Report to the Joint Standing Committee on Environment and Natural Resources

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Marine Vegetation Mapping Program Report

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Introduction

The Marine Vegetation Mapping Program (MVMP) was established by P.L. 2021, Ch. 424, an Act to Restore Eelgrass Mapping and Enhance Salt Marsh Vegetation Mapping in the State, by the 130th Legislature in 2021. The MVMP is now defined by 38 M.R.S. §1805, which mandates a 5-year rotation regional survey and biennial reports to the Joint Standing Committee on Environment and Natural Resources. The first report for the 2023 mapping survey of the Midcoast Region was submitted in 2024. This final report for the 2024 and 2025 mapping survey of the Penobscot Bay Region and the Acadia Region is organized into an Introduction, Executive Summary, and the following main sections:

1. Background
2. Aerial Photography Survey Coordination
3. Seagrass Delineation and Mapping
4. Tidal Marsh Delineation and Mapping

The full report is available on the Department of Environmental Protection (DEP) Marine Unit website at:

https://www.maine.gov/dep/water/monitoring/coastal/index.html

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Acronyms

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2DRMS	2x Distance Root Mean Square (95% precision)
BGR	Bangor International Airport
CDOM	Colored Dissolved Organic Matter
CIR	Color Infrared
DD	Decimal Degrees
DEM	Digital Elevation Model
DEP	Department of Environmental Protection
DMR	Department of Marine Resources
DOC	Department of Commerce
DQI	Data Quality Indicators
DQO	Data Quality Objectives
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSD	Ground Sample Distance
HICSL	Hurricane Island Center for Science and Leadership
IMU	Inertial Measurement Unit
LiDAR	Light Detection and Ranging
MEMP	Marine Environmental Monitoring Program
MLLW	Mean Lower Low Water
MMU	Minimum Mapping Unit
MNAP	Maine Natural Areas Program
M.R.S.	Maine Revised Statute
MVMP	Marine Vegetation Mapping Program
NAD	North Atlantic Datum
NAIP	National Agriculture Imagery Program
NCCA	National Coastal Condition Assessment
NIR	Near Infrared
NOAA	National Oceanic and Atmospheric Administration
PSU	Practical Salinity Units
QA/QC	Quality Assurance/Quality Control
RGB	Red, Green, Blue
SAV	Submerged Aquatic Vegetation
SOP	Standard Operating Procedure
TN	Total Nitrogen
TNC	The Nature Conservancy
UTM	Universal Transverse Mercator
WAAS	Wide Area Augmentation System

Executive Summary

Background

The Maine Department of Environmental Protection's (DEP) Marine Vegetation Mapping Program (MVMP) is responsible for implementing 38 M.R.S. §1805 to delineate eelgrass (*Zostera marina)* and salt marsh extent coastwide with a 5-year rotating regional survey (see Figure 1 for first 5-year rotation map). The MVMP is located in the Marine Unit within the Division of Environmental Assessment and Bureau of Water Quality.

Coastal vegetation provides critical habitat, nursery grounds, storm surge protection, carbon sequestration, and water quality benefits to the nearshore environment, and requires routine mapping to detect changes in extent and condition. The MVMP surveyed the Penobscot Bay Region (Port Clyde to Brooklin) in 2024 and the Acadia Region (Brooklin to Jonesport) in 2025 through the acquisition of high-resolution, low tide, four-band (true color Red, Green, Blue [RGB] and Near-Infrared [NIR]) aerial orthoimagery followed by targeted field-validation and photointerpretation of aerial signatures. The Department of Marine Resources (DMR) last surveyed these regions for eelgrass from 2003-2009. Existing state tidal marsh maps were not derived from tidally-coordinated imagery and are limited by landowner permission for field validation efforts. Although the statute only mandates the mapping of eelgrass and salt marsh distribution, an additional seagrass species (widgeon grass, *Ruppia maritima*) and tidal marsh habitat type (Freshwater Tidal Marsh) were included in the surveys to maintain consistency with previous methodology and existing databases.

Additional funding of $10,000 was obtained from The Nature Conservancy (TNC) to expand the Penobscot Bay Region survey area to include previously unmapped Matinicus Island and surrounding islands.
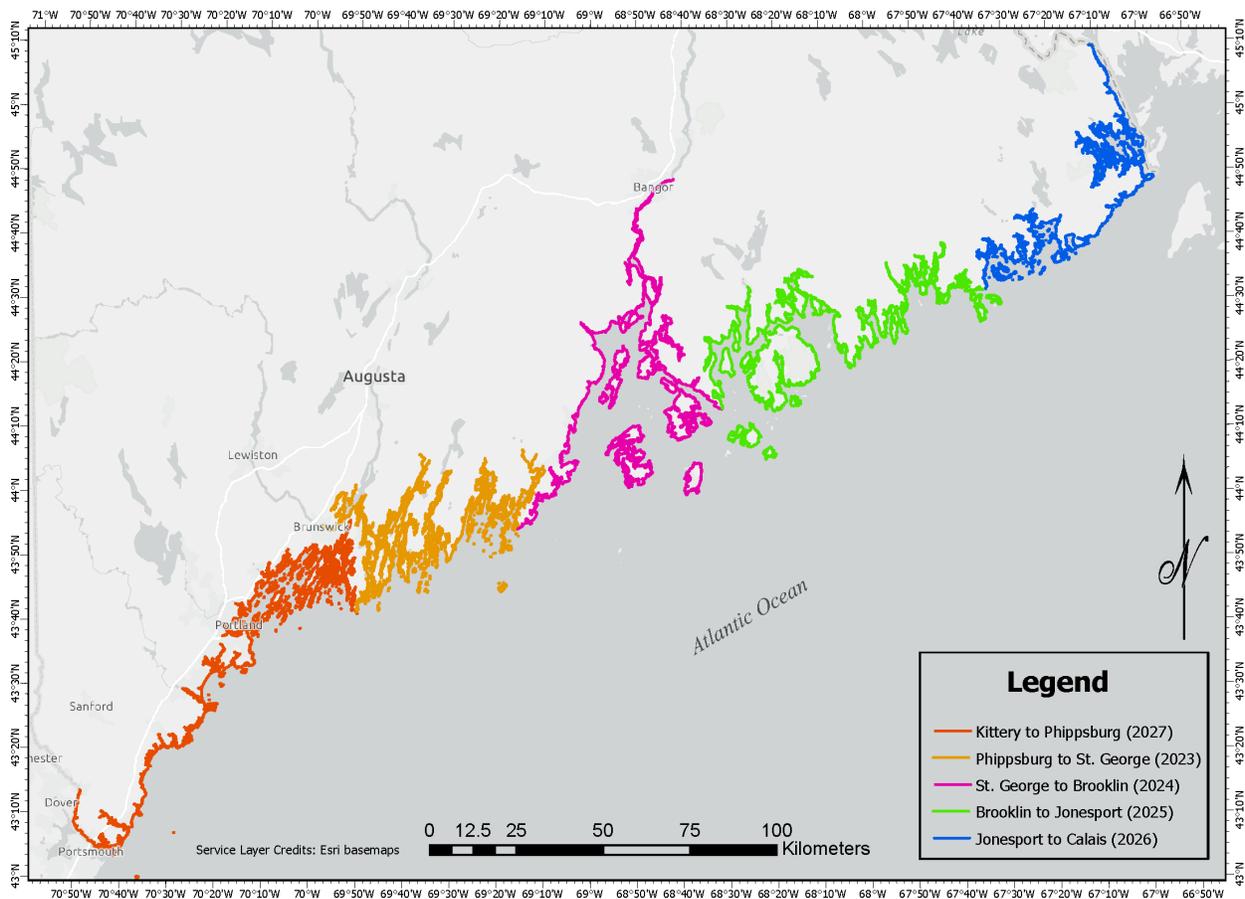
Figure 1. The first Marine Vegetation Mapping Program 5-year survey rotation schedule.

Aerial Photography Survey Coordination

Four-band (RGB and NIR), 6-inch resolution, low tide aerial orthoimagery with 1-foot accuracy was acquired by Bluesky Geospatial Ltd. under subcontract with James W. Sewall Co. during June through August of each year. Target flight conditions included survey within 2 hours of a spring low tide, a sun angle of 25-50 degrees above the horizon, less than 10% cloud cover, and less than 10 knots maximum predicted wind velocity. No precipitation within the preceding 48 hours and a Secchi disk depth ≥1.5 meters were also desirable, but a few minor exceptions were considered acceptable to ensure the acquisition of imagery for 100% of the survey areas. The 2024 project area was approximately 874,000 acres in size, and the aerial photography survey consisted of approximately 3,438 photos over 33 flight lines with 80% forelap and 30% sidelap acquired at an elevation of approximately 9,500 feet. The 2025 project area was slightly smaller at approximately 552,000 acres in size, and was surveyed with approximately 2,709 photos over 20 flight lines with the same photo overlap and elevation. The final imagery and associated metadata are available on the Maine GeoLibrary as imagery service layers.[1]

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[1] mainegeolibrary-maine.hub.arcgis.com/datasets/maine::maine-orthoimagery-coastal-acadia-2025 and mainegeolibrary-maine.hub.arcgis.com/datasets/maine::maine-orthoimagery-coastal-penobscot-bay-2024

Seagrass Delineation and Mapping

True color (RGB) aerial orthoimagery was photointerpreted to determine seagrass extent and assigned one of four percent cover classifications (0-10%, 10-40%, 40-70%, 70-100%) as per Orth et al. (1996). Since seagrass has many aerial signatures which vary depending on factors such as water depth, substrate type, bed density, and cohabitation with macroalgae, targeted field validation efforts are critical for accurate delineation and are based on an initial photointerpretation of draft imagery. Due to the limited window for field efforts between delivery of draft aerial orthoimagery and the expected time of seasonal senescence of seagrass beds, digitization of seagrass beds was completed with final aerial orthoimagery and following the collection of field observation waypoints and underwater video files. Field data collection began in July and was completed by the end of September each year. Staff spent 17 and 14 days on the water and completed 617 and 365 transects in 2024 and 2025, respectively. Between both years, slightly more than half of all mapped seagrass acreage was included in a bed that was visited in the field, and all but 3.7% of the unverified bed acreage has been mapped previously in the same or nearly the same location.

Across both years and survey regions, a **47.3% decline** in seagrass acreage relative to the most recent surveys in the 2000s was documented, and the distribution of loss is consistent between both regions. The beds that were lost or shrank were mostly located in the upper reaches of estuaries or other embayments, at more protected sites, or on tidal flats while areas with expanding seagrass beds or smaller declines were generally located along island shorelines or other relatively exposed areas with more oceanic influence. A small area around Naskeag Point, Brooklin, was mapped in both survey years to assess interannual variation and a 49.4% increase was documented between 2024 and 2025.

Key findings from the 2024 Penobscot Bay Region seagrass survey include:

- Approximately 2,446.0 acres of seagrass were mapped in 2024, which represents a **34.5% decline** since the Penobscot Bay Region was last surveyed in 2003-2008. Of that total seagrass acreage, approximately 22.9 acres of widgeon grass beds were observed in the tidally-restricted section of the Bagaduce River and a salt pond in North Haven.

- Although not included in historical DMR surveys, the Penobscot Bay project area was extended to include Matinicus Island and nearby islands in 2024 resulting in the novel delineation of 14.4 acres of seagrass beds.

- The seagrass resource in the Penobscot Bay Region was defined by growth in close proximity to, or intermixed with, macroalgae in clear and sometimes relatively deep (up to ~8 meters MLLW) water. Although the majority of mapped seagrass polygons are under 1 acre in size, several large (>25 acres) and a few extensive (>100 acres) beds were mapped.

- The largest documented seagrass beds in Penobscot Bay were located near Sprucehead Island in South Thomaston (two beds totaling 512.8 acres, not including smaller beds in the general vicinity), in the tidally restricted section of the Bagaduce River (two beds totaling 188.3 acres, not including smaller beds in the river section), along the Tenants Harbor shoreline

(60.1 acres), in Carvers Pond on Vinalhaven (55.3 acres), and along the Mosquito Island shoreline in Port Clyde (52.9 acres).

- Areas with the most considerable losses in Penobscot Bay include the Eggemoggin Reach and the southwestern Deer Isle/Little Deer Isle shoreline (685.7 acres in 2008 and 110.5 acres in 2024), the tidally restricted section of the Bagaduce River (448.8 acres in 2008 and 288.6 acres in 2024), Herrick Bay (190.1 acres in 2008 and 36.7 acres in 2024), the Stonington Islands (171.0 acres in 2008 and 78.1 acres in 2024), and the Islesboro Island shoreline (81.1 acres in 2003 and 5.0 acres in 2024).

- In the Penobscot Bay Region, areas with more seagrass losses (primarily in the more protected, upriver, warmer portions of the bay) were also the areas with the highest observed percentage of seagrass beds that were heavily fouled. Epiphytic filamentous macroalgae, in particular, may thrive in warming waters with excellent light penetration through the water column. However, whether epibiotic growth or warming waters may have been related to any recent seagrass losses or growth limitations cannot be clearly established since Penobscot Bay had not been mapped since the 2000s, and changes in seagrass distribution could have occurred at any time since the prior survey.

- In general, Penobscot Bay still hosts many dense, thriving seagrass beds despite recent losses closer to the head of the Penobscot River and protected reaches of embayments. Some areas, such as Isle Au Haut, have seen an increase in seagrass coverage and new seagrass resource was documented most notably in a 51.8-acre expansion of the eelgrass bed along the Mosquito Island shoreline in Port Clyde, relative to the most recent survey.

Key findings from the 2025 Acadia Region seagrass survey include:

- Approximately 2,338.7 acres of seagrass were mapped in 2025, which represents a **56.3% decline** since the Acadia Region was last surveyed in 2008-2009. Of that total seagrass acreage, approximately 3.48 acres of widgeon grass beds were observed in the tidally restricted Blue Hill Salt Pond.

- The seagrass resource in the Acadia Region was defined by growth in close proximity to, or intermixed with, macroalgae in clear and sometimes relatively deep (up to ~8 meters MLLW) water. Although the majority of mapped seagrass polygons are under 1 acre in size, several large (>25 acres) beds were mapped.

- The largest documented seagrass beds in the Acadia Region were located between the Cranberry Isles and Islesford (86.9 acres), off Tom Leighton Point (83.1 acres) and along the western shoreline of Bois Bupert Island in Milbridge (80.1 acres), between Fickett Point in Milbridge and Foster Island in Harrington (63.5 acres), and along the eastern shoreline of Petit Manan Point (54.2 acres).

- Areas with the most considerable losses in the Acadia Region include Taunton Bay (637.9 acres in 2008 and 75.3 acres in 2025), Pleasant Bay (1,221.3 acres in 2009 and 273.0 acres in 2025), Frenchman Bay (438.3 acres in 2008 and 106.6 acres in 2025), a portion of

Eggemoggin Reach (111.3 acres in 2003 and 36.4 acres in 2025), and Gouldsboro-Dyer Bays (1,328.1 acres in 2009 and 628.3 acres in 2025).

- In the Acadia Region, areas with more seagrass losses were primarily in the more protected, warmer, upper portions of bays and on intertidal flats. Most observed beds appeared healthy and relatively free of epibiotic growth. Seagrass distribution aligned with recorded light levels, where no seagrass was observed upstream of light levels likely to impede eelgrass growth or survival. However, any establishment of direct causes of recent seagrass losses or growth limitations cannot be clearly established since the region had not been mapped since the 2000s, and changes in seagrass distribution could have occurred at any time since the prior survey.

- In general, the Acadia Region still hosts many dense, thriving seagrass beds but has experienced major losses in protected reaches of embayments and tidal flats. Some areas, such as around Swans Island and Cranberry Isles, have seen an increase in seagrass coverage and new seagrass resource was documented most notably in a 53.3-acre expansion of the eelgrass beds between the Cranberry Isles and Islesford and a new 63.5-acre bed between Fickett Point in Milbridge and Foster Island in Harrington, relative to the most recent survey.

The final GIS maps of seagrass beds (polygon shapefiles) and associated metadata are available on the Maine GeoLibrary as service layers.[2]

Tidal Marsh Delineation and Mapping

True color (RGB) and color infrared (CIR) aerial orthoimagery was photointerpreted to refine polygon boundaries and improve acreage accuracy within the Penobscot Bay and Acadia Regions of the existing coastwide tidal marsh GIS map. The Maine Natural Areas Program[3] (MNAP) manages and hosts the polygon shapefile on the Maine GeoLibrary, housed within the Marsh Migration feature service, and has incorporated the 2024 and 2025 updates. Sites that were visited in the field were further refined based on waypoints and track logs. Tidal marsh natural community types (Salt-hay Salt Marsh, Mixed Graminoid-Forb Salt Marsh, Brackish Tidal Marsh, and Freshwater Tidal Marsh) were previously assigned to each site by MNAP according to Gawler and Cutko (2010) and were unchanged during the photointerpretation process. Tidal marsh sites larger than 2.5 acres are considered Element Occurrences by MNAP and are tracked in their georeferenced database, Biotics. Biotics is the official state record of tidal marsh sites, as well as other rare and exemplary natural communities and rare plant populations, and is utilized to inform conservation, development, and management planning. The season for tidal marsh field verification is approximately July through November, when there is sufficient aboveground biomass for the majority of characteristic plant species. Fieldwork occurred on October 24, 2024, and Jul 28, 2025. Five *de novo* sites that were not previously

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[2] mainegeolibrary-maine.hub.arcgis.com/datasets/maine::mainedep-penobscot-bay-seagrass-2024 and mainegeolibrary-maine.hub.arcgis.com/datasets/maine::mainedep-acadia-seagrass-2025

[3] The Maine Natural Areas Program (part of the Department of Agriculture, Conservation and Forestry) facilitates conservation of Maine's biodiversity by providing comprehensive information and scientific expertise on at-risk species, natural ecosystems, wildlife habitats, ecological reserves, and invasive plants to landowners, developers, resource managers, towns, and other conservation partners (https://www.maine.gov/dacf/mnap/).

included in the Biotics database due to lack of field verification, or sites that required an update, were selected by MNAP staff for field verification in 2024 and 2025 based on landowner permission and property boundaries. Only sites where landowners provide permission for a field survey were visited.

Key findings from the 2024 Penobscot Bay Region tidal marsh survey included:

- The Penobscot Bay Region hosted a relatively small amount of tidal marshes compared to other MVMP regions, comprising only 964.7 acres out of 22,186.8 coastwide acres.

- Two of three sites that were field-visited were found to be tidal marsh communities and were added to Biotics either as updates or new Element Occurrences. One site was found to be a degraded tidal marsh community that was no longer Element Occurrence quality and was added to Biotics as negative surveys to avoid duplicate effort in the future.

- Both sites that were added to or updated in Biotics were Salt-hay Salt Marshes (Crockett Cove and The Basin South).

- Approximately 21.9 acres of tidal marshes were added, updated, or otherwise improved in the Biotics database. Additionally, the most recent version of the existing coastwide tidal marsh shapefile was refined by approximately 11.6 acres within the Penobscot Bay Region, primarily through more accurate delineation of the seaward edge of marshes.

Key findings from the 2025 Acadia Region tidal marsh survey included:

- The Acadia Region hosted a relatively small amount of tidal marshes compared to other MVMP regions, comprising only 2,697.2 acres out of 22,186.8 coastwide acres.

- Both field-visited sites (Clark Cove and West Bay Marsh) were found to be Salt-hay Salt Marshes and were added to Biotics as new Element Occurrences.

- Approximately 31 acres of tidal marshes were added to the Biotics database. Additionally, approximately 54.9 acres were added to the most recent version of the existing coastwide tidal marsh shapefile within the Acadia Region, primarily through more accurate delineation of the seaward edge of marshes.

These changes were reviewed by MNAP staff and incorporated into the GIS map of coastwide tidal marshes (polygon shapefile) that is currently hosted on the Maine GeoLibrary.[4]

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[4] mainegeolibrary-maine.hub.arcgis.com/datasets/maine::mainenap-marsh-migration/explore?layer=1

1. Background

1.1 Program Overview and Updates

The Marine Vegetation Mapping Program (MVMP) was established in 2021 by the Maine State Legislature (38 M.R.S. §1805) to restore regular eelgrass (*Zostera marina*) mapping and enhance salt marsh mapping within the state. The program, housed within the Marine Unit of the Division of Environmental Assessment and Bureau of Water Quality at the Department of Environmental Protection (DEP), was initially developed and began collecting data in 2023, but enhancements continued in 2024 and 2025. In 2024 the MVMP acquired a second set of underwater videography equipment (SeaViewer Admiral Pro with 6000 SeaDrop Camera) and high-accuracy GPS equipment (Juniper Systems Geode GNS3S Global Navigation Satellite System [GNSS] Receiver), which provides critical redundancy in the event of mid-season equipment malfunction and allows for simultaneous work to be performed in different locations. In 2025, methodological improvements included updates to the QuickCapture application used to collect field data, the use of historical field data from the 2010s to better interpret historical eelgrass maps, and the use of reference aerial orthoimagery from the 1990s (made possible by the Maine Geological Survey digitization of historical analog photos). Finally, a seagrass data viewer[5] was developed in ArcGIS Experience Builder and published for public use. The data viewer enables the easy visualization of all available seagrass distribution layers, a change analysis for areas with recent survey data (currently the New Hampshire border to Jonesport), and an 'About' page with programmatic information, links to source data, and more.

The MVMP follows a 5-year rotating regional survey approach to coastwide mapping of the target coastal vegetation (Figure 1). In 2024, seagrasses and tidal marshes between Marshall Point, Port Clyde and Naskeag Point, Brooklin were mapped (Figure 2). This area is referred to as the Penobscot Bay Region throughout this report. In 2025, seagrasses and tidal marshes between Naskeag Point, Brooklin and Kelley Point, Jonesport were mapped (Figure 3). This area is referred to as the Acadia Region throughout this report. The survey area covered the supratidal, intertidal, and shallow subtidal from the exposed oceanic coast through the head-of-tide. Although the statute only mandates the mapping of eelgrass and salt marsh distribution, an additional seagrass species (widgeon grass, *Ruppia maritima*) and tidal marsh habitat type (Freshwater Tidal Marsh) were included in the survey to maintain consistency with previous DEP seagrass mapping efforts and the MNAP datasets, respectively. Additional funding of $10,000 was obtained from The Nature Conservancy (TNC) to expand the 2024 survey area to include Matinic and Matinicus Islands, and smaller nearby islands.
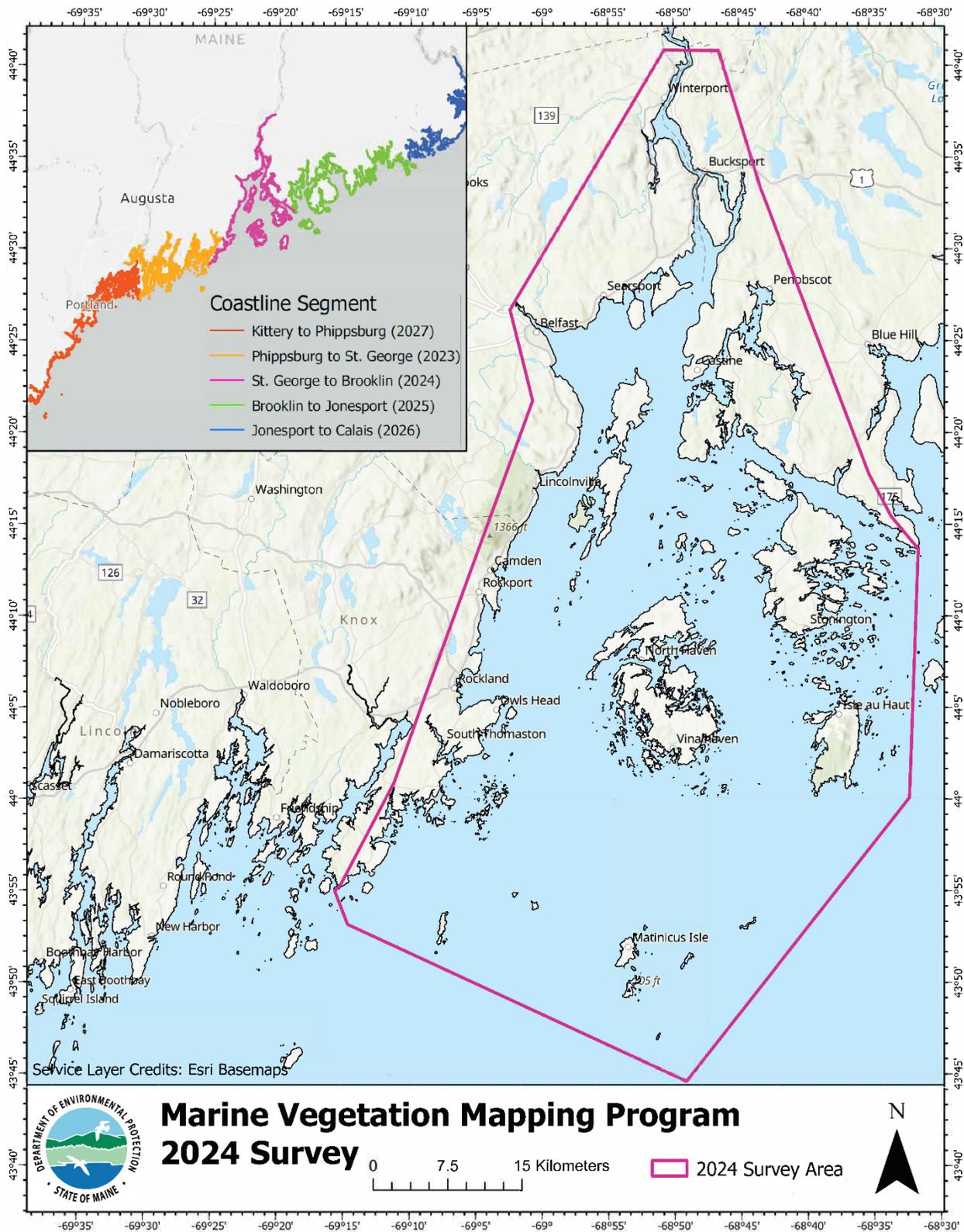
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[5] https://experience.arcgis.com/experience/95dfc22855bf4228939e6c6ec60294b4

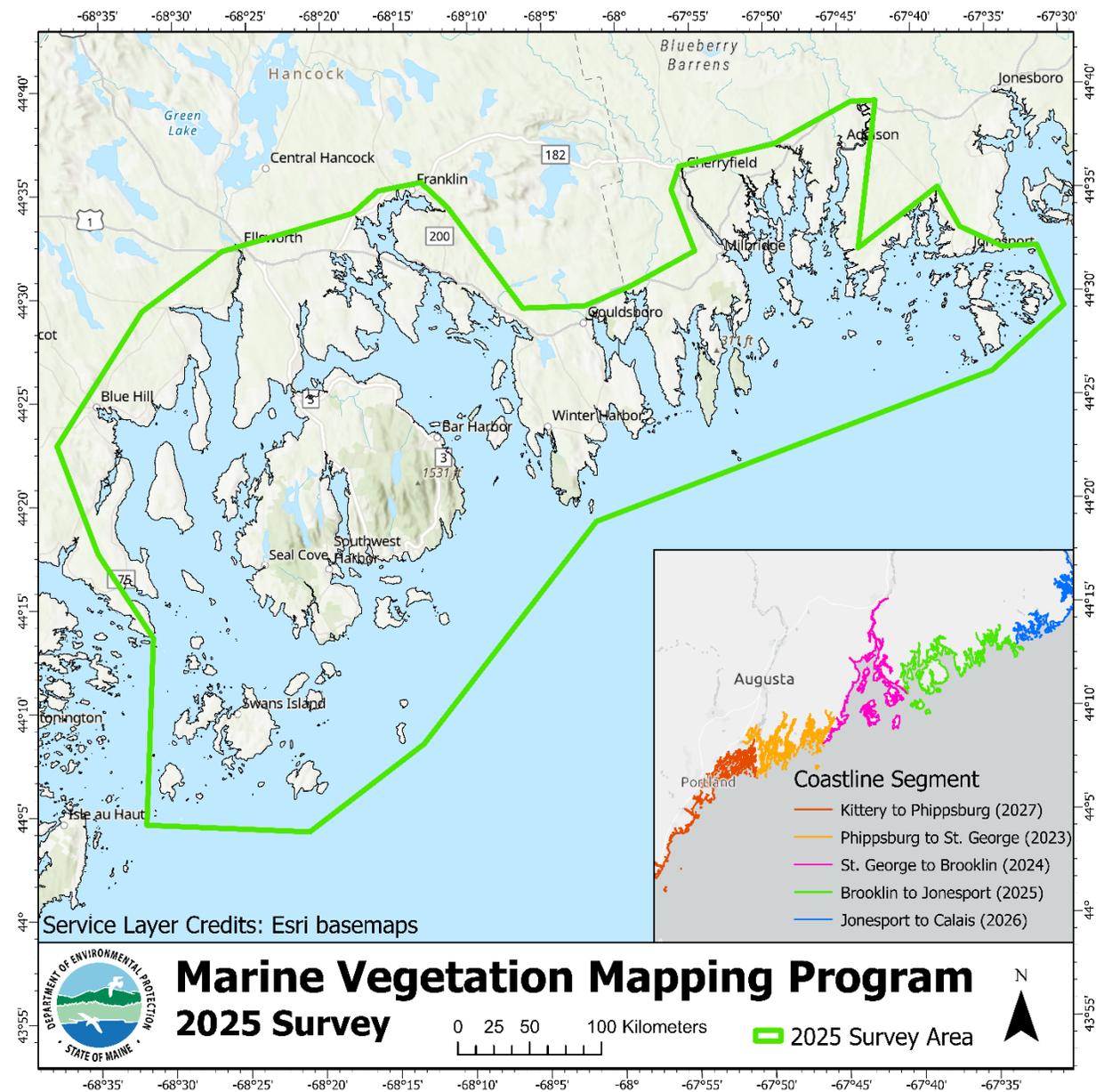**Figure 2. Penobscot Bay Region survey area (2024).**

Figure 3. Acadia Region survey area (2025).

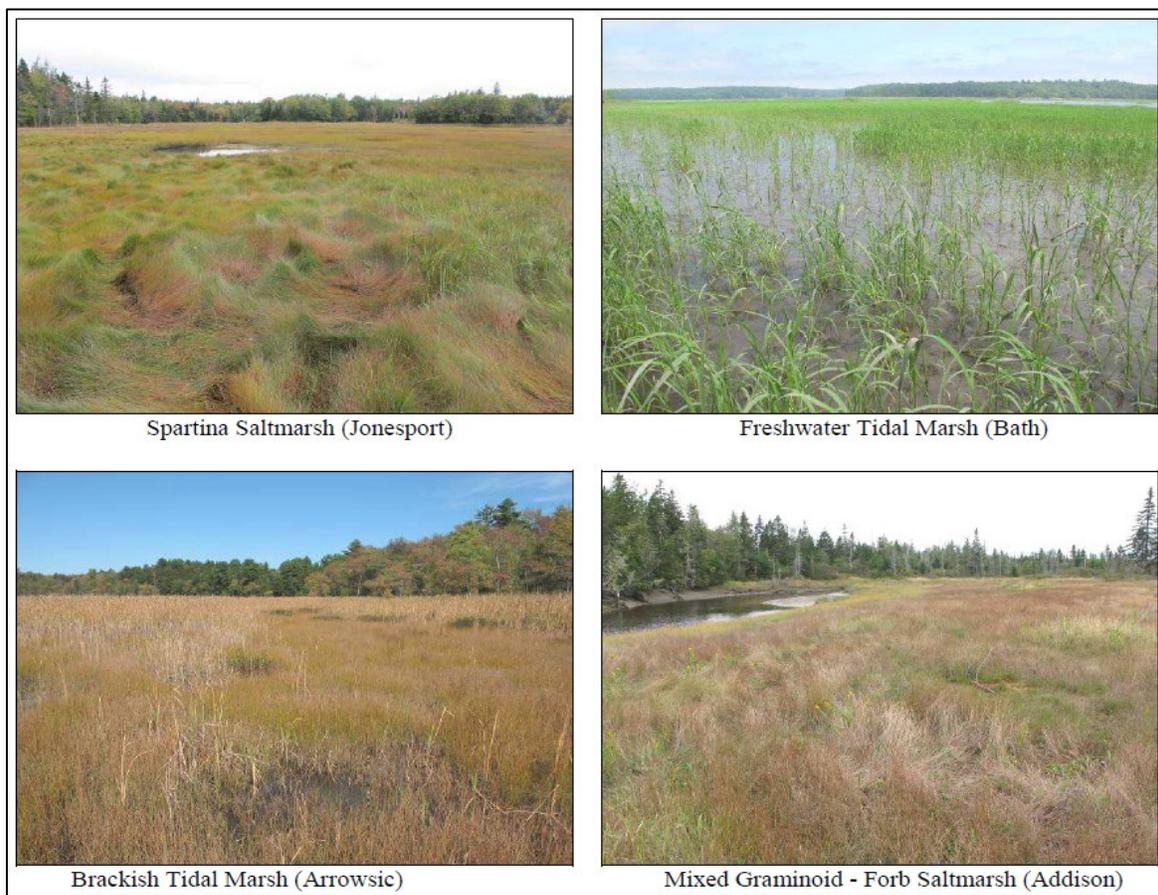# 1.2 Seagrass and Salt Marsh Benefits and Threats

Coastal vegetation, including seagrasses and tidal marshes, provides critical habitat and water quality benefits in the nearshore environment globally. In Maine, the predominant seagrass is eelgrass (Figure 4), which is a flowering perennial plant that grows in soft substrates of the shallow subtidal and low intertidal marine environments and forms extensive beds through both the spread of rhizomes and seed distribution. Several factors impact the distribution of eelgrass in Maine, including light availability, temperature, and disturbance regimes. This species faces several threats that can impact populations, including reduction of light (through suspended algae or sediment, or shading by structures), physical disturbance (by dredging or dragging, mooring tackle abrasion, propeller strikes, or pile installation), disease, and impact by invasive species such as the European green crab (*Carcinus maenus*) (Wippelhauser 1996; Neckles 2015). Eelgrass also serves as an indicator species for nutrient enrichment and, for this reason, can be a factor in determining the aquatic life attainment status of Maine's marine waters based on their respective statutory classification. Eelgrass is an important gauge of marine life support and knowledge of changes in bed extent and percent cover have led to impairment designations in the Piscataqua River estuary and Portsmouth Harbor. Although there are currently no established numeric criteria for eelgrass in Maine's Water Quality Standards (38 M.R.S. §§464-470), Consolidated Assessment and Listing Methodology (CALM) language is currently being drafted for inclusion in the DEP's 2026 Integrated Water Quality Monitoring and Assessment Report.

Maine has over 22,000 acres of tidal marshes that occupy significant portions of the intertidal zone, generally from mean tide level to the highest annual tide level. Salinity, watershed position, sediment supply, and tidal range gradients dictate the type of vegetation present; the predominant types are various cordgrasses, rushes, sedges, and forbs. Sediment deposition and subsequent colonization by marsh vegetation leads to the creation of high organic matter

Figure 4. Eelgrass growing with blue mussels in Mount Desert Narrows, Maine (2025).

sediment known as peat, which can store large quantities of carbon over long time-periods. Using the Maine Natural Areas Program (MNAP) classification system, tidal marshes in Maine are categorized into four natural community types: Salt-hay Salt Marsh, Mixed Graminoid-Forb Salt Marsh, Brackish Tidal Marsh, and Freshwater Tidal Marsh (Figure 5). Most, if not all, tidal marshes in Maine have been impacted by legacy agricultural features, such as ditches and berms, and many additionally experience restrictions to tidal flow due to undersized culverts. The associated changes to the natural hydrology of these systems, as well as coastal development and rising sea levels, threaten these sensitive natural communities. Both seagrass beds and tidal marshes are widely recognized as key habitat, nursery grounds, food sources, and refuge for a host of commercially important marine and estuarine animals, particularly during larval and juvenile life stages. Nearshore water quality benefits are provided in the form of nutrient uptake, sediment stabilization, and pH buffering. Carbon sequestration via belowground biomass and sediment accretion is an additional and critical climate resiliency contribution of these ecosystems, as is storm surge protection. Seagrass beds wax and wane on relatively short timescales due to a variety of stressors and coastal processes, and tidal marshes are increasingly subject to the impacts of erosion and inundation from sea level rise. Therefore, both ecosystems are in flux and require ongoing mapping surveys to inform permitting decisions (e.g., wastewater licensing, mooring and dock installation, aquaculture siting), restoration efforts, conservation planning, and carbon stock assessments.

Spartina Saltmarsh (Jonesport)

Freshwater Tidal Marsh (Bath)

Brackish Tidal Marsh (Arrowsic)

Mixed Graminoid - Forb Saltmarsh (Addison)

Figure 5. Tidal marsh natural communities recognized by MNAP (photo courtesy of MNAP).

1.3 Past Surveys

Eelgrass was historically mapped by the Department of Marine Resources (DMR) in two rounds of coastwide surveys, one in the 1990s (1992-1997) and one in the 2000s (2001-2010). Eelgrass maps along much of the coastline had not been updated since DMR's 2000s survey prior to the establishment of the MVMP. Exceptions were more recent maps produced by the Department of Environmental Protection's (DEP) Marine Environmental Monitoring Program (MEMP) of both eelgrass (2013 and 2018) and eelgrass and widgeon grass (2021-2022), collectively referred to as seagrass, in Casco Bay (Cape Elizabeth to Phippsburg) and the South Coast (Eliot to Cape Elizabeth). The MVMP mapped seagrass in the Midcoast Region (Phippsburg to Port Clyde) in 2023. All mapping efforts produced orthorectified, tidally coordinated coastal aerial imagery and GIS maps. The MEMP surveys produced high-resolution (at least 0.30 meter pixel resolution) 4-band digital aerial orthoimagery and GIS maps of eelgrass and seagrass with a Minimum Mapping Unit (MMU) of 0.5 acres. The MVMP survey produced 0.15 meter pixel resolution 4-band digital aerial orthoimagery and a GIS map of seagrass with an MMU of 100 square meters (~0.025 acres). All historical GIS maps (polygon shapefiles) and most historical aerial orthoimagery can be accessed through the Maine GeoLibrary, and are described in greater detail in Appendix C.

MNAP maintains both a GIS map and georeferenced database (Biotics) of tidal marshes, which includes freshwater tidal marshes in addition to the salt-tolerant marsh community types. Biotics is the official state record of tidal marsh sites, as well as other rare and exemplary natural communities and rare plant populations, that is available for conservation, development, and management planning. The GIS map was produced using the best available aerial imagery from 2013/2014 and was updated using National Agriculture Imagery Program (NAIP) imagery from 2021 and again with MVMP aerial orthoimagery from 2023. It should be noted that 'the best available aerial imagery' and 2021 NAIP imagery are not necessarily tidally coordinated, although the 2023 MVMP aerial orthoimagery was obtained within 2 hours of low spring tides. The GIS map includes some marshes smaller than 2.5 acres and those that have not been field verified, although these sites are not included in Biotics. The GIS polygon shapefile titled 'Current Tidal Marshes' is available through the Maine GeoLibrary within the Marsh Migration feature service and was updated in 2026 to reflect the 2024-2025 revisions made by the MVMP.[6]

2. Aerial Photography Survey Coordination

2.1 Specifications

The use of low-tide, high-resolution aerial orthoimagery as a raster base image is the standard method for seagrass delineation at a regional scale (DOC 1995; NOAA 2001) and has been employed in all historic seagrass mapping efforts in the state. The extent of tidal marshes can be delineated from the same imagery with higher accuracy than non-tidally coordinated imagery, as was used to develop and update the current MNAP tidal marshes GIS map. In 2024 and 2025, DEP contracted with James W. Sewall Co. to obtain tidally coordinated aerial orthoimagery

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[6] mainegeolibrary-maine.hub.arcgis.com/datasets/maine::mainenap-marsh-migration/explore?layer=1

within the survey area, who in turn subcontracted with Bluesky Geospatial Ltd. for flight operations and orthophoto processing and development. The four-band (Red, Green, Blue [RGB] and Near-Infrared [NIR]) images were captured by a Vexcel Eagle 80-mm Mark 3 digital aerial sensor mounted aboard a fixed-wing aircraft at 14.5 centimeters Ground Sample Distance (GSD) and processed to produce imagery with 6-inch pixel size and 1-foot accuracy. Digital orthorectified imagery was created using the raw digital aerial imagery, ground control, aerotriangulation, and the best available digital elevation model (DEM). Airborne GPS and an Inertial Measurement Unit (IMU) were utilized during photograph capture to improve the aerotriangulation solution. A combined total of 25 new or existing ground control points were installed or verified by James W. Sewall Co. to within 2 cm of the actual ground coordinates.

The 2024 project area was approximately 874,000 acres in size, and the aerial photography survey consisted of approximately 3,438 photos over 33 flight lines with 80% forelap and 30% sidelap acquired at an elevation of approximately 9,500 feet (Figure 6). Photos were acquired across four separate days (June 26 and July 8, 26, 27) due to the large size of the survey area, which is the largest of the five MVMP survey regions. Additionally, fringe imagery for Herrick Bay, just outside the designated survey area in Brooklin, was not clipped out of the final aerial orthoimagery by the contractor, and was therefore available for seagrass delineation in 2024. Herrick Bay was also included in the 2025 aerial orthoimagery, as it is part of the designated survey area, which allowed for a comparison of year-to-year seagrass distribution change at this location. The 2025 project area was slightly smaller at approximately 552,000 acres in size, and was surveyed with approximately 2,709 photos over 20 flight lines (Figure 7). Exceptionally wet and cloudy conditions, plus problematic wildfire smoke haze, occurred throughout the spring and summer of 2025, which resulted in multiple smaller flight windows across six separate days on June 26-27, July 26-27, and August 12-13 (although imagery captured on July 27 was ultimately not used to due to wind conditions exceeding project specifications).

