# Eelgrass Distribution in Casco Bay

2013

Final Project and Data Report
for the Casco Bay Estuary Partnership and
the Maine Department of Environmental Protection

Submitted by

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Vignette: Casco Bay Eelgrass Beds, 2013, (colored coded for cover class).

The following report was written in partial fulfillment of the contract entitled “**Aerial Eelgrass Photography Coordination, Photo Interpretation and GIS Mapping”.**

I would like to acknowledge the support provided by The Casco Bay Estuary Partnership, Maine DEP, Maine DMR, and the Friends of Casco Bay for help in carrying out this work. The following people provided invaluable assistance: Beverly Bayley-Smith (CBEP), Matt Craig (CBEP), Angela Brewer (MEDEP), Jim Stahlnecker (MEDEP), Mike Doan (FOCB), and Peter Milholland (FOCB).

## Introduction:

Monitoring eelgrass distribution over a large geographic area and identifying potential factors responsible for changes in distribution is no small task but most efforts to preserve the ecology of an area begin with these basic steps. Though direct cause and effect relationships are often difficult to prove, enough is known of the root causes of the decline of sea grasses that with careful collection of data on many of the parameters that are important to eelgrass and other SAV (submerged aquatic vegetation), well informed decisions can be made as to where to place scare resources to improve the environment and the future of this important habitat. A necessary first step is to periodically obtain documentation of the distribution and the relative density of eelgrass beds. This project is such a benchmark.

Surveys of eelgrass distribution have been carried out in most states where this species is found and in many countries in northern latitudes around the world (Walcott et al, 2009). Methods often differ but one of the most cost effect methods where a high level of accuracy is required has been the use of aerial photography and photointerpretation. This method was incorporated into the NOAA CCAP (Coastal Change Analysis Program) protocol and revised in NOAA guidance for benthic habitat mapping (NOAA 1995, 2001) which have served as standards for this type of work. These methods have proven to be effective where the objective has been to document distribution, categorize relative density using a percent cover classification, determine the area of beds, and to assess change with time.

In Maine, eelgrass has been mapped coast-wide on several occasions. Eelgrass was included as a feature in the Coastal Marine Geologic Environment (CMGE) maps (Timson 1976). In some portions of the Maine coast these maps have limited value historically as it appears that eelgrass beds were not consistently documented for the following reasons. First, the conditions at the time of the aerial photography may not have been optimal and eelgrass may not have been clearly identified in the black and white photography taken at that time. Second, the CMGE maps had over 50 categories of coastal features making it possible that other categories such as subtidal flats were used rather than eelgrass beds. It does appear, though, that in Casco Bay, this map series can serve as a benchmark.

In 1993, eelgrass distribution in nearly all of Casco Bay was mapped as were a number of other embayments along the coast (DMR, unpublished, Maine office of GIS, “Eelgrass97.shp”). In that effort the area around the New Meadows and Small Point were completed in 1994. The last time Casco Bay eelgrass distribution was mapped was 2001 and 2002 (DMR unpublished, Maine Office of GIS, “Eelgrass2010.shp”). Eelgrass distribution mapped in the present project will be the third time using standard methods found in NOAA protocols.

## <u>Methods</u>

**Aerial Photography -** Digital aerial photography was collected for this project by Sewall Company, Old Town, Maine, under a contract with the CBEP (Casco Bay Estuary Partnership). The photography was four band (three color and NIR) and was acquired near the time of low water. This type of photography is sometimes referred to as metric quality aerial photography as the camera and conditions are such that accurate measurements can be made from the photography. Additional processing steps are required before the original digital photography can be used for mapping over large areas or varied terrain. There are a number of corrections that are required for the original aerial photography to produce “map flat” photography and seamless mosaics. These corrections include adjustments for topography (features that are higher in elevation appear larger) and color. The protocol for acquiring the photography for this project was based on the NOAA CCAP protocol (NOAA 1995, 2001). The contract specification is given in Contract Rider A to the J.W. Sewall subcontract).

