7-1-2009

Green Pond Harbor Management Plan (DRAFT)

Urban Harbors Institute, University of Massachusetts Boston

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NOTE: Unless stated, all figures contain data provided by the Town of Falmouth, MassGIS and the Urban Harbors Institute.

1 PURPOSE, SCOPE AND AUTHORITY OF THE MANAGEMENT PLAN

1.1 PURPOSE, SCOPE AND AUTHORITY

Green Pond is one of a number of coastal ponds in Falmouth. It covers over 135 acres and is an important natural and recreational resource for the people of Falmouth and visitors. Most of the area around the pond is private residential property interspersed with a few commercial businesses and open space. As with other areas of Massachusetts, the tidelands around the pond fall within the jurisdiction of Chapter 91 (the Massachusetts Public Waterfront Act). Through Chapter 91, the Commonwealth seeks to preserve and protect the rights of the public, and to guarantee that private uses of tidelands and waterways serve a proper public purpose. In order to better protect the natural resources and to manage uses of the coastal ponds, the Town of Falmouth decided to develop harbor management plans for each of them. The Green Pond Harbor Management Plan is the first of these.

The Green Pond Harbor Management Plan presents the community's goals, objectives and recommendations for guiding public and private use of the land and water of Green Pond and establishes an implementation program to achieve the desired outcomes. The plan was prepared under the auspices of the Falmouth Board of Selectmen and guided by the Coastal Ponds Management Committee.

The Coastal Ponds Management Committee's Mission Statement it to:

> *"Evaluate each coastal pond separately and independently, taking into consideration all of the town sanctioned activities that take place in the particular pond and to integrate these activities into a management plan that balances the preservation of natural resources and improved water quality with the public use of the resource."*

There are seven members of this committee who are appointed annually by the Board of Selectmen. They possess varied related backgrounds including but not limited to marine science, recreational fishermen/shell fishermen, recreational boaters, commercial marine industry and commercial shell fishermen or shellfish dealers. Of these seven appointees, one member of this committee must be from the town Planning Board (or its designee), one member must be from the town Conservation Commission (or its designee), one member must be from the town Waterways Committee (or its designee).

The Coastal Ponds Management Committee is an advisory committee to the Board of Selectmen and may make recommendations to other boards and committees through the Board of Selectmen.

At the time of this study, the committee members are:

- Charles McCaffrey – Chairman
- Elizabeth Gladfelter – Vice-Chairman
- George Hampson
- Joseph Apicella
- Clarence Leonard
- Brendan Anett

The overarching goals for the Green Pond Harbor Management Plan (and future plans for the other coastal ponds in Falmouth) are to:

- Preserve and enhance the open space and recreational values provided by the town's system of coastal ponds;
- Reduce harmful effects of uses and activities in and surrounding the coastal ponds in order to restore and preserve coastal pond ecosystems and allow for sustainable human uses; and,
- Improve governance and stewardship of the coastal ponds through identification of regulatory designations.

1.2 THE PLANNING AREA

The planning area was developed with the Costal Ponds Management Committee and the Urban Harbors Institute. The planning boundary encompasses all of the land and water area relevant to the issues to be addressed by the Harbor Management Plan. It was also chosen so that this plan could be combined with other plans as they are developed. The approximate boundary runs from the southern corner of Vineyard Street and Ocean Avenue along Ocean Avenue to Bridge Street. It then runs along the western side of Bridge Street to Acapesket Road. It continues on the western side of Acapesket Road until it reaches Route 28 (East Falmouth Highway). Here it crosses Route 28 and continues eastwards to Davisville Road. It then runs on the eastern side of Davisville Road southwards until it means the Menauhant Road. The boundary then stays south of Menauhant Road to the west. At Davis Neck Road it remains on the eastern side of the road but follows it until running offshore. It runs offshore for about 260 feet and then connects in a straight line across the mouth of the pond to the corner of Vineyard Street and Ocean Avenue.

1.3 THE PLANNING PROCESS

In early 2008, the Town of Falmouth, MA issued a Request for Proposals for a Harbor Management Plan to be developed for Green Pond. Following a selection process, the town contracted the Urban Harbors Institute of the University of Massachusetts Boston to help develop the plan. Work began in March 2008.

The process began with a scoping meeting with the Coastal Ponds Management Committee. This was followed by regular meetings with the committee and a series of meetings with town officials and stakeholders.

The Urban Harbors Institute met with the committee eight times between March and December, 2008. These occurred on:

- March 31
- May 5
- June 2
- August 4
- September 8
- October 6
- November 17, and

- December 8.

A public meeting was held in the Selectmen's Meeting Room of the Town Hall at 7pm on July 2 to get further public input and to discuss the initial list of issues that had been developed. A second public meeting was held at **XXXXXXXXXX** to discuss the plan's recommendations and action items.

Figure 1: An aerial photograph of Green Pond showing the planning area boundary.

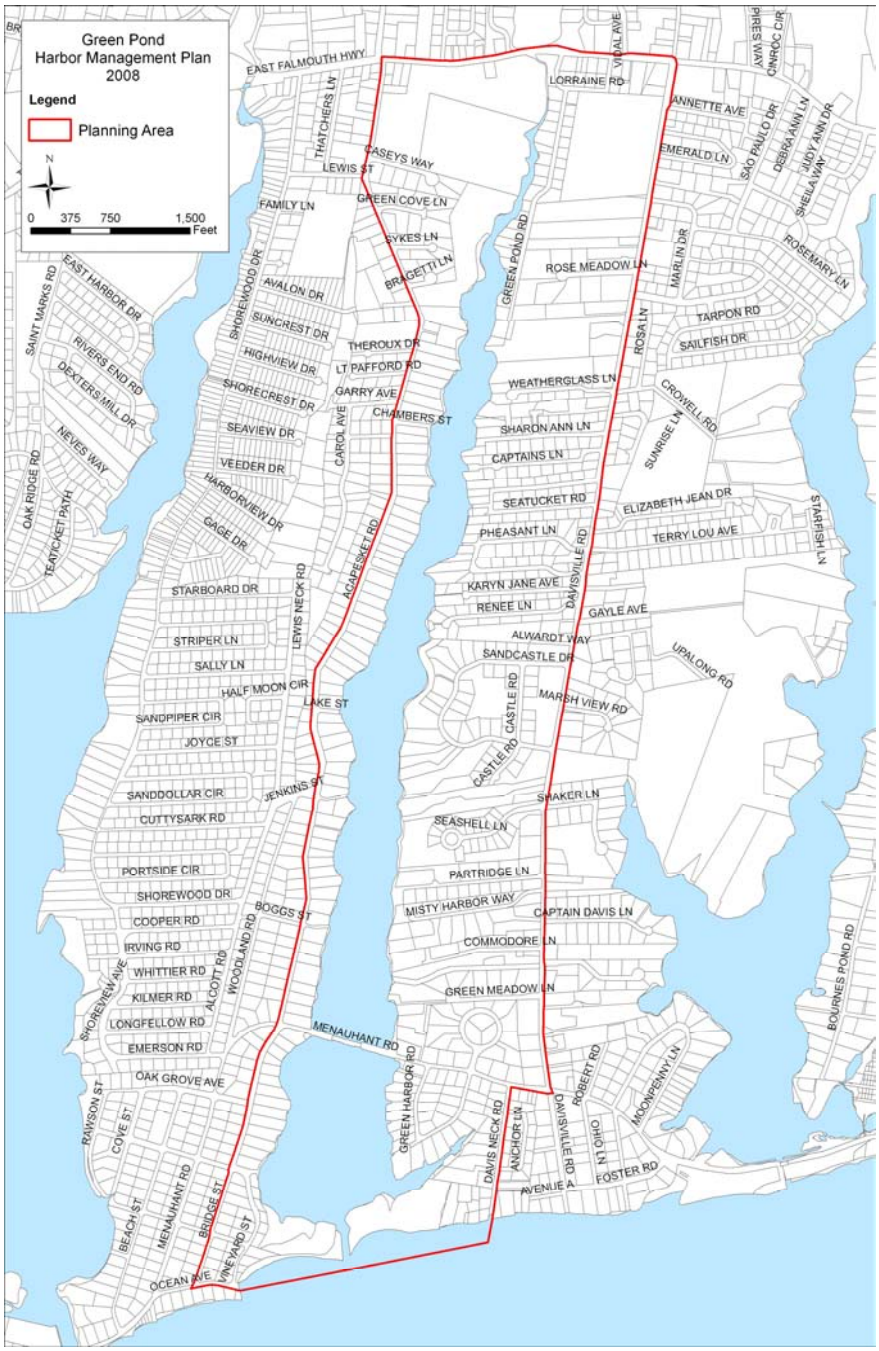


Figure 2: The Green Pond planning area.

Stakeholder and town official interviews were conducted with:

- Gregg P. Fraser – Harbormaster and Town Marina
- Mark Patton – Department of Natural Resources
- Charles Martinson – Department of Natural Resources and Shellfish Constable
- Jennifer L. McKay – Conservation Commission
- Peter McConarty – Department of Public Works

- Brian Currie – Planning Department
- Bud Ingalls – Manager, Green Pond Marina
- Lisa Landers – Green Pond Tackle and Marina

1.4 ISSUE IDENTIFICATION PROCESS

The issue identification process involved a number of meetings with the committee, various stakeholders (including local officials) and a public meeting to solicit input and ideas.

1.5 SUMMARY OF IDENTIFIED ISSUES

A number of issues and questions were identified as being important to stakeholders. Some of these were deemed to be beyond the scope of a Green Pond Harbor Management Plan and are therefore not addressed in this document. While they are included in the list below, they are shown in italics.

1.5.1 Water Quality

- *Septage/sewerage aspects of water quality are to be addressed by others and are not the focus of this plan.*
- The plan should assume that water quality will improve to the point where eelgrass will again populate significant portions of the pond.
- There are various sources of potential pollution (e.g., outfall pipes and catch basins along the shores of the pond).
- What can be done other than construction a sewerage system to also help improve water quality (e.g., vegetated buffers) to maintain or improve water quality and protect from stormwater impacts and sedimentation?
- What are the levels of water quality impairment from boating activities?
- Is the existing boat sewage pumpout facility sufficient?

1.5.2 Shellfish and Eelgrass

- The study by ENSR suggests that eelgrass and shellfish habitat will increase and improve as water quality improves.
- As this happens, the potential impact of boating (particularly moorings) on these habitats may also increase.
- Efforts to minimize such impacts could include regulating the type of tackle used, reorganizing existing mooring areas or restricting moorings in areas where they currently exist.

1.5.3 Alewife Run Through Green Pond to Mill Pond

- Status of the former Alewife run through Green Pond and into Mill Pond should be addressed and recommendations for improvements should be developed.

1.5.4 Moorings

- Within the pond, a mooring plan exists only for the area south of the bridge. However, mooring numbers are being restricted in the north of the pond. Why is this?
- Should the town limit the number of moorings that an individual may have?
- Should the transfer of mooring be limited to a spouse? I.e. should the transfer of mooring down to other generations be prohibited?
- *Could the existing waiting list for moorings be reduced by allowing waterfront property owners to have a mooring?*

1.5.5 Docks

- Are the existing docks in Green Pond in compliance with their Orders of Condition and Chapter 91 licenses?
- Is there a limit to how many new docks are desirable?
- Are there areas of the pond where docks should be encouraged or prohibited?
- *Is there any way to provide an incentive for the development of common docks rather than individual, private docks?*

1.5.6 Impacts to Circulation and/or Tidal Flushing by the Menauhant Road Bridge

- There are conflicting views as to whether or not the culverts that were constructed in the bridge are effective.
- Dredging should be facilitated as it would help flush the pond and help with water quality issues.

1.5.7 Dredging

- At this time, the only dredging that the Waterways Committee will consider in Green Pond is maintenance dredging of the entrance to the pond. However, future dredging may be required to maintain boating access to the two commercial boating facilities.
- Presently the MA Division of Marine Fisheries (DMF) limits timing of dredging at the mouth of the pond to protect winter flounder and horseshoe crab spawning. This is based on a "generic" timing assessment.
- The DMF limitations and the boating season means that the actual window for dredging is extremely limited and means that it often occurs at non-optimal times.
- *The northern part of the pond is becoming very shallow due to sedimentation. Some docks in the area now have insufficient water depths.*

1.5.8 Invasive Species

- Invasive species continue to be an issue in the pond and efforts are needed to reduce/eliminate them where possible. The most prevalent invasive in the pond is the common reed (*Phragmites australis*), but European green crabs (*Carcinus maenas*) and non-native tunicate species are also an issue.

1.5.9 Flood Hazard

- What are the flood hazard risks within the pond?
- *How could these change with possible sea level rise?*

1.5.10 Public Access

- Boating access to the pond is very limited.
- Parking is a significant limiting factor.
- Are there opportunities for increased access including (possibly non-motorized vessel) access in the north of the pond?

1.5.11 Vegetated Wetlands

- What should be done to protect vegetated wetlands in the pond?

1.5.12 Land and Water Use – Increased Development and Zoning

- Are there opportunities for expanded commercial development on the pond?
- If there are, should these be encouraged or discouraged?

2 INVENTORY AND ANALYSIS OF POND RESOURCES AND USES

2.1 NATURAL RESOURCES

2.1.1 Eelgrass

Eelgrass is a type of seagrass that grows in the shallow coastal waters with low nutrient inputs. It is able to grow in water as deep as 8 feet. This seagrass, both alive and dead, is an important and valuable part of the coastal ecosystem. As a live plant, eelgrass provides a sheltered habitat for many organisms, stabilizes sediment and also helps to improve water clarity. When eelgrass dies, it washes ashore and accumulates along the tide line. Here, the mass of dead eelgrass provides a nursery for the seeds of beach plants that will eventually help to form new dunes and stabilize existing ones. Shorebirds will also feed on insects and small crustaceans that are found in the mass of dead eelgrass.

Eelgrass is also an indicator of water quality. It is able to store nitrogen in its leaves and stems. This allows the plant to grow well in areas with low nutrients. However, when nutrient concentrations increase, algae are able to grow more successfully. Ultimately, the algae out-compete eelgrass by blocking sunlight penetration. As there is currently no significant eelgrass in Green Pond (Figure 3) and nutrient levels are known to be high, the recovery of this valuable resource in the pond is believed to be dependent on reducing nutrient loading – the most significant source of which is coming from septic systems. The premise behind this plan is that a local sewerage system needs to be developed before many of the significant recommendations can be implemented as effectively as possible.

A Green Pond benthic habitat assessment was conducted in June 2007 by the ENSR Marine and Coastal Center of Woods Hole, Massachusetts and was funded through the CPA (the summary report can be found in the Appendix). The goal was to determine the present health of the pond system, in particular, its ability to support viable populations of shellfish and eelgrass beds. The data gathered included biological, chemical and physical characteristics of the sediments that form the “land under ocean” and “land under salt pond” of Green Pond.

This benthic habitat assessment was a necessary pre-requisite for developing the Green Pond Harbor Management Plan. This plan balances the needs of the town to preserve natural resources as well as allow public use of open space. The results of this benthic habitat assessment have been used to determine what areas of the pond would be most likely to recover from the degradation of habitat that has occurred over the past 50 years (accelerated in the past 25 years). As importantly, these results provide baseline data so that efforts to restore pond health can be quantitatively assessed in the future. A variety of other needed information needed to formulate a management plan (such as presence and location of docks and moorings; regulations on coastal development; sites of stormwater outfalls; etc.) is available from local and state sources.

Shellfish and eelgrass are not only import resources in themselves but are good biological indicators of the general ecological health of the coastal ponds. In addition to these assessments, ENSR also sampled other biological, as well as chemical and physical characteristics of the “land under salt pond” in a number of sample sites. All the data collected were identified by sample site, which was located by GPS. The results were entered into the town GIS system, and all the data are available as data layers.

The physical data include:

- Depth (bathymetry)
- Sediment grain size;

The chemical data include:

- Total organic carbon (TOC)
- Apparent redox potential discontinuity (aRPD) layer depth; and

The biological data include:

- Invertebrate indicator species abundance and distribution
- Shellfish abundance (high, medium and low)
- Presence/absence of eelgrass;

These data, when evaluated by sample station enable the determination of whether a given site has:

- Potential physical habitat values for shellfish species (high, medium and low)
- Potential physical habitat values for eelgrass (high, medium and low)

ENSR sampled 158 stations for shellfish abundance, aRPD, and eelgrass presence or absence; as well as 40 stations for grain-size and TOC and 10 samples for benthic indicator species. The data obtained (depth, grain-size, TOC, ARPD, indicator species and the shellfish abundance) was utilized to map the existing and the potential habitat for shellfish and eelgrass. Maps were created based on the existing physical conditions and future water quality improvement. This information has been incorporated into this plan.

The GIS datalayers, developed in the course of this assessment, include attribute tables from which more detailed information can be obtained. The attribute tables are in the GIS database but were also provided to the town as Microsoft Excel spreadsheets of field data values. The attribute tables incorporated into the datalayers include the following:

- Coordinates of the stations sampled
- Number of rake hauls for shellfish at each station (for density measurements)
- Measurements (length, width and number) of the shellfish found by species
- All benthic invertebrate data by station
- Grain-size information by phi class

The data provided by this work is necessary for the harbor management plan under preparation, and can be used to aid decision making by the Conservation Commission and other agencies charged with protecting coastal resources. The utility of ArcMap GIS combined with the sets of scientific information places the Town of Falmouth in a position to become a leader on Cape Cod in the management of coastal ponds.

The ENSR study concludes that most of the pond to the north of the bridge is unlikely to be a suitable habitat for eelgrass, even when water quality has improved. In the majority of the rest of the pond eelgrass recolonization is expected to be slow. ENSR predicts a small area to the north east of the bridge could show intermediate recovery and a swath largely to the western side of the pond south of the bridge that could be expected to be recolonized most rapidly (Figure 4). Future eelgrass is expected to be found largely to the south of the bridge. This is significant as this is where the majority of the moorings in the pond are currently located and many types of mooring tackle are known to scour the seafloor and are therefore detrimental to eelgrass beds. It is possible that eelgrass in Vineyard Sound could naturally seed parts of the pond.

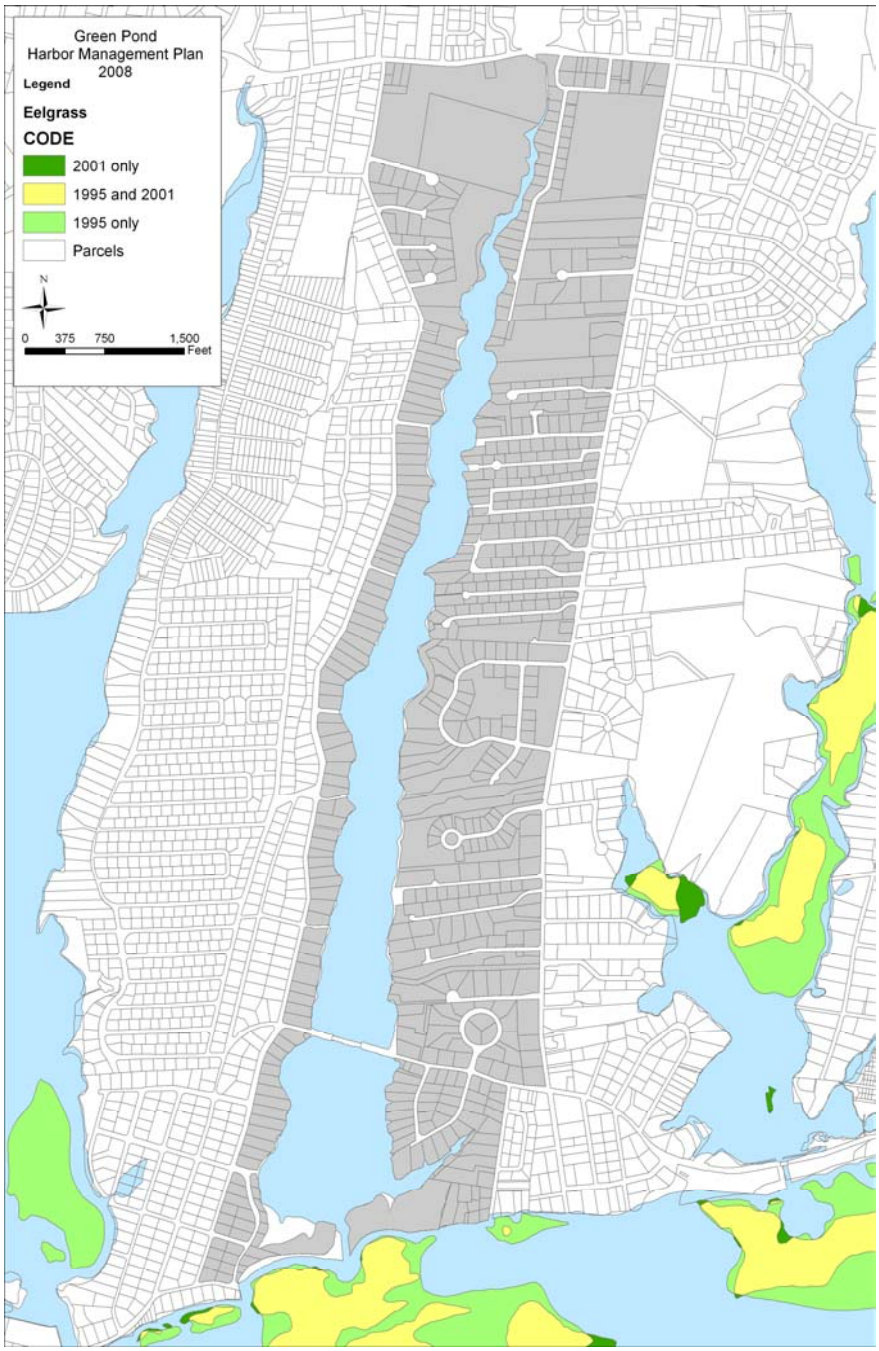


Figure 3: DEP's most recent data on eelgrass showing that there is none in Green Pond.

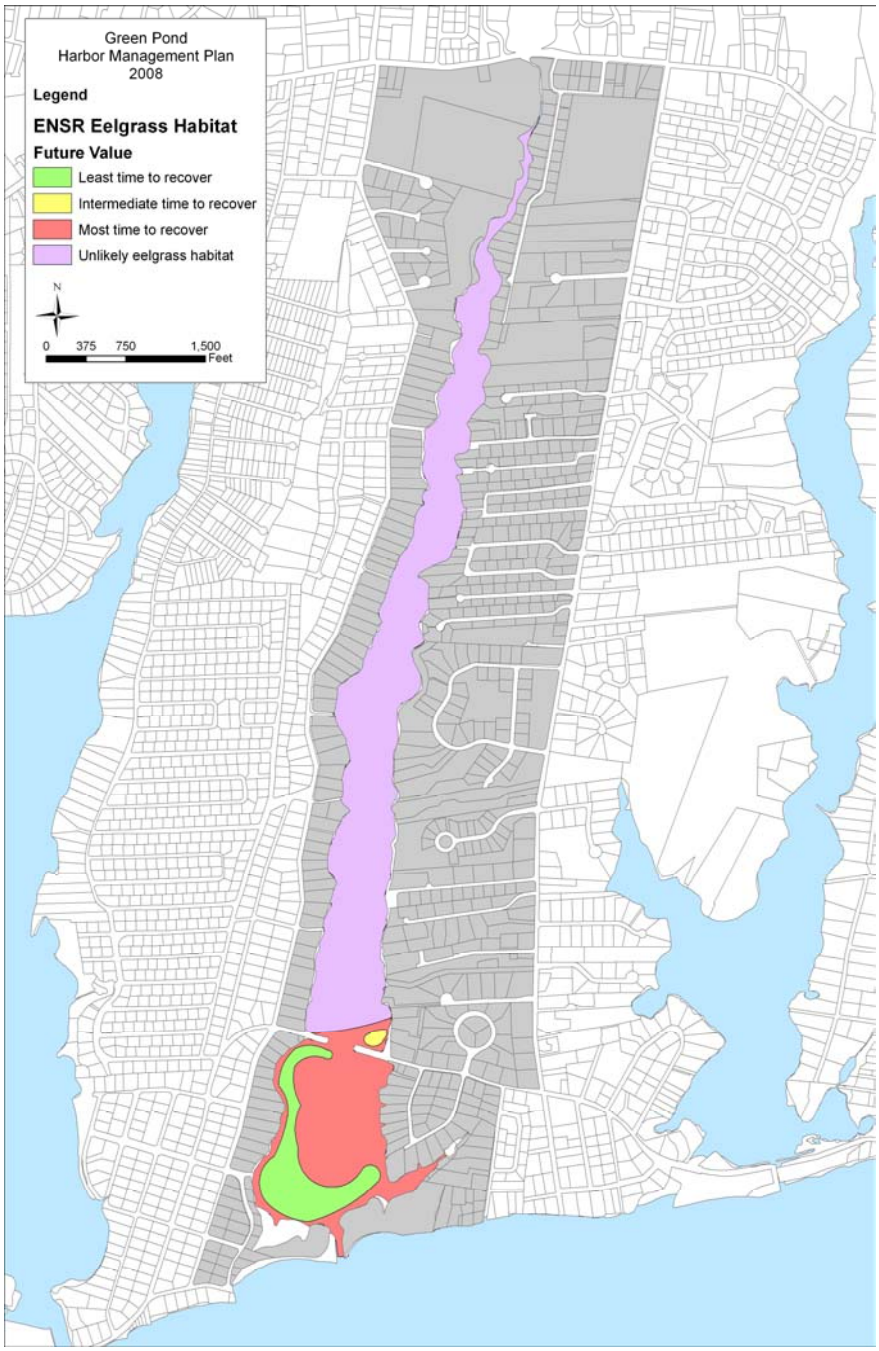


Figure 4: Predicted future eelgrass habitat within Green Pond based on the ENSR study.

