December 31, 2020

Edey Foundation
Attn: Bea Phear
beaphear2@gmail.com

Dear Ms. Phear,

Great Pond Foundation, a 501(c)3 non-profit (EIN 043446891) located in Edgartown, MA, respectfully submits for your review a report of our activities and results in fulfillment of the Edey Foundation funded project entitled *Conservation Can Combat Climate Change: Using eelgrass monitoring data on Edgartown Great Pond to educate and advocate for Blue Carbon.*

Eelgrass meadows have returned to Edgartown Great Pond as a result of conservation efforts and improved water quality over the last decade. The carbon stored in eelgrass meadows and other coastal ecosystems is termed Blue Carbon. During this project we, along with our project partners, monitored the health and distribution of eelgrass in Edgartown Great Pond, a proxy for the Blue Carbon resources, and prepared to launch an education and advocacy campaign that provides the Island with a model for using natural resource conservation in Island waters to mitigate climate change. Please learn more about Eelgrass and Blue Carbon on our website.

Data will be available to the public upon quest, infographics and images of the mapping are currently found in the Appendix of this report, and on or before January 2021, will also be available on GPF's website.

GPF Partner Organizations include:

- Martha's Vineyard Commission
- EPA Region 1 – Boston Office
- Massachusetts DEP

Contact

- Emily Reddington • e-mail: emily@greatpondfoundation.org • mobile: 508.245.9502

Sincerely,

Emily Reddington

Emily Reddington | Executive Director

Conservation Can Combat Climate Change

Using eelgrass monitoring data on Edgartown Great Pond to educate and advocate for Blue Carbon

2020 Report to the Edey Foundation

Primary Project Partners: Great Pond Foundation and Martha's Vineyard Commission

Grant Amount: $8,100

Since its founding in 1998, Great Pond Foundation (GPF) has been dedicated to preserving and protecting Edgartown Great Pond through science, collaboration, and education. Additionally, GPF is actively engaged in issues relating to climate change mitigation, preparedness, and education. As GPF looks toward the future and prepares for the climate challenges ahead, we strongly believe that scientifically informed and data-driven management techniques are the key to protecting and preserving Edgartown Great Pond (EGP), as well as other Vineyard coastal ponds. With these goals in mind, GPF proposed a study to monitor the health and distribution of eelgrass in Edgartown Great Pond, a proxy for the Blue Carbon resources. Additionally, GPF launched an education and advocacy campaign that which provides the Island with a model for using natural resource conservation in Island waters to mitigate climate change.

Blue Carbon refers to the carbon dioxide that is removed from the atmosphere by aquatic plants, where it is then stored in sediments for centuries. On Martha's Vineyard, Blue Carbon resources are mostly salt marshes and eelgrass (*Zostera marina*) meadows. By preserving these habitats, local conservation efforts can have a global impact by helping to mitigate climate change. To gain a more thorough understanding of our Blue Carbon resources, GPF proposed a collaboration with the Martha's Vineyard Commission (MVC) to map eelgrass beds in Slough Cove, part of EGP, using GIS & sUAS Mapping (aerial drone) technology. These aerial maps would then be verified by boat-based eelgrass survey methods to confirm the presence of eelgrass meadows. We also sought to continue our collaborations with EPA and WHOI scientists to evaluate the health of Slough Cove eelgrass meadows relative to other sites in the Pond, as part of a larger ongoing eelgrass study. Lastly, GPF proposed development of online educational resources about eelgrass, monitoring data generated from this study, and Blue Carbon.

Project Objectives

1) Produce maps of eelgrass extent in Slough Cove using sUAS technology
2) Ground-truth drone data with underwater surveys
3) Develop mapping protocol that can be easily replicated in other Island ecosystems
4) Educate the public on the importance of eelgrass and Blue Carbon
5) Promote the conservation of local ecosystems resources to combat climate change

Project Personnel

Chris Seidel | Cartographer/GIS Coordinator | Martha's Vineyard Commission
Julie Pringle | Scientific Program Manager | Great Pond Foundation
Emily Reddington | Executive Director | Great Pond Foundation

The remainder of this report is divided into two sections:

A. Slough Cove Mapping Project: Objectives 1-3
B. Educational Materials: Objectives 4-5.

A. Slough Cove Mapping Project (maps included in the Appendix)

Objective #1: Produce maps of eelgrass extent in Slough Cove using sUAS technology
Report text for objective #1 written by Chris Seidel, MVC Cartographer / GIS Coordinator

The Martha's Vineyard Commission (MVC), with the field assistance of the Great Pond Foundation (GPF) collected drone imagery of Slough Cove over several days in June and July of 2020 for the purposes of mapping the presence and distribution of eelgrass.