Sewall utilized airborne GPS and IMU technologies to capture 4-band aerial photography at a scale sufficient to produce digital orthoimagery at 0.15-meter pixel resolution. Flight lines were planned to systematically cover Casco Bay and arranged to minimize "empty" photographs over water and to preclude an excessive amount of land coverage without a coastline. The extent of area flown is shown in Figure 1. Flights were carried out on August 11th (highlighted in yellow) and August 12th. On August 11th, the first photograph was taken at 8:19 am and the last at 10:02 am. On August 12th, the first photograph was taken at 8:14 am and the last at 10:10 am. The predicted time of low water on those two days was 8:27 am and 9:09 am, respectively. Additional details can be found in the flight reports attached in Appendix A of this report. A total of 1272 photographs were taken. Each individual image was ortho-corrected using IMU and USGS DEM data to create individual digital ortho images at 0.15 meter pixel resolution. Data were delivered in a georeferenced mosaic GeoTiff file format, which is compatible with ArcGIS (ESRI, Inc). After approval of the GeoTiff dataset, Sewall delivered one copy of a seamless MrSID MG4 mosaic at a compression rate of 20:1 as well as tiled versions as GeoTIFFs and MrSID MG3 file formats. The files were in the UTM, NAD83, Zone 19, meters projection.

**Eelgrass Bed Mapping** - Polygons were screen digitized using the GIS software program Quantum GIS and saved in an ESRI shape file. Screen scale for digitizing was generally between 500 and 1000. Eelgrass beds are often continuous over large areas but sometime patchy in nature. To more clearly identify the degree of patchiness, four categories of coverage were used in the delineation of polygons. These categories were based on a density scale originally developed for forest crown cover and applied to eelgrass by Orth et al., 1996. The four categories are: >0-10%; >10-40%; >40-70%; >70-100% and were coded 1-4 respectively. A photointerpretation aid is shown in Figure 2. For this project a fifth category was created to accommodate portions of polygons that did not contain eelgrass. These polygons were interior to other polygons and coded as "0" and are often referred to as null polygons.

There were two basic types of observations of eelgrass and other biological features that were made throughout the course of this work. During the photointerpretation step, the digital photomosaic was inspected carefully at a large scale (zoomed in) on the screen. To the extent that features were visible and interpretation was possible, the aerial photographs provided an excellent overview of landscape of which eelgrass beds were an element. Features such as kelp beds, mussel bars, and mudflats were all fairly easily identified and provided visual clues to the type of environment present in the vicinity of an eelgrass bed. Observations on the ground provided details at a totally different scale. The second type of observation was made during the verification step, otherwise known as groundtruthing.

The normal mode of groundtruthing was in the form of observations from a boat but it was also done on occasion by foot or from an airplane. In the September-October time period, groundtruthing was carried out by boat using a GPS, drop camera and a monitor on the surface. The drop camera also provided digital recordings which were stored on a SD card. With all observations, a Trimble XM GPS unit was used. GIS software, ArcPad (ESRI, Inc), was used to provide a map display of draft eelgrass distribution for 2013. This allowed the evaluation of the mapping accuracy which was used to improve the accuracy of the mapped distribution.

**Results:**

Overall, where healthy beds were present, eelgrass distribution was similar to that found in previous years (1993/94 and 2001/02). To assist in the understanding of regional differences, Casco Bay was divided into four quadrants (Figure 3) and the years 2001/02 and 2013 compared. Quadrants were numbered 1 through 4. Quadrants 2-4 were similar in area but generally were different types of environments. Quadrant 1 constituted outer islands in the south western portion of the bay, had the least amount of habitat, and as would be expected, the least amount of eelgrass. Quadrant 2 extended from Portland Harbor to the Cousins Island Bridge and out past Great Chebeague. Quadrant 3 included the area from the Cousins Island bridge around to the western shore of Harpswell Neck. Quadrant 4 included the eastern shore of Harpswell Neck to Small Point.

The areal coverage of eelgrass in each quadrant for each cover category is given in Table 1. Quadrant 1 (outer islands) had the least amount of eelgrass. This not surprising for these are exposed locations and there is little in the way of eelgrass habitat. During groundtruthing, the several relatively protected locations on Halfway Rock were also checked with a drop camera and no eelgrass was seen. Though there is no aerial photography covering Halfway Rock, it appears to be too exposed a location for eelgrass to become established and it can be safely presumed that no eelgrass beds will be found there. Overall the area of eelgrass beds in quadrant 1 were similar to that mapped in 2001/02.

