

CHAPTER 4.

HARBOR FACILITIES AND NATURAL RESOURCES: MANAGEMENT ISSUES AND RECOMMENDATIONS FOR NANTUCKET SOUND

4.0 Introduction

The Nantucket Sound complex, the southern shoreline and adjacent waters of Chatham from Red River to the mouth of Stage Harbor (Figure 1), encompasses a diversity of coastal resources, each having distinct management concerns. Taylor's Pond, Mill Creek, Buck's Creek, Sulphur Springs, and Cockle Cove Creek are among the tidal ponds and estuaries that feed into Nantucket Sound. Key issues in these resource areas include protection of shellfish habitat, mooring placement, navigation and public access.

Over recent years shoreline erosion and accretion has emerged as a major threat to the continued enjoyment of the public beaches in this area. The sustainability of the shoreline for both recreational use and storm protection is a primary management challenge facing the town for the Nantucket Sound Complex.

Management objectives for the Nantucket Sound Complex are:

- To protect the natural beauty, ecological integrity and public enjoyment of Nantucket Sound beaches;
- To protect the water quality, habitat value and tranquility of the estuarine waters including Mill Creek, Buck's Creek, Taylor's Pond and Cockle Cove Creek and their associated wetlands; and
- To manage competing uses of the waterways and shoreline in a manner that protects natural resources and promotes public safety.

This chapter provides an overview of harbor facilities and activities in the Nantucket Sound Complex that include: public beaches, town landings and mooring areas. Natural resource conditions are also examined, with emphasis on water quality, the variety and vitality of habitats, shellfish resources and shoreline processes. Management issues associated with these topics are described, along with recommended actions to address management issues.

4.1 HARBOR FACILITIES AND ACTIVITIES

PUBLIC BEACHES

Nantucket Sound is the location of most of Chatham's primary recreational beaches. The beaches, collectively, are a destination for vacationers, a major local amenity for residents, and an important source of revenue for the town. All town beaches are under the jurisdiction of the Chatham Park and Recreation Commission, which administers the *Beach and Park Rules and Regulations*. The Commission's beach management responsibilities include: parking, public facilities,

bidding and management of concessions, hiring and training of life guards, demarcation of swimming areas, and enforcement of regulations. The Chatham Police Department issues non-criminal citations for prohibited activities and associated fines outlined in the regulations.

The Commission’s beach maintenance activities include managing the abundance of seaweed that washes onto some public beaches during the summer. Park and Recreation Commission staff rake seaweed along portions of Cockle Cove, Ridgevale and Harding’s beaches in front of the public swimming (life guarded) areas. The seaweed is piled in front of existing dunes where it catches sand and helps to fortify existing dunes.

Harding’s Beach, Ridgevale Beach, and Cockle Cove Beach are official town beaches. Official beaches are life guarded from the end of June through Labor Day. Parking is by permit or fee, although pedestrian access is free. In 2001, more than \$140,000 in revenue was generated from non-resident use of Harding’s, Ridgevale and Cockle Cove beaches, and almost \$95,000 was generated by beach sticker sales to local property owners. Even with recent growth in the heavy seasonal use of the Town’s official beaches, parking lot capacity is exceeded only a few days each summer. Overcrowding at Harding’s and Ridgevale Beaches tends to be absorbed at Cockle Cove, Forest and Pleasant Street beaches.

