Examining wetland loss and potential restoration opportunities in the Sandusky watershed, Ohio

Methodology for a GIS-based assessment of wetland functions

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Santina introduce speakers and title of presentation

The Great Lakes Restoration Initiative is the largest investment in the Great Lakes in two decades. A task force of 11 federal agencies developed an action plan to implement the initiative. This action plan covers fiscal years 2010 through 2014 and wetland restoration is a specific component of the plan.

Furthermore, Lake Erie in recent years has seen an increase in harmful algal blooms, hypoxia in the central basin, and nuisance benthic algae washing up on the shorelines, all due to excess nutrients coming into the lake. Nutrient reduction is one of three top priorities for implementation projects funded under GLRI, and many federal partners are collaborating in key watersheds of interest, with the goal to bring resources together to accelerate restoration of these watersheds.

Decision makers need more information to better target restoration efforts in the Lake Erie basin and maximize results.

In addition to providing habitat for wildlife, we know that wetlands also improve water quality by filtering nutrients and sediment, and have important hydrologic impacts to the watershed as a whole (reduction of peak flows and flood damage, water storage, protection of erodible shorelines) . Futhermore they provide a permanent alteration to the landscape, if properly designed are self-sustaining and thereby an appealing management strategy in terms of sustainability in the face of changing climate and growing populations.

And so for these reasons are important to evaluate as a resource, and as a potential management strategy in a watershed plan.

The watershed planning process seeks to identify and quantify specific causes and sources of water quality problems, set water quality goals and identify specific actions required to solve those problems.

Last year EPA Region 5 developed the Wetlands Supplement to EPA's watershed planning handbook, shown here. The purpose of the supplement is to encourage the inclusion of proactive wetland management into watershed plans.

As most of you know, EPA hosted a webinar on the supplement last fall. This project builds on the methods presented in the wetlands supplement, particularly MDEQ's **landscape-level wetland functional assessment Tool**

http://water.epa.gov/type/wetlands/outreach/fact26.cfm
http://water.epa.gov/polwaste/nps/handbook_index.cfm
http://www.epa.gov/region5/agriculture/pdfs/wetlands-in-watershed-planning-supplement-region-5-201302.pdf

- EPA's broad goal is to Develop tools and strategies to support implementation of wetland restoration, two stage ditches, and drainage water management for water quality and quantity. Information to support decision making and also tools that can be used/replicated by watershed planners and incorporated in watershed restoration plans.
- We're accomplishing this through a series of projects with our state and federal partners; first phase is complete but work is ongoing. For example, simultaneous with this project we also conducted a GIS – based suitability screening to rank potential two stage ditch locations in the sandusky. We also just started a project focused on assessing the watershed for dwm potential.
- The project we'll discuss today is the wetlands functional assessment for the sandusky but if you'd like information on the other projects, feel free to contact me directly after the webinar.

U.S. Army Corps of Engineers, Detroit District

- EPA is conducting assessments on multiple priority watersheds in the GL basin:
- Upper Blanchard subwatershed to the Maumee River in Ohio
- Swartz and Kearsley Creek subwatersheds to the Saginaw River in Michigan
- And the watershed we will focus on today is the Sandusky River watershed in Ohio, area shown in red
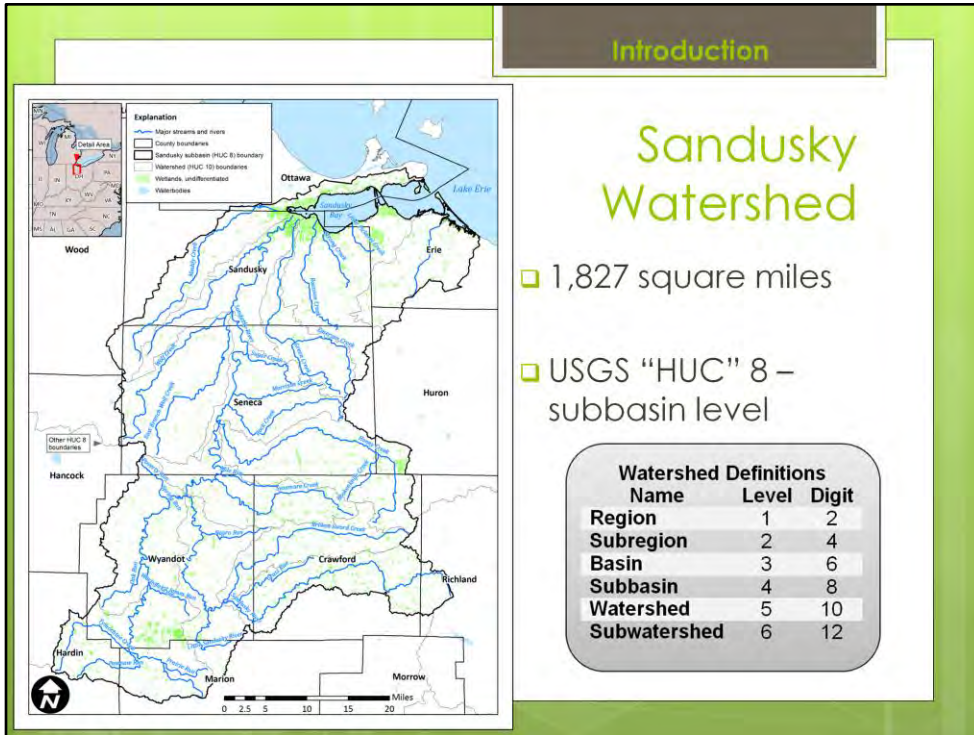
- Size
- About 1800 square miles (1,827 square miles)

- USGS HUC 8, the Sandusky subbasin

- Drainages, major rivers
  - Located on Lake Erie
  - Most prominent drainage is Sandusky River
  - Drains to Sandusky Bay

- Predominantly agricultural and urban

- Cities
  - Sandusky, Fremont

- 2012 Population: around 258,000
  - Only counting five main counties that span watershed
  - (258,022: 60,150 Sandusky County, 76,398 Erie County, 56,018 Seneca County, 22,607 Wyandot County, 42,849 Crawford County)

EPA approved a TMDL for the Upper Sandusky in 2004. Organic and nutrient enrichment, siltation, low dissolved oxygen, habitat and flow alterations, and pathogens have been identified as the primary causes of impairment. Total phosphorus, sediment, habitat, and pathogen TMDLs have been calculated. TMDL development and implementation plan are currently under development for the lower sandusky.

With that background in mind, I hope that provides some context for the project. At this time I want to turn it over to James to explain the actual wetlands functional assessment which he performed. James will walk you through the analysis which consists of three basic steps: first, develop a map of historic wetlands so that opportunities to restore wetlands that previously existed can be evaluated a long with the those still presnt today. The second step is assigning hydromorphic descriptors - **L**andscape Position, **L**andform, **W**aterbody Type, and **W**ater Flow Path (LLWW)

This is an enhancement to the existing wetland classification system inherent to NWI which james will explain in more detail. And finally to use the LLWW descripstors to evaluate functions, there are several such as sed retention and nutrient transformation. Again james will explain in more detail. Take it away james!
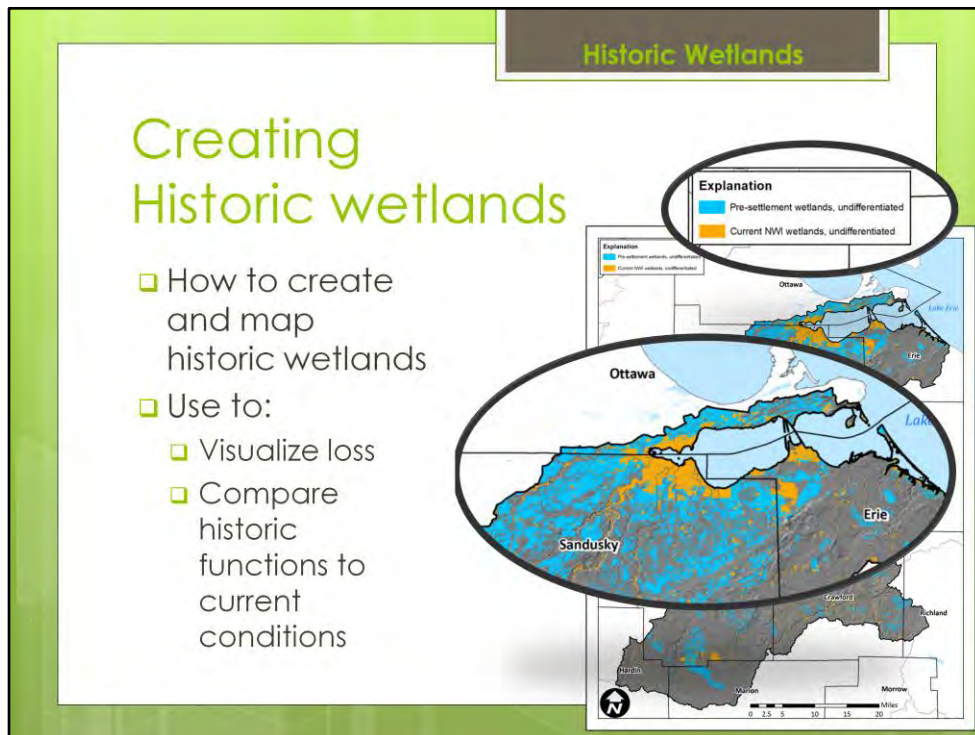
- Thank you Santina

- First I will talk about
- creating the interpretation of historic wetlands

- Then I will move into the specific GIS steps
- To find wetland functions in both historic and current day wetlands

- So, Historic wetlands
- If we want to quantify loss of wetland function in watershed

- Need some way to compare CURRENT functional analysis to a PREVIOUS point

- Ideal comparison is natural state of watershed, prior to:
  - wide-scale agricultural modifications,
  - deforestation,
  - roadway construction,
  - and hydromodification, such as canals, ditches, reservoirs,
    - as well as municipal storm sewer systems

- And, that starting point needs to be interpreted
- Which we did in a GIS
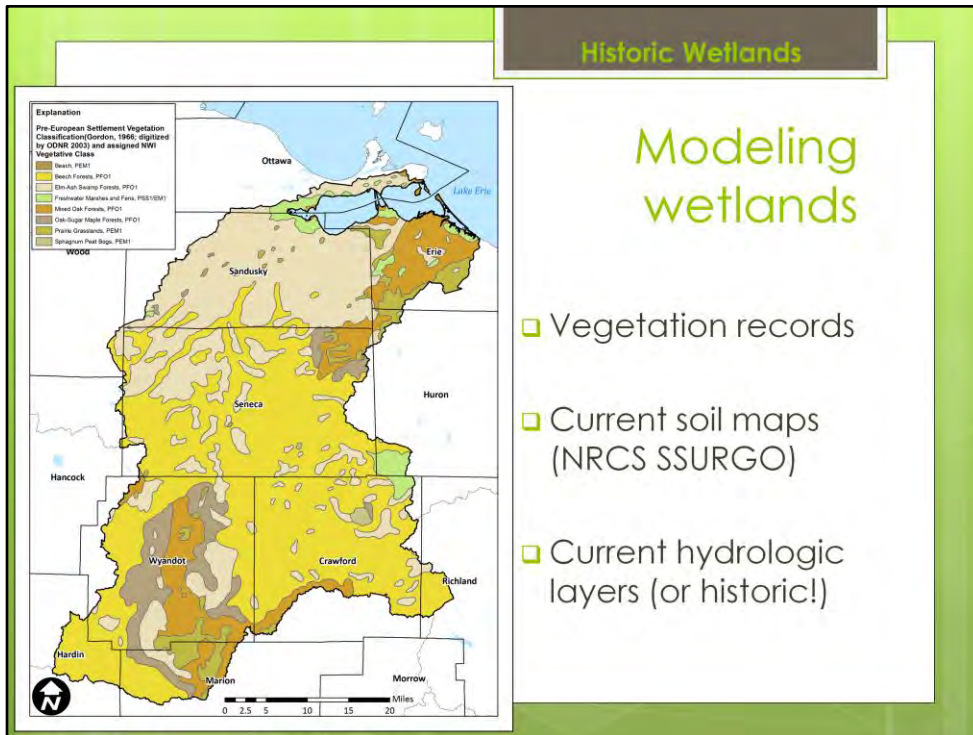
- That starting point of comparison in Ohio is generally taken to be around the late 1700s

