SEED BANK CHARACTERIZATION OF DREDGED SEDIMENT FROM LORAIN AND DULUTH HARBORS

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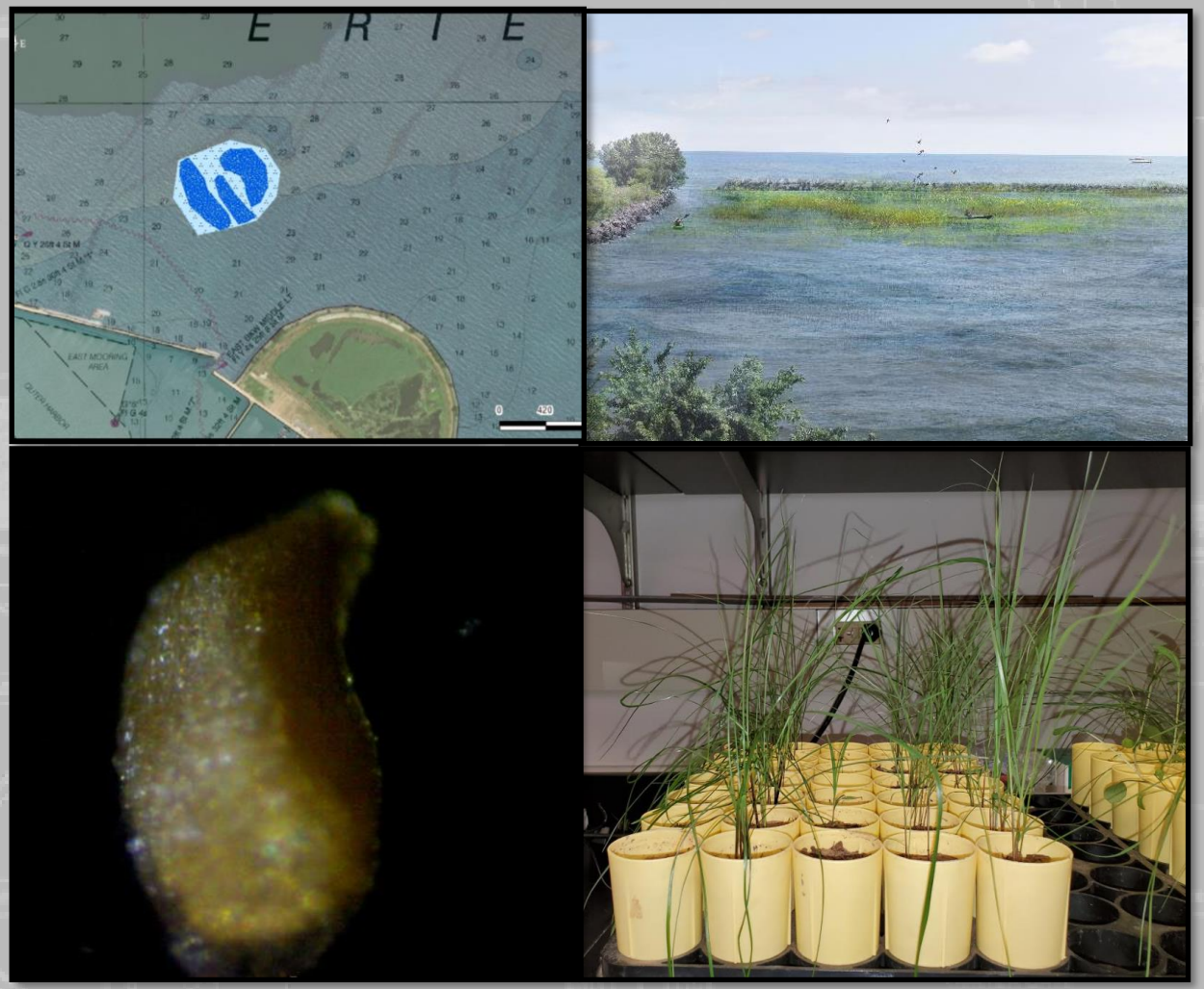

