180

Wetland Characterization Study and Preliminary Assessment of Wetland Functions for the Casco Bay Watershed, Southern Maine

U.S. Fish and Wildlife Service
National Wetlands Inventory
Northeast Region
Hadley, MA 01035

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Wetland Characterization Study and Preliminary Assessment of Wetland Functions for the Casco Bay Watershed, Southern Maine

by

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Table of Contents

Introduction

Today there is great interest in managing wetland resources from a watershed standpoint or landscape perspective. The health of many wetlands is largely determined by various land use practices in the watershed, with undeveloped portions of watersheds being "healthier" than the developed portions subjected to the introduction of a variety of pollutants, altered hydrologies, and other sources of degradation. In many respects, developed watersheds may be out-of-balance with the natural processes or forces that originally shaped them. For example, the flood storage capacity of watersheds will eventually be exceeded due to a number of factors including wetland destruction, wetland drainge, stream channelization, permanent clearing of forests, and an increase in the amount of impervious surfaces. Likewise, surface water runoff from lawns and agricultural lands (e.g., cropland and dairy operations) will often lead to nutrient loading of waterbodies, beyond the natural capacity of the system to renovate, especially where this capacity has been reduced by wetland destruction.

Wetlands perform many functions that are vital to maintaining a healthy watershed. They serve as flood storage basins (reducing the likelihood of flood damage to private property built on nonfloodplains), sinks for nutrients and sediments (aiding in water quality renovation), stabilizers of shorelines (by reducing wave action and binding the sediments with their vegetation), and providing habitat for many species of fish and wildlife. The quality of life for a society is, in many ways, determined by the abundance and condition of its natural resources. Recognizing these and other benefits of wetlands, the State of Maine is embarking on a program to develop watershed-based wetland protection plans. Such plans will identify significant wetland resources and strive to ensure that wetlands continue to provide the needed services to Maine citizens by strengthening existing efforts to protect, conserve, and restore these vital resources.

An inventory of Maine's wetlands was recently completed by the U.S. Fish and Wildlife Service, with funding support from the State of Maine. Maps and digital data on the location, distribution, and types of wetlands found in Maine are available statewide. Digital data are required for geographic information system (GIS) applications. The existence of these data makes it possible to conduct watershed assessments of wetland resources. More information can be added to the original wetland classifications to further aid in such assessments.

In 1998, the U.S. Fish and Wildlife Service and the Maine State Planning Office entered into an agreement to prepare a watershed-based wetland characterization and preliminary assessment of wetlands for the Casco Bay watershed in southern Maine. This would be the first attempt at producing a watershed-based wetland assessment in the State. It could serve as a prototype of what might be done elsewhere in other Maine watersheds. This work would involve adding landscape position and landform descriptors to existing NWI digital map data for the watershed. The information would expand existing descriptive information on the wetlands in this watershed to include other characteristics important for assessing wetland functions. Analysis of these data would produce a preliminary assessment of wetland functions for the watershed. Armed with this information and other data (e.g., actual observations, data from other studies and reports, and input from state and local natural resource scientists), the State of Maine will develop a wetland protection strategy for the watershed that will address wetland acquisition, restoration, and other means of strengthening wetland protection in priority areas.

Study Area

The study area is the Casco Bay watershed in southern Maine. Casco Bay itself dominates the terminus of the watershed. Numerous islands and peninsulas (or necks) characterize the Casco Bay ecosystem, where seawater mixes with freshwater runoff from the approximately 1,216-square mile watershed area[1]. Marine and estuarine waters (deepwater habitats) occupy nearly 180,000 acres of the watershed. Approximately 540,000 acres of upland form most of the drainage area for this watershed, whereas only about 47,000 acres of wetlands (including ponds) exist.

Rivers and lakes are prominent aquatic features of the watershed. The Presumpscot River (including Crooked River) is the principal river system in the Casco Bay watershed. One other substantial river system is also present in the Casco Bay watershed -- the Royal River. The rest of the freshwater drainage is from smaller streams discharging directly from the mainland or various islands into the Bay. The Fore River is perhaps the most prominent coastal river dominated by tidal action and salt water in the watershed. Approximately 1,000 acres of riverine fresh deepwater habitat are present plus hundreds of miles of narrow shallow water stream habitat.

Sebago Lake is the largest of the many lakes that characterize the Casco Bay watershed. Some of the other prominent lakes include Long Lake, Little Sebago Lake, Highland Lake, Pleasant Lake, Panther Pond, and Peabody Pond. Nearly 52,000 acres of lacustrine habitat exist in the watershed.

The Casco Bay watershed lies mostly in Cumberland County, with the northernmost portion of the watershed extending into Oxford County (Figure 1). Small parts of the watershed are in York County (to the south) and Androscoggin and Sagadahoc Counties (to the northeast). Major population centers in the watershed are the Greater Portland area (Westbrook to Brunswick) along the coast and North Windham, Naples, and Bridgton in the interior.

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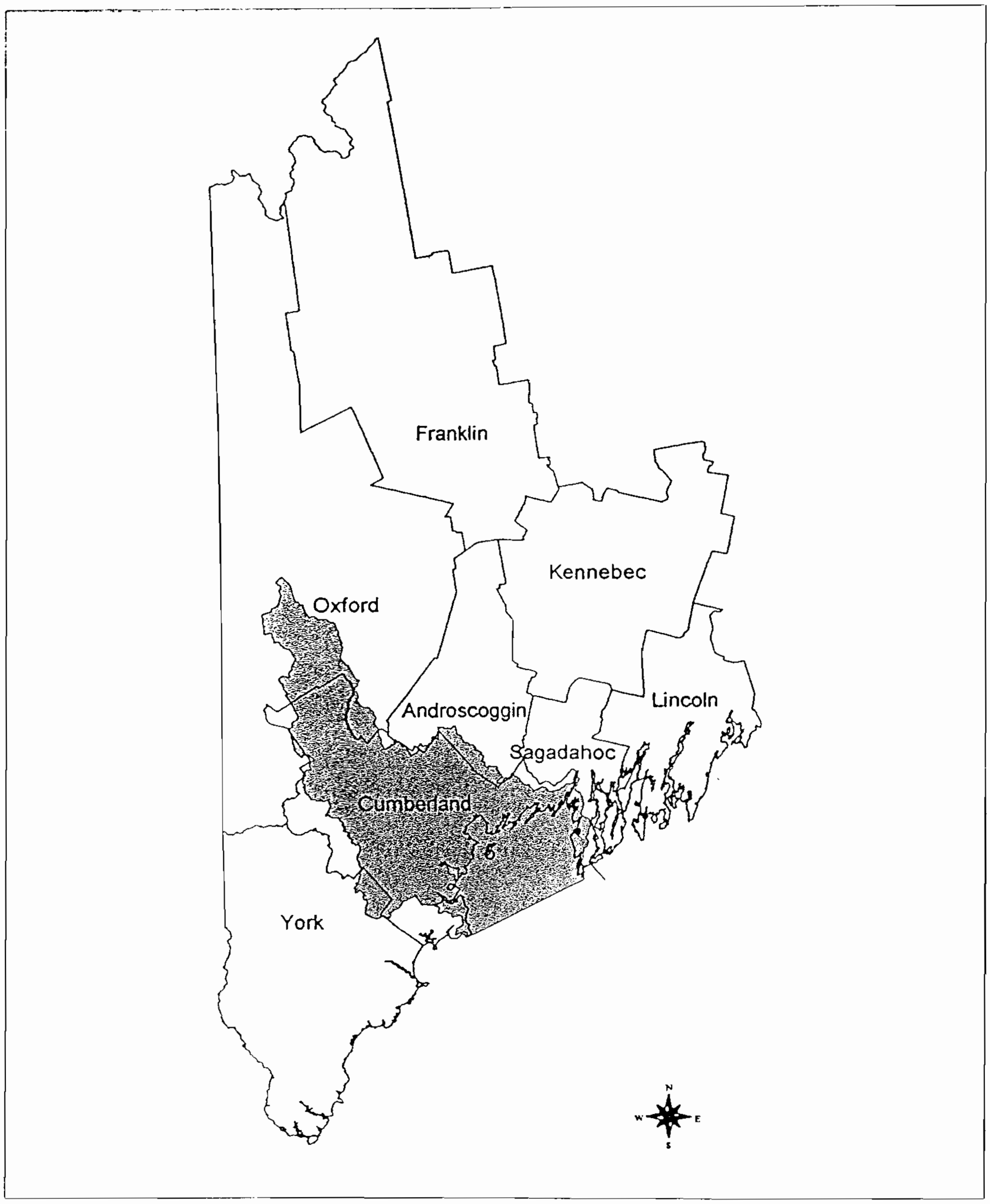
[1]The watershed acreage includes Casco Bay (from Cape Elizabeth to Small Point/Fuller Rock). The watershed boundaries are slightly different from that of U.S. Geological Survey hydrologic unit #01060001 which includes the Nonesuch and Spurwink Rivers draining into Saco Bay and the Atlantic Ocean directly.

Figure 1. The Casco Bay watershed, southern Maine.



Methodology

Existing NWI maps and digital data for the watershed were the base data set for this characterization. No attempt was made to improve the geospatial or original wetland classification accuracy of these data. We recognize the limitations of these data such as conservative interpretations of forested wetlands (especially evergreen types) and drier-end wetlands including wet meadows (especially those used as pastures) (see Tiner 1997a for additional information). Despite these limitations, the NWI dataset represents the most extensive database on the distribution, extent, and type of wetlands covering the entire state.

The purpose of the project was to take the existing NWI dataset and enhance it by adding hydrogeomorphic-type information to each NWI mapped wetland. Prior to initiating this watershed-wide characterization, a pilot study was conducted for the town of New Gloucester as a proof-of-concept (Tiner et al. 1997). The current study basically followed the approach used in the pilot study with some modifications in the analysis portion made based on discussions with others and further consideration of interrelationships between wetland characteristics and functions.

Landscape position, landform, water flow path, and other descriptors were first applied to existing NWI paper maps by interpreting maps plus consulting aerial photography where necessary (see Tiner 1997b; Appendix A for keys to these descriptors). Landscape position defines the relationship between a wetland and an adjacent waterbody, if present. Five landscape positions are relevant to the Casco Bay watershed: 1) marine (along the ocean and euhaline embayments), 2) estuarine (along brackish embayments and rivers), 3) lotic (along freshwater rivers and streams), 4) lentic (in lakes, reservoirs, and their basins), and 5) terrene (isolated, headwater, or throughflow wetlands with nonchannelized flow). Lotic wetlands are further separated by river/stream gradients as high (e.g., shallow mountain streams on steep slopes), middle (e.g., streams with moderate slopes), and low (e.g., mainstem rivers with considerable floodplain development). "Rivers" are separated from "streams" solely on the basis of channel width. Watercourses mapped as linear (one-line) features on an NWI map and a U.S. Geological Survey topographic map were designated as streams, whereas two-lined channels (polygonal features) on these maps were classified as rivers. Landform is the physical form of a wetland and six types are recognized in the study area: basin, slope, flat, floodplain, fringe, and island (see Table 1 for definitions). Additional modifiers were assigned to terrene and lentic wetlands to indicate water flow paths: throughflow, inflow, outflow, or isolated. Throughflow wetlands have either a watercourse or another type of wetland above and below it, so water flows through the subject wetland. (Note: All lotic and most lentic wetlands were considered to be throughflow wetlands.) Inflow wetlands are sinks where no outlets exist, yet water is entering via a stream or river or an upslope wetland. Outflow wetlands have water leaving them and moving downstream via a watercourse or a slope wetland. Isolated wetlands are essentially closed depressions where water comes from surface water runoff and/or ground water discharge.

After labeling polygon-only overlays of NWI maps with appropriate hydrogeomorphic-type codes, a field trip was conducted to the study area to verify the accuracy of the interpretations. Revisions were made where necessary. The data were then entered into the existing digital data file for the watershed on a quad-by-quad basis using ARC/INFO. Upon completion of the digital database, several analyses were performed to produce a preliminary assessment of wetland functions for the watershed: 1) surface water detention, 2) streamflow maintenance, 3) nutrient cycling, 4) sediment and particulate retention, 5) coastal storm surge detention and shoreline stabilization, 6) inland shoreline stabilization, 7) fish habitat, 8) waterfowl and waterbird habitat, 9) other wildlife habitat, and 10) biodiversity. Later, a series of maps for watershed were generated to highlight wetland types that may perform these functions at high or other significant levels. Statistics and topical maps for the study area were generated by ARC/INFO software.

Table 1. Definitions and examples of landform types (Tiner 1997b).

Landform Type	**Definition**	**Examples**
Basin	a depressional (concave) landform	lakefill bog; wetland in the saddle between two mountains; wetlands in closed or open depressions
Slope	a landform extending uphill (on a slope)	seepage wetlands on hillsides; wetlands along drainageways or mountain streams on slopes
Flat	a relatively level landform, often on broad level landscapes; may be a component of a floodplain	wetlands in relatively flat areas associated with seasonal high groundwater levels; wetlands on higher terraces along rivers/streams; wetlands on hillside benches; wetlands on level toes of slopes
Floodplain	a broad, generally flat landform occurring on a landscape shaped by fluvial or riverine processes	wetlands on alluvium; bottomland swamps
Fringe	a landform occurring along a flowing or standing waterbody (lake, river, stream) in an area typically subject to semipermanent or permanent flooding, but also including wetlands within stream or river channels	aquatic beds; nonpersistent emergent wetlands; buttonbush swamps
Island	a landform completely surrounded by water (including deltas)	deltaic and insular wetlands; floating bog islands

General Scope and Limitations of the Study[2]

At the outset, it is important to emphasize that this functional assessment is a preliminary one based on wetland characteristics interpreted through remote sensing and using the best professional judgment of the authors and the Maine Wetlands Steering Committee. Wetlands believed to be providing potentially high or other significant levels of performance for a particular function were highlighted. As the focus of this report is on wetlands, the assessment of waterbodies (e.g., lakes, rivers, and estuaries) at providing the listed functions was not done (e.g., it is rather obvious that such areas provide significant functions like fish habitat and surface water storage). Also, no attempt was made to produce a more qualitative ranking for each function or for each wetland based on multiple functions as this would require more input from others and more data, well beyond the scope of this study. The rationale for these assessments have been distributed to the State and others both in the pilot study done earlier and again prior to the analysis phase of the current study for review and comment. The correlations used in this analysis were approved by the Wetlands Steering Committee. For a technical review of wetland functions, see Mitsch and Gosselink (1993) and for a broad overview, see Tiner (1998).

Functional assessment of wetlands can involve many parameters. Typically such assessments have been done in the field on a case-by-case basis, considering observed features relative to those required to perform certain functions or by actual measurement of performance. The present study does not seek to replace the need for such assessments as they are the ultimate assessment of the functions for individual wetlands. Yet, for a watershed analysis, basinwide field-based assessments are not practical or cost-effective or even possible given access considerations. For watershed planning purposes, a more generalized assessment is worthwhile for targeting wetlands that may provide certain functions, especially for those functions dependent on landscape position and vegetation lifeform. Subsequently, these results can be field verified when it comes to actually evaluating particular wetlands for acquisition purposes, e.g., for conservation of biodiversity or for preserving its flood storage function. Current aerial photography may also be examined to aid in further evaluations (e.g., condition of wetland/stream buffers or adjacent land use) that can supplement the preliminary assessment.

This study employs a watershed assessment approach that may be called "Watershed-based Preliminary Assessment of Wetland Functions" (W-PAWF). W-PAWF applies general knowledge about wetlands and their functions to develop a watershed overview that highlights possible wetlands of significance in terms of performance of various functions. To accomplish this objective, the relationships between wetlands and various functions must be simplified into a set of practical criteria or observable characteristics. Such assessments could also be further expanded to consider the condition of the associated waterbody and the neighboring upland or to evaluate the opportunity a wetland has to perform a particular

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[2]See also first paragraph of Methodology section for other limitations re: use of NWI data as primary source of wetland habitats. More detailed and/or current mapping may provide better information on wetland type and location.

function or service to society, for example.

W-PAWF does not account for the opportunity that a wetland has to provide a function resulting from a certain land-use practice upstream or the presence of certain structures or land uses downstream. For example, two wetlands of equal size and like vegetation may be in the right landscape position to retain sediments. One, however, may be downstream of a land-clearing operation that has generated considerable suspended sediments in the water column, while the other is downstream from an undisturbed forested subbasin. The former should be actively performing sediment trapping in a major way, while the latter is not. Yet if land-use conditions in the latter subwatershed area change, the second wetland will likely trap sediments as well as the first wetland. The entire analysis tends to ignore opportunity since such opportunity may present itself sooner or later and the wetland is awaiting a call to perform this service at higher levels than presently.

W-PAWF also does not consider the condition of the adjacent upland (e.g., level of disturbance) or the actual water quality of the associated waterbody which may be regarded as important metrics for assessing the health of individual wetlands (not part of this study). Collection and analysis of these data were beyond the scope of the study, but could be incorporated at a later date by the State from digital data available in MaineGIS and supplemented with aerial photointerpretation as needed.

We further emphasize that the preliminary assessment does not obviate the need for more detailed assessments of the various functions. This assessment should be viewed as a starting point for more rigorous assessments, as it attempts to cull out wetlands that may likely provide significant functions based on generally accepted principles and the source information used for this analysis. This type of assessment is most useful for regional or watershed planning purposes. For site-specific evaluations, additional work will be required, especially field verification and collection of site-specific data for potential functions (e.g., following the HGM assessment approach and other onsite evaluation procedures). This is particularly true for assessments of fish and wildlife habitats and biodiversity. Many sources of data may exist to help refine the findings of this report. Additional modeling could be done, for example, to identify habitats of likely significance to individual species of animals (based on their specific life history requirements) as has been done for the Lower Casco Bay watershed by the Service's Gulf of Maine Project Office (Banner and Libby 1995). Incorporation of soils data (e.g., digital soil survey data) might also improve the analysis of certain functions (e.g., water quality renovation) or designation of floodplains (alluvial soils). We see these analyses as the next phase in an analysis of wetland functions, especially where a more indepth analysis of some functions for individual wetlands is warranted.

Appropriate Use of this Report

The report provides a basic characterization of wetlands in the Casco Bay watershed and a preliminary assessment of wetland functions in this area. Keeping in mind the limitations mentioned above, the results are a first-cut or initial screening of the watershed's wetlands to designate wetlands that may have a significant potential to perform different functions. The targeted wetlands have been identified as being predicted to perform a given function at a significant level presumably important to the watershed's ability to provide that function. "Significance" is a relative term and is used in this analysis to identify wetlands that are likely to perform a given function at a level above that of wetlands not designated.

While the results are useful for gaining an overall perspective of the watershed's wetlands and their relative importance in performing certain functions, the report does not identify differences among wetlands of similar type and function. The latter information is often critical for making decisions about wetland acquisition and designating certain wetlands as more important for preservation versus others with the same categorization. Additional information gained through consulting with agencies having specific expertise in the subject area and by conducting field investigations to verify the preliminary assessments are necessary. For example, various agencies may have water quality data for some areas (e.g., Presumpscot and Royal Rivers and numerous lakes) and wildlife observation data (e.g., based on fish electro-shocking surveys, site-specific wildlife use surveys, and wading bird heronry surveys) that could be used in further assessments of wetland functions. Consequently, when it comes to actually acquiring wetlands for preservation, other factors must be considered. Such factors may include: 1) the condition of the surrounding area, 2) the ownership of the surrounding area and the wetland itself, 3) site-specific assessment of wetland characteristics and functions, 4) more detailed comparison with similar wetlands based on field data, and 5) advise from other agencies (federal, state, and local) with special expertise on priority resources (e.g., for wildlife habitat, contact biologists within the Maine Department of Inland Fisheries and Wildlife). The latter agencies may have site-specific information or field-based assessment methods that can aid in further narrowing the choices to help insure that the best wetlands are acquired for the desired purpose.

The report is a watershed-based report for the Casco Bay watershed -- the lands that drain into the Bay. This watershed is actually comprised of two major watersheds: 1) the Presumpscot River system and 2) the Royal River system, with smaller watersheds being other lands along the coastline that drain directly into Casco Bay. The report does not make any comparisons between these watersheds. Be advised that there may be characteristics (e.g., water quality) that actually make acquisition or preservation of certain wetlands in one of these watersheds a higher priority than protection of similar wetlands in the other watersheds. This was beyond the scope of the present study. Also, recognize that the analysis presented in this report are specific to a "watershed area" and that the results cannot be used to make comparisons between watersheds (e.g., Casco Bay watershed vs. the Kennebec watershed).

