Maine Citizens Guide to Evaluating, Restoring, and Managing Tidal Marshes

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A NOTE ON THIS MANUAL

The *Maine Citizens Guide to Evaluating, Restoring, and Managing Tidal Marshes* (*Maine Citizens Tidal Marsh Guide*) is based on *The Method for the Evaluation and Inventory of Vegetated Tidal Marshes in New Hampshire* (*New Hampshire Coastal Method*: R.A. Cook et al., 1993). We are deeply indebted to the authors of *the New Hampshire Coastal Method*, whose pioneering work developed the backbone of this manual. Much of the material in this manual came directly from the *New Hampshire Coastal Method.*

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Section 1

INTRODUCTION

SECTION 1. INTRODUCTION

Tidal marshes are vital natural communities that contribute to the value and unique character of the Maine coast. Found in protected bays behind **barrier beaches** and rocky headlands or along coastal rivers, tidal marshes are ecological powerhouses that support abundant fish, shellfish, and wildlife resources, protect the shore from erosion and storm surges, maintain and enhance coastal water quality, offer exceptional recreational and educational opportunities, and contribute to open space and the aesthetics of the coastal environment.

Using the *Maine Citizens Tidal Marsh Guide*

This manual is designed to increase awareness and understanding of coastal wetlands and provide practical tools to evaluate, manage, and protect them. The information gathered will be useful for local planning purposes. With this manual, conservation commissions, planning boards, or interested individuals can evaluate tidal marshes in their community and develop plans for conservation and/or restoration of marshes. Specifically, the manual will help you:

- understand how tidal marshes are formed and the values they provide to society (Section 2);
- identify and inventory tidal marshes in your town or study area (Section 3);
- assess various benefits of tidal marshes, including wildlife **habitat**, recreational opportunities and use, shellfish harvesting, and educational opportunities (i.e., as an outdoor classroom for local schools) (Section 4);
- identify threats to tidal marshes, such as tidal restrictions (Section 4), and methods to restore the **ecological integrity** of **marsh systems** (Section 5);
- improve recreational and educational uses of marshes without compromising ecological processes (Section 6); and
- protect marshes through land use planning and zoning (Section 7).

Section 8 is a glossary of technical terms. The first occurrence of terms that are found in the glossary has been printed in bold type in the text.

Although this manual will help you make informed decisions as described above, it does not provide enough detail to evaluate the impact of a specific proposed development in or adjacent to a marsh. In those cases, a qualified wetland professional should be consulted. A wetland professional can provide you with a precise location of the wetland boundary, an assessment of all functions and values provided by the wetland, and assess the potential impact of the proposed project.

Protection of Tidal Marshes

Tidal marshes are regulated by federal, state, and local laws. Development or construction within a tidal marsh require both a federal and a state permit, while development adjacent to a tidal marsh will probably require both a state and a local permit.

The two federal laws that regulate tidal marshes are the Clean Water Act and the Rivers and Harbors Act. Generally, activities within a marsh require a Clean Water Act permit, while activities within **tidal creeks** and adjacent rivers will need a Rivers and Harbors Act permit. Federal permits are administered by the U.S. Army Corps of Engineers, with additional regulatory authority given to the U.S. Environmental Protection Agency. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service review and comment on federal permits. State permits are required under the Maine Natural Resources Protection Act for activities in or adjacent to coastal wetlands, freshwater wetlands, streams, and sand dunes. This law is administered by the Maine Department of Environmental Protection. A local shoreland zoning permit, generally administered by municipalities, is usually required for activities within 250 ft. of coastal wetlands.

Although these laws mean that tidal marshes receive greater regulatory review than most other wetlands in Maine, most regulatory efforts are focused within the marsh boundary or a narrow upland strip. However, impacts to water quality may come from distant sources, and many activities that occurred before these laws were enacted, such as construction of roads that restrict tidal flow, continue to degrade tidal marshes.

Wetlands and adjacent uplands are often protected by conservation organizations such as public wildlife agencies or private, non-profit land trusts. A conservation organization may hold full title to the land or it may hold a conservation easement, which is often designed to prevent or restrict future development while the landowner maintains other property rights.

Federal, state and local laws are subject to change. The best protection of wetlands comes from informed local citizens. Knowing how marshes work and learning to identify sources of potential impacts will help assure that marshes will continue to provide important benefits in the future.

How the *Maine Citizens Tidal Marsh Guide* Works

The *Maine Citizens Tidal Marsh Guide* will guide you through four major activities: 1) identify and inventory tidal marsh systems in a study area; 2) assess tidal marsh functions and values and the ecological integrity of the marsh system; 3) evaluate the potential for restoring a marsh; and 4) prepare a plan that balances use and protection of marsh systems. You may choose to do some or all of these activities.

The inventory (Section 3) will include all tidal marshes in a study area, as well as **formerly tidal wetlands** that have become non-tidal due to the effects of a man-made obstruction. A review of National Wetlands Inventory maps that cover your community combined with your own field observations will be used to identify all wetlands.

The marsh evaluation (Section 4) includes the process of evaluating the overall health or Ecological Integrity of a marsh, and determining the importance of a wetland, based on an assessment of the ecological functions that it performs and the societal benefits it provides. Ecological Integrity measures human impacts to marsh systems. The impact could be caused by the construction of roads or railroads across the marsh, changes in **hydrology**, or development in the adjacent upland. Some sources of degradation, such as undersized culverts, affect large areas of tidal marsh. These areas can often be restored with relatively little effort. In addition to assessing Ecological Integrity, this manual provides a method for assessing the following wetland functions and values: Wildlife, Finfish & Shellfish Habitat, Recreational and Commercial Potential, Aesthetic Quality, Education Potential, and Noteworthiness.

The *Maine Citizens Tidal Marsh Guide* evaluation should be applied to individual tidal marshes. The evaluation procedure for each of the functions in the *Maine Citizens Tidal Marsh Guide* is based on the answers to a series of "predictor questions." These questions are based on physical characteristics of wetlands that relate to the ecological and socio-economic functions that wetlands perform. The questions are answered using published data (such as aerial photographs and National Wetlands

Inventory maps) and on-site field investigation. Upon completion of the assessment of each function or value, a numerical score, called the **Average Functional Index**, is assigned to each marsh system (defined in Section 4). The scores can be used to compare wetlands in a community and help set priorities for restoration and/or management.

If you identify wetlands **degraded** by human development, Section 5 provides the information you need to undertake a **marsh restoration** project. Section 6 focuses on the use of tidal marshes for education and recreation.

Once a database of wetland functions and a description of the restoration potential has been established for the marshes in a particular study area, local planners and decision makers can use this information to review and to help guide local planning and zoning as described in Section 7. The *Maine Citizens Tidal Marsh Guide* may also be used as an educational tool to further the understanding of tidal marshes. By establishing a baseline of information, the guide can also be used to document changes in tidal marsh systems over time (e.g., 3 - 5 year intervals).

An outline of the *Maine Citizens Tidal Marsh Guide* process is included below.

1. **Select a Study Area.** The recommended study area is the entire coastal zone of a town.
2. **Identify Tidal Marsh Systems.** Identify all of the tidal marsh systems in the study area and assign each a name or number (Section 3).
3. **Prepare Marsh System Base Maps.** (See Section 3)
4. **Determine the Number of Evaluation Units.** (See Section 3)
5. **Evaluate the Ecological Integrity, Functions and Values of the Marsh System.** (See Section 4)
6. With the data collected in Steps 1 - 5, you now have the information needed to:
    - **Start a Restoration Project.** (See Section 5)
    - **Evaluate Options for Education and Recreation.** (See Section 6)
    - **Review Planning and Zoning for Adjacent Uplands.** (See Section 7)

Section 2

MAINE TIDAL MARSHES

SECTION 2. MAINE TIDAL MARSHES

Definition of Tidal Marshes as Used in the *Maine Citizens Tidal Marsh Guide*

Coastal wetlands can be divided into three broad categories: **marine** wetlands, estuarine wetlands, and intertidal **riverine** wetlands. **Marine wetlands** are adjacent to or in the open ocean, and include habitats such as beaches, mud flats, rocky shores, and headlands. **Estuarine wetlands** include those habitats partially enclosed by land but having an opening to the ocean, where saltwater from the ocean mixes with freshwater from upland rivers and **surface runoff**. Salt marshes and mudflats are common estuarine wetlands. **Intertidal riverine wetlands** are vegetated wetlands within a river channel that, while influenced by tides, are beyond the normal reach of saltwater. These are commonly referred to as **freshwater tidal marshes**.

The *Maine Citizens Tidal Marsh Guide* applies to **vegetated tidal marshes**. These wetlands occur in estuarine and intertidal riverine coastal habitats, and include salt marshes, **brackish marshes** and freshwater tidal marshes. The U.S. Fish and Wildlife Service Wetland Classification System (see Appendix C) uses water salinity levels to differentiate between these three types of marshes. In the Gulf of Maine, **salt marshes** develop in a range of salinities from that of seawater, about 34 parts per thousand (ppt) of salt, to approximately 18 ppt. Brackish marshes are characterized by salinities ranging from 0.5 - 18 ppt. Freshwater tidal marshes are located where the salinities average less than 0.5 ppt yet tides still affect the movement of water.

Because wetland plant species vary in salinity tolerance, marsh types are generally identified by the plant species present. Plant communities change with distance from the ocean, with salt marshes occurring seaward, merging into brackish and then freshwater tidal marshes farther upstream. In marsh systems with a strong marine influence and limited freshwater input, true salt marshes dominate. Brackish and freshwater tidal marshes are more prevalent in larger river systems.

Tidal Marsh Formation

Tidal marshes form in low-lying coastal areas that are protected from excessive winds, waves, and currents. Such low energy environments allow for the deposition of sediments suspended in tidal waters. Subsequently, marsh plant communities develop on this sediment base. Each of these two processes, the deposition of sediment material and the colonization by tidal marsh plants, reinforce one another. Once plants are established they trap additional sediments, and the increased deposition of sediments raises the marsh elevation, allowing expansion of the tidal marsh. These combined processes lead to the formation of marsh soil or peat made up of mineral sediments (trapped from the **water column**) and **organic matter** (derived from partly decayed plant material).

Along the Maine coast, **sea level** has risen over the past 4,000 to 5,000 years. Throughout this period salt marshes have maintained themselves at the tidal elevations necessary for plant growth through the **accretion** of sediments filtered from tidal waters and the formation of peat from plant fragments and sediments. Two common species are saltwater cordgrass (*Spartina alterniflora*), which grows in areas flooded by daily tides, and salt meadow grass (*Spartina patens*), which grows at a higher elevation in irregularly flooded areas. As a marsh keeps up with sea level rise, it spreads over adjacent freshwater wetlands and gently sloping uplands, while eroding at its seaward edge. This process is known as **transgression**. Marsh area may grow or shrink depending on differing rates of sea level change, sediment input, sheltering, and degree of human influence.

Important Tidal Marsh Habitats

Tidal marshes are not uniform systems. Within each marsh there may be a variety of habitats that support different plants and animals. Some of the more important habitat types are described below.

Low marsh is flooded twice daily by tidal action. Cordgrass (*Spartina alterniflora*) is the dominant plant in salt and many brackish low marshes. Low marsh typically occurs as a sloping fringe between the high marsh and a tidal creek or mudflat.

High marsh is flooded irregularly by above-average tides. Salt meadow grass (*Spartina patens*) and black grass (*Juncus gerardii*) are the dominant plants in most high marshes. In brackish marshes with a strong freshwater influence, plants such as freshwater cordgrass (*Spartina pectinata*), narrow-leaved cattail (*Typha angustifolia*) or rushes (*Scirpus sp.*) may dominate. High marsh is usually level and occurs between the low marsh and uplands.

Pannes are shallow "ponds" that form within high marsh. Flooded periodically by spring tides, pannes provide an abundance of food for waterfowl and migrating shorebirds.

Tidal creeks, open water, and tidal flats are all important components of the marsh **ecosystem**. For the purposes of this manual, open water is defined as a permanently flooded (i.e., below mean low water) water body greater than 100 meters (330 feet) wide. Tidal creeks are less than 100 meters wide at mean low water. Tidal flats are nearly level to gently sloping unvegetated areas located within the **intertidal zone**.

Classification of Tidal Marsh Systems

Variation in topography, geology, tides, sediment supply, wave exposure, and rate of sea level rise along the Maine coast lead to the development of different marsh types. The three basic **geomorphological** types used in this manual are **back-barrier marshes**, **finger marshes**, and **fringe marshes**. The three marsh types can be determined visually from maps (see Figure 1) and are described below.

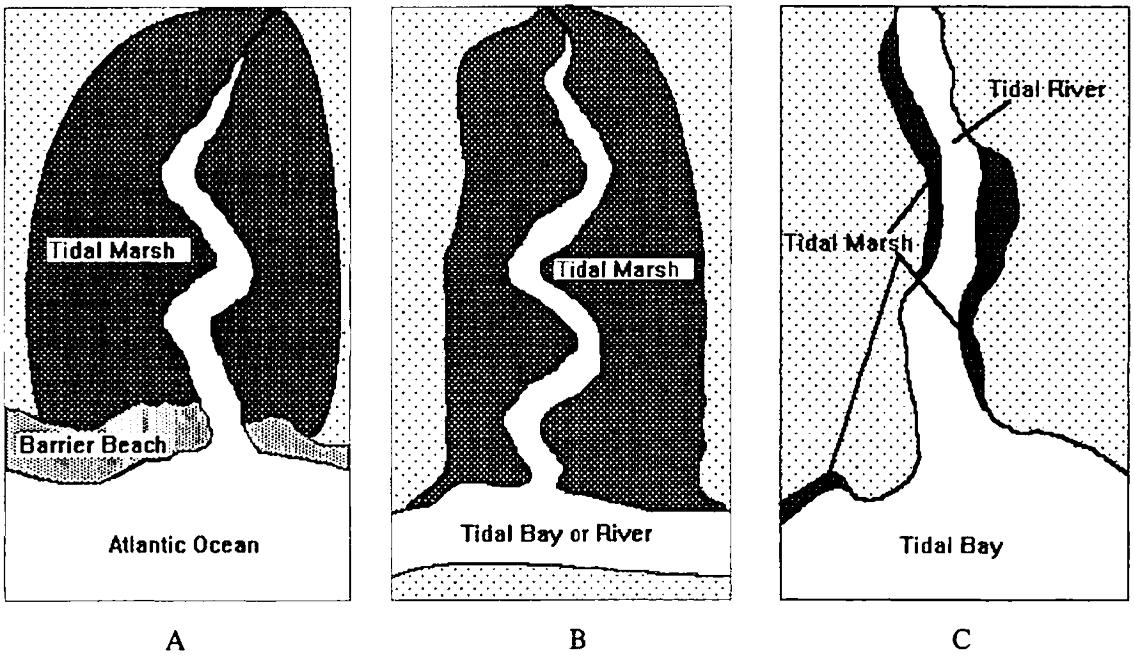

Figure 1. Marsh System Geomorphology: Back-Barrier (A), Finger (B), and Fringe(C) Marshes.

Back-Barrier Marshes

- associated with barrier beaches
- dominated by high marsh
- marshes located adjacent to Atlantic coast and have direct access to the ocean
- marshes in Scarborough and Wells are notable examples
- most common west of Sheepscot Bay

Riverine marshes are divided into two groups based on the size and shape of the associated water body:

Riverine Finger Marshes

- area of high marsh is large compared to size of channel
- elongate marsh that follows long axis of channel

Riverine Fringe Marshes

- found along protected shoreline in estuarine reaches of large rivers (coves, indentations, small tributaries, meanders) or at the toe of an eroding bluff
- limited development of high marsh
- strongly influenced by ice erosion; also affected by erosion from river flow and waves
- often bordered by mud flats

Depending on salinity levels, a range of plant communities may be found within each geomorphological type. Moving along the main marsh channel from the inlet to the head of tide, salinities decline, and the tidal saline marsh grades to tidal freshwater marsh. These marshes experience daily tidal flushing as do salt marshes, but are essentially freshwater marshes dominated by freshwater plants.

Tidal Marshes of the Maine Coast

Researchers at the University of Maine and the Maine Geological Survey found that Maine's convoluted shoreline, approximately 5,970 km (3,700 miles) in length, contains over 79 km^2 (19,500 acres) of salt marsh, far more than any other New England state, New York, or Canadian province on the Bay of Fundy (Jacobson et al. 1987). In reviewing the distribution of tidal marshes, these researchers found the geologic setting and abundance of marshes varied between four broad coastal regions (Figure 2). The following descriptions are based on the work of Jacobson et al. (1987) and Kelley et al. (1988):

> The **Arcuate Embayments** along the southwest coast from Kittery to Cape Elizabeth are characterized by sandy barrier beaches behind which extensive back-barrier marshes have developed. Although comprising a relatively short segment of the Maine coast, approximately 33% of the state's salt marshes are found in this area.
>
> The **Indented Shoreline,** formed by the peninsulas and islands from Cape Elizabeth to Spruce Head, provides protection from wind and waves. This protection combined with sediment supply from coastal rivers allows extensive salt marsh development. Approximately 35% of the state's tidal marshes are found in this region. The shoreline becomes highly convoluted and is dominated by narrow indented embayments and tidal rivers, with fringe marshes and finger marshes becoming more common. There are also notable barrier beaches and back-barrier marshes near the mouth of the Kennebec River in Phippsburg and Georgetown. In addition, extensive brackish marshes occur in the Kennebec River **estuary** and the majority of the state's freshwater tidal marshes are found in Merrymeeting Bay and its tributaries.
>
> The **Island - Bay Complex** extends from Spruce Head to Cross Island, including Machias Bay. This region is more exposed to wind and waves, and there are fewer rivers to provide the sediment needed for marsh accretion. Thus, only 26% of the state's marshes are found in this extensive region. Most of this, approximately 16.5 km^2 (4,000 acres), is found in the estuaries associated with the Penobscot, Pleasant, and Narraguagus Rivers. Fringe and finger marshes predominate; back-barrier marshes are limited to occasional small pockets behind a few sandy beaches.
>
> The **Eastern Cliff Shoreline** extends from Cross Island to the Canadian border. Erosion-resistant bedrock and few rivers offer limited protection and sediment supply for marsh development. Only 4.7% of the state's tidal marshes are found in this region, with most of these in Cobscook Bay.

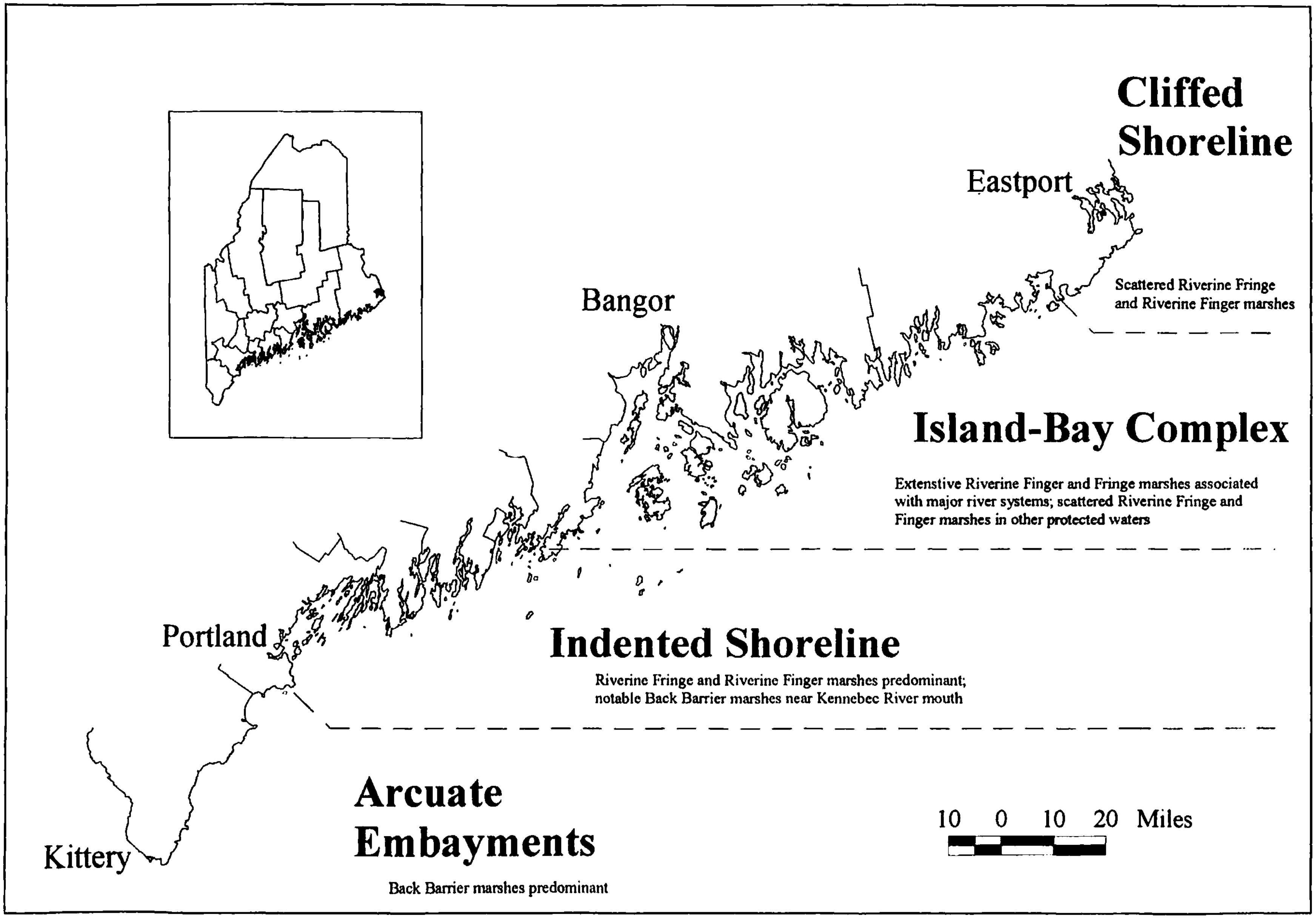

Figure 2. Marine Coastal Regions after Kelley et al. (1988) and Jacobson et al. (1987).

Functions and Values of Tidal Marshes

Tidal marshes can be described in terms of the ecological functions they perform and the values they hold for society. Many ecological functions and societal values are closely related (e.g., wildlife habitat and recreation). Assessing functions and values, an important component of this manual (Section 4), will provide you with knowledge important for restoring, managing and protecting marsh systems.

Ecological Functions of Tidal Marshes

Tidal marsh ecosystems are formed and persist through a combination of geological, hydrological and biological processes or functions. Several of these functions have been described in light of the tangible benefits they provide to the human community, directly or indirectly. These functions include:

- **Shoreline anchoring** - The accretion of peat and sediment maintains marsh elevation as sea level rises, and buffers the upland shoreline against the erosive action of the open water.
- **Storm Surge Protection** - The resistance to water flow presented by marsh vegetation slows the movement of water over the marsh, which protects adjacent uplands.
- **Water Quality Maintenance** - Marsh vegetation slows the movement of water, causing suspended sediments to be deposited on the marsh surface. Marsh vegetation also filters sediments and other materials that adhere to the dense, upright stems. Pollutants often enter aquatic systems attached to sediment particles. Many of these particles are deposited on the marsh, limiting their transport to other ecosystems. Some pollutants may then bind with soil particles and become unavailable for uptake by plants or animals.
- **Wildlife, Finfish, and Shellfish Habitat** - The rapid growth rates of salt marsh grasses form the base of a highly productive food web. Salt marshes are used for food and shelter by a diverse animal community, including many species of birds, finfish, shellfish and other invertebrates. The linkage between salt marsh productivity and the health of the Gulf of Maine remains to be studied, but it is likely that coastal marshes are important contributors to the productivity of the greater Gulf of Maine ecosystem.