The area of Slough Cove was divided into several individual drone flights for: 1) ease of imagery file management & processing; and 2) ensuring completion of planned flight within allotted field time on any one day. The cove was divided into five areas, each area was flown using the same equipment and parameters.

Flight Equipment/Software & Flight Specifications
Drone & Visual Display: DJI Phantom 4 Pro and iPad Mini
Software/Apps: DJI's Go 4 App and Map Pilot by Maps Made Easy
Parameters: Image Overlap — Front: 80%; Side: 80%; Altitude (height above ground) = 170ft;

Resolution: 0.6inch/pixel. The 80% front & side overlap was chosen since the purpose of the flight was to acquire images of water (which is flat, homogeneous terrain). The altitude was chosen to provide high resolution photos and to comply with the FAA's maximum altitude (200ft) for sUAS within this particular region of Class D airspace.

Flights
Flight dates included: 7/2/2020, 6/30/2020, and 6/25/2020
Flight preparation: The MVC's licensed Remote Pilot in Command, Chris Seidel, followed the FAA's sUAS Part 107 guidelines for planning and carrying-out all drone flights. Public notice for each flight was provided on the MVC's website, sent to the Edgartown Police Department, the MVY Airport, and the Katama Airfield.
Flight Crew: Remote Pilot in Command: MVC's Chris Seidel; Person Manning the Controls: Chris Seidel; Visual Observers: Edgartown Great Pond Foundation Staff
Pre-Flight Checks: Before every flight, the MVC's extensive pre-flight checklist was reviewed and certain weather parameters were checked for compliance with FAA's sUAS flight requirements

(i.e. minimum of 3 miles visibility, cloud base permitting a minimum of 500ft separation from drone's maximum height above ground and the cloud base - which is a function of the dew point temperature and ambient air temperature).

Mosaicing/Stitching Images
As the drone flies along the pre-planned flight path, it collects still JPG snapshots with the camera pointing straight down. For each of the 5 flights, the drone collected approximately 225 images. These images do have location information stored within the image file which permits the images to be stitched together into one seamless image.

Due to the complexity and complications with stitching together imagery of water, this process took several attempts before finding success. The software programs that do this stitching will stitch images based on the image's location information and the identification of identical objects in overlapping images. Since the surface of the water is homogeneous, this makes it difficult for the computer to identify visibly unique objects within overlapping images. Also, the movement of the water's surface is an additional complication. The MVC conducted the following analyses.

Drones Made Easy, an online service for stitching drone images, was used for the first batch of images from the flight on 6/25/2020. Drones Made Easy was successful for that first flight but unsuccessful for the subsequent flights.

The second attempt at stitching the images was made using ESRI's Drone2Map desktop software. The MVC received a trial version and processed all five flights of images. This software did a pretty good job but there were still some imagery gaps within each of the five flight areas.

The third attempt was completed using a trial version of DroneDeploy. This online processing software was completely successful at stitching together all images from the five flights.

Mosaicing the Mosaics

Using the resulting five images from the DroneDeploy stitching process, the MVC further processed those images into a mosaic dataset, which blends the five images together into one image covering all of Slough Cove. Several symbology variations were previewed to the GPF to identify which symbology color variation highlighted the eelgrass the most. The winner was a symbology of classic RGB with a stretch of Standard Deviation of 2 with gamma of 0.7 in each band.

Mapping Eelgrass

The MVC then pushed the mosaic dataset to the ArcGIS OnLine (AGOL) cloud as a Tile dataset. This dataset is used as the basemap for GPF to on-screen digitize the areas with eelgrass. In addition, the MVC setup an AGOL feature layer to store the digitized eelgrass areas along with site-specific information (i.e. density, submerged aquatic vegetation type, etc). Since GPF has their own AGOL subscription, they can do this mapping independently of the MVC. Maps and data stored within AGOL can readily be shared with the public at any time the owner of the data so chooses. Due to delays caused by the COVID-19 pandemic, GPF will digitize the areas with eelgrass in the beginning of 2021 and will publish these maps when they are completed.

Acknowledgements:

The MVC would like to thank the Edey Foundation for funding this new technology initiative. A huge bundle of gratitude also to the Great Pond Foundation staff for their patience, support, and encouragement of the scientific process.

Objective #2: Ground-truth drone data with underwater surveys

With the unexpected impact of the COVID-19 pandemic, GPF created a policy limiting the capacity of our boat and office space in order to maintain a safe work environment. Since many projects are collaborative and require multiple people to be efficient, this subsequently reduced the scope of our field work. Due to these COVID-19 safety policies, GPF postponed the boat-based quadrat surveys to ground-truth the aerial maps to 2021. Additionally, the scientific divers from the US Environmental Protection Agency (EPA) and Woods Hole Oceanographic Institution (WHOI) were unable to complete their annual survey of eelgrass extent and health in EGP, due to COVID-19 restrictions. Both the EPA survey and the GPF survey will be completed in 2021, or when COVID-19 is no longer a public health threat.

While the proposed method of ground-truthing aerial drone maps could not be performed, the drone map was corroborated by a newly formed collaboration with the Massachusetts state Department of Environmental Protection (DEP). The MA DEP regularly takes aerial photographs of coastal waters via a plane to assess eelgrass area, however these flyovers have excluded the south shore salt ponds of Martha's Vineyard up until 2020. In an effort to document the expansion of eelgrass beds that has occurred in EGP and to build on our drone mapping

project, MA DEP agreed to begin flying over EGP as well as the other great ponds on the Island. While the MA DEP map is not yet available to the public, it resulted in aerial photos similar to what was produced for this grant, but from a much higher elevation. While this MA DEP project is not yet complete, we are confident that it will confirm that the methods we developed for drone sUAS eelgrass mapping can accurately delineate eelgrass beds. When the DEP releases its eelgrass area delineations, estimated to be complete in July 2021, we will compare this dataset to the one produced by GPF and the MVC.

Further, after a site visit from a colleague at the US EPA, we developed a low-cost boat-based method for ground-truthing these aerial maps using a peep-sight commonly used for scallop fishing. This method was able to qualitatively assess whether submerged aquatic vegetation was present, which species was present, and estimate the percent cover. While this method is not quantitative, it was nonetheless extremely useful to confirm the presence of eelgrass beds, where the edges of these beds occurred, and when the habitat became dominated by a different aquatic species of aquatic vegetation. This method will be used in 2021 to ground-truth the MVC aerial map, and in addition to the quadrat surveys we had originally proposed in collaboration with the EPA. The quadrat survey will provide quantitative data on percent cover and the health of the eelgrass.

Objective #3: Develop mapping protocol that can be easily replicated in other Island ecosystems

This new mapping technique provided the first updated map of eelgrass area in Slough Cove since 1951. Since the photographs were taken from a drone at 170 feet, the map provides a level of detail unattainable with satellite photos or with photos taken from a plane or helicopter at much higher elevation. This allows us to delineate more precisely edges of eelgrass beds and see changes in the photographs that may signal a shift to a habitat dominated by another aquatic plant. This is extremely useful dataset, as this quantitatively shows an increase in eelgrass extent since the last mapping occurred.

While this method was effective for Slough Cove, it would likely run into problems if it were applied to larger basins of EGP or other ponds. First, the drone flight time was limited by battery life, which expired quickly due to the number of images taken in each predetermined section of Slough Cove. Even with multiple batteries, only a portion of the cove could be mapped each day. Further, software used to stitch the photographs together to form a map does not function well with photos that do not contain any land due to the homogenous features of moving water. After several attempts, Chris Seidel found a program that successfully stitched together the photographs. While this program worked in this instance, it may not be successful for more open bodies of water. For this reason, this method would work best applied to coves similar in size to Slough Cove. Mapping larger areas of water would likely not result in gaps in the image mosaic and would pose a risk to the drone due to limited battery life.