2.1.2 Shellfish

At this time, all of Green Pond is classified as "conditionally approved" for shellfishing based on the MA Division of Marine Fisheries regulations (Figure 5). This means that *"during the time area is approved it is open for harvest of shellfish for direct human consumption subject to local rules and state regulations."*

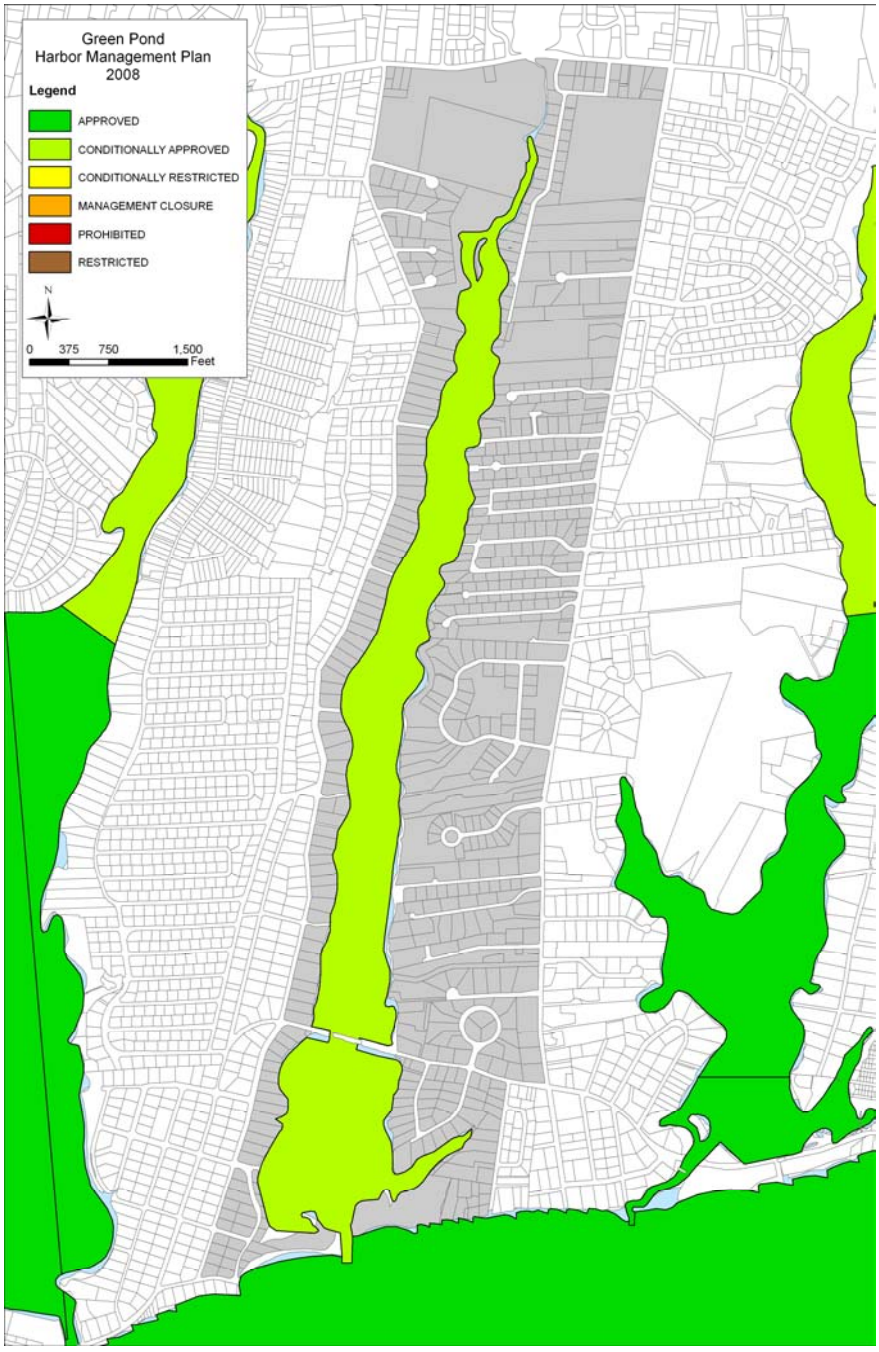


Figure 5: DMF's designated shellfish growing areas.

In 2006, 25 commercial shellfishermen used the pond with the greatest activity occurring in November. The pond is also popular for recreational shellfishing and approximately 1,600 bushels of quahogs are

harvested from the pond annually. The most common shellfishing techniques are bullraking for quahogs and using plungers for soft-shell clams. The Department of Natural Resources recognizes that some of these techniques may no longer be suitable when eelgrass begins to recover. In 2008, the town charged $200 for a commercial shellfish license, $20 for a recreational license for a resident/local tax payer and $50 for a non-residential recreational license.

The Department of Natural Resources maintains a shellfish upweller just to the south east of the bridge opening and uses the shallow area in the southwest corner of the pond for grow-out. By the end of 2006, DNR estimated that 8 million quahogs had been raised in partnership with Senior Americorps volunteers. These quahogs are seeded throughout the town's waters on an annual basis.

DMF also provides data on shellfish habitat suitability areas. These *"delineate areas that are believed to be suitable for shellfish based on the expertise of the Massachusetts Division of Marine Fisheries (DMF), the opinion of local Massachusetts Shellfish Constables, and information contained in maps and studies of shellfish in Massachusetts. The areas covered include sites where shellfish have historically been sighted, but may not currently support any shellfish. The shellfish suitability areas were not verified in the field and the boundaries were not surveyed."* (MassGIS website). However, it is felt that the data gathered during the ENSR study is of practical use as it focused on Green Pond.

The ENSR study found that the highest value shellfish habitat is currently to the south of the bridge. Moderate value shellfish habitat is currently found near to the shoreline throughout much of the pond. The central areas of the pond and the extreme northern end of the pond are classified as of low value shellfish habitat (Figure 6).

The ENSR study also predicts how the value of shellfish habitat might recover as water quality improves. It is predicted that the high value areas will spread throughout much of the area south of the bridge and will also include some areas immediately north of the bridge. Moderate value areas will also increase significantly south of the bridge. Ultimately all the area south of the bridge is predicted to be moderate to high value shellfish habitat. The current areas of moderate value near to the shoreline in much of the pond are expected to expand significantly, leaving a narrow strip of low value habitat in the middle of the pond above the bridge. The extreme northern end will continue to be of low value as shellfish habitat (Figure 7).

An additional valuable source of data on shellfish can be found at the Conservation Commission as information on shellfish must be gathered as part of the permitting process.

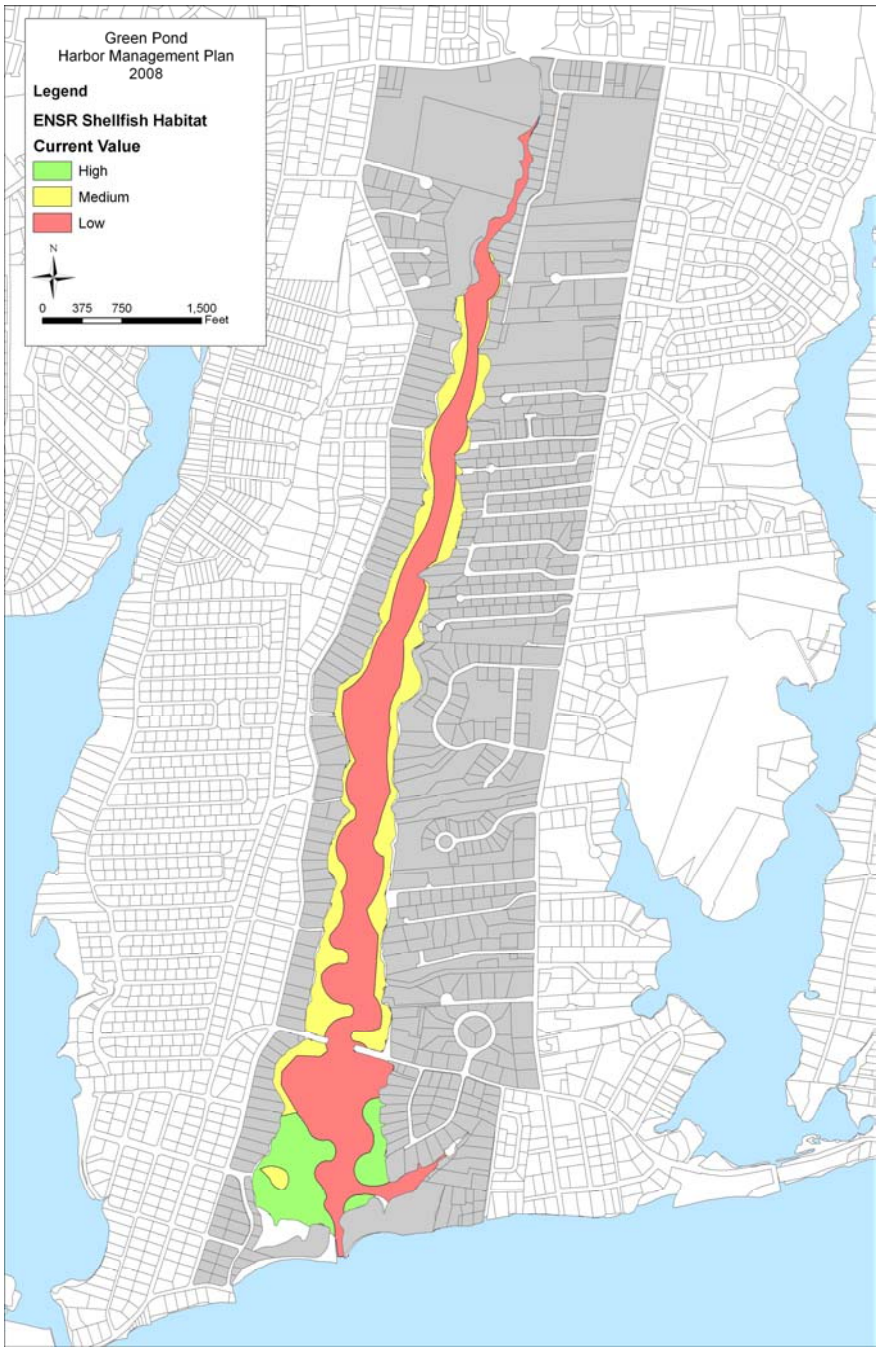


Figure 6: Current value of shellfish habitat within Green Pond based on the ENSR study.

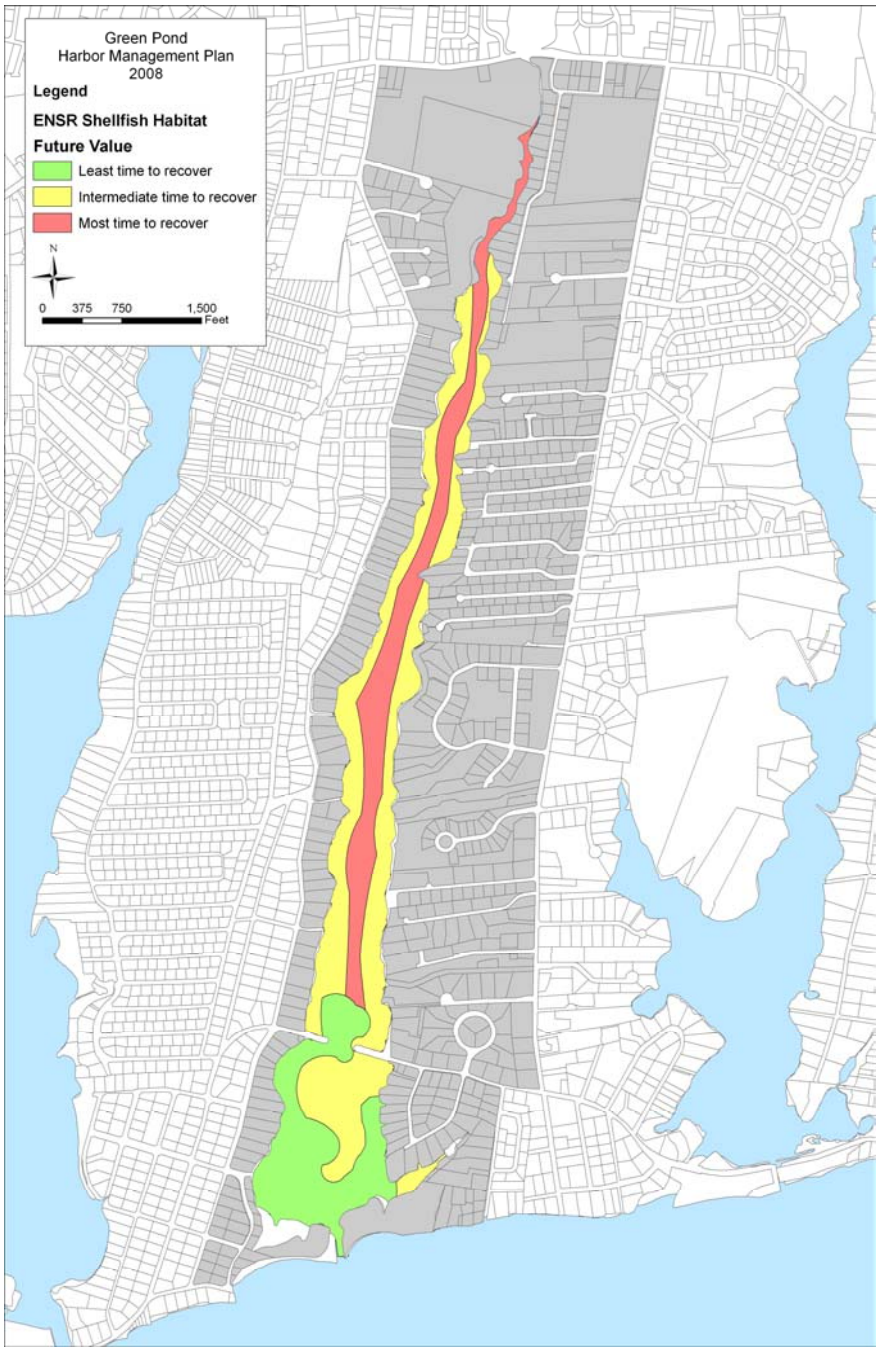


Figure 7: Predicted future value of shellfish habitat within Green Pond based on the ENSR study.

2.1.3 Fish

There are a number of types of fish that are commonly found in Green pond. These include:

- Fluke
- Striped Bass
- Bluefish
- Tomcod
- Scup
- Eels
- Pogies
- Sea Robins, and
- Winter Flounder

Historically Alewives (*Alosa pseudoharengus*) moved through Green Pond into Mill Pond (north of what is now Route 28) and spawned there and possibly in its tributaries. Some Alewives probably spawned in the generally freshwater (8 ppt. salinity per Ramsey *et al.*, 1999) reaches of Green Pond below the Mill Pond dam.

Figure 8: Approximate location of the Mill Pond dam.

An undated (probably 2003) grant application by Falmouth DNR (Martinsen, undated) entitled "Mill Pond Herring Run Restoration Project" reported that, *"Until 1988, Mill Pond in East Falmouth, Massachusetts was an active freshwater ecosystem that was abundant with spawning herring. In 1988, a water control structure at this location was modified which caused a 4.5-foot drop in the river. Since then, herring have not been able to return to the pond to spawn".*

The present dam includes a concrete structure with boards used to regulate water levels; a varying number of boards results in a change in both water depth in the pond and in the drop between the pond and the outfall stream.

2.1.4 Other Flora and Fauna

Apart from the fish species discussed previously, according to the Department of Natural Resources, there are a number of other marine organisms that are common to Green Pond. These include blue crabs, green crabs, softshell clams, quahogs, oysters, whelks, ribbed mussels and sea worms.

The Department of Natural Resources also lists a number of plant species that are common to Green Pond (Table 1).

Table 1: Plants that can be found in Green Pond.

Common Name	Scientific Name
Eelgrass	*Zostera marina*
Sea lettuce	*Ulva lactuca*
Salt haygrass	*Spartina patens*
Northern bayberry	*Myrica spp.*
American beachgrass	*Spartina spp.*
Hightide bush	*Iva frutescens*
Groundsel tree	*Baccharis halimifola*
Switchgrass	*Panicum virgatum*
Narrow-leaf cattail	*Typha angustifolia*
Common reed	*Phragmites australis*
Smooth cordgrass	*Spartina altinaflora*
Glassworts	*Salicornia spp.*
Seaside plantain	*Plantago spp.*

Common Name	Scientific Name
Bluegreen algae	*Schizophyceae*
Pitch pine	*Pinus rigida*
Eastern red cedar	*Juniperus virginiana*
Black oak	*Quercus negra*
Sassafras	*Sassafras spp.*
Shadbush	*Amelanchier alnifolia*
Beach plum	*Prunus maritima*
Black cherry	*Prunus serotina*
Virginia creeper	*Parthenosisis quinquefolia*
Poison ivy	*Rhus radicans*
Grape vine	*Vitus spp.*
Seaside goldenrod	*Solidago sempervirens*

Many bird species can be found around Green Pond. Table 2 lists the species based on information from the Department of Natural Resources. Their status is based on the following Natural Heritage and Endangered Species Program classifications:

“Endangered" – species are native species which are in danger of extinction throughout all or part of their range, or which are in danger of extirpation from Massachusetts, as documented by biological research and inventory.

"Threatened" – species are native species which are likely to become endangered in the foreseeable future, or which are declining or rare as determined by biological research and inventory.

"Special concern" – species are native species which have been documented by biological research or inventory to have suffered a decline that could threaten the species if allowed to continue unchecked, or which occur in such small numbers or with such restricted distribution or specialized habitat requirements that they could easily become threatened within Massachusetts.

Table 2: Birds species that have been spotted around Green Pond. The list was developed by the Department of Natural Resources in 2006.

Common Name	Has Been Seen	Rare or Unexpected
Red-throated Loon		X
Common Loon	X	
Pied-billed Grebe	X	
Horned Grebe	X	
Red-necked Grebe	X	
Great Cormorant	X	
Double-creasted Cormorant	X	
American Bittern		X
Great Blue Heron	X	
Great Egret	X	
Snowy Egret	X	
Little Blue Heron		X
Green-backed Heron	X	
Black-crowned Night-Heron	X	
Glossy Ibis		X
Mute Swan	X	
Snow Goose		X
Brant	X	
Canada Goose	X	
Wood Duck	X	
Green-winged Teal	X	
American Black Duck	X	
Mallard	X	
Northern Pintail	X	
Blue-winged Teal	X	
Northern Shoveler	X	
Gadwall	X	
Eurasian Wigeon		X
American Wigeon	X	
Canvasback	X	
Redhead	X	
Ring-necked Duck	X	
Greater Scaup	X	
Lesser Scaup	X	
Common Eider	X	
Oldsquaw	X	
Black Scoter	X	
Surf Scoter	X	
White-winged Scoter	X	
Common Goldeneye	X	

Common Name	Has Been Seen	Rare or Unexpected
Barrow's Goldeneye		X
Bufflehead	X	
Hooded Merganser	X	
Common Merganser	X	
Red-breasted Merganser	X	
Ruddy Duck		X
Osprey	X	
Bald Eagle	X	
Northern Harrier	X	
Virginia Rail	X	
Sora	X	
American Coot	X	
Black-bellied Plover	X	
Semipalmated Plover	X	
Piping Plover		X
American Oystercatcher	X	
Greater Yellowlegs	X	
Lesser Yellowlegs	X	
Willet	X	
Spotted Sandpiper	X	
Whimbrel		X
Ruddy Turnstone	X	
Red Knot		X
Sanderling	X	
Semipalmated Sandpiper	X	
Least Sandpiper	X	
White-rumped Sandpiper	X	
Dunlin	X	
Short-billed Dowitcher	X	
Common Snip	X	
American Woodcock	X	
Laughing Gull	X	
Bonaparte's Gull	X	
Ring-billed Gull	X	
Herring Gull	X	
Great Black-backed Gull	X	
Roseate Tern	X	
Common Tern	X	
Least Tern	X	

Endangered	As defined by the
Threatened	Natural Heritage & Endangered Species Program
Special Concern	August 8, 2008

Figure 9 shows the Natural Heritage and Endangered Species Program's estimated habitats of state-protected rare wildlife occurring in wetlands areas and the known state-protected rare plant and animal species occurrences in Massachusetts ("priority habitats").

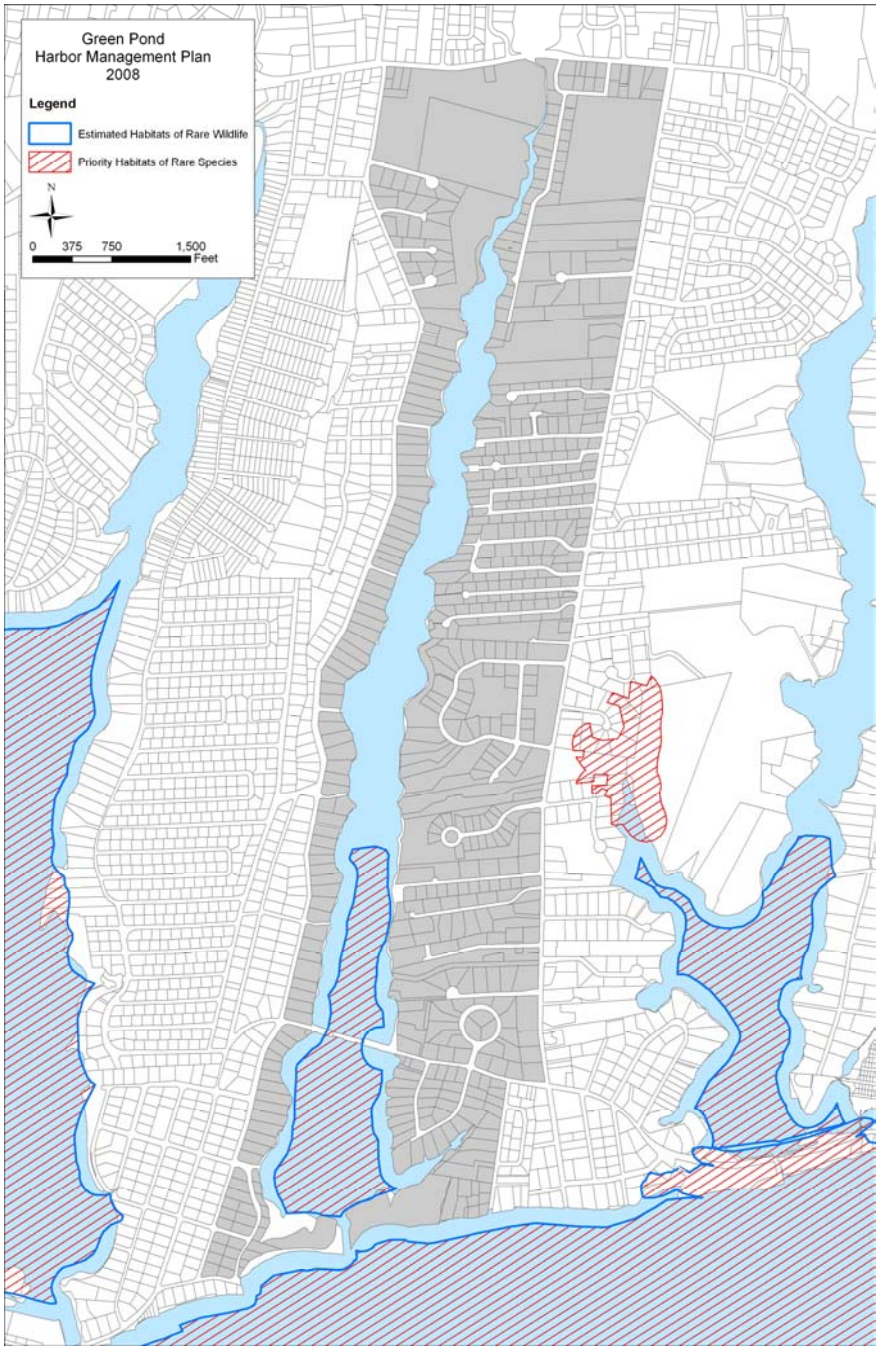


Figure 9: NHESP estimated habitats of rare wildlife and priority habitats of rare species.

2.1.5 Vegetated Wetlands

Based on the data available in the DEP Wetlands GIS layer, there are 53.50 acres of bordering vegetated wetlands and non-vegetated wetlands within the planning area of Green Pond (Table 3).

