Chesapeake Bay Program Wetlands Definitions: A White Paper to Create Common Terminology Around Wetlands Practices in the Chesapeake Bay Watershed

Prepared by: Chesapeake Bay Program's Wetlands Workgroup within the Habitat Goal Implementation Team

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Photo Credit: American black ducks and other waterfowl, including northern pintails, tundra swans and mallards visit Mason Neck National Wildlife Refuge in Fairfax County, Va., on Jan. 12, 2024. (Photo by Will Parson/Chesapeake Bay Program)

Executive Summary

The Chesapeake Bay watershed has lost over 1.5 million acres of tidal and non-tidal wetlands to development and agricultural practices. To offset some of these losses, the 2014 Chesapeake Bay Watershed Agreement identified a wetlands outcome of 85,000 acres of created or restored tidal and non-tidal wetlands in the watershed by 2025. In addition to the 85,000 acres of created and restored wetlands, the outcome targets another 150,000 acres of wetlands that would be enhanced by 2025 (Chesapeake Bay Program, 2014). The wetlands outcome was largely developed from commitments identified in the Watershed Implementation Plans developed by the Chesapeake Bay Program partners. Tracking the Bay Program's progress towards the wetlands outcome is complicated by the current lack of a common definition for wetlands restoration, creation, or enhancement techniques. Many federal agencies and other partners of the Agreement have different definitions. Each federal agency created their own definition based on their perspective, expertise, and focus. Consequently, each definition has aspects that others do not have and could be confusing to stakeholders within the region.

Using innovative wetland restoration, creation, and enhancement approaches; leveraging existing and new funding sources; and the Bay Program reprioritizing to address the lagging wetlands outcome provides an opportunity to make the goals a reality. Specifically, shared understanding of definitions will improve communications, thereby inspiring Bay Program partners to strategically prioritize wetlands efforts on the landscape; increasing capacity towards the wetlands outcome; providing robust outreach to engage landowners and partnering agencies within the community; and developing sustainable resources to support this effort.

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Introduction & Background

The Chesapeake Bay watershed has lost over 1.5 million acres of tidal and non-tidal wetlands to development and agricultural practices (Figure 1). To offset some of these losses, the 2014 Chesapeake Bay Watershed Agreement (the Agreement) identified a wetlands outcome of 85,000 acres of created or restored tidal and non-tidal wetlands in the watershed by 2025. In addition to the 85,000 acres of created and restored wetlands the outcome targets another 150,000 acres of wetlands that would be enhanced by 2025 (Chesapeake Bay Program 2014). The wetlands outcome was largely developed from commitments identified in the Watershed Implementation Plans developed by the Chesapeake Bay Program (Bay Program) partners.

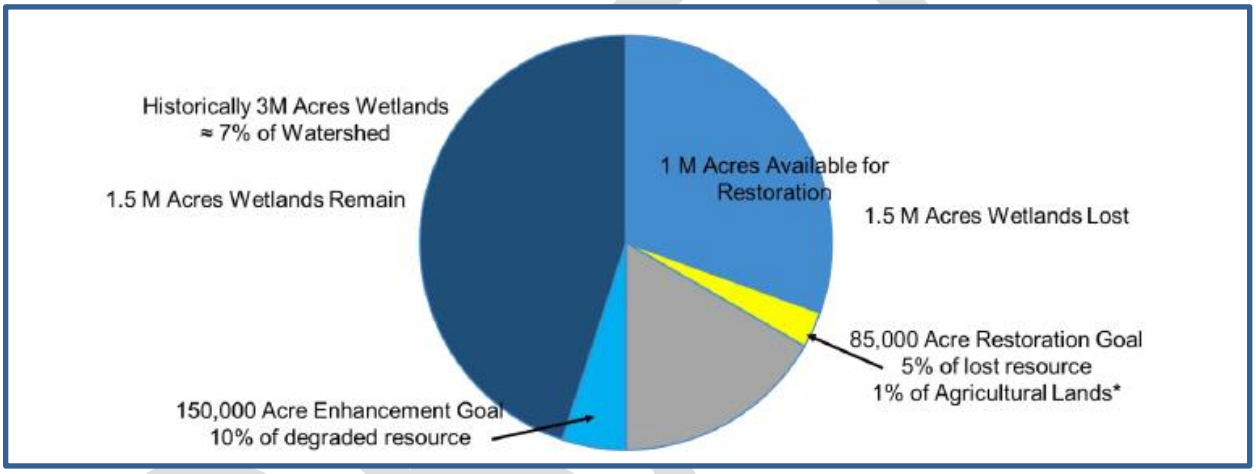

Figure 1: Historical Wetlands Loss and Chesapeake Bay Program Goals. Source: Amy Jacobs, The Nature Conservancy (Chesapeake Bay Program, 2023).

The Sackett vs. Environmental Protection Agency decision in 2023 (Sackett v. Environmental Protection Agency 2023) posed an additional challenge to achieving the outcomes. The Sackett decision found that protection under federal law only extends to wetlands that have continuous surface connection with Waters of the United States (WOTUS). This decision put those wetlands disconnected, or isolated, from WOTUS at risk of loss without any requirement for mitigation or compensation. The Wetlands Workgroup strives to work with greater urgency towards the wetlands outcome to preserve any progress made on wetland developments and protect water quality and habitats throughout the Chesapeake Bay.

Tracking the Bay Program's progress towards the wetlands outcome is complicated by the current lack of a common definition for wetlands, as well as wetland restoration, creation, or enhancement techniques. Many federal agencies and other partners of the Agreement have different wetlands definitions. Each federal agency created their own definition based on their perspective, expertise, and focus, i.e. the US Army Corps of Engineers include detailed vegetation and soil indicators of wetlands (U.S. Army Corps of Engineers 1987) whereas the National Oceanic and Atmospheric Administration emphasize their benefits to humans (NOAA 2024). Consequently, each definition has aspects that others do not have and could be confusing to stakeholders within the region.

Wetlands are diverse and critical ecosystems, hosting increased biodiversity, and providing important ecosystem services to the planet. Wetlands have the capacity to soak up stormwater, dampen storm flooding and tidal surges, prevent erosion, and store water for periods of drought. By trapping polluted runoff, they help slow the flow of nutrients, sediment and chemical contaminants and enhance groundwater quality and supply. Wetlands produce vegetative material that is a major contributor to the aquatic food webs, thus providing food and habitat for unique species specifically adapted to wetlands, many of which are threatened or endangered. Wetlands produce, store and cycle organic material including carbon. They also bring cultural, commercial, aesthetic, and recreational values through activities such as fishing and hunting across the watershed.

Wetland types, and function vary greatly as do the creation, enhancement, restoration, and rehabilitation techniques that are used to achieve the Bay Program outcomes. Such differences result in various approaches to delineation, assessment, landowner engagement and overall wetland improvement practices. This lack of consensus and standardized terminology makes it difficult for all partners to collaborate, follow guidance, monitor, and report on wetlands.

Using innovative wetland restoration, creation, and enhancement approaches; leveraging existing and new funding sources; and the Bay Program reprioritizing to address the lagging wetlands outcome provides an opportunity to make the goals a reality. Specifically, a wetland terminology consensus will inspire Bay Program partners to strategically prioritize wetland efforts on the landscape; increase capacity towards the wetlands outcome; provide robust outreach to engage landowners and partnering agencies within the community; and develop sustainable resources to support this effort.

Problem Statement: The need for a consensus definition for “wetlands”

Wetlands provide critical functions for our environment and are facing danger due to human activities, changing environmental conditions, and policy decisions. To successfully reach the outcomes set forth by the Agreement, the Wetlands Workgroup recognizes the importance of constructing a consensus definition of wetlands specifically to aid in the determination of wetlands. A wetland definition then allows for the consideration of which actions would be classified as restoration, creation, and/or enhancement techniques. Consensus definitions will outline a comprehensive framework to overcome uncertainty and track progress in future efforts.

