9 A Model for Assessing Visual-Cultural Values of Wetlands: A Massachusetts Case Study

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Introduction

This chapter addresses itself to the problem that land-use decisions affecting inland wetlands are being made without consideration of visual-cultural values because allegedly these values, which preempt their place in the decision-making process, cannot be "quantified." Chapter 9 summarizes the first known attempt to develop a fairly rigorous model for assessing visual-cultural values of wetlands.

Landscape Resources and Models

To deal with the values of wetlands in connection with land-use decisions, the Commonwealth of Massachusetts pioneered wetland legislation with the Hatch Act (1966) and the Inland Wetlands Protection Act (1968). Both acts and a few others are included in the umbrellalike Wetlands Protection Act (Commonwealth of Massachusetts, 1971). Many other states have drafted wetland protection legislation since 1966, the date of the initial Massachusetts Hatch Act.

A multidisciplinary inland-wetlands research project started at the University of Massachusetts soon after the Inland Wetlands Act became law. The objective of the project's organizer, Joseph S. Larson, was to create a tool that would help decision-makers reach better land-use decisions concerning inland wetlands. Larson assembled a team to formulate the decision-making tool and to investigate the many different types of inland-wetland resource values. This interdisciplinary study included a wildlife biology subproject, which assessed the wildlife values; an aerial photogrammetry subproject, which provided the wetland resource data; a hydrogeology subproject, which assessed the water supply and quality; a resource economics subproject, which assessed the economic value of each major wetland resource; and a landscape planning subproject.

The landscape planning subproject specifically addresses the issues of how to develop conceptually an overall model and how to incorporate the visual-cultural resource values of wetlands into the decision-making process. This has not yet been done comprehensively in any state under any legislation.

This chapter details how the landscape planning subproject of the inland-wetlands research team articulated the visual-cultural values of inland wetlands and designed a multistage assessment model to measure these values.

Study Objectives

The major study objectives were:

1. To identify, analyze, and classify inland wetland types and surrounding landscape types that are important for discerning and identifying different types of visual-cultural values.
2. To identify the major visual-cultural values that can be attributed to inland wetlands in Massachusetts and design an assessment model to estimate those values.
3. To design the inland wetlands assessment model for visual-cultural values as a module submodel in a larger inland-wetlands assessment model that inludes other inland wetland values.
4. To ensure that the inland-wetlands assessment model for visual-cultural values has utility at all decision-making levels and scales.

Definition of Critical Terms

Certain terms that are used throughout the chapter should be defined.

Resources: "Resources are entities which are useful and finite. They are like money held in the bank; they are available for human use, but scarcity dictates that some mechanism be established defining the objectives of use and the allocation of resources according to those objectives. Planning processes are one type of response to defining objectives and allocating resources" (Fabos, 1973, p. 1).

Visual-cultural: Refers to the visual landscape portion of the physical environment. "It consists of natural entities such as soil, trees, landform, water and various cultural entities or artifacts such as farms, recreational developments and housing. These entities or artifacts have various perceptual attributes and characteristics" (ibid, p. 2).

Wetlands: In this chapter, freshwater wetlands. Freshwater inland wetlands include marshes, swamps, meadows, and bogs by themselves, adjacent to, or part of streams, rivers, lakes, ponds, and reservoirs. They can be generally characterized as having a year-round surface or above-surface water level with submergent, surface, and emergent aquatic vegetation or herbaceae and woody vegetation resistant to frequent flooding.

Visual-cultural wetland resources: The finite natural resources available for human use that are perceived, found within, or associated with wetland areas. Examples of human use that treat wetlands as a visual-cultural resource are outdoor classroom use for natural history, canoeing, or hiking.

Visual-cultural wetland values: "Values are defined by human individuals and groups. The reason for segregating visual-cultural resource values for separate study is that they have received relatively little attention by the American decision-making process. A basic premise of this paper is articulation and definition of visual-cultural [wetland] values, even if through primitive quantitative techniques, will increase societies' favoring more explicit consideration of these values in individual and group decision-making processess" (ibid., p. 2).

Landscape resource variables: "Landscape resource variables represent a given quantity and quality of a resource [for example, visual contrast or wildlife productivity] that may have a number of different values" (ibid., p. 2). For instance, landform contrast may vary from high, owing to a 1,000-foot-high mountain situated adjacent to a wetland, to low, owing to no perceptual height difference of any landforms adjacent to a wetland. "The quantity (height difference) and quality all represent different values. They vary and yet they are still quantifiable within the metric; hence the term landscape resource variable" (ibid.).

Landscape dimension: The metric unit or measurement process used to rate a given landscape resource variable. In the case of landform contrast, the two landscape dimensions are relative relief measured in feet and ratio of relative relief to wetland width, a pure number.

Measurement: "A process which estimates the magnitude of a visual-cultural wetland value at a given point in time. The measurement of the value of the landscape resource variable or the measurement of several attributes (parameters) of a landscape resource variable is directed toward defining physical units useful in considering collective human values" (ibid., p. 3).

Rating: "The process which orders [visual-cultural] values of a landscape resource variable in a hierarchy [from high value to low value] in respect to a larger geographic area" (ibid., p. 3).

Assessment: "The process which combines the measurements and ratings of all landscape variables" (ibid., p. 3).

Inland-Wetland Assessment Model

The visual-cultural assessment submodel developed as an integral part of the overall inland-wetland assessment model (Figure 9.1). This was done to ensure that all the different subproject efforts would culminate in an effective interdisciplinary tool for assessing wetland resource values.

The inland-wetland assessment model has three major parts: classification, natural cultural resource evaluation, and economic valuation. The classification part of the assessment model necessitated a separate classification for each of the three subprojects: wildlife, visual-cultural, and hydrogeologic. The second part, the natural-cultural resource evaluation section, has three different levels, which constitute an eliminative system in that a wetland is "eliminated" from further deliberation or analysis if the wetland has a high value or scores high within any given level of evaluation. A wetland receiving a high value early in the evaluation process may require top priority for preservation or protection and is accordingly eliminated from further evaluation.

Level 1 evaluates a given wetland for a possible single outstanding natural or cultural value (for example, is it a major flyway and feeding area for large numbers of migratory waterfowl?). If a single outstanding value is not found, the wetland area is assessed at Level 2, which evaluates a wetland for several possible values simultaneously (for example, water-supply quantity and quality; wildlife-habitat quality and quantity; visual diversity and contrast) by rating the natural attributes and characteristics of the wetland area. If the combined value of the natural attributes is not substantial, the wetlands cultural attributes (for example, accessibility or proximity to urban areas) are then evaluated at Level 3. In each evaluation level the wetlands can be ranked from most to least valuable for wildlife and for visual-cultural and water-resource values.

The third major part of the assessment model deals with the economic evaluation of the combined values of each of the three subprojects: wildlife, visual-cultural, and hydrogeologic. In addition, it assesses the flood storage value of the wetlands. This assessment model can be used with or without the economic evaluation by the decision-maker, who has the option of using any combination of levels and resource factors, depending on the types of wetland values with which he or she is concerned.

Framework of the Visual-Cultural Submodel

The visual-cultural submodel (Figure 9.2), as part of the wetland assessment model, has two basic parts: the wetland and landscape context classification system; and the visual-cultural resource evaluation as a three-level eliminative process, described in detail by Smardon (1972).