- Sometimes called "pre-European settlement" conditions, or more generally the term historic wetlands is used

- The goal was to create a GIS layer that was directly comparable to the main wetland database of today
- That main database being the Fish and Wildlife Service's National Wetlands Index or NWI
- Which we will take a look at here shortly
- We want our pre-historic wetland database to be similar in form and function to that NWI
- So that we can perform the same GIS analysis steps

- So, our starting point for comparison is around the late 1700
- And for that, we used the work of RB Gordon from 1966
    - His map of the "Original vegetation of Ohio at the earliest land surveys"

- That map was digitized by ODNR for use in GIS, 2003

- From that vegetation map,
    - We designed a crosswalk correlation between current day wetland vegetative class codes - - the same codes that are in the NWI - - and the historic vegetation types
    - You can see those different vegetation types represented in the map to the left as different color patches

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Figure from MDEQ, 2011
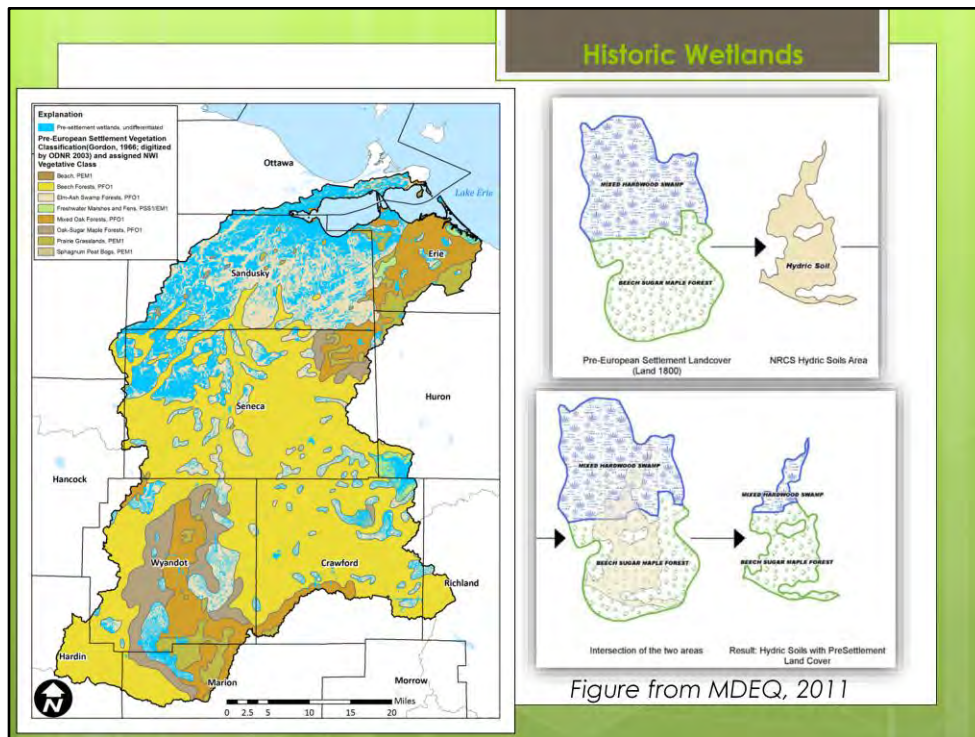
- …We combined them in the GIS

- And created a new historic wetland database, similar in form and functions to the NWI

- In the diagram to the left you can see the blue of the interpreted historic wetlands,
- overlain on top of one of our primary data layers, the historic vegetation map

- To the right
- Is an illustration to show you conceptually what is meant by combining those data layers
- In the top are visualizations of the historic vegetation
- [THIS BLUE AND GREEN]
- And then the hydric soils from the NRCS SSURGO database
- [THIS LIGHT BROWN]
- When overlain, as you see at the bottom
- That intersection becomes, in this example, two different types of wetlands

- SO
- This historic wetland map
- Becomes our starting point
- To perform the same wetland function analysis that we used on the current-day wetlands

- Later in the presentation
- I will show you the results of that functional analysis, but first

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Historic Wetlands

Modeling wetlands

- Wetland model results on a Digital Elevation Model surface

- Historic wetlands cluster in north
- Isolated patches in south
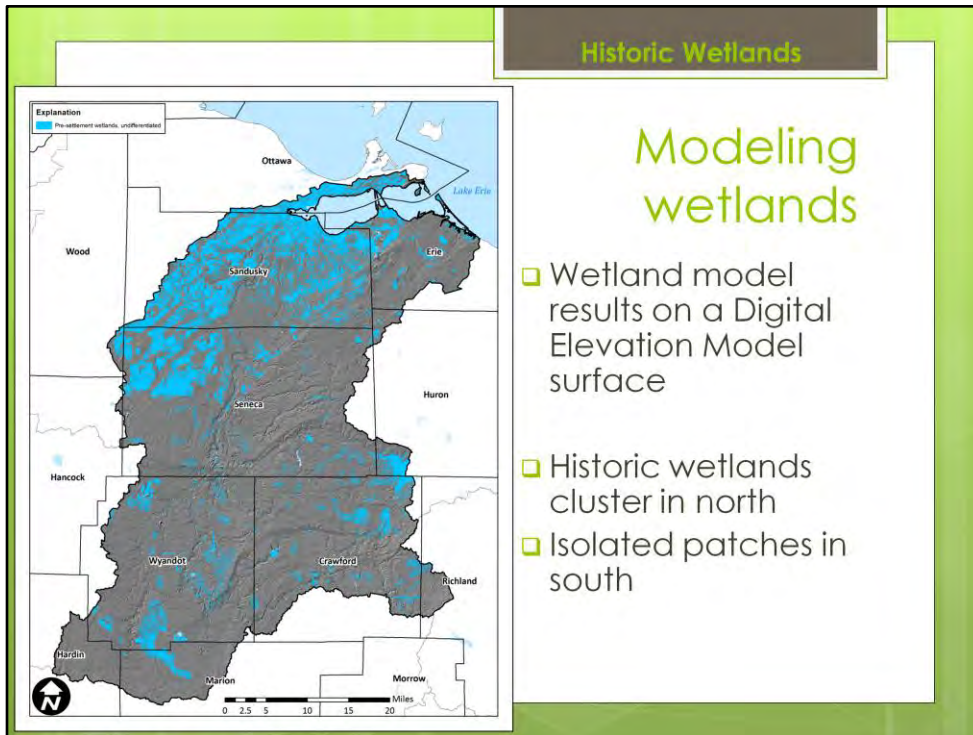
- Here is
- Another view of the wetlands
- Without the vegetation

- Overlain instead on topography, in the form of a Digital Elevation Model or DEM

- Note that
- Wetlands cluster in the northern section of watershed

- In the flat lowlands

- And then in the rougher highlands to the south

- There are smaller patches of interpreted wetlands
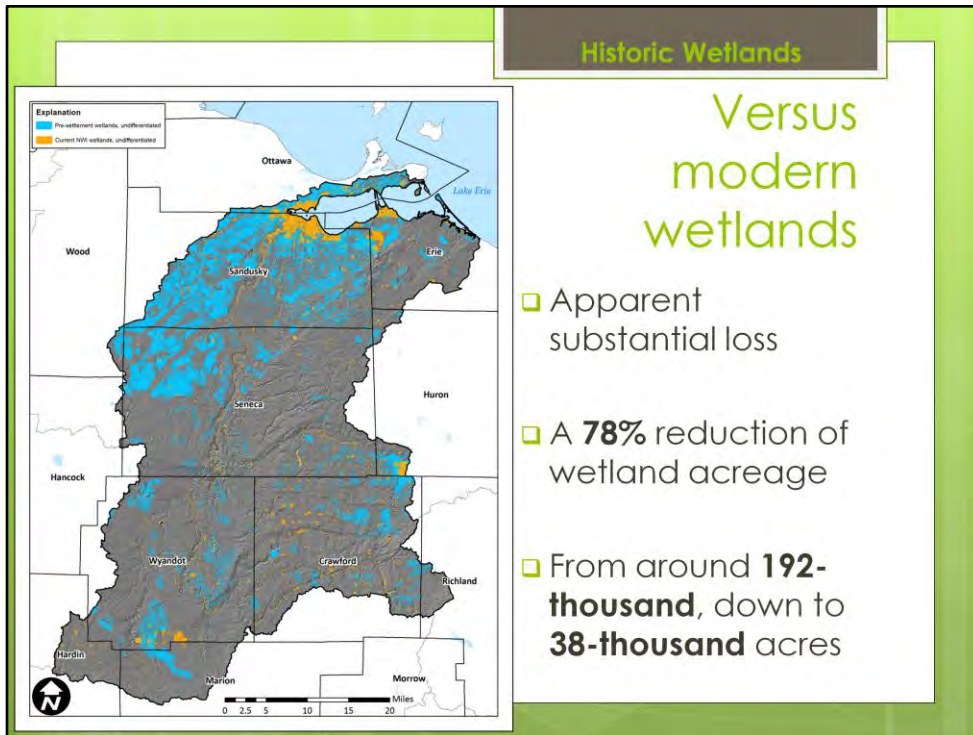
- And, here we are looking at the modern wetlands from the NWI, in orange, superimposed on historic wetlands

- There's an apparent substantial loss

- It's about a 78% reduction
- We go from around 192 thousand
- Down to 38 thousand acres

- Let's look at some more specific numbers of those results
- of the comparison
- Between historic and current-day

- In this table…

Historic Versus Current Wetlands

	Pre-European Settlement Wetlands	Current Wetlands	Difference
Forested Wetlands	159,485 acres	15,436 acres	90% loss
Emergent Wetlands	1,578 acres	11,859 acres	6.5-fold increase
Scrub-Shrub Wetlands	16,084 acres	2,484 acres	85% loss
Open Water	14,676 acres	8,009 acres	55% loss
TOTAL	191,823 acres	37,788 acres	78% loss
Total vegetated only	177,147 acres	29,779 acres	81% loss

… Here we see
The details of the comparison

As I said, here's the bottom line
A greater percentage of the Sandusky watershed's acreage
was wetland prior to European settlement

And here's our
78% loss in wetlands overall,

That number includes open-water wetlands
If you look at just vegetated wetland
It's an 81% loss overall

This is
Unsurprising and to be expected
due to increases in agriculture and development

The primary loss of acreage was observed in forested wetlands,
And a similar loss in scrub-shrub wetlands.
Those wetlands were replaced by emergent wetlands
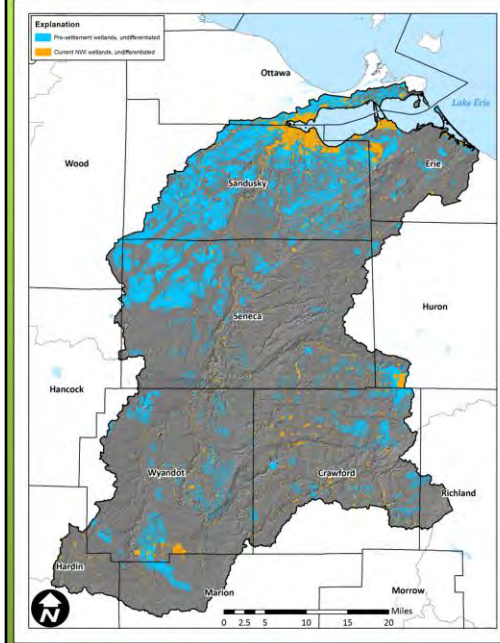
- So, to return to this pattern of distribution for historic wetlands across the watershed

- When we first ran it,
- we asked,
- do we believe this pattern?