Methodology

Developing a Bay Program Definition of Wetlands

To develop the Chesapeake Bay Program’s Wetlands Workgroup definition of wetlands we started with the Agreement. Using the Agreement, we identified federal and jurisdictional partners, academic partners, and the non-government organizations (NGOs) of the Chesapeake Bay Program partnership. After we identified the Bay Program partners, we conducted a literature search for each organization's wetland definitions (Appendix A). If a federal or state partner did not have a definition, we still identified them and made a note that they did not have a formal definition. Only academic partners and NGOs that have a definition for wetlands are included in Appendix A. In addition to the current definition, we went back through previous Bay Program agreements to identify historic definitions of wetlands for the Chesapeake Bay Program. Where appropriate, we have included these in Appendix A. After we completed the literature search, we synthesized a common wetland definition that best incorporated all the functions identified by the individual Bay Program partners. The definition along with the supporting materials were sent to the Bay Program Wetlands Workgroup for formal consensus and adoption in July 2025.

Categorizing and Defining Creation, Re-establishment (Restoration) and Enhancement Techniques

The Agreement identifies the wetlands outcome as “Continually increase the capacity of wetlands to provide water quality and habitat benefits throughout the watershed. Create or re-establish 85,000 acres of tidal and non-tidal wetlands and enhance the function of an additional 150,000 acres of degraded wetlands by 2025. These activities may occur in any land use (including urban), but primarily occur in agricultural or natural landscapes.”

When the outcome was established the terms creation, re-establishment and enhancement were not defined.

These terms were later defined when the Wetlands Workgroup approved the formation of an expert panel to evaluate the effectiveness of non-tidal wetland best management practices (BMPs) to reduce loads of nitrogen, phosphorus and sediment to the Chesapeake Bay (WEP, 2016). This panel expanded on the Bay Program approved report by a previous Wetland Expert Panel that clarified the wetland restoration BMP and established two non-tidal wetland land uses in the Phase 6 Chesapeake Bay Watershed Model (WEP, 2016). The definitions outlined below were crafted from the perspective of water quality and specifically reduction of sediment, nitrogen and phosphorus. This limited perspective did not adequately consider the "habitat benefits" called for in the 2014 outcome.

Definitions from the "Recommendations of the Wetland Expert Panel for the Nitrogen, Phosphorus and Sediment Effectiveness Estimates for Non-tidal Wetland Best Management Practices"

Wetland restoration is the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland.

Wetland rehabilitation is the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded wetland. Wetland enhancement is the manipulation of the physical, chemical, or biological characteristics of a wetland to heighten, intensify, or improve a specific function(s).

Wetland creation (establishment) is the manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist at a site (Chesapeake Bay Program Quick Reference Guide for BMPs). For the purposes of this paper, wetland re-establishment and rehabilitation are considered restoration.

Figure 2. Definitions from the Non-tidal Wetland Creation, Rehabilitation and Enhancement. Recommendations of the Wetland Expert Panel for the nitrogen, phosphorus and sediment effectiveness estimates for non-tidal wetland best management practices (BMPs).

In an effort to address concerns regarding a lack of a shared understanding of the terms used to name common wetlands practices and the actions that define those terms, the

Wetlands Workgroup facilitated several brainstorming sessions to garner input from the membership on definitions. The intended output was the development of a set of definitions to be universally applied to Bay Program efforts. The Wetlands Workgroup also decided to further refine the list by identifying techniques that are commonly used in a tidal, and/or non-tidal wetlands context (Appendix B). We created tidal and non-tidal subcategories under restoration, creation, and enhancement. Many of the techniques can be found under more than one of the practices.

Using a data quality objective hierarchy (Figure 3), we identified the most appropriate definition for each technique (i.e., a specific technique may have a different definition depending on its practice). Due to sources defining techniques in varying ways, the Wetlands Workgroup then worked together to synthesize them into a definition for each technique. The compilation of techniques defined under restoration, creation, and enhancement practices for tidal and non-tidal wetlands make up the body of this report.

Data Quality Objective Hierarchy

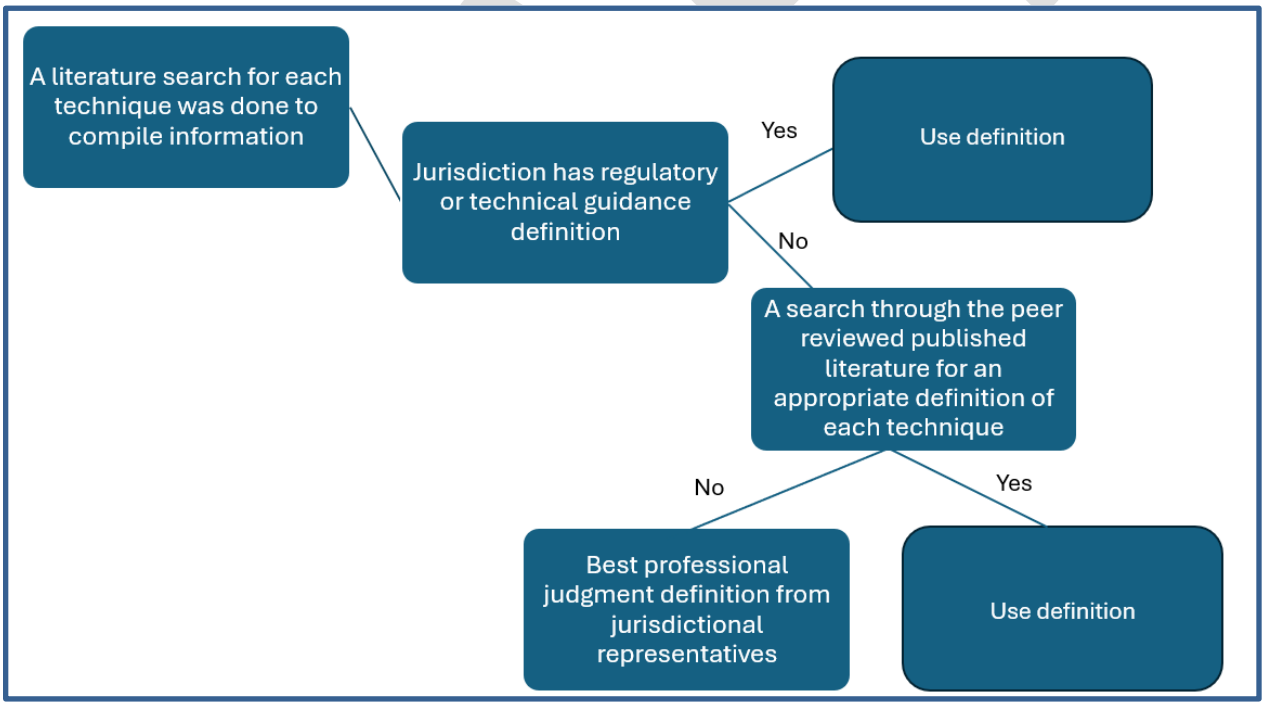

Figure 3. Visual representation of the data quality objective hierarchy.

The data quality objective hierarchy follows a specific process. A literature search for each technique was done to identify if each jurisdiction had a regulatory and or technical guidance definition. If there were no regulatory or jurisdictional definitions found for a technique, a search was done through the peer reviewed published literature for an appropriate definition of each technique. If there was no peer reviewed published

literature, we went back to the identified jurisdictional representatives to develop a best professional judgment definition for each technique.

We chose to limit the literature search for the techniques to the jurisdictional definition because they were the most relevant to this region (i.e., federal definitions applicable nation-wide are not as applicable). In addition, the jurisdictions are largely responsible for reporting wetlands data to the Bay Program and having consistent terminology that can be supported and agreed upon by the overall partnership is the goal.

Synthesis of Definitions

The techniques defined below may have different definitions depending on the practice and type of wetland that is described. The technique definitions are a compilation of jurisdiction regulatory or technical guidance and peer reviewed literature. While this was the best effort we could afford with the resources available, the Wetlands Workgroup is aware that there may be other sources not included. This is a living document, and as these sources are identified techniques will be reviewed and added on a 3-to-5-year basis. The sources used in the wetlands definition can be found in Appendix A and the sources used in the technique definitions can be found in Appendix B.