Level 1 evaluates a given wetland for a possible single outstanding value (for example, an outstanding natural area for nature education). If outstanding values are not present, the wetland is further evaluated at Level 2. At this level, visual, recreational, and educational values (landform contrast, land-use diversity, associated water body size, and so forth) are rated by the attributes and characteristics of the wetland and its surroundings. If the combined value is not substantial, the wetlands cultural variables (educational proximity, physical accessibility, and ambient quality) may be evaluated at Level 3 and rated from the most to the least valuable.

Visual-Cultural Classification Systems

A two-part inland-wetland classification system (see Figure 9.2) was developed as part of the visual-cultural assessment submodel. One classification system served to differentiate the interior landscapes of inland wetlands them-

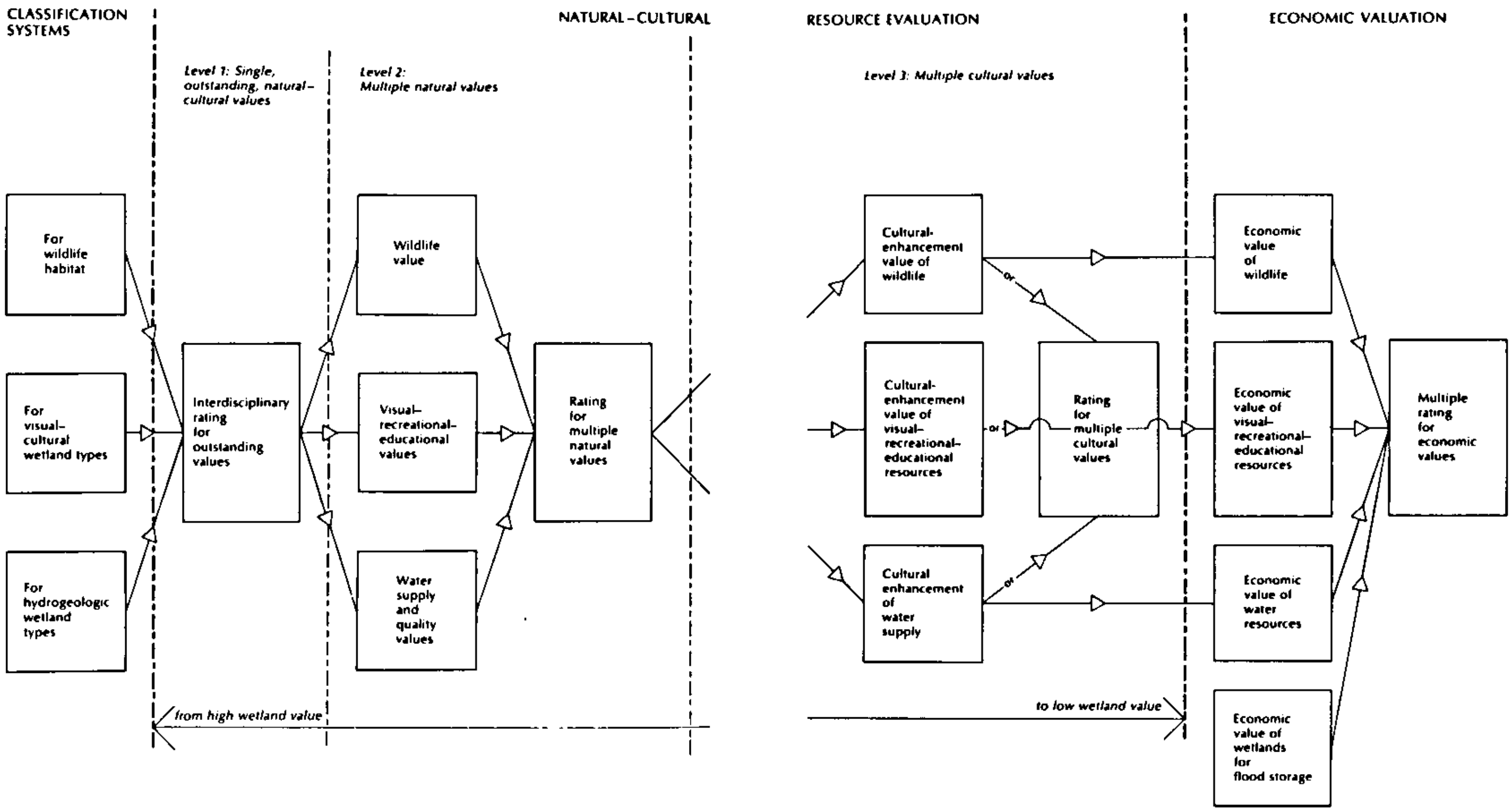

Figure 9.1. Inland-wetland assessment model.

