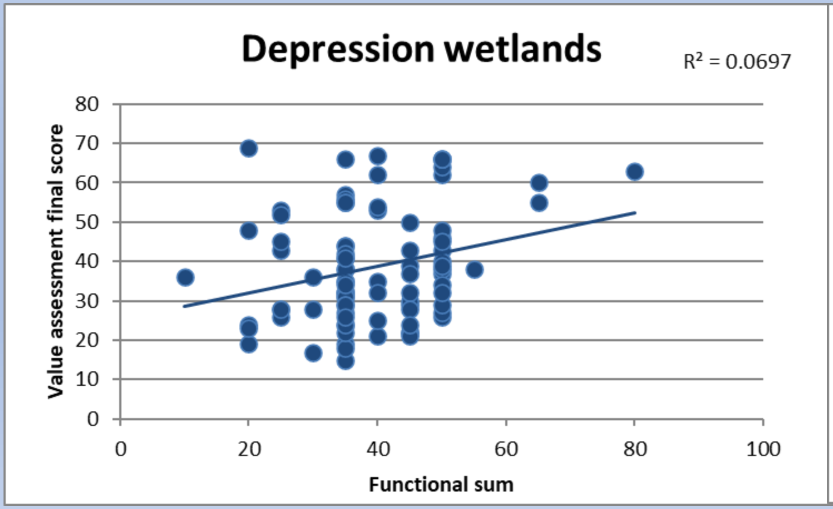
Value-Added Metrics – wetland values based on the opportunity of a wetland to provide a function of societal value

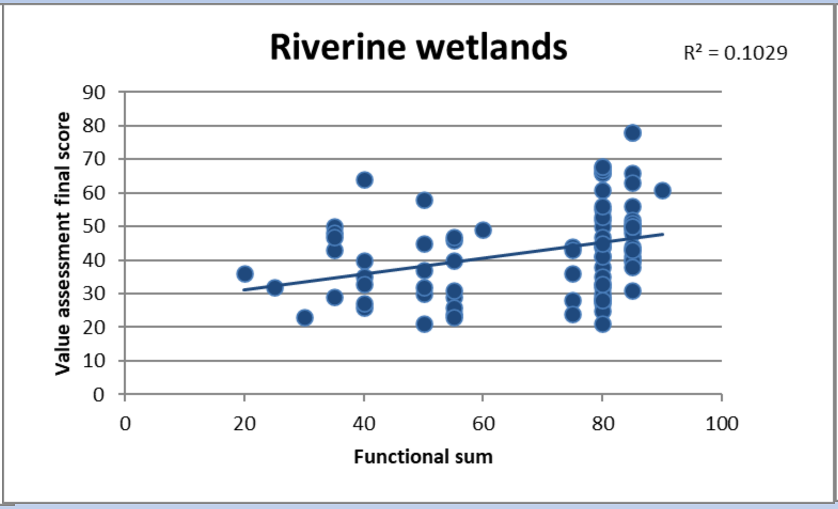
Such as: uniqueness, size, habitat availability educational value, habitat structure, etc.

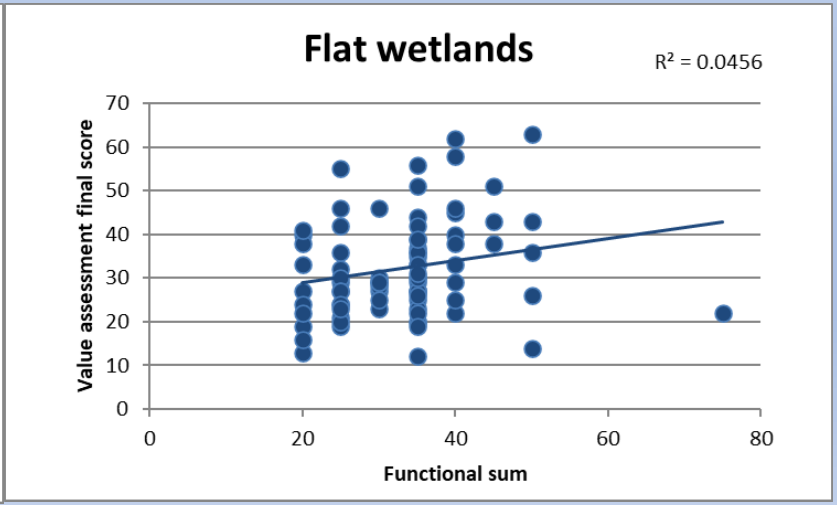
Both condition and wetland value are scored

Example: A pristine wetland with a high condition score may score lower than a disturbed wetland based on societal benefits provided by that wetland system









Lessons Learned for Landscape-level vs. Site-level Functional Comparison

Improvement to mapping techniques will improve accuracy of landscape-level data

More detailed elevation data will reveal more depressions and anthropogenic factors

Refine the functional estimates of simply high and moderate

Determine if site-level data can improve the landscape-level predictions

Consider how biological integrity (IBI) and floristic quality (FQI) can assist with functional prediction

Accurate landscape-level predictions will allow for tracking functions and how those increase or decrease due to climate change

Wetland Functional Trends Assessment

- Significant differences in most functions between 2007 and 2017 that don't align well with the spatial extent (acreage) differences

- Improved mapping techniques, succession/change in type, gains/losses, and the incorporation of hydrography data as polygons contributed to wide swings in functional prediction

- Some functions increased and some decreased

- Overall accuracy improved which will lead to more concise functional assessment and tracking over time

Thank you for the opportunity:
NAWM
MAWWG
NEBAWWG

Questions?

Mark Biddle, PWS
Environmental Program Manager
Delaware DNREC, Division of Watershed Stewardship
Watershed Assessment Section
302-739-9939
Mark.Biddle@delaware.gov