The majority of this (33.01 acres) is vegetated wetlands (Figure 10). Almost 73 percent of the bordering vegetated wetland is classified as salt marsh (24.06 acres). Wooded wetland account for a further 6.3 acres. The remaining 2.65 acres are made up of shrub wetland and shallow marsh.

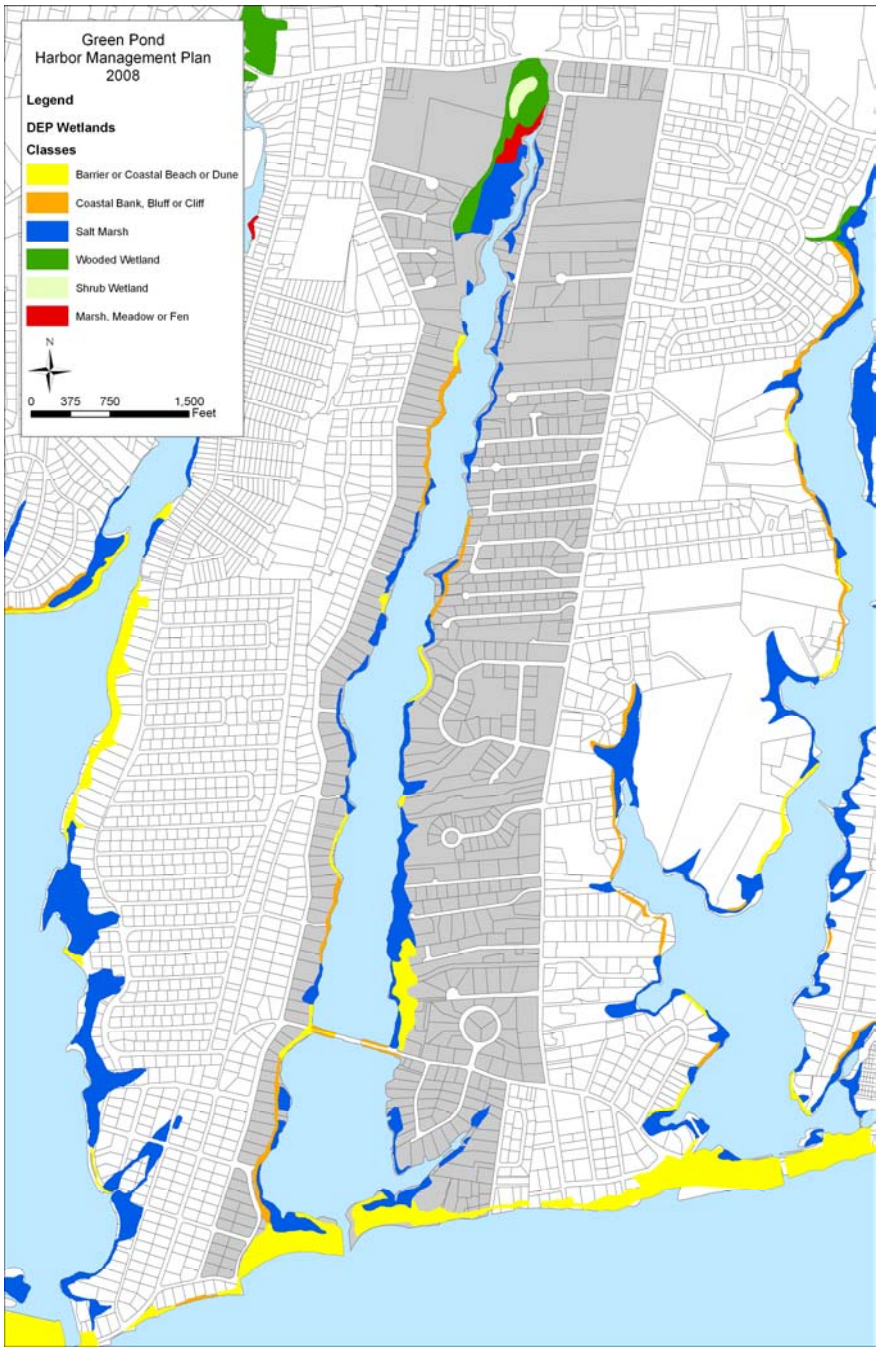


Figure 10: Vegetated and non-vegetated wetlands around Green Pond.

Table 3: Acreage of wetland types within the planning area. *Data: DEP Wetlands from MassGIS*

Type	Acres
Salt Marsh	24.06
Wooded Wetland (Deciduous)	5.31
Wooded Wetland (Mixed Trees)	0.99
Shrub Marsh	1.16
Shallow Marsh, Meadow or Fen	1.49
Barrier Beach - Coastal Beach	3.13
Barrier Beach - Coastal Dune	3.74
Coastal Beach	3.83
Coastal Dune	4.93
Coastal Bank, Bluff or Sea Cliff	4.86
TOTAL	**53.50**

2.1.6 Non-vegetated Wetlands - Coastal and Barrier Beaches and Dunes

Non-vegetated wetland includes beaches, dunes, banks, bluffs and cliffs. In the planning area, there are 20.49 acres of non-vegetated wetland (Table 3; Figure 10)

Coastal Regulations of the Massachusetts Wetlands Protection Act, describe barrier beaches as: *"A narrow low-lying strip of land generally consisting of coastal beaches and coastal dunes extending roughly parallel to the trend of the coast. It is separated from the mainland by a narrow body of fresh, brackish, or saline water or marsh system. A barrier beach may be joined to the mainland at one or both ends"* (310 CMR 10.29(2)).

Barrier beaches provide several different services, including acting as storm buffers by deflecting onshore waves and absorbing wave energy, providing and protecting habitat located on the beach, in the dune system, and in the water body between the beach and the mainland, and serving as a recreational and/or aesthetic resource. Surrounded by water on at least three sides, barrier beaches are highly influenced by wind and water which can alter their form, location, and volume.

Based upon the definition of a barrier beach provided above and outlined in Massachusetts Executive Order 181, the Office of Coastal Zone Management inventoried the state's barrier beaches and identified the seaward side of the entrance to the pond as a barrier beach system.

The Massachusetts Wetland Protection Act regulations define *coastal beach* as, *"unconsolidated sediment subject to wave, tidal and coastal storm action which forms the gently sloping shore of a body of salt water and includes tidal flats. Coastal beaches extend from the mean low water line landward to the dune line, coastal bank line or the seaward edge of existing man-made structures, when these structures replace one of the above lines, whichever is closest to the ocean"* (CMR 310 10.27(2)).

Coastal beaches provide flood protection and help to dissipate wave energy. Exposed to tidal, wind, and wave action, as well as human forces, coastal beaches are dynamic resources, supplying sediment in some cases, and accumulating sediment in others.

Based on the DEP wetlands GIS data, there are also a number of smaller coastal beach systems along either side of the pond.

2.2 WATER QUALITY

The water quality in Green Pond has been an issue for many years. The most serious problem is groundwater transportation of nutrients from residential septic systems; however, there are a number of other practices, which also contribute to pond degradation. The Massachusetts Estuaries Project (2005) estimated that 79% of the "Local Control Load" (only from sources within the watershed) of nitrogen in Green Pond came from wastewater. A further 9% was attributed to lawn fertilizer, 7% to impervious surfaces and 5% to wastewater treatment facilities. The report states that *"No wastewater treatment facilities (WWTFs) currently exist in the watersheds, but the nitrogen additions are included from the old MMR WWTF effluent discharge beds that are the source of the Ashumet Valley Plume of treated wastewater"*. The same report suggests that the present controllable watershed nitrogen loading rate for Green Pond is 23.72 kg/day and that a loading rate of 10.16 kg/day is necessary to reach the suggested target threshold nitrogen concentrations. This represents a 54.6 percent reduction.

Clearly the most effective way to remove the largest source of nutrients is to move properties within the pond's watershed off septic systems and establish a sewerage system that services them. As efforts are underway to achieve this, nutrient input from residential septic systems will not be discussed in detail. However, this plan fully supports efforts to sewer the area and some of the recommendations are based on the presumption that the sewering will occur and will result in a significant improvement in water quality.

Another source of pollution is stormwater. It is the largest component of non-point source pollution in our nation's watersheds. Stormwater is discharged into coastal waters from a variety of sources, including groundwater, stormwater outfall pipes, as well as stormwater runoff (sheetflow). Major sources for contaminants in the stormwater are from:

- Impermeable surfaces
- Development activities
- Landscape activities
- The atmosphere
- Automobiles
- Fertilizers
- Animal waste
- Winter road applications

Often the contaminants are filtered out through natural vegetated systems. However, where there is little or no vegetation between an impervious surface (e.g. a road end) and a waterbody, this will not occur. Additionally, manmade infrastructure helps to manage stormwater, discharges from outfall pipes, for example, can also act as the transport vehicle for sediment originating from development activities and dump it directly into the coastal environment. Outfall pipes are often too small to accommodate current flow rates, and some are poorly located with regards to current land and water uses. Town officials suggest that their system parameters are a 24 hour storm of 2.5 inches. Additionally, catch basins and other infrastructure need to be maintained and cleaned in order to remain effective.

While septic systems are the most significant issue, another source of potential sewage pollution comes from boats. Vessel sewage, like many other pollutants, can be harmful to the environment when it is not adequately treated. Sewage contains high concentrations of nitrogen, as well as bacteria and viruses

that can make shellfish unsuitable for human consumption, can be a risk to human health and can severely restrict recreational opportunities.

Every boat with an installed marine head (toilet) must have a US Coast Guard approved Marine Sanitation Device (MSD). The US Coast Guard tests and certifies MSDs as Type I, Type II, or Type III. A Type I MSD is a device that treats the waste on board before the sewage is discharged overboard. Under the test conditions a Type I MSD produces an effluent with a fecal coliform count not greater than 1,000 per 100 milliliters and no visible floating solids. A Type II MSD also treats the sewage prior to it being discharged but, under the test conditions, produces an effluent having a fecal coliform count not greater than 200 per 100 milliliters and suspended solids not greater than 150 milligrams per liter. Type III MSDs are holding tanks designed to prevent the overboard discharge of any sewage, treated or untreated. However, some Type III MSDs are fitted with a "y" valve that allows boaters to discharge the contents of the holding tank overboard. As this sewage is untreated, it is illegal for a boater to do this within 3 miles of the shoreline. Boats larger than 65 feet in length must use a Type II or Type III MSD, while boats under 65 feet can use a Type I, II or III MSD. There are no legal requirements for boats under 65 feet to have a head on board.

There are a number of different treatments that are utilized by Type I and Type II MSDs. Some of the newer technologies can significantly reduce bacterial and viral levels but these systems must be carefully maintained in order for them to remain effective. Older systems are less effective at reducing bacterial and viral levels and none of the existing technologies remove significant amounts of nitrogen from the waste.

Certain waters of high public and environmental value that require greater environmental protection than existing laws provide, can be designated No Discharge Areas (NDAs) under the federal Clean Water Act. Due to the risk that sewage may negatively impact these sensitive areas, the discharge of any vessel sewage, even if treated by a Type I or Type II MSD, is prohibited in NDAs.

Sewage discharged from boats contributes to poor water quality, especially in poorly flushed embayments. Eliminating the discharge of boat sewage into such waters will further improve water quality.

The state's Office of Coastal Zone Management is actively working towards having all the waters of Massachusetts designated as NDAs and an application for the waters of Vineyard Sound is currently being developed. Such a designation would prohibit the discharge of any boat sewage in the waters in the NDA and this would include all the waters of the Town of Falmouth including the ponds. However, if these efforts were to stall, the town could develop their own NDA application. The key to any application is to demonstrate that there are sufficient pumpout facilities to service the boating population. The EPA's minimum criterion is one pumpout facility for 450 boats equipped with Type III MSDs. There is one pumpout located in Green Pond and it is clear that there are fewer than 450 vessels that might be expected to have a Type III MSD. Therefore it is likely that Green Pond would meet EPA's criteria for designating a No Discharge Area.

Another way to help reduce the nutrient load is to increase the circulation and flushing of the pond. Key to this is the regular dredging of mouth of the pond. This is discussed in the Dredging section.

The Cape Cod Atlas of Tidally Restricted Salt Marshes identifies the Menauhant Road Bridge as a restriction within the pond. More discussion of this can be found in the Tidal Restriction section.

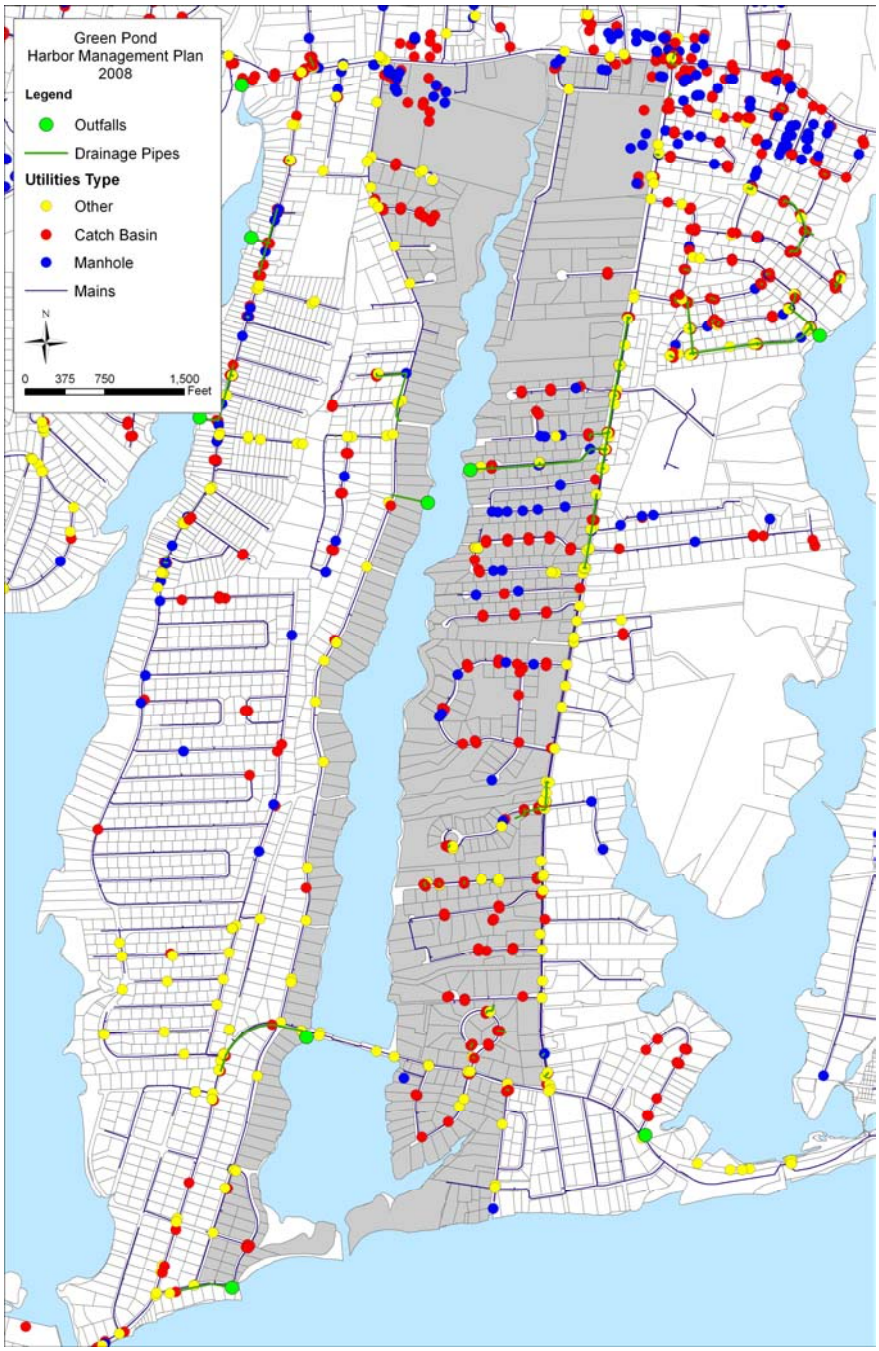


Figure 11: Outfalls, manholes and catch basins around Green Pond.

2.3 USES OF GREEN POND

Green Pond represents a resource that is of great value to the town of Falmouth. The pond itself and the land surrounding it are used by many different stakeholders for many different reasons. People use the pond for boating, kayaking, swimming, fishing, shellfishing, birdwatching and some simply enjoy the aesthetic beauty of the pond itself. Boating occurs throughout the pond. North of the bridge the size of vessel is limited by the clearance under the bridge and much of the boating is associated with those who

live alongside the pond and keep their boats at a dock or on a mooring. However there is also a boating facility on the western side of the pond just north of the bridge. The very north of the pond is a popular area for kayaking and canoeing. Motorized boating is largely unfeasible in this area as the water is shallow and there are many submerged objects that represent a hazard to larger motorized vessels. The most significant boating activity occurs south of the bridge. There are a number of moorings in this area as well as the Green Pond Marina and the town boat ramp. This area is also not limited by the bridge clearance.

Fishing is a popular recreational activity in Green Pond. The most popular fishing spot is along the bridge. However, fishing also occurs from the jetties at the entrance to the pond. Shellfishing occurs in many areas of the pond with the majority of this activity happening south of the bridge. The pond is also a popular place for birding. The South Shore and Brookline Bird clubs frequently use the pond for bird tours.

The pond is also valued by many people simply for its aesthetic beauty. The value of this is difficult to quantify as what one person sees as aesthetically pleasing may not be pleasing to another. However what is clear is that Green Pond is still somewhere where people like to simply come and watch the world go by.

Managing a resource such as Green Pond requires balancing the various uses of the resource while minimizing conflict and ensuring that the resource remains available for everyone to use and to enjoy both now and in the future. This can be a challenge. Shellfishing and boating are not always compatible. Boat moorings can damage eelgrass beds and propellers can leave scars on benthic habitats. The potential conflict between moorings and eelgrass can be managed by restricting the areas where moorings can be deployed so that they are located in areas where there is less eelgrass. It is also possible to control the type of mooring tackle that is used. Some tackle types are more damaging to eelgrass than others and new technology continues to be developed. Currently, helix moorings are believed to be the least harmful to eelgrass as little or no tackle rests on the seafloor. Helix moorings can also be installed closer to one another compared to traditional mooring systems that require significant amounts of scope to ensure that the moorings do not drag. However, helix moorings require specialized equipment for installation and cannot easily be moved once they have been installed. Currently there is no eelgrass in Green Pond so this conflict is not significant. However, eelgrass is predicted to return to many areas of the pond once water quality improves. The area where the most significant recolonization by eelgrass is predicted, is south of the bridge. As this is where most of the boating occurs within the pond and where there are already a number of moorings, the potential for future conflict between moorings and eelgrass habitat is likely to increase.

Docks can also have a detrimental effect on benthic habitats and on wetland resources. Minimizing the effect of docks on wetlands resources is achieved by the conservation commission orders of condition on dock design. However, it is believed that some of the docks that currently exist on not in compliance with the orders of condition and with chapter 91 licensing requirements. Docks can also have a visual impact on the pond and some feel that uncontrolled proliferation of docks diminishes the aesthetic value of the pond.

A significant constraint on using Green Pond is that there are a limited number of places where the general public can physically access the pond itself. Much of the waterfront is private residential property. Public access is limited to the town boat ramp on the eastern side of the pond south of the bridge (with four boat slips), Green Pond Marina (67 slips) which is adjacent to the boat ramp, Dinghy Beach on the west side of the pond south of the bridge, Green Pond Tackle and Marina (65 slips) immediately north of the bridge on the west side of the pond, Green Harbor Waterfront Lodging in the

north of the pond and the Donald Weldon Preserve. Some of these sites are not officially accessible to the public but access is often possible. The Donald Weldon preserve offers a potential non-motorized boating access location. It may be possible to develop a simple launch site or to construct racks for non-motorized vessels. However, details of how this access might be configured have yet to be developed.

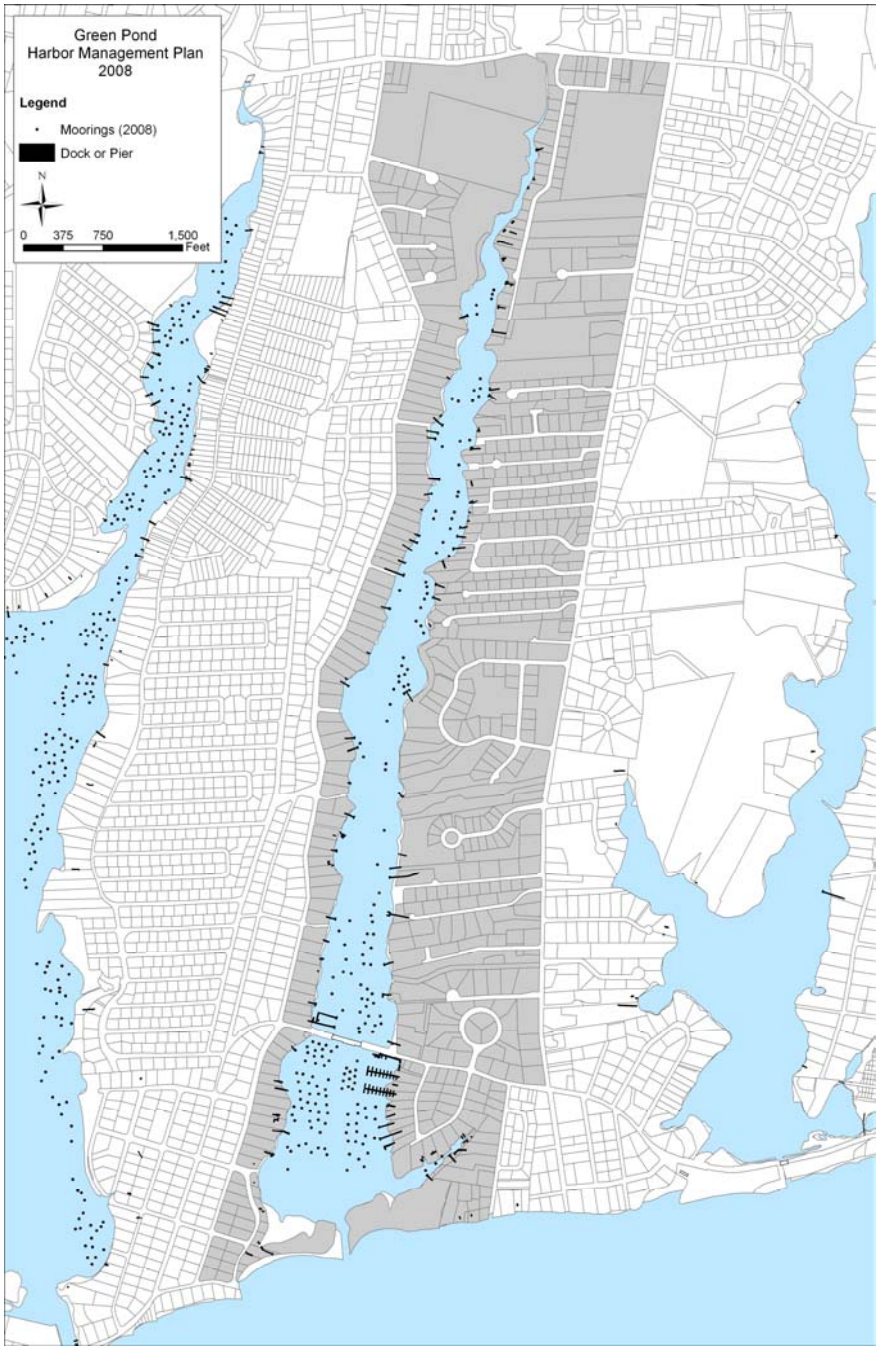


Figure 12: Docks and moorings.

The Harbormaster has established a number of locations where boaters who have moorings in the pond can store their dinghies so that they can access their mooring. However it is likely that dinghy storage and parking will continue to be a limitation on access to the pond.

One way to manage multiple uses of the pond and to reduce potential conflict is to develop a watersheet plan for the pond. Such a plan outlines what activities should be allowed to occur in which areas of the pond. This allows decision makers to prioritize certain uses in some areas and allow other uses in other areas. While this will not prevent potential conflicts of use, it can help to minimize such conflicts and to help users understand how and why the resources are being managed. If stakeholders are able to understand the reasoning behind management decisions they are more likely to be supportive of a management plan. A preliminary draft watersheet plan can be found in Section 4.

