# NANTUCKET EELGRASS MAPPING PROJECT
# SUMMER 2015

Final Project Report

*submitted to*

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*by*


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*on*

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## EXECUTIVE SUMMARY

The eelgrass resources of Nantucket have experienced a significant decline in areal measure during the last 20 years. These declines have been located in areas where runoff from nearby uplands have introduced nutrients which are harmful to the lifecycle of eelgrass. Other forms of vegetation (macroalgae and phytoplankton) have the capability to utilize these nutrients and out-compete eelgrass for sunlight. Healthy eelgrass beds demand "untainted" watersheds. Development in the near coastal upland poses a real threat to the future health of eelgrass and the many shellfish and finfish that reside there.

This comprehensive mapping project is an important building-block step toward effective management of the eelgrass resource, future efforts should be aimed at preventing further degradation to the coastal watersheds that directly impact eelgrass.

## Introduction

Nantucket has been endowed with large areas of eelgrass beds. These beds have been an important habitat which has been the source of food for the diverse shellfish and finfish resources that have always been in great demand for quality and uniqueness in both national and international markets.

As the landscape in Nantucket began to change in the 1970's with increased development, the eelgrass resources were introduced to the resultant enriched nitrogen run-off and other stresses from the landuse change. Other regions of the MA coast experienced similar increased residential and commercial growth and their eelgrass resources declined, in some areas to an alarming degree.

Eelgrass bed are a relatively low maintenance wetland system. They require sunlight and a water column which allows a moderate amount of the sun's energy to reach the bottom (on average > 20% of the surface light). When those light conditions are not met, the eelgrass is stressed and is less able to maintain its shoot density, maximum depth and unique ecological function.

Nantucket's eelgrass resources have experienced decline during the last 25 years. These declines have been especially apparent in the Nantucket Harbor area. The MA Department of Environmental Protection has conducted several aerial photography/digital imagery mapping projects in Nantucket. The resultant data from these surveys has revealed a dramatic decline in the eelgrass resources of the island.

This 2015 eelgrass mapping project has been designed and conducted to provide Nantucket resource managers with quantative eelgrass data that has been extensively field-checked and evaluated. This data should be considered the "time1" starting point for future efforts to quantify the eelgrass trends on the Island.

## METHODS

The eelgrass mapping process involves the acquisition of high resolution digital imagery captured within strict environmental conditions. The imagery is interpreted initially and questionable areas are highlighted for investigation during fieldwork. Extensive fieldwork is conducted to provide feedback for the initial interpretation questions. Final digital interpretation is completed on-screen using the field data.

<u>Data Acquisition and Image Interpretation</u>
Strict Specifications are required for the acquisition of acceptable imagery:

- when conditions are as near to low tide as possible,
- sun angle <25°,
- winds <5 mph,
- cloud cover minimal,
- no haze, no fog, and no rainfall or high wind conditions within previous 48 h.

Prior to interpretation, sample images were checked for quality within 48 hours of acquisition. Segments of flight lines that were rejected were reflown in the next available window of acceptable environmental conditions within the same growing season. *See Figure 1 Aerial Imagery Capture Schedule*

<u>Digital Imagery</u>
Digital imagery was acquired through a contract with GeoVantage Corporation (Peabody, MA, USA). The GeoVantage sensor consists of a digital camera with four bands centered on blue (450 nm), green (550 nm), red (650 nm), and near-infrared (850 nm). The output of the camera system are GeoTiff image products which were created from the true color imagery captured with a 0.5 m ground sample distance resolution and 8-bitradiometric resolution. The images were orthorectified, terrain-corrected (using 7.5 m USGS DEMs), geo-registered, and mosaics were created for each flight mission with a spatial accuracy of ±3 m (90% of pixels). The digital images were interpreted monoscopically on screen. The digital imagery was analyzed and interpreted using a high resolution CRT 22-in. monitor.

<u>Fieldwork</u>
Fieldwork was conducted in a 22’ seaworthy skiff. High accuracy GPS technology was used to log fieldnotes onto the digital mapping database. Underwater digital video was used to document the conditions at questionable areas. The video has been archived and geo-registered to be retrievable for future resource managers and researchers. The outer edge of each eelgrass polygon was carefully surveyed to verify that the outer edge of the interpreted polygon as accurate. Field data was logged to the specific coordinate where it is observed. *See Figure 2 Sample of Field Data Sheet*

<u>Final Data</u>
Polygons of seagrass were hand-digitized on screen using the ArcGIS 10.3 suite of software.Data is created and displayed in the .shp format. The data is distributed thru the NOAA Coastal Service Center Database and the MASSGIS system and the Massachusetts Department of Environmental Protection website.

