4 Existing Environment

The following sections provide a description of the types and general conditions of natural and man-made features currently present in the Herring River system.

4.1 The Herring River

The Herring River, its floodplain, its tributary streams, and the estuarine habitats into which the river and streams flow, is the largest tidal river and estuary complex on the outer Cape. Most of the river floodplain is within the jurisdictional boundaries of the Cape Cod National Seashore (CCNS). The river itself extends from Wellfleet Harbor northeast for nearly four miles to Herring Pond near Newcomb Hollow Beach (Figure 1). The river system, approximately defined by the landward limit of the river's floodplain and including adjacent wetland habitats and those of tributary streams, encompasses approximately 1,100 acres. The Herring River is a prime example of a tidal river system that has suffered decades of extensive hydrologic and subsequent ecologic disturbance as a result of human activities.

The Herring River passes under Chequesset Neck Road through an earthen dike, which was constructed in 1909 and rebuilt in 1974. The dike contains three six-foot wide openings as part of a cast-in-place reinforced concrete box culvert. Two culverts are equipped with large, top-hinged timber flap gates and one is equipped with a vertical lift sluice gate. The flap gates open outward to allow discharge of water to Wellfleet Harbor, while the sluice gate allows bi-directional flow.

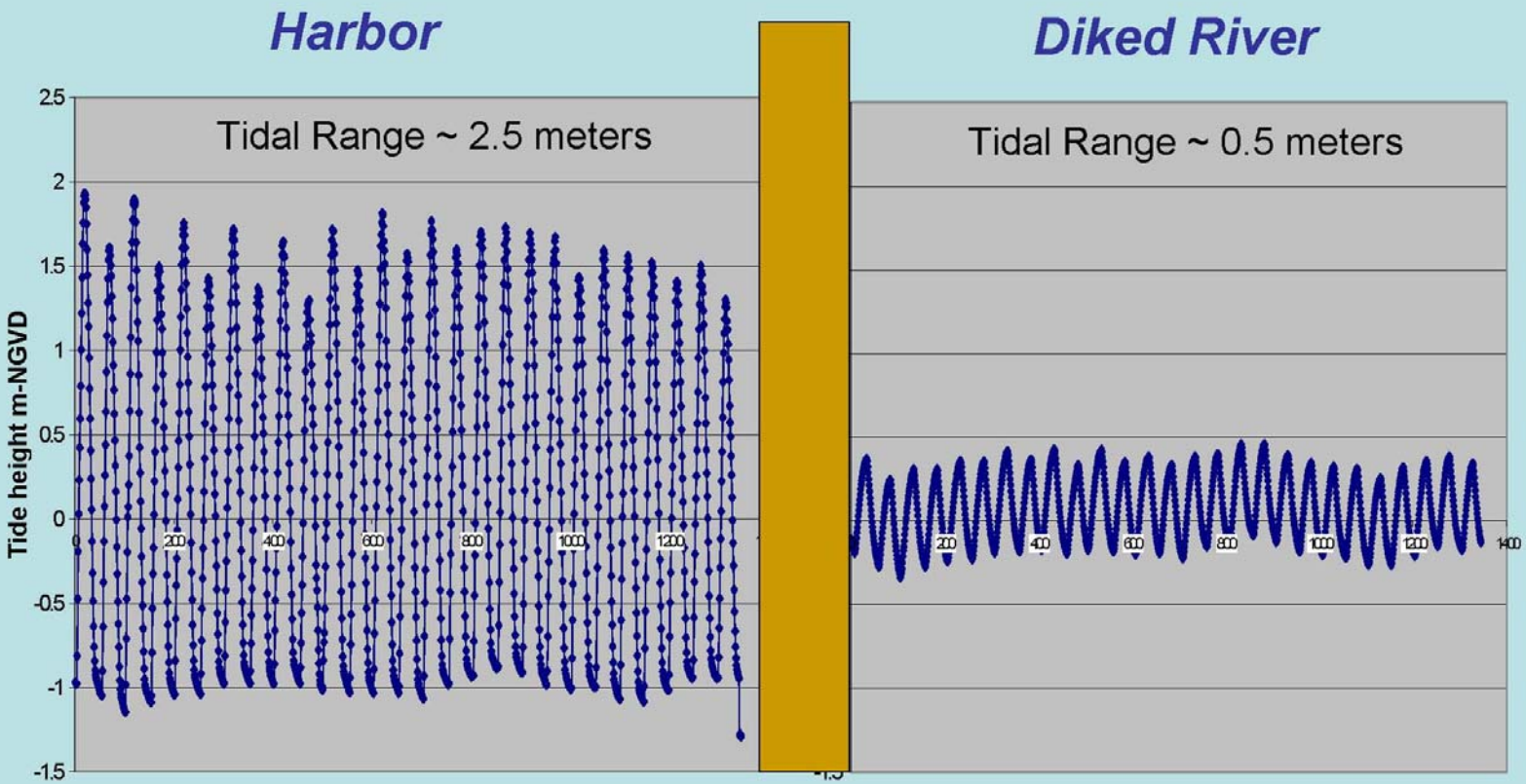
4.1.1 High tide heights and ranges

The presence of the dike has dramatically reduced the height of high tides in the river basin and has greatly impeded drainage from the basin during low tides. While the normal tidal range in Wellfleet Harbor just seaward of the dike is –5 to +5 feet NAVD88, the normal tidal range in the Herring River above the dike is only –1.1 to +0.9 feet (Figure 4). As a result, seawater reaches only approximately 3000 feet north of the dike. Under the original natural conditions seawater would reach well upstream to points located beyond Old County Road and would support most estuarine plants and animals.

4.1.2 Physical modifications to the river channel

The river has suffered the emplacement of tidal restrictions and river channel modifications. Segments of the river were straightened and channelized in efforts to increase the rate at which the river water flowed toward the ocean during ebb tides. The spoils that were generated along these segments from channelizing were deposited on the riverbank, creating a barrier to water flow between the river and its adjacent floodplain. In addition, saltmarshes were ditched in a widespread and often misapplied and unsuccessful effort to control mosquitoes by increasing floodplain drainage.

Figure 4. Hydrographs of Existing Tidal Range in the Herring River and Wellfleet Harbor



Tides above and below the present Herring River dike. The dike both reduces high-tide height and impedes low-tide drainage, thereby reducing tidal range in the river. Salt marsh productivity is directly related to tidal range. Large differences in water levels above and below the dike cause very rapid flows and impede fish passage.

4.2 Tributary Stream Basins

In addition to the Herring River's upper and lower basins, the restoration project area is composed of important stream sub-basins including: Duck Harbor, Mill Creek, Bound Brook, and both Lower and Upper Pole Dike Creek (Figure 5).

Each basin is distinct physically, and thus chemically and biologically, because of its elevation and hydrologic relationship to the Herring River and Wellfleet Harbor. Therefore, tidal restoration will influence each basin to different degrees due to a basin's land-surface elevation and distance from the harbor. Distance alone will affect both tide heights and salinity distribution (Spaulding & Grilli 2001, 2005).

In addition, each basin has a different land-management history and has therefore undergone a unique set of habitat impacts such as habitat fragmentation from road construction and residential development. It follows that tidal restoration will affect each basin differently and to a different degree. A summary description of each basin, mapped on Figure 5, is provided below.

