September 4, 2015

To: Water Quality Goal Implementation Team
From: *On behalf of Wetlands Workgroup—*
Amy Jacobs, TNC, Co-Chair
Erin McLaughlin, MD DNR, Co-Chair
On behalf of the Wetlands Expert Panel—
Pam Mason, VIMS, Panel Co-Chair
Ralph Spagnolo, EPA Region 3, Co-Chair
Jeremy Hanson, Virginia Tech, Coordinator
Re: Wetlands Land Use Classification for Phase 6.0 Watershed Model

Summary of recommended land uses and relative loading targets

The proposed land uses and relative loading rates for nontidal wetlands in the Phase 6.0 Watershed Model are summarized in Table 1 below. It is the understanding of the panel that the Modeling Workgroup plans to transition tidal wetlands to the estuarine water quality model due to their continuous interactions with the tidal water column, and therefore a tidal wetlands land use and loading rate is not needed for the Phase 6 Watershed Model.[1, 2]

Table 1. Recommended land use classes and relative loading rates for nontidal wetlands in the Phase 6 Watershed Model

Proposed wetland land uses for Phase 6 Watershed Model	*Relative Loading Rate (TN)*	*Relative Loading Rate (TP)*	*Relative Loading Rate (Sediment)*
Floodplain Wetland	100% Forest	100% Forest	100% Forest
Other Wetland (non-floodplain)	100% Forest	100% Forest	100% Forest

Background

The Wetland Expert Panel was charged to recommend new land uses and evaluate nutrient and sediment reductions associated with wetland BMPs (the existing restoration BMP, and new BMPs for wetland enhancement and wetland creation), for incorporation into the Phase 6 Chesapeake Bay Watershed Model (CBWM). The panel seeks to address concerns and recommendations that have been expressed about the lack of wetlands as an explicit set of land use classifications, as well as the limited availability of CBP-approved wetlands BMPs.

The Wetlands Expert Panel convened in Fall 2014 following approval of its charge and membership by the Wetlands Workgroup. A transition in panel coordination from The Center for Watershed Protection (CWP) to Virginia Tech resulted in delaying the panel's work from approximately February until May 2015 when Virginia Tech reconvened the panel.

---

[1] The panel will work with the modeling team to determine how to apply and credit tidal wetland BMPs in the next version of the partnership modeling tools, but that issue is outside the scope of this current memo and will be addressed in the panel's subsequent full BMP report. However, it is likely that the reporting and crediting of tidal wetland BMPs would function similar to the recently approved Shoreline Management BMP, which reduces shoreline erosion loads that are part of the sediment transport model and not the Watershed Model.
[2] Some members of the panel may provide input to the CBPO modeling team as they build tidal wetlands into the next version of the modeling tools, but that effort falls under the purview of the Modeling Workgroup and CBPO modeling team, not the expert panel.

Subsequently, two panel Co-Chairs were selected and the panel worked to provide recommended land uses for the initial October 2015 Chesapeake Bay Watershed Model (CBWM) calibration. The panel's initial recommendations were amended based on input and a conference call held with the Wetlands Workgroup on August 28th.

The panel and workgroup arrived at a set of recommended land uses and relative loading rates for natural existing wetlands described in this memorandum. These recommendations only apply to land uses that will represent these natural nontidal wetlands within the Phase 6 CBWM, and do not represent recommended efficiencies or reductions associated with any wetland best management practices (BMPs) such as restoration, creation or enhancement. While these BMPs are a part of the panel's overall charge, they will be provided in a separate detailed report to be delivered at a later date in accordance to the WQGIT BMP Panel Protocol. Given the need to meet the Phase 6 CBWM development schedule, the panel and workgroup are recommending these land uses and relative loading rates for approval by the Water Quality GIT. Following the WQGIT's decision the CBPO Modeling Team and Modeling Workgroup can proceed with the October 1st calibration with the inclusion of wetlands as a separate set of land uses. However, the panel is still assessing possible methods to calculate and apply reduction efficiencies for natural wetlands that would quantify the water quality services by wetlands as they treat runoff from surrounding landscapes.[3]

