The Sustainability of a Tidal Salt Marsh Restoration Effort in Jamaica Bay, New York

National Conference on Ecosystem Restoration 2011
Baltimore, Maryland
02-August-11

Roy C. Messaros, Ph.D.
Coastal and Hydraulic Engineer
US Army Corps, NY District

Michael Morgan
Geographer
US Army Corps, NY District

Gail S. Woolley
Hydraulic Engineer
US Army Corps, NY District

Patricia S. Rafferty
Coastal Ecologist
US National Park Service, Northeast Region
Overview

• History of Jamaica Bay
• General Background
• Restoration of Elders East and Elders West
• Monitoring Results of Elders East
  - Topography
  - Vegetative Analysis
• Conclusions
History of Jamaica Bay

► Covering 67.3 km² (6,730 ha/16,630 ac) and opens into the Atlantic Ocean via Rockaway Inlet.

► In the early 1900’s it was an extensive estuarine ecosystem that sustained large expanses of tidal salt marsh.

Over the last century, urban and industrial development has modified the natural environment surrounding the marsh islands through activities such as dredging and filling, construction, pollution, and over-harvesting or eradication of native plant and animal species.
History of Jamaica Bay

1818
History of Jamaica Bay

1835
“Modern engineering is about to undertake another of its gigantic tasks. Work is soon to be begun which will ultimately lead to the conversion of the shallows and marshlands of Jamaica Bay into a sheltered harbor... which will ultimately lead to the destruction of a vast tidal salt marsh that is vital to the ecology of Jamaica Bay and surrounding upland areas.
General Background

• Elders Point currently comprised of two separate islands, Elders Point East (Elders East) and Elders Point West (Elders West).

• Approximately 4.9 ha of salt marsh prior to USACE project in 2006.

• Historically one island, 53.4 ha but over the last 80+ years, marsh loss in the center of the island severed the connection creating two distinct islands connected only by mud flat.

• In 1907 6,549 ha consisted of salt marsh islands with most of the wetland loss in the Bay prior to early 1970’s attributed to human activity such as dredging/filling and anthropogenic input.
General Background

Environmental Stresses

- Water logging (subsidence, lack of sediment accretion)
- Increase in tidal prism as a result of marsh loss
- Water fowl predation (i.e., goose grazing)
- Sea level rise (2.7 mm yr\(^{-1}\))
- Alteration of sediment availability, distribution, and accumulation
- Nitrogen (eutrophication) and Sulfide inputs
- Various other anthropogenic input and contaminants from CSO discharge
General Background

Table 1. Total area of vegetated marsh islands in Jamaica Bay (GATE and JBWPAC 2007).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetated Marsh (ha)</td>
<td>950</td>
<td>652</td>
<td>539</td>
<td>355</td>
</tr>
</tbody>
</table>

Table 2. Rate of loss of vegetated marsh islands in Jamaica Bay (GATE and JBWPAC 2007).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Rate of Loss (ha/yr)</td>
<td>6.9</td>
<td>7.3</td>
<td>13.4</td>
</tr>
</tbody>
</table>
Jamaica Bay Tidal Wetlands

Elders East

Elders West

1985
Jamaica Bay Tidal Wetlands

Elders East

Elders West

2024
Restoration of Elders East and Elders West

Restoration of Elders Point, Jamaica Bay, an interagency project: USACE, NPS, NY/NJ Port Authority, NYS DEC, and NYC DEP
Restoration of Elders East and Elders West

Design Fill Templates

Elders West

Elders East
Restoration of Elders East

LEGEND

FINAL CONTOURS

EXISTING SPARTINA ALTERNIFLORA
AREA OF SELECT FILL PLACEMENT AND
SPARTINA ALTERNIFLORA PLANTING

EXISTING UPLAND

SPARTINA ALTERNIFLORA PLUGS

TRI-PLUG PLANTINGS

APPROXIMATE LOCATION OF EXISTING
SPARTINA ALTERNIFLORA (HUMMOCKS)
Restoration of Elders East

Fill Material:
- Maintenance dredging of the Rockaway Inlet: 158,000 yd³
- Dredging Ambrose Navigational Channel: 46,000 yd³
- Purchased material to complete the design fill: 45,000 yd³
  **Total**: 249,000 yd³

Vegetation:
- Mixture of *Spartina alterniflora*, *Spartina patens*, and *Distichlis spicata*
- *Spartina alterniflora* plugs: 580,000
- *Spartina alterniflora* pots: 45,876

Tri-plugs (*S. alterniflora, Distichlis spicata, and S. patens*) were planted over a total of 16.2 ha (40.0 ac). **33,640**

Most of the project (i.e., > 95%) was planted with *S. alterniflora*. 
Restoration of Elders East

October 2006

Photo courtesy of Galvin Brothers, Inc.

