Deemed Complete - 05.26.2026

APPLICATION FOR LEASE RENEWAL

Lease Acronym	BHB-GC4
Name of Leaseholder	Acadia Aqua Farms, LLC
Name of Contact Person	Mary de Koning
Address	806 Bar Harbor Rd
City	Trenton
State, Zip	04605
Telephone	207-664-1644
Email	info@hollanderanddekoning.com
Term Requested	20 years

1. Describe the type and amount of aquaculture to be conducted during the new lease term:
We will continue to increase our floating cage oyster aquaculture capacity on this farm site to approach the maximum allowable capacity. This includes slowly growing our number of cages to approach the maximum allowable capacity of 2,500 cages per tract. Farming oysters involves seeding in ½" oysters in mesh bags inside our six bay cages. During the warm water season the cages are flipped by swimming about once a week to allow the bags and oysters to dry and kill off biofouling. Once a year or so we remove the oysters from the cages to tumble them to help form the shell, and grade them before thinning the bags out and bringing them back to the farm for more growth. At harvest time the market sized oysters are transplanted to our land based aquaculture facility for finishing and packing. In winter we will sink the cages to the bottom of the substrate to prevent them getting damaged by storms and ice.

2. Describe the amount of aquaculture conducted on the lease site during the previous lease term, including but not limited to seeding, cultivation or harvest of organisms:
Over the last 5 years we have transformed the lease from an abandoned, derelict farm to a well run, successful, floating top culture oyster farm using about 700 cages. When we took over the farm the cages were tangled, overgrown, and sunk. We completely re-designed the mooring system, and moved all the cages from the eastern tract to the western tract to get a fresh start. We dove up all the old gear we could find on the western tract, and from there have annually seeded the oysters in, controlled biofouling by drying the oysters, graded, thinned, and transplanting to our land based aquaculture facility for finishing, grading, and packaging.
3. Suspended culture gear can attract birds that roost on the gear and defecate, potentially creating a pollution source impacting shellfish held within gear. In order to comply with the National Shellfish Sanitation Program (NSSP) Model Ordinance (MO), if the lease site is permitted for the culture of shellfish in suspended gear, please include a description of mitigation or deterrent measures to minimize the potential pollution impacts of birds at the lease site. If appropriate, include Sketches or photos that clearly depict those measures put into practice.
We have predator dummies on site that we move around. All oysters are kept within our land based aquaculture facility a minimum of 24 hours before shipping to customers.

4. Tax Maps and Riparian List

Is your existing lease within 1,000ft of shorefront land (**which extends to mean low water or 1,650 ft. from shore, whichever is less, according to NOAA charts**)?

x Yes ☐ No

If yes, the following supporting documents are required:

A. Tax Map.

A labeled copy of the appropriate tax map(s) depicting the location of the proposed lease site.

The map(s) needs to include the following elements:

- Label the map "Tax Map: Town of (name of town)."
- Legible scale
- Tax lot numbers clearly displayed
- The boundaries of the existing lease

B. Riparian List.

Please use the Riparian Landowner List (included on the next page) to list the name and address of every shorefront landowner within 1,000 feet of your existing lease. Have the tax collector or clerk of the municipality certify the riparian list. Refer to the Riparian Determination guidance document to ensure all riparian landowners are included: https://www.maine.gov/dmr/aquaculture/forms/documents/RiparianDetermination.pdf

C. Check for $1500 application fee

Signature of Leaseholder: _____ Date: 5/15/26

(Alex de Koning)

RIPARIAN LANDOWNER LIST

THIS LIST MUST BE **CERTIFIED**

On this list, please show the current landowners' names and mailing addresses as listed in the municipal tax records for all riparian shorefront parcels within 1,000 feet of the existing lease site along with the map and lot number for each parcel. **It is the applicant's responsibility to assemble the information for the Town Clerk to certify.** The Town Clerk *only* certifies that the information is correct according to the Town's records. Once you have completed the form, ask the Town Clerk to complete the certification section below. If the parcels are within more than one municipality, provide a separate, certified riparian list for each municipality.

TOWN OF: Trenton

MAP #	LOT #	Landowner name(s) and address(es)
7	4	**Copp, Roger, Stanley & Cynthia Ann, Trustee** ***Indianois, Rose E., Kaufman & Sadyi Callahan, Trustee*** **1501 West Horation St., Apt. 108** **Tampa, FL 33606**
7	5	**Clarke, Kevin & Urillo, Mary** **98 Paradis Drive** **Trenton, ME 04605**
7	6	**Lieblich, Roger F & Lieblich, Therese D** **30 Commodore Rd** **Chappaqua, NY 10514**
7	7	**Emery, William & Judith, Co-Trustee** **2381 SE 24th Blvd** **Okeechobee, FL 34974**
7	8	**Adams, Hannah K. & Daniels, George W.** **70 Paradis Drive** **Trenton, ME 04605**
7	9	**Pettegrow, Josette G & Pettegrow, Anthony D** **1237 Bar Harbor Rd** **Trenton, ME 04605**

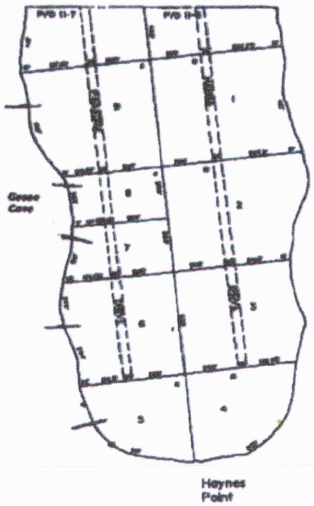
CERTIFICATION

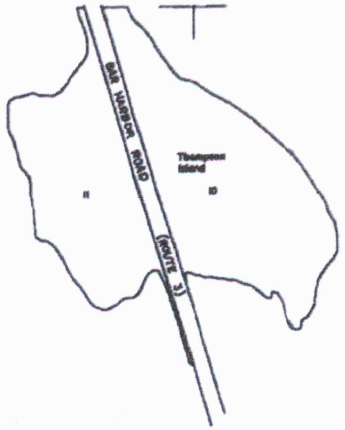
Carol Walsh

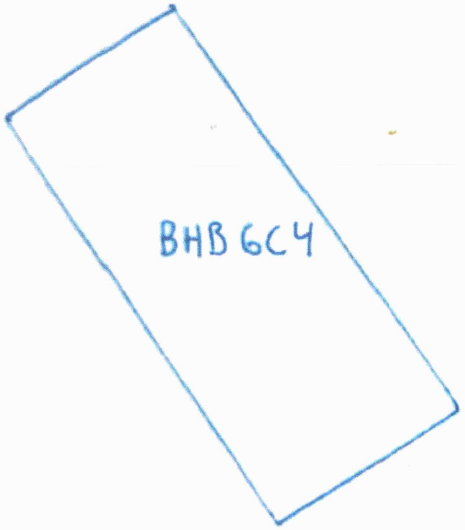
I, CAROL WALSH, Town Clerk for the Town of Trenton certify that the names and addresses of the property owners listed above, as well as the map and lot numbers, are those listed in the records of this municipality and are current as of this date.

