Standard Operating Procedures: Survey Marker Installation and Monitoring

Introduction

The Buzzards Bay NEP and the Buzzards Bay Coalition are collaborating on a long-term study of salt marsh loss, sea level rise, and habitat change around Buzzards Bay. Monitoring the selected sites will help improve our understanding of the causes of marsh loss around Buzzards Bay and help develop possible mitigation strategies. This summary provides an overview of the monitoring approach. Details that are more specific will be contained in an EPA-approved Quality Assurance Project Plan that will be provided to municipal conservation commissions prior to survey work and posted online. Protocols will be put in place to minimize impacts and disturbance to the marsh.

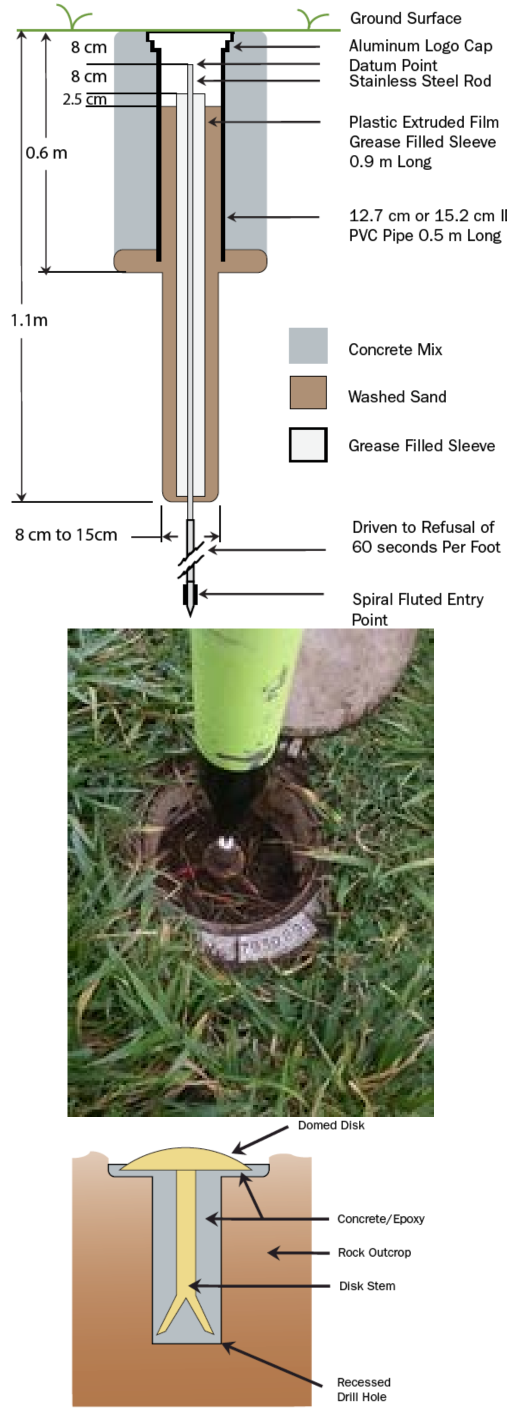

Fig. 1. Top: Schematic of the monument (from NGS (2010), *Bench Mark Reset Procedures*). Middle: finished installation. Bottom: Optional disk marker for existing structure.

Work to be undertaken

Six activities are planned as part of this long-term salt marsh loss monitoring study:

1) Install a NGS rod type survey benchmark in an adjacent upland area (Fig. 1, top and middle; disk marker optional),
2) depending on the site, install 4-10 PVC pipe markers (2 to 5 transects) within the marsh to establish permanent transect lines (1-inch PVC pipe driven with a hammer to within 4 inches of the marsh surface and capped),
3) monitor elevation, vegetation, and other features along these transects up to 3 times per year for the first two years, then once per year thereafter (some *Phragmites* or vegetation trimming may be required around the benchmark to allow line of sight),
4) conduct a crab population survey with pitfall traps,
5) install a temporary staff with sensors in a tidal creek to document tidal elevation, and
6) periodically document the elevation of the High Tide Line during different tidal and weather conditions.

Elevation Benchmark Monument Installation

Factors in the selection of elevation benchmark sites include:

- Sites 1-2 feet above the high tide line are preferred.
- Avoid installing monuments behind active barrier beaches, migrating dunes, or areas prone to overwash.
- Elevation markers must be placed where there is a clean line of sight to the marsh transect site (the marker should not be enclosed by dense high brush, *Phragmites*, or tree stands).

Elevation benchmark monuments will be installed in uplands adjacent to selected marshes within 500 feet of monitoring work. The survey markers will be NGS 3-D deep driven rod markers made of 9/16" stainless steel (Fig. 1), driven to refusal. The steel rod is driven with a gas-powered hammer as shown in Fig. 2. The top 2.5 feet of the steel rod is surrounded by a 1-inch PVC pipe containing food-grade non-toxic grease. This design prevents movement of the ground due to frost heaves from affecting the elevation of the marker, and this benchmark type meets the highest government standards for benchmark elevation stability. The housing for elevation markers must be installed at ground level and any excavated materials must be removed from the immediate site.

Transect Marker Installation

To establish permanent monitoring transects in the marsh, 4 to 10 capped one-inch PVC pipe (about two-foot lengths) will be hammered into upland and low marsh within 4 inches of the marsh surface. The number of markers will depend on marsh size and other factors.

Pairs of these markers will establish permanent transect lines across the marsh. One of these marker pairs will be located in an upland area at an elevation about one foot higher than the upper marsh boundary (the high tide line; HTL). The low marsh marker will be installed near the low marsh boundary, but no closer than five feet from the low-marsh edge of the marsh (greater if there is evidence of rapid marsh loss). A surveyor's 300-foot steel blade measuring tape will be used to define quadrat placement between transect markers.

Fig. 2. Using a gas powered jackhammer to drive the steel rods into the ground (from a URI guide for installing elevation monuments on National Park Lands).

Transect Monitoring Protocols

Monitoring surveys will document elevation, vegetation, and mussel and crab burrows along transects. To minimize human impacts, investigators will walk on only one side of the transect lines, and make measurements on the other. Vegetation within monitoring quadrats will be with field data sheets supplemented by digital photography. Surveys will be undertaken along these transects up to three times per year for the first two years, then once per year thereafter.

Elevation measurements along transect lines will include a comparative analysis of three technologies: 1) a digital bar-code laser level (2.5 mm expected accuracy), 2) a precision pressurized hydrostatic altimeter (e.g. ZIPLEVEL; 1 to 5 mm expected accuracy), and 3) a survey grade GPS with a base station establish on the benchmark (5 to 20 mm expected accuracy).

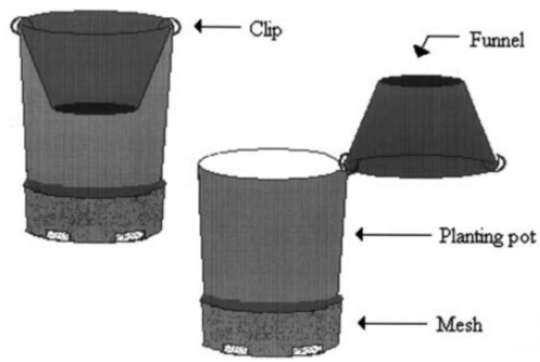

Fig. 3. Crab pitfall trap after Kent and McGinnis (2018)

Additional measurements

Tidal range and elevations will be documented at least once in each marsh using HOBO™ pressure sensing data loggers. These data loggers will be installed on a temporary PVC pipe set in a tidal creek for two to three weeks. Researchers will also periodically document the high tide line near the benchmarks using small flags, and measure elevations of the high tide line.

A crab population survey will be undertaken at least once during the study using pitfall traps. Up to six pitfall traps will consist of 18 cm diameter black plastic potting containers, with a screen mesh around the drainage holes, and with a funnel made from cutting another planting pot (Fig. 3). In this method, a plug of salt marsh peat is removed and replaced with a trap and set out overnight. The next day, crabs are counted and measured and released, and the original peat plug is returned to fill the hole. If traps are needed for longer use (e.g. a capture-recapture study), when traps are not in use, screens will staked down over the pitfall traps to prevent crabs or other animals from entering.