THE OPTIMIZATION OF BENEFITS FROM WETLANDS RESTORATION
A Workshop

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&
The Scientific and Technical Advisory Committee

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The Scientific and Technical Advisory Committee (STAC) provides scientific and technical guidance to the Chesapeake Bay Program on measures to restore and protect the Chesapeake Bay. As an advisory committee, STAC reports quarterly to the Implementation Committee and annually to the Executive Council

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Chesapeake Research Consortium, Inc.
645 Contees Wharf Road
Edgewater, MD 21037
Telephone: 410-798-1283; 301-261-4500
Fax: 410-798-0816
http://www.chesapeake.org

Table of Contents

Optimization of Benefits from Wetlands Restoration

Executive Summary

This workshop was conducted to give Chesapeake Bay Program partners an opportunity to exchange information, discuss emerging ideas, and suggest future directions in the effort to restore 25,000 acres of wetlands in the Bay watershed by the Year 2010, a Chesapeake 2000 Commitment.

Highlights of the workshop discussions include the following:

- The bottom line in current wetlands restoration programs is the number of acres created. Available programmatic resources make other considerations secondary (e.g. optimization of wetland functions).
- Monitoring restoration efforts is broadly viewed as critical for both short-term and long-term program success. Workshop participants were of the opinion monitoring should probably be required for much longer periods than is typical at present.
- Recommendations for future research included development of inventories and assessment tools to support new restoration efforts. A high priority need was identified for an inventory and assessment of existing restoration programs' accomplishments.
- Additional program staff and funding are necessary to truly achieve the "no net loss/net resource gain" goals for both acreage and function. Current resources may support the acreage goal, but are insufficient for consistent focus on protecting and enhancing values from wetland functions.
- The Chesapeake Bay Program has important roles to play in interstate coordination and development of resources needed by state and NGO programs.

Workshop participants also identified two policy recommendations.

- Treat wetlands as part of the larger system. This reflects the state of the science and the cumulative experience of existing programs, which together suggest success in restoring wetlands and the values derived from wetlands are strongly linked to the condition of the surrounding landscape.
- Concentrate on improvement of the condition of existing wetlands. Research findings suggest that much can be gained in value of existing wetlands by mitigating factors that reduce their function.

Introduction

The “Optimization of Benefits from Wetlands Restoration” Workshop was planned to afford practitioners and interested parties from Chesapeake Bay Program partners an opportunity to exchange information, discuss emerging ideas, and suggest future directions.

The workshop outcomes are grouped in four general areas:

1. **What is currently going on in Chesapeake Bay wetlands restoration?**
   Prior to the workshop, representatives of Bay Program partners were asked to summarize current wetland restoration practices by their organizations. This was accomplished using a questionnaire. Responses were solicited from Pennsylvania, Maryland, Virginia, the District of Columbia, and the Chesapeake Bay Foundation. The results are summarized in Table 1, and the full responses are included in Appendix 1.

2. **What is the state of the science available to guide Chesapeake Bay wetlands restoration?**
   The status of the science applicable to wetlands restoration was presented by Denice Wardrop of Penn State University, and Carl Hershner of the Virginia Institute of Marine Science. Brief background papers were prepared prior to the workshop and those papers are included in Appendix 2.

3. **What has been learned from ongoing efforts to restore Chesapeake Bay wetlands?**
   Workshop participants reviewed their cumulative experiences and developed a number of consensus observations summarized under the general topics of Planning, Construction, and Monitoring. One outcome of this discussion was identification of some Interesting Ideas – things developed in one program that might be of interest to other programs.

4. **What should happen next in restoration of Chesapeake Bay wetlands?**
   The cumulative experience of implementing policies for wetland restoration generated a number of suggestions for consideration by researchers, program managers/legislators, the Bay Program, and policy developers.

The workshop was held in Annapolis, Maryland over a two-day period. Approximately 45 individuals attended representing a wide variety of state and federal agencies, non-governmental organizations, academia, and private sector interests. The product of the workshop is this report, which includes the materials prepared for the workshop and a summary of the discussions and ideas developed by the participants.

1. What is currently going on in Chesapeake Bay wetlands restoration?

State and federal agencies have been engaged in restoration and creation of wetlands for many years, generally as part of programs focused on habitat and water quality management. In the late 1990's recognition of the growing cumulative loss of wetland resources, spurred Chesapeake Bay Program partners to make commitments to seek not only no net loss of the resource, but an effective net resource gain. A goal of restoring 25,000 acres of wetlands within the Chesapeake watershed by 2010 was adopted through the Chesapeake 2000 Agreement.

Table 1 presents a summary of ongoing wetlands restoration programs. The information is derived from questionnaire responses (see Appendix 1) from Maryland, Virginia, Pennsylvania, the District of Columbia, and the Chesapeake Bay Foundation.

Table 1: Wetland Restoration Characterization

	Site Selection		Design Criteria		Management Response		
Program	**Location**	**Priorities**	**Type**	**Goal & function**	**Watershed**	**Monitoring**	**Success Criteria**
MD - MDE	Based on primarily on opportunity; GIS targeting will be important in the future	Key functions; CWAP sites; Prior wetlands; Marginal, non-wooded land, drained forest land	**Forested wetlands;** Landowner choice – emergent #1	Designed w/ surface runoff as source, flood retention, & WQ treatment; NWI/HGM assessment when available	Funding to WO Outreach & coordination through SAMP & WRAS under CWAP & TST	Mitigation = 5yr other depends on funding source	Mitigation = presence of hydric soils & hydrology & wetland plants on 85%; other depends on funding source
VA – DGIF & DCR	Based on voluntary landowner; CREP and other grants sought for priority areas	Prior-converted cropland; functionally destroyed wetlands; Areas with declining WQ; Focal areas for the NAWMP	Landowner & funding source dependent but, emphasis placed on habitat quality & heterogeneity	Designed to provide the highest habitat & migration corridor value w/in the existing ecosystem	The VWRCC (EO 72) is charged w/ coordinating state efforts – goals include C2K; Diverse Partnerships	Qualitative varies w/ funding source	Establishment of functional hydrology & wetland vegetation for 5yrs; Wildlife use; landowner satisfaction
PA - DEP	Opportunity, private land	Return of drained, ditched, or filled wetlands	Project dependent	Contribute to overall WQ; protect ecological integrity of site; provide wildlife corridors	Growing Greener provides funds & support as does PWRP;	All PWRP sites are monitored for at least 5 years	Each project has stated goals and objectives. Success is measured against the achievement of the goals.

	Site Selection		Design Criteria		Management Response		
Program	**Location**	**Priorities**	**Type**	**Goal & function**	**Watershed**	**Monitoring**	**Success Criteria**
DC - DOH	Geographic targeting; most available sites are on NPS land	Tidal wetlands; middle & low marsh; High marsh is avoided due to invasion by exotic species	Tidal wetlands; middle & low marsh	Created for habitat, storm water detention & treatment; Restoration of High marsh not done due to the invasive species threat.	Work closely with various federal agencies but need & seek support form various communities.	A recent project had 3 yrs of monitoring prior to restoration, monitoring is expected to continue.	Undefined; expected to have native plants, wildlife use & uptake of toxins
NGO - CBF	Opportunity, PC cropland, throughout Bay watershed	Headwater areas: first and second order streams	Landowner objectives, water quality benefits	Water quality, wildlife, ecosystem diversity,	Work with diversity of partners including agencies, watershed groups, and volunteers	Annual inspections for structural integrity, invasives. Limited long term, quantitative monitoring	85% coverage by emergent vegetation or 435 woody stems per acre

Acronym Key:

CBF	Chesapeake Bay Foundation
CREP	Conservation Reserve & Enhancement Program
CWAP	Clean Water Action Plan
DCR	Department of Conservation and Recreation
DEP	Department of Environmental Protection
DGIF	Department of Game and Inland Fisheries
DOH	Department of Health
EO	Executive Order
ERC	Environmental Review Committee
GIS	Geographic Information System
HGM	hydrogeomorphic
MDE	Maryland Department of the Environment
NAWMP	North American Waterfowl Management Plan
NGO	Non-government organization
NPS	National Park Service
NWI	National Wetlands Inventory
PWRP	Pennsylvania Wetland Replacement Project
SAMP	Special Area Management Plans
TST	Tributary Strategy Teams
VWRCC	Virginia Wetland Restoration Coordinating Committee
WO	Watershed Organization
WQ	Water Quality
WRAS	Watershed Restoration Action Strategies

2. What is the state of the science available to guide Chesapeake Bay wetlands restoration?

While wetland research continues to cover the gamut from investigations of basic structure and function to very applied design criteria development, the state of the science in providing guidance for wetlands restoration is reflected in two lines of work. One is hydrogeomorphic (HGM) model development. The other is analysis of ecological processes at the scale of landscapes.

HGM model development is being pursued at multiple institutions throughout the Chesapeake Bay watershed. The primary contributions to wetlands restoration efforts include the focus on establishment of “reference” sites that can provide guidance for design and performance expectations of varying types of wetlands. Additionally, HGM models provide a basis for rapid assessment of wetland functions, and can be developed to guide enhancement of existing wetlands through removal of stressors.

Landscape scale studies consider wetlands as one of many elements in a landuse/land cover pattern. The distribution of elements ultimately affects the type and level of potential functions each element can provide. This perspective is beginning to generate models that can have application to wetland restoration, but much of the work remains theoretical.

Brief reviews of some of this ongoing work are contained in two papers generated for the workshop. These are included in Appendix 2.