The report is useful for general natural resource planning, as an initial screening for considering prioritization of wetlands (for acquisition or strengthened protection), as an educational tool (e.g., helping the public and nonwetland specialists better understand the functions of wetlands and the relationships between wetland characteristics and performance of individual functions), and for characterizing the differences among wetlands in terms of both form and function within a watershed.

Rationale for Preliminary Functional Assessments

The list of functions evaluated included ten functions: 1) surface water detention, 2) streamflow maintenance, 3) nutrient cycling, 4) sediment and particulate retention, 5) coastal storm surge detention and shoreline stabilization, 6) inland shoreline stabilization, 7) fish habitat, 8) waterfowl and waterbird habitat, 9) other wildlife habitat, and 10) biodiversity. The criteria used for identifying these functions using the digital wetland database are discussed below. The criteria were developed jointly by the principal author of the report and the State's Wetlands Steering Committee, with input from local experts (see Acknowledgments).

In developing a protocol for designating wetlands of potential significance, wetland size was generally disregarded from the criteria, with the exception of the "other wildlife habitat" function. This approach was followed because it was felt that the State and others using the digital database and charged with setting priorities should make the decision on appropriate size criteria as a means of limiting the number of priority wetlands, if necessary. For our study, it was viewed as more important to present a more expansive characterization of wetlands and their likely functions rather than develop a method for ranking wetlands for acquisition, protection, or other purposes.

Surface Water Detention

This function is important to reducing downstream flooding and lowering flood heights, both of which aid in reducing property damage from such events. This function was restricted to nontidal wetlands, with the flood storage function of tidal wetlands included in the coastal storm surge detention function.

In a landmark report on the relationships between wetlands and flooding at the watershed scale, Novitzki (1979) reported that watersheds with 40% coverage by lakes and wetlands had significantly reduced flood flows -- lowered by as much as 80% -- compared to similar watersheds with no or few lakes and wetlands in Wisconsin. Floodplain wetlands and other lotic wetlands (basin and flat types) provide this function at significant levels. Wetlands dominated by trees and/or dense stands of shrubs (with higher frictional resistance) could be deemed to provide a higher level of this function as such vegetation may further aid in flood desynchronization versus similar wetlands with emergent cover. Trees and dense shrubs produce high roughness which helps dissipate energy and lower velocity of flood waters. Yet, this requirement was not applied to the data set as emergent wetlands along waterways are also likely to provide significant flood storage. Floodplain width could also be an important factor in evaluating the significance of performance of this function by individual wetlands (e.g., for acquisition or strengthened protection). There is no quantitative information to establish a significance threshold for size so floodplain width was not used as a selection factor in this study. Terrene throughflow basins should provide similar functions, so they were also designated with predicted high potential for performing this function. Terrene outflow basin wetlands may be important detention basins for local areas and were, therefore, designated as wetlands of possible local significance for this function.

While wetlands are the focus of the study, it should be recognized that lakes are important surface water storage basins. Lentic basin wetlands were identified as wetlands with predicted high potential for surface water detention. These wetlands are believed to function much like floodplain wetlands along rivers in that they store surface water during periods of high lake levels.

Nontidal fringe wetlands were not included as significant for this function, since these wetlands are in water for most or all of the year. They possess some ability to perform this function (especially during low water periods), yet do so at lower levels of significance from those designated as having possible high potential for surface water detention.

Streamflow Maintenance

Many wetlands are sources of groundwater discharge and some may be in a position to sustain streamflow in the watershed. Such wetlands are critically important for supporting aquatic life in streams. Terrene headwater wetlands (by definition, the sources of streams) and lentic wetlands (all except those associated with inflow lakes) perform these functions at notable levels. Lakes themselves are also important providers of streamflow, but they are deepwater habitats (not wetlands) and were, therefore, not highlighted in this analysis.

Certain lotic wetlands may also be important for streamflow maintenance, but could not be identified without intensive field studies. Groundwater discharging into streamside wetlands in sloping terrain may also contribute substantial quantities of water for sustaining baseflows. Floodplain wetlands are known to store water in the form of bank storage, later releasing this water to maintain baseflows. This also aids in reducing flood peaks and improving water quality (Whiting 1998). Among several key factors affecting bank storage are porosity and permeability of the bank material, the width of the floodplain, and the hydraulic gradient (steepness of the water table). The wider the floodplain, the more bank storage given the same soils. Gravel floodplains drain in days, sandy floodplains in a few weeks to a few years, silty floodplains in years, and clayey floodplains in decades. In good water years, wide sandy floodplains may help maintain baseflows. Perhaps, floodplains with sandy loam soils may contribute significant amounts of water for streamflow maintenance. For this preliminary analysis, no lotic wetlands were designated as important for streamflow maintenance, because the relationship is not as clearcut as for the terrene headwater wetlands and lentic wetlands. Perhaps, coupling wetland digital data with soils data may aid in future analysis.

Large wetlands along streams (e.g., lotic stream basin wetlands) in near-headwater positions may also be sources of groundwater discharge and thereby important for maintaining base flows. This relationship was not confirmed for the subject watershed, so such types were not highlighted as significant for the streamflow maintenance function for the Casco Bay watershed. In general, the wetlands designated as significant for this function for this watershed should be considered a conservative listing.

Nutrient Cycling

All wetlands recycle nutrients, but those having a fluctuating water table are best able to recycle nitrogen and other nutrients. Vegetation slows the flow of water which causes deposition of mineral and organic particles and nutrients (nitrogen and phosphorus) bound to them, whereas hydric soils are the places where chemical transformations occur (Carter 1996). Microbial action in the soil is the driving force behind chemical transformations in wetlands. Microbes need a food source -- organic matter -- to survive, so wetlands with high amounts of organic matter should have an abundance of microflora to perform the nutrient cycling function. Wetlands are so effective at filtering and transforming nutrients that artificial wetlands are constructed for water quality renovation (Hammer 1992). Natural wetlands performing this function help improve local water quality of streams and other watercourses.

Simmons et al. (1992) found high removal of nitrate (greater than 80% removal) from groundwater during both the growing season and dormant season in Rhode Island streamside (lotic) wetlands. Groundwater temperatures throughout the dormant season were between 6.5 and 8.0 degrees C, so microbial activity was not limited by temperature. Even the nearby upland, especially transitional areas with somewhat poorly drained soils, experienced an increase in nitrogen removal during the dormant season. This was attributed to a seasonal rise in the water table that exposed the upper portion of the groundwater to more organic matter (nearer the ground surface), thereby supporting microbial activity and denitrification. Riparian forests dominated by wetlands have a greater proportion of groundwater (with nitrate) moving within the biologically active zone of the soil that makes nitrate susceptible to uptake by plants and microbes (Nelson et al. 1995). Riparian forests on well-drained soils are much less effective at removing nitrate. In a Rhode Island study, Nelson et al. (1995) found that November had the highest nitrate removal rate due to the highest water tables in the poorly drained soils, while June experienced the lowest removal rate when the deepest water table levels occurred.

From the water quality standpoint, wetlands associated with watercourses are probably the most noteworthy. Numerous studies have found that forested wetlands along rivers and streams are important for nutrient retention and sedimentation during floods (Whigham et al. 1988; Yarbro et al. 1984; Simpson et al. 1983; Peterjohn and Correll 1982). Consequently, lotic wetlands that are seasonally flooded or wetter (e.g., semipermanently flooded) should be performing this function at significant levels. Lentic wetlands (along lakes) with similar water regimes should also perform this function well. These types of wetlands also tend to have a build-up of organic matter at the surface that provides for increased microbial populations responsible for denitrification and nutrient cycling. Lotic and lentic wetlands with seasonally flooded and wetter water regimes were designated as wetlands with predicted high potential for nutrient cycling in the Casco Bay watershed. Terrene basin and slope wetlands with throughflow may also be significant nutrient recyclers due to high contact with low order streams that may be carrying nutrient loads from various developments or other sources upstream in the watershed. These types were also identified as having high potential for nutrient cycling. Terrene outflow basin and slope wetlands may function at moderate levels that could be important locally and were designated as wetlands of possible local significance for providing this function.

Retention of Sediments and Other Inorganic Particulates

Many wetlands owe their existance to being located in areas of sediment deposition. This function also supports water quality maintenance by capturing sediments with bonded nutrients or heavy metals (as in and downstream of urban areas). Floodplain wetlands plus lotic basin and terrene throughflow basin wetlands are likely to trap and retain sediments and particulates at significant levels. Estuarine fringe wetlands may also accumulate sediments and particulates at notable levels. Salt and brackish marshes in this fringe category were predicted to have high potential for significant sediment and particulate retention, while eelgrass beds and other aquatic beds were not.

Other wetlands may also perform this function at moderate or locally significant levels. Terrene outflow basins, lentic fringe and basin wetlands, and lotic flats were predicted to perform this function at moderate levels. Terrene basins that are isolated or subjected to inflow may be of local significance in retaining such materials. For the latter, it may be worth considering a size requirement with the larger basins (perhaps $\geq$10 acres) being identified as those of local importance, although this was not done for the present study.

Coastal Storm Surge Detention and Shoreline Stabilization

Vegetated wetlands along tidal shores (e.g., embayments and coastal rivers) provide these functions. Vegetation stabilizes the soil, thereby preventing erosion. Salt marshes and other vegetated coastal wetlands serve as buffers to reduce erosion of uplands from tidal waters. The analysis emphasized the irregularly flooded zone which usually borders the upland and therefore would be most significant for providing shoreline stability. The marshes in this zone also represent the most common type of estuarine vegetated wetland in the watershed. The basins where such wetlands have formed also serve as areas where extremely high tides generated by coastal storms (e.g., northeasters) can be detained, thereby reducing the frequency and magnitude of local flooding. Consequently, all irregularly flooded estuarine vegetated wetlands and seasonally flooded tidal palustrine vegetated wetlands were identified as possible wetlands of significance regarding these functions.

The regularly flooded zone of the estuarine wetlands was not included as significant for this function since such areas occur at low elevations that are flooded daily by the tides. They are not likely to provide significant floodwater storage of higher-than-daily tides including storm surges due to their topographic position and relative scarcity in the watershed. While such wetlands may promote shoreline stabilization in places where they lie directly between upland and deepwater, for the Casco Bay watershed, they were not considered particularly significant contributors to shoreline stabilization for the reasons stated above.

The characterization emphasized vegetated wetlands in the analysis. The existence of extensive tidal flats should also have some benefit re: coastal storm surge protection, especially if a northeaster occurs at low tide. They were not included as having high potential since they are underwater for significant periods daily.

Inland Shoreline Stabilization

Like their coastal (estuarine) counterparts, inland vegetated wetlands located along shorelines of rivers, streams, and lakes, help prevent upland erosion and stabilize shorelines. Water level fluctuations may be due to natural events or artificial manipulation. The former changes occur during snowmelt, spring runoff season, and after heavy rainfalls, while the latter changes may be caused by reservoir management or by hydroelectric dam management. Shorelines along large lakes are often exposed to long wind-driven fetches that can cause significant shoreline erosion. Vegetated wetlands along these waterbodies help stabilize the shoreline.

For this analysis, all lotic and lentic wetlands were predicted as having high potential for this function. In the future, any nonvegetated wetlands (e.g., streamside ponds) that fall within the lotic category should be eliminated from this high ranking as well as considering removal of lotic or lentic island wetlands from the potentially significant wetlands for this function. None of these types, however, were not abundant in the Casco Bay watershed.

Provision of Fish Habitat

The assessment of potential habitat for fish is based on generalities that could be refined for fish species of interest at a later date. For this preliminary assessment, fish were first separated into three general categories: coastal fish (estuarine/marine species), lake species (requiring deepwater habitat of lakes and deep ponds), and river/stream species. All fish require permanent water, yet many also require and utilize seasonally flooded and semipermanently flooded wetlands for breeding and nursery grounds.

For coastal species, intertidal flats, coastal marshes (including freshwater tidal marshes), and eelgrass beds were designated as having high potential due to their well-known functions as feeding areas and nursery grounds for marine species. Intertidal vegetated rocky shores (i.e., rockweed-covered shores) were deemed as wetlands with some potential for coastal fishes based on Wippelhauser (1996) and Tort (1993) per suggestion of Alison Ward with Wetlands Steering Committee concurrence.

For freshwater species in general, the assessment emphasized semipermanently flooded wetlands over seasonally flooded types due to the longer duration of surface water. Areas that are flooded for about 3 months in spring are important fish habitats (Francis Brautigam, pers. comm. 1999). For lake fishes, lentic fringe wetlands and lentic basin wetlands that were semipermanently flooded were identified as potentially significant habitat as they may provide important spawning habitat and/or nursery grounds. Semipermanently flooded wetlands associated with flowing waters (lotic) were predicted as having high habitat potential for river and stream fishes. Forested and deciduous shrub wetlands along streams provide canopy coverage over the water thereby lowering stream temperatures and moderating daily fluctuations. These types of lotic stream wetlands were identified as having moderate to high potential as fish habitat for stream species per suggestion of Francis Brautigam (state fisheries biologist) with Wetlands Steering Committee concurrence.

Other wetlands providing significant fish habitat may not be identified due to the study methods. Such wetlands may be individually identified based on actual observations or culled out from site-specific fisheries information available from the State. Also recall that this asssessment is focused on wetlands, not deepwater habitats[3], hence the exclusion of the latter from this analysis. In addition, all wetlands that are significant for the streamflow maintenance function should be considered vital to sustaining the watershed's ability to provide instream fish habitat. While these wetlands may not be providing significant fish habitat themselves, they support base flows essential to keeping water in streams for aquatic life.

Provision of Waterfowl and Waterbird Habitat

For the pilot study (Tiner et al. 1997), wetlands considered to be important waterfowl habitat were the emergent and scrub-shrub wetlands contiguous with open water (beaver-influenced and diked/impounded), wetlands with dead trees (e.g., PFO5 types), and wetlands with semipermanently flooded water regimes (e.g., PEM1F and PSS1F). These habitats are also important habitats for various waterbirds such as great blue herons, green herons, rails, American bitterns, grebes, and shorebirds (e.g., spotted sandpiper and snipe). All beaver-influenced wetlands were also placed in this category. Wetlands with a high interspersion of vegetation and open water are also significant, but no wetlands were mapped as such by the NWI and the scope of work for this project did not encompass a thorough examination of the aerial photos to locate wetlands with this property.

For the watershed-wide analysis, discussions with Dr. Jerry Longcore suggested that it may be possible to indicate habitats for certain waterfowl species with common life history requirements, recognizing the general nature of this functional assessment. Wetlands important to overwintering black ducks and mallards were estuarine emergent wetlands and all tidal flats (estuarine unconsolidated shores). The latter areas are also especially important shorebird feeding areas at low tide in summer and during migration. Estuarine wetlands with fresh water inflow may be of the highest value for overwintering waterfowl but were not

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[3]These habitats are the primary residences for fish.

identified in this assessment.[4] Estuarine aquatic beds (e.g., eelgrass) and shellfish beds may also be considered important feeding habitats for black ducks and mallards (U.S. Fish and Wildlife Service, Gulf of Maine Coastal Ecosystems Program, pers. comm. 1999). These habitats were not included in the present assessment, but could be added at a later date based on further technical review. Wetlands with potentially high spring-summer use by black ducks, mergansers, wood ducks, green-winged teal, and ring-necked ducks were semipermanently flooded and seasonally flooded/saturated wetlands of various types that were either beaver-influenced or impounded (likely waterbody nearby). Ponds were identified as areas of possible significant spring-summer use by mallards. They may also be utilized by other waterbirds such as the great blue heron. Seasonally flooded wetlands forming the shores of lakes, rivers, and streams were deemed as wetlands with some potential for spring-summer use by wood ducks, hooded mergansers, and green-winged teal. Some of these wetlands are also important for other waterbirds (e.g., spotted sandpiper and snipe) and for woodcock (especially alder swamps along streams).

Provision of Other Wildlife Habitat

The provision of other wildlife habitat by wetlands was evaluated in general terms. Species-specific habitat requirements were not considered. In developing an evaluation method for wildlife habitat in the glaciated Northeast, Golet (1972) designated several types as outstanding wildlife wetlands including: 1) wetlands with rare, restricted, endemic, or relict flora and/or fauna, 2) wetlands with unusually high visual quality and infrequent occurrence, 3) wetlands with flora and fauna at the limits of their range, 4) wetlands with several seral stages of hydrarch succession, and 5) wetlands used by great numbers of migratory waterfowl, shorebirds, marsh birds, and wading birds. Golet subscribed to the principle that in general, as wetland size increases so does wildlife value, so wetland size was important factor for determining wildlife habitat potential in his approach. Other important variables included dominant wetland class, site type (bottomland v. upland; associated with waterbody v. isolated), surrounding habitat type (e.g., natural vegetation v. developed land), degree of interspersion (water v. vegetation), wetland juxtaposition (proximity to other wetlands), and water chemistry.

For the Casco Bay project, wetlands important to waterfowl and waterbirds were identified in a separate assessment (see above). Emphasis for assessing "other wildlife" was placed on conditions that would likely provide significant habitat for other vertebrate wildlife (mainly herps, interior forest birds, and mammals). Opportunistic species that are highly adaptable to fragmented landscapes were not among the target organisms, since there seems to be more than ample habitat for these species now and in the future. Rather, animals whose populations may decline as wetland habitats become fragmented by development are of more concern. For example, breeding success of neotropical migrant birds in fragmented forests of

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[4]Such areas may be detected on the NWI maps -- estuarine wetlands with a freshwater stream discharging into them.

Illinois was extremely low due to high predation rates and brood parasitism by brown-headed cowbirds (Robinson 1990). Newmark (1991) reported local extinctions of forest interior birds in Tanzania due to fragmentation of tropical forests. Fragmentation of wetlands is an important issue for wildlife managers to address. The significance of fragmentation in Maine is a topic for discussion among the state's wildlife biologists and was not an objective of the current study. Some useful references on fragmentation relative to forest birds are Askins et al. (1987), Robbins et al. (1989), Freemark and Merriam (1986), and Freemark and Collins (1992).

The analysis identified several wetland types as potentially significant for other wildlife: 1) large wetlands ($\geq$ 20 acres) regardless of vegetative cover, 2) smaller diverse wetlands, 3) areas with a large number of very small isolated wetlands, and 4) urban wetlands. Wetlands in these categories were culled out in a hierarchial fashion beginning with the first category, so that large urban wetlands fell, for example, under category one "large wetlands" and not under category 4 "urban wetlands". Wetlands 10-20 acres in size with diverse covertypes were also chosen as potentially significant wildlife habitat in an attempt to identify smaller wetlands that may support diverse animal communities. Localities with a large number of small isolated wetlands in close proximity may be significant for amphibian breeding and were designated as potentially important wildlife habitat. Numerous urban wetlands were identified as significant to highlight the special needs of urban species. Selected wetlands were chosen based largely on size and association with other wetlands.[5] These wetlands were designated in the category "other wetland with predicted high potential to support urban wildlife", recognizing that some urban wetlands were already designated as significant for wildlife by virtue of their size.

Given the general nature of this assessment of "other wildlife habitat", the State may want to refine this assessment in the future by having biologists designate "target species" that may be used to identify important wildlife habitats in the Casco Bay watershed. After doing this, they should identify criteria that may be used to identify potentially significant habitat for these species in the watershed. An example of this type of analysis has been produced by the Service for the lower Casco Bay watershed (Banner and Libby 1995; see website - http://www.gulfofmaine.org/library/casco/casco.htm).

Dr. Hank Short (U.S. Fish and Wildlife Service, retired) compiled a matrix listing 332 species of wildlife and their likely occurrence in wetlands of various types in New England

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[5]The urban region in the Casco Bay watershed was generally defined by road density in the Greater Portland to Brunswick area as observed on a 1:130,000 map. The interpretation is liberal and includes some suburban areas and possibly some lower density areas. The entire area however is in close proximity to and undoubtedly significantly affected by urban development. The region extended approximately from Cape Elizabeth to Westbrook and Portland to Dunns and Freeport along a corridor about 3 miles inland from Rt. 95, and then to Brunswick.

(Appendix B) from ECOSEARCH models (Short et al. 1996, 1999) that he developed with Dr. Dick DeGraaf (U.S. Forest Service) and Dr. Jay Hestbeck (U.S. Fish and Wildlife Service). Wetland types are NWI types (e.g. PFO1, PFO4, etc. that are further defined by water regime: A- temporarily flooded, B - saturated, and C - seasonally flooded [including E - seasonally flooded/saturated wetlands shown on NWI maps), and F- semipermanently flooded). If interested in the likely occurrence of certain species in a given wetland, one may simply consult this matrix. The assumption in this matrix and ECOSEARCH models is that wildlife species in wetlands tend to be dependent more on covertypes than individual plant species and that the combination of structure (e.g., deciduous tree canopy) and water regime are important habitat descriptors and predictors for wetland-oriented wildlife. DeGraaf and Rudis (1986) summarized habitat, natural history, and distribution of New England wildlife. Much of what is in the ECOSEARCH models comes from this source. Freemark and Collins (1992) prepared a list of area-sensitive or forest interior birds for the eastern U.S. (see Appendix C for list).