B. Educational Materials

Objectives #4-5: Educate the public on the importance of eelgrass and Blue Carbon, Promote the conservation of local ecosystems resources to combat climate change

In addition to producing an updated map of eelgrass extent in Slough Cove, GPF also proposed support for development of online educational resources about eelgrass, monitoring data generated from this study, and Blue Carbon. The connection between coastal vegetated ecosystems and global climate change is not well known among the public, and GPF and the MVC sought to bridge this gap between science and education. The results from this project and the educational materials produced will help stakeholders understand their impact, promote conservation, and influence policymakers on the importance of this precious resource.

As part of this project, GPF has dedicated sections of its website to Blue Carbon and Eelgrass Ecosystem educational resources for the community. These pages are highlighted on the homepage of the GPF website, which has over a thousand of unique visitors every month. On the website we define Blue Carbon and explain the importance of these eelgrass and other blue carbon ecosystems. The educational information also focuses on the ecosystem services this environmental resource provides to humans, as well as the role Blue Carbon plays in the carbon cycle and its mitigation potential for combating climate change. These pages will be continually updated with new content, including underwater videos of the quadrat surveys when the survey is conducted.

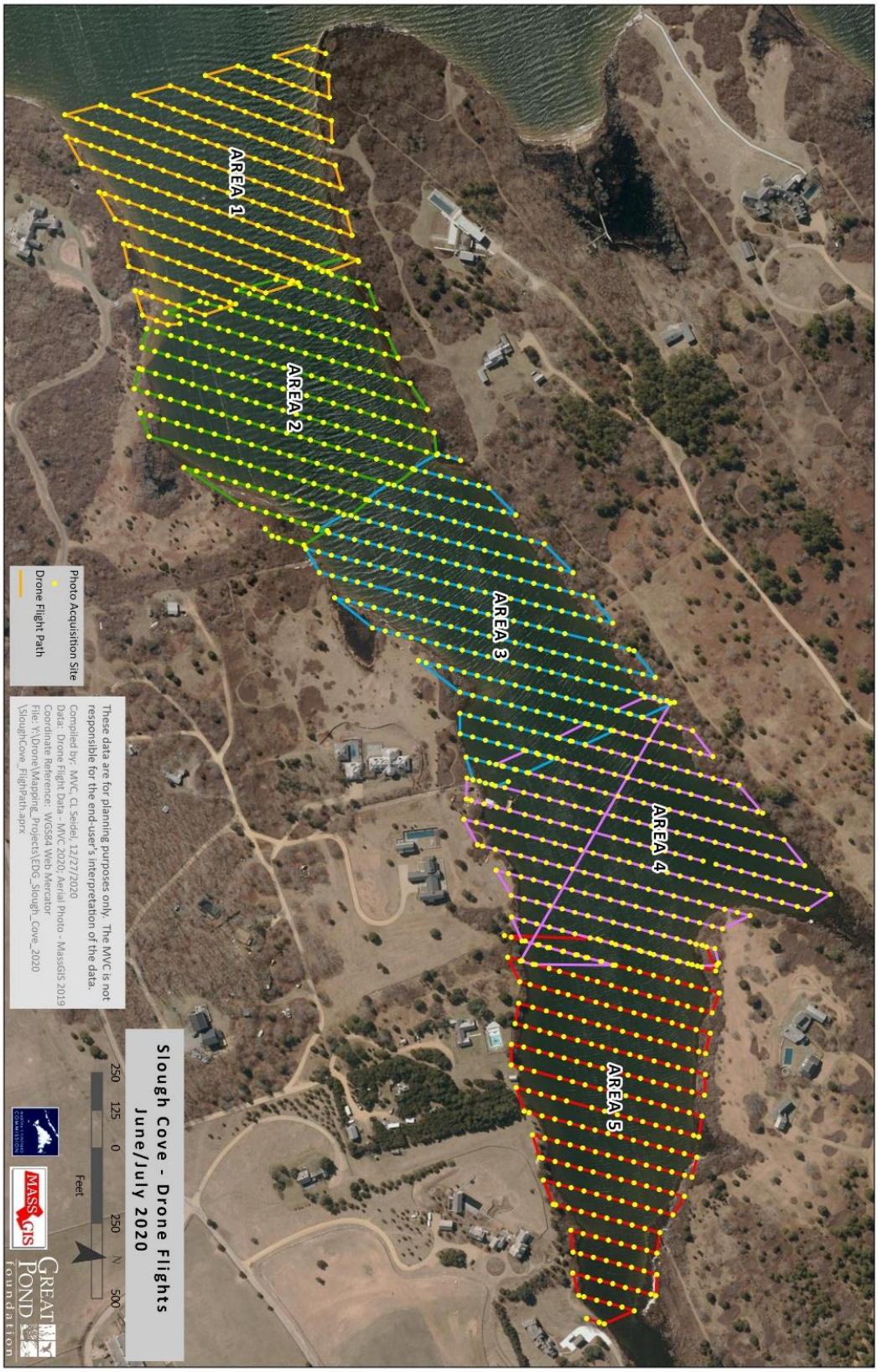
Additionally, GPF contracted local artist John Holladay to produce two infographics to illustrate the value of Blue Carbon ecosystems. These infographics, which are featured on the GPF website, provide a visual representation of the importance of eelgrass ecosystems. One focuses on the value of eelgrass as a habitat and the benefits it provides to other wildlife and to humans. The second aims to raise awareness of the impact Blue Carbon has in carbon dioxide sequestration, and thus how eelgrass conservation is a tool to combat global climate change. These infographics are included in the appendix of this report. These graphics will also be promoted on GPF social media pages as an additional form of science communication and education. Our social media pages are popular with many age groups and posts often have hundreds of views.