Flight windows occurred within 2 hours of low spring tides and required atmospheric conditions including sun angle of 25 to 50 degrees, no more than 10% cloud cover, and less than 10 knots maximum predicted wind velocity. Additionally, Secchi disks were used to monitor for suitable water column clarity to enable visualization of the benthos in the aerial orthoimagery at seven sites within the survey area in 2024 and eight sites in 2025, prior to each flight window and during late ebb tidal stage whenever possible (Table 1). Water clarity (also known as water transparency) readings collected by DEP staff or partner organizations followed an established SOP (DEP SOP No. 5: Transparency Data Collection and Processing) which includes triplicate estimates of disk disappear and reappear depths, selecting the shaded side of the dock when possible, and taking measurements between 9:00 AM and 3:00 PM when possible, although collection of Secchi disk depth measurements at an appropriate tidal stage was prioritized over time of day. These controls account for some variability in Secchi disk data due to changes in light or water surface conditions that could possibly affect the observer's accuracy. Due to travel logistics to the 2025 Secchi depth measurement sites and the need for quick-turnaround time on last-minute requests for water clarity observations, several partner organizations collected Secchi depth measurements from across the 2025 project areas to inform the aerial photography survey timing (see Acknowledgements), after attending an MVMP-led training event on May 21. Factors that can contribute to loss of water column clarity include turbidity or Colored Dissolved Organic Matter (CDOM) from recent precipitation events, wind wave sediment resuspension, and phytoplankton blooms.
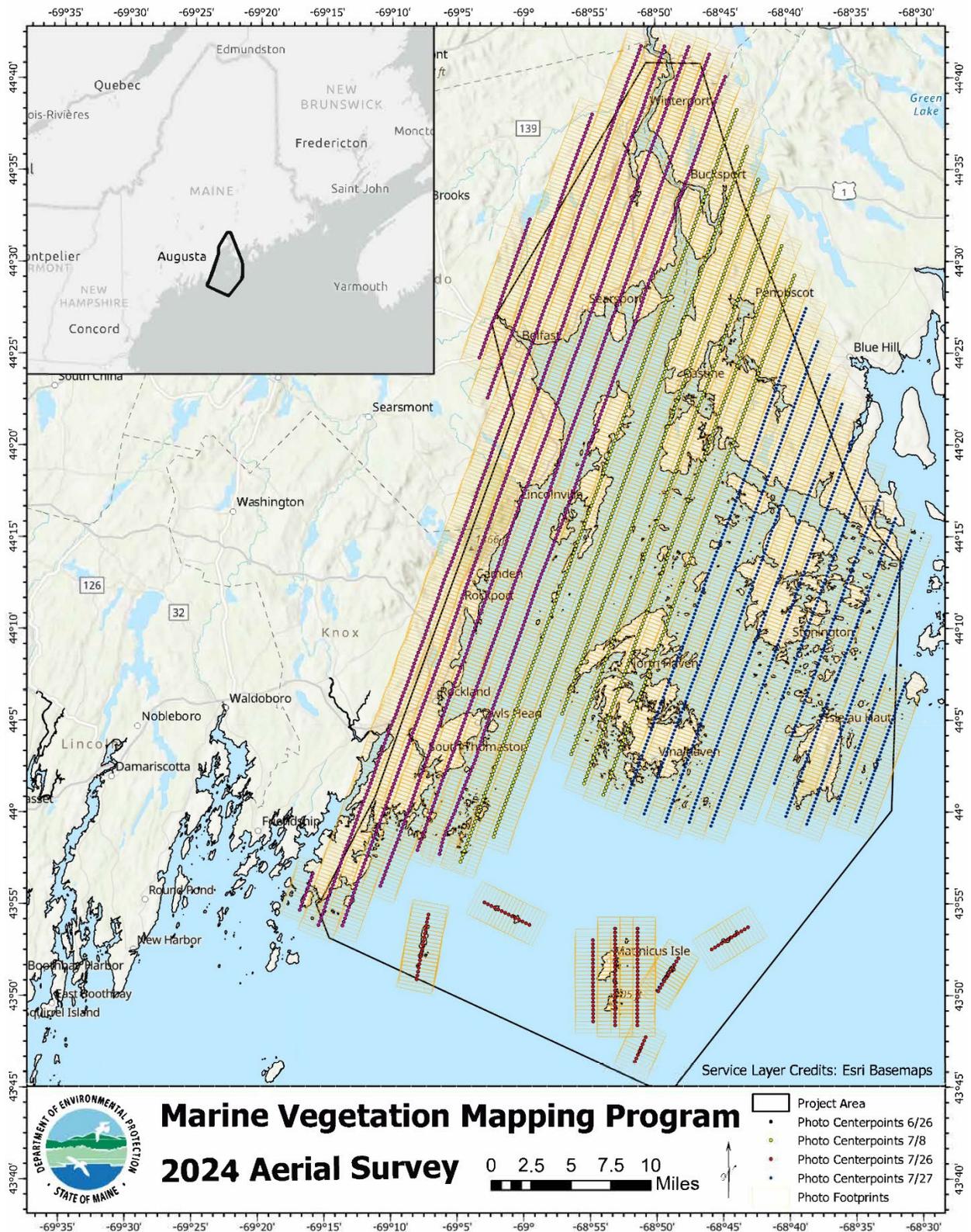
Figure 6. Flight lines, photo center points and footprints for 2024 aerial flight photographs.

Figure 7. Flight lines, photo center points and footprints for 2025 aerial flight photographs.

Table 1. Water column clarity measurement locations (NAD 1983 (2011) UTM Zone 19N).

Site Name	Municipality	Latitude (DD)	Longitude (DD)	Data Collection Organization	Year
Snow Marine Park floats	Rockland	44.092539	-69.104381	DEP	2024
Stockton Harbor floats	Stockton Springs	44.46954	-68.856563	DEP	2024
Castine Town Dock	Castine	44.387457	-68.795632	DEP	2024
Bagaduce Lunch	Penobscot	44.398887	-68.703816	DEP	2024
Castine Town Dock	Castine	44.387457	-68.795632	DEP	2024
Stonington Public Landing	Stonington	44.155153	-68.663318	DEP	2024
HICSL Pier	Hurricane Island	44.034239	-68.886145	HICSL	2024
Taunton Bay	Hancock	44.54084	-68.265071	Friends of Taunton Bay	2025
MDI Biological Laboratory Pier	Bar Harbor	44.433476	-68.29006	MDI Biological Laboratory	2025
Bernard Public Boat Launch	Tremont	44.24097	-68.351733	Public Volunteer	2025
Bartlett Narrows Boat Launch	Mount Desert	44.342785	-68.417252	MDI Biological Laboratory	2025
Milbridge Marina	Milbridge	44.543835	-67.87827	Downeast Salmon Federation	2025
Harrington Boat Landing	Harrington	44.544523	-67.804278	Downeast Salmon Federation	2025
Addison Town Landing	Addison	44.50228	-67.725235	Downeast Salmon Federation	2025
Downeast Institute	Beals	44.480561	-67.599447	Downeast Institute	2025

2.2 Flight Reports

In 2024 and 2025, Bluesky Geospatial Ltd. flew the annual project areas across four and five days, respectively (see Table 2 for flight lines, dates and tides). All photos were acquired within the two-hour window of low spring tide as predicted by the tide station nearest to each flight line. Flight and ground conditions were monitored the week leading up to each flight to capture the best conditions. A decision to fly was made the morning of June 26, 2024 and July 27, 2025 based on predicted maximum wind velocities below 10 knots, but actual conditions during both flights included winds up to 11 knots according to the National Oceanic and Atmospheric Administration (NOAA) weather stations closest to each area flown. For the June 26, 2024 imagery, the acquisition of an initial set of aerial orthoimagery early in the season was critical for project success, as it allowed the seagrass field verification efforts to get underway during the tight seasonal window before the annual senescence of aboveground biomass, and there was no opportunity to re-fly the area later in the season. The area flown on July 27, 2025 was re-flown on August 12. Actual conditions during all other lifts were within wind specifications.

In the 48 hours prior to each flight, cumulative precipitation above 0.12 inches was only recorded on one occasion: the NOAA weather station at the Bangor International Airport reported 0.28 inches of precipitation on the evening of June 24, and an additional 0.01 inches on the morning of June 25.

Table 2. Flight lines, date flown, and tide height for the 2024 and 2025 surveys.

Flight Lines	Year	Date	NOAA Tide Station	MLLW Height (ft)
1-8	2024	June 26	Belfast	-0.51
9-14	2024	July 8	Belfast	-0.03
15-26, 30-32	2024	July 27	Belfast / Matinicus	-0.21 / -0.17
26-33	2024	July 26	Belfast	-0.53
1-4	2025	June 26	Bar Harbor	-1.18
5-7	2025	August 13	Bar Harbor	-0.47
Eastern half of 8-12	2025	July 26	Bar Harbor	-0.64
Western half of 8-12, 13-14	2025	August 12	Bar Harbor	-0.59
15-20	2025	June 27	Bar Harbor	-1.01

In 2024, water column clarity was checked by DEP staff on June 24 and June 25 with the use of a Secchi disk and although the upper Bagaduce River was turbid (average 1.08 meter Secchi disk depth), the remainder of the project area was acceptable for the June 26 flight despite the recent rainfall. Excluding this period immediately following the rainfall event on June 24, water column clarity throughout the survey area was exceptional at all sampling sites (seasonal average >3.00 meter Secchi disk depth, as the disk was visible while resting on the sediment on four occasions across three sites) except the upper Bagaduce River (seasonal average 0.91 meter Secchi disk depth). Local hydrologic conditions related to the tidal restriction at the Route 175 causeway immediately upstream of the Bagaduce River sampling site likely contributed to the observed elevated turbidity. Secchi depth data were provided by the Hurricane Island Center for Science and Leadership (HICSL) on July 24, and water quality observations from partner organizations were also utilized to inform understanding of water clarity at additional locations. In 2025, water column clarity was checked by DEP staff and trained volunteers on June 24, July 10-12 and 25-26, and August 8 and 11. On all sampling events, Secchi depths were consistently low at the Milbridge Marina (seasonal average 0.88 meters) and Harrington Boat Landing (seasonal average 1.35 meters), but otherwise water clarity was exceptional throughout the survey area (seasonal average >2.43 meter Secchi disk depth, as disk was visible while resting on the sediment on five occasions across three sites).

2.3 Draft and Final Orthoimagery

The draft aerial orthoimagery had the image frame assembly, color balancing, and radiometry completed with the software program Ultramap by Vexcel, and the final mosaicking routine completed with the software program Inpho by Trimble. DEP provided comments on the 2024 draft imagery to Bluesky Geospatial Ltd. which, in part, requested that some tiles with wind impacts on June 26 be replaced with tiles from July 8 wherever possible. The final aerial orthoimagery was processed as standard orthoimagery with no water mask and global radiometry in Ultramap and Inpho as described for the draft imagery. Sample tiles of final imagery were provided to DEP and global radiometry was subsequently adjusted in post-processing. The post-processed final imagery mosaic included a small area immediately east of the designated survey area in 2024 (Herrick Bay) and a small area immediately west of the designated survey area in 2025 (Eggemoggin Reach), which were both included in the annual seagrass delineations in order to assess inter-annual variation in this area. James W. Sewall Co. provided the imagery metadata and Verified QC Checklist, and other deliverables were provided by Bluesky Geospatial Ltd. (e.g., flight reports, photo centers, and camera calibration report). The final imagery and associated metadata are available on the Maine GeoLibrary as imagery service layers.[7]

2.4 Quality Assurance/Quality Control

Data Quality Objectives (DQOs) assess the adequacy of data collected relative to their intended uses and present the specifications necessary to support the qualitative and quantitative data collection effort. These specifications address the acceptable probability of error, define the type

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[7] mainegeolibrary-maine.hub.arcgis.com/datasets/maine::maine-orthoimagery-coastal-acadia-2025 and
mainegeolibrary-maine.hub.arcgis.com/datasets/maine::maine-orthoimagery-coastal-penobscot-bay-2024

of data needed to support the decision, and identify the conditions under which the data should be collected. Performance criteria are presented in quantitative terms as Data Quality Indicators (DQIs) for those parameters most important capturing high quality imagery for seagrass and saltmarsh delineation are presented in Table 3. Although Secchi disk depth was less than 1.5 meters on a few occasions and small precipitation events occurred in the 48 hours preceding some flights, all DQIs established as requirements for seagrass delineation were met during the 2024 and 2025 surveys.

To inform evaluation of quality control for the aerial orthoimagery, Bluesky Geospatial Ltd. provided flight reports for all lifts, the latest camera/sensor calibration report, documentation of the GSD for imagery acquisition, and horizontal positional accuracy verification. James W. Sewall Co. additionally provided aerotriangulation reports and a Verified QC Checklist and installed 12 new ground control points in 2024 and 11 in 2025 to improve aerotriangulation and ensure spatial accuracy of the final imagery.

Table 3. Data quality indicators for the aerial survey.

DQI	Criteria
Imagery Completeness	Imagery obtained for 100% of annual survey area with ≥60% forelap and ≥30% sidelap
Imagery Spatial Resolution	Ground Sample Distance (GSD) ≤0.15 meters
Imagery Spectral Resolution	At least 4-band (RGB and NIR)
Imagery Spatial Accuracy	Horizontal positional accuracy of ≤1 meter
Season	June-August
Tidal Coordination	Imagery obtained within ± 2 hours of low spring tide
Environmental Conditions	Sun angle: 20-50° Cloud cover: 0-10% Wind: 0-10 knots Precipitation events: generally, none in past 48 hours Water Clarity: generally, ≥1.5 meter Secchi depth

3. Seagrass Delineation and Mapping

3.1 Methods

3.1.1 Photointerpretation

The Penobscot Bay Region survey area was subdivided into eight geographic sections for the purpose of organizing field efforts, photointerpretation, and analysis. The subdivision was loosely based on similar habitat type and amount, and also proximity to boat ramps, hotels, and other logistical considerations for the completion of field verification. These geographic sections are Upper Penobscot Bay, Bagaduce River, Islesboro Island, Deer Isle-Stonington, Muscle Ridge, Vinalhaven-North Haven, Isle Au Haut, and Outer Islands (Figure 8). The Acadia Region survey area was subdivided into 7 geographic sections, which are Blue Hill-Union Bays, Swans-Cranberry Isles, Taunton Bay, Frenchman Bay, Gouldsboro-Dyer Bays, Pleasant Bay, and Jonesport-Beals (Figure 9). The size of each geographic section varies, along with the seagrass habitat type and quality within each section.

Aerial orthoimagery was photointerpreted using methods from NOAA (DOC 1995; NOAA 2001). Seagrass has many aerial signatures which vary depending on factors such as water depth, substrate type, bed density, and cohabitation with macroalgae, along with imagery quality. The consistent identification of seagrass signature within a given area is critical to the production of accurate maps. Some characteristics of seagrass signature include a clumpy growth pattern, a pointillism appearance, dark color that contrasts against sediment, a green tint to the color, and a varied/inconsistent tone within a bed. Historical eelgrass signatures from previous mapping efforts within the Penobscot Bay and Acadia Regions (DMR 2010), as well as seagrass signature from more recent mapping efforts in other parts of the state (DEP 2013, 2018, 2021, 2022, and 2023), were reviewed for calibration and to reinforce the seagrass signature and other common features (ledge, macroalgae). The DMR shapefile from the 1990s (DMR 1997) was used primarily as a reference for historical bed extent only since associated aerial orthoimagery is not available as a web service. The above referenced seagrass map polygon shapefiles, along with associated aerial orthoimagery for all but the DMR 1990s shapefile, are publicly available through the Maine GeoLibrary[8] and are described in more detail in Appendix C.

Once draft aerial orthoimagery was delivered to DEP, priority sites for targeted field verification were identified and transect shapefiles developed. Transects were established in areas of unclear signatures, to delineate the deep edge of beds, for general confirmation of seagrass presence, and as quality control checks in historical eelgrass beds that lacked a visible aerial signature in the 2024 and 2025 imagery. To the extent practicable, transects were also selected at locations representative of all substrate types, water depths, and overlapping signatures (macroalgae, ledge, etc.) present within each survey region.

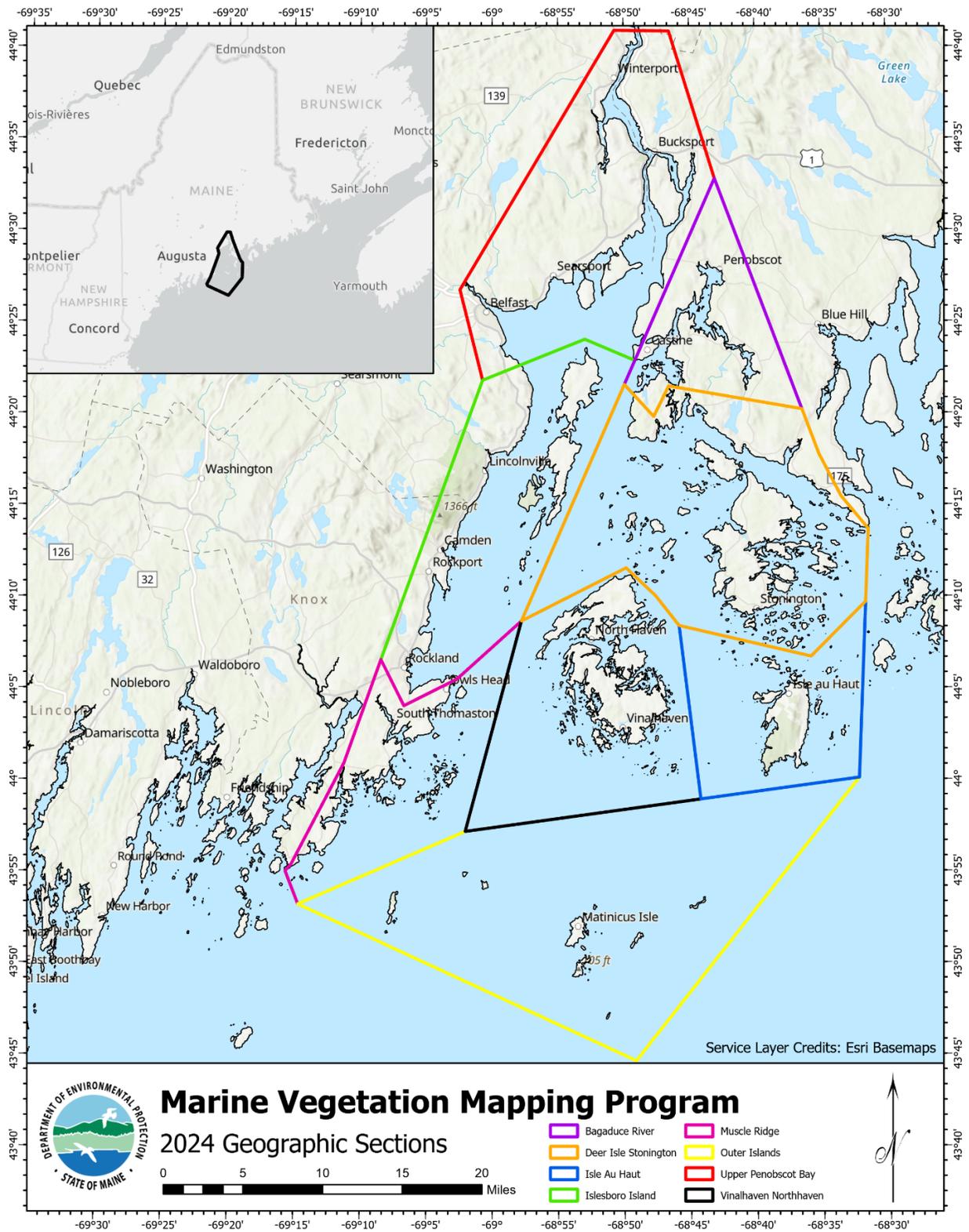
[8] mainegeolibrary-maine.hub.arcgis.com/

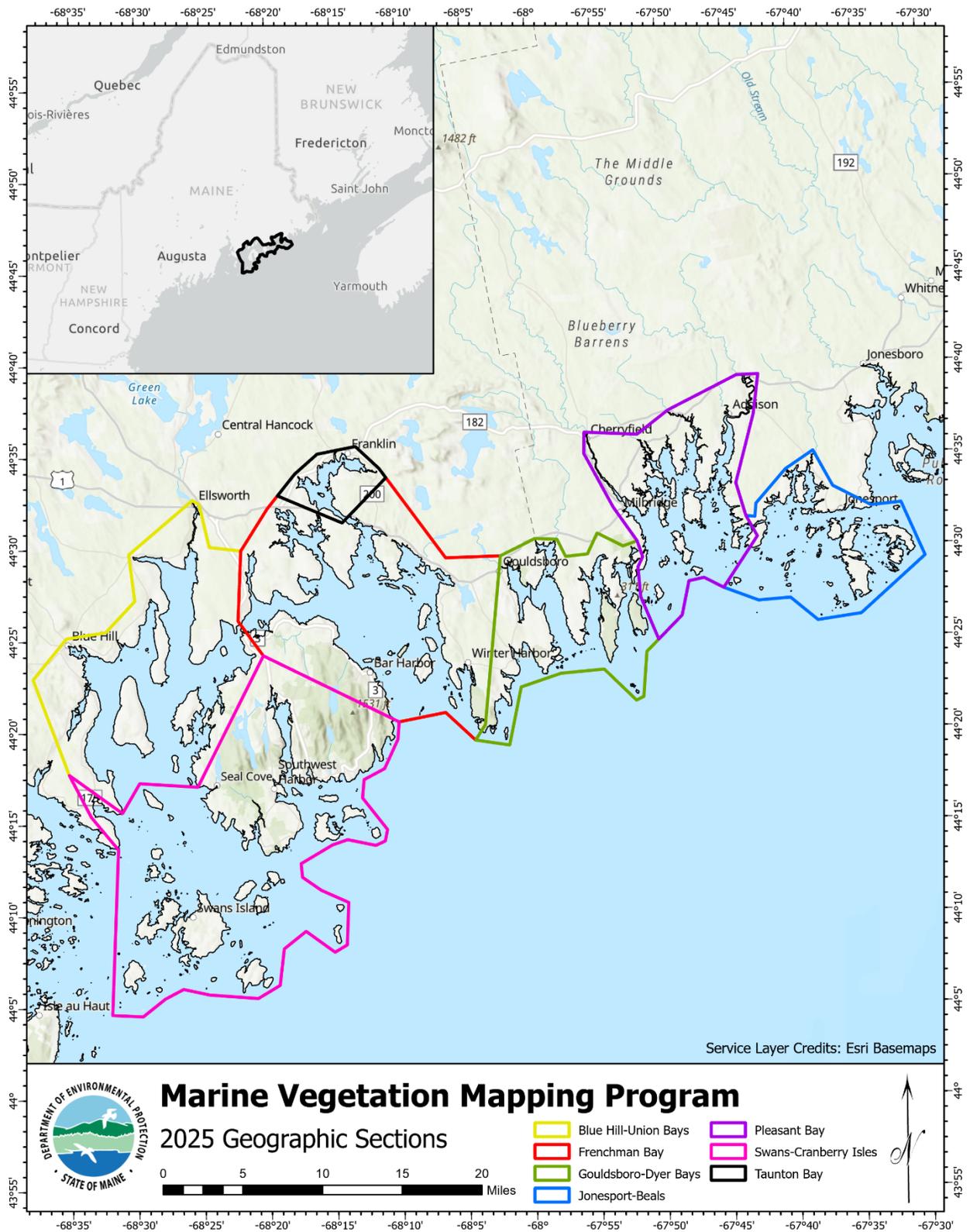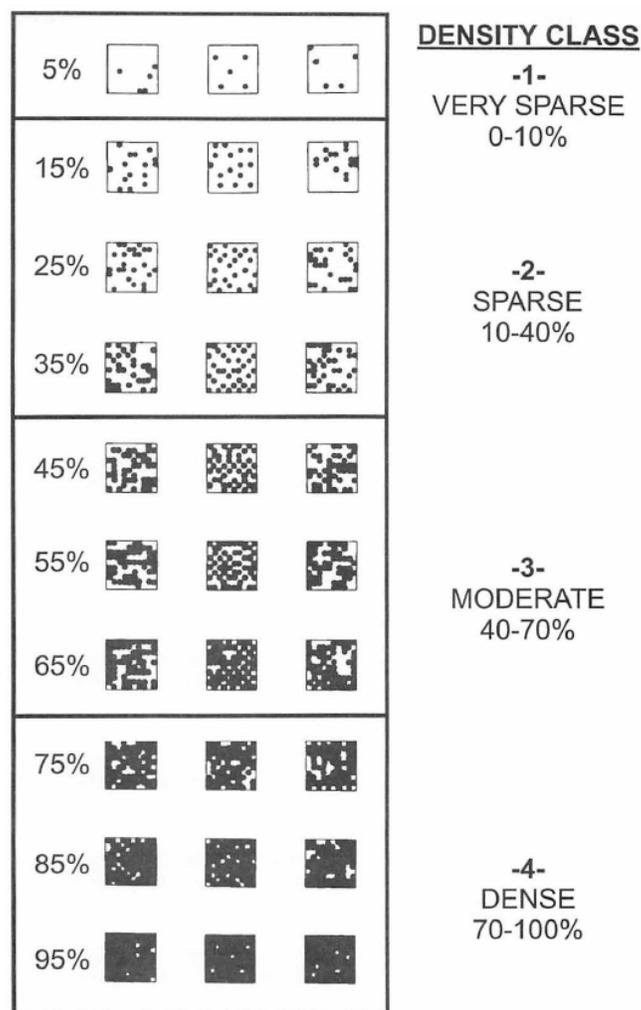**Figure 8. Geographic sections within the 2024 survey area.**

Figure 9. Geographic sections within the 2025 survey area.

Seagrass bed digitization was completed following field verification due to the tight window for field efforts, which necessarily must occur after the aerial photography survey and before seasonal dieback of seagrass beds. In addition to photointerpretation of the aerial signature, bed boundaries were refined with the use of field waypoints, vessel track logs, and georeferenced underwater video files. Contiguous seagrass beds were split into estimated percent cover classifications (0-10%, 10-40%, 40-70%, 70-100%, see Figure 10) per Orth et al. (1996) based on the aerial signature, field waypoints, and georeferenced underwater video files. This is a useful framework since percent cover, unlike density, can be estimated by photointerpretation of aerial imagery and accounts for patchiness while allowing delineation of non-continuous seagrass distribution.

Eelgrass and widgeon grass were distinguished where possible based on field verification data. Distinguishing between these two species of seagrass cannot occur based on aerial signature alone and therefore, seagrass beds without field verification were not identified to the species level. In general, however, eelgrass is the predominant seagrass species in Maine and prefers full oceanic salinity, whereas widgeon grass may grow in either more brackish or hypersaline waters and has been mapped in areas upstream of tidal restrictions in multiple previous mapping efforts (DEP 2021, 2022, and 2023) and in both the Penobscot Bay and Acadia Regions in 2024 and 2025, respectively.

Figure 10. Percent cover categories (Orth et al. 1996).

Due to variation in image quality, seagrass beds were partially delineated with draft imagery on a few occasions and then checked against the final imagery. Draft imagery was fully orthorectified with 1-foot accuracy, but lacked full color balancing for a seamless mosaic between each flight lift. Delineations were completed according to the following specifications:

- For both transect and polygon development, a percent clip stretch was applied to the orthophotography tiles in most locations to enhance the seagrass signature. Additionally, increases of up to 35 percent in contrast and 30 percent in brightness were applied in some locations in response to varying types of substrate, water depth, bed density, and lighting.
- A minimum mapping unit (MMU) of 100 square meters (~0.025 acres) was employed, but seagrass beds as small as 2.3 square meters (0.0006 acres) were mapped where conditions such as water depth and clarity allowed.

- Beds less than 100 square meters in size were typically combined with nearby beds when possible and/or within 30 meters, which is consistent with both NOAA guidance (DOC 1995; NOAA 2001) and the most recent mapping efforts in the state (DEP 2021, 2022, and 2023). Individual seagrass shoots or isolated clumps from individual plants with no aerial signature were not mapped, with the exception of areas with density greater than 10%, which were mapped as a 3-m radius circle to account for GPS error (i.e., boat movement, GNSS receiver accuracy, etc.) but not overestimate bed size.
- In cases of ambiguous signature or diffuse beds, mapping was adjusted to be consistent with the DMR 2010 shapefile.
- Photointerpretation was done at a scale ranging from 1:250-1:2,000 depending on bed size and other landscape features, and beds that were mapped at a scale at or close to 1:2,000 were reviewed at a larger scale after initial polygon development to ensure boundary accuracy.
- Void areas (interior to a seagrass polygon but with zero percent cover of seagrass, such as rocks or bare substrate) were clipped, or removed, from the features. This approach is consistent with the most recent mapping efforts in the state (DEP 2021, 2022, and 2023), but it should be noted that some historical maps (e.g., DMR 1997) retained the void areas within eelgrass polygons and assigned a 0% cover category.
- In the final attribute table, polygons and contiguous seagrass beds (which often consist of multiple polygons with different percent covers) were numbered sequentially approximately from west to east along the coast.
- ArcGIS Pro v. 2.9.9 was used for all desktop GIS workflows in 2024 and v. 3.3.5 in 2025.

3.1.2 Field Verification

The seagrass field verification survey occurred following transect development based on draft orthoimagery tiles. Due to the limited time window for field verification, which should be completed prior to seasonal senescence of seagrass beds, the survey occurred prior to draft seagrass polygon development. The objectives of the field investigation are, in order of priority, to

1) confirm presence/absence of seagrass beds,
2) locate bed boundaries,
3) collect percent cover data, and
4) document other features along a transect that may produce a similar aerial signature (e.g., macroalgae, ledge).

Field verification to locate bed boundaries is of paramount importance at the deep edges of seagrass beds, particularly in turbid waters. The field survey entailed the use of an underwater video camera system, high-accuracy GNSS receiver, and ruggedized tablet. Field verification occurred primarily by boat, but some efforts were carried out by foot and by canoe where motorboat access was restricted or otherwise impractical. In some instances, the sea floor could be observed without the use of the underwater video camera system and logistics (i.e., wading) prevented the deployment of the camera. In those cases, the GNSS receiver and tablet were utilized to record the GPS location of observations, but no recorded video file was produced. On

most days, the crew consisted of three personnel: camera operator, vessel captain, and video observer/waypoint recorder. To maintain consistency, the video observation and waypoint collection was completed by either MVMP Manager Cheyenne Adams or MVMP Environmental Technicians Eric Rainey and John Fisher. On one occasion, waypoint collection was completed by DEA GIS Specialist Becky Schaffner under the supervision of Cheyenne Adams.

On most days, the DEP Marine Unit's 21-foot Maritime Skiff was launched to support field efforts. Occasionally, when the size of the Maritime Skiff was prohibitive in accessing the necessary field sites, field verification was carried out aboard a smaller motorized DEP vessel (12-foot Tracker jon boat with 4-horsepower outboard) or canoe. Field equipment included a SeaViewer High-Definition Admiral Pro underwater video system with digital video recording capabilities and 6000 SeaDrop Camera, AccuView 21.5-inch high-brightness, sunlight-readable monitor mounted inside a Display Shield weatherproof display enclosure, Juniper Systems Geode GNS3S GNSS receiver with real-time Wide Area Augmentation System (WAAS) corrections and capable of submeter accuracy, and Samsung Tab Active3 tablet (Figure 11). The SeaViewer underwater camera system was cabled to the Geode GNSS receiver to enable high-accuracy GPS coordinate overlay, along with date and time stamp, to be recorded in the

Figure 11. Field verification equipment aboard the 21-foot Maritime Skiff.

video files. The Geode GNSS receiver was also wirelessly paired to the Samsung Tab Active3 tablet, which has an 8-inch, high-brightness, sunlight-readable screen and is field-ruggedized, for the collection of vessel track logs, observation waypoints, and high-accuracy GPS metadata.

Transect locations were loaded onto the vessel's Garmin 1243xsv chartplotter to enable navigation to and along each transect by the vessel captain. Once the vessel was on the site of a transect, the underwater camera was lowered over the vessel gunwale by rope with an 8-lb downrigger weight and fin attached to achieve an approximately 45-degree orientation relative to the sea floor. Depth of the camera above the sea floor varied with conditions (e.g., turbidity, seagrass canopy height), but was typically 0.3 to 2 meters. The external monitor displayed the video feed in real time and allowed the camera operator to make necessary adjustments to maintain optimal positioning of the camera. The georeferenced and timestamped video feed was also recorded for future reference. Tow speeds were approximately 2 knots in most conditions.

Esri Field Maps and QuickCapture mobile applications were installed on the field tablet. QuickCapture was used for high-speed data collection of new waypoints with field observations,

GPS coordinates, and associated high-accuracy metadata, as well as vessel track logs. In 2024, this application had an offline map which displayed vessel location relative to transects, historical eelgrass maps (DMR 1997, 2010), and waypoints collected that day only, but the Field Maps application was used to visualize waypoints collected on previous days in order to assess progress. In 2025, a beta version of QuickCapture was released to DEP through the early adopter program that is capable of displaying waypoints collected on both previous days and the current day in the offline map. This improvement eliminated the need for using Field Maps in 2025 and allowed staff to more effectively assess progress while in the field. Waypoints were collected for the following observation types: seagrass absent, seagrass present, seagrass drift, macroalgae, shell, ledge, epiphytes,[9] green crabs, 0-10% seagrass cover, 10%-40% seagrass cover, 40%-70% seagrass cover, 70%-100% seagrass cover, and notes/other. At the beginning of each field day, QuickCapture was used to record the waypoint observer, crew members, and weather conditions. At the end of each field day, data were uploaded from the field tablet to cloud storage on an ArcGIS Online hosted feature layer.

Due to the limited timeframe to conduct field investigations after draft aerial imagery was received and before seasonal loss of seagrass biomass, some field efforts were conducted during mist or light rain conditions, but no field efforts were conducted immediately following large wind or rain events that significantly reduced underwater visibility. The exact transect location was often modified in the field based on the presence of obstacles (e.g., lobster trap buoys, other vessels), environmental conditions (e.g., wind, waves, current), personnel safety considerations, and underwater observations. Transects were labeled with two to three letters corresponding to the geographic section (i.e., MR for Muscle Ridge and SCI for Swans-Cranberry Isles) followed by a numeric value. The underwater video files are named by transect name and provided in the "Video" column of the seagrass polygon shapefile attribute table.

3.1.3 Quality Assurance/Quality Control

To ensure that DQOs were met, all field crew members were adequately trained on survey methodology. The DQIs for those parameters most important to accurately delineating seagrass are presented in Table 4. The GPS horizontal accuracy for all field observation waypoints collected by the Geode GNSS receiver was ≤0.7 meters 2DRMS (2x Distance Root Mean Square, 95% precision). On one occasion in 2024, due to technical difficulties with the Geode GNSS receiver, field observation waypoints were collected with the integrated GPS receiver on the tablet, but horizontal accuracy was ≤2.5 meters 2DRMS for all data points. These waypoints were used to confirm seagrass presence/absence only, and bed edge delineations at these locations were derived solely from the aerial imagery. Similarly, vessel track logs were constrained to ≤2.5 meters 2DRMS horizontal accuracy by the QuickCapture application. Instances when vessel track logging accuracy would have been greater than 2.5 meters 2DRMS due to insufficient satellite coverage or signal, the application settings precluded data collection. The georeferencing overlay on underwater video files was unfortunately subject to a technical error that caused coordinate rounding thus the horizontal positional accuracy of ≤2.5 meters was not achieved on many occasions in 2024. However, location of any given underwater frame can be geolocated by use of the timestamp, which is acquired via the GPS satellite fix and is accurate to the second, compared

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[9] Epiphyte: a plant or alga that grows on the surface of another plant or alga but is not parasitic.

to the vessel track logs. The GPS overlay coordinate rounding issue was rectified for the 2025 season.

Underwater video files were reviewed as needed during photointerpretation for polygon development, but particularly to confirm percent cover estimates and to calibrate those estimates with the aerial signature. In addition to review of aerial signature, field observation waypoints, vessel track logs, and underwater video files, seagrass delineation was informed by historical imagery from 2003, 2008, and 2009. In some cases in the Acadia region (2025 survey), historical imagery from 1996-1997 was spot checked to confirm historical aerial signature. Finally, seagrass bed edge as determined by photointerpretation was compared to the field-verified bed edge at 12 Quality Assurance/Quality Control (QA/QC) points approximately evenly distributed throughout the survey area with at least one QA/QC point in each relevant geographic section. All QA/QC photointerpreted bed edge points were within 5.0 meters of field-verified bed edges with an average distance of 1.5 meters in 2024 and 2.3 meters in 2025. Although a second senior delineator was unavailable to perform a complete digitization and identify areas of disagreement, MVMP Environmental Technician Eric Rainey completed a small set of delineations in the upper Bagaduce River and the North Haven Salt Pond in 2024, and MVMP Environmental Technician John Fisher performed a complete delineation of the entire survey area in 2025. The resulting polygon shapefiles were compared to that developed by MVMP Manager Cheyenne Adams and any differences were reconciled and incorporated into the final shapefiles.

The final digitized seagrass bed shapefile was evaluated for completeness and correctness. First, the associated attribute table was filtered and sorted to identify any omissions or errors and all polygons smaller than the MMU were reviewed as potentially erroneous sliver polygons. The 'Dissolve Boundary' geoprocessing tool was used to confirm the accuracy of the contiguous seagrass bed naming system and the 'Check Geometry' geoprocessing tool was run to identify any invalid geometry in the dataset. Finally, attribute rules and a topology were created to check for polygon overlaps, duplicate features, duplicate vertices, gap slivers, unclosed polygons, and unnecessary boundaries. Vertex snapping was used when appropriate throughout seagrass polygon development to reduce topology errors.

Table 4. Data Quality Indicators for seagrass delineation.

Work Stage	DQI	Criteria
Field Verification Survey	Spatial Accuracy	GNSS receiver reported accuracy ≤1 meter 2DRMS
	Survey Completeness	Field transects completed for ≥50% of all mapped beds
	Season	June-October
	Underwater Videography Equipment	GPS coordinates overlay with horizontal spatial accuracy of ≤2.5 meter 2DRMS
	Representativeness	Field observations made at locations representative of diverse environmental and bed conditions throughout the survey area
Photointerpretation	Mapping Completeness	Seagrass presence/absence mapped for 100% of annual survey area
	Minimum Mapping Unit	100 square meters
	Spatial Accuracy	Vegetation edge measured during field verification is within ≤5 meters of bed vegetation determined by photointerpretation

3.2 Results

3.2.1 Field Verification

In 2024, field data collection began on August 1 and was completed by September 24 over the course of 17 days on the water. In 2025, field data collection began on July 29 and was completed by September 22 over the course of 14 days on the water. No seasonal senescence or decline of seagrass biomass was noted during field activity. Targeted field observations were used to verify seagrass extent and percent cover, and a total of 982 transects were completed across both years, resulting in the collection of 53,294 waypoints. Although transects were established for the Outer Island geographic section in 2024, weather conditions and seasonal limitations prevented field verification efforts at Matinicus and Matinic Islands, and surrounding islands, which are approximately 20 miles offshore. The total number of transects, and thus amount of time required to complete the field-validation survey, is dependent on the amount of target vegetation present in the survey area, water clarity, sediment type, overlapping signatures, and the quality of the aerial orthoimagery. Clear water and dense eelgrass beds on sandy substrate require less field-validation effort than turbid water and patchy or sparse eelgrass beds intermixed with macroalgae, for example.

A useful metric for evaluating field effort is the proportion of seagrass beds that were visited, which was slightly less than a quarter of all beds (193/801 in 2024 and 174/964 in 2025). However, this value may not be the best assessment of field effort since some large seagrass beds

were visited at multiple locations to determine the bed boundary, while other beds in close proximity to field verified beds with visibly similar signatures were not visited. Additionally, the presence of many small, unverified patches of seagrass, as was the case in 2024 and 2025 with exceptionally clear water allowing for the identification of even minute individual patches, will skew this percentage lower than if there were fewer, larger beds.

Over 63% of the total mapped seagrass acreage was included in field verified beds in 2024, and 42% in 2025. Of the beds that were not visited in the field, many had been previously mapped in the same or nearly the same location in either the DMR 1997 or 2010 shapefile. Only 3.5% of the total mapped seagrass acreage was incorporated in beds that were unverified and not within 100 meters of a historically mapped bed in 2024, and 3.9% in 2025. Finally, many of these beds are nearby beds that were field verified and display a similar aerial signature. In general, water clarity throughout Penobscot Bay and the Acadia Region was excellent in areas that supported seagrass beds and seagrass photosignature, where present, was clearly visible, although often intermixed with, or adjacent to, macroalgal photosignatures. Field verification was critical for accurate digitization of seagrass beds, particularly for areas of unclear imagery, or that had overlapping signatures with macroalgae or optically deep water (Figure 12).

The seagrass resource in the Penobscot Bay and Acadia Regions was defined by frequent cohabitation with macroalgae, particularly sugar kelp (*Saccharina latissima*), in clear and sometimes relatively deep waters (up to ~8 meters MLLW). A common look-alike signature was the macroalga sea lace (*Chorda filum)*, which has similar morphology to eelgrass, but was not commonly observed growing intermixed with eelgrass beds. Epibionts[10] were a mixed composition of primarily filamentous macroalgal, hydroid or bushy bryozoan species, colonial tunicate or sponge species, and tube worms (*Spirorbis* spp.). Eelgrass beds in a few areas of the Penobscot Bay Region (upper section of the Bagaduce River, Eggemoggin Reach and nearby areas, between Sprucehead and Burnt Islands in South Thomaston), exhibited extremely high levels of epibiotic growth, which was primarily epiphytic filamentous macroalgae (Figure 13). In the Acadia Region, large filamentous green algal mats (probably *Ulva intestinalis*) were commonly observed on tidal flats, primarily in the upper Pleasant Bay area where historically extensive intertidal eelgrass was mapped. Additionally, several eelgrass beds were growing intermixed with blue mussels (*Mytilus edulis*) in the Mount Desert Narrows area. In both years, a small herbivorous snail, *Lacuna vincta,* was often seen residing on eelgrass shoots, and sand dollars (*Echinarachnius parma*) were frequent in the benthos. Several overlapping signatures were present within and nearby mapped seagrass beds, most commonly sugar kelp and sea lace, but also including fucoid (e.g., *Ascophyllum nodosum* and *Fucus vesiculosus)* and turf macroalgal species (e.g., *Chondrus crispus*, *Chaetomorpha* spp., and what appeared to be *Ectocarpus* sp.), ledge, shell rubble, and general detrital drift.