<u>RESULTS/REGION REPORTS</u>
The Nantucket Project is divided into 6 sub-areas for narrative description.
The rose-colored polygons on the images below describe each sub-area.

Region 1, Downtown

2015 EELGRASS

1995 EELGRASS

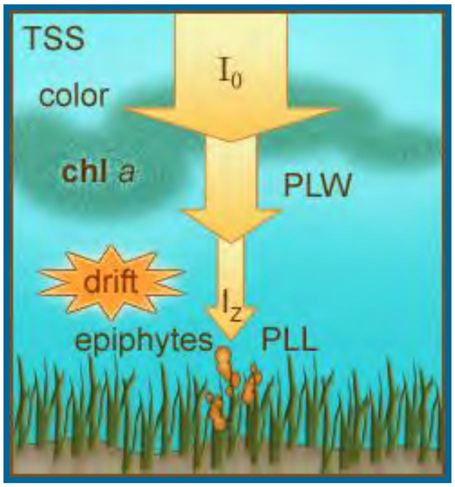
| Eelgrass Area Acres | 1995 | 2015 | 20yr % Change | Ave.% Decline/yr |
|---|---|---|---|---|
| | 50.1 | 35.2 | -30% | -1.5% |

This area of the Harbor has experienced the largest decline in eelgrass. Most notably the polygon in vicinity of Steamship Authority terminal north to the Town boat ramp and along the shore to the Coast Guard Station disappeared between 1995 and 2001. It could be expected that water quality issues related to point and non-point sources contributed to this rapid loss of habitat.

A similar change occurred in the Town Marina area. This area could have been stressed with water quality stresses coming from the adjoining watershed and also the impacts from the busy marina (fuel spillage and mechanical disturbance from prop-wash.

The relatively stable outer eelgrass boundaries in the area East of the Great Harbor Yacht Club Complex which enjoys a relatively undeveloped to sparsely developed watershed appears to have maintained its health. The eelgrass resources in this area should be surveyed carefully to detect future changes resulting from increased boat traffic from the Yacht Club.

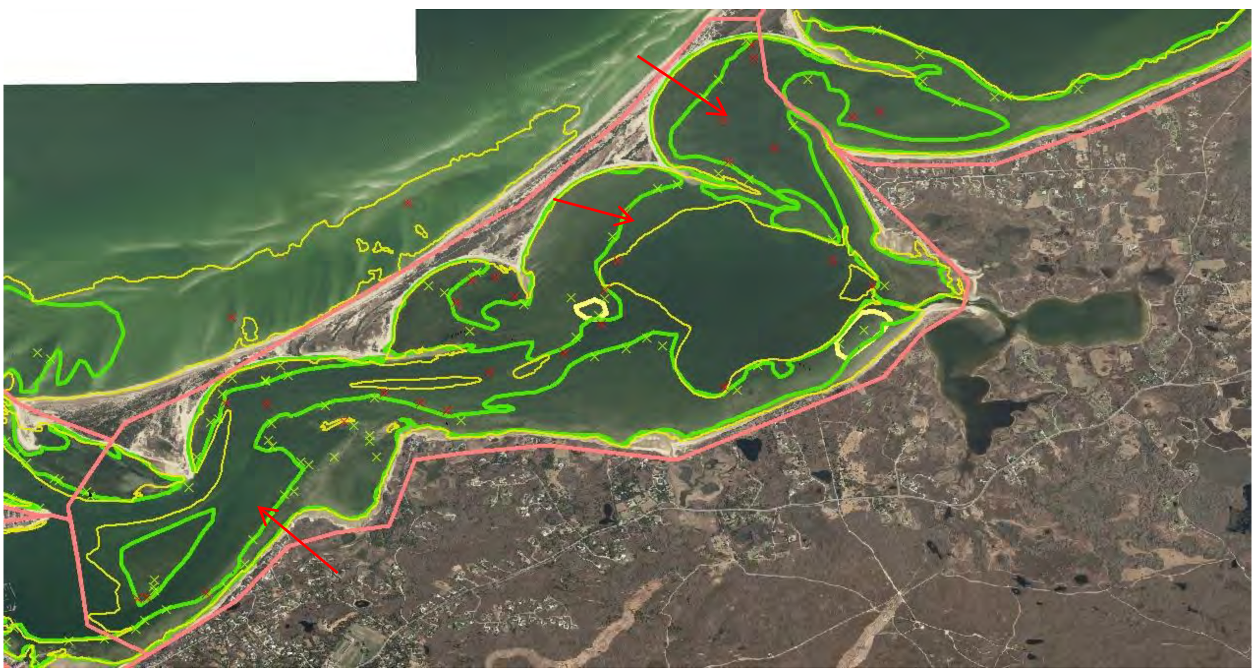
Note: Eelgrass in stressed conditions often is recognized by a decline in the outer boundary of the bed. This loss results from increased turbidity in the water column (caused by increased nutrients) attenuating the sun’s energy and reducing the amount of available light on the bottom.