- Is it a good starting point for our comparison?

- Note that
- There is a sharp line between historic wetlands in the north and sparse wetlands to south
- And we wanted to know what might cause these patches of wetlands in the south

- We wanted to validate the interpretation,
- so I looked to compare results to other physiographic data

- TO do that,
- I sought out information on the overarching physiographic provinces of Ohio

- Here is a figure from Ohio Division of Geologic Survey, published 1998

- **It shows the physiographic provinces of Ohio:**

- Physiography, of course,
- being the characteristic geomorphology or shape of landforms
- And those landforms often have
    - A specific subsurface rock type
    - OR are related to a specific geologic structure

Let's zoom in on our study area in this physiographic map…

… note these three colors here
  - Blue
  - Teal-green
  - Pale blue patches within teal
- And, also, note this dividing line between the blue and teal-green, just south of Sandusky Bay

The blue province here to the north and west of this line
  - Is the area where the ancient Lake Maumee from geologic pre-history was located

And the teal to the south of line
  - Is glacial till from the last glaciation

And, the blobs
  - are isolated ancient lake sediments
  - of a similar age to Lake Maumee
  - within the glacial till

This line is the Columbia Escarpment,
  - Marks the join of the western edge of Columbus and Delaware Limestones **here** and ancient Maumee Lake sediments

- When we take those boundaries…

Historic Wetlands

Physiography & wetlands

- Distribution pattern of historic wetlands in a physiographic context
- Reasonable agreement
- Appears to be a valid interpretation
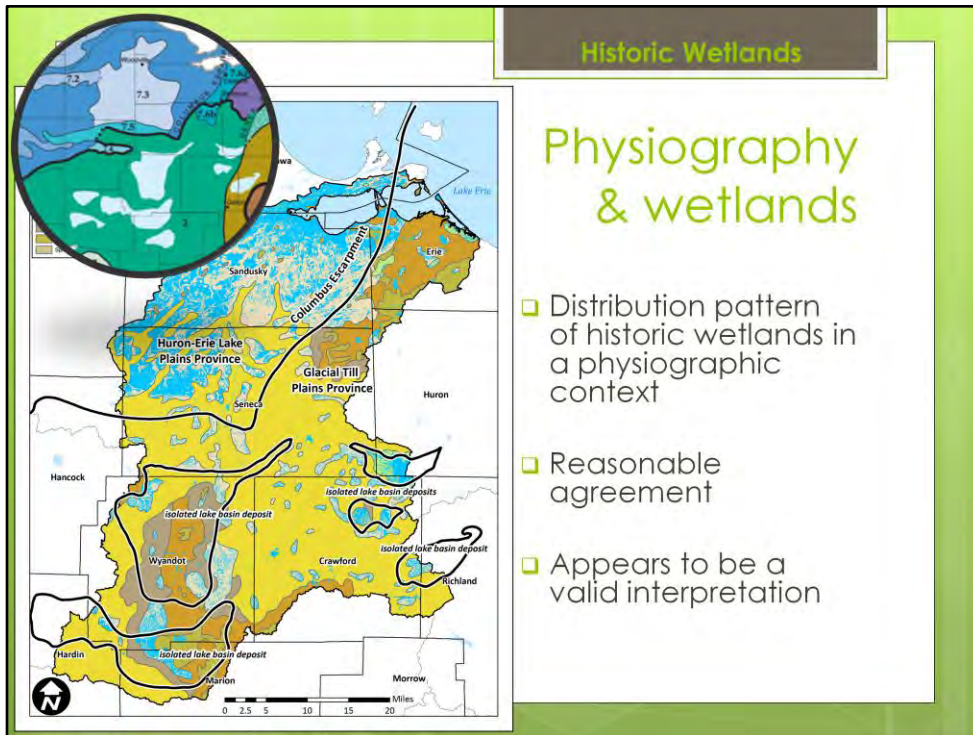
- …And superimpose them on our historic wetlands
- As well as the Pre-European settlement vegetation for reference

- We see that the northern cluster of wetlands is located within the ancient lake sediments
- Seems logical,
- that hydric soils from the bottom of lake
- in a lowland area
- would do a good job of supporting wetlands

- And, the rocky till to the south is not as likely to support wetlands
- Except for where there are isolated lake sediments
- Similar to those here in the north

- Not a perfect match to the location of isolated lake sediments
- From the physiographic map
- But, that map is a coarse representation
- And the agreement seems close enough

- Also, it makes sense
- That there are not as many wetlands
- HERE
- on the east
- in an area of limestone bedrock

- So, this appears to be
- a reasonable

Enhancing the FWS' NWI

How to rapidly and methodically assign **hydrogeomorphic** descriptors to the U.S. Fish and Wildlife Service's **National Wetlands Inventory** GIS data

- OKAY

- Now that we have our historic wetland database, let's talk about our current day wetland database

- I am going to show you the GIS steps necessary to arrive at a functional assessment of wetlands

- First before we get to the functional assessment
- We need to add additional information to these two datasets

- Remember, there were two steps under the GIS assessment of wetland functions
- One was Enhancing the National Wetlands Inventory
- And two was then Assigning and Mapping Wetland Functions

- So, first we will talk about enhancing the NWI

- By adding new, additional hydrogeomorphic descriptors
- And,
- we will perform the same steps
- To our historic wetlands database
- So that we can compare the two datasets

- TO THE LEFT
- Illustration of the FWS website where you can obtain NWI data

- Briefly, I want to provide you some framing
- and potential resources you can look into if you want more examples

- This method of enhancing the National Wetlands Inventory with hydrogeomorphic descriptors
- Has been around since the 90s, starting with RW TINER

- His original publications defined these hydrogeomorphic descriptors
- And, he has kept publishing and refining the technique
- Which is well-recognized and supported
- by the USGS and the Fish and Wildlife Service

- There are also currently
- multiple other groups
- working on methods to assign
- these additional wetland descriptors
- Using a GIS
- And, they are also performing it
- As a first step for assessing wetland functions in a watershed, too

- Some of those groups
- Are listed here…
- [READ OFF]

- For this study, we relied heavily on the MDEQ methods and approach
- And if you wanted to look at just one resource, their 2011 report is a good

What we mean

A system that provides information about - -
- where a wetland sits,
- such as along a river or stream or in a lake basin

- As well as
- How the wetland is connected to the hydrologic network
- And
- whether that wetland is isolated
- located in the middle of a stream network
- or
- is perhaps the headwater source of a stream

- These descriptors also identify
- whether a waterbody that is associated with the wetland
- is natural or constructed;
- And gives an idea of the scale of that waterbody.

We call this system "LLWW"

Landscape Position, **L**andform, **W**aterbody Type, and **W**ater Flow Path (LLWW)

This is an enhancement to the existing wetland classification system inherent to NWI

Enhancing the NWI

Assigning LLWW with a GIS

❑ Why use a GIS?

❑ Sorting, selecting, and coding wetlands is performed in the GIS, based on:

   ❑ Whether within or outside of other layers (e.g., Hydrography, DEM analyses, and soils)

   ❑ Possessing traits already assigned (e.g. NWI water regimes or acreage of wetland)

Let's talk about why we use a partially automated GIS screening methodology
Versus hand-screening the wetlands

Hand-screening:
- Loosely documented
- Multiple analysts
- Long time frame for a medium-to-large project

All lead to inconsistent decisions and irregularities

Partial automation with GIS:
- Implemented by a basic GIS operator
- Doesn't require extensive involvement of specially trained interpreters
- Reduces time burden

Here's the basic idea
of how the method of assigning the LLWW works in the GIS

Look to see if the wetland polygon - - the shape in the GIS that defines the position and size of the wetland
- Overlaps or doesn't overlap other data layers in the GIS, such as hydrography data, elevation, or soils

- And, we also define groupings of wetlands
- To be placed into different LLWW categories
- based on information that they already possess
- Such as the data already present in the NWI

L andform

Slope (SL)	Wetlands occurring on a slope of 5% or greater, as indicated by a slope raster generated from the OSIP 2.5-foot DEM	**35.66%** (3,566 of 10,000 records)
Island (IL)	A wetland completely surrounded by water, as indicated by the NHD Waterbody layer.	Less than 1 percent (36 of 10,000)
Fringe (FR)	Wetland occurs in the shallow water zone of a permanent waterbody. ***NWI water regimes F, G, and H**	27.13% (2,713 of 10,000)
Floodplain (FP)	**Wetland occurs on an active alluvial plain along a river and some streams, as defined through the use of FEMA floodplain data.**	**8.02%** (802 of 10,000 FP; 436 FPba, 366 FPfl)
Basin (BA)	Wetland occurs in a distinct depression. ***NWI water regimes C and E**	15.2% (1,520 of 10,000)
Flat (FL)	Wetland occurs on a nearly level landform. ***NWI water regimes A, B, and K.**	13.63% (1,363 of 10,000)

Landform -
This refers to the physical shape of wetland
OR the landscape
where the wetland is located

Here in the table we have the classes within Landform
You can see the groupings
and in the middle
we define each of those classes

On the right
are the results of assigning these
to the current day Sandusky wetlands from the NWI

Note that as we talk about parts of the LLWW
I am not going to go in depth about
all of the CLASSES within each DESCRIPTOR

For Landform, I do want to point out

- SLOPE
- and
- FLOODPLAIN

- Which I will show examples of their processing in the GIS

Cowardin codes are a classification system

That describes the wetland habitat

They are built into the NWI GIS data

However, they are lumped into one single string of characters

For instance, this one, "L2UBGx" which translates to a wetland that is **[read frame from slide]**

We need some of that information
for instance that WATER REGIME
This "G"
As one of the criteria for **LANDFORM**,
As you saw from the previous table
[FLIP BACK TO PREVIOUS SLIDE, SHOW NWI CRITERIA]

We want to split this information apart
into separate fields
To easily use in the GIS
So that we don't need complex logical arguments
to sort and query the data from the NWI in the GIS

To do that, we created a relatively simple, straightforward script
Using the PYTHON language in the GIS