Quadrant 2, Portland Harbor to the lower end of Great Chebeague, had by far the greatest amount of eelgrass. Patterns were similar to those found in 2001/02. As has been the case in the past, no eelgrass was found in the inner portion of the Fore River, Back Cove, or the Presumpscot River inside the Martin Point Bridge. Several small patches of eelgrass persisted near the Coast Guard Base in South Portland. Some of the largest and most dense beds of eelgrass were found around the islands in this quadrant. The total area of eelgrass beds in quadrant 2 was slightly more than that mapped in 2001/02.

Eelgrass was found primarily in the southern and eastern portions of quadrant 3. The shallow subtidal flats which supported dense eelgrass beds in 2001 are now nearly devoid of eelgrass. Where eelgrass had been present in Maquoit and upper Middle Bays, only scattered plants were found. Eelgrass beds were present along the mainland shore and islands in lower Middle Bay and around to Great Chebeague and Cousins Island. The lack of eelgrass in this quadrant is in stark contrast to what was mapped in 2001/02.

Much of the eelgrass found in quadrant 4 was in the vicinity of Basin Point and Harpswell Sound. The upper New Meadows, south of the State Road bridge, the upper Harpswell Sound, and the middle portions of the New Meadows were nearly devoid of eelgrass. An exception that should be noted that the tidal ponds above the State Road support eelgrass. Mapping has not been carried out previously so historical records are lacking. Overall, there was less eelgrass in this quadrant than previously mapped.

In 2001/02, when the last mapping was done, there were 8789 acres of eelgrass in Casco Bay. As of this mapping, the amount had decreased to 3650 acres, largely due to losses in the Freeport, Brunswick, and parts of Harpswell (quadrant 3). A map showing change to the extent that eelgrass was present in 2001/02, but absent in 2013, is shown in Figure 4. The yellow polygons shown are eelgrass beds that were present in 2001/02, but were not found in 2013.

In addition to presence/absence, an important factor in characterizing eelgrass distribution is the relative density in a bed. This measure is often included as a per cent cover based on measurements on the ground or from the photointerpretation of aerial photography. In this project, percent cover was determined by photointerpretaton and each polygon mapped was coded on a scale from 1-4; one being the least dense (>0 to 10%) and 4 being the most dense (>70% to 100%).

When compared to 2001/02, the greatest change in percent cover categories was the loss of 4392 acres of dense beds (>70 to 100% ) which is largely attributable to losses in Maquoit Bay and vicinity (Table 2). There also was a sizable loss in the moderate cover category (>10% to 40%). This was primarily due to losses in upper Middle Bay. There was a slight increase in eelgrass beds for the categories >0 to 10% and >40 to 70% but this increase totaled only 388 acres combined as compared to the 5527 acres lost in the other two categories.

The video recordings that were used to assist the mapping process showed the presence of tunicates on eelgrass throughout the bay and these were in greatest concentrations in the more sheltered locations. Green crab were occasionally seen but never in large numbers.

**Next Steps:**

The results of this round of mapping suggest that more frequent mapping of the bay is warranted. Changes in eelgrass distribution can take place over several years and though long term changes are apt to be captured in a ten year interval, this interval provides an incomplete picture at best. It is recommended that bay-wide mapping be done every 5 years.

Annual monitoring is also warranted, particularly in the embayment near Little River, Freeport, and Maquoit and Middle Bays. This could be accomplished with small format digital imagery taken from a single engine airplane. This would provide information as to whether eelgrass is naturally recovering and if not, would help in decisions whether to undertake restoration.

The establishment of several stations for monitoring bed parameters would be a valuable means of collecting information on the status of beds at selected locations. Some suggested locations for monitoring are near the Brothers in Falmouth; Broad Cove, Cumberland; Little Flying Point, Freeport; and/or Simpson Point in Brunswick. Seagrass.net provides a well-established set of protocols. See: http://www.seagrassnet.org/ .

**Notes concerning video, GPS, and GIS files:**

GPS data has been combined in a single shape point file, "CascoBayTracklogs.shp". Included are default attributes for Trimble GPS log files, in particular date and times associated with each point. Video files are date and timed stamped and can be located on a frame by frame basis by matching time in the GPS file attribute table provided with the time in the video. Once matched, the GPS file provides the location.

