2018

Eelgrass Distribution in Casco Bay 2018

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Final Project and Data Report
for the
Maine Department of Environmental Protection

Submitted by

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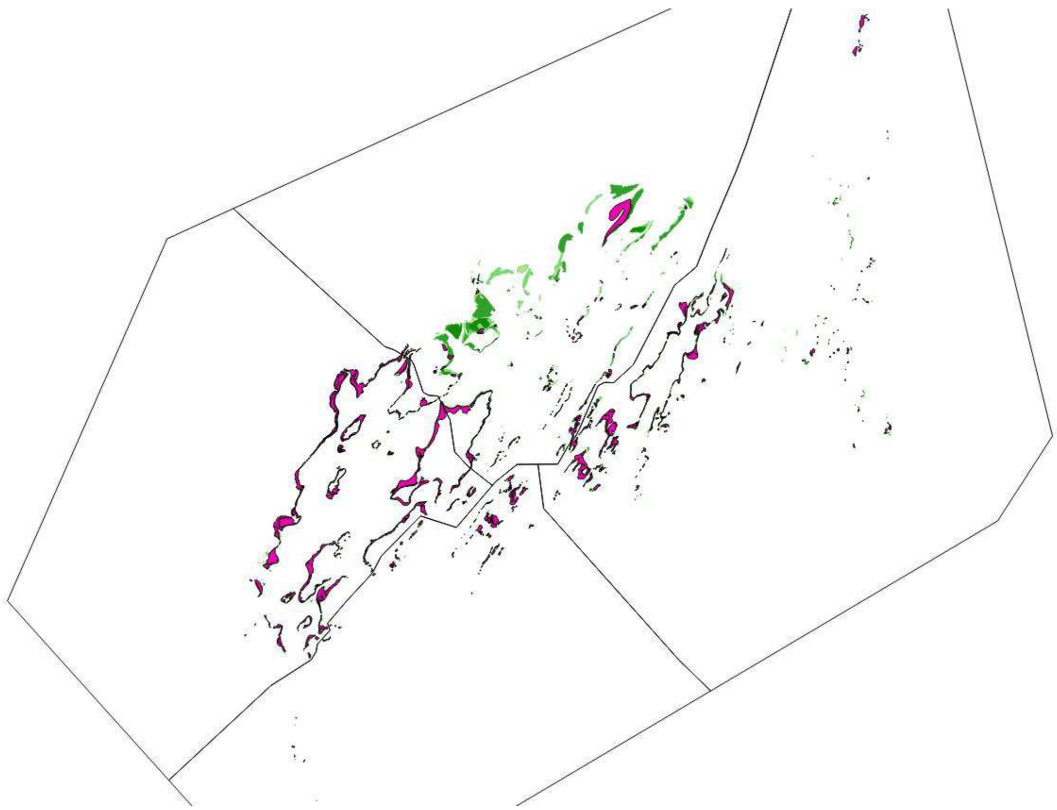
Vignette: Casco Bay Eelgrass Beds, 2018, color coded for year and cover class and showing the difference between 2013 and 2018 distribution. The 2013 distribution is shown in magenta and overlays the 2018 distribution (shades of green).



The following report was written in partial fulfillment of the contract Advantage Number 06A 20180328*2842 with the State of Maine, Department of Environmental Protection**.**

I would like to acknowledge the support provided by the Casco Bay Estuary Partnership and Maine DEP in carrying out this work. The following people provided invaluable assistance: Angela Brewer (MEDEP), Matt Craig (CBEP), Joseph Glowa (MEDEP), and Joshua Noll (MEDEP).

Introduction:

Eelgrass, *Zostera marina*, is one of many marine and estuarine flowering plants that grow in intertidal and subtidal locations around the world. In Maine, only one other flowering plant occupies similar habitats, Widgeon Grass, or *Ruppia maritima*. The focus of this project is the distribution of eelgrass in Casco Bay.

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 support, enough is known of the root causes of the decline of sea grasses that with careful collection of data for 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 scarce 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.

Methods for surveys of large geographic areas often differ, but one of the most cost effective methods where a high level of accuracy is required over a large geographic area 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, NOAA 2001), which have served as standards for this type of work. These methods have proven to be effective where the objectives have been to document distribution, categorize relative density using a percent cover classification, determine the area of beds, and to assess change with time. 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). In the United States and Canada, inventories have been carried out, often on a regular basis.

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 photographs taken at that time. Second, the CMGE maps were comprised of over 50 categories of coastal features. Since only one feature was chosen to describe an area it is possible that other categories such as subtidal flats were used rather than eelgrass beds. It does not appear that the CMGE maps for eelgrass can reliably serve as a benchmark in Casco Bay without a careful review of the original photography used for that mapping.