3. What has been learned from ongoing efforts to restore Chesapeake Bay wetlands?

The practice of restoring wetlands on the landscape can be divided into three general activities: planning, construction, and monitoring. In wide ranging discussions of these three aspects of the undertaking, workshop participants developed a number of consensus observations about the practices to date in the Chesapeake Bay watershed.

<u>Planning</u>
The bottom line in current wetlands restoration programs is acreage restored. Available programmatic resources make other considerations secondary.

Targeting wetlands restoration, in terms of selecting and pursuing optimal locations for cumulative functional value, is not a typical practice in current programs. This is not because practitioners are unaware of the issue, or because they are uninterested in the outcome. Current program activities are driven primarily by opportunity to create or restore acreage. Landowner willingness, suitable conditions, and available resources – the “practical” considerations in creating or restoring a wetland - overwhelm all other factors in determining where program efforts will be directed.

Efforts to be more proactive in using emerging science or even best-professional-judgement to target restoration are hampered by a number of constraints. Available program resources are a universal limitation. Analyzing landscapes to select optimal sites, working with property owners to gain access, and managing surrounding landuse to preserve benefits are actions that require personnel, funding, and authority beyond the capacity of most existing programs.

Construction

Workshop participants identified two key factors in "successful" wetlands restoration efforts: experience and suitable location.

Interestingly, restoration practitioners agreed that having a project managed on-site by someone with experience in creating/restoring wetlands was far more important than sophisticated design or detailed criteria. The necessity of responding to emergent site conditions and avoiding creation of maintenance problems is best addressed by engaging experienced personnel.

Both short-term and long-term success in wetlands creation/restoration are significantly increased by choosing a site which might naturally support a wetland. This seemingly intuitive observation has been repeatedly confirmed by experience. Engineering solutions to inappropriate hydrologic conditions or uncharacteristic soils are risky, and can pose long-term maintenance difficulties. For a wetland restoration to be truly "sustainable" site suitability must also consider site protection authority and potential for landscape change.

Monitoring

Monitoring is critical for both short-term and long-term program success. It should probably be required for much longer than is typical.

There are three reasons for monitoring restored wetlands. Monitoring is the only meaningful way to document a restoration program's performance. It is also essential for validation of design criteria. And, it can enable adaptive management of restored sites (e.g. correcting design or construction mistakes). For these three reasons, a continuous monitoring program needs to be a significant component of any restoration program.

Workshop participants generally agreed that it was important to monitor four parameters at a restoration site in order to meet the three objectives. To actually determine if a wetland has been successfully restored, the three basic identification parameters (hydrology, soils and vegetation) need to be documented. In addition, if any attention is to be paid to wetland function, the monitoring must also record landscape condition (surrounding landuse/land cover).

Many wetland restorations, whether part of a regulatory compensation or a voluntary creation, involve limited-monitoring requirements – typically three to five years. Workshop participants agreed that the normal variation in hydrologic conditions and the normal development of plant communities made three years a bare minimum for determination of success. Five years or more was much preferred. It was agreed that monitoring frequency needed to be relatively high in the first years to allow correction of problems, with longer term frequency declining. A commitment to long term tracking was key however, to real utility of monitoring programs.

Interesting Ideas

Discussions of existing wetlands restoration programs (i.e., what works and what is needed), brought several items to light which participants believed noteworthy. Among these was the Chesapeake Bay Foundation's recognition that incorporating citizen involvement as an element in their restoration efforts had long term educational benefits, facilitating better resource management practices by creating an informed public. Among the unique elements in Pennsylvania's program is the use of an acreage cap (< 0.5 acres). This cap in conjunction with the standard environmental review for avoidance and minimization of impacts is used to determine an applicant's participation in the in-lieu fee program commonly referred to as the Pennsylvania Wetland Replacement Project. This encourages impact minimization (to get under the cap), and keeps individual restoration efforts at the scale of naturally occurring wetlands. Maryland operates a registry program for property owners interested in restoration, and has developed a watershed assessment program to target restoration needs. Virginia has implemented an adaptive management element in its regulatory program through the Partners for Fish and Wildlife Program.

Short summaries of these program elements, and contact information for each are included in Appendix 3.

5. What should happen next in restoration of Chesapeake Bay wetlands?

Workshop participants were given the opportunity to develop suggestions for consideration by researchers, program managers/legislators, the Bay Program, and policy developers. There were multiple suggestions in each category that were grouped/interpreted by the facilitator as follows.

Research: The ideas for research contributions to wetlands restoration efforts could be linked to the planning, construction, and monitoring elements of programs discussed earlier in the workshop.

Planning

- Develop an inventory of restoration opportunities (a consensus recommendation reflecting the desire to know where restoration is most likely to succeed)
- Develop an inventory/assessment of needs for wetland functions (where in the landscape wetlands can be of significant value)
- Develop riparian wetland sensitivity maps (addresses preservation and enhancement of existing wetland functions -– see policy recommendation section below)
- Develop a comprehensive inventory of wetland resource status and trends (reflects limitations of NWI particularly in ridge and valley areas, and the need for an iterating inventory to track changes)
- Develop socioeconomic models to aid in siting, marketing, and managing wetlands restoration

Construction

- Develop a quick method to predict design: function relationship (a consensus recommendation reflecting the desire for simple guidance on siting and designing a wetland to optimize certain functions)

- Develop wetland reference sites (reflects the utility of HGM models for design and assessment guidance, and the need for sites covering the range of wetland types, settings and condition)

Monitoring

- Inventory and assess accomplishments of existing restoration programs (a consensus recommendation reflecting a desire to have quantitative evidence to guide program evolution)
- Develop remote sensing methods for assessment of restoration efforts (reflects the recognition that monitoring is a task that will constantly grow, and the need for a rapid, validated methodology)
- Develop monitoring tools such as biological indicators and wetland function assessments

Program managers/legislators: Recommendations for this group focused on resource needs to meet existing policy goals.

- Additional program staff and funding (this was a consensus recommendation and reflects the sense that programs generally have about one half of the resources necessary to truly achieve the "no net loss/net resource gain" goals for both acreage and function)
- Increased public education and marketing of restoration programs
- Support for centralized data base and geographic information system development

Chesapeake Bay Program: Suggested activities fell in three areas all reflecting a focus on multi-state efforts.

Policy advocate/education

- Lobby for relevant program continuance/expansion at the federal level (a consensus recommendation reflecting the dependence of goal attainment on numerous federal programs)
- Provide education outreach to public and local governments (reflects the need to expand public support for restoration efforts)

Coordination

- Provide a forum and facilitate communication among partners (a consensus recommendation reflecting the advantage of sharing experience and ideas)
- Facilitate development of consistent data analysis protocols (responds to the problem of variation among program definitions and procedures)
- Maintain a restoration program accomplishment data base (clearly a Bay watershed level activity)

Technical resource

- Facilitate development of consistent GIS data layers (recognizes the benefits of advocacy for common data needs)
- Develop technical guidance (recognizes the efficiency in shared efforts to address common needs)
- Provide evaluation of completed projects (recognizes the benefits of objective and consistent information)
- Develop research support (reflects limited resources to support research funds in most state programs)

Policy: Ideas for new or amended policy for wetland resource management centered on two strongly supported concepts.

- Treat wetlands as part of larger system (a strong consensus that this was critical to effective attainment of existing policy goals) There were two relevant suggestions here:
  1. manage wetland resources at a watershed or subwatershed scale; and
  2. work to achieve consistency among resource management programs.
- Concentrate on improvement of condition of existing wetlands (a strong consensus reflecting research findings that much can be gained in wetland values by mitigating factors that reduce function) There were two relevant related suggestions here:
  1. improve protection of existing wetlands (reduce probability of direct impacts); and
  2. implement a program of wetland BMPs (manage indirect/secondary impacts associated with surrounding landuse practices).

APPENDICES

1. Questionnaire responses from Maryland, Virginia, Pennsylvania, the District of Columbia, and the Chesapeake Bay Foundation
2. State of the Science papers:
   - Denice Wardrop. Integrating wetland inventory, assessment, and restoration for watershed: Optimizing benefits from wetlands restorations. Penn State Cooperative Wetlands Center, Penn State University.
   - Jennifer Newton and Carl Hershner. Wetland restoration: Landscape considerations for design and function. Center for Coastal Resources Management, Virginia Institute of Marine Science.
3. Interesting Ideas from existing wetland restoration programs.
4. Workshop Participants List

Appendix 1:

Questionnaire responses from Maryland, Virginia, Pennsylvania, the District of Columbia, and the Chesapeake Bay Foundation

Maryland Department of the Environment
Information provided by Denise Clearwater
dclearwater@mde.state.md.us

Site Selection:

1. What criteria do your state or federal wetland restoration programs use to select restoration sites (e.g. geographic targeting vs. opportunity)?

Maryland uses a combination approach of targeting and opportunity. Targeting has begun using a GIS approach to identify technically suitable areas. There will be greater emphasis on targeting to restore particular functions. Priority watersheds under the Clean Water Action Plan have also been targeted. However, interested landowners are assisted with technical and financial support.

2. Identify some of the problems and solutions encountered when applying these site selection criteria.

Better data layers are needed for GIS targeting, such as a digital soils information and elevation data. More funding, particularly for non-agricultural lands, is needed along with additional staff.

Former wetlands or marginal, non-wooded lands are preferred sites. A reliable source of hydrology, from groundwater or over-bank flooding is needed. Seasonal high ground water is usually within 1-2 feet of the surface. Many federal projects follow SCS or interagency recommendations or standards.

