

FY21 Predicting the Fate of Dredged Material Placed as Beach Nourishment, Duluth-Superior Harbor



Rachel Malburg, LRE; Heidi Wadman, ERDC-CHL

BLUF

- High lake levels = eroding shorelines
- Agreements with local stakeholders for beach nourishment placement
- Determine fate of placement material and overall benefit to the beach
- Need higher frequency surveys than just pre- and post-placement
- Establish long-term placement options



Challenge/Objectives

- Need robust system that collects data during storms and at night, when vessel surveys are not feasible
- Hourly measurements are needed for real-time tracking of sediment transported from the beach into the nearshore
- Need to quantify volume of sediment moved into nearshore vs. volume lost

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APPROACH – Radar Inlet Observing System (RIOS)

- X-Band radar used to collect breaking wave & surface current information, hourly during storm events, when vessel-based surveys could not otherwise be collected
- Breaking waves subsequently used to compute bathymetry and other nearshore parameters
- Test rigor of RIOS in monitoring placement on the beach and within the nearshore
- Test whether RIOS measures of radiation stresses can predict direction of sediment transport from the initial placement
- Test whether volume estimates derived from RIOS can be directly compared to traditional methods and subsequently used to identify percentage of placement preserved or lost from the littoral cell
- Evaluate efficacy of beach nourishment as shore protection



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District/Other USACE PDT Members

Rachel Malburg, LRE
Heidi Wadman, ERDC-CHL
Jesse McNinch, Sealaska
Dan Freer, ERDC-CHL
Monica Anderson, LRE
Corey Weston, LRE

Leveraging/Collaborative Opportunities

Great Lakes Restoration Initiative (GLRI)
Dredging Operations Technical Support (DOTS) Program

Stakeholders/Partners

Minnesota Pollution Control Agency
Wisconsin Department of Natural Resources
Minnesota Department of Natural Resources
Fond Du Lac Band of Lake Superior Chippewa
St. Louis River Alliance
Duluth Seaway Port Authority
City of Duluth
USGS Upper Midwest Environmental Sciences Center

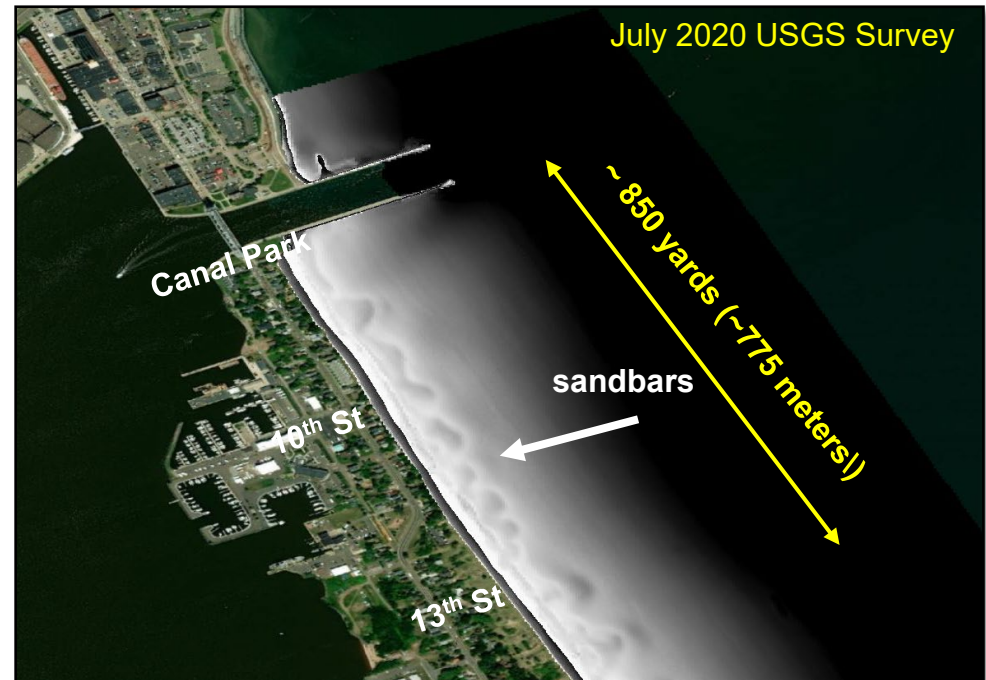
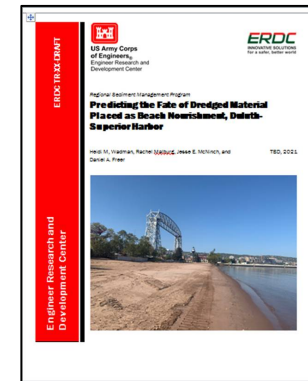
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Accomplishments/Deliverables