The two recommended land uses and their relative loading rates are supported by the Wetlands Workgroup following their August 28th conference call, with one dissention from Pennsylvania. Pennsylvania supports establishing wetlands as a land use, which would provide a means to apply the new wetlands enhancement BMP, but they dissented given concerns about the inaccuracy of current NWI data for their state and the inconsistency of the NWI data across the jurisdictions. The panel and workgroup understand that there is opportunity to adjust the data inputs during the 2016 review period, and hopefully that will allow for improvements to the mapped wetland land uses in Pennsylvania or other jurisdictions, but they also understand that changes past the October 2015 calibration cannot be guaranteed by the Modeling Workgroup. The wetlands panel and wetlands workgroup strongly recommend that if updated and/or improved wetland mapping data is available before the final calibration date, the Modeling Workgroup and CBPO Modeling Team will make it a priority to update these data in the modeling tools. With the addition of wetlands as an explicit set of land uses, updating wetland mapping will also be a high priority for partnership resources.

Mapping the recommended land uses

The National Wetlands Inventory (NWI) is available for the entire Chesapeake Bay Watershed and explicitly provides the information needed to map the proposed land uses for the Phase 6 CBWM. The NWI provides additional information for wetlands (such as vegetation type and hydrologic information) that can potentially be used by the partnership for other purposes in the

[3]This continued analysis will compare results from a watershed-wide application of the first order kinetic equation to nontidal wetlands with the SPARROW model, which will allow the panel to better understand the kinetic equation's ability to explain expected nutrient and sediment reductions from nontidal wetlands (see Jordan et al 2003 and STAC 2008 for more about the first order kinetic equation). The results of the analysis have yet to be seen and reviewed by the panel and compared to the collected literature, so this is a tentative direction that remains subject to deliberation by the panel. If that analysis yields defensible results that the panel believes should be incorporated into subsequent calibrations of the Phase 6 CBWM, the panel will detail that recommendation at an appropriate future time.

future. The acreage of nontidal wetlands for the proposed land uses will be calculated using the publically available NWI layer from the U.S. Fish and Wildlife Service.[4] The NWI wetland classes will consist of vegetated palustrine, lacustrine and riverine wetland systems, which will be queried according to the NWI attributes in accordance to Cowardin et al. (1979) wetland classification system. The acres of those wetland classes will be subdivided into the two proposed land use classes: floodplain and other (non-floodplain). The floodplain boundaries will be determined by merging the FEMA Flood Hazard Layer with the SSURGO layer. If approved by the WQGIT as new land uses, CBPO staff have indicated that the wetland land uses can be mapped and ready for the October 2015 calibration.

Justification for wetlands land uses

The recommendation to add wetlands as their own land use classification has been suggested by others in the past (e.g., STAC 2012), due to the understanding that they perform natural functions that benefit water quality. Recently, however, it has been suggested that wetlands could potentially be captured in the Phase 6 Watershed Model without an explicit set of land uses. If this occurred and wetlands are not included as Phase 6 land uses, they will continue to be lumped with Forest or other land uses similarly to how they are in the Phase 5.3.2 and earlier versions of the Watershed Model. This would limit the recommendations by the expert panel to evaluate how to apply wetlands BMPs based on landscape position (a larger driver of BMP efficiency). While wetland BMPs could still potentially be reported on non-wetland land uses, such an approach would ignore an explicit accounting of the water quality functions performed by approximately 900,000 acres[5] of nontidal wetlands in the Chesapeake Bay watershed. CBP partnership efforts to incorporate the habitat benefits of wetlands into planning tools or management actions would also benefit from explicit land uses in the modeling tools. Currently the partnership relies on BMP implementation data for its wetland indicators and these efforts could be enhanced for nontidal wetlands with these new land uses. The panel and workgroup agree that establishing wetlands as a set of Phase 6 land use classes will provide a better basis for the reporting and crediting of wetlands BMPs and also improve the modeling tools by explicitly simulating the presence and function of natural nontidal wetlands.

The proposed wetlands land uses satisfy all of the Land Use Workgroup's criteria for establishing new Phase 6 land uses:

(1) They can be mapped, albeit imperfectly as conveyed by Pennsylvania. Establishing the land use, however, could incentivize partners and stakeholders to improve available wetlands data. Without wetland land uses there is less incentive to improve wetlands data in the context of CBP partnership modeling inputs.