These ecological functions have a tremendous financial value. Two-thirds of commercial shellfish and finfish landed in the United States depend on coastal wetlands for nursery and breeding habitat or on forage fish that breed in our coastal wetlands (Gosselink et al. 1974). The estimated total income for the harvest and processing of finfish and shellfish in Maine in 1993 was $462 million, resulting in 22,000 jobs (Wilson 1993). Recreational fishing, hunting, wildlife watching, and boating in coastal wetlands also contribute signficant economic value.

Societal Values of Tidal Marshes

Humans have depended on tidal marshes in Maine for millennia. Native Americans harvested birds, fish and shellfish from tidal marshes for thousands of years. In historic times, uplands adjacent to salt marshes were preferred sites for European settlement. The early colonists harvested the animals of the marshes, and, in a region dominated by extensive forest, used marsh grasses as fodder for their livestock. By 1650, thirty-four such communities had been established in Massachusetts and Maine (Nixon 1982), including most of the present-day coastal towns from the south shore of Boston north to Portland.

Today, tidal marshes are valued by society for a variety of reasons. Tidal marshes offer opportunities for bird watching, canoeing, sport fishing, hunting and other sorts of recreation. Salt marshes are the major native grasslands of coastal New England, and their open expanses and coastal vistas are aesthetically attractive to many. As ecosystems that have maintained themselves for thousands of years, they provide excellent outdoor classrooms for the teaching of basic ecological concepts. Many salt marsh sites retain evidence of early European and Native American use. Societal values that can be evaluated by the *Maine Citizens Tidal Marsh Guide* include:

- **Recreational and Commercial Potential** - The use of tidal marshes for hunting, fishing, boating, birdwatching, clamming or similar activities;
- **Aesthetic Quality** - The appearance of the tidal marsh and its impact on the visual landscape of a community;
- **Educational Potential** - The opportunity to use a tidal marsh as a field trip site for schools and other groups;
- **Noteworthiness** - Other important values of a marsh, such as habitat for endangered species, the location of important historical or archeological sites, its use as a research site, or its benefit as a "green space" in a developed area.

Threats to Tidal Marshes

Many of Maine's salt marshes have persisted or grown at the same sites for up to 4,000 years, demonstrating a remarkable ecological sustainability throughout their geologic history. However, in the past 300 to 400 years, since European colonization, humans have used tidal marsh ecosystems in ways that have altered the basic geological, hydrological and biological processes that sustain their ecological integrity. An assessment of human influence on marsh ecological integrity is an important aspect of this evaluation method.

The bounty that once was harvested from Maine coastal marshes has declined significantly. Many of the tidal marsh shellfish beds in the state are closed due to poor water quality; road and dam construction along the coast has severely altered many marshes; and over-fishing in the nearby coastal waters has depleted stocks of nursery fish. The numbers of ducks and shorebirds that frequent tidal marshes are a small fraction of the tremendous flocks of migrating birds that European colonists found when they arrived in North America.

Human activities can negatively impact the functions, values and ecological integrity of tidal marshes in numerous ways. Freshwater tributaries are often diverted, dammed, or channeled, greatly altering the seasonal inputs of fresh water and sediments to the marsh. This can affect salinity levels and alter habitat sustainability of saline-sensitive species of plants, fish, and other animals. Shorelines of tributaries and marshes are often heavily developed, replacing forest and pasture with roads, buildings, parking areas and lawns, leading to dramatic changes in the pattern and quality of freshwater runoff. Bluffs, beaches and inlets have been stabilized with sea walls and jetties, reducing the amount of available sediment for marsh accretion. Marshes themselves have been filled, dredged, or fragmented by roads, culverts and tide gates that interfere with normal tidal flow, and adversely affect water and soil quality. Like tourniquets on a leg or arm, these restrictions limit vital salt water from reaching portions of the marsh. If tidal restrictions are significant enough, marsh grasses die back, marsh peat degrades, and marsh elevation subsides. Areas of marsh affected by tidal restrictions are often invaded by pest plants [e.g., purple loosestrife (*Lythrum salicaria*) or common reed (*Phragmites australis*)] or may be transformed into mudflat, panne, or fresh marsh. Tidal restrictions may also allow plants that are found in the less saline portions of a marsh, such as narrow-leaved cattail, to invade areas normally dominated by *Spartina*. In New Hampshire, 20% of existing coastal marshes have been degraded by tidal restrictions (NRCS 1995), and this figure is probably similar for large sections of the Maine coast, especially west of the Sheepscot River.

High marsh habitats have been ditched for mosquito control, or more commonly in Maine, for salt hay production. Ditches alter a marsh's natural hydrology, in some cases causing excess drainage, and in others trapping water behind ditch spoils.

Sea level is rising worldwide (Belknap et al. 1989). This, coupled with residential and commercial development extending to the intertidal zone, poses a threat to the future of tidal marshes. The daily cycle of alternate flooding and draining is critical to maintaining a natural tidal marsh community because the flooding tidal water brings in salt, sediment, and nutrients, and the draining allows marsh grasses to thrive. These processes have allowed peat to accumulate and marsh elevations to keep pace with rising sea levels. The oldest marshes, which have been developing for about 4,000 years, have accumulated a layer of peat 5 meters thick (about 16 feet) in response to an equivalent rise in sea level (Kelley et al. 1995). During past geological periods of worldwide sea level rise, marshes have kept pace with this rise by continuing to expand into newly flooded areas. Today the extensive commercial and residential development along our coast makes the natural landward expansion of tidal marshes into adjacent, low-lying, developed areas problematic. Decisions may have to be made that weigh the benefits of tidal marshes against the loss of private property. As sea level continues to rise, large areas of tidal marsh that benefit both wildlife and humans could be lost if development impedes landward transgression of marshes. Marshes need sufficient sediment to grow vertically and horizontally. If adequate sediment is not available, the increased duration of flooding that accompanies sea level rise could result in the loss or dieback of tidal marshes, with dramatic changes in ecosystem functions and values.

The majority of tidal marsh that has been lost through dredging or drainage and filling will probably never be replaced. But much can be done to restore lost functions, values and ecological integrity to the many remaining acres of marsh in Maine that have been degraded as the result of human activities. Buffers and catch basins can be established to restore natural runoff patterns. Tidal flushing can be restored by removing tide gates, adding culverts, or enlarging existing culverts. This in turn reverses the process of marsh degradation, allows the recovery of salt marsh plants and rebuilding of the underlying peat. Tidal ditches created to drain the marsh can be plugged to restore natural hydrology.

If present and future generations are to use and enjoy the bounty and beauty of healthy tidal marshes, then understanding how they work, protecting them from negative impacts, and restoring their ecological integrity is essential. This manual will help you do just that.

Section 3

IDENTIFYING AND CLASSIFYING TIDAL MARSH SYSTEMS

SECTION 3. IDENTIFYING AND CLASSIFYING TIDAL MARSH SYSTEMS

Before you can evaluate a tidal marsh it will be necessary to collect data and prepare maps of each marsh. This section will:

1. Describe how to locate marshes on National Wetlands Inventory maps;
2. Show how to identify and map each marsh system from National Wetlands Inventory maps; and
3. Describe how to create a base map.

Using National Wetlands Inventory Maps

National Wetlands Inventory (NWI) maps are available for all coastal towns and will serve as the primary source of information to locate and classify tidal marsh systems. These maps identify tidal marshes that should be included in the evaluation and other tidal wetlands that should be field checked to determine if they should be evaluated. Your town may already have these maps or you may purchase them from the Maine Geologic Survey (see Appendix A). The Maine Geologic Survey can confirm if you have the most current version of the maps.

Sample NWI maps are included in Appendix F. The coastal wetlands on the sample NWI maps have been separated into different *marsh systems.* Each marsh system is encircled by a solid line. These lines were positioned according to location of the marsh, its **watershed** (including freshwater and tidal sources), and continuity of marsh along a shoreline. When you identify marsh systems for your town, be aware that some marsh systems may extend into adjacent communities. Whenever possible, you should coordinate with neighboring towns to make sure that these systems are evaluated in their entirety.

We suggest you review the U.S. Fish and Wildlife Service Wetlands Classification System (Cowardin et al., 1979) found in Appendix C before proceeding with this section. This classification system is the basis of the wetland identification codes used on all NWI maps. The NWI maps include both tidal and non-tidal wetlands. These maps use a combination of letters and numbers to identify different types of wetlands (see Figure 3). At first they will seem quite confusing, but focusing on a few key letters will help. All wetlands mapped as E2EM1P (Estuarine intertidal (2)EMergent marshes) should be included in the tidal wetlands inventory and assessment (see Figure 3). These mapping units include both high and low salt and brackish marshes, which will constitute the majority of wetlands in the inventory.

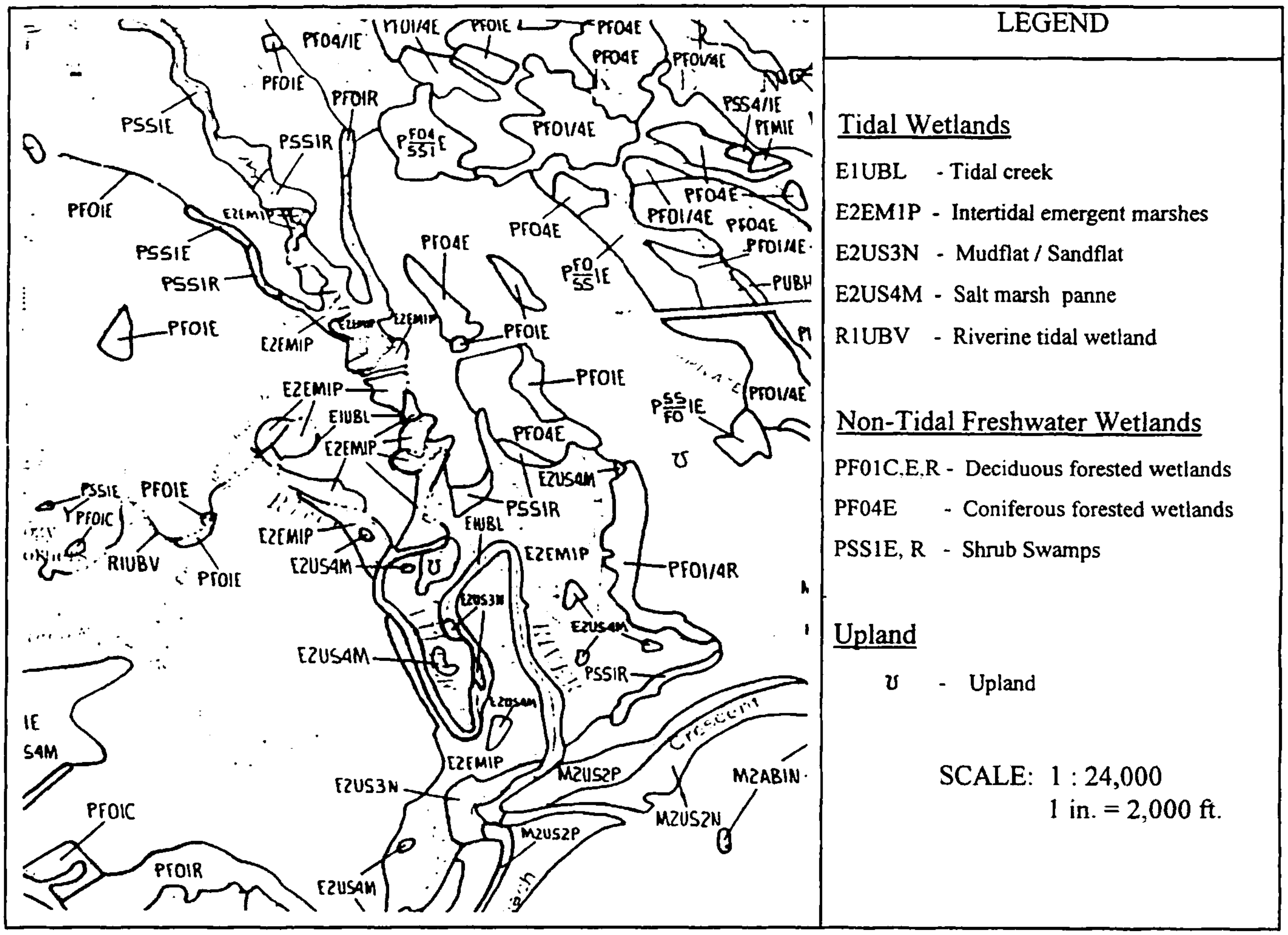

Figure 3. Sample National Wetlands Inventory (NWI) Map

In addition, the NWI maps include several other wetland classifications that may qualify as tidal marshes or former tidal marshes but will require field checking to verify their inclusion in the inventory and evaluation. To make the search easier, focus on the first four or five characters of the map symbol (e.g. <u>E2EM</u>1P).

Likely tidal marshes are mapped as:

E2EM	Estuarine Intertidal Emergent (Salt or Brackish Marsh)
R1EM	Riverine Intertidal Emergent (Tidal Freshwater Marsh)

Other areas that may include salt and brackish marshes are mapped as:

E2US	Estuarine Intertidal Unconsolidated Shore

E1UB	Estuarine Subtidal Unconsolidated Bottom

Tidal freshwater marshes may be mapped as:

R1US	Riverine Intertidal Unconsolidated Shore
R1UB	Riverine Intertidal Unconsolidated Bottom
PEMR	Palustrine Emergent Persistent Seasonally Tidal

Former salt or brackish marshes that have been converted to freshwater systems are often mapped as:

PUBHh	Palustrine Unconsolidated Bottom Permanently Flooded, Diked/Impounded

These classifications represent several types of tidal wetland that may or may not support tidal marsh vegetation such as tidal creeks (often mapped as E2US or E1UB), and shoreline along bays and tidal rivers (usually E2US). If these areas do support tidal marsh plants, they should be included in the evaluation. Areas within a marsh system that do not support **persistent** tidal marsh vegetation, such as pannes and tidal creeks, should be included in the evaluation (see Figure 3). These features are an important component of habitat diversity within the system. Pannes, which are often mapped as E1UB, can usually be identified because they are completely surrounded by marsh vegetation (E2EM).

The inventory and evaluation should also include wetlands that have become degraded because the free flow of tidal waters has been altered by artificial obstructions, allowing invasive plants (e.g., purple loosestrife or common reed) to dominate. These plants may also dominate at the upper reaches of tidal marsh systems that do not have artificial restrictions. Areas immediately inland of coastal wetlands frequently include wetlands that were once tidal but have since transformed to non-tidal freshwater wetlands due to the construction of tide gates, dams, roads, dredge spoils, inadequate culverts, or dikes. Sections 4 and 5 will help you evaluate the restoration potential of these areas.

Finally, a word of caution. Wetlands are sometimes incorrectly classified on the NWI maps. Any mapping errors noted during the field inventory should be corrected on the wetland base map. The user of this manual may add or subtract wetlands that appear on the marsh system maps based on their own familiarity with the tidal marshes in the study area. The NWI maps are based on aerial photos from the mid-1980s and do not always reflect the present condition of the tidal marsh. Also, the small scale of the aerial photos and varying tide levels affect the accuracy of the NWI maps. When a survey of the study area has been completed the NWI map should show the current status of each of the wetlands included in the inventory.

An initial field survey of the study area is recommended. The survey will enable you to become more familiar with the maps and aerial photographs you will be using and help you prepare a more accurate base map.

Identifying and Mapping Marsh Systems

After completing your initial field survey, you will need to prepare two sets of maps for the inventory and evaluation process. First you will need a composite NWI map for the entire coastal zone of the town at the original map scale (1:24,000 or 1 in. = 2,000 ft.). See Appendix J for an explanation of map scales. All of the towns' coastal marsh systems should be delineated and labeled on this map. Second, you will need a set of enlarged NWI base maps, prepared at a scale of 1 in. = 1,000 ft. (1:12,000), that will be used for evaluation of each marsh system. We recommend you prepare a separate enlarged map for each marsh system.

Town-wide Composite NWI Map

Mapping, field work, and analysis will be much easier if you prepare a composite NWI map for the entire coastal zone of your town. For some towns, more than one NWI map may be needed to show the entire coastal zone. To prepare a coastal zone map for the entire town, simply cut the NWI maps at the edge and tape together with clear plastic tape. This map will give you an overall perspective on the town's coastal zone and can be used to separate the town's tidal marshes into different marsh systems.

Marsh System Identification

All the tidal marshes on the composite NWI map should then be delineated into separate *marsh systems* for further analysis. A sample map with marsh systems delineated is shown in Appendix F.

For back-barrier marshes, all marshes associated with a single beach outlet should be considered as a single system. For large, complex marsh systems with large tributaries (such as the marsh systems associated with the Scarborough River), each major tributary could be used to define a separate marsh system. Headlands can be used as boundaries between marsh systems.

Fringe marshes along larger tidal rivers that are separated by open water (see definition) and/or uplands should be considered separate systems. Isolated finger marshes along smaller tidal creeks should be evaluated as a single system.

Because NWI maps can be difficult to read, coloring the tidal marsh units shown on the NWI map with a highlighting marker or colored pencil will make the marsh systems easier to identify. Make a photocopy of the town-wide composite map and save the original. On the copy, draw a boundary line around each marsh system. This boundary line should be placed one half mile from the marsh. If two marsh systems are less than one mile apart, use one half the distance for the **Zone of Influence**, or separate the two based on watershed boundaries (see Sample map in Appendix F). Determine the distance of the one half mile boundary based on the map scale you are using (about 1.3in. on a 1in. = 2,000 ft. map). Identify each marsh system with a name, number or letter on the map.

Base Map Preparation

An enlarged **base map** should be prepared for each marsh system to be analyzed. Although ultimately it would be desirable to evaluate all marsh systems in a town, you may want to start with a study area that only includes the largest, most heavily used, or potentially threatened systems.

NWI maps are produced at a scale of 1 in. = 2,000 ft or 1:24,000, the same scale as a USGS topographic quad sheet. The maps should be enlarged to a scale of 1 in. = 1,000 ft.(1:12,000). Recording information on the maps will be easier at this scale. In addition, town maps developed for comprehensive planning and aerial photographs are frequently available at 1 in. = 1,000 ft. Having all maps at the same scale will greatly facilitate base map preparation.

NWI maps can be enlarged by three methods:

1. The simplest and least expensive is to enlarge sections of the map using a photocopier and 11 x 17 in. paper. Copy the map scale at the bottom of the map and paste it near the area you wish to enlarge. Use the percent enlargement function of the photocopier, until 1 in. on a ruler covers 1,000 ft. on the map scale. With most copiers the enlargement can be done in one or two steps. See Appendix J for details on enlarging maps.
2. You can pay to have the map enlarged by a professional copy center.

3. The most accurate but also possibly the most costly method is to have the map reproduced from a Geographical Information System (GIS) database. Some towns have GIS capability, and may already have the NWI map data. NWI maps are on the state GIS system (Appendix A) and may also be available from regional planning commissions, councils of government, or other sources.

The U.S. Fish and Wildlife Service in Falmouth (Appendix A) has NWI maps for many coastal towns in its GIS system. The USFWS is interested in sharing information on tidal marshes with users of this manual and may be able to assist your efforts by providing mapped wetland information. Users may also obtain NWI maps free of charge via the Internet. The address is www.nwi.fws.gov. Maps can be directly downloaded to an Arc/Info system.

Have several map copies made for use in the field and by various members of the inventory team. Always keep one clean original in the event that more copies must be made.

Base Map Overlay

Pencil marks are difficult to erase from some papers and ink is almost impossible to remove. The best solution is to record information on a clear mylar overlay placed over the base map. Both pencil and ink can be erased from mylar if necessary. When using mylar be sure to buy pencils with film lead (regular pencil will smudge). If you prefer ink, Pilot SCA-UF and Staedtler Lumicolor fine point pens are easy to use, non-technical pens. Mylar and good pens are available at larger office supply stores or stores that sell engineering and drafting supplies.

Fasten the overlay to the top of the enlarged base map with clear tape. Just tape the upper edge so the mylar can be lifted when necessary. Make an “X” near each corner of the base map. With a permanent marker, trace over the “X” on the mylar overlay so that they can be easily re-aligned if they become separated. Also, mark reference points that are easy to find on the mylar overlay such as road crossings, bridges, or shorelines for subsequent alignment of aerial photo overlays.

Aerial Photos

Aerial photos can be helpful sources of information about coastal wetlands and surrounding land uses. They are excellent references while working in the field and can be used to refine boundaries of wetlands shown on NWI maps. Aerial photographs are available for all coastal towns, although the date, scale, and quality of the photos may vary considerably. Photos at a scale of 1 in. = 1,000 ft. that correspond with the base map scale are preferable. Town assessors frequently have photos taken for tax map purposes. If photos are not available in your town office, check with one of the sources listed in Appendix A. If 1 in. = 1,000 ft. photos are not available, it will be necessary to enlarge or reduce the base map to correspond with the photo scale.

Aerial photos are available in stereo pairs that show three-dimensional relief and extra detail when viewed with a stereoscope (inexpensive models are available for about $25.00 from a forestry supply catalog). This is a great tool for the optically inclined. However, use of a stereoscope is not necessary for this manual. Single (non-stereo) photos will provide all the information required.

Other Tools

A compass (the kind with a pencil and pivot point for drawing circles), dividers (like a compass with two metal points) or an engineer's scale can be used to measure distances on a map or photo. The most basic method is to cut out a photocopied graphic scale from the NWI map (enlarged to the correct scale) and use this to measure distances on the enlarged map (see Appendix J).

Completing the Base Map Overlay

Identify Evaluation Units

As discussed in Section 2, the fragmentation of marshes and restriction of tidal flow can have a serious negative impact on the ecological integrity of the entire marsh system. In order to better understand the effects of fragmentation on the ecological integrity of the marsh system, each portion of the marsh affected by potential tidal restrictions will be analyzed separately (Section 4, Assessment 1).

Trace the tidal marsh boundaries on the mylar overlay. Then, following the example shown in Figure 4, divide the marsh system into evaluation units based on tidal restrictions. Evaluation units are most easily determined from aerial photos. Place the photos under the mylar overlay and tape in place with drafting tape when properly aligned.

Evaluation units (EU) include tidal marsh, pannes, creeks or mud flats located within the marsh system. Do not include adjacent uplands or water bodies. Trace all roads and railroad crossings, dikes, or other restrictions within the marsh system. Each restriction that crosses the marsh forms an evaluation unit boundary. Number each evaluation unit beginning at the tidal source and continue upland.