It is planned that the aerial photography mosaic will be made available by the Maine office of GIS as a web mapping service which can be found at: http://mapserver.maine.gov/wms/mapserv.exe?map=c:/wms/orthos.map& and through a viewer found at http://mapserver.maine.gov/basemap/index.html.

**Literature Cited:**

NOAA Coastal Change Analysis Program (C-CAP). 1995. Guidance for Regional Implementation, NOAA Technical Report 123, Department of Commerce.

NOAA Coastal Services Center. 2001. Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach by Mark Finkbeiner [and by] Bill Stevenson and Renee Seaman, Technology Planning and Management Corporation, Charleston, SC. (NOAA/CSC/20117-PUB).

Orth, R. J., J. F. Nowak, G. F. Anderson, D.J. Wilcox, J. R. Whiting, and L.S. Nagey. 1996. Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay and Tributaries and Chincoteague Bay - 1995. Final Report to U.S. EPA, Chesapeake Bay Program, Annapolis, MD. Grant No. CB993267-01-0. 293 pp.

Timson, Barry S. 1976. Coastal Marine Geologic Environments. Maine Geological Survey (Department of Conservation), Open-File Maps

Walcott et al. 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. PNAS. Vol. 106 no. 3012377-12381.

Figure 1. Flight lines for aerial photography, August 11 and 12, 2013. (Flight lines highlighted in yellow were flown on August 11.) Graphic provided by J.W. Sewall Co.

