MARYLAND DEPARTMENT OF THE ENVIRONMENT (MDE)

LANDSCAPE LEVEL WETLAND FUNCTIONAL ASSESSMENT METHOD

ADDITIONAL GUIDANCE FOR USE, REGIONALIZATION, AND REVISIONS

MARCH 26, 1997

This document is intended to provide additional guidance to users of the MDE Landscape Level Wetland Functional Assessment Method. The method has been designed for use by local governments and may be a field, office, or combination approach. The user may find that the method requires revisions to be appropriate for a specific wetland and watershed study. Prospective users are encouraged to contact the Nontidal Wetlands and Waterways Division, MDE for assistance in using or revising the method.

This guidance is primarily for desk top use of the model.

A. Assessment areas

The size of the wetland assessment area unit should vary in proportion to the size of the study area. The larger the study area, the larger the wetland assessment unit boundaries should be. It is most likely that wetland class boundaries as shown on the National Wetland Inventory or Maryland Nontidal Wetland Guidance Maps will be for areas that are too small and numerous to yield meaningful results on a watershed scale.

We recommend that the user begin setting the assessment area boundaries by looking at wetlands in association with stream order. For example, in a small study area, wetlands adjacent to or within the drainage of first order streams may be single assessment units, and become a different assessment unit where the first order stream/wetland complex becomes a higher order stream. As study area increases, a single assessment area may encompass streams of higher order, their headwater streams, and other wetlands within the same drainage. Fragmenting features of the wetland complex, such as roads, should not be considered as boundary points unless the road is a major transportation corridor with multiple lanes, such as I-95, I-495, etc. Wetlands on opposite sides of a river or stream should usually be considered part of the same assessment area.

As the assessment is conducted, only similar wetland units should be compared. For example, wetlands and their associated first- or second- order streams should not be compared to a higher order complexes because the complexes are not expected to function in the same manner (see E 1 below). The larger size of the higher order complex also inevitably results in higher functional capacity scores for the larger system.

B. Wetland integrity

The wetland study sponsor and work group should decide early on how man-influenced disturbed wetlands versus "natural" or relatively undisturbed wetlands should be considered in terms of wetland function. For example, an impoundment in a stream represents an alteration from how the wetland/stream complex would normally function, particularly for movement of aquatic life. However, the impounded area may also provide water quality improvement functions and habitat for some types of aquatic life.

C. Base map

A good base map is essential for using the desk top model and for preliminary work using the field approach. A recent photographic or satellite image is most useful for identifying wetlands, land uses, and land cover. Maps of this type are available at various scales from the Departments of Environment or Natural Resources. Soil survey maps often have useful information, despite the age of some of the photographs. Topographic maps are also useful in calculating slope and identifying small drainages.

Certain GIS layers are particularly important for study sponsors who have the ability to combine the layers over a good base map. The layers include: National Wetland Inventory wetlands, Department of Natural Resources wetlands (over digital orthophoto quarter quads) Maryland Office of Planning land use/land cover and zoning maps, streams, and roads.

D. Spot field checks

The amount of time spent in the field will depend upon the number of staff and time available for evaluating wetlands. If the study area is small enough, a consultant is hired, or numerous agencies with wetland personnel are available to provide staff assistance, it may be possible to visit all of the wetland complexes. If there is not sufficient time or personnel, then it will be useful to visit a selected number of representative and unique areas to gauge how well the desk top results match with those from the field visit. When watershed plan goals include recommending an intense land use in wetlands with lower functional values of interests, it will also be useful to visit those wetlands to ensure that the best management recommendation has been made.

E. Indicators and functions

1) Headwaters

These are considered to be 1st and 2nd order streams. They generally have a steeper gradient and more narrow floodplains than higher order streams. Wetlands associated with headwaters are considered to be primarily supported by groundwater as a response to model questions.

Rationale: The steeper gradient and more narrow floodplains typically prevent long-term inundation by flood waters or overland flow.

2) Slopes and soils

Soil surveys may be used to approximate field data for steep slopes, erodibility, permeability, and flood frequency. Scoring may be on a 1-3 scale for slow, moderate, or rapid permeability.

Steep slopes were scaled to match information from soil survey 15% or greater.

Erodibility scores are reflect low, moderate, or severe erosion hazards. Highly erodible soils adjacent to wetlands or streams are susceptible to disturbances and when disturbed, degrade wetland integrity.

Rationale: Soils criteria were originally based on field data.

3) Area calculations

If you do not have a GIS system to calculate areas for you, you may use a topographic map and a ruler or calipers to determine drainage areas, gradients, and wetland areas.

Wetlands of variable width: To calculate an area score, the user may take an average width or measure total area at several locations, if calipers are not available.

Rationale: Maps are the best information available without extensive field inventories.

4) Inlets and outlets

There was presumed to be perennial inlet and perennial flow out of ponds.

Rationale: Ponds are typically designed to have a constant release rate. A perennial stream is needed to generate enough flow to maintain an open water pond.

Road crossings: Roads were presume to be a negative influence on flow through an outlet. road crossings were scored as an intermittent or restricted outlet.

Rationale: Roads constrict the floodplain at the crossing point. Roads also are frequently installed improperly and create a backwater effect. they may also be complete or partial barriers to movement of aquatic life.

5) Intensity of land use in wetland

A mixture of forested and open area was assigned a moderate score. A predominantly forested wetland with adjacent houses and a major road was also given a score for moderate intensity.

Rationale: The examples represent an intermediate condition not described in the model.

6) Vegetative cover class

Photographic base maps were used to estimate cover class. Forested were identified by solid dark appearance. Light or mixed areas were presumed to be scrub-shrub areas. Cover was presumed to be continuous unless there was a discrete break, such at a forest-field boundary, or the vegetation appeared patchy.

Rationale: Approach consistent with aerial photographic interpretation methods.

7) Overland flow from upland

Scores for this indicator should be adjusted according to how the functions is being evaluated: If a wetland is favored by plan goals because it is <u>currently</u> receiving runoff from impervious surface or a sediment source, and is providing water quality improvement, the wetland should be scored higher than a wetland that has potential, but is not now receiving additional runoff. If preference under plan goals is to favor the least disturbed wetlands, the wetland receiving additional runoff and sediment would receive a lower score.

8) Aquatic diversity

a) Dominant vegetation type

If there is exclusively a riparian forested system, there will not be diversity of vegetation types, as suggested in indicator #5. There will be aquatic habitat diversity if there is a pond as well as a stream. If the model is designed to favor diversity over less altered systems, a higher score should be given when a pond is present. If preference is for least disturbed systems, then riparian systems without ponds should have a higher score.

b) Wetland contribution to aquatic diversity

An indicator score should be added to recognize contributions wetlands make when they are adjacent to streams, in addition to when the wetlands themselves directly support aquatic life.

Rationale; Wetlands adjacent to streams provide ground water discharge for base flow support, vegetation for shade, cover, and organic matter for the food chain, and water quality improvement functions, which improve instream habitat.

c) First order or intermittent streams

First order or intermittent streams were given scores indicating that presence of aquatic species is unknown.

Rationale: As these areas have less flow, there is much less habitat for aquatic species. Aquatic life may largely be absent.

d) Land use and aquatic diversity

Score areas with low density of vegetation or early successional vegetation as having a land use of moderate intensity. Also, consider presence of road crossings or ponds in relation to wetlands.

Rationale: Low densities of vegetative cover provides less roughness to slow overland flows that transport sediment and pollutants into waters. Road (culvert) crossings are a direct loss of aquatic habitat (stream channel) and also contribute polluted impervious surface runoff. Ponds may trap some of the pollutants, but if the ponds are instream, they also reduce natural stream habitat.

e) Wetland buffer to a water body

A wetland of forested area contiguous to a water body typically performs water quality improvement, habitat, or corridor functions. A minimum preferred width for a stream is 100-300 feet on either side of the stream.

9) Wildlife Diversity/Abundance

The watershed study sponsor, in consultation with other agencies and the citizen work group (if applicable) must decide if wetland integrity is to be favored over wetland/wildlife diversity. Indicators #2,4,5,11,14, all favor a mixture of habitats, which probably reflects man-altered conditions. Indicators #8 and 13 favor open water areas, which are best for waterfowl but at the expense of other species.

F. Existing Information

Users should be aware of existing information sources that can provide actual data for model input to replace indicators. most of the information is related to fish and wildlife records, though some flood studies exist. Species identified and habitat quality indices have been developed for tidal and nontidal waters. Threatened and endangered species have also been identified. Contact the following agencies in the Department of Natural Resources:

Maryland Biological Stream Survey	(410) ~~974-3782~~
Tidewater Ecosystem Assessment	(410) 974-3767
Forest, Wildlife, and Heritage Service	(410) 974-3195

G. Tidal Wetlands

The landscape level assessment method was developed for nontidal wetlands. Indicators and scoring would likely require adjustment. It will be useful to consider tidal wetlands in terms of their integrity, adjacency of point discharges and impervious surfaces, water quality and aquatic life, and submerged aquatic vegetation.

A METHOD FOR THE ASSESSMENT OF WETLAND FUNCTION

Prepared for:
Maryland Department of the Environment

Prepared by:
Fugro East, Inc.
Six Maple Street
Northborough, MA 01532

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1.0 BASIC WETLAND ASSESSMENT METHOD ELEMENTS

1.1 INTRODUCTION

This manual prepared for the Maryland Department of the Environment (MDE), formerly the Maryland Department of Natural Resources, concerns the development and design of a predominantly desk top wetland assessment method. This method was designed for use by informed lay persons dealing with watershed management issues, particularly county planners. This manual defines the rationale used to design such a method and describes the method. The method is the result of testing in two different watersheds in Maryland.

1.2 LITERATURE REVIEW

Four basic types of wetland assessment methods exist in the literature. These methods are: semi-quantitative; using indicators with weights and scores; classification systems; assessment questions, and cumulative impact-landscape level methods. The Phase One literature review of this study (Review of Existing Wetland Assessment Methods and Their Applicability to a Landscape Level Desk Top Method, Fugro-McClelland, August 1993) consisted of a detailed discussion of the various method types and specific individual methods. No existing method is capable of being applied to Maryland's needs without modification. Liebowitz, et al. (1993) is the one method most applicable to a desk top landscape method because it is a synoptic method capable of being applied to large areas where assessment is based partially on existing data suitable for GIS use. The first draft of the report proposed a method based primarily on Liebowitz, et al. (1993) with elements from other methods. One method that was not reviewed in the Phase One literature review, because it only became available on August 24, 1993, is Smith, et al. (1993) of the U.S. Army Corps of Engineers. Because this is the first draft of the new Corps wetland assessment method and the contract calls for creation of a Maryland method that will be compatible with federal methods, elements from both Smith, et al. (1993) and Rose, et al. (1993) are included as much as possible. Both of those methods require field investigations and therefore, are not directly applicable to the Maryland method. Based on comments from the MDE concerning the first draft method, the method proposed in this report is less similar to a synoptic method and more similar to the proposed Corps method as of August 1994.

Some of the listed variables can be obtained from MDE's GIS data layers, while many others require field data collection. Therefore, two wetland assessment model types are presented: 1) a desk top model requiring no field work, and; 2) a method that is similar to the desk top method, but includes variables that must be obtained by field investigations. These field investigation variables are ones that most informed lay persons can observe during a short (<1 hour) visit to the wetland. Wetland assessment based upon field visits are more robust (have more variables) and accurate as some information used in a desk top method may be out of date (i.e., wetland has been turned into agricultural use since the aerial photography was taken). It is the end user's decision which assessment models to use, the desk top models or the field inspection models.

1.3 UTILIZATION AND LIMITATIONS OF THE METHOD

This method is designed for rapid assessment of wetland functions for broad area planning purposes where the relative function of wetlands to each other is assessed. The method is strictly qualitative and the functional capacity indices and functional capacity units generated, must not be treated as quantitative data. The method is based primarily upon existing data sources for the desk top method. The accuracy of this data is variable. Some data may be out of date and not reflect present, on the ground conditions. Simple field investigations can increase the accuracy of the input data and models. As a result, a field assessment method is also offered.

The science of wetland functions and the assessment of those functions is poorly understood. No strictly science based method, or reference based method currently exist. This method, as are other existing methods, is an attempt to model and assess wetland functions and therefore, must be a qualitative method. The method can be used to assess a single wetland, but is more applicable to large area assessments of wetlands, such as a watershed regime. The method was tested in the Maryland Piedmont and Eastern Shore (Coastal Plan). In other geomorphic regions variations in indicator conditions and ranges may occur and the models should be modified as necessary.

The method could be used for determining long-term trends in wetland functions over time. It could also be used for assessment of mitigation/compensation schemes, but was not designed specifically for use as a tool for permit applications concerning compensation, or wetland banking. If the method is used for permitting purposes only the field models should be used, not the desk top models.

The method could be used to predict future wetland conditions. Running the model to simulate wetland impact by a particular activity can be done by answering the appropriate questions as if the impact occurred. The model results can be used to predict potential consequences to wetland functional capacity. To aid in selecting mitigation or restoration sites, the questions can be answered as if a certain wetland type existed in a particular location.

The method also helps to determine land use practices and decisions within a watershed. For example, if poor water quality is a major concern in a watershed, the focus of future planning could be protection of wetlands in that watershed that have been determined by the method to provide the modification of water quality function. Planners could also increase water quality improvement functions by enhancing existing wetlands, or by creating wetlands designed especially for providing water quality improvement.

The method provides a better understanding of the components in a wetland that enable the wetland to provide certain functions. Knowing more about wetlands and wetland functional capacity enables the planner to make better decisions regarding protection, development, restoration enhancement and mitigation of wetland systems and their surrounding watershed.

The method allows for the identification of resistance or sensitivity of a wetland or wetland complexes that should be considered when guiding land use and practices. Local planners should consider factors such as land features, input sources, and/or other stress factors that result in sensitive or resistant resources, when involved in the decision making process.

A desired "end goal" for the condition of the wetlands or stream systems in the watershed should be identified when considering ultimate buildout in the watershed. For example, in an area planned for the most intense development, a high quality urban stream may be desired. Practices and restoration or enhancement measures can be identified to obtain the desired condition.

The end user is required to make interpretations and judgements in answering many model queries. Variations in query answers will occur based on end user expertise in wetland and natural resource knowledge. The method is designed, so that a minor error in judgement will not result in a major impact to the final functional capacity unit. This is accomplished by using a qualitative rule based scaling method for indicator condition ranges, and numerous indicators per model to increase model robustness.

The author assumes no responsibility for misuse of this method.

The method only applies to non-tidal Palustrine vegetated wetlands.

1.4 Basics of Wetland Assessment

Wetlands are very complex ecosystems, where terrestrial processes and aquatic processes combine to create wetland processes. Wetlands are dynamic land forms that are products of long and complex histories of geologic events, climatic changes, and animal and human land use. Like other land forms, wetlands are natural museums containing a record of their history, a history which in many ways dictates their characteristics, functions and values. Wetlands are landscape features, directly the result of and influenced by the landscape in which they occur. Wetlands are constantly changing as a result of impacts occurring within them and in their landscapes. Failure to recognize a wetland's history, relationship to its landscape and its dynamic nature, results in a poor understanding of the wetland and a faulty assessment of its functions and values. The wetland assessor is required to understand the wetland's characteristics to gain knowledge of its history and functions.

All wetland assessment methods are based on the understanding that wetlands are the result of a combination of parts, which create processes. This combination of parts and processes allows the wetland to have functions. Functions may have direct application to human ecosystem values. Some of the wetland's parts and processes are indicators of function. The wetland assessor attempts to identify those indicators so that he or she can determine if a wetland has a function and to what extent.

Wetlands consist of a wide variety of parts that include their morphology (size and shape), hydrology, geology, soils, vegetation and wildlife. These basic parts (characteristics or inventory elements) occur in nature in a wide variety. No two wetlands have identical parts. A wetland 10 acres in size is comparable of storing more storm and flood water than one five acres in size, all other parts being equal. Therefore, wetland size is an indicator of storm and flood water storage. However, storm and flood water storage is a volume and thus, three dimensional.

Size is only two dimensional. The shape of the basin is necessary to determine the water storage volume and must be combined with size to assess a wetland's function for storm and flood water storage. The five acre wetland may store more water if its basin shape is deeper than a 10 acre wetland that is shallower.

This assessment of function cannot be done with disregard for the landscape in which the wetland lies. Wetlands in a landscape containing nearly flat slopes and high infiltration soils may receive little or no runoff, while wetlands in landscapes containing steep slopes and low infiltration soils will receive larger amounts of runoff. The actual storm and flood water storage function of a wetland is a result of both its internal parts (morphology) and the runoff characteristics of its watershed. The storm and flood water storage (flood flow attenuation) function of wetlands is of value to humans, because it helps to prevent storm and flood damage and protects the health, safety and welfare of human society.

Wetland characteristics (parts) are indicators of wetland functions that contribute to societal values. This concept is critical to all wetland assessment methods and is illustrated in Figure 1. Figure 2 illustrates the relationships between watershed, wetland and reference wetland processes in wetland assessment. Figure 3 illustrates the relationship of wetland parts to Maryland's defined wetland functions. The arrows are indicator paths that illustrate some of the linkages between wetland parts and functions. A more detailed discussion of indicators specific to each function is contained in Section 3.0.

1.5 Identification of Functions and Values

The wetland science literature includes references to over thirty different possible functions wetlands may have, because wetlands perform a myriad of functions. Many of these functions are the same,.but have been given slightly different names. The wetland protection statues of many states list functions and values attributable to wetlands. Although there is overlap between many statutes different terms are used to define identical functions. The Clean Water Act in Section 404 adds to the confusion by identifying functions deemed important to the public interest. All of this leads to a great deal of confusion and mixing of concepts and processes, and commonly the difference between indicators, functions and values is confused. Maryland is fortunate in having eight statutory functions listed in The State of Maryland Nontidal Wetlands Protection Act of 1989. These functions are:

- Ground Water Discharge
- Flood Flow Attenuation
- Sediment/Toxic Retention
- Aquatic Diversity/Abundance
- Production Export
- Sediment Stabilization
- Nutrient Removal/Transformation
- Wildlife Diversity/Abundance

For the purposes of this method, per the suggestion of the MDE, the statutory functions of Sediment/Toxic Retention and Nutrient Removal/Transformation have been combined into the function, Modification of Water Quality. The statutory function Production Export has been combined into the Aquatic Diversity/Abundance and Wildlife Diversity/Abundance functions.

FIGURE 1
RELATIONSHIPS OF INDICATORS, FUNCTIONS AND VALUES

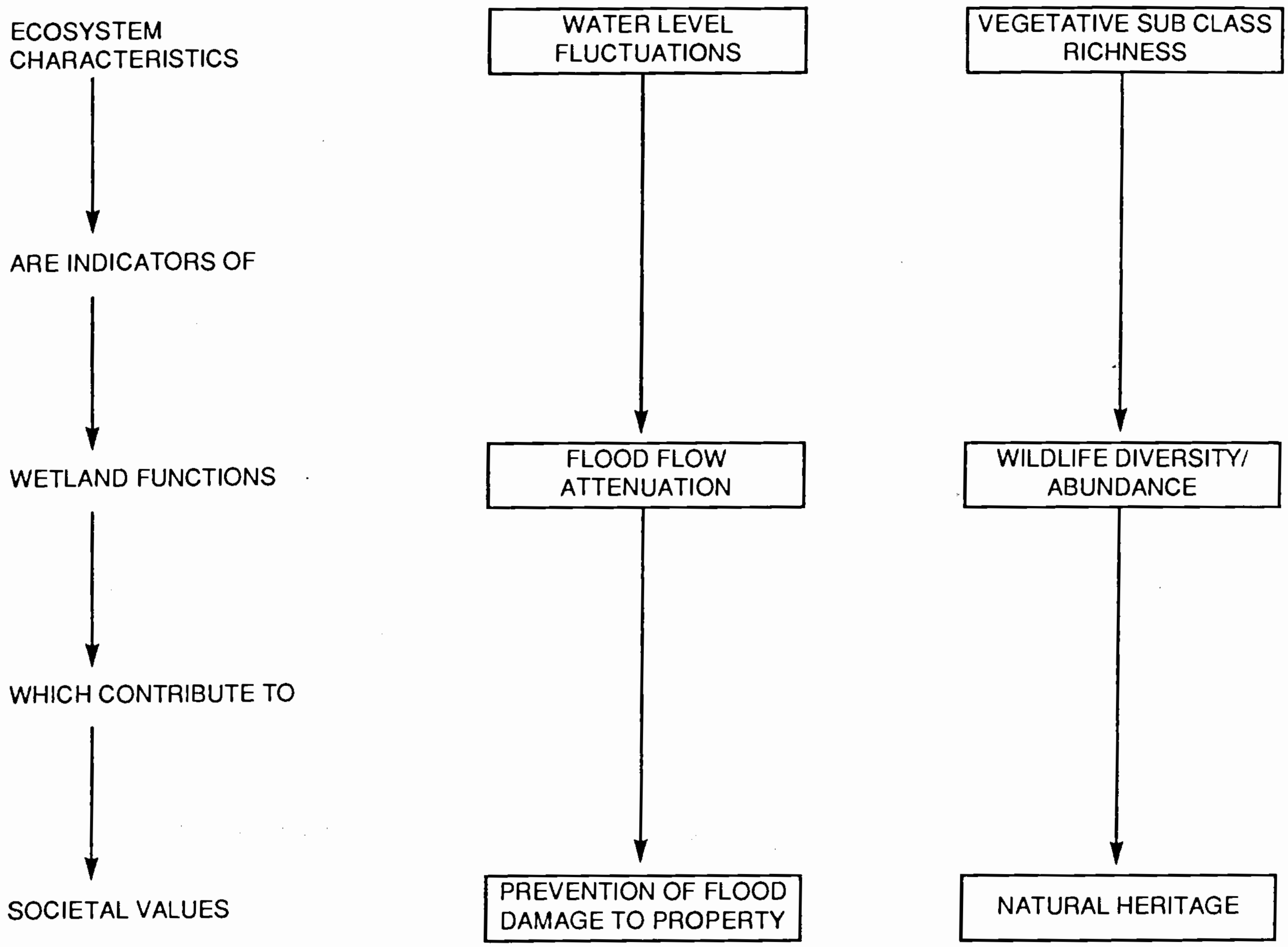
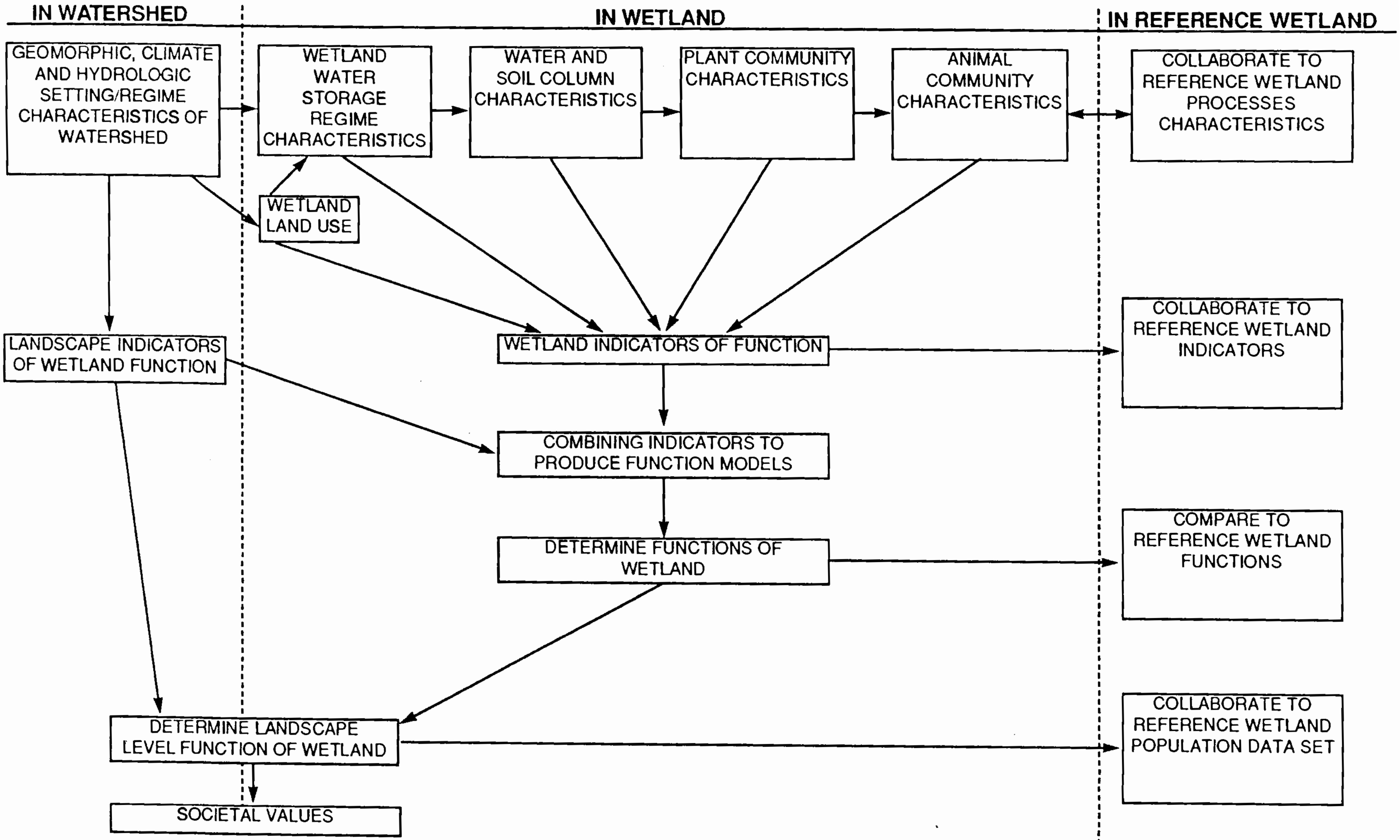


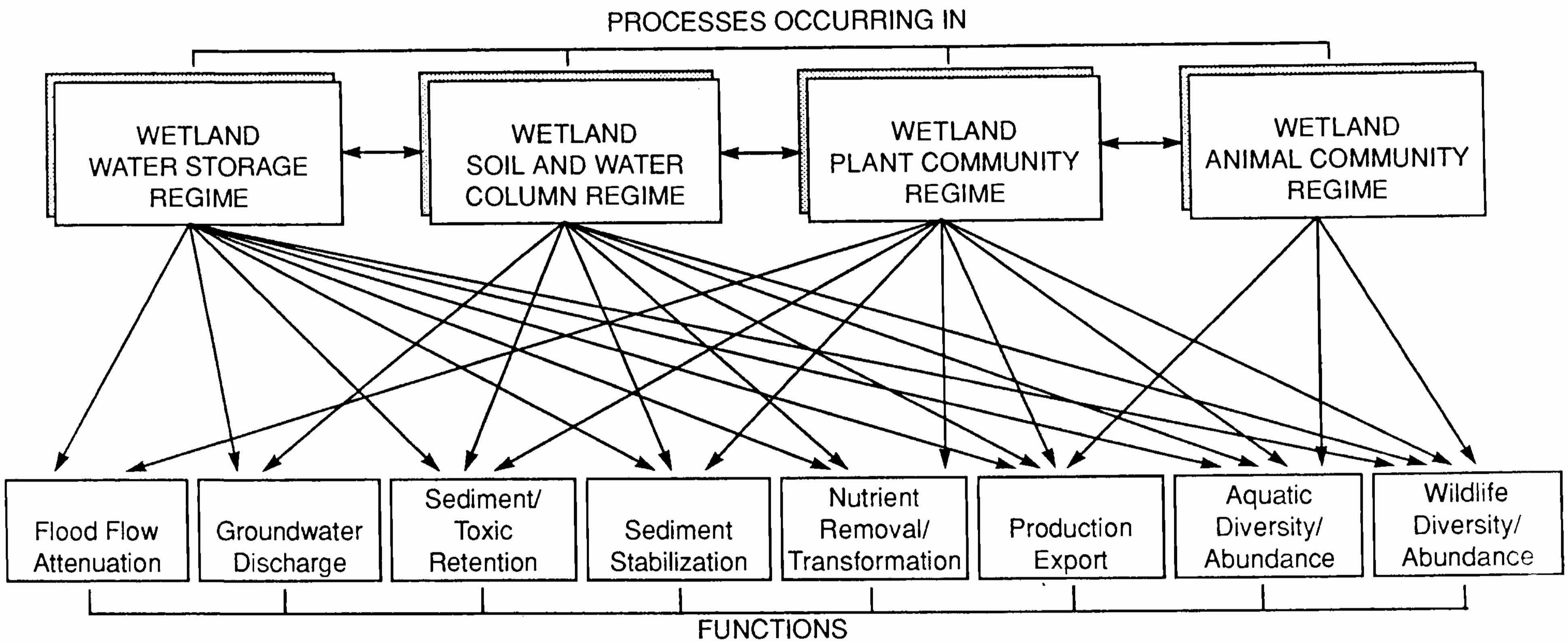
FIGURE 2
WETLAND ASSESSMENT PROCESS
FLOW CHART



Modified from Rosen, et al., 1993.

FIGURE 3

RELATIONSHIPS OF WETLAND PROCESSES AND WETLAND FUNCTIONS



1.5.1 Ground Water Discharge Function

Definition

The capacity of processes in a wetland to influence the amount of water moving from the ground water regime to the surface water regime.

Discussion

Ground water discharge is the movement of ground water, due to aquifer parameters, from the geologic materials of an aquifer, into and through the hydric soil of a wetland (Figure 4). It then flows into the surface water flow system, or into the atmosphere by evaporation and transpiration. Ground water discharge is important as it impacts the hydroperiod of wetlands and helps determine the wetland's water balance and water chemistry. It is critical to the formation of hydric soils and the maintenance of palustrine, riverine and lacustrine habitats. Ground water discharge influences aquifer dynamics which include, potentiometric surfaces, flow rates and storage volumes (Figure 5). All of these contribute to the equilibrium of the aquifer. Wetlands may serve as ground water discharge, recharge or horizontal flow areas, and these conditions may fluctuate seasonally. Nearly all of Maryland's wetlands are ground water discharge areas, at least for some portion of the year. Small hydrologically isolated depressional wetlands may be the primary exception. Few definitive indicators of ground water discharge occur in nature and are observable as natural resource data on maps. Only field observations of nested piezometers for one water year, will definitively establish if a wetland's hydrologic condition is one of recharge, discharge or horizontal flow. Seasonal fluctuations from one condition to the another are common in wetlands. Generally, large wetlands adjacent to riverine and lacustrine deep water habitats, are year long ground water discharge areas and serve a critical role in maintaining the hydroperiod of the wetland's palustrine habitat and the adjacent deep water habitats. They may also help maintain the baseflow of downstream rivers, streams, springs and seeps and are important indicators of ground water discharge.

Most wetland assessment methods have not assessed ground water discharge, and therefore, there are not a large number of indicators in the wetlands assessment literature. Adamus, et al. (1987) is the only method that specifically assesses ground water discharge. Hollands and Magee (1986) addresses ground water function and hydrologic support function, as separate functions. Hydrologic support is most similar to ground water discharge as it assesses base flow discharge from a wetland. Both methods correlate ground water discharge with its association with surface water connection. Hollands and Magee (1986) also uses the presence of organic soils as a ground water discharge indicator.

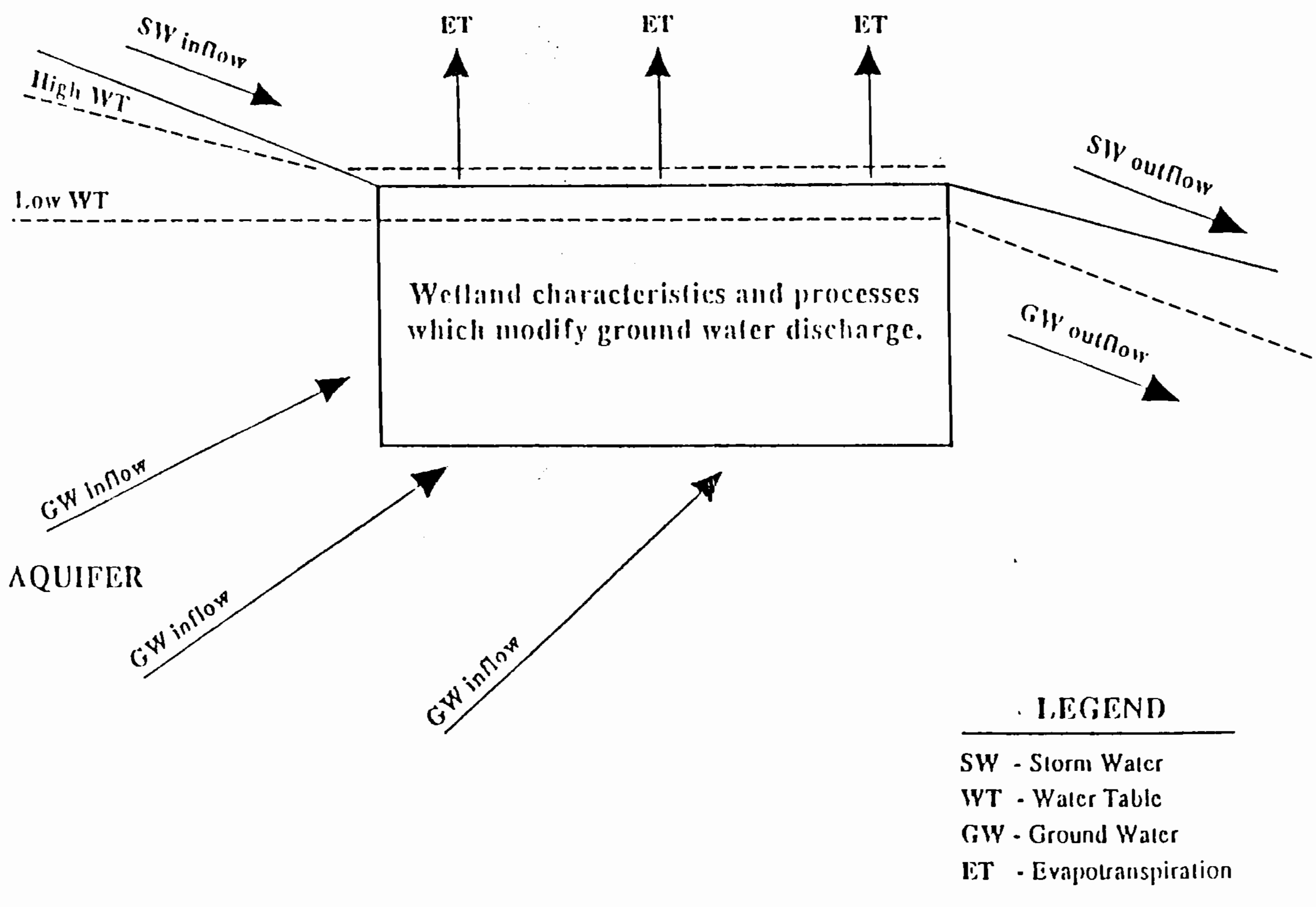
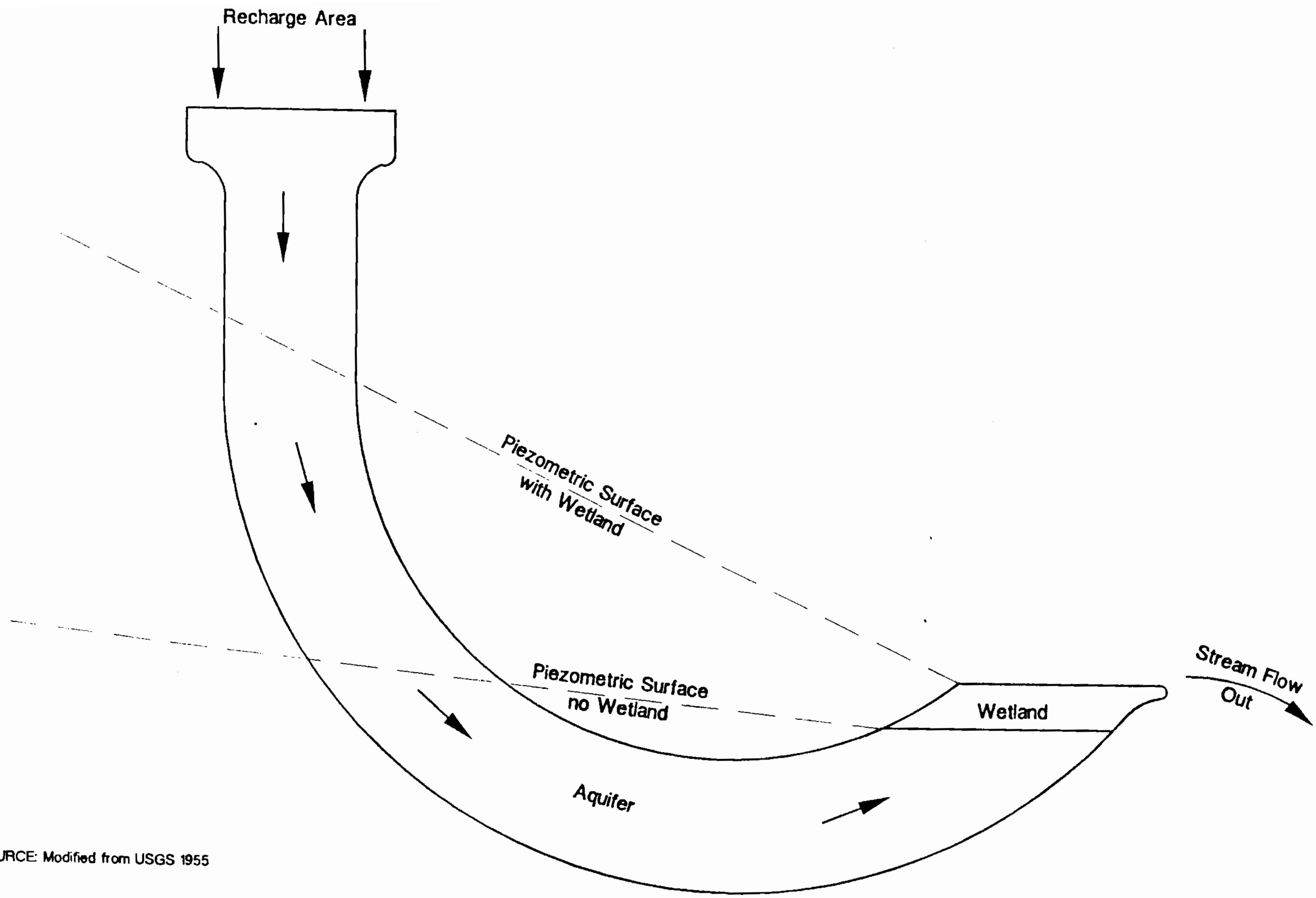


FIGURE 4
MODIFICATION OF GROUND WATER DISCHARGE



SOURCE: Modified from USGS 1955

FIGURE 5
WETLAND AS PART OF THE GROUND WATER PIPELINE

Variables that have been traditionally associated with ground water discharge have included:

- * • Hydrogeomorphic type
- • Nested piezometer data
- * • Inlet/outlet Class
- • Relationship to regional potentiometer surface
- * • Presence of springs and seeps
- * • Wetland soil type
- * • Surface water hydrologic connection
- • Water chemistry
- * • Surficial geologic deposit under wetland
- * • Water regime
- • Microrelief of wetland surface
- • Relationship to steep slopes

Many of these variables require detailed, expensive and time consuming field investigations, such as the installation of monitoring wells. These variables have been eliminated from this desk top model and only those variables indicated by an * are included in the desk top assessment models. If detailed field data is available, it can be applied as indicators of direct dysfunction or direct function. Each of these variables is discussed separately in Section 3.0.

1.5.2 Flood Flow Attenuation Function

Definition

The capacity of a wetland to modify the hydrograph of an inflowing stream, so that the outflowing stream hydrograph has a decrease in peak discharge and an increase in time of concentration.

Discussion

Flood flow attenuation is a direct result of the wetland's capacity to store storm and flood water for a period of time. The time of concentration is the increase in lag between precipitation falling in the watershed and runoff reaching the waterway. Commonly, wetlands occur intermediate between the watershed and the stream and their characteristics, such as flat slope and dense vegetation, increase the time runoff takes in passing through the wetland. This results in an increase in the lag for runoff to reach the outlet stream. The concept is illustrated in Figure 6.

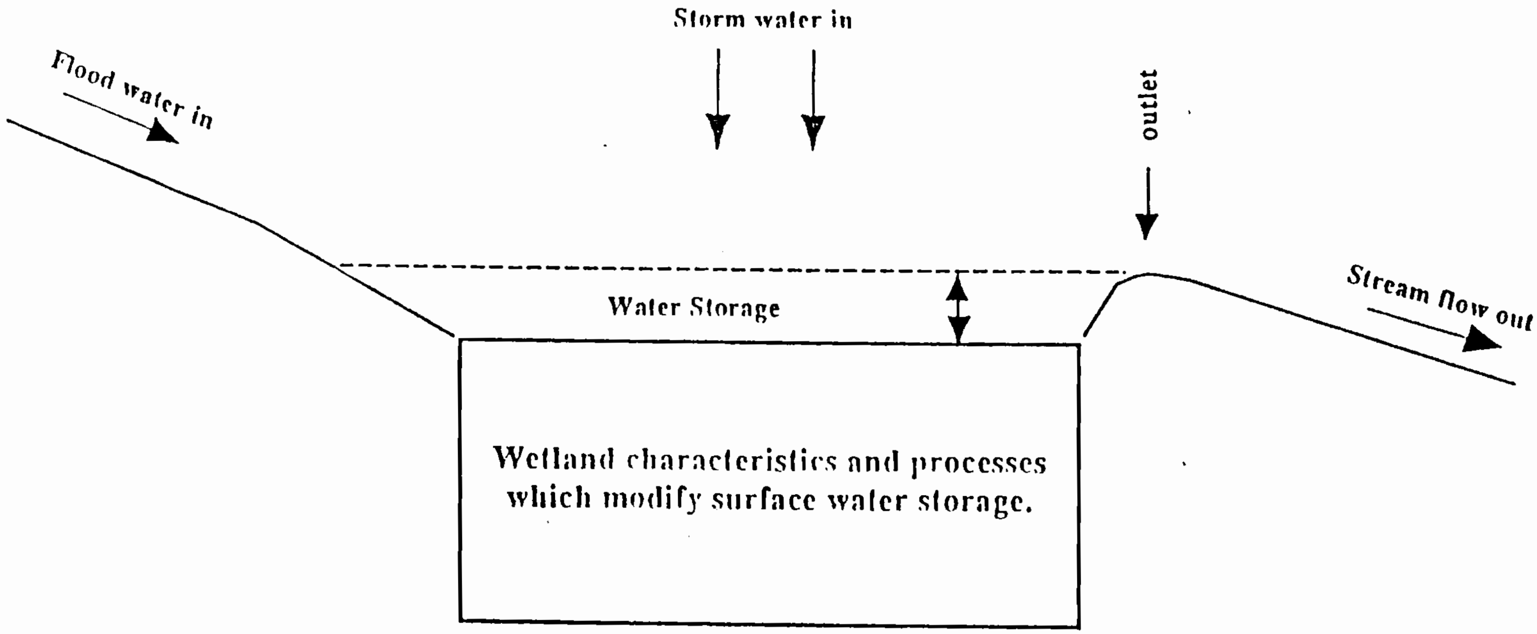


FIGURE 6
FLOOD FLOW ATTENUATION

The flow of the inflowing stream is modified by the wetland's topography, soils, vegetation and its outlet dimensions. The net effect is that water is stored (detained) for a period of time and then released downstream, resulting in a decrease in flood peaks. Also, some water will be retained in the wetland, removed from downstream discharge by ground water seepage (recharge), soil moisture retention, and evapotranspiration. This further reduces peaks and volumes.

Of all the functions which have been assessed by different authors, the flood flow attenuation or flood and storm water storage function, is the function which has the highest level of confidence of indicator predictability because it is based upon proven engineering principles. Almost all existing and under development wetland assessment methods model this function. It is also the one function which is most often related to landscape functions.

Those variables that have traditionally been associated with flood flow have included:

- * Hydrogeomorphic type
- * Inlet/outlet class
- * Degree of outlet restriction
- * Basin topographic gradient
- * Wetland water regime
- Surface water fluctuations
- * Ratio of wetland area to watershed size
- Stem density
- Microrelief of wetland surface
- Presence of dead plant material
- * Adjacency to a water body or water way
- Occurrence of down cut stream channel
- Occurrence of ditching

Only those variables which do not require a field investigation are included in the desk top model and are indicated by an *. Each of these variables is discussed separately in Section 3.0.

1.5.3 Modification of Water Quality Function

Definition

Removal of suspended and dissolved solids and nutrients from surface and ground water and conversion of them into other forms, such as plant or animal biomass, or gases.

Discussion

This function combines the Maryland statutory function of Sediment/Toxic Retention and Nutrient Removal/Transformation because the two statutory functions are directly related since both functions result from attachment of nutrients or toxics to sediment or uptake and transformation in dissolved form by plants or soil organism.

Water may enter the wetland by means of surface inflow or ground water discharge and be discharged with a different quality as a result of passing through the wetland. Debris and suspended solids may be removed by physical processes, such as filtering and sedimentation (Figure 7). Nutrients, dissolved solids and other constituents may be removed or broken down and degraded, such that they become inactive, or are incorporated into biomass. There are several ways in which this may occur including adsorption and absorption by soil particles, uptake by vegetation and loss to the atmosphere. Recycling of these elements between soil, water, vegetation and the atmosphere, occurs by means of uptake during plant growth, release through decomposition and exchange with the atmosphere and water. As part of this process, there may be a dynamic conversion between inorganic and organic forms. This process may result in the attainment of a balance between element uptake, release and exchange on some sites, whereas on another site, retention of elements in soil and vegetation or accumulation of biomass may occur over the long-term.

There is also a direct correlation between detention removal or transformation of dissolved elements and compounds, and flood water storage. Nutrients and contaminants, for example, generally are carried into the wetland basin by surface water inflow and are generally attached to suspended solids, but also occur as dissolved solids. When the inflowing water slows down or becomes still, sedimentation occurs and suspended solids drop to the wetland surface where they are trapped and become part of the wetland's soil. In depressions with no outlet, dissolved solids are trapped in the basin and not allowed to move to down-stream surface water (although they could enter ground water). As the retained water infiltrates into the wetland soil, dissolved solids interact with the soils and biota are removed from the water and retained in the wetland.

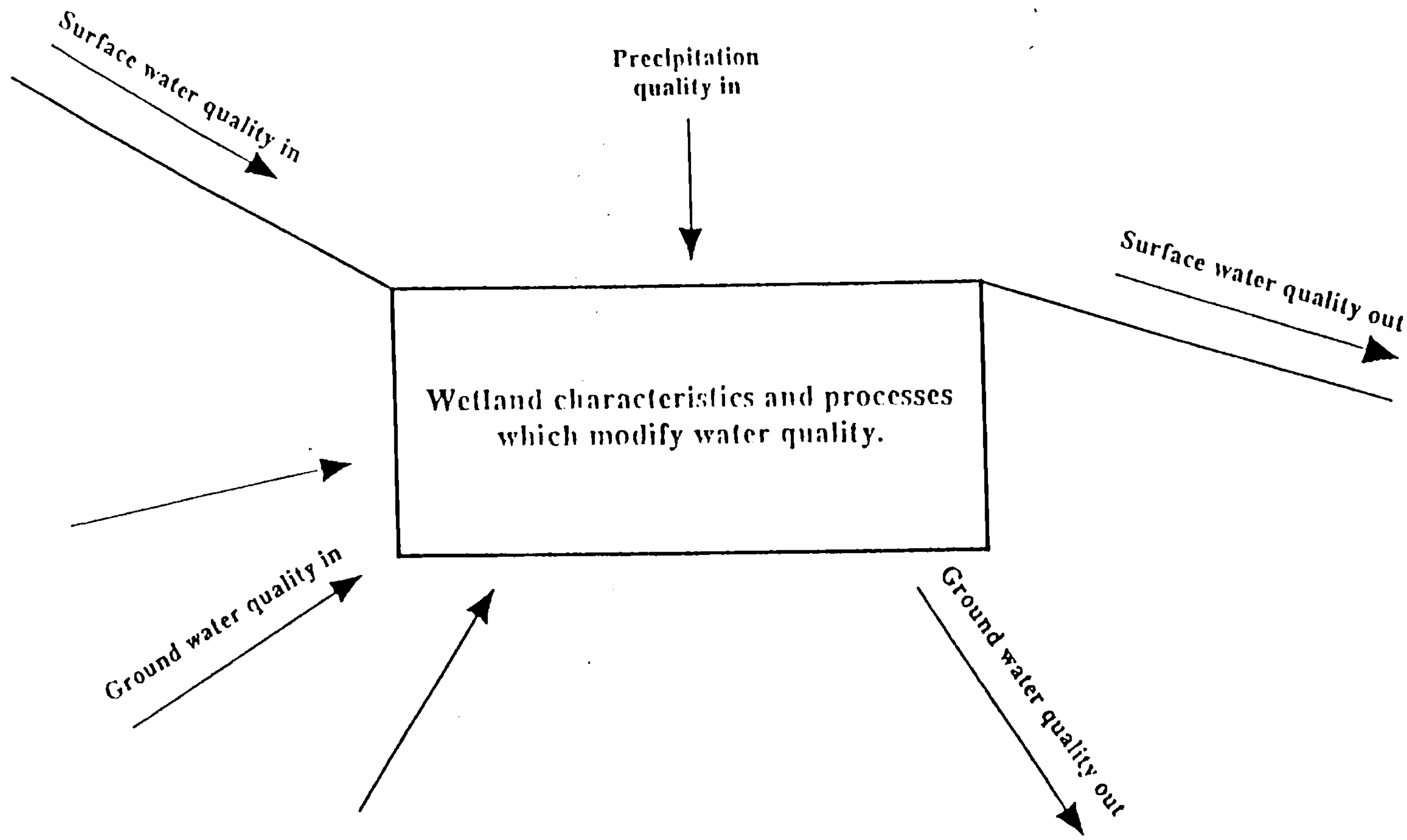


FIGURE 7
MODIFICATION OF WATER QUALITY

The longer water spends in a wetland, the greater will be the opportunity for biogeochemical transformations and internal processing. Those wetlands which have basins that maximize long-term water storage and minimize surface water discharge, also maximize biogeochemical transformations and internal processing. The combination of a high potential for long-term water storage, sedimentation, and retention of nutrients and contaminants creates the opportunity for biogeochemical transformations such as detrification to occur.

Variables traditionally used to indicate the capacity of wetlands to modify water quality include:

- Frequency of overbank flooding
- Microrelief of wetland surface
- * • Wetland land use
- * • Basin topographic gradient
- * • Degree of outlet restriction
- * • Topographic position in the watershed
- * • Hydrogeomorphic type
- * • Water regime
- * • Inlet/outlet class
- * • Stream sinuosity
- * • Dominant vegetation type
- * • Occurrence of overbank flooding
- * • Percent of wetland edge bordering a sediment source
- * • Occurrence of ditching
- Cover distribution
- Occurrence of dead plant material
- * • Hydric soil type

Only those variables which do not require a field investigation are included in the desk top model and are indicated by an *. Each of these variables is discussed in Section 3.0.

1.5.4 Sediment Stabilization Function

Definition

The capacity of processes in the wetland to cause the deposition and retention on the wetland surface of inorganic and organic forms from the water column, primarily through physical processes.

Discussion

The sediment stabilization function of a wetland includes a wetland's generally flat surface and basin morphology's ability to slow down inflowing water, allow sediment to settle from the stored water and to incorporate that sediment into the wetland's soil column (Figure 8). In many ways this function is very dependent upon many of the same characteristics and processes as in the flood flow attenuation function.

One of the best indicators of a wetland's morphology is determined by its hydrogeomorphic type. The vegetation of the wetland, usually of high density, adds to the wetland's roughness coefficient, slowing down inflowing sediment laden water, physically filtering debris and suspended solids from the water column. Wetland vegetation prevents resuspension of sediments from the wetland's soil and from the banks of streams and deep water habitat

Sediment stabilization is another function which appears in most functional assessment methods (Adamus, et al., 1987; Ammann, et al., 1991; Rosen, et al., 1993). Hollands and Magee (1986) include sediment trapping under their water quality improvement model. The sediment stabilization function of a wetland is controlled by many of the same factors which dictate a wetland's storm water storage, and there is a direct relationship between the two functions. Both are based on the length of residence time of water in a wetland to allow for physical, chemical and biological processes to occur.

A wetland's ability to retain sediment and particulates is a direct result of its ability to store surface water. Sediment settles from water most rapidly when the water flow is laminar and not turbulent, and settles most rapidly in still water. Those wetland basin characteristics which influence storm water storage, such as a nearly flat slope, also directly influence a wetland's potential for sediment and particulate retention. Those wetlands with high potential for flood water storage will also have a high potential for sediment and particulate retention.

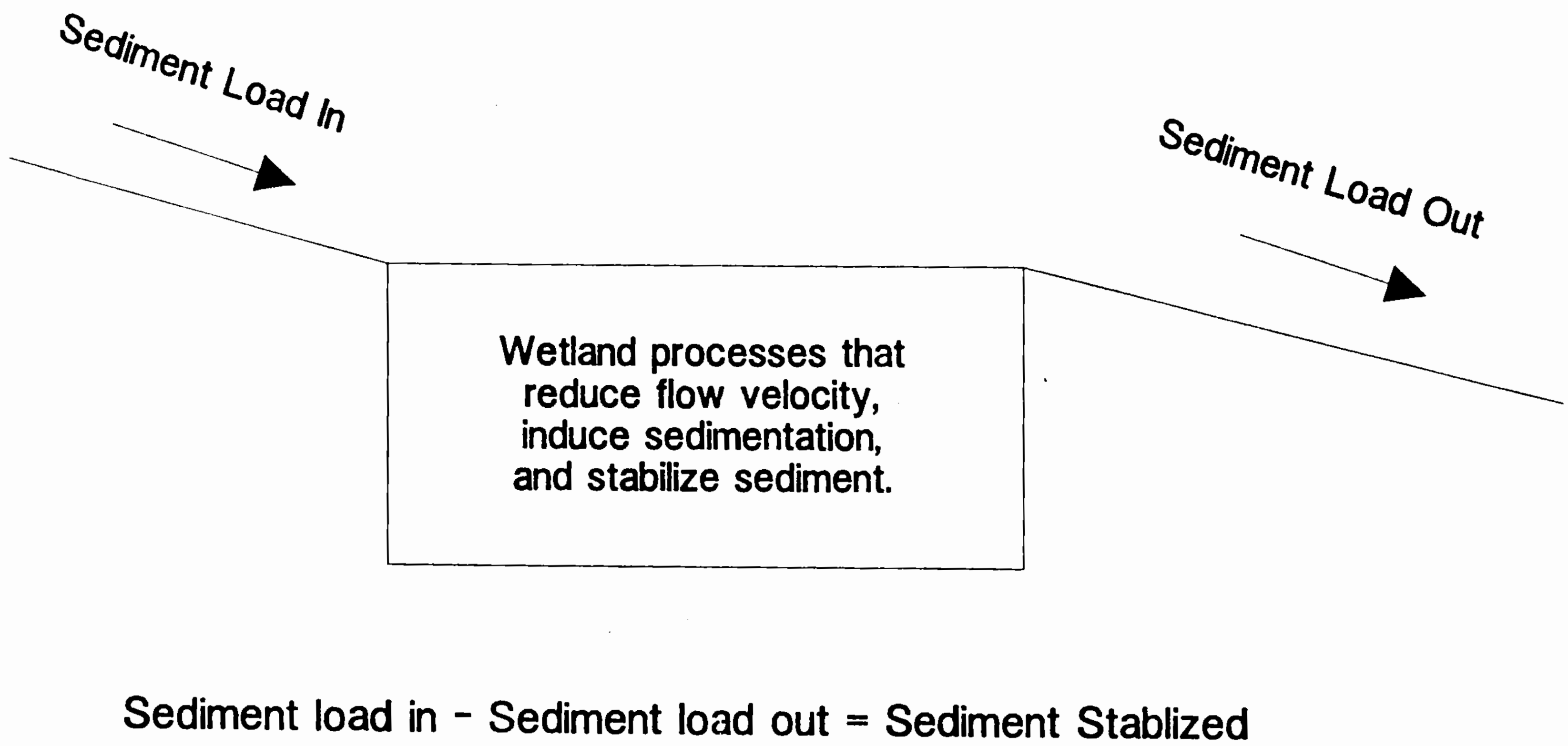


FIGURE 8
SEDIMENT STABILIZATION FUNCTION

Variables which traditionally have been used as indicators of a wetland's capacity to retain particulates include:

- * • Hydrogeomorphic type
- * • Frequency of overbank flooding
- * • Overland flow from uplands potential
- • Evidence of retained sediments
- • Microrelief
- • Stem density
- * • Percent of wetland edge bordering a sediment source
- * • Wetland area to watershed area ratio

Only those variables which do not require a field investigation are included in the desk top model and are indicated by an *. Each of these variables is discussed in Section 3.0.

1.5.5 Aquatic Diversity/Abundance Function

Definition

The capacity of a wetland to produce an abundance and diversity of hydrophytic plant species and communities, and aquatic habitats for animals.

Discussion

The production and support of abundant and diverse hydrophytic vegetation is vital to the maintenance of energy and nutrient cycling and production export (Figure 9). Wetland processes produce and accumulate live and dead organic matter. The export of detritus produced by hydrophytic plants is important to downstream receiving ecosystem food webs. Organic carbon is produced and exported as dissolved and particulate organic carbon by leaching, flushing, displacement, and erosion. The function is a measure of the wetland's primary productivity to produce and export organic matter.

Wetlands offer a number of aquatic habitats not found in deep water habitats (> 2 meters of permanent water depth, per Cowardin, et al., 1979). These habitats include a variety of palustrine habitats and lacustrine and riverine habitats. Lacustrine habitats include, littoral aquatic bed, emergent and unconsolidated bottom habitats. Riverine habitats include, unconsolidated shore, unconsolidated bottom, aquatic bed, and emergent habitats. These habitats occur within or adjacent to wetlands. Each of these habitats are important to a diversity of aquatic life.

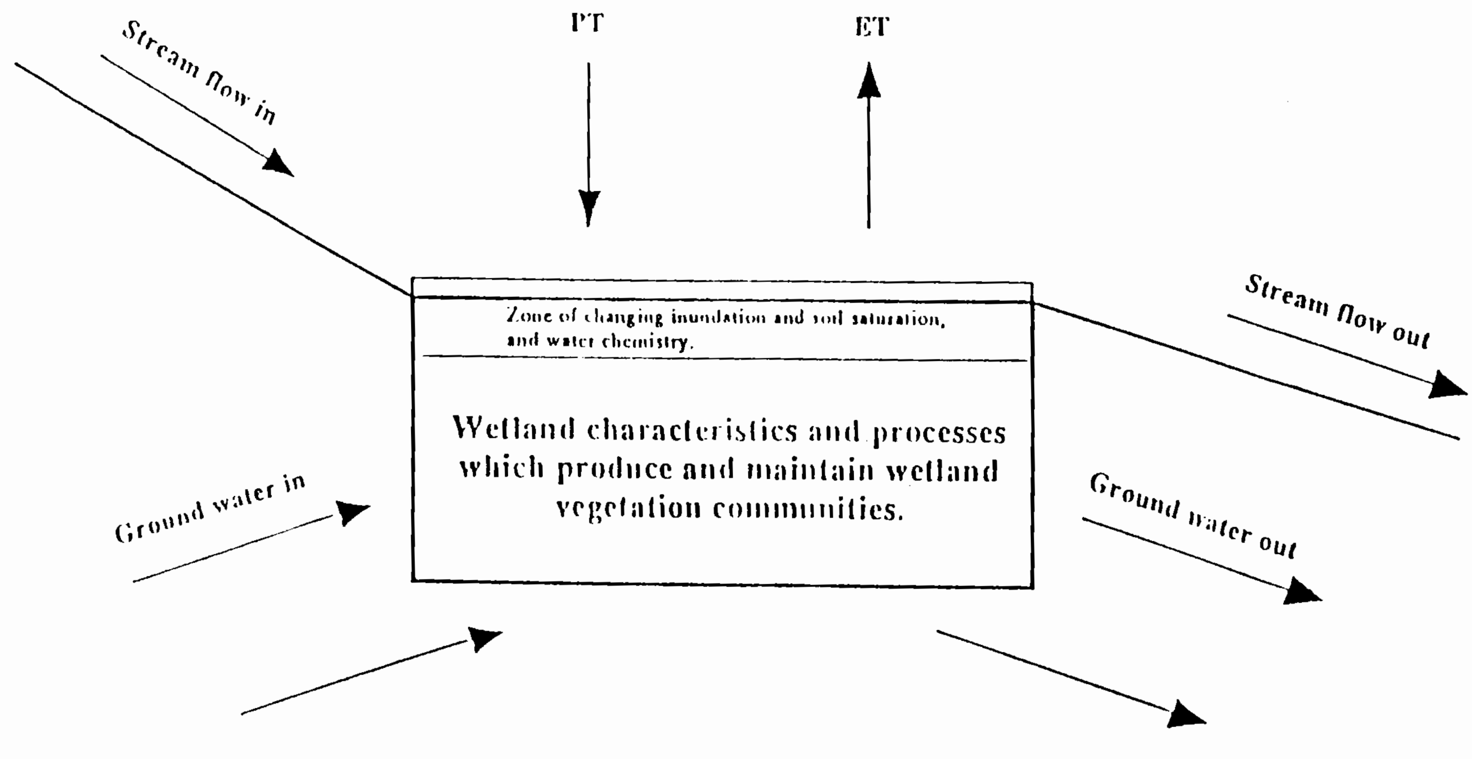


FIGURE 9
AQUATIC DIVERSITY/ABUNDANCE

Most wetland assessment methods do not address aquatic diversity as a function, but many (e.g., Adamus, et al., 1987; Ammann, et al., 1991) address the finfish habit function of wetlands.

Variables used to indicate the capacity of a wetland to provide aquatic diversity and abundance include:

- * Hydrogeomorphic type
- * Association with open water
- * Water regime
- * Water/cover ratio
- * Stream sinuosity
- * Dominant vegetation
- * Wetland class richness
- * Vegetative density
- * Wetland juxtaposition
- * Known habitat for anadromous or catadromous fish, trout, or warm water fish
- * Habitat for aquatic invertebrates, reptiles or amphibians
- * Wetland land use
- * Adjacent to undisturbed upland habitat
- * Adjacent to known upland wildlife habitat
- * Buffer for a water body
- Occurrence of debris dams in wetland stream

Only those variables which do not require a field investigation are included in the desk top model and are indicated by an *. Each of these variables is discussed in Section 3.0.

1.5.6 Wildlife Diversity/Abundance Function

Definition

The capacity of a wetland to produce large and/or diverse populations of animal species that spend part or all of their life cycle in wetlands individually or as part of a group of wetlands.

Discussion

Wetland processes create the necessary conditions for the wetland to sustain animal populations and guilds through the complexity created by vertical layers and stand density gradients of vegetation (Figure 10). This provides potential nesting, perching, escape and feeding sites. It also increases the capacity for the wetland to sustain a wide range of animal species. It also contributes to the temporal diversity, heterogeneity, and quality of organic matter inputs to detrital food webs. Wetland wildlife diversity function also determines the density and spartical distribution of invertebrates utilizing detrital and grazing base food webs. Wetland processes contribute to the density and spatial distribution of vertebrates utilizing wetlands for food web support, cover, nesting, long-term or short-term habitat and reproduction.

The most effort in wetland assessment has been made in the assessment of the wildlife function of wetlands. Golet (1971) began this effort and every wetland assessment method since has modeled this function, with little improvement. Golet and Larson (1974) assume that the greater the vegetative diversity, the greater will be the wildlife use. Hollands and Magee (1986) assumed that the greater the wildlife use, the greater will be the overall biological activity of both animals and plants, and therefore, greater overall primary productivity. The proposed wildlife diversity/abundance model is based primarily on Golet and Larson (1974) and Hollands and Magee (1994).