Chesapeake Bay Program Wetlands Workgroup Wetland Definition

The Chesapeake Bay Program's Wetlands Workgroup defines a wetland as: any area saturated with or covered by water long enough to develop hydric soils and allow for hydrophytic vegetation establishment in wet soil. The Wetlands Workgroup further classifies wetlands into two subcategories: non-tidal wetlands and tidal wetlands. Non-tidal wetlands are freshwater swamps, bogs, and ponds supplied by precipitation (rain/snow), groundwater, or both. Tidal wetlands are marshes, tidal swamps, and lands, where runoff and groundwater may be sources, but the daily and periodic rise and fall of the tide is the primary source of water.

TIDAL – Restoration Techniques Defined

Thin Layer Placement: Thin layer placement is the use of sediment placement to increase surface elevations to improve biotic and abiotic environmental conditions and mitigate erosion in some cases. Thin layer placement does not create new wetlands. It works to extend the provision of functions in the receiving marshes and enhances that function over time.

Ditch-plugging: Ditch-plugging is a hydrologic alteration method used to increase surface water in marshes by blocking drainage sites using soil or other materials.

Native Planting: Native planting uses native species specifically adapted to the local environment that grow more efficiently and provide resources for other species to restore a wetland.

Runnel: A runnel is a small channel that drains standing water on the marsh surface using hand-digging and low-ground pressure excavators or ditchers to follow topographical low areas, and only drain water within the rooting zone.

Tidal Restriction: Tidal restriction removal is the elimination of artificial barriers to tidal exchange that reduce or decrease tidal flooding, impedes drainage of freshwater from upstream, and interferes with accretion and organic matter accumulation processes. Such restrictions can be associated with agriculture, pasture, salt works, flood prevention, transportation, and access to uplands.

Living Shorelines: Living shorelines use native vegetation, alone or in combination with low-lying structures to provide shoreline stabilization in the least adverse way and with the greatest likelihood to restore, or conserve habitat, and maintain coastal processes. Living shorelines can be resilient to natural disturbances and are dynamic components of the ecosystem**.**

TIDAL – Creation Techniques Defined

Hydrology Modification: Hydrology modification is the reintroduction of tidal flooding to an upland or minimally tidally flooded site to replicate the hydrological regime of natural coastal wetlands. It often focuses on recreating hydrologic connections between tidal waters, floodplain and main stem rivers, and between oceans and historic tidal channels.

Treatment wetlands: Treatment wetlands are systems that emphasize specific characteristics of wetland ecosystems for improved treatment capacity. They can be effective at nitrification and nitrogen removal and deliver advanced tertiary treatment. They have these characteristics: macrophytic vegetation, water-logged or saturated substrate conditions for at least part of the time, and inflow of contaminated water with constituents to be removed.

Re-creation: Re-creation is the deposition of new marine or estuarine sediment on top of an old, reclaimed soil surface to restore the wetland to a condition that once prevailed or deduced to have prevailed previously.

TIDAL – Enhancement Techniques Defined

Legacy Sediment Removal: Legacy sediment removal is the elimination of anthropogenically derived sediment accumulated in valley bottoms to reconnect incised streams to their floodplains, return the floodplain to its pre-European elevation and increase overbank flows and floodplain residence time.

Fencing: Fencing is the practice of installing intertidal sediment barriers that increase the efficiency of trapping sediments on unvegetated tidal flats to raise elevation and allow for colonization by intertidal vegetation.

Rehabilitation: Rehabilitation is the process of reinstating natural ecological driving forces within part or the whole of a degraded or declining wetland to recover former or desired ecosystem structure, function, biotic composition and ecosystem services.

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Ditch-plugging: Ditch-plugging is a habitat alteration method used to increase surface water in marshes by blocking drainage sites using soil or other materials.

Vegetation Removal: Vegetation removal is the elimination of non-native vegetation to rebalance the existing ecosystem using mechanical, biological, chemical, ecosystem manipulation or a combination of one or more of these techniques.

Thin Layer Placement: Thin layer placement is using a sediment slurry in which sediments are hydraulically dredged, liquefied, and then pumped through a high-pressure spray nozzle in thin, uniform layers to improve biotic and abiotic environmental conditions and mitigate erosion in some cases. Thin layer placement does not transform the receiving marshes' ecological functions but rather enhances that function over time and extends the life of the marshes.

Native Planting: Native planting uses native species specifically adapted to the local environment that grow more efficiently and provide resources for other species to enhance a wetland.

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Re-creation: Re-creation is the deposition of soil on top of an old, reclaimed soil surface to restore the wetland to a condition that once prevailed or deduced to have prevailed previously.

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Conclusion

The white paper is a synthesis of a wetlands definition and of its restoration, creation, and enhancement techniques. We combine various sources ranging from peer-reviewed journals, articles, books to websites and research papers. This paper is under an ongoing process of revision and will be updated to reflect new knowledge of wetlands practices and evolving techniques. It will serve as the guideline for progress tracking and point of reference by the Chesapeake Bay Program experts in ongoing and future restoration, creation, and enhancement projects. It reflects the Wetlands Workgroup's commitment to clarity and uniformity in wetlands conservation (protection) work. We acknowledge that there are limitations to the synthesis definitions because of limited time and access to the current scientific literature. We welcome comments and feedback from scientists/experts in the Bay Program to keep the program up to date with existing technology.

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Appendix A: Chesapeake Bay Program Partners' Definitions of Wetlands

Academic Partners

College of William and Mary:
"Wetland is a land area that is saturated with water, either permanently or seasonally (Knobloch 2017)."

Cornell:
"Wetlands are areas of water or wet soils that support wetland vegetation ("Wetlands | Environment, Health and Safety," n.d.)."

Pennsylvania State University:
"Because "wetland" is a collective term encompassing a wide range of wet environments, all wetlands must share three basic characteristics: There must be water present at or near the surface of the ground for a portion of the year, there must be plants adapted to wet conditions, there must be soil types that develop from wet conditions (hydric soils). Wetlands provide a variety of ecological values and functions that directly and indirectly benefit people. Most residents of rural communities have taken advantage of recreational opportunities afforded by wetlands, such as boating, hunting, and fishing. However, many important functions are far less obvious. For example, a wetland may enhance downstream water quality by filtering chemicals, excess nutrients, and sediments. Wetlands can also act as natural flood control areas through retaining floodwaters and delaying their release downstream. Because of their numerous ecological and sociological functions, every effort should be made to protect existing wetlands and to restore those degraded by human activities (Cole, n.d.)."

Virginia Institute of Marine Science:
"Wetlands are areas where water is either at or near the surface for all or part of the year. Scientists typically recognize two wetland types: coastal or tidal wetlands and inland or non-tidal wetlands. Virginia has an exceptional diversity of both wetland types, from upland bogs and forested headwater swamps to tidal freshwater marshes and the iconic salt marshes of the coastal plain. Wetlands provide a number of important "ecosystem services." They serve as nursery and feeding grounds for waterfowl, fish, and shellfish; protect against flooding and erosion; and provide for recreational and aesthetic opportunities. They also play a key role as filters in keeping silt and pollutants from flowing into Chesapeake Bay ("VIMS Infographic," n.d.)."

Virginia Cooperative Extension Office:
“Wetland is a land that has hydric soil and wetland vegetation and is periodically saturated with water (Sample et al. 2019).”

Chesapeake Bay Program

Current Definition:
“Located where land meets water, wetlands are vital habitats in the Chesapeake Bay watershed. Wetlands act like a sponge, soaking up stormwater and dampening storm surges. By trapping polluted runoff, they help slow the flow of nutrients, sediment and chemical contaminants into rivers, streams and the Bay. Hundreds of species of fish, birds, mammals and invertebrates depend on wetlands, and humans rely on wetlands to support recreational fishing and hunting across the watershed (“Wetlands,” n.d.).