As a second phase of the Blue Carbon educational materials, we proposed presenting the results of this study at an MV Water Alliance meeting. Water Alliance meetings have been put on hold during the COVID-19 pandemic and have yet to resume. However, once they resume, we will present our findings to explain our project and mapping techniques to other water management groups, while also raising awareness of the importance of Blue Carbon ecosystems. Many local towns are participating in committees focused on climate change, such as the Climate Action Task Force and Climate Resilience Committee meetings held by the MVC. These groups of policy makers represent another opportunity to educate the public on the importance of blue carbon ecosystems, especially since conservation of eelgrass and improvement of water quality can be included in municipal climate response plans.

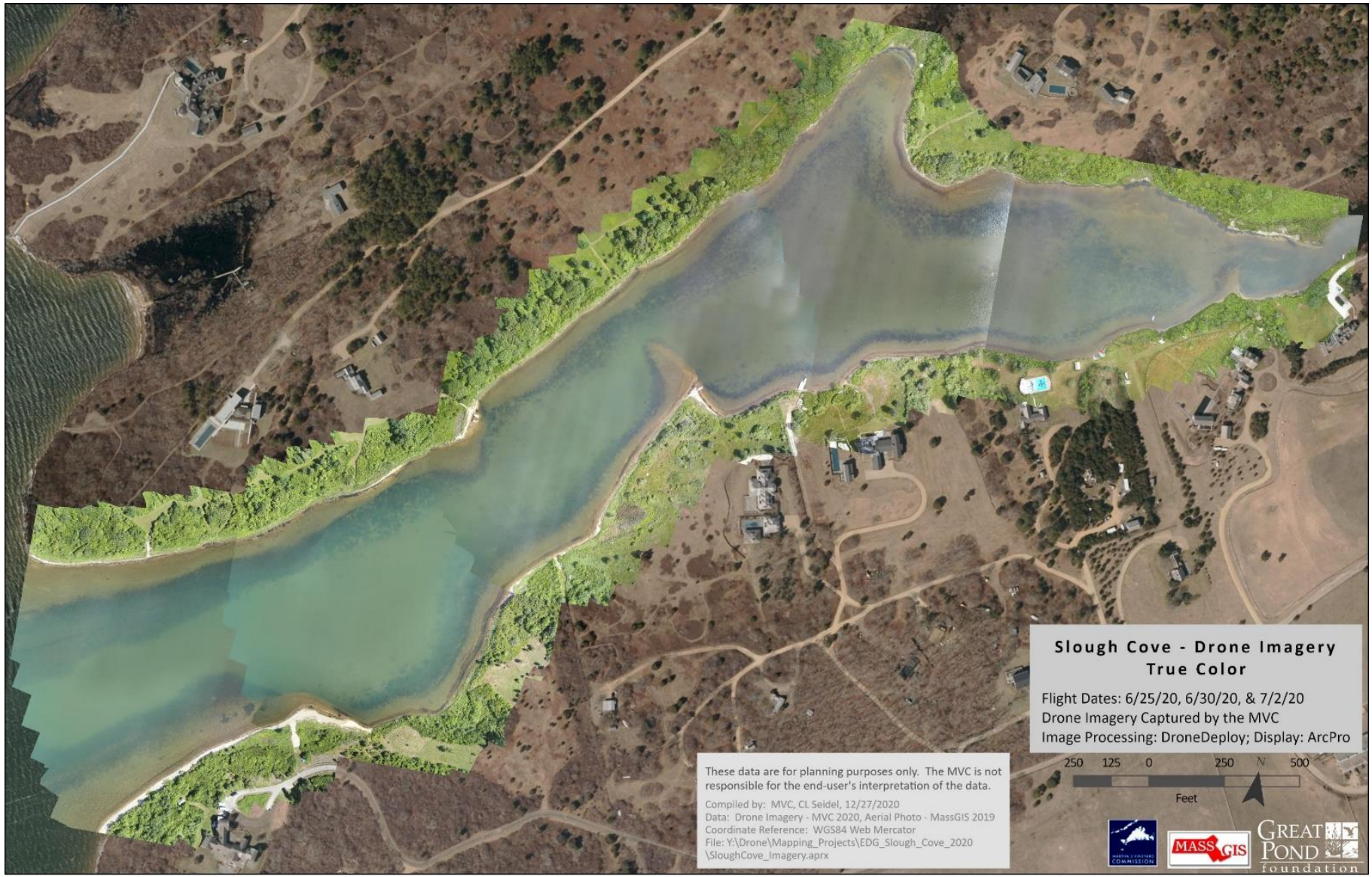
Acknowledgements:
Great Pond Foundation would like to thank the Edey Foundation for funding this study and the development of Blue Carbon and Eelgrass Ecosystem educational resources for the Island community. We would also like to express our gratitude to the Martha's Vineyard Commission, and specifically Chris Seidel, for her dedication and expertise in developing and executing the first quantitative drone-based eelgrass mapping on Martha's Vineyard—a critical step for the protection and restoration of local Blue Carbon resources.