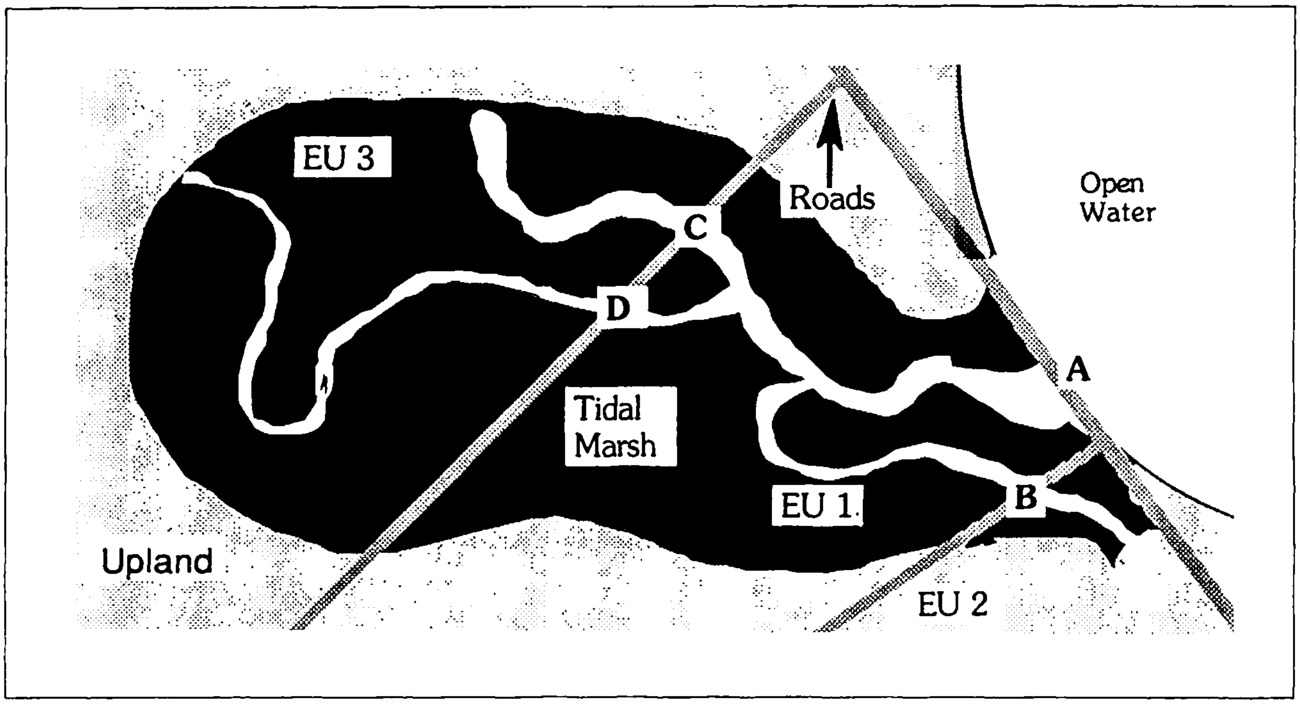

Figure 4. Delineation of Evaluation Units

Although the maps and photos will give you a good start, it is possible that you will need to modify evaluation unit boundaries after conducting the field evaluation.

Measure the Evaluation Unit Areas

Appendix E provides a description of methods that may be used to determine the acreage of the evaluation unit. The area of the evaluation unit should include any pannes, creeks, and other types of habitat that are within the evaluation unit, but not the area in the surrounding Zone of Influence. Record the area of each evaluation unit on the Marsh System Summary Data Sheet (Appendix D, page D-14).

Zone of Influence & Shoreland Zone

Each base map should include the area within one half mile (2.6 inches on a 1 in. = 1,000 ft. base map) of the marsh boundary shown on the underlying base map. Land use in this Zone of Influence affects the condition of the marsh through, for example, disturbance of wildlife and water quality effects. In addition, the Shoreland Zone, that area within 250 feet of the marsh boundary (¼ inch on a 1 in.=1,000 ft. base map) should also be marked. Use the dividers or engineer's scale to mark the ½ mile

Zone of Influence and 250 foot Shoreland Zone. Questions in Section 4 will focus on land use features in the Zone of Influence such as forests, fields, and developed areas that can be identified on the aerial photos.

Location of each tidal restriction

The location of the tidal restrictions and the cause of the restriction in an Evaluation Unit, such as roads or railroads etc., should be identified on the base map. This information will be needed in the tidal marsh evaluation (Section 4) as well as in beginning plans for a restoration project (Section 5). Identify likely restrictions from the aerial photos and modify the map as necessary during the field evaluation.

Location of any fill placed on the marsh surface

Using the aerial photographs and information gathered during the field evaluation, plot the size and location of the area of **fill** as accurately as possible on the base map.

Location of ditches

Ditches can often be identified on aerial photos as thin, straight, dark lines extending from tidal creeks. Trace ditches on the overlay and modify as necessary during the field evaluation.

Location of educational sites, viewing sites, and public boat launches

Mark on the base map the location of each site that currently is or could be used for educational purposes or for viewing the marsh. Also indicate the location of public boat launches, boardwalks, trails, or visitor centers. This information should initially be determined from information on maps and photos, and supplemented by the field evaluation.

The enlarged (1 in. = 1,000 ft.) NWI maps together with the aerial photos can provide most of the information for that portion of the functional assessment that does not require field observation. Additional information, may also be available or more easily interpreted from other maps. For example, the DeLorme *Maine Atlas and Gazetteer* shows public boat launches, while areas where shellfishing is restricted due to pollution are usually shown on maps at town offices. A list of sources of additional information useful for completing the base map overlay can be found in Appendix A. The field evaluation can be used to confirm and refine base map information.

Work on the base maps should be done before beginning the evaluation in Section 4. However, during the process of evaluating the marsh system, the user will be directed to plot additional information on the base map overlay. An example of a base map overlay is provided in Appendix F.

Section 4

TIDAL MARSH EVALUATION

SECTION 4. TIDAL MARSH EVALUATION

Overview

This section will help you evaluate human impacts within and adjacent to the marsh system, the biological potential of the marsh to support wildlife and shellfish, and important social values of marshes, such as recreation, scenic character, and outdoor education. These functions and values affect many people on a daily basis, but they also can be dramatically affected by land use within and adjacent to the marsh. The information gathered during the evaluation will provide a sound basis for land use decisions such as marsh restoration, access for recreation and education, and protection of water quality and habitat values.

The *Maine Citizens Tidal Marsh Guide* uses seven assessments to evaluate the overall health of a marsh as well as the functions and values of tidal marshes that are important to local communities. The seven assessments described in Section 4 are:

Assessment 1	**Ecological Integrity of the Marsh System:** The ecological impacts of human activity within the marsh system.
Assessment 2	**Ecological Integrity of the Zone of Influence:** The ecological impacts of human activity within the Zone of Influence surrounding the marsh system.
Assessment 3	**Wildlife, Finfish, and Shellfish Habitat:** The suitability of the marsh as habitat for those animals typically associated with tidal marshes and the upland border.
Assessment 4	**Recreational and Commercial Potential:** Boating, hunting and wildlife observation are among the recreational activities that may take place in or adjacent to tidal marshes. Recreational and commercial shellfishing may be important activities in creeks and tidal flats associated with marshes.
Assessment 5	**Aesthetic Quality:** The visual and aesthetic quality of the marsh.
Assessment 6	**Educational Potential:** The suitability of the marsh as an outdoor classroom.
Assessment 7	**Noteworthiness:** Those attributes that are not identified in the previous functions, but that may be locally, regionally or nationally significant.

The Assessment Process

The following pages provide the framework for evaluating tidal marsh systems. Each assessment is prefaced by a short introduction describing its significance in tidal marshes. This is followed by a series of predictor questions. Each question has a set of directions (instructions on how to answer the question); evaluation criteria (descriptive categories and scores ranging from 0.1 to 1.0); and a rationale (reasons why the question is being asked). This structure will assist you in understanding the fundamental concepts underlying each question.

After each question has been answered, an Average Functional Integrity (AFI) is calculated for the assessment. The AFI is a relative value, and can be used to compare marsh systems within your community. Because the impact of tidal restrictions on Ecological Integrity may vary significantly from one evaluation unit to another, for Assessment 1, an AFI will be calculated for each evaluation unit *and* for the entire marsh system. All other assessments look at the entire marsh system and *not* individual evaluation units.

The questions in each assessment are divided into those that require you to be at the study site to answer the question, and those that may not require a site visit. It is important that users of the *Maine Citizens Tidal Marsh Guide* spend time in the tidal marshes in their community learning about the plant and animal communities present. This personal knowledge will be helpful when trying to understand the present condition of the marshes and the effects of human disturbance on these systems.

Data sheets found in Appendix D should be used when recording the results of the evaluation. At the top of each data sheet is a list of materials needed to complete the questions for each function or value. The sheets are divided into four columns:

- **Column A - Evaluation Questions**: Repeats the question as stated in Section 4.
- **Column B - Data and Notes**: Provides space for data and notes and should be used to include items of interest in the marsh as they apply to the question and any calculations that are needed to complete the question. This information can prove very valuable for future reference.

- **Column C - Evaluation Criteria**: Repeats the Criteria from Section 4.

- **Column D - Functional Index (FI)**: Each criterion in Column C is assigned a FI of 0.1, 0.5, or 1.0 to rate the criteria for each question. When none of the categories seems to clearly define the situation in the marsh system, the user may interpret the situation and give a score of 0.3 or 0.75 if it seems that the correct answer is somewhere in between the described categories.

When all of the questions in a function or value have been completed, the scores received for each question should be totaled, divided by the number of questions in the function or value, and rounded off to two decimal places. The resulting number is called the **Average Functional Index** (AFI) and should be recorded in the space provided at the bottom of the data sheet. The AFI is an indicator of the relative health, productivity, or value of the marsh system, and can be used to identify marshes in your town that can most benefit from restoration or protection.

For many questions in the following section there is no right or wrong answer. Don't worry; just use your best judgment. Because the AFI is a relative value, what is important is that you are consistent when evaluating different wetlands in the study area. If you are consistent, wetlands can be more easily prioritized for restoration and conservation based on their relative scores. Taking notes in the field and photographs can't be emphasized enough. This information will help you finalize your answers and allow others to understand your decisions.

Examples of completed data sheets are included in Appendix G.

Several questions ask for a percentage of the area in a given condition. These may be calculated mathematically or estimated from the charts in Appendix K.

ASSESSMENT 1 - Ecological Integrity of the Marsh System

The impacts of tidal restrictions and other human activities on marsh systems were described in Section 2. Assessment 1 evaluates the ecological integrity within the marsh system by looking at the impacts of tidal restrictions, fill, and ditching on individual evaluation units. Marsh systems that have a high Average Functional Index (AFI) for ecological integrity have most likely undergone little alteration or degradation. A low AFI for ecological integrity indicates a marsh system that has suffered a high degree of degradation.

Pages 2 and 3 of the Assessment 1 data form expand on Questions 1.2, 1.3, 1.4, and 1.5. The additional data and observations recorded on these pages will be helpful later when determining the restoration potential of each evaluation unit. It will be helpful to bring your camera along when visiting a marsh and take pictures that illustrate the problems you are documenting.

First calculate the Assessment 1 AFI for each evaluation unit. Then an overall AFI will be calculated for the entire marsh system.

Questions that may require field observation.

Question 1.1: Number of tidal restrictions.

Directions -Count the number of tidal restrictions between the evaluation unit (EU) and unrestricted tidal flow by the shortest route (see Figure 5). In the example shown in Figure 5, EU 1 has one tidal restriction. From Point A in EU 2 tidal waters may flow in either direction to reach unrestricted tidal flow. To place this EU in proper criterion, the shortest route would follow the arrow and have two man-made tidal restrictions. EU 3 has 3 tidal restrictions. Bridges on pilings over major tidal rivers are not generally restrictive, unless they are associated with a fill approach over a marsh, or have abutments that constrict flow.

a.	no tidal restrictions	1.0
b.	one tidal restriction between EU and free tidal flow	0.5
c.	more than one tidal restriction between the EU and free tidal flow	0.1

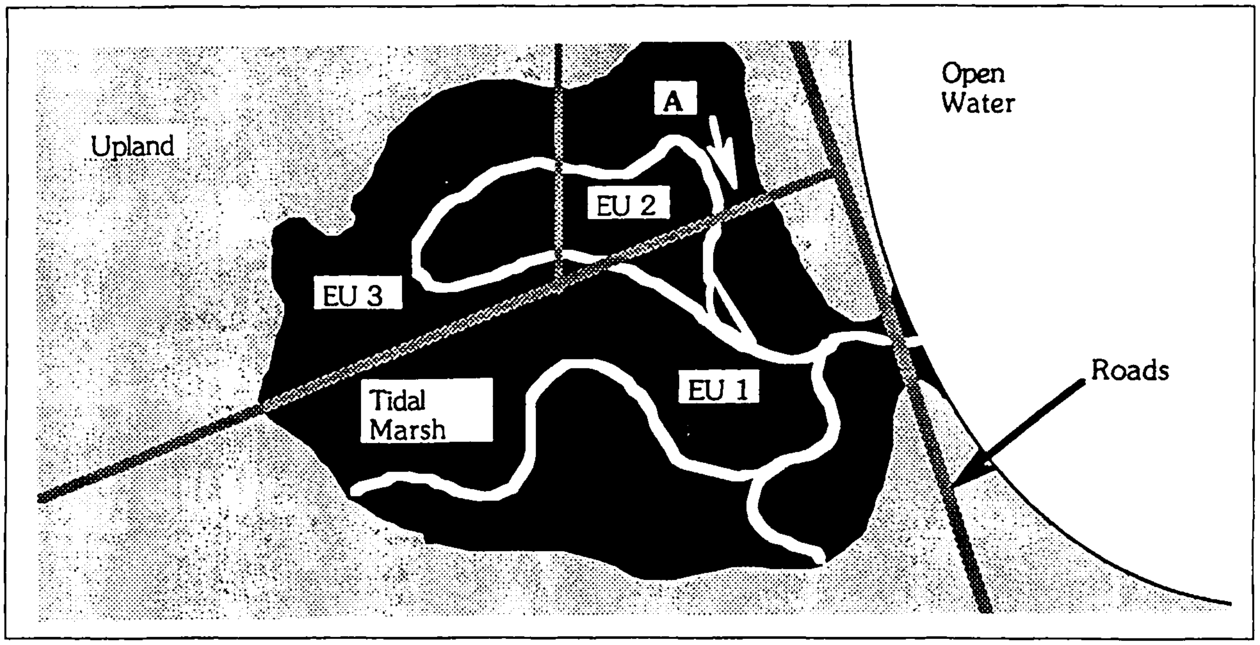

Figure 5. Counting Tidal Restrictions

Rationale - The restriction of seawater to, and the detention of the freshwater in the marsh can cause changes in the salinity which in turn may affect the natural plant and animal communities of the marsh. The fragmentation of the system by the construction of roads or other types of impoundments and restrictions may influence all functions and values of the marsh. The present condition of the evaluation unit may be caused by the cumulative impact of two or more sequential restrictions of tidal flow. Examples of tidal restrictions are shown in Appendix I.

Question 1.2: Type of tidal restriction.

Directions - Identify all the tidal restrictions between the evaluation unit and unrestricted tidal waters by the shortest route (see Figure 4). Determine which restriction is the most severe and apply the following criteria. Be sure to consider all tidal restrictions affecting flow into or across the evaluation unit.

Some culverts are adequately sized and do not cause severe tidal restrictions. If possible, check the marsh during one of the twice-monthly **spring high tides**. If the depth of flooding over the high marsh above the restriction is similar to that below, enter a 0.5 instead of 0.1 for this question.

Another common problem is the "hanging culvert." If a culvert is placed above the low water level at low tide the lower evaluation unit will be fully drained while the upper is still flooded. In this case, a reasonably accurate estimate of the restriction can be evaluated by dividing the tidal range above the culvert by that of an unrestricted portion of the marsh and use the number as the answer to this question.

Record all observations of all tidal restrictions on Page 2 of the Assessment 1 data form.

a.	Headland to headland bridge or no restriction	1.0
b.	Free flow over marsh surface obstructed by road but bridge or culverts not restricting flow through tidal creek	0.5
c.	Tidal gate, culvert, road or bridge on the marsh surface that significantly restricts tidal flow through creeks and channels	0.1

Rationale - There are many types of structures that can influence the free flow of tides, ranging from jetties to culverts and tide gates. The type of tidal restriction may significantly affect the extent of degradation in a marsh system. The presence and type of flow restriction may also cause freshwater flooding in the marsh system during springtime runoff or major rainstorms.

Bridges and culverts in the marsh can be of two different types. The restriction with the least effect on a marsh is a structure spanning a tidal creek from headland to headland. The other type is a road across the surface of the marsh with bridges or culverts over tidal creeks. The construction of the road across the marsh fragments the marsh and can create impoundments that prevent the free flow of tidal waters across the surface of the marsh during spring high tides. Thus, even if the bridge is properly sized for the creek it spans, the amount of tidal water reaching the far side of the road may be limited by the presence of the road. Culverts may be adequately sized or undersized (see Directions). Undersized culverts and tide gates are the most restrictive and are often associated with severe degradation in evaluation units because of the limited amount of tidal flow that reaches the far side of the restriction.

Question 1.3: Fill on Marsh Surface.

Directions - Determine from aerial photos and site visit the area of fill on the marsh surface. Roads that form a boundary between two evaluation units are considered fill on the landward of the two evaluation units. Sketch the fill area on the base map overlay and record your observations on Page 2 of the Assessment 1 data form.

a.	< 5% of EU filled	1.0
b.	5% - 15 % filled	0.5
c.	> 15% filled	0.1

Rationale - Fill on the marsh surface results in a direct loss in marsh area and ecological function. In addition, fill is a source of marsh system fragmentation and often becomes a vector for **invasive species**, such as purple loosestrife or common reed, to enter the marsh.

Question 1.4: Ditching on the surface of the Evaluation Unit.

Directions - Determine from the aerial photos or a site visit the extent of impact caused by man-made ditches. Large pannes or water on the marsh surface adjacent to the ditches are possible indicators of degradation. Most ditches were dug years ago and may be obscured by vegetation. Look for long, straight lines on the aerial photographs and then field check them. Shade in possibly degraded areas on base map overlay and record your observations on Page 3 of the Assessment 1 data form.

Interpretation of this question requires judgment because the relative impact of ditching cannot be precisely estimated. There is no right or wrong answer. It may be easier to view this as a high / medium / low impact question. If there are no ditches, enter a 1.0. If there are ditches but no or few signs of degradation, enter a 0.5. If there are many ditches and much apparent degradation, enter a 0.1. As indicated previously, consistency in answering this question for each evaluation unit and for other marsh systems is more important than your actual answer. If you answer "b" or "c," note on Page 3 of the data form the information that led to your decision.

a. no ditching within the EU	1.0
b. ditches affect 0 - 20% of EU	0.5
c. ditches affect more than 20% of EU	0.1

Rationale - Many of the larger marshes in Maine were ditched either for agricultural purposes or in an attempt to help in the control of salt marsh mosquitoes. The effects of the ditching on the integrity of a marsh are not fully understood, but it is clear that they alter **marsh hydrology** by allowing high marsh to drain more quickly following "spring" tides. Many times the spoils from the ditching were left on the surface of the marsh next to the ditch, creating a berm that traps water on the high marsh and leads to degradation of the marsh peat. Berms may also provide habitat for invasive plants. A grid pattern of ditches and the associated spoils is more likely to have a negative impact on the marsh system by trapping both tidal waters and freshwater drainage from the surrounding upland on the marsh surface, which may lead to the dieback of natural tidal marsh plant communities, degradation of the marsh peat and changes in water and soil chemistry.

Question 1.5: Alteration of the natural marsh plant community.

Directions - Sketch and label areas where restricted tidal flow, ditching, or fill has altered the natural plant community, and estimate the size of the altered area within each evaluation unit. Invasive plants may include common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*), or other freshwater or upland species that do not naturally occur in tidal marsh communities. If brackish species such as narrow-leaved cattail (*Typha angustifolia*) or slough grass (*Spartina pectinata*) appear to be dominating a marsh due to restrictions to tidal flow that are causing decreased salinity, they should be considered to be invasive for the purposes of this question.

Interpretation of this question will require some judgment. In areas with a strong freshwater influence of natural origin, such as marshes along the Kennebec River near Bath or those in the Presumpscot River estuary, brackish marshes dominated by narrow-leaved cattail are normal. In most riverine marsh systems (finger marshes and fringe marshes) there will be a transition from pure salt marsh species to brackish and fresh marsh species as one travels inland. In many tidal marshes influenced by water of higher salinity (typically *Spartina*-dominated salt marshes) narrow-leaved cattail is commonly found at the upland edge where groundwater or small streams drain into the marsh. It will be necessary to familiarize oneself with the local vegetation patterns and the extent of natural freshwater influence before determining if some species, especially narrow-leaved cattail, are "invasive" in any particular marsh.

Comparing the vegetation in the evaluation units you are studying with one that has no tidal restriction or ditching will provide clues as to the influence of tidal restrictions. A good method is to look at the marsh plants on either side of a restriction. For example, an abundance of narrow-leaved cattail or common reed in the evaluation unit on the landward side of a restriction as compared to an evaluation unit on the seaward side probably indicates that adequate saltwater is not reaching the landward side. In this case, these species should be considered "invasive."

Record information about invasive species and your rationale for calling brackish species such as narrow-leaved cattail "invasive" on Page 3 of the Assessment 1 data form.

a.	less than 5% of EU dominated by invasive species	1.0
b.	5% - 20% of EU dominated by invasive species	0.5
c.	more than 20% of EU dominated by invasive species	0.1

Rationale - Invasive plant species and dominance of brackish species can be good indicators of the impacts to a marsh system caused by changes in **drainage patterns** associated with road construction, excessive development in the upland, fragmentation of the marsh system, restriction of tidal flow, drainage of the marsh through ditching, or placement of fill.

Ecological Integrity of the Marsh System: Summary Table

The information gathered on tidal marsh restrictions, ditching, and fill will be used to determine the restoration potential of individual evaluation units. Because the entire marsh functions as a system, however, it is helpful to look at the cumulative impact of alterations to each evaluation unit on the functions and values of the entire marsh system. To do this, a Marsh System AFI, based on the AFI of each evaluation unit, is calculated in the Assessment 1 Summary Table as shown in Figure 6. The Assessment 1 Summary Table is located on the Marsh System Summary Data Sheet (Appendix D, page D-14).

The AFI for each evaluation unit is calculated by averaging the results of Questions 1.1 to 1.5 of Assessment 1 (see sample data sheets in Appendix G). Record the AFI for each evaluation unit on Line 1. Record the area in acres of each evaluation unit on Line 2. Record the total of the marsh acreage on Line 3. For Line 4, multiply Line 1 by Line 2 and divide by Line 3 for each evaluation unit. The marsh system AFI (Line 5), or the weighted average functional index for the marsh system, is the sum of Line 4.

ASSESSMENT 1 SUMMARY TABLE

	EU 1	EU 2	EU 3	EU 4	EU 5	EU 6	EU 7	EU 8
1. AFI of Evaluation Unit (from Assessment 1 data)	0.21	0.80	0.65	0.40				
2. Acres in Evaluation Unit	65	30	80	5				
3. Total Acreage of Marsh System (Sum of Line 2): 180								
4. $\frac{\text{AFI of EU x Acres in EU}}{\text{Total Acres of Marsh}}$	0.08	0.13	0.29	0.01				
5. Marsh System AFI for Assessment 1 = Sum of Line 4 = 0.51								

Figure 6. Calculating the Marsh System AFI for Assessment 1

ASSESSMENT 2 - Ecological Integrity of the Zone of Influence

The extent of development surrounding a tidal marsh can affect wildlife habitat, water quality, recreational potential, aesthetics, and commercial use of the marsh. Assessment 2 evaluates the extent of development and human activity on lands that surround the marsh system.

Reminder: For the remaining questions, *the entire marsh system*, not each evaluation unit, will be evaluated as a whole.

Questions that may require field observation.

For Assessment 2, lay the base map overlay over the aerial photos. Usually all questions can be answered using the photos but a field visit may help, especially with Question 2.3. A magnifying glass may help interpret these questions, especially Question 2.2.

Question 2.1: Dominant land use in the ½-mile Zone of Influence surrounding the marsh system.

Directions - Using aerial photos, estimate the dominant land use based on the current use of the land surrounding the marsh system. The dominant land use refers to the use which occupies the largest percentage of the Zone of Influence.

a.	forests, fields, dune/beach, freshwater wetlands, open water, or similar open space	1.0
b.	agriculture or rural residential (average lot size greater than two acres)	0.5
c.	commercial, industrial, high density residential or heavily used highways	0.1

Rationale - The *Maine Citizens Tidal Marsh Guide* assumes that marshes in areas which have low intensity use, such as forestry or open space, are least likely to be affected by development. In highly developed areas, polluted urban runoff can travel a great distance before entering a marsh system. Although not accounting for all sources of pollution in the marsh system, the land within ½-mile of the marsh system provides a qualitative indicator of potential pollution and surrounding habitat quality. High levels of human activity in the Zone of Influence may also be a detrimental disturbance factor for marsh wildlife.

Question 2.2: Ratio of the number of buildings within the marsh system, and/or within the 250 foot Shoreland Zone, to the total area of the marsh system.

Directions - Count the number of buildings in the marsh system and/or within 250-feet of the marsh system edge. Use the marsh system acreage as previously determined on the base map (see Ecological Integrity of the Marsh System Summary Table, line 3). Express the number of buildings as a ratio to the area of the marsh system. If a structure falls half in and half out of the 250-foot Shoreland Zone it should be counted as being in.

$$\frac{\text{\# of Buildings}}{\text{Total Acres of Marsh System}} = \text{Buildings Per Acre}$$

a. less than 0.1 building per acre	1.0
b. from 0.1 to 0.5 buildings per acre	0.5
c. more than 0.5 buildings per acre	0.1

Rationale - Buildings are an indicator of the human impact on the marsh system. These impacts can include increased runoff, nutrient loading from malfunctioning septic systems and use of fertilizers and increased activity in and around the marsh system. In addition, human activity associated with buildings can disturb marsh wildlife. The 250 foot distance was selected to coincide with Maine's Shoreland Zoning laws.

Question 2.3: Percent of the marsh system boundary that has a buffer of woodland or idle land at least 250 feet in width.

Directions - Using the base map, measure the total length of the marsh system/upland boundary. Then measure the length of this boundary that has a 250 foot **buffer zone** of woodland or idle land. The 250 foot buffer zone will coincide with the shoreland zone as mapped. Do not include those areas bordered by agricultural lands.

The curved lines of the marsh boundary and Zone of Influence are simple to measure with the correct tools. The most basic method is to wrap a piece of fine string (dental floss works well) around the marsh perimeter and then measure the length of the string with an engineer's scale or the enlarged graphic scale on the base map. A map measuring wheel, available from forestry suppliers, can also be used.

Express the length of the buffer as a percentage of the total length of the marsh system/upland boundary.

$$\frac{\text{Length of 250 foot wide woodland and idle land buffer}}{\text{Length of boundary between marsh system and upland}} \text{ X } 100 = \text{Percent Buffered}$$

a. more than 70% woodland/idle land buffer	1.0
b. from 30% to 70% woodland/idle land buffer	0.5
c. less than 30% woodland/idle land buffer	0.1

Rationale - A buffer zone (an area of uncut vegetation providing wildlife cover, and helping to control erosion and maintain water quality) increases the ecological integrity of a marsh system in several important ways. It provides habitat for upland animals, which may use a tidal marsh during parts of their life cycle, and habitat for water-dependent wildlife species that require upland habitat for parts of their life cycle. A buffer also filters noise and screens human activity that can disturb wildlife. The vegetation in an undisturbed buffer zone acts as a filter to absorb some of the contaminants from residential, agricultural or commercial development before they can enter the marsh system. During severe storm events the buffer zone can provide refuge for marsh animals to escape high winds and flooding. These undisturbed areas may also slowly evolve into tidal marsh as sea level rises. Agricultural land is not counted as a buffer zone because the application of fertilizers and pesticides can be harmful to the marsh ecosystem.

ASSESSMENT 3 - Wildlife, Finfish & Shellfish Habitat

Tidal wetlands in Maine are used by a variety of terrestrial and avian species for feeding, breeding, cover, resting on long migration flights, and wintering. Many marine animals spend a portion of their lives in the marsh, or depend on resident marsh species for food. Certain environments in marsh channels and creeks provide habitat for the numerous species of shellfish and finfish.

Questions that may not require field observation.

Question 3.1: Acreage of the marsh system.

Directions - Use the total acreage of the marsh system (see Assessment 1 Summary Table).

a.	greater than 100 acres	1.0
b.	between 10 and 100 acres	0.5
c.	less than 10 acres	0.1

Rationale - The size of the marsh system is one of the most important factors in determining the diversity and abundance of wildlife living in or using the marsh system. It is generally accepted that the larger the marsh, the greater the species diversity and abundance.

Question 3.2: Ecological Integrity of the marsh system.

Directions - Record the marsh system AFI from Assessment 1 Summary Table, Line 5.

Rationale - The ecological integrity of the marsh system will affect its use by all types of fauna. Areas that have been heavily impacted by human activity are regarded as providing less suitable habitat for wildlife.

Questions that may require field observation.

Use page 2 of the data form to record field observations, including any wildlife seen.

Question 3.3: Diversity of habitat types.

Directions - Count the number of different types of marsh habitats, from those listed below, that occur in the marsh system at low tide (See the Glossary and Appendix B for habitat type definitions). Record your field observations on page 2 of the data form.

1. high marsh
2. low marsh
3. open water
4. tidal flats
5. upland islands
6. pannes
7. freshwater source
8. tidal creek
9. naturally vegetated transition zone at marsh system/upland edge
10. freshwater tidal marsh

a.	8 - 10 types present	1.0
b.	4 - 7 types present	0.5
c.	less than 4 types present	0.1

Rationale - A higher diversity of the available habitats will increase both richness and diversity of the wildlife population.

Question 3.4: Presence of submerged (aquatic bed) vegetation.

Directions - On the aerial photos, locate up to three of the largest pannes or ponds in the marsh system. Field check these sites in July or August at low tide and estimate the percent cover of submerged vegetation such as widgeon grass (*Ruppia maritima*). Tidal creeks should be evaluated for the presence of eelgrass (*Zostera marina*). For tidal creeks, only evaluate the area that is not exposed at *low tide*. An "ocular estimate" (best guess based on area observed; see Appendix K) is adequate.

Record observations on page 2 of the data form. If the evaluation is conducted at a time of year that this question cannot be answered, eliminate it and only use those questions answered to determine the AFI.

a.	submerged vegetation covers more than 25% of submerged habitat	1.0
b.	submerged vegetation 5 - 25% of submerged habitat	0.5
c.	submerged vegetation covers less than 5% of submerged habitat	0.1

Rationale - The presence of this vegetation adds to the diversity of the plant communities and provides habitat and food for various animals such as black ducks. Eelgrass beds serve as important nursery areas for many fish and marine invertebrate species.

Question 3.5: Percent of the marsh system edge bordered by a buffer of woodland, idle land or agricultural land at least 250 feet in width.

Directions - Use the measurement of the total length of the marsh system/upland border from Question 2.3. Then measure the length of this border which has a 250 foot buffer zone of dune/beach, woodland, agricultural land, and idle land. (This question is identical to Question 2.3, except that here agricultural land is also included in the buffer. To answer this question, simply add the length of agricultural border to the numerator of the equation in Question 2.3.) Express the length of the buffer as a percentage of the total length of the marsh system/upland border.

$$\frac{\text{Length of 250 ft. wide undeveloped and agricultural land}}{\text{Total length of marsh system boundary}} \text{ X } 100 = \text{\% Undeveloped Buffer}$$

a.	more than 70% undeveloped buffer	1.0
b.	from 30% to 70% undeveloped buffer	0.5
c.	less than 30% undeveloped buffer	0.1

Rationale - A buffer zone (an uncut area of vegetation providing wildlife cover) increases the wildlife habitat potential of a marsh in several important ways. In addition to providing habitat for upland animals that may use the marsh for feeding, a buffer zone provides habitat for water dependent wildlife species that require upland habitat for parts of their life cycle. Agricultural land is included in this question because these areas can provide foraging areas for wildlife which might not use woodlands. A relatively undisturbed buffer zone decreases the amount of human impact within the marsh, and during severe storm events it may act as a refuge for marsh animals to escape high winds and flooding.

*Question 3.6: **Proximity to perennial stream or freshwater wetlands.***

Directions - Determine from NWI maps and site visits if the marsh system is connected to a perennial stream, or if there are any freshwater wetlands within a quarter mile.

a.	marsh system connected to a perennial stream or freshwater wetland	1.0
b.	marsh system not connected to a perennial stream but within a quarter mile of a freshwater wetland	0.5
c.	marsh system not connected to a perennial stream and not within a quarter mile of a freshwater wetland	0.1

Rationale - Marsh systems connected to perennial streams have the potential to provide a linkage to spawning habitat for migratory fish. Marsh systems that are connected to other wetlands by a perennial water course allow the free movement of aquatic species and may provide corridors for the movement of avian and terrestrial species. Other freshwater wetlands that are in close proximity to the marsh system but not hydrologically connected also offer a more diverse habitat for wildlife.

ASSESSMENT 4 - Recreational and Commercial Potential

Tidal marshes are important areas for recreation along the Maine coastline. The extensive use of these marshes by nesting and migrating birds makes them popular sites for hunting and birdwatching. Some marshes have shellfish beds or flats with marine worms that attract commercial and recreational harvesters. Several marsh systems in the state are located in state or federal areas that are managed for recreation and may have visitor centers, trails and boardwalks. The presence of these facilities enhance the recreational potential of a marsh and improve public access.

Boating takes place in some of the larger marshes. While some of the larger rivers and creeks within or adjacent to these systems can handle power boats, the wakes, noise and water pollution from motorized watercraft can affect the wildlife and other qualities that enhance the recreation potential. Non-motorized boating is a less disturbing way to enjoy tidal marshes.

Questions that may require field observation.

Question 4.1: Presence of shellfish beds.

Directions - Determine from state and local officials if there are shellfish beds large enough to allow for commercial or recreational harvest within or immediately adjacent to the marsh system and if these beds are presently closed due to poor water quality.

a.	shellfish beds present and all are open for harvest	1.0
b.	shellfish beds present but some currently closed for harvest	0.5
c.	no shellfish beds present or all currently closed	0.1

Rationale - The harvesting of shellfish has long been an important industry on the Maine coast. Recreational harvesting is also an important activity. Today many of the beds are closed because poor water quality contaminates the shellfish, thereby endangering the health of human consumers.

Question 4.2: Presence of marine worms.

Directions - Check with the local shellfish warden or town shellfish committee to determine if tidal flats within the marsh system are used by commercial worm diggers.

a.	marsh system used by worm diggers	1.0
b.	marsh system not used by worm diggers	0.1

Rationale - Marine worms of the genera *Nereis* and *Glycera* often occur in the fine-textured sediments of mud flats near salt marshes. These worms, which are used as bait by recreational fishermen, are among the most valuable marine resources on a per-pound basis.

Question 4.3: Waterfowl hunting.

Directions - Determine if the marsh system is accessible for hunting by land or boat, and whether it is currently being used for that purpose. The Maine Warden Service and local hunters may know if an area is presently used for hunting.

a.	marsh system accessible and currently used by hunters	1.0
b.	marsh system accessible but not presently used	0.5
c.	marsh system not easily accessible or hunting not permitted	0.1

Rationale - Hunting is a popular sport in Maine and many of the tidal marshes are used for waterfowl hunting. The presence of dwellings and the ease of access can influence the use of the marsh for hunting.

Question 4.4: Opportunities for wildlife observation.

Directions - Record the AFI from Assessment 3 -Wildlife, Finfish, Shellfish Habitat.

Rationale - Non-consumptive recreation, which includes observation, photography, etc., is the most popular form of wildlife-related recreation. The marshes that rank higher for the Wildlife Habitat Function are more likely to be potential sites for wildlife observation.

Question 4.5: Canoe, kayak, or other non-motorized boat passage in or adjacent to the marsh system.

Directions - Determine the suitability of tidal rivers and creeks within the marsh system or water adjacent to the marsh system for canoeing and other forms of non-motorized boating. In some cases, water levels may only be adequate during high tide.

a.	watercourses within marsh system at least 10 feet wide and 3 feet deep at high tide and free of obstructions to canoeing and non-motorized boating, or marsh system adjacent to a canoeable waterway	1.0
b.	watercourses within marsh system contain some exposed obstructions and/or shallow areas which may hinder the use of canoes or non-motorized boats, **and** marsh system not adjacent to canoeable waterway	0.5
c.	watercourses too small and shallow or non-existent, watercourses contain obstructions which prohibit the use of canoes and non-motorized boats **and** marsh system is not adjacent to canoeable waterway	0.1

Rationale - Some marsh systems are large enough to have rivers or creeks within them which can support use by canoes and other non-motorized boats. Some marsh systems are adjacent to open waters such as the major tidal rivers or and bays. Both allow for the enjoyment of the aesthetic beauty and the wildlife of the marsh.

Question 4.6: Canoe and boat access.

Note: If the marsh system received a 0.1 in Question 4.5, do not answer Question 4.6. When calculating the AFI, divide only by the number of questions answered.

Directions - Determine the distance from the closest public canoe or boat launch to the marsh system.

a.	access point within a half mile of marsh system by non-motorized boat	1.0
b.	access point between a half mile and a mile from marsh system by non-motorized boat	0.5
c.	no access or access point more than one mile from marsh system by non-motorized boat	0.1

Rationale - The presence of a boat launch near the marsh system may determine the marsh system's availability as a boating site. Most public boat ramps and launching points are shown in the DeLorme *Maine Atlas and Gazetteer*, although there may be other points from which a canoe could be launched.

Question 4.7: Off-road public parking at or near the potential recreation site.

Directions - Determine if there is a suitable parking area at the marsh system edge. Adequate parking requires an open area with a firm soil or gravel base. For safety on heavily traveled roads, the parking area should be located on the same side of the road as the marsh system and should have an unobstructed view of oncoming traffic at the point of entrance and exit.

a.	marsh system is within 10-minute walk of suitable parking	1.0
b.	suitable parking more than 10-minute walk but less than 20 minute walk from the marsh system	0.5
c.	parking is not available within 20-minute walk of the marsh system	0.1

Rationale - Parking near the marsh system is necessary to allow access for many types of recreation.

Question 4.8: Access for disabled persons.

Directions - Determine whether the upland border of the marsh system is accessible to the disabled, e.g. trails designed for wheelchair accessibility, special disabled parking areas, or access via existing roads or trails.

a.	specially constructed disabled access	1.0
b.	access via existing roads and trails	0.5
c.	no disabled access	0.1

Rationale - The recreation potential of the marsh is increased if it is accessible to both disabled and non-disabled persons alike.

Question 4.9: Presence of visitors center, maintained trails or boardwalks.

Directions - Determine if the marsh system is associated with a visitors center or has trails and/or boardwalks that provide non-destructive access to the marsh.

a.	visitors center and maintained trails and/or boardwalks present	1.0
b.	maintained trails and/or boardwalks present but no visitors center	0.5
c.	neither a visitors center nor maintained trails and/or boardwalks present	0.1

Rationale - The presence of a visitors center or properly designed and maintained trails and boardwalks that do not adversely impact tidal marsh functions can enhance the recreational opportunity by providing activities and easy access to the marsh system.

ASSESSMENT 5 - Aesthetic Quality

The open spaces of tidal marshes are highly valued for their aesthetic quality and contrast with the forests which dominate much of the Maine landscape. Marshes that are surrounded by fields, upland forests or freshwater wetlands appear more attractive than those systems which have urban development within the marsh or adjacent to the marsh edge. Tidal marsh vistas add diversity to the transition of open waters and tidal flats to upland forests and fields, affording the viewer an opportunity to enjoy a vista that is uncommon within the state.

Before answering the questions for this value, visit the marsh system and determine if there are one or more viewing sites. Most marshes are viewed from public roads, but other important viewing points might be located along rivers or bays, from a canoe, from a nature trail, or from an overlook. Because some marsh systems are large and can be viewed from several locations it is important to note on the base map which viewing locations are being evaluated. The Average Functional Index can be based on an average of several viewing locations or the marsh system can be rated on one outstanding location.

Questions that may not require field observation.

Question 5.1: Ecological Integrity of the marsh system.

Directions - Record the Marsh System AFI from Assessment 1 - Ecological Integrity of the Marsh System.

Rationale - The ecological integrity of the marsh system will give some indication of the impacts that transportation, residential, and commercial development have had on the marsh. These types of development affect the aesthetic quality of the marsh system.

Question 5.2: Opportunities for wildlife observation.

Directions - Record the AFI from Assessment 3 - Wildlife, Finfish, Shellfish Habitat.

Rationale - Vistas that include wildlife enhance the aesthetic quality of the marsh system. The Average Functional Index received for Assessment 3 will indicate the potential for wildlife observation.

Questions that may require field observation.

Question 5.3: Dominant visible land use surrounding the marsh system from primary viewing location(s).

Directions - Determine the dominant land use visible in the Zone of Influence from the primary viewing location(s). Mark viewing locations on base map overlay.

a.	woodland, agricultural land, or similar open space	1.0
b.	rural residential use (such as 2 acre lots)	0.5
c.	commercial, industrial, transportation use or high density residential use (such as quarter acre lots) dominates the visible area	0.1

Rationale - The *Maine Citizens Tidal Marsh Guide* assumes that the most appealing views of tidal marshes include other areas of natural beauty such as upland forests or other open space.

Question 5.4: General appearance of the marsh system from the primary viewing location(s).

Directions - Judge the visual quality of the marsh system from the primary roads that offer veiws, or if there is access, views can be assessed from a boat on the water. Use the following criteria:

a.	undisturbed and natural with no visual detractors present (such as litter)	1.0
b.	limited disturbance in the marsh system; minor visual detractors present	0.5
c.	severe detractors present	0.1

Rationale - The aesthetic quality of the marsh system lies in the natural beauty of its open space and tidal marsh plant community. Trash and other signs of disturbance detract from this beauty.

Question 5.5: Noise level at the primary viewing location(s).

Directions - In most cases, it will be sufficient to judge the sound level after a period of careful listening at a time at which visitors would be present. It may be necessary to visit several sites in the study area to determine what constitutes low, medium, or high noise levels in a town.

a.	low: birds, wildlife, wind, surf and other natural sounds predominate	1.0
b.	moderate: some traffic, airplane or other noise audible	0.5
c.	loud: continuous traffic, industrial or other noise	0.1

Rationale - Subjective impressions of noise levels vary from person to person, but it is assumed that continual noise such as that from a busy highway detracts significantly from the aesthetic appreciation of marshes. Noise can be particularly distracting when listening for bird songs and other wildlife sounds.

Question 5.6: Odors present at the primary viewing location(s).

Directions - Attempt to identify odors present at viewing locations. This may require becoming familiar with the sometimes unpleasant natural odors of tidal marshes.

a.	natural odors only (some natural odors may be unpleasant)	1.0
b.	unnatural odors present at certain times (such as auto exhaust or a sewage treatment plant)	0.5
c.	unnatural odors distinct, more or less continuous, and noticeably unpleasant	0.1

Rationale - Unnatural odors, such as auto exhaust and factory emissions, are assumed to reduce aesthetic quality of tidal marshes.

ASSESSMENT 6 - Educational Potential

Tidal marshes can be important outdoor classrooms for teaching ecological principles, and the impact of coastal development is easily illustrated by comparing a healthy tidal marsh community to a marsh community that has been degraded. The ease of access, safety, and the diversity of habitat types influence the educational potential of the marsh system.

Determine the location of sites which are appropriate for educational purposes and mark them on the base map. A marsh system may have one or more educational sites.

Questions that may not require field observation.

Question 6.1: Opportunity for wildlife observation.

Directions - Record the AFI from Assessment 3.

Rationale - The educational potential of a site is enhanced by high value wildlife habitat.

Question 6.2: Presence of visitors center, maintained trails or boardwalks.

Directions - Record the FI from Question 4.9.

Rationale - Management for public use or wildlife can increase the educational opportunities associated with a marsh system. Visitor centers, kiosks, and well marked trials provide interpretation and visual access to tidal marsh communities.

Questions that may require field observation.

Question 6.3: Diversity of tidal habitats at potential educational site.

Directions - Record FI from Question 3.3.

Rationale - The presence of other natural habitats increases the educational value of the marsh by allowing students to compare and contrast different habitat types.

Question 6.4: Off-road parking at potential educational site for school buses or other vehicles (carpools, vans etc.).

Directions - Determine if there is an area large enough for parking and turning a school bus or a small number of cars associated with a carpool.

a.	potential educational site within 10-minute walk of suitable parking	1.0
b.	suitable parking more than 10-minute walk but less than 20 minutes from the potential educational site	0.5
c.	parking not available within 20-minute walk of potential educational site	0.1

Rationale - Parking within easy walking distance of the potential educational site increases its value as an education site.

*Question 6.5: **Student safety.***

Directions - Examine the potential education site for possible hazards, such as busy roads, railroad trestles, etc.

a. no known safety hazards (such as busy roads, steep embankments, railroad trestles, etc.)	1.0
b. safety hazard present but easily avoidable	0.5
c. safety hazards present and not easily avoidable	0.1

Rationale - A safety hazard is an obvious drawback to a potential educational site.

*Question 6.6: **Access for disabled persons at potential education site.***

Note: While disabled access was assessed in Recreation Potential (Assessment 4), the education site may or may not have disabled access.

Directions - Determine whether the education site is accessible to the disabled (i.e., the site has trails designed for wheelchair accessibility special disabled parking areas, or access via existing roads or trails).

a. specially constructed disable access	1.0
b. access via existing roads and trails	0.5
c. no handicap access	0.1

Rationale - The education potential of the marsh is increased if it is accessible to both disabled and non-disabled persons alike.

ASSESSMENT 7 - Noteworthiness

Noteworthiness refers to physical, biological or social features that may entitle the marsh system to be considered especially significant. This may include the presence of a rare or endangered plant or animal species, a site of historical significance, or the designation of the site as an exemplary natural community. If the AFI for this function is greater than 0.1 the marsh system should be considered significant. The more significant features present, the higher the AFI.

Questions that may not require field observation.

Question 7.1: Marsh system is habitat for a state- or federally-listed threatened or endangered species.

Directions - Determine if the marsh system is used by any threatened or endangered plant or animal species. This information may be obtained from the Maine Natural Areas Program (MNAP) (state-listed plants), the Maine Department of Inland Fisheries and Wildlife (state-listed animals), and the US Fish and Wildlife Service (federally-listed species only).

a. marsh system is currently habitat for threatened or endangered species	1.0
b. marsh system is not currently habitat for threatened or endangered species	0.1

Rationale - Marsh systems that provide habitat for threatened or endangered species may be necessary for the survival of those species. Marsh systems that are currently used by these species should be considered for protection to help ensure their survival.

Question 7.2: Marsh system has significance because it has biological, geological or other features which are locally rare or unique, or it contains an exemplary community.

Directions - Determine if the MNAP database has records of biological or geological features of significance within the marsh system. This could be a unique plant community, the presence of plant and animal species of concern that are not on the threatened or endangered species list, or noteworthy geological features. Local knowledge may be used to supplement MNAP records.

a.	marsh system contains feature(s) of significance	1.0
b.	marsh system does not contain feature of significance	0.1

Rationale - It is possible that the marsh system has an attribute which in itself makes the marsh valuable, but was not identified by the functional assessment. These locally rare or unique factors can be highlighted in this question.

Question 7.3: Marsh system is known to contain an important historical or archaeological site.

Directions - Consult state and local historic resources or inquire through Maine Historic Preservation Commission (MHPC) to determine if the marsh system has any sites of significance. Photographs or visits to the marsh system may reveal evidence of historical use.

a.	marsh system is a known site of historical or archaeological significance	1.0
b.	no known evidence of historical or archaeological significance	0.1

Rationale - Coastal marshes have been used by humans as a source of food for consumption and fodder for livestock for a very long time. Some marshes still have remnants of the **staddles** used to store salt hay until such time as the marsh was flooded or frozen to the point that barges or horse drawn wagons could get to the site to haul the hay off. Shellfishing has been an important source of food for centuries (in particular by Native Americans) and evidence of the historical harvest is still visible in certain marshes as **shell middens**.

Questions that may require field observation.

Question 7.4: Tidal marshes in a developed setting.

