Seagrass Restoration and Protection using Conservation Moorings:

Successes and Challenges in Coastal New England

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Abstract

Seagrass is vital spawning and nursery habitat for numerous fish and invertebrate species, though almost 30% of seagrass beds have disappeared worldwide since the late nineteenth century[1]. Most of the loss is a result of human activity: primarily nutrient and chemical loading, dredging, and boating impacts. One way boating activity induces seagrass degradation is via the placement of mooring fields. Many mooring fields are situated within seagrass beds, where traditional mooring tackle using a chain and block system creates a halo of bare substrate caused by the chain sweeping the vegetation as the boat moves with shifting winds and currents. In an effort to reduce such impacts, the Atlantic Coastal Fish Habitat Partnership (ACFHP) has been working with partners along the New England coast to retrofit traditional moorings with conservation mooring systems. These systems use an elastic connection, similar to a bungee cord, to connect the anchoring block or embedded anchor to the surface buoy, minimizing seagrass interaction. Over the past few years, ACFHP has supported installation and monitoring of conservation moorings in multiple boatyards and harbors in Massachusetts and Rhode Island. Results have been mixed for systems deployed for multiple years, with siting and maintenance playing a crucial role in effectiveness. Boater and boatyard owner confidence is essential for the new technology to become more commonplace, which would have a greater positive impact on seagrass beds.

The Importance of Seagrass

Seagrass is found fringing the shallow waters of most continents, providing spawning and nursery habitat for many species of fish and invertebrates. As a primary producer, it serves an important role at the bottom of the food web – acting as a critical food source for many endangered species such as sea turtles and manatees. Seagrass also improve water quality by stabilizing sediments, producing oxygen, and cycling nutrients. In fact, one hectare of seagrass produces 100,000 liters of oxygen every day, and removes 1.2 kg of nutrients from the water column each year[2]. Seagrasses also helps mitigate climate change, sequestering carbon at a rate ten times greater than tropical rainforests[3].

Despite all of its benefits, seagrasses are disappearing at a rate of 110 km^2 per year since 1980, and the loss has been accelerating in recent years[1]. They are considered one of the most threatened ecosystems in the world, in part due to the 1 billion+ people that reside within 50 km of them[1]. Coastal development, nutrient and chemical loading, dredging, and boating impacts have all greatly reduced the expanse and quality of seagrass meadows. One way to reduce the impact of boats is with conservation moorings. Conservation moorings use a buoyant bungee-like cord or floating, flexible rodes to minimize contact with the seafloor. This reduces the halo effect created in seagrass beds by traditional chain moorings, caused by the sweep of the chain along the bottom with shifting winds and tides (Fig.1).

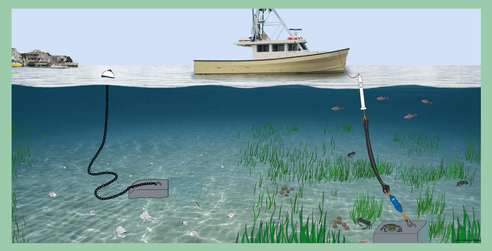

Fig. 1 Traditional moorings (left) create a halo of bare substrate whereas conservation moorings (right) allow for seagrass to thrive.

Conservation Moorings

Conservation moorings all have a buoy and helix anchor, the latter of which has a much smaller impact (approximately 26 cm^2) on the substrate than a traditional cement block mooring (Fig. 2). Depending on the system, they also have a floating rode and chain or bungee-like cord, which stays afloat in the water column. Traditional moorings have a heavy chain at least twice the depth of the water that drags along the bottom, scouring the seafloor and creating a scar of bare sand where seagrass has been damaged or destroyed (Figs. 3 and 6).

Fig. 2 Low-impact helix anchor.

Fig. 3 Seagrass haloing caused by traditional boat moorings.

Multiple brands of conservation moorings are available. Eco-Mooring (Fig. 4) and Hazelett (Fig. 5) systems have been installed along the Massachusetts coast at Gloucester, Manchester-by-the-Sea, Boston, Wareham, and Falmouth; and Hazelett systems have also been installed in Jamestown, Rhode Island. One downside is that they are more expensive than traditional moorings, and there are costs associated with installation equipment and training. However, maintenance is considerably less than traditional moorings and with some systems replacement is recommended only every ten years (though maintenance to prevent fouling is still necessary).

Methods

Candidate moorings to be retrofitted with conservation moorings were identified using aerial photography then surveyed using SCUBA. These sites had significant haloing or scouring of the seagrass around the mooring (Fig. 6). The halo area was measured prior to retrofitting. Seagrass parameters such as shoot density, percent cover, and canopy height were calculated at the Massachusetts sites. Post-installation monitoring on the same parameters allowed for direct comparisons and analysis of success.

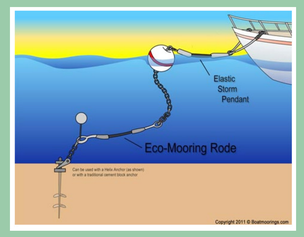

Fig. 4 Eco-Mooring system.

Fig. 5 Hazelett mooring system. (left)
Fig. 6 Seagrass bed damage caused by chain sweep.

Results

Massachusetts Division of Marine Fisheries has observed that conservation moorings are effective in many cases (Fig. 7). There have been some problems, however, with installation and maintenance that have prevented seagrass regrowth around some of the installation sites. In Rhode Island, initial results (one year) are promising, with halo reductions at all sites where mooring owners did not move the moorings post-installation (Fig. 8).

For example, in 2010, eight conventional moorings were retrofitted with Hazelett moorings in Manchester Harbor, and at three of those moorings, seagrass was planted in the halos following installation. Seedling growth occurred in 2011 but the halo depressions collected detritus making it difficult for the seagrass to take hold. There were no observable differences in regrowth between planted and unplanted sites, and full regrowth did not occur within four years of retrofitting (Fig. 9). Some of this was due to mooring owners neglecting or modifying the gear once it was installed.

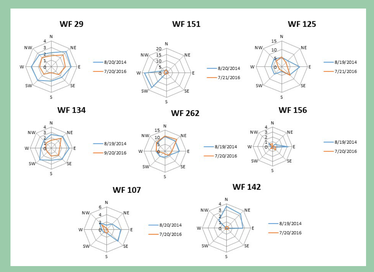

Fig. 7 Polar plots of halo area (m^2) around eight conservation moorings in West Falmouth, MA. Blue plots are from August 2014, red plots are from July or September 2016.

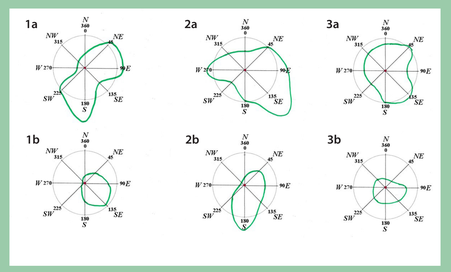

Fig. 8 Halo area after mooring installation in 2015 (top row) and one year later (in 2016, bottom row) at Clark Boat Yard (mooring 1: a, b) and Conanicut Marine Services (mooring 2: a,b; mooring 3: a,b) in Jamestown, Rhode Island.

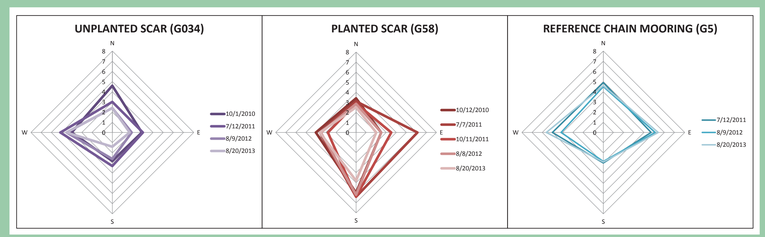

Fig. 9 Polar plots of halo at representative conservation mooring (unplanted), conservation mooring (seagrass planted), and traditional mooring (control) in Manchester Harbor over three years of monitoring.

Lessons Learned and Recommendations

- ***Follow the manufacturer's installation and maintenance manual for the mooring as a first step.***
- ***Consider the depth and tidal range when fitting the mooring.*** Fitting at a low-low tide has been most successful. Some sites might be too shallow for certain models to work effectively, as the top chain can hit the seafloor. Different designs or shorter rodes should be considered if there is any contact with the bottom.
- ***Regularly maintain the mooring.*** Seasonal maintenance with a scrub brush and gloved hand is recommended, and heavy fouling has been observed when moorings are not cleaned at least once per season (Figs. 10 and 11). These fouling loads can weigh the equipment down to the bottom, reducing the benefits to seagrass. The cost associated with mooring maintenance should be considered prior to installation, but should still be cheaper than the maintenance and regular chain replacement associated with traditional moorings.
- ***If using an Eco-Mooring, store the flexible rode on land during the winter off-season, and replace it with a winter stick.*** This will ensure the equipment is not resting on and scouring the bottom while not in use. Water removal also allows for a closer inspection of the equipment. Hazlett Systems are not removed during the winter.
- ***Conservation moorings may not be suitable for all circumstances.*** Massachusetts DMF has found that shallow sites, sites with high energy, and those with sparse seagrass may not benefit from these moorings. If the harbor conditions (e.g. storm surge) require a setup where the rode drags during low tide, the site is not suitable for conservation moorings.
- ***Be cognizant of mooring placement.*** Grouping conservation moorings in one place can have greater benefits to seagrass regrowth than if they are dispersed among traditional moorings. Conservation moorings should also not be placed too close together – though the system allows for more moorings in a given area, extra boats can shade the seagrass, reducing photosynthesis and recovery rates.
- ***Boater and harbor manager confidence is essential.*** This new technology needs support from the boating community to become more common, and an understanding of changing Army Corps of Engineer regulations increases confidence in the systems.
- ***Not all mooring systems are equal.*** We have heard reports that certain conservation mooring brands last longer than others, so talk to those that are familiar with different systems about the best fit for your needs. Sometimes 'you get what you pay for.'
- ***More studies are needed.*** Understanding performance in a wider array of conditions over a longer period of time will reduce negative results and provide more benefits to seagrass.

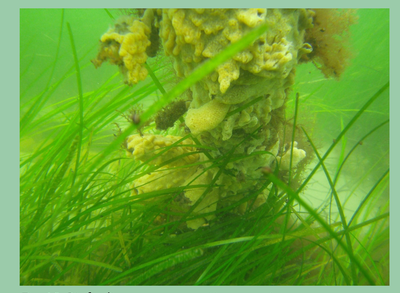

Fig. 10 Biofouling on conservation moorings.

Fig. 11 Biofouling on conservation moorings.

Citations
[1]Waycott et al. 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. PNAS 106: 12377-12381.
[2]http://www.projectseagrass.org/one-hectare
[3]Fourqurean et al. 2012. Seagrass ecosystems as a globally significant carbon stock. Nature Geosciences 5: 505-509.

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