Conservation of Biodiversity

In the context of this report, the term "biodiversity" is used to identify certain wetland types that appear to be scarce or relatively uncommon in the watershed, or individual wetlands that possess several different covertypes (i.e., diverse wetland complexes). For example, large wetland complexes composed on multiple wetland types are highlighted as potentially significant for maintaining biodiversity due to the variety of wetland plant community types (covertypes) found within their borders. Schroeder (1996) noted that to conserve regional biodiversity, maintenance of large-area habitats for forest interior birds is essential.

By recognizing the conservation of biodiversity function, we attempted to highlight areas that may contribute to the preservation of an assemblage of wetlands that encompass the natural diversity of wetlands in the Casco Bay watershed. Some of the wetlands designated may be quite common or even abundance in other areas (watersheds) of the State, but when viewing biodiversity from a watershed perspective, they may be significant by their scarcity alone. Moreover, their plant composition and structure may be somewhat different than similar types elsewhere. These wetlands should also be important to the residents of Casco Bay watershed for nature observation and outdoor education.

As mentioned earlier, there was no attempt to incorporate Maine Natural Heritage Program data into this analysis. It is expected that this information will be utilized at a later date by the State when it develops a wetland resources plan for the Casco Bay watershed. Consequently, the wetlands designated as potentially significant for biodiversity are simply a foundation to build upon. Local knowledge of significant wetlands will further expand the list of wetlands important for this function.

Results

Wetland Characterization

Wetlands were classified according to the U.S. Fish and Wildlife Service's official wetland classification system (Cowardin et al. 1979) and by landscape position, landform, and water flow path descriptors following Tiner (1997b). Summaries for the study area are given in Tables 2 and 3 and illustrated in Maps 1 through 5.[6] The maps are presented in a separate folder accompanying this report. Table 2 summarizes covertypes through the subclass level of the FWS classification ("NWI types"), while Table 3 tabulates statistical data on wetlands by landscape position and landform ("HGM types").

Wetlands by NWI Types

According to the NWI, the Casco Bay watershed had nearly 9,500 wetlands totaling 46,681 acres. Palustrine wetlands were the most abundant types with over 35,500 acres. Freshwater swamps, bogs, marshes, and ponds represented about 76 percent of the watershed's wetlands. Estuarine wetlands accounted for only 14 percent of the wetlands (about 6500 acres), while marine wetlands represented about 10 percent (about 4600 acres). Only 13.5 acres of lacustrine wetlands (unconsolidated shore) were inventoried; aquatic beds and nonpersistent emergent wetlands that may be associated with some lakes were not detected due to spring aerial photos used for NWI mapping (high water and no visible leafcover).

Forested wetlands were the predominant palustrine type in the watershed accounting for about 56 percent of the palustrine wetlands (excluding dead forested wetlands which were mainly shallow water wetlands). Scrub-shrub wetlands were next in abundance among these wetlands, representing about 26 percent. Emergent wetlands (including shrub/emergent mixtures) made up nearly 13 percent. The remaining palustrine wetlands were ponds (unconsolidated shores). Appendix D presents four tables listing examples of palustrine wetland plant communities found in the watershed.

Estuarine wetlands were dominated by tidal flats (unconsolidated shores) which comprised about 74 percent of these wetlands. Salt marshes (emergent) represented about 23 percent of the estuarine wetlands. The remainder were either aquatic beds (mostly rocky shores vegetated by fucoid algae; 3.3 percent) or nonvegetated rocky shores (0.3 percent).

Marine wetlands were mostly tidal flats (57 percent) and aquatic beds (34 percent; including mostly vegetated rocky shores). Nonvegetated rocky shores accounted for about 9 percent of the marine wetlands. Mussel reefs comprised about 0.2 percent of the marine wetlands in

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[6]Please note that these maps are reductions of 1:130,000 maps, so some of the footnotes may be somewhat difficult to read.

Casco Bay.

Table 2. Wetlands in the Casco Bay watershed, southern Maine classified by NWI wetland type to the class level (Cowardin et al. 1979). Other modifiers (e.g., beaver, diked/impounded, partly drained) have been deleted from NWI types for this compilation.

NWI Wetland Type	Acreage
Marine Wetlands	
Aquatic Bed	1550.4
Reef	9.4
Rocky Shore	417.1
Unconsolidated Shore	2625.7
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Subtotal	4602.6
Estuarine Wetlands	
Aquatic Bed	215.7
Emergent	1491.7
Rocky Shore	18.7
Unconsolidated Shore	4799.2
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Subtotal	6525.3
Lacustrine Wetlands	
Unconsolidated Shore	13.5
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Subtotal	13.5
Palustrine Wetlands	
Aquatic Bed	8.3
Emergent (Nontidal)	3260.7
Emergent (Tidal)	64.6
Emergent/Scrub-Shrub (Nontidal)	1101.5
Emergent/Scrub-Shrub (Tidal)	49.7
Broad-leaved Deciduous Forested (Nontidal)	6944.1
Broad-leaved Deciduous Forested (Tidal)	17.6
Needle-leaved Deciduous Forested	3.4
Needle-leaved Evergreen Forested (Nontidal)	6632.4
Needle-leaved Evergreen Forested (Tidal)	75.3
Mixed Forested (Nontidal)	5494.6
Mixed Forested (Tidal)	2.4
Forested/Emergent	120.4
Evergreen Forested/Scrub-Shrub	432.7
Deciduous Forested/Scrub-Shrub	107.6

Deciduous Scrub-Shrub (Nontidal)	6736.8
Deciduous Scrub-Shrub (Tidal)	79.2
Broad-leaved Evergreen Scrub-Shrub	370.3
Needle-leaved Evergreen Scrub-Shrub (Nontidal)	419.2
Needle-leaved Evergreen Scrub-Shrub (Tidal)	5.6
Evergreen Scrub-Shrub (unspecified/Nontidal)	155.9
Mixed Scrub-Shrub (Nontidal)	1292.3
Mixed Scrub-Shrub (Tidal)	8.7
Unconsolidated Bottom (Nontidal)	1986.5
Unconsolidated Bottom (Tidal)	14.8
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Subtotal	35,539.3
GRAND TOTAL (ALL WETLANDS)	46,680.7

Hydrogeomorphic-Type Wetlands[7]

Most of the wetlands in the Casco Bay watershed were terrene wetlands, principally headwater and isolated types. Terrene wetlands accounted for 66 percent of the wetlands by number, yet only 38 percent of the wetland acreage classified to hydrogeomorphic (HGM) type (Table 3). This contrast means that many of the terrene wetlands were rather small. Lotic wetlands ranked second in abundance (2,105 wetlands; 26 percent of the number of wetlands), but first in acreage totaling 19,364 acres, accounting for 52 percent of the wetland acreage (that was classified by HGM-type descriptors) in the watershed. This suggests that lotic wetlands were, on average, much larger in size than the terrene wetlands. Estuarine wetlands (essentially vegetated types) represented almost 5 percent of the watershed's wetlands by number and by acreage. Wetlands associated with lakes -- lentic wetlands -- comprised nearly 4 percent by number and about 5 percent by acreage.

From the landform perspective, basin wetlands were most abundant, accounting for 84 percent of the wetlands by number (6,826) and about 74 percent of the total acreage (27,354 acres). Due to the fact that most estuarine vegetated wetlands are fringe types, the fringe wetlands were second-ranked in regard to number (484 wetlands = 6%), yet fourth-ranked in acreage (2,227 acres = 6%). Floodplain wetlands were second in acreage (with 2,814 acres = 8%) and fourth in number (244 = 3%). Slope wetlands were third-ranked in both categories (438 wetlands = 5%; 2,702 acres = 6%). Fifth-ranked in both categories were flat wetlands (108 = 1%; 2,072 acres = 6%). Island wetlands were poorly represented -- 26 wetlands (9 estuarine; 3 lotic river; 14 lentic) for a total of 21 acres.

Considering water flow path for freshwater wetlands, five types were recognized: 1) inflow, 2) outflow, 3) throughflow[8], 4) bidirectional flow (associated with lakes), and 5) isolated. Isolated wetlands were most numerous (4,255 wetlands), representing 55 percent of the freshwater wetlands. These wetlands, however, occupied 6,171 acres, only 17 percent of the acreage. Most of the freshwater wetland acreage (19,716 acres; 56%) was composed of throughflow wetlands, mainly associated with rivers and streams. These wetlands accounted for about 28 percent of the number of freshwater wetlands in the Casco Bay watershed (2,141 wetlands). Outflow wetlands made up about 22 percent of the freshwater wetland acreage

[7]Note that all wetlands were not characterized by HGM-type descriptors. All freshwater wetlands were categorized, but for coastal areas, the emphasis was on salt and brackish marshes (estuarine emergent wetlands). No marine wetlands were categorized as emergent wetlands do not exist in this system and all marine wetlands are simply "fringe" types. Hence, when percentages are given in the following discussion, they are relative to the wetlands that were characterized by HGM-type codes (8126 wetlands totaling 37,190 acres which actually represent about 80 percent of the wetland acreage in the Casco Bay watershed; the remainder are the marine wetlands and the majority of nonvegetated estuarine wetlands).

[8]Includes freshwater tidal wetlands which are actually bidirectional.

(7,620) and almost 13 percent of the wetlands by number (978). Bidirectional flow wetlands associated with lakes comprised about 4 percent by number (312) and nearly 5 percent by acreage (1,688 acres). Inflow wetlands were scarce representing almost 1 percent by number (67) and about 0.5 percent by acreage (189 acres).

Table 3. Estuarine and freshwater wetlands in the Casco Bay watershed, southern Maine classified by landscape position, landform, and water flow path (Tiner 1997b). See Appendix A for definitions. Codes in parentheses refer to codes used in the text, for example, TEBAIS represents a terrene basin isolated wetland.

Landscape Position	Landform	Water Flow	# of Wetlands	Acreage
Terrene (TE)			5336	14281.4
	Slope (SL)		224	1602.1
		Inflow (IN)	10	52.6
		Isolated (IS)	84	391.2
		Outflow (OU)	114	1055.7
		Throughflow (TH)	16	102.6
	Basin (BA)		5104	12473.6
		Inflow (IN)	57	136.5
		Isolated (IS)	4171	5779.6
		Outflow (OU)	856	6358.2
		Throughflow (TH)	20	199.3
	Flat (FL)	Outflow (OU)	8	205.7
Lentic (LE)			312	1688.3
	Basin (BA)		199	1285.9
	Fringe (FR)		99	390.8
	Island (IS)		14	11.6
Lotic River (LR)			324	3582.8
	Basin (BA)		91	1817.4
	Flat (FL)		11	169.4
	Floodplain (FP)		217	1589.8
	Fringe (FR)		2	1.0
	Island (IS)		3	5.2

Lotic Stream (LS)	1781	15831.1
Basin (BA)	1408	11639.1
Flat (FL)	89	1697.1
Floodplain (FP)	27	1224.3
Fringe (FR)	43	171.1
Slope (SL)	214	1099.5
Estuarine (ES)	373	1805.9
Basin (BA)	24	137.6
Fringe (FR)	340	1664.3
Island (IS)	9	4.0

Note: Most nonvegetated estuarine wetlands were not classified by these descriptors as the emphasis on this characterization was largely based on vegetated types, especially in the marine and estuarine systems. The nonvegetated estuarine wetlands, namely intertidal flats and rocky shores are "fringe" wetlands.

Maps

A series of 15 maps have been produced at 1:130,000 to profile the watershed's wetlands. These maps have been distributed to the Maine State Planning Office. Maps at that scale for the Casco Bay watershed are too large to include in a report, so they were reduced to an 11" x 12" format. They were then printed in a panel format, so that the 15 maps fit onto two approximately 28" x 44" sheets. These panels are enclosed in a separate folder accompanying this report.

A list of the 15 maps follows:

Map 1 - Wetlands and Deepwater Habitats Classified by NWI Types
Map 2 - Wetlands Classified by Landscape Position
Map 3 - Wetlands Classified by Landform
Map 4 - Estuarine and Marine Wetlands Classified by Landscape Position and Landform
Map 5 - Inland Wetlands Classified by Landscape Position and Landform
Map 6 - Inland Wetlands and Surface Water Detention
Map 7 - Wetlands and Streamflow Maintenance
Map 8 - Wetlands and Nutrient Cycling
Map 9 - Wetlands and Sediment/Particulate Retention
Map 10 - Coastal Wetlands and Storm Surge Detention/Shoreline Stabilization
Map 11 - Wetlands and Inland Shoreline Stabilization
Map 12 - Wetlands and Fish Habitat
Map 13 - Wetlands and Waterfowl/Waterbird Habitat
Map 14 - Wetlands and Other Wildlife Habitat
Map 15 - Wetlands and Biodiversity

The first five maps depict wetlands by the FWS system (NWI types) and by landscape position/landform (HGM types). Each of the remaining maps (Maps 6 through 15) highlight wetlands that perform each of the assessed functions at a significant level.

Summary of Thematic Map Data

The rationale for preliminary assessment of wetlands for performing each of ten functions is given in the Methods section. The following section summarizes the results for each function, mostly in tabular form. The percentages given relative to the total watershed wetlands are based on a wetland acreage of about 37,190 -- the total acreage of wetlands classified by HGM-type descriptors. The remaining wetlands are estuarine nonvegetated and marine wetlands that can be considered fringe wetlands. The percentages for the "Other Wildlife Habitat" and "Biodiversity" functions were an exception to this as they were based on the total acreage of NWI types (46,681 acres).

Surface Water Detention

Roughly 27 percent of the watershed's wetlands by number and 65 percent by acreage were categorized as having possible high potential or local significance for this function.

With Predicted High Potential

Wetland Type	# of Wetlands	Acreage
Lentic Basin (LEBA)	199	1285.9
Lotic River Basin (LR1BA)	91	1817.3
Lotic River Flat (LR1FL)	11	169.4
Lotic River Floodplain (LR1FP)	217	1589.8
Lotic Stream Basin (LS1BA)	1408	11642.6
Lotic Stream Flat (LS1FL)	89	1697.1
Lotic Stream Floodplain (LS1FP)	27	1224.5
Terrene Basin Throughflow (TEBATH)	20	199.3
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Total	2062	19625.9

These wetlands represent about 25 % of the number of wetlands in the Casco Bay watershed and about 53% of the wetland acreage in watershed.

With Possible Local Significance

Wetland Type	# of Wetlands	Acreage
Terrene Basin Outflow (TEBAOU)	133	4606.3
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Total	133	4606.3

These wetlands comprise about 1% of the number and about 12% of the wetland acreage in the watershed.

Streamflow Maintenance

About 16 percent of the watershed's wetlands by number and 25 percent by acreage were identified as potentially significant for streamflow maintenance.

With Predicted High Potential - Wetlands Associated with Lakes:

Wetland Type	# of Wetlands	Acreage
Lentic Basin (LEBA)	198	1279.9

Lentic Fringe (LEFR)	99	390.7
Lentic Island (LEIS)	14	11.6
Total	311	1682.2

These wetlands represent about 4% of the watershed's wetlands by both number and acreage.

With Predicted High Potential - Wetlands Serving as Source of Stream:

Wetland Type	# of Wetlands	Acreage
Terrene Basin Outflow (TEBAOU)	855	6354.4
Terrene Flat Outflow (TEFLOU)	8	205.7
Terrene Slope Outflow (TESLOU)	114	1055.7
Total	977	7615.8

These wetlands represent about 12% of the watershed's wetlands by number and about 20% by acreage.

Nutrient Cycling in Freshwater Areas

Several wetland types were considered to be potentially important for nutrient cycling. Freshwater types were emphasized. About 50 percent of the watershed's wetlands were identified as potentially significant for this function (excluding coastal wetlands).

Wetlands with Predicted High Potential Along Lakes:

Wetland Type	Acreage
Lentic Basin (LEBA)	1,143.6
Lentic Fringe (LEFR)	261.0
Lentic Island (LEIS)	3.7
Total	1408.3

These wetlands represent 4% of the watershed's wetland acreage.

Wetlands with Predicted High Potential Along Rivers and Streams:

Wetland Type	Acreage
Lotic River Basin (LR1BA)	1624.9

Lotic River Flat (LR1FL)	169.4
Lotic River Floodplain (LR1FP)	1474.8
Lotic River Fringe (LR1FR)	1.0
Lotic River Island (LR1IS)	5.2
Lotic Stream Basin (LS1BA)	10019.1
Lotic Stream Flat (LS1FL)	1548.7
Lotic Stream Floodplain (LS1FP)	1096.6
Lotic Stream Fringe (LS1FR)	77.4
Lotic Stream Slope (LS1, 2, or 3SL)	1061.8
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Total	17078.9

These wetlands represent 46% of the watershed's wetland acreage.

Other Wetlands with Predicted High Potential:

Wetland Type	Acreage
Terrene Basin Throughflow (TEBATH)	171.8
Terrene Slope Throughflow (TESLTH)	98.7
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Total	270.5

These wetlands represent 0.7% of the watershed's wetland acreage.

Other Wetlands of Possible Local Significance:

Wetland Type	Acreage
Terrene Basin Outflow (TEBAOU)	5286.0
Terrene Slope Outflow (TESLOU)	1003.5
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Total	6289.5

These wetlands represent about 17% of the watershed's wetland acreage.

Retention of Sediments and Other Inorganic Particulates

About 86 percent of the watershed's wetland acreage was designated as having possible high or moderate levels of sediment and inorganic particulate retention.

Wetlands with Predicted High Potential:

Wetland Type	Acreage
Estuarine Basin (ESBA)	121.9
Estuarine Fringe (ESFR)	1515.2
Lotic River Basin (LR1BA)	1817.4
Lotic River Floodplain (LR1FP)	1589.7
Lotic River Fringe (LR1FR)	1.0
Lotic Stream Basin (LS1BA)	11637.0
Lotic Stream Floodplain (LS1FP)	1224.3
Lotic Stream Fringe (LS1FR)	171.1
Terrene Basin Throughflow (TEBATH)	199.3
Total	18276.9

These wetlands account for 49% of the watershed's wetland acreage.

Wetlands with Possible Moderate Potential:

Wetland Type	Acreage
Terrene Basin Outflow (TEBAOU)	6354.2
Lentic Fringe (LEFR)	390.8
Lentic Basin (LEBA)	1285.9
Lotic River Flat (LR1FL)	169.4
Lotic Stream Flat (LS1FL)	1697.1
Total	9897.4

These wetlands account for about 27% of the watershed's wetland acreage.

Wetlands of Possible Local Significance:

Wetland Type	Acreage
Terrene Basin Inflow (TEBAIN)	136.5
Terrene Basin Isolated (TEBAIS)	5779.0
Total	5915.5

These wetlands account for 16% of the watershed's wetland acreage.

Coastal Storm Surge Detention and Shoreline Stabilization

About 4 percent of the watershed's wetland acreage was categorized as having possible high potential for coastal surge protection and shoreline stabilization. Rocky shores were not included in these figures since the analysis focused on emergent wetlands in the estuarine and marine systems. Freshwater tidal wetlands were included in the analysis of surface water detention and inland shoreline stabilization functions and were not represented for the subject function. It should be understood, however, that they do serve as significant water storage areas for coastal storm surge and their acreage (303 acres) can be added to the total below for wetlands with predicted high potential. As noted in the rationale section, the regularly flooded estuarine marshes were not included as having high potential. In certain areas, they lie between erodable upland and nonvegetated tidal flats and are important for coastal shoreline stabilization. Such areas were not identified in the Casco Bay watershed, yet a total of 176 acres of this type of wetland were inventoried.

Wetlands with Predicted High Potential:

Wetland Type	Acreage
Estuarine Emergent Irregularly Flooded	1315.4
Total	1315.4

Inland Shoreline Stabilization

Vegetated wetlands along lakes, rivers, and streams help stabilize the soils and protect adjacent uplands from water-borne erosion.