Design Criteria:

3. Once a site has been selected, what evaluation methods and planning criteria do your state or federal wetland restoration programs use to design a wetland restoration project (e.g., wetland type, hydrology and landscape)?

See above. Forested wetlands are usually preferred by MDE or DNR but ultimately the design reflects landowner interests. Landowners most often want wildlife, usually waterfowl habitat. The majority of wetlands voluntarily created, restored, or enhanced in Maryland are emergent. Most wetlands replaced through mitigation are forested.

Watershed Management:

4. Describe some of the efforts of your state or federal wetland restoration programs to integrate wetland restoration with the efforts of community watershed groups, and other state and federal agency efforts that support watershed-based restoration.

There are several funding sources available to watershed organizations for restoration. Community groups are also solicited in targeted restoration areas. Increased outreach and coordination is expected through Watershed Restoration Action Strategies under the Clean Water Action Plan and overall voluntary restoration efforts through the Tributary Strategy teams. An increase in coordination is expected to occur through recommendations of the Governor's Wetland Restoration Steering Committee and the Maryland Wetland Conservation Plan.

5. How are landscape and ecosystem function criteria being incorporated into restoration projects?

Projects may be designed to receive surface runoff as a hydrology source, flood water retention, and to treat for water quality. More refined criteria are expected to be developed in the near future. A recent study by the U.S. Fish and Wildlife Service has adapted the National Wetlands

Inventory classifications to provide a coarse hydrogeomorphic assessment of wetland function. The study was limited to parts of the lower Eastern Shore.

Monitoring Approach:

6. Indicate the scope of your wetland restoration monitoring programs (e.g., what parameters, how often and how long).

Monitoring is done in accordance with the pertinent funding entity requirements. For mitigation projects, there is a 5-year monitoring period in which hydrology, soils, and vegetation are evaluated.

Success Criteria:

7. What criteria do your state or federal wetland restoration programs use to determine the success of a wetland restoration project?

Success criteria, if any, would be part of the funding entity program. Mitigation project criteria require that hydric soils and adequate hydrology be present, and that 85% of the site support an acceptable wetland plant composition.

Management Response:

8. Indicate the major management and data gaps affecting your state or federal wetland restoration programs and how they are being addressed.

Management recommendations and gaps are being identified by a Governor-appointed Wetland Restoration Steering Committee. Data gaps include lack of detailed statewide soils mapping and digital elevation data. Restoration sites reported to the State often lack location information. There is also much less funding available for restoration of non-agricultural lands.

The Wetland Restoration Steering Committee reports that landowners are concerned about future regulatory authority over voluntarily created wetlands, and that this is a disincentive. Federal and state regulations do allow resumption of agricultural activities on farmland voluntarily converted to wetlands through most cost share programs.

Recommendations are presented in an annual report with specific action items to be undertaken by State agencies. Recommendations will also be part of Maryland's Wetland Conservation Plan. In order to advise landowners of funding opportunities, a guidebook of funding sources and contacts has been prepared. Information is also available online.

The Governor has issued an executive order directing each State agency to integrate wetland restoration into existing programs and land holdings where feasible.

Additional targeted public outreach is planned.

Funding programs will be evaluated for efficiency and effectiveness and recommendations will be made for improvement.

Virginia Department of Game and Inland Fisheries
Information provided by David Norris
dnorris@dgif.state.va.us

Site Selection:

1. What criteria do your state or federal wetland restoration programs use to select restoration sites (e.g. geographic targeting vs. opportunity)?

The current Virginia Wetland Restoration Program is voluntary with the exception of state land-owning agencies. Therefore the opportunity for restoration is largely in the form of volunteer landowners that enter into cooperative agreements with a state or federal agency. Landowners contact either the Department of Game or Inland Fisheries or one of our partner agencies for assistance in restoring wetlands on their property. Department Biologists then work with the landowner to design a project that fits our objectives as well as those of the landowner. We also attempt to target certain areas within our state for restoration. In these areas we intensify efforts through our partnerships with other agencies thereby increasing manpower and available resources. Targeting is typically undertaken on a watershed basis, usually under the auspices of a larger regional program such as the Chesapeake Bay Program or Coastal Zone Management Program. Most of these watersheds have impaired or declining water-quality or are focal areas for the North American Waterfowl Management Plan. Grant funding is sought wherever possible to assist in the process. Other factors that play a role in site selection include the presence of hydric soils, evidence of man induced impacts to the site such as draining and ditching, position of the site in the landscape, topography, watershed, current wetland status, and current land use. Generally prior-converted cropland or functionally destroyed wetlands are preferred sites for wetland restoration projects as these areas have the highest potential for success.

2. Identify some of the problems and solutions encountered when applying these site selection criteria.

A voluntary program does not allow the multiplication of benefits that watershed-targeting presents. By concentrating effort and resources in one watershed, the benefits to that watershed can be increased. The opportunity to educate the local landowners in the available programs is increased and recruitment of additional landowners may be facilitated.

We have observed that the construction of a successful project in an area produces interest in additional projects in that area. The landowners talk with each other and satisfied customers let other individuals know about the assistance received. This helps concentrate projects and increases benefits to watersheds. Additionally, targeting programs to geographic locations can result in accepting marginal projects simply because they are located in the "preferred" area. More viable Projects outside of the targeted watershed may not be restored, even if they have more functions than approved projects in targeted areas. The lack of emphasis on non-target areas may also cause desirable projects to remain overlooked, resulting in lost restoration opportunities

Design Criteria:

3. Once a site has been selected, what evaluation methods and planning criteria do your state or federal wetland restoration programs use to design a wetland restoration project (e.g., wetland type, hydrology and landscape)?

Under Virginia's voluntary program projects are frequently located on private land. In these projects the landowners' considerations have to be included in the final design. Generally the landowner will need specific habitat objectives or water quality objectives addressed with the project. These typically shape the planning criteria and evaluation of the success of a completed project. Additionally, The funding mechanism selected for the project typically has constraints *upon the type of wetland restored. This will in turn influence the type of wetland constructed. The Virginia Wetland Restoration Program seeks to incorporate an eco-regional approach to the extent the constraints of a voluntary process allow. It is preferred that restored wetlands be integrated into the mosaic of habitats present within the watershed and surrounding landscape. Emphasis is placed upon habitat quality and heterogeneity as an adjunct in facilitating biodiversity. This approach seeks to provide corridors of high quality habitat for nesting cover, forage and other functions critical to a healthy ecosystem, rather than the more simplistic approach of re-establishing a pre-disturbance condition.*

Watershed Management:

4. Describe some of the efforts of your state or federal wetland restoration programs to integrate wetland restoration with the efforts of community watershed groups, and other state and federal agency efforts that support watershed-based restoration.

Governor Jim Gilmore issued Executive Order 72(00) on October 26, 2000 (See http://www.thedigitaldominion.com/press.cfm). This order establishes the Virginia Wetland Restoration Coordinating Committee, which under the leadership of the Department of Game and Inland Fisheries (DGIF) and the Department of Conservation and Recreation (DCR) is charged with the coordination of the various state wetland restoration efforts. The committee is comprised of the major land owning, regulatory, and natural resources management agencies. Representatives of these agencies meet on a frequent basis to coordinate their restoration efforts to fulfill the restoration goals of the Commonwealth. These goals include the Chesapeake Bay Program commitments and the community based efforts to achieve them.

Additionally we have since 1989, and continue to, partner with a diverse group of other organizations to restore wetlands in Virginia. These include The United States Fish and Wildlife Service, The Chesapeake Bay Foundation, The Nature Conservancy, Ducks Unlimited and similar organizations. In the course of our partnerships, groups such as The United States Fish and Wildlife Services' Partners for Fish and Wildlife Program and Ducks Unlimited have written grants for support of watershed based restoration. These grants have allowed the partners to emphasize advertising, manpower and money into the targeted watersheds.

5. How are landscape and ecosystem function criteria being incorporated into restoration projects?

Within the constraints inherent with a voluntary program, landscape and ecosystem function are incorporated in several ways. These include but are not limited to the following steps. First a review of the existing ecosystem within the drainage is undertaken using available digital orthography, soil surveys, vegetative surveys, and topographic map tools. Secondly, an attempt is made to determine which wetland type might produce the best qualitative fit within the existing system. Finally, where vegetative augmentation is desirable, selection focuses on native species with high habitat value. Additionally, some areas may be permitted to proceed through a normal sequence of ecological succession in order to provide the broadest ecosystem benefits. Ultimately, where it is feasible, emphasis on corridors, which facilitate the unimpeded migration of organisms, is a priority.

Monitoring Approach:

6. Indicate the scope of your wetland restoration monitoring programs (e.g., what parameters, how often and how long).

Monitoring to date has largely been qualitative rather than quantitative. This is in large measured due to the considerable resources that quantitative monitoring entails both in terms of manpower and equipment. To undertake comprehensive monitoring of a single large project would exhaust *the resources of most natural resource management agencies and impede the restoration process.*

Existing wetland restorations are monitored differently depending on the funding source. Some sites are monitored on an annual basis for several years to determine vegetative response, site hydrology and wildlife use. Other sites are monitored frequently for the first year to determine the same parameters, and then occasionally as opportunity arises, other sites are visited infrequently. Some landowners provide frequent feedback, others provide infrequent or no feedback

Success Criteria:

7. What criteria do your state or federal wetland restoration programs use to determine the success of a wetland restoration project?

Establishing success criteria has been a subject of many debates in the professional wetland community. Frequently the establishment of hydrology and wetland vegetation for a period of 5 years has been the only criteria. While these are not entirely adequate they are expedient and conserve valuable resources for the restoration process. Currently in Virginia, Success of projects is determined by several factors. These include landowner satisfaction, ability of the site to reach the predicted hydrology, wetland vegetation presence, and the use of the site by wetland wildlife.

