Green Boston Harbor Project: Marine Invasive Species Monitoring in Boston Harbor

REPORT
By
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Photo by A. Frankic

December 2009
In October 2008, the Memorandum of Understanding (MOU) was established between UMass Boston Departments of Marine Operations (DMO), Environmental Earth and Ocean Sciences (EEOS) and Urban Harbors Institute and the City of Boston to designate responsibilities of the listed parties in providing pump-out service, conducting marine research, promoting water quality awareness and education.

The operational aspects of education, research and outreach are spearheaded by Dr. Anamarija Frankic, EEOS, which resulted in establishment of the Green Boston Harbor project (GBH; www.gbh.umb.edu). The main vision of the GBH is that a “green urban harbor” is a harbor that is managed within environmental limitations, recognizes strength in ecological and human diversities, and supports local and place-specific economic production within a regional and global context (Frankic 2004; Bowen et al 2006). Human and non-human natural systems are tightly coupled, with complicated feedbacks between systems on multiple spatial scales and time frames; thus creating and supporting a green harbor will require a deep understanding of the ways that human behaviors respond to changes in the coastal environment as well as the ways coastal systems respond to changing patterns of human uses and activities. The research undertaken by the GBH project will contribute both to developing an understanding of coupled systems, as well as assisting communities in implementing changes in use patterns needed to sustain or restore the health of harbor ecosystems, with a long term goal of integrating human activities more seamlessly within local physical, chemical, and biological cycles. This integrated research can thus support effective coastal zone management based with both the best available science and the strengths of local human communities.

**GBH Project Goals:**

1. To assess, monitor, and evaluate relationships between natural changes in coastal ecosystems and corresponding local community changes, with an initial focus on water quality concerns.
2. To support coastal ecosystem stewardship through effective education, outreach, and other activities with local communities and harbor users, including involving these communities in research and monitoring efforts.
3. To serve as a laboratory for transferable green harbor practices, including developing criteria for green harbors, methodologies for monitoring them, and strategies for incorporating broad community participation in green harbor efforts.
4. To establish the first Urban Coastal Forecasting Network to disseminate our results as widely as possible, including publication in the scientific literature as well as distribution through more popular outlets (both traditional loci
Invasive species have been identified as a major threat to local and global ecology and economy. The annual cost of invasive species is estimated at $120 billion in the United States alone (Pimentel et al. 2005). The Nature Conservancy estimates that invasive species have contributed to the decline of 42% threatened and endangered species in the US. (http://www.nature.org/initiatives/invasivespecies/about/).

The Massachusetts office of Coastal Zone Management (CZM) in collaboration with the Massachusetts Bays Program completed the Aquatic Invasive Species (AIS) Management Plan in 2002 to address the complexity of this issue and to design a monitoring program. In the beginning of 2009, the GBH team joined CZM efforts as a volunteer in the Marine Invader Monitoring and Information Collaborative (MIMIC). By signing the 2009 MIMIC monitoring agreement, the GBH became responsible for using MIMIC protocols to monitor and report data from various sites within the harbor. In June 2009, the GBH team members began monitoring invasive species at six locations throughout the harbor (Table 1; Fig 1).

METHODOLOGY

Site monitoring was conducted using MIMIC protocol and site visits were conducted twice a week on average (CZM 2008). The MIMIC protocol involves making repeated visits to selected sites. MIMIC protocol outlines methods for monitoring cobble shores, tidal pools and floating docks. According to the MIMIC protocol, floating docks are currently the only available type of sites within the inner Boston Harbor (Fig 1). MIMIC protocol involves taking a visual assessment of species present and categorizing frequency as: “ABUNDANT, COMMON, FEW, RARE, ABSENT”. Images of were taken for unknown or uncertain species and sent to CZM experts for identifications.
## Table 1. Invasive species monitoring sites in Boston Harbor

