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# **Casco Bay Seagrass Mapping**

## **Aerial Photography Survey Coordination & GIS Mapping**

### **Cape Elizabeth to Phippsburg**

#### **Prepared For**

STATE OF MAINE  
Department of Environmental Protection  
Bureau of Water Quality  
Division of Environmental Assessment



#### **Prepared By**

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## Executive Summary

The Maine Department of Environmental Protection, Bureau of Water Quality, Division of Environmental Assessment contracted with Normandeau Associates, Inc. to map seagrasses in the coastal areas between Cape Elizabeth and Phippsburg. Normandeau managed the imagery acquisition, production and deliverables of low tide, high-resolution, true color aerial imagery produced by James W. Sewall Company. Normandeau used this imagery to delineate seagrass and estimate vegetation density using the four-category scale developed by Orth *et al.* (1991). Normandeau also performed field surveys to verify delineated beds, taking both GPS point data and underwater video footage at 486 locations. Results of the mapping indicate an overall decrease in seagrass from previous mapping efforts in 2001-2, 2013, and 2018. Approximately 2,286 acres of seagrass were mapped in 2022, including about 2,254 acres of eelgrass (*Zostera marina*) and roughly 32 acres of a mix of eelgrass and widgeon grass (*Ruppia maritima*). The largest decreases in bed presence and boundaries were observed near South Freeport, Maquoit Bay, and northern Harpswell Sound. Slight increases in bed boundaries were observed, such as on the south side of Cliff Island, but these increases are thought more to be omissions in previous mappings than increases in eelgrass abundance.

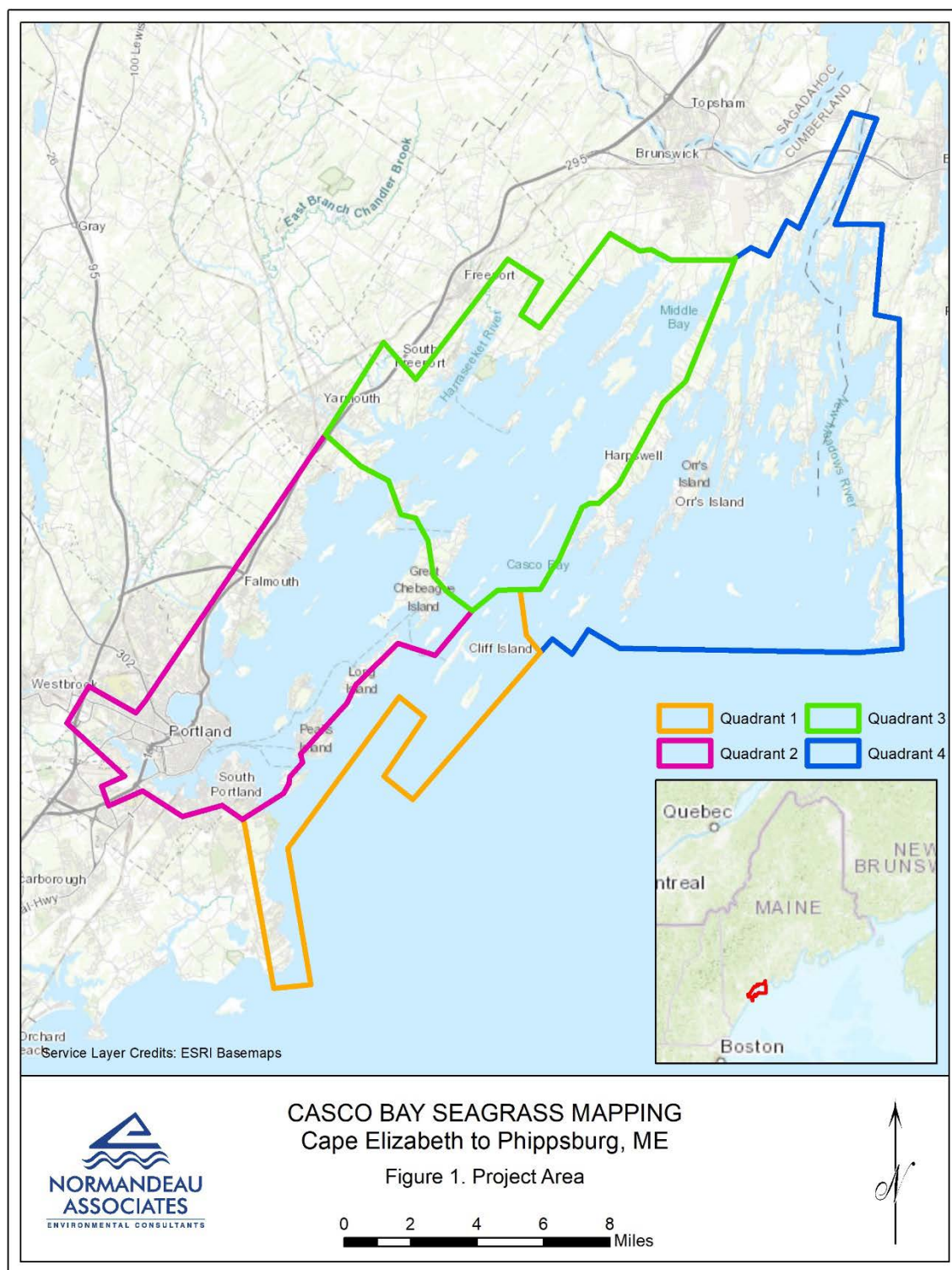
## 1 Introduction

The Maine Department of Environmental Protection, Bureau of Water Quality, Division of Environmental Assessment (Department) contracted with Normandeau Associates, Inc. (Normandeau) to map seagrasses in the coastal areas between Cape Elizabeth and Phippsburg, in the area known as Casco Bay. The purpose of the work was to update mapping efforts conducted by the Maine Department of Marine Resources (DMR) from 2001 to 2010 and by an independent contractor in 2013 and 2018 to assess the extent and percent cover of seagrass, primarily eelgrass (*Zostera marina*). Eelgrass is a flowering perennial that grows in submerged, marine environments. It prefers softer substrates such as mud and sand and was observed in marine waters from areas exposed at low tide to approximately 23 feet (7 meters) water depth. It plays an important role in the nearshore environment by sequestering carbon, buffering acidification of surface sediments, oxygenating bottom water, reducing water column turbidity and buffering wave impacts, and providing habitat, nursery grounds, food and refuge for a host of invertebrate and vertebrate marine animals, including commercially important species. This plant often grows from vegetative rhizomes but can also spread through seed germination. Several factors impact the presence and abundance of eelgrass, such as light availability, water quality, temperature, and disturbance. This species faces several threats that can impact populations, including reduction of light (through nutrient loading, sediment, or shading by structures), physical disturbance, overharvesting, disease, and impact by invasive species such as the European green crab (Whippelhauser 1996). The Department will use the results of the survey to inform seagrass protection, restoration and enhancement opportunities, and to assist with assessment of marine life use attainment based on mapped eelgrass change over time.

The Department contracted with James W. Sewall Company (Sewell) to acquire low tide aerial imagery during June-September 2022 of the supratidal, intertidal and shallow subtidal shoreline of Casco Bay (Cape Elizabeth to Phippsburg; Figure 1). Sewell subcontracted with Bluesky for aerial imagery acquisition. Normandeau managed the imagery acquisition, production, and deliverables. Images were photointerpreted to develop maps of the seagrass boundaries and estimated percent cover, mapping was field verified, and GIS maps and a summary report pertaining to seagrass distribution were produced.

## 2 Aerial Photography Survey Coordination

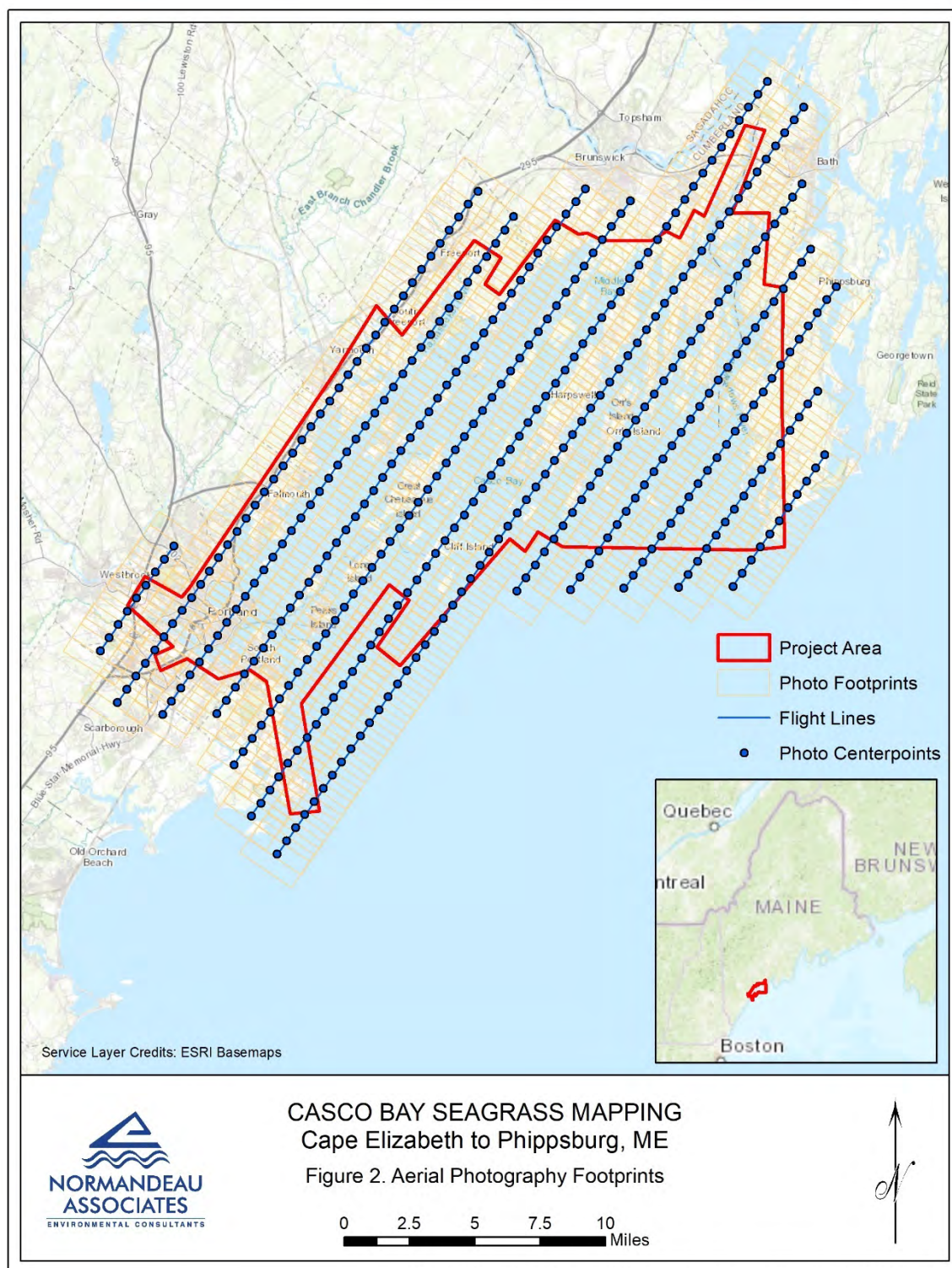
Sewell subcontracted with Bluesky to collect high-resolution true color (RGB-NIFR) aerial imagery for use as a raster base image for coastal mapping projects on the coast of Maine. The imagery was captured at 5.7-inch (14.5-cm) ground sample distance (GSD) and was used to produce high resolution 6-inch (15 cm) orthorectified imagery with a 1-foot (30 cm) accuracy. The project area consisted of approximately 400 images on approximately twelve flight lines with 60% forelap and 30% sidelap (Figure 2). An airborne global positioning system (GPS) and inertial measurement units (IMU) were utilized during the acquisition to improve the aerotriangulation solution. Bluesky acquired the raw imagery using a Vexcel Eagle 80-mm Mark 3 aerial camera mounted on a fixed wing aircraft and flown at an elevation of approximately 9,500 feet. Digital orthorectified imagery was created using the raw digital aerial imagery, ground control, aerotriangulation, and a digital elevation model. Existing State of Maine ground control was utilized in the aerotriangulation solution for this project.



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**Figure 1. Project area for aerial imagery acquisition and seagrass delineation, 2022.**  
(Geographic sections were used previously in the 2013 and 2018 seagrass reports and used again here for discussion purposes.)





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**Figure 2. Flight lines, photo center points, and photo footprints for aerial flight photographs.**

On July 16, 2022 Bluesky flew the project corridor, capturing approximately 400 photos across twelve flight lines. This flight began recording at approximately 7:52 AM and concluded at approximately 9:30 AM, which was within the required two-hour window of the low spring tide of -1.4 ft mean lowest low water (MLLW) occurring at 7:45 AM as predicted by the Portland, Maine (NOAA Station ID 8418150) tide table. Flight and ground conditions were monitored the week leading up to the flight to capture best conditions, including early-mid morning, low sun angle (25-50°), low wind velocity (<10 miles per hour [mph]), and low cloud cover (<10%). Actual conditions included mostly cloudy to overcast skies with calm winds according to the NOAA station closest to the project area (Portland International Jetport). Notes from the flight crew indicated “the water conditions in terms of tides and calmness looked great. We had overcast cloud at 20,000ft but the high pressure did its job of keeping it thin so the imagery looked nice and bright”. The survey did not occur immediately following a period of high winds, or during a phytoplankton bloom in order to minimize water column turbidity. Three small rainstorms occurred the week prior to survey (7/12 PM, 7/14 AM, 7/14 PM), each totaling less than 0.2 inches. Water column was checked by the Maine Department of Environmental Protection on July 13 and 14, and the mid/northern Bay was “still looking productive”, eastern Bay looked “typical”, and the western Bay was “acceptable”.

Sewell used the imagery from Bluesky to produce draft ortho tiles and a mosaic, which were provided to Normandeau on September 5, 2022. Normandeau used the draft mosaic to plan target locations for field verification. Comments and corrections were provided from Normandeau to Sewell for processing of the final imagery. Final imagery was delivered to Normandeau on October 14 and was used for desktop delineation of seagrass beds. The final imagery and metadata are included with this deliverable.

### 3 Seagrass Delineation and Mapping

#### 3.1 Methods

##### 3.1.1 *Photointerpretation*

Normandeau reviewed the shapefiles and imagery from previous seagrass mapping efforts to understand the previous distributions and photosignatures of seagrass. Sources were publicly available from the Maine.gov, Maine Geolibrary (<https://www.maine.gov/geolib/catalog.html>) and included:

- 2010 Maine DMR Eelgrass: This shapefile (MEDMR 2010) contains a compilation of seagrass from multiple survey years. Surveys in the Casco Bay area occurred in 2001 and 2002. Corresponding imagery (MEGIS 2001) is also publicly available. Imagery was flown and photographed near low tide. Polygons were screen digitized and field verification was conducted by boat, on foot, and by plane. This dataset is referred to as 2001 mapping throughout this report.
- 2013 Casco Bay Eelgrass: Both imagery (MEGIS 2013) and eelgrass shapefile (MEDEP 2013) are publicly available and can be added to ArcMap through ArcGIS Online. Imagery was acquired on August 11 and 12, 2013 at low tide.
- 2018 Casco Bay Eelgrass: Both imagery (MEGIS 2018) and eelgrass shapefile (MEDEP 2018) are publicly available and can be added to ArcMap through ArcGIS Online.



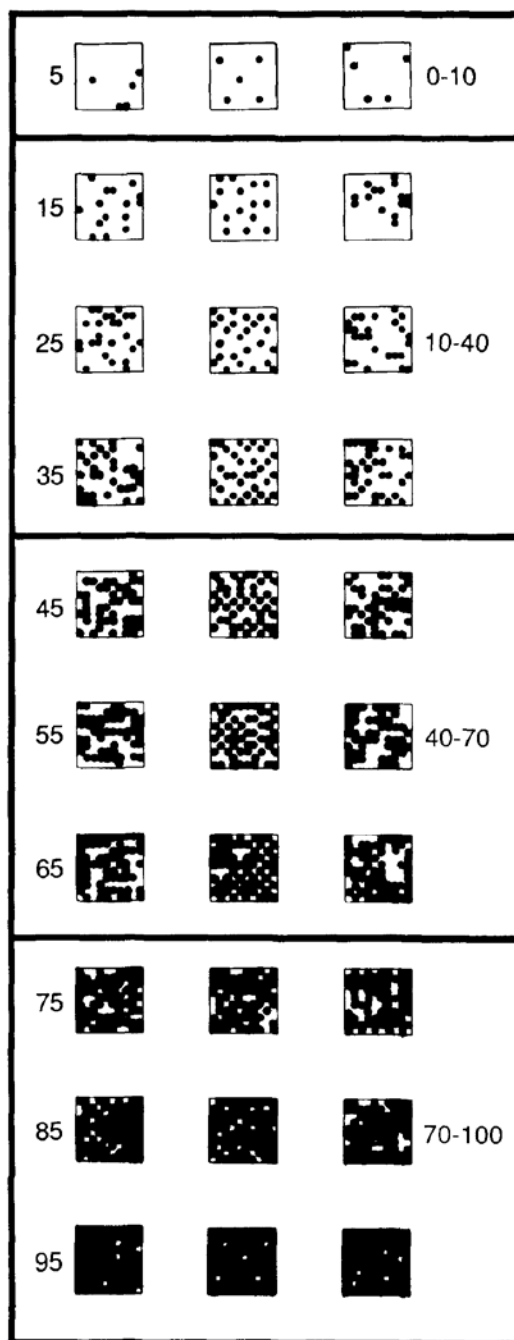
Imagery was acquired on June 16 and 17, 2018 at low tide, and polygons delineating eelgrass were screen digitized. Field verification of digitized polygons was conducted by boat, on foot, and by plane.

These sources were reviewed prior to and during desktop delineations to reinforce the photo signatures for eelgrass, as well as other features in the area such as macroalgae and ledge. A shapefile of polygons mapped in 1993-4 is also available from the Maine Geolibrary (MEDMR 1997), but corresponding metadata regarding survey methods and imagery was not located. These polygons are included in the acreage comparisons discussed in Section 4 only.

Normandeau completed all field verification efforts before October 1, when biomass could start to decline. Dead grass was observed in several locations throughout the Bay, and first noted during field verification on September 14. Due to the tight field survey window, mapping of seagrass was performed after all field work had concluded. Normandeau's photointerpreters delineated seagrass and estimated vegetation density using the four-category scale developed by Orth *et al.* (1991), where 1=0-10% cover (very sparse), 2=10-40% cover (sparse), 3=40-70% cover (moderate), and 4=70-100% cover (dense; Figure 3). Because of the complexity of substrates and water depths, up to a 35 percent change in contrast was applied to the final imagery in some areas of the Bay to assist with mapping.

The minimum map unit was assumed to be 0.5 acres (0.20 hectares), but areas as small as 444 square feet (0.01 acres; 0.004 hectares) were delineated where shallow water and good lighting permitted higher resolution. Areas less than 0.07 acres (0.03 hectares) were typically combined with nearby beds. Combining patchy areas of this size is consistent with guidance for mapping submerged vegetation by DOC (1995) and NOAA (2001). Areas less than 0.07 acres that were adjacent to other small patches were mapped separately if consistent with previous mapping efforts. Strands of seagrass observed from one or two plants during field verification or small, isolated clumps that had no obvious signature were not delineated. All GPS points taken during field verification are provided with this deliverable.

For mapping and comparison purposes, the project area was broken into four geographic sections: Quadrants one through four (Figure 1). These quadrants were designated by Seth Barker during his analysis in 2013 and 2018 and are used again here to maintain consistency. Quadrant 1 comprises the coastline from Cape Elizabeth to South Portland and the eastern portion of several islands up to Cliff Island before terminating south of Eagle Island. Quadrant 2 includes coastline from South Portland up to Yarmouth, as well as interior islands and the western extent of islands shared with Quadrants 1 and 3 (Cushing Island, Peaks Island, Long Island, and Great Chebeague Island, Littlejohn Island and Cousins Island, respectively). Quadrant 3 includes coastline from Yarmouth to Harpswell and several islands up through Bangs Island and Little Birch Island. Quadrant 4 comprises the eastern side of Harpswell Neck and Eagle Island east to Cape Small near Phippsburg. The sizes of the Quadrants vary, as does the habitat type and quality for seagrass. An original shapefile of these quadrants was not available, so slight differences in acreages may have resulted from recreating these quadrants during georeferencing a figure from the 2018 seagrass report.



**Figure 3. Depiction of Orth *et al.* (1991) percent cover classes.**

Upon completion of screen digitizing seagrass polygons, each delineated feature was numbered sequentially starting at the southwest project area at Cape Elizabeth and moving north and east along the coastline to the northeastern project extent in Phippsburg. Numbering continued in the opposite direction to include the offshore islands. GPS point data and underwater video footage were used to refine percent covers in the final mapping.

### **3.1.2 Field Verification**

Field verification was conducted over fifteen days between August 29 and September 27, 2022. Given the limited timeframe to conduct investigations, five days of survey occurred prior to receiving draft imagery and after rain events. Ten days, or one-third of all days in the month of September, had precipitation totaling 0.01 inches or more, with five days amounting to over one-half inch. No field surveys were conducted during rainstorms or high wind or wave conditions. Field surveys conducted prior to receiving draft imagery were to document presence and absence based on the 2013 and 2018 mapped polygons. Numerous locations were visited throughout the project area to capture localized differences in seabed composition and water depth. Bed presence and absence was the main priority for field efforts, followed by bed boundary confirmation and percent cover verification. Some transect locations were modified in the field depending on progress, safety, and weather. Transects were labeled with one to two characters followed by a numeric value. During the first field visit (8/29-9/2), characters corresponded to general area, where CL=Cliff Island, FA= Falmouth, HN= Harpswell Neck, NM=New Meadows, and SP= South Portland. The second field visit (9/12-9/16) included transects labeled A through E, and generally were located from Cape Elizabeth to Great Chebeague Island. Transects labeled J through N were allotted for the third visit (9/19-9/27) and covered areas from Winnegance Bay to South Freeport. Z and X transects were also added should time allow for additional coverage of Cliff Island and the New Meadows River. The underwater videos are labeled by transect name and provided in the 'Video' column of the 2022 Seagrass GIS file attribute table.

Field notes from all field efforts are provided in Appendix A. The field verification team consisted of a Maine Department of Environmental Protection (DEP) boat captain and DEP staff to operate the camera and one Normandeau staff to observe the video and record findings. Equipment included a Maine DEP vessel (20-foot Maritime Skiff with a 115-horse outboard motor), Ocean Systems High-definition (HD) underwater video camera and SeaViewer 950 Sea-Drop Analog underwater video camera, and Eos Positioning Systems Arrow Gold GNSS GPS systems that pair wirelessly to Android powered ruggedized field tablets and are capable of submeter accuracy. The camera was attached via cable and secured approximately one foot from the side of the vessel. A fin was attached to the camera to help achieve the desired orientation. The camera operator manually controlled the position of the camera by watching the viewer and observing water depths. Depth of the camera above the sediment varied depending on water clarity and was often within one foot from the sea floor due to turbidity. Tow speeds during camera operation were typically one mile per hour or less.

The GPS tablet was loaded with the seagrass maps from the 2001, 2013 and 2018 delineations. The target field verification locations, including bed presence-absence confirmation areas, boundary determination areas, and signature check areas, were also loaded into the GPS tablet. The data dictionary on the GPS tablet incorporated points for seagrass presence (eelgrass, widgeon grass, and mix of both species), percent cover (0, 1-10, 10-40, 40-70, 70-100), macroalgae, epiphytes, and a generic point for additional comments and observations. Due to water turbidity, the eelgrass presence GPS point type was used almost exclusively.

### **3.1.3 GIS**

The final GIS file includes all mapped polygons as well as metadata containing survey and mapping specifics. Shapefiles for field verification transects, GPS data points of seagrass presence, percent cover, and comments/observations, quadrants, and track logs are also provided.

### **3.1.4 Quality Control/Quality Assurance**

Photointerpretation was conducted by two primary interpreters. Due to timing of the aerial flight and need to conduct field verification prior to seagrass senescence, no mapping was performed prior to field investigations. After all field work was completed, the two interpreters digitized seagrass beds using the aerial imagery and GPS data collected during field work. Comparison of these files was made to produce the final seagrass GIS layer, which was also informed by underwater video, and previous imagery from 2013 and 2018. Underwater video was reviewed for most available field verification areas to confirm collected GPS points were accurate and the percent cover estimates were consistent with the video. The ArcMap Topology toolset was used to check for overlap, omissions, and inconsistencies in polygon shapes and all attribute tables were reviewed for completeness.

The accuracy of the GPS unit was less than 3.3 feet (1 meter) for all field efforts. The GPS receiver paired with the tablet was separate from the camera, which often resulted in a spatial difference between the GPS points and a corresponding point from the underwater video. Occasionally GPS points and the boat track log did not line up precisely, likely due to boat movement, so seagrass boundaries were adjusted to split the difference between these features if there was not a prevalent aerial signature.

## **3.2 Results**

### **3.2.1 Field Verification**

Field verification took place over fifteen field days between late August and late September. Transects were used to collect information on seagrass beds, and 486 targeted locations were visited. These locations covered roughly half (255/505) the number of all mapped seagrass beds, although this number is not an accurate representation of effort as many polygons are in close proximity to verified areas, while other polygons had multiple transects due to their large size. Additionally, of the 250 polygons that were not field verified, all but nine had been mapped in the same or nearly the same location in previous years based on the 2001-2, 2013, and 2018 data. Field verification played a vital role in determining presence-absence for areas that had overlapping signatures with macroalgae, deep water and/or ledge (Figure 4).

### **3.2.2 Final Maps**

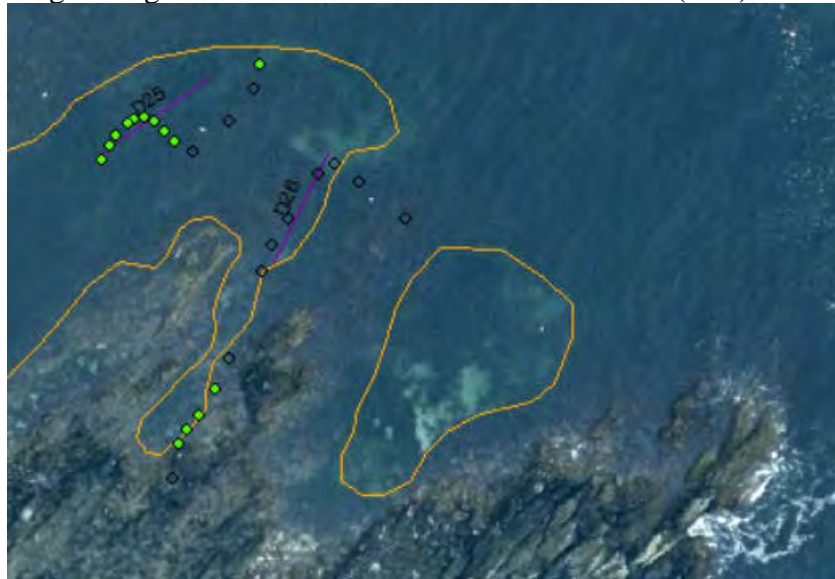
The final mapped seagrass dataset contains 505 mapped seagrass beds and covers approximately 2,286.0 acres. Approximately 306 acres of seagrass were mapped as category 1, 0-10 percent cover, 1,110.8 acres of seagrass were mapped as category 2, 10-40 percent cover, 657.7 acres of seagrass were mapped as category 3, 40-70 percent cover, and 211.6 acres were mapped as category 4, 70-100 percent cover (Figure 5). Polygons that were visited in the field have an associated species identification, which is based solely on underwater video observation unless otherwise noted. Polygons that were not visited are assumed to be eelgrass but lack a species identification in the GIS shapefile as it is recommended these areas be field verified in future



Eelgrass signature confirmed in sand/mud substrate (B35)



Other species with visually similar signature to eelgrass (M09)



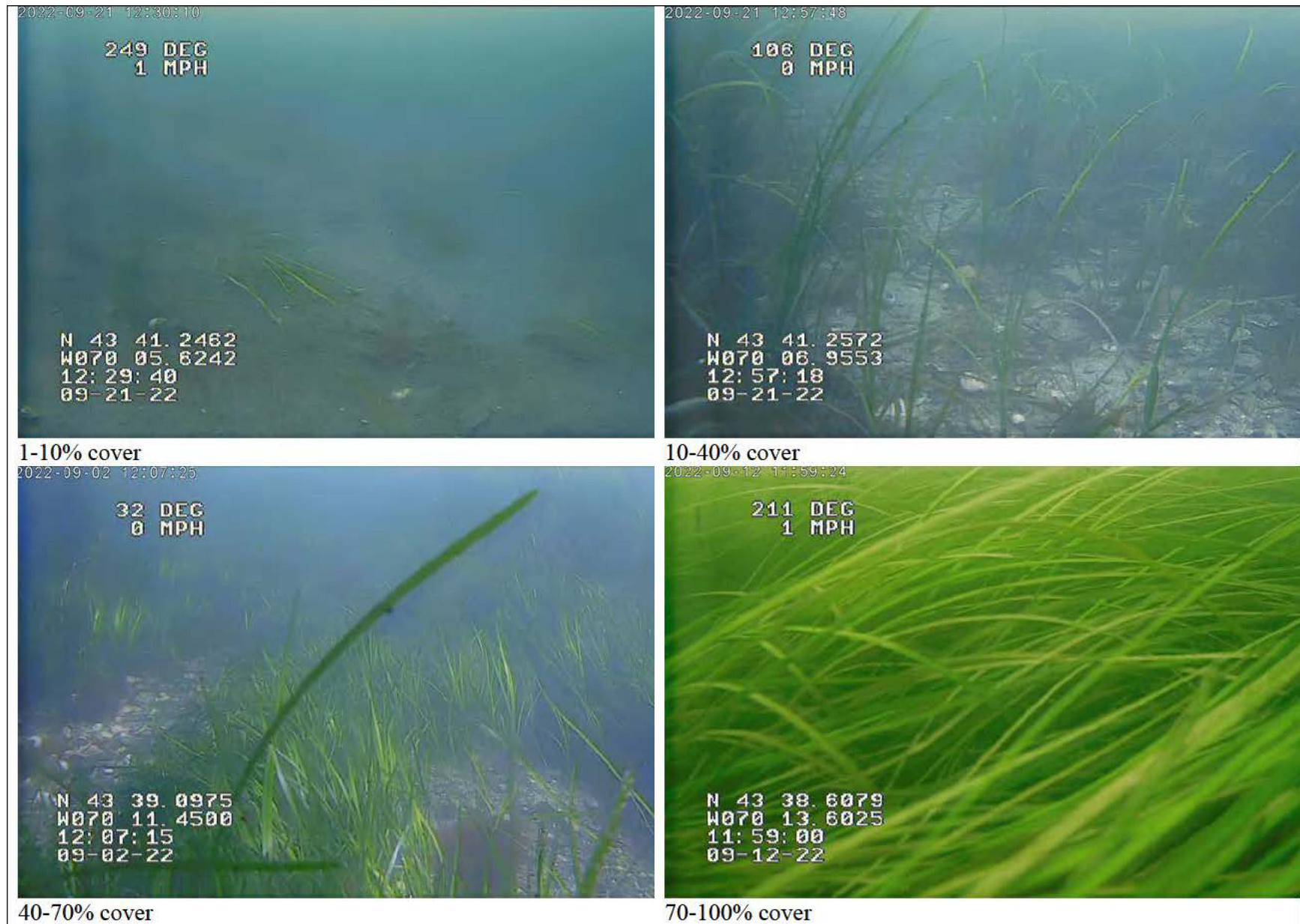
Eelgrass signature confirmed among rockier substrate (D25/26)



Other species with visually similar signature to eelgrass (L39)

**Figure 4. Seagrass signatures and look-a-likes shown at approximately the same scale. (Green circles= eelgrass presence)**





**Figure 5. Percent cover categories observed in the field.**



mapping efforts. Eelgrass was the dominant vascular species, covering approximately 2,247.8 acres. Sparse beds were prevalent, and eelgrass was often seen with epiphytes, covered in sediment, with filamentous algae, and intermixed with a range of macroalgae species, comprised of red algae that appeared to include *Dasysiphonia japonica*, as well as sea lettuce (*Ulva lactuca*) fucoids (likely *Ascophyllum* and *Fucus* species), and kelp (*Laminaria digitata*). Ectoprocts, chordates, and snails were often observed on seagrass blades in the underwater video. Widgeon grass was noted from the shoreline of the New Meadows River from Old Bath Road/Old Brunswick Road, as was eelgrass, and both species were assumed mixed in composition. These polygons account for approximately 32.3 acres of seagrass coverage. No other locations for widgeon grass were observed. Both video coordinates and field GPS points were used to refine the photointerpreted boundaries of mapped beds (Figure 6).



**Figure 6. Field Transects, GPS points, and underwater video were used to inform seagrass boundaries during digitizing. (Green=eelgrass presence, dark blue=70-100% cover. Orange polygons are from 2022 mapping, green polygons are from 2018 mapping.)**

## 4 Discussion

### 4.1 Distribution and Coverage of Seagrass

Seagrass abundance was assessed by both location and percent cover (Tables 1 and 2)<sup>1</sup>. Prior to field investigations, Maine DEP reported a large decrease in seagrass was suspected due to filamentous algae observed during other field studies. This decline in bed presence and abundance was confirmed during this mapping effort, with a staggering loss of 54.5% of beds from the total acreage reported in 2018. Total acres of seagrass was the lowest in 2022 out of all previous mapping years. Percent cover for classes 3 (40-70%) and 4 (70-100%) also decreased, and the most commonly observed cover class was 10-40%, which accounted for 51% of total

<sup>1</sup> For consistency and repeatability, all shapefiles were projected into PCG UTM NAD83 Zone 19N, clipped to the Quadrant Layer by quadrant, new acreages were calculated, and cover class '0' was removed before summing totals.

seagrass in 2022. From the imagery, subtidal flats such as those in Quadrant 3 that appear to have suitable sediment and water depths and were mapped as dense beds in 2018, were nearly devoid of grass, similar to what was observed in 2013. The 2022 mapping shows decreases in Harpswell Sound and Middle Bay, which supported larger seagrass beds in 2013.

It is suspected that light availability was a crucial factor in the seagrass decline observed in 2022. Many of the beds were noted with algae or sediment on the blades (Figure 7). These conditions were not present across the entire Bay, which also supported healthy, dense beds in many areas. Some of the largest, densest beds continue to be associated with the islands in Quadrant 2, and Quadrant 1 remains the most stable quadrant in terms of seagrass quantity. Beds bordered by rocky outcrops also tended to support dense, healthy-looking beds. No seagrass was identified in the major rivers within the Project Area, which include the Fore River, Presumpscot River, Royal River, and Harraseeket River.

Distribution of eelgrass is subject to several potential sources of error during the mapping process. While surveys aim to be consistent among all survey years, differences in observers, their aerial interpretation, level of effort, and quality assurance procedures can result in differences in final mapped seagrass layers. Error introduced from GPS equipment and post processing of data (GPS accuracy and averaging, point conversion between coordinate systems, differing datums, etc.) can all result in slight variation of bed boundaries and acreages if not consistent. Furthermore, incorporating GPS points that are taken on a moving boat or based on video that is recorded off the side of a boat while towed adds a degree of inaccuracy to mapped boundaries.

**Table 1. Seagrass Acreage by Survey Area**

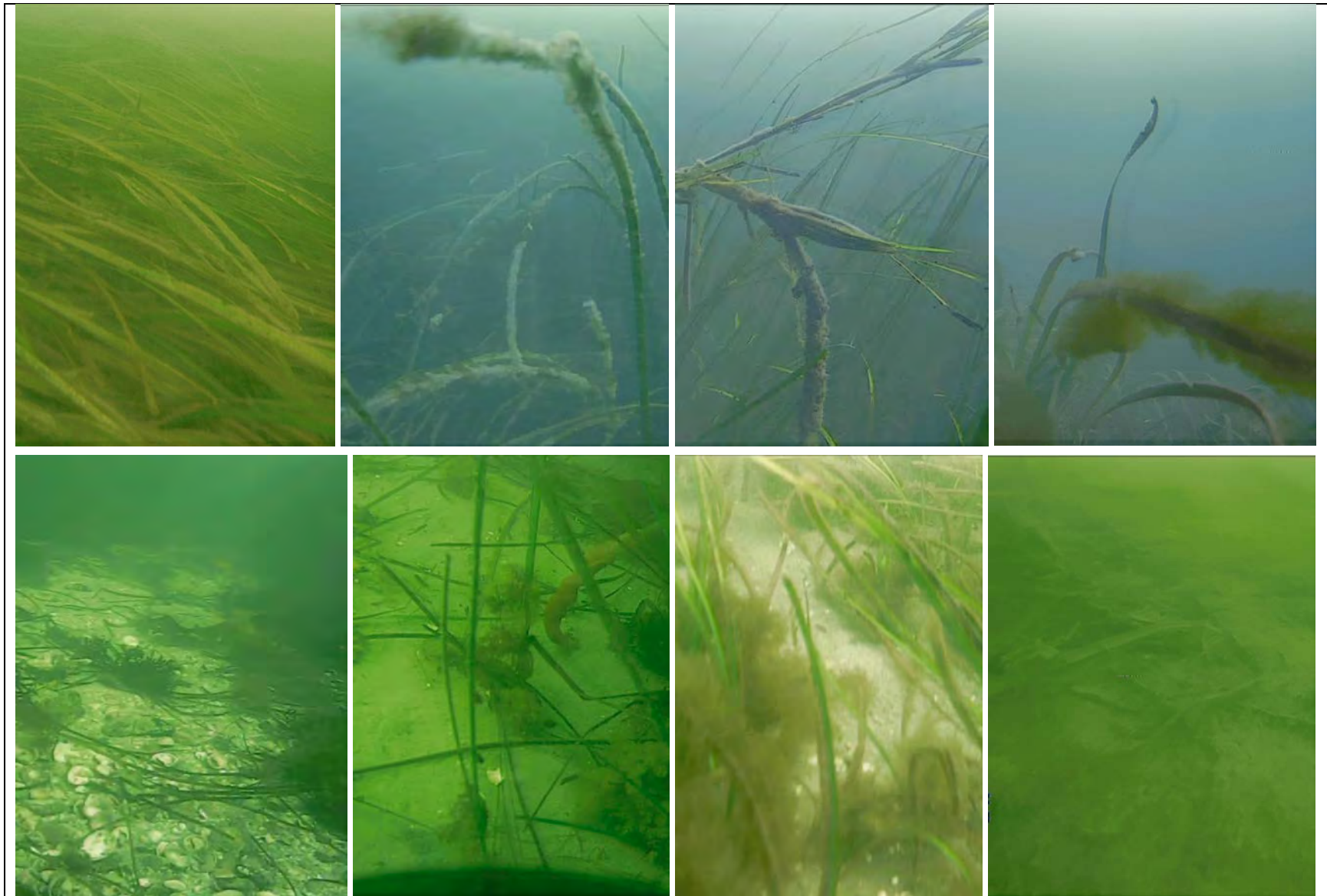
Year	Quadrant				
	1	2	3	4	Total <sup>2</sup>
1993-4	155.3	1681.5	4270.6	944.3	7051.7
2001-2	235.4	1670.4	5198.3	1089.8	8194.0
2013	247.1	1873.1	645.5	884.8	3650.5
2018	215.8	1759.9	2155.2	881.3	5012.1
2022	184.1	1265.9	403.6	432.4	2286.0

**Table 2. Seagrass Acreage by Percent Cover**

Year	Percent Cover				
	0-10	10-40	40-70	70-100	Total <sup>2</sup>
1993-4	911.1	1226.7	1362.4	3551.5	7051.7
2001-2	280.2	1825.3	828.1	5260.3	8194.0
2013	524.6	691.7	983.9	1450.5	3650.7
2018	128.5	788.7	2115.9	1979.0	5012.1
2022	306.0	1110.8	657.7	211.6	2286.1

<sup>2</sup> Acreages do not include Cover=0, which are described in the 2018 report as “null polygons”, areas having 0% cover but that are completely surrounded by higher cover classes.





**Figure 7. Condition of eelgrass beds was variable across surveyed locations, and often observed with algae.**

## 4.2 Comparison with Previous Years

The delineated beds from this effort are directly comparable to mapping from previous years. However, differences between methods and available information could account for some of the differences in the mapping. Other differences in seagrass bed abundance and distribution may have resulted from observer interpretation, imagery signature interpretation, and/or GPS accuracy. The 2001 Maine DMR metadata does not describe the methods used for mapping or field verification. The methods for digitizing and field verification in 2013 and 2018 were generally similar to those in 2022, with possibly less intensive field verification as apparent by the GIS tracklog from 2018.

Large, dense seagrass beds declined in area and/or density in comparison to all previous years. Many dense beds mapped in 2022 were mapped with low cover in 2022 such as those around Great Chebeague Island. As mentioned previously, subtidal flats near South Freeport and Maquoit Bay that were mapped in 2018 were not present during 2022. This area also saw decline in 2013. In comparison to 2013, bed size and presence was generally similar, but notable declines or increases were evident between these years in some areas. Beds mapped in Harpswell Sound were lacking in the 2022 mapping. The area between the north side of Cliff Island to north of Upper Flag Island showed a decrease in bed boundary from those mapped in 2013. The area northeast of White Island and off of Blaney and Cornfield Points saw an increase in seagrass presence from 2013, which had little to no eelgrass at these locations. Although there is a noted increase in bed presence between 2013 and 2022 in these three areas, the beds were smaller than those mapped in 2018 in all three locations.

## 5 References

- Department of Commerce (DOC). 1995. NOAA Coastal change analysis program (C-CAP): Guidance for regional implementation. NOAA Technical Report NMFS 123.
- Orth, R.J., Nowak, J.F, Frisch, A.A, Kiley, K. and Whiting, J. 1991. Distribution of submerged aquatic vegetation in the Chesapeake Bay and tributaries, and Chincoteague Bay – 1990. US EPA, Chesapeake Bay Program, Annapolis, MD
- Maine Department of Environmental Protection (MEDEP). 2013. Eelgrass 2013 (Casco Bay Only). <https://hub.arcgis.com/datasets/maine::mainedep-eelgrass-2013-casco-bay-only/explore>
- \_\_\_\_\_. 2018. Eelgrass 2018 (Casco Bay Only). <https://maine.hub.arcgis.com/datasets/9ff06215dcb945c2879b52413fc954c1/explore?location=43.750094%2C-70.039450%2C11.87>
- Maine Department of Marine Resources (MEDMR). 1997. Eelgrass 1997. [https://dmr-maine.opendata.arcgis.com/datasets/25d11cbf476944bc8dc985d2454d01d6\\_3/explore?location=44.077851%2C-68.894379%2C8.75](https://dmr-maine.opendata.arcgis.com/datasets/25d11cbf476944bc8dc985d2454d01d6_3/explore?location=44.077851%2C-68.894379%2C8.75)
- \_\_\_\_\_. 2010. Eelgrass 2010. [https://dmr-maine.opendata.arcgis.com/datasets/25d11cbf476944bc8dc985d2454d01d6\\_2/explore?location=43.352616%2C-70.382245%2C11.02](https://dmr-maine.opendata.arcgis.com/datasets/25d11cbf476944bc8dc985d2454d01d6_2/explore?location=43.352616%2C-70.382245%2C11.02)
- Maine GIS (MEGIS). 2001. Maine Orthoimagery Coastal Central Coast 2001 (Imagery Layer). <https://maine.hub.arcgis.com/datasets/8dd91e179cf14f19baeb1bc307d8100a/explore>
- \_\_\_\_\_. 2010. Maine Orthoimagery Coastal South Coast 2010 (Imagery Layer). <https://maine.hub.arcgis.com/datasets/41ffdca13b0a434db1cad596dc617301/explore>
- \_\_\_\_\_. 2013. Maine Orthoimagery Coastal Casco Bay 2013 (Imagery Layer) <https://hub.arcgis.com/datasets/maine::maine-orthoimagery-coastal-casco-bay-2013-imagery-layer/about>
- \_\_\_\_\_. 2018. Maine Orthoimagery Coastal Casco Bay 2018 (Imagery Layer). <https://maine.hub.arcgis.com/datasets/20aa93f6789f410ebad2e43b9622d728/explore>
- U.S. National Oceanic and Atmospheric Coastal Services Center (NOAA). 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.
- Wippelhauser, G. 1996. Ecology and Management of Maine's Eelgrass, Rockweeds, and Kelps. Maine Natural Areas Program, Dpartment of Conservation, Augusta, ME. 73pp. <https://www.govinfo.gov/content/pkg/CZIC-qh90-8-b46-w57-1996/pdf/CZIC-qh90-8-b46-w57-1996.pdf>

## **6 Appendices**



## **Appendix A. Field Notes**

## **Field Verification**

**08/29/2022, Monday**-----

Previous weather summary: rain totaling 2.19 in (8/23/24), 0.01 in (8/26) and 1.51 in (8/27) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 63 to a high of 82 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: partly cloudy, temperature range 62 to 81 degrees Fahrenheit, no precipitation.

Meet at Yarmouth boat launch on Old Shipyard Road, near Yarmouth Boat Landing Town Park, north side of Royal River, Yarmouth, ME, approximately 0800.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
29	Mon	12:53	9.9	1:19	9.4	7:05	0.1	7:17	0.5

### Field Notes:

- Launched from Yarmouth Boat launch approx. 0800. The weather conditions were good for maneuvering, calm seas with full sun and a steady breeze. Water quality was poor for viewing with high turbidity and green tinted water.
- The camera monitor proposed an initial challenge as its picture came in and out due to a bad connection piece on the camera. (The flickering of picture was worse as camera moved up and down.) The direct sunlight also obstructed viewing with intense glare on the screen, wind made shading with jacket difficult. The team tried the old camera but was unsuccessful. Due to these initial challenges I resorted to viewing the camera (new camera) on the small screen of the recorder and moved the unit to the stern of the boat. Behind the center console I was able to avoid the glare and view the small screen which allowed us to view the bottom (in areas where turbidity wasn't too high.) Unfortunately, the camera operator was not able to view the monitor while operating the camera. Therefore, the camera operator adjusted its level by listening to commands from the tablet operator.
- Soft substrate stations were too turbid for viewing so the team moved to hard substrate locations off rocky coastline. These locations made for much easier viewing however the camera had to stay close to the bottom (1ft or less) in order to keep it in view.
- At the end of the day the team was met with one final obstacle as the cable attached to the camera rope broke. This was reattached back at the hotel.

**08/30/2022, Tuesday**-----

Previous weather summary: rain totaling 2.19 in (8/24), 0.01 in (8/26) and 1.51 in (8/27) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 63 to a high of 82 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: mostly sunny, temperature range 68 to 81 degrees Fahrenheit, no precipitation.

Meet at Mere Point boat launch off Mere Point Road, between Paul's Marina and Mere Point Yacht Club, west side of Mere Point Bay, Brunswick, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
30	Tue	1:29	9.8	1:52	9.6	7:39	0.1	7:57	0.3

Field Notes:

- Launched from the Mere Point boat launch at approx. 0800. Water clarity was worse than the previous day with higher turbidity. Weather conditions were more challenging as well with higher seas and lack of cloud cover. Camera operator could not view monitor and relied on verbal cues from tablet operated like previous day. Wave action made keeping the camera stable difficult at times.
- The team decided to move offshore as the day progressed in search of better water clarity. Offshore the water clarity improved, substrate was more variable lacking the mud flats observed at the inshore transects.
- As a side note, when viewing the footage if you see little black dots all over the eelgrass blades and you're wondering what those are... they're little gastropods (snails).



**08/31/2022, Wednesday**-----

Previous weather summary: rain totaling 0.01 in (8/26) and 1.51 in (8/27) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 63 to a high of 82 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: foggy, temperature range 62 to 80 degrees Fahrenheit, 1.14 in precipitation in the morning.

Meet at Mere Point boat launch off Mere Point Road, Between Paul's Marina and mere Point Yacht Club, west side of Mere Point Bay, Brunswick, ME, approximately 12:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
31	Wed	<b>2:08</b>	9.7	<b>2:28</b>	9.8	<b>8:16</b>	0.2	<b>8:39</b>	0.2

Field Notes:

- Launched from Mere Point boat launch around 12:00.
- I went to Hampton that morning and picked up a small television monitor for better viewing. Also troubleshooted old camera to ensure it would work properly and was informed that the green picture on the new camera was due to the water conditions, unfortunately it could not be adjusted. Josh [MEDEP] also built a wooden shelter to place over the monitor which kept the glare off the screen.
- The weather conditions were fair with partly sunny skies and steady winds, seas were calmer than the previous day. Additions to the camera set-up made viewing much easier and allowed the camera operator to view the screen. As a result, the overall quality of camera operation improved significantly. Water clarity inshore was extremely poor due to the recent rain activity earlier in the day. The team decided to start offshore around the outer islands (Cliff Island). Here the water clarity allowed for successful viewing and together with the new set-up we got our best footage of the trip so far.

**09/01/2022, Thursday**-----

Previous weather summary: rain totaling 0.01 in (8/26), 1.51 in (8/27) and 1.14 in (8/31) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 63 to a high of 82 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: partly cloudy, temperature range 56 to 74 degrees Fahrenheit, 0.01 in precipitation.

Meet at New Meadow boat launch off Bushy Isle View, less than one mile south of Brighams Cove, East side of Winnegance Bay, Phippsburg, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
1	Thu	2:50	9.4	3:09	9.9	8:56	0.3	9:27	0.2

Field Notes:

- Launched from a boat ramp on Bushy Isle View around 0800 entering Winnegance Bay. The Weather conditions were partly cloudy with strong winds in the morning which dissipated as the day went on.
- The water clarity was better compared to the previous day with slightly less turbidity. The Team covered the transects in the upper region of the polygon. Viewing was very successful with the new set-up, with smoother camera operation.
- I also changed the setting on the tablet to average only two GPS points which allowed me to drop data points much faster. The camera wire attached to the rope was also replaced with a bungee cord which stabilized the camera much better than the metal wire.
- The team had more success at shallow stations compared to previous days, even though turbidity at mud flats was consistently high.



**09/02/2022, Friday**-----

Previous weather summary: rain totaling 0.01 in (8/26), 1.51 in (8/27) and 1.14 in (8/31) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 62 to a high of 81 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: mostly sunny, temperature range 48 to 69 degrees Fahrenheit, no precipitation.

Meet at East End boat launch off Cutter Street, near Eastern Promenade, Portland, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
2	Fri	<b>3:37</b>	9.1	<b>3:56</b>	9.9	<b>9:42</b>	0.5	<b>10:19</b>	0.3

Field Notes:

- Launched from South Portland around 0800, weather was good with clear skies, calm water, and light winds.
- The water clarity continued to improve from the previous days. Transects with soft substrate had higher turbidity compared to the areas where the substrate varied or was solid. As a result, the camera traveled close to bottom (6in – 1ft) over soft substrate (mudflats) in order to maintain visual. In areas with hard or varied substrate, the camera could be raised several feet above the bottom which allowed for a wider visual, capturing more of the benthic landscape. Though the visuals varied by location and substrate the team was able to successfully identify the bottom along both inshore and offshore transects.



**09/12/2022, Monday**-----

Previous weather summary: rain totaling 0.85 in (9/6), and 0.54 in (9/7) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 50 to a high of 80 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: cloudy, temperature range 63 to 79 degrees Fahrenheit, no precipitation.

Meet at East End boat launch off Cutter Street, near Eastern Promenade, Portland, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
12	Mon	12:47	10.8	1:12	10.5	6:58	-0.8	7:20	-0.6

Field Notes:

- Launched from East End Boat Launch approximately 0800. Covered Cape Elizabeth to Portland. The weather was in the 70s and sunny.
- The water quality depends on location. Some areas were turbid resulting in green tinted poor-quality footage, particularly towards the end of the day. Upon impact [with the sea floor] the camera visual quality and color changes then slowly returns to normal.
- A few transects were surveyed twice for learning or change in tide. Plants brought up on the camera after surveying a transect were photographed and saved on my phone.
- A25- 2 takes- bed
- A24- bed low density
- A23- 0-10%, redo later
- A22- no bed
- A21- no bed
- A01- no bed, other spp
- A02- no bed, other spp
- A03-beds small high density, may have added points on other spp?
- A04- no bed in transect, bed after, end hard to see if grass or other spp
- A05- bed mid/high to high, small patch before
- A06- small patch, hard to see, went down and back
- A07- bed mid density, gap between
- A08- bed up to 40% density
- A10- no bed, plants around
- A11- went back to start- small patch then bed
- A12- healthy patch
- A13- no bed, other spp
- A14- Bed

- A16- bed high density
- A15- bed mid/high density
- A17- 1 cluster, rest other spp
- A18- bed high density
- A19- very low density to sparsely distributed
- A20- 2 clusters
- A23 take 2\_ bed low density
- A34- bed
- A33- individual spread out plants, 1 grouping
- A31- bed up to 40%, some plants before
- A32- Shell bed, bed high density
- A30- no bed, other spp
- A29 take 2- hard to see, bed, few plants before
- A28- few plants
- A27- high density bed
- A26- few plants

**09/13/2022, Tuesday**-----

Previous weather summary: rain totaling 0.85 in (9/6) and 0.54 in (9/7) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 50 to a high of 80 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: foggy, temperature range 62 to 70 degrees Fahrenheit, no precipitation in the morning.

Meet at East End boat launch off Cutter Street, near Eastern Promenade, Portland, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
13	Tue	<b>1:35</b>	10.4	<b>1:56</b>	10.4	<b>7:42</b>	-0.4	<b>8:09</b>	-0.4

Field Notes:

- Launched from East End Boat Launch approximately 0800. Covered Islands southwest of Long Island. The weather was 60s and overcast.
- The water quality depends on location. Some areas were turbid resulting in green tinted poor-quality footage, particularly towards the end of the day. Upon impact the camera visual quality and color changes and slowly returns to normal.
- B24- 1 cluster
- B23- bed
- B22- no bed other spp
- B28- bed mid/high density
- B29- bed med density
- B30- bed high density
- B32- no bed, few plants/blades
- B33- bed small at start, not in old bed
- B34- bed
- B35- spread out seagrass, algae/filaments on grass
- B37- no bed, other spp
- B38- bed
- B40- bed with filament algae
- B39- small beds
- B38- bed low to med density
- B37.5- bed
- B36.5- bed med density
- B17- bed
- B18- 1 cluster
- B19- bed low density

- B31- no bed, red plant
- B20- low density spread out
- B21- low density to short to dead
- B25- low density plant clusters
- B26- clusters to high density bed
- B27- no bed
- B09- Bed high density
- B10- spread out plants to clusters
- B11- bed, plants before
- B12- bed high density
- B13- bed, algae
- B05- low density
- B06- bed high density with breaks
- B07- no bed in transect small bed in old bed
- B08- no bed
- B14- low quality plants to small clusters
- B15- bed, plants before and after
- B16- bed mid/high density
- B04- small spread out plants
- B03- few blades around
- B02- bed
- B01- Low density



**09/14/2022, Wednesday**-----

Previous weather summary: rain totaling 0.54 in (9/7) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 50 to a high of 80 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: mostly sunny, temperature range 62 to 79 degrees Fahrenheit, 0.01 in precipitation.

Meet at Royal River boat launch at Yarmouth Boat Landing Town Park off Old Shipyard Road, across the Royal River from Yarmouth Boat Yard, Yarmouth, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
14	Wed	<b>2:23</b>	9.9	<b>2:41</b>	10.1	<b>8:26</b>	0.2	<b>8:57</b>	0.0

Field Notes:

- Launched from Yarmouth Boat Landing Town Dock approximately 0800. The weather was 70s, partly cloudy and western winds gusting up to approximately 30mph.
- Transects on the eastern side of islands were surveyed due to wind and turbidity. The water quality was turbid resulting in low visibility, green tinted poor-quality footage. Upon impact the camera visual quality and color changes and slowly returns to normal.
- E20- bed high density, few plants extend out
- E19- bed mid/high density, few plants extend out
- E18- bed small low density
- E15- bed before transect runs parallel
- E17- no bed in transect, small bed after
- E16- 0 to bed to 0
- E14- bed small, dead patches before
- E13- few spread out small plants
- E12- couple plants at beginning
- E08- bed, density rises up to ~40-70%
- E09- bed high density, few spread out patches before
- E10- bd low density
- E11-bed high density, spread out plants before
- E07- bed high density to plowed to spread out plants
- E06- bed high density
- D13- bed below 40% density
- D14- bed high density, spread out plants before
- D15- bed to 0 to bed
- D16- bed low density
- D17- bed to 0 to bed

- D18- 1 cluster to 0 to bed high density
- D19- bed high density after transect
- D20- bed small
- D21- bed small
- D22- bed high density, starts before transect
- D23- dead grass to bed to blown off course to turbid dead to turbid bed
- D24- bed, scoured form mooring
- D25- bed high density, scoured
- D26- no bed in transect, small patches after
- D27- no bed, kelp
- D29- bed high density
- D29.5- few clusters, dead blades
- D32- few clusters/ scoured in transect, bed after
- D33- bed high density
- D31- bed high density
- D30- no bed in transect, some plants in old bed
- D28- bed high density
- E29- bed high density
- E30- bed high density
- E31- bed mid/high density
- E32- 0-10%
- E33- Bed high density
- E34- low
- E26- no bed
- E27- no bed
- E28- no bed

**09/15/2022, Thursday**-----

Previous weather summary: rain totaling 0.01 in (9/14) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 50 to a high of 80 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: mostly sunny, temperature range 49 to 66 degrees Fahrenheit, no precipitation.

Meet at Royal River boat launch at Yarmouth Boat Landing Town Park off Old Shipyard Road, across the Royal River from Yarmouth Boat Yard, Yarmouth, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
15	Thu	<b>3:12</b>	9.3	<b>3:27</b>	9.7	<b>9:12</b>	0.8	<b>9:49</b>	0.4

Field Notes:

- Launched from Yarmouth Boat Landing Town Dock approximately 0920 due to delayed personnel. Weather was sunny and NW winds gusting up to approximately 33mph.
- Covered area up in Harpswell inlet for wind cover.
- The water quality was turbid resulting in low visibility, green tinted poor-quality footage.
- N31- no bed
- N32- no visibility, will return
- N27- no bed, 2 plants
- N28- need review- wind=too fast, believe no bed.
- N09- no bed, other spp
- M01- bed 0-25% density
- M27- no bed, few spread out pants/blades
- M26- bed high density
- M34- 2 small beds then large high-density bed
- M33- bed starts before high density
- L31- bed mid to low density
- L30- low density bed? Turbid
- L29- small plants, turbid
- L28- no bed? Redo? Turbid
- L27- no bed, turbid
- L26- no bed, maybe few plants, turbid
- L19- no bed, few blades
- L15- no bed, 2 plants in old bed
- L16- small cluster
- L17- no bed
- M02- small patches out of transect



**09/16/2022, Friday**-----

Previous weather summary: rain totaling 0.01 in (9/14) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 51 to a high of 80 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: mostly sunny, temperature range 45 to 68 degrees Fahrenheit, no precipitation.

Meet at Royal River boat launch at Yarmouth Boat Landing Town Park off Old Shipyard Road, across the Royal River from Yarmouth Boat Yard, Yarmouth, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
16	Fri	<b>4:04</b>	8.7	<b>4:17</b>	9.3	<b>10:00</b>	1.3	<b>10:43</b>	0.8

Field Notes:

- Launched from Yarmouth Boat Landing Town Dock approximately 0800 with a two-person crew. The boat captain recorded approximate start of seagrass bed along transect in addition to driving. I operated the camera and recorded notes in a field notebook.
- Covered most transects from the boat launch along Little John Island, and along the coast to Cumberland Foreside wrapping up around 1230.
- The weather was in the 80s and cloudy. The water quality was turbid with poor visibility. Glare/reflection on the monitor with the turbidity made viewing difficult.
- N01- no bed
- N02- bed, starts ~ beginning of transect
- N03- bed
- N04- handful of mid to high density clusters throughout transect
- N05- no bed. Saw plant cluster from the boat
- N06- few small beds/clusters, easy to see from boat.
- N07- 1 plant
- N08- small cluster
- N09- few clusters/beds
- E23- bed in transect, few plants before
- N10- bed bigger, extends past transect
- C19- ~ 3 plants
- C20- bed
- C21- few plants around
- C22- no bed
- C23- bed, extends most of transect
- C24- bed
- C25- few plants around, no bed



**09/19/2022, Monday**-----

Previous weather summary: rain totaling 0.01 in (9/14) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 43 to a high of 79 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: cloudy, temperature range 52 to 58 degrees Fahrenheit, 0.56 in precipitation.

Meet at New Meadow boat launch off Bushy Isle View, less than a mile south of Brighams Cove, East side of Winnegance Bay, Phippsburg, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
19	Mon	6:58	7.7	7:09	8.6	12:42	1.4	12:49	2.3

Field Notes:

- Launched from New Meadows boat launch approximately 0800. Covered from Bath covering the eastern transects down to West Point. The weather was overcast, in the 50s and rain towards the end of the day.
- The water quality depends on location. Some areas were turbid resulting in green tinted poor-quality footage. The first few video recordings were captured in black and white due to power trouble. Upon impact the camera visual quality and color changes and slowly returns to normal.
- K01- no bed
- K09- no bed
- K06- no bed
- K07- no bed
- K05- no bed
- K02- no bed, rockweed
- K11- 1 small cluster near edge of old bed
- K12- 2 beds, algae/other growth on grass
- K13- seagrass along transect
- K15- saw 1 plant, rest other spp
- K14- small bed, small dying clusters
- K16- 2 separate plants, no bed
- K17- spread-out low density bed
- K18- 2 plants near edge of old bed, no bed observed
- K19- no bed, other spp
- J42- 0 to small cluster to 0 to small bed to 0

- J41- bed, mid to mid/high density
- J40- no bed
- J38- no bed, either rockweed, other spp, or dead seagrass, hard to see on boat
- J35- primarily rockweed, may have been some seagrass plants mixed in, hard to see on boat
- J33- no bed, rockweed
- J32- no bed, rockweed, may have some dead seagrass plants
- J30- small poor quality bed
- J29- small low density bed, dock at transect
- J28- bed, starts low density up to 40-70%
- J27- 2 plants near end of old bed. No bed
- J26- no bed, maybe 1 plant off to side
- J23- no bed, maybe 1 plant
- J24- 1 small bed
- J15- no bed, few blades ~1" tall
- J14- no bed
- J11- no bed, maybe plants near lobster trap
- J10- few individual plants/ blades around
- J09- bed out past transect
- J08- few individual plant/blades
- J07- few short plants
- J05- few blades, no bed
- J04- few dead plants or other spp?, moorings and lines in way
- J25- small spread-out low-density bed
- J03- 1 plant
- J02- short, dispersed plants
- J01- 1 plant

**09/20/2022, Tuesday**-----

Previous weather summary: rain totaling 0.01 in (9/14) and 0.56 in (9/19) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 43 to a high of 79 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: cloudy, temperature range 52 to 58 degrees Fahrenheit, 1.04 in precipitation.

Meet at New Meadow boat launch off Bushy Isle View, less than a mile south of Brighams Cove, East side of Winnegance Bay, Phippsburg, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
20	Tue	7:58	7.7	8:08	8.7	1:44	1.5	1:51	2.2

Field Notes:

- Launched from New Meadows boat launch approximately 0800. Covered from Phippsburg Covering remaining transects from 09/19/22 down to Mackerel Cove/Jaquish Island. The weather was in the low 60s, overcast and northern winds up to approximately 10 mph.
- The water quality depends on location. Some areas were turbid resulting in green tinted poor-quality footage. Upon impact the camera visual quality and color changes and slowly returns to normal.
- K30- no bed
- K29- no bed, few blades around
- K23- no bed, may have saw a plant, hard to see
- K31- no bed, 1 blade
- K23- no bed
- J22- no bed, maybe dead cluster, hard to see, Red plant
- J21- bed 1 mid density, bed 2 mid/high density
- J20- bed, high to low density to dead plants with areas of bed plowed down, invasive growth on grass?
- J17- 0 to bed to 0 to low density
- J18- small bed
- K33- low/mid density bed, growth on blades
- K36- bed, missed first part of transect turned around to get all
- K34- no bed, rockweed
- K44- 0 to few plants to bed with growth on it
- K46- bed starts before transect, high density with plowed down areas throughout (traps)

- K48- no bed, few plants/blades around
- K49- No bed, maybe 2 dead plants?
- K37- bed low to mid density
- K38- no bed
- K20- bed mid/high density
- K39- bed before mooring/line, no bed to dead bed past
- K40- large high density bed disrupted with rocks
- K35- algae?, mid density bed start before transect
- K21- Need review saw plants (grass?) hard to see- 1 cluster in transect
- K41- no bed
- K24- no bed, turbid may have seen some grass in the algae?
- K26- no bed, maybe few plants turbid
- K27- no bed, few blades or rockweed? Turbid
- K28- small cluster, turbid
- K25- no bed, turbid
- K42- no bed, few blades
- L42- bed, medium to high density, few dispersed plants before
- L32- patches, individual plants, and plowed down areas
- L33- individual plants, no bed in transect, small patch of grass after
- L34- bed mid density
- L36- short individual plants around that could be grass? Turbid, no bed
- L37- bed low density
- L39- no bed, kelp
- M39- bed high density, extends past old bed
- M38- bed mid/high density
- M37- no bed, maybe a plant



**09/21/2022, Wednesday**-----

Previous weather summary: rain totaling 0.01 in (9/14), 0.56 in (9/19) and 1.04 in (9/20) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 43 to a high of 79 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: mostly cloudy, temperature range 49 to 67 degrees Fahrenheit, no precipitation.

Meet at Dolphin boat launch on Malcom Drive off Basin Point Road, at Dolphin Marina, west side of Potts Harbor, Harpswell, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
21	Wed	8:52	7.9	9:01	9.0	2:41	1.3	2:47	1.9

Field Notes:

- Launched from Dolphin Boat Launch approximately 0800. Completed transects through Harpswell Sound, down to Jewell Island, then completed the remaining transects on the Islands east of Great Chebeague Island up to Little Whale boat Island and wrapped up transects west of Harpswell Neck south of Shelter Island. The weather was in the low 60s, cloudy and winds from north, west the south up to approximately 7 mph.
- The water quality depends on location. Some areas were turbid resulting in green tinted poor-quality footage, especially up in Harpswell Sound. Upon impact the camera visual quality and color changes and slowly returns to normal. Reflection/glare on the monitor provided even more of a viewing challenge, additional general point comments added with viewing uncertainty.
- L06- no bed
- L07- no bed
- L08- 1 plant and 1 cluster, turbid
- L04- low density small bed
- L05- no bed, 1 or few plants, turbid
- L03- no bed, maybe few plants, turbid, shell bed
- L25- no bed, some plants around, turbid
- L02- either patches of dead seagrass or rockweed, turbid
- L01- turbid, think everything is rockweed
- L24- turbid, dead grass covered in sediment and rockweed
- L23- no bed, turbid
- L22- no bed, dead to mostly dead patches, turbid
- L11- no bed

- L13- no bed, maybe 1 patch
- L14- no bed, maybe 1 patch, turbid
- L21- no bed, turbid
- L20- plant and blades, no bed, video recorded around 1120 incase hard to see ID in video
- L41- beds/patches, turbid
- L40- boat in transect went around, and line from boat to dock disrupted viewing. Bed before and after line.
- M35- bed starts before transect
- M28- bed high density
- M29- bed high density
- X02- no bed, kelp
- X01- bed low to mid density
- X14- bed starts before transect
- X12- bed mid density
- X13- small patches
- X11- bed smallish mid density
- X09- bed low/mid density
- X10- bed low to mid density, extends past transect, may have mislabeled a point or missed a point just after located in the middle at 0
- X05- no bed in transect just kelp, in old bed 0-10% density
- X04- seagrass bed to algae/kelp to seagrass bed
- X03- bed mainly outside transect
- M30- bed before transect, nothing in transect
- M31- low density bed
- M32- no bed, rockweed
- M07- no bed, rockweed
- M08- no bed
- M11- no bed, rockweed
- M10- no bed
- M06- no bed maybe few plants
- M05- small patch (bed?)
- M04- no bed, rockweed
- M03- few patches off to side of camera

**09/26/2022, Monday**-----

Previous weather summary: rain totaling 0.56 in (9/19), 1.04 in (9/20), 0.05 in (9/22) and 1.02 in (9/23) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 41 to a high of 67 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: cloudy, temperature range 57 to 70 degrees Fahrenheit, 0.12 in precipitation.

Meet at Mere Point boat launch off Mere Point Road, between Paul's Marina and mere Point Yacht Club, west side of Mere Point Bay, Brunswick, ME, approximately 08:30.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
26	Mon			12:07	9.8	5:54	0.1	6:11	0.0

Field Notes:

- Launched from Mere Point Boat Launch approximately 0830. Wrapped up transects west of Harpswell down to Cousins Island. The weather started off with quick passing showers. The remainder of the day was sunny and high 60s.
- Visibility was problematic today at all locations due to turbidity from rain yesterday, and glare/reflection on the monitor. A few transects were marked with points commenting seagrass or other spp needs footage review due to viewing difficulty. A few transects were recorded in black and white due to power problems.
- Almost all transects had no seagrass beds. Most did not have seagrass or dead seagrass covered in sediment.
- M17- No bed, marked a few dead plants, turbid
- M18- Same as above
- M19- No bed, few dead plants, turbid
- M16- No bed, maybe few dead plants hard to see, turbid and waves
- M15- No bed, a couple plants and dead plants observed
- M14- No bed, few plants past transect
- M25- No bed, turbid
- M24- No bed, turbid
- M13- No bed, turbid, black and white footage
- M12- Review footage from office. Lost monitor power shortly during survey, black and white footage, think all rockweed
- N30- On skip list, did not survey, footage recorded of ID nothing else
- N29- No bed, maybe small plants around, mainly other species, turbid
- N25- No bed, turbid

- N23- No bed, some dead plants around covered in sediment
- N22- No bed, dead plants around covered in sediment, turbid
- N26- No bed, few plants after transect covered in sediment, turbid
- N21- No bed, few plants covered in sediment maybe, turbid
- N19- No bed, turbid
- N18- No bed
- N16- No bed, bad glare may have missed some individual plants
- N15- No bed, some seagrass or other plants around trouble determining due to glare
- N14- No bed, few plants covered in sediment
- N12- No bed, difficulty reviewing glare and turbid
- C33- No bed, other species, few blades may be around
- C32- No bed
- C30- Low percent cover of dead vegetation covered in sediment seagrass or other species hard to see
- C26- Low percent cover of dead grass covered in sediment
- C29- No bed
- N33- Spread out low density alive grass observed
- N32- No bed, turbid
- M21- No bed, supper turbid and wavy, stall in transect due to marine patrol
- M20- No bed, supper turbid and wavy



**09/27/2022, Tuesday**-----

Previous weather summary: rain totaling 1.04 in (9/20), 0.05 in (9/22), 1.02 in (9/23) and 0.12 in (9/26) occurred the week prior to field effort. Temperatures during this same time ranged from a low of 41 to a high of 70 degrees Fahrenheit. [Portland International Jetport Weather Station]

Daily weather summary: partly cloudy, temperature range 52 to 69 degrees Fahrenheit, 0.01 in precipitation.

Meet at Royal River boat launch at Yarmouth Boat Landing Town Park off Old Shipyard Road, across the Royal River from Yarmouth Boat Yard, Yarmouth, ME, approximately 08:00.

Date		High Tide				Low Tide			
		AM	ft	PM	ft	AM	ft	PM	ft
27	Tue	12:25	9.9	12:41	10.1	6:29	0.0	6:51	-0.2

Field Notes:

- Launched from Yarmouth Boat Landing Town Dock approximately 0800. Finished survey covering from Yarmouth down to Overset Island. The weather was partly cloudy in the 60s.
- The water quality depends on location. Some areas were turbid resulting in green tinted poor-quality footage, particularly towards the end of the day. Upon impact the camera visual quality and color changes and slowly returns to normal.
- D35- Bed mid to mid/high density
- D34- Bed mid/high density
- D01- Bed lower density
- D03- Bed low to high density
- D04- Mooring in way circled around, kelp with grass to dispersed clusters of grass to bed to dispersed clusters of grass and kelp
- D06- No bed, short spread out (practically nothing), mainly other species
- D09- No bed, short spread out (practically nothing), mainly other species
- D12- Few disperse plants to bed to other species
- E05- No bed, small cluster around rocks, rest short dispersed individual plants
- E03- Dense clusters of grass with algae
- E02- Dead to clusters to small bed to dispersed clusters
- C08- Dead low density bed to mostly dead or short plants
- C13- No bed, other species
- C10- Bed low to mid density
- C17- Low density spread out mostly dead or short
- C04- Bed

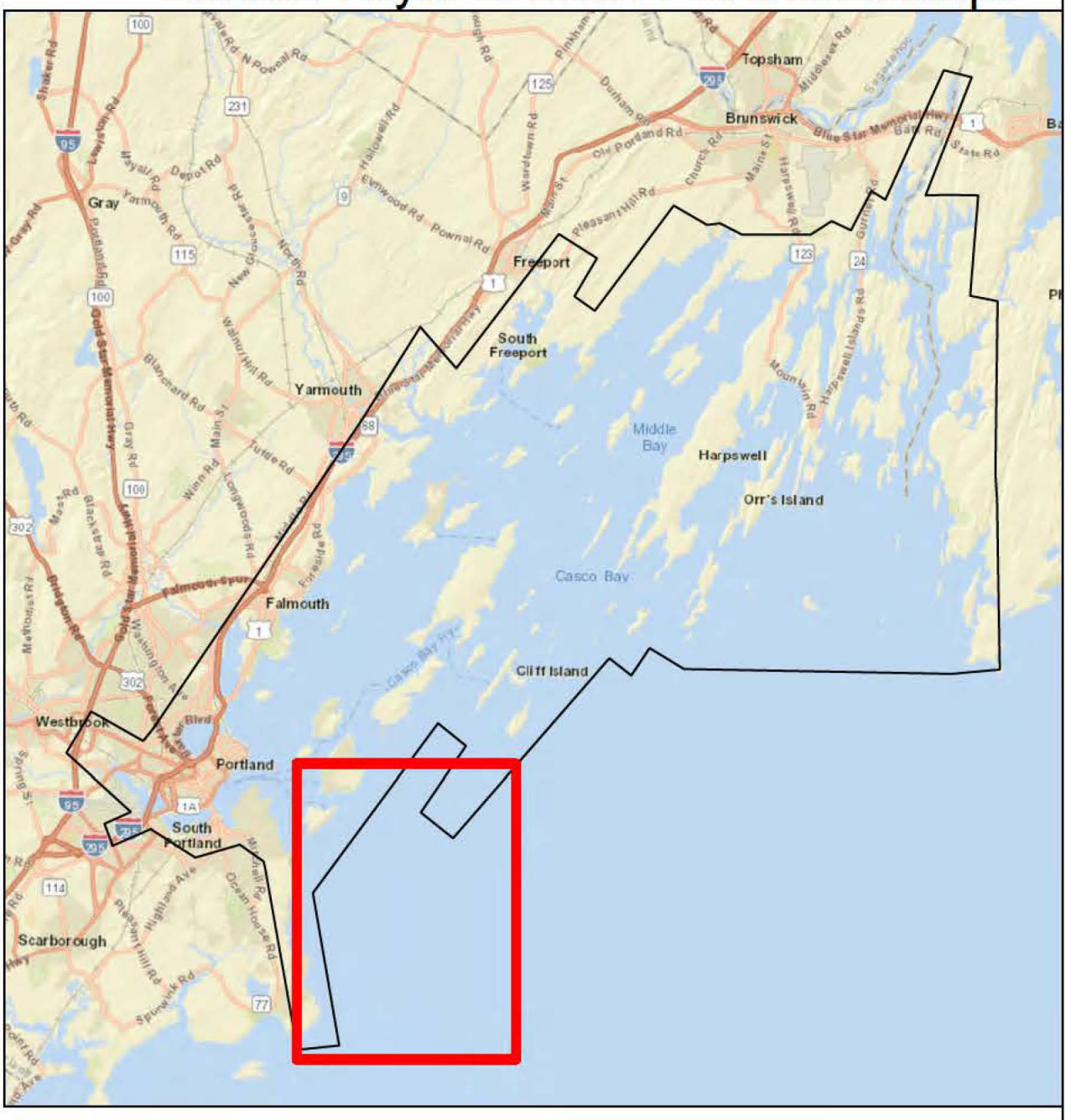
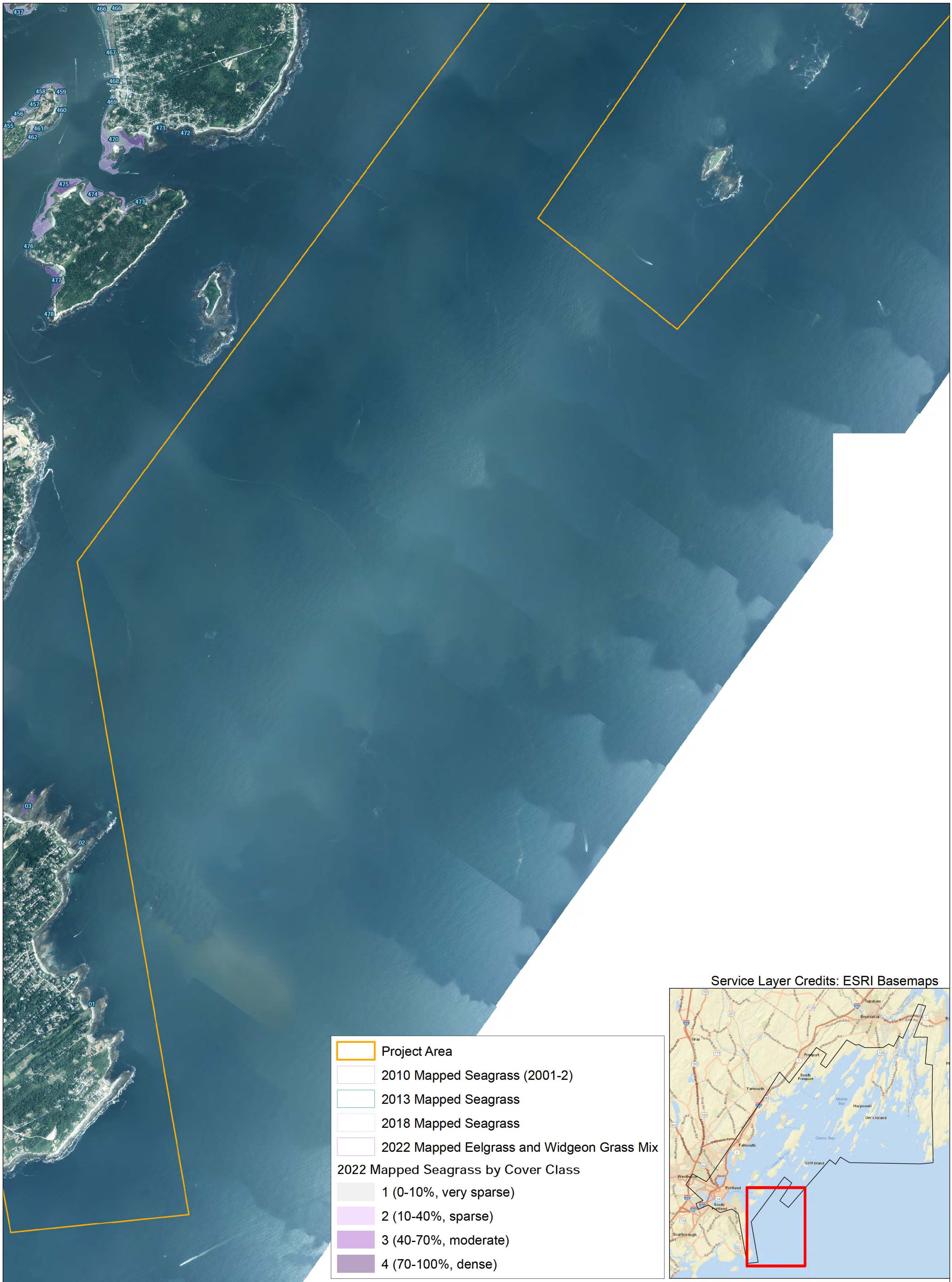
- C01- All dead
- C02- Nothing
- E24- Nothing to mostly dead to bed
- E22- Nothing to some dead plants around to dead or dying clusters
- N11- No bed, few plants or dead clusters around

## **Appendix B. Distribution Maps and Density of Seagrass**





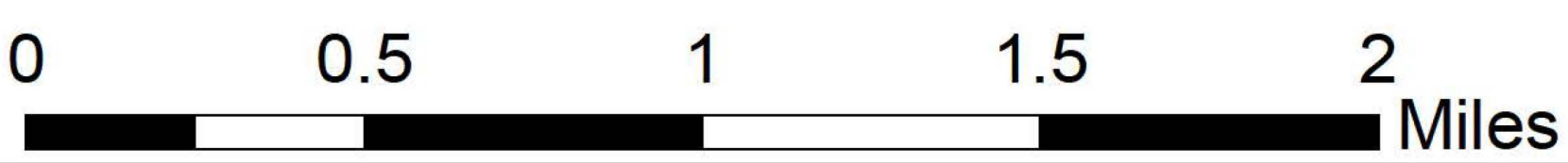




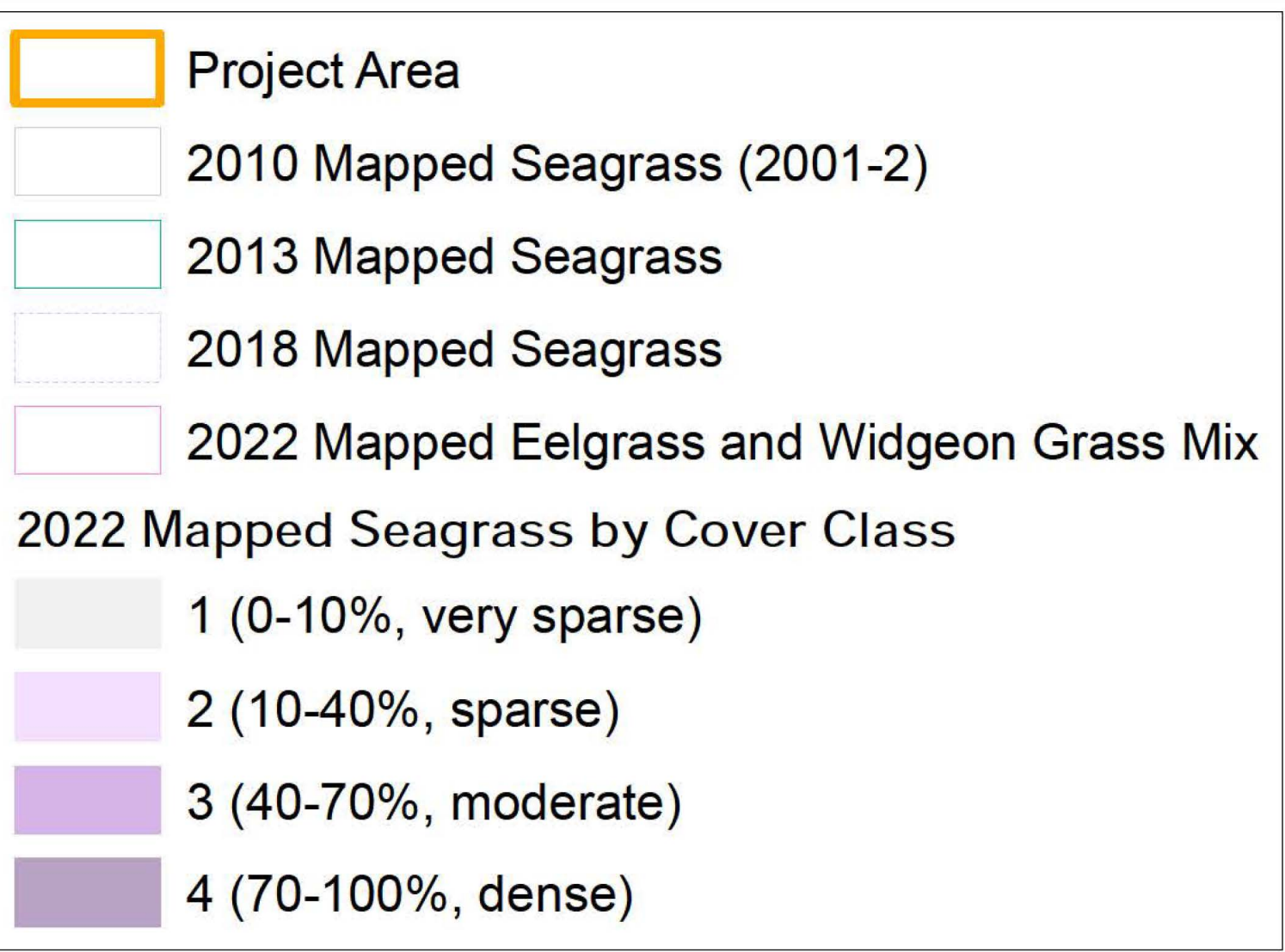
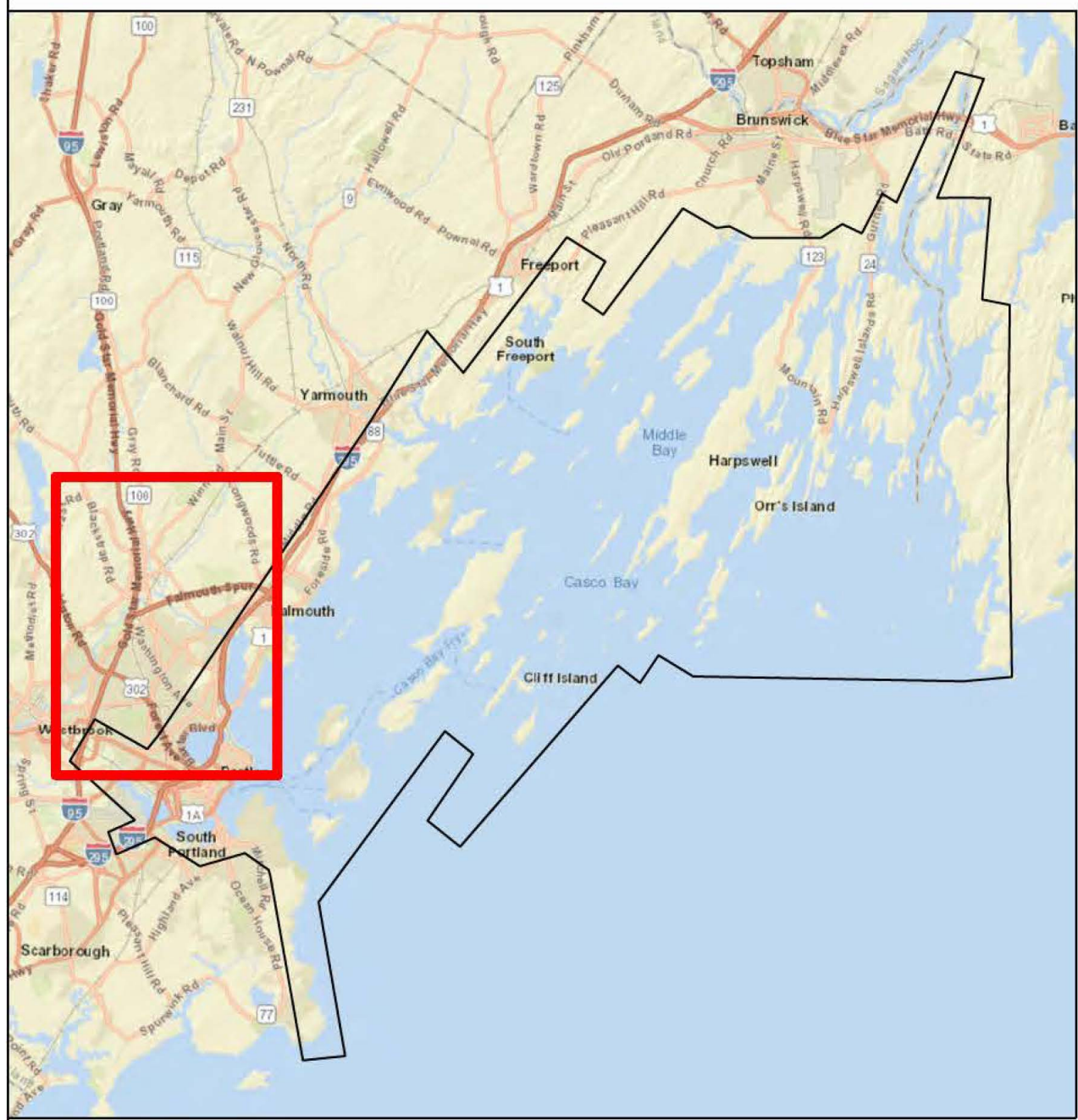
# CASCO BAY SEAGRASS MAPPING

## Cape Elizabeth to Phippsburg, ME

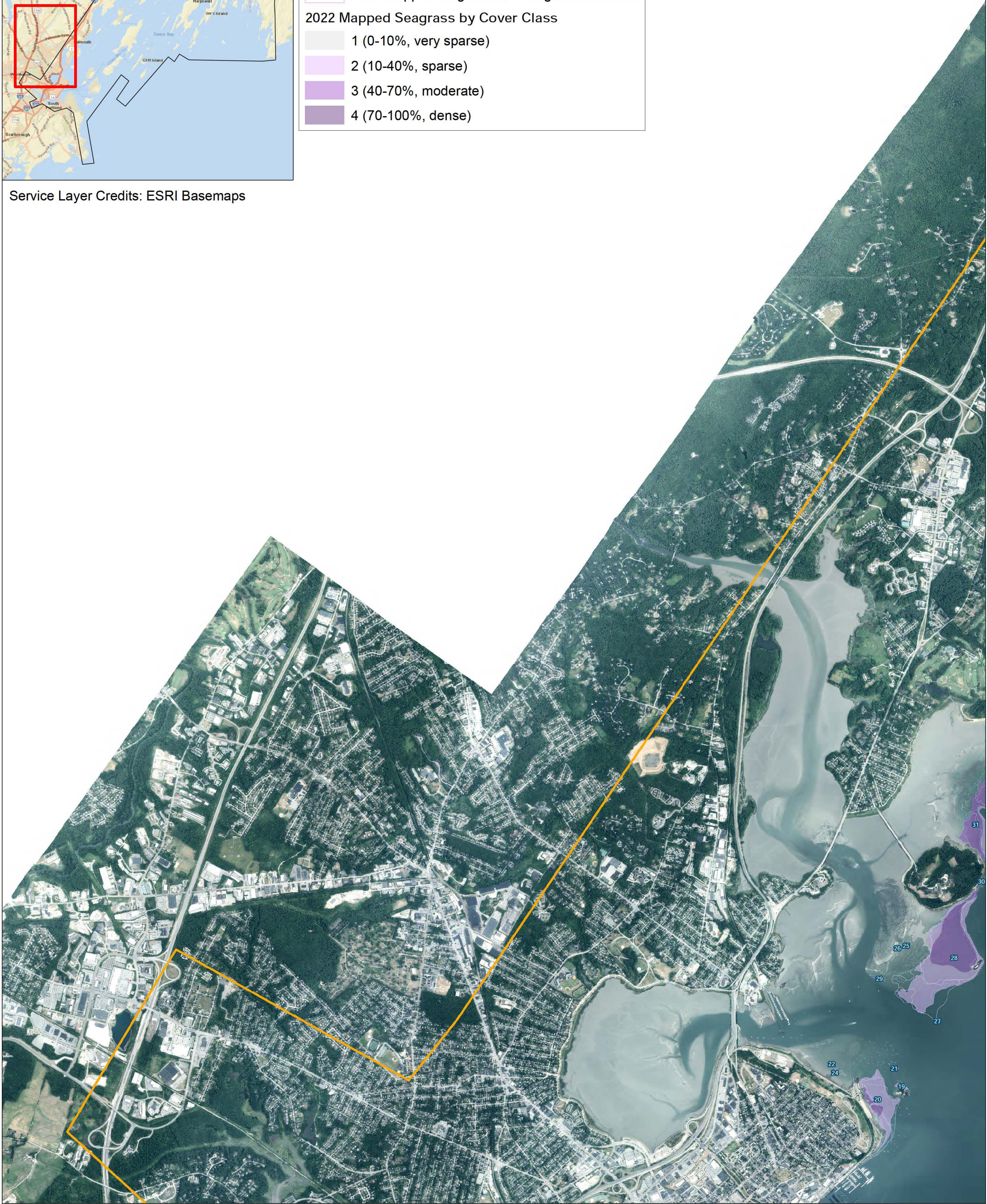
### Appendix B. Seagrass Distribution and Density







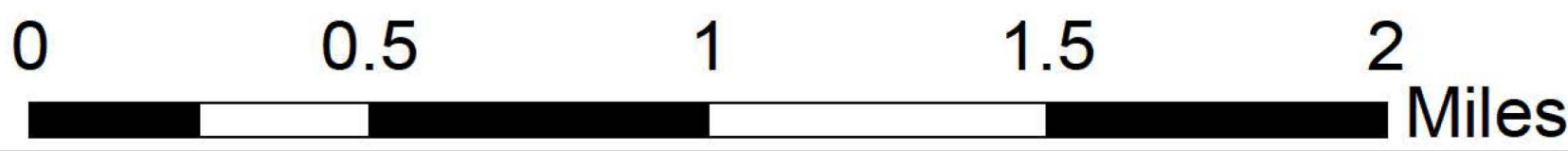
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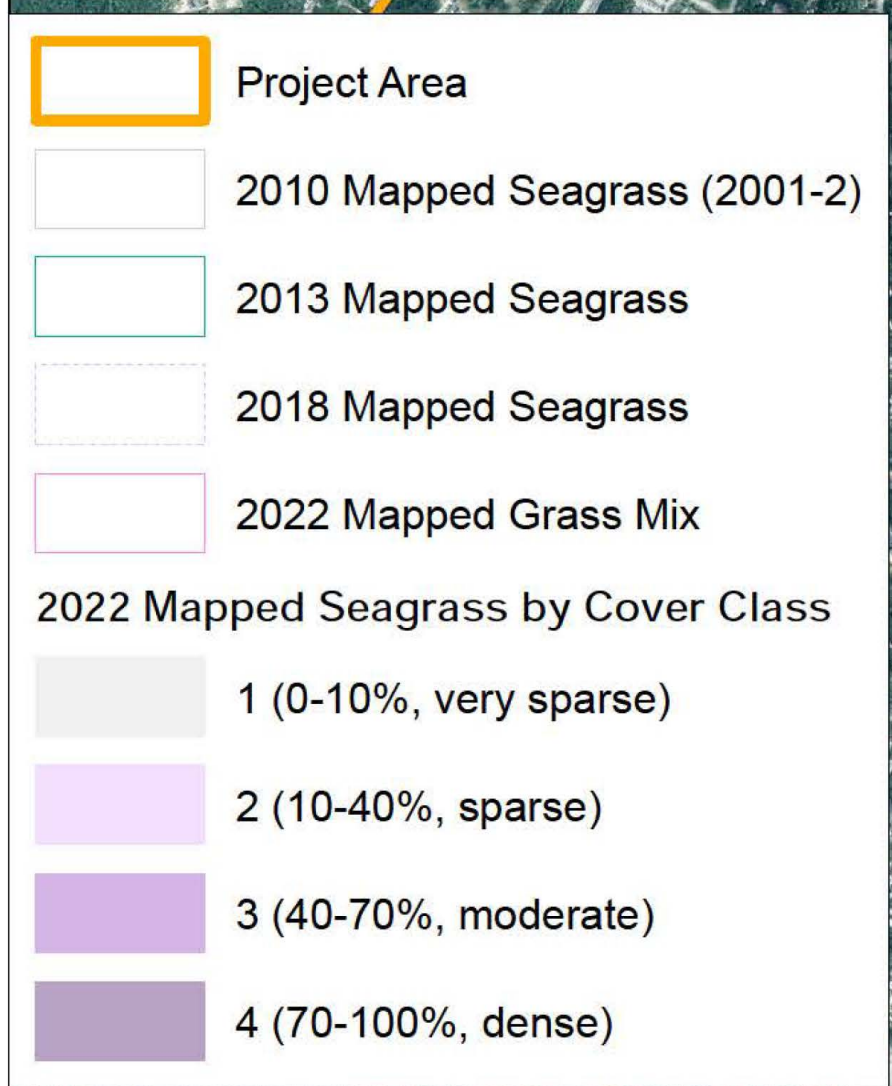
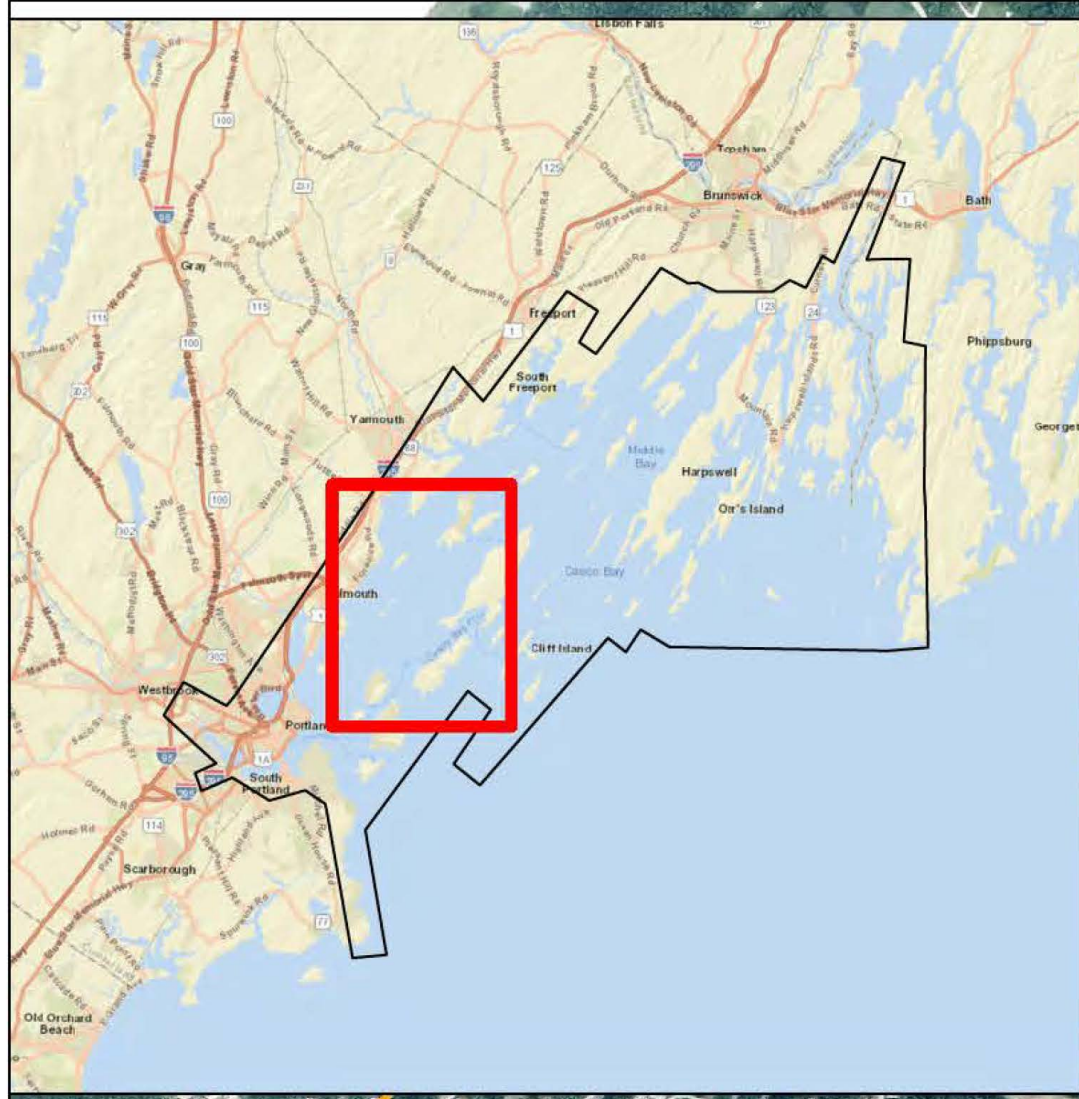
# CASCO BAY SEAGRASS MAPPING

## Cape Elizabeth to Phippsburg, ME

### Appendix B. Seagrass Distribution and Density





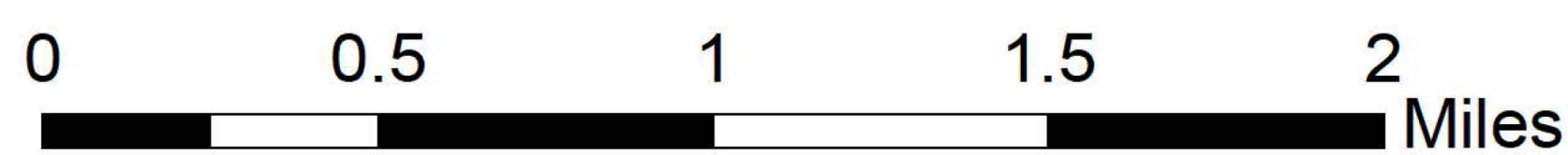


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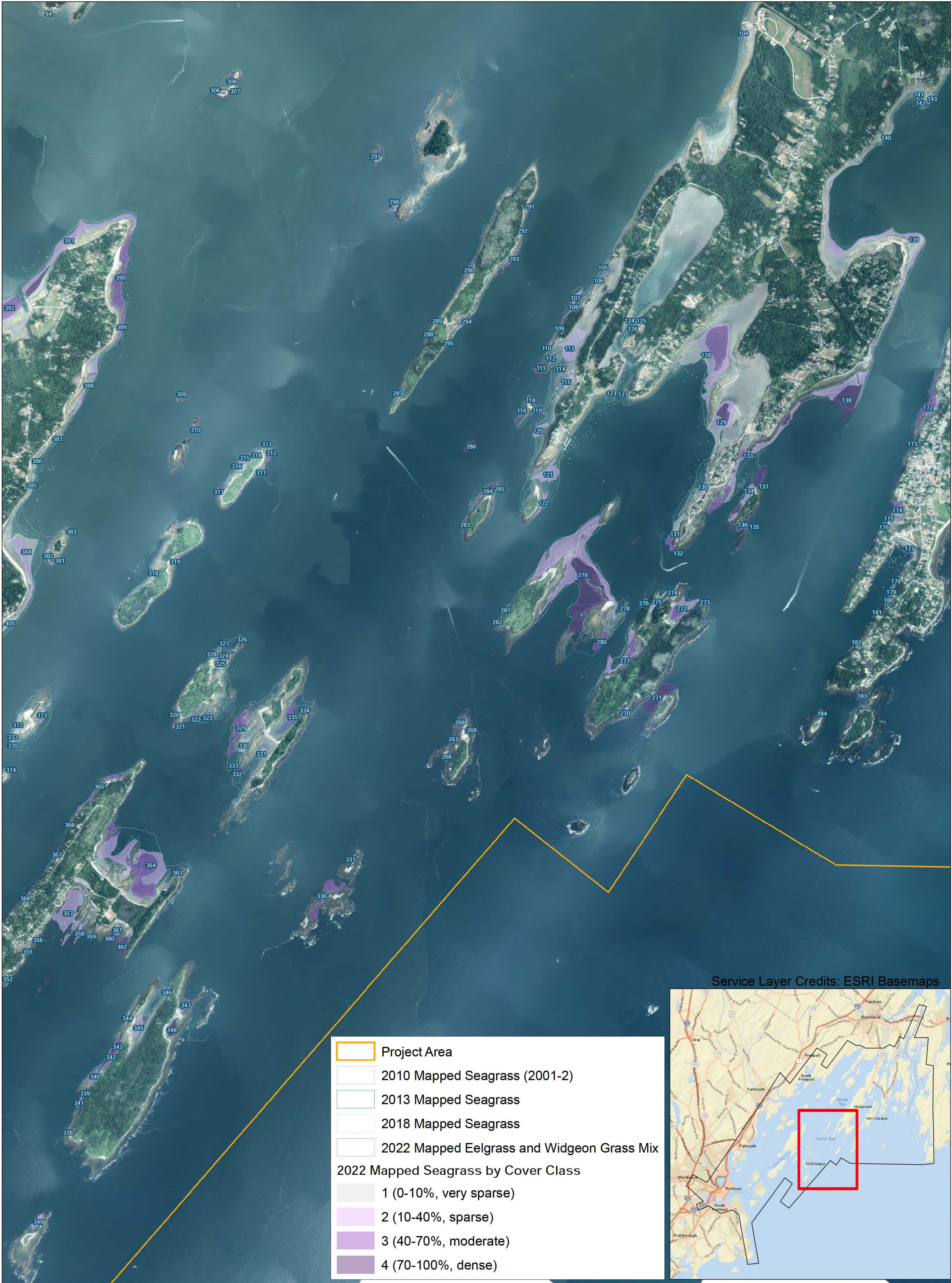


## CASCO BAY SEAGRASS MAPPING Cape Elizabeth to Phippsburg, ME

### Appendix B. Seagrass Distribution and Density







## CASCO BAY SEAGRASS MAPPING Cape Elizabeth to Phippsburg, ME

### Appendix B. Seagrass Distribution and Density

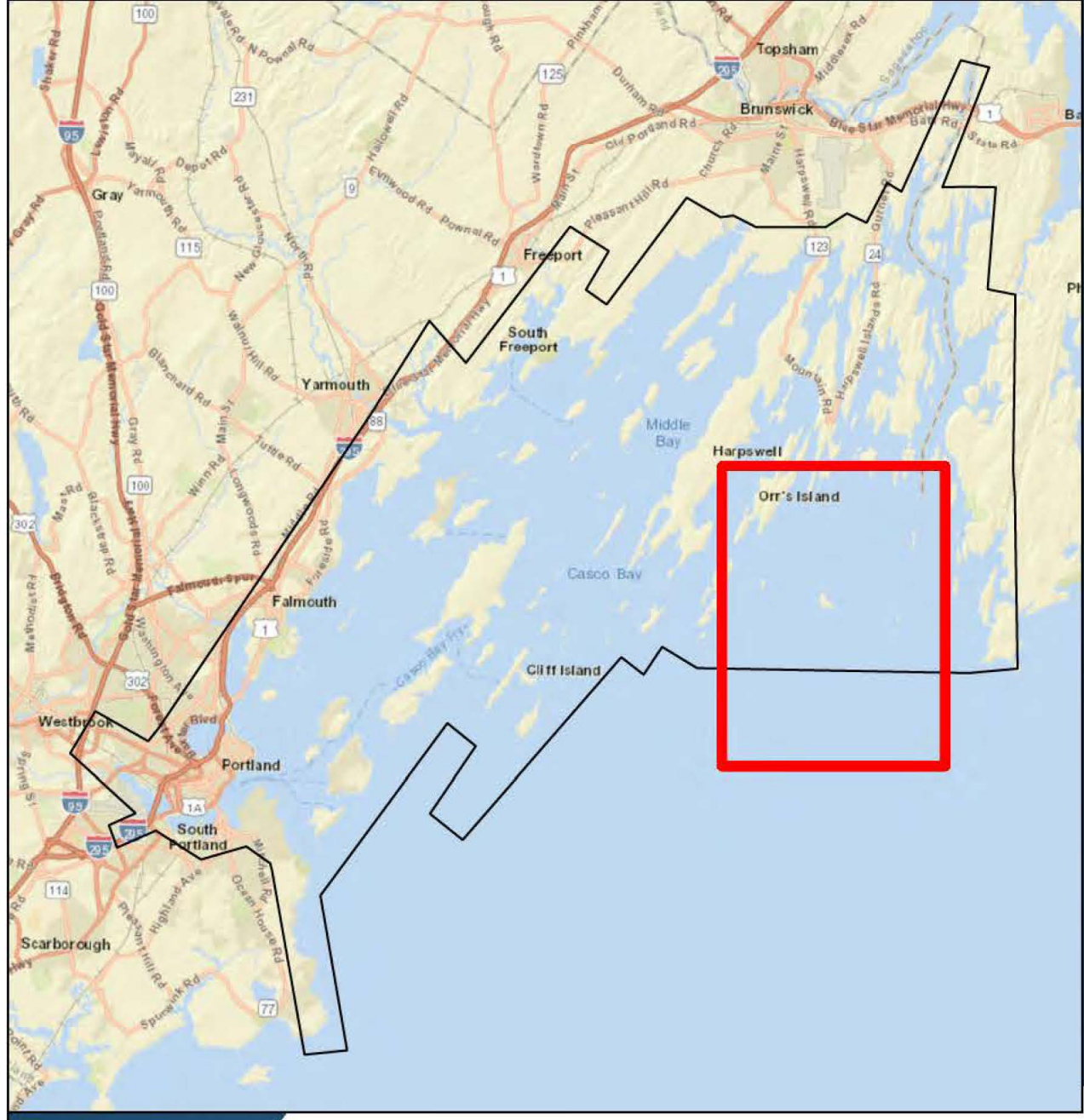
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Service Layer Credits: ESRI Basemaps



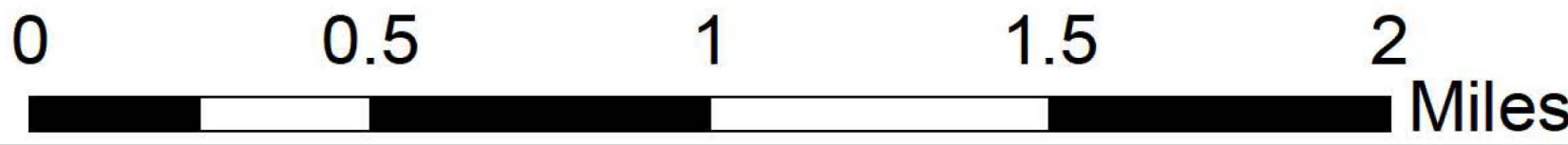
- Project Area
- 2010 Mapped Seagrass (2001-2)
- 2013 Mapped Seagrass
- 2018 Mapped Seagrass
- 2022 Mapped Eelgrass and Widgeon Grass Mix
- 2022 Mapped Seagrass by Cover Class
  - 1 (0-10%, very sparse)
  - 2 (10-40%, sparse)
  - 3 (40-70%, moderate)
  - 4 (70-100%, dense)



# CASCO BAY SEAGRASS MAPPING

## Cape Elizabeth to Phippsburg, ME

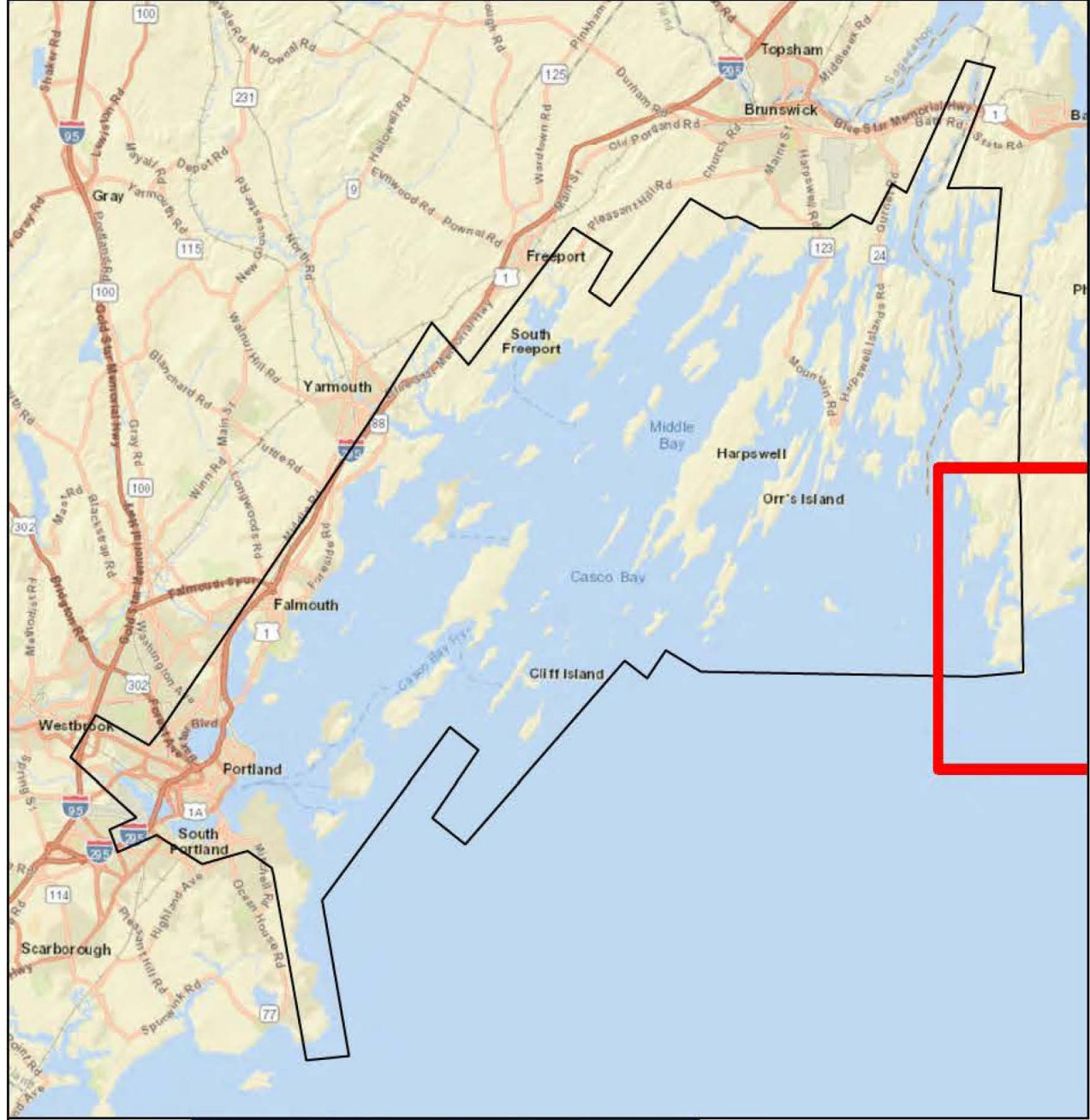
### Appendix B. Seagrass Distribution and Density







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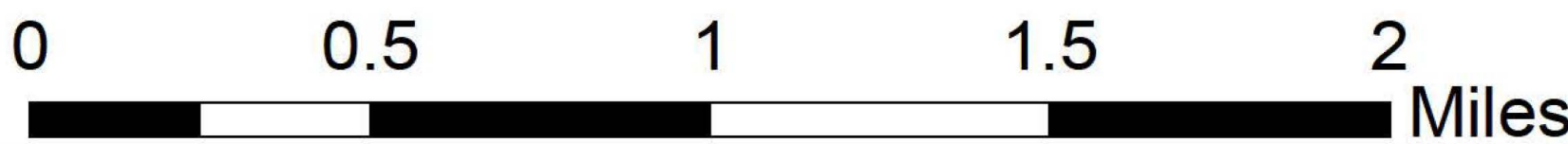


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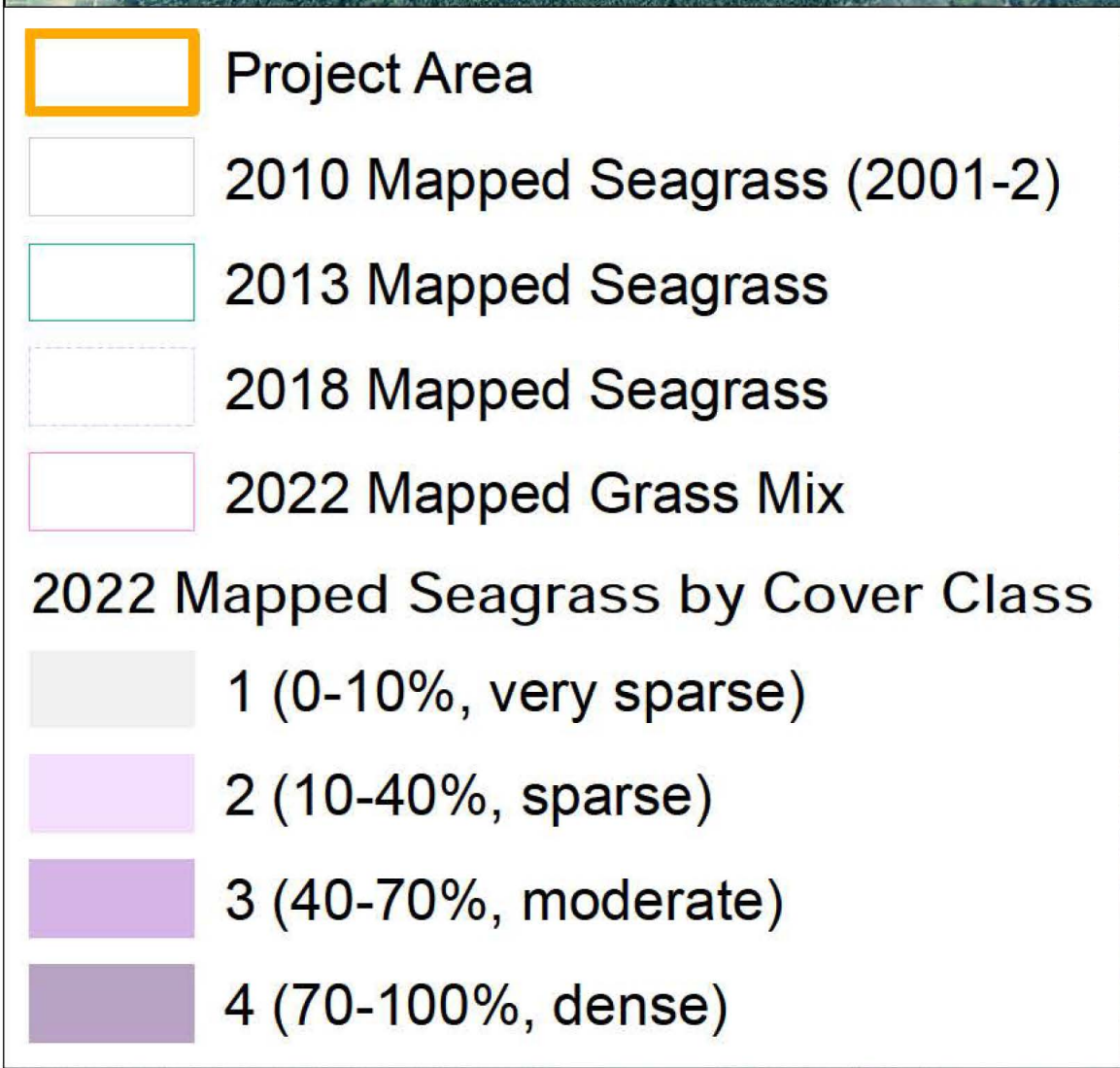
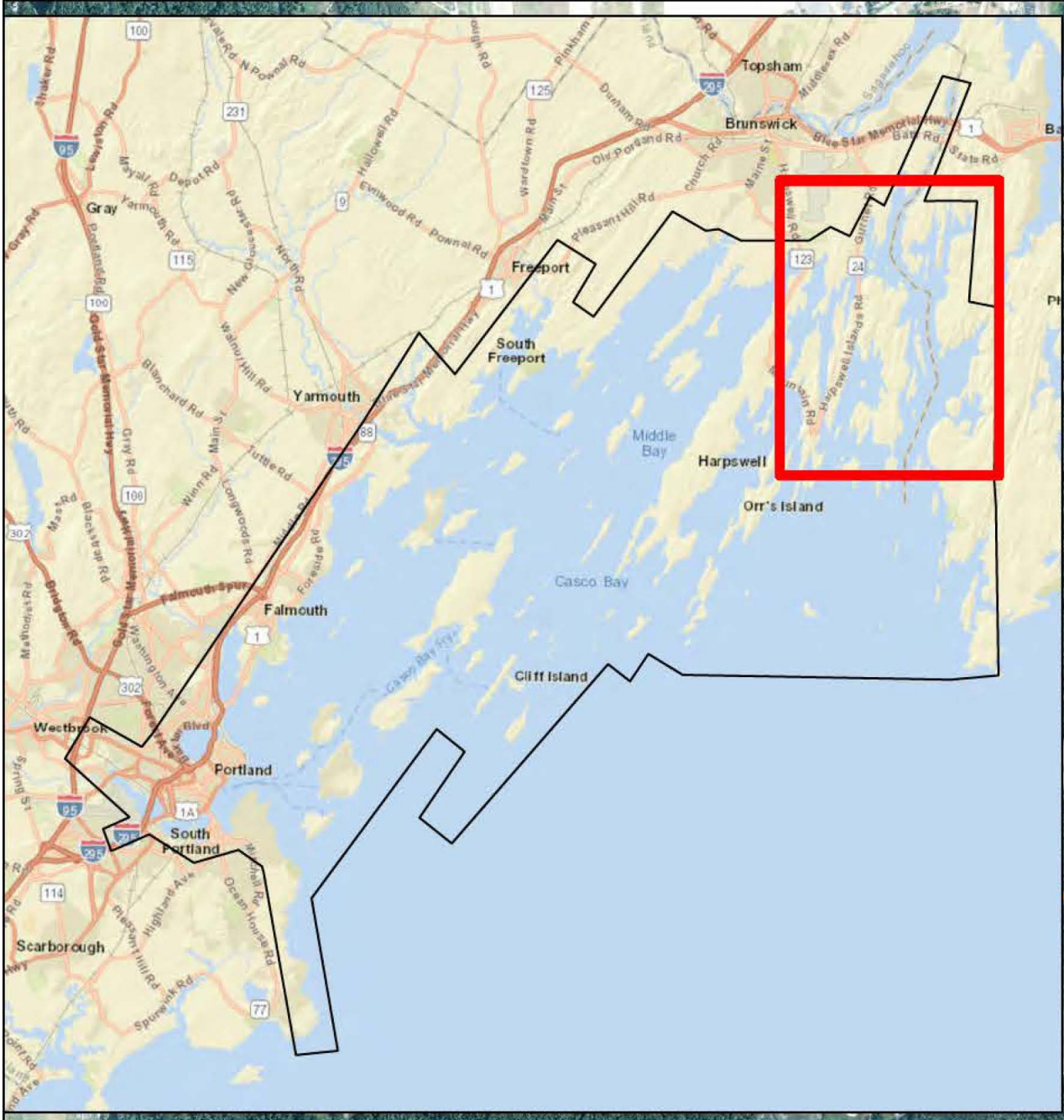


# CASCO BAY SEAGRASS MAPPING Cape Elizabeth to Phippsburg, ME

## Appendix B. Seagrass Distribution and Density

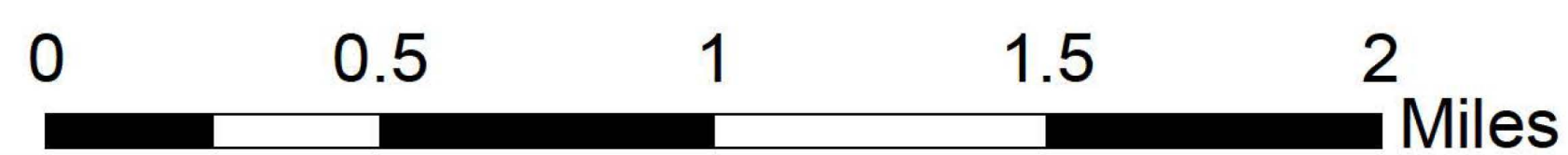




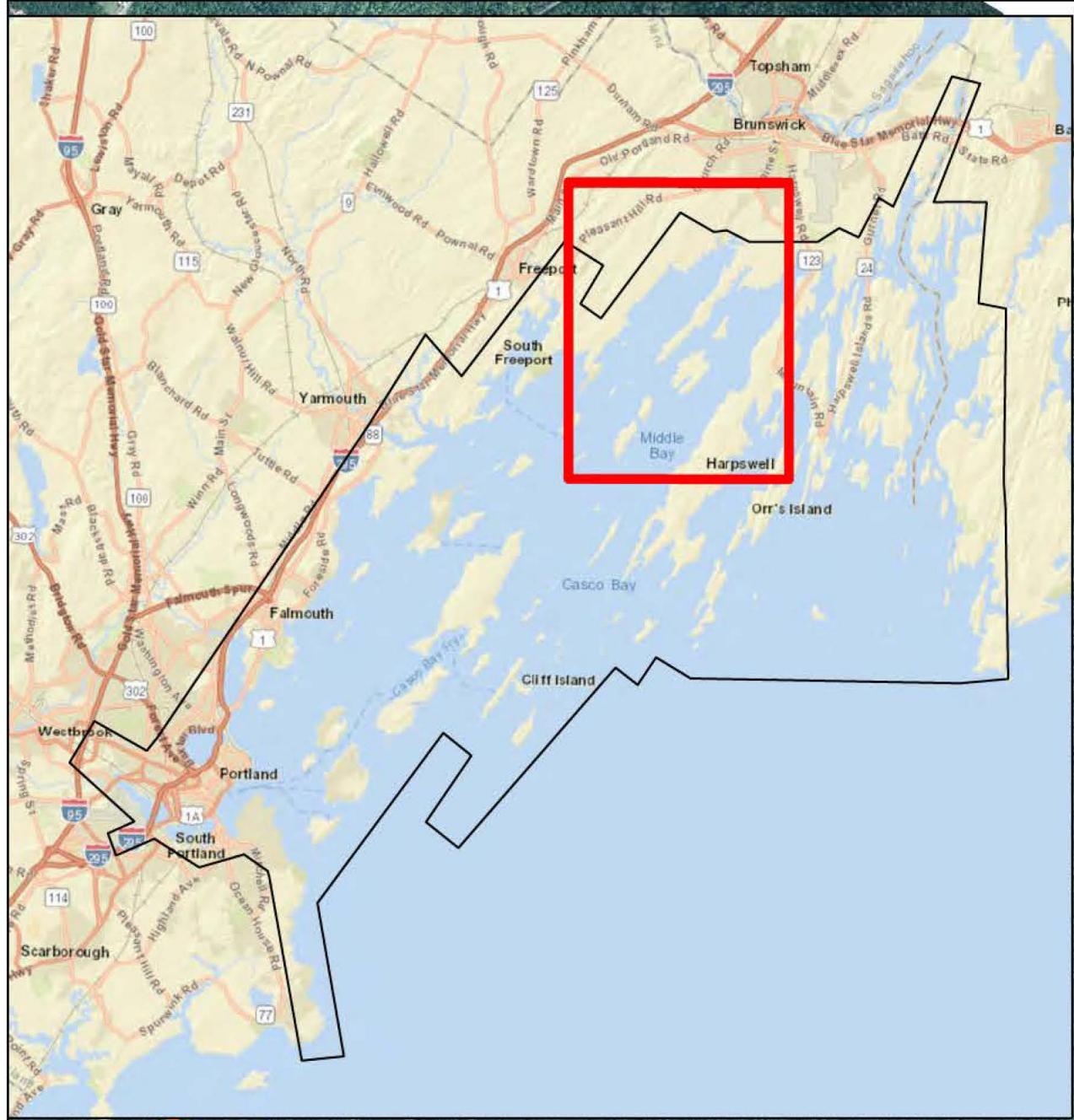


## CASCO BAY SEAGRASS MAPPING Cape Elizabeth to Phippsburg, ME

### Appendix B. Seagrass Distribution and Density







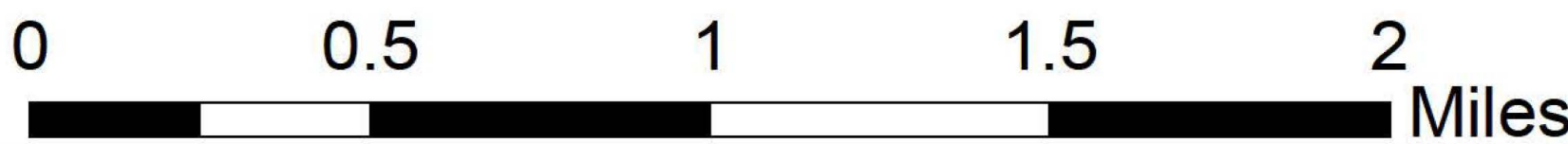
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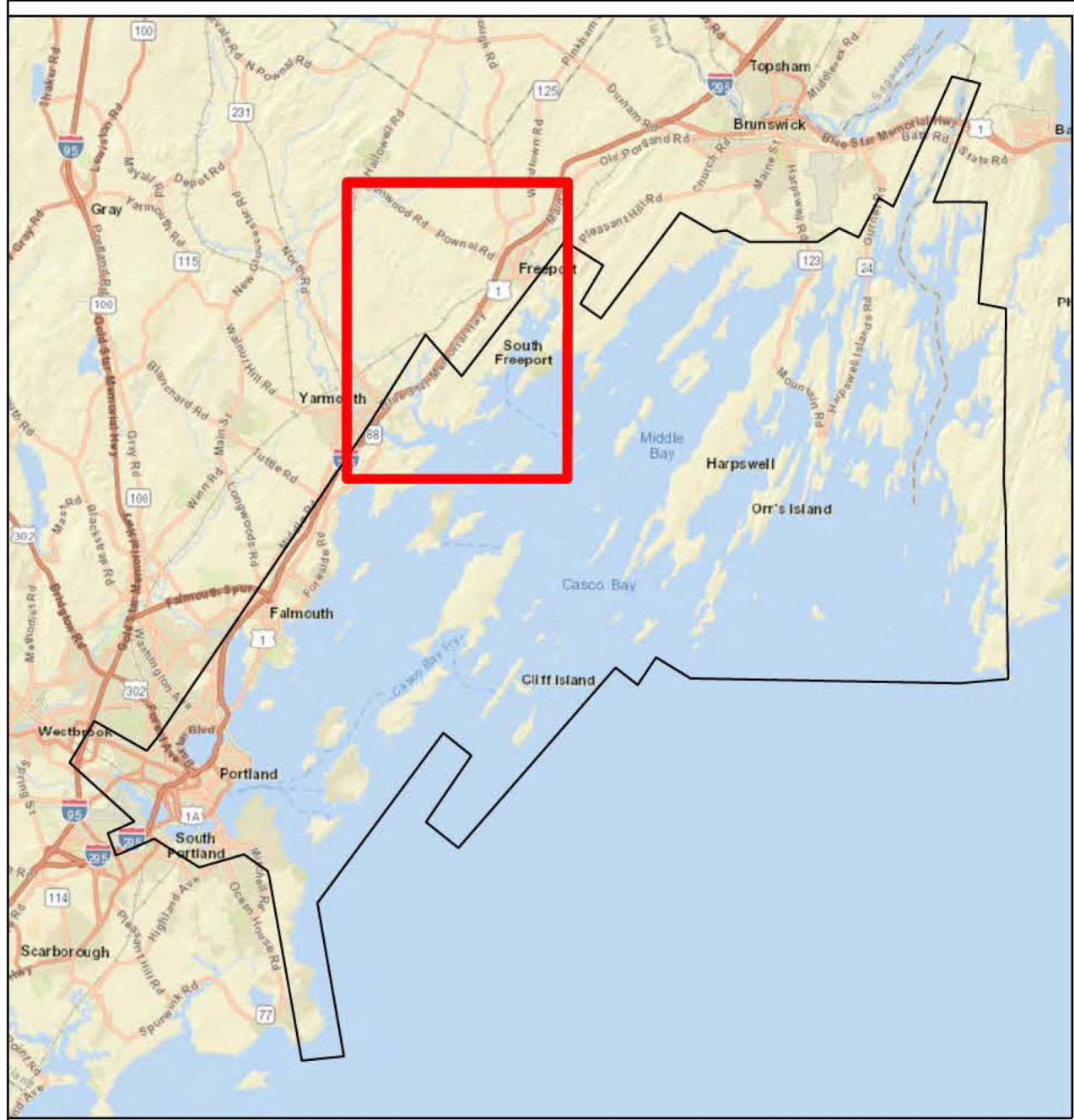
# CASCO BAY SEAGRASS MAPPING

## Cape Elizabeth to Phippsburg, ME

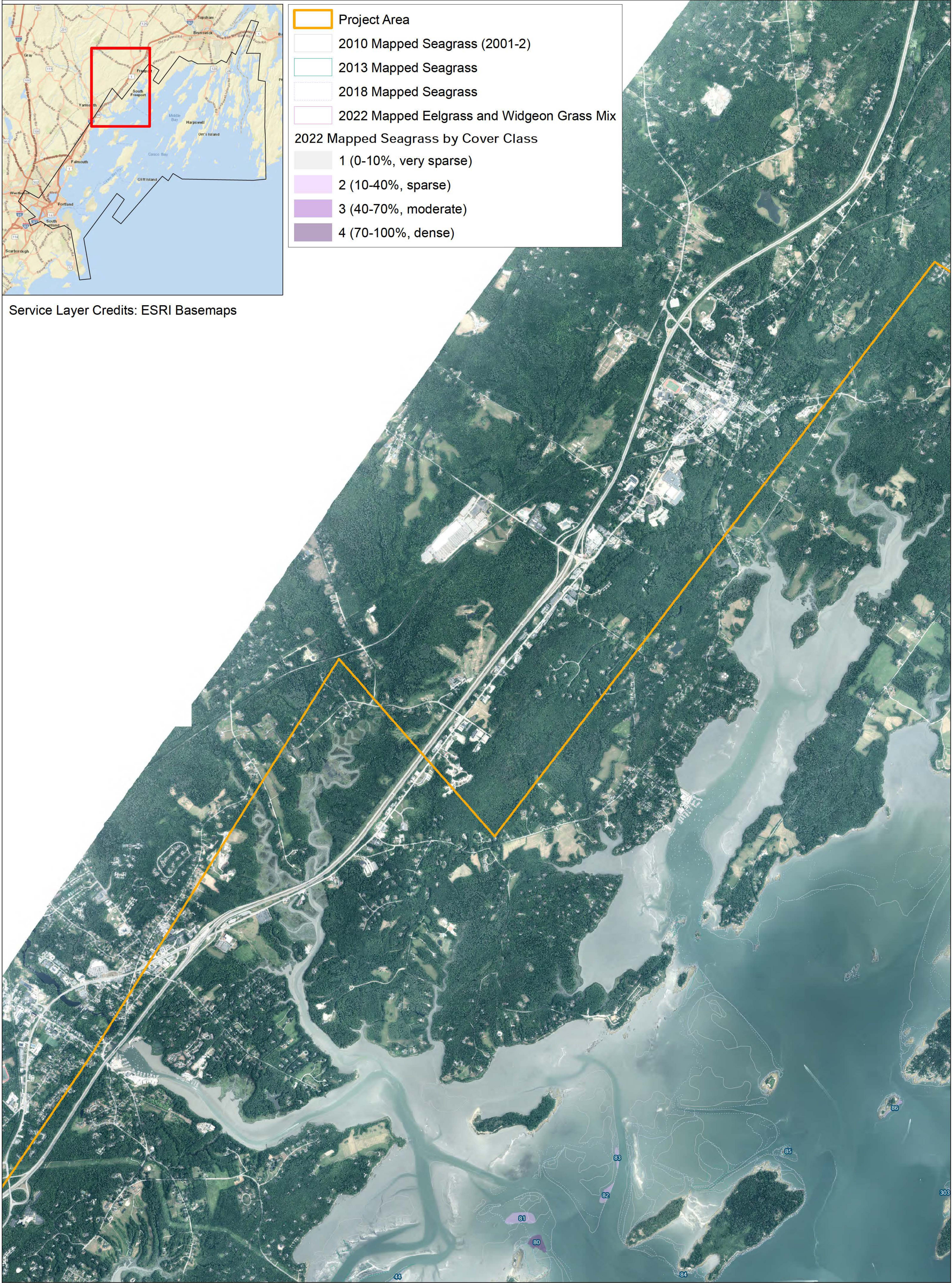
### Appendix B. Seagrass Distribution and Density







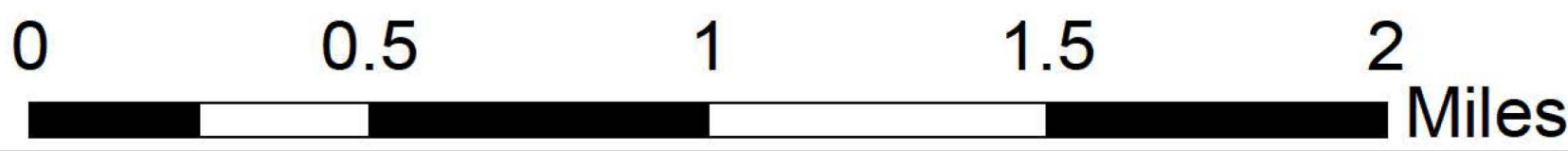
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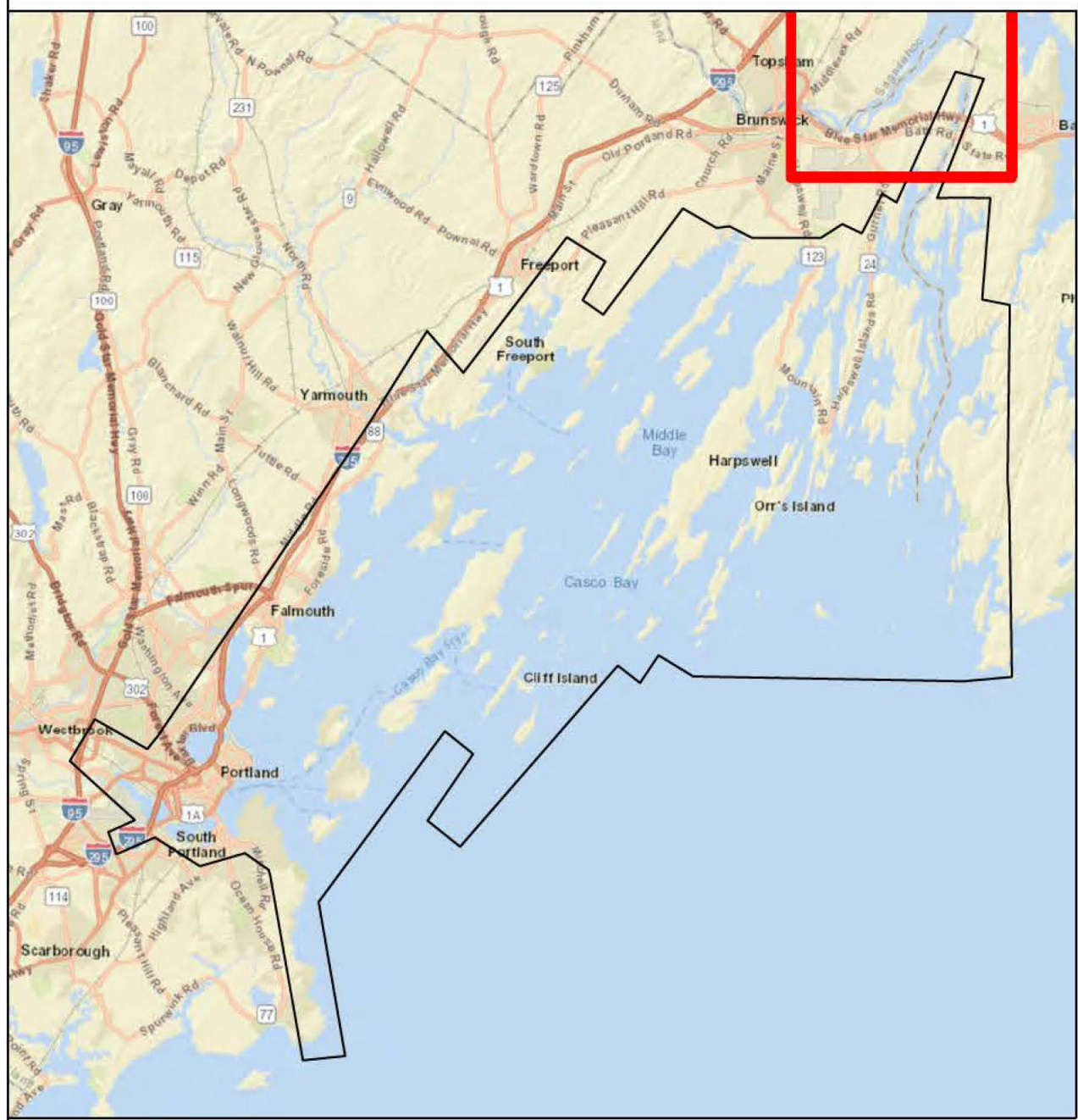
# CASCO BAY SEAGRASS MAPPING

## Cape Elizabeth to Phippsburg, ME

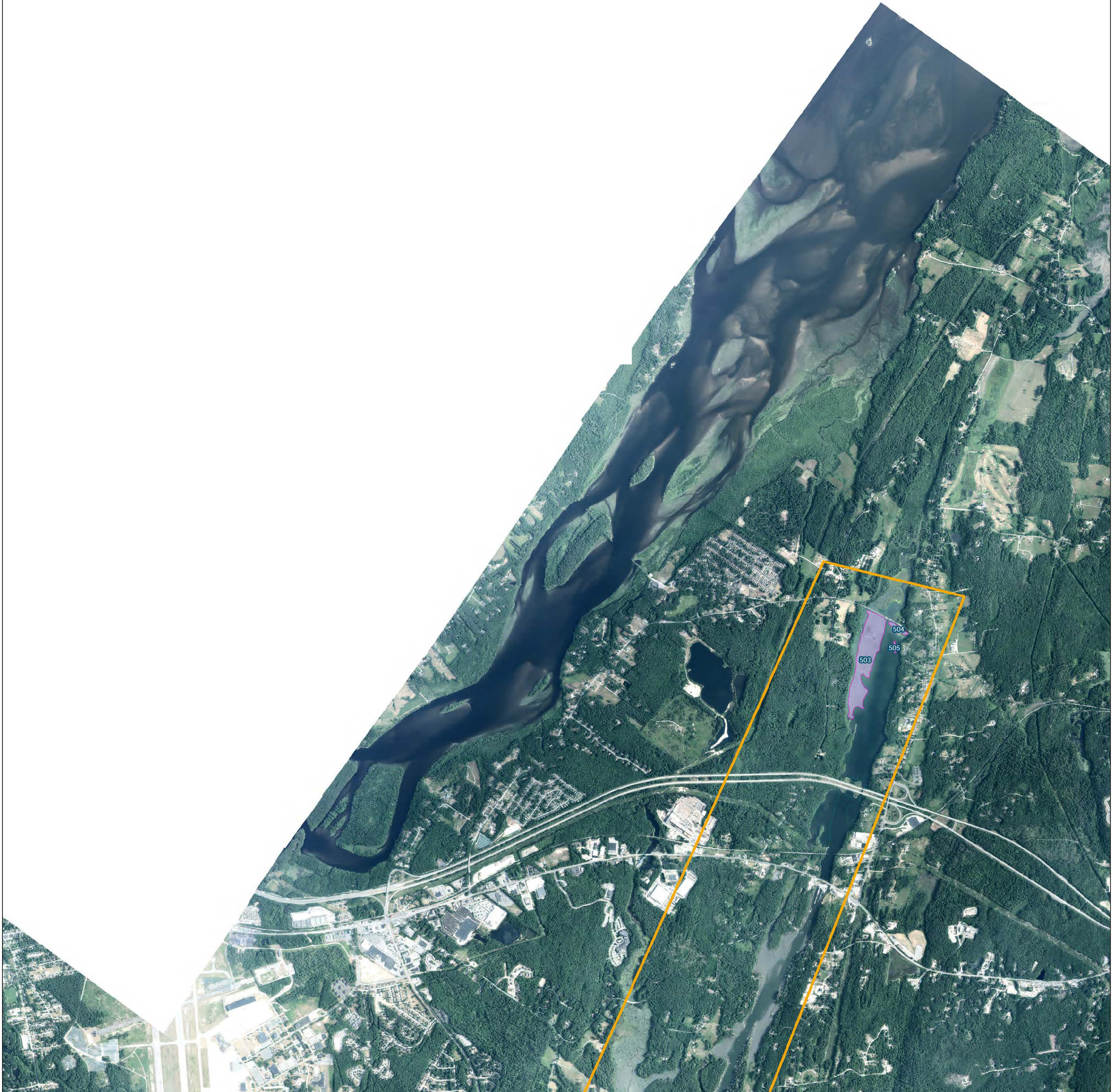
Appendix B. Seagrass Distribution and Density







Service Layer Credits: ESRI Basemaps



# CASCO BAY SEAGRASS MAPPING

## Cape Elizabeth to Phippsburg, ME

### Appendix B. Seagrass Distribution and Density