(2) They have a unique contribution to the landscape. Though the panel is not quantifying this in terms of a distinct loading rate, the panel's future recommendations of estimated natural effectiveness values will quantify their unique role in the landscape. Without a land use these natural functions and benefits could not be applied or simulated in the modeling tools. Indeed, wetlands play an important role between the "edge of field" and

[4] The initial acres for the October 2015 calibration will be based on the currently available NWI data layer, but as mentioned above the jurisdictions will have the opportunity to provide improved data as it is available.
[5] This is an estimate based on acreage of inland wetlands, excluding freshwater ponds, in Tiner (1987). If adopted as Phase 6 land uses, the actual acreage of nontidal wetlands based on current NWI data may be different.

the “edge of stream” pollutant loads that has not been explicitly captured in previous versions of the modeling tools, and their inclusion as land uses will be a basis for simulating their contribution.

(3) They will have unique BMPs applied to them. Though the panel’s BMP recommendations are yet to be developed, wetland restoration and wetland creation will likely be eligible for many non-wetland land uses, but their estimated reductions may partially depend on a wetland land use if they are simulated as land use change BMPs. In other words, if the panel recommends that wetland restoration or wetland creation is best simulated as a land use change BMP in the Phase 6 Watershed Model, the net reduction for that practice would then be the sum of the difference between the previous land use and the new wetland land use plus any estimated efficiency for the treatment of upland loads. Wetland enhancement will likely be eligible for the wetlands land uses, perhaps exclusively. Without wetland land uses the crediting and application of these BMPs would become much more complicated for the expert panel, jurisdictions, and the public.

The panel and workgroup support classifying the wetland acres according to their landscape position over alternatives (e.g., by vegetative cover) because it is more reflective of expected water quality function in terms of nutrient transformation and sediment retention. More detail is provided below. Having these classifications may also be useful for the forthcoming wetlands BMPs, both the revised wetland restoration BMP and the new wetland enhancement BMP.

Justification for suggested relative loading rate and the separation of land uses according to landscape position (floodplain)

While wetlands are generally a subject of thorough and widespread interest to researchers there are few studies that evaluate the loading rate of a wetland separately from surrounding land uses. This is due to the nature of wetlands as transition zones within their catchment, which means that any appropriate loading rate depends on the location of the particular wetland within their watershed. The panel agreed, therefore, that assigning loading rates similarly to those of other land uses would not reflect the multitude of studies that support the conceptual model that a wetland’s water quality functions depend on the hydrogeologic setting and the nutrient/sediment load delivered to that wetland. Some limited loading rate data is summarized in this section, but due to the inherent nature of wetlands there is little purpose in establishing a unique base loading rate, whereas the real water quality impact is dependent on quantifying the wetland’s function based on available information about relevant properties (e.g., location, hydrogeologic setting, vegetation type, hydroperiod, etc.).

A preliminary literature review conducted for the panel by Tetra Tech found only two studies that attempted to define loading rates for wetland areas, neither of which were located in the Chesapeake Bay region. Baker et al. (2014) evaluated Barnegat Bay-Little Egg Harbor HUC14 watersheds and determined the export concentration for forest and wetlands combined was 1.17 mg/L for TN and 0.021 mg/L for TP. Similarly, Dodd et al. (1992) created nutrient budgets for the Albemarle-Pamlico Sound area; forest and wetlands were again considered as having the same loading rate, which Dodd et al. determined to be 2.08 lbs/ac/yr for TN and 0.12 lbs/ac/yr for TP. Neither study separated the loading from forest and wetland areas into distinct categories. No other studies were identified that provided a loading rate for wetlands as a uniform land use. However, the panel has concern that the literature review may have omitted pertinent research.

Therefore, the recommended loading rates may be adjusted for the next calibration following further investigation and the inclusion of additional studies.

One study by Harrison et al. (2011) calculated the surface water and groundwater concentrations of TN and TP within wetlands, however, the export rates were not calculated. The wetlands, located near Baltimore, MD, were two restored relic oxbow wetlands in an urban area and two reference forested floodplain wetlands. Across the restored oxbow wetlands, the groundwater concentrations for TN and TP, respectively, were 0.72 mg/l and 11.5 µg/L. The average at the forested floodplain wetlands were 0.37 mg/L and 114.7 µg/L for TN and TP, respectively. Surface water nutrient concentrations measured within the oxbow wetlands averaged 0.6 mg/L for TN and 24 µg/L for TP. A study of natural depressional wetlands in the Choptank watershed found that nitrogen concentrations in groundwater were generally less than 0.1 mg/L N beneath the depressional wetlands as well as their surrounding wooded upland areas (Denver et al 2014). Natural groundwater on the Delmarva Peninsula is generally found to be 0.4 mg/L as N, which is primarily defined by investigation of forested areas that also contain wetlands (Hamilton et al 1993).

