Wetland Functions and Values: Descriptive Approach to Visualizing and Assessing Wetland Systems

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The environmental assessment process is a cornerstone of the National Environmental Policy Act (NEPA) of the United States, and part of that policy of environmental conservation includes protection of the nation's wetland resources. The U.S. Army Corps of Engineers (USACOE) has jurisdiction over the federal permit required by the Clean Water Act concerning wetland impacts (Section 404). As a consequence, the Regulatory Division of the USACOE New England Division promulgated a highway methodology to guide the preparation of assessments required as part of its permit process in New England. The methodology emphasizes the function and value of wetlands. That determination can be most efficiently accomplished by using computer-aided drafting and design and geographic information systems, although neither of these computer techniques is essential to the procedure. It is adapted to help describe complex wetland systems and their interrelationships without bias because it does not weight functions. Such weighing of functions by other methods has created difficulty in assessing wetlands as resources in light of other cultural, natural, and socioeconomic issues that are also considered by the NEPA process. The present methodology is consistent with NEPA, recognizing sensitivity to habitat preservation on the one hand and socioeconomic development, on the other. It has been used to clarify impacts associated with large and small transportation related projects in New England. Examples of resource mapping and checklist and forms to guide wetland function and value assessment are based on projects in which the authors have participated individually or collectively.

From the perspective of applied ecology in the transportation industry, environmental regulation of large projects in the United States requires the development of tools and methods that can be used to assess both social (i.e., cultural) and natural (i.e., ecological) resources. Such assessments are intended to help weigh benefits and impacts likely to be associated with development projects. In that sense, the goals of environmental protection are dependent on the practical application of environmental management to link science, engineering, socioeconomics, and law (*1,2*). The evolution of such environmental management has taken many pathways, one of which began in the United States at the first Earth Day on April 22, 1970. That event was sponsored by the then new movement of environmental activists who vowed to pursue political action against those in government who did not match their environmental protection rhetoric with action. That growing and dedicated movement for environmental protection is clearly accomplishing its 1970 goal.

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A negative consequence of adopting laws and regulations that focus on preserving natural resources is the growing estrangement between natural resource protection and socioeconomic resource management. These antagonistic aspects of environmental management are not balanced evenly in the law because the broad reach of present environmental laws generally is biased toward natural environment preservation, such as wetlands, and laws that pertain to socioeconomic issues (i.e., human issues related to quality of life and lifestyle) do not provide the same measure of impact quantification. A valid comparison of the costs and benefits of natural resources and those of human resources is still being sought. Such issues are complicated further by the diversity of the professional competence of individuals who must deal with them. Such skill requires a wide range of technical proficiency as well as diplomatic and social cognizance and competence. These important issues will not be explored here because they are all well-summarized and reviewed elsewhere (*3–5*).

Because of the usually mutually exclusive nature of social and economic development versus natural resource preservation, genuine conflicts arise when project alternatives are assessed in light of cultural and socioeconomic resource management as opposed to environmental conservation. These conflicts can be resolved when the consideration of alternatives is faithful to the scientific method, thus defining resources based on objective, unbiased, and appropriately detailed standardized methods. During the linear projects associated with highways and railroads, such methods help to avoid the entanglement of regulatory gridlock that otherwise tends to delay or prevent conclusion of the permit process. Such deadlocks prevent definitive choices and project implementation. Often an evaluation of the impacts on resources caused by the alternatives of a particular project is required for a USACOE permit to construct within a wetland.

For example, a USACOE permit is likely to be required for proposed highway or railroad projects. Discharges of dredged or fill material in waters of the United States, including wetlands, require a permit under Section 404 of the Clean Water Act; coastal and certain inland projects may also require a permit under Section 10 of the Rivers and Harbors Act. These requirements are in addition to state and local permits (*6–11*). In 1987 the USACOE Regulatory Division, New England Division, promulgated its highway methodology, which it subsequently published as a booklet (*11*). It serves as a means to integrate highway, railroad, or other planning and design projects with (*a*) the requirements of the USACOE permit regulations, (*b*) the National Environmental Policy Act, and (*c*) FHWA funding approval requirements.

The highway methodology is consistent with the principles of overlaying land use and geographic constraints advocated by

McHarg (*12*). In that process, maps of such resources as wetlands, soil types, habitats, structures, roads, and other features of the landscape are combined. The composite picture illustrates the geography of landscape features and includes socioeconomic factors, such as neighborhoods, that help reviewers make objective judgments about those resources and the consequential impacts and benefits to regional interrelationships caused by using (i.e., changing or removing) these diverse features as part of a proposed project. The highway methodology is one defined and tested procedure to assemble resource characteristics that are needed in order to proceed with the USACOE environmental permit process. Its principles organize and prioritize resources such that project planning incorporates the appropriate avoidance of impacts, the minimization of unavoidable impacts, and the compensation of impacts in order to offset those minimized, yet still residual, impacts.