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Overview

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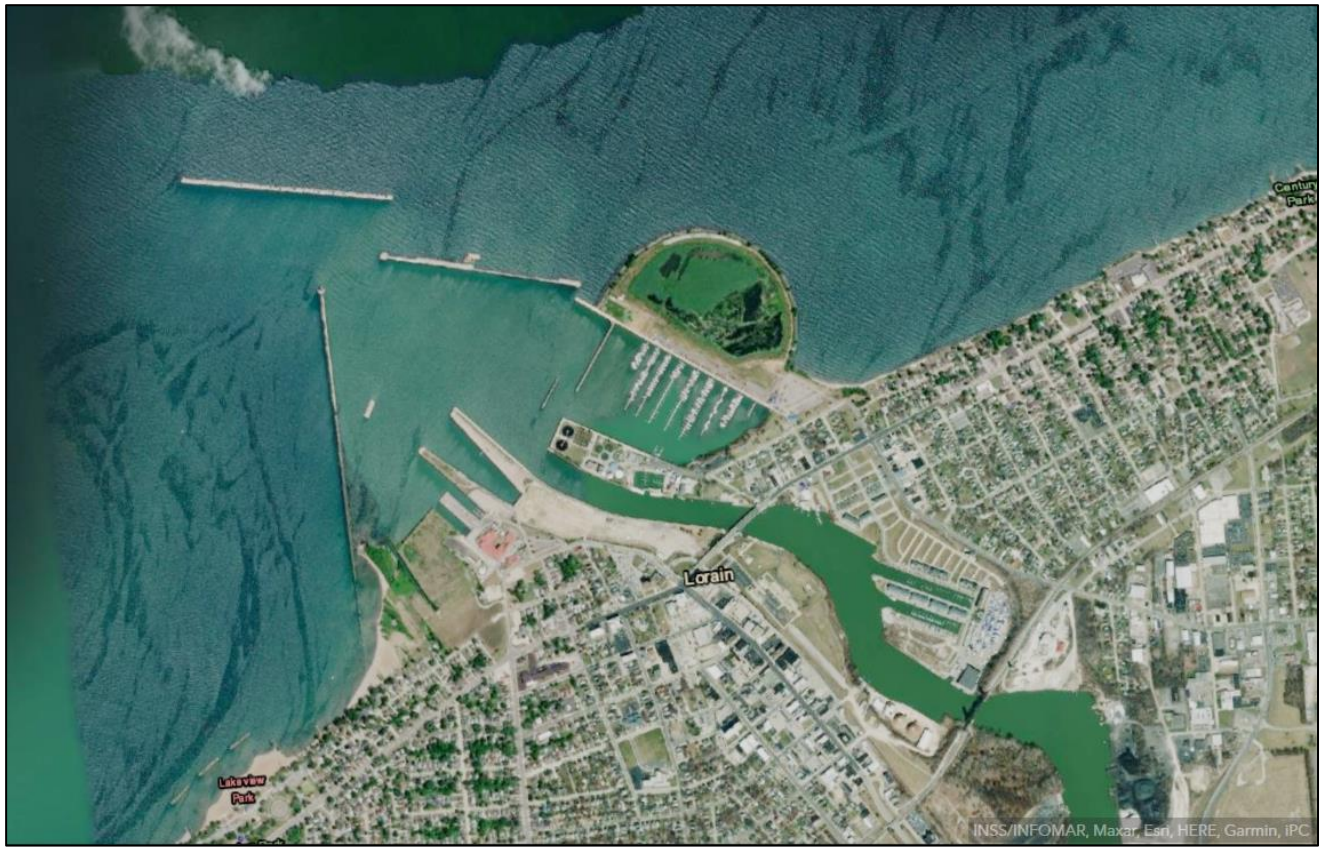
Background

Lorain Harbor

- Located on the southern shore of Lake Erie in Lorain, OH, Lorain Harbor is a major regional receiving port on the Great Lakes

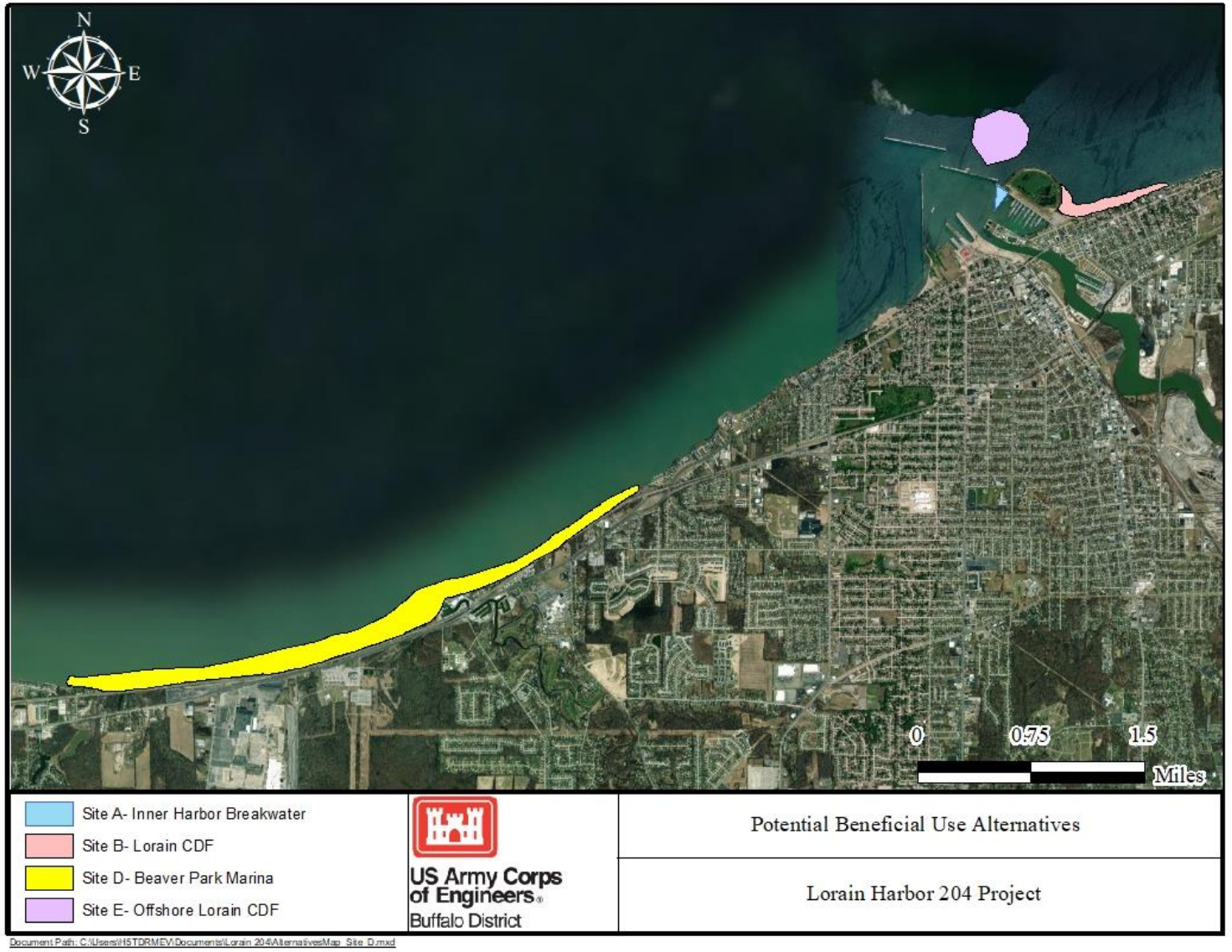
- In-lake CDF located on the lake side of the east breakwater shorearm
  - 58 acres with a total capacity of 1.85M CY
  - ~100K CY remaining vs. ~75K CY annual dredging volume



- USACE, Buffalo District
  - Great Lakes Restoration Initiative (GLRI); Section 204 Beneficial Use of Dredged Sediments for Aquatic Habitat Restoration

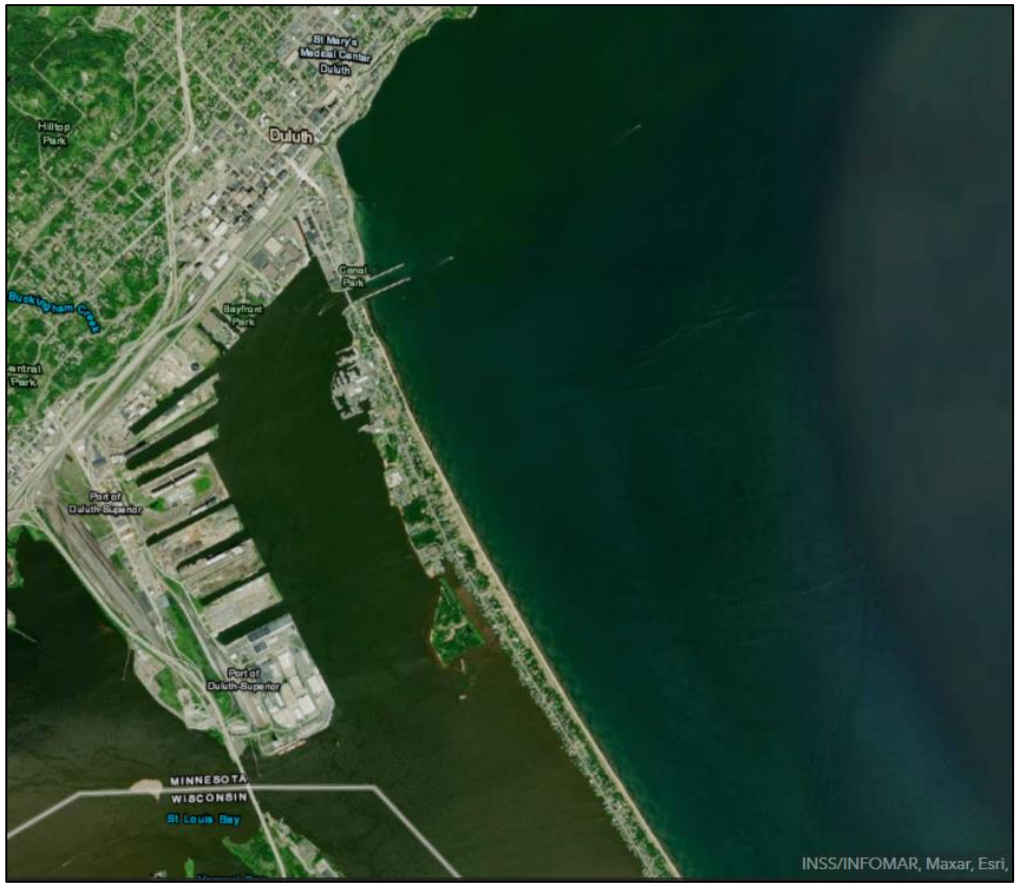
Background

Lorain Harbor



Background

Duluth Harbor



- Duluth-Superior Harbor, is located at the extreme western end of Lake Superior
- The 'Re-use of Regional Waste in Sustainably Designed Soils' study began in 2019 with the primary goal of identifying, selecting, and combining regional waste materials to create a soil to meet the Minnesota Department of Transportation's (MnDOT) topsoil specifications
- USACE, Detroit District
  - Planning Assistance to States (PAS)
  - Natural Resources Research Institute (NRRI), University of Minnesota Duluth, and the MnDOT

Purpose

The purpose of the seed bank characterization of dredged material from both harbors was to assist USACE Districts in determining the feasibility of the sediments to be used as a beneficial material

Goal

- The overarching goal of this effort was to identify the extent to which invasive species were present and viable in the sediments

Objectives

- The objectives were to 1) assess the composition & density of the existing seed bank of the dredged material, and 2) evaluate the effect of the existing seed bank on the growth of desired plant species

Approach – Lorain Harbor

- **Vegetation Characterization Survey**
  - Conducted to assess the plant species in proximity of areas where sediments were collected and where placement for beneficial use may occur
    - Survey locations included the U.S. Steel Corporation property, French Creek Reservation, Cromwell Park, Lakeview Beach, Beaver Park Marina, and Century Park
- **Seed Extraction**
  - Sediments passed through sieves (2.0 – 0.85 mm) to filter small organic debris
  - Organic debris treated with tetrazolium chloride to stain viable seeds for identification
  - Organic debris containing seeds sown into plant growth mesocosms
- **Emergence Study**
  - Sediments mixed with thermally treated sand or garden soil
  - Plant growth mesocosms placed and maintained under greenhouse conditions
    - To encourage growth from all plant species present, mesocosm simulated riparian upland conditions, bottomland or marsh conditions, and submerged conditions

Approach – Duluth Harbor

- **Emergence Study**
  - Recycled material mixed with thermally treated sand and placed under greenhouse conditions simulating upland and marsh conditions
    - 'Recycled material' was comprised of dredged sediment from Duluth Harbor mixed with 10% compost.

- **Plant Growth Study**
  - Recycled material were used as growth media for 4 plant species, Kentucky bluegrass (*Poa pratensis*), Little bluestem (*Schizachyrium scoparium*), Sideoats grama (*Bouteloua curtipendula*), and Switchgrass (*Panicum virgatum*)
    - Plant microcosms maintained under controlled laboratory conditions
    - Controlled microcosms prepared using thermally treated media

Results – Lorain Harbor

Vegetation Survey

Table 1. Invasive plant species from 6 locations identified during vegetation survey.

Common Name	Scientific Name
Canada Golden Rod	*Solidago Canadensis*
Canada Thistle	*Cirsium arvense*
Common Burdock	*Arctium minus*
Common Reed	*Phragmites australis*
Yellow Sweet Clover	*Melilotus officinalis*
Black Locust	*Robinia pseudoacacia*
Chicory	*Chichorium intybus*
Glossy Buckthorn	*Frangula alnus*
White Mulberry	*Morus alba*
Wild Carrot	*Daucus carota*
Foxtail	*Setaria viridisis*
Japanese Knotweed	*Polygonum cuspidatum*
Tree of Heaven	*Ailanthus altissima*
Non-native Honeysuckle	*Amur tatarian*
Purple Loosestrife	*Lythrum salicaria*
Reed Canarygrass	*Phalaris arundinacea*
Northern Catalpa	*(Catalpa speciosa*