Wetlands provide critical habitat for hundreds of species of fish, birds, mammals and invertebrates while improving the health of the Bay by collecting and storing flood waters, filtering polluted runoff and weakening storm surges. Wetlands also help protect shorelines and property, as well as provide opportunities for outdoor activities like hunting, fishing and birdwatching (“Wetlands,” n.d.).

Wetlands act as buffers by slowing the flow of pollutants into the Bay and its tributaries. As polluted stormwater runs off the land and passes through wetlands, the trees and grasses filter and absorb nutrients, sediment and chemical contaminants before these pollutants can flow to nearby waterways (“Wetlands,” n.d.).

Wetlands also help control erosion. Just like a sponge, wetlands soak up and hold large amounts of flood water and stormwater runoff, releasing the water slowly over time. Wetlands along the edges of streams, creeks, rivers and the Bay stabilize shorelines and protect properties from floods and wave action (“Wetlands,” n.d.).

Wetlands are especially important in our cities, towns and suburbs, where development and impervious surfaces increase the rate and volume of polluted stormwater runoff (“Wetlands,” n.d.).”

Chesapeake Bay Program Quick Reference Guide for BMPs:
Acreage Gains:
“Wetland Restoration (re-establishment): The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland (Chesapeake Bay Program, n.d.).

Wetland Creation (establishment): The manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist at a site (Chesapeake Bay Program, n.d.)."

Functional Gains:
"Wetland Rehabilitation: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded wetland (Chesapeake Bay Program, n.d.).

Wetland Enhancement: The manipulation of the physical, chemical, or biological characteristics of a wetland to heighten, intensify, or improve a specific function(s) (Chesapeake Bay Program, n.d.)."

Environmental Protection Agency

"Wetlands are areas where water covers the soil or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season. Water saturation (hydrology) largely determines how the soil develops and the types of plant and animal communities living in and on the soil. Wetlands may support both aquatic and terrestrial species. The prolonged presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic wetland (hydric) soils ("What Is a Wetland? | US EPA" 2024).

There are two main types of wetlands: tidal and non-tidal. Many of these wetlands are seasonal (they are dry one or more seasons every year), and, particularly in the arid and semiarid West, may be wet only periodically. The quantity of water present and the timing of its presence in part determine the functions of a wetland and its role in the environment. Even wetlands that appear dry at times for significant parts of the year -- such as vernal pools-- often provide critical habitat for wildlife adapted to breeding exclusively in these areas ("What Is a Wetland? | US EPA" 2024)."

Department of Agriculture

<u>Cooperative Research and Extension Services</u>:
No formal definition found.

<u>Farm Service Agency:</u>
"A "wetland" is an area that has a predominance of hydric soils (wet soils), is inundated or saturated by surface or groundwater (hydrology) at a frequency and duration sufficient to support a prevalence of hydrophytic (water tolerant) vegetation typically

adapted for life in saturated soil conditions, and, under normal circumstances, supports a prevalence of such vegetation (United States Department of Agriculture, Farm Service Agency, and Natural Resources Conservation Service 2012) ."

Natural Resources Conservation Service:
"Wetlands occur where water covers the soil or is present near the soil surface either seasonally or year-round. They include marshes, swamps, bogs, and fens. Beyond providing wildlife habitat and increasing biodiversity, wetlands serve to remove sediment, nutrients, and other pollutants, contain floodwaters, and store carbon (United States Department of Agriculture, n.d.)."

"NRCS wetland protection policy defines wetlands as areas, natural or artificial, that have hydric soil, hydrophytic vegetation, and indicators of wetland hydrology. Generally, wetlands include swamps, marshes, bogs, many bottomland hardwood areas and similar areas (United States Department of Agriculture 2012)."

U.S. Department of Agriculture Forest Service

No official definition but there is a publication.

US National Arboretum

No formal definition found.

Department of Commerce

National Oceanic and Atmospheric Administration:
"A wetland is an area of land that is saturated with water and varies widely due to differences in soil, topography, climate, water chemistry, and vegetation. Classified into marine (ocean), estuarine (estuary), riverine (river), lacustrine (lake), and palustrine (marsh) ("What Is a Wetland?," n.d.).

Wetland habitats serve essential functions in an ecosystem, including acting as water filters, providing flood and erosion control, and furnishing food and homes for fish and wildlife. They do more than sustain plants and animals in the watershed, however. Many wetlands are not wet year-round because water levels change with the seasons. During periods of excessive rain, wetlands absorb and slow floodwaters, which helps to alleviate property damage and may even save lives ("What Is a Wetland?," n.d.).

Wetlands also absorb excess nutrients, sediments, and other pollutants before they reach rivers, lakes, and other waterbodies. They are also great spots for fishing,

canoeing, hiking, and bird-watching, and are enjoyable outdoor "classrooms" for people of all ages (“What Is a Wetland?,” n.d.).”

National Weather Service:
No formal definition found.

Department of Defense

US Army Corps of Engineers:

*Baltimore District**:***

“Wetlands are defined as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands are transitional areas between open water and dry land and are often found along bays, lakes, rivers and streams. Some are drier than others and may have standing water or saturated soil conditions only during part of the year. Examples include bottomland forests, swamps, bogs, marshes, wet meadows and seasonal wet woods.

Vegetation: Wetland vegetation consists of plants that require saturated soils to survive as well as plants that gain a competitive advantage over others because they can tolerate prolonged wet soil conditions. Over 5,000 plant types in the United States may occur in wetlands. For example: cattails, bulrushes, cordgrass, sphagnum moss, bald cypress, willows, mangroves, sedges, rushes, arrowheads and water plantains usually occur in wetlands. Also, wetland vegetation may sometimes exhibit physical adaptations, which indicate the presence of water. The adaptations include shallow root systems, swollen trunks or roots growing from the plant stem or trunk above the soil surface.

Soil: Soils that occur in wetlands are called hydric soils. Hydric soils have characteristics that indicate they were developed in conditions where soil oxygen is/or was limited by the presence of water for long periods of the growing season. By examining the soil, one can determine if hydric indicators are present.

Hydric soils contain predominantly decomposed plant material (peat or muck), have a bluish gray or gray color at 10 to 12 inches below the surface layer, have dark and dull (brownish black or black) soil as the major color have the odor of rotten eggs, may be sandy and have dark stains or streaks of organic material in the upper layer (3 to 12 inches below the surface).

Hydrology: Wetland hydrology refers to the presence of water, either above the soil surface or within the soil, but near the surface (12 to 18 inches below the soil surface, depending on the soil type). For a sufficient period of the year, to deprive the soils of oxygen and significantly influence the plant types which occur in the area. Gauging station or ground water well data provides the most reliable evidence. However, there are field indicators that provide evidence of the periodic presence of inundation or soil saturation.

Some include standing or flowing water, waterlogged soil, water marks on trees, rift lines - which are piles of debris oriented in the direction of water movement, debris lodged in trees, thin layers of sediment deposited on leaves or other objects (Baltimore District, n.d.)."

Norfolk District:

"Wetlands are areas that are covered by water or have waterlogged soils for long periods during the growing season. Plants growing in wetlands are capable of living in saturated soil conditions for at least part of the growing season. Wetlands such as swamps and marshes are often obvious, but some wetlands are not easily recognized, often because they are dry during part of the year or "they just don't look very wet" from the roadside. Some of these wetland types include, but are not limited to, many bottomland forests, pocosins, pine savannahs, bogs, wet meadows, potholes, and wet tundra.

Vegetation indicators: Nearly 5,000 plant types in the United States may occur in wetlands. These plants, known as *hydrophytic vegetation,* are listed in regional publications of the US Fish and Wildlife Service, such as cattails, bulrushes, cordgrass, sphagnum moss, bald cypress, willows, mangroves, sedges, rushes, arrowheads, and water plantains usually occur in wetlands. Other indicators of plants growing in wetlands include trees having shallow root systems, swollen trunks (e.g., bald cypress, tupelo gum), or roots found growing from the plant stem or trunk above the soil surface.

Soil indicators: H*ydric soils* have characteristics that indicate they were developed in conditions where soil oxygen is limited by the presence of saturated soil for long periods during the growing season. If the soil in your area is listed as hydric by the Natural Resources Conservation Service, the area might be a wetland.