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[10] Epibiont: an organism that lives on the surface of another organism but is not parasitic.
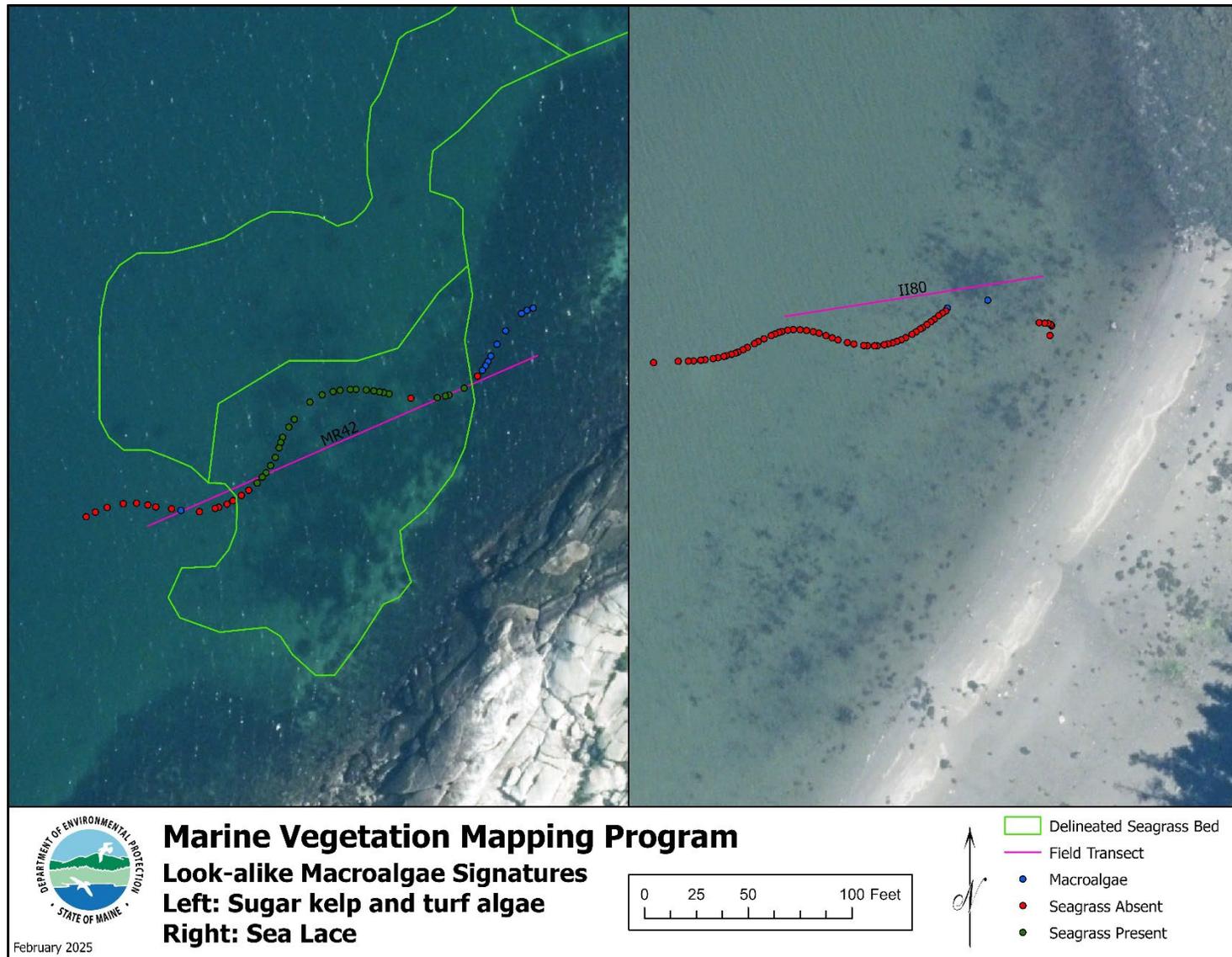
Figure 12. Look-alike and nearby signatures. Left: field data the edge of an eelgrass bed in deep water and adjacent to macroalgae signatures. Right: the look-alike aerial signature of the macroalga sea lace.
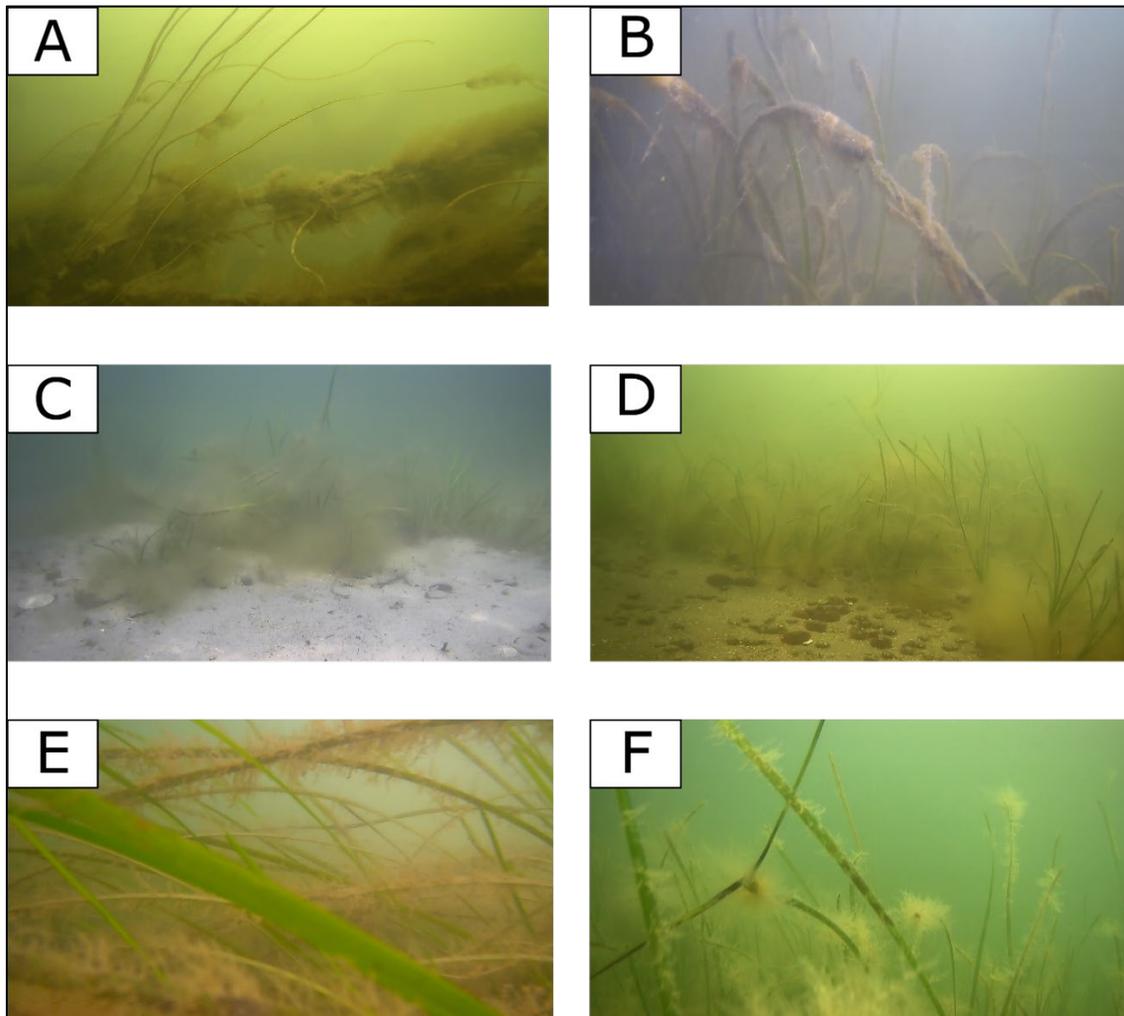
Figure 13. Epiphytic filamentous macroalgae on sea lace (A) and on eelgrass in the Bagaduce River (Panel B) and the Eggemoggin Reach area (C & D). Unidentified epibiotic growth was also recorded on eelgrass in the Eggemoggin Reach area (E & F).

Other species observed on underwater footage include lobsters (*Homarus americanus*), green sea urchins (*Strongylocentrotus droebachiensis*), sea stars (*Asterias forbesi* and/or *A. rubens*), skeleton shrimp (family Caprellidae), barnacles (*Balanus balanoides*), sausage weed (*Scytosiphon lomentaria*), horsetail kelp (*Laminaria digitata*), winged kelp (*Alaria esculenta*), what appeared to be sour weed (*Desmarestia* sp.), horseshoe crabs (*Limulus polyphemus*), benthic diatom and/or bacterial (e.g. *Beggiatoa* sp.) mats, lion's mane jelly (*Cyanea capillata*), hair sea-mat (*Electra pilosa*), burrowing anemones, and various snails and small schooling fish. Invasive species captured in videography include European green crabs (*Carcinus maenus*), carpet tunicate (*Didemnum vexillum*), sheath tunicate (*Botrylloides violaceus*), European sea squirt (*Ascidiella aspersa*), what appeared to be siphoned feather weed (*Dasysiphonia japonica*), oyster thief (*Colpomenia peregrina*), and green fleece (*Codium fragile*). Interestingly, the field crew also observed an ocean sunfish (*Mola mola*) from the surface in Narraguagus Bay.

3.2.2 Final Maps

Seagrass beds were delineated and digitized for a total of 801 beds and 2,446.0 acres within the Penobscot Bay Region, and 964 beds and 2,338.7 acres within the Acadia Region. Across both survey years, 1,243.1 acres were classified as Orth percent cover category 1 (0%-10%), 673.0 acres were classified as Orth percent cover category 2 (10%-40%), 972.5 acres were classified as Orth percent cover category 3 (40%-70%), and 1,896.1 acres were classified as Orth percent cover category 4 (70%-100%) (Figure 14). As noted above, populations of eelgrass and widgeon grass are impossible to distinguish by aerial signature alone. Therefore, only seagrass beds that were observed in the field are assigned a species in the shapefile attribute table, and the species identification is based on visual analysis only. However, since eelgrass is the dominant seagrass species along the Maine coastline, most non-speciated seagrass beds are assumed to be eelgrass for the purpose of this report but should be field-verified in future survey years. In 2024, widgeon grass was documented in two tidally restricted waterbodies (a salt pond on North Haven and a section of the Bagaduce River), totaling 22.9 acres of seagrass beds. Interestingly, in the upper segment of the Bagaduce River, upstream of the causeway on Route 175 that partially restricts tidal flow, widgeon grass was observed growing intermixed with eelgrass in a 3.4-acre bed. Some unverified beds in this section of the Bagaduce River may be widgeon grass, particularly the beds closest to the head of the Bagaduce River which field staff were unable to access due to limited water depth even at high tide. In 2025, a 3.5-acre widgeon grass bed was documented in the upper reaches of the tidally restricted Blue Hill Salt Pond.

In Penobscot Bay, clear waters allowed the delineation of many small beds and patches, and therefore the majority of beds (554/801) were under 1 acre in size. However, the average bed size was 3.1 acres due to several large beds (16 beds greater than 25 acres in size) and a few extensive beds (3 beds greater than 100 acres in size). The largest beds were documented along the shoreline north of Sprucehead Island in South Thomaston (270.9 acres), along the shoreline south of Sprucehead Island (242.0 acres), in the tidally restricted section of the Bagaduce River (124.7 and 63.6 acres), along the Tenants Harbor shoreline (60.1 acres), in Carvers Pond in Vinalhaven (55.3 acres), and along the Mosquito Island shoreline in Port Clyde (52.9 acres), which are all the beds greater than 50 acres in size. The area around Sprucehead Island, just south of the mouth of the Weskeag River, hosts many smaller beds in addition to the two largest beds for a total of 609.8 acres of seagrass beds between Thorndike Point and Whitehead Island. This is the greatest seagrass extent in a localized area within the survey region, although most of the acreage consists of very low percent cover beds (category 1, 0-10% cover). It is also noteworthy that two of the seven largest beds mapped in the project area were located within the tidally restricted section of the Bagaduce River, which also hosted two of the five largest high percent cover (category 4, 70%-100% cover) polygons (65.8 and 28.9 acres). Other large, high percent cover polygons were located in Carvers Pond (55.3 acres), in the Muscle Ridge Archipelago off the coast of South Thomaston (33.8 acres), and along the Mosquito Island shoreline (26.9 acres). In total, high percent cover beds comprised the most abundant cover category in Penobscot Bay, followed by very low percent cover beds, moderate percent cover beds (category 3, 40-70% cover), and then low percent cover beds (category 2, 10-40% cover).
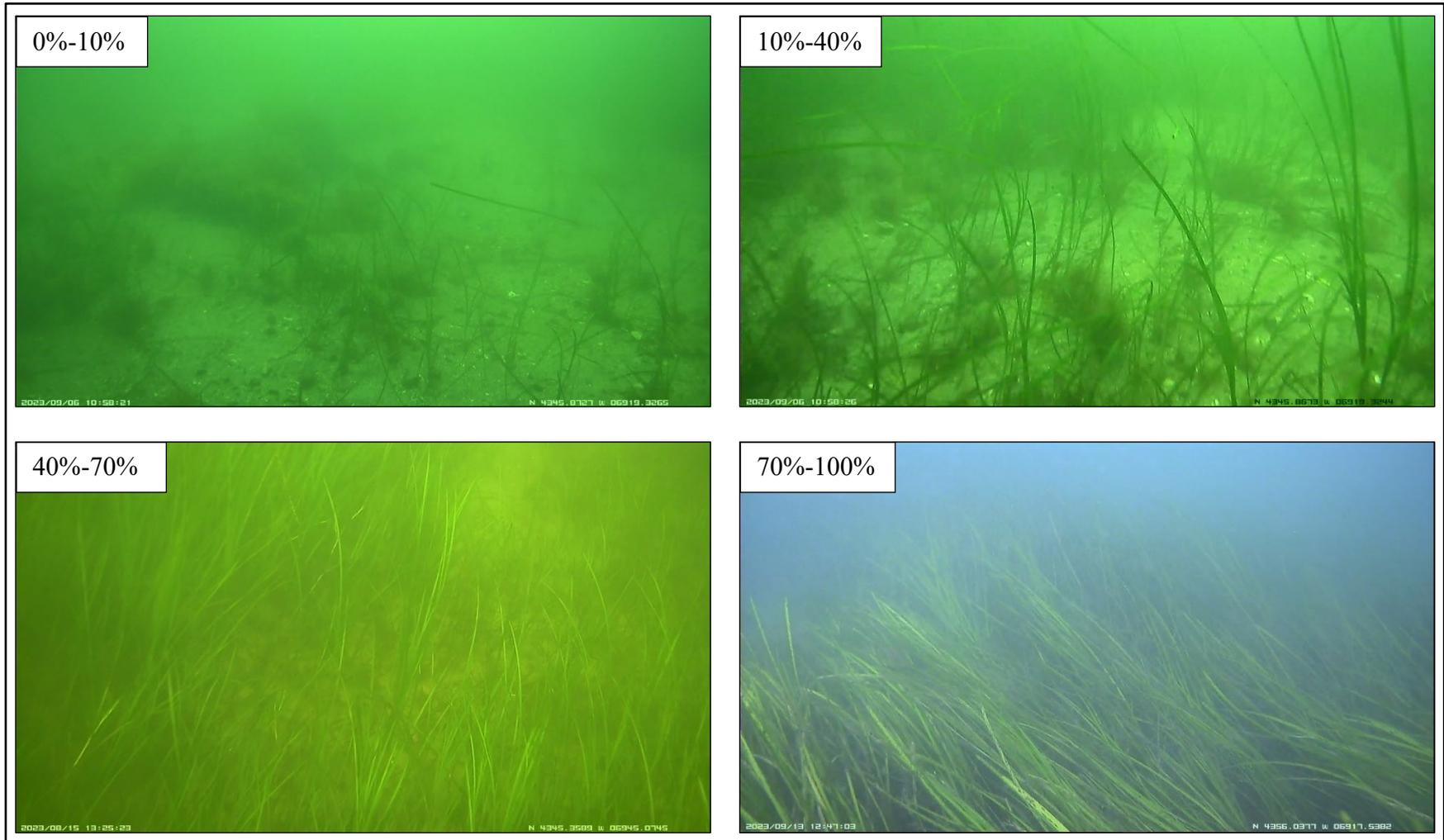
Figure 14. Seagrass percent cover categories observed in the field.

Similarly clear waters allowed the delineation of many small beds and patches in the Acadia Region and most beds (660/964) were also under 1 acre in size. The average bed size was slightly smaller than in Penobscot Bay (2.4 acres) due to several large beds (17 beds greater than 25 acres in size) but no extensive beds (i.e., greater than 100 acres in size). The largest beds were documented between the Cranberry Isles and Islesford (86.9 acres), off Tom Leighton Point (83.1 acres) and along the western shoreline of Bois Bupert Island in Milbridge (80.1 acres), between Fickett Point in Milbridge and Foster Island in Harrington (63.5 acres), and along the eastern shoreline of Petit Manan Point (54.2 acres), which are all the beds greater than 50 acres in size. The area between Tom Leighton Point, Bois Bupert Island, and Petit Manan Point in Milbridge, hosts many smaller beds in addition to the three large beds for a total of 327.6 acres. This is the greatest seagrass extent in a localized area within the survey region, and most of the acreage consists of high percent cover beds (category 4, 70-100% cover). It is also noteworthy that this area hosts five of the six largest high percent cover polygons, totaling 173.1 acres. The sixth and largest high percent cover polygon is 43.3 acres and is located just outside Corea Harbor. In total, high percent cover beds comprised the most abundant cover category in the Acadia Region, followed by moderate percent cover beds (category 3, 40-70% cover), very low percent cover beds (category 1, 0-10% cover) and then low percent cover beds (category 2, 10-40% cover).

The final GIS map of seagrass beds (polygon shapefiles) and associated metadata are available on the Maine GeoLibrary as feature service layers.[11]

3.3 Discussion

3.3.1   Distribution and Coverage of Seagrass

European green crabs (*Carcinus maenus)*, an invasive species, have been implicated in loss of eelgrass density and extent in Maine, particularly in Casco Bay (Neckles 2015). Green crabs feed on benthic prey such as shellfish and worms, but the foraging activity of green crabs within eelgrass beds involves uprooting and clipping off eelgrass shoots. Green crabs were observed occasionally throughout both field verification surveys. Although there was no direct evidence of green crab disturbance to eelgrass beds in the Penobscot Bay or Acadia Regions in 2024 or 2025, the length of time since the last eelgrass mapping surveys (2003, 2005, 2008, or 2009 depending on the location) and the lack of empirical studies to provide quantitative data on the matter cannot rule out the possibility. Moreover, loss of eelgrass beds due to crab foraging behavior can potentially lead to increased water column turbidity from sediment destabilization, creating a feedback loop that precludes eelgrass recolonization in previously suitable habitat.

Penobscot Bay Region

In general, the seagrass in Penobscot Bay was characterized by growth in close proximity to macroalgae, or even intermixed with macroalgae at several locations throughout the project area. Seagrass beds were most commonly observed in the outer, more exposed shorelines of the bay,

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[11] mainegeolibrary-maine.hub.arcgis.com/datasets/maine::mainedep-penobscot-bay-seagrass-2024 and
mainegeolibrary-maine.hub.arcgis.com/datasets/maine::mainedep-acadia-seagrass-2025

often in relatively deep and clear water. The exception to this is the tidally restricted section of the Bagaduce River, which hosts abundant and dense beds of both eelgrass and widgeon grass.

Epibiont observations were recorded opportunistically during the course of fieldwork, and generally only for heavily fouled beds. Seagrass bed acreage with one or more associated epibiont observation were classified as 'fouled.' Of the eight geographic sections, two had no recorded epibiont observations (no seagrass was mapped in Upper Penobscot Bay, and no field verification was performed for the Outer Islands). The remaining six geographic sections exhibit a clear distinction between sections with a relatively low percent of fouled beds (Muscle Ridges, Vinalhaven-North Haven, and Isle Au Haut; 6% ± 2% [average ± standard deviation] of total mapped seagrass acres), and a relatively high percent (Islesboro Island, Bagaduce River, and Deer Isle-Stonington; 38% ± 15% [average ± standard deviation] of total mapped seagrass acres). The presence of epibiotic growth on seagrass blades can affect light penetration to the shoots, which is required by seagrass for photosynthesis, and eelgrass is more sensitive to light limitation than many other marine macrophytes such as macroalgae (Larkum et al. 2006). Although an imperfect measure with error contributions from opportunistic epibiont observations and unaccounted variation in fouling intensity across seagrass beds, the stark contrast between geographic sections with relatively high or low percentage of fouled beds is striking nonetheless, with the generally more oceanic geographic sections hosting healthier eelgrass beds.

The DEP Marine Environmental Monitoring Program (MEMP) monitored ten sites in Rockland and Camden Harbors (within the Islesboro Island geographic section) and the Bagaduce River (downstream of the tidal restriction at Route 175) for several water quality parameters every three weeks from May to October 2024, including the light attenuation coefficient (a measure of water clarity or light transmission through the water column, K_d, m^{-1}), temperature, and nutrient concentrations. Although there were no sampling sites near the major islands (Vinalhaven, North Haven, Deer Isle, Isle Au Haut), the Muscle Ridge area, or the upper bay, water quality conditions at the sampling sites were generally suitable to support eelgrass growth, with an abundance of exceptionally clear water sites. Based on the New Hampshire Department of Environmental Services (NHDES) established K_d threshold of ≤0.75 m-1 for eelgrass restoration to a depth of 2 meters (NHDES 2009), only the uppermost Bagaduce River sampling site was likely too turbid to support eelgrass beds, with a seasonal median K_d value of 0.86 m^{-1} ± 0.15 m^{-1} (standard deviation). Elevated turbidity at this site is likely attributable to the local hydrologic conditions related to the tidal restriction at the nearby Route 175 causeway, and no eelgrass was observed in the immediate vicinity. The seasonal average Total Nitrogen (TN) values were highest in Camden Harbor (0.25 mg/L) and the eelgrass resource in this area is consistent with the larger geographic area in terms of both distribution and change over time. The seasonal average surface water temperature (≤8 meters) was <17°C at all sampling sites, which is below the upper thermal limit (26.7° C) for eelgrass as established by Marba et al. (2022). However, site-specific variation in thermal tolerance (Franssen et al. 2011) is understudied in Maine and there is evidence that even modest (e.g., 0.5° C) increases in temperature above average can negatively impact local eelgrass performance (Plaisted et al. 2022).

Acadia Region

In general, the seagrass in the Acadia Region was also characterized by growth in close proximity to macroalgae, or even intermixed with macroalgae at several locations throughout the project area. Seagrass beds were most commonly observed along the outer, more exposed mainland and island shorelines with the most resource mapped in the geographic sections with limited shallow, protected, upper reaches of estuaries or other embayments and with more oceanic influences (Swans-Cranberry Isles, Gouldsboro-Dyer Bays, and Jonesport Beals). No clear trend was noted in the spatial distribution of epiphyte observations within the survey area.

The MEMP monitored 13 sites in the Union River Estuary and Bay, Taunton and Frenchman Bays, and the Narraguagus River following the sampling design as 2024. Although there were no sampling sites in the Swans-Cranberry Isles, Gouldsboro-Dyer Bays, or Jonesport-Beals geographic sections, the upper and mid-estuaries generally experience higher levels of turbidity with elevated K_d values toward the landward end of these systems. Based on the New Hampshire Department of Environmental Services (NHDES) established K_d threshold of ≤ 0.75 m^{-1} for eelgrass restoration to a depth of 2 meters (NHDES 2009), the upper Union River and Taunton Bay, plus all Narraguagus sampling stations were likely too turbid to support eelgrass beds, and no seagrass beds were observed up-estuary of measured median K_d values above 0.75 m^{-1}. The seasonal average TN values were highest in the upper Union River (~0.35 mg/L), but eelgrass has never been mapped in this area likely due to high light attenuation and low salinity (seasonal average 18 PSU). The seasonal average surface water temperature (≤ 8 meters) was <15°C at all sampling sites located near any historical or current seagrass beds, which is again below the upper thermal limit (26.7° C) for eelgrass as established by Marba et al. (2022), but site-specific thermal tolerance and variation should be considered as described above.

3.3.2 Comparison with Previous Years

Differences in delineated beds between seagrass surveys may arise from variation in methods, field observation interpretation, aerial signature interpretation, or equipment and data accuracy. Although the results from this survey are comparable to previous seagrass maps, the DMR eelgrass digitization and field verification methodology is not documented in a detailed manner. The DMR personnel responsible for eelgrass mapping produced a protocol document for mapping eelgrass in Maine (Barker 2015), which outlines a generalized survey approach that the MVMP survey methodology was largely modelled after.

Across both years and survey regions, a percent decline in seagrass acreage relative to the most recent surveys in the 2010s was 47.3%. Although more of the loss occurred in the Acadia Region, the distribution of loss is consistent between both regions. The beds that were lost or shrank were mostly located in the upper reaches of embayments, at relatively protected sites, or on tidal flats. Conversely, areas with expanding seagrass beds or smaller declines were generally located along island shorelines or other relatively exposed areas with more oceanic influence. The seagrass habitat within Penobscot Bay is largely of the latter type, which may account for the smaller percent decline of seagrass in this region than in other recently surveyed regions, including the Acadia Region which historically supported abundant intertidal eelgrass beds that are now gone. More region-specific information are included in the regional sections below.

Table 5. Seagrass acreage by geographic section and year for both Penobscot Bay (2024) and Acadia (2025) region surveys.

Geographic Section	Survey Years			2000s -> 2020s Areal Change
	1992/3/5/6/7	2003/5/8/9	2024/5	
Upper Penobscot Bay	338.1	58.3	0	-100.0%
Bagaduce River	1,126.6	591.5	364.8	-38.3%
Islesboro Island	782.9	199.8	71.4	-64.3%
Deer Isle-Stonington	1,125.7	859.5	201	-76.6%
Herrick Bay	103.3	190.1	36.7	-80.7%
Muscle Ridges	1,314.9	1,472.2	1,305.9	-11.3%
Vinalhaven-North Haven	445.4	265.3	309.5	16.7%
Isle Au Haut	84.2	97.4	142.3	46.1%
Outer Islands	n/a	n/a	14.4	n/a
Total Penobscot Bay Region	**5,321.2**	**3,734.1**	**2,446.0**	**-34.5%**
Taunton Bay	1,572.7	637.9	75.3	-88.2%
Blue Hill-Union Bays	77.5	113.9	18.3	-84.2%
Pleasant Bay	2,346.9	1,221.3	273	-77.6%
Frenchman Bay	1,527.4	438.3	106.6	-75.7%
Eggemoggin Reach	102.6	111.3	36.4	-67.3%
Gouldsboro-Dyer Bays	2,803.4	1,328.1	628.3	-52.7%
Jonesport-Beals	1,720.4	840.1	517	-38.4%
Swans-Cranberry Isles	553.9	662.2	683.8	3.3%
Total Acadia Region	**10,704.7**	**5,353.1**	**2,338.7**	**-56.3%**

Table 6. Seagrass acreage by percent cover and survey year for both Penobscot Bay (2024) and Acadia (2025) region surveys.

Percent Cover	Region and Survey Years					
	Penobscot Bay			Acadia		
	1992/3/5/6	2003/4/5/8	2024	1996/7	2008/9	2025
0-10	358.8	661.3	758	901.1	1,147.50	485.1
10-40	660.5	1,056.50	327.1	2,671.70	2,290.50	345.9
40-70	872.6	1,135.60	405	4,968.30	1,150.10	567.5
70-100	860.2	880.8	955.8	2,163.50	765	940.3
Unassigned	2,569.10	n/a	n/a	n/1	n/a	n/a
Total	**5,321.20**	**3,734.10**	**2,446.00**	**10,704.70**	**5,353.10**	**2,338.70**

Penobscot Bay Region

Compared to the most recent historic seagrass surveys in 2003, 2005, and 2008 (DMR 2010), the Penobscot Bay Region lost 34.5% of total seagrass bed extent, or 1,288.1 acres (Table 5). This calculation includes the seagrass acreage mapped in the Outer Islands geographic section, and although this area is not included in historical seagrass surveys, the resulting value is not largely affected by the additional 14.4 acres (34.9% loss excluding the novel acreage). The level of loss documented in Penobscot Bay is considerable, although it should be noted that it is less than recently documented losses for other DEP survey areas (59.9% in the Midcoast Region in 2023, 54.5% in Casco Bay in 2022, and 56.3% in the Acadia Region in 2025, compared to the most recent surveys in each region).

Areas with the most considerable losses include:

- The Upper Penobscot Bay geographic section (58.3 acres in 2003 and 0.0 acres in 2024)
- The tidally restricted section of the Bagaduce River (448.8 acres in 2008 and 288.6 acres in 2024)
- The Islesboro Island shoreline (81.1 acres in 2003 and 5.0 acres in 2024)
- Eggemoggin Reach and the southwestern Deer Isle/Little Deer Isle shoreline (685.7 acres in 2008 and 110.5 acres in 2024)
- The Stonington Islands (171.0 acres in 2008 and 78.1 acres in 2024)
- Herrick Bay (190.1 acres in 2008 and 36.7 acres in 2024)

For the purposes of this section, Eggemoggin Reach is considered to be the southwestern Brooklin, Sedgewick, and Brooksville shorelines, the northeastern Little Deer Isle and Deer Isle shorelines, and southeastern Deer Isle islands. Eggemoggin Reach, Herrick Bay, and the Stonington Islands combined account for 821.5 acres of the 1,288.1-acre decline since the last survey. No eelgrass was mapped in the Upper Penobscot Bay in 2024, resulting in a 100% loss for that geographic section, but historical beds were small and fringing and therefore the total areal loss is less than many other areas. Conversely, a total 166.3 acreage reduction was documented for the Muscle Ridge geographic section, but this is largely due to the extensive seagrass beds in this area, both historically and recently, and the change relative to 2003/2005 was a relatively small 11.3% decline. The beds that were lost or shrank in the Muscle Ridge geographic section were mostly located in the upper reaches of embayments and/or more protected sites.

Total seagrass acreage expanded in the Vinalhaven-North Haven (44.2 acres, 16.7% gain) and Isle Au Haut (44.9 acres, 46.1% gain) geographic sections. Although these are relatively small gains compared to the documented losses, it is notable that the two geographic sections with expanding seagrass beds and the geographic section with the smallest declines are located at the outer bay and comprise the three most exposed sections for which there is a historical comparison. Seagrass beds have not previously been mapped in the Outer Islands geographic section, and therefore a change analysis is not possible. Although not included in the historical DMR surveys, the Outer Islands geographic section was surveyed in 2024 and 14.4 acres of seagrass were documented and delineated on Matinicus, Matinic, Ragged, and Large Green

Islands for the first time. New seagrass resource was documented most notably in a 51.8-acre expansion of the eelgrass bed along the Mosquito Island shoreline in Port Clyde relative to 2005.

In addition to the shift in seagrass extent, the relative abundance of the cover classes changed over time. The proportion of 70-100% cover beds increased in 2024 relative to the previous survey, as did the proportion of 0-10% cover beds, with 10-40% and 40-70% cover beds declining in proportion to the total mapped acreage (Table 4). In general, Penobscot Bay still hosts many dense, thriving seagrass beds despite recent loss closer to the head of the Penobscot River and protected reaches of embayments.

Finally, the geographic sections with the highest percent decline of seagrass extent correspond to the sections with the highest percent of fouled beds. The degree of fouling is generally understood to increase with nutrient loading, but clear warming waters (GMRI 2024) could also accelerate epiphytic growth. Likewise, thermal stress can additionally or simultaneously reduce seagrass population success. Since there is spatial overlap of the areas with generally warmer waters, more abundant epiphytes, and lower light transmission through the water column, it is not currently possible to clearly identify the stressor(s) driving the documented seagrass loss.

Acadia Region

Compared to the most recent historic seagrass surveys in 2008 and 2009 (DMR 2010), the Acadia Region lost 56.3% of total seagrass bed extent, or 3,014.4 acres (Table 5). The level of loss documented in the Acadia Region is greater than the Penobscot Bay (34.5%) and the Midcoast Regions (54.5%), but less than Casco Bay (72.1%) over roughly the same time period.

Areas with the most considerable losses include:

- Taunton Bay (637.9 acres in 2008 and 75.3 acres in 2025)
- Blue Hill and Union Bays (115.9 acres in 2008 and 18.3 acres in 2025)
- Pleasant Bay (1,221.3 acres in 2009 and 273.0 acres in 2025)
- Frenchman Bay (438.3 acres in 2008 and 106.6 acres in 2025)
- A portion of Eggemoggin Reach (111.3 acres in 2008 and 36.4 acres in 2025)
- Gouldsboro-Dyer Bays (1,328.1 acres in 2009 and 628.3 acres in 2025)

Pleasant, Gouldsboro-Dyer, and Taunton Bays geographic sections combined account for 2,210.7 acres of the 3,014.4-acre decline since the last survey. Taunton Bay exhibited the highest percent loss of any geographic section at 88.2% (562.2 acres) and the loss is visually striking in many places (Figure 15). Very few eelgrass beds were mapped in the Blue Hill-Union Bays geographic section in 2025, resulting in an 88.2% loss for that geographic section, but historical beds were small, fringing, and widely dispersed and therefore the total areal loss (95.6 acres) is much less than most other areas. Conversely, a total 699.8 acreage reduction was documented for the Gouldsboro-Dyer Bays geographic section, but this is largely due to the extensive seagrass beds in this area, both historically and recently, and the decline relative to 2009 (52.7%) was less than many other geographic sections. The beds that were lost or shrank in the Gouldsboro and Dyer Bay area were almost entirely located in the upper reaches of embayments, more protected sites, and/or tidal flats.
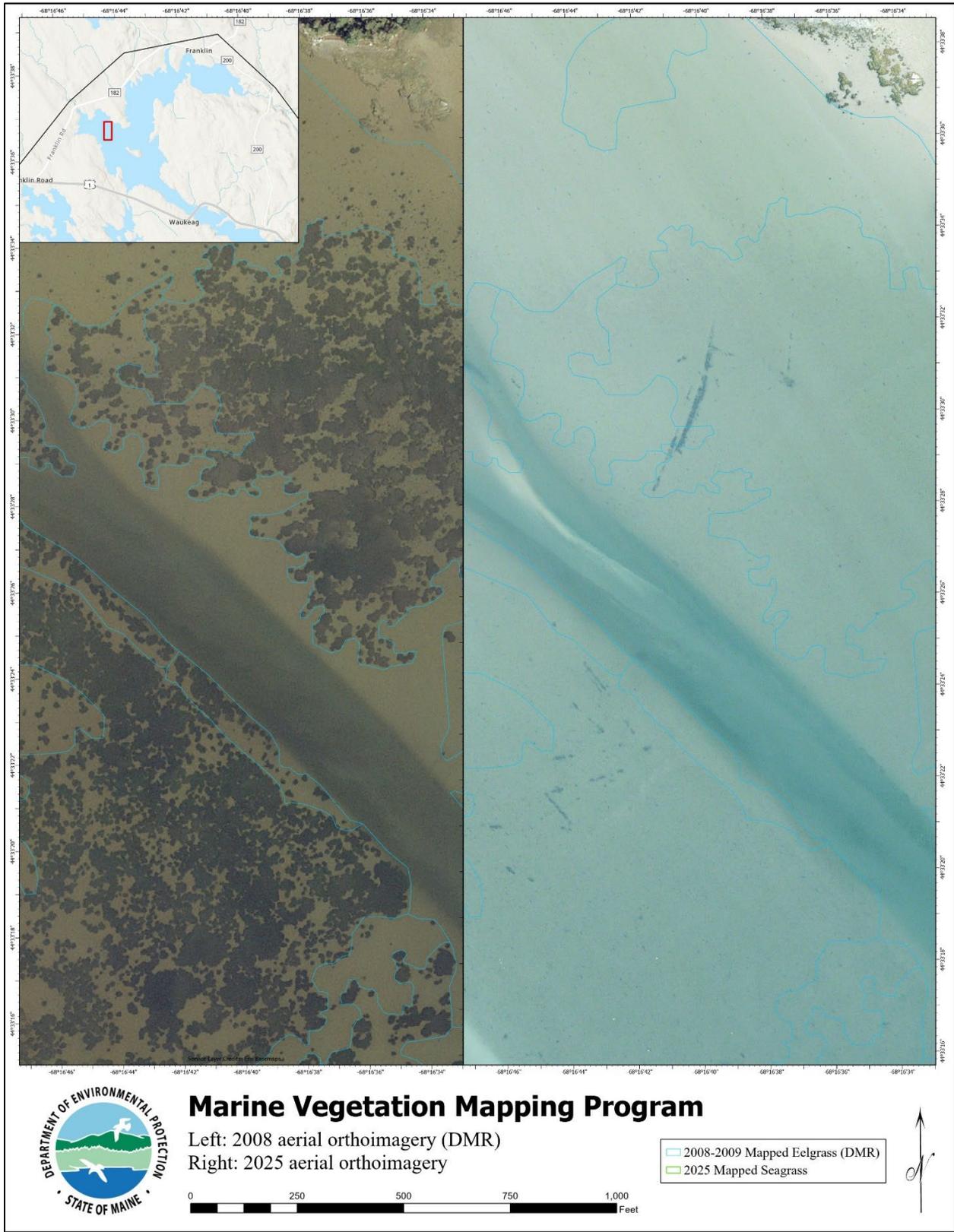
Figure 15. Visual loss of seagrass in Taunton Bay between 2008 and 2025. Left: 2008 aerial orthoimagery from DMR. Right: 2025 aerial orthoimagery.

Total seagrass acreage expanded only in the Swans-Cranberry Isles geographic section (21.6 acres, 3.3% gain), but the Jonesport-Beals geographic section saw the lowest percent decline at 38.4%. Although this is a very small gain compared to the documented losses, and a large amount of area (323.1 acres) was lost in the Jonesport-Beals geographic section, it is notable that the shoreline in the geographic section with expanding seagrass beds and the geographic section with the smallest percent declines are both largely comprised of islands. These areas likely have more oceanic influence and host less shallow subtidal/intertidal habitat that historically supported expansive eelgrass beds. New seagrass resource was documented most notably in a 53.3-acre expansion of the eelgrass beds between the Cranberry Isles and Islesford and a new 63.5-acre bed between Fickett Point in Milbridge and Foster Island in Harrington, relative to the most recent survey in 2009/2009.

In addition to the shift in seagrass extent, the distribution and abundance of the varying cover classes changed over time. The proportion of 70-100% cover beds increased in 2025 relative to the previous survey, while the proportion of 10-40% cover beds declined (Table 4). In general, the Acadia Region still hosts many dense, thriving seagrass beds but has experienced major losses in protected reaches of embayments and tidal flats.

Eggemoggin Reach and Herrick Bay Interannual Variability

The area around Naskeag Point was captured in the aerial survey in both 2024 and 2025. Herrick Bay, east of Naskeag Point, was mistakenly included in the 2024 Penobscot Bay aerial survey and a portion of Eggemoggin Reach, west Naskeag Point, was mistakenly included in the 2025 Acadia Region aerial survey. Conversely, field verification was completed for Herrick Bay as part of the regular 2025 Acadia Region survey, and for Eggemoggin Reach as part of the regular 2024 Penobscot Bay survey. However, with all datasets combined, the area around Naskeag Point can assessed for interannual variability based on two years of field-verified seagrass bed distribution data. In 2024, there were 56.1 acres and in 2025 there were 83.8 acres, which is a 49.4% increase. Based on a review of imagery and field verification data, this appears to mostly be a true expansion of beds and establishment of new beds in 2025 relative to 2024, although there are a few localized examples of higher imagery quality in 2025 where a boat wake or similar obstruction was captured in 2024. It should be noted that this is a relatively small study area, and the observed trend may or may not hold at a regional or coastwide scale.

4. Tidal Marsh Delineation and Mapping

4.1 Methods

4.1.1 Photointerpretation

The Penobscot Bay and Acadia Regions survey areas were subdivided into the same geographic sections as used for the seagrass mapping for the purpose of organizing field efforts and photointerpretation (Figures 8 and 9). The size of each geographic section varies, along with the tidal marsh habitat type and quality within each section. Aerial orthoimagery was photointerpreted to refine polygon boundaries in the existing tidal marsh polygon shapefile. The most recent version of the tidal marsh shapefile was updated, and MNAP incorporated edits made by DEP into the shapefile that is currently hosted on the Maine GeoLibrary (MNAP 2026). The tidal marsh aerial signature can be relatively clearly distinguished along the seaward edge in low tide imagery, which often transitions to mudflat or other habitat types along a visually distinct edge.

Changes made to the tidal marsh shapefile primarily included refining the seaward edge of marsh polygons and removing open water stream and river channels to improve acreage accuracy. In instances of unclear signature in the true color imagery (RGB band combination), the decision tree shown in Figure 16 was used to select data sources with which to delineate tidal marsh boundaries, where CIR (Color Infrared) imagery indicates the
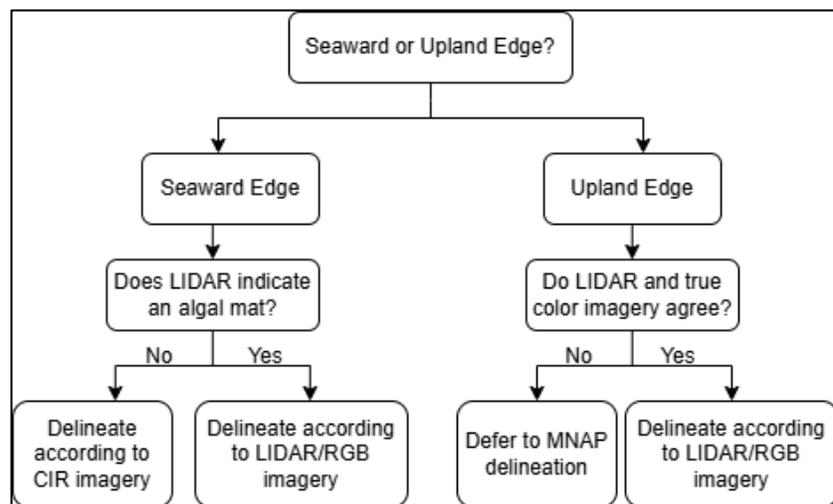
Figure 16. Marsh delineation data source decision tree.

NIR, red, green band combination and LiDAR (Light Detection and Ranging) refers to the 2-foot elevation contours and 1-meter DEM layers hosted by the (Maine GeoLibrary 2021). Sites that were visited in the field were further refined based on waypoints and track logs. The combined data used in delineations, including LiDAR, imagery, and field data, are shown in Figure 17. Natural community types (Salt-hay Salt Marsh, Mixed Graminoid-Forb Salt Marsh, Brackish Tidal Marsh, and Freshwater Tidal Marsh) were previously assigned to each site by MNAP according to Gawler and Cutko (2010) and were unchanged during the photointerpretation process. An MMU was not employed by MNAP in the development of the tidal marsh shapefile, but marsh polygons as small as 0.3 acres and 0.2 acres were previously mapped in the Penobscot Bay and Acadia Region, respectively, where conditions and context allowed, such as more extensive but multipart tidal marsh areas. Tidal marsh sites larger than 2.5 acres are considered Element Occurrences by MNAP and are tracked in their georeferenced database, Biotics.
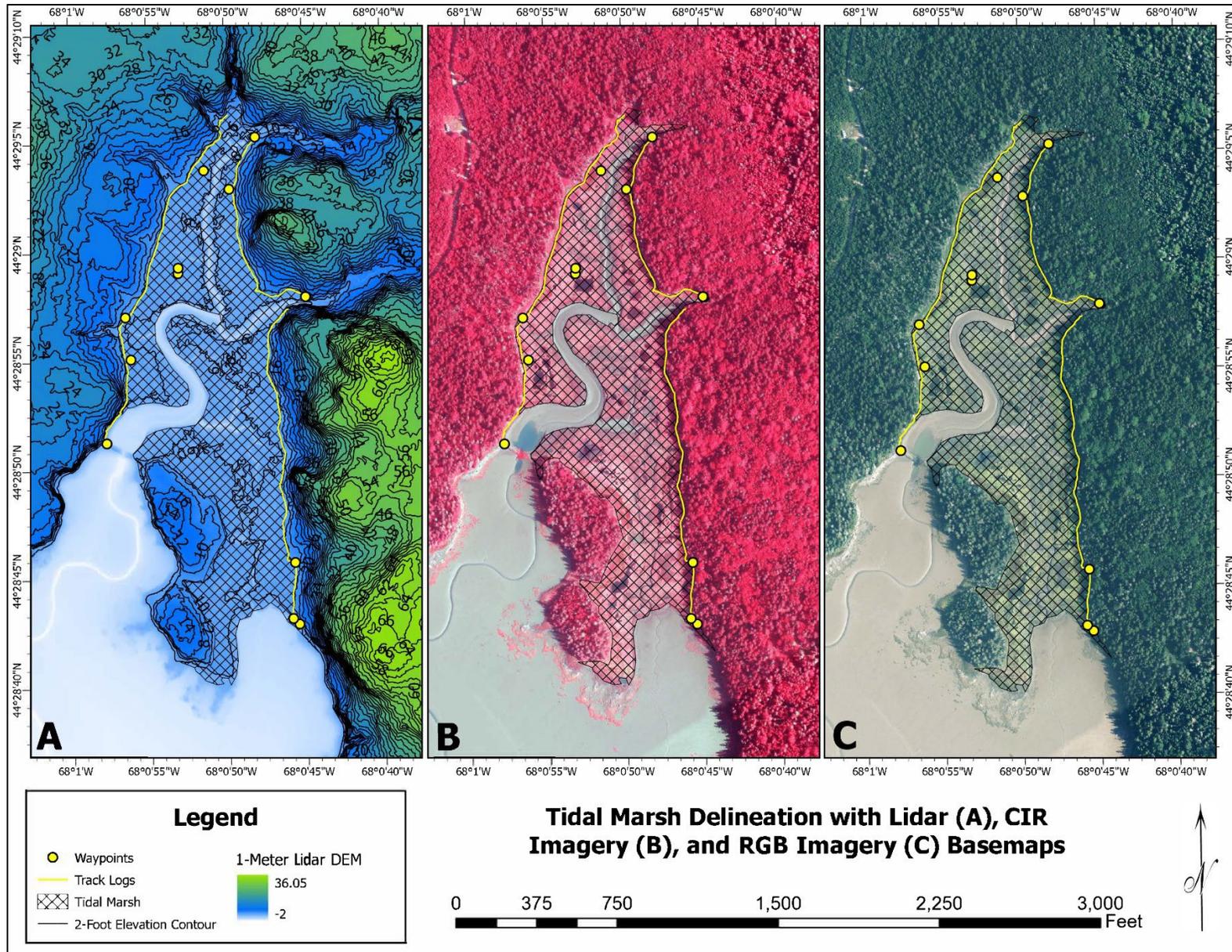
Figure 17. Data sources used in marsh delineation process.

