

NOMINATION REPORT

to the

CONVENTION ON WETLANDS OF INTERNATIONAL IMPORTANCE

CONNECTICUT RIVER ESTUARY AND TIDAL RIVER WETLANDS COMPLEX

INTRODUCTION

A dominant feature of the New England landscape, the Connecticut River is the longest and largest river system in New England and, at its mouth, the widest. Its headwater origins begin in the mountains of northern New Hampshire above Fourth Connecticut Lake near the Canadian border and flow south some 660 kilometers (410 miles) to Long Island Sound, where the river provides nearly 70 percent of the freshwater input into that nationally recognized estuary. The watershed basin encompasses an area of approximately 2.9 million hectares (7.1 million acres), or over 11,000 square miles, located in four states—New Hampshire, Vermont, Massachusetts, and Connecticut. There are 16 dams on the river, mostly utility-owned, that impound nearly 200 miles of its length, and many other dams on its tributaries. The lower 96 kilometers (60 miles) of the river, however, from Windsor Locks near the Connecticut-Massachusetts border to Long Island Sound, are both free-flowing and tidal. The river's tidal boundary occurs 90 kilometers (56 miles) from the mouth, and the lower 58 kilometers (36 miles) are the primary subject area of this designation under the Ramsar Convention.

The Connecticut River and its watershed as a whole are of major importance to the region, providing essential habitats, nutrients, and energy flows for a great many species of native plant, fish, and wildlife, and providing homes, jobs, and recreational opportunities to over two million people living in the nearly 400 cities and towns in the basin. It is, however, at the lower, tidal reaches of the river at its confluence with Long Island Sound that the river and its associated tidal wetlands and wetlands-dependent species achieve their greatest prominence and ecological significance.

The Connecticut River is the only principal river in the northeastern United States without a major port, harbor or urban area at its mouth. This is the result of shifting sandbars in Long Island Sound which impede navigation, and this situation has served to preserve the largely rural character of the regional landscape and maintain the river's extraordinary assemblage of natural and relatively undisturbed biotic communities. The lower Connecticut River, beginning near its mouth and continuing upstream for a distance of approximately 58 kilometers (36 miles), contains one of the least developed or disturbed large-river tidal marsh systems in the entire United States, and the most pristine large-river tidal marsh system in the Northeast. From a regional standpoint, there are no other areas in the Northeast that support such extensive or high quality fresh and brackish tidal wetland systems as do those in the Connecticut River estuary. These tidal river waters and marshes provide essential habitat, not only for several federally-listed and candidate species and globally rare species, including bald eagle, shortnose sturgeon, piping plover, and Puritan tiger beetle, but also for dozens of state-rare and endangered species. Waterfowl

concentrations in this section of the river, especially those of American black duck, are among the highest and most significant in the region. Several important restoration programs for anadromous fish species, including Atlantic salmon and American shad, are underway in the Connecticut River, especially at its mouth and major tributary confluences with the mainstem.

The wetlands and waters in the estuarine and tidal river complex of the lower river, with its extensive, high-quality tidal freshwater and brackish marshes and remarkable clusterings of rare and endangered species, waterfowl, and anadromous fishes, is the focus of this site designation under the Ramsar Convention. It is important to recognize this internationally significant area as a single integrated complex comprised of many individual wetlands units, or core sites, and shallow water riverine habitats, all of which are inextricably linked by the tidal waters of the Connecticut River itself. There is a tremendous degree of ecological interaction and interdependence among its tidal waters, tidal wetlands, adjacent uplands, and species populations within an ecosystem or watershed framework. This concept of a single integrated ecological complex forms the basis of this nomination.

1. GEOGRAPHICAL LOCATION:

The area is located entirely within the state of Connecticut, in the northeastern United States, and consists of portions of the lower, tidal reaches of the Connecticut River and adjacent lands. The nominated area is a linear river valley complex located in the south-central portion of the state and extending in a SE-NW direction from 41° 15' 00" N. Latitude and 72° 18' 00" W. Longitude, near the confluence of the Connecticut River and Long Island Sound, to an area just north of the town of Middletown, at 41° 37' 30" N. Latitude and 72° 37' 30" W. Longitude, approximately 58 linear kilometers (36 miles) northwest (upstream) of the river mouth. Hartford, the capitol of Connecticut, is located along the west bank of the river approximately 24 kilometers (15 miles) north of the northwestern edge of the complex (see Figure 1).

2. AREA:

The total project area within the overall boundary of the complex is 8,325 hectares (20,570 acres) (see Figure 2 and large folded map in back pocket). The project area consists of 4,993 hectares (12,338 acres) of open water, 2,416 hectares (5,970 acres) of mostly tidal wetlands, 617 hectares (1,525 acres) of floodplain, 256 hectares (633 acres) of river islands and uplands, and 30 hectares (74 acres) of beaches and dunes. The actual designated areas and their areal extent are listed in Appendix A. A general overview map of designated areas is provided as a folded map in the back pocket. Individual maps of these areas at a scale of 1:24,000 are contained in Appendix B. These proposed designated areas comprise a total of 6,602.8 hectares (16,315.4 acres), of which 4,993 hectares (12,338 acres) are public trust waters, 9,949^h hectares (2,458.4 acres) are vegetated wetland, 183.4 hectares (453.3 acres) are floodplain, 348.7 hectares (861.7 acres) are upland, and 9.7 hectares (24 acres) are beach and dune complex.

3. DEGREE OF PROTECTION:

A large proportion of the nominated lands consists of public trust lands and waters, that is, those wetlands and waters of the Connecticut River and Long Island Sound that lie below mean high water. A listing of all nominated lands currently being held for conservation purposes, their ownership, and acreages is

identified in Appendix A. Of these lands, twenty-eight units are state-owned lands managed by the Connecticut Department of Environmental Protection (CTDEP); twenty of these are Wildlife Management Areas, and the remainder are mostly classified as State Parks. Also included are six municipally-owned lands and twenty-eight private land units or complexes held by various private conservation organizations for primarily conservation purposes. The most extensive wetland network in private conservation ownership included in this nomination are those lands owned by The Nature Conservancy. There are no Federal lands present in the project area.

In addition, all of the tidal wetlands in the project area, regardless of ownership, are regulated under the Federal Clean Water Act and the State of Connecticut's Tidal Wetland Act. The latter is one of the nation's strongest wetland regulatory programs and is administered by the Connecticut Department of Environmental Protection. Activities proposed for tidal wetlands may only be permitted if they preserve tidal wetlands, which limits the types of activities that can be permitted to those which are non-destructive, such as elevated boardwalks and wetland restoration projects. Both the state regulatory program and Federal oversight under the Clean Water Act assure that the conservation requirements of the Ramsar Convention are met on all wetlands within the project boundary regardless of ownership and whether or not they are held for conservation purposes. Species of Federal and state trust responsibilities occurring in the project area are protected under a number of statutes and regulations concerning endangered species, waterfowl and other migratory birds, anadromous fish, and various game species.

4. SITE DESCRIPTION:

A. Project Area, Core Sites, and Designated Areas:

The project area constitutes all of the tidal waters of the mainstem, tributaries, and coves of the Connecticut River, including all associated tidal wetlands, from Long Island Sound to the northern boundary in Cromwell/Portland (see Figure 2), approximately 58 river kilometers (36 river miles). Consistent with the Ramsar Convention, primary emphasis is placed upon wetlands but, in several instances, proposed sites include riparian and coastal zones adjacent to these wetlands, such as Griswold Point barrier beach, and riverine levees between the coves and rivers and islands, such as at Seldens Neck and Goose Island. This area represents the complex of all wetlands and tidal waters that meet the criteria for Wetlands of International Importance (see Section 5), regardless of ownership.

Within the overall project area boundary are approximately 20 discrete major wetland complexes, listed below, referred to within this document as **core sites** (see Figure 2). These are relatively large wetland units occurring along, and connected to, the river itself; they are commonly identified by specific geographic place names, such as Lord Cove and Great Meadows. While meeting the Ramsar wetlands inclusion criteria from strictly a biological standpoint, these core sites may be comprised of various ownership parcels, often numerous, not all of which are included in the designation, particularly if such lands are not being managed for conservation purposes. In some cases, the number of individual parcels in a core site may be fairly extensive and may represent a mosaic of conservation and non-conservation lands. *Only those parcels within each core site that specifically meet both the ownership requirements and inclusion criteria are included in this nomination, with the owners' permission.* These sites are the **actual designated areas** (i.e., those areas specifically included in the Ramsar designation), and include all tidal waters of the Connecticut River from the mouth to the vicinity of Cromwell/Portland below mean high water (i.e., public trust waters and submerged lands), as well as adjacent wetlands owned by the state, municipalities, land trusts, and other private conservation organizations where these lands are held specifically for conservation purposes. For non-state properties, the owners have formally agreed to

allow their lands to be included in the designation and to conform with the requirements of the Ramsar Convention. A list of designated areas and their extent is listed in Appendix A. The location of these areas is shown on a set of maps (1:24,000) contained in Appendix B. A summary table showing the breakdown of designated areas by ownership follows:

| Owner | No. of Parcels | Vegetated Wetland | Floodplain | Upland | Beach & Dune |
|---|-------------------|----------------------|--------------|--------------|-----------------|
| Connecticut Department of Environmental Protection | 95 | 2197.3 | 388.4 | 644.8 | |
| The Nature Conservancy | 31 | 243.5 | 53.9 | 213.9 | 24.0 |
| East Haddam Land Trust | 5 | 15.0 | 11.0 | 3.0 | |
| Connecticut Audubon Society | 1 | 2.6 | | | |
| | | | | | |
| Total | 132 | 2458.4 | 453.3 | 861.7 | 24.0 |

Establishing a project area boundary serves to emphasize the ecological connectivity of all of the wetlands, tidal waters, and adjacent uplands over the entire estuarine complex, and will further allow for and facilitate the expansion of the number and size of designated areas within each of the core sites and project area as new acquisition projects arise or as interest by existing or future land owners to include their wetlands under the Ramsar designation continues to grow. Additions will be on a voluntary basis. It is anticipated that additional designated areas would be submitted to the U.S. Fish & Wildlife Service (Service) for review and approval on a regular basis.

List of Core Sites: Those core sites containing the majority of designated areas are listed below along with the town names (in parentheses) where they occur. It should be noted that the public trust waters and submerged lands of the Connecticut River mainstem represent the primary core site linking all of the other core sites in the project area.

1. **Connecticut River Mainstem** - All tidal waters and submerged lands below mean high water of the mainstem of the Connecticut River. All these waters and submerged lands are under public trust ownership. Except for some dredged navigational channel areas, most of these waters are less than 6 meters (18 feet) in depth.
2. **Great and Upper Island Complex (Old Lyme)** - An extensive system of salt and brackish meadow marshes, including Griswold Point, an important barrier beach and dune complex at the mouth of the river. Great and Upper Islands are mostly state-owned, but include parcels owned by The Nature Conservancy, Old Lyme Land Trust, and private owners. In the tidal tributaries, ownership is mostly private, with the exception of a number of properties owned by the Old Lyme Land Trust. Griswold Point is owned by The Nature Conservancy.

3. **Ragged Rock Creek and South Cove Complex (Old Saybrook)** - Brackish marsh system including Lynde Point, a coastal barrier with one of the most extensive sandflat communities in Connecticut. Ragged Rock is owned mostly by the state, but includes private lands and lands owned by the town of Old Saybrook and The Nature Conservancy. Ownership in South Cove is mixed state and private.
4. **Turtle Creek (Essex, Old Saybrook)** - Brackish reed marsh with some wild rice. Owned by The Nature Conservancy.
5. **Lord Cove Complex (Lyme)** - An extensive area of brackish reed marsh and floodplain forest. Includes Nott, Goose, and Calves Islands. The Lord Cove wetlands are predominantly held for conservation purposes by the state, The Nature Conservancy, Lyme Land Conservation Trust, and the Potapaug Gun Club. Nott Island is owned by the state, Goose Island is owned by the Potapaug Gun Club and the Old Lyme Land Trust, and Calves Island is owned by the Old Lyme Land Trust and private owners.
6. **Great Meadows (Essex)** - A brackish reed marsh. Mostly privately owned; three parcels on Great Meadow are owned by the Essex Land Conservation Trust, and Thatchbed Island is owned mostly by the Essex Land Conservation Trust and the state.
7. **Hamburg Cove (Lyme)** - A tidally-influenced freshwater cove noted for its ecologically important intertidal flats and diversity of submerged aquatic vegetation. In late summer, salt water reaches the deeper waters of the mouth of the cove, which allows access by estuarine fish such as bluefish. Public trust waters; the uplands to the south of the cove inlet are owned by The Nature Conservancy.
8. **Pratt and Post Coves (Deep River)** - Well-developed freshwater tidal marshes dominated by dense stands of wild rice on low marsh and diverse forb communities on the high marsh. Extensive submerged aquatic vegetation in the tidal creeks. Mixed ownership, including the state, the town of Deep River, Deep River Historical Society, and Deep River Conservation Trust.
9. **Selden Creek and Joshua Creek (Lyme)** - Area consists of Selden Neck (bedrock island), Selden Cove, and Selden Creek, extensive freshwater tidal marshes and alluvial wetlands, and a narrow upland slope. Numerous creeks flow into the cove from the surrounding uplands. Joshua Creek contains high quality freshwater tidal marsh. The Selden Cove complex is owned principally by the state; the remainder is owned privately and by The Nature Conservancy.
10. **Chester Creek and Deep River Complex (Chester, Deep River)** - Extensive freshwater tidal wild rice marsh. Chester Creek has mixed ownership with conservation lands owned by the Connecticut River Gateway Commission, The Nature Conservancy, and the town of Chester. Deep River is mostly in private ownership, except for a parcel owned by the Connecticut River Gateway Commission.
11. **Whalebone Creek and Cove (Lyme)** - One of the most extensive freshwater tidal wild rice marshes in the state, surrounded by forested uplands. Numerous creeks flow into the marsh system before entering the cove. Mostly in private ownership, with two tracts owned by The Nature Conservancy.

12. **Chapman Pond (East Haddam)** - A 24-hectare (60 acre) tidal freshwater pond connected to the Connecticut River by two narrow inlets. The pond is surrounded by freshwater tidal marsh ringed by floodplain forest and steep, ledgy upland slopes vegetated with hemlock forest. Mostly in conservation ownership, with the largest tract owned by The Nature Conservancy and several small parcels owned by the East Haddam Land Trust.

13. **Salmon Cove and River (East Haddam)** - A complex of high-quality freshwater tidal marshes, intertidal flats, floodplain forest, and alluvial swamp bounded by forested uplands. Area includes the tidal marshes at the mouth of the Salmon River and Salmon Cove up to Leesville Dam. Mixed ownership: state, East Haddam Land Trust, Connecticut Audubon Society, Northeast Utilities, and extensive private ownership.

14. **Haddam Meadows State Park (Haddam)** - Alluvial wetlands and floodplain that are entirely owned by the state.

15. **Higganum Meadows (Haddam)** - Freshwater tidal marshes, alluvial wetlands and floodplain owned mostly by the state.

16. **Pecauset Meadows (Portland)** - High quality freshwater tidal marsh. Mostly under private ownership, with four parcels owned by the state and one parcel by the Middlesex Land Trust.

17. **Cromwell Meadows (Cromwell, Middletown)** - Freshwater tidal and alluvial marsh. Mostly state-owned Wildlife Management Area.

18. **Dead Mans Swamp (Cromwell)** - An alluvial floodplain, swamp, and marsh system with well-developed vegetation characteristic of the upper tidal Connecticut River. All in private ownership.

19. **Gildersleeve Island (Cromwell)** - Sandy island and sand bar system and floodplain forest on west side of upper tidal Connecticut River. Privately-owned.

20. **Wangunk Meadows (Portland, Glastonbury)** - A large complex of floodplain forest and alluvial marsh east of Gildersleeve Island. This area is owned in large part by the CTDEP, with a number of private inholdings.

B. Climate:

The climate of the region is characterized by prominent seasonal temperature changes that produce distinct winters and summers; precipitation is evenly distributed throughout the year. The project area is also strongly influenced by the proximity of Long Island Sound, which modifies both summer and winter temperature extremes. The mean annual temperature of the area is about 51°F (10.5°C). Average winter temperature is about 32°F (0°C) with a mean monthly minimum of 23°F (-5°C) in the coldest month. Mean annual minimum temperature is approximately 0°F (-18°C). The average seasonal snowfall accumulation is generally around 76 centimeters (30 inches), with lesser amounts closest to the coast (river mouth). Frost-free season averages between 180-190 days. Average summer temperature is about 21°C (70°F); the warmest month has a monthly mean maximum temperature of about 28°C (82°F). Annual precipitation ranges from 109-117 centimeters (43-46 inches) (Brumbach 1965).

C. Physiography/Geomorphology:

Figure 3 is a computer-produced map of the physiography of the project area showing the regional landscape through which the river flows in the State of Connecticut. At the northern, inland extent of the project area, the principally south-flowing Connecticut River abruptly veers off to the southeast, exiting the broad, flat Hartford Basin, or Central Valley, which consists of relatively soft sedimentary strata. The river in the Central Valley is slow-flowing and meandering, and the substrate has favored the development of broad floodplains. Once it leaves the Central Valley, the river crosses the Eastern Border Fault and enters into the Eastern Crystalline Highlands which are characterized by hard metamorphic rock (Bell 1985). The project area section of the river is for the most part located in the Crystalline Highlands region, where the resistant metamorphic rocks constrict the river and have permitted only narrow marshes to form along the mainstem and secondary drainages of the Connecticut River. Where it enters into Long Island Sound, the river at its mouth flows across a low, flat coastal plain, distinguished by expansive brackish marshes. Most of the core sites are discontinuous from one another and reflect local geological conditions where sufficient sediment accumulation has enabled marshes to form.

D. Hydrology:

The main stem of the Connecticut River is 660 kilometers (410 miles) long and drains an area of approximately 2.9 million hectares (7.1 million acres), making it the largest riverine ecosystem in the northeastern United States. The lower Connecticut River, which is the subject of this Ramsar designation, encompasses approximately the lowermost 58 river kilometers (36 miles) of the mainstem of the river from its mouth to the vicinity of Portland/Cromwell, or 9 percent of the river's total length. The drainage area of this section of the mainstem of the river and tributaries is approximately 46,647 hectares (115,263 acres), less than 2 percent of the total drainage area of the Connecticut River.

The Connecticut River has a mean freshwater discharge of 560 cubic meters/second, a rate comparable to that of major rivers such as the Hudson and Delaware. In contrast to the valleys of these rivers, the lower valley of the Connecticut River is tightly constricted by hills of crystalline bedrock. As a drowned river valley, the river is strongly influenced by Long Island Sound. Consequently, this section of the river functions as a narrow conduit to tidal currents induced by the rise and fall of waters in Long Island Sound. The Connecticut River provides nearly 70 percent of the freshwater input into the Sound and thus exerts a profound influence on this major East Coast estuary.

The river is tidal as far north as Windsor Locks, nearly 96 river kilometers (60 river miles) from its mouth. Figure 4 illustrates the position of mean high and mean low water with respect to National Geodetic Vertical Datum (NGVD) from the mouth of the river to Hartford, approximately 85 kilometers (53 miles) inland. High slack water arrives first at the mouth, occurs one hour later at Hadlyme and nearly three and a half hours later at Hartford. The tidal wave progresses northward at an average rate of 45 kilometers/hour (28 miles/hour). The mean tidal range decreases progressively northward from 61 centimeters (2.0 feet) at the mouth at Old Saybrook to 33.5 centimeters (1.1 feet) at Hartford. The actual elevation of these tidal datums increases with increasing distance northward (upstream) and reflects the effect of freshwater discharge upon water level elevations. Thus, throughout much of its length, the Connecticut River in this area has a mixed tidal and nontidal hydrology.

The Connecticut River supports relatively little tidal volume flux because of its small cross-sectional area. Its ratio of tidal inflow volume to freshwater flow volume during the flood portion of the tidal cycle is

about 0.5 for mean conditions, compared to 10 and 140 for the Hudson and Delaware rivers, respectively. The Connecticut River Estuary therefore falls into the type 4, or salt wedge, class. As such, it is unique among major rivers of the U.S. East Coast and is comparable in general character to that stem of the Mississippi River within its delta.

During times of peak freshwater discharge in the spring, in response to snowmelt, the water levels in the river rise significantly (see Figure 5). These rises are greatest in the northern section and least at the mouth of the river. Even during peak flood stage, there is a discernable, albeit minor, tidal signature to the water levels as far north as the Hartford vicinity. At times there may be two discrete seasonal freshets. The first is characterized by a small rise in water level and increased freshwater discharge volume associated with runoff from snowmelt in the minor drainage basins in the State of Connecticut. This is generally followed by significantly higher water levels associated with heavier snowfall amounts and snowmelt in the northern section of the drainage basin in the states of Massachusetts, New Hampshire, and Vermont.

Although there is this very distinct seasonal pattern of extremes from the high water spring freshet to low flow conditions during late summer and early autumn, river waters levels are also quick to respond to major daily precipitation events, wind set-up, and other factors.

E. Salinity Distribution:

An important parameter affecting the distribution of plants, animals, and habitat types on the river is salinity. The source of salt water to the Connecticut River estuary is Long Island Sound, which on average has a relatively consistent salinity of 26 to 28 parts per thousand (ppt). In contrast, salinity in the Connecticut River exhibits wide daily fluctuations due to tides as well as seasonal fluctuations due to freshwater river discharges. For plants, the most significant salinity conditions are those which exist during the growing season. Figures 6 and 7 illustrate the distribution of the major salinity zones for surface and bottom waters at slack high and low tide conditions in May and August. There are two broad categories of water in the river based upon the presence or absence of seawater. These are: mixohaline, i.e., brackish water with a salinity of 0.5 to 30 parts per thousand (ppt), and fresh, i.e., less than 0.5 ppt. Brackish water can be further subdivided into the following categories: polyhaline (18-30 ppt), mesohaline (5-18 ppt), and oligohaline (0.5-5 ppt).

At the beginning of the growing season in early May, when river flows are at their peak, there is no detectable saltwater in the surface waters of the river estuary, regardless of the stage of the tide. As the summer season progresses and the river flow decreases, the penetration of salt water corresponding increases; by August, the freshwater boundary is located near the southern tip of Lord Cove. Thus, the freshwater/salt water boundary migrates approximately 8 kilometers (5 miles) four times daily in response to the semi-diurnal tidal cycle.

In addition to the horizontal distribution of salinity, there is also a discrete vertical zonation of salt and freshwater in the river. Since the density of freshwater is less than that of salt water, freshwater lies above the denser sea water, often as a discrete lens or salt wedge.

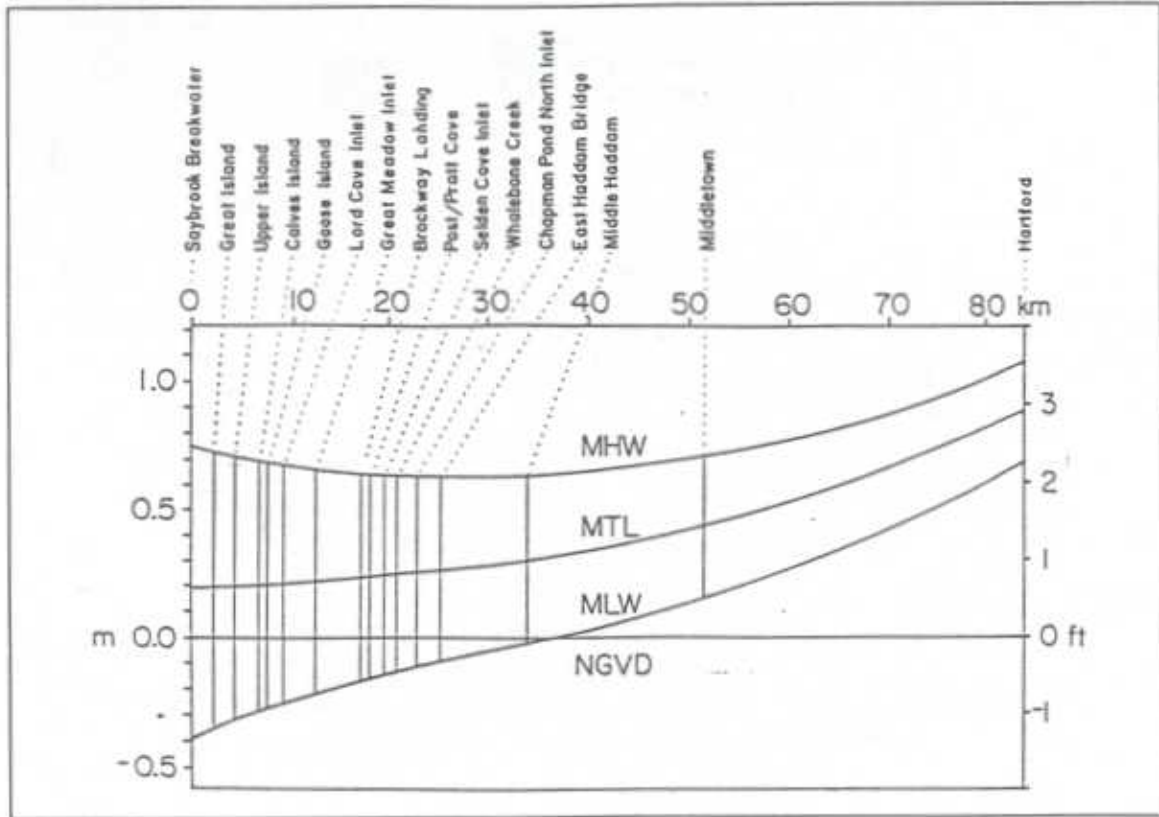


Figure 4. Relationship between tidal datums and the National Geodetic Vertical Datum along the Connecticut River (Source: Barrett, 1989).

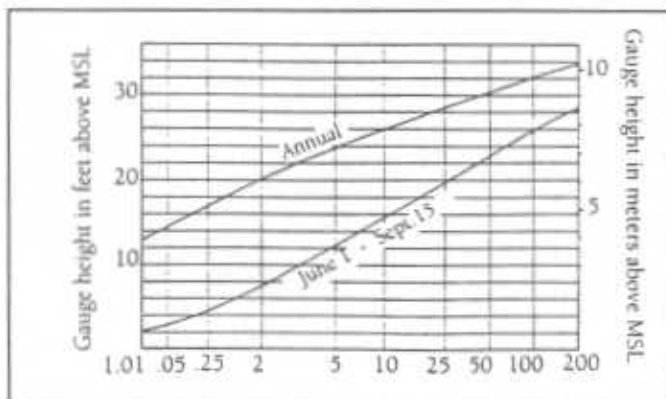
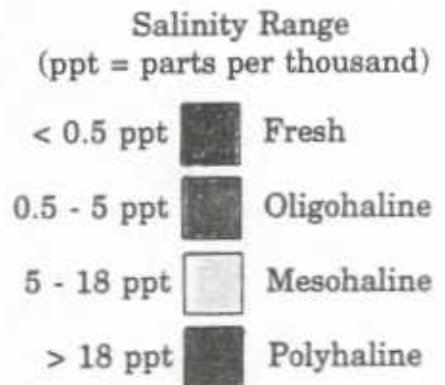


Figure 5. Recurrence interval of annual and summer flooding on the Connecticut River (Source: Metzler and Damman, 1985).

Spring Salinity Profile, Connecticut River
(early May, 1993)



Surface water - All tide stages



1/4 inch = 1 mile

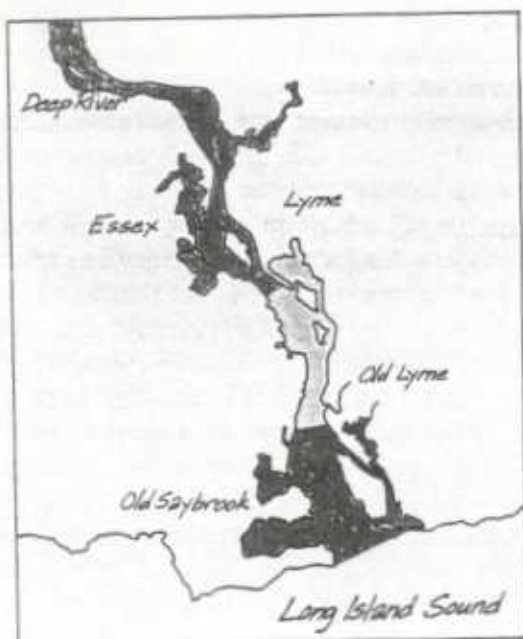


Bottom water - Slack high tide



Bottom water - Slack low tide

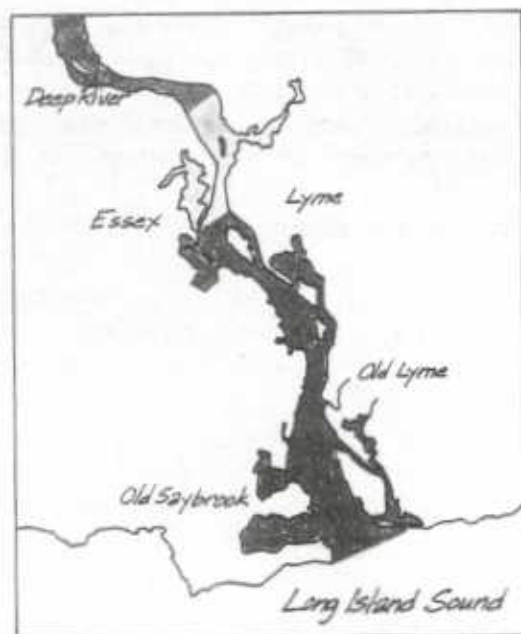
Summer Salinity Profile, Connecticut River
(late August, 1992)



Surface water - Slack high tide



Surface water - Slack low tide

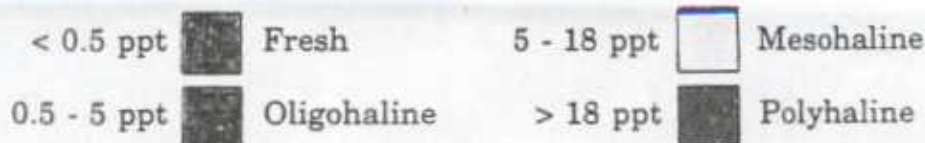


Bottom water - Slack high tide



Bottom water - Slack low tide

Salinity Range
(ppt = parts per thousand)



1/4 inch = 1 mile

F. Wetland Classification and Characterization:

The tidal wetlands along the lower Connecticut River are exemplary and yet representative examples of the variation in the types of tidal wetlands found along most of the larger estuaries in the northeastern United States. Tidal inundation is the common factor shared by salt, brackish, and freshwater tidal marshes, with dissimilarity in major floristic elements and physiognomy correlated to variations in salinity and duration of flooding. The classification established by the National Wetlands Inventory is used here to provide a general characterization of the wetlands in the project area. Three systems of wetlands are present in this area: namely, the Estuarine, Riverine, and Palustrine. A general description of the floristic and vegetational variation that can be observed in these marshes is presented below and is based upon a synthesis of information contained in Barrett (1989), Hotchkiss (1947), Metzler and Rozsa (1982, 1986), and Nichols (1920).

Estuarine System: The Estuarine System embraces those tidal waters with a salinity greater than 0.5 ppt and less than 30 ppt. Surface water salinities are the most important determinant of wetland vegetation, because these are the waters that will actually flood the marsh surface. Since plants are most actively growing during the late spring and summer months, the salinity conditions at that time of year are of the greatest importance to determining the characteristics of the vegetation. The estuarine system in the lower Connecticut River extends from the mouth of the river north to, and including, Great Meadows in Essex, a distance of approximately 13 kilometers (8 miles). Estuarine marshes in the lower Connecticut River system include both salt and brackish tidal marshes, described below.

Salt Marshes: Salt marshes are those tidal wetlands with a soil salinity greater than 18 ppt and, thus, attain their optimal development in the project area in proximity to the chief source of salt water, Long Island Sound. At the beginning of the growing season, there is little or no detectable salt water in the surface waters of the river. By late July and early August, surface waters with a salinity greater than 18 ppt penetrate as far north as the railroad bridge in Old Lyme/Old Saybrook, a distance of approximately 8 kilometers (5 miles). However, throughout much of Great Island soil salinities are still below 18 ppt, except for the extreme southern portion. Here, in a very narrow zone, salt marshes occur.

As is typical of most salt marshes along the shoreline of Long Island Sound, the dominant vegetation zone is the high marsh, characterized by black grass (*Juncus gerardii*), salt-meadow cord-grass (*Spartina patens*), and spike grass (*Distichlis spicata*). The vegetation here often forms a mosaic rather than a distinct zone. Other plant associates include seaside goldenrod (*Solidago sempervirens*), perennial salt marsh aster (*Aster tenuifolius*), salt marsh aster (*Aster subulatus*), and spearscale (*Atriplex patula* var. *hastata*). Also found on the high marsh are pannes, or shallow depressions, containing glasswort (*Salicornia europaea*), stunted smooth cordgrass (*Spartina alterniflora*), sea lavender (*Limonium nashii*), seaside plantain (*Plantago oliganthos*), sea blite (*Sueda maritima*), and arrow-grass (*Triglochin maritimum*). The low marsh zone exists as a narrow band along the waterward edge of the marsh, including creeks and ditches. Smooth cordgrass typically forms a monoculture here.

In the shallow subtidal waters of South Cove and near the lower portion of Great Island occur submerged aquatic vegetation beds composed of a sparse cover of eelgrass (*Zostera marina*).

Brackish Marshes: The second type of tidal wetlands in the estuarine system is that occupying the mesohaline and oligohaline portions of the river from Great Island to Great Meadows. There is a gradual but progressive change in physiognomy (life form or structure) in the vegetation from short brackish

meadows at the downstream end of the mesohaline zone to tall common reed (*Phragmites australis*) at the upstream end of the oligohaline zone.

The primary vegetational community in areas such as Great and Upper Islands and Ragged Rock Creek is the brackish meadow. Dominant plants include salt-meadow cordgrass and black grass, and this vegetation differs little in appearance from that of the high salt marshes. Certain salt marsh associates are even more abundant here, however, such as seaside goldenrod and arrow-grass. Saltwort and sea lavender are less abundant in the brackish meadow than in the high salt marshes. As the soil salinity diminishes, the above-named grasses and rushes give way to other graminoids, especially bentgrass (*Agrostis stolonifera* var. *palustris*) and the spike rushes (*Eleocharis palustris* and *E. rostellata*). Other common associates include straw sedge (*Carex straminea*), red fescue (*Festuca rubra*), mock bishop-weed (*Ptilimum capillaceum*), New York aster (*Aster novi-belgii*), salt marsh fleabane (*Pluchea purpurascens*), silverweed (*Potentilla anserina*), common threesquare (*Scirpus pungens*) and Olney threesquare (*S. americanus*).

Smooth cordgrass is the characteristic plant of the low marsh zone in brackish marshes. In contrast to this zone in the salt marsh, a distinctive understory vegetation is present and composed of one or more of some of the following: dwarf spike rush (*Eleocharis parvula*), the diminutive umbellifer lilaepsis (*Lilaeopsis chinensis*), and, less commonly, mudwort (*Limosella subulata*) and pygmy-weed (*Crassula aquatica*). All of these except for dwarf spike rush are state-listed species of special concern.

Several species of bulrushes and threesquare sedges form a very distinctive community type in the brackish marshes. These are all clonal or colony-forming species, and individual colonies may cover up to five acres. Common threesquare occurs throughout the brackish marsh complex and Olney threesquare is found only at lower salinity sites. The three bulrushes in this community type are the short bayonet grass (*Scirpus paludosus* var. *atlanticus*), the tall saltmarsh bulrush (*S. cylindricus*) and robust bulrush (*S. robustus*); the first two are state-listed species of special concern (see Appendix D). *S. robustus* is chiefly a species of mesohaline waters and is replaced by *S. cylindricus* in fresher, oligohaline waters. While *S. robustus* usually occurs as monospecific stands, colonies of *S. cylindricus* generally contain a number of associates such as dotted smartweed (*Polygonum punctatum*), showy bur-marigold (*Bidens laevis*), rush (*Juncus acumunatus*), water parsnip (*Sium suave*), and softstem-bulrush (*Scirpus validus*).

From Upper Island to Great Meadows, the vegetation is predominantly brackish reed. The dominant species here is narrow-leaved cattail (*Typha angustifolia*) which often forms extensive monospecific colonies. The average height of this cattail is 1.6 meters (5 feet). Other reed species that may form extensive colonies here include robust bulrush, common threesquare, common reed, and rose mallow (*Hibiscus palustris*). In brackish meadows, colonies of reed vegetation may occur throughout. Likewise, in reed dominated areas, pockets of brackish meadow vegetation occur throughout. As in the salt and brackish marshes, the low marsh zone in the reed communities principally supports smooth cordgrass.

At Great Meadows, there is a unique tall reed vegetational community dominated by the hybrid cattail (*Typha x glauca*) on the high marsh. This cattail can grow to heights of 2.5-3.3 meters (8-10 feet). Common reed and rose mallow are often codominants, and the former may occur in dense, monospecific stands. Associates include marsh fern (*Thelypteris palustris*), spike rush (*Eleocharis smallii*), arrow arum (*Peltandra virginica*), purple loosestrife (*Lythrum salicaria*), bur-marigold (*Bidens cernua*), mermaid weed (*Proserpinaca palustris*), and dotted smartweed. In the drier upland borders, freshwater cordgrass (*Spartina pectinata*) and switch grass (*Panicum virgatum*) are often dominant plants. The low marsh zone

along North Cove is composed principally of common threesquare, and associates include salt marsh hemp (*Amaranthus cannabinus*), dotted smartweed, and sweet flag (*Acorus calamus*).

On muddy intertidal flats, the vegetation is often sparse and composed of a variety of herbs. These include dwarf spike rush and several state-listed species of special concern, including lilaeopsis, tidal arrow-head (*Sagittaria spatulata*), mudwort, and Hudson arrowhead (*Sagittaria subulata*). The last species is more prevalent on freshwater tidal mudflats.

In the protected subtidal waters and tidal creeks of the brackish marsh system, a distinctive community of submerged aquatic vegetation develops. The primary species here are horned pondweed (*Zannichellia palustris* var. *major*), Sago pondweed (*Potamogeton pectinatus*), pondweed (*Potamogeton richardsonii*), redhead-grass (*Potamogeton perfoliatus*), red pondweed (*Potamogeton alpinus*), tape-grass or wild celery (*Vallisneria americana*), widgeon grass (*Ruppia maritima*), and water-weed (*Elodea nuttallii*).

Riverine System: As defined by the National Wetlands Inventory, the riverine system includes those freshwater wetlands and deepwaters contained within the river channel and composed of *nonpersistent* vegetation, as contrasted with the palustrine wetlands described below which contain *persistent* vegetation. In the project area, this system lies principally between Great Meadows and the northern boundary. The dominant plants are nonpersistent emergent herbaceous plants, and include wild rice (*Zizania aquatica*), pickerelweed (*Pontederia cordata*), common threesquare, softstem-bulrush, bullhead-lily (*Nuphar variegatum*), and arrow-arum intermixed with arrowheads (*Sagittaria* spp.), bur-marigolds (*Bidens* spp.), and other low-growing species which occur in the low marsh zone. Pure and mixed stands of wild rice generally characterize the majority of riverine tidal marshes in the project area (Metzler and Rozsa, 1982), although nearly pure stands of common threesquare and arrowheads, or both, are common along the exposed shore of the river. Associates include Hudson arrowhead, common arrowhead (*Sagittaria latifolia*), common threesquare, water purslane (*Ludwigia palustris*), false pimpinell (*Lindernia dubia*), and golden club (*Orontium aquaticum*), the last of which is a state-listed species of special concern.

Palustrine System: These are wetlands of freshwater environments, both tidal and nontidal, which support *persistent* vegetation and occur primarily above the mean high tide mark. Several vegetation types of **palustrine tidal emergent wetlands** are present in the project area, and are especially well-developed and rich in species diversity. The first is the *Acorus* community-type of the mid-tidal marsh with sweet flag, three-way sedge (*Dulichium arundinacium*), and reed canary-grass (*Phalaris arundinaceum*). Associates include tussock sedge (*Carex stricta*), water horsetail (*Equisetum fluviatile*), yellow iris (*Iris pseudacorus*), purple loosestrife, spotted jewelweed (*Impatiens capensis*), common bur-marigold (*Bidens frondosa*), water smartweed (*Polygonum amphibium*), bur-reed (*Sparganium eurycarpum*), swamp dock (*Rumex verticillata*), and rice cutgrass (*Leersia oryzoides*).

In the *Peltandra* community-type, in addition to arrow-arum, a number of species may dominate including common cattail (*Typha latifolia*), river bulrush (*Scirpus fluviatilis*), and common reed. This type occurs on regularly flooded marshes, and community associates include sedges, rice cutgrass, common bur-marigold, and blue flag (*Iris versicolor*).

The *Onoclea* community-type of the high marsh is the most floristically diverse of the freshwater wetland community types. Characteristic and often dominant plants include sensitive fern (*Onoclea sensibilis*), common cattail, and river bulrush. Associates include marsh fern (*Thelypteris palustris*), ground-nut (*Apios americana*), clearweed (*Pilea pumila*), cut-leaved water-horehound (*Lycopus americana*), arrow-

leaved tearthumb (*Polygonum sagittatum*), spotted Joe-Pye-weed (*Eupatorium maculatum*), marsh bellflower (*Campanula aparinoides*), and tall meadow-rue (*Thalictrum polygamum*).

In the subtidal areas, there are nearly twenty species of aquatic vascular plants (see Table 2) that occur in the submerged aquatic vegetation beds in the project area waters. The most common species are tape-grass, pondweed (*Potamogeton* spp.), coontail (*Ceratophyllum demersum*), and water-weed. The core site waterbodies containing the greatest diversity of submerged aquatic vascular plant species are Hamburg Cove, Selden Cove, and Salmon River.

5. SOCIO-ECONOMIC VALUES:

The waters of the Connecticut River have long played an important role in the history of New England and, indeed, in providing for the growth of the emerging nation at the time of its settlement. They powered its mills, factories, cities, and towns, served as a means of transportation for its people and goods, and irrigated its rich farmland. The river also suffered from years of overuse and abuse, resulting in high levels of pollution and, ultimately, necessitating extensive efforts to abate further degradation and restore water and habitat quality. To date, Federal, state and local governments have spent over \$600 million to clean up the river and its tributaries and improve the quality of its fish and wildlife habitat, an environment also shared by the region's two million people.

Tourism is important in the project area. The aesthetic beauty and quality of the river and the quaint nature of the riverine towns serve as a strong draw to tourists. A great variety of tourist facilities and activities exists in the lower Connecticut River valley which are either river dependent or substantially enhanced by their proximity to the river, such as the Essex steam train and river cruise and a variety of other transportation-related recreational activities. For example, year-round scenic rail excursions are available along a 19.3 kilometer (12 mile) shoreline route from Essex to Chester. Riverboat rides offer scenic tours of the river, while recreational fishing opportunities are provided by charter boat operations. Year-round aerial sightseeing tours, including sea plane rides, are offered by riverside airports. A number of cultural facilities are present along the river, among them is the Connecticut River Museum in Essex which offers exhibits of historical and cultural river uses, including shipbuilding and maritime commerce, as well as natural resource displays. Four state parks are located along the lower river corridor: Selden Neck State Park and Gillette Castle State Park in East Haddam, Hurd State Park in East Hampton, and Haddam Meadows State Park in Haddam. Together they provide a total of more than 688 hectares (1,700 acres) of public land along the shore of the river. These parks provide opportunities for boating, canoe rental and canoe camping, and fishing.

Ecotourism is small but significant, and much of it concentrates on the bird species of the river, particularly bald eagles in the winter season. The lower river is one of the premier bird-watching areas in the state for shorebirds, eagles, osprey, and waterfowl. Waterfowl hunting is popular in this area, as is furbearer trapping, and both contribute considerable revenue to the state. State wetlands are leased for the trapping of furbearers, especially muskrat. It is estimated that the annual revenue generated from hunting is on the order of \$1,100,000 statewide.

The project area supports both active commercial and recreational fisheries. The commercial fishery focuses on American shad (*Alosa sapidissima*), white catfish (*Amerius catus*), channel catfish (*Ictalurus punctatus*), white perch (*Morone americana*), common carp (*Cyprinus carpio*), alewife (*Alosa pseudoharengus*), and American eel (*Anguilla rostrata*). Annual commercial landings of these species generate over \$130,000 annually. Bluefish (*Pomatomus saltarix*), winter flounder (*Pleuronectes*

americanus), summer flounder (*Paralichthys dentatus*), striped bass (*Morone saxatilis*), hickory shad (*Alosa mediocris*), and blue crabs (*Callinectes sapidus*) dominate the recreational harvest in estuarine portions of the project area. Alternatively, largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), northern pike (*Esox lucius*), white catfish, channel catfish, white perch, and yellow perch (*Perca flavescens*) dominate the harvest in the more upstream, freshwater portions of the project area. Striped bass are targeted by recreational anglers throughout the project area. In recent years, the number of recreational fishing tournaments in the Connecticut River has dramatically increased, and the majority of this activity occurs within the project area. In all, the recreational fishery is estimated to sustain a total economic value of over \$2 million.

6. CRITERIA FOR INCLUSION:

Under Article 2(2), the Ramsar Convention specifies that the selection of wetlands for the List of Wetlands of International Importance (List) should be based on their international significance in terms of ecology, botany, zoology, limnology, or hydrology. Member countries adopted general criteria and expanded guidelines at the Conferences of the Parties at Heiligenhafen (1974), Regina (1987), and Montreux (1990) for nominating wetland sites for the Ramsar List. These three categories for selecting internationally significant wetlands are: 1) representative or unique wetlands in a region; 2) wetlands using plants and animals as indicators of importance, especially rare and endangered species; and 3) wetlands of particular value to waterfowl. According to the Convention, a wetland is considered suitable for inclusion in the List if it meets any one of the established criteria. The Lower Connecticut River tidal wetlands complex has been determined to meet the following criteria in support of its inclusion in the List:

- *Is a particularly good example of a specific type of wetland characteristic of its biogeographical region; is part of a complex of high quality wetland habitats; and plays a substantial biological, ecological or hydrological role in the functioning of an international river basin or coastal system;* (Criterion 1)
- *Supports an appreciable assembly of rare, vulnerable or endangered species of plant or animal or an appreciable number of individuals of any one or more of these species;* (Criterion 2a)
- *Has special value as the habitat of plants or animals at critical stages of their biological cycles;* (Criterion 2c)
- *Regularly supports substantial numbers of individuals from particular groups of waterfowl, or other groups of organisms, indicative of wetland values, productivity or diversity, e.g., loons or divers (Gaviidae), grebes (Podicipedidae), herons or bitterns (Ardeidae), swans, geese or ducks (Anatidae), shorebirds or waders (Charadrii) or terns (Sternidae).* (Criterion 3b)

7. INTERNATIONAL AND NATIONAL IMPORTANCE:

A. Tidal Marshes: The most distinguishing and ecologically important feature of this complex is its extensive system of high quality freshwater and brackish tidal marshes that serves as essential habitat for a number of regionally, nationally, and globally rare or otherwise significant species. The flowing waters and shallow water habitats of the river itself also provide the essential linkage among all the marshland units in this complex. In addition, they are of vital importance to a number of finfish species, especially anadromous fish including the federally-endangered shortnose sturgeon (*Acipenser brevirostris*) and the Atlantic salmon (*Salmo salar*); the latter has been petitioned for listing under the U.S. Endangered Species Act and is the subject of extensive state and Federal restoration efforts in New England. From a regional standpoint, there are no other areas in the Northeast that support such extensive or high quality fresh and brackish tidal wetland systems as do those in the Connecticut River estuary. The marshes here are probably the best example of these types of marshes anywhere in the northeastern United States, far better than similar types of marshes on the Hudson, Housatonic, and Merrimac Rivers. Wild rice is an especially important and characteristic species of these marshes, but they are also characterized by a high species diversity of both plants and animals. For example, within the project area there are 17 plant species in the salt marshes, 36 in the brackish marshes, and over 150 in the freshwater tidal marshes (Barrett 1989). Those characteristics of this complex of tidal marshes that contribute most to the area's overall significance are:

- 1) Tidal freshwater and brackish marshes in this region are far more diverse in species and structure than salt marshes, which contributes to their greater use by fish and wildlife of all types;
- 2) They are critical habitats for a variety of rare plants and animals, e.g., bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), black rail (*Laterallus jamaicensis*), least bittern (*Ixobrychus exilis*), northern harrier (*Circus cyaneus*), American bittern (*Botaurus lentiginosus*), northern diamondback terrapin (*Malaclemys t. terrapin*), golden club (*Orontium aquaticum*), and Parker's pipewort (*Eriocaulon parkeri*) (see Section D and Appendix D);
- 3) Habitat diversity throughout the complex is exceedingly high, with no two marshes being identical, owing in part to the pronounced and rapid change of the salinity/vegetation gradient over short distances;
- 4) Wild rice marshes in the lower Connecticut River are an outstanding and extremely well-developed representative of this wetland habitat type in the Northeast and are biologically important as resting and feeding areas for migratory waterfowl, shorebirds, and rails. These areas are especially important migratory habitats for American black duck (*Anas rubripes*); and
- 5) Productivity in these freshwater and brackish tidal wetlands is exceptionally high. Aside from the marshes themselves, the waters, tidal flats, and river bed of the Connecticut River are important finfish and shellfish areas, especially for anadromous fish such as Atlantic and shortnose sturgeons (*Acipenser oxyrinchus* and *A. brevirostrum*), Atlantic salmon (*Salmo salar*), American shad, and blueback herring (*Alosa aestivalis*), as well as for American oyster (*Crassostrea virginica*) and soft-shelled clam (*Mya arenaria*).

B. Migratory Species: The linear, interconnected riparian and riverine system that the lower Connecticut River provides is important as a **migratory corridor** for many species of anadromous and catadromous fish, including American shad, river herrings, Atlantic salmon, shortnose and Atlantic sturgeon, American eel, and sea lamprey (*Petromyzon marinus*), many of which migrate upstream into Massachusetts and northern New England through an extensive biological corridor that links marine and estuarine waters of the Atlantic Ocean with freshwaters of cool, inland streams.

The Atlantic salmon is an anadromous species that depends on unpolluted, high quality riverine habitat for spawning. Spawning takes place in late October or November, and the newly hatched fish emerge in late March or April of the following year. These fish grow as they feed on the variety of food available to them in the river and spend from 1 to 2 years in the river growing to approximately 15 centimeters (6 inches) in length. In the spring of their second year they change physiologically to adapt their bodies for living in salt water and begin their migration downstream to the ocean. During the oceanic phase of their life history these fish migrate to the rich feeding areas in the north Atlantic Ocean near Greenland where for 1 to 3 years they grow rapidly and mature to a fish of 0.1 to 0.2 kilograms (8 to 15 pounds). In the early spring adult fish migrate to their home river, arriving from May onwards to start their cycle of life again. Unlike other salmon, after spawning these fish may return to the sea again as "kelts" to feed and grow larger and return a second or third time to spawn. The lower river is an especially important area for both young fish migrating to the ocean and returning adults.

The lower Connecticut River valley is also an important movement corridor for migratory birds, especially waterfowl, rails, many species of Neotropical migrants, and raptors, that annually use this area during the spring and fall migration periods as a migration pathway north or south through the region en route to breeding or wintering grounds. Many bird species also nest in the project area or spend the winter in the marshes. Some species, such as the American black duck, use the lower Connecticut River as breeding, wintering, and migration areas.

The Connecticut River valley as a whole is an important navigation and migratory stopover for numerous waterfowl, wading birds, and shorebirds. Within the project area itself, the combination of diverse and abundant wetland types, extensive intertidal flats, a wide range of salinity gradients, and relatively low human disturbance attracts a high diversity and substantial number of waterbirds. The abundance of wild rice marshes in the project area provides an especially important food resource for waterfowl and rails.

The lower Connecticut River regularly supports over 10,000 individuals, principally wintering birds, consisting of 18 species of waterfowl, including dabbling ducks, diving ducks, mergansers, and geese. The primary waterfowl that use this area, listed in decreasing order of abundance, are: American black duck, mallard (*A. platyrhynchos*), blue-winged teal (*A. discors*), and green-winged teal (*A. crecca*).

The area is especially important for American black duck. During the migration and wintering periods, the most important habitats for black ducks in southern New England are the tidal wetlands of the Connecticut River and tidal wetlands, bays, and mudflats along the coast (Merola and Chasko, 1989). Black ducks originating in Canada and northern New England rest and feed here during migration. The river provides open-water wintering habitat at a time when much of the inland freshwater areas are frozen over. The Connecticut River wetlands have been identified as regionally important black duck habitat under the North American Waterfowl Management Plan.

Three species of rails are regularly found as nesters and migrants in the project area: Sora (*Porzana carolina*), Virginia rail (*Rallus limicola*), and clapper rail (*Rallus longirostris*). Also present are king rail

(*Rallus elegans*) and black rail as rare nesters and migrants. Sora are especially abundant in the fall and are concentrated in the wild rice marshes.

The intertidal mudflats and shores associated with freshwater brackish marshes and high salt marshes around the mouth of the river are especially attractive to **migratory shorebirds**. The area regularly supports a minimum of 5,000 individuals, composed mostly of 9 species, though about 30 species can be found here. The most abundant species are black-bellied plover (*Pluvialis squatarola*), semipalmated plover (*Charadrius semipalmatus*), greater yellowlegs (*Tringa melanoleuca*), lesser yellowlegs (*T. flavipes*), and semipalmated sandpiper (*Calidris pusilla*). These species are commonly observed resting and feeding along the shoreline and on the marshes and mudflats during the migration periods of late spring and late summer.

There is a considerable diversity of summer avifauna in the project area; a significant percentage is composed of **Neotropical migratory landbirds**. This is a large and diverse group of birds consisting of many unrelated families and species that are linked primarily on the basis of a single criterion: they all breed in the North American temperate zones and migrate south of the continental United States during non-breeding seasons. As a group they have been receiving a great deal of attention in recent years owing to the fact that a number of them have been experiencing long-term declines, some rather seriously.

Craig (1973) surveyed the summer avifauna of most of the core wetlands in the project area and recorded the presence of 142 species (see Appendix C). These can be categorized as follows:

| | |
|-----------------------|----|
| wetland species | 42 |
| upland border species | 73 |
| migrants | 31 |

Forty-two species, approximately 46 percent of the all species observed in Craig's study, are classified as Neotropical migrants. Twenty-one of these, or 50 percent of the Neotropical migrants, have been determined recently to be experiencing statistically significant declines in the Northeast (Smith, et al., 1993). In a separate analysis, data available from the breeding bird atlas project for Connecticut (Bevier, 1994) was analyzed to determine summer bird use in the vicinity of the project area and revealed that 134 species of birds are known to breed (106) or possibly breed (28) within the boundary of the project area. In this group, 76 species, or 57 percent, can be classified as Neotropical migrants. Nineteen of these species, or 25 percent of the Neotropical migrants, are currently undergoing statistically significant declines in the Northeast (Smith et al., 1993). Thus, the project area provides important nesting habitat for approximately 20 species of seriously declining Neotropical migrants.

C. Unfragmented Habitat: The lower Connecticut River corridor and its complex of wetlands provides a linear system of relatively undisturbed and contiguous wetland and upland habitats that is especially important to species that are sensitive or vulnerable to habitat fragmentation through loss of intervening essential habitat and buffers. This is particularly significant to species that occur naturally in small localized populations, such as piping plover and least terns, but which are nonetheless highly dependent on interactions among other local populations in a region for alternate breeding sites, gene flow, recolonization, stepping stones, etc.. These local population assemblages of interactive and interdependent populations within an area are referred to as **metapopulations**. Maintenance of linkages among local populations of species in a metapopulation is essential to the long-term survival of such species within this region. Unbroken, contiguous habitats are also important to species such as forest

interior breeding birds, particularly Neotropical migrants (discussed above), that are sensitive to "edge effects" produced by fragmented forests and other landscapes which render such species populations vulnerable to increased predation, parasitism, and other adverse effects.

D. Rare and Endangered Species: The Connecticut River watershed as a whole is remarkable in the region for the number of rare or endangered species that occurs there, but there are few areas in all the Northeast that contain such a high concentration of rare, declining, or protected species as does the lower Connecticut River near its mouth. A large number of these species is legally protected by the Federal government and the State of Connecticut under their respective endangered species statutes (see Appendix D). In 1990, the U.S. Fish and Wildlife Service conducted a Congressionally-mandated study of regionally significant habitats along the coast of southern New England and Long Island, New York; this study focused primarily on those habitats of importance to Federal trust species, i.e., U.S. endangered/threatened species, migratory birds, anadromous fish, and marine mammals (U.S. Fish & Wildlife Service 1991). The study identified the lower Connecticut River and its associated tidal marshes as a regionally significant habitat complex based on the area's extraordinary habitat quality and its importance to Federal trust species, especially rare and endangered species. Among the 40 significant habitats identified in the study, the lower Connecticut River complex emerged as superior on the basis of rare species concentrations and species diversity. The report concluded that this area should be considered for listing under the Ramsar Convention.

In 1991, the Service was directed by Congress as part of the Conte National Fish and Wildlife Refuge authorization and planning study to undertake a study of the fish and wildlife resources of the entire Connecticut River watershed, from its headwaters near the Canadian border to its mouth at Long Island Sound, a distance of 660 kilometers (410 miles) and encompassing a watershed of over 2.9 million hectares (7.1 million acres). In addition to Federal trust species, this study also focused on many state-listed species and regionally rare species of fish, wildlife (including invertebrates), and plants, over 600 species in all. As in the earlier coastal study, the mouth of the river and its tidal marshes showed exceptional clusterings of state, regionally, nationally, and globally rare and/or endangered species.

Of special prominence in the lower river are wintering bald eagles (*Haliaeetus leucocephalus*), nesting osprey (*Pandion haliaetus*) (see below), shortnose and Atlantic sturgeon, piping plover (*Charadrius melodus*), northern diamondback terrapin (*Malaclemys t. terrapin*), several species of rare plants, Puritan tiger beetle (*Cicindela puritana*), colonial waterbirds, rails, and other species of regional management concern. The tidal marshes and forested areas along the river and many of its islands are major bald eagle concentration areas for feeding during the winter and osprey concentration areas for both nesting and feeding. This area is rapidly becoming an important viewing area for both these birds in the northeastern United States, especially for wintering bald eagle. Eagles formerly nested in this area as late as the 1950's, and there is optimism that nesting will be reestablished in the near future, as several adult bald eagles have been observed during the summer months. Harbor seals (*Phoca vitulina*), too, are becoming more common in this area of late. The area is also one of the most important shortnose sturgeon sites in the region, both for spawning and feeding, and is the site of Atlantic salmon releases and restoration efforts. A complete listing of Federal- and state-listed species and candidate species occurring in the project area is provided in Appendix D.

A species of particular importance in the project area is the osprey. While the area contains the highest concentration of breeding ospreys along this section of the southern New England coast, current numbers of osprey are still only a shadow of their former abundance. In the late 1930's and early 1940's, there were approximately 200 nesting pairs of ospreys at the mouth of the Connecticut River. While nest sites

were primarily in trees, ground nesting was known to occur on islands in the river mouth such as Great Island. This species experienced a long-term decline due to reproductive failure resulting from biomagnification of break-down products of the pesticide DDT. Populations steadily declined to only a few pairs by early 1960. Subsequently, the populations began a gradual increase as a result of the ban on the use of DDT. In 1994, there were 29 nesting pairs in the lower river; this represents only 14 percent of the 1930-1940 population. Recently, a small, short-term decline has been documented in the Connecticut River population, the significance or cause of which is not known.

E. Submerged Aquatic Vegetation: Submerged aquatic vegetation (SAV) is a highly important food source and shelter for many species of birds, finfish, and shellfish, but very little is currently known about its status or long-term trends in the Connecticut River. It is surmised that SAV declines occurred prior to the water quality restoration efforts that commenced in the 1960's. In an attempt to gather more information on this ecologically important resource, the Connecticut Department of Environmental Protection provided a Long Island Sound Research Grant in the spring of 1994 to The Nature Conservancy to map the SAV beds in the project area. The results of this study will be compared to a descriptive survey of SAV species and distribution conducted in the 1940's (Hotchkiss 1947) by the then Connecticut Board of Fisheries and Game to establish a baseline of information from which to assess the SAV beds' future status and trends.

F. Fisheries: Like Long Island Sound, a nationally recognized estuary, the lower Connecticut River is also an estuary, or mixing zone of fresh and saline waters. As such, it is characterized by estuarine dependent fish, shellfish, bird, and invertebrate species. Estuaries are important nutrient traps, which makes them especially productive and important fish nursery habitats. The greatest diversity of fish species in the region occurs in this area due to the presence of freshwater, estuarine, and marine fish that utilize the tidal river and shoals at the river mouth in Long Island Sound at various times of the year.

The marine fish community is comprised of over 25 species that commonly use the estuary and an additional 25 species that occasionally use the area. Of these, winter flounder, summer flounder, striped bass, and bluefish are commercially and recreationally important. Most notably, the estuary provides significant spawning habitat for the winter flounder, a species whose coast-wide stocks are decreasing. The extreme abundance of marine fish and invertebrates adds immensely to the productivity of the overall system by providing a forage base of substantial proportions for piscivorous (fish eating) fish and birds, including several rare and endangered species of birds. The highly abundant bay anchovy (*Anchoa mitchilli*), Atlantic silverside (*Menidia menidia*), killifish (*Fundulus* spp.), and American sand lance (*Ammodytes americanus*), as well as grass shrimp (*Palaemonetes pugio*) and bay shrimp (*Crangon septemspinosa*) form the foundation of this highly productive system.

Similarly, freshwater fishes in the project area are both abundant and diverse. With over 28 species known to occur in the project area, the lower Connecticut River supports the most diverse freshwater fishery in New England. Northern pike, largemouth and smallmouth bass, yellow perch, and channel and white catfish comprise the bulk of the recreational fishery and, to a lesser extent, the commercial fishery. In addition, the Connecticut Department of Environmental Protection maintains and manages a northern pike spawning marsh within the project area, using the progeny produced at the marsh to augment northern pike stocks throughout the state.

The diadromous community includes 13 anadromous forms, as well as one catadromous (those that spawn in salt water and move to freshwater for development). This diadromous community, comprised of fishes that spawn in freshwater and use marine areas to mature, represents a majority of the diadromous stocks.

In particular, the estuary supports one of the largest and most stable populations of American shad in the U.S., an anadromous form which, in turn, supports one of the oldest, most productive, and most renowned commercial and recreational fisheries in the region. Similarly, the population of the blueback herring, another anadromous form, is estimated to be the largest in the world. Other anadromous clupeids include the alewife, hickory shad, and gizzard shad (*Dorosoma cepedianum*); the last is in the process of naturally colonizing the river through range extension. These herring are more common in the mid-Atlantic riverine systems to the south; interestingly, the estuary also constitutes the southern extent of the range of Atlantic salmon and rainbow smelt (*Osmerus mordax*). The river's unique geographic location, productivity, and habitat variety allow it to support this correspondingly unique diversity of both southern and northern fishes.

Of particular note in the project area is the presence of shortnose sturgeon, a federally-listed endangered species. This species is known to use the project area waters for overwintering and feeding and, perhaps, to support juvenile development, although this has yet to be confirmed. White perch and sea lamprey are two other prominent anadromous fishes of the project area. While both are found in great abundance, white perch is prominent in the commercial and recreational fisheries. Although striped bass do not currently spawn in the Connecticut River, there is a very large run of the fish ascending the river for foraging on fishes, most notably blueback herring. This run of popular game fish has evolved into a nationally renowned sport fishery and multi-million dollar industry. The catadromous American eel spends the majority of its life in the river. It is abundant in all lifestages from elver to adult, and is a nocturnal scavenger; it, too, is fished commercially.

In summary, the Connecticut River estuary and tidal wetlands represent the most productive and diverse estuarine system for fisheries in New England. As a reflection of that productivity, the project area also supports the greatest fishing effort, recreationally and commercially, of any river system in New England. The river's location in the densely populated region of New England, halfway between New York City, New York, and Boston, Massachusetts, provides easy access for millions of anglers. This location, coupled with the river's high environmental quality, presents tremendous fishing and economic opportunities for the regional populace.

8. CHANGES IN ECOLOGICAL CHARACTER:

A. Invasive and Nuisance Species:

Invasion by *Phragmites australis*: Common reed is displacing native tidal wetland vegetation in the lower Connecticut River marshes at an alarming rate. Recent estimates for the Great Island and Lord Cove area have determined that the spread of this species is occurring at a linear rate of 1 to 2 percent per year. It appears that this spread commenced in the late 1960's.

Although this grass is known to be native in North America, it has been speculated that the highly invasive and aggressive *Phragmites* in the project area and elsewhere along the coast may represent an introduced variety or spontaneous mutation from some other part of the globe. For the most part, *Phragmites* is not invasive into tidal wetlands where the soil salinity is greater than 18 ppt. Nearly all of the tidal wetlands in the Connecticut River, however, have soil salinities less than 18 ppt, which indicates that there may be no natural chemical barrier to prevent *Phragmites*' spread throughout this area.

It is projected that, unless action is taken fairly quickly to check and reverse the spread of this grass, the diversity of tidal wetland vegetation types will soon give way to the formation of a monoculture of *Phragmites* over nearly the entire extent of tidal wetlands in the project area. Efforts by the State of Connecticut, U.S. Fish and Wildlife Service and The Nature Conservancy are currently underway to not only study this problem in more detail, but also to restore marshes that have been invaded by *Phragmites* and to check its spread. Related to the spread of this grass is a concomitant decrease in plant community and species diversity. Dense stands of *Phragmites* pose a physical barrier to access by most wildlife species, which will likely result in an increasing diminishment in wildlife use and productivity over time. Decreased use and abundance of Federal and state trust species will also likely occur as a consequence.

Other Invasive Plants: In addition to common reed discussed above, two other plants are commonly invasive in tidal wetlands and continuing to spread: indigo bush (*Amorpha fruticosa*) and purple loosestrife (*Lythrum salicaria*). There are several tidal wetland areas where these species are locally invasive and where future control practices may be warranted to preserve the natural diversity of these systems.

Mute Swans: The mute swan (*Cygnus olor*) is not native to North America, but has become thoroughly naturalized in this and many other areas in the U.S. The number of mute swans in the Northeast continues to increase, with the greatest increase occurring in coastal tidal areas. Since 1972, wintering swans in the State of Connecticut have increased from 505 to at least 1,300. The number of breeding pairs has increased in direct proportion to winter population numbers. Mute swans are largely non-migratory and large concentrations of individuals occur in both winter and summer in most of the major rivers near the coast, including the lower Connecticut River. In the summer of 1993, over 800 birds were observed in the lower Connecticut River alone. Swans are aggressive and compete with native waterfowl for food and space, especially during the breeding season. They have been observed to consume tidal wetland vegetation and submerged aquatic plants in large quantities, including rare plants such as golden club. The swans' long necks allow them to browse beds of submerged aquatic plants to a considerable depth, beyond the reach of native dabbling ducks.

B. Mosquito Ditching: Throughout much of the northeastern U.S. during the first half of the twentieth century, nearly all salt and brackish tidal wetlands, including the project area marshes, were ditched for mosquito control purposes. While ditching did not destroy tidal wetlands, it did drain the marsh of standing water and in so doing reduced or eliminated pool, panne, and stunted smooth cordgrass (*Spartina alterniflora*) habitats. Stunted *Spartina* habitat is now known to be a critical habitat for seaside sparrows (*Ammodramus maritimus*). Presently, seaside sparrows are listed as a species of special concern in the state and a Federal species of management concern in the Northeast. The sparrows' low abundance probably reflects the reduced acreage of stunted smooth cordgrass associated with past ditching practices. There are virtually no natural pools and ponds occurring on ditched marshes in Connecticut. Studies have shown that wildlife diversity is greatest on those natural marshes containing pools and ponds, even through these critical habitat types originally covered only a small percentage of the total wetland area during prior to ditching.

C. Stormwater Discharges: For many years, stormwater discharges were considered to have little or no impact upon wetlands and waters. It is now well documented that stormwater discharges, in fact, can cause water quality degradation and loss of aquatic habitat through the deposition of sediment. Equally important in an estuary such as the Connecticut River are the dilution effects caused by stormwater discharges. While dilution effects upon estuarine organisms are not well documented, it is known that

dilution of the salt content in the soils of brackish and salt marshes can facilitate the spread of *Phragmites australis*. In addition, the deposition of waterborne sediment can increase site elevations, thereby increasing the distance between the soil surface and water table, creating habitat disturbance and conditions ideally suited for the spread of *Phragmites*. The specific areas of the Connecticut River and its wetlands which have been lost, degraded, or altered as a result of stormwater discharges have not been quantified.

D. Dredging and the Disposal of Dredged Sediments: There are two general categories of dredging in the project area. The first is maintenance dredging of the Federal navigation channel between the mouth of the river and Hartford. There are approximately 20 shoal areas within the project area that have been subject to dredging for commercial navigation purposes. Oil barges are currently the primary commercial vessels using this channel. The frequency of maintenance dredging is highly variable and is controlled, in large part, by the volume and velocity of waters discharged during the spring freshets.

The authorized depths of the navigation channel are 4.5 meters (15 feet). With the exception of the five southernmost channel segments, all shoal areas are sandy and dredging in these areas does not significantly alter the depth or sediment type. In the southernmost five segments, however, the sediments are fine textured silts and clays, coarser in texture than the adjacent river margin sediments.

Historically, dredged sediments were disposed of in a number of ways. At one time, sandy sediments were deposited on certain tidal wetland areas such as Nott Island and Calves Islands. While this practice of disposal is no longer permitted, it appears that some of these created upland sandy habitats which have become critical habitats for Federal and state trust species such as bald eagles and northern diamondback terrapins.

Upland and wetland disposal was subsequently replaced by in-river disposal at certain designated mid-depth sites. While this practice continues today, in the last five years field studies have revealed that several of the in-river disposal sites are concentration areas for the federally-listed endangered shortnose sturgeon. As a result of these studies, no disposal has been allowed at the sturgeon concentration areas. The fine-textured sediments derived from the five southernmost shoal areas are now deposited at the Cornfield Shoals disposal site located southwest of the mouth of the river.

At this time, it appears that the minimal dredging done for the maintenance of the Federal channel has not significantly altered habitat conditions in the river and is probably not causing any significant water quality problems. The dredged sediments are relatively free of contaminants and are not known to contain contaminants at levels to cause toxic effects in estuarine organisms.

The second category of dredging in the project area estuary is that done for recreational purposes, specifically for marinas and anchorage areas, e.g., at North Cove in Old Saybrook. Although no detailed investigations have been conducted at these sites, it is very likely that dredging has changed the benthic sediment type from sand to fine silts, clays, or muds. It is not known whether the conversion of the otherwise shallow North Cove to a deepwater anchorage is causing water quality degradation as a result of reduced tidal flushing and increased biological oxygen demand from the organic material that accumulates in the bottom waters. The marina basin for Ragged Rock Marina in Old Saybrook was excavated from tidal wetlands prior to the passage of Connecticut's Tidal Wetland Act in 1969. Although there is some freshwater drainage from the upland that flows through the outer channel, this marina is largely a cul-de-sac, and water quality degradation is likely due to reduced tidal flushing and a decrease in dissolved oxygen in bottom waters. Aside from these examples, many of the marina facilities in the

project area are located on the mainstem of the river where flushing is maximal and water quality degradation is minimal and short-lived or non-existent. The sediments dredged from recreational marinas are primarily fine-textured in nature and are deposited in Long Island Sound at designated disposal sites.

E. Water Quality: Over the last few decades there have been tremendous improvements in the water quality of the Connecticut River. Many of these improvements are due to the establishment of secondary sewage treatment plants (STPs) for the major metropolitan areas, particularly Hartford in the late 1960's and Springfield in the late 1970's. Coupled with this were improved treatment for and sewage treatment tie-ins by industrial facilities. On a more localized basis, the establishment of STPs in Chester in the early 1980's and Deep River in the late 1980's and combined sewer overflow (CSO) corrections in Middletown and Portland, have improved the water quality in those estuarine segments of the river. Long-term water quality monitoring has shown reductions in turbidity, total organic carbon, total phosphorus, dissolved iron, dissolved zinc, dissolved nickel, and fecal coliforms. Oxygen levels have improved and nitrogen concentrations have increased slightly.

9. MANAGEMENT PRACTICES:

In 1985, Connecticut replaced the standard practice of maintaining the existing mosquito ditch network throughout its tidal marsh system with that of open marsh water management (OMWM) techniques. Abandonment of the ditch network restores preditching water table conditions and habitats such as pannes. Although OMWM was developed as a mosquito control technique for natural marshes, certain OMWM techniques actually serve an important habitat restoration function in ditched tidal marshes. For example, the construction of shallow ponds quickly recreates a habitat type - open water ponds - that was lost from the marsh landscape as a result of intense ditching. It is uncertain whether natural ponds will ever reestablish on the marsh simply through the abandonment of ditches without any other active management practice. To date, OMWM techniques have been used for only a few small wetland areas on the lower Connecticut. CTDEP and the USFWS are experimenting with the use of OMWM techniques expressly for waterfowl management purposes in the McKinney National Wildlife Refuge in Westbrook, Connecticut. If positive results culminate from these practices, this program will likely be extended into Connecticut River sites such as the Great and Upper Islands.

Tidal wetland restoration projects have occurred at three sites on the lower river. The first includes tidal flow restoration and herbicide control at the small wetland located between CTDEP's marine headquarters at Old Lyme and the railroad embankment. The second project includes creek and tidal flow restoration at a small wetland at Saybrook Point in Old Saybrook. The third site is a diked marsh in Ragged Rock Creek to the north of the railroad embankment. At this location the existing small culvert was replaced with four large culverts. Each pipe was set at an angle positioning the seaward end of the pipe at approximately -1 meter (-3.0 feet) below mean low water. At this depth, the salt content has been observed at times to exceed 20 ppt. In addition, the internal creek and ditch network were cleaned to facilitate better flushing. This combination of flushing and elevated salt concentration is expected to reduce the areal extent of common reed in this wetland.

Haddam Meadows contains an 18-acre marsh that is currently managed for the enhancement of northern pike, accomplished through the use of dikes and weirs to regulate water levels. In the spring, rainfall and high river flows allow the marsh to be filled to an optimal depth for spawning. Adult pike are captured in the downstream section and introduced to the upper marsh to spawn. Later in the season, water levels are drawn down and juveniles are captured and transported to other water bodies, mostly along the Connecticut River.

The lower Connecticut River from Salmon River Cove to the mouth is part of CTDEP's annual statewide midwinter waterfowl survey, and the entire river is part of the annual statewide wintering bald eagle survey. CTDEP takes an annual census of the osprey population on the river, annually measures its breeding success, and constructs and maintains osprey nesting platforms. At Griswold Point, CTDEP annually conducts censuses, measures breeding success, and encloses nesting areas for piping plover and least tern. The population of the Puritan tiger beetle, a U.S. threatened species and state endangered species, is counted and monitored annually, and a translocation of individuals to establish a new population is being attempted.

10. SCIENTIFIC RESEARCH AND FACILITIES:

There are a number of research facilities and academic institutions in the vicinity of the project area that are actively engaged in scientific studies and research on the lower Connecticut River and associated tidal wetlands. These include: Connecticut College, Trinity College, University of Connecticut, University of Massachusetts, University of New Haven, University of Southern Connecticut, Wesleyan University, and Yale University, as well as several community colleges. Drs. Suzanne O'Connell and Peter Patton of Wesleyan University and Dr. Ralph Lewis of CTDEP's Long Island Sound Natural Resources Center are jointly conducting studies to use shallow water side-scan sonar technology to map the bottom sediments/cover types in Long Island Sound between Hachetts and Cornfield Points and in the lower Connecticut River as far north as Salmon Cove. This project will endeavor to enter the shallow coves of the river and will supplement The Nature Conservancy's SAV project (see below). Drs. Scott Warren and Paul Fell from Connecticut College are investigating the ecological role of *Phragmites australis* in several brackish marshes in the estuary. Drs. Evamaria Koch and Charles Yarish of the University of Connecticut (Stamford) are conducting a coastwide survey of eelgrass and widgeon-grass to determine present-day distribution. This study will provide much-needed data on the distribution of these species at the mouth of the Connecticut River, and will be used to assist in restoration planning efforts. Drs. James O'Donnell and Frank Bohlen of the University of Connecticut (Avery Point) are characterizing and modeling the flow dynamics of the lower river.

The Nature Conservancy, as part of its Connecticut River Tidelands Program, is especially active in conducting various research studies in the project area. One of their major studies is mapping the submerged aquatic vegetation in the project area and studying its patterns of distribution within the river, using both field investigations and aerial photo interpretation. The organization is also funding and overseeing research projects on the Puritan tiger beetle, relationships between *Phragmites australis* and bird populations in marshes along the lower river, vegetation dynamics of freshwater tidal wetlands, and mapping of invasive species populations within some of the lower Connecticut River marshes.

CTDEP's Wildlife Division is conducting a survey of northern diamondback terrapins in coastal waters, with an emphasis on their status in the Connecticut River estuary. The CTDEP's Fisheries Division, located at the CTDEP Marine Headquarters near the mouth of the river in Old Lyme, routinely conducts estuarine and riverine fisheries surveys in the project area. One such study involves the use of radio-telemetry to monitor the movement of shortnose sturgeon, estimate population abundance, and identify important concentration and use areas. CTDEP's Wildlife Division conducts annual winter waterfowl surveys throughout the state and provides critical data on waterfowl use on the Connecticut River. Both the State of Connecticut and U.S. Fish and Wildlife Service conduct population surveys on Federal and state-listed species in this area.

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