An examination of the soil can determine the presence of any hydric soil indicators, including:

- Soil consists predominantly of decomposed plant material (peats or mucks).
- Soil has a thick layer of decomposing plant material on the surface.
- Soil has a bluish gray or gray color below the surface, or the major color of the soil at this depth is dark (brownish black or black) and dull.
- Soil has the odor of rotten eggs.
- Soil is sandy and has a layer of decomposing plant material at the soil surface.
- Soil is sandy and has dark stains or dark streaks of organic material in the upper layer below the soil surface. These streaks are decomposed plant material attached to the soil particles. When soil from these streaks is rubbed between the fingers, a dark stain is left on the fingers.

Hydrology indicators: Wetland hydrology refers to the presence of water at or above the soil surface for a sufficient period of the year to significantly influence the plant types and soils that occur in the area. Although the most reliable evidence of wetland hydrology may be provided by gaging station or groundwater well data, such information is limited for most areas and, when available, requires analysis by trained individuals. Thus, most hydrologic indicators are those that can be observed during field inspection. Most do not reveal either the frequency, timing, or duration of flooding or the soil saturation.

However, the following indicators provide some evidence of the periodic presence of flooding or soil saturation:

- Standing or flowing water is observed in the area during the growing season.
- Soil is waterlogged during the growing season.
- Water marks are present on trees or other erect objects. Such marks indicate that water periodically covers the area to the depth shown on the objects.
- Drift lines, which are small piles of debris oriented in the direction of water movement through an area, are present. These often occur along contours and represent the approximate extent of flooding in an area.
- Debris is lodged in trees or piled against other objects by water.

Thin layers of sediments are deposited on leaves or other objects. Sometimes these become consolidated with small plant parts to form discernible crust on the soil surface (Norfolk District, n.d.).”

Department of Education

No formal definition found.

Department of Homeland Security

Coast Guard:

“A Wetland is Any area of land covered by water, swamps, marshes, bayous. They can be impacted by tides (United States Coast Guard, n.d.).”

Department of Interior

Bureau of Land Management:

No formal definition found.

Fish & Wildlife Services:

“Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification, wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes (plants specifically adapted to live in wetlands); (2) the substrate is predominantly undrained hydric (wetland) soil; and (3) the substrate is non soil and is saturated with water or covered by shallow water at some time during the growing season of each year (“Wetlands Classification System | U.S. Fish & Wildlife Service” 1993).”

National Park Services:

“Wetlands are the links between land and water. Different types of wetlands include salt and freshwater marshes, swamps, and bogs, and they are some of the most important ecosystems in our parks (“Why Are Wetlands Important? - Wetlands (U.S. National Park Service),” n.d.).”

“Water Quality: Wetlands act as natural water purifiers, filtering sediment and absorbing many pollutants in surface waters. In some wetland systems, this cleansing function also enhances the quality of groundwater supplies.

Reduction of Coastal Storm Damage: Coastal wetlands help to blunt the force of major storms, reduce flooding, coastal erosion, and property damage during major storms.

Flood Control and Streamflow Maintenance: Wetlands along rivers and streams absorb energy and store water during storms, which reduces downstream flood damage and lessens the risk of flash floods. The slow release of this stored water over time can help keep streams flowing during periods of drought.

Streambank Stabilization and Erosion Control: Wetland vegetation binds the soil on streambanks and riparian wetlands, preventing excessive erosion and sedimentation downstream.

Wildlife Habitat: Wetlands provide habitat for many species of amphibians, reptiles, birds and mammals that are uniquely adapted to aquatic environments. Upland

wildlife like deer, elk and bears commonly use wetlands for food and shelter. Wetlands are particularly vital to many migratory bird species. For example, wood ducks, mallards, and sandhill cranes winter in flooded bottomland forests and marshes in the southern U.S., and prairie potholes provide breeding grounds for over 50% of North American waterfowl.

Fish and Shellfish Habitat: Freshwater and marine life including trout, striped bass, pike, sunfish, crappie, crab, and shrimp rely on wetlands for food, cover, spawning, and nursery grounds. Between 60% and 90% of U.S. commercial fisheries depend on wetlands.

Habitat for Threatened and Endangered Species: About one-third of all plants and animals listed as threatened or endangered species in the United States depend on wetlands for their survival, including whooping cranes, American crocodiles, the dwarf lake iris and several orchid species.

Specialized Plant Habitat: Nearly 7000 plant species live in U.S. wetlands, many of which can only survive in these wet environments.

Ecosystem Productivity: Some wetland types are among the most productive ecosystems on earth. A stand of cordgrass in a salt marsh can produce more plant material and store more energy per acre than any agricultural crop except cultivated sugar cane. Nutrients and plant material flushed from some wetland systems during storms provide essential food for plants, fish, and wildlife in estuaries and other downstream ecosystems.

Recreational Opportunities: Many wetlands contain a diversity of plants, animals and water features that provide beautiful places for sightseeing, hiking, fishing, hunting, boating, bird watching, and photography.

Water Supply: Some wetlands help provide clean, plentiful water supplies. For example, wetlands in Florida's Everglades help recharge the Biscayne Aquifer, the sole source of drinking water for the Miami metropolitan area (“Why Are Wetlands Important? - Wetlands (U.S. National Park Service),” n.d.).”

US Geological Survey:

“Wetlands are transitional areas, sandwiched between permanently flooded deepwater environments and well-drained uplands, where the water table is usually at or near the surface or the land is covered by shallow water. They include mangroves, marshes (salt, brackish, intermediate, and fresh), swamps, forested wetlands, bogs, wet prairies, prairie potholes, and vernal pools. In general terms, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. The single feature that most wetlands share is soil or substrate that is at least periodically

saturated with or covered by water (“What Are Wetlands? | U.S. Geological Survey” 2017).”

“In addition, wetlands provide habitat, shelter and nursery areas for commercially and recreationally important animals, for thousands of species of aquatic and terrestrial plants and animals. Wetlands are valuable for flood protection, water quality improvement, shoreline erosion control, natural products, recreation, and aesthetics. Coastal marshes help moderate extreme floods and buffer the land from storms; they also form natural reservoirs and help maintain desirable water quality (“Why Are Wetlands Important? | U.S. Geological Survey” 2017).”

Department of Transportation

“The Federal Highways Administration 2001 Definition adopted The National Academy of Sciences Wetland Characterization Committee’s definition: Wetland is "an ecosystem that depends on constant or recurrent, shallow inundation or saturation with water at or near the surface of the substrate." Common diagnostic features of wetlands are moist soils and aquatic vegetation. Fresh water and estuarine marshes, fens, bogs, prairie potholes, and swampy forests are all considered wetlands (White, n.d.).”

Headwater State Partners (when formal definitions were found)

Pennsylvania Fish and Boat Commission:

“A wetland is an area of land that has water-loving plants and has undrained wet soils saturated with or covered by shallow water sometime during the year. Main functions of wetlands: a habitat for life and reproduction, important ecosystem and food sources, absorption of toxic chemicals/water pollution prevention, erosion prevention (Gergel, n.d.).”

Delaware

Department of Natural Resources and Environmental Control:

““State-regulated” wetlands protected by law are defined as “those lands lying at or below two feet above local mean high water which support or are capable of supporting” certain plant species that are listed in the law and regulations (“What’s Regulated? - DNREC” 2024).”

“A “wetland” is an area of land that is wet during the growing season. A true wetland has three characteristics: wetland plants, wetland soils, and evidence of water at or near the surface. Wetlands provide many important services to humans and the environment. They improve water quality. They provide habitat for fish, wildlife and rare plants. They

protect us from flooding and storm damage. And they provide open space on the landscape (“Delaware Wetlands - DNREC” 2024).”

Pennsylvania

Field Office Technical Guide:

“An area of any size that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. The NRCS National Food Security Act Manual (NFSAM) also requires a predominance of hydric soils (NRCS 2009).”

Pennsylvania Department of Environmental Protection:

“A wetland occurs in flat areas and has soils that are permanently saturated in water (hydric soils) and vegetation that is adapted to survive in hydric soils. When subsidence occurs in flat areas, wetlands can spontaneously form. The subsidence creates a depression allowing water to collect and remain in the depression. Over time, the soils become saturated and eventually hydric. When waterfowl (ducks, geese, etc.) visit the saturated depressions, they bring with them vegetation seeds which get deposited and, over time, will lead to the development of characteristic wetland vegetation (DEP, n.d.).”

Maryland

Maryland Department of the Environment:

“Tidal wetlands are all State and private tidal wetlands, marshes, submerged aquatic vegetation, lands, and open water affected by the daily and periodic rise and fall of the tide within the Chesapeake Bay and its tributaries, the coastal bays adjacent to Maryland's coastal barrier islands, and the Atlantic Ocean to a distance of 3 miles offshore of the low water mark (“Definition of Wetland Functions,” n.d.).

Nontidal wetlands are "(a) ...an area that is inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation;
(b) is determined according to the Federal Manual; (c) does not include tidal wetlands regulated under Natural Resources Article, Title 9, Annotated Code of Maryland (“Definition of Wetland Functions,” n.d.).”

“Wetlands are the result of a combination of physical characteristics which drive wetland processes. Wetland functions are the result of interactions between the three major

components of wetland ecosystems: hydrology, biology, and soils. These interactions produce complex chemical reactions and the transfer of materials and energy which drive wetland processes. Wetland processes - such as transfer of oxygen or nutrients and weathering of soil or rock - determine the functions of wetlands ("Definition of Wetland Functions," n.d.)."

New York

New York State Department of Environmental Conservation:

"Wetlands (swamps, marshes, bogs, and similar areas) are areas saturated by surface or ground water sufficient to support distinctive vegetation adapted for life in saturated soil conditions. Wetlands serve as natural habitat for many species of plants and animals and absorb the forces of flood and tidal erosion to prevent loss of upland soil. In New York State, two main types of wetlands are the focus of protection: tidal wetlands around Long Island, New York City and up the Hudson River all the way to Troy Dam; and freshwater wetlands found on river and lake floodplains across the state ("Wetlands," n.d.)."

New York City Department of Environmental Protection:

"Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year." (Cowardin et al. 1979). This definition includes both vegetated wetland types such as marshes and swamps, and nonvegetated wetland types such as ponds, shallow river bottoms, and lake shores. This definition does not include deepwater habitats such as lakes and reservoirs where the depth of standing water is greater than 6.6 feet." ("Wetlands in the Watersheds of the New York City Water Supply System" 2005)."

Virginia

Virginia Department of Environmental Quality:

""Wetlands" means those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas (The Department of Environmental Quality, Virginia Institute of Marine Science - Center for Coastal Resources Management, and Virginia Marine Resources Commission 2015)."

Washington D.C.

Council of the District of Columbia:

""Wetland" means a marsh, swamp or other area periodically inundated by tides or having saturated soil conditions for prolonged periods of time and capable of supporting aquatic vegetation ("§ 8–103.01. Definitions. | D.C. Law Library," n.d.)."

Department of Energy and Environment:

"Wetland means an area that is inundated by tides or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, and includes a marsh, swamp, pond, or vernal pool (District Department of Energy and Environment 2020)."

"There are many types and sizes of wetlands, but all of them must have water long enough each year that will allow plants adapted to wet conditions to grow ("Wetlands FAQs," n.d.)."

West Virginia

West Virginia Department of Environmental Protection:

"Wetlands are defined based on their hydrology, soils, and plants. The U.S. EPA defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas ("Wetland Resources Guide," n.d.)."

Non-governmental Organizations

American Forests:

"Wetlands is the broad term used to describe areas that often find their soil saturated with water and as a result support flora and fauna that need these saturated-soil conditions to survive. While water is often prevalent in wetlands, wetlands aren't necessarily wet all the time. The most common types of wetlands in the U.S. are marshes, swamps, bogs and fens. Because of their unique wet-dry conditions — which enable them to act as transitions from wet habitats to dry ones — wetlands are essential to maintaining nature's balance. Wetlands improve water quality, help with flood protection, control shoreline erosion, provide fish and wildlife habitat and contribute billions in recreation value annually ("Wonderful Wetlands - American Forests" 2012)."

Chesapeake Bay Foundation:

“Located where land meets water, wetlands—which include marshes, swamps, and bogs—are low-lying areas covered by water some or all of the time (“Wetlands Protection,” n.d.).”

Ducks Unlimited:
“Wetlands are diverse ecosystems categorized primarily based on soils, water source and the types of vegetation they support. Here are the two main categories: coastal wetlands and inland wetlands, each with its unique subtypes. Coastal Wetlands include: Tidal Salt Marshes, Tidal Freshwater Marshes and Mangroves. Inland Wetlands include: Freshwater Swamps, Peatlands, Freshwater Marshes and Riparian Systems (“Wetlands: Essential Ecosystems for Waterfowl, Wildlife and People,” n.d.).”

Friends of the Rappahannock:
“Wetlands are areas of land flooded by water at some point during the year, either permanently or seasonally. These ecosystems offer many benefits including pollution filtration, flood reduction and wildlife habitat creation (Bieri 2023).”

Izaak Walton League:
“A wetland is an ecosystem that has both land and water characteristics. Although wetlands are often covered in water or saturated to the surface, some are wet only during certain times of the year. Swamps, marshes, bogs, and fens are types of wetlands commonly found in the United States. Wetlands provide habitats for wildlife, floodwater storage, erosion control, water purification, economic benefits and recreation (“What Is a Wetland,” n.d.).”

National Geographic Society:
“A wetland is an area of land that is either covered by water or saturated with water. The water is often groundwater, seeping up from an aquifer or spring. A wetland’s water can also come from a nearby river or lake. Seawater can also create wetlands, especially in coastal areas that experience strong tides (“Wetland,” n.d.).

A wetland is entirely covered by water for at least part of the year. The depth and duration of this seasonal flooding varies. Wetlands are transition zones. They are neither totally dry land nor totally underwater; they have characteristics of both (“Wetland,” n.d.).

The saturation of wetland soil determines the vegetation that surrounds it. Plants that live in wetlands are uniquely adapted to their watery (hydric) soil. Wetland plants are called hydrophytes. Seasonally dry wetlands or wetlands with slow-moving water can

often support trees and other sturdy vegetation. More frequently flooded wetlands have mosses or grasses as their dominant hydrophytes (“Wetland,” n.d.).”

National Academy of Sciences:
“An ecosystem that depends on constant or recurrent, shallow inundation or saturation with water at or near the surface of the substrate." Common diagnostic features of wetlands are moist soils and aquatic vegetation. Fresh water and estuarine marshes, fens, bogs, prairie potholes, and swampy forests are all considered wetlands (White, n.d.).”

National Research Council:
“A wetland is an ecosystem that depends on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics of a wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical, and biological features reflective of the recurrent, sustained inundation or saturation. Common diagnostic features of wetlands are hydric soils and hydrophytic vegetation. These features will be present except where specific physicochemical, biotic, or anthropogenic factors have removed them or prevented their development (Heimlich et al. 1998).”

Appendix B: Tidal and Non-tidal Wetland Techniques Used for Restoration, Creation and Enhancement Practices

TIDAL

RESTORATION

Thin layer placement

- "Depositing thin layers of sediment, usually by spraying a sediment slurry under high pressure over the marsh surface. The technique is essentially a modification of existing hydraulic dredging methods in which sediments are hydraulically dredged, liquefied, and then pumped through a high-pressure spray nozzle (Ray 2007)."

- "Placement of a thickness of dredged material that does not transform the receiving habitat's ecological functions (Ray 2007)."

- "Thin layer placement (TLP) is a common restoration management strategy used throughout the Gulf, Atlantic, and Pacific coasts of the United States that focuses on improving biotic and abiotic environmental conditions through pumping hydraulically dredged sediments onto the marsh platform (Harris et al. 2021)."

- "Thin layer placement (TLP), involves depositing dredged sediments in thin, uniform layers over eroding marshes, emergent marsh vegetation, or shallow bay bottom (Myszewski and Alber 2017)."

Ditch plugging

- "Ditch-plugging is a more recent methodology used for salt marsh habitat enhancement and mosquito control. Ditch-plugging is a habitat alteration method that increases surface water habitat for larvivorous fish in an attempt to control mosquitoes, as well as provide wading bird and waterfowl habitat (Vincent, Burdick, and Dionne 2013)."

- "Ditch-plug creation involves excavating marsh soils from an upstream portion of the mosquito ditch and plugging the seaward end of the ditch with the spoils. Plywood boards are typically inserted vertically into the plug in an effort to

stabilize the soils, and a pool forms behind the channel plug (Vincent, Burdick, and Dionne 2013)."

Native planting

- "Native species are considered in the literature to be better adapted to the local environment, which will mean they will grow more efficiently and require less maintenance; and also to provide better habitat resources for other native species (Berthon, Thomas, and Bekessey 2021)."

- "Given the highly dynamic nature of tidal rivers, a reasonable restoration goal may be to restore native plant communities to conditions similar to nearby reference wetlands, which are a foundation of the reference models used for planning (Borde et al. 2020)."

Creation of runnels:

- "One technique involved digging "runnels"—small channels meant to drain standing water and promote revegetation (Besterman et al. 2022)."

- "A runnel is a small channel (generally ≤ 30 cm wide and deep) that drains standing water on the marsh surface. Runnels are constructed using hand-digging and low-ground pressure excavators or ditchers (Supplemental File 1) to follow topographical low areas, and only drain water within the rooting zone (Hulsman et al. 1989; Wigand et al. 2017). Runnels are similar in principle to tidal creek extension projects that connect an area of inundation to the tidal creek network, though tidal creek extensions are larger in scale than runnels (Besterman et al. 2022)."

Tidal restriction removal:

- Removal of structures that reduce or eliminate tidal flooding, impedes drainage of freshwater from upstream, result in decreased soil salinity, interfere with accretion and organic matter accumulation processes. Restriction can be in the form of agriculture, pasture, salt works, flood prevention, transportation, and access to uplands (Burdick and Roman 2012).

- "Removing artificial barriers to tidal exchange. Tide restrictions reduce the tidal prism and thereby limit seawater flushing and dilution of constituents delivered to the estuary in discharging freshwater (Portnoy and Allen 2006)."

Living shoreline – existing marsh

- “Living shorelines typically involve the use of coastal habitats, such as wetlands, that have a natural capacity to stabilize the shore, restore or conserve habitat, and maintain coastal processes. They provide stability while still being dynamic components of the ecosystem, but due to their dynamic nature, careful designs and some maintenance will be required if habitat conservation is a goal (Bilkovic et al. 2016).”

- “The concept of "living shorelines" involves the use of native vegetation and low-lying structures to provide shoreline stabilization, while attempting to mimic the natural landscape (Walker, Bendell, and Wallendorf 2011).”

CREATION

Hydrology modification

- “Hydrology modification is the process to replicate the hydrological regime of natural coastal wetlands (Twomey et al. 2024).”

- “Hydrologic restoration: an activity that results in the reintroduction of tidal flooding to a non- tidal or minimally tidally flooded site (Dionne et al. 2012).”

- “Restoration efforts in large coastal rivers and estuaries have focused on recreating hydrologic connections between the floodplain and main stem rivers, and between oceans and historic tidal channels. When historic tidal sloughs and back-waters are newly re-exposed to tidal forcing, dynamic changes to vegetative communities and channel morphology follow (Guthrie 2012).”

Treatment wetland: post-treatment (after primary, secondary and tertiary water) water

- “Treatment wetlands involve: The presence of macrophytic vegetation; the existence of water-logged or saturated substrate conditions for at least part of the time; and inflow of contaminated water with constituents to be removed (Fonder and Headley 2013).”

- “Tidal flow treatment wetlands can be effective at nitrification and nitrogen removal and can deliver advanced tertiary treatment (Austin 2006).”

- “Modern treatment wetlands are man-made systems that have been designed to emphasize specific characteristics of wetland ecosystems for improved treatment

capacity. Treatment wetlands can be constructed in a variety of hydrologic modes (Kadlec and Wallace 2009)."

Re-creation

- "Habitat re-creation has been defined as restoring a site to a condition that once prevailed, or deduced to have prevailed previously (Johnson et al. 2007)."

- "Re-creation of tidal marsh usually involves the deposition of new marine or estuarine sediment on top of an old reclaimed soil surface. The old soil will have ripened, a process that is irreversible, and, although its moisture content will increase with regular flooding, it will not return to the same physical state as before reclamation (Boorman et al. 2002)."

Legacy sediment removal

- **"**Legacy sediment is Post-settlement alluvium overlying older surfaces. The definition of LS should include alluvium and colluvium resulting to a substantial degree from a range of human-induced disturbances; e.g., vegetation clearance, logging, agriculture, mining, grazing, or urbanization. Moreover, LS should apply to sediment resulting from anthropogenic episodes on other continents and to sediment deposited by earlier episodes of human activities (James 2013)."

- "Legacy sediment removal (LSR) and floodplain reconnection (FR) involve removing anthropogenically derived sediment accumulated in valley bottoms to reconnect incised streams to their floodplains. These projects also present an opportunity to create high-quality riparian and wetland plant communities and provide information about the early stages of wetland vegetation development and succession (Baltzer et al. 2024)."

- "The combination of legacy sediment removal and floodplain reconnection ("LSR/FR," also referred to herein as "restoration") has emerged as a process-based restoration technique that alters floodplain geomorphology and is also designed to restore ecosystem structure and biological processes. By removing as much of the anthropogenic legacy sediment as possible, the goal of this technique is to return the floodplain to its pre-European elevation, eliminate a major source of sediment input, and increase overbank flows and floodplain residence time (Baltzer et al. 2024)."

ENHANCEMENT

Legacy sediment removal

- **“**Legacy sediment is Post-settlement alluvium overlying older surfaces. The definition of LS should include alluvium and colluvium resulting to a substantial degree from a range of human-induced disturbances; e.g., vegetation clearance, logging, agriculture, mining, grazing, or urbanization. Moreover, LS should apply to sediment resulting from anthropogenic episodes on other continents and to sediment deposited by earlier episodes of human activities (James 2013).”

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Fencing

- **“**Intertidal sediment fences are designed to increase the efficiency of trapping sediments on unvegetated tidal flats, in order to raise elevation and to allow for colonization by intertidal vegetation (Scarton et al. 2000).”

Rehabilitation

- **“**‘Wetland rehabilitation’ is defined as the process of reinstating natural ecological driving forces within part or the whole of a degraded wetland to recover former or desired ecosystem structure, function, biotic composition and ecosystem services (Grenfell et al. 2007).”

- “Wetland rehabilitation refers to the process of assisting in: (1) the recovery of a degraded wetland’s health and ecosystem service-delivery by reinstating the natural ecological driving forces or (2) halting the decline in health of a wetland

that is in the process of degrading, so as to maintain its health and ecosystem service-delivery (William 2009)."

- "Conversion of an upland area that was previously a wetland into another wetland type deemed better for the overall ecology of the system (Kusler and Kentula 1991)."

Hydrology modification

- "Hydrology modification is the process to replicate the hydrological regime of natural coastal wetlands (Twomey et al. 2024)."

- "Hydrologic restoration: an activity that results in the reintroduction of tidal flooding to a non- tidal or minimally tidally flooded site; and excavation/fill restoration as activity that results in the expansion or reconfiguration of a tidal marsh surface at an already tidally influenced site (Dionne et al. 2012)."

- "Restoration efforts in large coastal rivers and estuaries have focused on recreating hydrologic connections between the floodplain and main stem rivers, and between oceans and historic tidal channels. When historic tidal sloughs and back-waters are newly re-exposed to tidal forcing, dynamic changes to vegetative communities and channel morphology follow (Guthrie 2012)."