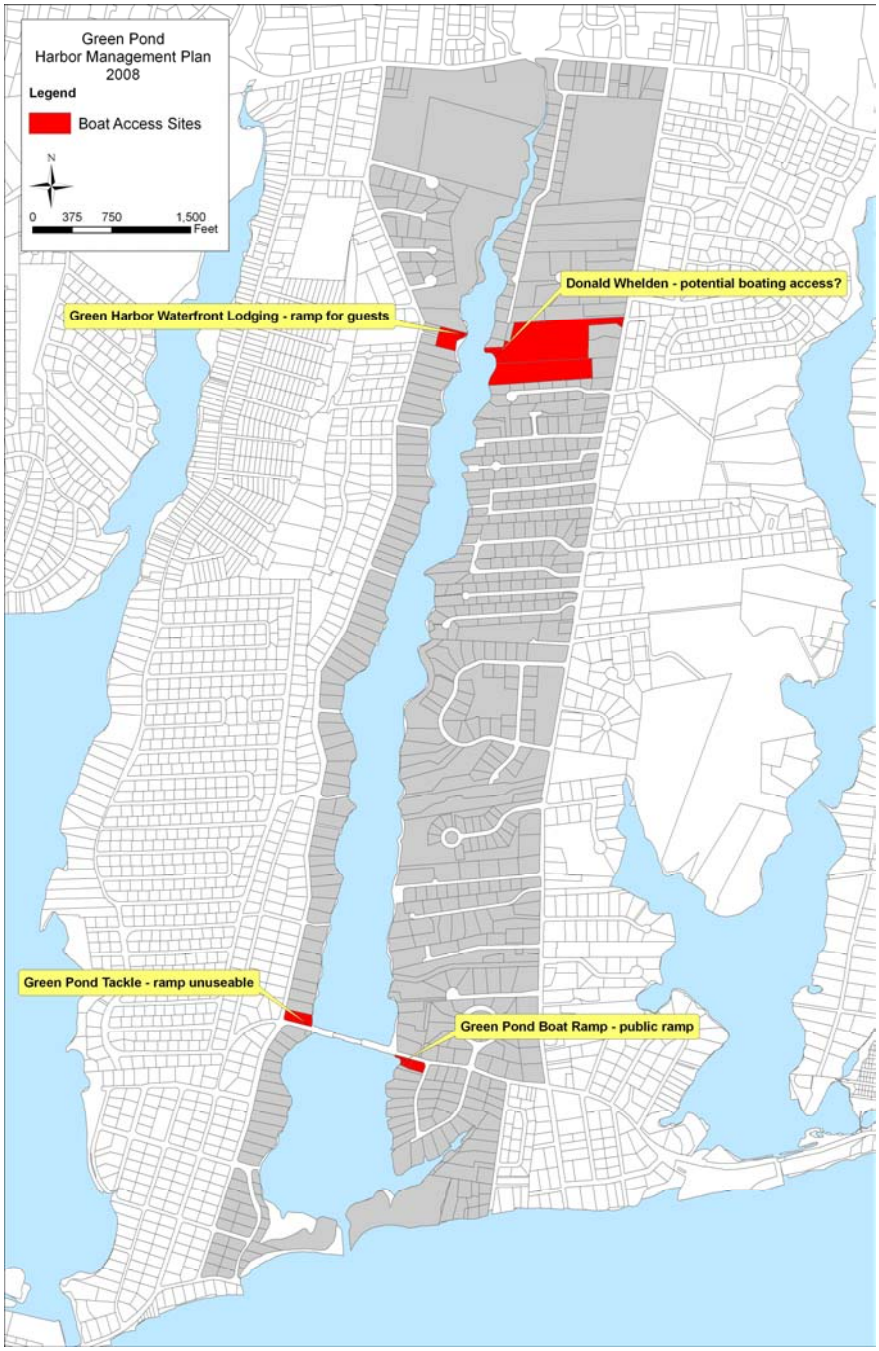


Figure 13: Existing and potential boating access points.

2.4 LAND USE

There are just over 548 acres of property in the Green Pond Harbor Plan study area (Table 4). Almost two-thirds of the parcels are developed for residential use, with 80 percent of that being single family residential (Table 4). The second largest category of land use is commercial, most of which is in motel and marina use.

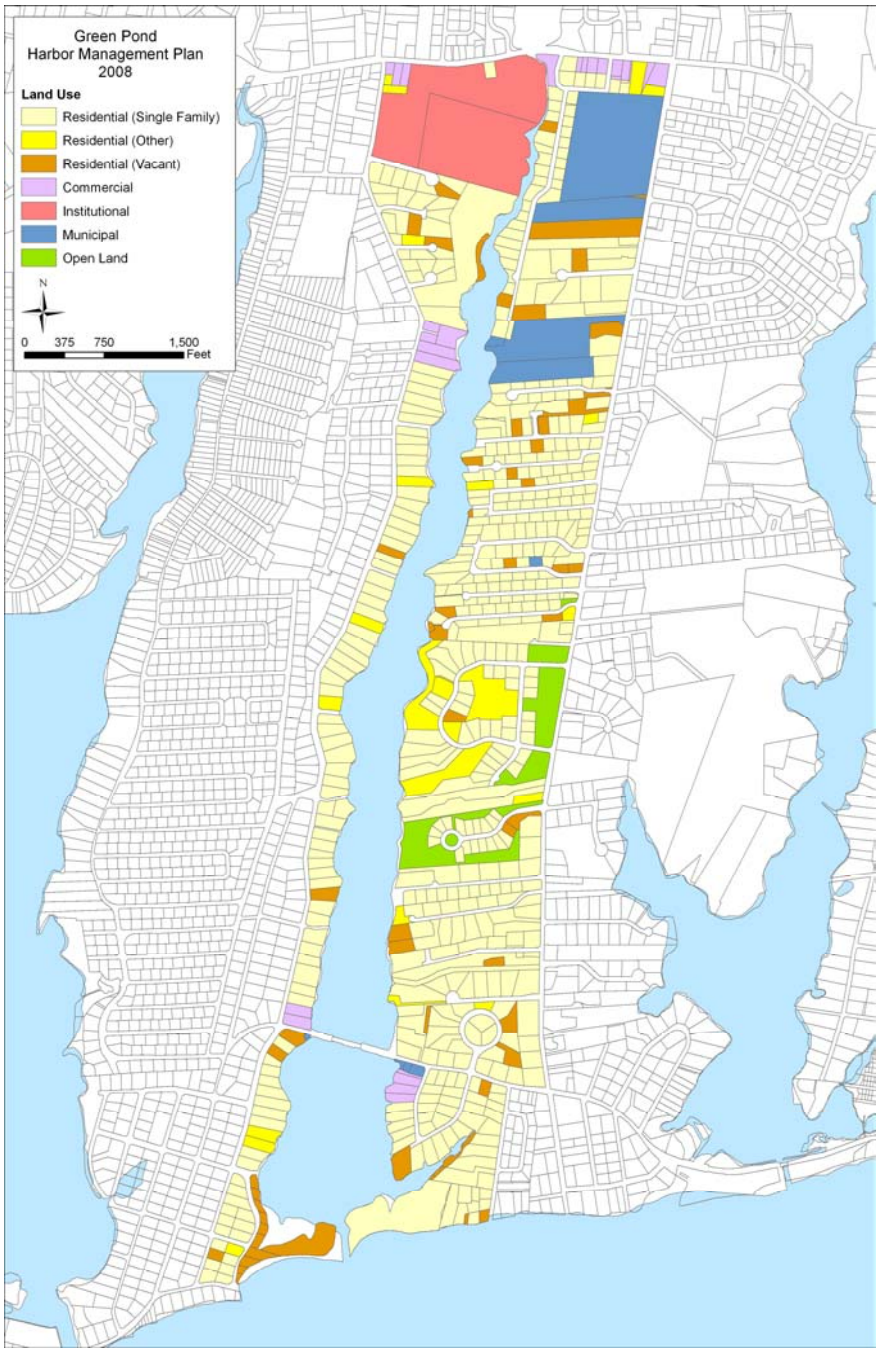


Figure 14: Land use by parcel within the planning area.

There is very little (less than one percent) undeveloped property in the study area. Of the forty-seven acres in undeveloped parcels, five acres have development restrictions and another 13 are considered undevelopable. There is approximately 28 acres of developable land in parcels zoned residentially and another half acre zoned commercially.

Table 4: Land use around Green Pond. *Data: Town of Falmouth's Property Assessor*

Land Use	Acres	Percent
Residential	356.5	65.10%
Single family	*284.4*	
Commercial	81.4	14.80%
Municipal	44.6	8.10%
Institutional	57.4	10.50%
Open land	5.2	0.90%
Multiple use	3.1	0.60%
Total	548.2	100%

2.5 MANAGEMENT AND REGULATORY AUTHORITIES

2.5.1 Chapter 91 and the Massachusetts Waterways Regulations

Massachusetts' principal waterfront regulatory program in tidelands and other waterways is Massachusetts G.L. Chapter 91 (Public Waterfront Act, 1866). Chapter 91 and the corresponding Waterways Regulations (310 CMR 9.00) are administered by the Division of Wetlands and Waterways of the Massachusetts Department of Environmental Protection (DEP).

Chapter 91 applies in tidelands, great ponds, and along certain rivers and streams. Tidelands refer to all land presently or formerly beneath the waters of the ocean, including lands that are always submerged as well as those in the intertidal area, i.e., below the mean high water mark. This area is governed by a concept in property law known as the public trust doctrine which establishes that all rights in tidelands and the water are held by the state "in trust" for the benefit of the public for the purposes of fishing, fowling, and navigation. The Waterways Act and its corresponding regulations codify the public trust doctrine in Massachusetts.

As clarified by the 1983 amendments to the waterways regulations, Chapter 91 jurisdiction extends landward to the historic high water line and seaward three miles to the limit of state jurisdiction. The historic high water line is the farthest landward tide line which existed "prior to human alteration" by filling, dredging, impoundment or other means (310 CMR 9.02). Thus, Chapter 91 applies to filled as well as flowed tidelands, so that any filled areas, moving inland to the point of the historic high tide line, are subject to Chapter 91 jurisdiction.

Chapter 91 authorization is generally required for any fill, structure, or use not previously authorized in tidelands, including any changes of use and structural alterations. Types of structures include: piers; wharves; floats; retaining walls; revetments; pilings; bridges; dams; and waterfront buildings (if located on filled lands or over the water).

The benefits that the Chapter 91 program can afford a town are best captured in the five basic objectives of the program:

1. ensure the waterfront is used primarily for water-dependent purposes;
2. provide public access;
3. facilitate other state programs related to shoreline use and conservation;
4. strengthen local controls and encourage harbor planning; and
5. ensure accountability to present and future public interests.

For planning purposes, the location of the historic high water line (i.e., upland limits of Chapter 91 jurisdiction) must be established through a review of maps that may reliably show the original natural shoreline or through engineering studies. Previously issued Chapter 91 licenses are also a source of information on the historic high tide line for specific parcels. The Massachusetts Office of Coastal Zone Management (CZM) is completing a project to map the historic shoreline of the Commonwealth.

Special Acts of the Legislature

Prior to 1866 when Chapter 91 was first promulgated, the Massachusetts legislature issued Special Acts to transfer title of a property from the Commonwealth to a waterfront landowner and to enable particular types of development to take place on the property as specified in the Act. The rights granted within a Special Act are transferred to each successor at the time of sale, but they do not exempt a property owner from Chapter 91 review for a new or modified use of the property.

Municipal Harbor Plans

In September 1990 the Secretary of Environmental Affairs adopted regulations for "Review and Approval of Municipal Harbor Plans" (301 CMR 23.00). The regulations established a voluntary procedure by which municipalities could obtain state approval of a municipal harbor plan.

A municipal harbor plan is defined as a document setting forth the community's objectives, standards, and policies for guiding public and private use of the land and water areas of a harbor and an implementation program to achieve the desired plan.

A plan prepared and approved in accordance with these regulations serves to guide EOEA agency actions, including the regulatory decisions of the MA Department of Environmental Protection under M.G.L. Chapter 91. When an approved harbor plan exists, any project seeking a Chapter 91 permit from DEP must be in conformance with that plan. In essence, a municipality with an approved harbor plan utilizes the state regulatory authority to help implement its own objectives.

Through a locally-prepared harbor plan, a municipality has the ability to "substitute" local standards for certain state Chapter 91 requirements such as building height limits and to "amplify" certain discretionary state standards.

The standards that can be substituted by an approved harbor plan apply only to nonwater-dependent uses. Section 9.51(3) establishes minimum standards and limitations on building height, site coverage, waterfront setback, and encroachment into flowed tidelands. Section 9.53(2)(b)-(c) pertains to the provision of interior and exterior public space in a project. Section 9.52(1)(b)(1) is a requirement for a waterfront walkway with a minimum width of 10 feet to be included with any non water-dependent use. In those instances where non water-dependent uses are allowed, this public access requirement exists, as does the ability to modify it through a municipal harbor plan.

The provisions of a municipal harbor plan can also be effective in providing guidance for DEP in applying the numerous discretionary requirements of the Chapter 91 regulations to projects under review.

Harbormaster's Authority

Under state statutes a harbormaster has the following authorities:

- To enforce the rules and regulations for motorboats and other vessels (M.G.L. C. 90B)
- To authorize by permit the mooring on a temporary basis of floats or rafts held by anchors or bottom moorings, within the jurisdiction of the town and, further, to remove such floats or rafts installed without permission (M.G.L. C. 91, sec. 10A)
- To station vessels and make rules for and to direct the anchoring of vessels in the harbor and, as necessary, to direct the berthing of vessels at public piers and wharves (M.G.L. C. 102).

Much of the authority that a harbormaster has with regards to the number, location and types of moorings within a town's waters is codified in Section 10A of the Chapter 91 regulations: "*Temporary moorings of floats or rafts; permits, issuance or refusal; review; public nuisances"*. These state that:

> *"Notwithstanding any contrary provision of law, the harbormaster of a city or town or whomsoever is so empowered by said city or town may authorize by permit the mooring on a temporary basis of floats or rafts held by anchors or bottom moorings within the territorial jurisdiction of such city or town upon such terms, conditions and restrictions as he shall deem necessary."*
>
> *"A reasonable fee for such mooring, proportionate to the city or town's cost of overseeing mooring permit, may be imposed by the city or town or whoever is so authorized by the city or town, provided, however, that no such mooring fees may discriminate on the basis of residence; and provided further, that any mooring fee collected shall be deposited into and used in accordance with the purposes of the Municipal Waterways Improvement and Maintenance Fund, pursuant section 5G of chapter 40."*
>
> *"Actions by a harbormaster and/or the division under this section shall be subject to applicable laws administered by the division of motor boats, the division of marine fisheries, the United States Coast Guard and the United States Corps of Engineers.*
>
> *Floats or rafts held by anchors or bottom moorings installed without permission from a harbormaster and/or said division shall be considered a public nuisance and may be removed by the harbormaster at the expense of the owner in the event he fails to remove same after notice in writing from the harbormaster.*
>
> *For the purpose of this section, temporary shall mean for no longer than to the end of any given calendar year."*

While Chapter 91 gives a harbormaster overall control over the number, location and types of moorings that can be used within a town's jurisdiction, the state's waterways regulations address the "*Terms and Conditions Applicable to all Annual Permits",* which includes permits for moorings and floats. 310 CMR §9.07 (4)(e) states that:

> *"No permit shall be inconsistent with the municipal harbor plan, if any, …."*

Therefore, once a harbor plan has been formally adopted by a municipality, the harbormaster can only issue mooring permits that are consistent with the conditions stated within the plan. For this reason, it is important that a plan's recommendations that relate to a harbormaster's

activities are developed in conjunction with the harbormaster, the waterways committee and other relevant parties.

The Town of Falmouth's mooring regulations also state that:

> *"Certain provisions of these town-wide mooring regulations may be waived by the Harbor Master for any harbor which has a Selectmen-approved harbor management plan in effect."*

2.5.2 Falmouth Zoning Bylaw

Note: All section references are to Chapter 240, Zoning, of the Code of the Town of Falmouth.

Zoning is the principle tool of municipal government for regulating the use of land. The town's zoning bylaw is Chapter 240 of the Code of the Town of Falmouth. An official Zoning Map depicts the districts. Basically, zoning divides the community into uniform districts within which all property is subject to the same regulations, governing three factors: the allowable uses of the land and any buildings on it, the allowable bulk (size and shape) of buildings, and the overall density of development, measured in square footage or housing units per unit of land area. Each district has a list of principal and accessory uses permitted by-right or by special permit. The regulations for each district also set out requirements for where buildings and other structures may be located within each parcel of land (setbacks from lot lines and building heights). Density of development is controlled through minimum lot size, minimum street frontage, and maximum lot coverage. Overlay districts are in addition to the basic use districts and are often created, as is the case in Falmouth, for purposes of protecting environmental resources and public health and safety.

The study area is zoned predominantly for single family residential use in Single Residence A, B. and C districts (Figure 15). The principal use allowed in each of these districts is detached single-family dwellings; the districts vary by minimum dimensional standards (Table 5).

Piers, floats and docks are also principal uses permitted in the residential districts when approved by the Conservation Commission and the Board of Selectmen as a common pier, float or dock (Section 240-21.B).

The regulations require a minimum setback of 50 feet from the tidal waters of the pond for all principal structures (Section 240-68.D of Article XIV, Dimensional Regulations). Tidal waters in Green Pond are defined by the three-foot contour line (NGVD).

for marinas and boatyards within Falmouth's Marine zoning districtTwo areas bordering Green Pond are in the Marine district (Article IX) and these are developed for boating-related uses. According to Section 240-39, the purpose of this district "is to preserve and protect uses which are dependent on access to marine and tidal waters in accordance with the goals and policies of the Federal Coastal Zone Management Act, the Massachusetts Coastal Zone Management Program and the Comprehensive Plan of Falmouth. Other uses which are not directly dependent on access to marine and tidal waters will only be allowed if they are supportive to the principal use and granted by special permit."

Permitted uses in the Marine District are marinas and boatyard and marine-related research and equipment manufacturing, and community service uses such as parks and town wharves. Accessory uses include one dwelling per parcel for employee housing and activities related to boat building. Special permit uses include private clubs, restaurants (limited to no more than 25 percent of floor area of all structure), business and professional offices and nonmarine-related retail (limited to no more than 50 percent of the floor area of all structures on the property). The cumulative amount of all nonmarine related uses cannot exceed 50 percent of the total floor area. Among the additional standards for uses

allowed by special permit in the Marine district (Section 240-45) is that public amenities; e.g., launching ramps, access to the waterfront, public fishing areas and visual access to the water, must be considered wherever there is no threat to public health and safety, or unreasonable liability to the property owner.

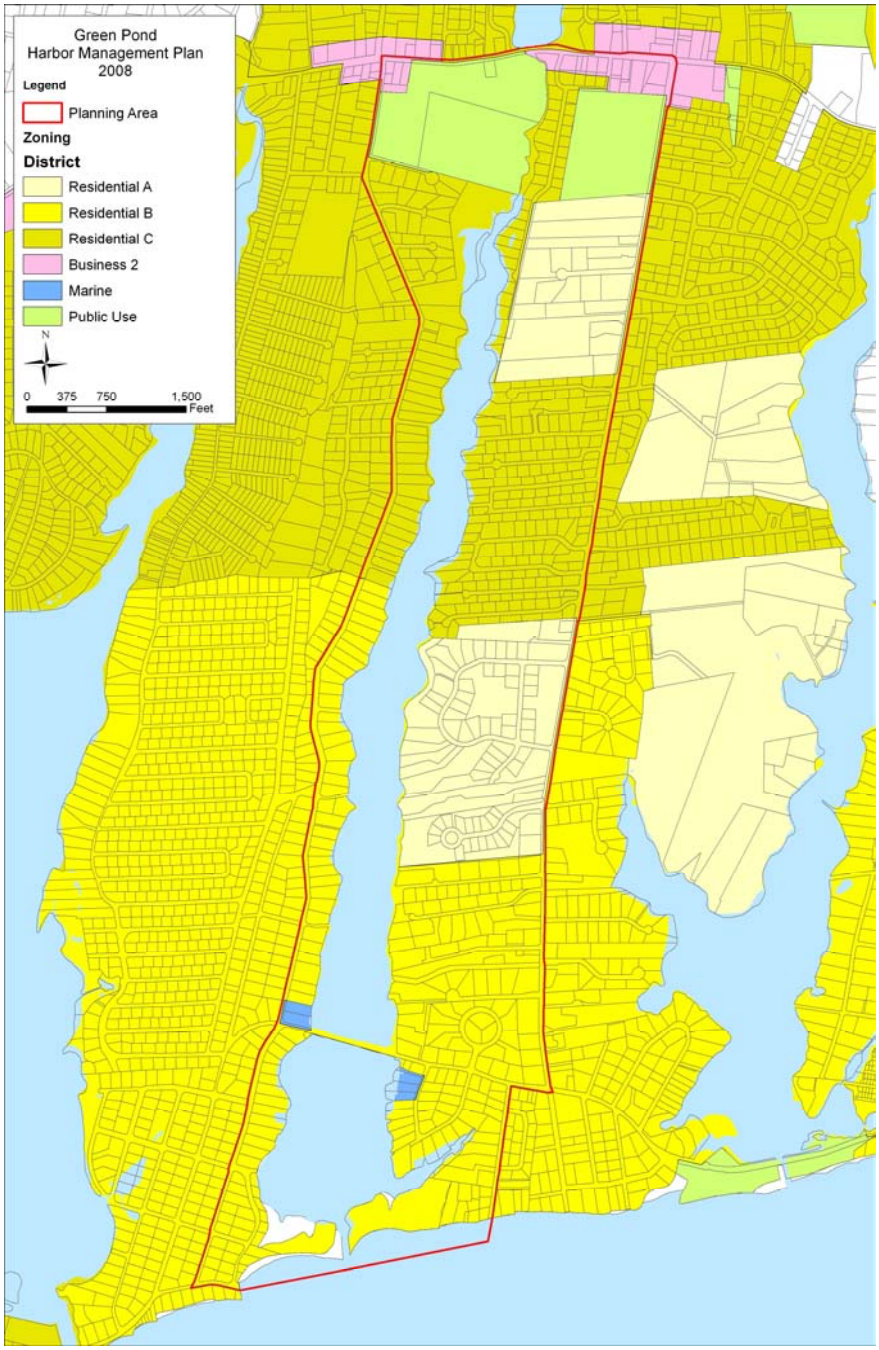


Figure 15: Zoning around Green Pond.

Table 5: Dimensional standards for zoning districts in the Green Pond planning area (Section 240-67 and 240-69).

District	Min Lot Area	Min Lot Width	Min Frontage	Max Lot Coverage		Max Building Height	
				By Structures	By Structures & Parking	Principal Stories / Feet	Accessory Stories / Feet
Single Residence A	450,004	150	100	20	40	2 ½ 35'	1 ½ 18'
Single Residence B[7]	40,000	125	100	20	40	2 ½ 35'	1 ½ 18'
Single Residence C[7]	40,000	100	100	20	40	2 ½ 35'	1 ½ 18'
Marine	20,000	100	100	40	70	2 ½ 35'	1 ½ 18'
Business 2	40,000	200	200	40	70	2 ½ 35'	1 ½ 18'
Public Use	45,000	150	100	40	70	2 ½ 35'	1 ½ 18'

The Green Pond harbor planning area is also within the Coastal Pond Overlay District (Article XXI). The purpose of this overlay district is to preserve the water quality in all coastal ponds and harbors with the goal of attaining/maintaining fishable, swimmable and usable waters. This overlay district is superimposed on the town's zoning districts and is depicted on a map "Recharge Areas of Coastal Ponds in Falmouth" (Figure 16).

The requirements of the Coastal Pond Overlay District are applicable to proposed subdivisions greater than five lots or five acres, commercial development requiring site plan review, and special permit uses within 2,000 feet of waterbodies. Such proposals are required to submit an analysis of development impact on the existing condition of the water body including physical characteristics and water chemistry, expected changes, and information on the total nutrient loading from the proposal and the existing development and acreage (Sec. 240-113C).

Areas within the Coastal Pond Overlay District are further identified as high quality, stabilization, or intensive water activity areas, each of which has different standards for water quality based on goals for ecosystem health and human services (see Sec. 240-100). Proposed land and water uses are restricted and conditioned accordingly. Green Pond is apportioned as follows:

- High Quality Area – Vineyard Sound to Green Harbor Road
- Stabilization Area – Above the Menauhant Bridge
- Intensive Water Activity Area – Between the south end of Green Harbor Road and Menauhant Road.

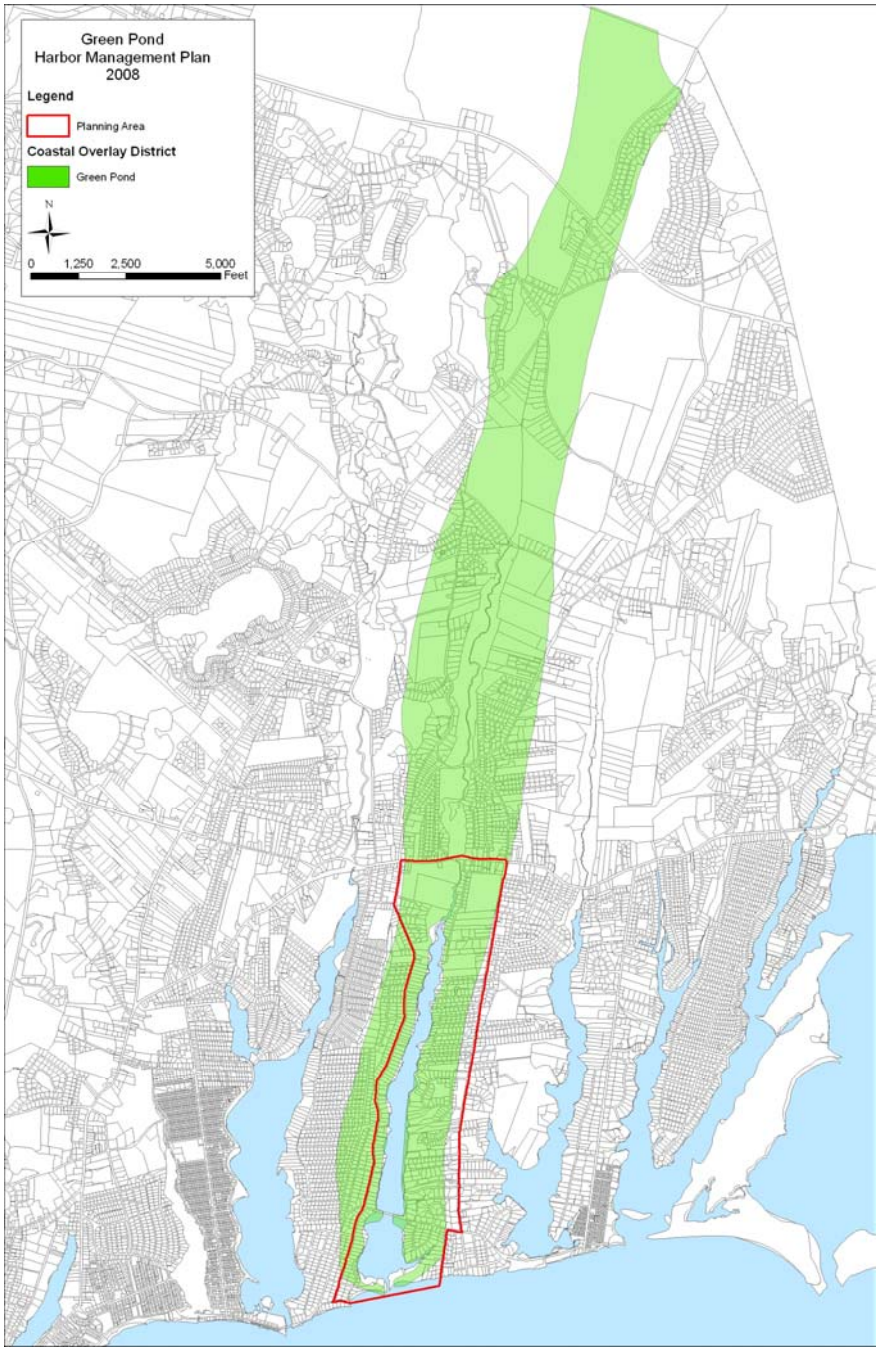


Figure 16: Coastal Pond Overlay District for Green Pond.

2.5.3 Falmouth Wetlands Bylaw

One of the primary responsibilities of the Falmouth Conservation Commission is the administration and enforcement of the Massachusetts Wetlands Protection Act (MGL Ch. 131, sec. 40) along with its corresponding Wetlands Regulations (310 CMR 10.00). In addition, Falmouth has adopted under general Home Rule powers a municipal Wetlands Bylaw (Chapter 235).

Under the Wetlands Act and local regulations, the Conservation Commission has authority over projects in or affecting any categories of wetland resource areas, including bank, beach, dune, flat, marsh,

swamp, freshwater or coastal wetlands, which border on the ocean or any estuary, creek, river, stream, pond, or lake. The Commission also has jurisdiction for land under water bodies, land containing shellfish, land subject to coastal storm flowage, the banks along and land under fish runs, land subject to flooding, and estimated habitat for rare/significant wildlife, flora and fauna. Activities within these resource areas subject to jurisdiction include activities that would remove, fill, dredge, or alter the resource. The Commission also has the right of review for activities within a 100-foot buffer zone around wetlands bordering water bodies, banks, beaches, and dunes.

2.5.4 Falmouth Board of Selectmen's Wetlands Regulations

Section 240-77 of the Code of the Town of Falmouth establishes a requirement to obtain a special permit from the Board of Selectmen for any proposed activity that would obstruct, fill, dredge, excavate or change the course of any stream or tidal water, or for any filling, excavating, diking, bulkheading, or riprapping within any marsh, along the shore of a pond, bay, harbor or tidal river that would alter the shoreline. The purpose is to protect and conserve wetlands, shellfish and other aquatic resources.

2.5.5 Falmouth Herring, Shellfish and Eel Regulations

Chapter 275 of the Town Code contains the regulations pertaining to herring, shellfish and eels. Article I addresses the permit requirements, catching days, method of capture, quantity restrictions and use of fish cars with regards to herring. These were adopted in 1991 and amended in 2002.

Article II addresses shellfish and eel regulations relating to both recreational and commercial catches. These regulations address the permit requirements, areas where these activities are allowed, days and times when they can occur, methods of catching, minimum sizes and catch limits.

Article III contains the regulations relating to aquaculture activities. Specifically, these address the application requirements and procedures, the fees, required signage and uses of the site.

2.5.6 Federal Emergency Management Act Regulations

FEMA administers the National Flood Insurance Program which produces Flood Insurance Rate Maps (FIRMs). FIRM is the official map of a community on which FEMA has delineated both the special flood hazard areas and the flood risk premium zones applicable to the community.

The majority of the planning area, including a number of properties along the water's edge, are in zones VE, AE and X500 (a more detailed sicussion can be found in Section 3.9). The following provides a further description of the zone designations:

- Zone VE: Areas within the 1-percent annual chance coastal floodplain (i.e. a "100 year flood") that have additional hazards associated with storm waves. Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.
- Zone AE: Areas subject to 1-percent annual chance with base flood elevation determined.
- Zone X500: Areas not in a Special Flood Hazard Area, within the 500 year floodplain.

FEMA periodically updates flood hazard maps by conducting a detailed reevaluation of flood hazards, referred to as a flood study. However, flood studies are time consuming and expensive, so far fewer than needed are done. As an alternative, FEMA has established procedures by which a community may compile appropriate data and request a map revision. Further, if an individual homeowner has technical information to indicate that his or her home has been inadvertently shown within the Special Flood Hazard Area on a Flood Insurance Rate Map, the homeowner may submit that information to FEMA and

request that FEMA remove the flood zone designation from the home by issuing a Letter of Map Amendment (LOMA) or a Letter of Map Revision Based on Fill (LOMR-F). Requests for LOMAs/LOMR-F must include the surveyed elevation of the lowest grade adjacent to the structure or the lowest enclosed level of the structure, along with certain other information.

2.5.7 US Army Corps of Engineers Regulations

Section 404 of the Clean Water Act authorizes the Corps to regulate the discharge of dredged or fill material into "waters of the United States" which are all navigable waters, tributaries to navigable waters, and wetlands adjacent to those waters. The limit of jurisdiction is the high tide line in tidal waters; where adjacent wetlands are present, it is the limit of the wetland. Regulated activities include the placement of fill for construction, site-development fill, riprap, seawalls, and beach nourishment.

Section 10 of the Rivers and Harbors Act of 1989 authorizes the US Army Corps of Engineers to regulate structures and work in navigable waters of the US. Jurisdiction extends shoreward to the mean high water line. Regulated activities include construction of piers and wharves, permanent mooring structures such as pilings, intake and outfall pipes, boat ramps, and dredging and disposal of dredged material, excavation, and filling.

The Corps' other major responsibility is to plan and carry out water resources projects such as improvements to navigation. Since 1986, the cost for such projects is shared between the federal government and the nonfederal sponsors. An important consideration in the Corps' decision to undertake a project is that its benefits exceed the cost. For projects such as dredging of harbors and navigation channels, highest priority goes to projects that benefit maritime industry such as shipping and fishing.

2.5.8 Federal Consistency

NOAA's Office of Ocean and Coastal Resource Management website states:

> *"The Coastal Zone Management Act (CZMA) was enacted on October 27, 1972, to encourage coastal states, Great Lake States, and United States territories and commonwealths (collectively referred to as coastal states) to develop comprehensive programs to manage and balance competing uses of and impacts to coastal resources. The CZMA emphasizes the primacy of state decision-making regarding the coastal zone. Section 307 of the CZMA (16 USC § 1456), called the federal consistency provision, is a major incentive for states to join the national coastal management program and is a powerful tool that states use to manage coastal uses and resources and to facilitate cooperation and coordination with federal agencies.*
>
> *Federal consistency is the CZMA requirement where federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone (also referred to as coastal uses or resources and coastal effects) must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally approved coastal management program. (Federal agency activities are activities and development projects performed by a federal agency, or a contractor for the benefit of a federal agency).*
>
> *Federal license or permit activities and federal financial assistance activities that have reasonably foreseeable coastal effects must be fully consistent with the enforceable policies of state coastal management programs. (Federal license or permit activities are activities proposed by a non-federal applicant requiring federal authorization, and federal financial assistance*

activities are proposed by state agencies or local governments applying for federal funds for activities with coastal effects.)

A lead state agency performs federal consistency reviews (usually the same agency that implements or coordinates the state's federally approved coastal management program). At the federal level, the Office of Ocean and Coastal Resource Management (OCRM), within the National Oceanic and Atmospheric Administration's (NOAA's) National Ocean Service (NOS), among other duties and services, interprets the CZMA and oversees the application of federal consistency; provides management and legal assistance to coastal states, federal agencies, tribes and others; and mediates CZMA related disputes. NOAA's Office of the Assistant General Counsel for Ocean Services assists OCRM and processes federal consistency appeals to the Secretary of Commerce." (http://coastalmanagement.noaa.gov/consistency/welcome.html).

2.5.9 Water Quality Certification

Any activity that would result in a discharge of a pollutant, dredging, dredged material disposal of greater than 100 cubic yards, and that require a federal permit (such as a 404 permit from the Corps) must also obtain a Water Quality Certification (authority derives from Section 401 of the Clean Water Act). The DEP's Division of Wetlands and Waterways administers the program which seeks to ensure that a proposed project does not violate the Massachusetts Surface Water Quality Standards or the Massachusetts Wetlands Protection Act, and otherwise avoids or minimizes individual and cumulative impacts to Massachusetts waters and wetlands. If a project would result in minimal fill within wetlands, the Order of Conditions issued by the Conservation Commission can serve as the Section 401 Water Quality Certificate.

2.5.10 Massachusetts Ocean Sanctuary Program

In 1970, Massachusetts passed the Ocean Sanctuaries Act (Ch. 132A, Section 12A) which applies to the area between the mean low water line and three miles offshore, except for the area between Lynn and Marshfield. The Ocean Sanctuaries Act is designed to protect coastal waters by prohibiting activities that could be environmentally or aesthetically damaging. The Act prohibits exploitation or development that would seriously alter or endanger the ecology or appearance of the ocean, seabed, or the subsoil. Some of these prohibited activities include building on the seabed, drilling, dumping wastes, and commercial advertising. However, fishing, sand extraction, and special projects are still allowed under the act. The Department of Conservation and Recreation (DCR) has jurisdiction over the ocean sanctuaries and DCR must approve all activities that occur on, or in, these areas.

3 GOALS, OBJECTIVES AND RECOMMENDATIONS / ACTIONS

3.1 WATER QUALITY

Goal: **Improve water quality to a level where the pond can support healthy habitats and water quality issues do not limit human uses of the pond.**

Objective: ***Reduce the amount of pollutants entering the pond.***

Background

The most significant source of pollution in Green Pond comes from septic systems associated with nearby residential development. The Town of Falmouth's on-going Wastewater and Nutrient Management Planning Projects and the work of the Nutrient Management Working Group are addressing this issue with the aim of moving residential properties off septic systems and onto a municipal sewerage system. This is a major undertaking and will require both time and resources. However, while these significant and important efforts are underway, other steps can be taken to reduce other sources of pollution and improve the water quality of the pond.

Massachusetts Surface Water Quality Standards are contained in 314 CMR 4.00 and are largely based on measurements of dissolved oxygen, temperature, pH, bacteria levels, solids, color and turbidity, oil and grease and taste and odor. The key to these standards is maintaining or enhancing the uses of a water body. Surface water quality has been the focus of the Massachusetts Estuaries Project and the following is taken from the July 21, 2003 (revised September 16 and December 22, 2003) Interim Report from the Technical Team (Brian L. Howes, Roland Samimy and Brian Dudley) of the Massachusetts Estuaries Project entitled "*Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators*".

> *"The current Commonwealth Surface Water Quality Standards are presented in 314 CMR 4.05(4). The standards, presented in detail below, relate to both human health and ecological health. However, it is clear that nutrient related habitat quality is not a major focus of the present standards and that overall, the standards applicable to habitat criteria are qualitative assessments (except for DO) of a few general nutrient and habitat indicators and overarching statements of anti-degradation.*
>
> *The anti-degradation provisions, simply stated, require that for all existing uses associated with a specific surface water body, water quality shall be maintained such that existing uses can be sustained. The regulations further require that certain high quality and significant resource waters be protected beyond the minimum national criteria. This requirement is especially true in cases where the character and value of the resource water cannot be adequately described or protected by traditional criteria. Eutrophication is specifically addressed in these anti-degradation provisions, although qualitatively.*
>
> *The Commonwealth's water quality regulations also call for prohibition of new point source discharge of nutrients to lakes and ponds and the implementation of the highest and best practical treatment to control nutrients in existing point source discharges. Non-point source nutrient control is required at the level of best management practice. While the eutrophication provisions specifically address lakes and ponds, statutory requirements at both the federal and state level require the protection of all navigable waters, including coastal embayments and*

estuaries. Accordingly, appropriate management practices also must be employed to protect and preserve coastal resources.

The current "Massachusetts Surface Water Quality Standards" set forth classifications for coastal and marine waters. These classifications apply standards that are both quantitative and descriptive and, at a minimum, require "good aesthetic value". The three classes are SA, SB and SC. A description of each follows:

- ***Class SA –*** *As quoted from 314 CMR 4.05(4)(a) "These waters are designated as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. In approved areas, they shall be suitable for shellfish harvesting without depuration (Open Shellfish Areas). These waters shall have excellent aesthetic value."*
- ***Class SB –*** *As quoted from 314 CMR 4.05(4)(b), "These waters are designated as a habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. In approved areas they shall be suitable for shellfish harvesting with depuration (Restricted Shellfish Areas). These waters shall have consistently good aesthetic value."*
- ***Class SC –*** *As quoted from 314 CMR 4.05(4)(c), "These waters are designated as a habitat for fish, other aquatic life and wildlife and for secondary contact recreation. They shall also be suitable for certain industrial cooling and process uses. These waters shall have good aesthetic value."*

Additionally, the regulations apply additional minimum criteria to all surface waters. These are listed below:

- ***Aesthetics*** *– All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.*
- ***Bottom Pollutants or Alterations*** *– All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.*
- ***Nutrients*** *– Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication.*
- ***Radioactivity*** *– All surface waters shall be free form radioactive substances in concentrations or combinations that would be harmful to human, animal or aquatic life or the most sensitive designated use.*
- ***Toxic Pollutants*** *– All surface waters shall be free form toxic substances in concentrations or combinations that would be harmful to human, animal or aquatic life or wildlife. This includes consideration of site-specific limits, human health risk levels and accumulation of pollutants.*

Of these general criteria, the nutrient and dissolved oxygen requirements relate most directly to the Estuaries Project; however, the aesthetic and bottom pollutant/alteration requirements must also be considered. Under this classification system almost all of the habitat health

requirements are set forth under the "nutrient" parameter, which refers to both site-specific limits and control of eutrophication. This provides a mechanism for linking the current system with more detailed habitat health criteria thus providing a translator between the water quality standards and direct habitat health indicators.

Overall, the regulations present public health criteria that are generally quantitative while ecological health, as currently described in the surface water classifications, is essentially qualitative. One major reason for this difference is that public health is significantly controlled by disease prevention, and based on bacterial indicators (Fecal Coliform, and more recently Enterococcus). These indicators are relatively straight-forward to establish and support quantitative thresholds. Protection of ecological or habitat health is more difficult to develop given the complexity of biological systems and the diversity of potential indicators. In addition, it is difficult to couple habitat health to a single indicator.

In addition to the difference in approach of the regulatory standards for protection of the public versus ecological health of coastal embayments, there is a significant discontinuity between the spectrum of habitat qualities and the range of water quality classifications. In effect, the classes of water quality all represent systems with nutrient related health ranging from excellent to good. In contrast, the Commonwealth's embayments fall into 6 categories of nutrient related health, ranging from excellent to severely degraded with the upper 4 categories supporting some fish and shellfish species and likely acceptable under some circumstances (refer above). Reconciliation of the current classifications with a broader range of ecological health classes is a major challenge for the development of embayment nutrient related thresholds in the Commonwealth.

In the interest of providing more descriptive and understandable classifications, it is proposed to describe six classes of water quality ranging from Excellent to Severely Degraded. These classes ideally would be determined both by numerical standards or ranges for specific constituents and also by more qualitative indicators of ecological health. Specific parameters would include dissolved oxygen, organic and inorganic nitrogen, transparency, phytoplankton (as chlorophyll-a pigments), and temperature. Indicators of ecological health would include eelgrass distribution, macroalgal distribution and benthic animal populations."

All efforts should continue to be made to reach and maintain the highest possible water quality level for Green Pond for both ecological reasons and to allow for the widest range of uses of the resource.

Recommended Action

- **Adopt new regulations/bylaws minimizing the use of fertilizers, pesticides, herbicides within watershed. This could be achieved by prohibiting their use within a specific distance of the water.**

  Responsible Agencies or Groups

  - ✓ Board of Selectmen

- **Organize annual meetings between the Conservation Commission, Department of Natural Resources and the Department of Public Works to ensure regular maintenance of catch basins, and other stormwater run-off systems and to prioritize the tasks necessary to achieve this.**

  Responsible Agencies or Groups

  - ✓ Conservation Commission

- ✓ Department of Natural Resources
- ✓ Department of Public Works
- ✓ Town Administrator's Office

- **The Town of Falmouth should support continuing state efforts to have Vineyard Sound designated as a No Discharge Area (NDA).** However, if these efforts were to stall, the town should apply to have its waters designated as an NDA. To do this, it would be necessary to determine the vessel population within Green Pond and the types of MSDs that are being used to calculate the pumpout needs and present capacity, and, if necessary, increase pumpout services within the pond.

  Responsible Agencies or Groups

  - ✓ Department of Natural Resources
  - ✓ Harbormaster
  - ✓ Town Manager
  - ✓ Board of Selectmen
  - ✓ CZM
  - ✓ EPA

- **Develop educational outreach about non-point source pollution, role of vegetated buffers, importance and role of wetland in helping maintain/restore water quality**

  Responsible Agencies or Groups

  - ✓ Conservation Commission

3.2 SHELLFISH AND EELGRASS

Goal: **Implement measures so that the pond can support healthy shellfish and eelgrass habitat.**

Objective: ***Improve conditions and control uses in the pond so that eelgrass is able to re-establish itself and shellfish beds can thrive.***

Background

In 2007, ENSR Marine & Coastal Center at Woods Hole was hired to perform a shellfish habitat assessment of Green Pond. This key study provided baseline information on eelgrass and shellfish as well as predicted the future recovery of both. The information was provided in GIS format and is shown below. With regards to eelgrass, the study stated that:

> *"The eelgrass habitat value layer polygon is a subjective representation of the potential value to successfully restore eelgrass based on current conditions, and with the premise that the water quality within Green Pond will be improved in the future though reduction of nitrogen loading entering the pond. Eelgrass restoration success is dependent upon many factors, including; light penetration, sediment grain-size and water quality. For the purposes of mapping habitat potential it is assumed that the water quality will not be a limiting factor once improved, and that the sediment characteristics will be changed only through tidal flushing and storm events, and not through mechanical means such as dredging. Therefore, because eelgrass shoots require a substrate less than 70% silt/clay in order to take hold, the areas depicted as medium*

and high habitat quality are areas where there is a sandier substrate and where there will be good tidal flushing. It is ENSR's opinion that most of the pond north of the bridge will not be suitable habitat even after water quality is enhanced."

With regards to shellfish, the study stated that:

"The shellfish habitat value layer polygon is a subjective representation of the potential value to restore shellfish beds based on current conditions, and with the premise that the water quality within Green Pond will be improved in the future through reduction of nitrogen loading entering the pond. The areas where shellfish were found during the current field effort are generally included in the medium to high value areas because it is assumed that with increased water quality the already productive areas will at a minimum remain productive, and will likely increase in habitat value. It is ENSR's opinion that the channel and marina areas will not be good candidates for shellfish restoration due to boat traffic, though shellfish that do settle within these areas will certainly provide stock to the other areas of the pond."

The Falmouth Department of Natural Resources has an upwelling site near the existing Town ramp and uses a portion of the southwest corner of the pond for grow-out of shellfish.

As the shellfish and eelgrass recover, the potential for conflict between users of the pond will increase. Boating clearly represents one use that can have a negative impact on shellfish and eelgrass. The ground tackle on moorings can scour the substrate and docks can shade eelgrass and their construction can harm benthic habitat.

Recommended Actions

- **Improve shellfish populations by continued support of town's shellfish propagation program.**

  Responsible Agencies or Groups

  - ✓ Department of Natural Resources

- **As recommendations are adopted and actions implemented, undertake periodic re-assessments of shellfish and eelgrass populations (and other indicators of benthic habitat health) to compare with 2007 ENSR study, to determine whether the health of the system is improving as predicted**. The frequency of such reassessments will depend on how quickly water quality improves and shellfish and eelgrass habitat recovers. Data gathered during the Conservation Commission permitting process should be used when available.

  Responsible Agencies or Groups

  - ✓ Department of Natural Resources

- **Schedule regular meetings between the Harbormaster, Department of Natural Resources and the Conservation Commission to review mooring styles and locations (more under moorings) and to restrict activities that will inhibit the recovery of eelgrass and shellfish habitat.**

  Responsible Agencies or Groups

  - ✓ Harbormaster
  - ✓ Department of Natural Resources
  - ✓ Conservation Commission

- **Hire an enforcement/compliance officer in the Conservation Commission; survey properties to determine if Orders of Conditions and Chapter 91 licenses requirements are in compliance.**

  Responsible Agencies or Groups

  - ✓ Town Manager
  - ✓ Conservation Commission

3.3 ALEWIFE RUN THROUGH GREEN POND TO MILL POND

Goal: **Enhance the capability for fish to reach spawning areas in Mill Pond and return.**

Objective: ***Improve the capacity of the fish ladder running underneath Route 28 into Mill Pond***

Background

Historically Alewives (*Alosa pseudoharengus*) moved through Green Pond into Mill Pond (north of what is now Route 28) and spawned there and possibly in its tributaries. Some Alewives probably spawned in the generally freshwater (8 ppt. salinity per Ramsey *et al.*, 1999) reaches of Green Pond below the Mill Pond dam.

An undated (probably 2003) grant application by Falmouth DNR (Martinsen, undated) entitled "Mill Pond Herring Run Restoration Project" reported that, "Until 1988, Mill Pond in East Falmouth, Massachusetts was an active freshwater ecosystem that was abundant with spawning herring. In 1988, a water control structure at this location was modified which caused a 4.5-foot drop in the river. Since then, herring have not been able to return to the pond to spawn.

The present dam includes a concrete structure with boards used to regulate water levels; a varying number of boards results in a change in both water depth in the pond and in the drop between the pond and the outfall stream.

Basic information about the current status of the Alewife run through Green Pond into Mill Pond is provided by Reback *et al.* (2004) who describes the run as currently "poor, not passable". Consequently a very limited number, if any, alewives actually succeed in passing through the historic run to Mill Pond for spawning. Reback *et al.* (2004) show a 7.4 foot drop at the Mill Pond dam. The difference between the 4.5 foot drop mentioned by Martinsen and the 7.4 foot suggests that measurements were taken with varying numbers of boards in the structure.

Mill Pond is approximately 12.5 acres in size and a maximum depth of less than 5 feet (Karasack, 2000 unpublished data cited in Ramsey *et al.,* 1999). This is near the lower size limit recommended by the Massachusetts Division of Marine Fisheries (MA DMF) for spawning areas (Philips Brady, MA DMF, 2008, personal communication).

In 2003 there was an on-site meeting that included representatives of the Falmouth Department of Natural Resources, the MA MF, and the MA Highway Department. At this meeting it was generally agreed that the best time to make permanent repairs to the dam and fishway is when work is done on Route 28.

According to the MA DMF, a fishway with a drop/rise of seven feet would be expected to cost in the $200K range – estimated at $25K–$30K per foot of rise – beyond the present funding capabilities of the MA DMF (Brady, 2008, personal communication).

Because of the cost and the limited size of Mill Pond, repairs to the fishway are not high on the MA DMF priority list at this point (Brady, 2008, personal communication).

While a permanent solution to the difficulties in the fishway probably are too expensive to be completed until major work is done on Route 28, it might be possible to produce a temporary solution by installing a fish ladder in the culvert under Route 28. One possibility would be an Alaskan Steep Pass – a prefabricated aluminum structure similar to a Denile ladder – which could be slid into the culvert. These come in 10-foot sections costing approximately $8K–$9K per section (Brady, 2008, personal communication). Total cost for such an option would be in the $50K range for purchase and installation. Even with the ladder in place, there might still be some difficulties reaching the top of the spillway from the northern end of the culvert.

Recommended Actions

- **When work is done on Route 28 in the vicinity of the Mill Pond, improve the fishway to allow fish to reach the spawning grounds. The current situation has been in place for some 30 years. Mill Pond is of limited size as a spawning site to maintain a significant run of fish. And it would be relatively expensive to construct a temporary solution with no guarantee of success.**

  Responsible Agencies or Groups

  - ✓ Department of Natural Resources – Work with the Massachusetts Highway Department and the Massachusetts Division of Marine Fisheries to ensure that improvements to the fishway remain part of any Route 28 Improvement project.

- **Once the fishway has been improved, establish a program to ensure spawning in the pond and monitor the spawning runs for several years to ensure that the fishway was designed and built to optimize the run.**

  Responsible Agencies or Groups

  - ✓ Department of Natural Resources – Once fishway improvements are made, ensure that an initial group of spawning Alewives reach Mill Pond and monitor the return of their offspring in ensuing years to ensure an optimal run.

Citations

Martinsen, R.C., undated. "Mill Pond Herring Run Restoration Project." A grant application prepared by the Falmouth Department of Natural Resources.

Reback, K.E., P.D. Brady, K.D. McLauglin, and C.G. Milliken. 2004."A survey of anadromous fish passage in coastal Massachusetts: Part 2. Cape Cod and the Islands" Technical Report #16 of the Massachusetts Division of Marine Fisheries found at www.mass.gov/dfwele/dmf/publications/technical.htm

Ramsey, J.S., S.W Kelley, and B.L. Howes. 1999. Water Quality Analysis of Great, Green, and Bournes Ponds, Falmouth MA. Report prepared for the Town of Falmouth, MA. Applied Coastal Research and Engineering, Inc., Mashpee, MA, USA.

3.4 MOORINGS

Goal: **Manage moorings in the pond to balance environmental, aesthetic and boating needs.**

Objective I: ***Manage the type, number and location of moorings in different areas of the pond so that they do not inhibit the recovery of eelgrass and shellfish habitat.***

Background

The demand for moorings exceeds the numbers that are available in Falmouth. Currently all harbors are closed to new moorings but interested individuals can place their name on the waiting lists for individual harbors. The harbormaster maintains a separate waiting list for each harbor and an individual may add their name to up to two waiting lists. There is a $10 fee to add ones name to a list and an annual $10 renewal fee. Failure to pay the renewal fee results in the individual's name being dropped to the bottom of the waiting list.

As the waiting lists are on a first-come-first-served basis, it could be years before a boater has reached the top of the list. In some areas the harbormaster estimates the wait time to be 3-5 years and up to 10 years in areas with a slow turnover. In general, moorings are replaced from the waiting list when a current permit is relinquished to the town or when the town cancels a permit. In most areas of Falmouth, the ownership of a mooring can be transferred from one generation to another within a family. Therefore, once a mooring permit has been granted, it may remain within a family for as long as successive generations wish to use it. This is not the case in Falmouth Harbor where the moorings are permitted by the Army Corps of Engineers and, as such, can only be transferred to a spouse. Especially in areas where moorings can be passed down to other generations, the turnover of moorings is further limited by the fact that there is currently no limit on the number of moorings that a person may have.

While there may physically be space to accommodate a greater number of moorings, there is currently a cap on the number of mooring permits that are being issued by the Harbormaster's office for many of the harbor areas (this includes the area of Green Pond above the bridge). If a cap is in place, no new moorings will be permitted in the area. Only when a current permit is relinquished to the town or when the town cancels a permit current permit can a new permit be issued to whoever is at the top of the waiting list. Caps are in place because many feel that the number of moorings cannot be increased without significantly impacting the environment, and the other users of the ponds and waters of the town. It is felt that there are already too many moorings in some harbor areas. The Harbormaster's Office is currently trying to reduce the numbers of moorings in these areas by capping the number of moorings below the current number. In these cases, when a current permit is relinquished or cancelled, the mooring is physically removed. Only when the total number of moorings falls below the cap, will new permits again be issued. The area of Green Pond north of the Menauhant Road Bridge is one such area where this is occurring (Table 6). When deciding how many moorings should be available in an area, it is necessary to balance several different uses and factors. The current caps have been set in part to address a number of environmental, navigational and aesthetic concerns. In addition, an increase in the number of boats would create new opportunities for user conflicts. Finally, an increase in the number of boats in the town's waters would require increased parking and landside dinghy storage areas. Green Pond has extremely limited water access and there is little opportunity for expanded parking. This is particularly true above the bridge.

Although mooring numbers have been capped in a number of areas, the town has never officially defined a "carrying capacity" for each of the areas. A mooring plan was developed for Green Pond in 1998 but was focused on the area of the pond south of the bridge. The plan specified anchor and tackle requirements and concluded that the pond could support a small number of additional moorings. The main limiting factors were water quality issues, potential conflicts between the need for moorings and the shellfishermen, the shortage of parking and the limitation of the storage and launching of dinghies.

As discussed, one of the factors that must be considered when discussing mooring numbers is the environment. As water quality within the pond improves, it is likely that shellfish and eelgrass habitat will also improve (Figures 17 and 18) and this may lead to increasing conflict between shellfishermen

and boaters. Currently, moorings located above the bridge are meant to be Dor Mor anchors or other approved short shank anchors. The majority of the moorings are located in areas that, in 2007, ENSR Marine & Coastal Center at Woods Hole estimated were of low value in terms of shellfish. As water quality increases, ENSR predicts that shellfish habitat will recover. The current locations of moorings will then be in areas that have the potential to be valuable shellfish habitats.

Table 6: Estimate waiting periods for moorings in Falmouth.

Harbor Area	Oldest Application	Comments
Child's River	2004	low turn over
Eel Pond Woods Hole	1991	very low turn over
Eel River East	2005	**mooring cap in place**
Eel River West – North	2004	**mooring cap in place**
Eel River West – South	2005	**mooring cap in place**
Falmouth Inner Harbor	1996	very low turn over
Great Harbor Woods Hole	1997	low turn over
Great Pond Maravista	2005	**mooring cap in place**
Great Pond Coonamessett	2005	**mooring cap in place**
Green Pond North	2005	**mooring cap in place**
Green Pond South	1997	low turn over
Little Harbor Woods Hole	1995	low turn over
Megansett Harbor	1995	low turn over
Megansett Outer Harbor	1996	**mooring cap in place**
Rand's Canal	2006	deeded rights required
Seapit River	2008	average turn over
Quissett Harbor	1997	low turn over
Waquoit Bay	2003	average turn over
West Falmouth	1998	low turn over
Wild Inner Harbor	1989	**mooring cap in place**
Wild Outer Harbor	2005	**mooring cap in place**

Source: Falmouth Harbormaster's website

One option to reduce potential conflicts it to change the mooring systems used in the pond. Of the mooring systems currently available, it if felt that helix anchors, with elastic and floatation to keep the ground tackle off the bottom, will help reduce potential impacts on the eelgrass habitat. However, such systems are more costly than traditional mooring systems. Helix mooring systems may also allow for greater density of moorings. While more moorings may not be acceptable, helix systems may allow for mooring to be moved into less environmentally sensitive habitats while still maintaining the number of moorings. The cost of transitioning to new mooring systems should be borne by the owner of the mooring. If ownership changes at a later date, a fair price for existing tackle etc. can be privately negotiated.

Another issue that has been raised about moorings is that some property owners located on the pond feel that they should be allowed to have a mooring off their property. Some residents are on the current waiting list but feel that there is no possibility of getting a mooring permit in the near future. However, it is felt that such a move would be unfair to those already on the waiting list.

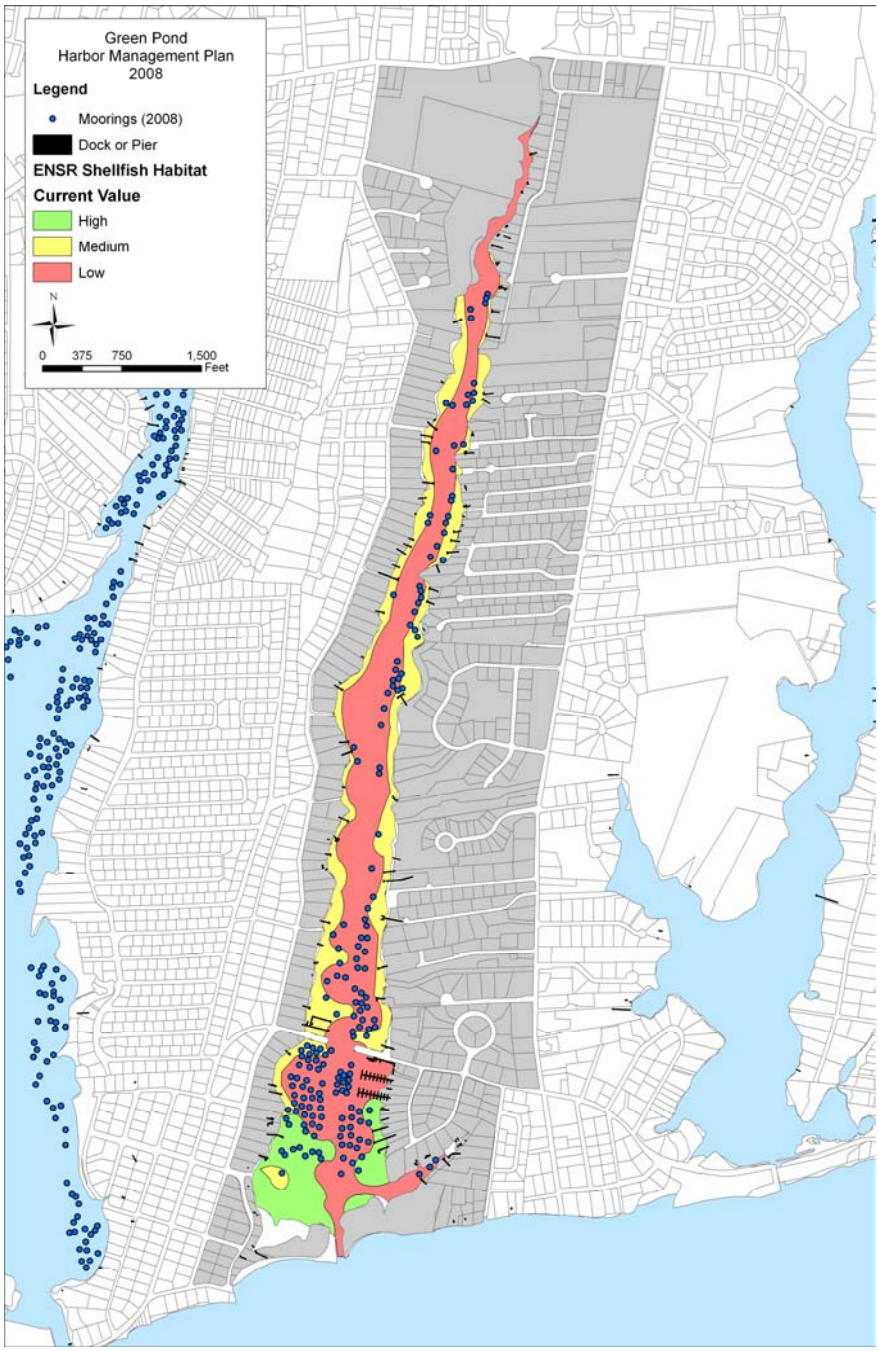


Figure 17: Current shellfish habitat value from ENSR Marine & Coastal Center at Woods Hole 2007 data with 2008 mooring locations and existing docks.

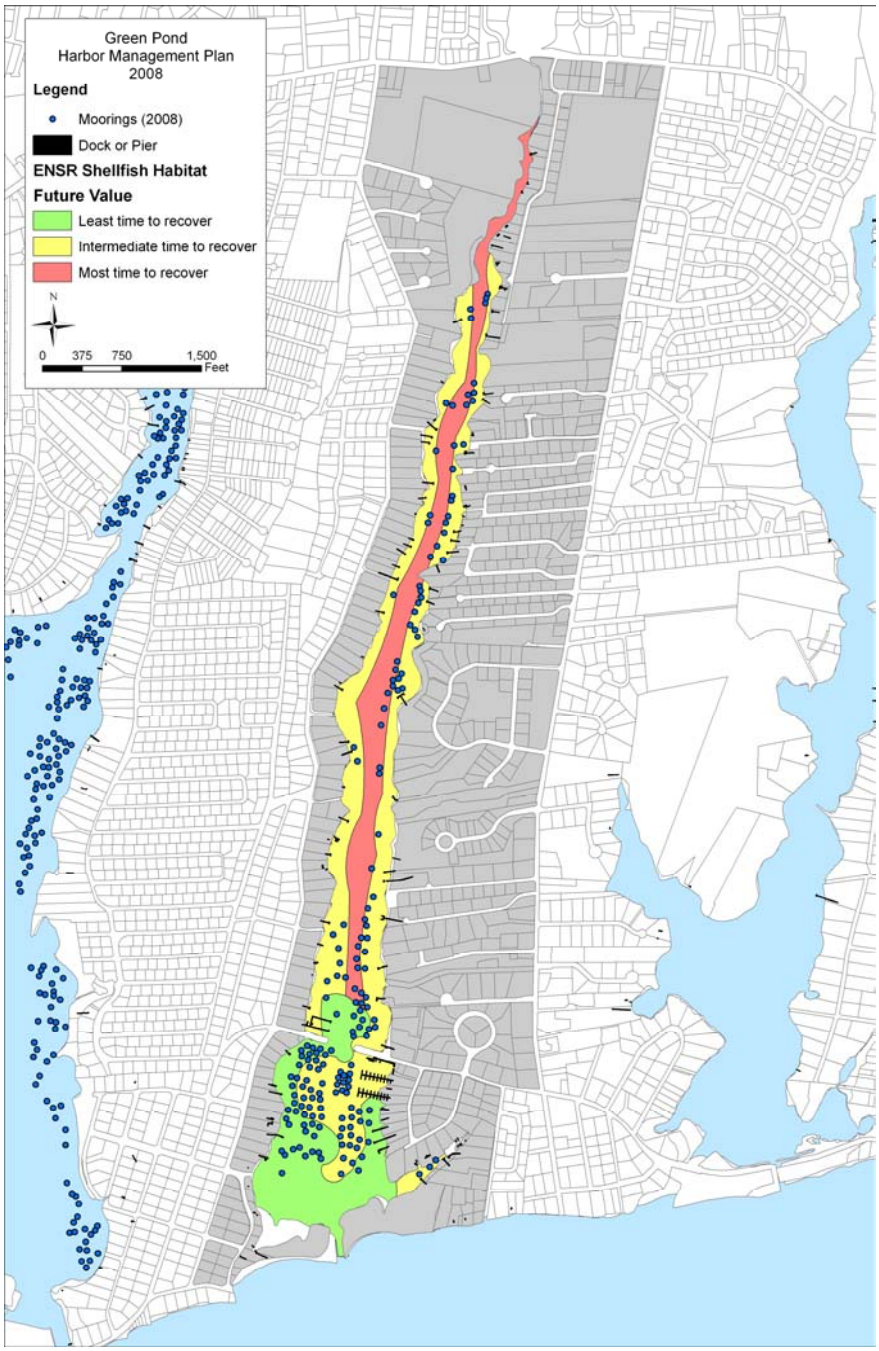


Figure 18: Future shellfish habitat recovery from ENSR Marine & Coastal Center at Woods Hole 2007 data with 2008 mooring locations and existing docks.

Recommended Actions

- ***Moorings should be established only in certain areas (to minimize impacts of natural resources, while ensuring boater safety and maintaining navigation) and within defined mooring areas, based on approved harbor plans, or when these do not exist, based on the harbormaster's expertise.***

Responsible Agencies or Groups

- ✓ Harbormaster
- ✓ Waterways Committee
- ✓ Coastal Ponds Management Committee
- ✓ Department of Natural Resources

- ***As eelgrass and shellfish habitat returns, moorings should be relocated to out of rich habitat areas and mooring type should be transitioned to the most advanced standard (ecologically) and cost borne by the owner.***

  Responsible Agencies or Groups

  - ✓ Harbormaster
  - ✓ Waterways Committee
  - ✓ Coastal Ponds Management Committee
  - ✓ Department of Natural Resources

Objective II ***Reduce current waiting lists for moorings and ensure that moorings are allocated in the most equitable way possible.***

Background

There is currently no limit to the number of moorings that can be held by an individual and in many areas of the town, mooring ownership can be transferred down from generation to generation. Both of these factors limit the "turnover" of moorings and mean that those on the waiting list may have to wait between 3 and 10 years before a mooring comes available to them. Increasing the turnover of moorings and ensuring a more equitable system for administering moorings would increase the fairness of the system.

Recommended Actions

- ***Limit the number of moorings that can be held by an individual.***

  Responsible Agencies or Groups

  - ✓ Board of Selectmen
  - ✓ Harbormaster
  - ✓ Waterways Committee
  - ✓ Department of Natural Resources

- ***Limit the transfer of moorings to a spouse (i.e. prohibit the transfer of moorings down from one generation to the next).***

  Responsible Agencies or Groups

  - ✓ Board of Selectmen
  - ✓ Harbormaster
  - ✓ Waterways Committee
  - ✓ Department of Natural Resources

3.5 DOCKS

Goal: **Minimize impacts to natural resources, shellfishing, navigation, and visual impacts from new or expanded docks in Green Pond.**

Objective: ***Manage docks in Green Pond consistent with existing and proposed regulatory management programs.***

Background

There are many private, community and communal docks within the pond (these are shown on the maps in the moorings section). Docks are known to have detrimental effects on marine habitats and natural resources. This occurs during their construction but docks can also shade benthic habitats and saltmarsh vegetation. The Town of Falmouth has significant standards in its Wetlands Protection Bylaw and regulations designed primarily to protect public values associated with wetlands. Docks call also alter the flow of water and there have been reports of sea lettuce (*Ulva lactuca*) getting trapped downwind of some docks rather than being washed up onto the shore.

An increase in the number, size, nature or design of docks can have impacts other than environmental. Docks can interfere with access to and use of the nearshore areas. It is therefore important to recognize that the effects of docks can be cumulative.

Other impacts include those that are often referred to as visual impacts, scenic impacts, or changes to community character, but basically they are changes from a natural condition to a built environment. The State of Maine presently reviews all dock proposals for visual impacts and many communities limit size, length, materials or other aspects of private docks to maintain existing conditions. The Town of Falmouth has significant limits in its Wetlands Protection Bylaw and regulations designed primarily to protect public values associated with wetlands. The regulations also allow for the protection of "Aesthetics" and "Recreation" (FWR 10.01 (2)) although these aspects are not discussed in great detail. Management of the number and nature of docks could also be managed through the establishment of an overlay zoning district for shorefront properties in the Green Pond area.

The Falmouth Wetlands Regulations contain specific standards for docks (FWR 10.16). Unless stated below, these standards apply to private, community and common docks. The regulations state that:

- Docks shall not exceed over one hundred (100) feet in length beyond mean high tide, or one hundred (100) feet in length beyond the landward edge of salt marsh, or otherwise prohibit or unreasonably impede legitimate passage along a beach or through navigation over the waters for recreational or aquacultural purposes;
- To keep disturbance of the bottom minimal at all times during both construction and use, the water depth at the end of the dock shall be a minimum of three (3) feet at the time of mean low water.
- For private and community docks - The area of the terminal "L" or "T" shape in a fixed dock, or the float, or combination thereof, shall not exceed one hundred (100) square feet;

  For common docks **-** The Commission shall consider the reduction of the total number of potential docks in the area in permitting a common dock. In no case may the mooring field of a common dock be larger than what would have been permitted by the total area of the individual potential docks of common owners.
- The design and construction shall not interfere with recreational intertidal lateral access;

- For private and community docks - No portion of the dock or pier may be closer than 10 feet from the property boundary or extended property boundary line into the intertidal and tidal zones.
- Floating docks shall be fixed by piers utilizing a hoop roller or other approved designed fastening system;
- The landward approach to a dock shall not harm vegetation on a coastal wetland, freshwater wetland or coastal bank (a marsh shall be crossed by a raised walkway, and coastal banks must be preserved by use of suitable stairs.);
- An area where the float(s), if any, will be stored shall be designated on the plan;
- Except for floating portions of a dock, the decking surface shall not reduce normal ambient lighting, i.e. sunlight, by more than 50 percent.
- The maximum horizontal footcandle level as measured directly below each complete lighting unit shall not exceed two-tenths (0.2) footcandle (Fc)
- For community docks - In addition to the marking contained in FWR 10.16(1)(i)(4), the following message shall be displayed on each section of the dock identified for the attachment of dinghies "dinghies only".

FWR 10.16(1)(h) contains General Requirements and Prohibitions all Docks and Piers:

1. No new docks or piers or extension of an existing dock or pier may be constructed in any portion of FEMA designated velocity zone (V-Zone) unless the applicant demonstrates that there will be public benefit from the project. The Commission shall weigh the potential likelihood, damage and harm that any such dock or pier would cause during a storm event with the public benefit demonstrated by the applicant in determining whether the project should be allowed.
2. No new dock or pier shall be allowed if, within 35 feet of the area designated by the applicant as the mooring field, there are significant quantities of shellfish as defined by FWR 10.34 (3) and the area has been historically used for shellfishing or has potential for shellfishing, and the sediment provides a viable shellfish habitat.
3. If, within 50 feet of any portion of the dock or pier, there are significant quantities of shellfish as defined by FWR 10.34 (3) or the area has been historically used for shellfishing or has potential for shellfishing, or the sediment provides a viable shellfish habitat, the applicant shall provide a shellfish mitigation plan.
4. The Commission shall presume that there are significant quantities of shellfish in any area actively shellfished within the previous six months of the shellfish survey.
5. No new, replacement, or substantial alteration of an existing dock or pier shall be permitted within fifty (50) feet of an area of eel grass (*Zostera marina*).
6. No toxic materials may be used to construct a dock or pier.
7. Any floating section of a dock or pier shall have a minimum water depth of three feet under all portions of that floating section of the dock or pier including times of extreme low water. This depth shall be measured as the shortest distance from any portion of the bottom of the floating section to the seabed.

Below is an illustrative map of the docks currently shown in the Town of Falmouth Geographic Information System (GIS) and visible on orthophotographs. Also shown are areas where new docks

might possibly be constructed under existing provisions of the town Wetlands Bylaw and regulations. However, existing data for both water depth and shoreline/salt marsh are limited and an actual map would not be possible without significant additional data.

Figure 19: Illustrative map showing where docks exist and where they could possibly be developed around Green Pond. NOTE: this is for illustrative purposes as the existing data are accurate enough to make a final determination.

There is anecdotal evidence that some docks in Green Pond have not been constructed or maintained according to the conditions established through a permitting process. It is presently unclear how many docks are out of compliance.

Recommended Actions

- **Define areas suitable, under the provisions of the existing regulatory programs, for new or expanded docks within Green Pond. Define areas where new docks should not be constructed due to potential conflicts with uses of the pond, critical natural resources, or other reasons related to public health, welfare and safety. Define areas where new dock construction or expansion should be allowed only under heightened standards in the permitting process.**

  This would require the establishment of criteria for areas where docks should be more limited than existing standards or where new construction or expansion should be prohibited. Either the criteria can first be established, after which the shoreline of the pond would have to be assessed to identify specific sites where such heightened standards should apply. Alternatively, specific sites can be identified as needing extra protection and a set of criteria are then developed based on the characteristics of the sites.

  Responsible Agencies or Groups

  - ✓ Conservation Commission – establish criteria
  - ✓ Coastal Ponds Management Committee – coordinate assessment of pond segments for suitability according to criteria.

- **Support the Town Administrator's 5 - year staffing plan to establish, and fill, an Enforcement / Compliance Officer position within the Conservation Commission, one of whose responsibilities would be to determine that docks are in compliance with state and local permits and licenses.**

  Responsible Agencies or Groups

  - ✓ Town Administrator – establish staffing plan
  - ✓ Conservation Commission – hire and supervise position
  - ✓ Board of Selectmen – support the 5-year staffing plan as it relates to the Enforcement/Compliance Officer position.

3.6 IMPACTS TO CIRCULATION AND/OR TIDAL FLUSHING BY THE MENAUHANT ROAD BRIDGE

Goal: **To maximize circulation of waters within Green Pond and flushing from the pond to Vineyard Sound to improve water quality.**

Objective: ***Assess whether the culverts and bridge opening under the Menauhant Road Bridge adversely impact circulation or tidal flushing within the pond***

Background

The "Atlas of Tidally Restricted Salt Marshes" published in 2001 by the Cape Cod Commission includes the following language regarding the salt marshes within Green Pond:

"Menauhant Road crosses Green Pond between Acapesket and Davisville roads via a 280-foot bridge. The bridge abutments extending into the pond are significant enough to effectively sever Green Pond so that it appears to be two distinct water bodies. …The seaward and upstream ponds are both approximately 600 feet wide, more than twice the bridge span. Recognizing that

the bridge span was insufficient, five box culverts were later cut into the berms by the Massachusetts Highway Department. However, these culverts were sited and constructed too high and therefore do not pass tidal flow except during extreme high tides."

The stated purpose of the Atlas is *"to identify salt marsh systems impaired by the restriction of tidal flow along the coast of Cape Cod, Massachusetts."* (There are 18+ acres of salt marsh located along the shores of Green Pond.) The implication is that the bridge/culvert system limits tidal flow to the upper portion of the pond.

According to the Atlas, *"A study completed for Falmouth in 2000 determined Great, Green, and Bourne Ponds to be rapidly flushing systems. …Tide attenuation through Green Pond inlet was negligible suggesting that improvements to the inlet will have a negligible impact on estuarine water quality."* (Applied Coastal Research and Engineering, Inc., 2000, p. 8 and Task 2 p. 32.)

This has led to a series of public comments suggesting that the "correction" of the elevation of the culverts and/or widening of the bridge span would improve tidal flow, thereby leading to larger and healthier salt marsh areas – and possibly improved water quality.

We have had second-hand responses from scientists who have conducted research within the pond that the issue is not one of flushing but rather that the bridge abutments have created "pockets" of water that do not circulate well. It is unclear to the writers of this document whether there truly is a circulation or flushing issue that needs to be addressed. We had hoped to have a more certain understanding to include within this draft plan, but the necessary information has not been forthcoming.

Recommended Actions

- **Do a further assessment as to whether there is truly an impact to either tidal flushing or water circulation within Green Pond from the abutments, opening through, or culverts associated with the Menauhant Road Bridge. This would include a thorough review of engineering drawings, scientific research, and monitoring data provided by the Falmouth PondWatchers.**

  Responsible Agencies or Groups

  - ✓ Department of Public Works – Engineering Division
  - ✓ Independent Engineering Company

- **If a problem is found, develop a design to improve flow and/or circulation between the northern and southern portions of the pond including costs and a description of benefits that would accrue from the proposed action.**

  Responsible Agencies or Groups

  - ✓ Department of Public Works – Engineering Division
  - ✓ Independent Engineering Company

- **Develop a new culvert design to increase water circulation in upper pond**

  Responsible Agencies or Groups

  - ✓ Department of Public Works – Engineering Division
  - ✓ Independent Engineering Company

3.7 DREDGING

Goal: **To ensure regular and effective dredging of the entrance to the pond to ensure safe navigation and to enhance the flushing of the pond.**

Objective: ***Ensure that dredging can occur in the most efficient manner while protecting important marine fauna and flora.***

Background

Due to the accumulation of sand, it is necessary for the entrance to the pond to be dredged annually or bi-annually. The work is done using the county dredge and there are rarely problems with its availability. However, the ability to dredge is limited by the Massachusetts Division of Marine Fisheries (DMF) which restricts dredging during times where it might interfere with the spawning of winter flounder or horseshoe crab. The state's Standards for Dredging and Dredged Material Disposal state:

> *"The design and timing of dredging and dredged material disposal activity shall be such as to avoid interference with anadromous/catadromous fish runs. At a minimum, no such activity shall occur in such areas between March 15th and June 15th of any year, except upon a determination by the Division of Marine Fisheries, pursuant to M.G.L. c. 130, § 19, that such an activity will not obstruct or hinder the passage of fish."*

In Massachusetts, winter flounder spawn between January and May with the peak of the season being between February and March. Generally, horseshoe crabs spawn between May and July. Consequently, it is difficult to carry out dredging in the first half of the year. As dredging is not a viable option during the boating season, the window for such activity occurs during the last few months of the year. While dredging can be done at this time, to do so that far in advance of the start of the boating season increases the likelihood that winter storms will transport sediment back into the mouth of the pond and so create hazardous shoals.

The communities on Cape Cod and the Islands are currently asking the Secretary of Energy and Environmental Affairs to request that his staff reconsider the blanket ban on dredging during the spawning seasons of winter flounder and horseshoe crabs. Some people suggest that horseshoe crab do not spawn in Green Pond and others suggest that it might be possible to dredge the mouth of the pond when winter flounder have moved further up the pond during their spawning period. However, it is likely that it will be necessary to undertake some scientific sampling to show when and if these species are using the pond and how dredging might be undertaken without having a detrimental effect on spawning behavior. If such studies were coordinated with surrounding communities, it might be possible to develop a "rolling" dredging schedule that allows for all dredging to be done closer to the start of the boating season but without harming the winter flounder or horseshoe crab populations.

Recommended Actions

- **Request that the state reassess the blanket ban on dredging on based on winter flounder and horseshoe crab.**

  Responsible Agencies or Groups

  - ✓ Department of Natural Resources
  - ✓ Board of Selectmen
  - ✓ Communities of Cape Cod and the Islands.

- **Assess existing data and conduct studies to determine the spawning activity of winter flounder and horseshoe crab. If possible, develop a rolling schedule that allows for dredging to occur in the first half of the year before the boating season starts**

  Responsible Agencies or Groups

  - ✓ Department of Natural Resources
  - ✓ Communities of Cape Cod and the Islands.

Goal: **To ensure that dredged material is disposed of in a way that is of greatest benefit to the town.**

Objective: ***Dredged material should be disposed of in areas where it can help to reduce coastal erosion.***

Background

An additional issue associated with dredging is the disposal of dredged material. Much of the material dredged from Green Pond is clean sand that can be used for beach nourishment. While the sand may initially have an odor due to a build-up of hydrogen sulfide, this quickly dissipates when the sand is placed on a beach. The town's general policy for the disposal of suitable dredged material is that where possible, it is placed on town property or where the public will benefit from it. However, such disposal is only financially viable when such land is in close proximity to the dredge operations. When this is not possible, the dredged material is disposed of where possible, even if this is on private land.

The 2003 report by the Coastal Resources Working Group titled *The Future of Falmouth's South Shore* recommends that the town should:

> *"Adopt a policy or regulation to ensure that all suitable dredge materials from coastal inlets and ponds are disposed of on beaches, particularly downdrift of jetties."*

Longshore drift across the mouth of Green Pond moves sediment from the west to the east. The western jetty tends to trap sediment and so reduce the sediment transportation to the eastern side of the mouth of the pond. Consequently the beach immediately to the east of the eastern jetty is being eroded (Figure 20) and, if this continues, the jetty could become separated from the shoreline.

If dredged material from a publicly funded project is disposed of on private land, the Department of Environmental Protection (DEP) has the right to seek a greater degree of public access. However, due to the continued erosion that is occurring at the mouths of the ponds, it is felt that the shoreline protection afforded by disposing of dredged material on private property represents a public benefit that out-weights the need to seek additional public access in such cases.

Recommended Action

- ***Adopt a policy or regulation to ensure that all suitable dredge materials from coastal inlets and ponds are disposed of so as to be of the greatest benefit to the town, even if this is on private property. The public benefit of shoreline protection negates the requirement for additional public access. Where possible, disposal should occur on beaches downdrift of jetties.***

  Responsible Agencies or Groups

  - ✓ Board of Selectmen
  - ✓ Department of Natural Resources

- ✓ Conservation Commission
- ✓ Waterways Committee
- ✓ Harbormaster
- ✓ DEP

Figure 20: The areas where sediment is being deposited and eroded at the mouth of Green Pond.

3.8 INVASIVE SPECIES

Goal: **Minimize the presence of invasive species that disrupt the natural resources of Green Pond.**

Objective I: ***Remove existing stands of Phragmites and keep them from returning.***

Background

Presently there are several areas of *Phragmites australis* (common reed) around the shores of Green Pond, particularly in the northern portion of the pond. This plant is generally considered an invasive species and is of concern as (adapted from the MA Department of Conservation and Recreation's Invasive Species fact sheet):

- Once established, it can negatively impact native vegetation and wildlife.
- It can form very dense impenetrable monospecific stands that may exclude native vegetation and not provide ideal shelter or food for wildlife.

- As it spreads rapidly and fills in wetlands, water flow is reduced and the flood retention of the wetland is decreased.
- Its stems can trap sediments, causing the waterbody to become increasingly shallow.

In 2004 a group of volunteers, under the direction of Dr. Richard Payne, surveyed the wetlands in Falmouth for *Phragmites* and produced the map below showing locations and sizes of patches of this plant in the Green Pond area. The various sized and delineated circles indicate the size of the stands of *Phragmites* in square meters.

Dr. Payne and other volunteers initiated three pilot control projects (and there are currently several other privately funded control projects under way) in the western part of Falmouth but none currently taking place in East Falmouth (Richard Payne, 2008, personal communication).

The methodology exists for volunteers in the Green Pond area to attempt control projects for this plant.

Recommended Actions

- **Establish a line item in the town Department of Public Works budget to assist with the planning and execution of an invasive species removal/control program for the Green Pond.**

  The Department of Public Works has the equipment and staffing to assist in the development and implementation of a program for the removal and/or control of *Phragmites.* Providing funding through the town budget will help ensure that this task is accomplished.

  Responsible Agencies or Groups

  - ✓ Coastal Ponds Management Committee – work with the Falmouth Department of Public Works to establish a realistic task list and budget to plan and execute an invasive species removal/control program for Green Pond.
  - ✓ Board of Selectmen – ensure that sufficient funding be recommended for the Department of Public Works to be able to perform the tasks identified for invasive species control.

- **Develop a community volunteer program for *Phragmites* removal/control in the Green Pond.**

  The Town could encourage volunteers in the Green Pond area to become more knowledgeable about the issues and devise and implement control programs for stands of *Phragmites.* This could include a workshop by Dr. Payne or some of the other volunteers could be facilitated to provide a better understanding. Permission of property owners where the stands exist would be required prior to any work being done and approval by the Conservation Commission for work done in or near wetlands would probably be required. The techniques utilized in the ongoing projects in other areas of the town could probably be adapted for the Green Pond area. Expenses have not been calculated for this option and it would require ongoing volunteer efforts both for initial control actions and for ongoing monitoring of results. The volunteer effort should work with and complement efforts by the Department of Public Works in this project.

  Responsible Agencies or Groups

  - ✓ Coastal Ponds Management Committee – work with volunteer groups and the Falmouth Department of Public Works to develop and implement a community volunteer program for the removal of invasive species.

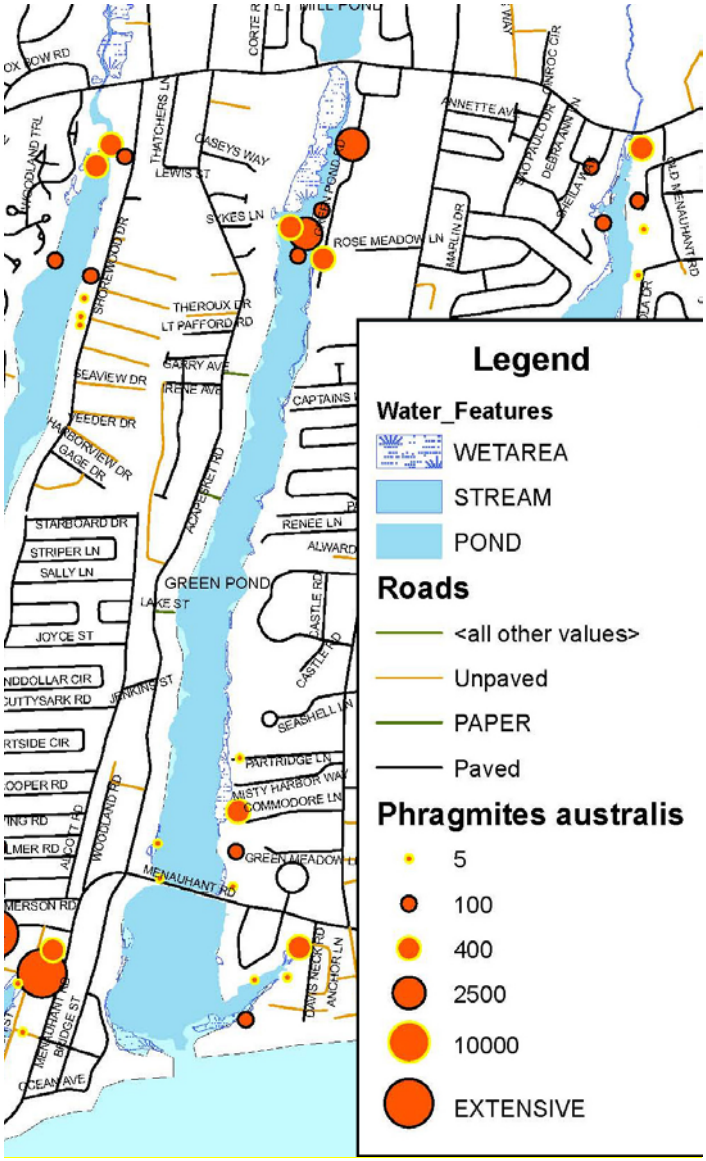


Figure 21: Map showing location of *Phragmites* stands in the Green Pond area. Circles show area of the stands in square meters. Map adapted from the work of Dr. Richard Payne from 2004.

Objective II: Monitor the occurrence and prevalence of other invasive species in the pond.

Background

The invasive European green crab (*Carcinus maenas*) and some non-native tunicate species have been reported in the pond. The following is adapted from the MA Office of Coastal Zone Management's "*Guide to Marine Invaders in the Gulf of Maine*":

The green crab prefers sheltered areas and is commonly found on mud, sand, or pebbles in the lower intertidal and nearshore subtidal zones. Habitat includes salt marshes, sandy beaches and rocky shores. The green crab can also tolerate a wide range of salinities.

The green crab is native to the North Atlantic coast of Europe and the North African coast. It is believed to have first arrived in eastern North America around 1817, most likely in the dry ballast of cargo ships.

The species has since established itself from Delaware to Nova Scotia and is the most common crab species in many locations throughout this range. An omnivorous scavenger, this crab is one of New England's dominant benthic predators, feeding on clams, oysters, crabs and mollusks. It is often blamed for the collapse of Maine's soft shell clam industry, and it competes with native fishes, birds, and humans for the same food.

Invasive tunicate species are of concern as they grow quickly and can smoother other organisms. Their spread is assisted by the fact that there are often no natural predators that feed on them.

Responsible Agencies or Groups

- ✓ Department of Natural Resources
- ✓ Conservation Commission

3.9 FLOOD HAZARD

Goal: **Reduce flood hazards in Green Pond**

Objective: ***Work to reduce erosion that could increase wave action and flood hazards within Green pond.***

Background

FEMA administers the National Flood Insurance Program which produces Flood Insurance Rate Maps (FIRMs). FIRM is the official map of a community on which FEMA has delineated both the special flood hazard areas and the flood risk premium zones applicable to the community.

All of the shoreline of the Green Pond Harbor Plan study area is, to some extent, within the 100-year flood zone (A zone) and parts are also within the high velocity zone (V Zone) (Figure 22). Property within an A Zone has a one percent probability of flooding in any year. Properties in the V Zone not only have a one percent chance of annual flooding, but are also subject to additional hazards due to velocity (wave action of 3 foot amplitude or greater).

The areas most vulnerable to flooding and wave action are the shoreline of Vineyard Sound. This beach, which encloses the river mouth, does provide some protection for the area behind from storm waves, but the broad area of water and adjacent shoreline south of the bridge is also in a high velocity zone.

The Coastal Resources Working Group's (CRWG) 2003 study *The Future of Falmouth's South Shore* noted that the town's south coast has seen an unprecedented increase in overall erosion rate over the past 30 years. The south coast has retreated (lost shoreline) by anywhere from 0.5 to 1 foot per year. The report notes that the main reason for the erosion and loss of sand along the south coast is that sediment supply and sediment transport have been blocked by coastal armoring structures. Exacerbating this situation is rising sea level, the rate of which is expected to increase over the coming decades. The CRWG's report recommends planning and management strategies for minimizing the risks to properties and resources from coastal storms and flooding.

Recommended Action

- **Pursue implementation of the recommendations in *The Future of Falmouth's South Shore* to stem erosion along the Vineyard Sound shoreline to maintain the protection afforded by the beach.**

  Responsible Agencies or Groups

  - ✓ Waterways Committee

- ✓ Harbormaster
- ✓ Department of Public Works
- ✓ Department of Natural Resources
- ✓ Board of Selectmen

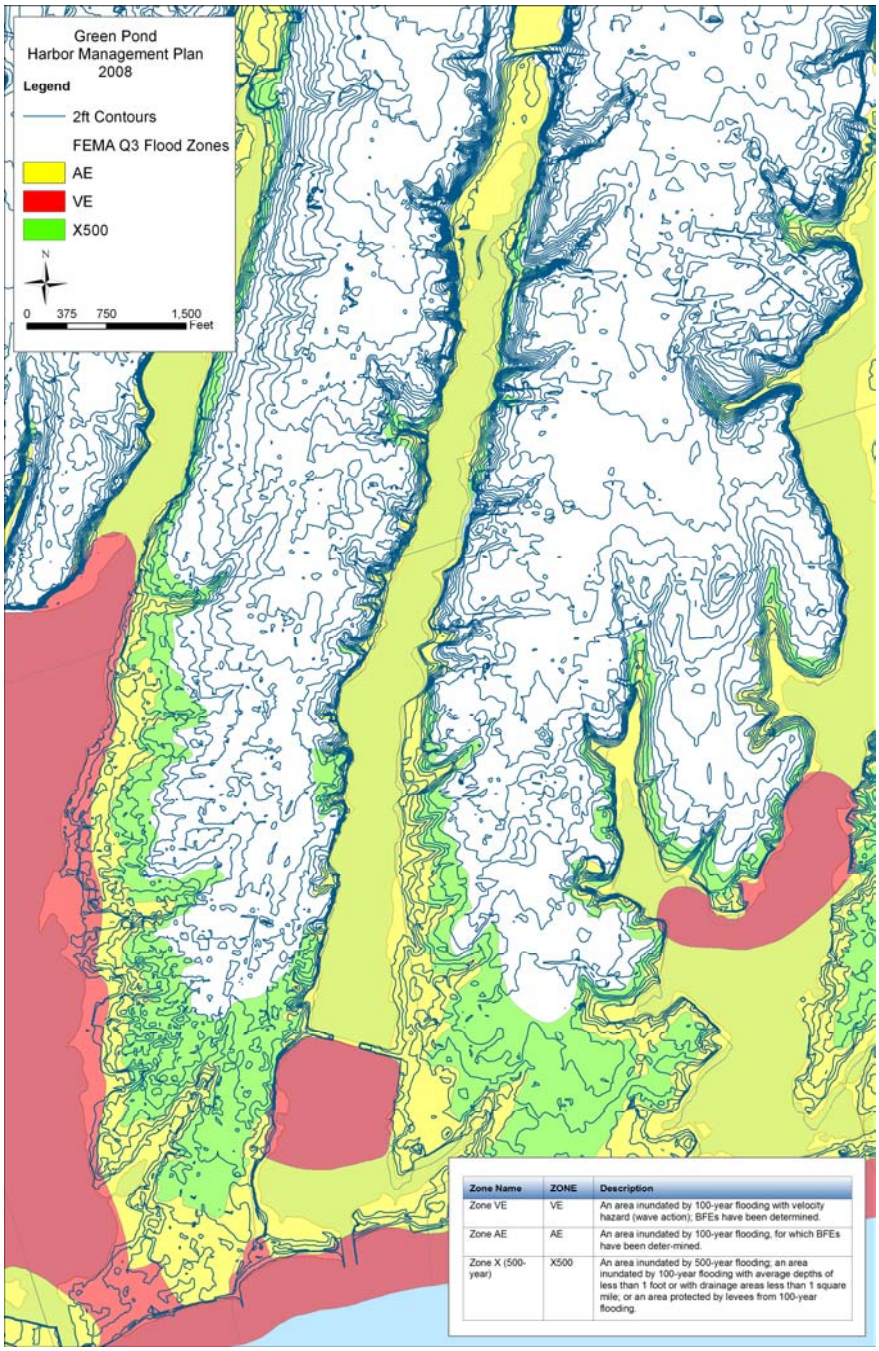


Figure 22: FEMA Q3 Flood Zones and 2-foot contours.

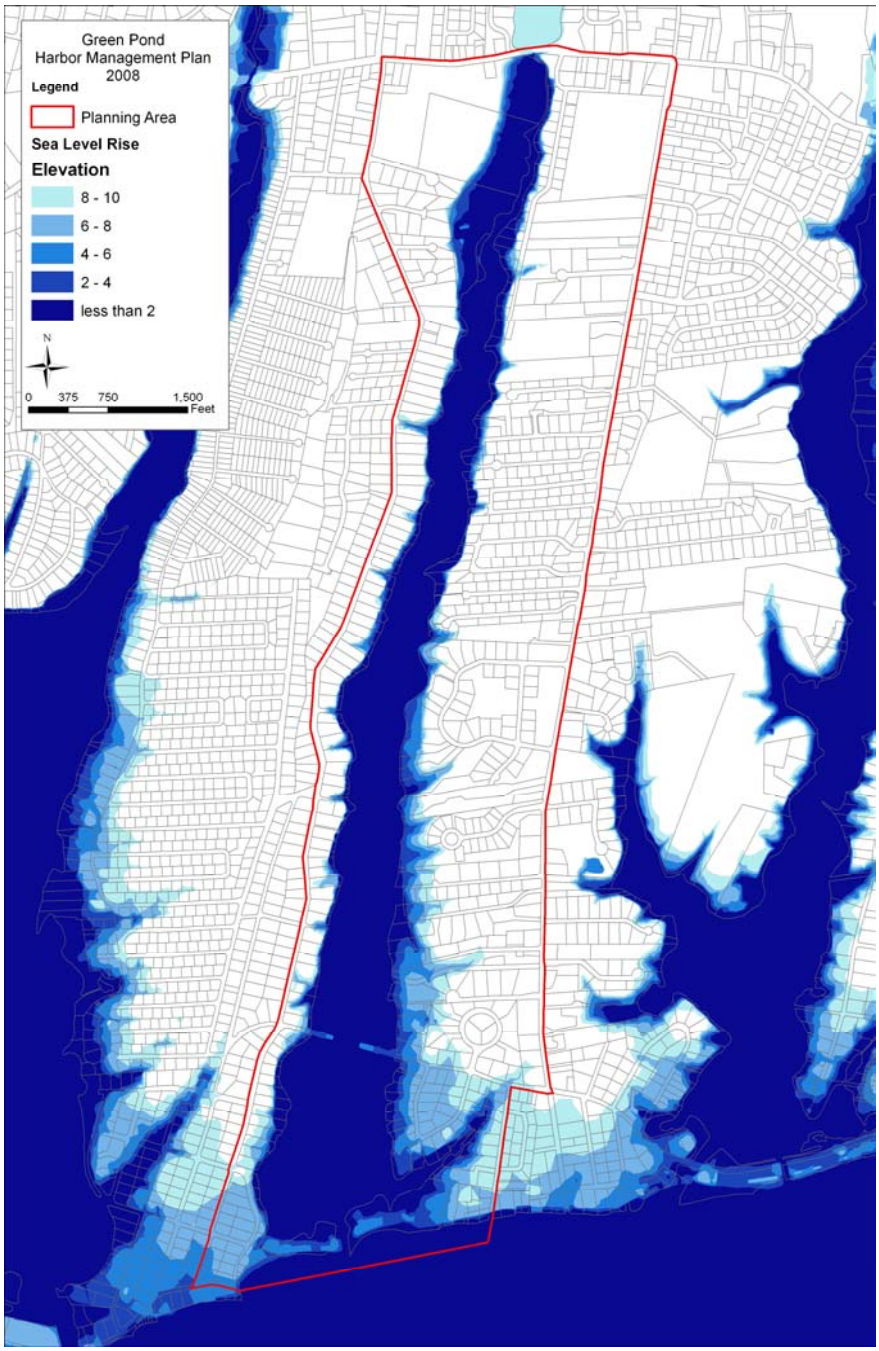


Figure 23: Illustrative map showing the potential effect of various degrees of sea level rise. NOTE: this is based solely on 2-ft contour data.

Citations

Coastal Resources Working Group, 2003, *The Future of Falmouth's South Shore.*

3.10 PUBLIC ACCESS

Goal: To preserve and improve public access to the waters and shorelines of Green Pond.

Objective I: Identify, maintain, and improve existing public access sites to and along the shore

Background

Presently there are a limited number of ways for boaters to access the waters of Green Pond:

1. **Private docks along the shores of the pond or moorings within the pond.**

   Ownership of a dock requires ownership of land along the shore and permits from the Falmouth Conservation Commission and the Massachusetts Department of Environmental Protection. There are a limited number of moorings available within the pond and the Harbormaster maintains a significant waiting list for access to a mooring.

2. **Slips at two facilities adjacent to the Menauhant Road Bridge.**

   The Green Pond Marina has slips and moorings at its facility on the southeast side of the bridge and Green Pond Tackle maintains slips at its facilities on the northwest side of the bridge. These slips/moorings are typically long-term rentals (a season or even longer) and do not turn over frequently.

3. **Access from another waterbody through the inlet to the pond.**

   Boats can enter the pond via the inlet but anchoring is discouraged, thereby limiting any stay in the pond.

4. **The Town Boat ramp at the southeast end of the bridge.**

   A boat ramp operated by the Town of Falmouth is located at the southeast side of the bridge. It is presently being renovated. When operational, it is limited by parking spaces to approximately 30 vehicles.

5. **A ramp at Green Pond Tackle on the northwest side of the bridge**

   This ramp is not functional at the present time but it could be renovated and made usable. Even if functional, it would be limited by the number of parking spaces at Green Pond Tackle; parking spaces that are shared by renters of slips and the commercial trade at Green Pond Tackle.

6. **A ramp at Green Harbor Waterfront Lodging in the northern portion of the pond.**

   This facility is limited to guests of the facility and, because of its location in the northern portion of the pond, boats must be of sufficiently shallow draft to navigate the shallower waters of the upper pond and sufficiently low to maneuver through the bridge. The facility works well for paddle craft and small power boats.

7. **Dinghy Beach off Menauhant Road.**

   A Town of Falmouth publication entitled “Public Access to Falmouth Lands” (1992) identifies a Town parcel immediately south of the Menauhant Road Bridge on the western shore of the pond as a public access site (Map 45, Section 9 Parcel 41A). The name provided is Dinghy Beach with an area of 0.06 acres (~2,600 square feet). It is described as having limited parking with potential use as a site to tie up dinghies and access to the pond for fishing and shellfishing.

As noted above, several of these options are not open presently functional (the ramp at the Green Pond Tackle Shop) are not open to the general public (private docks, the ramp at Green Harbor Waterfront Lodging), or require a season-long commitment (slips at the Green Pond Tackle Shop and Green Pond marina). Presently, Dinghy Beach and the town ramp, both south of the bridge, are the only locations for townspeople to launch paddlecraft and other small vessels. The section of this plan related to moorings addresses limitations on the increase of access through that option.

Recommended Action

- **Explore options to repair and/or improve the ramp facilities at the Green Pond Tackle Shop. As this is a private enterprise, it will require interest from the proprietors. Further, it would require review and permitting by the Falmouth Conservation Commission.**

  Responsible Agencies or Groups

  - ✓ Coastal Ponds Management Committee – contact the Green Pond Tackle Shop to ascertain whether there is interest in improving the ramp facilities. Identify what would be needed to make the improvements.

Objective II: Expand the number of access points in a systematic way that responds to the needs of the various segments of the population that use the harbors.

Background

The Town of Falmouth owns a significant parcel of land abutting Green Pond that would allow access to navigable waters – the Donald Welden Preserve. This 10-acre property is located off Davisville Road on the east side of the pond approximately opposite the Green Harbor Waterfront Lodging facility. As such, it has the same limitations as to depth of water and being above the bridge. However, it might offer the possibility of a launch site for paddle craft and/or other vessels that could be hand-launched. Presently there is a small parking area along the road and pathways that lead somewhat over 1000' to the water's edge. To become a usable access point to the water would require construction of a laneway, passable by vehicles, to a parking area on the elevated area near the water, a safe pathway way from there to the shore, and a small dock into the water. Limitations would be slightly increased traffic along Davisville Road, clearing of vegetation and construction of a laneway and parking area, and work along the shore of the pond in or near salt marsh.

There appear to be no restrictions on the deed for the Donald Welden Preserve that would preclude such construction. According to the newsletter of the 300 Committee, the reasons given for acquisition of the property at Town Meeting were that it provided *"the last open access to Green Pond"* and that it would be used for open space preservation and recreation. The land is presently under the management of the Falmouth Conservation Commission.

The Town Boat Ramp presently has four slips that are made available to the public. It may be possible to increase the number of slips at this location.

Presently, there is a limit on the number of moorings in the northern portion (north of the bridge) of the pond. Residents of the area have expressed interest in increasing the number to improve their ability to gain boating access to the pond and potentially to Vineyard Sound. There is currently no mooring plan for this area. A mooring plan, based on suitability for moorings (navigation, safety, natural resources, shellfishing, etc.) might more clearly define whether it would be possible to add moorings without adverse impacts.

It has been reported that there are several instances where town roads lead to the shores of Green Pond. These might provide suitable locations for enhanced public access. These potential sites should be identified and their suitability addressed as public access sites; considerations should include accessibility of parking, sensitivity of natural resources, whether the site is suitable for a launch structure, and depth of water.

As noted above, there is a boat ramp at the Green Pond Waterfront Lodging facility for the benefit of the Inn's guests. The Town could explore whether the proprietors have any interest in making the ramp available to non-guests and whether the ramp is suitable for increased access. As with the ramp at the Green Pond Tackle Shop, this is on private property and so cooperation of the owners would be necessary.

Recommended Actions

- **Explore the possibility of developing a launch facility for hand-launched, small craft (*e.g.,* canoes, kayaks) at the town-owned land at the Donald Weldon Preserve.**

  Responsible Agencies or Groups

  - ✓ Coastal Ponds Management Committee – work with the Conservation Commission (managers of the Donald Weldon Preserve) and other suitable town agencies and/or public groups to ascertain the possibility of developing a launch facility. If feasible, identify a group to design such a facility.

- **Explore the options of increasing the number of public slips at the town boat ramp.**

  Responsible Agencies or Groups

  - ✓ Coastal Ponds Management Committee – work with appropriate Town and/or state agencies to ascertain whether the number of public slips could be increased and what agency would be most appropriate to implement such an increase, if feasible.

- **Develop a mooring plan for the northern portion of the pond that determines locations and numbers (if any) of possible additional moorings with suitability based on navigation, safety, presence of critical natural resources, shellfishing use, etc.**

  Responsible Agencies or Groups

  - ✓ Falmouth Harbormaster – coordinate and oversee the development of a mooring plan for the northern portion of Green Pond. Work with the Coastal Ponds Management Committee, the Conservation Commission and user groups in establishing criteria to balance moorings, access points, natural resource protection, protection of navigation, and other important potential areas of interest.

- **Identify locations where endings of town roads that might be suitable for public access and develop them as appropriate.**

  Responsible Agencies or Groups

  - ✓ Coastal Ponds Management Committee – work with the Department of Public Works and other appropriate agencies and local groups to identify road ends that could potentially provide public access and define constraints to their use.

- **Explore the possibility of expanding access to the launch facility at Green Pond Waterfront Lodging.**

  Responsible Agencies or Groups

  - ✓ Coastal Ponds Management Committee – contact the Green Pond Waterfront Lodging facility to ascertain whether there is interest in providing access to their ramp facilities for the public. Define how such access would be established and implemented.

3.11 VEGETATED WETLANDS

Goal: **Minimize adverse impacts to the vegetated wetlands within the Green Pond.**

Objective I: ***Develop a detailed map showing significant vegetated wetland resources.***

Background

Vegetated wetlands provide a wide range of public benefits as described in the Massachusetts Wetlands Protection Act and the Falmouth Wetlands Protection bylaw. Within the Green Pond study area there are significant areas of vegetated wetlands, principally salt marsh, protected by the regulatory programs listed above. Most salt marsh areas within Falmouth have also been restricted as to use under the Massachusetts Coastal Wetlands Restriction Program (M.G.L. 130 s. 105). These restrictions were put in place on 3 June 1981 and are recorded at the Barnstable county registry of deeds. Presently, however, there is no current, accurate map of the wetlands within the Green Pond study area sufficiently detailed to make wetland planning- and management-related decisions.

Recommended Action

- **Develop a baseline map identifying the existing type and location of vegetated wetlands in the Green Pond study area. These would best be done through the use of aerial photography mapping and subsequent ground truthing.**

  Responsible Agencies or Groups

  - ✓ Conservation Commission

Objective II: ***Improve enforcement of and compliance with existing regulatory programs designed to protect vegetated wetlands within the Green Pond Planning Area***

Background

As noted above, there are three regulatory programs to protect wetlands in the Green Pond Study Area, all administered at the local level by the Conservation Commission; 1) the Massachusetts Wetlands Protection Act, 2) the Falmouth Wetlands Protection Bylaw and related regulations, and 3) the Massachusetts Wetlands Restriction Act. The Conservation Commission is presently understaffed and unable to ensure thorough compliance with and enforcement of these regulatory programs. The Commission needs a Compliance/Enforcement Office to assist existing staff in the protection of vegetated wetlands.

Recommended Action

- **Support the town Administrator's 5-year staffing plan to establish, and fill, an Enforcement/Compliance Officer position within the Conservation Commission whose responsibilities would include determining whether docks are in compliance with state and local permits and licenses.**

  Responsible Agencies or Groups

  - ✓ Town Administrator – establish staffing plan
  - ✓ Conservation Commission – hire and supervise position
  - ✓ Board of Selectmen – support the 5-year staffing plan as it relates to the Enforcement/Compliance Officer position.

3.12 LAND AND WATER USE – INCREASED DEVELOPMENT AND ZONING

Recommended Actions

- **Make the town boat ramp part of Marine District**
- **Utilize the special permit provisions allowing boat-related uses in residential districts**
- **Promote the improvement/expansion of facilities at existing locations and utilizing best management practices for all land- and water-side improvements and operations.**
- **Town-owned land on east side: potential to expand public access and boating access (see public access issue discussion).**

4 PRELIMINARY DRAFT WATERSHEET PLAN

A watersheet plan can provide guidance for the on-going management of a resource such as Green Pond. The goal of a watersheet plan is to manage the uses of the resource so that the maximum benefits can be gained from it while, at the same time user conflicts are minimized and the resource is protected and maintained for the use and enjoyment of current and future generations of Falmouth residents and visitors. To do this effectively, it is necessary to balance the needs and desires of different user groups. The aim is not to exclude any particular use but to balance these uses. Balancing the uses of the resource may occur on a physical/spatial scale by restricting uses in some areas and encouraging them in others. However, balancing uses may also occur on a temporal scale. An example of this is the current restriction on when dredging can occur based on the spawning behavior of winter flounder and horseshoe crabs (as discussed previously). It could also apply restricting boats from shellfish areas during the shellfishing season.

A full watersheet plan for Green Pond will require significant input from the Coastal Ponds Management Committee, the Waterways Committee, the Harbormaster, the Department of Natural Resources, the Shellfish Constable, the Conservation Commission and other stakeholders. Ultimately, such a plan would need to be formally adopted by the town to ensure that the recommendations are implemented.

Where are we now?

As a final step in the planning process we will integrate these recommendations and data into a vision for Green Pond that :

- Preserves a significant area of open water as both a community amenity and a benefit to the Pond's natural resources
- Maintains a high level and range of boating activities, and
- Improves opportunities for shellfishing.

We will reflect this vision on a map of Green Pond that delineates areas where the priority among the principles uses - resource protection and restoration, boating facilities (public and private, community and individual), navigation, shellfishing, and open space or water and aesthetic enjoyment varies - not that other uses are necessarily excluded.

The key data that is the basis for this map includes:

- The maps of current and likely future shellfish habitat
- The existing docks and moorings
- Bathymetry (the Con Com standard of 3' at mean low water)
- 100' distance from shore
- Channels and fairways

This is a first draft of that map and it delineates areas devoted to specific uses - docks and moorings and areas of open water (with open water being viewed as providing for resource protection, community aesthetics as well as fishing access).

The map reflects that given existing standards (i.e., adequate depth within a reasonable distance of shore and the density of shellfish) few areas that are now open water will have new docks. The map shows modified mooring areas that avoid the more significant resource areas while accommodating at least the existing number of moorings in proximate locations.

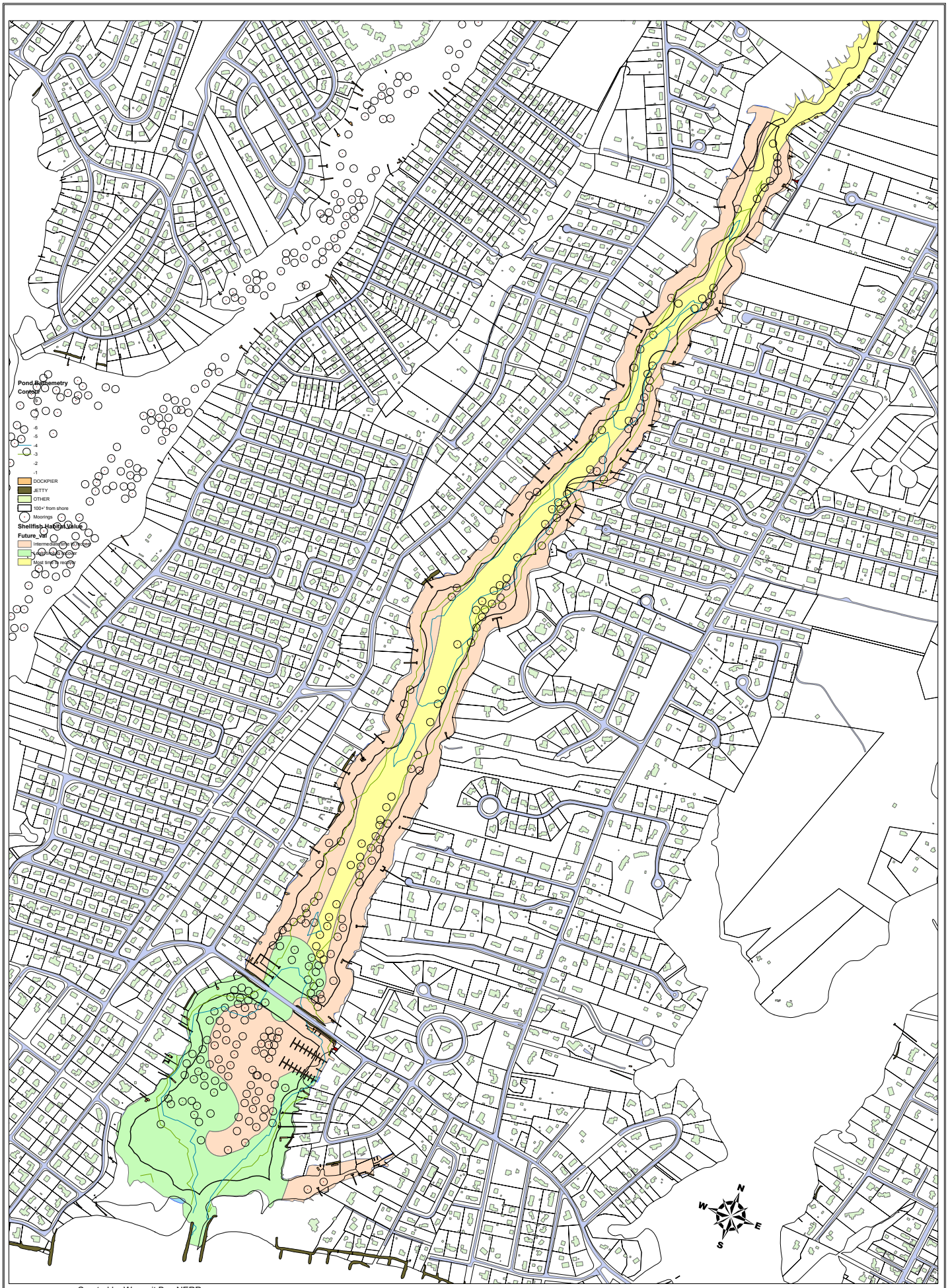
This is a first draft and we seek your comments before we make a final recommendation to the Selectmen.

Green Pond Potential Open Waters and Existing Moorings

Created by Waquoit Bay NERR
Date July 2009
Source Data Mass GIS, Town of Falmouth
Map is not for legal purposes

0 250 500 1,000 1,500 2,000 Feet

Potential Shellfish Value Recovery



Created by Waquoit Bay NERR
Date July 2009
Source Data Mass GIS, Town of Falmouth
Map is not for legal purposes

0 250 500 1,000 1,500 2,000
Feet

5 APPENDIX – ENSR SUMMARY REPORT

Town of Falmouth, Green Pond Shellfish Habitat Assessment (August, 2007)

The following information is provided to the Town of Falmouth to be included as metadata with the GIS layers for the Green Pond Shellfish Habitat Assessment project completed in September, 2007. The project was awarded to ENSR Marine and Coastal Center of Woods Hole, Massachusetts in April, 2007. A field survey of the entire Pond as described in the methodology section was conducted in June, 2007. Draft layers were provided to the town in August, and were presented to the Coastal Ponds Management Committee on September 10. ENSR accepted comments during the presentation, and allowed a minimum of two weeks after for additional comments to be received. Revised, final copies of all layers and data were given to the town on October 5, 2007. This information shall not be used for anything other than the Town of Falmouth Green Pond Habitat Assessment Project without previous permission from ENSR.

Survey Approach and Methodology

The pond was divided into upper habitat and lower habitat using the demarcation on the Massachusetts GIS website where MA DEP designated the lower pond (south of Jenkins Street) as suitable habitat for *Mercenaria mercenaria* (quahogs) as well as *Mya arenaria* (soft-shell clams), while designating only the shoreward edges of the upper reaches (north of Jenkins Street) as suitable for soft-shell clams. On paper, prior to the start of field efforts, the lower pond was gridded into north/south and east/west transects spaced 100 feet apart. Each intersection was assigned a number (GP1 – GP204) and was considered a potential sampling station. Of the 204 potential sampling sites, 80 were randomly selected and 20 specifically chosen (for larger areas missed by random selection) for analysis of shellfish and eelgrass presence or absence (100 stations). The upper reaches were to be surveyed sampling at 100 foot intervals along 500 foot long transects. The transects ran parallel to the shore, and were to be sampled at a distance of 100 feet from mean high water if possible. In addition, each transect included one "shore normal" transect which ran perpendicular to the shore, with sampling stations at the intertidal area as well as the mid-point of one transect station (e.g. Transect 1 at the 300-foot station was sampled at 50 feet from shore, 25-feet from shore, and at the intertidal area). A total of seven (7) transects with eight (8) stations each were sampled for shellfish in the upper reaches (56 stations). Additionally, in an attempt to find the transition between the upper and lower reaches portrayed by MA DEP a central rake haul transect was to be sampled to see if there was an ascertainable transition.

In the field all proposed stations were sampled for shellfish using rakes outfitted with ¼" mesh around the baskets in order to retain juvenile specimens. An area of the substrate approximately 1 square foot and one foot deep was sampled with the rake. All shellfish found were identified, enumerated and measured with all information recorded directly into field logbooks. In the lower Pond, if no shellfish were found in the initial rake, a second rake was performed. Two rakes hauls were routinely taken in the upper Pond. All station locations were documented using handheld Garmin GPS units. At each station in the lower pond where eelgrass may have been present, an underwater investigation of the area was performed using a view box. No eelgrass was present. At each station sampled for shellfish, sediment was collected for the analysis of grain-size and total organic carbon (TOC). From the 156 stations, forty stations along cross-pond transects were selected to have the sediment samples analyzed for grain-size and TOC, with five duplicate samples run for QA/QC purposes (total of 45 samples). Ten sites were selected randomly from the shellfish stations for analysis of a 0.04 m^2 Van Veen benthic grab for the presence or absence of species indicative of poor or stressed habitat.

Survey Participants

Name	Dates	Affiliation
Pamela Neubert, Ph.D.	6/5-6/8/2007	ENSR
Paula Winchell	6/5-6/8, & 6/13/2007	ENSR
Steve Aubrey	6/5-6/8, & 6/13/2007	Rogue Wave Field Services
Michael Bartlett	6/5-6/6/2007	Rogue Wave Field Services
Jack Steele	6/5-6/6/2007	Marine BioControl

Apparent Redox Potential Discontinuity Depth (aRPD) displayed in centimeters

For each station sampled an intact representation of the substrate/water interface was obtained. For all stations sampled in the lower Pond this sediment was obtained by deploying a 0.04 m^2 Van Veen grab over the side and retrieving the sediment. For all stations sampled in upper transects, the sediment was collected using the rake. To determine the apparent Redox Potential Discontinuity (aRPD) depth the upper most sediment is gently scraped away in small increments until such time as a change in coloration is observed. Oxidized benthic sediments are light in color, then turn darker as the sediments show signs of anoxic conditions. The turning point is what is called the aRPD depth. Most benthic species prefer to live in well oxygenated sediments. In general, anoxic sediments will have no or shallow aRPD depths, and more oxygenated sediments will have deeper aRPD depths. All aRPD values were entered into the field logbooks and are shown as centimeter depth. Green Pond aRDP depths ranged from anoxic (no aRPD) and surficial (or <0.1cm) to 3.0 cm (at Sta. GP-88), and to depth (no aRPD found in the depth of the grab sediments – or all of the sediment appeared oxygenated).

Total Organic Carbon (TOC)

A total of 45 samples (40 stations plus 5 duplicate samples) were analyzed for total organic carbon (TOC) by Alpha Woods Hole Group of Raynham, Massachusetts. Organic carbon is broken down by micro-organisms, which consume oxygen in the process. If the TOC is present in high concentrations, then oxygen may be used up in this process such that the remaining oxygen cannot support fish and other animals. The TOC analysis was performed using EPA method 9060. In the upper transect areas the TOC values ranged from 0.09 at T-2-200 at 35 feet to 1.2 at T-5-200 at 70 feet. TOC values in the lower stations ranged from 0.07 at GP-23 to 1.8 at GP-101.

Grain-size Analysis

A total of 45 samples (40 stations plus 5 duplicate samples) were analyzed for grain-size by GEO/PLAN Associates of Hingham, Massachusetts. A full phi class analysis was performed for this study. GEO/Plan utilizes a sieve methodology for determining percents for phi classes of gravel and sand, and a pipette analysis to determine percent silts and clays. For visual interpretation the mapping of the grain-size layer is shown as percent total gravel, total sand, total silt and total clay as a pie chart at each station where the grain-size analysis was performed. However, the individual phi class measurements are included as fields in the attribute table for each station. For the five stations where duplicate samples were obtained, the information depicted in the pie chart is presented as a mean of the two measurements, but the individual sample measurements obtained are included in the attribute table. Also included in the attribute table are columns for total sample mean and standard deviation as well as coarse fraction only mean and standard deviation. These columns show the average size grain for the entire sample, or for the gravel and sand fractions only. The mean and standard deviation values correspond to the following tables:

Grain size descriptors *based on the Wentworth Scale* (phi units)		
From	**To**	**Size Classification**
under	-8	Boulder
-8	-6	Cobble
-6	-2	Pebble
-2	-1	Granule
-1	0	Very Coarse Sand
0	1	Coarse Sand
1	2	Medium Sand
2	3	Fine Sand
3	4	Very Fine Sand
4	5	Coarse Silt
5	6	Medium Silt
6	7	Fine Silt
7	8	Very Fine Silt
8	or greater	Clay

Sorting descriptors *based on Folk* (Standard Deviation of phi units = Sorting Coefficient)		
From	**To**	**Sorting**
under	0.35	Very Well Sorted
0.35	0.5	Well Sorted
0.5	0.71	Moderately Well Sorted
0.71	1	Moderately Sorted
1	2	Poorly Sorted
2	4	Very Poorly Sorted
4	or greater	Extremely Poorly Sorted

Benthic Indicator Species

Ten shellfish sampling station sites representing all areas of Green Pond were chosen for analysis of one benthic grab to determine absence/presence of benthic species indicative of compromised habitat. At these ten locations a 0.04m^2 van veen grab was deployed by hand from the boat, and once retrieved the collected sediment was rinsed into a bucket. The buckets were returned to ENSR, where the samples were sieved through a 0.5 mm mesh sieve using filtered seawater until the sample was clean. The remaining material on the sieve was placed in a jar with 10 percent buffered formalin to preserve the organisms. After three days the samples were transferred to 75% ethanol. The samples were then brought to Ocean's Taxonomic Services (OTS) of Plymouth, Massachusetts. At OTS the samples were sorted and the animals identified to species (or lowest possible taxon) and enumerated. In some cases only an aliquot of the sample was sorted. The map layer provided to the Town of Falmouth only depicts whether benthic indicator species were present or absent, however the complete data with names and

count for all species found is included in the attribute table for the layer. At Station GP-51 no determination of indicator species was made because the entire sample produced only eight animals in total; therefore ENSR concluded that the area was anoxic and would not support a benthic community.

Eelgrass Habitat Value

The eelgrass habitat value layer polygon is a subjective representation of the potential value to successfully restore eelgrass based on current conditions, and with the premise that the water quality within Green Pond will be improved in the future though reduction of nitrogen loading entering the pond. Eelgrass restoration success is dependent upon many factors, including; light penetration, sediment grain-size and water quality. For the purposes of mapping habitat potential it is assumed that the water quality will not be a limiting factor once improved, and that the sediment characteristics will be changed only through tidal flushing and storm events, and not through mechanical means such as dredging. Therefore, because eelgrass shoots require a substrate less than 70% silt/clay in order to take hold, the areas depicted as medium and high habitat quality are areas where there is a sandier substrate and where there will be good tidal flushing. It is ENSR's opinion that most of the pond north of the bridge will not be suitable habitat even after water quality is enhanced.

Shellfish Habitat Value

The shellfish habitat value layer polygon is a subjective representation of the potential value to restore shellfish beds based on current conditions, and with the premise that the water quality within Green Pond will be improved in the future through reduction of nitrogen loading entering the pond. The areas where shellfish were found during the current field effort are generally included in the medium to high value areas because it is assumed that with increased water quality the already productive areas will at a minimum remain productive, and will likely increase in habitat value. It is ENSR's opinion that the channel and marina areas will not be good candidates for shellfish restoration due to boat traffic, though shellfish that do settle within these areas will certainly provide stock to the other areas of the pond.