1. Groundwater refugia for eelgrass restoration Contract Number

(NEPCWG-22-SUNY-PEP) Grant Period (3/1/2023 - 2/29/2024) Restore America's Estuaries

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Reporting Period: 7/1/2023 - 9/30/2023
Progress Report #1

10/31/2023

2. Project Report Narrative

Summarize the Project activities undertaken during the reporting period within the following headings, building upon the narrative from previous reports, if any.

In July 2023 the QAPP entitled "Groundwater refugia for eelgrass restoration" was approved. Team and partner meetings were initiated in March 2023 to outline summer field efforts. The airborne thermal infrared survey was successful in documenting regions along open bay shorelines and semi-enclosed embayments where the cooling influence of groundwater discharge could be documented. Field teams completed radon surveys and subtidal sampling to guide eelgrass planting siting.

Eelgrass sites “Southport” and “Noyak” were chosen for eelgrass restoration areas. Eelgrass restoration mats/discs were woven by the project field team and a large group of volunteers. Plantings occurred at two site locations following the associated QAPP.

Outreach efforts engaged the Stony Brook University Chapter of the Society of Women in Marine Science (SWMS). Outreach efforts included field research team participation in SMWS panel chapter meetings, hands-on in weaving discs for restoration sites as well as networking time and educational Q & A with field researchers.

2. A. Results & Progress to Date

Describe in sufficient detail the goals of the Project, and the progress and results achieved during the current reporting period, building on the narrative from previous reports, if any. Report accomplishments, setbacks, or delays on specific tasks as described in the scope of work, ***Attachment 1****, as well as any new issues that may have arisen, including: • Progress toward meeting short- and long-term objectives;*

• Activities carried out in this reporting period, including specific techniques and materials used;

• Deliverables or milestones completed or partially completed during the reporting period (if partially completed, describe current status, percentage completion, etc.) • Findings to date or lessons learned during this reporting period;

• Challenges or potential roadblocks to future progress, if any (Note: If you have immediate concerns about the Project, please contact RAE to discuss the issue as soon as possible.)

As described in Scope of Work, attachment 1, rising water temperatures are restricting seagrass coverage to areas of increased oceanic influence throughout the northeastern US. Resource managers are faced with the reality that climate change is rendering many current restoration strategies ineffective. This project will demonstrate the use of groundwater as thermal refugia in an emerging restoration strategy.

Using assessments of key parameters (e.g.: radon, groundwater discharge) and novel seagrass transplant techniques, we will test and demonstrate an approach that has the potential to transform this type of eelgrass restoration. Doing so will make such projects more predictable and effective, allowing for larger-scale efforts in estuaries impacted by groundwater discharge.

In July 2023 the QAPP, attachment 2, entitled “Groundwater refugia for eelgrass restoration” was approved (Project Task 1). Team meetings were initiated in March 2023 to outline summer field efforts (Task 2). Tamborski (co-PI) met twice with the US Geological Survey New York Water Science Center (Don Walter, Groundwater modeling specialist; and Kalle Jahn, physical scientist) to review hydrogeologic model outputs for Peconic Bay, to guide planning efforts for

field sampling (Figure 4 of the approved QAPP).

On August 9, 2023, a preliminary airborne thermal infrared survey was performed around the perimeter of Flanders Bay, Great Peconic Bay, Little Peconic Bay, and Noyak Bay (Figure 3 of the approved QAPP; Task 5). A helicopter flight was commissioned (Helicopter Flight Training Inc.) during low tide, where a handheld thermal infrared camera was used to locate areas of cold groundwater seepage along potential shoreline areas of interest, previously determined from the USGS hydrologic model outputs. Inclement weather on August 7 and 8, 2023 pushed our flyover to mid-week when low tide was closer to midday (~13:30), which was less advantageous than early morning flights for identifying thermal differences between water masses. Further, strong winds limited our ability to remain airborne, and thus only one flight pass was performed, at 5,000' altitude. Despite these challenges, the airborne thermal infrared survey was successful in documenting regions along open bay shorelines (e.g., Figures S1 - S4) and semi-enclosed embayments (e.g., Figures S5 - S6) where the cooling influence of groundwater discharge could be documented.

In total, 145 thermal infrared images were acquired along the broader Peconic Bay region, covering over 80 km of shoreline. These images were promptly QA/QC'd by graduate student Moira Taylor (ODU) and then by Joseph Tamborski (ODU). All raw images remain archived in ODU's OneDrive cloud storage for backup and have also been stored on an external drive. Images were flagged for motion blur, sediment signals, shadows, etc. that might otherwise obscure the thermal signatures observed (see Section B5: Quality Control in the approved QAPP). Following, we selected images in open shoreline settings for further investigation, as open shorelines are our targeted zones for eelgrass restoration. Select images were georectified in Google Earth Pro by selecting ground-control tie points; thermal infrared anomalies were outlined and maps were generated for key areas of interest (Figures S1 - S6).

Sea-surface temperature alone cannot tell us that groundwater is discharging into an area. Thus, we performed shoreline radon surveys (Task 5) from 8/8/2023 to 8/11/2023 to ground truth our

TIR imagery and map potential discharge zones. The composite 222Rn distribution along Great Peconic Bay, Little Peconic Bay, and Noyak Bay shorelines (Figure S7) shows generally low 222Rn activities (<10 Bq/m3). Relatively high winds earlier in the week (>15 mph) likely enhanced loss of 222Rn due to degassing. Nonetheless, we observed several shoreline 222Rn enrichments (warm colors) indicating recent inputs from a source, likely groundwater discharge. Most prominent was a 222Rn enrichment in Bullhead Bay (>60 Bq/m3), one of the few remaining areas with known eelgrass in the Peconics. 222Rn enrichments were also observed along the Little Peconic Bay shoreline, coincident with observed thermal infrared anomalies (Figures S1, S2); thus this site was chosen for initial eelgrass test planting. This site will be resurveyed, at higher spatial resolution, in December 2023.