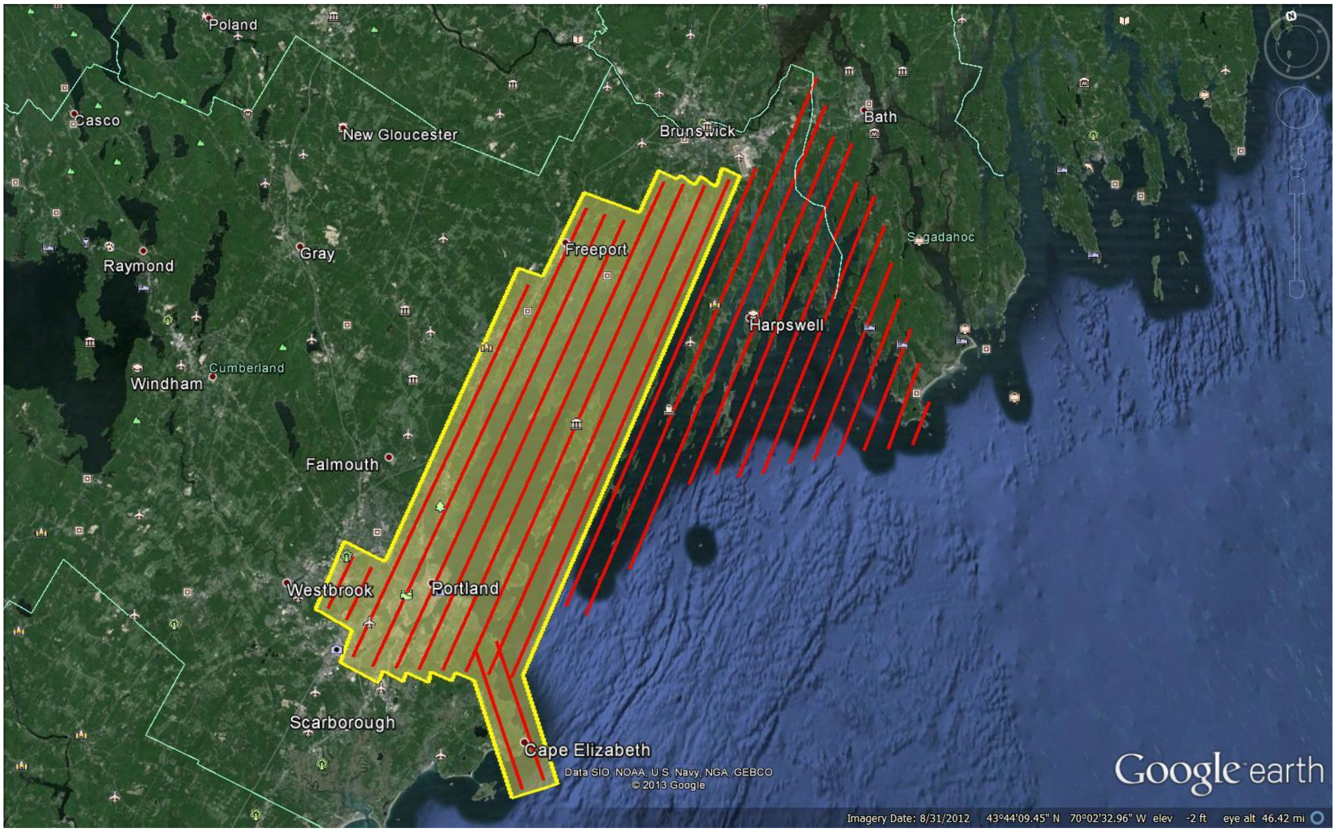

Figure 2.  Percent Cover scale used to categorize the relative density of eelgrass beds. From Orth, et al. (1996).

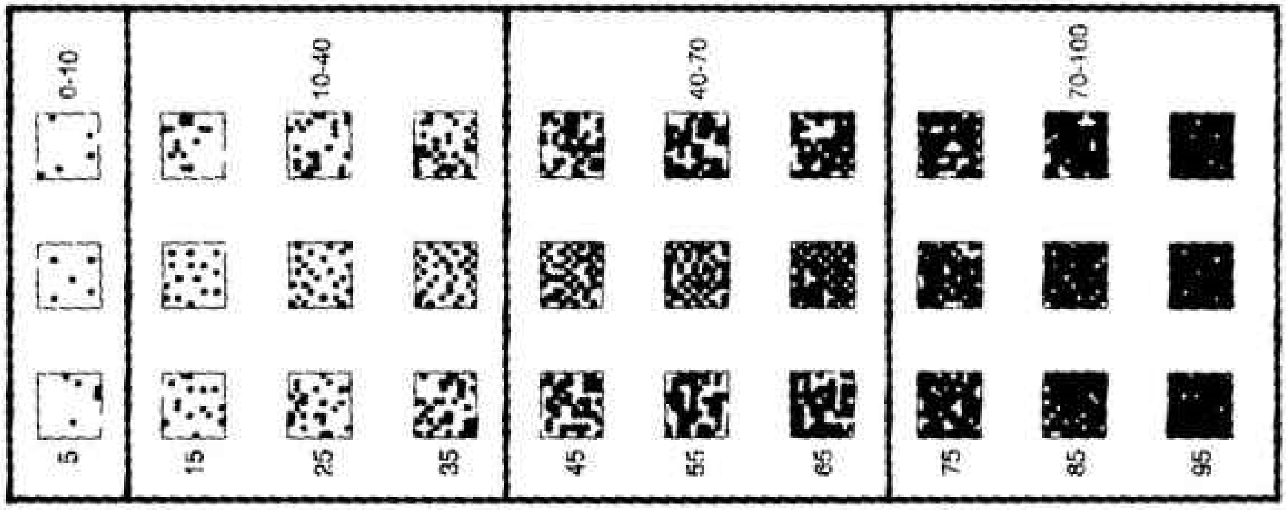

Figure 3. Location of quadrants used to compare area of Casco Bay eelgrass beds in 2013 with that of 2001/02.