Photointerpretation was done at a scale ranging from 1:1,000-1:2,500 depending on marsh or channel size and other landscape features. Marshes and channels that were mapped at a scale at or close to 1:2,500 were reviewed at a larger scale after initial edits to ensure boundary accuracy. Void areas (interior to a marsh polygon but not marsh habitat, such as uplands) were clipped, or removed, from the features. This approach is consistent with the existing tidal marsh shapefile. No stretch, brightness, or contrast was applied to the imagery during polygon refinement, though different band combinations were employed as described above. The final shapefile was checked for accuracy and errors as described below in Section 4.1.4 Quality Assurance/Quality Control. ArcGIS Pro v. 2.9.9 was used for all desktop GIS workflows in 2024 and v 3.3.5 in 2025.

4.1.2 Field Verification

Tidal marsh field visits were performed by both DEP and MNAP staff. The season for tidal marsh field verification is approximately July through November, when there is sufficient aboveground biomass for the majority of characteristic plant species. *De novo* sites that are not currently included in the Biotics database due to lack of field verification, or sites that required an update, were selected for field verification by MNAP staff based on landowner permission and property boundaries. Only sites where landowner permission was acquired were field surveyed. The objectives of field visits included walking the upland edge to create a GPS track line, collecting waypoints for any notable features (i.e., rare species, upland 'islands'), and completing an MNAP Natural Community Survey form. Information was collected regarding plant species composition (including rare or invasive species), relevant landscape features (including hydrology and land use in the surrounding area), and disturbance history. Based on the results of the Natural Community Survey form, MNAP staff ranked each site from A (Excellent) to D (Poor) according to condition, landscape context, and size. Field verification occurred on foot and entailed the use of a Bad Elf GNSS Surveyor high-accuracy receiver capable of submeter accuracy, and a field notebook. The crew consisted of three to four individuals, with an MNAP staff member present for all site visits.

4.1.3 Database Updates

Biotics is the database maintained by MNAP that is the official geo-referenced tracking system of rare plants and rare or exemplary natural communities, including tidal marshes, which are considered vulnerable in Maine. Biotics data are provided annually to the NatureServe program, which hosts data from all U.S. state natural heritage programs to track species, communities, and biodiversity across state lines with comparable methodology. MNAP's database serves as a valuable tool for conservation planning, among other uses, and is available to municipalities, state, and federal agencies, as well as the general public. All tidal marshes greater than 2.5 acres in size are considered Element Occurrences of a rare natural community type and are tracked in Biotics following field verification. *De novo* sites and site updates were added to Biotics following field visits, completion of MNAP's Natural Community Survey form and Site Survey form, finalization of the site delineation polygon in GIS, and creation of a site map (see Appendix B for Biotics submission maps, courtesy of MNAP staff Emily Carty).

4.1.4 Quality Assurance/Quality Control

To ensure that DQOs were met, all field crew members were adequately trained on survey methodology. The DQIs for those parameters most important to accurately delineating tidal marshes are presented in Table 7. Data quality objectives (DQOs) assess the adequacy of data collected relative to their intended uses and present the specifications necessary to support the qualitative and quantitative data collection effort. These specifications address the acceptable probability of error, define the type of data needed to support the decision, and identify the conditions under which the data should be collected. To ensure that DQOs were met, all field crew members were adequately trained on survey methodology. Performance criteria are presented in quantitative terms as data quality indicators (DQIs) for those parameters most important to accurately delineating tidal marshes (Table 7). All DQIs established for tidal marsh delineation were met during the 2024 and 2025 surveys.

To inform evaluation of quality control for the aerial orthoimagery, Bluesky Geospatial Ltd. provided flight reports for all lifts, the latest camera/sensor calibration report, documentation of the GSD for imagery acquisition, and horizontal positional accuracy verification. James W. Sewall Co. additionally provided aerotriangulation reports and a Verified QC Checklist and installed 12 new ground control points in 2024 and 11 in 2025 to improve aerotriangulation and ensure spatial accuracy of the final imagery.

The accuracy of GPS for all field observations waypoints was ≤2.5 meters. Due to occasionally beginning track logging during a cold start of the GNSS receiver when satellite fix and WAAS correction was still limited, and due to occasional obstruction of satellite signal by forest canopy, the accuracy of track logs was occasionally greater than 2.5 meters. Field staff paused walking the upland edge in those instances until greater accuracy could be achieved, or noted the low accuracy in order to avoid relying on those data for delineations. Five sites were identified within the Penobscot Bay Region by MNAP for field verification, and three were visited by DEP and MNAP staff. The additional two sites were not visited due to staff-shortage-induced time constraints on the day of the field visit, and logistical hurdles to accessing Vinalhaven Island for a second day of field verification work. Two sites were identified within the Acadia Bay Region and both were visited. Natural Community Survey forms were completed for each site that was visited and used to verify the natural community type. In addition to review of aerial signature, field observation waypoints, track logs, field notes, and Natural Community Survey forms, tidal marsh delineation was informed by historical NAIP imagery from 2021 and the available 2-ft elevation contours. To maintain consistency between previous and current mapping efforts, refined tidal marsh delineation polygons were reviewed by MNAP Community Ecologist Kristen Puryear.

The final digitized tidal marsh shapefile was evaluated for completeness and correctness within the Penobscot Bay and Acadia Regions. First, the associated attribute table was sorted and all polygons smaller than the MMU were reviewed as potentially erroneous sliver polygons. The 'Check Geometry' geoprocessing tool was run to identify any invalid geometry in the dataset. Finally, attribute rules and a topology were created to check for polygon overlaps, duplicate features, gap slivers, unclosed polygons, and unnecessary boundaries. Vertex snapping was used as appropriate throughout tidal marsh polygon refinement to reduce topology errors.

Table 7. Data quality indicators for tidal marsh delineation.

Work Stage	DQI	Criteria
Field verification Survey	Spatial Accuracy	GNSS receiver reported accuracy ≤2.5 meters 2DRMS
	Survey Completeness	Field visits completed for all *de novo* sites with sufficient landowner access permission
	Season	July-November
Photointerpretation	Mapping completeness	Tidal marsh polygon boundaries refined for 100% of annual survey area
	Minimum Mapping Unit	2.5 acres

4.2 Results

4.2.1 Field Verification

Field data collection occurred on October 24, 2024 and July 28, 2025. No seasonal senescence or decline of vegetation biomass of characteristic plant species was noted during field activity. Field visits were used to verify tidal marsh presence and community type for *de novo* sites that were not previously included in Biotics, or sites that required an update, and a total of five sites were visited by DEP staff across both survey years.

4.2.2 Database Updates and Final Maps

In 2024, two sites were found to be tidal marsh communities and were added to Biotics as new Element Occurrences (Crockett Cove and Basin South Marshes). One additional site was found to be a tidal marsh community but was too small to be considered an Element Occurrence (<2.5 acres, Ballground Marsh), and it was therefore added to Biotics as negative surveys to avoid duplicate effort in the future. In 2025, both sites were found to be tidal marsh communities and were added to Biotics as new Element Occurences. No endangered, threatened, or species of concern were noted during field efforts. In total, approximately 21.9 acres in the Penobscot Bay Region and 31.0 acres in the Acadia Region of tidal marshes were updated, added to, or improved in the Biotics database. All four sites that were added to or updated in Biotics (Crockett Cove, Basin South, Clark Cove, and West Bay) are Salt-hay Salt Marshes. The sites were ranked in quality by MNAP Community Ecologist Kristen Puryear in accordance with the standard ranking system employed for all Element Occurrences and are as follows:

- Crockett Cove Marsh – Rank C (small size and evidence of sea level rise stress)
- Basin South Marsh – Rank C (small size, fragmented, and along edge of road)
- Clark Cove Marsh – Rank C (small size, limited buffer)
- West Bay Marsh – Rank B (small size but in excellent landscape context)

Additionally, the tidal marsh shapefile was refined by approximately 11.6 acres within the Penobscot Bay Region, and 54.9 acres within the Acadia Region through more accurate delineation, particularly of the seaward edge of marshes, and by removing open water stream and river channels. Although below the threshold to be considered an Element Occurrence and included in the Biotics database, the Ballground Marsh site was added to the tidal marsh shapefile. These changes have been incorporated into the GIS map of statewide tidal marshes (polygon shapefile) that is currently hosted on the Maine GeoLibrary.[12]

4.3 Discussion

Most of Maine's 22,000+ acres of tidal marsh have been mapped with a remote landscape analysis using the best available aerial orthoimagery, but accuracy improvements have been made in the Penobscot Bay and Acadia Regions based on high-resolution low tide aerial orthoimagery with this 2024 and 2025 surveys. Accurate baseline maps could function to inform future assessments of marsh migration due to sea level rise at a regional or coastwide scale. Additionally, a subset of these marsh sites has been the subject of field inventory and added to the MNAP database, Biotics, which serves as the official state record of tidal marsh sites. The ability to field verify and add new sites to Biotics is limited by access to the sites, which is in turn dictated by landowner permission and property boundaries, as many tidal marsh sites exist across multiple private parcels and, therefore, only partial access permission is granted in some cases.

The Penobscot Bay and Acadia Regions host a relatively small amount of tidal marshes compared to other MVMP regions. Based on the 2024 and 2025 adjustments to the existing tidal marsh shapefile within the two survey regions, approximately 964.7 acres and 2,697.2 acres out of 22,186.8 acres of coastwide tidal marsh reside within the Penobscot Bay and Acadia Regions, respectively. Across both regions, the total acreage includes primarily Salt-hay Salt Marshes (2,986.6 acres) and Brackish Tidal Marshes (691.8 acres), with additional small extents of Mixed Graminoid-Forb Salt Marshes (31.6 acres, Penobscot Bay only) and Freshwater Tidal Marshes (6.8 acres, Acadia Region only).

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[12] mainegeolibrary-maine.hub.arcgis.com/datasets/maine::mainenap-marsh-migration/explore?layer=1

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6. Appendices

Appendix A. Seagrass Distribution and Percent Cover Maps

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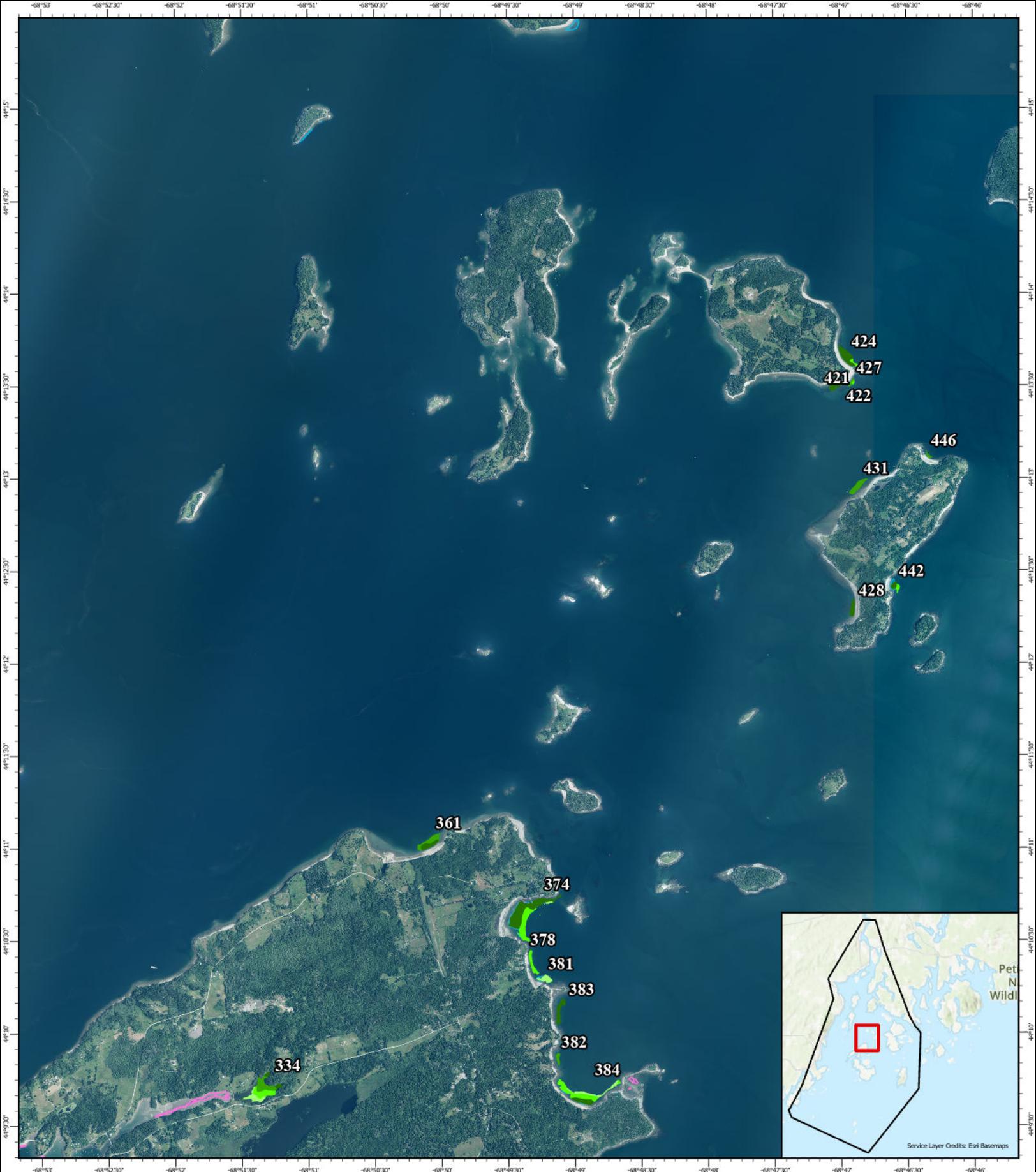
PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

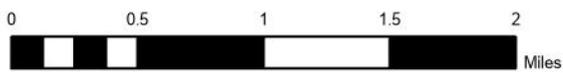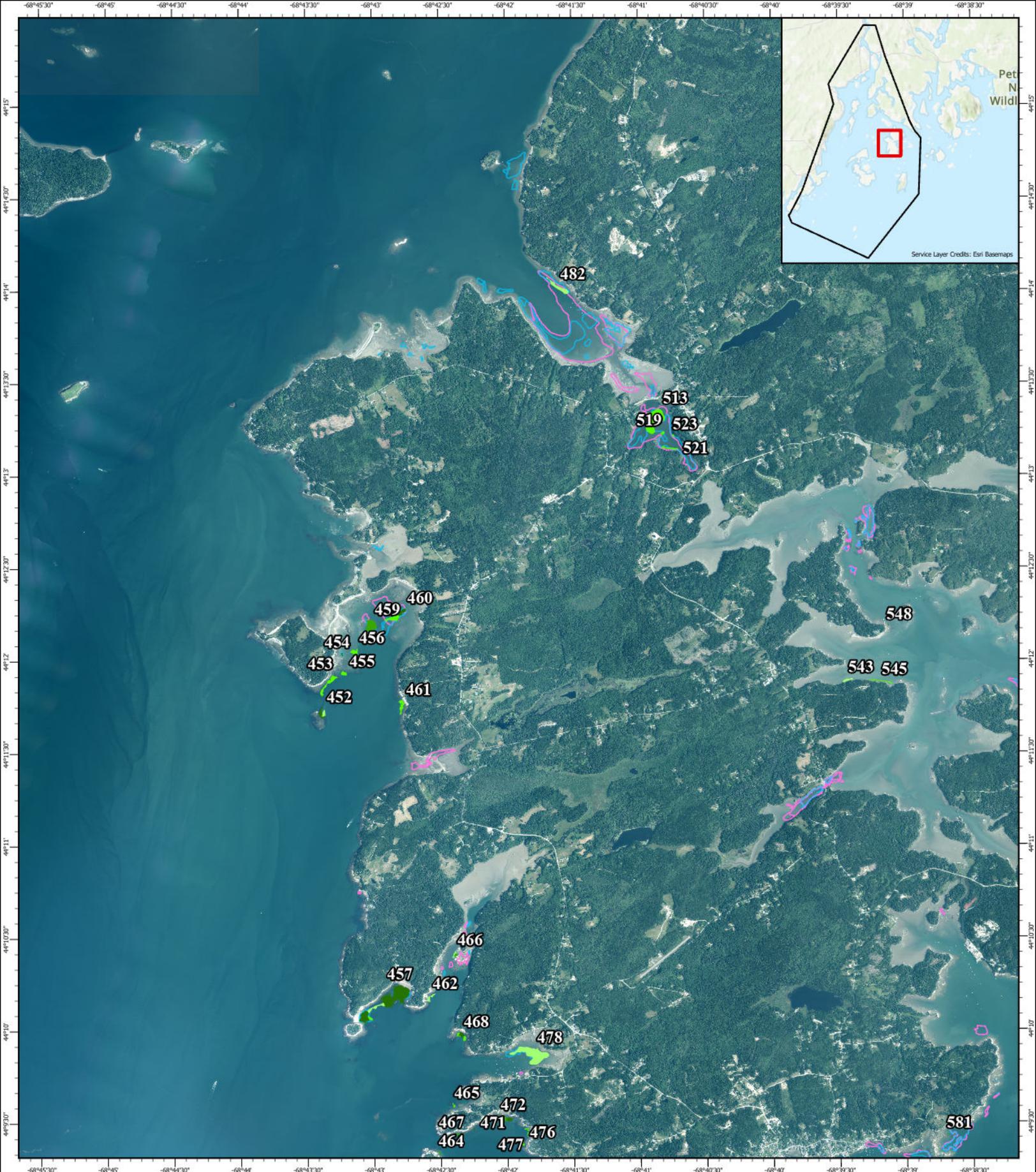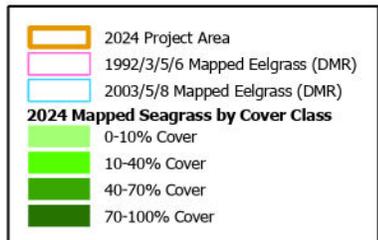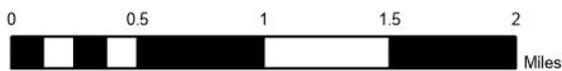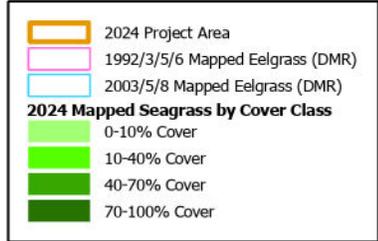2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 1 of 29

	Legend
	2024 Project Area
	1992/3/5/6 Mapped Eelgrass (DMR)
	2003/5/8 Mapped Eelgrass (DMR)
2024 Mapped Seagrass by Cover Class	
	0-10% Cover
	10-40% Cover
	40-70% Cover
	70-100% Cover

Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING
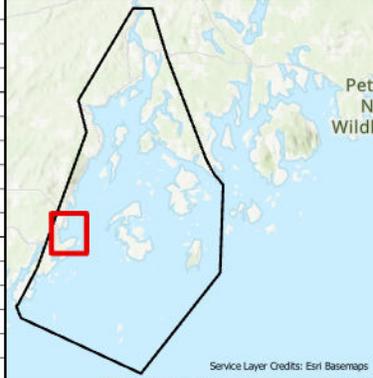
Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 2 of 29

Legend:

- 2024 Project Area
- 1992/3/5/6 Mapped Eelgrass (DMR)
- 2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

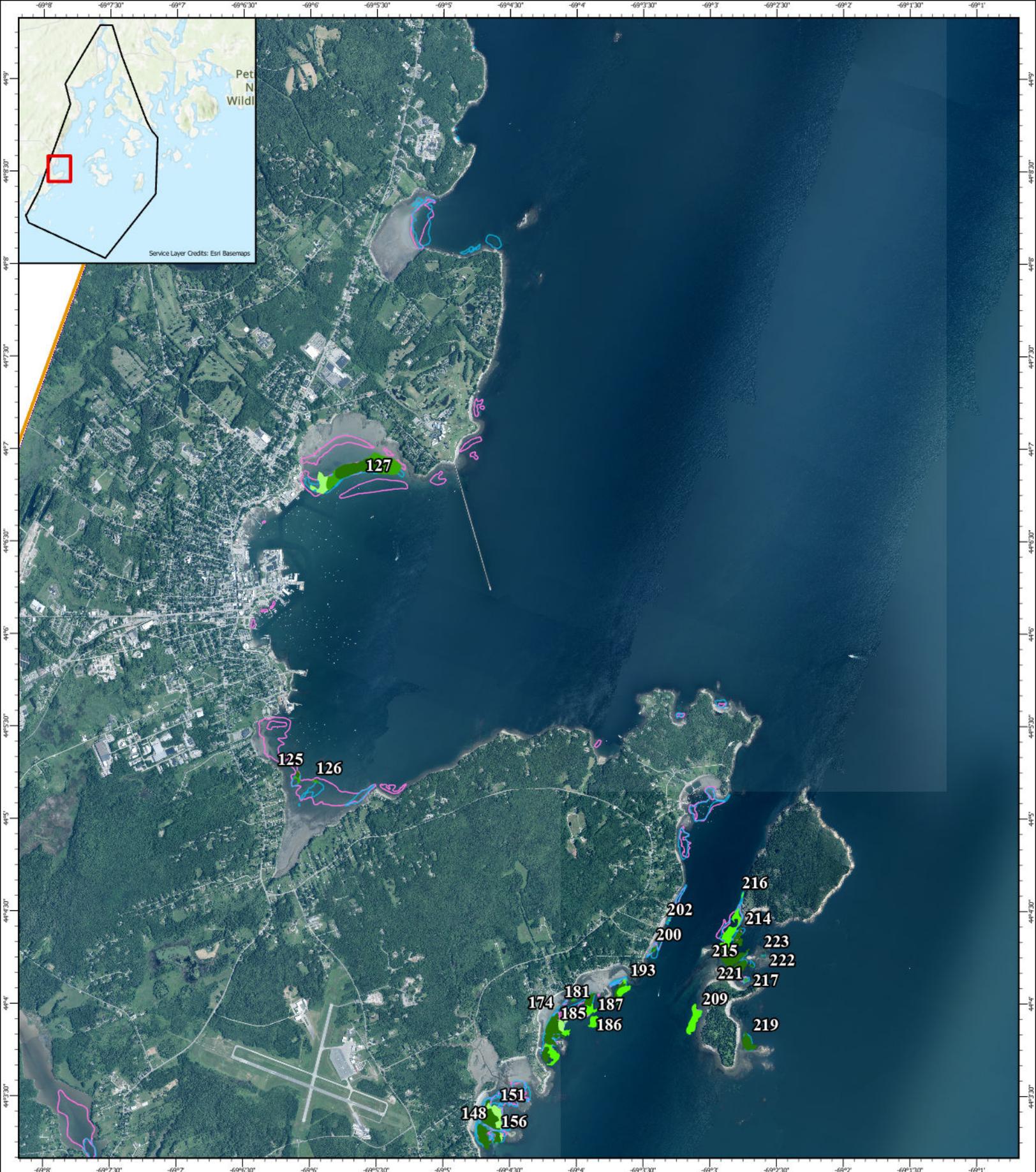Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

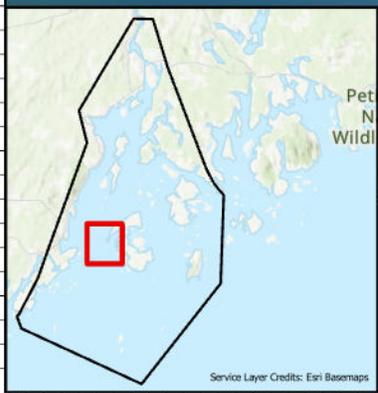2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 3 of 29

Legend

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

Service Layer Credits: Esri Basemaps

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE ·

0   0.5   1   1.5   2 Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

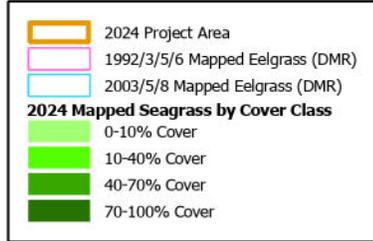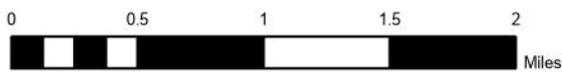Map Page 4 of 29

Legend:

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

Service Layer Credits: Esri Basemaps

PENOBSCOT BAY REGION SEAGRASS MAPPING
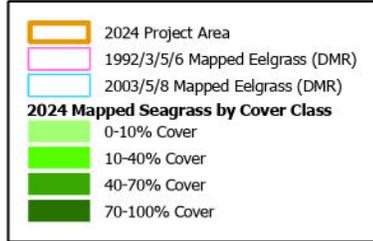
Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 5 of 29

Legend:

- 2024 Project Area
- 1992/3/5/6 Mapped Eelgrass (DMR)
- 2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

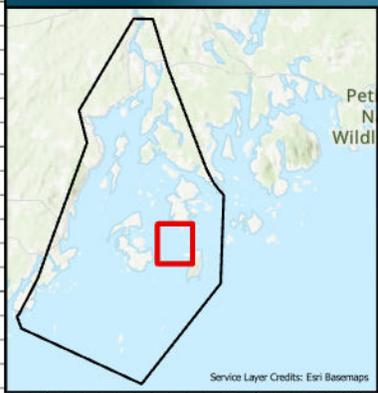2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 6 of 29

Legend:
- 2024 Project Area
- 1992/3/5/6 Mapped Eelgrass (DMR)
- 2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

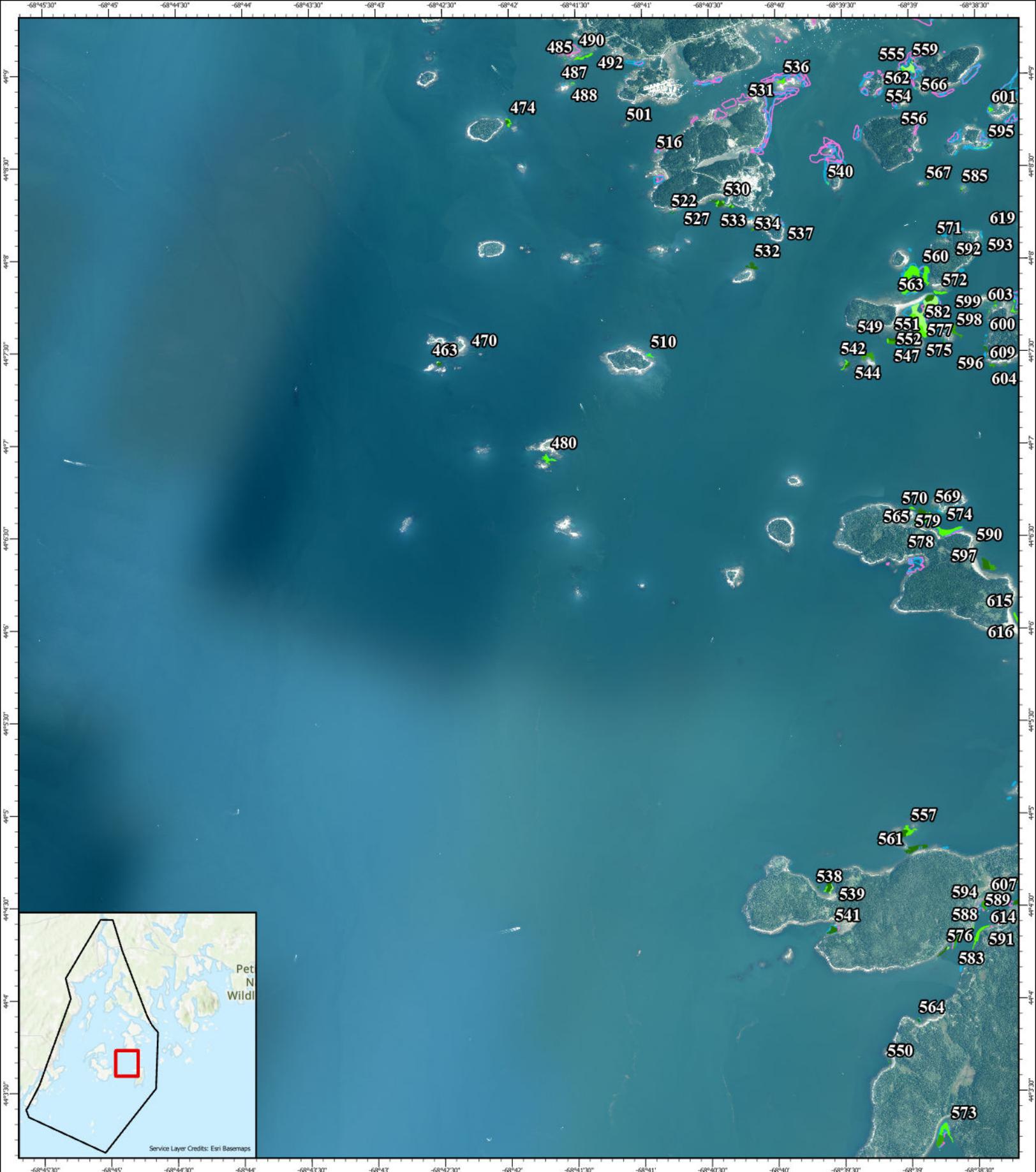Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

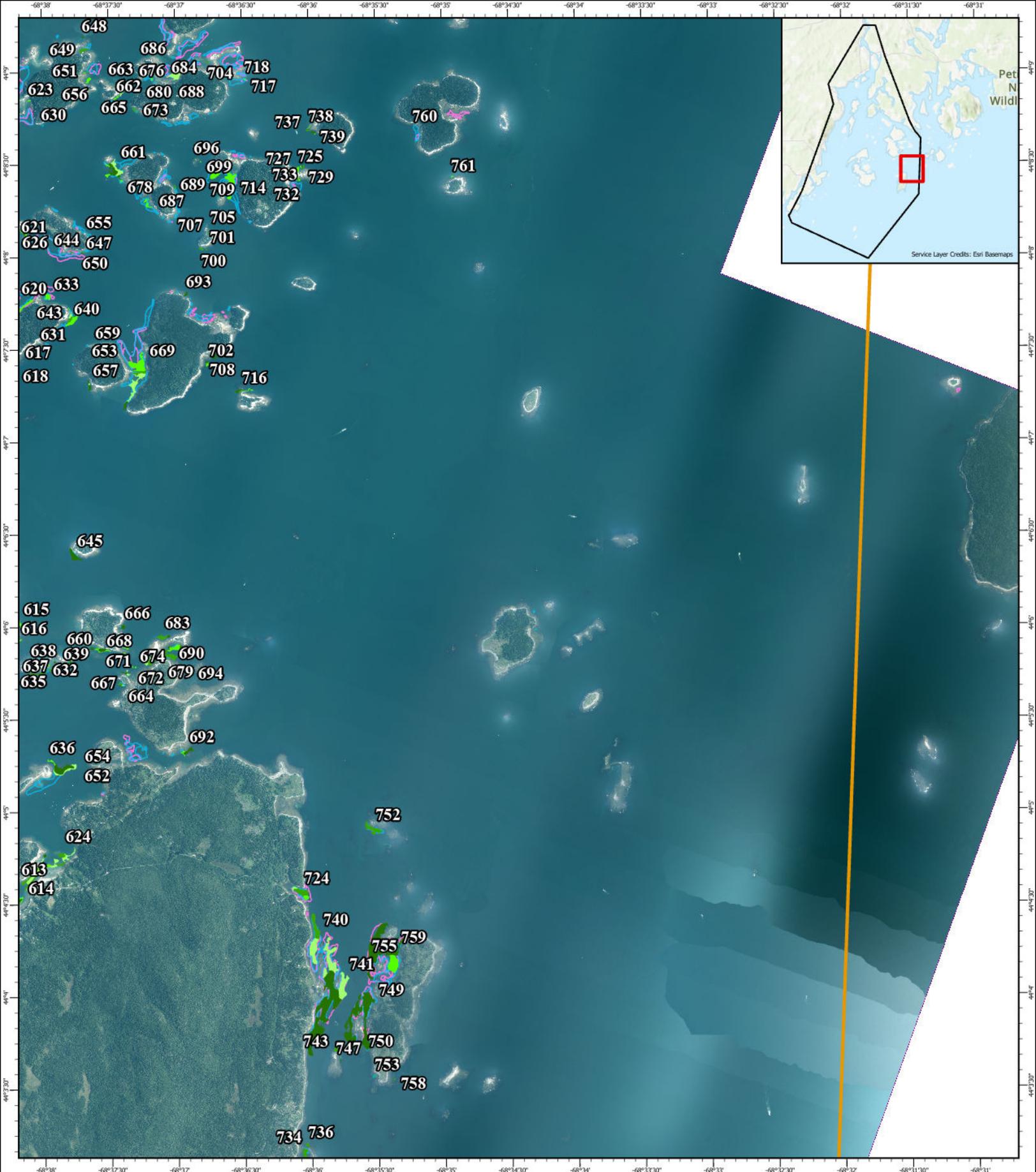2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Legend:

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

Service Layer Credits: Esri Basemaps

Service Layer Credits: Esri Basemaps

675
682
691
706
720
745
795

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE ·

Map Page 8 of 29

0	0.5
1	1.5
	2

Miles

Legend

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)
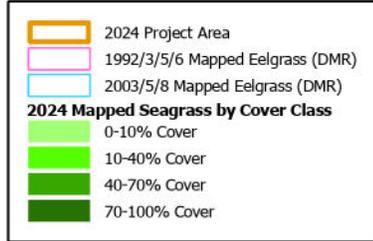**2024 Mapped Seagrass by Cover Class**
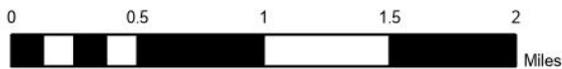0-10% Cover
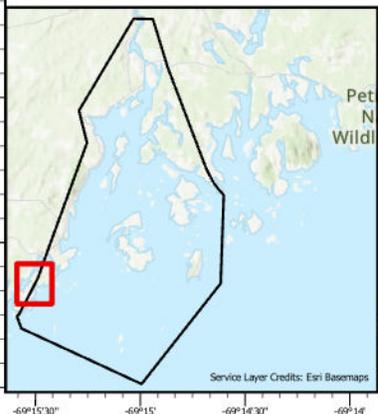10-40% Cover
40-70% Cover
70-100% Cover

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 9 of 29

Legend:

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

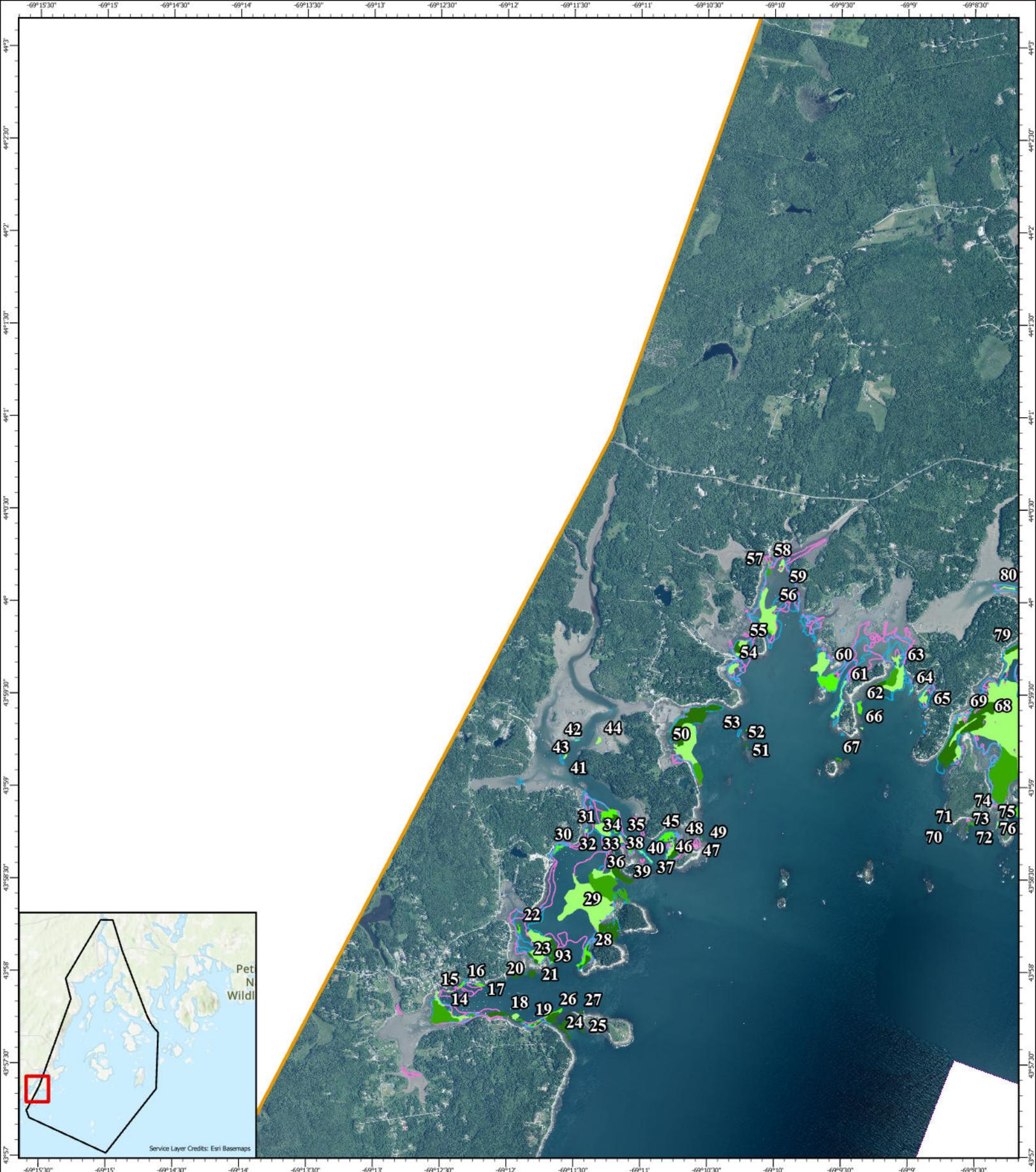DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE ·

Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2 Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 10 of 29

Legend:

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
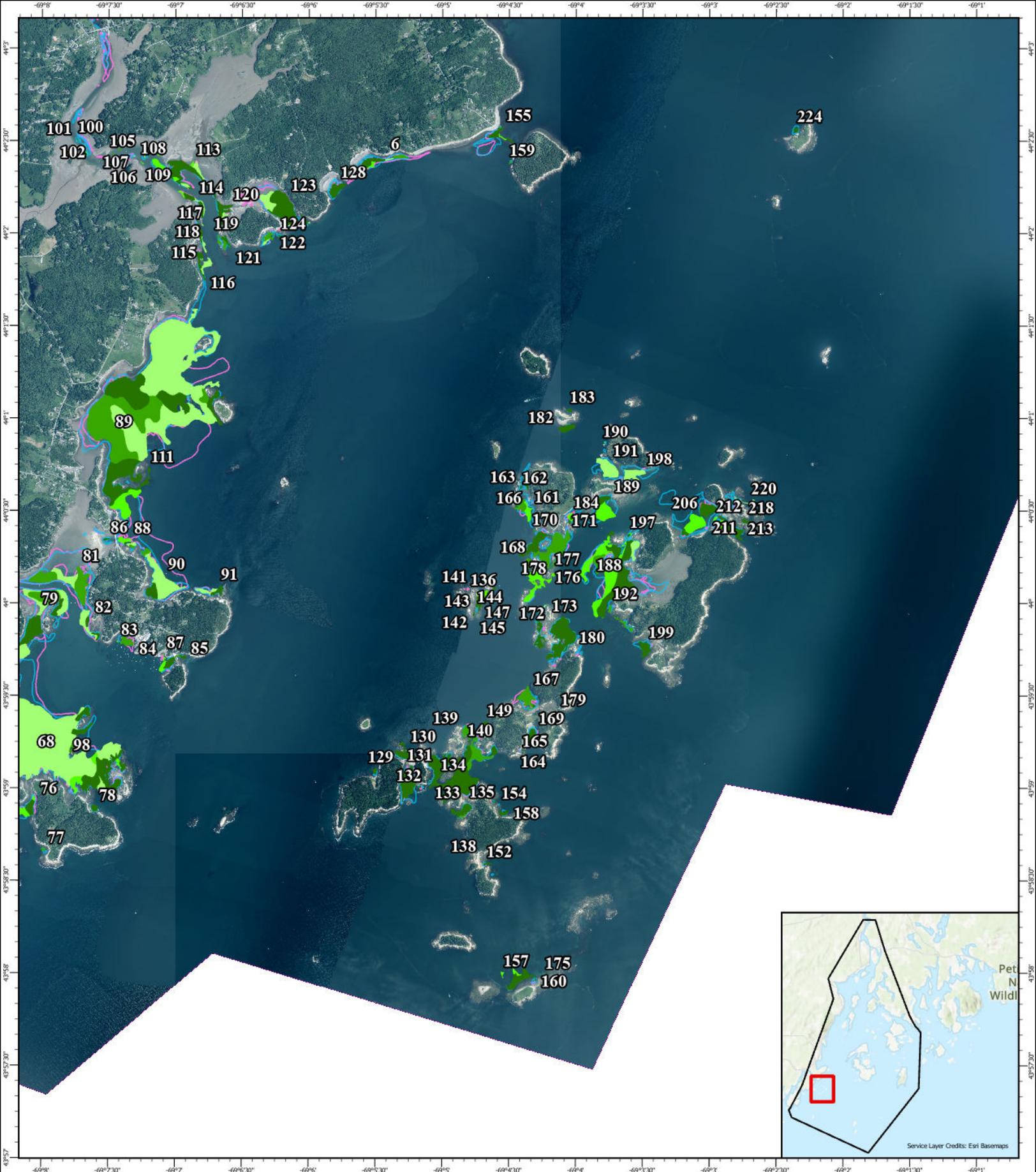0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 11 of 29

0   0.5   1   1.5   2   Miles

2024 Project Area

1992/3/5/6 Mapped Eelgrass (DMR)