Table 9. Public Beaches, Nantucket Sound

Beach Name	Acres	Parking Spaces	Restrooms
Forest	25	31	—
Pleasant Street	.25	20	—
Cockle Cove	.72	76	Portable
Ridgevale	27	100	Portable
Harding’s	228	397	Restrooms
Total	280.97	624	

Forest Beach and Pleasant Street Beach originally were designated as town landings until the mid-1980’s when Town Meeting changed the designations to rural beaches. Rural beaches differ from official beaches in that there is no lifeguard on duty, and there is no permit or fee required for parking. In 1999 the Town acquired the former MCI property adjacent to Forest Beach, which previously had been leased by the Town. Recently the newly acquired area south of (but not including) the jeep trail was designated a public beach to be managed as a rural beach with no Town staff or facilities provided. At a public comment session held in the summer of 2002, residents and users of Forest Beach underscored the importance of the traditional multi-use nature of the beach. They expressed a concern that additional regulation to manage competing uses could aggravate conflicts. However there seemed to be recognition of a need to plan ahead for potential increases in congestion at the beach that could generate public safety concerns.

TOWN LANDINGS AND MOORINGS

Town landings and mooring fields within the Nantucket Sound Complex are limited as compared to the Stage Harbor Complex. Most Chatham-based boaters rely on landings within the Stage Harbor Complex as their point of entry into Nantucket Sound.

The only boat ramp within the system is a small timber pier and ramp located at Taylor’s Pond landing appropriate for launching hand carried boats such as canoes, kayaks and small sailboats. Motorboats are moored within Taylor’s Pond. However in order to get from Taylor’s Pond to Nantucket Sound vessels must travel through Mill Creek, which is shallow due to shoaling and is only inches deep at low tide.

Table 10. Town Landings, Nantucket Sound Complex

Location	Waterway	Ramp	Parking	Features
Forest Beach	Nantucket Sound	None	31	Mooring access
Pleasant Street	Nantucket Sound	None	20	Hand-carried boat launching
Ridgevale Beach	Nantucket Sound	None	100	Hand-carried boat launching
Ridgevale South	Buck’s Creek	None	0	Hand-carried boat launching
Taylor’s Pond	Taylor’s Pond	Wood*	6	Hand-carried boat launching
Mill Creek	Taylor’s Pond	None	3	Hand-carried boat launching

*Functionally limited to mid-high tide

Table 11. Mooring Permits, Nantucket Sound Complex

Location	Mooring Permits
Taylor’s Pond	30
Forest Beach	40
Pleasant Street	14
Cockle Cove	5
Total	89

The placement of moorings throughout the Nantucket Sound Complex is limited by a number of factors. The presence of eelgrass, shellfish beds and the Town’s aquaculture grow-out area limit the placement of moorings in the more protected areas of Taylor’s Pond and Mill Creek. These resource sensitivities, coupled with the shallow nature of the water bodies as noted above, make the addition of further moorings unadvisable. Within Nantucket Sound proper, parking necessary for mooring access is limited, and heavy weather and wave conditions make the placement of additional moorings there similarly inadvisable. Presently, the Harbormaster has issued 89 mooring permits in four areas throughout the system, and there is a waiting list to obtain a mooring permit in each of the areas.

The storage of small sailboats and dinghies along the shoreline—which does not require a permit or proof of residency—has increased in recent years. Forest Beach, and the stretch of shoreline between Cockle Cove and Ridgevale beaches are among the popular locations for dry sailing. Dry sailing (storing small sail boats on a beach) is a significant convenience to boaters who do not need a mooring and would otherwise have to transport their boat each time. Traditionally this activity has been allowed because it was felt to cause negligible impacts and, in fact, may have reduced impacts by limiting the number of times boats are hauled over beach grass or marsh areas. However the increased number of dry sailors has raised concerns about trampling of dunes and beach grass, crowding along the beach, and a growing number of boats launching in proximity to swimmers.