SIGNED: DATE: 2/6/2026

Tax Map: Town of Trenton



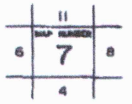


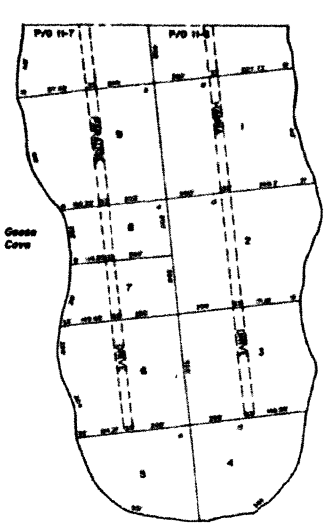


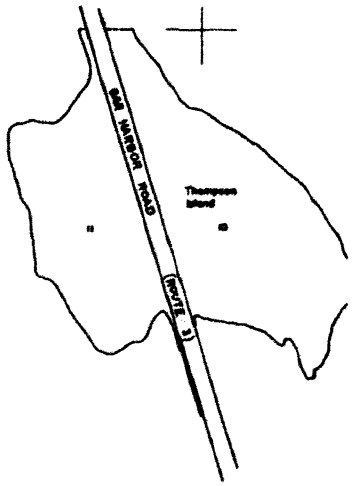
Attest a True Copy
Carol Reed Walsh
Municipal Clerk

Eastern Mapping Services
115 North Road
Newburgh, ME 04444
Tel. (207) 234-2777
Updated April 1, 2019

TAX MAP
TOWN OF TRENTON.
HANCOCK COUNTY, MAINE
PREPARED BY
JAMES W. SEWALL COMPANY, OLD TOWN, MAINE
SCALE: 1 INCH = 200 FEET







Mount Desert Narrows

LEGEND

PARCEL NUMBERS 2

MARSH LINE

DATE OF AERIAL PHOTOGRAPHY 5-9-55

DATE OF COMPLETION 4-1-57

DATE OF REVISIONS

For Assessment Purposes Not to be used for Conveyances

TAX MAP

TOWN OF TRENTON.

HANCOCK COUNTY, MAINE

PREPARED BY

JAMES W. SEWALL COMPANY, OLD TOWN, MAINE

SCALE: 1 INCH = 200 FEET

	11	
6	MAP NUMBER 7	8
	4	

I would like to request modifications to the lease conditions during the renewal process of our BHBGC4 oyster lease. Below are the existing lease conditions in black with my requested changes and reasoning in red.

Current lease conditions

1. Two navigation corridors 250ft wide must be maintained on each lease tract, located according to a gear plan approved by the department, as more particularly described in the text of the decision. The corridors must be maintained free from all floating and bottom gear, including mooring gear and moored boats and work platforms, so that vessels can freely navigate across each tract. Each corridor must be marked with floating buoys at each corner containing the words “Area open to navigation” in letters at least two inches high.

Over the past five years of operating the farm, the required navigation corridors have been clearly marked and consistently maintained. During that time, they have seen very limited use. Based on our crew’s observations, estimated usage during the summer ranges from roughly once per month (Noah Goodman) to perhaps ten boats total over the entire season (Theo de Koning). To be clear, those figures reflect combined use across all of the designated corridors.

These corridors currently account for approximately 14 acres of leased area. That represents a meaningful portion of our footprint and significantly limits how efficiently we can configure and operate the farm. At the same time, they do not materially change how vessels navigate around the site.

For example, when the mooring hauler vessel “ Tubby “approaches riparian landowner Mr. Grunze’s mooring from under the bridge, the absence of the designated corridor would increase travel distance from approximately 7,030 feet to 7,250 feet. That is an additional 220 feet, or about 26 seconds of travel time at 5 knots. In practical terms, this is a negligible difference and does not appear to justify the ongoing cost of approximately $1,400 per year in lease fees for unusable acreage, along with the time and expense required to maintain corridor markings.

Importantly, access through the farm will always remain available. We rely on clear routes ourselves for daily operations. Removing the formal corridor requirement would simply allow us to position access lanes where they make the most operational and navigational sense, while still maintaining safe and reasonable passage for all local users.

We respectfully request the removal of this modification so that the leased area can be used more efficiently, without materially impacting navigation in the area.

2. All gear and equipment must be kept sufficiently far away from existing moorings so as not to interfere with their use.

This condition makes sense and we do not request any modifications.

3. Between May 1 and October 30 of each year, all work on the lease site must be conducted within the boundaries of the site, and all vessels, barges, rafts, work platforms, and other floating craft or gear associated in any way with the lease operations must be anchored or moored within the boundaries of the lease. Site work, anchoring, and mooring must not impede the transit of vessels through the navigation corridors required to be established on the lease tracts.

Based on the lease decision, this condition appears to have been imposed due to fears surrounding navigation within Goose Cove and the general unknowns of what a farm would look like. Based on the low amount of traffic through the navigation corridors that we have observed, it does not appear the concerns regarding navigation are warranted to the extent they were expressed in the original lease hearing. After discussion with our farm crew, and managers, the consensus is that we very rarely see any vessels traveling through the navigational corridors. While we have not recorded dates of the vessels transiting, the consensus is that we see 5-10 vessels travel through the navigational corridors per summer, and two of those are the Tubby putting in and removing Mr. Grunze's mooring. The majority of the rest of the vessel traffic in the area is Brian Harvey accessing his farm in the northern point of Goose Cove, and he doesn't transit across our lease site.

My major concern with this restriction is two-fold:

- As it reads now "all vessels……associated in any way with the lease operations must be anchored or moored within the boundaries of the lease" is not achieving the goal it intended. As a result of our conversations with the riparian landowners, we have started mooring our vessels outside of Goose Cove and on the other side of the bridge. This was much appreciated to reduce the amount of traffic on Hanes Point, and the amount of loading and unloading in the intertidal area. Since we occasionally do mooring maintenance work with our 74ft aquaculture vessel Stewardship, a restrictive reading of this condition would require all our skiffs, and the Stewardship to be permanently moored in Goose Cove within the lease boundaries. That would create more navigation congestion and be impractical with the tidal restrictions. So I request that the requirement for mooring within the lease boundaries be removed.
- Secondly Between May and October the condition that "All work on the lease site must be done within the boundaries of the site" seems to be focused on not creating large amounts of traffic associated with the farm, but not located on the lease site. Given the lack of traffic observed within Goose Cove, I don't believe this condition is justified. Additionally, some work on the lease site needs to be done by repeatedly coming up to the farm from outside the lease area. Specifically mooring work with the farm vessel Stewardship will have the Stewardship outside of the lease area regularly. Restricting mooring work so it is only possible from Nov-April is not practical.

My request is that this condition be modified to simply state that "farm operations must not impede transit of vessels through the navigation corridors, or the transit of vessels in the waters surrounding the farm". This broadening of the language allows us to achieve work efficiency,

while maintaining the need to prevent the farm operations from creating an unreasonable interference for navigation.

4. Small-boat navigation and recreational fishing are allowed within the open areas of the lease site. Dragging is prohibited

This condition makes sense, we do not request any modifications.

5. All significant amounts of fouling material (i.e., more than a layer of slime) removed from gear at the lease site must be collected and disposed of in a land-based composting facility.

In reviewing the lease decision, it appears this condition was put in place to mitigate risk regarding the original lessee's lack of experience, large scale, and unknown impacts of the farm. The lessee proposed a novel way of managing biofouling by pressure washing everything as a biofouling management strategy. We dry the cages as recommended in the BMP's, as most other farms in the state do. That being said, when a mussel seed recruitment event occurs, or first thing in spring when the tunicates have had a chance to set over winter, we do occasionally see more fouling.

Based on my observations while working on the farm and diving under it, I have not seen any significant amount of biofouling that would overload the area's carrying capacity. Even when we first took over the farm and the cages were neglected and the significant amount of fouling was sloughing off, I did not see evidence of anoxic conditions or excessive nutrient loading. At no point have I observed large areas of beggiatoa spp coverage, even in locations with much higher than normal biofouling loading. That would indicate to me that the biofouling is not causing a problem and there is no reason to hold us to a higher standard than the other farms in the state.

Of note here is Mr. Lewis from the DMR's testimony that "biofouling material is good for the ecosystem if gear is cleaned frequently;" We do clean our gear frequently, and our farm is in good repair so we request this condition be removed.

6. Cages and other gear at the lease site must be flipped to clean them of biofouling material. Power washing is prohibited on the lease site.

We flip our cages to remove the fouling, if for no other reason that it is by far the most efficient way of removing fouling and growing a quality oyster. That being said, there are parts of the farm that can't be air dried, for example mooring lines, gangions, and mooring buoys. At the moment the fouling builds up on those and then sloughs off. I would like the ability to periodically power wash those items. This is consistent with the statement in the lease decision that a powerwasher is comparable in volume to a lawnmower, but the duration of use was the main concern. We do not plan on cleaning all the cages with the power washer so this condition can

be removed, or at the least modified to indicate that some power washing is allowed, but it can't be the main form of biofouling control.