October 2006

July 2010
Elders East Elevation Changes
July 2007 to July 2010

Restoration of Elders East

Wind Rose Plot of Resultant Wind Speed and Direction for JFK Wind Data (1984 – 2006)
Restoration of Elders West

Fill Material:
Maintenance dredging of the Rockaway Inlet 0 yd\(^3\)
Dredging Ambrose Navigational Channel 301,976 yd\(^3\)
Purchased material to complete the design fill 0 yd\(^3\)
Total 301,976 yd\(^3\)

Vegetation:
No *Spartina alterniflora* plugs or pots, all the low marsh plants were relocated *Spartina* hummocks from the project site which covered approximately 7.0 ha (7.2 ac)
High marsh transition planting 85,580
covering approx. 1.6 ha (4 ac)
Restoration of Elders East and Elders West

Elders West

Elders East

2009
Restoration of Elders West

July 2010
## Restoration of Elders East and Elders West

### Elders East and West Restoration/Mitigation Costs

#### Construction

<table>
<thead>
<tr>
<th>Summaries</th>
<th>ha (ac) Restoration</th>
<th>Total Cost GE</th>
<th>Total Cost A Bid</th>
<th>Cost/ha A Bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elders East</td>
<td>15.86 (39.20)</td>
<td>$10,097,128</td>
<td>$12,949,569</td>
<td>$830,100</td>
</tr>
<tr>
<td>Elders West</td>
<td>11.45 (28.30)</td>
<td>$8,419,866</td>
<td>$5,742,100</td>
<td>$501,493</td>
</tr>
</tbody>
</table>

#### Monitoring

- $2 Million for 5 years, includes Elders Point West Island as well
# Restoration at Elders East

## Vegetation Analysis

**Table 3.** 2008 average point-intercept values and percent of total (in parentheses) per 1m² plot for vegetation covers. Number of plots (n). “−” indicates cover not present.

<table>
<thead>
<tr>
<th>Species/cover name</th>
<th>Common Name</th>
<th>Elders East</th>
<th>JoCo</th>
<th>Fertilizer</th>
<th>No Fertilizer</th>
<th>Relocation Area I</th>
<th>Relocation Area II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare ground</td>
<td>bare ground</td>
<td>4.4 (8)</td>
<td>4.8 (10)</td>
<td>7.1 (14)</td>
<td>17.1 (34)</td>
<td>2.8 (5)</td>
<td>40 (78)</td>
</tr>
<tr>
<td><em>Distichlis spicata</em></td>
<td>spikegrass</td>
<td>−</td>
<td>5.6 (7)</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td><em>Spartina alterniflora</em></td>
<td>saltmarsh cordgrass</td>
<td>√43.5 (72)</td>
<td>√35.2 (62)</td>
<td>42.9 (86)</td>
<td>32.9 (66)</td>
<td>47 (80)</td>
<td>11 (22)</td>
</tr>
<tr>
<td><em>Spartina patens</em></td>
<td>saltmeadow cordgrass</td>
<td>−</td>
<td>14.5 (20)</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td><strong>Total vegetative cover</strong></td>
<td></td>
<td>√ 91</td>
<td>√ 90</td>
<td>86</td>
<td>66</td>
<td>95</td>
<td>22</td>
</tr>
</tbody>
</table>

**Note:**

Fertilizer: Osmocote® slow release [18:6:11 (N:P:K)] 15 g per plug.

Point intercept method following Roman *et al.* (2001).

Two-tailed paired/unpaired t-Test was used for statistical evaluations.
### Restoration at Elders East

#### Vegetation Analysis

Table 4. 2008 average (standard deviation) live stem density (count 0.25 m\(^2\)) and number of plots (n) for live vegetation. “−” indicates stems not present.

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
<th>Elders East</th>
<th>JoCo</th>
<th>Fertilizer</th>
<th>No Fertilizer</th>
<th>JUN06</th>
<th>OCT06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distichlis spicata</td>
<td>spikegrass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spartina alterniflora</td>
<td>salt marsh cordgrass</td>
<td>√81 (45)</td>
<td>√143 (186)</td>
<td>X87 (29)</td>
<td>X57 (44)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spartina patens</td>
<td>saltmeadow cordgrass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: JUN06 and OCT06 columns represent the data collected in June and October 2006, respectively.
## Restoration at Elders East

### Vegetation Analysis

Table 5. 2008 average height (cm ± standard deviation) and number of plots (n) for *Spartina alterniflora* within 1m² vegetation plots.