Wetlands with Predicted High Potential Along Rivers and Streams

Wetland Type	# of Wetlands	Acreage
Lotic River Basin (LR1BA)	91	1817.4
Lotic River Flat (LR1FL)	11	169.4
Lotic River Fringe (LR1FR)	2	1.0
Lotic River Floodplain (LR1FP)	217	1589.8
Lotic River Island (LR1IS)	3	5.2
Lotic Stream Basin (LS1BA)	1408	11639.1
Lotic Stream Flat (LS1FL)	89	1697.1
Lotic Stream Floodplain (LS1FP)	27	1224.3
Lotic Stream Fringe (LS1FR)	43	171.1
Lotic Stream Slope (LS1SL)	142	832.5
Total	2033	19146.9

About 51 percent of the watershed's wetland acreage and about 25 percent of the watershed's wetlands (by number) were represented by wetlands with a high potential to aid in inland shoreline stabilization along rivers and streams. These figures include about 45 acres of impounded waters along streams that actually do not provide this function; they were included because they are part of a larger wetland complex that does perform this function at significant levels.

Wetlands with Predicted High Potential Along Lakes

Wetland Type	# of Wetlands	Acreage
Lentic Basin (LEBA)	199	1285.9
Lentic Fringe (LEFR)	99	390.8
Lentic Island (LEIS)	14	11.6
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Total	312	1688.3

These wetlands represent about 4% of the wetlands in the Casco Bay watershed by number and roughly 5% of the acreage.

Fish Habitat

Wetlands with predicted high potential to serve as fish habitat represented about 27 percent of the watershed's wetland acreage. Another 29 percent of the Casco Bay watershed's wetland acreage was designated as having moderate to high potential for stream fish habitat. It is crucial to realize that they are forested and/or deciduous shrub wetlands believed to be important for maintaining water temperatures in streams and thereby maintaining suitable fish habitat; they are not serving as fish habitat themselves. Other wetlands -- those designated as significant for the streamflow maintenance -- were not identified as significant for fish habitat, yet may also be considered vital to sustaining the watershed's ability to provide instream fish habitat; they can be observed on the map of streamflow maintenance.

Wetlands with Predicted High Potential for Coastal Species:

Wetland Type	Acreage
Estuarine Aquatic Bed (eelgrass beds)	149.2
Estuarine Emergent	1491.7
Estuarine Unconsolidated Shore (tidal flats)	4799.2
Marine Aquatic Bed (eelgrass beds)	444.7
Marine Unconsolidated Shore (tidal flats)	2625.7

Palustrine Emergent - Tidal	64.6
Palustrine Emergent/Shrub - Tidal	49.7
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Total	9624.8

These wetlands represent nearly 26 % of the watershed's wetland acreage.

Wetlands with Predicted Some Potential for Coastal Species:

Wetland Type	Acreage
Estuarine Aquatic Bed (vegetated rocky shore)	66.5
Marine Aquatic Bed (vegetated rocky shore)	1105.7
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Total	1172.2

These wetlands comprise about 3 percent of the watershed's wetland acreage.

Wetlands with Predicted High Potential for Lake Species:

Wetland Type	Acreage
Lentic Fringe	390.8
Lentic Basin and Semipermanently Flooded	7.5
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Total	398.3

These wetlands account for about 1% of the watershed's wetland acreage.

Wetlands with Predicted High Potential for River and Stream Species:

Wetland Type	Acreage
Lotic River and Semipermanently Flooded	36.4
Lotic Stream and Semipermanently Flooded	130.8
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Total	167.2

These wetlands account for 0.4% of the watershed's wetland acreage.

Wetlands with Predicted Some Potential for River and Stream Species:

Wetland Type	Acreage
Lotic Stream Basin	7643.0
Lotic Stream Flat	1563.9
Lotic Stream Floodplain	628.2
Lotic Stream Fringe	36.0
Lotic Stream Slope	991.1
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Total	10862.2

These wetlands account for 29% of the watershed's wetland acreage.

Waterfowl and Waterbird Habitat

Coastal Wetlands with Predicted Moderate to High Potential for Overwintering Waterfowl and for Spring-Summer Use by Waterbirds:

Wetland Type	Acreage
Estuarine Emergent	1491.7
Estuarine Unconsolidated Shore (tidal flat)	4799.2
Marine Unconsolidated Shore (tidal flat)	2625.7
Palustrine Emergent - Tidal	61.2
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Total	8977.8

Wetlands important for overwintering waterfowl and for other waterbirds in spring and summer along the coast represent about 24% of the watershed's wetland acreage.

Inland Wetlands with Predicted High Potential for Spring-Summer Use by Waterfowl and Waterbirds:

Wetland Type	Acreage
PFO5	154.8
PFO4/SS1F	1.9
PEM1/SS1F	9.6
PEM1Eh	71.4
PEM1F	259.3
PFO1/4Eh	25.4
PFO1Eh	58.6

PFO1Eb	15.0
PSS1/EM1Eh	14.8
PSS1/EM1Fh	16.2
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Total	626.9

These wetlands account for about 1.7% of the watershed's wetland acreage.

Wetlands with Predicted Some Potential for Spring-Summer Use by Mallards:

Wetland Type	Acreage
Palustrine Unconsolidated Bottom	691.8
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Total	691.8

These ponds represent nearly 2% of the watershed's wetland acreage.

Wetland with Possible Spring-Summer Use by Wood Ducks, Hooded Mergansers, and Green-winged Teal

Wetland Type	Acreage
Lentic Basin	1135.5
Lotic River Basin	1549.6
Lotic River Flat	167.7
Lotic River Floodplain	1230.8
Lotic Stream Basin	9585.4
Lotic Stream Flat	1499.0
Lotic Stream Floodplain	1029.3
Lotic Stream Fringe	13.0
Lotic Stream Slope	941.6
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Total	17151.9

These wetlands amount to about 46% of the watershed's wetland acreage.

Other Wildlife Habitat

Several categories of wetlands were identified as potentially significant for other wildlife: 1) 315 wetlands ≥ 20 acres, 2) 38 small diverse wetlands (10-20 acres and with 2 or more different covertypes at the class level), 3) 13 areas of "clusters of small wetlands" that may represent possible vernal pool areas, and 4) other wetlands designated in urban areas that were predicted as potentially important to urban wildlife. Note that summary statistics for each of the 13 areas of cluster wetlands are given in Appendix E.

Wetland Type	Acreage
Large Wetlands	20,527.3
Small Diverse Wetlands	555.0
Clusters of Small Wetlands	461.5
Urban Wildlife Wetlands (not designated above)	2165.3
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Total	23709.1

These wetlands comprise about 51% of the watershed's wetland acreage (including marine wetlands).[9]

Conservation of Biodiversity

Certain wetland types appeared relatively uncommon or rare in the watershed. While they may be abundant elsewhere in the state, they may be viewed as important for maintaining biodiversity within the limits of the Casco Bay watershed, given the watershed focus of this analysis. The following types were highlighted: 1) mussel reefs (9.4 acres), 2) freshwater tidal wetlands (303.4 acres; 0.7% of all wetlands -- these wetlands should be field checked to verify their tidal fresh status), 3) lotic fringe wetlands (172.1 acres; 0.4% of wetlands), 4) lentic fringe wetlands (390.8 acres; 0.8% of all wetlands), 5) freshwater wetlands with a co-dominance of larch (Larix laricina; 3.4 acres), 6) evergreen shrub bogs (862.4 acres; 1.9% of all wetlands), 7) eelgrass beds (593.9 acres; 1.3% of all wetlands), and 8) estuarine vegetated wetlands (1491.7 acres; 4.0% of all wetlands). In reviewing the color-coded watershed map of NWI wetland types, 18 large wetland complexes appeared to have a diverse assemblage of covertypes that suggested their possible importance to species conservation. Appendix F contains summary statistics for each of these 18 complexes. In total, almost 10,500 acres of wetlands were designated as potentially important to conserving wetland biodiversity in the Casco Bay watershed. This total represents about 22 percent of the total wetland acreage (including marine wetlands).[10]

Remember that this assessment was based on remote sensing techniques and known sites important to maintaining biodiversity such as those on record with the Maine Natural Heritage Program or reported in other sources were not used. Consequently, the listing is conservative and represents a starting point, not an end point for an assessment of wetlands important for

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[9]A total wetland acreage of 46,681 acres was used to calculate the percent of the wetland acreage represented by the subject wetlands.

[10]A total wetland acreage of 46,681 acres was used to calculate the percent of the wetland acreage represented by the subject wetlands.

conservation of species. These sources should be added to the list at a later date by the State as they proceed to develop a wetland protection strategy for the Casco Bay watershed.

Suggestions for Future Characterizations and Analyses

1. Improving the wetland database. As a first step in future analyses, it may be worth considering the following: 1) combine any available digital county soils survey data with NWI data to identify possible missed wetlands, 2) re-examine original NWI photos or preferably more recent photos (1:40,000 color infrared photos) to identify any needed revisions to the existing NWI digital database, and 3) update the wetland digital data in the process if evaluating more recent imagery. Also it may be suggested that Maine DEP permit inspectors help improve the wetland data layer through their on-the-ground observations (e.g., adding location/type of missed wetlands to a paper NWI map, noting any other errors, and marking locations of destroyed wetlands). These data could then be used to improve the existing wetland inventory data for other uses, such as watershed planning.

2. Additional possibilities for improved classification. Some other descriptors can be added to aid in better classification and characterization of wetlands and deepwater habitats.

a. Identify "rivermouth" wetlands where rivers and streams empty into lakes. These wetlands may have high values re: fish spawning and nursery grounds for lake species and perhaps for species that seasonally migrate from lake to river. They may also serve as important places for sediment retention and nutrient cycling as they develop in areas where lotic waters meet lentic waters.
b. Add a pond fringe descriptor ("pf") to identify wetlands that fringe ponds.
c. Classify lakes as inflow or outflow; otherwise assume throughflow. Outflow lakes are in headwater positions.
d. Add a meander scar descriptor ("ms") for such basins on floodplains.
e. Ponds in rivers and streams were classified as LR1BATH and LS1BATH, respectively. They could be culled out by combination of the latter code plus PUBH, for example. The same thing holds true for ponds that were classified within terrene basins (TEBA...). Future studies should at least identify such ponds with a human-impacted modified (e.g., LR1BATHhi)
f. Omit "TH" from mapping codes of lotic and estuarine wetlands since by definition, these wetlands are throughflow in the former and bidirectional flow in the latter. May want to consider restricting use of throughflow in estuarine wetlands to those that have a freshwater stream entering them. Currently, terrene wetlands that are connected to estuarine wetlands and deepwater habitats are designated with an "es" (estuarine) modifier.
g. The use of throughflow for lentic wetlands could be restricted to situations where a stream runs through the lakeside wetland. In this way, lentic wetlands with streams (LEBATH) would be easily distinguished from thoses along the lakeshore that lack a stream (LEBA or LEBABI). For the latter areas, the water flow path should be considered "bidirectional" (BI) as the presence of surface water and/or groundwater levels are likely affected by lake water levels.

3. Inclusion of other data sources in the analysis. The next step in an analysis of wetland

functions would be to include other data sources to provide site-specific or more detailed information on various functions and especially for setting priorities for wetland/land acquisition and strengthened protection in specific areas. This may best done after the "preliminary assessment" stage portrayed in this report. Consultation with local people knowledgeable about local fish and wildlife resources (e.g., amphibians and location of known vernal pool sites, known deer or moose wintering yards and other significant wildlife wetlands) will help improve upon the preliminary findings of the current study. Some examples are listed below.

a. Natural Heritage Program biodiversity data. If possible, incorporate Maine Natural Heritage Program data into the assessment of wetlands important for maintaining biodiversity. These data, however, are usually considered sensitive and their input may best be done as a separate step in the State's preparation of a wetland conservation plan for the Casco Bay watershed.

b. Inclusion of site-specific data on important fish and wildlife habitats. The next step would be to add first-hand knowledge of the location of wetlands of known importance to fish and wildlife to the maps, e.g., known deer yards, rookeries, bald eagle/osprey nest sites, and seal haul-out areas (e.g., Jones et al. 1988). GIS may be used to identify wetlands that may serve as deer wintering areas by searching for preferred habitats like large stands of evergreen forested wetlands (>500 acres) with a southern exposure that are 3-5 miles from a known deer wintering area (Jones et al. 1988). Review eelgrass data for Casco Bay from Maine GIS and highlight these areas as significant estuarine habitat if not otherwise designated as such.

4. <u>Size classes of wetlands</u>. In the context of identifying large wetlands for wildlife, be sure to include wetlands on both sides of rivers (which divide a wetland into two or more units) as one wetland. These units should have the same landscape position and landform classification. Also a size class distribution map could be prepared to display the abundance of wetlands by size. Size class should consider the issue of minimum-sized habitat for area-sensitive species and interior forest birds.

5. <u>Multiple function analyses and map products</u>. Given that the wetland data are in digital form available for GIS applications, various types of map products could be made beyond those made for the watershed study. For example, if desireable, a map highlighting wetlands that perform multiple functions or combinations of specific functions of priority interest to the State may be produced from the database.

6. <u>Wetland buffer classification, inventory, and evaluation</u>. Consider adding an evaluation of the condition of the wetland buffer (adjacent upland) to the assessment. This may be particularly important for assessing the wetland function of providing habitat for other wildlife (excluding fish and waterfowl). This is especially valuable for establishing priorities for acquisition. The condition of the wetland buffer, the quality of the water entering the

wetland, and the predominant land use/cover within the small upstream watershed (or within 0.5 miles of the wetland) may be used as an indicator of the "health" of the wetland. Knowing the condition of stream, river, and lake buffers would also be beneficial. A 300-foot buffer has been reported to be important for neotropical migrant bird species (Keller et al. 1993) and streamside vegetation providing canopy coverage over streams is important for lowering stream temperatures and moderating daily fluctuations that is vital to providing suitable habitat for certain fish species (e.g., trout). The condition of these buffers is also significant for locating possible sources of water quality degradation, as wooded corridors should provide the best protection, while developed corridors (e.g., urban or agriculture) should contribute to substantial degradation. This information would, however, require additional photointerpretation and mapping, unless a decision is made to designate the entire 300-foot zone as potentially important fish and wildlife habitat (regardless of vegetation cover or land use). Review of the literature on buffers may suggest wider buffers, such as 600 feet or more for certain species of wildlife (e.g., Kilgo et al. 1998 for southern bottomland hardwood stream corridors). An interesting article by Finlay and Houlahan (1996) suggests that land use practices around wetlands may be as important to wildlife as the size of the wetland itself. They reported that removing 20 percent of the forest within 1000m of a wetland may have the same effect on species as destroying 50 percent of the wetland. For literature reviews of wetland and stream buffers, see Castelle et al. (1994) and Desbonnet et al. (1994).

7. <u>Potential wetland restoration sites identification, inventory, and evaluation</u>. For meeting the State's ultimate objective of producing a watershed-based wetland protection plan, it would also be worthwhile identifying potential wetland restoration sites. Many degraded wetlands can be identified from the existing NWI database. For example, impounded, excavated, and partly drained wetlands are noted by the use of special modifiers ("h", "x", and "d", respectively). Other possible wetland restoration sites could be detected through aerial photointerpretation (e.g., former wetlands and existing wetlands with signs of stress due to adjacent land use). The Service is doing this type of work in Massachusetts and Rhode Island for various state programs interested in wetland restoration.

8. <u>Identification of potential wildlife travel corridors</u>. While many stream corridors are important for wildlife movement, there may be other wildlife corridors that state wildlife biologists could help identify based on their knowledge of wildlife movement throughout the state.

9. <u>Watershed health and ecological condition</u>. The health and ecological condition of a watershed may be assessed by considering the integrity of the lotic wetlands and riparian forests (upland forests along streams), the percent of land uses that may adversely affect water quality in the watershed (% urban, % agriculture, % mining, etc.), the actual water quality, the percent of forest in the watershed, the number of dams on streams, etc., if this is useful. Recent work on this is being done in the Pacific Northwest due to the concerns for salmon (Wissmar et al. 1994; Naiman et al. 1992). In a Wisconsin study, Wang et al. (1997) found that instream habitat quality declined when agricultural land use in a watershed exceeded 50

percent, while when only 10-20 percent of the watershed was urbanized, severe degradation occurred. The NWI Program in the Northeast has developed five indices to help characterize the overall condition of a watershed from an ecological standpoint. These indices may be used as one useful measure for assessing the ecological condition of the watershed. A report on this will soon be available, contact R. Tiner (principal investigator) for details.

10. Opportunity to currently perform wetland functions. Perhaps "opportunity" to perform certain functions (e.g., flood storage wetlands above floodprone areas or nutrient cycling wetlands in/downstream of urban areas) can be later added to the assessment by the State if this is deemed necessary or worthwhile for prioritization purposes.

Remaining Issues For Future Resolution

1. Fragmentation of wetlands. Although not a prime purpose of the current study, we attempted to identify wetlands that were subjected to significant fragmentation. In the Portland area, many small wetlands were actually the remaining fragments (remnants) of once large wetlands. For this report, we attempted to apply the fragmentation descriptor ("fg") to wetlands that were divided into two or more units by roads, railroads, or other structures which likely disrupted the hydrology and created an increased risk for wildlife crossing. Fragmentation in this context, therefore, did not address the issue from the broad landscape perspective which is more encompassing and requires documentation of changes in large tracts of forests as a result of increasing human-use (e.g., conversion to agricultural lands or to other types of human development such as residential housing or urbanization).

During the study, the question arose as to what level of separation constitutes significant fragmentation of wetlands to warrant "flagging"? While a 4-lane highway (interstate) should represent sufficient fragmentation, does a 2-lane paved road produce similar consequences? How about unpaved roads? Also, fragmentation seems to be a major issue for wildlife usage and movement. Perhaps the fragmentation descriptor should be restricted to wetlands that are chopped up into multiple pieces by developments and associated roadways and only note the presence of a "fragmentation feature" (e.g., I-95) for larger wetlands crossed by major highways. The application of the "fg" descriptor was not as consistent as we would have liked as this was our first attempt using it. Consequently, we have not reported any results on the extent of fragmented wetlands in the watershed, yet these data are in the digital database for possible future use.

Another question arose in applying the fragmentation descriptor to wetland polygons - should this descriptor be applied to: 1) the entire wetland (main wetland body and the fragmented section), or 2) only to the fragmented piece(s)? Many large wetlands only had a small portion that was fragmented and we don't want to overexaggerate the effect of fragmentation. Fragmented coastal wetlands (separated by roads with culverts or bridges) were identified as "potentially tidally restricted" ("tro" - by road; "trr" - by railroad; "tr" - by other).

A Wetlands Steering Committee member indicated that the Maine Dept. of Inland Fisheries and Wildlife (MDIFW) has been investigating the issue of fragmentation effects on Maine's wildlife. They should be consulted regarding the significance of fragmentation relative to wildlife concerns and landscape-level considerations.

2. Recognition of NWI map and USGS topographic map limitations. Both NWI and USGS topographic maps have limitations that affect the analysis and evaluation.

a. There was some inconsistency in separating wetlands crossed by roads based on the original NWI mapping. When crossed by 2-lane roads, some wetlands were separated, while others were not.
b. Isolated wetlands were classified as such based on a review of the NWI maps and applicable USGS topographic maps. While many streams are shown on these products, many others (especially narrow, intermittent streams) are not. The latter wetlands are relatively "isolated" when compared to those along perennial or more well-defined streams. If more detailed geospatial data on stream locations are available in digital or map form, they should be used to provide a better assessment of hydrologic connectivity between wetlands.
c. Some wetlands mapped as PSS1E seem to be flooded PEM1E. This was especially noted when the wetland was contiguous with a large waterbody (pond or river). At some point, this should be reviewed and corrected where necessary in future characterizations. PEM1F wetlands should also be reviewed for the same reason. Review of original interpretation prior to initiating future projects would be beneficial.
d. Perennial v. intermittent streams were interpreted based on USGS topographic maps which are not always accurate in this regard; this is the best that can be done without a major validation effort, in the absence of supplemental data.
e. Eelgrass beds were conservatively mapped by NWI. Due to the importance of these resources, supplemental investigations should be done in the future whenever possible to provide a more accurate inventory of this resource.

3. Headwater wetland designation. For this study, headwater wetlands were strictly defined as those that were sources of streams. In the future, wetlands along stream channels in low order streams (orders 1 and 2) might also be considered headwater wetlands, especially in the absence of strictly headwater wetlands (stream sources). Also "headwater wetlands" with intermittent streams above them were not designated as headwater wetlands in this study, but probably should be so-designated in future characterizations. Some large wetlands in headwater positions were mapped as throughflow (e.g., TEBATH) because they had short streams upstream that may or may not have come from a small headwater wetland. In the future, they should also be designated as headwater wetlands. Large lotic wetlands in the upper reaches of watersheds are also likely sources of groundwater discharge and should be noted as headwater wetlands or, at least, designated as important for streamflow maintenance. We are considering introducing and employing a concept of primary and secondary headwater wetlands, with the former being the origin of streams and the latter being situated in lower order streams, but not the source of a stream.