This schematic shows sunlight at the water's surface(Io) traveling through enriched water column with a "cloud" TSS (total suspended solids comprised of chlorophyll a (algae) and natural color). Drift algae epiphytes on the leaves further attenuate the sun's energy(PLL (percent light at leaf) available to the eelgrass shoots. On average a minimum of22% of the surface light is required for eelgrass health.

This is the most important element of healthy eelgrass systems.

## REGION 2, First to Fourth Point



2015 EELGRASS

1995 EELGRASS

| Eelgrass Area Acres | 1995 | 2015 | 20yr % Change | Ave.% Decline/yr |
|---|---|---|---|---|
| | 1486.5 | 1024.9 | -30% | -1.5% |

This region has also experienced significant decline over the 20 year period. Loss is seen in the western most red arrow in the deeper and shallower areas. Declines to the outer edges in region of third Point and Pocomo are indicative of lower amounts the sun's energy reaching the deeper plants.

## REGION 3, Head of Harbor

2015 EELGRASS

1995 EELGRASS

| Eelgrass Area Acres | 1995 | 2015 | 20yr % Change | Ave.% Decline/yr |
|---|---|---|---|---|
| | 380.8 | 291.7 | -24% | -1.2% |

This region has experienced decline in the deeper water East of Pocomo. The remaining linear eelgrass has remained relatively stable with a small increase in the polygon to the far East. The blue polygon shown here is one of three areas where hydrocoleum/lyngbya was mapped. This will be described in a later section of this report.

## Region 4, Harbor Entrance

2015 EELGRASS

1995 EELGRASS

| Eelgrass Area Acres | 1995 | 2015 | 20yr % Change | Ave.% Decline/yr |
|---|---|---|---|---|
| | 202.0 | 133.7 | -32% | -1.6% |

This Harbor Entrance Area has also declined at the same rate as the earlier areas. As this area is well-flushed with tidal flow it could be assumed that water quality (turbidity) is not the reason. The area along the Western Jetty has declined significantly along its deep edge. This could possibly be to winter storm events that have very severely reduced the eelgrass resources on the shoreline directly facing the wave action from the North (these coastal areas are not included in this report).

## Region 5, Madaket

2015 EELGRASS

1995 EELGRASS

| Eelgrass Area Acres | 1995 | 2015 | 20yr % Change | Ave.% Decline/yr |
|---|---|---|---|---|
| | 673.3 | 513.3 | -24% | -1.2% |

Madaket has declined along the deeper edges South of Eel Point possibly due to storm and tidal current action. Declines were noted in the deeper channel area on the outer edges of the polygons. A complete loss of habitat in the inner Madaket Harbor area on both sides of the channel and in the upper reaches of the inner harbor. Water quality issues could be suspected in these losses as the contributing watershed seems to have experienced increased development during this period.

## Region 6, Tuckernuck

2015 EELGRASS

1995 EELGRASS

| Eelgrass Area Acres | 1995 | 2015 | 20yr % Change | Ave.% Decline/yr |
|---|---|---|---|---|
| | 388 | 391 | +0.08% | ------ |

The Tuckernuck Region has been relatively stable during this 20 year period. Tidal action and storm events have understandably altered the eelgrass beds in the sandy shoal areas between this island and Madaket. This is the only area of Nantucket to have increased its eelgrass area during this time.