Slope – part of **L**andform
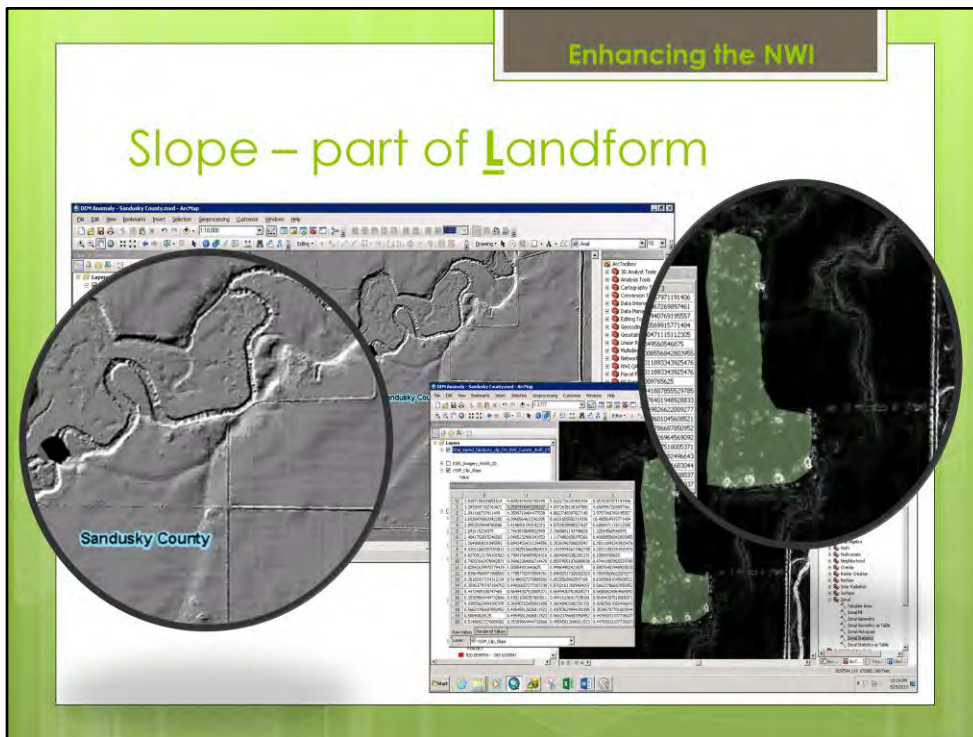
…Here are some screen captures and zooms of work within the GIS

On the left, we have a Digital Elevation Model - - a DEM - -
from the Ohio Statewide Imagery Project, which was a data source for us
We are seeing the bends of a river and floodplain
Note the roads and their width, which gives you a sense of scale

We used that DEM to make a high-resolution percent slope grid
Which is what you see on the right

Basically, in the GIS you examine each pixel in the DEM data
in comparison to other pixels near it
and calculate the change
From that calculation you assign a slope to a pixel
We call that new information a **SLOPE RASTER**,
and you can see it
HERE ON THE RIGHT

Note, that this is not the same area as the DEM on the left, it's just an example area
And, you can see roads and their width for scale
The bright-white colors are areas of higher slope,
and the black areas are lower slope

So, we use the slope raster
And assigned the average percent slope value
across each wetland polygon
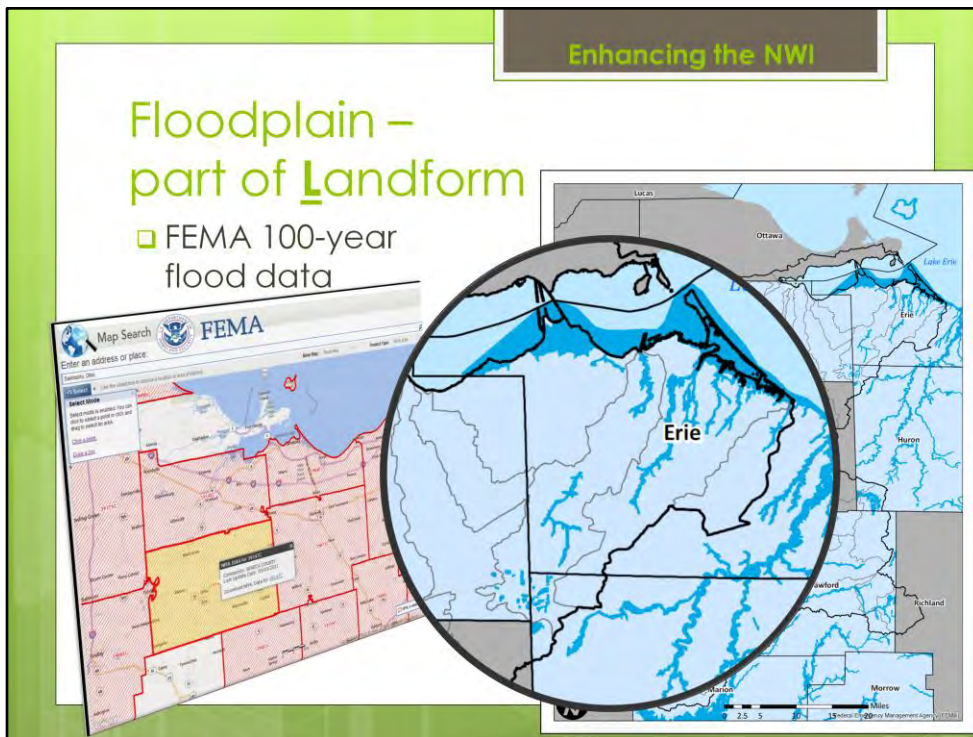
Let's look at one more class example
from the LANDFORM descriptor category

And
That is the FLOODPLAIN class

This one is quite simple
But it is facilitated by using the GIS

TO perform it
You look for the coincidence of wetlands
within the FEMA-designated 100-year floodplain areas
Which are easily obtained from the FEMA website
Screenshot of that to the LEFT

To the RIGHT I have a map from the GIS
And the darker blue areas
[POINT]
are regions that are classified as 100-year flood zones
Wetlands that fall within those areas
Are grouped into
the Floodplain class of the Landform descriptor

SO,
that's only two of the CLASSES within the LANDFORM descriptor

Landscape Position

Lentic (LE)	Wetland in or along lake (waterbody >= 5 acres) or within basin, defined as area contiguous to lake affected by rising lake levels. Contiguous area of effect found through Arc Hydro GIS analysis. *This landscape position type should be analyzed and assigned first.*	5.54% (554/10,000)
Lotic River (LR)	Wetland associated with (directly intersected by) a river or its active floodplain.	7.89% (789/10,000)
Lotic Stream (LS)	Wetland is associated with (directly intersected by) a stream or its active floodplain.	13.97% (1,397/10,000)
Terrene (TE)	Wetland that is: 1. Located in or borders pond, or wetland is a pond, (waterbody < 5 acres in size surrounded by upland); 2. Or, adjacent to but is not affected by a stream or river (located in or along, but NOT periodically flooded stream); 3. Or, completely surrounded by upland (non-hydric soils).	72.60% (7,260/10,000, of which 191, 1.91%, are headwater wetlands)

Here are the criteria for the Landscape Position descriptor

Landscape Position
Very simply defined,
Is the relationship between a wetland and nearby waterbodies

Again, we are not going to go into great detail
For each class within the Landscape Position descriptor

However, I will point out that the **Lentic** class is best performed in the GIS using DEM data
Which allows you to determine the actual drainage basins of lakes
and that waterbody's area of influence for wetlands
Those details and steps are provided in the larger report

As well, using a GIS is critical for determining the location of isolated **Terrene** wetlands
And, within the Terrene wetlands class
Is a very important subclass of Terrene wetlands,
called **headwater wetlands**
Headwater wetlands are an important source for streams and rivers
And, the GIS is useful to quickly sort for them

Instead of describing and discussing each Landscape class in detail…
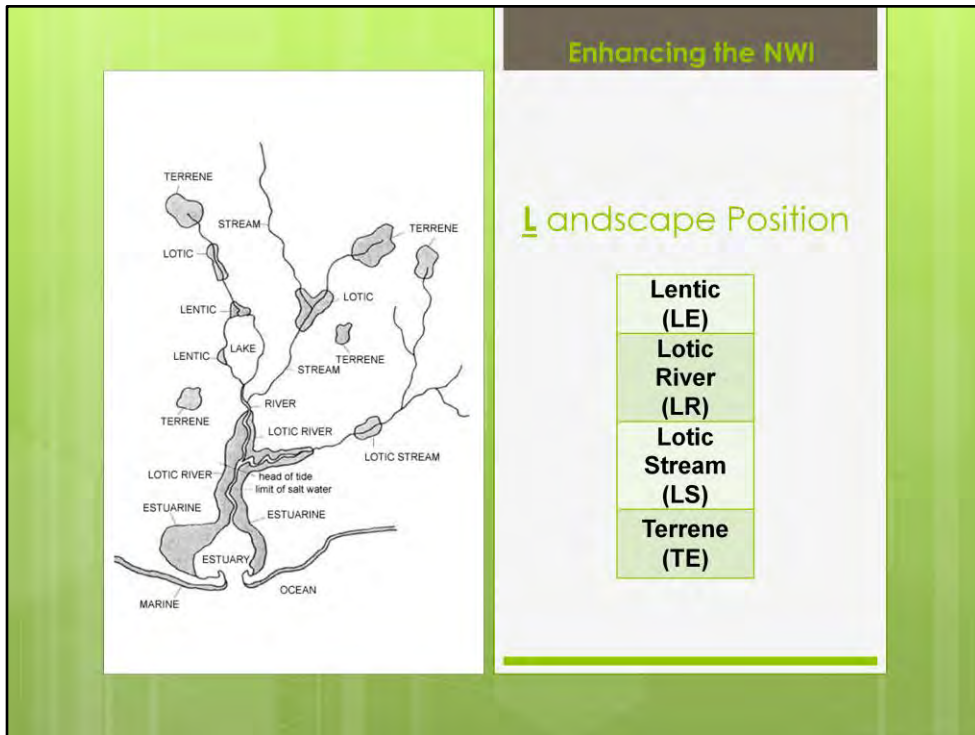
…Here is an illustration of how they are defined

This visualization helps to show the type of spatial relationships
That a GIS can quickly help find

You can see that
The Lotic River and Lotic Stream classes,
Are relatively straightforward,
An intersection of hydrography layers in the GIS,
Which is found quickly

Lentic, as I mentioned,
has a few more criteria that should be looked at in the GIS
In order to make sure that wetlands near lakes - -
- - but not directly on them - -
Are correctly assigned