Considering the nature of wetlands (as described above), the panel and workgroup agreed it is most reasonable to keep all wetland loading rates equivalent to the Phase 6 Forest land use, which is the lowest loading land use. Other Phase 6 land uses were less comparable and the lack of loading data in the literature reviewed to date did not meet the panel's burden of proof to distinguish the relative loading rate from Forest. As noted previously, the panel does feel that the services and functions provided by natural wetlands are understood well enough to quantify estimated reduction efficiencies, but that such analysis requires more time and, while it cannot be completed in time for the October 2015 calibration, it will be ready for subsequent calibrations. This additional reduction will represent the services wetlands provide in the overall landscape as they receive, trap, store and treat runoff and intercepted groundwater from surrounding lands. To reiterate, however, the conceptual base loading rate from the wetland area itself could not be distinguished from Forest at this time.

Given the importance of landscape position to wetland water quality function, the panel is exploring development of spatially-explicit retention efficiencies. Results could be applied, for example, by assigning a forest-based loading rate to each wetland acre, then adjusting the loading rate based on an overlay of assigned retention efficiencies, or perhaps by developing a spatially explicit algorithm to capture the interaction between up-gradient "contamination" and wetland landscape position. Assigning retention efficiencies within the model remains a challenging task for the panel, but they are regularly collaborating with CBPO staff as they continue their analysis. The recommended method for incorporating these wetland factors and functions into the CBWM will be provided in time for subsequent calibrations of the model. The panel acknowledges that following the October 2015 calibration there is no guarantee that potentially significant modeling changes can be incorporated into the final Phase 6 CBWM, but they will continue their analysis in good faith with the hope that their proposed methods will be a significant improvement to the representation of natural wetlands in the Watershed Model.

Caveats, uncertainty and future needs

Wetland processes that modify nutrient and sediment loads from the surrounding landscape are more informative for understanding the "load reduction" of a wetland than any estimated base loading rate. While the panel is recommending that the base TN, TP and TSS target loading rates for wetlands are set equivalent to forest for the initial Phase 6.0 CBWM calibration, the panel is still considering available methods to quantify the valuable water quality services that wetlands provide to surrounding landscapes (as described in footnote 3).

The expert panel recognizes that wetland retention capacity depends on the hydrologic flux (be it ground- or surface-waters or both) through a wetland system (Alexander et al. 2015). Further, the relative importance of ground- and surface-waters has major implications to retention potential. For instance, groundwater dominated systems have greater denitrification potential and therefore improved nitrate removal capacity for any nitrate in groundwater traveling along flow paths that pass through wetland sediments (e.g., Vidon & Hill 2006; Devito et al 1999). Whereas surface water dominated systems have greater potential to trap sediment and nutrients, especially during flood events (e.g., Noe and Hupp 2009). Biogeochemical processes are also related to the dominant vegetative community of the wetland. These studies support consideration of a wetland classification scheme that creates the opportunity for attribution of different load reduction values by landscape and hydrogeologic position. Accordingly, the panel agrees that wetlands have variable benefit or effect on downstream water quality, which they intend to capture in their future recommendations.

References

Alexander, L. C., Autrey, B., DeMeester, J., Fritz, K. M., Goodrich, D. C., Kepner, W. G., … Wigington, P. J. (2015). Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence, (September), 331. Retrieved from http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OW-2011-0880-0004

Baker, R.J., C.M. Wieben, R.G. Lathrop, and R.S. Nicholson. 2014. Concentrations, loads, and yields of total nitrogen and total phosphorus in the Barnegat Bay-Little Egg Harbor watershed, New Jersey, 1989–2011, at multiple spatial scales. *U.S. Geological Survey Scientific Investigations Report 2014–5072.* U.S. Geological Survey. Reston, VA.

Cowardin, L.M., Carter, V., Golet, F.C., and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. U.S. Fish and Wildlife Service Report No. FWS/OBS/-79/31.Washington, D.C.