Management Response:

8. Indicate the major management and data gaps affecting your state or federal wetland restoration programs and how they are being addressed.

At present there are significant data gaps which affect Virginia's Wetland Restoration Program. These include the lack of a comprehensive and accurate wetland inventory by Cowardin Type, lack of a comprehensive GIS based wetland restoration and mitigation database, incomplete digital orthographic coverage, incomplete soil mapping, and the lack of a county by county landowner database/plat map.

The management issues are primarily related to the panoply of state and federal agencies and programs involved in wetland restoration. Each agency has a role but may have differing and conflicting priorities. In Virginia this was partially resolved with Executive Order 72(00), which assigns the state agency leadership role to the DGIF and DCR. Currently DGIF coordinates the staff level operations through a technical workgroup. Unresolvable issues and issues which may require legislative or regulatory changes are brought before the full committee. The largest management issue is due to the necessarily voluntary nature of the program and the need to coordinate private landowner projects with state land projects within the resource constraints. Additionally, the funding priorities of the various state, federal and private programs can differ markedly, making coordinated efforts difficult. Finally, there is limited funding for restoration projects, specifically for land acquisition. It will be very difficult to achieve the acreage goals in the Chesapeake Bay drainage without state agencies having the resources necessary to acquire critical lands within watersheds for restoration, preservation or enhancement.

District Of Columbia Wetland Restoration Program
Information provided by Peter May
pmay@mail.environ.state.dc.us

Site Selection:

1. What criteria do your state or federal wetland restoration programs use to select restoration sites (e.g. geographic targeting vs. opportunity)?

The District's program primarily selects restoration sites based on geographic targeting. In the District, there are very few places which are open to non-tidal wetland restoration particularly and those open to tidal restoration have mostly been restored or are currently identified and being targeted for restoration.

2. Identify some of the problems and solutions encountered when applying these site selection criteria.

Much of the lands available for wetland restoration, tidal and non-tidal, are on National Park Service Property. This constitutes another level of approvals and input. Additionally, many District parklands were given to the Districts Parks and Recreation by the National Park Service with the criteria that the land only be used for recreation. Special approval is required for use as stormwater detention and treatment or habitat restoration. A close working relationship and ability to compromise with the NPS is crucial to moving potential projects forward.

Design Criteria:

3. Once a site has been selected, what evaluation methods and planning criteria do your state or federal wetland restoration programs use to design a wetland restoration project (e.g., wetland type, hydrology and landscape)?

The majority of wetland restoration projects planned and implemented by the District are in tidal areas. Identifying and implementing the proper elevational grade for suitable tidal depth of inundation of vegetation zones is crucial. It has been determined that high marsh zones only create suitable habitat for invasive exotic plant species and efforts to create more middle and low marsh types are made.

Watershed Management:

4. Describe some of the efforts of your state or federal wetland restoration programs to integrate wetland restoration with the efforts of community watershed groups, and other state and federal agency efforts that support watershed-based restoration.

The District, by its very nature, must work closely with federal programs and entities to implement projects. The National Park Service, US Army Corps of Engineers, US Geological Survey and US EPA to name a few which contribute funding, lands, implementation and technical expertise.

Increasingly, watershed based and neighborhood community groups have become an active part of levels of the restoration planning process. The Kingman Lake and Island restoration projects have been incorporating local input and support.

The proposed fringe marsh project expects to incorporate the views of the River Terrace Community as a major targeted fringe site is just outside its doorsteps. A stormwater quality and quantity wetland infiltration area on DC parks and recreation land is currently being proposed to the adjacent community and will go nowhere without their support.

5. How are landscape and ecosystem function criteria being incorporated into restoration projects?

In an effort to reduce the influence of invasive exotics on tidal wetland restoration projects, high marsh vegetative zones are no longer being created with current and future restoration projects. Several unavoidable nontidal wetland losses have been mitigated for in the immediate area of the wetland loss with a similar wetland type.

Monitoring Approach:

6. **I**ndicate the scope of your wetland restoration monitoring programs (e.g., what parameters, how often and how long).

For the most recent tidal wetland restoration project at Kingman Lake, a minimum of three years of benthic macroinvertebrate, fish, plankton, bird and water quality surveys were conducted prior to implementation. It is expected that a five year post implementation monitoring plan will be carried out as had been completed by an ad hoc group after the 1993 implementation of the Kenilworth Marsh Restoration. A coordinated effort from other federal, local and university entities will cover vegetation, sedimentation, and wildlife, toxics accumulation and other parameters.

Success Criteria:

7. What criteria do your state or federal wetland restoration programs use to determine the success of a wetland restoration project?

Currently, a successful wetland restoration project is not specifically defined. The persistence of native emergent vegetation, documentation of the utilization of the area by wildlife and analysis of potential toxics accumulation and uptake are all loosely expected to be used to evaluate the relative success of the project.

Management Response:

8. **I**ndicate the major management and data gaps affecting your state or federal wetland restoration programs and how they are being addressed.

Major issues affecting wetland restoration programs are the consistency of data reporting and the availability of funds and staff to cover all of the needed monitoring needs for pre and post restoration implementation. A major deficiency in monitoring is sufficient evaluation prior to restoration, especially in the case of tidal wetland restoration activities. Currently, pre and post restoration monitoring is addressed through an ad hoc group of federal local and university entities who either fund their own monitoring through program funds and grants or a bid for limited funds allocated for monitoring through the restoration funds. Pre restoration monitoring is often not fully funded through the restoration project funds.

Pennsylvania Department of Environmental Protection
Information provided by Kelly J. Heffner
717-772-5970

Site Selection:

1. What criteria do your state or federal wetland restoration programs use to select restoration sites (e.g. geographic targeting vs. opportunity)?

The goal of the Pennsylvania Wetland Replacement Project (PWRP) is to replace wetlands lost through permitted actions in each of the 20 major subbasins identified by the Pennsylvania State Water Plan.

Other volunteer efforts are opportunity based taking into account site conditions and landowner interest.

Potential mitigation sites are field reviewed for:

- *a) Hydrologic features*
- *b) Soil type*
- *c) Topography*
- *d) Old field with early succession plant communities*
- *e) Barren/open land*
- *f) Landscaped, managed areas*
- *g) Disturbed lands*
- *h) Prior-converted cropland as determined by NRCS*
- *i) Lands with any recorded and/or observation alterations to hydrology that can be reversed to allow restoration*
- *j) Intermittent drainage*
- *k) Lands converted through drainage or minor filling*

The site should have at least one, preferably more, of the following sources of water:

- *a) Seasonal high water table*
- *b) Perennial stream on site that contributes to overbank flow*
- *c) Connection to other wetlands or surface waters*

2. Identify some of the problems and solutions encountered when applying these site selection criteria.

Wetland restoration sites are located where there is a willing volunteer landowner, and the presence of suitable soils, hydrology and topography.

Design Criteria:

3. Once a site has been selected, what evaluation methods and planning criteria do your state or federal wetland restoration programs use to design a wetland restoration project (e.g., wetland type, hydrology and landscape)?

Projects should be self-sustaining and use natural construction materials whenever possible.

Watershed Management:

4. Describe some of the efforts of your state or federal wetland restoration programs to integrate wetland restoration with the efforts of community watershed groups, and other state and federal agency efforts that support watershed-based restoration.

The Pennsylvania Department of Environmental Protection's watershed approach is community based, locally driven and specific to the needs of the local watershed. Backed by over $250 million of state funds for the next four years, the Growing Greener program enables local watershed groups to plan and implement cost effective best management practices to support and attain the Commonwealth's water quality standards. Wetland protection, restoration and creation are critical components of effective watershed management in Pennsylvania.

5. How are landscape and ecosystem function criteria being incorporated into restoration projects?

Sites are selected that require only minor alterations to provide proper hydrology and the successful creation of the desired habitat. Restoring former wetland sites with the hydrology in place increases the change of restoring the wetland function.

Monitoring Approach:

6. Indicate the scope of your wetland restoration monitoring programs (e.g., what parameters, how often and how long).

Wetland restoration efforts funded by the PWRP are monitored annually by DEP for 5 years. Growing Greener projects are monitored for the duration of the grant period. Monitoring will include photographs, written descriptions of soils, vegetation, areal extent of wetland, associated functions, values, and water quality benefits. The measure of success depends upon how well the projects meet the stated objectives in their approved proposals.

Success Criteria:

7. What criteria do your state or federal wetland restoration programs use to determine the success of a wetland restoration project?

Each project has a stated goal against which project success is measured.

Management Response:

8. Indicate the major management and data gaps affecting your state or federal wetland restoration programs and how they are being addressed.

PA DEP publishes an annual report on wetland restoration/creation efforts as part of its net gain strategy. A standardized data form has been developed for use by partners to report their wetland restoration/creation projects. Occasionally this data is late or incomplete. DEP then follows up to ensure that all data is accurately reported.

Chesapeake Bay Foundation
Information provided by Bill Street and Rob Schnabel
RSchnabel@savethebay.cbf.org
Bstreet@cbf.org

Site Selection:

1. What criteria do your state or federal wetland restoration programs use to select restoration sites (e.g. geographic targeting vs. opportunity)?

The program is opportunistic depending on volunteers for both labor and restoration sites. CBF is focusing its restoration efforts in three watersheds: Pequea Mill Creek, PA, Shenandoah, VA, and the Lower Eastern Shore, MD. Priority sites include headwater areas with hydric soils, ditched prior-converted wetlands, tiled prior-converted wetlands, and grazed wetlands.

2. Identify some of the problems and solutions encountered when applying these site selection criteria.

The main problem encountered is the desire to restore entire systems coupled with the means to restore only system components. CBF is meeting the challenge with the Chesapeake Bay Conservation Planning Network and CBF targeting to enhance cumulative benefits to the entire system.

Design Criteria:

3. Once a site has been selected, what evaluation methods and planning criteria do your state or federal wetland restoration programs use to design a wetland restoration project (e.g., wetland type, hydrology and landscape)?

CBF uses the following methods to restore and/or enhance wetlands: ditch plugs, low earthen berms, excavation, and fencing to reduce the impacts from grazing.

Watershed Management:

4. Describe some of the efforts of your state or federal wetland restoration programs to integrate wetland restoration with the efforts of community watershed groups, and other state and federal agency efforts that support watershed-based restoration.

CBF integrates education, outreach, and advocacy into all programs including wetland restoration. CBF utilizes its 6,250 volunteers, local watershed groups and partners like Ducks Unlimited, and restoration programs like the Conservation Reserve and Enhancement Program (CREP) to maximize efforts.

5. How are landscape and ecosystem function criteria being incorporated into restoration projects?

These projects are targeted restoration projects. State and County agencies have completed watershed assessments and are prioritizing projects. One example is the work DNR is doing in the Little Pipe Creek watershed (Monocacy River drainage). DNR has approximately 10 projects scheduled between Westminster and Union Bridge. After these projects are complete, the goal is to make this area a greenway.

Monitoring Approach:

6. Indicate the scope of your wetland restoration monitoring programs (e.g., what parameters, how often and how long).

CBF does not monitor all 1,650 projects however; annual inspections are conducted on selected sites. Monitoring activities include measures of structural integrity, general wetland development, and invasive species as well as measures of biological, chemical, and physical components.

Success Criteria:

7. What criteria do your state or federal wetland restoration programs use to determine the success of a wetland restoration project?

85% coverage by 5th year for emergent wetlands
435 woody stems per Acre for shrub/scrub and forested wetlands

The goal is to also create a wetland that has high value and provides the desired function, for ex. Flood water desynchronization

Management Response:

8. Indicate the major management and data gaps affecting your state or federal wetland restoration programs and how they are being addressed.

The major management/data gap is the lack of progress toward system restoration as opposed to restoring single components within the system. Other gaps include design criteria to maximize water quality benefits and effective management of activities across the watershed including water quality benefits outside the Coastal Plain. An understanding of long-term succession of the entire system is also needed.

Appendix 2:

State of the Science Papers

Integrating Wetland Inventory, Assessment, and Restoration for Watersheds:
Optimizing Benefits from Wetlands Restorations

Penn State Cooperative Wetlands Center
301 Forest Resources Laboratory, University Park, PA 16802

Introduction

Optimization of wetland restoration can be approached on a number of fronts, and at a number of scales. Certainly, an overall framework is necessary into which various tools can be inserted. States and regional groups have developed these according to individual constraints and opportunities, and it is obvious that no single approach would satisfy all. From a technical perspective, it would seem most helpful to describe individual "tools" that have recently been developed, and that could be utilized within existing policy frameworks. The survey strikingly points to the need for assessment techniques that maximize opportunities within a watershed. In this vein, I'll describe a family of recently tested tools from the CWC, including the following:

- An approach that recognizes the need to acquire information for three separate, but integrated tasks; inventory, condition assessment, and restoration.
- In order to accommodate differences in resource availability among various agencies and organizations, there are three levels of effort for each of the three tasks, with increasing confidence in decisions made based on those levels of effort.
- The use of reference wetlands in both processes.
- The incorporation of TMDLs into wetland restoration.

Our overall goal is to make this approach operational in the state of Pennsylvania, USA, during the next few years. A pilot application of the approach is being conducted in several watersheds to both begin the assessment process for those watersheds, and to train agency staff.

The Process

The overall process is diagrammed in Figure 1, and begins with construction of a synoptic watershed map containing the best available wetlands inventory information. A synoptic map provides an overall visual representation of the watershed. We have modified the synoptic approach developed by Leibowitz et al. (1992) due to differences in the availability of remotely sensed data. We recommend that synoptic maps display at a minimum the most current land use and land cover data available. Although land use patterns do not completely describe disturbance levels, they are usually highly correlated (Brooks et al. 1996, Wardrop et al. 1998, O'Connell et al. 2000). A synoptic map provides a set of baseline conditions for comparing long-term changes, whether these changes involve degradation or restoration. The map can help identify potential landscape-level threats to parts of the watershed. Targeting of major projects, such as mitigation banks can be facilitated.

Using a digital database for a synoptic map, a set of metrics for spatial analysis can be generated from GIS software programs to characterize the patterns of the landscape (e.g., proportional land cover, connectivity, Brooks et al. 1996, Miller et al. 1997). Recommended resources for developing synoptic maps include:

- current land use and land cover from Thematic Mapper (TM) satellite imagery
- stream network (digitized 1:24,000 blue line database)
- wetlands and water bodies (National Wetlands Inventory digitized 1:24,000 base maps)
- road network (digitized 1:24,000 database)
- topography (Digital Line Graph (DLG) database)
- hydric and non-hydric soils (digitized county soil surveys as available, STATSGO)
- trends data (indicators of expected change, such as land use conversion rates, population growth rates, intensity of landscape use)

Once the synoptic map is assembled, an assessment of wetland condition can occur using only this set of existing remotely-sensed data. The assessment conducted at Level 1 serves as a screening tool to focus on broad areas of concern within portions of the watershed, focusing primarily on proportions of land use around each designated wetland. If the Level 1 wetland inventory is insufficient or too outdated to conduct an assessment, we use landscape-based decision rules that identify areas of high probability for wetland occurrence in which to search. The latter requires ground reconnaissance to locate and classify individual wetlands, and results in an enhanced or Level 2 inventory. A Level 2 assessment combines the land use analysis from Level 1 with a characterization of the area adjacent to the wetland of interest and a checklist of stressors (e.g., sedimentation, eutrophication, see Adamus and Brandt 1990) observed during ground reconnaissance to determine the overall condition of the wetland.

Based on the results from a Level 1 or Level 2 assessment, an estimate of wetland condition becomes available for the target watershed, but the estimate has wide confidence intervals. If this collective set of landscape and site indicators detects a problem or irregular disturbance "signal" within a specific area relative to an established reference condition, then a Level 3 assessment of hydrogeomorphic (HGM) functions and biological integrity (IBIs, Karr 1981, Karr and Chu 1999) can be used to diagnose specific stressors. Data collected during a Level 3 assessment is compared to an existing set of reference wetlands of similar HGM type and condition. The data collection effort for a Level 3 assessment is substantial, and hence, is intended for use only on priority areas in need of protection and restoration.

Selection and Classification of Reference Wetlands

The use of reference wetlands is increasingly more common as ecologists and regulators search for a reasonable and scientific method to measure and describe the inherent variability in natural wetlands (Hughes et al. 1986, Kentula et al. 1992). Using reference wetlands from a wide variety of wetland types, disturbance regimes, and landscape positions allows for that characterization. Although reference sites often represent areas of minimal human disturbance, in some instances it is more useful to represent a range of environmental conditions across a landscape. The primary reason for developing a set of reference sites is the need to compare impacted or degraded sites to a standard set of conditions. These baseline conditions can represent a starting point in time for trend analyses (e.g., long-term successional studies or impact analysis on a group of wetlands). Reference sites can also serve as alternatives to standard experimental controls that are seldom available. Reference sites provide the assessment criteria used in site evaluations. They can be used to set design standards for mitigation plans or provide performance criteria to measure success of projects.

Sites within the reference set should span several gradients. They should include, at a minimum, the common types of wetlands found within a region, and range across the conditions found from relatively pristine (ecologically intact) to severely disturbed sites (degraded ecological integrity and functions). This will provide the data necessary to assess and rank the condition of other sites that are being assessed. If the measurement and establishment of baseline conditions is important for evaluating some anticipated impacts, then this could favor selection of sites either in degraded conditions facing further degradation, or sites with pristine conditions against which relatively minor impacts can be compared. The hydrogeomorphic (HGM) approach is based on characterization of reference wetlands across a wide range of conditions (Brinson 1993, Smith et al. 1995).

Given limited human and financial resources, creating a pool of reference wetlands that satisfies multiple objectives is desirable. Investigators must decide upon the acceptable level of analytical compromise they can tolerate versus the advantages of shared data and resources. Most studies will be able to benefit from some overlap among populations of reference sites. Once established, a set of reference wetlands can be used to set the standards by which wetland creation and restoration projects can be judged.

Since 1993, the Penn State Cooperative Wetlands Center (CWC) has established and studied a set of reference wetlands; the current total is approaching 200. Reference wetlands were chosen according to three criteria. First was long-term access, which suggested use of sites on public lands or on private lands with a written agreement from the landowner and an expectation of continued access if ownership changed. The CWC secured access agreements in all cases, with most sites being located on public lands. Second, the CWC emphasized wetland types and landscape settings that are most commonly impacted during the permitting process or prescribed under permit conditions. In general, these are HGM subclasses without significant amounts of open water. Third, sites were selected primarily at random. Randomized selection procedures should be followed during an assessment of wetlands for any given watershed. To ensure that all major HGM subclasses of wetlands were represented in our reference set, however, we selected individual wetlands from a pool of sites across a disturbance gradient. Also, part of our set of reference sites contained sites previously studied. Photographs and descriptions of many of our wetlands can be viewed on the web site, www.wetlands.cas.psu.edu.

Based on the observed characteristics of our original set of 51 reference wetlands and preliminary information received during the evolution of the Corps' HGM program, we developed a regional HGM classification key for the inland freshwater wetlands of Pennsylvania, with further relevance to other Mid-Atlantic states. This dichotomous key is used to designate the HGM subclass based on examination of field characteristics (Brooks et al. 1996, Cole et al. 1997). Classifying by HGM is not enough; one should link or modify regional HGM schemes to include wetland vegetation types (Cowardin et al. 1979) and disturbance levels. As with any classification system, there is overlap among subclasses, but if recognized, this aspect does not nullify the benefits of using the approach as proposed. Professional judgment must be used to select the best possible match to a subclass. Most actual wetlands contain a mix of water sources and vegetation communities, and hence, will not result in perfect correspondence with reference subclasses. Usually a single HGM subclass will dominate a wetland site, but in some cases, two or more HGM subclasses will be present.

Incorporation of TMDLs

The use of TMDLs as a part of an overall restoration program is in the early stages of development, but TMDLs could prove to be a useful approach for optimizing restoration efforts. In conjunction with Pennsylvania DEP, we have postulated the following scenario to illustrate how the process might proceed utilizing the three-level approach described previously:

Level I

- Select a watershed for assessment
- Sample 50 points from NWI
- Analyze landscape circles based on sites
- Compare results to those from other watersheds in the same ecoregion
- Prioritize top 20% watersheds of concern

Level II

- In the selected watershed, and using the same points, conduct Level II assessments
- Level II assessment provides a distribution of scores for sites; identify lowest category of site scores
- Based on stressor diagnosis and site visits, we find that the predominant HGM type of the lowest category sites is headwater floodplain in agricultural land use setting.
- Coordinate with other agencies and programs, integrate various BMPs for HWFP in agricultural setting (TMDL is off-the-shelf)

Level III

- Utilize HGM and IBI assessments for site-specific or highly controversial TMDLs

The process repeats as necessary.

Conclusion

This comment document outlines a proposed approach to targeting opportunities for wetland restoration in a watershed context and optimizing those opportunities, when appropriate. The CWC is currently testing these approaches to demonstrate their feasibility and effectiveness.

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Wetland Restoration: Landscape Considerations for Design and Function

Jennifer Newton and Carl Hershner
Center for Coastal Resources Management
Virginia Institute of Marine Science

Wetland restoration is a noble endeavor, an "act of human creativity" as Barbara Bedford says in her 1999 *Wetlands* contribution. Recent work suggests, however, that the caliber of our creations would be greatly improved if we were to undertake several steps to further our "artistic" abilities

- Thinking big – Considering the larger scale while designing at the project level is crucial to successful restoration. Many of the commentaries on how wetland restoration projects fail, point to the lack of recognition of the wetland within its larger landscape context as the reason (e.g., Brinson, 1993; Zedler, 1997; Bedford, 1999). Most scientists would agree that the appropriate scale at which to think is the watershed. Recognition of large-scale hydrologic processes, for example, can be critical to successful restoration of wetland conditions.

- Balancing components – Just as there are general rules of visual harmony, so there are some generally defined ecological considerations that should be taken into account if wetland construction is to function fully in the landscape. The relationship between wetlands and surrounding land uses is defined as much by proportion and pattern as it is by area and type.

- Planning for sustainability – Accounting for the certain and probable changes that will occur through time is basic to long term success. There are fundamental factors restorers must consider in both what restoration efforts are possible, and which will remain stable given the climate, hydrology and geology of the restoration site and it's landscape setting.

- Learning from nature - There is much to be learned from the body of wetlands that are already in the landscape, even those that are degraded. Current thinking on this suggests the use of reference wetlands to guide restoration projects, for three reasons: 1. Information gained from observing reference wetlands can help in the planning of restoration efforts to help decrease the likelihood of failure. 2. Comparing restoration wetlands to reference wetlands can help illuminate whether or not a wetland is "functional." 3. In the case that a restored wetland is not functioning to the standard of reference wetlands, comparison can help suggest further alterations that need to be made to the restored site (Whigham, 1999).

Restoration Objectives

If the effort is to restore loss of function, one must be able to categorize both patterns of loss and degradation within the watershed to assess what functions need to be replaced. An important question is whether to replace functions lost in a specific project, or functions lost historically in the watershed (Zedler 1997). Another alternative is to attempt restoration of some "most needed function" within the current context of the watershed.

Additionally, the scale of project planning depends on whether the objective is mitigation for a degradation of a wetland or degradation of the surrounding landscape. Degradation in the form of fragmentation, creation of "hostile" surrounding landuse, toxic or nutrient influxes, exotic invasions, loss of connectivity with other wetlands or critical landuse types all will necessitate different planning scopes

Design Guidance

Restoration projects need to include landscape considerations that determine how a wetland will function and constrain a wetland's ability to be self-sustaining. These considerations must include the climactic and geologic settings that mediate both hydrology and mineral/nutrient concentrations found at the site. These in turn influence the wetland's ability to perform target functions. When undertaking restoration efforts, function often follows form.

There are two models currently in use that provide a framework for designing wetland restorations according to these considerations: the hydrogeomorphic model and the hydrogeologic model. Use of these models, may be considered more appropriate for guiding restoration than the ubiquitous NWI Cowardin classification, that was originally created for the purpose of identifying habitat types.

Hydrogeologic Model – Identifies factors that determine what kind of wetland can be restored and maintained at a given site. The approach views entire landscapes in terms of underlying geologic formations and overlying soil types. These parameters combined with topographic features, and coupled with evapotranspiration rates, will affect how water from precipitation moves through a landscape (Winter 1988). The three main factors used for assessment are: 1) regional climate, which drives precipitation and evapotranspiration rates; 2) hydrologic setting in terms of flows of surface and ground water; and 3)geologic characteristics of the site and surrounding area (Bedford, 1999). These, in turn, determine the biological and functional diversity of wetlands in the landscape. Vegetation and subsequent faunal assemblages are seen as outcomes of the long-term interaction of climate and landscape - "If you build it (properly), they will come". (There is some research on use of seedbanks as a mechanism for enhancing predictability and speed of outcomes (e.g., DeBerry and Perry 2000, Whigham 1999)). One of the benefits of the hydrogeologic system of classification is that biogeochemical processes and nutrient retention behavior are better predicted by hydrogeological parameters than by typical vegetation classifications of wetlands (Hill and Devito1997 in Bedford 1999; Lent et al. 1997).

> *A corollary to this approach, however, is that one must consider the system as a whole. The underlying assumption is that changes made in the hydrology of one area will affect the hydrology in others. In practice this involves not only looking at alterations such as dams, levees, channelization and groundwater withdrawal, but also considering the effect of the restoration project on hydrologically linked areas (Winter 1988)*

Hydrogeomorphic Model (HGM) - The basic premise of this approach is classification of wetlands according to their biogeochemical processes and functioning. While also primarily landscape based, HGM places greater emphasis on the wetland itself than the hydrogeologic model does. HGM employs greater definition of hydrodynamics, establishing both the strength and direction of water movements in and through a wetland. The purpose is identification of a wetland's ability to transport sediments, nutrients and other substances within, as well as to and from the site (Bedford, 1999). The utility of using this system to guide restoration efforts is the focus on wetland function, which is frequently the objective of restoration. HGM classifies wetlands in terms of three components: geomorphic setting, water source, and hydrodynamics. The six main classes of wetlands for HGM models are riverine, depressional, slope, flats, estuarine fringe and lacustrine fringe. Wetland functions such as nutrient cycling, groundwater recharge and biodiversity are defined for each class based on position of the wetland within the landscape, the primary source of water to the wetland and the direction of water movement within the site (Whigham 1999; Rheinhardt et al. 1997)

HGM Reference Sites - Given the complex nature of ecological systems, HGM relies on reference sites to establish observable parameters correlated to wetland functions. Reference sites can be compared with restoration projects to assess functional ability and stability of restored sites (Zedler 1997). Sites with similar hydrogeomorphic settings can be compared, using reference sites chosen for high levels of sustainable functioning, to set standards for both restoration planning and monitoring (Brinson and Reinhardt 1996). There is an increasing body of literature on the use of reference sites and templates for wetland restoration projects (e.g. Brinson and Rheinhardt 1996; Rheinhardt et al. 1997; Rheinhardt et al. 1999; Bedford 1999).

Consideration of Landuse Pattern

Ideally, a descriptive and predictive model of ecosystem dynamics could illuminate key areas within a watershed critical to maintaining system integrity and areas most suitable for wetland restoration efforts. While modeling capabilities are not yet so precise, work on many topics such as landscape ecology, patch dynamics, metapopulation dynamics, and impact assessments can help in identification of key areas and patterns within landscapes which need to be restored to promote ecosystem integrity.

One key factor emerging from these studies is the landscape scale at which effects of wetland loss or creation are realized. Much concern has been raised that the current site by site approach to wetland permitting allows piecemeal destruction of wetland systems across landscapes. Narrowly focused impact reviews do not consider potential cumulative effects at scales beyond project boundaries. These effects are often not explainable by simple addition of individual project impacts (Hemond and Benoit 1988). Cumulative effects need to be assessed in terms of number, type, and areal extent of losses, and should include consideration of wetland placement within a watershed.

Dahl (1991) cites "ponds" as the only wetland type increasing in U.S. Bedford (1999) notes that the type of freshwater emergent wetlands most commonly created, the cattail marsh (*Typha spp*.), is also the type that typically evolves in degraded wetlands. The consequence of this trend is skewing the resultant mix of wetlands in the landscape towards one predominant type. Moreover, this type is often constructed in areas where such wetlands would not occur naturally. This results in the issue of "no net loss" of acreage not resulting in an equivalent "no net loss" of function. The wetland types most affected by this conversion through mitigation are isolated and headwater wetlands.

Water Quality

Nutrients and toxics can enter wetlands from either adjacent upland areas or flooding by adjacent bodies of water such as rivers or streams. Brinson (1993) calls the former riparian transport, and the latter overbank transport, with riparian transport responsible for most of the nutrient removal and sediment deposition that occurs in wetlands. Since riparian transport is more common the further upstream a wetland is, wetlands in the upper drainage systems are believed to have the greatest impact on water quality. A 1 hectare loss in a lower order stream can have a more detrimental effect than the same loss in a higher order stream (Whigham et al. 1988, Brinson 1993).

Palustrine wetlands have been found to be major sinks for nitrogen, phosphorus and other potential water pollutants (Whigham et al. 1988, Brinson 1988). Phillips et al (1993) found that nitrate concentrations in both ground and surface water are inversely related to the extent of forested wetlands.

Wetlands in riparian areas are particularly valuable as filters of waterborne pollutants transported from adjacent intensively managed landscapes. Isolated wetlands (without an inlet or outlet for water flow) exist in extreme headwater positions with little catchment area or opportunity to interact with upland runoff. This setting results in typically low pollutant loadings. Brinson (1988) suggests isolated wetlands should therefore be considered important to production of good quality water and protected from development that could cause them to lose nutrients to downstream areas.

Saturated wetlands may be particularly efficient at improving the quality of the water passing through them, as maximum exchange between the water and plant roots can occur, resulting in maximum retention of toxicants or nutrients (Hemond and Benoit 1988).

Finally, while fringe wetlands such as tidal marshes may not have great impact on water quality, their value as habitat for fish and wildlife calls for management of upstream wetlands to maintain water quality and protect them from inflows of pollutants (Brinson 1988).

Cumulative impacts are an important consideration in assessment of the water quality functions of wetlands in a landscape. Loss of a wetland not only eliminates the functions that wetland had performed, it places greater burdens on the functional capacity of the remaining wetlands within a drainage system. Filling or draining of a wetland changes it from an area of accretion to an area of erosion, allowing nutrients and toxicants which had been sequestered over time to rapidly re-enter the system (Brinson 1988). As a consequence, the impacts of wetland alteration or destruction go beyond the wetland itself, and may include increased levels of toxicants and nutrients entering the downstream system. Finally, alterations in surrounding land-use can also affect the water balance and the amount of pollutants entering a wetland (Pearson 1994). This can result in a change in efficiency or sustainability of an otherwise undisturbed wetland, and should be considered in efforts to maintain wetland water quality functions.

Habitat

Theories of biodiversity point to preservation of large, pristine tracts of land as the ideal method to maintain high levels of species diversity (MacArthur and Wilson 1967, Diamond 1975). As a result, some researchers espouse building larger wetland tracts to both support species diversity and to reinforce resistance to natural and man-made perturbations (Zedler 1997). However, what may be an isolated fragment of habitat for some species, may provide an important aspect of landscape heterogeneity for more wide-ranging species (Harris 1988). In the southeastern U.S., small isolated wetlands are critical breeding sites for many species of amphibians and can be important nesting and feeding sites for waders and shorebirds (Bradshaw 1991). Canvasbacks (*Aythya valisineria*), whose populations on their wintering ground in Chesapeake Bay are one-fifth what they were 40 years ago, actually prefer to nest in small, semi-permanent wetlands, in stands of cattail, bulrush or whitetop grass (Haramis 1991). Another Chesapeake Bay inhabitant, the wood duck (*Aix sponsa*), depends upon bottomland hardwood forests, shrub swamps, and flooded shrub fringes of forests along small watercourses for breeding (Haramis 1991). Wetland tracts as small as 0.1 acres may, depending on type and location, have significant value in terms of productivity, detritus availability, and habitat (Silberhorn et al. 1974). Many small tracts, including those with low species diversity, can harbor rare species or be one of the last remaining examples of a particular habitat type (Shafer 1995). In James City County, Virginia, Skiffe's Creek and Graylin Woods both provide sites where very rare species of plants exist in wetland habitats as small as 5 and 7 acres (Clark 1993). Such fragments can be cores for habitat restoration. Individuals from these sites can be introduced to other suitable habitats, or cultivated to increase population levels. An important additional consideration is that wetlands may be complete even at small sizes: that is, they are not necessarily fragments of larger wetlands that have been lost or isolated by development. Weakley and Schafale (1994) point out that most of the wetlands found in the Southern Blue Ridge are small (<10 ha), and many are too small to be recognized or mapped on NWI maps with a scale of 1:24,000. Yet these wetlands have great species and community diversity and provide habitat for many rare as well as common plants and animals.

Loss of wetlands not only has an effect on total wetland habitat available, it changes the ecosystem dynamics across the landscape in which they are found. Theories of metapopulation dynamics (Levins 1970, Hanski and Gilpin 1991) may be applied to populations of animals or plants that are isolated in patches of habitat. These patches are, in effect, islands of habitat surrounded by areas inhospitable either due to human development or unsuitable habitat type. The theory argues that while local populations may go extinct, having multiple sources, on other "islands", can serve to rescue, or recolonize the area. It may be argued that since wetlands are often isolated from one another, species making use of these areas are already dispersing some distance between habitats, exhibiting the migration facet of metapopulation theory. This ability of individuals or propagules to move between multiple tracts can protect a population against demographic accidents, genetic erosion, localized environmental change, natural catastrophes and human disturbance (Shafer 1995). While each species will probably have a different maximum dispersal distance (Pickett and Thompson 1978), elimination of small wetlands in the landscape may destroy critical "stepping stones", limiting the ability of species to move between suitable larger wetlands. Species richness of amphibians has been negatively correlated with wetland isolation and road density of the intervening landscape (Lehtinen et al.1999). Semlitsch and Bodie (1998) noted the potential effects of loss of small wetlands on amphibian metapopulations, based solely on dispersal distances. Their results demonstrated that loss of small wetlands may decrease the chance of local population rescue and result in loss of diversity in the regional amphibian fauna. Some areas, such as riparian forests, may act as habitat to some species, and provide a corridor linking habitats for others (Simberloff and Cox 1987, Pearson 1994). Other species, including such highly mobile organismas such as shorebirds, wading birds and waterfowl, need suites of wetland sites within the landscape to accommodate both their within and among season habitat requirements (Haig et al., 1998)

Gibbs (1993) created a simplified spatial model to simulate the loss of all <10 acre palustrine scrub/shrub and palustrine emergent wetlands in a 600 km2 area of Maine. The purpose was to determine the effects of such a loss on metapopulation dynamics of salamanders, newts, frogs, turtles, small birds, and small mammals. He observed elevated extinction risks for turtles, small birds, and small mammals, suggesting that "the presence of small wetlands may be critical for the persistence of certain wetland taxa, particularly those with low population growth rates and low densities."

While most scientists and managers would agree with the concept that to be truly saved, species and habitat must be saved in replicate, current understanding points to the need to consider interaction dynamics between wetlands and other nearby non-wetland habitat as well. Many wetland plant and animal populations depend on aspects of habitats in the surrounding landscapes. Without these complementary habitats, populations can collapse (Pearson 1994, Semlitsch 1998). The presence of wetlands as ecotones in a landscape can also affect plant and animal distributions and diversity in surrounding areas (Risser 1995, Trettin et al. 1994). Management of entire drainage basins, including protection of buffer zones around wetlands, is necessary to increase the viability of some species in wetlands (Semlitsch 1998, Shafer 1995, Holland 1993, Harris 1988). Improved water quality that can result from these buffer zones may be as important for wildlife as maintenance of habitat diversity. This connectivity to upland areas highlights the need for restoration efforts to eliminate barriers impeding the flow of water and movement of animals into and out of the site (Zedler 1997, Winter 1988).

Implementation of Adaptive Management

While current understanding of cumulative impacts, matrix interactions between wetlands, and upland-wetland linkages remains far from complete, there is certainly enough knowledge currently to guide wetland restoration efforts. One of the most important aspects of successful wetlands restoration, however, is recognition of limitations in technical understanding and acceptance of the need to sustain its evolution. This translates to a consistent and meaningful commitment to monitoring of restoration efforts. It also implies a continuing focus on integration of new findings, all to facilitate achievement of the “no net loss” goal.

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Appendix 3:

Interesting Ideas from Existing Wetland Restoration Programs

Maryland:
A registry of Approved Nontidal Wetland Mitigation Sites

Maryland has developed a registry in the form of a GIS map showing sites technically suitable for establishing wetlands and a listing of landowners open to the prospect of allowing mitigation on their land. Applicants for which onsite mitigation is not practicable nor desirable can contact landowners on the registry about using their land for mitigation. The pre-approval by the Department of the Environment (MDE) of these sites eliminates the need for time consuming additional site searches in appropriate watersheds, allows for design to begin, and in some cases for construction to be completed. Maryland's mandate of "no net loss" of nontidal wetlands is more readily achieved with the use of the registry.