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
<th>× Elders East</th>
<th>JoCo</th>
<th>× Fertilizer</th>
<th>No Fertilizer</th>
<th>× Relocation Area I</th>
<th>Relocation Area II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n=31</td>
<td>n=25</td>
<td>n=33</td>
<td>n=30</td>
<td>n=12</td>
<td>n=7</td>
</tr>
<tr>
<td><em>Spartina alterniflora</em></td>
<td>salt marsh cordgrass</td>
<td>109 (39)</td>
<td>66 (27)</td>
<td>105 (20)</td>
<td>86 (35)</td>
<td>118 (17)</td>
<td>72 (30)</td>
</tr>
</tbody>
</table>

Table 6. 2008 average total (live + dead) standing biomass (g m⁻² ± standard deviation) and number of samples (n).

<table>
<thead>
<tr>
<th>Biomass</th>
<th>Elders East n = 15</th>
<th>JoCo n = 13</th>
<th>√ Fertilizer n = 16</th>
<th>√ No Fertilizer n = 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aboveground</td>
<td>√ 867 (626)</td>
<td>√ 822 (282)</td>
<td>448 (428)</td>
<td>213 (216)</td>
</tr>
<tr>
<td>Belowground 0-15 cm</td>
<td>× 2121 (1789)</td>
<td>× 7001 (3329)</td>
<td>572 (500)</td>
<td>430 (614)</td>
</tr>
<tr>
<td>Belowground 15-30 cm</td>
<td>× 544 (1739)</td>
<td>× 6684 (3628)</td>
<td>91 (152)</td>
<td>68 (90)</td>
</tr>
</tbody>
</table>
## Restoration at Elders East

### Vegetation Analysis

Table 7. 2008 average net annual belowground production (g m\(^{-2}\) ± standard deviation) and number of samples (n).

<table>
<thead>
<tr>
<th>Biomass</th>
<th>Elders East</th>
<th>JoCo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td>Belowground 0-10 cm</td>
<td>274±229 (10)</td>
<td>262±224 (10)</td>
</tr>
<tr>
<td>Belowground 10-20 cm</td>
<td>123±146 (10)</td>
<td>90±193 (11)</td>
</tr>
<tr>
<td>Belowground 20-30 cm</td>
<td>14±20 (9)</td>
<td>20±41 (11)</td>
</tr>
</tbody>
</table>

Table 8. 2008 average net annual belowground production (g m\(^{-2}\) ± standard deviation) and number of samples (n) for fertilizer treatments.

<table>
<thead>
<tr>
<th>Biomass</th>
<th>Fertilizer</th>
<th>No Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td>Belowground 0-10 cm</td>
<td>413±424 (14)</td>
<td>392±394 (10)</td>
</tr>
<tr>
<td>Belowground 10-20 cm</td>
<td>376±335 (14)</td>
<td>201±244 (10)</td>
</tr>
<tr>
<td>Belowground 20-30 cm</td>
<td>70±86 (14)</td>
<td>95±128 (9)</td>
</tr>
</tbody>
</table>
In the summer of 2010, Melissa D. Alvarez, a Senior Project Biologist with the US Army Corps, NY District, was inspecting the island:

“I found a nest of Diamondback Terrapins, a New York State protected species. This represents the success we’ve had at Elders Point East and will soon have at Elders Point West”
Conclusions

- *Spartina alterniflora* has exhibited a growth rate consistent with the control.

- No appreciable sediment transport (loss/gain) has occurred.

On the west side of Elders East there is some decrease in elevation likely a result of the historic patterns of sediment transport occurring in a northerly direction of the accreting sand spit.
Conclusions

► By the end of the second growing season (2008), the restored marsh achieved 50% vegetative cover, with *S. alterniflora* the dominant species.

For the *S. alterniflora* plugs the plant communities in the restorted (Elders East) and reference marsh (JoCo) have converged with respect to total canopy cover, stem density, total standing aboveground biomass, and annual net belowground production.

► Project has provided much of the anticipated ecological benefits.

► The sustainability of Elders East and West serve as a benchmark for future projects within Jamaica Bay (e.g., Yellow Bar).
Acknowledgements

The authors would like to acknowledge the U. S. Army Corps of Engineers, New York District, for the lead role in this multi-agency project in cooperation with:

U. S. National Parks Services (Gateway) (USNPS),
Port Authority of New York and New Jersey (PANY/NJ),
New York City Department of Environmental Protection (NYCDEP),
New York State Department of Environmental Conservation (NYSDEC),
New York State Department of State (NYDOS),
National Oceanic and Atmospheric Administration (NOAA),
National Marine Fisheries Program (NIMFP),
NOAA Fisheries: Office of Protected Resources,
National Resources Conservation Service (NRCS), and
U. S. Fish and Wildlife Services (USFWS).