Directions - Refer to Question 2.1.

a.	FI = 0.1	1.0
b.	FI = 1.0 or 0.5 (dominant land use rural residential, agricultural, forestry or similar open space)	0.1

Rationale - Tidal marshes have the potential to enhance the quality of life in a highly developed environment. Historically, many marshes in developed areas were left undeveloped because of severe site limitations. As a result, those marshes remaining in developed areas may be among the last refuges for wildlife as well as some of the few remaining natural landscapes.

Because of the impact of intense human activity, marshes in highly developed areas may not perform certain functions as well as marshes in undeveloped areas. For this reason, these marshes tend to rank low in the *Maine Citizens Tidal Marsh Guide* on several assessments including Ecological Integrity, Wildlife Habitat, and Aesthetic Potential. This should not be interpreted to mean that urban marshes have little value. These marshes may have considerable value when considered in the context of the surrounding urban land.

Tidal marshes in developed settings are often marred by dumping of trash and litter. However, when evaluating an urban marsh, take into account how easily the visual detractors can be removed. A somewhat degraded marsh can be the target of a neighborhood cleanup campaign, for instance.

Question 7.5: Marsh system used as long-term research site.

Directions - Check with local colleges, universities and research labs to determine if the marsh system is used as a site for long-term research.

a.	marsh system is a site for long-term research	1.0
b.	marsh system is not a site for long-term research	0.1

Rationale - Data that has been collected over a number of years at a single site provides scientists with valuable information about changes in our environment.

Marsh System Summary Data Sheet

A Marsh System Summary Data Sheet is included on Page D-14 of Appendix D. This sheet includes the Assessment 1 Summary Table and a table to list the AFI for each assessment, and to record other key information about the marsh system.

Section 5

HOW TO START A RESTORATION PROJECT

SECTION 5. HOW TO START A RESTORATION PROJECT

Now that you have evaluated the coastal wetlands in your town for their ecological integrity and have an understanding of how that ecosystem has been negatively altered, you can compare the restoration potential for each marsh system and choose areas that would benefit from a restoration project. Getting a restoration project off the ground may seem daunting, but there are resources available to help you. This section will give you an overview of the process and includes:

- Selecting a marsh system for restoration
- The role of the town in developing a restoration project
- Technical assistance and funding for a specific plan of action
- Permits needed

The circumstances and process of restoring a marsh will be unique for each project. In general, restoration works best if a plan is developed from the bottom up by working with local landowners and government first. The next step is to develop a partnership with local, state, and federal cooperators that will develop a specific plan and get approval for a project.

Selecting a Site for Restoration

Assessment 1, Ecological Integrity of the Marsh System, provides a comparative analysis of cumulative human-caused impacts to marsh systems and narrative description of the restoration potential within each evaluation unit. Low AFI scores for Assessment 1 may indicate that a marsh system or evaluation unit has suffered a high degree of degradation making it a possible candidate for restoration. Compare the Assessment 1 AFIs of the various evaluation units you studied and select evaluation units with the lowest scores for consideration. Next, review the Narrative Description of Restoration Potential that you completed for these wetlands. In selecting a specific site, keep in mind patterns of ownership, area affected and potential benefits of restoration. Because professional expertise is necessary to design and implement a restoration project, consider requesting guidance from the state and/or federal agencies listed below. Your narrative descriptions and AFI calculations will be readily understood and appreciated by them.

The Role of Municipalities in Developing Restoration Projects

You will need to work closely with town officials and landowners in the area to create a restoration plan and address local concerns early in the process. During the first visit with town officials (conservation commission, town manager, selectmen, councilors), your photographs of the area and narrative descriptions will give them a sense of the benefits and scope of a potential project. This is a good time to find out if there are any local concerns that could prevent a project from going forward, such as increased risk of flooding to adjacent landowners or strong opposition to the change from the local residents. It is better to address any opposition and educate at the local level first, since it is unlikely that technical assistance or funding will be available without that support.

If there are no major problems from adjacent landowners and town government, you are ready to create a specific restoration plan. Keep in mind that each town may have specific requests for permitting the project. Some towns may request that abutting landowners be notified about the restoration project or even that landowners give permission prior to any project going forward. Other towns may request approval from the planning board or conservation commission.

Creating a Restoration Plan: Sources of Technical Assistance and Funding

The costs and benefits of a restoration project can be an important factor in determining whether or not funding or technical assistance is available from outside sources. Projects that restore a relatively large section of marsh for minimal cost may be favored over more expensive projects. Developing a specific plan may be relatively simple or multifaceted and complex. Although this manual can help you identify areas with restoration potential, it does not provide the tools to create a restoration plan. This is the time to call in expert advice.

Several people in the state have experience in coastal marsh restoration and can advise you or work directly on the project. Make a point of asking your regional biologist from the Department of Inland Fisheries and Wildlife (DIFW) for a field visit. Often, they have firsthand knowledge of the area and can help devise a specific plan. In addition, your regional biologist may ultimately need to approve the project when you apply for a permit from the Department of Environmental Protection (DEP).

If you live between New Hampshire and the Kennebec River contact:

Phil Bozenhard
Maine Department of Inland Fisheries and Wildlife
Region A
328 Shaker Road
Gray, ME 04039 (207) 657-3258

If you live between the Kennebec and Penobscot rivers contact:

Gene Dumont
Maine Department of Inland Fisheries and Wildlife
Region B
RFD 1, Box 6378
Waterville, ME 04901 (207) 547-4165

From the Penobscot River north to New Brunswick contact:

Thomas Schaeffer
Maine Department of Inland Fisheries and Wildlife
Region C
68 Water Street
Machias, ME 04654 (207) 255-4715

You can also get technical assistance from federal wildlife biologists or scientists. In addition to providing wetlands information and fish and wildlife data, they can help you work out a specific restoration plan, provide assistance with the federal agencies responsible for permits and guide you to federal funds that may be available. Funding for restoration projects will vary greatly. The more complex the project, the more technical and financial support it will need. For additional assistance on developing a restoration plan or identifying sources of funding write or call:

Stewart Fefer
U.S. Fish and Wildlife Service - Gulf of Maine Project
4R Fundy Road
Falmouth, ME 04105 (207) 781-8364

Ron Joseph
U.S. Fish and Wildlife Service
Partners for Wildlife
1033 So. Main St.
Old Town, ME 04473 (207) 827-5938

Michelle Dionne
Wells National Estuarine Research Reserve
324 Laudholm Farm Rd.
Wells, ME 04090 (207) 646-1555

Bob Wengrzynek
U.S. Department of Agriculture
Natural Resources Conservation Service
5 Godfrey Drive
Orono, ME 04469 (207) 866-7249

Jackie Sartoris
Maine Coastal Program
State Planning Office
State House Station #38
Augusta, ME 04333-0038 (207) 287-1494

Biologists at the U.S. Fish and Wildlife Service will help devise a specific restoration plan and offer knowledge of federal funding opportunities for wetland restoration. The Natural Resources Conservation Service has funding for restoration projects, and coastal wetlands are their top priority. As of 1996, they will pay 75 - 100% of the cost of a restoration project. In addition, the Natural Resources Conservation Service has experienced engineers that will develop cost estimates for a restoration project, and it will also help select contractors with experience in this type of work. The Maine Coastal Program may help identify additional state sources of funding and give technical assistance on your restoration plan.

A consultant or other wetland professional who might be contacted for assistance may live in or near the study area. For a statewide list of wetland professionals contact:

Maine Association of Wetland Scientists
P.O. Box 202
Yarmouth, ME 04096

As you start to put together a specific plan of action, you may be able to have a portion of the project paid for by municipalities or state officials responsible for maintaining a road. They may be willing to replace a culvert that is restricting flow to a section of marsh during regularly scheduled road work. Such creative solutions may not require additional permits if no other changes are proposed for the road or its embankment. Always verify that a permit is not needed with the Department of Environmental Protection (DEP) and the U.S. Army Corps of Engineers (see below).

Applying for Permits

Once you have addressed local concerns, have worked with regional and federal biologists to create a specific restoration plan, and have located potential sources of funding, you are ready to apply for the permits you need for the project. All the people you have worked with to develop a restoration plan can assist you in the application procedure. The extent of their involvement will depend on the scope of the project.

The State Permit

The Department of Environmental Protection (DEP) requires a permit for all activities conducted in coastal marshes. It is helpful to meet with a project analyst at DEP to find out what to include in the permit before you submit an application. The permit may be considered under the simpler "Permit by Rule" statute or as a more complex "Individual Permit," depending on the type and extent of the restoration project that is proposed. If an individual permit is required, it will be sent to the Department of Inland Fisheries and Wildlife (DIFW) for review. If you have worked with the regional biologist already, this should be a simple formality. To schedule a meeting with the DEP before submitting an application contact:

Doug Burdick
Maine Department of Environmental Protection
312 Canco Rd
Portland, ME 04103 (207) 774-7708

The Federal Permit

Current policy in Maine requires all activities proposed within tidal marshes to have an individual permit from the U.S. Army Corps of Engineers (ACE). It is important to meet with officials from ACE *before* you submit an application to find out exactly what format they would like you to use and what types of materials to include. ACE permit applications are reviewed by biologists at the U.S. Fish and Wildlife Service. Therefore, working with Fish and Wildlife Service personnel prior to contacting the ACE will help the permit process. To learn about permit applications and set up an informational meeting contact:

Jay Clement
U.S. Army Corps of Engineers
RR 2, Box 1855
Manchester, ME 04351 (207) 623-8367

Your restoration plan and selection of contractors will be part of any process of applying for state and federal permits. Once permits are in hand, actual restoration can begin.

Section 6

IMPROVING EDUCATIONAL AND RECREATIONAL OPPORTUNITIES

SECTION 6. IMPROVING EDUCATIONAL AND RECREATIONAL OPPORTUNITIES

Local Considerations, Technical Assistance and Permits

Before embarking on any project to improve educational sites or recreational opportunities, you should follow a process identical to the one described in Section 5 for restoration projects. You must consider ownership and access to the marsh, as well as the concerns of local residents. The state and federal agencies listed in Section 5 should be contacted. These agencies may be able to provide technical assistance and funding for the project. Because construction in or adjacent to tidal marshes may require both state and federal permits, you should also contact both the Maine Department of Environmental Protection and the U.S. Army Corps of Engineers (see Section 5).

Educational Opportunities

Tidal marshes provide fascinating outdoor classrooms for many coastal communities. School trips to a nearby marsh can add depth and local flavor to a science curriculum, and nature trails can provide valuable information to residents and visitors alike. Having one marsh system identified for educational use may be enough and will help protect other systems in the area from excessive use. However, the opportunity to compare different types of marsh systems (e.g., finger marshes vs. back-barrier marshes or degraded marshes vs. relatively pristine marshes) is an important consideration.

Choosing an Educational Marsh System

When choosing a marsh system for educational use several factors should be considered. First, rank the marsh systems in the study area by their Educational Potential AFI (Assessment 6). The system with the highest AFI may be the best choice for an educational site. If access problems or other factors limit the educational potential of all marsh systems in the study area, it may be possible to enhance the educational opportunities of a marsh with high Ecological Integrity (Assessments 1 and 2) and Wildlife, Finfish, Shellfish Habitat (Assessment 3) values. Selection based on these assessments will allow the public to view a less disturbed marsh system with greater numbers of native species. Marsh systems with a high Noteworthiness value (Assessment 7) should also be considered as an educational site because of their unique physical, biological, or societal features. If the reason for a high value is due to the presence of a threatened or endangered species, check with the groups listed in Question 7.1, to ensure that development of an educational site will not harm the species present.

Be aware of falling into the trap of thinking that the highest value marsh is always the best one for educational purposes. Adding public use to a pristine marsh may decrease the value of the marsh itself. (Don't love it to death!) Where to locate educational facilities depends on educational objectives and the ability to site facilities in a way that promotes effective stewardship of the marsh and its resources. Working with state and federal wetland cooperators will help you maximize educational potential while minimizing wetland impacts.

Improving Educational Sites

After selecting a marsh system for educational use, several areas for improvement can be looked at. First is student safety (Question 6.5). Second is off-road parking for buses or other vehicles (Question 6.4). Third is access to the educational site for for disabled persons(Question 6.6). Last is the presence of a visitors center, maintained trails or boardwalks (Question 6.2). Each of these areas can be improved on the municipal level and make a large difference in the effectiveness of the educational site.

Improvement in student safety can be accomplished in many ways. Creating crosswalks, reduced speed zones, or relocating parking areas can help improve safety. Creating adequate parking for buses can be a challenge but greatly enhances a site's educational value. There are some common sense principles to keep in mind when planning for parking. If possible, place the parking on the same side of the road as the access to the marsh to keep road crossing by people to a minimum. Keep the distance between the parking area and the marsh educational site within a ten minute walk to accommodate people of varying ages and abilities. Parking and access for the disabled at the educational site will greatly enhance the experience and value of the site, and may be required by law. Solutions to all safety problems should be found before the site is used.

If you plan to create a hiking trail, consult with state and federal fish and wildlife agencies to minimize impacts to the marsh system. The prepared base map can be used to help guide its placement. Boardwalks should be used instead of foot trails to decrease the impact on the marsh if it is economically feasible to do so. Boardwalks, since they are not affected by tidal changes, will also provide more flexibility of trail location. The primary trail could provide the visitor with views of healthy marsh with a smaller portion showing areas that have been degraded if possible. This type of comparison will provide a cause and effect example that increases the learning potential. While not necessary, a centrally located visitors center will enhance the learning experience for visitors and provide a viewing area.

Recreational Opportunities

The most important consideration in selecting a marsh for recreation is the type of activities that will be available at the marsh. Look back at Recreational and Commercial Potential (Assessment 4). Marsh systems in your town having a high Recreational and Commercial AFI should be selected as general recreational sites. If none of the marsh systems in the area had a high AFI, then proceed to select a system based on Aesthetic Quality (Assessment 5) and Wildlife, Finfish, and Shellfish Habitat (Assessment 3). Having access, or the potential to develop areas, is critical for recreational use. Developing a hand-carry launch site for canoes and other small craft is an excellent method to enhance recreational potential.

If your town experiences high recreational use it may be more effective to select more than one system for improvement. Dispersing recreational use enhances the experience for a visitor and helps protect the marsh from overuse.

Having smaller specialized recreational sites will help to prevent overcrowding at one general site, and enable your town to track recreational activities and the number of people participating in those activities. If hunting is allowed in your town, it may be necessary to evaluate the amount of hunting activity and the potential for conflicts with other uses.

Improving Recreational Marsh systems

It is usually undesirable to try to enhance all recreational values in a single marsh unless the system is extremely large. Different recreational values may conflict with one another or may be poorly suited to the marsh. For example, size of the marsh and depth of the tidal creek will determine whether or not motorized watercraft can travel through a marsh without causing erosion. Some small marshes may not be accessible by boat at all, but a perimeter footpath may be a valuable recreational resource. Recreational and commercial shellfishing may also be helped by seeding a mud/sand flat.

Consider modest improvements such as a roadside pull-off for two cars next to the marsh. Hiking trails should be ecologically sensitive. Improvements for boat passage should be made only when a man-made obstruction makes it impossible or unsafe to maneuver around, since many of the natural obstructions enhance aquatic habitat. When considering improving access for motor boats, remember that many marshes can be degraded by this activity unless the channel depth is adequate. Also, motor boat use can conflict with non-motorized boating in the confined waters of a tidal marsh system. "No-wake" zones and limited parking should be encouraged to minimize impacts on the banks of marsh channels.

Preventing Marsh System Degradation from Educational and Recreational Use

While recreational and educational use will benefit local residents and visitors, excessive use may be a concern. Limiting parking and the type of boat access will help prevent overuse. In general, boat launches should be designed to accommodate canoes, kayaks, and small skiffs. Access for larger boats should be provided on large rivers and bays and not within tidal marsh systems. Trails should be designed to prevent disturbance to wildlife and compaction of the marsh surface. Signs at access points can be used to educate the public about the value and sensitivity of marsh systems. Sign-in sheets may be helpful to monitor use. Teaming with a qualified wetland scientist and wildlife biologist is suggested.

Section 7

REMEMBER THE UPLANDS

SECTION 7. REMEMBER THE UPLANDS

Protection and management of tidal marshes should include the uplands. As we saw in evaluating the Ecological Integrity of the Zone of Influence (Assessment 2), land use adjacent to a marsh and within its watershed has an effect on the water quality, wildlife habitat, recreational and commercial potential, and aesthetics of the marsh system. Decisions a town makes in granting development permits, comprehensive planning, and zoning shorelands are critical to the health of the tidal marshes.

The inventory and evaluation information gathered in Sections 3 and 4 of this manual can be incorporated into the planning process. The town should also consult the Maine Department of Inland Fisheries and Wildlife, the Maine Department of Marine Resources, and the Coastal Program of the State Planning Office when making land use plans that will affect land adjacent to tidal marshes. *The Estuary Book* (Maine State Planning Office, 1991) is an excellent source of information on coastal planning.

When a general land use plan has been formulated for the area, specific regulatory measures will help protect marsh systems. Maine's Shoreland Zoning law is an important tool to control land use within 250 feet of a marsh. Zoning can be used to minimize the impact of development near areas with high wildlife, finfish, and shellfish value (as identified by Assessment 3). Just because a marsh scores low for a number of values does not mean that it does not warrant protection however. Restoration could enhance a marsh's ecological integrity, and hence value for wildlife. The Maine Department of Inland Fisheries and Wildlife has rated wildlife values for most coastal wetlands, and the U.S. Fish and Wildlife Service may have additional data. Gathering information on wetland values will support the case for proposed zoning changes.

Other planning decisions affect marsh functions and values. One of the most important ways to protect a marsh is to protect water quality within the watershed of the marsh. Any **point sources** of pollution, such as sewage discharges, should be identified and eliminated. Malfunctioning or non-existent septic systems have resulted in the closure of many clam flats throughout Maine. These failures should be identified by the town's code enforcement officer and corrected.

Towns should also identify ways to control **non-point sources** of pollution. Runoff from streets, parking lots, farms and other developed areas is a major source of pollution that affects coastal water quality. For example, runoff from non-point sources can carry enough bacteria to cause clam flat closures. Control of runoff through stormwater control and the use of **best management practices** should always be used in new construction, and potential remediation of existing sources should also be considered. The Maine State Planning Office Coastal Program and the Maine Department of Environmental Protection can provide assistance with both point and non-point source pollution control and protection.

Careful land use planning should be an ongoing part of marsh system management that will require coordination between the town's planning board, code enforcement officers, conservation commission and shellfish committee. Additional sources of information to help with the planning process are included in Section 9.

Section 8

GLOSSARY OF TECHNICAL TERMS

SECTION 8. GLOSSARY OF TECHNICAL TERMS

This glossary provides non-technical definitions of technical terms, some of which are used in this manual. This is by no means an exhaustive list of all the terminology pertaining to tidal marshes. For more detailed reference to tidal marsh terminology, see the references listed in Section 9 of this manual.

accretion	the gradual build up of surface elevations due to the deposition of suspended sediments on the marsh surface
avian	relating to birds
back-barrier marsh	a marsh that forms in the low-lying area behind a barrier beach formation
barrier beach	an elongated landform created by the deposition of sedimentary materials by wind and wave currents, usually parallel to the shoreline, with water on at least two sides, and composed of sand, gravel, or cobblestones
best management practice	design or construction standards that are recommended to minimize the impact of development on the environment
brackish marsh	tidal marshes where the average water salinity is less than 18 parts per thousand (ppt) but greater than 0.5 ppt which is the upper limit of salinity in a freshwater tidal wetland
buffer zone	an undeveloped area bordering on a wetland that serves to lessen the impact of disturbance (e.g., urban development)
degraded	characterized by loss of natural ecological structure or function
drainage pattern	the paths followed by surface runoff from precipitation within a watershed
ecological integrity	the natural (undisturbed) quality of an ecosystem
ecosystem	a community of plants and animals and the physical environment they inhabit (such as estuaries and tidal wetlands) which results from the interactions among soil, climate, vegetation, and animal life
emergent plant	erect, rooted, herbaceous plants that can tolerate flooded soil conditions, but not prolonged periods of being completely submerged, these include grasses, sedges, rushes, and rooted aquatic plants; emergent plants are classified as persistent and non-persistent
estuary	habitats partially enclosed by land but having an opening to the ocean where saltwater from the ocean mixes with freshwater from inland rivers and surface runoff
exemplary community	an area selected by the Maine Natural Heritage Program as being an outstanding example of the natural plant and animals found in a particular ecosystem

fill	material, usually associated with the dredging of a harbor or inlet, placed on the surface of the marsh; the change in elevation caused by the disposal of this material in the marsh can lead to the loss of the area as a functioning tidal marsh
formerly tidal wetlands	coastal wetlands that were once connected to tidal flow but have since been isolated from tidal waters by the construction of a man-made obstruction
freshwater source	the point of origin of nontidal waters including rivers, streams and surface runoff
freshwater tidal marshes	marshes that are tidally influenced, but where the average water salinity is less than 0.5 parts per thousand
habitat	the environment in which the requirements of a specific plant or animal are met
high marsh	areas of tidal marshes that are irregularly flooded (frequently beyond the reach of daily flooding) and are typically dominated by salt meadow grass (*Spartina patens*)
hydrology	the scientific study of the properties, circulation, and distribution of water as it occurs in the atmosphere and at the earth's surface as streamflow, precipitation, soil moisture, and ground water
intertidal emergent	an erect rooted herbaceous plant growing in the intertidal zone
intertidal unconsolidated bottom	wetlands that have at least 25% cover of particles smaller than stones, less than 30% vegetative coverage, and are only intermittently exposed, such as pannes and tidal creeks
intertidal unconsolidated shore	wetlands which have at least 75% coverage of stones, boulders or rocks, less than 30% vegetative coverage, and are alternately flooded and exposed by tides
intertidal zone	areas that are alternately exposed and flooded by tides
invasive species	plant species that, when introduced to an ecosystem, can disturb the natural balance and habitat diversity by invading and dominating the natural tidal marsh plant community, frequently establishing dense monotypical (single species) stands of vegetation
low marsh	areas of marsh that are flooded twice a day and are dominated by saltwater cordgrass (*Spartina alterniflora*)
marine	relating to ocean environments
marsh hydrology	this term includes 1) the hydrologic pathways such as precipitation, surface runoff, ground water, tidal fluctuations and flooding rivers which transport nutrients to and from wetlands; 2) the water depth; and 3) frequency and duration of flooding in tidal marshes
marsh peat	the organic soil formed by the accumulation of dead marsh plant material and trapped sediments from tidal waters
marsh restoration	improvement of existing marsh condition by reversing some of the adverse impacts caused by coastal development

marsh system	an area of marsh associated with a single opening to the ocean, a single freshwater input, or adjacent to and contiguously along the shore of a tidal river or bay
non-point source	a pollution source that does not come from a single point; typical non-point sources include parking lots, roads, and agricultural fields
open water	areas within or adjacent to a marsh that are below mean low water and greater than 100 meters wide (330 feet); this manual uses an arbitrary division of 100 meters to distinguish between open water and tidal creeks
organic matter	a combination of decayed and decaying plant and animal residue
pannes	shallow ponds that form on the surface of the marsh and hold salt water between tides
persistent emergent plants	emergent plants whose stems remain standing through the winter until the beginning of the next growing season (e.g., cattails or bulrushes)
point source	a pollution source that comes from an identifiable point, such as a factory discharge pipe or septic system outlet
riverine	of or pertaining to a river
sea level	the level of the surface of the ocean at its mean (average) position between high and low tide
shell middens	a pile of shells remaining from the harvesting of shellfish by Native Americans and early settlers; shell middens are historic relics
spoils	dredged or excavated soil
spring high tide	tides associated with the full and new moon that are higher and lower than the average tide
staddle	a structure consisting of numerous pilings driven into the marsh on which to stack salt hay to keep it above the tidewaters until it could be hauled off
surface runoff	the movement of water over the land surface (usually in defined channels) resulting from rainfall or snowmelt; the percentage of precipitation that becomes runoff varies depending on the slope of the area, the degree of soil saturation, amount of vegetated coverage, or type of surface (e.g., paved areas)
tidal creeks	streams in the tidal marsh that are less than 100 meters wide at mean low water and whose main source of water is dominated by tidal action
tidal flats	areas that are irregularly exposed and are devoid of emergent vegetation, also called mud flats or unconsolidated bottom
transition zone	area surrounding a wetland where conditions gradually change from wetland biota to upland biota
upland islands	areas of upland soils and vegetation located within a tidal marsh
vegetated tidal marsh	marshes dominated by emergent vegetation and influenced by the tides
water column	the habitat that exists in standing or flowing water extending in a

	column from the surface of the water to the surface of the substrate
watershed	the area from which all water including precipitation, streams and rivers drain to a single point
Zone of Influence	area surrounding a wetland in which the activities that take place have an impact on the wetland; the *Maine Citizens Tidal Marsh Guide* considers a ½-mile Zone of Influence, with particular focus on activities within the 250 foot Shoreland Zone

Section 9

REFERENCES

SECTION 9. REFERENCES

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Recommended Reading/Suggested Field Guides

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Natural Resources Handbook, A Planning Tool for Maine Communities. Prepared for the Maine State Planning Office, by the Maine Association of Conservation Commissions. July 1987.