4. Floodplain wetlands. Wetlands classified as LR1BATH may include some narrow floodplain wetlands (perhaps better typed as LR1FPTH). More time consulting soil surveys would help, but this did not have an impact on the analysis as both types were placed in the same category in regard to significance for providing surface water detention, for example. Some narrow LR1FLTH may also represent narrow floodplain wetlands. "Floodplain" wetlands with organic soils perhaps should be classified as LR1BATH, with LR1FPTH restricted to sites with alluvial mineral soils. Given the level of analysis, it did not appear to make a difference in the identification of wetlands important to various functions as both types were considered equally important. If considerations of long-term and short-term water storage were required, then the classification would be more significant, although we should be able to address this situation through the use of Cowardin water regimes.

5. Other wetland mapping issues.

a. It might be advantageous to examine summer photos for aquatic beds and nonpersistent wetlands in lakes, rivers and ponds as these wetlands are not inventoried by the NWI due to use of spring/high water photography.
b. Wetlands designated as former oxbows did not appear to be connected to the river, therefore annual flooding by river overflow unlikely; there may be narrow swales that connect to river and allow for annual flooding. This needs to be resolved on a case-by-case basis during subsequent assessments by field inspection, aerial surveys during floods, or interpreting larger-scale aerial photography.
c. There may be some inconsistency re: classification of flats v. basins on some rivers; lotic flats tended to be wetlands with an "A" (temporarily flooded) water regime, whereas the "C" or "E" wetlands (seasonally flooded) were classified as basin wetlands. Wetlands with multiple water regimes were characterized on the basis of the wettest regime (usually C or E) which tended to indicate a basin landform.
d. Isolated wetlands in flat areas on USGS maps may be designated as basins (rather than flats) due to "E" (seasonally flooded/saturated) water regime on NWI maps, whereas similar areas with the "A" water regime should be classified as flats. More field work is needed to resolve this issue for each watershed evaluated.

Considerations for Improved Wetland Conservation

The following actions may be worth considering when developing a watershed-based wetland protection strategy for the Casco Bay watershed.

1. Continue to implement existing wetland regulations to their fullest, including improved annual reconnaissance (by airplane fly-overs) and by bringing violators into compliance.

2. Identify wetlands performing significant levels of functions that are currently at risk of

degradation or destruction and those that are likely to be under threat in the near future. This may help prioritize protection and conservation approaches.

3. Try to preserve, restore, and enhance linkages between wetlands. This includes restoration of stream corridor buffers to woody vegetation. Protection of buffers around first and second order streams is especially important as they typically represent the majority of the length of the watershed, especially the interface between land and water.

4. Preserve naturally vegetated buffers around wetlands, especially those deemed potentially significant to fish and wildlife and promote restoration of such buffers around both wetlands and watercourses.

5. Protect large wetland complexes and surrounding forests from future alteration (i.e., conversion to development or agricultural land). In managing the adjacent forests, employ best management practices to ensure minimal adverse impacts to wetlands during timber harvest. Consider acquisition of such areas.

6. Identify potential wetland restoration sites and initiate restoration on a priority basis.

7. Develop a public outreach/education campaign on wetland functions and values and the need to conserve wetlands/streams and their buffers. Encourage schools to adopt a wetland in their town (Adopt-A-Wetland Program) and to conduct various studies (through the middle/high school science program). Publicize the activities and results of such studies. Produce materials to aid in such efforts (e.g., booklet on wetlands of the Casco Bay watershed and teacher's aids including collection of selected reference materials).

8. Develop a wetland stewardship program -- a voluntary program to have landowners sign some type of conservation agreement recognizing the importance of his/her wetland, perhaps modeled after the forest stewardship program. These agreements should be publicized; perhaps give the landowner an embossed certificate. Ideally landowners should have such lands taxed at lowest rate possible, given the land's conservation status.

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[11]Most but not all of these members played an active role in reviewing and commenting on this characterization project.

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APPENDICES

Appendix A. Keys to Landscape Position and Landform Descriptors for U.S. Wetlands (Operational Draft) (Tiner 1997b).

Keys to Landscape Position and Landform Descriptors for U.S. Wetlands
(Operational Draft)

U.S. Fish and Wildlife Service
National Wetlands Inventory Project
Northeast Region
300 Westgate Center Drive
Hadley, MA 01035

March 1997

Keys to Landscape Position and Landform Descriptors for U.S. Wetlands (Operational Draft)

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March 1997
(August 1997 edits)

Introduction

The U.S. Fish and Wildlife Service's wetland classification emphasizes a host of wetland characteristics including vegetation, soils, hydrology, salinity, and certain impacts (e.g., beaver, partly drained, and impounded) (Cowardin et al. 1979). These are important characteristics for describing wetlands and for assessing fish and wildlife habitat, but are not adequate for addressing abiotic features important for evaluating other wetland functions (e.g., chemical characteristics of the water, habitat maintenance, and water storage and transport) (Brinson 1993). Mark Brinson created a hydrogeomorphic (HGM) classification system to fill this void (Brinson 1993). The HGM system is actually more of "a generic approach to classification and not a specific one to be used in practice" (p. 2). It is a way of looking at wetlands in a geographic region for assessing ecosystem functions. Current studies are underway in several regions to develop HGM profiles for certain types of wetlands.

To aid in use of HGM data when available and to better describe wetlands from the abiotic standpoint, a set of keys have been developed. These keys attempt to bridge the gap between the Service's classification and the HGM system by providing descriptors for landscape position and landform. While more specific than the basic HGM types, the new descriptors can be easily correlated with these types to make use of HGM data when they become available. The landscape position and landform descriptors can be added to existing National Wetlands Inventory maps and digital data or to other wetland maps. These descriptors can also be used to describe wetlands for reports of various kinds including wetland permit reviews, wetland trend reports, and other reports requiring more comprehensive descriptions of individual wetlands. This information can be used to prepare a characterization of the functions performed by similar wetland types. These characterizations may be used to predict the likely functions of individual wetlands or to estimate the capacity of an entire suite of wetlands to perform certain functions in a watershed, for example. These characterizations would be derived from our current knowledge of wetland functions for specific types and be refined in the future, as needed, based on the applicable HGM profiles.

Three keys are provided to identify wetland landscape position and landform for individual wetlands: Key A for classifying the former and Keys B and C for the latter (for inland wetlands and coastal wetlands, respectively). Users should first identify the landscape position associated with the subject wetland following Key A. Afterwards, using Key B for inland wetlands and Key C for salt and brackish wetlands, users will determine the associated landform. The landform keys include provisions for identifying specific regional wetland types such as Carolina bays, pocosins, flatwoods, cypress domes, prairie potholes, playas, woodland vernal pools, West Coast vernal pools, interdunal swales, and salt flats. Various modifiers may also be applied to better describe wetlands, such as inflow, throughflow and outflow types, pond types, headwater areas, and other features of interest. A glossary of technical terms is provided at the end of this publication.

Key A: Key to Landscape Position

This key characterizes wetlands based on their location in or along a waterbody, in a drainageway, or in isolation.

1. Wetland is located in or along a lake, estuary, ocean, stream, or river and any associated floodplain....2
1. Wetland occurs on a slope or in a depression (including ponds, potholes, and playas) lacking a stream*....**Terrene** (*go to Key B for landform*)

> *Stream may originate from a terrene wetland or enter it, but does not extend throughout wetland; in other words, there is no continuous channelized flow through terrene wetlands.

2. Wetland is located in or along a salt or brackish waterbody (ocean or estuary)....3
2. Wetland is located in or along a fresh waterbody....4

3. Wetland is located along shores of the ocean....**Marine** (*go to Key C for landform*)
3. Wetland is located in or along an estuary (salt or brackish waters)....**Estuarine** (*go to Key C for landform*)

4. Wetland is located in or along a lake (standing waters)....**Lentic** (*go to Key B for landform*)
4. Wetland is located in or along a river or stream (flowing waters)....**Lotic** (*specify River or Stream - see following note, then go to couplet "a" below*)

[Note: A River is a broad channel mapped as a polygon (2-lined watercourse) on a U.S.G.S. topographic map, while a narrower channel mapped as a linear feature is a Stream. Artificial drainageways--ditches--are only considered streams when they represent a ditched natural stream, so completely artificial ditches are not part of the Lotic classification. *Modifiers* may be applied: Perennial (flowing water year-round), Intermittent (seasonal flow only), Headwater (first and second order streams only), and Channelization (excavated and/or stream course modified).]

a. Flow of water is bidirectional due to tidal influence (freshwater tidal areas)....**Tidal Gradient** (*go to Key B for landform*)
a.Flow is unidirectional; no tidal influence....b

b. Water flow is generally rapid due to steep gradient; typically little or no floodplain development; watercourse is generally shallow with rock, cobbles, or gravel bottoms; first and second order "streams"; part of Cowardin's Upper Perennial and Intermittent subsystems....**High Gradient** (*go to Key B for landform*)
b. Watercourse characteristics are not so; "stream" order greater than 2....c

c. Water flow is generally slow; typically with extensive floodplain; water course shallow or deep with mud or sand bottoms; typically fifth and higher order "streams", but includes lower order streams in nearly level landscapes such as the Great Lakes Plain (former glacial lakebed) and the Coastal Plain (the latter streams may lack significant floodplain development); Cowardin's Lower Perennial subsystem....**Low Gradient** (*go to Key B for landform*)

c. Water flow is fast to moderate; with little to some floodplain; usually third and fourth order "streams"; part of Cowardin's Upper Perennial subsystem....**Middle Gradient** (*go to Key B for landform*)

Key B: Key to Inland Landforms

1. Wetland occurs on a noticeable slope (e.g., greater than a 2 percent slope)....**Slope Wetland**

a. Wetland created by paludification processes (where in areas of low evapotranspiration and high rainfall, peat moss moves uphill creating wetlands on hillslopes) which cause wetland to develop upslope of primary water source....Paludified Slope Wetland

a. Wetland not formed by paludification processes....b

b. No surface water inflow from a stream or other waterbody, or no suspected significant surface or ground water inflow from nonslope wetland or other waterbody at a higher elevation and no outflow to a stream or no suspected significant surface or ground water flow to a wetland or waterbody at a lower elevation....Isolated Slope Wetland

b. Wetland not hydrologically isolated....c

c. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a nonslope wetland or other waterbody at a higher elevation and no observable or known significant outflow of surface or ground water to a stream or a nonslope wetland or waterbody at a lower elevation....Inflow Slope Wetland

c. Wetland not an inflow wetland, but either throughflow or outflow....d

d. No surface water inflow from a stream or other waterbody, or no suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation, and water is discharged from this wetland to a stream or other waterbody, or there is significant outflow of surface or ground water to a wetland or other waterbody at a lower elevation....Outflow Slope Wetland

d. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a nonslope wetland or other waterbody at a higher elevation and water passes through the subject wetland to a stream, another wetland, or other waterbody at a lower elevation....Throughflow Slope Wetland (*see subtypes below for situations where wetland occurs within the banks of a river or stream*)

(1) Wetland is an island in a river or stream....Throughflow Slope Wetland-

River Island or Throughflow Slope Wetland-Stream Island
(2) Wetland forms a fringe along a river or stream....Throughflow Slope Wetland-River Fringe or Throughflow Slope Wetland-Stream Fringe.

[*Modifiers* can be applied to Slope Wetlands to designate the type of inflow or outflow as Channelized (intermittent or perennial, stream or river), Nonchannelized-wetland (wetland lacking stream), or Nonchannelized-subsurface flow (suspected subsurface flow to neighboring wetland downslope).]

1. Wetland does not occur on a distinct slope....2

2. Wetland forms an island....**Island Wetland**

a. Island formed in a delta at the mouth of a river or stream....Delta Island Wetland
a. Island not formed in a delta....b

b. Island surrounded by a river or stream....River Island Wetland or Stream Island Wetland
b. Island formed in a lake or pond....Lake Island Wetland or Pond Island Wetland

[Note: Vegetation class and subclass from Cowardin et al. 1979 should be applied to characterize the vegetation of these wetland islands; vegetation is assumed to be rooted unless designated by a *modifier* to indicate a floating mat (Floating Mat).]

2. Wetland does not form an island....3

3. Wetland occurs within the banks of a river or stream or along the shores of a lake or island, or behind a barrier beach or island, and is typically permanently inundated, semipermanently flooded, or seasonally flooded for most of the growing season, or permanently saturated due to this location....**Fringe Wetland**

a. Wetland forms along the shores of an upland island within a lake, river, or stream....b
a. Wetland does not form along an island shore...c

b. Wetland forms along an upland island in a river or stream....River Island Fringe Wetland or Stream Island Fringe Wetland
b. Wetland forms along an upland island in a lake....Lake Island Fringe Wetland

c. Wetland forms in or along a river or stream....River Fringe Wetland or Stream Fringe Wetland
c. Wetland forms in or along a lake....d

d. Wetland forms behind a barrier island or beach along a lake....Barrier Island Fringe Wetland or Barrier Beach Fringe Wetland
d. Wetland forms along the lakeshore....Lake Fringe Wetland

[Note: Vegetation is assumed to be rooted unless designated by a *modifier* to indicate a floating mat (Floating Mat).]

3. Wetland does not exist along these shores....4

4. Wetland occurs on an active or inactive (former) floodplain (alluvial processes dominate currently or did so in the past, historically)....**Floodplain Wetland*** (could specify the river system, if desirable)

a. Wetland occurs on the active floodplain, not separated from the river by dikes or artificial levees....b
a. Wetland is now isolated from typical floodplain processes, separated by dikes, artificial levees, or road/railroad embankments (former or historic floodplain)....c

b. Wetland forms in a depressional feature on a floodplain....Floodplain Basin Wetland or Floodplain Oxbow Wetland (a special type of depression)
b. Wetland forms on a broad nearly level terrace....Floodplain Flat Wetland

c. Wetland is a depressional feature on an isolated floodplain....Former Floodplain Basin Wetland or Former Floodplain Oxbow Wetland (a special type of depression)
c. Wetland forms on a broad nearly level terrace....Former Floodplain Flat Wetland

*[Note: Questionable floodplain areas may be verified by consulting soil surveys and locating the presence of alluvial soils, e.g., Fluvaquents or Fluvents, or soils with Fluvaquentic subgroups.]

[*Modifiers*: Partly Drained.]

4. Wetland does not occur on a floodplain....5

5. Wetland occurs on an interstream divide (interfluve)....**Interfluve Wetland** or specify *regional types* of interfluve wetlands, for example: **Carolina Bay Interfluve Wetland, Pocosin Interfluve Wetland**, and **Flatwood Interfluve Wetland** (in the Southeast).

a. Wetland forms in a depressional feature.... Interfluve Basin Wetland
a. Wetland forms on a broad nearly level terrace ....Interfluve Flat Wetland

[*Modifiers*: Partly Drained.]

5. Wetland does not occur on an interfluve....6

6. Wetland exists in a distinct depression....**Basin Wetland** or specify *regional types* of basin wetlands, for example: **Carolina Bay Basin Wetland** and **Pocosin Basin Wetland** (along the Atlantic Coastal Plain), **Cypress Dome Basin Wetland** (in Florida), **Prairie Pothole Basin**

Wetland (in the Upper Midwest), **Playa Basin Wetland** (in the Southwest), **West Coast Vernal Pool Basin Wetland** (in California and Pacific Northwest), **Interdunal Basin Wetland** (in sand dunes), **Woodland Vernal Pool Basin Wetland** (in forests throughout the country), **Polygonal Basin Wetland** (in Alaska), **Sinkhole Basin Wetland** (in karst/limestone regions), or **Grady Pond** (western U.S.), or **Pond Wetland Basin** (throughout country).

a. No surface water inflow from stream or other waterbody, or no suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and no outflow to stream or no suspected significant surface or ground water flow to a wetland or waterbody at a lower elevation ....Isolated Basin Wetland

a. Wetland not hydrologically isolated....b

b. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and no observable or known significant outflow of surface or ground water to a stream or a wetland or waterbody at a lower elevation....Inflow Basin Wetland

b. Wetland not an inflow wetland, but either throughflow or outflow....c

c. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and water passes through the subject wetland to a stream, another wetland, or other waterbody at a lower elevation....Throughflow Basin Wetland

c. No surface water inflow from a stream or other waterbody, or no suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation, and water is discharged from this wetland to a stream or other waterbody, or there is significant outflow of surface or ground water to a wetland or other waterbody at a lower elevation.....Outflow Basin Wetland

[Note: *Modifiers* may be applied to indicate artificially created basins due to beaver activity or human actions or artificially drained basins: Beaver (beaver-created), Human-caused (created for various purposes or unintentionally formed due to human activities; may want to specify purpose), and Partly drained (drainage ditches observed). Other *modifiers* may be applied to designate the type of inflow or outflow as Channelized (intermittent or perennial, stream or river), Nonchannelized-wetland (contiguous wetland lacking stream), or Nonchannelized-subsurface flow (suspected subsurface flow to neighboring wetland), or to identify a headwater basin (Headwater) or a drainage divide wetland that discharges into two or more watershed (Drainage divide), or to denote a spring-fed wetland (Spring-fed), a wetland bordering a pond (Pond border) and a wetland bordering an upland island in a pond (Pond island border). For ponds may also want to add modifiers that identify the nature of the area surrounding the pond, e.g., farm, residential, commercial, industrial, coal mine, forest, and others.]

6. Wetland exists in a relatively level area....**Flat Wetland** or specify *regional types* of flat

wetlands, for example: **Salt Flat Wetland** (in the Great Basin).

a. Wetland created by paludification processes (where in areas of low evapotranspiration and high rainfall, peat moss moves uphill creating wetlands on hillslopes and broad upland flats) which cause wetland to develop upslope of primary water source....Paludified Flat Wetland
a. Wetland not formed by paludification processes....b

b. No surface water inflow from stream or other waterbody, or no suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and no outflow to stream or no suspected significant surface or ground water flow to a wetland or waterbody at a lower elevation....Isolated Flat Wetland
b. Wetland not hydrologically isolated....c

c. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and no observable or known significant outflow of surface or ground water to a stream or a wetland or waterbody at a lower elevation....Inflow Flat Wetland
c. Wetland not an inflow wetland, but either throughflow or outflow....d

d. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and water passes through the subject wetland to a stream, another wetland, or other waterbody at a lower elevation....Throughflow Flat Wetland
d. No surface water inflow from a stream or other waterbody, or no suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation, and water is discharged from this wetland to a stream or other waterbody, or there is significant outflow of surface or ground water to a wetland or other waterbody at a lower elevation.....Outflow Flat Wetland

[Note: If desirable a *modifier* for drained flats can be applied: Partly drained. Other *modifiers* can be applied to designate the type of inflow or outflow as Channelized (intermittent or perennial, stream or river), Nonchannelized-wetland (contiguous wetland lacking stream), or Nonchannelized-subsurface flow (suspected subsurface flow to neighboring wetland).]

Key C: Key to Coastal Landforms

1. Wetland forms an island....**Island Wetland**

a. Occurs in a delta....Delta Island Wetland
a. Occurs elsewhere either in a river or an embayment....b

b. Occurs in a river....River Island Wetland
b. Occurs in a coastal embayment....Bay Island Wetland

1. Wetland does not form an island, but occurs elsewhere....2

2. Wetland occurs along the shore....**Fringe Wetland**

a. Occurs behind a barrier island or barrier beach spit....Barrier Island Fringe Wetland or Barrier Beach Fringe Wetland [*Modifier* for overwash areas....Overwash]
a. Occurs elsewhere....b

b. Occurs along a coastal embayment or along an island in a bay....Bay Fringe Wetland or Bay Island Fringe Wetland or Coastal Pond Fringe Wetland (a special type of embayment, typically with periodic connection to the ocean unless artificially connected by a bulkheaded inlet) or Coastal Pond Island Fringe Wetland
b. Occurs elsewhere....c

c. Occurs along a coastal river or along an island in a river....River Fringe Wetland or River Island Fringe Wetland
c. Occurs elsewhere....d

d. Occurs along an oceanic island....Ocean Island Fringe Wetland
d. Occurs along the shores of exposed rocky mainland....Headland Fringe Wetland

2. Wetland occurs in an artificial impoundment....**Basin Wetland**

[*Modifiers* may be applied to designate created basins: Human-induced (managed fish and wildlife areas; salt hay; tidally restricted-road, tidally restricted-railroad, other road crossing (no significant tidal restriction suspected), other railroad crossing (no significant tidal restriction suspected), and other situations to be determined.]