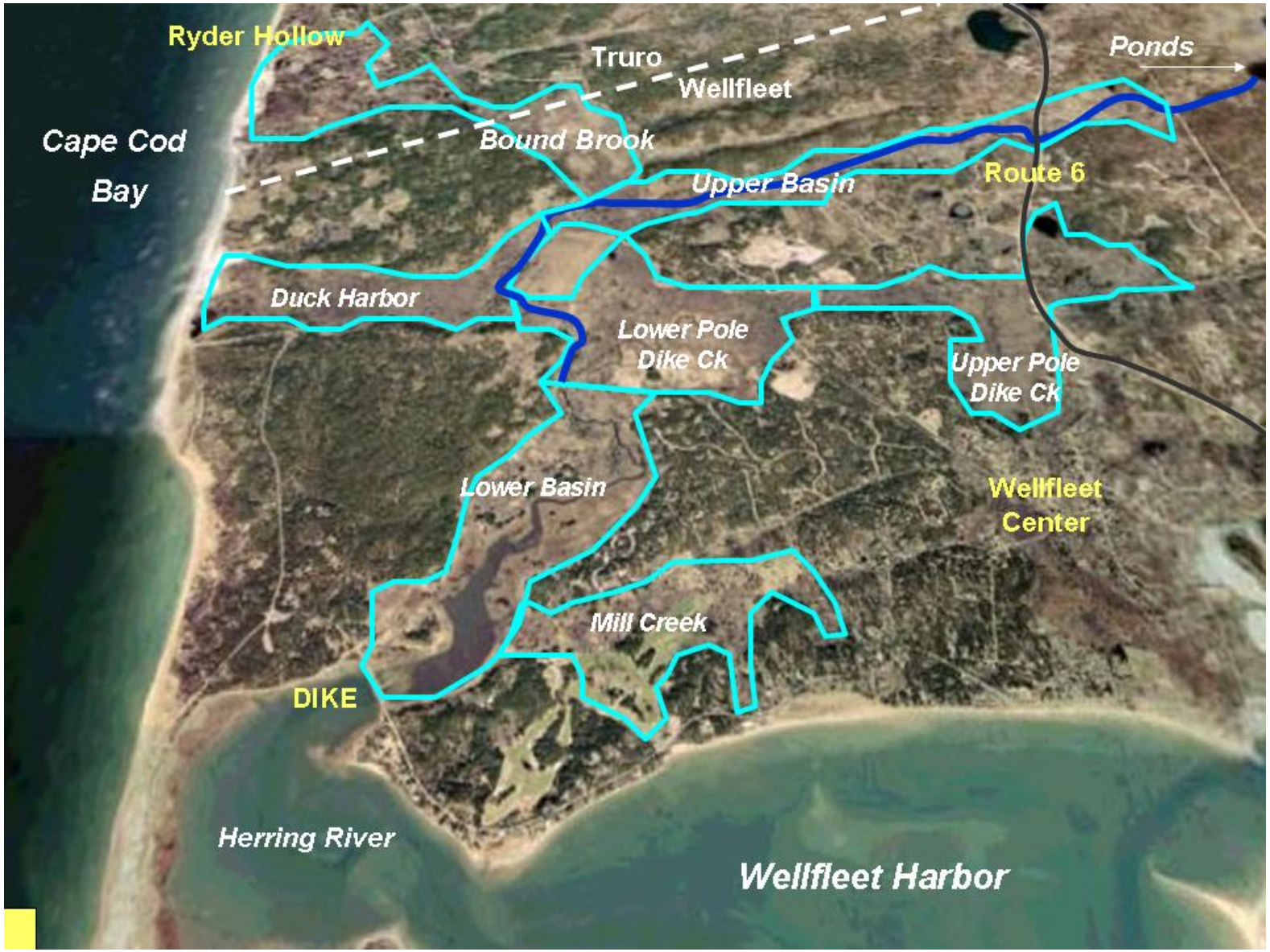
Lower Basin: The Lower Basin area of the Herring River is the southern-most portion, situated immediately upstream of the Chequesset Neck Road dike and extending northerly to the High Toss Road crossing. This basin covers roughly 170 acres, and includes subtidal, riverine, vegetated wetland, and fringing upland floodplain habitats. The only remaining saltmarsh in the Herring River system (approximately 13.6 acres) is located here, along with about 40 acres of exotic *Phragmites*.

Mill Creek: The Mill Creek tributary extends easterly of the Herring River approximately 1600 feet above the Chequesset Neck Road dike. The former floodplain portion of the Mill Creek basin comprises just over 100 acres. *Phragmites* marsh and disturbed wooded wetland habitat covers much of this floodplain in the Mill Creek basin, although there is some saltmarsh vegetation on the creek banks at the mouth of Mill Creek itself. In the 100 years since the Herring River dike was constructed, a golf course (Chequesset Yacht and Country Club – CYCC) and several private properties were constructed in the former Mill Creek floodplain.

Lower Pole Dike Creek Basin: This central portion of the Herring River basin extends north from High Toss Road to the north side of Merrick Island, easterly to Pole Dike Road, and is bounded on the west by the Duck Harbor basin. Covering approximately 180 acres, this basin is at the confluence of flows from the Herring River, Pole Dike Creek, Bound Brook, and Duck Harbor basins. This is the most severely drained portion of the original saltmarsh with soil pH almost everywhere below 4 (Figure 7, extent of acid sulfate soils), extremely acidic surface waters, and vegetation dominated by dry deciduous woodland.

Upper Pole Dike Creek Basin: Extending east of Pole Dike Road and covering wetland and former floodplain north of Wellfleet Center and east of Route 6, this distinct basin area

Figure 5. Delineation of Herring River Sub-basins



comprises approximately 180 acres of what is today freshwater marsh, dominated by cattail (*Typha angustifolia*). This basin contains by far the most private property abutters within the Herring River system. Unlike most of the other major basins, this area has not been extensively surveyed, modeled, or studied. Pending the outcome of further studies, including detailed hydrologic modeling currently underway, restoration of the Upper Pole Dike Creek basin will likely require a small dike with a tidal control device, possibly where the old rail-road dike crosses Pole Dike Creek just south of the Wellfleet Transfer station.

Bound Brook Basin: The Bound Brook basin area extends northerly from the Herring River above Old County Road. This basin comprises upwards of 240 acres, including a large wetland area that extends into the Ryder Hollow area of Truro. Due to generally low elevations, the peat has remained saturated, albeit fresh, and vegetation comprises wetland shrubs and cattail.

Upper Basin: The northern-most portion of the Herring River system extends northeast along the Herring River, crossing Route 6 and ending just below the headwater ponds within the CCNS. This 180-acre area currently supports primarily wooded wetland habitat along the Herring River.

Duck Harbor Basin: Extends westerly from the river main stem to the Duck Harbor barrier beach and comprises about 130 acres of floodplain north of Griffin Island and south of Bound Brook Islands. Black cherry woodland and acid sulfate soils (pH < 4) are typical in the eastern portion, while wetland shrubs dominate in the lower, and thus wetter, western portion except where it grades up to the barrier beach.

4.3 Water and Sediment Chemistry / Quality

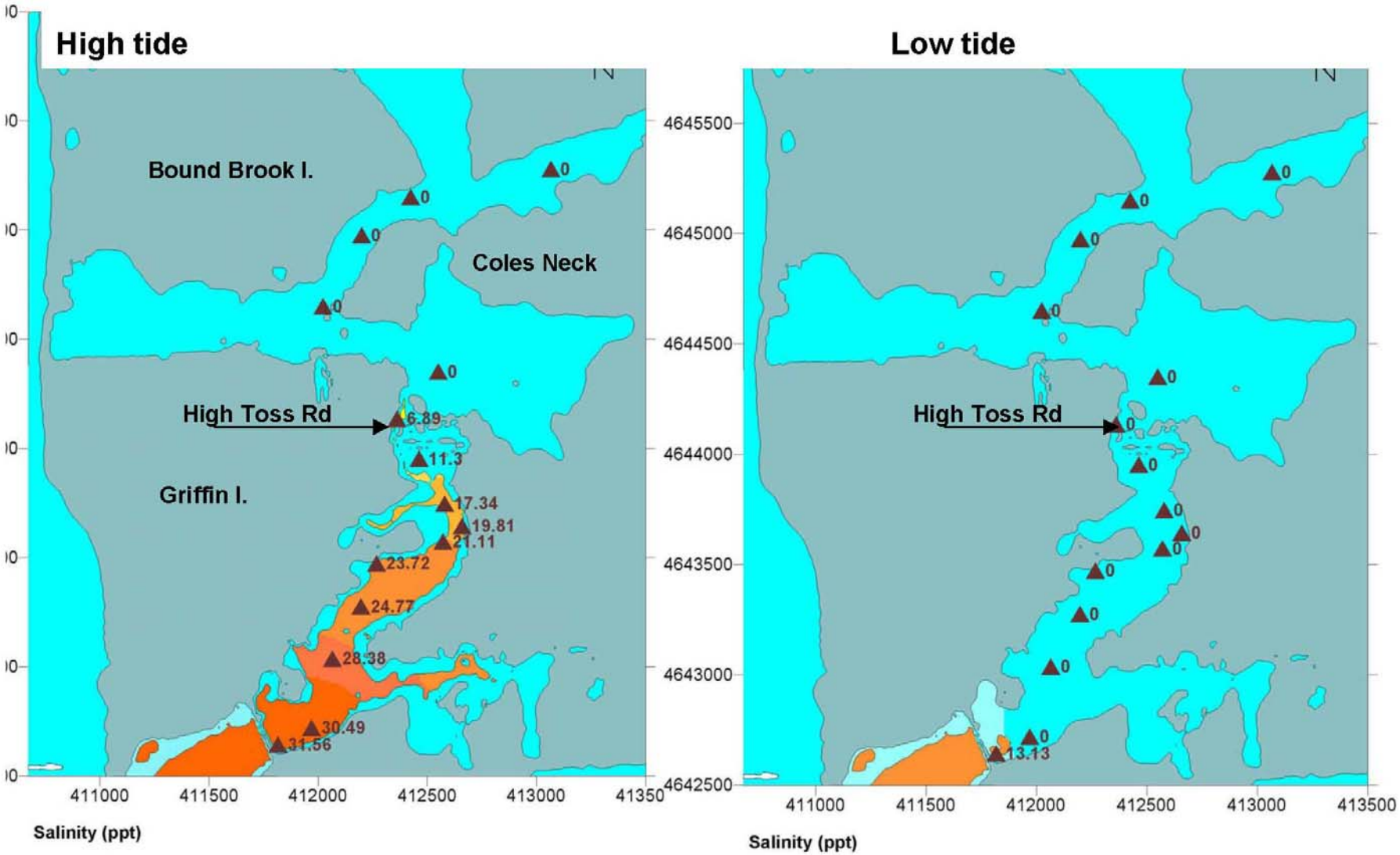
Numerous studies (reviewed in Portnoy 1999) have demonstrated that tidal restrictions, which reduce salinity and tidal flushing of estuarine habitats and dewater salt-marsh peat, increase the potential for poor water quality in aquatic ecosystems by disturbing natural biogeochemical cycling.