2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class

0-10% Cover

10-40% Cover

40-70% Cover

70-100% Cover

Service Layer Credits: Esri Basemaps

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 12 of 29

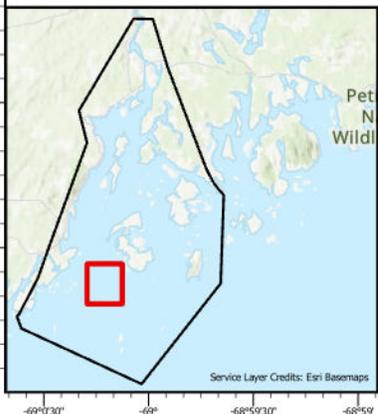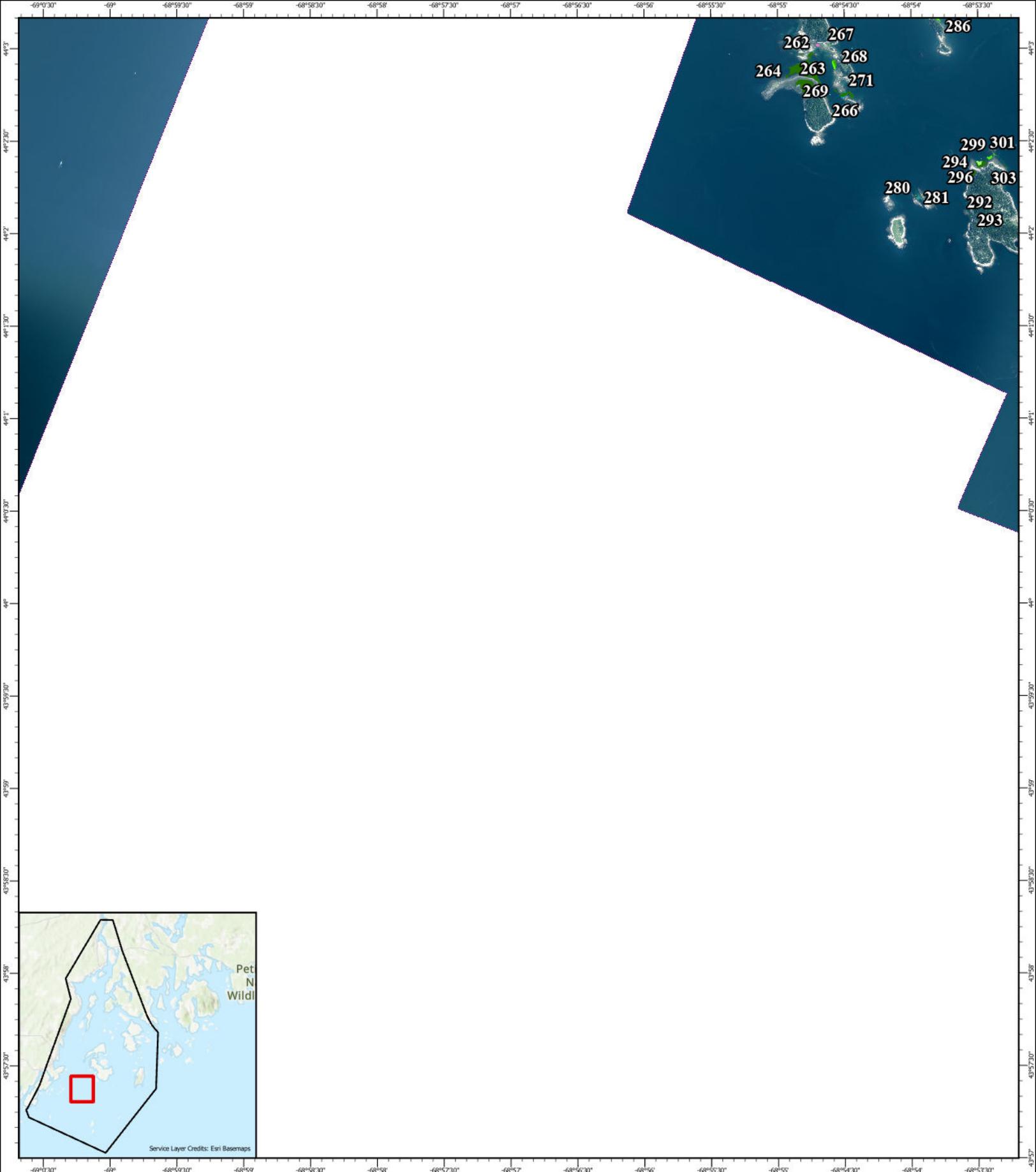Service Layer Credits: Esri Basemaps

Legend:

- 2024 Project Area
- 1992/3/5/6 Mapped Eelgrass (DMR)
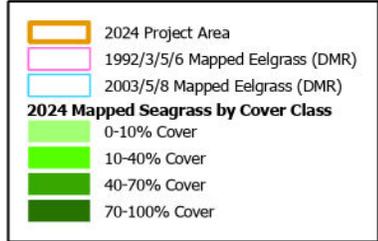- 2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2 Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 13 of 29

Legend:
- 2024 Project Area
- 1992/3/5/6 Mapped Eelgrass (DMR)
- 2003/5/8 Mapped Eelgrass (DMR)
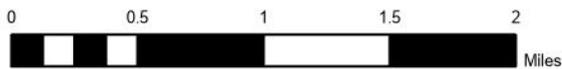- **2024 Mapped Seagrass by Cover Class**
  - 0-10% Cover
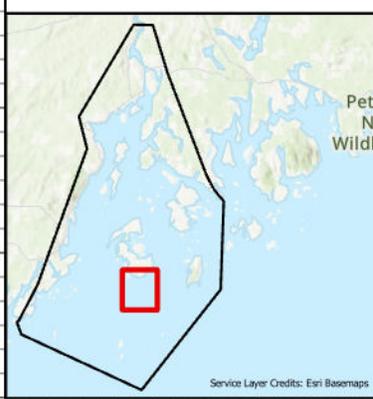 - 10-40% Cover
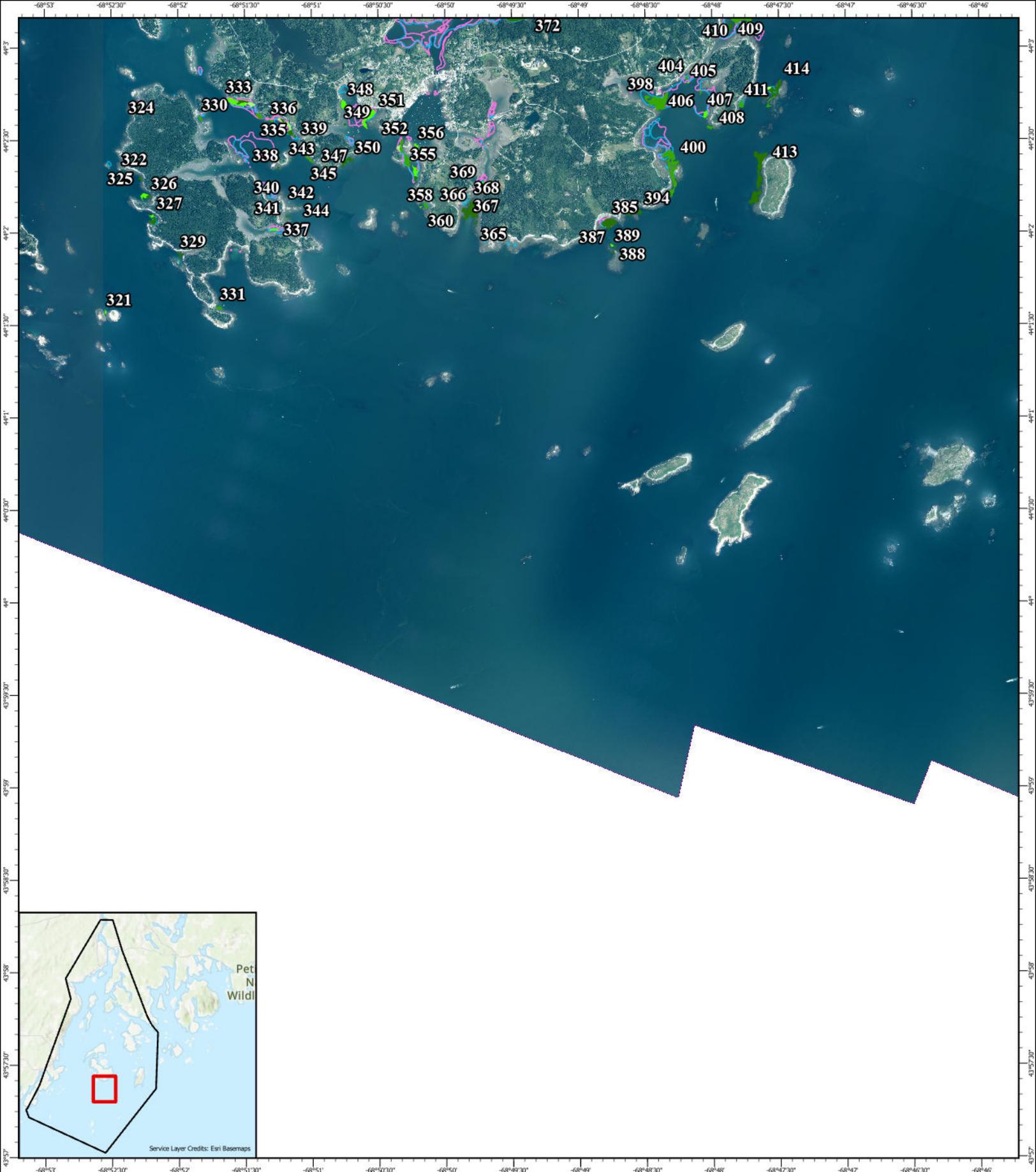 - 40-70% Cover
  - 70-100% Cover

Service Layer Credits: Esri Basemaps

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 14 of 29

Legend:

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Service Layer Credits: Esri Basemaps

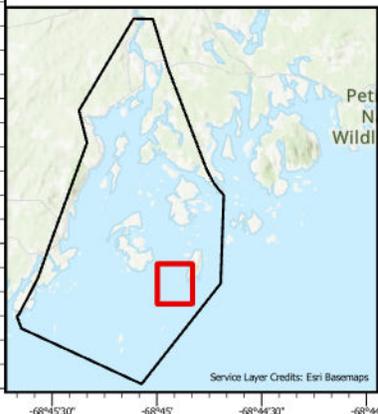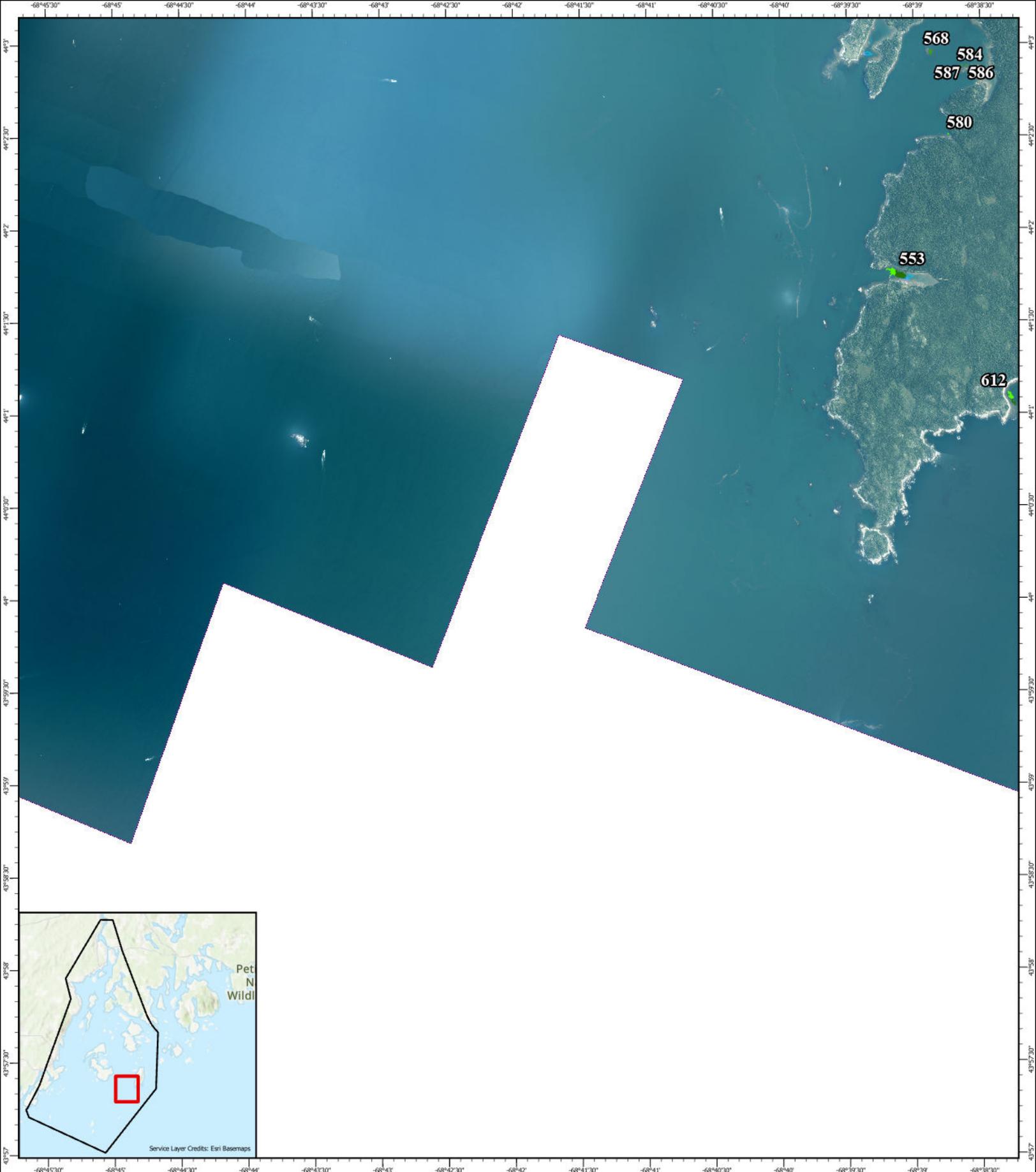DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Legend

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

Service Layer Credits: Esri Basemaps

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover
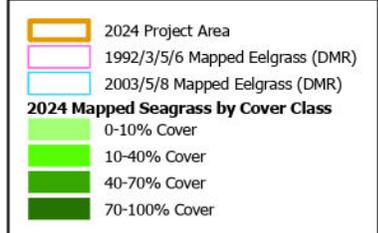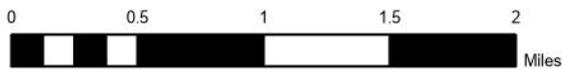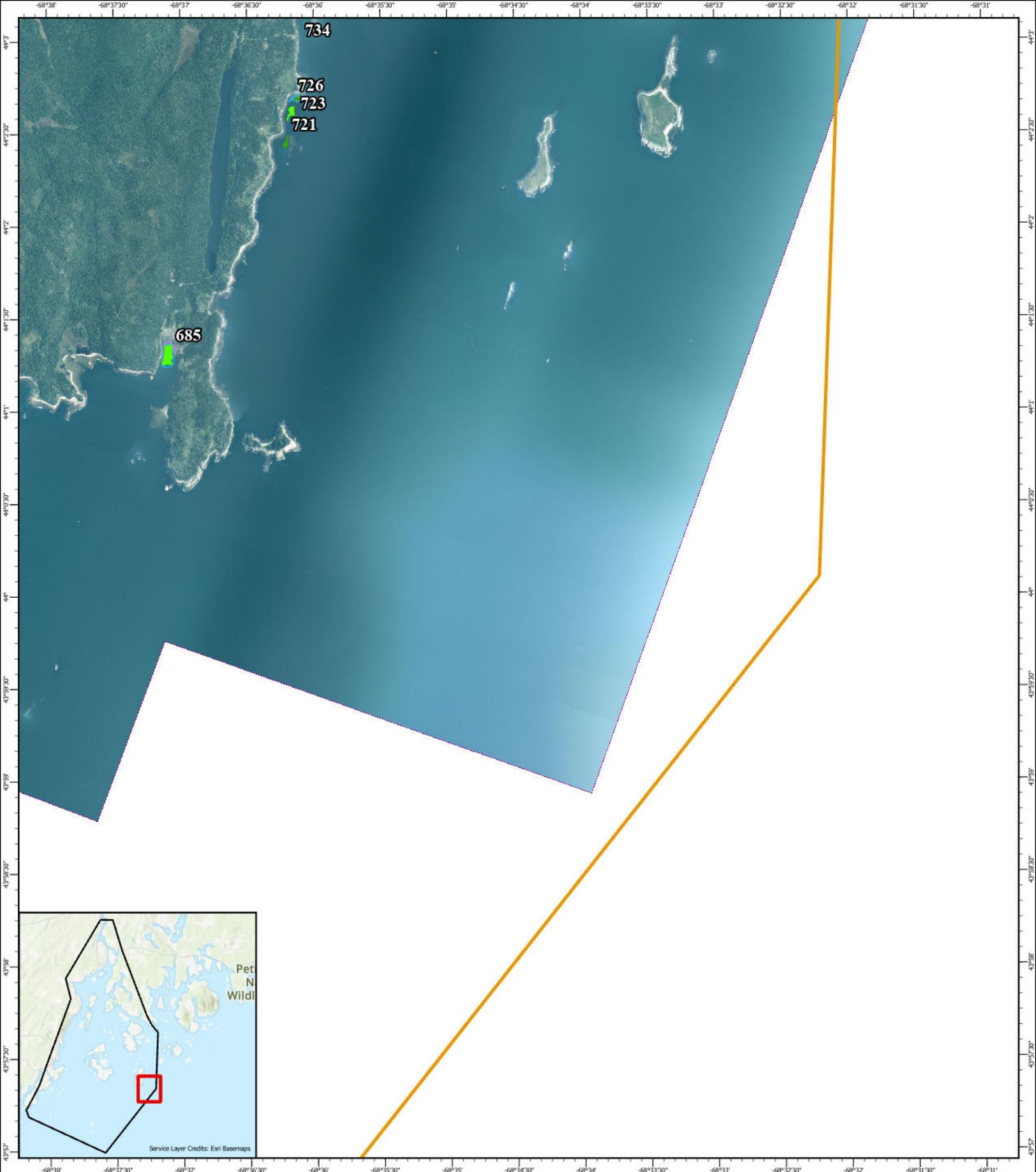
Map Page 16 of 29

Legend:

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

Service Layer Credits: Esri Basemaps

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 17 of 29

| | 2024 Project Area |
| 1992/3/5/6 Mapped Eelgrass (DMR) |
| 2003/5/8 Mapped Eelgrass (DMR) |

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 18 of 29

Legend:

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

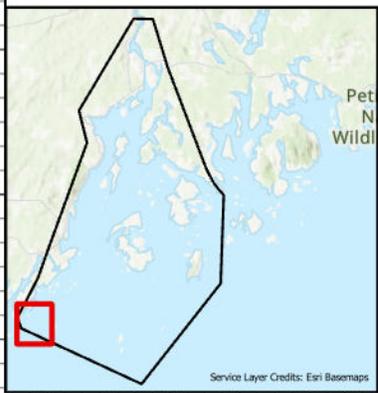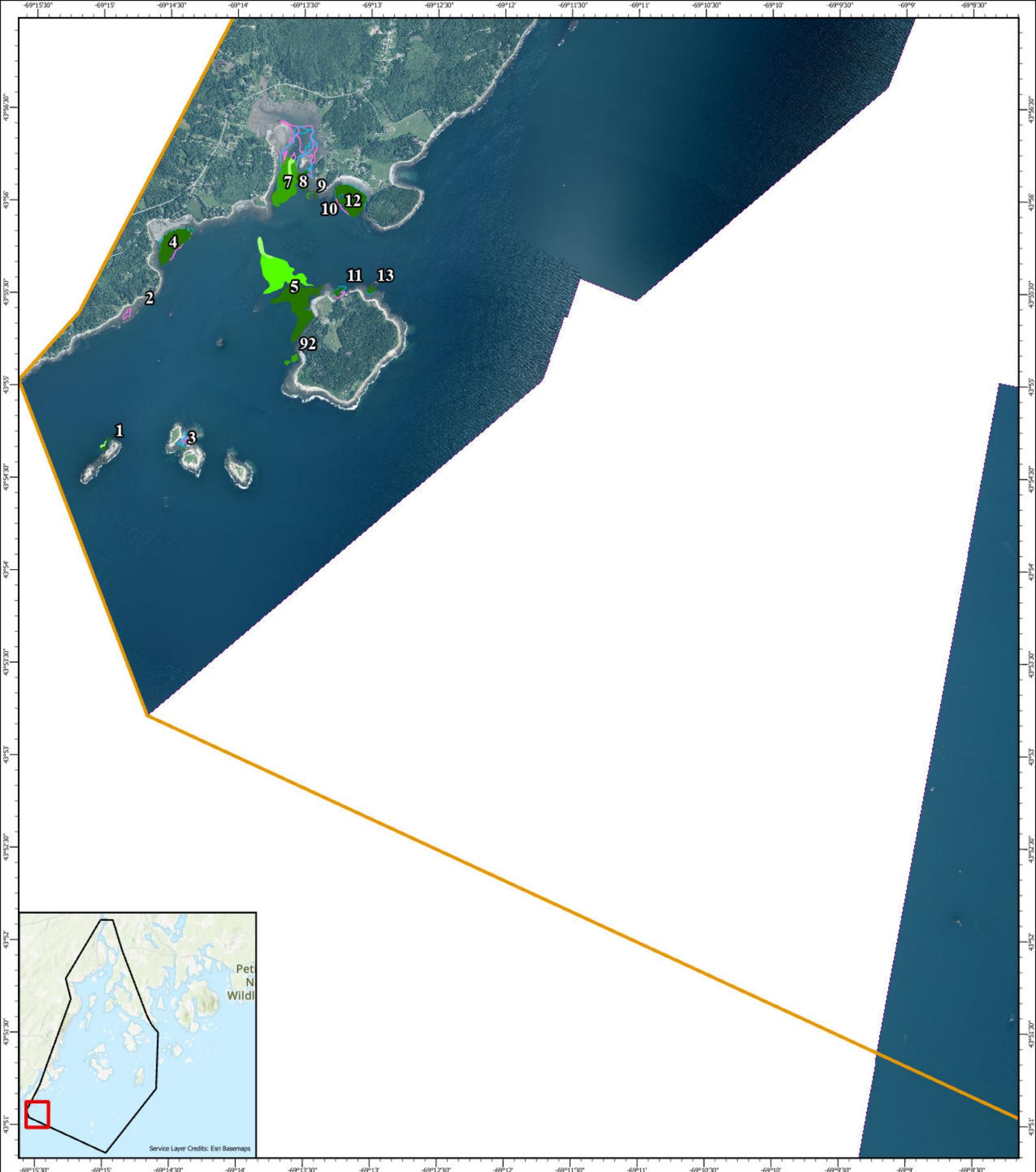Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 19 of 29

Legend

- 2024 Project Area
- 1992/3/5/6 Mapped Eelgrass (DMR)
- 2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Service Layer Credits: Esri Basemaps

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2   Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover
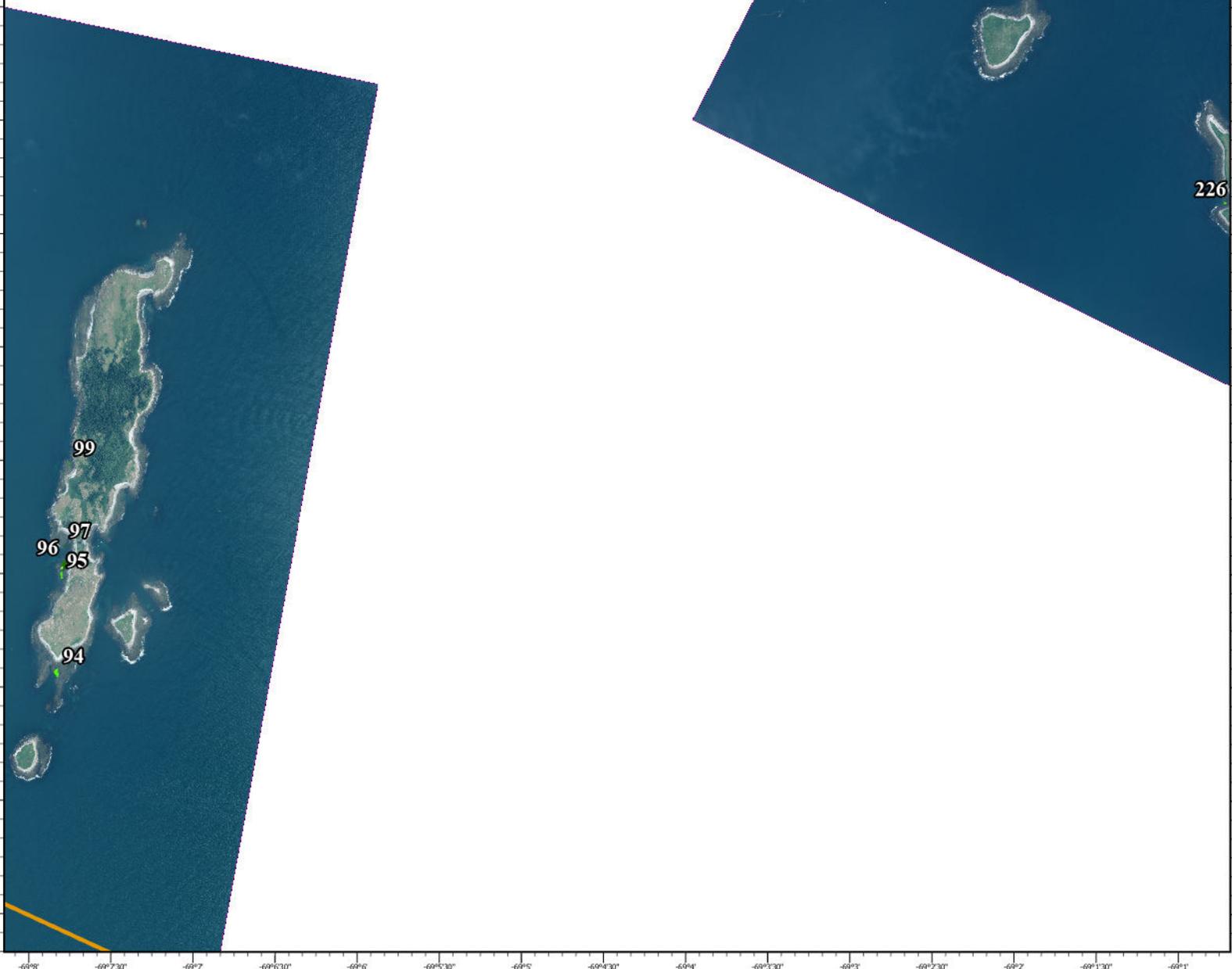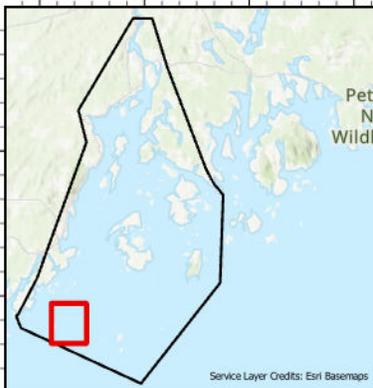
Map Page 20 of 29

Legend:
- 2024 Project Area
- 1992/3/5/6 Mapped Eelgrass (DMR)
- 2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

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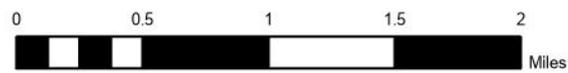- 2024 Project Area
- 1992/3/5/6 Mapped Eelgrass (DMR)
- 2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
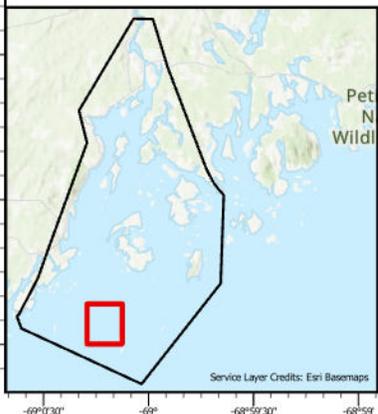- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Service Layer Credits: Esri Basemaps
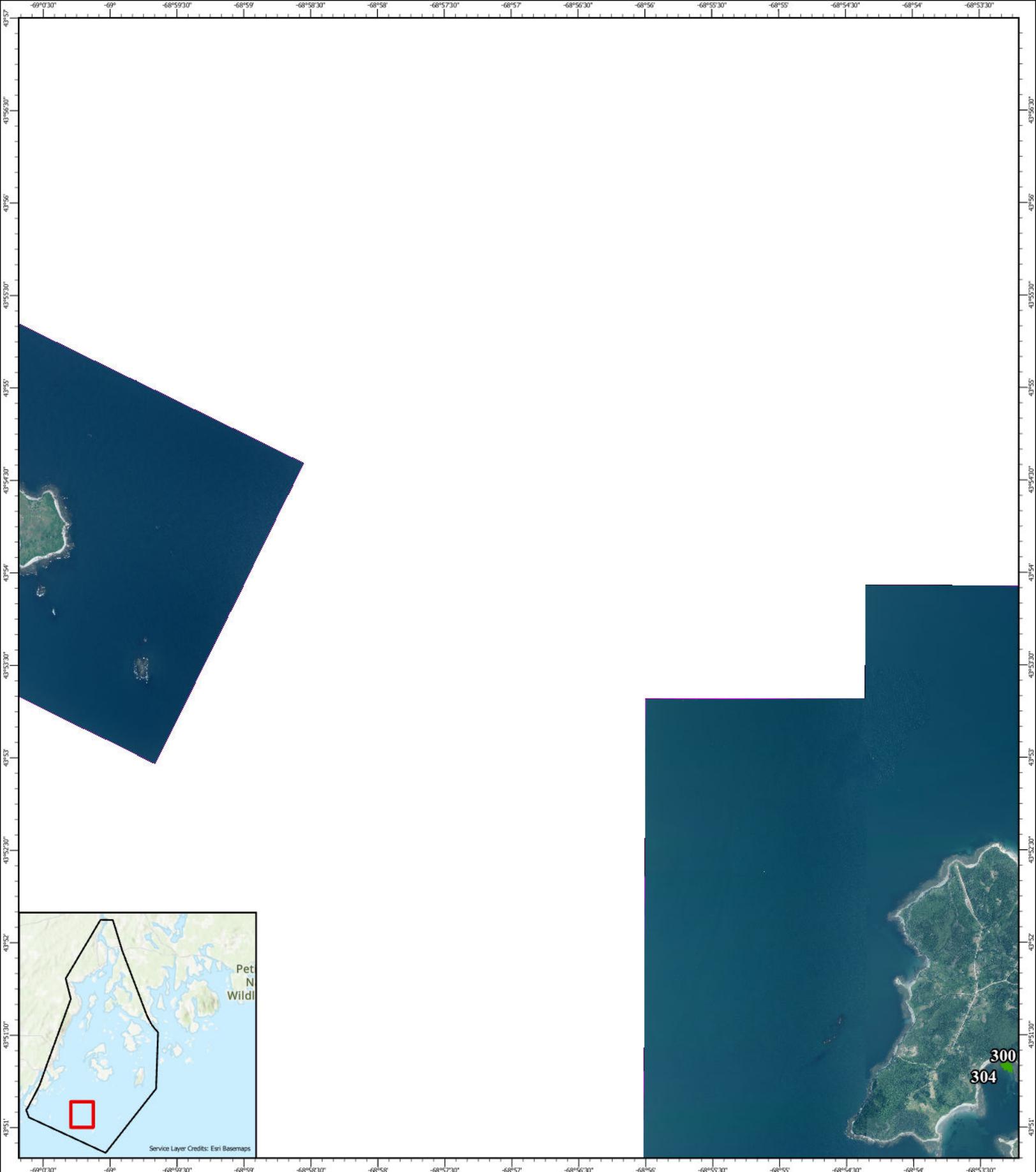
PENOBSCOT BAY REGION SEAGRASS MAPPING
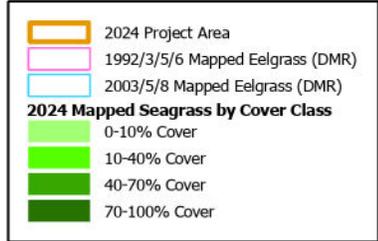
Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

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▭	2024 Project Area
▭	1992/3/5/6 Mapped Eelgrass (DMR)
▭	2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class

▪	0-10% Cover
▪	10-40% Cover
▪	40-70% Cover
▪	70-100% Cover

0   0.5   1   1.5   2 Miles
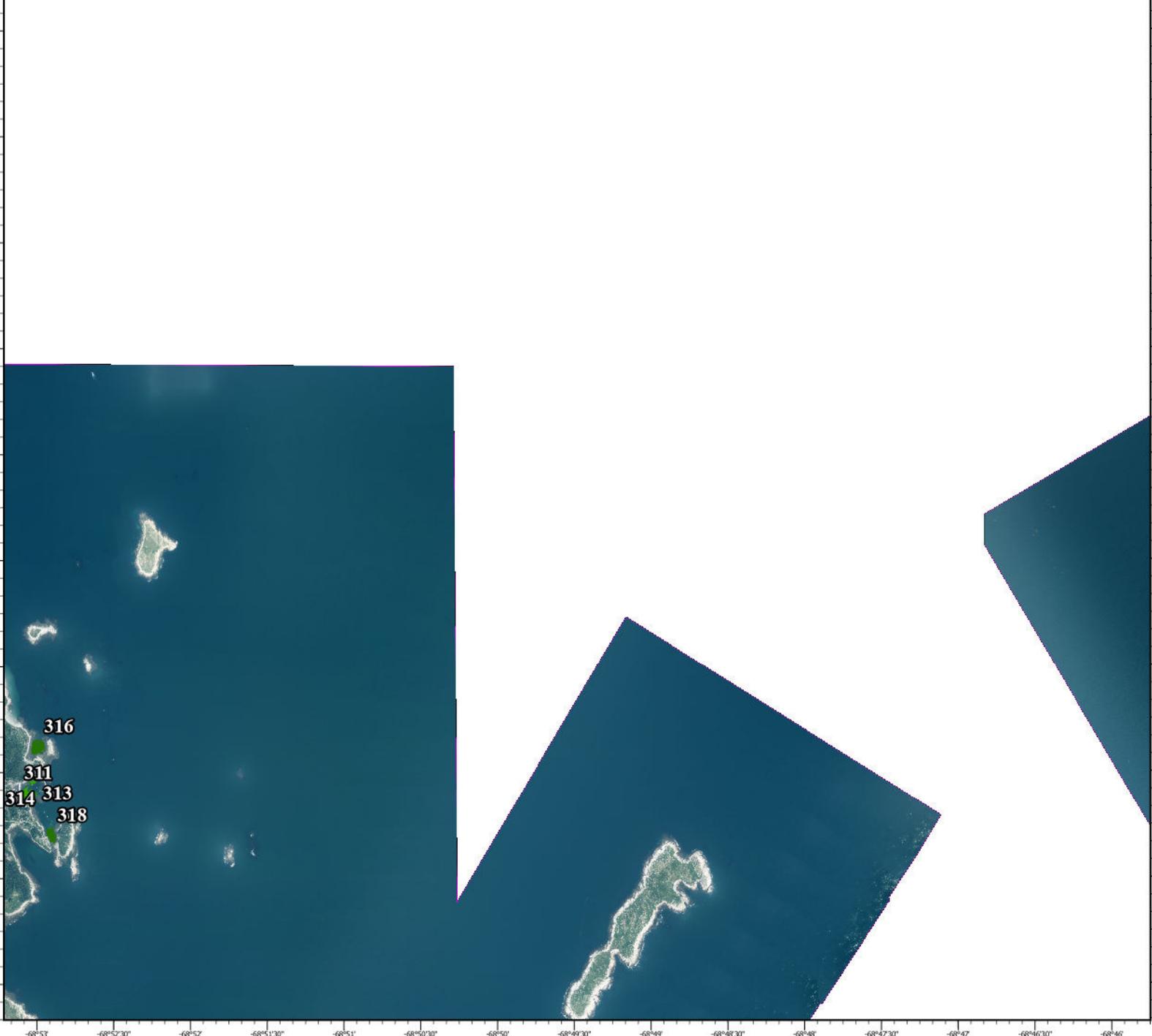
568
584
587 586
580
553
612

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 23 of 29

	Miles
0 0.5 1 1.5 2	

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

Service Layer Credits: Esri Basemaps

Pet
N
Wildl

2024 Project Area
1992/3/5/6 Mapped Eelgrass (DMR)
2003/5/8 Mapped Eelgrass (DMR)
2024 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
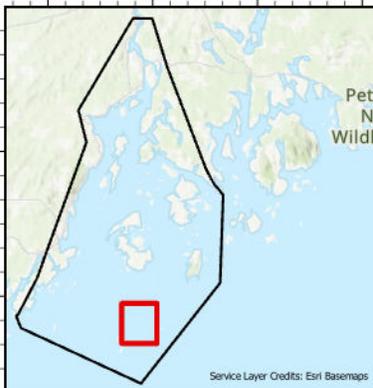40-70% Cover
70-100% Cover

734

726
723
721

685

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

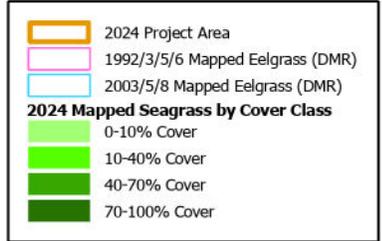Map Page 24 of 29

Pet
N
Wildl

Service Layer Credits: Esri Basemaps

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2
Miles

	2024 Project Area
	1992/3/5/6 Mapped Eelgrass (DMR)
	2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class

0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

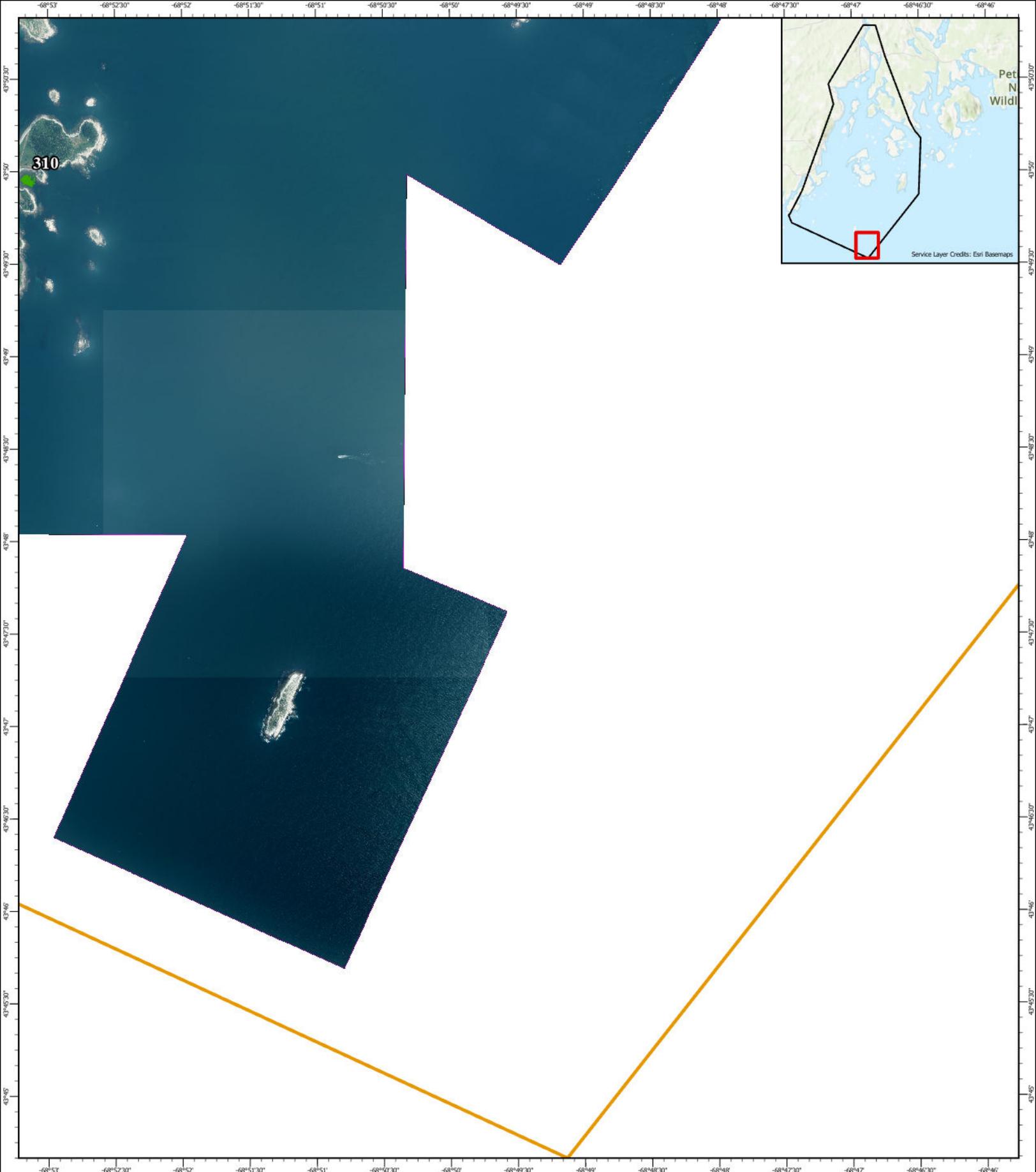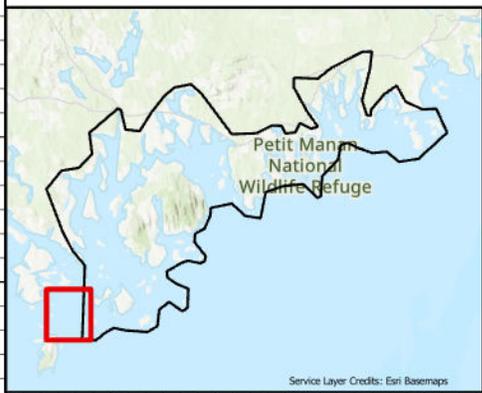2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 25 of 29

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

	2024 Project Area
	1992/3/5/6 Mapped Eelgrass (DMR)
	2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

0   0.5   1   1.5   2   Miles

Service Layer Credits: Esri Basemaps

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

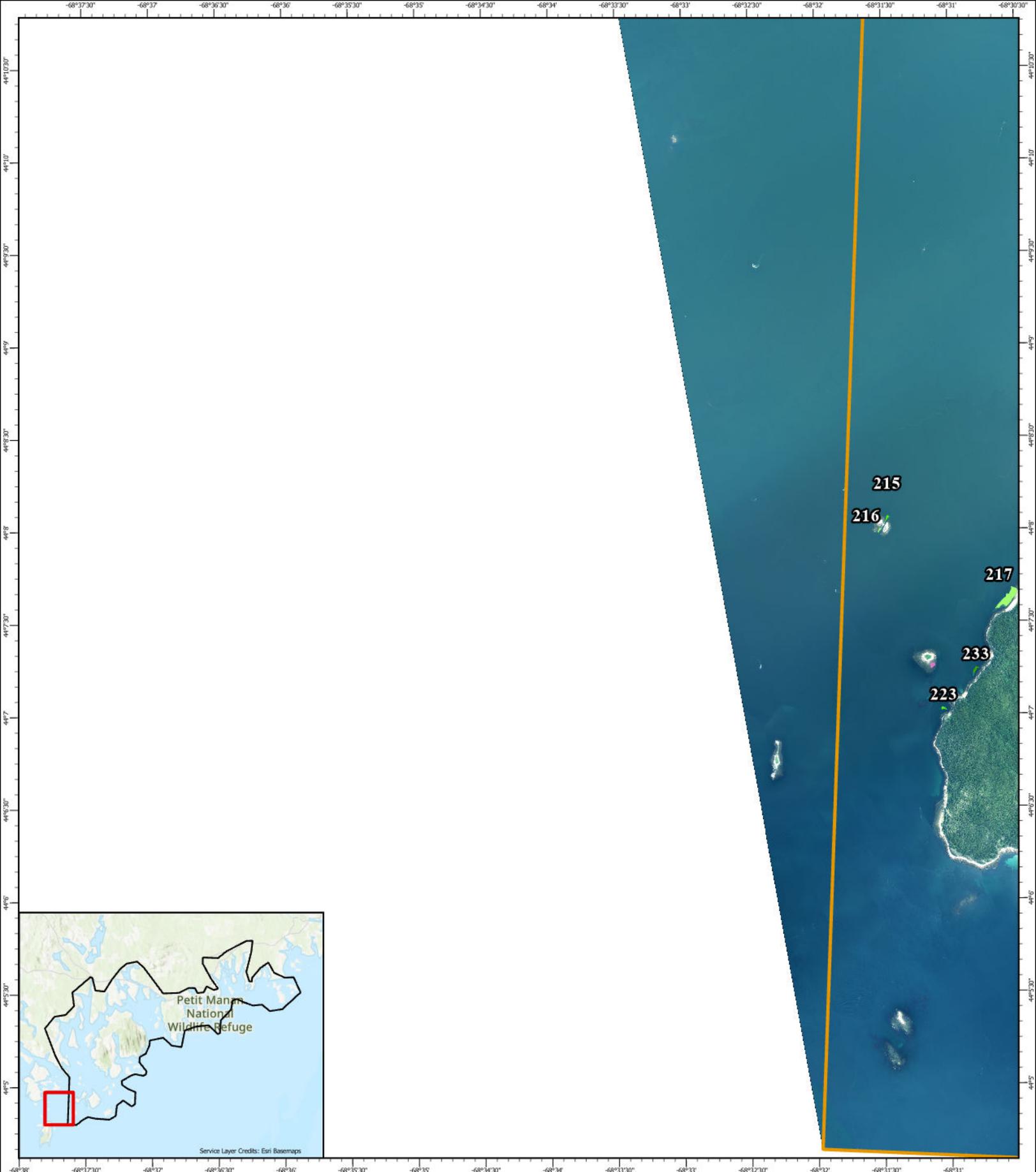2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 26 of 29