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Glossary

Barrier Beach -- a coastal peninsular landform extending from the mainland into the ocean or large embayment or large lake (e.g., Great Lakes), typically providing protection to waters on the backside and allowing the establishment of salt marshes; similar to the barrier island, except connected to the mainland

Barrier Island -- a coastal insular landform, an island typically between the ocean (or possibly the Great Lakes) and the mainland; its presence usually promotes the formation of salt marshes on the backside

Basin -- a depressional (concave) landform; various types are further defined by the absence of a stream (isolated), by the presence of a stream and its position relative to a wetland (throughflow, outflow, inflow), or by its occurrence on a floodplain (floodplain basins include ox-bows and sloughs, for example)

Bay -- a coastal embayment of variable size and shape that is always opens to the sea through an inlet or other features

Carolina Bay -- a wetland formed in a semicircular or egg-shaped basin with a northwest to southeast orientation, found along the Atlantic Coastal Plain from southern New Jersey to Florida, and perhaps most common in Horry County, South Carolina

Channelization -- the act or result of excavating a stream or river channel to increase downstream flow of water or to increase depth for navigational purposes

Channelized -- water flow through a conspicuous drainageway, a stream or a river

Cypress Dome -- a wetland dominated by bald cypress growing in a basin that may be formed by the collapse of underlying limestone, forest canopy takes on a domed appearance with tallest trees in center and becoming progressively shorter as move toward margins of basin

Delta -- a typically lobed-shaped or fan-shaped landform formed by sedimentation processes at the mouth of a river carrying heavy sediment loads

Drained, Partly -- condition where a wetland has been ditched or tiled to lower the ground water table, but the area is still wet long enough and often enough to fall within the range of conditions associated with wetland hydrology

Estuarine -- the landscape of estuaries (salt and brackish tidal waterbodies, such as bays and coastal rivers) including associated wetlands, typically occurring in sheltered or protected areas, not exposed to oceanic currents

Flat -- a relatively level landform; may be a component of a floodplain or the landform of an interfluve

Flatwood -- forest of pines, hardwoods or mixed stands growing on interfluves on the Gulf-Atlantic Coastal Plain, typically with imperfectly drained soils; some flatwoods are wetlands, while others are dryland

Floodplain -- a broad, generally flat landform occurring in a landscape shaped by fluvial or riverine processes; for purposes of this classification limited to the broad plain associated with large river systems subject to periodic flooding (once every 100 years) and typically having alluvial soils; further subdivided into several subcategories: flat (broad, nearly level to gently sloping areas) and basin (depressional features such as ox-bows and sloughs)

Fringe -- a wetland occurring along a flowing or standing waterbody, i.e., a lake, river, stream, estuary, or ocean; note that ponds are excluded

Ground Water -- water below ground, held in the soil or underground aquifers

Headland -- the seaward edge of the major continental land mass (North America), commonly called the mainland; not an island

High Gradient -- the fast-flowing segment of a drainage system, typically with no floodplain development; equivalent to the Upper Perennial and Intermittent Subsystems of the Riverine System in Cowardin et al. 1979

Inflow -- water enters; an inflow wetland is one that receives surface water from a stream or other waterbody or from significant surface or ground water from a wetland or waterbody at a higher elevation and has no significant discharge

Interdunal -- occurring between sand dunes, as in interdunal swale wetlands found in dunefields behind ocean and estuarine beaches and in sand plains like the Nebraska Sandhills

Interfluve -- a broad level to imperceptibly depressional poorly drained landform occurring between two drainage systems, most typical of the Coastal Plain in the Southeast

Island -- a landform completely surrounded by water (including deltas); some islands are entirely wetland, while others are uplands with or without a fringe wetland

Karst -- a limestone region characterized by sinkholes and underground caverns

Lentic -- the landscape position associated with large standing waterbodies (such as lakes and reservoirs) and contiguous wetlands formed in the lake basin; does not include large shallow waterbodies such as playa lakes (which are considered ponds)

Lotic -- the landscape position associated with flowing water systems (such as rivers, creeks, perennial streams, intermittent streams, and similar waterbodies) and contiguous wetlands

Low Gradient -- the slow-flowing segment of a drainage system, typically with considerable floodplain development; equivalent to the Lower Perennial Subsystem of the Riverine System in Cowardin et al. 1979 plus contiguous wetlands

Marine -- the landscape position (or seascape) associated with the ocean's shoreline

Middle Gradient -- the segment of a drainage system with characteristic intermediate between the high and low gradient reaches, typically with limited floodplain development; equivalent to areas mapped as Riverine Unknown (R5) in the Northeast Region plus contiguous wetlands

Nonchannelized -- water exits through seepage, not through a river or stream channel

Outflow -- water exits; an outflow wetland has water leaving via a stream or seepage to a wetland or waterbody at a lower elevation, it lacks an inflow source

Oxbow -- a former mainstem river bend now partly or completely cut off from mainstem

Paludified -- subjected to paludification, the process by which peat moss engulfs terrains of varying elevations due to an excess of water, typically associated with cold, humid climates of northern areas (boreal/arctic regions and fog-shrouded coasts)

Playa -- a type of basin wetland in the Southwest characterized by drastic fluctuations in water levels over the normal wet-dry cycle

Pocosin -- a shrub and/or forested wetland forming on organic soils in interstream divides (interfluves) on the Atlantic Coast Plain from Virginia to Florida, mostly in North Carolina

Pond -- a natural or human-made shallow open waterbody that may be subjected to periodic drawdowns

Prairie Pothole -- a glacially formed basin wetland found in the Upper Midwest especially in the Dakotas, western Minnesota, and Iowa.

Salt Pond -- a coastal embayment of variable size and shape that is periodically and temporarily cut off from the sea by natural accretion processes; some may be kept permanently open by jetties and periodic maintenance dredging

Salt Flat -- a broad expanse of alkaline wetlands associated with arid regions, especially the Great Basin in the western United States

Sinkhole -- a depression formed by the collapse of underlying limestone deposits; may be wetland or nonwetland depending on drainage characteristics

Slope -- a wetland occurring on a slope; various types include those along a sloping stream (fringe), those (paludified) formed by paludification -- the process of bogging or swamping of uplands by peat moss in northern climes (humid and cold), and those not designated as one of the above and typically called seeps

Subsurface Flow -- water leaves via ground water

Surface Water -- water occurring above the ground as in flooded or ponded conditions

Terrene -- wetlands surrounded or nearly so by uplands and lacking a channelized outlet stream; a stream may enter or exit this type of wetland but it does not flow through it as a channel; includes a variety of wetlands and natural and human-made ponds

Throughflow -- water entering and exiting, passing through; a throughflow wetland receives significant surface or ground water which passes through the wetland and is discharged to a stream, wetland or other waterbody at a lower elevation

Tidal Gradient -- the segment of a drainage basin that is subjected to tidal influence; essentially the freshwater tidal reach of coastal rivers; equivalent to the Tidal Subsystem of the Riverine System in Cowardin et al. 1979 plus contiguous wetlands

Vernal Pool -- a temporarily flooded basin; woodland vernal pools are found in humid temperature regions dominated by trees, these pools are surrounded by upland forests, are usually flooded from winter through mid-summer, and serve as critical breeding grounds for salamanders and woodland frogs; West Coast vernal pools occur in California, Oregon, and Washington on clayey soils, they are important habitats for many rare plants and animals.

Appendix B. Wildlife x Freshwater Wetland Type Matrix based on ECOSEARCH models (prepared by Dr. Hank Short, U.S. Fish and Wildlife Service). Expected occurrence of certain wildlife in nontidal wetlands in New England.

Note: Wetland types are NWI types based on a combination of predominant vegetative life form (e.g., broad-leaved deciduous trees and shrubs [PFO1; PSS1], needle-leaved evergreen trees [PF04], broad-leaved evergreen shrubs [PSS3], persistent emergent herbs [PEM1], and nonpersistent emergent herbs [PEM2]) and water regime (a - temporarily flooded, b - saturated, c - seasonally flooded [including seasonally flooded/saturated - e water regime on NWI maps], and f- semipermanently flooded.). Common names are given for animal species. The first three columns address other habitat requirements related to wetlands, namely special requirements (springs, seepage areas, temporary rain pools, ponds, and bogs), lotic (associated with rivers and streams), and lentic (associated with lakes).

MATRIX 332 x
WETLAND TYPE

SPECIES	Special *	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Mudpuppy	d	x	x			x			x								x		
Marbled salamander				x	x	x				x	x	x	x	x	x			x	x
Jefferson salamander	d			x	x	x				x	x	x	x	x	x	x	x	x	x
Blue-spotted salamander	d, e			x	x	x				x	x	x	x	x	x			x	x
Spotted salamander	d	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Red-spotted newt	d	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Northern dusky salamander	a, b, d	x				x			x			x		x	x			x	x
Redback salamander	e			x	x	x	x	x	x	x	x	x	x						
Slimy salamander	e			x	x	x				x	x	x	x						
Four-toed salamander	d, e	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Northern spring salamander	a, b, e	x				x			x			x							
Northern two-lined salamander	a, b, e	x		x	x	x	x	x	x	x	x	x	x						
Eastern spadefoot	c																		
Eastern American toad	d	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Fowler's toad	d		x	x	x	x				x	x	x	x	x	x			x	x
Northern spring peeper	d	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Gray treefrog	d, e		x	x	x	x				x	x	x	x				x		
Bullfrog	d	x	x			x						x				x	x		
Green frog	d	x	x			x						x		x	x	x	x	x	x
Mink frog	d	x	x			x						x				x	x		
Wood frog	d, e	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Northern leopard frog	d, e	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x
Pickerel frog	d, e	x	x	x	x	x	x	x	x	x	x	x	x						
Common snapping turtle	d, e	x	x			x						x				x	x		
Stinkpot	d	x	x														x		
Spotted turtle	d, e	x												x	x	x	x	x	x
Bog turtle	e					x						x		x	x	x	x	x	x
Wood turtle	d	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Eastern box turtle	e	x		x	x	x				x	x	x	x	x	x			x	x
Map turtle		x	x																
Plymouth redbelly turtle			x																
Eastern (Midland) painted turtle	d	x	x			x						x		x	x		x	x	x

* a = springs
b = seepage area
c = temporary rain pools
d = pond
e = bog

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Blanding's turtle	d,e		x														x		
Eastern spiny softshell		x	x																
Five-lined skink				x	x					x	x		x						
Northern water snake	d,e	x	x			x						x		x	x			x	x
Northern brown snake				x	x	x				x	x	x	x	x	x			x	x
Northern redbelly snake	e			x	x	x				x	x	x	x	x	x			x	x
Eastern garter snake	e	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Eastern ribbon snake	d,e	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x
Eastern hognose snake																x			
Northern ringneck snake				x	x	x	x	x	x	x	x	x	x						
Eastern worm snake																			
Northern black racer				x	x	x				x	x	x	x			x	x		
Eastern smooth green snake				x	x	x				x	x	x	x	x	x	x		x	x
Black rat snake				x	x	x				x	x	x	x						
Eastern milk snake	e	x		x	x	x				x	x	x	x						
Northern copperhead				x	x	x				x	x	x	x						
Timber rattlesnake				x	x					x	x		x						
Common loon	d	x	x																
Pied-billed grebe	d	x	x											x	x	x	x	x	x
Double-crested cormorant	d	x	x	x	x	x	x	x	x										
American bittern	d											x		x	x	x	x	x	x
Least bittern	a,e	x	x									x		x	x	x	x	x	x
Great blue heron	d,e	x	x	x	x	x						x		x	x	x	x	x	x
Snowy egret	d		x	x	x	x				x	x	x		x	x	x	x	x	x
Cattle egret				x	x	x				x	x	x		x	x			x	
Green heron	a	x	x	x	x	x						x		x	x	x	x	x	x
Black-crowned night heron	d	x										x				x	x		
Yellow-crowned night heron												x		x	x	x	x	x	x
Glossy ibis	d	x	x									x		x	x	x	x	x	x
Mute swan	d	x	x											x	x		x	x	x
Canada goose		x	x													x			
Wood duck	d	x	x	x	x	x						x				x	x		

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Green-winged teal	d															x	x		
American black duck	d, e	x	x			x						x		x	x	x	x	x	x
Mallard	d, e	x	x									x		x	x	x	x	x	x
Northern pintail																x	x		
Blue-winged teal	d															x	x		
Gadwall	d		x									x		x	x	x	x	x	x
American wigeon	d		x											x	x	x	x	x	x
Canvasback			x													x	x		
Ring-necked duck	d	x	x									x					x		
Common goldeneye	d	x	x			x			x										
Bufflehead		x	x			x													
Hooded merganser	d	x	x			x			x								x		
Common merganser	d	x	x			x			x										
Red-breasted merganser	d	x	x																
Turkey vulture				x	x	x													
Osprey		x	x																
Bald eagle		x	x						x										
Northern harrier										x	x	x	x	x	x	x	x	x	x
Sharp-shinned hawk				x	x	x	x	x	x										
Cooper's hawk				x	x	x	x	x	x										
Northern goshawk				x	x	x	x	x	x										
Red-shouldered hawk				x	x	x				x	x	x	x						
Broad-winged hawk				x	x	x													
Red-tailed hawk				x	x	x													
Rough-legged hawk										x	x	x	x	x	x	x		x	x
Golden eagle	d						x	x	x					x	x	x		x	x
American kestrel				x	x	x				x	x	x	x	x	x	x		x	x
Merlin							x	x	x	x	x	x	x	x	x	x		x	x
Peregrine falcon				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Gray partridge																			
Ring-necked pheasant																			
Spruce grouse	e						x	x	x										

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Ruffed grouse				x	x	x	x	x	x										
Wild turkey				x	x	x													
Northern bobwhite																			
King rail														x	x	x	x	x	x
Virginia rail														x	x	x	x	x	x
Sora	d											x		x	x	x	x	x	x
Common moorhen	d		x													x	x		
American coot	d		x													x	x		
Killdeer														x	x			x	x
Spotted sandpiper	d	x	x																
Upland sandpiper																			
Common snipe	e											x		x	x	x		x	x
American woodcock	e			x	x	x	x	x	x	x	x	x	x	x	x			x	x
Ring-billed gull		x	x											x	x			x	x
Herring gull		x	x																
Great black-backed gull																			
Common tern																			
Black tern			x													x	x		
Rock dove																			
Mourning dove				x	x	x	x	x	x										
Black-billed cuckoo							x	x	x	x	x	x	x						
Yellow-billed cuckoo				x	x	x													
Common barn owl																			
Eastern screech owl				x	x	x	x	x	x					x	x	x		x	x
Great-horned owl				x	x	x	x	x	x	x	x	x	x	x	x			x	x
Snowy owl														x	x			x	x
Northern hawk owl	e						x	x	x	x	x	x	x						
Barred owl		x		x	x	x	x	x	x										
Great gray owl	e			x	x	x	x	x	x	x	x	x	x						
Long-eared owl	e			x	x	x	x	x	x					x	x			x	x
Short-eared owl																x			
Boreal owl	e						x	x	x										

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Northern saw-whet owl				x	x	x	x	x	x										
Common nighthawk				x	x	x	x	x	x					x	x			x	x
Whip-poor-will				x	x	x													
Chimney swift														x	x			x	x
Ruby-throated hummingbird				x	x	x	x	x	x										
Belted kingfisher	d	x	x																
Red-headed woodpecker				x	x	x													
Red-bellied woodpecker				x	x	x													
Yellow-bellied sapsucker				x	x	x	x	x	x										
Downy woodpecker				x	x	x	x	x	x										
Hairy woodpecker				x	x	x	x	x	x										
Three-toed woodpecker	e						x	x	x										
Black-backed woodpecker	e						x	x	x										
Northern flicker				x	x	x	x	x	x										
Pileated woodpecker				x	x	x	x	x	x										
Olive-sided flycatcher	d, e			x	x	x	x	x	x										
Eastern wood-pewee				x	x	x	x	x	x										
Yellow-bellied flycatcher	e						x	x	x	x	x	x	x						
Acadian flycatcher				x	x	x													
Alder flycatcher	e			x	x	x	x	x	x	x	x	x	x						
Willow flycatcher				x	x	x													
Least flycatcher				x	x	x	x	x	x										
Eastern phoebe				x	x	x	x	x	x										
Great crested flycatcher				x	x	x	x	x	x										
Eastern kingbird				x	x	x													
Horned lark																			
Purple martin	d	x	x	x	x	x	x	x	x					x	x	x	x	x	x
Tree swallow	d, e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Northern rough-winged swallow	d	x		x	x	x	x	x	x					x	x	x	x	x	x
Bank swallow	d	x		x	x	x	x	x	x					x	x	x	x	x	x
Cliff swallow	d			x	x	x	x	x	x					x	x	x	x	x	x
Barn swallow	d	x		x	x	x	x	x	x					x	x	x	x	x	x

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Gray jay							x	x	x										
Blue jay				x	x	x	x	x	x										
American crow				x	x	x	x	x	x										
Fish crow	d	x	x													x	x		
Common raven	e		x	x	x	x	x	x	x										
Black-capped chickadee				x	x	x	x	x	x										
Boreal chickadee	e						x	x	x										
Tufted titmouse				x	x	x													
Red-breasted nuthatch	e						x	x	x										
White-breasted nuthatch				x	x	x													
Brown creeper	e			x	x	x	x	x	x										
Carolina wren				x	x	x													
House wren				x	x	x													
Winter wren				x	x	x	x	x	x	x	x	x	x						
Sedge wren														x	x			x	x
Marsh wren																x	x		
Golden-crowned kinglet				x	x	x	x	x	x										
Ruby-crowned kinglet							x	x	x										
Blue-gray gnatcatcher				x	x	x				x	x	x	x						
Eastern bluebird				x	x	x													
Veery				x	x	x	x	x	x										
Gray-cheeked thrush							x	x	x										
Swainson's thrush							x	x	x										
Hermit thrush	e			x	x	x	x	x	x	x	x	x	x						
Wood thrush				x	x	x	x	x	x										
American robin	e			x	x	x	x	x	x	x	x	x	x						
Gray catbird	e			x	x	x													
Northern mockingbird				x	x	x													
Brown thrasher				x	x	x													
Bohemian waxwing				x	x	x	x	x	x										
Cedar waxwing				x	x	x	x	x	x	x	x	x	x						
Northern shrike				x	x	x	x	x	x					x	x	x		x	x

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Loggerhead shrike							x	x	x					x	x	x		x	x
European starling				x	x	x								x	x				
White-eyed vireo				x	x	x				x	x	x	x						
Solitary vireo				x	x	x	x	x	x										
Yellow-throated vireo				x	x	x													
Warbling vireo				x	x	x													
Philadelphia vireo				x	x	x													
Red-eyed vireo				x	x	x	x	x	x										
Blue-winged warbler				x	x	x				x	x	x	x						
Golden-winged warbler				x	x	x													
Tennessee warbler	e			x	x	x	x	x	x	x	x	x	x						
Nashville warbler	e			x	x	x	x	x	x	x	x	x	x						
Northern parula	e			x	x	x	x	x	x	x	x	x	x						
Yellow warbler				x	x	x	x	x	x	x	x	x	x						
Chestnut-sided warbler				x	x	x				x	x	x	x						
Magnolia warbler							x	x	x										
Cape May warbler							x	x	x										
Black-throated blue warbler				x	x	x	x	x	x										
Yellow-rumped warbler				x	x	x	x	x	x	x	x	x	x						
Black-throated green warbler				x	x	x	x	x	x										
Blackburnian warbler							x	x	x										
Pine warbler																			
Prairie warbler																			
Palm warbler	e						x	x	x	x	x	x	x						
Bay-breasted warbler							x	x	x										
Blackpoll warbler							x	x	x										
Cerulean warbler				x	x	x													
Black-and-white warbler	e			x	x	x	x	x	x										
American redstart				x	x	x	x	x	x										
Prothonotary warbler				x	x	x				x	x	x	x						
Worm-eating warbler																			
Ovenbird				x	x	x	x	x	x										

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Northern waterthrush	e	x		x	x	x	x	x	x	x	x	x	x						
Louisiana waterthrush				x	x	x				x	x	x	x						
Mourning warbler	e			x	x	x	x	x	x	x	x	x	x						
Common yellowthroat	d,e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hooded warbler				x	x	x				x	x	x	x						
Wilson's warbler	e						x	x	x	x	x	x	x						
Canada warbler	e			x	x	x	x	x	x	x	x	x	x						
Yellow-breasted chat				x	x	x													
Scarlet tanager				x	x	x													
Northern cardinal		x		x	x	x				x	x	x	x						
Rose-breasted grosbeak				x	x	x	x	x	x										
Indigo bunting				x	x	x													
Rufous-sided towhee				x	x	x													
American tree sparrow				x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Chipping sparrow				x	x	x	x	x	x										
Field sparrow				x	x	x													
Vesper sparrow														x	x			x	x
Savannah sparrow														x	x	x		x	x
Grasshopper sparrow																			
Henslow's sparrow														x	x			x	x
Fox sparrow				x	x	x													
Song sparrow				x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Lincoln's sparrow	e						x	x	x	x	x	x	x						
Swamp sparrow	d,e						x	x	x	x	x	x	x	x	x	x	x	x	x
White-throated sparrow				x	x	x	x	x	x										
Dark-eyed junco				x	x	x	x	x	x										
Lapland longspur																			
Snow bunting														x	x	x		x	x
Bobolink														x	x	x		x	x
Red-winged blackbird	d,e			x	x	x				x	x	x	x	x	x	x	x	x	x
Eastern meadowlark																			
Rusty blackbird	d,e	x		x	x	x	x	x	x	x	x	x	x						

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Common grackle	e		x	x	x	x				x	x	x	x	x	x	x	x	x	x
Brown-headed cowbird				x	x	x	x	x	x					x	x	x	x	x	x
Orchard oriole				x	x	x													
Northern oriole				x	x	x													
Pine grosbeak				x	x	x	x	x	x										
Purple finch				x	x	x	x	x	x										
House finch																			
Red crossbill							x	x	x										
White-winged crossbill							x	x	x										
Common redpoll							x	x	x										
Hoary redpoll							x	x	x										
Pine siskin	e			x	x	x	x	x	x										
American goldfinch	e			x	x	x	x	x	x	x	x	x	x			x			
Evening grosbeak				x	x	x	x	x	x										
House sparrow																			
Virginia opossum				x	x	x				x	x	x	x	x	x	x	x	x	x
Masked shrew	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Water shrew	d, e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Smoky shrew	e			x	x	x	x	x	x										
Long-tailed shrew							x	x	x										
Pygmy shrew	e						x	x	x	x	x	x	x	x	x			x	x
Northern short-tailed shrew	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Least shrew				x	x	x								x	x	x		x	x
Hairy-tailed mole				x	x	x	x	x	x										
Eastern mole				x	x	x													
Star-nosed mole	d, e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Little brown myotis	d, e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Northern long-eared bat	d, e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Indiana myotis	d, e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Small-footed myotis	d, e	x					x	x	x	x	x	x	x	x	x	x	x	x	x
Silver-haired bat	a, e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Eastern pipistrelle	d, e	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
	d,e	x	x	a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Big brown bat	d,e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Red bat	d,e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hoary bat				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Eastern cottontail				x	x	x				x	x	x	x	x	x	x	x	x	x
New England cottontail				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Snowshoe hare	e			x	x	x	x	x	x	x	x	x	x						
European hare				x	x	x													
Eastern chipmunk				x	x	x	x	x	x										
Woodchuck				x			x												
Gray squirrel				x	x	x													
Red squirrel				x	x	x	x	x	x										
Southern flying squirrel				x	x	x													
Northern flying squirrel							x	x	x										
Beaver	d,e	x	x			x			x			x				x	x		
Deer mouse				x	x	x	x	x	x										
White-footed mouse	e			x	x	x	x	x	x	x	x	x	x	x	x			x	x
Southern red-backed vole	e			x	x	x	x	x	x	x	x	x	x						
Meadow vole	e			x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Rock vole	-						x	x	x										
Woodland vole				x	x	x													
Muskrat	d,e	x	x							x	x	x	x	x	x	x	x	x	x
Southern bog lemming	e			x	x	x	x	x	x					x	x	x		x	x
Northern bog lemming	e						x	x	x					x	x	x		x	x
Norway rat																			
House mouse																			
Meadow jumping mouse	e			x			x			x	x	x	x	x	x	x		x	x
Woodland jumping mouse				x			x			x	x	x	x						
Porcupine				x	x	x	x	x	x	x	x	x	x	x	x			x	x
Coyote	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Red fox	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Gray fox				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Black bear	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Raccoon	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Marten							x	x	x										
Fisher	e			x	x	x	x	x	x	x	x	x	x	x	x			x	x
Ermine	e			x	x	x	x	x	x	x	x	x	x						
Long-tailed weasel	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Mink	d,e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Striped skunk	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
River otter	d,e	x	x			x			x			x				x	x		
Lynx	e			x	x	x	x	x	x	x	x	x	x						
Bobcat	e			x	x	x	x	x	x	x	x	x	x	x	x			x	x
White-tailed deer	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Moose	d,e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Table 1
Eastern Forest Birds Classified as Either Area Sensitive or Forest Interior Occupants (from Freemark and Collins 1992)

Species	Area Sensitive	Forest Interior
Cooper's hawk (*Accipiter cooperii*)		X
Red shouldered hawk (*Buteo lineatus*)	X	
Broad-winged hawk (*Buteo platypterus*)		X
Barred owl (*Strix varia*)		X
Red-bellied woodpecker (*Melanerpes carolinus*)	X	
Hairy woodpecker (*Picoides villosus*)	X	X
Pileated woodpecker (*Dryocopus pileatus*)	X	X
Olive-sided flycatcher (*Contopus borealis*)		X
Acadian flycatcher (*Empidonax virescens*)	X	X
Least flycatcher (*Empidonax minimus*)	X	
Great crested flycatcher (*Myiarchus crinitus*)	X	
American crow (*Corvus brachyrhynchos*)	X	
Common raven (*Corvus corax*)		X
Tufted titmouse (*Parus bicolor*)	X	
Red-breasted nuthatch (*Sitta canadensis*)		X
White-breasted nuthatch (*Sitta carolinensis*)	X	X
Brown creeper (*Certhia americana*)	X	X
Winter wren (*Troglodytes troglodytes*)		X

(Continued)

Table 1 (Concluded)		
Species	**Area Sensitive**	**Forest Interior**
Golden-crowned kinglet (*Regulus satrapa*)		X
Blue-gray gnatcatcher (*Polioptila caerulea*)	X	
Veery (*Catharus fuscescens*)	X	X
Swainson's thrush (*Catharus ustulatus*)		X
Hermit thrush (*Catharus guttatus*)	X	X
Wood thrush (*Hylocichla mustelina*)	X	
Yellow-throated vireo (*Vireo flavifrons*)	X	
Red-eyed vireo (*Vireo olivaceus*)	X	
Chestnut-sided warbler (*Dendroica pensylvanica*)	X	
Magnolia warbler (*Dendroica magnolia*)		X
Black-throated blue warbler (*Dendroica caerulescens*)	X	X
Yellow-rumped warbler (*Dendroica coronata*)		X
Black-throated green warbler (*Dendroica virens*)	X	X
Blackburnian warbler (*Dendroica fusca*)		X
Yellow-throated warbler (*Dendroica dominica*)		X
Pine warbler (*Dendroica pinus*)		X
Cerulean warbler (*Dendroica cerulea*)	X	X
Black and white warbler (*Mniotilta varia*)	X	X
American redstart (*Setophaga ruticilla*)	X	X
Worm-eating warbler (*Helmintheros vermivorous*)	X	X
Ovenbird (*Seiurus aurocapilus*)	X	X
Northern waterthrush (*Seiurus noveboracensis*)	X	X
Louisiana waterthrush (*Seiurus motacilla*)	X	X
Kentucky warbler (*Oporornis formosus*)	X	X
Mourning warbler (*Oporornis philadelphia*)	X	
Hooded warbler (*Wilsonia citrina*)	X	X
Canada warbler (*Wilsonia canadensis*)	X	X
Summer tanager (*Piranga rubra*)	X	
Scarlet tanager (*Piranga olivacae*)	X	X
Rose-breasted grosbeak (*Pheucticus ludovicianus*)	X	

Appendix C. List of Area-sensitive or Forest Interior Birds of the Eastern United States (Source: Freemark and Collins 1992 as reported in Schroeder 1996).

Appendix D. Examples of Palustrine Wetland Plant Communities in the Casco Bay watershed (Tables D-1 through D-4).

Table D-1. Examples of palustrine emergent wetlands in the Casco Bay Watershed, Maine.

Wetland Type (water regime)	Dominant Species	Associated Vegetation
PEM1E (seasonally flooded /saturated)	Typha latifolia	Spiraea tomentosa, Calamagrostis canadensis, Thelypteris palustris, Carex sp., Epilobium sp., Alnus rugosa, Acer rubrum
PEM1E (seasonally flooded /saturated)	Calamagrostis canadensis	Spiraea latifolia, Carex sp.
PEM1E (seasonally flooded /saturated)	Typha latifolia, Scirpus cyperinus, Calamagrostis canadensis	Ilex verticillata, Lyonia ligustrina, Spiraea latifolia, Spiraea tomentosa, Juncus canadensis, Eriophorum virginicum, Rhynchospora sp., Scirpus c.f. microcarpus
PEM1E (seasonally flooded /saturated)	Calamagrostis canadensis	Abies balsamea, Alnus rugosa, Viburnum trilobum, Ilex verticillata, Typha latifolia, Juncus effusus, Onoclea sensibilis, Carex sp., Scirpus microcarpus, Bidens connata
PEM1F (semipermanently flooded)	Typha angustifolia	

Table D-2. Examples of palustrine scrub-shrub wetlands in the Casco Bay Watershed, Maine.

Wetland Type (water regime)	Dominant Species	Associated Vegetation
PSS1C (seasonally flooded)	Alnus rugosa, Viburnum cassinoides	Prunus serotina, Solidago sp., Polygonum sagittatum, Onoclea sensibilis, Geum laciniatum, Rubus sp., Elymus sp.
PSS1Cd (seasonally flooded)	Betula populifolia, Acer rubrum	Viburnum sp., Spiraea latifolia, Spiraea tomentosa, Solidago sp.
PSS1E (seasonally flooded /saturated)	Alnus rugosa	Quercus velutina, Solidago rugosa, Geum laciniatum
PSS1E (seasonally flooded /saturated)	Ilex verticillata	Acer rubrum, Abies balsamea, Picea rubens, Pinus strobus, Vaccinium corymbosum, Lyonia ligustrina, Vaccinium pallidum, Kalmia angustifolia, Sarracenia purpurea, Osmunda regalis
PSS1E (seasonally flooded /saturated)	Ilex verticillata	Acer rubrum, Lyonia ligustrina, Alnus rugosa, Pinus strobus, Hamamelis virginiana, Osmunda regalis, Lycopodium c.f. obscurum, Carex sp.
PSS1E (seasonally flooded /saturated)	Alnus rugosa	Larix laricina, Pinus rigida, Picea rubens, Aronia melanocarpa, Cornus amomum, Lyonia ligustrina, Sambucus canadensis, Viburnum dentatum, Spiraea latifolia, Osmunda regalis, Onoclea sensibilis, Clematis virginiana
PSS1/EM1E (seasonally flooded /saturated)	Alnus rugosa, Carex sp., Calamagrostis canadensis	Abies balsamea, Betula populifolia, Rubus hispidus, Dryopteris cristata, Spiraea latifolia, Onoclea sensibilis, Aster puniceus, Solidago rugosa

PSS1E (seasonally flooded saturated)	Alnus rugosa	Ilex verticillata, Betula populifolia, Abies balsamea, Calamagrostis canadensis, Leersia oryzoides, Aster puniceus, Spiraea latifolia
PSS1E (seasonally flooded saturated)	Acer rubrum, Myrica gale, Chamaedaphne calyculata	Acer rubrum, Quercus c.f. rubra, Tsuga canadensis, Betula alleghaniensis, Ilex verticillata, Vaccinium corymbosum, Alnus rugosa, Lyonia ligustrina, Rhododendron canadense, Osmunda regalis, Rubus hispidus, Mimulus ringens
PSS1E (seasonally flooded /saturated)	Salix sp., Cephalanthus occidentalis	Acer rubrum, Betula populifolia, Ulmus americana, Spiraea latifolia, Cornus amomum, Ilex verticillata, Myrica gale, Typha latifolia, Dryopteris sp., Calamagrostis canadensis
PSS1/3Ba (saturated)	Ilex verticillata, Chamaedaphne calyculata	Acer rubrum, Vaccinium corymbosum, Kalmia angustifolia, Rhododendron canadense, Sphagnum sp., Dulichium arundinaceum, Unidentified fern, Unidentified graminoid
PSS3/1Ba (saturated)	Chamaedaphne calyculata	Myrica gale, Carex sp., Vaccinium macrocarpon, Scirpus cyperinus, Juncus canadensis, Calamagrostis canadensis
PSS3Ba (saturated)	Chamaedaphne calyculata	Pinus strobus, Picea rubens, Kalmia angustifolia, Rhododendron canadense, Carex c.f. trisperma, Sarracenia purpurea, Eriophorum virginicum, Vaccinium oxycoccus
PSS1F (semipermanently flooded)	Cephalanthus occidentalis	Not recorded

Table D-3. Examples of palustrine deciduous forested wetlands in the Cusco Bay watershed, Maine.

Wetland Type (water regime)	Dominant Species	Associated Vegetation
PFO1E (seasonally flooded /saturated)	Acer rubrum	Pinus strobus, Abies balsamea, Betula populifolia, Ilex verticillata, Viburnum cassinoides, Osmunda cinnamomea
PFO1/SS1E (seasonally flooded /saturated)	Acer rubrum, Ilex verticillata, Alnus rugosa	Pinus strobus, Quercus rubra/velutina, Viburnum cassinoides,Vaccinium corymbosum, Osmunda cinnamomea, Carex sp., Chamaedaphne calyculata, Rubus hispidus
PFO1E (seasonally flooded /saturated)	Acer rubrum	Quercus velutina, Fagus grandifolia, Pinus strobus, Corylus cornuta, Betula nigra, Viburnum cassinoides, Osmumda regalis, Lycopodium lucidulum, Rubus hispidus, Dryopteris cristata, Carex sp.
PFO1E (seasonally flooded /saturated)	Acer rubrum	Pinus strobus, Betula papyrifera, Fraxinus pennsylvanica, Betula populifolia, Ulmus americana, Fagus grandifolia, Ilex verticillata, Alnus rugosa, Vaccinium corymbosum, Quercus alba, Osmunda regalis, Coptis trifolia, Carex sp., Onoclea sensibilis, Aster sp., Dryopteris sp., Rubus hispidus, Lysimachia quadrifolia, Cornus canadensis
PFO1/SS1E (seasonally flooded /saturated)	Acer rubrum, Alnus rugosa	Pinus strobus, Abies balsamea, Spiraea latifolia, Fraxinus pennsylvanica, Ulmus americana, Cornus amomum, Viburnum cassinoides, Lyonia ligustrina, Osmunda regalis, Onoclea sensibilis, Unidentified graminoid, Aster puniceus, Dryopteris cristata

PFO1E (seasonally flooded /saturated)	Acer rubrum	Fagus grandifolia, Pinus strobus, Quercus c.f. rubra, Betula alleghaniensis, Betula populifolia, Betula papyrifera, Ilex verticillata, Hamamelis virginiana, Lyonia ligustrina, Vaccinium corymbosum, Osmunda cinnmomea, Rubus hispidus, Gaultheria procumbens, Coptis trifolia, Chamaedaphne calyculata, Epigea repens, Pteridium aquilinum, Bidens connata
PFO1/4E (seasonally flooded/saturated)	Acer rubrum, Pinus strobus	Tsuga canadensis, Betula alleghaniensis, Abies balsamea, Picea rubens, Viburnum cassinoides, Lyonia ligustrina, Cornus canadensis, Gaultheria procumbens, Coptis trifolia, Rubus hispidus, Osmunda cinnamomea, Carex stricta, Dryopteris cristata
PFO1/4E (seasonally flooded /saturated)	Acer rubrum, Abies balsamea, Tsuga canadensis	Fraxinus pennsylvanica, Ulmus americana, Cornus amomum, Fagus grandifolia, Carex c.f. crinita, Carex sp., Unidentified graminoid, Onoclea sensibilis, Dryopteris c.f. cristata, Epilobium sp.
PFO1/4E (seasonally flooded /saturated)	Acer rubrum, Abies balsamea	Betula populifolia, Pinus strobus, Picea rubens, Betula alleghaniensis, Ilex verticillata, Alnus rugosa, Osmunda cinnamomea, Cornus canadensis, Carex sp., Calamagrostis canadensis
PFO1C (seasonally flooded)	Ulmus americana	Acer rubrum, Alnus rugosa, Viburnum dentatum, Cornus stolonifera, Sambucus canadensis, Onoclea sensibilis, Calamagrostis canadensis, Polygonum sp., Geum laciniatum, Prunus sp.

PFO1A (temporarily flooded)	Acer rubrum	Quercus rubra, Betula papyrifera, Betula populifolia, Abies balsamea, Corylus cornuta, Dryopteris sp., Osmunda regalis, Unidentified grass, Pyrola sp., Aster sp., Viburnum cassinoides
PFO1A (temporarily flooded)	Acer rubrum	Fraxinus pennsylvanica, Ulmus americana, Prunus serotina, Ilex verticillata, Viburnum c.f. dentatum, Alnus rugosa, Onoclea sensibilis, Osmunda regalis, Solidago rugosa, Aster sp., Carex sp., Viola sp.
PFO1/SS4Ba (saturated)	Acer rubrum	Pinus strobus, Tsuga canadensis, Picea rubens, Abies balsamea, Betula alleghaniensis, Betula populifolia, Vaccinium corymbosum, Osmunda regalis, Kalmia angustifolia, Coptis trifolia, Vaccinium pallidum

Table D-4. Examples of palustrine evergreen forested wetlands in the Casco Bay Watershed, Maine.

Wetland Type (water regime)	Dominant Species	Associated Vegetation
PFO4B (saturated)	Pinus strobus, Acer rubrum, Picea rubens	Vaccinium corymbosum, Ilex verticillata, Aronia melanocarpa, Kalmia angustifolia, Chamaedaphne calyculata
PFO4A (temporarily flooded)	Abies balsamea	Acer rubrum, Betula papyrifera, Quercus velutina, Betula alleghaniensis, Lycopodium obscurum, Lycopodium c.f. clavatum, Viburnum cassinoides, Gaultheria procumbens
PFO4A (temporarily flooded)	Pinus strobus	Acer rubrum, Quercus c.f. rubra, Fagus grandifolia, Abies balsamea, Fraxinus pennsylvanica, Tsuga canadensis, Osmunda regalis, Dryopteris sp.
PFO4/SS1E (seasonally flooded /saturated)	Pinus rigida, Chamaedaphne calyculata, Vaccinium corymbosum, Rhododendron canadense	Pinus strobus, Betula populifolia, Lyonia ligustrina, Ilex verticillata, Kalmia angustifolia, Carex sp.

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Appendix E. Summary Statistics for Areas Designated as "Clusters of Small Wetlands That May Contain Vernal Pools."