This approach to environmental management is important to all objectives of good environmental stewardship. It guides a significant government environmental permit process (i.e., Section 404 of the Clean Water Act) that affects habitats and species both directly and indirectly. The better the analytical tools on which it is based and the better it serves to support environmental stewardship, the better it can help conserve, manage, and restore habitat values for both nonhuman and human populations.

The highway methodology continues to be tested, modified, and adapted each time it is used. As an oversight of its primary goal, it advocates tools and methods that qualify and, to the extent practical, quantify various aspects of environmental assessment that may then be used to facilitate permit decisions. Although a central consideration of the USACOE is to avoid harming the functions and values of wetlands, it is also charged with weighing other environmental impacts and societal issues when reaching its decisions. These issues include habitat fragmentation, community cohesion, and socioeconomics. For the purpose of this paper, however, only the New England Division approach to wetland functions and values assessment will be addressed. Those other evolving methods and tools of environmental impact assessment are left for papers in preparation.

ITEMIZED FUNCTIONS AND VALUES OF WETLANDS

A major emphasis of the highway methodology concerns wetlands because they are at the center of the Clean Water Act Section 404 regulatory program. For this reason, considerable research has been contributed to this field; this paper focuses on nontidal wetlands and is largely dependent on that literature—for example, see the review by Mitsch and Gosselink (*13*). Wetlands contribute to water quality and quantity management, wildlife management, recreational resources, and habitat stability. In particular, the web of wetland ecology functions to restore and protect water quality through biofiltration—that is, wetlands are living filters that help renovate storm water by "digesting" or adsorbing pollutants, sediments, and nutrients (*14*). These important attributes lend further importance to the consideration of wetland functions and values in the protection of habitat as interpreted by the procedures of the USACOE.

The wetland assessment approach in the USACOE New England Division Highway Methodology diverges from the Wetland Evaluation Technique II (WET II) (*15*), because the highway methodology places no weightings on evaluation factors of those functions that guide wetland inspection criteria. The purpose of this assessment procedure is threefold: (*a*) to report the presence or absence of 13 generally accepted wetland functions, (*b*) to report which one or more of these 13 functions are predominant in each wetland studied, and (*c*) to provide descriptive information, including photographs, to help reviewers make informed judgments, whether or not those reviewers can conduct their own direct field inspections.

This approach identifies the 13 wetland functions listed in the following. The rationale that defines each category is contained in Appendix A. Although these categories are not necessarily the only wetland functions possible, nor are they necessarily precisely defined, they do represent the best working "pallet" of descriptors that can be used to paint a useful and objective representation of the wetland resources associated with a proposed project.

1. *Groundwater interchange (recharge/discharge).* This function considers the potential for a wetland to serve as a groundwater recharge or discharge area (or both). It reflects the fundamental interaction between wetlands and aquifers, regardless of the size or importance of either.
2. *Flood flow alternation (storage and desynchronization).* This function considers the effectiveness of the wetland in reducing flood damage by water retention for prolonged periods following precipitation events. It adds to the stability of the wetland ecological system or its buffering characteristics and provides social and economic value relative to erosion and flood control.
3. *Sediment and shoreline stabilization.* This function represents the effectiveness of a wetland to stabilize stream banks and shorelines against erosion.
4. *Sediment, toxicant, and pathogen retention.* This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants, or pathogens in runoff water from surrounding uplands, or upstream eroding wetland areas.
5. *Nutrient removal, retention, and transformation.* This function represents the effectiveness of the wetland to trap nutrients in runoff water from surrounding uplands or contiguous wetlands, and the ability of the wetland to convert these nutrients into other chemical forms or tropic levels. One aspect of this function is to prevent the ill effects of nutrients from entering aquifers or surface waters such as ponds, lakes, streams, rivers, and estuaries.
6. *Production export (nutrient).* This function represents the effectiveness of the wetland to produce food or usable products for man and other living organisms.
7. *Fish and shellfish habitat.* This function represents the effectiveness of seasonal or permanent water courses associated with the wetland in question as fish and shellfish habitat.
8. *Wildlife habitat.* This function represents the effectiveness of the wetland as habitat for various types and populations of animals typically associated with wetlands and the wetland edge. It also represents the use of the wetland as habitat for migrating species and species dependent on the wetland at some time in their life cycles. Species lists or observed and potential animals should be included in the wetland assessment as documentation of this function.
9. *Threatened or endangered species habitat.* This function represents the suitability of the wetland to support threatened or endangered species whose survival has been officially acknowledged as being threatened or endangered.

10. *Visual quality and aesthetics.* This function represents the visual and aesthetic quality or usefulness of the wetland.

11. *Educational and scientific value.* This function considers the suitability of the wetland as a site for an "outdoor classroom" or as a location for scientific study or research.

12. *Recreation (consumptive and nonconsumptive).* This function represents the suitability of the wetland and associated water courses to provide recreational opportunities such as canoeing, boating, fishing, hunting, and other active or passive activities. Consumptive opportunities consume or diminish the plants, animals, and other wetland resources. Nonconsumptive uses do not consume or diminish the wetland or its resources.