And, Terrene wetlands,
which are seen HERE

These isolated wetlands ,
can also be repidly identified in the GIS

We can also see several **Terrene headwater** wetlands
HERE that are stream sources
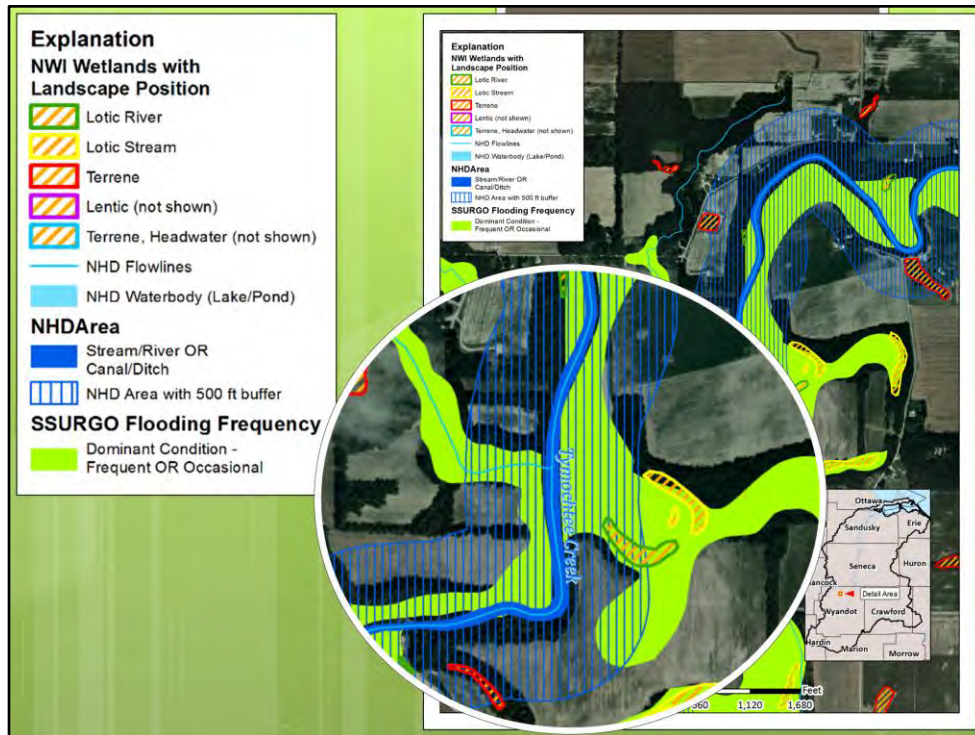
…**This**, which is a visual representation
of putting everything together **for Landscape Position descriptor**

Several things going on here, let's pick out a few

First
Lotic River and Lotic Stream
[ZOOMED IN SECTION]
[HERE IS A LOTIC RIVER]
Outlined in green
[HERE IS A LOTIC STREAM]
Outlined in yellow

This illustrates not just how direct intersection of the hydrographic lines
[LIKE THESE LIGHT BLUE FLOWLINES]
But also the proximity of a wetland to BUFFERS
[THESE BLUE HATCHED AREAS]
That we defined
Were used to identify Landscape Position classes

This 500 foot buffer
Is meant to represent the influence that a river would have
Beyond it's immediate linear representation in the GIS

To constrain that buffer some
so as not to blindly assign any wetland within the buffer as LOTIC RIVER

Water Flow Path — Enhancing the NWI

Class	Description	Percent
Outflow (OU)	Water flows out of the wetland naturally, but does not flow into this wetland from another source.	Less than 1 percent (75/10,000)
Outflow Intermittent (OI)	Water flows out of the wetland intermittently, but does not flow into this wetland from another source.	Less than 1 percent (63/10,000)
Outflow Artificial (OA)	Water flows out of the wetland, in a channel that was manipulated or artificially created.	Less than 1 percent (53/10,000)
Bidirectional (BI)	Wetland along a lake and not along a river or stream entering this type of waterbody; its water levels are subjected to the rise and fall of the lake levels. Lentic wetlands with no streams intersecting them.	3.48% (348/10,000)
Throughflow (TH)	Water flows through the wetland, often coming from upstream sources (typically wetlands along rivers and streams). Lentic wetlands with streams running through them are classified as throughflow (or throughflow intermittent, if stream is classed as intermittent).	19.15% (1,915/10,000)
Throughflow Intermittent (TI)	Water flows through the wetland intermittently, often coming from upstream sources (typically wetlands along streams).	11.02% (1,102/10,000)
Throughflow Artificial (TA)	Water flows through the wetland, in a channel that was manipulated or artificially created.	1.16% (116/10,000)
Isolated (IS)	Wetland is typically surrounded by upland (nonhydric soil); receives precipitation and runoff from adjacent areas with no apparent outflow.	63.85% (6,385/10,000)

Here we have the criteria
for waterflow path

Waterflow path –
is a way of coding the type of water associated with a wetland
AND
the flow direction

This looks like a lot of criteria, however…

In order to help you to see,
I've highlighted the

4 main classes,
Which each have some additional modifiers

Those four types, broadly, are

Outflow
Bidirectional
Throughflow
and, Isolated

Outflow and Throughflow
Get additional modifiers
for
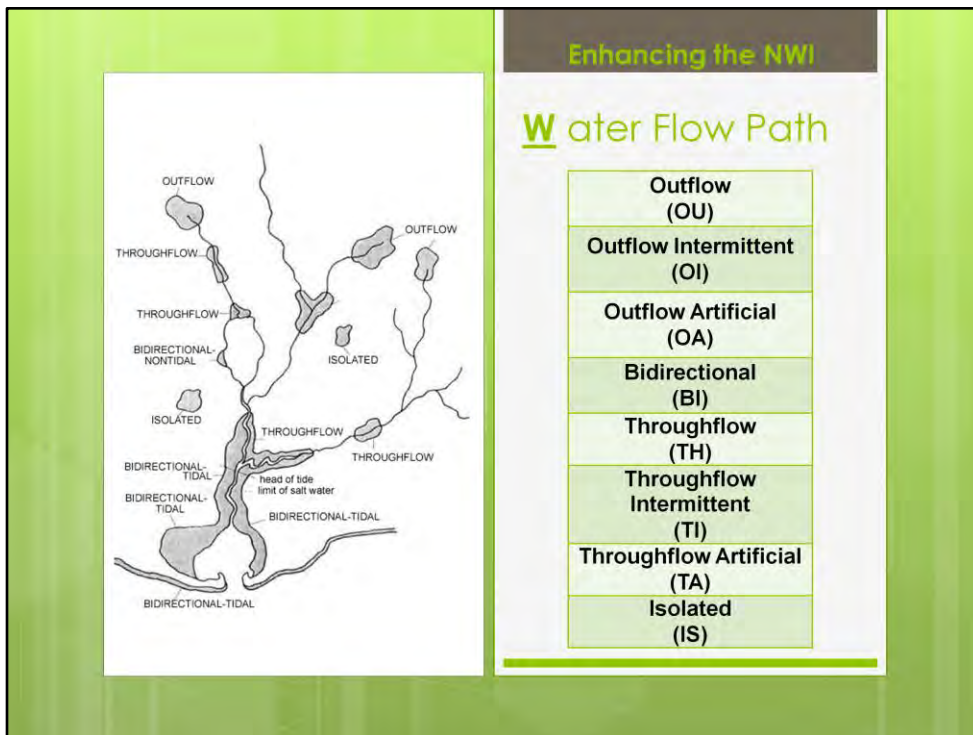
Again, the general approach for classifying this descriptor

Is best show in an illustration

Here, you can see we are finding intersections
between flowlines and wetlands

Outflow, where streams issue from a wetland
And, the Intermittent and Artificial types are what they sound like

Bidirectional, these are near waterbodies that fluctuate in water level

Throughflow, just what it sounds like, streams and rivers that move through the wetland
Again, the modifiers of
Intermittent and Artificial are what they sound like

lastly **Isolated,** wetlands which are not directly connected to the hydrologic network

To perform this analysis in the GIS, our primary dataset is…
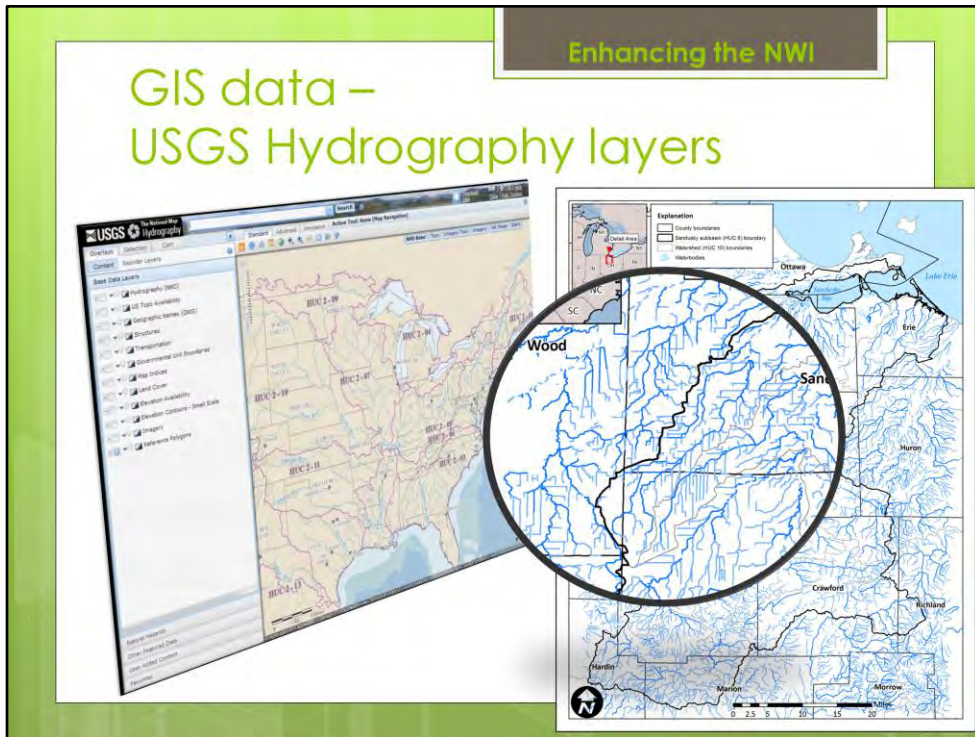
...The USGS National Hydrography Database (NHD)

Or "flow lines" as they are sometimes called

Database has coding within it for types of waterways

Such as
If a stream or river is Perennial or Intermittent

OR if a waterway is
A Pipe, a Canal, or a Ditch
- - artificial

Not as simple as just **intersections**, though

**Need to account for groundwater influence,
Which TINER specified in his original LLWW definitions**

- **Wetlands assigned**
- **to the Throughflow** water flow path are defined by - -
- - Receiving either surface
OR
- - ground water from a stream, other waterbody, or another wetland at a higher elevation;
- - And, that the surface or ground water passes **through** that wetland
- - and on to another stream or waterbody.
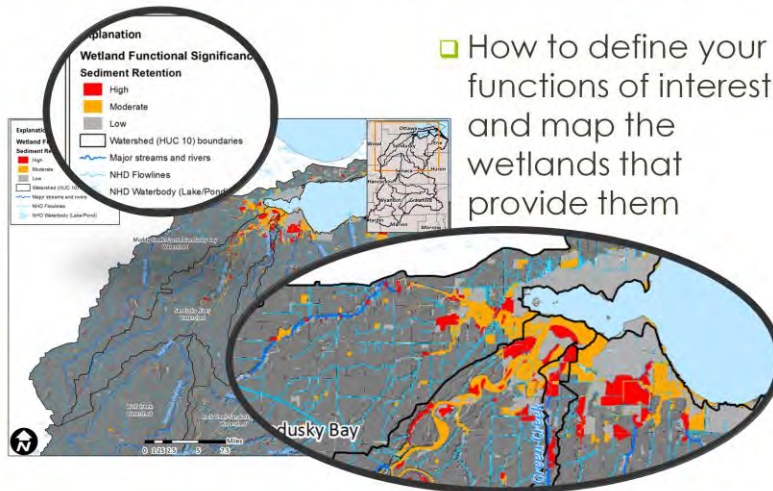
- Okay, moving onto the next part of our GIS analysis