One unforeseen challenge was the loss of a pCO2 (Licor) sensor that was originally planned to be used in concert with the radon sensor. Tamborski has quoted out a new product and is aiming to have a new sensor ready for our winter survey. It must be noted that the loss of pCO2 mapping has no significant impact on the identification of groundwater discharge zones or any test planting to be carried out.

To overcome the loss of pCO2 data, we opportunistically sampled submarine (i.e., subtidal) groundwaters. During our shoreline radon survey, we occasionally stopped the boat and inserted a stainless steel drive-point piezometer approximately 50 cm below the seafloor along our survey track. Submarine groundwaters were collected via peristaltic pump after purging the piezometer three volume equivalents and once general physiochemical parameters had stabilized. Here we generated maps of submarine groundwater temperature and salinity *anomalies*, where an anomaly is simply represented as the temperature or salinity deviation from that of the overlying water column (Figures S8, S9), such that positive anomalies represent *cooler* groundwater and *fresher* groundwater, respectively. Importantly, in Bullhead Bay, where known eelgrass beds exist, we observed substantial groundwater temperature and salinity anomalies (n=3). These groundwater temperature and salinity anomalies were observed within a thermal infrared anomaly footprint identified from our airborne overflight in Great Peconic Bay (Figure S1, S2) and thus this was the second site chosen for initial eelgrass test planting. This site will be resurveyed, at higher spatial resolution, in December 2023.

The initial findings from project Task #5 illustrate the potential for eelgrass restoration in areas of known groundwater discharge. Bullhead Bay, the last known area of Peconic Bay with eelgrass, was found to experience significant reductions in submarine groundwater temperature and salinity, as compared to overlying bay waters.

Salinity and radon maps were used to select two of the six survey regions identified from USGS model outputs for test plantings. The two regions with the greatest spatial footprint of the

bottom area receiving 22% surface light within the extent of the mapped temperature and radon anomalies were selected. Thermal imaging and radon testing information determined Southport and Noyac as the two eelgrass test planting sites(task 7), see figure E1.

Eelgrass mats/discs were woven by the project field team and a large group of volunteers. Large patches of burlap fabric were cut into circles 6-8 in. in diameter. Using a specifically designed tool, 20 holes were punched into the burlap discs in two concentric circles of ten holes each. Individual seagrass shoots were isolated from bunches collected in the field, specimens were sorted and processed. Ten individual shoots of seagrass were weaved into each burlap disc, by threading the rhizome into the outer circle of holes, and back again through the corresponding

hole in the inner circle. Shoots were oriented such that the leafy part of each was facing the same direction. Discs were stored in bunches of 25 in a flow-through tank until planting.

Seagrass was harvested from the seagrass meadows in Eastern Shinnecock Bay by Shinnecock Road beach (task 6). Individual shoots were pulled for weaving into discs, and large sods were collected individually and planted the same day. Collection and planting schedules were interrupted by inclement weather creating unsafe conditions but schedules were adapted and work moved forward. Shoots were collected for weaving all 250 discs on October 3rd, 5th, and 9th 2023. Shoots were planted (task 8) on October 2nd, 10th, 11th, and 19th. Sods were collected and planted on October 12th (24 sods) and October 19th (12 sods). See attachments 3,4, and 5 for images of seagrass plantings.

The methodology for planting the burlap discs and sods was as follows: At each of the two sites, five 3x3 m grids were established, with a central grid, and one grid each to the NW, NE, SE, and SW of the center grid. Each of these 3x3 m grids contained 5 1x1 m plots in which we planted burlap discs (mirroring the larger pattern of the grids), and 4 1x1 m plots in which we planted sods, as seen in the diagram of Figure E2. Finally, within each 1x1 m plot dedicated to burlap discs, 5 were planted, once again mirroring the configuration with a central disc and four in the corners. Overall, (5 discs per plot) x (5 plots per grid) x (5 grids per site) x (2 sites) for a total of 250 discs, and (1 sod per plot) x (4 plots per grid) x (5 grids per plot) x (2 sites) for a total of 40 sods.

After determining where discs were to be planted, the disc was placed in the shallow hole, with rhizomes down. Several handfuls of sediment were then gently placed back on the disc, burying it. For the sods, the containers in which they were held were placed next to the site of their planting, and after scooping away several handfuls of sediment, the sod was pushed out from the container into its shallow hole. Every reasonable strategy was employed to be precise in the layout and configuration of the seagrass plantings. Minor issues in placement were faced due to visibility constraints and the sediment stirred up by planting activities

The Noyac site consistently had significant current, and low visibility, making planting across tens of feet extremely challenging. Furthermore, seagrass appeared to be in distress and being preyed upon quite rapidly at this site, making the plots more difficult to find upon each successive visit. Due to visibility, weather conditions, time, and resource constraints, only 36 of the planned 40 sods were able to be planted.

2.B. Work Remaining Under Current Contract

Describe in sufficient detail the activities remaining and the next steps to be completed under the current contract. Provide an updated timeline of major Project tasks, as applicable.

Airborne thermal infrared overflights and radon surveys of the two initial test planting locations will be performed in December 2023, with subsequent mapping outputs expected in February 2024.

Due to eelgrass planting schedule disruptions from inclement weather, outreach efforts will invite SWMS students to participate in future field days for future work (Task 3a). Project results will be incorporated into the Eelgrass Story Map currently being developed by PEP and Dr. Peterson to showcase the results of the recently completed PEP Eelgrass Habitat Suitability Model (a presentation of the development of this model is available here) and will be shared with the public via the PEP website and presentations at completion. Progress on the eelgrass story map will shared following planned Task 3b & 3c.
A seagrass restoration workshop will be held for the second stakeholder group, a regional PEP endeavor that will include all NEPs in the Northeast, EPA, National Parks Service, States, and other PEP stakeholders. This group is currently being established as a response to regional eelgrass loss in the face of climate change.