4.2 NATURAL RESOURCES

Water Quality and Wetlands

The Nantucket Sound Complex includes significant salt marsh, shrub swamp and tidal flats in and around Taylor's Pond, Mill, Cockle Cove and Buck's Creeks, Forest Beach Sulphur Springs (Figure 12). These various types of wetlands help to filter nutrients from in-flowing groundwater, absorb wave energy, and provide habitat to numerous avian, terrestrial and aquatic species. The area supports a seabird population that includes Piping Plover, Least tern, Common Tern, Arctic Tern (each of special concern); Roseate Tern (endangered), and Northern Harrier (threatened) ¹ (Figure 13)

A recent study of water quality shows evidence of nitrogen overloading in the estuarine waters of the Nantucket Sound Complex. This is due primarily to limited flushing of these estuaries, and the density of surrounding residential development, which contributes nitrogen through groundwater. The study, conducted by the Massachusetts Estuaries Project, evaluates habitat value throughout the waters based on the standards for a healthy estuary. The report finds that Taylor's Pond and most of the Cockle Creek system have high habitat value but are experiencing poor water quality that threatens habitats. However the portions of these systems that are functional salt marshes appear to be of moderate to high quality. Taylor's Pond is sufficiently over loaded with nitrogen as to be unable to support significant eelgrass or infaunal populations. Water quality conditions in Sulphur Springs are believed to be having negative impacts on habitat value there. ²

The Town is in the process of incorporating study results in a comprehensive nutrient management plan. The plan will identify the specific nutrient management alternatives needed to manage nitrogen levels and improve the habitat quality of the estuaries.

Shoreline Processes

Chatham's Nantucket Sound shoreline is located at the end of the Cape's expansive south-facing shoreline that begins in Falmouth. Waves pushed by prevailing southwest winds tend to transport sediment in a west to east direction. However, groin fields and jetties located along much of the Cape's south facing shoreline effectively trap sediment and limit its further migration. While in many instances these structures have helped to preserve segments of shoreline, they have also resulted in pockets of severe erosion. Chatham's section of Nantucket Sound shoreline exemplifies both positive and negative impacts from such structures over time.

Portions of Chatham's south facing shoreline—notably Cockle Cove—have experienced a continued loss of sediment over the past four decades. Other sections, such as Harding's Beach, have remained fairly stable. This variation is understood in terms of the location of the shoreline in relation to groins and jetties. In the 1940's, a sand spit extended eastward of Mill Creek approximately 1,500 feet, forming Cockle Cove. In the 1950's, a series of groins were built along the Harwich and Chatham shoreline west of Mill Creek. These structures, most of which remain today, were built to trap eastward migrating sand and stabilize the shoreline. However when the groins were built they effectively starved the Cockle Cove spit of sediment leading to its eventual deterioration. The remnants of the spit were pushed by waves and storms toward the shore, forming bars.

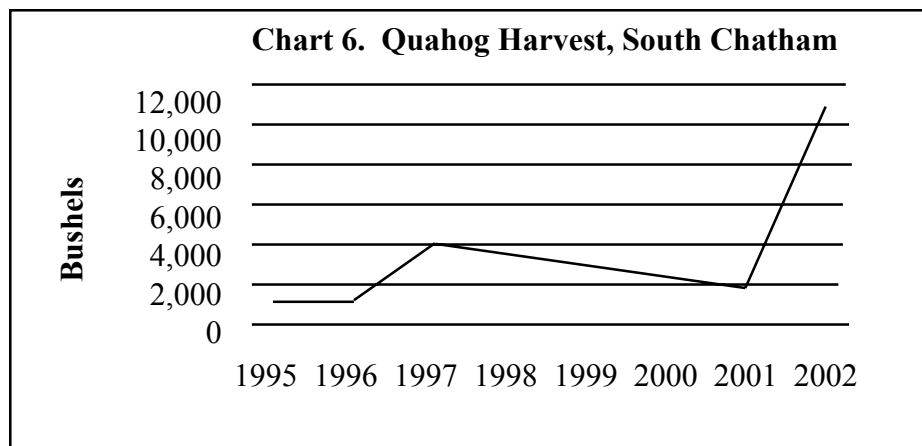
Over time the sediment from the spit and bars has continued to migrate eastward, unimpeded by groins, to feed Ridgevale and Harding’s Beaches. However the dearth of sediment coming from the west has resulted in a severe loss of beach area at Cackle Cove.³

In response, the Town is undertaking a project to re-nourish Cackle Cove Beach. The project involves taking dredged material from the Stage Harbor entrance channel and pumping it to Cackle Cove Beach. The dredged material will immediately replenish Cackle Cove Beach and, over time, will migrate eastward to nourish Ridgevale and Harding’s beaches as well.