- Now that we understand the general process by which LLWW descriptors are added to the wetlands

- We can discuss how to map wetland functions
- using those newly assigned LLWW descriptors,
- In combination with
- Again, information already in the NWI,
- and as well
- drawing in and using other GIS data

- I will talk about the GIS methods we used

- But first, lets briefly review **what a wetland function is**

- And,
- let's take a look at the list of wetland functions
- That we selected for this analysis…

- Here on the left are the specific wetland functions
- that we used

- And, on the right is a simple, succinct definition of what we mean by a **"wetland function"**

- **Many of you are already familiar with this concept, but just to ensure we are all on the same page**

- **We are talking about processes - - natural, physical, or biological - - that a wetland provides**

- Sometimes these are referred to as "ecosystems services"

- These functions can be a core feature of the wetland that sustain it, or might be incidental

- We talk and use the term function in this analysis
- By saying that a wetland has a **"high, medium, or low functional significance"**

Some examples of that in conversation would be :

a High functional significance for nutrient transformation

OR

a Low functional significance for sediment retention

Defining *significance* of a wetland function

- Significance is a __relative__ measure - - comparison of wetlands to each other

- Meant to classify and rank wetlands for ability to perform natural processes

- "High" "Moderate" and "Low" - - used without any social/regulatory value or quantitative limits

- "**High**" simply means "**performing process at better/higher rate than other wetlands in area**"

Wetland Functions

- The significance of a wetland function

- So, if I say - -

a low functional significance for fish habitat

Or,

a high functional significance for floodwater storage

- That term **significance**

- Simply refers to the **ABILITY and LEVEL** of that natural process to occur
- in comparison to other wetlands

It's that **"in comparison"** part that we need to emphasize

Significance is a **relative measure**

We are describing levels of a function that one group of wetlands has in comparison to another.

We use the terms "high," "moderate," and "low" to talk about those levels

Those terms used without regard to the perceived human value of any wetland function or its benefit to a watershed.
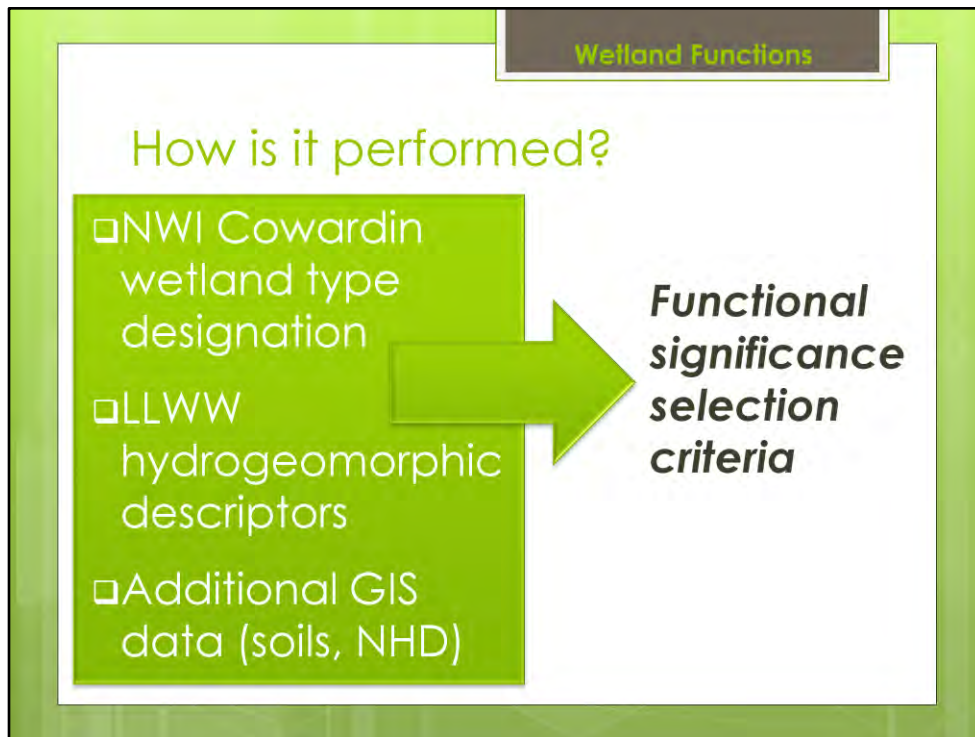
- So, how do we define those wetland functions we saw in the list, like nutrient removal

- A wetland function in this analysis is a combination of

- Our new LANDSCAPE and WATER data added in the form of the LLWW descriptors

- …PLUS the NWI's original VEGETATION and WETLAND TYPE data…

- …Plus, adding in additional data layers in the GIS, such as
    - the USGS' NHD
    - And Soils data

- We combine the presence or absence of those traits and features
- into categories to represent functional levels

- For instance, as the analyst, you decide which combination of traits from those categories equals a "high" "medium" or "low"

- Those combinations are determined by the needs and requirements of regulators and watershed planners.

- And, as well as working from previous examples

- Here, we relied on the Michigan Department of Environmental Quality's (MDEQ's) definitions

Functional Significance	Selection Criteria	Results	
		NWI	Historic
High	• Wetlands along streams and rivers • Island wetlands • Ponds that are throughflow, throughflow intermittent, bidirectional, and isolated and that are = or > 0.59 acres	31.76% (13,175 of 41,489 acres)	21.48% (41,338 of 192,451 acres)
Moderate	• All of the above in the High category that are < 0.59 acres • Terrene basin isolated • Terrene & outflow or outflow intermittent wetlands • Other ponds and terrene wetlands associated with ponds connected to hydrography network • Terrene wetlands that are associated with ponds • All lake-side wetlands not already ranked high	40.16% (16,661 of 41,489 acres)	64.09% (123,350 of 192,451 acres)
Low	• All remaining wetlands	28.09% (11,653 of 41,489 acres)	14.43% (27,763 of 192,451 acres)

Floodwater Results

- Floodwater storage is the ability of a wetland to **detain** or **delay** the effects of flooding

- In this table, we can see the criteria selected for the Floodwater Storage function
- As well as results for both the historic and current day NWI wetlands, on the right

- In general, this function depends primarily on the size of the wetland as one of its selection criteria

- With the presumption that a larger wetland would have greater floodwater storage capacity

- For a size criteria, we decided on a threshold value of .59 acres

- This is based on looking at the entire size population of wetlands in the Sandusky watershed

- And finding the median value of wetland size, which was .59 acres

- Looking at additional criteria
- naturally, those wetlands along streams and rivers, or that are ponds,
- are also highly rated for the floodwater function

- You can see the new LLWW descriptors we added, such as "throughflow" or "terrene"
- Which are mentioned in the selection criteria
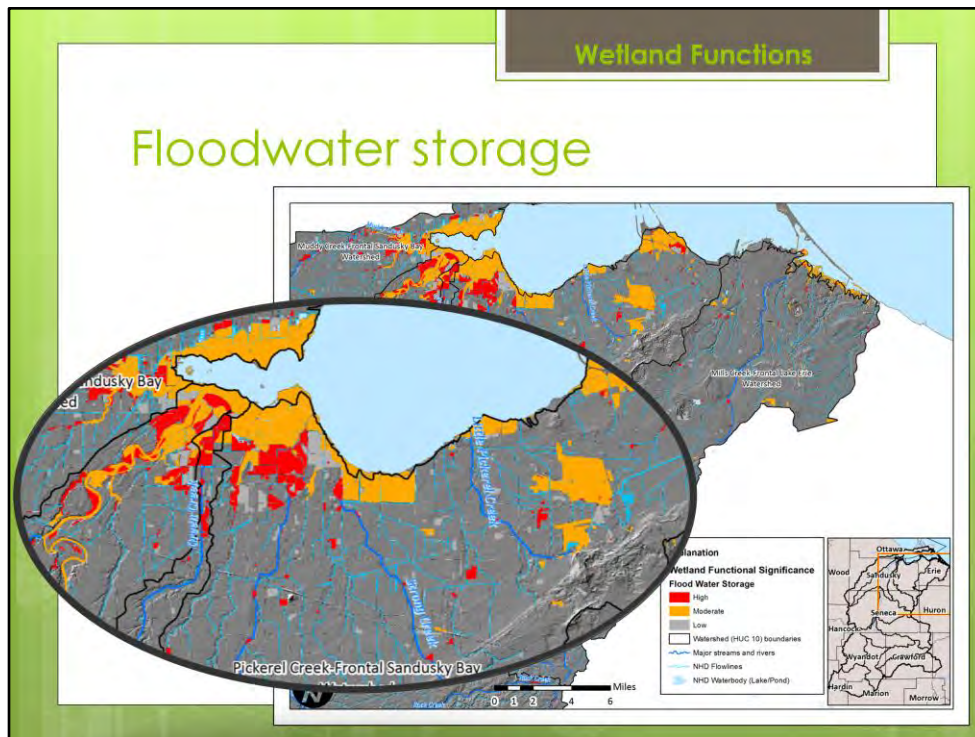
- Here I am showing a map of the northern part of the Sandusky watershed

- For current-day wetlands

- This follows the standard color themes
- that other researchers have used for wetland functions,

- red is a "high" functional significance
- And, orange and grey are the "moderate" and "low" functional significance ratings, respectively

- We will take a look at some historic wetland results shortly

- But next, another function from the analysis
- That I have chosen to share with you today
- And that is **nutrient transformation**

Functional Significance	Selection Criteria	Results	
		NWI	Historic
High	Vegetated wetlands from NWI P_ (AB, EM, SS, FO, and mixes) with water regime C, E, F, H, G. No open water types – with SSURGO Flood Frequency of "Frequent" or "Occasional"	**10.13%** (4,205 of 41,489 acres)	**25.37%** (48,827 of 192,451 acres)
Moderate	• Vegetated wetlands from NWI P_ (AB, EM, SS, FO, and mixes) with water regime C, E, F, H, G. No open water types – with SSURGO Flood Frequency of "Rare" or "None" ("Very Rare" not found in this data set) • Seasonally Saturated and Temporarily Flooded Vegetated Wetlands from NWI P_ (AB, EM, SS, FO, and mixes) with A, B water regime <u>or</u> lacustrine vegetated wetlands (no open water) – with SSURGO Flood Frequency of "Frequent" or "Occasional"	**32.11%** (13,323 of 41,489 acres)	**62.01%** (119,339 of 192,451 acres)
Low	• All remaining wetlands	**57.75%** (23,961 of 41,489 acres)	**12.62%** (24,284 of 192,451 acres)

- Nutrient transformation is the **ability of a wetland to perform nutrient uptake or removal**

- And, for our purposes here's a general description of the two ways nutrients can be transformed

    - **ONE,** fluctuation of water table,
    - which increases - -
        - precipitation of minerals
        - And the deposition of suspended particulates, and the nutrients attached to those particulates
        - Also, wetting and drying from water table fluctuation
            - increases the probability of successful completion
            - of the denitrification process
            - Which removes dissolved nitrogen from water

    - **SECOND,** uptake and usage of nutrients by wetland vegetation

- **SO**
- In our criteria, we rate highly
- The vegetated wetlands
- And
- The wetlands with frequent water level fluctuations

- The analysis results for both
- the NWI wetlands and the Historic wetlands are provided on the right