<table>
<thead>
<tr>
<th>Site name</th>
<th>Site GPS</th>
<th>Location description/ Street access</th>
<th>Monitoring Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Black Falcon Terminal</td>
<td>42.3432,-71.0370</td>
<td>Black Falcon Ave. Boston, MA 02210</td>
<td>Marine Invasive sp. Primary Pump-out boat discharge station</td>
</tr>
<tr>
<td>2. BH Shipyard &amp; Marina</td>
<td>42.3634,-71.0341</td>
<td>Opposite 218 Marginal Street Boston, MA 02128</td>
<td>Marine Invasive sp.</td>
</tr>
<tr>
<td>3. Rowes Wharf</td>
<td>42.3574,-71.0489</td>
<td>E. India Row Boston, MA 02110</td>
<td>Marine Invasive sp.</td>
</tr>
<tr>
<td>4. Constitution Marina</td>
<td>42.3712,-71.0596</td>
<td>Warren Street, Boston, MA 02129</td>
<td>Marine Invasive sp.</td>
</tr>
<tr>
<td>5. Mystic Marine and Fuel</td>
<td>42.3803,-71.0503</td>
<td>00 Terminal Street, Charlestown, MA, MA 02129 (Mystic Marine Discounts)</td>
<td>Marine Invasive sp. Secondary Pump-out boat discharge station</td>
</tr>
<tr>
<td>6. Fox Point Landing</td>
<td>42.3114,-71.0399</td>
<td>UMASS Boston DMO dock Boston, MA 02125</td>
<td>Invasive sp.; Plankton Ware quality</td>
</tr>
</tbody>
</table>

Figure 1: Invasive species six monitoring sites in Boston Harbor
RESULTS

Species occurrence varied slightly from site to site and is detailed in Table 2. Ten invasive species indicated in the MIMIC protocol were identified throughout the season. Non-native species that were not specified by MIMIC include: *Ciona intestinalis* (solitary tunicate) and *Caprella mutica* (Japanese skeleton shrimp). Findings for each site are presented below in Figures 2 – 11. Abundance values are displayed on the Y axis and were adapted from the CZM protocol (0 = absent, 1 = rare, 2 = few, 3 = common, 4 = abundant). Dates of visits are listed along the X axis and species are designated by different colors. Please note that data from some sites are displayed on two separate graphs.

**Site #1:** The Black Falcon Cruise Terminal features a 120 foot steel float that was monitored five times from July through September (Figs 2 and 3). Located adjacent to MASSPORT Conley Container Terminal, this site receives a high volume of large international shipping. The species *Didemnum* was observed for the first and in Boston Harbor at this site on 29-July, 2009. The observed colonies persisted and continued to grow throughout the season.
Site #2: Boston Harbor Shipyard was the only site located on the eastside of the Inner Harbor. The site featured wooden floats with abundant shade on one side and sunlight on the other. The majority of invasive animals were found on the shaded side of the floats while algal growth was dominant on the sunlit side. Observations of large predatory fish such as *Morone saxatilis* (Striped Bass) and *Tautoga onitis* (Tautog) were common among the pilings at this site (Figs 4 and 5).
Site #3: Rowes Wharf featured the red algae *G. turuturu*, which was unique to the inner harbor sites. This was also the only site other than Black Falcon Terminal to have the presence of *Didemnum*. The floats here featured plastic materials that were regularly scraped by the marina employees (Figs 6 and 7).

**Rowes Wharf Invasive Species 2009**

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**Figure 5**

Boston Harbor Shipyard Invasives (2009)

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**Figure 6**

Boston Harbor Shipyard Invasives (2009)
Site #4: Constitution Marina is located directly adjacent to the freshwater input from the Charles River resulting in a distinctly deeper halocline that restricted near-surface growth of most species. The only species found near the surface, was *D. lineate*. It has been observed that invasions in North American water are related to salinity with significantly more invasions occurring in high (polyhaline and euhaline) than low salinity zones (Ruiz et al. 2000). The other species observed were found on hanging lines typically about 5 feet below the surface of the water(Figs 8 and 9).

Constitution Marina Invasive Species 2009
Site #5: Mystic Marine was added to late in the season and was monitored once (Fig. 10).

Mystic Marine Fuel Invasive Species 2009
Site #6: Fox Point Landing, located at UMass Boston, is the only site located outside the Inner Harbor. No observed species were unique to this site (Fig. 11).

Fox Point Landing Invasive Species 2009

Figure 11
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**Invasive species images** (by C. McIntyre):

- *Ascidiella aspersa* (European sea squirt)
- *Botryllus schlosseri* (Star tunicate)
- *Carcinus maenas* (European green crab)
- *Hemigrapsus sanguineus* (Asian shore crab)
- *Botryloides violaceus* (Orange sheath tunicate)
- *Styela clava* (Club tunicate)
Invasive species images continued:

<table>
<thead>
<tr>
<th>Membranipora membranacea (Lacy crust bryozoans)</th>
<th>Diadumene lineate (Orange-striped anemone)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didemnum sp (Mystery tunicate)</td>
<td>Grateloupia turuturu (Red algae)</td>
</tr>
<tr>
<td>Ciona intestinalis (Not listed by MIMIC)</td>
<td>Caprella mutica (Japanese skeleton shrimp)</td>
</tr>
<tr>
<td></td>
<td>Not listed by MIMIC</td>
</tr>
</tbody>
</table>
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Table 2. Names, description and locations of identified invasive species