Eelgrass survival, growth, and germination will be assessed in the replicate planting areas and drone imagery will be re-captured for these locations in May 2024 (Task 9).

In June 2024, large-scale restoration efforts will be conducted based on the success metrics of test plantings (task 10)

Large-scale restoration efforts and activities continue. Drone visible light imagery will be collected after all activities are concluded (October 2024) to quantify eelgrass coverage change pre- and post-restoration (task 11).

2.C. Compliance

Describe the status of the Quality Assurance Project Plan (QAPP) completion, submittal, and approval. List any permits required for the Project, and their status (e.g., not yet applied for, submitted and under review, approved on [date], etc.).

Task 4 The initial review of the QAPP entitled “Groundwater refugia for eelgrass restoration”, was completed by Brian Hulme (EPA) and Phil Colarusso (EPA) on 6/28/2023. The final QAPP was reviewed and approved by Brian Hulme (EPA) and Phil Colarusso (EPA) on 7/20/2023 and all signatures were approved on 8/7/2023.

No permits were required for the initial thermal infrared overflight or shoreline radon surveys. A NYS Department of Environmental Conservation permit for eelgrass restoration was obtained.

No additional permits were needed for this effort.

2.D. Project Partners

- Joyce Novak (Peconic Estuary Program): project oversight and overall management ● Bradley Peterson (Stony Brook University): initial test planting of eelgrass ● Joseph Tamborski (Old Dominion University): coordination with the US Geological Survey on hydrogeologic model outputs; performed initial thermal infrared overflights and shoreline radon surveys
- Jade Blennau (Peconic Estuary Program): Outreach coordination
- Tara Rider (Stony Brook University): SWMS Chapter lead, Outreach coordination

2.E. Volunteer and Community Involvement

This project engaged the Society of Women in Marine Science (SWMS) Stony Brook University Chapter to share the value of eelgrass ecosystems and participate in restoration efforts. Non-affiliated members of the public were invited to volunteer their time to our restoration efforts as well.

Overview:

- 09-23-2023: 6 volunteers, 4 hours = 36 hours
- 10-05-2023: 38 volunteers, 3.5 hours = 133 hours
- 10-08-2023: 1 volunteer, 8 hours = 8 hours

Total volunteer hours thus far: **177 hours**

September 23, 2023, a group of six SWMS members volunteered four hours to weave seagrass discs alongside researchers and project leads. On this day, volunteers met at the Stony Brook University Marine Science Wet lab prepped materials for 180 discs, and weaved 50 discs to completion.

On October 5th, 2023 a large group of volunteers weaved approximately 180 discs led by the project team. This work included 38 volunteers contributing 3.5 hours each. October 10th field planting effort included a single volunteer contributing 8 hours.

2.F. Outreach & Communications

Describe any outreach or educational activities (e.g. training, brochures, videos, press releases, or public events) related to the Project. ***Include PDF copies of press releases, outreach documents, newspaper articles, etc. as described under "Supporting Materials," below.***

Project leads coordinated with the Society of Women in Marine Science (SWMS) Stony Brook

University Chapter's lead, Tara Rider Ph.D., and elected president Faith Keller for the field teams' successful participation in a chapter meeting held May 1st, 2023. This informational session presented the status of eelgrass habitat in the region, the importance and value of restoration efforts, and the scope of this project to 28 SWMS members. Presentations discussed the restoration plan and invited these members to participate in hands-on work to support restoration efforts. The informational session included networking and a Q&A panel with eelgrass research field teams. See Attachment 6 for the presentation given and Attachment 7 for the panelist information handout.

See attachment 8 showing the flyer developed to advertise our outreach events. These flyers were posted in advance of events across Stony Brook University's main campus, and Southampton campus, and distributed to faculty members that engage student participation. Unfortunately, due to inclement weather boat days planned for September 25th and 27th were canceled for safety concerns. Days were rescheduled and work was carried out with volunteer help.

September 23, 2023, a group of six SWMS members volunteered four hours to weave seagrass discs alongside researchers and project leads. On this day, volunteers toured the Stony Brook University Marine Science Wet lab, participated in an educational panel, and assisted in the preparation of materials for 180 discs while weaving 50 seagrass discs to completion. See outreach attachments 9, 10, 11, and 12 showing SWMS members participating in weaving discs. It is acknowledged that participation in this event was limited due to storm conditions in the area. Contact information was saved for interested volunteers unable to attend and they will be notified of future outreach opportunities.

3. Project Budget Report

The budget report must provide sufficient information and detail to explain Project expenses, for the reporting period and cumulative through the reporting period, including match, in the

*context of the objectives, tasks, and categories provided in the Project narrative and budget under **Attachment 1**. The budget report should be organized so that a reviewer can easily judge whether expenditures to date for the Project are tracking well with progress toward objectives and, if not, to understand why.*

3. A. Summary Budget Tables

Summary Budget Table 1: Expenditures by Federal Cost Category							
Budget Category	Total Approved Budgeted Funds	Total Approved Budgeted Match	Grant Funds Expended this Period	Grant Funds Expended Cumulative	Match Funds Expended This Period	Match Funds Expended Cumulative	Match Source (note cash or inkind)
Personnel	$ 55,020	$ 20,847	$ 3,246	$ 3,246	$ 4,524	$ 4,524	$ 7,770
Fringe	$ 7,153	$ 13,284	$ 422	$ 422	$ 2,893	$ 2,893	$ 3,315
Travel	$ 2,384	$ -					$ -
Equipment	$ -						$ -
Supplies	$ 18,500						$ -
Contractual	$ 120,000	$ 39,603					$ -
Other	$ 14,752						$ -
Total Direct	$ 217,809	$ 73,734					$ -
Indirect	$ 31,930	$ 8,874	$ 954	$ 954	$ 1,928	$ 1,928	$ 2,882
Total	$ 249,739	$ 82,608					$ -

3.B. Budget Narrative

Salary and fringe were expended as per the original proposal.