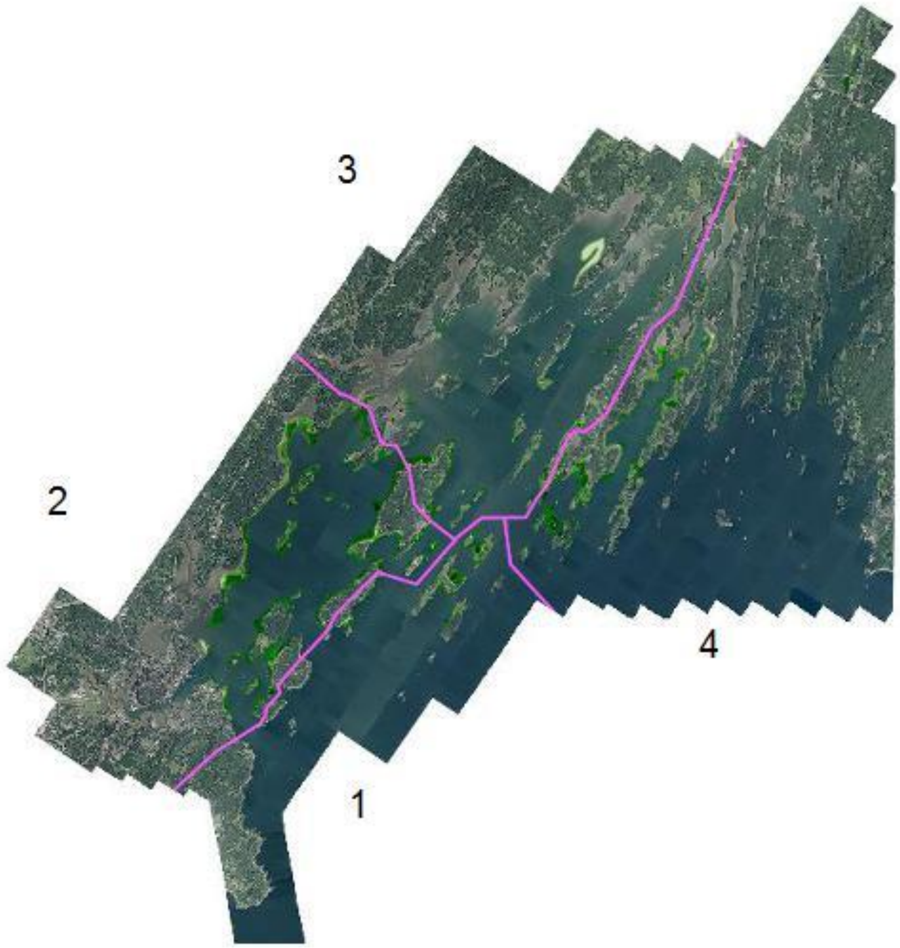

Figure 4. A comparison of eelgrass distribution between 2013 (shades of green) and 2001/02 (yellow). Yellow polygons were present in 2001/02 but are no longer present.