Denver, J.M., Ator, S.W., Lang, M.W., Fisher, T.R., Gustafson, A.B., Fox, R., Clune, J.W., and McCarty, G.W., 2014. Nitrate fate and transport through current and former depressional wetlands in an agricultural landscape, Choptank Watershed, Maryland, United States: *Journal of Soil and Water Conservation*, v. 69, no. 1, doi:10.2489/jswc69.1.1

Devito, K. J., Fitzgerald, D., Hill, A. R., & Aravena, R. (1999). Nitrate dynamics in relation to lithology and hydrologic flow path in a river riparian zone. *Journal of Environmental Quality*. 29(4), 1075–1084.

Dodd. R.C., G. McMahon, and S. Stichter. 1992. *Watershed Planning in the Albemarle-Pamlico Estuarine System. Report 1 – Annual Average Nutrient Budgets*. North Carolina Department of Environment, Health, and Natural Resources and U.S. Environmental Protection Agency, National Estuary Program.

Hamilton, P.A. , Denver, J.M., Phillips, P.J., and Shedlock, R.J., 1993. Water-Quality assessment of the Delmarva Peninsula, Delaware, Maryland, and Virginia--Effects of agricultural activities on, and the distribution of, nitrate and other inorganic constituents in the surficial aquifer: *U.S. Geological Survey OFR 93-40*, 87 p.

Harrison, M.D., P.M. Groffman, P.M. Mayer, S.S. Kaushal, and T.A. Newcomer. 2011. Denitrification in alluvial wetlands in an urban landscape. *Journal of Environmental Quality*. 40:634-646.

Jordan, T.E., D.F. Whigham, K.H. Hofmockel, and M.A. Pittek. 2003. Nutrient and sediment removal by a restored wetland receiving agricultural runoff. *Journal of Environmental Quality*. 32:1534-1547.

Noe, G. B., & Hupp, C. R. (2009). Retention of Riverine Sediment and Nutrient Loads by Coastal Plain Floodplains. *Ecosystems*, *12*(5), 728–746. http://doi.org/10.1007/s10021-009-9253-5

STAC (Scientific and Technical Advisory Committee). 2008. *Quantifying the Role of Wetlands in Achieving Nutrient and Sediment Reductions in Chesapeake Bay*. Publication 08-006. Annapolis, MD.

STAC. 2012. The role of natural landscape features in the fate and transport of nutrients and sediment. STAC Rpt. 12-04, Edgewater, MD. http://www.chesapeake.org/pubs/293_2012.pdf

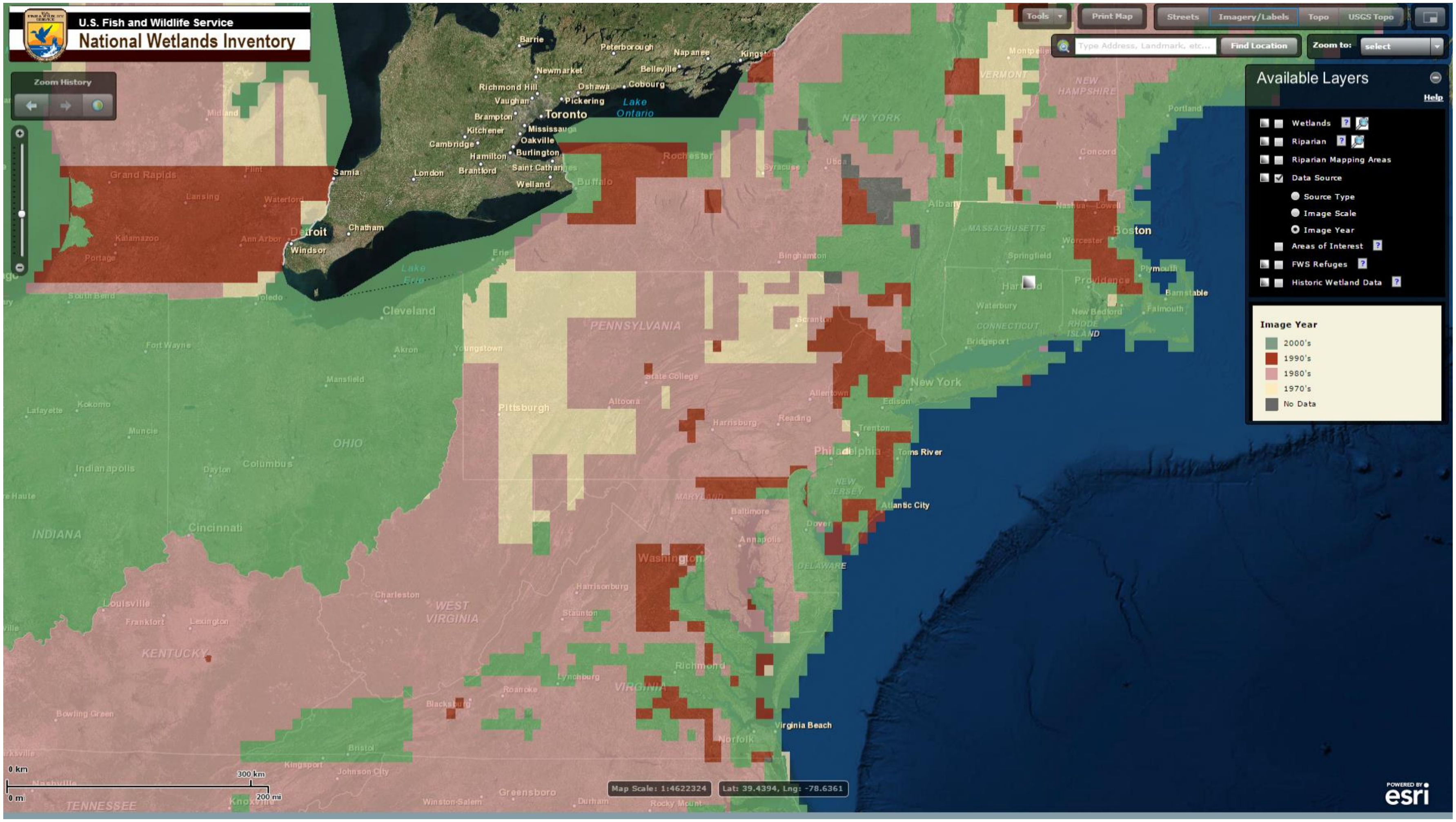
Tiner, R.L. 1987. *Mid-Atlantic Wetlands: A Disappearing Natural Treasure*. U.S. Fish and Wildlife Service and U.S. Environmental Protection Agency.