4. Supporting Materials

Include high-resolution digital images of supporting materials related to the Project, including:

- *Project maps and drawings;*
- *Technical memoranda, data analyses and modeling reports;*
- *Project photographs, including photos depicting implementation sites before, during, and after implementation; photos of Project signs, etc.;*
- *Press releases, news articles, brochures, educational curricula, etc.*

Where file sizes allow, include all supporting materials in the same, single PDF document as the progress report. In the event that file sizes for supporting materials are too large to include in a single PDF of the report, contact RAE to set up a shared online approach.

All supporting materials are attached with online access here:https://drive.google.com/drive/folders/1YZ8yWn32St2Thhk-RtS01fziyQipPwmf?usp=sharing

figures as referenced:

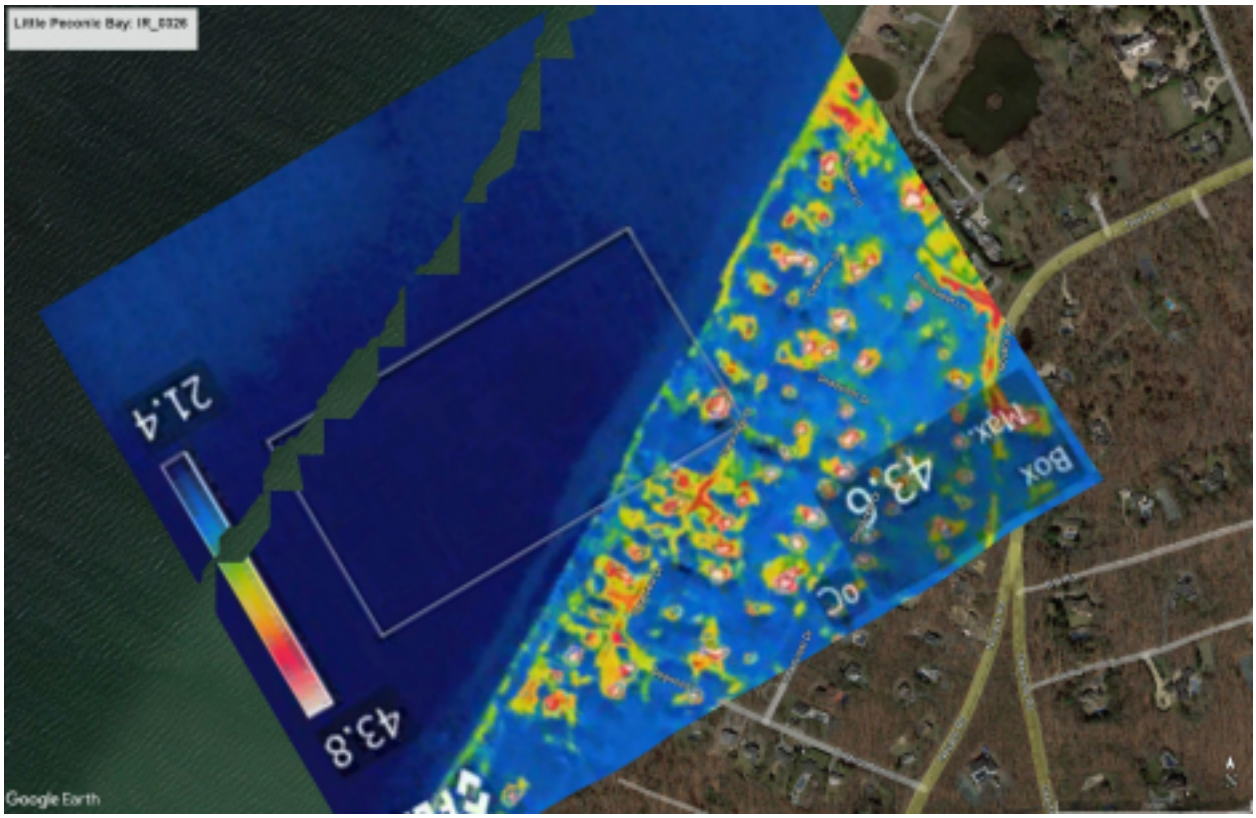


Figure S1. Georectified thermal infrared imagery of an open shoreline in Little Peconic Bay, NY during low tide on 8/9/2023.



Figure S2. Outline of a thermal infrared anomaly (2,700 m2) in Little Peconic Bay, NY during low tide on 8/9/2023; anomalous temperatures suggest a cooling influence by discharging groundwater. Image field of view is the same as in Figure S1. This thermal anomaly was selected as one of the two test planting sites for initial restoration efforts.