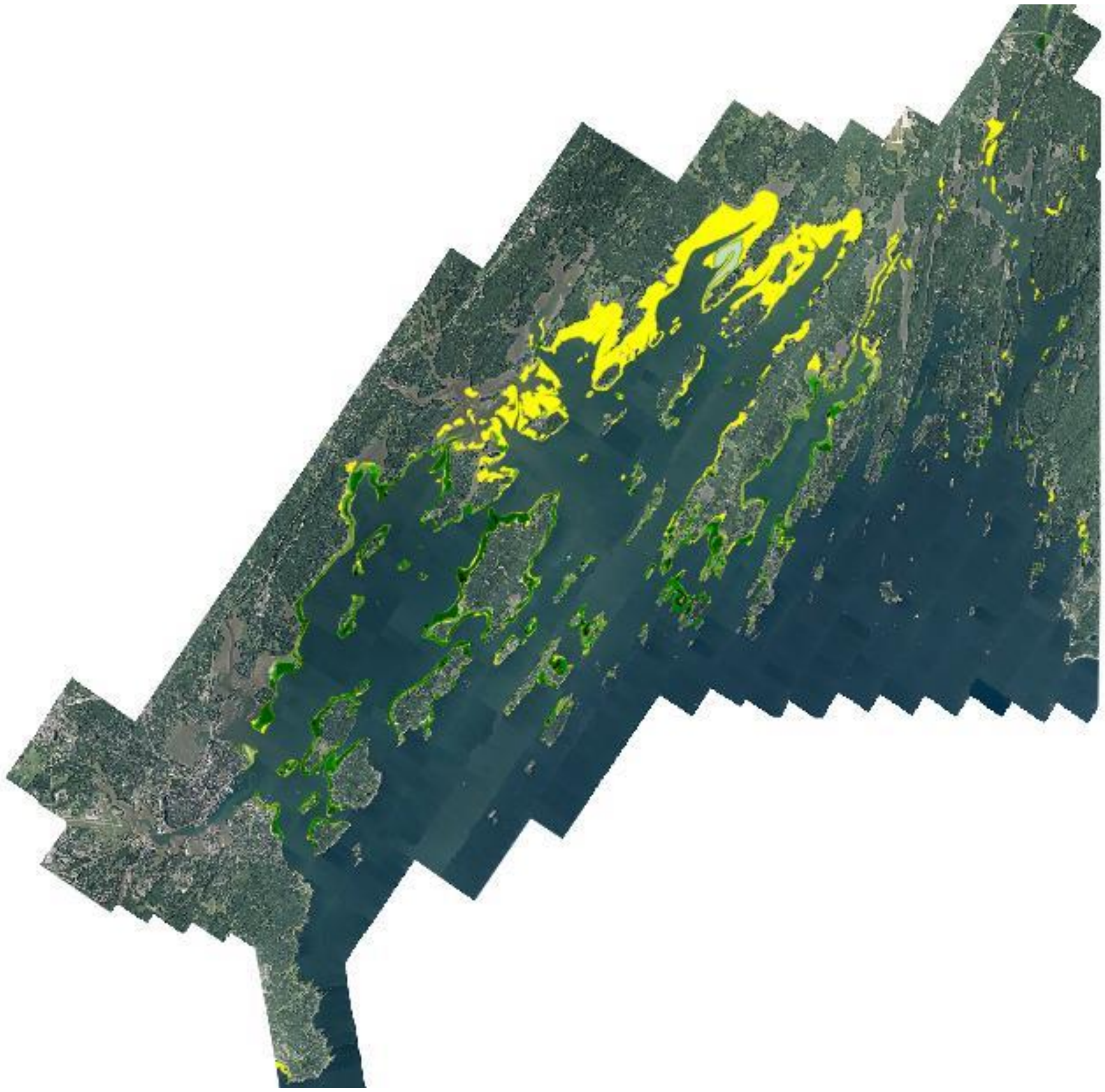

Table 1. Area (acres) of eelgrass in Casco Bay, 2013, by quadrant with a comparison to 2001/02.

(Highlight added for emphasis.)

| Quadrant / Year | 1 | 2 | 3 | 4 | Total (Acres) |
|---|---|---|---|---|---|
| 2013 | 220.6 | 1901.7 | 642.8 | 885.6 | 3650.7 |
| 2001/02 | 235.2 | 1877.4 | 5585.8 | 1091.0 | 8789.4 |

Table 2. Eelgrass cover category area (acres), Casco Bay, 2013 as compared with that of 2001/02. (Highlight added for emphasis.)

| Cover Category / Year | >0-10% | >10%-40% | >40%-70% | >70%-100% | Total (Acres) |
|---|---|---|---|---|---|
| 2013 | 54.6 | 619.7 | 983.9 | 1450.5 | 3650.7 |
| 2001/02 | 280.2 | 1826.8 | 839.2 | 5843.2 | 8789.4 |

# Appendix A

RC&A Maine

## DMC FLIGHT LOG

Finish: 7916.7
Start: 7913.8
TT: 2.9

Date: 8/11/2013
N#: 3520X
Crew: Dwyer | Burbank
Z/I Project Name: 1038me-15cm-dmc1 (if multiple jobs, write on remarks)
Local Time Correction: -4 hr
Itinerary: OLD-OLD

DMC S/N: 131
SSD Number: 3
GPS Base Station Name/CORS:
Min. Sun Angle Requirement: 25°-45°
GSD(cm): 15cm
Page 1 of 1

| Line/Dir | Drift | UTC Start | UTC End | Event Start | Event End | Flt Alt (ft) | Line Status * | Photo ID Start | Photo ID End | Light Values | Turb ** | Remarks | RCAJob Number | Client |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5S | -6 | 12:19 | 12:25 | 1 | 75 | 4996 | C | 75 | 1 | 250, 150, 250 | M | winds 5 knots @PWM | 1038ME | JWS |
| 4 N | -1 | 12:29 | 12:35 | 76 | 151 | | C | 76 | 1 | | | | | |
| 3 S | -5 | 12:40 | 12:45 | 152 | 212 | 5010 | C | 61 | 1 | | | | | |
| 2 N | -1 | 12:50 | 12:51 | 213 | 221 | 4986 | C | 1 | 9 | | | | | |
| 1 S | 1 | 12:54 | 12:55 | 222 | 230 | 4994 | C | 9 | 1 | | | | | |
| 6 N | -1 | 12:59 | 13:05 | 231 | 304 | 4947 | C | 1 | 74 | | | | | |
| 7 S | -5 | 13:10 | 13:17 | 305 | 385 | 4957 | C | 81 | 1 | | | | | |
| 8 N | 5 | 13:20 | 13:27 | 386 | 466 | | C | 1 | 81 | | | | | |
| 9 S | -6 | 13:32 | 13:38 | 467 | 547 | 4941 | C | 81 | 1 | | | | | |
| 25 N | 2 | 13:44 | 13:45 | 548 | 568 | 4928 | C | 1 | 21 | | | | | |
| 24 S | -1 | 13:50 | 13:51 | 569 | 589 | 4964 | C | 21 | 1 | | | | | |
| 10 N | 3 | 13:55 | 14:02 | 590 | 671 | 4931 | C | 1 | 82 | | | Winds 5 knots @ PWM | | |
| | | | | | | | | | | | | | | |
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**Notes and Overall weather condition at the time of survey:**