Lyngbya Section

2015 Lyngbya

Lyngbya, a black filamentous algae found in many warm water embayments throughout the world, has appeared in three locations in Nantucket Harbor during our summer 2015 survey. Recent research work has determined the cyanobacterium formerly termed lyngbya to be hydrocoleum spp. Fortunately, at this time it is isolated to these sites as shown on the map above. Hydrocoleum/Lyngbya appears when there are high nutrient levels in the water stemming from lawn fertilizers, road runoff, storm water runoff and other types of pollution created by increased development near water bodies. The appearance of the Nantucket hydrocoleum is the first to be recorded in Massachusetts. An active method to stop it would be to aggressively curtail unnecessary overuse of lawn fertilizers and farming chemicals. Hydrocoleum growth can be stopped by starving it of the diet in needs. Recent investigations on the Nantucket hydrocoleum by Pia Moisainder of University of Massachusetts - Dartmouth, has indicated a link to land-source phosphorous and the ability of the algae to utilize excess nitrogen in the Harbor.

Eventually, researchers will develop a benign form of algae that will help to consume the excess nutrients in embayments (exciting work is coming from Florida where hydrocoleum has become a major problem threatening seagrass beds and manatees). Though this research offers hope for a future solution, the immediate need is a reduction of nutrients entering the coastal areas.

The Future

The future success of Nantucket's eelgrass resources will be directly related to several strategies that can/need be continued :

Management Strategies:

1. Now that there is an accurate base map of the eelgrass resource, several re-mappings should be planned to document the near-term changes. The re-mappings should continue until the annual declines have stopped. Normally areas where there are chronic declines of eelgrass, a schedule of re-mapping on a 3-5 year timeframe is followed. In the Nantucket Harbor area, a re-mapping should be considered at least more frequently to verify problem areas (and the possible spread of hydrocoleum). The Harbor area is relatively small and the cost of re-mapping is relatively small. This data will be helpful in determining the possible causes of future declines.

2. The digital database of the eelgrass resources should be used to include information about impacts possibly resulting from commercial shell-fishing, recreational boating and known points of point and non-point source run-off and pollution. Special attention should be given to the downtown area near ferry terminal and town pier as there has been conspicuous decline in eelgrass in that area over a short period of time.

3. Many data points should be established in areas where eelgrass has historically declined to document the changes. The use of digital high resolution color video is a low cost, achievable and graphic way to video record and track changes. These points could be of a fixed nature providing data in a fixed pattern around a logged point data or a transect displaying the data between 2 known points.

4. Data points and transects (similar to #4 above) should be established in areas have been resistant to decline and possibly have shown healthy conditions.

5. Nantucket should continue its efforts to control non-point sources of nitrogen and other contaminants. The nutrient enrichment from these sources is quickly utilized by macro-algae and phyto-plankton in the Harbor to attenuate the sunlight's penetration to the bottom.

6. Surface and groundwater discharges should be surveyed and monitored to determine If and where enriching pollution is entering Nantucket's water bodies.

7. Bathymetric data would be a very beneficial to track changes to Nantucket's eelgrass resources. An accurate bathymetric survey of the Harbor would be an expensive dataset for Nantucket to acquire. Several federal agencies(NOAA, EPA, and Army Corps of Engineers) have begun acquiring bathymetric lidar datasets. When this data is available it should be incorporated into the on-going eelgrass mapping data.

8. Develop an aggressive local educational campaign to raise the public awareness about the relationship of the landuse choices they make and their adverse effects on the eelgrass resources and the many forms of life that depend on them. Communities on Cape Cod and Buzzards Bay have lost much of their eelgrass resources from failing to curtail nutrient flow into their embayments.

Figure 1

## Aerial Imagery Capture Schedule 2015

| AREA | ZULU TIME | Eastern Time | Date |
|---|---|---|---|
| Madaket | 12:55/13:28 | 8:55/9:28 | 6/30 |
| " | 10:43/13:55 | 6:43/9:55 | 6/4 |
| Tuckernuck | 11:10/12:49 | 8:52/9:29 | 6/5 |
| Downtown | 12:52/13:29 | 8:52/9:29 | 6/5 |
| Mid Harbor | 13:31/14:04 | 9:31/10:04 | 6/5 |
| " | 12:22/12:45 | 8:22/8:45 | 6/7 |
| Harbor Entrance | 10:52/12:19 | 6:52/8:19 | 6/7 |
| Head Harbor | 11:07/12:20 | 7:07/8:20 | 6/30 |
| North Shore | 11:39/12:59 | 7:39/8:59 | 8/28 |

Figure 2

**SAMPLE FIELD DATA SHEET**

Latitude/LongitudeAlgae Type

Date/Time

Eelgrass (presence/absence)

Algae (presence/absence)

Algae density

Algae Type

Epiphytes

Observations

Underwater Image Number

Figure 3

SAMPLE DATA POINT MAP

POINTS 1995 – 2015