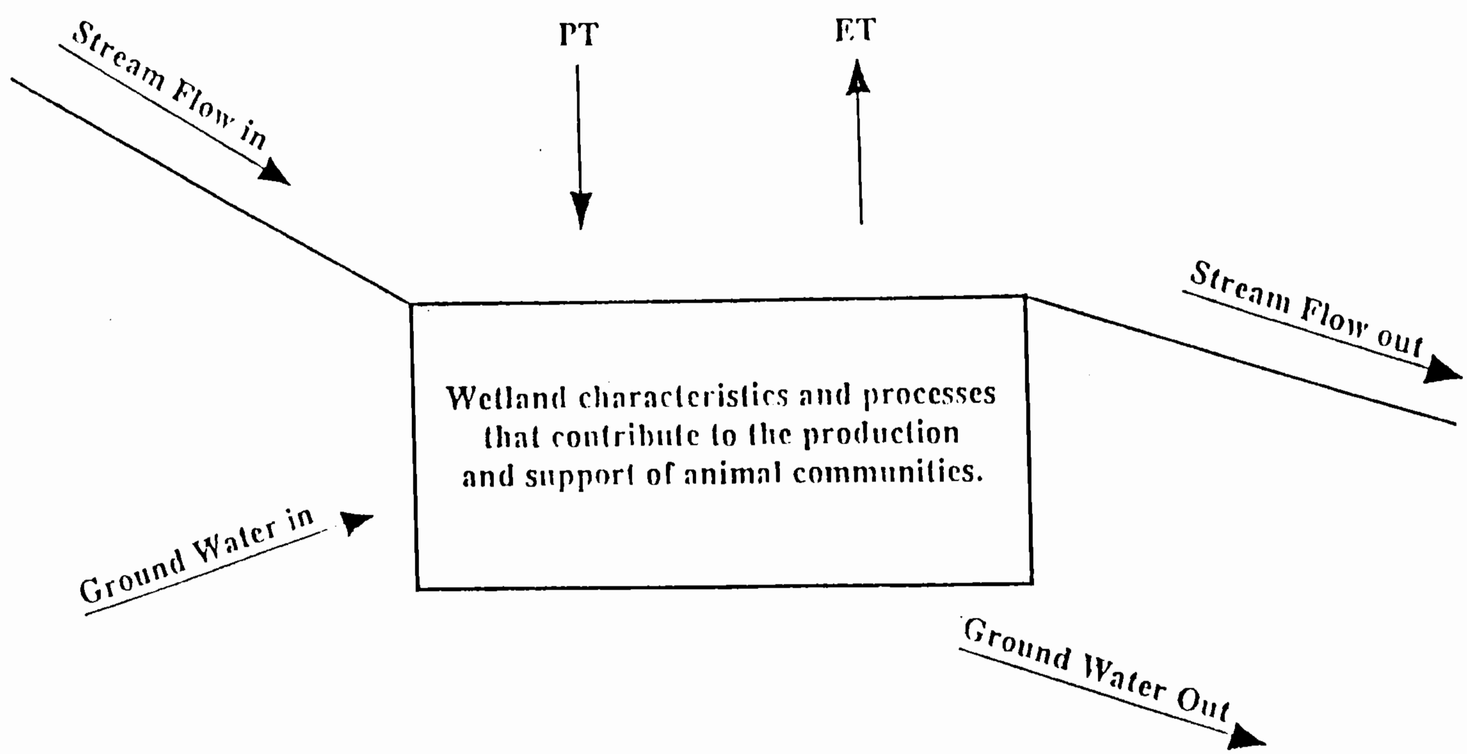


FIGURE 10
WILDLIFE DIVERSITY/ABUNDANCE FUNCTION

Variables traditionally used to assess the Wildlife Diversity/Abundance Function of wetlands include:

- * • Wetland size
- * • Wetland class richness
- * • Wetland class rarity
- * • Wetland class edge complexity
- * • Surrounding upland habitat
- * • Wetland juxtaposition
- * • Water regime
- * • Wetland land use
- • Microrelief of wetland surface
- * • Presence of seeps and springs
- • Water chemistry
- * • Vegetative interspersion
- • Interspersion of vegetation cover and open water
- * • Presence of islands
- * • Presence of rare, endangered or threatened species
- * • Linked to a significant habitat
- * • Connected to a known wildlife corridor
- • Number of vegetation layers and percent of cover
- * • Fragmentation of once larger wetland
- * • Watershed land use

Only those variables which do not require a field investigation are included in the desk top model and are indicated by an *. Each of these variables is discussed in Section 3.0.

1.6 DETERMINATION OF ASSESSMENT AREA BOUNDARIES

Assessment compares one entity with another. Basic to assessment is the ability to compare one apple with other apples, and not to compare apples to oranges. A nontidal freshwater wetland must be compared with other nontidal freshwater wetlands and not with tidal salt water or tidal fresh water wetlands. The processes which determine functions are too different between these wetland types to allow them to be lumped together for a functional assessment. Defining one apple from another apple is an easy task, but this is not always the case with wetlands. Hydrologically isolated wetlands, such as those that occur in closed depressions, are discreet entities separated from all other wetlands by uplands which completely surround them. Defining this type of wetland is easily accomplished, as its boundary closes upon itself. This is not the case with most wetlands as they are part of riparian systems where one wetland flows into another.

The upland-wetland boundary is continuous and an interconnected mosaic of wetlands is most typical. Each wetland assessment method has attempted to address the bounding issues, some to a lesser or greater degree of definition. Some methods have used only those breaks between wetlands shown on wetland maps, such as NWI maps. Others have used distinct breaks in hydrology or geomorphology to separate riparian wetlands. Some methods ignore the bounding issue completely and leave the separation of one wetland from another to the end user's professional judgement, with little or no guidance. Methods based upon existing data may be forced to rely on wetland divisions as shown on existing wetland maps. Errors in the wetland mapping will affect the assessment process.

Wetland functions are cumulative as many upstream wetlands may contribute to the function of an individual wetland. This is especially relative to the flood attenuation and modification of water quality functions. It is even more so for wildlife habitat functions. Wetland assessment areas must be viewed in a local context. The functional capacity of a given wetland may also change with time and increasing urbanization.

For the purposes of this method, the wetland assessment area is defined primarily by hydrogeomorphic type. Wetlands may also be assessed separately because they are physically separated. Smith et al., 1994 provides four criteria for separating wetlands into wetland assessment areas, and are depicted in Figure 11.

Physical Separation Criteria:

1. Designate wetland areas without permanent or seasonal surface water connections with other wetland areas as separate wetland assessment areas.
2. Divide a wetland into separate wetland assessment areas at any point where it narrows significantly (e.g. less than 50 feet) unless the entire wetland has a narrow, linear configuration.
3. Divide a wetland into two wetland assessment areas if it is bisected by a railroad, two lane road, or similar barrier or structure that significantly impedes the free exchange of surface water between the two areas.
4. Divide the wetland into separate wetland assessment areas if it is bisected by a stream or river of a width greater than the narrowest portion of the wetland area.

Other physical separation criteria determined from the field tests of this model are:

- divide riverine wetland based upon stream order (i.e., a first order stream meets a second order stream),
- the division of a riverine wetland into hydraulic reaches, such as are created by the presence of a dam, road crossing and culvert, or a naturally occurring significant change in stream gradient.

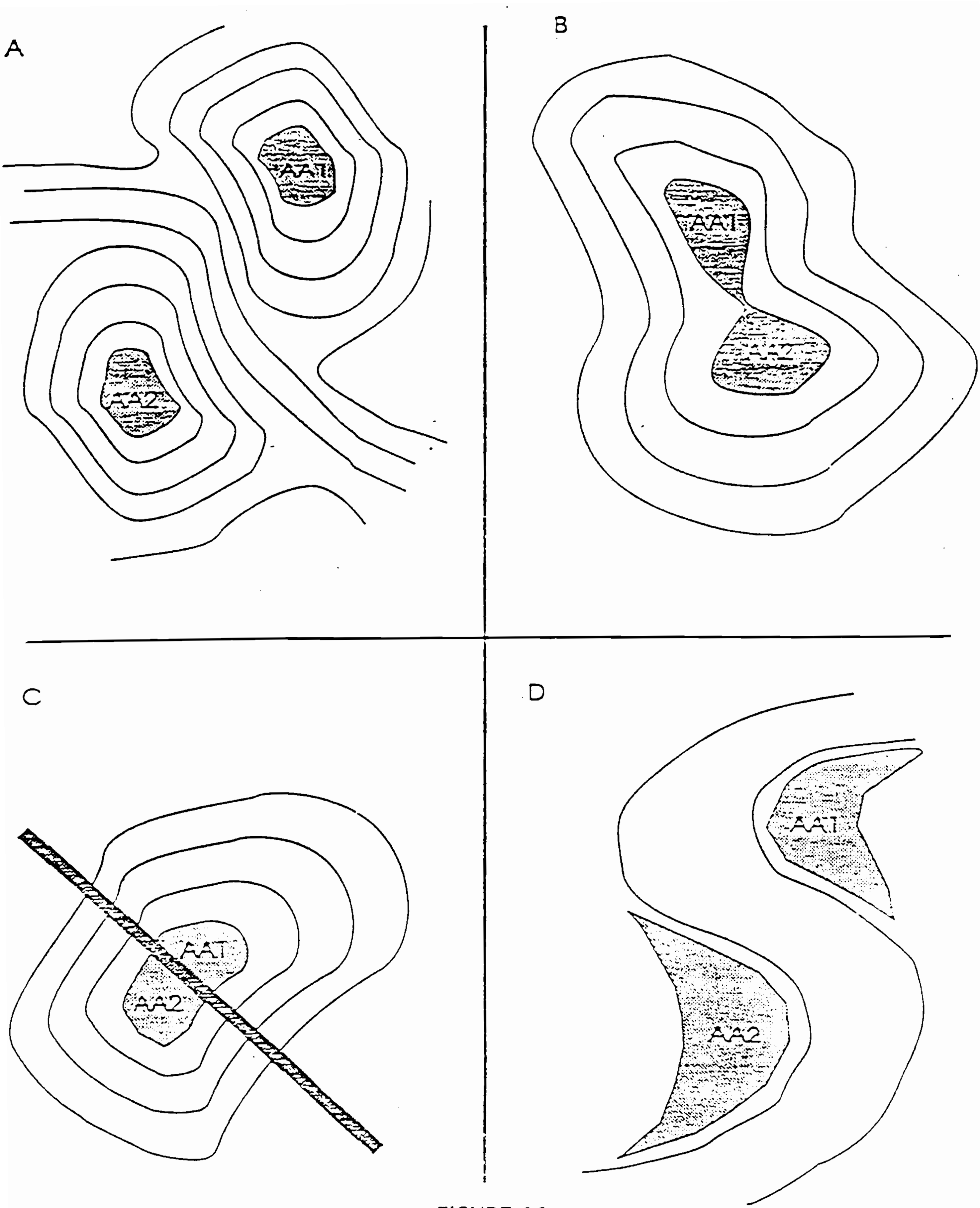


FIGURE 11
WETLAND ASSESSMENT AREA DIVISIONS

Source: Smith, et al. 1993

Hydrogeomorphic Separation Criteria

The second set of criteria used to further distinguish separate wetland assessment areas in the project area are hydrogeomorphic. If it becomes apparent during the classification process that one of the wetland assessment areas, identified using the physical separation criteria, encompasses more than one major hydrogeomorphic wetland class, divide the wetland assessment area into two separate wetland assessment areas based on the hydrogeomorphic discontinuities identified. Classes that comprise less than 25 percent of the wetland area need not be assessed separately.

Experience indicates that in certain hydrogeomorphic wetland classes additional characteristics that fundamentally influence how the wetland functions can be used to further distinguish separate wetland assessment areas. For example, on river floodplain/terrace complexes, it may be reasonable to distinguish separate wetland assessment areas based on the characteristic of primary source of water which can be very different. In some portions of a floodplain wetland, overbank flooding may be the primary source of water throughout the year. In other portions of the floodplain that are further from a channel, the dominant source of water is often precipitation, overland flow, or shallow subsurface flow, with inundation by overbank flooding occurring infrequently. In this situation the primary source of water is a functional characteristic that can be used to distinguish separate wetland assessment areas.

The user will be faced with the problem of separating one hydrogeomorphic class from others. Figure 12 illustrates typical landscape relationships. When adequate topographic maps are available hydrogeomorphic class separations can be approximated on the topographic map, and then verified by field examination, if possible. The user is required to determine the separation boundary location between each hydrogeomorphic class. Breaks between hydrogeomorphic classes must be grounded on the basic principles of the typical types, defined by topography and water flow vectors. In areas where regional and local topography is steep to moderate and drainage is immature, separation of hydrogeomorphic types is easily accomplished. Where topography is flat and drainage is mature, wetlands may exist over broad flat areas and consist of a mosaic of hydrogeomorphic classes. In these areas separation of hydrogeomorphic classes is more difficult.

The boundaries of wetland assessment areas can be enlarged to include an entire wetland/stream system, or divided into smaller individual units depending on how the user establishes assessment area boundary criteria. The distinctions made when establishing boundary criteria should make ecological sense, and consideration should be given to potential upstream, downstream, and cumulative impacts to the system, if applicable.

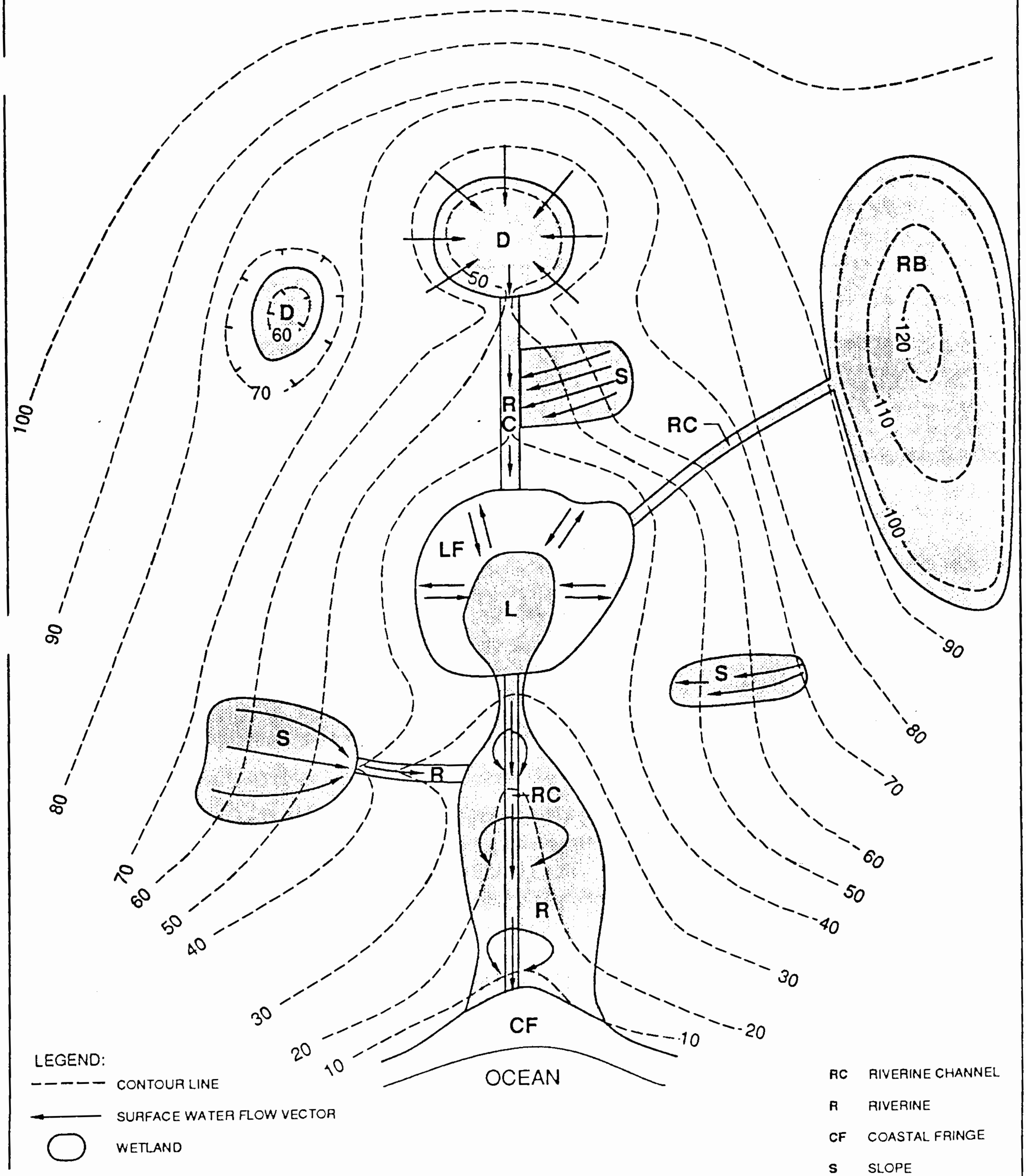


FIGURE 12
HYDROGEOMORPHIC WETLAND TYPES ON A LANDSCAPE LEVEL

Wetland Mosaics

Large amounts of Maryland's area of wetlands occur in large low flat topographic settings where hydrogeomorphic classes co-mingle to form a mosaic. This is particularly true for the coastal plain. The term mosaic has been assigned for these areas. Mosaic is an inclusive regional term which may include all other hydrogeomorphic classes, because separation of hydrogeomorphic classes in such a situation may be impossible or impracticable. On the other hand, detailed site investigations should allow the user to identify the dominant hydrogeomorphic type(s) of the area proposed for assessment. Small area (large scale topographic map) investigations will allow and require assignment of a particular hydrogeomorphic class other than mosaic to the Wetland Assessment Area (WAA). Large area (small scale topographic map) assessments may make separation of mosaics of wetland into hydrogeomorphic types impracticable, therefore, the class mosaic may be used.

1.7 The Identification and Use of Indicators

From a scientific viewpoint, wetlands are extremely complex ecosystems where numerous physical, chemical and biological processes combine to create more complex wetland processes. Attempts to model how the various processes interact to create wetland functions, has been extremely difficult for wetland scientists, the most difficult of all problems facing wetland scientists and managers. Systems ecologists have attempted to qualitatively model these interactions using time averaging and loop analysis, but no suitable wetland assessment modeling method has yet to be developed. No quantitative methods have been applied, other than for very narrow specific functions, such as counting the number of observed nesting pairs of red wing black birds. Since the early 1970s the wetland assessor has attempted to identify easily observed indicators of function (Golet, 1972).

An indicator is a quantifiable expression of an ecological function (Olsen, 1992), that allows estimation of the condition of ecological resources, magnitude of stress, exposure of a biological component to stress, or the amount of change in a condition. Indicators of condition can be substitutes for quantitative data which is unavailable, impossible to collect, too time consuming, labor intensive or expensive.

Most indicators contain a range of conditions which can be scaled to predict the value of the condition as an indicator of predictability or function. Indicators occur in two basic types. "Red flags" are indicators which alone indicate that a wetland performs or does not perform the function. They can be used to separate those wetlands which perform a function from those that do not. Occasionally direct indicators or red flags may indicate the degree of function of the individual wetland.

All other indicators are not capable of separating wetlands that have a specific function from those that do not. They are contributing indicators or primary indicators which when combined with other indicators produce a product that predicts the wetland function. Primary indicators do not have enough predictive strength to stand alone, whereas direct indicators do. Most indicators fall in the primary class. Some indicators are site specific and others are landscape specific.

Indicators are identified and scaled by best professional opinion, rather than by empirical data. The test of "more likely to indicate" is used. For example, a wetland with a large size, deep basin morphology and a restricted outlet, is more likely to store more flood water than a wetland that has a small size, occurs on a slope and has no outlet restriction. The challenge to the wetland assessor is to identify a sufficient number and combination of red flags and combinations of contributing primary indicators to create an assessment model.

1.8 REFERENCE WETLANDS

The concept of reference wetlands is a much discussed topic at this time in the evolution of wetland assessment. A reference wetland is one which contains identified indicators of condition. Reference sites have been widely used in science. For example, geologists use "type localities" to identify geologic formations and geologic time periods. These are rock outcrops which contain particular stratigraphic characteristics and fossil assemblages, which have been inventoried, published and established by a committee of stratigraphers as reference sites. Other geologists, working in other regions of the world can compare their outcrop data with that of type localities and determine if their outcrops are of the same age and formation. If needed, they can visit the type locality and conduct their own comparative research. Botanists use herbarium collections as reference sources whereby, vegetation can be identified by comparing the plant sample in question with the preserved plants in the herbarium collection.

Reference wetlands can be used in four manners for wetland assessment purposes. Wetlands where specific scientific research has been conducted, subjected to peer review and then published, can serve as "type localities" that other wetland scientists can visit and compare research. For wetland assessment purposes, wetland processes can be confirmed using data from reference wetlands. Next, a proposed indicator of function could be confirmed and scaled using data from a number of reference wetlands. Third, wetland functions could be confirmed and rated by comparison to reference wetlands or a reference wetland data population could be used to identify, calibrate and scale landscape indicators and conditions. An individual wetland function score could be compared with the reference data population to rank a wetland within a landscape unit.

Lastly, reference wetlands could be used in cumulative impact assessments and for compensation design. Stresses could be identified from the reference data population and management plans designed.

A reference wetland's population data set must range from pristine to highly degraded to be of complete value for wetland assessment. In order to scale the condition indicators the various degrees of predictability must be observed. The larger the number of reference wetlands and the greater their diversity, the more useful and accurate will be their usefulness. Few reference wetlands exist and those that would qualify, have only been investigated for very specific scientific purposes. Few, if any wetlands have been studied for the expressed purposes of being used as reference wetlands. Therefore, the use of a reference data set of wetlands which have been assessed using field visits or landscape level desk top assessments is more practicable, at this point in time, for the intended purposes for which the MDE proposes to use this desk top method. The basic process is to assess all wetlands within a watershed or landscape unit, enter all of their scores in a data bank, and then compare individual wetlands against the total data bank. Scores can be illustrated as indices or as deciles.

This is a desirable method from a landscape level viewpoint, because no site specific field investigations are needed and a large data bank evens out any errors in the predictability of indicators contained in the assessment methodology. This approach has been used by Hollands and Magee (1986), Michenner (1986), and Liebowitz, et al. (1993).

The method proposed in this report is based upon the professional opinion of the author and draws heavily upon the professional opinions being expressed in the Corps' hydrogeomorphic method (Brinson, et al. 1994; Hollands and Magee, 1994). All variables and variable conditions proposed on this method have been used in the Corps' proposed methods presently under preparation. The lack of adequate populations of reference data sets for variables and their conditions forces the user to create a method which is based on best professional opinion, but is capable of using reference data when it becomes available. For example, the variable "wetland size" has three conditions; large, >100 acres; medium 00 to 10 acres; and small <10 acres. If reference data becomes available that shows that these separations are not valid, then the range of conditions can be adjusted accordingly. This is true for the vast majority of variables.

No quantitative data has been generated that allows one to scale variables, let alone to prove that a variable has value in relationship to a specific function. One reference method presently being tested by the Hydrogeomorphic Method, is to identify the edaphic climax vegetative community for a given region, and to inventory the indicators which occur within that edaphic climax for each hydrogeomorphic class. Then it is assumed that the edaphic climax contains the maximum functional capacity for a wetland in that region and the indicators in the wetland contain the highest scale values. Indicators from wetlands degraded from the edaphic climax are scaled lower.

This concept of the edaphic climax may be useful in regions where there is little regional diversity in vegetation type, such as the coastal plain of North and South Carolina. In more diverse topographic areas, such as the glaciated northeast, numerous edaphic climax vegetation types may occur within a small region. In Maryland the edaphic climax concept may apply to the Eastern Shore where the red maple, sweetgum, oak, and loblolly pine forested community is the dominant edaphic climax. It is probable that in more geomorphically diverse regions, such as the Valley and Ridge and even the Piedmont that multiple edaphic climax vegetative communities may exist.

It is also questionable if the vegetative edaphic climax community contains the maximum functional capacity for all functions. Functions dominated by vegetation indicators, such as the wildlife abundance/diversity function may be closely related to the edaphic climax. Other functions, such as the flood flow attenuation or ground water discharge functions may have little correlation between the edaphic climax and the conditions which give rise to maximum functional capacity.

The issue of establishing a practicable wetland reference data bank from which functions can be identified and defined, indicators identified and scaled, and assessment models calibrated is still being debated and may exist sometime in the future. Presently, particularly for a desk top wetland assessment method, one is severely limited in being able to base the method on reference wetland data.

2.0 GEOGRAPHIC INFORMATION SYSTEMS DATA SOURCES

This assessment method may use GIS data layers as much as possible for data concerning indicators. At present, the MDE's GIS program does not yet contain adequate data layers to create a true GIS base wetland assessment method. Data layers may be used to gather information on indicators in some cases. The use of GIS for wetland assessment places severe limitations on the assessment procedure and the usefulness of an entirely GIS based system is questionable (Dr. Frank Golet, 1994, personal communication). Entirely GIS based assessment procedures are dependent upon GIS attributes. The existence of truly suitable GIS files easily applicable to wetland assessment do not exist. All existing files require complex manipulation for them to become useful. Until the science of GIS evolves into a more useful format, only the simplest of uses are applicable to wetland assessment modeling. Therefore, the method proposed in this report lists the required variables and condition for assessment. If GIS can provide the necessary data concerning each variable and condition, then GIS may be used. If not, then the other data sources need to be reviewed by the user, and if at all possible, a limited field inspection of the wetland assessment area may be needed.

Table 1. Available Maryland Data Layers
Description Summary and Relevance to this Method

Layer Name	Description	Attributes	% State	Scale	Type
CAC County Parcel Maps	Only Within Critical Area		1,000' buffer of coastline	1":600'	DXF vector
CAC Boundary Line Maps	" " "		" "	" "	" "
CAC Land Use Designation Maps	" " "		" "	" "	" "
CAC County Zoning Maps	" " "		" "	" "	" "
CAC Proposed Project Information Maps	" " "		" "	" "	" "
FHW Waterfowl Concentration and Staging Areas	Unattributed polygons circa inland Ches. Bay	None	Ches. Bay	1:24,000	MIPS
FHW Breeding Bird Atlas of MD and DC	NOT easily accessible				Revelation
FHW County Bdys.	" " "				
FHW Quad Bdys.	" " "				
FHW Wildlife Database	NOT easily accessible, but may be worth trying to get. W/L species specific re: distribution, association by env'l features, mgmt. practices, etc.	Numerous	Statewide		Revelation
FHW NHP Environmental Review Areas	Polygons of general areas containing threatened or endangered species	N/A	" "	1:24,000	MIPS
FHW Marsh Birds	NOT easily accessible				Revelation
FHW Colonial Nesting Water Birds	NOT easily accessible				Revelation
MOP Land Use	Level 2 USGS classification and land use cover from aerial photos	Numerous	Statewide	1:63,360	A/I
MOP Natural Soils Group for Maryland	Aggregated soils types into natural soil groups for planning purposes	" "	All except Baltimore City	1:63,360	A/I

Table 1. Available Maryland Data Layers Description Summary (continued)

Layer Name	Description	Attributes	% State	Scale	Type
MOP Watersheds	Outline of watershed with streams and tribs.	Numerous	Statewide	1:24,000	A/I
PLG Roads	Have been told that this data is not the best quality		" "	1:100,000	A/I
PLG Hydrography	" " "		" "	" "	" "
PLG Political Boundaries	" " "		Almost Statewide	" "	" "
PLG MDE Properties	May not be all that useful for this project	Code, Labels, Acres, etc.	Statewide	1:24,000	ARC dBase
PLG County Open Space Properties	Property boundaries for local public park and open space	" "	" "	" "	" "
PLG Reservoir Properties	Property boundaries for local public park and open space	" "	" "	" "	" "
PLG Private Conservation Organization Properties	Property bdys. for reservoirs	" "	" "	" "	" "
PLG Historic Structure	Property bdys. for land holdings of private conservation organiz's	None	Tidal Region	1:24,000	A/I
PLG Ches. Bay Public Access Locations	NOT useful, as it only deals with tidal areas	" "	Tidal Region	1:24,000	A/I
PLG Historic Sites	Limited to state forests	" "	Partial	1:24,000	ARC dBase
PLG Deer Concentration Areas	" " "	" "	" "	" "	" "
PLG NHP Natural Areas	" " "	" "	" "	" "	" "
PLG Water Management Zone	" " "	" "	" "	" "	" "
TID County Topography Maps	Rasters, we could use Cadcore to put them into a useful format	" "	Statewide	1:62,500	MIPS
TID Shoreline Characteristics	" " "	" "	Shoreline	1:24,000	" "
WRA NWI Wetlands	Pretty decent wetland data layer in somewhat easily accessible format	Cowardin, special state concern code	Statewide	1:24,000	" "
WRA Roads	Probably a better roads coverage than PLG's	USGS Code	Statewide	1:24,000	MIPS
WRA Hydrography	" " "	" "	" "	" "	" "

Table 1. Available Maryland Data Layers Description Summary (continued)

Layer Name	Description	Attributes	% State	Scale	Type
WRA SPOT Satellite Images	Rather expensive, but would be GREAT for accuracy control	None	" "	" "	" "
WRA Digital Ortho-Photo Quads	Too BIG for our system and does not cover all	" "	Partial	1:12,000	" "
WRA Contours	10 foot contours, but not complete	Elevation in feet	Only West Carroll City	1:12,000	" "
WRA MDE Wetlands	More accurate than NWI, but not complete	Cowardin	Worcester, Wicomico, and Carroll	1:12,000	" "

Key:
CAC- Critical Area Commission (MDE)
FHW- Fish, Heritage, and Wildlife (MDE)
MOP- Maryland Office of Planning
PLG- Public Lands and Greenways (MDE)
TID- Tidewater Administration (MDE)
WRA- Water Resource Administration(MDE)

The most accurate data seems to come from the WRA, which also houses the MDE's GIS group.

3.0 DESCRIPTION OF VARIABLES USED IN THE MODELS

3.1 HYDROGEOMORPHIC CLASS

Introduction

The definitions which follow are based upon Brinson (1993). The user is directed to review and understand that publication prior to attempting to use this method. This classification has three component parts: (1) geomorphic setting, (2) water sources, and (3) transport and hydrodynamics (Figure 12).

Depressional Wetlands

Depressional wetlands occur in the geomorphic setting of a topographic depression. This is described most simply as a "hole in the ground." A depression is a topographic feature defined by a "closed contour inside of which the ground is at a lower elevation than that outside the contour" (American Geological Institute, 1972).

A depression is defined geomorphically as "Any hollow in a relatively sunken part of the Earth's surface; especially a low-lying area completely surrounded by higher ground and having no natural outlet for surface drainage, as an interior basin or karstic sink" (American Geological Institute, 1972). Surface water flow vectors are from all directions toward the depression's lowest point. The dominant hydrodynamic type is vertical fluctuation and water sources predominantly are direct precipitation, surface water runoff and ground water (Brinson, 1993). In nature many depression have a surface water outlet, either ephemeral or perennial, and they may not meet the strict topographic definition given above, but their overall topographic shape and dominant flow vectors are more like a true depression than any other type. The upper limit of depressional wetlands is upland habitat, or that point where water flow vectors cease to be predominately converging depressional vectors, and become predominately flow vectors of another hydrogeomorphic class. This also applies to the lower limit.

Slope Wetlands

Slope wetlands occur in the geomorgraphic setting of a hillside. A hillside is "a part of a hill between its crest and the drainage line at the foot of the hill" (American Geological Institute, 1972). A hillslope is "the sloping surface that forms a hillside" (American Geological Institute, 1972). Water flow is predominantly unidirectional parallel to slope, with parallel flow vectors. Water source is predominantly ground water, and occasionally precipitation (Brinson, 1993). Habitat type is palustrine system. The upper and lower limits are those points where slope flow vectors no longer predominate and another hydrogeomorphic class or upland predominates.

Mosaics

Geomorphically a mosaic is a flat landscape "having or marked by a continuous surface or stretch of land that is smooth, even, or horizontal, or nearly so, and that lacks any significant curvature, slope, elevations or depression. A general term for a level or nearly level surface marked by little or no relief, as a plain" (American Geological Institute, 1972). Mosaics are generally level or have a very slight slope. Their water sources may be precipitation, ground water and over bank flooding. Unidirectional flow is dominant with parallel flow vectors. The habitat type is predominantly palustrine system, but may include lacustrine and riverine system habitats. Mosaics cover predominantly large regions and commonly consist of two or more wetland hydrogeomorphic types which blend together because of the flat regional landscape. Distinct separation of hydrogeomorphic types may be difficult or impossible, and flow vectors are dominated by regional trends.

Raised Peatlands

A raised peatland is topographically a slight hill. A hill is "a natural elevation of the land surface, raising above the surrounding land" (American Geological Institute, 1972). A hill is a topographic feature defined by a closed contour within which elevation is higher than the area outside of the contour. Peatlands are areas where the dominant unconsolidated deposit is peat, defined as semi-carbonized plant remains of a water saturated environment and of persistently high moisture content. The dominant plant particles in peat are sphagnum moss, sedge and wood. The primary water source is precipitation. Water flow vectors are radial from the hill top and parallel to slope. Habitat is palustrine system, but may include minor amounts of lacustrine system habitat. The lower limit of lacustrine fringe wetlands is upland or another hydrogeomorphic class.

Lacustrine Fringe Wetlands

A lacustrine fringe wetland is a palustrine or lacustrine system (including non persistent emergent wetland, aquatic beds and vegetated shores) habitat that is directly attached to or borders a Lacustrine system habitat. The surface of the fringe wetland is smooth, even, or horizontal (or nearly so), and lacks any significant topographic features. Predominant surface water flow vectors are to and from the lacustrine system habitat and the hydrodynamics consist of bidirectional flow. Water source is predominantly surface flow. The upper limit is upland or another hydrogeomorphic class. The lower limit is limnetic lacustrine habitat.

Coastal Fringe

A coastal fringe wetland is esturine intertidal or subtidal habitat that is directly attached to or borders a marine system habitat. The surface of the coastal fringe wetland is smooth, even or horizontal (or nearly so), and lacks any significant microrelief and is a product of seal level. Predominant surface water flow vectors are tidally controlled and are bidirectional. Water source is predominantly surface water. The upper limit of coastal fringe wetland is the limit of tidal influence defined by extreme high water of spring tides. The lower limit is marine intertidal or subtidal habitat.

Riverine

Riverine hydrogeomorphic class wetlands are palustrine system, or riverine system aquatic bed or nonresistant emergent wetland habitats. For palustrine system habitats to be included in the riverine hydrogeomorphic class they must be adjacent to a riverine system habitat and have a hydrology dominated by surface water from the riverine system habitat. Flow direction is bidirectional locally with a regional flow down valley.

Riverine wetlands occur in topographic valleys which are . . . elongated, gently sloping depression of the earth's surface, commonly situated between two mountains or ranges of hills or mountains, and often containing a stream with an outlet. . .usually developed by stream erosion . . ." Valleys may also include . . . "a broad area of generally flat land extending inland for a considerable distance, drained by. . . a large river an its tributaries" (American Geological Institute, 1972). For the purpose of this methodology a valley has a longitudinal profile which slopes, producing a hydraulic gradient for stream flow. A stream exist in the valley. The upper limit of the riverine hydrogeomorphic class is that point in the valley side where riverine overbank flooding hydrology ceases to be the dominant hydrology which influences the vegetation community characteristics and soil type. The upper limit may be upland or another hydrogeomorphic type. The lower limit is always Riverine system unconsolidated bottom.

Assigning Hydrogeomorphic Classes

Following is a discussion of how to determine the predominant HGM type of a wetland preparatory to performing an assessment of its functions. The process is based upon two references, Cowardin et al. (1979) and Brinson (1993), users of this method must be familiar with both references and refer to them for technical terminology.

Hydrogeomorphic Wetland Classification

The ability to read topographic maps and to visualize elevational contours in the field allows one to determine water vector flow directions which is the basis for HGM classification.

Five basic landforms are used in reading topographic maps and are the basis for distinguishing HGM wetland types in the field:

- hilltop
- depression
- valley
- ridge
- saddle

These landforms are defined in any basic text concerning topographic map reading, and are mutually exclusive and easily recognized on most topographic maps and in the field. One must be able to recognize these landforms on a topographic map and identifying them in the field to separate HGM wetland types. If the user cannot recognize the five basic landforms, then he or she must acquire that skill before proceeding further.

Depressional wetlands occur predominantly in topographically defined depression and occasionally in valleys. Riverine wetlands occur in topographically defined valleys, and raised bog wetlands occur as topographically defined hilltops. Slope wetlands occur on hillsides that are part of valley and ridge complexes. Lacustrine fringe wetlands occur adjacent to lacustrine habitats in topographically defined depression or valleys. Commonly these types are found in a landscape association, one interconnecting with another in a linear sequence or as a mosaic.

The idealized topographic maps that accompany the discussion of each HGM class illustrate the relationship between basic map reading, land forms, contour intervals and water flow vectors.

<u>Depressional Wetlands</u>

Figure 13 illustrates the simplest topographic landform/hydrogeomorphic wetland type relationship. A depression is a topographic landform which is defined by a closed contour illustrating lower elevations in relationship to surrounding land. Depression contour intervals are commonly indicated by hasher lines on USGS topographic maps. Since surface water flows perpendicular to contour lines, surface water flow vectors, which are the basis for HGM wetland classification, can be predicted by the contour lines. Visualizing contour lines in the field, and recognizing physical evidence of surface water flow allow the user to identify surface water flow vectors. Surface water flows are towards the center (bottom) of the depression.

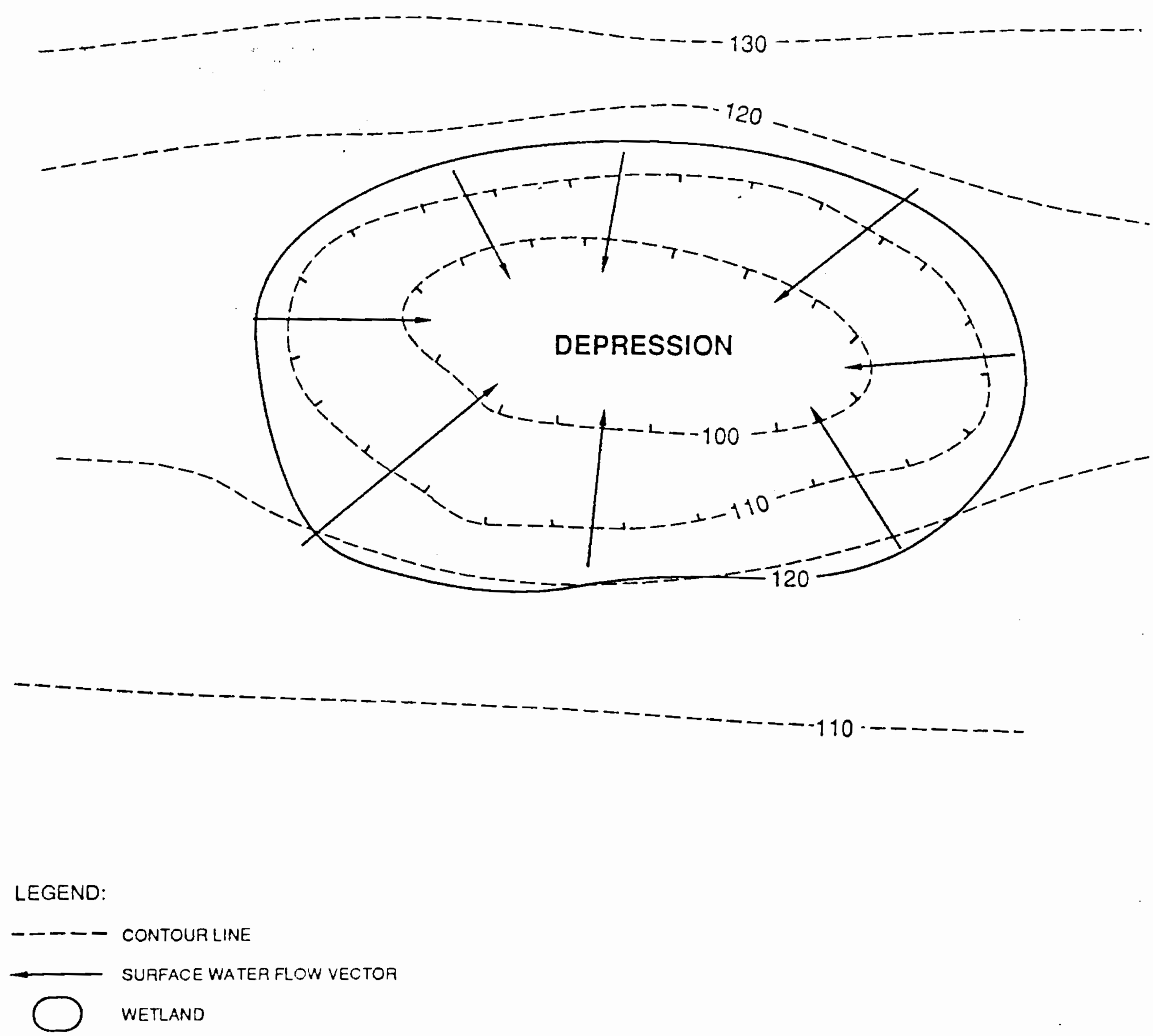


FIGURE 13
DEPRESSIONAL WETLAND

A departure from the classical depressional wetland defined above may be observed in more complex wetlands commonly found in the field. The wetland scientist will be required to decide if these complex situations behave more as depressional wetlands or as slope, riverine or lacustrine fringe HGM types. Depressional wetlands may have an outlet stream, either intermittent or perennial; however, the predominant flow vectors are toward the center from at least 3 directions. Some have a threshold at the outlet behind which lower elevations occur. Others have a slight gradient sloping to the outlet. Field investigations will need to determine if the wetland water flow vectors are predominantly similar to a classical depressional wetland or another type.

Depressional wetlands can occur as isolated wetlands or they can occur connected to other HGM types. Riverine wetlands may flow into or out of depressional wetlands. Slope wetlands may flow into depressional wetlands. Depressional wetlands may occur together with other wetland types in a large landscape wetland mosaic.

Depressional wetlands can occur as isolated wetlands or they can occur in various shapes. In many cases they are oblong and blend into a riverine system.

Slope Wetlands

Slope wetlands occur where surface water or ground water occurs on hillsides ranging from steep to slight gradients. They commonly are ground water discharge areas. They may be narrow or wide, long or short. Water flow vectors on slope wetlands are generally parallel to each other. Figure 14 illustrates an idealized slope wetland occurring on a hillside. They may be isolated or hydrologically connected to other HGM wetland types. The distinction between slope wetlands and riverine wetlands in headwater areas is often slight. Slope wetlands can occur on valley sides. In these cases the field investigator should closely examine the surface water and shallow ground water (interflow) flow vectors through the wetland. If the water flows parallel to slope in many small discontinuous channels or through the upper soils then the area is a slope wetland. If the wetland hydrology is dominated by overbank flooding then the wetland is a riverine.

A stream channel is a geomorphic landform having a definite linear shape in the land surface created by fluvial erosion and deposition, containing evidence of water flow in the form of fluvial features, such as cutbanks and sediment deposits containing fluvial bedforms. Stream channels created artificially contain evidence of streamflow in the form of fluvial features.

Interflow (shallow ground water flow) occurs in wetlands generally within the upper 18 inches of the soils where water flows downgradient through subsurface channels called pipes, created by burrowing animals, worms, decaying roots and stems, and by hydraulic piping. In slope wetlands with pool and mound microrelief, interflow commonly breaks out into surface pools, flows in the pools as surface water and reenters the shallow ground water system down-gradient under and through mounds.

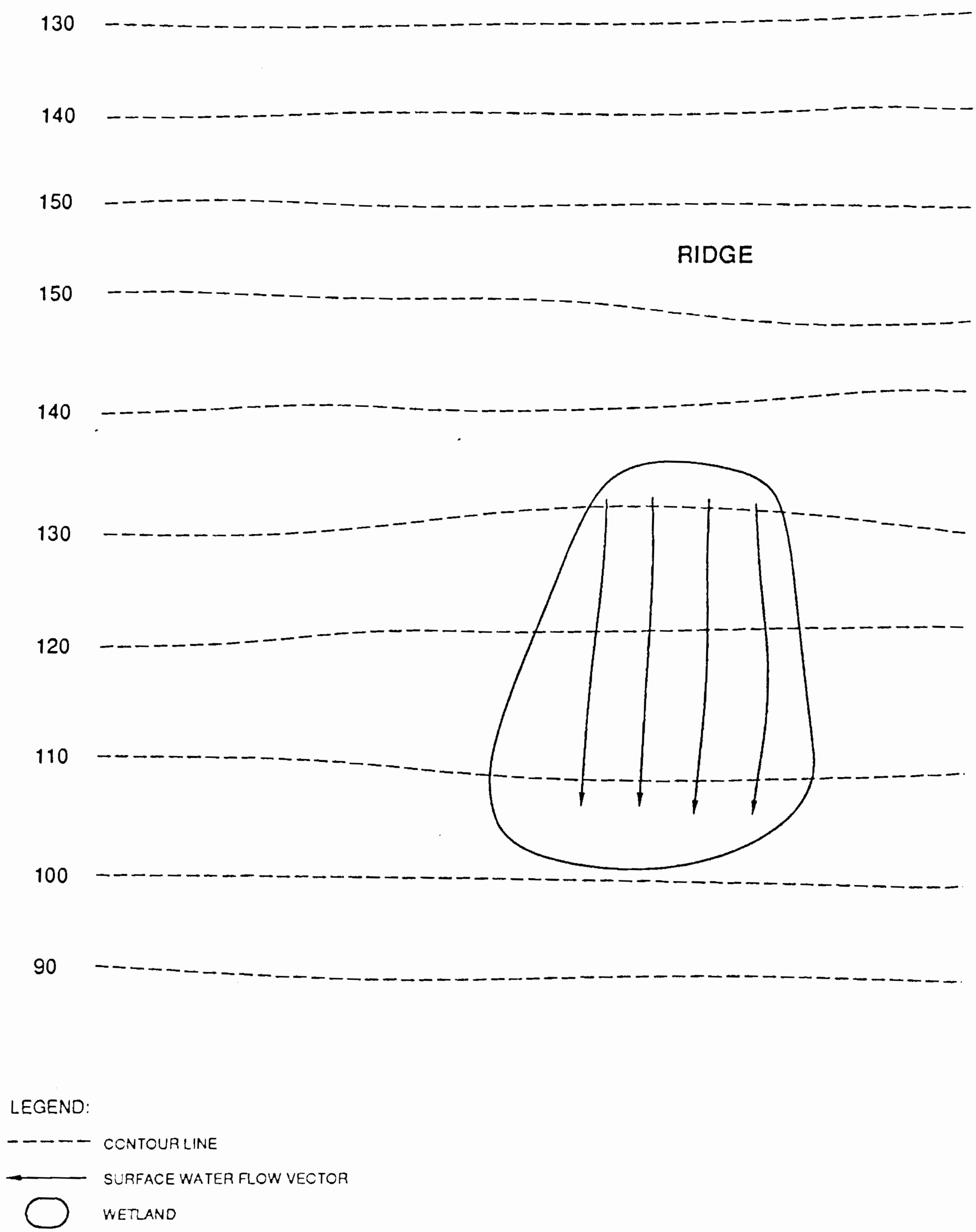


FIGURE 14
SLOPE WETLAND

Raised Peatlands

This HGM does not exist in Maryland and the following description is included for completeness. Raised peatlands are the topographic opposite of depressional wetlands. Raised peatlands have waterflow vectors which radiate from a central high point, a topographic hilltop (Figure 15).

These wetlands are restricted by climate primarily to northern Maine and Minnesota. They generally began as depressional wetlands which have filled their basin with peat and are continuing to grow upward and outward. Many raised peatlands are very large in geographic extent and can be easily observed on topographic maps by the closed contours of a hilltop in conjunction with "swamp symbols." Others are not observable on topographic maps but are so in the field. Commonly raised peatlands are interconnected with riverine wetlands. Most raised peatlands have been identified by the State of Maine and Minnesota. Others are known to exist in Wisconsin. The governments of those states can greatly aid in the identification of the HGM type.

Riverine Wetlands

Riverine wetlands predominantly occur in topographic valleys, but also may occur in broad flat areas where no large scale topographic land form is evident. They may contain a stream channel which ranges from very small intermittent headwater channels to very large river channels. Riverine wetlands border stream channels which have floodplains. Waterflow vectors are from the valley edges towards the stream channels during non flood periods. During high water periods (flooding events) water overtops the stream channel banks and floods into the adjacent vegetated wetland. Water levels in the wetland will rise and fall as a result of overbank flooding, ground water flooding and inflowing runoff from valley sides. As floodwaters recede, the water level will fall and water will drain back towards the channel. The hydrology of the riverine wetland is hydrologically dominated by flooding from the adjacent channel. Figure 16 illiterates idealized riverine wetland flow vectors. That area flooded by overbank flooding is considered the channel's floodplain and may either be upland or wetland. Cowardin et al. (1987) limits use of the term "riverine" to those habitats occurring in the stream channel, excluding upland islands and wetland habitats dominated by persistent vegetation; wetland habitats adjacent to a river channel (e.g., floodplains) usually are palustrine. The separation between riverine wetlands and other HGM classes when they are contiguous is the limit of the 5-year floodplain as determined by FEMA and shown on a flood insurance rate map (FIRM) or on the flood profile. When FEMA flood data is lacking, the upper limit is determined by field observation of evidence of flooding by a predominance of the vegetation community being reflective of overbank flooding, and/or the presence soils created by overbank flooding. The river channel is excluded from the class.

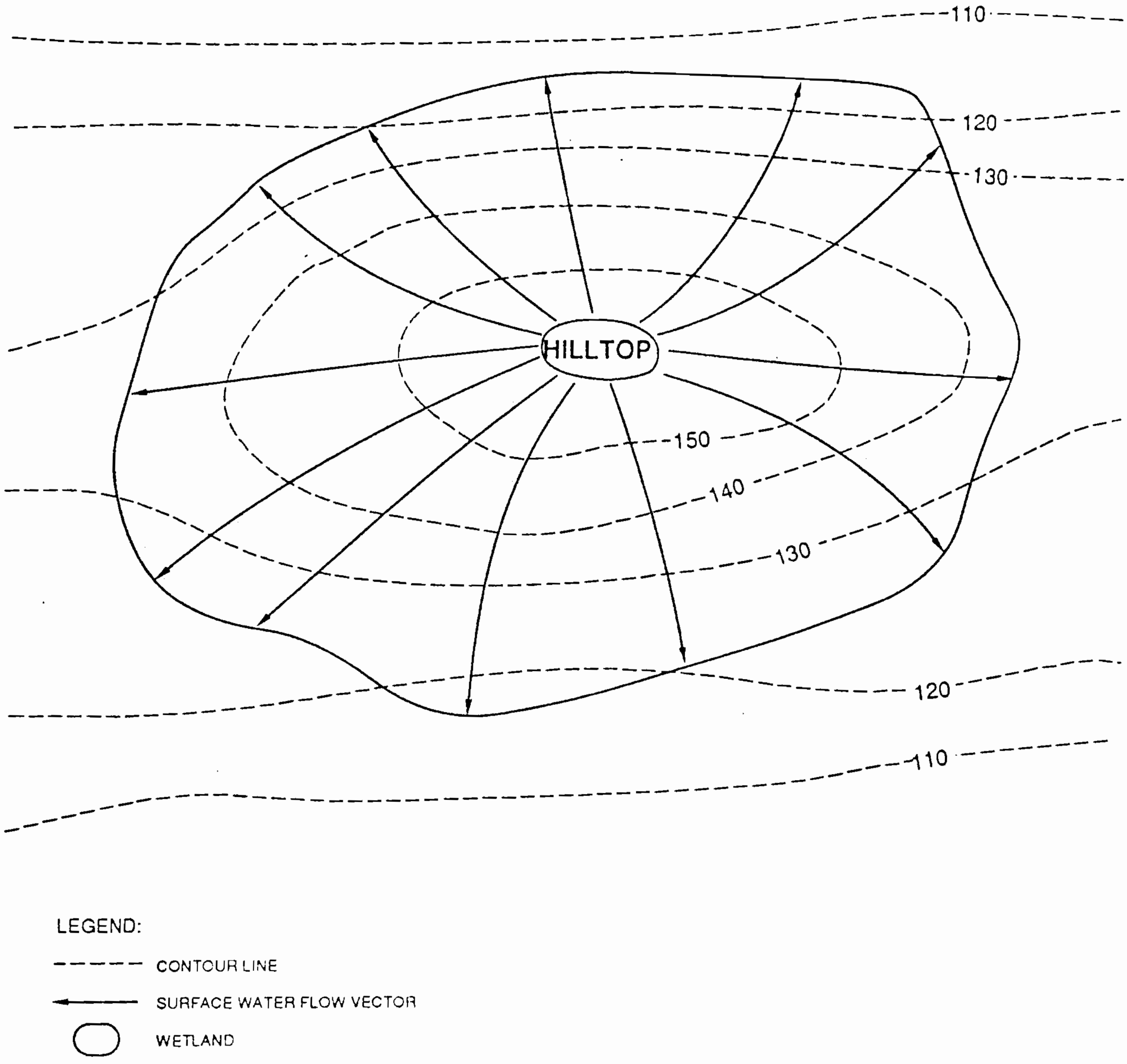


FIGURE 15
RAISED BOG WETLAND

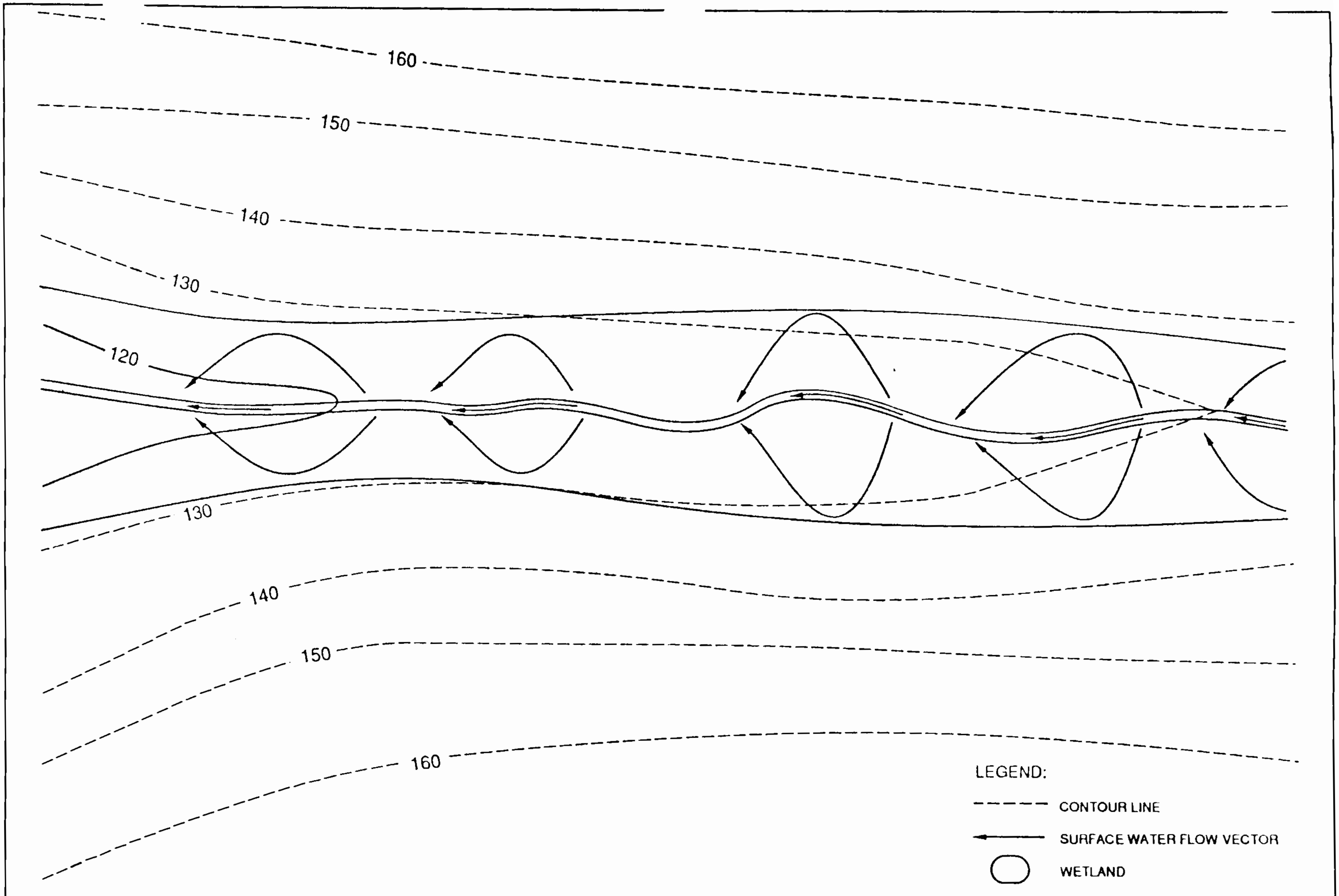


FIGURE 16
RIVERINE WETLAND IN A VALLEY DURING FLOOD

In headwater areas, intermittent and small upper perennial streambeds may have little or no floodplain, the channel itself having the capacity to carry all flood waters. These streambeds may be continuously or discontinuously vegetated. Narrow streamside wetlands any occur above the top of the channel's banks and are commonly slope wetlands. These areas are predominantly not riverine wetlands because they are beyond influence of flood waters originating in the channel and are not the product of overbank hydrology.

Lacustrine Fringe Wetlands

Lacustrine fringe wetlands occur adjacent to and are hydrologically dominated by the adjacent lake. They are palustrine littoral habitats. Surface water vectors are to and from the lake and up and down as a result of lake level fluctuation.

To determine whether a wetland is a lacustrine fringe HGM wetland type it is important to establish the occurrence of a limnetic habitat of the lacustrine system (per Cowardin et al. 1979). Lacustrine fringe wetlands occur in the littoral habitats of aquatic bed, emergent wetland-nonresistant, and unconsolidated shore.

Lacustrine fringe wetlands may also include palustrine system wetlands that are within the highwater mark of the limnetic habitats and are temporarily or seasonally flooded by the highwater plain of the lake. Palustrine wetlands above the highwater mark will be riverine, slope or raised bog. Lacustrine fringe wetlands occur in two topographic settings, depression (Figure 17) and valleys (Figure 18).

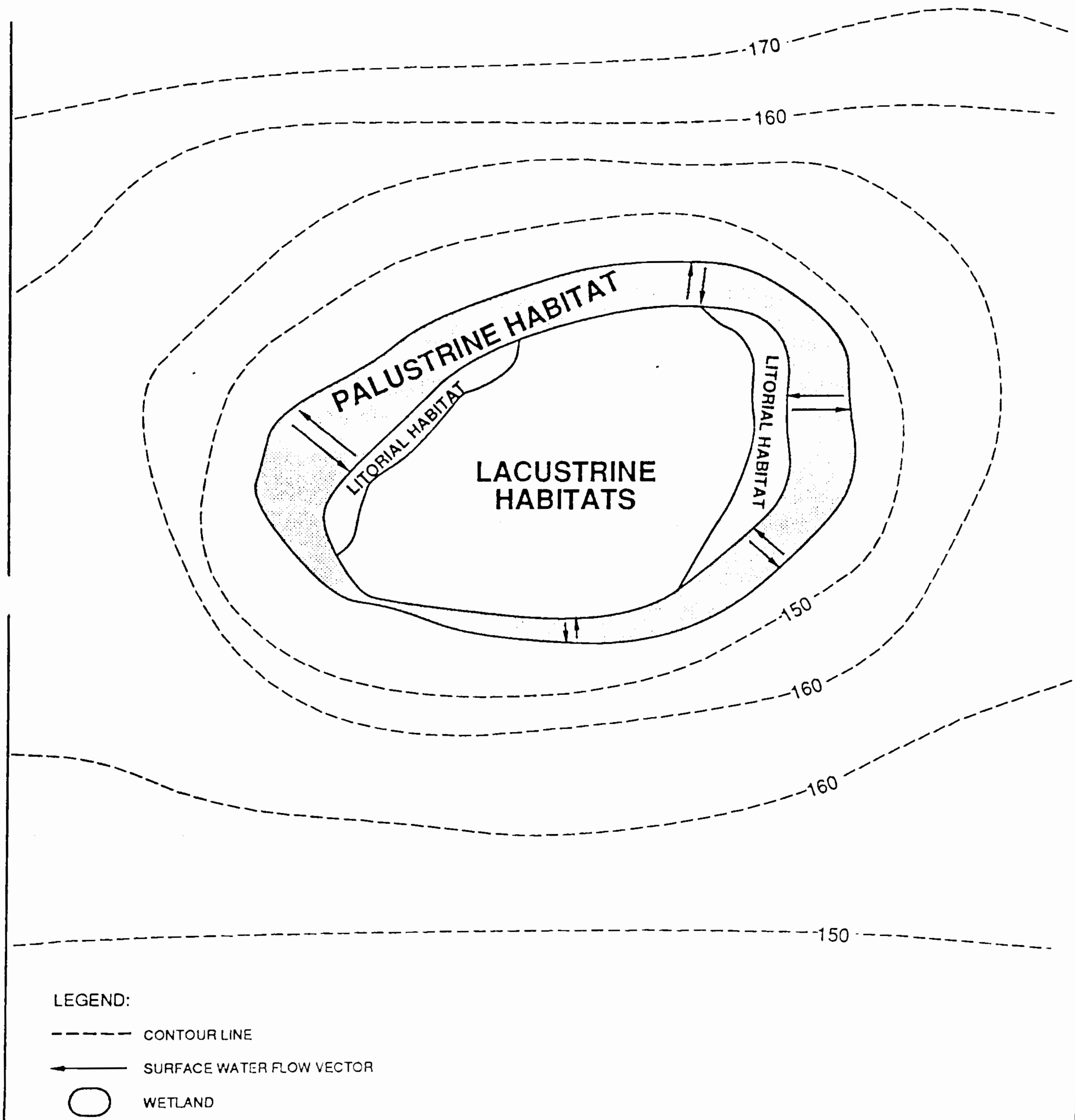


FIGURE 17
LACUSTRINE FRINGE WETLAND IN A DEPRESSION

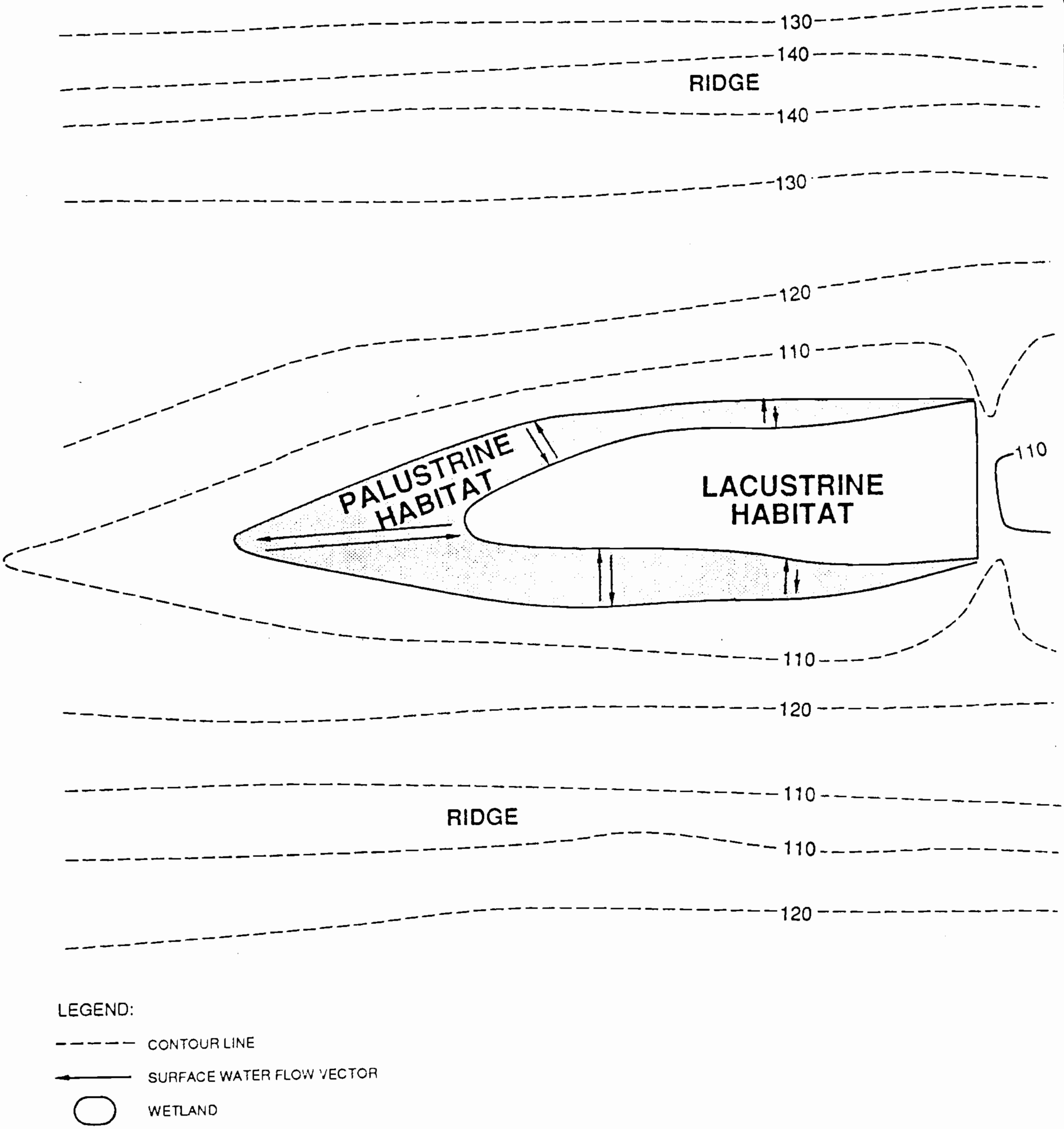


FIGURE 18
LACUSTRINE FRINGE WETLAND IN A VALLEY

3.2 LANDSCAPE VARIABLES

SIZE

Definition

Size is the area of the wetland.

Discussion

The size of a wetland has a direct bearing on its level of performance for most of the defined functions. In many cases the larger the wetland, the larger will be the function per unit area of the wetland. Also, all other factors being equal, a larger wetland will have more total capacity for a given function than a smaller one.

Inventory Methods

The size of the wetland is measured on a map or aerial photograph. It is obtained from the MDE's GIS WRA NWI Wetlands data layer.

Range of Conditions

- >100 acres: Large
- 10-100 acres: Medium
- <10 acres: Small

WETLAND JUXTAPOSITION

Definition

The location of a wetland relative to other wetlands.

Discussion

Wetlands may be completely isolated, that is not hydrologically connected by surface streams or lake waters to another wetland, or located at a considerable distance from other wetlands. Wetlands may also occur near other wetlands but may not be connected, or they may be connected by surface streams.

Inventory Methods

Proximity to other wetlands and surface connections can be determined from leaf-off aerial photographs or USGS maps. A walk around the wetland boundary in the field is necessary in many situations. The WRA NWI Wetland data layer also provides this information.