<table>
<thead>
<tr>
<th>Species</th>
<th>Sites Observed</th>
<th>Average abundance/Seasonal Population Patterns</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ascidiella aspersa</em> (European sea squirt)</td>
<td>Present at all sites except Rowes Wharf</td>
<td>Abundant at 3 sites (1,2,4) from mid July to late August and declined significantly by mid September.</td>
<td>Not observed at Rowes wharf and generally in higher abundance at deeper/ saltier zone.</td>
</tr>
<tr>
<td><em>Botrylloides violaceus</em> (orange sheath tunicate)</td>
<td>Observed at every site</td>
<td>Abundance peaked in July and August and declined in mid September.</td>
<td>Observed near the surface in many locations and formed large communities with varying color morphs.</td>
</tr>
<tr>
<td><em>Botryllus schlosseri</em> (star tunicate)</td>
<td>Observed at every site</td>
<td>B. Schlosseri displayed a consistent population rise and fall reaching abundance at 4 sites (1,3,4,5) and declined to “few” by 9/16/09.</td>
<td>Communities of this tunicate tend to be smaller and non-contiguous forming the characteristic “gold star” configuration.</td>
</tr>
<tr>
<td><em>Carcinus maenas</em> (European green crab)</td>
<td>Observed at every site</td>
<td>The green crab was found at every site and was generally seen near pilings and structure that hung low in the water.</td>
<td>All sites incorporated or consisted solely of floating docks that limit the access by non-swimming crabs.</td>
</tr>
<tr>
<td><em>Hemigrapsus sanguineus</em> (Asian shore crab)</td>
<td>Observed at sites (1,2,4,6)</td>
<td>As with the green crab, this crab was observed near structure that reached the bottom. Sightings were random.</td>
<td>On a single visit to Lovell’s Island, both crabs were observed under rocks in heavy abundance.</td>
</tr>
<tr>
<td><em>Styela clava</em> (Club tunicate)</td>
<td>Observed at every site</td>
<td>Very common and abundant at all sites in early July. Abundance peaked in August and populations declined in September.</td>
<td>Club tunicate was subject to encrustation by B. violaceus and Didemnun.</td>
</tr>
<tr>
<td><em>Membranipora membranacea</em> (lacy crust bryozoan)</td>
<td>Observed at 3 sites (1,3,4)</td>
<td>The bryozoan was found consistently in “common” abundance at sites where it was present</td>
<td>This encrusting bryozoan was common on native red algae <em>P. palmata</em>.</td>
</tr>
<tr>
<td><em>Diadumene lineate</em> (orange-striped anemone)</td>
<td>Observed at 4 sites(1,2,5,6)</td>
<td>This anemone reached peak abundance in August and declined by mid September</td>
<td>Clusters of this anemone were found near the surface in isolated but dense communities.</td>
</tr>
<tr>
<td><em>Didemnum</em> sp. (mystery tunicate)</td>
<td>Observed at 2 sites (3,4)</td>
<td>Initially observed in small clusters at Black Falcon in late July, the population grew rapidly and maintains an “abundant” presence.</td>
<td>According to CZM representatives this is the first time Didemnum has been observed in Boston Harbor.</td>
</tr>
<tr>
<td><em>Grateloupe turuturu</em> (red algae)</td>
<td>Observed at Rowes Wharf only</td>
<td>Initially documented in late August by CZM observer and was abundant into mid September.</td>
<td>Presently isolated population was observed in previous years.</td>
</tr>
</tbody>
</table>
DISCUSSION

GBH team is planning to expand the invasive species monitoring project, and include water quality monitoring at the sites by using YCI probe (model 556). For the Season 2010, starting on May 1, we are going to continue with public outreach and education, by improving our GBH brochures and web site information. Invasive species are potential indicators of water quality and incorporating this study with other GBH projects such as plankton monitoring, oyster/mussel restoration, and salt marsh restorations will contribute to better assessment of the harbor ecosystems conditions and bring the GBH a step closer to the goal of becoming a “Green Harbor”.

In addition, we are considering a possibility of expanding the invasive species monitoring to incorporate assessment of native species monitoring at the same sites in Boston harbor. However, current MIMIC protocols will need to be enhanced in order to make more accurate assessments of species composition, abundance and correlation with native species composition and abundance in the Boston Harbor.
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References:


