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# TECHNICAL MEMORANDUM

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|---|---|---|---|
| **To:** | Lisa Standley, VHB | **Date:** | September 28, 2010 |
| **From:** | Ryan Davis, Anchor QEA | **Project:** | 100710-01.01 |
| **Cc:** | Nathan Kelsall, Anchor QEA | | |
| **Re:** | Potential eelgrass mitigation sites | | |

## INTRODUCTION

The Massachusetts Port Authority (Massport) recently completed a Draft Environmental Assessment/Environmental Impact Report (Draft EA/EIR) for the proposed Boston-Logan International Airport Runway Safety Area Improvements Project (VHB 2010). As described in the Draft EA/EIR, approximately 66,000 square feet (1.5 acres) of eelgrass (*Zostera marina*) may be directly or indirectly impacted by the construction of the runway safety area improvement project. In order to offset those impacts, Massport has proposed to undertake a site selection process to identify potential restoration sites in the greater Boston Harbor area (i.e., Boston Harbor and southern bays).

This technical memorandum describes the results of the initial site selection process conducted for Massport. The analysis is based on reevaluating potential eelgrass restoration areas previously identified by the Massachusetts Division of Marine Fisheries (MDMF; Estrella 2009) and Battelle (Battelle 2009a).

## BACKGROUND

Two eelgrass site selection studies were recently completed to identify potential eelgrass mitigation sites to offset impacts associated with the construction of the HubLine natural gas pipeline in Massachusetts Bay in 2002 to 2003. One study was led by the MDMF (Estrella 2009), the other by Battelle (Battelle 2009a). Both site selection studies were based on modified versions of the Short et al. (2002) eelgrass site selection model, and focused on physical site characteristics such as light availability, wave energy, depth, and substrate to identify eelgrass test transplant sites. Test transplanting was completed in 2004 for the MDMF project, with larger scale plantings in 2005 to 2007 at the successful test transplant locations (Estrella 2009). Test transplanting was completed in 2009 for the Battelle project, with full scale planting planned for the successful test transplant sites at a later time (Battelle 2009b).

## APPROACH

Anchor QEA used the results from the Battelle 2009 study to re-evaluate the potential sites selected by MDMF and Battelle to account for actual light conditions in 2009. While there are numerous factors that can influence the suitability of an area to support eelgrass, light availability is the most critical factor. When there is insufficient light, eelgrass will not survive regardless of other site conditions; when there is sufficient light, other factors such as sediment composition/chemistry and exposure/disturbance become important (Davis et al. 1998; Koch 2001; Short et al. 2002). The two previous site selection models used many of the same parameters (see Methods section below) and identified several of the same areas as suitable for eelgrass, with some differences due primarily to predicated light availability. The Battelle study used light availability as one of the highest weighted factors in their model (other factors that differed between the models include exposure and desiccation).

Over the course of a few years, factors such as depth, exposure, and sediment composition are unlikely to change significantly. However, light availability can vary considerably within and between years due to changes in water quality and tides. In 2009, the period from early June through July 8 was the coolest, wettest, cloudiest period on record in Boston.[1] There were numerous severe storms that produced significant rainfall and associated runoff (Bluehill 2009). The clouds and wind associated with the storm systems would have increased turbidity and reduced light availability in the harbor area. In addition, sea level was documented to be abnormally high in the northeast during this same time period (National Oceanic and Atmospheric Administration (NOAA) 2009). These factors likely contributed to decreased light availability and reduced transplant survival at sites that otherwise had suitable conditions.

[1] (http://www.boston.com/news/weather/articles/2009/06/23/so_far_june_sunlight_in_boston_is_lowest_in_past_century/).

## METHODS

Both the MDMF and Battelle site selection analyses used a modified version of the Preliminary Transplant Suitability Index (PTSI) model (Short et al. 2002) to score areas of the bay for eelgrass restoration based on several parameters. Using the PTSI approach, an individual score is assigned to each parameter, and all of the scores are multiplied, with higher scores indicating higher site suitability. As a result of the multiplicative approach, if any one element receives a zero score, the final score is also zero and the site is considered to be unsuitable for eelgrass restoration.

### MDMF Site Selection Model

The MDMF site selection model included:

- Depth – Average depth at mean low water was estimated for discrete points from NOAA electronic navigation chart data and the shoreline shapefile from MassGIS. Depth for all of Boston Harbor was interpolated using the inverse distance weighting (IDW) method.
- Exposure – Fetch in the northeast direction was used as a surrogate for exposure since that is the primary direction of winds in the area. Fetch was estimated using the shoreline cover from MassGIS.
- Historical eelgrass distribution – Historical eelgrass distribution was determined from surveys conducted by the Mass DEP Wetlands Conservancy Program in 1951, 1971, and 1995.
- Current eelgrass distribution – The most recent (2001) Mass DEP Wetlands Conservancy Program survey was used.
- Water Quality – Water quality data from Massachusetts Water Resources Authority (MWRA) were the primary data set. These were supplemented with measurements taken by Marine Fisheries eelgrass project staff. Median water quality criteria for April to October were interpolated using IDW.
- Bioturbation – Density of bioturbating organisms (green crabs, skates, etc.) was estimated from figures in Davis et al. 1998.

- Sediment type – Sediment composition data were obtained from the United States Geological Survey (USGS). These data were later found to be inaccurate in the near-shore zone and the parameter was removed from the model. Instead, extensive groundtruthing of sediment type at potential restoration sites was performed.

**Table 1**
**MDMF Model PTSI Scoring for Site Selection**

| Parameter | PTSI Scoring |
|---|---|
| Depth | 0: < 0.5 m or > 4 m<br>1: 3 - 4 m<br>2: 0.5 - 3 m |
| Sediment | 0: gravel or > 70% silt/clay<br>1: coarse sand to very coarse sand<br>2: < 70% silt/clay to medium sand |
| Historical SAV Distribution | 0: previously unvegetated<br>1: previously vegetated in 1 survey<br>2: previously vegetated in 2 or more surveys |
| Exposure | 0: NE fetch > 2724 m<br>1: 1866 – 2724 m<br>2: < 1866 m |
| Current SAV Distribution | 0: currently vegetated<br>2: unvegetated |
| Water Quality | 0: > 1 WQ value does not meet eelgrass requirements<br>1: all but one requirement is met<br>2: all requirements are met |
| Bioturbation | 0: > 1 crab/$m^2$<br>1: 1 crab/$m^2$<br>2: < 1 crab/$m^2$ |

## Battelle Site Selection Model

The environmental factors in Battelle's site selection model included:

- Light Availability – The light attenuation coefficient was derived from Secchi depth readings from MWRA's Boston Harbor monitoring program and interpolated across the harbor using IDW at 30 m resolution. The attenuation coefficient was used in conjunction with depth to determine percent of photosynthetically active radiation (PAR) at depth according to Lambert-Beer's Law:

$$\% \text{ PAR} = e^{(-Kd^{*}z)}$$

Kd = attenuation coefficient

z = depth

For Boston Harbor,

Kd = 1.7/Secchi disk reading

- Desiccation – Bathymetric data (depth at mean sea level, 30 m resolution) was obtained from the NOAA Coastal Service Center. Depth was used to estimate if an area would be dried out at low tide to the point of killing planted eelgrass.
- Temperature – Temperature data were obtained from MWRA's Boston Harbor monitoring program for the period 2003 to 2006. Temperature was later determined to be non-essential to the model.
- Salinity - Salinity data were obtained from MWRA's Boston Harbor monitoring program for the period 2003 to 2006. Salinity was later determined to be non-essential to the model.
- Wave energy – Wind speed and direction data were obtained from the National Data Buoy Center and the National Climatic Data Center. These data were used in the Wave Energy Model (WEMo) from NOAA (NOAA CFHR 2007).
- Sediment Type – Sediment type data were obtained from the USGS. These were determined to be inaccurate after comparison with more recent surveys. USGS multibeam data from 2006 were used instead, which classified areas more broadly. Unsuitable sediment types (anthropogenically modified, high-relief bedrock and boulder, and medium-relief and cobble) were used to mask out areas unsuitable for eelgrass restoration.

**Table 2**
**Battelle Model PTSI Scoring for Site Selection**

| Parameter | PTSI Scoring |
|---|---|
| Light Availability | 0: 0 - 10% |
| | 1: 10 - 20% |
| | 2: 20 - 35% |
| | 3: 35 - 50 |
| | 4: < 50% |
| Dessication | 0: at or above -0.3 m MLW |
| | 1: below -0.3 m MLW |
| Temperature | Eliminated as factor |
| Salinity | Eliminated as factor |
| Wave Energy | 0: energies above 475 W/m |
| | 1: energies below 475 W/m |
| Sediment Type | Areas with Anthropogenic Influence, High Relief or Medium Relief Cobble were eliminated as potential restoration sites |

To select potential restoration sites, Anchor QEA used the desiccation, percent PAR at depth, and sediment type parameters from the Battelle model. Wave energy (and exposure) did not appear to greatly influence the Battelle model results and was not included in the analysis. We used both the normal and a conservative estimate for PAR at depth, the latter due to the above average rainfall, cloud cover, and tides observed during summer 2009. Specifically, percent PAR at depth was recalculated by increasing depth by 0.1 m to simulate the higher than normal tides, and reducing incoming PAR by 10% as a surrogate for the effect of increased cloud cover, rain, and wind driven turbidity. The revised model was used to re-evaluate restoration areas identified by the MDMF model that are not currently slated for restoration, and the 2009 Battelle test transplant sites that had poor survival results (Battelle 2009b). Sites with PAR greater than or equal to 20% under both the normal and reduced PAR scenarios were selected for additional evaluation.

## RESULTS

Estimates of PAR at depth are shown on Figures 1 and 2 for the normal and reduced light conditions, respectively. The MDMF and Battelle sites are also shown on the figures for comparison. Many locations appear to have marginal light availability under normal conditions (e.g., Slate Island, Hull Bay) and are even less suitable under the reduced light condition scenario. In some instances, slight adjustment to the planting site location may have improved light conditions (e.g., Hull Bay).

Additional factors that limit site suitability including desiccation, unsuitable bottom type (i.e., areas of boulder and bedrock), and anthropogenic stressors (i.e., anchoring areas, navigational channels, and cables) were used to further refine potential locations. Figures 3 and 4 show the predicted PAR at depth in relation to these additional factors for the normal and reduced light conditions, respectively.

As shown on Figures 3 and 4, incorporating these additional factors further limits the number and spatial extent of potentially suitable eelgrass restoration sites. While the majority of the mapped unsuitable bottom type is located in deeper water, there are numerous anchoring areas and navigational channels that further limit the spatial extent of suitable sites.

The results of the revised analysis were used to identify six primary and three backup sites for additional field evaluation (Table 3, Figures 5 and 6). Three of the six primary sites are close to test-transplant sites by Battelle and are relatively large areas that have high PAR at depth, even under the reduced light conditions. Focusing on areas where percent PAR at depth remains high under the reduced light conditions may allow the establishment of eelgrass populations where they can withstand the types of stresses experienced in 2009.

**Table 3**
**Sites Selected for Additional Evaluation**

| Location | Designation | Notes |
|---|---|---|
| White Head Flats | Primary | Slightly inshore of Hull Bay site. Sediments reported to be fine grained. |
| World's End | Primary | Existing eelgrass bed at outer edge of site. Need to evaluate potential shellfishing conflict. |
| Grape Island | Backup | Evidence of historic eelgrass bed. |
| Hough's Neck | Primary | Battelle reported significant difference in transplant survival at shallow and deep edge of site |
| Hough's Neck West | Primary | Northeast of Battelle test planting site. |
| Squantum | Primary | New sites; no test-transplanting data available. |
| Old Harbor West | Primary | Southwest of Battelle site and in area with higher light availability. |
| Lovell Island East | Backup | Point bar to north may reduce exposure |
| Lovell Island North | Backup | High exposure |

## SUMMARY/NEXT STEPS

Site visits will be completed at the primary sites in mid-October 2010 to collect bathymetric and sediment data. Backup sites will be used, if needed, if any primary site appears unsuitable based on field observations. Sediment samples will be used to verify the results of the site selection model that the substrate is not predominately anoxic mud. Final test transplanting site(s) will be recommended based on the results of the bathymetric surveys and sediment analyses.

## REFERENCES

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Short, F.T., R.C. Davis, B.S. Kopp, C.A. Short, and D.M. Burdick, 2002. Site-selection model for optimal transplantation of eelgrass *Zostera marina* in the northeastern US. *Marine Ecology Progress Series* 227: 253-267.

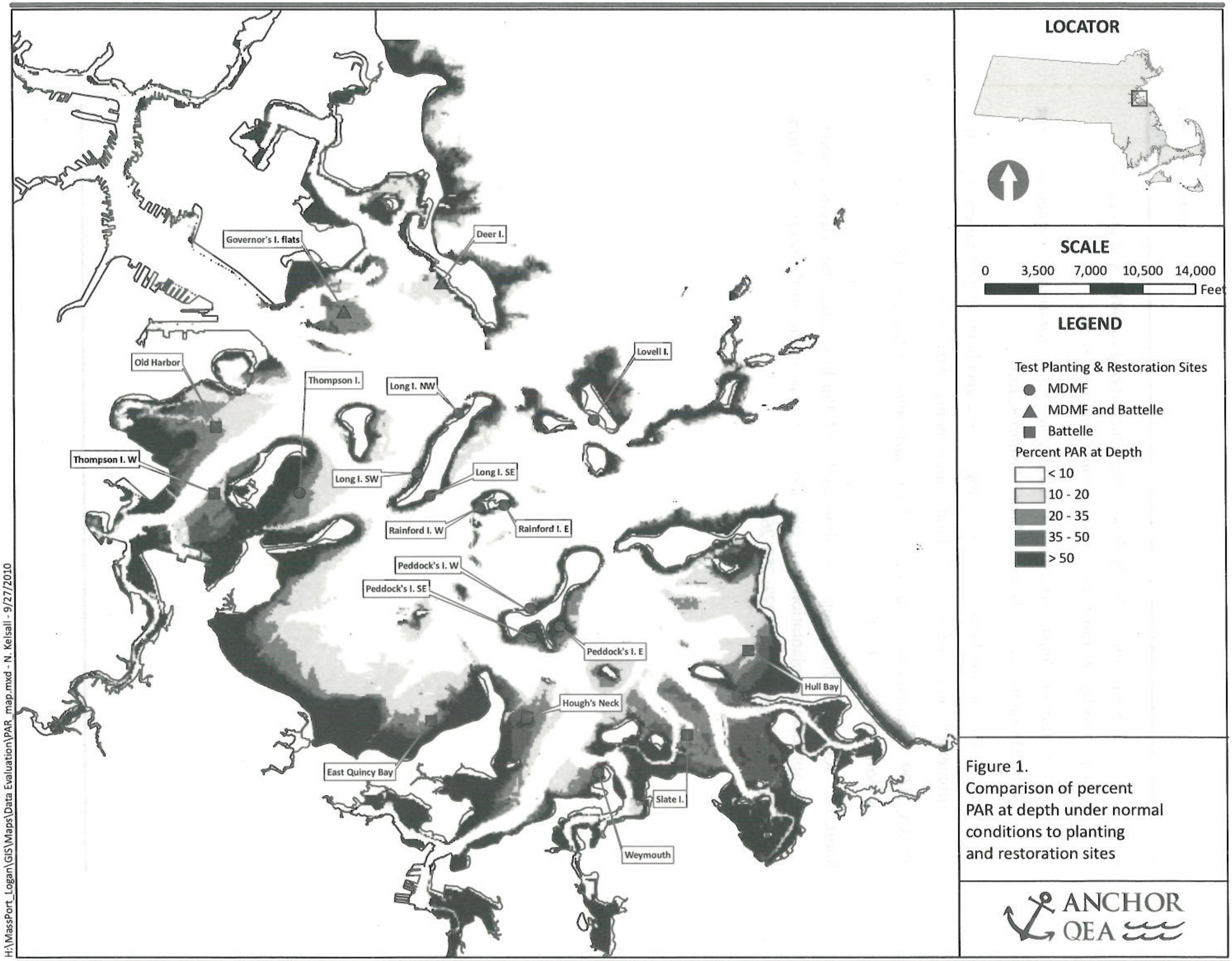


Figure 1.
Comparison of percent PAR at depth under normal conditions to planting and restoration sites

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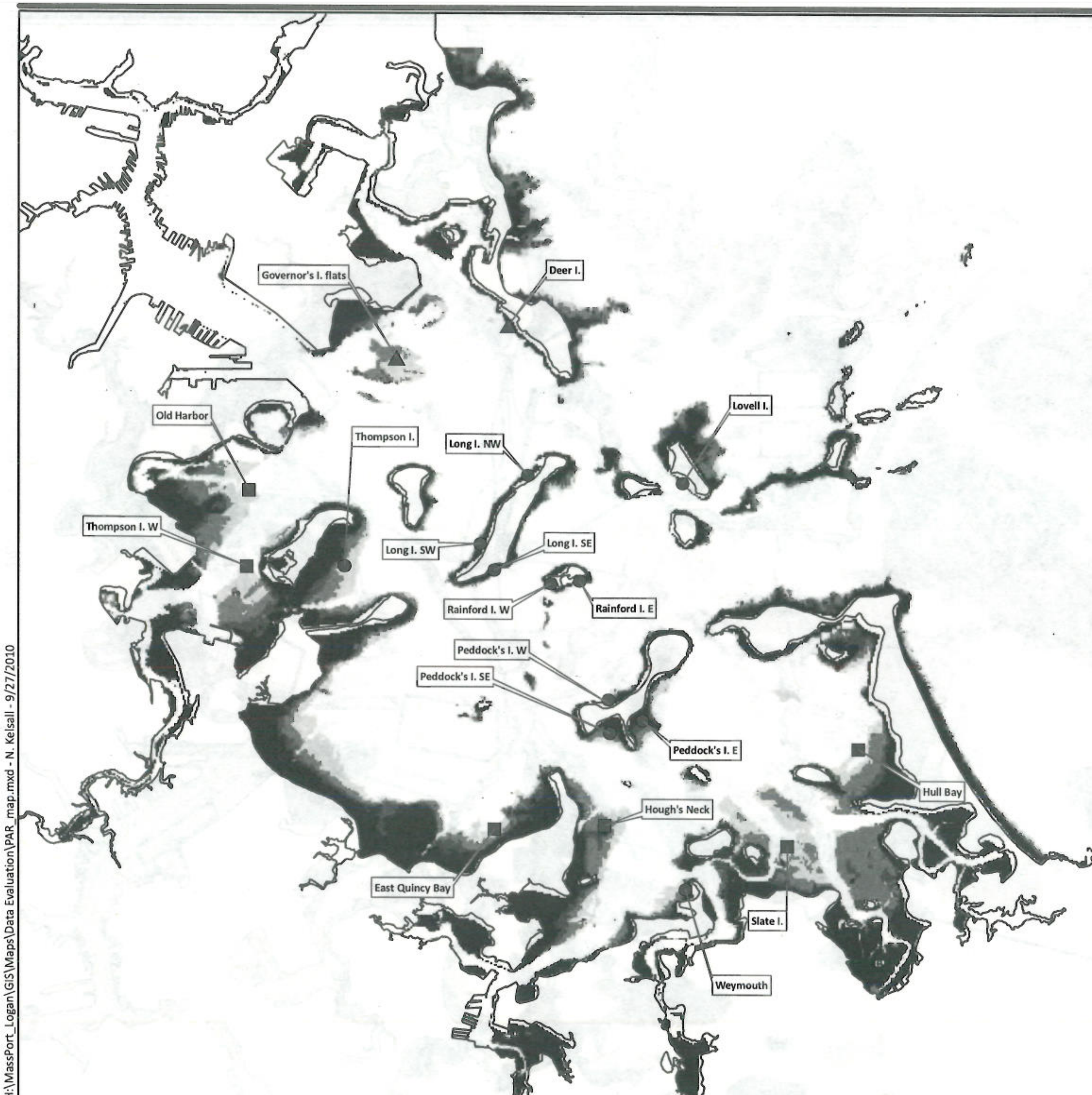


**LOCATOR**

**SCALE**

0 3,500 7,000 10,500 14,000 Feet

**LEGEND**

Test Planting & Restoration Sites
- ● MDMF
- ▲ MDMF and Battelle
- ■ Battelle

Percent PAR at Depth
- < 10
- 10 - 20
- 20 - 35
- 35 - 50
- > 50

*Notes:*
*Sea level increase assumed 0.1 m*
*Cloud cover PAR reduction of 10%*

Figure 2.
Comparison of percent PAR at depth under decreased light availability to planting and restoration sites.

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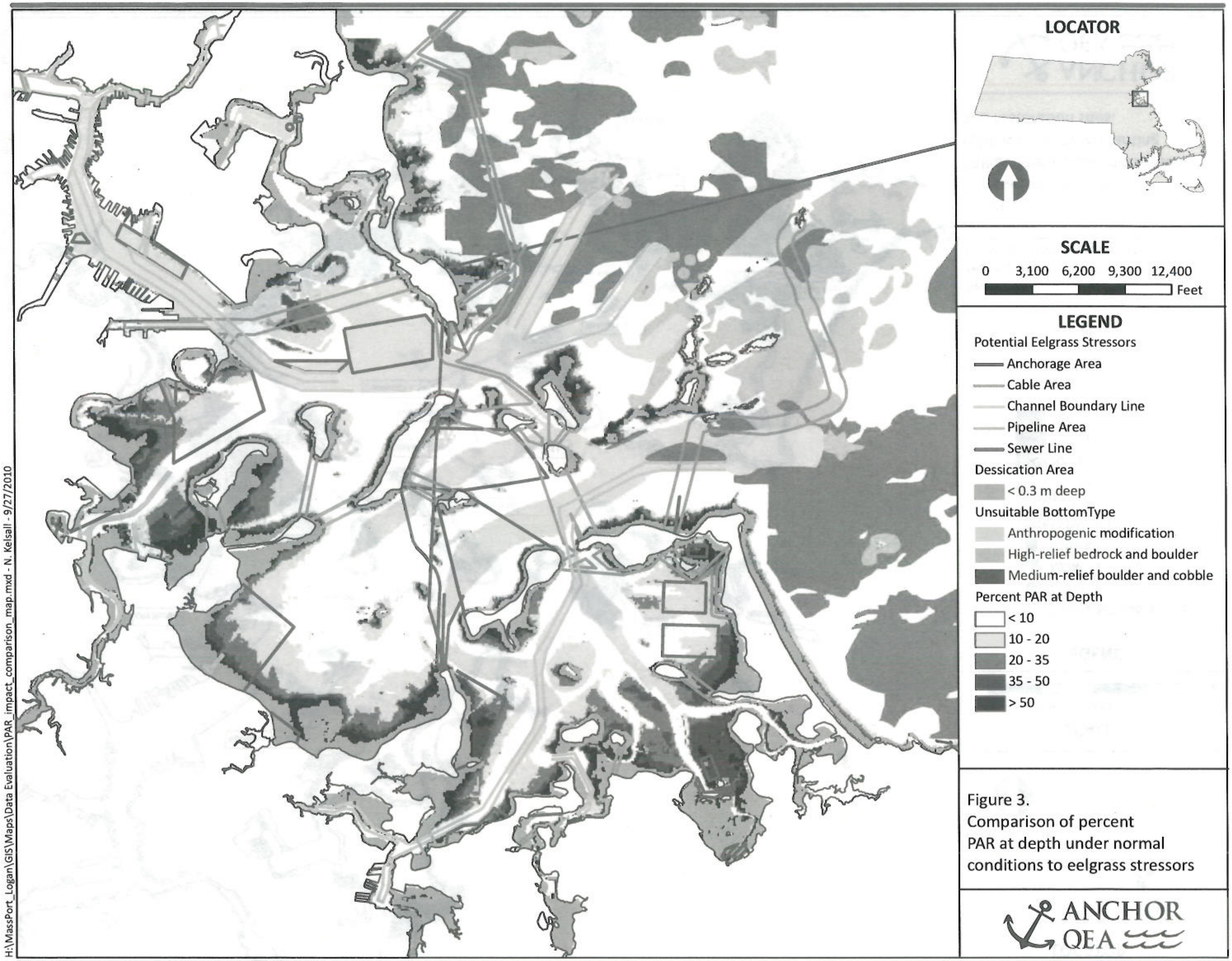


Figure 3.
Comparison of percent PAR at depth under normal conditions to eelgrass stressors

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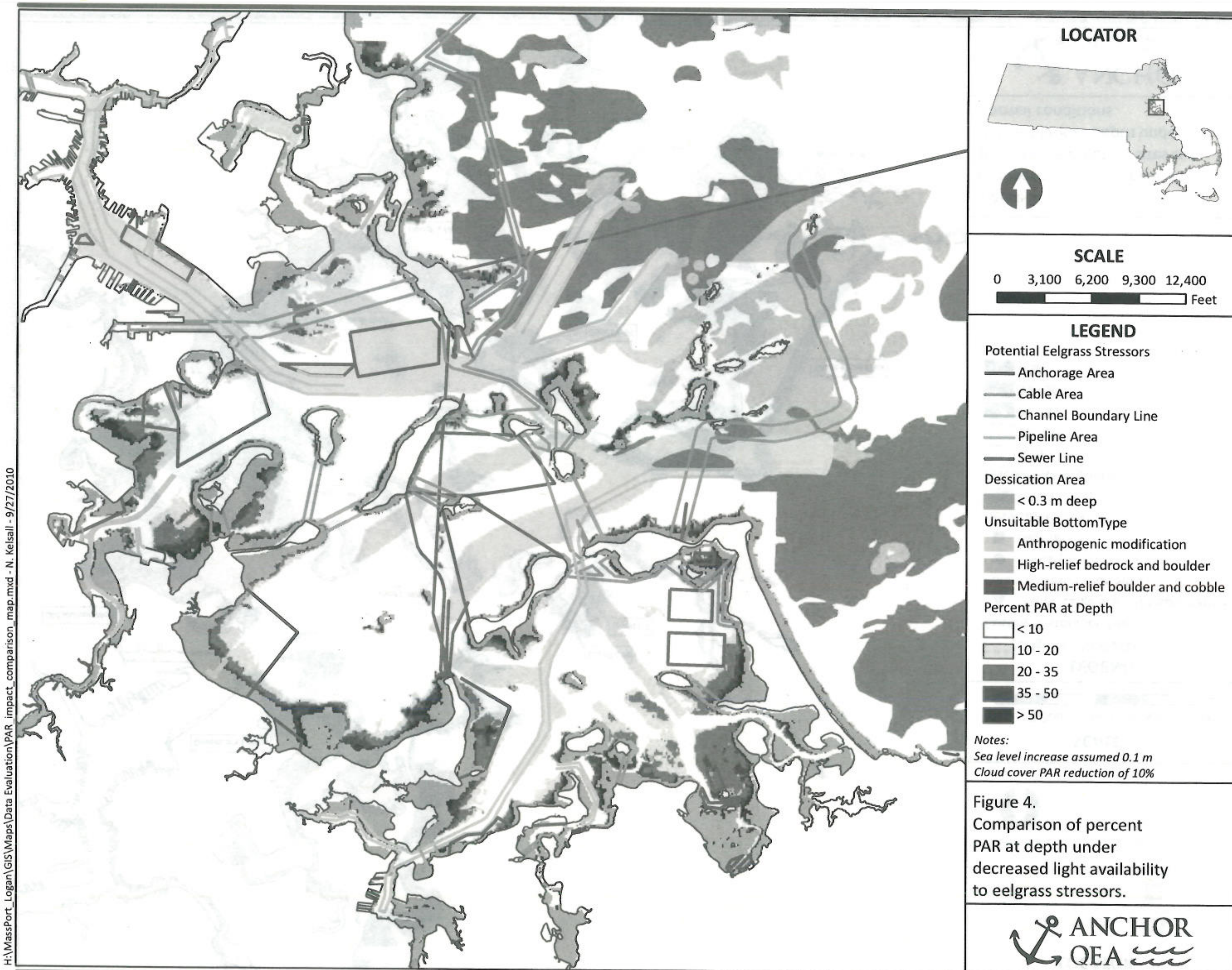


Figure 4. Comparison of percent PAR at depth under decreased light availability to eelgrass stressors.

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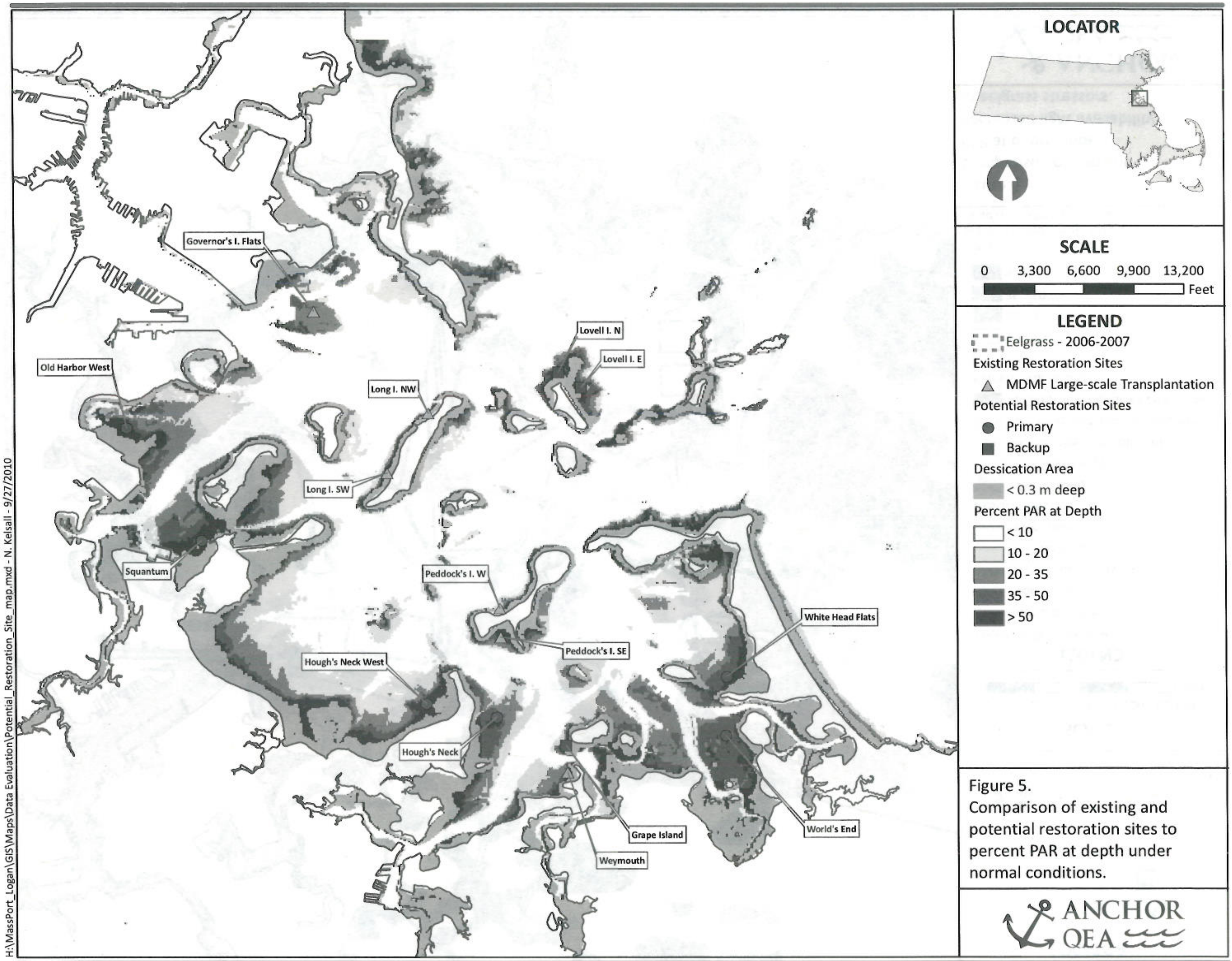


Figure 5.
Comparison of existing and potential restoration sites to percent PAR at depth under normal conditions.

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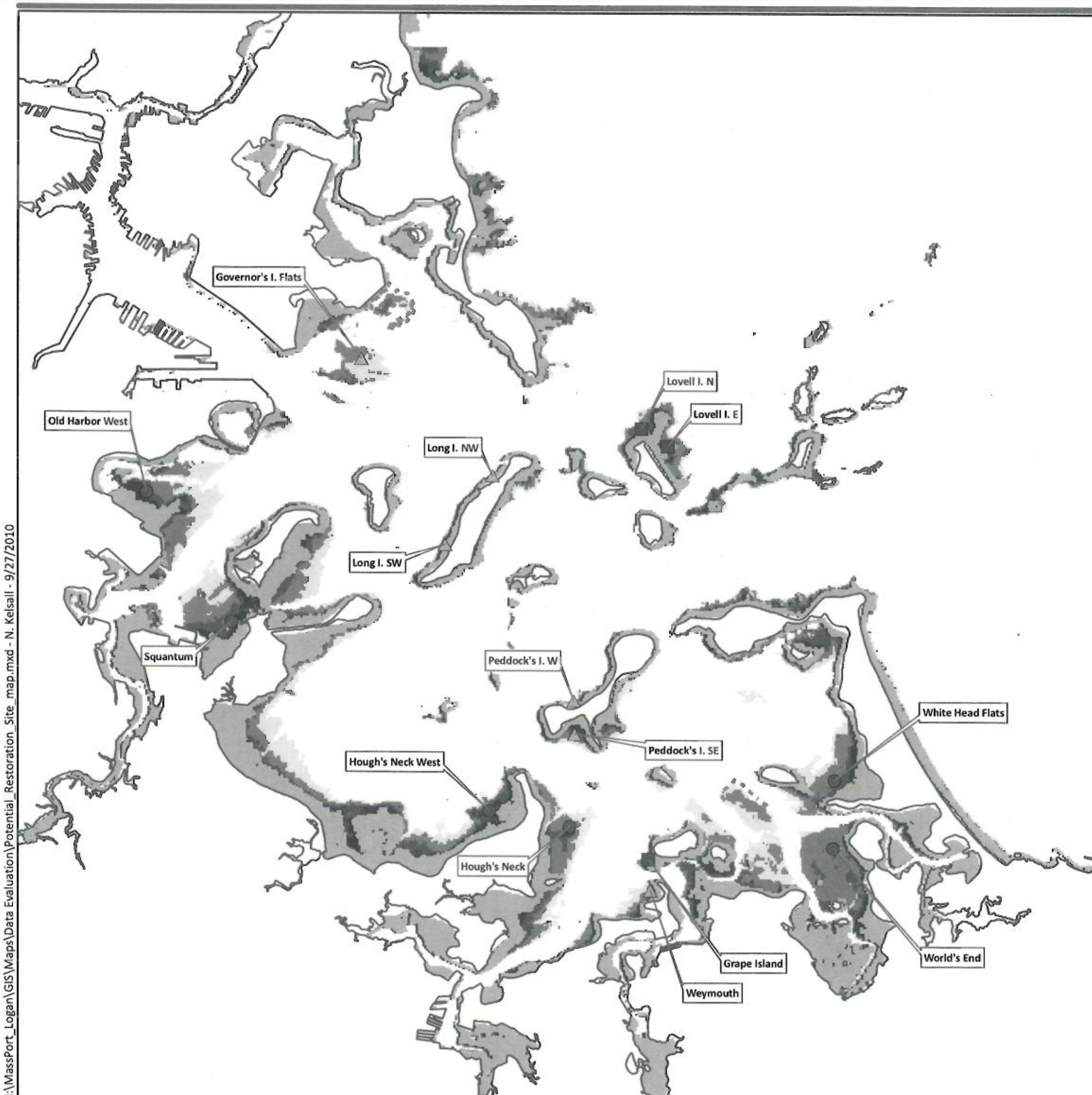



**SCALE**

0 3,300 6,600 9,900 13,200 Feet

**LEGEND**

Eelgrass - 2006-2007

Existing Restoration Sites

- MDMF Large-scale Transplantation

Potential Restoration Sites

- Primary
- Backup

Dessication Area

- < 0.3 m deep

Percent PAR at Depth

- < 10
- 10 - 20
- 20 - 35
- 35 - 50
- > 50

*Notes:*
*Sea level increase assumed 0.1 m*
*Cloud cover PAR reduction of 10%*

Figure 6.
Comparison of existing and potential restoration sites to percent PAR at depth under decreased light availability.

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**Table 4.2-2. Estimated Entrainment of Ichthyoplankton Under the Proposed Action (11 Billion Gallons per Year)at the Northeast Gateway Deepwater Port based on Monthly Mean Density of Ichthyoplankton October 2005 through December 2009.**

| Species | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Lower Estimate | Annual Entrainment | Upper Estimate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alligator fish | Larvae | 0 | 0 | 0 | 1,840 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 88 | 1,840 | 3,591 |
| American eel | Larvae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| American lobster | Larvae | 0 | 0 | 0 | 0 | 191 | 53,316 | 16,184 | 11,063 | 1,125 | 0 | 0 | 0 | 21,082 | 81,879 | 142,872 |
| American plaice | Eggs | 264 | 15,032 | 147,884 | 4,202,108 | 2,003,086 | 263,589 | 83,933 | 2,252 | 0 | 0 | 0 | 0 | 4,218,547 | 6,718,148 | 9,267,460 |
| | Larvae | 0 | 0 | 225 | 5,145 | 24,071 | 35,667 | 14,585 | 18,438 | 1,385 | 0 | 0 | 0 | 30,362 | 99,516 | 186,073 |
| American sand lance | Larvae | 639,174 | 1,880,252 | 461,647 | 606,486 | 25,830 | 2,745 | 0 | 0 | 0 | 0 | 0 | 1,469,146 | 1,175,390 | 5,085,281 | 8,996,227 |
| Atlantic cod | Eggs | 3,163,917 | 162,451 | 28,660 | 5,244 | 5,816 | 0 | 0 | 170 | 0 | 2,310 | 112,997 | 5,299,733 | 4,970,135 | 8,781,299 | 12,594,105 |
| | Larvae | 22,367 | 4,616 | 4,017 | 5,880 | 2,091 | 12,216 | 50,475 | 25,020 | 0 | 0 | 6,395 | 37,865 | 32,856 | 170,942 | 313,240 |
| Atlantic herring | Larvae | 2,444 | 4,840 | 14,112 | 28,139 | 0 | 0 | 0 | 2,451 | 11,576 | 89,816 | 509,220 | 40,144 | 283,719 | 702,742 | 1,140,243 |
| Atlantic mackerel | Eggs | 0 | 0 | 0 | 0 | 8,307,046 | 6,948,153 | 151,626 | 0 | 0 | 0 | 0 | 0 | 7,791,112 | 15,406,825 | 23,022,537 |
| | Larvae | 0 | 0 | 0 | 0 | 21,033 | 1,982,187 | 578,506 | 135 | 0 | 0 | 0 | 0 | 858,129 | 2,581,861 | 4,305,730 |
| Atlantic menhaden | Eggs | 0 | 0 | 0 | 0 | 71,818 | 824,542 | 43,769 | 2,587 | 0 | 0 | 0 | 0 | 51,300 | 942,716 | 1,873,168 |
| | Larvae | 0 | 0 | 0 | 0 | 0 | 45,011 | 423,625 | 19,965 | 1,376 | 0 | 0 | 0 | 97,230 | 489,977 | 885,597 |
| Atlantic wolffish | Larvae | 0 | 166 | 828 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 994 | 2,300 |
| Black sea bass | Larvae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Butterfish | Eggs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 170 | 497 | 1,718 | 0 | 0 | 0 | 2,385 | 6,281 |
| | Larvae | 0 | 0 | 0 | 0 | 0 | 0 | 1,213 | 5,996 | 1,559 | 263 | 0 | 374 | 2,216 | 9,405 | 19,202 |
| Cod/Haddock | Eggs | 0 | 426,527 | 450,070 | 466,535 | 0 | 31,743 | 0 | 0 | 0 | 172 | 0 | 0 | 366,760 | 1,375,047 | 2,508,936 |
| Cod/Haddock/Witch flounder | Eggs | 0 | 0 | 60,185 | 954,286 | 998,970 | 476,636 | 174,765 | 45,290 | 7,774 | 521 | 0 | 0 | 1,556,225 | 2,718,428 | 3,993,752 |
| Cods | Eggs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Larvae | 11,399 | 1,436 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 426 | 13,966 | 1,044 | 27,228 | 58,464 |
| Cunner | Eggs | 0 | 0 | 0 | 0 | 0 | 1,268,593 | 929,648 | 16,517 | 248 | 0 | 0 | 0 | 137,196 | 2,215,007 | 4,722,591 |
| | Larvae | 0 | 0 | 0 | 0 | 0 | 11,268,017 | 19,636,833 | 2,093,668 | 25,749 | 0 | 0 | 0 | 12,750,327 | 33,024,267 | 53,298,206 |
| Cusk | Eggs | 0 | 0 | 0 | 0 | 0 | 18,244 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18,244 | 48,109 |
| | Larvae | 0 | 0 | 0 | 0 | 0 | 3,751 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 3,751 | 7,482 |
| Fourbeard rockling | Eggs | 0 | 0 | 0 | 130,292 | 701,480 | 1,261,877 | 216,721 | 97,192 | 21,552 | 2,768 | 0 | 0 | 1,450,856 | 2,431,882 | 3,412,969 |
| | Larvae | 170 | 0 | 0 | 0 | 154,146 | 951,010 | 264,006 | 177,463 | 82,066 | 7,086 | 2,251 | 1,841 | 767,853 | 1,640,040 | 2,513,591 |
| Fourbeard rockling/Hake | Eggs | 0 | 0 | 513 | 94,879 | 3,186,369 | 3,166,888 | 2,781,569 | 755,058 | 1,090,166 | 7,635 | 0 | 0 | 6,589,399 | 11,083,077 | 15,577,291 |
| Fourspot flounder | Eggs | 0 | 0 | 0 | 0 | 0 | 283 | 15,422 | 21,387 | 0 | 0 | 0 | 0 | 0 | 37,092 | 102,524 |
| | Larvae | 0 | 0 | 0 | 0 | 0 | 0 | 558 | 119,394 | 11,457 | 0 | 0 | 0 | 37,890 | 131,408 | 225,170 |
| Goosefish | Larvae | 0 | 0 | 0 | 0 | 0 | 954 | 1,082 | 4,410 | 0 | 0 | 0 | 0 | 0 | 6,446 | 18,642 |
| Grubby | Larvae | 220 | 264 | 0 | 217 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 701 | 2,128 |

| Species | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Lower Estimate | Annual Entrainment | Upper Estimate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gulf seasnail | Larvae | 0 | 0 | 0 | 0 | 1,374 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,374 | 4,156 |
| Haddock | Eggs | 0 | 0 | 0 | 0 | 0 | 668 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 668 | 2,016 |
| | Larvae | 0 | 0 | 0 | 188 | 304 | 596 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,087 | 2,987 |
| Hake species | Eggs | 0 | 0 | 0 | 0 | 14,715 | 276,711 | 8,707,868 | 7,127,952 | 2,585,123 | 1,176 | 0 | 0 | 7,588,844 | 18,713,546 | 29,838,524 |
| | Larvae | 0 | 0 | 0 | 0 | 0 | 9,662 | 7,866,543 | 3,768,403 | 843,960 | 27,079 | 4,896 | 1,348 | 2,135,255 | 12,521,891 | 22,910,003 |
| Herring family | Larvae | 0 | 0 | 0 | 0 | 0 | 697 | 0 | 0 | 0 | 1,535 | 0 | 0 | 0 | 2,232 | 6,311 |
| Longhorn sculpin | Larvae | 243 | 3,774 | 30,603 | 10,431 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6,558 | 45,051 | 83,802 |
| Lumpfish | Larvae | 0 | 0 | 0 | 0 | 304 | 703 | 0 | 257 | 0 | 0 | 0 | 0 | 0 | 1,264 | 3,527 |
| Northern pipefish | Larvae | 0 | 0 | 0 | 0 | 0 | 0 | 21,849 | 0 | 0 | 0 | 0 | 0 | 0 | 21,849 | 65,975 |
| Pollock | Eggs | 112,186 | 159,206 | 2,914 | 1,741 | 0 | 0 | 0 | 0 | 0 | 301 | 99,772 | 936,664 | 768,568 | 1,312,783 | 1,857,431 |
| | Larvae | 283,734 | 245,825 | 16,149 | 0 | 189 | 1,406 | 0 | 0 | 0 | 0 | 3,513 | 228,757 | 264,269 | 779,572 | 1,296,817 |
| Radiated shanny | Larvae | 831 | 3,716 | 10,344 | 5,570 | 39,423 | 41,375 | 6,212 | 3,547 | 0 | 0 | 0 | 0 | 19,062 | 111,017 | 218,250 |
| Red hake | Larvae | 0 | 0 | 0 | 0 | 174 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 174 | 528 |
| Redfish | Larvae | 0 | 0 | 0 | 0 | 39,543 | 15,190 | 5,954 | 3,608 | 196 | 0 | 0 | 0 | 2,916 | 64,490 | 136,900 |
| Rock gunnel | Larvae | 3,480 | 2,237 | 3,666 | 5,121 | 482 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 432 | 14,986 | 31,484 |
| Scup | Eggs | 0 | 0 | 0 | 0 | 3,632 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,632 | 9,061 |
| | Larvae | 0 | 0 | 0 | 0 | 8,688 | 0 | 43,346 | 665,955 | 2,430 | 0 | 0 | 0 | 132,580 | 720,418 | 1,345,994 |
| Scup/Weakfish | Eggs | 0 | 0 | 0 | 0 | 81,484 | 0 | 0 | 0 | 253 | 0 | 0 | 0 | 0 | 81,737 | 247,205 |
| Searobin sp. | Eggs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,731 | 0 | 0 | 0 | 0 | 2,731 | 8,247 |
| Seasnail | Larvae | 0 | 0 | 0 | 217 | 1,781 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,998 | 4,670 |
| Shorthorn sculpin | Larvae | 0 | 421 | 700 | 7,597 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,096 | 8,717 | 16,071 |
| Silver hake | Eggs | 0 | 0 | 0 | 0 | 0 | 156,505 | 1,608,785 | 2,004,674 | 1,654,207 | 6,727 | 0 | 0 | 2,042,723 | 5,430,898 | 8,819,074 |
| | Larvae | 0 | 0 | 0 | 0 | 0 | 42,190 | 5,148,119 | 1,736,075 | 293,876 | 9,308 | 0 | 0 | 506,788 | 7,229,568 | 13,976,894 |
| Smallmouth flounder | Larvae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 664 | 0 | 0 | 0 | 0 | 664 | 2,004 |
| Snake blenny | Larvae | 0 | 12,010 | 36,207 | 33,726 | 346 | 0 | 5,007 | 0 | 0 | 0 | 0 | 0 | 16,625 | 87,296 | 172,901 |
| Striped anchovy | Eggs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,634 | 0 | 0 | 0 | 0 | 3,634 | 8,147 |
| Summer flounder | Larvae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,568 | 1,785 | 0 | 0 | 3,353 | 8,984 |
| Tautog | Eggs | 0 | 0 | 238 | 0 | 0 | 245,966 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 246,204 | 739,295 |
| | Larvae | 0 | 0 | 0 | 0 | 599 | 11,185 | 56,054 | 215,992 | 1,865 | 0 | 0 | 0 | 73,347 | 285,695 | 523,829 |
| Threespine stickleback | Larvae | 0 | 0 | 0 | 0 | 395 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 395 | 1,196 |
| Unidentifiable | Eggs | 0 | 0 | 0 | 0 | 0 | 24,664 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24,664 | 72,706 |
| | Larvae | 0 | 0 | 0 | 124 | 3,666 | 1,226 | 18,784 | 0 | 0 | 0 | 0 | 0 | 0 | 23,800 | 69,409 |
| Windowpane | Eggs | 0 | 0 | 0 | 0 | 3,963 | 97,849 | 68,978 | 2,835 | 1,559 | 229 | 0 | 0 | 28,396 | 175,412 | 358,221 |
| | Larvae | 0 | 0 | 0 | 0 | 807 | 41,780 | 57,312 | 28,539 | 10,503 | 977 | 0 | 0 | 23,666 | 139,918 | 264,342 |

| Species | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Lower Estimate | Annual Entrainment | Upper Estimate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Windowpane/Fourspot/Summer flounder | Eggs | 0 | 0 | 0 | 0 | 6,110 | 0 | 0 | 37,503 | 22,272 | 0 | 0 | 0 | 2,337 | 65,884 | 136,188 |
| Winter flounder | Eggs | 0 | 352 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 352 | 852 |
| | Larvae | 0 | 0 | 0 | 484 | 228,491 | 14,491 | 0 | 0 | 0 | 0 | 0 | 0 | 21,493 | 243,466 | 465,639 |
| Witch flounder | Eggs | 0 | 0 | 0 | 0 | 0 | 75,580 | 38,398 | 10,279 | 0 | 0 | 0 | 0 | 17,032 | 124,257 | 245,914 |
| | Larvae | 0 | 0 | 0 | 0 | 0 | 58,154 | 1,168 | 51,656 | 2,358 | 0 | 0 | 0 | 21,396 | 113,336 | 211,338 |
| Wrasses | Eggs | 0 | 0 | 0 | 0 | 0 | 0 | 450,005 | 0 | 0 | 0 | 0 | 0 | 0 | 450,005 | 1,358,808 |
| Wrymouth | Larvae | 0 | 596 | 9,273 | 8,305 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18,174 | 37,110 |
| Yellowtail flounder | Eggs | 0 | 0 | 502 | 100,186 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100,688 | 205,394 |
| | Larvae | 0 | 0 | 0 | 0 | 371,006 | 235,432 | 23,567 | 25,652 | 1,559 | 0 | 0 | 0 | 41,132 | 657,215 | 1,295,068 |
| Yellowtail flounder/Labridae | Eggs | 0 | 0 | 17,342 | 1,122,423 | 8,077,089 | 11,793,407 | 6,072,275 | 322,497 | 10,279 | 0 | 0 | 0 | 14,277,762 | 27,415,313 | 40,552,863 |
| **Total** | **Eggs** | **3,276,368** | **763,568** | **708,308** | **7,077,694** | **23,461,578** | **26,931,900** | **21,343,762** | **10,446,364** | **5,400,295** | **23,555** | **212,769** | **6,236,397** | **51,857,192** | **105,882,559** | **161,589,670** |
| | **Larvae** | **964,062** | **2,160,153** | **587,772** | **719,470** | **924,933** | **14,828,961** | **34,240,980** | **8,977,687** | **1,293,703** | **137,632** | **528,486** | **1,793,441** | **19,325,820** | **67,157,280** | **115,274,946** |
| **All Lifestages** | | **4,240,430** | **2,923,721** | **1,296,080** | **7,797,164** | **24,386,511** | **41,760,861** | **55,584,742** | **19,424,051** | **6,693,998** | **161,187** | **741,255** | **8,029,838** | **71,183,012** | **173,039,839** | **276,864,616** |