- Utilization of RIOS in Duluth won an LRD Innovation of the Year Award
- RIOS effectively used to monitor beach placement at Duluth, MN (MN Point); **TR in progress**
- Collection of pre- and post-placement (six total) RIOS observations up until ice cover on Lake Superior
- Collection of topo/bathy surveys pre- and post-placement by USGS (GLRI funded) and spring of 2021 by Duluth Area Office (RSM funded)



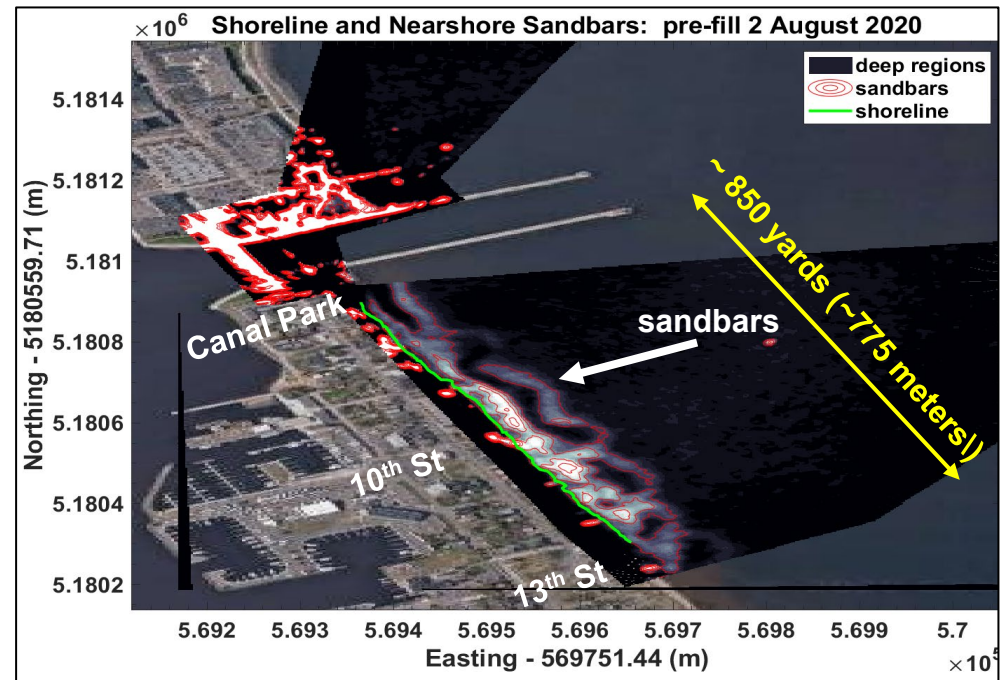
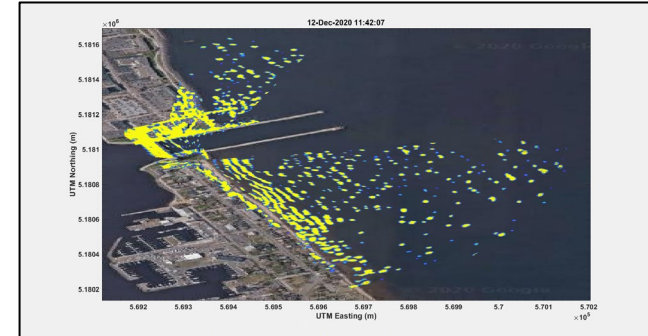
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Accomplishments/Deliverables

- RIOS-derived nearshore bathymetry captures complexity also mapped by the USGS, but in real-time, during storms
 - Validates other wave-derived parameters such as radiation stress and direction/rate of sediment transport
- RIOS observations were used to identify reversal in alongshore transport direction (nodal point) within the project area