13. *Uniqueness/Heritage.* This function represents the wetland or its associated water bodies for certain special characteristics. These may include archaeological sites, critical habitat, overall health and appearance, role in the ecological system of the area, or relative importance as a typical wetland class for its geographic region. Such functions are clearly important wetland attributes relative to aspects of public health, recreation, and habitat diversity.

From consideration of these 13 wetland functions and values, wetland assessment is intended to document, without bias, as much hydrologic, biologic, and cultural information as is practically possible and necessary in order for reviewers to judge potential impacts and select from among imperfect project choices. The necessarily biased judgments of these reviewers are expected to consider the data presented in a straightforward format, which is the basis on which such subjective judgments can be made. The presentation of these data is, therefore, intended to allow a reviewer to envision the subject wetland and consider its characteristics from whatever perspective that the reviewer deems appropriate. It is assumed that those subjective (i.e., biased) judgments would be explained and discussed in open forum in order to ensure that all parties can represent their particular concerns and solutions. When those conditions are met and carried out in good faith, the debate of priorities and choices is open and productive. Although consensus is an admirable goal in this process, the USACOE is the ultimate decision maker in this Clear Water Act Section 404 permit process (although a Section 404(c) veto process can be initiated by the Environmental Protection Agency). It weighs all comments, facilitated by an orderly and unbiased presentation of such key factors as wetlands functions and values. Therefore, consistent with the objective of making the best overall choice and with the requirements of the regulatory program, documentation of each resource (i.e., wetland) is unweighted and thus unbiased. Figure 1 is one example of the format that guides wetland functions and values assessments. The top portion of the form reports the physiographic characteristics of the subject wetland, including its size, type, location in the watershed, habitat characteristics, aquatic and vegetative diversity, and anticipated impacts. The lower portion of the form focuses on specific functional characteristics of the subject wetland, annotated by numbers in the "Rationale Why" column. These reference numbers are a shorthand to identify specific and important characteristics from the accompanying checklists in Appendix A. Comments may be added for special emphasis, and space is provided for a USACOE *Confidence Level* of reported findings made by the evaluator.

The "Principal Valuable Function(s)" column is used to identify dominant functions. Space is provided at the bottom of the form for a narrative of the wetland in order to record unusual or noteworthy conditions, or to add comments helpful in defining unique aspects of the wetland being studied. This form continues to evolve with its use. Data, therefore, may be recorded in different formats, provided that the format is clear, unambiguous, and appropriately comprehensive.

After these procedures, each wetland involved in a Phase 2 study (*10*) is evaluated for 13 possible functions and values all derived from the evolving literature (*15–20*). That literature provides documentation of the functions being evaluated and helps ensure uniformity and objectivity in guiding field inspections. Each wetland is inspected and photographed to illustrate potential impact areas, unusual aspects of the wetland, or other significant features. A generalized sketch of each wetland is also prepared to summarize shape, vegetative interspersion, cover type, interconnections, number and types of inlets and outlets, cross sections, bank height, open water, vegetation zonation, and the location of each photograph. The dominant plant species and observed or signed wildlife is also recorded. All this information is collected in data files, an example of which is shown in Figures 1 and 2.

GRAPHICAL REPRESENTATION

A graphical representation of the functions and values of each wetland involved with the overall assessment of a project is important as a means of providing both technical and lay reviewers with an intuitive perspective of the "big picture." Once a study area is defined and resources are identified at scales such as U.S. Geologic Survey quadrangle maps (24,000 scale), a Phase 1 assessment leads to screening candidate alignments. This process results in a manageable number of three to five for Phase 2 study. The Phase 1 screening is the first step in recognizing interrelationships, indirect and direct impacts, and the significance of choices between alternative alignments of a project plan. Increasing detail is developed during Phase 2 when functions and values are represented more graphically. Figure 3 illustrates the graphical means of summarizing wetland functions and values developed during the Nashua-Hudson Circumferential Highway project in New Hampshire and the Route 6 project in Connecticut. It represents all the basic characteristics of each wetland investigated using symbols (i.e., icons) that, when taken together, represent complex ecological and sociological relationships. The specific and complete documentation of each such relationship appears to be beyond the need for agencies to make initial choices between the project alternatives that are the subject of USACOE jurisdictional requirements. Refinement of that initial choice and the final issuance of a Section 404 permit to allow project construction requires that this initial information be augmented. The augmentation includes detailed delineation of wetlands and project construction monitoring specifications. Both are needed to ensure that contract stipulations be present to protect important resources to the extent that they are defined and their functions and values are recognized and conserved through the permit process.

Once the characteristics of each wetland are identified by an icon box, a map is prepared to show the geographic relationship between each such wetland and the alternative alignments of the proposed project. Figure 4 is a sample of a portion of such a map that shows part of one alternative alignment.

NASHUA-HUDSON CIRCUMFERENTIAL HIGHWAY
WETLANDS EVALUATION

FUNCTION-VALUE ASSESSMENTS
42 45.82 Lat.
71 23.23 Long.