Recognizing the dynamic shoreline changes in the area, the town, with help from the Friends of Chatham Waterways, is monitoring shoreline change on Nantucket Sound. Presently the monitoring includes two locations on Harding’s Beach, two locations at Cackle Cove and two at Ridgevale Beach. The monitoring data will help to establish a baseline measure of the shoreline against which changes in beach width and shape can be measured.

Shellfish Resources

The estuarine and open ocean conditions within the Nantucket Sound Complex provide a variety of shellfish habitat. Prolific eelgrass beds south of Ridgevale, Cackle Cove and Forest beaches provide habitat for bay scallops (Figure 10). Oyster habitat is found along the shores of Mill Creek and Taylor’s Pond (Figure 10). Softshell clam habitat is located in upper Mill Creek, where a town-owned quahog aquaculture grow-out area is also located, in the entrance to Taylor’s Pond, and in limited areas of Buck’s Creek and Sulphur Springs (Figure 8). Quahog habitat extends from Red River to Ridgevale Beach, and into Mill Creek, Taylor’s Pond, Buck’s Creek and Sulphur Springs (Figure 9).



Source: Chatham Shellfish Department.

In 2002 the Town designated a subtidal hydraulic dredge quahog fishery in Nantucket Sound (Figure 9). Within the area water depths are twenty feet or greater in order to avoid eelgrass beds. The area is also a potential location for the state-regulated sea clam fishery, although the species has not been actively fished in the area for the past several years. The only other hydraulic shellfishery allowed in town waters is located east of the Morris Island dike where hydraulic pumping for softshell clams is allowed during low tide.

The town-owned quahog aquaculture grow-out area in Mill Creek is the primary grow-out area for the Town. Three to four million seed quahogs are planted at the Town's grow out facilities each year, and a similar number of juveniles are taken and replanted throughout town waters. The town has recently taken steps to upgrade its successful public aquaculture program, including the upgrading of a staff position to oversee propagation activities.

4.3 Management Issues and Recommendations

MANAGEMENT ISSUE: SHORELINE PROTECTION

Protection of public and private shoreline from the process of erosion is a major management objective in Nantucket Sound. The Town's efforts to stabilize the shoreline should place priority on the protection of the Town's public beaches, and the safety of navigation.

RECOMMENDED ACTIONS: SHORELINE PROTECTION

1. The Town should place high priority on nourishment of public beaches as needed to mitigate erosion. Sections of the Nantucket Sound shoreline should be evaluated and prioritized for periodic re-nourishment. The Town has already identified a need to nourish Cockle Cove Beach and has done so with material from the dredging of Stage Harbor channel. Erosion along Forest, Pleasant Street and Ridgevale beaches should also be evaluated for future nourishment projects. Harding's Beach, which has been fairly stable over recent years, should also be carefully monitored. The Town should also identify a list of potential sediment sources that could include upcoming channel dredgings, and the Army Corp of Engineer dredged material disposal site located in Nantucket Sound just offshore of Harding's Beach.
2. Undertake an assessment of the entire Nantucket Sound Complex shoreline, focusing on the public access, navigation, and natural resource values addressed by the management plan. The assessment is necessary to determine where along the shoreline of the Complex new private shoreline structures may be found in compliance with the plan, and any areas where new private shoreline structures are not in compliance with the plan. The assessment should evaluate primary and secondary impacts on natural resources, public access, water quality, and navigation. A similar assessment conducted as part of the Pleasant Bay Resource Management Plan provides a useful model.
3. The assessment should be used to designate areas where the location of private piers may or may not be consistent with the management plan. The assessment should also be used to develop performance standards and design criteria for private docks in areas where they may be consistent with the goals of the management plan. Recommendations for the designation of areas off limits to new docks based on a resource assessment, or for performance standards and design criteria for new docks where they may be allowable should be adopted into the local zoning bylaw governing docks, as well as the town's wetland protection regulations. A document called *Guidelines and Performance Standards for Docks and Piers in Pleasant Bay* provides a useful model for providing a basis for regulatory changes.