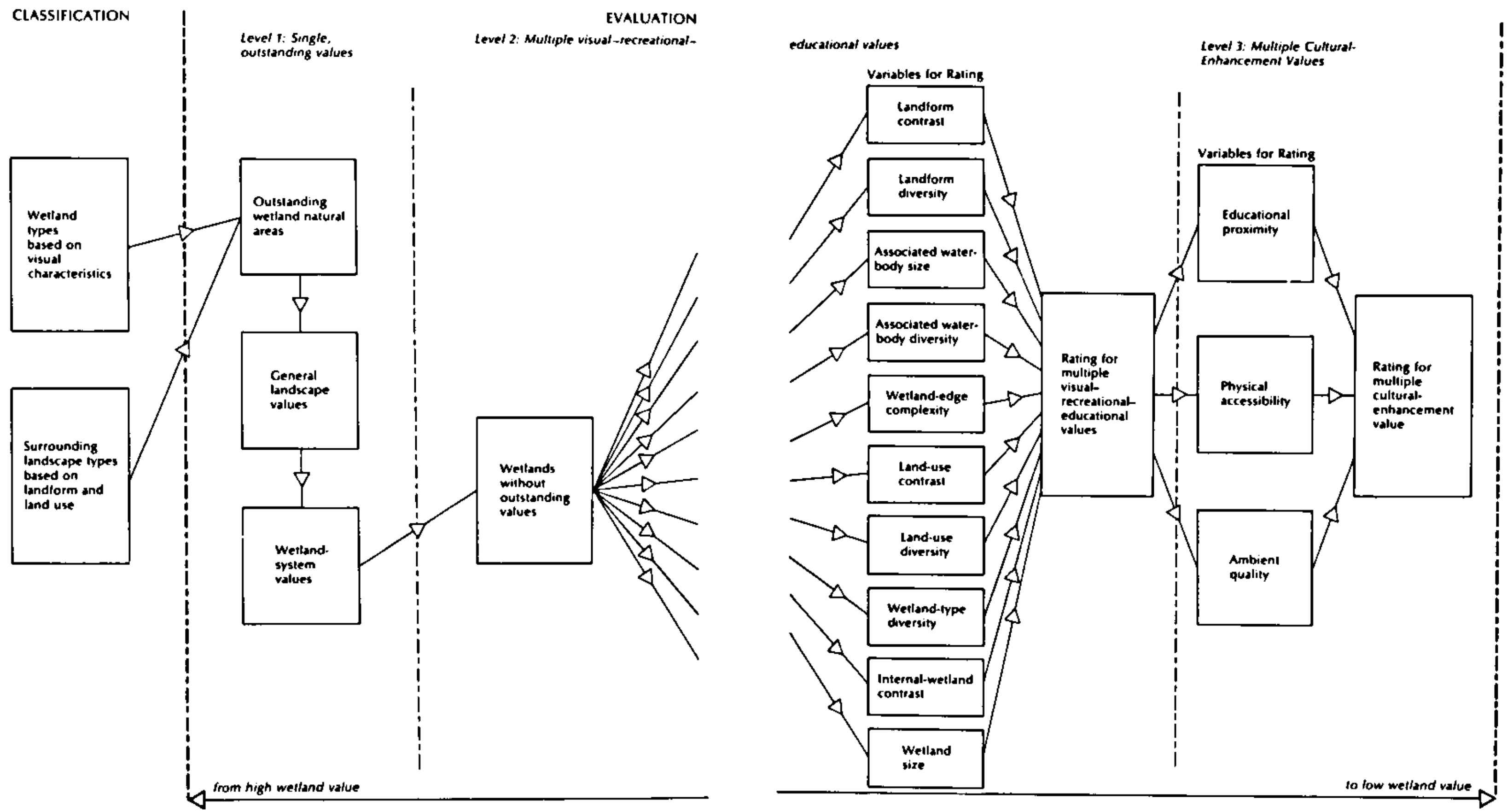

Figure 9.2. Visual-cultural wetlands assessment model.

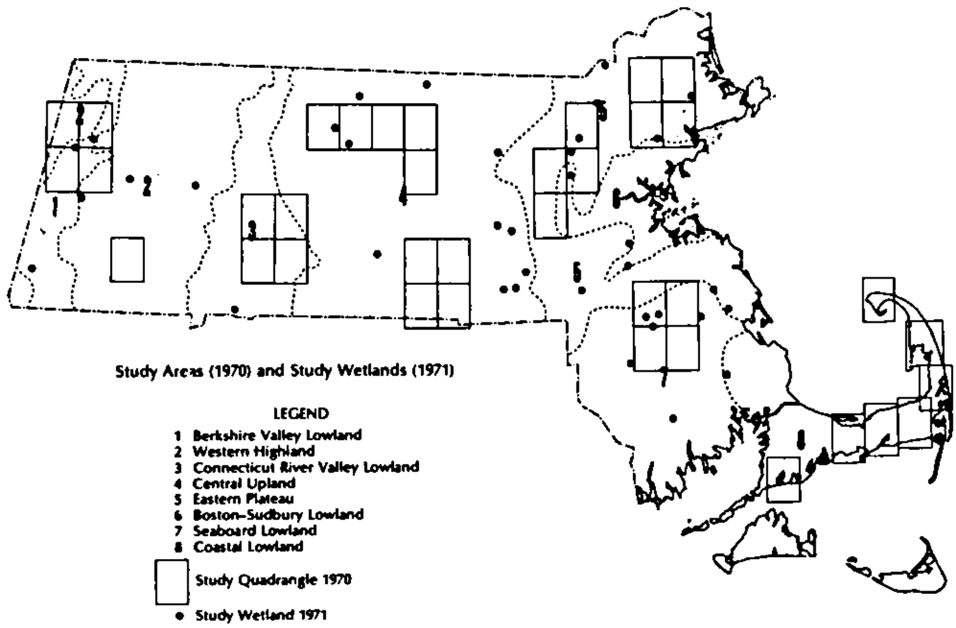

Figure 9.3. Physiographic regions of Massachusetts.

selves. The second system was needed to identify and differentiate the many different land scape contexts in which wetlands are found.

Identifying and Classifying Inland Wetland Types

Previous wetland classification systems (Lacate, 1969; Shaw and Fredline, 1956; USDI, Fish and Wildlife Service, 1954a) used the criteria of water level, vegetation, and soils to differentiate wetland types.

MacConnell and Garvin's wetland classification system was used to identify and map inland wetlands in Massachusetts in 1952. This system (1956) was slightly revised by MacConnell and is presently being used to identify and map wetlands in Massachusetts, using 1971–72 photos (MacConnell, 1971). The utility of this system (composed of mapped data from 1951–52 and 1971–72) and its similarity with the Shaw and Fredline and U.S. Fish and Wildlife Service systems made it acceptable for adaptation to the visual-cultural wetland submodel.

This inland-wetland classification system then was tested in the field. The types tested included open freshwater, deep fresh marsh, shallow fresh marsh, shrub swamp, wooded swamp, and bog (see Figures 9.3–9.10).

Identifying and Classifying Surrounding Landscape Contexts

Wetlands cannot be separated from their surrounding physical landscape. To evaluate the visual-cultural values of inland wetlands that were dependent on the immediately surrounding landscape, it was important to be able to identify and classify that landscape accurately. There are two components or parts of the surrounding landscape context: (1) the land use, and (2) the landforms underlying the land use.

Land Use: The continuum of cultural or man-affected land use can be classified from center city to forest wilderness. A number of descriptive systems were reviewed that classified the cultural characteristics of the landscape (Lewis et al., 1969; Olin et al., 1971; Zube et al., 1970). MacConnell's land-use and vegetative types were used to identify and classify the surrounding vegetation. Land use of the one to five U.S. Geological Survey quadrangle map areas were picked out within the physiographic region to best represent all wetland types occurring

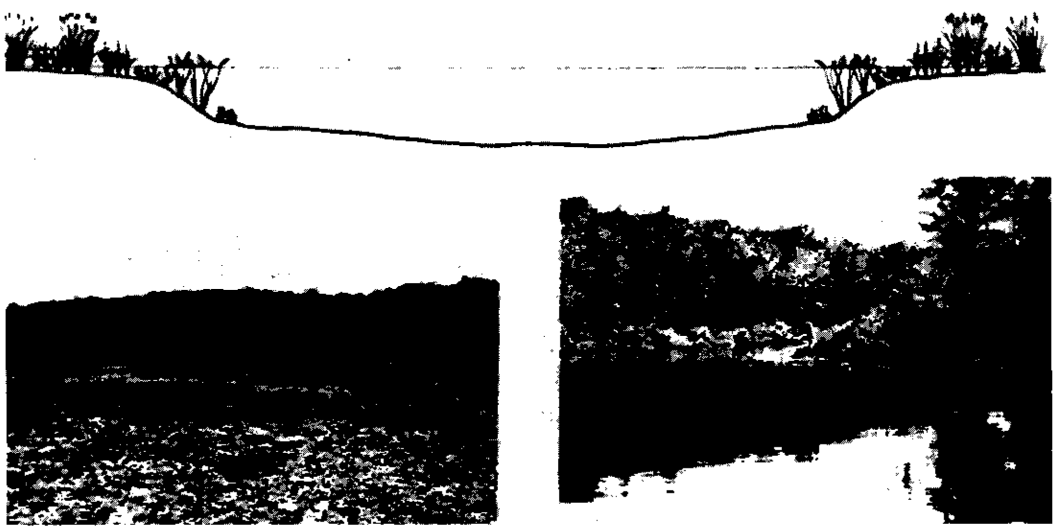

Figure 9.4. Typical cross-section and examples of open freshwater.