7. Only floating aquaculture gear may be used on the lease site. No gear is to be deployed on the bottom, other than necessary mooring gear for any floating equipment. Oyster cages are not to be sunk in an emergency without prior permission in writing from the Department.

This condition was put in place due to fear of sediment resuspension and its impact on local eelgrass bed. Based on the study done by Tom Kiffney from Umaine (attached) it is apparent that raising and lowering a line of cages has no greater impact than a storm, and does not cause the widespread increase in turbidity that was feared. Additionally, the dive survey shows the eelgrass bed that was previously near the lease is no longer there, reflecting a statewide decrease in eelgrass coverage. We request that this condition be removed.

Of particular relevance is the last line of the conclusion in the study:

“Based on the magnitude, duration, and spatial extent of turbidity observed, it is unlikely that raising of submerged oyster gear would result in detrimental impacts to nearby historic eelgrass bed locations, particularly given the absence of eelgrass observed during the 2024 survey.”

The reason we request removal of the condition instead of merely limiting it to one raising and one lowering per year is that birds roosting on cages appears to be becoming a more significant public health threat, and the DMR’s recommendation is sinking the cages for two weeks prior to harvest. If it becomes a problem in our area I would like to be able to sink the cages as needed to clear out any bacteria introduced by birds prior to harvest.

I thank you for your consideration of this request.

Alex de Koning

Monitoring turbidity plumes from raising submerged oyster surface gear in Goose Cove, Maine

Thomas Kiffney[1], Colby Johns[1], Elizabeth Maxwell[1], Damian C. Brady[1]
University of Maine, School of Marine Sciences

Report prepared for Acadia Aqua Farms LLC

1. Background

Acadia Aqua Farms LLC holds a lease for the surface culture of oysters in Goose Cove, Trenton ME. The lease was purchased from the previous holders with an existing condition that prohibits the use of sunken culture gear. The condition restricts sinking of aquaculture gear due to concerns over potential sedimentation impacts on nearby submerged aquatic vegetation (eelgrass, *Zostera Marina*) beds:

"*Activities that disturb this soft bottom, such as the placing and raising of oyster cages as proposed in the application, are clearly likely to create mud plumes, causing, as Dr. Disney described, sediment resuspension in the water and increased sedimentation, which would be likely to harm the eelgrass beds in the cove.*" - (Department of Marine Resources lease approval)

With their lease renewal, Acadia Aqua Farms is seeking the removal for the condition for both floating oyster cages and proposed hexel oyster cages. A study was conducted with the previous lease holders and UMaine that included turbidity sensor deployment and a dive survey. However, the data were inadequate for DMR to make a ruling on the condition due to the short-term deployment of the sensors and the dive survey being conducted over the winter. More high-quality data were needed to (1) determine the scope and potential impact of turbidity potentially created by sinking and raising surface gear that had been sunk and (2) determine if any measurable increases in turbidity are transient and/or not more significant than turbidity observed from natural phenomena, such as tidal cycles or storms. This report summarizes the results of a series of sensor deployments to measure the magnitude and duration of sediment plumes resulting from the raising of sunken gear types, measurements of the baseline turbidity variability in Goose Cove, and a summer dive survey of the eelgrass bed.

2. Methods

2.1 Study area & leases

Goose cove is a wide, shallow (1-9 m mean low water) bay located in the Mount Desert Narrows off of the Union River Bay and West of the bridge to Mount Desert Island. The cove is bordered by tidal flats on the North, West, and East. Acadia Aqua Farms lease, BHB GC4,

is 50 acres in total, split into eastern and western tracts (Fig. 1), referred to as tract-1 and -2 respectively in this report. Bottom types of both lease tracts are dominated by soft mud, while tract 2 has softer sediment than tract 1 (DMR lease approval).

For the purposes of this study, five limited purpose aquaculture leases (LPAs), two on tract-1 and three on tract-2, were granted with conditions that allow for gear sinking (Fig. 1 - *Farm sonde locations also mark the location of LPAs*). Acadia Aqua Farms proposes to use two gear types for future farming operations, floating cages (e.g. oysterGro) on tract-2 and hexel oyster baskets (smaller containers than cages, similar to FlipFarm gear) on tract-1. The LPAs on each tract reflect this gear arrangement. Tract-1 LPA's (ADEK523 & MDEK123) will use 110 hexel oyster baskets each for a total of 220 hexyl oyster baskets and tract-2 LPA's (TDEK423, TDEK523, and TDEK623) will use ten, six-bay oyster grow cages each for a total of 30 cages. DMR requires data on the raising of both gear types in order to rule on the existing condition banning bottom gear at the time of renewal. The historic locations of eelgrass beds are ~100-150 ft. from the Northeast edge of tract-1.

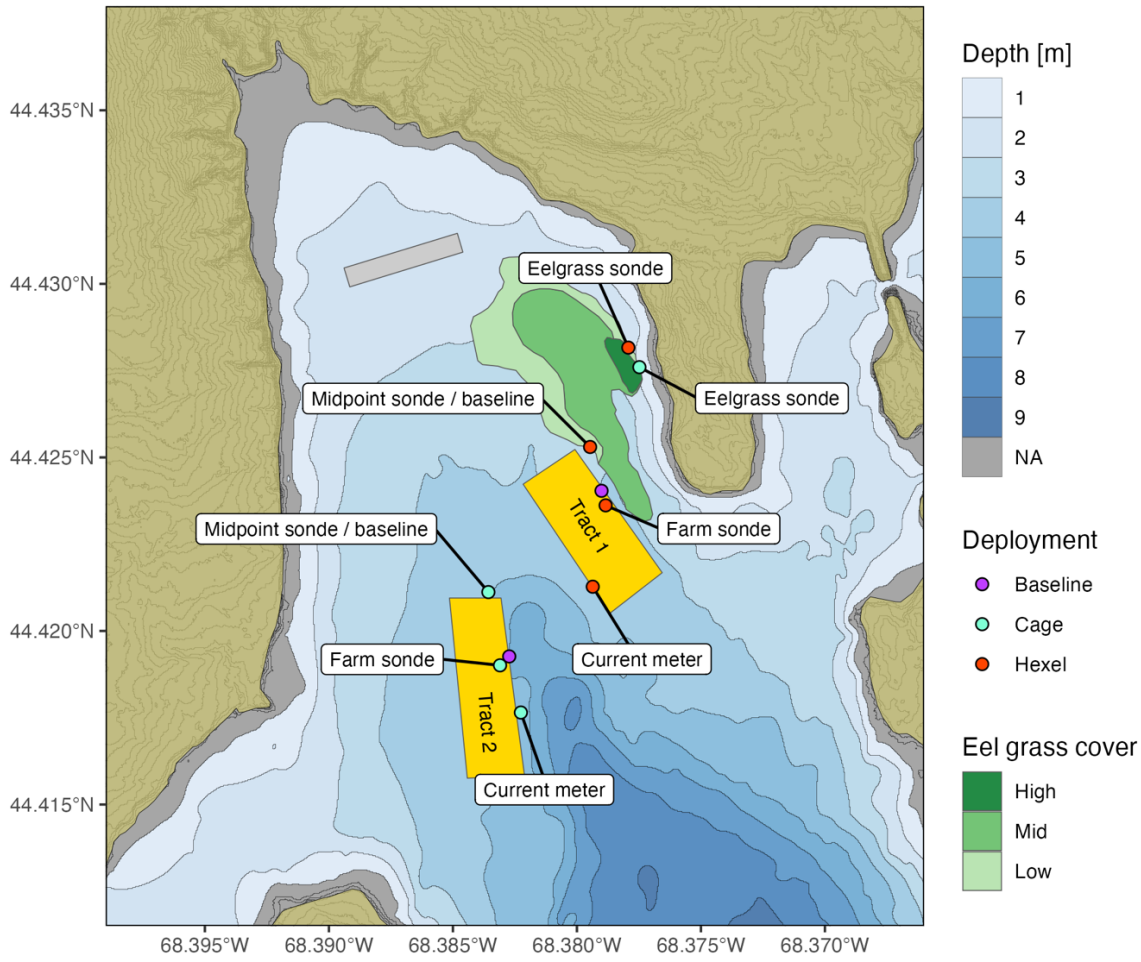


Figure 1. Map of Goose Cove in Trenton Maine. Yellow boxes are the two tracks of AAF's BHB GC4 standard lease. Grey box in the northern end of cove is a standard oyster lease held by another operator. Historic eel grass cover estimates from 2010 surveys.

2.2 Deployment overview

Sensors were deployed three times from late 2023 through 2024. The initial deployment, referred to as 'baseline', collected turbidity variability in the cove when no raising or sinking was occurring. Two separate deployments in the spring and summer of 2024, referred to as 'cage' and 'hexel' deployments, were designed to capture the potential plume effects of raising gear. In all cases, turbidity was measured on Yellow Spring Instruments Exo2 multiparameter sondes with turbidity sensors and automatic wipers. While turbidity is an optical measurement of water clarity it is well correlated with the concentrations of suspended particulate material (SPM) in mg L^{-1} from Maine estuaries (Fig. 2) making it an appropriate metric to approximate potential sedimentation impacts.

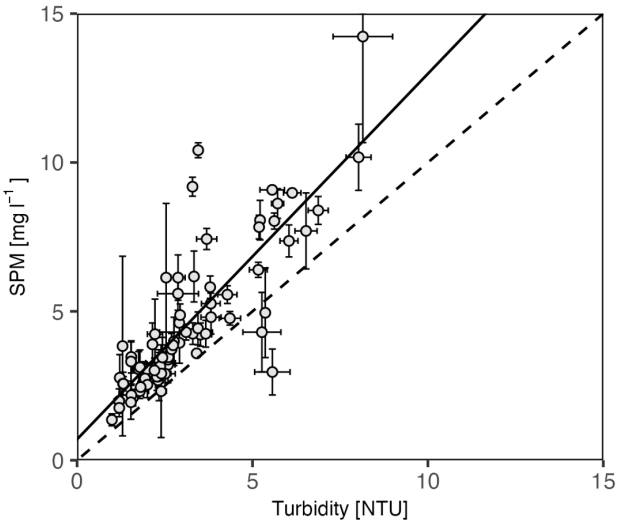


Figure 2. Relationship between optical turbidity measurements from sensors in NTU and measured concentrations of suspended particulate matter (SPM) in mg L^{-1} from Maine estuaries.

For the baseline deployment, two sondes were deployed at the LPA sites on tract-1 and -2 (Fig. 1) set to record on hourly intervals. The sonde (cage baseline) on tract-1 was deployed for 28 days from 12/22/2023 to 1/19/2024. The batteries failed near the end of the deployment period for the tract-2 sonde (hexel baseline) and resulted in 23 days of data ending on 1/14/2024.

Figure 3. Deployment setup of eelgrass sonde attached to a PVC pole.

Cage and hexel raising experiments had similar experimental designs. During both deployments, sondes were placed near the historical highest density portion of the eelgrass bed (eelgrass sonde), at a midpoint between the LPA and the eelgrass bed (midpoint sonde), and at the Northern end of the LPA (farm sonde). The eelgrass sondes were attached to a PVC pole with a dock auger attached at one end. The poles were inserted into the sediment until the sensors were ~5 inches off the bottom (Fig. 3). Midpoint and Farm sondes were either attached to temporary moorings or existing farm infrastructure. Midpoint locations relative to the LPA sites were determined the day prior to deployment by checking current directions at mid-flood tide. On both trials,

Nortek Aquadopp single-point current meters were deployed up-current of LPAs. Sondes were set to record on 30 second intervals and the current profiler recorded measurements every minute. After slack high tide, sensors were retrieved and a single sonde was re-deployed at the midpoint location and set to record at hourly intervals to record additional baseline data. The first 30 minutes of data from the deployment sondes were removed to minimize any impact of experimental set up on the analysis.

Prior to each raising experiment the oyster gear was sunk to the bottom by removing caps from pontoons and floats used to keep the gear on the surface. Gear was sunk at least two weeks in advance of the raising experiment to allow for settlement into the mud. Cages and hexels were raised at mid tide on April 26th and August 7th, 2024, respectively which had similar tidal cycles (Fig. 4). After the cages and hexels were raised above water, the pontoons, which can fill with sediment, had to be flushed with seawater before being re-capped (Fig. 5a, b, c).

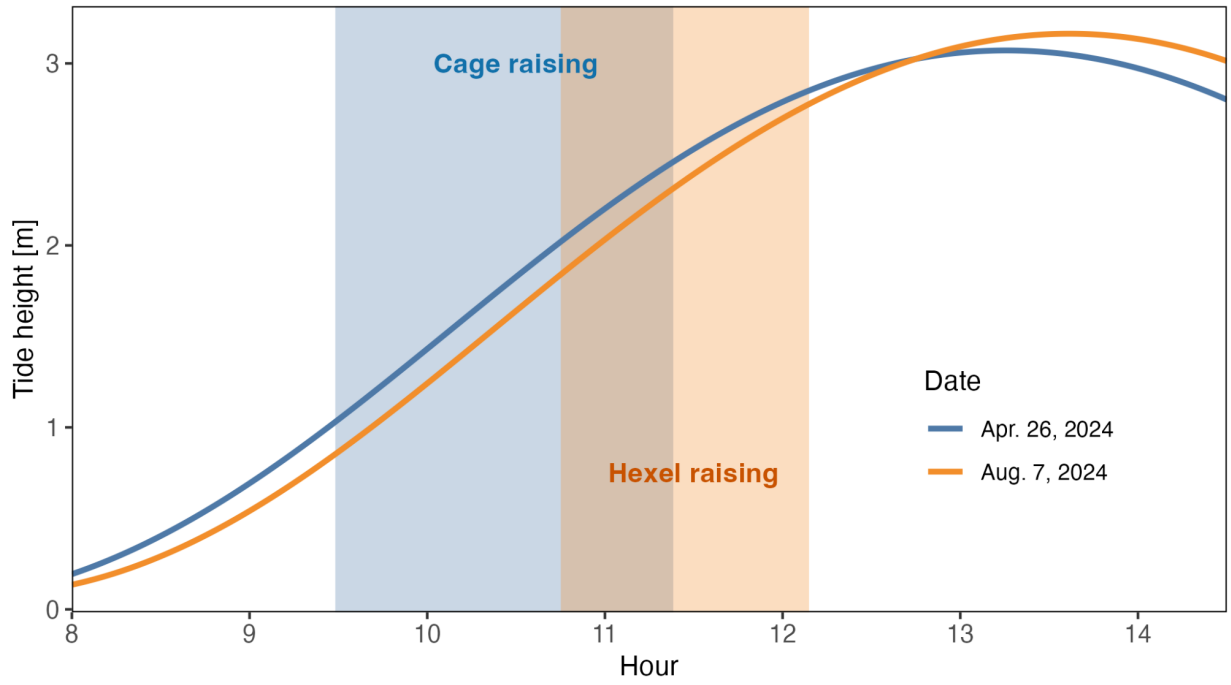


Figure 4. Tide height from the nearby NOAA Bar Harbor tide station. Shaded portions display the durations of gear raising on April 26th, 2024 (Cages, *blue*) and August 7th, 2024 (Hexel cages, *orange*).

Figure 5. Six-bay oyster cage raised from the bottom (*a*). Washing out pontoons on a raised cage (*b*). Sediment plume from raised cages, oranges used to track plume direction (*c)*.

2.3 Dive survey

The survey was conducted on Tuesday August 27th, 2024, by scientific divers Colby Johns and Elisabeth Maxwell. Divers were in the water from 10:30am-12:30pm. Low tide for Trenton was to occur at 11:55 am.

The divers used snorkeling as the primary method for scouting and there was the occasional need for a breath hold to observe the bottom. Average depth of the surveyed area was four feet. The diver's entry was from roughly the center of Haynes Point though an old pathway to the water. The divers began their surface swim due Northwest in the direction of the historic 70-100% (high-density) bed coverage of the eelgrass (Fig. 6). A GPS tracker was attached to the dive flag and set to "track" to map the area the divers surveyed (Fig. 6).

Underwater visibility was about one foot. Water temperatures were recorded to be at 68 °F. The sun was present throughout the survey with little wind and very mild swell. The primary area of interest for the

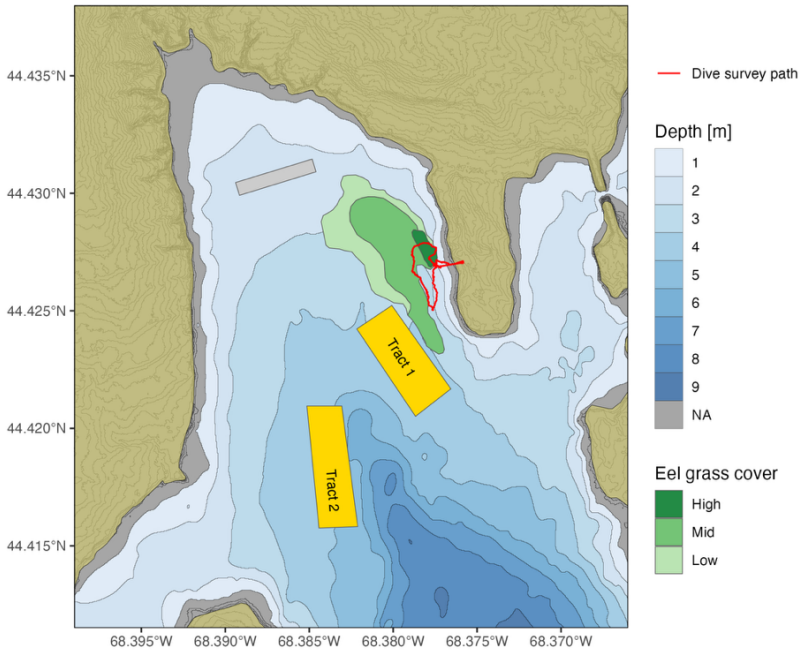


Figure 6. Study area and the dive survey GS track (*red line*).

survey was the site of the historic eelgrass bed in the cove identified by the Maine Department of Marine Resources in 1997 and 2010 (Fig. 1 & 6). The eelgrass had been observed to take over a large portion of the northeastern/eastern shoreside. The particular concern was how close the previous survey shows the bed to be in relation to the aquaculture lease

2.4 Data and Analysis

Turbidity data was visualized with actual measurements for the baseline and experimental deployments as well as a rolling 30-minute coefficient of variation (CV) for the experimental deployments to assess turbidity variability.

$$Coefficent\ of\ variation\ (CV) = \frac{Standard\ deviation}{Mean}$$

Each rolling CV contains 90, 30-second measurements. Additional data was collected from online sources to give context to observed results. Modeled tide height data from the nearby NOAA Bar Harbor tide gauge was retrieved with the R package '*r tide.*' Daily averages of wind data from January 2024 and historic daily averages from 2000 - 2023 were from the Bar Harbor airport (BHB) were downloaded from Iowa State University Mesonet site (https://mesonet.agron.iastate.edu).

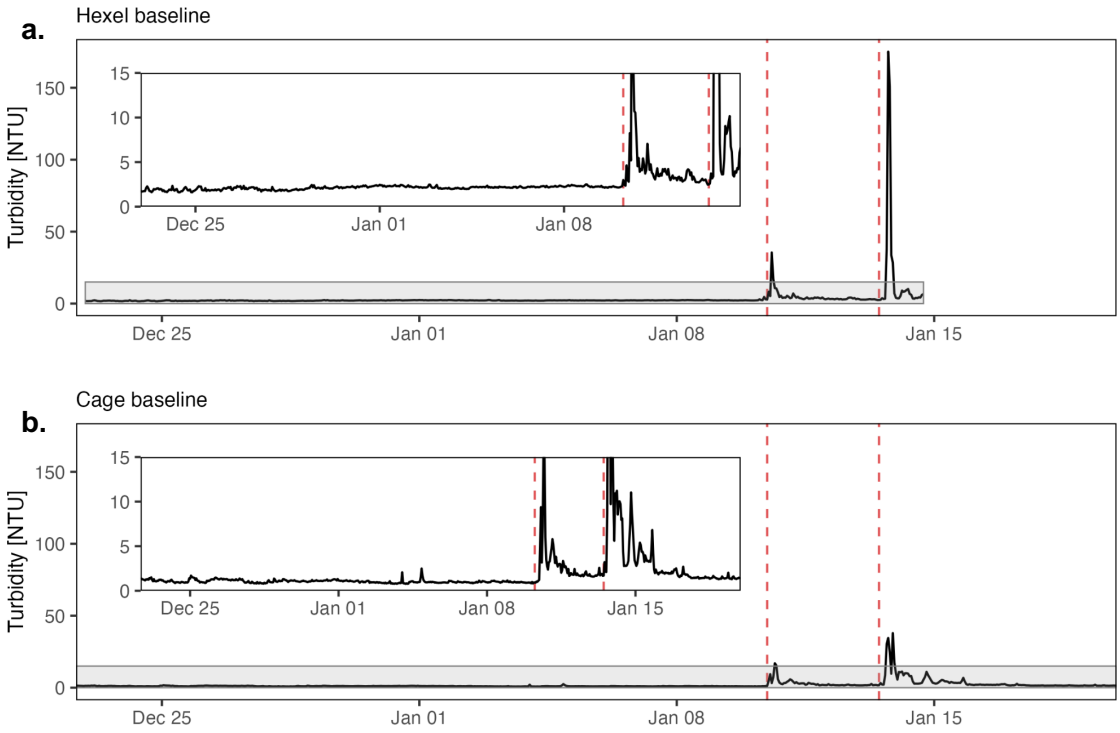


Figure 7. Hourly turbidity measurements from winter (2023-2024) baseline deployments on the hexel (*a*) and cage (*b*) LPAs. Inset plots show the data from the zoomed in gray shaded areas. Red dashed lines mark the start of two large coastal storms in Maine.

3. Results & discussion

3.1 Baseline deployment

During the baseline deployment the turbidity ranged from a minimum of 0.77 to a maximum of 38 NTU at the cage LPA and from 1.6 to 175 NTU at the hexel LPA (Fig. 7a, b). Most of the baseline measurements were between 0 and 3 NTU (Fig. 7a, b). The large spikes of turbidity near the end of the deployments were due to two large storms that hit the Maine coast on January 10th and 13th of 2024. During the storms, high winds coincided with large tides, making damage severe along the coast. Storm driven turbidity peaked at 35 NTU on January 10th on the cage site and 175 on January 14th at the hexel site (Fig. 7a). While the deeper cage site had lower turbidity on both storm days, it still reached 17 and 38 NTU on January 10th and 13th respectively (Fig. 7b). The baseline measurements were initially designed to capture natural turbidity variability in Goose Cove during times of high eelgrass productivity. However, work on the LPA's delayed their deployment until the early winter, a time eelgrass is typically dormant. While the variability during high productivity time was missed, the winter deployment captured two large storm events allowing for an assessment of wind and wave driven sediment re-suspension.

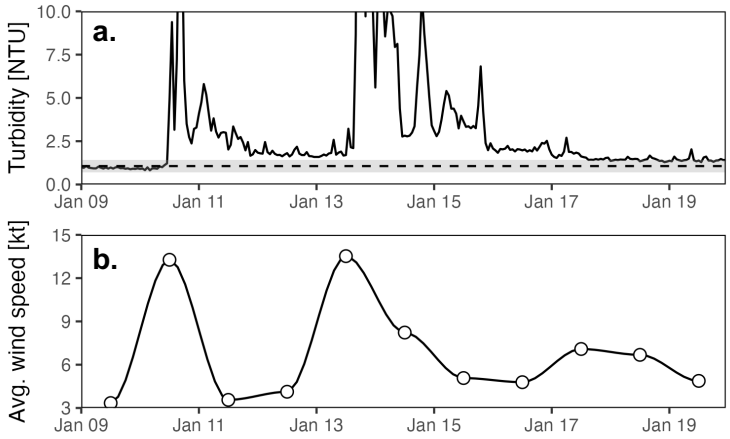


Figure 8. (*a*) Baseline turbidity at the cage LPA during the two January winter storms. Dashed line represents median turbidity from all measurements before 1/9/24 and shaded area is two standard deviations of the mean. (*b*) Hourly windspeed from Bar Harbor airport.

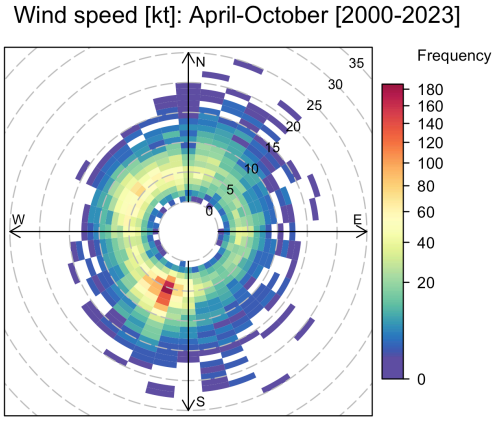


Figure 9. Frequency of wind directions and speed from Bar Harbor airport from April through October, 2000-2023

Goose Cove has a long fetch of over three and half miles from the South South-East (SSE). On both storm days the average direction was out of the SSE with daily wind speed averages of 13-14 knots (Fig. 8*b*). The spikes in turbidity are well correlated with the wind speed on these days (Fig. 8*a*, *b*). While these storm driven resuspension events were large, they were also short lived. After the wind speeds fell, the turbidity returned to normal levels after 24-

72 hours (Fig. 8). These results show that the potential for wind driven sediment resuspension is large in Goose Cove, particularly when winds are above 6 knots and out of the SSE. Typical daily wind speed speeds are ~5 knots out of the Southwest during the season of higher eelgrass productivity (April through October) (Fig. 9). However, from 2000 to 2023, strong winds out of the SSE were also frequently present in this area (Fig. 9) indicating that any eelgrass bed in Goose Cove has dealt with similar resuspension events during summer months when productivity is high.

3.2 Current speeds and direction

Both gear raising experiments occurred on a flood tide. The cage raising experiment took place directly at mid tide, while the hexel raising occurred slightly after mid-tide (Fig. 4). Current speeds during the deployments were similar ranging from 0.0020 to 0.21 m s^{-1} during cage raising and 0.029 to 0.18 m s^{-1} during the hexel raising (Fig. 10). For both experiments the current direction at the LPA sites was North to Northwest during the actual raising (Fig. 9). The midpoint sondes were located North-northwest of the farms, indicating that potential resuspension plumes would have traveled past the deployed sensors.

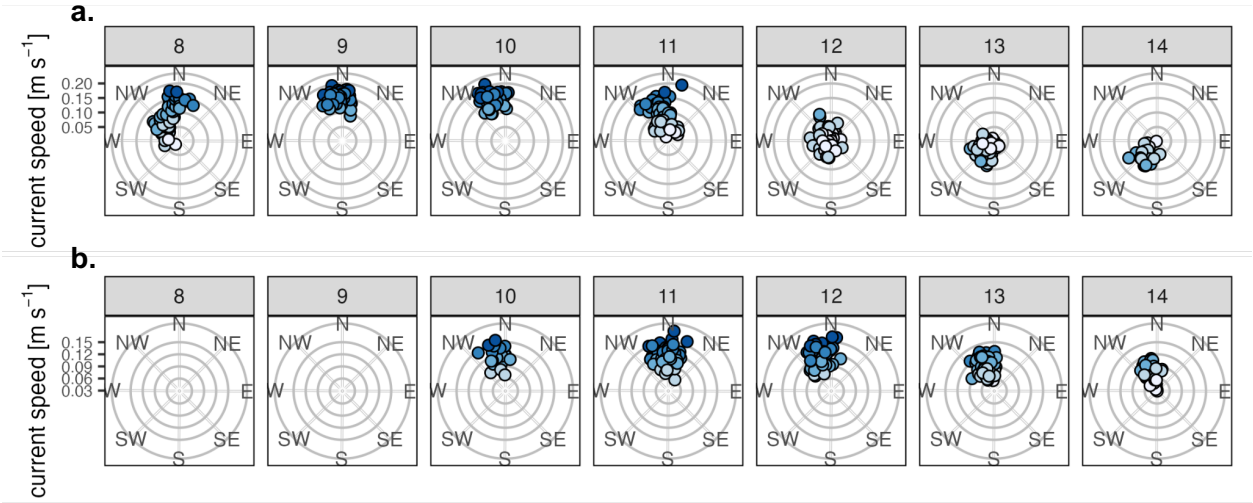


Figure 10. Current speed and cardinal direction from the cage raising experiment (*a*) and hexel bag raising experiment (*b*).

3.3 Turbidity observations during gear raising & continued monitoring

For the cage-raising experiment, mean turbidity across the high-frequency monitoring period was highest at the farm site (2.09 ± 0.22 NTU), followed by the eelgrass bed (1.54 ± 0.24 NTU), and lowest at the midpoint location (0.88 ± 0.17 NTU; Fig. 13a). During the cage-raising period itself, small turbidity spikes were observed at the farm sonde, with a maximum value of 4.14 NTU (Fig. 11a). At the midpoint location, smaller increases were also detected, reaching up to 1.41 NTU during this same period (Fig. 11a). Although the elevated turbidity at the farm site is likely attributable to cage raising, the drivers of variability at the

midpoint and eelgrass sites are less clear. Importantly, the magnitude of these turbidity spikes (Fig. 11a) and associated increases in coefficient of variation (CV; Fig. 12a) were comparable to background variability observed during the hour prior to gear retrieval (Figs. 11 & 12) and to tidal-scale fluctuations recorded during post-experiment baseline monitoring at the midpoint (Figs. 12b, c).

During the hexel-raising experiment, mean turbidity was highest at the eelgrass site (2.81 ± 0.36 NTU), followed by the midpoint (1.68 ± 0.26 NTU), and lowest at the farm site (0.98 ± 0.16 NTU). In contrast to the cage experiment, no clear turbidity signal was associated with hexel retrieval. At the farm site, a slight increase in CV was observed near the end of the raising period (Fig. 12), but this was not accompanied by a corresponding spike in turbidity (Fig. 13c). At the eelgrass site, turbidity was highest prior to the raising period (5.67 NTU) and declined over the course of the experiment. The hexel containers are significantly smaller and lighter than the trap wire cages, likely leading to much less resuspended sediment during raising.

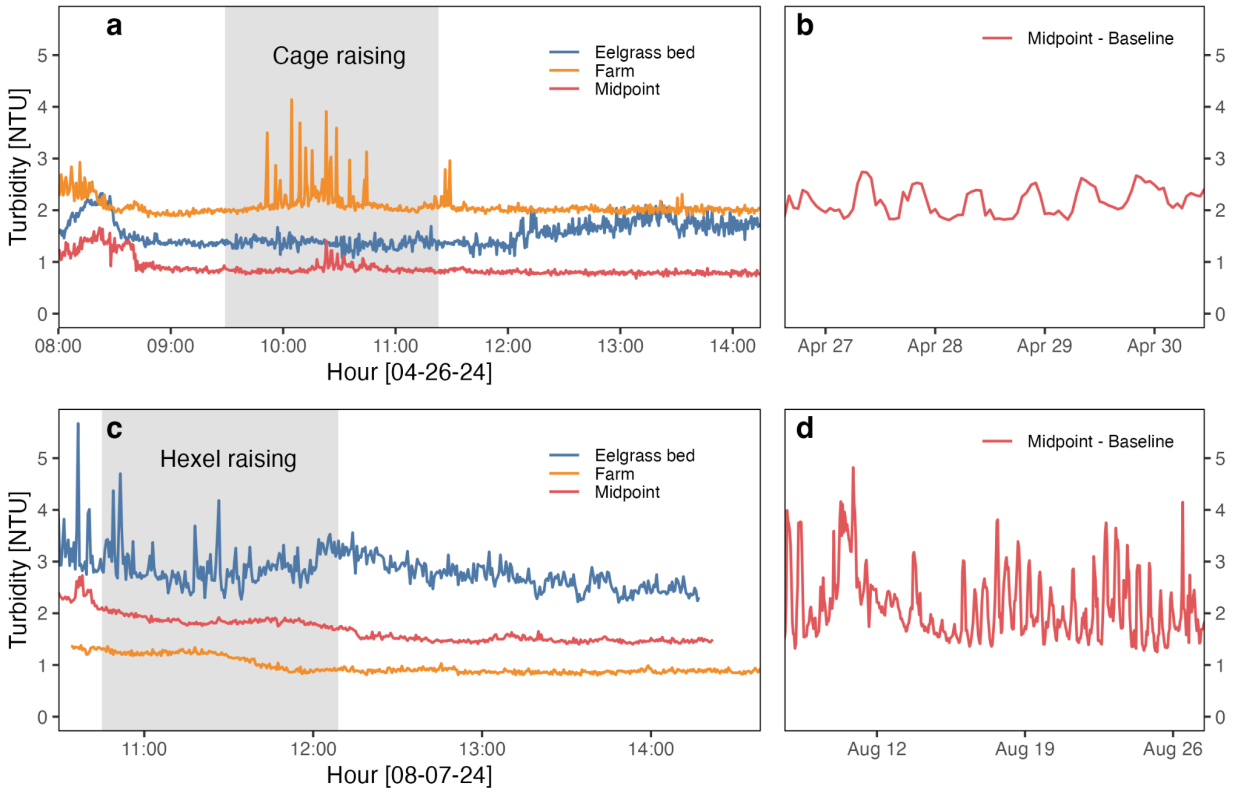


Figure 11. 30 second turbidity measurements from cage (*a*) and hexel (*c*) raising experiments on 4/26/24 and 8/7/24 respectively. Hourly measurements from sondes left at midpoint stations for 4 and 19 days after each experiment (*b* & *d*).

If turbidity plumes generated during gear retrieval were affecting adjacent eelgrass beds, the expected pattern would include a pronounced turbidity increase at the farm site, followed sequentially by increases at the midpoint and eelgrass locations. While minor increases

were observed at the farm during cage retrieval, these were not accompanied by substantial or sustained increases in turbidity or variability at the midpoint or eelgrass sites. During the hexel experiment, this expected pattern was not observed. Moreover, baseline monitoring conducted after the experiments, particularly the extended August deployment, documented natural turbidity variability ranging from approximately 1 to 5 NTU, comparable in magnitude to fluctuations observed during both gear-raising events (Figs. 11b, d). Collectively, these results indicate that turbidity changes associated with gear retrieval were small relative to ambient variability and did not produce clear downstream signals at the eelgrass site.

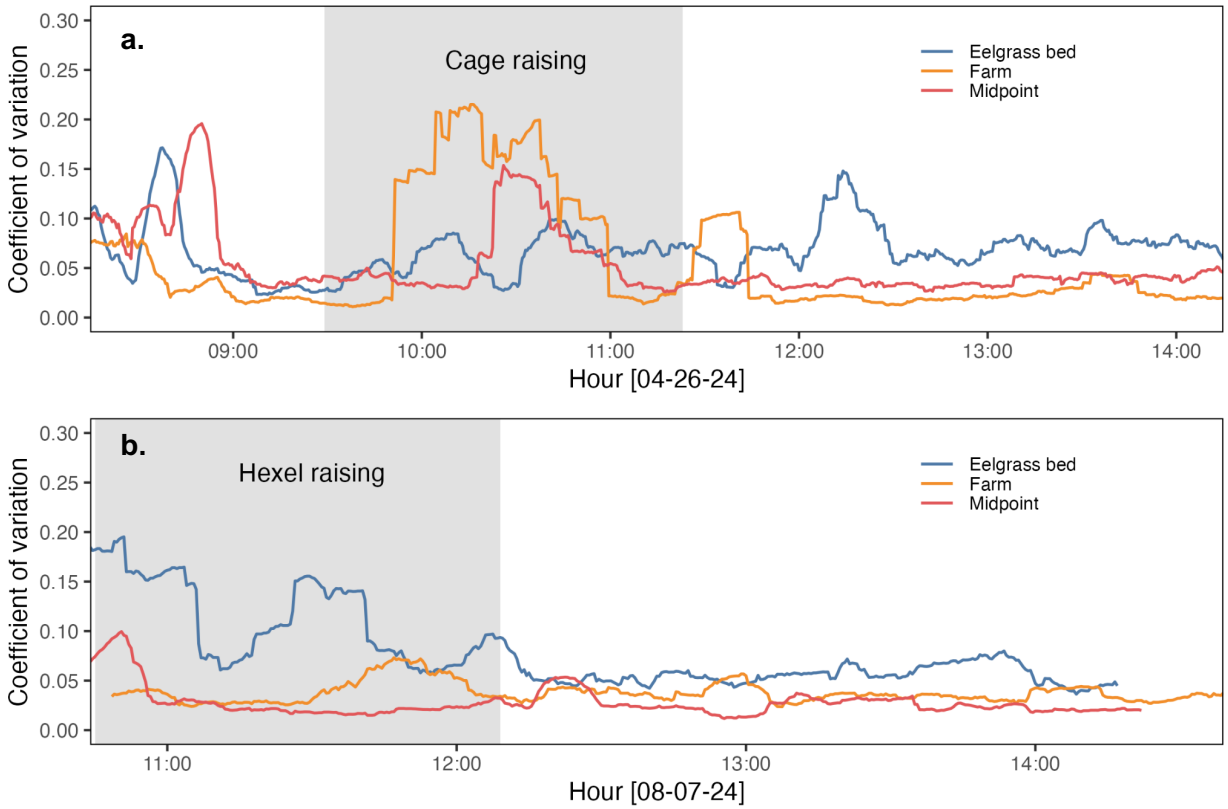


Figure 12. Rolling 30-minute coefficient of variation on turbidity data from cage raising (*a*) and hexel raising (*b*) experiments. Grey shading indicates duration of sunken gear raising.

3.4 Dive survey observations

The area that was surveyed had a substrate of fine silty mud with a gentle slope as it gradually increased in depth. Along the shoreline were some large boulders with some cobbles observed throughout the survey. Observed species included: Frilled anemone (*Metridium senile*, Fig. 13a), green crab (*Carcinus maenas*, Fig. 13b), orange sheath tunicate (*Botrylloides violaceus,* Fig. 13c), the shoreline is also lined with plenty of knotted wrack (*Ascophyllum nodosum),* with various bivalves scattered around (Fig. 15d, e).

Within the area surveyed, there was no eelgrass bed observed or any remnants of a pre-existing one within the area surveyed by the divers (Fig. 6). A video full video can be provided to show the observed bottom substrate seen through the extent of the survey.

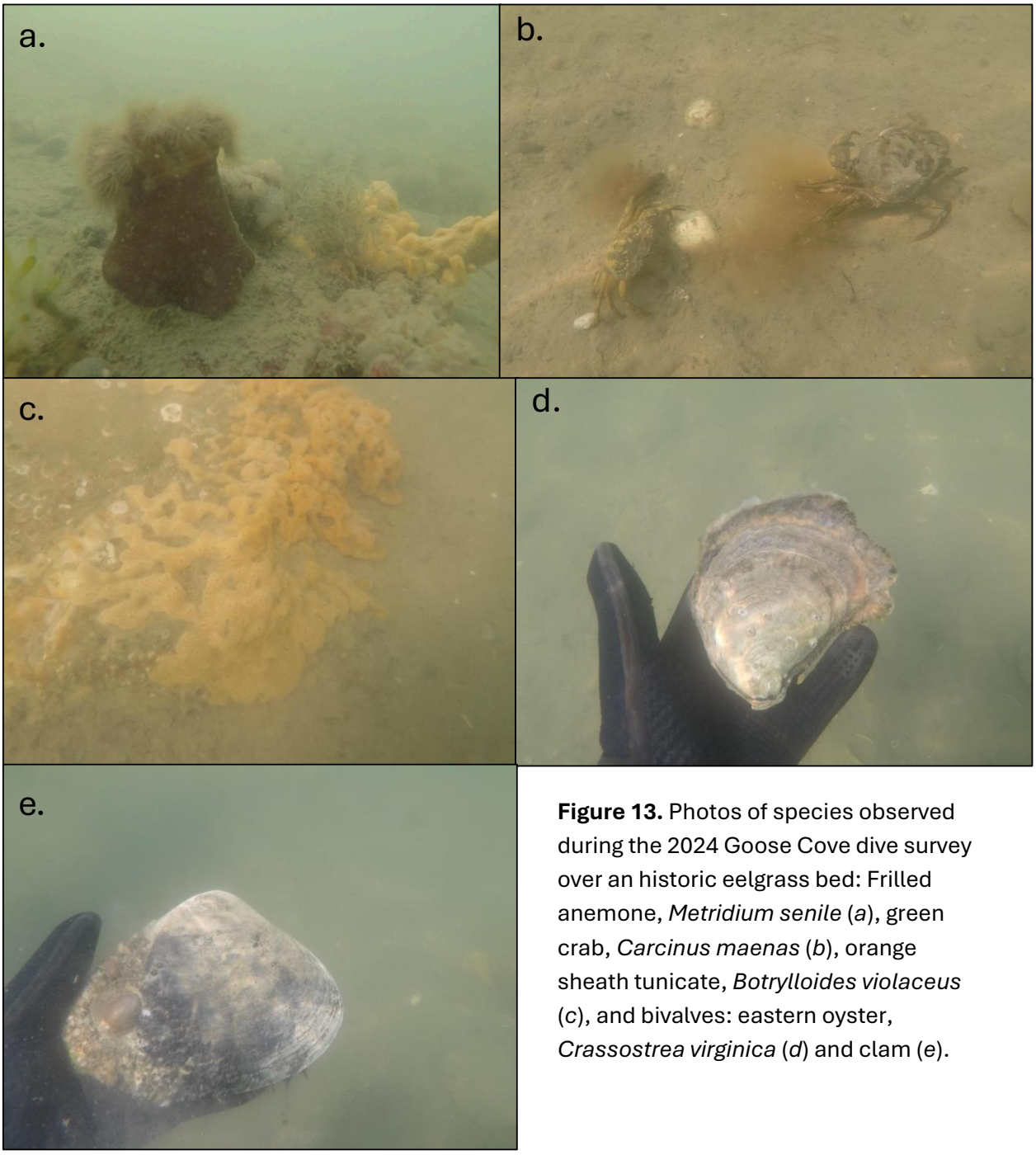


Figure 13. Photos of species observed during the 2024 Goose Cove dive survey over an historic eelgrass bed: Frilled anemone, *Metridium senile* (*a*), green crab, *Carcinus maenas* (*b*), orange sheath tunicate, *Botrylloides violaceus* (*c*), and bivalves: eastern oyster, *Crassostrea virginica* (*d*) and clam (*e*).

4. Conclusions

To assess whether raising submerged oyster gear generates turbidity plumes capable of affecting nearby eelgrass habitat, this study combined a dive study, baseline turbidity monitoring, targeted gear-raising experiments, and current measurements to evaluate plume magnitude, duration, and transport. This data allowed for observation of sediment resuspension during gear retrieval and comparison with natural background variability. The results of these deployments support the following conclusions:

- Current speed and direction data supports the placement of experimental sondes to capture potential plumes from the cage raising experiments.
- Raising trap wire cages created small (~2 NTU increase over existing conditions) and short term (~1 hour) plumes that were visible at the farm site, but not at the midpoint or eelgrass beds.
- Raising smaller hexel cages created no detectable turbidity plumes at any of the monitoring locations.
- Natural tidal turbidity variability was similar in magnitude to gear-raising effects, whereas wind- and storm-driven events produced extreme turbidity spikes 8–35 times greater (38–175 NTU) than those observed during gear raising (~4-5 NTU maximum).
- No eelgrass was observed over the extend of the dive survey.

Eelgrass is sensitive to multiple climate and human related stressors, including warming, eutrophication, invasive species, and chronic sedimentation (Duarte et al. 2025); however, it is also adapted to natural fluctuations in turbidity characteristic of estuarine systems. Submerged aquatic vegetation restoration has been successful in estuaries with mean suspended particulate matter concentrations below 20 mg L^{-1} (Stevenson et al. 1993), levels substantially higher than turbidity observed during gear raising, baseline conditions, and all but the most extreme storm events documented in this study.

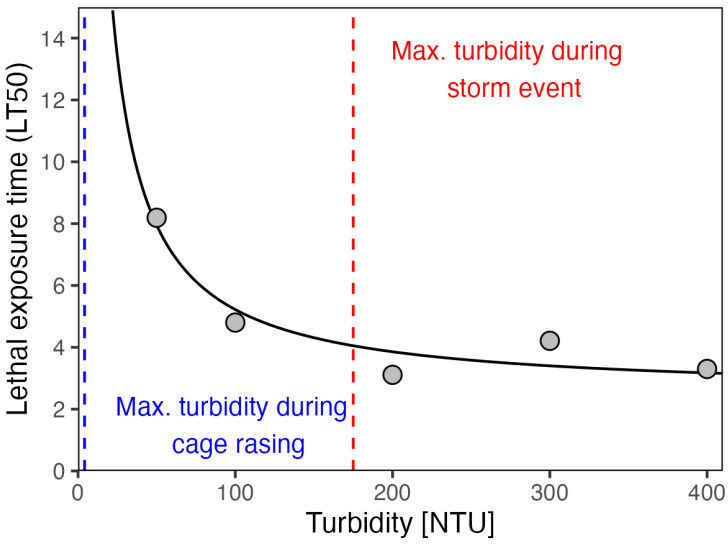


Figure 14. Lethal time to 50% mortality of experimental eelgrass (*Z. marina*) and maximum turbidity observed during cage raising (blue dashed line) and a storm event (red dashed line). Figure reproduced from Li et al. 2021.

The ecological significance of turbidity pulses depends on both magnitude and duration (Moore et al. 1997). A recent experimental study on *Z. marina* reported a lethal time to 50% mortality of approximately four days at sustained turbidity of 175 NTU (Fig. 14, Li et al. 2021). In Goose Cove, storm-driven turbidity peaks of comparable magnitude persisted for only several hours, and gear-raising effects peaked near 4–5 NTU, comparable to control conditions in Li et al. (2021).

Based on the magnitude, duration, and spatial extent of turbidity observed, it is unlikely that raising of submerged oyster gear would result in detrimental impacts to nearby historic eelgrass bed locations, particularly given the absence of eelgrass observed during the 2024 survey.

5. Funding

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6. Citations

Duarte, C. M., Apostolaki, E. T., Serrano, O., Steckbauer, A., & Unsworth, R. K. (2025). Conserving seagrass ecosystems to meet global biodiversity and climate goals. *Nature Reviews Biodiversity*, *1*(3), 150-165.

Moore, K. A., Wetzel, R. L., & Orth, R. J. (1997). Seasonal pulses of turbidity and their relations to eelgrass (Zostera marina L.) survival in an estuary. *Journal of Experimental Marine Biology and Ecology*, *215*(1), 115-134.

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Stevenson, J., Staver, L. W., & Staver, K. W. (1993). Water quality associated with survival of submersed aquatic vegetation along an estuarine gradient. *Estuaries*, *16*(2), 346-361.