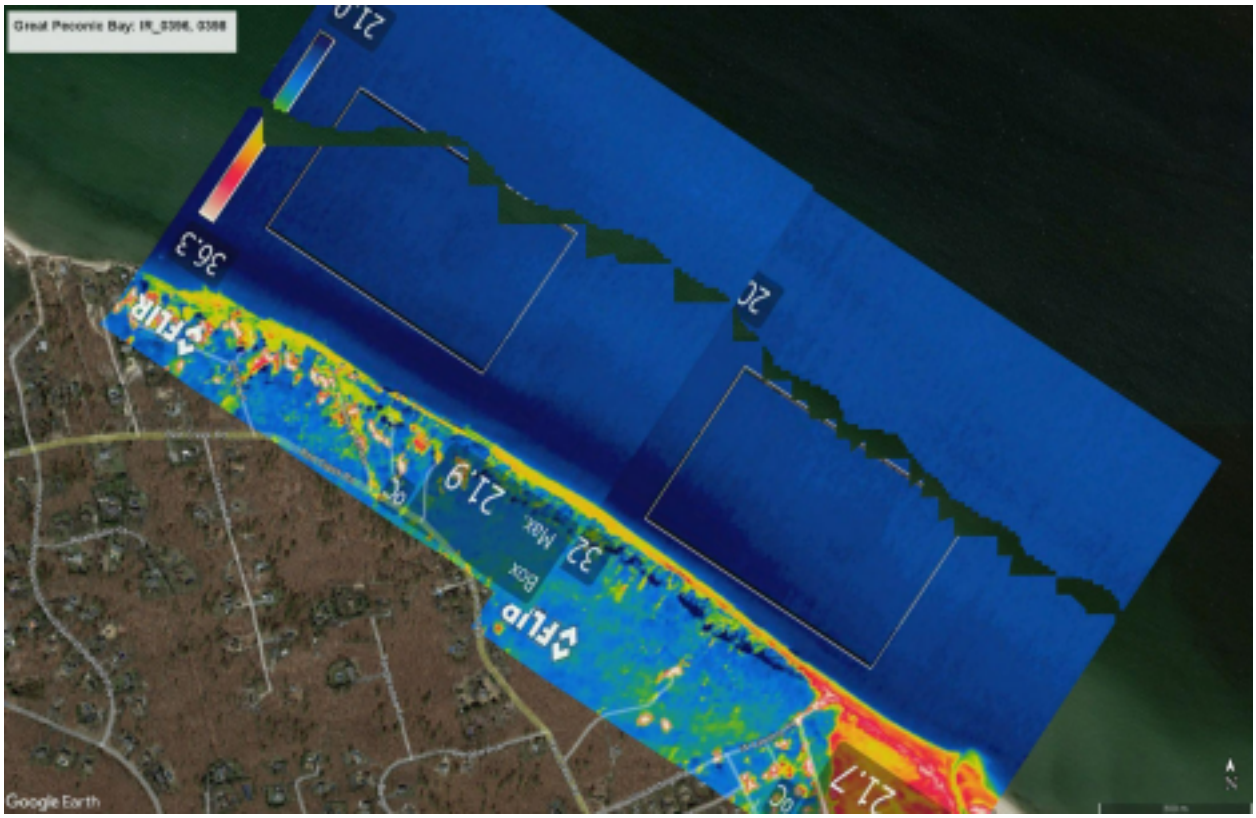


Figure S3. Composite georectified thermal infrared imagery of an open shoreline in Great Peconic Bay, NY during low tide on 8/9/2023.



Figure S4. Outline of a thermal infrared anomaly (103,000 m2) in Great Peconic Bay, NY during

low tide on 8/9/2023; anomalous temperatures suggest a cooling influence by discharging groundwater. Image field of view is the same as in Figure S3. This thermal anomaly was selected as one of the two test planting sites for initial restoration efforts.

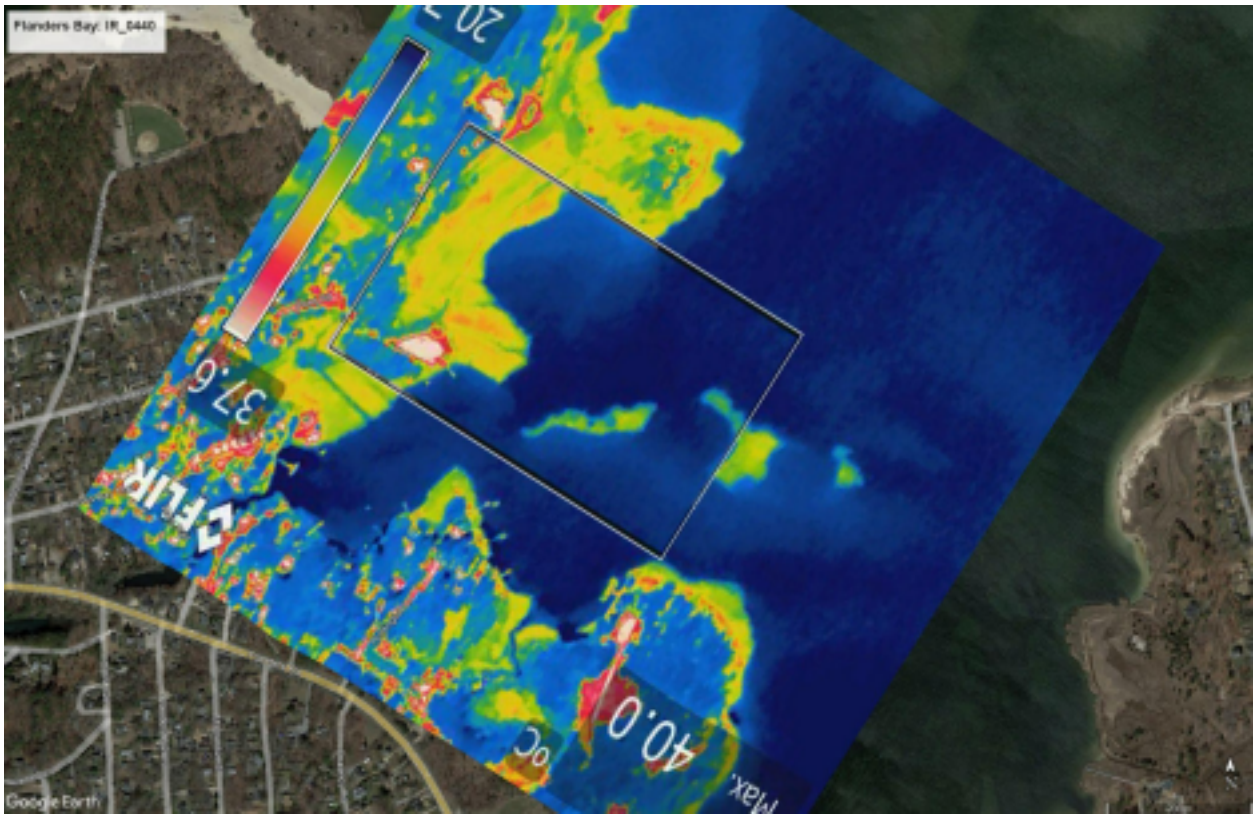


Figure S5. Georectified thermal infrared imagery of Flanders Bay, NY during low tide on 8/9/2023.