Range of Conditions

- connected upstream and downstream
- only connected above
- only connected below
- other wetlands nearby but not connected
- wetland isolated

WATERSHED COVER TYPE

Definition

The urban and non-urban cover types of the wetland's watershed.

Discussion

The general kinds of non-urban cover types of the watershed surrounding a wetland are agriculture, forest land and abandoned open land. General kinds of urban land uses may include residential commercial industrial and transportation uses and rural recreational facilities such as golf courses and ski slopes.

The life cycle requirements of many wildlife species are satisfied partly in wetlands and partly in the adjacent uplands. Uplands may also serve to provide a buffer against human disturbance. Wetlands bordered by agriculture, forest land and abandoned open land provide better habitat for wildlife than those surrounded by industrial, housing or outdoor recreational facilities. This variable plays an important role in maintenance of wetland animal communities.

Inventory Methods

This variable may be inventoried using recent aerial photographs or by field reconnaissance. The MOP Land Use data layer may provide this data, but statewide coverage is not presently available.

Range of Conditions

- greater than 90% of two or more non-urban cover types
- 50-90% of one or more; >90% of one non-urban cover type
- less than 50% of one or more of non-urban cover types

REGIONAL SCARCITY OF WETLAND VEGETATION TYPE

Definition

Regional scarcity is relative scarcity, region wide, of the dominant wetland vegetated types contained in the wetland.

A region is a larger political, ecological, hydrologic or jurisdictional area (i.e., state, ecoregion, flyway, Corps district, EPA region, hydrologic unit) which is relatively homogeneous in terms of topography and landscape pattern. In selecting a region, use the most geographically restricted area that is larger than a local township, watershed, county, etc., and favor the use of hydrologic criteria over geopolitical criteria.

Discussion

All wetland vegetation types do not occur with total equal area within a given region. For example, in Massachusetts red maple forested wetlands are the dominant wetland type, comprising nearly 80 percent of the wetland area of the state (region). Shallow fresh marsh is much more scarce, comprising only approximately 6 percent of the total wetland area. Regional scarcity of vegetation type is a useful tool to the regulatory decision maker to insure that the wetland resources are properly managed. Scarce wetland vegetation types may provide critical habitat for rare plants for wildlife.

Inventory Methods

Using maps which indicate individual wetland vegetated type or the WRA NWI Wetlands data layer, the total area is computed for each vegetation type.

Those dominant vegetation types which comprise 10 percent or less of the total area of all combined wetland vegetation types are considered scarce.

Range of Conditions

- Not scarce
- Scarce

WETLAND OF REGIONAL SIGNIFICANCE

Definition

A wetland which has been identified by a natural resources government agency as having functions or characteristics which are important to a region.

Discussion

Some wetlands have been studies and their characteristics inventoried and analyzed to establish their relationship to other wetlands and/or uplands. These wetlands are important for the maintenance of other wetland habitats and upland habitats in the region. These wetlands are generally large in size, but can occasionally be small. They are generally habitat for a specific species.

Inventory Methods

These wetlands have been designated by a natural resource government agency.

Range of Conditions

- Designated
- Not designated

WETLAND'S WATERSHED LAND USE

Definition

Watershed land use refers to those human activities which modify the vegetation cover and hydrologic patterns of the land surface. They range from the most intense such as industrial, to the least intense, such as open space. Other typical land use activities include commercial, residential, agricultural and forestry.

WETLAND'S WATERSHED LAND USE-*CONTINUED*

Discussion

Land use within the watershed to a large degree governs the amount, rate and chemical nature of runoff reaching the wetland. Urbanized areas with industrial, commercial and dense residential land uses have high rates of runoff which produces "flashy" turbid stream flow. These high intensity land uses also add pollutants to the runoff.

Less intensive land uses generate fewer impacts to the hydrology and chemistry of surface water. Many of the physical parameters of a wetland can be the product of or have been greatly modified by watershed land use. Land use also creates the opportunity for a wetland to perform many of its functions.

Inventory Methods

The nature of watershed land use may be determined using a variety of methods. In some locations state or local government agencies have land use maps from which the land use of the watershed can be determined directly. MOP land use data layers exist for portions of the state. If such a map is not available current aerial photos can be obtained and interpreted to determine land use. A field reconnaissance of the watershed can also be conducted and land use directly observed; this is the most accurate method.

Range of Conditions

Land use can be divided into three general classes:

- **High intensity land uses,** including industrial, commercial and urban residential
- **Moderate intensity land uses,** including suburban residential, agricultural and forestry.
- **Low intensity use**, which includes undeveloped open space.

TOPOGRAPHIC POSITION OF THE WETLAND IN THE WATERSHED

Definition

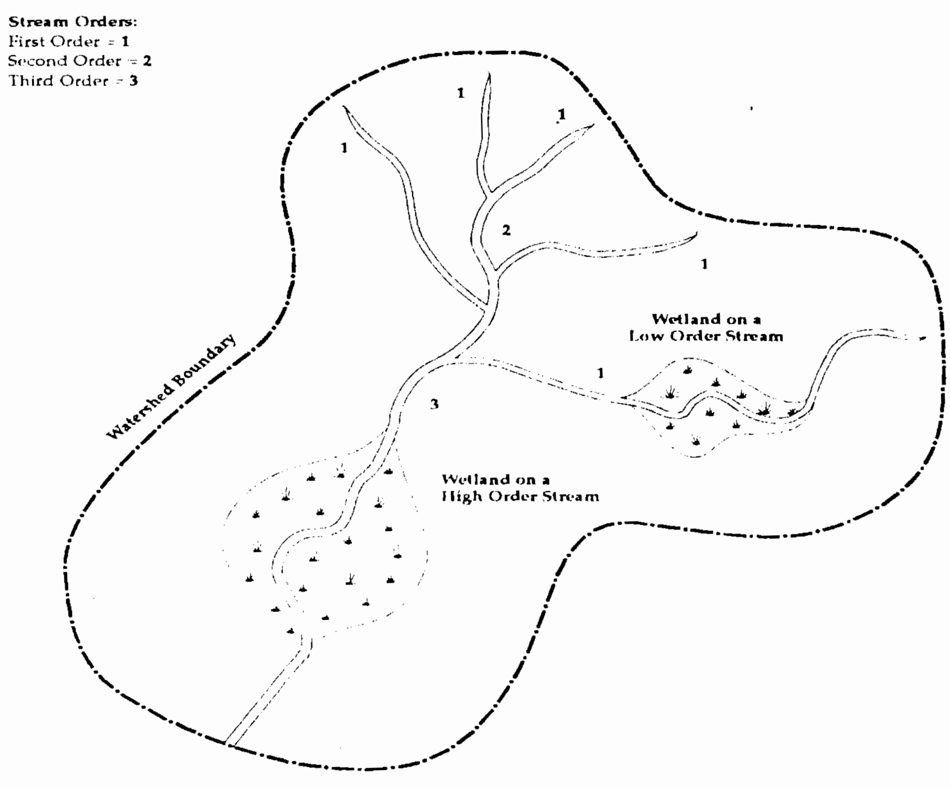
The location of the wetland relative to stream order.

Discussion

Where a wetland occurs in the watershed of its stream system dictates in some ways how it may function. Wetland associated with low order stream (1 and 2) in the headwaters of a stream system, generally do not contain floodplains and have a low frequency for overbank flooding, whereas wetland in higher order streams (3 or above) have a greater likelihood of experiencing overbank flooding. In some geologic setting headwater stream significantly contribute to base flow, especially during the spring when interflow is active.

Inventory Method

Stream order is typically determined by use of the best available topographic map which shows the streams of the watershed. Usually this is the USGS topographic quadrangle map of 1:25000 scale. The PLG Hydrology data layer which has statewide coverage may be used, but does not show all stream, particularly small first order streams.

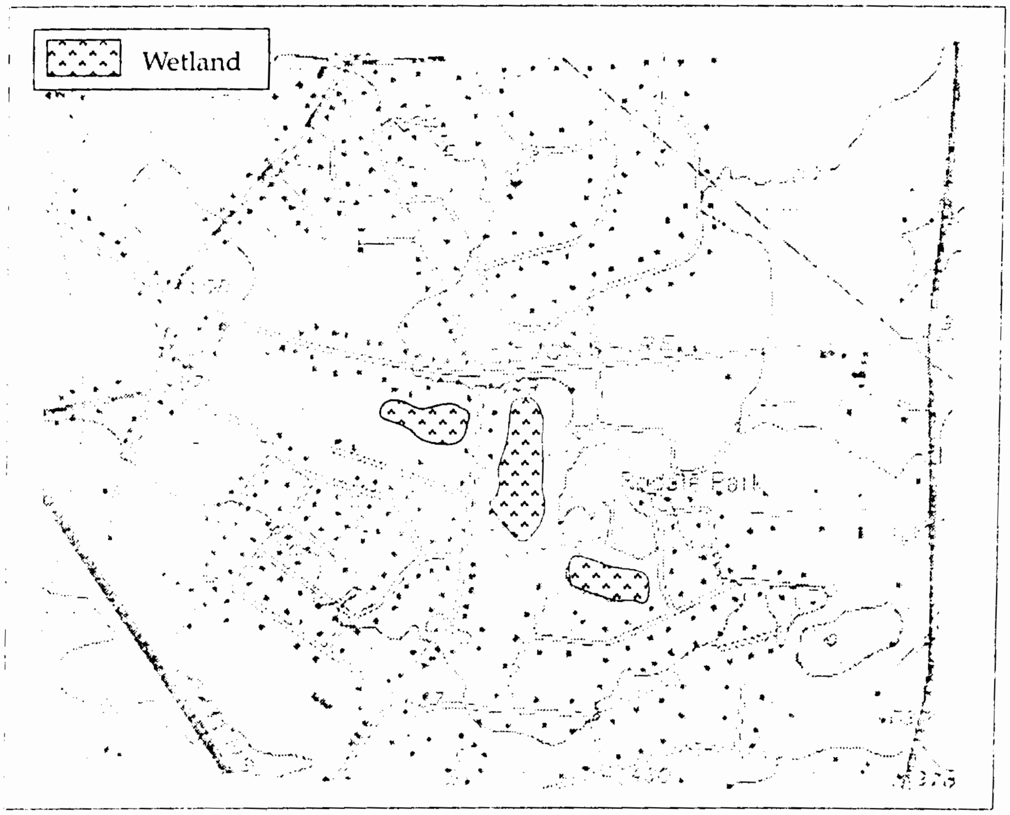


Wetland topographic position within a watershed.

TOPOGRAPHIC POSITION OF THE WETLAND IN THE WATERSHED- *CONTINUED*

Range of Conditions

- Isolated
- Headwater (order 1 or 2)
- Lower reach (order 3 or above)



Example of wetland fragmentation due to road construction and residential development.

WETLAND FRAGMENTATION

Definition

A wetland which is a remaining fragment (smaller part) of a once larger wetland.

Discussion

Human land use commonly destroys wetlands or reduces their size, in some cases requiring the remaining small wetland to serve the function of the once larger wetland. The smaller wetland takes on increased significance.

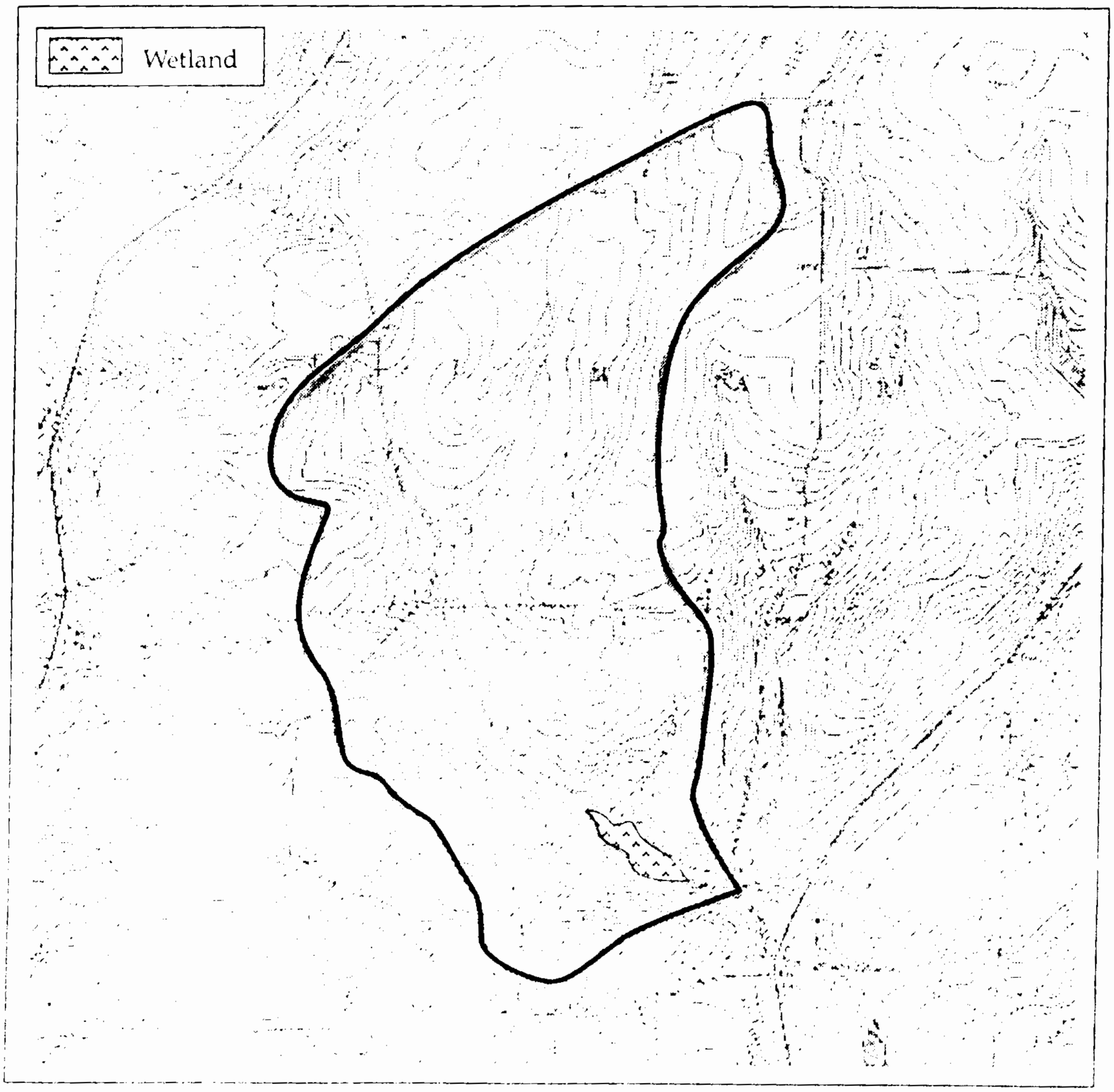
WETLAND FRAGMENTATION-*CONTINUED*

Inventory Method

Aerial photography, USGS Maps, WRA NWI Wetland data layer and the WRA DNR Wetland data layer may show features which indicate fragmentation, such as unnaturally straight wetland edges, road crossings, etc. The presence of agricultural fields containing hydric or relic hydric soils, as shown on the County Soils Services Map, illustrate fragmentation.

Range of Conditions

- Fragmented
- Not fragmented



Example of determining the watershed for a wetland on a first order stream.

ADJACENT TO CRITICAL AREA OR AREA OF SPECIAL CONCERN

Definition

The Critical Area relates to the state designated Critical Area for the protection of Chesapeake Bay. Areas of Special Concern are designated by the MDE.

Discussion

Wetlands included in or adjacent to these designated areas have been determined to have special increased functions to protect the designated area.

Inventory Method

Wetlands of Special Concern are shown by a color code on the WRA MDE Wetland data layer and the WRA NWC Wetland data layer. The Chesapeake Bay Critical Area is shown on the County Tax Map overlays as well as WRA MDE wetland 1/4 quads.

Range of Conditions

- Adjacent
- Not adjacent

PERCENT OF WETLAND EDGE BORDERING UPLAND SEDIMENT SOURCE

Definition

Upland sediment sources are considered to be any upland land use which increases the sediment load above that of natural vegetation cover type yields (e.g. row crops); and which borders a wetland and slopes towards the wetland so that sediment laden runoff may flow into the wetland.

$$= \frac{\text{Length of wetland edge bordering a sediment source}}{\text{Total wetland length}} \times 100$$

Discussion

Sediment enters wetlands from two possible sources: 1) overbank flooding from streams within the wetland; and 2) runoff from surrounding upland slopes. This sediment modifies the functions of the receiving wetland, as the wetland traps the sediment. Wetlands with large amounts of surrounding uplands, that are a sediment source, will be modified by sediment inflows more than wetlands with little or no adjacent sediment sources.

PERCENT OF WETLAND EDGE BORDERING UPLAND SEDIMENT SOURCE-*CONTINUED*

Inventory Method

The upland land use is determined using aerial photographs, orthophoto 1/4 quads or MOP Land Use data layer, or by a site inspection. Erodible soils are identified by consulting the County Soil Survey. The perimeter of the entire wetland edge is measured on the wetland map and may also be obtained from the WRA NWI Wetland data layer. The length of wetland edge bordering a sediment source is divided by the total wetland length to produce a percentage.

Range of Conditions

- 0 percent
- 50 percent or less
- 51 percent or greater

3.3 HYDROLOGIC VARIABLES

SURFACE WATER LEVEL FLUCTUATION OF THE WETLAND

Definition

Water level fluctuation is the measure of the yearly rise and fall of surface water above the wetland/substrate.

Discussion

Water level fluctuations occur for many reasons including ground water recharge and discharge, stream or lake overbank flooding, accumulation of runoff and precipitation, and ET. Water level rises occur when water is detained and stored in a wetland following a storm event. The morphology of the wetland allows for this detention of water and also controls the release of water to downstream areas, the ground water table and the atmosphere. Storage occurs when inflow equals or exceeds outflow. Water levels drop when outflow exceeds inflow. Some wetlands never are inundated, or are inundated so infrequently and to such a shallow depth that no evidence of water level fluctuation can be observed during dry periods.

Water level fluctuation influences most wetland functions. It may be an indicator of long-term and short-term surface water storage, and ground water discharge. Water level fluctuations have a direct impact on characteristic faunal and plant communities. They bring nutrients into the wetland and may result in export of detritus.

Inventory Methods

The degree of water level fluctuation can be directly measured in the field by various types of water level gauges. Generally this information is not available. Also because of the temporal nature of water direct observation of the highest level of flooding usually is not possible. Therefore, indirect physical evidence of flooding is normally used. The invert elevation of a basin's threshold commonly determines the upper level of flooding; this can be surveyed in the field and the elevation compared to the lowest elevation of the floor of the basin to obtain an estimate of water fluctuation. Hydrologic modeling could also be applied to predict water level fluctuations. Evidence of rare event water level fluctuations may occur and should be differentiated from the yearly event. The relationship of the wetland to FEMA FIRM data may be used. At a minimum, county offices have 100-year flood plain data. If detailed, FIRM's exist, the flood profile can be used to determine the frequency of overbank flooding.

SURFACE WATER LEVEL FLUCTUATION OF THE WETLAND-*CONTINUED*

Range of Conditions

- high frequency:
  1 to 10 year flood
- low frequency:
  10 to 100 year flood

Physical Indicators of Water Level Fluctuation in Wetlands:

A. Water Marks/Silt Rings on Tree Trunks
B. Ice Marks on Stems
C. Absence of Leaf Litter
D. Drift Line Deposition/Stain Lines
E. Sediment Deposit on Plants
F. Debris Deposited in Stream Channels

WATER CHEMISTRY

Definition

This variable is here defined as the chemical composition of the water in the wetland.

Discussion

Water chemistry within the wetland can have an impact on the characteristics of the faunal and plant communities. It can also be of value in predicting if the wetland is a ground water discharge point or its water budget is dominated by precipitation and runoff. This information is important in predicting the wetland's modification of water flow from the ground water system to the surface water system (streamflow).

Inventory Methods

To inventory the wetland's water chemistry a field measurement of the wetland surface water conductivity is done using a conductivity meter. An adequate number of readings at the proper locations must be taken at each site. The wetland pH is also measured in the field at an adequate number of sites.

WATER CHEMISTRY-*CONTINUED*

Range of Conditions

Salinity	μMos
• Hypersaline	60,000
• Eusaline	45,000
• Polysaline	30,000
• Mesosaline	8,000
• Oligosaline	800
• Fresh	<800

pH	
• Acid	<5.5
• Circumneutral	5.5-7.4
• Alkaline	>7.4

SURFICIAL GEOLOGIC DEPOSIT UNDER WETLAND

Definition

The dominant type of surficial geologic deposit which occurs under the wetland's hydric soil.

Discussion

The type of surficial geologic deposit under the wetland influences the wetland's ground water recharge and discharge functions. Low permeability deposits are not high transmissivity aquifers, is not likely to be significant areas for ground water discharge. High permeability deposits, are generally high transmissivity aquifers. Wetlands associated with these deposits are generally discharge areas. Borings are the only absolute data for this variable, but the underlying surficial geologic deposit can be predicted by the surrounding surficial geologic deposit. These are illustrated on USGS surficial geologic quadrangle maps or can be implied from SCS soil series maps. The Maryland Geological Survey has county geologic maps that may be useful.

Indicators

- Low permeability deposits
- High permeability deposits

WETLAND LAND USE

Definition

Wetland land use consists of those human activities which occur within the boundaries of the wetland and which alter the wetland's vegetation, hydrology, chemistry or soil. Examples include cutting of trees and cattle grazing.

Discussion

Land use of wetlands can directly impact wetland functions. For example, damming the threshold of a wetland's outlet may decrease flood water storage by flooding the wetland substrate and also change the vegetation community by destroying vegetation not tolerant of flooding. Active uses such as forestry or clearing for agricultural row crops drastically change the vegetation community, diminishing its value for many of the functions. In general, the larger the area of land use within the wetland the greater the impact on functions. Passive recreational use, such as hunting and nature study will have little impact on wetland functions.

Inventory Methods

Information pertaining to wetland land use may be obtained from land use maps available from state and local government planning agencies. The MOP Land Use data layer is an excellent source. Current aerial photographs can also be interpreted. The best method, however, is a site inspection of the wetland.

Range of Conditions

- High intensity land use. Included in this category are land uses such as intense agricultural (row crops), activities which remove the natural vegetation and modify the soils and hydrology.
- **Moderate intensity land uses**. Included in this category are land uses such as grazing and forestry, where the natural vegetation is modified but not entirely replaced, plowing does not occur and the soils and hydrology are generally undisturbed.
- **Low intensity land use**. This category includes those land uses, such as open space and recreation, which have little or no impact on the wetland's vegetation, soils and hydrology.

WATER REGIME

Definition

The duration and timing of surface water inundation caused by surface water, precipitation and ground water inflow.

Discussion

The wetland's water regime has an influence on all wetland functions.

Inventory Methods

The dominant water regime modifiers per Cowardin et al. (1979) are used to determine hydrologic regime. This information is available on NWI and MRA maps, but should be confirmed by field observations. The MRA NWI Wetlands data layer can provide this information.

Range of Conditions

Wet regimes

- *Large water budget.* This condition is indicated by those vegetation communities which are tolerant of permanently flooded, intermittently exposed, and semi-permanently flooded (i.e. aquatic bed, marsh) conditions.

Drier regimes

- *Small water budget.* This condition is indicated by those vegetation communities which are indicative of seasonally flooded, temporarily flooded and saturated (i.e. Wet meadow, scrub/shrub, forested wetland) conditions.

Examples of Wetlands With Wet and Drier Water Regimes:

Examples of Wetlands with Drier Water Regimes:

A. Temporarily Flooded Wetlands-
Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season. Plants that grow in uplands and wetlands are characteristic of the temporarily flooded regime.

B. Intermittently Flooded Wetlands-
The substrate of the wetland is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation.

C. Saturated Wetlands-
The substrate of the wetland is saturated to the surface for extended periods during the growing season, but surface water is seldom present.

Examples of Wetlands with Wetter Water Regimes:

A. Seasonally Flooded Wetlands-
Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent by the end of the season in most years. When surface water is absent, The water table is often near the land surface.

B. Semi Permanently Flooded Wetlands-
Surface water persists throughout the growing season in most years. When surface water is absent, the water table is often near the land surface.

C. Intermittently Exposed Wetlands-
Surface water is present throughout the year except in years of extreme drought.

D. Permanently Flooded Wetlands-
Water covers the land surface throughout the year in all years.

BASIN TOPOGRAPHIC GRADIENT

Definition

The gradient of a wetland's basin is the change in elevation between the inlet and outlet divided by length.

Discussion

The gradient of a basin is one factor which controls the storage of water within the basin. Basins with nearly flat gradients generally have a larger and longer detention potential than basins with steep gradients. Nearly flat gradients have a higher potential for sediment retention than ones with steep gradients where erosion may occur.

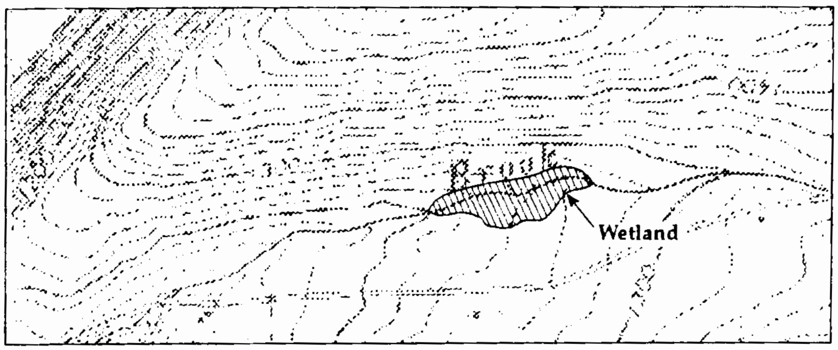
BASIN TOPOGRAPHIC GRADIENT-*CONTINUED*

Inventory Methods

Topographic gradient is measured either from a topographic map having a suitable scale and contour interval, or in the field. Using a topographic map the length of the wetland is measured from the inlet farthest from the outlet, to the outlet. The elevation of the invert of the outlet is subtracted from the invert elevation of the inlet giving the difference in elevation from the inlet to the outlet. The difference in elevation is divided by the length to give a percent gradient. If a suitable topographic map is not available, this measurement must be made in the field using a level and a tape measure or the stadia method.

Range of Conditions

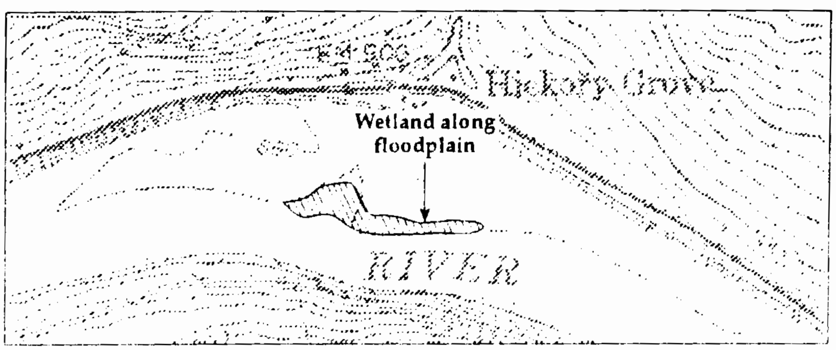
- High gradient: >2%
- Low gradient: <2%



A. Example of a High Gradient Class Wetland

Definitions:
Gradient-
The elevation at the inlet (highest) minus the elevation at the outlet (lowest) divided by the straight line distance separating the inlet and outlet.

Generally: The steeper the slope in the wetland, the higher the gradient class.



B. Example of a Low Gradient Class Wetland

DEGREE OF OUTLET RESTRICTION

Definition

The degree of outlet restriction of a wetland basin is that point of its outlet which hydraulically controls the outflow.

Discussion

The degree of outlet restriction controls the rate of discharge through the outlet. The time of storage ("Ts") is a governing factor in determining flood storage function and this factor is equally a function of both change in outflow and change in storage per unit change in stage. A change in the stage-discharge characteristics of a wetland can have as much effect on its flood control value as a loss of a sizable portion of the wetland area. The stage discharge relation of most wetlands is a function of the stage-discharge relation of the adjacent river channel or the backwater from downstream outlet controls. Outlet controls can be a natural flat gradient stream, bedrock controlled outlet invert, a man made dam or culvert, etc.

A highway culvert can be an effective flood control mechanism for a wetland since once full it has a small change in discharge per unit change in stage. However, this applies if storage capacity is not exceeded. A highway embankment across a wetland is an effective control, but if the culvert is overly restrictive, the wetland will fill and spill over the road embankment during major floods causing a sudden change in the "Ts" factor and accompanying loss of flood control effectiveness.

If a wetland outlet is weir controlled and maintenance of more constant water levels is desirable, such as for wildlife, then the normal procedure is to lengthen (widen) the weir. Doubling the outflow capacity by doubling the weir length would be the same as reducing the wetland size by one-half with respect to its downstream flood control function.

It can be argued that beaver dams reduce the flood storage function of wetlands by modifying the stage-discharge relation. Beaver dams often replace a narrow restrictive outlet with a long overflow dam across an existing wetland. Their action can increase the size of the wetland but reduce the flood storage function by the change in stage-discharge relation.

Inventory Methods

The outlet of a wetland basin must be identified in the field by direct observation. The use of maps for this purpose can be misleading. Observations of the outlet's width and depth must be made, and it must be determined whether the outflow through the outlet is restricted or unrestricted.

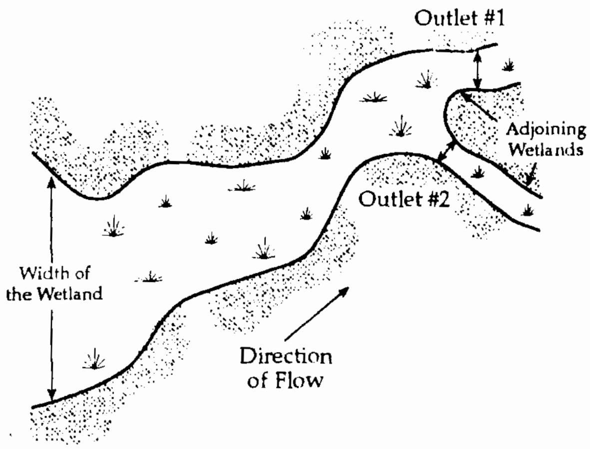
DEGREE OF OUTLET RESTRICTION-*CONTINUED*

Range of Conditions

- Restricted outflow
- Unrestricted outflow

Restricted Outlet

A. Outlet flow associated with a channel



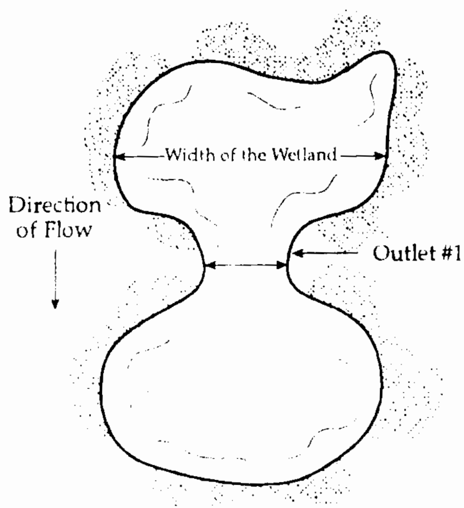
Definitions:

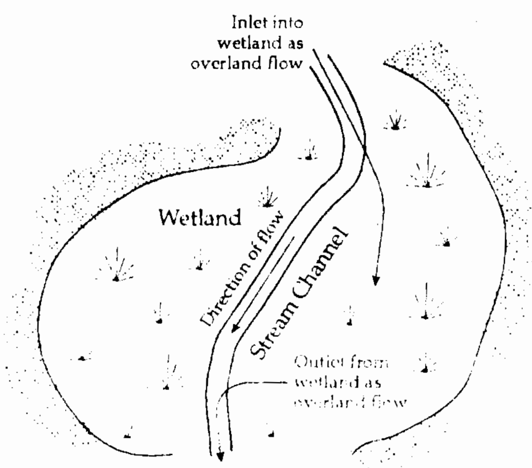
Restricted Outlet-
A surface outlet on a channel that is less than one-third the maximum width of the wetland or larger adjoining wetland, or a surface outlet without channel flow that is less than one-tenth the width of the wetland or adjoining wetland.

Unrestricted Outlet-
A surface outlet that is not defined as above. The outlet does not become narrow, or flow does not become constricted into the outlet. Unconstricted outlets are usually associated with wetlands along stream channels that receive overland flow as the primary source of hydrology.

* *Typical restricted outlets occur when a stream body of water and associated wetlands are culverted and piped under highways or roads.*

B. Outlet flow not associated with a channel





RATIO OF WETLAND AREA TO WATERSHED AREA

Definition

The ratio of wetland area to watershed area is the division of the wetland area by the wetland's watershed area to produce a percentage.

Ratio of Wetland Area to Watershed Area:

$$\frac{\textbf{Area of Wetland}}{\textbf{Area of Watershed}} \times 100$$

Discussion

The size or area of the wetland's watershed is one factor controlling the wetland's water budget: the larger the surface area of the watershed which flows to a wetland, the more water will flow to the wetland. This, as well as other factors, also control the amount of sediment and particulates which enter the wetland, the wetland's water regime, its flood storage and recharge potential.

Inventory Methods

Watershed area is most commonly measured on a topographic map. The watershed is delineated by locating the divides between the watershed and the others which surround it. In urbanized areas review of city engineering plans for storm drains may be necessary to establish the exact watershed. The wetland area is measured on the best available map or aerial photograph. The size of the wetland can be obtained from the MRA NWI Wetlands data layer, but the size of the wetland's watershed must be measured on a topographic map.

Range of Conditions

- Large: >10%
- Small: <10%

MICRORELIEF OF WETLAND SURFACE

Definition

Microrelief of the wetland surface is the degree of difference between the highest and lowest average elevations (the relief).

Discussion

Microrelief of the wetland surface is one component of the roughness factor (Manning's equation) with respect to the water that flows through the wetland, the rougher the wetland surface the slower water will pass through. This increases detention time. Microrelief results in hummocks and depressions where long-term storage of water can occur and habitats for wildlife are provided.

Hummocks are observable in the field as distinct mounds, small hills or islands generally formed by woody or herbaceous plants in response to the high water table. Pools are areas of shallow open water which surround or are interspersed with hummocks.

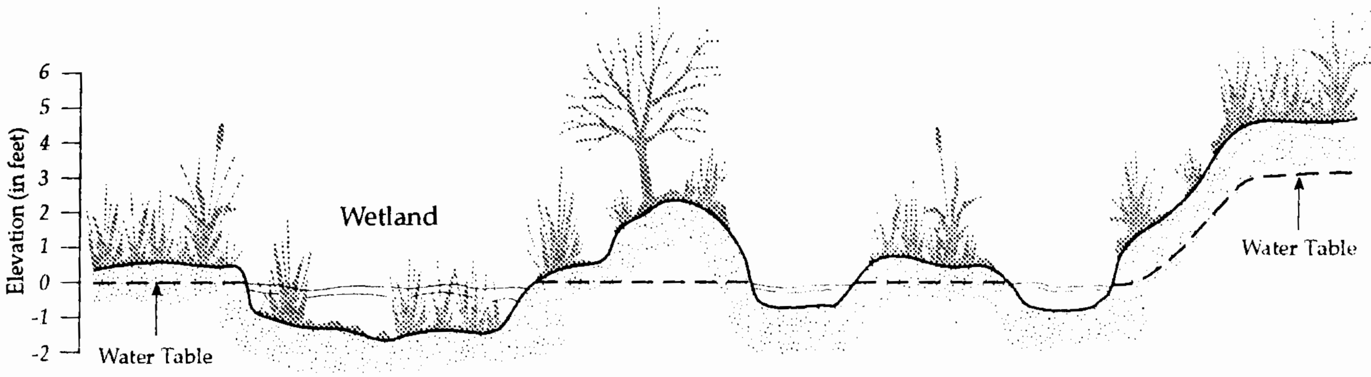
Inventory Methods

Microrelief of the wetland can only be determined by visual observations in the field, where the investigator assesses the occurrence of hummocks and depressions.

MICRORELIEF OF WETLAND SURFACE-*CONTINUED*

Range of Conditions

- Pronounced: > 45 cm
- Well developed: 5-45 cm
- Poorly developed: < 15 cm



Pronounced Microrelief-
Wetland topography characterized by many shallow depressions or pockets intermixed throughout the wetland surface, creating a "hill and valley" effect. The depressions usually become inundated with ground water, tidal or overland flow.

Poorly Developed Microrelief-
Wetland topography characterized by few/no shallow depressions or pockets intermixed throughout the wetland surface. The wetland is generally flat with gradual/consistent elevation gradients throughout.

Well Developed Microrelief-
Wetland topography characterized by conditions between that of poorly developed and pronounced microrelief.

INLET/OUTLET CLASS

Definition

The occurrence and relationship of surface water inlets and outlets of a wetland.

Discussion

Water may enter a wetland by a surface water channel cut into the land surface by fluvial process or discharge from an artificial structure such as a culvert or ditch. Surface water flows from a wetland through a natural or man-made channel. The relationship or lack of inlets and outlets can be indicators of a wetland's functions. A wetland with a perennial outlet and no inlet is a ground water discharge area. Wetlands having a perennial inlet and ephemeral outlet may indicate ground water recharge is occurring through the wetland. A wetland having no inlet or outlet performs long-term flood storage.

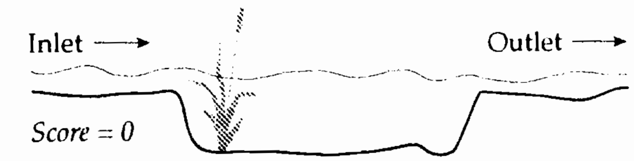
Inventory Methods

In order to insure all inlets and outlets are observed and classified, the entire perimeter of the wetland should be walked. In the absence of a field inspection aerial photographs and NWI and WRA MDE wetland maps may be inspected but may not show all inlets and outlets. When more than one inlet occurs, the type of inlet, whether intermittent or perennial, is designated on the basis of the dominant (largest) inlet.

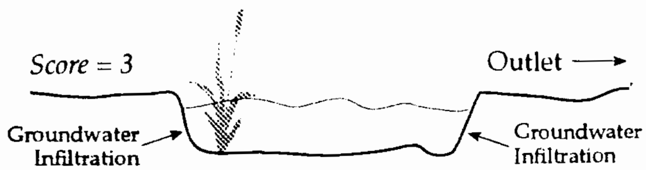
Range of Conditions

- No inlet-no outlet
- No inlet/intermittent outlet
- No inlet-perennial outlet
- Intermittent inlet/no outlet
- Intermittent inlet/intermittent outlet
- Intermittent inlet/perennial outlet
- Perennial inlet/no outlet
- Perennial inlet/intermittent outlet
- Perennial inlet/perennial outlet

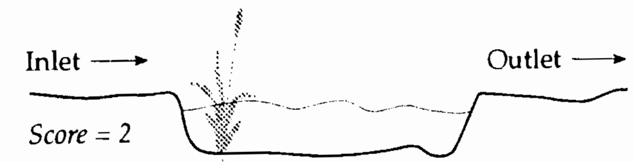
INLET/OUTLET CLASS-*CONTINUED*



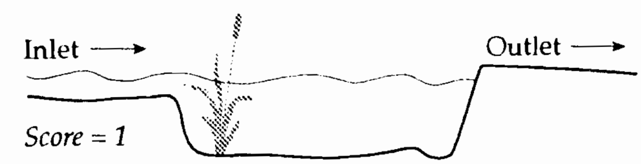
Perennial Inlet/Perennial Outlet



No Inlet/Intermittent Outlet



Intermittent Inlet/Intermittent Outlet



Perennial Inlet/Intermittent Outlet

Definitions:

Perennial Outlet-
Outlet elevation is topographically low in the wetland. Water moves out of the wetland on a regular/constant basis. Little/no free board (storage volume).

Intermittent Outlet-
Free board is below the invert of the outlet. The water level must reach the height of the outlet in order to flow out of the wetland.

Perennial Inlet-
Surface water flow or flooding from an adjoining body of water is regularly/constantly moving into the wetland.

Intermittent Inlet-
Surface water flow or flooding from an adjoining body of water is moving into the wetland for at least 10 consecutive days at least once every 10 years, and becomes dry for at least 10 consecutive days every growing season.

NESTED PIEZOMETER DATA

Definition

A piezometer is a small diameter well designed to read water table elevations. A piezometer nest is two or more piezometers placed adjacent to each other, with screens set at substantially different depths in the water table.

Discussion

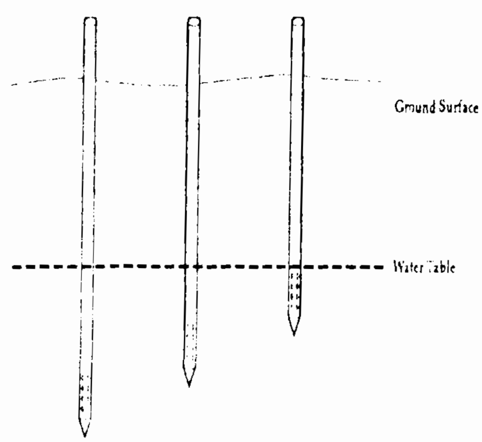
Data obtained from ground water table level reading from nested piezometer provide data concerning the hydraulic direction of flow in a water bearing geologic unit. Three hydraulic flow directions are possible; upward movement (discharge), downward movement (recharge) and horizontal flow. These data are the most positive for determining the recharge or discharge conditions of a wetland. It can be difficult, expensive and time consuming data to collect.

Inventory Methods

Nested piezometers are installed and monitored to determine aquifer hydraulic flow directions. This is site specific data which is rarely available but occasionally detailed site geohydrology has been investigated and is available from the project engineer.

Range of Conditions

- Recharge
- Discharge
- Horizontal flow



Nested Piezometers

RELATIONSHIP OF A WETLAND'S SUBSTRATE TO REGIONAL POTENTIOMETRIC SURFACE

Definition

The potentiometric surface is the level to which ground water will rise in a piezometer for a given aquifer. The relationship of a wetland's substrate to the regional potentiometric surface is the elevation of the substrate relative to the elevation of the potentiometric surface.

Discussion

Some areas have had detailed regional ground water investigations conducted by the USGS or state geologic survey. The elevation of the regional potentiometric surface is shown on a map as contours. Occasionally, the potentiometric surfaces may have been determined for a specific site. Knowing the elevation of the potentiometric surface at the wetland, and the elevation of the wetlands' substrate, allows for a comparison of the two elevations. If the potentiometric surface elevation is greater than or equal to that of the wetland substrate ground water will be flowing into the wetland substrate by moving upward or by horizontal flow, and discharge will occur. If the elevation of the potentiometric surface is less than that of the wetland's substrate elevation, then recharge will occur.

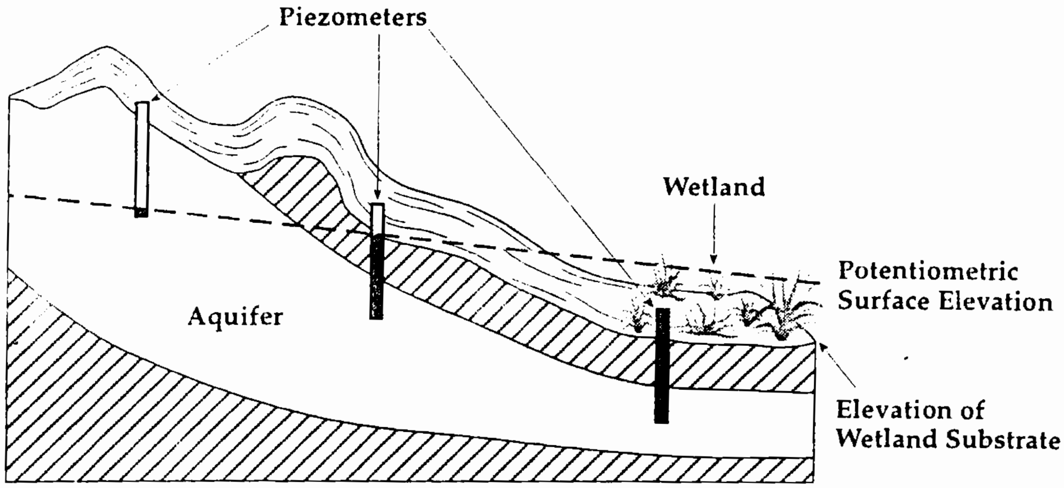
Inventory Methods

Data is obtained from the USGS or state geological survey. Potentiometric surface can be determined using water table elevations obtained from water table monitoring wells and known discharge points, such as perennial springs, streams, rivers and lakes known to be discharge areas. An approximate method can be accomplished by reading the elevation of lakes, pond, rivers and large stream on the USGS topographic map and contouring these elevations. If a wetland is near a lake or river which is a discharge area and the wetland has an elevation similar to the lake or river it can be assumed that the wetland is a discharge area.

Range of Conditions

- Piezometric surface above or at wetland substrate elevation
- Piezometric surface **below** wetland substrate elevation

RELATIONSHIP OF A WETLAND'S SUBSTRATE TO REGIONAL POTENTIOMETRIC SURFACE-*CONTINUED*



Groundwater discharge in a wetland where the potentiometric surface is greater than the elevation of the wetland's substrate.

EVIDENCE OF SEEPS AND SPRINGS

Definition

Springs are distinct points on the land surface where ground water discharges from the underlying geologic units as a point source and becomes surface water, soil water or lacustrine water. Seeps are broad areas where ground water discharges to the land surface.

Discussion

Water enters wetlands in a number of ways. Direct precipitation enters all wetlands and for some wetlands may be the dominant inflow. Other wetlands receive surface water inflow from streams and runoff from the surrounding watershed. Many wetlands are discharge areas for ground water. An excellent indicator of ground water discharge into a wetland is the presence of perennial springs and seeps. Ground water has a relative constant temperature, flow, and chemistry. These unique characteristics of ground water allow certain vegetation communities to occur, and allow for maintenance of outflow characteristics which contributes to downstream ecosystems.

Inventory Methods

The wetland and its edge as well as the bottom of inundated sites must be visually inspected for the presence of springs or seeps. When a field visit is not possible the presence of springs or seeps may have been recorded in hydrologic publications or site specific data. Review of NWI or WRA MDE wetlands maps may show that a portion of the wetland has a vegetation community with a wetter water regime modifier than the remainder of the wetland. This may indicate that ground water discharge from springs is creating this difference.

Range of Conditions

- No seeps or springs
- Seeps observed
- Perennial spring
- Intermittent spring

SURFACE WATER HYDROLOGIC CONNECTION

Definition

Surface water hydrologic connection is the presence and form of a surface water connection to other wetlands, to lakes, and/or to streams.

Discussion

In nature there are many ways in which individual wetlands are connected to other wetlands, or riverine and lacustrine habitats. Wetland functions may be additive and interactive on a landscape scale and the connection between wetlands can be the avenue for this interaction. The fact that some wetlands are hydrologically isolated from other wetlands can also be a positive or negative influence relative to wetland functions.

Inventory Methods

The determination of how one wetland is connected to another is established by observations in the field or through the use of aerial photographs and maps. The PLG Hydrology data layer can be reviewed, but will not show many small streams. A complete walk around the wetland may be necessary to locate all possible inlets and outlets and to classify them. This information is also used later to characterize inlets and outlets. Wetlands may have no distinct hydrologic connection by a stream channel to another wetland, but physically may touch another wetland. This may occur when one hydrogeomorphic type is separated from another hydrogeomorphic type by definition, rather than by upland. For example, a slope wetland may touch a riverine fringe wetland, the only separation being that point where slope wetland flow vectors give rise to riverine flow vectors.

Range of Conditions

- Not connected
- Connected to an intermittent stream
- Connected to a perennial stream or river
- Connected to a lake

EVIDENCE OF SEDIMENTATION

Definition

Evidence of sedimentation consists of direct observation of sediment on the surface of the wetland's recent soil or within the wetland's soil profile which has occurred as a result of particulates settling from flood water.

Discussion

The best indicator that the process of sedimentation is occurring within a wetland is the direct observation of accumulations of sediment on the wetland's soil. This illustrates that sediment is entering the wetland and the wetland has the necessary characteristics to store the water long and slow enough to allow for sediment to drop from the water column. Contaminants are normally attached to silt and clay grains and the sedimentation incorporates these contaminates in the soil column where they may be subject to biogeochemical transformations.

Inventory Methods

Evidence of sedimentation can only be gathered by direct observation of the wetland surface. Sediment can be observed on leaves and other surfaces. The presence of sediment-created soils, such as fluviquents (alluvial soils), can be proof that sedimentation is occurring if the conditions which allowed their formation still exist. Soil observation pits need to be dug to identify layered sediment indicative of fluviquent soils. SCS soil maps may describe soil types which are indicative of sedimentation.

Range of Conditions

- No evidence observed
- Sediment observed on wetland substrate
- Fluviquent (alluvial) soils present

FREQUENCY OF OVERBANK FLOODING

Definition

The re-occurrence interval of floodwater exceeding the capacity of the river channel, over topping the channel banks and flowing into the floodplain.

Discussion

Overbank flooding is the transport mechanism by which water from streams enters floodplains. This water carries suspended solids, nutrients, dissolved solids and detritus. The frequency of flooding impacts the characteristics of the vegetative community and the soils of the floodplain.

Inventory Methods

The frequency of overbank flooding may be contained in publications concerning the river's hydrology, as gage data, FEMA profiles or FEMA flood maps. USGS hydrologic data sources may contain overbank flooding data. Hydrologic models can predict frequency of overbank flooding. Field evidence of flooding (i.e. direct observations, wrack piles, surface scour) may be interpreted.

Range of Conditions

- High frequency: <5 years
- Moderate frequency : 6 to 20 years
- Low frequency: >20 years to 100 years

Field Evidence of Flooding:

A. Direct observation
B. Watermarks/silt marks
C. Scouring
D. Debris deposition

POTENTIAL FOR OVERLAND FLOWS FROM SURROUNDING UPLAND

Definition

Surface water, in the form of non-channelized flow, which enters the wetland from the surrounding upland slopes.

Discussion

Upland runoff is an important source of surface water flow into a wetland. This water adds to the water within the wetland affecting the wetlands hydroperiod and water regime. The water brings with it suspended solids, dissolved solids, nutrients, heavy metals and detritus, which impact the wetland water quality, vegetation and wildlife. Wetlands having large areas of overland flow contributory to them will receive more overland runoff than those with smaller areas.

Inventory Methods

Topographic maps define the watershed area which contributes unchannelized runoff directly into the wetland. The MOP Land Use data layer can be viewed to determine erodibility of soils.

Range of Conditions

- High potential: >100 acres of upland contributing overland flow
- Low potential: 100 or less acres of upland contributing overland flow

WET HYDROLOGIC REGIME WITHIN A DRIER REGIME

Definition

Hydrologic wetland regimes are defined by Cowardin et al., 1979. A hydrologic regime which is wetter than the dominant regime may occur as an inclusion.

Discussion

Commonly, a wetter hydrologic regime occurring within a drier regime is a result of ground water discharge as a spring or seep. It may also be a result of a surface water discharge, but for the purposes of this method, the occurrence of a wetter regime within a drier regime is assumed to be the product of ground water discharge unless field observations prove differently.

WET HYDROLOGIC REGIME WITHIN A DRIER REGIME-*CONTINUED*

Inventory Methods

The MRA NWI Wetland data layer or MRA MDE Wetlands 1/4 quadrangle maps provide information concerning the Cowardin hydrologic regime. Field investigations may show smaller areas if wetland types with wetter regimes are not observed on the NWI or MRA delineations.

Range of Conditions

- Wetter regime inclusion present
- Wetter regime inclusion not present

See **Water Regime** for definition of wet and dry hydrologic regimes (page 65).

WETLAND OCCURRENCE AT BASE OF STEEP SLOPE

Definition

Base of a steep slope is that point on the land surface where a significant change in slope occurs, where a steep slope becomes a gentle slope.

Discussion

Wetlands occurring at the base of a steep slope commonly are the result of the intersection of the water table and the land surface at the point of change in slope. This results in ground water discharge and the creation of a wetland. Wetlands occur at the base of steep slopes and generally are indications of ground water discharge.

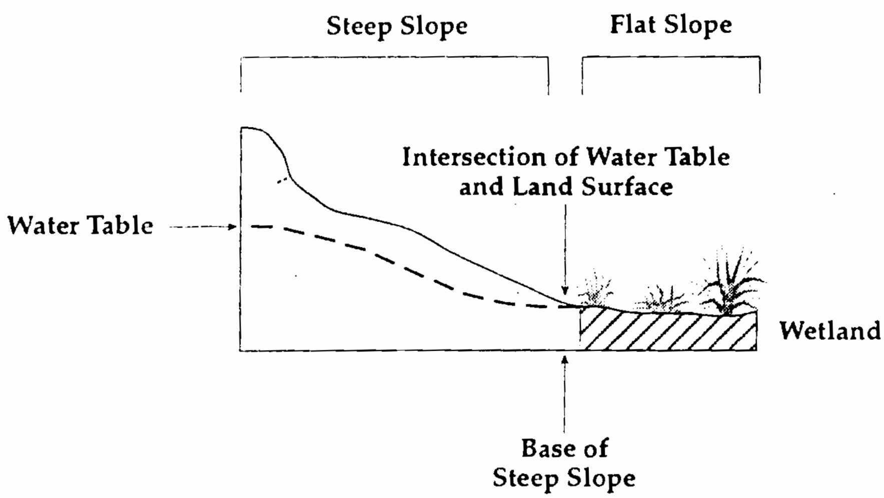
Inventory Methods

The location of the wetland is observed on a topographic map to observe this relationship. A field inspection will often observe this relationship, when topographic maps are at too small a scale or too large a contour interval.

WETLAND OCCURRENCE AT BASE OF STEEP SLOPE-*CONTINUED*

Range of Conditions

- Does occur
- Does not occur



INCISED STREAM CHANNEL

Definition

A stream channel in the wetland which is down cutting into its channel bed, due to degradation (erosion).

Discussion

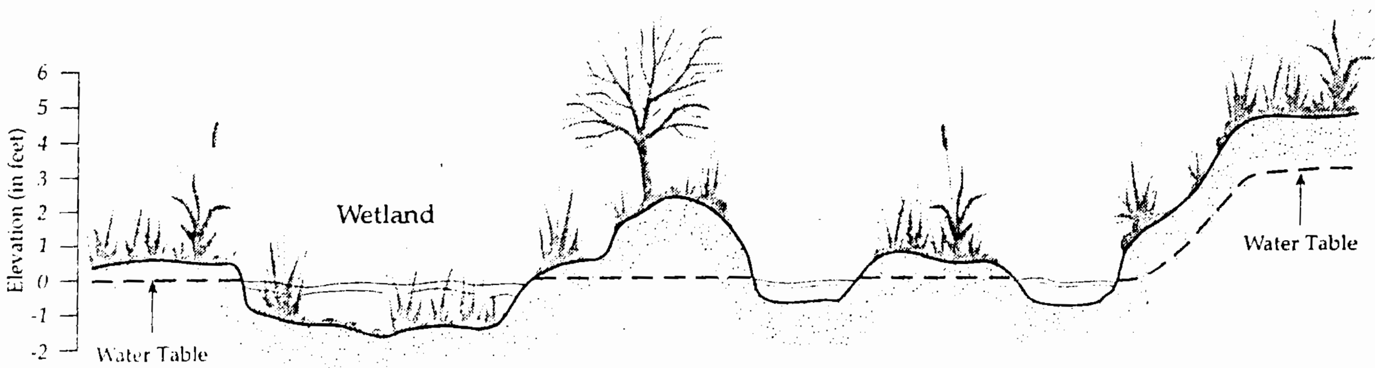
Changing hydrologic characteristics of the wetland's watershed (i.e., urbanization) may lead to "flashy" stream hydraulics, resulting in a down cutting, eroding stream bed bottom. This may decrease the frequency of overbank flooding, lower water table levels within the wetland, altering the wetland's hydroperiod. This modifies the wetland's flood flow attenuation and water quality modification functions.

Inventory Methods

To determine this indicator a site visit must be made.

Range of Conditions

- Does occur
- Does not occur



Pronounced Microrelief-
Wetland topography characterized by many shallow depressions or pockets intermixed throughout the wetland surface, creating a "hill and valley" effect. The depressions usually become inundated with ground water, tidal or overland flow.

Poorly Developed Microrelief-
Wetland topography characterized by few/no shallow depressions or pockets intermixed throughout the wetland surface. The wetland is generally flat with gradual/consistent elevation gradients throughout.

Well Developed Microrelief-
Wetland topography characterized by conditions between that of poorly developed and pronounced microrelief.

DITCHING

Definition

A ditch is a man dug channel in the wetland's surface for the purpose of draining the surface and ground water in the wetland.

Discussion

Ditching is normally the result of agricultural practices designed to make the wetland hydroperiod drier so that farming uses can be made of the wetland. Ditching has also been done for mosquito control. Ditching modifies the wetland's hydrologic regime, causing impacts to all of its functions. Ditches may provide aquatic habitat.

Inventory Methods

Ditches appear on county tax maps, USGS topographic maps, aerial photography and orthophoto 1/4 quadrangles. They are best observed in the field.

Range of Conditions

- Does occur
- Does not occur

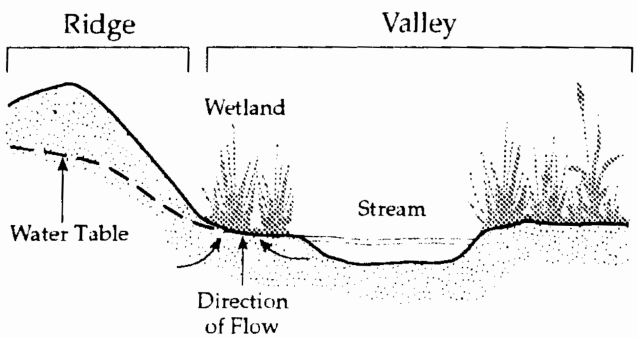
ADJACENT TO A WATER BODY

Definition

The wetland edge touches a pond, lake, stream or river (lacustrine or riverine open water habitat).

Discussion

Wetlands that abut an open water habitat may be interconnected ecologically and hydrologically to that water body, each gaining function from this interconnection.



Wetlands which abut water bodies are assumed to be discharge areas.

Inventory Methods

Aerial photographs, topographic maps, 1/4 quadrangles and wetland maps are reviewed in the office. Observations are made in the field.

Range of Conditions

- Does abut
- Does not abut

BUFFER TO A WATER BODY

Definition

A wetland which lies adjacent to a water body (pond, lake, stream or river), so that it may buffer the water body from upland land use and human intrusion.

Discussion

Wetlands commonly form the shoreline of water bodies and water ways and buffer the water body from upland impacts such as turbid runoff or human activities.

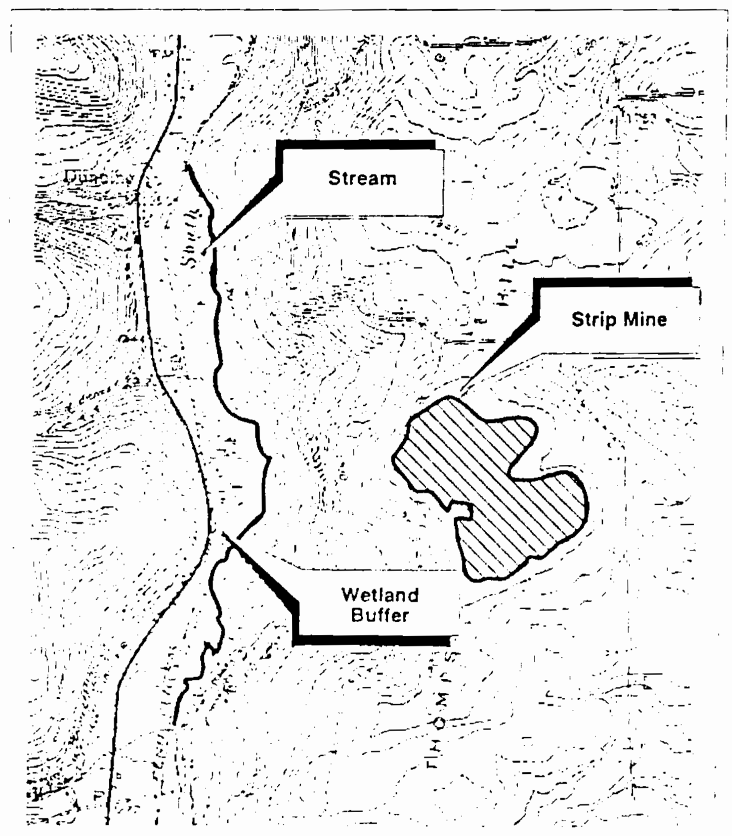
Inventory Methods

Aerial photographs, orthophoto 1/4 quads., USGS topographic quads., WRA NWI Wetland data layer, WRA DNR Wetland data layer and site inspections are data sources for this indicator.

Range of Conditions

- Does not serve as a buffer
- Serves as a buffer

Example of a Wetland Buffer



DEBRIS DAMS

Definition

Debris dams are accumulations of woody dead plant material and leaves which create small natural dams within a stream channel, modifying the hydraulic flows of the channel.

Discussion

Debris dam create upstream pools that can be habitat for aquatic species and wildlife. They also can trap sediment and improve water quality. They may serve as long- or short-term flood storage areas.

Inventory Methods

Debris dams cannot be observed on typical aerial photography and must be observed by a field visit.

Range of Conditions

- Debris dams present
- Debris dams absent

3.4 SOIL VARIABLES

Soil Type

Definition

Soil type is defined by the dominant soil series or mapping unit, as determined by the Soil Conservation Service, occurring within the wetland. The soil is identified as either a histosol (organic hydric soil) or one of the various mineral hydric soils.

Discussion

Soil is an important variable of a wetland. Histosols contain organic particles which influence removal and detention of dissolved elements and as the site for biogeochemical transformations. Histosols may provide long-term water storage. Mineral hydric soils may have high permeabilities allowing ground water recharge, while histosols generally have low permeabilities, reducing ground water recharge. Soil type may also limit vegetation type and influence wildlife community composition.

Inventory Methods

Soil type is determined by locating the wetland on the County Soil Map prepared by the Soil Conservation and if possible by field examination of the soil in the wetland using soil pits. MOP Natural Soils Group data layer may be useful, but general soil series level of detail is needed.

Range of Conditions

Histosol: Soils that have over 50-75% organic matter to 80 cm, or to any depth if on bedrock or fragmented rock.

- **Fibric:** Fibric soils are the least decomposed organic soils and consist of readily identifiable plant fibers that are three-fourths or more of its volume before rubbing. Water content when saturated ranges from 850 to more than 3000% of ovendry material. The colors of fibric soils are commonly light yellowish brown, dark brown or reddish brown.

- **Hemic:** Intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric materials. The fiber content is normally between one-third and two-thirds of the volume before rubbing, and the maximum water content when saturated commonly ranges from about 450 to > 850%. The fibers are largely destroyed when the wet organic material is rubbed. Colors are commonly dark grayish brown to dark reddish brown.

SOIL TYPE-*CONTINUED*

- **Sapric:** These are the most highly decomposed of the organic soils. The fiber content averages less than one-third of the volume before rubbing, and the maximum water content when saturated normally is <450% on the ovendry basis. They are commonly very dark gray to black.

Mineral Hydric Soil: Soils that consist of < 20% organic carbon by weight.

- **Gravelly** Soil with rock fragments.
- **Sandy** Soil consisting mostly of sand.
- **Silty** Soil in which the smooth soapy feel of silt is dominant.
- **Clayey** Soil with a plastic sticky feel when moistened.

Definition of Properties of Several Soil Texture Classes Useful for Field Determinations:

TEXTURE CLASS	PROPERTIES
Sand	A coarse-textured soil. A sand in a wet or moist state will form a cast which will crumble when touched. In a dry state, sand is loose and single grained and will not form a cast.
Sandy Loam	Sand grains readily felt with enough silt and clay present tobind particles. Sandy loams when moist will form a cast which will withstand pressure. A dry cast will crumble and readily fall apart. When rubbed between fingers a sheen forms on the rubbed surface. Sandy loams will not ribbon.
Loam	A medium-textured soil. A loam has a relatively even mixture of sand, silt and clays. It is mellow, may feel somewhat gritty, slightly smooth and plastic. Dry casts will bear careful handling. Moist casts can withstand pressure.
Silt Loam	A medium-textured soil. A silt loam when dry has a floury or talcum powder feel and is slightly plastic when wet. When dry it appears cloddy and can be readily broken. Silt loam will ribbon slightly but will form cracks and have a broken appearance. Wet silt loam forms casts that will withstand rough handling.
Clay Loam	A fine-textured soil that forms hard lumps or clods when dry. Clay loam in a moist state will form a ribbon that will break readily, barely sustaining its own weight. When moist it is plastic and readily forms a cast. It has a smooth feel but some grittiness can be detected when rubbed between fingers.
Clay	A fine-textured soil that forms hard aggregates when dry. Clay in a moist state forms ribbons, is sticky, plastic and will exhibit a bright sheen when rubbed. No coarse fragments (sand), can be detected by rubbing between fingers.

3.5 VEGETATION VARIABLES

DOMINANT WETLAND VEGETATION TYPE

Definition

Dominant wetland type is defined as that vegetation type that occupies the greatest area of the wetland. A wetland type consists of the wetland class, subclass and dominance type of Cowardin et al. (1979). A red maple broad-leaved deciduous forested wetland is an example of a dominant wetland type.

Discussion

Wetland types seldom consist of a single life form, but commonly contain multiple life forms and species. For example, a red maple forested wetland may also contain elm and tupelo, but with red maple having the highest percentage of cover; or the wetland may contain one or more types dominated by other life forms or species, but with the red maple palustrine forested wetland occupying the greatest area of the wetland. Dominant type can be distinguished on the basis of class and subclass alone, or on the species that are dominant. Dominant wetland type affects structure and composition characteristics of the wetland that influence several of the functions.

Dominance of species can be measured by the following:

- basal area (trees)
- aerial cover (herbaceous)
- stem density (shrubs)

Dominance is determined technically during the wetland delineation using the Army Corps of Engineers 1987 *Wetland Delineation Manual*. Each vegetative stratum (or layer) is measured within a 30 foot radius plot. Dominant species are the most abundant plant species that immediately exceed 50% of the total dominance measure (e.g. basal area or aerial coverage) for the stratum, plus any additional species comprising 20% or more of the total dominance measure for the stratum.

Inventory Methods

Dominant wetland type is identified by the dominant life form and the dominance type as defined by Cowardin et al. (1979). Dominant wetland type can often be determined from aerial photographs, NWI wetland maps, or WRA MDE wetland maps, but a site visit is usually necessary to confirm these interpretations, particularly dominant species. The WRA NWI Wetland data layer will provide some generalized vegetation data. Moreover, changes may have occurred since the photos were taken, as for example, in the case of timber harvesting or fire.

DOMINANT WETLAND VEGETATION TYPE-*CONTINUED*

Range of Conditions

Dominant species names can be added to further subdivide the following wetland types (as defined by Cowardin et al., 1979).

Forested Wetland: Woody vegetation that is 6 meters (20 feet) tall or taller

Evergreen

- **Broad-leaved:** Includes magnolias and mangroves (estuarine)
- **Needle-leaved:** Includes black spruce, Northern white cedar, Atlantic white cedar (palustrine)

Deciduous

- **Broad-leaved:** Includes red maple, American elm, ashes, black gum, tupelo, and swamp white oak (palustrine)
- **Needle-leaved:** Includes bald cypress, pond cypress, and tamarack (palustrine)

Emergent Wetland: Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens

- **Persistent:** Dominated by species that normally remain standing at least until the beginning of the next growing season
- **Non-persistent:** Dominated by species that fall to the surface of the substrate or water at the end of the growing season so that no obvious sign of vegetation exists at certain seasons.

Scrub-Shrub Wetland: Woody vegetation that is less than 6 meters (20 feet) tall.

Evergreen

- **Broad-leaved:** Includes mangroves (estuarine) and leatherleaf, inkberry, fetterbush, bog rosemary (palustrine)
- **Needle-leaved:** Includes young or stunted trees such as black spruce or pond pine

Deciduous

- **Broad-leaved:** Includes alders, willows, buttonbush, red osier dogwood, spirea and young trees such as red maple (palustrine)
- **Needle-leaved:** Includes stunted bald cypress or tamarack (palustrine)

Aquatic Bed: Dominated by plants that grow principally on or below the surface of the water for most of the growing season.

WETLAND CLASS RICHNESS

Definition

This wetland inventory variable is defined by the number of different wetland types occurring within the wetland boundary.

Discussion

A wetland may contain more than one wetland type, each having a distinct life form and/or species composition. In general, as the number of vegetation types increases so does structural and plant species diversity of the wetland.

Inventory Methods

The number of wetland types in a wetland can be determined directly, in the field or by delineating the boundary of each distinct type on stereo pairs of aerial photographs, and totaling the number of types. A site visit is generally necessary to confirm the wetland types identified on the photographs and their boundaries. The MRA NOI Wetlands data layer separates wetland types by the Cowardin system and can be useful for both desk top and field method assessments.

The various wetland types that are present are identified on the basis of the dominant life forms and species.

Range of Conditions

- 6 or more types
- 3-5 types
- 1 or 2 types
- No vegetation

See **Dominant Wetland Vegetation Type** for examples of different wetland classes, page 93.

VEGETATIVE INTERSPERSION

Definition

Vegetation interspersion is defined on the basis of the number of kinds of edge (line of contact between two or more vegetation types) and the length of each kind.

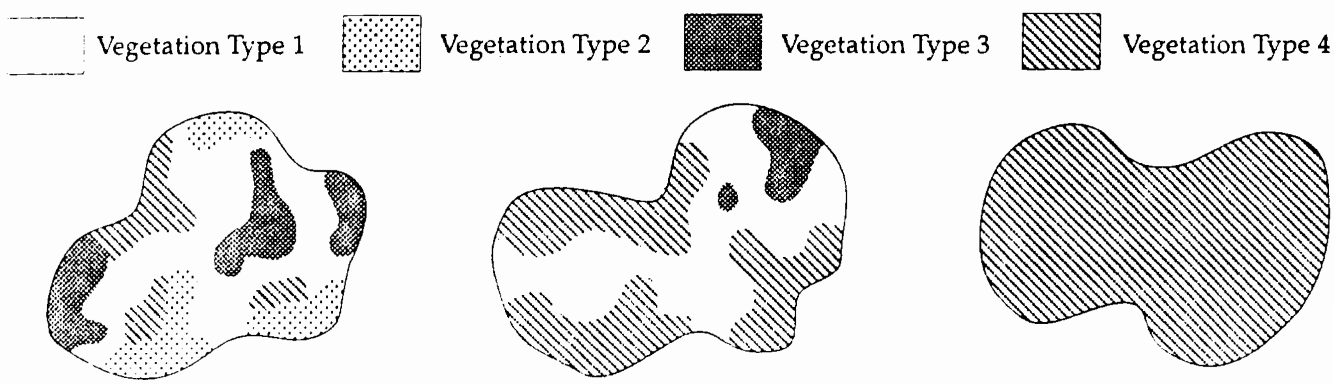
Discussion

Interspersion increases as the tendency toward dominance by one or two vegetation types decreases, the variety of groups increases, the boundaries become more irregular and the percent area occupied by the groups becomes more even. Overall, vegetative interspersion increases as both the number of kinds of edge and total length of edge increase. This variable plays an important role in wildlife diversity/abundance.

Inventory Methods

Interspersion of the wetland classes and subclasses of Cowardin et al. (1979) can be assessed using stereo pairs of aerial photographs. Interspersion is assessed in the photos by observing cover distribution patterns, diversity of types and evenness in percent area occupied by the vegetation types discernible on stereo aerial photographs. This information is available on NWI wetland maps and the WRA NWI Wetland data layer.

Types of Vegetation Interspersion



High Interspersion | Moderate Interspersion | Low Interspersion

VEGETATIVE INTERSPERSION-*CONTINUED*

Range of Conditions

- **High Interspersion**--groupings of vegetation are small, diverse and interspersed, and length and types of edge are high.

- **Moderate Interspersion**--vegetation types occur in broken, irregular rings and length and types of edge are moderate.

- **Low Interspersion**--vegetation types occur in large, homogenous patches or in concentric rings, and length and types of edge are low.

- **No Vegetation**

NUMBER OF VEGETATION LAYERS AND PERCENT COVER

Definition

The number of distinct vertically distributed vegetation life form layers and percent cover of each layer.

Percent Cover - the visual estimation of vegetative cover that each species makes up in a measured data plot. Percent cover can exceed 100 percent for a measured area if there are several vegetation layers growing together.

Average Percent Cover - average of the percent cover of each individual layer.

Discussion

Starting at the ground surface there can be a number of distinct layers, each composed of a distinct life form, such as herbaceous, low shrub, tall shrub, sapling and tree. This condition is known as foliage-height diversity, which is a measure of stratification and evenness in the vertical distribution of vegetation. Foliage-height diversity increases with the number of layers and the density of branches and leaves in each layer. The highest diversity is attained in highly stratified communities with dense growth of foliage from the ground to the canopy. This variable provides an important means of characterizing wetland community structure, which can affect several of the functions.

Inventory Methods

This variable is best inventoried by means of direct field observation at the wetland. The layers corresponding to vegetation life forms are defined based on whether sufficient coverage is present for a given life form to be clearly discernible as a distinct layer (at least 10% cover). An estimate of percent cover expressed for the entire wetland is then made for each distinct layer. In deciduous forest or shrub communities, where two or more distinct layers are present, a rough estimate of percent cover for certain layers may be possible on stereo pairs of leaf-off aerial photos.

NUMBER OF VEGETATION LAYERS AND PERCENT COVER-*CONTINUED*

Range of Conditions

Layer Types:

submergents
floating
mosses and lichens
short herbs (< 1 m)
tall herbs (>1 m)
dwarf shrubs (<0.5 m)
short shrubs (0.5-2 m)
tall shrubs (>2-4 m)
saplings (>4-5 m)
trees (>6 m)
no vegetation

VEGETATION COVER DISTRIBUTION

Definition

The manner in which the vegetation in each layer is distributed in the wetland, whether growing singly, in small clumps or in dense stands.

Discussion

A given layer of vegetation may have very different distribution characteristics than a comparable layer in another wetland having a similar percent cover. This difference may be due to the growth characteristics of the dominant species, distribution mechanisms or environmental gradients. This variable provides information on surface roughness of the wetland and habitat characteristics that affects several of the functions.

Inventory Methods

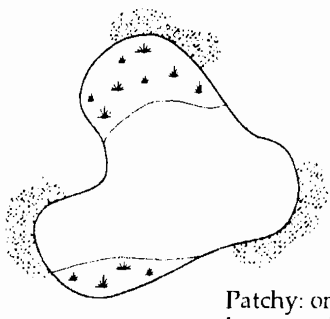
Cover distribution of the dominant layer, and often the understory layers in a deciduous community can be determined from leaf-off aerial photographs; however, a site visit is necessary to confirm distribution of the understory layers.

VEGETATION COVER DISTRIBUTION-*CONTINUED*

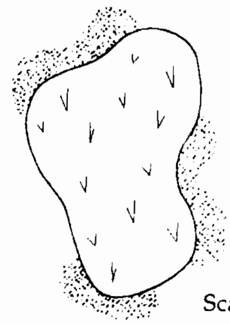
Range of Conditions

- forming a **continuous** cover
- growing in small **scattered patches**
- growing in **one or more large patches** with portions of the site open
- growing as solitary, **scattered stems**
- none

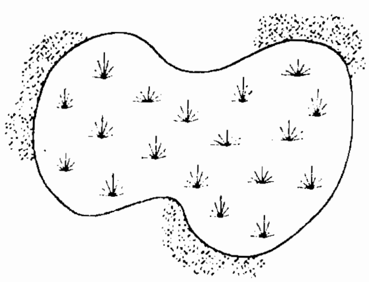
Types of Vegetation Cover Distribution:



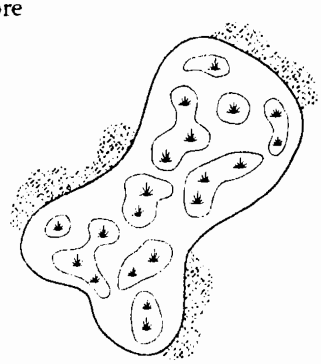
Patchy: one or more large patches



Scattered stems



Continuous distribution



Patchy: small scattered patches

DEAD PLANT MATERIAL

Definition

Standing and fallen trunks, stems and branches of woody plants.

Discussion

Due to senescence of woody plants and plant parts, and/or changes in environmental gradients causing an increase in plant mortality rates, dead woody material generally becomes a component of wetland vegetation community structure. This differs from an emergent wetland dominated by annual and perennial herbs where yearly dieback of most of the vegetation is a characteristic of community dynamics. In general, the amount of dead woody plant material in a wetland will be directly related to the proportion of woody plants in the wetland. Thus forested wetlands would be expected to have the largest amount of dead woody plant material and emergent wetlands the least.

Dead plant material decomposes into detritus and particulates, which support detrital-based food chains in the wetland and downstream. Decomposition of plant material also removes nutrients from long-term storage, which perpetuates recycling and export.

Inventory Methods

The amount of dead woody plant material in a wetland can only be assessed from visual estimation during a site visit. If only aerial photos can be used accurately used, then woody forested wetlands can be expected to produce more dead plant material than emergent wetlands.

Range of Conditions

- abundant
- moderate abundance
- low abundance

INTERSPERSION OF OPEN WATER AND VEGETATION COVER

Definition

The relative proportions and distribution of open water and vegetation cover expressed as the ratio of open water to vegetation cover.

Discussion

Interspersion of open water and vegetation generally varies with developmental stage of the wetland community. In forested wetlands for example, the vegetated portion may occupy nearly all of the wetland, whereas in emergent wetlands and aquatic beds the proportions may be more nearly equal. Vegetation may occur in a peripheral band in the wetland or in scattered patches. The open water portion of a wetland may change during the year due to the growth of wetland plants, particularly floating-leaved aquatics.

Inventory Methods

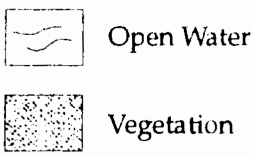
This variable is generally best observed using stereo aerial photographs. However, field reconnaissance, particularly in problem areas such as wetlands having standing water under a closed canopy, may also be necessary. The estimate of cover and water interspersion should be made when the growing season is well underway, after changes in proportion of open water due to plant growth have occurred. To a limited degree the WRA NWI Wetland data layer may be useful.

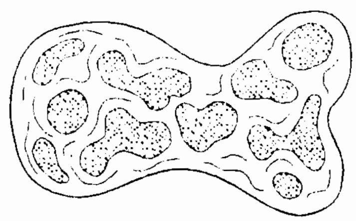
INTERSPERSION OF OPEN WATER AND VEGETATION COVER-*CONTINUED*

Range of Conditions

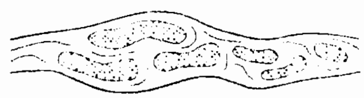
- scattered cover
- peripheral cover
- complete cover
- complete open water

Types of Interspersion of Open Water and Vegetation

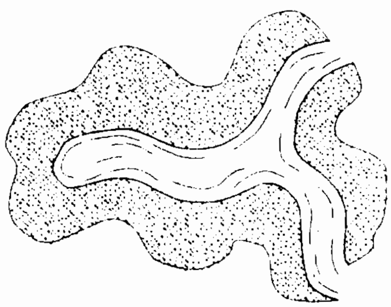




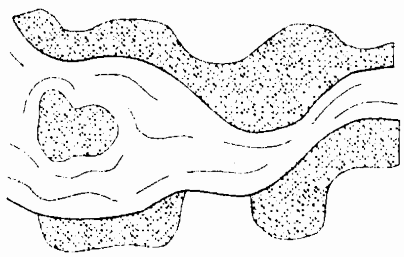
Scattered cover with moderate water/ vegetative cover ratio (26-75%)



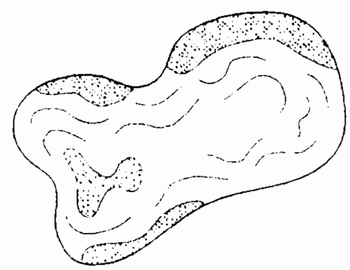
Scattered cover with lower water/ vegetative cover ratio (<25%)



Peripheral cover with lower water/ vegetative cover ratio (<25%)



Peripheral cover with moderate water/vegetative cover ratio (26-75%)



Peripheral cover with high water/ vegetative cover ratio (<75%)

SHORELINE/WETLAND LENGTH RATIO

Definition

This variable is defined by the degree of shoreline irregularity of a wetland bordering a lake or river.

Discussion

The shoreline/wetland surface ratio is an expression of the peninsulas, embankments and other irregularities or convolutions of the wetland shoreline.

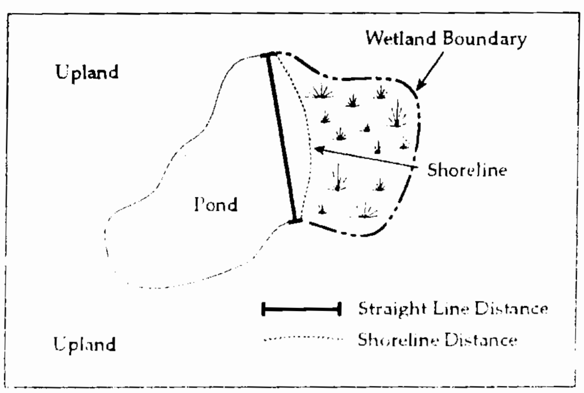
Inventory Methods

The degree of shoreline irregularity is most readily assessed from aerial photos or USGS maps. **It is determined by measuring the straight line distance between two points on the shoreline where the wetland meets the shoreline. This distance is divided by the total length of the wetland/lake or river boundary.**

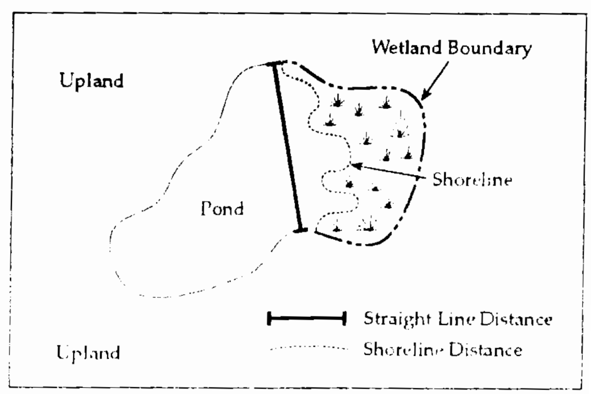
Range of Conditions

- low ratio: .67 and higher
- medium ratio: .33 to .66
- high ratio: less than .33

Types of Shoreline/Wetland Length Ratio



Low Ratio



High Ratio

WETLAND EDGE COMPLEXITY

Definition

This variable is defined by the degree of irregularity of a wetland at the upland edge.

Discussion

Wetland edge complexity is an expression of the extent of irregularity of the wetland boundary.

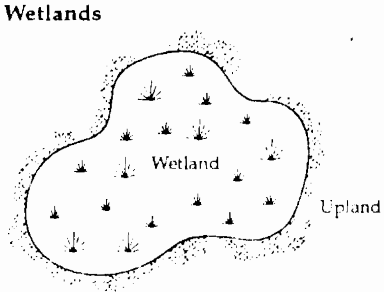
Inventory Methods

The degree of irregularity in the wetland boundary is most readily assessed from aerial photographs with ground checking as appropriate, depending upon how distinct the boundary is. The wetland boundary is often discernible on stereo-aerial photos unless the difference between upland and wetland vegetation is unclear, as in a forested wetland dominated by evergreens, or a scrub/shrub wetland with a predominance of facultative species. In such cases the signatures visible on the photos will be of little use, and reliance on observation of the boundary in the field as a direct indicator will be necessary.

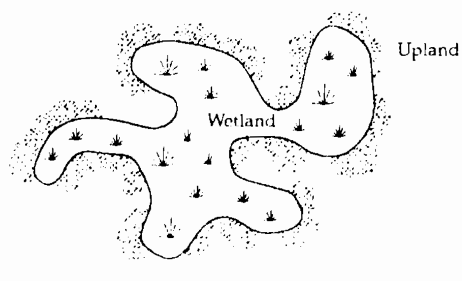
Range of Conditions

- highly convoluted (irregular edge)
- low level of convolution (regular edge)

A. Nonlinear Wetlands

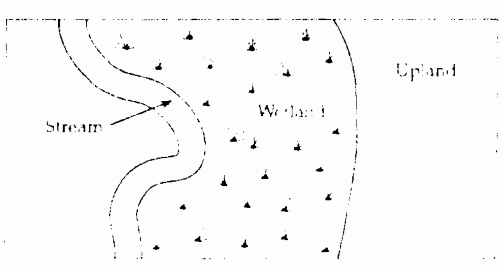


Regular Edge

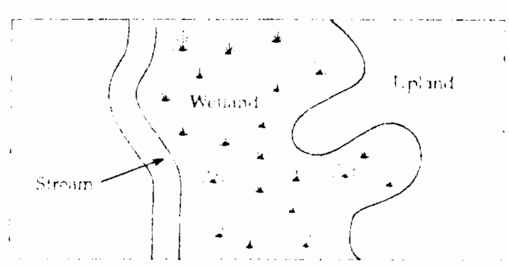


Irregular Edge

A. Linear Wetlands



Regular Edge



Irregular Edge

STREAM SINUOSITY

Definition

Stream sinuosity is the degree of irregularity of a stream course within a wetland.

Discussion

A streamcourse can vary from being nearly straight or with a few meanders to being highly convoluted. As the degree of convolution or irregularity increases so does the level of surface contact between the wetland and the edge of the stream, which can have important implications for certain functions. Streams are generally not present or are ill-defined in emergent wetlands and other wetland categories having large areas of permanent standing units.

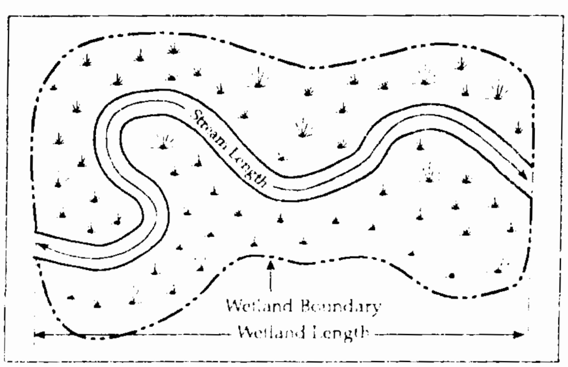
Inventory Methods

Stream sinuosity is most readily inventoried from leaf-off aerial photos, site topographic maps or USGS maps. In small wetlands having easy access this variable can be assessed visually on site. **The wetland length where the stream runs through (measured from wetland boundary to wetland boundary at the longest point) and the length of the stream (including all meanders and bends) are measured, and the ratio is determined.**

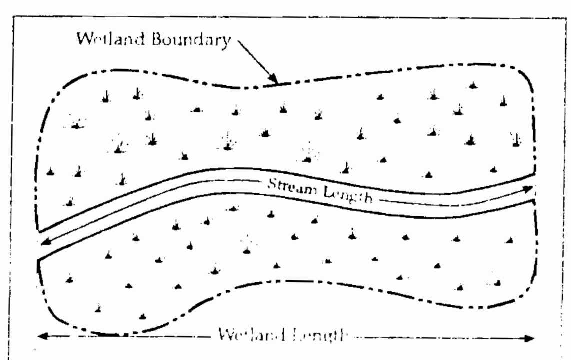
Range of Conditions

- High stream length /wetland length ratio: >0.67
- Moderate stream length /wetland length ratio: 0.33-0.66
- Low stream length /wetland length ratio: <0.33

Types of Stream Sinuosity



High Sinuosity



Low Sinuosity

PRESENCE OF ISLANDS

Definition

Islands are areas of solid land occurring within bodies of open water or areas of upland habitat occurring in palustrine habitat.

Discussion

Islands can be natural or man-made, surrounded by shallow to relatively deep water, they may be barren or vegetated by wetland or upland plants.

Inventory Methods

Presence or absence of islands is readily determined from aerial photos or USGS maps. The WRA NWI Wetland data layer may show some upland islands within a wetland.

Range of Conditions

- present
- absent

STEM DENSITY

Definition

The number of plant stems per unit area.

Discussion

Stem density offers resistance to water flow through the wetland, adding to the surface roughness. This decreases water flow velocity and results in sedimentation. Stem density is an indicator of root mass which offers resistance to erosion.

Inventory Methods

Stem density is best assessed in the field but may be assessed using aerial photographs.

STEM DENSITY-*CONTINUED*

Range of Conditions

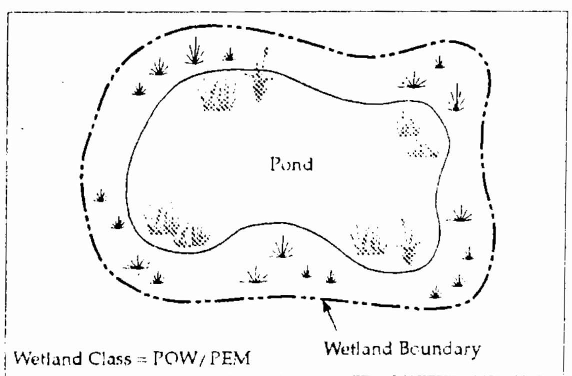
- High
- Moderate
- Low

Definitions:
High Density-Stem density in the form of woody or emergent vegetation that covers the entire wetland with little/no open water or bare ground surface present. Can only be determined accurately during the growing season.

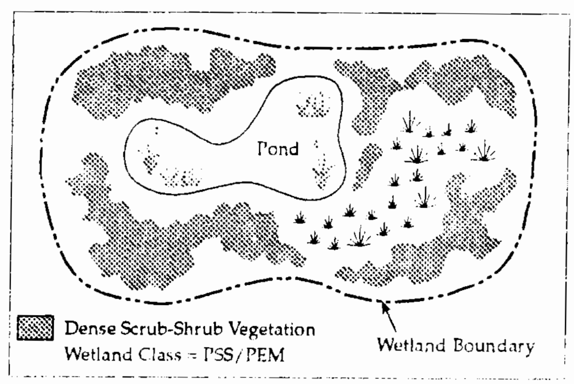
Low Density-Stem density in the form of woody or emergent vegetation that is sparsely distributed throughout the wetland due to large amounts of open water or bare ground surface.

Moderate Density-Stem density that covers the wetland in a condition between high and low density.

Types of Stem Density



Low Stem Density



High Stem Density

ADJACENT TO FISH HABITAT

Definition

Wetland touches open water which contains know fish habitat.

Discussion

Wetland habitat provides a variety of habitats and uses for fish, such as spawning, escape, feeding, and resting habitats. Wetlands provide detritus and insect food sources for the fish food web. Vegetation provides shade and modifies water quality.

Inventory Methods

Existing fisheries publication are reviewed concerning the lacustrine or riverine habitats adjacent to the wetland assessment area.

Range of Conditions

- Anadromous or Catadromous fish
- Cold water fish
- Warm water fish
- No fish present

Definitions:

Anadromous Fish- Migratory fish that are spawned in fresh water and return to salt water to reach adulthood.

Catadromous Fish- Migratory fish that are spawned in salt water and return to freshwater to reach adulthood.

Cold Water Fish- Fish indigenous to cold water habitat- including Salmonids (trout).

Warm Water Fish- Fish indigenous to warm water habitat.

HABITAT FOR LISTED RARE, ENDANGERED OR THREATENED SPECIES

Definition

The wetland provides habitat for species listed by the Natural Heritage Program as rare, threatened, or endangered.

Discussion

Wetlands may be habitat for rare endangered or threatened vegetation or wildlife species. Commonly the life cycle requirements of listed species are associated with the unique wetland processes which create habitats for listed species.

Inventory Methods

Data is obtained from the habitat maps of the State's Natural Heritage Program.

Range of Conditions

- No listed species present
- Listed species present

ADJACENT TO UNDISTURBED UPLAND HABITAT

Definition

Undisturbed upland habitat is habitat that has a benign, non-consumptive land use, where a natural vegetative community exists. A wetland which is adjacent to undisturbed upland habitat touches that habitat. Non-consumptive land use is any land with a natural vegetative community cover.

Discussion

Many wetland wildlife species require upland habitat for their life cycles. Undisturbed upland habitat adjacent to a wetland is ecologically interconnected to the wetland, increasing the wetland's wildlife habitat function.

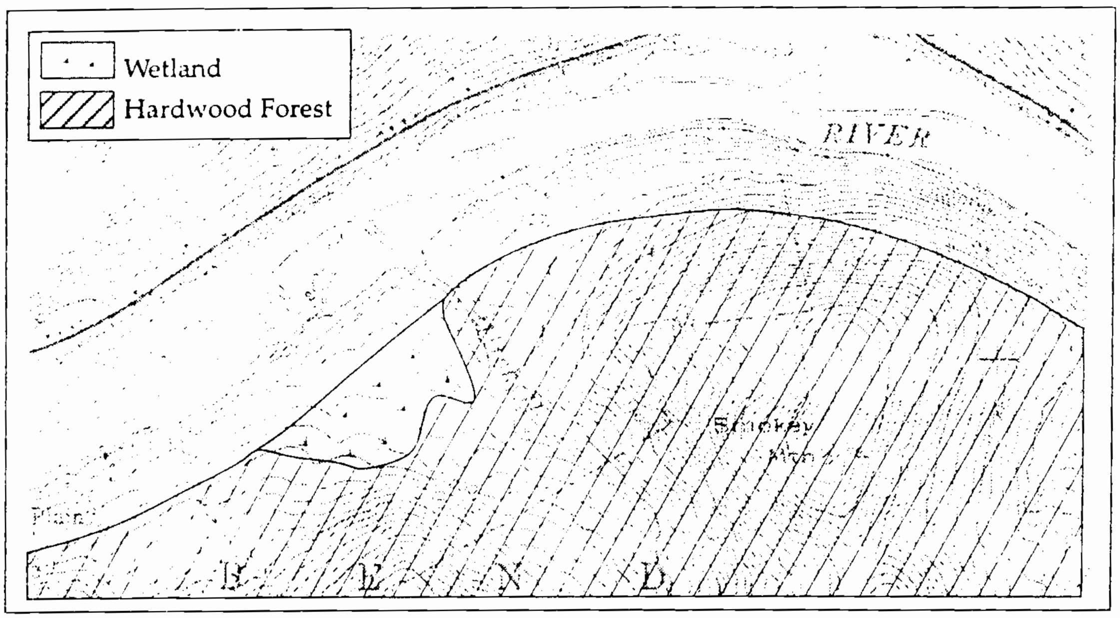
Inventory Methods

Aerial photographs, orthophoto 1/4 quads. and the MOP Land Use data layer can be used as sources for determining adjacent habitat. The best source is a field inspection.

ADJACENT TO UNDISTURBED UPLAND HABITAT-*CONTINUED*

Range of Conditions

- Present
- Not present



Example of a wetland that is adjacent to an undisturbed upland habitat.
The wetland is ecologically interconnected to the undisturbed upland.

ADJACENT TO DESIGNATED UPLAND WILDLIFE HABITAT

Definition

Designated upland wildlife habitat is land which is preserved and managed as a wildlife refuge or game management area by a state or federal agency or private organization such as Audubon.

Discussion

Wetland wildlife species may have life cycles that require upland habitat. Wetlands adjacent to upland habitat may have greater functional capacity.

ADJACENT TO DESIGNATED UPLAND WILDLIFE HABITAT-*CONTINUED*

Inventory Methods

Data sources designated upland wildlife habitat include the following data layers:

- PLG MDE Properties
- PLG County Open Space Properties
- PLG Private Conservation Organization Properties
- PLG Reservoir Properties
- PLG NHP Natural Areas

Also county tax maps show property ownership and can be used to identify designated open space.

Range of Conditions

- Adjacent
- Not adjacent

CONNECTED TO WILDLIFE CORRIDOR

Definition

A wildlife corridor is a vegetated wetland or upland which wildlife use to move from one habitat type to another for life cycle purposes, such as feeding, watering, or resting. Wetlands are connected to a wildlife corridor if they touch or are part of the corridor.

Discussion

Corridors are commonly linear features along a stream, a interconnected series of wetlands creating a landscape network which wildlife use for movement for various life cycle purposes. Deer, for example, commonly follow riparian wetland systems when moving from feeding to resting areas.

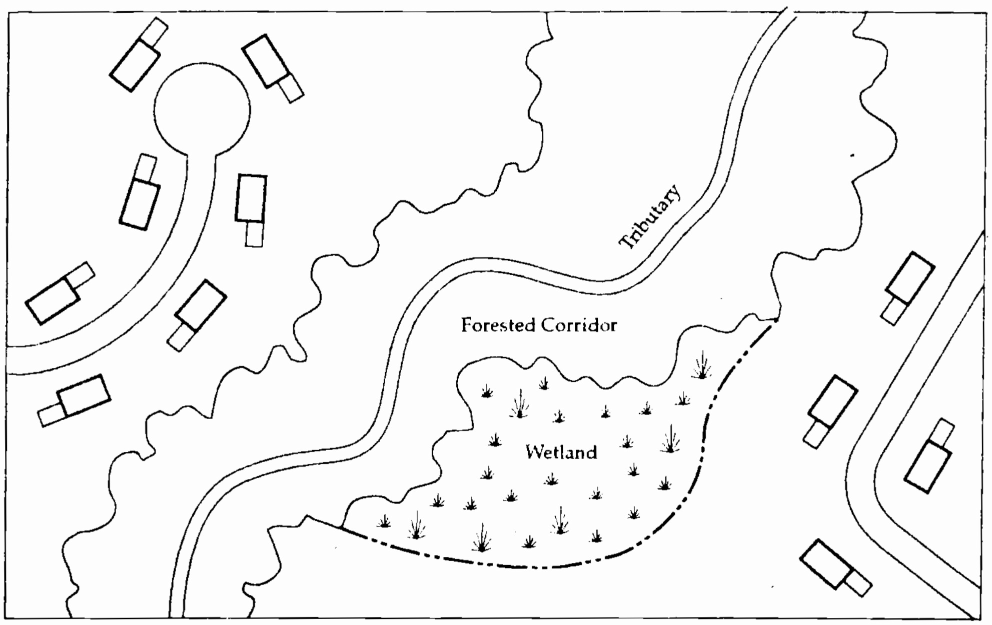
Inventory Methods

Field observations are necessary to observe various wildlife tracks and trails which establish use of the wetland as a wildlife corridor.

CONNECTED TO WILDLIFE CORRIDOR-*CONTINUED*

Range of Conditions

- Is a wildlife corridor
- Is not a wildlife corridor



Example of a wetland that is connected to a forested wildlife corridor located between two housing developments.

4.0 INVENTORY SHEET

The following four-page form is the inventory data sheet to be completed as part of the field investigation process.

WETLAND INVENTORY DATA

Project Name: ______________________________ Date: ______________________________

.land Number: ______________________________ Investigators: ______________________________

Cowardin Class: ______________________________ Area: ______________________________

______________________________ Area: ______________________________

______________________________ Area: ______________________________

______________________________ Total Area: ______________________________

Hydrogeomorphic Class

- ☐ Depressional
- ☐ Slope
- ☐ Lacustrine Fringe
- ☐ Riverine
- ☐ Mosaic

Dominant Vegetation Type Palustrine

- ☐ **Aquatic Bed**
  - ☐ Algal
  - ☐ Aquatic Moss
  - ☐ Rooted Vascular
  - ☐ Floating Vascular
  - ☐ Unknown Submergent
  - ☐ Unknown Surface
- ☐ **Emergent**
  - ☐ Persistent
  - ☐ Nonpersistent
- ☐ **Open Water**
- ☐ **Shrub/Scrub**
  - ☐ Broad-leaved Deciduous
  - ☐ Needle-leaved Deciduous
  - ☐ Broad-leaved Evergreen
  - ☐ Needle-leaved Evergreen
  - ☐ Dead
- ☐ **Forested**
  - ☐ Broad-leaved Deciduous
  - ☐ Needle-leaved Deciduous
  - ☐ Broad-leaved Evergreen
  - ☐ Needle-leaved Evergreen
  - ☐ Dead

Water Regime

Temporarily Flooded
Saturated
Seasonally Flooded
Semi Permanently Flooded
Intermittently Exposed
Permanently Flooded
Intermittently Flooded
Artificially Flooded

LANDSCAPE VARIABLES

Size
- ☐ > 100 acres
- ☐ 10 - 100 acres
- ☐ < 10 acres

Wetland Juxtaposition
- ☐ Connected upstream and downstream
- ☐ Only connected above
- ☐ Only connected below
- ☐ Other wetlands nearby but not connected
- ☐ Wetland isolated

Watershed Land Use
- ☐ > 90% of two or more non-urban cover types
- ☐ 50-90% of one or more; >90% of non-urban cover type
- ☐ < 50% of one or more of non-urban cover types

Regional Scarcity of Wetland Vegetation Type
- ☐ Not scarce
- ☐ Scarce

Wetland's Land Use
- ☐ High intensity
- ☐ Moderate intensity
- ☐ Low intensity

Topographic Position of Wetland in the Watershed
- ☐ Isolated
- ☐ Headwater (order 1 & 2)
- ☐ Lower reach (order 3 and above)

Is the Wetland a Fragment of a Once Larger and Complete Wetland?
- ☐ Yes
- ☐ No

HYDROLOGIC VARIABLES

Surface Water Level Fluctuation of Wetland
- ☐ High
- ☐ Low
- ☐ No fluctuation

Surface Hydrologic Water Connection
- ☐ Not connected
- ☐ Connected to an intermittent stream
- ☐ Connected to a perennial stream or river
- ☐ Connected to a lake

Nested Piezometer Data
- ☐ Recharge condition
- ☐ Discharge condition
- ☐ Horizontal flow

Relationship of Wetland's Substrate to Regional Potentiometric Surface
- ☐ Piezometric surface above wetland substrate
- ☐ Piezometric surface below wetland substrate

Water Regime
- ☐ Wet regimes
- ☐ Dry regimes

Water Chemistry
- ☐ Fresh < 800 µ Mos

pH
- ☐ Acid < 5.5
- ☐ Circumneutral 5.5 - 7.4
- ☐ Alkaline > 7.4

Surficial Geologic Deposit Under Wetland
- ☐ Low permeability deposits
- ☐ High permeability deposits

Basin Topographic Gradient
- ☐ High gradient > 2%
- ☐ Low gradient 2% or less

Degree of Outlet Restriction
- ☐ Restricted outlet
- ☐ Unrestricted outlet

Ratio of Wetland Area to Watershed Area
- ☐ Large > 10%
- ☐ Small 10% or less

Microrelief of Wetland
- ☐ Pronounced > 45 cm
- ☐ Well developed 15-45 cm
- ☐ Poorly developed < 15 cm

Does the Wetland Occur at the Base of a Steep Slope?
- ☐ Yes
- ☐ No

Is the Wetland Adjacent to or Part of a Critical Area of Special Concern?
- ☐ Yes
- ☐ No

Wetland Occurrence at Base of Steep Slope
- ☐ Does occur
- ☐ Does not occur

Evidence of Springs and Seeps

- ☐ No seeps or springs
- ☐ Seeps only
- Perennial spring
- ☐ Intermittent spring

Wet Regime Within a Drier Regime

- ☐ Yes
- ☐ No

Evidence of Sedimentation

- ☐ No evidence observed
- ☐ Sediment observed on Wetland Substrate
- ☐ Fluviquent soil present

Frequency of Overbank Flooding

- ☐ High 5 or less years
- ☐ Moderate 6 to 20 years
- ☐ Low > 20 years to 100 years

Potential for Overland Flows From Surrounding Upland

- ☐ High potential > 100 acres
- ☐ Low potential 100 or less

.t - Outlet Class

- ☐ No inlet - no outlet
- ☐ No inlet - intermittent outlet
- ☐ No inlet - perennial outlet
- ☐ Intermittent inlet - no outlet
- ☐ Intermittent inlet - intermittent outlet
- ☐ Intermittent inlet - perennial outlet
- ☐ Perennial inlet - no outlet
- ☐ Perennial inlet - intermittent outlet
- ☐ Perennial inlet - perennial outlet

Is the Wetland Associated With an Incised Stream Channel?

- ☐ Yes
- ☐ No

Does the Wetland Occur Downstream of an Urbanized Area?

- ☐ Yes
- ☐ No

Does the Stream Channel Within the Wetland Have Blockages Such as Debris, Dams?

- Yes
- No

Is the Wetland Ditched

- ☐ Yes
- ☐ No

Is the Wetland a Buffer for a Stream, River or Lake?

- ☐ Yes
- ☐ No

Is the Wetland Adjacent to a Water Body?

- ☐ Yes
- ☐ No

SOIL VARIABLES

Soil Type Histol

- ☐ Fibric
- ☐ Hemic
- ☐ Sapric

Mineral Hydric Soil

- ☐ Gravely
- ☐ Silty
- ☐ Sandy
- ☐ Clayey

VEGETATIVE VARIABLES

Dominant Wetland Type

Forested Wetland

Evergreen

- ☐ Needle-leaved

Deciduous

- ☐ Broad-leaved
- ☐ Needle-leaved

Scrub Shrub

Evergreen

- ☐ Needle-leaved

Deciduous

- ☐ Needle-leaved
- ☐ Broad-leaved

Emergent Wetland

- ☐ Persistent
- ☐ Non-persistent

Aquatic Bed

- ☐ No Vegetation

Number of Wetland Types

- ☐ >5
- ☐ 5
- ☐ 4
- ☐ 3
- ☐ 2
- ☐ 1
- ☐ No Vegetation

Number of Layers and Percent Cover
- ☐ Layer 1 submergents
- ☐ Layer 2 floating
- ☐ Layer 3 mosses and lichens
- ☐ Layer 4 short herbs (< 1m)
- ☐ Layer 5 tall herbs (≥ 1m)
- ☐ Layer 6 dwarf shrubs (< 0.5m)
- ☐ Layer 7 short shrubs (0.5-2m)
- ☐ Layer 8 talls shrubs (> 2-4m)
- ☐ Layer 9 saplings (> 4-5m)
- ☐ Layer 10 trees (≥ 6m)
- ☐ No Vegetation

Plant Species and Percent Cover by Layer
- ☐ 1 dominant species
- ☐ 2 codominant species
- ☐ 3 codominant species
- ☐ No Vegetation

Cover Distribution
- ☐ Continuous cover
- ☐ Small scattered patches
- ☐ One or more large patches with portions of the site open
- ☐ Solitary, scattered stems

Dead Plant Material
- ☐ Abundant
- ☐ Moderately abundant
- ☐ Low abundance
- ☐ None

Interspersion of Vegetation Cover and Open Water
- ☐ Scattered cover
- ☐ Complete cover
- ☐ Peripheral cover
- ☐ Complete open water

Shoreline/Wetland Length Ratio
- ☐ Low (.67 and higher)
- ☐ Medium (.33 to .66)
- ☐ High (less than .33)

Wetland Edge Complexity
- ☐ High convoluted
- ☐ Low level of convolution

Is the Wetland Part of a Known Wildlife Corridor?
- ☐ Yes
- ☐ No

Adjacent to Known Upland Wildlife Habitat
- ☐ Adjacent
- ☐ Not Adjacent

Evenness Distribution
- ☐ Even distribution
- ☐ Moderately even distribution
- ☐ Highly uneven distribution
- ☐ No Vegetation

Vegetative Interspersion
- ☐ High
- ☐ Moderate
- ☐ Low

Number of Layers
- ☐ >5
- ☐ 5
- ☐ 4
- ☐ 3
- ☐ 2
- ☐ 1
- ☐ No Vegetation

Stream Sinuosity
- ☐ SL/WL > 0.67
- ☐ SL/WL 0.33 - 0.66
- ☐ SL/WL <0.33
- ☐ No Stream

Presence of Islands
- ☐ Present
- ☐ Absent

Stem Density
- ☐ High
- ☐ Moderate
- ☐ Low
- ☐ No Vegetation

Adjacent to Fish Habitat
- ☐ Andromous or Catadromous
- ☐ Cold water fish
- ☐ Warm water fish
- ☐ No fish present

Habitat for Listed Species
- ☐ No listed species
- ☐ Listed species present

Does the Wetland Occur Adjacent to a Relatively Undisturbed Upland Habitat?
- ☐ Yes
- ☐ No

5.0 FIELD METHOD WETLAND FUNCTIONAL ASSESSMENT MODELS

The following models shown on Figures 19 through 24 are used for the assessment of Maryland's eight statutory functions. The method combines the assignment of numerical scores to scale variable conditions as used by Golet and Larson (1974) and others with a landscape assessment method of using indices similar to Ammann, et al. (1991), Liebowitz, et al. (1993), and Smith, et al. (1995).

The models consist of a list of indicators which are assumed, in combination, to give rise to sustainable function. Each indicator contains a range of conditions which are scaled from that which is assumed to provide the least function, to the condition which gives the most function.

Values are assigned to each condition, which gives robustness to the models. A condition which indicates no contribution to function is given a zero. As the conditions progressively increase in indicator status, a higher number is assigned. For example, if these conditions occur, they will range from 1 for the one having lesser indicator status to 3 for the one having the most indicator status. If the range of conditions is a simple "Yes" or "No", the "No" gets a zero and the "Yes" a 1, 2, or 3 based on professional judgement.

The total model score is divided by the maximum possible score (assumed to equal the maximum sustainable function) to produce a functional capacity index, with the maximum sustainable function capacity equaling 1.00. This is the function capacity index for a unit area of wetland.

The function capacity index is multiplied by the area of the wetland to produce the wetland's functional capacity. The functional capacity for each of the six functions can be added to produce a total functional capacity for the wetland.

FIGURE 19

GROUND WATER DISCHARGE FUNCTION (FIELD METHOD)

Indicator #1

Does the wetland contain any direct indicators of dysfunction?

- perennial inlet/no outlet
- nested piezometers show recharge condition
- wetland surface elevation is above potentiometric surface

1 Query Data Base

Yes: Stop, wetland does not have this function:
Score = 0

No: Dysfunction is not proven, proceed to next step.

Indicator #2

Does the wetland contain any direct indicators of function?

- presence of perennial seeps or springs
- nested piezometers show discharge condition
- wetland surface elevation below potentiometric surface
- no inlet/perennial outlet

2 Query Data Base

Yes: Stop, wetland has this function:
Score = 27

No: Proceed to primary indicators.

Indicator #3

Is the wetland soil a histosol?

3 Query Data Base

Yes:
Score = 3

No:
Score = 0

Indicators of Dysfunction

There are three variable conditions that, if present indicate that the wetland does not perform this function:

- Perennial inlet/no outlet
- Nested piezometers data show recharge
- Wetland substrate elevation is above potentiometric surface

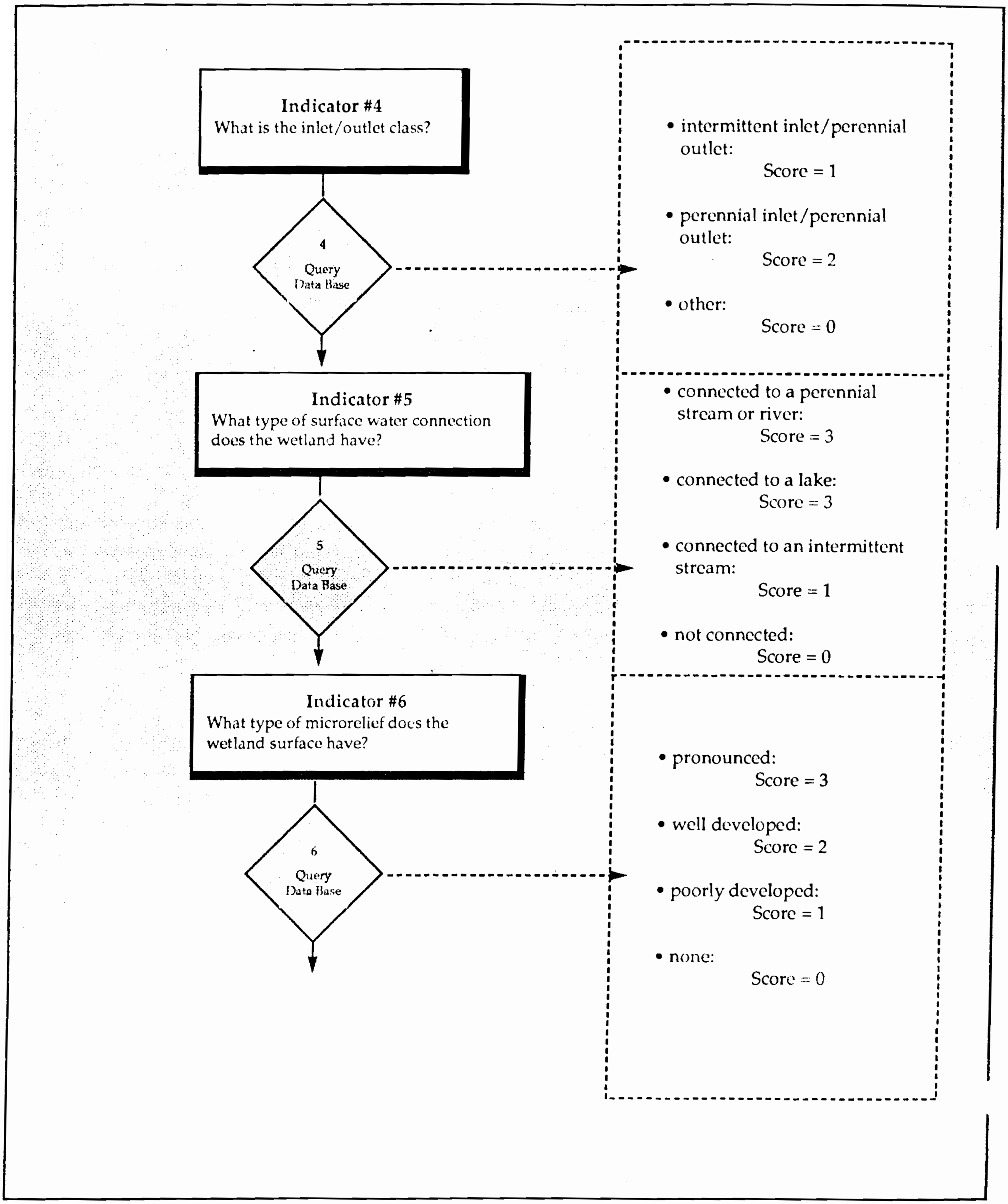
Direct Indicators of Function

There are four direct indicators of this function which, if present, circumvent the need to evaluate the function by evaluating the other variables, these are; no inlet-perennial outlet, evidence of perennial seeps and springs, wetland substrate elevation below potentiometric surface, and nested piezometers data showing discharge. All of these are absolute indicators of function and are assumed to indicate the maximum sustainable functional capacity, which yields a score of 27 for the field method and a score of 22 for the desk top method.

Soil Type

Ground water discharge areas generally contain histosols (soils with high organic content) because the constant swelling of ground water allows for anaerobic conditions to persist throughout the year, which allows for the accumulation of organics. Histosols, therefore, are more likely to indicate the presence of ground water discharge to streams than are mineral hydric soils. Histosols are assigned a score of 3. The lack of histosol (or the presence of mineral hydric soils) is more indicative of areas where recharge occurs since saturation does not occur long enough to create organics (histosols), and is assigned a score of zero.

FIGURE 19
GROUND WATER DISCHARGE FUNCTION (FIELD METHOD) (page 2 of 5)



Inlet/Outlet Class

Wetlands having a perennial inlet and a perennial outlet indicate that the wetland is in direct communication with the regional water table and is very likely to be a discharge area and is assigned a score of 2. Wetlands with an intermittent inlet and a perennial outlet are less likely to be a ground water discharge area and are assigned a score of 1.

Surface Water Connection Types

Large perennial streams, rivers and lakes are predominantly ground water discharge areas, directly connected to the water table and are assigned a score of 3. Intermittent streams are likely to be ground water discharge areas in the spring, when water tables are high and interflow is present. They are not likely to be discharge areas in the summer when water tables are low and the stream is dry. They are assigned a score of 1.

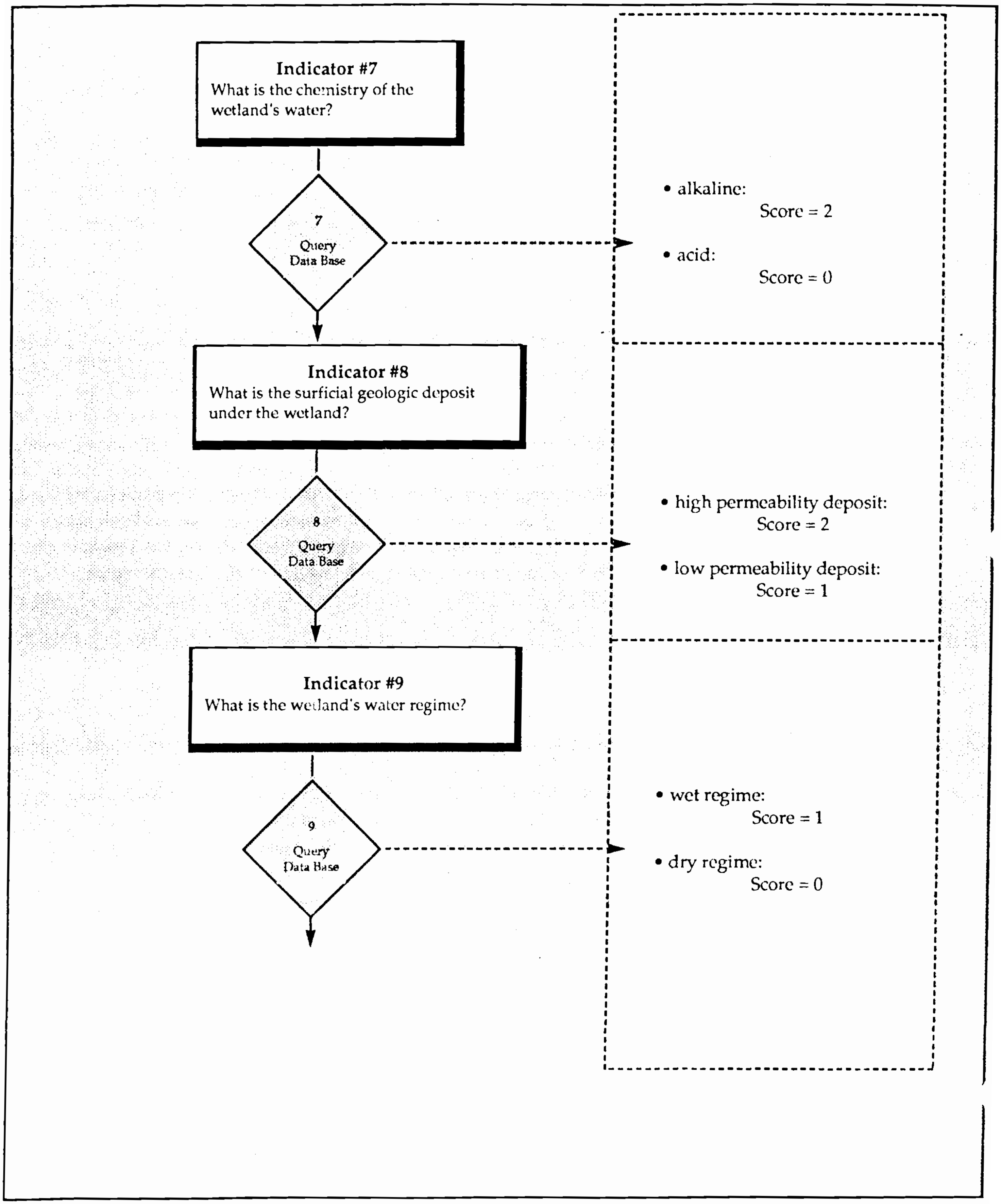
Microrelief of Wetland Surface

Wetlands having pronounced microrelief acquire this relief because they are wet throughout most of the growing season and the woody plants elevate their roots above the water table, creating mounds. Constant water in pools prevents woody plant growth. This indicates a water table near the wetland surface for much, if not all, of the growing season predominantly indicative of ground water discharge. This is believed to be the maximum sustainable condition and is assigned a 3. Wetlands with poorly developed microrelief are less indicative of ground water discharge are assigned a score of 1. Well developed microrelief is intermediate and assigned a 2.

Range of Conditions:

- Pronounced: > 45 cm
- Well Developed: 15-45 cm
- Poorly Developed: < 15 cm

FIGURE 19
GROUND WATER DISCHARGE FUNCTION (FIELD METHOD) (page 3 of 5)



Wetland Water Chemistry

Ground water is alkaline, high in mineral content and has a high conductivity. Wetlands having alkaline water chemistry are likely to be ground water discharge areas and are assigned a score of 2. Wetlands with acid water chemistry are likely to have water budgets driven predominantly by precipitation and will be low in mineral content and have a low conductivity. These wetlands are not likely to be ground water discharge areas and are assigned a score of zero.

Range of Conditions:

- Acid: <5.5
- Circumneutral: 5.5 - 7.4
- Alkaline: > 7.4

Surficial Geologic Deposit Under the Wetlands

Wetlands associated with high permeability surficial geologic deposits are likely to be discharge areas, since these types of deposits predominantly have a gently sloping water table, the upland is a primary recharge area and wetlands occur where topographic lows intersect the nearly flat regional water tables. These wetlands are assigned a score of 2. Low permeability geologic deposits are less likely to have a gently sloping water table, less likely to have uplands which are a regional recharge area and, therefore, their wetlands are less likely to be discharge areas and are assigned a score of 1.

Wetland Water Regime

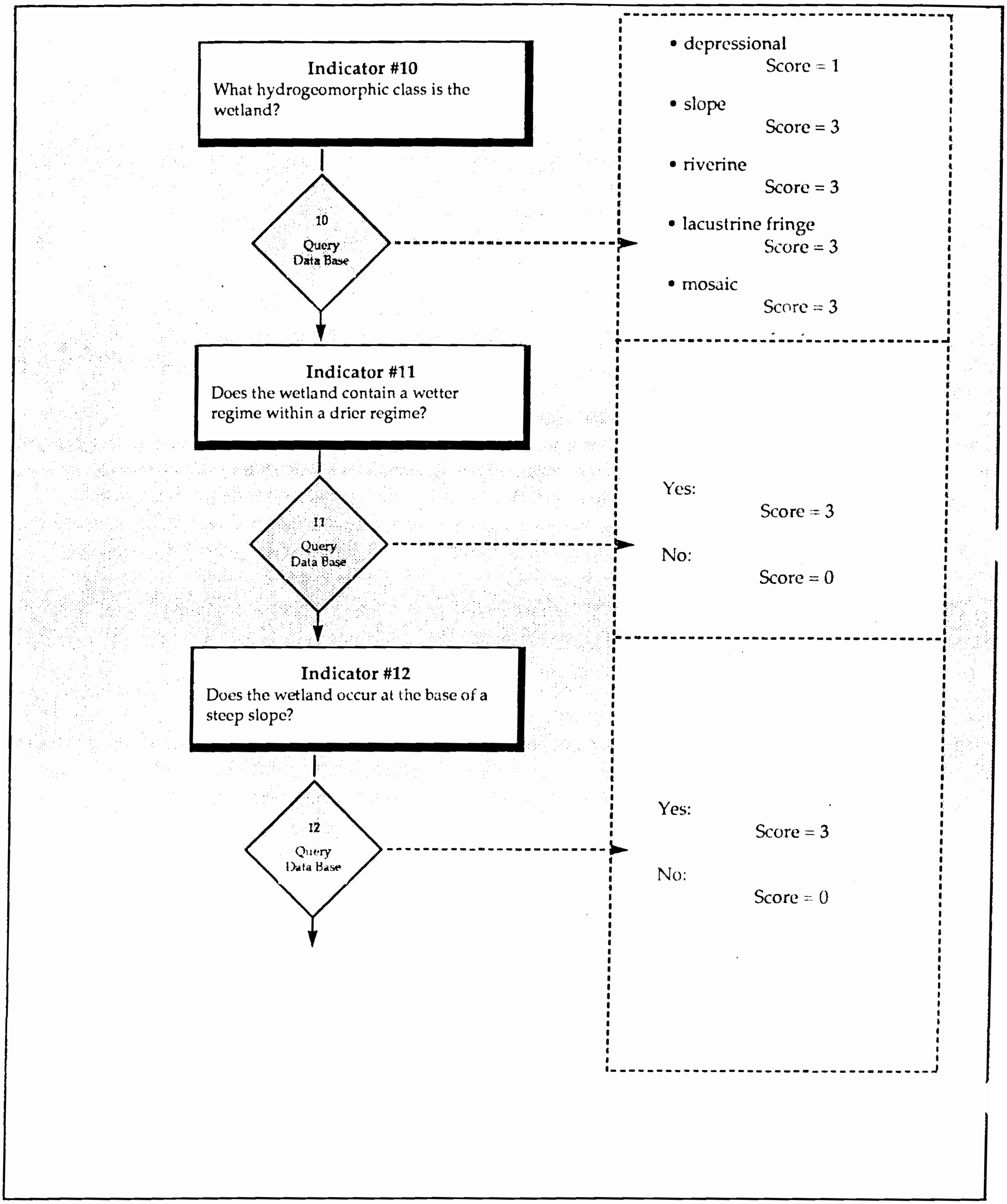
Wet water regimes indicate the presence of saturated or inundated conditions for the majority of the growing season and are more likely to be discharge areas than are drier water regimes. They are assigned a score of 1 and drier regimes a zero.

Wet Water Regimes: Vegetative communities which are tolerant of permanently flooded, intermittently exposed, and semi-permanently flooded (i.e. aquatic bed, marsh) conditions.

Dry Water Regimes: Vegetative communities which are indicative of seasonally flooded, temporarily flooded, and saturated (i.e. wet meadow, scrub-shrub, forested wetland) conditions.

FIGURE 19

GROUND WATER DISCHARGE FUNCTION (FIELD METHOD) (page 4 of 5)



Hydrogeomorphic Class

Slope, riverine, lacustrine fringe and mosaic wetlands all are likely to be ground water discharge areas because they are generally associated with the regional table, and are all assigned a score of 3. Depressional wetlands are most likely to be recharge areas, where water is trapped and allowed to seep into the water table, but occasionally may be discharge areas, and are assigned a score of 1.

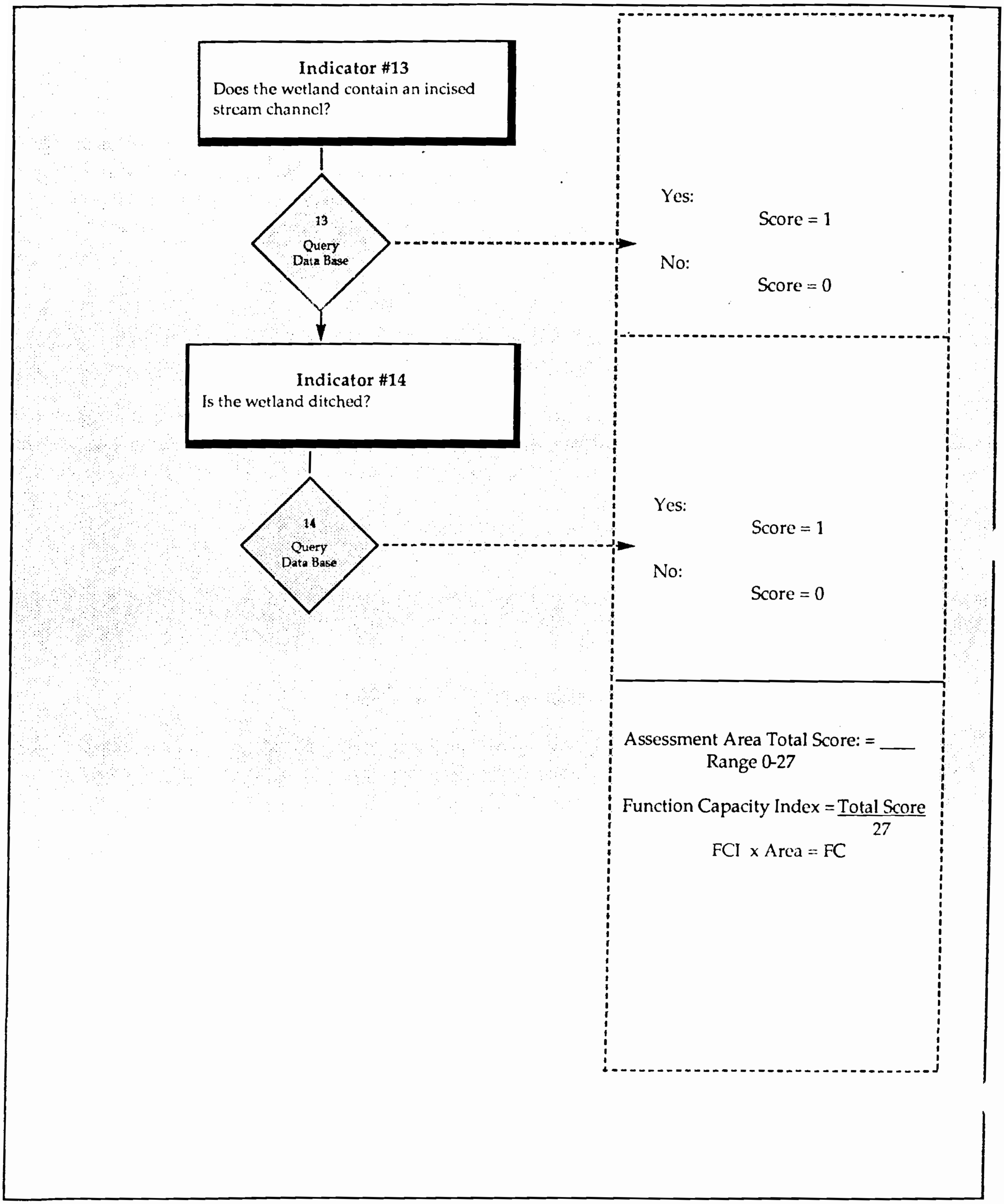
Occurrence of a Wetter Hydrologic Regime within a Drier Regime

The occurrence of a wetter hydrologic regime within a wetland dominated by a drier regime may indicate that a seep or spring occurs in the wetter regime area, indicating ground water discharge, and is assigned a score of 3.

Occurrence of the Wetland at the Base of a Steep Slope

Wetlands commonly occur where the water table intersects the land surface, which commonly occurs at the base of a steep slope. Wetlands occurring at the base of a steep slope are assumed to be ground water discharge areas and are assigned a score of 3.

FIGURE 19
GROUND WATER DISCHARGE FUNCTION (FIELD METHOD) (page 5 of 5)



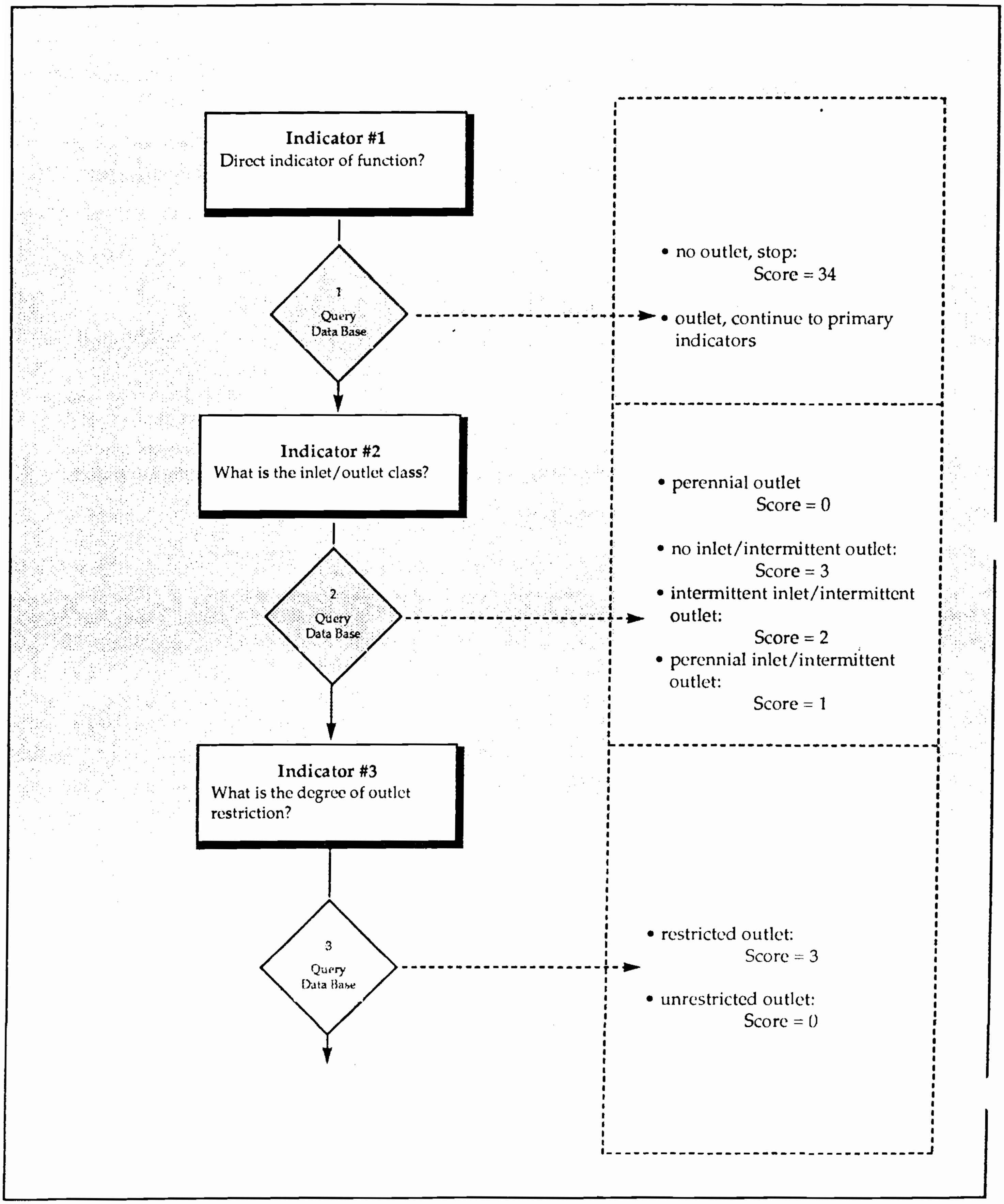
Presence of an Incised Stream Channel

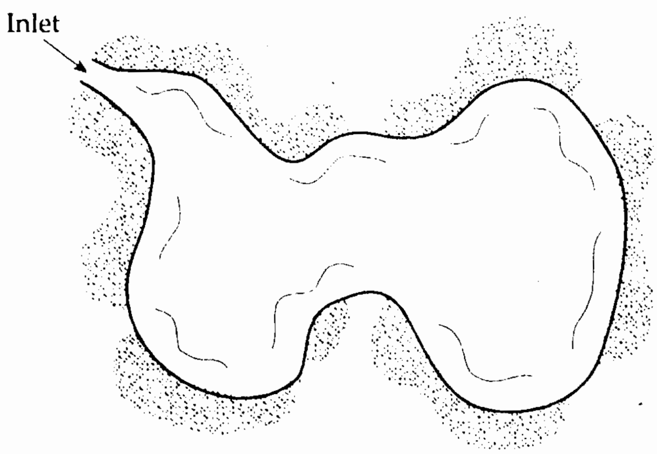
Stream channels incised into a wetland are assumed to intersect the wetland's water table which discharges into the stream channel. Presence of an incised stream channel is assigned a score of 1.

Occurrence of Ditches

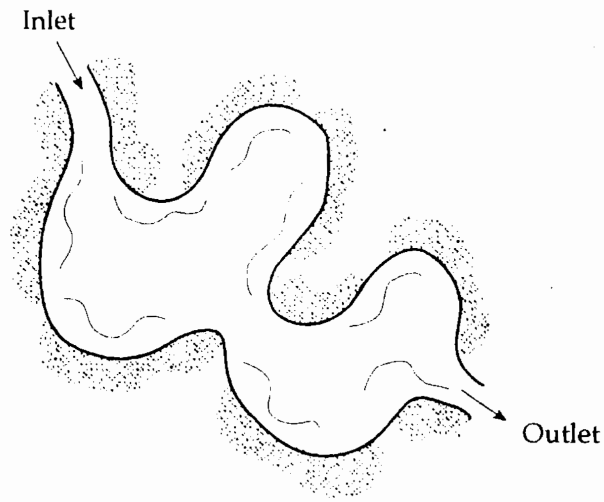
Ditches are dug to drain wetlands so that land use activities can occur, such as agriculture. It is assumed that these ditches lower the water table in the wetland, therefore, discharging ground water into the ditches. Wetlands with ditches are assumed to be more likely to be discharge areas and are assigned a score of 1.

FIGURE 20
FLOOD FLOW ATTENUATION MODEL (FIELD METHOD)





Wetland with no outlet



Wetland with outlet

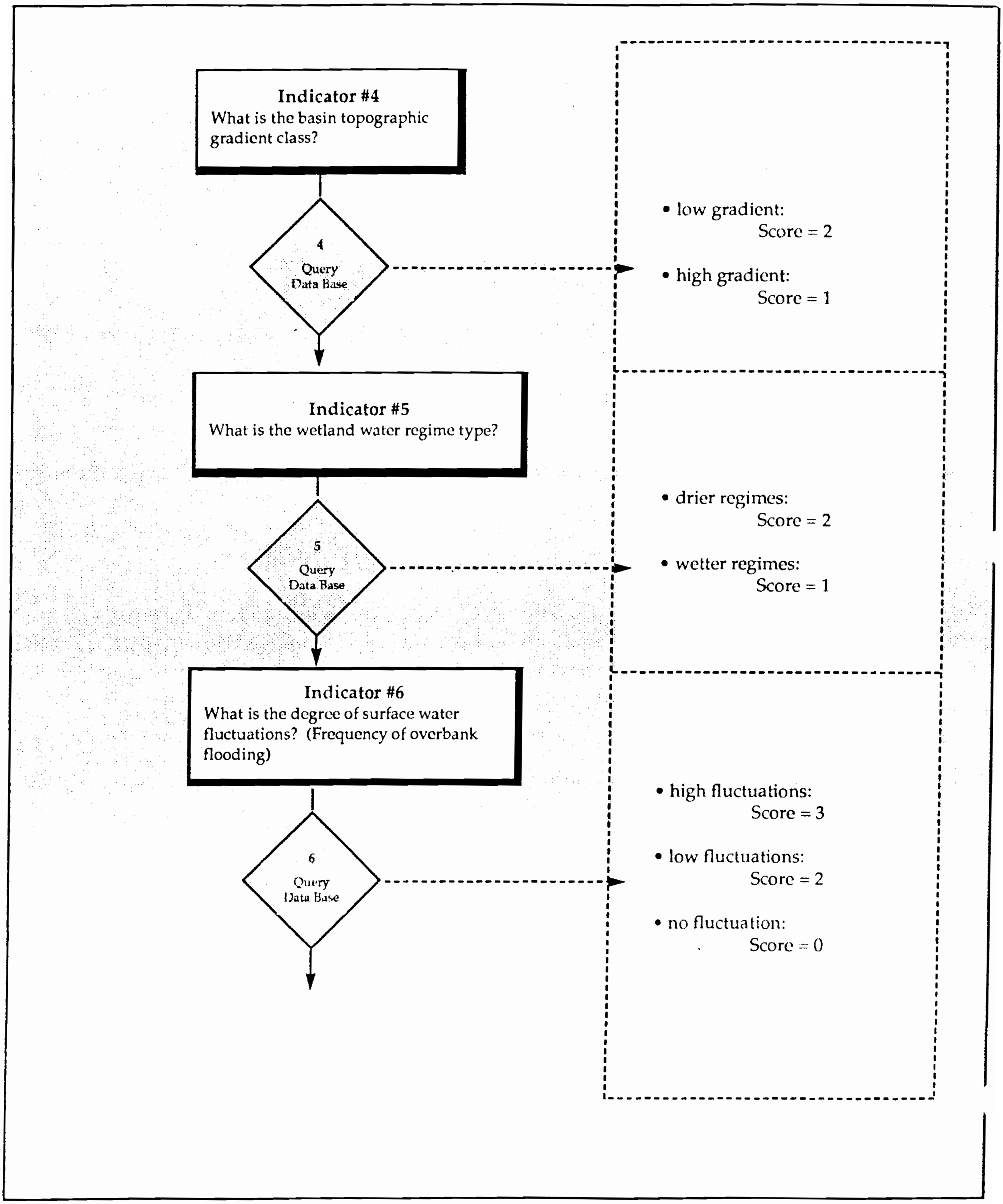
Inlet/Outlet Class

Wetlands with no outlet provide the highest capacity for flood flow attenuation because they store all water that flows into their basin. The condition of no outlet is considered in the model to be a direct indicator of this function and receives a maximum score of 34. Wetlands with intermittent outlets have free board (storage volume) below the invert of their outlet between flood flows, which must be satisfied before outlet flow begins. This storage is likely to be greatest in wetlands having no inlet but an intermittent outlet and is assigned a score of 3. Wetlands with intermittent inlets or perennial inlets are progressively less likely to have free board available and are assigned a 2 and 1 respectively. Wetlands with perennial outlets do not have free board available and are assigned a zero.

Degree of Outlet Restriction

Restricted outlet conditions will result in increased flood stage levels within the wetland, when inflow exceeds the outlet's hydraulic capacity. Flood water will back up behind the restricted outlet, attenuating flood flow. Restricted outlets are assigned a score of 3. Unrestricted outlets do not result in increase flood stage within the wetland and no flood flow attenuation occurs as a result of outlet control. Unrestricted outlets are assigned a score of zero.

FIGURE 20
FLOOD FLOW ATTENUATION MODEL (FIELD METHOD)



Basin Topographic Gradient

The slope of the wetland basin surface is one factor which limits the amount of water that can be stored over the wetland surface. When all other factors are equal, the wetland with the lowest gradient will store the most flood water, and a low gradient is given the score of 2. High gradient wetlands are assigned a score of 1.

Range of Conditions:

- High gradient: > 2%
- Low gradient: < 2%

Wetland Water Regime Type

Wetlands with drier water regimes periodically are not inundated and their surfaces periodically or seasonally become unsaturated, allowing for water storage on and in the wetland substrate. They then have a low coefficient of runoff than wetter regimes which have a high coefficient of runoff. These wetlands are assigned a score of 2 while wetter regimes, which are permanently saturated or inundated are assigned a 1.

Wet Water Regimes: Vegetative communities which are tolerant of permanently flooded, intermittently exposed, and semi-permanently flooded (i.e. aquatic bed, march) conditions.

Dry Water Regimes: Vegetative communities which are indicative of seasonally flooded, temporarily flooded, and saturated (i.e. wet meadow, scrub-shrub, forested wetland) conditions.

Surface Water Fluctuations

Wetlands with high water level fluctuations illustrate that flood water is being stored and attenuated periodically in the wetland. The higher the fluctuation the more flood water being attenuated. High fluctuations are assigned a 3, low a 2, and no fluctuation a zero.

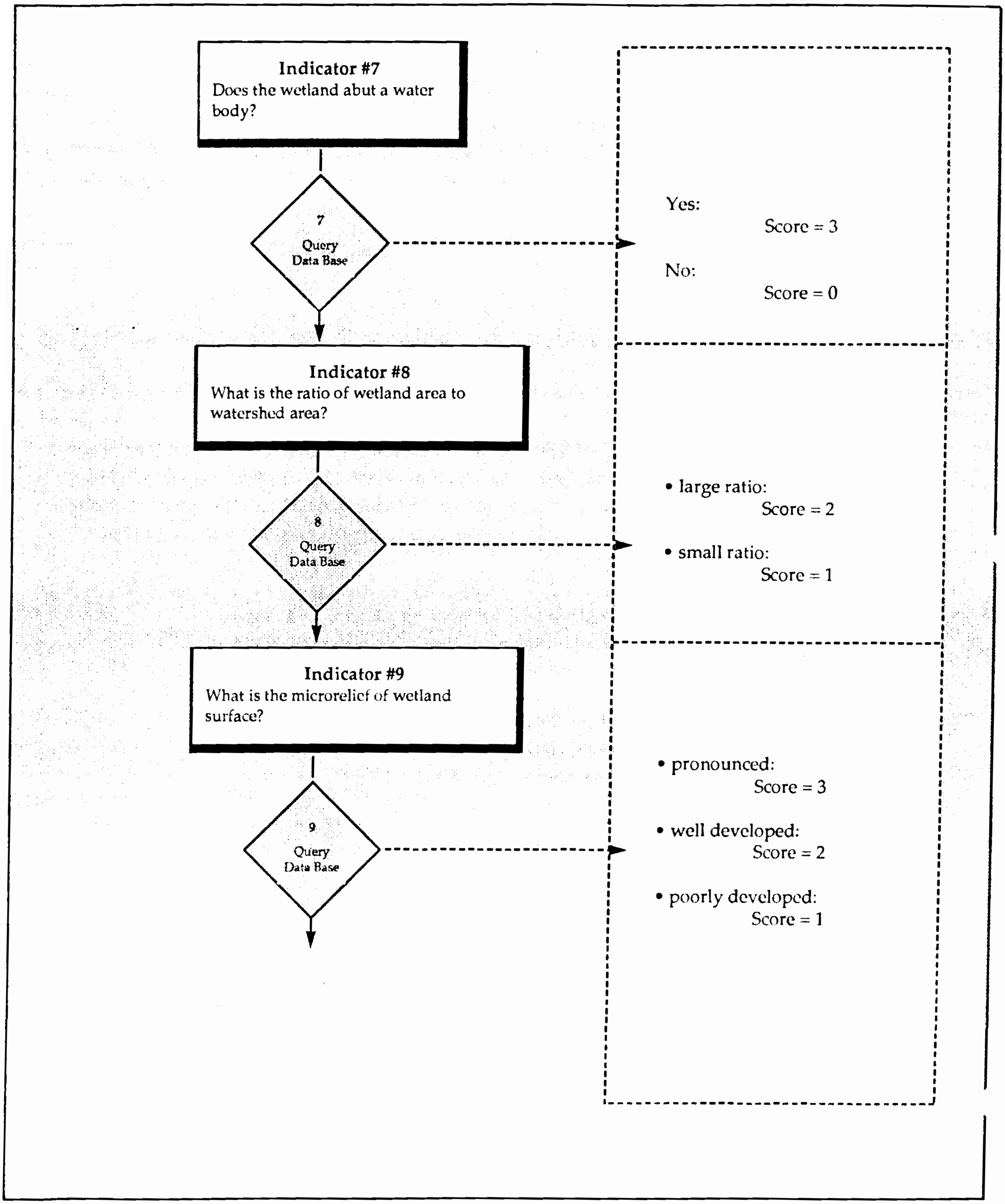
Indirect Physical Indicators of Flooding:

- silt stained leaves
- silt rings on stems
- ice marks on stems
- strand lines
- debris lines
- stain lines

Direct Indicators of Flooding:

water level gauges
FEMA/FIRM maps

FIGURE 20
FLOOD FLOW ATTENUATION MODEL (FIELD METHOD) (page 3 of 5)



Wetland Abuts a Water Body

Wetlands which abut water bodies are assumed to be discharge areas and are assigned a score of 3.

Ratio of Wetland Area to Wetland Watershed Area

When the watershed of two wetlands are equal and all other factors constant except wetland area, the larger wetland area can store and attenuate more flood flows than the smaller wetland area. Wetlands with a large ratio of wetland area to wetland watershed area are assigned a 2, while a low ratio is assigned a 1.

Range of Conditions:

- Large ratio: >10%
- Small ratio: <10 %

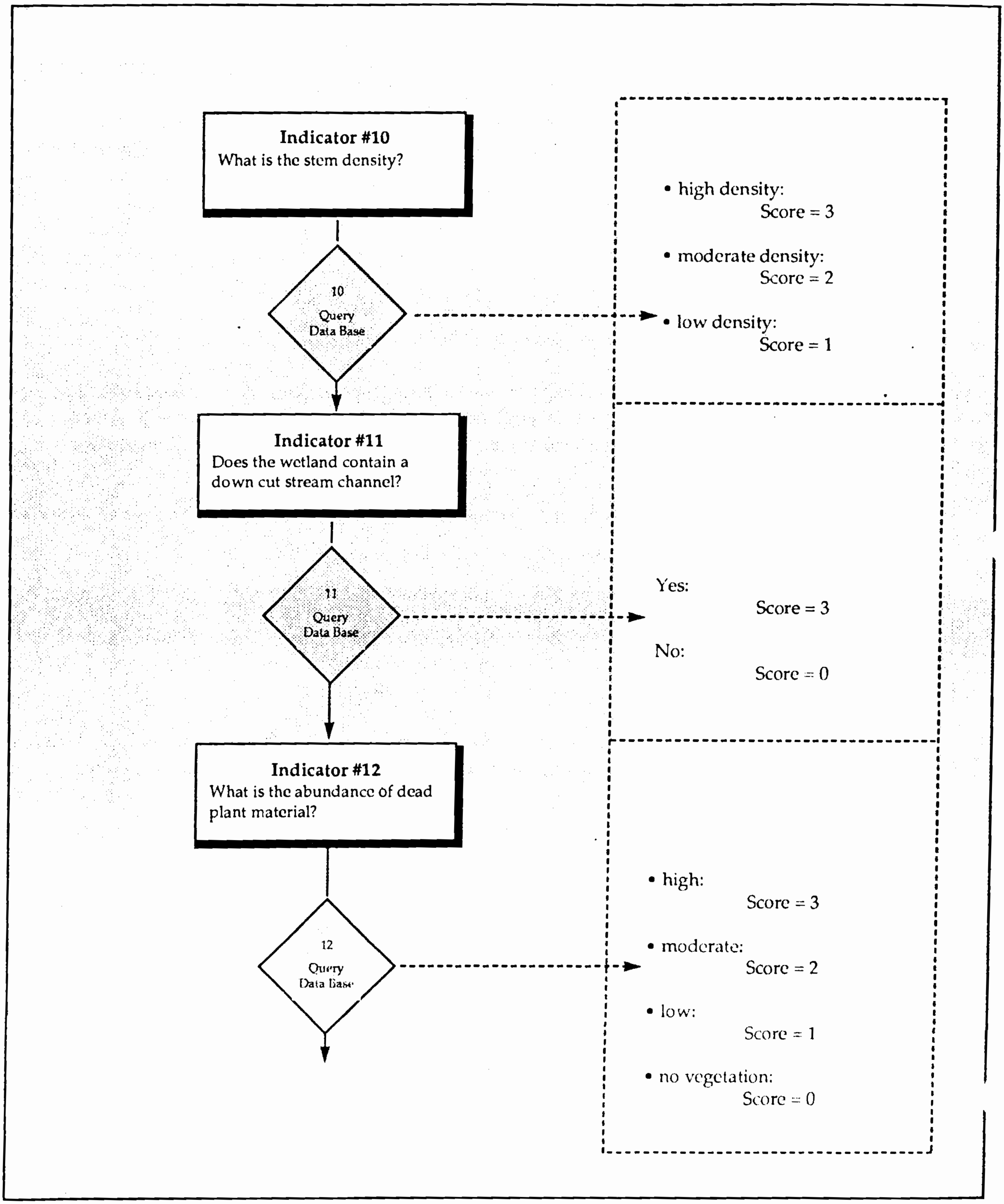
Microrelief of Wetland Surface

Microrelief serves two functions in attenuating flood flows. First it contains pools where water may be retained. Second, it offers roughness to flood flow through the wetland, helping slow down and detain flood flows. Wetlands with pronounced microrelief are assigned a 3, well developed a 2 and poorly developed a 1.

Range of Conditions:

- Pronounced: >45 cm
- Well Developed: 15-45 cm
- Poorly Developed: < 15 cm

FIGURE 20
FLOOD FLOW ATTENUATION MODEL (FIELD METHOD)



Stem Density

Stem density also offers roughness to the wetland surface, which reduces flood flow velocities through the wetland helping to detain flood flows. High stem density is assigned a score of 3, and low density 1.

Range of Conditions:

- High
- Medium
- Low

Definitions:

High Density: Stem density in the form of woody or emergent vegetation that covers the entire wetland with little/no open water or bare ground surface present.

Low Density: Stem density in the form of woody or emergent vegetation that is sparsely distributed throughout the wetland due to large amounts of open water or bare ground surface.

Moderate Density: Stem density whose distribution pattern is between the low and high conditions.

Incised Stream Channel

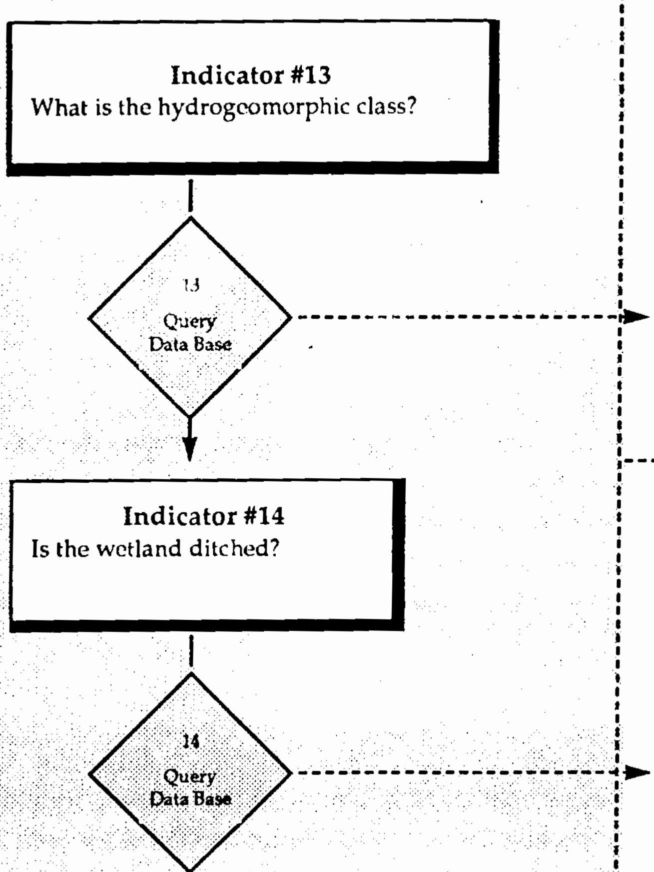
Wetlands that have incised (down cut) stream channels are less likely to receive overbank flooding from high frequency flood events than are wetlands with streams that are not incised. Wetlands without incised streams are given the score of 3, while those with incised stream channels are assigned a score of zero.

Abundance of Dead Plant Material

Dead plant material on the surface of a wetland adds to the roughness of the surface. Dead plant material is washed into debris dams which impedes the flow of water access to the wetland, reducing flow velocity and attenuating flood flows. High amounts of dead plant material is assigned a score of 3, moderate a score of 2, and low a 1.

FIGURE 20

FLOOD FLOW ATTENUATION MODEL (FIELD METHOD)



- depressional:
  Score = 4
- slope:
  Score = 1
- riverine:
  Score = 3
- lacustrine fringe:
  Score = 2
- mosaic:
  Score = 3

Yes:
Score = 0

No:
Score = 3

Assessment Area Total Score: = ____
Range 0-34

$$\text{Functional Capacity Index} = \frac{\text{Total Score}}{34}$$

FCI x Area = FC

Hydrogeomorphic Class

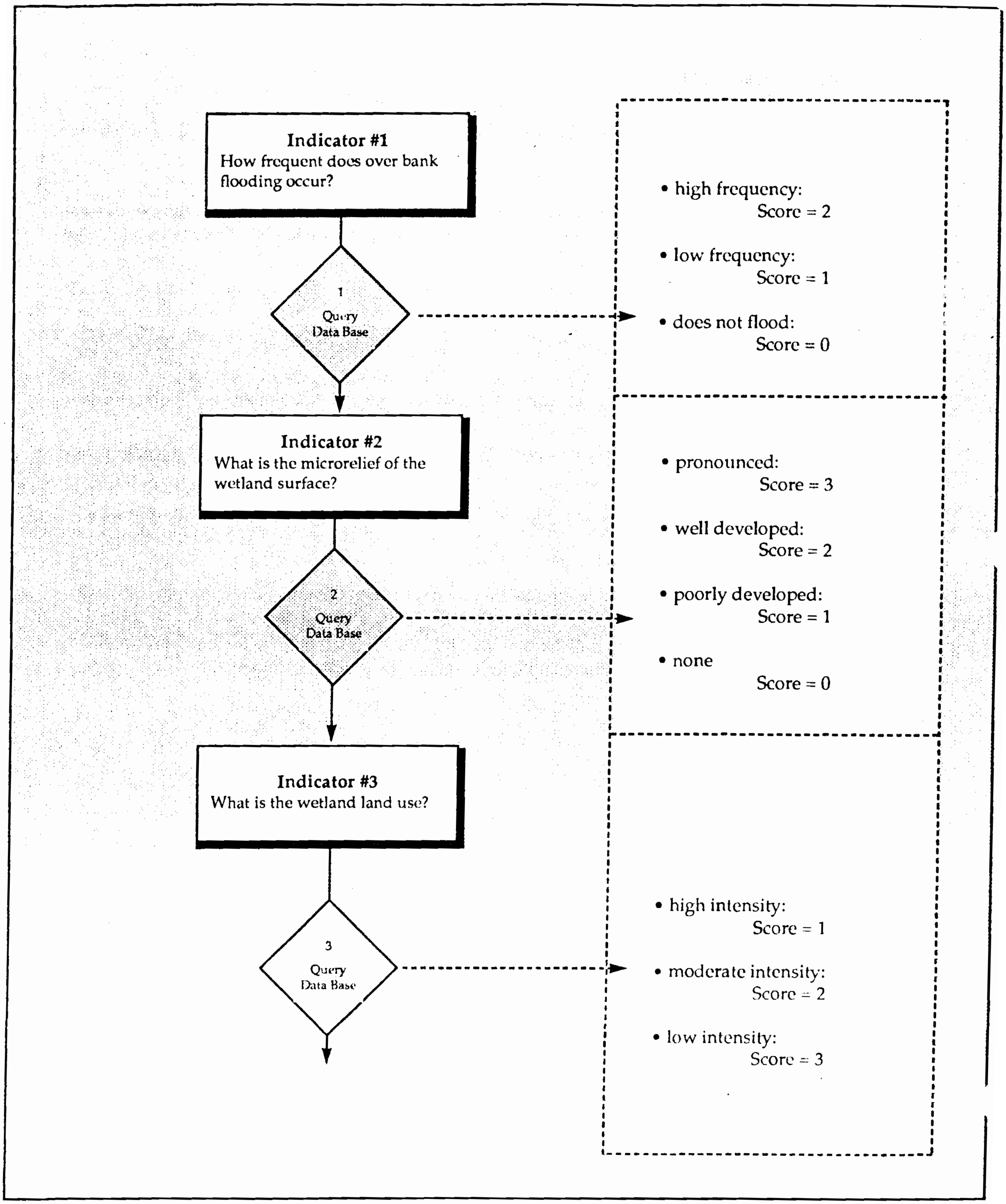
The geomorphology of a wetland's basin controls the movement of water into, through and out of the wetland.

- **Depressional** wetlands have the greatest potential for flood flow attenuation because the depressional basin shape collects water from all directions, depressional wetlands commonly have restricted outlets, and free board below the outlet invert. They are assigned a score of 4.
- **Riverine** wetlands are periodically flooded and offer natural valley food storage sites, as well as roughness to flow. They are assigned a score of 3.
- **Mosaic** wetlands commonly are nearly flat, contain riverine wetlands and depressional wetlands and are also assigned a score of 3.
- **Lacustrine** fringe wetlands may be flooded by lake level increases, but because lake level flooding predominantly has less fluctuations than riverine flooding, they are assigned a score of 2.
- **Slope** wetlands offer no flood storage above their substrate, and only offer roughness to attenuate flood flows and are assigned a score of 1.

Ditching

Ditches drain water from wetlands. Ditched wetlands are less likely to store long-term flood water than are unditched wetlands. Wetlands without ditches are assigned a score of 3 while those wetlands with ditches are assigned a score of zero.

FIGURE 21
MODIFICATION OF WATER QUALITY FUNCTION
(FIELD METHOD)



Frequency of Overbank Flooding

In order for a wetland to modify inflowing water, the inlet stream must flood the wetland by overbank flooding. Therefore, overbank flooding is the transport mechanism by which sediment, nutrient, dissolved solids and suspended solids enter the wetland. When all other factors are equal, the wetland with more frequent overbank flooding will have the highest effect on modifying water quality. High frequency of flooding is assigned a score of 3, moderate a 2, and low a 1. Wetlands that do not flood are assigned a zero.

Range of Conditions:

- High frequency: < 5 years
- Moderate frequency: 6-20 years
- Low frequency: 20 years to 100 years

Field Evidence of Flooding:

A. Direct Observation
B. Watermarks/silt rings on tree trunks
C. Scouring
D. Debris deposition

Microrelief of Wetland Surface

Wetlands with microrelief are more likely to perform this function than those without microrelief because they are more likely to provide better water storage, which allows for sedimentation of particulates from the water column and interaction of water with plants and soil. Accordingly, wetlands with the larger microrelief are assigned a higher score of 3, well developed a 2, and poorly developed 1.

Range of Conditions:

- Pronounced: > 45 cm
- Well Developed: 15-45 cm
- Poorly Developed: <15 cm

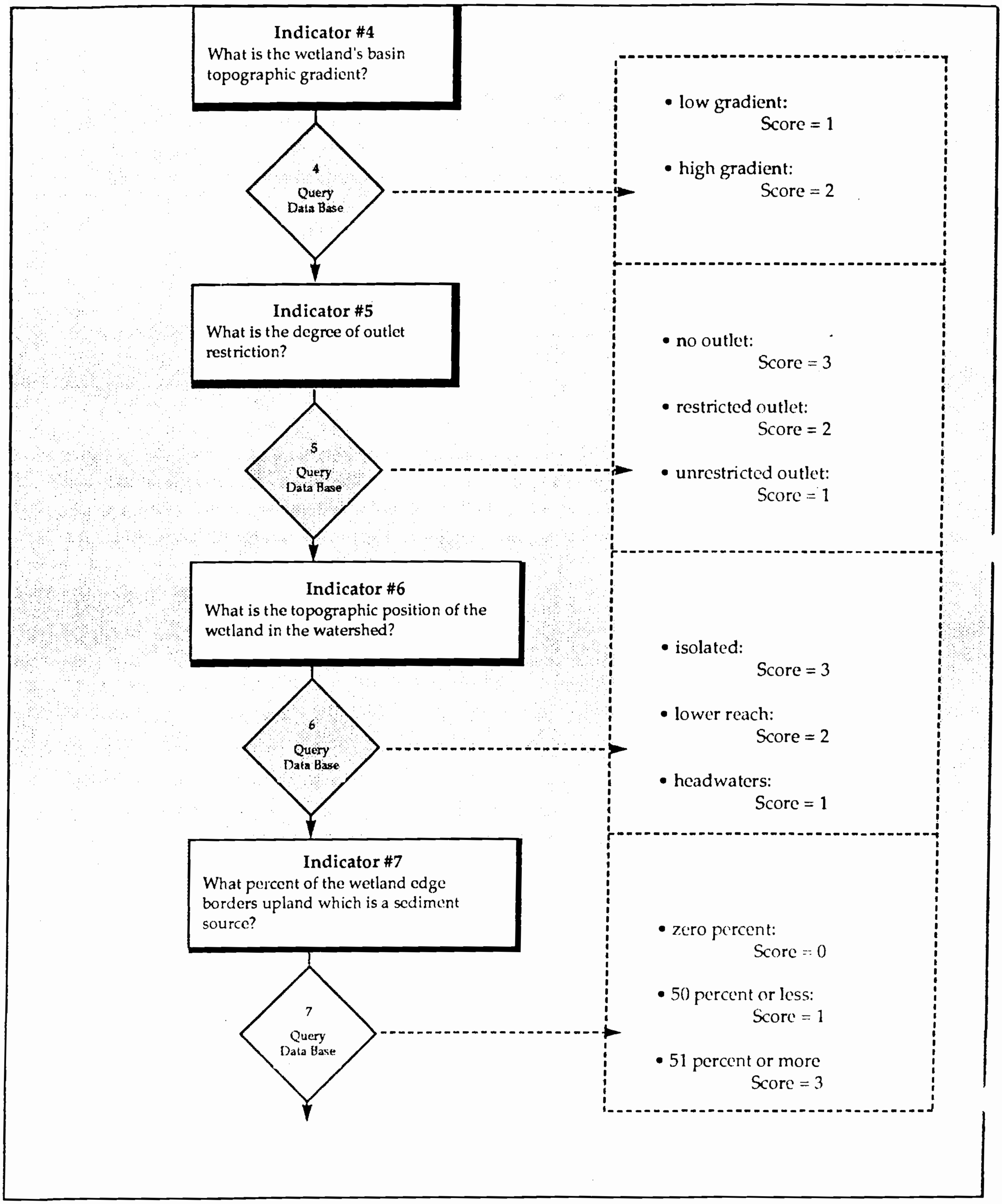
Wetland Land Use

Land use activities within a wetland can directly influence a wetland's capacity to perform this function. High intensity land use of a nature that alters hydrology, soils and/or vegetation can have a major effect on water storage and sedimentation and on wetland capacity to perform water quality modification; this condition was assigned a score of 1. Moderate intensity uses that do not alter soils or hydrology or entirely remove the vegetation were assigned a score of 2 and low intensity uses such as open space or passive recreation were given a 3.

Range of Conditions:

- **High intensity land use**. Included in this category are land uses such as intense agricultural (row crops), activities which remove the natural vegetation and modify the soils and hydrology.
- **Moderate intensity land uses**. Included in this category are land uses such as grazing and forestry, where the natural vegetation is modified but not entirely replaced, plowing does not occur and the soils and hydrology are generally undisturbed.
- **Low intensity land use.** This category includes those land uses, such as open space and recreation, which have little or no impact on the wetland's vegetation, soils, and hydrology.

FIGURE 21
MODIFICATION OF WATER QUALITY FUNCTION
(FIELD METHOD)



Basin Topographic Gradient

Wetlands with a low gradient are more likely to perform this function than one with a high gradient, because of the longer time for water to reside in the wetland, where it can interact with the soils and vegetation. Accordingly, low gradient wetlands were assigned a score of 3 and high gradient wetlands a score of 2.

Range of Conditions:

- High Gradient: >2%
- Low Gradient: < 2%

Degree of Outlet Restrictions

Wetlands with no outlet are very likely to serve this function because the length of time that water remains in the wetland where it can interact with the wetland plants and soils is maximized. This condition was assigned a score of 3. Wetlands with unrestricted outlets have much less capacity to serve this function because they pass water through the wetland and do not allow it to spread out over the wetland's surface, therefore, this condition was assigned a score of 1. Wetlands with restricted outlets fall between these two situations and were assigned a score of 2. These assignments are made as a result of the ability of the outlet to control water storage.

Topographic Position in the Watershed

Isolated wetlands are most likely to perform this function because of their high long-term water storage capabilities and this condition was assigned a score of 3. Lower reach wetlands are more likely to perform this function than headwater wetlands, because of their greater likelihood of a high frequency of flooding which allows water interaction with soil and vegetation; this condition was assigned a score of 2. Headwater wetlands were assigned a score of 1 because they generally pass water rapidly down to lower reach wetlands.

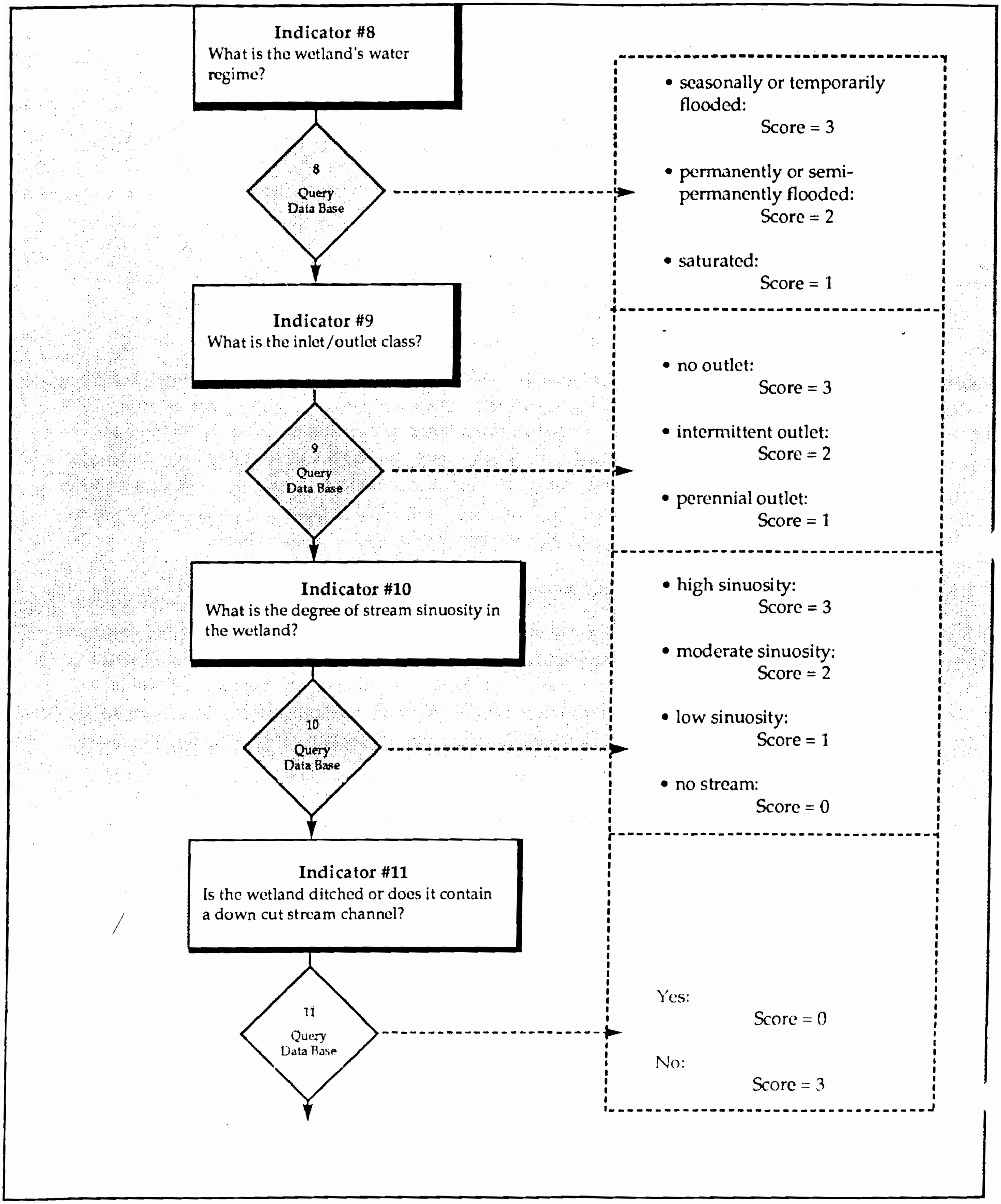
Percent of Wetland Edge Bordering Upland Sediment Source

Wetlands which have edges that border uplands which are potential sediment sources are more likely to modify inflowing water quality. Those with 51 percent or more of the wetland edge bordering a sediment source are assigned a score of 3, those with 50 percent or less are assigned a score of 1. Those which do not border a sediment source are assigned a score of zero.

Uplands considered potential sediment sources include:

- Actively cultivated agricultural fields
- Surface mines
- Soil-slope areas classified by Soil Conservation Service as eroding or erosion hazard
- Severely eroding stream or road banks

FIGURE 21
MODIFICATION OF WATER QUALITY FUNCTION
(FIELD METHOD)



Water Regime

Permanently flooded and semi-permanently flooded water regimes are less likely to be indicative of this function than are saturated, temporarily flooded and seasonally flooded areas, because interaction of water with soil and plants occurs more on sites without surface water than on flooded sites. A permanently or semi-permanently flooded condition was assigned a 1, seasonally or temporarily flooded a 2, and saturated a 3.

Inlet/Outlet Class

The outlet of a wetland may control how much and how long water is stored in the wetland, allowing processes involving plants, soils and animals to modify water quality. A wetland with no outlet maximizes these interactions and is assigned a score of 3. An intermittent outlet results in less interaction of water with wetland processes and is assigned a score of 2. A perennial outlet is likely to result in the least interaction and is assigned a score of 1.

Stream Sinuosity

In wetlands that contain streams, the degree of convolution of the stream course can play a role in this function. As the degree of irregularity of the stream course increases, so also do water residence time and the quantity of dispositional environments. A condition of maximum stream length/straight line distance ratio was assigned a score of 3, an intermediate ratio a 2 and a low ratio a 1.

$$\text{STREAM SINUOSITY} = \frac{\text{Stream Length}}{\text{Straight Line Distance}}$$

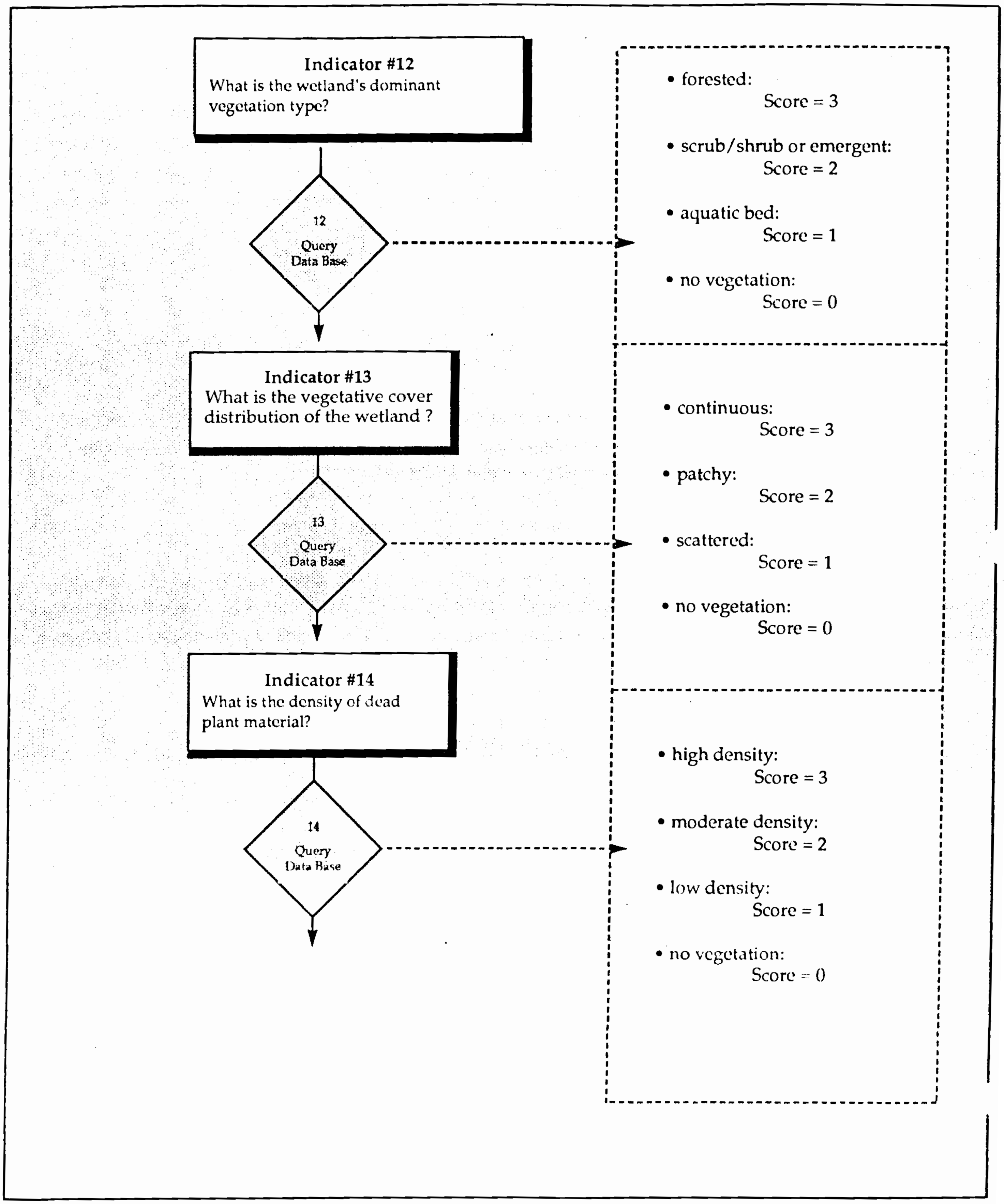
Range of Conditions:

- Stream length/wetland length ratio: > 0.67
- Stream length/wetland length ratio: 0.33-0.66
- Stream length/wetland length ratio: < 0.33

Ditching or Down Cut Stream

Wetlands with a down cut stream channel or which have been ditched, are less likely to retain water long enough to modify its water chemistry and are, therefore, assigned a score of zero. Those without ditches or a down cut stream channel are assigned a score of 3.

FIGURE 21
MODIFICATION OF WATER QUALITY FUNCTION
(FIELD METHOD)



Dominant Vegetation Type

Dominant vegetation type can predict detention and retention of water, which allows for interaction of nutrients and contaminants with soil and vegetation. Dominant vegetation type can also predict whether removal will result in short-term or long-term storage of nutrients and contaminants, depending upon the density of woody species present. Relative productivity and nutrient uptake occur at a faster rate in immature wetland plant communities. However, storage time is shorter in the younger stages compared to a mature community. The variable condition having the highest correlation with these conditions is forested wetland; all factors considered. Accordingly, this condition was assigned a score of 3. Scrub shrub and emergent wetlands and aquatic beds were scored 2 and 1 respectively.

Vegetation Cover Distribution

Vegetation cover physically retains water, providing particulate retention and interaction of nutrients and contaminants with soil and vegetation. The indicator value of vegetative cover distribution for this function, therefore, is closely related to that for water storage. Cover evenly distributed throughout the wetland provides greater particulate retention and greater opportunity for interaction of nutrients and contaminants than a patchy cover or isolated stems. A condition of continuous cover was assigned a score of 3, whereas conditions typified by a more patchy, scattered cover would be scored a 2 or 1.

Abundance/Density of Dead Plant Material

The presence of a certain proportion of dead woody plant material has predictive value for storm and floodwater detention, which increases opportunities for interaction of water with soil and live vegetation. The presence of a high density of standing and fallen logs and woody litter is the most favorable condition, and was assigned a score of 3. The condition score assigned was a 2 for medium density and 1 for low density.

FIGURE 21
MODIFICATION OF WATER QUALITY FUNCTION
(FIELD METHOD)

Indicator #15
What type of soil occurs in the wetland?

15
Query
Data Base

- histosol or mineral hydric soil with high clay content:
  Score = 3
- silty hydric soil:
  Score = 2
- sandy hydric soil:
  Score = 1

Indicator #16
What is the wetland's hydrogeomorphic class?

16
Query
Data Base

- depressional:
  Score = 4
- slope:
  Score = 1
- riverine:
  Score = 3
- lacustrine fringe:
  Score = 2
- mosaic:
  Score = 3

Assessment Area Total Score: = ____
Range 8-47

Functional Capacity Index = $\frac{\text{Total Score}}{47}$

FCI x Area = FC

Soil Type

Soil type plays an important role in this function because of the chemical reactions that take place in the soil and at the soil, water, vegetation interface. Condition scores can vary from 3 for a type characterized by a high density of chemically reactive surfaces, such as a histosol (organic soil) or a mineral hydric soil with a high clay component, to a 1 for soil with a high proportion of sand. An intermediate condition would receive a score of 2.

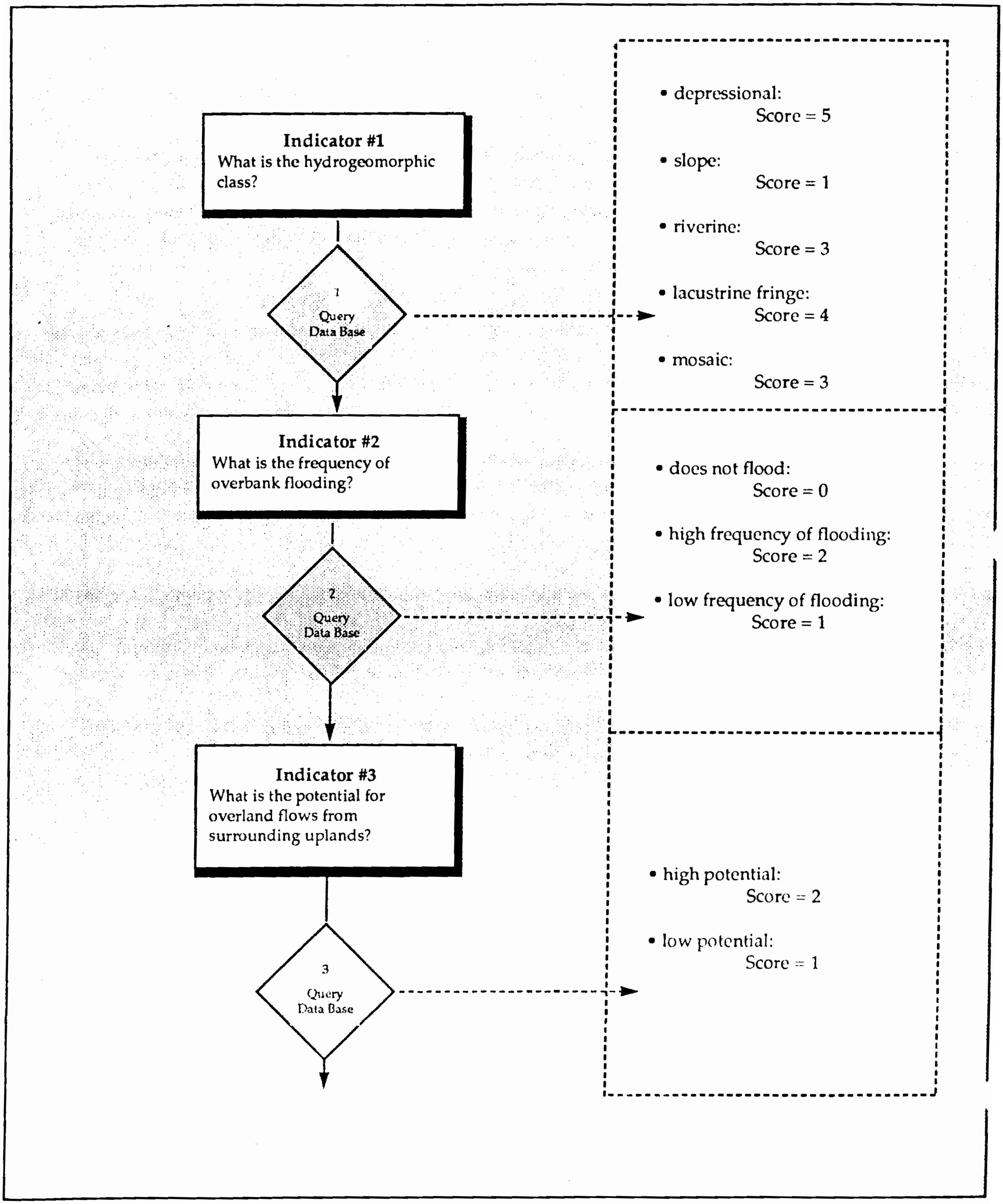
Hydrogeomorphic Class

The geomorphology of the wetland basin controls the water flow vectors, hydrodynamics and interaction of water with wetland processes occurring in the wetland's water column regime, soil regime and vegetation regime.

Range of Conditions:

- **Depressional wetlands** predominating maximum water residency time, allowing for maximum interaction and are assigned a score of 4.
- **Riverine wetlands** are frequently inundated by overbank flooding and include certain vegetation, soils and natural valley flood storage conducive to processes which modify water quality. They are assigned a score of 3.
- **Mosaic wetlands**, because of their flatness, also induce interactions and are also assigned a score of 3.
- **Lacustrine fringe** wetlands generally flood less frequently and are assigned a score of 2.
- **Slope wetlands** retain and detain water less than other hydrogeomorphic classes and are assigned a score of 1.

FIGURE 22
SEDIMENT STABILIZATION FUNCTION MODEL
(FIELD METHOD)



Hydrogeomorphic Class

The wetland's geomorphology has a major influence on the hydrodynamics of the water which passes through the wetland.

Range of Conditions:

- **Depressional wetlands**, because of their shape and general lack of flow through hydrology and outlets, perform sediment stabilization by trapping the sediment within their basin and are assigned a score of 5.
- **Lacustrine fringe** wetlands are predominantly nearly flat and their surface is controlled by the adjacent lake's water plain. They are predominately densely vegetated and serve as excellent sediment traps and are assigned a score of 4.
- **Riverine wetlands** are associated with flood plains, where they are periodically inundated with flood water which typically contains sediment. The riverine wetland vegetation creates roughness which slows water allowing for sedimentation to occur. Floodplains are also areas where the hydrology is dynamic and flood water may erode sediment and prevent stabilization. Therefore, riverine wetlands are given a score of 3.
- **Mosaic wetlands** are generally broad flat wetlands containing riverine, lacustrine fringe and depressional wetland subareas. They are assigned a score of 3.
- **Slope wetlands** do not store flood water and lack the sedimentation function of the other wetland types. They do offer roughness to through-flowing sediment rich water, which results in a limited sediment stabilization function, and they are assigned a score of 1.

Frequency of Overbank Flooding

Overbank flooding is the transport mechanism by which sediments from streams enter floodplain wetlands. This function primarily relates to riverine wetlands, but lacustrine fringe wetland receive flood water from the lake. Mosaic wetlands generally contain floodplains, and occasionally so do depressional wetlands. Those wetlands with a high frequency of overbank flooding are assigned a score of 2, those with low frequency a 1. Wetlands that do not flood are assigned a zero.

Range of Conditions:

High Frequency:	< 5 years
Moderate Frequency:	6 to 20 years
Low Frequency:	> 20 years to 100 years

Field Evidence of Flooding:

A. Direct Observation
B. Watermarks/Silt marks on tree trunks
C. Scouring
D. Debris Deposition

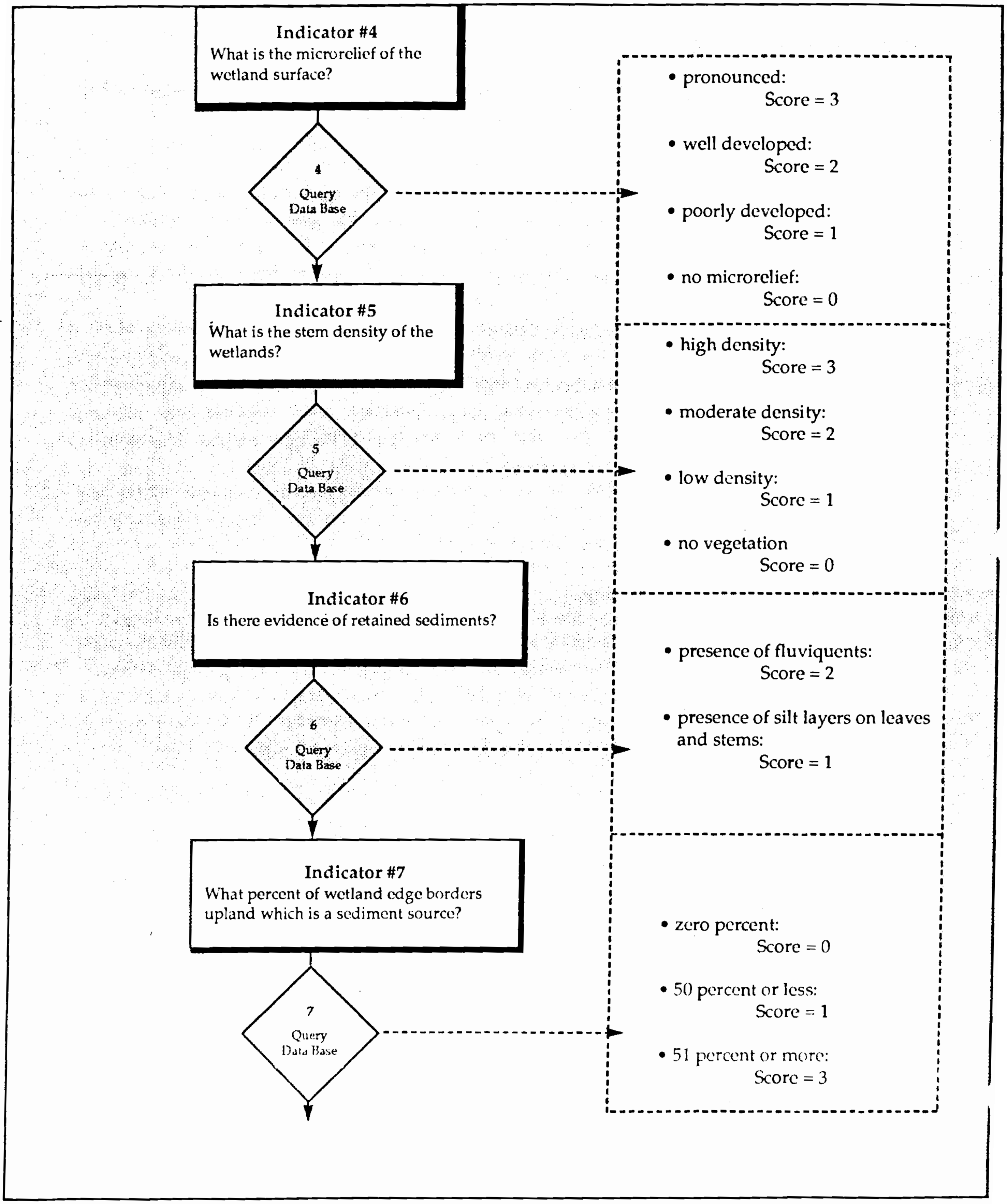
Potential of Overland Flows From Surrounding Uplands

Another source of sediment rich water to the wetland is runoff from the surrounding upland. Those upland areas surrounding the wetland which have a high potential are assigned a score of 2, those with a low potential a 1.

Range of Conditions:

High Potential:	> 100 acres of upland contributing to overland flow
Low Potential:	100 or less acres of upland contributing to overland flow

FIGURE 22
SEDIMENT STABILIZATION FUNCTION MODEL
(FIELD METHOD)



Microrelief of Wetland Surface

Microrelief adds to the roughness of the wetland surface, slowing down flood water and trapping sediment within the pools of the mound and pool microtopography. Pronounced microrelief performs this process the best and is assigned a score of 3, well developed a 2, and poorly developed a 1. No microrelief is assigned a zero.

Range of Conditions:

Pronounced:	> 45 cm
Well Developed:	15-45 cm
Poorly Developed:	<15 cm

Stem Density

Vegetation stems offer resistance to through-flowing flood waters carrying sediment and adds to the roughness of the wetland surface. This slows down water allowing sedimentation. Fine grained sediment is deposited downstream of dense vegetation. New vegetation holds the trapped sediment in place preventing erosion and resuspension of the sediment. High stem density is assigned a score of 3, low a 1.

Range of Conditions:	***Definitions:***
• **High**	**High Density**: Stem density in the form of woody or emergent vegetation that covers the entire wetland with little/no open water or bare ground surface present.
• **Low**	**Low Density:** Stem density in the form of woody or emergent vegetation that is sparsely distributed throughout the wetland due to large amounts of open water or bare ground surface.
• **Moderate**	**Moderate Density:** Stem density whose distribution pattern is between the low and high conditions.

Evidence of Retained Sediment

Silt covered leaves, silt rings on stems, and silt shadows downstream of stems and dense stands of vegetation indicate that sedimentation is occurring. These indicators are assigned a 1. Fluviquents are soils which form from numerous sedimentation events on floodplains. They not only illustrate that process occur in the wetland which induce sedimentation, but that the sediment accumulates over years to produce the fluviquent soil and the sediment is stabilized for the long-term. The presence of fluviquent soils is assigned a 2.

FIGURE 22
SEDIMENT STABILIZATION FUNCTION MODEL
(FIELD METHOD)

Indicator #8
What is the ratio of wetland area to watershed area?

8
Query
Data Base

- large ratio:
  Score = 2
- small ratio:
  Score = 1

Assessment Area Total Score: =
Range 4-22

Functional Capacity Index = $\frac{\text{Total Score}}{22}$

FCI x Area = FC

Percent of Wetland Edge Bordering Upland Sediment Source

Sediment may enter a wetland carried by runoff from adjacent upland. Some upland, such as agricultural land may be a sediment source. The wetland can trap this inflowing sediment. The amount of wetland edge bordering erodible upland influences how much sediment a wetland may trap. If 51 percent or more of the wetland edge borders erodible upland then a score of 3 is assigned. If 50 percent or less of the wetland edge borders erodible upland then a score of 1 is assigned. If none of the wetland edge borders erodible upland then a score of zero is assigned.

Ratio of Wetland Area to Watershed Area

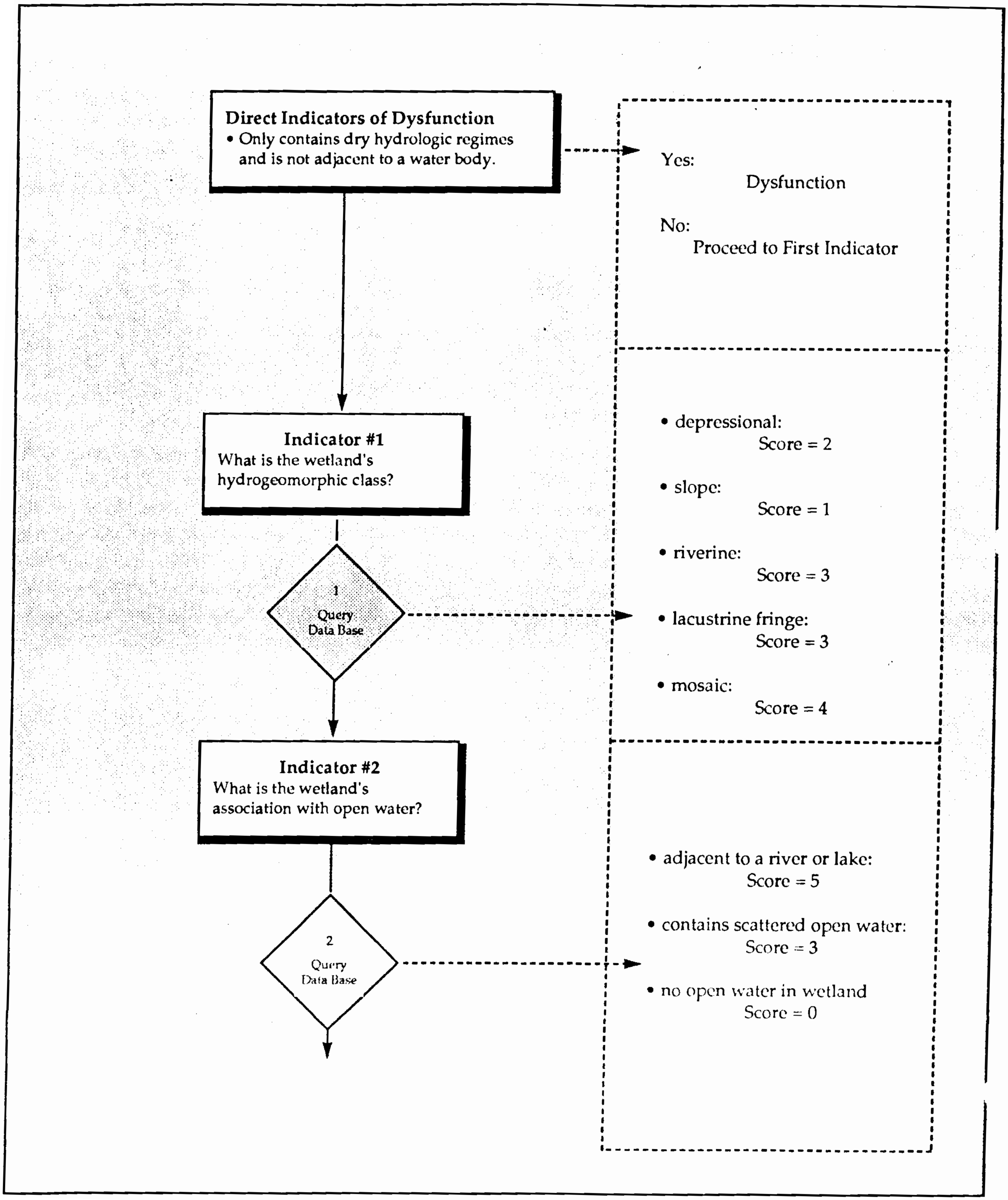
The amount of sediment entering a wetland may be influenced by its watershed size. All other characteristics being equal, the larger the wetland, the more opportunity to trap sediment, and the larger the watershed, the more potential sediment enters the wetland. A large ratio is assigned a score of 2, a small ratio is assigned a score of 1.

Range of Conditions:
Large ratio: >10%
Small ratio: <10%

$$\textbf{Ratio} = \frac{\textbf{wetland area}}{\textbf{watershed area}} \times 100$$

FIGURE 23

AQUATIC DIVERSITY/ABUNDANCE MODEL (FIELD METHOD) (page 1 of 6)



Direct Indicator of Dysfunction

The dominance of dry hydrologic regimes to include temporarily flooded and saturated regimes do not provide habitat for aquatic species and are direct indicators of dysfunction.

Vegetative Communities that typically have dry hydrologic regimes:

- **Wet meadows**
- **Scrub-shrub wetland**
- **Forested wetland**

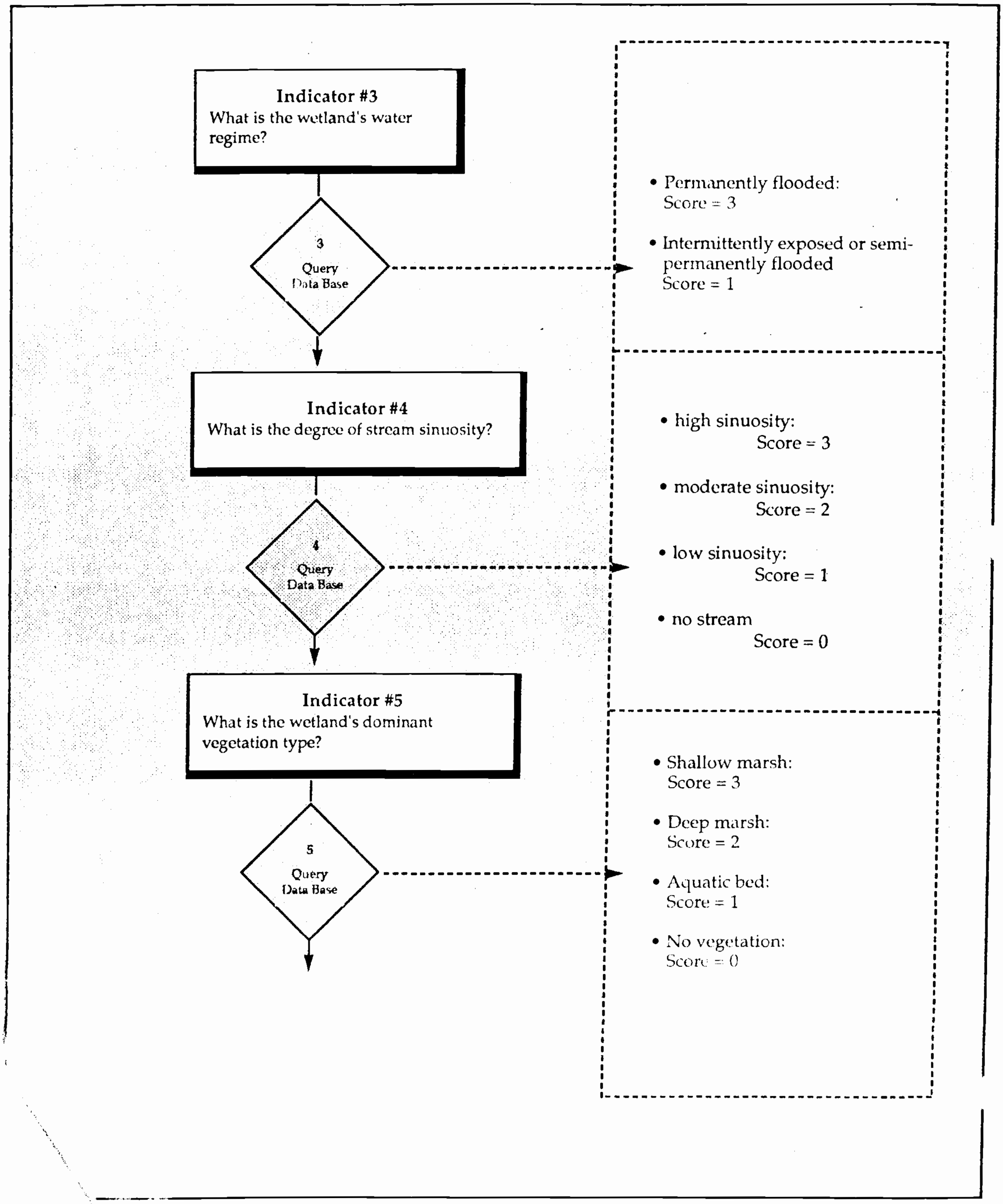
Hydrogeomorphic Class

Mosaic wetlands contain a variety of hydrogeomorphic subareas. They generally are broad flat regional wetlands containing a wide variety of sites where aquatic habitats may occur. Because of this diversity they are assigned the highest score, a 4. Lacustrine fringes and riverine wetlands are assigned the next highest score, a 3, because they are associated with the adjacent aquatic habitats of the lake and/or river channel. They are periodically inundated by the lake or river and become interconnected with those aquatic habits. Depressional wetland may contain limited aquatic habitats and are assigned a score of 2, while slope wetlands seldom contain standing water long enough to provide an aquatic habitat and are assigned a score of 1.

Association With Open Water

Open water is habitat for aquatic species. Wetlands associated with open water are more likely to provide habitat than those not associated. Wetlands not associated with open water are assigned a score of zero. Wetlands adjacent to a river or lake are assigned a score of 3, while wetlands containing scattered open water are assigned a score of 2.

FIGURE 23
AQUATIC DIVERSITY/ABUNDANCE MODEL (FIELD METHOD) (page 2 of 6)



Wetland Water Regime

The water regime dictates the presence or lack of aquatic habitats. The dominance of permanently flooded wetlands are most likely to support aquatic habitats, while dominance of intermittently exposed or semi-permanently flooded wetlands are less likely.

Vegetative communities that typically have wet hydrologic regimes that are permanently flooded:

- **Aquatic bed wetland**
- **Deep marsh**
- **Shallow marsh**
- **Open water pond**

Stream Sinuosity

The more convoluted a steam channel is, the more likely it will have a variety of aquatic habitats, and the more likely those habitats will overlap into the adjacent wetland. High sinuosity is assigned a score of 3. medium a 2, and low a 1.

$$\textbf{Stream Sinuosity} = \frac{\textbf{Stream Length}}{\textbf{Straight Line Distance}}$$

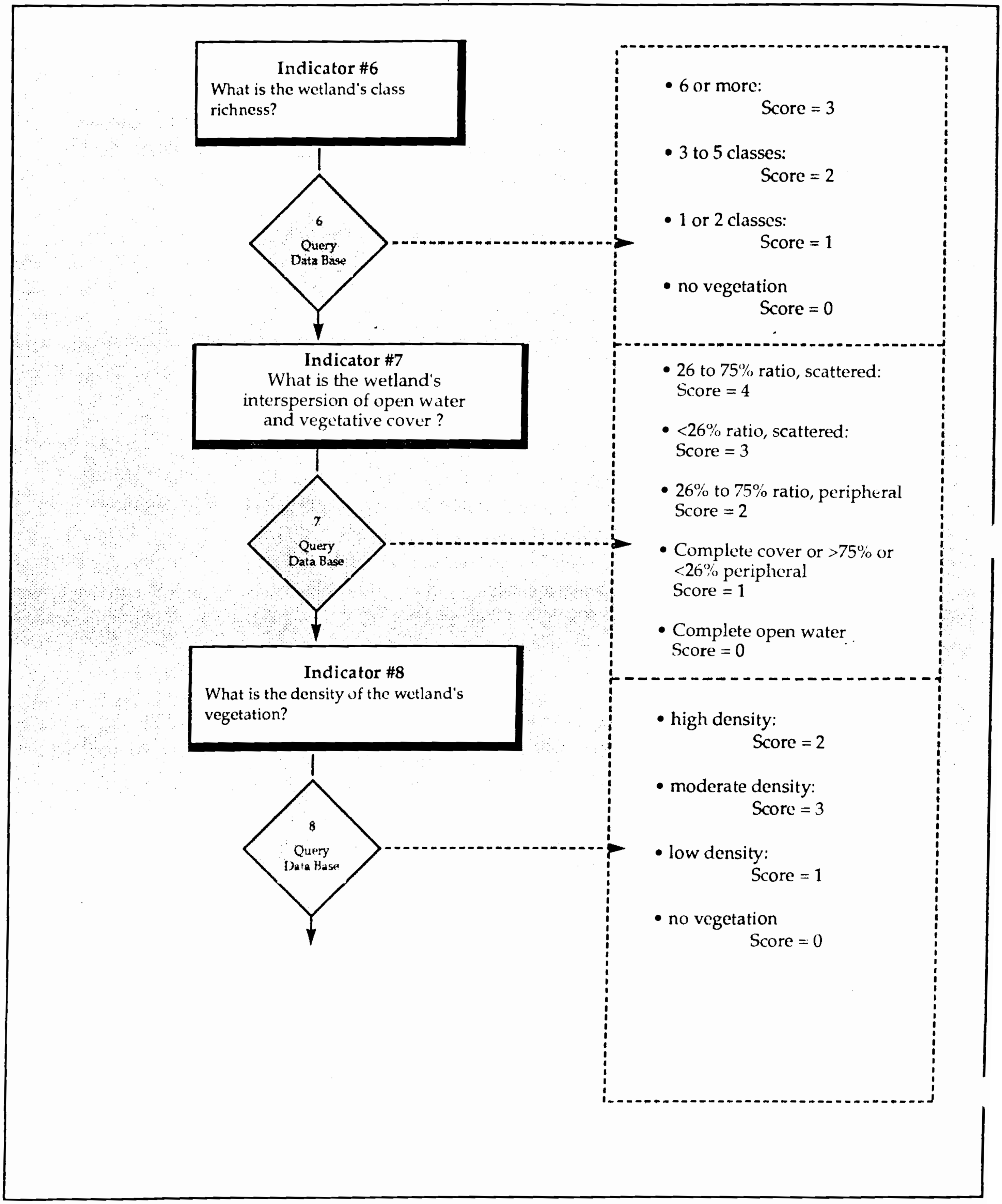
Range of Conditions

- Stream length/wetland length ratio: >0.67
- Stream length/wetland length ratio: 0.33-0.66
- Stream length/wetland length ratio: <0.33

Dominant Wetland Vegetation Type

Shallow marsh is assumed to provide the most diverse habitat and is assigned a score of 3. Deep marsh is assigned a score of 2 and aquatic bed is assigned a score of 1.

FIGURE 23
AQUATIC DIVERSITY/ABUNDANCE MODEL (FIELD METHOD) (page 3 of 6)



Wetland Class Richness

Wetland class richness is the measurement of wetland vegetation diversity. The greater the number of wetland classes found in the wetland assessment area, the larger the likelihood that the wetland aquatic diversity/abundance will be high. Six or more classes are assigned a 3, three to five a 2, and one to two classes a 1.

Wetland classes and subclasses are listed and defined by Cowardin et al., (1979), and include the following as examples:

PEM Palustrine emergent
PSS Palustrine scrub-shrub
PFO Palustrine forested
POW Palustrine open water
PAB Palustrine aquatic bed

Interspersion of Open Water and Vegetation Cover

The larger the ratio of water to vegetation cover and the more scattered the open water the more diverse will be the aquatic habitats. Scattered high ratio is assigned a 4. Scattered lower ratio is assigned a 3, and peripheral, moderately scattered a 2. Low ratio, peripheral is assigned a 1.

Ratio: Area Open Water/Vegetation Cover Area

Range of Conditions

- **Scattered Cover:** Vegetation cover is scattered throughout
- **Peripheral Cover:** Vegetation cover is clumped or along shoreline only
- **Complete Cover:** Vegetation completely covers water
- **Complete Open Water:** No vegetation present

Wetland Vegetation Density

Vegetation density, or the percentage of the site covered by vegetation, serves to indicate whether an abundance of hydrophytic vegetation is being produced by the wetland. High vegetation density is assigned a score of 3, moderate a 2 and low density a 1.

FIGURE 23

AQUATIC DIVERSITY/ABUNDANCE MODEL (FIELD METHOD) (page 4 of 6)

Indicator #9
What is the favorability of the wetland's juxtaposition?

Query Data Base

- highly favorable:
  Score = 3
- moderately favorable:
  Score = 2
- unfavorable
  Score = 0

Indicator #10
Is the wetland or adjacent river, stream, or lake habitat for fish?

Query Data Base

- warmwater fish:
  Score = 1
- coldwater fish:
  Score = 2
- anadromous fish:
  Score = 3
- catadromous fish:
  Score = 3
- not adjacent to fish habitat
  Score = 0

Indicator #11
Is the wetland habitat for any reptiles, amphibians, or aquatic invertibrates which are listed as rare, endangered or threatened by Natural Heritage?

Query Data Base

- listed species present:
  Score = 3
- aquatic species present, but not listed:
  Score = 2
- aquatic species presence unknown:
  Score = 1

Wetland Juxtaposition

The proximity of a wetland to other wetlands may be an important factor in evaluating its overall biodiversity at the landscape level if it is part of a mosaic of wetlands in an area. A condition in which other wetlands are within 200 m. would be assigned a score of 3, 200-400 m. a 2 and 400-600 m. a 1; wetland situated with other wetlands farther than 600 m. would receive a zero for juxtaposition.

Adjacent Fish Habitat

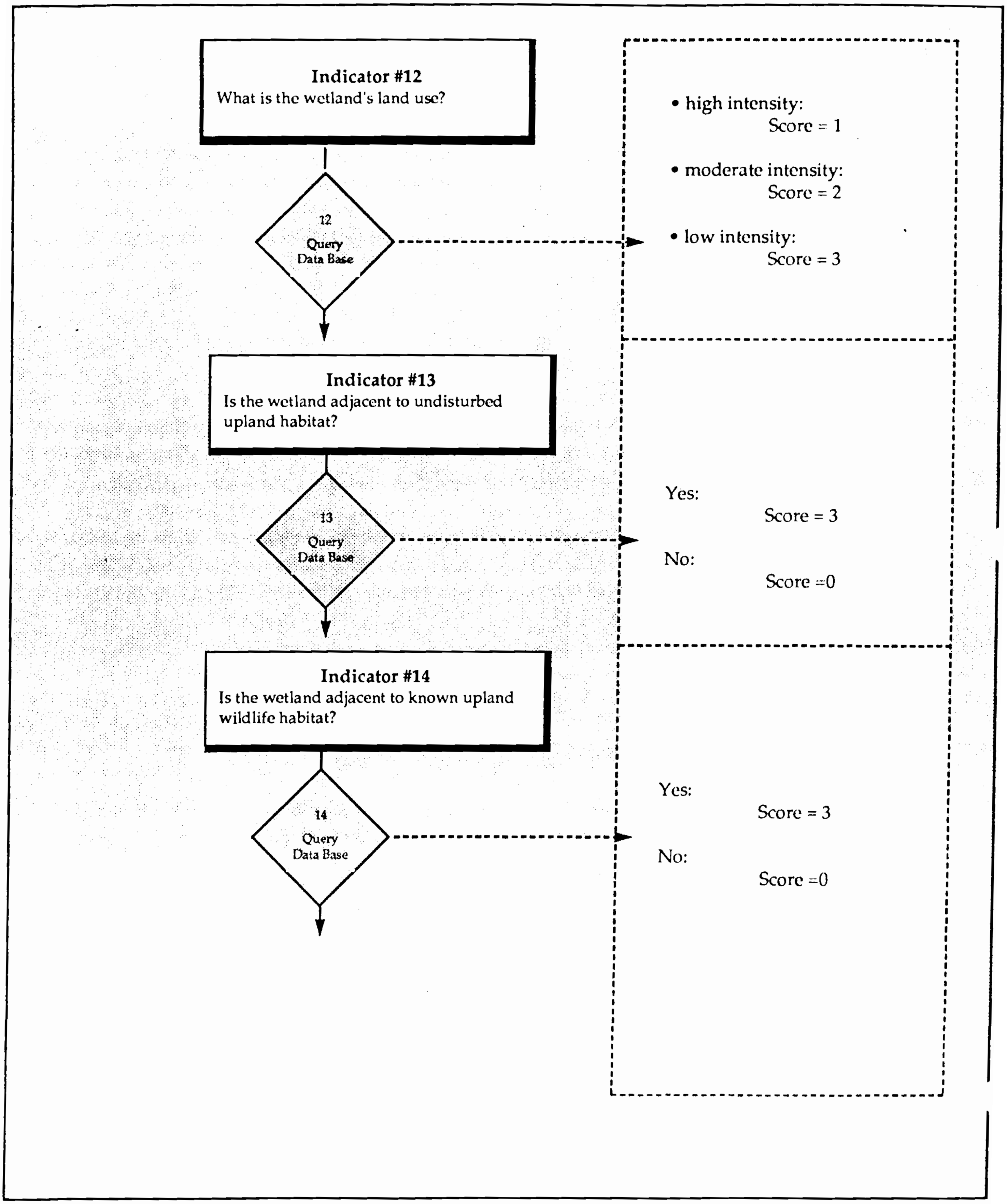
Wetlands may be used by fish if the wetland contains the necessary hydrologic characteristics. Wetlands adjacent to fish habitat may offer shade, spawning, feeding or resting habitat. The wetland may export nutrients and detritus necessary for the fish food web. Adjacency to anadromous or catadromous fish habitat is assigned the highest score, a 3, because these fish are part of a much larger ecosystem and contribute to the ecology of the ocean waters. Cold water fish are very sensitive to increases in temperature and shade created by adjacent wetland can be critical during the summer for the survival of fish. Cold water fish is assigned a 2. Warm water fish are less sensitive to shade and generally water quality, thus their habitat is assigned a 1.

Rare, Endangered, Threatened or Listed Aquatic Species

If listed aquatic species occur in the wetland, the wetland is assigned a score of 3. If aquatic species are know to exist but are not listed, a score of 2 is assigned. If it is unknown if any aquatic species exist, then a score of 1 is assigned.

Data is obtained from the habitat maps of the State's Natural Heritage Program.

FIGURE 23
AQUATIC DIVERSITY/ABUNDANCE MODEL (FIELD METHOD) (page 5 of 6)



Wetland Land Use

The more intense the land use in the wetland the more likely that aquatic diversity will be decreased. High intensity wetland land use is assigned a score of 1, while moderate intensity is assigned a score of 2 and low intensity is assigned a score of 3.

Range of Conditions:

- **High intensity land use**. Included in this category are land uses such as intense agricultural (row crops), activities which remove the natural vegetation and modify the soils and hydrology.
- **Moderate intensity land uses.** Included in this category are land uses such as grazing and forestry, where the natural vegetation is modified but not entirely replaced, plowing does not occur and the soils and hydrology are generally undisturbed.
- **Low intensity land use**. This category includes those land uses, such as open space and recreation, which have little or no impact on the wetland's vegetation, soils and hydrology.

Adjacent to Undisturbed Upland Habitat

Many aquatic species require undisturbed upland habitat to complete their life cycles. the presence of undisturbed upland habitat adjacent to the wetland is assigned a score of 3, while disturbed habitat is assigned a score of zero.

Adjacent to Known Upland Wildlife Habitat

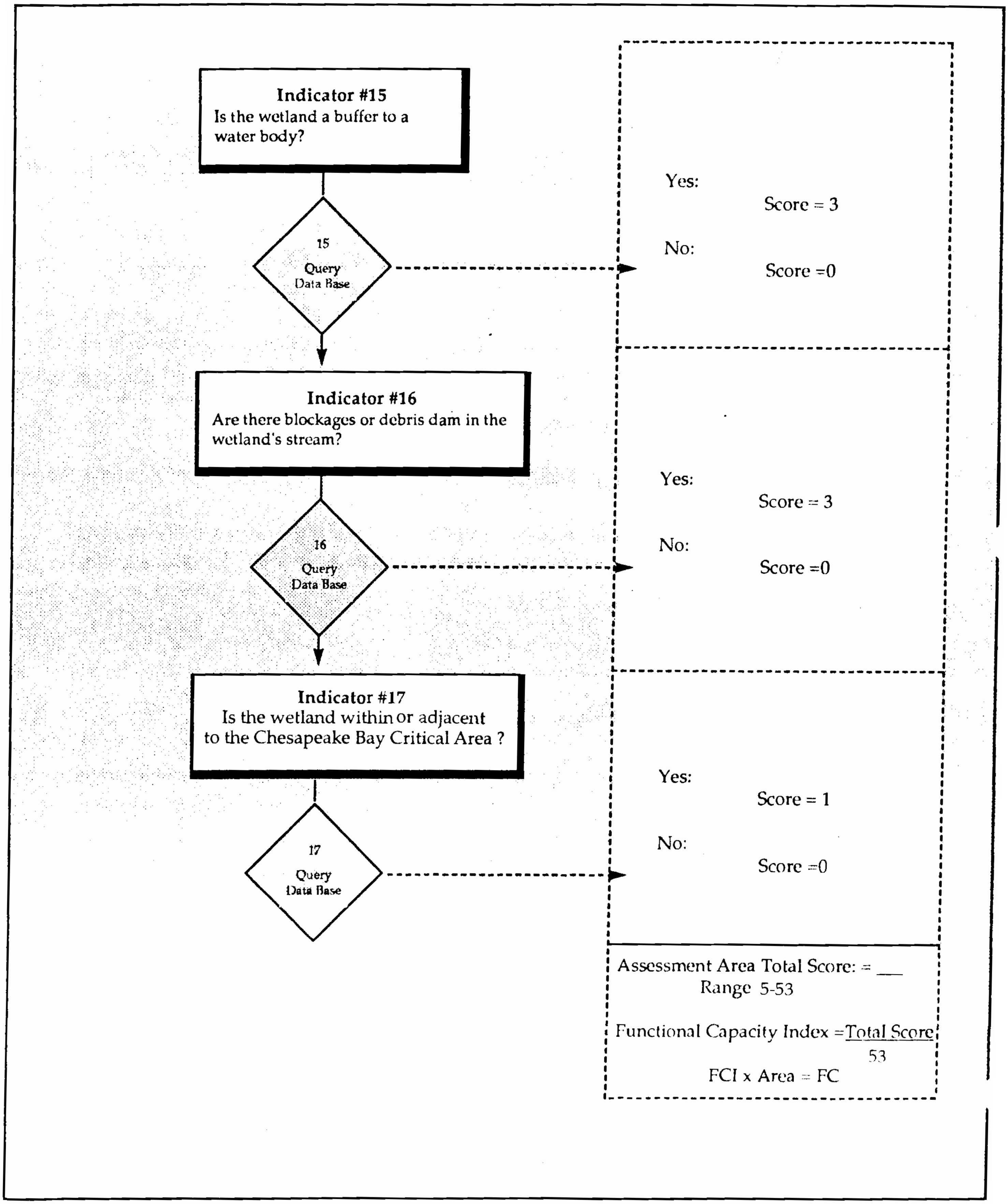
Some wetlands occur adjacent to upland habitat that has been recognized or preserved for wildlife purposes, such as game management areas. Those that are adjacent to such areas are assigned a score of 3, those that are not, a score of zero.

Data sources for designated upland wildlife habitat include the following data layers:

- PLG MDE Properties
- PLG County Open Space Properties
- PLG Private Conservation Organization Properties
- PLG Reservoir Properties
- NHP Natural Areas

FIGURE 23

AQUATIC DIVERSITY/ABUNDANCE MODEL (FIELD METHOD) (page 6 of 6)



Wetland Serves as a Buffer for a Water Body or Water Way

Commonly, wetland occur between upland and open water, and serve as a buffer to protect and enhance the habitat of the open water. Those that provide a buffer are assigned a score of 3, those that do not buffer, a zero.

Stream Blockages or Debris Dams

Streams passing through wetlands often contain blockages or debris dams which create pools suitable for habitat for aquatic species. Wetlands with these features are assigned a score of 3, those without these features are assigned a score of zero.

Adjacent to or within Chesapeake Bay Critical Area or Area of Special Concern

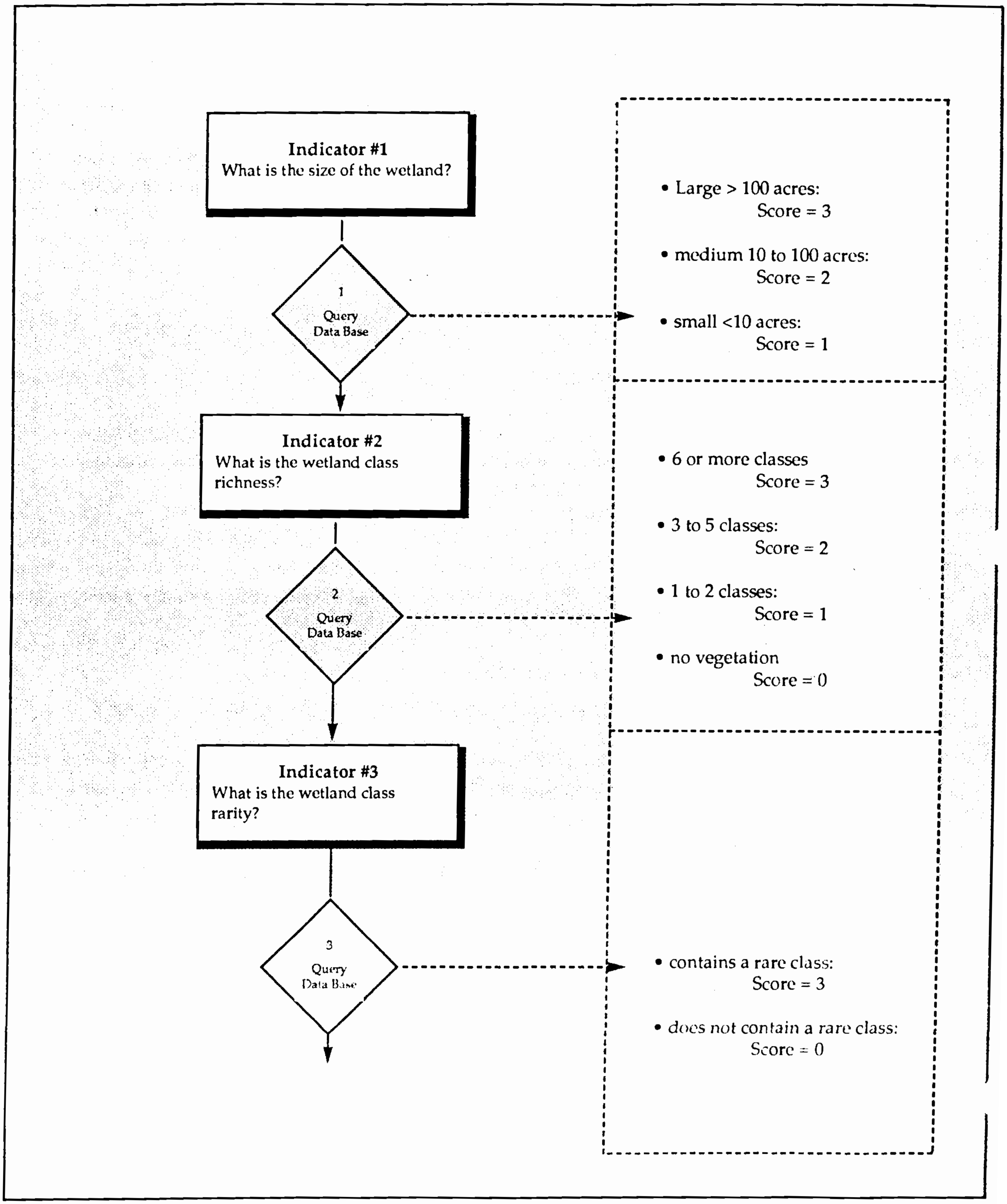
Many wetlands in Maryland are within or adjacent to the designated Chesapeake Bay Critical Area, and are a buffer to or part of this critical habitat. Those that are, are assigned a Score of 1. Those that are not are assigned a score of zero.

The Chesapeake Bay Critical Area is shown on the County tax map overlays as well as WRA MDE wetland 1/4 quads.

Wetlands of Special Concern are shown on the WRA MDE wetland data layer and the WRA NWC wetland data layer.

FIGURE 24

WILDLIFE DIVERSITY/ABUNDANCE MODEL (FIELD METHOD)(page 1 of 7)



Size

Size of a wetland is of high predictive value in assessing its capacity for maintenance of wildlife communities. In general, habitat diversity increases with wetland size, such that a larger wetland would likely be more capable of satisfying life cycle requirements of certain fauna than a smaller one. Size also provides a greater buffer from disturbance on the periphery. Also, those factors that determine permanence of a wetland, such as watershed size and groundwater discharge, correlate well with wetland size. The condition scores vary with wetland size, a score of 3 being given to a large wetland, a 2 to a medium size one and a 1 to a small one.

Range of Conditions:

- **Large**: >100 acres
- **Medium**: 10-100 acres
- **Small:** <10 acres

Wetland Class Richness

As the diversity of wetland vegetation types increases, generally so do those factors that are important in the life cycles of many annual species, such as habitat and food. This variable, therefore, serves as a predictor of the kinds, numbers and relative abundance of wildlife species, and of wildlife production and use. Condition scores are assigned based on the number of classes and range from 3 to 1.

Wetland classes and subclasses are listed and defined by Cowardin et al., (1979), and include the following as examples:

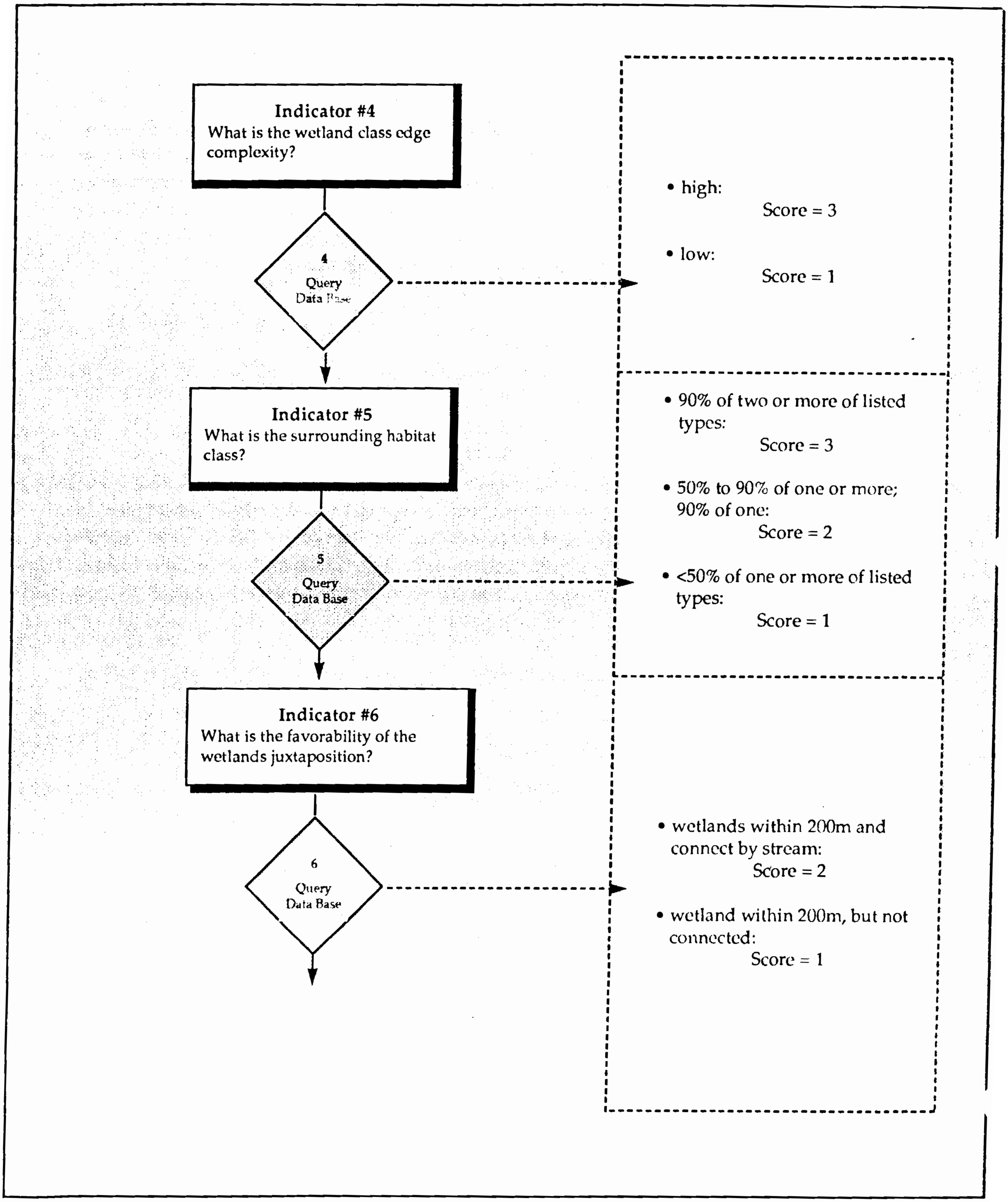
PEM	Palustrine emergent	**POW**	Palustrine open water
PSS	Palustrine scrub-shrub	**PAB**	Palustrine aquatic bed
PFO	Palustrine forested		

Regional Scarcity of Wetland Vegetation Type

In every region there will be one or a few wetland classes which are rare. The presence of a rare/scarce wetland class may provide unique habitat for wildlife species. The presence of the wetland in the region add diversity to the regional wildlife population. A wetland contains a rare vegetation class is assigned a score of 3. Wetlands which are not scarce are assigned a score of zero.

Definition: Dominant vegetation types which comprise **10 percent or less** of the total area of all combined wetland vegetation types for the region are considered scarce.

FIGURE 24
WILDLIFE DIVERSITY/ABUNDANCE MODEL (FIELD METHOD)(page 2 of 7)



Wetland Edge Complexity

Highly complex or convoluted wetland edges with surrounding upland or with another wetland assessment area create more ecotone than do wetland edges that are smooth, or have a low complexity. High complexity is assigned a score of 3 while low complexity is given a 1.

Surrounding Habitat Class

Surrounding habitat refers to the percentage of the surrounding landscape which is in agriculture, abandoned open land, and the number of the categories present. Habitat surrounding a wetland is an important factor affecting its wildlife production since the life cycle requirements of many species is satisfied partly in wetlands and partly in uplands. The nature of the surrounding upland also determines which upland wildlife will likely use the wetland. Uplands also offer a buffer against human disturbance. Greater than 90% of two or more listed types is the best condition and is assigned a score of 3. Less than 50% of one or more is the least optimal condition and is assigned a 1. The intermediate condition is assigned a 2.

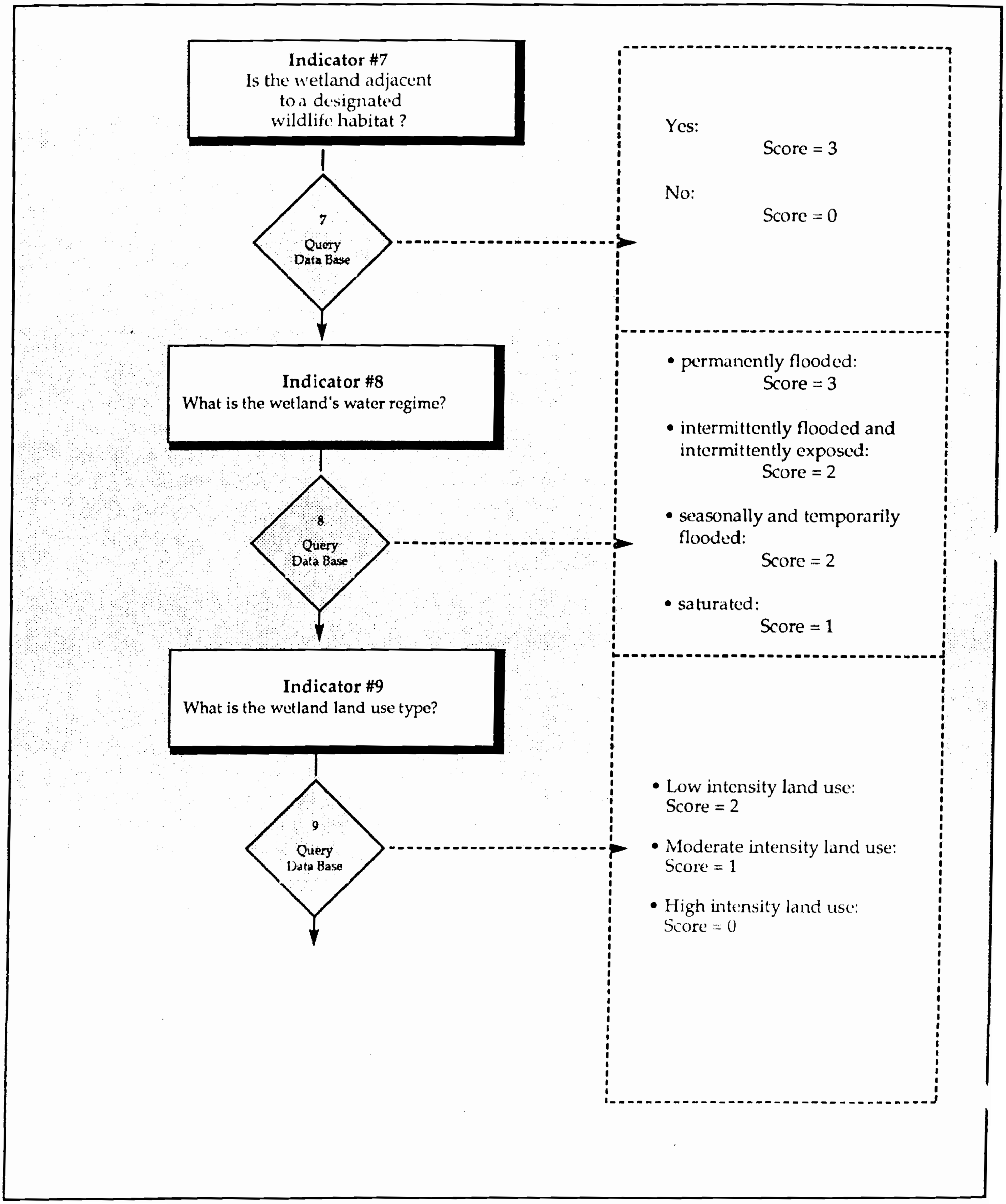
Range of Conditions

- forestland
- agricultural or open land
- salt marsh

Wetland Juxtaposition

The value of a wetland relative to maintenance of wildlife communities is higher if it is located near other wetlands, particularly if the wetlands are connected by surface water. Stream connections provide travel corridors for wildlife between wetlands. This factor becomes less important in large, diversified wetlands in which life cycle requirements are entirely provided without the necessity to travel to other wetlands. Depending on wetland size and diversity therefore, this variable can be useful as a predictor of this function. A condition in which other wetlands are within 200 m. and connected by streams is optimal, and is assigned a score of 2. A condition of wetlands within 200 m. but not connected is assigned a 1.

FIGURE 24
WILDLIFE DIVERSITY/ABUNDANCE MODEL (FIELD METHOD)(page 3 of 7)



Adjacent to Designated Upland Wildlife Habitat

Some wetlands interconnect with upland or other wetland habitat that has been preserved and managed as a wildlife refuge or game management area, etc. Such wetlands are assigned a score of 3.

Data sources for designated upland wildlife habitat include the following data layers:

- PLG MDE Properties
- PLG County Open Space Properties
- PLG Private Conservation Organization Properties
- PLG Reservoir Properties
- PLG NHP Natural Areas

Water Regime

The presence of standing water in a wetland bears relevance to the diversity of faunal species it can support compared to a wetland which does not have any standing water. Standing water also provides habitat for aquatic invertebrates, which serve as a food source for certain vertebrates. The most optimal condition is permanently flooded which is assigned a 3; permanently flooded and intermittently exposed would receive a 2, seasonally flooded and temporarily flooded also a 2 and saturated a 1.

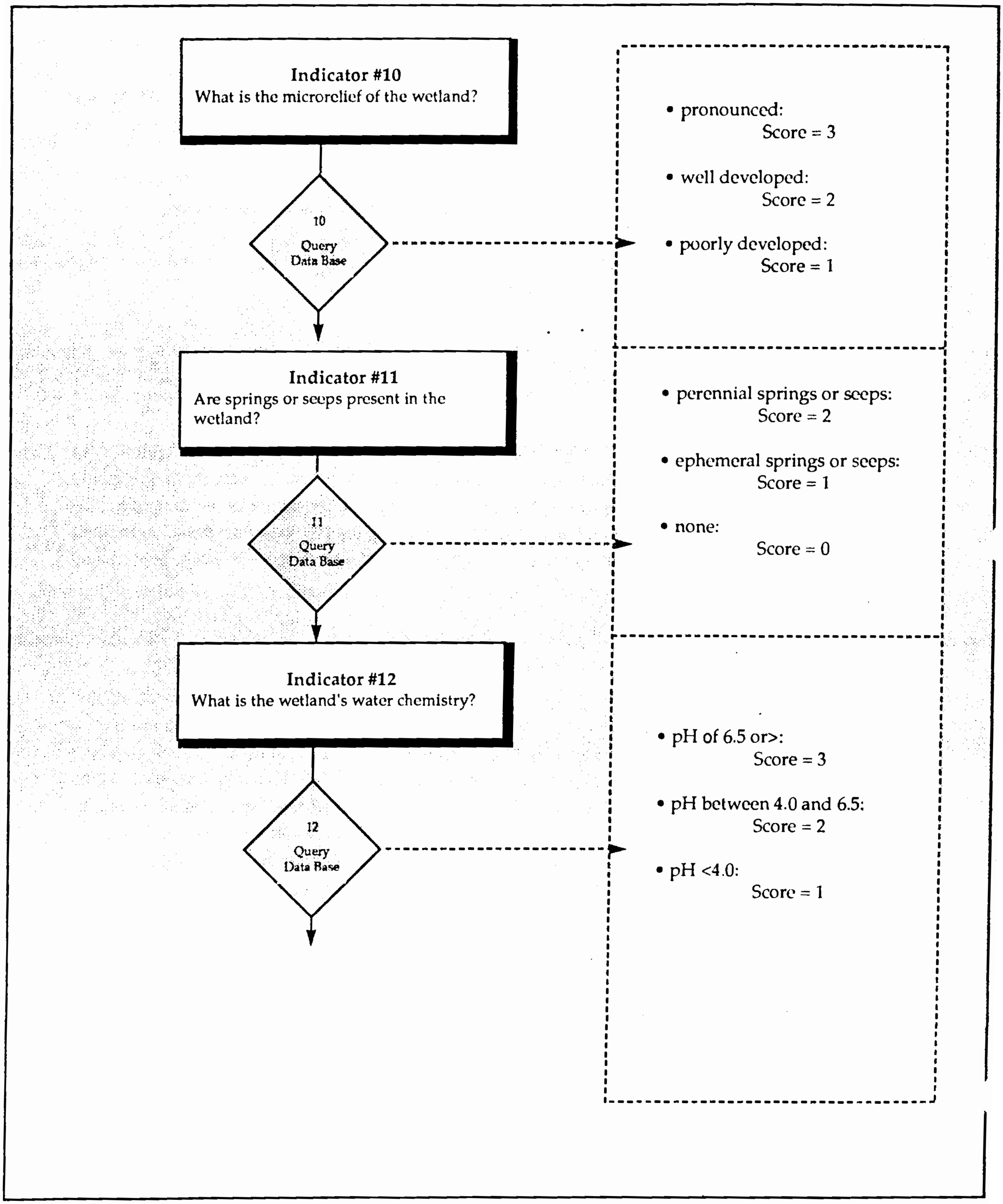
Wetland Land Use

Land use activities in a wetland can have a direct effect on its capacity for wildlife diversity and abundance. These effects can range from inconsequential, where the activity is of a passive nature such as in wildlife observation, to highly destructive, as in removal of timber or other products from the wetland. This variable, therefore, can serve as a predictor of wetland capacity to maintain its fauna under various land use and management scenarios, given knowledge of the tolerance of dominant members of the faunal community to various activities. A condition in which use and management of the wetland does not occur or is benign in nature is assigned a score of 3; one in which the use is of consumptive nature would receive a 2 or 1, depending upon the nature and level of the activity in the wetland.

Range of Conditions:

- **High intensity land use**. Included in this category are land uses such as intense agricultural (row crops), activities which remove the natural vegetation and modify the soils and hydrology.
- **Moderate intensity land uses**. Included in this category are land uses such as grazing and forestry, where the natural vegetation is modified but not entirely replaced, plowing does not occur and the soils and hydrology are generally undisturbed.
- **Low intensity land use**. This category includes those land uses, such as open space and recreation, which have little or no impact on the wetland's vegetation, soils and hydrology.

FIGURE 24
WILDLIFE DIVERSITY/ABUNDANCE MODEL (FIELD METHOD)(page 4 of 7)



Microrelief of Wetland Surface

Variations of microrelief at the wetland surface provide an additional element of habitat diversity. Plant species diversity is improved in a wetland with an irregular surface compared to one in which the surface is at constant elevation relative to water level at or below the soil surface. Certain faunal species also benefit from the presence of slightly elevated surfaces in the wetland based on nest site preference, drier soil for burrow construction or the differences in vegetation structure and composition. A condition of pronounced microtopographic relief would receive a 3, well-developed relief a 2 and poorly developed relief a 1.

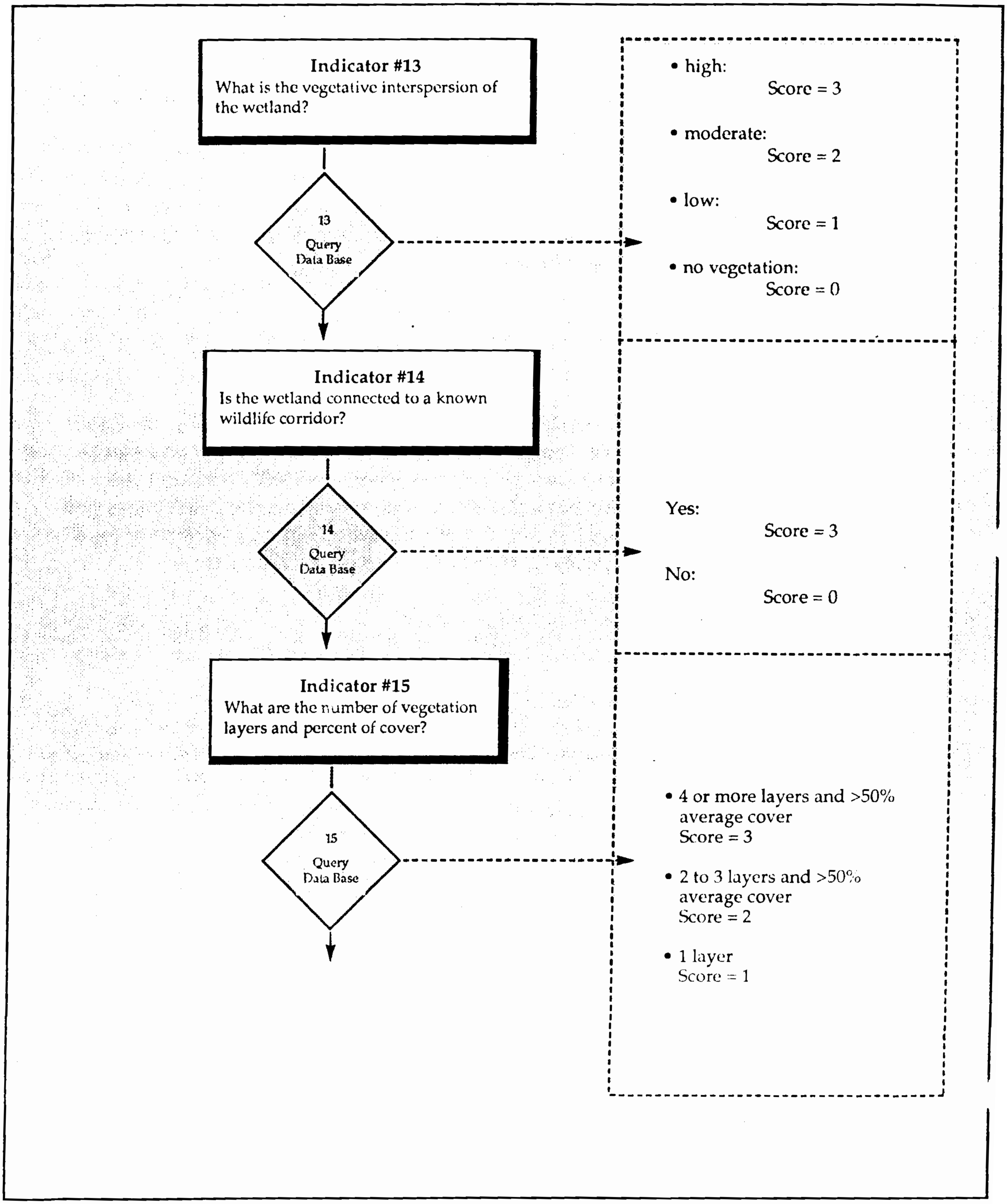
Presence of Seeps or Springs

Presence of seeps and springs can be an important factor for wetland fauna requiring surface water in situations where other surface water is absent. Their occurrence can be especially important for certain species during winter, providing a source of drinking water when other sources are frozen. Plant species frequently associated with seeps provide overwintering structures and green parts that are available as food sources throughout winter. A perennial spring or seep would receive a score of 2, an ephemeral spring or seep a score of 1, and absence of seeps or springs a zero.

Water Chemistry

Water chemistry is a contributing factor in the capacity of a wetland to maintain wildlife diversity and abundance. Water chemistry characteristics influence the presence, density and diversity of aquatic plants and microinvertebrates, which constitute the principal food sources for wetland wildlife. High pH correlates with more favorable water chemistry conditions, whereas low pH environments having low alkalinity correlate with less favorable conditions relative to the quantity and nutritional quality of vegetation. The condition corresponding to a pH of 6.5 is optimal, and is assigned a 3; pH values are assigned between 4.0 - 6.5 condition score of 2 and a pH value of less than 4.0 is assigned a 1.

FIGURE 24
WILDLIFE DIVERSITY/ABUNDANCE MODEL (FIELD METHOD)(page 5 of 7)



Vegetative Interspersion

Most wildlife species require more than one vegetation type to complete their life cycle, and the density and diversity of wildlife populations are closely related to the length and types of vegetative edge. Interspersion correlates well with amount and type of edge, and is a good indicator of wildlife abundance and diversity. The conditions are scored in descending order from 3 to 1. Several different vegetation types distributed in broken patches would produce maximum interspersion and would be assigned a score of 3; a single vegetation type would produce very little, if any, interspersion and would be assigned a score of 1, whereas an intermediate condition would be assigned a 2.

Connected to Wildlife Corridor

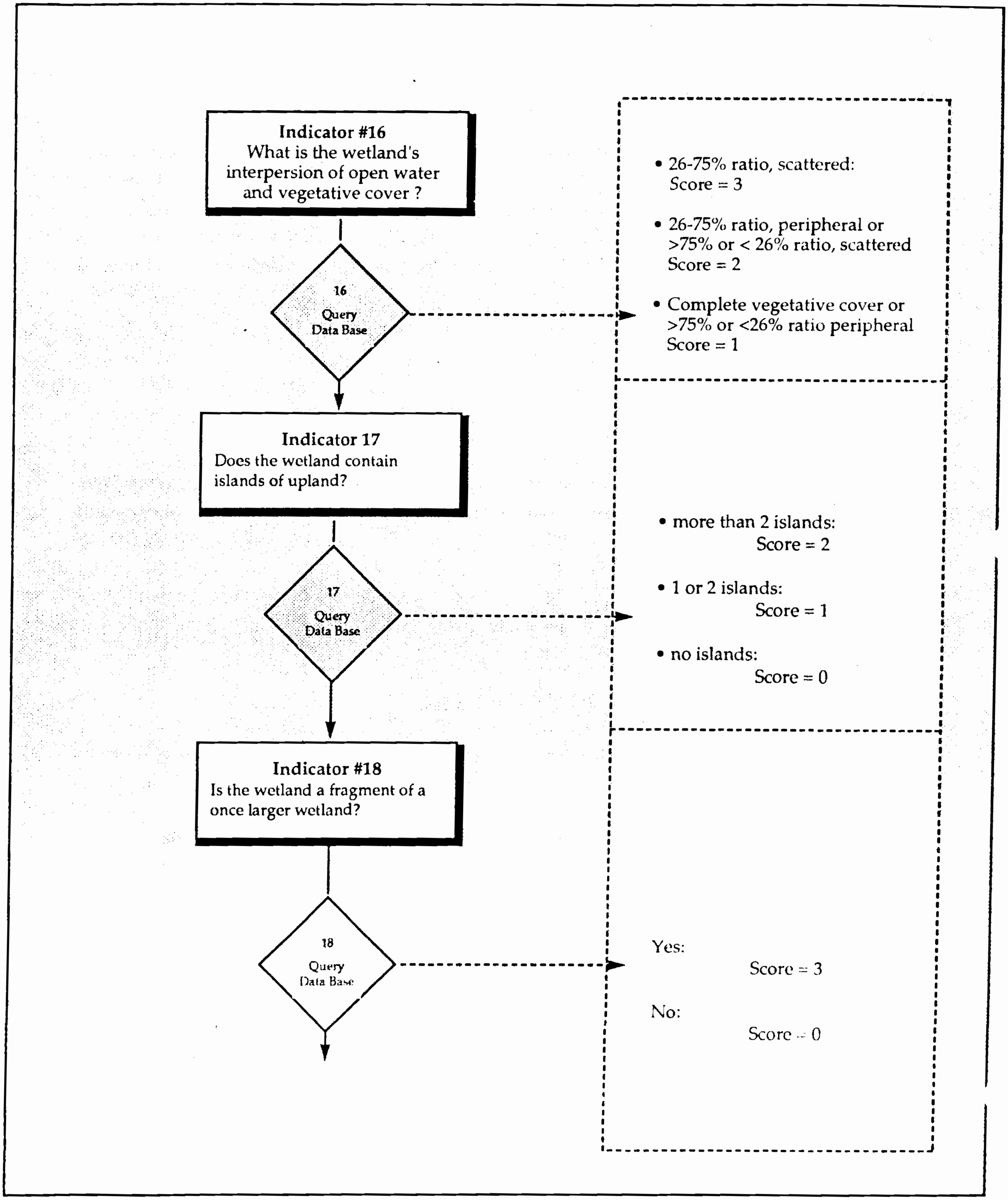
In urbanized areas, wildlife move along corridors from one habitat to another. These corridors are critical to their life cycles. Commonly, wetlands occur as linear features which serve as wildlife corridors and are adjacent to upland wildlife corridors. Wetlands which are or are adjacent to wildlife corridors are assigned a score of 3.

Number of Vegetation Layers and Percent Cover

The correlation between foliage height diversity and wildlife, particularly bird species, diversity has been well established. The predictability of this variable is directly related to the number of vegetative layers in the vegetation community. The variable condition having 4 or more layers and an average percentage cover of greater than 50 percent was assigned a score of 3. The condition scores are reduced with fewer layers and lower percentage of cover, a score of 1 represents the least optimal condition with respect to performance of the function.

Average Percent Cover: Average of percent cover for each individual layer

FIGURE 24
WILDLIFE DIVERSITY/ABUNDANCE MODEL (FIELD METHOD)



Interspersion of Open Water and Vegetative Cover

The correlation between interspersion of vegetation cover and open water, and habitat conditions for wildlife, particularly waterfowl, has been well established. Some species are very territorial, and the density of the breeding population is closely related to interspersion. The optimal condition for this variable is one in which cover/water ratio is approximately equal and interspersion is high; this condition is assigned a score of 3. As the ratio and interspersion diminish, the condition scores assigned are 2 or 1.

Presence of Islands

The presence of islands of upland within a wetland or open water area can be important relative to habitat value for certain wildlife. Wildlife such as loons, geese and ducks will readily nest on islands surrounded by water when they are present owing to the safety afforded from predators. There is no minimum size for an island beyond the minimum space requirements for an individual of a given species. The limitation on maximum size would be reached at a point where the island was sufficiently large to support 1 or more predators. The presence of islands, evaluated in the context of other factors important for wildlife, such as size of the wetland or open water area and surroundings, can provide useful information relative to habitat quality for certain species. The variable condition most conducive to this function is one of more than 2 islands present; this condition is assigned a score of 2. A condition of 1 or 2 islands would receive a score of 1, and complete absence of islands or presence of islands large enough to support predators would be given a zero.

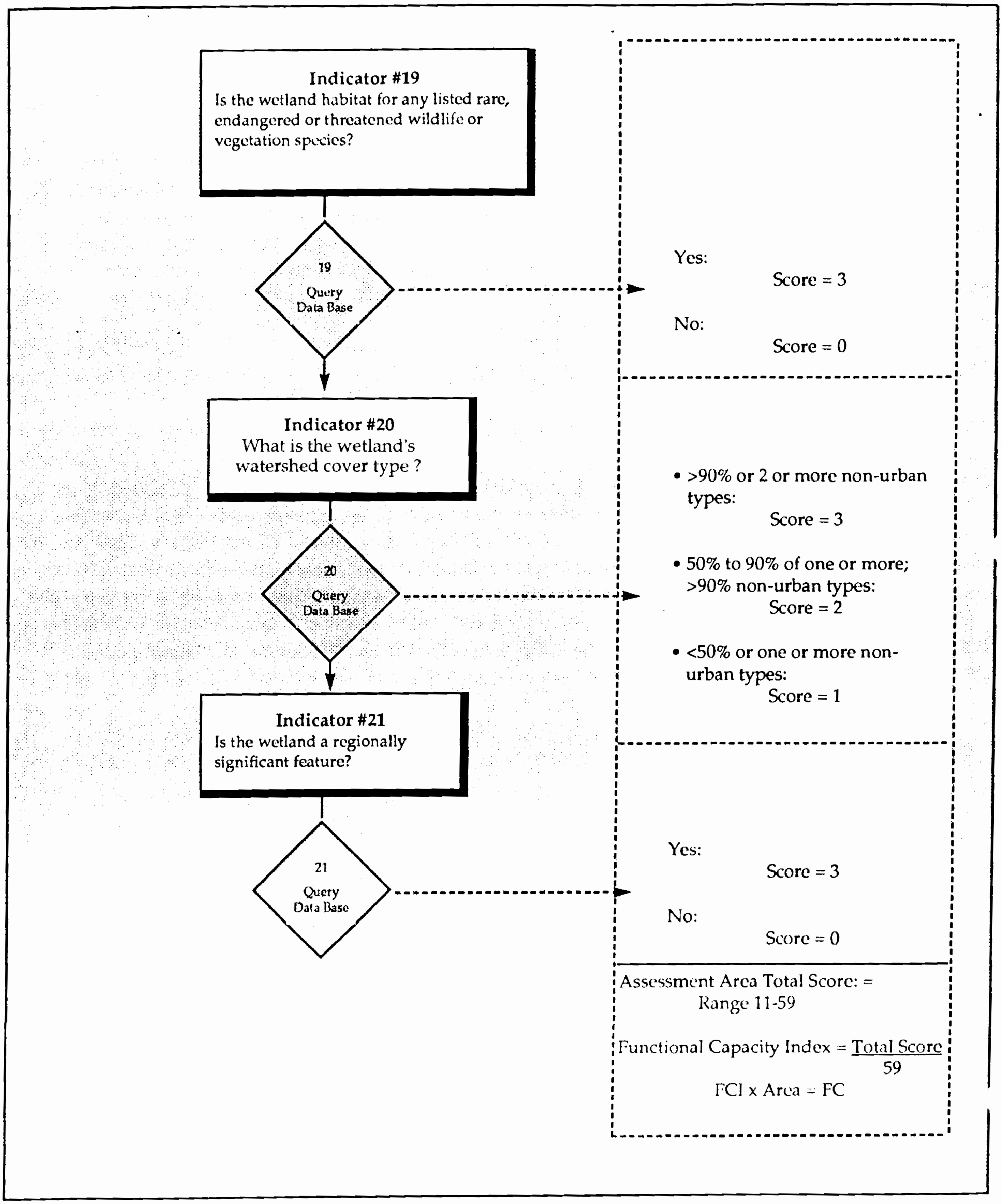
Fragment of Once Larger Wetland

Many wetlands have been decreased in size from their original natural size, causing increased function to be obtained from the small, remaining wetland area. Those that are a fragment of a once larger wetland are assigned a score of 3.

Data sources used to determine wetland fragmentation:

- Aerial photography
- USGS mapping
- NRA NWI wetland data layer
- WRA MDE wetland data layer

FIGURE 24
WILDLIFE DIVERSITY/ABUNDANCE MODEL (FIELD METHOD)(page 7 of 7)



Rare, Endangered or Threatened Listed Wildlife or Vegetation Species

If the wetland contains one or more wildlife species which are listed as rare, endangered or threatened by the Maryland Natural Heritage program or by the Federal Government the wetland is assigned a score of 3. If the wetland does not contain a listed species then it is assigned a score of zero.

Data is obtained from the habitat maps of the State's Natural Heritage Program.

Watershed Cover Type

Since many wildlife species that inhabit wetlands also fulfill part of their habitat requirements in the surrounding watershed and vice-versa, the nature of the habitat and land use activities in the watershed are very important determining factors in the capacity of a wetland for this function. Destruction of habitat due to development in the watershed, alteration of drainage patterns, and human activity are all factors that could substantially alter the capacity of the wetland to fulfill the life cycle requirements of many wildlife species typically found in wetlands. The most favorable condition relative to performance of function is a watershed consisting of a high proportion of 2 or more landscape elements such as shrub land and forest land; this condition is assigned a score of 3. The score assigned becomes less as the proportion of urban development becomes higher, the least valuable condition being a watershed more than half urbanized; this condition is assigned a score of 1.

Regional Significance

Wetlands that have been identified by natural resources government agencies as regionally significant are designated as such because of a special quality, topographic feature, or function the wetland provides to the surrounding region. More often, a wetland can be designated regionally significant if it provides specific plant and animal habitat that is considered important to the region, or if a known occurrence of a threatened or endangered plant/animal species exists in the wetland. If the wetland is designated as regionally significant, it is assigned a score of 3. If the wetland is not designated as such, it is assigned a score of zero.

6.0 DESK TOP METHOD WETLAND FUNCTIONAL ASSESSMENT MODELS

The following models shown on Figures 25 through 30 are used for the assessment of Maryland's eight statutory functions. The method combines the assignment of numerical scores to scale variable conditions as used by Golet and Larson (1974) and others with a landscape assessment method of using indices similar to Ammann, et al. (1991), Liebowitz, et al. (1993), and Smith, et al. (1995). The modeling methodology has been selected for its application to a desk top method using GIS and available published data.

As in the Field Method Models, the Desk Top Models consist of a list of indicators which are assumed, in combination, to give rise to sustainable function. Each indicator contains a range of conditions which are scaled from that which is assumed to provide the least function, to the condition which gives the most function.

Values are assigned to each condition, which gives robustness to the models. A condition which indicates no contribution to function is given a zero. As the conditions progressively increase in indicator status, a higher number is assigned. For example, if these conditions occur, they will range from 1 for the one having lesser indicator status to 3 for the one having the most indicator status. If the range of conditions is a simple "Yes" or "No", the "No" gets a zero and the "Yes" a 1, 2, or 3 based on professional judgement.

The total model score is divided by the maximum possible score (assumed to equal the maximum sustainable function) to produce a functional capacity index, with the maximum sustainable function capacity equaling 1.00. This is the function capacity index for a unit area of wetland.

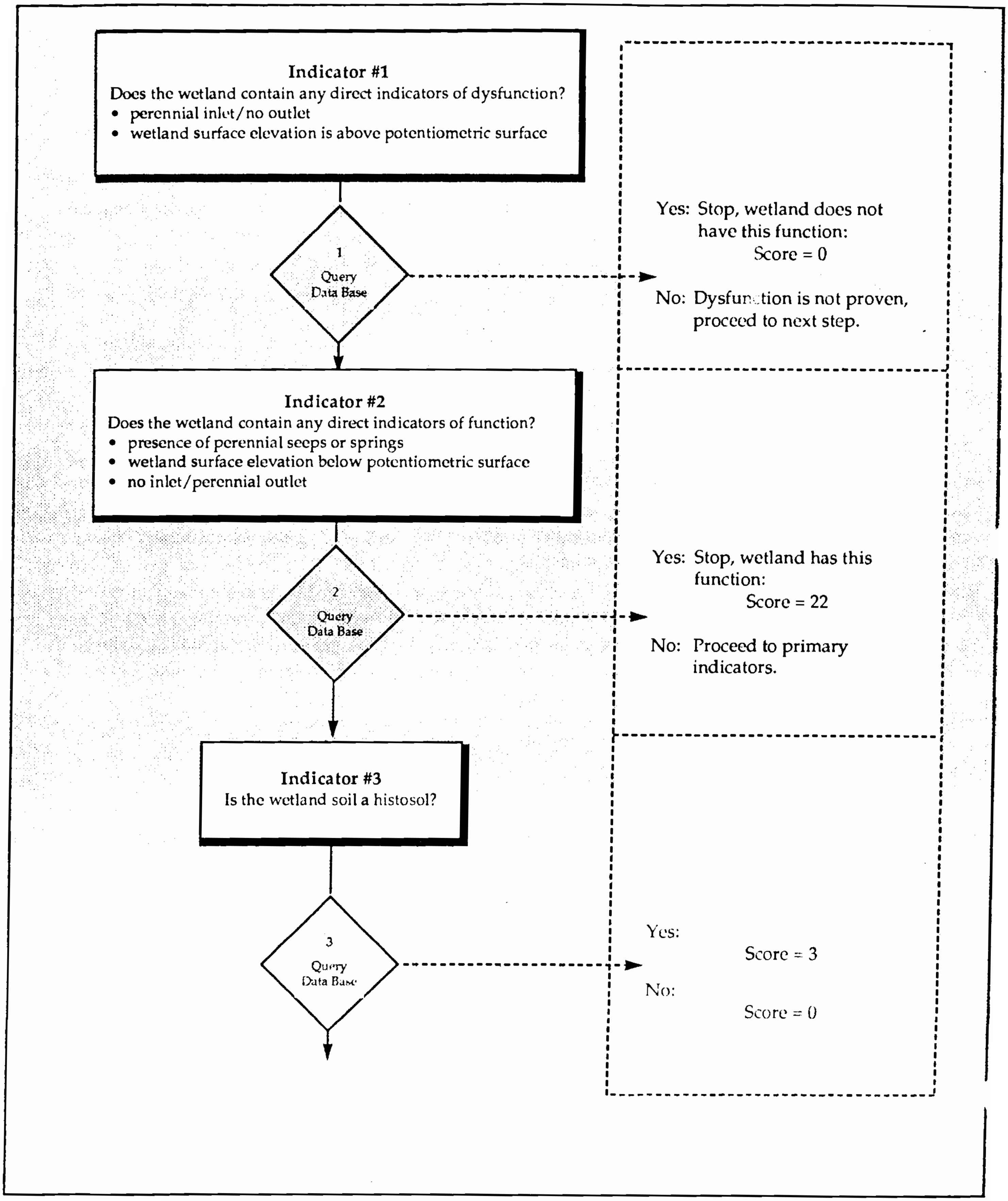
The function capacity index is multiplied by the area of the wetland to produce the wetland's functional capacity. The functional capacity for each of the six functions can be added to produce a total functional capacity for the wetland.

The Desk Top Method Models are designed for use on a landscape level, requiring no field work, and using secondary sources of information, such as; U.S.G.S. topography maps, U.S. Fish and Wildlife National Wetlands Inventory Maps, Soil Conservation Service maps, and GIS use.

If a definition of a term or idea is needed, refer to **Section 3.0, Description of Variables Used in the Models.**

FIGURE 25

GROUND WATER DISCHARGE FUNCTION (DESK TOP METHOD)(page 1 of 4)



Indicators of Dysfunction

There are three variable conditions that, if present indicate that the wetland does not perform this function:

- Perennial inlet/no outlet
- Nested piezometers data show recharge
- Wetland substrate elevation is above potentiometric surface

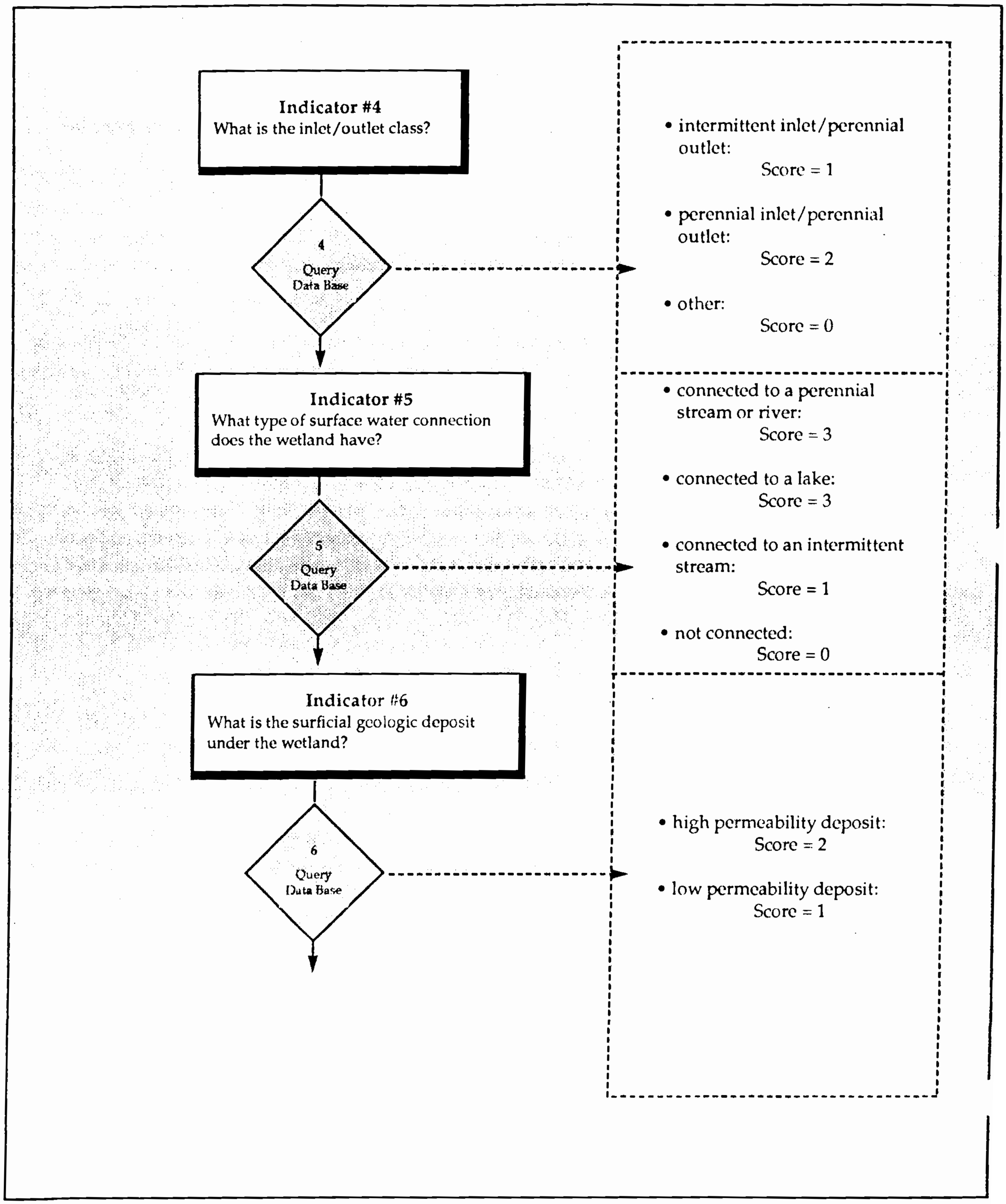
Direct Indicators of Function

There are four direct indicators of this function which, if present, circumvent the need to evaluate the function by evaluating the other variables, these are; no inlet-perennial outlet, evidence of perennial seeps and springs, wetland substrate elevation below potentiometric surface, and nested piezometers data showing discharge. All of these are absolute indicators of function and are assumed to indicate the maximum sustainable functional capacity, which yields a score of 27 for the field method and a score of 22 for the desk top method.

Soil Type

Ground water discharge areas generally contain histosols (soils with high organic content) because the constant swelling of ground water allows for anaerobic conditions to persist throughout the year, which allows for the accumulation of organics. Histosols, therefore, are more likely to indicate the presence of ground water discharge to streams than are mineral hydric soils. Histosols are assigned a score of 3. The lack of histosol (or the presence of mineral hydric soils) is more indicative of areas where recharge occurs since saturation does not occur long enough to create organics (histosols), and is assigned a score of zero.

FIGURE 25
GROUND WATER DISCHARGE FUNCTION (DESK TOP METHOD)(page 2 of 4)



Inlet/Outlet Class

Wetlands having a perennial inlet and a perennial outlet indicate that the wetland is in direct communication with the regional water table and is very likely to be a discharge area and is assigned a score of 2. Wetlands with an intermittent inlet and a perennial outlet are less likely to be a ground water discharge area and are assigned a score of 1.

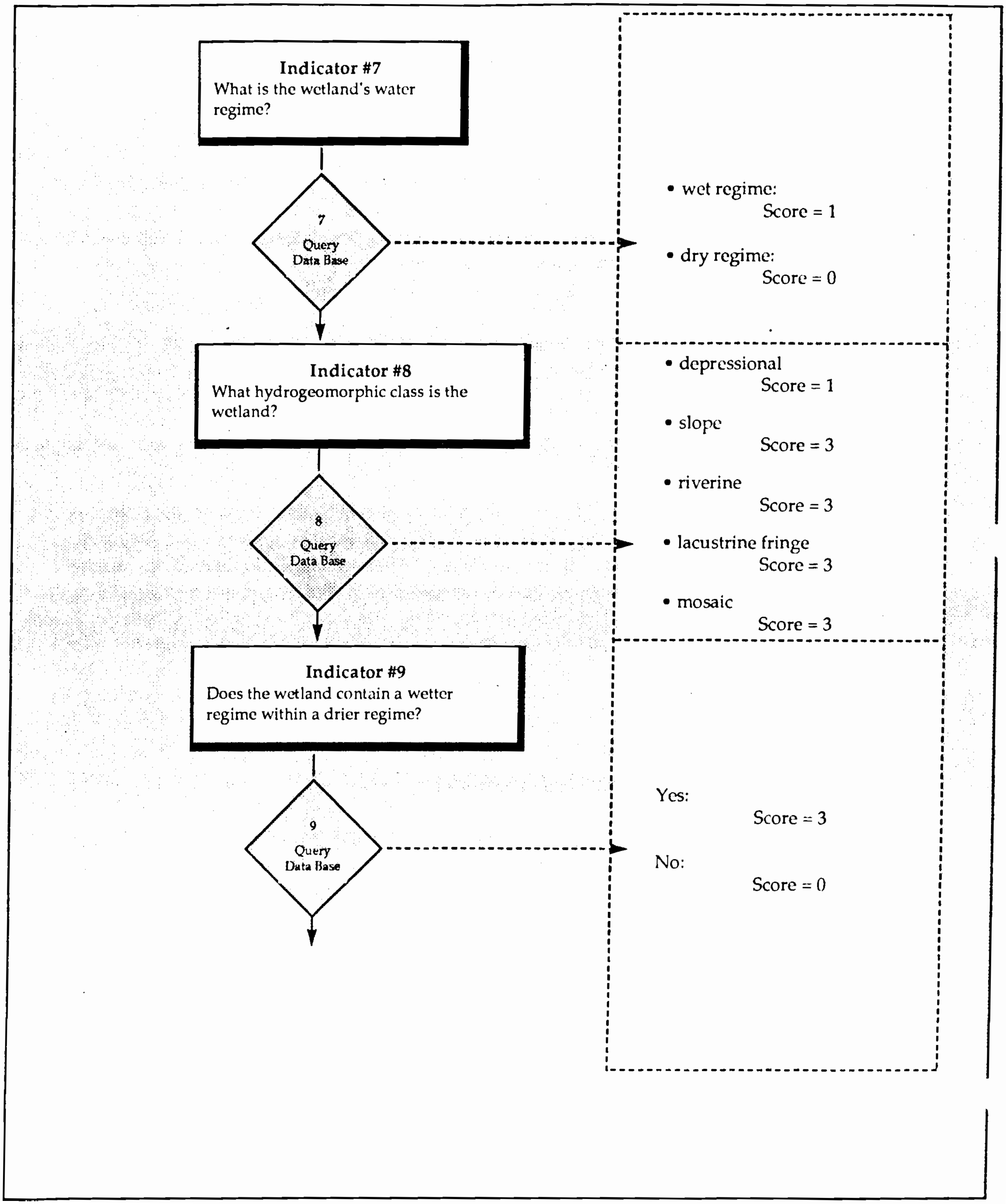
Surface Water Connection Types

Large perennial streams, rivers and lakes are predominantly ground water discharge areas, directly connected to the water table and are assigned a score of 3. Intermittent streams are likely to be ground water discharge areas in the spring, when water tables are high and interflow is present. They are not likely to be discharge areas in the summer when water tables are low and the stream is dry. They are assigned a score of 1.

Surficial Geologic Deposit Under the Wetlands

Wetlands associated with high permeability surficial geologic deposits are likely to be discharge areas, since these types of deposits predominantly have a gently sloping water table, the upland is a primary recharge area and wetlands occur where topographic lows intersect the nearly flat regional water tables. These wetlands are assigned a score of 2. Low permeability geologic deposits are less likely to have a gently sloping water table, less likely to have uplands which are a regional recharge area and, therefore, their wetlands are less likely to be discharge areas and are assigned a score of 1.

FIGURE 25
GROUND WATER DISCHARGE FUNCTION (DESK TOP METHOD)(page 3 of 4)



Wetland Water Regime

Wet water regimes indicate the presence of saturated or inundated conditions for the majority of the growing season and are more likely to be discharge areas than are drier water regimes. They are assigned a score of 1 and drier regimes a zero.

Wet Water Regimes:	Vegetative communities which are tolerant of permanently flooded, intermittently exposed, and semi-permanently flooded (i.e. Aquatic bed, marsh) conditions.
Dry Water Regimes:	Vegetative communities which are indicative of seasonally flooded, temporarily flooded, and saturated (i.e. wet meadow, scrub-shrub, forested wetland) conditions.

Hydrogeomorphic Class

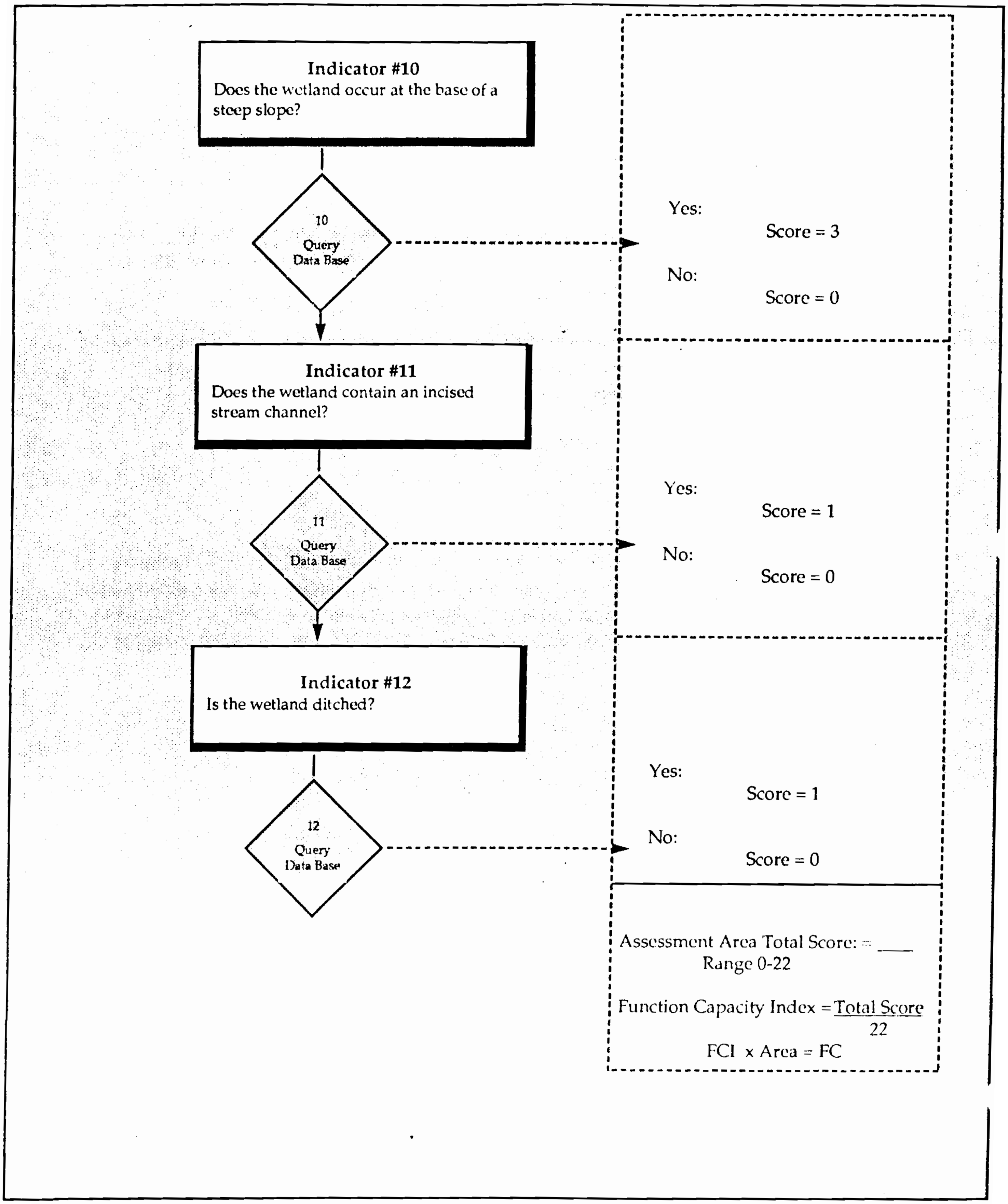
Slope, riverine, lacustrine fringe and mosaic wetlands all are likely to be ground water discharge areas because they are generally associated with the regional table, and are all assigned a score of 3. Depressional wetlands are most likely to be recharge areas, where water is trapped and allowed to seep into the water table, but occasionally may be discharge areas, and are assigned a score of 1.

Occurrence of a Wetter Hydrologic Regime within a Drier Regime

The occurrence of a wetter hydrologic regime within a wetland dominated by a drier regime may indicate that a seep or spring occurs in the wetter regime area, indicating ground water discharge, and is assigned a score of 3.

FIGURE 25

GROUND WATER DISCHARGE FUNCTION (DESK TOP METHOD)(page 4 of 4)



Occurrence of the Wetland at the Base of a Steep Slope

Wetlands commonly occur where the water table intersects the land surface, which commonly occurs at the base of a steep slope. Wetlands occurring at the base of a steep slope are assumed to be ground water discharge areas and are assigned a score of 3.

Presence of an Incised Stream Channel

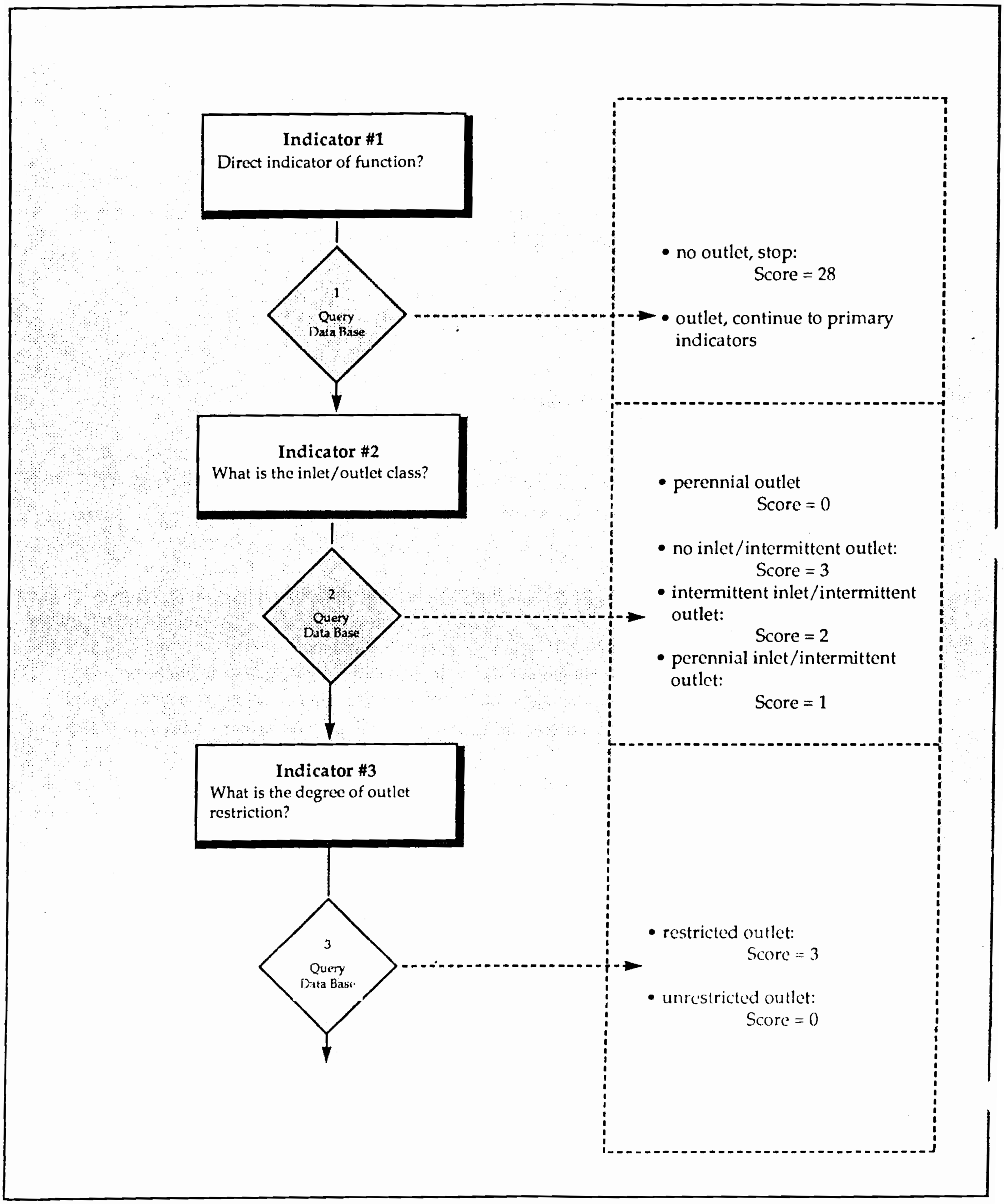
Stream channels incised into a wetland are assumed to intersect the wetland's water table which discharges into the stream channel. Presence of an incised stream channel is assigned a score of 1.

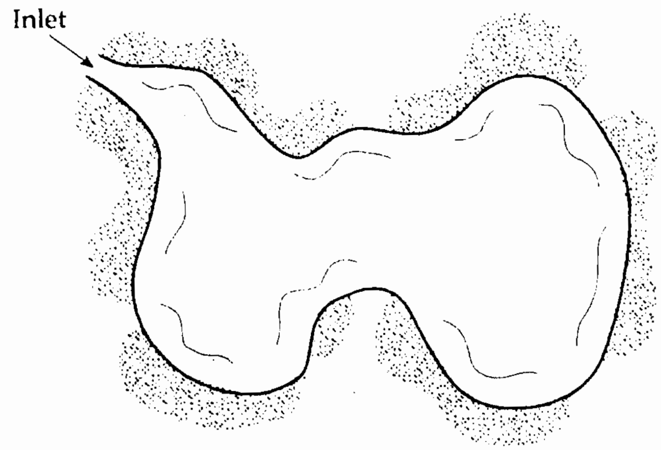
Occurrence of Ditches

Ditches are dug to drain wetlands so that land use activities can occur, such as agriculture. It is assumed that these ditches lower the water table in the wetland, therefore, discharging ground water into the ditches. Wetlands with ditches are assumed to be more likely to be discharge areas and are assigned a score of 1.

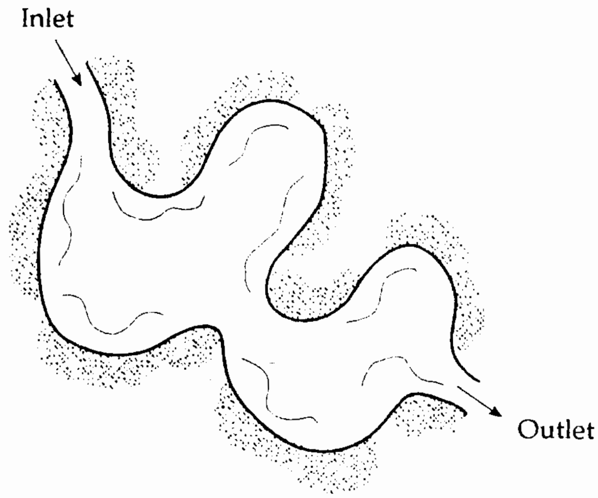
FIGURE 26

FLOOD FLOW ATTENUATION MODEL (DESK TOP METHOD) (page 1 of 4)





Wetland with no outlet



Wetland with outlet

Inlet/Outlet Class

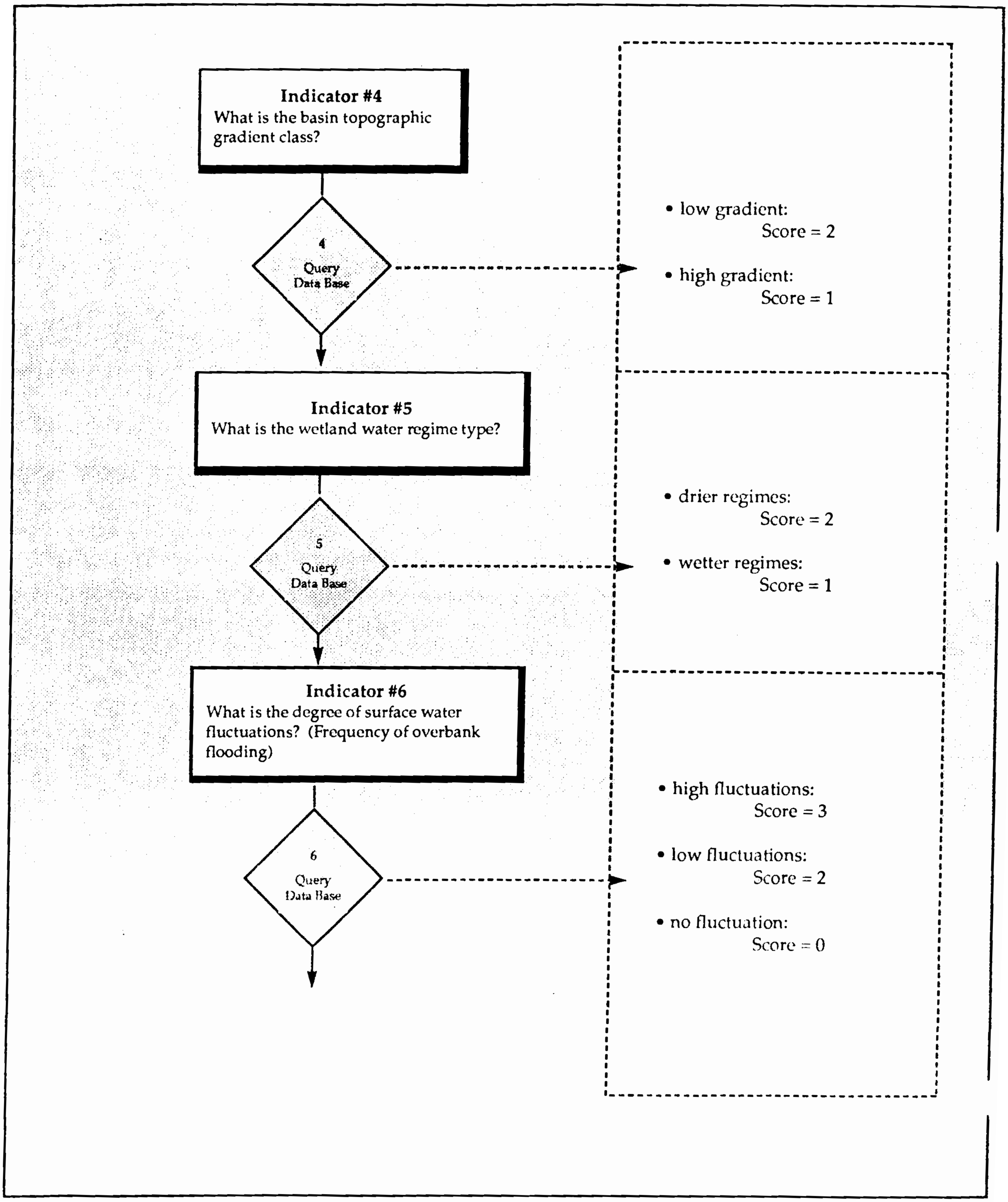
Wetlands with no outlet provide the highest capacity for flood flow attenuation because they store all water that flows into their basin. The condition of no outlet is considered in the model to be a direct indicator of this function and receives a maximum score of 34. Wetlands with intermittent outlets have free board (storage volume) below the invert of their outlet between flood flows, which must be satisfied before outlet flow begins. This storage is likely to be greatest in wetlands having no inlet but an intermittent outlet and is assigned a score of 3. Wetlands with intermittent inlets or perennial inlets are progressively less likely to have free board available and are assigned a 2 and 1 respectively. Wetlands with perennial outlets do not have free board available and are assigned a zero.

Degree of Outlet Restriction

Restricted outlet conditions will result in increased flood stage levels within the wetland, when inflow exceeds the outlet's hydraulic capacity. Flood water will back up behind the restricted outlet, attenuating flood flow. Restricted outlets are assigned a score of 3. Unrestricted outlets do not result in increase flood stage within the wetland and no flood flow attenuation occurs as a result of outlet control. Unrestricted outlets are assigned a score of zero.

FIGURE 26

FLOOD FLOW ATTENUATION MODEL (DESK TOP METHOD) (page 2 of 4)



Basin Topographic Gradient

The slope of the wetland basin surface is one factor which limits the amount of water that can be stored over the wetland surface. When all other factors are equal, the wetland with the lowest gradient will store the most flood water, and a low gradient is given the score of 2. High gradient wetlands are assigned a score of 1.

Range of Conditions:

- High gradient: > 2%
- Low gradient: < 2%

Wetland Water Regime Type

Wetlands with drier water regimes periodically are not inundated and their surfaces periodically or seasonally become unsaturated, allowing for water storage on and in the wetland substrate. They then have a low coefficient of runoff than wetter regimes which have a high coefficient of runoff. These wetlands are assigned a score of 2 while wetter regimes, which are permanently saturated or inundated are assigned a 1.

Wet Water Regimes: Vegetative communities which are tolerant of permanently flooded, intermittently exposed, and semi-permanently flooded (i.e. aquatic bed, marsh) conditions.

Dry Water Regimes: Vegetative communities which are indicative of seasonally flooded, temporarily flooded, and saturated (i.e. wet meadow, scrub-shrub, forested wetland) conditions.

Surface Water Fluctuations

Wetlands with high water level fluctuations illustrate that flood water is being stored and attenuated periodically in the wetland. The higher the fluctuation the more flood water being attenuated. High fluctuations are assigned a 3, low a 2, and no fluctuation a zero.

Indirect Physical Indicators of Flooding:

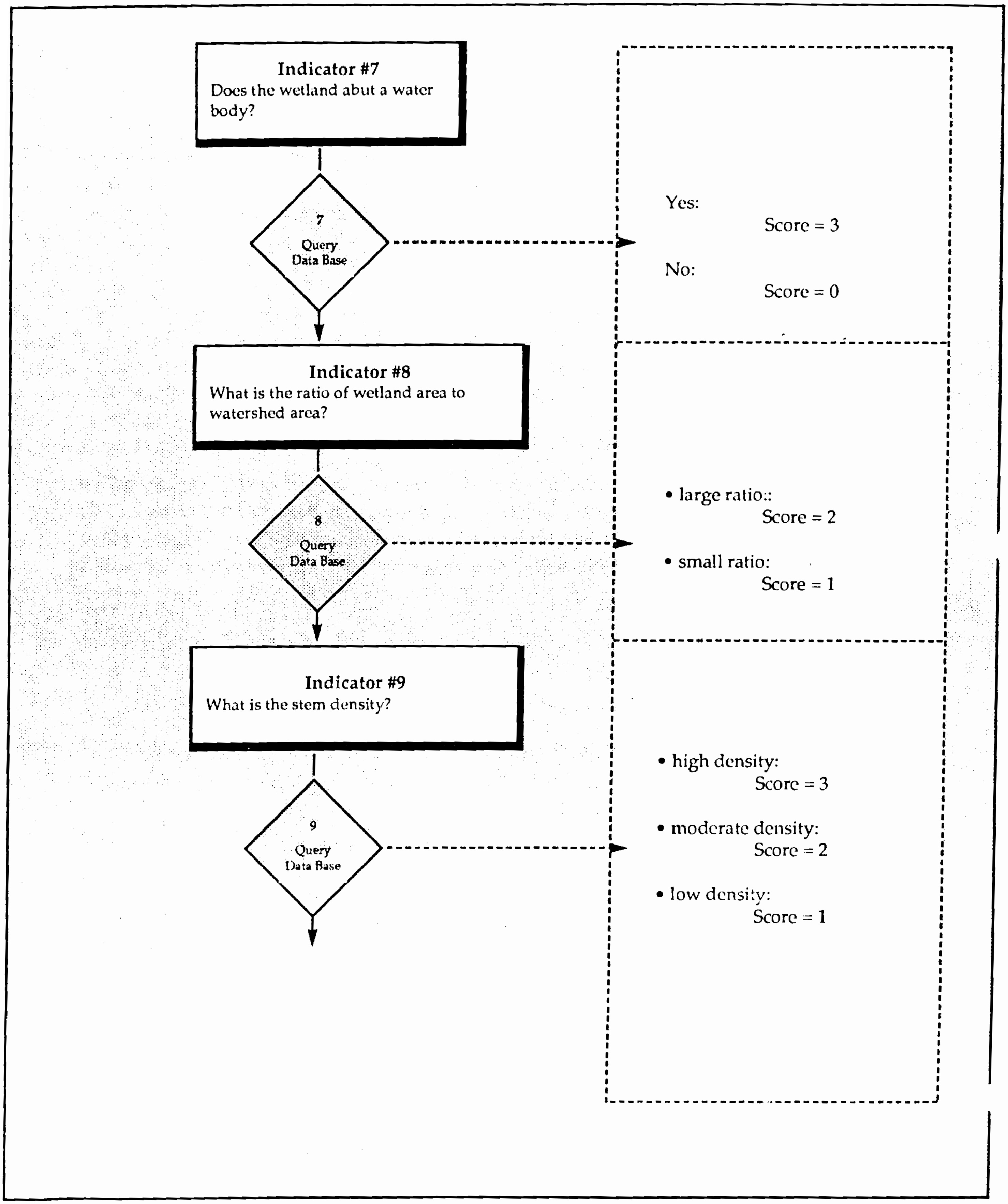
- silt stained leaves
- silt rings on stems
- ice marks on stems
- strand lines
- debris lines
- stain lines

Direct Indicators of Flooding:

- water level gauges
- FEMA/FIRM maps

FIGURE 26

FLOOD FLOW ATTENUATION MODEL (DESK TOP METHOD) (page 3 of 4)



Wetland Abuts a Water Body

Wetlands which abut water bodies are assumed to be discharge areas and are assigned a score of 3.

Ratio of Wetland Area to Wetland Watershed Area

When the watershed of two wetlands are equal and all other factors constant except wetland area, the larger wetland area can store and attenuate more flood flows than the smaller wetland area. Wetlands with a large ratio of wetland area to wetland watershed area are assigned a 2, while a low ratio is assigned a 1.

Range of Conditions:

- Large ratio: >10%
- Small ratio: <10 %

Stem Density

Stem density also offers roughness to the wetland surface, which reduces flood flow velocities through the wetland helping to detain flood flows. High stem density is assigned a score of 3, and low density 1.

Range of Conditions:

- High
- Medium
- Low

Definitions:

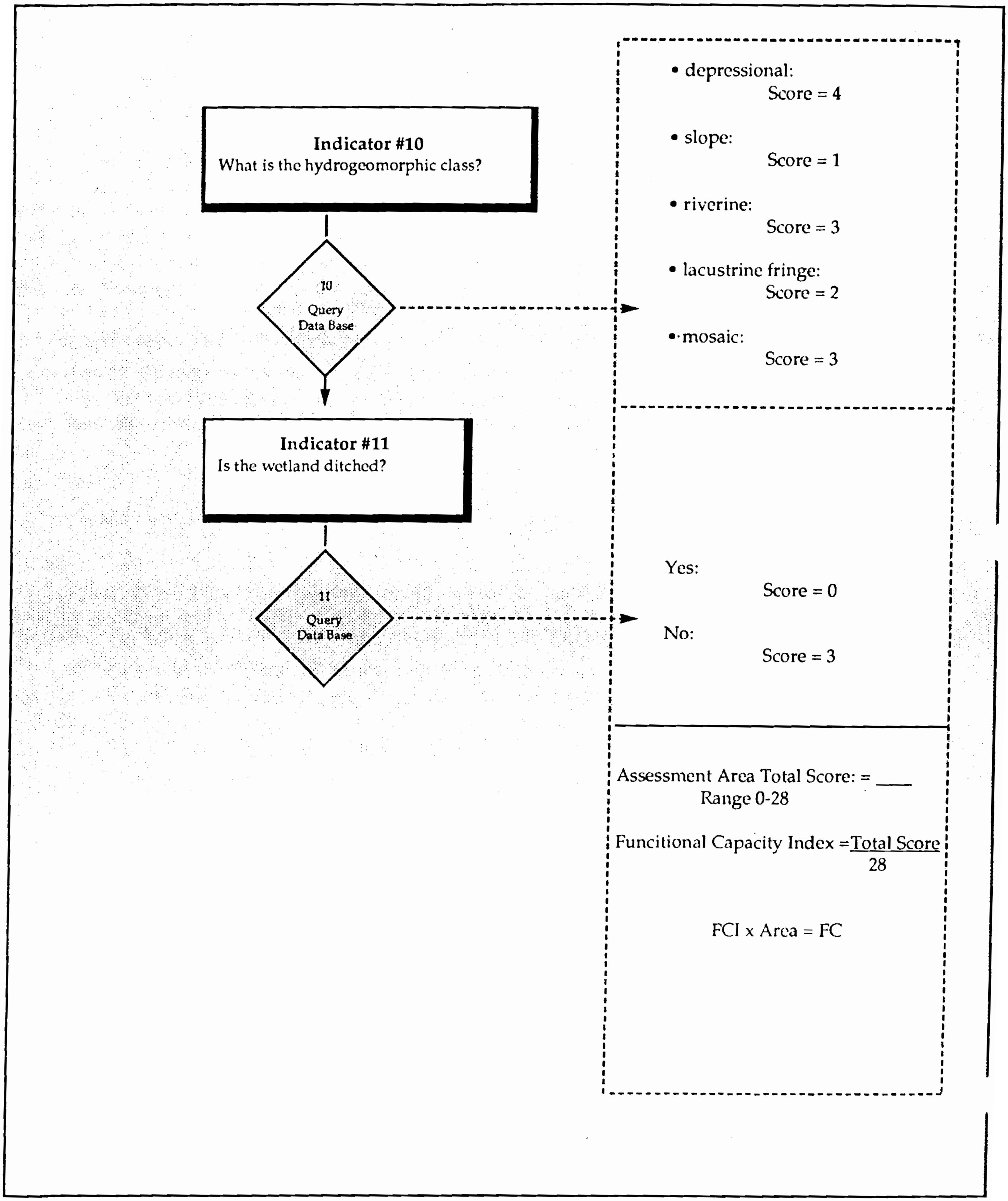
High Density: Stem density in the form of woody or emergent vegetation that covers the entire wetland with little/no open water or bare ground surface present.

Low Density: Stem density in the form of woody or emergent vegetation that is sparsely distributed throughout the wetland due to large amounts of open water or bare ground surface.

Moderate Density: Stem density whose distribution pattern is between the low and high conditions.

FIGURE 26

FLOOD FLOW ATTENUATION MODEL (DESK TOP METHOD) (page 4 of 4)



Hydrogeomorphic Class

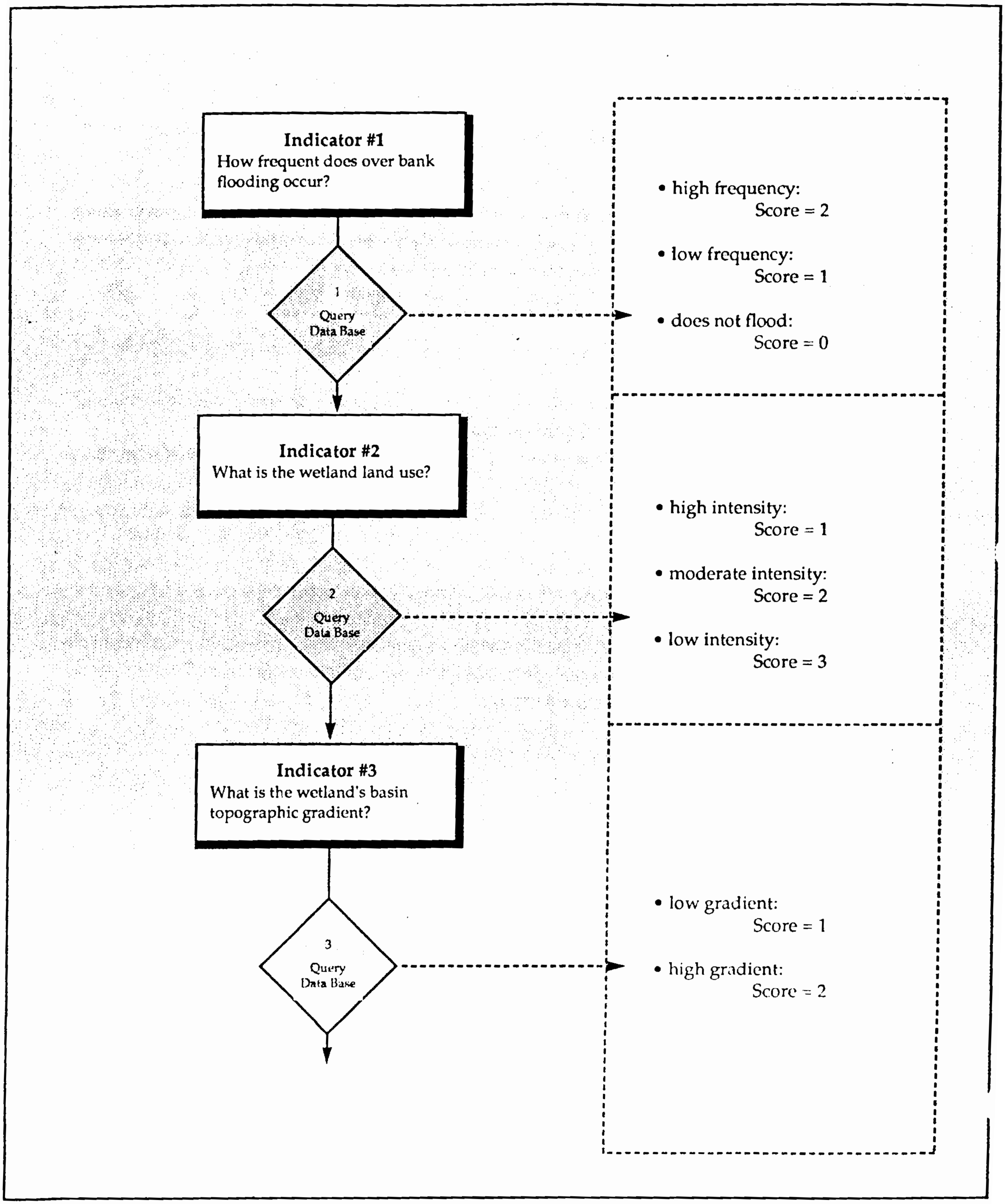
The geomorphology of a wetland's basin controls the movement of water into, through and out of the wetland.

- **Depressional** wetlands have the greatest potential for flood flow attenuation because the depressional basin shape collects water from all directions, depressional wetlands commonly have restricted outlets, and free board below the outlet invert. They are assigned a score of 4.
- **Riverine** wetlands are periodically flooded and offer natural valley food storage sites, as well as roughness to flow. They are assigned a score of 3.
- **Mosaic** wetlands commonly are nearly flat, contain riverine wetlands and depressional wetlands and are also assigned a score of 3.
- **Lacustrine** fringe wetlands may be flooded by lake level increases, but because lake level flooding predominantly has less fluctuations than riverine flooding, they are assigned a score of 2.
- **Slope** wetlands offer no flood storage above their substrate, and only offer roughness to attenuate flood flows and are assigned a score of 1.

Ditching

Ditches drain water from wetlands. Ditched wetlands are less likely to store long-term flood water than are unditched wetlands. Wetlands without ditches are assigned a score of 3 while those wetlands with ditches are assigned a score of zero.

FIGURE 27
MODIFICATION OF WATER QUALITY FUNCTION
(DESK TOP METHOD)



Frequency of Overbank Flooding

In order for a wetland to modify inflowing water, the inlet stream must flood the wetland by overbank flooding. Therefore, overbank flooding is the transport mechanism by which sediment, nutrient, dissolved solids and suspended solids enter the wetland. When all other factors are equal, the wetland with more frequent overbank flooding will have the highest effect on modifying water quality. High frequency of flooding is assigned a score of 3, moderate a 2, and low a 1. Wetlands that do not flood are assigned a zero.

Range of Conditions:

High frequency:	< 5 years
Moderate frequency:	6-20 years
Low frequency:	20 years to 100 years

Field Evidence of Flooding:

A. Direct Observation
B. Watermarks/silt rings on tree trunks
C. Scouring
D. Debris deposition

Wetland Land Use

Land use activities within a wetland can directly influence a wetland's capacity to perform this function. High intensity land use of a nature that alters hydrology, soils and/or vegetation can have a major effect on water storage and sedimentation and on wetland capacity to perform water quality modification; this condition was assigned a score of 1. Moderate intensity uses that do not alter soils or hydrology or entirely remove the vegetation were assigned a score of 2 and low intensity uses such as open space or passive recreation were given a 3.

Range of Conditions:

- **High intensity land use.** Included in this category are land uses such as intense agricultural (row crops), activities which remove the natural vegetation and modify the soils and hydrology.
- **Moderate intensity land uses.** Included in this category are land uses such as grazing and forestry, where the natural vegetation is modified but not entirely replaced, plowing does not occur and the soils and hydrology are generally undisturbed.
- **Low intensity land use.** This category includes those land uses, such as open space and recreation, which have little or no impact on the wetland's vegetation, soils and hydrology.

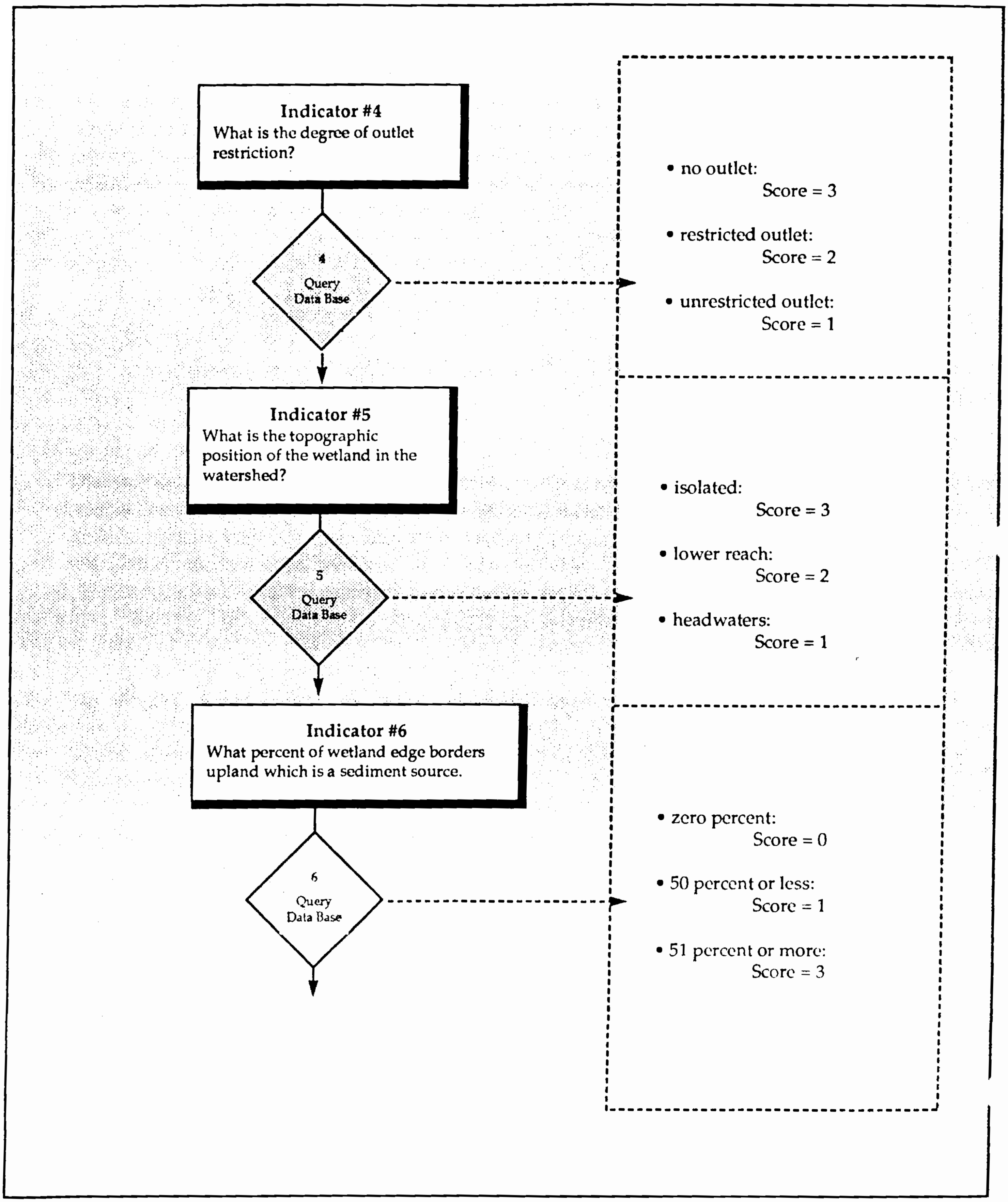
Basin Topographic Gradient

Wetlands with a low gradient are more likely to perform this function than one with a high gradient, because of the longer time for water to reside in the wetland, where it can interact with the soils and vegetation. Accordingly, low gradient wetlands were assigned a score of 3 and high gradient wetlands a score of 2.

Range of Conditions:

- High Gradient: >2%
- Low Gradient: < 2%

FIGURE 27
MODIFICATION OF WATER QUALITY FUNCTION
(DESK TOP METHOD)



Degree of Outlet Restrictions

Wetlands with no outlet are very likely to serve this function because the length of time that water remains in the wetland where it can interact with the wetland plants and soils is maximized. This condition was assigned a score of 3. Wetlands with unrestricted outlets have much less capacity to serve this function because they pass water through the wetland and do not allow it to spread out over the wetland's surface, therefore, this condition was assigned a score of 1. Wetlands with restricted outlets fall between these two situations and were assigned a score of 2. These assignments are made as a result of the ability of the outlet to control water storage.

Topographic Position in the Watershed

Isolated wetlands are most likely to perform this function because of their high long-term water storage capabilities and this condition was assigned a score of 3. Lower reach wetlands are more likely to perform this function than headwater wetlands, because of their greater likelihood of a high frequency of flooding which allows water interaction with soil and vegetation; this condition was assigned a score of 2. Headwater wetlands were assigned a score of 1 because they generally pass water rapidly down to lower reach wetlands.

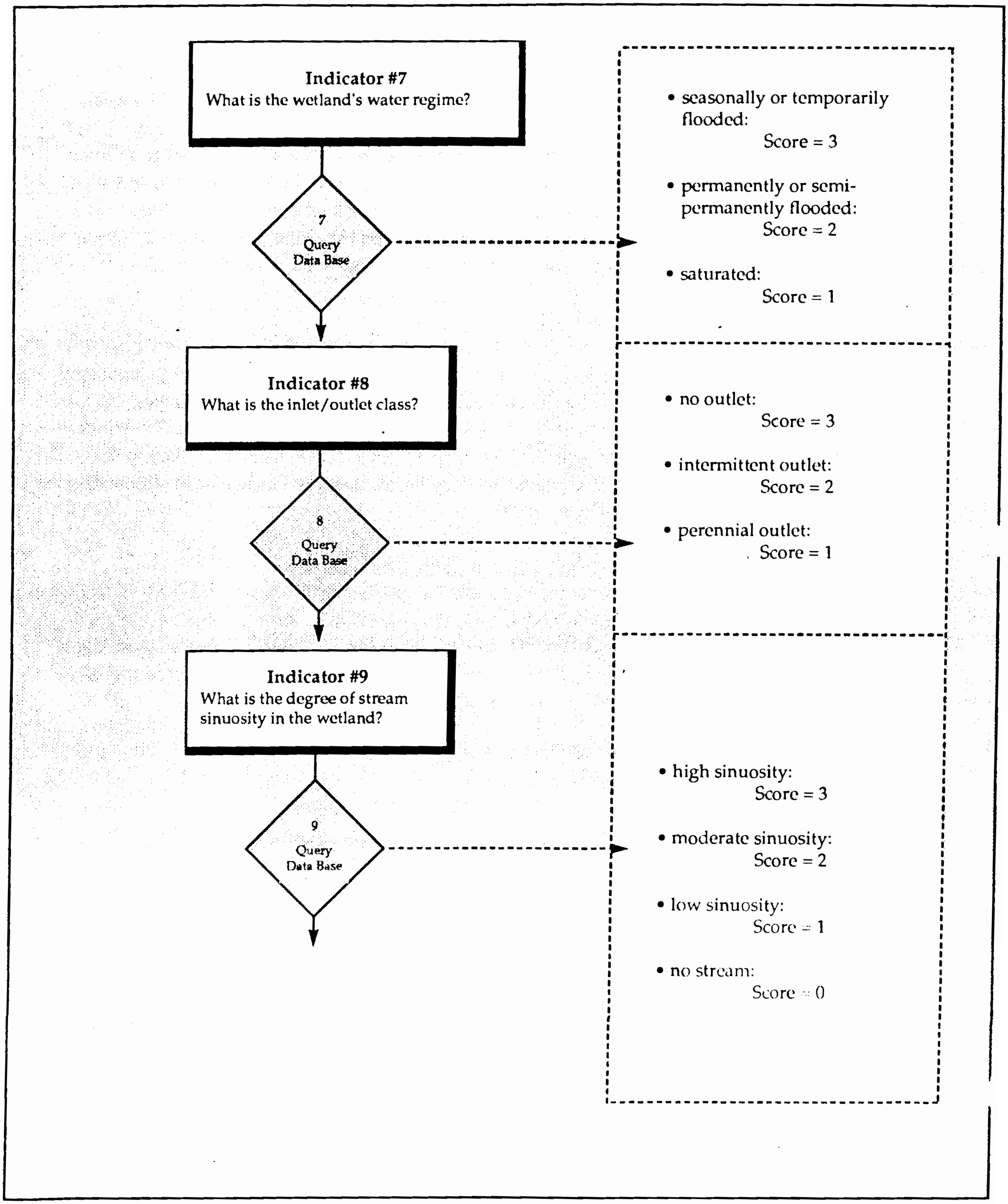
Percent of Wetland Edge Bordering Upland Sediment Source

Wetlands which have edges that border uplands which are potential sediment sources are more likely to modify inflowing water quality. Those with 51 percent or more of the wetland edge bordering a sediment source are assigned a score of 3, those with 50 percent or less are assigned a score of 1. Those which do not border a sediment source are assigned a score of zero.

Uplands considered potential sediment sources include:

- Actively cultivated agricultural fields
- Surface mines
- Soil-slope areas classified by Soil Conservation Service as eroding or erosion hazard
- Severely eroding stream or road banks

FIGURE 27
MODIFICATION OF WATER QUALITY FUNCTION
(DESK TOP METHOD)



Water Regime

Permanently flooded and semi-permanently flooded water regimes are less likely to be indicative of this function than are saturated, temporarily flooded and seasonally flooded areas, because interaction of water with soil and plants occurs more on sites without surface water than on flooded sites. A permanently or semi-permanently flooded condition was assigned a 1, seasonally or temporarily flooded a 2, and saturated a 3.

Inlet/Outlet Class

The outlet of a wetland may control how much and how long water is stored in the wetland, allowing processes involving plants, soils and animals to modify water quality. A wetland with no outlet maximizes these interactions and is assigned a score of 3. An intermittent outlet results in less interaction of water with wetland processes and is assigned a score of 2. A perennial outlet is likely to result in the least interaction and is assigned a score of 1.

Stream Sinuosity

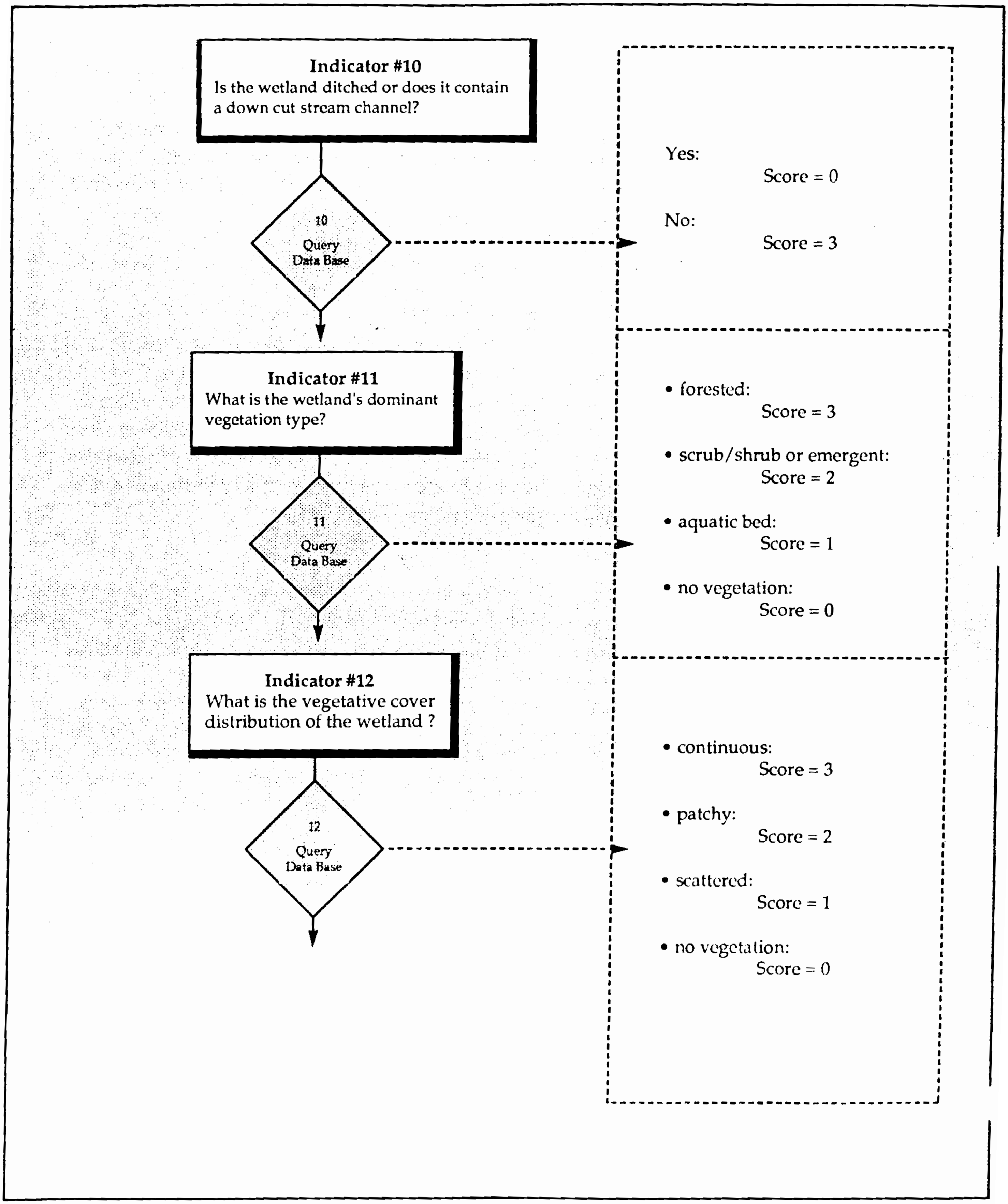
In wetlands that contain streams, the degree of convolution of the stream course can play a role in this function. As the degree of irregularity of the stream course increases, so also do water residence time and the quantity of dispositional environments. A condition of maximum stream length/straight line distance ratio was assigned a score of 3, an intermediate ratio a 2 and a low ratio a 1.

$$\textbf{STREAM SINUOSITY} = \frac{\textbf{Stream Length}}{\textbf{Straight Line Distance}}$$

Range of Conditions:

Stream length/wetland length ratio: > 0.67
Stream length/wetland length ratio: 0.33-0.66
Stream length/wetland length ratio: < 0.33

FIGURE 27
MODIFICATION OF WATER QUALITY FUNCTION
(DESK TOP METHOD)



Ditching or Down Cut Stream

Wetlands with a down cut stream channel or which have been ditched, are less likely to retain water long enough to modify its water chemistry and are, therefore, assigned a score of zero. Those without ditches or a down cut stream channel are assigned a score of 3.

Dominant Vegetation Type

Dominant vegetation type can predict detention and retention of water, which allows for interaction of nutrients and contaminants with soil and vegetation. Dominant vegetation type can also predict whether removal will result in short-term or long-term storage of nutrients and contaminants, depending upon the density of woody species present. Relative productivity and nutrient uptake occur at a faster rate in immature wetland plant communities. However, storage time is shorter in the younger stages compared to a mature community. The variable condition having the highest correlation with these conditions is forested wetland; all factors considered. Accordingly, this condition was assigned a score of 3. Scrub shrub and emergent wetlands and aquatic beds were scored 2 and 1 respectively.

Vegetation Cover Distribution

Vegetation cover physically retains water, providing particulate retention and interaction of nutrients and contaminants with soil and vegetation. The indicator value of vegetative cover distribution for this function, therefore, is closely related to that for water storage. Cover evenly distributed throughout the wetland provides greater particulate retention and greater opportunity for interaction of nutrients and contaminants than a patchy cover or isolated stems. A condition of continuous cover was assigned a score of 3, whereas conditions typified by a more patchy, scattered cover would be scored a 2 or 1.

FIGURE 27
MODIFICATION OF WATER QUALITY FUNCTION
(DESK TOP METHOD)

Indicator #13
What type of soil occurs in the wetland?

13
Query
Data Base

- histosol or mineral hydric soil with high clay content:
  Score = 3
- silty hydric soil:
  Score = 2
- sandy hydric soil:
  Score = 1

Indicator #14
What is the wetland's hydrogeomorphic class?

14
Query
Data Base

- depressional:
  Score = 4
- slope:
  Score = 1
- riverine:
  Score = 3
- lacustrine fringe:
  Score = 2
- mosaic:
  Score = 3

Assessment Area Total Score: =
Range 8-41

Functional Capacity Index = $\frac{\text{Total Score}}{41}$

FCI x Area = FC

Soil Type

Soil type plays an important role in this function because of the chemical reactions that take place in the soil and at the soil, water, vegetation interface. Condition scores can vary from 3 for a type characterized by a high density of chemically reactive surfaces, such as a histosol (organic soil) or a mineral hydric soil with a high clay component, to a 1 for soil with a high proportion of sand. An intermediate condition would receive a score of 2.

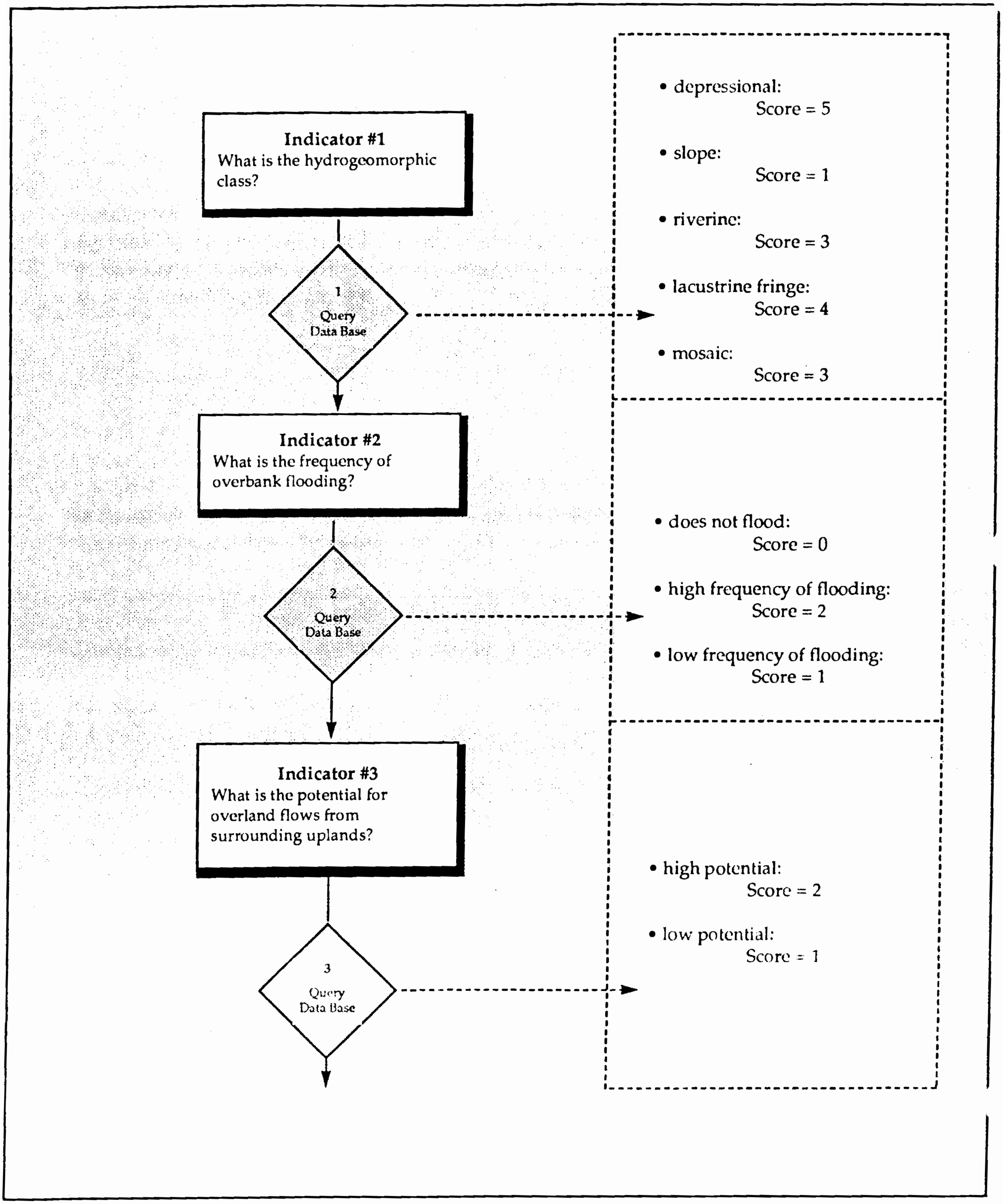
Hydrogeomorphic Class

The geomorphology of the wetland basin controls the water flow vectors, hydrodynamics and interaction of water with wetland processes occurring in the wetland's water column regime, soil regime and vegetation regime.

Range of Conditions:

- **Depressional wetlands** predominating maximum water residency time, allowing for maximum interaction and are assigned a score of 4.
- **Riverine wetlands** are frequently inundated by overbank flooding and include certain vegetation, soils and natural valley flood storage conducive to processes which modify water quality. They are assigned a score of 3.
- **Mosaic wetlands**, because of their flatness, also induce interactions and are also assigned a score of 3.
- **Lacustrine fringe** wetlands generally flood less frequently and are assigned a score of 2.
- **Slope wetlands** retain and detain water less than other hydrogeomorphic classes and are assigned a score of 1.

FIGURE 28
SEDIMENT STABILIZATION FUNCTION MODEL
(DESK TOP METHOD)



Hydrogeomorphic Class

The wetland's geomorphology has a major influence on the hydrodynamics of the water which passes through the wetland.

Range of Conditions:

- **Depressional wetlands**, because of their shape and general lack of flow through hydrology and outlets, perform sediment stabilization by trapping the sediment within their basin and are assigned a score of 5.
- **Lacustrine fringe** wetlands are predominantly nearly flat and their surface is controlled by the adjacent lake's water plain. They are predominately densely vegetated and serve as excellent sediment traps and are assigned a score of 4.
- **Riverine wetlands** are associated with flood plains, where they are periodically inundated with flood water which typically contains sediment. The riverine wetland vegetation creates roughness which slows water allowing for sedimentation to occur. Floodplains are also areas where the hydrology is dynamic and flood water may erode sediment and prevent stabilization. Therefore, riverine wetlands are given a score of 3.
- **Mosaic wetlands** are generally broad flat wetlands containing riverine, lacustrine fringe and depressional wetland subareas. They are assigned a score of 3.
- **Slope wetlands** do not store flood water and lack the sedimentation function of the other wetland types. They do offer roughness to through-flowing sediment rich water, which results in a limited sediment stabilization function, and they are assigned a score of 1.

Frequency of Overbank Flooding

Overbank flooding is the transport mechanism by which sediments from streams enter floodplain wetlands. This function primarily relates to riverine wetlands, but lacustrine fringe wetland receive flood water from the lake. Mosaic wetlands generally contain floodplains, and occasionally so do depressional wetlands. Those wetlands with a high frequency of overbank flooding are assigned a score of 2, those with low frequency a 1. Wetlands that do not flood are assigned a zero.

Range of Conditions:

High Frequency:	< 5 years
Moderate Frequency:	6 to 20 years
Low Frequency:	> 20 years to 100 years

Field Evidence of Flooding:

A.	Direct Observation
B.	Watermarks/Silt marks on tree trunks
C.	Scouring
D.	Debris Deposition

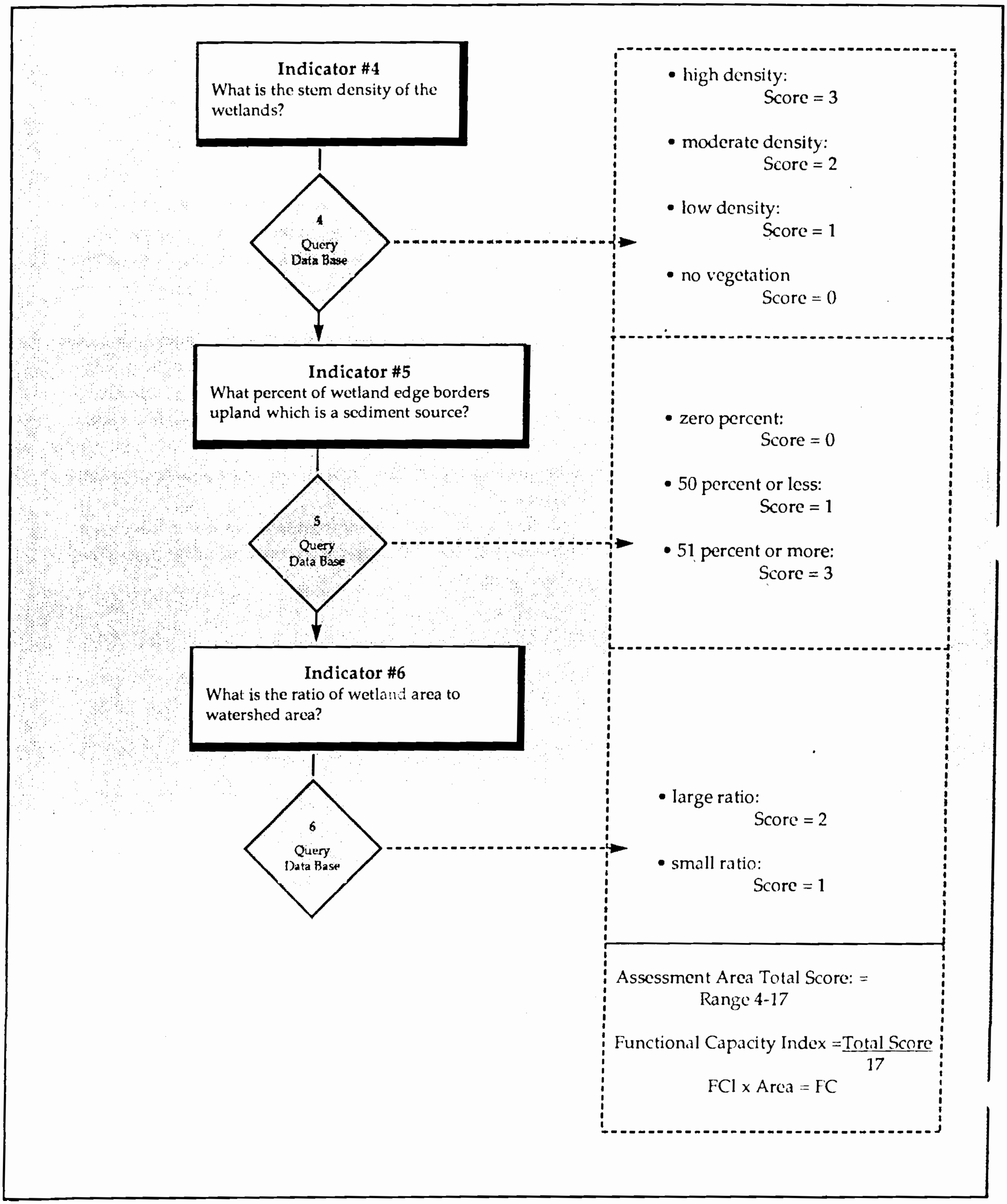
Potential of Overland Flows From Surrounding Uplands

Another source of sediment rich water to the wetland is runoff from the surrounding upland. Those upland areas surrounding the wetland which have a high potential are assigned a score of 2, those with a low potential a 1.

Range of Conditions:

High Potential:	> 100 acres of upland contributing to overland flow
Low Potential:	100 or less acres of upland contributing to overland flow

FIGURE 28
SEDIMENT STABILIZATION FUNCTION MODEL
(DESK TOP METHOD)



Stem Density

Vegetation stems offer resistance to through-flowing flood waters carrying sediment and adds to the roughness of the wetland surface. This slows down water allowing sedimentation. Fine grained sediment is deposited downstream of dense vegetation. New vegetation holds the trapped sediment in place preventing erosion and resuspension of the sediment. High stem density is assigned a score of 3, low a 1.

Range of Conditions:	*Definitions:*
• **High**	**High Density**: Stem density in the form of woody or emergent vegetation that covers the entire wetland with little/no open water or bare ground surface present.
• **Moderate**	**Moderate Density:** Stem density whose distribution pattern is between the low and high conditions.
• **Low**	**Low Density:** Stem density in the form of woody or emergent vegetation that is sparsely distributed throughout the wetland due to large amounts of open water or bare ground surface.

Percent of Wetland Edge Bordering Upland Sediment Source

Sediment may enter a wetland carried by runoff from adjacent upland. Some upland, such as agricultural land may be a sediment source. The wetland can trap this inflowing sediment. The amount of wetland edge bordering erodible upland influences how much sediment a wetland may trap. If 51 percent or more of the wetland edge borders erodible upland then a score of 3 is assigned. If 50 percent or less of the wetland edge borders erodible upland then a score of 1 is assigned. If none of the wetland edge borders erodible upland then a score of zero is assigned.

Ratio of Wetland Area to Watershed Area

The amount of sediment entering a wetland may be influenced by its watershed size. All other characteristics being equal, the larger the wetland, the more opportunity to trap sediment, and the larger the watershed, the more potential sediment enters the wetland. A large ratio is assigned a score of 2, a small ratio is assigned a score of 1.

Range of Conditions:

Large ratio: >10%
Small ratio: <10%

$$\text{Ratio} = \frac{\text{wetland area}}{\text{watershed area}} \times 100$$

FIGURE 29

AQUATIC DIVERSITY/ABUNDANCE MODEL

(DESK TOP METHOD)

Direct Indicators of Dysfunction
- Only contains dry hydrologic regimes and is not adjacent to a water body.

Yes:
Dysfunction

No:
Proceed to First Indicator

Indicator #1
What is the wetland's hydrogeomorphic class?

1
Query
Data Base

- depressional:
  Score = 2
- slope:
  Score = 1
- riverine:
  Score = 3
- lacustrine fringe:
  Score = 3
- mosaic:
  Score = 4

Indicator #2
What is the wetland's association with open water?

2
Query
Data Base

- adjacent to a river or lake:
  Score = 5
- contains scattered open water:
  Score = 3
- no open water in wetland
  Score = 0

Direct Indicator of Dysfunction

The dominance of dry hydrologic regimes to include temporarily flooded and saturated regimes do not provide habitat for aquatic species and are direct indicators of dysfunction.

Vegetative Communities that typically have dry hydrologic regimes:

- **Wet meadows**
- **Scrub-shrub wetland**
- **Forested wetland**

Hydrogeomorphic Class

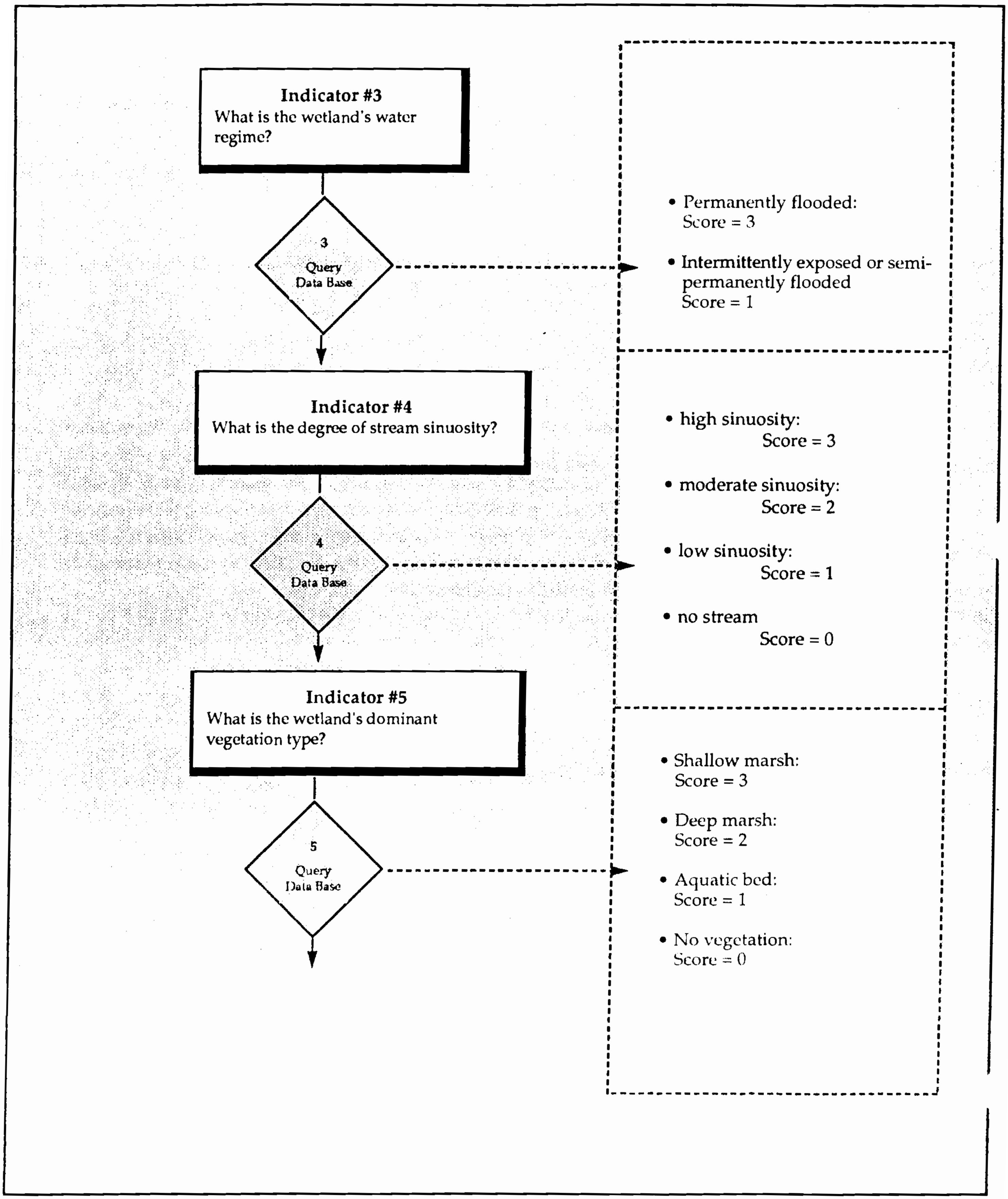
Mosaic wetlands contain a variety of hydrogeomorphic subareas. They generally are broad flat regional wetlands containing a wide variety of sites where aquatic habitats may occur. Because of this diversity they are assigned the highest score, a 4. Lacustrine fringes and riverine wetlands are assigned the next highest score, a 3, because they are associated with the adjacent aquatic habitats of the lake and/or river channel. They are periodically inundated by the lake or river and become interconnected with those aquatic habits. Depressional wetland may contain limited aquatic habitats and are assigned a score of 2, while slope wetlands seldom contain standing water long enough to provide an aquatic habitat and are assigned a score of 1.

Association With Open Water

Open water is habitat for aquatic species. Wetlands associated with open water are more likely to provide habitat than those not associated. Wetlands not associated with open water are assigned a score of zero. Wetlands adjacent to a river or lake are assigned a score of 3, while wetlands containing scattered open water are assigned a score of 2.

FIGURE 29

AQUATIC DIVERSITY/ABUNDANCE MODEL
(DESK TOP METHOD)



Wetland Water Regime

The water regime dictates the presence or lack of aquatic habitats. The dominance of permanently flooded wetlands are most likely to support aquatic habitats, while dominance of intermittently exposed or semi-permanently flooded wetlands are less likely.

Vegetative communities that typically have wet hydrologic regimes that are permanently flooded:

- **Aquatic bed wetland**
- **Deep marsh**
- **Shallow marsh**
- **Open water pond**

Stream Sinuosity

The more convoluted a steam channel is, the more likely it will have a variety of aquatic habitats, and the more likely those habitats will overlap into the adjacent wetland. High sinuosity is assigned a score of 3. medium a 2, and low a 1.

$$\textbf{Stream Sinuosity} = \frac{\textbf{Stream Length}}{\textbf{Straight Line Distance}}$$

Range of Conditions:

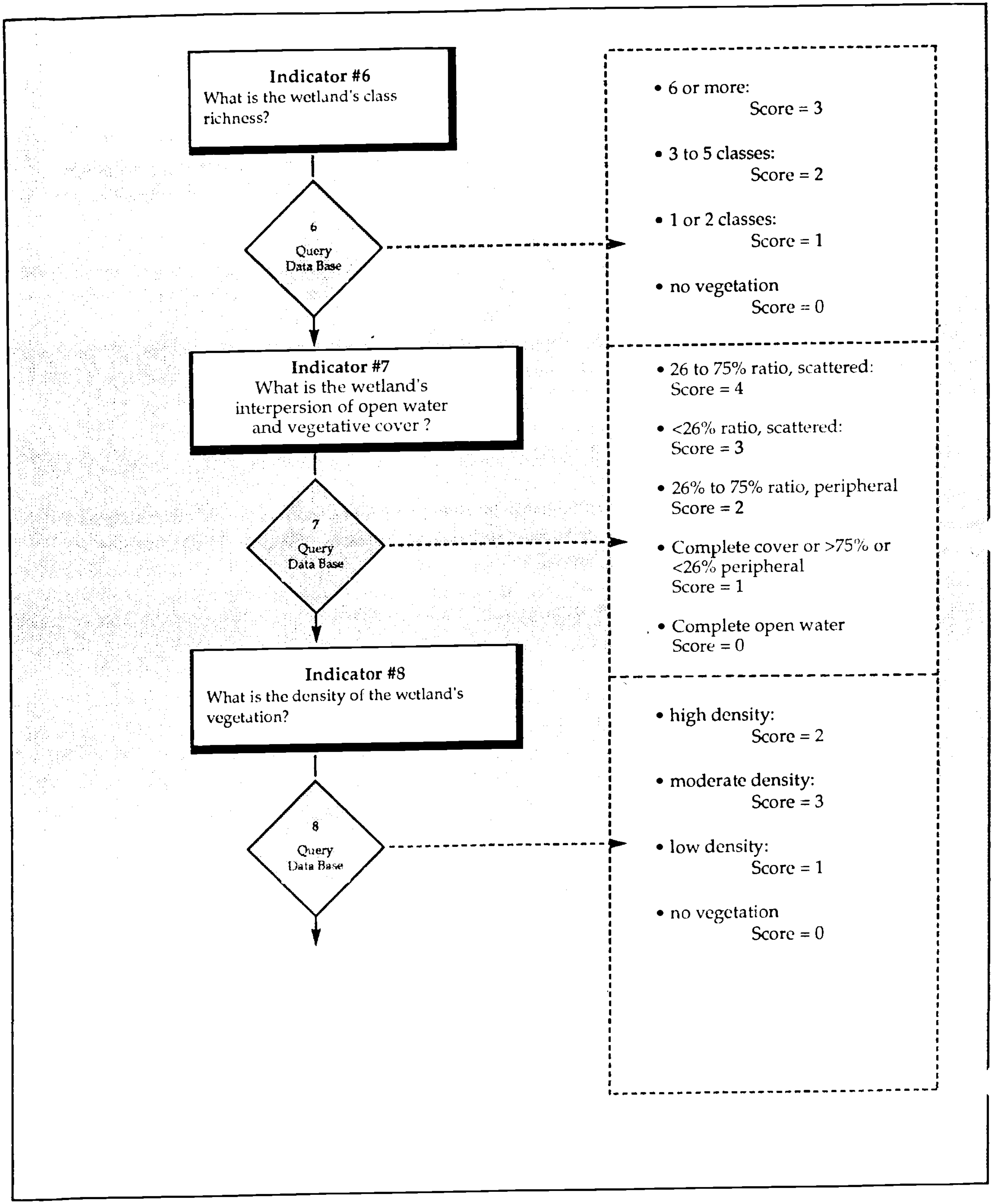
- Stream length/wetland length ratio: >0.67
- Stream length/wetland length ratio: 0.33-0.66
- Stream length/wetland length ratio: <0.33

Dominant Wetland Vegetation Type

Shallow marsh is assumed to provide the most diverse habitat and is assigned a score of 3. Deep marsh is assigned a score of 2 and aquatic bed is assigned a score of 1.

FIGURE 29

AQUATIC DIVERSITY/ABUNDANCE MODEL
(DESK TOP METHOD)



Wetland Class Richness

Wetland class richness is the measurement of wetland vegetation diversity. The greater the number of wetland classes found in the wetland assessment area, the larger the likelihood that the wetland aquatic diversity/abundance will be high. Six or more classes are assigned a 3, three to five a 2, and one to two classes a 1.

Wetland classes and subclasses are listed and defined by Cowardin et al., (1979), and include the following as examples:

PEM	Palustrine emergent	**POW**	Palustrine open water
PSS	Palustrine scrub-shrub	**PAB**	Palustrine aquatic bed
PFO	Palustrine forested		

Interspersion of Open Water and Vegetation Cover

The larger the ratio of water to vegetation cover and the more scattered the open water the more diverse will be the aquatic habitats. Scattered high ratio is assigned a 4. Scattered lower ratio is assigned a 3, and peripheral, moderately scattered a 2. Low ratio, peripheral is assigned a 1.

Ratio: Area Open Water/Vegetation Cover Area

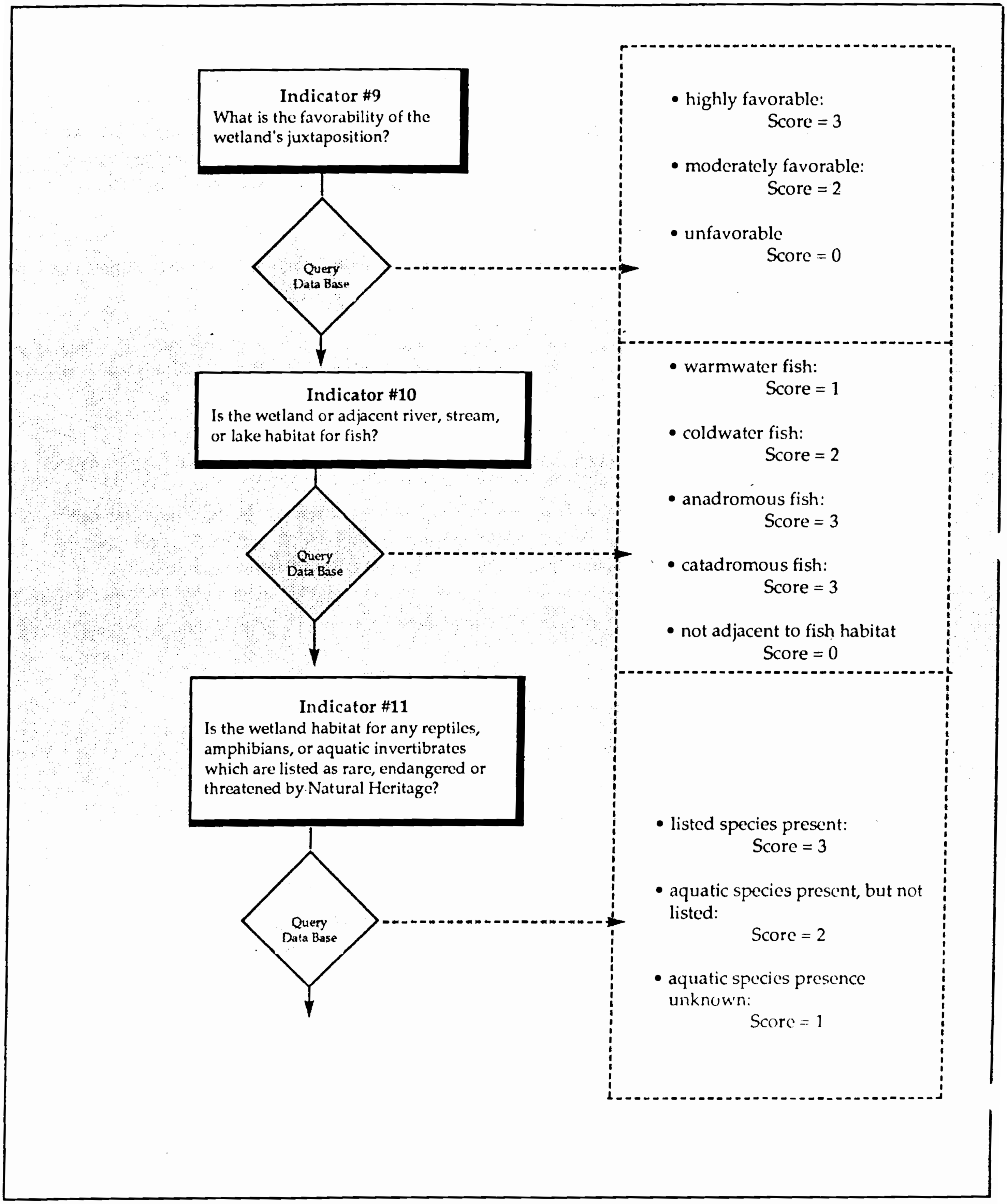
Range of Conditions

- Scattered Cover: Vegetation cover is scattered throughout
- Peripheral Cover: Vegetation cover is clumped or along shoreline only
- Complete Cover: Vegetation completely covers water
- Complete Open Water: No vegetation present

Wetland Vegetation Density

Vegetation density, or the percentage of the site covered by vegetation, serves to indicate whether an abundance of hydrophytic vegetation is being produced by the wetland. High vegetation density is assigned a score of 3, moderate a 2 and low density a 1.

FIGURE 29
AQUATIC DIVERSITY/ABUNDANCE MODEL
(DESK TOP METHOD)



Wetland Juxtaposition

The proximity of a wetland to other wetlands may be an important factor in evaluating its overall biodiversity at the landscape level if it is part of a mosaic of wetlands in an area. A condition in which other wetlands are within 200 m. would be assigned a score of 3, 200-400 m. a 2 and 400-600 m. a 1; wetland situated with other wetlands farther than 600 m. would receive a zero for juxtaposition.

Adjacent Fish Habitat

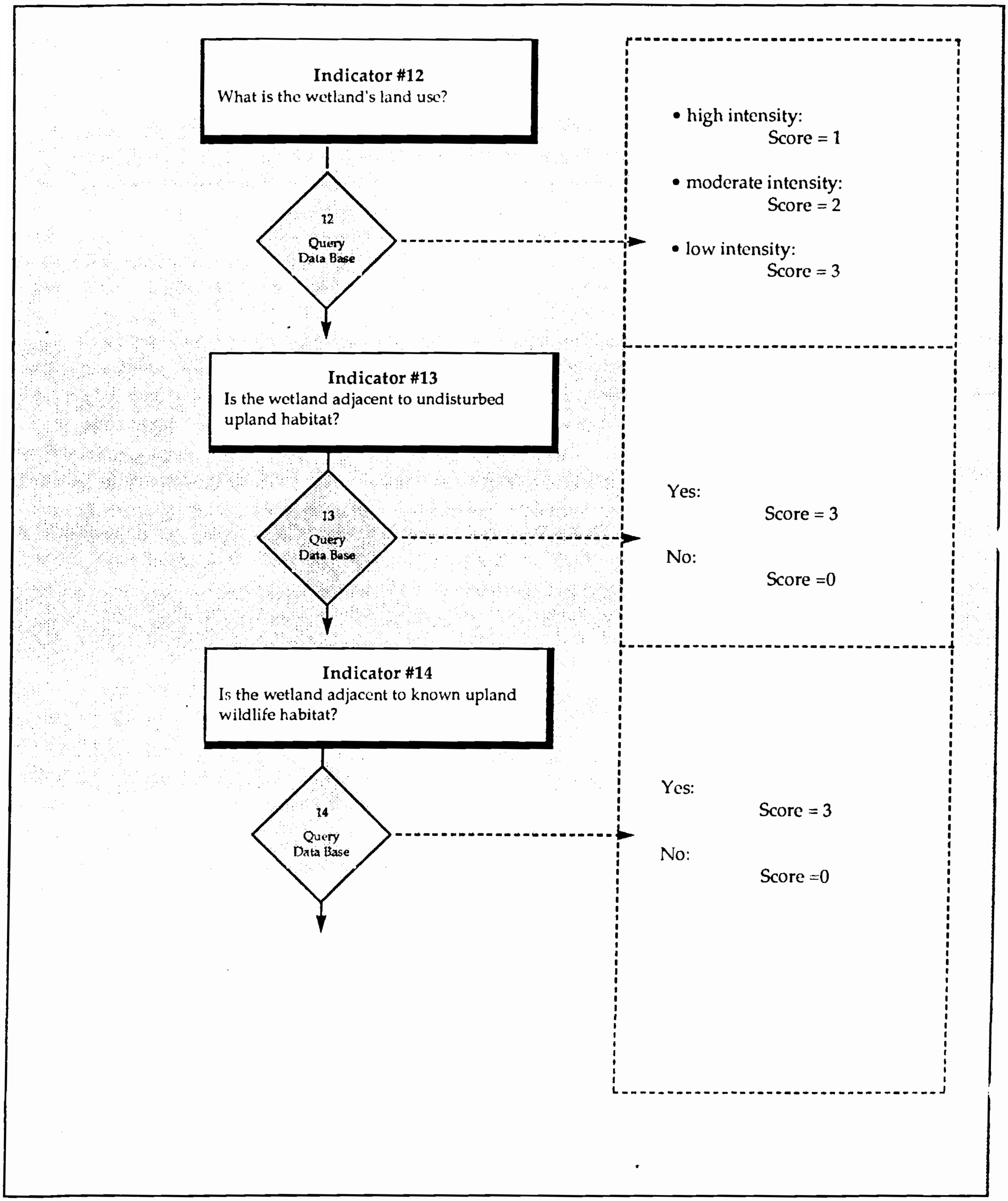
Wetlands may be used by fish if the wetland contains the necessary hydrologic characteristics. Wetlands adjacent to fish habitat may offer shade, spawning, feeding or resting habitat. The wetland may export nutrients and detritus necessary for the fish food web. Adjacency to anadromous or catadromous fish habitat is assigned the highest score, a 3, because these fish are part of a much larger ecosystem and contribute to the ecology of the ocean waters. Cold water fish are very sensitive to increases in temperature and shade created by adjacent wetland can be critical during the summer for the survival of fish. Cold water fish is assigned a 2. Warm water fish are less sensitive to shade and generally water quality, thus their habitat is assigned a 1.

Rare, Endangered, Threatened or Listed Aquatic Species

If listed aquatic species occur in the wetland, the wetland is assigned a score of 3. If aquatic species are know to exist but are not listed, a score of 2 is assigned. If it is unknown if any aquatic species exist, then a score of 1 is assigned.

Data is obtained from the habitat maps of the State's Natural Heritage Program.

FIGURE 29
AQUATIC DIVERSITY/ABUNDANCE MODEL
(DESK TOP METHOD)



Wetland Land Use

The more intense the land use in the wetland the more likely that aquatic diversity will be decreased. High intensity wetland land use is assigned a score of 1, while moderate intensity is assigned a score of 2 and low intensity is assigned a score of 3.

Range of Conditions:

- **High intensity land use.** Included in this category are land uses such as intense agricultural (row crops), activities which remove the natural vegetation and modify the soils and hydrology.
- **Moderate intensity land uses.** Included in this category are land uses such as grazing and forestry, where the natural vegetation is modified but not entirely replaced, plowing does not occur and the soils and hydrology are generally undisturbed.
- **Low intensity land use.** This category includes those land uses, such as open space and recreation, which have little or no impact on the wetland's vegetation, soils and hydrology.

Adjacent to Undisturbed Upland Habitat

Many aquatic species require undisturbed upland habitat to complete their life cycles. the presence of undisturbed upland habitat adjacent to the wetland is assigned a score of 3, while disturbed habitat is assigned a score of zero.

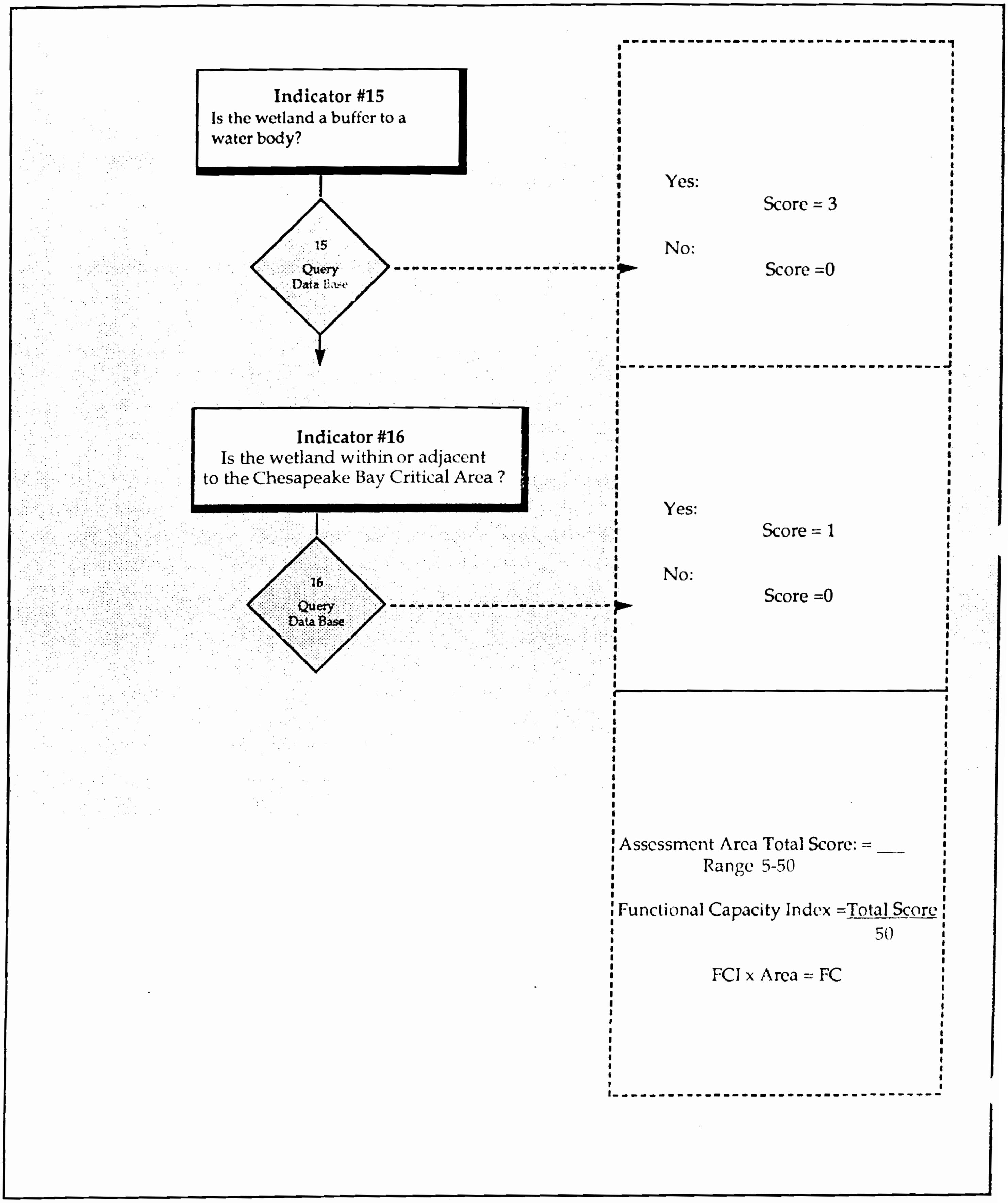
Adjacent to Known Upland Wildlife Habitat

Some wetlands occur adjacent to upland habitat that has been recognized or preserved for wildlife purposes, such as game management areas. Those that are adjacent to such areas are assigned a score of 3, those that are not, a score of zero.

Data sources for designated upland wildlife habitat include the following data layers:

- PLG MDE Properties
- PLG County Open Space Properties
- PLG Private Conservation Organization Properties
- PLG Reservoir Properties
- NHP Natural Areas

FIGURE 29
AQUATIC DIVERSITY/ABUNDANCE MODEL
(DESK TOP METHOD)



Wetland Serves as a Buffer for a Water Body or Water Way

Commonly, wetland occur between upland and open water, and serve as a buffer to protect and enhance the habitat of the open water. Those that provide a buffer are assigned a score of 3, those that do not buffer, a zero.

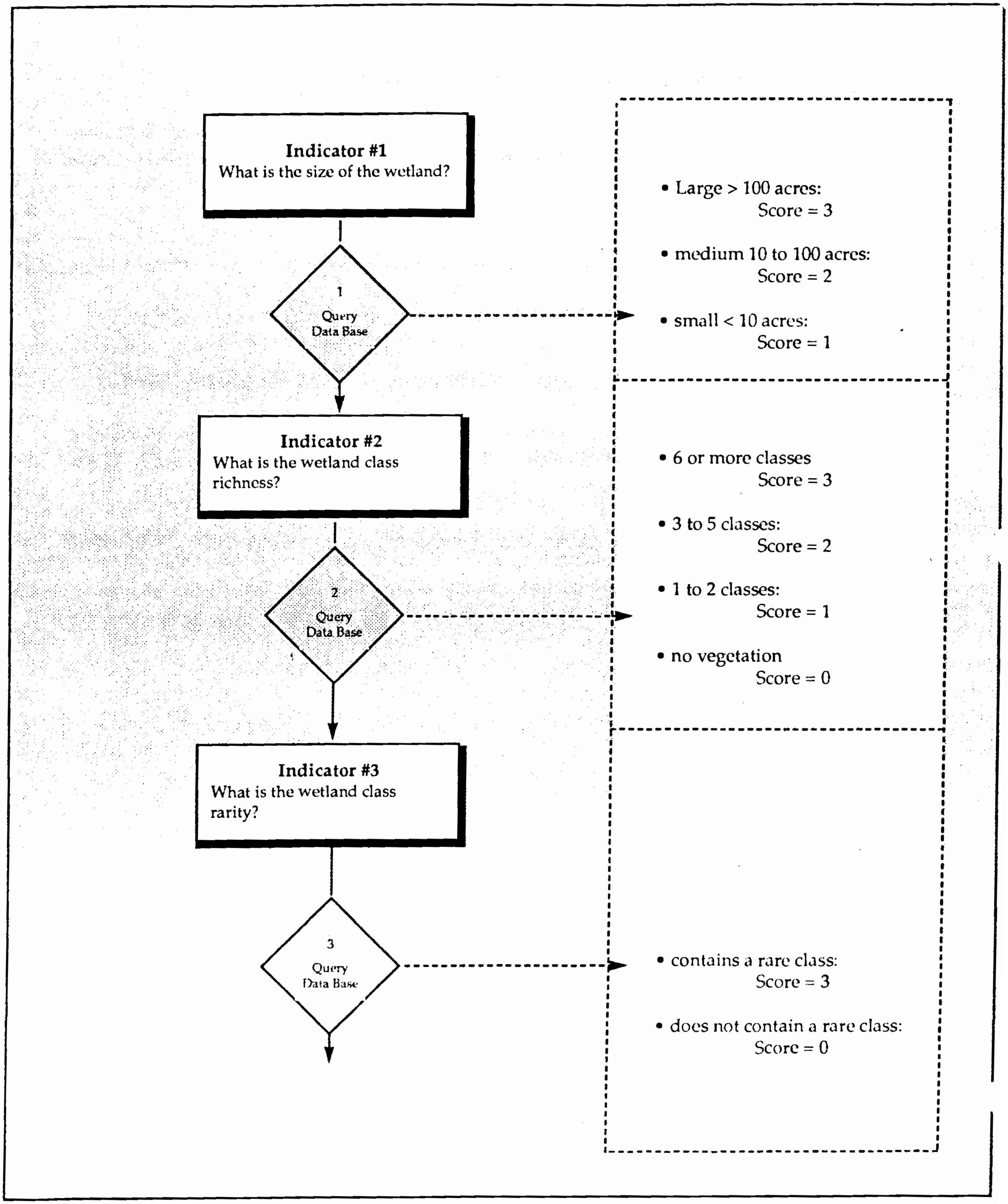
Adjacent to or within Chesapeake Bay Critical Area or Area of Special Concern

Many wetlands in Maryland are within or adjacent to the designated Chesapeake Bay Critical Area, and are a buffer to or part of this critical habitat. Those that are, are assigned a Score of 1. Those that are not are assigned a score of zero.

The Chesapeake Bay Critical Area is shown on the County tax map overlays as well as WRA MDE wetland 1/4 quads.

Wetlands of Special Concern are shown on the WRA MDE wetland data layer and the WRA NWC wetland data layer.

FIGURE 30
WILDLIFE DIVERSITY/ABUNDANCE MODEL
(DESK TOP METHOD)



Size

Size of a wetland is of high predictive value in assessing its capacity for maintenance of wildlife communities. In general, habitat diversity increases with wetland size, such that a larger wetland would likely be more capable of satisfying life cycle requirements of certain fauna than a smaller one. Size also provides a greater buffer from disturbance on the periphery. Also, those factors that determine permanence of a wetland, such as watershed size and groundwater discharge, correlate well with wetland size. The condition scores vary with wetland size, a score of 3 being given to a large wetland, a 2 to a medium size one and a 1 to a small one.

Range of Conditions:

- **Large:** >100 acres
- **Medium:** 10-100 acres
- **Small:** <10 acres

Wetland Class Richness

As the diversity of wetland vegetation types increases, generally so do those factors that are important in the life cycles of many annual species, such as habitat and food. This variable, therefore, serves as a predictor of the kinds, numbers and relative abundance of wildlife species, and of wildlife production and use. Condition scores are assigned based on the number of classes and range from 3 to 1.

Wetland classes and subclasses are listed and defined by Cowardin et al., (1979), and include the following as examples:

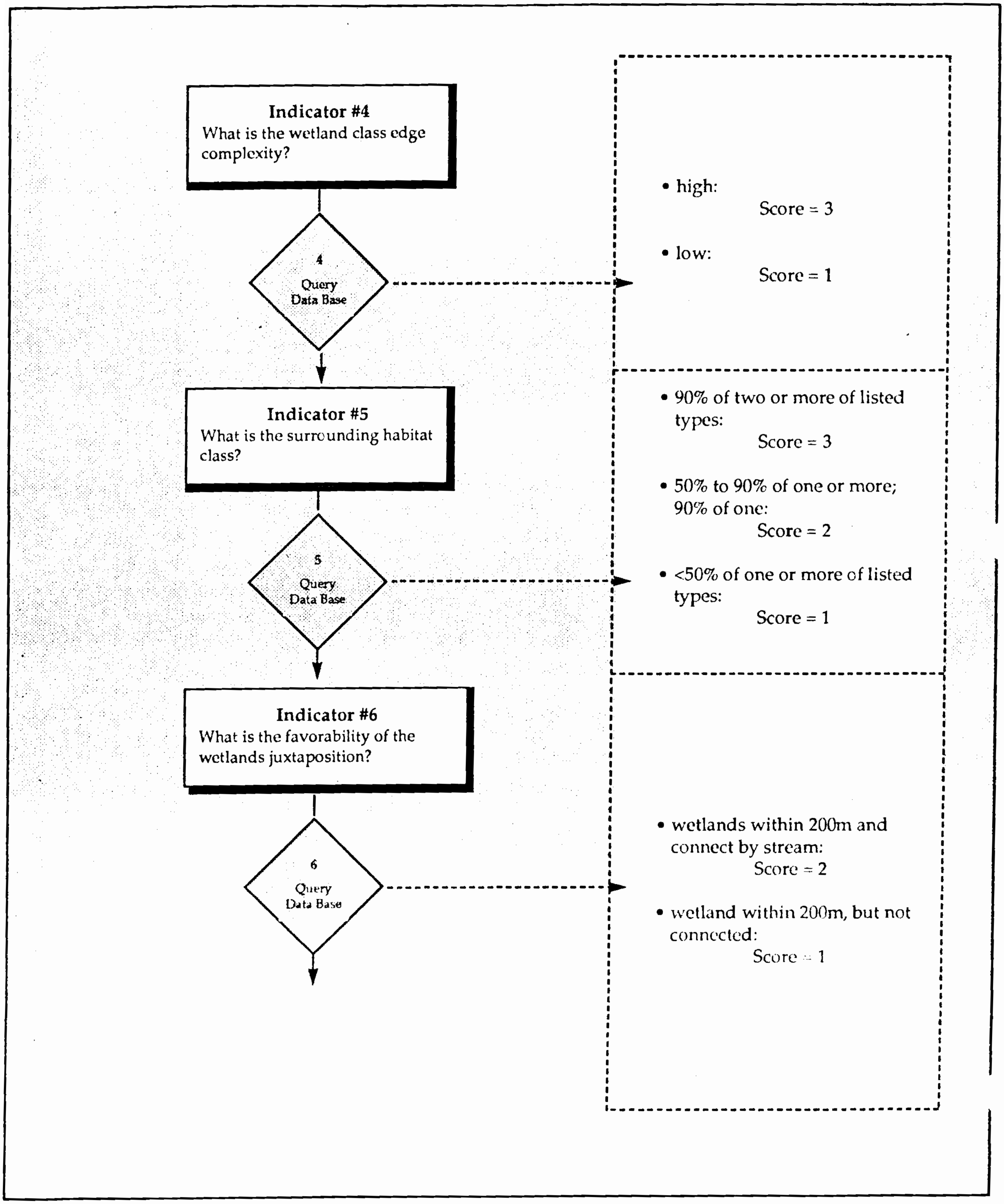
PEM	Palustrine emergent	**POW**	Palustrine open water
PSS	Palustrine scrub-shrub	**PAB**	Palustrine aquatic bed
PFO	Palustrine forested		

Regional Scarcity of Wetland Vegetation Type

In every region there will be one or a few wetland classes which are rare. The presence of a rare/scarce wetland class may provide unique habitat for wildlife species. The presence of the wetland in the region add diversity to the regional wildlife population. A wetland contains a rare vegetation class is assigned a score of 3. Wetlands which are not scarce are assigned a score of zero.

Definition: Dominant vegetation types which comprise **10 percent or less** of the total area of all combined wetland vegetation types for the region are considered scarce.

FIGURE 30
WILDLIFE DIVERSITY/ABUNDANCE MODEL
(DESK TOP METHOD)



Wetland Edge Complexity

Highly complex or convoluted wetland edges with surrounding upland or with another wetland assessment area create more ecotone than do wetland edges that are smooth, or have a low complexity. High complexity is assigned a score of 3 while low complexity is given a 1.

Surrounding Habitat Class

Surrounding habitat refers to the percentage of the surrounding landscape which is in agriculture, abandoned open land, and the number of the categories present. Habitat surrounding a wetland is an important factor affecting its wildlife production since the life cycle requirements of many species is satisfied partly in wetlands and partly in uplands. The nature of the surrounding upland also determines which upland wildlife will likely use the wetland. Uplands also offer a buffer against human disturbance. Greater than 90% of two or more listed types is the best condition and is assigned a score of 3. Less than 50% of one or more is the least optimal condition and is assigned a 1. The intermediate condition is assigned a 2.

Range of Conditions:

- forestland
- agricultural or open land
- salt marsh

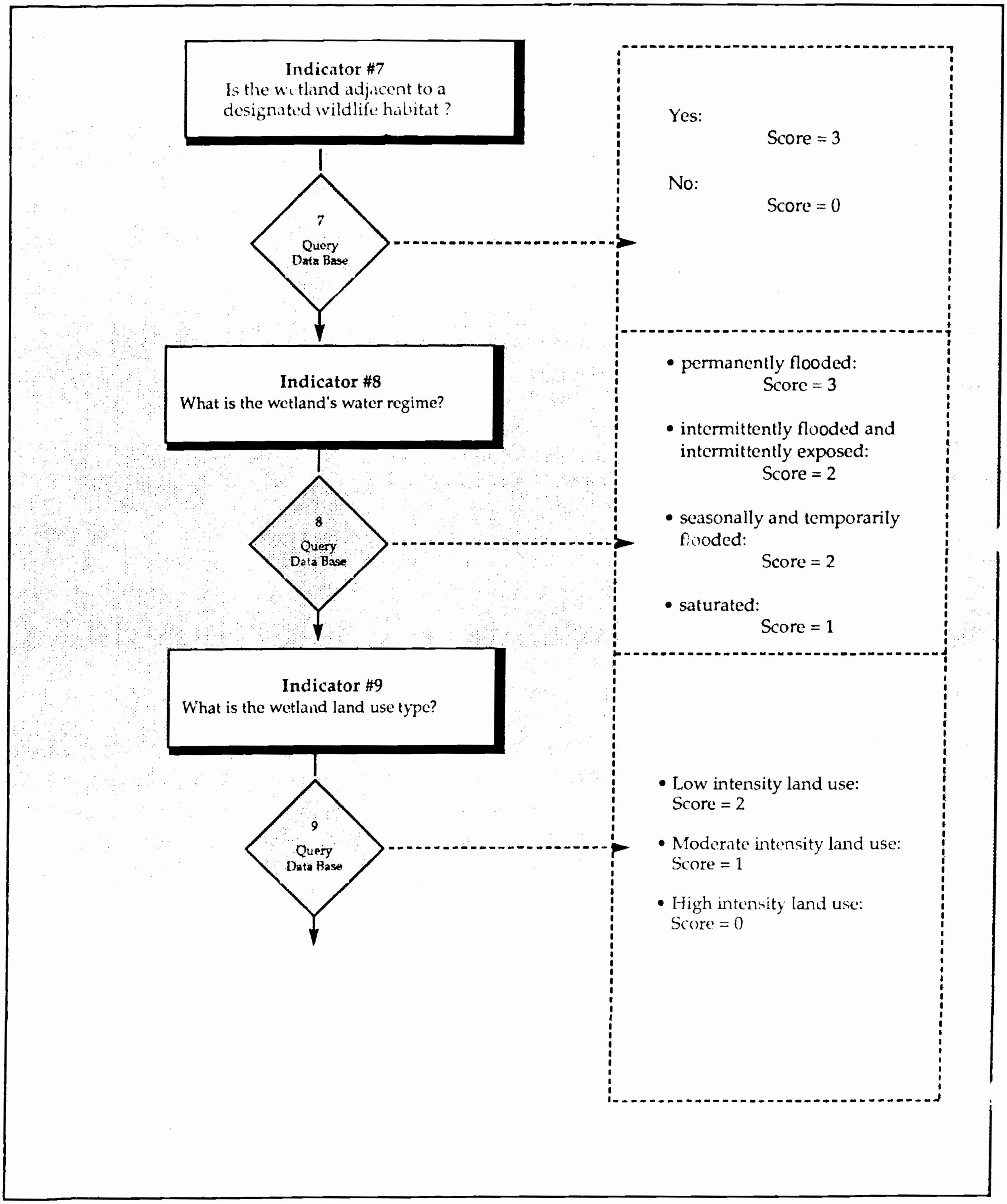
Wetland Juxtaposition

The value of a wetland relative to maintenance of wildlife communities is higher if it is located near other wetlands, particularly if the wetlands are connected by surface water. Stream connections provide travel corridors for wildlife between wetlands. This factor becomes less important in large, diversified wetlands in which life cycle requirements are entirely provided without the necessity to travel to other wetlands. Depending on wetland size and diversity therefore, this variable can be useful as a predictor of this function. A condition in which other wetlands are within 200 m. and connected by streams is optimal, and is assigned a score of 2. A condition of wetlands within 200 m. but not connected is assigned a 1.

FIGURE 30

WILDLIFE DIVERSITY/ABUNDANCE MODEL

(DESK TOP METHOD)



Adjacent to Designated Upland Wildlife Habitat

Some wetlands interconnect with upland or other wetland habitat that has been preserved and managed as a wildlife refuge or game management area, etc. Such wetlands are assigned a score of 3.

Data sources for designated upland wildlife habitat include the following data layers:

- PLG MDE Properties
- PLG County Open Space Properties
- PLG Private Conservation Organization Properties
- PLG Reservoir Properties
- PLG NHP Natural Areas

Water Regime

The presence of standing water in a wetland bears relevance to the diversity of faunal species it can support compared to a wetland which does not have any standing water. Standing water also provides habitat for aquatic invertebrates, which serve as a food source for certain vertebrates. The most optimal condition is permanently flooded which is assigned a 3; permanently flooded and intermittently exposed would receive a 2, seasonally flooded and temporarily flooded also a 2 and saturated a 1.

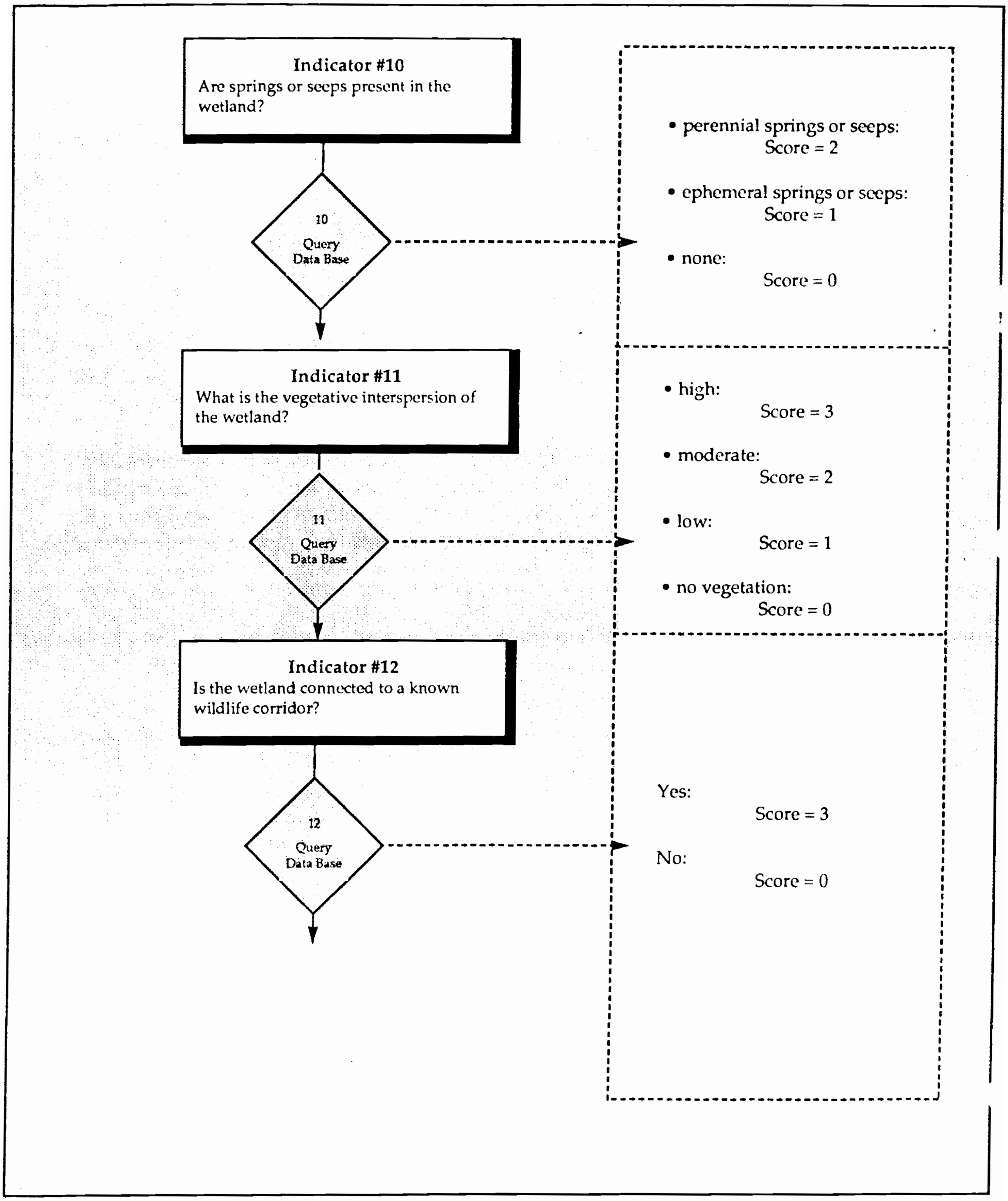
Wetland Land Use

Land use activities in a wetland can have a direct effect on its capacity for wildlife diversity and abundance. These effects can range from inconsequential, where the activity is of a passive nature such as in wildlife observation, to highly destructive, as in removal of timber or other products from the wetland. This variable, therefore, can serve as a predictor of wetland capacity to maintain its fauna under various land use and management scenarios, given knowledge of the tolerance of dominant members of the faunal community to various activities. A condition in which use and management of the wetland does not occur or is benign in nature is assigned a score of 3; one in which the use is of consumptive nature would receive a 2 or 1, depending upon the nature and level of the activity in the wetland.

Range of Conditions:

- **High intensity land use.** Included in this category are land uses such as intense agricultural (row crops), activities which remove the natural vegetation and modify the soils and hydrology.
- **Moderate intensity land uses.** Included in this category are land uses such as grazing and forestry, where the natural vegetation is modified but not entirely replaced, plowing does not occur and the soils and hydrology are generally undisturbed.
- **Low intensity land use.** This category includes those land uses, such as open space and recreation, which have little or no impact on the wetland's vegetation, soils and hydrology.

FIGURE 30
WILDLIFE DIVERSITY/ABUNDANCE MODEL
(DESK TOP METHOD)



Presence of Seeps or Springs

Presence of seeps and springs can be an important factor for wetland fauna requiring surface water in situations where other surface water is absent. Their occurrence can be especially important for certain species during winter, providing a source of drinking water when other sources are frozen. Plant species frequently associated with seeps provide overwintering structures and green parts that are available as food sources throughout winter. A perennial spring or seep would receive a score of 2, an ephemeral spring or seep a score of 1, and absence of seeps or springs a zero.

Vegetative Interspersion

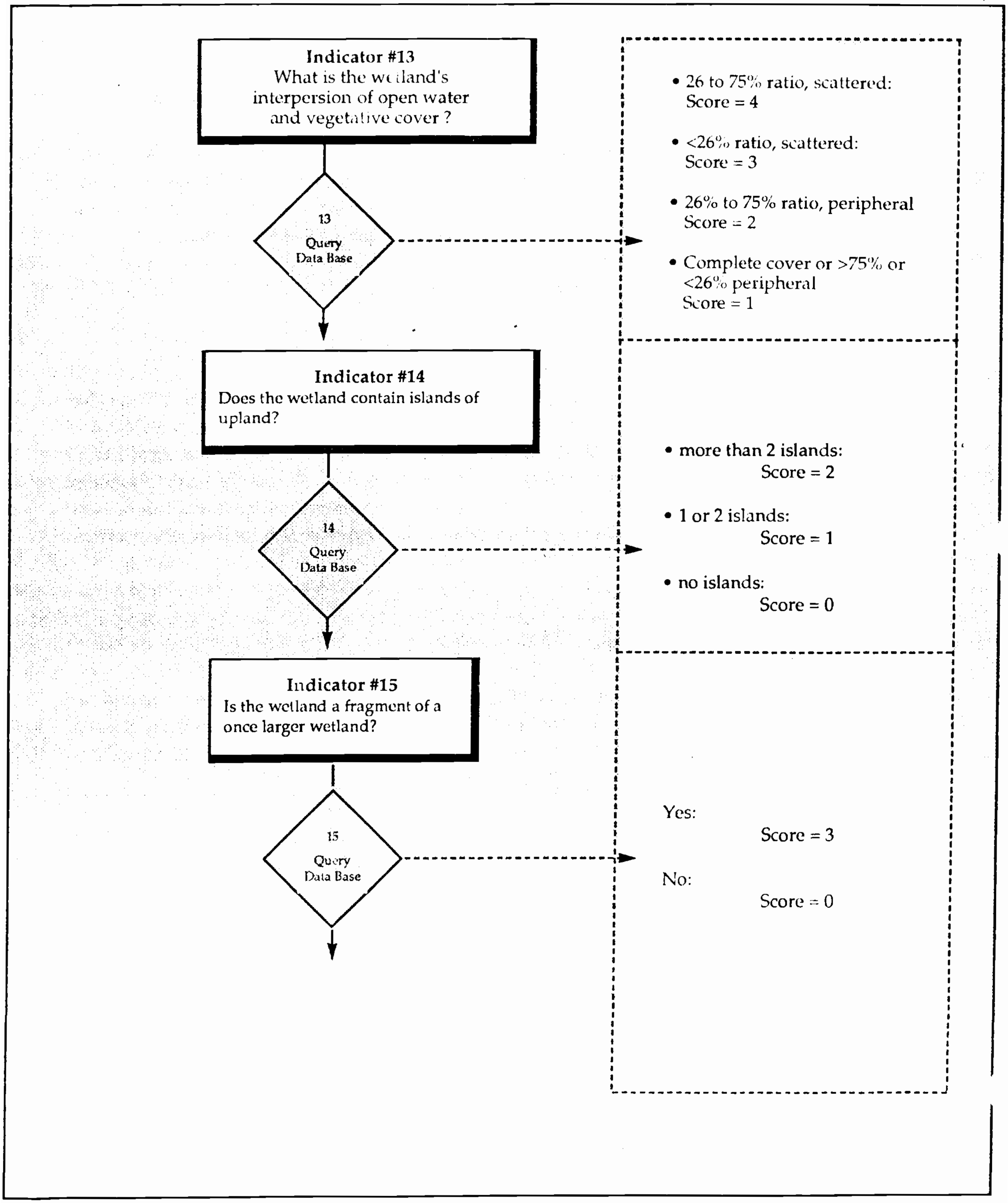
Most wildlife species require more than one vegetation type to complete their life cycle, and the density and diversity of wildlife populations are closely related to the length and types of vegetative edge. Interspersion correlates well with amount and type of edge, and is a good indicator of wildlife abundance and diversity. The conditions are scored in descending order from 3 to 1. Several different vegetation types distributed in broken patches would produce maximum interspersion and would be assigned a score of 3; a single vegetation type would produce very little, if any, interspersion and would be assigned a score of 1, whereas an intermediate condition would be assigned a 2.

Connected to Wildlife Corridor

In urbanized areas, wildlife move along corridors from one habitat to another. These corridors are critical to their life cycles. Commonly, wetlands occur as linear features which serve as wildlife corridors and are adjacent to upland wildlife corridors. Wetlands which are or are adjacent to wildlife corridors are assigned a score of 3.

FIGURE 30

WILDLIFE DIVERSITY/ABUNDANCE MODEL
(DESK TOP METHOD)



Interspersion of Open Water and Vegetative Cover

The correlation between interspersion of vegetation cover and open water, and habitat conditions for wildlife, particularly waterfowl, has been well established. Some species are very territorial, and the density of the breeding population is closely related to interspersion. The optimal condition for this variable is one in which cover/water ratio is approximately equal and interspersion is high; this condition is assigned a score of 3. As the ratio and interspersion diminish, the condition scores assigned are 2 or 1.

Presence of Islands

The presence of islands of upland within a wetland or open water area can be important relative to habitat value for certain wildlife. Wildlife such as loons, geese and ducks will readily nest on islands surrounded by water when they are present owing to the safety afforded from predators. There is no minimum size for an island beyond the minimum space requirements for an individual of a given species. The limitation on maximum size would be reached at a point where the island was sufficiently large to support 1 or more predators. The presence of islands, evaluated in the context of other factors important for wildlife, such as size of the wetland or open water area and surroundings, can provide useful information relative to habitat quality for certain species. The variable condition most conducive to this function is one of more than 2 islands present; this condition is assigned a score of 2. A condition of 1 or 2 islands would receive a score of 1, and complete absence of islands or presence of islands large enough to support predators would be given a zero.

Fragment of Once Larger Wetland

Many wetlands have been decreased in size from their original natural size, causing increased function to be obtained from the small, remaining wetland area. Those that are a fragment of a once larger wetland are assigned a score of 3.

Data sources used to determine wetland fragmentation:

- Aerial photography
- USGS mapping
- NRA NWI wetland data layer
- WRA MDE wetland data layer

FIGURE 30
WILDLIFE DIVERSITY/ABUNDANCE MODEL
(DESK TOP METHOD)

Indicator #16
Is the wetland habitat for any listed rare, endangered or threatened wildlife or vegetation species?

16
Query
Data Base

Yes:
Score = 3

No:
Score = 0

Indicator #17
What is the wetland's watershed cover type ?

17
Query
Data Base

- >90% or 2 or more non-urban types:
  Score = 3
- 50% to 90% of one or more; >90% non-urban types:
  Score = 2
- <50% or one or more non-urban types:
  Score = 1

Indicator #18
Is the wetland a regionally significant feature.

18
Query
Data Base

Yes:
Score = 3

No:
Score = 0

Assessment Area Total Score: =
Range 9-50

Functional Capacity Index = $\frac{\text{Total Score}}{50}$

FCI x Area = FC

Rare, Endangered or Threatened Listed Wildlife or Vegetation Species

If the wetland contains one or more wildlife species which are listed as rare, endangered or threatened by the Maryland Natural Heritage program or by the Federal Government the wetland is assigned a score of 3. If the wetland does not contain a listed species then it is assigned a score of zero.

Data is obtained from the habitat maps of the State's Natural Heritage Program.

Watershed Cover Type

Since many wildlife species that inhabit wetlands also fulfill part of their habitat requirements in the surrounding watershed and vice-versa, the nature of the habitat and land use activities in the watershed are very important determining factors in the capacity of a wetland for this function. Destruction of habitat due to development in the watershed, alteration of drainage patterns, and human activity are all factors that could substantially alter the capacity of the wetland to fulfill the life cycle requirements of many wildlife species typically found in wetlands. The most favorable condition relative to performance of function is a watershed consisting of a high proportion of 2 or more landscape elements such as shrub land and forest land; this condition is assigned a score of 3. The score assigned becomes less as the proportion of urban development becomes higher, the least valuable condition being a watershed more than half urbanized; this condition is assigned a score of 1.

Regional Significance

Wetlands that have been identified by natural resources government agencies as regionally significant are designated as such because of a special quality, topographic feature, or function the wetland provides to the surrounding region. More often, a wetland can be designated regionally significant if it provides specific plant and animal habitat that is considered important to the region, or if a known occurrence of a threatened or endangered plant/animal species exists in the wetland. If the wetland is designated as regionally significant, it is assigned a score of 3. If the wetland is not designated as such, it is assigned a score of zero.

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