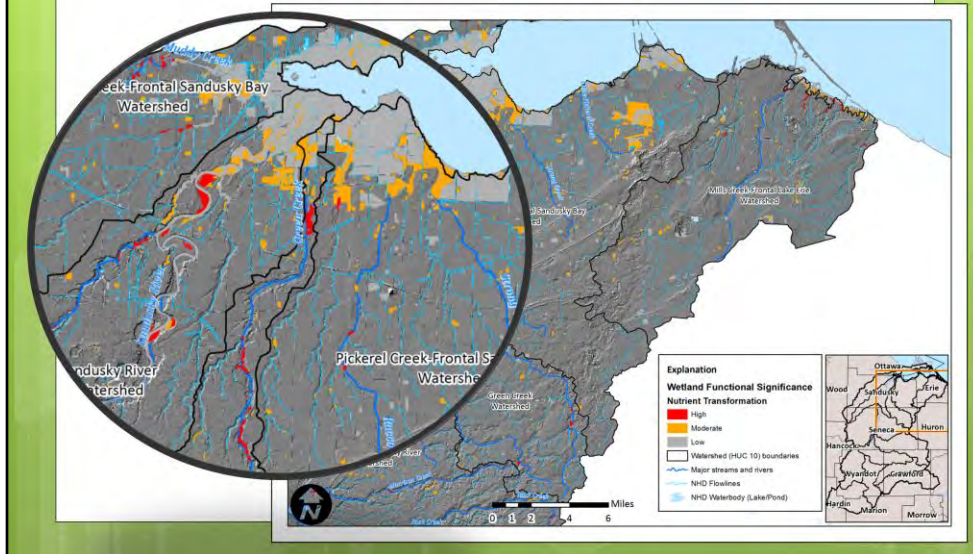- Again, I am showing a map of the northern part of the Sandusky watershed

- For current-day wetlands

- Once more, the standard color theme that other researchers have used
- with red as a "high" functional significance
- And, orange and grey as the "moderate" and "low" ratings

- We will take a look at some historic wetland results in a minute

- But first, let's examine how we can take the results of all eleven **(11)** of these functions

- and combine them into a meaningful composite score

Wetland Functions

Total composite scores

- Gives us a way to quickly compare wetlands to each other

- Assign a score of –
  - three (3) to **High**
  - two (2) to **Moderate**
  - And one (1) to **Low**
- **Maximum of 33**
- **Minimum of 11**

High
Moderate
Low

- Here's what I mean
- by combining functional significance results into a **"composite score"**

- A "total score" for a wetland offers us a way to rank wetlands overall to each other

- The idea is simple

  - Assign a score of one **(1)** to low, two **(2)** to moderate, and three **(3)** to high functional significance rankings

  - Sum up all of those functional criteria for a wetland, and you have **composite score** for that wetland

  - A bottom composite score of eleven **(11)** and a top score of thirty-three **(33)** is possible

- Now
- quite quickly you can compare the wetlands to each other and see the highest functioning wetlands across all categories

- Let's take a look at some of that raw composite score data, and then some maps

Wetland Functions

Composite scores

| FloodW_Sto	Nutr_Tra	Sed_Ret	SFlow_Mai	Shore_Stab	Fish_Hab	Stream_Sha	WaterBird	ShoreBird	FoBird_Hab	Amphib_Hab	TOTAL Composite Score
High	Low	High	Low	High	Moderate	Moderate	Low	Moderate	High	Low	22
Low	Moderate	Low	Moderate	Low	Low	Low	Moderate	Moderate	High	Low	17
Low	Moderate	Moderate	Low	Low	Low	Low	Moderate	Moderate	High	Low	17
High	Moderate	Low	Low	High	High	Low	Moderate	Moderate	High	Low	22
High	Moderate	High	Moderate	High	High	Low	Moderate	Moderate	High	High	27
High	High	High	Moderate	High	High	Low	Moderate	Moderate	High	High	28
Low	Moderate	Low	Low	Low	Low	Low	Moderate	Moderate	High	Low	16
High	Moderate	Low	High	Low	Moderate	High	Moderate	Moderate	High	Low	23
High	Low	Moderate	Moderate	Moderate	High	Low	Low	Low	Low	Moderate	19
High	Low	Moderate	Low	Low	High	Low	Low	Low	Low	Low	16
Low	Moderate	Moderate	Low	Low	Low	Low	Moderate	Moderate	High	Low	17
Low	Moderate	Moderate	Low	Low	Low	Low	Moderate	Moderate	High	Low	17
High	Low	High	Moderate	Low	Low	Low	Low	Low	Low	Low	16
Moderate	Low	Low	Low	Low	High	Low	Low	Low	Low	High	16
High	High	Low	Low	High	High	Low	Moderate	Moderate	High	Low	23
High	High	High	Moderate	High	High	Low	High	Moderate	High	High	29
High	Low	Low	Low	High	Low	Low	Low	Low	Low	Moderate	16
High	High	Low	Low	High	High	Low	Moderate	Moderate	High	Low	23
High	High	Low	Low	High	High	Low	High	Moderate	Low	Low	22
High	High	Low	Low	High	High	Low	High	Moderate	High	Low	24
High	High	Low	Low	High	High	Low	High	Moderate	High	Low	24
High	High	Low	Low	High	High	Low	High	Moderate	High	Low	24
High	Low	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	14
High	High	Low	Low	High	High	Low	High	Moderate	High	Low	24
High	Moderate	Low	Low	High	High	Low	High	Moderate	Low	Low	19
High	High	Low	Low	High	High	Low	Moderate	Moderate	High	Low	23
High	Low	Moderate	Moderate	Moderate	High	Low	Low	Low	Low	Moderate	19
Moderate	Low	High	Moderate	Low	Low	Low	Low	Low	Low	Low	15
Low	Moderate	Moderate	Low	Low	Low	Low	High	Moderate	Low	High	18
Low	Low	Low	Low	Low	Low	Low	Low	Moderate	Low	Low	12
High	High	Moderate	Low	High	High	Low	High	Moderate	Low	Moderate	24
High	High	Low	Low	High	Low	Low	Moderate	Moderate	High	Low	21
High	High	Moderate	Low	High	High	Low	Moderate	Moderate	High	Moderate	25
High	High	High	Moderate	High	High	Low	High	Moderate	High	High	29

- Not trying to make you blind, I promise

- This is just an example of the raw data for current-day wetlands

- Straight out of the GIS, exported from the system's database after analysis

- Each line of data represents a wetland polygon

- Note the top header row
- Which contains the names of our functions

- And
- It's cut off, but out to the left there are a few dozen more columns
    - With identifiers for each wetland
    - As well as LLWW descriptors
    - NWI Cowardin codes
    - And other GIS data fields

- So, let's just look at a few composite score examples
    - Very bottom green box highlights a wetland with a composite score of twelve (12), so LOW in all categories except one
    - And, the top green box highlights a wetland with a score of twenty-nine (29),
        - That's only four away from the maximum,
        - That wetland scored HIGH in eight of the eleven categories
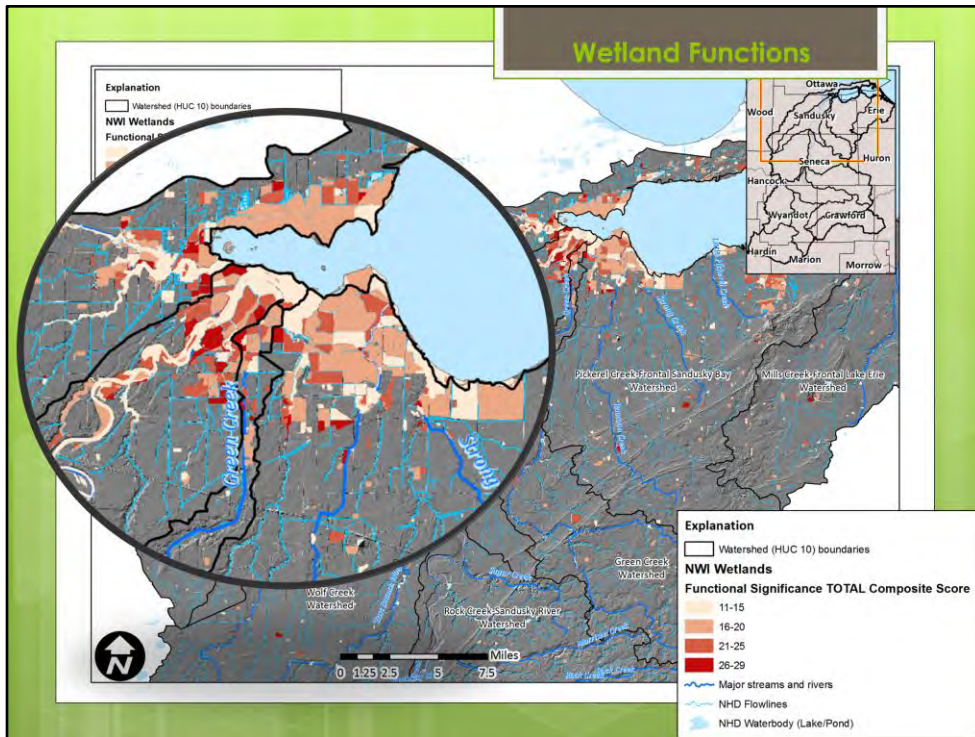
Focusing on northern Sandusky watershed

These darker wetlands compared to the lighter shaded ones - -
- - are performing at a higher level of functional significance
- - for a greater number of criteria

Note that the upper limit is 29
- - There were no wetlands that scored above 29 throughout the watershed
- - In both current day AND historic wetlands, interestingly
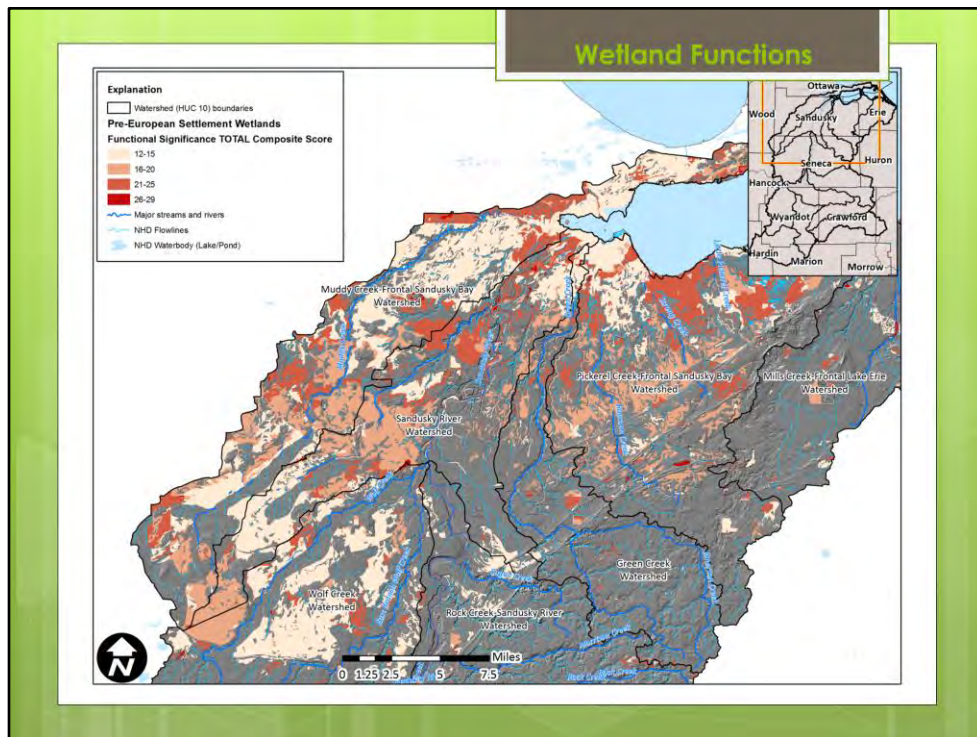
Here's some of the historic wetland data I promised you