Seed Extraction Study

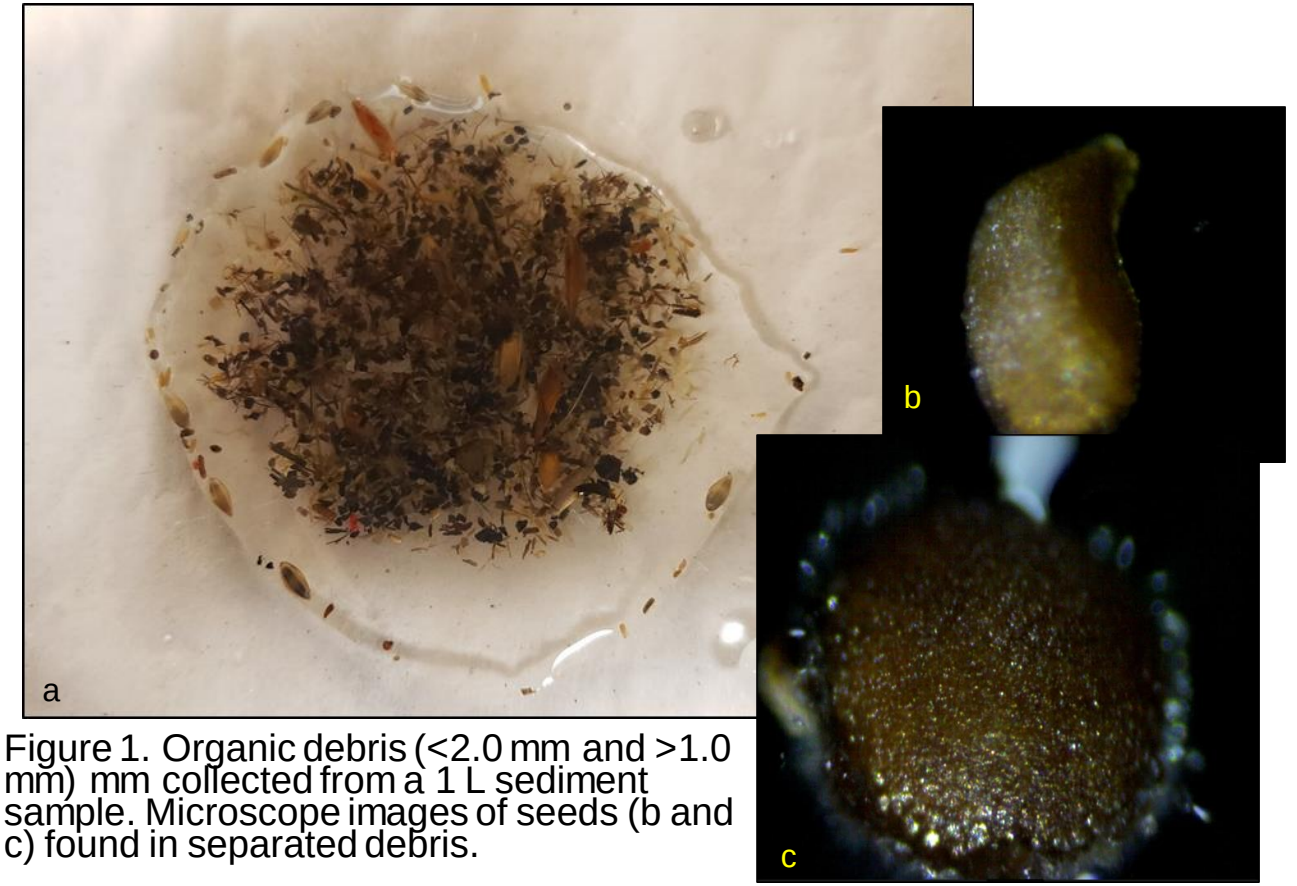


Figure 1. Organic debris (<2.0 mm and >1.0 mm) mm collected from a 1 L sediment sample. Microscope images of seeds (b and c) found in separated debris.

Outer harbor: 134 seeds/L (32% viable)

River channel: 108 seeds/L (44% viable)

Results – Lorain Harbor

Emergence Study

Table 2. Plant species identified in Lorain Harbor sediments

Sediment ID	Common Name	Scientific Name
LH-01-05-C	Night shade	*Solanum sp.*
	Canada goldenrod	*Solidago canadensis*
	Annual bluegrass	*Poa annua*
	Wild lettuce	*Lactuca virosa*
	Burdock	*Arctium sp.*
	Unidentified graminaceous species	*n.a.*
LH-02-03-C	Elm sapling	*Ulmus americana*

Figure 2. Plant species emerging from the existing seed bank of Lorain Harbor sediments (LH-01-05-C and LH-02-03-C). Canada goldenrod (b), an unidentified graminaceous species (c), and an elm sapling were identified.

Results – Duluth Harbor

Emergence Study

Figure 3. Duluth Harbor sediment with plants growing from the existing seedbank at Day 140.

Table 3. Plant species of the existing seed bank identified in emergence study after 140 days.

Common Name	Scientific Name
Common Nettle	*Urtica dioica*
Smartweed	*Polygonum sp.*
Dogfennel	*Eupatorium capillifolium*
Wild Geranium	*Geranium molle*
Unidentified graminaceous species	*n.a.*

Results – Duluth Harbor

Plant Growth Study

Figure 4. Grasses growing in dried (control) media.

Figure 5. Plants from the existing seed bank and sown seeds growing in the test sediment.

Results – Duluth Harbor

Plant Growth Study

Table 4. Plant heights and biomasses for each plant species evaluated in control (dried) and experimental (undried) sediments under laboratory conditions. Average root lengths were comparable for each species, except little bluestem, in both media types. With the exception of Kentucky bluegrass, shoot lengths were considerably longer in the experimental media compare to the control material. However, root and shoot biomass were greater in the control media compared to the experimental.

Plant Species	Shoots		Roots	
Dried Sediment	**Length (in)**	**Biomass (in)**	**Length (in)**	**Biomass (in)**
Kentucky bluegrass	*14.4*	*0.12*	*6.8*	*0.04*
Little bluestem	*3.9*	*0.01*	*4.7*	*0.00*
Sideoats grama	*9.5*	*0.06*	*6.2*	*0.03*
Switchgrass	*11.8*	*0.10*	*6.6*	*0.04*
Undried Sediment				
Kentucky bluegrass	*12.3*	*0.07*	*6.4*	*0.03*
Little bluestem	*4.1*	*0.00*	*3.0*	*0.00*
Sideoats grama	*11.4*	*0.06*	*6.1*	*0.02*
Switchgrass	*12.3*	*0.03*	*6.1*	*0.02*

Conclusions

Lorain Harbor

- Relatively low seed viability overall
  - 32 to 44% from extraction & chemical analysis
  - Seed densities quantified by extraction not represented in emergence study
  - However, limited time & germination stimuli
- Most plants that emerged study were characterized as invasive with the exception of the elm sapling and the annual bluegrass
  - The magnitude of invasiveness can vary depending on species
- Implications depend on application—outer harbor vs. river channel; upland vs. submerged placement; plant growth objectives

Duluth Harbor

- The plants identified in the emergence test were all invasive species
- The presence of existing plant species was shown to have a moderate effect on growth of the planted species

Questions

Lorain Harbor Seed Bank Characterization Study

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Duluth Harbor Sediment Characterization Study

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