Ditch plugging

- "Ditch-plugging is a more recent methodology used for salt marsh habitat enhancement and mosquito control. Ditch-plugging is a habitat alteration method that increases surface water habitat for larvivorous fish in an attempt to control mosquitoes, as well as provide wading bird and waterfowl habitat (Vincent, Burdick, and Dionne 2013)."

- "Ditch-plug creation involves excavating marsh soils from an upstream portion of the mosquito ditch and plugging the seaward end of the ditch with the spoils. Plywood boards are typically inserted vertically into the plug in an effort to stabilize the soils, and a pool forms behind the channel plug (Vincent, Burdick, and Dionne 2013)."

Vegetation removal

- **"**The presence of the nonnative species is a detriment to the persistence of the wetland vegetation at this site, and the wetland is not likely to remain or offer wildlife habitat value if the non-native vegetation is not removed. Improvements

that include removal of the non-native vegetation would support enhancement or protection of downstream habitats (Brown 2007)."

- "The best form of management is eradication - but this is often impossible to achieve - thus we usually refer to control as the process for reducing an invasion to tolerable levels. Control of invasive in water-dependent ecosystems follows the normal methods for other ecosystems, but does have a special relationship with water due to the associated problems of access, visibility and connection to other ecosystems through the watery environment (Gupta, Bartley, and Acosta 2004):
    - Mechanical: Control by removal, destruction, trapping or catching.
    - Chemical: Control by pesticides, herbicides and poisons - few of which are specific.
    - Biological: Control of exotics and usually with exotic biocontrol agents.
    - Ecosystem manipulation: management, such as watershed management, water management, pollution control, competition with crops or local species.
    - Integrated management: strategies using some or all of the above (Gupta, Bartley, and Acosta 2004)."

Thin layer placement

- "Depositing thin layers of sediment, usually by spraying a sediment slurry under high pressure over the marsh surface. The technique is essentially a modification of existing hydraulic dredging methods in which sediments are hydraulically dredged, liquefied, and then pumped through a high-pressure spray nozzle (Ray 2007)."

- "Placement of a thickness of dredged material that does not transform the receiving habitat's ecological functions (Ray 2007)."

- "Thin layer placement (TLP) is a common restoration management strategy used throughout the Gulf, Atlantic, and Pacific coasts of the United States that focuses on improving biotic and abiotic environmental conditions through pumping hydraulically dredged sediments onto the marsh platform (Harris et al. 2021)."

- "Thin layer placement (TLP), involves depositing dredged sediments in thin, uniform layers over eroding marshes, emergent marsh vegetation, or shallow bay bottom (Myszewski and Alber 2017)."

Native planting

- “Native species are considered in the literature to be better adapted to the local environment, which will mean they will grow more efficiently and require less maintenance; and also to provide better habitat resources for other native species (Berthon, Thomas, and Bekessey 2021).”

- “Given the highly dynamic nature of tidal rivers, a reasonable restoration goal may be to restore native plant communities to conditions similar to nearby reference wetlands, which are a foundation of the reference models used for planning (Borde et al. 2020).”

NON-TIDAL

RESTORATION

Thin layer placement

- “Depositing thin layers of sediment, usually by spraying a sediment slurry under high pressure over the marsh surface. The technique is essentially a modification of existing hydraulic dredging methods in which sediments are hydraulically dredged, liquefied, and then pumped through a high-pressure spray nozzle (Ray 2007).”

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- “Thin layer placement (TLP), involves depositing dredged sediments in thin, uniform layers over eroding marshes, emergent marsh vegetation, or shallow bay bottom (Myszewski and Alber 2017).”

Ditch plugging

- “The objective of ditch plugging is to re-establish a hydrologic regime on the ditched marsh that is characterized by permanent water on the marsh surface, thereby restoring fish and wildlife habitat functions while controlling mosquito production (Roman 2016).”

Vegetation removal

- **“**The presence of the nonnative species is a detriment to the persistence of the wetland vegetation at this site, and the wetland is not likely to remain or offer wildlife habitat value if the non-native vegetation is not removed. Improvements that include removal of the non-native vegetation would support enhancement or protection of downstream habitats (Brown 2007).”

- “Possible relevant methods: The best form of management is eradication - but this is often impossible to achieve - thus we usually refer to control as the process for reducing an invasion to tolerable levels. Control of invasive in water-dependent ecosystems follows the normal methods for other ecosystems, but does have a special relationship with water due to the associated problems of access, visibility and connection to other ecosystems through the watery environment (Gupta, Bartley, and Acosta 2004):
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    - Integrated management: strategies using some or all of the above (Gupta, Bartley, and Acosta 2004).”

Hydrology modification

- No definition was found for non-tidal wetlands.

Legacy sediment removal

- **“**Legacy sediment is Post-settlement alluvium overlying older surfaces. The definition of LS should include alluvium and colluvium resulting to a substantial degree from a range of human-induced disturbances; e.g., vegetation clearance, logging, agriculture, mining, grazing, or urbanization. Moreover, LS should apply to sediment resulting from anthropogenic episodes on other continents and to sediment deposited by earlier episodes of human activities (James 2013).”

- “Legacy sediment removal (LSR) and floodplain reconnection (FR) involve removing anthropogenically derived sediment accumulated in valley bottoms to reconnect incised streams to their floodplains. These projects also present an

opportunity to create high-quality riparian and wetland plant communities and provide information about the early stages of wetland vegetation development and succession (Baltzer et al. 2024)."

- "The combination of legacy sediment removal and floodplain reconnection ("LSR/FR," also referred to herein as "restoration") has emerged as a process-based restoration technique that alters floodplain geomorphology and is also designed to restore ecosystem structure and biological processes. By removing as much of the anthropogenic legacy sediment as possible, the goal of this technique is to return the floodplain to its pre-European elevation, eliminate a major source of sediment input, and increase overbank flows and floodplain residence time (Baltzer et al. 2024)."

Rehabilitation

- **"**'Wetland rehabilitation' is defined as the process of reinstating natural ecological driving forces within part or the whole of a degraded wetland to recover former or desired ecosystem structure, function, biotic composition and ecosystem services (Grenfell et al. 2007)."

- "Wetland rehabilitation refers to the process of assisting in: (1) the recovery of a degraded wetland's health and ecosystem service-delivery by reinstating the natural ecological driving forces or (2) halting the decline in health of a wetland that is in the process of degrading, so as to maintain its health and ecosystem service-delivery (William 2009)."

- "Conversion of an upland area that was previously a wetland into another wetland type deemed better for the overall ecology of the system (Kusler and Kentula 1991)."

CREATION

Hydrology modification

- No definition was found for non-tidal wetlands.

Treatment wetland

- **"**Treatment wetlands are either natural or constructed systems managed in a specific manner for the treatment of wastewaters. Although traditionally applied for the treatment of domestic and municipal sewage from both separate and combined sewerage, treatment wetlands have been applied globally since the

late 1980s to treat various types of wastewaters, including agricultural wastewaters, mine drainage, food processing wastewaters, heavy industry wastewaters, landfill leachate and runoff waters (Chouinard et al. 2014)."

Re-creation

- "Habitat re-creation has been defined as restoring a site to a condition that once prevailed or deduced to have prevailed previously (Johnson, Bartlett, and Nash, 2007)."
- "Re-creation of functioning vegetated marshes relies on capturing recirculated estuarine mud in the ponds to allow the surface to rise to mature marsh elevations (David and Williams 2010)."

Legacy sediment removal

- **"**Legacy sediment is Post-settlement alluvium overlying older surfaces. The definition of LS should include alluvium and colluvium resulting to a substantial degree from a range of human-induced disturbances; e.g., vegetation clearance, logging, agriculture, mining, grazing, or urbanization. Moreover, LS should apply to sediment resulting from anthropogenic episodes on other continents and to sediment deposited by earlier episodes of human activities (James 2013)."

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ENHANCEMENT

Legacy sediment removal

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Fencing

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Hydrology modification

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Ditch plugging

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Native planting

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