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #1 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1E	3	6.741000
PFO1/4E	3	10.424000
PFO1E	6	11.369000
PFO4E	1	9.491000
PSS1/4E	4	12.718000
PSS1E	17	21.039000
PSS4E	1	0.428000
PUBF	8	2.431000
PUBH	3	1.406000
U	1	469.140000
	==========	==================
	47	545.187000

05/10/99

CLUSTER #1 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	15	55.972000
TEBAIS	31	20.075000
U	1	469.140000
	==========	==================
	47	545.187000

05/10/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #2 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PFO1/4E	1	4.002000
PFO1E	7	5.119000
PFO4E	5	5.722000
PSS1/FO4E	1	1.811000
PSS1E	3	1.963000
PUBHx	1	1.298000
U	1	253.440000
	==========	==================
	19	273.355000

05/10/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #2 - HGM

LFCLASS	FREQUENCY	ACRES
TEBAIS	12	5.687000
TEBAIShi	1	1.298000
TEBAOUhw	2	5.960000
TESLIS	2	3.169000
TESLOUhw	1	3.801000
U	1	253.440000
	==========	==================
	19	273.355000

05/10/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #3 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1E	1	0.583000
PFO1/4E	3	5.536000
PFO1E	16	16.555000
PFO4E	2	6.048000
PFO4Eh	1	6.366000
PSS1E	5	1.697000
PUBH	1	0.167000
PUBHh	1	0.315000
PUBHx	1	0.217000
U	1	26,232.531000
	==========	==================
	32	26,270.015000

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WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #3 - HGM

LFCLASS	FREQUENCY	ACRES
TEBAIS	27	30.636000
TEBAIShi	1	0.217000
TEBAOUhw	3	6.631000
U	1	26,232.531000
	==========	==================
	32	26,270.015000

05/10/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #4 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PFO1E	1	1.373000
PFO4E	2	2.101000
PSS1E	1	0.381000
PUBF	1	0.712000
U	1	170.825000
	==========	==================
	6	175.392000

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WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #4 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	1	0.381000
TEBAIS	3	2.716000
TEBAOUhw	1	1.470000
U	1	170.825000
	==========	==================
	6	175.392000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #5 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PFO1E	43	39.994000
PFO4/1E	2	3.160000
PSS1E	3	0.591000
PUBHh	1	0.244000
PUBHx	1	0.256000
U	2	406.299000
	==========	=================
	52	450.544000

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WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #5 - HGM

LFCLASS	FREQUENCY	ACRES
TEBAIN	1	0.730000
TEBAIS	47	43.015000
TEBAIShi	1	0.256000
TEBAOUhw	1	0.244000
U	2	406.299000
	==========	=================
	52	450.544000

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WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #6 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PFO1/4E	5	3.177000
PFO1E	3	3.222000
PFO4E	2	2.065000
PUBF	7	1.776000
PUBH	6	1.668000
U	2	356.415000
	==========	==================
	25	368.323000

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WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #6 - HGM

LFCLASS	FREQUENCY	ACRES
TEBAIS	23	11.908000
U	2	356.415000
	==========	==================
	25	368.323000

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WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #7 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PFO1/4E	3	7.900000
PFO1E	6	4.174000
PUBHx	2	0.833000
U	2	91.414000
	==========	==================
	13	104.321000

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WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #7 - HGM

LFCLASS	FREQUENCY	ACRES
TEBAIS	8	10.982000
TEBAIShi	2	0.833000
TESLIS	1	1.092000
U	2	91.414000
	==========	==================
	13	104.321000

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WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #8 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PFO1/4E	5	12.463000
PFO1E	6	5.380000
PFO1F	2	1.480000
PSS1E	2	1.592000
PUBHx	1	0.430000
U	2	267.122000
	==========	=================
	18	288.467000

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WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #8 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	1	4.715000
TEBAIS	12	14.958000
TEBAIShi	1	0.430000
TEBAOUhw	2	1.242000
U	2	267.122000
	==========	=================
	18	288.467000

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WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #9 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PFO1/4E	11	4.057000
PFO1E	29	37.857000
PFO4/1E	1	7.780000
PSS1E	2	0.612000
PSS1Fh	1	10.109000
PUBH	1	0.222000
U	3	263.624000
	==========	=================
	48	324.261000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #9 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	1	0.035000
LS1FLTH	3	36.074000
LS1FRstTH	1	10.109000
TEBAIS	40	14.419000
U	3	263.624000
	==========	=================
	48	324.261000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #10 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PFO1/4E	5	7.763000
PFO1E	28	24.661000
PFO4E	2	2.568000
PSS1E	20	15.176000
PSS1F	1	1.392000
PUBH	2	1.659000
PUBHh	3	0.719000
PUBHx	5	4.553000
U	2	914.970000
	==========	==================
	68	973.461000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #10 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	15	19.589000
LS1BATHhi	2	0.652000
LS1SLTH	1	0.406000
LS2SLTH	1	1.854000
LS3SLTH	3	3.046000
TEBAIS	32	19.813000
TEBAOUhw	5	10.077000
TEBAOUhwfg	5	2.693000
TEBAOUhwhi	2	0.361000
U	2	914.970000
	==========	==================
	68	973.461000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #11 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PFO1E	14	44.854000
PFO4/1E	4	7.905000
PFO4E	10	19.118000
PSS1E	3	2.999000
PUBHx	1	0.261000
U	2	456.729000
	==========	==================
	34	531.866000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #11 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	3	8.970000
TEBAIS	16	27.144000
TEBAISfg	3	6.583000
TEBAIShi	1	0.261000
TEBAOU	5	15.183000
TEBAOUhw	3	15.066000
TESLOU	1	1.930000
U	2	456.729000
	==========	==================
	34	531.866000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #12 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	4	4.648000
TEBAIS	10	11.497000
U	2	258.030000
	==========	==================
	16	274.175000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #12 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1E	1	1.392000
PFO1E	11	12.522000
PFO4E	1	1.479000
PSS1E	1	0.752000
U	2	258.030000
	==========	==================
	16	274.175000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #13 - HGM

LFCLASS	FREQUENCY	ACRES
LS2SLTH	1	2.549000
TEBAIS	6	7.700000
TEBAIShi	1	0.246000
TEBAOUhw	3	10.112000
TESLIS	1	2.032000
U	1	552.477000
	==========	==================
	13	575.116000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
CLUSTER #13 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PFO1E	8	17.810000
PFO4B	1	1.817000
PUBHh	2	2.766000
PUBHx	1	0.246000
U	1	552.477000
	==========	==================
	13	575.116000

Appendix F. Summary Statistics for Large Diverse Wetland Complexes.

06/17/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #1 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1E	2	49.548000
PFO1/4E	2	6.511000
PFO1E	1	16.209000
PFO4E	6	57.031000
PSS1E	4	27.167000
PSS4E	2	14.728000
U	4	241.186000
	==========	=================
	21	412.380000

05/11/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #1 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	17	171.194000
U	4	241.186000
	==========	=================
	21	412.380000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #2 - NWI

ATTRIBUTE	FREQUENCY	ACRES
L1UBH	1	50.497000
PEM1/FO1E	1	27.422000
PEM1E	1	12.148000
PFO1E	2	8.711000
PFO4/1E	2	39.059000
PFO4E	1	5.586000
PSS3Ba	2	18.864000
PSS7Ba	1	6.789000
U	1	137.601000
	==========	=================
	12	306.677000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #2 - HGM

LFCLASS	FREQUENCY	ACRES
LEBAOU	6	56.123000
LEBATH	1	36.803000
LEFROU	3	25.653000
LKEOU	1	50.497000
U	1	137.601000
	==========	=================
	12	306.677000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #3 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1E	2	66.642000
PFO1/4E	2	14.655000
PFO1E	4	5.543000
PFO4E	5	32.094000
PSS1/4E	1	26.657000
PSS1E	4	16.166000
PSS3/1Ba	1	26.882000
PSS3Ba	1	1.072000
PUBH	2	19.411000
PUBHx	1	0.299000
U	3	390.828000
	==========	==================
	26	600.249000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #3 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	14	154.561000
LS1BATHpb	1	26.882000
LS1SLTH	3	14.819000
LS1SLTh	1	0.669000
TEBAIS	1	0.350000
TEBAIShi	1	0.299000
TESLOU	1	1.794000
TESLOUnc	1	10.047000
U	3	390.828000
	==========	==================
	26	600.249000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #4 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1/SS1E	1	5.078000
PEM1E	1	4.551000
PFO1/4E	2	58.476000
PFO1E	3	104.975000
PFO4/1E	1	15.119000
PFO4E	3	13.895000
PSS1/4E	1	1.203000
PSS1E	3	51.868000
PSS1Eh	1	0.338000
PSS1Fh	1	1.019000
PUBHh	1	0.261000
U	1	626.388000
	==========	==================
	19	883.171000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #4 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	10	194.836000
LS2SLTH	2	37.182000
TEBAIS	3	1.618000
TEBAOUhw	1	4.065000
TESLOU	1	3.963000
TESLOUhw	1	15.119000
U	1	626.388000
	==========	==================
	19	883.171000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #5 - NWI

ATTRIBUTE	FREQUENCY	ACRES
L1UBH	1	17.715000
PEM1/FO4E	1	15.195000
PEM1E	4	33.903000
PFO1/4E	1	20.385000
PFO1E	2	4.421000
PFO4/1E	2	52.700000
PFO4E	4	31.751000
PSS1E	2	31.540000
PSS4E	1	1.490000
U	7	219.435000
	==========	==================
	25	428.535000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #5 - HGM

LFCLASS	FREQUENCY	ACRES
LEBATH	11	101.115000
LKE	1	17.715000
TEBAIS	1	1.490000
TESLOU	1	1.211000
TESLOUhw	4	87.569000
U	7	219.435000
	==========	=================
	25	428.535000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #7 - NWI

ATTRIBUTE	FREQUENCY	ACRES
L1UBH	2	184.472000
PEM1E	2	5.824000
PFO1E	3	9.926000
PFO4E	4	22.714000
PSS1/FO1Ed	1	3.101000
PSS1/FO4E	1	9.730000
PSS1E	5	72.914000
PSS1Eh	1	2.138000
PSS4/EM1E	1	13.108000
PSS7E	1	25.256000
U	3	505.829000
	==========	=================
	24	855.012000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #7 - HGM

LFCLASS	FREQUENCY	ACRES
LEBATH	9	126.635000
LKE	1	34.463000
LKEOU	1	150.009000
LS1BATH	6	17.021000
LS1FLTH	1	2.253000
LS1SLTH	1	4.578000
TEBAOUhw	1	3.101000
TESLOU	1	11.123000
U	3	505.829000
	==========	=================
	24	855.012000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #8 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1/FO4E	1	5.498000
PEM1/SS4E	1	17.161000
PEM1E	3	76.015000
PFO1/4E	1	69.086000
PFO4/1E	1	14.473000
PFO4E	3	62.755000
PSS1E	1	37.064000
PSS4E	4	53.962000
U	4	32,576.450000
	==========	==================
	19	32,912.464000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #8 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	12	285.484000
LS1SLTH	1	3.744000
LS2SLTH	1	4.090000
TESLOU	1	42.696000
U	4	32,576.450000
	==========	==================
	19	32,912.464000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #9 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1/SS1E	1	9.005000
PEM1C	2	8.347000
PEM1Cd	2	3.614000
PEM1E	15	112.948000
PEM1Ed	3	80.775000
PEM1Eh	1	0.347000
PEM1F	1	0.646000
PEM1Fb	1	0.800000
PFO1/4E	9	107.171000
PFO1C	2	4.973000
PFO1E	10	124.178000
PFO4/1E	2	59.431000
PFO4E	13	76.296000
PFO5F	1	5.022000
PSS1/4C	1	7.336000
PSS1/4E	6	154.636000
PSS1/EM1C	2	17.727000
PSS1/EM1E	4	82.451000
PSS1/FO4E	1	5.565000
PSS1C	5	5.930000
PSS1Ch	1	1.117000
PSS1E	22	230.856000
PSS1Eh	1	0.232000
PSS1F	1	13.768000
PSS1Fh	1	7.236000
PSS4/1E	3	80.095000
PSS4E	2	3.250000
PUBH	2	3.656000
PUBHh	1	1.146000
PUBHx	1	0.330000
R2UBH	5	6.711000
U	22	1,619.484000
	==========	=================
	144	2,835.079000

05/12/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #9 - HGM

LFCLASS	FREQUENCY	ACRES
LR1BATH	1	0.449000
LR1BATHfg	1	1.936000
LS1BATH	11	43.276000
LS1BATHfg	6	27.098000
LS1FPba	30	279.006000
LS1FPbafg	57	786.930000
LS1FPfo	1	1.146000
RVR	1	4.085000
TEBAIS	5	3.276000
TEBAISfg	1	2.725000
TEBAIShi	1	0.330000
TEBAOUhw	5	36.367000
TESLIS	1	1.810000
U	23	1,646.645000
	==========	==================
	144	2,835.079000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #10 - NWI

ATTRIBUTE	FREQUENCY	ACRES
L1UBH	1	51.471000
PEM1E	6	23.508000
PFO1E	9	101.565000
PFO4/1E	1	1.486000
PFO4E	5	97.168000
PSS1E	9	56.395000
PSS1Ed	1	10.790000
U	9	347.179000
	==========	=================
	41	689.562000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #10 - HGM

LFCLASS	FREQUENCY	ACRES
LEBATH	10	24.327000
LEISlkTH	2	0.866000
LKEfg	1	51.471000
LS1BATH	6	21.747000
TEBAOUhwdd	13	243.972000
U	9	347.179000
	==========	=================
	41	689.562000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #11 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1C	1	3.284000
PEM1E	1	0.276000
PEM1Eb	1	2.785000
PFO1/4C	1	9.265000
PFO1/4E	1	16.678000
PFO1/4Ed	2	32.825000
PFO1E	2	7.058000
PFO4/SS1Ed	1	6.093000
PFO4E	7	83.765000
PFO4Ed	1	14.623000
PSS1/EM1E	1	3.930000
PSS1/EM1Eb	1	1.974000
PSS1C	1	1.654000
PSS1E	8	25.212000
PSS1Ed	3	13.770000
PSS1Fb	1	9.324000
PSS4Ed	1	25.886000
PUBFx	1	0.484000
PUBH	2	2.000000
PUBHx	1	0.466000
U	9	482.627000
	==========	=================
	47	743.979000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #11 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	13	34.379000
LS1FRstTH	1	9.324000
LS1SLTH	2	12.051000
LS2SLTH	1	23.072000
TEBAIS	4	12.156000
TEBAIShi	2	0.950000
TEBAOUhw	2	1.582000
TEBAOUhwdd	13	167.838000
U	9	482.627000
	==========	=================
	47	743.979000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #12 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1E	2	6.801000
PEM1Eb	1	1.234000
PEM1Ed	2	11.612000
PEM1Fb	2	6.784000
PFO1/4E	1	8.547000
PFO1/SS1C	1	4.700000
PFO1C	4	9.715000
PFO1E	9	76.336000
PFO1Eb	1	2.695000
PFO1Eh	1	3.349000
PFO4/1E	5	178.672000
PFO4E	4	44.165000
PSS1/4Ed	1	4.958000
PSS1/EM1E	1	14.078000
PSS1/FO4E	1	7.206000
PSS1C	1	12.153000
PSS1E	10	31.268000
PSS1Ed	2	27.984000
PSS1Eh	1	0.704000
PSS4/1E	1	20.130000
PUBFb	1	2.729000
PUBHx	3	1.016000
R2UBH	1	14.825000
U	5	983.784000
	=========	=================
	61	1,475.445000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #12 - HGM

LFCLASS	FREQUENCY	ACRES
LR1BATH	6	2.989000
LS1BATH	15	59.011000
LS1FLTH	2	35.706000
LS1SLTH	2	28.908000
RVR	1	14.825000
TEBAIS	1	15.086000
TEBAIShi	2	0.625000
TEBAOUhw	8	34.256000
TEBAOUhwdd	5	83.555000
TEBAOUhwddfg	3	44.177000
TEBAOUhwfg	9	136.130000
TEBAOUhwhifg	1	0.391000
TESLOUhwfg	1	36.002000
U	5	983.784000
	==========	==================
	61	1,475.445000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #13 - NWI

ATTRIBUTE	FREQUENCY	ACRES
L1UBH	1	24.608000
PEM1E	11	28.769000
PFO1/4E	2	56.943000
PFO1C	1	3.203000
PFO1E	30	231.514000
PFO4/1E	2	25.319000
PFO4/EM1E	1	2.280000
PFO4E	27	259.799000
PSS1/3E	3	31.128000
PSS1C	1	2.652000
PSS1E	23	327.714000
PSS3/1E	1	56.626000
PSS3Ba	8	25.979000
PSS4Ba	1	5.222000
PSS4E	4	12.909000
PSS7Ba	1	19.562000
PSS7E	1	6.515000
PUBH	2	19.301000
PUBHh	1	0.314000
PUBHx	1	0.388000
U	23	2,072.049000
	==========	==================
	145	3,212.794000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #13 - HGM

LFCLASS	FREQUENCY	ACRES
LEBATH	3	28.899000
LEFRTHfm	1	17.244000
LKE	2	42.053000
LR1BATH	48	755.451000
LR1FLTH	10	127.474000
LS1BATH	21	75.468000
LS1BATHhi	1	0.388000
LS1SLTH	1	12.210000
TEBAIS	31	74.172000
TEBAOUhw	3	7.064000
TESLIS	1	0.322000
U	23	2,072.049000
	==========	==================
	145	3,212.794000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #14 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1Cd	1	0.662000
PEM1E	4	189.011000
PFO1Cd	2	1.146000
PFO1E	6	16.744000
PFO4/1E	3	25.712000
PFO4E	1	6.820000
PSS1/4E	1	9.810000
PSS1E	8	31.754000
PSS4/FO4E	1	34.921000
PUBH	1	0.231000
U	7	408.125000
	==========	==================
	35	724.936000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #14 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATHfg	20	310.930000
LS1BATHhifg	2	1.639000
TEBAIS	5	2.611000
TEBAISfg	1	1.631000
U	7	408.125000
	==========	==================
	35	724.936000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #15 - NWI

ATTRIBUTE	FREQUENCY	ACRES
L1UBH	1	112.793000
PEM1/FO4E	1	4.838000
PEM1E	4	50.558000
PFO1E	1	5.733000
PFO4B	2	3.966000
PFO4E	3	12.423000
PSS1/3Ba	1	7.690000
PSS1/3E	1	4.117000
PSS1/4E	2	4.167000
PSS1/EM1E	1	2.417000
PSS1E	7	35.984000
PSS1F	2	2.237000
PSS3/1Ba	1	10.210000
PSS3Ba	13	65.610000
PSS4Ba	1	4.589000
PSS4E	1	4.290000
PUBH	3	4.591000
U	8	528.254000
	==========	==================
	53	864.467000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #15 - HGM

LFCLASS	FREQUENCY	ACRES
LEBATH	15	66.048000
LEFRlkTH	3	3.962000
LEISlkTH	2	3.587000
LKE	1	112.793000
LS1BATH	15	132.664000
LS1SLTH	1	1.229000
TEBAIS	6	7.720000
TEBAOUhw	2	8.210000
U	8	528.254000
	==========	==================
	53	864.467000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSLITY
CLUSTER #16 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1E	1	7.280000
PFO1/4E	1	4.236000
PFO1E	4	16.479000
PFO4E	5	60.582000
PSS1E	4	28.340000
PSS3Ba	2	17.998000
PUBHx	1	0.946000
U	3	126.951000
	==========	==================
	21	262.812000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #16 - HGM

LFCLASS	FREQUENCY	ACRES
LS2SLTH	1	4.236000
TEBAIShi	1	0.946000
TEBAOUhw	16	130.679000
U	3	126.951000
	==========	==================
	21	262.812000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #17 - NWI

ATTRIBUTE	FREQUENCY	ACRES
PEM1/FO4E	1	4.118000
PEM1/SS1E	1	4.782000
PEM1Cd	2	4.197000
PEM1E	4	8.974000
PFO1/4E	4	16.958000
PFO1E	8	27.144000
PFO4/1E	4	64.543000
PFO4/SS1E	1	5.595000
PFO4E	15	158.170000
PSS1/4E	3	22.087000
PSS1/EM1E	3	49.747000
PSS1/FO4E	1	7.757000
PSS1Cd	1	3.157000
PSS1E	6	28.557000
PSS1Ed	1	6.351000
PUBFx	1	0.216000
PUBH	2	0.619000
PUBHx	4	2.067000
U	9	713.864000
	==========	==================
	71	1,128.903000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVESITY
CLUSTER #17 - HGM

LFCLASS	FREQUENCY	ACRES
LS1BATH	23	103.767000
LS1BATHfg	2	3.381000
LS1FLTH	10	135.087000
LS1FLTHfg	13	106.538000
TEBAIS	3	4.517000
TEBAIShi	5	2.283000
TEBAOUhwfg	2	7.281000
TEFLOUfg	3	50.115000
TESLIS	1	2.070000
U	9	713.864000
	==========	==================
	71	1,128.903000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #18 - NWI

ATTRIBUTE	FREQUENCY	ACRES
L1UBH	3	103.388000
PEM1E	6	32.123000
PEM1F	8	23.513000
PFO1/4B	1	5.871000
PFO1/4E	2	36.693000
PFO1C	1	38.271000
PFO1E	4	64.384000
PFO4/1B	1	19.817000
PFO4/1E	1	17.522000
PFO4B	3	8.403000
PFO4E	2	47.140000
PFO5Fh	1	0.230000
PSS1/EM1E	2	3.789000
PSS1E	5	9.106000
PSS3/1Ba	1	11.292000
PSS3Ba	1	2.022000
PUBH	1	5.862000
PUBHx	2	1.082000
U	5	230.304000
	==========	==================
	50	660.812000

05/13/99

WETLAND ACREAGE SUMMARY
CASCO BAY WATERSHED
WETLANDS AND BIODIVERSITY
CLUSTER #18 - HGM

LFCLASS	FREQUENCY	ACRES
LEBATH	13	77.636000
LEFR1kTH	10	28.283000
LKE	1	0.554000
LKEOU	1	100.800000
LS1BATH	3	23.025000
LS1BATHfg	5	77.445000
TEBAIS	1	0.138000
TEBA[illegible]Shi	2	1.082000
TEBAOU	1	2.196000
TEBAOUhwfg	7	117.315000
U	6	232.338000
	==========	==================
	50	660.812000