Figure S6. Outlines of thermal infrared anomalies (8,600 m2) in Flanders Bay, NY during low tide on 8/9/2023; anomalous temperatures suggest a cooling influence by discharging groundwater. Image field of view is the same as in Figure S4.

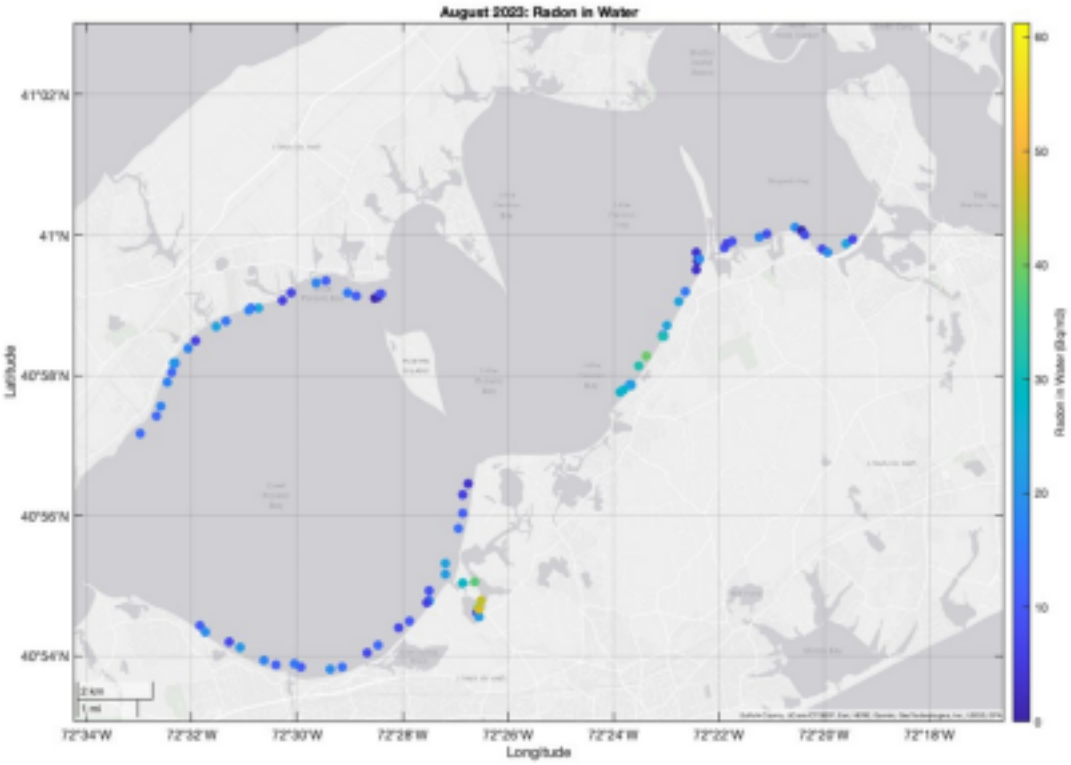


Figure S7. Composite 222Rn distribution in Great Peconic Bay, Little Peconic Bay, and Noyak Bay

(8/8/2023 - 8/11/2023). ^{222}Rn enrichments (warm colors) indicate recent inputs from a source, likely groundwater discharge.

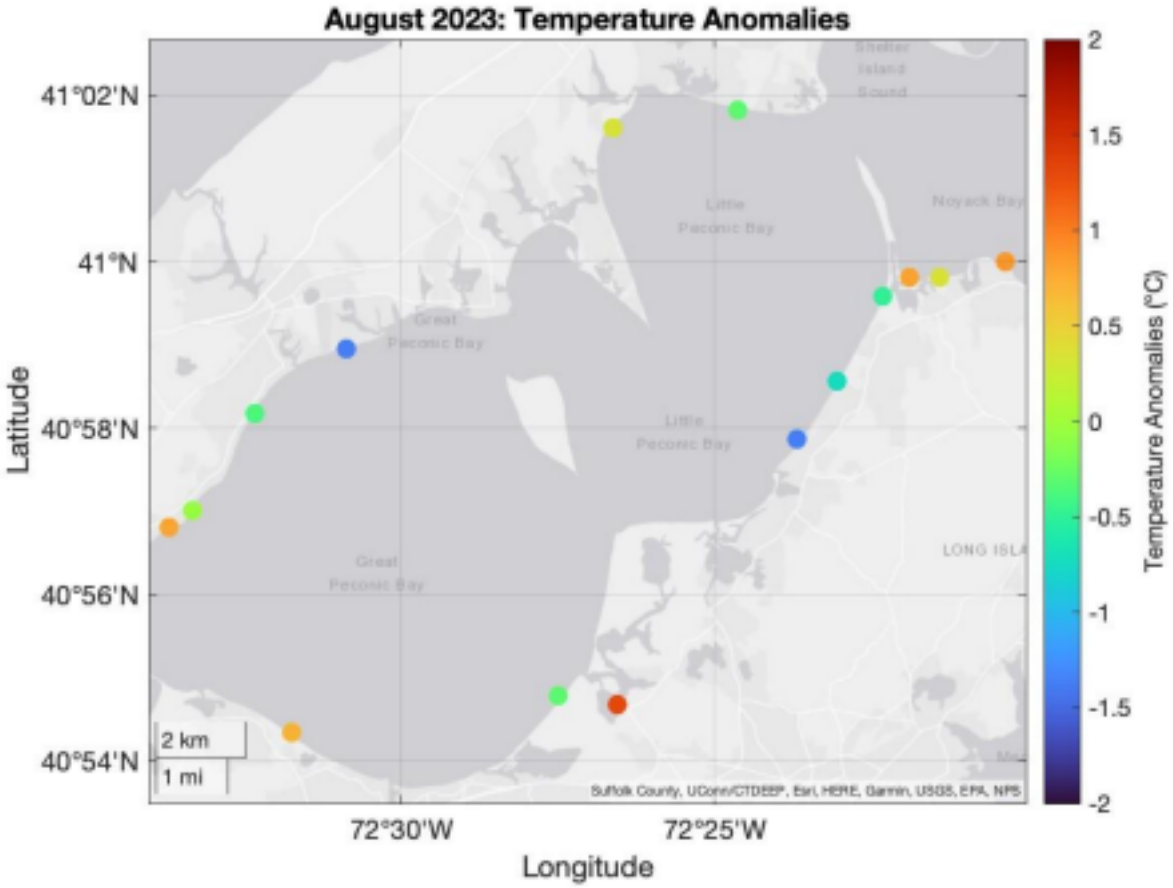


Figure S8. Composite temperature anomaly distribution of submarine groundwaters (~50 cm below seafloor) in Great Peconic Bay, Little Peconic Bay, and Noyak Bay (8/8/2023 - 8/11/2023). A positive temperature anomaly (warm colors) indicates that the submarine groundwater temperature is significantly colder than the overlying water column.

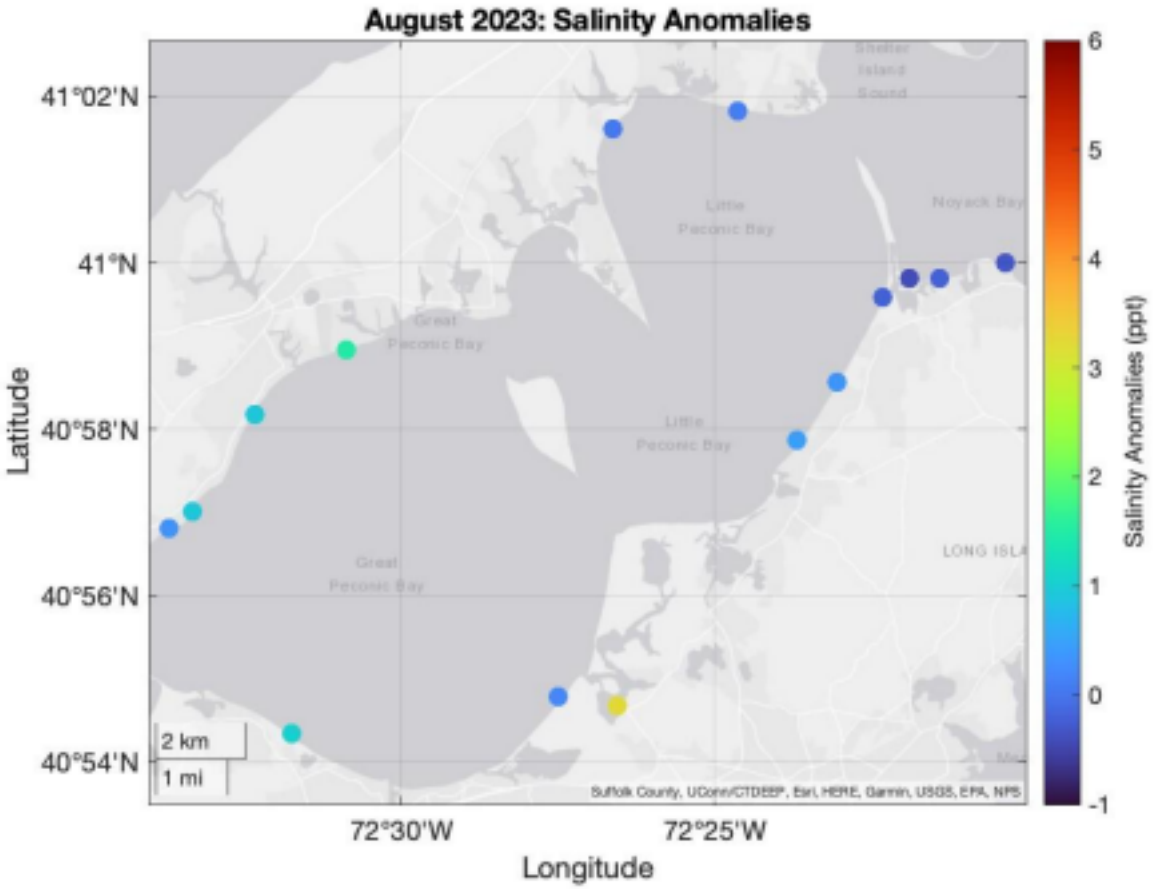


Figure S9. Composite salinity anomaly distribution of submarine groundwaters (~50 cm below seafloor) in Great Peconic Bay, Little Peconic Bay, and Noyak Bay (8/8/2023 - 8/11/2023). A positive salinity anomaly (warm colors) indicates that the submarine groundwater salinity is

significantly fresher than the overlying water column.