WETLAND I.D. EF3A WP28

Prepared by: KLS, LDC, DMM
Date: 10-10-91

TOTAL AREA OF WETLAND: NWI 1.15 acres SCS None MAN MADE? No IS THE WETLAND PART OF A WILDLIFE CORRIDOR? Yes

OR A "HABITAT ISLAND"? No ADJACENT LAND USE Deciduous forest DISTANCE TO NEAREST ROADWAY OR OTHER DEVELOPMENT 300'-400'

DOMINANT WETLAND SYSTEMS PRESENT PFOIE CONTIGUOUS UNDEVELOPED BUFFER ZONE PRESENT No

IS THE WETLAND A SEPARATE HYDRAULIC SYSTEM? No IF NOT, WHERE DOES THE WETLAND LIE IN THE DRAINAGE BASIN? Upper

HOW MANY TRIBUTARIES CONTRIBUTE TO THE WETLAND? 1 AQUATIC DIVERSITY/ABUNDANCE Y/N VEGETATIVE DIVERSITY/ABUNDANCE Y/Y

WILDLIFE DIVERSITY/ABUNDANCE N/N ANTICIPATED IMPACTS Cut and fill - eliminate

WETLAND IMPACTED: NWI 1.15 acres SCS None

FUNCTION	Function Occurrence Y	N	Rationale Why (Number)	Principal Valuable Function(s)	Comments	ACOE Confidence Level
Groundwater Interchange Recharge/Discharge	X		1, 2, 6, 7, 11-13, (15)		Underlain by bedrock and till. Occurs along base of slope.	
Floodflow Alteration (Storage & Desynchronization)	X		5-9, 11, 12, 14, 16		Wetland is in upper watershed & protects downstream low density residential area.	
Sediment/Shoreline Stabilization	X		1, 4, 6, 8, 9, 12-15		Flood storage/detention. Soil stabilized by vegetation in this wetland.	
Sediment/Toxicant Retention	X		1-4, 6, 9-12	X	Runoff enters from roads & upstream trailer park. Sediment trap function. Diffuse flow thru herb. veg.enhances filtration.	
Nutrient Removal/Retention/ Transformation		X	3, 5-9, 11, 12, (13)			
Production Export (Nutrient)		X	1, 2, 5, 7, 8, 10, 14		Some export but primary function is nutrient attenuation.	
Fish & Shellfish Habitat	X		1, 2, 4, 7-10, 14-17		Food, cover, spawning possible, but small & shallow limits value. Linked by watercourse to other wetlands.	
Wildlife Habitat	X		1-9, 11, 13-15, 18, 19		Stratified vegetation. Corridor, not nesting or feeding habitat.	
Endangered Species Habitat		X	6, 7		No known T&E species present.	
Visual Quality/Aesthetics		X	3-5, 7, 10, 11		Homogeneous and inconspicuous structure.	
Educational Scientific Value		X	2, 4, 9-11, 13			
Recreation (Consumptive and Non-Consumptive)		X	4, 6		Limited value. Small & near houses.	
Uniqueness/Heritage		X	6-8, 10, 11, 15, 16, 18, (19), 22		Hunting incompatible. Hiking possible. Nature watching limited by small area.	

NOTES: Wetland in upper limits of Second Brook tributary. Alternately diffuse and defined channel and associated flat, vegetated flood plain. Wetland width varies. Windthrows produce discontinuous tree canopy. Shrub layer patchy, interspersed with open herbaceous flats. Runoff enters from near roads and an upstream trailer park. Evidence of siltation present.

FIGURE 1 Guide for field inspectors in using descriptive categories to document characteristics for judging environmental impacts on wetland systems.

CONCLUSIONS

The USACOE wetlands functions and value assessment approach is intended to avoid any hidden weighing of evaluation criteria. It holds promise as a tool in planning transportation projects, as well as for other projects that require an evaluation of wetland resources. The approach is used primarily to facilitate determination of potential impacts and to compare project alternatives with respect to the functions and values of wetlands. It can also be used to select sites in the landscape where wetland creation would compensate for wetland takings, and to assist in the evaluation of wetland monitoring activities where it serves to document whether specified functions were indeed realized after the subject wetlands were created.

The wetland assessment approach defined here permits biasing to take place in an open forum where agencies or other interested parties can review and argue their individual perspectives. The raw data that define the resources under consideration are documented in appropriate detail and are easily recoverable. The process thus supports open debate of the scientific methods used, and of the alternatives defined, by the assessment. In that respect, the USACOE can openly solicit input from commentors on the values of each subject wetland. Using the data forms and methods described herein will lead to better informed decisions. Although gaining a consensus on these values of wetlands and the selection of alternatives is an admirable goal, the USACOE remains the decision maker in this process and must arrive at a decision in light of its Section 404 jurisdiction.

Vegetative

Red Maple	*Acer rubrum*
Slippery Elm	*Ulmus rubra*
White pine	*Pinus strobus*
Ash	*Fraxinus sp.*
Yellow birch	*Betula lutea*
Grey birch	*Betula populifolia*
Speckled alder	*Alnus rugosa*
Poison sumac	*Rhus vernix*
Dogwood	*Corunus sp.*
Highbush blueberry	*Vaccinium corymbosum*
Maleberry	*Lyonia ligustrina*
Winterberry	*Ilex verticillata*
Sensitive fern	*Onoclea sensibilis*
Poison ivy	*Rhus radicans*
Skunk cabbage	*Symplocarpus foetidus*
Steeple bush	*Spirea tomentosa*

Wildlife

Black capped chick-a-dee	*Parus atricapillus*
Blue jay	*Cyanocitta cristata*
Green frogs	*Rana clamitans melanota*
Grey squirrel	*Sciurus carolinensis*

DIAGRAM NOT TO SCALE

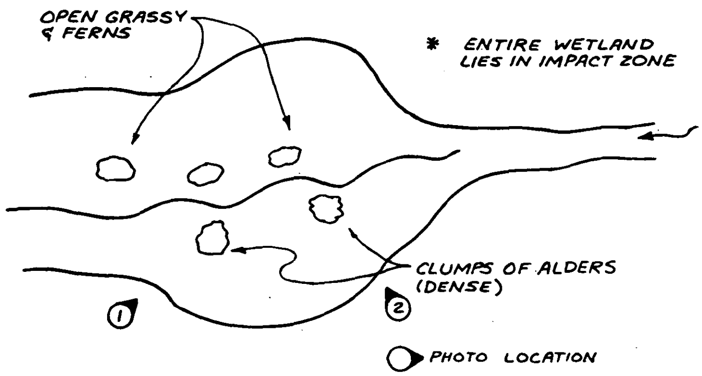

FIGURE 2 Species list based on observed species, or their signs, during site investigations used to provide site-specific detail for Phase 2 planning.

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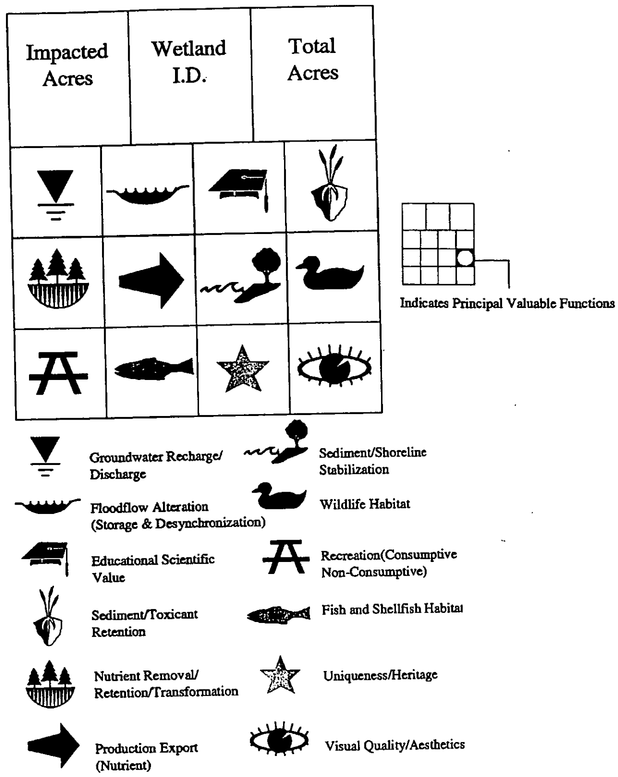

FIGURE 3 Graphical summary of wetland characteristics; endangered species habitat is not illustrated by an icon, so 12 icon possibilities are shown.

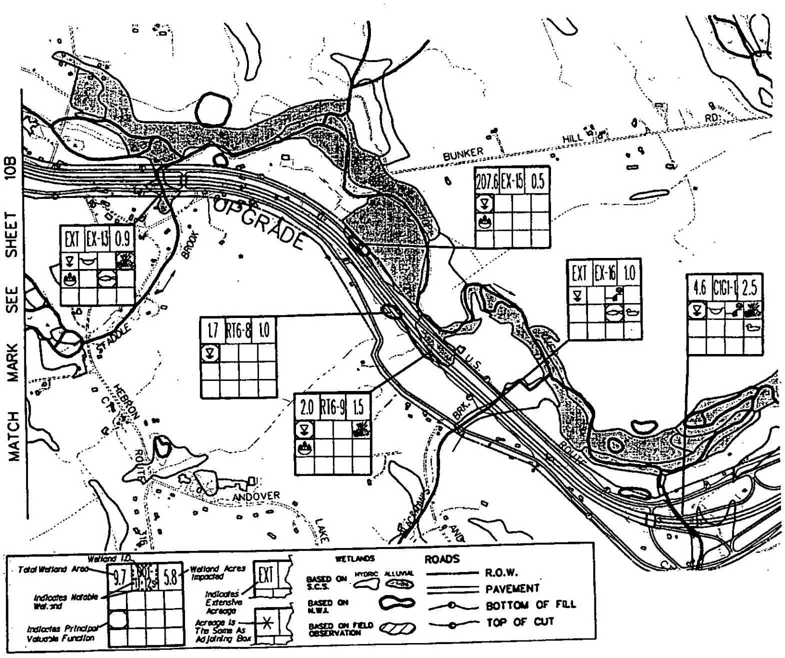

FIGURE 4 Icon boxes summarizing functions and values for each wetland investigated.