Service Layer Credits: Esri Basemaps

	2024 Project Area
	1992/3/5/6 Mapped Eelgrass (DMR)
	2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
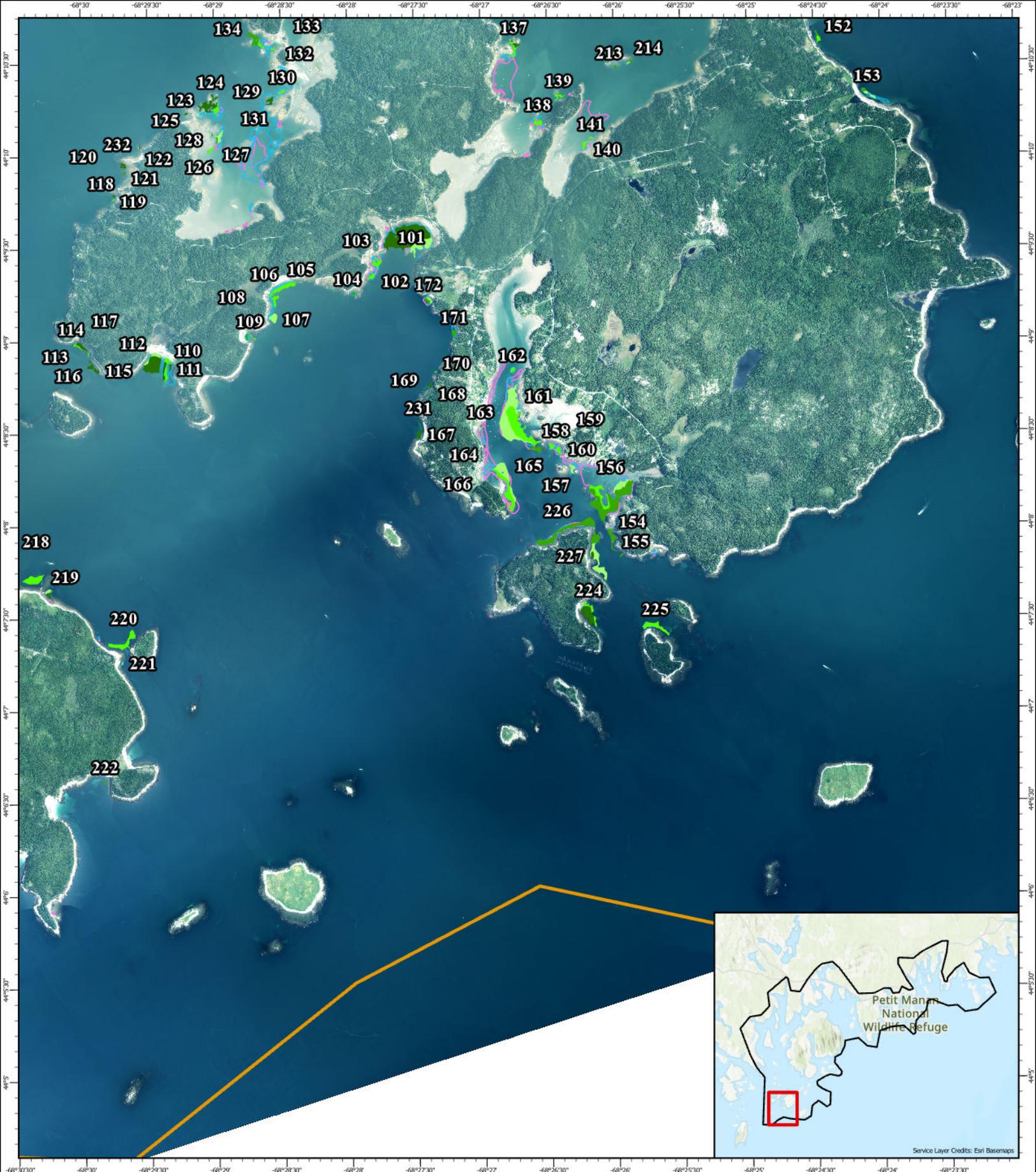- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2   Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Legend:

- 2024 Project Area
- 1992/3/5/6 Mapped Eelgrass (DMR)
- 2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
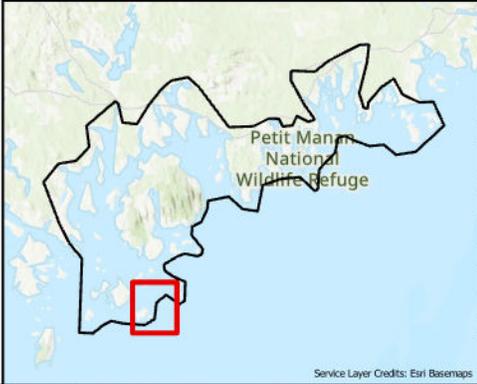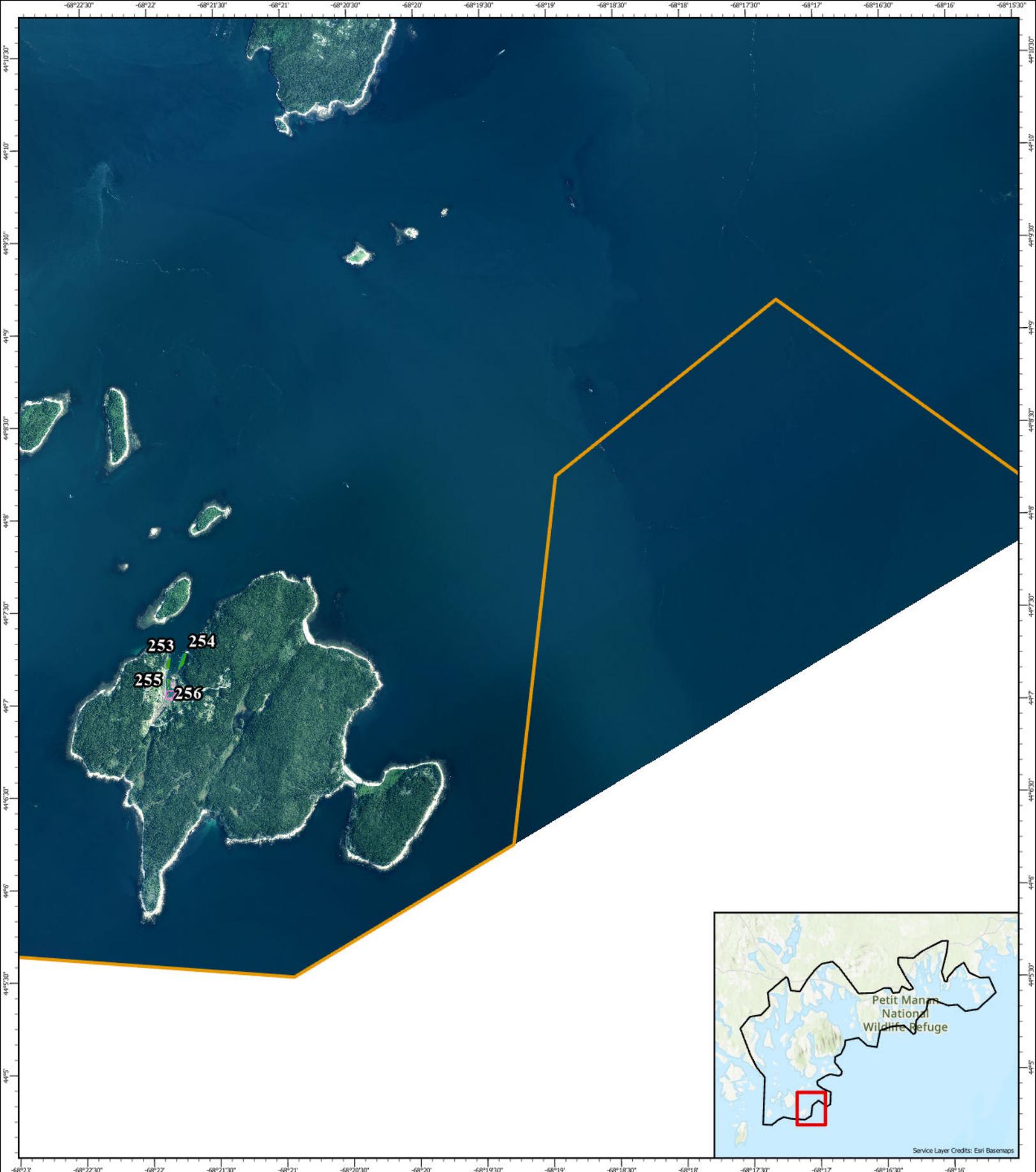- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

300
304

Service Layer Credits: Esri Basemaps

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2   Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

Service Layer Credits: Esri Basemaps

316
311
314 313
318

	2024 Project Area
	1992/3/5/6 Mapped Eelgrass (DMR)
	2003/5/8 Mapped Eelgrass (DMR)

2024 Mapped Seagrass by Cover Class

	0-10% Cover
	10-40% Cover
	40-70% Cover
	70-100% Cover

0   0.5   1   1.5   2
Miles

PENOBSCOT BAY REGION SEAGRASS MAPPING

Port Clyde to Brooklin, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

310

| 2024 Project Area |
| 1992/3/5/6 Mapped Eelgrass (DMR) |
| 2003/5/8 Mapped Eelgrass (DMR) |

2024 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

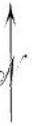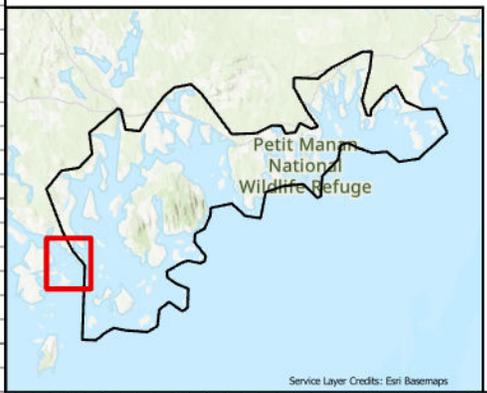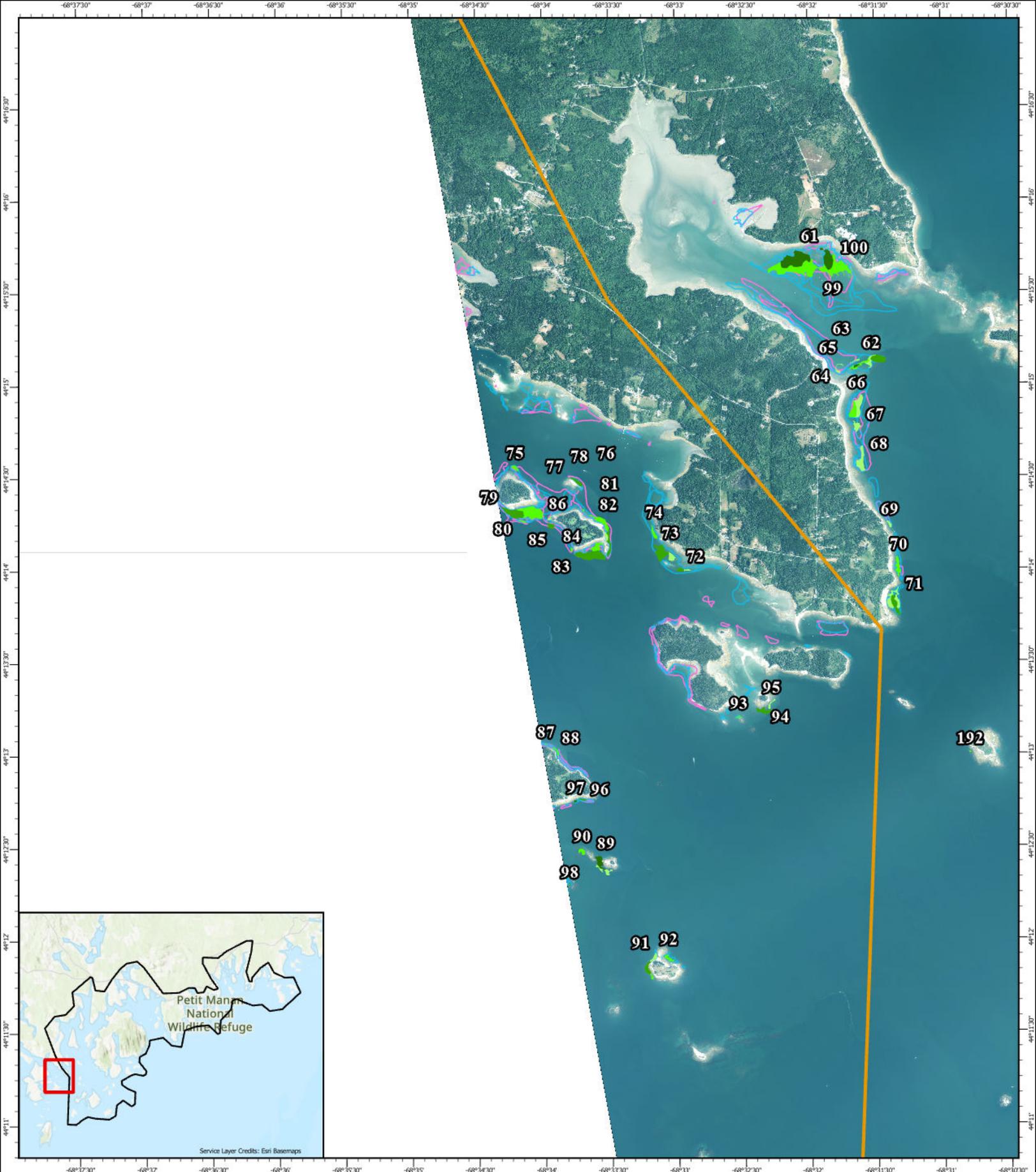Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 1 of 32

	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2 Miles

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 2 of 32

Legend:

2025 Project Area
2008-2009 Mapped Eelgrass (DMR)
1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
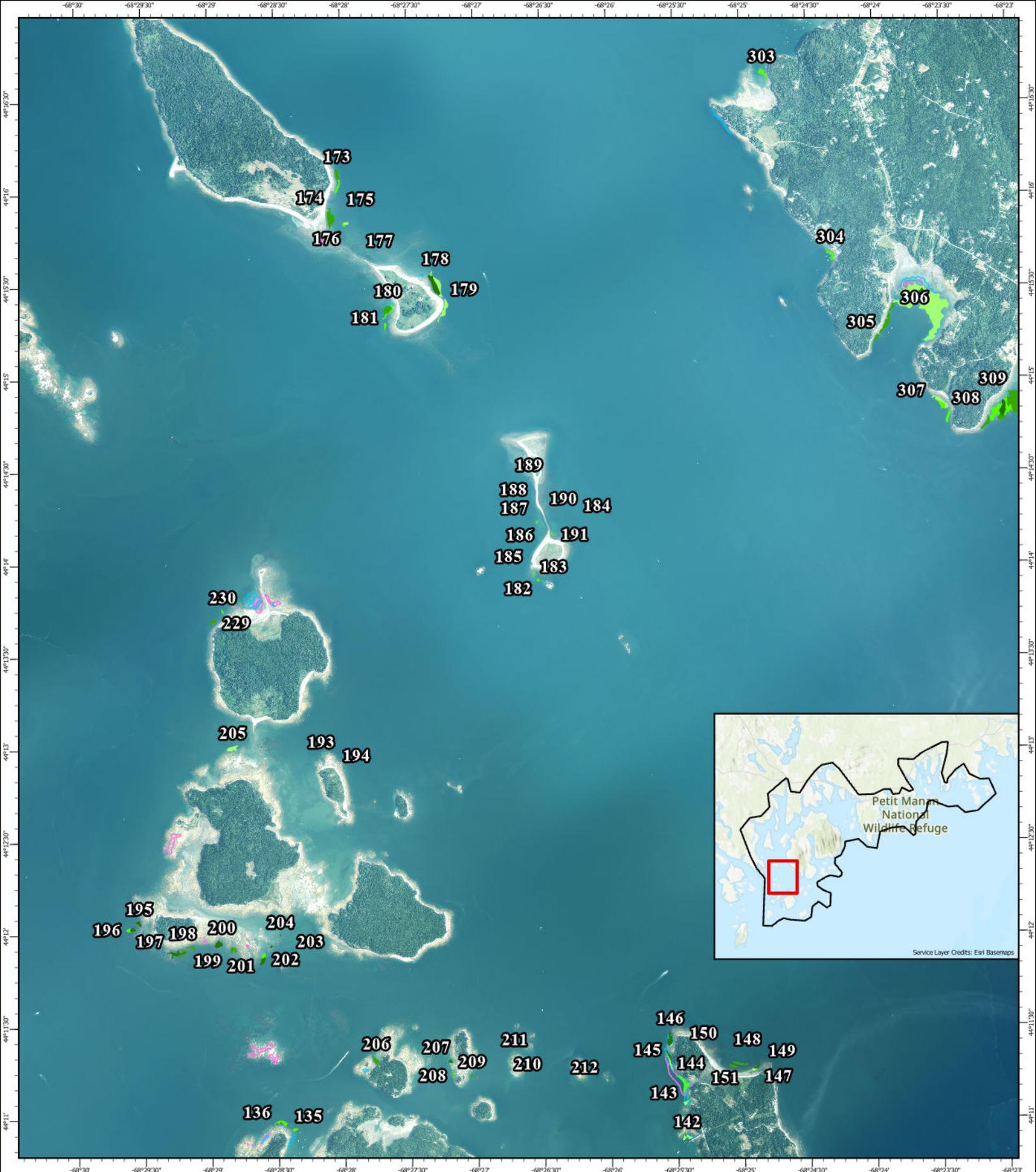0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

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Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

253   254

255   256

Petit Manan
National
Wildlife Refuge

Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

2025 Project Area

2008-2009 Mapped Eelgrass (DMR)

1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class

0-10% Cover

10-40% Cover

40-70% Cover

70-100% Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE
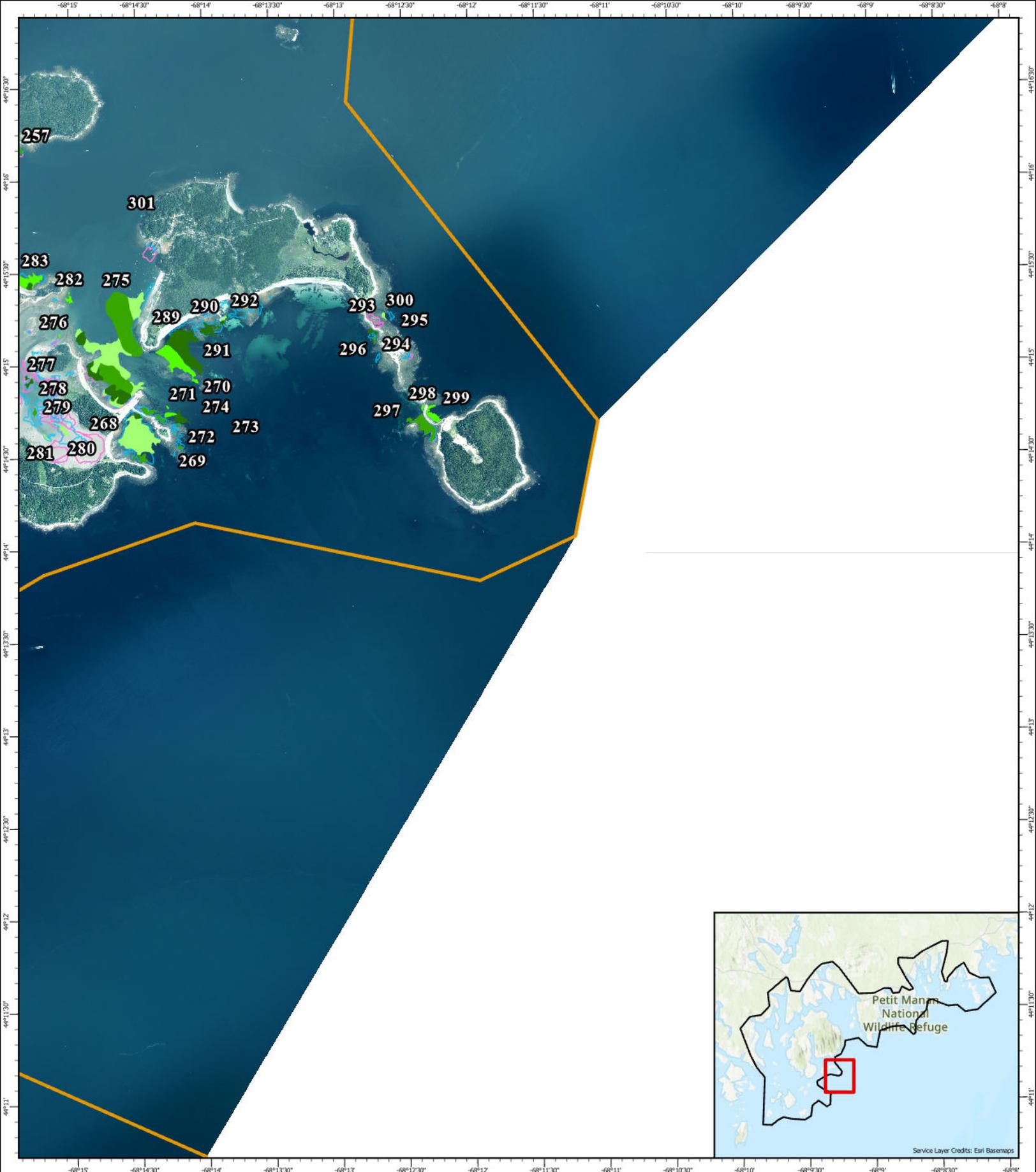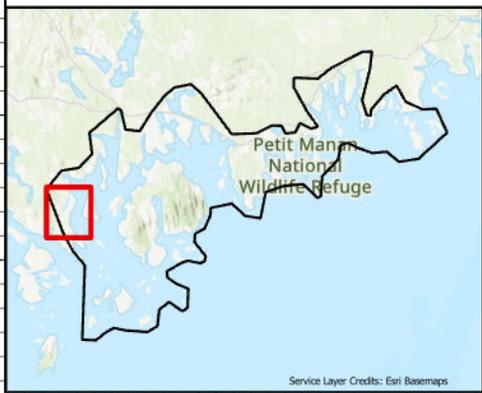
ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

	Miles
0 0.5 1 1.5 2	

Legend

- 2025 Project Area
- 2008-2009 Mapped Eelgrass (DMR)
- 1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps
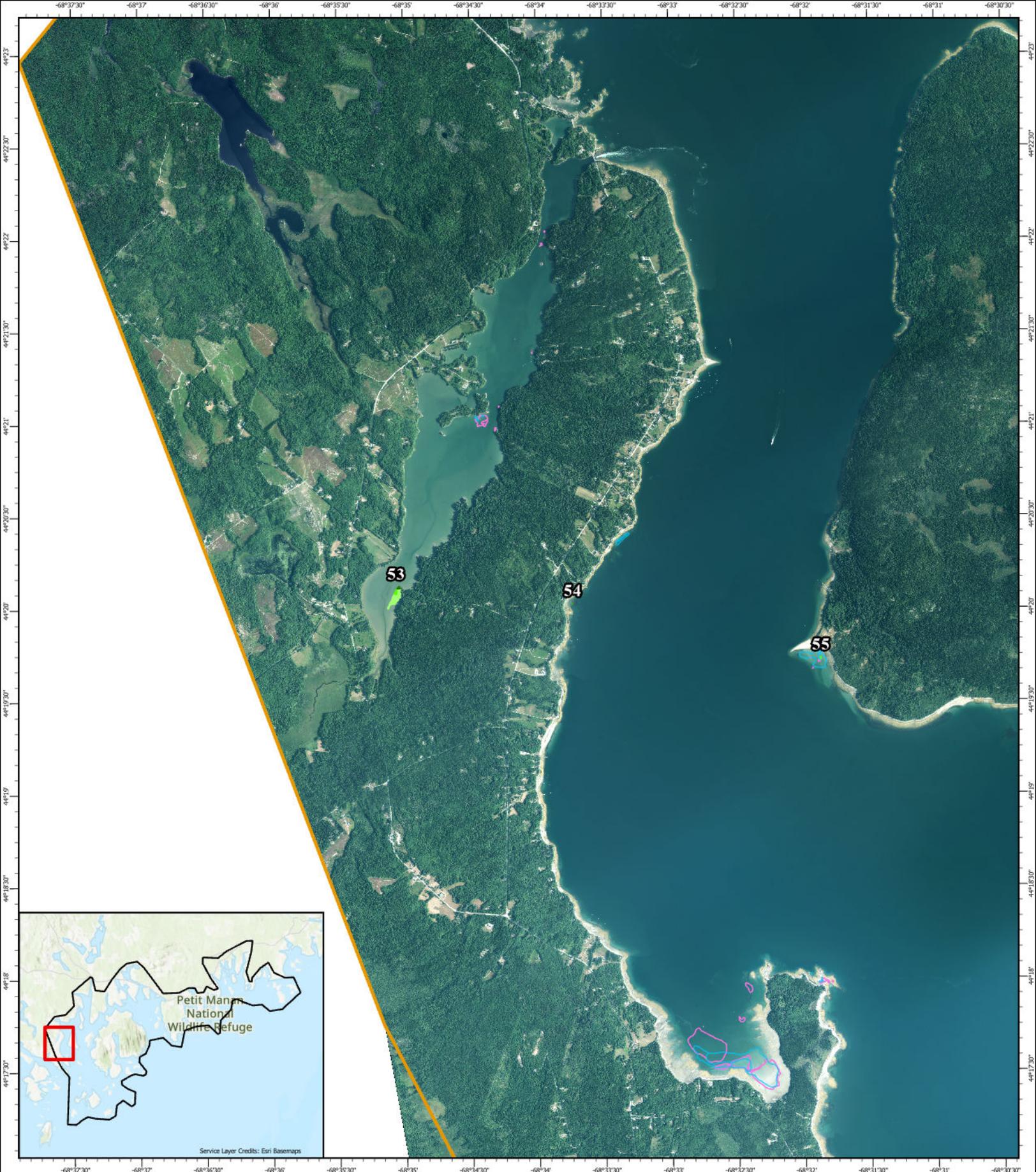
ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 5 of 32

2025 Mapped Seagrass by Cover Class

Legend	
2025 Project Area	
2008-2009 Mapped Eelgrass (DMR)	
1996-1997 Mapped Eelgrass (DMR)	
0-10% Cover	
10-40% Cover	
40-70% Cover	
70-100% Cover	

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

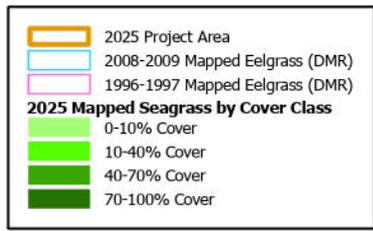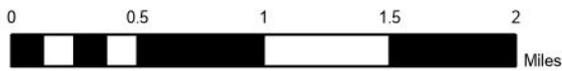|	
2025 Project Area	
2008-2009 Mapped Eelgrass (DMR)	
1996-1997 Mapped Eelgrass (DMR)	

2025 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover
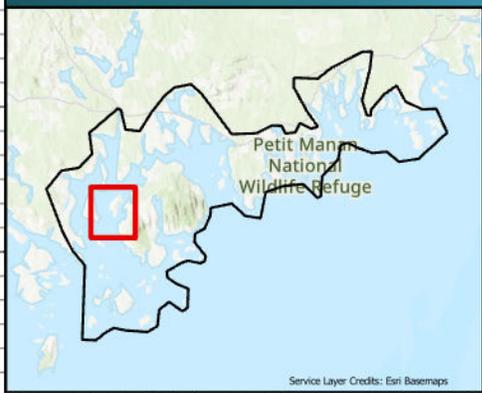
ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

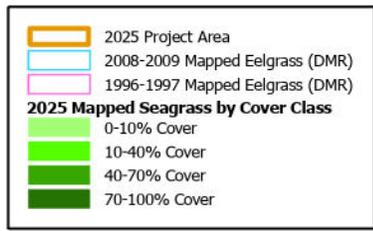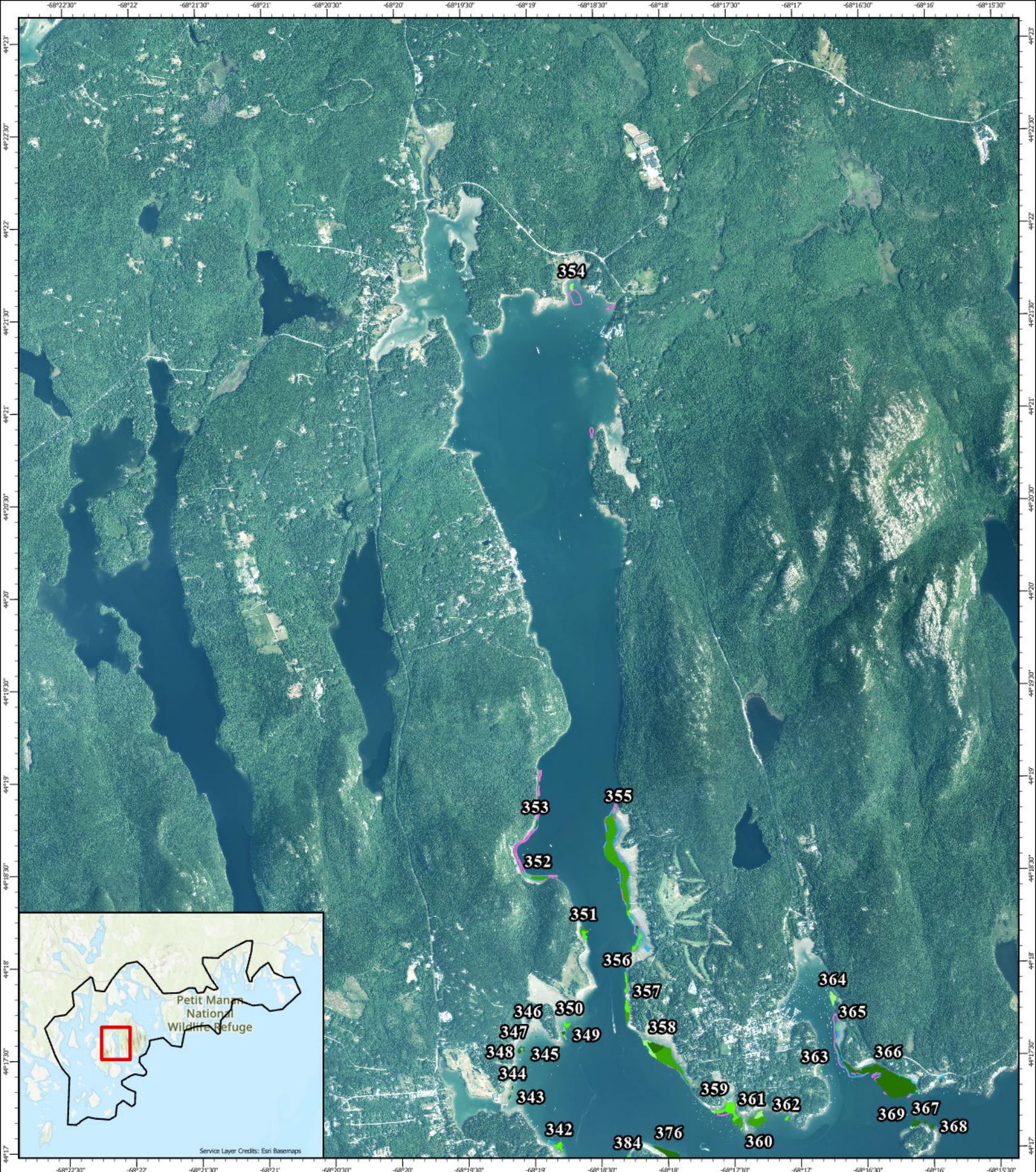2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

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Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps

Legend

2025 Project Area
2008-2009 Mapped Eelgrass (DMR)
1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2   Miles

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

	Miles
0 0.5 1 1.5 2	

Legend

2025 Project Area
2008-2009 Mapped Eelgrass (DMR)
1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

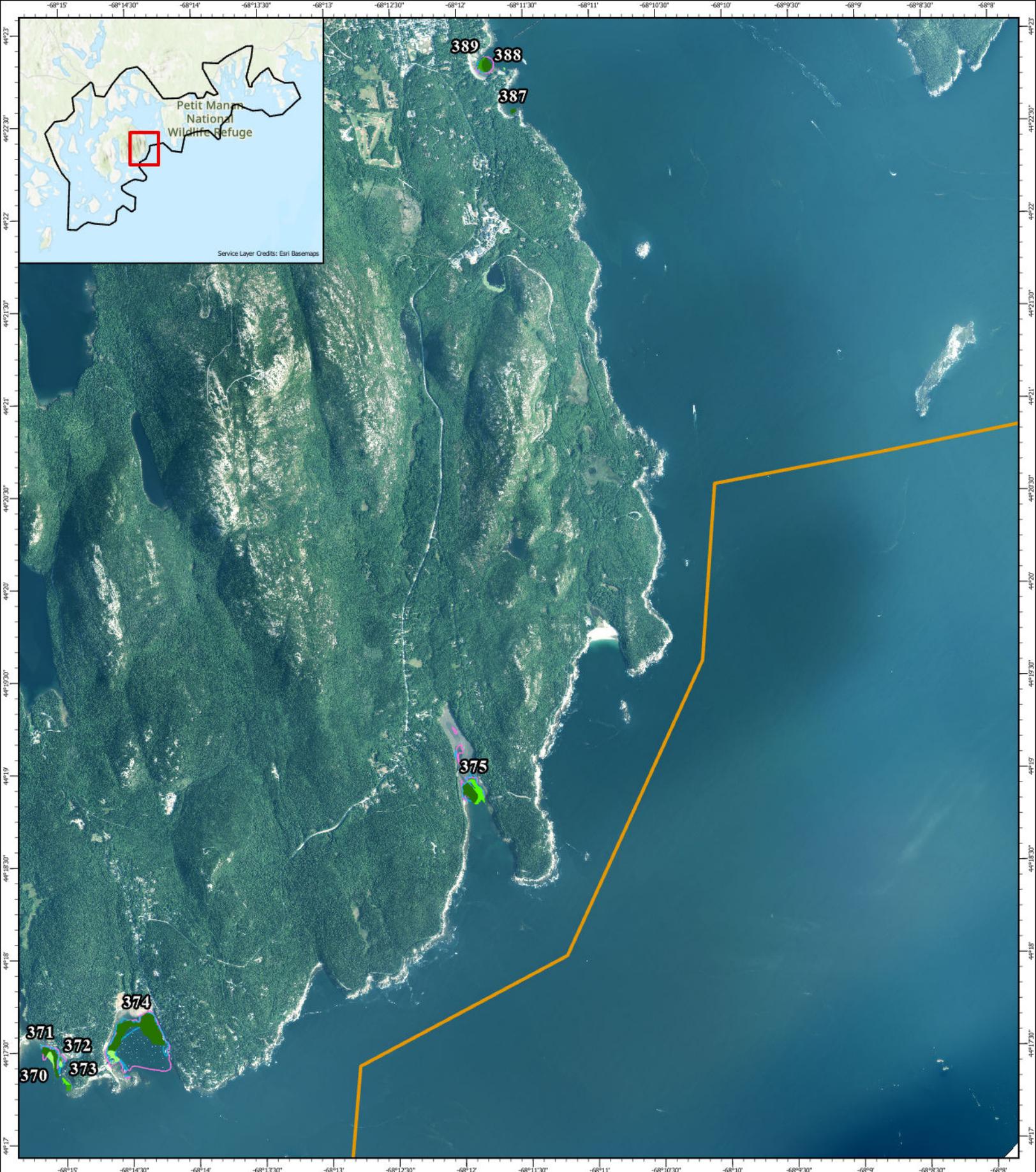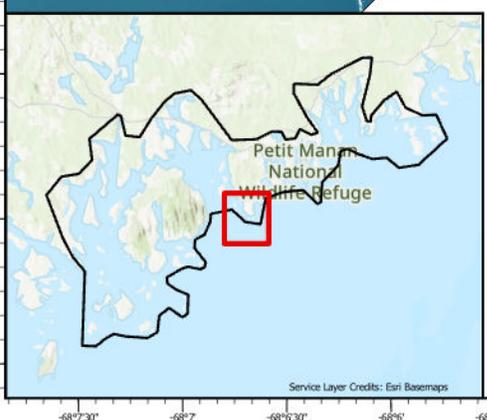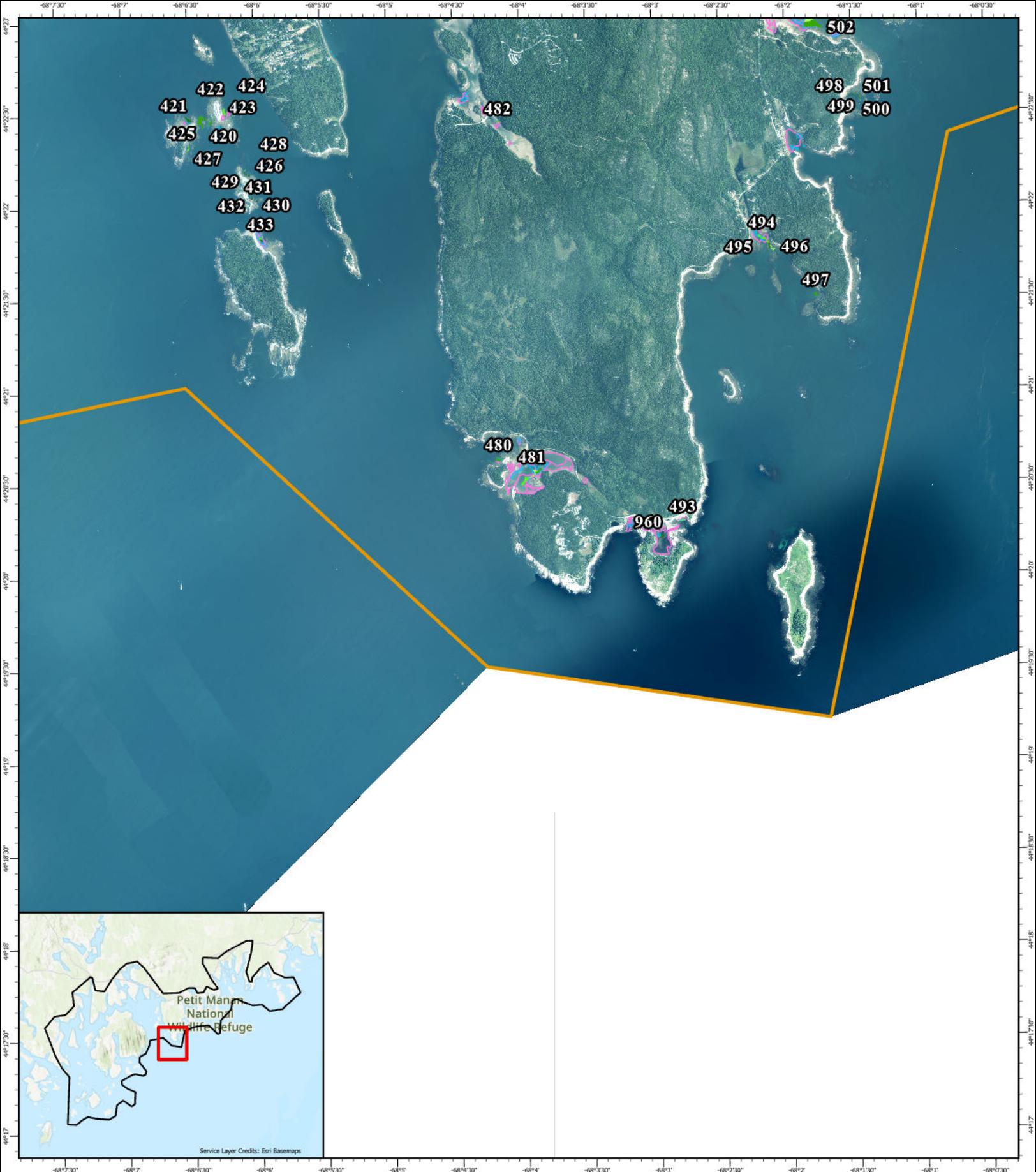Petit Manan National Wildlife Refuge

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ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Petit Manan
National
Wildlife Refuge

Service Layer Credits: Esri Basemaps

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

| | Miles |
| 0 | 0.5 | 1 | 1.5 | 2 |

Legend

	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class

	0-10% Cover
	10-40% Cover
	40-70% Cover
	70-100% Cover

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

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Legend:

- 2025 Project Area
- 2008-2009 Mapped Eelgrass (DMR)
- 1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Service Layer Credits: Esri Basemaps

Petit Manan National Wildlife Refuge

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2   Miles
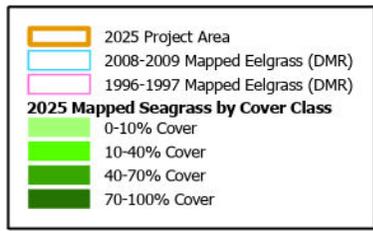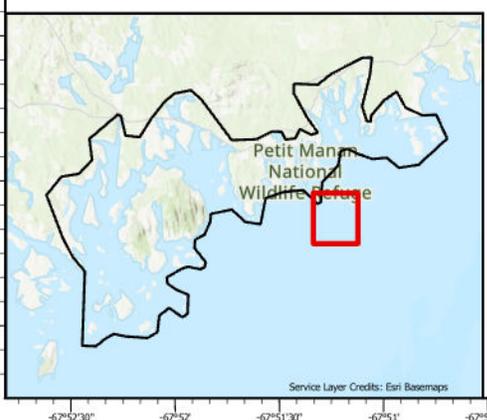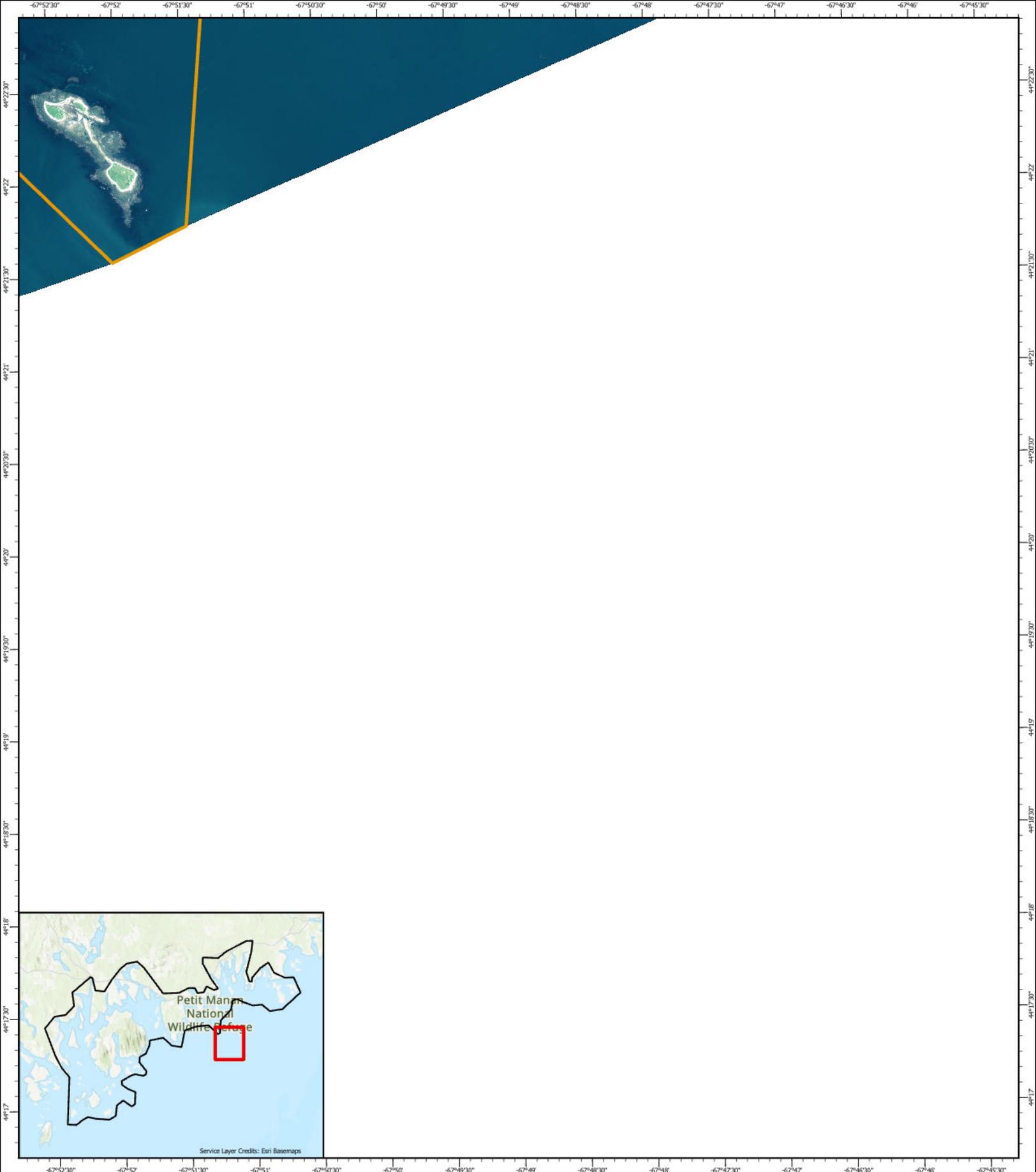
ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE ·

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	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps
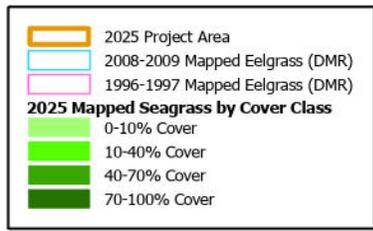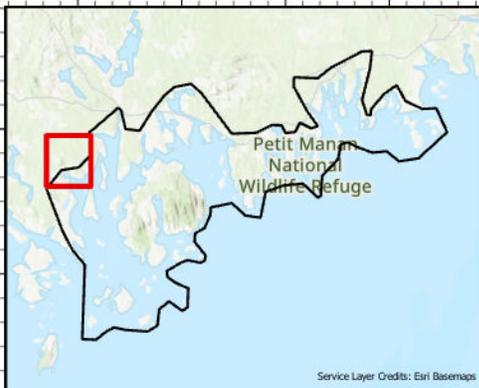
389
388
387

375

374
371
372
370 373

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2
Miles

Map Page 12 of 32

2025 Project Area
2008-2009 Mapped Eelgrass (DMR)
1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

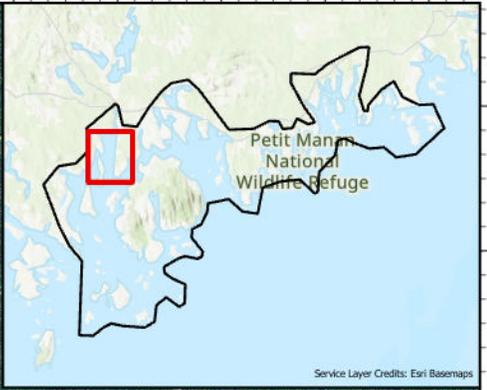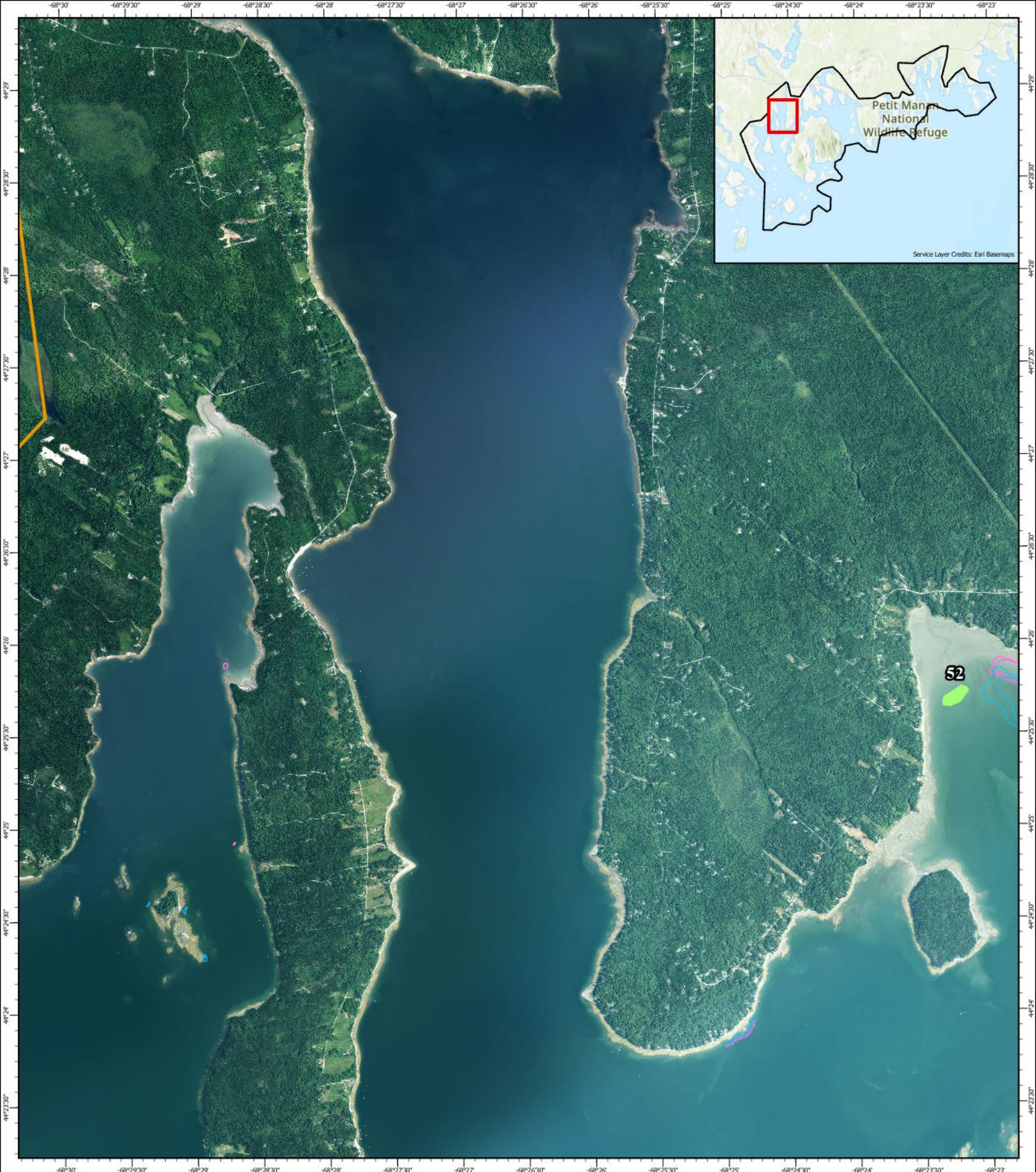2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 13 of 32

	Legend
	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Service Layer Credits: Esri Basemaps

Petit Manan National Wildlife Refuge

0   0.5   1   1.5   2 Miles

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE
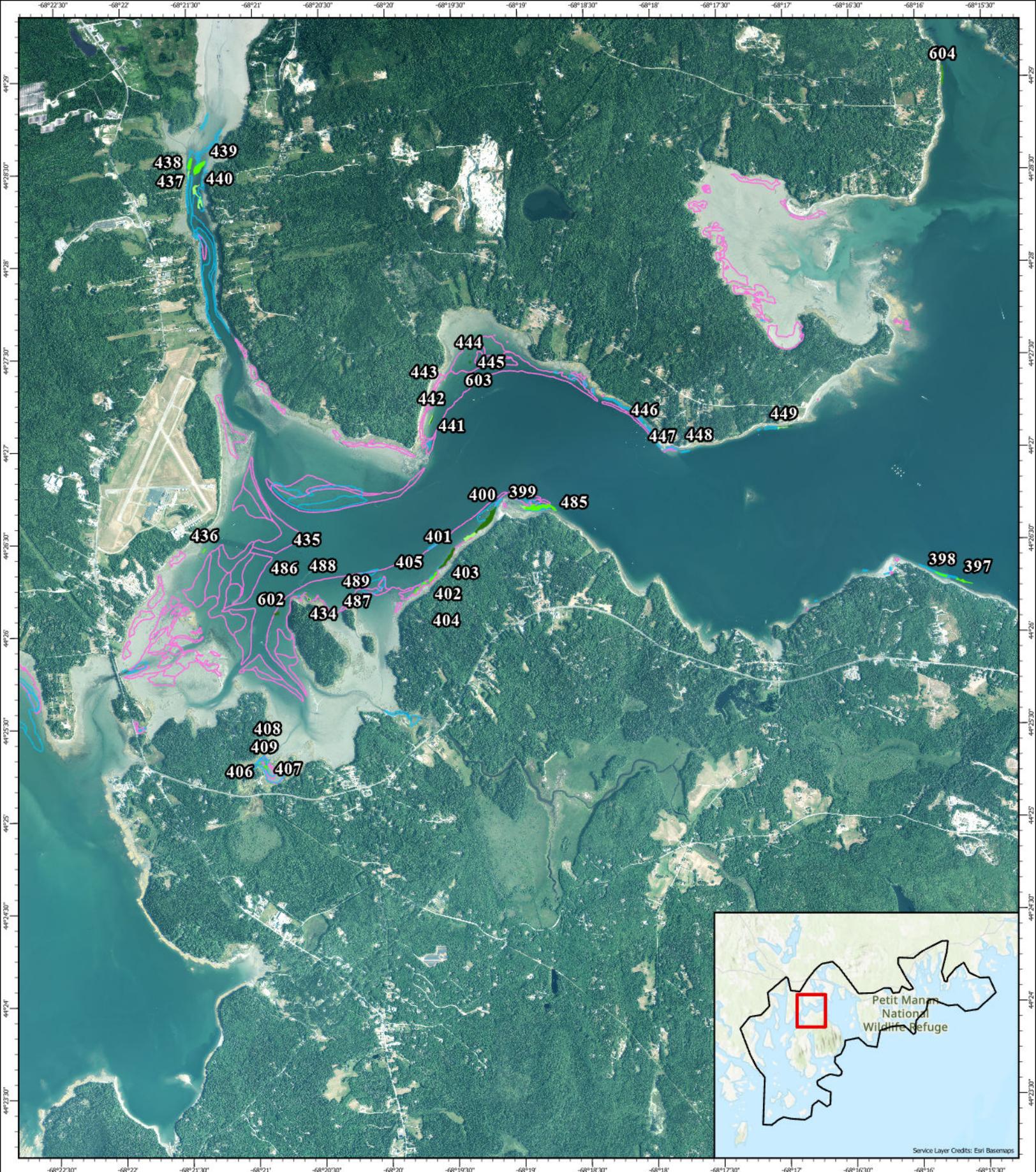
ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 14 of 32

	Miles
0	0.5 1 1.5 2

Legend

- 2025 Project Area
- 2008-2009 Mapped Eelgrass (DMR)
- 1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
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Petit Manan National Wildlife Refuge

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DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

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Petit Manan
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Wildlife Refuge

Service Layer Credits: Esri Basemaps

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Map Page 15 of 32

0	0.5	1	1.5	2

Miles

Legend

	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class

	0-10% Cover
	10-40% Cover
	40-70% Cover
	70-100% Cover

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

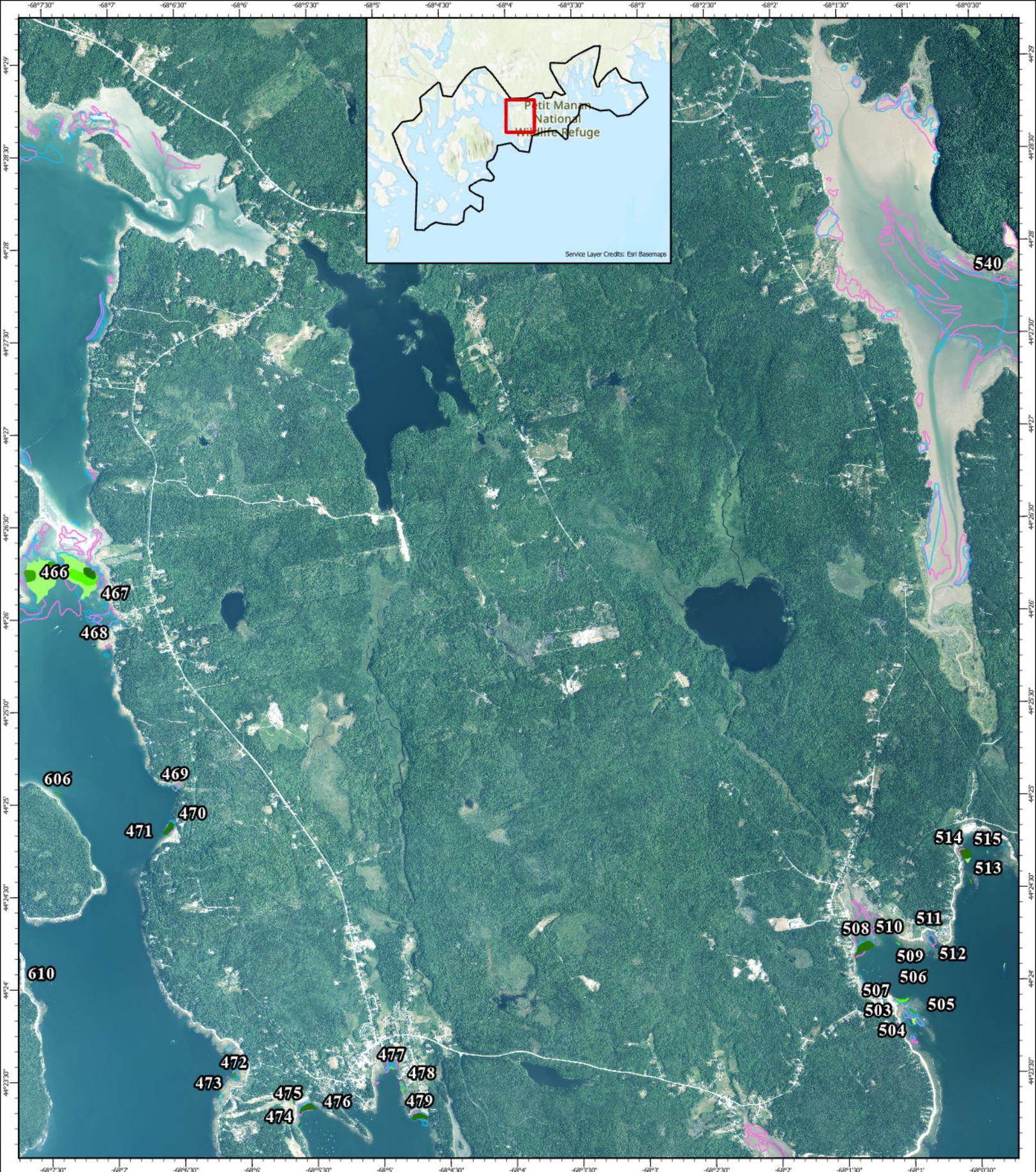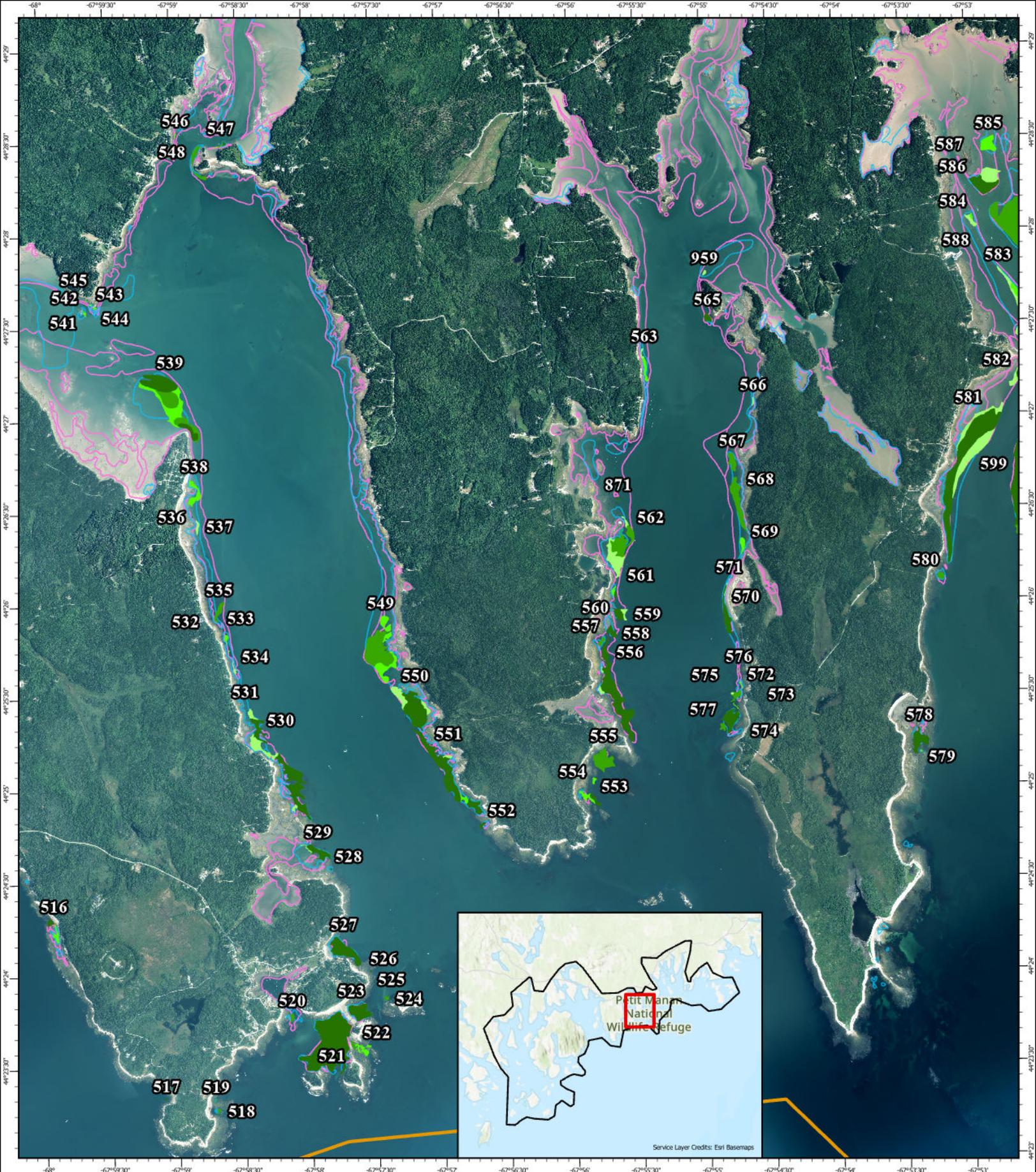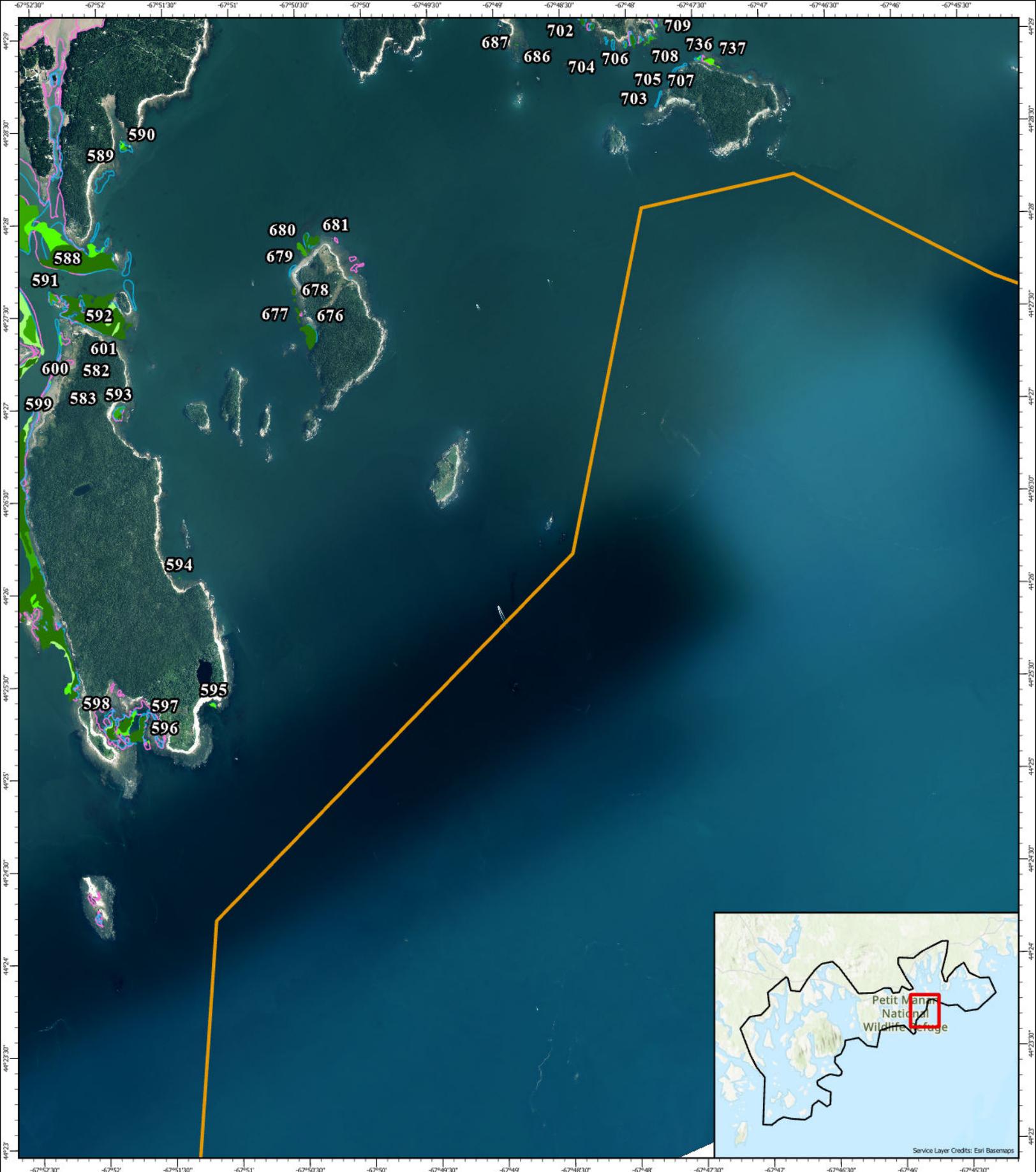2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 16 of 32

	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class

	0-10% Cover
	10-40% Cover
	40-70% Cover
	70-100% Cover

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Service Layer Credits: Esri Basemaps

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2   Miles

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE ·

Map Page 17 of 32

0   0.5   1   1.5   2
Miles

2025 Mapped Seagrass by Cover Class

	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

0-10% Cover
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40-70% Cover
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Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps
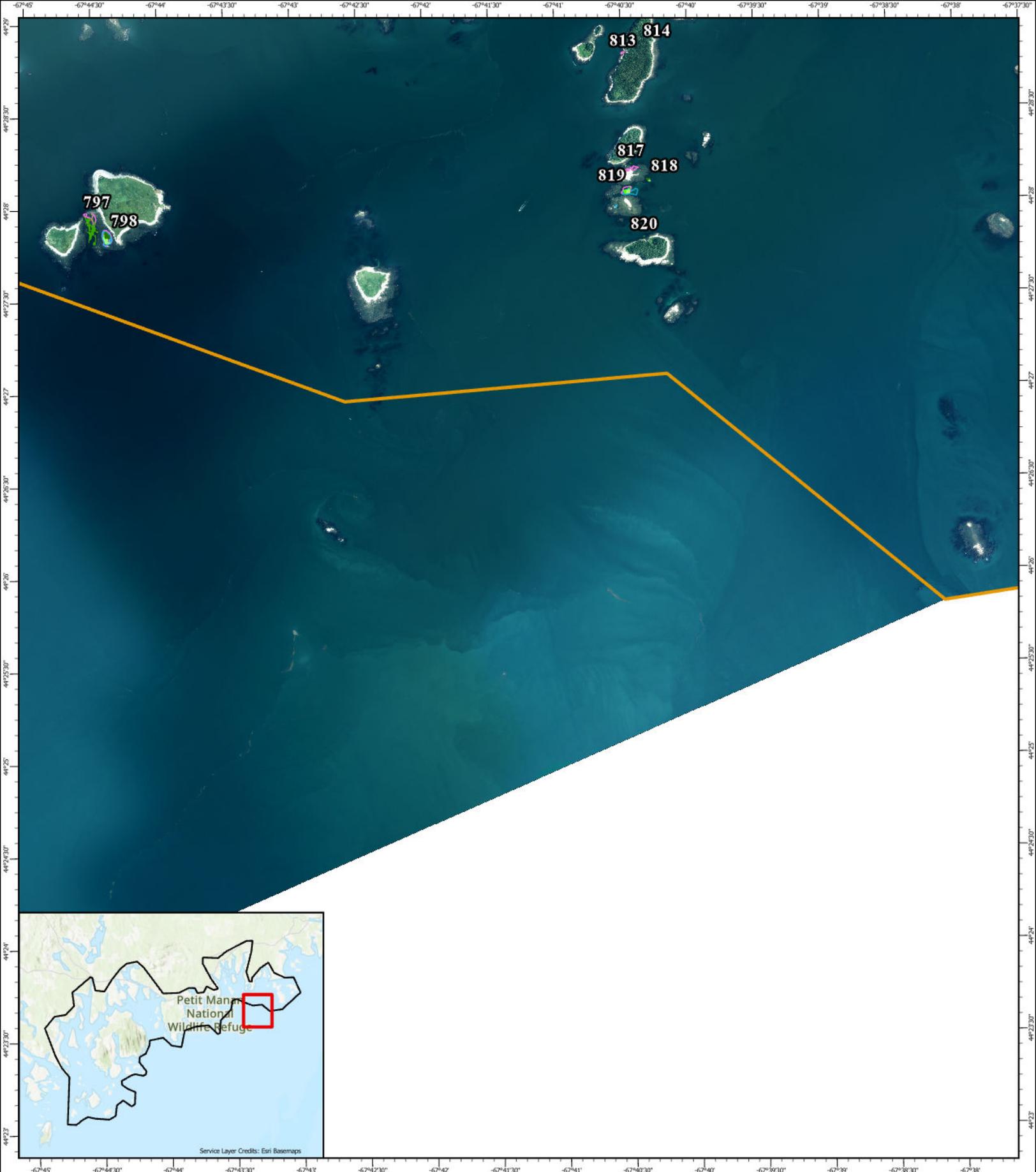
ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 18 of 32

Legend:
- 2025 Project Area
- 2008-2009 Mapped Eelgrass (DMR)
- 1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
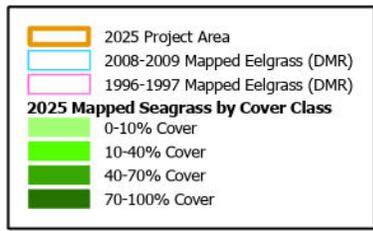- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps

0   0.5   1   1.5   2   Miles

Legend

- 2025 Project Area
- 2008-2009 Mapped Eelgrass (DMR)
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ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

0   0.5   1   1.5   2   Miles

Legend

2025 Project Area
2008-2009 Mapped Eelgrass (DMR)
1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
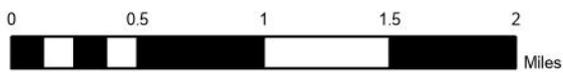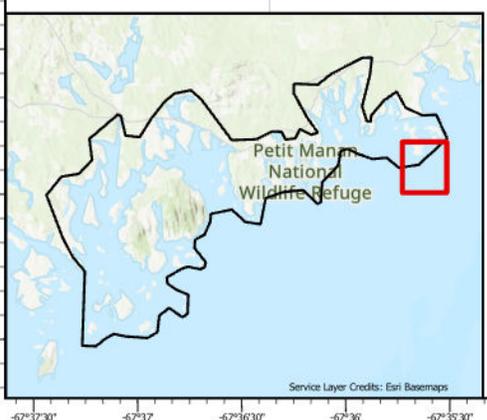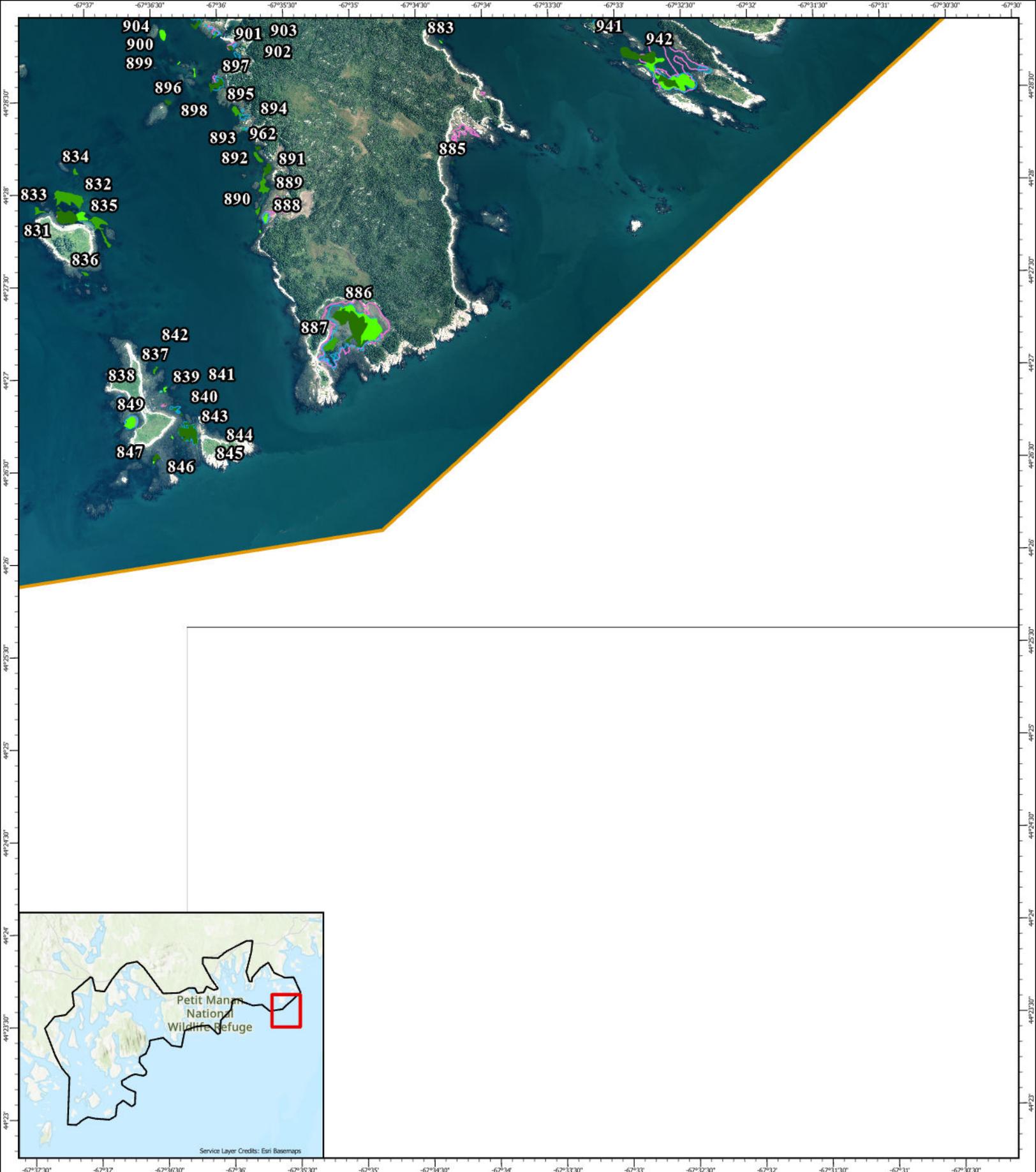0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover
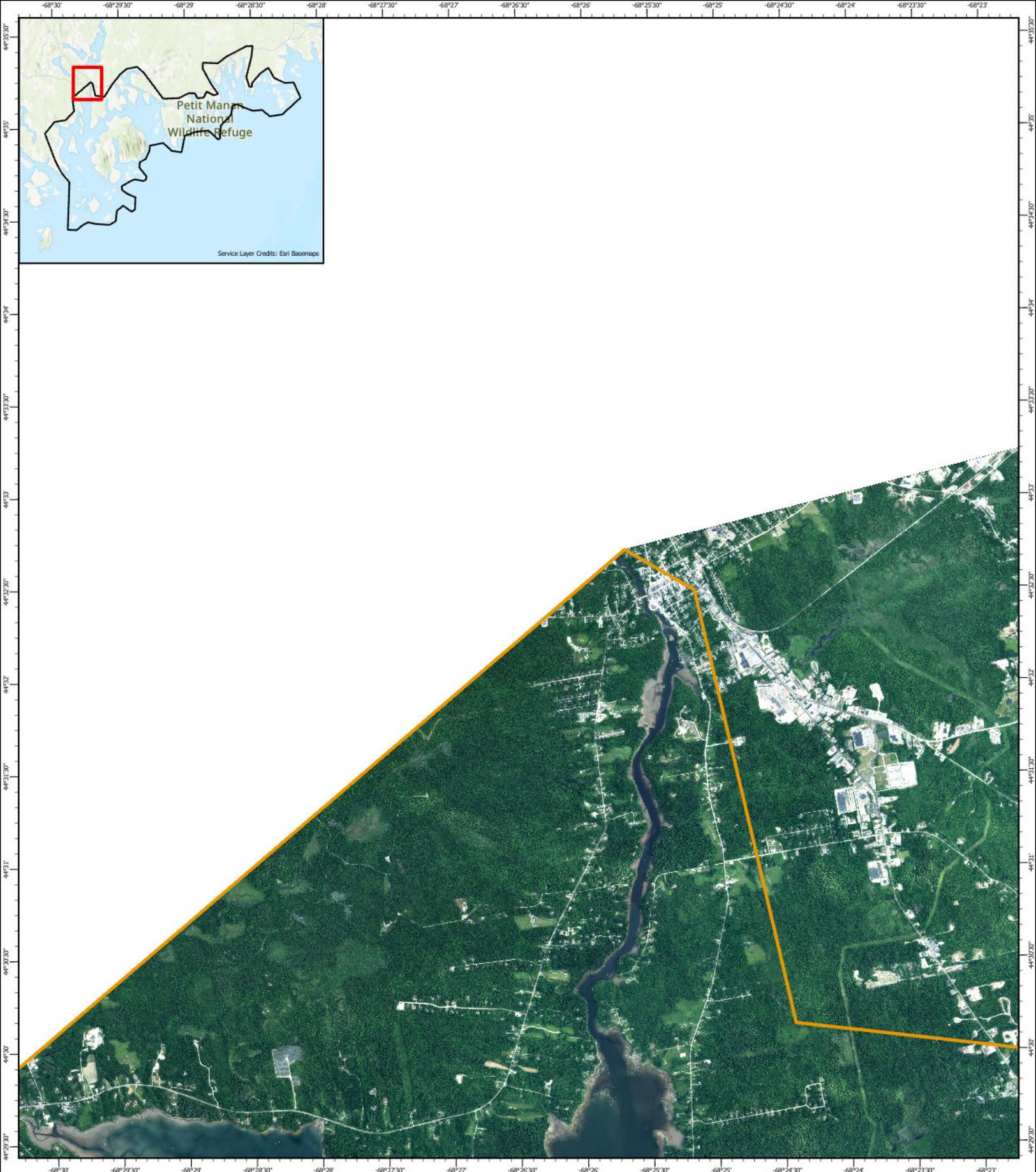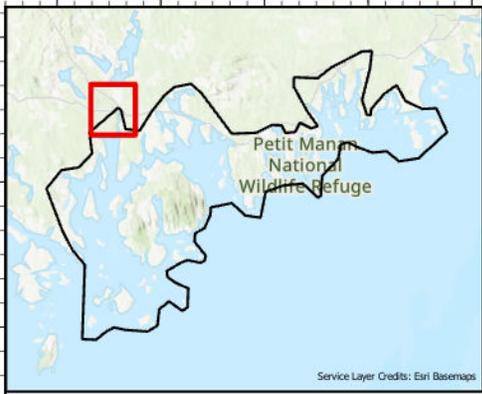
Map Page 21 of 32

	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class

- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

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813 814

817
819 818

820

797
798

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Wildlife Refuge

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DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2
Miles

Legend

2025 Project Area
2008-2009 Mapped Eelgrass (DMR)
1996-1997 Mapped Eelgrass (DMR)
2025 Mapped Seagrass by Cover Class
0-10% Cover
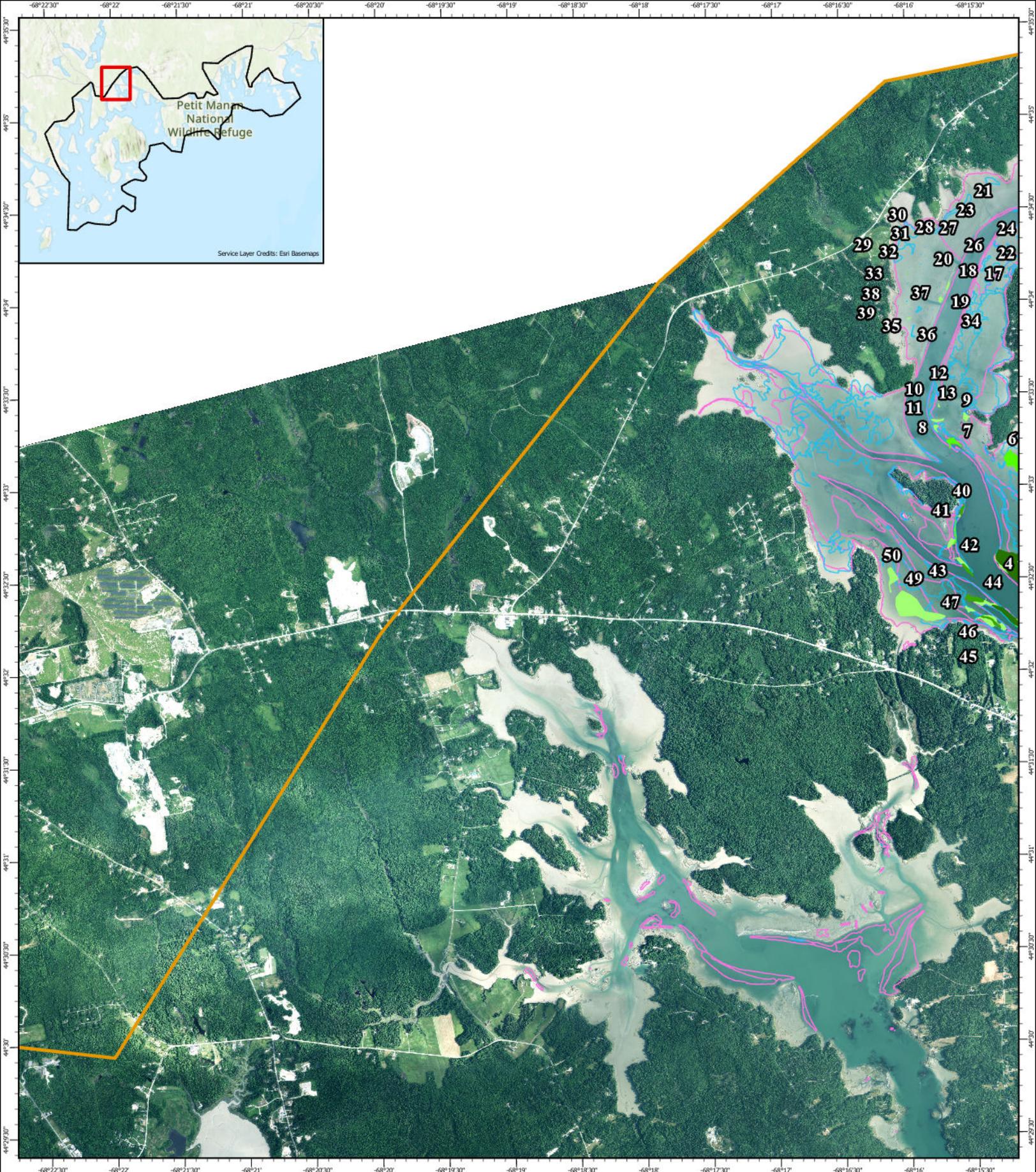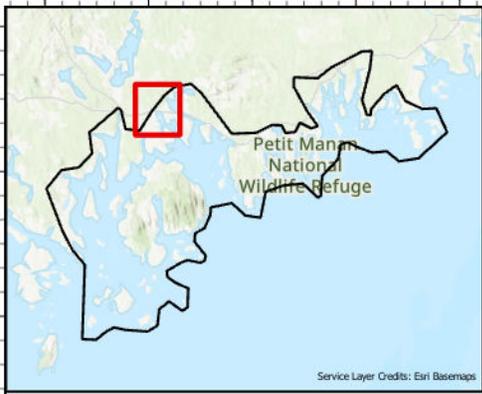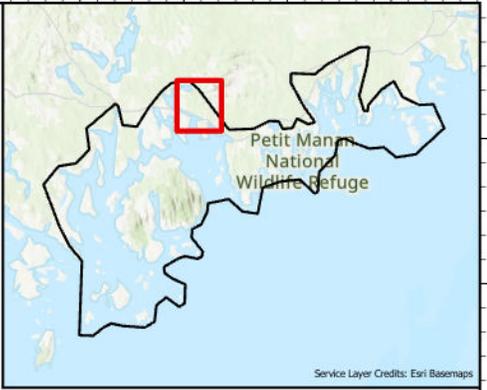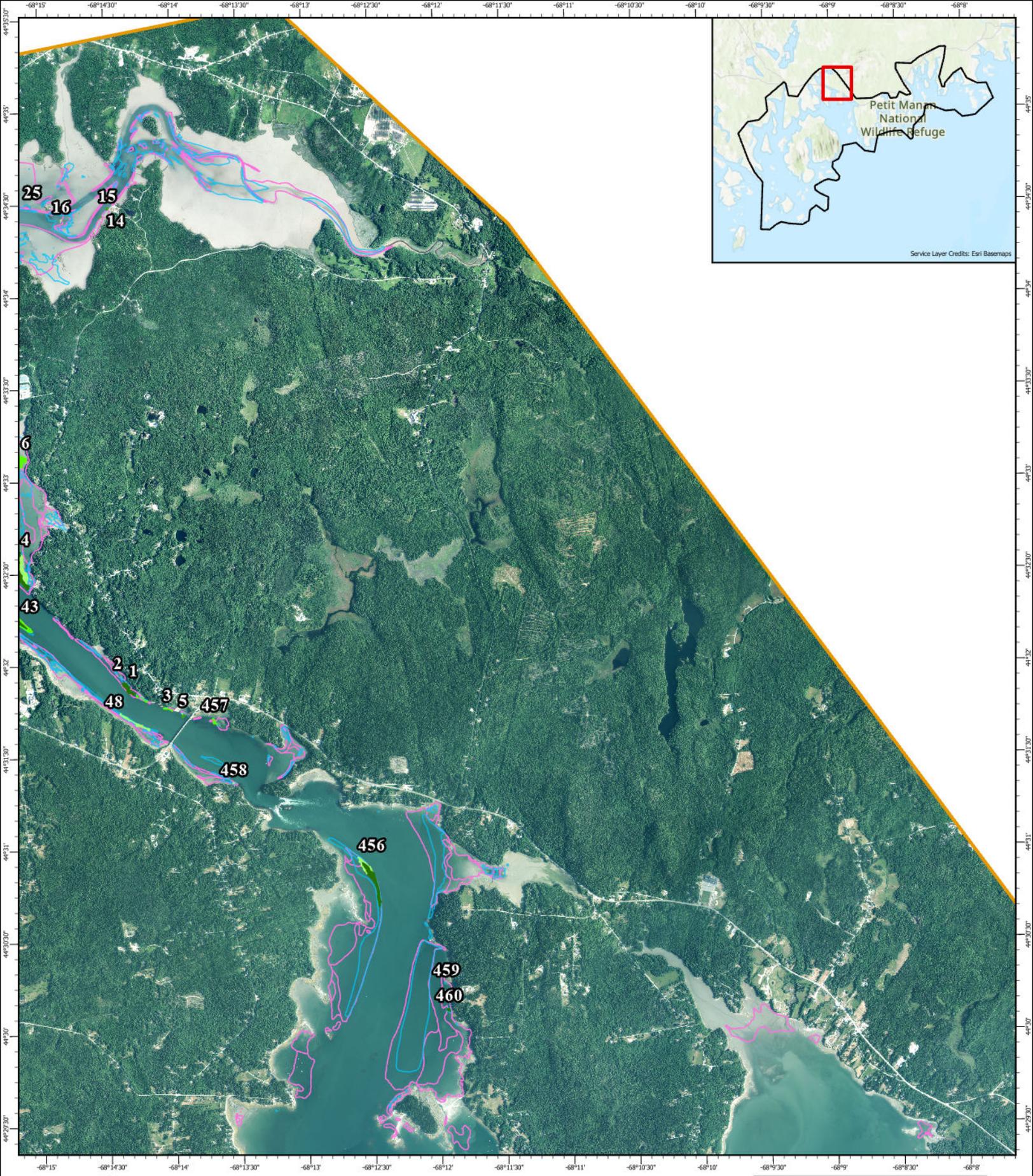10-40% Cover
40-70% Cover
70-100% Cover

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

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Map Page 23 of 32

	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class

	0-10% Cover
	10-40% Cover
	40-70% Cover
	70-100% Cover

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Wildlife Refuge

Service Layer Credits: Esri Basemaps

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

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0   0.5   1   1.5   2
Miles

2025 Project Area
2008-2009 Mapped Eelgrass (DMR)
1996-1997 Mapped Eelgrass (DMR)
2025 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

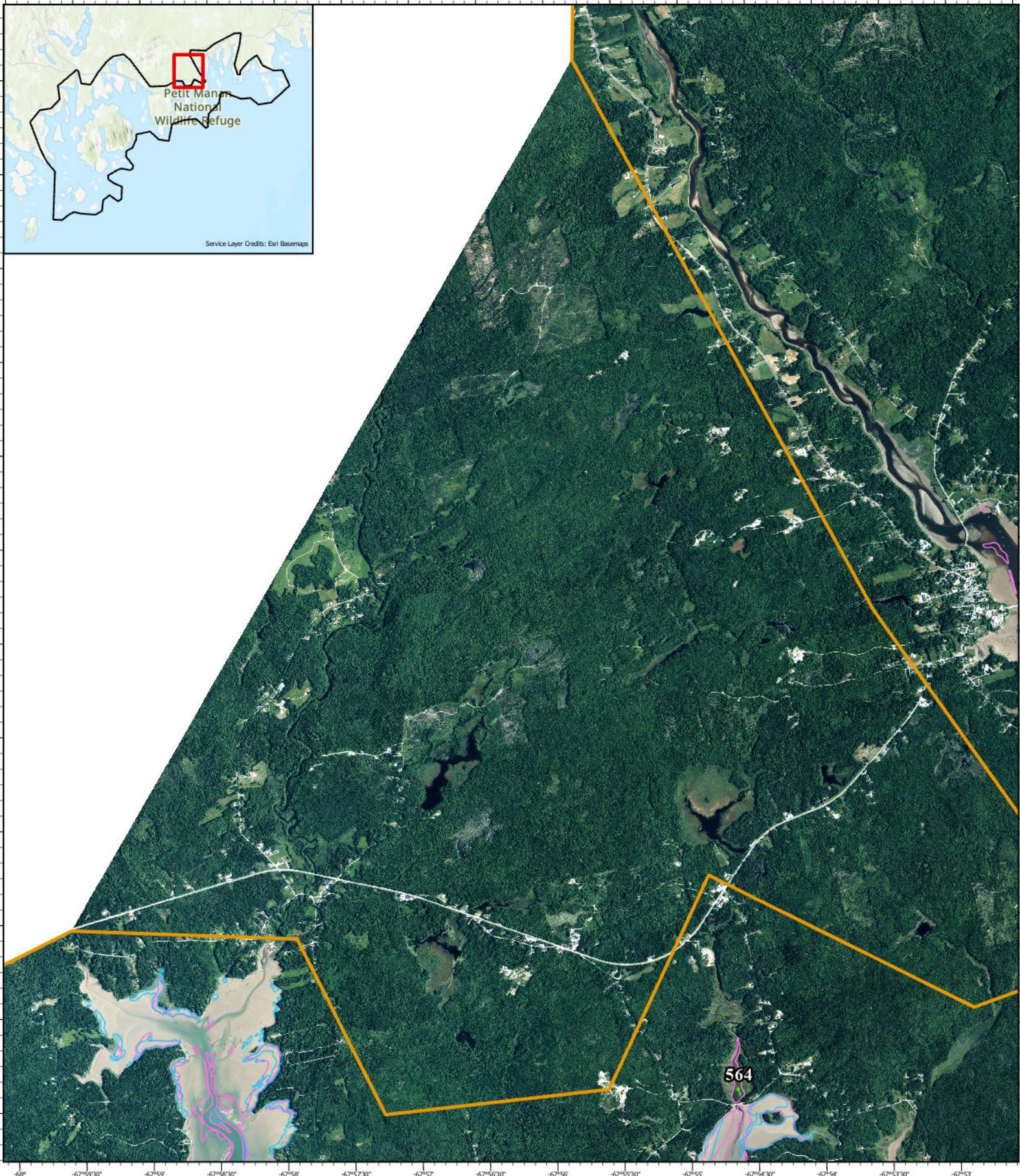ACADIA REGION SEAGRASS MAPPING
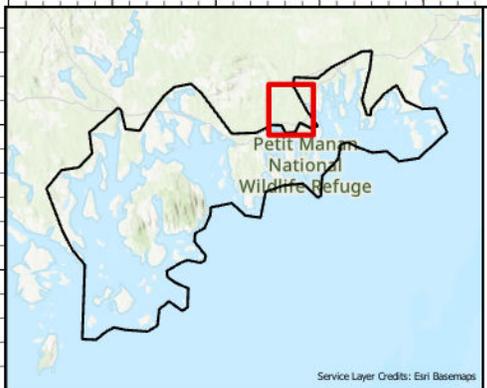
Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

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Petit Manan National Wildlife Refuge

2025 Project Area
2008-2009 Mapped Eelgrass (DMR)
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2025 Mapped Seagrass by Cover Class
0-10% Cover
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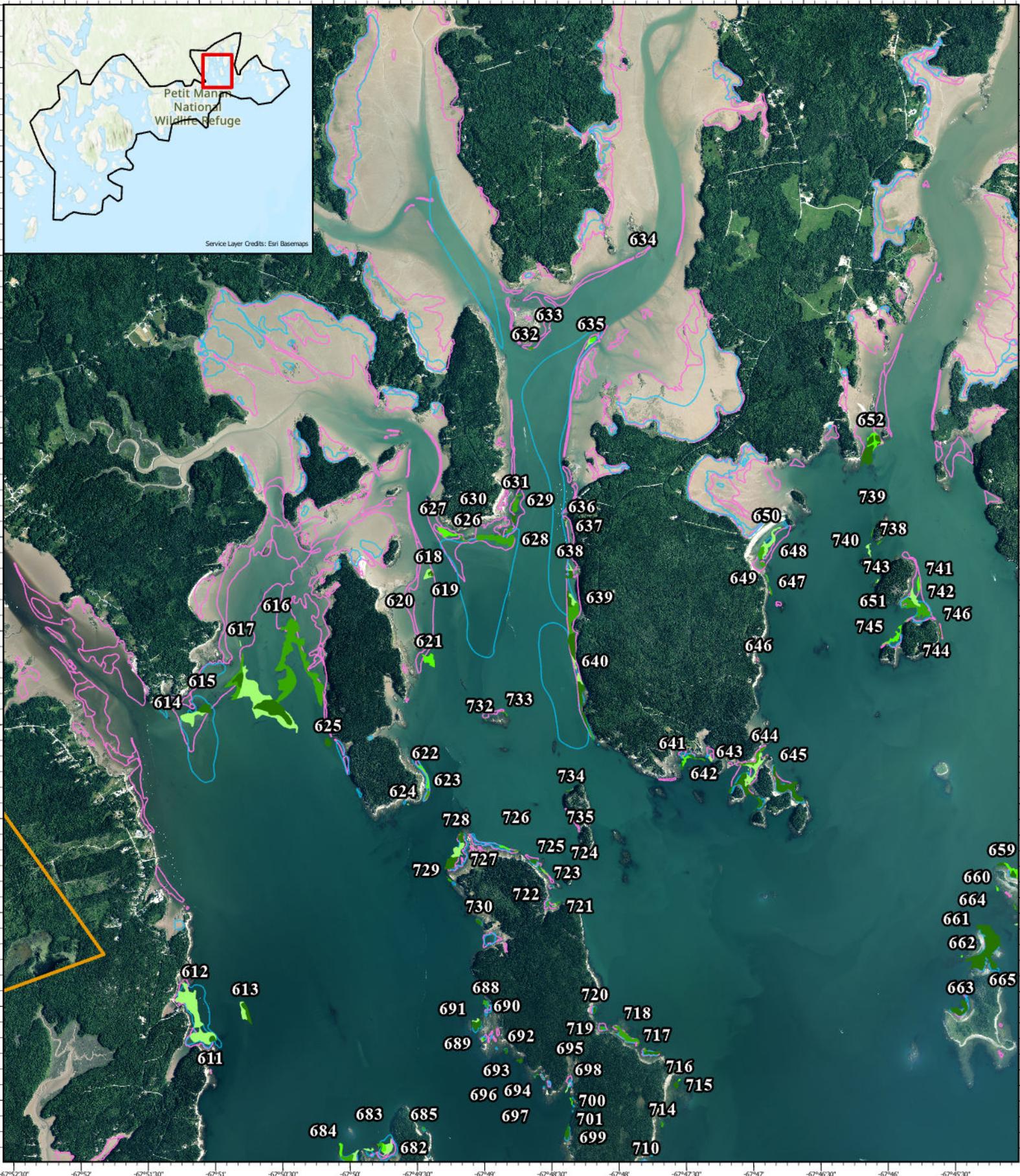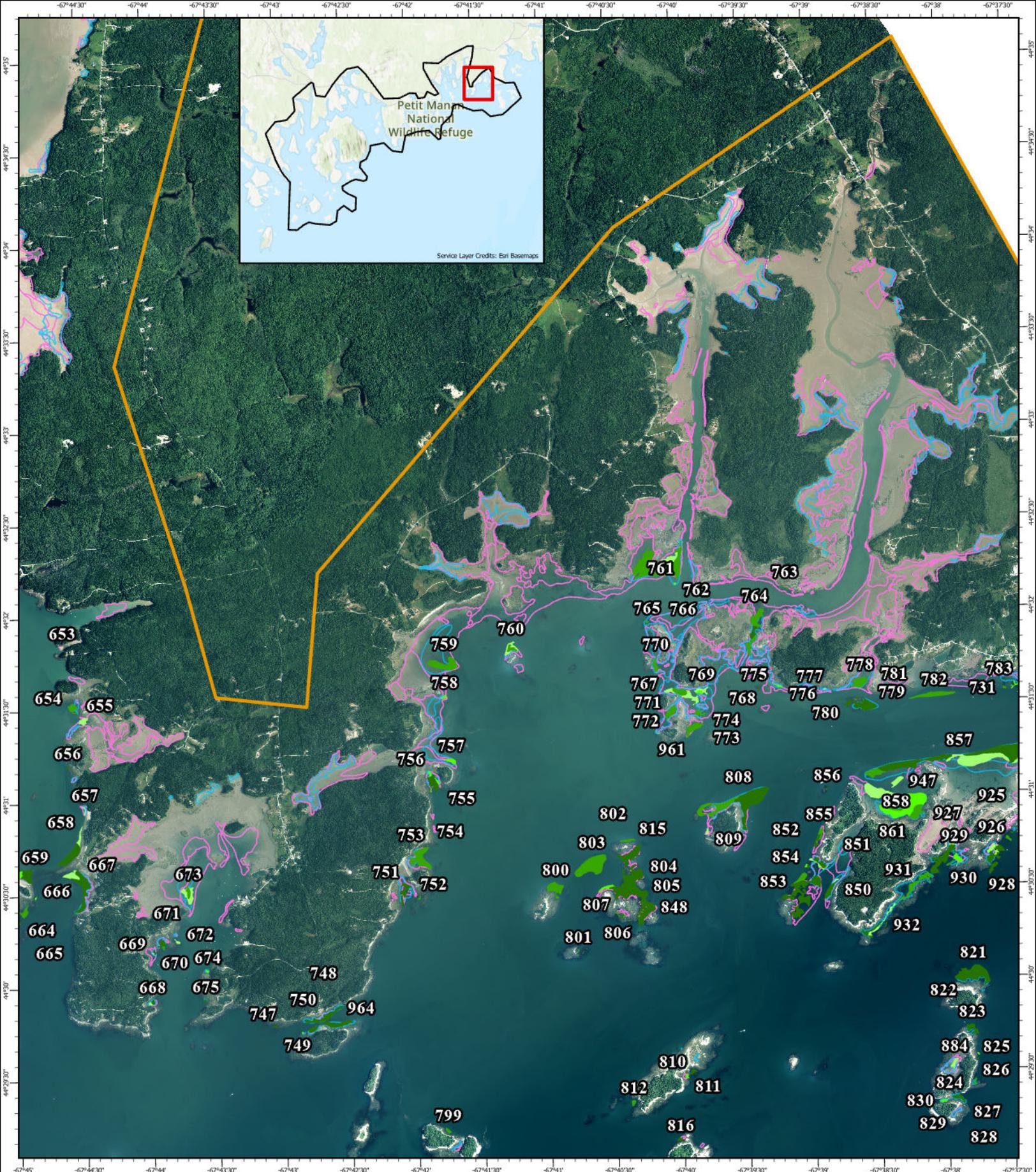DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2 Miles

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 26 of 32

	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class

	0-10% Cover
	10-40% Cover
	40-70% Cover
	70-100% Cover

0   0.5   1   1.5   2 Miles

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ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

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Petit Manan National Wildlife Refuge

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2025 Project Area
2008-2009 Mapped Eelgrass (DMR)
1996-1997 Mapped Eelgrass (DMR)
2025 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

0   0.5   1   1.5   2
Miles

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ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

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Legend:

2025 Project Area	
2008-2009 Mapped Eelgrass (DMR)	
1996-1997 Mapped Eelgrass (DMR)	

2025 Mapped Seagrass by Cover Class

- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Service Layer Credits: Esri Basemaps

Petit Manan National Wildlife Refuge

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2   Miles

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

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Legend

- 2025 Project Area
- 2008-2009 Mapped Eelgrass (DMR)
- 1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
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- 70-100% Cover

0   0.5   1   1.5   2 Miles
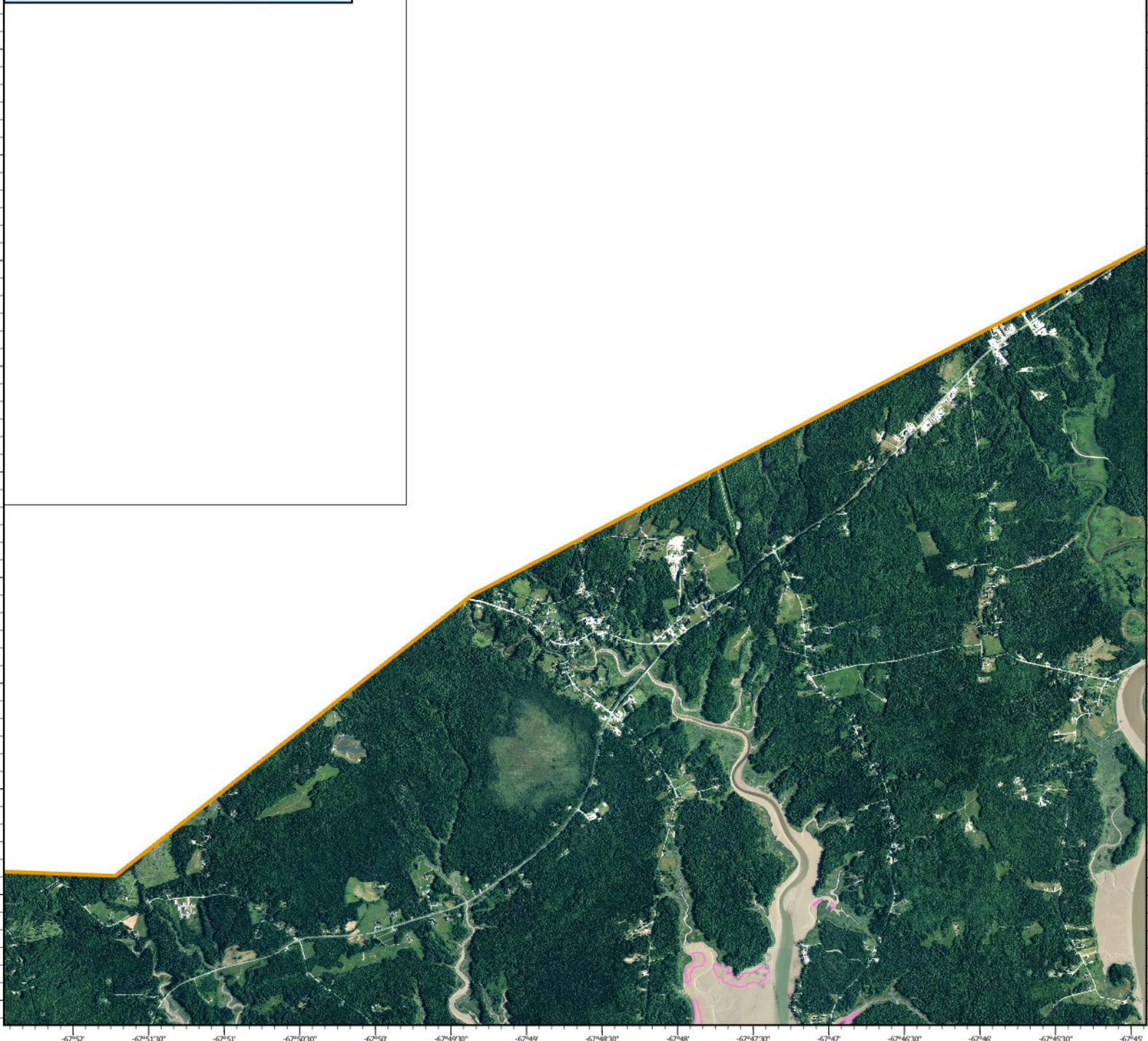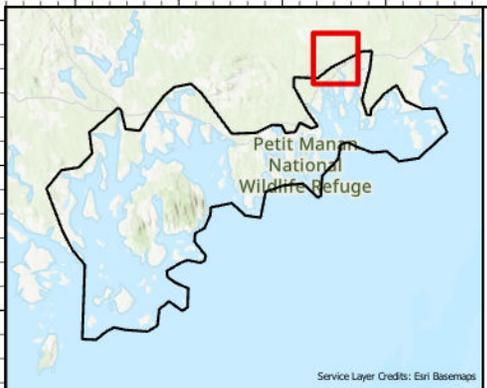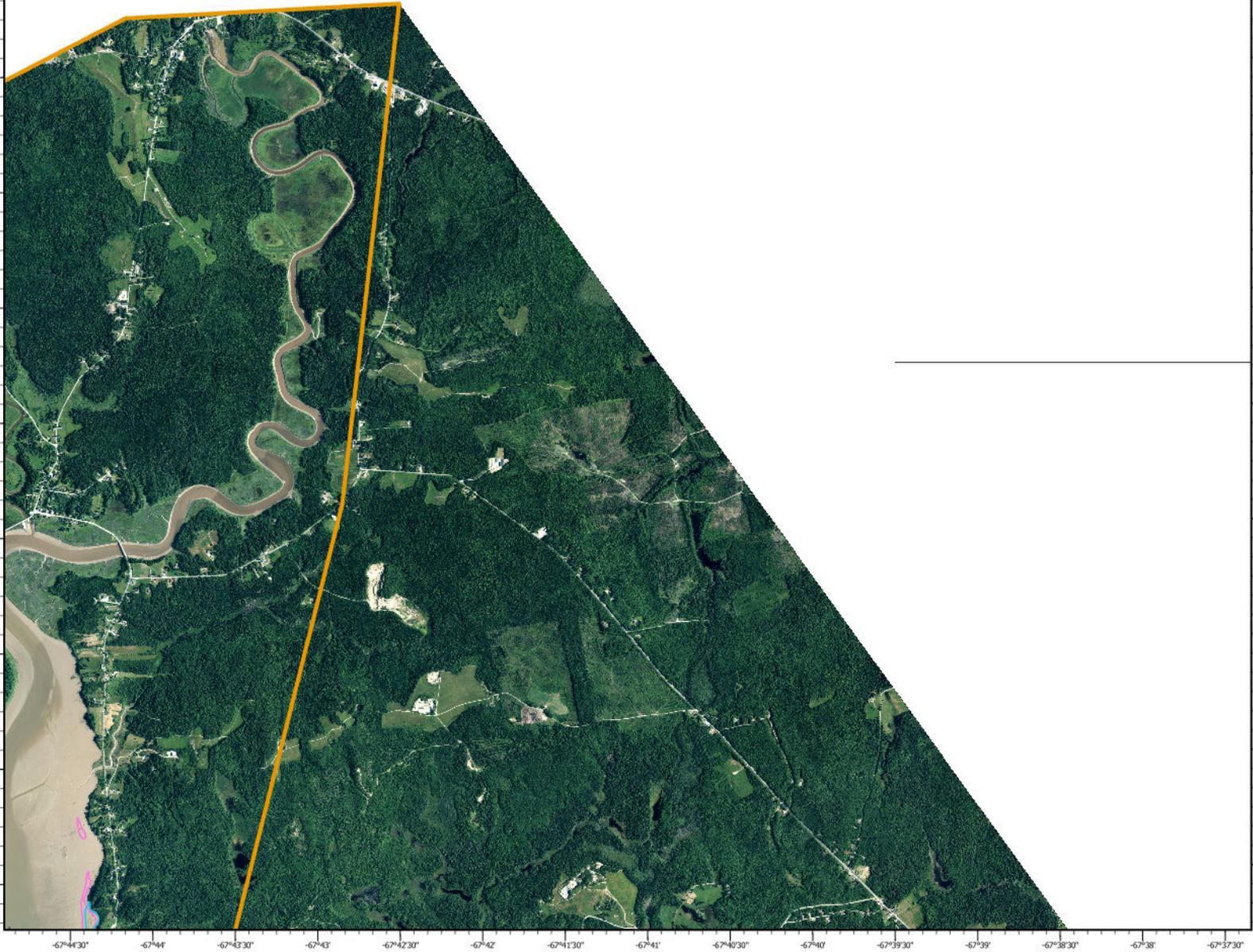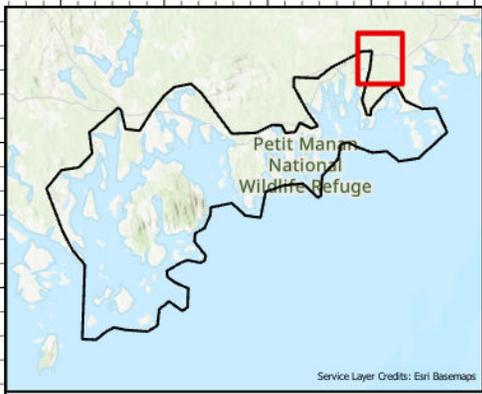
ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Map Page 30 of 32

	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class

- 0-10% Cover
- 10-40% Cover
- 40-70% Cover
- 70-100% Cover

Service Layer Credits: Esri Basemaps

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

0   0.5   1   1.5   2   Miles

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

Petit Manan National Wildlife Refuge

Service Layer Credits: Esri Basemaps

DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

Map Page 31 of 32

| | 0 | 0.5 | 1 | 1.5 | 2 |
| Miles |

Legend

	2025 Project Area
	2008-2009 Mapped Eelgrass (DMR)
	1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class

	0-10% Cover
	10-40% Cover
	40-70% Cover
	70-100% Cover

Petit Manan
National
Wildlife Refuge

Service Layer Credits: Esri Basemaps

ACADIA REGION SEAGRASS MAPPING

Brooklin to Jonesport, ME

2024-2025 MVMP Report Appendix A. Seagrass Distribution and Percent Cover

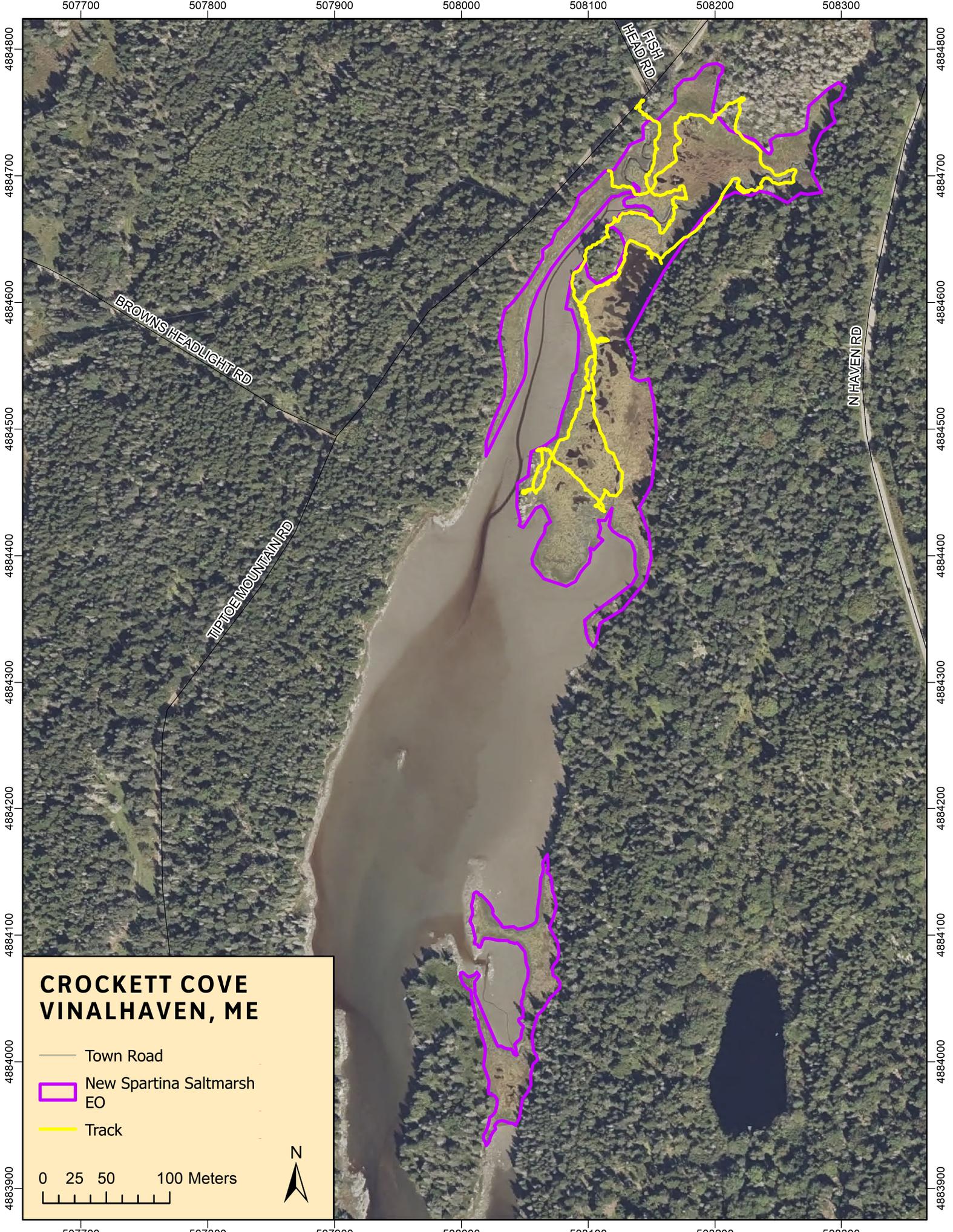DEPARTMENT OF ENVIRONMENTAL PROTECTION · STATE OF MAINE

Map Page 32 of 32

| 0 | 0.5 | 1 | 1.5 | 2 | Miles |

2025 Project Area
2008-2009 Mapped Eelgrass (DMR)
1996-1997 Mapped Eelgrass (DMR)

2025 Mapped Seagrass by Cover Class
0-10% Cover
10-40% Cover
40-70% Cover
70-100% Cover

Appendix B. Tidal Marsh Biotics Submission Maps

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CROCKETT COVE
VINALHAVEN, ME

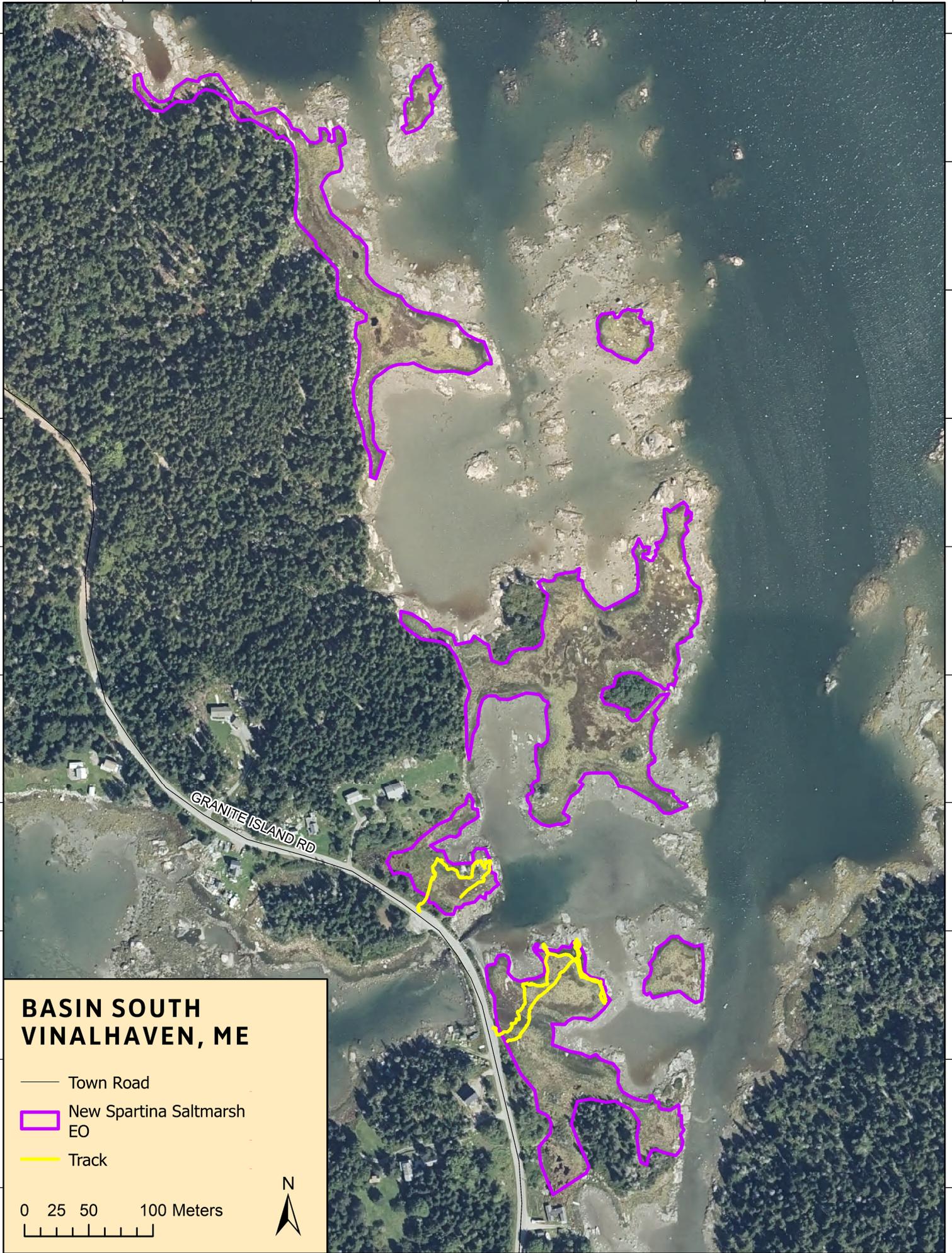— Town Road

New Spartina Saltmarsh EO

Track

0 25 50 100 Meters

N

FISH HEAD RD

BROWNS HEADLIGHT RD

TIPTOE MOUNTAIN RD

N HAVEN RD

BASIN SOUTH
VINALHAVEN, ME

— Town Road

☐ New Spartina Saltmarsh EO

— Track

0 25 50   100 Meters

N

West Bay Marsh
Gouldsboro, ME

Fletcher Wood Road

Jonathans Landing

Legend
- Rare Plant
- Rare Plant
- Rare/Exeplary Natural Community/Ecosystem
- New Salt-Hay Saltmarsh EO

0   50   100   200 Meters
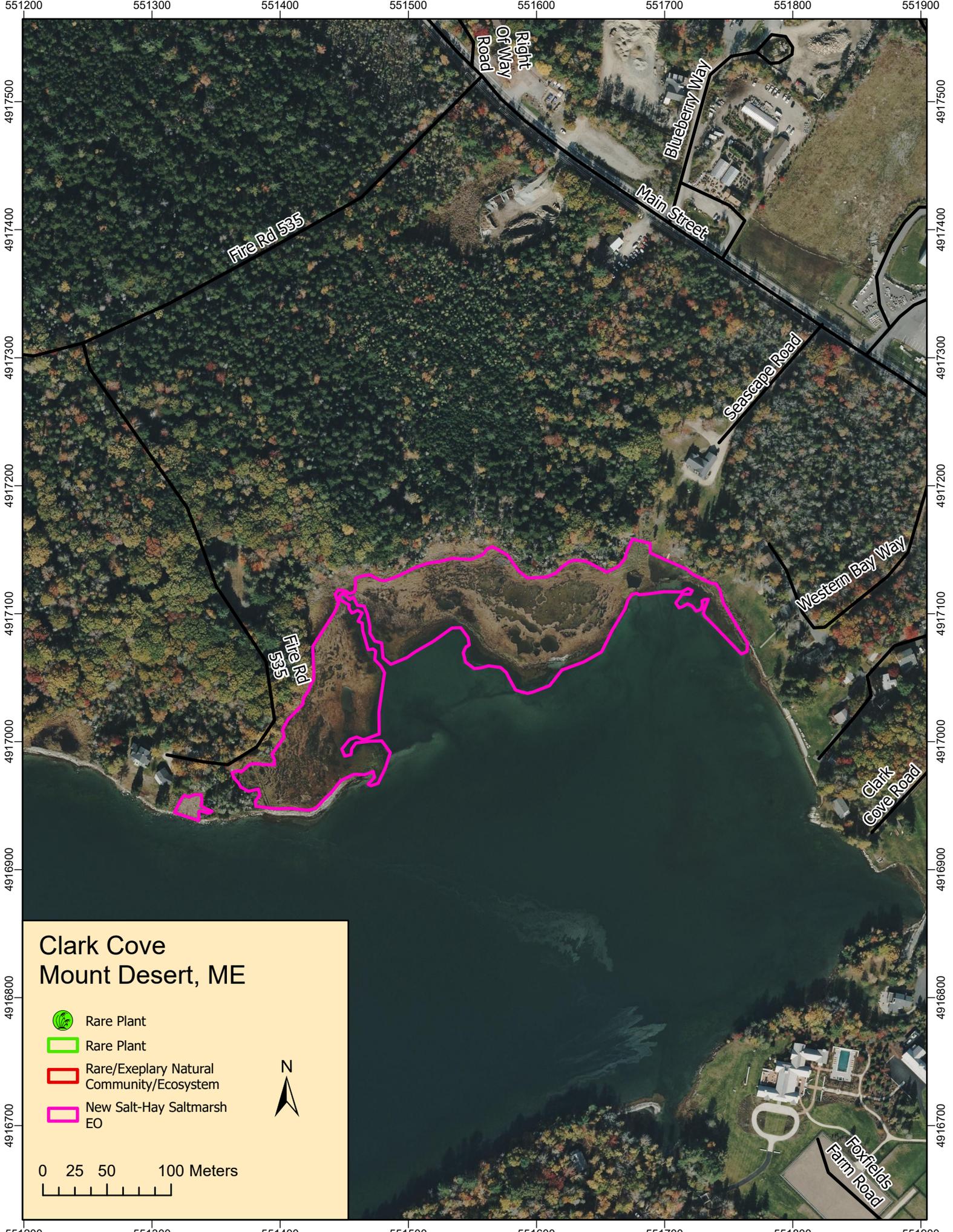
N

Clark Cove
Mount Desert, ME

Rare Plant
Rare Plant
Rare/Exeplary Natural
Community/Ecosystem
New Salt-Hay Saltmarsh
EO

N

0 25 50   100 Meters

Appendix C. Historical Seagrass Map Polygon Layers

MaineDMR – Eelgrass 1997: This shapefile (DMR 1997) is a coast-wide eelgrass survey completed by DMR over the course of several years. Mapping efforts from 1992 to 1997 are included in this compilation. Portions of the Penobscot Bay Region were surveyed in 1992, 1992, 1995, and 1996, but the survey area likely did not extend to Matinicus Island or nearby islands. The Acadia Region was surveyed over the course of 1993, 1994, 1996, and 1997. Corresponding low tide aerial orthoimagery was collected between July and October for each survey year at times of low wind velocity and good water clarity. Polygons were screen digitized and assigned an Orth percent cover (Figure 8) and field verified by boat, on foot, and by plane. The MMU is conservatively estimated at 150 square meters. The corresponding aerial orthoimagery transparencies are maintained by DMR and a subset of them are digitized and available via the Digital Maine Repository,[13] and can be searched using the Maine Geological Survey's Maine Air Photos web map.[14]

MaineDMR – Eelgrass 2010: This shapefile (DMR 2010) is a coast-wide eelgrass survey completed by DMR over the course of several years. Mapping efforts from 2001 to 2010 are included in this compilation. Portions of the Penobscot Bay Region were surveyed in 2003, 2005, and 2008 but the survey area did not extend to Matinicus Island and nearby islands. The Acadia Region was surveyed over the course of 2008 and 2009. Corresponding low tide aerial orthoimagery was collected between June and September for each survey year at times of low wind velocity and good water clarity. Polygons were screen digitized and assigned an Orth percent cover (Figure 8) and field verified by boat, on foot, and by plane. The MMU is conservatively estimated at 150 square meters. The corresponding aerial imagery can be viewed either as an imagery service layer or the tiles can be downloaded from the Maine GeoLibrary (Maine Orthoimagery Coastal Central Coast 2003 and 2005, Maine Orthoimagery Coastal Downeast 2008, and Maine Orthoimagery Coastal Downeast 2009).

MaineDEP Casco Bay Eelgrass 2013: This shapefile (DEP 2013) is an eelgrass survey completed by DEP in 2013 for Casco Bay only. Corresponding low tide aerial orthoimagery was collected on August 11 and 12 at a time of low wind velocity and good water clarity. Polygons were screen digitized and assigned an Orth percent cover (Figure 8) and field verified by boat, on foot, and by plane. The MMU is conservatively estimated at 150 square meters. The corresponding aerial imagery is 0.15 meter resolution and can be viewed either as an imagery service layer or the tiles can be downloaded from the Maine GeoLibrary (Maine Orthoimagery Coastal Casco Bay 2013).

MaineDEP Casco Bay Eelgrass 2018: This shapefile (DEP 2018) is an eelgrass survey completed by DEP in 2018 for Casco Bay only. Corresponding low tide aerial orthoimagery was collected on June 16 and 17 at a time of low wind velocity and good water clarity. Polygons were screen digitized and assigned an Orth percent cover (Figure 8) and field verified by boat, on foot, and by plane. The MMU is conservatively estimated at 150 square meters. The corresponding aerial imagery is 0.30 meter resolution and can be viewed either as an imagery

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[13] https://digitalmaine.com/mgs_aerial_photos/
[14] https://www.maine.gov/dacf/mgs/explore/maps/airphotos/

service layer or the tiles can be downloaded from the Maine GeoLibrary (Maine Orthoimagery Coastal Casco Bay 2018).

MaineDEP Seagrass 2021 (South Coast – Elliot to Cape Elizabeth): This shapefile (DEP 2021) is a seagrass survey completed by DEP in 2021 for the South Coast only. Widgeon grass (*Ruppia maritima)* was included in the survey, in addition to eelgrass (*Zostera marina*). Corresponding low tide aerial orthoimagery was collected on June 29 within 2 hours of low tide and at a sun angle of 25-50 degrees. Additional environmental considerations included no more than 10% cloud cover, less than 10 knots maximum predicted wind velocity, and a 48-hour precipitation-free period preceding the flight. Polygons were screen digitized and assigned an Orth percent cover (Figure 8) and field verified by boat, on foot, and with view tubes and an SAV rake. Field GPS equipment was capable of submeter accuracy. The MMU was assumed to be 0.5 acres, but areas as small as 55 square feet were delineated. The corresponding aerial orthoimagery is approximately 0.15 meter resolution and can be viewed either as an imagery service layer or the tiles can be downloaded from the Maine GeoLibrary (Maine Orthoimagery Coastal South Coast 2021).

MaineDEP Casco Bay Seagrass 2022: This shapefile (DEP 2022) is a seagrass survey completed by DEP in 2022 for Casco Bay only. Widgeon grass (*R. maritima)* was included in the survey, in addition to eelgrass (*Z. marina*). Corresponding low tide aerial orthoimagery was collected on July 16 within 2 hours of low tide and at a sun angle of 25-50 degrees. Additional environmental considerations included no more than 10% cloud cover, less than 10 knots maximum predicted wind velocity, and a 48-hour precipitation-free period preceding the flight. Polygons were screen digitized and assigned an Orth percent cover (Figure 8) and field verified by boat and on foot. Field GPS equipment was capable of submeter accuracy. The MMU was assumed to be 0.5 acres, but areas as small as 444 square feet were delineated. The corresponding aerial orthoimagery is approximately 0.15 meter resolution and can be viewed either as an imagery service layer or the tiles can be downloaded from the Maine GeoLibrary (Maine Orthoimagery Coastal Casco Bay 2022).

MaineDEP Midcoast Seagrass 2023: This shapefile (DEP 2023) is a seagrass survey completed by the DEP MVMP in 2023 for the Midcoast Region. Widgeon grass (*R. maritima)* was included in the survey, in addition to eelgrass (*Z. marina*). Corresponding low tide aerial orthoimagery was collected on July 7, August 2, August 3, and August 6 within 2 hours of low tide and at a sun angle of 20-50 degrees. Additional environmental considerations included no more than 10% cloud cover, less than 10 knots maximum predicted wind velocity, and a 48-hour precipitation-free period preceding the flight. Polygons were screen digitized and assigned an Orth percent cover (Figure 8) and field verified by boat and on foot. Field GPS equipment was capable of submeter accuracy. The MMU was 100 square meters, but areas as small as 4 square meters were delineated. The corresponding aerial orthoimagery is approximately 0.15 meter resolution and can be viewed either as an imagery service layer or the tiles can be downloaded from the Maine GeoLibrary (Maine Orthoimagery Coastal Midcoast 2023).