***Archive Drive*** 269

***Proc Drive*** 280

***Applanix Raw Files*** .000 - .030

*Line Status: C=Complete, P=Partial X= Rejected
** Turbulence Intensity on the flight line S= Smooth M=Moderate T=Turbulent VT=VeryTurbulent

Form Revised 05/21/2013 Rev7

# Appendix A (cont.)

RC&A Maine

**DMC FLIGHT LOG**

Finish 7919.8
Start 7916.7
TT 3.1

Date 8/12/2013
N# 352 0x
Crew Dwyer | Burbank
Z/I Project Name 1038me_15cm_dmc1 (if multiple jobs, write on remarks)
Local Time Correction -4hr Itinerary: OLD-OLD

DMC S/N 131
SSD Number 4
GPS Base Station Name/CORS
Min. Sun Angle Requirement 25°-45°
GSD(cm) 15 cm
Page 1 of 1

| Line/Dir | Drift | UTC Start | UTC End | Event Start | Event End | Flt Alt (ft) | Line Status * | Photo ID Start | Photo ID End | Light Values | Turb ** | Remarks | RCAJob Number | Client |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 S | -1 | 12:14 | 12:19 | 1 | 51 | 4951 | C | 51 | 1 | 250, 125, 250 | S | winds calm @PWM | 1038ME | JWS |
| 17 N | 2 | 12:22 | 12:26 | 52 | 99 | 4944 | C | 1 | 48 | | | | | |
| 18 S | -1 | 12:30 | 12:34 | 100 | 140 | 4954 | C | 41 | 1 | | | | | |
| 19 N | 2 | 12:38 | 12:41 | 141 | 174 | 4964 | C | 34 | 1 | | | | | |
| 20 S | -1 | 12:45 | 12:48 | 175 | 201 | 4967 | C | 27 | 1 | | | | | |
| 21 N | | 12:51 | 12:53 | 202 | 222 | 4950 | C | 1 | 21 | | | | | |
| 22 S | | 12:57 | 12:59 | 223 | 237 | 4954 | C | 15 | 1 | | | | | |
| 23 N | | 13:02 | 13:03 | 238 | 245 | 4945 | C | 1 | 8 | | | winds 6 knots @ PWM | | |
| 11 S | | 13:10 | 13:16 | 246 | 319 | 4935 | C | 74 | 1 | 250, 175, 250 | | | | |
| 12 N | | 13:19 | 13:27 | 320 | 411 | 4954 | C | 1 | 92 | | | | | |
| 13 S | | 13:32 | 13:39 | 412 | 491 | 4947 | C | 80 | 1 | | | | | |
| 14 N | | 13:43 | 13:48 | 492 | 552 | 4961 | C | 1 | 61 | | | | | |
| 15 S | | 13:52 | 13:57 | 553 | 610 | 4951 | C | 58 | 1 | | | | | |
| 12 N | | 14:02 | 14:10 | 611 | 702 | 4954 | * | 92 | 1 | | | * use this line for patches if previous line 12 had cloud shadow | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

**Notes and Overall weather condition at the time of survey:**

| Archive Drive | Applanix Raw Files |
|---|---|
| 269 | 000 - .031 |
| **Proc Drive** | - |
| 280 | - |

*Line Status: C=Complete, P=Partial X= Rejected
** Turbulence Intensity on the flight line S= Smooth M=Moderate T=Turbulent VT=VeryTurbulent

Form Revised 05/21/2013 Rev7