4.3.1 Salinity

Prior to construction of the main dike in 1909, the surface waters and surficial sediments within the Herring River estuary were flooded regularly with water ranging from full-strength seawater (32 parts per thousand [ppt]) at the river mouth, to probably at least 25 ppt at High Toss Road, 20 ppt at Old County Road and 10 ppt at the present Route 6. These estimates are based on the analysis of plant remains in sediment cores (Orson, R.A. in Roman 1987), and on hydrodynamic modeling of an unrestricted system (Spaulding & Grilli 2005). With the present tidal restriction, seawater extends upriver only a few thousand feet, just seaward of High Toss Road (see Figure 6). Under current diked conditions, even at high tide, brackish waters extend only to High Toss Road and at low

Figure 6

Current salinity distribution in the Herring River flood plain. At high tide, brackish water extends only about 3000 feet upstream of the dike, and does not reach High Toss Road. Low tide salinity is near zero throughout most of the river above the dike structure. Thus, estuarine animals and plants are severely limited.



tides salinity is near zero throughout most of the river above the dike. The remainder of the system north of High Toss is freshwater. Besides the profound effects of salinity reduction on vegetation, reduced pH buffering and ionic strength made Herring River's waters highly vulnerable to the chemical disturbance described below.

4.3.2 pH and metals

Diking and draining original saltmarsh habitats along the river have resulted in significantly increased surface water and soil acidity due to oxidation of the sulfur that naturally occurs in saltmarsh peat (Soukup & Portnoy 1986); the production of acid sulfate soils and acidified surface waters is an impact of salt-marsh drainage recognized throughout the world (Bremen 1982, Melville 1999). Wellfleet Harbor with its surface water at approximately pH 8 provides a natural reference site in comparison with the acidity levels found throughout parts of the river system. Acid sulfate soils with acidity levels at less than pH 4 can be found throughout much of the Duck Harbor, Lower Pole Dike Creek, Lower Basin and Mill Creek sub-systems (Figure 7). These conditions create major problems as the soils leach toxic acidity and aluminum from native alumino-silicate clays into surface water, stressing and killing aquatic organisms.

4.3.3 Dissolved oxygen

The elimination of tidal flushing in a wetland system that, albeit diked, still contained abundant organic matter, has caused regular summertime dissolved oxygen depletions and fish kills in the river main stem (Portnoy 1991). Conditions are worst in mid-summer, when oxygen demand is highest (see Figure 8), and has in the past compelled NPS to control the emigration of juvenile herring (*Alosa* spp.) to avert complete mortality and loss of the anadromous run (Portnoy et al. 1987). Conditions have improved since annual dredging of the main stem, purportedly for mosquito-control drainage, ended in 1984.

4.3.4 Fecal coliform

Tidally restricted estuaries also accumulate fecal coliform bacteria, producing concentrations during low tides and after heavy rain events that have led to the closure of local shellfish waters (Portnoy & Allen 2006). Fecal coliform was monitored at nine surface water stations in the Herring River from High Toss Road to Egg Island in 2005 (see Figure 9). Because of the low human population density along the Herring River, coliform here probably derive from wild animals. Hydrodynamic modeling (Spaulding & Grilli 2005) has shown that the dike decreases the dilution of coliform-rich river water, with relatively clean Cape Cod Bay seawater, by at least 13 times; this explains why fecal coliform (FC) is most abundant just below and above the dike structure. It also explains why coliform concentrations are highest during low tide, when high-FC river water predominates. If tides were restored and FC concentrations typically observed in the "contaminated" reaches of Herring River were diluted 13 times by clean bay water, resulting concentrations would be low enough to permit the re-opening of shellfish beds that have been closed for over 20 years. FC would probably be further reduced by increased salinity, which is well known to decrease coliform survival time in the environment (Bordalo et al. 2002).