Definition: water less than 10 feet deep bordered by emergent vegetation: pondweed, naiads, wild celery, water lilies. (Photos by R.C. Smardon; cross-section by C.H. Greene.)

within the region. Each study area included all the wetland types as well as large complexes of wetlands and small isolated wetlands (see Figure 9.3).

The actual study procedure consisted of documenting individual wetland attributes and characteristics using field sheets and photography (see Smardon, 1972). Study-area results indicated that MacConnell's aerial photogrammetric land-use and vegetative-cover maps, as well as the wetland types and surrounding land-use types, were accurate and usable for the general assessment of visual-cultural values. A more refined classification system for wetlands was desirable at the time the study was done (Golet, 1973). No suitable set of detailed landform types existed in mapped form for the purpose of visual-cultural evaluation.

Landforms: Little work has been done in Massachusetts to identify and describe distinct landform types in the same detail as has been done for land use. Physiographic regions for Massachusetts, however, have been suggested (Beaumont, 1956; Fenneman, 1938; U.S. Fish and Wildlife Service, 1954). Each of these studies uses a gross continuous pattern of similar landforms. The landforms of the surrounding landscapes were identified using similar criteria suggested by these studies. The visual-cultural subproject, together with the wildlife and geology subproject, used criteria such as topography, surficial geology, bedrock geology, and drainage patterns to define physiographic regions for Massachusetts. Through the application of this process, eight distinct physiographic regions were identified (see Figure 9.3).

Visual-Cultural Valuation

The results of the classification indicated that different kinds of visual-cultural values could be related to wetlands or to wetlands and their landscape contexts. Three potential visual-cultural values were identified:

1. That inland wetlands themselves have educational and scientific values as outstanding natural areas.
2. That inland wetlands and their landscape contexts have visual, recreational, and educational value at a given site because of the attributes of the wetland, surrounding landform, water bodies, and surrounding vegetation and land use.

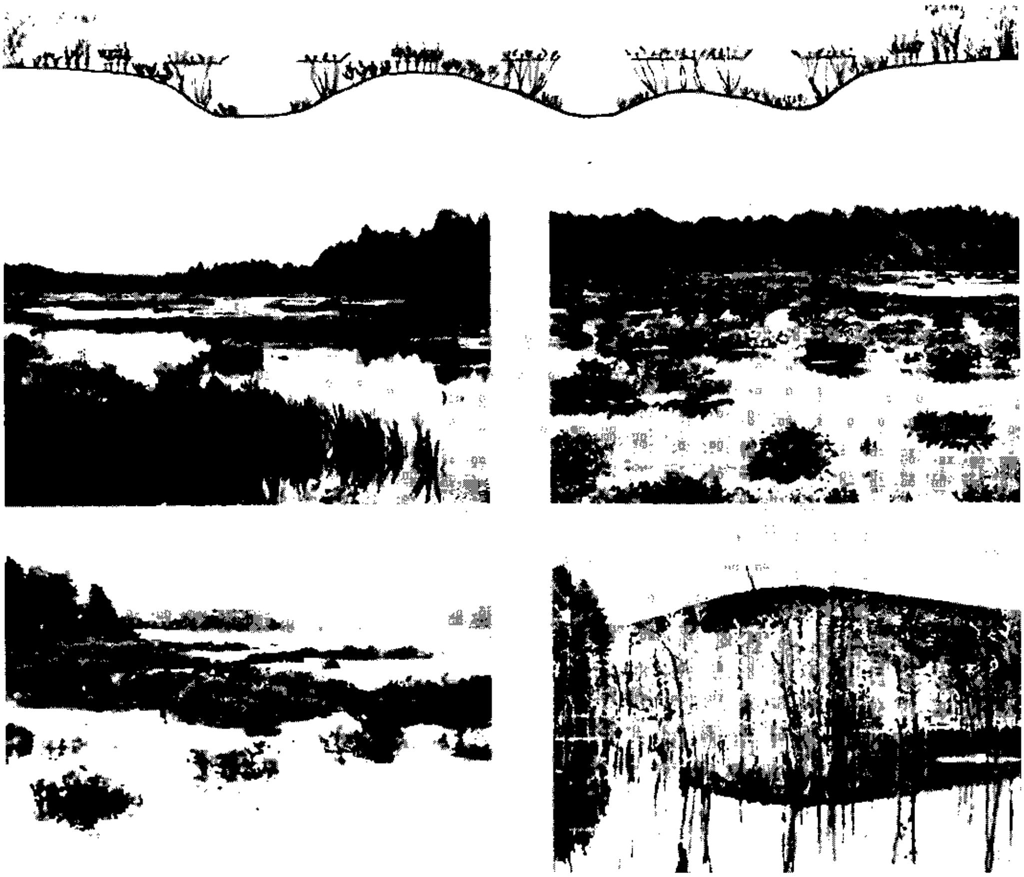

Figure 9.5. Typical cross-section and examples of deep fresh marsh. Definition: soil covered with 6 inches to 3 feet of water. Cattails, reeds, bulrushes, spike rushes, wild rice. (Photos by R.C. Smardon and F.C. Golet; cross-section by C.H. Greene.)

3. That large inland wetland complexes have visual-cultural values not found in small individual wetland sites.

The following evaluation section of the submodel defines the visual-cultural values indicated and includes methodologies for the measurement of these values. The process used here is the same as discussed earlier under the inland-wetland assessment model; that is, a three-level eliminative model.

Level 1: Individual Outstanding Values

Certain wetlands may have a single natural visual or cultural value that merits top priority for preservation or protection. These single outstanding attributes in most cases were jointly identified and defined by all the subprojects within an interdisciplinary framework.

It was concluded that certain unique wetland resources should not be assessed quantitatively. It was also concluded and widely accepted by the interdisciplinary team that there could be no monetary value attached to outstanding wetland resources, and that their greatest value to society is their present natural state. It was therefore proposed to use social norms to preserve outstanding wetlands similar to those used to create national parks, wildlife refuges, and wilderness areas. Thus the purpose of level 1 is to flag those wetland areas that are outstanding either by virtue of a single attribute or a number of attributes. Three types of values are examined in Level 1:

Figure 9.6. Typical cross-section and examples of shallow fresh marsh. Definition: soil waterlogged during growing season, often covered with 6 or more inches of water. Grasses, bulrushes, spike rushes, cattails, arrowhead, smartweed, pickerelweed. (Photos by R.C. Smardon and F.C. Golet; cross-section by C.H. Greene.)

1. Outstanding wetland natural area, such as an endangered-species habitat
2. General landscape values, such as a scarce wetland type within a region
3. Wetland system value, such as several significant wetlands interconnected with rivers and lakes

The first and third values cannot readily be separated into subproject areas because they draw on all subproject research areas. The second value represents primarily a visual-cultural value.

Outstanding wetland natural areas: This submodel defines wetland areas with high or outstanding visual, educational, or scientific value. Previous attempts to deal with this type of value in assessment literature have resulted in the concept of "uniqueness" (Leopold, 1969) or "being unique" (USDI, National Park Service, 1954). The similar concept of "outstanding areas" corresponds closely with the concept of nationally significant natural areas used by the National Park Service (1954b). The only difference is that wetland natural areas can be "outstanding" in a statewide or regional context. "Natural areas" as defined in the literature are "areas where at present natural processes predominate and are not significantly influenced by either deliberate manipulation or interference by man" (Maryland State Planning Department, 1968, p. 1).