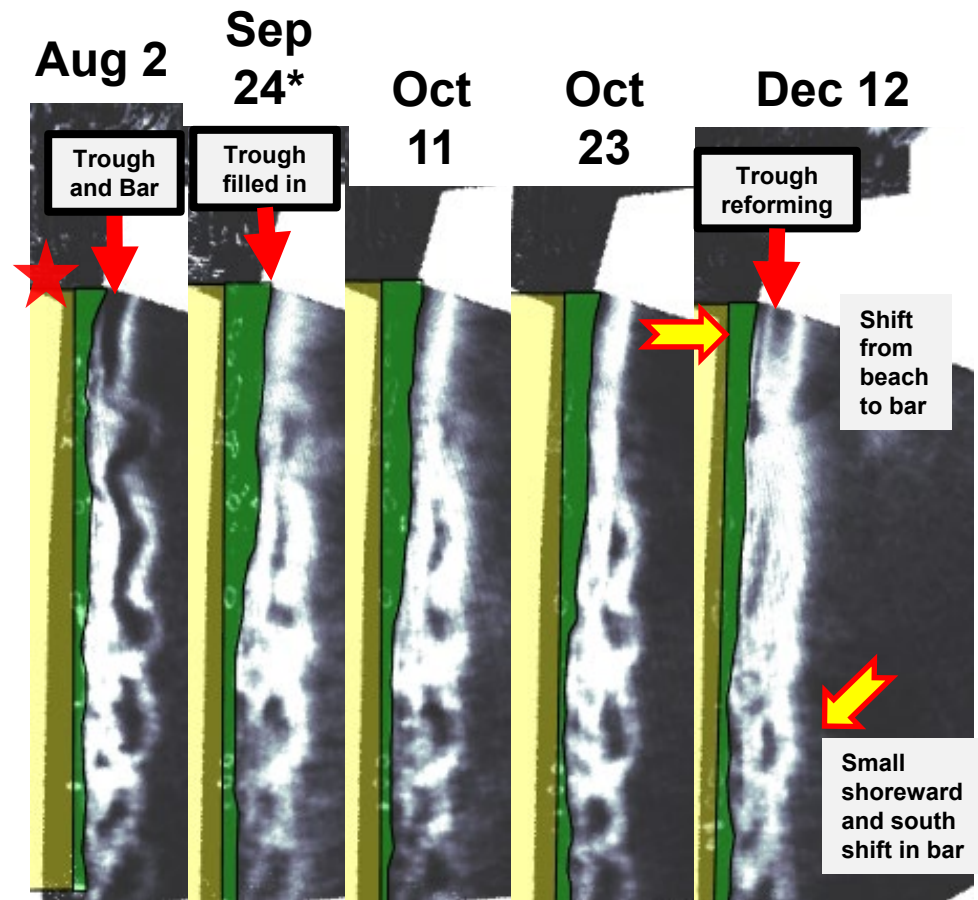
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Accomplishments/Deliverables

- Specific Findings:
 - ~55% of the fill was retained on the beach (above water), post-placement. Most of the loss happened in the first 3-4 weeks.
 - Continued subaerial loss is mostly accounted for in change in nearshore bar morphology and location (bars enlarged; moved south & onshore)
 - Post-stabilization, beach volume is ~30% larger than pre-fill volume.



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CHALLENGES AND LESSONS LEARNED

- RIOS is effective and accurate, 24 hours a day...when there are storms. No storms? No waves and thus no data...but probably minimal significant sediment transport.
- IT continues to be an issue...limitations on wireless capabilities, IT support for remote login, purchasing various equipment. **ALSO- we actually killed Verizon for a 1 mile radius. It was awesome...**
- Field deployments are always challenging...local support critical for project success (and safety of equipment). Shipping continues to pose a challenge...
- RIOS imaged BOTH ice cover AND surface currents very well – significant future research potential.
- Despite wind & solar, battery storage still needs work.



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Benefit to the USACE and Nation

- 2020 Duluth maintenance dredging contract ~\$2.15 million
 - Included placement at two locations, MN Point and Interstate Island
 - **Quantity placed at MN Point ~50,000 CY**
 - **Placement cost at MN Point ~\$800,000**
- Comparison of Jul 2020 pre-placement and Sep 2020 post-placement surveys provides snapshot of placement evolution
 - *What happens in-between and after surveys??*
 - Survey comparison accounts for ~50% of material placed
 - **Equates to ~\$400,000 that cannot be quantified**
 - **NOTE: Survey of the placement area is not typically conducted on the Great Lakes; traditionally we only survey the dredge area**
- Accordingly, we have little quantifiable knowledge of where material goes after placement

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Benefit to the USACE and Nation

- With RIOS, we monitored during every storm event pre- and post-placement completion until ice cover on Lake Superior (six total)
- For an additional ~\$70,000 under RSM, we were able to account for the unknown subaqueous sediment transport
 - **~3% of total contract cost**
 - **~9% of placement cost at MN Point**
- In contrast, high resolution topo/bathy surveys collected in Jul and Sep 2020 cost ~\$125,000
 - RSM study was about half the cost and provided more data

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Benefit to the USACE and Nation

- RIOS is proven to be an effective method for quantifying the efficacy of beach nourishment
 - Provides confidence in placement strategy; invaluable when communicating with homeowners and stakeholders
 - Similar methodology can be applied across the GL's and other coastal regions
- **With military support, the overall cost of a RIOS deployment is being greatly decreased in FY22**