The last time that eelgrass distribution was mapped throughout Casco Bay was in 2013. This was done using methods nearly identical to those used in this project. Previously it had been mapped in the 1993/1994 and 2001/2002 time periods. The GIS files associated with that mapping are identified as "Eelgrass97.shp and "Eelgrass2010.shp". The dated files indicate the end date for coastwide mapping with the dates of actual mapping identified in the attributes of each file.

Methods:

Aerial Photography - Digital aerial photography was acquired in two flights by Geomni of Old Town and processed for this project by the Bangor office of Cornerstone Energy Services, Inc. ("Cornerstone"), under a contract with the State of Maine, Maine Department of Environmental Protection. 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 several 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 Coastal Change Analysis Program protocol (NOAA 1995, NOAA 2001).

Geomni utilized airborne GPS and IMU technologies to capture four band aerial photography at a scale sufficient to produce digital orthoimagery at 1 foot 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. Fights were carried out on June 16th (highlighted in red) and June 17th (highlighted in yellow). A total of 388 photographs were taken. Each individual image was ortho-corrected using IMU and USGS DEM data to create individual digital ortho images at 1 foot pixel resolution. Data were initially delivered in a direct georeferenced GeoTiff file format, which is compatible with ArcGIS (ESRI, Inc). After approval of the GeoTiff dataset, Cornerstone delivered one copy of a seamless MrSID mosaic as well as tiled versions as GeoTIFFs, both of which were enhanced to provide clear subtidal signatures. 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 800 and 1200. Eelgrass beds are often continuous over large areas but also patchy in nature. To more clearly identify the degree of patchiness and the extent of coverage, four categories of coverage were used in the polygons delineated. 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 through 4 respectively. This is further described in Moore et al (2000), in the context of a larger, long term study of Chesapeake Bay. 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 photography was inspected carefully at a large scale (zoomed in) on the screen. To the extent that features were visible and interpretation was possible, the 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 context of areas potentially identified as eelgrass is important since factors such as water depth, light penetration and substrate, affect the distribution of eelgrass.

The normal mode of groundtruthing was in the form of observations from a boa,t but it was also done on occasion by foot. During August, 2018, 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 and were used to aid photointerpretation. The digital files are provided with this report. With all observations, a Trimble GeoExplorer XH GPS unit was used along with a Garmin Colorado GPS. GIS software, ArcPad (ESRI, Inc), provided a high accuracy map display of draft eelgrass distribution to be taken in the field. This allowed the evaluation of the mapping accuracy and was used to improve the accuracy of the mapped distribution and also provided a better understanding of the signatures seen in the aerial photography.

Results:

To assist in the understanding of regional differences, Casco Bay was divided into four quadrants (Figure 3) and the years 2001/02, 2013, and 2018 compared. Quadrants were numbered 1 through 4. Quadrants 2-4 were similar in shoreline area but generally consisted of different types of environments. Quadrant 1 constituted outer islands in the southeastern 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 Island, and contained sizeable areas that could be considered habitat. Quadrant 3 included the area from the Cousins Island bridge around to the western shore of Harpswell Neck, and also contained considerable habitat. Quadrant 4 included the eastern shore of Harpswell Neck and extends east to Small Point.

The areal coverage of eelgrass in each quadrant for each cover category is given in Table 1. Quadrant 1 (Figure 5) had the least amount of eelgrass. This is not surprising for there are many exposed locations and little in the way of eelgrass habitat. Overall, the area of eelgrass beds in quadrant 1 was similar to that mapped in 2013.

Quadrant 2 (Figure 6) had 135.3 acres less eelgrass than that mapped in 2013, but patterns of distribution were similar. 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's 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 1,766.3 acres.

Eelgrass was found throughout quadrant 3 (Figure 7). The shallow subtidal flats which supported dense eelgrass beds in 2001 and which were nearly devoid of eelgrass in 2013, now support a considerable amount of eelgrass. Eelgrass beds were present along the mainland shore and islands in lower Middle Bay and around to Great Chebeague and Cousins Islands, as has been the case previously. The increase in eelgrass for this quadrant marks a significant change and the return of eelgrass throughout the area.

Much of the eelgrass found in quadrant 4 (Figure 8) was in the vicinity of Basin Point and Harpswell Sound. The upper New Meadows River, south of the State Road bridge, the upper Harpswell Sound, and the middle portions of the New Meadows River were nearly devoid of eelgrass, as in 2013. An exception that was again noted is that the New Meadows "Lakes" above the State Road continue to support eelgrass. Overall, eelgrass beds remain unchanged in this quadrant.