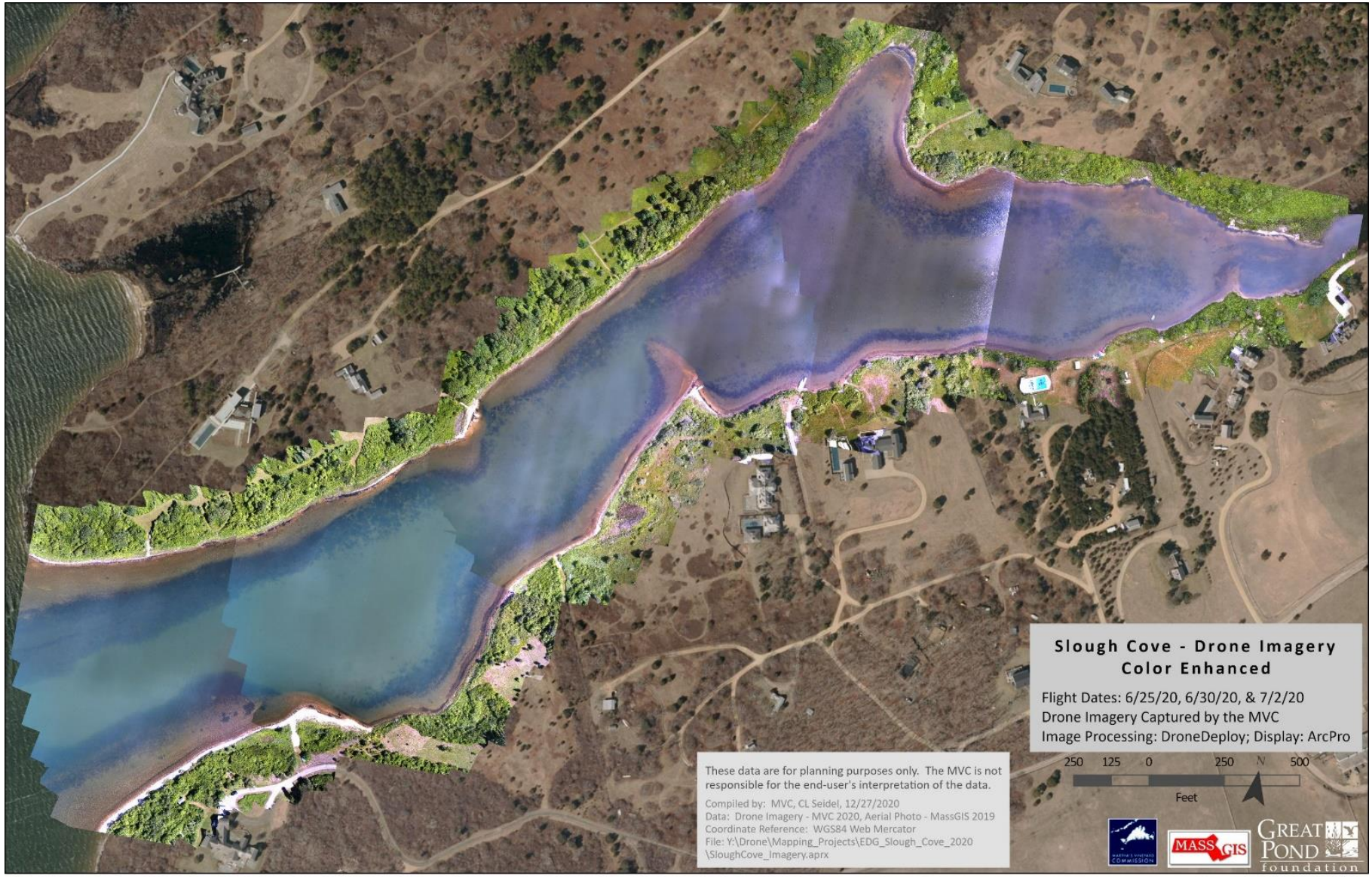
Appendix

Slough Cove Mapping Project images:




Slough Cove - MassGIS Imagery
Acquired Early Spring 2019
250 125 0 250 N 500
Feet
These data are for planning purposes only. The MVC is not responsible for the end-user's interpretation of the data.
Compiled by: MVC, CL Seidel, 12/27/2020
Data: Aerial Photo - MassGIS 2019
Coordinate Reference: WGS84 Web Mercator
File: Y:\Drone\Mapping_Projects\EDG_Slough_Cove_2020
\SloughCove_Imagery.aprx
MASS GIS
GREAT POND foundation


Slough Cove - Drone Imagery
True Color
Flight Dates: 6/25/20, 6/30/20, & 7/2/20
Drone Imagery Captured by the MVC
Image Processing: DroneDeploy; Display: ArcPro
250 125 0 250 N 500
Feet
These data are for planning purposes only. The MVC is not responsible for the end-user's interpretation of the data.
Compiled by: MVC, CL Seidel, 12/27/2020
Data: Drone Imagery - MVC 2020, Aerial Photo - MassGIS 2019
Coordinate Reference: WGS84 Web Mercator
File: Y:\Drone\Mapping_Projects\EDG_Slough_Cove_2020\SloughCove_Imagery.aprx
MASS GIS
GREAT POND foundation


Slough Cove - Drone Imagery
Color Enhanced
Flight Dates: 6/25/20, 6/30/20, & 7/2/20
Drone Imagery Captured by the MVC
Image Processing: DroneDeploy; Display: ArcPro
These data are for planning purposes only. The MVC is not responsible for the end-user's interpretation of the data.
Compiled by: MVC, CL Seidel, 12/27/2020
Data: Drone Imagery - MVC 2020, Aerial Photo - MassGIS 2019
Coordinate Reference: WGS84 Web Mercator
File: Y:\Drone\Mapping_Projects\EDG_Slough_Cove_2020
\SloughCove_Imagery.aprx
250 125 0 250 N 500
Feet
MASS GIS
GREAT POND foundation

Educational Materials/Infographics: