Development of a Comprehensive State Monitoring and Assessment Program for Wetlands in Massachusetts

Appendix T

Standard Operating Procedures: Photo Interpretation of Coastal Structures

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Purpose

Since colonization, coastal engineering structures have been constructed along beaches of Massachusetts in an effort to control coastal processes. These structures essentially consist of ways to harden the beach and minimize the affects of wave action along the beach or the adjacent shore. Hardened structures that are perpendicular to the beach such as groins and jetties, are designed to interrupt longshore drift. These perpendicular structures allow sand to build up (accrete) on the upcurrent side, yet down current sides are starved of sand. Hardened structures parallel to the trend of the coast including seawalls, bulkheads, and revetments are designed to minimize the affect of waves on the beach or shoreline behind them. However they often prevent the normal erosion of coastal banks that allows for replenishment of downdrift beaches. In the case of seawalls, waves often "bounce" off the seawall, causing scouring and increased erosion at the base of the seawall. While these hardened structures can have their desired effect on the area where they are constructed, it is widely accepted that they interfere with the ecological integrity of the overall beach ecosystem either in the immediate vicinity or in downdrift locations.

In order to document the presence and density of such hardened structures, the Massachusetts Office of Coastal Zone Management (CZM) has conducted a coastal structure inventory. The *Massachusetts Coastal Structures Inventory* provides a database for users to locate and gather information about coastal structures such as docks, piers, jetties, groins, bulkhead, revetments, and seawalls, among other structures. Using Trimble GeoExplorer 3 GPS units, trained field staff identified and collected latitudinal/longitudinal coordinates, attribute information, and photos for each structure. Where necessary, coordinates were collected from afar, using a laser range finder and compass to determine the distance and bearing, respectively. However, due to private property concerns and accessibility issues, not all areas of the coast were covered. Gaps in the data exist, .Major gaps are presented in Figure 1 below.

The purpose of this project is to provide data, based on photointerpretation, for those areas of gaps. Upon completion there will be a comprehensive state wide data base of hardened structures. This database will allow for the development of a Conservation Assessment and Prioritization System (CAPS) model metric. Once this hardened structure metric is included in CAPS, it will serve as one indicator of ecological integrity of coastal shoreline areas (i.e. a low density of hardened structures indicates a higher ecological integrity and a high density of hardened structures indicates a lower ecological integrity). At this time the effort will not be used to develop a GIS layer for other purposes.

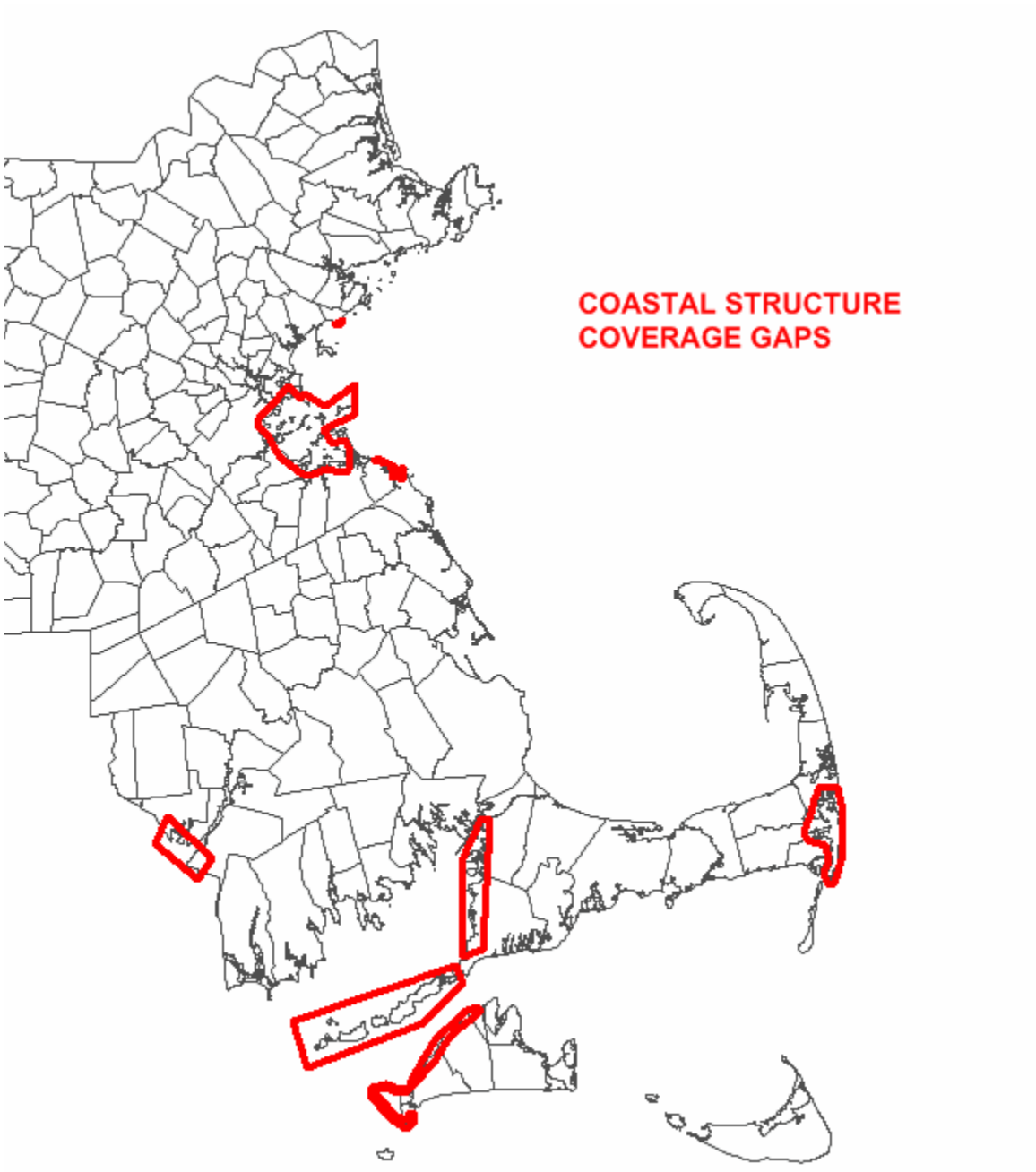

Figure 1. Areas where CZM inventories of Coastal Structures have not been conducted.

Definitions

For the purposes of this mapping project we have adopted the following definitions developed by the US Army Corps of Engineers and adapted by CZM and NOAA.

Seawalls - Seawalls are usually massive, vertical structures used to protect backshore areas from heavy wave action, and in lower wave energy environments, to separate land from water. These are usually poured concrete, steel sheet pile, concrete blocks, gabions, or timber cribs.

Bulkheads - These are vertical retaining walls to hold or prevent the soil from sliding seaward. These include steel sheet piles or gravity structures such as rock-filled timber cribs and gabions, concrete blocks, or armorstone units.

Revetments - Revetments are a cover or facing of erosion resistant material placed directly on an existing slope, embankment or dike to protect the area from waves and strong currents. They may be either watertight, covering the slope completely, or porous, to allow water to filter through after the wave energy has been dissipated. Revetments are commonly constructed using armorstone (high wave energy environments), or rip-rap stone (lower wave energy environments), in combination with smaller stone and geotextile fabrics to act as a filter and under-layer. Other construction materials have also been used to form the armor layer including gabions, poured concrete (usually in stepped fashion), pre-cast concrete blocks, and grout filled bags.

Breakwaters - Breakwaters are generally shore-parallel structures that reduce the amount of wave energy reaching the protected area. *Headland Breakwaters* are a series of breakwaters constructed in an "attached" fashion to the shoreline and angled in the direction of predominant wave approach such that the shoreline behind the features evolves into a natural "crenulate" or log spiral embayment. *Detached Breakwaters*, as the name implies, are breakwaters that are constructed away from the shoreline, usually a slight distance offshore. They are detached from the shoreline, and are designed to promote beach deposition on their leeside. *Single Breakwaters* may be attached or detached depending on what they are being designed to protect. A single detached breakwater may protect a small section of shoreline. A single attached breakwater, may be a long structure designed to shelter marinas or harbors from wave action.

Groins - Groins are the oldest and most common shore-connected, beach stabilization structure. They are structures that extend, fingerlike, perpendicularly or at nearly right angles from the shore, and are relatively short when compared to navigation jetties at tidal inlets. *Normal or Straight Groin* is the standard shore perpendicular construction. *Angled or Inclined Groin* is a standard groin set at a slight angle to the shoreline. *Single Groin* is a solitary groin, usually used to anchor or build a small, site specific, sand accumulation. In some cases these may serve as a "terminal" groin to anchor a nourished beach. A *Groin System or Field* contains numerous groins constructed along a significant reach of shoreline. A *Notched or Zig-Zag Groin* is a groin with small notches or compartments that help anchor sand and sediment. *Permeable Groins* are groins with gaps in them that allow currents and sediment to pass through them, thereby maintaining some of the natural littoral drift. *Adjustable Groins* are groins that can be moved landward or seaward accordingly with long-term rises or falls in water elevation. *T, L, or Y Shaped Groins* are groins with small attachments on their seaward end that are designed to better trap and anchor sediment trapped by the groin structure.

Jetties - Jetties are shore-normal stone structures commonly used for training navigation channels and stabilizing inlets.

Docks and Piers - Piers are usually pile-supported structures with wooden or steel decks and are used for pedestrian access, fishing, research, and supporting commercial establishments. Docks are similar to piers and are typically used as a landing or moorage place for boats.

Photointerpretation

The primary source for photointerpretation will be the most recent statewide orthophotos dated 2005. However, photointerpreters will also consult the black and white imagery (1993-95), the 2001 color orthophotos, the 2008 color orthophotos, and the 2003 and 2008 oblique angle aerial photos (Pictometry) as needed. The primary focus of this project is to accurately capture all coastal structures and then secondly, to classify them consistently with existing CZM policy. The following classification, based on the definitions above, will be used. An additional class "parallel structure" has been added for structures parallel to the shoreline that cannot be reliably classified as seawalls, bulkheads or revetments.

Classification for Coastal Structures

a) Seawall
b) Bulkhead
c) Revetment
d) Breakwater
e) Groin
f) Jetty
g) Dock or Pier
h) Parallel structure

In the event that a coastal structure represents two or more of the classification features, it shall be mapped based on the effect the structure is having on littoral processes. For example, a groin-like structure that is parallel to the trend of the coast and is exhibiting sand accretion and starvation, yet has a dock affiliated with it will be mapped as a groin. Likewise, a solid fill jetty that is also used as a pier will be mapped as a jetty. For the purposes of this project, mapping will only occur seaward of the mouth of rivers, as identified by MassDEP Massachusetts Mouth of Coastal Rivers Maps. These maps provide a clear, consistent, and predictable means of locating all river mouths in the Commonwealth, and have been reviewed and approved by all pertinent state agencies.

The photointerpreter will use what ever imagery or scale is necessary to achieve that goal. All line work format will be consistent with the existing CZM Data; point files for dock or pier and groins, line files for jetties, revetments, bulkheads, and seawalls. Large hardened structures that are perpendicular to the trend of the coast are generally easily recognized on aerial photography, parallel structures can be much more subtle. Due to the limitations of aerial photography it is understood that some hardened parallel structures will be missed or misclassified. Some structures are so narrow that they are essentially invisible on the imagery. In other cases the resolution and or contrast on available imagery is such that narrow features cannot be discerned. Two-dimensional orthophotography can preclude the ability to differentiate between sloping face of a revetment, and the ninety degree face of a seawall or bulkhead. All data that have been

photointerpreted will be identified as such, so it can easily differentiated from existing field verified hardened structure data.

Key Personnel

Michael McHugh, MassDEP, Overall coordination. Provide training of photointerpreter. Perform quality assurance checks to ensure compliance with these mapping standards.

Bradley Compton, UMass, Review data for compliance with CAPS standards.

Marc Carullo, CZM, Perform quality assurance checks to ensure compliance with CZM mapping standards.

Nathalie Regis, UMass, Primary Photointerpreter.

Quality assurance/Quality control (QA/QC)

Photointerpretation and digitization will be conducted by the primary photointerpreter, Nathalie Regis, who has previous experience in mapping coastal features. Mike McHugh and Marc Carullo will do preliminary QA/QC; Brad Compton will do secondary QA/QC. Quality Assurance/Quality Control will consist of comparing linework with imagery.

All linework will be reviewed and 10 percent will be carefully examined by Mike McHugh and Marc Carullo to determine whether it meets QA/QC objectives. Brad Compton will review linework after the first day of digitizing; throughout as requested, and at end of project to ensure its usability for CAPS metric development and modeling.

Data Quality Objectives

Parameter	Units	MDL	RDL	Expected Range	Accuracy (+/-)	Precision
Coastal Structures	Jetty, groin, breakwater, seawall, bulkhead, revetment	NA	NA	Jetty, groin, breakwater, seawall, bulkhead, revetment	90% accuracy in identifying and classifying features	95% of coastal structures linework will be within 15 m of feature in the image based on 10% QA/QC review