Criteria for the identification of outstanding natural wetland areas were derived from professional judgment and other existing criteria (USDI, National Park Service, 1954b; Natural

Figure 9.7. Typical cross-section and examples of fresh meadow. Definition: without standing water during growing season; waterlogged to within a few inches of surface. Grasses, sedges, rushes, broadleaf plants. (Photos by R.C. Smardon and F.C. Golet; cross-section by C.H. Greene.)

Areas Criteria Committee, 1972) for identifying outstanding natural areas.

General landscape values: There are two kinds. One is the value of a wetland type that is relatively scarce within a specific geographic or physiographic region. Scanning of the aerial photogrammetric land-use and vegetative-cover maps of the state produced several relatively scarce wetland types within physiographic regions (Table 9.1).

The second general landscape value is that of visual contrast. Visual contrast is produced by a wetland providing openness in a predominantly forested landscape with little physical relief, or providing both forest and openness in a predominantly urban landscape. Visual contrast is provided in the landscape by keeping or introducing landscape types that contrast in height or texture with the general surrounding landscape. Table 9.2 summarizes the outstanding wetland types that provide visual contrast to the various geographic or physiographic regions.

Wetland system value: Wetland systems are combinations of wetlands, rivers, streams, lakes, and ponds. Because of their size and interconnectedness, large wetland systems have many conservation and open-space values. From the visual-cultural point of view, an important role is structuring urban development by providing open-space linkages; giving visible form to towns to improve their perceptual identity; serving as buffers or wedges between incompatible land uses or different areas of development; and

Figure 9.8. Typical cross-section of examples of shrub swamp. Definition: soil waterlogged, often covered with 1 or more feet of water. (Photos by F.C. Golet; cross-sections by C.H. Greene.)

by defining and separating towns, cities, and metropolitan areas (Central Massachusetts Regional Planning District, 1967; Lynch, 1960; USDA, Economic Research Service, 1968).

Because of the open-space values that a large system has, all wetlands within the system should be protected if the wetland system values are to be kept. The criteria developed for identifying large wetland systems within a New England landscape context are:

1. The wetland should be connected to another wetland by a large river or stream of at least fifteen miles navigable length; or
2. A wetland must be connected to another wetland by a lake, pond, or reservoir of more than 200 acres in area; or
3. The wetland should constitute a continuous 1,000 acres in size.

If a wetland does not meet any of the criteria for individual outstanding values in Level 1, it is then further evaluated at Level 2.

Level 2: Multiple Visual, Recreational, and Educational Values of Inland Wetlands

The purpose of Level 2 is to evaluate the large bulk of wetland areas that may not have a single outstanding visual, recreational, or educational

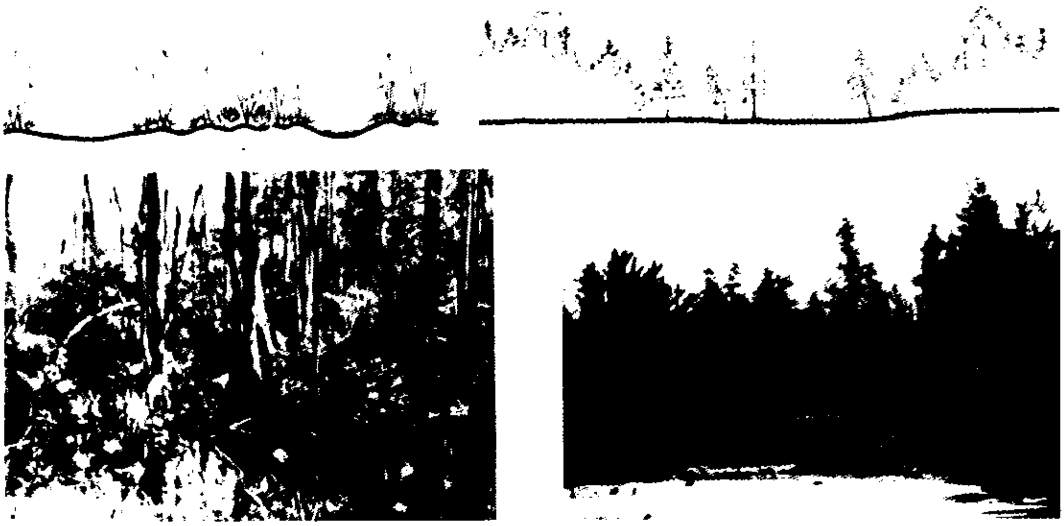

Figure 9.9. Typical cross-section and examples of wooded swamp. Definition: soil waterlogged, often covered with 1 foot of water. Along sluggish streams, shallow lake basins, and flat uplands. (Photos by F.C. Golet; cross-sections by C.H. Greene.)

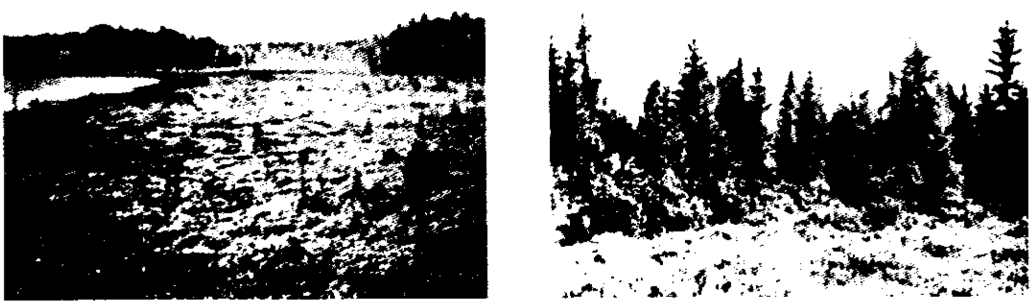

Figure 9.10. Typical examples of bogs. Definition: soil waterlogged, spongy covering of mosses. Heath shrubs, sphagnum, sedges. (Photos by F.C. Golet.)

characteristic. However, several attributes together may result in a wetland with a high value in each characteristic. Level 2 is more quantitative and more complex than Level 1.

This part of the model is developed on the premise that values of the wetland benefit both recreational and educational uses. Primary recreational uses are fishing, hunting, bird watching, and nature study. Other recreational uses include hiking, photography, canoeing, boating, and ice skating. Recreational uses of areas adjoining the wetland could include camping and picnicking; recreational activities involving movement include using trails and roads adjacent to wetlands for walking, cycling, horseback riding, cross-country skiing, and pleasure driving. Educational uses of wetlands include outdoor educational and scientific laboratories.

Obviously, there is a great overlap among the visual-recreational-educational attributes of a wetland. For example, a wetland has recreational value for canoeing, visual value for the scenery experienced while canoeing, and educational value for the species of fauna and flora that can be seen and identified while canoeing.

Key attributes were used to derive *variables,* which indicate differences in the visual, recreational, and educational quality of inland wetland sites. The two significant visual variables selected and substantiated were *visual contrast,* which can be attributed to the variables of landform contrast, water-body size or length, surrounding land-use contrast, and internal wetland contrast, and *visual diversity,* which can be attributed to the variables of landform diversity, wetland-edge complexity, and wetland-type diversity.

The *recreational carrying capacity* of wetlands was also estimated. It, too, can be attributed to the variables of landform diversity and wetland-edge *complexity;* but water-body size or length are equally important. Opportunity for *recreational diversity* and *educational diversity* of wetlands can be attributed to the variables of landform diversity, water-body diversity, surrounding land-use diversity, wetland-edge complexity, and wetland-type diversity. As a result of this rationale, the following resource variables were identified and measured.

Table 9.1 Scarce Wetlands within Specific Geographic Regions of Massachusetts

Physiographic Region	*Scarce Wetland Type*
Western highlands	Seasonally flooded flats Deep fresh marsh Shallow fresh marsh Fresh meadow
Berkshire valley lowland	Seasonally flooded flats Bogs
Connecticut valley lowland	Seasonally flooded flats Bogs
Central upland	Seasonally flooded flats
Eastern plateau	Seasonally flooded flats Bogs
Boston–Sudbury basin	Bogs
Seaboard lowland	Seasonally flooded flats
Coastal plain	Seasonally flooded flats Wooded swamp

Table 9.2 Wetlands with Outstanding Visual Contrast within Specific Geographic Regions of Massachusetts

Physiographic Region	*Wetland Types*
Western highlands	Deep fresh marsh Shallow fresh marsh Seasonally flooded flats Fresh meadow Bogs
Berkshire valley lowland	All types
Connecticut valley lowland	All types
Central upland	Deep fresh marsh Shallow fresh marsh Seasonally flooded flats Fresh meadow Bogs
Boston–Sudbury basin	All types
Seaboard lowland	Deep fresh marsh Shallow fresh marsh Seasonally flooded flats Fresh meadow Bogs
Coastal plain	All types

1. *Landform contrast* is the amount of visual edge manifested in the form of object dominance or spatial enclosure of the wetland in reference to a given landform.
2. *Landform diversity* is the variety of shape and/or mode or origin of landforms surrounding, adjacent to, or part of a wetland.
3. *Wetland-edge complexity* is the degree of irregularity of the physical boundary of the wetland where it meets a landform or vegetated edge.
4. *Associated water-body size* is the area of any lake, pond, or reservoir, or the length of a river or stream that borders, goes through, or is part of a wetland.
5. *Diversity of associated water bodies* is the number of different types of water features surrounding or comprising the given wetland.
6. *Surrounding land-use contrast* is the amount of contrast generated by the difference in vegetative and structural height and texture between the wetland and the adjacent land use or uses.
7. *Surrounding land-use diversity* is the amount of contrast generated by the different vegetative and compatible land uses bordering a wetland.
8. *Wetland-type diversity* is the number of variety of different wetland types or micro-landscapes within the wetland itself.
9. *Internal wetland contrast* is the amount of contrast generated within a wetland by differences in vegetative and water height and in texture.
10. *Wetland size* is the gross area of the continuous wetland area.

A measuring and rating procedure was developed on a scale from 1 to 5, with 5 the highest and 1 the lowest. The procedure was substantiated from research results of behavioral scientists. (For a full discussion of the development of and sources for the rating system, see Smardon, 1972 and 1975.) Table 9.3 displays the measuring and rating for the resource variables.

Weighting the Visual-Resource Variables: After each variable is rated, the score is adjusted by using significance coefficients based on two criteria, immutability and multiple value. Immutability is the degree of permanence. The landscape attributes that are more permanent are more valuable for visual-cultural values because they are less likely to be changed naturally or by man's actions. Immutability in the landscape attribute means long-term benefits without extra efforts, such as maintenance, to sustain visual, recreational, and educational quality (Fabos, 1971). Immutability was rated on a scale from 1 to 3, with 1 representing high mutability (vegetation) and 3 representing immutability (landform) (see Table 9.4).

The other criterion, multiple value, compensates for some variables having multiple-use values (visual, recreational, and educational), whereas other variables are significant for only one use value. The significance coefficients for visual resource variables are calculated by multiplying the number of use values (visual, recreational, and educational) that the given variable pertains to by the immutability number (see Table 9.4).

The overall visual resource is computed with the algebraic formula:

$$\sum_{t=1}^{m=1...11} (RVm)SCm = X$$

where RV = visual-resource variable
SC = significance coefficient
m = number of visual-resource variables
X = visual resource value

Higher scores indicate greater visual, recreational, and educational value. Thus evaluation Level 2, the visual-resource evaluation system, can be used to rate inland wetlands from the highest to the lowest values. If a wetland did not receive a high enough score to be eliminated from further analysis, the evaluation process continues to Level 3.

Level 3: Multiple Cultural-Enhancement Values of Inland Wetlands

The purpose of Level 3 is to acknowledge the man-made or cultural attributes, both positive and negative, of wetlands. A cultural attribute may increase the visual-cultural value to society (for example, greater accessibility). At the same time, pollution may decrease the visual-cultural values of a wetland.

Cultural-Enhancement Variables and Corresponding Landscape Dimensions: Cultural variables are what Lewis et al. (1969) term "extrinsic," which can be defined as "man-made changes, adaptations, and additions to the natural resources" (p. 23). Thus cultural variables are concerned with the existence or nonexistence of man-made effects, which can both add to and detract from the natural resource value. The cultural-enhancement variables are briefly defined:

1. *Educational proximity* is the measure of elementary schools, high schools, and colleges to a wetland area.
2. *Physical accessibility* is the degree of accessibility to a wetland by trail or road, and accessibility within the wetland by boat, trail, or road.
3. *Ambient quality* is the physical condition of the wetland as indicated by the lack of water pollution, air pollution, high noise level, and visual misfits or noncompatible land uses.

Table 9.5 summarizes the measurement and rating processes of the cultural-enhancement variables. The rating scales are the same as Level 2 (see Figure 9.2).

Weighting the Cultural-Enhancement Variables: The cultural variables are weighted by using significance coefficients or multipliers. The criterion used was the relative importance of the variable to visual, recreational, and educational quality. A summary of the significance coefficients, the maximum points possible per variable, and the total number of points possible from the Level 3 evaluation are shown in Table 9.6.

A wetland's rank in relation to other wetlands may change from the rank received in Level 2 owing to the ratings given in Level 3. Its rank may increase or decrease.

A wetland's score after a Level 3 evaluation is the cultural-enhancement value of the wetland site for visual, recreational, and educational quality. This can be expressed algebraically as:

$$\sum_{t=1}^{n=1...3} (CVn)SCn = Y$$

where CV = cultural enhancement variable
SC = significance coefficient
n = number of cultural variables
Y = cultural-enhancement value

When a wetland is ranked with other wetlands after the Level 3 evaluation, it can be ranked on its cultural-enhancement value (y) alone, or with both scores from the visual, recreational, educational resource value and the cultural-enhancement value (x + y) to yield the total visual-cultural resource value (z). Furthermore, the visual-cultural resource values can be expressed in dollars if an economic valuation is conducted as developed by members of our economics subproject.

Economic Valuation

The inland-wetland assessment model described earlier (see Figure 9.1) shows the evaluation of three separate resource values of wetlands: wildlife-habitat, visual-cultural, and water-resource values. Each separate study developed a submodel to assess the qualities of all wetlands in Massachusetts. The submodels did not valuate, however, the economic value to society of any of these resources. The landscape planner may rank a highly rated wetland for visual-cultural value as number 10 among 130 wetlands. But what can a decision-maker who needs to translate ratings into monetary values be told? He or she may use the economic valuation submodel developed by our resource economists.

The economics subproject of the wetland study developed techniques to estimate visual-cultural, wildlife-habitat, and water-supply values of wetlands. In addition, benefits to society resulting from flood control by preserving wetlands were included (Gupta, 1973). We describe here only the technique used to obtain values for the visual-cultural wetland resources (Gupta and Foster, 1973).

The basis for the economic valuation of visual-cultural values was provided by data on land purchases made by conservation commissions in Massachusetts during the fiscal year 1972. The open-space value was assumed to correlate visual, recreational, and educational values in Level 2. Particular attention was paid to open-

Table 9.3 Measuring and Rating Procedures for Visual-Resource Variables

Visual-Resource Variables	Landscape Dimensions	Measurement Process	Rating Procedure				
1 Landform contrast	Relative relief	Calculate difference between wetland elevation and adjacent landform height.	Assign rating.	Adjacent landform height (ft)	Rating		
	Ratio of relative relief to wetland width	Divide relative relief of adjacent landform by average width of wetland.	Multiply ratio by 3.	800–1000	5	Average two ratings	
				600–800	4		
				400–600	3		
				200–400	2		
				0–200	1		
2 Landform diversity	Number of landform types	Count number of different landform types on and surrounding wetland.	Assign rating.	Number of landform types	Rating		
				6	5		
				5	4		
				4	3		
				3	2		
				2	1		
3 Wetland-edge complexity	Wetland-edge configuration	Measure outer edge, length of wetland (S).	Plug into formula	Wetland-edge configuration	Rating		
		Measure total area of wetland (A)	$\frac{S}{2\sqrt{\pi A}}$	5.0	5		
				4-5	4		
				3-4	3		
			Assign rating	2-3	2		
				1-2	1		
4 Associated water-body size	Navigable length of stream by canoe (100 CFS discharge) or acreage of pond or lake	Measure navigable length (mi.) or acreage.	Assign rating.	Miles	Rating	Acres	Rating
				12-15	5	101+	5
				9-12	4	51-100	4
				6-9	3	21-50	3
				3-6	2	9-20	2
				3	1	8	1

5 Associated water-body diversity	Number of water bodies are in or adjacent to wetland	Count number of water bodies in or adjacent to wetlands.		Assign rating.	Number of water bodies 5+ 4 3 2 1	Rating 5 4 3 2 1
6 Surrounding land-use contrast	Difference between average height of wetland vegetation and average height of surrounding land use	Determine height class of wetland vegetation and height class of surrounding land use.	Average heights / Height class 0′ / 1 0–2′ / 2 2–4′ / 3 4–15′ / 4 15′ + / 5	Assign rating	Height class combinations 1/5 2/5, 1/4 1/3, 2/4, 3/5 1/2, 2/3, 3/4, 4/5 same heights	Rating 5 4 3 2 1
7 Surrounding land-use diversity	Number of height classes and wildlife habitat classes bordering wetland	Count number of height classes and wildlife habitat classes bordering on wetland and average both figures.	Wildlife habitat classes woods brush grass cultivation water	Assign rating	Average 5 4 3 2 1	Rating 5 4 3 2 1
8 Wetland-type diversity	Number of wetland types	Count number of different wetland types within a given wetland.	Wetland types Bog Deep fresh marsh Shallow fresh marsh Seasonally flooded flats Fresh meadow Shrub swamp Wooded Swamp		Number of wetland types 5 4 3 2 1	Rating 5 4 3 2 1
9 Internal wetland contrast	Internal wetland-edge contrast	Measure length of edges between vegetation types of different heights and measure total length of interior wetland edges, exclusive of perimeter. Determine percent of total edge occupied by each height-class combination (see 6 above). Multiply edge percentage by height-class combination rating (see 6 above) and add for rating.		Assign rating		Rating 5 4 3 2 1
10 Wetland size	Size of wetland in acres	Measure wetland acreage.		Assign rating	Acres 501-1000 251-500 101-250 51-100 10-50	Rating 5 4 3 2 1

Table 9.4 Weighting the Visual-Resource Variables

Natural Resource Variable	*Landform (3)*	*Water Body (2)*	*Vegetation (1)*	*Visual (1)*	*Recreation (1)*	*Education (1)*	*Significance Coefficient*	*Highest Possible Rating*	*Highest Possible Total Score*
Landform contrast	×			×			3	5	15
Landform diversity	×				×	×	6	5	30
Associated water-body size		×			×		2	5	10
Associated water-body diversity		×		×	×	×	6	5	30
Wetland-edge complexity	×			×	×	×	9	5	45
Land-use contrast			×	×			1	5	5
Land-use diversity			×	×	×		2	5	10
Wetland-type diversity			×	×	×	×	3	5	15
Internal wetland contrast			×	×			1	5	5
Wetland size			×		×		1	5	5
								Total	170

space lands for nonactive recreation, the purchase of which was made with the aid of a subsidy of 50 percent of the price through the "Self-Help" program using state funds.

Data were collected from twenty-nine municipalities that received "Self-Help" assistance from the Division of Conservation Services, Massachusetts Department of Natural Resources, to acquire fourty-two parcels of open-space lands totaling 1,516 acres. The average price was $1,608 per acre.

The range of the five highest prices of land purchased was from $3,684 to $5,769 per acre. Based on these results, the resource economists estimated what they considered to be a fair maximum price that society had agreed to pay for high-quality open-space land, which was $5,000 per acre. If 5.375 percent is used as the capitalization rate of interest, the public cost of acquiring visual-cultural benefits on such lands was calculated to be approximately $270 per acre per year. If 7 percent is used, the figure would be $350 per acre per year. Based on the assumption of maximum willingness, $270 was accepted as an economic-value measure of the annual productivity per acre of visual-cultural values of high-quality wetlands as assessed by the visual-cultural evaluation. This economic figure was correlated with the high-quality visual-cultural values assessed by our submodel.

Similar values for wildlife-habitat, water-supply, and flood-control benefits were also derived by the economics subproject. Table 9.7 summarizes the results in terms of high, medium, and low values of benefits per acre of wetlands per year.

These benefits were then translated through computer analysis into capitalized values for different types of wetlands. They were capitalized over a number of years using two different rates of interest. A summary of the results is presented in Table 9.8.

The figures in the two right-hand columns imply that, given a rate of interest, society is supposedly better off purchasing and preserving a wetland for its accrued benefits so long as its price is less than or equal to the respective figures in the table.

Potential Utility of the Visual-Cultural Submodel

In this section we discuss the third study objective, which is to ensure that the visual-cultural wetlands assessment submodel has utility at all decision-making levels and scales. Illustrating the utility of the submodel can be done by showing who can use it, how they can use it, and what tasks it can be used for.

At the site scale, an inland wetland could be rated by a wetland owner—whether a private individual, conservation commission, state agency, or federal agency—to see if the individual wetland achieves a high, middle, or low score for visual-cultural values. The score may indicate the desirability of preserving or protecting the wetland, developing it for multiple or single use, or trading it for another use. Ideally, the wetland score for visual-cultural values as well as other values, such as water supply and wildlife habitat, could serve as a preliminary assessment for the wetland owner of the degree of difficulty the owner might expect from an agency in obtaining a permit to alter the wetland.

At the town scale, the ideal user would be

Table 9.5 Measuring and Rating Procedures for Cultural-Enhancement Variables

Cultural-Enhancement Variables	Landscape Dimensions	Measuring Process		Rating Procedure			
1 Educational proximity	Proximity of elementary and high schools	Locate all elementary and high schools within 10-mile radius of wetland. Locate all colleges within 50-mile radius of wetland.	Measure distance to closest school along existing roads. Measure distance to closest college along existing roads.	Distance zone (mi.) adjacent	Rating	Distance zone (mi.) adjacent	Rating
				0–1	5	0–10	5
				1–5	4	10–20	4
				5–10	3	20–30	3
				10–15	2	30–50	2
				15+	1	50+	1
				Average two ratings			
2 Physical accessibility	Number of access types	Check wetland and surroundings for different types of access to and on the wetland.	Access types	Access types	Rating		
			Trail access	5	5		
			Boat access	4	4		
			Road access	3	3		
			Trail access	2	2		
				1	1		
3 Ambient quality	Number of ambient-quality problems	Check for number of ambient problems on or near wetland.	Ambient problems	Number of problems	Rating		
			Water quality	0	5		
			Air quality	1	4		
			Noise level	2	3		
			Visual quality	3	2		
			Misfits	4	1		

Table 9.6 Weighting the Cultural-Enhancement Variables

Cultural Resource Variable	*Visual (1)*	*Recreational (1)*	*Educational (1)*	*Significance Coefficient*	*Highest Possible Rating*	*Highest Possible Total Score*
Educational proximity			×	1	5	5
Physical accessibility	×	×	×	3	5	15
Ambient quality	×	×	×	3	5	15
						35

town or city conservation commissions, town selectmen, planning boards, and city-town planners. Conservation commissions in Massachusetts and their parallels in other states could use the visual-cultural submodel to rate various wetlands within their own towns or cities. The rated wetlands could then be ranked to help determine which wetlands should be acquired first, using money from the state's "Self-Help" program or the equivalent and/or federal outdoor-recreation programs. The visual-cultural resource value could be translated into the economic worth of the wetland by using the economic valuation. This would help to indicate whether the land is worth preserving solely for its visual-cultural values for a certain acquisition price. A combined economic valuation, including water-supply, wildlife-habitat, and flood-control values, might indicate to the conservation commission that the purchase price is more than worth the combined values of the wetland.

Table 9.7 Monetary Equivalents of High, Medium, and Low Values of Annual Benefits of Wetland Preservation

Type and Nature of Benefits	Dollar Values of Benefits per Acre of Wetlands: High	Medium	Low[a]
Wildlife	70	35	10
Visual-cultural	270	135	30
Water supply	2,800	1,400	400
Flood control	80	40	10

[a]The dollar figures of low benefits bear no proportionate relationship to the high figures.

Source: Gupta, 1973, p. 153.

At the regional scale, planning agencies or comparable agencies in other states would be ideal users. In Massachusetts, planning agencies could use the visual-cultural submodel to rate and rank wetlands on a regional basis to indicate priorities for preservation of wetlands, especially regional wetland systems.

At the state scale, planning agencies could use the visual-cultural submodel or the larger inland-wetlands assessment model to rate inland wetlands statewide. This could indicate preservation priorities for wetlands with visual-cultural values of statewide significance, water-supply values, wildlife-habitat values, wetlands with single "outstanding" values for educational and scientific use, and even wetlands for flood-control purposes as outlined in the economic valuation. The economic valuation would indicate whether the wetlands should be purchased with state funds.

Interstate users would be primarily federal wetland regulatory agencies, such as the Environmental Protection Agency and the Corps of Engineers under Section 404 of the Water Pollution Control Act, which pertains to dredge and fill permits in water bodies. Other potential federal users are land-management agencies, such as the Forest Service, the National Park Service, the Bureau of Land Management, the Bureau of Reclamation, Fish and Wildlife Service, and the Department of Defense. In addition, certain federal agencies offer specific programs and advice to local agencies. Wetland evaluation could become part of programs administered by the Soil Conservation Service, the Extension and Education Administration, and the National Park Service.

With some alteration the submodels could probably be used on a national scale for rating wetlands. The assessment systems could be used to indicate wetland areas of extremely high natural value or "outstanding" wetlands that would merit national status for preservation. River basins commissions and the Corps of Engineers could use the visual-cultural, wildlife-

Table 9.8 Summary of the Computer Analysis Showing the Nature of Benefits from Preserved Wetlands and Their Capitalized Values per Acre, Massachusetts, 1972

Nature of Benefits				Capitalized Value of Wetland Benefits per Acre at (percentage)	
Wildlife	Visual-cultural	Water supply	Flood control	5.375 ($)	7 ($)
High	High	High	High	59,000	64,000
High	High	Medium	High	33,800	26,000
High	High	Low	High	15,200	11,700
High	High	None	High	7,800	6,000
Medium	Medium	None	Medium	3,900	3,000
Low	Low	None	None	700	500
High	Low	None	None	1,800	1,400
Low	High	None	Low	5,300	4,100
Low	Low	None	High	2,200	1,700
Low	Low	High	Low	53,000	40,700
Low	Low	Low	Low	8,300	6,400

Note: Figures in the two right-hand columns have been rounded to the nearest $100.

Source: Gupta, 1973, p. 175.

habitat, and water-supply submodels, and especially the economic valuation of flood-control benefits of wetlands, to rate wetland systems on an interstate river-basin scale.

This partial listing of possible users and the possible uses of the visual-cultural submodel or the overall inland-wetlands assessment model merely indicates the value of a comprehensive wetland assessment system. There are many more probable uses of the system at many different scales.

The visual-cultural submodel is an assessment system for measuring the visual-cultural values of inland wetlands. As an integral part of the overall inland-wetlands assessment model, it could help to facilitate better wetland-use decision making. It is needed now. Land-use allocation questions concerning wetlands are in the news every day and confront many decision-making bodies on many political levels and geographic scales.

It should be realized, however, that the system as a whole has not been thoroughly tested through actual use. Evaluation Level 2 has been extensively pretested in the field to determine if there is a good point spread between rating scores and to see if the variables account for reasonable differences in visual-cultural value. Level 2 sample ratings were also compared with expert panel ratings of the same wetlands. Evaluation Levels 1 and 3 have not been developed to the same degree.

To improve the model, research is proposed in three areas. First, the design of the model should be modified in such a way that the average conservation commission member could use it. Then, through the use of the model, additional necessary changes and modifications should be made to improve the submodel.

Second, the validity of the submodel should be improved through behavioral studies and by testing each variable and criterion, as well as the overall structure of the submodel. Perhaps new, additional variables should be developed to improve the value-rating procedure.

Third, assessment systems for evaluating the visual-cultural values of the large surrounding landscapes of wetland environment might be developed. Many of the variables and assessment principles used in this study are central to visual-cultural values for many other types of environments.

In short, much more research is needed in assessment systems to enable better environmental-resource decision-making.

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