Additional individual functional significance results for the historic wetlands can be found in the report

Broadly, though, overall

The comparison of historic to modern
Unsurprisingly shows
That there was a loss of more highly functioning wetlands

There are fewer wetlands
And what wetlands there are
Are rated lower for functional significance
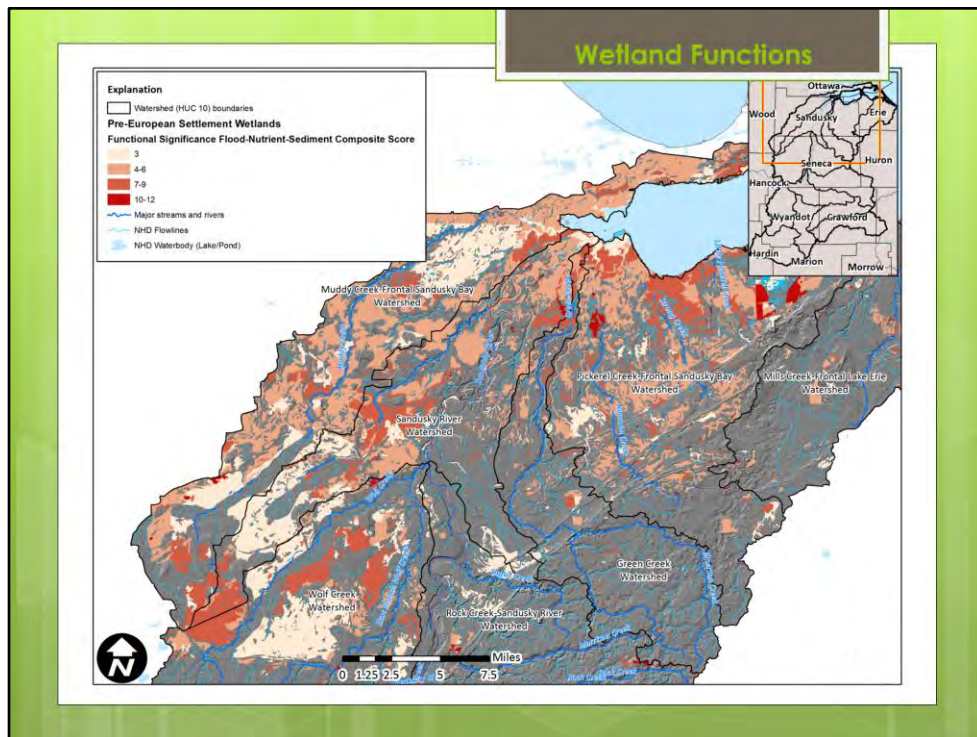as compared to the historic wetlands.

OKAY, so
There's a problem with this composite scoring approach, though

As some of you might already be thinking

Some of these functional criteria are mutually exclusive

And, by combining them,
we are canceling out our efforts to rank them

So, to try and focus in
only on functions that compliment each other

We selected several functions
that when combined
can tell us something more focused
about wetlands in the watershed

Here, we've selected **floodwater storage-nutrient reduction-and sediment retention**

And, we're looking at historical wetlands here

For a new composite score - - note the maximum score of 12
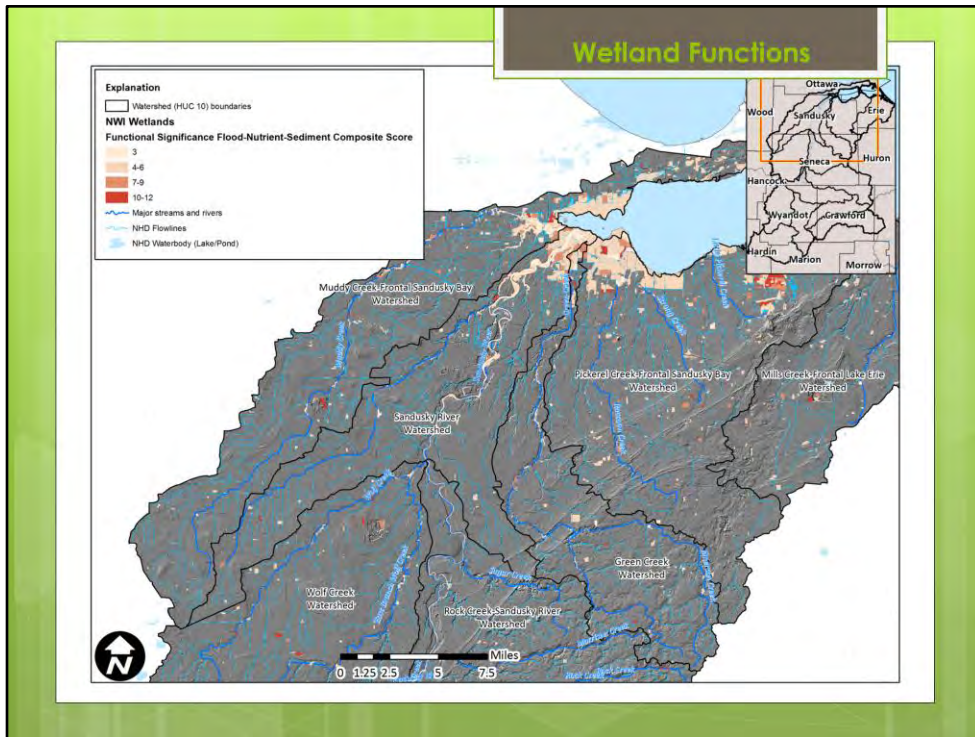
In comparison, here's that same composite sub-score, but for current day wetlands

So, when we look back and forth between these two points in time

[Flip back and forth between two slides]

**What can we say we that have we learned
about our management opportunities and restoration targets in this watershed?**

Here's a conclusion that we can take from this…

Wetland Functions

Historic versus current wetlands – the takeaway

Ideal targets for wetland management in the Sandusky watershed –

- ❑ Wetland types
  - ❑ Vegetated palustrine and lacustrine
  - ❑ Non-open water

- ❑ Located
  - ❑ In lowlands
  - ❑ In geologic pre-history lake sediments

- ❑ Flood occasionally or frequently

…In general,
when we sum the scores
and observe what wetland types and locations have higher composite scores
we can conclude that

The ideal targets for management are:

- vegetated palustrine and lacustrine,
- non-open-water wetlands
- Located in the ancient lake sediments of the lowlands
- and
- That flood occasionally or frequently

These types of wetlands are the ones with the highest functional significance scores
And, as well,
the lowland areas offer the highest density of potential locations for the creation of new wetlands

Those are our ideal candidates for preservation, restoration, and creation
And can offer the most benefit to
Water quality, quantity, and the potential for nutrient reduction, too
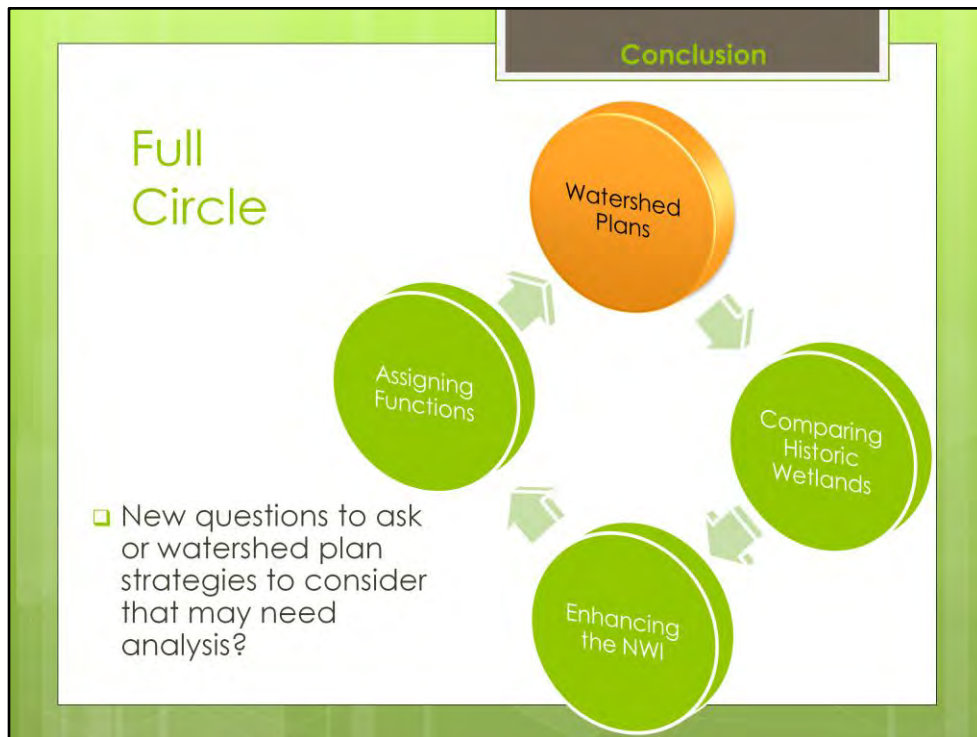
- Turn it back over to Santina to wrap up

- Santina: thanks James, you did a great job explaining the methods and results. To review then, the steps we performed were to develop the historic wetlands layer, enhance NWI with hydrogeomorphic descriptors and then evaluate the wetland functions.

- Full circle would be taking this assessment

- …and bringing it back into the watershed plan (which we hope to do)

•This assessment gives us a good understanding and ability to quantify what has been lost in terms of specific wetland functions
•Further analysis could be done to examine the trends in more detail and to examine the results by subwatershed
•the case studies of the supplement describe how to take results from this assessment and build into a model to rank wetlands in order to further prioritize where to restore
•An implementation plan to restore the sandusky is currently being developed and EPA intends to incorporate results of this study in that plan
•Some ways it could be incorporated are to aid in identification of critical areas and management measures to reduce nutrients
•In addition, there is a lot of work underway in the lake erie basin under the great lakes water quality agreement, a binational agreement between the US and Canada signed in 2012. One of the commitments under the agreement is to develop P target loads for Lake Erie and a strategy to achieve the necessary reductions by 2018. The results of this analysis could inform the development of this strategy.

Finally, we're interested in opportunities to restore and enhance wetlands along with other practices to better manage drainage as a means of supporting the more direct nutrient control practices being implemented/promoted in these watersheds. Implementing suites of practices to control nutrients together as a system for greater impact to water quality. So as the results of the other projects are aviable we will Need to integrate them and synthesize that information.

Ultimately we hope to better target our outreach efforts and implementation to accelerate the restoration of the great lakes.

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Final report will be available next week. GIS Methods are described in detail for those who would want to replicate in another watershed.
EPA is also glad to share the supporting GIS data and results – email Santina

Acknowledgements

- ❑ Kerryann Weaver
- ❑ Andrea Bolks
- ❑ Tom Davenport
- ❑ Chad Fizzell

Questions?