4. The plan does not address the impacts of other types of structures such as erosion control structures, stairways or walkways. The potential impacts or benefits of these types of structures must also be evaluated, and guidelines for permitting should be developed. Recommendations 1 and 2 above should also be applied to the permitting of:
 - Catwalks as allowed under the Chatham Zoning Bylaw. Currently a catwalk may extend below mean high water and require a Chapter 91 permit and consistency review. However the performance and design standards for these structures are not the same as for private docks, even though catwalks function as docks in some cases.
 - New erosion control structures, or Chapter 91 licensing of existing erosion control structures.
5. The current configuration of groins and jetties along the Nantucket Sound shoreline, particularly between Red River and Mill Creek, should be evaluated to determine their current effectiveness in shoreline stabilization and their role in eroding down drift beaches. The Town of Harwich, which is experiencing erosion at Red River Beach, should be invited to participate in the evaluation and re-design discussion. The evaluation process must include the participation of shoreline property owners who would need to participate in, or could be affected by, any proposed redesign of structures. The objectives of the evaluation and redesign discussion should be the continued stabilization of public and private shoreline, the protection of public beaches, and the preservation of wildlife habitat.
6. The shoreline monitoring program underway under the auspices of the Town and the Friends of Chatham Waterways is an important step in developing baseline data and monitoring trends in shoreline conditions. The Town should provide the necessary support to ensure that the monitoring program continues. Results from the monitoring program should be considered in the evaluation of areas for re-nourishment, as outlined above.

MANAGEMENT ISSUE: MAINTENANCE OF PUBLIC BEACHES

Chatham's Nantucket Sound beaches are critical community assets. The maintenance and protection of the beaches should continue to be a community priority. The Park and Recreation Commission will continue to manage and maintain the public beaches. The Coastal Resources Department and Harbormaster also will have roles in ensuring the protection and safe use of the public beaches. The following actions are recommended to guide the management activities of Town officials and departments.

RECOMMENDED ACTIONS: MAINTENANCE AND MANAGEMENT OF PUBLIC BEACHES

1. The existing official beaches adequately meet current demand for public beaches. However, should demand for beach access reach a point where Ridgevale, Cockle Cove, and Harding's Beaches are experiencing consistent saturation of available parking, the Town may need to consider management options and strategies for addressing demand. Any such management action, strategy or policy should strive to maintain the environmental integrity of the beaches and surrounding wetlands, respect traditional uses of the areas, and preserve the quality of beach experience provided. Accordingly, the following conditions and options should be considered in order to relieve stress on those beaches while responding to demand:

- Expansion of parking is not advisable at any Nantucket Sound beach. This is due in part to the practical limitations imposed by land cost and availability. Equally compelling are considerations of environmental impacts resulting from paving and the introduction of more cars into environmentally sensitive areas.
 - Designation of either Forest Beach or Pleasant Street Beach as official beaches is not currently advisable. However, if demand for beach access continues to grow, consideration should be given to designating one or both of those beaches as official beaches. In evaluating the potential for a change in designation, consideration should be given to the capacity of the beaches to accommodate additional beach goers without adversely impacting natural resources, conflicts with other traditional uses at those locations, the need for and impacts from public facilities, and access issues. Where existing parking at either location will continue to be limited, the potential for providing limited off-site shuttle service to those locations would need to be evaluated.
 - Offsite shuttle service to any of the existing official beaches—Harding’s, Ridgevale and Cockle Cove—should only be pursued after a careful analysis of the capacity the respective beach to accommodate additional beach goers without adversely impacting natural resources, conflicts with other traditional uses at those locations, and the need for and impacts from public facilities.
1. Public safety is a concern in locations where boating activity takes place in proximity to swimmers and moored vessels. Forest Beach and Ridgevale Beach are areas where increased boating and beach activities have heightened concerns for potential conflicts. The Harbormaster and Park and Recreation Commission should address potential conflicts by:
 - Demarcating with buoys designated swimming areas at Pleasant Street and Forest Beach where moorings are accessed in close proximity to swimmers and beach goers;
 - Expanding public education efforts regarding the rules of vessel operation near swimming areas;
 - Enforcement of boating regulations pertaining to the operation of vessels near swimming areas, moored vessels and the shoreline;
 - Possible further demarcation of boating areas or relocation of moorings;
 - Consider more restrictive actions if the steps listed above are not effective in addressing threats to public safety.
 1. The raking and piling of seaweed at Harding’s, Cockle Cove and Ridgevale beaches has helped to stabilize dunes and reduce a public nuisance caused by excessive seaweed. The Park and Recreation Commission should adopt a plan to:
 - Ensure the proper placement of the raked seaweed to stabilize the dunes and shoreline areas;
 - Ensure that all necessary resources and administrative procedures are in place to continue the activity; and
 - Develop a protocol to monitor benefits or impacts from the seaweed raking on dune and shoreline stabilization.
 1. The Park and Recreation Commission govern commercial activity at public beaches. Currently the Commission bids out the rights to provide mobile food and beach related sundries service at all Nantucket Sound beaches except Ridgevale, where such goods are sold on adjacent private property. The Commission should continue the current bidding process, limiting the extent of items sold to food and beach related sundries, and prohibit the expansion of commercial activities at beaches.

2. Rules for pet access at public beaches should be continued and enforced. Signs indicating access rules, and “Mutt Mitt” dispensers, should be installed and maintained at all public beaches. Continued public education is needed regarding the need to pick up pet waste, especially along the shoreline where shellfishing and swimming occur.

MANAGEMENT ISSUE: PROTECTION OF HABITAT

The waters and associated upland of the Nantucket Sound Complex provide a variety of marine, terrestrial and avian habitat. The quality of the various habitat types is under assault on a variety of fronts that include overloading of nitrogen from surrounding land uses; noise, emissions and scouring from motorized vessels; bottom scouring caused by moorings; and trampling of marsh and dunes by people walking or by the storage of vessels on shore. Each of these threats relates to the intensifying use of the Sound and the land surrounding it. Adequate steps must be taken to ensure that the habitat value of the Nantucket Sound Complex is preserved and, if necessary, restored.

RECOMMENDED ACTIONS: PROTECTION OF HABITAT

1. The Town, through the Health and Environment Department and Harbormaster, should pursue the federal designation of Nantucket Sound within the three-mile limit of local jurisdiction as a No Discharge Area. The disposal of treated or untreated boat sewage is illegal within a No Discharge Area. Currently disposal of treated sewage in the area is permitted, although strongly discouraged. Disposal of untreated sewage is permissible in federal waters (beyond three miles off shore). The adequacy of pump out capacity at Old Mill Boat Yard in Stage Harbor will need to be evaluated as part of the application process. The Town should identify and secure resources necessary to ensure adequate pump out capacity and public outreach and education activities to support the designation.
2. The Town should continue a high level of commitment to water quality monitoring throughout the Nantucket Sound system. Implementation of the recommendations of the nutrient management plan should be a priority. Developments and activities that fall within the jurisdiction of health and wetland protection regulations should be held to the strictest standards applicable.
3. The Town should carefully consider employing DNA testing, or other feasible method of determining bacteria sources, in areas where sustained high bacteria counts have been recorded on a frequent basis. If in those areas a bacteria source is identifiable, the Town should undertake or require responsible parties to undertake remediation efforts. (See discussion on bacterial contamination, page 52.)
4. The Town should review the Coast Guard Area Committee Oil Spill Contingency Plan for Southern Massachusetts and Rhode Island and ensure that it adequately addresses local emergency response needs. Recognizing that the Harbormaster must notify the Coast Guard of any fuel spill, the Town should also consider whether a locally tailored plan is necessary to address spills that, while harmful to the area, may not trigger intervention by the Coast Guard. (See discussion on oil and fuel spill, page 52.)