Virginia:
Partnership for Fish and Wildlife

The Partnership for Fish and Wildlife program through the US Fish and Wildlife Service (USFWS) is a national effort supported by federal and state agencies, private landowners and non-governmental organizations (NGOs) to restore wetlands and other vital habitats on private land. Virginia has benefited greatly from the program and has restored 5,000 acres in the past 11 years. Virginia's 12 partners have contributed to the program's success in a number of ways. The USFWS provides funding, design, and technical assistance. State agencies encourage landowner participation in the program through advertisement and directed solicitation. NGOs like American Forester, The Chesapeake Bay Foundation, Ducks Unlimited, and others provide 70% of the funding the USFWS uses to administer the program. Landowners not only allow restoration on their land but they also pay 5-10% of the restoration costs in in-kind services.

The program mobilizes people toward the accomplishment of a common goal – habitat restoration – but it is not without risk. Landowners, more so that any other partner, are susceptible to time and circumstance. The USFWS understands this and has met the needs of the landowner though a 10-year landowner agreement. By signing on as a partner the landowner has agreed to protect the wetland or other restored habitat for the duration of the contact. In the event that the landowner is unable to provide that protection, the landowner must notify the USFWS within 30 days and will be held responsible for some portion of the restoration costs. In the case of wetlands, the USFWS provides the landowner with a five year grace period, after the terms of the contract have been fulfilled, before declaring the wetland jurisdictional. By meeting the needs of the landowner and mobilizing support from the private and public sectors the Partnership for Fish and Wildlife will continue to be important for the restoration of critical habitats in Virginia.

Pennsylvania:
In-Lieu-Fee's and the Wetland Replacement Project

Pennsylvania's Wetland Replacement Project (PWRP) was implemented in 1995 as an alternative to traditional mitigation. PWRP, is an in-lieu fee program where the fund is jointly administered by the National Fish and Wildlife Foundation and the Pennsylvania Department of Environmental Protection for the creation and restoration of aquatic resources as a means of mitigating unavoidable impacts under 0.50 acres. Applicants who propose impacts less than .50 acres of wetland and met all other requirements related to avoidance and minimization can contribute to the fund as determined by the reviewing office. The amount of the contribution ranges from $0 to $7,500.00 depending on the size of the impact. The in-lieu-fee-program is a very effective way of reducing impacts and for ensuring successful wetland replacement for small wetland impacts.

Bay-wide through CBF:
Volunteer Restoration

The Chesapeake Bay Foundation (CBF) uses volunteers and partner agencies to restore wetlands throughout the watershed. To date CBF has completed 1,650 projects restoring a total of 5,541 acres of wetlands and 845 miles of riparian buffers. The program is an opportunistic, voluntary, broad-based program aimed at maximizing restoration accomplishments and building public awareness.

Appendix 4:

Workshop Participants List

Workshop Participants

Jenn Aiosa
CBF
Merrill Environmental Center
6 Herndon Avenue
Annapolis, MD 21403
410-268-8833
jaiosa@savethebay.cbf.org

Matt Airhardt
CBF
Phillip Merrill Environmental Center
6 Herndon Avenue
Annapolis, MD 21403
410-268-8816
mairhardt@savethebay.cbf.org

Sydney Arny
CRC
645 Contees Wharf Road
Edgewater, MD 21037
410-798-1283
arny@serc.si.edu

Russell Bellmer
NOAA
1315 East-West Highway
Bldg. SSMC3 Rm. 15317
Silver Spring, MD 20910-3282
301-713-0174 X186
Russell.Bellmer@noaa.gov

Chet Bigelow
VA DGIF
5806 Mooretown Road
Williamsburg, VA 23188
757-253-7072
cbigelow@dgif.state.va.us

David Bleil
MD DNR
Watershed Management Division
580 Taylor Avenue
F-2 CCWS, Tawes State Office Bldg.
Annapolis, MD 21401
410-260-8784
dbleil@dnr.state.md.us

Trevor Clark
US FWS
177 Admiral Cochrane Drive
Annapolis, MD 21401
410-573-4527
trevor_clark@fws.gov

Catherine Clark
CRC
410 Severn Ave., Ste. 109
Annapolis, MD 21403
410-267-5718
clark.catherine@epa.gov

Denise Clearwater
MDE
2500 Broening Highway
Baltimore, MD 21224
410-631-8094
dclearwater@mde.state.md.us

Frank Dawson
MD DNR
Tawes State Office Building, D-2
580 Taylor Avenue
Annapolis, MD 21401
410-260-8795
fdawson@dnr.state.md.us

Dave Davis
VA DCR
203 Governor Street, Third Floor
Richmond, VA 23219
804-786-1712
ddavis@dcr.state.va.us

Stuart Demanski
PA DEP
Bureau of Waterways and Wetlands
P.O. Box 8775
Harrisburg, PA 17105-8775
717-772-5976
sdemanksi@state.pa.us

Katia Englehardt
UMCES APL
301 Braddock Road
Frostburg, MD 21532-2307
301-689-7140
engelhardt@al.umces.edu

Thomas J. Filip, III
U.S. Army Engineer District
Baltimore Regulatory Branch
P.O. Box 1715
Baltimore, MD 21203-1715
410-962-3670
tom.filip@nab02.usace.army.mil

Tara Frates
MD Environmental Service
2011 Commerce Park Drive
Annapolis, MD 21401
410-974-7261
tfrat@menv.com

Mike Fritz
EPA CBPO
410 Severn Ave., Ste. 109
Annapolis, MD 21403
410-267-5721
fritz.mike@epa.gov

Dick Hammerschlag
USGS
Patuxent Wildlife Research Center
11510 American Holly Drive
Laurel, MD 20708
301-497-5555
richard_hammerschlag@usgs.gov

Louise Hanson
MD DNR
Tawes State Office Building
580 Taylor Avenue
Annapolis, MD 21401
410-260-8774
lhanson@dnr.state.md.us

Carl Hershner
VIMS
College of William and Mary
P.O. Box 1346
Gloucester Point, VA 23062
804-642-7387
carl@sweethall.wetlan.vims.edu

Lee Hill
VA DCR
203 Governor Street, Ste. 206
Richmond, VA 23219
804-786-3998
leehill@dnr.state.va.us

Curtis Hutto
VA DCR
203 Governor Street, Third Floor
Richmond, VA 23219
804-692-0479
cjhutto@dcr.state.va.us

Ann Jennings
CBF
1108 East Main Street, Ste. 1600
Richmond, VA 23219
804-780-1392
ajennings@savethebay.cbf.org

Jamie Keefer
Alliance for the Chesapeake Bay
6600 York Road, Ste. 100
Baltimore, MD 21212
410-377-6270
jkeefer@acb-online.org

Erika Kehne
MES
2011 Commerce Park Drive
Annapolis, MD 21401
410-974-7281
ekehn@menv.com

David Knepper
US ACE
803 Front Street
Attn: Regulatory Branch
Norfolk, VA 23510-1096
757-441-7488
david.a.knepper@usace.army.mil

Julie LaBranche
MDE
2500 Broening Highway
Baltimore, MD 21224
410-631-6687
jlabranche@mde.state.md.us

Garry Mayer
NOAA
1315 East-West Highway F/HC
Silver Spring, MD 20910
301-713-0174
garry.mayer@noaa.gov

Michael McCoy
MDE
2500 Broening Highway
Baltimore, MD 21224
410-631-6681
mmcoy@mde.state.md.us

Stacey Moulds
Alliance for the Chesapeake Bay
P.O. Box 1981
Richmond, VA 23218
804-775-0951
moulds.acb@verizon.net

Gwen Neate
MD Environmental Service
2011 Commerce Park Drive
Annapolis, MD 21401
410-974-7261
gneat@menv.com

Monaca Noble
CRC
410 Severn Avenue, Ste. 109
Annapolis, MD 21403
410-267-9830
noble.monaca@epa.gov

David Norris
VA DGIF
5806 Mooretown Road
Williamsburg, VA 23188
757-253-4180
dnorris@dgif.state.va.us

Frank Payer
PA DEP
Bureau of Watershed Management
400 Market Street
10th floor, RCSOB
Harrisburg, PA 17105
717-772-5994
fpayer@pa.state.us

Scott Phillips
USGS
8987 Yellow Brick Road
Baltimore, MD 21237
410-238-1972
swphilli@usgs.gov

Regina Poeske
EPA Region III
1650 Arch Street
Philadelphia, PA 19103
215-814-2725
poeske.regina@epa.gov

Jaclin Schweigart
CRC
645 Contees Wharf Road
Edgewater, MD 21037
410-798-1283
schweigart@serc.si.edu

Melissa Jachelski Slatnick
MES
2011 Commerce Park Drive
Annapolis, MD 21401
410-974-7261
mslat@menv.com

Khervin Smith
PA DEP
Bureau of Watershed Management
400 Market Street
10th floor, RCSOB
Harrisburg, PA 17105
717-772-5972
Khsmith@state.pa.us

Will Smith
U.S. Fish and Wildlife Service
6669 Shore Lane
Gloucester, VA 23061
804-693-6694 X145
willard_smith@fws.gov

Arthur Spingarn
EPA Region III
1650 Arch Street
Philadelphia, PA 19103
215-814-2719
spingarn.arthur@epa.gov

William Street
CBF
Phillip Merrill Environmental Center
6 Herndon Avenue
Annapolis, MD 21403
410-268-8816
bstreet@savethebay.cbf.org

Rich Takacs
NOAA Restoration Center
410 Severn Ave., Ste. 107A
Annapolis, MD 21403
410-267-5672
rich.takacs@noaa.gov

Denise Heller Wardrop
Penn State Cooperative Wetlands Center
301 Forest Resources Lab
University Park, PA 16802
814-863-1005
dhw110@psu.ed