Vidon, P. G., & Hill, A. R. (2006). A Landscape-Based Approach to Estimate Riparian Hydrological and Nitrate Removal Functions. *Journal of the American Water Resources Association*. 42(4), 1099–1112. http://doi.org/10.1111/j.1752-1688.2006.tb04516.x

Wetlands Expert Panel membership and other participants		
Name	*Role (post-CWP)*	*Organization*
Erin McLaughlin	Panel member	MD DNR, Wetland Work Group Co-Chair
Steve Strano	Panel member	NRCS
Judy Denver	Panel member	USGS - DE
Ken Staver	Panel member	Wye Research and Education Center
Kathy Boomer	Panel member	TNC
Pam Mason	Co-Chair	VIMS
Dave Davis	Panel member	VA DEQ
Jeff Hartranft	Panel member	PA DEP
Ralph Spagnolo	Co-Chair	USEPA Region 3
Jeff Thompson	Panel member	MDE
Tom Uybarreta	Panel member	USEPA Region 3
Quentin Stubbs	Panel member	USGS, CBPO
Rob Brooks	Panel member	Penn State
Dr. Jarrod Miller	Panel member	UMD Extension
Michelle Henicheck	Panel member	VA DEQ
Denise Clearwater	Panel member	MDE
Panel support		
Jeremy Hanson	Panel Coordinator	Virginia Tech, CBPO
Jennifer Greiner	HGIT Coordinator	USFWS, CBPO
Hannah Martin	Support	CRC, CBPO
Kyle Runion	Support	CRC, CBPO
Aileen Malloy	Support	Tetra Tech
Jeff Sweeney	CBPO Modeling and WTWG rep	EPA CBPO
David Wood	CBPO Modeling rep	CRC, CBPO
Peter Claggett	GIS Support	USGS, CBPO
Brian Benham	Va Tech Project Director	Virginia Tech
Additional panel guest participants: Ken Murin (PA DEP), Kristen Saacke-Blunk (AgWG Co-Chair), Anne Wakeford (WV DNR) Previous participants who contributed previously and are no longer active (post-CWP): Brian Needelman (UMD), Tom Jordan (SERC), and Robert Kratochvil (UMD)		

NWI Source Imagery Year

As of September 1, 2015



Source: U. S. Fish and Wildlife Service. May 28, 2015. National Wetlands Inventory - Wetlands Mapper website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.