5. The Town should continue to monitor research and policy develop regarding Harmful Algal Blooms (HABs). Based on information generated from regional and national institutions, and based on local conditions, the town should develop a plan to address the prevention, mitigation, and control of HABs. (See discussion on HABs, page 53.)
6. The Town is encouraged to continue a high level of commitment to public aquaculture projects, such as the grow-out area in Mill Creek, which seek to build the vitality of public shellfisheries. Through the Shellfish Constable the Town should seek to identify potential new grow-out locations within Nantucket Sound or elsewhere in Chatham's waters.

MANAGEMENT ISSUE: BOATING AND NAVIGATION

As with all Chatham waterways, boat traffic has intensified throughout the Nantucket Sound Complex. Recreational and commercial boating is integral to Chatham's community character and local economy, and the Town should continue to promote policies and regulations that support safe boating. In some instances in the Nantucket Sound Complex, increased boating activity conflicts with other uses or natural resource conditions. The following recommendations are provided to augment existing regulations and policies in addressing those issues.

RECOMMENDED ACTIONS: BOATING AND NAVIGATION

1. The Town has issued approximately twenty-four weir permits in its Nantucket Sound waters (Figure 5). Approximately one-third of those permits are active at any one time. The location of active weirs is based on a number of factors and changes from year to year. As commercial and recreational boat traffic continues to grow throughout Nantucket Sound it is important to affirm the importance of the permitted sites to the local fishing industry, as well as the potential for any of the alternate permitted sites to be used at any one time.
2. The Harbormaster has issued 89 mooring permits throughout the Nantucket Sound Complex. The Harbormaster should continue to limit the issuance of new mooring permits and maintain waiting lists at these locations. An abundance of eelgrass and shellfish habitat, shallow water, and the location of a Town aquaculture grow-out facility are factors that support a limit on mooring permits in Taylor's Pond and Mill Creek. Limited parking, the presence of swimmers in proximity to moorings, and frequent severe weather conditions are the basis for limiting moorings in the open Sound.
3. The demand for and impacts from dry sailing and dinghy storage at public beaches and landings need to be evaluated. The evaluation should consider the need for the permitting or registration of boats left on shore, use of courtesy dinghies at town landings, and other management recommendations.
4. Due to the importance of shellfish habitat in the estuarine waters of the Nantucket Sound Complex, dredging in those areas should be limited to extreme storm events or other uncontrolled events that may modify channel conditions and thereby preclude use of traditionally navigable waterways. In such cases dredging should only be pursued to approximate conditions that existed immediately prior to the event. Dredging in the outer waters of Nantucket

Sound, for navigation or for mining of sediment for nourishment of beaches and other vulnerable shoreline areas may be necessary. Under any circumstances dredging should only be undertaken if all applicable federal, state, county and local environmental standards and requirements for dredging and dredged material disposal are met.

¹ Horsley Witten Hegemann, Inc., *Comprehensive Harbor Management Plan, Town of Chatham*, 1992, p 29.

² Applied Coastal Research and Engineering, Inc. et al, *Water Quality Analyses of Coastal Embayments in Chatham ,MA*, 2001, p83.

³ Applied Coastal Research and Engineering, Inc., *Tidal Flushing Analysis of Coastal Embayments in Chatham, MA*. 2001, p.10.