Figure 7. Acid Sulfate Soils in Herring River Marshes

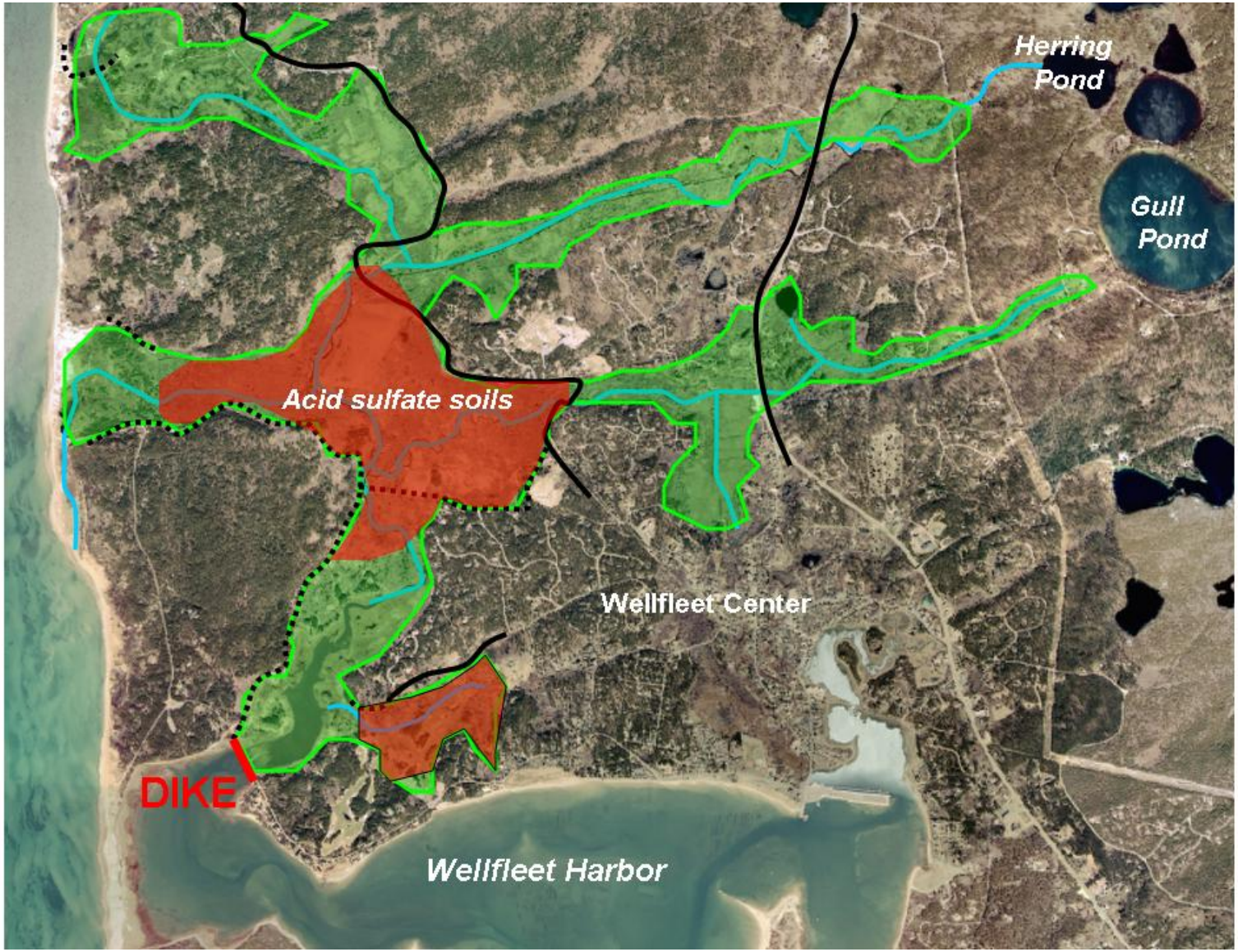


Figure 8. Summertime Dissolved Oxygen Depletions

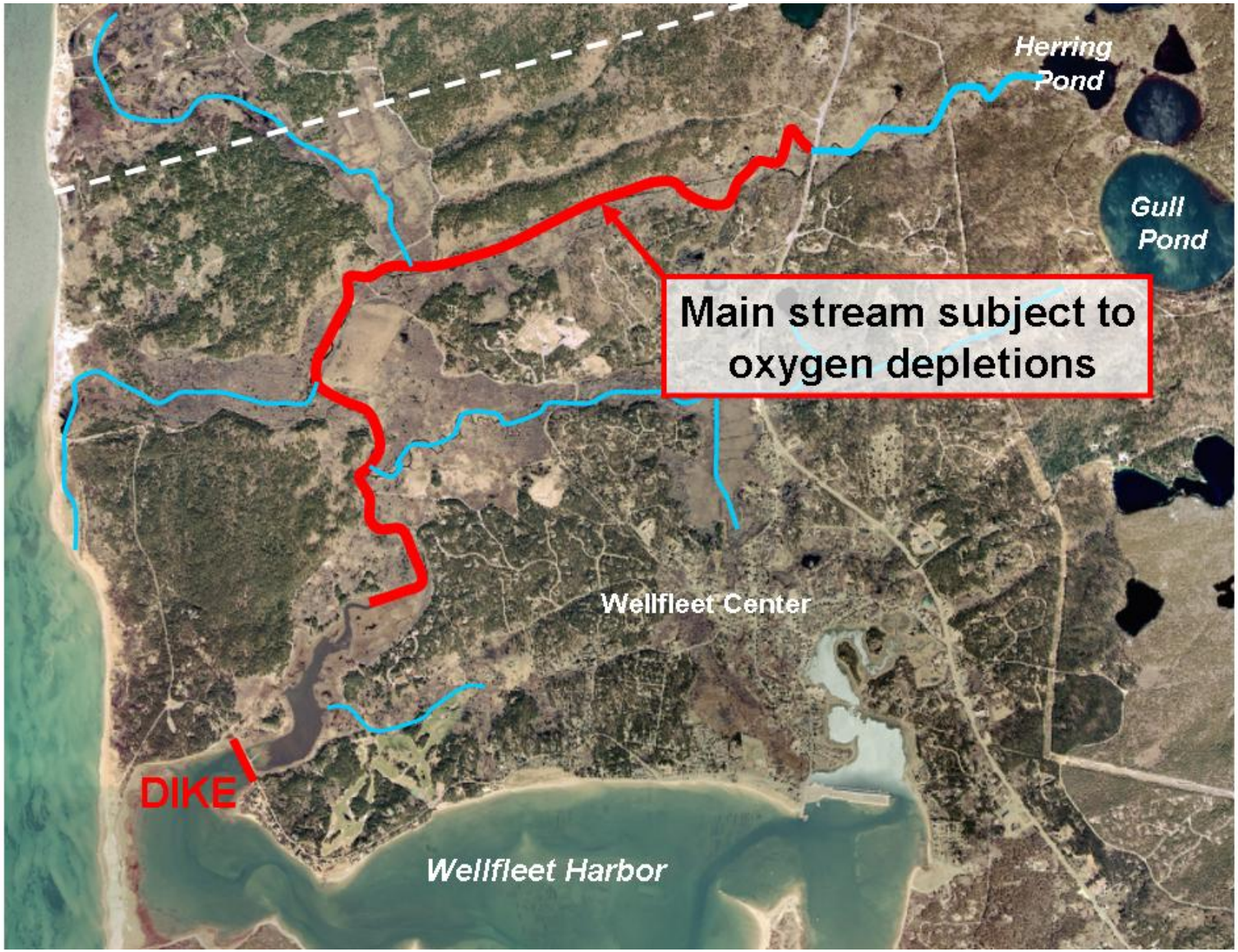


Figure 9. Fecal Coliform Concentrations in Herring River

Typical low-tide fecal coliform concentrations (colony-forming units per 100 ml) in Herring River. Fecal bacteria tend to accumulate around tidal restrictions because of poor tidal flushing, and low salinity increases bacteria survival time (Portnoy & Allen 2006). Shellfish harvest is prohibited if concentrations exceed 14 CFU/100 ml.

4.4 Surficial Geology

The Geological Map of the Wellfleet Quadrangle classifies most of the land area surrounding Wellfleet Harbor as either post-glacial outwash plain deposits or more recent marsh and swamp deposits. This glacial outwash valley comprises the aquifer that is integrally tied to the Herring River's hydrologic regime. Outwash plain deposits in the area are characterized by a combination of fine and coarse gravelly sand with a high content of quartzite stones. Boulders, cobbles, and stones are also found in the area. The marsh and swamp deposits, on the other hand, are soils characterized by decaying marine detritus, mixed with differing amounts of marine silt, sand, and clay (Oldale 1968).

4.5 Biota

Biota are collectively all of the animal, plant and microbial life in an area. Knowledge of the occurring species of plants and animals is critical for understanding any ecological system. This information is particularly important prior to implementation of restoration activities, as it provides a baseline dataset for current conditions against which any changes can be compared. Certain species are considered sentinels or bioindicators and their presence can be an indicator of a habitat's health.

4.5.1 Estuarine habitats

An estuary is a semi-enclosed coastal body of water with one or more rivers or streams flowing into it and with a free connection to the open sea (Cowardin et al. 1978). An estuary generally includes a range of subtidal and intertidal habitats, vegetated and unvegetated, that are influenced by regional tidal patterns. Subtidal habitats of the estuary typically include the beds of tidal rivers and creeks with a salinity gradient that ranges from full seawater to freshwater. Intertidal habitats of a New England estuary typically include mud flats exposed between high tides, low saltmarsh, high saltmarsh, brackish marsh, freshwater tidal marsh, and shrubland (Swain and Kearsley 2000). Excellent examples of some of these habitats, primarily subtidal and intertidal flats and saltmarsh, are presently found on the seaward side of the Chequesset Neck Road dike.

Estuary habitats at the mouth of the Herring River on the up-river side of the dike do not have a free connection to the open sea. These habitats are, therefore, not subject to the free exchange of sediment, nutrients, organic matter and biota with the ocean. This condition has existed for nearly a century. Furthermore, the remaining saltmarsh includes drainage ditches dug to drain standing water for mosquito control. Technically, therefore, while once functioning as a classic example of an estuary, the mouth of the Herring River contains habitats that are more typical of freshwater and brackish marsh.

Saltmarsh

Saltmarshes are intertidal wetland areas that typically occur at the mouths of coastal rivers in high-salinity waters and are vegetated by communities of salt-tolerant plants (Tiner 1987). In regions such as New England that are subject to a semi-diurnal tidal pattern (see

Glossary) the lower elevations of the saltmarsh (or "low marsh") are subject to daily inundation by tidal waters while higher saltmarsh elevations (or "high marsh") are subject to tidal inundation only during spring high tides and storm events. Each of these zones has a characteristic set of plant species adapted to conditions resulting from specific tidal flooding regimes. The following diagram depicts a typical profile of an estuarine habitat extending from a tidal river channel landward to upland habitat (Figure 10).

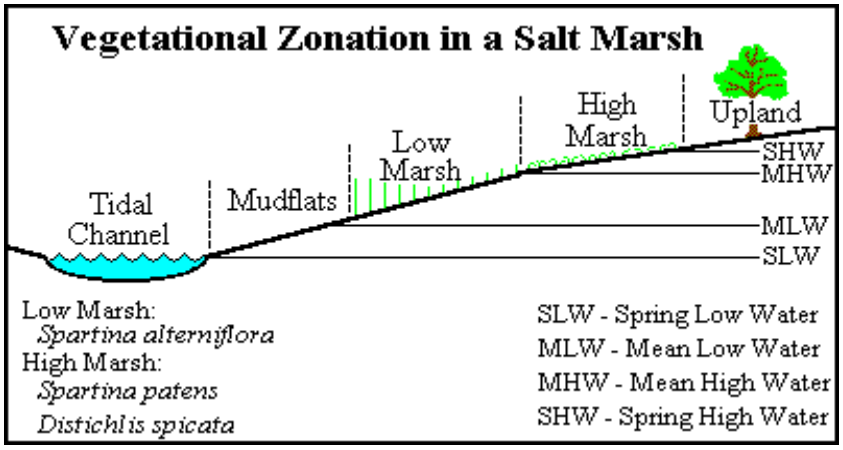


Figure 10: Generalized Saltmarsh Zonation

Numerous factors influence the formation of a saltmarsh, including climate, hydrology, and physical factors. Climatic factors include precipitation and temperature, hydrologic factors include tides, wave energy and patterns of fresh groundwater discharge, and physical factors include elevation, slope, sediment and soil composition, surface water, and salinity. Saltmarshes form in protected shallow-waters between the land and ocean and both salt and freshwater affect their formation. As these areas are somewhat physically protected, with slowly flowing waters, sediments carried both downstream from rivers and upstream by flood tides accumulate and are slowly colonized by saltwater grasses (Warren 1997). *Spartina alterniflora*, for example, creates habitat for other organisms, such as ribbed mussels (*Guekensia demissa*) and fiddler crabs (*Uca* spp.), which then create a positive feedback for cord-grass, which increases sediment deposition and helps to form the saltmarsh community (Warren 1997). With time, the saltmarsh develops into a rich, complex, and diverse community. Saltmarsh habitats play an important role in pollution control, storm surge protection, fish and shellfish nursery habitat, waterbird use, and overall near-shore marine productivity. As tidal range increases, saltmarsh productivity does as well (Steever et al. 1976).

Saltmarsh habitat in the Herring River

While once present in vast expanses within the Herring River estuary, tidal restriction and drainage efforts have converted these characteristic, highly productive saltmarsh habitats into freshwater wetland habitats, including river floodplain woodlands, shrub-dominant marsh areas, and *Phragmites*-dominant marshes. Only 13.6 acres of saltmarsh persists above

the Herring River dike, where before 1909 diking there were approximately 1,100 acres of productive coastal wetland habitats.

Subsidence of the marsh surface

In addition to the dramatic change in the plant community on the marsh surface since dike construction, the marsh surface itself has subsided considerably. Measurements indicate that much of the coastal floodplain is approximately three feet below its historic elevation and the surfaces of existing saltmarshes seaward of the dike (Portnoy 1999). Restricting daily tidal exchange between Wellfleet Harbor and the estuary effectively eliminated the important process of sedimentation on the saltmarsh surface. The import of inorganic sediment into an estuary and its deposition onto the marsh surface during flood tides must occur to promote the growth of *Spartina* grasses and to gradually increase the elevation of the marsh surface to keep pace with sea-level rise. The dike effectively blocked the inorganic sediment from reaching the saltmarshes within the Herring River basin.

While the deposition of organic sediment on the marsh surface continued, marsh draining increased the amount of available oxygen at the marsh surface and boosted the rate at which this organic material degraded. Marsh drainage also promotes the drying and compaction of saltmarsh peat. This compaction of pore spaces in the marsh peat and the lack of continuous sedimentation have resulted in subsidence of the marsh surface in the river basin.

Landward extent of existing saltmarsh at harbor margins

Expansive areas of saltmarsh habitat exists on the harbor side of the dike north of Great Island. The boundary of this saltmarsh habitat coincides with the spring high tide mark, which is approximately elevation 5.1 feet NAVD 88 (See Figure 2). These areas illustrate the normal habitat and reference conditions that are targeted by the Herring River restoration project.

Submerged aquatic vegetation

Submerged aquatic vegetation (SAV) in a New England estuary typically includes eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*). As primary producers, SAVs contribute to net estuarine productivity by manufacturing organic matter and releasing dissolved oxygen into the water column. SAVs are also important to the ecosystem as they provide habitat for many animal species and stabilize the sediment surface, thus promoting water clarity (Stevenson et al. 1979). SAVs are sensitive to nutrient loading and decline in embayments where excess nitrogen and/or poor flushing cause algae blooms. Thus, they are good indicators of development impacts on water and general estuarine habitat quality.

SAV Presence in Herring River

According to the NPS, there is a relatively extensive community of widgeon grass and a

smaller area of eelgrass in an area just above the dike. Both are often covered by macro-algae. The NPS has plans to map and monitor existing SAV communities in the near future.

4.5.2 Freshwater wetland habitats

The dramatic decrease in tidal range and salinity in the Herring River basin from diking resulted in conditions that favored the conversion of characteristic saltmarsh plant communities to freshwater plant communities. These new freshwater marsh habitats emerged atop a thick substrate of saltmarsh peat, rather than on top of peat that developed from the decomposition of freshwater plants. This freshwater plant/saltmarsh peat mismatch contributes to a number of the unnatural and undesirable conditions in the Herring River floodplain.

Plant communities found along the Herring River were surveyed during the 1980s and described as follows:

Phragmites australis-dominant marsh

Phragmites australis, or common reed, occurs downstream of High Toss Road. *Phragmites* has some salt tolerance and therefore competes for space against freshwater wetland plants at moderate salinities, e.g. 10-20 ppt. When tidal flow was restricted, the river's salinity levels were greatly reduced, which allowed for *Phragmites* to invade places previously dominated by *Spartina alterniflora* and *S. patens* (see Photo 8). Besides the large monotypic stand just upstream of the dike, scattered small patches of *Phragmites* occur throughout the Herring River basin. Where this plant dominates close to the dike (within about 1,200 meters), small stands of *Spartina alterniflora* and *S. patens* occur at lower elevations adjacent to the river while a shrub zone, dominated by poison ivy (*Toxicondendron radicans*) and northern bayberry (*Myrica pensylvanica*) occurs slightly higher (Art 1981; Beskenis and Nuzzo 1984).

Photo 8: *Phragmites*-dominant marsh along Herring River

The Invasive Plants Atlas of New England (IPANE) lists this tall (2 to 4 meters), stout grass species an invasive plant. IPANE indicates that "*Common reed can grow in a variety of habitats. It is most often found in wet or marshy areas. This plant grows best in fresh water, but also can be found in brackish, acid or alkaline wetlands. It is also found at the interface between wetlands and uplands*" (Mehrhoff et al. 2003). *Phragmites* tend to tolerate polluted conditions, which gives it an advantage over other plants that do not possess this tolerance. Wetland restoration project often are designed to control *Phragmites* because it will form expansive monotypic stands and by doing so displace valuable native coastal wetland plant communities, primarily saltmarsh.

Recent research (Saltonstall 2002) has documented the presence of numerous genetic strains of *Phragmites australis* throughout the world, including both native and non-native types occurring in New England. The native type is now classified as the sub-species *Phragmites australis* ssp. *americanus* (Saltonstall, P.M. Peterson & Soreng 2004). This sub-species was historically a common, non-invasive component of New England wetland plant communities. But, once the invasive type was introduced from Europe, it spread rapidly and outcompeted the native type, which is now rare compared to the massive stands of non-native *Phragmites* found in many locations. The presence of native *Phragmites* has just recently gained the attention of ecologists and its implication for tidal restoration projects in still unclear. For the Herring River, *Phragmites* has always been assumed to be the non-native type, but this needs to be confirmed and explored before implementation of the restoration project.

Typha-dominant marsh

Cattail dominated *(Typha* spp.*)* communities tend to occur as the river loses more salinity. *Typha* is more indicative of fresh water and thus dominates the edges of the river, often along with *Phragmites*, as close as 1,200 m upstream of the dike (see Photo 9).

Photo 9: *Typha*-dominant marsh along Herring River

River floodplain woodland and shrub-dominant habitats

Tree species including, red maple, pitch pine, aspen, and black cherry comprise woodland areas that were once saltmarsh habitats. Some of these former woodland areas exhibit freshwater wetland hydrology while other areas lack sufficient soil inundation and/or saturation and are upland. In many other areas, shrub-swamp is the predominant habitat type where saltmarsh once existed.

Black cherry woodland

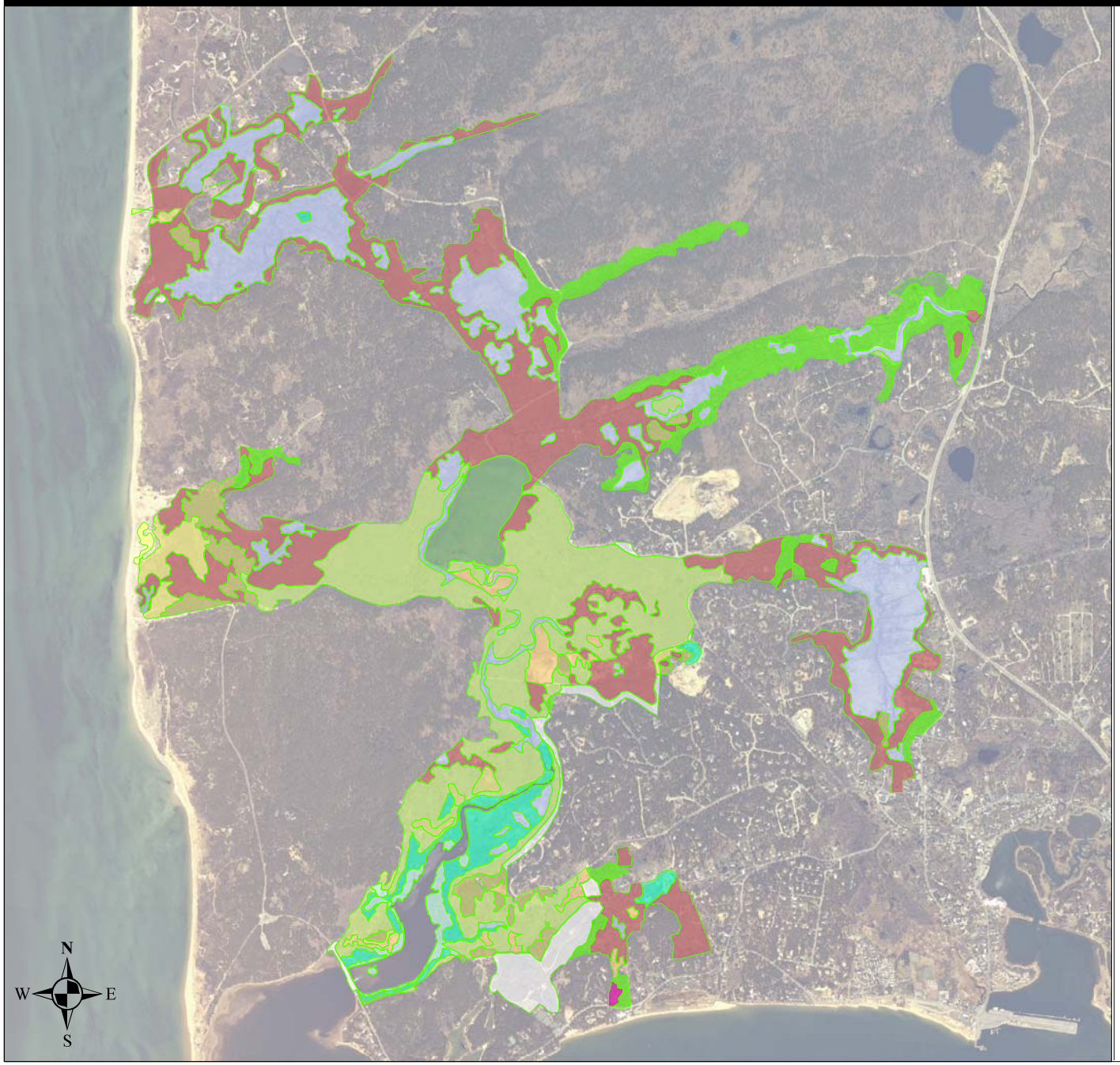
This vegetation cover type (Dry Deciduous Woodland in Figure 11, Vegetation Map) is typical of Duck Harbor and Lower Pole Dike Creek sub-basins. *Typha* and *Phragmites* are rare and black cherry can be found along with an understory of old field species, including goldenrod (*Solidago* sp.), Canadian lettuce *(Lactuca canadensis*), common velvet grass *(Holcus lanatus*), and Alleghany blackberry *(Rubus allegheniensis*). These old field species continue to

Herring River Vegetation

Updated from 2000 aerial photos with 2007 field observations .

Figure 11

Cape Cod National Seashore
National Park Service
U.S. Department of the Interior



Legend

- FRESHWATER MARSH
- BRACKISH MARSH
- SALT MARSH
- DUNE GRASSLAND
- HEATHLAND GRASSLAND
- OLD FIELD HERBACEOUS
- WET SHRUB
- DRY SHRUBLAND
- PINE WOODLAND
- DRY DECIDUOUS WOODLAND
- DRY DECIDUOUS FOREST
- WET DECIDUOUS FOREST
- DEVELOPED

TYPE	TYPICAL SPECIES
FRESHWATER MARSH	Typha angustifolia, Scirpus cyperinus, Calamagrostis canadensis, Juncus spp., Sparganium americanum.
BRACKISH MARSH	Phragmites australis, Scirpus pungens.
SALT MARSH	Spartina alterniflora, Spartina patens,
DUNE GRASSLAND	Ammophila breviligulata, Deschampsia flexuosa.
HEATHLAND	Arctostaphylos uva-ursi, Morella pensylvanica, Vaccinium angustifolium, Hudsonia ericoides, Hudsonia tomentosa, Corema conradii.
OLD FIELD HERBACEOUS	Schizachyrium scoparium, Deschampsia flexuosa, Holcus lanatus, Festuca rubra.
WET SHRUBLAND	Vaccinium corymbosum, Clethra alnifolia, Rhododendrum viscosum, Decodon verticillatus, Cephalanthus occidentalis, Alnus spp., Chamaedaphne calyculata.
DRY SHRUBLAND	Morella pensylvanica, Quercus velutina, Amelanchier spp.
PINE WOODLAND	Pinus rigida, Gaylusaccia baccatta, Deschampsia flexuosa, Vaccinium angustifolium.
DRY DECID. WOODLAND	Prunus serotina, Amelanchier spp., Viburnum spp.
DRY DECIDUOUS FOREST	Quercus velutina, Quercus alba, Fagus grandifolia, Robinia pseudoacacia.
WET DECIDUOUS FOREST	Acer rubrum, Rhododendron viscosum, Clethra alnifolia.

HOW THIS MAP WAS MADE:

Seemingly “natural” vegetation communities often contain unexpected assemblages of species because of habitat alterations caused by human intervention. For example, Herring River’s diked and drained floodplains have dry woodland communities where wet shrubs and marshes would be expected to occur. This general vegetation map of Herring River shows these human-influenced plant communities which are very different from the floodplain types that would result from restoration of tidal influences.

To make this map, color infra red aerial photos were interpreted and assigned vegetation types from a broad classification system of New England plant communities (Sneddon, Leslie, Vegetation of Cape Cod National Seashore Natureserve, 2004). New vegetation classes were then added based on extensive field observations to reflect actual vegetation within the tidal-deprived floodplain. In particular, the apparent wet woodland types dominated by red maple interpreted from aerial photography are actually dry woodlands dominated by black cherry and shadbush.

0 155 310 620 930 1,240 Meters

File: HRveg2000_nvc07

Date:082007

dominate miles upstream from the dike, where meadowsweet (*Spiraea latifolia)*, smartweeds (*Polygonum* spp.), and goldenrods are all prominent (Art 1981; Beskenis and Nuzzo 1984).

Other Invasive Plants

A 2001 study (Martin and Hanley 2001) of Herring River vegetation identified the following additional invasive plant species: multiflora rose (*Rosa multiflora*), bittersweet nightshade (*Solanum dulcamara*), watercress (*Rorippa nasturtium-aquaticum*), oriental bittersweet (*Celastrus orbiculata*), Morrow's honeysuckle (*Lonicera morrowii*), and Japanese honeysuckle (*L. japonica*). These species and others that have been found in the area (including velvet grass, black locust, cheatgrass, and curly dock) could be eliminated or greatly reduced through tidal restoration (Smith 2005).

Another invasive species that has the potential to become a nuisance around Herring River is purple loosestrife, *Lythrum salicaria*. It has already been identified on the shore of Higgins Pond, which connects to Herring Pond, where the Herring River originates (Martin & Hanley 2001).

4.5.3 Fish and wildlife

The following sections discuss finfish, shellfish, birds, mammals, insects, reptiles and amphibians, including rare animals known to occur in the system and surrounding areas. The NPS currently runs a monitoring program documenting the presence of shellfish, estuarine fish, birds, and mosquitoes in the Herring River system.

River herring

River herring include two anadromous species: alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) (Haas-Castro 2006). The alewife ranges from Labrador to South Carolina, while the blueback's range is from Nova Scotia to Florida (Haas-Castro 2006). Alewives typically live about ten years and grow up to 36 cm (14 in), while bluebacks typically live for about seven or eight years and can grow up to 32 cm (13 in) (Haas-Castro 2006). Procreation of these fish, and the persistence of an individual herring run, depends on a reliable connection, with good water quality, between the marine environment and their freshwater spawning ponds (Naiman et al. 2002).

River herring typically migrate up and down the Herring River from March through early December. The majority of adults are present in the river system from March through mid-June. Herring spawn in ponds including Gull, Higgins, Williams, Herring, and Black and in the upper reaches of the river. The young of the year (or "fry") make their seaward migration from July through November, although it is possible for large schools of fry to go downstream as early as mid-June and as late as mid-December (see Figure 12).

Figure 12. Herring River Anadromous Fish Run

Herring River, Wellfleet, MA
Anadromous Fish Run

Scale 1:30

3,000 0 3,000 6,000 9,000 Feet

Prepared: 10/29/2007

N

Legend

anadromous fish runs

MassGIS 2005 - NRCS Data Layer
Department of Fisheries, Wildlife and Environmental Law Enforcement (DFWELE)

Agency: NRCS
Field Office: HYANNIS SERVICE CENTER
State and County: MA, BARNSTABLE

District: CAPE COD CONSERVATION DISTRICT

Riverine estuaries form important migratory staging areas for anadromous river herring and catadromous eels (see below), allowing them time to adjust physiologically to radical changes in salinity. Tidal restrictions, like the Herring River dike, create a much steeper salinity gradient between marine and freshwater environments, making it more difficult for migratory species to adapt. Observed acidification (Soukup & Portnoy 1986) and summertime oxygen depletion (Portnoy 1991) have likely contributed to the decline in Herring River herring since the river was diked (Portnoy & Reynolds 1997).

Other anadromous and catadromous fish species

During the 1980s white perch and hickory shad were found at the mouth of the Herring River (Roman 1987). White perch can be found in abundance in the estuary and use the upper main stream and ponds as spawning sites. Like the alewife and blueback herring, white perch use the river to spawn in late spring, from April to June. White perch spawn over sandy bottoms, and are plentiful in coastal ponds with connections to the sea, brackish bays, estuaries, and river mouths (Bigelow & Schroeder 1953).

In addition to anadromous fish, the catadromous species, American eel (*Anguilla rostrata*), is also found in the river. Eels spend most of their lives in the upstream freshwater ponds and migrate to the open sea to spawn. The young eels, known as "elvers" enter the river on their way to the ponds in April and May and the adults travel the river on their way out in June.

Other fish species

There are also resident and transient fish in the river and its tributaries. These estuarine and freshwater species use these waterways for specific life stages, seasonal migrations or spend all of their lives in the river. Thus, the Herring River acts as an important habitat for dozens of nekton species, although diversity and abundance decline precipitously with distance above the dike (Roman 1987). When the dike's opening increased in 1984, large numbers of Atlantic menhaden began to utilize the ecosystem upstream from the dike as a nursery (Wellfleet Comprehensive Plan 1994). Other fish that have been found in the river include Atlantic mackerel, Atlantic silverside, bluefish, chain pickerel, common killifish, three-spine stickleback, golden shiner, hogchoker, pumpkinseed, sheepshead minnow, striped killifish, tidewater silverside, and winter flounder (Gwilliam 2006).

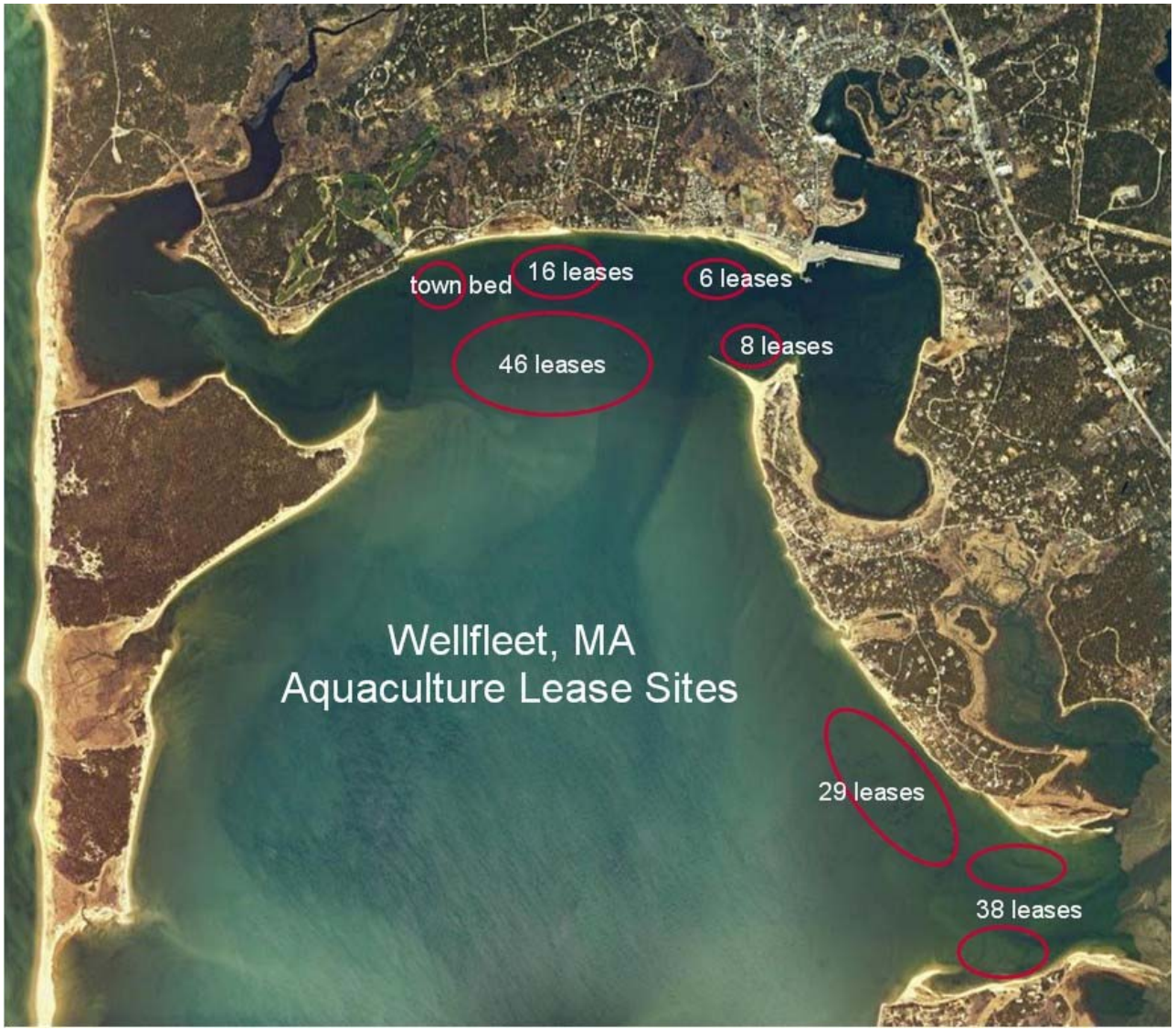
Shellfish resources

Oysters and soft-shelled clams could at one time be found widely in the Herring River estuary; oysters currently extend only a few tens of meters upstream of the dike structure, due to low salinity and pH. In addition, poor tidal flushing and consequently high fecal coliform both above and, for 3000 feet below, the dike have kept otherwise dense beds of oysters in the river mouth closed to harvest (Figure 13), and may even threaten the large aquaculture beds farther downstream (Figure 14) (Portnoy & Allen 2006). The Division of Marine Fisheries has prohibited shellfishing and shellfish propagation in all areas on the upstream side of the Chequesset Neck Road dike, for 3000 feet seaward of the dike, and

Figure 13. Designated Shellfish Closure Areas

Status of shellfish closures in Wellfleet Harbor including Herring River, fall 2007. State coliform sampling determines whether shellfish beds are open to harvest in “conditionally open” areas; typically these areas are closed for several days after major rain events. The waters just above and below the Herring River dike have been closed to shellfishing due to observations of high fecal coliform since the mid-1980s.

Figure 14. Aquaculture Lease Areas



farther depending upon season and rainfall. Although under current conditions this area remains closed to shellfishing due to bacteria contamination, it should be noted that the abundant resident oyster population still has great value, in providing spawn to the harbor, because it is protected from harvest. Thus, the mouth of the river presently functions as shellfish sanctuary with benefits to shellfish propagation throughout the harbor, something that the town may wish to perpetuate.

Birds

Many birds use saltmarsh habitats for breeding, foraging and roosting, including several species of waterfowl, raptors, wading birds, shorebirds and songbirds. Seasonal use of intertidal and saltmarsh habitat also varies, with some species using the saltmarsh for breeding and others during migration or the wintering period. The habitats, and consequently many of birds, found in the Herring River likely are different today when compared to what existed prior to the construction of the Chequesset Neck Road Dike. Much of the change in bird occurrence and use likely has been the result in the change of a system dominated by intertidal flats and cordgrass (*Spartina* spp.) to one that currently is dominated by freshwater (cattail and common reed) and mixed upland vegetation. Concurrent with these changes has been the resulting poor water quality conditions in the Herring River, e.g. acidification and oxygen depletions, and the limited tidal range that has adversely affected forage fish populations that are important seasonal food resources for many birds.

Species common to shrub thickets and freshwater habitat likely have increased in the Herring River floodplain as conditions changed landward of the dike due to the tidal restriction. These include, red-winged blackbirds, song sparrows, prairie warblers, common yellowthroats, eastern towhees, and grey catbirds. Many of these species are abundant nesters elsewhere on Cape Cod and southeastern Massachusetts (Veit and Peterson 1993). Tidal restoration eventually will permanently alter the current habitat conditions for some of these species and where it is possible, cause them gradually to shift to appropriate habitats higher in the Herring River system.

Several high priority tidal creek and saltmarsh-dependent species such as saltmarsh sharp-tailed sparrows, willets, American black ducks (especially winter), common and roseate terns, as well as several species of shorebirds and wading birds (USFWS, 2006) are expected to benefit directly through restoration of nesting (*Spartina* dominated habitat) and/or foraging opportunities (primarily estuarine fish) in the Herring River. Other species, including but not limited to, osprey, northern harrier, belted kingfisher, and American bittern will benefit from the restoration of foraging habitat.

Mammals

Small mammals, such as mice, voles, and shrews are very abundant in marsh grasses around Herring River. Larger mammals, such as coyotes, river otters, raccoons, and deer also utilize the floodplain. The most common group of mammals found in saltmarsh

habitats in the New England region are rodents, such as the meadow vole (*Microtus pennsylvanicus*), which are an important prey-species for Northern harriers and other raptors. Other common mammals of the saltmarsh include red fox, opossum, chipmunk, and muskrat (Smith 1997).

Most of these mammals are, at most, indirectly affected by saltmarsh restrictions and therefore tidal restoration may have an insignificant effect on them. The prevalent mammals in the area are generalists, highly adaptable, and likely to move to adjacent habitat unaffected by tidal restoration (Smith 1997).Mosquitoes

Surveys of both mosquito adults and larvae by both the NPS and CCMCP in around the Herring River floodplain have identified a normally brackish-water breeder, *Ochlerotatus cantator*, as the dominant species. This insect is also the most common biter of humans throughout outer Cape Cod, where diked marshes are considered a primary source of this nuisance species. At least 17 other mosquito species occur here, but only a few feed on people. Work on mosquito breeding ecology (Portnoy 1984) has shown close links among diking, consequent water quality impacts, and nuisance mosquito production, with *O. cantator* benefiting from surface-water acidification that excludes predatory fish from floodwater breeding sites.

Reptiles and Amphibians

Snapping turtles (Chelydra serpentine) and the American toads (*Bufo a. americanus*) are typically found within saltmarshes (West & Skelly 1997). Turtles such as the State-listed diamond-backed terrapin and eastern box turtle (further described below) are also known to use saltmarshes for habitat (Carlisle et al. 2002). It is also likely that many other species of reptiles and amphibians including green frog (*Rana clamitans melanota*), Fowler's toad (*Bufo woodhousii fowleri*), painted turtle (*Chrysemys picta*), eastern garter snake (*Thamnophis s. sirtalis*), and northern water snake (*Nerodia s. sipedon*) utilize saltmarsh habitats similar to those found at the Herring River and Wellfleet Harbor estuary. In a Cape Cod National Seashore study, spring peepers, bullfrogs, green frogs, and pickerel frogs were heard calling from Gull and Herring ponds (Paton et al. 2003).

Northern diamondback terrapins, the signature reptile of southern New England saltmarshes, is fairly abundant but at the apparent northern limit of its range in Wellfleet Harbor just seaward of the dike. A few individuals have been observed upstream of the Herring River dike structure.

Rare animal species in the Herring River system

The Herring River system contains habitats for a number of State-listed rare animal species and no Federally-listed rare species. The State-listed species include northern harrier (*Circus cyaneus*), diamondback terrapin (*Malaclemys terrapin*), eastern box turtle (*Terrapene c. carolina*), water willow stem borer (*Papaipema sulphurata*), and four-toed salamander (*Hemidactylium scutatum*). The Natural Heritage and Endangered Species Program (NHESP) of the Massachusetts Division of Fisheries and Wildlife provides maps of areas

that contain habitats supporting rare species.

Northern Harrier

Harriers (*Circus cyaneus)* regularly hunt throughout the year within the Herring River floodplain and surrounding heathlands. In addition, this State-listed threatened species regularly hunts and may breed in the Bound Brook area (Bowen 2006) in which case increased tide heights and salinity and consequent vegetation changes with tidal restoration may affect nesting locations and success. Harriers typically nest and forage in grasslands, rather than shrubby woodlands.

Diamondback terrapin

The terrapin is a marine turtle that will use the brackish marsh habitats of the Herring River estuary as foraging habitat and will use sandy shoreline habitats along the river as nesting habitat. Cape Cod is the northern extent of its range. In Massachusetts this species of reptile is state-listed as threatened. This animal would likely extend, or more accurately reestablish, its range in Herring River with tidal restoration.

Eastern box turtle

Eastern box turtles are a relatively common terrestrial reptile on Cape Cod that will use dry and moist woodland and marsh habitats. The pine barrens and oak thickets that are present in areas adjacent to the Herring River estuary are considered optimal habitat types for this species. Upland habitats that support communities of bearberry (*Arctostaphylos uva-ursi*), lowbush blueberry (*Vaccinium angustifolium*), and bracken fern (*Pteridium aquilinum*), which are common upland habitat plant species near the estuary, are also preferred habitat for the turtle (Degraff 1986). In Massachusetts, NHESP lists this reptile as a species of special concern. Box turtles frequent at least the edges of the diked floodplain, especially during dry summer periods when they move into fresh surface water for hydration.

Water-willow stem borer

Water-willow stem borer is a nocturnal moth found only on the coastal plain of southeastern Massachusetts and Cape Cod, in the shallowest portions of vernal ponds and seasonally flooded swamps and along upland edges of streams, ponds, and other permanent bodies of water. Only wetlands supporting a significant amount of water willow (*Decodon verticillatus*) within a restricted shallow-water zone are inhabited by this species according to the NHESP. Water-willow stem borers use water willow to lay eggs, for feeding, and growth. Along the margins of the Herring River and its tributaries there are numerous water willow communities that are known to support the stem borer (Beskenis and Nuzzo 1984); these sites were recently surveyed, mapped, and studied (Mello 2007). In Massachusetts this moth is a State-listed threatened species. In informal discussions, NHESP staff have expressed an appreciation for the benefits of whole-system restoration to thousands of native plant and animal species, and support tidal restoration provided it occurs gradually to allow salt-sensitive and rare animals like the stem borer to shift its local range.

Four-toed salamander

Adult four-toed salamanders are terrestrial amphibians and are usually found in forested areas near their breeding habitat. Breeding habitat is found in wetland areas that contain *Sphagnum* moss under which this salamander deposits it eggs. Their distribution is limited to areas that provide both breeding and upland habitats in close proximity. According to NHESP records, there are presently a number of locations along the Herring River and its tributaries where there is habitat suitable for this species. These habitats were surveyed and mapped (Cook 2006); breeding (egg masses and attendant females) were found above Route 6, in the Bound Brook sub-basin, and in Upper Pole Dike Creek marshes. This animal, which does occur and breed elsewhere on the outer Cape, prefers steep *Sphagnum* hummocks over open water for nesting sites. In Massachusetts this amphibian is a species of special concern. As for the stem borer, NHESP staff understand the system-wide ecological impacts of diking and support estuarine restoration provided that it is undertaken gradually to allow animals to re-adjust to lower-salinity environments within and adjacent to the floodplain.