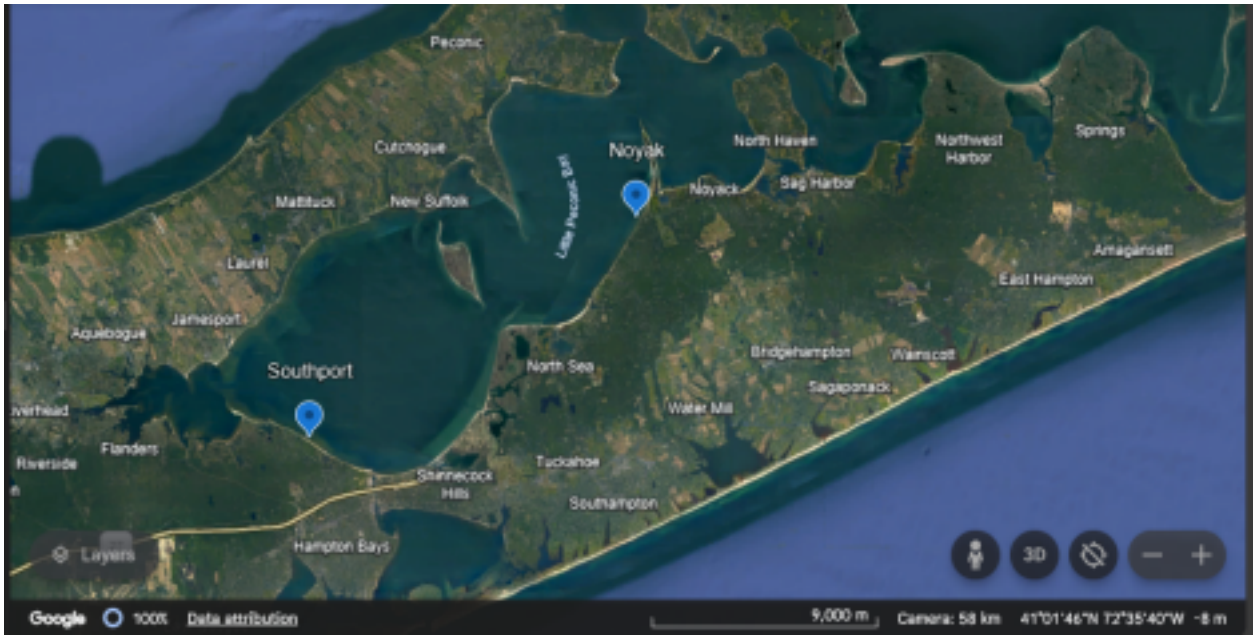


Figure E1. Map of eelgrass planting locations including Southport and Noyac.

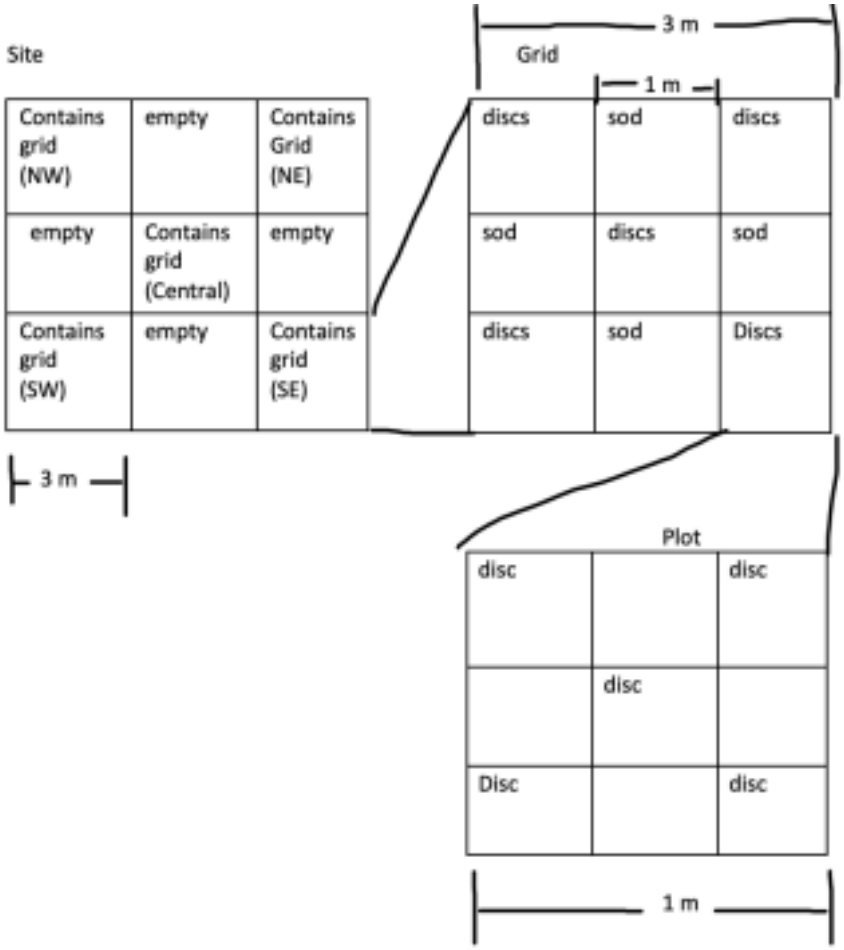
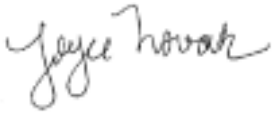


Figure E2: Configuration for discs and sod planting at each site.

5. Certification

The undersigned verifies that the descriptions of activities and expenditures in this progress report are accurate to the best of my knowledge; and that the activities were conducted in agreement with the grant contract. I also understand that matching fund levels established in the grant contract must be met.

Grantee Signature: 

Name: Joyce Novak
Job Title: Executive Director, Peconic Estuary Partnership
Date: 10-31-2023
Organization: Peconic Estuary Partnership