Watershed: An Action Guide to Improving Maine Waters. Maine State Planning Office, Maine Department of Environmental Protection, and University of Maine Cooperative Extension, Augusta, ME. April 1990.

Appendix A

SUGGESTED SOURCES OF INFORMATION

Information on:	**Available From:**
Aerial Photographs	James W. Sewall Co. Greater Portland Council of Governments Municipal Offices
Archaelogical and Historic Information	Maine Historic Preservation Commission
Endangered and Threatened Wildlife	Maine Department of Inland Fisheries and Wildlife Endangered and Nongame Program U.S. Fish and Wildlife Service Gulf of Maine Project
Exemplary Natural Community and Rare Plant Listings	Maine Natural Areas Program
Municipal Tax and Zoning Maps	Municipal Offices
National Wetland Inventory Maps	Maine Geological Survey Maine Office of GIS (digital information) U.S. Fish and Wildlife Service Gulf of Maine Project 1 (800) USA-MAPS www.nwi.fws.gov
Protected Lands	Local Land Trusts Municipal Offices Maine Coast Heritage Trust Maine Office of GIS
Public Boat Launches	DeLorme *Maine Atlas and Gazetteer*
Restoration	U.S. Fish and Wildlife Service U.S. Army Corps of Engineers Maine Department of Inland Fisheries and Wildlife Maine Department of Environmental Protection
Shellfishing Information	Maine Department of Marine Resources
USGS Topographic Maps	Maine Geological Survey local bookstores and sporting goods stores 1 (800) USA-MAPS
Migratory Birds, Anadromous Fish, and Wetland Wildlife Habitat	U.S. Fish and Wildlife Service Gulf of Maine Project, Maine Department of Inland Fisheries and Wildlife Maine Department of Marine Resources

Contact Addresses

Greater Portland Council of Governments
233 Oxford Street
Portland, ME 04101 (207) 774-9891

Maine Audubon Society
P.O. Box 6009
118 US Route 1
Falmouth, ME 04105 (207) 781-2330

Maine Dept. of Environmental Protection
State House Station #17
Augusta, ME 04333-0017 (207) 287-7688

Maine Dept. of Marine Resources
State House Station #21
Augusta, ME 04333-0021 (207) 287-2291

Maine Office of GIS
State House Station #125
Augusta, ME 04333-0125 (207) 287-6144

Maine Historic Preservation Commission
55 Capital Street
State House Station #65
Augusta, ME 04333 (207) 287-2132

State Planning Office
Maine Coastal Program
State House Station #38
Augusta, ME 04333-0038 (207) 287-3261

U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02254-9149 1 (800) 343-4789
or
RR 2, Box 1855
Manchester, ME 04351 (207) 623-8367

U.S. Department of Agriculture
NRCS
5 Godfrey Drive
Orono, ME 04473

James W. Sewall Co.
P.O. Box 433
147 Center Street
Old Town, ME 04468 (207) 827-4456

Maine Coast Heritage Trust
167 Park Row
Brunswick, ME 04011 (207) 729-7366

Maine Dept. of Inland Fisheries & Wildlife
Endangered and Nongame Wildlife Program
650 State Street
Bangor, ME 04401-5609 (207) 941-4466

Maine Dept. of Transportation
State House Station #16
Augusta, ME 04333-0016 (207) 287-2841

Maine Geological Survey
Dept. of Conservation
State House Station #22
Augusta, ME 04333-0022 (207) 287-2801

Maine Natural Areas Program
Dept. of Conservation
State House Station #93
Augusta, ME 04333-0093 (207) 287-8044

Wells National Estuarine Research Reserve
342 Laudholm Farm Road
Wells, ME 04090 (207) 646-4521

Casco Bay Estuary Project
312 Canco Road
Portland, ME 04103 (207) 879-6300

US Fish and Wildlife Service
Gulf of Maine Project
4R Fundy Road
Falmouth, ME 04105 (207) 781-8364

U.S. Fish and Wildlife Service
1033 So. Maine Street
Old Town, ME 04468 (207) 827-5938

Appendix B

COASTAL WETLAND TYPES

Aquatic Beds: These wetlands form in sub-tidal areas of both marine and estuarine waters. Along the coast, aquatic beds are areas of seaweed that grow below the low tide level. In the estuarine waters of the state the most important aquatic beds are eelgrass (*Zoster marina*) found in protected bays and the major tidal rivers. Eelgrass beds are important as nursery and feeding areas for fish, as feeding areas for geese, ducks and wading birds, and for trapping and accreting suspended sediments in the water column. Within some of the larger tidal marshes along the Maine coast aqautic beds of widgeon grass (*Ruppia maritima*) can add to the diversity of the tidal marshes.

Brackish Marshes: In areas where average salinities range from 0.5 ppt. to 18 ppt., a wide variety of plant communities can grow which represent the transition from salt marsh to freshwater marsh. These marshes can be found along the major tidal rivers and bays and along the smaller freshwater tributaries flowing into salt marshes. Plants that can be found in brackish areas include black grass (*Juncus gerardii*), narrow-leaved cattail (*Typha angustifolia*), and salt marsh bulrush (*Scirpus robustus*).

Cobble, Gravel, and Sand Beaches: These are high-energy coastal wetlands formed by the sorting of sediment material moved by wind and wave energy. The intertidal zone of these wetlands is nearly devoid of visible biota. The higher reaches of these wetlands, where the wave energy only reaches during storm events, may form sand dunes. Maine has few remaining dune fields, but all of these areas are presently protected by law. Dunes support a specialized plant community that is very susceptible to damage during the dune overwash that accompanies large storms.

Freshwater Tidal Marshes: In areas where the tides still affect the flow of waters but where the average salinity is below 0.5 ppt. freshwater tidal marshes can form. Vegetation in these marshes is extremely diverse. In the regularly flooded areas one may find pickerel weed (*Pontederia cordata*) and wild rice (*Zizania aquatica*). In areas that are irregularly flooded sweet flag (*Acorus calamus*) and river bulrush (*Scirpus fluviatillis*) are common. Freshwater tidal marshes are predominantly associated with the Kennebec River above Bath.

Rocky Shores: This type of coastal wetland is very common in northern New England. It can be found in areas where bedrock is exposed by nearly continuous wind and water driven energy. These wetlands can be divided into three zones: the salt spray zone - rarely flooded but influenced by waves; the intertidal zone - regularly flooded and exposed by the tides; and the sub-tidal zone - rarely exposed and underwater most of the time. Plants and animals such as seaweeds, barnacles, and periwinkles can be easily found.

Salt Marshes: These vegetated tidal wetlands, where salinities range from 18 ppt. to 34 ppt. (the latter is that of seawater), are dominated by *Spartina* grasses. In low marsh areas that are flooded twice daily, saltwater cordgrass (*Spartina alterniflora*) forms nearly mono-specific stands that vary in height from a few inches to five feet in height. On the high marsh salt meadow grass (*Spartina patens*) is the dominant plant, but it is usually found in association with numerous other plants that can tolerate high salinity levels (halophytes).

Tidal or Mud Flats: These wetlands are unvegetated, low relief environments particularly common in protected coastal environments. They are of critical importance for the production of numerous invertebrate species which are a food source for many bird and fish species. When flooded, the mud flats are scoured by fish feeding on the worm and mollusk population found in the muddy substrate. As the tide recedes, wading birds feed on the same food source. Mudflats can also be found in the larger tidal marshes providing diverse habitat within the marsh.

Appendix C

U.S. FISH & WILDLIFE SERVICE WETLAND CLASSIFICATION SYSTEM

In 1979 the U.S. Fish & Wildlife Service (USFWS) published a classification of wetlands and deepwater habitats (Cowardin et al., 1979). In this classification scheme, wetlands are defined by hydrology, soils, and vegetation. The USFWS classification scheme serves as the national standard for wetland classification, and has been used to classify wetlands appearing in National Wetlands Inventory (NWI) maps which are used to define marsh systems in the *Maine Citizens Tidal Marsh Guide*.

The wetland and deepwater habitats of the coastal zone are defined in the USFWS classification as follows:

Wetlands: Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water. For the purposes of the classification, wetlands must have one or more of these three attributes: (1) at least periodically, the land must support predominantly hydrophytes (wetland plants); (2) the substrate is predominantly undrained hydric soil; and (3) rocky, gravelly, or sandy areas that are saturated with or covered by shallow water at some time during the growing season.

Deepwater Habitats: Deepwater habitats include permanently flooded areas deeper then 6.6 feet. Shallower permanently flooded areas are often vegetated with emergent plants and are considered wetlands rather than deepwater habitats.

The structure of the classification scheme is hierarchical, with systems forming the highest level of the classification hierarchy. Of the five major systems, three are of interest with regard to tidal waters.

1. **Marine System** - Open ocean overlying the continental shelf including high energy shore line such as beaches and rocky headlands.
2. **Estuarine System** - Deepwater and wetland areas that are usually semi-enclosed with an opening to the ocean and in which there is some mixing of fresh and sea water.
3. **Riverine System** - Freshwater rivers and their tributaries along with most associated wetlands.

Marine and Estuarine systems are divided into two sub-systems:

1. **Sub-tidal** - Areas that are continuously submerged.
2. **Intertidal** - Areas that are alternately flooded and exposed.

Riverine systems are divided into four sub-systems, only one of which is relevant to the *Maine Citizens Tidal Marsh Guide*:

1. **Tidal** - the movement of the water is influenced by the tides but water salinity is less than 0.5 ppt.

The next step in the hierarchical system is class. These classification terms describe the general appearance of the habitat in terms of substrate or the dominant plant community type.

1. **Aquatic Bed** - Wetlands that are dominated by plants that grow principally on or below the surface of the water.
2. **Rocky Shore** - Wetlands that are characterized by bedrock, boulders or stones which cover more the 75% of the area.
3. **Unconsolidated Shore** - Wetland habitats having three characteristics. (1) less than 75% coverage by bedrock, boulders, or stones; (2) less than 30% coverage by persistent vegetation; and (3) alternately exposed and flooded.
4. **Unconsolidated Bottom** - Wetland habitats having at least 25% cover of particles smaller than stones, and a vegetation cover of less than 30%.
5. **Emergent Wetland** - Wetlands dominated by erect, rooted herbaceous hydrophytes.

These wetland classifications should cover any tidal wetland that will be evaluated using the *Maine Citizens Tidal Marsh Guide*. Formerly tidal areas that will be included in the inventory may have changed to any one a variety of freshwater systems. A brief description of some of these systems may help in the identification of these formerly tidal wetlands.

1. **Palustrine System** - All non-tidal wetlands dominated by trees, shrubs, and persistent emergent vegetation.
2. **Lacustrine System** - Open water wetlands situated in topographic depressions with less than 30% vegetative cover and greater than 20 acres in size.

Some of the classes that may apply to these formerly tidal areas are:

1. **Scrub-shrub** - Wetlands dominated by shrubs and tree saplings less than twenty feet in height (e.g., buttonbush, alders and red maple saplings).
2. **Forested Wetland** - Wetlands dominated by trees greater than twenty feet in height (e.g., red maple, ash, spruce).
3. **Emergent Wetland** - Wetlands dominated by erect, rooted herbaceous hydrophytes.

Also included in the classification scheme are a number of modifiers that are added to the end of the classification abbreviation. One of these is important in the recognition of formerly tidal areas. **A small "h" signifies that a wetland has been impounded by the purposeful obstruction of flow.**

The USFWS wetlands classification system is used as the basis for the wetland identification codes used on the National Wetland Inventory maps. On the bottom of each NWI map is a key to the complete codes. The examples below provide examples of some of the wetland classes that will be encountered when using the NWI maps in coastal areas.

E2EM1P
E = Estuarine
2 - Intertidal
EM = Emergent
1 = Persistent
P = Irregularly Flooded

E2US3N
E = Estuarine
2 = Intertidal
US = Unconsolidated Shore
3 = Mud
N = Regularly Flooded

E1UB4
E = Estuarine
1 = Subtidal
UB = Unconsolidated Bottom
4 = Organic

E2US4M
E = Estuarine
2 = Intertidal
US = Unconsolidated Shore
4 = Organic
M = Irregularly Exposed

PUBHh
P = Palustrine
UB = Unconsolidated Bottom
H = Permanently Flooded
h = Diked/Impounded

R1UBH
R = Riverine
1 = Tidal
UB = Unconsolidated Bottom
H = Permanently Flooded

For a more complete explanation of the classification scheme, the reader may obtain copies of the *Classification of Wetlands and Deepwater Habitats of the United States* from the US Fish & Wildlife Service. Reprints of the publication may be purchased from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia.

Appendix D

DATA SHEETS REQUIRED FOR THE ASSESSMENTS

Checklist of Materials Needed to Complete the Maine Citizens Tidal Marsh Guide

☐ Aerial photos (preferably 1 in. = 1,000 ft.) for each tidal marsh system in the study area (see Appendix A).

☐ National Wetlands Inventory (NWI) maps for study area (see Appendix A).

☐ *Coastal Wetland Plants of the Northeastern United States* by Ralph Tiner (see Section 9). This book should be used in conjunction with Appendix I which lists tidal marsh plant species found in Maine.

☐ Area calculation grid (see Appendix E).

☐ Map measuring wheel to measure marsh perimeter; available from office supply store or forestry supply catalog (string or dental floss can also be used - see Question 2.3 in Section 4).

☐ Dividing compass or engineer's scale to plot Zone of Influence; available from office supply store (a photocopied map scale may also be used as described in Section 3).

☐ Calculator.

☐ Clear mylar for base map overlay.

☐ List of federal and state endangered or threatened species that inhabit the study area (see Appendix A).

☐ Location of Maine Natural Areas Program (MNAP) exemplary communities and rare plants in study area (see Appendix A).

☐ Information from the National Register of Historic Landmarks (see Appendix A).

☐ List of shellfish beds that are open to harvest (check with your town office).

☐ Location of public boat launches (refer to DeLorme *Maine Atlas and Gazeteer*).

Marsh System: ______________________ **Evaluation Unit** ______ **of** _____

Assessment 1 *(Page 1 of 3)*
Ecological Integrity of the Marsh System

FIELD VISIT:
Date:____________ Time:___________
Tide:____________
Weather:_____________________________
Observers:____________________________

Note: Results should be based on evaluation units and placed in the summary table on Page D-14.

Questions that may require field observation:

A **Evaluation Questions**	**B** **Dates, Calculations, and Notes**	**C** **Evaluation Criteria**	**D** **Functional Index (FI)**
1.1. Number of tidal restrictions.		a. no tidal restrictions	1.0
		b. one tidal restriction	0.5
		c. more than one tidal restriction	0.1
1.2. Type of tidal restriction.		a. headland to headland bridge or no restriction	1.0
		b. free flow over marsh surface obstructed by road but bridge or culverts not restricting flow through tidal creek	0.5
		c. tidal gate, culvert, road or bridge on the marsh surface that significantly restricts tidal flow including through creeks and channels	0.1
1.3. Fill on marsh surface (spoils, crossroads, etc.).		a. < 5% of EU filled	1.0
		b. 5% - 15% filled	0.5
		c. > 15% filled	0.1
1.4. Ditching on surface of the EU.		a. no ditching within EU	1.0
		b. ditches affect ≤20% of EU	0.5
		c. ditches affect > 20% of EU	0.1
1.5. Alteration of the natural marsh plant community: dominance of invasive species within EU		a. < 5% of EU dominated by invasive species	1.0
		b. 5% - 20%	0.5
		c. > 20%	0.1

AVERAGE FUNCTIONAL INDEX for Assessment 1 = Average of Column D = _______.

Marsh System ______________________________ **Evaluation Unit** _______ **of** ______

Assessment 1 *(Page 2 of 3)*

Ecological Integrity of the Marsh System

Narrative Description of Restoration Potential

1. Describe the exact locations and types of restrictions affecting the evaluation unit. Include a description of the extent of the flow that is restricted (e.g., culvert restricting flow at mid-tide).

2. Describe the area of the evaluation unit that was filled including current uses, approximate acreage, and plant community.

Marsh System: ______________________________ **Evaluation Unit** _______ **of** ______

Assessment 1 *(Page 3 of 3)*

Ecological Integrity of the Marsh System

Narrative Description of Restoration Potential *(Continued)*

3. Describe the exact location and arrangement of ditching relative to the tidal flow and apparent impact (area, affect on evaluation unit hydrology). Supplement with sketch map or photos.

4. Describe the area of the evaluation unit with invasive plant species by estimating the size of the area, listing the species present and the relative proportion of each species.

Marsh System: ______________________________

Assessment 2
Ecological Integrity of the Zone of Influence

FIELD VISIT:
Date:____________ Time:____________
Tide:____________
Weather:______________________________
Observers:______________________________

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may require field observation:			
2.1. Dominant land use in the ½ mile Zone of Influence surrounding the marsh system.		a. forests, fields, dune/beach, freshwater wetlands, open water or similar open space	1.0
		b. agricultural or rural residential (ave. lot size > 2 acres)	0.5
		c. commercial, industrial, high density residential or heavily used highways	0.1
2.2. Ratio of the number of buildings within the marsh system **and/or** within the 250 foot Shoreland Zone to the total area of marsh system.		a. < 0.1 building/acre	0.1
		b. from 0.1 - 0.5 building/acre	0.5
		c. > 0.5 building/acre	0.1
2.3. Percent of the marsh system/upland boundary that has a buffer of woodland or idle land at least 250 feet in width.		a. > 70%	1.0
		b. from 30% - 70%	0.5
		c. < 30%	0.1

AVERAGE FUNCTIONAL INDEX for Assessment 2 = Average of Column D = _______.

Marsh System: ______________________________

Assessment 3 *(Page 1 of 2)*
Wildlife, Finfish & Shellfish Habitat

FIELD VISIT:
Date:______________ Time:____________
Tide:______________
Weather:________________________________
Observers:______________________________

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may not require field observation:			
3.1. Acreage of the marsh system.		a. > 100 acres__	1.0
		b. from 10 - 100 acres	0.5
		c. < 10 acres	0.1
3.2. Ecological Integrity of the marsh system.		Record the Marsh System AFI for Assessment 1	________
Questions that may require field observation:			
3.3. Diversity of habitat types. See Page 2 of Assessment 3.		a. 8 - 10 types present	1.0
		b. 4 - 7 types present	0.5
		c. < 4 types present	0.1
3.4. Submerged (aquatic bed) vegetation expressed as percent of submerged habitat.		a. >25%	1.0
		b. from 5% - 25%	0.5
		c. < 5%	0.1
3.5. Percent of marsh system edge bordered by a buffer of woodland, idle land, or agricultural land at least 250 feet in width.		a. > 70%	1.0
		b. from 30% - 70%	0.5
		c. < 30%	0.1
3.6. Proximity to perennial stream or freshwater wetlands.		a. marsh system connected to a perennial stream or freshwater wetland	1.0
		b. marsh not connected to a perennial stream but within ¼ mile of freshwater wetland	0.5
		c. marsh not connected to a perennial stream and not within ¼ mile of freshwater wetland	0.1

AVERAGE FUNCTIONAL INDEX for Assessment 3 = Average of Column D = _______.

Marsh System: ______________________

Assessment 3 *(Page 2 of 2)*

Wildlife, Finfish & Shellfish Habitat

Diversity of Habitat Types (Check presence or estimate percent)

high marsh ____________
low marsh ____________
open water ____________
tidal flats ____________
upland islands ____________

pannes ____________
freshwater source ____________
tidal creek ____________
natural transition zone ____________
freshwater tidal marsh ____________

Comments:

Presence of submerged vegetation

Observations and comments:

Wildlife Observations:

Marsh System: ______________________________

Assessment 4 *(Page 1 of 2)*
Recreational and Commercial Potential

FIELD VISIT:
Date:____________ Time:__________
Tide:____________
Weather:__________________________
Observers:________________________

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may require field observation:			
4.1. Presence of shellfish beds.		a. shellfish beds present and all are open for harvest	1.0
		b. shellfish beds present but some currently closed to harvest	0.5
		c. no shellfish beds present or all currently closed	0.1
4.2. Presence of marine worms.		a. marsh system used by worm diggers	1.0
		b. marsh system not used by worm diggers	0.1
4.3. Waterfowl hunting.		a. marsh system accessible and currently used by hunters	1.0
		b. marsh system accessible, but no evidence of use	0.5
		c. marsh system not easily accessible, **or** hunting not permitted	0.1
4.4. Opportunities for wildlife observation.		Record the AFI for Assessment 3	________
4.5. Canoe, kayak or other non-motorized boat passage in or adjacent to the marsh system.		a. watercourses within marsh system at least 10 feet wide and 3 feet deep at high tide and free of obstructions, **or** marsh system adjacent to canoeable waterway	1.0
		b. watercourses within marsh system contain some exposed obstructions and/or shallow areas, **and** marsh system not adjacent to canoeable waterway	0.5
		c. watercourses too small and shallow or non-existent, has obstructions, **and** marsh system not adjacent to canoeable waterway	0.1

Continued on next page . . .

Marsh System: ______________________________

Assessment 4 *(Page 2 of 2)*

Recreational & Commercial Potential

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
4.6. Canoe and boat access.		a. access point within ½ mile of marsh system by non-motorized boat	1.0
		b. access point between ½ - 1 mile of marsh system by non-motorized boat	0.5
		c. no access point or access greater than 1 mile from marsh system by non-motorized boat	0.1
4.7. Off-road public parking at or near the potential recreation site.		a. marsh system within 10-minute walk of suitable parking area	1.0
		b. suitable parking more than 10-minute walk but less than 20-minute walk away	0.5
		c. parking not available within 20-minute walk of marsh system	0.1
4.8. Access for disabled persons.		a. specially constructed disabled access	1.0
		b. access via existing roads and trails	0.5
		c. no disabled access	0.1
4.9. Presence of visitors center, maintained trails, or boardwalks.		a. visitors center and maintained trails, and/or boardwalks present	1.0
		b. maintained trails and/or boardwalks present, but no visitors center	0.5
		c. neither a visitors center nor trails or boardwalks present	0.1

AVERAGE FUNCTIONAL INDEX for Assessment 4 = Average of Column D = ________.

Marsh System: ______________________________

Assessment 5
Aesthetic Quality

FIELD VISIT:
Date:____________ Time:__________
Tide:____________
Weather:______________________________
Observers:_____________________________

VIEWING LOCATION(S): ____
____

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may not require field observation:			
5.1. Ecological Integrity of the marsh system.		Record the AFI for Assessment 1	______
5.2. Opportunities for wildlife observation.		Record the AFI for Assessment 3	______
Questions that may require field observation:			
5.3. Dominant visible land use <u>surrounding</u> the marsh system from primary viewing location(s).		a. woodland, agricultural land, or similar open space	1.0
		b. rural residential	0.5
		c. commercial, industrial, transportation use, or high density residential use dominates the visible area	0.1
5.4. General appearance of <u>the marsh system</u> from primary viewing location(s).		a. undisturbed and natural with no visual detractors present	1.0
		b. limited disturbance; minor visual detractors present	0.5
		c. severe detractors present	0.1
5.5. Noise level at the primary viewing location(s).		a. low: natural sounds predominate	1.0
		b. moderate: some traffic or other noise audible	0.5
		c. loud: continuous traffic, industrial or other noise	0.1
5.6. Odors present at the primary viewing location(s).		a. natural odors only	1.0
		b. unnatural odors present at certain times	0.5
		c. unnatural, unpleasant odors distinct and fairly continuous	0.1

AVERAGE FUNCTIONAL INDEX for Assessment 5 = Average of Column D = ______.

Marsh System: ______________________________

Assessment 6
Educational Potential

FIELD VISIT:
Date:____________ Time:___________
Tide:____________
Weather:______________________________
Observers:_____________________________

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may not require field observation:			
6.1. Opportunity for wildlife observation.		Record the AFI from Assessment 3	_______
6.2. Presence of visitors center, maintained trails or boardwalks		Record the FI from Question 4.9	_______
6.3. Diversity of tidal habitats at potential educational site.		Record the FI from Question 3.3	_______
Questions that may require field observation:			
6.4. Walking time from potential educational site to off-road parking for school buses or other vehicles (carpools, vans, etc.).		a. within 10-minute walk b. within 20-minute walk c. parking not available within 20-minute walk	1.0 0.5 0.1
6.5. Student safety.		a. no known safety hazards b. safety hazards present but easily avoidable c. safety hazards present and not easily avoidable	1.0 0.5 0.1
6.6. Access for disabled persons at potential educational site.		a. specially constructed disabled access b. access via existing roads and trails c. no disabled access	1.0 0.5 0.1

AVERAGE FUNCTIONAL INDEX for Assessment 6 = Average of Column D = _______.

Marsh System: ______________________ Compiled by: ______________

Date: ______________

Assessment 7
Noteworthiness

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may not require field observation:			
7.1. Marsh system is habitat for a state or federally listed threatened or endangered species.		a. marsh system is currently habitat for a threatened or endangered species	1.0
		b. marsh system is not currently habitat for threatened or endangered species	0.1
7.2. Marsh system has significance because it has biological, geological or other features which are locally rare or unique, or it contains an exemplary community.		a. marsh system contains feature(s) of significance	1.0
		b. marsh system does not contain feature of significance	0.1
7.3. Marsh system is known to contain an important historical or archeological site.		a. marsh system is a known site of historical or archaeological significance	1.0
		b. no known historical or archeological significance	0.1
7.4. Tidal marshes in a developed setting.		a. FI of Question 2.1 = 0.1	1.0
		b. FI of Question 2.1 = 1.0 or 0.5	0.1
7.5. Marsh system used as long-term research site.		a. marsh system is a site for long-term research	1.0
		b. marsh system is not a site for long-term research	0.1

AVERAGE FUNCTIONAL INDEX for Assessment 7 = Average of Column D = ________.

Marsh System: ______________________ Compiled by: ______________

Date: ______________

MARSH SYSTEM SUMMARY DATA SHEET

This worksheet is designed to help you calculate the final scores of each marsh system using AFIs from all seven assessments and to record features of particular interest.

ASSESSMENT 1 SUMMARY TABLE

	EU 1	EU 2	EU 3	EU 4	EU 5	EU 6	EU 7	EU 8
1. AFI of Evaluation Unit (from Assessment 1 data)								
2. Acres in Evaluation Unit								
3. Total Acreage of Marsh System (Sum of Line 2) :_______________								
4. $\frac{\text{AFI of EU x Acres in EU}}{\text{Total Acres of Marsh}}$								
5. Marsh System AFI for Assessment 1 = Sum of Line 4 =__________								

MARSH SYSTEM SUMMARY TABLE

Assessment	Average Functional Index (AFI)
1. Ecological Integrity of the Marsh System	______________
2. Ecological Integrity of the Zone of Influence	______________
3. Wildlife, Finfish & Shellfish Habitat	______________
4. Recreational and Commercial Potential	______________
5. Aesthetic Quality	______________
6. Educational Potential	______________
7. Noteworthiness	______________

Best education site(s) in marsh system: ______________________________

Best recreation site(s) in marsh system: ______________________________

Public access points in or adjacent to the marsh system: ______________________

Noteworthy feature(s): ______________________________

Appendix E

CALCULATION OF EVALUATION UNIT SIZE

There are two widely available methods for measuring the area of a wetland from a base map: the **grid method** and a **planimeter**.

The **grid method** is a simple, inexpensive technique that is sufficiently accurate for the purposes of this manual. A measuring grid is provided in this appendix. It is made up of individual ¼ inch blocks. For every 16 blocks (one square inch), the lines are bolded to make it simpler to count large areas.

1. Make a transparent copy of the grid.
2. Place the transparent grid over the area to be measured. If the area to be measured is larger than the grid, mark the location of the grid corners on the map so that it can be moved around in order that the whole area can be determined.
3. Count all of the squares that are completely within the tidal marsh.
4. Count all of the squares which are partially within the tidal marsh and divide this number by two.
5. Add the totals from Steps 3 & 4.
6. To determine acreage, multiply the total from Step 5 by the conversion factor at the bottom of the grid (acres/square) that matches the map scale.

For example: 56 whole blocks and 34 partial blocks =
56 + (34/2) = 73
73 x conversion factor for appropriate scale = area of marsh in acres.

A **planimeter** is a small device with a hinged mechanical arm. One end of the arm is fixed to a weighted base while the other end has an attached magnifying lens with a cross hair or other pointer. The user spreads the map with the wetland area on a flat surface. After placing the base of the planimeter in a convenient location the user traces the perimeter of the wetland area to be measured. A dial or other readout registers the area being measured.

Planimeters can cost up to $1,000 or more depending on the degree of sophistication. For the purpose of the *Maine Citizens Tidal Marsh Guide*, a basic model would be sufficient. Planimeters are available from engineering and forestry supply companies. Some towns may currently own a planimeter or regional planning commissions may have one that towns could use.

Some regional planning commissions may have a Geographic Information System (GIS) that is capable of producing computer generated maps and other information that could be used in the *Maine Citizens Tidal Marsh Guide* such as wetland size and perimeter. Check with your regional planning commission to see if GIS maps are available for the tidal marshes in your town.

ACREAGE GRID

Scale:		Miles/inch	Acres/square
1:2,400	or 1" =200 '	0.038	0.057
1:12,000	or 1" =1000'	0.189	1.438
1:2,000	or 1" =1667'	0.316	3.987
1:24,000	or 1" =2000'	0.379	5.739
1:31,680	or 1" =2640'	0.5	10.0
1:63,360	or 1" =5280'	1.0	40.0

Appendix F

SAMPLE MARSH SYSTEM MAPS

Appendix G

EXAMPLES OF COMPLETED DATA SHEETS

Marsh System: FORE RIVER NORTH **Evaluation Unit** 5 **of** 7

Assessment 1 *(Page 1 of 3)*
Ecological Integrity of the Marsh System

FIELD VISIT:
Date: 20 Nov. 1996 Time: 2:00 - 4:00
Tide: ebbing, near low
Weather: drizzle, 40°, light breeze
Observers: R. Bryan, J. Jones

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)

***Note**: Results should be based on evaluation units and placed in the summary table on Page D-13.*

Questions that may require field observation:

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
1.1. Number of tidal restrictions.	Congress St. bridge, footpath bridge (on old canal towpath) and railroad	a. no tidal restrictions b. one tidal restriction c. more than one tidal restriction	1.0 0.5 [✓ 0.1]
1.2. Type of tidal restriction.	Fore River passes through three culverts under the railroad. The cross-sectional area of the culverts is less than half that of the river and significantly restricts tidal flow.	a. headland to headland bridge b. road on marsh surface with bridge or culverts not significantly restricting flow through tidal creeks c. tidal gate, culvert, or road or bridge on the marsh surface that significantly restricts tidal flow including through creeks and channels	1.0 0.5 [✓ 0.1]
1.3. Fill on marsh surface (spoils, crossroads, etc.).	Approximately 3.6 acres due to railroad	a. < 5% of EU b. from 5% - 15% c. > 15%	1.0 0.5 [✓ 0.1]
1.4. Ditching on surface of the EU.	creek channel altered follow railroad in one section but no drainage ditches	a. no ditching b. ditches affect < 20% of EU c. ditches affect ≥ 20% of EU	[✓ 1.0] 0.5 0.1
1.5. Percent of the marsh plant community dominated by invasive plant species.	None evident	a. < 5% dominated by invasive species b. 5% - 20% dominated c. > 20% dominated	[✓ 1.0] 0.5 0.1

AVERAGE FUNCTIONAL INDEX for Assessment 1 = Average of Column D = 0.46.

Marsh System FORE RIVER NORTH **Evaluation Unit** 5 **of** 7

Assessment 1 *(Page 2 of 3)*

Ecological Integrity of the Marsh System

Narrative Description of Restoration Potential

1. Describe the exact locations and types of restrictions affecting the evaluation unit. Include a description of the extent of the flow that is restricted (e.g. culvert restricting flow at mid-tide).

The seaward edge of this E.U. is bounded by a railroad crossing, which was originally built in 1869 (S. Linnell thesis). The r.r. crosses the main branch of the Fore River near the east side of the Marsh. There is a 36" dia culvert and two 60" culverts at this point. This is less than 20% of the cross sectional area of the river, which is 50 ft. wide and 7 ft. deep at high tide at this point. ② 400 ft. west two culverts are located in a branch creek. These culverts were recently replaced and flow may be improved. ③ A third creek at the west end of EU originally flowed from EU 6 into the west end of EU 3. This channel was blocked by the r.r. and a ditch was dug to connect the creek to the main branch of the Fore River. The ditch is about 800 ft. long and runs along the north side of the railroad.

2. Describe the area of the evaluation unit that was filled including current uses, approximate acreage, and plant community.

The railroad fill is approximately 3800 ft. x 40 ft., or 3.5 acres. The fill area is primarily bare gravel with scattered upland shrubs and small trees on the banks. No invasive species were noted on the fill.

A very small berm may have impounded water and caused pannes to develop near the end of "Winding Way". The berm is low (about 6") and breached in one or two locations. It appears to be very old (> 100 yrs.). No invasive species are associated with the berm, and restoration does not seem warranted.

Marsh System: FORE R. NORTH **Evaluation Unit** 5 **of** 7

Assessment 1 *(Page 3 of 3)*

Ecological Integrity of the Marsh System

Narrative Description of Restoration Potential *(Continued)*

3. Describe the exact location and arrangement of ditching relative to the tidal flow and apparent impact (area, affect on evaluation unit hydrology). Supplement with sketch map or photos.

No ditches for mosquito control or hay production were observed in the field or on photos. As noted in #1 above a ditch connects the creek from E.U. 6 to the lower portion of E.U. 5. This does not seem to have affected the plant community.

4. Describe the area of the evaluation unit with invasive plant species by estimating the size of the area, listing the species present and the relative proportion of each species.

No invasive species were noted in EU 5. The extent of narrow leaf cattail and Scirpus sp. in EU 6 may be in part due to the tidal restrictions caused by the railroad.

Consideration should be given to restoring full tidal flow by replacing the existing culverts on the main branch of the Fore River with larger culverts or a small bridge. The original tidal creek channel at the west end of the railroad crossing could be restored as well. Review restoration options with U.S. Fish and Wildlife Service.

Marsh System: FORE RIVER NORTH

Assessment 2
Ecological Integrity of the Zone of Influence

FIELD VISIT: *

Date: 21 NOV 1996 Time: PM

Tide: MID

Weather: SUNNY, 50° F, light breeze

Observers: R. BRYAN, J. JONES

* Calculations from aerial photos and base map overlay

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may require field observation:			
2.1. Dominant land use in the ½ mile Zone of Influence surrounding the marsh system.		a. forests, fields, dune/beach, freshwater wetlands, open water or similar undeveloped open space	1.0
	estimate: 70% high-density residential 30% forest	b. agricultural or rural residential	0.5
		c. commercial, industrial, high density residential, or heavily used highways	[✓ 0.1]
2.2. Ratio of the number of buildings within the marsh system and/or 250 feet to total area of marsh system.	$\frac{42 \text{ buildings}}{90 \text{ acres}} = 0.47/\text{acre}$	a. < 0.1 building/acre	0.1
		b. from 0.1 - 0.5 building/acre	[✓ 0.5]
		c. > 0.5 building/acre	0.1
2.3. Percent of the marsh system/upland boundary that has a buffer of woodland or idle land 250 feet in width.		a. > 70%	1.0
		b. from 30% - 70%	[✓ 0.5]
		c. < 30%	0.1

Marsh system boundary: 26" on map

map scale = 1000 ft./in

length = 26,000 ft.

woodland + idle land: length = 12,000 ft.

percent buffer = $\frac{12,000}{26,000} \times 100 = 46\%$

Comments:

Much of the western half of the marsh is buffered by oak-pine forest which is part of the Fore River Sanctuary (M. Audubon). The relatively steep hilside to the Southeast is also undeveloped.

AVERAGE FUNCTIONAL INDEX for Assessment 2 = Average of Column D = 0.36.

Marsh System: FORE RIVER NORTH

Assessment 3 *(Page 1 of 2)*
Wildlife, Finfish & Shellfish Habitat

FIELD VISIT:
Date: 20-21 NOV 96 Time:
Tide: SEE ASSESSMENT 1 & 2
Weather:
Observers: BRYAN/JONES

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may not require field observation:			
3.1. Acreage of the marsh system.	90 acres using grid method	a. > 100 acres b. from 10 - 100 acres c. < 10 acres	1.0 [✓ 0.5] 0.1
3.2. Ecological Integrity of the marsh system.		Record the Marsh System AFI for Assessment 1	0.60
Questions that may require field observation:			
3.3. Diversity of habitat types. See Page 2.	9 types observed	a. 8 - 10 types present b. 4 - 7 types present c. < 4 types present	[✓ 1.0] 0.5 0.1
3.4. Presence of submerged (aquatic bed) vegetation.	Unknown – late fall evaluation	a. >25% b. from 5% - 25% c. < 5%	~~1.0~~ ~~0.5~~ ~~0.1~~
3.5. Percent of marsh system edge bordered by a buffer of woodland, idle land, or *agricultural land* at least 250 feet in width.	$\frac{12,200'}{26,200'} = 46\%$ *	a. > 70% b. from 30% - 70% c. < 30%	1.0 [✓ 0.5] 0.1
3.6. Proximity to perennial stream or freshwater wetlands.	Capissic Brook (perennial) and Capissic Pond drain into Marsh. Perennial streams also feed into E.U. 3 and E.U. 6 (from USGS Topo Map). NWI Map shows two small freshwater wetlands adjacent to the west end of the Marsh.	a. marsh system connected to a perennial stream or freshwater wetland b. marsh not connected to a perennial stream but within ¼ mile of freshwater wetland c. marsh not connected to a stream and not within ¼ mile of freshwater wetland	[✓ 1.0] 0.5 0.1

* NO AGRICULTURAL LAND, THEREFORE SAME AS 2.3

AVERAGE FUNCTIONAL INDEX for Assessment 3 = Average of Column D = 0.72.

Marsh System: Fore River North

Assessment 3 *(Page 2 of 2)*

Wildlife, Finfish & Shellfish Habitat

Diversity of Habitat Types (Check presence or estimate percent)

high marsh	60%	pannes	✓
low marsh	25%	freshwater source	3 brooks
open water	-	tidal creek	10%
tidal flats	adjacent	natural transition zone	✓
upland islands		freshwater tidal marsh	

Comments:

High marsh predominates in the inner marsh while low marsh becomes more prevalent at the lower end of EU 5 and near the Fore River in EU 2 and 3. Pannes are located in EU 3 and 5 but are not extensive. See Question 3.6 for notes on freshwater sources. Most of the marsh system has a natural transition zone, the exception being EU 4 and its boundary with EU 3, which consists of the old canal and towpath. The upper half of EU 6 is likely brackish (Cattail and Scirpus spp.) but not freshwater tidal. Tidal flats are located adjacent to E.U. 1.

Presence of submerged vegetation

Observations and comments:

No data due to late fall observation. Check next summer if possible.

Wildlife Observations:

Black ducks seen throughout the marsh were surprisingly tame due to sanctuary status of this marsh. Mallard, great blue heron also observed. Deer tracks seen adjacent to EU 6. Mammal skull (probably raccoon) also found near EU 6. Canoeists reported seeing otters in October.

Marsh System: FORE RIVER NORTH

Assessment 4 *(Page 1 of 2)*
Recreational and Commercial Potential

FIELD VISIT:
Date:______________ Time:____________
Tide:
Weather: SEE ASSESSMENTS 1 & 2
Observers:

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may require field observation:			
4.1. Presence of shellfish beds.	Fore River closed to digging.	a. shellfish beds present and all are open for harvest	1.0
		b. shellfish beds present but some currently closed to harvest	0.5
		c. no shellfish beds present or all currently closed	[✓ 0.1]
4.2. Presence of marine worms.		a. marsh system used by worm diggers	1.0
		b. marsh system not used by worm diggers	[✓ 0.1]
4.3. Waterfowl hunting.	Audubon Sanctuary; within city limits	a. marsh system accessible and currently used by hunters	1.0
		b. marsh system accessible, but no evidence of use	0.5
		c. marsh system not easily accessible, or hunting not permitted	[✓ 0.1]
4.4. Opportunities for wildlife observation.		Record the AFI for Assessment 3	0.72
4.5. Canoe, kayak or other non-motorized boat passage in or adjacent to the marsh system.	Marsh system canoeable from mid to high tide. Canoe can follow main course of Fore River from EU 1 north to EU6. Short carries (50 ft.) over the RR track and between EU5 and EU6	a. watercourses within marsh system at least 10 feet wide and 3 feet deep at high tide and free of obstructions, or marsh system adjacent to canoeable waterway	[✓ 1.0]
		b. watercourses within marsh system contain some exposed obstructions and/or shallow areas, and marsh system not adjacent to canoeable waterway	0.5
		c. watercourses too small and shallow or non-existent, has obstructions, and marsh system not adjacent to canoeable waterway	0.1

Continued on next page . . .

Marsh System: FORE RIVER NORTH

Assessment 4 *(Page 2 of 2)*

Recreational & Commercial Potential

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
4.6. Canoe and boat access.	Business parking lots on Congress St. are a short carry for canoe/kayak from EU 2. Canoeists can also drive to EU 3 on the access road along the RR tracks. However, all access points are on private property – permission would be needed.	a. access point within ½ mile of marsh system by non-motorized boat b. access point between ½ - 1 mile of marsh system by non-motorized boat c. no access point or access greater than 1 mile from marsh system by non-motorized boat	1.0 0.5 [✓ 0.1]
4.7. Off-road public parking at or near the potential recreation site.	Public parking for the Fore River Sanctuary trail is avalable at Maine Orthopedic on Frost Ave (off Congress St.) and at the end of Rowe Ave. (off Brighton St.)	a. marsh system within 10-minute walk of suitable parking area b. suitable parking more than 10-minute walk but less than 20-minute walk away c. parking not available within 20-minute walk of marsh system	[✓ 1.0] 0.5 0.1
4.8. Access for disabled persons.		a. specially constructed disabled access b. access via existing roads and trails c. no disabled access	1.0 0.5 [✓ 0.1]
4.9. Presence of visitors center, maintained trails, or boardwalks.	Maine Audubon maintains a two-mile trail system.	a. visitors center and maintained trails, and/or boardwalks present b. maintained trails and/or boardwalks present, but no visitors center c. neither a visitors center nor trails or boardwalks present	1.0 [✓ 0.5] 0.1

AVERAGE FUNCTIONAL INDEX for Assessment 4 = Average of Column D = ________.

Marsh System: FORE RIVER NORTH

Assessment 5
Aesthetic Quality

FIELD VISIT:

Date: Time:

Tide:

Weather: SEE ASSESSMENTS 1&2

Observers:

VIEWING LOCATION(S): Congress St. Bridge (EU 1&2); Fore River Trail Bridge (EU 2&3); canal towpath (EU 3&4); Falls Trail (EU 6)

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may not require field observation:			
5.1. Ecological Integrity of the marsh system.		Record the AFI for Assessment 1	0.60
5.2. Opportunities for wildlife observation.		Record the AFI for Assessment 3	0.36
Questions that may require field observation:			
5.3. Dominant visible land use surrounding the marsh system from primary viewing location(s).	Views range from commercial/high density resid. at Congress St. to woodland/undeveloped on Falls Trail. Houses set well back from marsh in most areas.	a. woodland, agricultural land, or similar open space	1.0
		b. rural residential	[✓ 0.5]
		c. commercial, industrial, transportation use, or high density residential use dominates the visible area	0.1
5.4. General appearance of the marsh system from primary viewing location(s).	Marsh system generally attractive except for railroad and powerlines seen from footbridge & towpath	a. undisturbed and natural with no visual detractors present	1.0
		b. limited disturbance; minor visual detractors present	[✓ 0.5]
		c. severe detractors present	0.1
5.5. Noise level at the primary viewing location(s).	Congress St traffic, other traffic	a. low: natural sounds predominate	1.0
		b. moderate: some traffic or other noise audible	[✓ 0.5]
		c. loud: continuous traffic, industrial or other noise	0.1
5.6. Odors present at the primary viewing location(s).	Sewer vent adjacent to footbridge; otherwise OK	a. natural odors only	1.0
		b. unnatural odors present at certain times	[✓ 0.5]
		c. unnatural, unpleasant odors distinct and fairly continuous	0.1

AVERAGE FUNCTIONAL INDEX for Assessment 5 = Average of Column D = _______.

Marsh System: Fore River North

Assessment 6
Educational Potential

FIELD VISIT:
Date:________ Time:________
Tide:________
Weather: See Assessments 1 & 2
Observers:________

A **Evaluation Questions**	B **Dates, Calculations, and Notes**	C **Evaluation Criteria**	D **Functional Index (FI)**
Questions that may not require field observation:			
6.1. Opportunity for wildlife observation.		Record the AFI from Assessment 3	0.72
6.2. Presence of visitors center, maintained trails or boardwalks		Record the FI from Question 4.9	0.50
6.3. Diversity of tidal habitats at potential educational site.		Record the FI from Question 3.3	1.0
Questions that may require field observation:			
6.4. Walking time from potential educational site to off-road parking for school buses or other vehicles (carpools, vans, etc.).	See 4.7	a. within 10-minute walk b. within 20-minute walk c. parking not available within 20-minute walk	[✓ 1.0] 0.5 0.1
6.5. Student safety.		a. no known safety hazards b. safety hazards present but easily avoidable c. safety hazards present and not easily avoidable	[✓ 1.0] 0.5 0.1
6.6. Access for disabled persons at potential educational site.		a. specially constructed disabled access b. access via existing roads and trails c. no disabled access	1.0 0.5 [✓ 0.1]

Entire Marsh System except EU1 can be accessed without crossing a street.

Maine Orthopedic site better for car and van parking than for buses; could be used as a drop-off site for bus passengers.

AVERAGE FUNCTIONAL INDEX for Assessment 6 = Average of Column D = ________.

Marsh System: FORE RIVER NORTH

Compiled by: R. BRYAN
Date: 3/3/97

Assessment 7
Noteworthiness

A Evaluation Questions	B Dates, Calculations, and Notes	C Evaluation Criteria	D Functional Index (FI)
Questions that may not require field observation:			
7.1. Marsh system is habitat for a state or federally listed threatened or endangered species.	No known records but no recent surveys have been conducted	a. marsh system is currently habitat for a threatened or endangered species	1.0
		b. marsh system is not currently habitat for threatened or endangered species	[✓ 0.1]
7.2. Marsh system has significance because it has biological, geological or other features which are locally rare or unique, or it contains an exemplary community.		a. marsh system contains feature(s) of significance	1.0
		b. marsh system does not contain feature of significance	[✓ 0.1]
7.3. Marsh system is known to contain an important historical or archeological site.	Cumberland and Oxford Canal (1828) runs along edge of EUs 3 & 4	a. marsh system is a known site of historical or archaeological significance	[✓ 1.0]
		b. no known historical or archeological significance	0.1
7.4. Tidal marshes in a developed setting.	Marsh and trail system provide important open space for Portland	a. FI of Question 2.1 = 0.1	[✓ 1.0]
		b. FI of Question 2.1 = 1.0 or 0.5	0.1
7.5. Marsh system used as long-term research site.		a. marsh system is a site for long-term research	1.0
		b. marsh system is not a site for long-term research	[✓ 0.1]

AVERAGE FUNCTIONAL INDEX for Assessment 7 = Average of Column D = ________.

Marsh System: FORE RIVER NORTH

Compiled by: R. BRYAN
Date: 3/3/97

MARSH SYSTEM SUMMARY DATA SHEET

This worksheet is designed to help you calculate the final scores of each marsh system using AFIs from all seven assessments and to record features of particular interest.

ASSESSMENT 1 SUMMARY TABLE

	EU 1	EU 2	EU 3	EU 4	EU 5	EU 6	EU 7	EU 8
1. AFI of Evaluation Unit (from Assessment 1 data)	0.80	0.72	0.62	0.28	0.46	0.64	0.64	X
2. Acres in Evaluation Unit	7.5	15.8	23.7	4.0	22.2	15.1	2.1	X
3. Total Acreage of Marsh System (Sum of Line 2) : 90.4								
4. $\frac{\text{AFI of EU x Acres in EU}}{\text{Total Acres of Marsh}}$	0.066	0.126	0.163	0.012	0.113	0.107	0.015	X
5. Marsh System AFI for Assessment 1 = Sum of Line 4 = 0.60								

MARSH SYSTEM SUMMARY TABLE

Assessment	Average Functional Index (AFI)
1. Ecological Integrity of the Marsh System	0.60
2. Ecological Integrity of the Zone of Influence	0.36
3. Wildlife, Finfish & Shellfish Habitat	0.72
4. Recreational and Commercial Potential	0.45
5. Aesthetic Quality	0.49
6. Educational Potential	0.72
7. Noteworthiness	0.46

Best education site(s) in marsh system: FORE RIVER TRAIL beginning at Maine Orthopedic (Frost St.) and following canal towpath between EU 3 and EU 4.

Best recreation site(s) in marsh system: Entire Maine Audubon trail system.

Public access points in or adjacent to the marsh system: Maine Orthopedic (Frost St.), end of Rowe Ave (off Brighton), and Hillcrest Ave (off Brighton).

Noteworthy feature(s): Historic canal (1828); open space in urban setting

Appendix H

SALT AND BRACKISH MARSH PLANTS OF MAINE

The following list of plants contains those species found in Maine salt and brackish marshes. This list should be used in conjunction with *Coastal Wetland Plants of Northeastern United States* by Ralph Tiner to help in the identification of plant species needed to complete the *Maine Citizens Tidal Marsh Guide*.

Agalinis maritima	Seaside Gerardia
Amaranthus scanabinus	Water Hemp
Ammophila breviligulata	Marramor Beachgrass
Arenaira peploides	Seabeach Sandwort
Artemesia stelleriana	Dusty Miller
Artemisia caudata	Tall Wormwood
Aster subulatus	Annual Salt Marsh Aster
Aster tenuifolius	Perennial Salt Marsh Aster
Atriplex glabriuscula	Orach
Atriplex patula	Orach
Bassia hirsuta	Hairy Smotherweed
Cakile edentula	Sea-Rocket
Carex scoparia	Pointed Broom Sedge
Carex hormathodes	Marsh Straw Sedge
Cladium mariscoides	Twig-Rush
Distichlis spicata	Spike Grass
Eleocharis halophila	Salt Marsh Spike-Rush
Eleocharis parvula	Dwarf Spike-Rush
Eleocharis smallii	Small's Spike-Rush
Elymus virginicus	Virginia Rye Grass
Euphorbia polygonifolia	Seaside Spurge

Glaux maritima	Sea Milkwort
Hordeum jubatum	Squirrel-Tail Grass
Hudsonia tomentosa	Beach Heather
Iva frutescens	Marsh Elder of High-Tide Bush
Juncus balticus	Baltic Rush
Juncus canadensis	Canada Rush
Juncus gerardii	Black Grass
Juncus greenei	Green's Rush
Lathyrus japonicus	Beach Pea
Leachea maritima	Pinweed
Limonium nashii	Sea Lavender or Marsh Rosemary
Lythrum salicaria	Purple Loosestrife
Myrica pensylvanica	Northern Bayberry
Panicum virgatum	Switchgrass
Phragmites australis	Common Reed
Pinus rigida	Pitch Pine
Plantago maritima	Seaside Plantain
Polygonella articulata	Sand Jointweed
Polygonum aviculare	Common Knotgrass
Polygonum ramosissium	Bushy Knotweed
Potamogeton pectinatus	Sago Pondweed
Potentialla anserina	Silverweed
Prunus maritima	Beach Plum
Puccinellia maritima	Seaside Alkali Grass
Quercus alba	White Oak
Quercus bicolor	Swamp White Oak
Ranunculus cymbalaria	Seaside Crowfoot
Rosa palustris	Swamp Rose
Rosa rugosa	Salt Spray Rose or Rugosa Rose
Rosa virginiana	Virginia Rose
Ruppia maritima	Dtich or Widgeon Grass
Salicornia bigelovii	Bigelow's Glasswort

Salicornia europaea	Common Glasswort or Samphire
Salicornia virginica	Perennial or Woody Glasswort
Sanguisorba canadensis	Canadian Burnet
Scirpus acutus	Hard-Stemmed Bulrush
Scirpus americanus	Three-Square
Scirpus atrovirens	Green Bulrush
Scirpus cyperinus	Wool Grass
Scirpus maritimus	Salt Marsh Bulrush
Scirpus paludosus	Bayonet-Grass
Scirpus robustus	Salt Marsh Bulrush
Scirpus validus	Gerater Soft-Stemmed Bulrush
Smilax rotundifolia	Common Greenbriar
Solidago sempervirens	Seaside Goldenrod
Spartina alterniflora	Saltwater Cordgrass
Spartina patens	Salt Meadow Grass
Spartina pectinata	Freshwater Cordgrass or Slough Grass
Spergularia canadensis	Canada Sand Spurrey
Spergularia marina	Salt Marsh Sand Spurrey
Suaeda linearis	Sea Blite
Suaeda maritima	Sea Blite
Suaeda richii	Sea Blite
Toxicodendron radicans	Poison Ivy
Triglochin maritima	Seaside Arrow Grass
Typha angustifolia	Narrow-Leaved Cattail
Typha latifolia	Broad-Leaved or Common Cattail
Zannichellia palustris	Horned Pondweed
Zostera marina	Eelgrass

Appendix I

PHOTOGRAPHIC EXAMPLES OF SOME TIDAL MARSH FEATURES

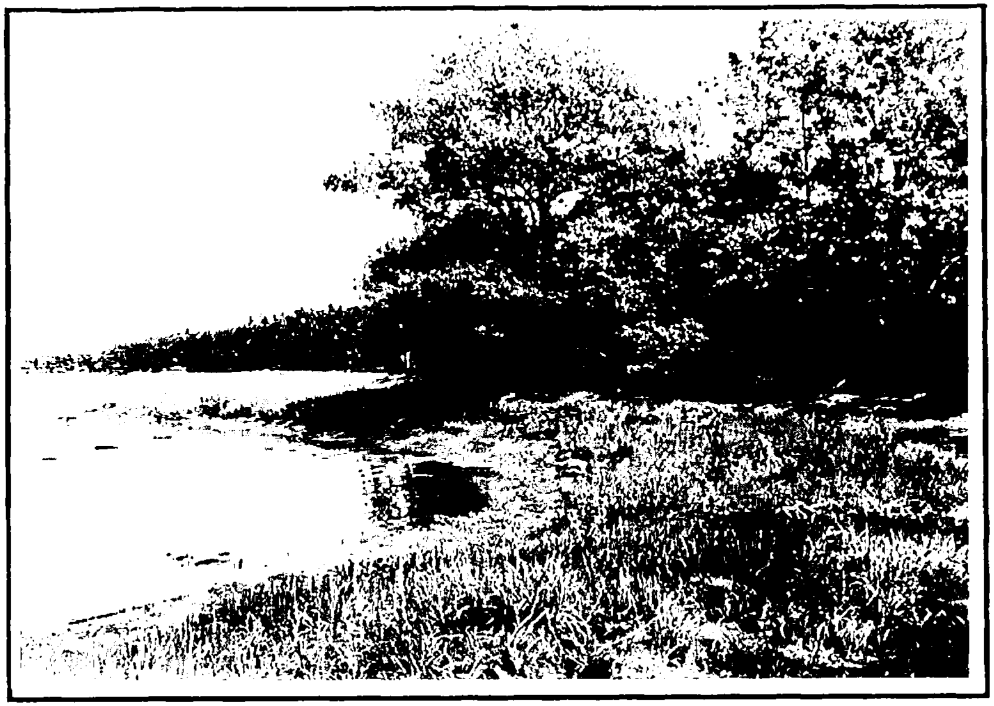


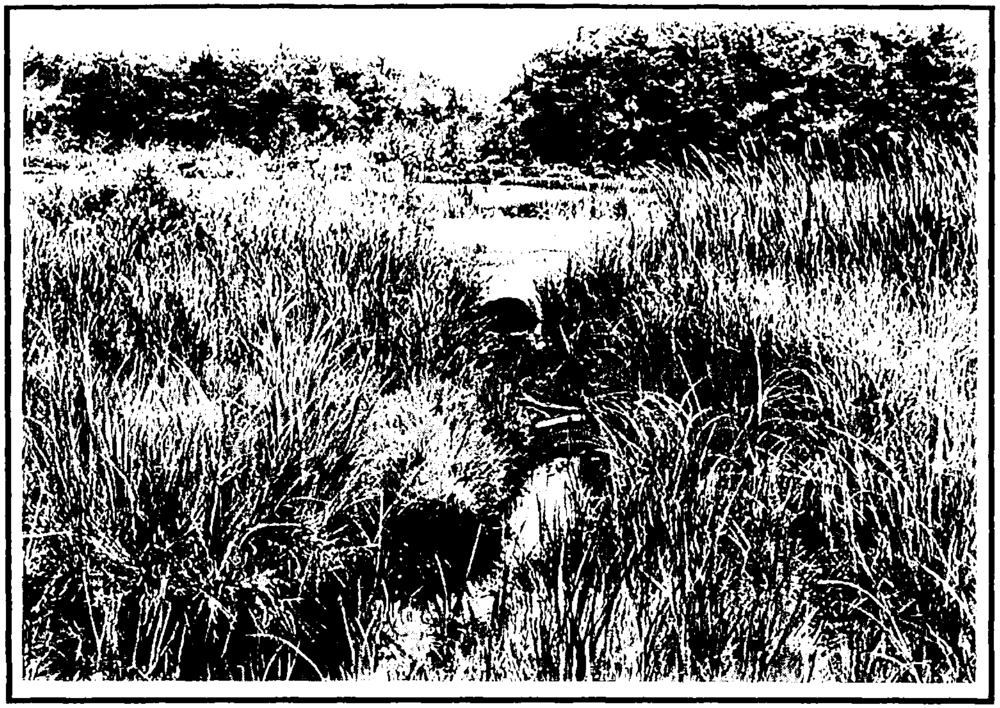
Figure 1 (top left). An example of fringing marsh (Great Bay, NH). In this case, only the low marsh plant, *Spartina alterniflora* is present. Fringing marsh can also include the high marsh plant, *Spartina patens*. These marshes form swaths along the protected shores of large tidal rivers.

Figure 2 (top right). An example of a finger marsh, from Casco Bay, ME. The area of open water within the marsh is small, relative to total marsh area. Note the absence of a protective barrier beach.

Figure 3 (bottom left). An example of a back barrier marsh, from Wells, ME. The marsh has formed behind a barrier beach system that protects it from open ocean waters. Note the large area of the marsh relative to the area of open water within the marsh.

Figure 4. Culverts are often the cause of serious tidal restriction in coastal marshes. In this example, a tidal channel of the Webhannet River (Wells, Maine) is crossed by a road. The upstream and downstream segments of the channel are connected by a 36" diameter culvert. This degree of restriction can affect the tidal marsh plant community in the upstream marsh unit, and is often associated with the spread of invasive species. It should be designated "c" and receive a score of 0.1 when assessing marsh ecological integrity (Assessment 1, Question 1.2).

Figure 5. This is an aerial view of the road and culvert in Figure 4. It shows that the culvert flow capacity is much less than that of the natural channel. Culverts of this size can also be clogged by debris, further reducing flow. The photo was taken at low tide, showing a lack of drainage in the upstream marsh. Note also that raised road beds crossing the marsh as in this example often create conditions that allow the establishment of invasive species along their perimeter.



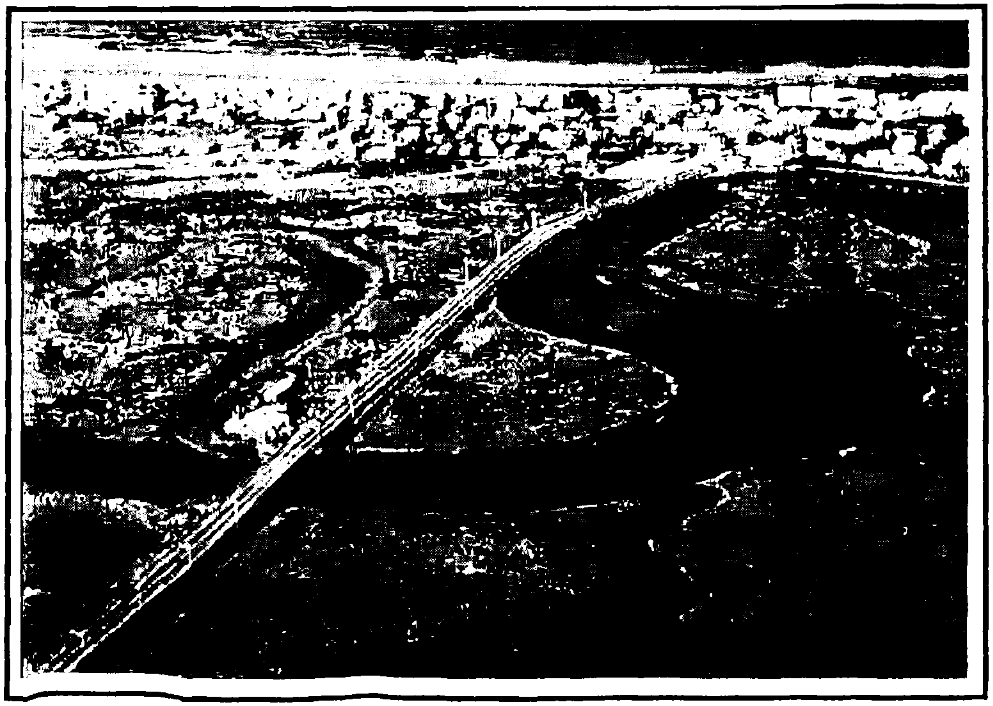


Figure 6 (top left). This culvert was installed (replacing a tide gate) to restore tidal flow to a marsh in Stratham, New Hampshire. Note that the culvert diameter matches the channel width. Because the marsh is very narrow at this point, the road bed has minimal influence on tidal flow to the upstream part of the marsh. This type of restriction should be designated "b" and receive a score of 0.5 when assessing ecological integrity (Assessment 1, Question 1.2).

Figure 7 (top right). Culverts such as this restrict flow so severely that the wetland on the upstream side may no longer function as a tidal system. Often these areas are dominated by invasive species. Careful consideration is needed to determine whether to include the area in the evaluation as a tidal marsh, or to designate it as a formerly tidal marsh.

Figure 8 (bottom left). Bridges that span the width of a tidal channel do not interfere greatly with channel flow. Flow restriction has not perceptibly influenced the plant community on this marsh in Wells, Maine. Road beds that cross the marsh create dams that do interfere with surface flow over the marsh on spring tides. This type of restriction should be designated "b" and receive a score of 0.5 when assessing ecological integrity (Assessment 1, Question 1.2).

Figure 9. This marsh has been deprived of adequate tidal flow by a road that forms a complete dam, with no bridge or culvert (foreground). The marsh does not drain properly, and is partially submerged much of the time. Salt marsh plants require a regular pattern of tidal submergence and drainage to maintain vigor. In this marsh, much of the plant cover has been lost. Without a living cover of plants, marsh peat will degrade, erode and subside.

Figure 10. This back barrier marsh in Wells, Maine shows the typical pattern of salt marsh plant zonation. *Spartina alterniflora* forms a zone of low marsh at the interface with the open water of the creek channel. *Spartina patens* forms the high marsh meadow on the landward side of the low marsh. In this view, the tide is relatively high, so much of the low marsh is submerged.

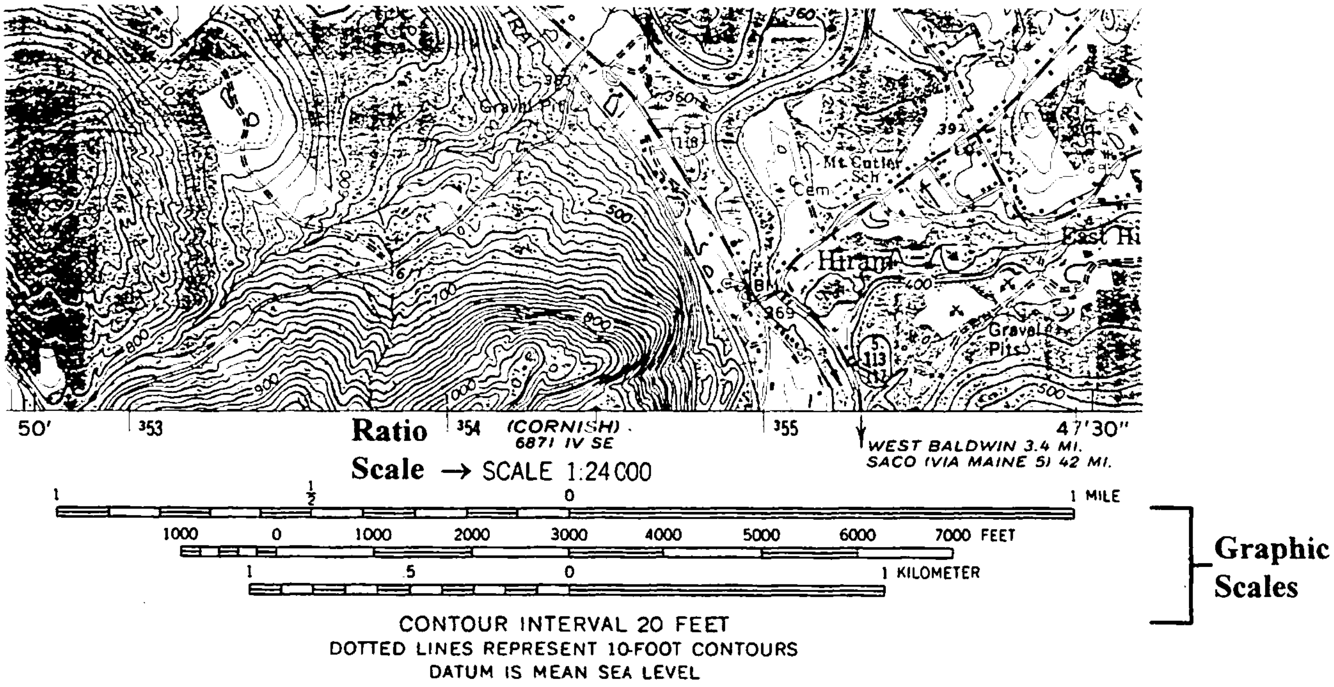
Appendix J

MAP SCALE MEASUREMENTS

Ratio Scales and Graphic Scales

Most maps have both a ratio scale and a graphic scale. The **ratio scale** shows the ratio of a given unit of measurement on the map to the same unit of measurement on the ground. For example, in the legend of an NWI map you will see the ratio 1:24,000 at the bottom of the map. This means that one inch on the map equals 24,000 inches on the ground. Because we can't easily visualize 24,000 inches, it's typical to relate the distance on the map in inches to feet (or miles in the case of maps covering large areas) on the ground. To convert from inches to feet, divide the large number in the ratio scale by 12. Thus, the NWI map has a scale of 1 in. = 2,000 ft. (24,000 ÷ 12), or 1 in. on the map represents 2,000 feet on the ground.

Graphic scales are the bars at the bottom of maps. On an NWI map the graphic scale shows the distance in feet, miles, and kilometers represented by the map.



Enlarging an NWI Map to the Correct Scale

Most commonly a photocopier will be used to enlarge an NWI map to create a base map. Assume the NWI map is at a scale of 1 in. = 2,000 ft. and you want to enlarge it to 1 in. = 1,000 ft. but your copier will only enlarge an image by 50%.

Original Scale (SO)	1 in. = 2,000 ft.
New Scale (SN)	1 in. = 1,000 ft.
Maximum Copy Size	150% of original

The total amount you will need to enlarge the original expressed as a percent of the original (% SO):

$$\begin{aligned}\%\ \mathrm{SO} &= \mathrm{SO} \div \mathrm{SN} \times 100\\ &= 2{,}000 \div 1{,}000 \times 100\\ &= 200\%\end{aligned}$$

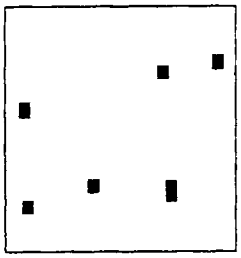
Because the copier will only produce a copy 150% of the original size, the original will need to be enlarged twice to reach the new scale. On your first enlargement use the maximum enlargement possible (150% of the original size). Be sure to tape a copy of the graphic scale near the enlargement area so you can check the enlargement. To calculate the second enlargement divide % SO by the maximum copy size:

$$\begin{aligned}\text{Second Enlargement} &= (\%\ \mathrm{SO} \div \text{Maximum Copy Size}) \times 100\\ &= (200\% \div 150\%) \times 100\\ &= 133\%\end{aligned}$$

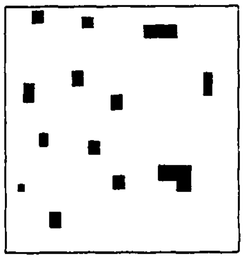
After enlarging the original the second time, check to see if the new scale is in fact 1 in. = 1,000 ft..

Appendix K

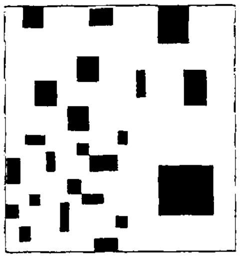
CHARTS FOR ESTIMATING PERCENT COVER



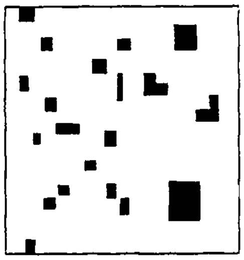
2%



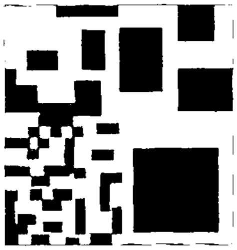
5%



20%



10%



50%