In 2013, when the last mapping was carried out, there were 3,650.7 acres of eelgrass in Casco Bay. As of 2018, the amount had increased to 5,018 acres, largely due to increases along the Freeport, Brunswick, and parts of Harpswell shorelines (quadrant 3). A map showing change to the extent that eelgrass was present in 2013 and returned in 2018 is shown in Figure 4. The magenta polygons shown are eelgrass beds that were present in 2013 and are overlaid on the 2018 eelgrass mapping which is shown in green. Areas where eelgrass was not present in 2013 and has returned in 2018 are visible as green polygons in the graphic provided.

In addition to presence/absence, an important factor in characterizing eelgrass distribution is the patchiness in a bed. This measure is often included as a percent 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 2013, the greatest change in percent cover categories was the increase in combined area of 1,665.3 acres of dense beds (>70 to 100%) and moderately dense beds (>40 to 70%) (Table 2). There was little change in the moderate cover category (>10% to 40%) and the sparse cover category, >0 to 10%.

Notes concerning video, GPS, and GIS files:

GPS data as files (WGS84) for each field visit are provided along with associated video files. 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. GPS files are named "track" + the month and day that files were collected. On July 20, field work was done on foot and on July 21 by kayak. Video files are not available for either of these dates.

The aerial photography mosaic can be found at:
https://geolibrary-maine.opendata.arcgis.com/datasets/maine-orthoimagery-coastal-casco-bay-2018-imagery-layer

Literature Cited:

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Figure 1. Flight lines for aerial photography, June 16 and 17, 2018. Flight lines highlighted in red were flown on June 16 and those in yellow were flown on June 17.

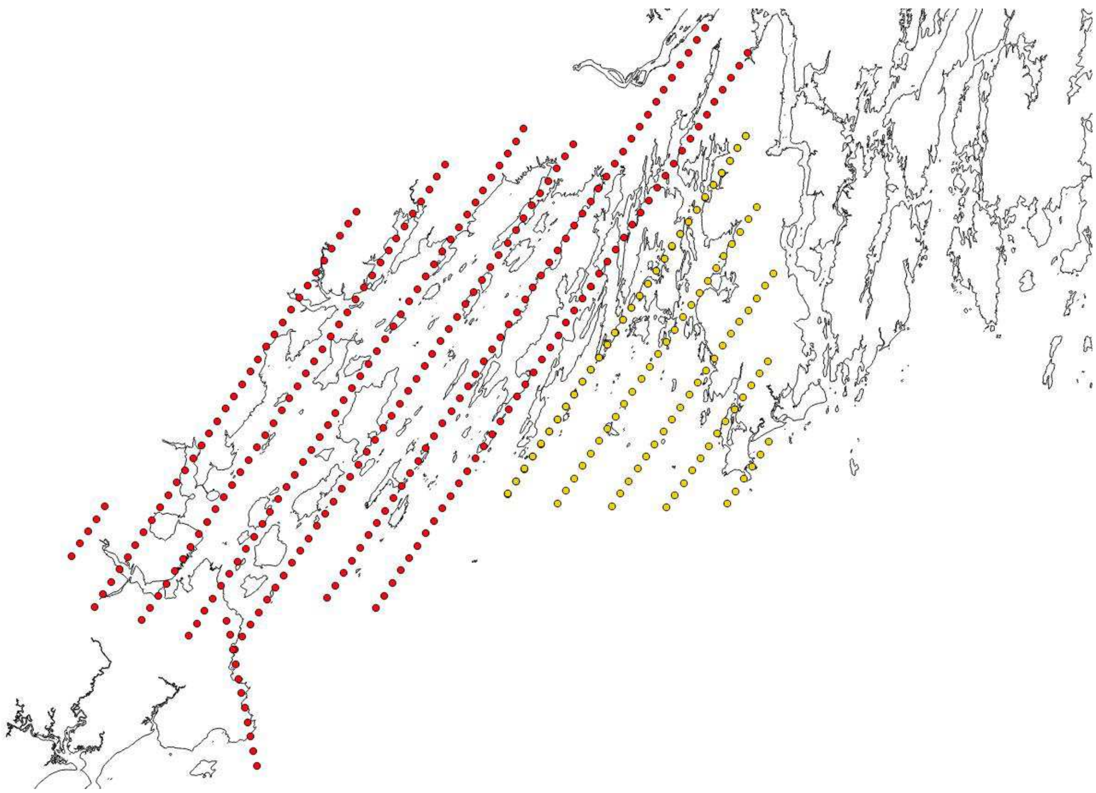

Figure 2. Percent cover scale used to categorize the relative density of eelgrass beds. From Orth *et al.* (1996).

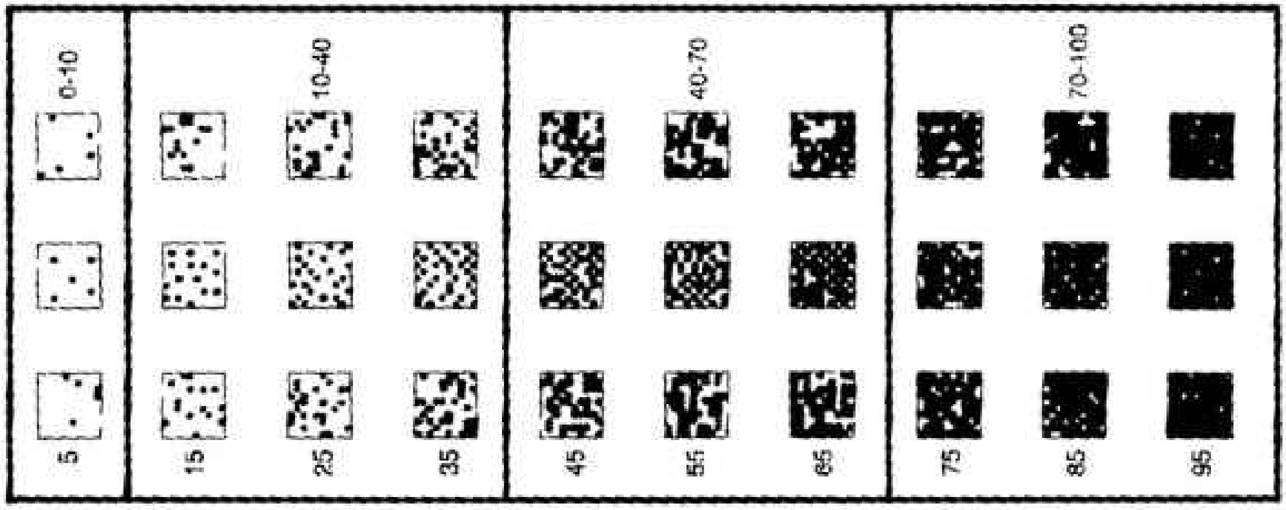

Figure 3. Location of quadrants used to compare area of Casco Bay eelgrass beds in 2018 with that of 2001/02 and 2013.

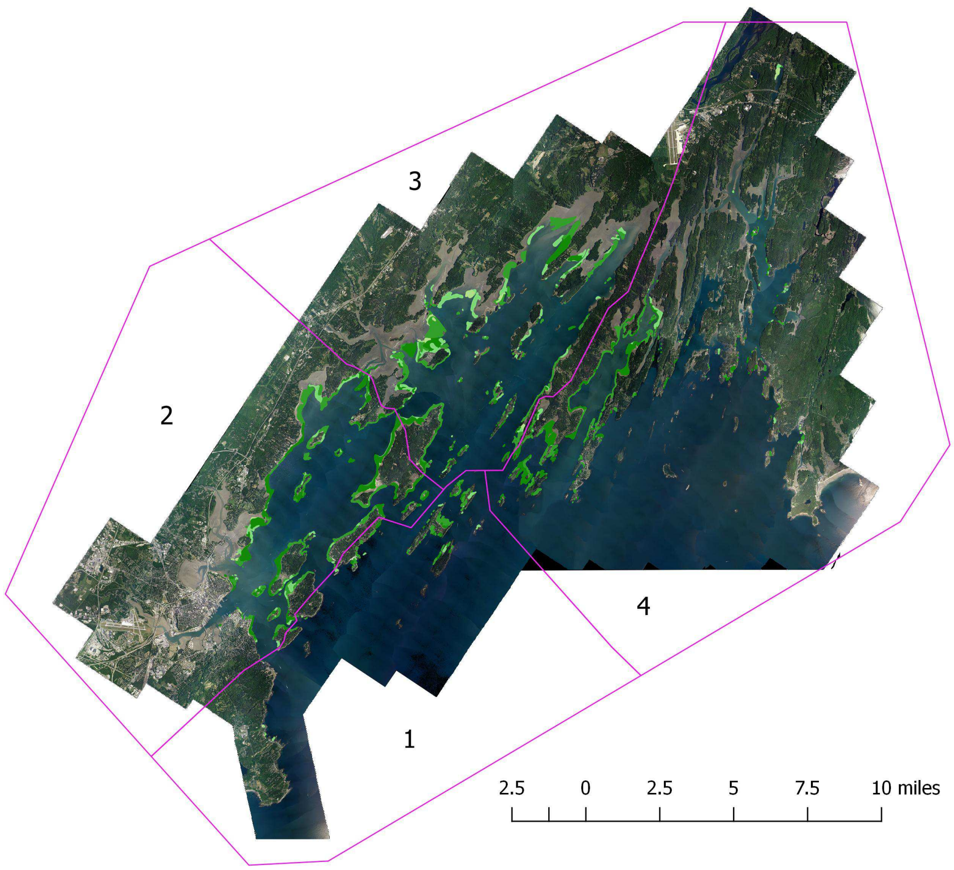

Figure 4. A comparison of eelgrass distribution between 2018 (shades of green) and 2013 (magenta). The 2013 polygons are overlaid on the 2018 polygons. Green polygons are new in 2018.

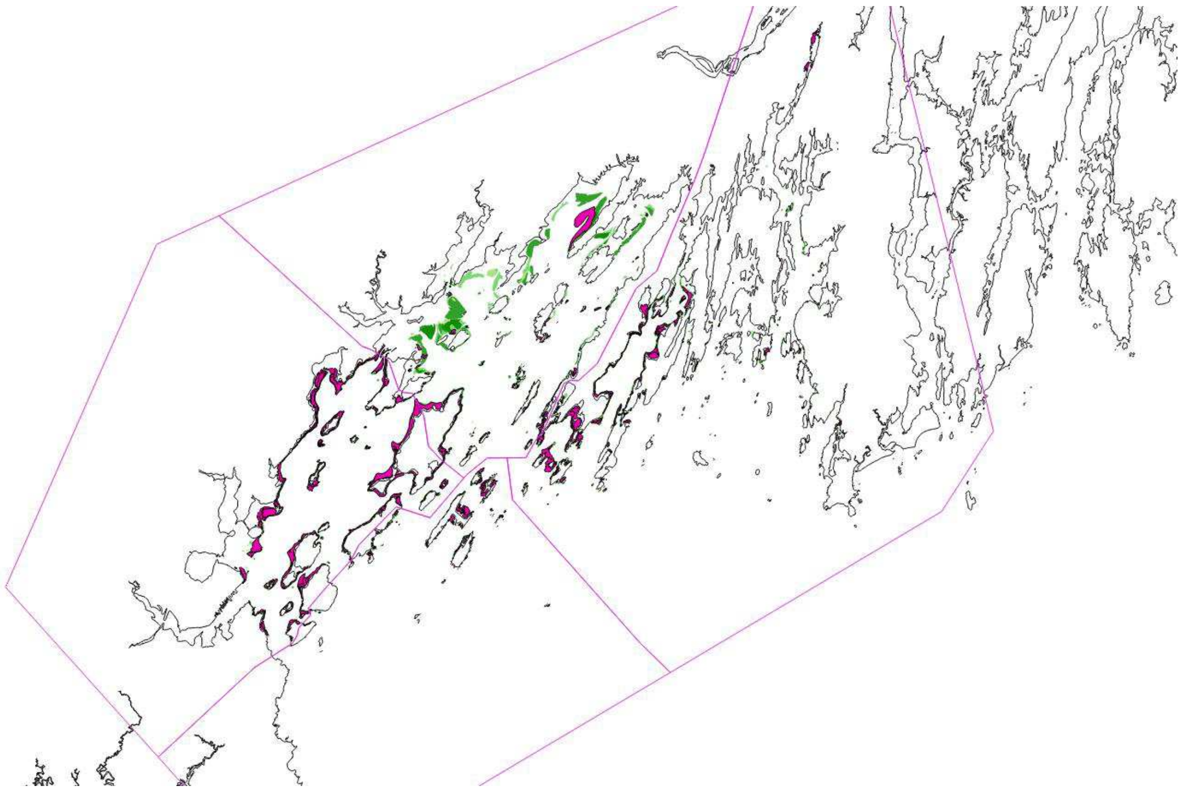

Figure 5. Distribution of eelgrass in quadrant 1.

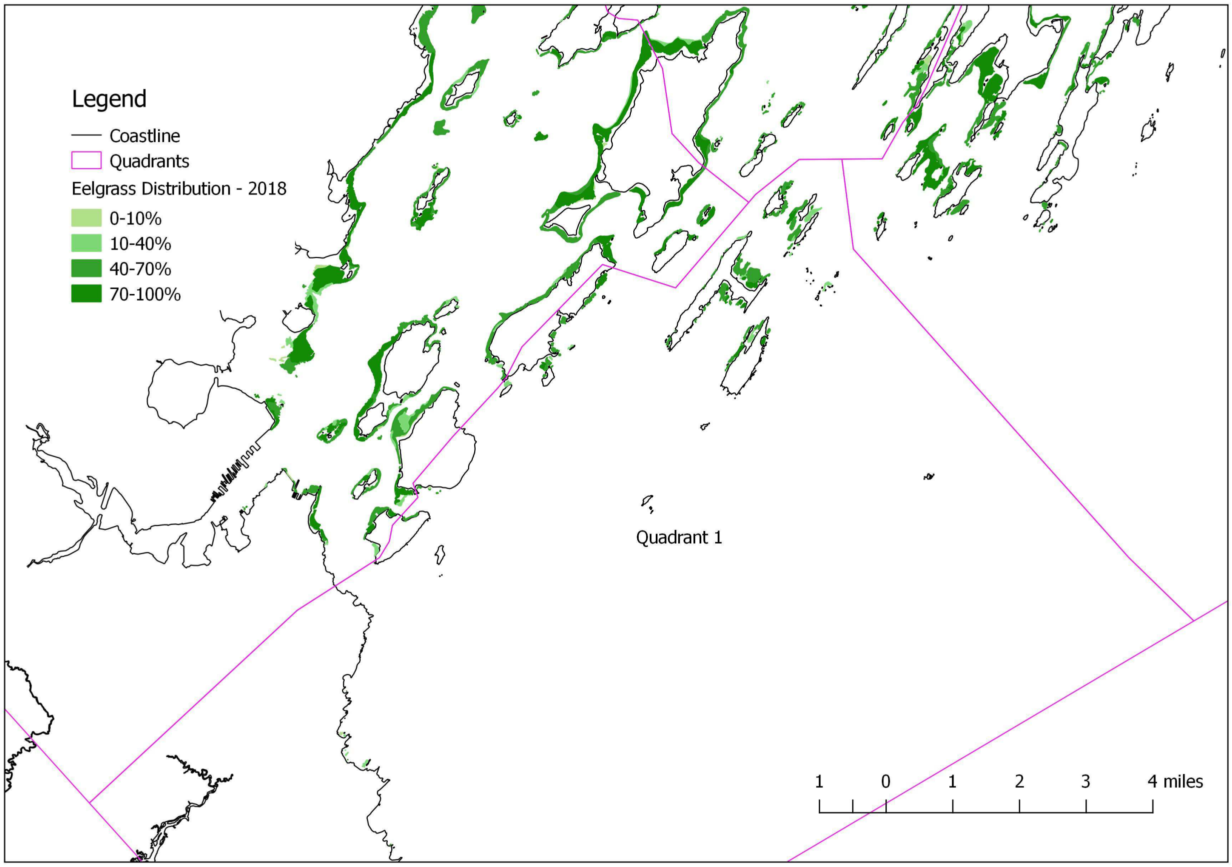

Figure 6. Distribution of eelgrass in quadrant 2.

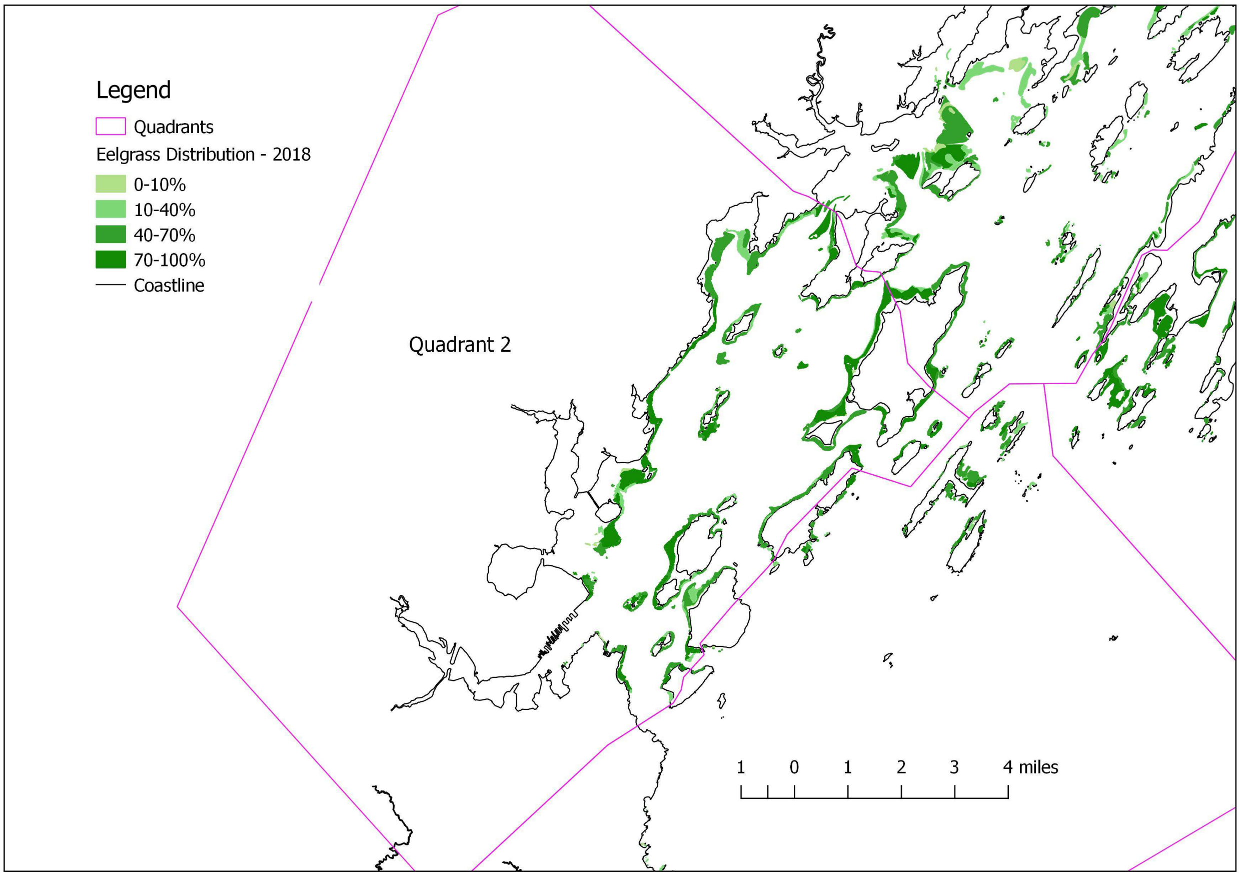

Figure 7. Distribution of eelgrass in quadrant 3.

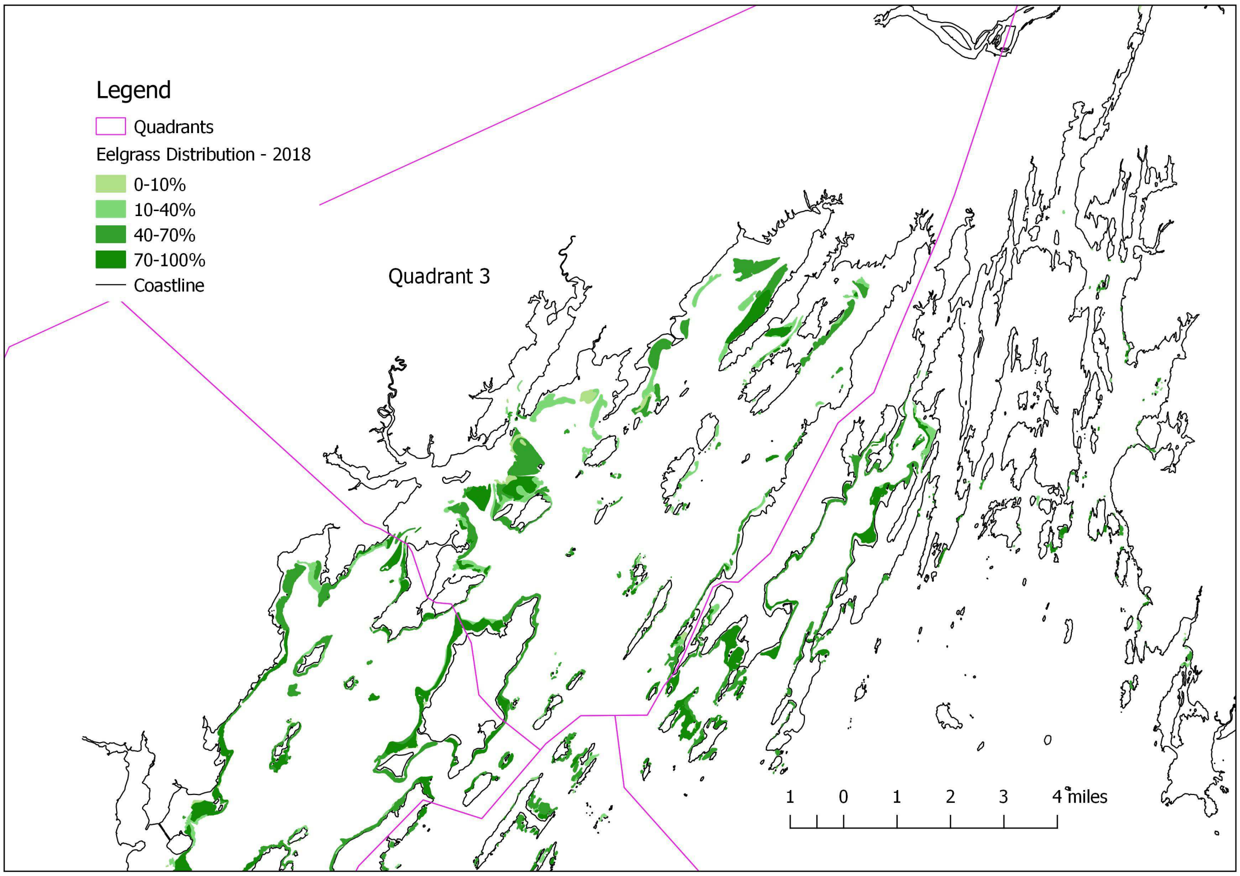

Figure 8. Distribution of eelgrass in quadrant 4.

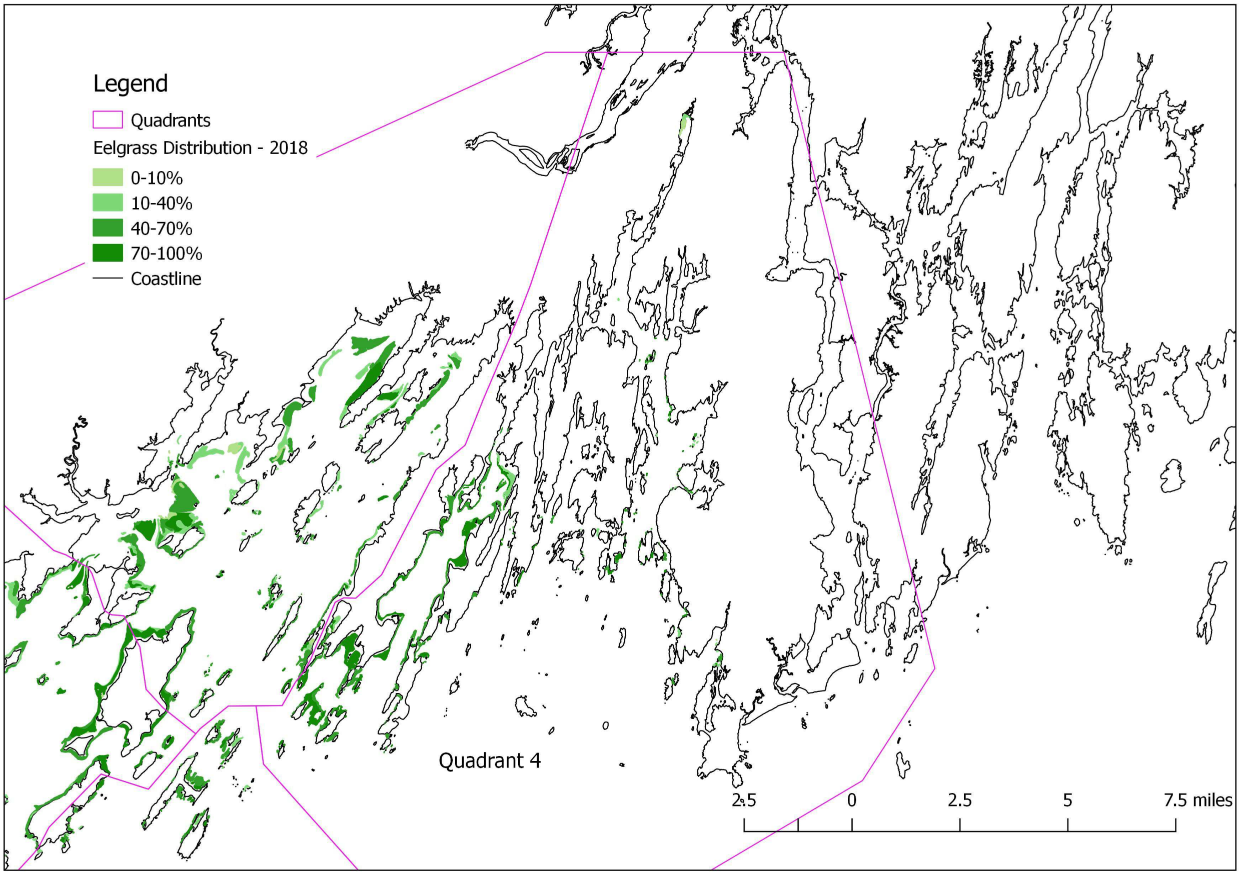

Table 1. Area (acres) of eelgrass in Casco Bay, 2018, by quadrant with a comparison to 2001/02 and 2013.

	Quadrant				
Year	**1**	**2**	**3**	**4**	**Total (Acres)**
2018	217.9	1766.4	2158.4	889.6	5032.3
2013	220.6	1901.7	642.8	885.6	3650.7
2001/2002	235.2	1877.4	5585.8	1091.0	8789.4

Table 2. Area (acres) of eelgrass in Casco Bay, 2018, per cover category, as compared with that of 2001/2002 and 2013.

	Percent Cover				
Year	**0%-10%**	**>10%-40%**	**>40%-70%**	**>70%-100%**	**Total (Acres)**
2018	128.7	789.7	2118.4	1981.3	5018.1
2013	54.6	619.7	983.9	1450.5	3650.7
2001/2002	280.2	1826.8	839.2	5843.2	8789.4