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APPENDIX A

GROUNDWATER INTERCHANGE (RECHARGE/DISCHARGE)

1. Public or private wells occur downstream of wetland.
2. Potential exists for public or private wells downstream of wetland.
3. Wetland is underlain by stratified drift.
4. Gravel or sandy soils are present or adjacent to wetland.
5. Fragipan does not occur in wetland.
6. Fragipan, impervious soil, or bedrock does occur in wetland.
7. Wetland is associated with a perennial or intermittent water course.
8. Signs of groundwater recharge are present or piezometer data demonstrate recharge.
9. Wetland is associated with a water course but lacks a defined outlet or contains a constricted outlet.
10. Wetland contains only an outlet.
11. Groundwater quality of stratified drift aquifer within or downstream of wetland meets drinking water standards.
12. Quality of water associated with wetland is high.
13. Signs of groundwater discharge are present (e.g., springs).
14. Water temperature suggests that it is a discharge site.
15. Wetland shows signs of variable water levels.
16. Gravel or sandy soils are present in or adjacent to wetland.
17. Piezometer data demonstrate discharge.
18. Other.

FLOOD FLOW ALTERNATION (STORAGE AND DESYNCHRONIZATION)

1. Area of wetland is large relative to its watershed.
2. Wetland occurs in the upper portions of its watershed.
3. Effective flood storage is small or nonexistent upslope of or above wetland.
4. Wetland watershed contains a high degree of impervious surfaces.
5. Wetland contains hydric soils that are able to absorb and detain water.
6. Wetland exists in a relatively flat area that has flood storage potential.
7. Wetland has an intermittent outlet or ponded water, or signs are present of variable water level.
8. During flood events, wetland can retain higher volumes of water than under normal or average rainfall conditions.
9. Wetland receives and retains overland or sheet flow runoff from surrounding uplands.
10. In the event of a large storm, wetland may receive and detain excessive floodwater from a nearby water course.
11. Valuable properties, structures, or resources are located in or near the floodplain downstream from wetland.
12. Watershed has a history of economic loss due to flooding.

[Stop here if this wetland is not associated with a water course.]

13. Wetland is associated with one or more water courses.
14. Wetland water course is sinuous or diffuse.
15. Wetland outlet is constricted.
16. Channel flow velocity is affected by wetland.
17. Land uses downstream are protected by wetland.
18. Wetland contains a high density of vegetation.
19. Other.

SEDIMENT AND SHORELINE STABILIZATION

1. Indications of erosion, siltation are present.
2. Topographical gradient is present in wetland.
3. Potential sediment sources are present up-slope.

[Stop here if this wetland is not associated with a water course.]

4. No distinct shoreline or bank is evident between the waterbody and wetland or upland.

5. A distinct step between the open water body or stream and the adjacent land exists (i.e., sharp bank) with dense roots throughout.
6. Wide wetland (> 10 ft) borders water course, lake, or pond.
7. High flow velocities exist in wetland.
8. Potential sediment sources are present upstream.
9. The watershed is large enough to produce channelized flow.
10. Open water fetch is present.
11. Boating activity is present.
12. Dense vegetation borders water course, lake, or pond.
13. High percentage of energy-absorbing emergents or shrubs borders water course, lake, or pond.
14. Vegetation is composed of large trees and shrubs that withstand major flood events or erosive incidents and stabilize the shoreline on a large scale (feet).
15. Vegetation is composed of a dense resilient herbaceous layer that stabilizes sediments and the shoreline on a small scale (inches) during minor flood events or potentially erosive events.
16. Other.

SEDIMENT, TOXICANT, AND PATHOGEN RETENTION

1. Potential sources of excess sediment are in the watershed above wetland.
2. Potential or known sources of toxicants are in the watershed above wetland.
3. Opportunity for sediment trapping by slow-moving water or deepwater habitat are present in wetland.
4. Mineral, fine-grained, or organic soils are present.
5. Long-duration water retention time is present in wetland.
6. Public or private water sources occur downstream.
7. Wetland edge is broad and intermittently aerobic.
8. Wetland is known to have existed for more than 50 years.
9. Drainage ditches have not been constructed in wetland.

[Stop here if wetland is not associated with a water course].

10. Wetland is associated with an intermittent or perennial stream or a lake.
11. Channelized flows have visible velocity decreases in wetland.
12. Effective floodwater storage in wetland is occurring. Areas of impounded open water are present.
13. No indicators of erosive forces are present. No high water velocities are present.
14. Diffuse water flows are present in wetland.
15. Wetland has a high degree of water and vegetation interspersion.
16. Dense vegetation provides opportunity for sediment trapping or signs of sediment accumulation are present by dense vegetation.
17. Other.

NUTRIENT REMOVAL, RETENTION, AND TRANSFORMATION

1. Wetland is large relative to the size of its watershed.
2. Deep water or open water habitat exists.
3. Overall potential for sediment trapping exists in wetland.
4. Potential sources of excess nutrients present in the watershed above wetland.
5. Wetland is saturated for most of the season. Ponded water is present in wetland.
6. Deep organic and sediment deposits are present.
7. Slowly drained mineral, fine-grained, or organic soils are present.
8. Dense vegetation is present.
9. Emergent vegetation or dense woody stems are dominant.
10. Aquatic diversity and abundance are sufficient to use nutrients.
11. Opportunity for nutrient attenuation exists.
12. Vegetation diversity and abundance are sufficient to use nutrients.

[Stop here if wetland is not associated with a water course.]

13. Waterflow through wetland is diffuse.
14. Water retention and detention time in wetland is increased by constricted outlet or thick vegetation.
15. Water moves slowly through wetland.
16. Other.

PRODUCTION EXPORT (NUTRIENT)

1. Wildlife food sources grow within wetland.
2. Detritus development is present within wetland.
3. Economically or commercially used projects found in wetland.
4. Evidence of wildlife use found within wetland.
5. Higher trophic level consumers use wetland.
6. Fish or shellfish develop or occur in wetland.
7. High vegetation density is present.
8. Wetland exhibits high degree of plant community structure and species diversity.
9. High aquatic diversity and abundance are present.
10. Nutrients exported in wetland watercourses (permanent outlet present).
11. "Flushing" of relatively large amounts of organic plant material occurs from wetland.
12. Wetland contains flowering plants that are used by nectar-gathering insects.
13. Indications of exports are present.
14. High production levels occur; however, there are no visible signs of export (assuming export is attenuated).
15. Other.

FISH AND SHELLFISH HABITAT

1. Forest land is dominant in the watershed above wetland.
2. Abundance of cover objects are present.

[Stop here if this wetland is not associated with a water course.]

3. Size of wetland is able to support large fish and shellfish populations.
4. Wetland is part of a larger, contiguous watercourse.
5. Wetland has sufficient size and depth in open water areas so as not to freeze and retains some open water during winter.

6. Stream width (bank to bank) is more than 50 ft.
7. Quality of the watercourse associated with wetland is able to support healthy fish and shellfish populations.
8. Streamside vegetation provides shade for the water course.
9. Spawning areas are present (submerged vegetation or gravel beds).
10. Food is available to fish and shellfish populations within wetland.
11. Barrier(s) to anadromous fish (such as dams, including beaver dams, waterfalls, and road crossing) are absent from the stream reach associated with wetland.
12. Evidence of fish is present.
13. Wetland is stocked with fish.
14. Water course is persistent.
15. Man-made streams are absent.
16. Water velocities are not too excessive for fish usage.
17. Defined stream channel is present.
18. Other.

WILDLIFE HABITAT

1. Wetland is not degraded by human activity.
2. Water quality of the water course, pond, or lake associated with wetland meets or exceeds Class A or B standards.
3. Wetland is not fragmented by development.
4. Upland surrounding this wetland is undeveloped.
5. More than 40 percent of wetland edge is bordered by upland wildlife habitat (i.e., brushland, woodland, active farmland, or idle land) at least 500 ft wide.
6. Wetland is contiguous with other wetland systems connected by water course or lake.
7. Wildlife overland access to other wetlands is present.
8. Wildlife food sources are within wetland or nearby.
9. Wetland exhibits a high degree of interspersion of vegetation classes and open water.
10. Two or more islands or inclusions of upland with wetland are present.
11. Dominant wetland class includes deep or shallow marsh or wooded swamp.
12. More than 3 acres of shallow permanent open water (less than 6.6 ft deep), including steams in or adjacent to wetland, is present.
13. Density of wetland vegetation is high.
14. Wetland exhibits a high degree of diversity in plant species.
15. Wetland exhibits a high degree of diversity in plant community structure (e.g., trees, shrubs, vines, grasses, mosses, etc.).
16. Plant and animal indicator species are present.
17. Animal signs are observed (tracks, scats, nesting areas, etc.).
18. Seasonal uses vary for wildlife, and wetland appears to support varied population diversity and abundance during different seasons.
19. Wetland contains or has potential to contain a high population of insects.
20. Wetland contains or has potential to contain large population of amphibians.
21. Wetland contains or has potential to contain high avian utilization.
22. Indications of less disturbance-tolerant species are present.
23. Signs of wildlife habitat enhancement are present (birdhouses, nesting boxes, food sources, etc.).
24. Other.

ENDANGERED SPECIES HABITAT

1. Wetland contains or is known to contain threatened or endangered species.
2. Wetland contains critical habitat for a state or federally listed threatened or endangered species.
3. Wetland is a national natural landmark or recognized by a state natural heritage or similar agency noting exemplary nature of the site.
4. Wetland has local significance because it has biological, geological, or other features that are locally rare or unique.
5. Wetland is known to be a study site for scientific research.
6. Little disturbance has occurred in and around wetland.
7. A large area of undeveloped land surrounds wetland.
8. Other.

VISUAL QUALITY AND AESTHETICS

1. Multiple wetland classes are visible from primary viewing locations.
2. Emergent marsh and open water are visible from primary viewing locations.
3. Diversity of vegetation species is visible from primary viewing locations.
4. Wetland is dominated by flowering plants or plants that turn vibrant colors in different seasons.
5. Land use surrounding the wetland is undeveloped as seen from primary viewing locations.
6. Visible surrounding land use form contrasts with wetland.
7. Wetland views are absent of trash, debris, and signs of disturbance.
8. Wetland is considered to be a valuable wildlife habitat.
9. Wetland is accessed easily.
10. Noise level is low at primary viewing locations.
11. Unpleasant odors are absent at primary viewing locations.
12. Relatively unobstructed sight line exists through wetland.
13. Other.

EDUCATIONAL AND SCIENTIFIC VALUE

1. Wetland contains threatened, rare, or endangered species.
2. Little or no disturbance is occurring in wetland.
3. Potential educational site contains a diversity of wetland classes that are accessible or potentially accessible.
4. Potential educational site is undisturbed and natural.
5. Wetland is considered to be a valuable wildlife habitat.
6. Wetland is located within a nature preserve or wildlife management area.
7. Signs of wildlife habitat enhancement are present (bird houses, nesting boxes, food sources, etc.).
8. Off-road parking at potential educational site is suitable for school bus access in or near wetland.
9. Potential educational site is within safe walking distance or a short drive to schools.
10. Potential educational site is within safe walking distance to other plant communities.

11. Direct access to perennial stream at potential educational site is available.
12. Direct access to pond or lake at potential educational site is available.
13. No known safety hazards exist within the potential educational site.
14. Public access to the potential educational site is controlled.
15. Handicap accessibility is available.
16. Site is currently used for educational or scientific purposes.
17. Other.

RECREATION (CONSUMPTIVE AND NONCONSUMPTIVE)

1. Wetland is part of a recreation area, park, forest, or refuge.
2. Fishing is available within or from wetland.
3. Hunting is permitted in wetland.
4. Hiking occurs or has potential to occur within wetland.
5. Wetland is a valuable wildlife habitat.
6. Water course, pond, or lake associated with wetland is unpolluted.
7. High visual and aesthetic quality exists in potential recreation site.
8. Access to water is available at this potential recreation site for boating, canoeing, or fishing.
9. Water course associated with wetland is wide and deep enough to accommodate canoeing or nonpowered boating.
10. Off-road public parking is available at the potential recreation site.
11. Accessibility and travel ease is present.
12. Wetland is within a short drive or safe walk from highly populated public and private areas.
13. Other.

UNIQUENESS AND HERITAGE

1. Upland surrounding wetland is primarily urban.
2. Upland surrounding wetland is developing rapidly.
3. More than 3 acres of shallow permanent open water exist in wetland (less than 6.6 ft deep) including stream.
4. Three or more wetland classes are present.
5. Deep or shallow marsh, or wooded swamp dominate.
6. High degree of interspersion of vegetation or open water occurs wetland.
7. Well-vegetated stream corridor (15 ft on each side of the stream) occurs in wetland.
8. Potential educational site is within a short drive or a safe walk from schools.
9. Off-road parking at potential educational site is suitable for school buses.
10. No known safety hazards exist within this potential educational site.
11. Direct access to perennial stream or lake exists at potential educational site.
12. Two or more wetland classes are visible from primary viewing locations.
13. Low-growing wetlands (marshes, scrub-shrub, bogs, open water) are visible from primary viewing locations.
14. Half an acre or open water of 200 ft of stream is visible from the primary viewing locations.
15. Large area of wetland is dominated by flowering plants or plants that turn vibrant colors in different seasons.
16. General appearance of wetland visible from primary viewing locations is unpolluted or undisturbed.
17. Overall view of wetland is available from the surrounding upland.
18. Quality of the water associated with wetland is high.
19. Opportunities for wildlife observations are available.
20. Historical buildings occur within wetland.
21. Presence of pond or pond site and remains of a dam occur within wetland.
22. Wetland is within 50 yd of nearest perennial water course.
23. Visible stone or earthen foundations, berms, dams, standing structures or associated features occur within wetland.
24. Wetland contains critical habitat for a state or federally listed threatened or endangered species.
25. Wetland is known to be a study site for scientific research.
26. Wetland is a natural landmark or recognized by the state natural heritage inventory authority as an exemplary natural community.
27. Wetland has local significance because it serves several functional values.
28. Wetland has local significance because it has biological, geological, or other features that are locally rare or unique.
29. Wetland is known to contain an important archaeological site.
30. Wetland is hydrologically connected to a state or federally designated scenic river.
31. Wetland is located in an area experiencing a high wetland loss rate.
32. Other.

Responsibility for any errors that may remain in this paper is the authors' alone.

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